TEMASEK JUNIOR COLLEGE
PRELIMINARY EXAMINATION
JC2 2018

CANDIDATE NAME													
CENTRE NUMBER	S							INDEX NUMBER					
CLASS	C	G			/	1	7						

H1 BIOLOGY

Multiple Choice

8876/01

Wednesday 14 September 2018
1 hour

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **18** printed pages.

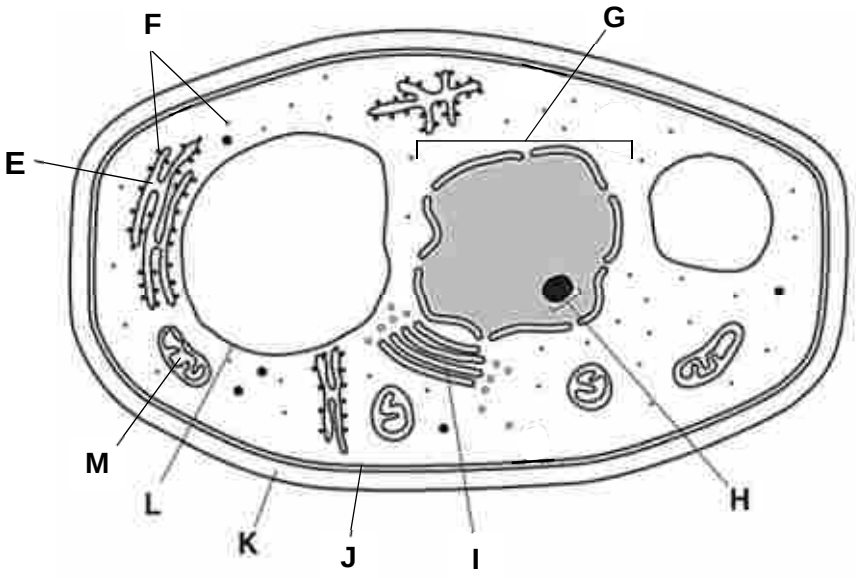
Section A

Answer **all** the questions in this section.

1 Tuberculosis and candidiasis are two opportunistic infections that may develop during AIDS.

Tuberculosis is caused by *Mycobacterium tuberculosis*, a prokaryote that lives in human lungs; whereas candidiasis is caused by *Candida albicans*, a yeast-like fungus that lives in human lungs.

The figure below shows the structure of *Candida*.



Which of the structure(s) can also be found in the causative agent that causes tuberculosis?

A None

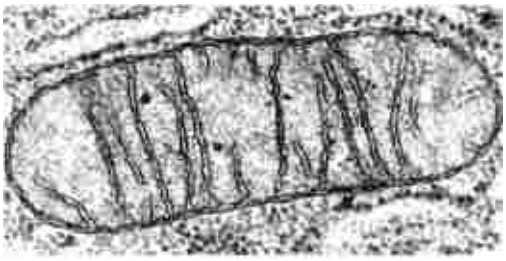
B **F** only

C **F**, **J**, **K** only

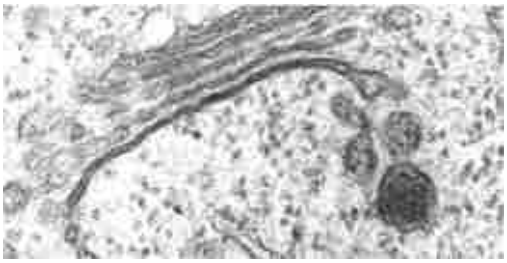
D **H**, **J**, **K** only

2 The images below show the electron micrographs of some organelles found in eukaryotic cells.

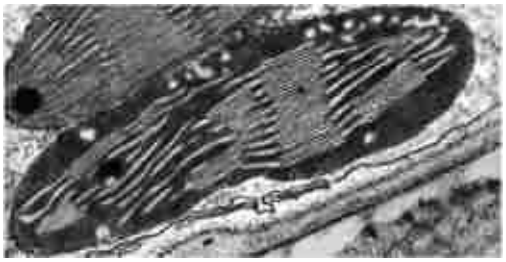
P



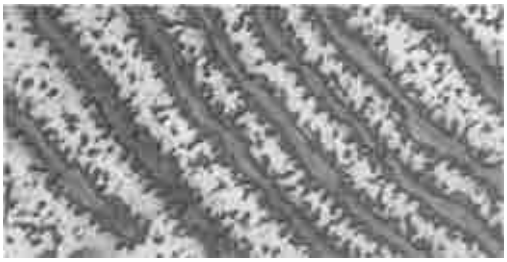
Q



R



S



The following statements are descriptions of membranous cell structures.

1 formed by a single membrane and enclosing a large fluid-filled space and regulating the osmotic pressure of the cell

2 formed by a single membrane and enclosing inactivated enzymes

3 formed by a single membrane that has flattened sacs and tubular structures inter-connected throughout the cell, sometimes with a complex of nucleic acid and protein attached

4 formed by a single membrane that has tubular structures and containing enzymes to add carbohydrate side chains to proteins

5 formed by two membranes and internal membranes that contain pigments

6 formed by two membranes whereby the inner membrane is folded extensively

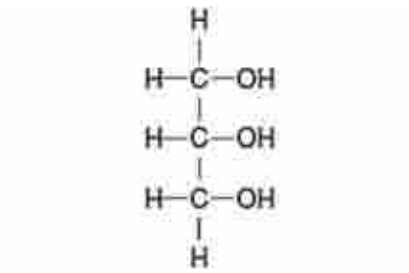
7 formed by two membranes, the outer membrane is continuous with another membranous organelle

Which of the following row correctly matches the descriptions of the cell structures?

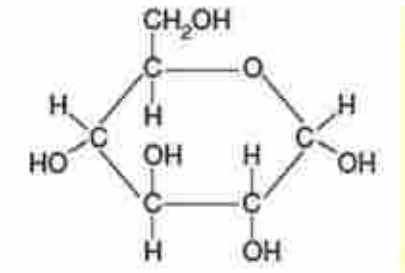
	P	**Q**	**R**	**S**
A	5	3	6	1
B	5	2	4	7
C	6	4	5	3
D	7	1	2	6

3 Which molecule is found in glycogen?

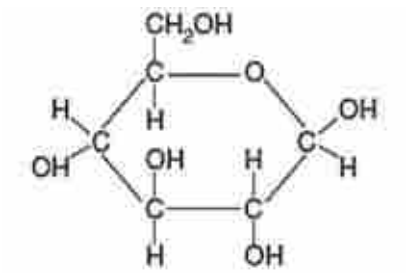
A



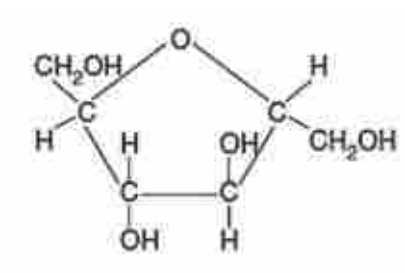
B



C



D



4 Particular biological molecules react with chemicals called reagents to give distinct colour changes. The colour depends on the kind of biological molecule and the type of reagent used, as shown in the following table.

chemical reagent	biological molecule	colour change observed
L	protein	violet
M	lipid	red
N	nucleic acid	green

A researcher added different reagents to some isolated ribosomes.

The colour change observed are

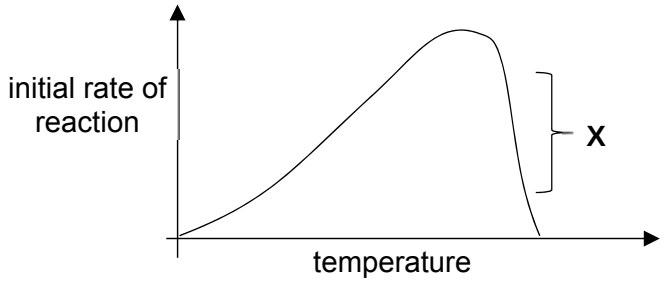
A green only.

B red and green.

C green and violet.

D violet, red and green.

5 The diagram shows the initial rate of reaction using constant amounts of substrate and enzyme at different temperatures.



What is the reason for the decline in the level of activity in region **X**?

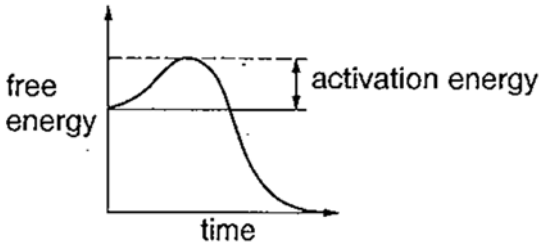
A breaking of sulphur bridges and ionic bonds in the enzymes

B competition between substrate and product for the active site

C breaking of hydrogen bonds and hydrolysis of peptide bonds in the enzyme

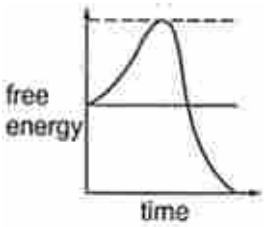
D insufficient substrates to occupy all the active sites

6 The graph shows energy changes during an uncatalysed chemical reaction.

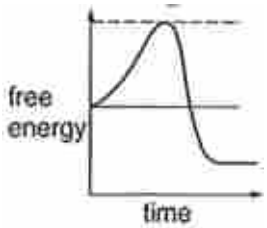


Which graph shows the energy changes for the same reaction when it is catalysed by an enzyme?

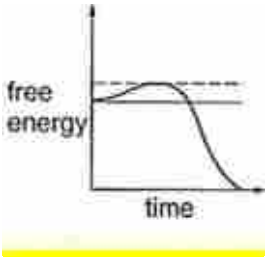
A



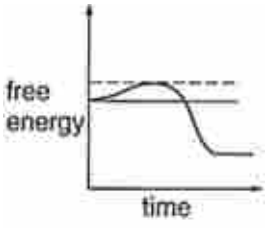
B



C



D



7 Some of the molecules found in animal tissues are grouped into three lists.

1 glucose, cholesterol, triglycerides, water

2 glycogen, adenine, phospholipids

3 haemoglobin, carbon dioxide, mRNA, fructose

Which lists include one or more molecules that always contain nitrogen atoms?

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

8 Proteins in the cell surface membranes of human cells and mouse cells were labelled with red and green fluorescent dyes respectively.

When a human cell and a mouse cell were fused together, the red and green fluorescent dyes were at first found in different regions of the cell surface membrane of the hybrid cell, but after 40 minutes, they were evenly distributed in the entire cell surface membrane.

What explains this observation?

A All protein molecules in the cell surface membrane are fixed to structures within the cell, but phospholipid molecules move freely between them.

B Groups of protein and phospholipid molecules in the cell surface membrane are attached to each another and move together.

C Only protein molecules in the outer layer of the cell surface membrane can move freely between phospholipid molecules.

D Protein molecules in the outer layer of the cell surface membrane and those which span the bilayer can move freely between phospholipid molecules.

9 At prophase of mitosis, a eukaryote chromosome consists of two chromatids.

What is the structure of a single chromatid?

A one molecule of single-stranded DNA coiled around protein molecules

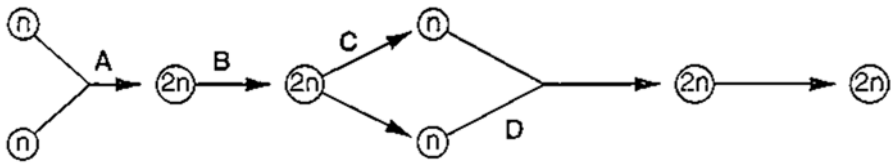
B two molecules of single-stranded DNA each coiled around protein molecules

C one double helix of DNA coiled around protein molecules

D two double helices of DNA each coiled around protein molecules

10 The diagram represents the life cycle of an animal.

At which stage in the life cycle does mitosis occur?



11 Which is the correct statement concerning cell and nuclear division?

A Haploid eukaryotes can reproduce by mitosis whereas diploid eukaryotes can reproduce by mitosis or meiosis.

B Just before prophase, the mass of DNA is double the normal mass. Following anaphase, this mass is reduced by half and following cytokinesis this mass halves again.

C Mutagens can cause mutations whereas carcinogens can cause cancer. This means that all mutagens are carcinogenic.

D Some of the roles of mitosis are growth, asexual reproduction, cell repair following tissue damage and cell replacement.

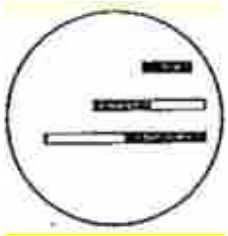
12 The diagram shows the maternal and paternal chromosomes from a diploid cell.

If the cell divides by meiosis, which diagram shows a possible viable gamete?

A

B

C



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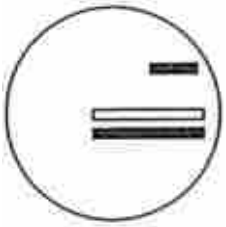


13 Stem cells are found in many tissues that require frequent cell replacement such as the skin, the intestine and the blood.

However, within their own environments, a blood cell cannot be induced to produce a skin cell and a skin cell cannot be induced to produce a blood cell.

Which statement explains this?

A Different stem cells have only the genes required for their particular cell line.

B Genes not required for the differentiation of a particular cell line are methylated.

C Binding of repressor molecules prevents the expression of genes not required for a particular cell line.

D Expression of gene not required for a particular cell line is controlled at translational level.

14 Which row represents the correct features of the nitrogenous base adenine?

	has a single ring structure	is a purine	joins its complementary base by three hydrogen bonds	pairs with uracil in RNA
A	✓	✓	✗	✗
B	✓	✗	✓	✗
C	✗	✓	✗	✓
D	✗	✗	✗	✓

key

✓ = true

✗ = false

15 The table shows the mode of action of two antibacterial drugs that can affect the synthesis of proteins.

antibacterial drug	rifampicin	streptomycin
mode of action	binds to RNA polymerase	causes errors in translation

If bacteria are treated with both drugs, what will be the immediate effects?

1 Transcription will stop, but non-functional proteins may continue to be synthesised.

2 If translation has started, proteins may be non-functional.

3 Translation will be inhibited.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

16 A peptide consists of ten amino acids of four different kinds.

What is the theoretical minimum number of different kinds of tRNA molecules required to translate the mRNA for this peptide?

A 4

B 10

C 12

D 30

17 Activation of an amino acid for translation requires

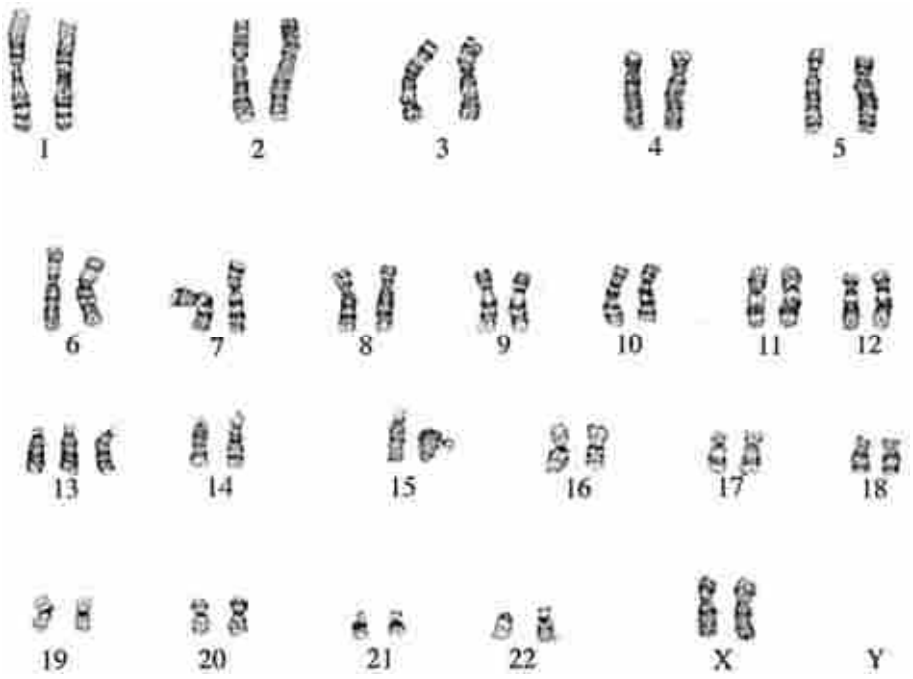
A joining the amino group of the amino acid to the 5'-end of the tRNA.

B matching the anticodon of the tRNA to the codon of the mRNA.

C hydrolysis of ATP.

D one enzyme that is specific for both a particular amino acid and a particular tRNA.

18 A newborn baby was diagnosed with Patau syndrome. The diagram below shows her chromosomes.



This is an example of

A frameshift mutation

B silent mutation

C aneuploidy

D polyploidy

19 Cancer cells divide out of control, forming tumours.

Which statement describes the difference between a cancer cell and a normal cell?

A Cancer cells do not undergo cytokinesis

B Cancer cells have a shorter interphase

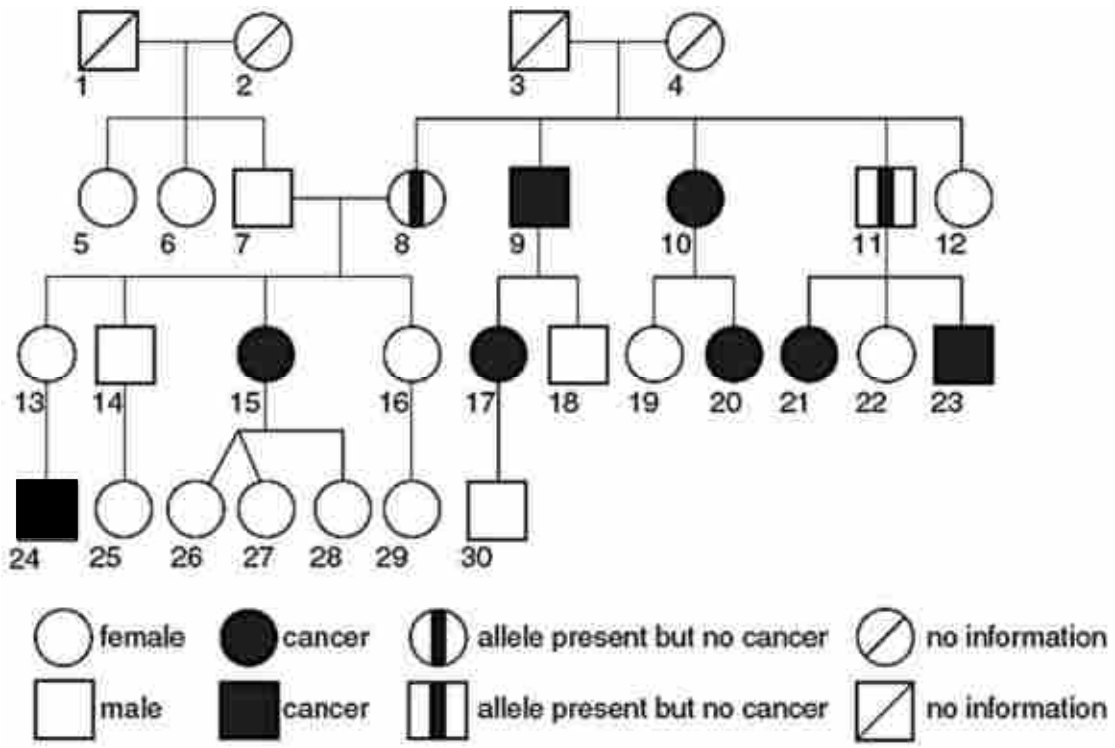
C Cancer cells do not have metaphase

D Only cancer cells have mutated DNA

20 The BRCA2 protein is involved in suppressing the development of tumours. The gene that codes for this protein is on chromosome 13.

Several different dominant alleles of this gene, *BRCA2*, code for faulty versions of the protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast cancer. Not everyone with one of these alleles develops cancer.

The pedigree (family tree) below shows the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. For individuals 17 to 30, only one of their parents is shown in the pedigree. Individuals 24–30 are all under twelve years old.



Which one of the following statement is **not** correct?

A Individuals 8 and 11 have *BRCA2* allele and may develop cancer later in life.

B Individuals 8 to 11 may have inherited *BRCA2* allele from either of their parents.

C Individual 15 may have inherited one copy of *BRCA2* allele from her mother.

D Individual 24 may have inherited the *BRCA2* allele only from his mother and not his father.

21 In mice, the gene for 'dappled' coat (**D**) and its recessive allele, the gene for 'plain' coat (**d**), are located on the X chromosome. The gene for 'straight' whiskers (**W**) and its recessive allele, the gene for 'bent' whiskers (**w**), are autosomal.

A male mouse with plain coat and bent whiskers was mated on several occasions to the same female and the large number of offspring consisted of the following phenotypes in equal proportion:

dappled male with straight whiskers	plain male with straight whiskers
dappled female with straight whiskers	plain female with straight whiskers
dappled male with bent whiskers	plain male with bent whiskers
dappled female with bent whiskers	plain female with bent whiskers

If X^D represents an **X** chromosome carrying an allele for 'dappled' coat and X^d represents an **X** chromosome carrying an allele for 'plain' coat, what is the genotype of the female parent?

A X^DX^DWW

B X^DX^DWw

C X^DX^dWW

D X^DX^dWw

22 A trial breeding programme between Nepalese yaks and a breed of British cattle called the Dexter was carried out to develop a hybrid that was hardy, easy to handle, produced good quality meat and high milk yield. The preliminary results of the trial showed the relative strengths of the alleles of the genes for desired characteristics.

desired characteristic	Dexter	Yak	hybrid
aggression	low	high	low
intelligence	low	high	high
hardiness	low	high	high
meat quality	high	low	high
milk yield	high	low	high

Which combination shows the animals that appear to have alleles dominant for the desired characteristic?

	aggression	intelligence	hardiness	meat quality	milk yield
A	Dexter	Dexter	Dexter	Yak	Yak
B	Dexter	Yak	Yak	Dexter	Dexter
C	Yak	Dexter	Dexter	Dexter	Dexter
D	Yak	Dexter	Dexter	Dexter	Yak

23 *Staphylococcus aureus* is a common bacterium, found on human skin. There are many strains of *S. aureus*. The antibiotic methicillin was then used to treat infection by *S. aureus*. Now there are at least 15 different strains of MRSA (methicillin resistant *Staphylococcus aureus*).

Which of the following are valid reasons for the emergence of 15 different strains of MRSA?

1 The bacteria mutated when it was exposed to methicillin, thus becoming resistant.

2 The bacteria underwent spontaneous mutation and some strains happened to be resistant to methicillin.

3 The antibiotic caused the bacteria to produce methicillin-resistant proteins.

A 2 only

B 1 and 2

C 2 and 3

D 1, 2 and 3

24 During aerobic respiration ATP can be formed by glycolysis and oxidative phosphorylation in the electron transport system.

In the complete oxidation of one molecule of glucose, approximately what percentage of ATP is formed by oxidative phosphorylation?

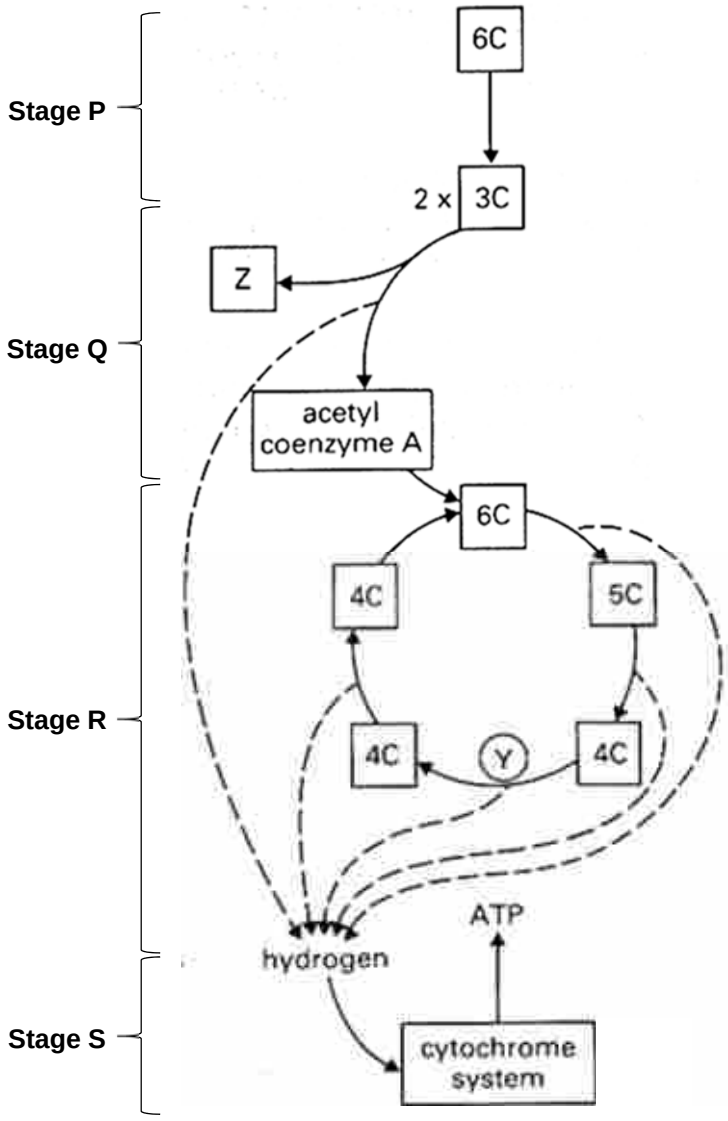
A 10%

B 25%

C 75%

D 90%

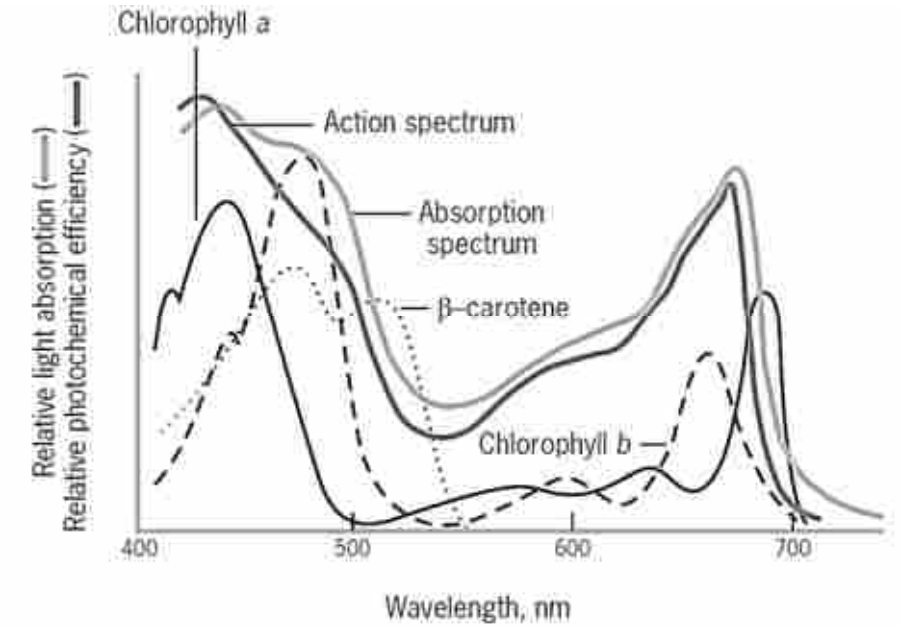
25 The diagram shows a biochemical pathway in a typical eukaryotic cell.



Which of the following row is correct?

	cristae	cytosol	mitochondrial matrix	final electron acceptor
A	**R**	**P, Q**	**R**	NADP
B	**R**	**P, Q**	**R**	Oxygen
C	**S**	**P**	**Q, R**	Oxygen
D	**S**	**P**	**Q, R**	NADP

26 The figure below shows the absorption spectrum of the photosynthetic pigments of a flowering plant and its action spectrum.



What can be concluded from the graph above?

1 The relative light absorption will be higher at higher temperatures, as temperature is a limiting factor.

2 The green leaves reflect light of wavelength 550 nm, hence the photochemical efficiency is low.

3 The compensation point of β-carotene, whereby the rate of photosynthesis equals the rate of respiration, occurs at 550nm.

4 The accessory pigments chlorophyll b and β-carotene absorb light energy mostly at 480nm.

A 2 and 4

B 1, 2 and 3

C 1, 3 and 4

D All of the above

27 Homogenized leaf suspensions containing the cytoplasm and organelles were then placed in two different test-tubes.

Test-tube **A** contains non-labelled water ($H_2{}^{16}O$)

Test-tube **B** contains radioactively-labelled water ($H_2{}^{18}O$)

A few drops of DCPIP, a hydrogen acceptor, were added to each test-tube. DCPIP will turn from blue to colourless when it is reduced and this colourless DCPIP can be reoxidized to blue.

The test-tubes were then exposed to red light for 30 minutes.

Which of the following shows the results of the two test-tubes after 30 minutes?

	Tube **A**		Tube **B**	
	Gas evolved	DCPIP colour	Gas evolved	DCPIP colour
A	$^{16}CO_2$	Blue	$^{18}CO_2$	Blue
B	$^{16}CO_2$	Colourless	$^{18}CO_2$	Colourless
C	$^{16}O_2$	Blue	$^{16}O_2$	Blue
D	$^{16}O_2$	Colourless	$^{18}O_2$	Colourless

28 An investigation was carried out to assess the effect of diet on the milk yield and methane production of cows. The cows in group **A** were fed a traditional diet and those in group **B** were fed the same diet with a mixture of chopped hay and straw added.

The table below shows the results of this investigation.

Group	Diet	Mean milk yield per cow/ dm^3 day^{-1}	Methane emission for each dm^3 milk produced / dm^3
A	Traditional with no added material	24.0	30.0
B	Traditional with added chopped hay and straw	27.6	24.0

Which of the following actions will help reduce the impact of global warming?

1 Decreasing consumption of beef and milk

2 Creating more foraging grounds to feed the cows

3 Adding chopped hay and straw to the cows' diet.

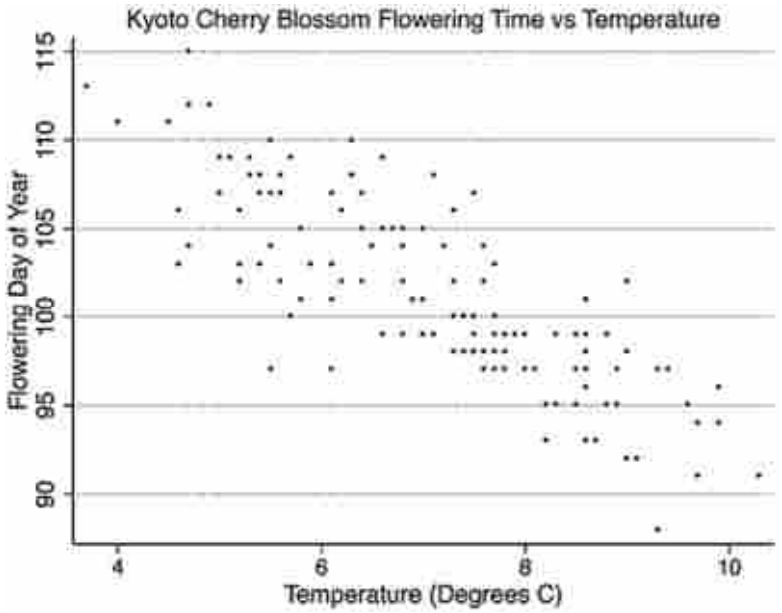
A 1 only

B 1 and 3 only

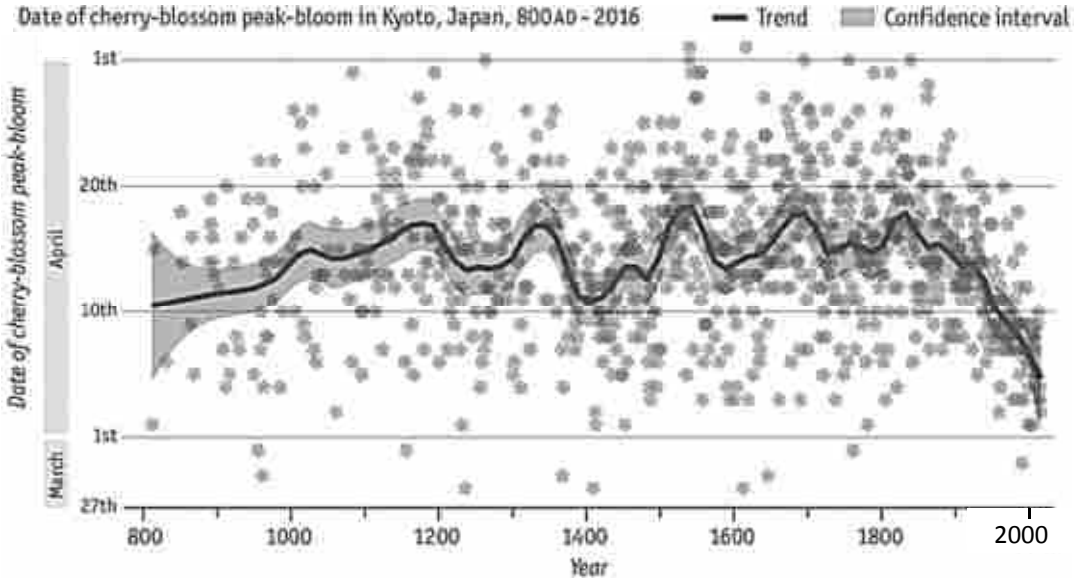
C 2 and 3 only

D All of the above

29 The effect of temperature on cherry blossom flowering time (day of the year) is shown below.



The records of timing of cherry blossoms in Japan from 800 A.D is shown below.



Which conclusions can be made from both graphs?

1 The peak of cherry blossoms has consistently been earlier since 1850. Cherry blossoms begin earlier as temperature increases from 4 to 10°C.

2 The temperature in Japan has been increasing since 800 A.D., resulting in later blooming and pollinators are unable to pollinate the cherry trees.

3 No conclusion can be made as the data points are scattered and lack clear trend.

A 1 only

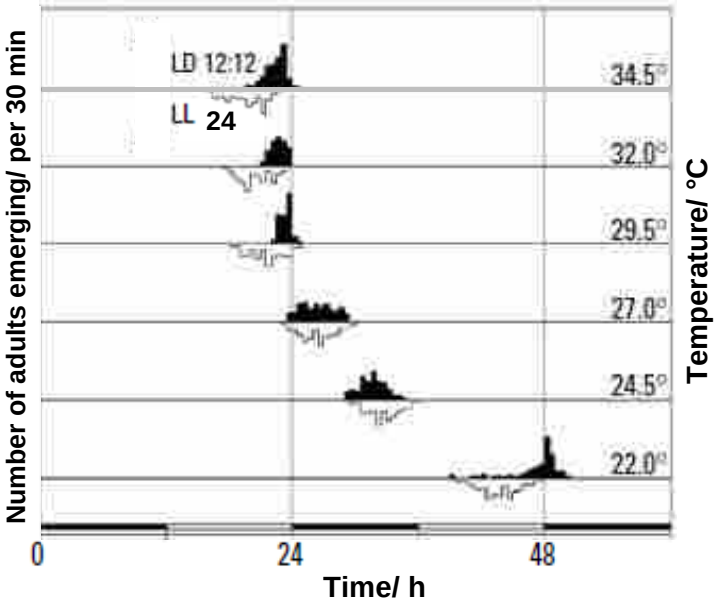
B 2 only

C 3 only

D 1 and 2

30 The figure below shows the effect of temperature on the emergence of a particular species of mosquitoes.

The mosquitoes were bred either in a constant 24 hours light condition (LL white bars), or a 12 hours light followed by 12 hours dark condition (LD 12:12 black bars).



Which of the following row is correct?

	life cycle of mosquito	descriptions
A	egg → larva → pupa → adult	As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h
B	egg → larva → pupa → adult	As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h
C	egg → pupa → larva → adult	As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h
D	egg → pupa → larva → adult	As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h

TEMASEK JUNIOR COLLEGE
PRELIMINARY EXAMINATION
JC 2 2018

CANDIDATE NAME											
CENTRE NUMBER	S							INDEX NUMBER				
CLASS	C	G			/	1	7				

H1 BIOLOGY

Paper 2 Structured Questions

8876/02
Friday 24 August 2018
2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number, index number and class in the spaces at the top of the page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use			
Q1	/ 6	Q5	/ 8
Q2	/ 10	Q6	/ 7
Q3	/ 5	Q7 / 8	/ 15
Q4	/ 9		
Total			/ 60

This document consists of **16** printed pages.

Answer **all** the questions in this section.

1 Sugar molecules enter cells through transport proteins.

(a) Explain why transport proteins are required for the movement of sugar molecules, such as glucose and fructose, into cells.

_____

_____

_____

_____

_____ [2]

Some plant cells convert fructose and glucose into sucrose for transport from the leaves to the roots. Sucrose is moved into phloem sieve tubes as shown in Fig. 1.1.

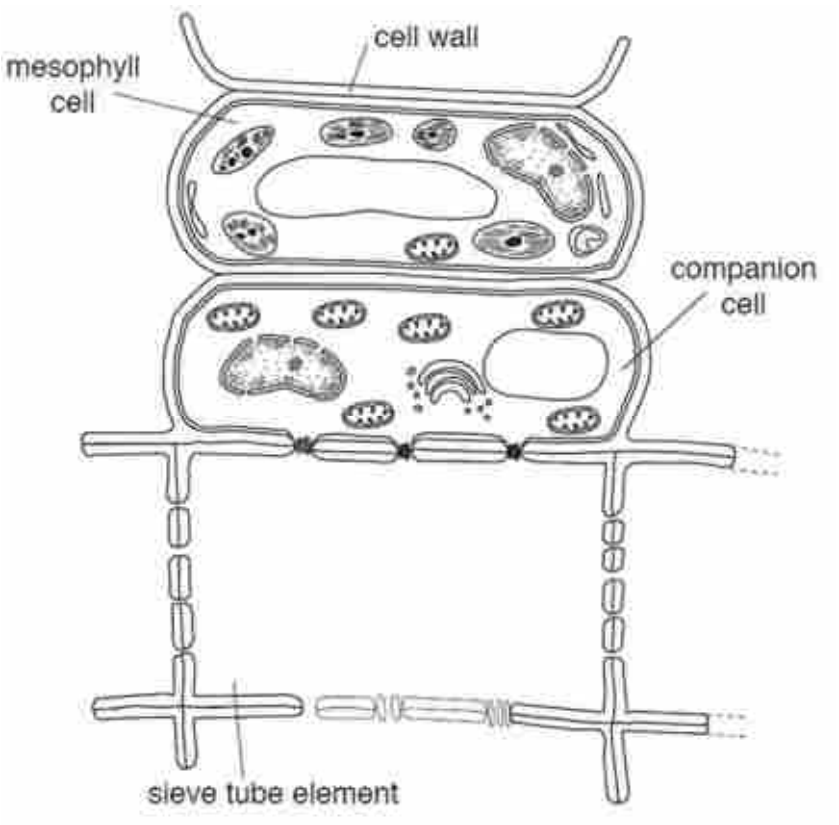


Fig. 1.1

Each cell has a specialized function.

(b) With reference to Fig. 1.1 and the information provided, state **one** difference between a mesophyll cell and companion cell.

_____

_____ [1]

Fig. 1.2 shows how sucrose is transported into the companion cell from mesophyll cell.

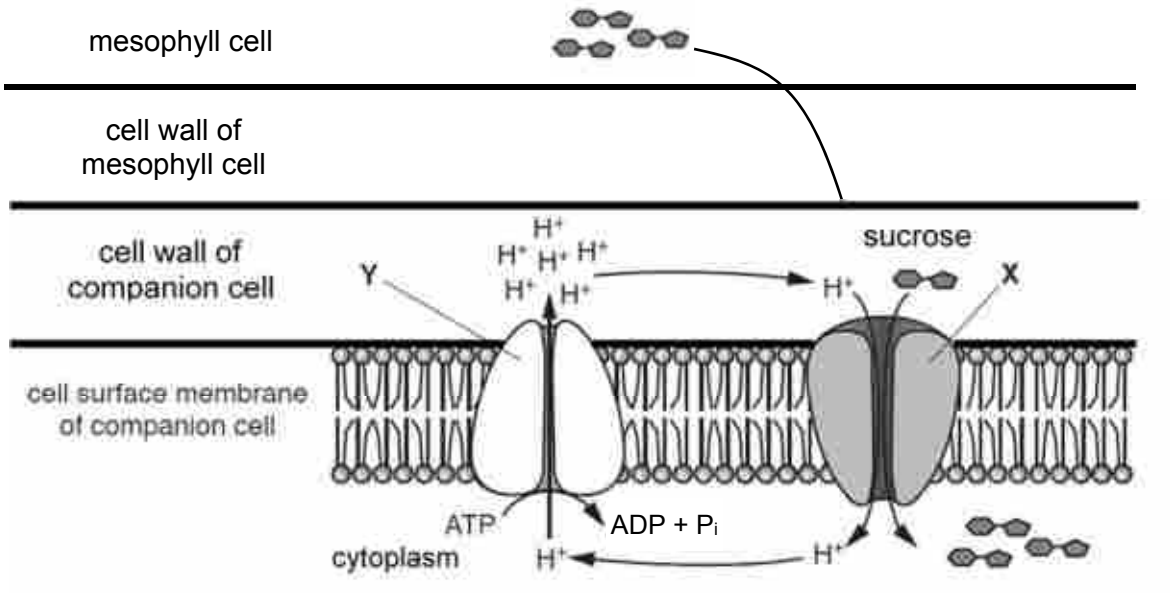


Fig. 1.2

(c) Using the information in Fig. 1.1 and Fig. 1.2, explain how sucrose moves into the companion cell.

_____

_____

_____

_____

_____

_____

_____ [3]

[Total: 6]

2 The yeast, *Saccharomyces cerevisiae*, is a single-celled, eukaryotic organism that is often used in the laboratory.

When yeast is mixed with glucose solution, the yeast absorbs the glucose. Each molecule of glucose is then broken down into pyruvate molecules in exactly the same way as in any other eukaryotic organism.

(a) Outline the breakdown of glucose to pyruvate in this stage.

_____

_____

_____

_____

_____ [2]

Yeast cells sometimes carry out anaerobic respiration. Fig. 2.1 outlines the process of anaerobic respiration in yeast cells.

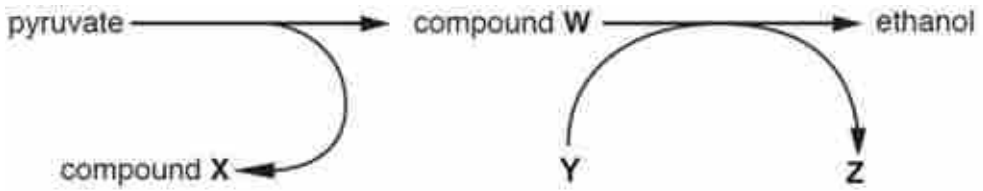


Fig. 2.1

(b) **(i)** Identify molecule **Z**.

_____ [1]

(ii) State why molecule **Y** is converted to **Z**.

_____

_____ [1]

Yeasts are often used in bread-making. The bread dough is kneaded to introduce and trap air so that the yeasts in the dough can respire aerobically. Besides carbon dioxide that is released during respiration, the evaporation of water or ethanol released during respiration also causes the dough to rise.

Table 2.1 shows the differences in the height of dough that was placed at different locations, after the dough was kneaded.

Table 2.1

Time/ min	Height of dough/ cm		
	Fridge	Room temperature	Next to window (hot day)
0	2.5	2.5	2.5
20	2.5	2.9	3.3
40	2.7	3.7	4.0
60	2.9	3.9	4.7
80	3.0	4.0	5.2
100	3.0	4.0	5.8
120	3.0	4.0	6.0

(c) **(i)** Account for the difference in the overall increase in the height of dough that was placed in the fridge with that placed next to the window.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(ii) Suggest why the increase in the height of dough that was placed at room temperature was higher between 0 and 40 minutes than between 40 minutes and 60 minutes.

_____

_____

_____

_____

_____ [2]

[Total: 10]

3 Fig. 3.1 shows the effect of increasing substrate concentration on the rate of a particular reaction in the presence and absence of an enzyme.

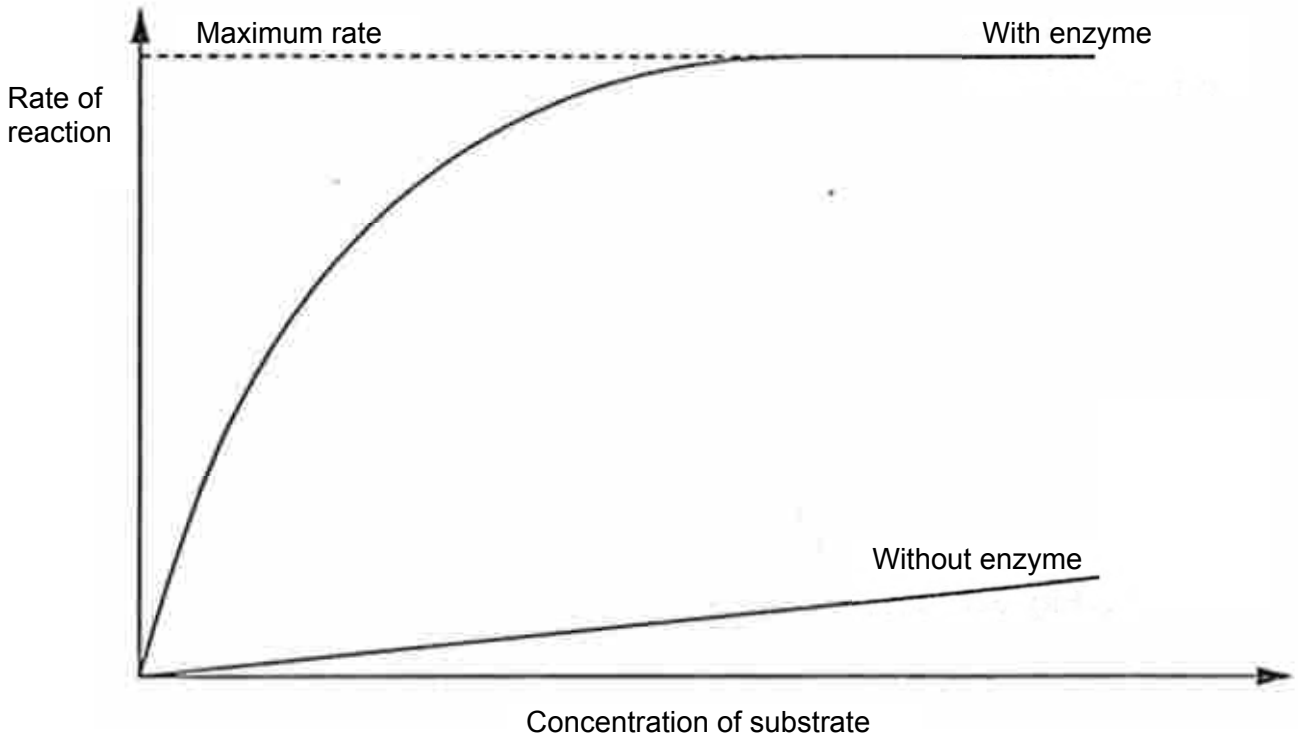


Fig. 3.1

(a) On Fig. 3.1, draw **two** labelled curves to show the effect on the rate of the enzyme catalysed reaction upon the addition of

(i) a competitive inhibitor;

(ii) a non-competitive inhibitor. [2]

(b) Explain the effect of a competitive inhibitor on the rate of enzyme activity.

_____

_____

_____

_____

_____

_____

_____ [3]

[Total: 5]

4 Table 4.1 shows some of the common fatty acids and their melting points.

Table 4.1

Symbol (number of carbon atoms : number of double bonds)	**Common Name**	**Melting point (ºC)**
Saturated fatty acids		
12 : 0	Lauric acid	44.2
14 : 0	Myristic acid	52
16 : 0	Palmitic acid	63.1
18 : 0	Stearic acid	69.6
20 : 0	Arachidic acid	75.4
22 : 0	Behenic acid	81
Unsaturated fatty acids		
16 : 1	Palmitoleic acid	-0.5
18 : 1	Oleic acid	13.4
18 : 2	Linoleic acid	-9
18 : 3	α-linolenic acid	-17
20 : 4	Arachnidonic acid	-49.5

(a) Arachidonic acid is a polyunsaturated fatty acid.

Explain the term *polyunsaturated fatty acid.*

_____

_____ [1]

(b) With reference to Table 4.1,

(i) describe the effect of increasing number of carbon atoms in saturated fatty acids on the melting point;

_____

_____

_____

_____

_____

_____

_____ [3]

(ii) describe the effect of the presence of double bonds in fatty acids on the melting point;

_____

_____ [1]

(iii) explain the trend described in **b(ii)**.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

[Total: 9]

5 Table 5.1 provides statements regarding the bonds found in four biological molecules.

Table 5.1

statement	protein	DNA	messenger RNA	cellulose
hydrogen bonds stabilise the molecule				
subunits are joined by peptide bonds				

(a) Complete Table 5.1 by indicating with a tick (✓) or a cross (×) whether the statements apply to proteins, DNA, messenger RNA and cellulose.

You should put a tick or a cross in each box of the table. [2]

(b) A piece of mRNA is 660 nucleotides long but the DNA coding strand from which it was transcribed is 870 nucleotides long.

(i) Explain this difference in the number of nucleotides

_____

_____ [1]

(ii) What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer.

Number of amino acids _____

Explanation

_____

_____

_____ [2]

(c) Identify **one** other process that lead the formation of mature mRNA and state its function.

_____

_____

_____

_____ [2]

(d) Describe **one** difference between the structure of mRNA and tRNA.

_____

_____ [1]

[Total: 8]

6 The evolutionary origin of the four-legged amphibians (such as frogs and toads) from fish has been the subject of much debate for many years.

Among living fish, the rarely-caught coelacanth and the lungfish are thought to be most closely related to these amphibians.

Samples of blood were taken from two coelacanths that were captured recently near Comoros.

The amino acid sequences of the α and β chains of coelacanth and lungfish haemoglobin were compared with the known sequences of amphibian adults and their aquatic larvae (tadpoles).

Organisms with more matches in the amino acid sequence of a polypeptide chain share a more recent common ancestor than those with fewer matches.

The comparisons with three species of amphibians, *Xenopus laevis* (Xl), *X. tropicana* (Xt) and *Rana catesbeiana* (Rc) are shown in Table 6.1.

Table 6.1

		percentage of matches of amino acid sequence					
		species of amphibian adults			**species of amphibian larvae (tadpoles)**		
	fish species	*Xl*	*Xt*	*Rc*	*Xl*	*Xt*	*Rc*
α chains	coelacanth	42.0	47.5	no data	45.4	42.6	48.2
	lungfish	40.4	42.1	no data	40.7	39.0	37.9
β chains	coelacanth	42.1	43.2	40.7	52.1	52.1	58.2
	lungfish	44.1	45.9	41.4	47.3	45.9	48.6

(a) Explain whether or not the information in Table 6.1 supports the suggestion that coelacanths and amphibians share a more recent common ancestor than do lungfish and amphibians.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(b) Coelacanth haemoglobin has a very high affinity for oxygen, suggesting that coelacanths, which have been captured at depths of between 200 m and 400 m, live in water that has a low concentration of oxygen.

Explain how an environmental factor, such as the low concentration of oxygen in deep water, can act as an evolutionary force in natural selection.

_____

_____

_____

_____

_____

_____

_____ [3]

[Total: 7]

End of Section A

2018 PRELIMINARY EXAMINATION

H1 BIOLOGY PAPER 2 [SECTION B]:

Essay Question

Name: _____

Civics Group: _____/17

For Examiner's Use	
Q7 / 8	**/ 15**

Section B

Answer **one** question.
Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must set out in sections **(a)**, **(b)** etc., as indicated in the question.

EITHER

7 **(a)** Discuss the suggestion that all living organisms on earth depend on nitrogen. [6]

(b) Discuss the extent to which mitosis and the different types of stem cells can account for the principles behind the cell theory in humans, from one generation to the next. [9]

OR

8 **(a)** Discuss possible impact of global warming on geographical patterns of distribution of mosquito-borne diseases. [6]

(b) DNA molecules are replicated with a high degree of accuracy yet not always perfectly. [9]

Describe how this occurs and discuss why the survival of a species depends on DNA molecules being stable, yet not *absolutely* stable.

TEMASEK JUNIOR COLLEGE
PRELIMINARY EXAMINATION
JC2 2018

CANDIDATE NAME												
CENTRE NUMBER	S							INDEX NUMBER				
CLASS	C	G			/	1	7					

H1 BIOLOGY

8876/01

Multiple Choice

Wednesday 14 September 2018
1 hour

Additional materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the one you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

This document consists of **18** printed pages.

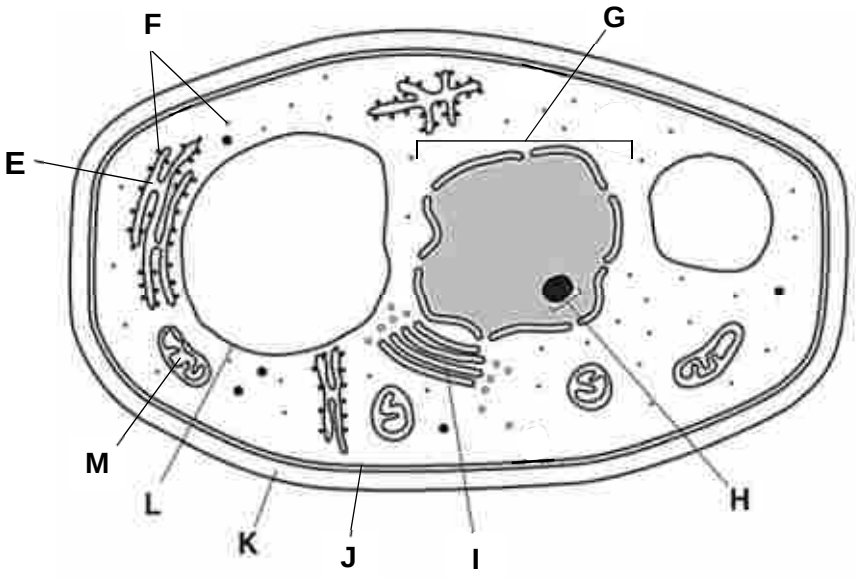
Section A

Answer **all** the questions in this section.

1 Tuberculosis and candidiasis are two opportunistic infections that may develop during AIDS.

Tuberculosis is caused by *Mycobacterium tuberculosis*, a prokaryote that lives in human lungs; whereas candidiasis is caused by *Candida albicans*, a yeast-like fungus that lives in human lungs.

The figure below shows the structure of *Candida*.



Which of the structure(s) can also be found in the causative agent that causes tuberculosis?

A None

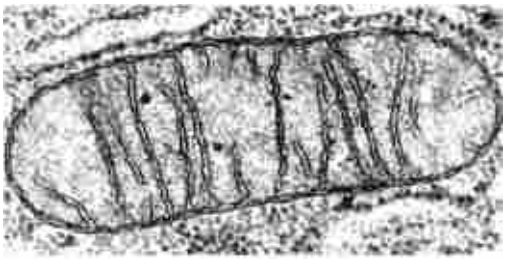
B **F** only

C **F**, **J**, **K** only

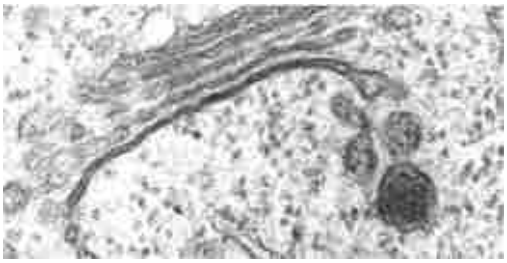
D **H**, **J**, **K** only

2 The images below show the electron micrographs of some organelles found in eukaryotic cells.

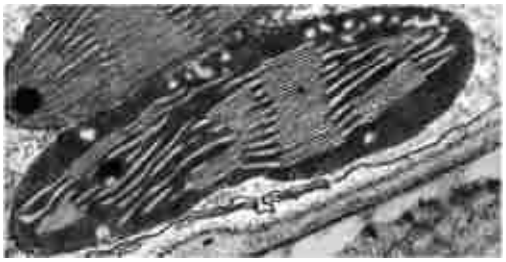
P



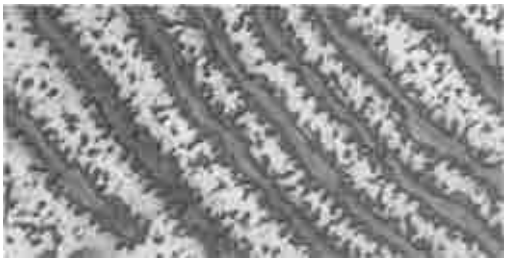
Q



R



S



The following statements are descriptions of membranous cell structures.

1 formed by a single membrane and enclosing a large fluid-filled space and regulating the osmotic pressure of the cell

2 formed by a single membrane and enclosing inactivated enzymes

3 formed by a single membrane that has flattened sacs and tubular structures inter-connected throughout the cell, sometimes with a complex of nucleic acid and protein attached

4 formed by a single membrane that has tubular structures and containing enzymes to add carbohydrate side chains to proteins

5 formed by two membranes and internal membranes that contain pigments

6 formed by two membranes whereby the inner membrane is folded extensively

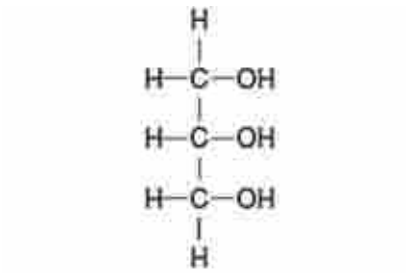
7 formed by two membranes, the outer membrane is continuous with another membranous organelle

Which of the following row correctly matches the descriptions of the cell structures?

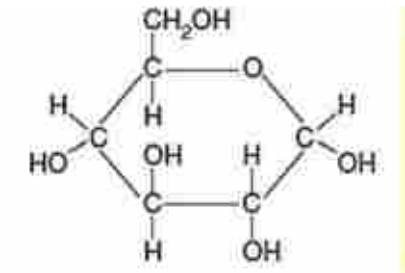
	P	**Q**	**R**	**S**
A	5	3	6	1
B	5	2	4	7
C	6	4	5	3
D	7	1	2	6

3 Which molecule is found in glycogen?

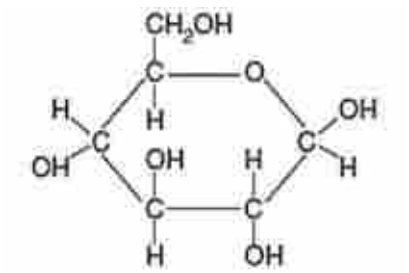
A



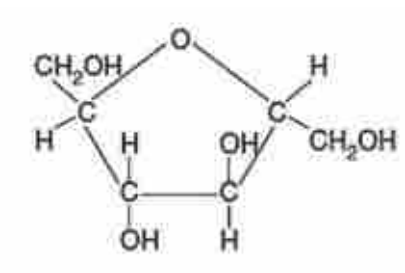
B



C



D



4 Particular biological molecules react with chemicals called reagents to give distinct colour changes. The colour depends on the kind of biological molecule and the type of reagent used, as shown in the following table.

chemical reagent	biological molecule	colour change observed
L	protein	violet
M	lipid	red
N	nucleic acid	green

A researcher added different reagents to some isolated ribosomes.

The colour change observed are

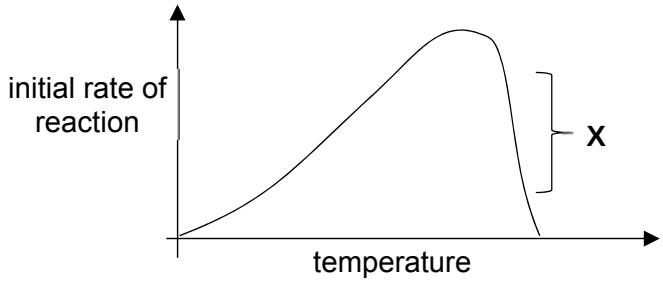
A green only.

B red and green.

C green and violet.

D violet, red and green.

5 The diagram shows the initial rate of reaction using constant amounts of substrate and enzyme at different temperatures.



What is the reason for the decline in the level of activity in region **X**?

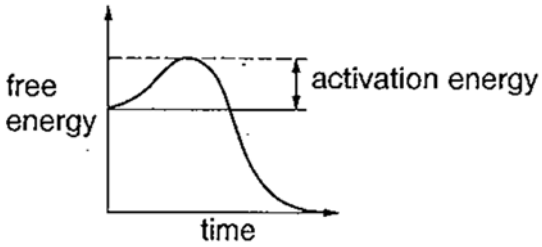
A breaking of sulphur bridges and ionic bonds in the enzymes

B competition between substrate and product for the active site

C breaking of hydrogen bonds and hydrolysis of peptide bonds in the enzyme

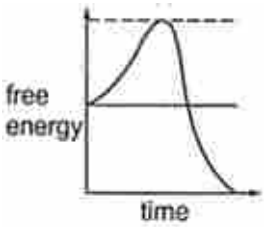
D insufficient substrates to occupy all the active sites

6 The graph shows energy changes during an uncatalysed chemical reaction.

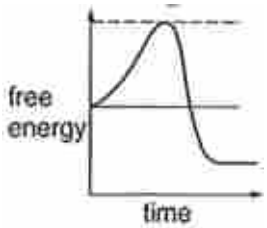


Which graph shows the energy changes for the same reaction when it is catalysed by an enzyme?

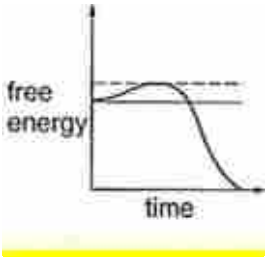
A



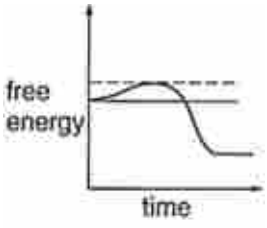
B



C



D



7 Some of the molecules found in animal tissues are grouped into three lists.

1 glucose, cholesterol, triglycerides, water

2 glycogen, adenine, phospholipids

3 haemoglobin, carbon dioxide, mRNA, fructose

Which lists include one or more molecules that always contain nitrogen atoms?

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

8 Proteins in the cell surface membranes of human cells and mouse cells were labelled with red and green fluorescent dyes respectively.

When a human cell and a mouse cell were fused together, the red and green fluorescent dyes were at first found in different regions of the cell surface membrane of the hybrid cell, but after 40 minutes, they were evenly distributed in the entire cell surface membrane.

What explains this observation?

A All protein molecules in the cell surface membrane are fixed to structures within the cell, but phospholipid molecules move freely between them.

B Groups of protein and phospholipid molecules in the cell surface membrane are attached to each another and move together.

C Only protein molecules in the outer layer of the cell surface membrane can move freely between phospholipid molecules.

D Protein molecules in the outer layer of the cell surface membrane and those which span the bilayer can move freely between phospholipid molecules.

9 At prophase of mitosis, a eukaryote chromosome consists of two chromatids.

What is the structure of a single chromatid?

A one molecule of single-stranded DNA coiled around protein molecules

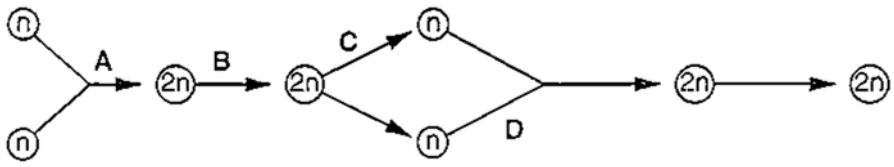
B two molecules of single-stranded DNA each coiled around protein molecules

C one double helix of DNA coiled around protein molecules

D two double helices of DNA each coiled around protein molecules

10 The diagram represents the life cycle of an animal.

At which stage in the life cycle does mitosis occur?



11 Which is the correct statement concerning cell and nuclear division?

A Haploid eukaryotes can reproduce by mitosis whereas diploid eukaryotes can reproduce by mitosis or meiosis.

B Just before prophase, the mass of DNA is double the normal mass. Following anaphase, this mass is reduced by half and following cytokinesis this mass halves again.

C Mutagens can cause mutations whereas carcinogens can cause cancer. This means that all mutagens are carcinogenic.

D Some of the roles of mitosis are growth, asexual reproduction, cell repair following tissue damage and cell replacement.

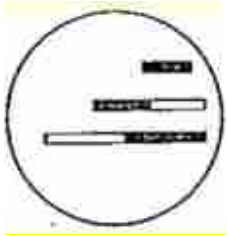
12 The diagram shows the maternal and paternal chromosomes from a diploid cell.

If the cell divides by meiosis, which diagram shows a possible viable gamete?

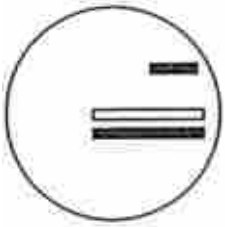
A

B

C



D



13 Stem cells are found in many tissues that require frequent cell replacement such as the skin, the intestine and the blood.

However, within their own environments, a blood cell cannot be induced to produce a skin cell and a skin cell cannot be induced to produce a blood cell.

Which statement explains this?

A Different stem cells have only the genes required for their particular cell line.

B Genes not required for the differentiation of a particular cell line are methylated.

C Binding of repressor molecules prevents the expression of genes not required for a particular cell line.

D Expression of gene not required for a particular cell line is controlled at translational level.

14 Which row represents the correct features of the nitrogenous base adenine?

	has a single ring structure	is a purine	joins its complementary base by three hydrogen bonds	pairs with uracil in RNA
A	✓	✓	✗	✗
B	✓	✗	✓	✗
C	✗	✓	✗	✓
D	✗	✗	✗	✓

key

✓ = true

✗ = false

15 The table shows the mode of action of two antibacterial drugs that can affect the synthesis of proteins.

antibacterial drug	rifampicin	streptomycin
mode of action	binds to RNA polymerase	causes errors in translation

If bacteria are treated with both drugs, what will be the immediate effects?

1 Transcription will stop, but non-functional proteins may continue to be synthesised.

2 If translation has started, proteins may be non-functional.

3 Translation will be inhibited.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

16 A peptide consists of ten amino acids of four different kinds.

What is the theoretical minimum number of different kinds of tRNA molecules required to translate the mRNA for this peptide?

A 4

B 10

C 12

D 30

17 Activation of an amino acid for translation requires

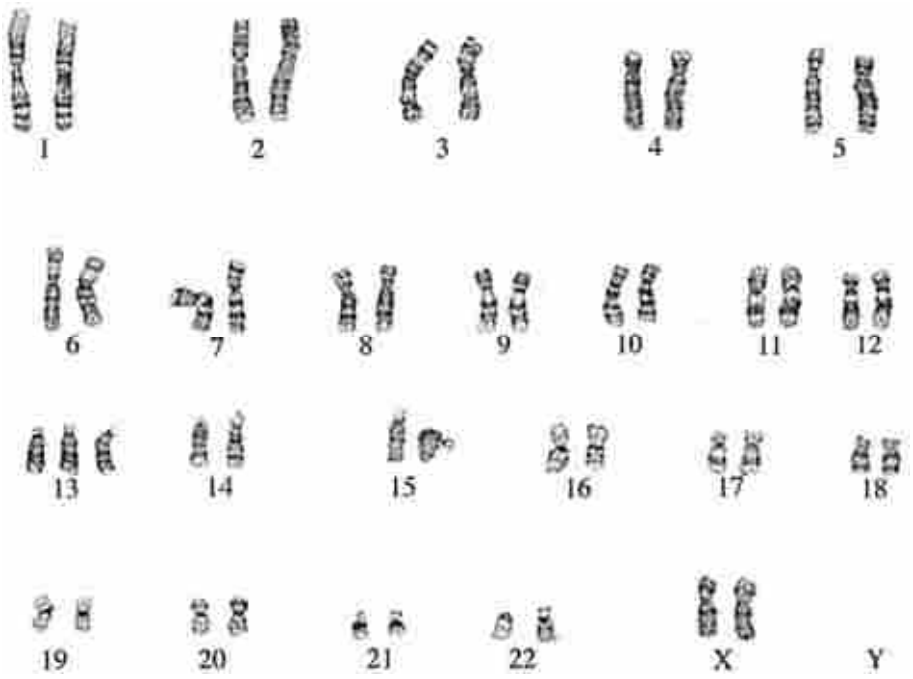
A joining the amino group of the amino acid to the 5'-end of the tRNA.

B matching the anticodon of the tRNA to the codon of the mRNA.

C hydrolysis of ATP.

D one enzyme that is specific for both a particular amino acid and a particular tRNA.

18 A newborn baby was diagnosed with Patau syndrome. The diagram below shows her chromosomes.



This is an example of

A frameshift mutation

B silent mutation

C aneuploidy

D polyploidy

19 Cancer cells divide out of control, forming tumours.

Which statement describes the difference between a cancer cell and a normal cell?

A Cancer cells do not undergo cytokinesis

B Cancer cells have a shorter interphase

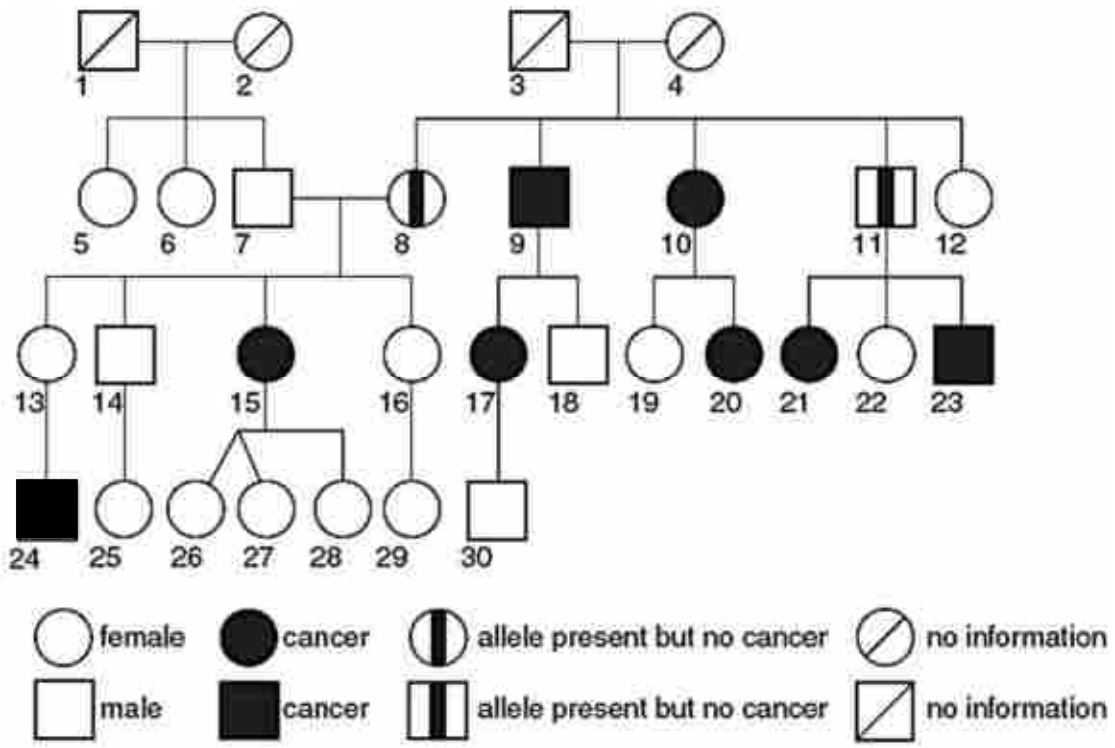
C Cancer cells do not have metaphase

D Only cancer cells have mutated DNA

20 The BRCA2 protein is involved in suppressing the development of tumours. The gene that codes for this protein is on chromosome 13.

Several different dominant alleles of this gene, *BRCA2*, code for faulty versions of the protein. The presence of any one of these faulty alleles leads to an increased chance of developing several types of cancer, including breast cancer. Not everyone with one of these alleles develops cancer.

The pedigree (family tree) below shows the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. For individuals 17 to 30, only one of their parents is shown in the pedigree. Individuals 24–30 are all under twelve years old.



Which one of the following statement is **not** correct?

A Individuals 8 and 11 have *BRCA2* allele and may develop cancer later in life.

B Individuals 8 to 11 may have inherited *BRCA2* allele from either of their parents.

C Individual 15 may have inherited one copy of *BRCA2* allele from her mother.

D Individual 24 may have inherited the *BRCA2* allele only from his mother and not his father.

21 In mice, the gene for 'dappled' coat (**D**) and its recessive allele, the gene for 'plain' coat (**d**), are located on the X chromosome. The gene for 'straight' whiskers (**W**) and its recessive allele, the gene for 'bent' whiskers (**w**), are autosomal.

A male mouse with plain coat and bent whiskers was mated on several occasions to the same female and the large number of offspring consisted of the following phenotypes in equal proportion:

dappled male with straight whiskers	plain male with straight whiskers
dappled female with straight whiskers	plain female with straight whiskers
dappled male with bent whiskers	plain male with bent whiskers
dappled female with bent whiskers	plain female with bent whiskers

If X^D represents an **X** chromosome carrying an allele for 'dappled' coat and X^d represents an **X** chromosome carrying an allele for 'plain' coat, what is the genotype of the female parent?

A X^DX^DWW

B X^DX^DWw

C X^DX^dWW

D X^DX^dWw

22 A trial breeding programme between Nepalese yaks and a breed of British cattle called the Dexter was carried out to develop a hybrid that was hardy, easy to handle, produced good quality meat and high milk yield. The preliminary results of the trial showed the relative strengths of the alleles of the genes for desired characteristics.

desired characteristic	Dexter	Yak	hybrid
aggression	low	high	low
intelligence	low	high	high
hardiness	low	high	high
meat quality	high	low	high
milk yield	high	low	high

Which combination shows the animals that appear to have alleles dominant for the desired characteristic?

	aggression	intelligence	hardiness	meat quality	milk yield
A	Dexter	Dexter	Dexter	Yak	Yak
B	Dexter	Yak	Yak	Dexter	Dexter
C	Yak	Dexter	Dexter	Dexter	Dexter
D	Yak	Dexter	Dexter	Dexter	Yak

23 *Staphylococcus aureus* is a common bacterium, found on human skin. There are many strains of *S. aureus*. The antibiotic methicillin was then used to treat infection by *S. aureus*. Now there are at least 15 different strains of MRSA (methicillin resistant *Staphylococcus aureus*).

Which of the following are valid reasons for the emergence of 15 different strains of MRSA?

1 The bacteria mutated when it was exposed to methicillin, thus becoming resistant.

2 The bacteria underwent spontaneous mutation and some strains happened to be resistant to methicillin.

3 The antibiotic caused the bacteria to produce methicillin-resistant proteins.

A 2 only

B 1 and 2

C 2 and 3

D 1, 2 and 3

24 During aerobic respiration ATP can be formed by glycolysis and oxidative phosphorylation in the electron transport system.

In the complete oxidation of one molecule of glucose, approximately what percentage of ATP is formed by oxidative phosphorylation?

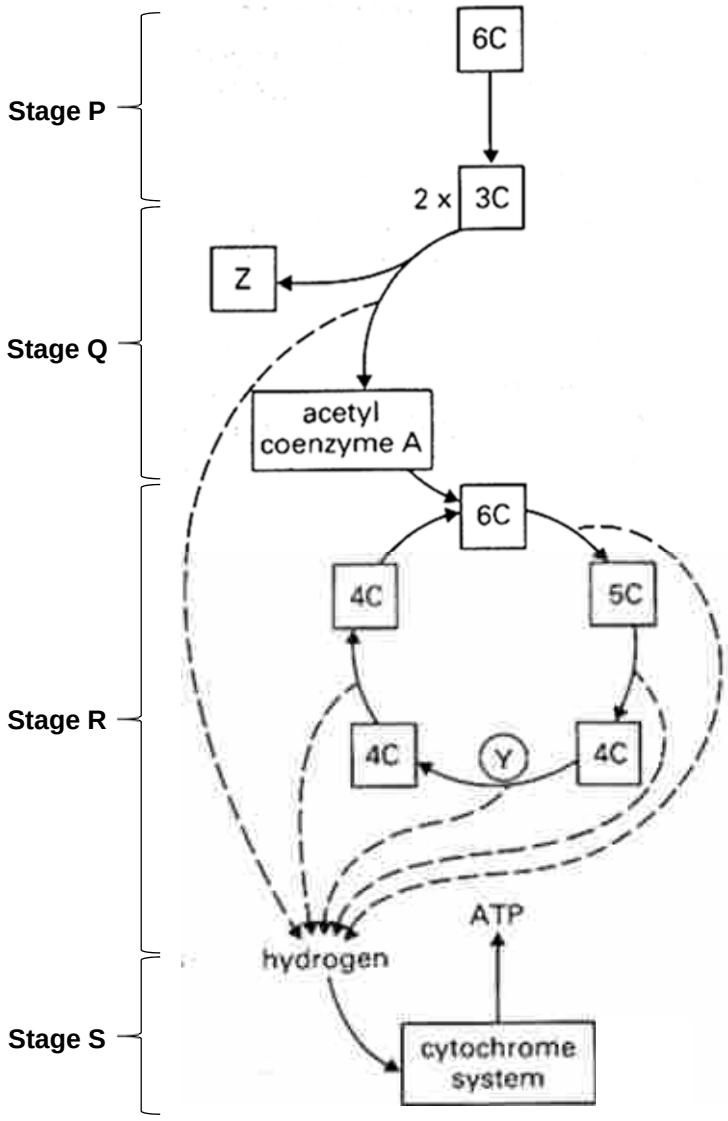
A 10%

B 25%

C 75%

D 90%

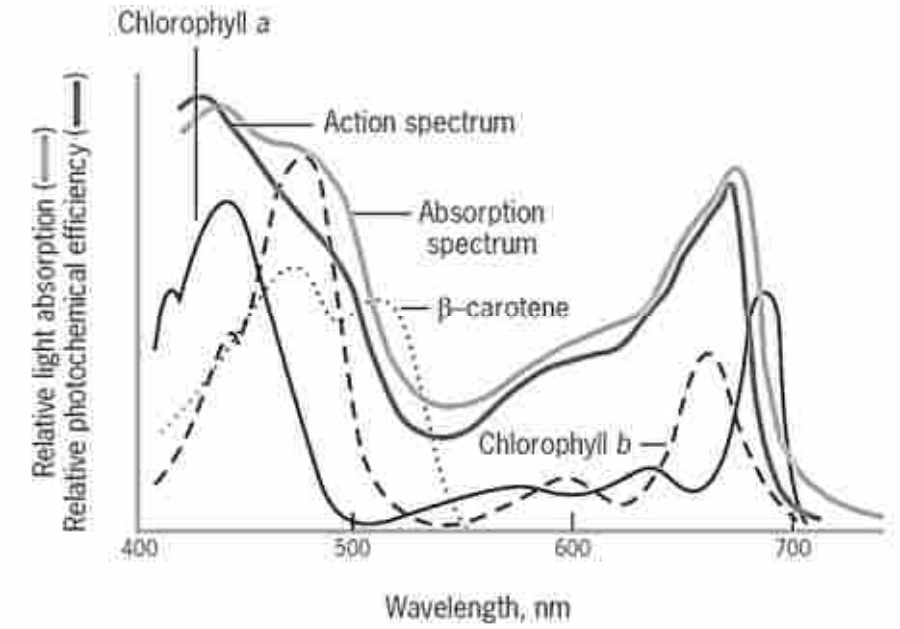
25 The diagram shows a biochemical pathway in a typical eukaryotic cell.



Which of the following row is correct?

	cristae	cytosol	mitochondrial matrix	final electron acceptor
A	**R**	**P, Q**	**R**	NADP
B	**R**	**P, Q**	**R**	Oxygen
C	**S**	**P**	**Q, R**	Oxygen
D	**S**	**P**	**Q, R**	NADP

26 The figure below shows the absorption spectrum of the photosynthetic pigments of a flowering plant and its action spectrum.



What can be concluded from the graph above?

1 The relative light absorption will be higher at higher temperatures, as temperature is a limiting factor.

2 The green leaves reflect light of wavelength 550 nm, hence the photochemical efficiency is low.

3 The compensation point of β-carotene, whereby the rate of photosynthesis equals the rate of respiration, occurs at 550nm.

4 The accessory pigments chlorophyll b and β-carotene absorb light energy mostly at 480nm.

A 2 and 4

B 1, 2 and 3

C 1, 3 and 4

D All of the above

27 Homogenized leaf suspensions containing the cytoplasm and organelles were then placed in two different test-tubes.

Test-tube **A** contains non-labelled water ($H_2{}^{16}O$)

Test-tube **B** contains radioactively-labelled water ($H_2{}^{18}O$)

A few drops of DCPIP, a hydrogen acceptor, were added to each test-tube. DCPIP will turn from blue to colourless when it is reduced and this colourless DCPIP can be reoxidized to blue.

The test-tubes were then exposed to red light for 30 minutes.

Which of the following shows the results of the two test-tubes after 30 minutes?

	Tube **A**		Tube **B**	
	Gas evolved	DCPIP colour	Gas evolved	DCPIP colour
A	$^{16}CO_2$	Blue	$^{18}CO_2$	Blue
B	$^{16}CO_2$	Colourless	$^{18}CO_2$	Colourless
C	$^{16}O_2$	Blue	$^{16}O_2$	Blue
D	$^{16}O_2$	Colourless	$^{18}O_2$	Colourless

28 An investigation was carried out to assess the effect of diet on the milk yield and methane production of cows. The cows in group **A** were fed a traditional diet and those in group **B** were fed the same diet with a mixture of chopped hay and straw added.

The table below shows the results of this investigation.

Group	Diet	Mean milk yield per cow/ dm^3 day^{-1}	Methane emission for each dm^3 milk produced / dm^3
A	Traditional with no added material	24.0	30.0
B	Traditional with added chopped hay and straw	27.6	24.0

Which of the following actions will help reduce the impact of global warming?

1 Decreasing consumption of beef and milk

2 Creating more foraging grounds to feed the cows

3 Adding chopped hay and straw to the cows' diet.

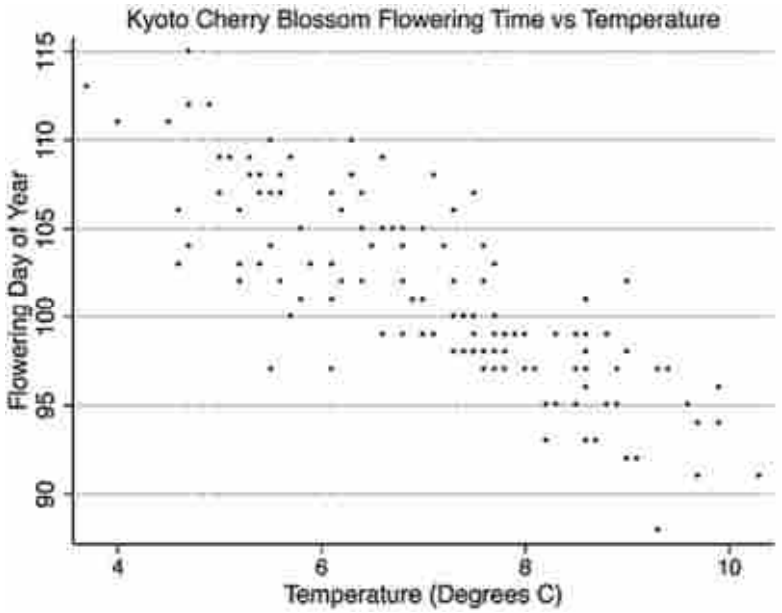
A 1 only

B 1 and 3 only

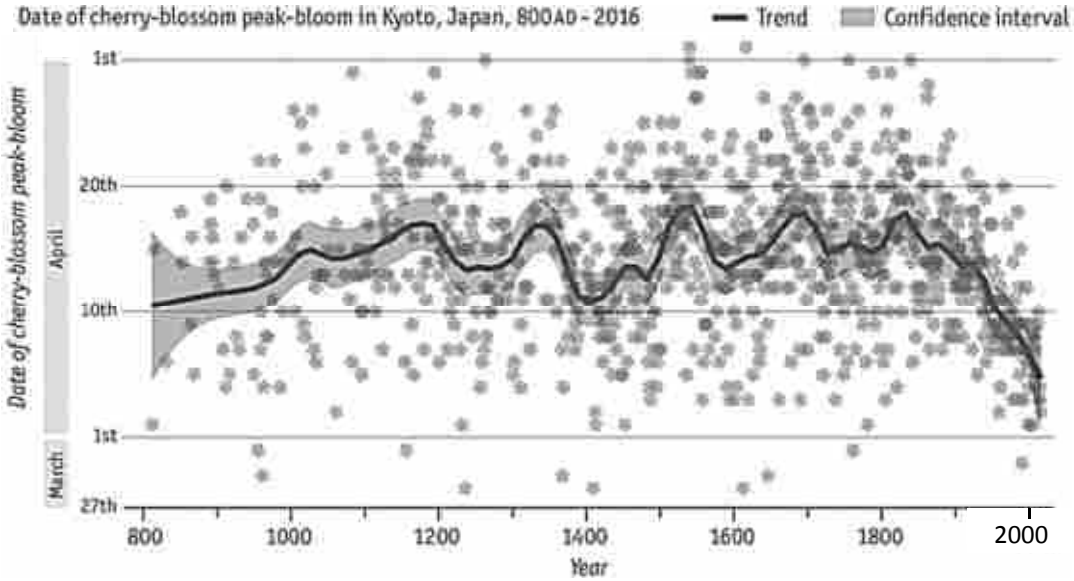
C 2 and 3 only

D All of the above

29 The effect of temperature on cherry blossom flowering time (day of the year) is shown below.



The records of timing of cherry blossoms in Japan from 800 A.D is shown below.



Which conclusions can be made from both graphs?

1 The peak of cherry blossoms has consistently been earlier since 1850. Cherry blossoms begin earlier as temperature increases from 4 to 10°C.

2 The temperature in Japan has been increasing since 800 A.D., resulting in later blooming and pollinators are unable to pollinate the cherry trees.

3 No conclusion can be made as the data points are scattered and lack clear trend.

A 1 only

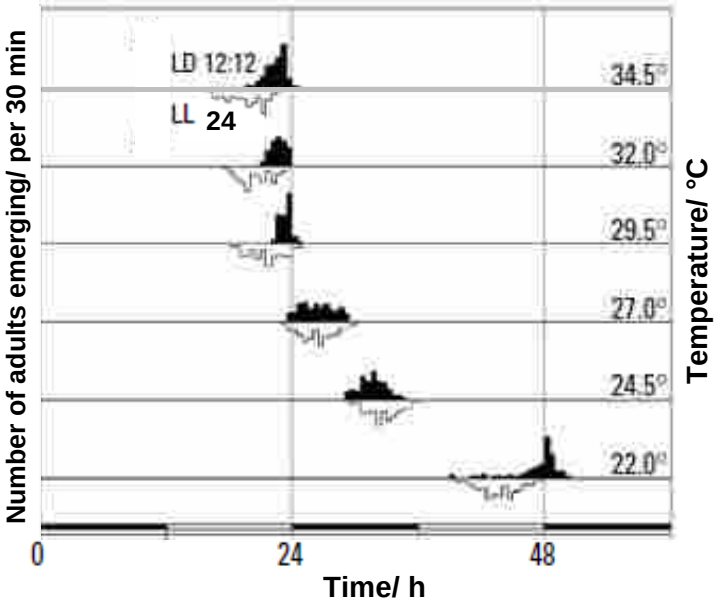
B 2 only

C 3 only

D 1 and 2

30 The figure below shows the effect of temperature on the emergence of a particular species of mosquitoes.

The mosquitoes were bred either in a constant 24 hours light condition (LL white bars), or a 12 hours light followed by 12 hours dark condition (LD 12:12 black bars).



Which of the following row is correct?

	life cycle of mosquito	descriptions
A	egg → larva → pupa → adult	As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h
B	egg → larva → pupa → adult	As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h
C	egg → pupa → larva → adult	As temperature increases, the timing in which the adult mosquitoes emerged increases from 24h to 48h
D	egg → pupa → larva → adult	As temperature increases, the timing in which the adult mosquitoes emerged decreases from 48h to 24h

TEMASEK JUNIOR COLLEGE
PRELIMINARY EXAMINATION
JC 2 2018

CANDIDATE NAME											
CENTRE NUMBER	S							INDEX NUMBER				
CLASS	C	G			/	1	7				

H1 BIOLOGY

Paper 2 Structured Questions

8876/02
Friday 24 August 2018
2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, Centre number, index number and class in the spaces at the top of the page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use			
Q1	/ 6	Q5	/ 8
Q2	/ 10	Q6	/ 7
Q3	/ 5	Q7 / 8	/ 15
Q4	/ 9		
Total			/ 60

This document consists of **16** printed pages.

Answer **all** the questions in this section.

1 Sugar molecules enter cells through transport proteins.

(a) Explain why transport proteins are required for the movement of sugar molecules, such as glucose and fructose, into cells. [2]

1. **Glucose and fructose are polar molecules.**

2. **They are unable to cross**
3. **the hydrophobic core of the phospholipid bilayer.**

4. **Transport proteins shield them from the hydrophobic core of plasma membrane (e.g. channel proteins provide a hydrophilic channel for their movement across the membrane).**

Some plant cells convert fructose and glucose into sucrose for transport from the leaves to the roots. Sucrose is moved into phloem sieve tubes as shown in Fig. 1.1.

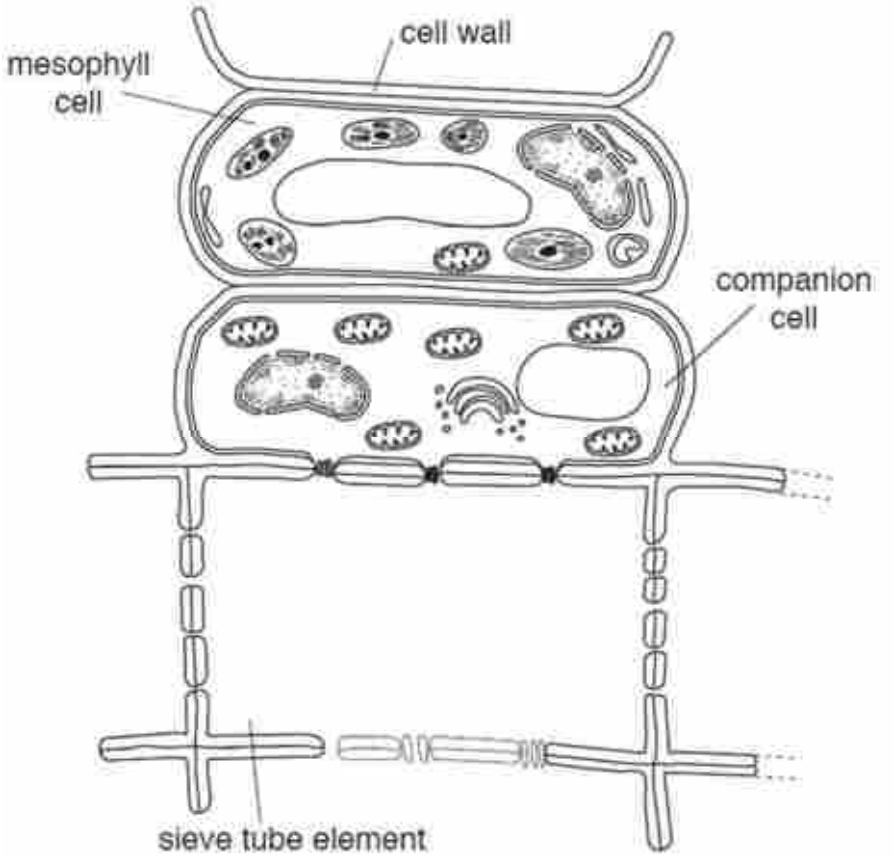


Fig. 1.1

Each cell has a specialized function.

(b) With reference to Fig. 1.1 and the information provided, state **one** difference between a mesophyll cell and companion cell. [1]

1. **Companion cells (6 mitochondria) have more mitochondria than mesophyll cells (1 mitochondrion). [1]**
   OR
   Mesophyll cells (5 chloroplasts) have chloroplasts whereas companion cells have none. [1]

Fig. 1.2 shows how sucrose is transported into the companion cell from the mesophyll cell.

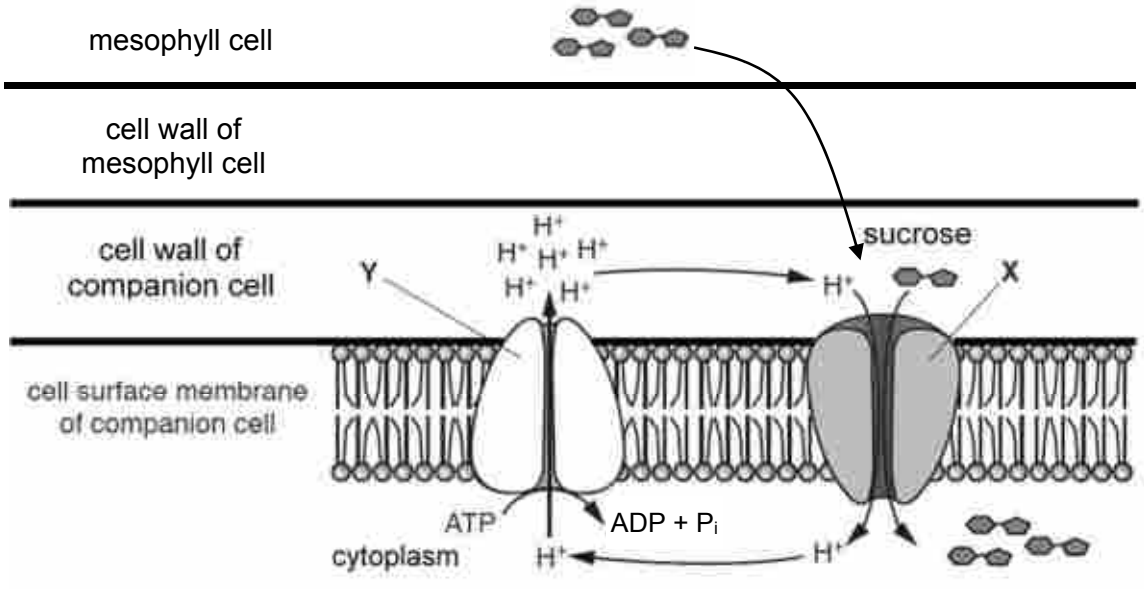


Fig. 1.2

(c) Using the information in Fig. 1.1 and Fig. 1.2, explain how sucrose moves into the companion cell. [3]

1. **Sucrose diffuses from mesophyll cell to the cell wall of companion cell.**

2. **Protons are actively pumped out from the cytoplasm of companion cell into its cell wall through carrier protein Y via active transport (hydrolysis of ATP). [1]**
   [Reject: Diffuse]

3. **Protons then diffuses from the cell wall of companion cells into the companion cell through transport protein X (cotransporter) via facilitated diffusion [1]**

4. **which is coupled with the transport of sucrose**
5. **against the sucrose concentration gradient.**

[Total: 6]

Extension Question
Plants vary greatly in terms of size.

(d) Explain whether the cell theory is applicable to plants. [2]

1. **Applicable.**
2. **Plants are living organisms, which are composed of (many, different plant) cells,**
3. **which are basic/ smallest unit of life.**

4. **All plant cells come from pre-existing plant cells via cell division (e.g. mitosis or meiosis).**

2 The yeast, *Saccharomyces cerevisiae*, is a single-celled, eukaryotic organism that is often used in the laboratory.

When yeast is mixed with a glucose solution, the yeast absorbs the glucose. Each molecule of glucose is then broken down into pyruvate molecules in exactly the same way as in any other eukaryotic organism.

(a) Outline the breakdown of glucose to pyruvate in this stage. [2]

Respiration Lecture Notes p.9, 10

1. **Glucose is broken to pyruvate during glycolysis.**

2. **Glucose is first phosphorylated to glucose-6-phosphate**
3. **which is (isomerized to fructose-6-phosphate and then phosphorylated to) converted to fructose-1,6-bisphophate**

4. **before being cleaved/ broken down into 2 three-carbon sugars (OR glyceraldehyde-3-phosphate and dihydroxyacetone phosphate),**
5. **which is then oxidised/ converted to form 2 molecules of pyruvate.**

Yeast cells sometimes carry out anaerobic respiration. Fig. 2.1 outlines the process of anaerobic respiration in yeast cells.

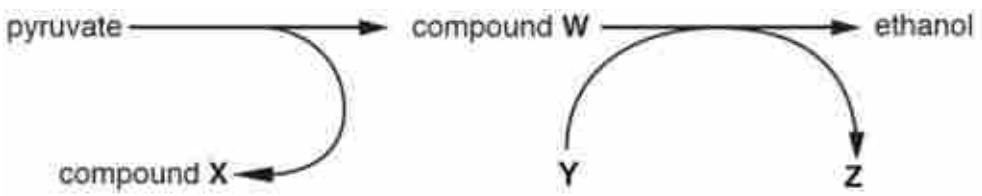


Fig. 2.1

(b) (i) Identify molecule **Z**. [1]

NAD or NAD^+

(ii) State why molecule **Y** is converted to **Z**. [1]

Respiration Lecture Notes p.26

1. **Regenerate NAD**
2. **required for glycolysis to continue.**

[Accept: Reduce compound W (ethanal) to ethanol]

Yeasts are often used in bread-making. The bread dough is kneaded to introduce and trap air so that the yeasts in the dough can respire aerobically. Besides carbon dioxide that is released during respiration, the evaporation of water or ethanol released during respiration also causes the dough to rise.

Table 2.1 shows the differences in the height of dough that was placed at different locations, after the dough was kneaded.

Table 2.1

Time / min	Height of dough / cm		
	Fridge	Room temperature	Next to window (hot day)
0	2.5	2.5	2.5
20	2.5	2.9	3.3
40	2.7	3.7	4.0
60	2.9	3.9	4.7
80	3.0	4.0	5.2
100	3.0	4.0	5.8
120	3.0	4.0	6.0

(c) (i) Account for the difference in the overall increase in the height of dough that was placed in the fridge with that placed next to the window. [4]

1. **The height of the dough when placed in the fridge (F) increases from 2.5 at 0 min to 3.0cm at 120 min**
   is LOWER than
   that when placed next to window (W) which increases from 2.5 to 6.0 cm. [1]

2. **The temperature of the dough in F is lower than that of W.**
3. **Hence, the kinetic energy of respiratory enzymes and substrates is lower.**
   [Accept: Enzymes are inactivated]

4. **The frequency of effective collisions between enzymes and substrates is lower**
5. **hence the rate of formation of enzyme-substrate complexes is lower.**

6. **The rate of respiratory enzyme activity / rate of respiration is lower.**
7. **and less carbon dioxide are released and less evaporation of water or ethanol, which causes the dough to rise less.**

(ii) Suggest why the increase in the height of dough that was placed at room temperature was higher between 0 and 40 minutes than between 40 minutes and 60 minutes. [2]

1. **The height of dough increases from 2.5 to 3.7cm between 0 and 40 min**
   is HIGHER than
   3.7 to 3.9cm between 40 and 60 minutes. [1]

WITH

2. **There are more oxygen between 0 and 40 min, hence the yeast undergoes aerobic respiration which releases more molecules of CO_2 (6 molecules of CO_2**

and 6 molecules of H_2O) than anaerobic respiration (2 molecules of CO_2 and 2 molecules of ethanol) from 40 minutes and 60 minutes. [1]

OR

There are more respiratory substrates at the start between 0 and 40 min, the rate of formation of enzyme-substrate complexes is higher, hence the rate of respiration is higher than between 40 minutes and 60 minutes. [1]

OR

From 40 minutes and 60 minutes, the yeast undergoes anaerobic respiration and high concentration of ethanol produced is toxic and kills the yeast. [1]

[Total: 10]

3 Fig. 3.1 shows the effect of increasing substrate concentration on the rate of a particular reaction in the presence and absence of an enzyme.

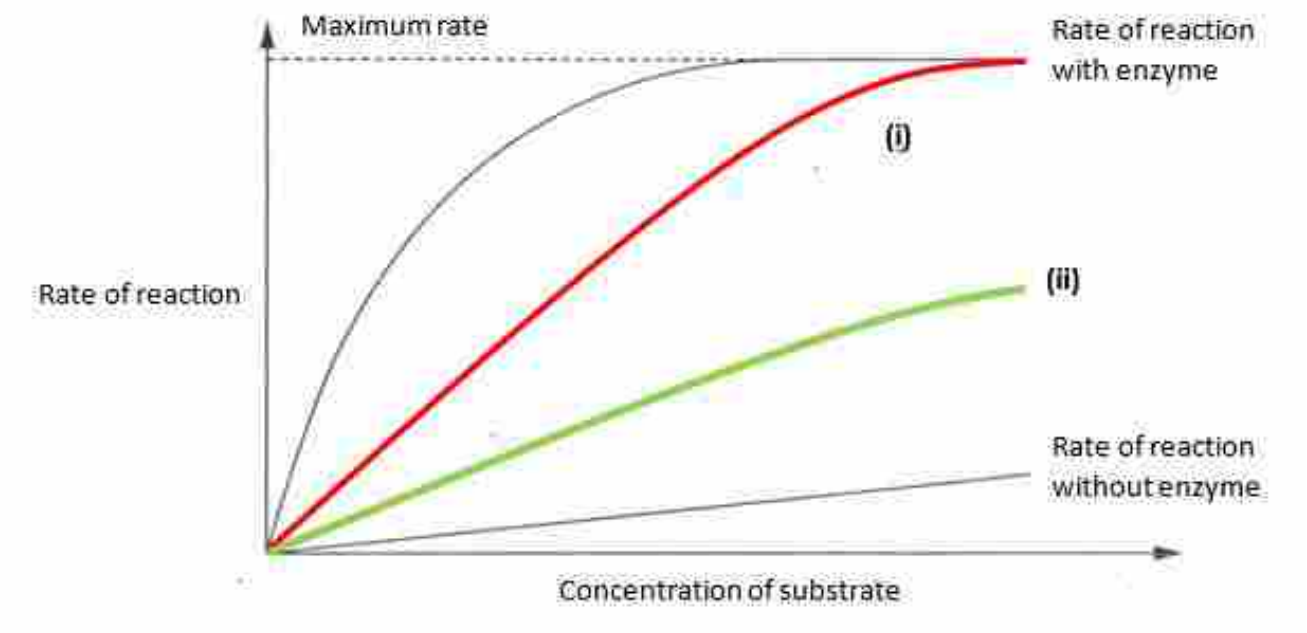


Fig. 3.1

(a) On Fig. 3.1, draw **two** labelled curves to show the effect on the rate of the enzyme catalysed reaction upon the addition of

(i) a competitive inhibitor;

(ii) a non-competitive inhibitor. [2]

(b) Explain the effect of a competitive inhibitor on the rate of enzyme activity. [3]

1. **Shape of inhibitor is similar in shape of substrate**
2. **Shape of inhibitor is complementary to the shape of active site**
3. **Competitive inhibitors compete with the substrate molecules for the active site and bind at the active site of the enzyme**
4. **blocking / prevents substrate molecules from binding to active site,**
5. **reducing**
   i. **number of enzyme-substrate complex formed per unit time**
   or
   ii. **rate of enzyme-substrate complex formation**
6. **thus decreasing rate of enzyme activity**

[Total: 5]

4 Table 4.1 shows some of the common fatty acids and their melting points.

Table 4.1

Symbol (number of carbon atoms : number of double bonds)	**Common Name**	**Melting point (ºC)**
Saturated fatty acids		
12 : 0	Lauric acid	44.2
14 : 0	Myristic acid	52
16 : 0	Palmitic acid	63.1
18 : 0	Stearic acid	69.6
20 : 0	Arachidic acid	75.4
22 : 0	Behenic acid	81
Unsaturated fatty acids		
16 : 1	Palmitoleic acid	-0.5
18 : 1	Oleic acid	13.4
18 : 2	Linoleic acid	-9
18 : 3	α-linolenic acid	-17
20 : 4	Arachnidonic acid	-49.5

(a) Arachidonic acid is a polyunsaturated fatty acid.

Explain the term *polyunsaturated fatty acid.* [1]

- **A fatty acid with many C=C double bonds.**
  Reject : many kinks

(b) With reference to Table 4.1,

(i) describe the effect of increasing number of carbon atoms in saturated fatty acids on the melting point; [3]

1. **As the number of carbon atoms increased 12 to 22, the melting point increased from 44.2 to 81 °C.**

2. **An initial increase of every 2 carbon atoms from 12 to 18 leads to a sharp increase in the melting point from 44.2 to 69.6 °C.**
3. **Further increase of every 2 cabon atoms from 18 to 22 lead to a lesser increase in melting point from 69.6 to 81°C.**
4. **As the number of carbon atoms increases, the melting point increases.**

(ii) describe the effect of the presence of double bonds in fatty acids on the melting point; [1]

1. **As the number of double bonds increases, the melting point decreases.**

2. **As the number of double bonds increased from 1 (in oleic acid) to 3 (in α-linolenic acid), the melting point decreased from 13.4 to -17 °C.**

(iii) explain the trend described in **b(ii)**. [4]

1. **Presence of double bonds results in the fatty acid molecules being bent/ kinked.**

2. **This means that the molecules cannot be closely packed together / less contact between molecules,**

3. **resulting in weaker hydrophobic interactions.**

4. **Therefore, less energy required to overcome the hydrophobic interactions / separate the fatty acid molecules during melting, resulting in the decrease in melting point.**

[Total: 9]

5 Table 5.1 provides statements regarding the bonds found in four biological molecules.

Table 5.1

statement	protein	DNA	messenger RNA	cellulose
hydrogen bonds stabilise the molecule	✓	✓	×	✓
subunits are joined by peptide bonds	✓	×	×	×

(a) Complete Table 5.1 by indicating with a tick (✓) or a cross (×) whether the statements apply to proteins, DNA, messenger RNA and cellulose.

You should put a tick or a cross in each box of the table. [2]

(b) A piece of mRNA is 660 nucleotides long but the DNA coding strand from which it was transcribed is 870 nucleotides long.

(i) Explain this difference in number of nucleotides. [1]

- **Introns present in DNA**
- **Introns absent in mRNA**

OR

- **introns removed by RNA splicing**

(ii) What is the maximum number of amino acids in the protein translated from this piece of mRNA? Explain your answer. [2]

Number of amino acids **220 OR 219**
Explanation

1. **3 bases code** for **1 amino acids**

(c) Identify **one** other process that leads to the formation of mature mRNA and state its function. [2]

1. Addition of 5' cap

[Significance]

2. **facilitate the binding of** Translation Initiation Factors and **small ribosomal subunit** for translation to occur.
OR
2. **facilitate the export of mature mRNA** from nucleus to cytoplasm for translation
OR
2. **protect the mature mRNA from degradation** by RNase in the cytoplasm

OR

1. Addition of 3' poly-A tail or 3' polyadenylation

[Significance]

2. **facilitate the export of mature mRNA** from nucleus to cytoplasm for translation
OR
3. **protect the mature mRNA from degradation** by RNase in the cytoplasm

(d) Describe **one** difference between the structure of mRNA and tRNA. [1]

Any one:

1. **mRNA** has **no base-pairing within** its **structure** while **tRNA** has **base-pairing between** regions to **fold back on itself**.
2. **mRNA** has **3' poly-A tail** while **tRNA** has **3' CCA end**.
3. **mRNA** does **not** have **hydrogen bonds** different regions of the single strand while **tRNA** has **hydrogen bonds** at different regions which cause it to **fold back on itself**.
4. **mRNA** is **linear** while **tRNA** **cloverleaf** shape;
5. **mRNA** has **no binding site for amino acids** while tRNA has.
6. **mRNA** **longer**/larger/more nucleotides than tRNA
7. **Mrna** **different** for **each gene**/many kinds, **only few/**20/64 **kinds of tRNA**;

6 The evolutionary origin of the four-legged amphibians (such as frogs and toads) from fish has been the subject of much debate for many years.

Among living fish, the rarely-caught coelacanth and the lungfish are thought to be most closely related to these amphibians.

Samples of blood were taken from two coelacanths that were captured recently near Comoros.

The amino acid sequences of the α and β chains of coelacanth and lungfish haemoglobin were compared with the known sequences of amphibian adults and their aquatic larvae (tadpoles).

Organisms with more matches in the amino acid sequence of a polypeptide chain share a more recent common ancestor than those with fewer matches.

The comparisons with three species of amphibians, *Xenopus laevis* (Xl), *X. tropicana* (Xt) and *Rana catesbeiana* (Rc) are shown in Table 6.1.

Table 6.1

		percentage of matches of amino acid sequence					
		species of amphibian adults			**species of amphibian larvae (tadpoles)**		
	fish species	*Xl*	*Xt*	*Rc*	*Xl*	*Xt*	*Rc*
α chains	coelacanth	42.0	47.5	no data	45.4	42.6	48.2
	lungfish	40.4	42.1	no data	40.7	39.0	37.9
β chains	coelacanth	42.1	43.2	40.7	52.1	52.1	58.2
	lungfish	44.1	45.9	41.4	47.3	45.9	48.6

(a) Explain whether or not the information in Table 6.1 supports the suggestion that coelacanths and amphibians share a more recent common ancestor than do lungfish and amphibians. [4]

1. **Data largely support that coelacanth and amphibians share a more recent common ancestor. [1]**

2. **The α chain of all 3 species of ADULT amphibians have a higher match with that of coelacanth (42 and 47.5) than lungfish (40.4 and 42.1). [1]**

3. **The α chain of all 3 species of LARVAL amphibians also have a higher match with that of coelacanth (45.4, 42.6 and 48.2) than lungfish (40.7, 39.0 and 37.9). [1]**

4. **Only the β chain of all 3 species of LARVAL amphibians (rather than adults) have a higher match with that of coelacanth (52.1, 52.1 and 58.2) than lungfish (47.3, 45.9 and 48.6). [1]**

(b) Coelacanth haemoglobin has a very high affinity for oxygen, suggesting that coelacanths, which have been captured at depths of between 200 m and 400 m, live in water that has a low concentration of oxygen.

Explain how an environmental factor, such as the low concentration of oxygen in deep water, can act as an evolutionary force in natural selection. [3]

1. **Low oxygen concentration acts as selection pressure.**

2. **Individuals with haemoglobin with a higher affinity to oxygen are better adapted to low oxygen concentration are at selective advantage.**

3. **They survive to reproductive age to produce viable and fertile offspring,**
4. **hence passing their favourable alleles to their offspring.**

5. **This leads to an increase in frequency of favourable alleles in population, leading to more individuals with adaptation for low oxygen concentration.**

6. **Directional selection occurred.**

[Total: 7]

End of Section A

2018 PRELIMINARY EXAMINATION

H1 BIOLOGY PAPER 2 [SECTION B]:

Essay Question

Name: _____

Civics Group: _____/17

For Examiner's Use	
Q7 / 8	**/ 15**

Section B

Answer **one** question.
Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must set out in sections **(a)**, **(b)** etc., as indicated in the question.

EITHER

7 **(a)** Discuss the suggestion that all living organisms on earth depend on nitrogen. [6]

1 mark EACH

[Proteins/ Enzymes] **[Prot]**

1. **Amino group (containing N) of amino acid → Form peptide bond to form polypeptides / proteins → metabolic processes (e.g. enzymes for respiration)**

[Haemoglobin] **[Hb]**

2. **Nitrogen in porphyrin ring of haem in haemoglobin → Take up and release oxygen**

[Phospholipid] **[PL]**

3. **Nitrogen in choline bonded to phosphate head of phospholipid → Maintain cell structure / facilitate cell signaling / transport across membrane**

[Nucleotides and nucleic acids] **[NRep]**

4. **Nitrogenous bases in DNA (e.g. Adenine, Guanine, Cytosine, Thymine) → Stability of DNA structure via complementary base pairing**

5. **Nitrogenous bases in DNA (e.g. Adenine, Guanine, Cytosine, Thymine) → Hereditary material that is passed on to the offspring / Act as template for synthesis of daughter strands via complementary base pairing**

[Nucleotides and nucleic acids] **[DNA/ RNA-Transc/ RNA-Transl]**

6. **Nitrogenous bases in DNA (e.g. Adenine, Guanine, Cytosine, Thymine) → Store genetic information / Act as template for the synthesis of mRNA via complementary base pairing during transcription.**

   OR

7. **Nitrogenous bases in RNA (e.g. Adenine, Guanine, Cytosine, Uracil) → Act as template → Form complementary base pairing between codon of mRNA and anticodon of tRNA during translation.**

[Respiration / Cellular activities: ATP] **[ATP]**

8. Nitrogen is found in structure of ATP → Hydrolysis of high-energy bonds of ATP to provide energy for cellular/ metabolic activities
[Reject: Produce energy]

[Accept: Other roles of ATP: Phosphorylation of glucose / fructose-6-phosphate for glycolysis; Involvement in Calvin cycle; Amino acid activation]

[Respiration: NAD/ FAD] [NAD/ FAD]

9. Nitrogen is found in structure of NAD → Electron carrier in glycolysis, link reaction and Krebs cycle → Donate electrons and protons for oxidative phosphorylation to synthesize ATP

10. Nitrogen is found in structure of FAD → Electron carrier in Krebs cycle → Donate electrons and protons for oxidative phosphorylation to synthesize ATP.

[Respiration: $NADP^+$] [$NADP^+$]

11. Nitrogen is found in structure of $NADP^+$ → Final electron acceptor of non-cyclic photophosphorylation to form NADPH → Reduce glycerate-3-phosphate to glyceraldehyde-3-phosphate in Calvin cycle

[Photosynthesis: Chlorophyll] [Chl]

12. Nitrogen is found in structure of chlorophyll → Photosynthetic pigments that harvest light energy during photophosphorylation to produce ATP and NADPH for Calvin cycle to occur.

[Respiration: GTP] [GTP]

13. Nitrogen is found in structure of GTP → Product of substrate-level phosphorylation in Krebs cycle before conversion to form ATP

[Accept: Other roles of GTP: Translocation of ribosomes during translation]

[QWC] [QWC]

14. Paragraphing + At least 2 different biomolecules mentioned

(b) Discuss the extent to which mitosis and the different types of stem cells can account for the principles behind the cell theory in humans, from one generation to the next. [9]

[Cell Theory] [CT]

1. All living organisms are made up of cells.
2. Cell forms basic unit of life.
3. All cells come from pre-existing cells via mitosis.

4. New cells arise from stem cells.

[From parental cell to daughter cells within individual and description of stem cells in terms of contribution to cell theory]

[F]

5. In humans, life started from the fusion of gametes to form a zygote during fertilisation. [1]

[TSC]

6. Zygotic stem cells are totipotent which can give rise to all cell types. [1]

[PSC]

7. Embryonic stem cells are pluripotent stem cells give rise to almost all cell types. Inner cell mass (ICM) forms all different cells and tissues of human body. [1]

[MSC]

8. Multipotent stem cells (e.g. blood stem cells) give rise to a limited range of cell types. [1]

[From one parental generation of organism to the next generation] [M]

9. From one generation to the next, gametes are produced by meiosis. [1]

[Comment on extent] [C]

10. Stem cells and mitosis account for cell theory within organisms but not from one generation to the next (meiosis and fertilization). [1]

[QWC] [QWC]

11. Paragraphing + Explains cell theory + Explain potency of stem cells + Comment [1]

OR

8 (a) Discuss possible impact of global warming on geographical patterns of distribution of mosquito-borne diseases. [6]

1 mark EACH:

[Example of disease] [E]

1. Increase in mosquito-borne diseases (e.g. dengue) in Singapore.

[Geographic distribution: Range] [R]

2. Global warming will result in increase in range in terms of latitude (geographical location), e.g. spread from equator to subtropical regions (e.g. Europe)

[Geographic distribution: Altitude] [A]

3. and altitude (elevation) from plains to hills (e.g. Nepal)

[Impact: Increased temperature on mosquitoes' survival] [MS, DT]

4. Increased temperature (up till 32°C) increases the survival and reproduction of the mosquito,
5. and the female mosquitoes bite more often, increasing the transmission of dengue.

[Impact: Increased temperature on viral replication] [VR]

6. Increased temperature may negatively affect the reproductive cycle of dengue virus, as viral enzymes may be denatured, hence reducing the number of dengue virus and decreasing the transmission of dengue.

[Impact: Increased rainfall on breeding grounds] [BG]

7. Increased rainfall may result in more stagnant water and increases the number of breeding habitats for mosquitoes.

[QWC] [QWC]

8. Paragraphing + Explains geographical changes based on reasoning linked to 2 aspects of climate change (temperature and rainfall) [1]

[Accept: Other trends with justified claims]

(b) DNA molecules are replicated with a high degree of accuracy yet not always perfectly.

[9]

Describe how this occurs and discuss why the survival of a species depends on DNA molecules being stable, yet not *absolutely* stable.

1 mark EACH:

[High degree of accuracy: Complementary base pairing] [SCR, CBP]

1. **During semi-conservative DNA replication, each parental strand acts as a template for the synthesis of daughter strand.**

2. **Complementary base pairing occurs between nucleotides of template strand and free nucleotides.**

3. **DNA polymerase proofreads the newly synthesized daughter strand (replace incorrectly paired deoxyribonucleotides) / DNA repair occurs to replace damaged DNA strands/ OWTTE.**

[High degree of accuracy: Importance of genetic stability] [GI]

4. **This ensures that daughter cells (NOT strands) have genetically identical DNA as parental cell for growth and development of a multicellular organism/ replacement of worn-out parts of the body/ asexual reproduction.**

[Imperfect accuracy: Mutation] [M, ME]

5. **Errors in proofreading/ DNA repair mechanisms can result in mutation,**
6. **(e.g. insertion, deletion, substitution) whereby sequence of nucleotides in a gene is changed.**

[Imperfect accuracy: Disease] [D]

7. **This may result in diseases (e.g. cancer), or genetic disease that threatens the survival of the organism.**
   E.g. Sickle cell anaemia caused by a single nucleotide substitution (T→A), which results in mutant haemoglobin and sickle-shaped red blood cells that results in the less efficient transport of oxygen which may reduce the survivability of the individual.

[Imperfect accuracy: Genetic variation] [NA]

8. **Gene mutation results in the formation of new alleles / is the ONLY source of new alleles, thus increasing the gene pool (genetic variation) and results in new phenotypes.**

[Imperfect accuracy: Impacts of genetic variation on natural selection] [E]

9. **Genetic variation (diversity) within a population is crucial to the survival of species especially when there is a change in the environment/ selection pressure/ allows them to best adapt to the environment.**
   OR
   Individuals that have the favourable alleles are at selective advantage and they are selected for, thus they are more likely to survive and reproduce to produce more viable and fertile offspring, thus passing their favourable alleles to their offspring.

[Conclusion] [C]

10. **Hence, the continuity of a species and its continued evolution relies on a balance between accurate transmission of nucleotide sequences to the offspring and variation needed to allow continued evolution of the species such that it does not lead to death, thus allowing the species to respond to environmental changes/ OWTTE.**

[QWC] [QWC]

11. Paragraphing + Covers all requirements of questions (i.e. describe and explain stability and instability of DNA) + Explain how it affects survival of species

Civics Group	Index Number	Name (use BLOCK LETTERS)

H1

ST ANDREW'S JUNIOR COLLEGE
2018 JC2 Prelims

H1 BIOLOGY **8876/01**

Paper 1: Multiple Choice

Tuesday 18th Sept 2018 1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser (not supplied)
Soft pencil (type B or HB is recommended, not supplied)

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, civics group and index number on the multiple choice answer sheet in the spaces provided.

There are **30** questions in this paper. Answer all questions. For each question, there are four possible answers, A, B, C and D.

Choose the one you consider correct and record your choice in soft pencil on the separate multiple choice answer sheet.

INFORMATION TO CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for wrong answer. Any rough working should be done in this booklet.

At the end of the examination, submit the multiple choice answer sheet and question paper separately.

This document consists of **18** printed pages.

[Turn over

1 The figure below shows the structure of an animal cell.

Which of the following correctly identifies the functions of the labelled structures?

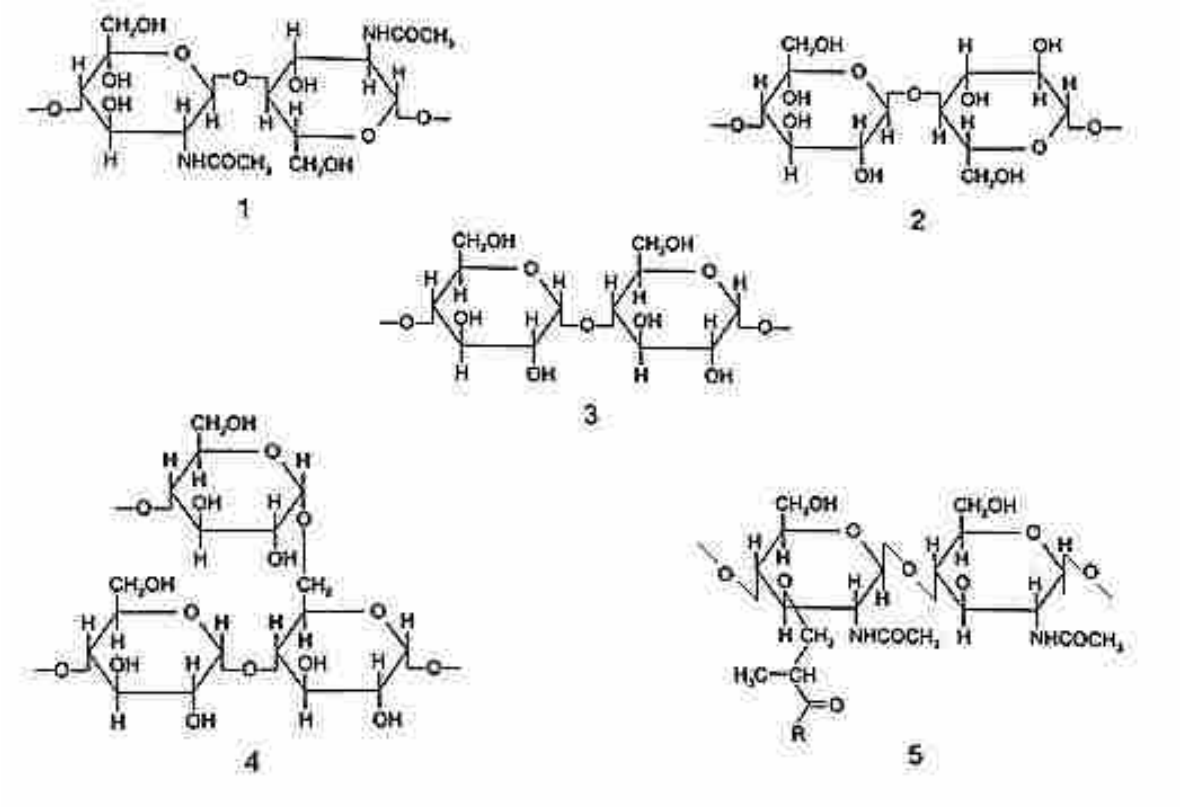
	Synthesising polypeptides from amino acids	Transporting proteins	Carrying out glycosylation	Secreting digestive enzymes
A	2	1	4	3
B	1	4	2	3
C	2	3	4	1
D	1	3	2	4

2 Nucleases are enzymes that hydrolyze phosphodiester bonds. In which of the following cell organelle(s) would one expect to see activity of this enzyme?

1 rough endoplasmic reticulum
2 mitochondrion
3 chloroplast
4 Golgi apparatus

A 1 only
B 1 and 4 only
C 2 and 3 only
D 1, 2 and 3 only

3 The diagrams show short sections of some common polysaccharides and modified polysaccharides.



The polysaccharides can be described as below.

- Polysaccharide **F** is composed of β-glucose monomers with 1,4 glycosidic bonds.
- Polysaccharide **G** is composed of α-glucose monomers with 1,4 and 1,6 glycosidic bonds.
- Polysaccharide **H** is composed of N-acetylglucosamine and N-acetylmuramic acid monomers with β-1,4 glycosidic bonds.
- Polysaccharide **J** is composed of α-glucose monomers with 1,4 glycosidic bonds.
- Polysaccharide **K** is composed of N-acetylglucosamine monomers with β-1,4 glycosidic bonds.

Which shows the correct pairings of polysaccharide descriptions and diagrams?

	Polysaccharide				
	F	**G**	**H**	**J**	**K**
A	2	4	5	3	1
B	2	5	4	1	3
C	3	4	1	2	5
D	3	5	4	1	2

4 Which statement is true for phospholipid, but **not** for protein?

A Its molecules have hydrophilic and hydrophobic components.
B Its molecules are synthesized from non-identical sub-units.
C It is a barrier to polar molecules.
D It is found in cell membranes.

5 With reference to carrier proteins, which of the following statements is/are true for all carrier proteins?

1 They contain binding sites for specific molecules or ions.
2 They directly require ATP to transport substances across the membrane.
3 They are soluble globular proteins.
4 They are embedded in membranes.

A 1 only
B 1 and 4
C 3 and 4
D 1, 2 and 4

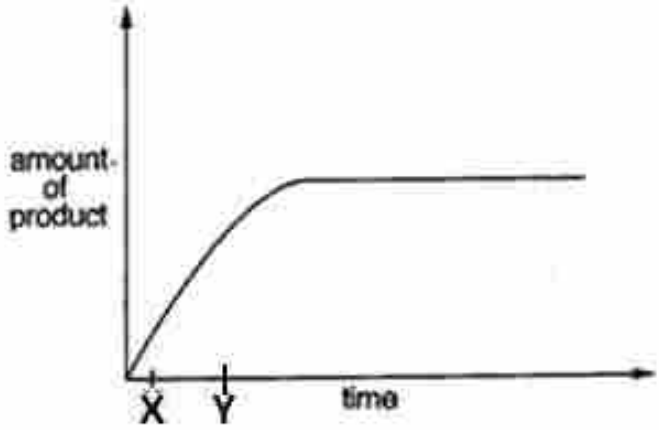
6 The list shows three characteristics of enzyme activity.

1 Reaction rate decreases if the concentration of non-competitive inhibitor increases.
2 Reaction rate is reduced at extremes of pH.
3 Reaction rate is reduced at low temperature.

What explains each of these characteristics?

	Availability of active sites is reduced	**Reduced kinetic energy reduces the rate of molecular collisions**	**Hydrogen bonding is disrupted**
A	1	2	3
B	2	1	3
C	1	3	2
D	2	3	1

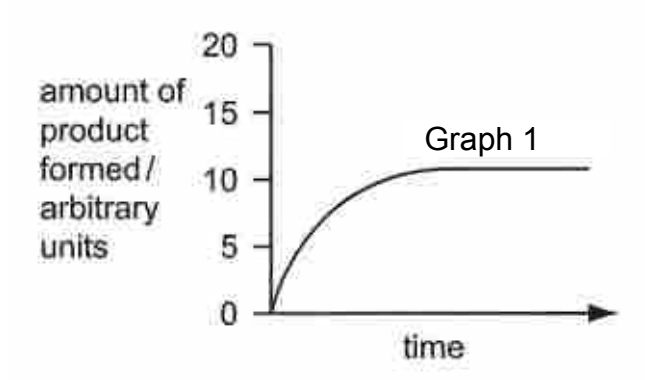
7 The graph below shows the amount of product formed in an enzyme-catalysed reaction over a certain period of time at 37°C.



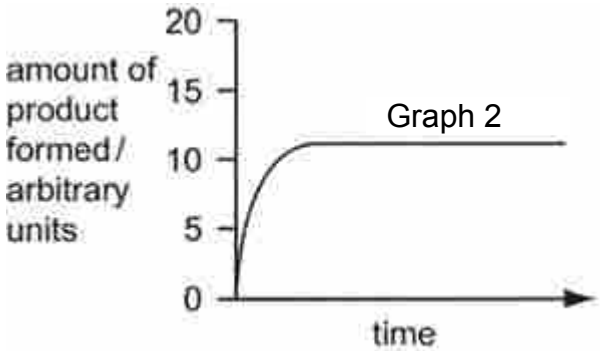
What is true at time **X**?

A Most enzyme molecules will have free active sites.
B The number of unreacted substrate molecules is high.
C The number of enzyme-substrate complexes is low.
D The rate of enzymatic reaction is lower than at time **Y**.

8 Graph 1 below shows the amount of product formed by a standard concentration of salivary enzymes and a standard concentration of substrate at a temperature of 15°C and pH of 7.



A change in condition(s) results in Graph 2.

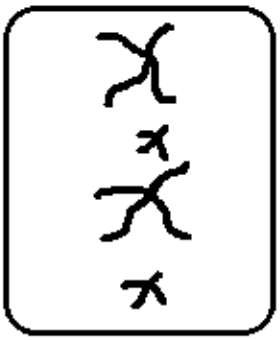


Which of the following conditions can best explain Graph 2?

1 Doubling of substrate concentration
2 Doubling of enzyme concentration
3 Increasing temperature to 20°C
4 Decreasing pH to 2

A 1 and 2
B 1 and 3
C 2 and 3
D 3 and 4

9 The diagram below shows metaphase of mitosis in a cell of an organism.



Each homologous pair of chromosomes in this organism contains 4 gene loci. This organism was genotyped and found to be heterozygous at all gene loci. The organism reproduces sexually via the production of millions of gametes by meiosis.

What is the maximum possible number of genetically different gametes that can be produced by this organism, assuming crossing over does not occur during meiosis in all cells?

A 2
B 4
C 16
D 256

10 Hybrid species can be produced from cabbage and radish.
The table below shows the chromosome numbers in the parental species and the hybrids.

type of cell	number of chromosomes per cell
parental cabbage	18
parental radish	18
parental gametes	9
F1 hybrids	18
F1 gametes	9
F2 hybrids	18
F2 gametes	18
F3 hybrids	36

Chromosomal mutation occurred at one stage. At which stage did it occur?

A during the formation of the F1 gametes.
B during the formation of the F2 gametes.
C during the fusion of the parental gametes.
D during the fusion of the F1 gametes.

11 3 different polynucleotide molecules (X, Y and Z) were isolated from a eukaryotic cell. One of them is a double-stranded DNA gene, while the other two are the pre-mRNA and mature mRNA that the DNA gene codes for.

The adenine nucleotide content of all 3 molecules was examined and shown in the table below:

Molecule	Percentage of adenine nucleotides in the molecule / %
X	49
Y	52
Z	53

Based on the information given, which of the following conclusions is/are valid and true?

1 X is definitely the DNA gene.
2 Z is definitely the mature mRNA.
3 The pre-mRNA molecule has more uracil than guanine in it.
4 Y has more purine nucleotides than pyrimidine nucleotides in it.

A 1 and 2
B 1, 2 and 4
C 2, 3 and 4
D 1, 3 and 4

12 Which of the following order of steps is true for transcription?

1 RNA polymerase II binds to promoter
2 Primase adds a RNA primer to the 3' end of template strand
3 General transcription factors recognize and bind to TATA box of promoter
4 DNA polymerase III adds complementary deoxyribonucleotides to the 3' end of the growing DNA chain
5 RNA polymerase II transcribes a DNA sequence which codes for a polyadenylation signal (AAUAAA) in the RNA transcript
6 RNA polymerase II transcribes a stop codon
7 RNA polymerase II adds complementary ribonucleotides to the 3' end of the growing RNA chain
8 DNA polymerase III binds to promoter
9 Primer is hydrolyzed and replaced by deoxyribonucleotides

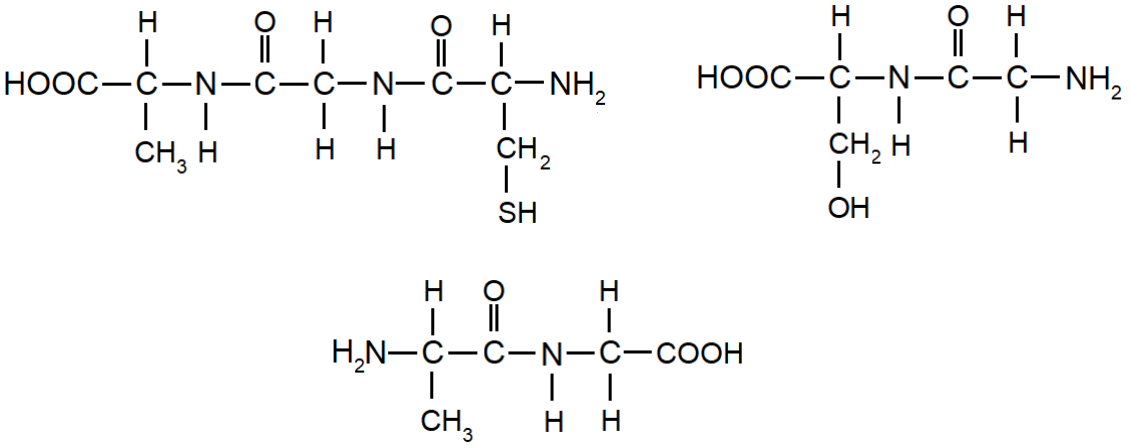
A 2, 1, 7, 5
B 2, 8, 4, 9
C 3, 1, 7, 5
D 3, 1, 7, 6

13 In an experiment, polypeptide A, which is coded for by a non-mutated version of a prokaryotic gene, was cleaved by a particular protease.

The cleavage produced 2 fragments, one of which contains the C-terminus of polypeptide A and is 5 amino acids long. This 5-amino-acid-long fragment, now called Peptide B, was then isolated for further investigation.

A solution containing many molecules of Peptide B was treated with another protease, called Protease X. The solution was analysed after the treatment and was found to contain various different fragments of different lengths and sequences.

The structures of 3 of these fragments are shown below:



It is known that Protease X is able to cleave any peptide bonds within the molecule of Peptide B. However, the cleavage of all peptide bonds within a single molecule is rare.

The mRNA codons involved in the synthesis of the Peptide B portion of Polypeptide A are shown below:

Amino acid	R group	mRNA codon
Glycine	H	5’ – GGC – 3’
Alanine	CH_3	5’ – GCC – 3’
Serine	CH_2OH	5’ – UCC – 3’
Cysteine	CH_2SH	5’ – UGU – 3’

Which of the following correctly shows a single point mutation in the portion of the template DNA sequence that codes for Peptide B, leading to a single amino acid substitution?

A 5’ – GGA GCC GCC GCC ACA – 3’
B 5’ – GCC GGA ACA GCC GCC – 3’
C 5’ – GCC GCC ACA GGA GCC – 3’
D 5’ – ACA GCC GCC GCC GGA – 3’

14 Translation did not occur successfully in a eukaryotic organism. Analysis of the structures in the cell revealed the following:

Structure	Presence (√) / Absence (X)
Free floating aminoacyl-tRNAs	√
Initiator tRNA- small ribosomal subunit complex	√
Initiator tRNA (base-pairing with AUG codon) in the P-site of large ribosomal subunit	√
Second aminoacyl-tRNA in the A-site of large ribosomal subunit	√
Polypeptide chain	X

Which is the most probable explanation for these observations?

A peptidyl-transferase is not functioning properly
B aminoacyl tRNA synthetases fail to attach amino acids to tRNA
C there is an error in the scanning for the start codon by tRNA-small ribosomal subunit complex
D release factor fails to hydrolyze polypeptide chain from the tRNA

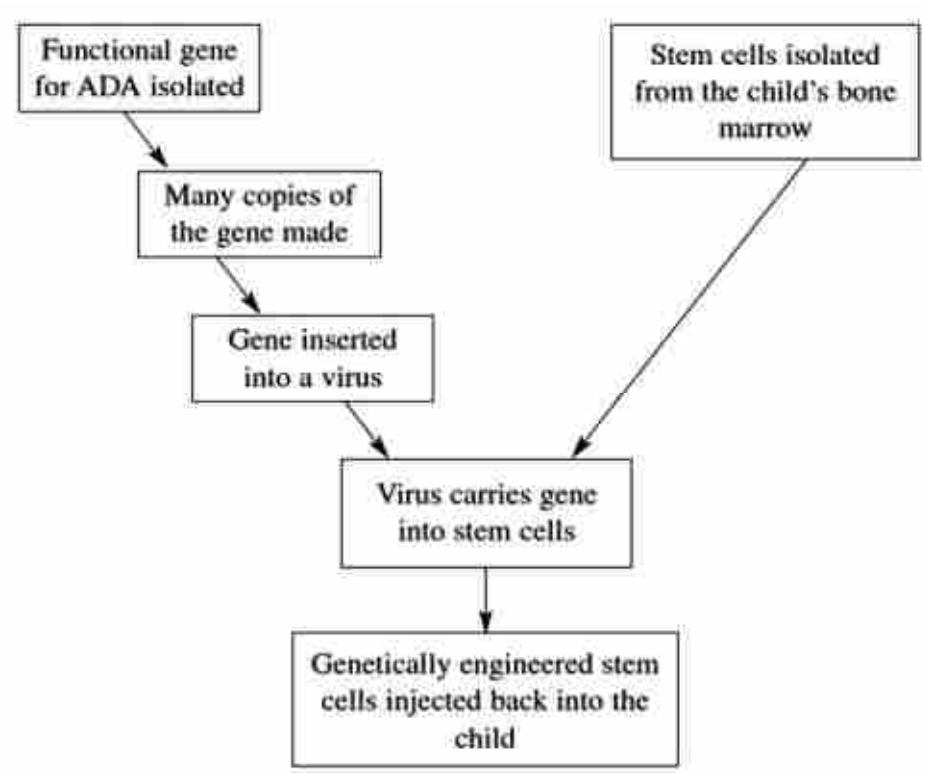
15 Which is a correct statement about obtaining human embryonic stem cells for research?

1 Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.
2 The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.
3 The cells must be removed immediately following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.
4 The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

A 2 only
B 1 and 2
C 2 and 3
D 3 and 4

16 Children with severe combined immunodeficiency disorder (SCID) cannot produce the many types of white blood cells that fight infections. This is because they do not have the functional gene to make the enzyme ADA. Some children with SCID have been treated with stem cells.

The treatment used with the children is described in the flowchart.



Which of the following explains why stem cells can be used in the treatment of SCID?

1 They can divide mitotically to replace existing cells.
2 Due to their pluripotent nature, they have the ability to form only certain types of white blood cells that restores the ability to fight infection.
3 As the stem cells are from the child's own cells, there is no/little risk of rejection.
4 They possess a unique set of genome to allow for multipotency.

A 1 and 2
B 1 and 3
C 2 and 4
D 3 and 4

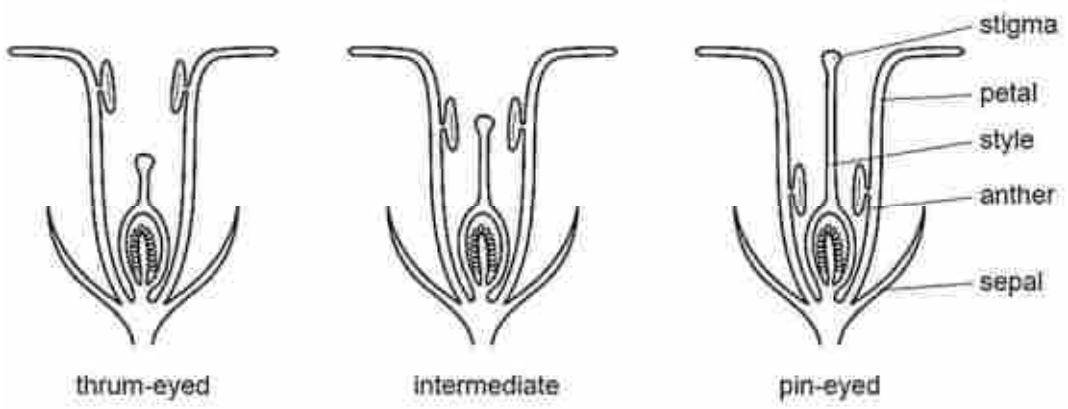
17 The primrose, *Primula vulgaris*, is a small herbaceous, yellow-flowered plant which is common in cooler areas of the Northern hemisphere including alpine and Arctic areas.

The flowers of the primrose have different flower shapes (polymorphic), which are adaptations for pollination. 'Thrum-eyed' primroses have a short style. 'Pin-eyed' primroses have much longer styles. The anther position also varies among the primrose.

Some populations of primrose consist almost entirely of plants with intermediate flowers. These populations are common where there are fewer winged insects.

Anthers produce pollen (male gametes) which land on the stigma, leading to fertilization.

The diagrams show polymorphic flowers of primroses.



Which statements are correct?

1 Cross-pollination will be favoured between pin-eyed and thrum-eyed primroses.
2 Primroses with pin-eyed flowers are likely to show more genetic diversity than primroses with intermediate flowers.
3 Primroses with thrum-eyed flowers are likely to be more able to adapt to changing environmental conditions than pin-eyed primroses.
4 Self-pollination is more likely to occur in primroses with intermediate flowers.

A 1 and 2
B 3 and 4
C 1, 2 and 4
D All of the above

18 On the tiny Lord Howe Island, 600 miles east of Australia, there are two species of palm which seem, from DNA analysis, to be descended from one original species. Factors involved in this speciation on this tiny island include:

1 linkage of genes for soil tolerance and flowering time
2 variation in flowering time
3 variation of soil tolerance
4 variation of soil types on the island

What is the correct sequence to explain this speciation?

A $1 \rightarrow 2 \rightarrow 3 \rightarrow 4$
B $2 \rightarrow 1 \rightarrow 4 \rightarrow 3$
C $3 \rightarrow 4 \rightarrow 1 \rightarrow 2$
D $4 \rightarrow 3 \rightarrow 2 \rightarrow 1$

19 A large population of equal numbers of dark and light mice was released into an area where owls are predators of mice. Because of predation, only 25 % of these mice survived and selective killing by owls changed the proportions of dark to light mice from 1:1 to 4:1.

If mice produce an average of eight offspring per litter and the pattern of predation remains the same, what would happen to the population of light mice?

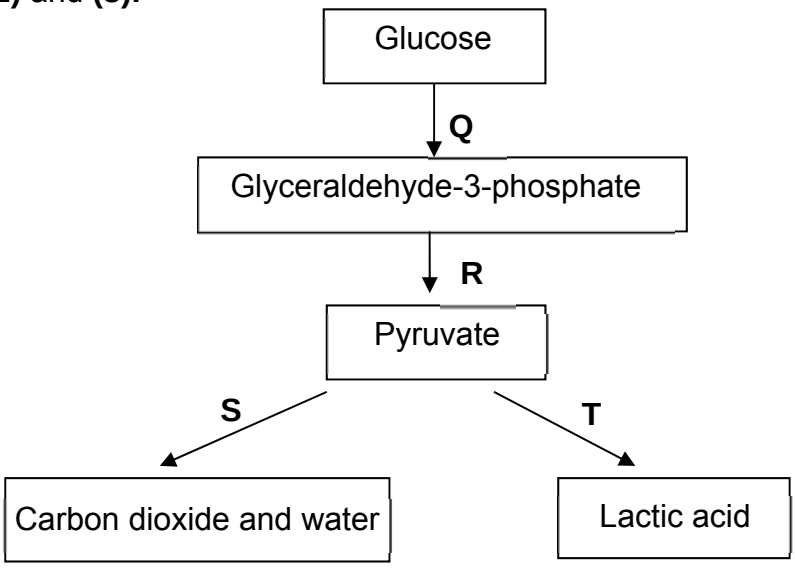
A They disappear after one further generation.
B They disappear after two further generations.
C They remain at the level of one fifth of the population.
D They will be reduced to a constant but very low frequency.

20 The frequency of recessive alleles in population is influenced by selection pressure.

Which row shows the conditions in which recessive alleles are retained in a population?

	Environmental variation of habitats	Heterozygote advantage	No selective advantage	Polymorphism (many phenotypes)
A	✓	✓	✓	✓
B	✓	×	×	✓
C	×	✓	×	×
D	×	×	✓	×

21 With reference to the diagram below, relate processes **Q, R, S, T** to statements **(1), (2)** and **(3).**



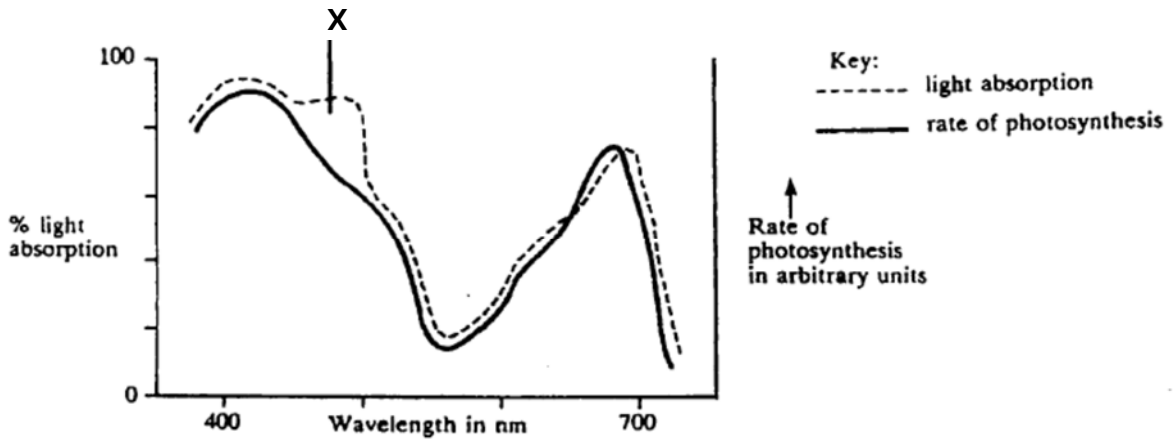
(1) NAD is regenerated without the use of the electron transport system
(2) ATP is synthesised via substrate level phosphorylation
(3) It can take place under anaerobic conditions.

	(1)	**(2)**	**(3)**
A	T only	R only	Q,R,T only
B	T only	R,S only	Q,R,T only
C	S,T only	R only	Q,R,S,T
D	S,T only	R,S only	Q,R,S,T

22 A major function of the mitochondrial inner membrane is the conversion of energy from electrons to the stored energy of the phosphate bond in ATP. To accomplish this function, this membrane must have all of the following features except

A high permeability to protons.
B integral, transverse ATP synthase.
C proteins to accept electrons from NADH.
D proton pumps embedded in the membrane.

23 The graph below shows the effect of different wavelengths of light on the rate of photosynthesis and on the amount of light absorbed by the pigments in a green seaweed.



The difference between the two curves at X is due to

A inefficient trapping of light energy by the chlorophyll
B no ATP production at that wavelength
C oxygen given off during photosynthesis interferes with the absorption of light.
D carotenes absorbing light that is not used in photosynthesis.

24 The incidence of primaquine sensitivity in a population is 14% in men and 2% in women. A proportion of the remaining women, but not the men, exhibit mild sensitivity.

What does this suggest about the inheritance of this defect?

A autosomal, codominant
B autosomal, recessive
C sex-linked, codominant
D sex-linked, recessive

25 In a series of plant breeding experiments, a pure-breeding plant with big and hairy leaves was crossed with a pure-breeding plant with small and hair-less leaves. The leaves in the F_1 generation were all big and hairy. Self-fertilisation of the F_1 generation produced the following results:

905	big and hairy leaves
301	big and hair-less leaves
305	small and hairy leaves
98	small and hair-less leaves

An F_2 plant with big and hairy leaves was crossed with an F_2 plant with small and hairy leaves. What is the maximum proportion of plants with small and hair-less leaves that could have appeared in the resulting progeny?

A 0%
B 12.5%
C 25%
D 50%

26 Fruit flies *Drosophila* homozygous for long wings, were crossed with flies homozygous for vestigial wings. The F_1 and F_2 generations were raised at three different temperatures.

At each temperature, the F_1 generation all had long wings.

The table below shows the results in the F_2 generation.

Temperature	***Result***
21°C	¾ long wings, ¼ vestigial wings
26°C	¾ long wings, ¼ intermediate wing length
31°C	all long wings

Which statement explains these results?

A Wing length is under polygenic control.
B Long wing and vestigial wing illustrate codominance at 26°C.
C Heterozygous flies have vestigial wings only at 21°C or below but have long wings at 31°C or above.
D Vestigial wing is recessive but causes a vestigial wing phenotype only at lower temperatures.

27 The table shows the results of a study made on a large number of twins.

Twin group	Mean difference in eye colour intensity/a.u.	Mean difference in weight/kg
Identical, raised together	1.7	2.0
Identical, raised apart.	1.8	4.8
Non-identical, same-sex, raised together	4.4	4.9

What do these results suggest about the influence of genes and environment on eye colour intensity and weight in humans?

A Genes have a greater influence than the environment on the eye colour intensity and the weight of identical twins.
B Eye colour intensity and weight are influenced by the environment.
C Weight is influenced by environment and genes; eye colour intensity is mainly influenced by genes.
D The environment has more effect than genes on the eye colour intensity and weight of non-identical twins.

28 The length of the petiole (leaf stalk) in a type of flowering plant is controlled by two genes, A and B. These genes are found on different loci on non-homologous chromosomes.

Homozygous dominant plants have long petioles (30 cm), homozygous recessive plants have short petioles (10 cm). Each dominant allele contributes 5cm to the petiole length.

F_1 plants with medium length petioles (20 cm) were obtained when a plant with short petiole is crossed with a plant with long petiole. If the F1 generation plants were allowed to cross, what proportion of their offspring would be expected to have medium length (20 cm) petioles?

A 0.0625
B 0.25
C 0.375
D 0.5

29 The Himalayan rabbits have white hair on the body and black hair on the extremities such as feet, tail, ears and face.

The allele for the Himalayan rabbit pigment pattern, $\mathbf{c^h}$, is recessive to the alleles for normal colour (all hair agouti), **C**, as well as dark chinchilla (all hair dark grey), $\mathbf{c^{chd}}$, and is dominant to the allele for albino (all hair white, no pigment production), **c**.

All of the alleles of this gene produce different versions of the same enzyme involved in pigment production.

A patch of white fur was removed from a Himalayan rabbit and an ice pack secured to the skin. The fur that grew back on the patch was black.

Which is correct?

	Genotypes of Himalayan rabbits	**Explanation for pigment pattern in Himalayan rabbits**
A	c^hc^h only	The enzyme is denatured at the high skin temperatures found on the rabbit's bodies
B	c^hc^h only	The enzyme becomes inactive at the low skin temperatures found on the rabbit's feet, tail, ears and face.
C	c^hc^h and c^hc only	The enzyme is denatured at the high skin temperatures found on the rabbit's bodies
D	c^hc^h and c^hc only	The enzyme becomes inactive at the low skin temperatures found on the rabbit's feet, tail, ears and face.

30 The Southern pine beetle is a pest native to pine forests in Central America and the southeastern U.S..

However recent observations show the latitude of this pest infestation creeping northward by about 40 miles a decade since 1980, and could damage 273,000 square miles of pine forests by 2080.

Which of the following explanations for the above observation are attributed to climate change?

1 Longer and more intense droughts weakening the defenses of trees, making them vulnerable to attack by the beetles.
2 Long-term suppression of forest fires leaving pine forests unnaturally dense and uniform, facilitating the beetles' spread from tree to tree.
3 Pines trees colonising new territories with cooler climates.
4 Increased temperatures in the winter allowing the beetles' lavae to survive.

A 1 and 4 only
B 2 and 3 only
C 1, 3 and 4 only
D All of the above

- **END OF PAPER** -

Civics Group	Index Number	Name (use BLOCK LETTERS)

H1

ST ANDREW'S JUNIOR COLLEGE
2018 JC2 PRELIMS

H1 BIOLOGY **8876/2**

Paper 2: Structured & Essay Questions

Monday 10 Sept 2018 2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A (Structured Questions)
Answer **all** questions.
Write your answers in the spaces provided in the question booklet.

Section B (Essay Question)
Answer **one** essay question.
Write your answers in the spaces provided in the question booklet.
All working for numerical answers must be shown.

The number of marks is given in brackets [ ] at the end of each question or part question.

Conceptual error (C)	Expression problem (E)	Misreading the question (Q)	Data quoting problem (D)

For Examiner's Use	
Section A	
1	/13
2	/12
3	/9
4	/11
Sub-total	/45
5/6	/15
Total	/60

This document consists of **17** printed pages.

[Turn over

Section A

Answer **all** *questions*.

QUESTION 1

Fig. 1.1 shows Process X in an eukaryotic cell which produces ribosomal RNA (rRNA).

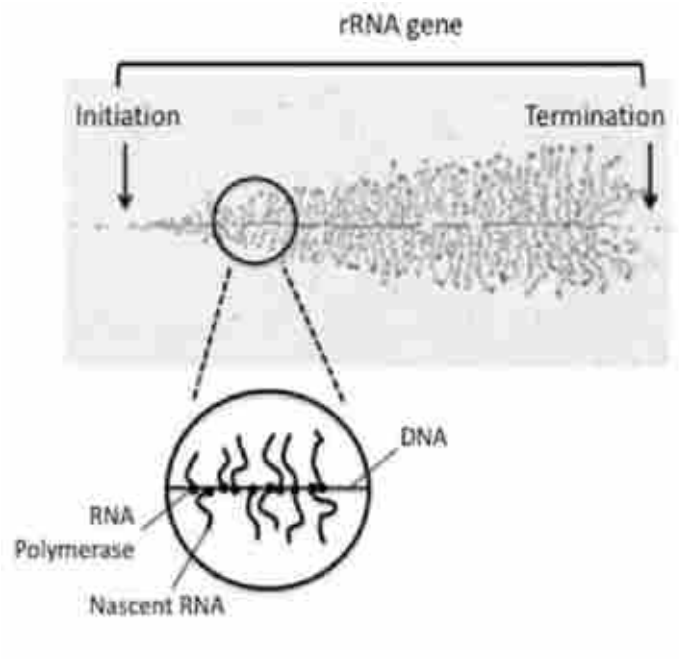


Fig. 1.1

(a)(i) Name the Process X occurring in **Fig. 1.1**.

……[1]

(ii) List one molecule **not mentioned in Fig. 1.1** that is required for Process X.

……[1]

(iii) Suggest how RNA polymerase is able to recognise and bind to the promoter on DNA and not to other DNA regions.

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……[2]

(iv) Explain for the observed pattern of Process X in **Fig. 1.1**.

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……[2]

(v) State the roles of rRNA in protein synthesis.

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……[2]

(b) During protein synthesis in cells of an embryo, all tRNA molecules with UAC anticodon sequence, are observed to be bound to the arginine amino acid instead of methionine.

(i) Suggest how these tRNA molecules attached with the wrong amino acid might arise.

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……[2]

(ii) Suggest and explain the effect of this wrong pairing of amino acid to tRNA on the embryo.

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……[3]

[Total: 13]

QUESTION 2

(a) About one third of the injuries to racehorses involve tendon damage.

In 2006, bone marrow stem cells were taken from injured racehorses and cultured so that they divided many times by mitosis. Each horse's cells (usually around 10 million cells for one tendon) were then injected into its damaged tendons.

80% of the treated horses returned to racing, compared with 30% of those treated conventionally.

(i) Explain how it is possible that bone marrow stem cells could differentiate into the range of cell types needed for repairing the tendon injuries.

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……[2]

(ii) Suggest an advantage of the above stem cell therapy.

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……[1]

(iii) Similar to stem cells, cancer cells are also capable to dividing many times via mitosis. List 2 differences between stem cells and cancer cells.

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……[2]

(b) In a dihybrid inheritance, gene B/b codes for flower colour while gene H/h codes for leaf shape of a plant.

The F1 progeny of a pure-bred plant with red flowers and oval leaves, and another pure-bred plant with yellow flowers and fan-shaped leaves, have red flowers and fan-shaped leaves.

F1 plants then undergo a test cross.

(i) Predict the expected phenotypic ratio in the F2 progeny.

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……[1]

(ii) Identify and explain which are the dominant traits in this dihybrid cross.

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……[2]

(iii) Using the symbols for the alleles stated above, draw a genetic diagram to show the expected phenotypic ratios for the offspring of the test cross if inheritance is Mendelian. [3]

(iv) Plants are a good choice of experimental organisms for carrying out such crosses and for performing statistical tests.

Compared to plants, humans are less ideal and it is usually more difficult to arrive at reliable conclusions for observations involving humans. Suggest why.

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……..…….....…[1]

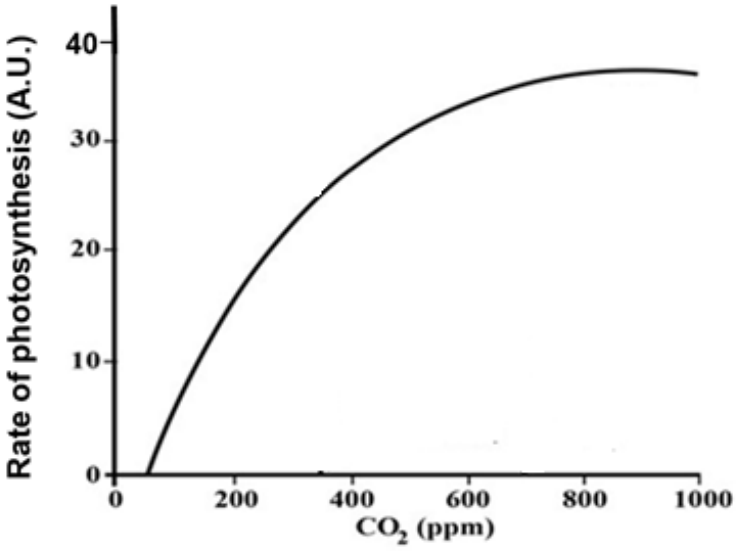
[Total: 12]

QUESTION 3

(a) In response to climate change, the rising carbon dioxide level has affected almost all crucial biological processes, including photosynthesis, respiration, and antioxidant systems, as well as other key secondary metabolisms in plants.

An experiment was designed to measure the rate of photosynthesis at a range of carbon dioxide concentrations provided to the plant.

The following results were obtained:



(i) Explain the experimental results obtained in relation to CO_2 being a limiting factor of photosynthesis.

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(ii) Suggest why the rate of photosynthesis reaches a plateau after a while, given that sufficient light was provided.

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(iii) $NADP^+$ is an important electron carrier found in plants, but its level decreases sharply in the day. Suggest the significance of the decrease of $NADP^+$ during the day.

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…..…..…….. [2]

(b) Central to the energy metabolism of aerobically respiring cells is the enzyme ATP synthase. It consists of multiple subunits, coded for by several genes.

The enzyme is located on the inner mitochondrial membrane and catalyses the reversible reaction of ATP synthesis from ADP in intact mitochondria. Here, the **proton motive force** is required to drive the ATP synthesis.

Explain how the structure, including protein components, of the inner mitochondrial membrane is significant in driving the reaction of ATP synthase towards ATP synthesis during aerobic respiration.

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[Total: 9]

QUESTION 4

(a) Climate change, in the form of global warming, is expected to have an impact on various organisms. This impact however, varies geographically, particularly for insects.

Fig. 4.1 and **Fig. 4.2** below show the fitness curves of representative insects from temperate and tropical locations respectively.

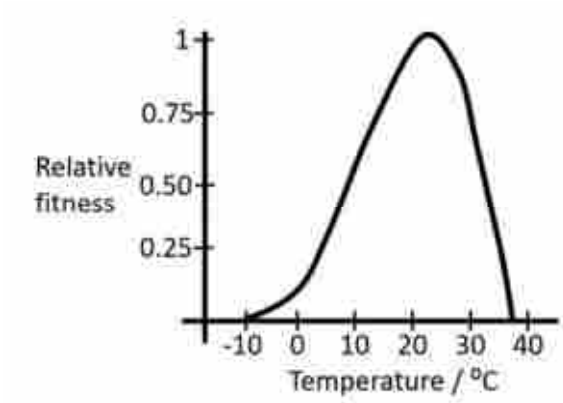

Fig. 4.1: Fitness curve of representative insect from temperate location

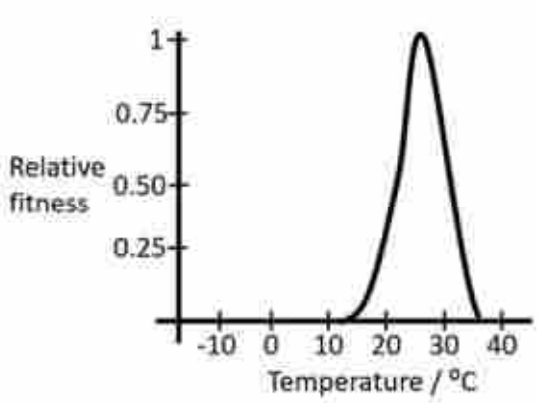

Fig. 4.2: Fitness curve of representative insect from tropical location

The mean annual temperature of the temperate location is 11□C, with a typical temperature range from 1□C to 20□C.

On the other hand, the mean annual temperature of the tropical location is 27□C, with a typical temperature range from 21□C to 31□C.

(i) Suggest what is meant by the term relative fitness in **Fig. 4.1** and **Fig. 4.2**.

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……[2]

(ii) With reference to **Fig. 4.1** and **Fig. 4.2** and the information given, predict and explain which insects, from the temperate or tropical location, would face a greater extinction risk as a result of global warming, assuming the warming elevates temperatures equally at both locations.

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……[4]

(iii) Suggest one strategy that the insects in **(ii)** can employ to reduce the impact of global warming on themselves.

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……[1]

(b) Carbon dioxide is one of the greenhouse gases that contribute to global warming and subsequently climate change.

A group of high school students decided to test whether varying temperatures would correspondingly affect the mean carbon dioxide gas emission.

Table 4.1 shows the mean carbon dioxide gas emission after exposing a fixed number of mealworms to different temperatures. Carbon dioxide gas emission was measured before and after exposure to experimental temperature.

Table 4.1 showing effects of varying temperatures on mean carbon dioxide gas emission, measured in parts per million (ppm).

Temperature /°C	**Mean Carbon dioxide gas emission /ppm**	
	Before exposure to experimental temperature	**After** exposure to experimental temperature
30.0	445 ± 25	450 ± 17
40.0	450 ± 20	500 ± 30
50.0	460 ± 17	540 ± 18

Values represent mean ± standard deviation.

(i) Describe the patterns shown by the data in **Table 4.1**.

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……[2]

(c) Corals are affected by rising temperatures in ocean waters. Explain how.

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……[2]

[Total: 11]

Section B

Answer **one** *question only*.

Write your answers on the spaces provided in this question booklet.

Your answer should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

QUESTION 5
Cellulose is the most abundant biopolymer on earth. It forms a significant proportion of the dry mass of plants.

Outline the role of atmospheric CO_2 in contributing to the structure of cellulose in plants. [15]

QUESTION 6
Without genetic variation, some of the basic mechanisms bringing about evolutionary change cannot operate.

Explain how mutation events may contribute to variation, and how this variation can influence natural selection. [15]

- **END OF PAPER** -

(a) Stem cells undergo cell division to produce genetically identical daughter cells. Radioactive thymine was supplied to some stem cells. Fig. 1.1 shows how the amount of DNA per cell varies during periods A to E in the cell cycle.

Which monomers and types of bond are found in both glycogen and amylopectin?
A α-glucose, glycosidic, 1,6
B α-glucose, hydrogen, 1,4
C β-glucose, glycosidic, 1,4
D β-glucose, hydrogen, 1,6

The huia, Heteralocha acutirostris, was found in New Zealand until 1907, when it became extinct. This bird had a ground-feeding habit and was particularly noted for large, attractive tail feathers. Males and females had very different beak forms, with the males having a short strong beak, whilst the females had a long curved beak to reach into otherwise inaccessible places. What is the most likely reason for the extinction of the huia?
A Huia fed on species introduced by humans. When these declined, the huia population fell.
B In the face of a declining population the huia evolved into a tree-living species.
C Male and female huia were unable to breed successfully owing to strong sexual dimorphism.
D New competitors in New Zealand occupied part of the huia's niche.

[Total: 10]

Time

QUESTION 2 DNA

Fig 3.1 shows part of a DNA molecule.

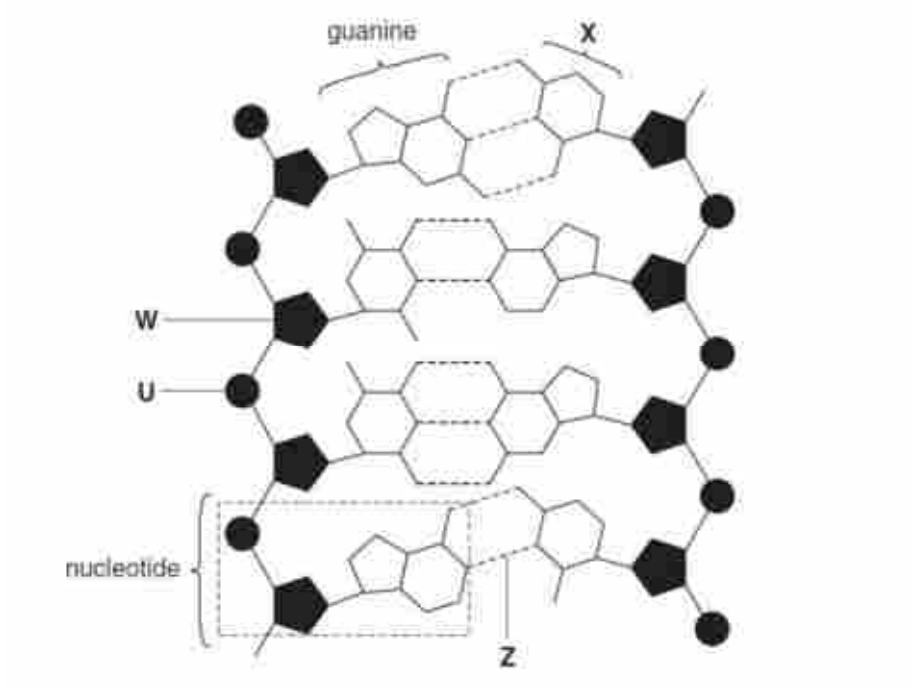


Fig 3.1

(a) (i) Name **U** to **X**.

U ……

W .....

X …….. [1]

1 **U** - phosphate / PO_4;
REJECT phosphoric acid / phosphorus / P
2 **W** - deoxyribose;
REJECT pentose
3 **X** - cytosine;
REJECT nitrogenous base / pyrimidine / C

(ii) Explain the significance of the bonds indicated by **Z** during the DNA replication process.

……..[2]

1 Hydrogen bonds
2 Allows for **complementary base pairing** (A = T, G =C) and DNA repair / **proof-reading**/replacement of incorrectly-inserted nucleotide;

3 Ref. genetic stability (DNA sequence remains intact) / maintains integrity of DNA base sequence;

(iii) Describe three features of a polypeptide molecule that are different from those found in a DNA molecule.

……..[3]

	polypeptide	**DNA**
1	amino acids as subunits/monomers;	Nucleotides as monomers;
2	one / single strand/chain	Exists as double helix; / two/double strandd/chains
3	peptide bonds between amino acids	Phosphodiester bonds between nucleotides;
4	Has no phosphate / PO_4	Has phosphate / PO_4
5	Consists of secondary and tertiary structure	Helical in structure

(b) Explain

☆☆……..[3]

[Total: 12]

Civics Group	Index Number	Name (use BLOCK LETTERS)

H1

ST ANDREW'S JUNIOR COLLEGE
2018 JC2 Prelims

H1 BIOLOGY **8876/01**

Paper 1: Multiple Choice (Mark Scheme)

Tuesday 18th Sept 2018 1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser (not supplied)
Soft pencil (type B or HB is recommended, not supplied)

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your name, civics group and index number on the multiple choice answer sheet in the spaces provided.

There are **30** questions in this paper. Answer all questions. For each question, there are four possible answers, A, B, C and D.

Choose the one you consider correct and record your choice in soft pencil on the separate multiple choice answer sheet.

INFORMATION TO CANDIDATES

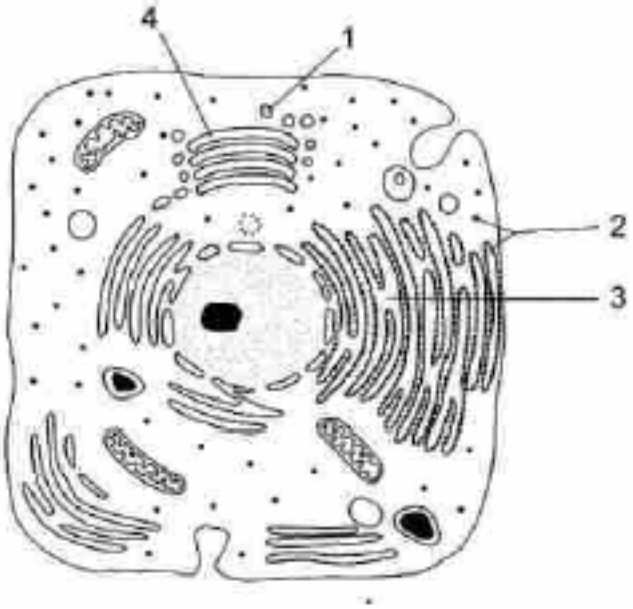
Each correct answer will score one mark. A mark will not be deducted for wrong answer. Any rough working should be done in this booklet.

At the end of the examination, submit the multiple choice answer sheet and question paper separately.

This document consists of **18** printed pages.

[Turn over

1 The figure below shows the structure of an animal cell.



Which of the following correctly identifies the functions of the labelled structures?

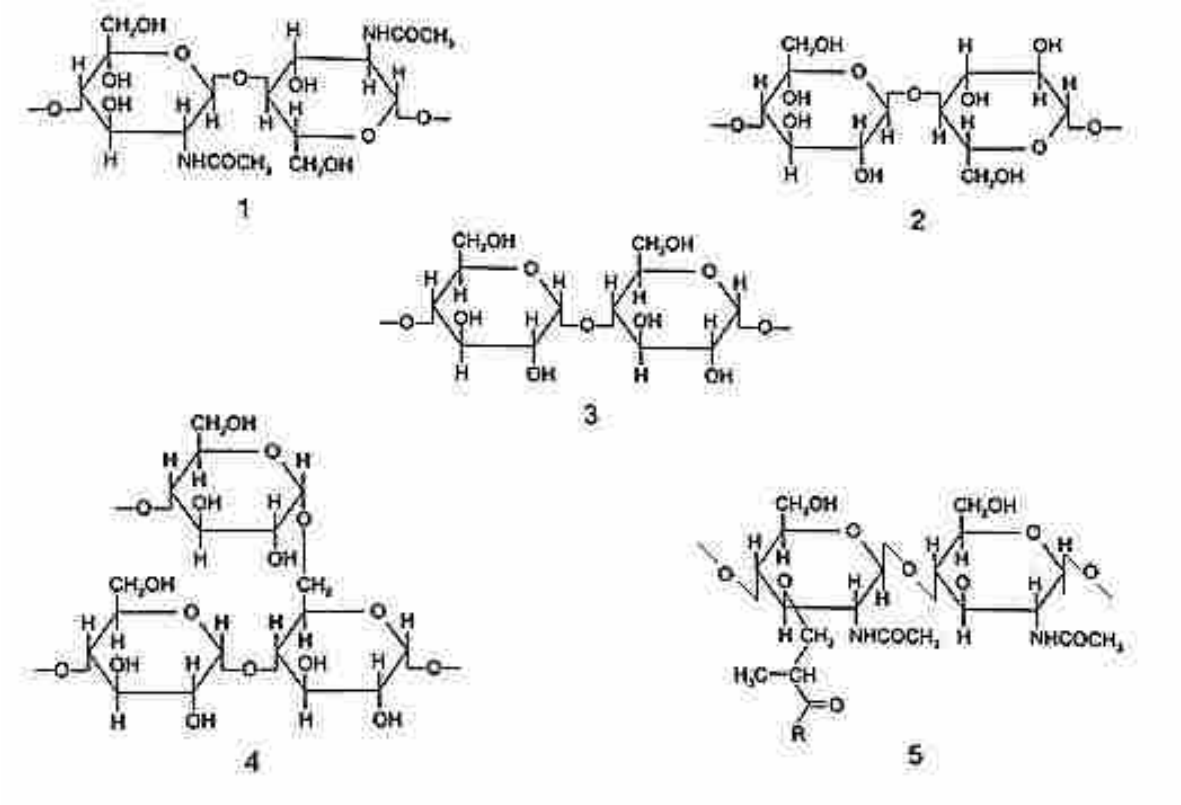
	Synthesising polypeptides from amino acids	Transporting proteins	Carrying out glycosylation	Secreting digestive enzymes
A	2	1	4	3
B	1	4	2	3
C	2	3	4	1
D	1	3	2	4

2 Nucleases are enzymes that hydrolyze phosphodiester bonds. In which of the following cell organelle(s) would one expect to see activity of this enzyme?

1 rough endoplasmic reticulum
2 mitochondrion
3 chloroplast
4 Golgi apparatus

A 1 only
B 1 and 4 only
C 2 and 3 only
D 1, 2 and 3 only

3 The diagrams show short sections of some common polysaccharides and modified polysaccharides.



The polysaccharides can be described as below.

- Polysaccharide **F** is composed of β-glucose monomers with 1,4 glycosidic bonds.
- Polysaccharide **G** is composed of α-glucose monomers with 1,4 and 1,6 glycosidic bonds.
- Polysaccharide **H** is composed of N-acetylglucosamine and N-acetylmuramic acid monomers with β-1,4 glycosidic bonds.
- Polysaccharide **J** is composed of α-glucose monomers with 1,4 glycosidic bonds.
- Polysaccharide **K** is composed of N-acetylglucosamine monomers with β-1,4 glycosidic bonds.

Which shows the correct pairings of polysaccharide descriptions and diagrams?

	Polysaccharide				
	F	**G**	**H**	**J**	**K**
A	2	4	5	3	1
B	2	5	4	1	3
C	3	4	1	2	5
D	3	5	4	1	2

4 Which statement is true for phospholipid, but **not** for protein?

A Its molecules have hydrophilic and hydrophobic components.
B Its molecules are synthesized from non-identical sub-units.
C It is a barrier to polar molecules.
D It is found in cell membranes.

5 With reference to carrier proteins, which of the following statements is/are true for all carrier proteins?

1 They contain binding sites for specific molecules or ions.
2 They directly require ATP to transport substances across the membrane.
3 They are soluble globular proteins.
4 They are embedded in membranes.

A 1 only
B 1 and 4
C 3 and 4
D 1, 2 and 4

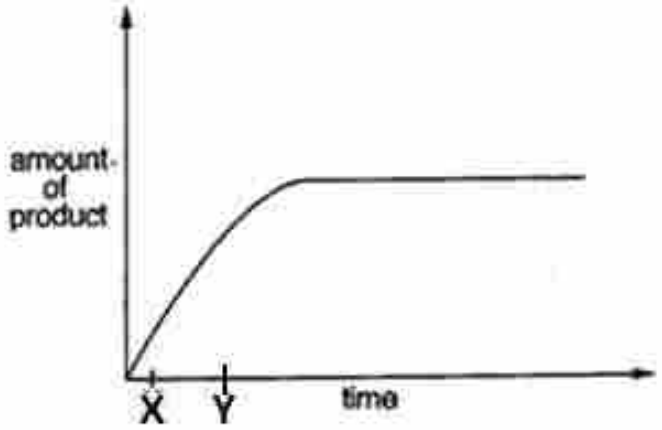
6 The list shows three characteristics of enzyme activity.

1 Reaction rate decreases if the concentration of non-competitive inhibitor increases.
2 Reaction rate is reduced at extremes of pH.
3 Reaction rate is reduced at low temperature.

What explains each of these characteristics?

	Availability of active sites is reduced	**Reduced kinetic energy reduces the rate of molecular collisions**	**Hydrogen bonding is disrupted**
A	1	2	3
B	2	1	3
C	1	3	2
D	2	3	1

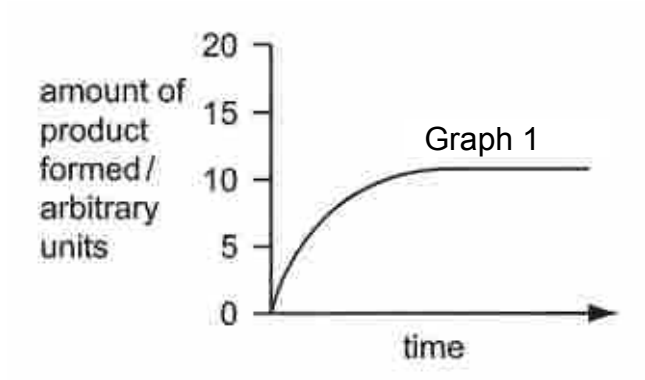
7 The graph below shows the amount of product formed in an enzyme-catalysed reaction over a certain period of time at 37°C.



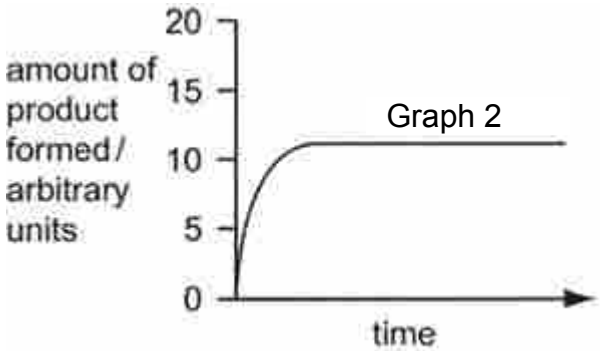
What is true at time **X**?

A Most enzyme molecules will have free active sites.
B The number of unreacted substrate molecules is high.
C The number of enzyme-substrate complexes is low.
D The rate of enzymatic reaction is lower than at time **Y**.

8 Graph 1 below shows the amount of product formed by a standard concentration of salivary enzymes and a standard concentration of substrate at a temperature of 15°C and pH of 7.



A change in condition(s) results in Graph 2.

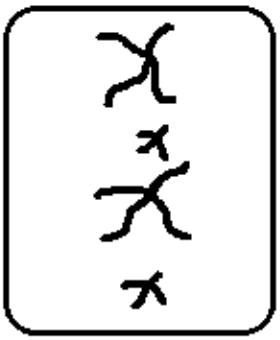


Which of the following conditions can best explain Graph 2?

1 Doubling of substrate concentration
2 Doubling of enzyme concentration
3 Increasing temperature to 20°C
4 Decreasing pH to 2

A 1 and 2
B 1 and 3
C 2 and 3
D 3 and 4

9 The diagram below shows metaphase of mitosis in a cell of an organism.



Each homologous pair of chromosomes in this organism contains 4 gene loci. This organism was genotyped and found to be heterozygous at all gene loci. The organism reproduces sexually via the production of millions of gametes by meiosis.

What is the maximum possible number of genetically different gametes that can be produced by this organism, assuming crossing over does not occur during meiosis in all cells?

A 2
B 4
C 16
D 256

10 Hybrid species can be produced from cabbage and radish.
The table below shows the chromosome numbers in the parental species and the hybrids.

type of cell	number of chromosomes per cell
parental cabbage	18
parental radish	18
parental gametes	9
F1 hybrids	18
F1 gametes	9
F2 hybrids	18
F2 gametes	18
F3 hybrids	36

Chromosomal mutation occurred at one stage. At which stage did it occur?

A during the formation of the F1 gametes.
B during the formation of the F2 gametes.
C during the fusion of the parental gametes.
D during the fusion of the F1 gametes.

11 3 different polynucleotide molecules (X, Y and Z) were isolated from a eukaryotic cell. One of them is a double-stranded DNA gene, while the other two are the pre-mRNA and mature mRNA that the DNA gene codes for.

The adenine nucleotide content of all 3 molecules was examined and shown in the table below:

Molecule	Percentage of adenine nucleotides in the molecule / %
X	49
Y	52
Z	53

Based on the information given, which of the following conclusions is/are valid and true?

1 X is definitely the DNA gene.
2 Z is definitely the mature mRNA.
3 The pre-mRNA molecule has more uracil than guanine in it.
4 Y has more purine nucleotides than pyrimidine nucleotides in it.

A 1 and 2
B 1, 2 and 4
C 2, 3 and 4
D 1, 3 and 4

12 Which of the following order of steps is true for transcription?

1 RNA polymerase II binds to promoter
2 Primase adds a RNA primer to the 3' end of template strand
3 General transcription factors recognize and bind to TATA box of promoter
4 DNA polymerase III adds complementary deoxyribonucleotides to the 3' end of the growing DNA chain
5 RNA polymerase II transcribes a DNA sequence which codes for a polyadenylation signal (AAUAAA) in the RNA transcript
6 RNA polymerase II transcribes a stop codon
7 RNA polymerase II adds complementary ribonucleotides to the 3' end of the growing RNA chain
8 DNA polymerase III binds to promoter
9 Primer is hydrolyzed and replaced by deoxyribonucleotides

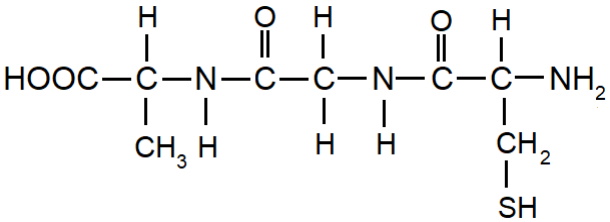
A 2, 1, 7, 5
B 2, 8, 4, 9
C 3, 1, 7, 5
D 3, 1, 7, 6

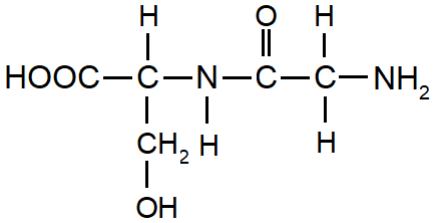
13 In an experiment, polypeptide A, which is coded for by a non-mutated version of a prokaryotic gene, was cleaved by a particular protease.

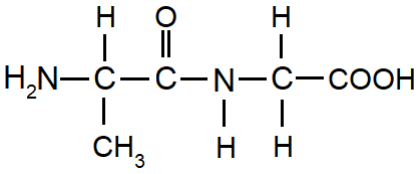
The cleavage produced 2 fragments, one of which contains the C-terminus of polypeptide A and is 5 amino acids long. This 5-amino-acid-long fragment, now called Peptide B, was then isolated for further investigation.

A solution containing many molecules of Peptide B was treated with another protease, called Protease X. The solution was analysed after the treatment and was found to contain various different fragments of different lengths and sequences.

The structures of 3 of these fragments are shown below:







It is known that Protease X is able to cleave any peptide bonds within the molecule of Peptide B. However, the cleavage of all peptide bonds within a single molecule is rare.

The mRNA codons involved in the synthesis of the Peptide B portion of Polypeptide A are shown below:

Amino acid	R group	mRNA codon
Glycine	H	5’ – GGC – 3’
Alanine	CH_3	5’ – GCC – 3’
Serine	CH_2OH	5’ – UCC – 3’
Cysteine	CH_2SH	5’ – UGU – 3’

Which of the following correctly shows a single point mutation in the portion of the template DNA sequence that codes for Peptide B, leading to a single amino acid substitution?

A 5’ – GGA GCC GCC GCC ACA – 3’
B 5’ – GCC GGA ACA GCC GCC – 3’
C 5’ – GCC GCC ACA GGA GCC – 3’
D 5’ – ACA GCC GCC GCC GGA – 3’

14 Translation did not occur successfully in a eukaryotic organism. Analysis of the structures in the cell revealed the following:

Structure	Presence (√) / Absence (X)
Free floating aminoacyl-tRNAs	√
Initiator tRNA- small ribosomal subunit complex	√
Initiator tRNA (base-pairing with AUG codon) in the P-site of large ribosomal subunit	√
Second aminoacyl-tRNA in the A-site of large ribosomal subunit	√
Polypeptide chain	X

Which is the most probable explanation for these observations?

A peptidyl-transferase is not functioning properly
B aminoacyl tRNA synthetases fail to attach amino acids to tRNA
C there is an error in the scanning for the start codon by tRNA-small ribosomal subunit complex
D release factor fails to hydrolyze polypeptide chain from the tRNA

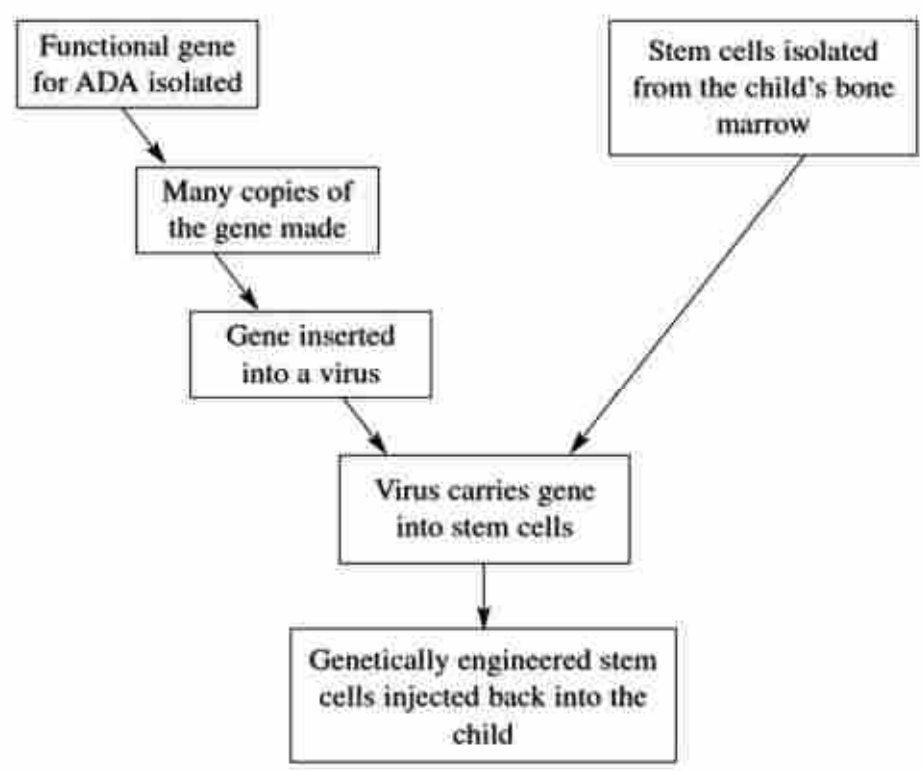
15 Which is a correct statement about obtaining human embryonic stem cells for research?

1 Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.
2 The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.
3 The cells must be removed immediately following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.
4 The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

A 2 only
B 1 and 2
C 2 and 3
D 3 and 4

16 Children with severe combined immunodeficiency disorder (SCID) cannot produce the many types of white blood cells that fight infections. This is because they do not have the functional gene to make the enzyme ADA. Some children with SCID have been treated with stem cells.

The treatment used with the children is described in the flowchart.



Which of the following explains why stem cells can be used in the treatment of SCID?

1 They can divide mitotically to replace existing cells.
2 Due to their pluripotent nature, they have the ability to form only certain types of white blood cells that restores the ability to fight infection.
3 As the stem cells are from the child's own cells, there is no/little risk of rejection.
4 They possess a unique set of genome to allow for multipotency.

A 1 and 2
B 1 and 3
C 2 and 4
D 3 and 4

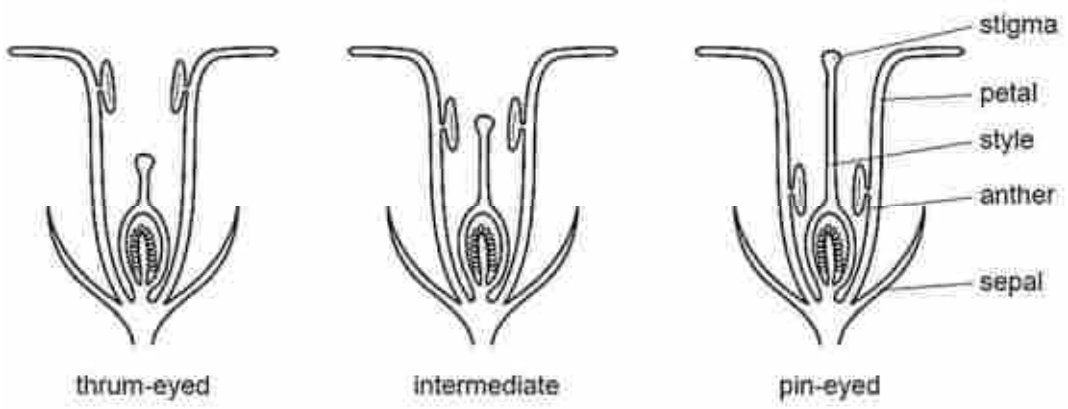
17 The primrose, *Primula vulgaris*, is a small herbaceous, yellow-flowered plant which is common in cooler areas of the Northern hemisphere including alpine and Arctic areas.

The flowers of the primrose have different flower shapes (polymorphic), which are adaptations for pollination. 'Thrum-eyed' primroses have a short style. 'Pin-eyed' primroses have much longer styles. The anther position also varies among the primrose.

Some populations of primrose consist almost entirely of plants with intermediate flowers. These populations are common where there are fewer winged insects.

Anthers produce pollen (male gametes) which land on the stigma, leading to fertilization.

The diagrams show polymorphic flowers of primroses.



Which statements are correct?

1 Cross-pollination will be favoured between pin-eyed and thrum-eyed primroses.
2 Primroses with pin-eyed flowers are likely to show more genetic diversity than primroses with intermediate flowers.
3 Primroses with thrum-eyed flowers are likely to be more able to adapt to changing environmental conditions than pin-eyed primroses.
4 Self-pollination is more likely to occur in primroses with intermediate flowers.

A 1 and 2
B 3 and 4
C 1, 2 and 4
D All of the above

18 On the tiny Lord Howe Island, 600 miles east of Australia, there are two species of palm which seem, from DNA analysis, to be descended from one original species. Factors involved in this speciation on this tiny island include:

1 linkage of genes for soil tolerance and flowering time
2 variation in flowering time
3 variation of soil tolerance
4 variation of soil types on the island

What is the correct sequence to explain this speciation?

A 1 → 2 → 3 → 4
B 2 → 1 → 4 → 3
C 3 → 4 → 1 → 2
D 4 → 3 → 2 → 1

19 A large population of equal numbers of dark and light mice was released into an area where owls are predators of mice. Because of predation, only 25 % of these mice survived and selective killing by owls changed the proportions of dark to light mice from 1:1 to 4:1.

If mice produce an average of eight offspring per litter and the pattern of predation remains the same, what would happen to the population of light mice?

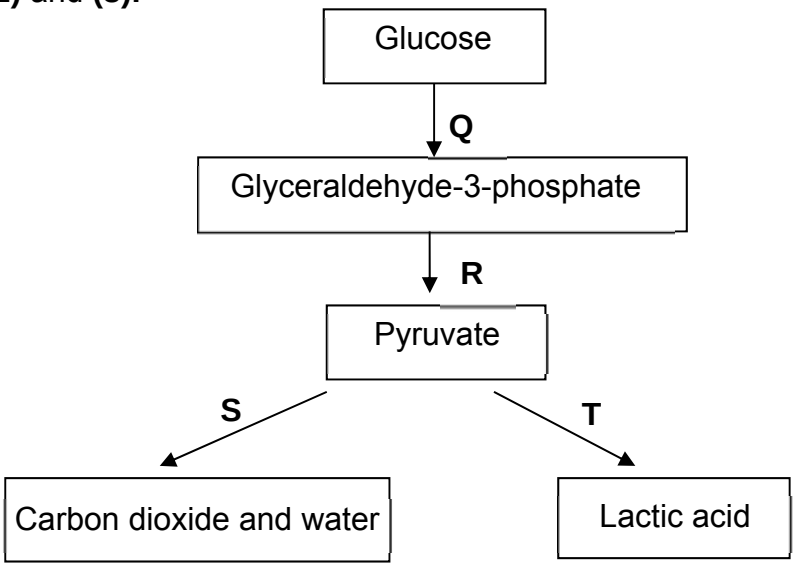
A They disappear after one further generation.
B They disappear after two further generations.
C They remain at the level of one fifth of the population.
D They will be reduced to a constant but very low frequency.

20 The frequency of recessive alleles in population is influenced by selection pressure.

Which row shows the conditions in which recessive alleles are retained in a population?

	Environmental variation of habitats	Heterozygote advantage	No selective advantage	Polymorphism (many phenotypes)
A	✓	✓	✓	✓
B	✓	×	×	✓
C	×	✓	×	×
D	×	×	✓	×

21 With reference to the diagram below, relate processes **Q, R, S, T** to statements **(1), (2)** and **(3).**



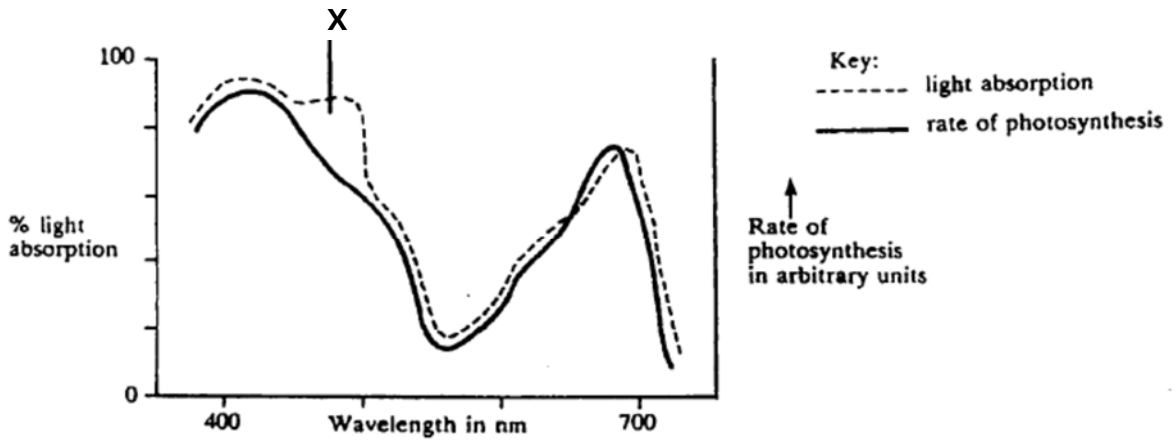
(1) NAD is regenerated without the use of the electron transport system
(2) ATP is synthesised via substrate level phosphorylation
(3) It can take place under anaerobic conditions.

	(1)	**(2)**	**(3)**
A	T only	R only	Q,R,T only
B	T only	R,S only	Q,R,T only
C	S,T only	R only	Q,R,S,T
D	S,T only	R,S only	Q,R,S,T

22 A major function of the mitochondrial inner membrane is the conversion of energy from electrons to the stored energy of the phosphate bond in ATP. To accomplish this function, this membrane must have all of the following features except

A high permeability to protons.
B integral, transverse ATP synthase.
C proteins to accept electrons from NADH.
D proton pumps embedded in the membrane.

23 The graph below shows the effect of different wavelengths of light on the rate of photosynthesis and on the amount of light absorbed by the pigments in a green seaweed.



The difference between the two curves at X is due to

A inefficient trapping of light energy by the chlorophyll
B no ATP production at that wavelength
C oxygen given off during photosynthesis interferes with the absorption of light.
D carotenes absorbing light that is not used in photosynthesis.

24 The incidence of primaquine sensitivity in a population is 14% in men and 2% in women. A proportion of the remaining women, but not the men, exhibit mild sensitivity.

What does this suggest about the inheritance of this defect?

A autosomal, codominant
B autosomal, recessive
C sex-linked, codominant
D sex-linked, recessive

25 In a series of plant breeding experiments, a pure-breeding plant with big and hairy leaves was crossed with a pure-breeding plant with small and hair-less leaves. The leaves in the F_1 generation were all big and hairy. Self-fertilisation of the F_1 generation produced the following results:

905	big and hairy leaves
301	big and hair-less leaves
305	small and hairy leaves
98	small and hair-less leaves

An F_2 plant with big and hairy leaves was crossed with an F_2 plant with small and hairy leaves. What is the maximum proportion of plants with small and hair-less leaves that could have appeared in the resulting progeny?

A 0%
B 12.5%
C 25%
D 50%

26 Fruit flies *Drosophila* homozygous for long wings, were crossed with flies homozygous for vestigial wings. The F_1 and F_2 generations were raised at three different temperatures.

At each temperature, the F_1 generation all had long wings.

The table below shows the results in the F_2 generation.

Temperature	***Result***
21°C	¾ long wings, ¼ vestigial wings
26°C	¾ long wings, ¼ intermediate wing length
31°C	all long wings

Which statement explains these results?

A Wing length is under polygenic control.
B Long wing and vestigial wing illustrate codominance at 26°C.
C Heterozygous flies have vestigial wings only at 21°C or below but have long wings at 31°C or above.
D Vestigial wing is recessive but causes a vestigial wing phenotype only at lower temperatures.

27 The table shows the results of a study made on a large number of twins.

Twin group	Mean difference in eye colour intensity/a.u.	Mean difference in weight/kg
Identical, raised together	1.7	2.0
Identical, raised apart.	1.8	4.8
Non-identical, same-sex, raised together	4.4	4.9

What do these results suggest about the influence of genes and environment on eye colour intensity and weight in humans?

A Genes have a greater influence than the environment on the eye colour intensity and the weight of identical twins.
B Eye colour intensity and weight are influenced by the environment.
C Weight is influenced by environment and genes; eye colour intensity is mainly influenced by genes.
D The environment has more effect than genes on the eye colour intensity and weight of non-identical twins.

28 The length of the petiole (leaf stalk) in a type of flowering plant is controlled by two genes, A and B. These genes are found on different loci on non-homologous chromosomes.

Homozygous dominant plants have long petioles (30 cm), homozygous recessive plants have short petioles (10 cm). Each dominant allele contributes 5cm to the petiole length.

F_1 plants with medium length petioles (20 cm) were obtained when a plant with short petiole is crossed with a plant with long petiole. If the F1 generation plants were allowed to cross, what proportion of their offspring would be expected to have medium length (20 cm) petioles?

A 0.0625
B 0.25
C 0.375
D 0.5

29 The Himalayan rabbits have white hair on the body and black hair on the extremities such as feet, tail, ears and face.

The allele for the Himalayan rabbit pigment pattern, $\mathbf{c^h}$, is recessive to the alleles for normal colour (all hair agouti), **C**, as well as dark chinchilla (all hair dark grey), $\mathbf{c^{chd}}$, and is dominant to the allele for albino (all hair white, no pigment production), **c**.

All of the alleles of this gene produce different versions of the same enzyme involved in pigment production.

A patch of white fur was removed from a Himalayan rabbit and an ice pack secured to the skin. The fur that grew back on the patch was black.

Which is correct?

	Genotypes of Himalayan rabbits	**Explanation for pigment pattern in Himalayan rabbits**
A	c^hc^h only	The enzyme is denatured at the high skin temperatures found on the rabbit's bodies
B	c^hc^h only	The enzyme becomes inactive at the low skin temperatures found on the rabbit's feet, tail, ears and face.
C	c^hc^h and c^hc only	The enzyme is denatured at the high skin temperatures found on the rabbit's bodies
D	c^hc^h and c^hc only	The enzyme becomes inactive at the low skin temperatures found on the rabbit's feet, tail, ears and face.

30 The Southern pine beetle is a pest native to pine forests in Central America and the southeastern U.S..

However recent observations show the latitude of this pest infestation creeping northward by about 40 miles a decade since 1980, and could damage 273,000 square miles of pine forests by 2080.

Which of the following explanations for the above observation are attributed to climate change?

1 Longer and more intense droughts weakening the defenses of trees, making them vulnerable to attack by the beetles.
2 Long-term suppression of forest fires leaving pine forests unnaturally dense and uniform, facilitating the beetles' spread from tree to tree.
3 Pines trees colonising new territories with cooler climates.
4 Increased temperatures in the winter allowing the beetles' lavae to survive.

A 1 and 4 only
B 2 and 3 only
C 1, 3 and 4 only
D All of the above

- **END OF PAPER** -

Civics Group	Index Number	Name (use BLOCK LETTERS)

H1

ST ANDREW'S JUNIOR COLLEGE
2018 JC2 PRELIMS

H1 BIOLOGY **8876/2**

Paper 2: Structured & Essay Questions

[MARK SCHEME]

Monday 10 Sept 2018 2 hours

Additional Materials: Answer Paper
Cover Sheet for Section B

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A (Structured Questions)
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B (Essay Question)
Answer **one** essay question.
Write your answers on the separate answer paper provided.
All working for numerical answers must be shown.

The number of marks is given in brackets [ ] at the end of each question or part question.

Conceptual error (C)	Expression problem (E)	Misreading the question (Q)	Data quoting problem (D)

For Examiner's Use	
Section A	
1	/13
2	/12
3	/9
4	/11
Sub-total	**/45**
5/6	/15
Total	**/60**

This document consists of **XX** printed pages.

[Turn over

Section A

Answer **all** *questions*.

QUESTION 1

Fig. 1.1 shows Process X in an eukaryotic cell which produces ribosomal RNA (rRNA).

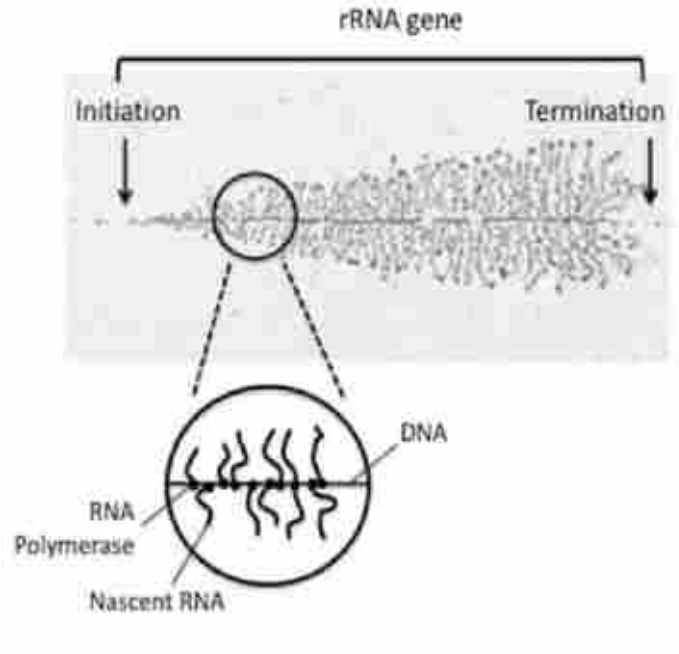


Fig. 1.1

(a)(i) Name the Process X occurring in **Fig. 1.1**.

……[1]

1. Transcription

(ii) List one molecule **not mentioned in Fig. 1.1** that is required for Process X.

……[1]

1. General <u>transcription factor</u> (**Reject**: Specific transcription factor due to it not being a real/essential requirement for transcription)
   / ribonucleotides
   / transcription initiation factors;

(iii) Suggest how RNA polymerase is able to recognise and bind to the promoter on DNA and not to other DNA regions.

……[2]

1. RNA polymerase contains a **DNA-binding site/domain** [Reject: active site] which recognize and bind to specific DNA sequence in the **promoter**;
2. ref. **Nucleotide sequence** / length / major and minor grooves of promoter offers a **complementary shape** to DNA-binding site/domain of RNA polymerase;

[Reject: complementary base pairing]

(iv) Explain for the observed pattern of Process X in **Fig. 1.1**.

……[2]

1. [Describe] **Shorter** RNA transcripts seen at the **beginning** of the DNA template strand, which get **longer** till the **end** of the transcription unit, (where the transcripts detach from the DNA template after transcription termination)
2. [Explain] Due to simultaneous transcription of rRNA gene **by multiple RNA polymerases**, causing RNA transcripts to extend perpendicularly from DNA template strand ;

(v) State the roles of rRNA in protein synthesis.

……[2]

1. The rRNA in ribosomes holds the tRNA and mRNA together in **close proximity**, (via complementary base pairing / hydrogen bonds)
2. positions the new amino acid for addition to the <u>carboxyl end</u> of the growing polypeptide
3. rRNA <u>peptidyl transferase</u> activity catalyzes formation of a <u>peptide bond</u> between the new amino acid and the polypeptide chain
4. Ref. rRNA associate with proteins to form ribosomal subunits / ribosomes (which synthesizes proteins)

(b) During protein synthesis in cells of an embryo, all tRNA molecules with UAC anticodon sequence, are observed to be bound to the arginine amino acid instead of methionine.

(i) Suggest how these tRNA molecules attached with the wrong amino acid might arise.

……[2]

1. Ref. possible mutation in the **gene** sequence for the aminoacyl tRNA synthetases,
2. resulting in **altered 3D conformation** of active site which is **complementary** (in shape) to the amino acid arginine and the corresponding tRNA with anticodon UAC

(ii) Suggest and explain the effect of this wrong pairing of amino acid to tRNA on the embryo.

……[3]

1. ref. altered **primary sequence** of polypeptides (all methionine replaced by arginine) and folding of polypeptides to **tertiary structure** / 3D conformation is affected;
2. ref. **non-functional proteins** made in cells
3. ref. possible disruption of metabolic processes in the **cell** / cells might die easily, **embryo cannot further develop** into a fetus

[Total: 13]

QUESTION 2

(a) About one third of the injuries to racehorses involve tendon damage.

In 2006, bone marrow stem cells were taken from injured racehorses and cultured so that they divided many times by mitosis. Each horse's cells (usually around 10 million cells for one tendon) were then injected into its damaged tendons.

80% of the treated horses returned to racing, compared with 30% of those treated conventionally.

(i) Explain how it is possible that bone marrow stem cells could differentiate into the range of cell types needed for repairing the tendon injuries.

……[2]

1 ref. bone marrow stem cells as **multipotent**;
/ able to differentiate into cells of **same/specific lineage;**
2 ref. bone marrow stem cells able to **respond to specific molecular signals** to differentiate;
3 AVP: stem cells containing a complete set of genome;

(ii) Suggest an advantage of the above stem cell therapy.

……[1]

1 Eliminates the risk of tissue/donor rejection if the cells were taken from another donor.
2 ref. stem cells **capable of continual self-renewal** and can be used **to expand cell numbers** in vitro **/** in the lab**;**

(iii) Similar to stem cells, cancer cells are also capable to dividing many times via mitosis. List 2 differences between stem cells and cancer cells.

……[2]

	Stem cells	**Cancer cells**
1	Differentiate into specialised cell types;	Do not differentiate into specialised cell types / remain undifferentiated and unspecialised;
2	Experience contact inhibition;	Does not experience contact inhibition;
3	Experience anchorage dependence / does not metastasize;	Does not experience anchorage dependence / metastasize to set up secondary tumors;
4	Divides or stops dividing upon response to molecular signals	Divides indefinitely / does not respond to molecular signals;
5	AVP: i.e. normal proto-oncogene / tumor suppressor gene	AVP: i.e. mutated proto-oncogene / tumor suppressor gene

(b) In a dihybrid inheritance, gene B/b codes for flower colour while gene H/h codes for leaf shape of a plant.

The F1 progeny of a pure-bred plant with red flowers and oval leaves, and another pure-bred plant with yellow flowers and fan-shaped leaves, have red flowers and fan-shaped leaves.

F1 plants then undergo a test cross.

(i) Predict the expected phenotypic ratio in the F2 progeny.

……[1]

1 1 Red flower, fan-shaped leaf : 1 Red flower, oval leaf : 1 Yellow flower, fan-shaped leaf: 1 Yellow flower, oval leaf

[**Reject**: 1:1:1:1 with no phenotypes]

(ii) Identify and explain the dominant traits in this dihybrid cross.

……[2]

1 red flowers and fan-shaped leaves;

2 ref. **dominant traits/alleles** being expressed in the **phenotype** in the **<u>heterozygous</u>** condition (i.e. F1 progeny)

/ **recessive <u>alleles</u>** (coding for yellow flowers and fan-shaped leaves), **being masked by dominant alleles** in the **<u>heterozygous</u>** condition;

(iii) Using the symbols for the alleles stated above, draw a genetic diagram to show the expected phenotypic ratios for the offspring of the test cross if inheritance is Mendelian.

……[3]

F_1 phenotypes:	Red flower, Fan-shaped leaf	x	Yellow flower, Oval leaf
F_1 genotype:	BbHh		bbhh
F_1 gametes	BH Bh bH bh		bh

F_2 genotypes:
<u>Punnett square:</u>

	BH	Bh	bH	bh
bh	BbHh (Red flower, Fan-shaped leaf)	Bbhh (Red flower, Oval leaf)	bbHh (Yellow flower, Fan-shaped leaf)	bbhh (Yellow flower, oval leaf)

F_2 / Progeny phenotypes:	Red flower, Fan-shaped leaf	Red flower, Oval leaf	Yellow flower, Fan-shaped leaf	Yellow flower, oval leaf
F_2 / Progeny phenotypic ratio:	1	1	1	1

Mark scheme:

1. F_1 phenotype and genotypes
2. Parental gametes – (Gametes **must** be circled)
3. F_2 genotypes correspond to phenotypes

(iv) Plants are a good choice of experimental organisms for carrying out such crosses and for performing statistical tests.

Compared to plants, humans are less ideal and it is usually more difficult to arrive at reliable conclusions for observations involving humans. Suggest why.
……[1]

1. Humans produce **limited offspring**. (This makes statistical tests difficult)
2. Humans have a long life span and **some traits only appear at a later stage in life**

[**Reject**: some human traits are under continuous variation. Plants also have continuous variation]

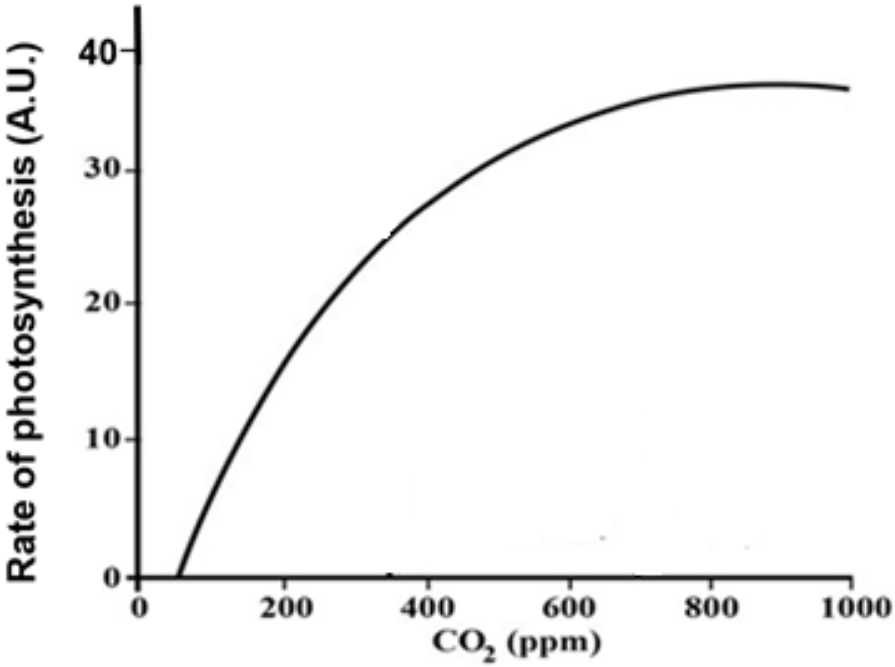
[Total: 12]

QUESTION 3

(a) In response to climate change, the rising carbon dioxide level has affected almost all crucial biological processes, including photosynthesis, respiration, and antioxidant systems, as well as other key secondary metabolisms in plants.

An experiment was designed to measure the rate of photosynthesis at a range of carbon dioxide concentrations provided to the plant.

The following results were obtained:



(i) Explain the experimental results obtained in relation to CO_2 being a limiting factor of photosynthesis.

…..…….. [2]

1 ref. carbon dioxide being a limiting factor of photosynthesis at values **lower than 700ppm** (Accept range: 700-800ppm)
/At higher concentrations of carbon dioxide tested (i.e. 700-800ppm and above), the rate of photosynthesis is affected by other limiting factors / carbon dioxide is no longer a limiting factor;

2 [Evidence] rate of photosynthesis reaches a **plateau** /**remains constant <u>around 35-37AU</u>**

(ii) Suggest why the rate of photosynthesis reaches a plateau after a while, given that sufficient light was provided.

…..…….. [1]

1 Rate of PS limited by **amount of Rubisco** in the plant;

(iii) $NADP^+$ is an important electron carrier found in plants, but its level decreases sharply in the day. Suggest the significance of the decrease of $NADP^+$ during the day.

…..…….. [2]

(ref. light-dependent reactions during day
/ photoexcited electrons (from PS I and II)being passed down ETC)

2 $NADP^+$ acts as the **final electron acceptor**, forming NADPH;
/ $NADP^+$ **accepts electrons and H^+ ions** to form NADPH;
3 NADPH (and ATP) used in **Calvin cycle** / light independent reactions to reduce PGA to PGAL **to synthesis of glucose;**

(b) Central to the energy metabolism of aerobically respiring cells is the enzyme ATP synthase. It consists of multiple subunits, coded for by several genes.

The enzyme is located on the inner mitochondrial membrane and catalyses the reversible reaction of ATP synthesis from ADP in intact mitochondria. Here, the **proton motive force** is required to drive the ATP synthesis.

Explain how the structure, including protein components, of the inner mitochondrial membrane is significant in driving the reaction of ATP synthase towards ATP synthesis during aerobic respiration.

……[4]

[Important structure – hydrophobic fatty acid tails]

1 **Hydrophobic** fatty acid tails / hydrocarbon chains / hydrophobic core of inner mitochondrial membrane **repels / does not allow hydrophilic / charged** H^+ ions to pass through membrane;

2 Allows **proton gradient / proton motive force** to be established;

[Important composition – series of electron carriers]

3 Electrons passed down a series of **electron carriers / ETC** present on membrane with increasing electronegativity and in order of **decreasing energy levels**; (until they reach final electron acceptor – oxygen)

4 Energy released during transfer of electrons along series of electron carriers used to **pump H^+ ions from mitochondrial matrix into intermembrane space**;

[Important composition – ATP synthase]

5 **ATP synthase** embedded in an orientation that allows facilitated **diffusion of H^+ ions from intermembrane space to mitochondrial matrix** to be coupled with ATP synthesis;

[Total: 9]

QUESTION 4

(a) Climate change, in the form of global warming, is expected to have an impact on various organisms. This impact however, varies geographically, particularly for insects.

Fig. 4.1 and **Fig. 4.2** below show the fitness curves of representative insects from temperate and tropical locations respectively.

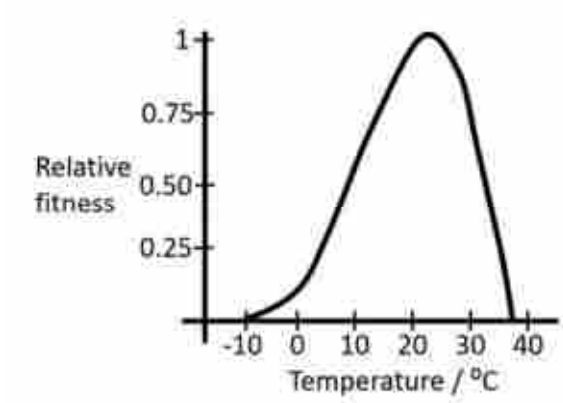


Fig. 4.1: Fitness curve of representative insect from temperate location

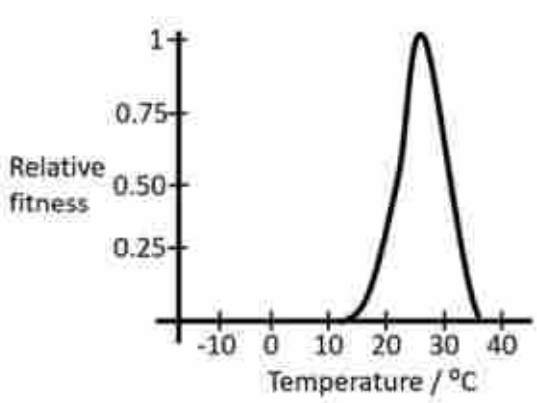


Fig. 4.2: Fitness curve of representative insect from tropical location

The mean annual temperature of the temperate location is 11□C, with a typical temperature range from 1□C to 20□C.
On the other hand, the mean annual temperature of the tropical location is 27□C, with a typical temperature range from 21□C to 31□C.

(i) Suggest what is meant by the term relative fitness in **Fig. 4.1** and **Fig. 4.2**.

……..[2]

1 **[Fitness]** a measure of evolutionary success as indicated by the number of surviving offspring left to produce the next generation;
2 **[Relative]** with reference to / as compared to **fitness at optimum temperature** (relative fitness of 1);

(ii) With reference to **Fig. 4.1** and **Fig. 4.2** and the information given, predict and explain which insects, from the temperate or tropical location, would face a greater extinction risk as a result of global warming, assuming the warming elevates temperatures equally at both locations.

……..[4]

[Predict]

1 Insects from the **<u>tropical location</u>**;

[Explain]

2 As these insects are already living **close to / just under / around /** (sometimes) **beyond** their **optimum temperature** for maximum relative fitness of 1 / these insects have a **narrower temperature tolerance**;

3 [Quote] Optimum temperature = 26 - 28□C (Accept: any figure within range) + mean annual temperature of the tropical location is 27□C OR typical temperature range from 21 to 31□C;

4 Ref. temperature predicted to increase by 2 – 3 □C as a result of global warming;

5 Ref. lower relative fitness beyond optimum temperature / Ref. temperature increase likely to lower relative fitness, thus, increasing extinction risk;

6 Ref. temperature increase likely to increase relative fitness of insects from temperate location instead, reducing extinction risk;

(iii) Suggest one strategy that the insects in **(ii)** can employ to reduce the impact of global warming on themselves.

……..[1]

1 Migration to cooler climate / regions / habitats / higher altitude / latitude;

(b) Carbon dioxide is one of the greenhouse gases that contribute to global warming and subsequently climate change.

A group of high school students decided to test whether varying temperatures would correspondingly affect the mean carbon dioxide gas emission.

Table 4.1 shows the mean carbon dioxide gas emission after exposing a fixed number of mealworms to different temperatures. Carbon dioxide gas emission was measured before and after exposure to experimental temperature.

Table 4.1 showing effects of varying temperatures on mean carbon dioxide gas emission, measured in parts per million (ppm).

Temperature /°C	**Mean Carbon dioxide gas emission /ppm**	
	Before exposure to experimental temperature	**After** exposure to experimental temperature
30.0	445 ± 25	450 ± 17
40.0	450 ± 20	500 ± 30
50.0	460 ± 17	540 ± 18

Values represent mean ± standard deviation.

(i) Describe the patterns shown by the data in **Table 4.1**.

……..[2]

1. [Trend] The mean carbon dioxide gas emission increases as temperature increases;
2. [Quote data] As temperature increases from 30.0°C to 50.0°C, emission increases from 450ppm to 540ppm.

OR

1. [Trend] **Increase** in carbon dioxide gas emission **after exposure** to experimental temperatures **compared to before** exposure, gets bigger as temperature increases
2. [Quote data] As temperature increases from 30.0°C to 50.0°C, increase in emission increases from 5ppm to 80ppm

(c) Corals are affected by rising temperatures in ocean waters. Explain how.

……..[2]

1. Ref. Absorption of **more carbon dioxide which dissolves** when ocean waters get warmer; **ocean pH decreases** / ocean acidification occurs
2. Hard **corals cannot absorb calcium carbonate** they need to maintain their **skeletons**, stony skeletons that support corals will dissolve and corals destroyed / Coral polyp metabolism is affected and **corals expels the zooxanthellae**, (leaving the coral skeleton bleached), and eventual **death of corals due to lack of nutrients (provided by zooxanthellae)**

OR

1. **Photosynthesis in zooxanthellae is disrupted** at higher than usual temperatures, thus producing an excess of **products that are toxic**

2. Coral polyp metabolism is affected and **corals expels the zooxanthellae**, (leaving the coral skeleton bleached), and eventual **death of corals due to lack of nutrients (provided by zooxanthellae)**

[Total: 11]

Section B

Answer **one** *question only*.

Write your answers on the lined paper provided at he end of this Question Paper.

Your answer should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in parts **(a)** and **(b)**, as indicated in the question.

QUESTION 5
Cellulose is the most abundant biopolymer on earth. It forms a significant proportion of the dry mass of plants.

Outline the role of atmospheric CO_2 in contributing to the structure of cellulose in plants. [15]

Process of Calvin cycle
1. ref. **Calvin cycle** / light-independent reactions in **stroma** of **chloroplast**;
2. **CO_2** (1-carbon molecule) is **fixed** by combining with (a 5C compound called) **ribulose 1,5-bisphosphate (RuBP)**;
3. catalysed by the enzyme **rubisco (RuBP carboxylase)**,
4. to form an **unstable intermediate 6C compound**, which immediately splits into half to form **2 molecules** of (a 3C compound called) **glycerate-3-phosphaste (PGA/GP)**;
5. **PGA/GP** is **reduced** to **triose phosphate (PGAL/TP)**;
6. The **electrons (hydrogen)** for this **reduction** come from **NADPH** produced from the **light-dependent reactions**
7. and the **energy** for this step comes from **ATP** produced from the **light-dependent reactions**;
8. For every ***3*** molecules of **CO_2**, there are ***6*** molecules of **triose phosphate / glyceraldehyde-3-phosphate / TP / PGAL / G3P**;
9. but only **1** molecule of **PGAL/TP** (**3C**) exits the cycle, and will be used by the plant cell to synthesise **carbohydrate** like glucose (sugar).
10. The other **5** molecules of **PGAL/TP** must be **recycled** to **regenerate** 3 molecules of **RuBP**;
11. RuBP is now prepared to receive **CO_2** again, and the cycle **continues**;

Max 8 pts

Structure of cellulose
12. ref. cellulose as a polymer of **β-glucose**;
13. Each β-glucose comes from **2 molecules of PGAL/TP** that exited Calvin cycle;
14. **6** carbon dioxide molecules required for synthesis of **1** molecule of β-glucose;

15. ref. **β(1→4) glycosidic bonds** between β-glucose molecules
16. catalyzed by the enzyme cellulose synthase.
17. adjacent units are oriented 180^0 to each other;
18. ref. cellulose exist as linear chains/form;
19. **Hydrogen bonds form between parallel chains** (as –OH points outwards) to establish cross-linkages between chains ;
20. ref. Microfibrils (and macrofibril) formation through association of many cellulose molecules (i.e. Many microfibrils combine to form macrofibrils)

Max 6 pts

QwC: [1mark] Clear, organised flow without ambiguity for Calvin cycle description and to include the link between cellulose (formed from **β**–glucose) and Calvin cycle.

QUESTION 6
Without genetic variation, some of the basic mechanisms bringing about evolutionary change cannot operate.

Explain how mutation events may contribute to variation, and how this variation can influence natural selection. [15]

1. ref. **germ-line mutations** / mutations that occur in the **gametes**, being **inherited** by the offspring;
2. ref. phenotype (characteristics) of the organism;

Gene mutation [max 4]

3. Spontaneous errors made during **DNA replication / DNA recombination / DNA repair**
4. ref. a change in the nucleotide / base sequence (may involve one or more bases) of the DNA molecule in a particular/single **gene locus / region** on a chromosome
5. ref. insertion/deletion/substitution/inversion of incorrect nucleotides
6. ref. an alteration in the DNA sequence may change the amino acid sequence
7. ref. introduction of **new alleles** into gene pool;

Chromosomal aberration [max 6]

8. Several gene loci are involved
9. Involves reshuffling of existing alleles in the gene pool (no creation of new alleles)

Change in the number of chromosomes

10. ref. **non-disjunction in mitosis or meiosis**
11. ref. failure of sister chromatids to separate during anaphase in mitosis / homologous chromosomes to separate during anaphase I in meiosis / chromatids to separate during anaphase II in meiosis
12. Can affect one, several or all the chromosomes within a nucleus
13. leads to a **change in the number of chromosomes**

Change in structure of chromosomes

14. ref. **chromosomal breaks that occur during mitosis or meiosis**
15. resulting in deletion, duplication, inversion or translocation of chromosomal segments
16. leads to a **change in the structure of chromosomes**
17. ref. reshuffling of alleles on the affected chromosomes

Natural Selection [max 3]

18. ref. different selection pressures which select for / favour individuals with selective advantage / beneficial phenotype/alleles;
19. More survive till reproductive age/maturity and reproduce to pass on advantageous alleles to their offspring;

20. After <u>many</u> generations / over time, natural selection will lead to change in frequency of alleles.

QwC: [1mark] Clear, organised flow without ambiguity for explanation of evolution with natural selection, and to include at least 1 description for gene mutation and chromosomal aberration;

- **END OF PAPER** -

CANDIDATE NAME: _____ **INDEX NUMBER** _____

CG _____

SERANGOON JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2018

H1 BIOLOGY **8876/01**
Paper 1 Multiple Choice

Friday
21 September 2018

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and CG in the spaces at the top of this page.

On the Multiple Choice Answer Sheet, write your name, subject title, test name and CG. For your index number, write your full NRIC number. Shade the corresponding lozenges on the Answer Sheet according to the instructions given by the invigilators.

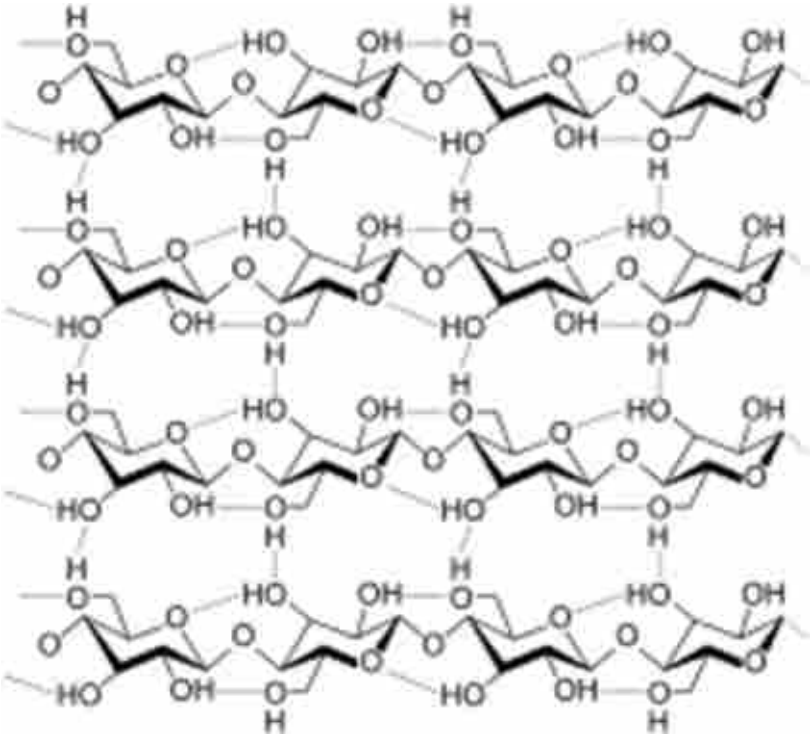
There are **thirty questions** on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

AT THE END OF THE EXAMINATION, SUBMIT BOTH THE MULTIPLE CHOICE ANSWER SHEET AND THE QUESTION PAPER.

This question paper consists of **18** printed pages including this cover page.

1. The following biomolecule is



A not a protein because of the presence of phenyl groups.

B a protein because of the presence of peptide linkages.

C not a carbohydrate because of the presence of regular repeated folding.

D a carbohydrate because of the presence of glycosidic linkages.

2. Some foods contain ‘hydrogenated vegetable oils’. These are unsaturated fats that have been converted to saturated fats.

   Which property of the fats will have changed?

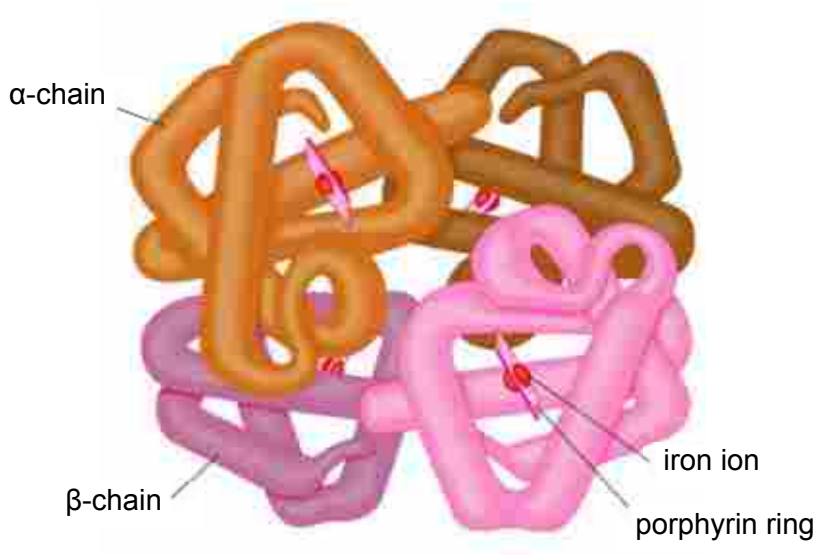
   A Their hydrocarbon chains will fit together more closely.

   B Their solubility in water will increase.

   C They will have more double bonds in their molecules.

   D They will remain liquid at room temperature.

3. A simplified representation of a haemoglobin molecule is shown below.



Several interacting pairs are listed below.

1 α-chain and β-chain
2 α-chain and porphyrin ring
3 iron ion and oxygen gas

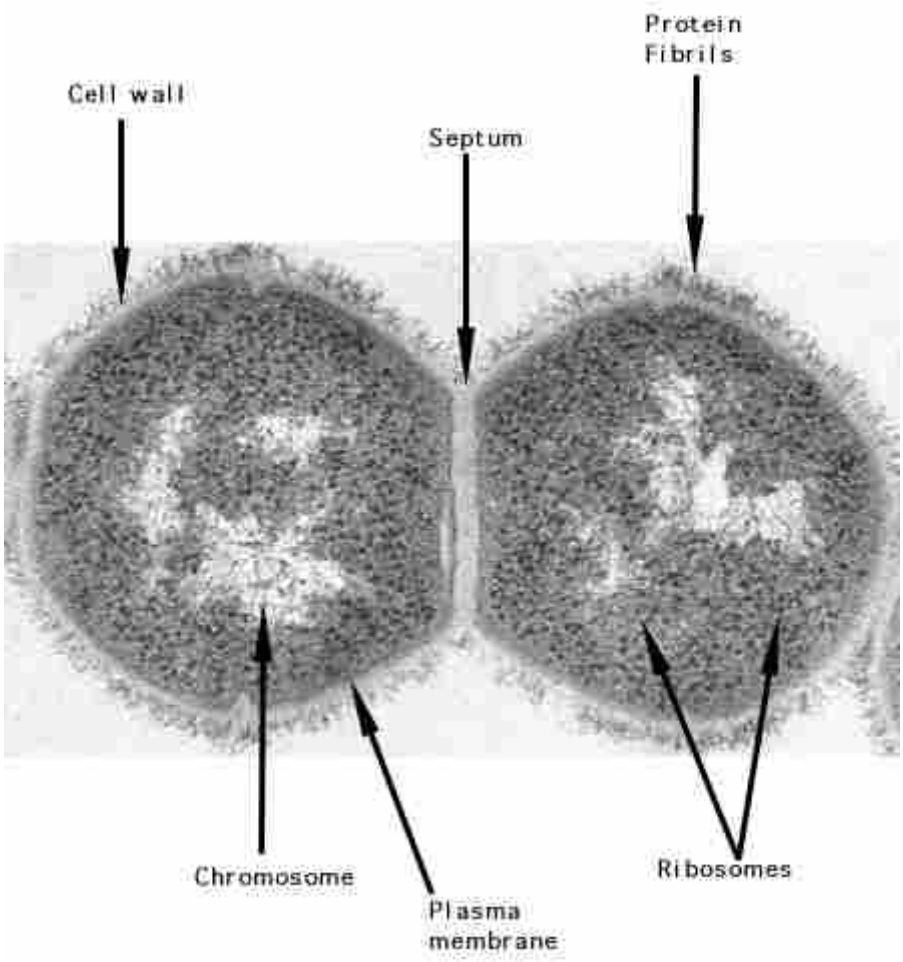
Which of the above pairs interact via weak interactions?

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

4. Which of the following does **not** describe a feature of an organelle that contributes to its respective function?

A The interior of a lysosome is acidic.
B The ribosome has rRNA and protein components.
C The Golgi body consists of membranous sacs that are independent.
D The smooth endoplasmic reticulum is not continuous with the nuclear membrane.

5. The following is an electron micrograph of a living cell that is dividing.



The following are some possible statements about the daughter cells:

1 These are a pair of plant cells as the septum represents the cell plate of the dividing cell.
2 These are a pair of bacterial cells as they have chromosomes and ribosomes.
3 These cannot be bacterial cells as they have a cell wall.
4 These are a pair of animal cells as they have proteins on their outer surface.
5 These cannot be animal cells as the ribosomes are located alongside the chromosomes.
6 These cannot be bacterial cells as circular DNA is not evident.

Which of the statements about these cells are correct?

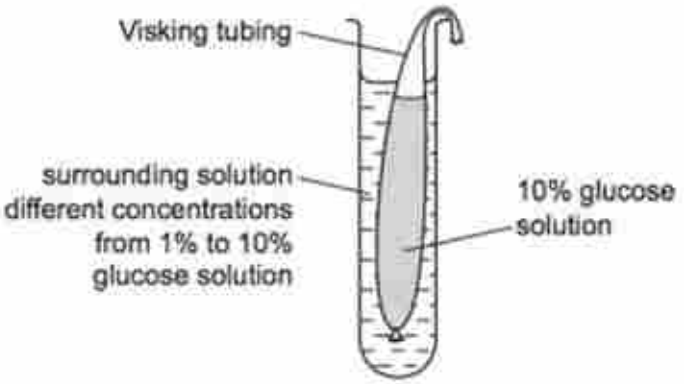
A 1 and 3

B 1 and 6

C 3 and 4

D 2 and 5

6. The diagram shows apparatus set up to investigate the effect of changing the concentration of glucose in the surrounding solution on the movement of molecules through a selectively permeable membrane (Visking tubing) in 15 minutes.



As the concentration of glucose solution in the surrounding solution increases, which statements are correct?

1 Net diffusion of water increases.

2 Glucose molecules reach an equilibrium quicker.

3 There is less change in the volume of surrounding solution.

4 Net diffusion of glucose increases.

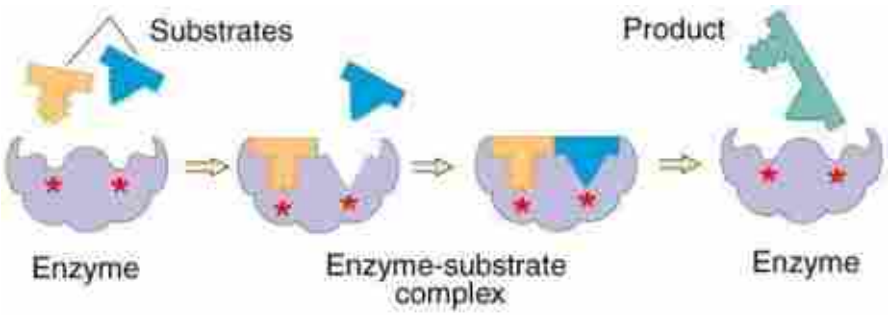
A 1 and 3 only

B 2 and 3 only

C 1, 2 and 4 only

D 1, 2, 3 and 4

7. The figure below shows the mode of action of a particular enzyme.



Which of the following is **only** true for the mode of enzyme action shown above?

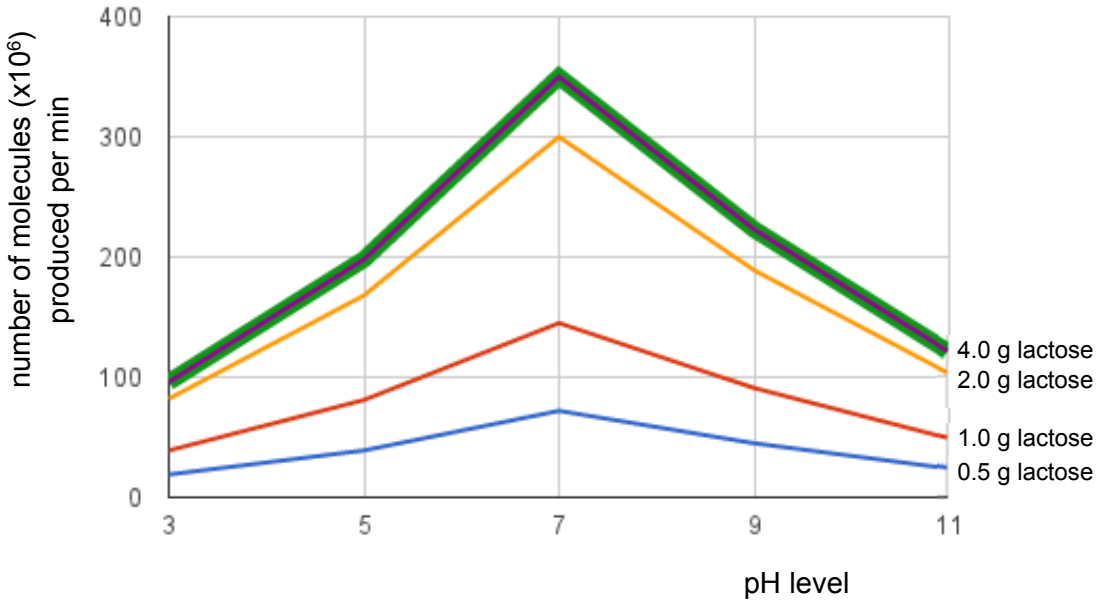
A A few amino acids give the active site a specific conformation.

B Both contact and catalytic residues interact with the substrate.

C The enzyme changes shape in the presence of the substrates.

D The substrate molecules are complementary to the active site.

8. The following is a graph showing the number of molecules of product produced from the digestion of lactose at different pH levels.



Which of the following is **not** a valid conclusion from this graph?

A Enzyme molecules are fully denatured at extreme pH levels.

B The reaction rate is likely to level off past a certain substrate concentration.

C pH level of 7 is the optimal pH for this enzyme.

D Increasing substrate concentration increases the rate of enzyme reaction.

9. The following are some statements related to cell and nuclear division in humans.

1 A diploid cell that results from mitosis will have the same alleles at the same loci.

2 The cell size increases significantly during cytokinesis.

3 Meiosis ensures that a fertilised cell has the diploid number of chromosomes.

4 The cell cycle of a specific cell includes either meiotic or mitotic division but never both at the same time.

Which pair of the above statements is **correct**?

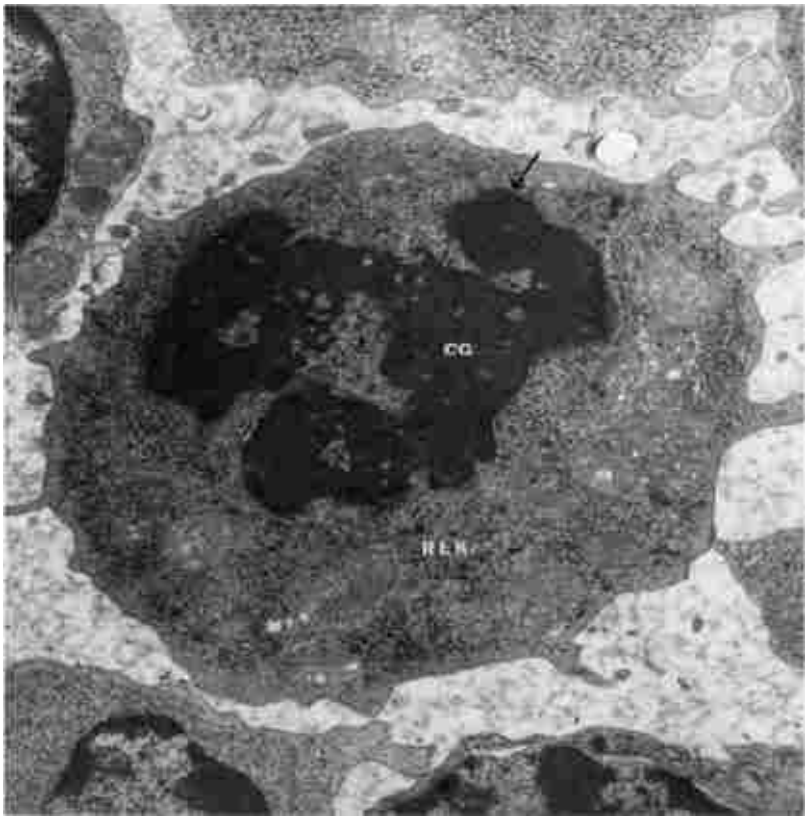
A 1 and 2 only

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

10. The following depicted cell is undergoing cell division.



(CG = chromatin granules, RER = rough endoplasmic reticulum, M = mitochondrion)

Which of the following is/are correct observations of the cell above that indicate(s) that it is undergoing division?

1 The nuclear membrane has been broken down.
2 Opposite poles have been established.
3 Rod-like chromosomes can be observed.

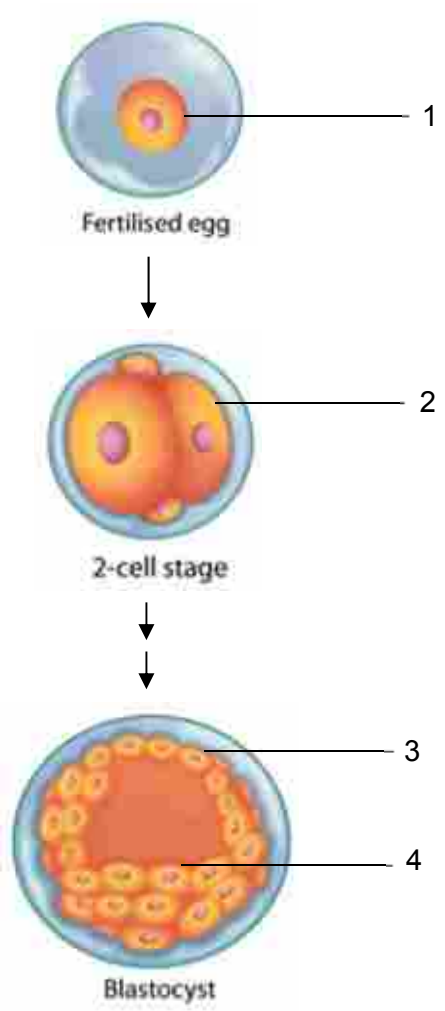
A 1 only

B 1 and 2 only

C 1 and 3 only

D None of the above

11. The figure below shows some stages of embryonic development. Four different cells are labelled 1, 2, 3 and 4 as shown.



Which of the following statements is incorrect?

A Cells 1 and 2 are totipotent.

B Cells 3 and 4 are pluripotent.

C Cell 3 is a result of mitoses involving Cell 1.

D Cells 2 and 4 can give rise to adult stem cells.

12. Scientists have made a nucleic acid (HNA) that has a sugar with the same number of carbon atoms as glucose instead of deoxyribose. Although genetic information can be stored by HNA, naturally occurring DNA polymerase cannot replicate HNA.

Which statements could explain why naturally occurring DNA polymerase cannot replicate HNA?

1 DNA polymerase cannot form bonds between the sugars of two HNA nucleotides.

2 DNA polymerase cannot form hydrogen bonds between two HNA nucleotides.

3 HNA nucleotides do not fit into the active site of DNA polymerase.

4 The shape of an HNA nucleotide is slightly larger than that of a DNA nucleotide.

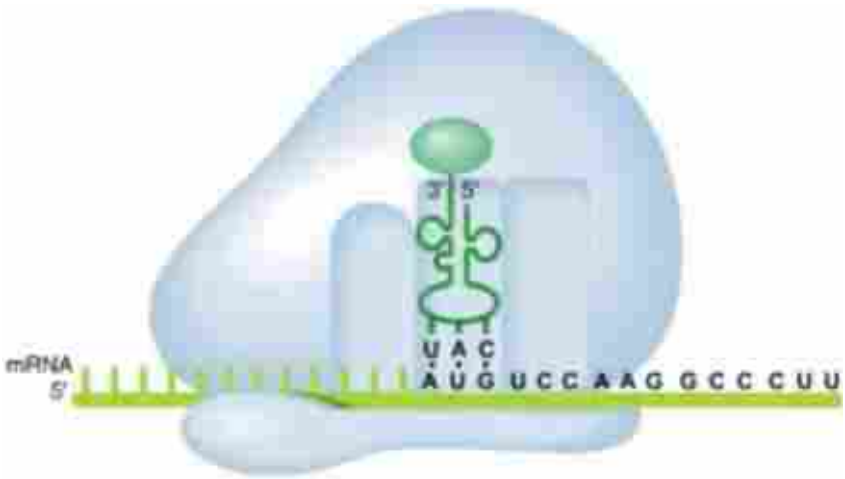
A 1, 2, 3 and 4

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

13. The figure below shows a stage in translation.



All of the following are events that occur after this stage **except** the

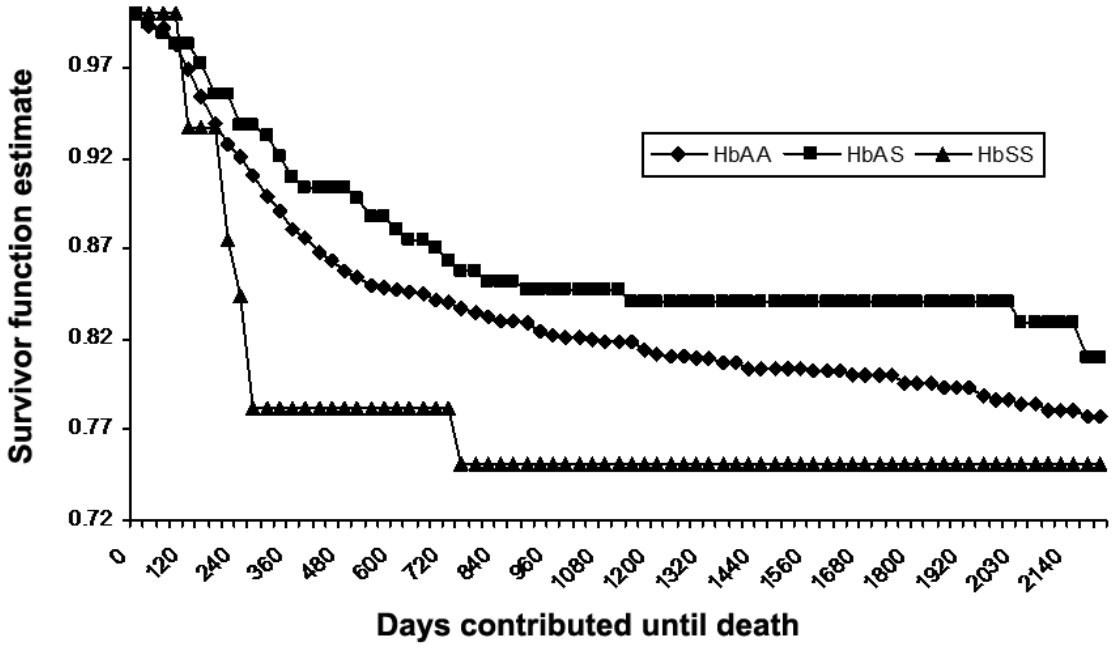
A addition of a poly(A) tail.

B folding of the polypeptide chain.

C use of GTP as an energy source.

D formation of peptide and hydrogen bonds.

14. The graph below shows the survival curves of children of the Luo ethnic group, which lives in an area of Kenya with widespread malaria.



(HbAS: Heterozygous sickle-cell haemoglobin; HbAA: normal haemoglobin; HbSS: homozygous sickle-cell haemoglobin.)

Which of the following is a valid interpretation of the data above?

A HbSS children have a higher chance of dying from sickle-cell anaemia than HbAA children.

B HbAS and HbSS children are selected against by the malarial parasite compared to HbAA children.

C HbAS children have a higher chance of dying due to susceptibility to both malaria and sickle-cell anaemia.

D HbAA and HbAS children show the same phenotype at all times and hence have similar survival rates.

15. The six statements are about the genes involved in the synthesis of particular glycoproteins referred to as human blood group antigens.

1 There are two genes, one carried on chromosome 19 and the other on chromosome 9.

2 The gene on chromosome 19 codes for an enzyme used for the synthesis of antigen H on the cell surface membrane of red blood cells.

3 The gene on chromosome 9 has variants that each codes for one of three different enzymes, two active and one inactive.

4 The active enzymes modify antigen H to produce different antigens.

5 If both active enzymes are present, red blood cells have two different modified antigens.

6 If only the genetic code for inactive enzyme is present, red blood cells have unmodified antigen H.

Which row links each genetic term to one or more statements that include an example of the genetic term?

	allele	codominant	locus	recessive	phenotype
A	1	4 and 5	2	3	5
B	1	4	2 and 3	2	3, 4 and 5
C	3	1	3	6	6
D	3	5	1, 2 and 3	6	5 and 6

16. In the magpie moth *Abraxas sp.*, the female is the heterogametic sex and the gene for wing colour is sex-linked.

In a cross between a normal coloured male and a pale coloured female, the F1 offspring consisted of all normal coloured individuals with the two sexes in equal proportions.

Which ratio would be obtained in the F2 generation produced from the F1 generation?

A Normal coloured males to normal females 1:1

B Normal coloured males and females to pale females 3:1

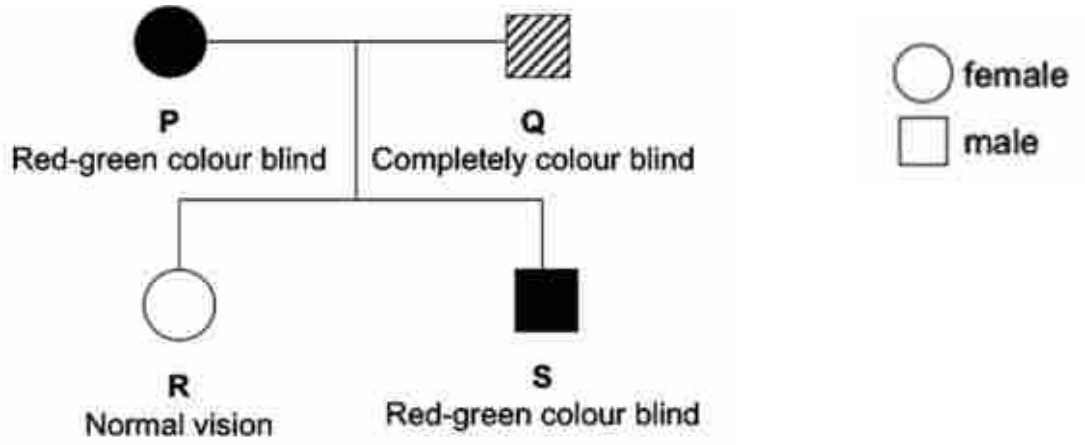
C Normal coloured males and females to pale males and females 1:1

D Normal coloured males to pale coloured females 1:1

17. Red-green colour blindness is controlled by a gene on the X chromosome. The allele for colour blindness, **g**, is recessive to the allele for normal colour vision, **G**.

Complete colour blindness is controlled by a different gene which is not on the X chromosome. The allele for the development of normal cones (pigment cells in the retinal layer of the eye), **B**, is dominant to the allele for no cone development, **b**.

The figure below shows the phenotypes of members of a different family in which both types of colour blindness occur.

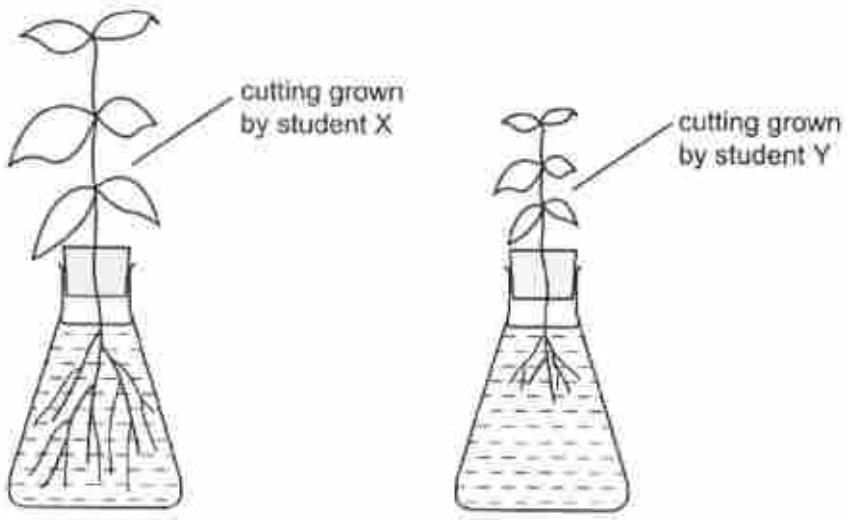


Which of the following are possible genotypes for individuals P, Q and S?

	P	Q	S
A	BBX^GX^G	bbX^GY	BBX^gY
B	BbX^GX^g	BbX^gY	BbX^GY
C	BBX^gX^g	bbX^GY	BbX^gY
D	BbX^GX^g	BbX^gY	BBX^GY

18. A student, X, looked after a plant. Another student, Y, looked after another plant of the same species. Each student followed the same instructions to set up apparatus to take cuttings from their plant and grow the cuttings next to the plant from which the cutting had been taken.

The diagrams show the results after one week.



Which factors could have caused the different appearance of the two cuttings?

1 phenotypic variation due to the environment
2 genetically different cuttings
3 mutation due to environment
4 genotypic variation due to environment

A 1 and 2 **B** 2 and 3 **C** 2 and 4 **D** 1, 3 and 4

19. Which stages of aerobic respiration in eukaryotes have the correct products?

	ATP	CO_2	FAD	NAD	reduced NAD
1 glycolysis	✓	×	×	×	✓
2 oxidative phosphorylation	✓	×	✓	✓	×
3 Krebs cycle	✓	✓	✓	×	✓
4 link reaction	✓	✓	×	×	✓

Key: ✓ = product × = not a product

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

20. In living cells, 2,4 dinitrophenol acts as a proton ionophore, an agent that can shuttle protons across biological membranes.

Which of the following is **not** a possible consequence of the introduction of 2,4 dinitrophenol into an animal cell?

A Less oxygen is taken up by the cell.

B The proton gradient across the inner mitochondrial membrane is dissipated.

C The rate of glycolysis in the cell will increase.

D The rate of Krebs cycle in the cell will increase.

21. There are two main forms of respiration, aerobic respiration and anaerobic respiration.

Which of the following only occurs during one form of respiration, but not the other?

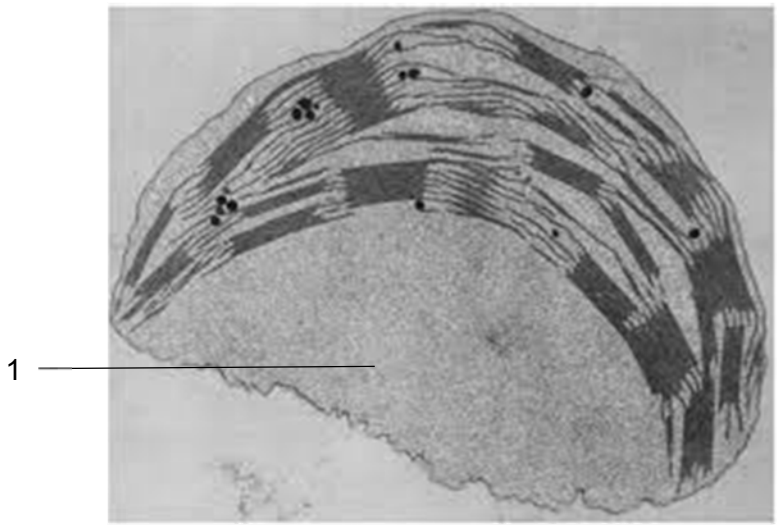
A Use of mitochondrial transport proteins

B Regeneration of hydrogen carriers

C Release of energy

D Substrate-level phosphorylation

22. An electron micrograph of a chloroplast is shown below, with region 1 marked out.



Which of the following does **not** occur in region 1?

A Synthesis of carbohydrates

B Storage of carbohydrates

C Synthesis of proteins

D Trapping of light

23. ...1… and …2… are reactants of the light-dependent stage of photosynthesis, but …3… is not a reactant of this stage.

	1	2	3
A	water	carbon dioxide	oxygen
B	NADP	carbon dioxide	water
C	water	NADP	ATP
D	NADP	ADP	water

24. Which of the following best explains why the population is the smallest unit that can evolve?

A There must be a group of individuals which have different phenotypes in order for selection to occur.

B Mutations must occur in different individuals in order for selection to occur.

C Individuals must be capable of producing fertile offspring in order for selection to occur.

D Individuals must be able to interact with their biotic and abiotic environment in order for selection to occur.

25. Deer mice are small, ground dwelling rodents. They normally have dark coats.

Some paler coated mice have been observed in an area where new sand hills were formed between 8000 and 15 000 years ago. The sand hills are sparsely covered with scrubby plants.

Studies have shown that the change in coat colour was due to a mutation in a gene, causing a single amino acid deletion from the protein for the coat colour pigment. This mutation seems to be spreading through the population.

Which statement most fully explains how the evolution of this species at this site has occurred?

A Better camouflage increases the chance of survival by reducing predation.

B Deer mice which live longer usually leave more offspring since they have more reproductive opportunities.

C The occurrence of the mutation provided new variation on which natural selection can act.

D The paler colour gives better camouflage against the background of the new sand hills.

26. New research conducted by evolutionary biologists worldwide paints cities as evolutionary "change agents", says a trio of biologists from the University of Toronto Mississauga (UTM). A compilation of 15 new research papers, published as a special issue of *Proceedings of the Royal Society B: Biological Sciences*, confirms that cities frequently alter evolution by natural selection.

The following statements are possible ways in which cities could alter evolution by natural selection.

1 Cities are generally warmer than natural areas and thus organisms adapted to higher temperatures would be selected for within cities.

2 Cities release large amounts of environmental pollutants and thus organisms with greater resistance to common pollutants would be selected for in areas within cities.

3 Cities provides additional food sources for many organisms and thus organisms that are adapted to feed on a wider range of food types would be selected for within cities.

4 Cities have a large human population so organisms that are better able to interact with humans will be selected for within the cities.

Which statements are potentially correct?

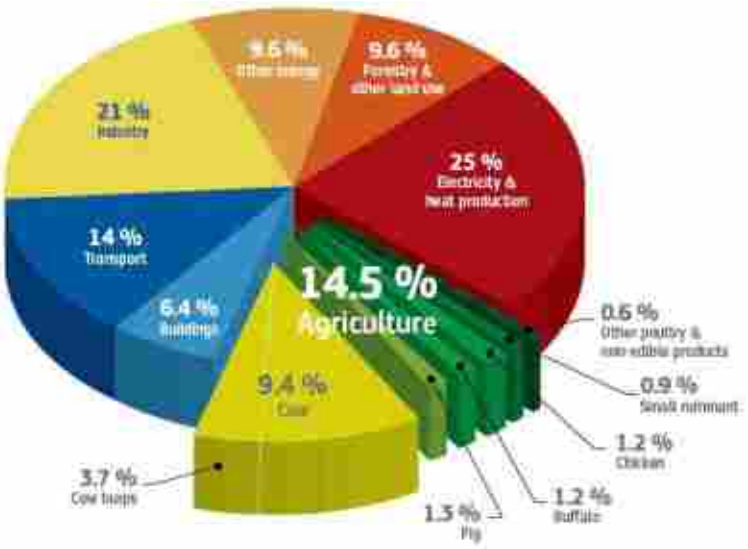
A 1 and 2 only

B 2 and 4 only

C 1, 2 and 3 only

D 1, 2, 3 and 4

27. The data below on greenhouse gas emissions by economic sector is reported by the Intergovernmental Panel on Climate Change and Food and Agriculture Organisation of the United Nations in 2015.



Based on the figure, what proportion of greenhouse gas emissions can be attributed to the use of fossil fuels?

A 25% **B** 46% **C** 76% **D** 85.6%

28. It has been discovered that deep corals, which are found at ocean depths below the reach of sunlight, is also affected by climate change.

Which of the following statements is a valid explanation as to why this is so?

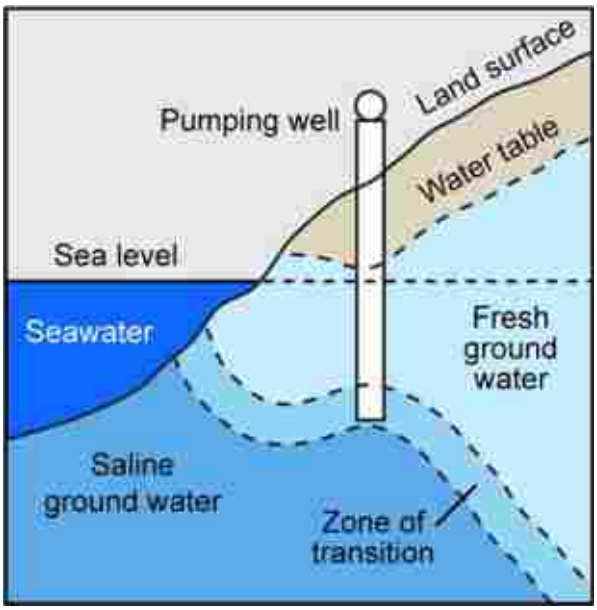
A The rate of photosynthesis at the deeper waters inhabited by the deep coral species is inhibited by a lack of carbon dioxide.

B Deep water coral species are adapted to lower temperatures and are unable to migrate to shallow waters which have a higher water temperature.

C The warming of surface water temperatures due to global warming has led to even the deeper waters heating up beyond the natural range of deep water coral species.

D The rising sea levels globally have led to deep corals being unable to receive sunlight for use by its symbiotic algae.

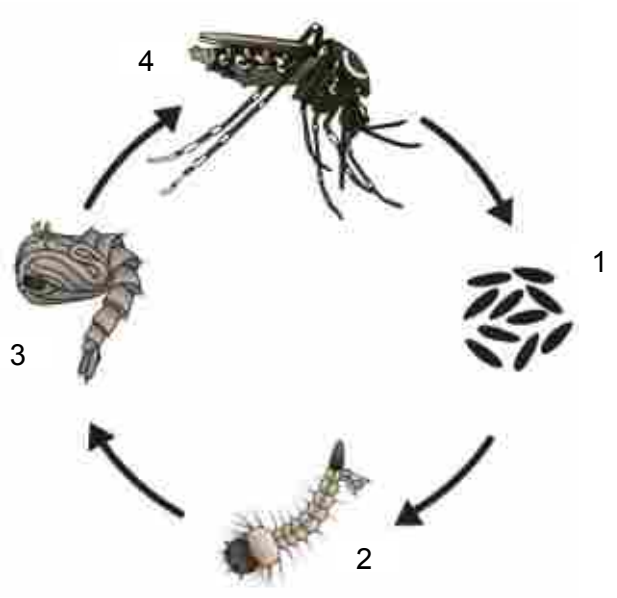
29. The figure below shows the distribution of water resources along a coast.



Which of the following reflects the correct changes in volume that occur with global warming?

	Seawater	Saline ground water	Fresh ground water
A	increase	decrease	decrease
B	increase	increase	decrease
C	decrease	decrease	increase
D	decrease	increase	increase

30. The life-cycle of *Aedes aegypti* is shown below.



Which is a correct statement related to the information above?

A Stage 1 can withstand prolonged periods of dry conditions.

B Only two out of the four stages above occur in water.

C Stage 3 is infected by the dengue virus before stage 4 infects human hosts.

D Both males and females of stage 4 can act as vectors for the dengue virus.

END OF PAPER

CANDIDATE NAME: _____ INDEX NUMBER _____

CG _____

SERANGOON JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2018

H1 BIOLOGY **8876/02**
Paper 2 Structured and Free-response Questions

Thursday
13 September 2018

2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, index number and CG in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINER'S USE	
Paper 1 (MCQ)	/30
Paper 2	
Section A	
1	/6
2	/8
3	/11
4	/9
5	/11
Section B	
6 or 7	/15
P2 Total	/60
Total	/90
TOTAL (100%)	

This question paper consists of **19** printed pages including this cover page.

Section A

Answer **all** the questions in this section.

1. Fig. 1.1 is an electron micrograph of part of an animal cell.

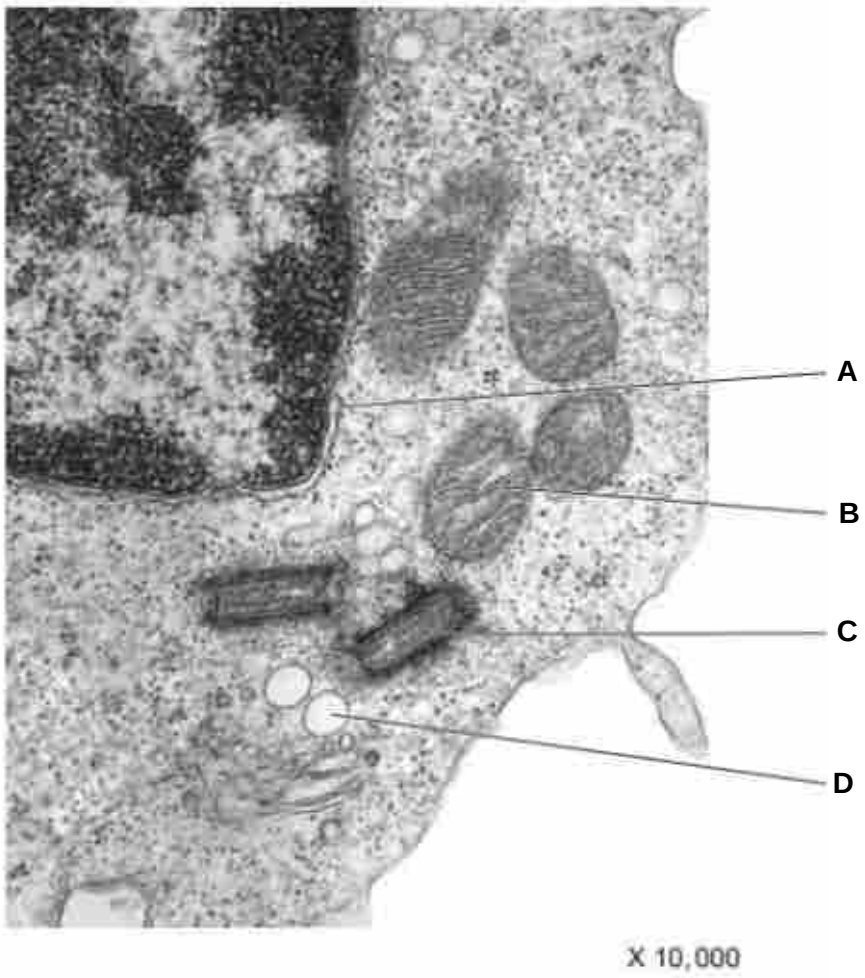


Fig. 1.1

(a) Name the membranes labelled **A** and **B**.

A ……

B ……
[2]

(b) Describe the role of structure **C** in cell division.

……

……

……

……[2]

(c) Explain how it possible for the pH in structure **D** to be kept constant.

……

……

……

……....[2]

[Total: 6]

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2. Fig. 2.1 is an electron micrograph of a cancer cell in the midst of mitosis.

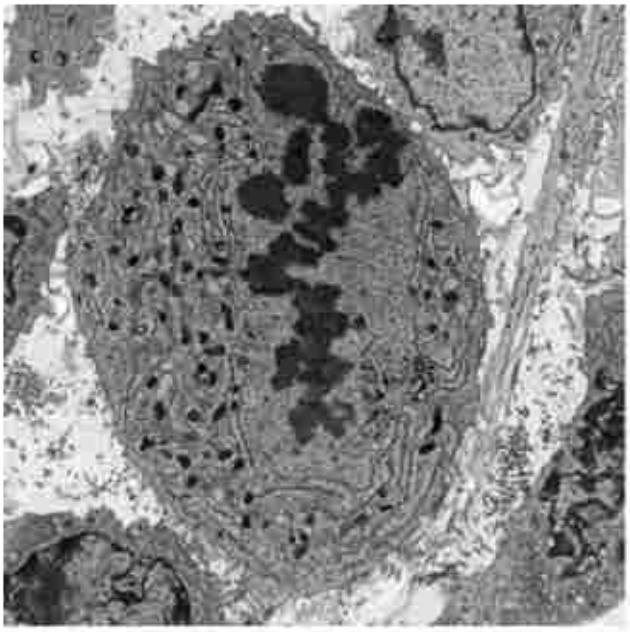


Fig. 2.1

(a) Identify the stage of mitosis, giving a reason for your answer.

stage ……

reason ……

……
[2]

People who have smoked cigarettes for many years are at risk of developing lung cancer.

(b) Explain why long-term smoking increases the risk of cancer in smokers.

……

……

……

……...[2]

Fig. 2.2 shows the change in the percentage of smokers in the male population of the UK between 1950 and 2005. Fig. 2.3 shows the change in mortality rate in the UK in men aged 75 to 84 between 1950 and 2005.

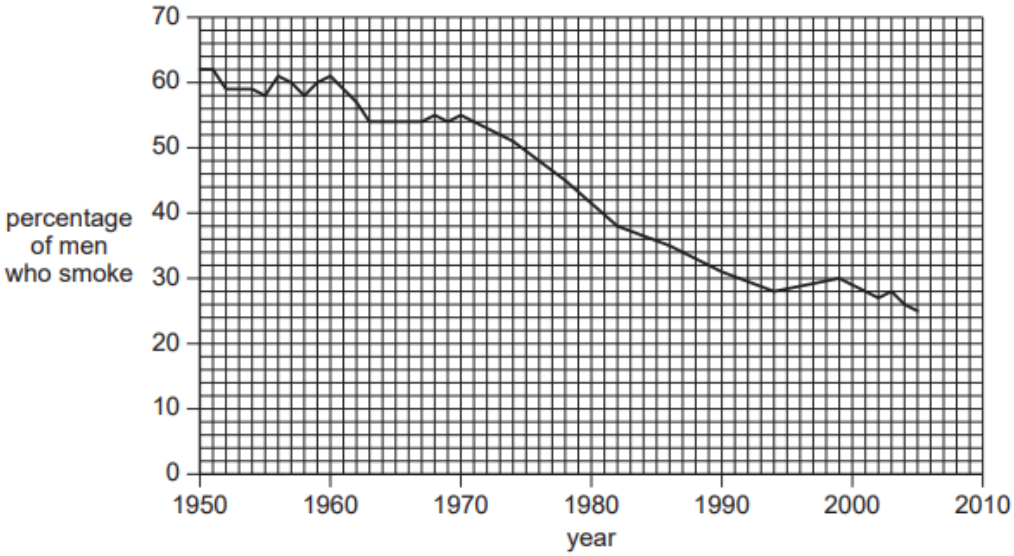


Fig. 2.2

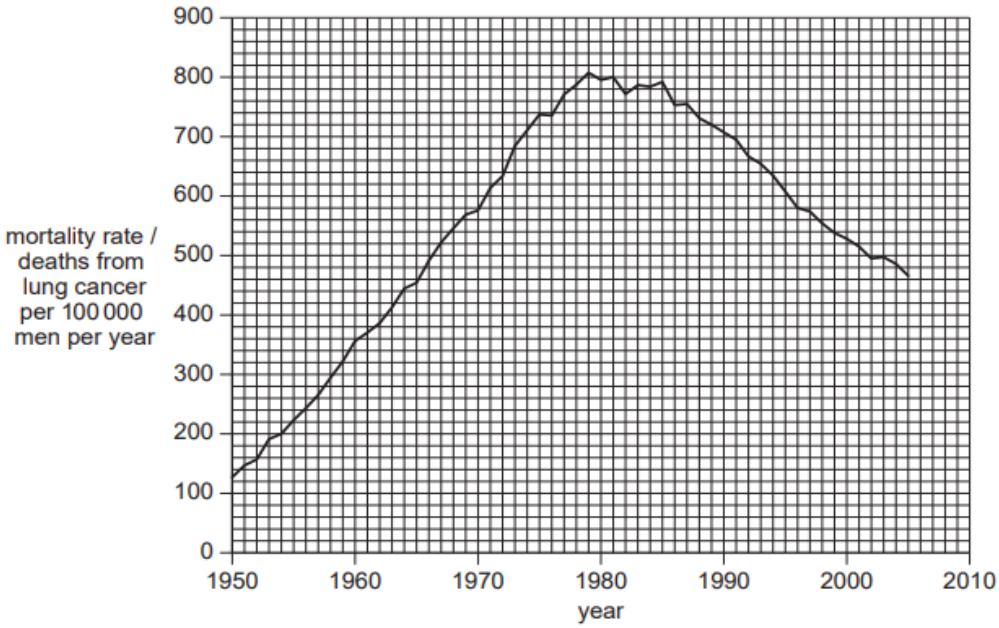


Fig. 2.3

(c) With reference to Figs. 2.2 and 2.3, discuss the observations made between 1950 and 2005.

……

……

……

……

……

……

……

……....[4]

[Total: 8]

3. DNA and RNA are some of the key molecules involved in the synthesis of proteins.

(a) Comment on how DNA and tRNA are different, in terms of the bases present.

……

……

……

……...[2]

(b) Calculate the minimum number of DNA nucleotides required to code for a polypeptide with 238 amino acids.

- Show your working in the space below.
- State the **two** properties of the genetic code that are considered in deriving your answer.

……

……

……

……...[3]

(c) Describe the role played by tRNA in polypeptide synthesis.

……

……

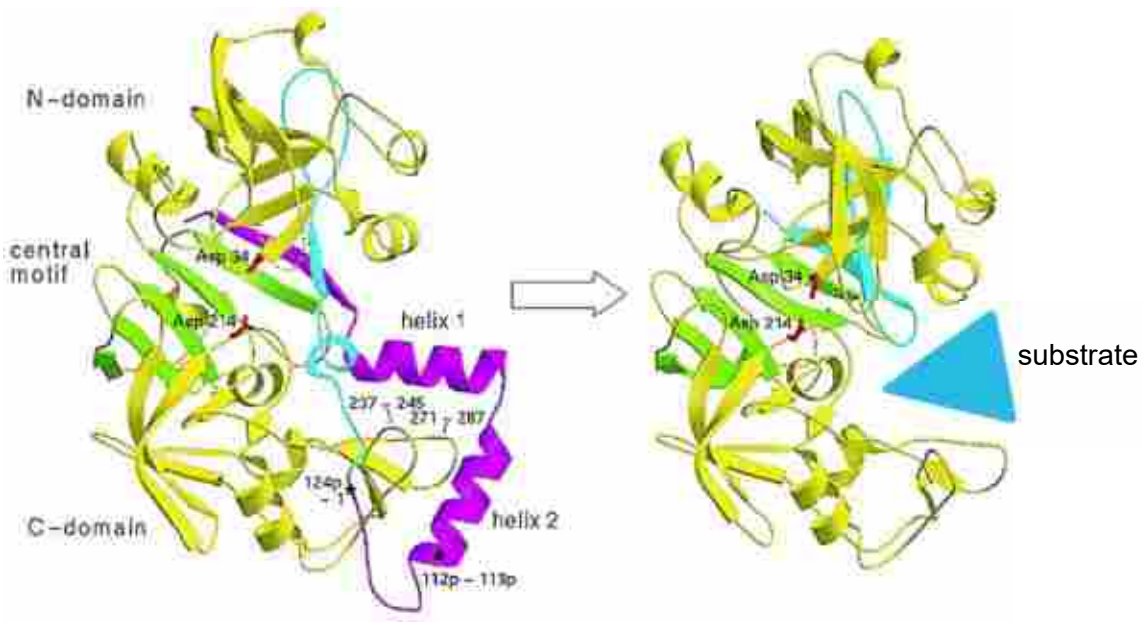
……

……

……

……...[3]

(d) Regulation can occur following the synthesis of proteins. An example of such regulation is shown in Fig. 3.1, where inactive enzyme precursor pepsinogen is modified post-translationally to form active pepsin.



Pepsinogen (Inactive) **Pepsin (Active)**

Fig. 3.1

(i) With reference to Fig. 3.1, describe the post-translational change observed in the enzyme and explain why it results in its activation.

……

……

……

……....[2]

(ii) Suggest why pepsin is synthesised as an inactive precursor pepsinogen.

……

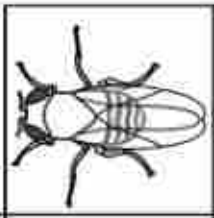
……....[1]

[Total: 11]

4. The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features. Table 4.1 shows diagrams of a wild-type fly and three other flies, each of which shows one **recessive mutation**.

Table 4.1

				
eyes	present	present	absent	present
abdomen	striped	black	striped	striped
wing description	long	long	long	short

(a) Explain what is meant by a "recessive mutation".

……

……

……

……....[2]

(b) Using appropriate symbols, illustrate a cross between a fly without eyes and long wings and one with eyes and short wings that would result in **four** different phenotypes being observed in the offspring.

[4]

(c) The class of mutations giving rise to the various mutant phenotypes in Table 4.1 are termed as **gene mutations**.

Explain how these mutations are different from chromosomal aberrations.

……

……

……

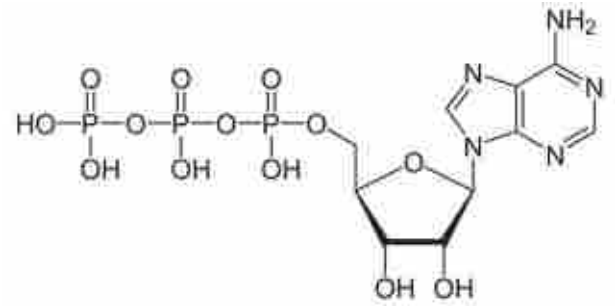
……

……

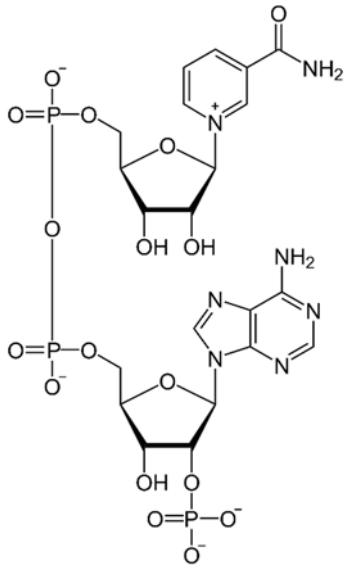
……...[3]

[Total: 9]

5. ATP and NADP both play important roles in photosynthesis. Fig. 5.1 represents the molecular structures of ATP and NADP.



ATP



NADP

Fig. 5.1

(a) Using Fig. 5.1, compare the structures of ATP and NADP.

……

……

……

……

……

……[3]

(b) Outline the roles of NADP in a cell.

……

……

……

……[2]

(c) State the names of the processes in which ATP is synthesised during photosynthesis and respiration respectively.

photosynthesis ……

……

respiration ……

……
[2]

(d) ATP serves as a source of energy for several metabolic processes in both photosynthesis and respiration.

Name one process in **respiration** that requires ATP as an energy source.

……....[1]

(e) The first substrate used in respiration is glucose. In a situation of excess glucose, some of these glucose is stored as fats instead of carbohydrates.

Explain why animals prefer to store lipid instead of carbohydrates.

……

……

……

……

……

……....[3]

[Total: 11]

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6. **(a)** Explain how climate change affects the spread of dengue beyond the tropics. [5]

(b) Discuss how variation is generated in a population, and explain why it is important in natural selection. [10]

[Total: 15]

7. **(a)** Explain how man's food choices can lead to climate change impacts. [5]

(b) Explain what is meant by the fluid mosaic model, and discuss the importance of membrane fluidity in biological processes. [10]

[Total: 15]

[Total: 15]

CANDIDATE NAME: _____ **INDEX NUMBER** _____

CG _____

SERANGOON JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2018

H1 BIOLOGY **8876/01**
Paper 1 Multiple Choice

Friday
21 September 2018

Additional Materials: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and CG in the spaces at the top of this page.

On the Multiple Choice Answer Sheet, write your name, subject title, test name and CG. For your index number, write your full NRIC number. Shade the corresponding lozenges on the Answer Sheet according to the instructions given by the invigilators.

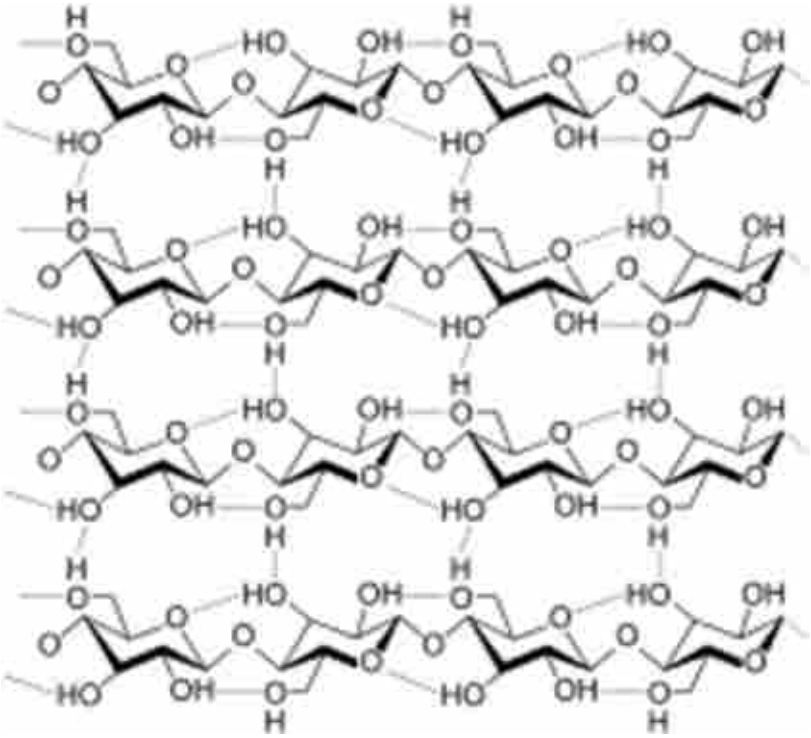
There are **thirty questions** on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

AT THE END OF THE EXAMINATION, SUBMIT BOTH THE MULTIPLE CHOICE ANSWER SHEET AND THE QUESTION PAPER.

This question paper consists of **18** printed pages including this cover page.

1. The following biomolecule is



A not a protein because of the presence of phenyl groups.

B a protein because of the presence of peptide linkages.

C not a carbohydrate because of the presence of regular repeated folding.

D a carbohydrate because of the presence of glycosidic linkages.

2. Some foods contain ‘hydrogenated vegetable oils’. These are unsaturated fats that have been converted to saturated fats.

Which property of the fats will have changed?

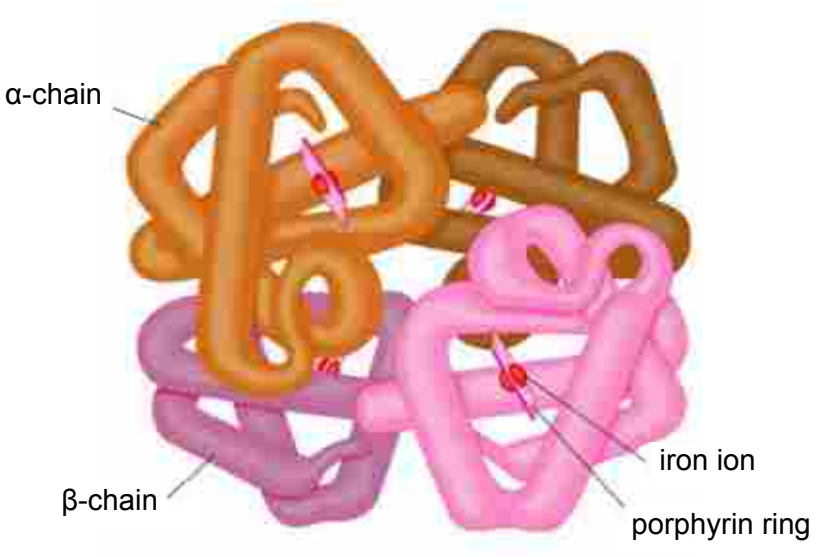
A Their hydrocarbon chains will fit together more closely.

B Their solubility in water will increase.

C They will have more double bonds in their molecules.

D They will remain liquid at room temperature.

3. A simplified representation of a haemoglobin molecule is shown below.



Several interacting pairs are listed below.

1 α-chain and β-chain
2 α-chain and porphyrin ring
3 iron ion and oxygen gas

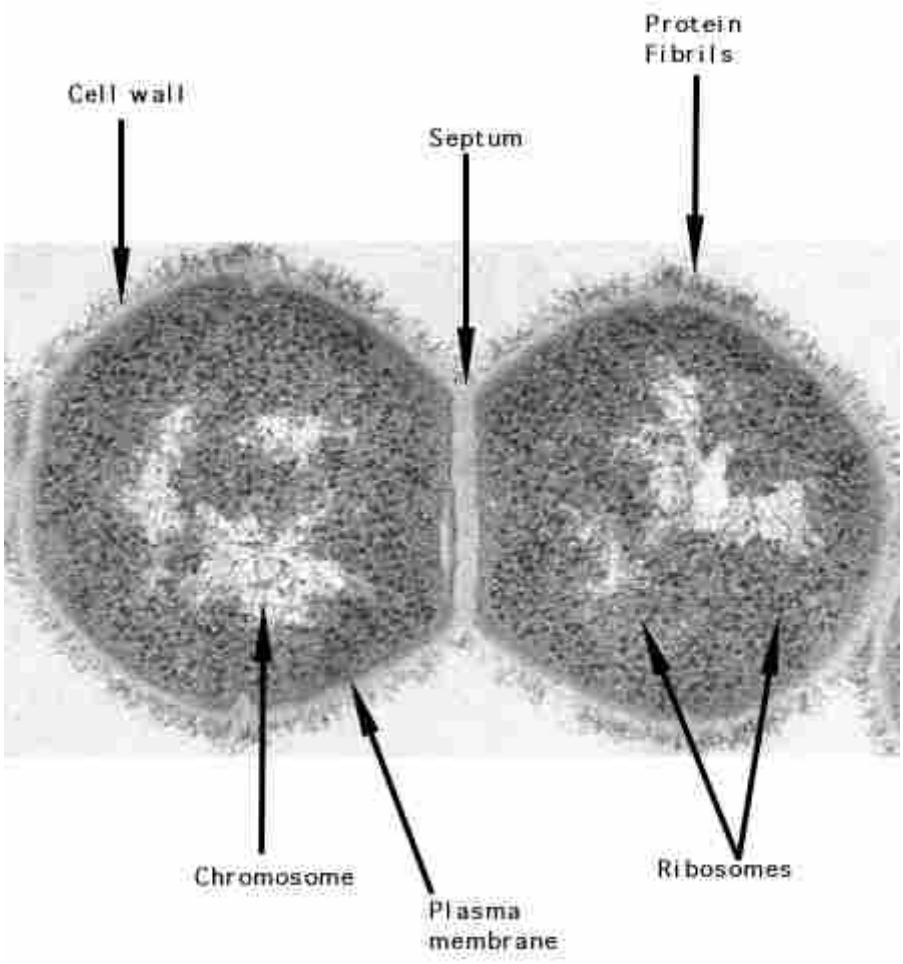
Which of the above pairs interact via weak interactions?

A 1 and 2 only
B 1 and 3 only
C 2 and 3 only
D 1, 2 and 3

4. Which of the following does **not** describe a feature of an organelle that contributes to its respective function?

A The interior of a lysosome is acidic.
B The ribosome has rRNA and protein components.
C The Golgi body consists of membranous sacs that are independent.
D The smooth endoplasmic reticulum is not continuous with the nuclear membrane.

5. The following is an electron micrograph of a living cell that is dividing.



The following are some possible statements about the daughter cells:

1 These are a pair of plant cells as the septum represents the cell plate of the dividing cell.
2 These are a pair of bacterial cells as they have chromosomes and ribosomes.
3 These cannot be bacterial cells as they have a cell wall.
4 These are a pair of animal cells as they have proteins on their outer surface.
5 These cannot be animal cells as the ribosomes are located alongside the chromosomes.
6 These cannot be bacterial cells as circular DNA is not evident.

Which of the statements about these cells are correct?

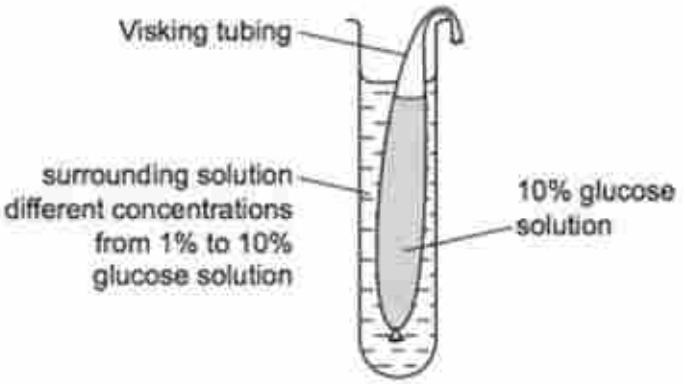
A 1 and 3

B 1 and 6

C 3 and 4

D 2 and 5

6. The diagram shows apparatus set up to investigate the effect of changing the concentration of glucose in the surrounding solution on the movement of molecules through a selectively permeable membrane (Visking tubing) in 15 minutes.



As the concentration of glucose solution in the surrounding solution increases, which statements are correct?

1 Net diffusion of water increases.

2 Glucose molecules reach an equilibrium quicker.

3 There is less change in the volume of surrounding solution.

4 Net diffusion of glucose increases.

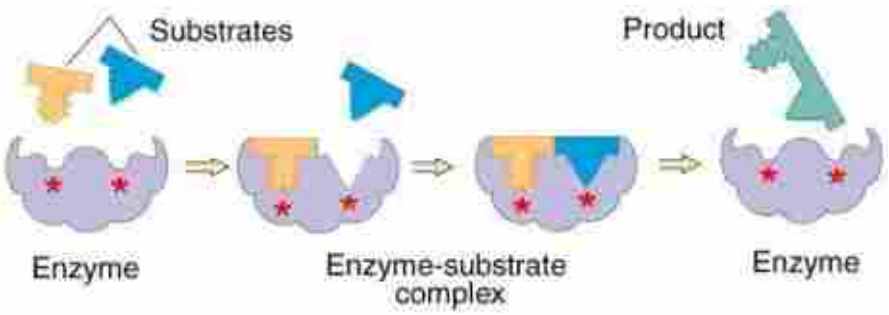
A 1 and 3 only

B 2 and 3 only

C 1, 2 and 4 only

D 1, 2, 3 and 4

7. The figure below shows the mode of action of a particular enzyme.



Which of the following is **only** true for the mode of enzyme action shown above?

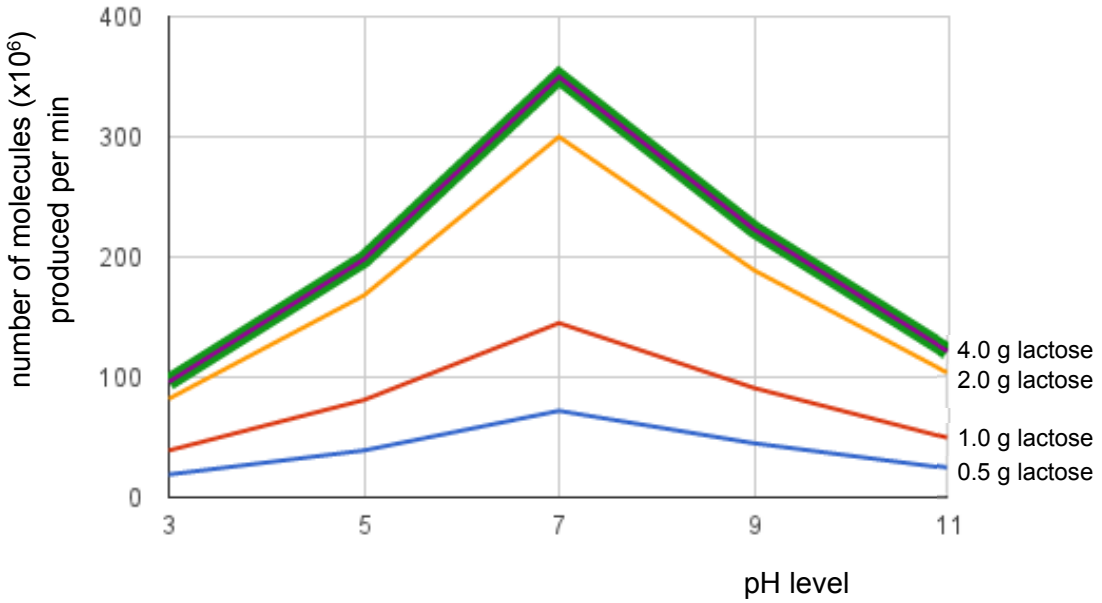
A A few amino acids give the active site a specific conformation.

B Both contact and catalytic residues interact with the substrate.

C The enzyme changes shape in the presence of the substrates.

D The substrate molecules are complementary to the active site.

8. The following is a graph showing the number of molecules of product produced from the digestion of lactose at different pH levels.



Which of the following is **not** a valid conclusion from this graph?

A Enzyme molecules are fully denatured at extreme pH levels.

B The reaction rate is likely to level off past a certain substrate concentration.

C pH level of 7 is the optimal pH for this enzyme.

D Increasing substrate concentration increases the rate of enzyme reaction.

9. The following are some statements related to cell and nuclear division in humans.

1 A diploid cell that results from mitosis will have the same alleles at the same loci.

2 The cell size increases significantly during cytokinesis.

3 Meiosis ensures that a fertilised cell has the diploid number of chromosomes.

4 The cell cycle of a specific cell includes either meiotic or mitotic division but never both at the same time.

Which pair of the above statements is **correct**?

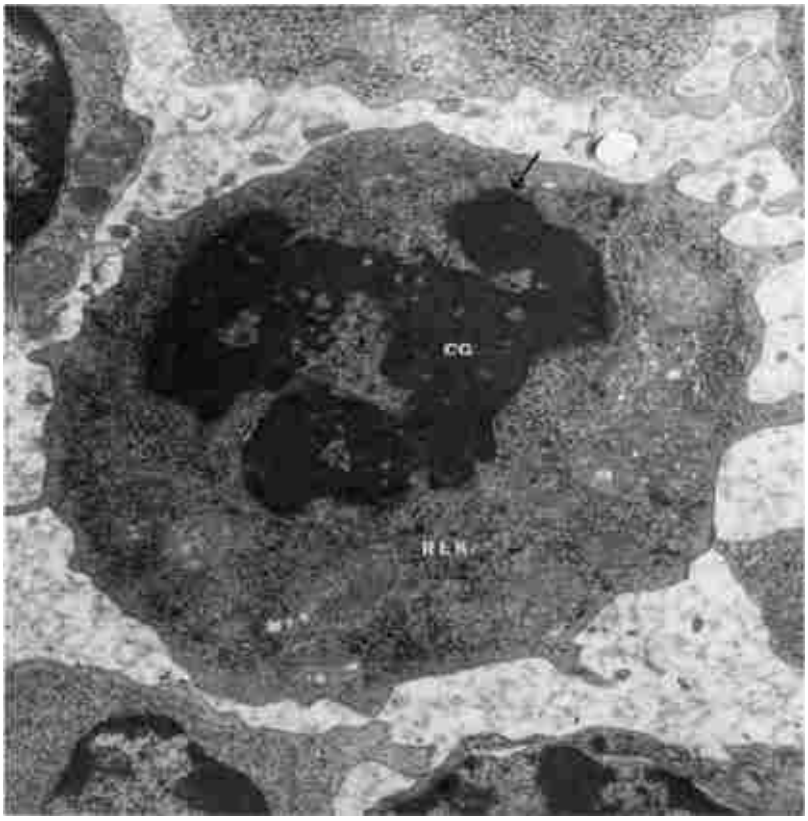
A 1 and 2 only

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

10. The following depicted cell is undergoing cell division.



(CG = chromatin granules, RER = rough endoplasmic reticulum, M = mitochondrion)

Which of the following is/are correct observations of the cell above that indicate(s) that it is undergoing division?

1 The nuclear membrane has been broken down.
2 Opposite poles have been established.
3 Rod-like chromosomes can be observed.

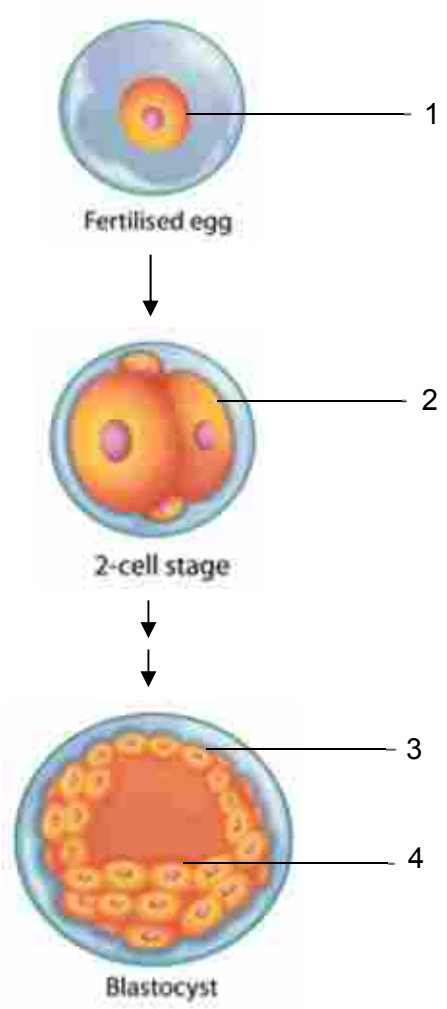
A 1 only

B 1 and 2 only

C 1 and 3 only

D None of the above

11. The figure below shows some stages of embryonic development. Four different cells are labelled 1, 2, 3 and 4 as shown.



Which of the following statements is incorrect?

A Cells 1 and 2 are totipotent.

B Cells 3 and 4 are pluripotent.

C Cell 3 is a result of mitoses involving Cell 1.

D Cells 2 and 4 can give rise to adult stem cells.

12. Scientists have made a nucleic acid (HNA) that has a sugar with the same number of carbon atoms as glucose instead of deoxyribose. Although genetic information can be stored by HNA, naturally occurring DNA polymerase cannot replicate HNA.

Which statements could explain why naturally occurring DNA polymerase cannot replicate HNA?

1 DNA polymerase cannot form bonds between the sugars of two HNA nucleotides.

2 DNA polymerase cannot form hydrogen bonds between two HNA nucleotides.

3 HNA nucleotides do not fit into the active site of DNA polymerase.

4 The shape of an HNA nucleotide is slightly larger than that of a DNA nucleotide.

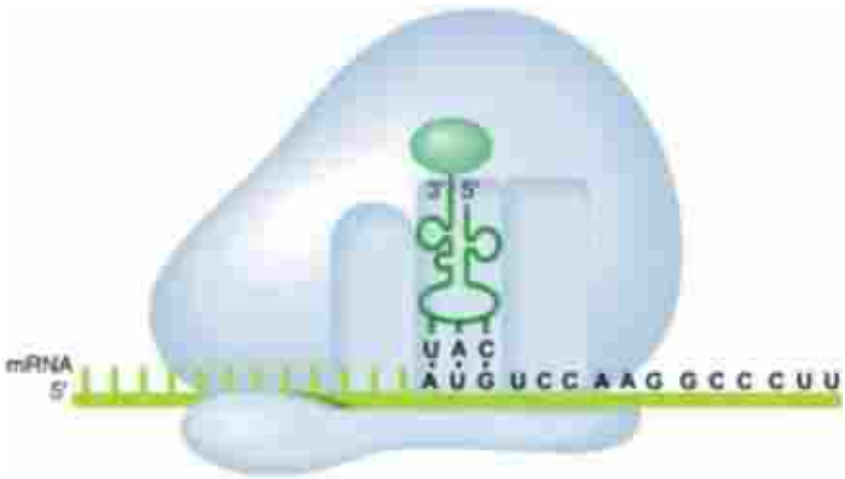
A 1, 2, 3 and 4

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

13. The figure below shows a stage in translation.



All of the following are events that occur after this stage **except** the

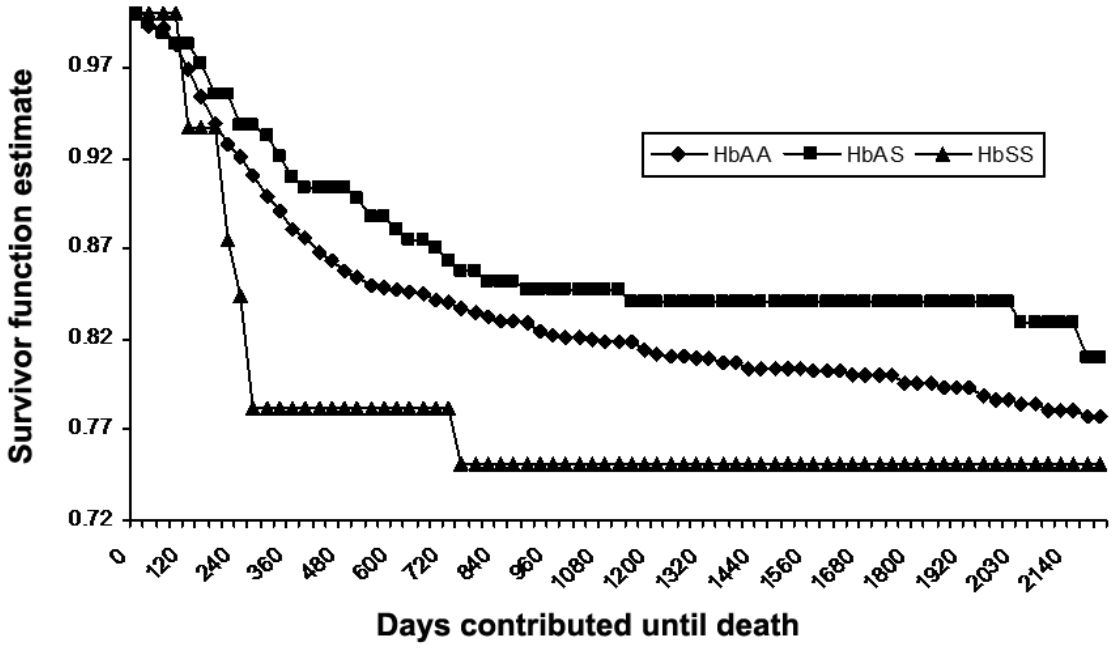
A addition of a poly(A) tail.

B folding of the polypeptide chain.

C use of GTP as an energy source.

D formation of peptide and hydrogen bonds.

14. The graph below shows the survival curves of children of the Luo ethnic group, which lives in an area of Kenya with widespread malaria.



(HbAS: Heterozygous sickle-cell haemoglobin; HbAA: normal haemoglobin; HbSS: homozygous sickle-cell haemoglobin.)

Which of the following is a valid interpretation of the data above?

A HbSS children have a higher chance of dying from sickle-cell anaemia than HbAA children.

B HbAS and HbSS children are selected against by the malarial parasite compared to HbAA children.

C HbAS children have a higher chance of dying due to susceptibility to both malaria and sickle-cell anaemia.

D HbAA and HbAS children show the same phenotype at all times and hence have similar survival rates.

15. The six statements are about the genes involved in the synthesis of particular glycoproteins referred to as human blood group antigens.

1 There are two genes, one carried on chromosome 19 and the other on chromosome 9.

2 The gene on chromosome 19 codes for an enzyme used for the synthesis of antigen H on the cell surface membrane of red blood cells.

3 The gene on chromosome 9 has variants that each codes for one of three different enzymes, two active and one inactive.

4 The active enzymes modify antigen H to produce different antigens.

5 If both active enzymes are present, red blood cells have two different modified antigens.

6 If only the genetic code for inactive enzyme is present, red blood cells have unmodified antigen H.

Which row links each genetic term to one or more statements that include an example of the genetic term?

	allele	codominant	locus	recessive	phenotype
A	1	4 and 5	2	3	5
B	1	4	2 and 3	2	3, 4 and 5
C	3	1	3	6	6
D	3	5	1, 2 and 3	6	5 and 6

16. In the magpie moth *Abraxas sp.*, the female is the heterogametic sex and the gene for wing colour is sex-linked.

In a cross between a normal coloured male and a pale coloured female, the F1 offspring consisted of all normal coloured individuals with the two sexes in equal proportions.

Which ratio would be obtained in the F2 generation produced from the F1 generation?

A Normal coloured males to normal females 1:1

B Normal coloured males and females to pale females 3:1

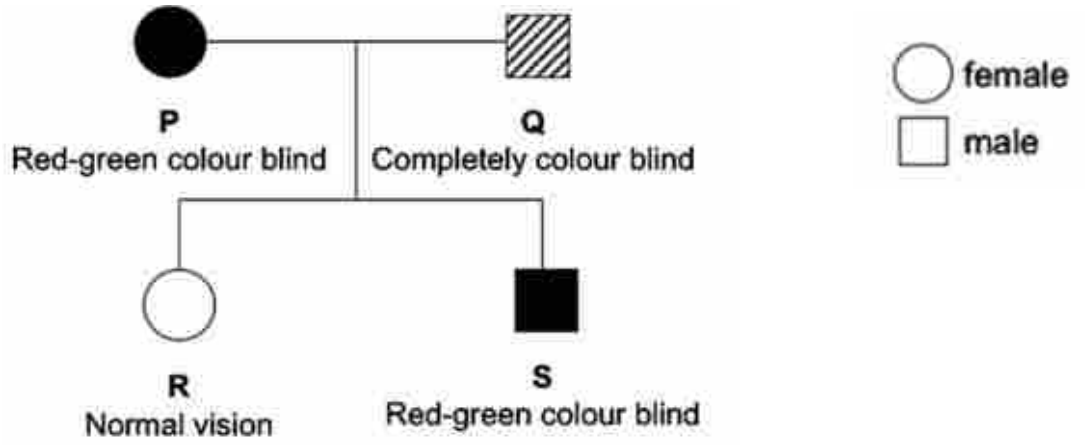
C Normal coloured males and females to pale males and females 1:1

D Normal coloured males to pale coloured females 1:1

17. Red-green colour blindness is controlled by a gene on the X chromosome. The allele for colour blindness, **g**, is recessive to the allele for normal colour vision, **G**.

Complete colour blindness is controlled by a different gene which is not on the X chromosome. The allele for the development of normal cones (pigment cells in the retinal layer of the eye), **B**, is dominant to the allele for no cone development, **b**.

The figure below shows the phenotypes of members of a different family in which both types of colour blindness occur.

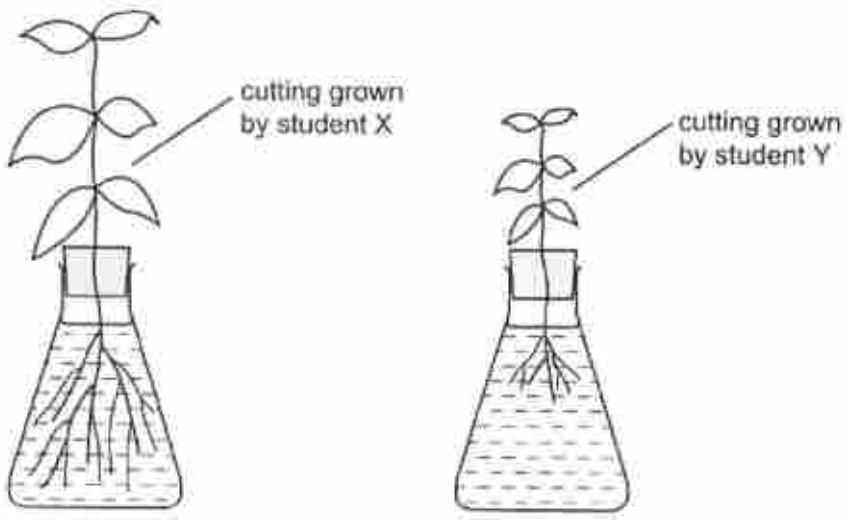


Which of the following are possible genotypes for individuals P, Q and S?

	P	Q	S
A	BBX^GX^G	bbX^GY	BBX^gY
B	BbX^GX^g	BbX^gY	BbX^GY
C	BBX^gX^g	bbX^GY	BbX^gY
D	BbX^GX^g	BbX^gY	BBX^GY

18. A student, X, looked after a plant. Another student, Y, looked after another plant of the same species. Each student followed the same instructions to set up apparatus to take cuttings from their plant and grow the cuttings next to the plant from which the cutting had been taken.

The diagrams show the results after one week.



Which factors could have caused the different appearance of the two cuttings?

1 phenotypic variation due to the environment
2 genetically different cuttings
3 mutation due to environment
4 genotypic variation due to environment

A 1 and 2 **B** 2 and 3 **C** 2 and 4 **D** 1, 3 and 4

19. Which stages of aerobic respiration in eukaryotes have the correct products?

	ATP	CO_2	FAD	NAD	reduced NAD
1 glycolysis	✓	×	×	×	✓
2 oxidative phosphorylation	✓	×	✓	✓	×
3 Krebs cycle	✓	✓	✓	×	✓
4 link reaction	✓	✓	×	×	✓

Key: ✓ = product × = not a product

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 3 and 4

20. In living cells, 2,4 dinitrophenol acts as a proton ionophore, an agent that can shuttle protons across biological membranes.

Which of the following is **not** a possible consequence of the introduction of 2,4 dinitrophenol into an animal cell?

A Less oxygen is taken up by the cell.

B The proton gradient across the inner mitochondrial membrane is dissipated.

C The rate of glycolysis in the cell will increase.

D The rate of Krebs cycle in the cell will increase.

21. There are two main forms of respiration, aerobic respiration and anaerobic respiration.

Which of the following only occurs during one form of respiration, but not the other?

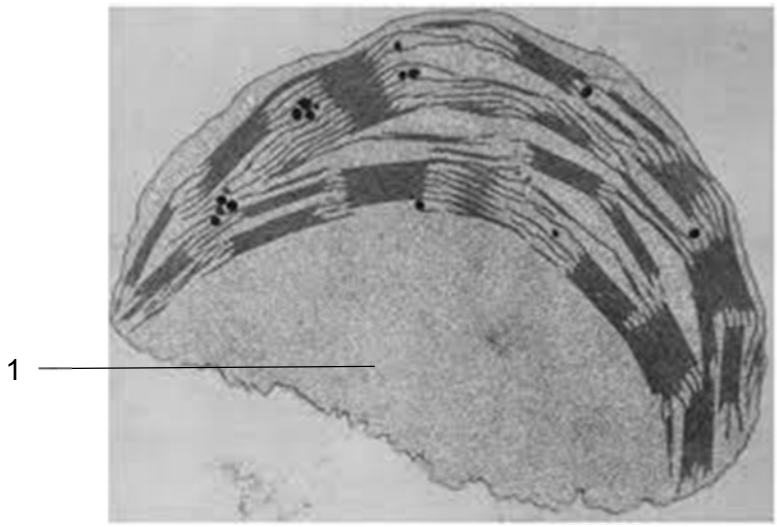
A Use of mitochondrial transport proteins

B Regeneration of hydrogen carriers

C Release of energy

D Substrate-level phosphorylation

22. An electron micrograph of a chloroplast is shown below, with region 1 marked out.



Which of the following does **not** occur in region 1?

A Synthesis of carbohydrates

B Storage of carbohydrates

C Synthesis of proteins

D Trapping of light

23. ...1… and …2… are reactants of the light-dependent stage of photosynthesis, but …3… is not a reactant of this stage.

	1	2	3
A	water	carbon dioxide	oxygen
B	NADP	carbon dioxide	water
C	water	NADP	ATP
D	NADP	ADP	water

24. Which of the following best explains why the population is the smallest unit that can evolve?

A There must be a group of individuals which have different phenotypes in order for selection to occur.

B Mutations must occur in different individuals in order for selection to occur.

C Individuals must be capable of producing fertile offspring in order for selection to occur.

D Individuals must be able to interact with their biotic and abiotic environment in order for selection to occur.

25. Deer mice are small, ground dwelling rodents. They normally have dark coats.

Some paler coated mice have been observed in an area where new sand hills were formed between 8000 and 15 000 years ago. The sand hills are sparsely covered with scrubby plants.

Studies have shown that the change in coat colour was due to a mutation in a gene, causing a single amino acid deletion from the protein for the coat colour pigment. This mutation seems to be spreading through the population.

Which statement most fully explains how the evolution of this species at this site has occurred?

A Better camouflage increases the chance of survival by reducing predation.

B Deer mice which live longer usually leave more offspring since they have more reproductive opportunities.

C The occurrence of the mutation provided new variation on which natural selection can act.

D The paler colour gives better camouflage against the background of the new sand hills.

26. New research conducted by evolutionary biologists worldwide paints cities as evolutionary "change agents", says a trio of biologists from the University of Toronto Mississauga (UTM). A compilation of 15 new research papers, published as a special issue of *Proceedings of the Royal Society B: Biological Sciences*, confirms that cities frequently alter evolution by natural selection.

The following statements are possible ways in which cities could alter evolution by natural selection.

1 Cities are generally warmer than natural areas and thus organisms adapted to higher temperatures would be selected for within cities.

2 Cities release large amounts of environmental pollutants and thus organisms with greater resistance to common pollutants would be selected for in areas within cities.

3 Cities provides additional food sources for many organisms and thus organisms that are adapted to feed on a wider range of food types would be selected for within cities.

4 Cities have a large human population so organisms that are better able to interact with humans will be selected for within the cities.

Which statements are potentially correct?

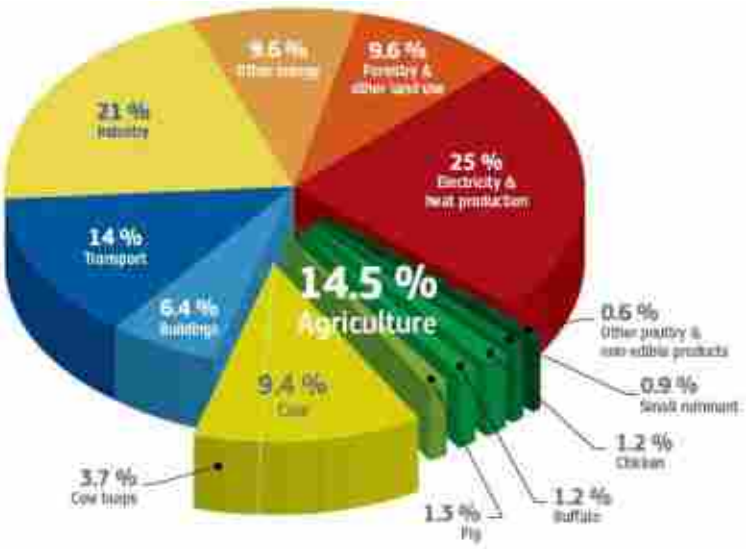
A 1 and 2 only

B 2 and 4 only

C 1, 2 and 3 only

D 1, 2, 3 and 4

27. The data below on greenhouse gas emissions by economic sector is reported by the Intergovernmental Panel on Climate Change and Food and Agriculture Organisation of the United Nations in 2015.



Based on the figure, what proportion of greenhouse gas emissions can be attributed to the use of fossil fuels?

A 25% **B** 46% **C** 76% **D** 85.6%

28. It has been discovered that deep corals, which are found at ocean depths below the reach of sunlight, is also affected by climate change.

Which of the following statements is a valid explanation as to why this is so?

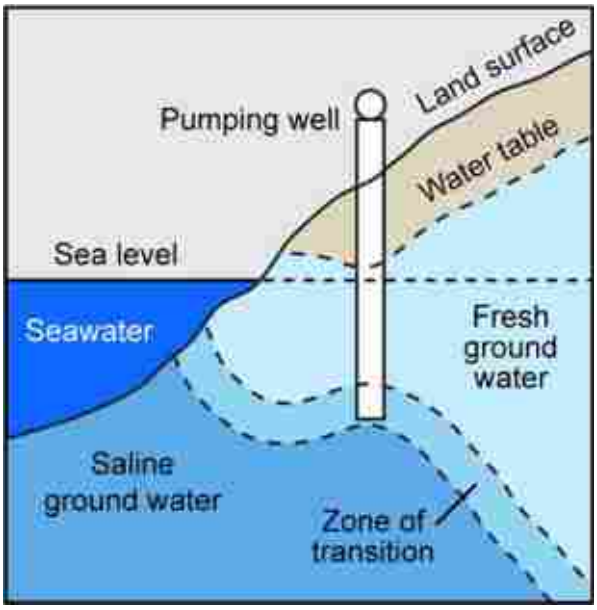
A The rate of photosynthesis at the deeper waters inhabited by the deep coral species is inhibited by a lack of carbon dioxide.

B Deep water coral species are adapted to lower temperatures and are unable to migrate to shallow waters which have a higher water temperature.

C The warming of surface water temperatures due to global warming has led to even the deeper waters heating up beyond the natural range of deep water coral species.

D The rising sea levels globally have led to deep corals being unable to receive sunlight for use by its symbiotic algae.

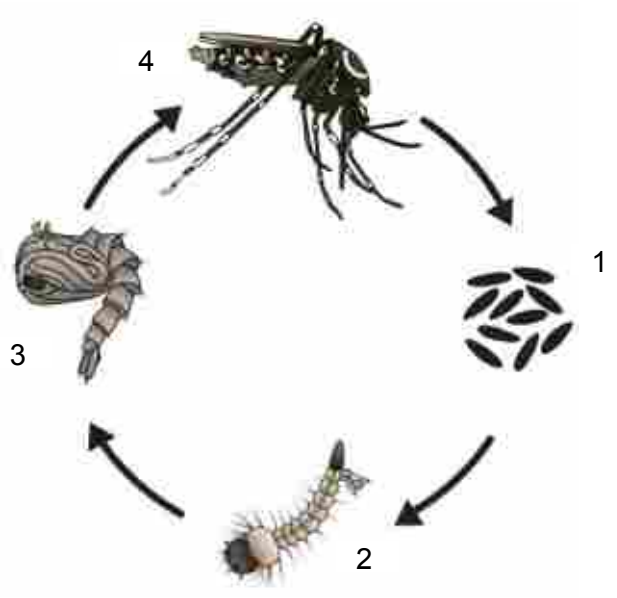
29. The figure below shows the distribution of water resources along a coast.



Which of the following reflects the correct changes in volume that occur with global warming?

	Seawater	Saline ground water	Fresh ground water
A	increase	decrease	decrease
B	increase	increase	decrease
C	decrease	decrease	increase
D	decrease	increase	increase

30. The life-cycle of *Aedes aegypti* is shown below.



Which is a correct statement related to the information above?

A Stage 1 can withstand prolonged periods of dry conditions.

B Only two out of the four stages above occur in water.

C Stage 3 is infected by the dengue virus before stage 4 infects human hosts.

D Both males and females of stage 4 can act as vectors for the dengue virus.

END OF PAPER

CANDIDATE NAME: _____ INDEX NUMBER _____

CG _____

SERANGOON JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2018

H1 BIOLOGY **8876/02**
Paper 2 Structured and Free-response Questions

Thursday
13 September 2018

2 hours

READ THESE INSTRUCTIONS FIRST

Write your name, index number and CG in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.

You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINER'S USE	
Paper 1 (MCQ)	/30
Paper 2	
Section A	
1	/6
2	/8
3	/11
4	/9
5	/11
Section B	
6 or 7	/15
P2 Total	/60
Total	/90
TOTAL (100%)	

This question paper consists of **16** printed pages including this cover page.

Section A

Answer **all** the questions in this section.

1. Fig. 1.1 is an electron micrograph of part of an animal cell.

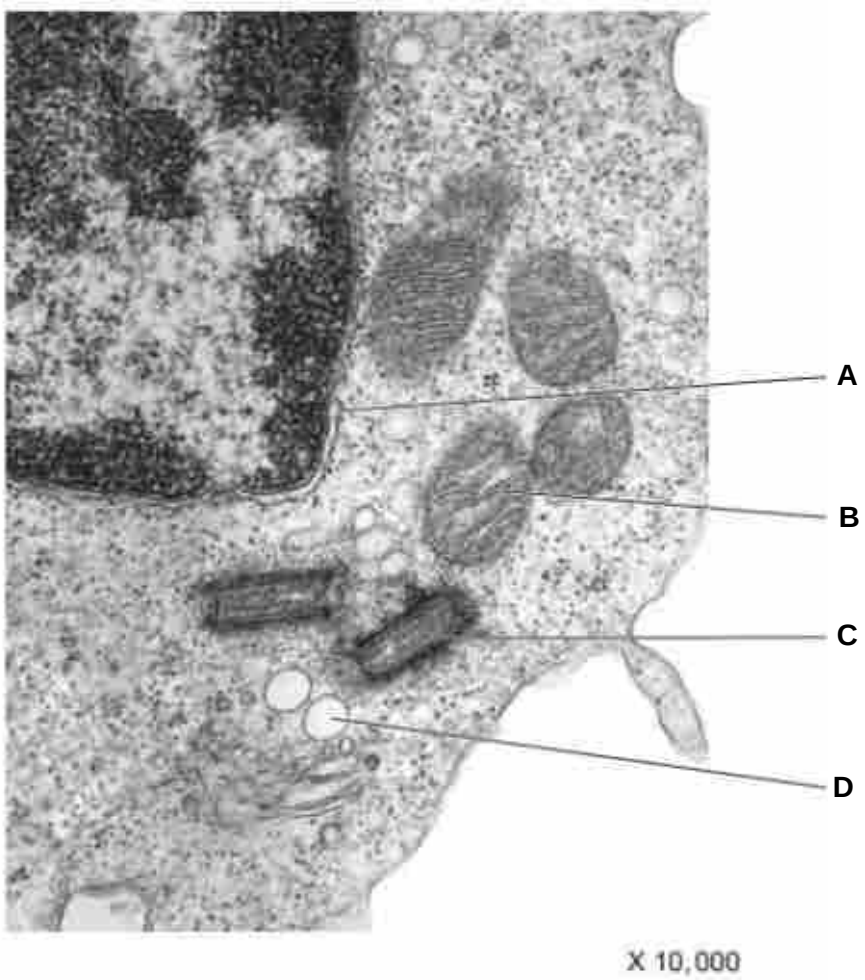


Fig. 1.1

(a) Name the membranes labelled **A** and **B**. [2]

A: nuclear envelope
B: crista(e)/ inner mitochondrial membrane

(b) Describe the role of structure **C** in cell division. [2]

1. Assembly/ organisation of spindle fibres/ microtubule
2. To separate chromosomes/ chromatids during mitosis/ meiosis/ cell division

(c) Explain how it possible for the pH in structure **D** to be kept constant. [2]

1. Membrane of structure D is largely hydrophobic due to hydrophobic fatty acid tails of phospholipid bilayer
2. Prevents charged/ hydrophilic H^+ *(Reject: polar)* from diffusing across freely

[Total: 6]

2. Fig. 2.1 is an electron micrograph of a cancer cell in the midst of mitosis.

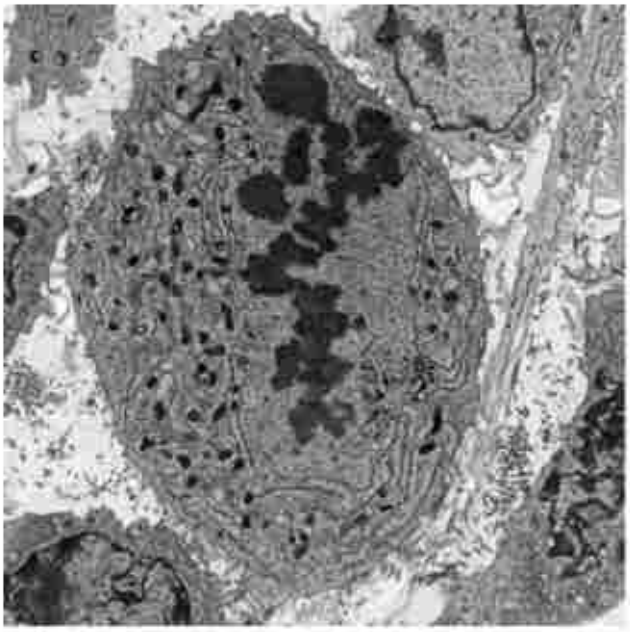


Fig. 2.1

(a) Identify the stage of mitosis, giving a reason for your answer. [2]

1. Stage: Metaphase
2. Reason: chromosomes align in a single/ one row at the equator/ metaphase plate

People who have smoked cigarettes for many years are at risk of developing lung cancer.

(b) Explain why long-term smoking increases the risk of cancer in smokers. [2]

1. Cigarettes contain chemical carcinogens/ or named example e.g. tar, nitrosamines which increases the rate of mutation
2. Ref. to long-term smoking and (idea of) continued exposure to carcinogens, hence leading to the accumulation of mutations that cause cancer

Fig. 2.2 shows the change in the percentage of smokers in the male population of the UK between 1950 and 2005. Fig. 2.3 shows the change in mortality rate in the UK in men aged 75 to 84 between 1950 and 2005.

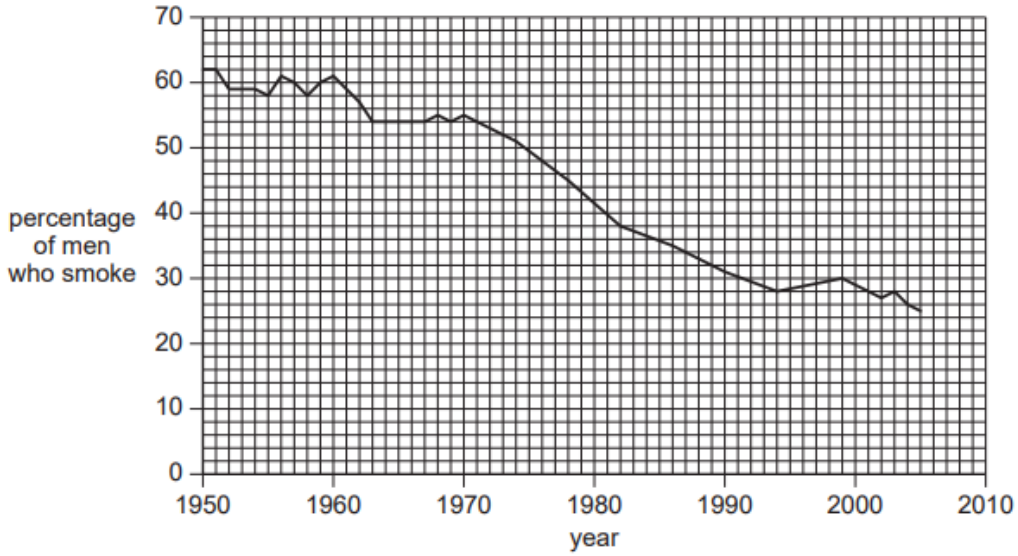


Fig. 2.2

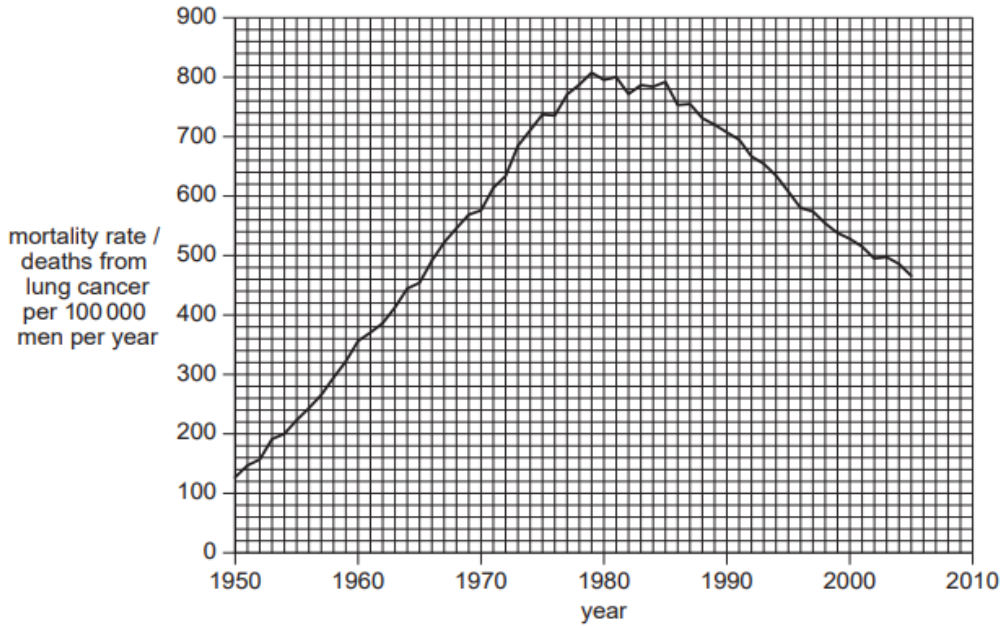


Fig. 2.3

(c) With reference to Figs. 2.2 and 2.3, discuss the observations made between 1950 and 2005. [4]

1. Percentage of men who smoke fell from 62 to 25% between 1950 and 2005
2. and mortality rate increased from 130 to 810 deaths from lung cancer per 100 000 men per year between 1950 and 1979 and then decreased to 470 in 2005
3. Increase in number of deaths despite fall in % smokers between 1950 and 1979 as cancer is multistep process/ requires multiple mutations to accumulate before it

develops into cancer hence lag time/ death from cancer is often associated with metastasis which occurs typically in the later stages of cancer development

4. fall in cancer deaths due to improvements in health care that allow for earlier diagnosis/ treatment/AVP

[Total: 8]

3. DNA and RNA are some of the key molecules involved in the synthesis of proteins.

(a) Comment on how DNA and tRNA are different, in terms of the bases present.

	DNA	tRNA
bases	Thymine present	Thymine absent, uracil is used instead
A:T/U G:C ratio	A:T and G:C ratio is always 1	A:T/U and G:C ratio varies

(b) Calculate the minimum number of DNA nucleotides required to code for a polypeptide with 238 amino acids.

- Show your working in the space below.
- State the **two** properties of the genetic code that are considered in deriving your answer. [3]

1. 238 x 3 = 714
2. Stop codon: 3 bases, Total: 714 + 3 = 717 DNA nucleotides

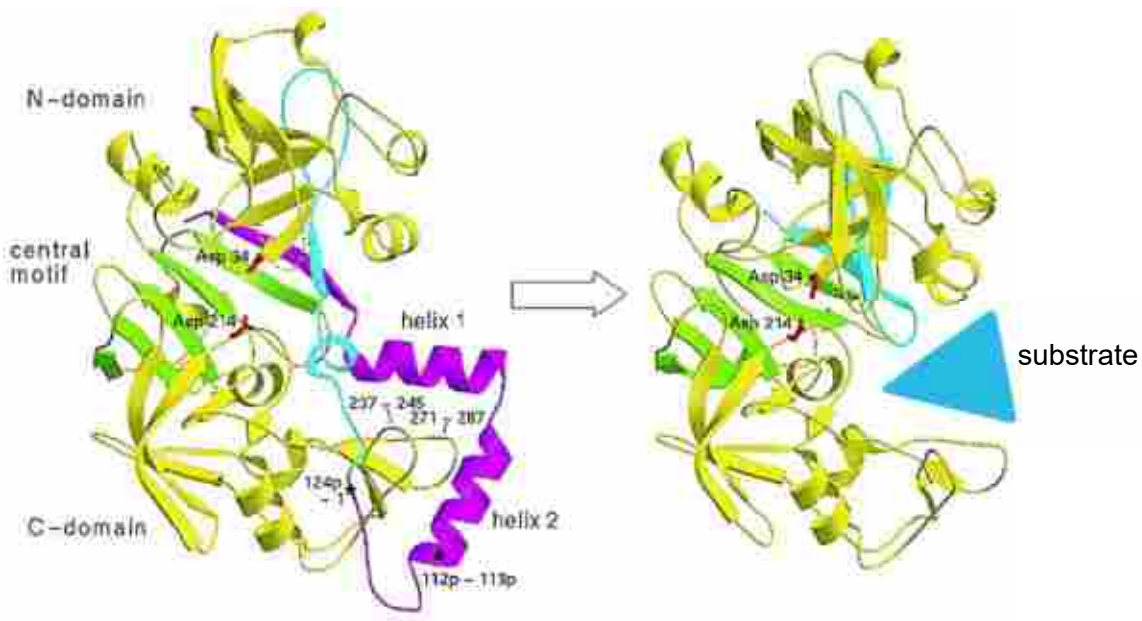
Property 1: The genetic code is a triplet code.

Property 2: The genetic code is punctuated/ contains stop codons.

(c) Describe the role played by tRNA in polypeptide synthesis. [3]

1. Carries amino acid to tRNA binding sites/ A site on ribosome
2. Brings growing polypeptide chain and incoming amino acid in close proximity for formation of peptide bond
3. Specific amino acid sequence ensured by complementary base pairing of anticodon on tRNA with codon on mRNA

(d) Regulation can occur following the synthesis of proteins. An example of such regulation is shown in Fig. 3.1, where inactive enzyme precursor pepsinogen is modified post-translationally to form active pepsin.



Pepsinogen (Inactive) **Pepsin (Active)**

Fig. 3.1

(i) With reference to Fig. 3.1, describe the post-translational change observed in the enzyme and explain why it results in its activation. [2]

1. Proteolytic cleavage/ activation of pepsinogen which removes helix 1 and 2
2. Exposes the active site to allow for substrate to bind and pepsin to catalyse breakdown of proteins

(ii) Suggest why pepsin is synthesised as an inactive precursor pepsinogen. [1]

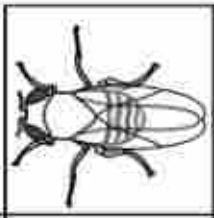
1. (Idea of) preventing pepsin from prematurely digesting protein components of the cells that synthesise them

[Total: 11]

4. The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features. Table 4.1 shows diagrams of a wild-type fly and three other flies, each of which shows one **recessive mutation**.

Table 4.1

				
eyes	present	present	absent	present
abdomen	striped	black	striped	striped
wing description	long	long	long	short

(a) Explain what is meant by a "recessive mutation". [2]

1. Change in DNA/ nucleotide sequence leading to the creation of a new allele, whose
2. expression is masked in the presence of a dominant/ normal allele OR only expressed in the presence of another recessive/ mutated allele

(b) Using appropriate symbols, illustrate a cross between a fly without eyes and long wings and one with eyes and short wings that would result in **four** different phenotypes being observed in the offspring. [4]

Let E represent the dominant allele for presence of eyes and e the recessive allele for absence of eyes

Let L represent the dominant allele for long wing and l the recessive allele for short wings

Parental phenotype: Without eyes, long wings x With eyes, short wings

Parental genotype: [1] eeLl x Eell

Gametes: [1] eL el x El el

Punnett square: [1]

	eL	el
El	EeLl	Eell
el	eeLl	Eell

Offspring genotype: EeLl: Eell: eeLl: eell

Offspring phenotype: [1]
with eyes, long wings:
with eyes, short wings:
without eyes, long wings:
without eyes short wings

Phenotypic ratio 1:1:1:1

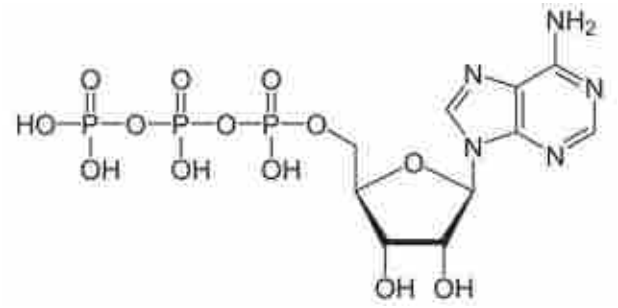
(c) The class of mutations giving rise to the various mutant phenotypes in Table 4.1 are termed as **gene mutations**.

Explain how these mutations are different from chromosomal aberrations. [3]

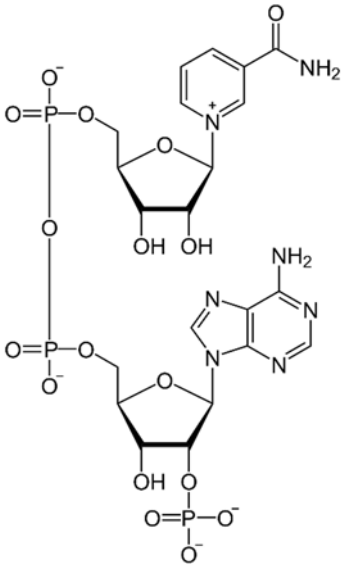
Gene mutation	**Chromosomal structural mutation**
1. Changes in DNA/nucleotide sequence of a gene	• Changes in chromosome structure/ involves exchange of chromosome segments • DNA/nucleotide sequence of gene (mostly) unchanged
2. Alters a single gene locus on a chromosome	Alters more than one loci on chromosomes
3. Caused by deletion, insertion, substitution or inversion of one/ several nucleotides	Deletion, inversion, translocation or duplication of chromosomal fragments/ several gene loci
4. Give rise to new alleles	Rearrangement of loci of genes / alleles / new combination of alleles
AVP:	
5. May change amino acid sequences or form non-functional proteins/ silent, missense, nonsense mutation	Amino acid sequences usually unchanged but changes the level of expression of genes / inactive, hyperactive, underproduction or overproduction of gene product
6. Play more important role in evolution than chromosomal mutations because new alleles increases variation in the gene pool for natural selection to operate	Play a less important role in evolution than gene mutations because chromosomal mutations involve only reshuffling of alleles that already exist in gene pool

[Total: 9]

5. ATP and NADP both play important roles in photosynthesis. Fig. 5.1 represents the



ATP



NADP

molecular structures of ATP and NADP.

Fig. 5.1

(a) Using Fig. 5.1, compare the structures of ATP and NADP. [3]

1. Both have three phosphate groups
2. Both have an adenine/ purine
3. Both have pentose sugar/ ribose
4. Both have phosphoanhydride bonds

Max 2

5. ATP has one pentose sugar while NADP has two
6. NADP has nicotinamide base which is absent in NADP
7. There are 2 phosphoanhydride bonds present in ATP, but only one present in NADP.

Max 2

(b) Outline the roles of NADP in a cell. [2]

1. Serves as final electron acceptor in non-cyclic photophosphorylation
2. To form reduced NADP/ NADPH which is used in light-independent reaction/ Calvin cycle

(c) State the names of the processes in which ATP is synthesised during photosynthesis and respiration respectively. [2]

1. Photosynthesis: cyclic and noncyclic photophosphorylation
2. Respiration: substrate level phosphorylation and oxidative phosphorylation

(d) ATP serves as a source of energy for several metabolic processes in both photosynthesis and respiration.

Name one process in **respiration** that requires ATP as an energy source. [1]

1. Active transport of pyruvate into mitochondrion
2. Phosphorylation of intermediate compounds in glycolysis
3. AVP

(e) The first substrate used in respiration is glucose. In a situation of excess glucose, some of these glucose is stored as fats instead of carbohydrates.

Explain why animals prefer to store lipid instead of carbohydrates. [3]

1. Twice the amount of energy produced per gram/ unit mass of lipid/ carbohydrate stored due to higher proportion of C-H to O present
2. Twice the amount of metabolic water per gram/ unit mass of lipid/ carbohydrate oxidised due to higher proportion of C-H to O present
3. Smaller volume stored for the same amount of energy hence aiding in locomotion

4. Ref. to lipids (triglycerides) being good thermal/ heat insulators
5. Ref. to lipids being stored around delicate organs hence acting as cushioning material/ protecting these organs
6. Ref. to lipids being less dense than water, thus providing buoyancy for aquatic animals

Max 1 for points 4-6

[Total: 11]

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

7. **(a)** Explain how climate change affects the spread of dengue beyond the tropics. [5]

(b) Discuss how variation is generated in a population, and explain why it is important in natural selection. [10]

[Total: 15]

8. **(a)** Explain how man's food choices can lead to climate change impacts. [5]

(b) Explain what is meant by the fluid mosaic model, and discuss the importance of membrane fluidity in biological processes. [10]

[Total: 15]

6 (a) Explain how climate change affects the spread of dengue beyond the tropics. [5]

1. Ref. to climate change causing **global warming**/ **increasing global temperatures** leading to **sub-tropical areas**/ **higher latitudes** experiencing **warmer temperatures**
2. Ref. to dengue being spread by the female ***Aedes aegypti* mosquito**
3. Which acts as the **vector** for the virus
4. (Idea of) warmer temperatures in sub-tropical areas being **more optimal/ conducive** for mosquito vector
5. in terms of **higher rate of development**/ **higher metabolic rate**/ **higher rate of survival** of mosquitoes
6. Ref. to climate change leading to **increased rainfall**, increased pools of **stagnant water/ breeding sites** for mosquitoes in sub-tropical regions.
7. Accept AVP, e.g. spread of dengue beyond the tropics is compounded by increased international travel/ population growth

6 (b) Discuss how variation is generated in a population, and explain why it is important in natural selection. [10]

1. Meiosis results in genetic variation

2. … due to crossing over between non-sister chromatids of homologous chromosomes, during prophase I;
3. where homologous regions/ regions containing same genes are exchanged at chiasmata;
4. creating new combination of alleles (Reject: form new genes);

5. … due to independent assortment of homologous chromosomes during metaphase I;
6. whereby the orientation of homologous pairs of chromosomes/ bivalents along the equator/ metaphase plate is random/ independent of other bivalents;
7. Ref. to daughter cells having equal probability of receiving either the paternal or maternal copy of each chromosome
8. Independent assortment of chromosomes/ pairs of chromatids also occurs during metaphase II, significant due to crossing over which occurred during prophase I;

9. In addition, during fertilisation, random fusion of gametes occurs, resulting in numerous combinations of chromosomes in a zygote.

10. Gene mutations contributes new alleles to the gene pool
11. Ref. to how gene mutations are caused, i.e. due to mistakes in DNA replication, due to mutagens (or named example)

Max 6

12. Genetic variation is the raw material for natural selection to occur
13. Ref. to a wide enough range of phenotypes/ alleles present in a population allowing for selection pressure to act on
14. Leading to differential reproductive success
15. Such that individuals with advantageous phenotypes will survive to reproductive age and pass the alleles that confer these advantageous phenotypes on to their offspring
16. Leading to change in allele frequencies in gene pool over time

Max 4

QWC: At least 2 causes of variation discussed, and why variation is important for natural selection systematically explained.

7 (a) Explain how man's food choices can lead to climate change impacts. [5]

1. Ref. to **increased consumption** of/ **demand** for **meat/ dairy products**
2. Leading to **more cattle/ cows** being reared as livestock
3. Ref. to cows being ruminant mammals which **release methane**
4. Ref. to methane being a **greenhouse gas** which **traps heat in the earth's atmosphere**
5. Causing **increasing global temperatures/ global warming**
6. **Clearing of forested land/ deforestation** to create **land for grazing** leads to **increased carbon dioxide emission/ reduced carbon sinks**
7. Accept AVP, e.g. increasing affluence leading to increased meat demand

7 (b) Explain what is meant by the fluid mosaic model, and discuss the importance of membrane fluidity in biological processes. [10]

1. Fluid refers to the **constant** lateral **movement** of **phospholipids** and other membrane components, e.g. membrane proteins
2. Due to **weak hydrophobic interactions** between fatty acid tails of phospholipids
3. Mosaic refers to the **random arrangement** of **membrane proteins** in bilayer
4. Named example of membrane protein, e.g. receptor, transport protein, aquaporin

Max 3

Importance of membrane fluidity in transport processes

5. Ref. to membrane fluidity creating **transient gaps** in phospholipid bilayer
6. Allowing **small/ uncharged/ non-polar/ water molecules** to **freely diffuse** across

7. Ref. to membrane fluidity allowing **fusion of vesicles** with endoplasmic reticulum in the **secretory pathway**/ in **intracellular transport of materials**
8. E.g. **fusion of transport vesicle with Golgi apparatus** + outcome, i.e. allowing proteins to undergo **chemical modification in the GA**

9. Ref. to **fusion of lysosome with food vacuole** + outcome, i.e. allowing for **digestion of ingested bacteria**

10. Ref. to **exocytosis**/ **fusion of secretory vesicles with the cell surface membrane** + outcome, i.e. **release of secretory proteins**, localisation of **transport proteins on cell surface membrane**

11. Ref. to importance of membrane fluidity in **endocytosis**
12. Where **cell surface membrane invaginates** to form endocytic **vesicles**/ **food vacuoles**
13. Hence allowing cell intake of **large quantities** of extracellular substances

Max 7

Importance of membrane fluidity in cell division

14. Allows for formation of **cleavage furrow** in animal cells
15. Thus facilitating **cytokinesis**

Max 2

QWC: Fluid mosaic defined + at least 2 named examples of how instances of membrane fluidity are evident in the cell AND importance of these processes discussed

Candidate Name: _____

Class	Adm No

H

millennia institute

2018 End-of-Year Exams
Pre-university 2

Biology Higher 1 **8876/01**

Paper 1 **17 September 2018**

1 hour

Additional Materials: Optical answer sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, Adm No. and class on all the papers you hand in.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Paper 1
There are **thirty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

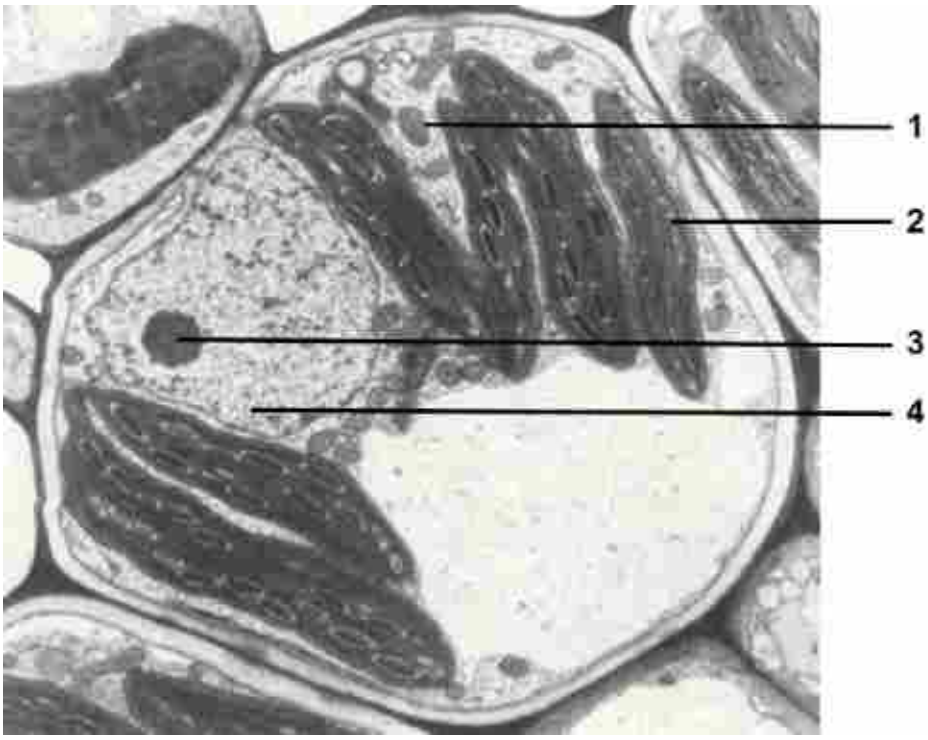
Calculators may be used.

This question paper consists of 25 printed pages.

[Turn over

Answer **all** questions

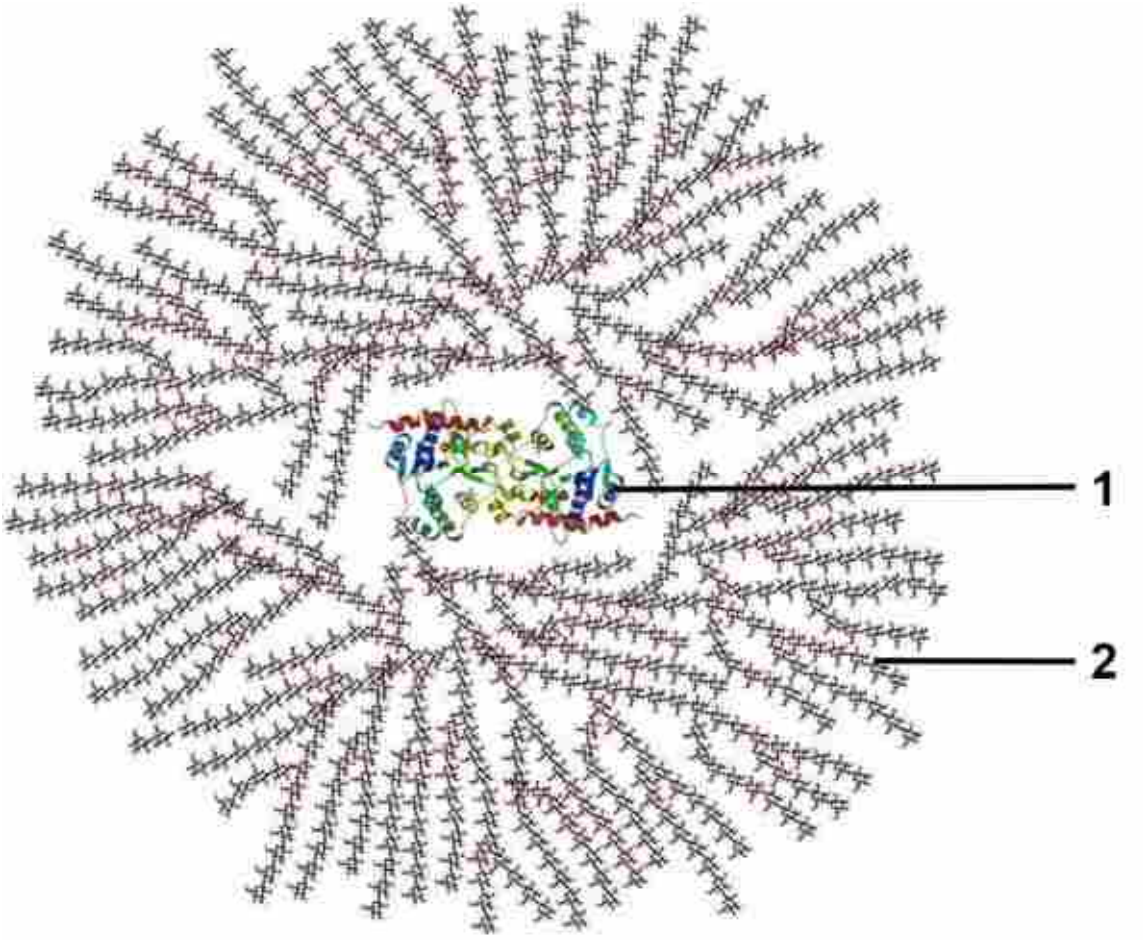
1. The figure below shows an electron micrograph of a plant cell.



Which of the following about structures **1-4** are correct?

	Take in oxygen	Take in carbon dioxide	Site of transcription	Site of translation
A	**1**	**1** and **2**	**3** and **4**	**1** and **2**
B	**1**	**2**	**1, 2, 3** and **4**	**1** and **2**
C	**2**	**1**	**1** and **2**	**4**
D	**1** and **2**	**2**	**1, 2** and **3**	**1**, **2** and **4**

2. Glycogen are polysaccharides that functions as energy stores in animals. Glycogen granules can consist up to 30 000 glucose monomers, the following figure shows the structure of a glycogen granule.

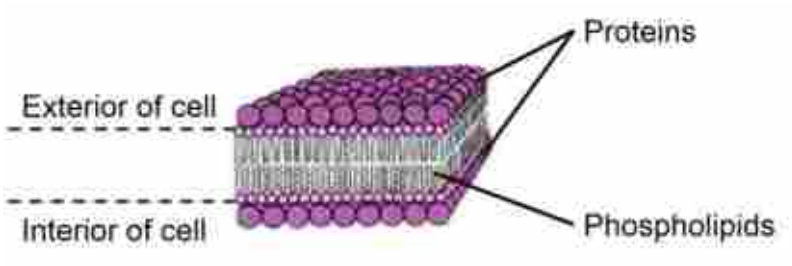


Which of the following statement(s) is/are true about structure **1** and **2**?

I Monomers in structure **1** and **2** are joined by only one type of bond.
II Helices can be found in both structures **1** and **2**.
III Monomers in structure **2** are identical, whereas monomers in structure **1** are only similar and not completely identical.
IV Both structures **1** and **2** can be hydrolysed to release the monomers that can enter glycolysis directly.

A **II** only
B **II** and **III** only
C **I**, **II** and **III** only
D **I**, **III** and **IV** only

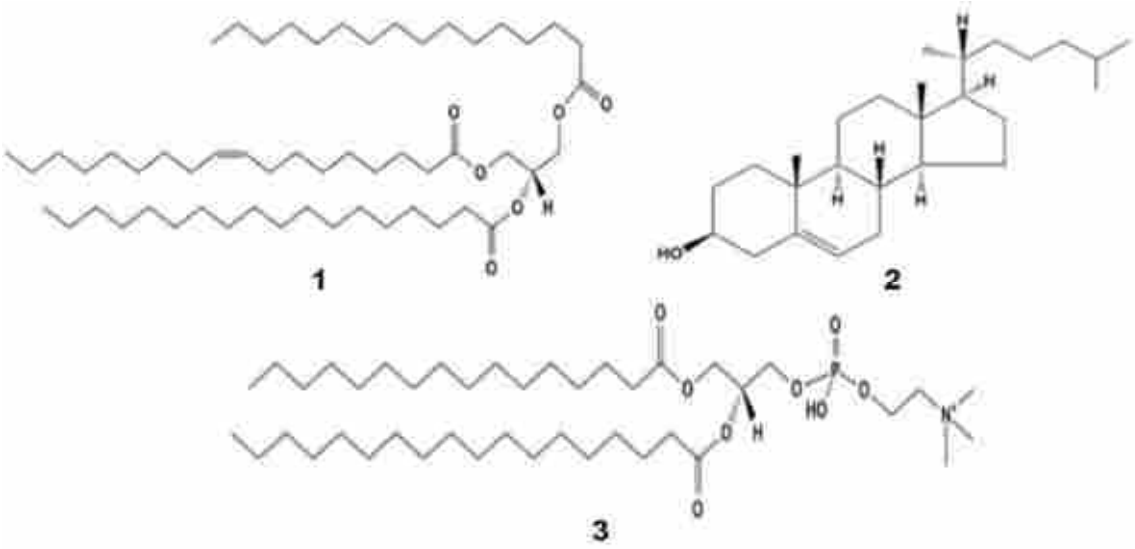
3. In the development of the fluid mosaic model of the membrane, there were other models that were suggested. The figure below shows a particular model suggested by a pair of scientists, Davson and Danielli.



Which of the following observation would be a valid evidence to disprove this model?

A Membrane fluidity increases with increasing temperature.
B Analysis of the elements found in biomolecules of the membrane identified: C, H, O, N and P.
C When the membrane were homogenised to a single layer, the surface area was twice that of the original membrane.
D When cells were placed in a glucose solution, glucose was found to be present in the interior of cells.

4. The figure below shows three types of lipids.

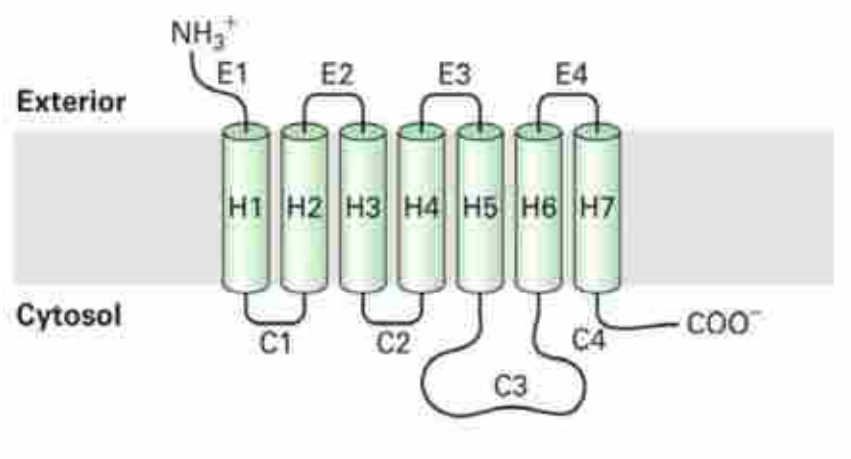


Which of the following statements about lipids **1**-**3** are correct?

I All three lipids are components of the cell membrane.
II Lipid **1** is hydrophobic while lipids **2** and **3** are amphipathic.
III Hydrolysis of lipids **1** and **3** produces glycerol and fatty acids, while hydrolysis of lipid **2** produces only fatty acids.
IV Lipid **1** stores more energy per gram as compared to glucose per gram due to a higher proportion of C-H bonds.

A **I** and **IV** only
B **II** and **IV** only
C **II** and **III** only
D **I**, **II** and **III** only

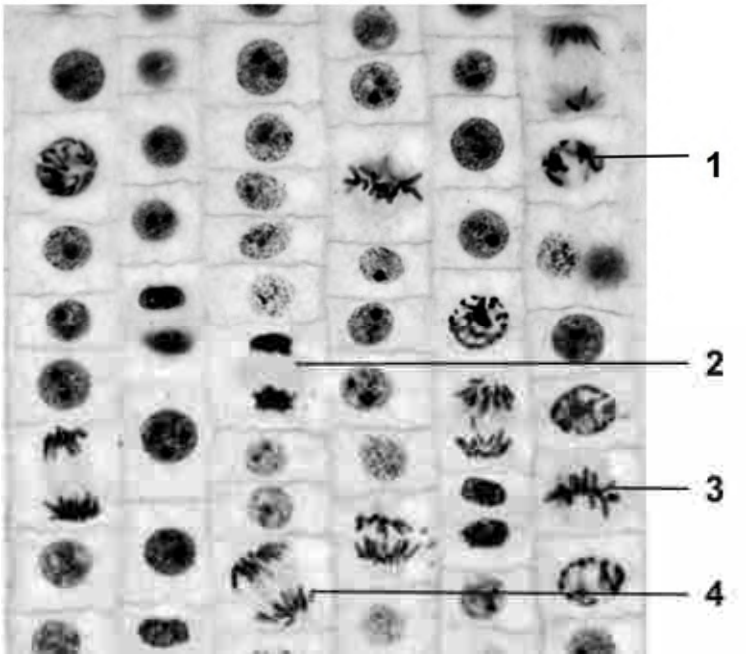
5. Rhodopsin is a receptor found in the rods of the retina. It is extremely sensitive to light, enabling vision under low-light conditions. Rhodopsin has a characteristic seven coiled cylindrical regions, which spans across the surface membrane bilayer, as shown in the diagram.



Which option best describes the regions containing **E3**, **H3** and **C3**?

	E3	**H3**	**C3**
A	interacts with G-protein	secondary structure held by hydrogen bonds	amino acids with polar R-groups
B	interacts with G-protein	tertiary structure held by R-group interactions	amino acids with polar R-groups
C	amino acids with polar R-groups	secondary structures held by hydrogen bonds	interacts with G-Protein
D	amino acids with polar R-groups	quaternary structure held by peptide bonds	interacts with G-Protein

6. The diagram shows an electron micrograph of onion root epidermal cells undergoing mitosis. Cells **1** to **4** are each at different stage of mitosis.

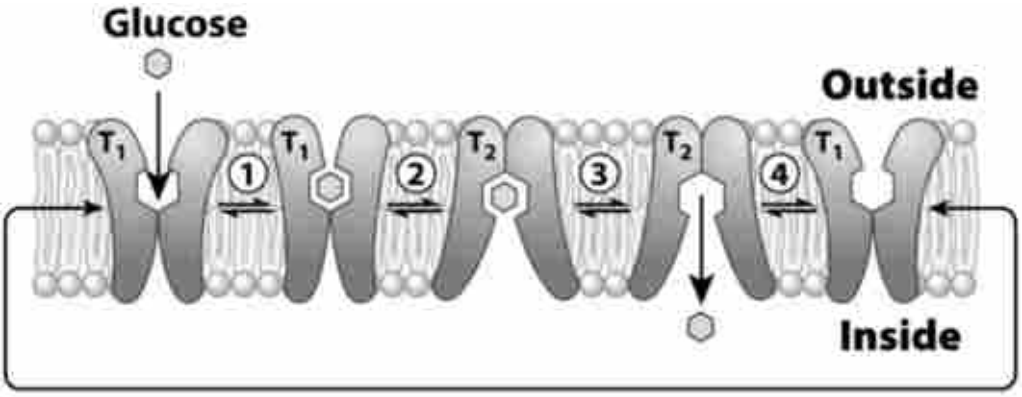


Which of the following statement(s) is/are true about cells **1** to **4**?

I The number of chromosomes per cell is doubled in cells **2** and **4** as compared to cells **1** and **3**.
II The order of the cells in sequential mitotic stages are: **3**, **4**, **2** and **1**.
III Sister chromatids found in cells **2**, **3** and **4** are no longer genetically identical due to crossing over that occurred during the stage that cell **1** is in.
IV Homologous chromosomes are present in all cells **1** to **4**.

A **I** only
B **I** and **IV** only
C **II** and **III** only
D **I**, **II** and **IV** only

7. When cells are placed in a solution containing glucose, membrane proteins called GLUT will transport glucose into the cell as shown in the figure below.



Which of the following statement is **false** about this process?

A The binding site of GLUT is complementary to the 3D structure of glucose, as such it is specific in transporting of only glucose.
B The interior lining of GLUT contains amino acids with polar R-groups.
C When exterior glucose concentration is very high, the rate of glucose uptake is limited by the amount of GLUT.
D Energy is required in the form of ATP hydrolysis to cause a conformation change of GLUT in step **2**.

8. Enzymes can be covalently bonded to the surface of a matrix (immobilised). The matrix has a very high surface area to volume ratio. A substrate can collide with the enzyme held in place for the reaction to occur.

The following data shows the effects of temperature on immobilised and free enzymes.

temperature / ºC	immobilised P1 nuclease activity / arbitrary units	free P1 nuclease activity / arbitrary units
30	20	20
40	41	35
50	56	54
60	67	65
70	78	52
80	58	47

Which of the following is a valid conclusion based on the data?

A As the enzymes are the same, the maximum activity for immobilised and free enzymes are the same.
B Covalently binding enzymes to a matrix allows it to resist a higher level of thermal agitation.
C Covalently binding enzymes to a matrix prevents it from denaturation.
D Free enzymes are more active at lower temperatures as they are able to collide with substrates at a higher rate

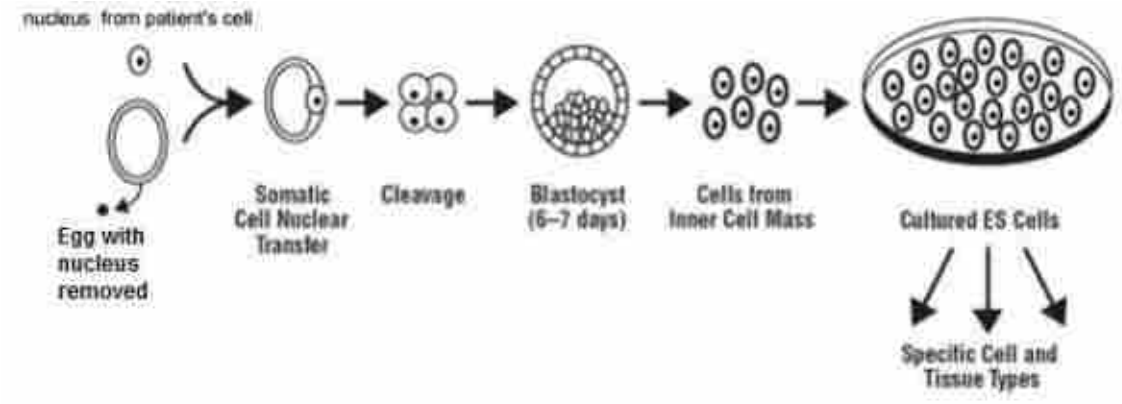
9. There are currently a variety of strategies applicable in treatment of wound healing like recovery from burns. Some of the options include:

- **Traditional strategies**: skin graft obtained from suitable donors.
- **Stem cell treatment**: make use of patient's own adult stem cells, donated embryonic stem cells or induced pluripotent stem cells to regenerate skin cells.

Which of the following correctly identifies a challenge for each method?

	skin graft from donor	**adult stem cells**	**embryonic stem cells**	**induced pluripotent stem cells**
A	availability of suitable donor	triggering immune response and cell rejection	ethical issues	reprogramming process
B	programming to differentiate into skin cells	triggering immune response and cell rejection	programming to differentiate into skin cells	ethical issues
C	availability of suitable donor	programming to differentiate into skin cells	ethical issues	reprogramming process
D	programming to differentiate into skin cells	programming to differentiate into skin cells	Differentiates to limited cell types	programming to differentiate into skin cells

10. Somatic cell nuclear transfer (SCNT) is a method used to develop embryonic stem cells from a patient's somatic cell. The developed embryonic stem cell can then be used to treat the patient. The process is outlined in the figure below.



Which of the following statements(s) is/are true?

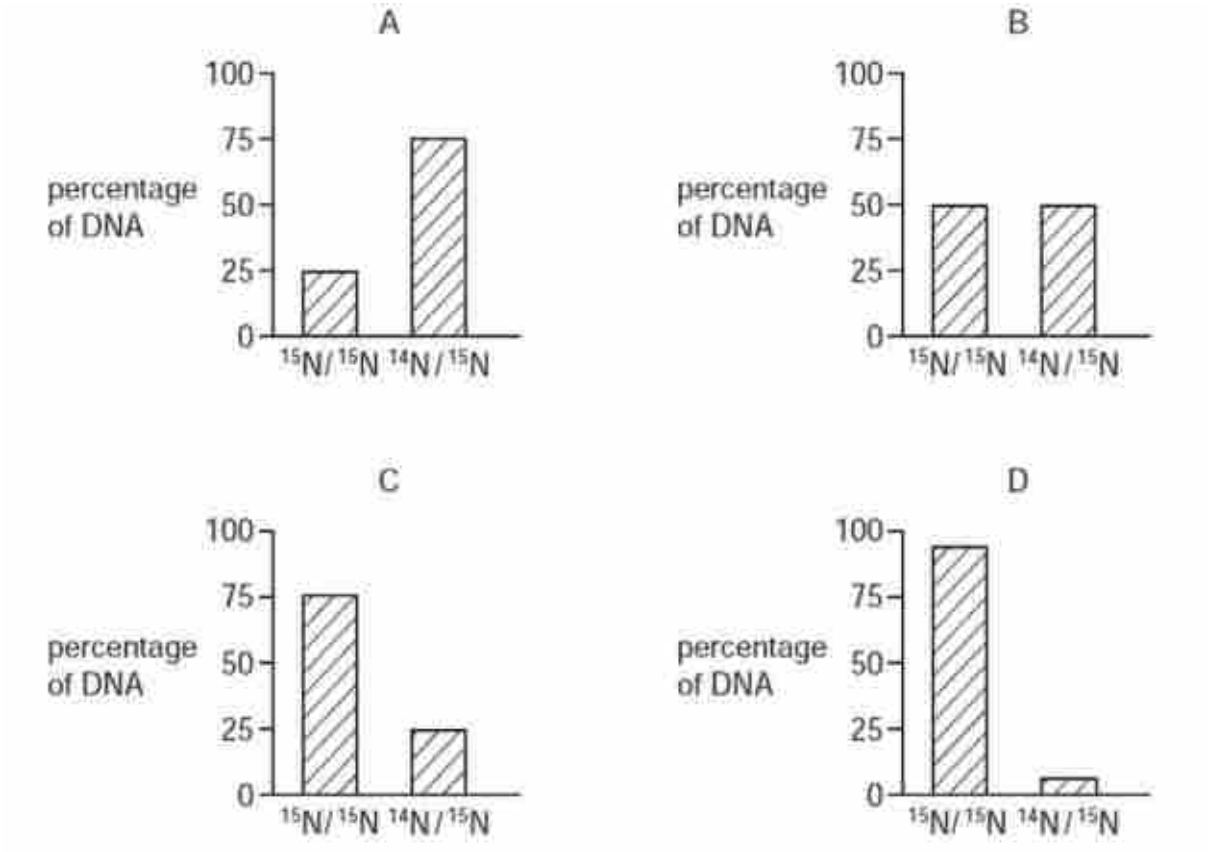
I Cultured embryonic stem cells obtained via SCNT overcomes the problem of immune response.
II SCNT pose no ethical concerns as it does not involve the destruction of embryos.
III One concern of using SCNT is the potential for reproductive cloning.
IV The potency of the cultured embryonic stem cells is limited by origin of the nucleus used.

A **I** only
B **I** and **III** only
C **II** and **IV** only
D **I**, **III** and **IV** only

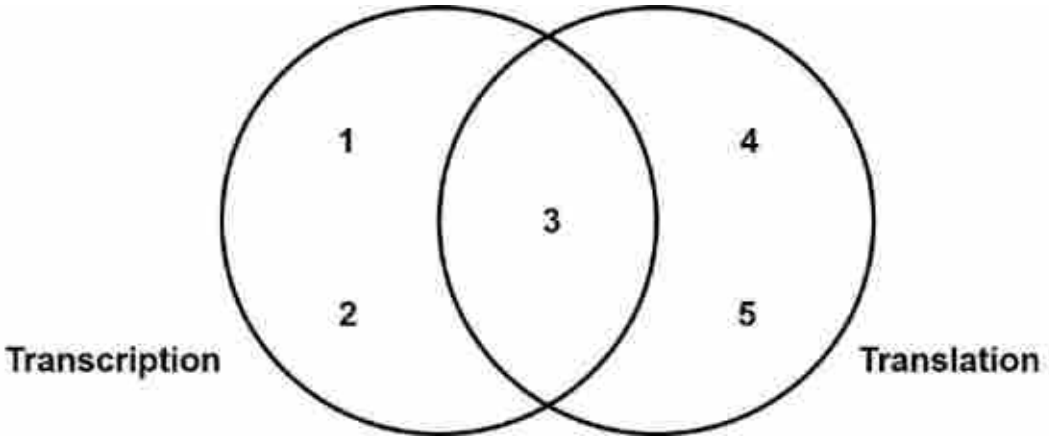
11. Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N. Some of these bacteria were transferred to a medium containing the common isotope of nitrogen, ^{14}N. The bacteria were allowed to divide once.

The bacteria were then transferred back to the medium containing ^{15}N. The bacteria were allowed to divide once more.

What would be the percentage of $^{15}N/^{15}N$ DNA molecules and $^{14}N/^{15}N$ hybrid DNA molecules in the DNA extracted from the bacteria at the end of the experiment?



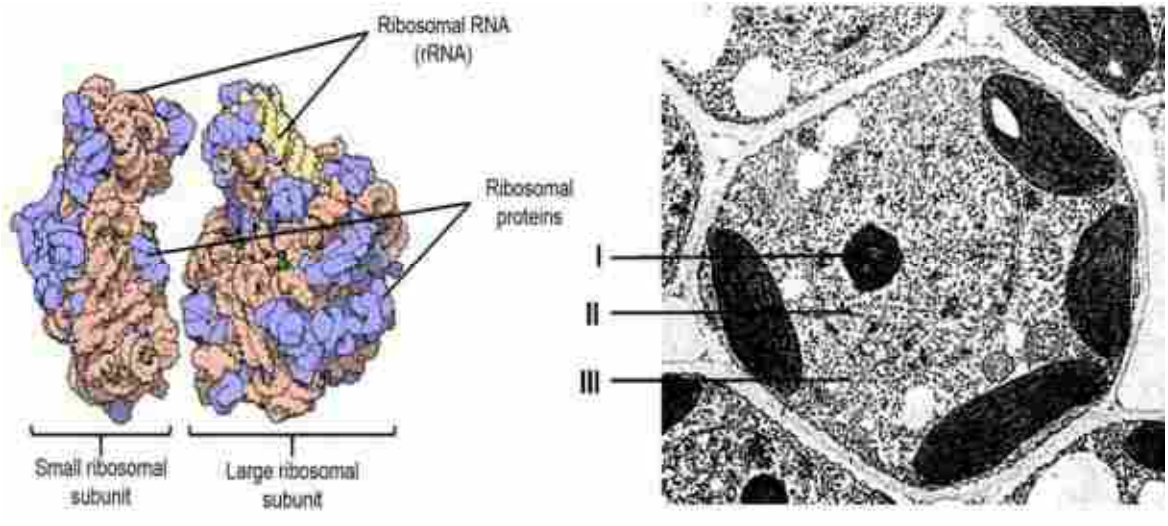
12. The following diagram shows two processes involved in the central dogma for eukaryotes, **1**, **2, 4** and **5** represent properties unique to the individual processes, while **3** represent a property that is similar between the two processes.



Which of the following correctly identifies **1-5**?

	1	**2**	**3**	**4**	**5**
A	formation of phosphodiester bonds	product synthesised from 5' to 3'	occurs in cytoplasm	formation of peptide bonds	product synthesised from N to C terminal
B	formation of peptide bonds	product synthesised from N to C terminal	occurs in cytoplasm	formation of phosphodiester bonds	product synthesised from 5' to 3'
C	formation of phosphodiester bonds	occurs in nucleus	requires energy	formation of peptide bonds	occurs in cytoplasm
D	formation of peptide bonds	occurs in nucleus	requires energy	formation of phosphodiester bonds	occurs in cytoplasm

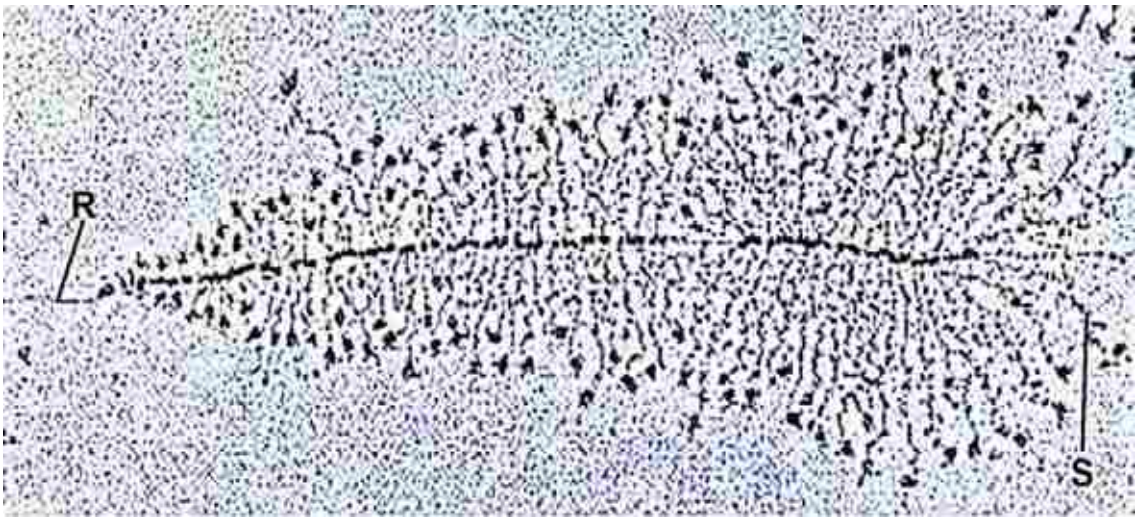
13. Ribosomes are organelles involved in protein synthesis, it is composed of two subunits, a small ribosomal subunit and a large ribosomal subunit. Each subunit consists of two components, a protein component and a RNA (rRNA) component. The ribosome structure is showed in the figure on the left. The figure on the right shows an electron micrograph of a eukaryotic cell with three regions labelled, **I**, **II** and **III**. These three regions are involved in the synthesis of each individual components and the assembly of each subunit (combining the protein component with rRNA component).



Which of the following correctly identifies the role(s) that each region plays in the synthesis of ribosomal subunits?

	I	II	III
A	transcription of rRNA genes to form rRNA	assembly of individual subunits	translation of rRNA to form ribosomal proteins
B	assembly of individual subunits	transcription of rRNA genes	translation of rRNA to form ribosomal proteins
C	assembly of individual subunits	transcription of rRNA and ribosomal protein genes to form rRNA and ribosomal protein mRNA	translation of ribosomal protein mRNA to form ribosomal proteins
D	transcription of rRNA genes to form rRNA and assembly of individual subunits	transcription of ribosomal protein genes to form ribosomal protein mRNA	translation of ribosomal protein mRNA to form ribosomal proteins

14. The electron micrograph shows protein synthesis in a bacteria cell.

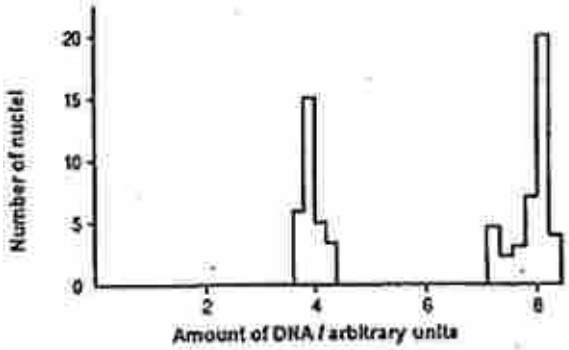


Which statements about the processes involved are correct?

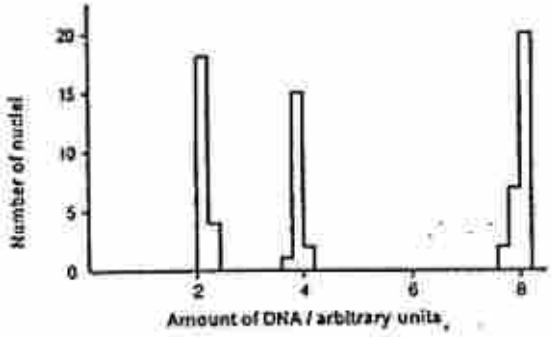
- **I** Transcription occurs from left to right along template DNA, **R**.
- **II** **S** is used as template for translation.
- **III** Translation initiates only after transcription is completed.
- **IV** Only one RNA polymerase is transcribing the template DNA, **R**, at any one time.
- **V** **R** is the mRNA and it is translated by ribosomes to form polypeptide chains, **S**.

A **V** only
B **I** and **II** only
C **I**, **II** and **IV** only
D **III**, **IV** and **V** only

15. The graphs below shows the amount of DNA per nuclei of cells taken from two different parts of a mammalian testis undergoing different types of nuclear division.



Graph 1



Graph 2

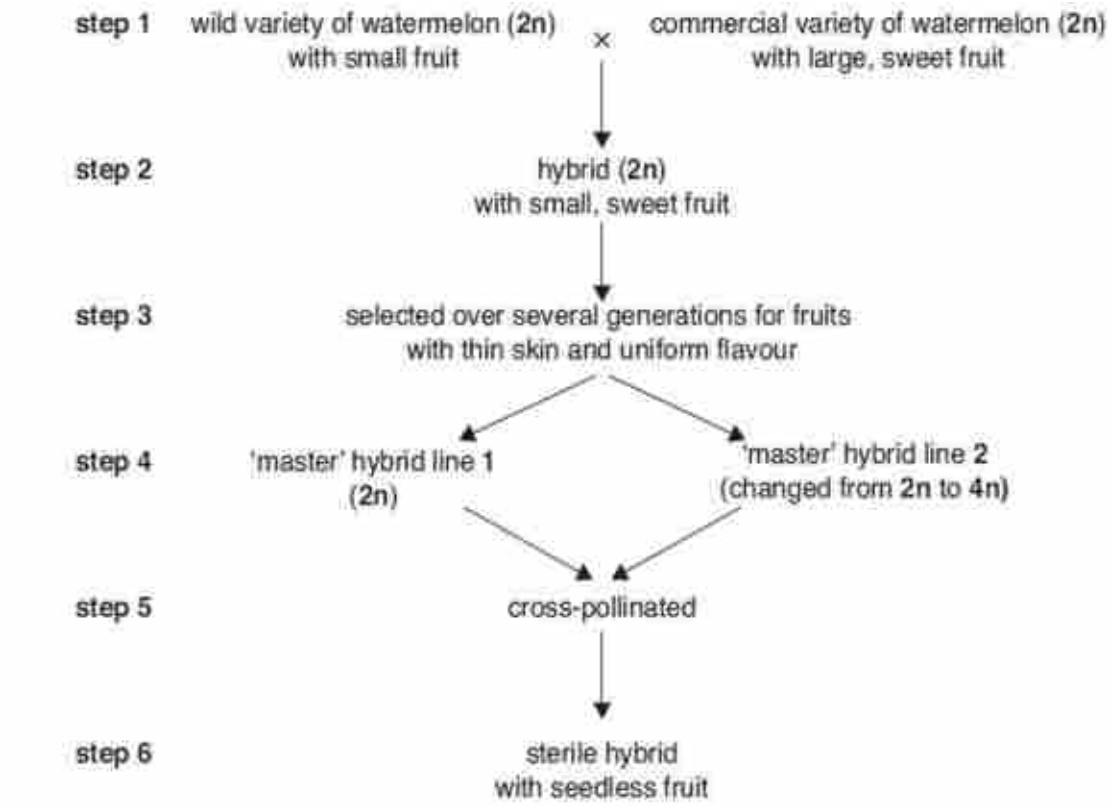
Various events that occurs in **graph 1** and **2** are listed as follows:

I DNA replication
II Breaking and rejoining of homologous regions of chromosomes
III Separation of homologous chromosomes
IV Separation of identical sister chromatids
V Separation of non-identical sister chromatids

Which of the following correctly identify events that occurred in each graph?

	Graph 1	**Graph 2**
A	**I** and **IV**	**I, II, III** and **V**
B	**II, III** and **V**	**I** and **IV**
C	**I** and **IV**	**II, III** and **V**
D	**III** and **IV**	**I, II** and **V**

16. The following flowchart shows the steps involved in cultivating watermelon of desired phenotypes.



Which of the following statement(s) is/are true regarding the steps involved?

I Step 3 is an example of artificial selection.
II Drugs that prevent spindle fibre formation can be used to form diploid gametes that allows the formation of tetraploid 'master' hybrid line 2.
III The seedless hybrid produced in step 6 is sterile due to absence of homologous chromosomes.
IV The seedless hybrid produced in step 6 can be made fertile again by using the same method used in step 4 in producing tetraploid 'master' hybrid line 2.

A **II** only
B **I** and **III** only
C **I**, **II** and **IV** only
D **II**, **III** and **IV** only

17. Ras is a protein that functions as a signalling molecule in cells. When the appropriate signals are present, Ras is activated, and it signals for cell proliferation. Many cancer development process involves the mutation of the Ras gene, resulting in a mutant Ras protein.

Which of the following best explain why a mutant Ras leads to tumour progression?

A Ras is a proto-oncogene, a loss of function mutation to Ras prevents it from detecting DNA damage and cell cycle arrest.
B Ras is a tumour suppressor gene, a loss of function mutation to Ras prevents it from signaling normal cell proliferation.
C Ras is a proto-oncogene, a gain of function mutation to Ras allows it to signal for cell proliferation in the absence of appropriate signals, resulting in uncontrolled cell division.
D Ras is a tumour suppressor gene, a gain of function mutation to Ras results in signaling that allows the cell to bypass cell cycle checkpoints.

Refer to the following information for questions **18** and **19**.

Dystrophin is a protein that function to maintain the cell membrane integrity of muscle fibers. Duchene muscular dystrophy (DMD) is a genetic disease caused by a mutation in the dystrophin gene.

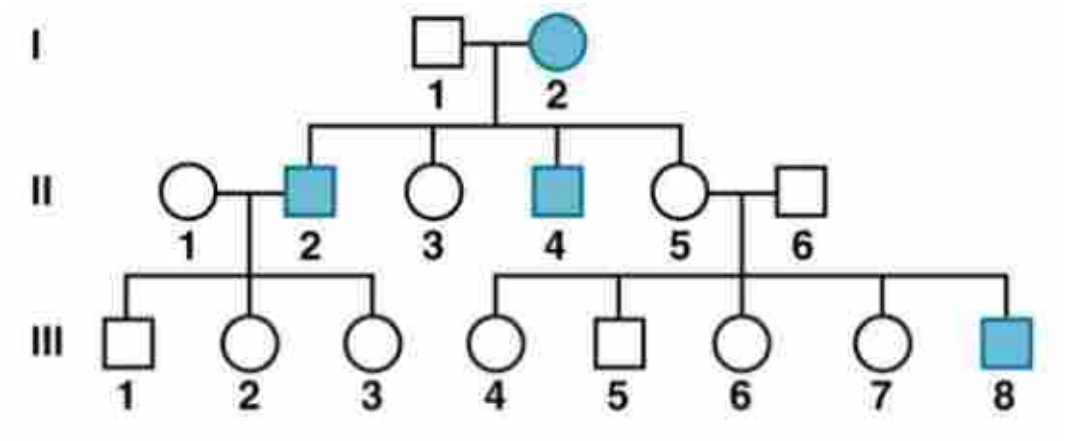
18. The sequence of part of the normal and mutated alleles for dystrophin gene is shown below.

Normal allele									
Codon	180	181	182	183	184	186	187	188	189
mRNA	CGU	AGA	UGG	AAA	UCA	UAA	ACU	GAC	UCU
Mutant allele									
Codon	180	181	182	183	184	186	187	188	189
mRNA	CGU	AGU	GAA	AUC	AUA	AAC	UGA	CUC	UUG

Using the information of the normal and mutated alleles above, which of the following is a valid conclusion?

A An addition of two nucleotides at codon 181 caused a frame shift mutation, resulting in a premature stop codon at codon 189.
B A deletion of a single nucleotide at codon 181 caused a frame shift mutation, resulting in a premature stop codon at codon 189.
C A substitution of a single nucleotide at codon 181 and a deletion of two nucleotides at codon 187, causing a frame shift, resulting in a premature stop codon at codon 187.
D A deletion of a single nucleotide at codon 181 and at codon 182 caused a frame shift mutation, resulting in a premature stop codon at codon 187.

19. The pedigree chart shows the inheritance of DMD in a family.



What is the mode of inheritance for DMD?

A Sex-linked dominant
B Autosomal dominant
C Sex-linked recessive
D Autosomal recessive

20. *Abraxas grossulariata* is a Moth native to North America. There are two different phenotypes observed for their wing colour, dark and light. Two crosses were carried out to determine the inheritance of wing colour in *Abraxas grossulariata*.

Cross 1: Pure-breeding female moths with dark coloured wings crossed with pure breeding male moths with light coloured wings
Result: All offspring were showed dark coloured wings.

Cross 2: Pure-breeding female moths with light coloured wings crossed with pure breeding male moths with dark coloured wings
Result: All female offspring had dark coloured wings while all male offspring had light coloured wings.

Based on the results of the two crosses, what can be deduced about the inheritance of wing colour in *Abraxas grossulariata?*

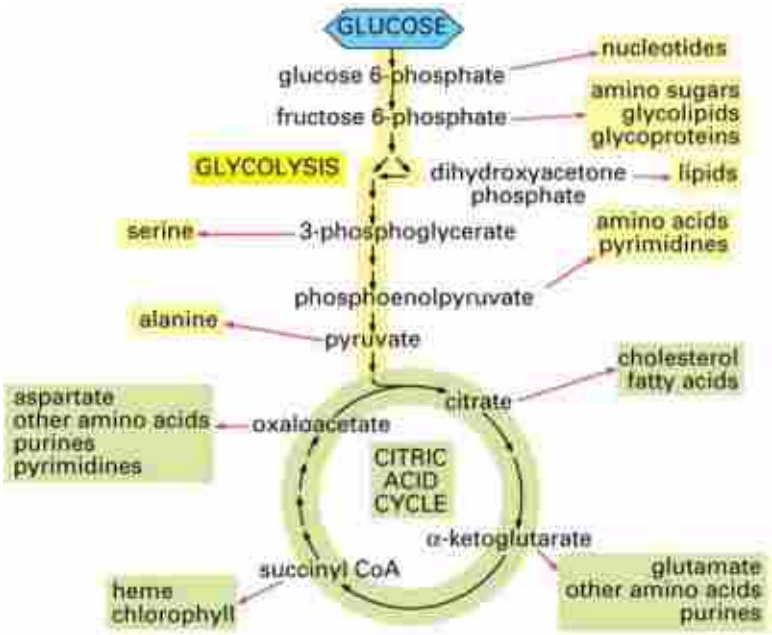
A Wing colour is sex-linked, the allele for dark wing colour is dominant to allele for light wing colour
B Wing colour is not sex-linked, the allele for dark wing colour is dominant to allele for light wing colour
C Wing colour is sex-linked, the allele for light wing colour is dominant to allele for dark wing colour
D Wing colour is not sex-linked, the allele for light wing colour is dominant to allele for dark wing colour

21. In a particular breed of tomato plant, the presence of hair on stems is determined by a single gene. Pure breeding tomato plant with hairy stem was crossed with pure breeding tomato plant with hairless stem. The resulting F1 all had a different phenotype of short hair on stem.

Which of the following best explains the result?

A The allele for hairy stem is dominant over the allele for hairless stem.
B For heterozygotes, the two alleles have an equal effect on the phenotype.
C There are multiple alleles for the gene controlling presence of hair on stems.
D For heterozygotes, the two alleles do not contribute equally to the phenotype.

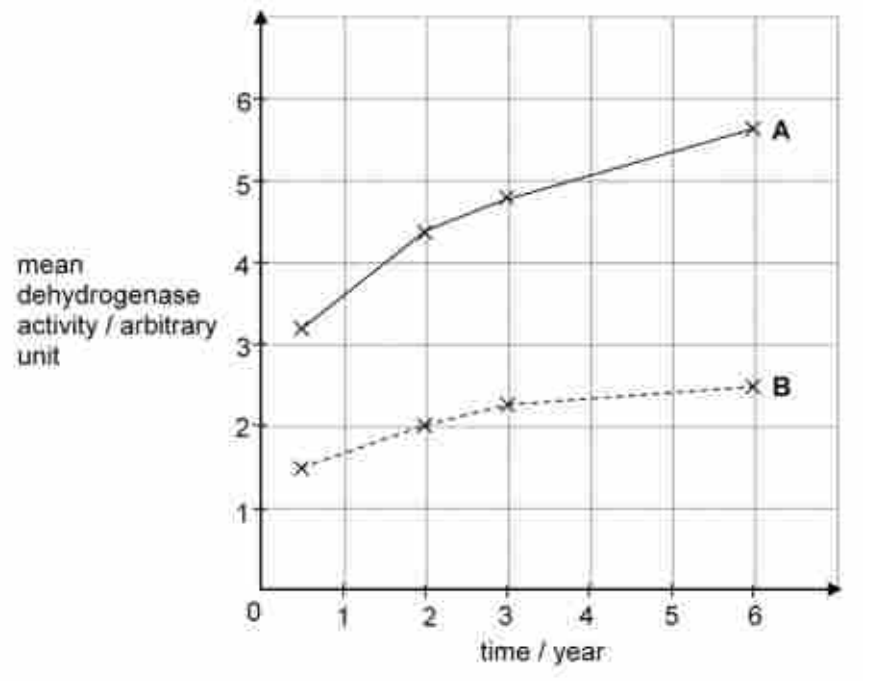
22. In cancer cells, it was observed that lactate fermentation occurs even under aerobic conditions. The uptake of glucose by cancer cells is also greatly increased by increasing the amount of glucose transporters on the cell surface membrane. Lactate fermentation under aerobic conditions is also commonly seen in normal cells that are rapidly dividing. The following figure outlines the relationship of glucose metabolism and other metabolic processes in normal cells.



Which of the following statements best explains how lactate fermentation in the presence of oxygen benefits cancer cells?

A Anaerobic respiration allows for production of intermediates that can be used to synthesise other biomolecules for growth.
B Glycolysis alone provides less ATP which allows for cancer cells to grow slowly over a prolonged period of time.
C Anaerobic respiration allows for the buildup of lactate which can be converted into other biomolecules for growth.
D Absence of citric acid cycle reduces the amount of cholesterol and fatty acids formed which prolongs the life-span of cancer cells.

23. To investigate the effect of soil depth on the rate of aerobic respiration in soil-dwelling aerobic bacteria, soil samples were taken at two depths. The samples were taken over a span of six years to determine the activity of dehydrogenases, enzymes involved in the Krebs cycle. The results are shown in the figure below.



Which of the following is a valid conclusion based on the results?

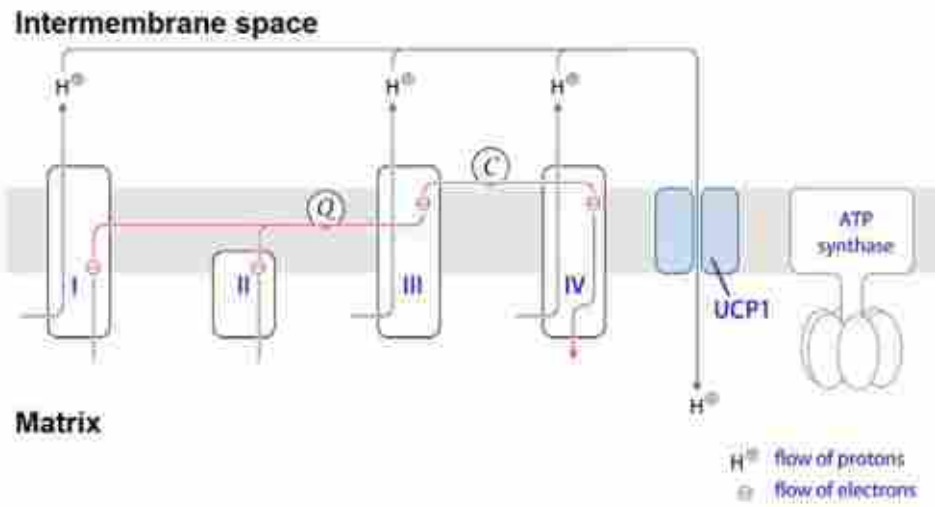
A Graph **A** shows the results of samples taken from a deeper depth as the amount of bacteria increases with increasing depth.

B Only samples from graph **A** showed an increasing rate of aerobic respiration over the time span of six years.

C Samples from graph **B** are taken from a deeper depth, as oxygen concentration decreases with deeper depth, resulting in lower dehydrogenase activity.

D Dehydrogenases found in bacteria samples from graph **B** have evolved higher affinity for substrates due to lower concentration of oxygen.

24. Brown adipose tissues are found together with white adipose tissues, they are present in all mammals but are more abundant in mammals that have to survive prolonged winters. The distinct difference of brown adipose tissues lies in the extra proton channel (UCP1) found in the inner membrane of mitochondria, which allows protons to flow back from the intermembrane space to matrix. The structure of the inner membrane along with the proteins embedded on it are shown in the figure below.



Which of the following explains the physiological significance of the proton channel UCP1 in mammals that have to survive prolonged winter?

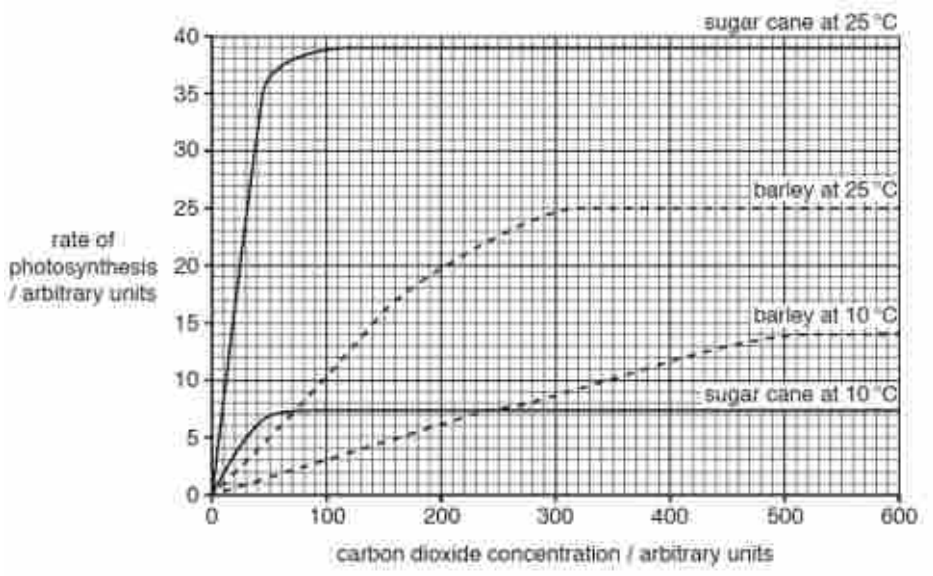
A Flow of proton back to matrix allows for more proton to be pumped across the membrane via the electron transport chain.

B Energy released from the flow of protons is loss as heat which helps keep the mammal warm.

C Less proton flowing through ATP synthase results in less ATP synthesised, this lowers the mammal's metabolism allowing it to survive better in the winter.

D Flow of proton back to matrix maintains the positive charge in the matrix which speeds up the rate of electron flow, allowing for faster rate of ATP synthesis.

25. IPCC has reported a rising trend in both global temperature and carbon dioxide levels. Both these factors are key variables to the process of photosynthesis in plants. The figure below shows how the rate of photosynthesis in two types of plants, sugar cane and barley plants are affected by changes in temperature and carbon dioxide levels.

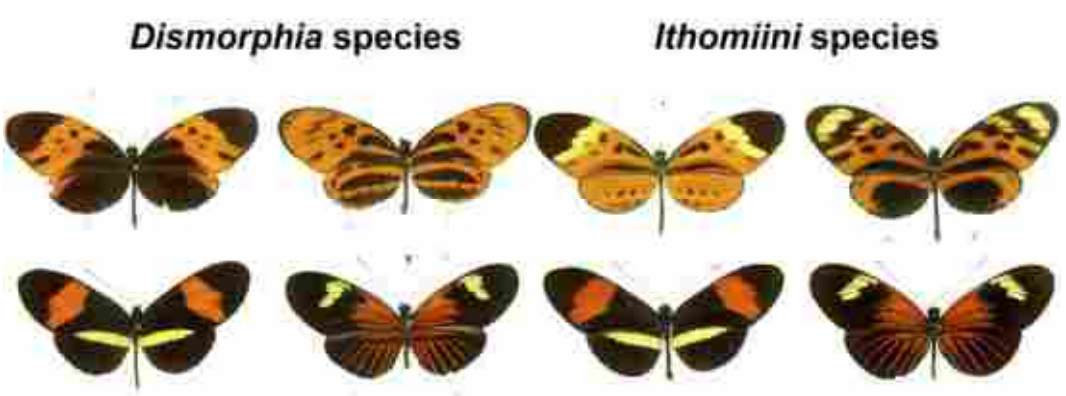


Which of the following is a valid conclusion from the data?

I Sugar cane is more sensitive to changes in carbon dioxide concentration at low carbon dioxide levels.
II Climate change is beneficial to plants as it results in the increase in rate of photosynthesis.
III Rubisco found in both sugar cane and barley are only saturated at high levels of carbon dioxide.
IV Sugar cane adapts better to increase in temperature and carbon dioxide.

A **I** and **IV** only
B **II** and **IV** only
C **II** and **III** only
D **I**, **III** and **IV** only

26. The figure below shows two species of butterfly commonly found together in the rainforests of Brazil, the *Dismorphia* species and the *Ithomiini* species.



A property about the *Dismorphia* species is that they produce a certain metabolite that deters predators. As such, predators would learn to avoid eating them. However, *Ithomiini* species on the other hand does not produce the metabolite.

In terms of appearance, the two species looks very similar. In fact, the *Ithomiini* species was found to have evolved to "mimic" the appearance of *Dismorphia* species.

Which of the following statement is true?

A *Dismorphia* species would benefit by being at a selective advantage when majority of the butterflies are *Ithomiini* species that mimics its appearance.

B *Ithomiini* species that mimics the appearance of *Dismorphia* species would be at a selective advantage when majority of the butterflies are *Ithomiini* species.

C *Dismorphia* species would not be affected by frequency of *Ithomiini* species that mimics its appearance.

D *Ithomiini* species that mimics the appearance of *Dismorphia* species would be at a selective advantage when majority of the butterflies are *Dismorphia* species.

27. Prior to Charles Darwin's publication on his theory of evolution by natural selection in his famous book, a French biologist by the name of Jean-Baptiste Lamarck crafted a hypothesis that tried to explain inheritance of traits and evolution. His hypothesis revolved around two central ideas:

I Individuals loses traits that are not required, or use, and develop characteristics that are useful.

II These acquired useful traits are passed on to subsequent generations.

His hypothesis was soon proved to be wrong with the introduction of Darwin's theory of evolution by natural selection, along with the better understanding of genetics contributed by Gregor Mendel.

Which of the following examples would **not** be evidence against Lamarck's hypothesis?

A Human ancestors used to feed primarily on plants, they had larger jaws and a third molar that was useful in grinding plant tissue, with the change in diet over time, the jaws became smaller but the third molar remains up till today, commonly known as the "wisdom tooth".

B Athletes who trained hard and excelled in their field of sports had children whom was not "naturally gifted" in the same field of sports.

C Scientists found that one's DNA can be modified during their lifetime via the addition of "chemical tags" based on their environmental conditions, and these "tags" would be passed on to their offspring.

D A couple whom was phenotypically normally throughout their lifetime had a child with sickle cell anaemia.

28. Evolution by natural selection provides an explanation for the vast number of species. Evolution can also be driven by artificial selection, where the selection pressure is applied by man and selected traits are chosen by man to be passed on.

Which of the following examples does not describe artificial selection?

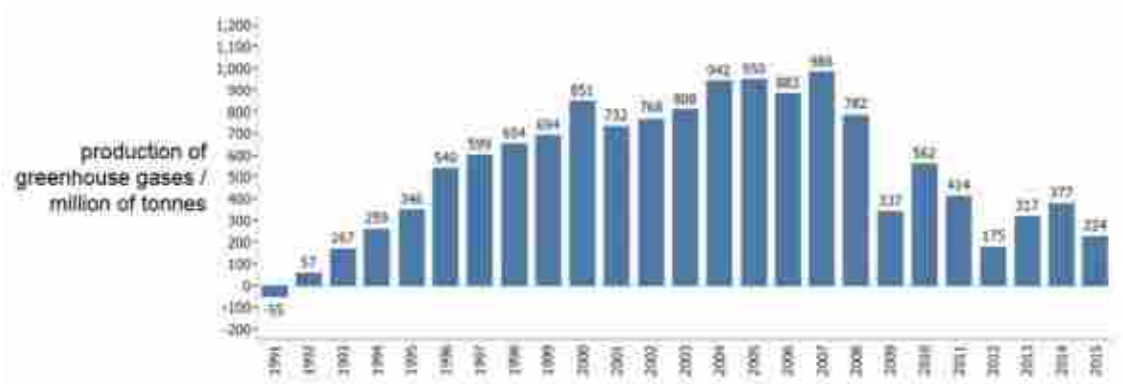
A Ancestral wolves that were domesticated by man were selected for tameness traits which gave rise to the various species of dogs today.

B Ancestral mammals that colonized Australia were isolated from the rest of the mainland with a unique environment and interactions with humans, resulting in development of unique species not seen anywhere else.

C Crops producing larger fruits were selected by farmers to breed resulting in the gradual increase in size of the fruit.

D The excessive use of antibiotics by farmers resulted in a population of bacteria that is resistant to all current known antibiotics

29. The graph shows the production of greenhouse gases (carbon dioxide and methane) in the United States from 1991 to 2015, measured in millions of tonnes.



Which of the following would **not** contribute to the trend seen between 2007 and 2015?

A increasing the cost of carbon tax

B decreased consumption of meat-based products

C increased import and export of crops with trade partners

D decreased use of agricultural machinery for crop harvesting

30. With recent changes to global climate, many agricultures have been negatively impacted. The following figure shows the changes in variables of climate conditions during the different seasons for each major crop in Pakistan. Each of the crops are harvested at specific seasons.

Variables	Major Crops			
	Wheat	Rice	Maize	Sugarcane
Max Temp	−1.7991 *	3.9200 *	0.1174	0.4743 *
Min Temp	0.6216 *	−0.7041 *	0.5458	0.2578 *
Rainfall	−0.1195 *	−0.0126	−0.703	−0.0094

***Indicates significant difference**

Which of the following statement(s) is/are valid conclusion(s) drawn from the data?

I Climate change has caused Pakistan to be drier and warmer for majority of the seasons.
II Climate change caused significant increased rainfall and flooding of all crops.
III Climate change caused an increase in variability of temperature range during the rice crop season.
IV The impact on wheat is likely to be more significant than the other three crops.

A **III** only
B **I** and **II** only
C **II** and **IV** only
D **I**, **III** and **IV** only

End of Paper

Class	Adm No

Candidate Name: _____

H

millennia institute

2018 End-of-Year Exams
Pre-University 2

H1 Biology **8876/02**

Paper 2 Core Paper **10 September 2018**

2 hours

Additional Materials: Writing paper

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your Admission number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **one** question.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question. At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Section A	
1	**/ 11**
2	**/ 8**
3	**/ 7**
4	**/ 10**
5	**/ 9**
Section B	**/ 15**
Total	**/ 60**

This question paper consists of 14 printed pages.

Section A

Answer **all** questions in this section.

1. The process of DNA replication is sometimes described as "*asymmetrical*" replication as the daughter strands are synthesised slightly differently in the form of a leading strand and a lagging strand. Fig. 1.1 shows a replication bubble and the origin of replication.

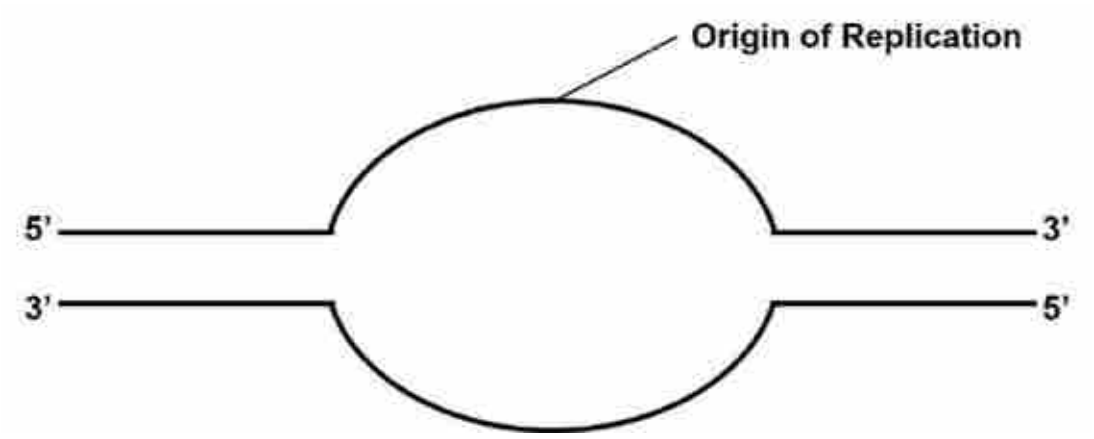


Fig. 1.1

(a) **(i)** On Fig. 1.1, draw the following with respect to one of the replication fork:

- Leading and lagging strands
- Arrow heads (→) on leading and lagging strands to indicate direction of synthesis
- 5' and 3' ends of leading and lagging strands

[2]

(ii) Explain why the two daughter strands are synthesised asymmetrically.

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.....**[2]**

Telomeres are short repetitive sequences found at the ends of chromosomes. Length of telomeres can be used to estimate cellular age as telomeres shorten over time.

(b) State what causes telomeres to shorten over time.

.....

.....**[1]**

A single human diploid cell contains around six billion base pairs, amounting to around two meters in length. The diameter of a nucleus is around 10^{-15} meters.

(c) Describe how DNA are packaged such that it can fit into the nucleus.

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.....

.....

.....**[3]**

Senescence cells are cells that have telomeres that have shortened to a critical length such that the cells no longer undergo cell division.

(d) (i) State the cell cycle stage that senescence cells are in.

.....**[1]**

(ii) Explain the purpose for limiting the number of times a cell can divide.

.....

.....

.....

.....**[2]**

[Total: 11]

2. Rubisco is an enzyme catalysing the first stage of Calvin cycle, its function is vital in maintaining life on Earth.

(a) (i) State the initial reactants and final product(s) of Calvin cycle.

.....

.....**[1]**

(ii) Explain how Rubisco plays a role in maintaining life on Earth.

.....

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.....**[2]**

Rubisco gene is found in all photosynthetic plants. A study was carried out to investigate the effect of temperature on the catalytic activity of Rubisco found in different plants. Fig. 2.1 shows the results.

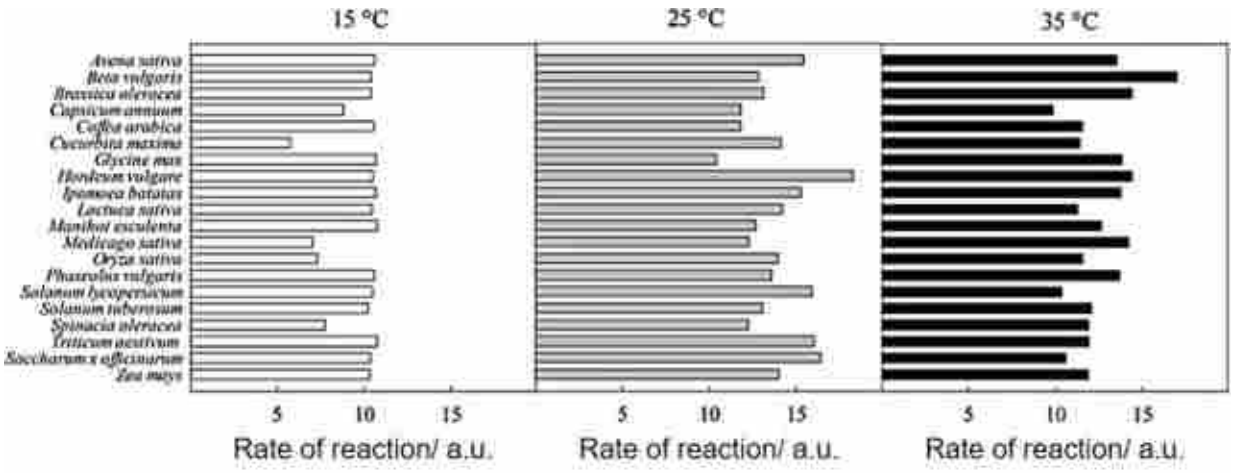

Fig. 2.1

(b) With reference to Fig. 2.1, conclude if Rubisco found in different plants have the same optimal temperature range.

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.....**[3]**

(c) Explain why Rubisco from different plants exhibit different catalytic activity under the same temperature condition with all other conditions kept constant.

.....

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.....

.....**[2]**

[Total: 8]

3. In *Drosophila melanogaster*, the common fruit fly, wing shape is controlled by a gene with multiple alleles. These alleles are listed below in no particular order. When pure-breeding *Drosophila* with long wings were crossed with pure-breeding *Drosophila* with vestigial wings, all offspring had long wings.

Long = W^L Vestigial = W^V Antlered = W^a

Drosophila with vestigial wings crossed with *Drosophila* with antlered wings produce all offspring with wings of a new phenotype that appears to be an intermediate between vestigial and antlered phenotype, called vestigial-antlered.

(a) Suggest an explanation for the new phenotype.

.....

.....

.....

.....**[2]**

Eye colour of *Drosophila* is determined by a gene located on the X chromosome. Sex determination in *Drosophila* is similar to that of humans. *Drosophila* can either have red eyes or white eyes, the allele coding for red eyes is dominant over the allele for white eyes.

Pure breeding female *Drosophila* with long wings and red eyes were crossed with pure breeding male *Drosophila* with vestigial wings and white eyes.

In the F1 generation, all female and male *Drosophila* had long wings and red eyes.

Female and male flies from F1 generation were then crossed to produce the F2 generation.

The observed number of F2 flies with each phenotype were as follows:

Female, long wings, red eyes	595
Female, vestigial wings, red eyes	201
Male, long wings, red eyes	304
Male, long wings, white eyes	299
Male, vestigial wings, red eyes	101
Male, vestigial wings, white eyes	100

(b) Draw a genetic diagram to explain the observed results of the cross between female flies and male flies from the F1 generation.

[5]

[Total: 7]

4. Global temperature records show temperature anomaly (°C), which is the difference in temperature of a particular year to the average temperature of a reference year-span. Fig 4.1 shows the global temperature records from 1900 to 2014 relative to the average temperature from 1951 to 1980.

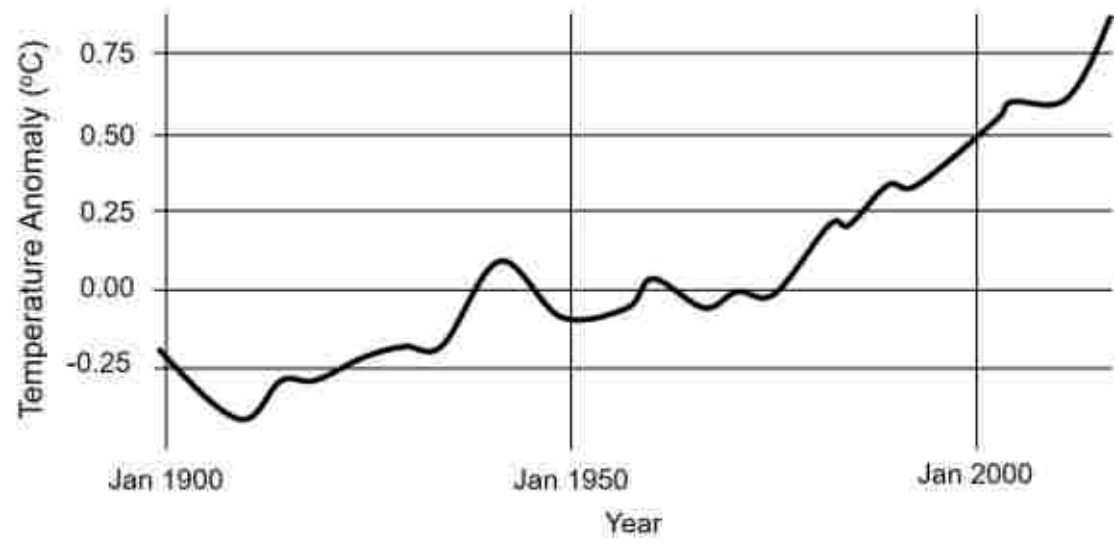

Fig. 4.1

Fig. 4.2 shows the global carbon emission from burning of fossil fuel from 1900 to 2014.

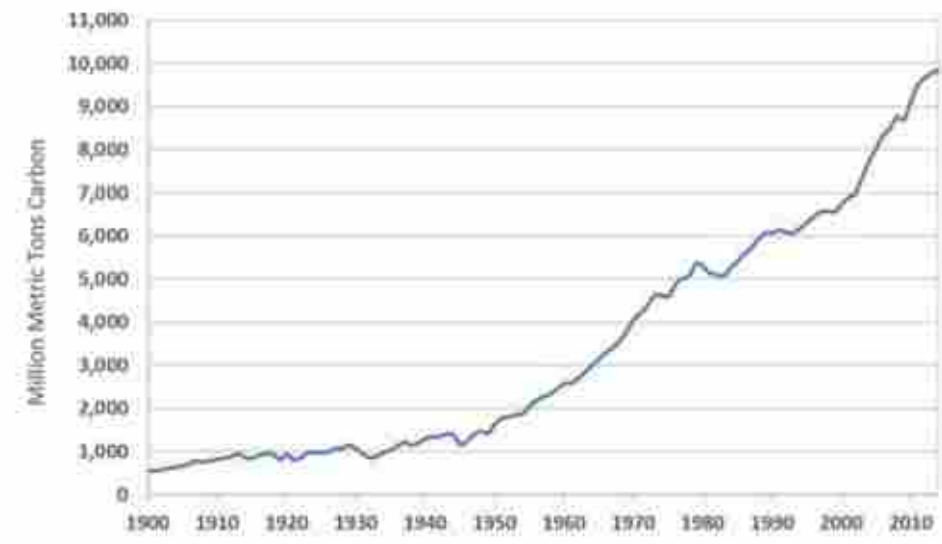

Fig. 4.2

(a) Comment on the trend observed for both global temperature records and global carbon emission from 1950s onwards.

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.....

.....**[2]**

Changes in global temperature will have an impact on many other abiotic and biotic factors, one of them being sea levels.

(b) With reference to Fig. 4.1, account for how sea levels have been affected.

.....

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.....

.....

.....**[3]**

Another factor that is impacted by changes in global temperature is the spread of mosquito borne diseases like Dengue fever (DF), caused by the dengue virus. Fig. 4.3 shows the number of reported DF cases globally from 1980 to 2002.

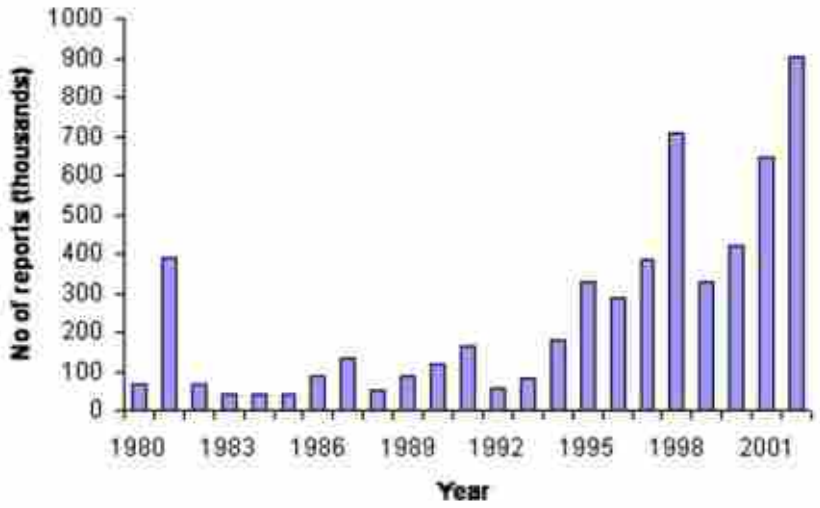

Fig. 4.3

(c) Explain the relationship between the data in Fig. 4.1 and the general trend observed in Fig. 4.3.

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.....**[3]**

The Intergovernmental Panel on Climate Change (IPCC) has made predictions on future global surface temperature based on past trends and existing data. If no actions are done, the trend observed in Fig. 4.1 can be expected to continue.

(d) Assuming if the trend in Fig. 4.1 continues, predict how dengue would spread in the future.

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……..

……**[2]**

[Total: 10]

5. The length of the upper leg bone is an important variable in research on human evolution as it provides information about the energy used in movement.

Fig. 5.1 shows the length of upper leg bone that have been measured or estimated from fossils of four hominid species (*Australopithecus, H. erectus, H. neanderthalensis and H. sapiens*) covering a time period of approximately three and a half million years.

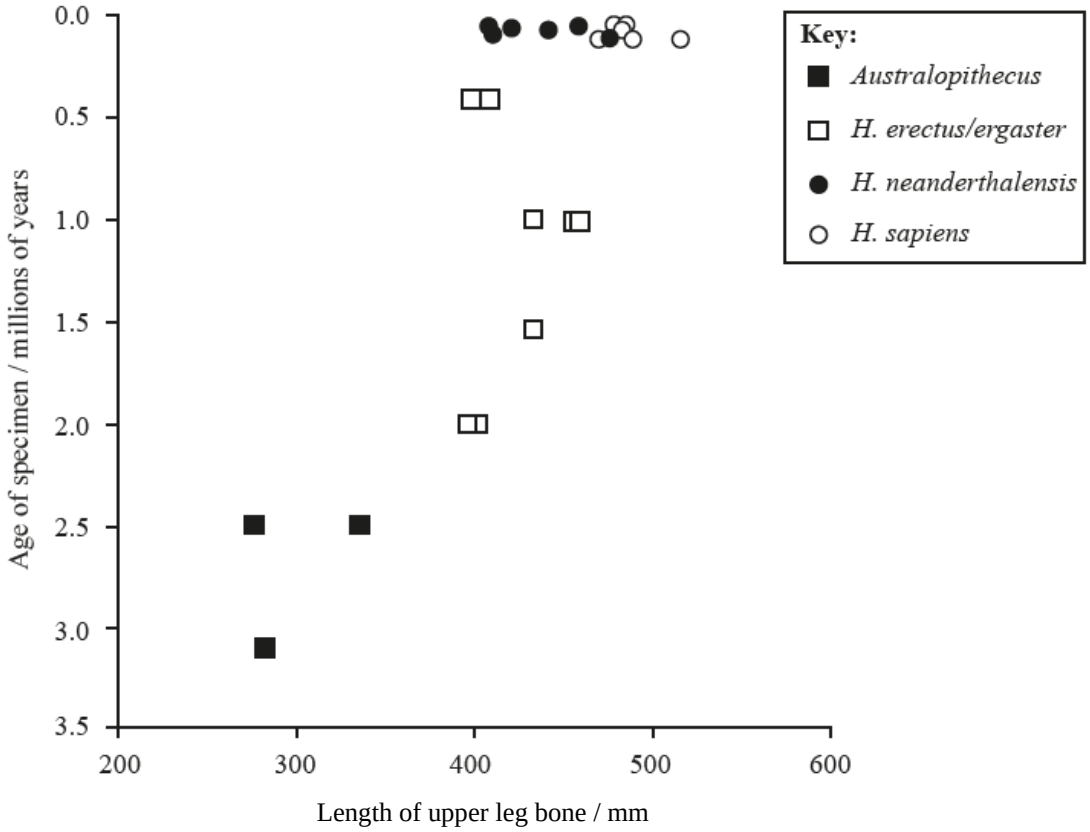

Fig. 5.1

Source: Adapted from K. Steudel-Numbers and M. Tilkens (2004) *Journal of Human Evolution*, 47, pages 95–109. 'The effect of lower limb length on the energetic cost of locomotion: implications for fossil hominins'

(a) With reference to Fig. 5.1, explain if increasing upper leg bone length provides an evolutionary advantage.

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.....**[3]**

(b) Suggest one limitation of using fossil records in evolutionary studies.

.....

.....**[1]**

We would expect natural selection to eliminate genetic variations with negative effects from human population. However, the study on human genetics reveals that several recessive alleles that are known to cause diseases have been preserved in human populations.

For instance, the sickle-cell allele is carried by half the people in some areas of Africa. This distribution seems to result from the counterbalancing effects of anaemia and malaria, a disease that formally causes high death rates in equatorial Africa.

(c) Account for the high frequency of sickle cell anaemia allele in the African populations.

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.....**[3]**

(d) Explain why population is the smallest unit that can evolve.

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.....**[2]**

[Total: 9]

Section B

Answer **one** question.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a), (b)** etc., as indicated in the question.

1.

(a) Compare aerobic and anaerobic respiration in animals. **[7]**

(b) Both Darwin and Wallace independently came up with the theory of evolution by natural selection. They concluded that organisms had to struggle for survival, and that each subsequent generation slowly became better adapted to the environment.

Using named example, explain how environmental factors act as forces of natural selection. **[8]**

[Total: 15]

2.

(a) Contrast between stem cells and cancer cells. **[6]**

(b) Based on data collected over the years on weather patterns and greenhouse gas emissions, researchers have concluded a causal relationship between greenhouse gas emission and enhanced global warming. Biotic factors like coral reefs are sensitive and vulnerable to changes in climate.

Discuss how weather patterns would be affected and the consequences of such changes, along with how corals reefs are impacted by enhanced global warming. **[9]**

[Total: 15]

End of Paper

[Total: 15]

Candidate Name: _____

Class	Adm No

H

millennia institute

2018 End-of-Year Exams
Pre-university 2

Biology Higher 1 **8876/01**

Paper 1 **17 September 2018**

1 hour

Additional Materials: Optical answer sheet

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, Adm No. and class on all the papers you hand in.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Paper 1
There are **thirty** questions in this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Multiple Choice Answer Sheet.

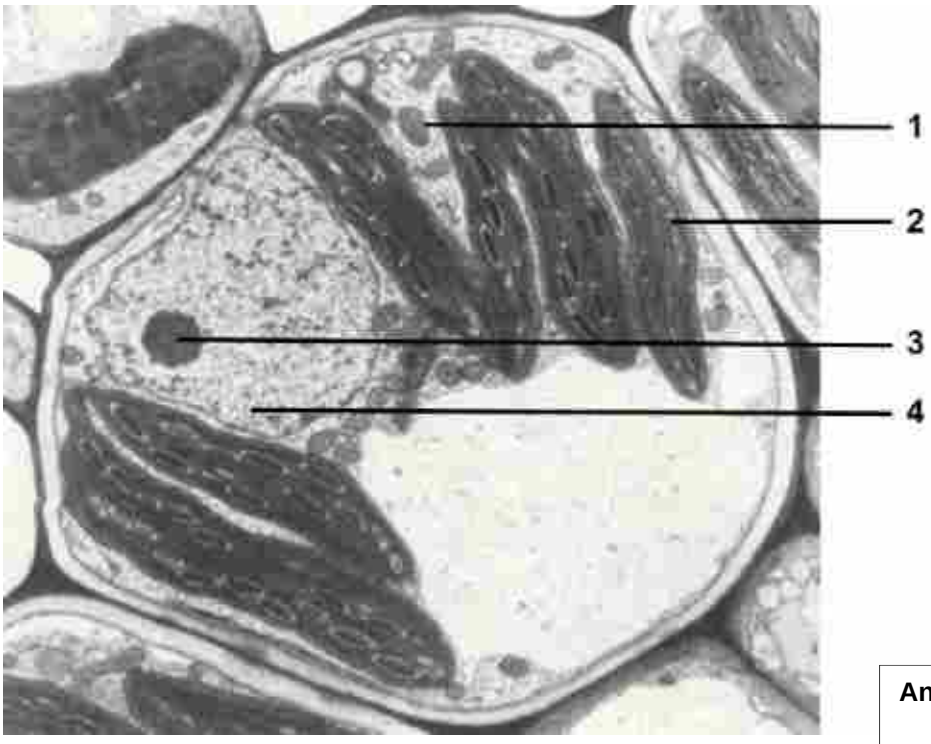
Calculators may be used.

This question paper consists of 25 printed pages.

[Turn over

Answer **all** questions

1. The figure below shows an electron micrograph of a plant cell.

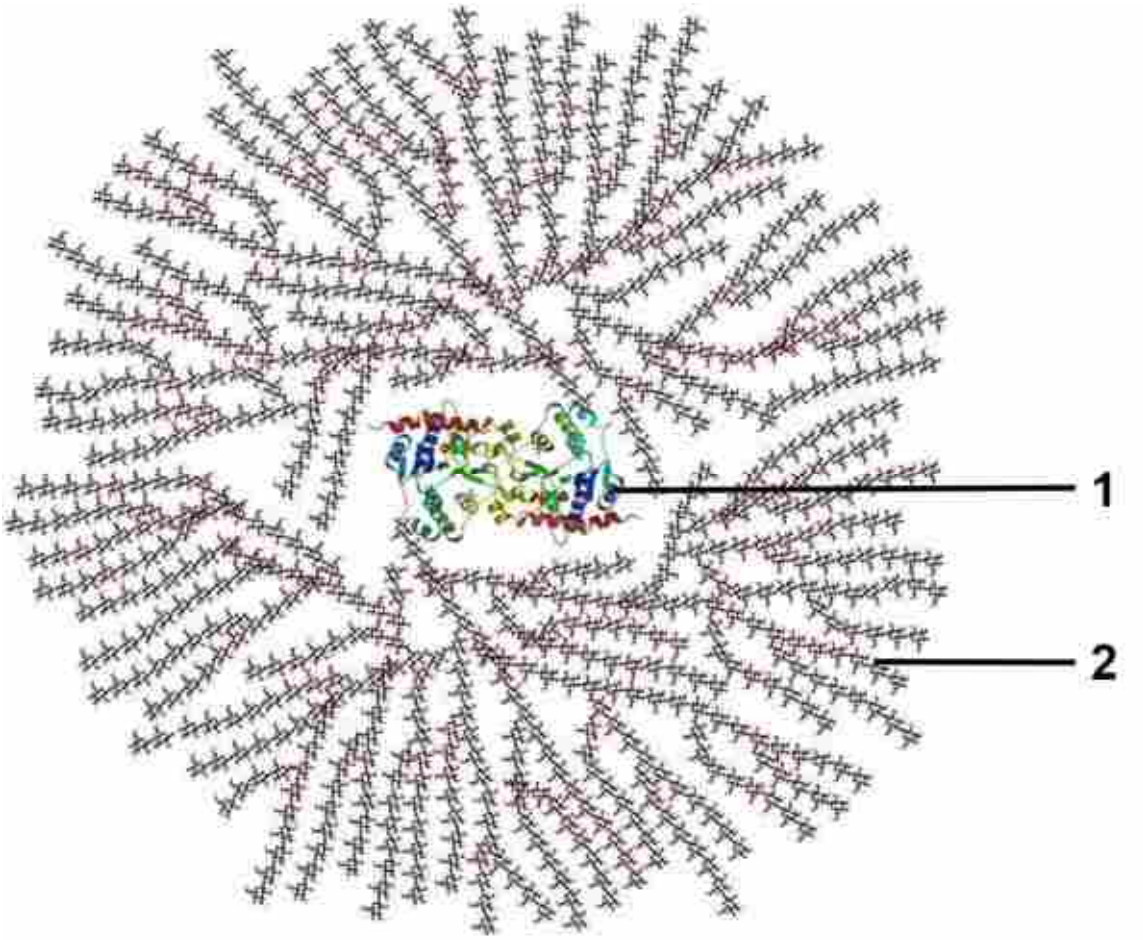


Answer: B

Which of the following about structures **1-4** are correct?

	Take in oxygen	Take in carbon dioxide	Site of transcription	Site of translation
A	**1**	**1** and **2**	**3** and **4**	**1** and **2**
B	**1**	**2**	**1, 2, 3** and **4**	**1** and **2**
C	**2**	**1**	**1** and **2**	**4**
D	**1** and **2**	**2**	**1, 2** and **3**	**1**, **2** and **4**

2. Glycogen are polysaccharides that functions as energy stores in animals. Glycogen granules can consist up to 30 000 glucose monomers, the following figure shows the structure of a glycogen granule.



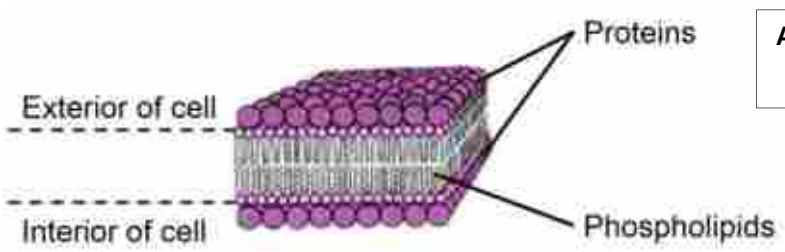
Which of the following statement(s) is/are true about structure **1** and **2**?

I Monomers in structure **1** and **2** are joined by only one type of bond.
II Helices can be found in both structures **1** and **2**.
III Monomers in structure **2** are identical, whereas monomers in structure **1** are only similar and not completely identical.
IV Both structures **1** and **2** can be hydrolysed to release the monomers that can enter glycolysis directly.

Answer: B

A **II** only
B **II** and **III** only
C **I**, **II** and **III** only
D **I**, **III** and **IV** only

3. In the development of the fluid mosaic model of the membrane, there were other models that were suggested. The figure below shows a particular model suggested by a pair of scientists, Davson and Danielli.

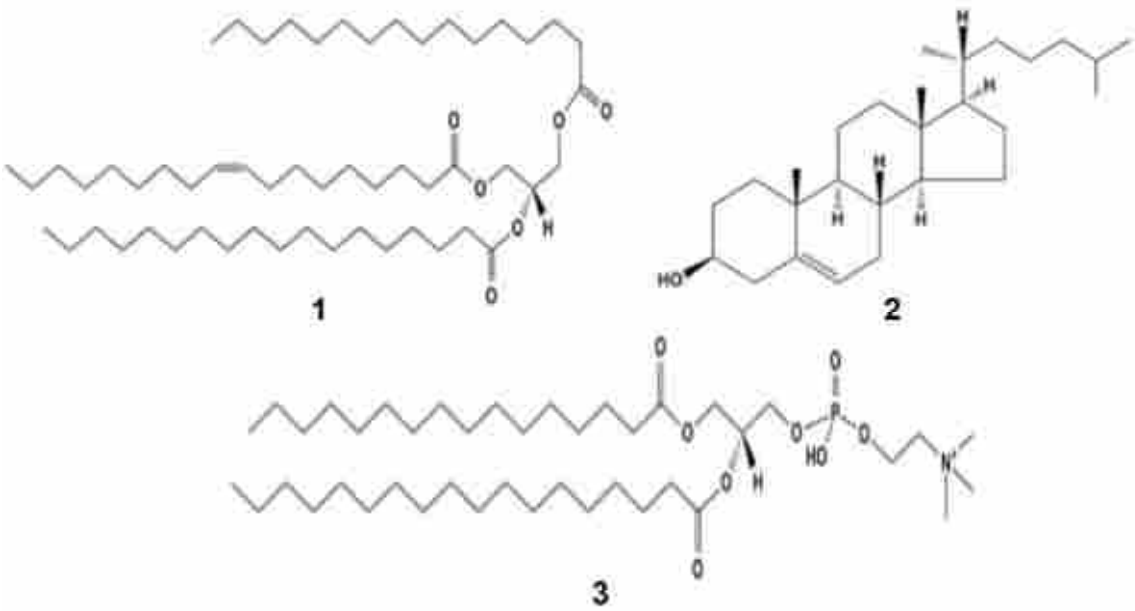


Answer: D

Which of the following observation would be a valid evidence to disprove this model?

A Membrane fluidity increases with increasing temperature.
B Analysis of the elements found in biomolecules of the membrane identified: C, H, O, N and P.
C When the membrane were homogenised to a single layer, the surface area was twice that of the original membrane.
D When cells were placed in a glucose solution, glucose was found to be present in the interior of cells.

4. The figure below shows three types of lipids.



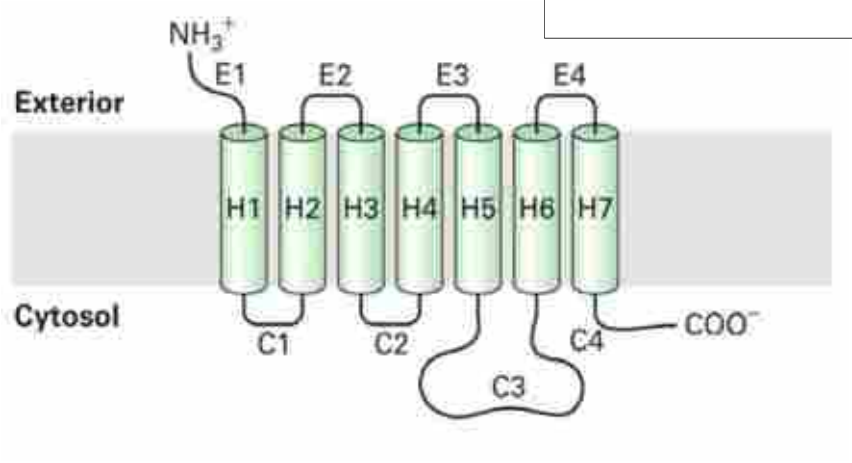
I All three lipids are components of the cell membrane.
II Lipid **1** is hydrophobic while lipids **2** and **3** are amphipathic.
III Hydrolysis of lipids **1** and **3** produces glycerol and fatty acids, while hydrolysis of lipid **2** produces only fatty acids.
IV Lipid **1** stores more energy per gram as compared to glucose per gram due to a higher proportion of C-H bonds.

A **I** and **IV** only
B **II** and **IV** only
C **II** and **III** only
D **I**, **II** and **III** only

Answer: B

5. Rhodopsin is a receptor found in the rods of the retina. It is extremely sensitive to light, enabling vision under low-light conditions. Rhodopsin has a characteristic seven coiled cylindrical regions, which spans across the surface membrane bilayer, as shown in the diagram.

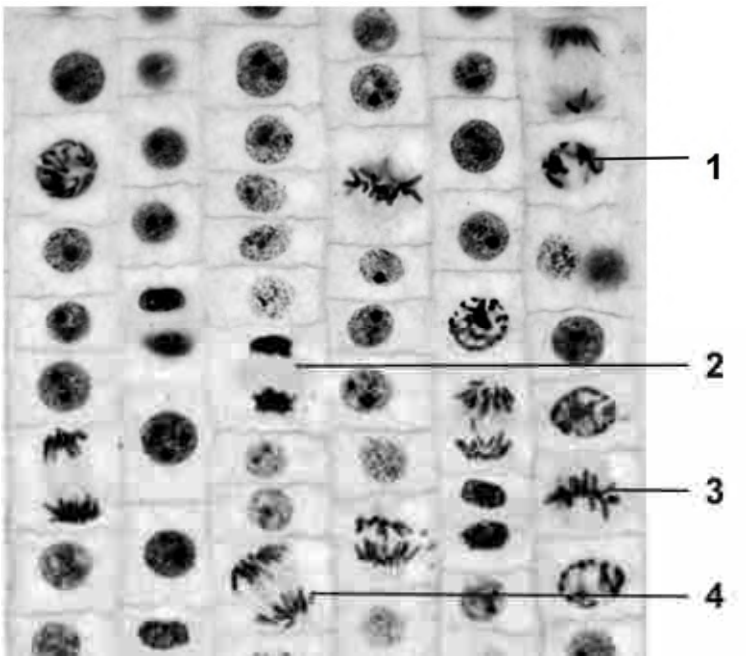
Answer: C



Which option best describes the regions containing **E3**, **H3** and **C3**?

	E3	**H3**	**C3**
A	interacts with G-protein	secondary structure held by hydrogen bonds	amino acids with polar R-groups
B	interacts with G-protein	tertiary structure held by R-group interactions	amino acids with polar R-groups
C	amino acids with polar R-groups	secondary structures held by hydrogen bonds	interacts with G-Protein
D	amino acids with polar R-groups	quaternary structure held by peptide bonds	interacts with G-Protein

6. The diagram shows an electron micrograph of onion root epidermal cells undergoing mitosis. Cells **1** to **4** are each at different stage of mitosis.



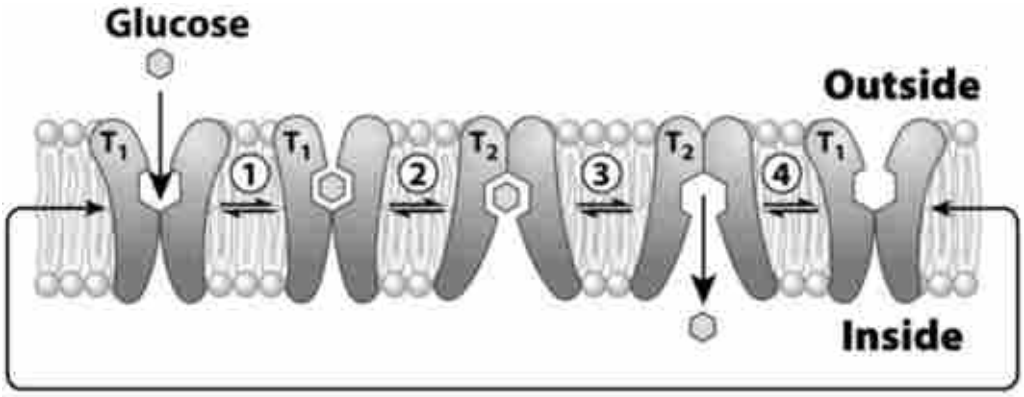
Which of the following statement(s) is/are true about cells **1** to **4**?

I The number of chromosomes per cell is doubled in cells **2** and **4** as compared to cells **1** and **3**.
II The order of the cells in sequential mitotic stages are: **3**, **4**, **2** and **1**.
III Sister chromatids found in cells **2**, **3** and **4** are no longer genetically identical due to crossing over that occurred during the stage that cell **1** is in.
IV Homologous chromosomes are present in all cells **1** to **4**.

Answer: B

A **I** only
B **I** and **IV** only
C **II** and **III** only
D **I**, **II** and **IV** only

7. When cells are placed in a solution containing glucose, membrane proteins called GLUT will transport glucose into the cell as shown in the figure below.



Which of the following statement is **false** about this process?

Answer: D

A The binding site of GLUT is complementary to the 3D structure of glucose, as such it is specific in transporting of only glucose.
B The interior lining of GLUT contains amino acids with polar R-groups.
C When exterior glucose concentration is very high, the rate of glucose uptake is limited by the amount of GLUT.
D Energy is required in the form of ATP hydrolysis to cause a conformation change of GLUT in step **2**.

8. Enzymes can be covalently bonded to the surface of a matrix (immobilised). The matrix has a very high surface area to volume ratio. A substrate can collide with the enzyme held in place for the reaction to occur.

The following data shows the effects of temperature on immobilised and free enzymes.

temperature / ºC	immobilised P1 nuclease activity / arbitrary units	free P1 nuclease activity / arbitrary units
30	20	20
40	41	35
50	56	54
60	67	65
70	78	52
80	58	47

Answer: B

Which of the following is a valid conclusion based on the data?

A As the enzymes are the same, the maximum activity for immobilised and free enzymes are the same.
B Covalently binding enzymes to a matrix allows it to resist a higher level of thermal agitation.
C Covalently binding enzymes to a matrix prevents it from denaturation.
D Free enzymes are more active at lower temperatures as they are able to collide with substrates at a higher rate

9. There are currently a variety of strategies applicable in treatment of wound healing like recovery from burns. Some of the options include:

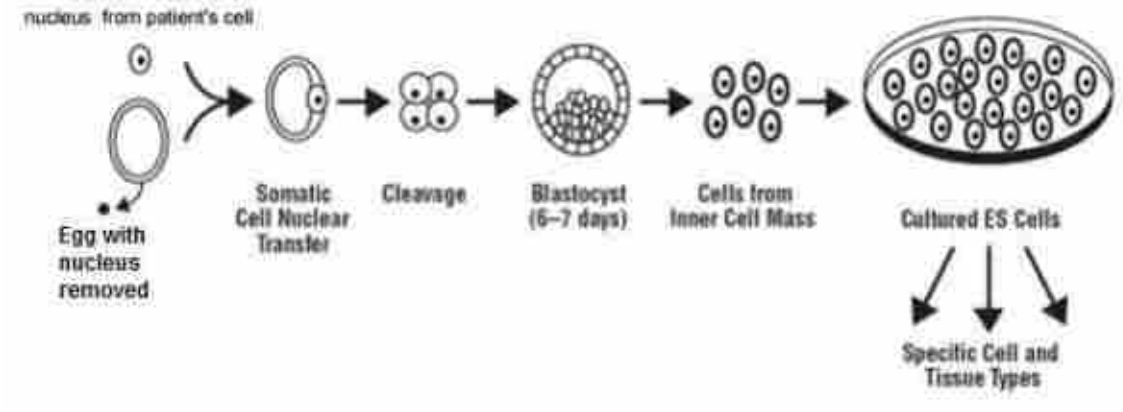
- **Traditional strategies**: skin graft obtained from suitable donors
- **Stem cell treatment**: make use of patient's own adult stem cells, donated embryonic stem cells or induced pluripotent stem cells to regene

Answer: C

Which of the following identifies a challenge of each method?

	skin graft from donor	**adult stem cells**	**embryonic stem cells**	**induced pluripotent stem cells**
A	availability of suitable donor	triggering immune response and cell rejection	ethical issues	reprogramming process
B	programming to differentiate into skin cells	triggering immune response and cell rejection	programming to differentiate into skin cells	ethical issues
C	availability of suitable donor	programming to differentiate into skin cells	ethical issues	reprogramming process
D	programming to differentiate into skin cells	programming to differentiate into skin cells	Differentiates to limited cell types	programming to differentiate into skin cells

10. Somatic cell nuclear transfer (SCNT) is a method used to develop embryonic stem cells from a patient's somatic cell. The developed embryonic stem cell can then be used to treat the patient. The process is outlined in the figure below.



Which of the following statements(s) is/are true?

I Cultured embryonic stem cells obtained via SCNT overcomes the problem of immune response.
II SCNT pose no ethical concerns as it does not involve the destruction of embryos.
III One concern of using SCNT is the potential for reproductive cloning.
IV The potency of the cultured embryonic stem cells is limited by origin of the nucleus used.

Answer: B

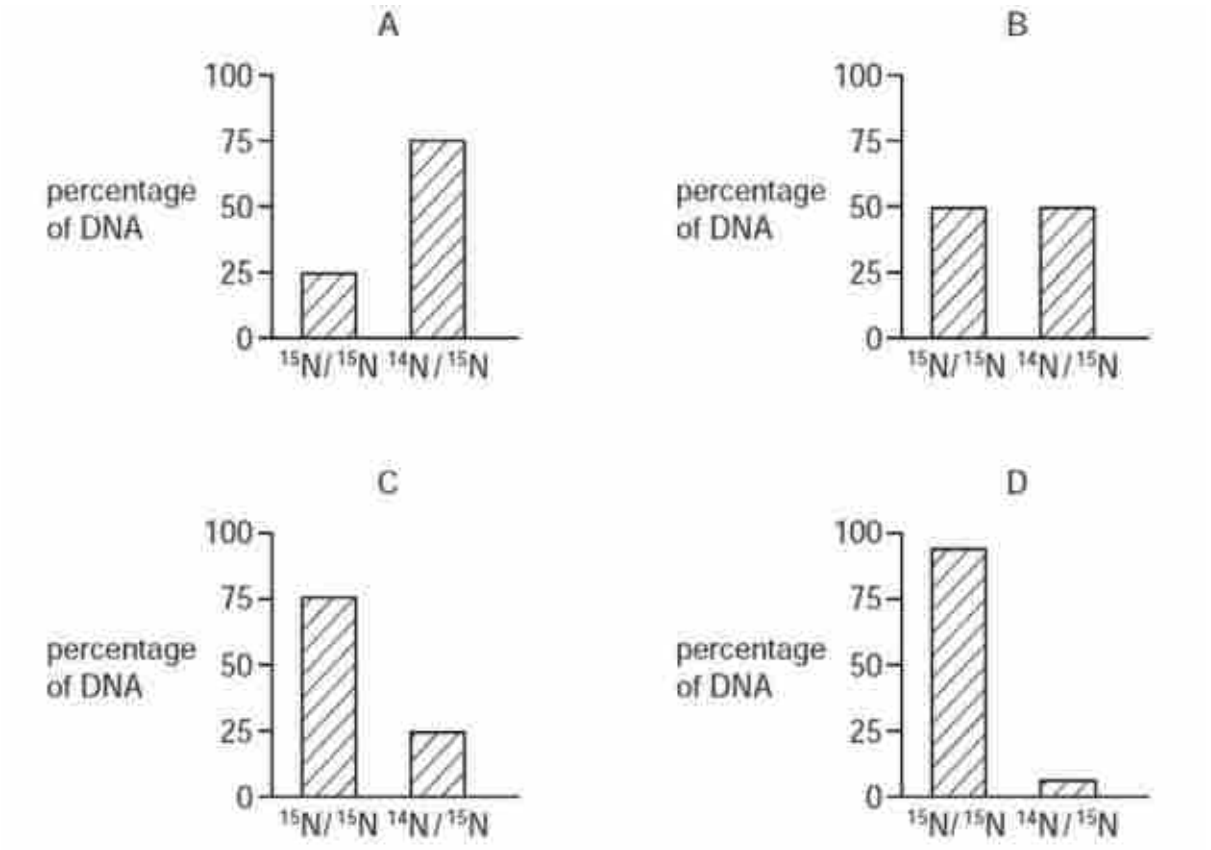
A **I** only
B **I** and **III** only
C **II** and **IV** only
D **I**, **III** and **IV** only

11. Bacteria were grown in a medium containing ^{15}N. After several generations, all of the DNA contained ^{15}N.
Some of these bacteria were transferred to a medium containing the cor
nitrogen, ^{14}N. The bacteria were allowed to divide once.

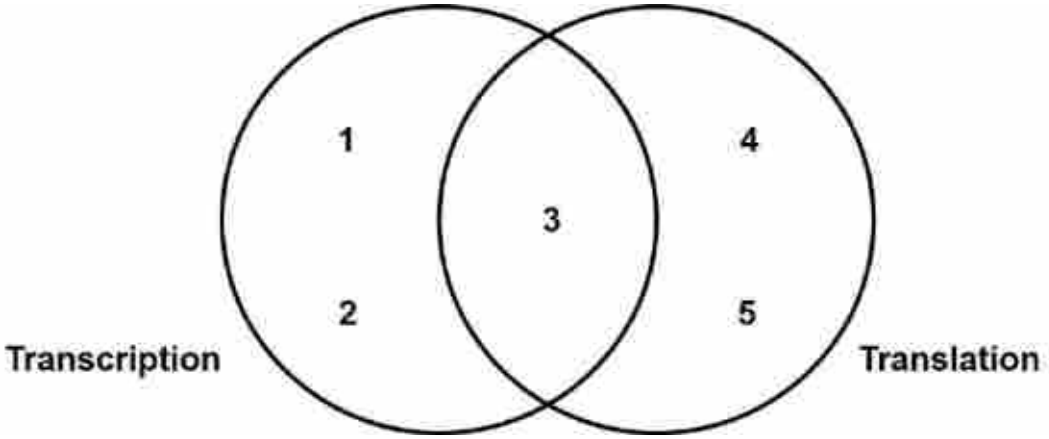
Answer: B

The bacteria were then transferred back to the medium containing ^{15}N. The bacteria were allowed to divide once more.

What would be the percentage of $^{15}N/^{15}N$ DNA molecules and $^{14}N/^{15}N$ hybrid DNA molecules in the DNA extracted from the bacteria at the end of the experiment?



12. The following diagram shows two processes involved in the central dogma for eukaryotes, **1**, **2, 4** and **5** represent properties unique to the individual processes, while **3** represent a property that is similar between the two processes.

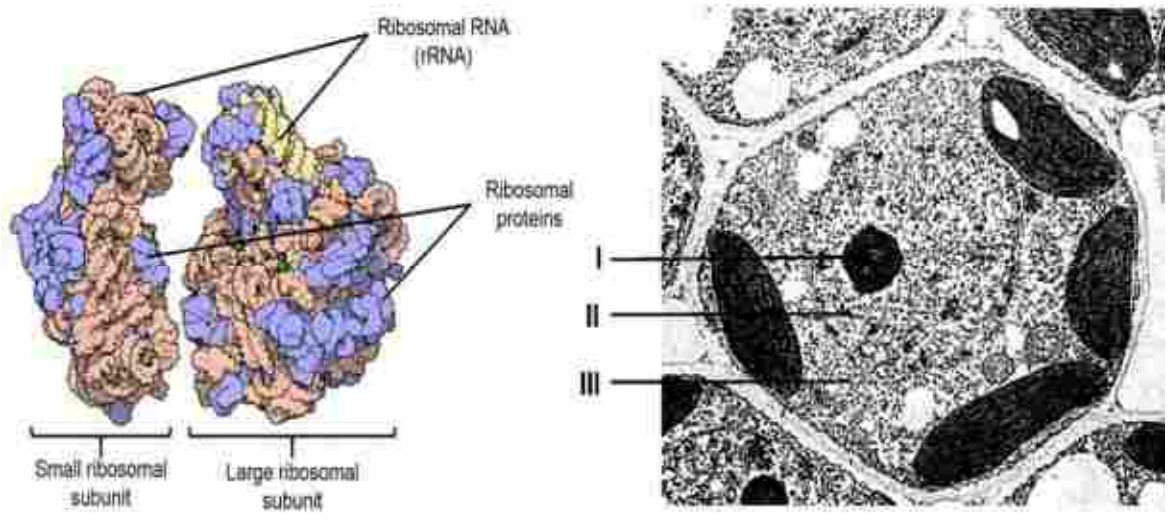


Answer: C

Which of the following correctly identifies **1-5**?

	1	2	3	4	5
A	formation of phosphodiester bonds	product synthesised from 5' to 3'	occurs in cytoplasm	formation of peptide bonds	product synthesised from N to C terminal
B	formation of peptide bonds	product synthesised from N to C terminal	occurs in cytoplasm	formation of phosphodiester bonds	product synthesised from 5' to 3'
C	formation of phosphodiester bonds	occurs in nucleus	requires energy	formation of peptide bonds	occurs in cytoplasm
D	formation of peptide bonds	occurs in nucleus	requires energy	formation of phosphodiester bonds	occurs in cytoplasm

13. Ribosomes are organelles involved in protein synthesis, it is composed of two subunits, a small ribosomal subunit and a large ribosomal subunit. Each subunit consists of two components, a protein component and a RNA (rRNA) component. The ribosome structure is showed in the figure on the left. The figure on the right shows an electron micrograph of a eukaryotic cell with three regions labelled, **I**, **II** and **III**. These three regions are involved in the synthesis of each individual components and the assembly of each subunit (combining the protein component with rRNA component).

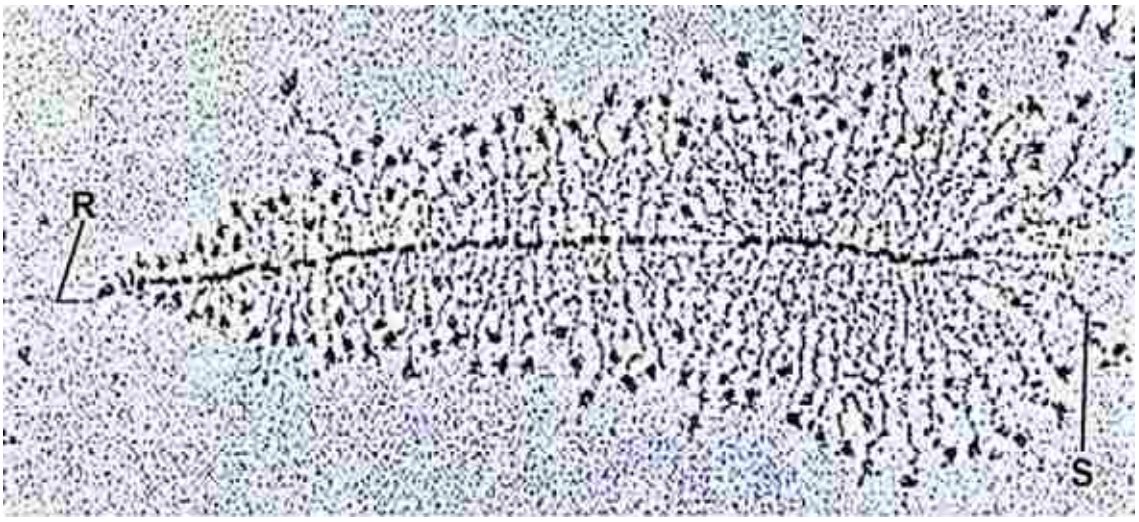


Which of the following correctly identifies the role(s) that each region plays in the synthesis of ribosomal subunits?

	I	II	III
A	transcription of rRNA genes to form rRNA	assembly of individual subunits	translation of rRNA to form ribosomal proteins
B	assembly of individual subunits	transcription of rRNA genes	translation of rRNA to form ribosomal proteins
C	assembly of individual subunits	transcription of rRNA and ribosomal protein genes to form rRNA and ribosomal protein mRNA	translation of ribosomal protein mRNA to form ribosomal proteins
D	transcription of rRNA genes to form rRNA and assembly of individual subunits	transcription of ribosomal protein genes to form ribosomal protein mRNA	translation of ribosomal protein mRNA to form ribosomal proteins

Answer: D

14. The electron micrograph shows protein synthesis in a bacteria cell.



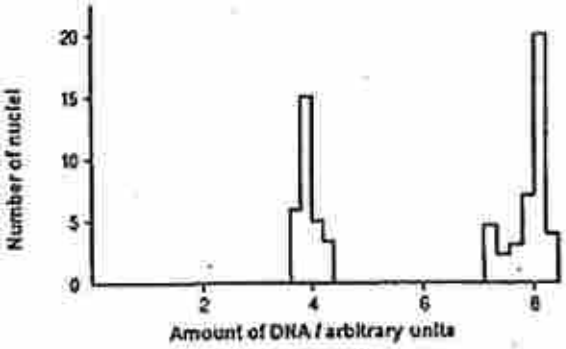
Which statements about the processes involved are correct?

- **I** Transcription occurs from left to right along template DNA, **R**.
- **II** **S** is used as template for translation.
- **III** Translation initiates only after transcription is completed.
- **IV** Only one RNA polymerase is transcribing the template DNA, **R**, at any one time.
- **V** **R** is the mRNA and it is translated by ribosomes to form polypeptide chains, **S**.

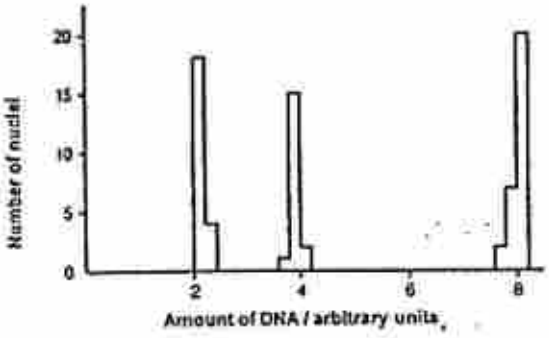
Answer: B

A **V** only
B **I** and **II** only
C **I**, **II** and **IV** only
D **III**, **IV** and **V** only

15. The graphs below show the amount of DNA per nuclei of cells taken from two different parts of a mammalian testis undergoing different types of nuclear division.



Graph 1



Graph 2

Answer: A

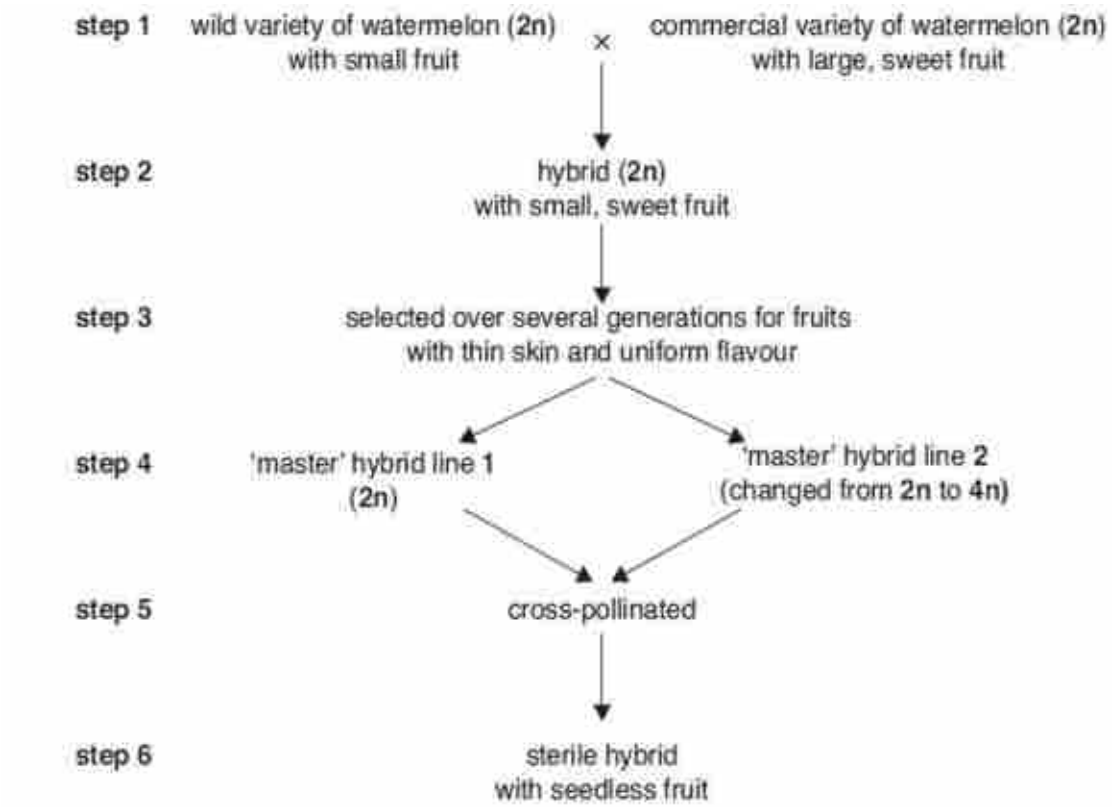
Various events that occurs in **graph 1** and **2** are listed as follows

I DNA replication
II Breaking and rejoining of homologous regions of chromosomes
III Separation of homologous chromosomes
IV Separation of identical sister chromatids
V Separation of non-identical sister chromatids

Which of the following correctly identify events that occurred in each graph?

	Graph 1	**Graph 2**
A	**I** and **IV**	**I, II, III** and **V**
B	**II, III** and **V**	**I** and **IV**
C	**I** and **IV**	**II, III** and **V**
D	**III** and **IV**	**I, II** and **V**

16. The following flowchart shows the steps involved in cultivating watermelon of desired phenotypes.



Which of the following statement(s) is/are true regarding the steps involved?

I Step 3 is an example of artificial selection.
II Drugs that prevent spindle fibre formation can be used to form diploid gametes that allows the formation of tetraploid 'master' hybrid line 2.
III The seedless hybrid produced in step 6 is sterile due to absence of homologous chromosomes.
IV The seedless hybrid produced in step 6 can be made fertile again by using the same method used in step 4 in producing tetraploid 'master' hybrid line 2.

Answer: C

A **II** only
B **I** and **III** only
C **I**, **II** and **IV** only
D **II**, **III** and **IV** only

17. Ras is a protein that functions as a signalling molecule in cells. When the appropriate signals are present, Ras is activated, and it signals for cell proliferation. Many cancer development process involves the mutation of the Ras gene, resulting in a mutant Ras protein.

Answer: C

Which of the following best explain why a mutant Ras leads to tumour progression?

A Ras is a proto-oncogene, a loss of function mutation to Ras prevents it from detecting DNA damage and cell cycle arrest.
B Ras is a tumour suppressor gene, a loss of function mutation to Ras prevents it from signaling normal cell proliferation.
C Ras is a proto-oncogene, a gain of function mutation to Ras allows it to signal for cell proliferation in the absence of appropriate signals, resulting in uncontrolled cell division.
D Ras is a tumour suppressor gene, a gain of function mutation to Ras results in signaling that allows the cell to bypass cell cycle checkpoints.

Refer to the following information for questions **10** and **11**.

Dystrophin is a protein that function to maintain the cell membrane integrity of muscle fibers. Duchene muscular dystrophy (DMD) is a genetic disease caused by a mutation in the dystrophin gene.

18. The sequence of part of the normal and mutated alleles for dystrophin gene is shown below.

Answer: D

Normal allele

Codon	180	181	182	183	184	186	187	188	189
mRNA	CGU	AGA	UGG	AAA	UCA	UAA	ACU	GAC	UCU

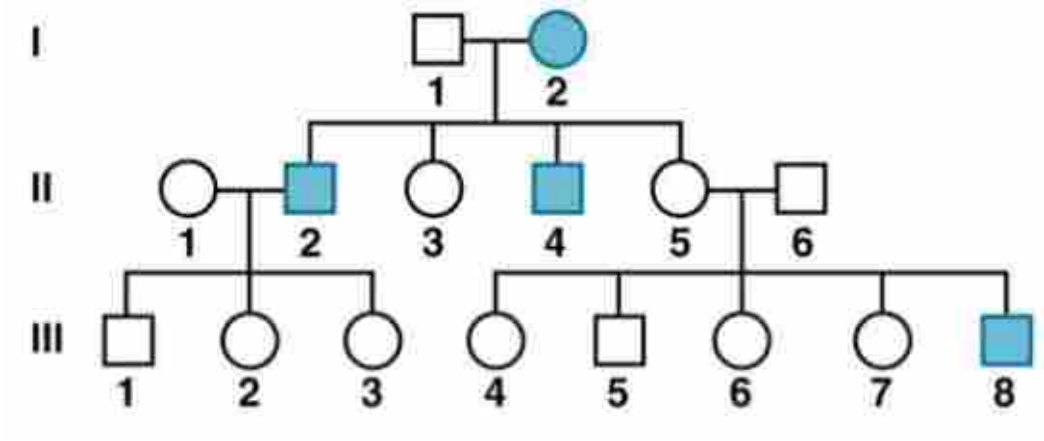
Mutant allele

Codon	180	181	182	183	184	186	187	188	189
mRNA	CGU	AGU	GAA	AUC	AUA	AAC	UGA	CUC	UUG

Using the information of the normal and mutated alleles above, which of the following is a valid conclusion?

A An addition of two nucleotides at codon 181 caused a frame shift mutation, resulting in a premature stop codon at codon 189.
B A deletion of a single nucleotide at codon 181 caused a frame shift mutation, resulting in a premature stop codon at codon 189.
C A substitution of a single nucleotide at codon 181 and a deletion of two nucleotides at codon 187, causing a frame shift, resulting in a premature stop codon at codon 187.
D A deletion of a single nucleotide at codon 181 and at codon 182 caused a frame shift mutation, resulting in a premature stop codon at codon 187.

19. The pedigree chart shows the inheritance of DMD in a family.



What is the mode of inheritance for DMD?

A Sex-linked dominant
B Autosomal dominant
C Sex-linked recessive
D Autosomal recessive

Answer: C

20. *Abraxas grossulariata* is a Moth native to North America. There are two different phenotypes observed for their wing colour, dark and light. Two crosses were carried out to determine the inheritance of wing colour in *Abraxas grossulariata*.

Cross 1: Pure-breeding female moths with dark coloured wings crossed with pure breeding male moths with light coloured wings
Result: All offspring were showed dark coloured wings.

Cross 2: Pure-breeding female moths with light coloured wings crossed with pure breeding male moths with dark coloured wings
Result: All female offspring had dark coloured wings while all male offspring had light coloured wings.

Based on the results of the two crosses, what can be deduced about the inheritance of wing colour in *Abraxas grossulariata?*

A Wing colour is sex-linked, the allele for dark wing colour is dominant to allele for light wing colour
B Wing colour is not sex-linked, the allele for dark wing colour is dominant to allele for light wing colour
C Wing colour is sex-linked, the allele for light wing colour is dominant to allele for dark wing colour
D Wing colour is not sex-linked, the allele for light wing colour is dominant to allele for dark wing colour

Answer: A

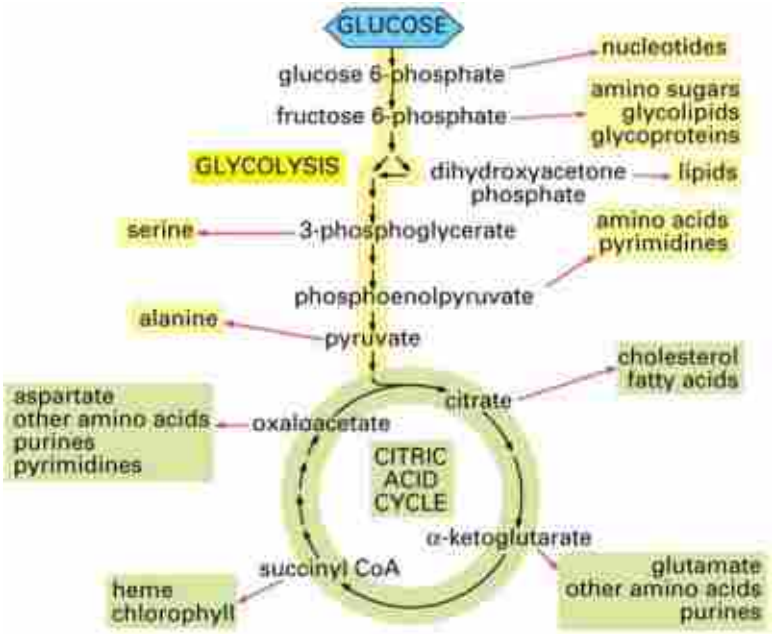
21. In a particular breed of tomato plant, the presence of hair on stems is determined by a single gene. Pure breeding tomato plant with hairy stem was crossed with pure breeding tomato plant with hairless stem. The resulting F1 all had a different phenotype of short hair on stem.

Answer: D

Which of the following best explains the result?

A The allele for hairy stem is dominant over the allele for hairless stem.
B For heterozygotes, the two alleles have an equal effect on the phenotype.
C There are multiple alleles for the gene controlling presence of hair on stems.
D For heterozygotes, the two alleles do not contribute equally to the phenotype.

22. In cancer cells, it was observed that lactate fermentation occurs even under aerobic conditions. The uptake of glucose by cancer cells is also greatly increased by increasing the amount of glucose transporters on the cell surface membrane. Lactate fermentation under aerobic conditions is also commonly seen in normal cells that are rapidly dividing. The following figure outlines the relationship of glucose metabolism and other metabolic processes in normal cells.

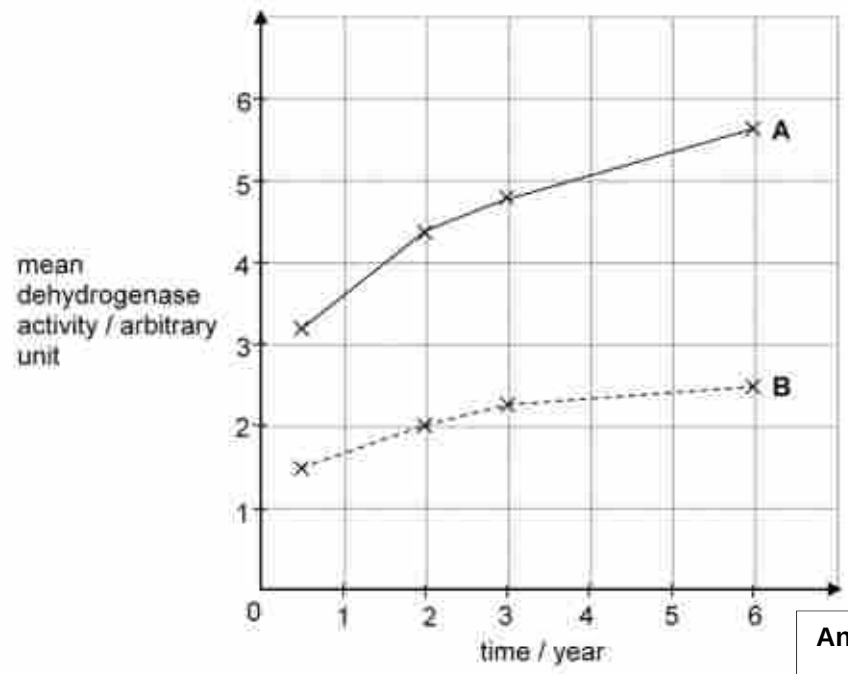


Answer: A

Which of the following statements best explains how lactate fermentation in the presence of oxygen benefits cancer cells?

A Anaerobic respiration allows for production of intermediates that can be used to synthesise other biomolecules for growth.
B Glycolysis alone provides less ATP which allows for cancer cells to grow slowly over a prolonged period of time.
C Anaerobic respiration allows for the buildup of lactate which can be converted into other biomolecules for growth.
D Absence of citric acid cycle reduces the amount of cholesterol and fatty acids formed which prolongs the life-span of cancer cells.

23. To investigate the effect of soil depth on the rate of aerobic respiration in soil-dwelling aerobic bacteria, soil samples were taken at two depths. The samples were taken over a span of six years to determine the activity of dehydrogenases, enzymes involved in the Krebs cycle. The results are shown in the figure below.



Answer: C

Which of the following is a valid conclusion based on the results?

A Graph **A** shows the results of samples taken from a deeper depth as the amount of bacteria increases with increasing depth.

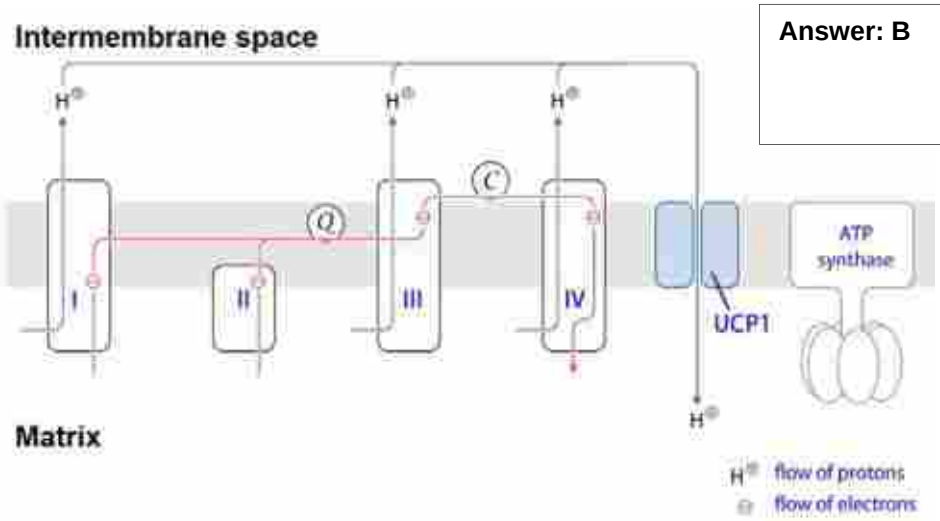
B Only samples from graph **A** showed an increasing rate of aerobic respiration over the time span of six years.

C Samples from graph **B** are taken from a deeper depth, as oxygen concentration decreases with deeper depth, resulting in lower dehydrogenase activity.

D Dehydrogenases found in bacteria samples from graph **B** have evolved higher affinity for substrates due to lower concentration of oxygen.

24. Brown adipose tissues are found together with white adipose tissues, they are present in all mammals but are more abundant in mammals that have to survive prolonged winters. The distinct difference of brown adipose tissues lies in the extra proton channel (UCP1) found in the inner membrane of mitochondria, which allows protons to flow back from the intermembrane space to matrix. The structure of the inner membrane along with the proteins embedded on it are shown in the figure below.

Answer: B



Which of the following explains the physiological significance of the proton channel UCP1 in mammals that have to survive prolonged winter?

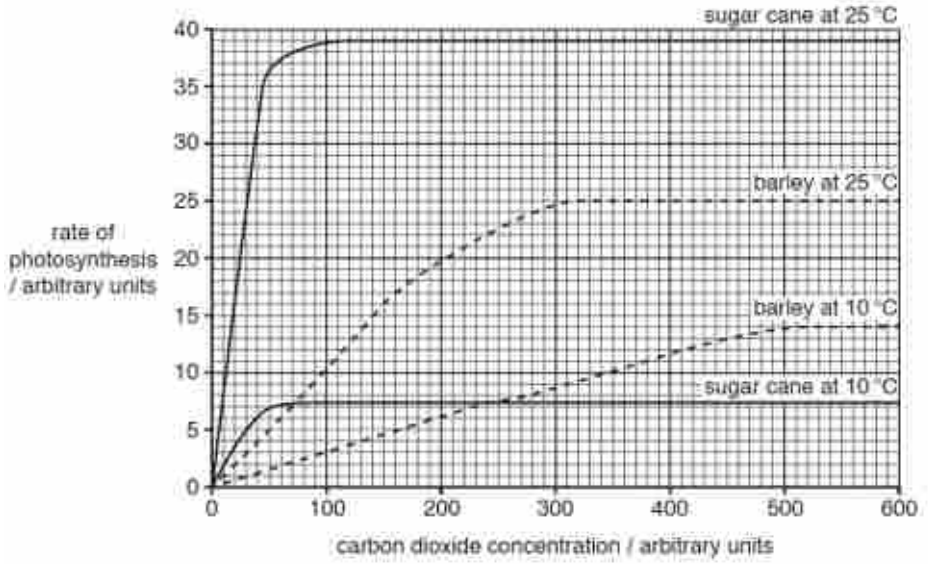
A Flow of proton back to matrix allows for more proton to be pumped across the membrane via the electron transport chain.

B Energy released from the flow of protons is loss as heat which helps keep the mammal warm.

C Less proton flowing through ATP synthase results in less ATP synthesised, this lowers the mammal's metabolism allowing it to survive better in the winter.

D Flow of proton back to matrix maintains the positive charge in the matrix which speeds up the rate of electron flow, allowing for faster rate of ATP synthesis.

25. IPCC has reported a rising trend in both global temperature and carbon dioxide levels. Both these factors are key variables to the process of photosynthesis in plants. The figure below shows how the rate of photosynthesis in two types of plants, sugar cane and barley plants are affected by changes in temperature and carbon dioxide levels.



Which of the following is a valid conclusion from the data?

Answer: A

I Sugar cane is more sensitive to changes in carbon dioxide at low carbon dioxide levels.

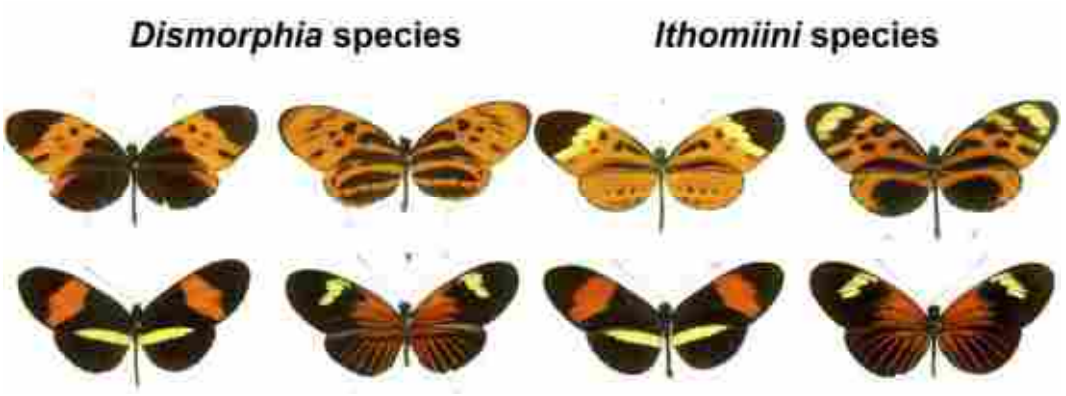
II Climate change is beneficial to plants as it results in the increase in rate of photosynthesis.

III Rubisco found in both sugar cane and barley are only saturated at high levels of carbon dioxide

IV Sugar cane adapt better to increase in temperature and carbon dioxide.

A **I** and **IV** only
B **II** and **IV** only
C **II** and **III** only
D **I**, **III** and **IV** only

26. The figure below shows two species of butterfly commonly found together in the rainforests of Brazil, the *Dismorphia* species and the *Ithomiini* species.



A property about the *Dismorphia* species is that they produce a certain metabolite that deters predators. As such, predators would learn to avoid eating them. However, *Ithomiini* species on the other hand does not produce the metabolite.

In terms of appearance, the two species looks very similar, in fact, the *Ithomiini* species was found to have evolved to "mimic" the appearance of *Dismorphia* species.

Which of the following statement is true?

A *Dismorphia* species would benefit by being at a selective advantage when majority of the butterflies are *Ithomiini* species that mimics its appearance.

B *Ithomiini* species that mimics the appearance of *Dismorphia* species would be at a selective advantage when majority of the butterflies are *Ithomiini* species.

C *Dismorphia* species would not be affected by frequency of *Ithomiini* species that mimics its appearance.

D *Ithomiini* species that mimics the appearance of *Dismorphia* species would be at a selective advantage when majority of the butterflies are *Dismorphia* species.

Answer: D

27. Prior to Charles Darwin's publication on his theory of evolution by natural selection in his famous book, a French biologist by the name of Jean-Baptiste Lamarck crafted a hypothesis that tried to explain inheritance of traits and evolution. His hypothesis revolved around two central ideas:

I Individuals loses traits that are not required, or use, and develop characteristics that are useful.

II These acquired useful traits are passed on to subsequent generations.

His hypothesis was soon proved to be wrong with the introduction of Darwin's theory of evolution by natural selection, along with the better understanding of genetics contributed by Gregor Mendel.

Answer: C

Which of the following examples would **not** be evidence against Lamarck's hypothesis?

A Human ancestors used to feed primarily on plants, they had larger jaws and a third molar that was useful in grinding plant tissue, with the change in diet over time, the jaws became smaller but the third molar remains up till today, commonly known as the "wisdom tooth".

B Athletes who trained hard and excelled in their field of sports had children whom was not "naturally gifted" in the same field of sports.

C Scientists found that one's DNA can be modified during their lifetime via the addition of "chemical tags" based on their environmental conditions, and these "tags" would be passed on to their offspring.

D A couple whom was phenotypically normally throughout their lifetime had a child with sickle cell anaemia.

28. Evolution by natural selection provides an explanation for the vast number of species. Evolution can also be driven by artificial selection, where the selection pressure is applied by man and selected traits are chosen by man to be passed on.

Which of the following examples does not describe artificial selection?

Answer: B

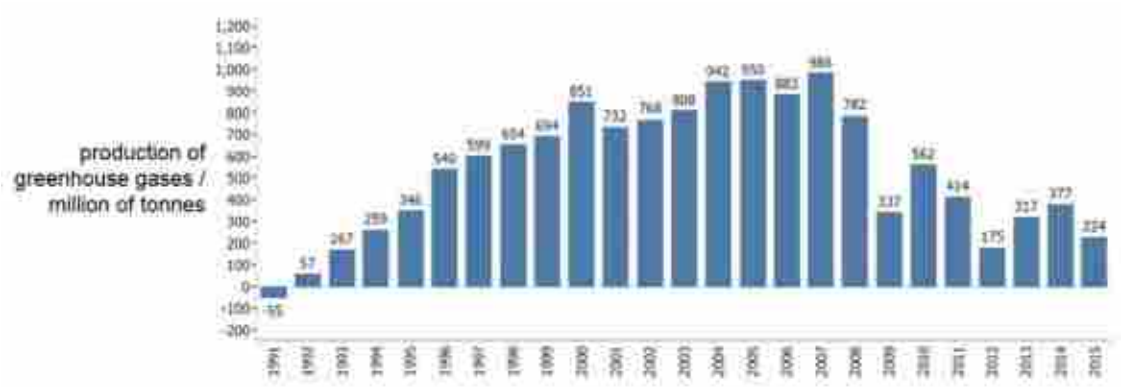
A Ancestral wolves that were domesticated by man were selected for tameness traits which gave rise to the various species of dogs today.

B Ancestral mammals that colonized Australia were isolated from the rest of the mainland with a unique environment and interactions with humans, resulting in development of unique species not seen anywhere else.

C Crops producing larger fruits were selected by farmers to breed resulting in the gradual increase in size of the fruit.

D The excessive use of antibiotics by farmers resulted in a population of bacteria that is resistant to all current known antibiotics

29. The graph shows the production of greenhouse gases (carbon dioxide and methane) in the United States from 1991 to 2015, measured in millions of tonnes.



Which of the following would **not** contribute to the trend seen between 2007 and 2015?

Answer: C

A increasing the cost of carbon tax

B decreased consumption of meat-based products

C increased import and export of crops with trade partners

D decreased use of agricultural machinery for crop harvesting

30. With recent changes to global climate, many agriculture has been negatively impacted. The following figure shows the changes in variables of climate conditions during the different seasons for each major crop in Pakistan. Each of the crops are harvested at specific seasons.

Variables	Major Crops			
	Wheat	Rice	Maize	Sugarcane
Max Temp	−1.7991 *	3.9200 *	0.1174	0.4743 *
Min Temp	0.6216 *	−0.7041 *	0.5458	0.2578 *
Rainfall	−0.1195 *	−0.0126	−0.703	−0.0094

***Indicates significant difference**

Which of the following statements are valid conclusions drawn from the data?

I Climate change has caused Pakistan to be drier and warmer for majority of the seasons.
II Climate change caused significant increased rainfall and flooding of all crops.
III Climate change caused an increase in variability of temperature range during the rice crop season.
IV The impact on wheat is likely to be more significant than the other three crops.

A **III** only
B **I** and **II** only
C **II** and **IV** only
D **I**, **III** and **IV** only

Answer: D

End of Paper

Class	Adm No

Candidate Name: _____

H

millennia institute

2018 End-of-Year Exams
Pre-University 2

H1 Biology **8876/02**

Paper 2 Core Paper **10 September 2018**

2 hours

Additional Materials: Writing paper

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.

Write your Admission number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **one** question.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question. At the end of the examination, fasten all your work securely together.

For Examiner's Use	
Section A	
1	**/ 11**
2	**/ 8**
3	**/ 7**
4	**/ 10**
5	**/ 9**
Section B	**/ 15**
Total	**/ 60**

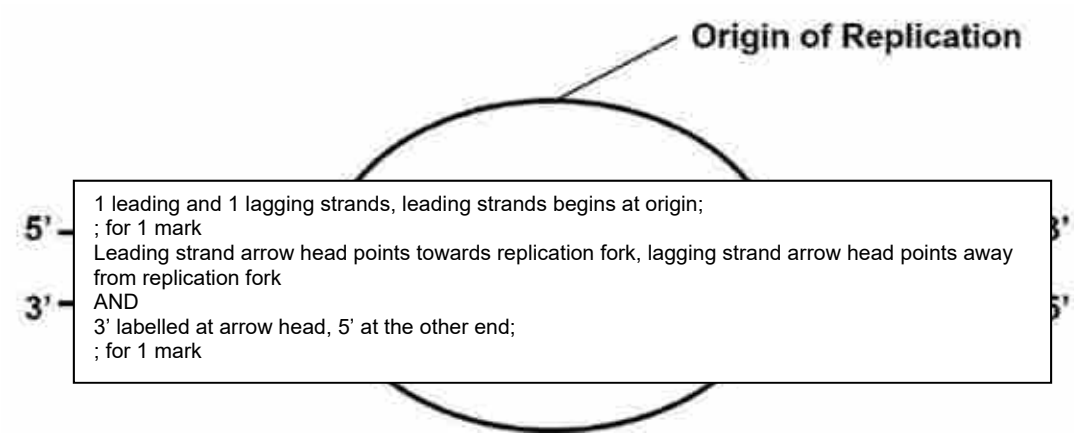
This question paper consists of 14 printed pages.

For Examiner's Use

Section A

Answer **all** questions in this section.

1. The process of DNA replication is sometimes described as "*asymmetrical*" replication as the daughter strands are synthesised slightly differently in the form of a leading strand and a lagging strand. Fig. 1.1 shows a replication bubble and the origin of replication.



1 leading and 1 lagging strands, leading strands begins at origin;
; for 1 mark
Leading strand arrow head points towards replication fork, lagging strand arrow head points away from replication fork
AND
3' labelled at arrow head, 5' at the other end;
; for 1 mark

Fig. 1.1

(a) **(i)** On Fig. 1.1, draw the following with respect to one of the replication fork:

- Leading and lagging strands
- Arrow heads (→) on leading and lagging strands to indicate direction of synthesis
- 5' and 3' ends of leading and lagging strands

[2]

(ii) Explain why the two daughter strands are synthesised, "asymmetrically".

.....

- DNA polymerase can only add new nucleotides to 3' -OH ends;
- DNA is anti-parallel;

; for 1 mark

.....

.....**[2]**

Telomeres are short repetitive sequences found at the ends of chromosomes. Length of telomeres can be used to estimate cellular age as telomeres shorten over time.

(b) State what causes telomeres to shorten over time.

End replication problem;
; for 1 mark

[1]

A single human diploid cell contains around six billion base pairs, amounting to around two meters in length. The diameter of a nucleus is around 10^{-15} meters.

(c) Describe how DNA are packaged such that it can fit in the nucleus.

- DNA is wound around histone proteins forming nucleosomes;
  ; for 1 mark
- Nucleosomes are packed/ fold up to form 30nm chromatin fibre;
- Chromatin fibres are further packed/ fold up to form 300nm loops;
- 300nm loops are further condensed to form chromosomes;
  ; for 1 mark, max 2 mark

[3]

Senescence cells are cells that have telomeres that have shortened to a critical length such that the cells no longer undergo cell division.

(d) (i) State the cell cycle stage that senescence cells are in.

G_o;
; for 1 mark

[1]

(ii) Explain the purpose for limiting the number of times a cell can divide.

- Prevent the loss of genetic information / coding sequence;
- Prevent the accumulation of mutations;
- Prevent oncogenesis / cancer formation;

; for 1 mark, max 2 marks

[2]

[Total: 11]

For Examiner's Use

2. Rubisco is an enzyme catalysing the first stage of Calvin cycle, its function is vital in maintaining life on Earth.

(a) (i) State the initial reactants and final product(s) of Calvin cycle.

Initial reactants: Carbon dioxide, RuBP, ATP and NADPH
Final Products: G3P, ADP and $NADP^+$;
; for 1 mark

.....[1]

(ii) Explain how Rubisco plays a role in maintaining life on Earth.

- Rubisco catalyses Calvin cycle which converts inorganic carbon to organic carbon;
- Heterotrophs / organisms / secondary consumers that are unable to make their own food relies on plants as food source for organic carbon that is essential for growth/OWTTE;

; for 1 mark

.....

.....

.....[2]

Rubisco gene is found in all photosynthetic plants. A study was carried out to investigate the effect of temperature on the catalytic activity of Rubisco found in different plants. Fig. 2.1 shows the results.

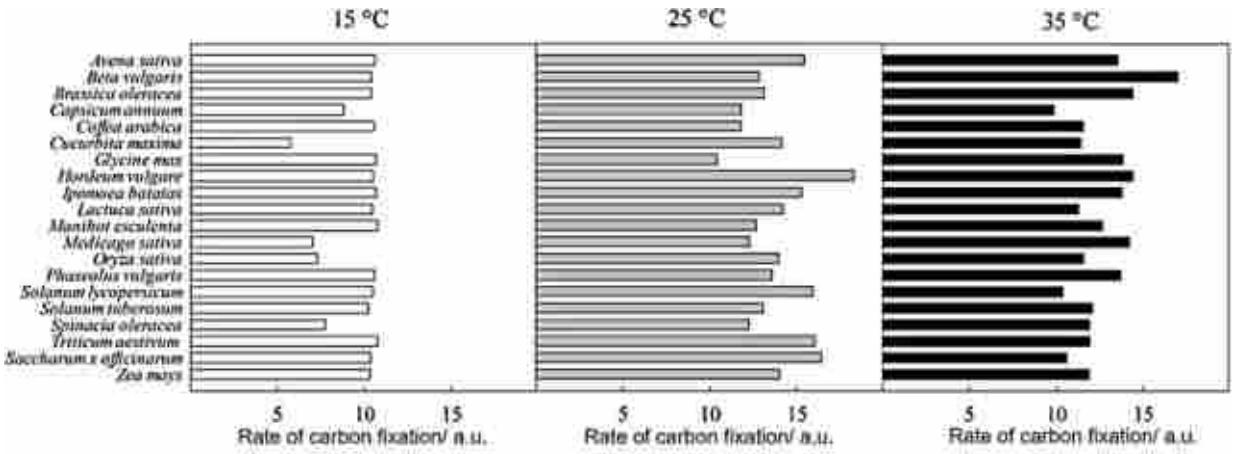


Fig. 2.1

(b) With reference to Fig. 2.1, conclude if Rubisco found in different plants have the same optimal temperature range.

.....

- Rubisco from different plants have different optimum temperature;
- Rubisco from Beta vulgaris have the highest activity of 17 a.u. at 35°C;
- Whereas Rubisco from Hordeum vulgare have the highest activity of 18 a.u. at 25°C; (accept any 2 valid comparison with correct name and data set)

; for 1 mark, max 3 marks

.....

.....

.....

.....

.....**[3]**

(c) Suggest why Rubisco from different plants exhibit different catalytic activity under the same temperature condition with all other conditions kept constant.

- Random mutations / genetic variation of Rubisco gene;
- Change in primary structure / sequence of Rubisco results in changes in folding;
- Causes variation in 3D conformation of Rubisco, resulting in variation of catalytic activity;

; for 1 mark, max 2 marks

.....**[2]**

[Total: 8]

For Examiner's Use

3. In *Drosophila melanogaster*, the common fruit fly, wing shape is controlled by a gene with multiple alleles. These alleles are listed below in no particular order. When pure-breeding *Drosophila* with long wings were crossed with pure-breeding *Drosophila* with vestigial wings, all offspring had long wings.

Long = W^L Vestigial = W^V Antlered = W^a

Drosophila with vestigial wings crossed with *Drosophila* with antlered wings produce all offspring with wings of a new phenotype that appears to be an intermediate between vestigial and antlered phenotype, called vestigial-antlered.

(a) Suggest an explanation for the cross.

- Vestigial allele / W^V and antlered allele / W^a exhibits incomplete dominance; ; for 1 mark .....
- Both parents are homozygotes / pure-bred / homozygous for vestigial and antlered wings respectively; ; for 1 mark .....

.....

.....[2]

Eye colour of *Drosophila* is determined by a gene located on the X chromosome. Sex determination in *Drosophila* is similar to that of humans. *Drosophila* can either have red eyes or white eyes, the allele coding for red eyes is dominant over the allele for white eyes.

Pure breeding female *Drosophila* with long wings and red eyes were crossed with pure breeding male *Drosophila* with vestigial wings and white eyes.

In the F1 generation, all female and male *Drosophila* had long wings and red eyes.

Female flies and male flies from F1 generation were then crossed to produce the F2 generation.

The observed number of F2 flies with each phenotype were as follows:

Female, long wings, red eyes	595
Female, vestigial wings, white eyes	201
Male, long wings, red eyes	304
Male, long wings, white eyes	299
Male, vestigial wings, red eyes	101
Male, vestigial wings, white eyes	100

For Examiner's Use

Draw a genetic diagram to explain the observed results of the cross between female flies and male flies from the F1 generation.

Let X^R be the allele on the X-chromosome that code for red eyes
Let X^r be the allele on the X-chromosome that codes for white eyes
Let W^L be the allele coding for long wings
Let W^V be the allele coding for vestigial wings

F1 phenotype	Female, long wings, red eyes	Male, long wings, red eyes
F1 genotype	$W^LW^VX^RX^r$	$W^LW^VX^RY$
Gamete	W^LX^R W^LX^r W^VX^R W^VX^r	W^LX^R W^LY W^VX^R W^VY

Punnett square

	W^LX^R	W^LY	W^VX^R	W^VY
W^LX^R	$W^LW^LX^RX^R$ Female, long wings, red eyes	$W^LW^LX^RY$ Male, long wings, red eyes	$W^LW^VX^RX^R$ Female, long wings, red eyes	$W^LW^VX^RY$ Male, long wings, red eyes
W^LX^r	$W^LW^LX^RX^r$ Female, long wings, red eyes	$W^LW^LX^rY$ Male, long wings, white eyes	$W^LW^VX^RX^r$ Female, long wings, red eyes	$W^LW^VX^rY$ Male, long wings, white eyes
W^VX^R	$W^LW^VX^RX^R$ Female, long wings, red eyes	$W^LW^VX^RY$ Male, long wings, red eyes	$W^VW^VX^RX^R$ Female, vestigial wings, red eyes	$W^VW^VX^RY$ Male, vestigial wings, red eyes
W^VX^r	$W^LW^VX^RX^r$ Female, long wings, red eyes	$W^LW^VX^rY$ Male, long wings, white eyes	$W^VW^VX^RX^r$ Female, vestigial wings, red eyes	$W^VW^VX^rY$ Male, vestigial wings, white eyes

F2 genotype	1/16 $W^LW^LX^RX^R$ 1/16 $W^LW^LX^RX^r$ 2/16 $W^LW^VX^RX^R$ 2/16 $W^LW^VX^RX^r$	1/16 $W^VW^VX^RX^R$, 1/16 $W^VW^VX^RX^r$	1/16 $W^LW^LX^RY$ 2/16 $W^LW^VX^RY$	1/16 $W^LW^LX^rY$ 2/16 $W^LW^vX^rY$	1/16 $W^VW^VX^RY$	1/16 $W^VW^VX^rY$
F2 phenotype	Female Long wings, red eyes	Female Vestigial wings, Red eyes	Male Long wings, red eyes	Male Long wings white eyes	Male vestigial wings, red eyes	Male vestigial wings, white eyes
F2 Phenotypic ratio	6 :	2 :	3 :	3 :	1:	1

Correct parental phenotypes and genotypes;
Correct gametes drawn;
Correct Punette's square drawn including phenotypes;
Correct F2 phenotypes and genotypes;
Correct phenotypic ratio;

[5]

[Total: 7]

For Examiner's Use

4. Global temperature records show temperature anomaly (°C), which is the difference in temperature of the measured year to the average temperature of a reference year-span. Fig 4.1 shows the global temperature records from 1900 to 2014 relative to the average temperature from 1951 to 1980.

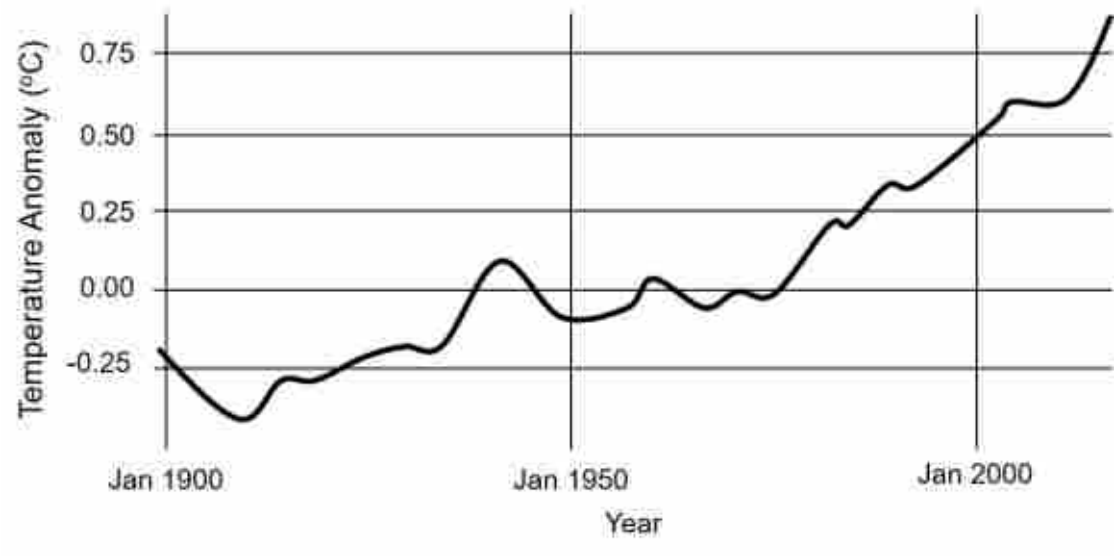


Fig. 4.1

Fig. 4.2 shows the global carbon emission from burning of fossil fuel from 1900 to 2014.

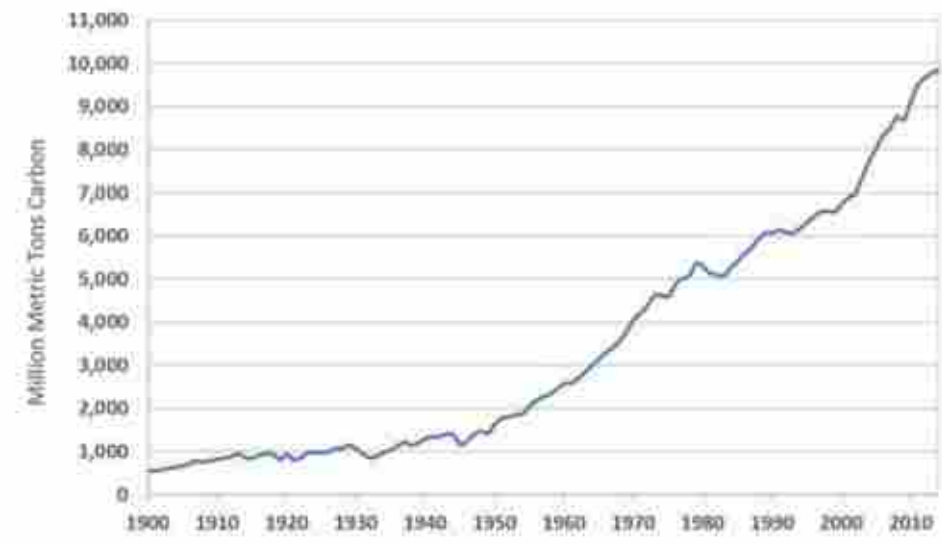


Fig. 4.2

For Examiner's Use

(a) Comment on the trend observed for both global temperature records and global carbon emission from 1950s onwards.

- Temperature anomaly increased from -0.2ºC to around +0.8ºC while carbon emission increased from around 1500 million metric tons to just below 10000 million metric tons;
- Increase in carbon emission imply the increase in the greenhouse gas carbon dioxide;
- Increase greenhouse gas results in absorbing of more solar radiation / enhancing greenhouse effect causing temperature to rise;
; for 1 mark, max 2 marks

[2]

Changes in global temperature will have an impact on many other abiotic and biotic factors, one of them being sea levels.

(b) With reference to Fig. 4.1, account for how sea levels have been affected.

- Rising temperatures have caused sea levels to rise;
; for 1 mark
- Higher temperature causes melting of ice sheets, which adds fresh water to sea water;
- Higher temperature causes thermal expansion of water;
- Loss of ice sheets leads to less reflective surface, more heat absorbed by sea water which further accelerates melting of ice sheets;
; for 1 mark

[3]

For Examiner's Use

Another factor that is impacted by changes in global temperature is the spread of mosquito borne diseases like Dengue fever (DF), caused by the dengue virus. Fig. 4.3 shows the number of reported DF cases globally from 1980 to 2002.

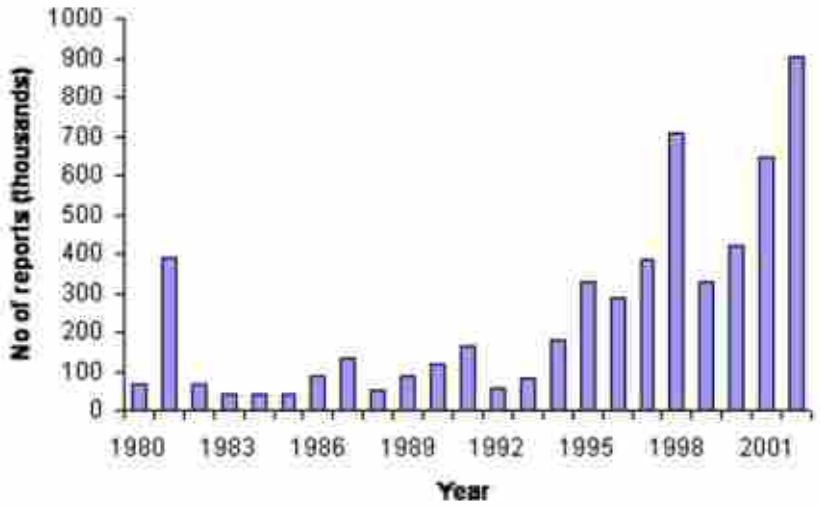


Fig. 4.3

(c) Explain how the data in Fig. 4.1 can account for the general trend observed in Fig. 4.3.

- Increased temperature, increased dengue fever cases;
- Higher temperature leads to <u>increased survival rate / less prone to predation / parasites and diseases</u> of Aedes Mosquito;
- Higher temperature leads to <u>increased metabolism rate</u> in Aedes Mosquito;
- accelerates emergence of mosquitoes /shorter hatching time / life cycle shorten;
- increasing mosquito population;
- reduce extrinsic incubation period of virus in insect;
- increasing the number of infective vector;
- female mosquitoes digest blood faster and feed more frequently;
- higher temperature may lead to increased precipitation, resulting in <u>more breeding sites</u> for mosquitoes;
- Expand towards higher latitudes;

; for 1 mark, max 3 marks

[3]

The Intergovernmental Panel on Climate Change (IPCC) has made predictions on future global surface temperature based on past trends and existing data. If no actions are done, the trend observed in Fig. 4.1 can be expected to continue.

(d) Assuming if the trend in Fig. 4.1 continues, predict how dengue would spread in the future.

- Global surface temperature is predicted to continue to increase, causing areas outside of the tropics to get warmer; .....
- Mosquitoes would spread to areas outside of the tropics, as such diseases like dengue would also spread beyond the tropics / towards to poles; .....
- Lower altitudes may get too hot, causing mosquitoes to spread to cooler higher altitudes;
- AVP
  ; for 1 mark .....

.....[2]

[Total: 10]

For Examiner's Use

5. The length of the upper leg bone is an important variable in research on human evolution as it provides information about the energy used in movement.

Fig. 3.1 shows the length of upper leg bone that have been measured or estimated from fossils of four hominid species (*Australopithecus, H. erectus, H. neanderthalensis and H. sapiens*) covering a time period of approximately three and a half million years.

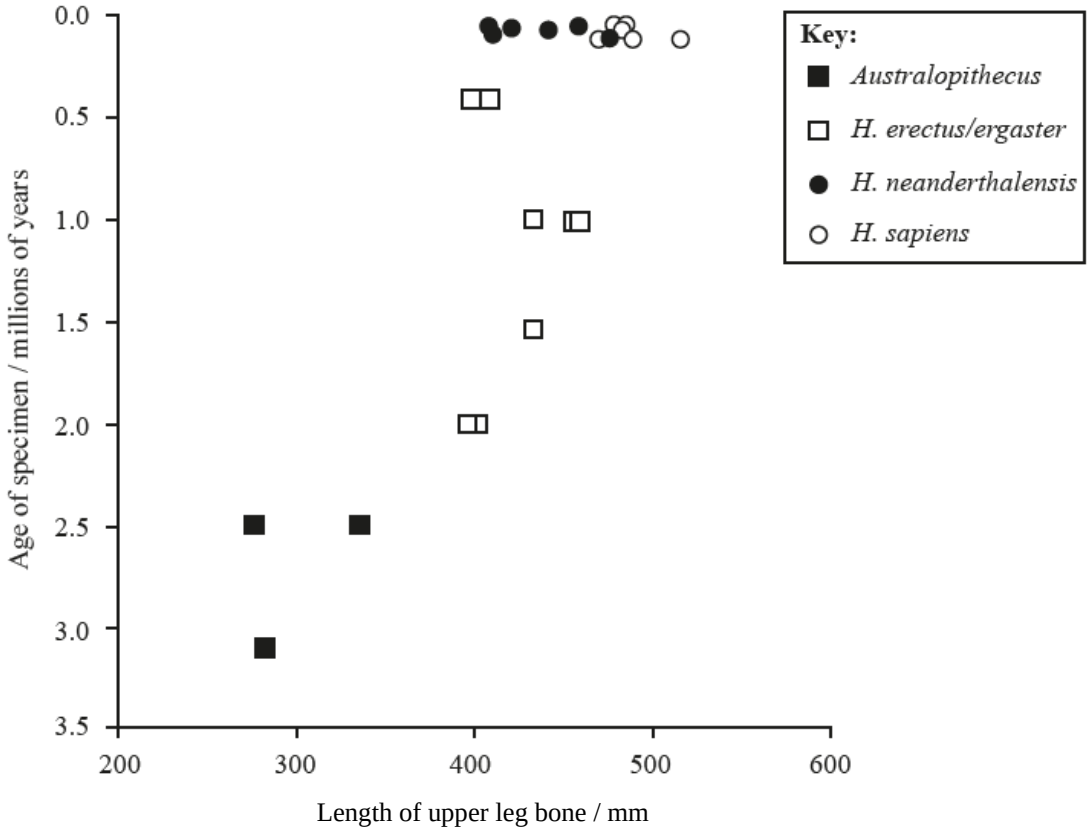


Fig. 3.1

Source: Adapted from K. Steudel-Numbers and M. Tilkens (2004) *Journal of Human Evolution*, 47, pages 95–109. 'The effect of lower limb length on the energetic cost of locomotion: implications for fossil hominins'

(a) With reference to Fig. 3.1, explain if increasing upper leg bone length provides an evolutionary advantage.

Overall trend of increasing upper leg bone length from ancient to recent species;
Upper leg bone length increases from about 300 mm in the oldest/most ancient *Australopithecus* to about 500 mm in modern human/*H. sapien*; ……

; for 1 mark, max is 1 mark ……

Longer upper leg bone is a selective advantage + may allow for more energy-efficient/faster movement/upright posture/gait/taller to see predators/other appropriate reason; ……
Species with shorter upper leg bone are selected against/died out; ……
However, overlap in ranges for more recent specimens/ *H. neanderthalensis and H. sapien* suggests no strong selective advantage; ……

for 1 mark, max is 2 marks

…[3]

(b) Suggest one limitation of using fossil records in evolutionary studies.

Fossil specimens may not be identified correctly;
Age of specimens may not be accurate;
Fossils may be incomplete;

for 1 mark, max is 1 marks

[1]

We would expect natural selection to eliminate genetic variations with negative effects from human population. However, the study on human genetics reveals that several recessive alleles that are known to cause diseases have been preserved in human populations.

For instance, the sickle-cell allele is carried by half the people in some areas of Africa. This distribution seems to result from the counterbalancing effects of anaemia and malaria, a disease that formally cause high death rates in equatorial Africa.

(c) Account for the high frequency of sickle cell anaemia allele in the African populations.

Heterozygous advantage;
Heterozygotes do not exhibit sickle cell anaemia / phenotypically normal;
Heterozygous / sickle cell traits individuals are at selective advantage in malaria affected areas / more resistant to malaria;
Heterozygous individuals survive to reproduce and pass on the sickle cell allele to offspring;
Hence increasing the HbS allele frequencies in the population within these malaria areas over time;

for 1 mark, max is 3 marks

[3]

(d) Explain why population is the smallest unit that can evolve.

Evolution takes place over extended periods of time/many generations through adaptations/favourable characteristics that are passed through the reproduction between individuals;
Evolution is measured only as change in relative proportions of variations / change in allele frequency in a population over a succession of generations;
Natural selection involves interactions between individual organisms and their environment;
Variation exists among individuals of a population;
Natural selection favours the survival and reproduction of some individuals over others;

for 1 mark, max is 2 marks

[2]

[Total: 9]

Section B

Answer **one** question.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a), (b)** etc., as indicated in the question.

1.

(a) Compare aerobic and anaerobic respiration in animals. **[7]**

(b) Both Darwin and Wallace independently came up with the theory of evolution by natural selection. They concluded that organisms had to struggle for survival, and that each subsequent generation slowly became better adapted to the environment.

Using named example, explain how environmental factors act as forces of natural selection. **[8]**

[Total: 15]

2.

(a) Contrast between stem cells and cancer cells. **[6]**

(b) Based on data collected over the years on weather patterns and greenhouse gas emissions, researchers have concluded a causal relationship between greenhouse gas emission and enhanced global warming. Biotic factors like coral reefs are sensitive and vulnerable to changes in climate.

Discuss how weather patterns would be affected and the consequences of such changes, along with how corals reefs are impacted by enhanced global warming. **[9]**

[Total: 15]

End of Paper

For Examiner's Use

1.

(a) Compare aerobic and anaerobic respiration in animals. **[7]**

Similarities:

- [Purpose] Both serve to generate energy in terms of ATP molecules to sustain energy-requiring activities;
- [Common process] Glycolysis is common to both, whereby glucose is broken down into pyruvate, giving rise to a net gain of 2 ATP molecules, and producing 2 NADH molecules as well in the cytoplasm;
- [Involvement of hydrogen acceptor] Both needs NAD^+ as a hydrogen acceptor / co-enzyme for dehydrogenase to complete dehydrogenation reactions in glycolysis;
- [Regeneration of NAD^+] Both have a process to regenerate the hydrogen acceptor NAD^+ to support further glycolysis (can also put this as a difference: describe the mechanism involved in regenerating NAD^+);
- Both only harvest a portion of the chemical energy stored in glucose molecule, with a large amount of energy lost as heat;.
- AVP

; for 1 mark, max 5 marks

Differences:

Feature	Aerobic respiration	Anaerobic respiration
Location	In cytoplasm and mitochondria	Only in cytoplasm
Hydrogen acceptor	NAD+ and FAD	Only NAD+
Stages involved in generating ATP	Glycolysis, link reaction, Krebs cycle and oxidative phosphorylation	Only glycolysis and fermentation
Mechanism of ATP synthesis	Direct ATP synthesis via Substrate level phosphorylation during glycolysis and krebs cycle; Oxidative phosphorylation through electron transport chain and chemiosmosis.	Only substrate-level phosphorylation during glycolysis
Number of ATP synthesized per glucose molecule	38 (4 via substrate-level phosphorylation and 34 via oxidative phosphorylation)	Only 2 via substrate-level phosphorylation
Final products	CO_2, ATP, H_20	Lactate, ATP
Type of chemical reactions involved in breaking down glucose	Dehydrogenation, Oxidative decarboxylation,	Only dehydrogenation
Mechanism where hydrogen acceptor is regenerated	Via electron transport chain during oxidative phosphorylation, whereby NADH and $FADH_2$ donate the electrons and protons to the electron carriers	Via reduction reaction (pyruvate to lactate) during fermentation
Involvement of O_2	Yes, as the final electron acceptor in the ETC (Reject: just 'Yes' without elaboration)	No.

; for 1 mark, max 5 marks

(b) Using named example, explain how environmental factors act as forces of natural selection. **[8]**

Example 1

- Industrial melanism in Britain/United Kingdom;
- Before the industrial revolution, light-coloured peppered moths dominated the moth population with the dark coloured/melanic moths being largely uncommon;
- Since the light-coloured peppered moths are extremely well camouflaged as its colouration merges with the pale lichens on trees;
- Light-coloured moths can better hide/escape from predators and are selected for to survive and reproduced;
- However, after industrial revolution, it was recorded that most of the moth population were dark coloured/melanic moths;

; for 1 mark, max is 3 marks

- During the industrial revolution, pollution from the burning coal killed off the lichens growing on trees in industrial areas, exposing the darker bark, which was further darkened by soot deposits;
- Therefore, light-coloured peppered moths are no longer as well camouflaged, and it became very conspicuous/obvious to its predators (name one predator) when they rest on the trunks of trees;
  OR
- The dark coloured/melanic form is in turn, now well camouflaged against the dark tree barks;
- This result in the predators (name one example), which acts as the selection pressure, select against the light-coloured peppered moth;

- It reduces the frequency/number of light-coloured peppered moth but increases the dark coloured/melanic form in polluted areas and vice versa for non-polluted areas/OWTTE;

; for 1 mark, max is 4 marks

Example 2

- The finches living on the Galapagos Islands;
- Each island had its own kind of finch (14 in all), found nowhere else in the world/OWTTE;
- The finches are closely related species arising from a common ancestor;
- Adaptive radiation led to the formation of so many species;

; for 1 mark, max is 2 marks

- Each of which specialises in eating a different type of food/diet;
- There were 3 main groups, ground, warbler, and tree finches, classified according to their beak sizes;
- This diversification into different ecological niches, is thought to be necessary to permit the coexistence of different species;
- In different parts of the Galapagos Islands, different types of beak sizes dominate/OWTTE;
- In this case, the different types of food available act as the selection pressure;
- Selecting for a particular beak size that favours adaptation and survival in a particular environment with a certain available type of food;

: for 1 mark, max is 3 marks

- *Name two examples of beaks:*
- Some had large and heavy beaks adapted for eating large seeds, others for small seeds;
- Some had parrot-like beaks for feeding on buds and fruits;
- Some had long and slender/thin beaks for feeding on small insects;

; for 1 mark, max is 2 marks

QWC:

Student's chosen example correctly identifies the selection pressure, selective advantage / disadvantage and outcome of natural selection

For Examiner's Use

2.

(a) Contrast between stem cells and cancer cells. **[6]**

1. Unlike stem cells, cancer cells do not differentiate;
2. Cancer cells divide indefinitely/ uncontrollably / do not respond to anti-growth signals while stem cell division is determined by molecular signals [that either stimulates cell division or stop it];
3. Cancer cells have self-sufficiency of growth signals, whereas stem cells relies on external growth signals;
4. Cancer cells experience no contact inhibition and is invasive while stem cells experience contact inhibition;
5. Cancer cells have abnormal morphology, whereas stem cells have more regular morphology;
6. Cancer cells metastasize (dislodge from original tumour and form secondary tumours) while stem cells remain in tissue of origin;
7. Cancer cells are able to signal for angiogenesis while stem cells do not;
8. Cancer cells have accumulated loss of function mutation in tumour suppressor genes and gain of function mutations converting proto-oncogenes to oncogenes;
9. Genome of cancer cells are unstable, there is high tendency of genome alteration / mutations where as stem cells have relatively more stable genomes, with mutations occurring at a much lower rate;
10. Cancer cells expresses high levels of telomerase activity whereas only zygotic/totipotent/embryonic/pluripotent expresses high levels of telomerase;
11. Stem cells responds to signal for programmed cell death / apoptosis, whereas cancer cells do not respond / avoids programmed cell death / apoptosis;
    AVP;

; for 1 mark

(b) Based on data collected over the years on weather patterns and greenhouse gas emissions, researchers have concluded a causal relationship between greenhouse gas emission and enhanced global warming. Biotic factors like coral reefs are sensitive and vulnerable to changes in climate.

Discuss how weather patterns would be affected and the consequences of such changes, along with how corals reefs are impacted by enhanced global warming. **[9]**

Weather patterns

1. A warmer climate creates an atmosphere that can collect / retain / drop more water, changing weather patterns;
2. This causes wet areas to become wetter / dry areas become drier;
3. This can lead to heat waves / heavy rain;
4. Heatwaves associated with low humidity may result in wildfire;
5. Heavy rain increases the amount of runoff into rivers and lakes, washing sediment, nutrients, pollutants, trash, animal waste, and other materials into water supplies (any 2), making them unusable/ unsafe/ need of water treatment;
6. Increase rainfall leads to increase breeding sites for mosquitoes, which would lead to an increase in mosquito-borne diseases like dengue;

; for 1 mark, min 2 marks

Coral reefs

7. Heat stress can cause coral bleaching;
8. This is because at higher temperatures, zooxanthellae photosynthesis is disrupted / zooxanthellae produce more toxic compounds;
9. Toxic compounds damages metabolism of coral poly which expels the zooxanthellae, leaving the coral skeleton a stark, "bleached" white;
10. Zooxanthellae and corals have a symbiotic relationship, where zooxanthellae provide corals with food;
11. If temperatures remain above the bleaching threshold for prolonged periods of time, corals will eventually die from starvation and disease /OWTTE;
12. Increase in atmospheric CO_2 cause more CO_2 to be dissolved in the ocean, decreasing the pH,/ resulting in ocean acidification;
13. Ocean acidification affects hard corals as they cannot absorb the calcium carbonate to maintain their skeletons / the stony skeletons that support corals will dissolve;

; for 1 mark, max 6 marks

QWC:

Student's answer cover at least 2 points from each section.

[Total: 15]

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

CLASS

BIOLOGY 8876/01

Paper 1 Multiple Choice **25 September 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name and CT on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

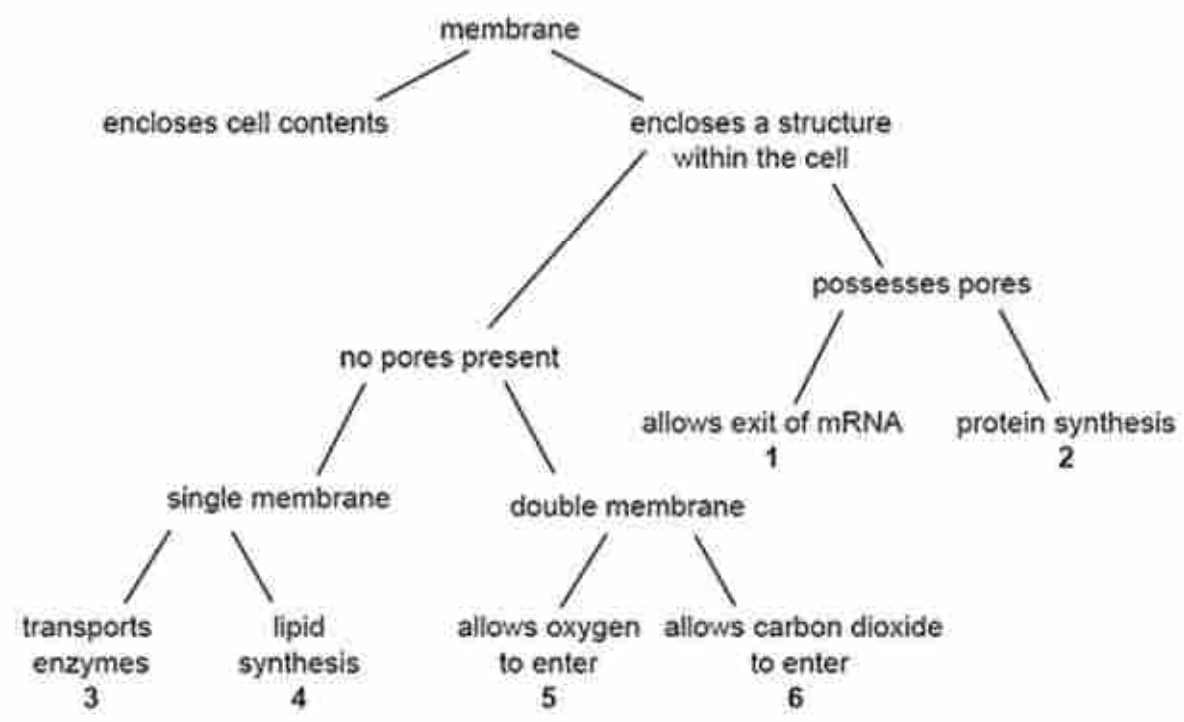
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Calculators may be used.

This document consists of **20** printed pages and **0** blank page.

[Turn over

1 Membranes within and at the surface of cells have different roles.

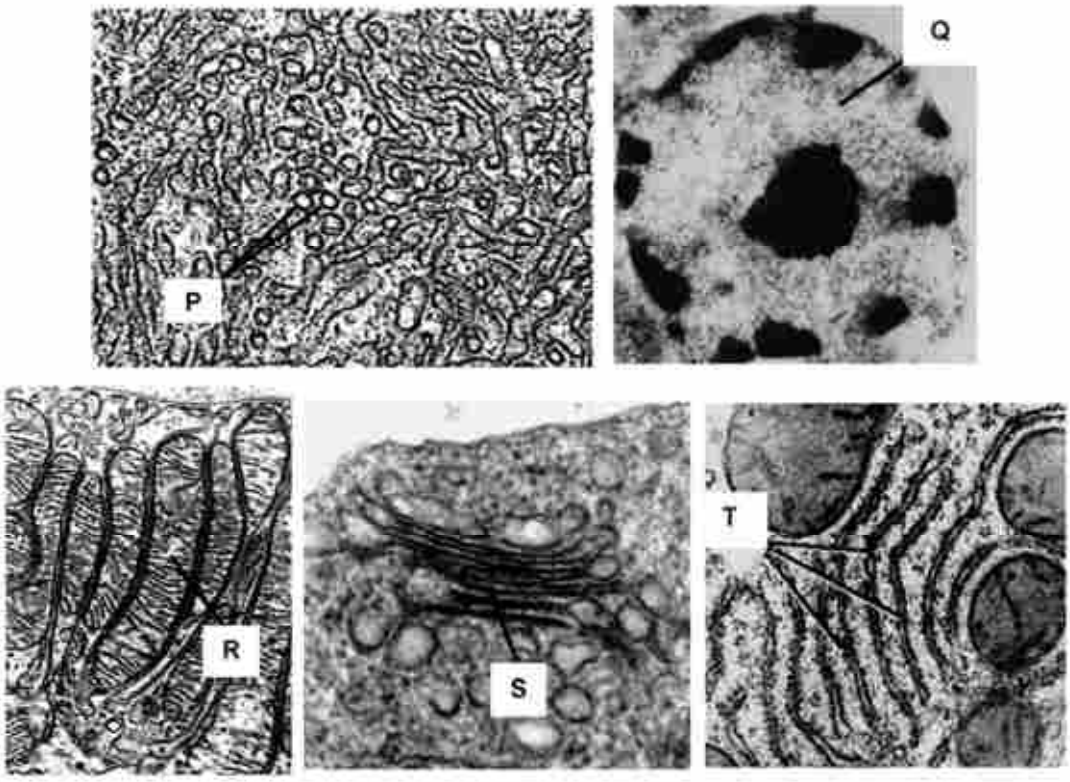
The diagram allows the identification of the various organelles within the cell, by describing the membrane structure and function.



Which of the outcomes shown below correctly identifies the organelles that possess the membrane and function concerned?

	1	2	3	4	5	6
A	nucleus	ribosome	vesicle	smooth ER	mitochondrion	chloroplast
B	nucleolus	rough ER	vesicle	smooth ER	nucleus	mitochondrion
C	nucleus	rough ER	vesicle	smooth ER	mitochondrion	chloroplast
D	nucleus	smooth ER	mitochondrion	rough ER	vesicle	chloroplast

2 The following electron micrographs show various organelles **P** to **T** present in a liver cell.



Radioactive amino acids are supplied to the liver cell to synthesise insulin receptors.

Which sequence shows the correct order in which these amino acids would be detected in the organelles during the synthesis of insulin receptors?

A Q → T → R → P → S

B Q → T → P → S

C T → P → S → R

D T → S → P

3 A symbiont may be defined as a species in which individuals live in a long-term, intimate and beneficial relationship with hosts of a different species. As the name suggests, endosymbionts live within their hosts.

Which statement provides evidence that mitochondria and chloroplasts are endosymbionts?

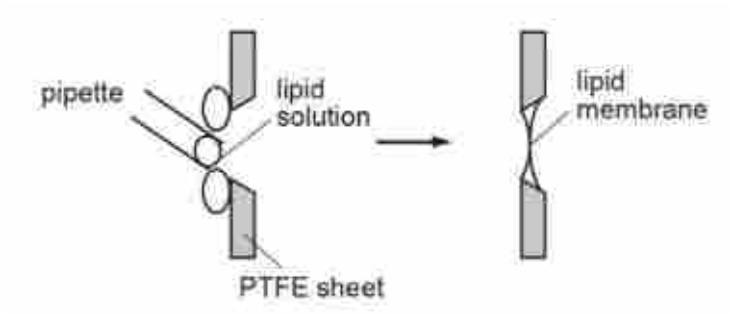
A Proteins encoded by the nucleus are exported to these organelles.

B Their inner membrane has different structure from other intracellular membranes.

C They are surrounded by double membrane.

D They contain their own ribosomes.

4 Lipid membranes can be formed in the laboratory by painting phospholipids over a PTFE sheet with a hole in it.



Such a lipid membrane is impermeable to water soluble materials including charged ions such as Na^+ or K^+.

In one experiment with Na^+ ions, no current flowed across the membrane until a substance called gramicidin was added to the membrane, at which time current flowed.

What kind of molecule is gramicidin?

A A carbohydrate molecule found only on the outside of the membrane.

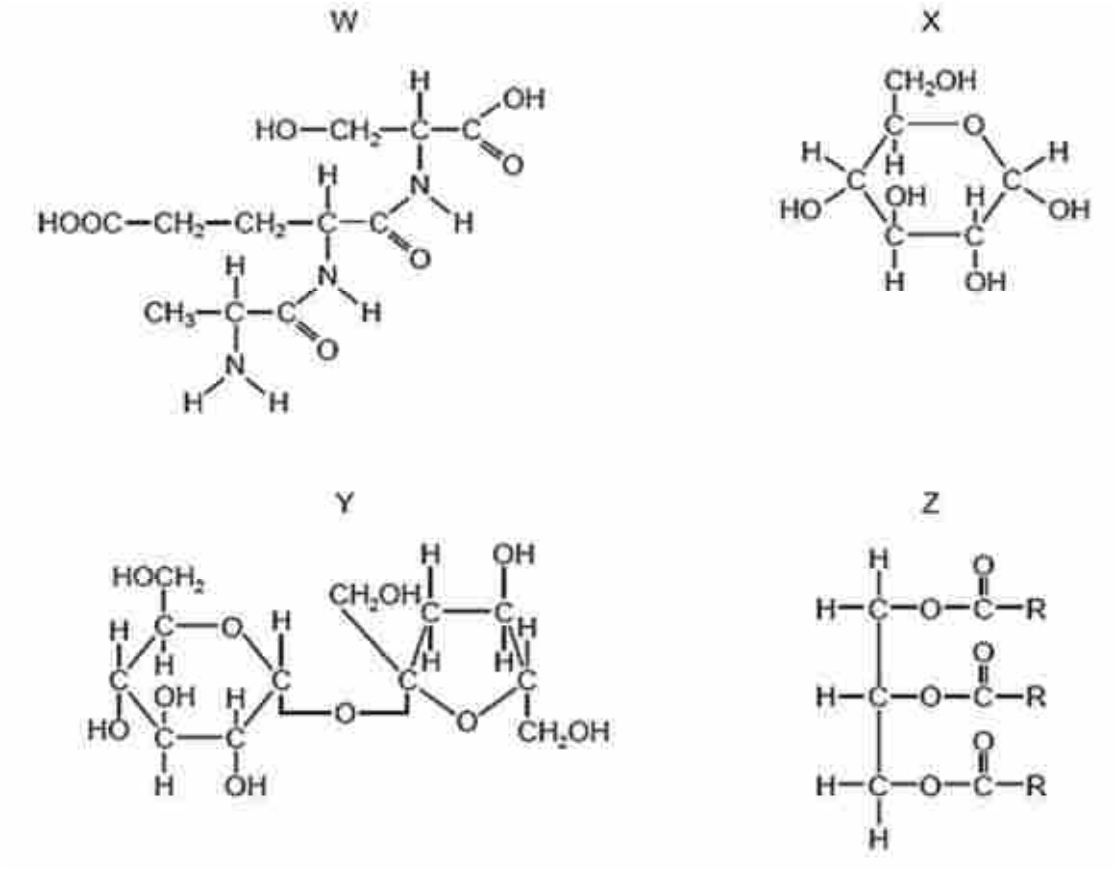
B A non-polar lipid which passes all the way through the membrane.

C A protein molecule with both hydrophilic and hydrophobic regions.

D A protein molecule which has only hydrophobic regions.

5 Samples of a mixture of biological molecules were tested using Benedict's reagent, biuret solution and ethanol. After testing, the solutions were blue with Benedict's reagent, purple with biuret solution and cloudy with ethanol emulsion test.

Which molecules could the mixture contain?



A W, X and Y

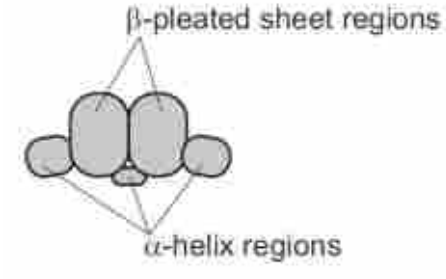
B W, X and Z

C W, Y and Z

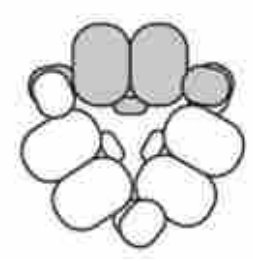
D X, Y and Z

6 Approximately half of the total protein in a pea seed consists of the storage protein vicilin.

- Each molecule of vicilin is made up of three identical polypeptides.
- Each polypeptide is made up of two β-pleated sheet regions with linking α-helix regions, folded into the shape shown to the right.



- This allows the three polypeptides to pack together into a compact, flat storage molecule, as shown below.

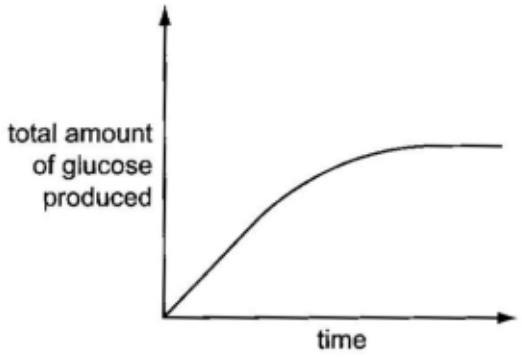


Which row correctly describes the structure of vicilin?

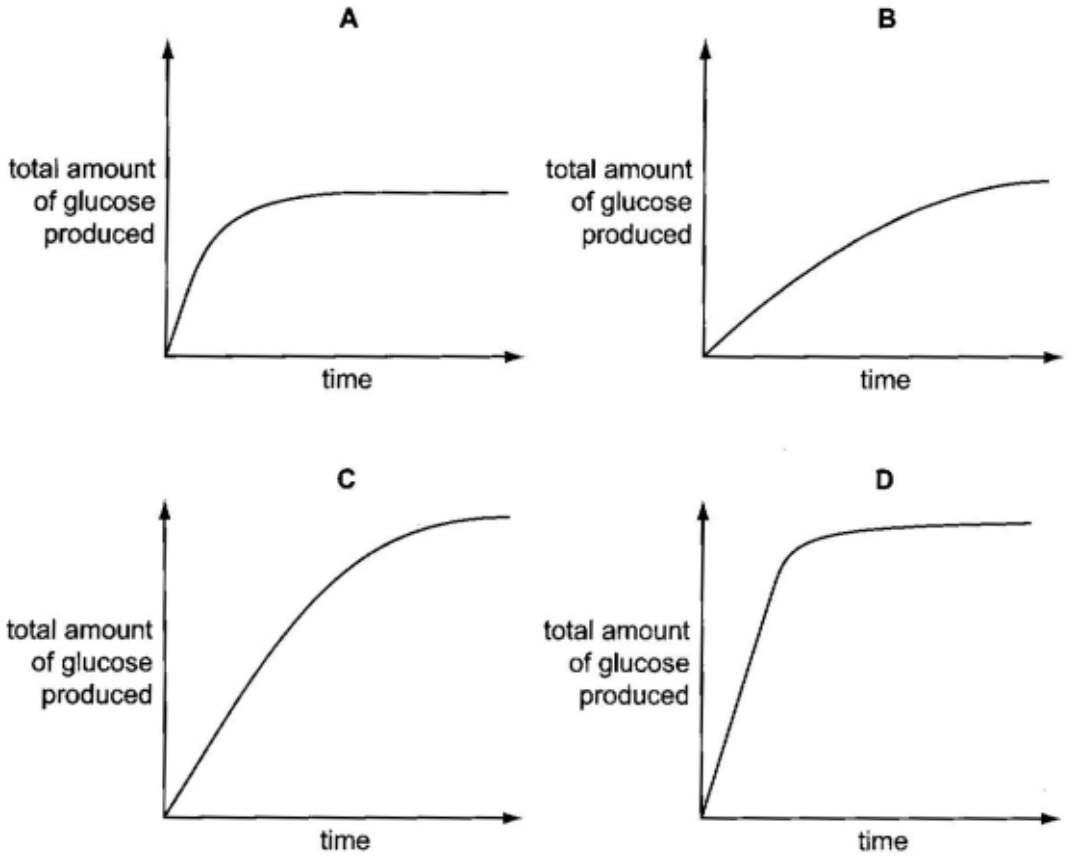
	primary structure	secondary structure	tertiary structure	quaternary structure
A	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	association of three polypeptides	folding of each polypeptide
B	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	folding of each polypeptide	association of three polypeptides
C	association of three polypeptides	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	folding of each polypeptide
D	association of three polypeptides	amino acid sequence of one polypeptide	folding of each polypeptide	α-helix and β-pleated sheet regions of each polypeptide

7 Lactose is a disaccharide present in milk. The enzyme β-galactosidase catalyses the conversion of lactose to glucose and galactose.

10 cm^3 of a 1% β-galactosidase solution was added to 10 cm^3 of milk. The graph shows the total amount of glucose produced over the next ten minutes.



Then, 10 cm^3 of a 2% β-galactosidase solution was added to 10cm^3 of milk. Which graph shows the results that would be obtained?



8 Serine proteases, such as chymotrypsin and trypsin, are enzymes that cleave peptide bonds in proteins. Three specific amino acids (aspartic acid, histidine, serine) arranged in a special alignment, are found conserved in all serine proteases. This conserved alignment is often referred to as "the catalytic triad". At the active site, scientists also found a variable region between different members in this class of enzymes.

Which feature allows different serine proteases to bind to different substrates?

A Different R-group properties of amino acids lining the variable region

B Specific spatial arrangement of aspartic acid, histidine, and serine at the active site

C Presence of a specific cofactor required for catalysis

D Different R-group properties of amino acids in the catalytic triad

9 Some RNA molecules, called ribozymes, can catalyse reactions in a similar way to protein enzymes. Most of these ribozymes have other RNA molecules as their substrates and catalyse reactions that break specific sugar phosphate bonds in the substrate molecules.

Which statements about these ribozymes are correct?

1 Hydrogen, ionic and disulfide bonds will be involved in the ribozyme structure.

2 The active site of a ribozyme is formed from a specific sequence of nucleotides

3 Ribozymes can form because RNA can have a specific secondary and tertiary structure.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

10 What is the role of stem cells with regards to the function of adult tissues and organs?

A Stem cells are fully differentiated cells that reside under the surface of epithelial tissue, in position to take over the function of the tissue when the overlying cells become damaged or worn out

B Stem cells are totipotent cells that divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter cell that will differentiate to replace damaged and worn out cells in the adult tissue or organ.

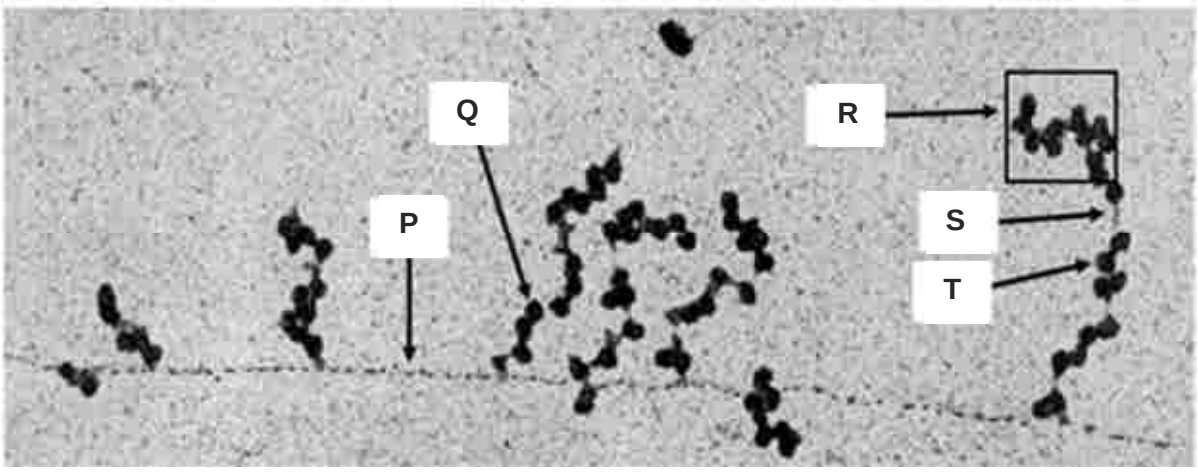
C Stem cells are embryonic cells that persist in the adult, and can give rise to all of the cell types in the body.

D Stem cells are cells that have yet to express the genes and produce proteins characteristic of their differentiated state, but do so when needed for repair of tissues and organs.

11 The table below shows the percentage of nitrogenous base in four samples of nucleic acids. Which base is adenine?

Sample	Bases				
	A	**B**	**C**	**D**	**Uracil**
1	19	31	30	19	Nil
2	27	23	24	26	Nil
3	25	25	Nil	25	25
4	17	32	33	18	Nil

12 The electron micrograph shows 5 structural components **P**, **Q**, **R, S and T** involved in the expression of a particular gene in a prokaryotic cell.



Which of the following statement(s) is / are true?

1 RNA polymerase adds incoming nucleotides to form **P**.

2 The products synthesized by **Q** and **T** are identical.

3 Structure **R** can also be found in eukaryotes.

4 **T** is involved in forming **S**.

A 3 only

B 2 and 3 only

C 1, 2 and 4 only

D All of the above

13 In a genetic engineering experiment, a piece of double-stranded DNA containing 6000 nucleotides is transcribed and translated into a polypeptide consisting of amino acids of fifteen different kinds.

What is the total number of amino acids used and the theoretical minimum number of different tRNA molecules required to translate the mRNA for this peptide?

A 500 amino acids and 20 different tRNA

B 1000 amino acids and 15 different tRNA

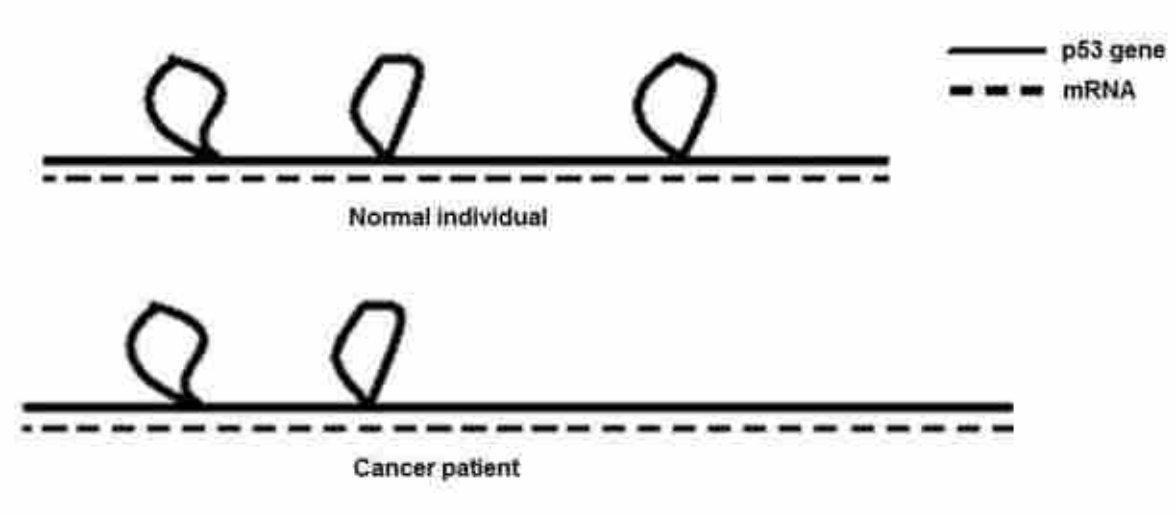
C 2000 amino acids and 20 different tRNA

D 3000 amino acids and 15 different tRNA

14 Which of the following shows the possible effects of a single nucleotide substitution in each of the following locations in a gene, on the production of the protein it codes for?

	Promoter	**Transcription terminator**	**Start codon**	**Stop codon**	**Middle of an intron**
A	No protein product is produced	Protein product is shorter than normal	Protein product is longer than normal	Protein product is normal	Too much protein product is produced
B	Too much protein product is produced	Protein product is normal	No protein product is produced	Protein product is longer than normal	Protein product is normal
C	Protein product is normal	Protein product is longer than normal	Protein product is shorter than normal	Too much protein product is produce	Protein product is longer than normal
D	Protein product is longer than normal	Too much protein product is produced	Protein product is normal	Protein product is shorter than normal	No protein product is produced

15 mRNA was isolated from a normal individual and a patient suffering from cancer. The mRNA was allowed to hybridise with the *p53* gene. The schematic diagram shows the results of the hybridisation process under the electron microscope.



Which of the following could be a possible explanation why the patient is suffering from cancer?

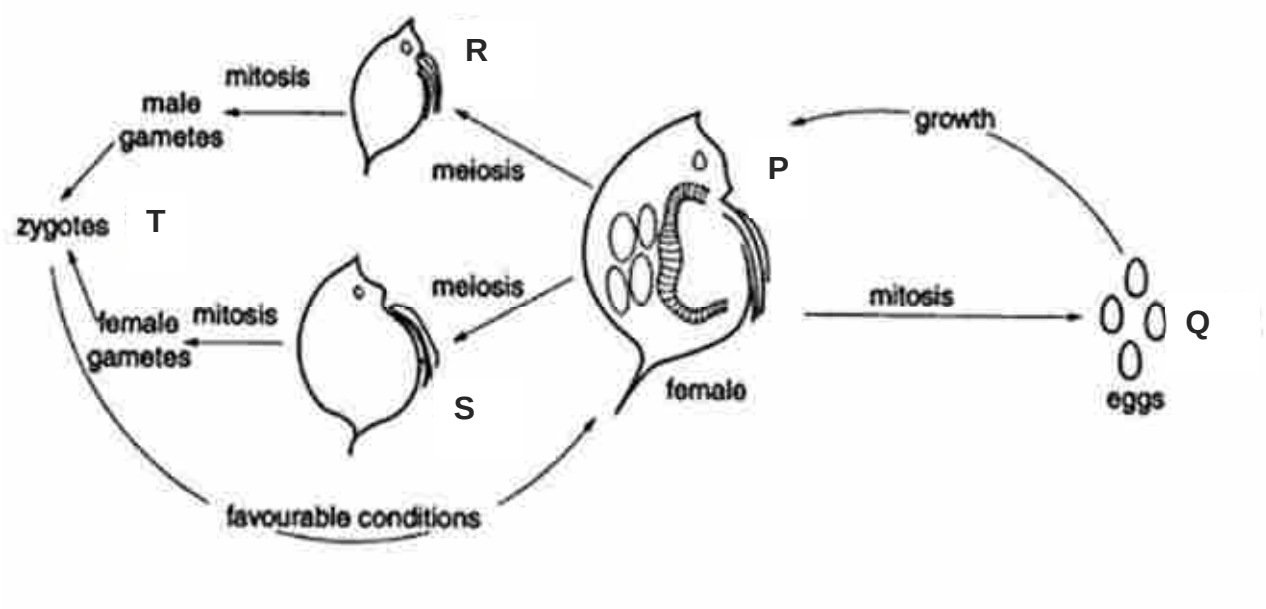
A A point mutation had occurred in the intron leading to the failure to excise one intron, hence leading to a longer dysfunctional protein being translated.

B A point mutation had occurred in the intron leading to an exon being excised, hence leading to a shorter dysfunctional protein being translated.

C A point mutation had occurred leading to the failure of spliceosome to recognise splice sites leading to the excision of the wrong intron, leading to a dysfunctional protein being translated.

D Gene amplification had occurred leading to the multiple copies of a trinucleotide repeat in an intron, hence causing splice site to be misread due to frameshift mutation, leading to a longer dysfunctional protein being translated.

16 The figure shows the life cycle of the water flea, *Daphnia*. The cells of individual **R** contain 10 chromosomes.



Which of the following are correct?

	Individual	Ploidy level	Number of chromosomes	Reason for choice
I	**P**	2n	20	The cells of **P** can undergo both mitosis and meiosis.
II	**Q**	2n	20	**P** produces eggs by mitosis which develop into females.
III	**S**	n	10	The gametic cells of **P** have undergone normal meiosis.
IV	**T**	2n	20	Random fertilisation of haploid gametes from **R** and **S** occurred to form zygote **T**.

A **I** and **II** only

B **I** and **III** only

C **II** and **IV** only

D All of the above

17 The cells of an organism contain six chromosomes, with an average of 18 units of DNA per chromosome.

The table below shows the results of measuring the amount of DNA in the cells of this organism at different stages of meiosis.

Which of the following shows the amount of DNA in the cell during anaphase I?

	Units of DNA per cell
A	36
B	54
C	108
D	216

18 Which pair of statements correctly describes how cellular DNA content and ploidy level change after meiosis I and meiosis II?

A Statement 1: Cellular DNA content is halved after both meiosis I and meiosis II.
Statement 2: Ploidy level changes from diploid to haploid only after meiosis II.

B Statement 1: Cellular DNA content is halved after both meiosis I and meiosis II.
Statement 2: Ploidy level changes from diploid to haploid after meiosis I, and remains haploid after meiosis II.

C Statement 1: Cellular DNA content is halved only after meiosis I.
Statement 2: Ploidy level changes from diploid to haploid only after meiosis II.

D Statement 1: Cellular DNA content is halved only after meiosis I.
Ploidy level changes from diploid to haploid after meiosis I, and remains haploid after meiosis II.

19 The sex chromosome combination XYY is found in a small proportion of men. Such a combination is possible if one contributory gamete to the zygote is

A a sperm produced by a father whose cells lack an X chromosome

B a sperm produced by non-disjunction at meiosis II

C an egg containing an X and a Y chromosome

D an egg produced by non-disjunction at meiosis I

20 A strain of toad has only one nucleolus in the nucleus of each cell instead of the usual two. When toads with one nucleolus per cell are mated, approximately a quarter of the offspring have two nucleoli per nucleus, half have one nucleolus per nucleus and a quarter have no nucleoli.

What is the most likely explanation of these results?

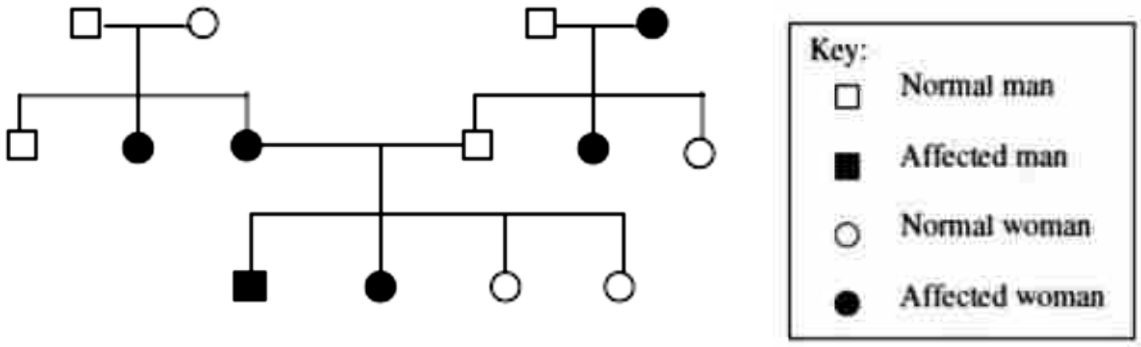
A The possession of one nucleolus is due to autosomal linkage.

B The possession of one nucleolus is due to the heterozygous condition.

C The allele for the presence of two nucleoli is recessive.

D The allele for the presence of two nucleoli is dominant.

21 The family tree shows the inheritance of a skin condition.



What is the genetic basis of the skin condition?

A autosomal dominant

B sex-linked dominant

C autosomal recessive

D sex-linked recessive

22 In birds, sex is determined by a ZW chromosome scheme. Males are ZZ and females are ZW. A recessive lethal allele that causes death of the embryo is sometimes present on the Z chromosome in pigeons. What would be the sex ratio in the offspring of a cross between a male that is heterozygous for the lethal allele and a normal female?

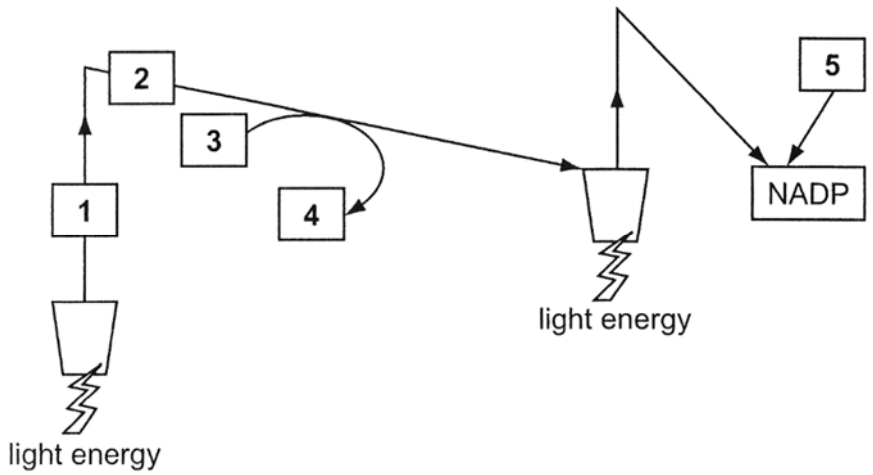
A 2:1 male to female

B 1:2 male to female

C 1:1 male to female

D 3:1 male to female

23 The diagram represents non-cyclic photophosphorylation.



Which reactants would be present at points **1**, **2**, **3**, **4**, and **5**?

	1	2	3	4	5
A	Electrons	Electron carrier	ATP	ADP	Hydrogen molecules
B	Electron carrier	Electrons	ADP	ATP	Electrons
C	Electrons	Electron carrier	ADP	ATP	Hydrogen ions
D	Electron carrier	Electrons	ADP	ATP	Electrons and hydrogen ions

24 Dinitrophenol is a compound that can lodge within the thylakoid membranes of chloroplasts. Its presence provides an alternative route for H^+ ions to diffuse across the thylakoid membranes.

In what way would the Calvin cycle be affected in chloroplasts poisoned with dinitrophenol?

A No effect since Calvin cycle is an enzyme-controlled process.

B The rate of Calvin cycle would increase as pH in the stroma decreases.

C The rate of Calvin cycle would decrease with the accumulation of glycerate-3-phosphate.

D The rate of Calvin cycle would decrease with the accumulation of glyceraldehyde–3-phosphate

25 Six tubes were set up as shown in the table.

tube	contents
1	Glucose + homogenized plant cells
2	Glucose + mitochondria
3	Glucose + cytoplasm lacking organelles
4	Pyruvate + homogenized animal cells
5	Pyruvate + mitochondria
6	Pyruvate + cytoplasm lacking organelles

After incubation, each sample was analysed to determine the presence of carbon dioxide and ethanol.

In which tube(s) is lactate most likely to be present?

A 1 and 3 only

B 2, 3, 5 and 6 only

C 4, 5, and 6 only

D 3 and 6 only

26 Which effect of natural selection is likely to lead to speciation?

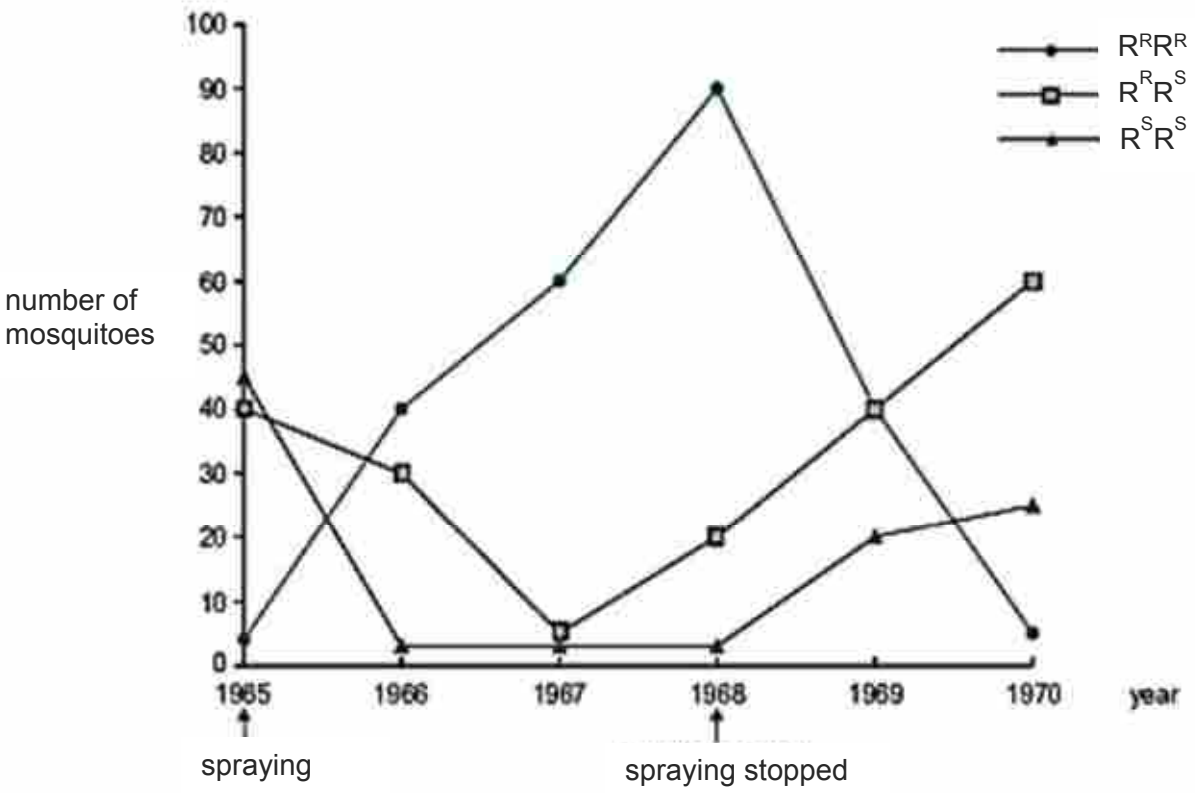
A Differences between populations are increased.

B Favourable genotypes are maintained in the population.

C Genetic diversity is reduced.

D Selection pressure on some alleles reduces reproductive success.

27 In the mosquito, there is a gene locus which has two alleles, R^R and R^s, involved in resistance to the insecticide DDT. R^R represents the allele for DDT resistance and R^s represents the allele for DDT sensitivity. The graph shows the number of mosquitoes of three genotypes collected from 1965, when DDT was first used, through to 1970, two years after the spraying of DDT stopped.



From the data, it is possible to conclude that

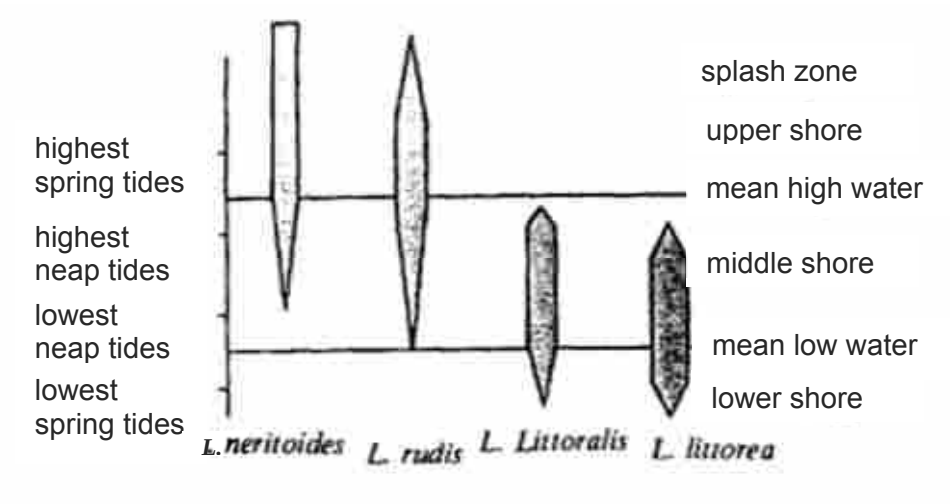
A the frequency of the R^S allele is greater than the frequency of the R^R allele in 1968.

B many generations after the removal of DDT, the R^R allele would disappear from the population.

C after removal of DDT from the environment in 1968, having the R^RR^R genotype reduces the chance of survival.

D in the presence of DDT in the environment between 1967 and 1968, mosquitoes with the R^RR^S genotype are most likely to survive.

28 The diagram below shows the frequency and distribution of four *Littorina* species on a rocky shore. All feed in a snail-like manner by grazing on algae.



spring tide: Refers to the 'springing forth' of the tide during new and full moon

neap tide: Happens seven days after a spring tide. Refers to a period of moderate tides when the sun and moon are at right angles to each other

Which one of the following factors could **not** directly contribute to this distribution pattern?

A Variation in the tolerance of each species to desiccation

B Competition between species for different feeding niches

C The photoperiod and seasonal change in day length

D The differential selection of Littorina by predators

29 Bacteria in the genus *Wolbachia* infect many butterfly species. They are passed from one generation to the next in eggs, but not in sperm, and they selectively kill developing male embryos.

In Samoa in the 1960s, the proportion of male blue moon butterflies fell to less than 1% of the population. However, by 2006, the proportion of males was almost 50% of the population.

Resistance to *Wolbachia* is the result of the dominant allele of a suppressor gene.

Which statements correctly describe the evolution of resistance to *Wolbachia* in the blue moon butterfly population?

1 *Wolbachia* acts as a selective agent.

2 The selective killing of male embryos is an example of artificial selection.

3 When infected with *Wolbachia*, male embryos that are homozygous for the recessive allele of the suppressor gene die.

4 All male embryos that carry the dominant allele of the suppressor gene pass that allele to their offspring.

5 The frequency of the dominant allele of the suppressor gene rises in the butterfly population.

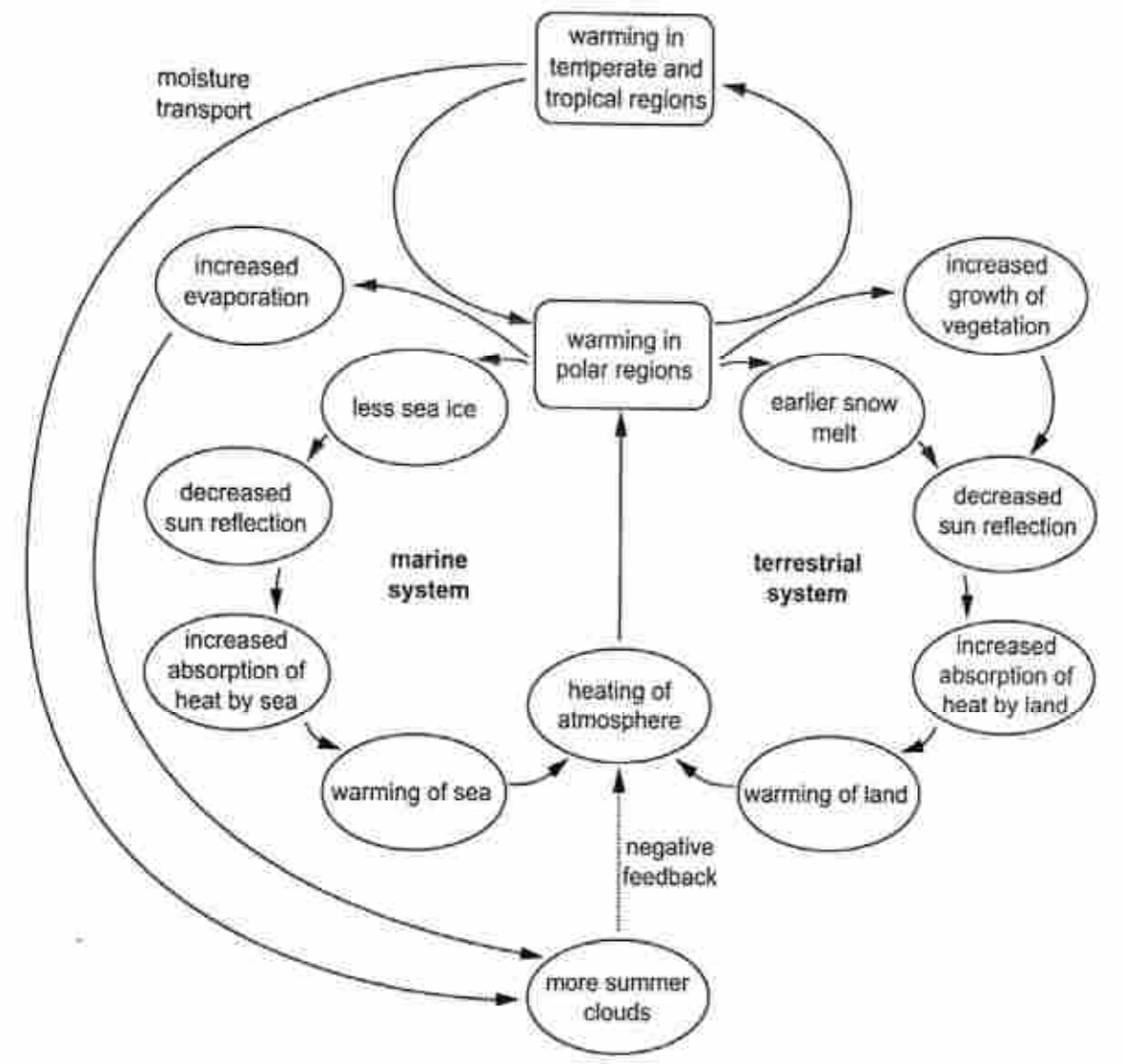
A 1 and 4 only

B 2 and 3 only

C 1, 3 and 5

D 2, 4 and 5

30 The diagram shows the effect of increasing temperatures on the ice and snow cover at the polar regions.



Which effect of higher temperatures in the polar regions could increase global warming?

A Melting of ice and snow results in less reflection of sunlight and more heat absorption by the Earth.

B Increased evaporation leads to more rainfall, which absorbs heat from the land and the sea.

C Melting sea ice causes more cloud formation, which increases absorption of heat in the atmosphere.

D Earlier melting of snow allows vegetation cover to increase faster, reducing loss of heat from the surface of the Earth.

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

CLASS

BIOLOGY

8876/02

Paper 2 Structured and Free-response Questions

13 September 2018

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do no use staples, paper clips, glue or correction fluid.

Section A

Answer **all** questions in the spaces provided on the Question Paper.

Section B

Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
Total	

This document consists of **15** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** the questions in this section.

1 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions.

Within the SER, molecules of cholesterol and triglycerides are surrounded by proteins and phospholipids to form lipoproteins. These lipoprotein particles enter the Golgi apparatus where they are packaged into vesicles and pass to the blood.

Fig. 1.1 is an electron micrograph of part of a liver cell showing lipoprotein particles within the Golgi apparatus.

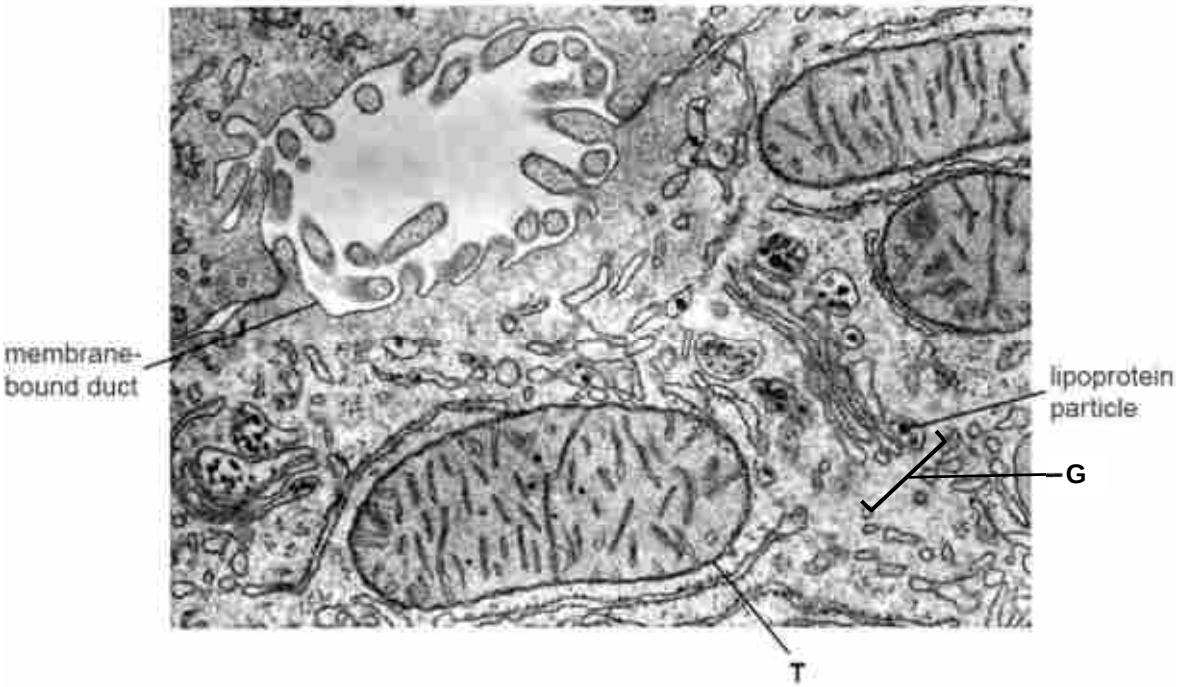


Fig. 1.1

(a) Name structure T in Fig. 1.1 and state its role in liver cells.

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.....

[2]

(b) Suggest why cholesterol is packaged into lipoproteins before release from liver cells into the blood.

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[1]

(c) Cholesterol is also packaged into vesicles by the SER and then secreted from the cell into small fluid-filled spaces between the liver cells. These spaces form ducts that drain into the gall bladder to form bile.

Explain how cholesterol is secreted into ducts, such as the duct in Fig. 1.1.

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[3]

(d) Both the Golgi body and the rough endoplasmic reticulum are part of the internal network of membranes in cells.

Outline structural features shown in Fig. 1.1 that identify **G** as the Golgi body and not the rough endoplasmic reticulum.

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[2]

Cholesterol is a major component of all membranes. The concentration of cholesterol largely varies between membranes of different cells and tissues. There are other differences in the chemical composition of cell membranes in different organisms, such as the type of fatty acid chains in phospholipids.

Fig. 1.2 shows the structure of the phospholipids in the membranes of Organism A, which is an extreme thermophile (live in extremely high temperature places like hot springs), and Organism B, which live in normal environment (non-thermophile).

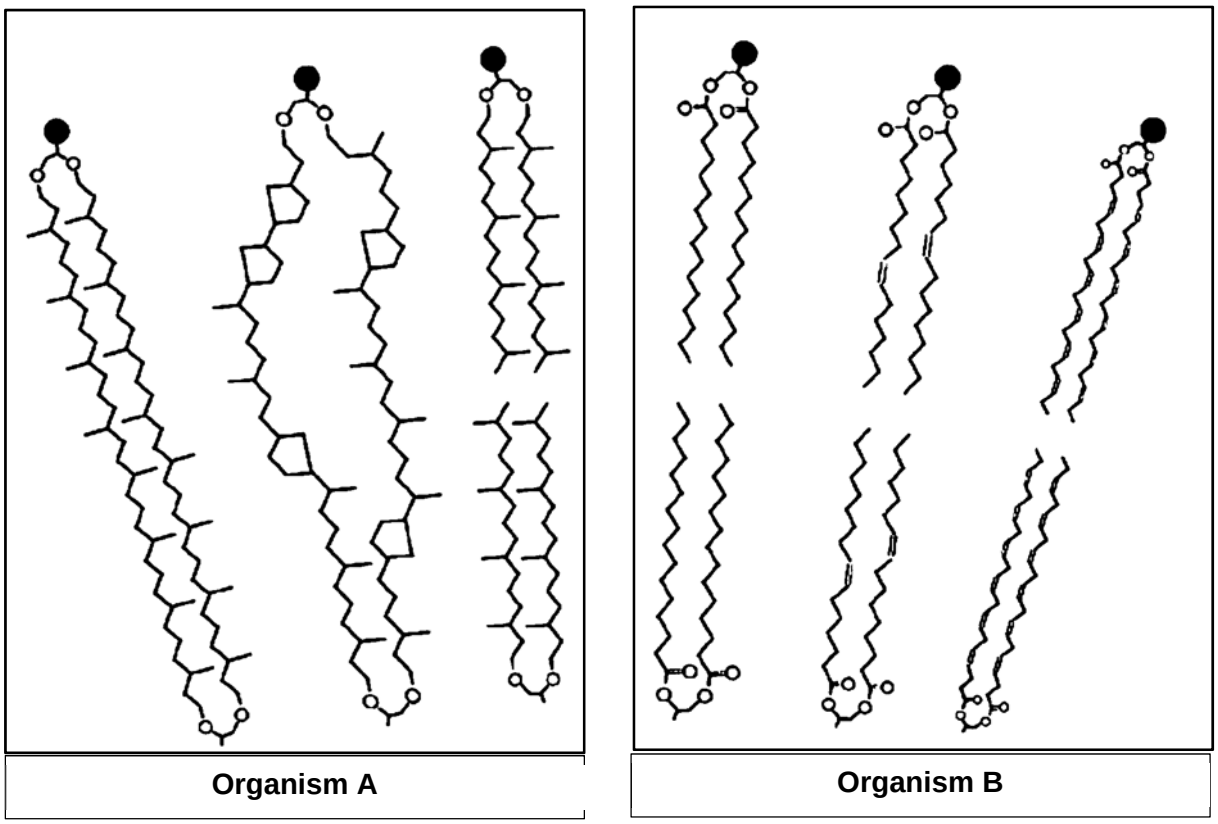

Fig. 1.2

(e) **(i)** With reference to Fig. 1.2, other than the presence of side branches and rings, state two structural differences between the phospholipids of Organism **A** and **B**.

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[2]

(ii) Suggest how the differences stated in **(e)(i)** enable Organism **A** to thrive in environments with extreme high temperature condition.

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[2]

[Total: 12]

2 Chitinases are enzymes synthesized by bacteria, fungi, yeasts, plants, that can degrade chitin into low molecular weight, soluble and insoluble oligosaccharides. Chitin is a modified polysaccharide found in a number of different organisms, for example in fungal cell walls and the hard outer skeletons of insects.

Chitinase is made up of 825 amino acids. Fig 2.1 shows the arrangement of some of the conserved amino acids found close together in the active site of chitinase. Fig. 2.2 shows the structure of a single chitinase molecule.

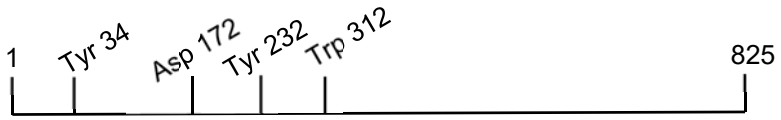

Fig. 2.1

Fig. 2.2

(a) With reference to Fig 2.2, describe how the amino acid residues at different positions may be brought together when chitinase is synthesized.

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[3]

Chitin and the products of chitin hydrolysis have many useful medical and environmental applications. Chitinase enzymes can be used commercially to hydrolyse chitin. Enzyme stability and activity are important considerations in technological applications of chitinase.

Fig. 2.3 is a graph showing the effects of temperature on chitinase extracted from a soil bacterium. The relative activity of the enzyme was measured at different temperatures, with 100% representing maximum enzyme activity.

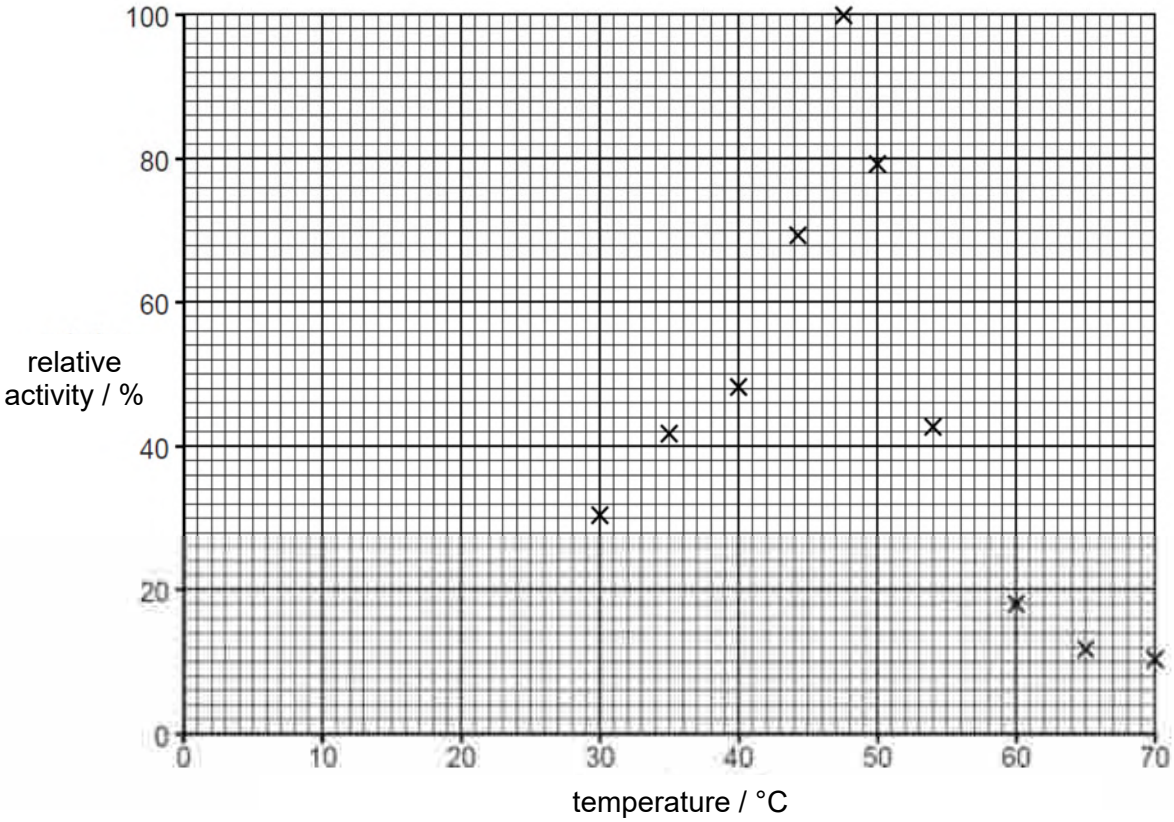

Fig. 2.3

(b) (i) With reference to Fig. 2.3, state the optimum temperature for the chitinase enzyme.

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[1]

Fig. 2.4 is a graph showing how temperature affects the stability of chitinase. The activity of the enzyme was measured over a time period of 72 hours at each of five different temperatures.

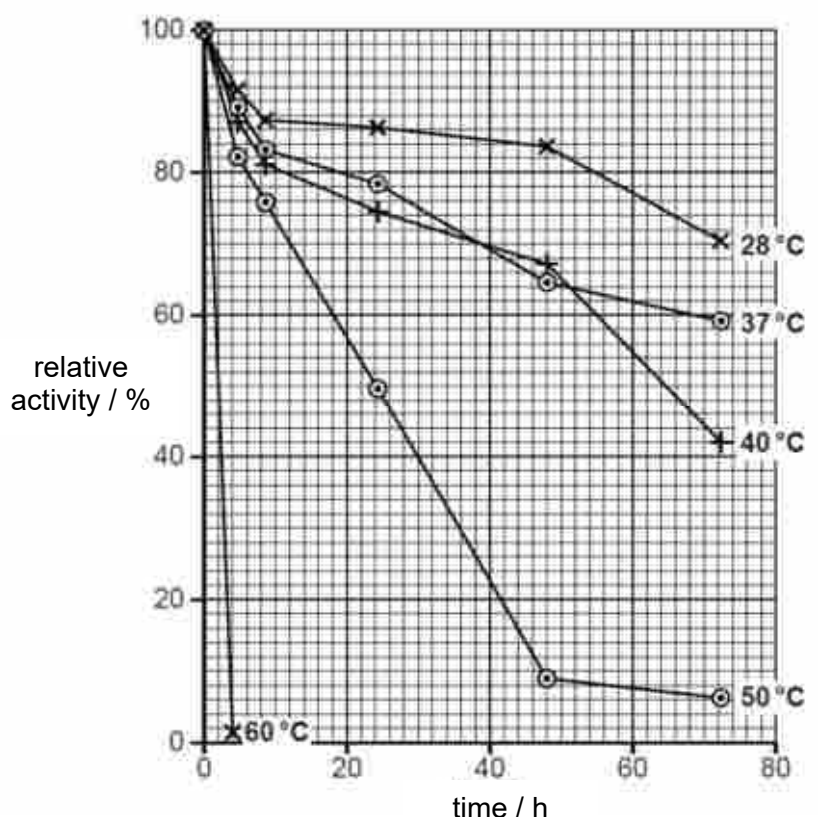

Fig. 2.4

(ii) With reference to Fig. 2.3 and Fig. 2.4, describe **and** discuss the effect of temperature on chitinase activity **and** stability.

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[5]
[Total: 9]

3 In mice, fur colour is controlled by a gene with multiple alleles. These alleles are listed below in no particular order.

black and tan = C^{bt}	yellow = C^{y}
agouti = C^{a}	black = C^{b}

(a) Explain how multiple alleles arise.

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..... [2]

(b) Suggest explanations for the results of the following crosses between mice.

(i) Mice with agouti fur crossed with mice with black fur may produce all agouti offspring **or** some agouti and some black offspring.

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..... [2]

(ii) Crosses between heterozygous parents with the genotype $C^{y}C^{b}$ always produce a ratio of two yellow mice to one black mouse.

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..... [2]

(iii) Mice with yellow fur crossed with mice with black fur will produce one of the following outcomes:

- some yellow offspring and some agouti offspring
- some yellow offspring and some black and tan offspring
- some yellow offspring and some black offspring.

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..... [2]

(c) A test cross is used to determine the genotype of an organism.

Describe how you would carry out a test cross to determine the genotype of a black and tan mouse.

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..... [2]

[Total: 10]

4 Global warming has changed both the thickness and surface area of sea ice of the Arctic Ocean as well as the Southern Ocean that surrounds Antarctica. Sea ice is highly sensitive to changes in temperature.

Scientists have calculated a long-term mean for the surface area of sea ice in the Arctic and in the Southern Ocean around Antarctica. This mean value is used as a reference to examine changes in ice extent. The graph Fig. 4.1 shows the variations from this mean (zero line) over a period of time.

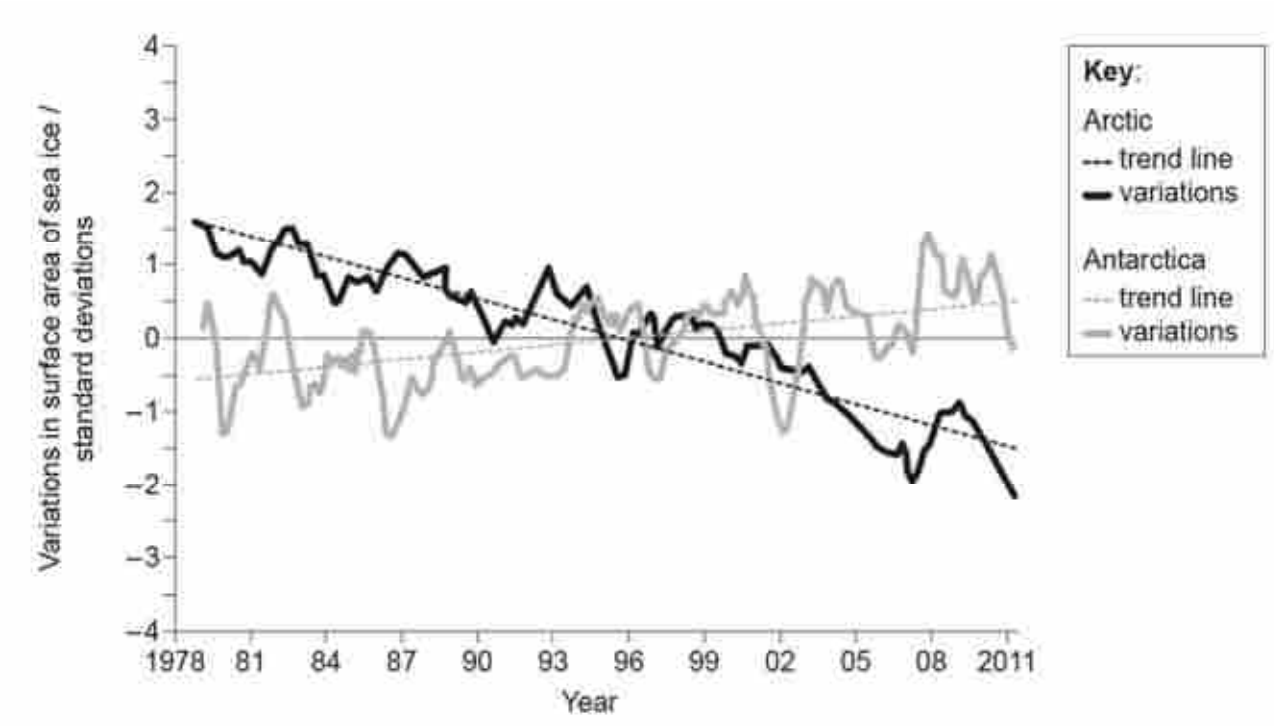

Fig. 4.1

(a) State the trend in the surface area of sea ice in the Southern Ocean around Antarctica.

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[1]

(b) Distinguish between changes in the surface area of sea ice in the Arctic and Antarctica.

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[2]

(c) Discuss the data as evidence of global warming.

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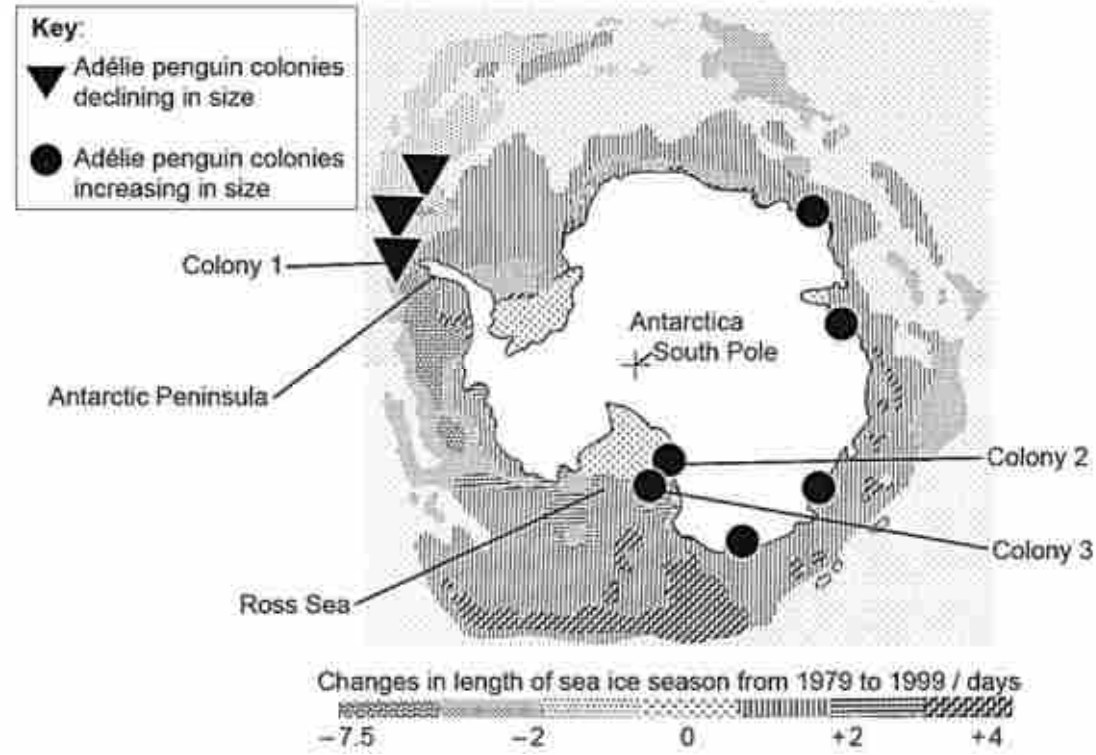
[3]

Adélie penguins (*Pygoscelis adeliae*) are only found in Antarctica and need sea ice for feeding and nesting. Biologists are able to deduce how these penguins have responded to changes in their environment for the last 35 000 years, as the Antarctic conditions have preserved their bones and their nests. The image is a map of Antarctica and the surrounding Southern Ocean. It shows the trends in the length of the sea ice season (days of the year when sea ice is increasing) and the sites of nine Adélie penguin colonies.



[Source: Data sourced from the penguinscience.com website]

Fig. 4.2

(d) Describe the trends in the length of the sea ice season around the Antarctic Peninsula and in the Ross Sea.

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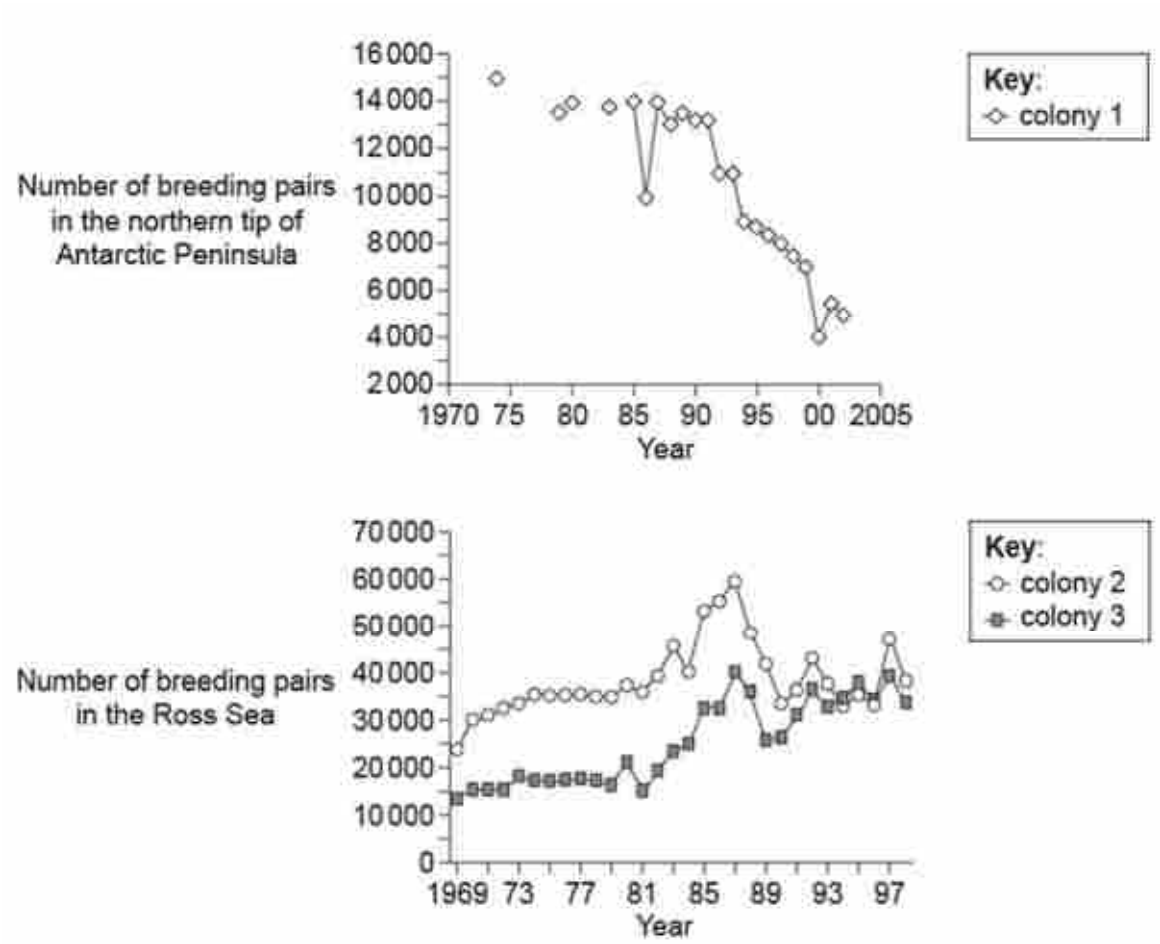
[2]

The graphs show the changes in penguin population in three of the colonies shown on the map.



[Source: Data sourced from: www.penguinscience.com/clim_change.php]

Fig. 4.3

(e) Analyse the trends in colony size of the Adélie penguins in relation to the changes in the sea ice.

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..... [3]

(f) Discuss the use of Adélie penguins in studying the effects of global warming.

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[3]

[Total: 14]

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

5 **(a)** Outline the structural differences between typical prokaryotic and eukaryotic cells and explain how it relates to differences in gene expression. [6]

(b) Explain, with examples, how environmental factors act as forces of natural selection. [9]

[Total: 15]

6 **(a)** Explain how organisms grown from genetically identical zygotes can have different phenotypes. [6]

(b) Charles Darwin proposed that evolution occurs primarily by natural selection. However deleterious recessive alleles are not eliminated from population. Describe and explain how these alleles remain in the population. [9]

[Total: 15]

H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME: ANSWER

CLASS

BIOLOGY

8876/01

Paper 1 Multiple Choice

26 June 2018

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name and CT on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

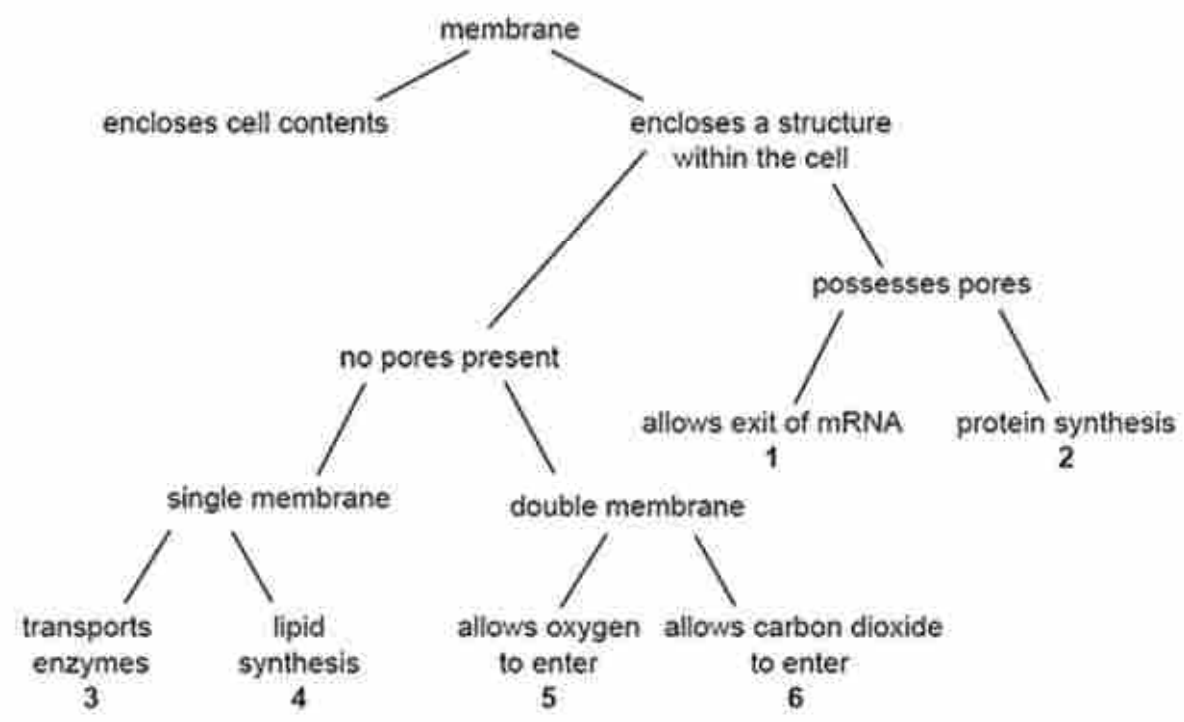
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Calculators may be used.

This document consists of **19** printed pages and **1** blank page.

[Turn over

1 Membranes within and at the surface of cells have different roles.

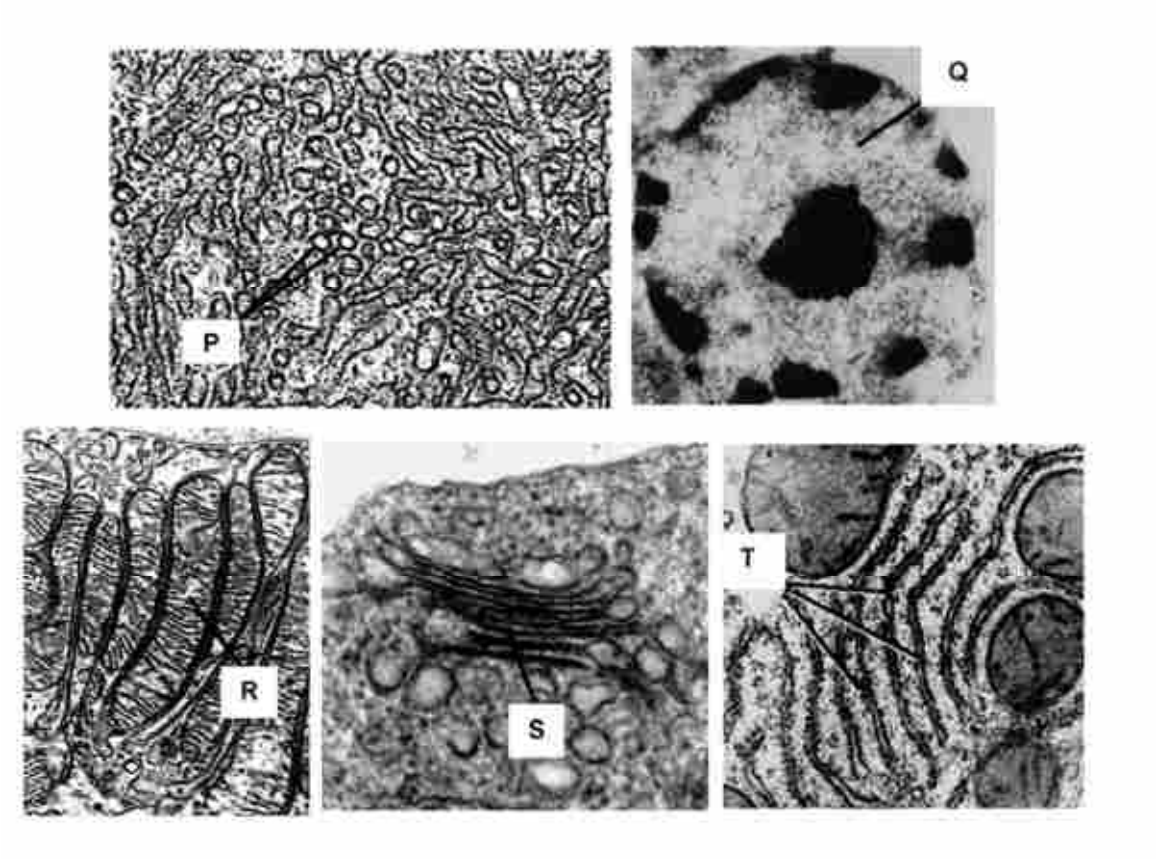
The diagram allows the identification of the various organelles within the cell, by describing the membrane structure and function.



Which of the outcomes shown below correctly identifies the organelles that possess the membrane and function concerned?

	1	2	3	4	5	6
A	nucleus	ribosome	vesicle	smooth ER	mitochondrion	chloroplast
B	nucleolus	rough ER	vesicle	smooth ER	nucleus	mitochondrion
C	nucleus	rough ER	vesicle	smooth ER	mitochondrion	chloroplast
D	nucleus	smooth ER	mitochondrion	rough ER	vesicle	chloroplast

2 The following electron micrographs show various organelles **P** to **T** present in a liver cell.



Radioactive amino acids are supplied to the liver cell to synthesise insulin receptors.

Which sequence shows the correct order in which these amino acids would be detected in the organelles during the synthesis of insulin receptors?

A Q → T → R → P → S

B Q → T → P → S

C T → P → S → R

D T → S → P

3 A symbiont may be defined as a species in which individuals live in a long-term, intimate and beneficial relationship with hosts of a different species. As the name suggests, endosymbionts live within their hosts.

Which statement provides evidence that mitochondria and chloroplasts are endosymbionts?

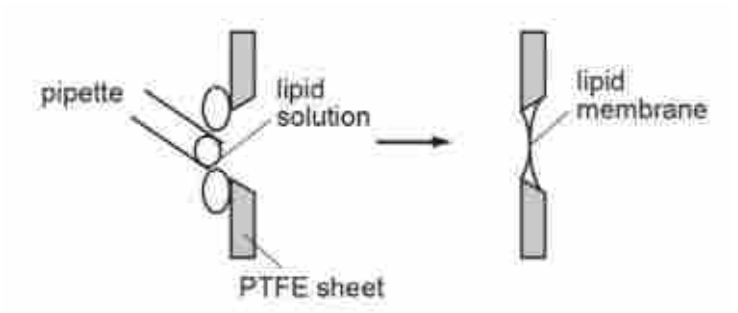
A Proteins encoded by the nucleus are exported to these organelles.

B Their inner membrane has different structure from other intracellular membranes.

C They are surrounded by double membrane.

D They contain their own ribosomes.

4 Lipid membranes can be formed in the laboratory by painting phospholipids over a PTFE sheet with a hole in it.



Such a lipid membrane is impermeable to water soluble materials including charged ions such as Na^+ or K^+.

In one experiment with Na^+ ions, no current flowed across the membrane until a substance called gramicidin was added to the membrane, at which time current flowed.

What kind of molecule is gramicidin?

A A carbohydrate molecule found only on the outside of the membrane.

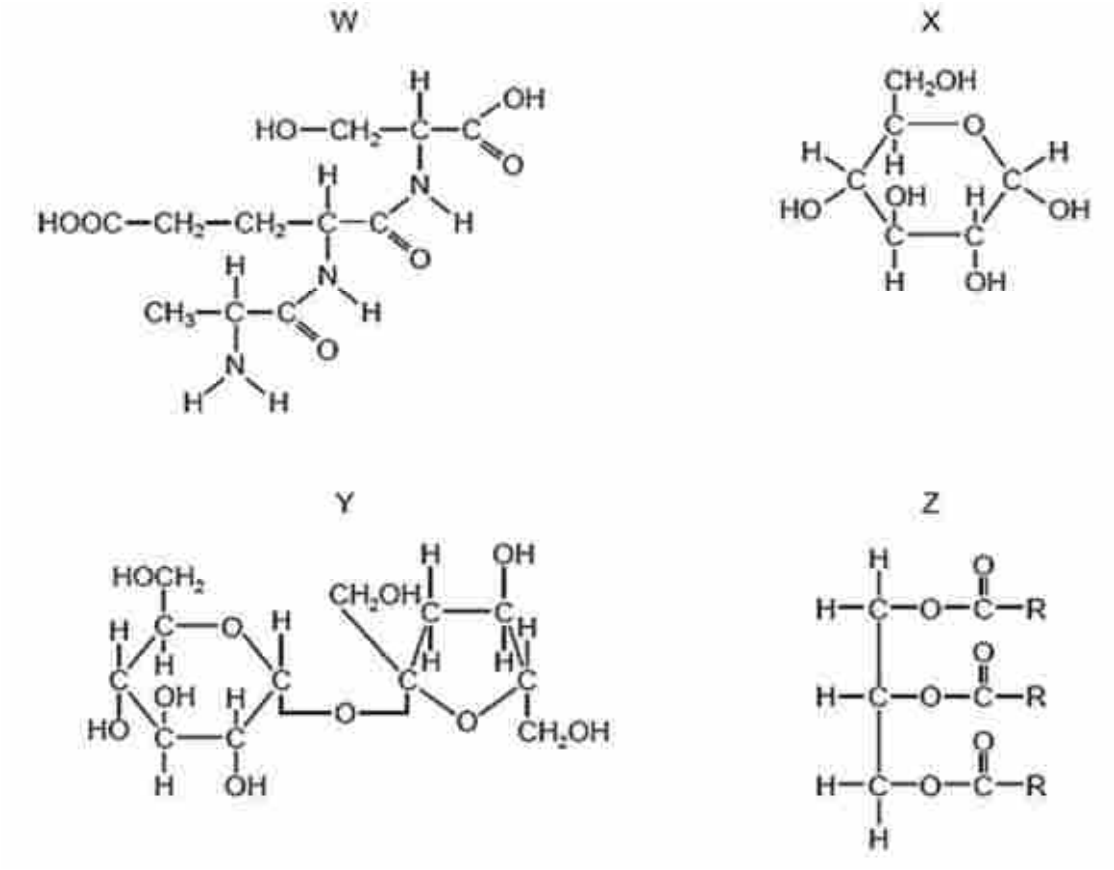
B A non-polar lipid which passes all the way through the membrane.

C A protein molecule with both hydrophilic and hydrophobic regions.

D A protein molecule which has only hydrophobic regions.

5 Samples of a mixture of biological molecules were tested using Benedict's reagent, biuret solution and ethanol. After testing, the solutions were blue with Benedict's reagent, purple with biuret solution and cloudy with ethanol emulsion test.

Which molecules could the mixture contain?



A W, X and Y

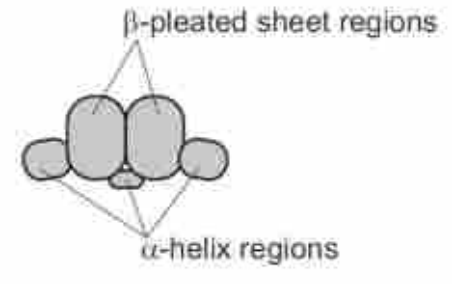
B W, X and Z

C W, Y and Z

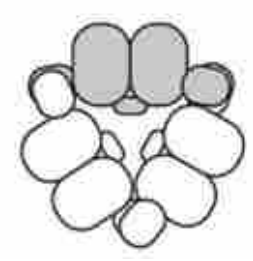
D X, Y and Z

6 Approximately half of the total protein in a pea seed consists of the storage protein vicilin.

- Each molecule of vicilin is made up of three identical polypeptides.
- Each polypeptide is made up of two β-pleated sheet regions with linking α-helix regions, folded into the shape shown to the right.



- This allows the three polypeptides to pack together into a compact, flat storage molecule, as shown below.

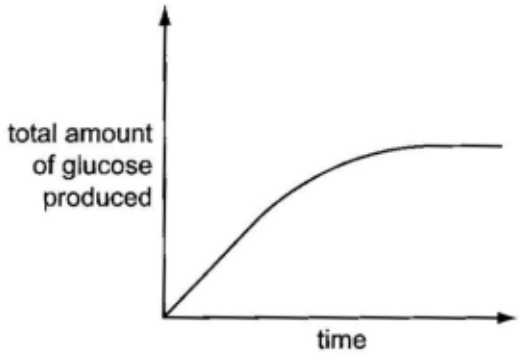


Which row correctly describes the structure of vicilin?

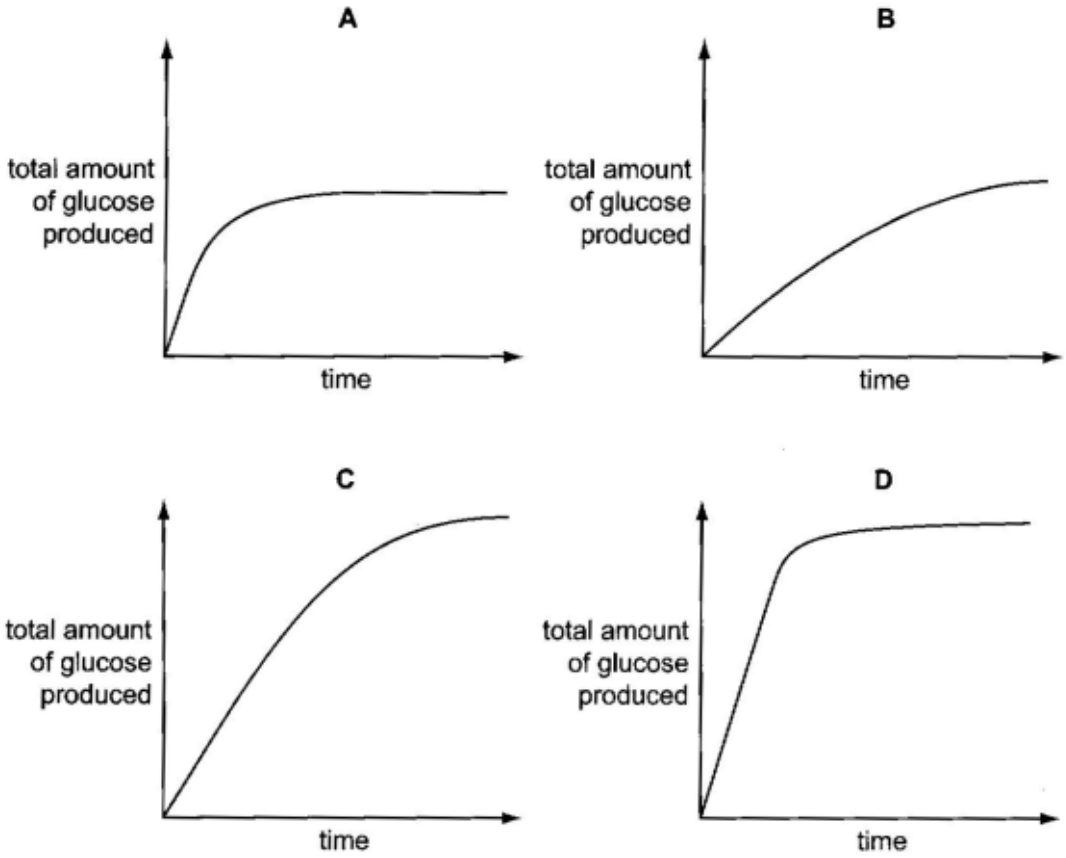
	primary structure	secondary structure	tertiary structure	quaternary structure
A	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	association of three polypeptides	folding of each polypeptide
B	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	folding of each polypeptide	association of three polypeptides
C	association of three polypeptides	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	folding of each polypeptide
D	association of three polypeptides	amino acid sequence of one polypeptide	folding of each polypeptide	α-helix and β-pleated sheet regions of each polypeptide

7 Lactose is a disaccharide present in milk. The enzyme β-galactosidase catalyses the conversion of lactose to glucose and galactose.

10 cm^3 of a 1% β-galactosidase solution was added to 10 cm^3 of milk. The graph shows the total amount of glucose produced over the next ten minutes.



Then, 10 cm^3 of a 2% β-galactosidase solution was added to 10cm^3 of milk. Which graph shows the results that would be obtained? AAAAAAAAAAAAAAAAAAAAAAA



8 Serine proteases, such as chymotrypsin and trypsin, are enzymes that cleave peptide bonds in proteins. Three specific amino acids (aspartic acid, histidine, serine) arranged in a special alignment, are found conserved in all serine proteases. This conserved alignment is often referred to as "the catalytic triad". At the active site, scientists also found a variable region between different members in this class of enzymes.

Which feature allows different serine proteases to bind to different substrates?

A Different R-group properties of amino acids lining the variable region

B Specific spatial arrangement of aspartic acid, histidine, and serine at the active site

C Presence of a specific cofactor required for catalysis

D Different R-group properties of amino acids in the catalytic triad

9 Some RNA molecules, called ribozymes, can catalyse reactions in a similar way to protein enzymes. Most of these ribozymes have other RNA molecules as their substrates and catalyse reactions that break specific sugar phosphate bonds in the substrate molecules.

Which statements about these ribozymes are correct?

- Hydrogen, ionic and disulfide bonds will be involved in the ribozyme structure.
- The active site of a ribozyme is formed from a specific sequence of nucleotides
- Ribozymes can form because RNA can have a specific secondary and tertiary structure.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

10 What is the role of stem cells with regards to the function of adult tissues and organs?

A Stem cells are fully differentiated cells that reside under the surface of epithelial tissue, in position to take over the function of the tissue when the overlying cells become damaged or worn out

B Stem cells are totipotent cells that divide asymmetrically, giving rise to one daughter cell that remains a stem cell and one daughter cell that will differentiate to replace damaged and worn out cells in the adult tissue or organ.

C Stem cells are embryonic cells that persist in the adult, and can give rise to all of the cell types in the body.

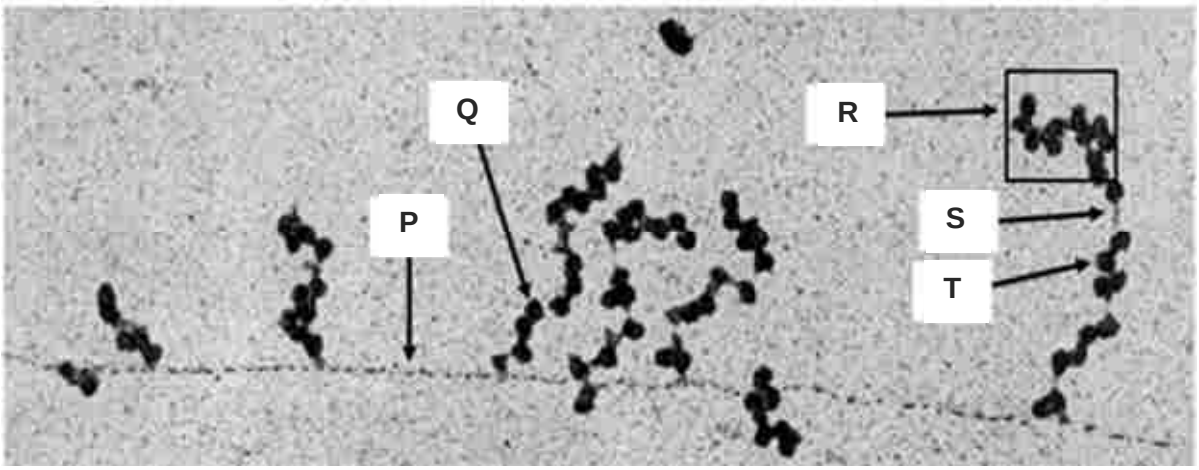
D Stem cells are cells that have yet to express the genes and produce proteins characteristic of their differentiated state, but do so when needed for repair of tissues and organs.

11 The table shows the percentage of nitrogenous base in four samples of nucleic acids.

Sample	Bases				
	A	**B**	**C**	**D**	**Uracil**
1	19	31	30	19	Nil
2	27	23	24	26	Nil
3	25	25	Nil	25	25
4	17	32	33	18	Nil

Which base is adenine? **BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB**

12 The electron micrograph shows 5 structural components **P**, **Q**, **R, S and T** involved in the expression of a particular gene in a prokaryotic cell.



Which of the following statement(s) is / are true?

- RNA polymerase adds incoming nucleotides to form **P**.
- The products synthesized by **Q** and **T** are identical.
- Structure **R** can also be found in eukaryotes.
- **T** is involved in forming **S**.

A 3 only

B 2 and 3 only

C 1, 2 and 4 only

D All of the above

13 In a genetic engineering experiment a piece of double-stranded DNA containing 6000 nucleotides is transcribed and translated into a polypeptide consisting of amino acids of fifteen different kinds.

What is the total number of amino acids used and the theoretical minimum number of different tRNA molecules required to translate the mRNA for this peptide?

A 500 amino acids and 20 different tRNA

B 1000 amino acids and 15 different tRNA

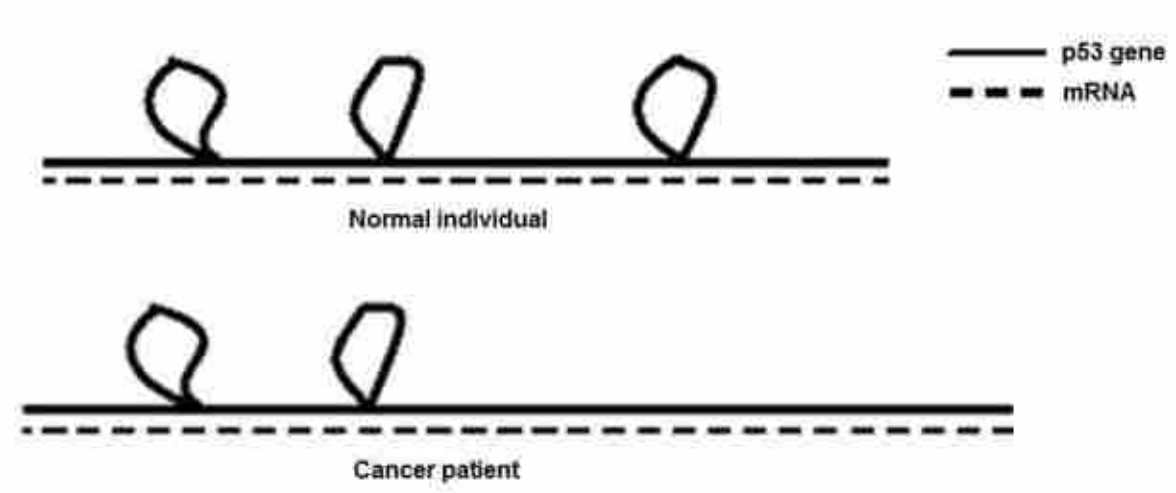
C 2000 amino acids and 20 different tRNA

D 3000 amino acids and 15 different tRNA

14 Which of the following shows the possible effects of a single nucleotide substitution in each of the following locations in a gene on the production of the protein it codes for?

	Promoter	**Transcription terminator**	**Start codon**	**Stop codon**	**Middle of an intron**
A	No protein product is produced	Protein product is shorter than normal	Protein product is longer than normal	Protein product is normal	Too much protein product is produced
B	Too much protein product is produced	Protein product is normal	No protein product is produced	Protein product is longer than normal	Protein product is normal
C	Protein product is normal	Protein product is longer than normal	Protein product is shorter than normal	Too much protein product is produce	Protein product is longer than normal
D	Protein product is longer than normal	Too much protein product is produced	Protein product is normal	Protein product is shorter than normal	No protein product is produced

15 mRNA was isolated from a normal individual and a patient suffering from cancer. The mRNA was allowed to hybridise with the *p53* gene. The schematic diagram shows the results of the hybridisation process under the electron microscope.



Which of the following could be a possible explanation why the patient is suffering from cancer?

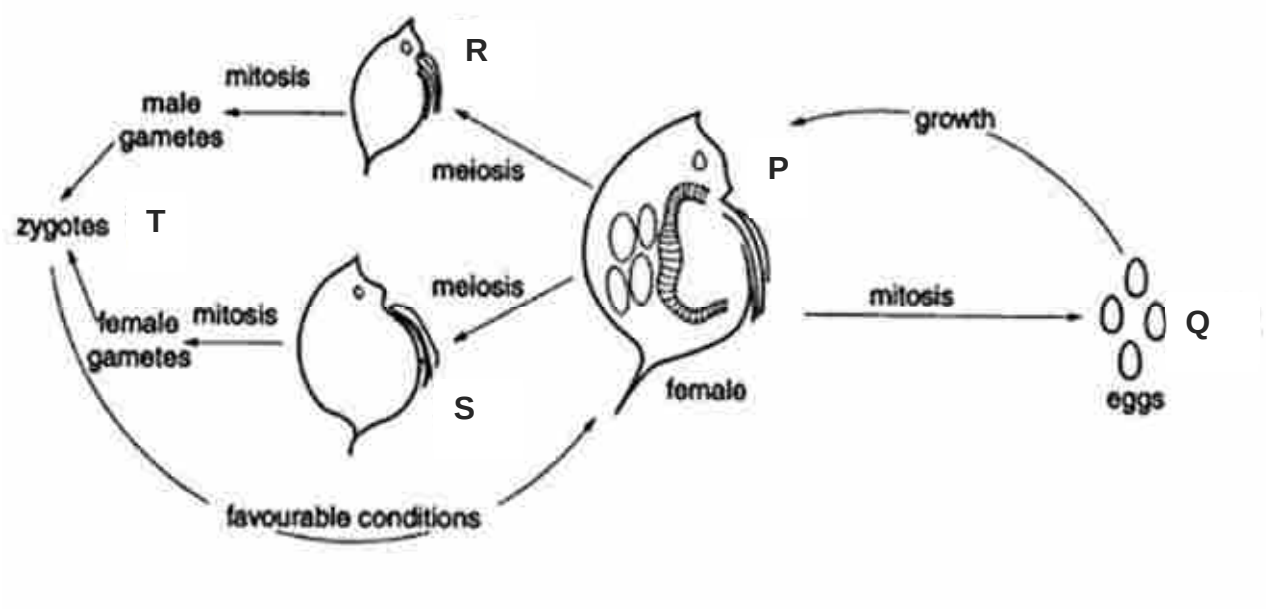
A A point mutation had occurred in the intron leading to the failure to excise one intron, hence leading to a longer dysfunctional protein being translated.

B A point mutation had occurred in the intron leading to an exon being excised, hence leading to a shorter dysfunctional protein being translated.

C A point mutation had occurred leading to the failure of spliceosome to recognise splice sites leading to the excision of the wrong intron, leading to a dysfunctional protein being translated.

D Gene amplification had occurred leading to the multiple copies of a trinucleotide repeat in an intron, hence causing splice site to be misread due to frameshift mutation, leading to a longer dysfunctional protein being translated.

16 The figure shows the life cycle of the water flea, *Daphnia*. The cells of individual **R** contain 10 chromosomes.



Which of the following are correct?

	Individual	Ploidy level	Number of chromosomes	Reason for choice
I	**P**	2n	20	The cells of **P** can undergo both mitosis and meiosis.
II	**Q**	2n	20	**P** produces eggs by mitosis which develop into females.
III	**S**	n	10	The gametic cells of **P** have undergone normal meiosis.
IV	**T**	2n	20	Random fertilisation of haploid gametes from **R** and **S** occurred to form zygote **T**.

A **I** and **II** only

B **I** and **III** only

C **II** and **IV** only

D All of the above

17 The cells of an organism contain six chromosomes, with an average of 18 units of DNA per chromosome.

The table below shows the results of measuring the amount of DNA in the cells of this organism at different stages of meiosis.

Which of the following shows the amount of DNA in the cell during anaphase I?

	Units of DNA per cell
A	36
B	54
C	108
D	216

18 Which pair of statements correctly describes how cellular DNA content and ploidy level change after meiosis I and meiosis II?

A Cellular DNA content is halved after both meiosis I and meiosis II.
Ploidy level changes from diploid to haploid only after meiosis II.

B Cellular DNA content is halved after both meiosis I and meiosis II.
Ploidy level changes from diploid to haploid after meiosis I, and remains haploid after meiosis II.

C Cellular DNA content is halved only after meiosis I.
Ploidy level changes from diploid to haploid only after meiosis II.

D Cellular DNA content is halved only after meiosis I.
Ploidy level changes from diploid to haploid after meiosis I, and remains haploid after meiosis II.

19 The sex chromosome combination XYY is found in a small proportion of men. Such a combination is possible if one contributory gamete to the zygote is

A a sperm produced by a father whose cells lack an X chromosome

B a sperm produced by non-disjunction at meiosis II

C an egg containing an X and a Y chromosome

D an egg produced by non-disjunction at meiosis I

20 A strain of toad has only one nucleolus in the nucleus of each cell instead of the usual two. When toads with one nucleolus per cell are mated, approximately a quarter of the offspring have two nucleoli per nucleus, half have one nucleolus per nucleus and a quarter have no nucleoli.

What is the most likely explanation of these results?

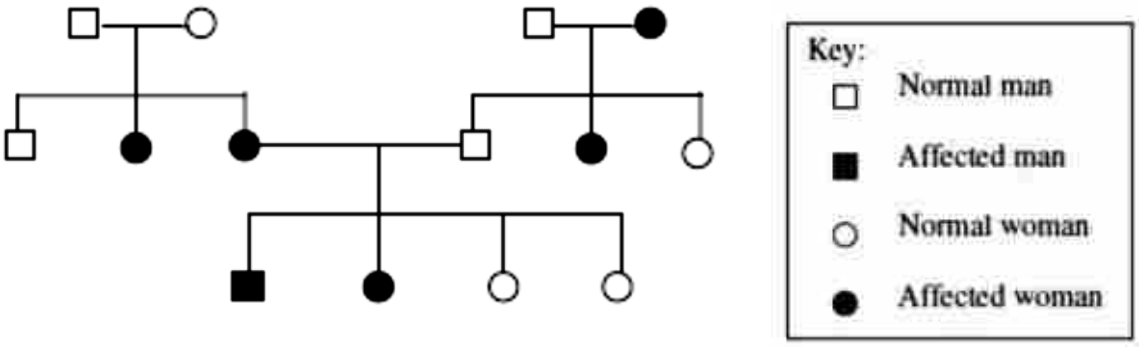
A The possession of one nucleolus is due to autosomal linkage.

B The possession of one nucleolus is due to the heterozygous condition.

C The allele for the presence of two nucleoli is recessive.

D The allele for the presence of two nucleoli is dominant.

21 The family tree shows the inheritance of a skin condition.



What is the genetic basis of the skin condition?

A autosomal dominant

B sex-linked dominant

C autosomal recessive

D sex-linked recessive

22 In birds, sex is determined by a ZW chromosome scheme. Males are ZZ and females are ZW. A recessive lethal allele that causes death of the embryo is sometimes present on the Z chromosome in pigeons. What would be the sex ratio in the offspring of a cross between a male that is heterozygous for the lethal allele and a normal female?

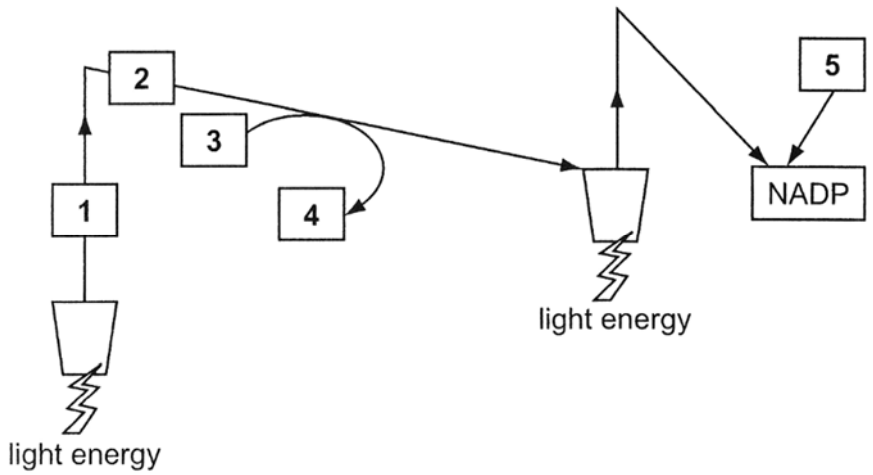
A 2:1 male to female

B 1:2 male to female

C 1:1 male to female

D 3:1 male to female

23 The diagram represents non-cyclic photophosphorylation.



Which reactants would be present at points **1**, **2**, **3**, **4**, and **5**?

	1	2	3	4	5
A	Electrons	Electron carrier	ATP	ADP	Hydrogen molecules
B	Electron carrier	Electrons	ADP	ATP	Electrons
C	Electrons	Electron carrier	ADP	ATP	Hydrogen ions
D	Electron carrier	Electrons	ADP	ATP	Electrons and hydrogen ions

24 Dinitrophenol is a compound that can lodge within the thylakoid membranes of chloroplasts. Its presence provides an alternative route for H^+ ions to diffuse across the thylakoid membranes.

In what way would the Calvin cycle be affected in chloroplasts poisoned with dinitrophenol?

A No effect since Calvin cycle is an enzyme-controlled process.

B The rate of Calvin cycle would increase as pH in the stroma decreases.

C The rate of Calvin cycle would decrease with the accumulation of glycerate-3-phosphate.

D The rate of Calvin cycle would decrease with the accumulation of glyceraldehyde–3-phosphate

25 Six tubes were set up as shown in the table.

tube	contents
1	Glucose + homogenized plant cells
2	Glucose + mitochondria
3	Glucose + cytoplasm lacking organelles
4	Pyruvate + homogenized animal cells
5	Pyruvate + mitochondria
6	Pyruvate + cytoplasm lacking organelles

After incubation, each sample was analysed to determine the presence of carbon dioxide and ethanol.

In which tube(s) is lactate most likely to be present?

A 1 and 3 only

B 2, 3, 5 and 6 only

C 4, 5, and 6 only

D 3 and 6 only

26 Which effect of natural selection is likely to lead to speciation?

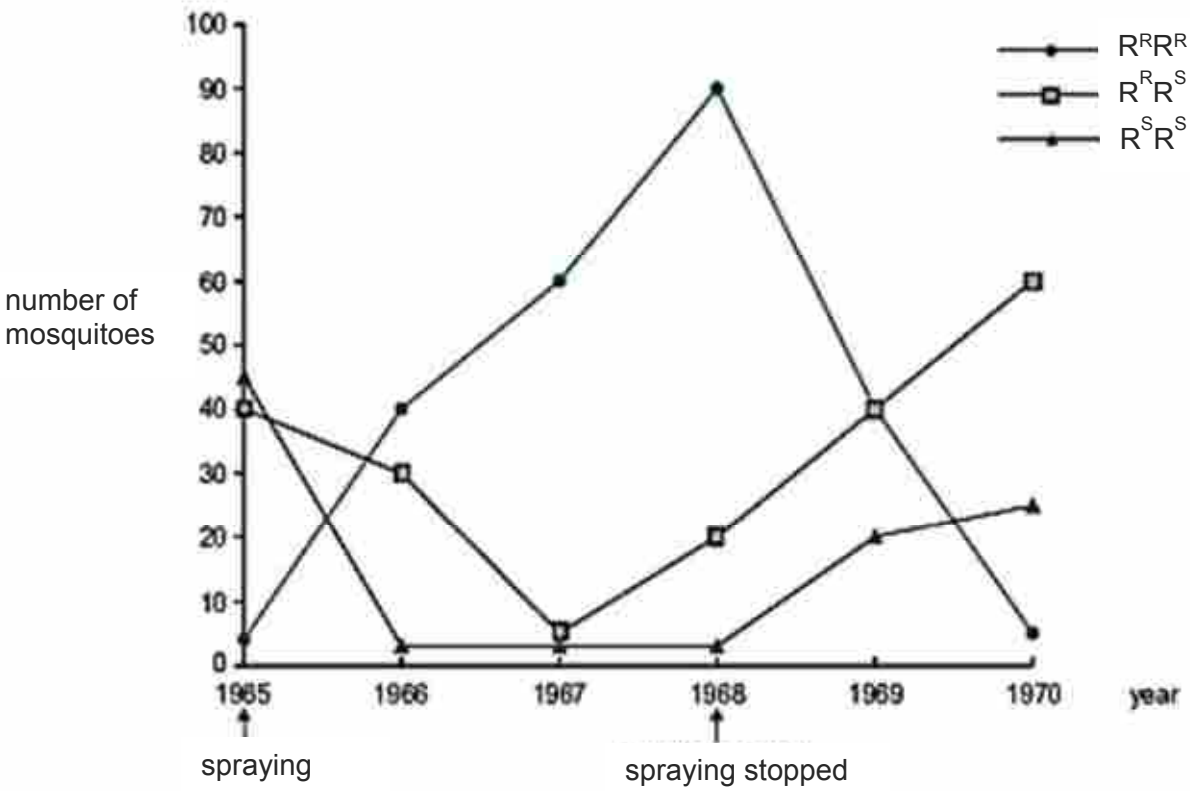
A Differences between populations are increased.

B Favourable genotypes are maintained in the population.

C Genetic diversity is reduced.

D Selection pressure on some alleles reduces reproductive success.

27 In the mosquito, there is a gene locus which has two alleles, R^R and R^s, involved in resistance to the insecticide DDT. R^R represents the allele for DDT resistance and R^s represents the allele for DDT sensitivity. The graph shows the number of mosquitoes of three genotypes collected from 1965, when DDT was first used, through to 1970, two years after the spraying of DDT stopped.



From the data, it is possible to conclude that

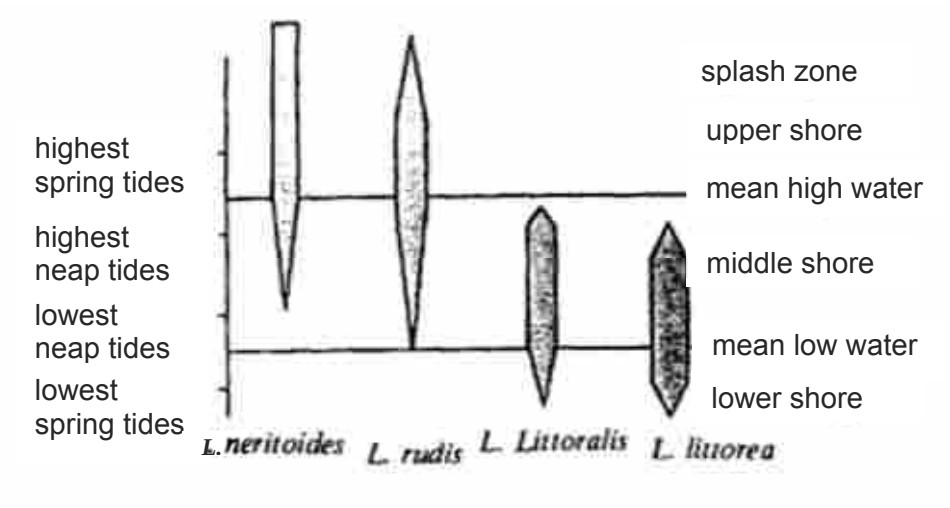
A the frequency of the R^S allele is greater than the frequency of the R^R allele in 1968.

B many generations after the removal of DDT, the R^R allele would disappear from the population.

C after removal of DDT from the environment in 1968, having the R^RR^R genotype reduces the chance of survival.

D in the presence of DDT in the environment between 1967 and 1968, mosquitoes with the R^RR^S genotype are most likely to survive.

28 The diagram below shows the frequency and distribution of four *Littorina* species on a rocky shore. All feed in a snail-like manner by grazing on algae.



spring tide: refers to the 'springing forth' of the tide during new and full moon

neap tide: Happens seven days after a spring tide. Refers to a period of moderate tides when the sun and moon are at right angles to each other

Which one of the following factors could **not** directly contribute to this distribution pattern?

A Variation in the tolerance of each species to desiccation

B Competition between species for different feeding niches

C The photoperiod and seasonal change in day length

D The differential selection of Littorina by predators

29 Bacteria in the genus *Wolbachia* infect many butterfly species. They are passed from one generation to the next in eggs, but not in sperm, and they selectively kill developing male embryos.

In Samoa in the 1960s, the proportion of male blue moon butterflies fell to less than 1% of the population. However, by 2006, the proportion of males was almost 50% of the population.

Resistance to *Wolbachia* is the result of the dominant allele of a suppressor gene.

Which statements correctly describe the evolution of resistance to *Wolbachia* in the blue moon butterfly population?

1 *Wolbachia* acts as a selective agent.

2 The selective killing of male embryos is an example of artificial selection.

3 When infected with *Wolbachia*, male embryos that are homozygous for the recessive allele of the suppressor gene die.

4 All male embryos that carry the dominant allele of the suppressor gene pass that allele to their offspring.

5 The frequency of the dominant allele of the suppressor gene rises in the butterfly population.

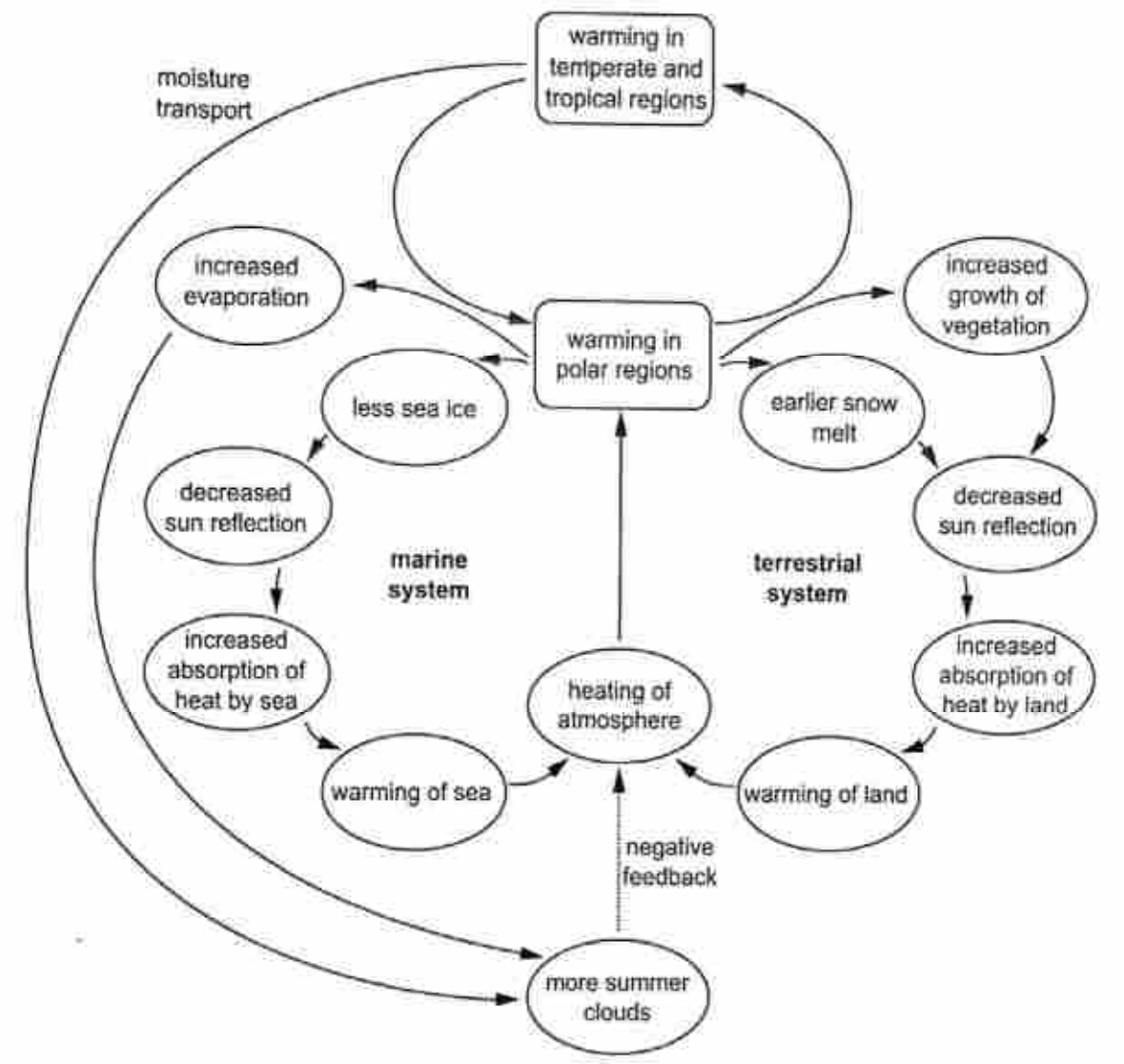
A 1 and 4 only

B 2 and 3 only

C 1, 3 and 5

D 2, 4 and 5

30 The diagram shows the effect of increasing temperatures on the ice and snow cover at the polar regions.



Which effect of higher temperatures in the polar regions could increase global warming?

A Melting of ice and snow results in less reflection of sunlight and more heat absorption by the Earth.

B Increased evaporation leads to more rainfall, which absorbs heat from the land and the sea.

C Melting sea ice causes more cloud formation, which increases absorption of heat in the atmosphere.

D Earlier melting of snow allows vegetation cover to increase faster, reducing loss of heat from the surface of the Earth.

H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CANDIDATE NAME

MARK SCHEME

CLASS

BIOLOGY

8876/02

Paper 2 Structured and Free-response Questions

13 September 2018

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and class in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do no use staples, paper clips, glue or correction fluid.

Section A

Answer **all** questions in the spaces provided on the Question Paper.

Section B

Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
Total	

This document consists of **15** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** the questions in this section.

1 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions.

Within the SER, molecules of cholesterol and triglycerides are surrounded by proteins and phospholipids to form lipoproteins. These lipoprotein particles enter the Golgi apparatus where they are packaged into vesicles and pass to the blood.

Fig. 1.1 is an electron micrograph of part of a liver cell showing lipoprotein particles within the Golgi apparatus.

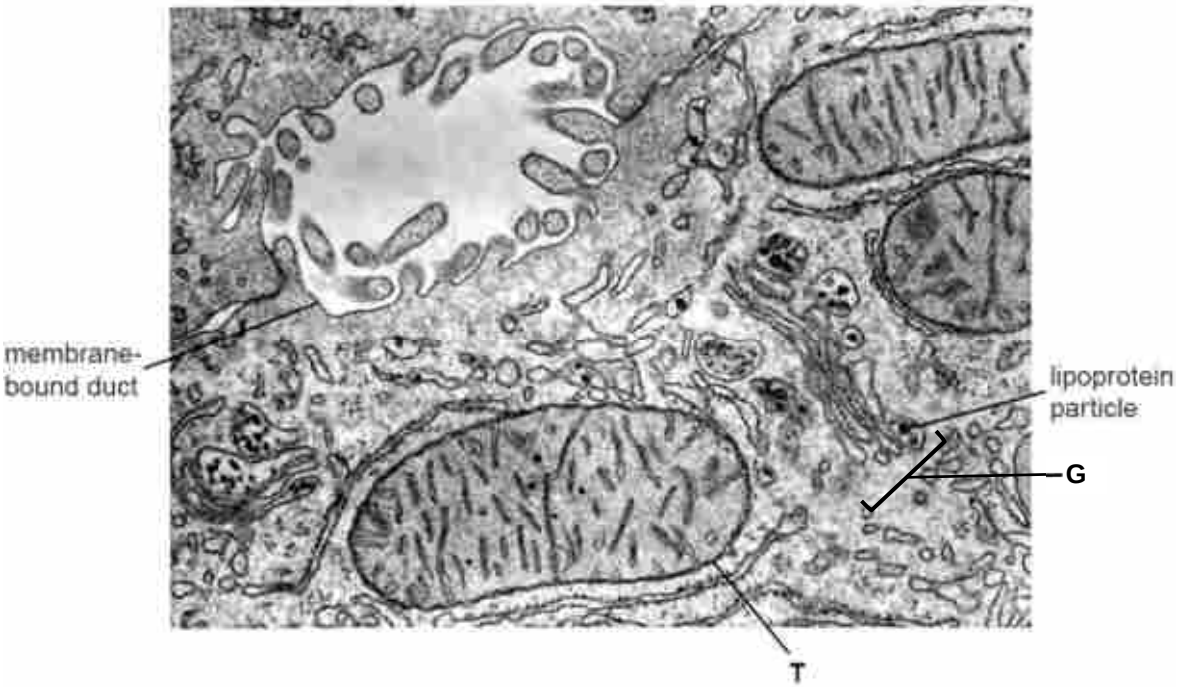


Fig. 1.1

(a) Name structure T in Fig. 1.1 and state its role in liver cells.

Mitochondrion;

---

produces / synthesises / AW, ATP ; @ release / supply, ATP / energy

® produces energy

® ATP energy

---

example of use of ATP in liver cells ;

e.g. for synthesis of, cholesterol / glycogen / protein / biological molecules / polymers / AW

intracellular movement of vesicles

exocytosis / endocytosis / bulk transport

active transport

---

[2]

(b) Suggest why cholesterol is packaged into lipoproteins before release from liver cells into the blood.

lipoproteins are soluble ;

cholesterol is not water-soluble ;

cholesterol surrounded by / lipoproteins have, phospholipid heads / proteins, that are hydrophilic ;

allows transport in blood ;

(max 1)

[1]

(c) Cholesterol is also packaged into vesicles by the SER and then secreted from the cell into small fluid-filled spaces between the liver cells. These spaces form ducts that drain into the gall bladder to form bile.

Explain how cholesterol is secreted into ducts, such as the duct in Fig. 1.1.

vesicles travel along microtubules / cytoskeleton towards the cell surface membrane;

exocytosis ;

vesicle membrane fuses with cell surface membrane;

vesicle contents containing cholesterol are released ;

[3]

(d) Both the Golgi body and the rough endoplasmic reticulum are part of the internal network of membranes in cells.

Outline structural features shown in Fig. 1.1 that identify **G** as the Golgi body and not the rough endoplasmic reticulum.

any two from:

(flattened) sacs have layered appearance / no **connection between membranes** / AW / ora;

not, connected to / contiguous with / continuous with, (outer membrane of) **nuclear envelope** / ora ;

swellings at end of sacs (for vesicle formation) / vesicles at ends of sacs ;

no **ribosomes** / ora ;

ora: or reverse argument

AW: alternative wording (where responses vary more than usual)

[2]

Cholesterol is a major component of all membranes. The concentration of cholesterol largely varies between membranes of different cells and tissues. There are other differences in the chemical composition of cell membranes in different organisms, such as the type of fatty acid chains in phospholipids.

Fig. 1.2 shows the structure of the phospholipids in the membranes of Organism A, which is an extreme thermophile (live in extremely high temperature places like hot springs), and Organism B, which live in normal environment (non-thermophile).

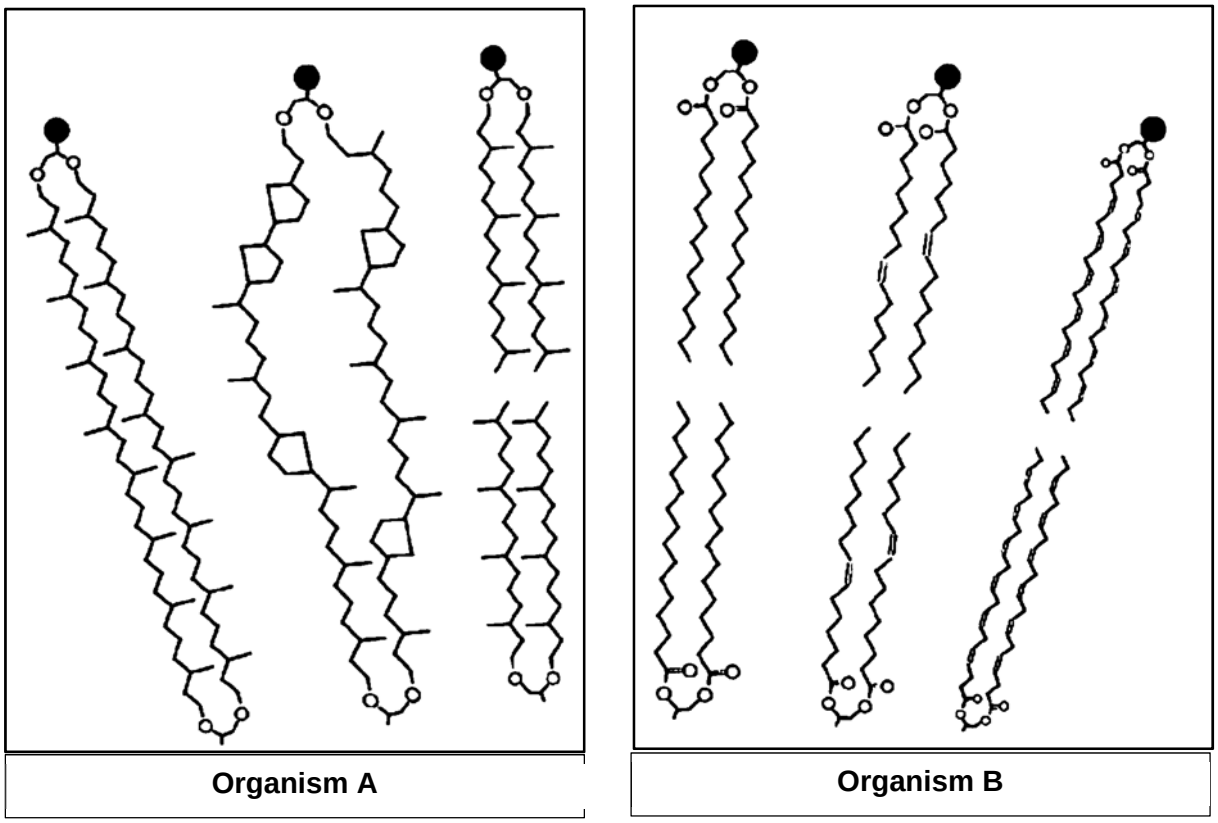


Fig. 1.2

(e) **(i)** With reference to Fig. 1.2, other than the presence of side branches and rings, state two structural differences between the phospholipids of Organism **A** and **B**.

Any two:

Archaea membranes	Bacterial membranes
▪ Phospholipid tails contain only saturated hydrocarbon chains.	▪ Phospholipid tails contain both unsaturated and saturated hydrocarbon chains.
▪ Hydrocarbon chains / phospholipid tails are longer / twice as long / pass completely through the membrane	▪ Hydrocarbon chains / phospholipid tails are shorter / do not pass completely through the membrane

▪ Absence of ester linkages / presence of ether linkages	▪ Presence of ester linkages
▪ Phospholipid molecules form a monolayer in the membrane	▪ Phospholipid molecules form a bilayer in the membrane

[2]

(ii) Suggest how the differences stated in **(e)(i)** enable Organism **A** to thrive in environments with extreme high temperature condition.

Any two (points must be related to differences stated in (b)(i)):

Longer phospholipid tails increase hydrophobic interactions, hence reduces membrane fluidity / increases stability of membrane at high temperatures.

Phospholipid monolayer reduces membrane fluidity / increases stability of membrane at high temperatures.

Presence of saturated hydrocarbon tails make organism A's membranes more resistant to oxidation / less fluid, thus increases stability at high temperatures

Absence of ester linkages / presence of ether linkages, therefore phospholipid molecules are more resistant to hydrolysis in an environment of high salinity.

[2]

[Total: 12]

2 Chitinases are enzymes synthesized by bacteria, fungi, yeasts, plants, that can degrade chitin into low molecular weight, soluble and insoluble oligosaccharides. Chitin is a modified polysaccharide found in a number of different organisms, for example in fungal cell walls and the hard outer skeletons of insects.

Chitinase is made up of 825 amino acids. Fig 2.1 shows the arrangement of some of the conserved amino acids found close together in the active site of chitinase. Fig. 2.2 shows the structure of a single chitinase molecule.

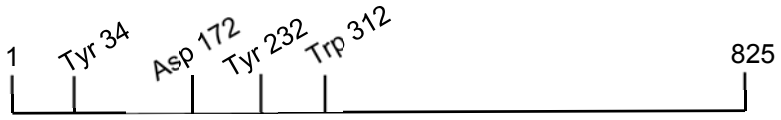


Fig. 2.1

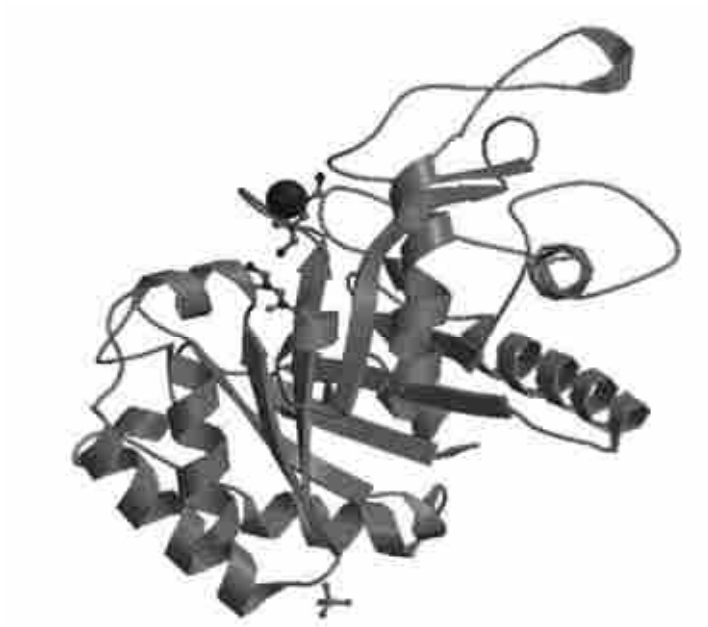


Fig. 2.2

(a) With reference to Fig 2.2, describe how the amino acid residues at different positions may be brought together when chitinase is synthesized.

1. Primary structure consisting of 825 amino acids joined together by peptide bonds; [1/2]
2. Is repeatedly coiled and folded;
3. to form secondary structures α- helices and β-pleated sheets respectively;
4. Held by hydrogen bonds formed between N-H group in a peptide bond of an amino acid and C=O group in a peptide bond of another amino acid.;
5. Secondary structures are then further coiled and folded to form tertiary structure;
6. Held by interactions + e.g. hydrogen bonds, disulphide bonds, ionic bonds and hydrophobic interactions between R-groups of amino acids;
7. give rise to specific three-dimensional structure of chitinase;

[3]

Chitin and the products of chitin hydrolysis have many useful medical and environmental applications. Chitinase enzymes can be used commercially to hydrolyse chitin. Enzyme stability and activity are important considerations in technological applications of chitinase.

Fig. 2.3 is a graph showing the effects of temperature on chitinase extracted from a soil bacterium. The relative activity of the enzyme was measured at different temperatures, with 100% representing maximum enzyme activity.

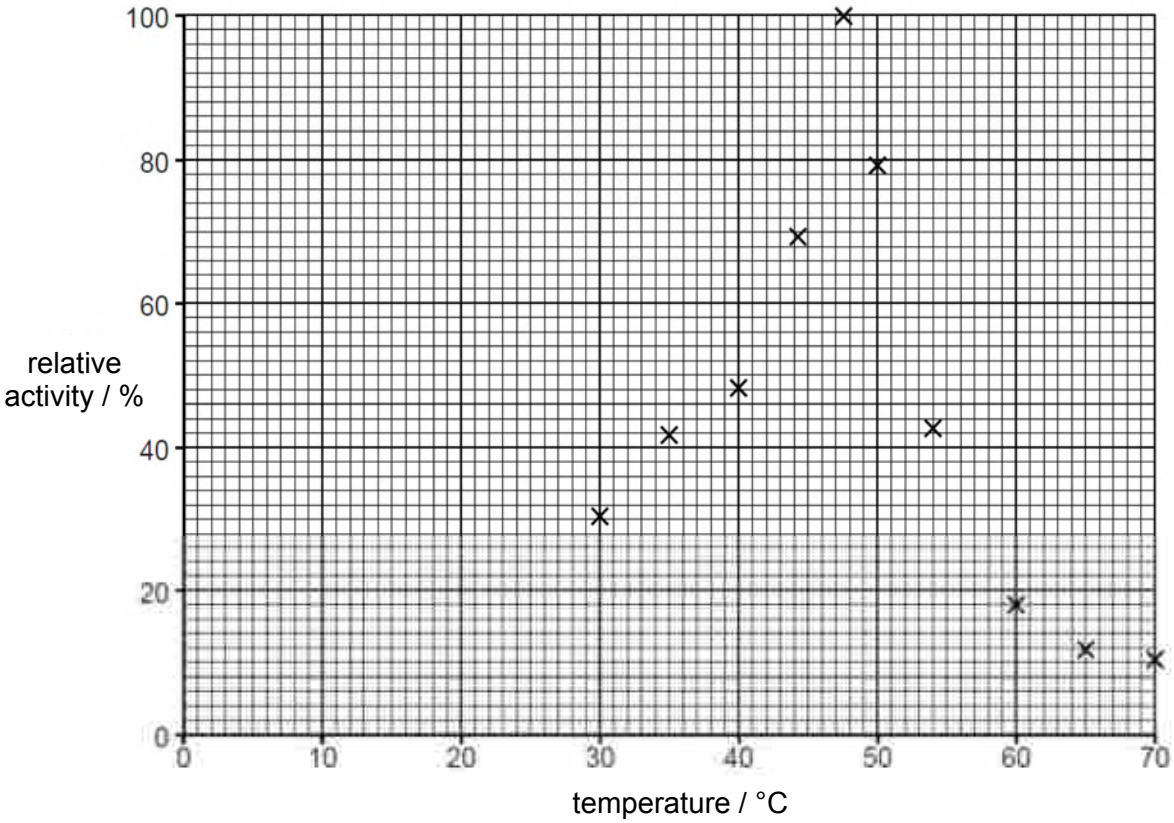


Fig. 2.3

(b) (i) With reference to Fig. 2.3, state the optimum temperature for the chitinase enzyme.

47.5 °C ;

[1]

Fig. 2.4 is a graph showing how temperature affects the stability of chitinase. The activity of the enzyme was measured over a time period of 72 hours at each of five different temperatures.

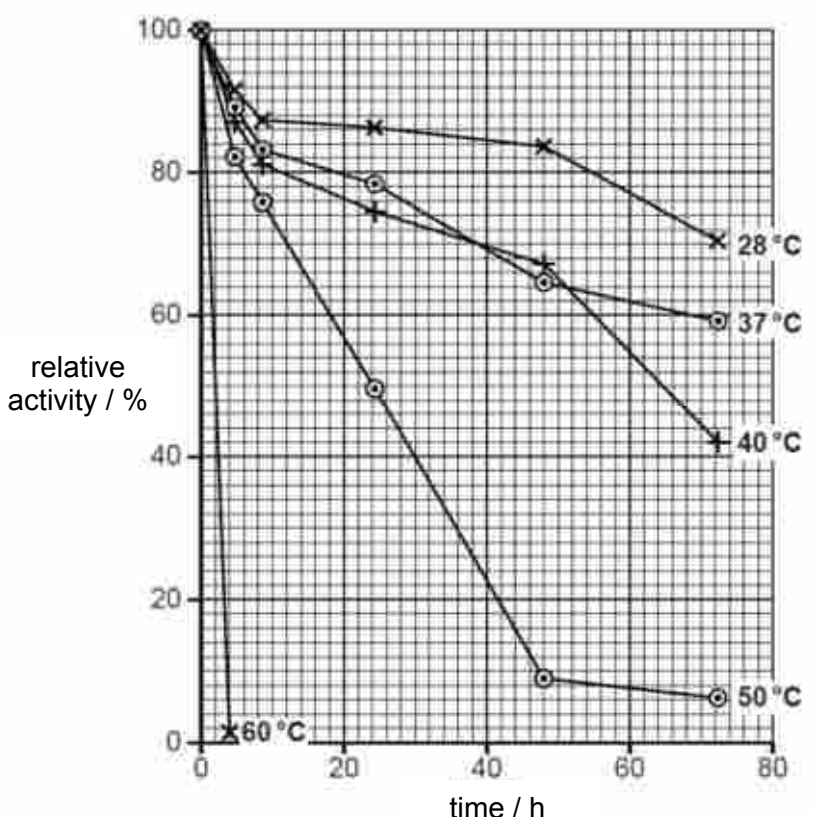


Fig. 2.4

(ii) With reference to Fig. 2.3 and Fig. 2.4, describe **and** discuss the effect of temperature on chitinase activity **and** stability.

accept activity for relative activity throughout

accept manipulated data quotes and penalise once for, incorrect / no, units

Describe [max 3]

Fig. 2.3 (relative activity of enzyme at different temperatures)

1 as temperature increases, activity increases up to, optimum / 47.5 °C (allow ecf from (i), then decreases ;

2 activity increases from 30 °C to 47.5 °C, then decreases to 70 °C ; also mp 1

or

increase <u>or</u> decrease, described with comparative data *(activity and temperature compared with another activity and temperature)*

3 at higher temperatures (compared to most others) enzyme still active ;

4 high optimum temperature (compared to most other enzymes) ;

Fig. 2.4 (stability over time for enzyme maintained at different temperatures)

5 enzyme becomes less stable over time ;

@ activity decreases over time

@ description if at least two temperatures described

6 data quote to support ; activity at two times for any one temperature

if time 0 or 'start', then assume 100% relative activity

if 100%, assume time 0

7 (over the time period) the lower the temperature, the more stable the enzyme ; ora

@ enzyme has higher activity at the lower temperatures

@ stated temperature**s** (at least two) to illustrate the point

e.g. 28 °C **higher** activity than 40 °C throughout

@ 28 °C, high**est** activity / enzyme most stable (throughout)

8 data quote to support ; *temperatures and (relative) activity (with one time)*

Discuss [2 marks]

9 e.g. Fig 2.3 reason for increasing activity up to optimum / decrease after optimum.

- freq of effective collisions, kinetic energy increase e.g. denaturation at 60–70 °C

® denaturation at 50 °C (but @ denaturation begins) [1/2]

- suggested reason for higher optimum temperature e.g. more bonds, more stronger covalent bonds [1/2]

Fig. 2.4

(suggests that) more molecules become, denatured / inactive, as time progresses

greater stability / higher activity, at 40 °C than 37 °C between 40–50 hours

Fig. 2.3 and 2.4

optimum temperature for activity not most stable temperature

steep decrease in stability at 60 °C in a short time as (nearly complete) denaturation occurs *(allow once only)*

commercial application e.g. if hydrolysis occurs over a longer time period, better to use a lower temperature than optimum [max 5]

---

[5]

[Total: 9]

3 In mice, fur colour is controlled by a gene with multiple alleles. These alleles are listed below in no particular order.

black and tan = C^{bt}	yellow = C^{y}
agouti = C^{a}	black = C^{b}

(a) Explain how multiple alleles arise.

gene mutation ;

a change in the, base(s) / nucleotide(s) ;

e.g. base, substitution / deletion / addition

[2]

(b) Suggest explanations for the results of the following crosses between mice.

(i) Mice with agouti fur crossed with mice with black fur may produce all agouti offspring **or** some agouti and some black offspring.

1 agouti allele / C^{a}, dominant to black allele / C^{b} ; ora

2 black parents homozygous recessive ;

3 agouti parents heterozygous **or** homozygous ;

[2]

(ii) Crosses between heterozygous parents with the genotype $C^{y}C^{b}$ always produce a ratio of two yellow mice to one black mouse.

1 yellow allele / C^{y}, dominant to, black allele / C^{b} ;

2 ref. to modified 3:1 ;

3 (homozygous) genotype C^{y} C^{y} , lethal / does not survive ;

[2]

(iii) Mice with yellow fur crossed with mice with black fur will produce one of the following outcomes:

- some yellow offspring and some agouti offspring
- some yellow offspring and some black and tan offspring
- some yellow offspring and some black offspring.

1 yellow allele / C^{y}, dominant to all others ;

2 agouti / C^{a} **or** black and tan / C^{bt}, allele, dominant to black allele ;

@ black allele recessive to all other alleles

3 yellow mice all heterozygous (must be stated) ;

[2]

(c) A test cross is used to determine the genotype of an organism.

Describe how you would carry out a test cross to determine the genotype of a black and tan mouse.

1 cross (black and tan mouse) with, black mouse / homozygous recessive mouse / C^b C^b ;

2 if **all** offspring black and tan then parent, C^{bt} C^{bt} / homozygous ;

3 if some offspring are black (and some are black and tan) then parent, $C^{bt}C^*$ / heterozygous ;

[2]

[Total: 10]

4 Global warming has changed both the thickness and surface area of sea ice of the Arctic Ocean as well as the Southern Ocean that surrounds Antarctica. Sea ice is highly sensitive to changes in temperature.

Scientists have calculated a long-term mean for the surface area of sea ice in the Arctic and in the Southern Ocean around Antarctica. This mean value is used as a reference to examine changes in ice extent. The graph Fig. 4.1 shows the variations from this mean (zero line) over a period of time.

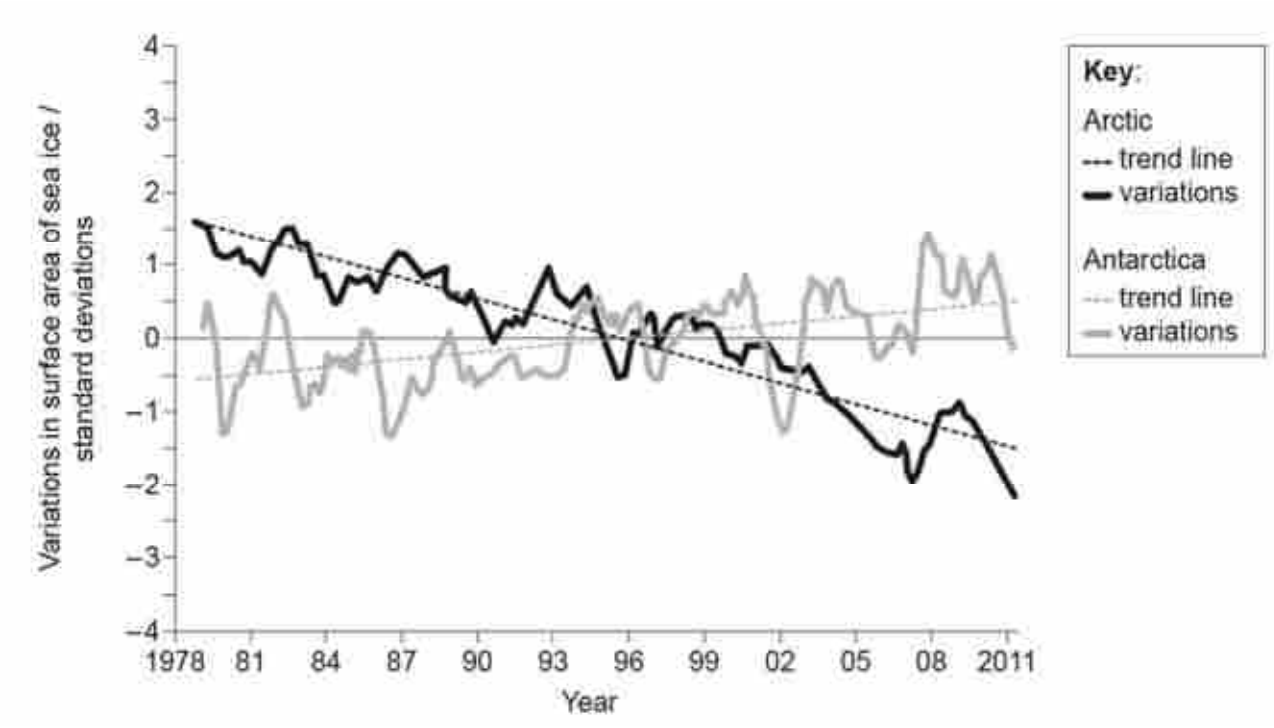


Fig. 4.1

(a) State the trend in the surface area of sea ice in the Southern Ocean around Antarctica.

increasing/positive trend/correlation;

[1]

(b) Distinguish between changes in the surface area of sea ice in the Arctic and Antarctica.

In the Arctic ocean the surface area of sea ice has declined whereas in Antarctica the surface area has increased;

it is acceptable if there is no comparative term such as "whereas" or "but";

the rate of change is greater for the Arctic than for Antarctica;

there are greater fluctuations in the surface area of sea ice in Antarctica than in the Arctic;

[2 max]

[2]

(c) Discuss the data as evidence of global warming.

a. change / decrease / melting of sea ice is expected with global warming;

b. decrease of sea ice in Arctic is supportive evidence of global warming;

c. increase in sea ice in Antarctic is not supportive evidence of global warming;

d. Antarctic increase / both changes may be associated with climate change (caused by global warming);

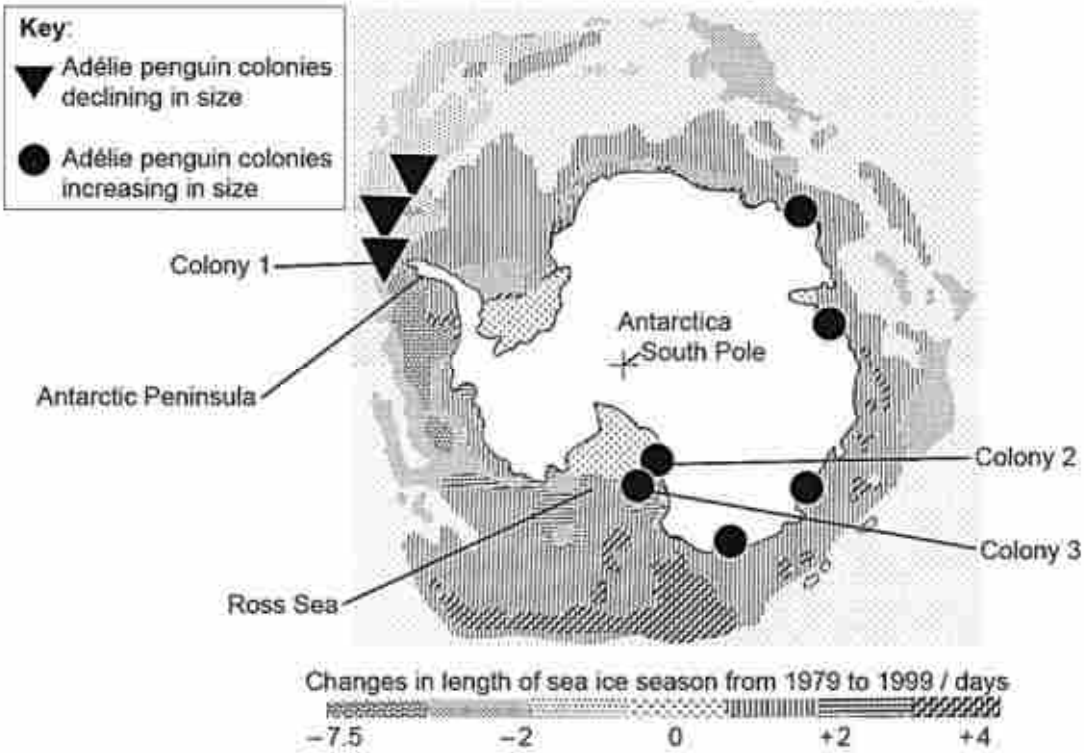
e. global warming does not affect all areas in the same way / global warming has complex effects;

f. data is inconsistent/inconclusive / data on its own does not establish cause and effect / not over a very long period of time;

[3 max]

[3]

Adélie penguins (*Pygoscelis adeliae*) are only found in Antarctica and need sea ice for feeding and nesting. Biologists are able to deduce how these penguins have responded to changes in their environment for the last 35 000 years, as the Antarctic conditions have preserved their bones and their nests. The image is a map of Antarctica and the surrounding Southern Ocean. It shows the trends in the length of the sea ice season (days of the year when sea ice is increasing) and the sites of nine Adélie penguin colonies.



[Source: Data sourced from the penguinscience.com website]

Fig. 4.2

(d) Describe the trends in the length of the sea ice season around the Antarctic Peninsula and in the Ross Sea.

One mark for correct description of the trend off the Antarctic Peninsula and

One mark for correct description for the Ross Sea;

accept correct statements other than those listed in the scheme but do not award a mark for contradictions; marks can be awarded for correct statements about the sea ice season for Antarctica overall;

Some students are referring to moving South in the Ross Sea when it is clear that they are moving North. If you can discern their intention, then give the BOD on this;

Antarctic Peninsula:

a. decrease/stable at the base of the peninsula / decrease in the area of the penguin colonies/West of the tip / increase/+1 above and below the peninsula / variable pattern;

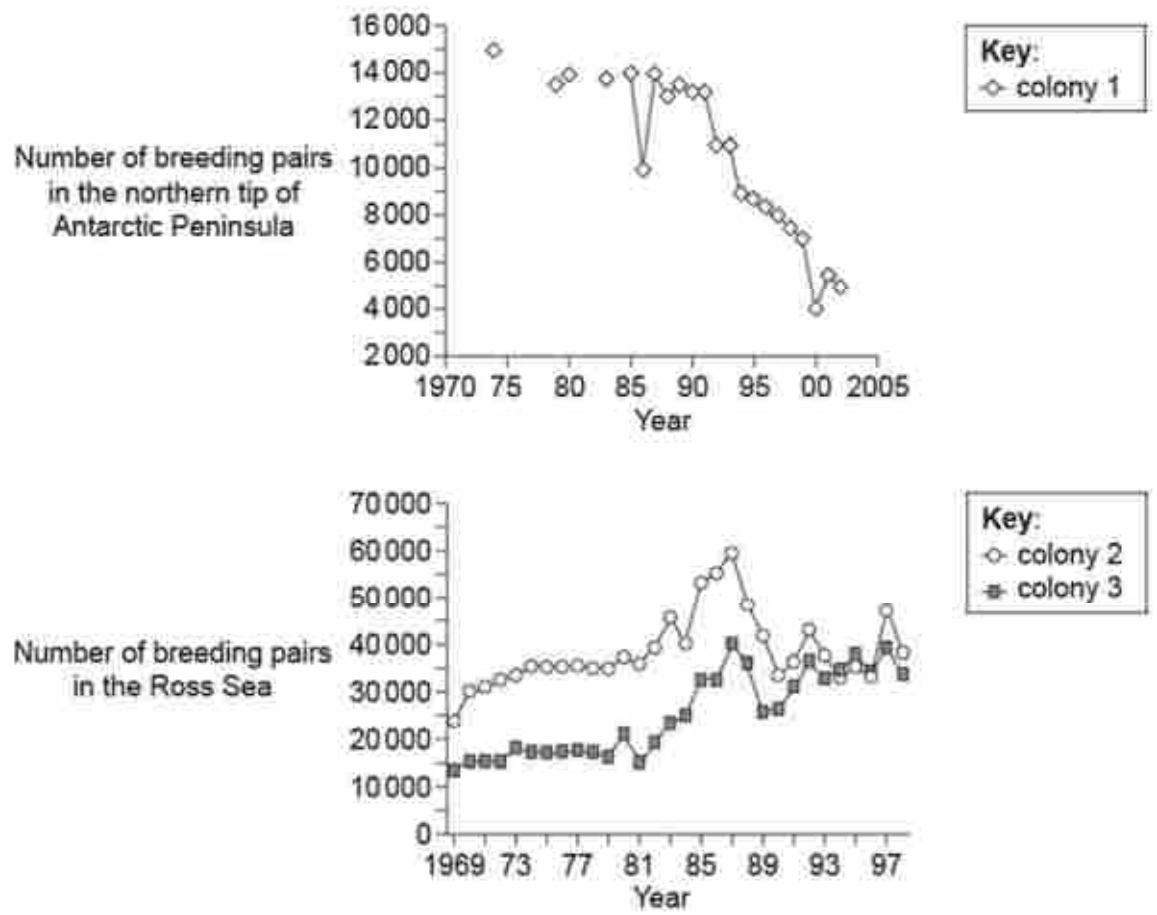
Ross Sea:

b. sea ice is increasing / +1 in the Ross Sea / area below / North of the Ross Sea

/ lower Ross Sea / Southern part of Ross Sea/closest to the South pole is stable/no change to the length of the sea ice season / variable pattern; [2 max]

[2]

The graphs show the changes in penguin population in three of the colonies shown on the map.



[Source: Data sourced from: www.penguinscience.com/clim_change.php]

Fig. 4.3

(e) Analyse the trends in colony size of the Adélie penguins in relation to the changes in the sea ice.

a. (off Antarctic Peninsula) sea ice season has declined as has penguin population;

b. colony 2 and 3 sea ice season has not declined and population increased;

c. colony 3 increase in population and growing length of **sea ice season**;

d. colony 2 has stable / increasing numbers and **sea ice season** is not changing;

e. colony size and sea ice season length/area are correlated;

f. Population numbers for colony 1 and 3 the same at start of study but both experience a big (opposite change);

[3 max]

[3]

(f) Discuss the use of Adélie penguins in studying the effects of global warming.

a. global warming leads to **climate / environmental change**; eg temperature change / ice melting

b. stable ice associated with stable population / no climate change;

c. ice changes associated with **population changes**;

d. changes in penguin population size can indicate climate change / global warming;

e. example of how climate change can alter population; eg prey availability / habitat loss;

f. not all species will be affected in the same way (so care needed in applying conclusions more widely)

g. there is information on changes of population over the past 35 000 years;

[3 max]

[3]

[Total: 14]

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

5 **(a)** Outline the structural differences between typical prokaryotic and eukaryotic cells and explain how it relates to differences in gene expression. [6]

(b) Explain, with examples, how environmental factors act as forces of natural selection. [9]

[Total: 15]

6 **(a)** Explain how organisms grown from genetically identical zygotes can have different phenotypes. [6]

(b) Charles Darwin proposed that evolution occurs primarily by natural selection. However deleterious recessive alleles are not eliminated from population. Describe and explain how these alleles remain in the population. [9]

[Total: 15]

5 (a) Outline the structural differences between typical prokaryotic and eukaryotic cells and explain how it relates to differences in gene expression. [6]

Structural differences	**Prokaryotes**	**Eukaryotes**
Presence of nucleus / nuclear membrane / nuclear envelope	No nuclear membrane. Genome exist in the nucleoid region	Have nuclear membrane, genome is enclosed within it
Size of genome	Smaller genome and smaller number of bases / smaller number of genes / coding regions.	More than one chromosome and larger <u>number</u> of chromosomes and <u>bases</u> / genome / larger number of genes / coding regions.
Level of compaction	Not as highly condensed as euk - form loop domains and undergoes further DNA supercoiling	Many levels of condensation of DNA - elaborate, multilevel system of DNA packing **to fit all the DNA into the nucleus** in preparation for cell division / 10 nm fiber to 30 nm chromatin fiber or solenoid to looped domain forming 300 nm

		fiber to metaphase chromosome.
Association with histone proteins	Non-histone proteins	DNA associated with histone proteins to form nucleosomes
Presence of introns	Absent	Present; interspersed between exons

Differences in gene expression:

1. Simultaneous transcription and translation can occur VS Absence of simultaneous transcription and translation. Transcription occurs within the nucleus and translation outside the nucleus in the cytoplasm.

2. No post-transcriptional modification VS need for post-transcriptional modification needed to produce mature mRNA for translation.

3. No RNA splicing VS need for RNA splicing to produce continuous coding sequence.

4. No alternative splicing, only one possible mRNA and protein product per gene VS introns which allows for alternative splicing → Different mature mRNA molecules and hence multiple protein variants are produced from the same gene.

5. mRNA is less stable / more easily degraded VS mRNA is more stable / less easily degraded.

5. Changes in chromosome structure not used as method to regulate transcription VS Rate of transcription is controlled by allowing for increased DNA condensation / conversion between euchromatin and heterochromatin states.

6. Fewer levels of control of gene expression VS more levels of control of gene expression.

7. QWC:
1 mark for relating **relevant** structural differences to differences in gene expression.

(c) Explain, with examples, how environmental factors act as forces of natural selection. [9]

For each example:
1 a **named example** of a species that has evolved in this way;
2 description/clear statement of the **change** that occurred in the environment / **Selection pressure**;
3 description/clear statement of **different varieties** (that existed at the same time);
4 **explanation** of/reason for one variant having a **selective advantage**;
5 the **change in the population/species** due to **natural selection/evolution**;

Example 1: Galapagos Finches (Darwin's finches)

1. For natural selection to occur, there must be **heritable variation** for a particular trait. In this case, it is the alleles of the gene which determine the size and depth of the beaks in Galapagos finches.
2. Give **e.g. of variation** - Some had large and heavy beaks adapted for eating large seeds, others for small seeds; some had parrot-like beaks for feeding o buds and fruits, and some had slender beaks for feeding on small insects. One used a thorn to probe for insect larvae in wood, like some woodpeckers do. (Six were ground-dwellers, and eight were tree finches.)
3. **Selection pressure: Limited food source**
4. The type of beak phenotype that is being **selected for** depends on the availability of the food source due to different environmental conditions or different habitats.
5. E.g. If small tender seeds are available at that island, finches with small beaks are at a **selective advantage** as it allows it to feed. If large hard seeds are available at that island, finches with large, more powerful beaks were **selected for / selective advantage**.
6. Individuals which are more adapted to surviving in a particular habitat will **survive to maturity, reproduce to produce viable offspring** and **pass on the beneficial alleles** to the next generation.
7. Hence there was **differential survival and reproductive success** associated with the possession of the particular beak type, therefore this leads to a change in **allele frequency** in a population for beak type.

Example 2: Soapberry bugs (*Jadera haematoloma*)

1. **Heritable variation** - beak length. Soapberry bugs feed most effectively when their beak length closely matches the depth at which the seeds are found within the fruit.

2. **Selection pressure: Change in food supply**

3. Food supply - the soapberry bug feeds on the seeds of a native plant, the balloon vine (*Cardiospermum corindum*). However in Central Florida, balloon vines have become rare and thus the soapberry bugs in this region feeds on the goldenrain tree (*Koelreuteria elegans*), a species that was introduced from Asia.

4. Seeds of the goldenrain tree fruit are much closer to the surface than seeds of the balloon vine. Therefore bugs with shorter beak lengths would be selected for by natural selection, as they would be able to feed on the seeds of goldenrain tree fruit, which are more widely available.

5. In Southern Florida where the balloon vine is more common, the seeds are found deeper within the fruit. Therefore bugs with longer beak lengths would be selected for by natural selection, as they would be able to feed on the seeds of balloon vine fruit, which are more widely available.

6 Individuals which are more adapted to feeding on the seeds of the plant at the specific region will survive to maturity, reproduce to produce viable offspring and pass on the beneficial alleles to the next generation.

7 Hence there was differential survival and reproductive success associated with the possession of the particular beak length, therefore this leads to a change in allele frequency in a population for beak length at that region. For central Florida, allele frequency for shorter beak length increased due to natural selection, over successive generations. For southern Florida, allele frequency for longer beak length increased due to natural selection, over successive generations.

Example 3: Evolution of drug-resistant bacteria (*MRSA: methicillin-resistant Staphylococcus aureus*)

Staphylococcus aureus/MRSA/*Clostridium difficile*/other named species;
Selection pressure: Use of methicillin antibiotic ;
some bacteria were resistant and others were not;
resistant bacteria survived (and multiplied) while non-resistant were killed;
percentage of the population showing resistance increased;

QWC:
At least 2 examples of natural selection including the respective type of environment factor acting as the force of natural selection.

[9] can be awarded if the candidate scores [5] for one example and [3] for the other.
Do not accept examples where the evidence of evolution comes from fossils, or where the variation is not heritable.
(Plus [1] for quality)

6 **(c)** Explain how organisms grown from genetically identical zygotes can have different phenotypes. [6]

Suggested introduction:
The **phenotype** of an organism refers to the observable characteristics of an individual (also accept: physical or chemical expression of the organism's genes) [1/2] while **genotype** refers to the genetic makeup of the organism or the alleles that an organism has [1/2]

Genotype is the ultimate factor determining a phenotypic expression but in some cases [1/2], the environment affects the level of expression of the genes / affects the subsequent expression of the genetic potential [1/2].

This is shown when genetically identical individuals develop differently in different environments. Hence, the expression of a phenotype is affected by interaction of genotype and environmental factors. [1/2]

1. Genetically identical zygote can be different due to wide range of environment effects;
2. idea that phenotype results from interaction of genotype and environment / The expression of genotype may be influenced by environment factors like nutrients, light, or temperature;
3. environment may, limit / modify, expression of gene(s) / AW ;
4. continuous variation example ; e.g. size / mass / height
5. due to environment factors; e.g. because, food / nutrients / ions, missing or malnutrition occurs
1. environment effect usually greater on polygenes ;
1. E.g. Fur colour in Himalayan rabbits is affected by a temperature-sensitive enzyme involved in pigment synthesis;
2. Low temperature can results in active enzyme that result in black pigment formation. Thus, Himalayan rabbit are black extreme parts of the body;
3. E.g. Phenotypes of honey bee (drones, queen or workers) are determined by the diet of larvae during development;
4. Royal jelly diet will give rise a queen bee;
5. Environment may induce mutation (affecting phenotype) / Spontaneous somatic mutation may occur and cause different phenotypes;

® meiosis / crossing over as gamete formation occurs before a zygote is formed.

Other named e.g.

Named example 1: Effect of environmental conditions (e.g. light) on plant development / height

(Height in plants)
- The height of a plant is genetically-determined [1/2] (e.g. Mendel's tall variety of the garden peas plant) but growth depends on adequate light, water and soil conditions [1/2]
- A reduction in the supply of any one condition prevent the gene for height from exerting its full potential [1]

(Chlorophyll synthesis in plants)
- Although the ability to synthesize chlorophyll is genetically determined [1/2], light is a requirement [1/2]
- Evidence: seeds grown in the dark; such plants exhibit etiolation (e.g. stems are long and thin; seedlings are yellow) [1]

(Floral colours in Hydrangea)
- Hydrangea may have different floral colours despite carrying the same alleles; [1/2]
- The soil acidity, in which the plants grow affects the plants' ability to take up aluminium; [1/2]
- In acidic soils (pH 5.5 or lower), aluminum assumes a form that is easily absorbed by plant roots, and thus flowers are predominately blue; [1/2]
- In soils where the pH is 6.5 or higher / alkaline, aluminum is unavailable and flower color is pink purple; [1]
- Sometimes a single plant will have both blue and pink flowers because of varying soil conditions around the plant; [1]

(Height of yarrow plants)
- Height is genetically determined; [1/2]
- Cuttings from the same plant have the same genotype but grow differently at different altitudes / elevations; [1/2]
- Cuttings from one plant grew tall at lowest and highest elevation; [1/2]
- But remained short at mid-elevation; [1/2]

Named example 2: Effect of temperature on development of animal
(max 2 marks)

(Wing development in fruit-flies)
- The allele for vestigial wing in Drosophila / "fruit-flies" is recessive to that for long wing [1/2]
- However individuals which are homozygous for this allele [1/2] will only express the vestigial wings at low temperatures [1/2]
- Reference to vestigial wings at 21oC; [1/2] intermediate wings (26oC); long wings (31oC) [1/2]

Named example 3: Effect of diet on development of human / animal
(max 3 marks)
(Phenylketonuria in humans)
- Diet affects traits such as height, weight and intelligence in humans [1/2]
- Phenylalanine is metabolized by phenylalanine hydroxylase [1/2]
- Individuals with two copies of the mutant recessive alleles (homozygous recessive condition) do not have functional enzyme [1/2] □ unable to break down the amino acid consumed through their diet [1/2] □ phenylalanine accumulates in their bodies [1/2] □ disease: phenylketonuria (PKU); mental retardation [1/2]
- Hence, these individuals need diet free from the particular amino acid [1/2]

(Reproductive system in honey bees)
- In a bee colony, the male bees or drones develop from unfertilized haploid eggs while the female bees develop from fertilized diploid eggs. [1/2]
- The worker bees are sterile while the queen bee is fertile
- Worker bees are smaller and have larger mouthparts and modified legs as compared to the queen bee; (they are phenotypically different even though genetically similar) ;
- The development of the female larvae to a queen bee or worker bee depends on the diet. [1/2]
- Once a particular female larva is selected to become the sexually mature queen bee, it is fed exclusively with royal jelly. [1/2]
- It is the high protein level in the royal jelly that stimulated the development of the female reproductive system. [1/2]
- Otherwise, it would be like the rest of the honey bee larvae which are fed royal jelly for the first few weeks after hatching (briefly) and then fed with a diet of honey and pollen. [1/2]

Named example 4: Effect of environment on development of human (max 3 marks)

(Pattern baldness in humans)
- male gender; premature pattern baldness due to an allele which is differentially expressed in the sexes; [1/2]
- both male homozygotes and heterozygotes develop bald patches; [1/2]
- only female homozygotes show balding; [1/2]
- expression of allele is probably triggered by testosterone; [1/2]
- females produce less of testosterone and thus seldom develop bald patches; [1/2]

(Skin colour in humans)
- exposure to the sun will result in the darkening of the skin / tanned skin;
- due to melanin production in cells;
- despite having an allele coding for fair skin;

(f) Charles Darwin proposed that evolution occurs primarily by natural selection. However deleterious recessive alleles are not eliminated from population. Describe and explain how these alleles remain in the population. [9]

Heterozygote protection/Diploidy

1. ***Heterozygote protection*/diploidy**** occurs in diploid organism with 2 copies of each gene
2. 2 different alleles at 1 gene locus where dominant allele determines the organism's phenotype/recessive allele remains hidden/masked
3. Recessive homozygote with unfavourable phenotype selected against/dominant phenotype selected for + heterozygotes survive
4. thus heterozygotes pass on recessive allele to offspring when heterozygotes propagate/interbreed maintaining recessive allele in population
5. e.g. Heterozygous condition hides recessive Hb^S allele that is less favourable from natural selection which only acts on sickle cell anaemia phenotypes
   any relevant example with details
   [cap at 4m for heterozygote protection]

Balancing selection

6. ***balancing selection**** where natural selection maintains two or more alleles at a gene locus (such as in heterozygote advantage and frequency dependent selection)

Heterozygote advantage

7. ***heterozygote advantage**** when individuals who are heterozygous at a particular locus have greater fitness than / selective advantage over / can survive and reproduce better than both kinds of homozygotes
8. Heterozygote is selected for with named e.g. in malaria prone regions, Hb^AHb^S do not suffer from negative effects/do not die of sickle cell anemia or more resistant to malaria
9. thus heterozygotes pass on recessive allele (Hb^S) to offspring when heterozygotes propagate/interbreed maintaining recessive allele in population
10. Both homozygotes are selected against with named e.g. Hb^SHb^S individuals will be disadvantaged due to serious effect of sickle-cell anaemia and Hb^A Hb^A will be susceptible to malaria.
    any relevant example with details

Frequency-dependent selection

11. ***frequency dependent selection**** is where the fitness/selective advantage of the phenotype depends on how common it is
12. the frequency of each phenotype oscillates over time but is kept close to 50%, thus maintaining both alleles
13. e.g. in Lake Tanganyika in Africa, there are two forms of the scale-eating fish i.e. left-mouthed and right-mouthed. The prey of the scale-eating fish guards itself against attack from whatever phenotype of scale-eating fish is most common in the lake. So from year to year, selection favours whichever mouth phenotype is least common.

Neutral mutations

14. ***Neutral mutations**** are those that do not undergo natural selection because when they are expressed, they do not confer a selective disadvantage or advantage to the individual/do not affect fitness/selectively neutral
15. They can occur as a result of: (any 1)
    - ***Silent mutations**** where despite a mutation, the same amino acid is coded for, so no change in protein structure and function
    - ***Conservative substitution**** where mutation codes for another chemically similar amino acid resulting in no change in protein structure and function
    - Mutations in non-regulatory sequences in non-coding regions/mutations that do not fall within regulatory sequences resulting in no change in protein function and quantity of protein produced

MERIDIAN JUNIOR COLLEGE
JC2 Preliminary Examination 2018
Higher 1

CANDIDATE NAME									
CIVICS GROUP	1	7					INDEX NUMBER		

H1 BIOLOGY 8876/01

Paper 1 Multiple Choice **20 September 2018**
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid/tape.
Write your name, civics group and index number on the Multiple Choice Answer Sheet provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the Multiple Choice Answer Sheet.

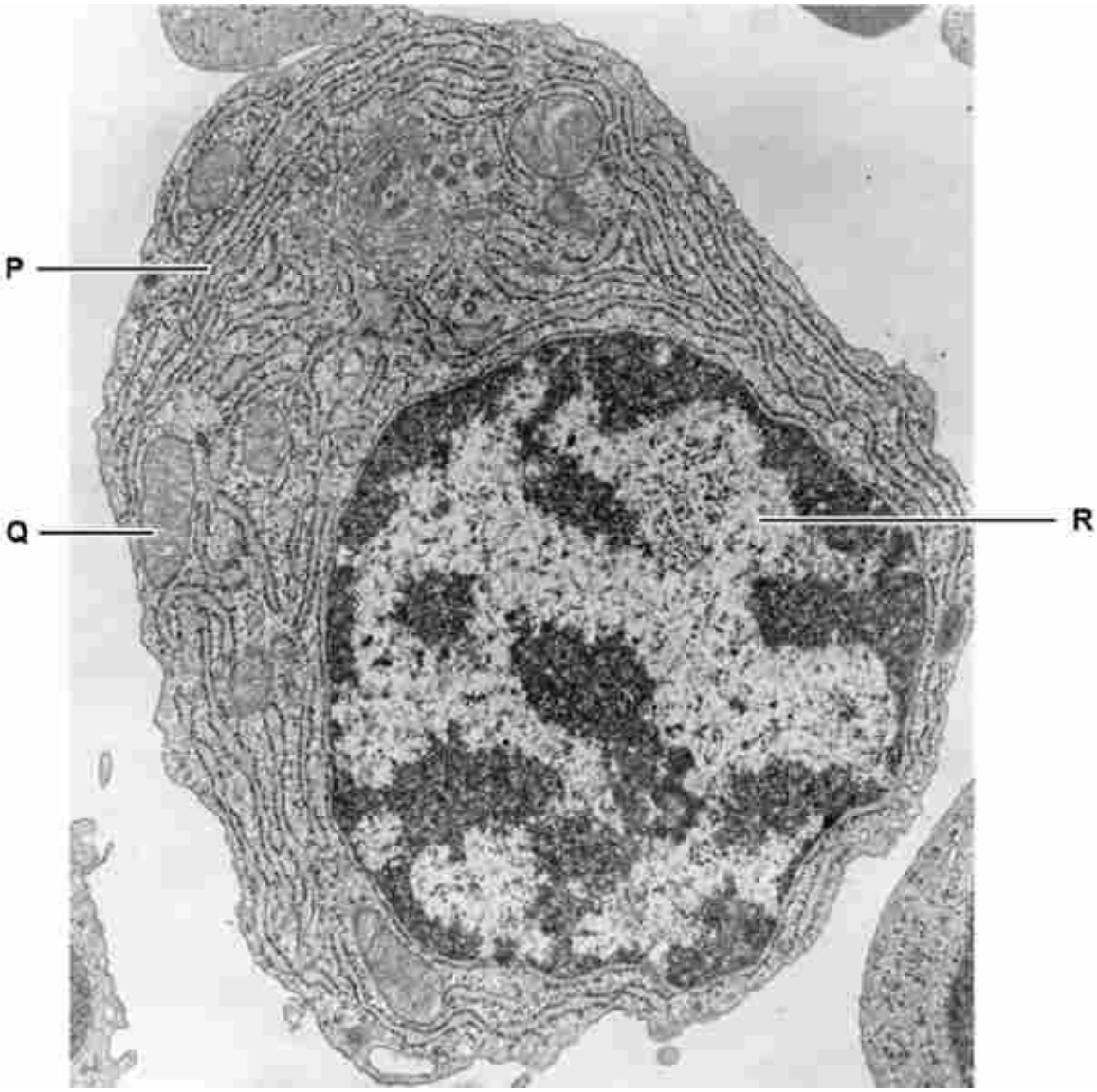
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

At the end of the examination, you may bring home Paper 1 question paper.

This document consists of **15** printed pages.

[Turn over]

QUESTION 1
The diagram shows an electron micrograph of a cell.



Which row correctly describes structures **P** – **R**?

	P	Q	R
A	synthesis of ribosomes	substrate level phosphorylation	active replication of genes
B	provision of large surface area for attachment of ribosomes	formation of ATP from light energy	active transcription of genes
C	synthesis of membrane proteins	oxidative decarboxylation	active transcription of genes
D	transport of proteins to Golgi apparatus	modification of mRNA transcripts	active replication of genes

QUESTION 2
A ribosome consists of a large and a small subunit, each subunit containing ribosomal RNA (rRNA) complexed with proteins.

Which sequence of events concerning ribosomes is correct?

A Within the nucleolus, rRNA and proteins are synthesised and subunits are formed. They become membrane bound as they are exported through the nuclear envelope to the cytoplasm and rough endoplasmic reticulum (rER).

B rRNA and proteins are synthesised in the Golgi body and are transported to the nucleolus for subunit formation.

C rRNA is synthesised in the nucleolus and proteins are synthesised by the rough endoplasmic reticulum (rER). Subunit formation occurs within the cytoplasm for free ribosomes and on the surface of the rER for attached ribosomes.

D rRNA synthesised within the nucleolus is complexed with proteins that have been imported from the cytoplasm. The subunits formed are exported to the cytoplasm via the nuclear pores.

QUESTION 3
Which two features contribute to the great tensile strength of cellulose?

1 glycosidic bonds linking the long chains of 1,4 α-glucose molecules

2 the –OH groups of the glucose molecules project outwards and form hydrogen bonds with neighbouring chains

3 the strength of the glycosidic bonds between the neighbouring chains of molecules

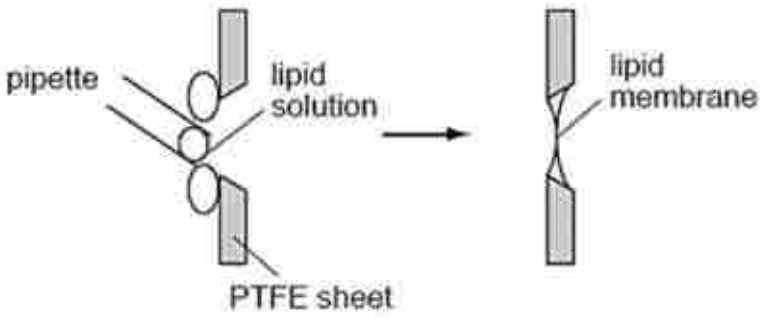
4 the successive glucose molecules are orientated at 180° to each other

A 1 and 3 only **B** 1 and 4 only **C** 2 and 3 only **D** 2 and 4 only

QUESTION 4
Lipid membranes can be formed in the laboratory by painting phospholipids over a PTFE sheet with a hole in it.

Such a lipid membrane is impermeable to water-soluble materials including charged ions such as Na^+ or K^+.

In one experiment with Na^+ ions, Na^+ ions did not flow across the membrane until a substance called gramicidin was added.



Which statement is consistent with this information and your knowledge of membrane structure?

Gramicidin becomes incorporated into the membrane and is

A a carbohydrate molecule found only on the outside of the membrane.

B a non-polar lipid which passes all the way through the membrane.

C a protein molecule with both hydrophilic and hydrophobic regions.

D a protein molecule which has only hydrophilic regions.

QUESTION 5
A symbiont may be defined as a species in which individuals live in a long-term, intimate and beneficial relationship with hosts of a different species. As the name suggests, endosymbionts live within their hosts.

Which statement provides the strongest evidence that mitochondria and chloroplasts in eukaryotes originated as prokaryotic endosymbionts?

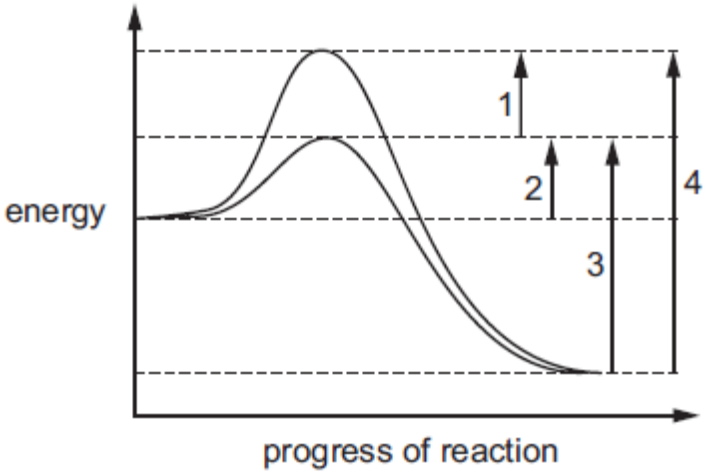
A Proteins encoded by the nucleus are exported to these organelles.

B Their inner membrane has a different structure from other intracellular membranes.

C They are surrounded by a double membrane.

D They contain their own DNA and have 70S, rather than 80S, ribosomes.

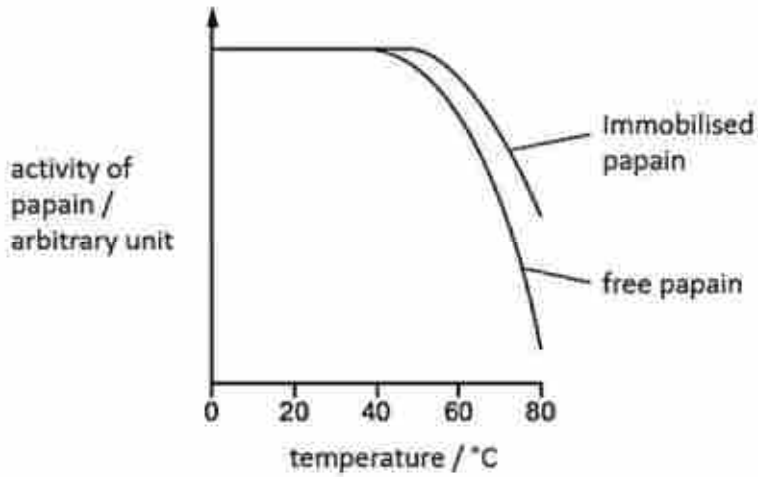
QUESTION 6
The graph shows energy changes in a chemical reaction.



What is the activation energy when an enzyme is added?

A 1 + 2 **B** 2 only **C** 3 – 2 **D** 4

QUESTION 7
The graph compares the effect of temperature on the activity of the protease enzyme, papain, when in solution (free) and when immobilised in alginate beads.



Which statement about the effect of immobilisation of papain is correct?

A It increases the stability of papain at higher temperatures.

B It alters the shape of papain's active site at higher temperatures.

C It decreases the activity of papain at higher temperatures.

D It reduces the number of collisions of papain with the substrate.

QUESTION 8
The table contains results recorded by a student from an investigation into the effect of temperature on an enzyme-catalysed reaction. All other variables were standardised.

temperature / ˚C	rate of reaction / arbitrary units
10	3
20	7
30	16
40	33
50	32
60	14

What can be best concluded from the results?

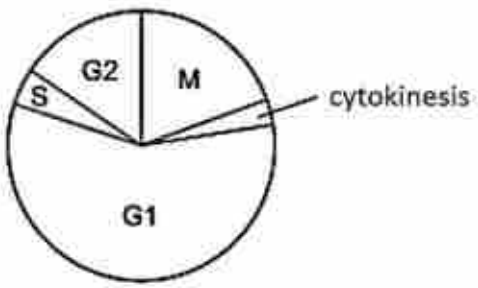
A The enzyme had the highest kinetic energy at 40˚C.

B The data for 50˚C was anomalous.

C The optimum temperature was between 30˚C and 50˚C.

D The enzyme was held by only disulfide bonds at 60˚C.

QUESTION 9
The diagram shows the cell cycle of a mammalian cell.



Checkpoints in the cell cycle of mammals prevent the cycle from continuing when mistakes are made or DNA is damaged.

Four of the checkpoints are described.

1 Mitosis is blocked if DNA replication is incomplete.

2 Anaphase is blocked if the assembly of chromatids on the spindle is unsuccessful.

3 DNA replication is blocked if DNA is damaged.

4 DNA replication stops if damage to DNA has not been repaired.

In which phases of the cell do these checkpoints occur?

	checkpoint			
	1	2	3	4
A	M	G1	S	G2
B	G2	M	G1	S
C	G2	S	G1	M
D	S	G2	M	G1

QUESTION 10
Which statement helps to explain how genetically identical cells are produced during the mitotic cell cycle?

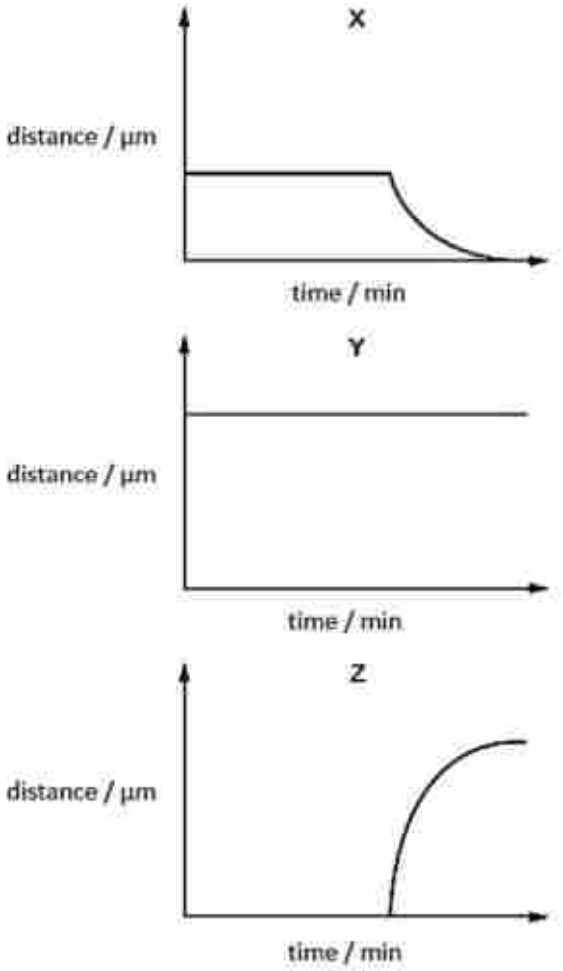
A There is only one origin of replication, which ensures that DNA replication begins at a controlled site.

B Checkpoints of cell division are carefully regulated.

C Complementary base pairing occurs during DNA replication.

D RNA polymerase can correct some mistakes during transcription.

QUESTION 11
The graphs show various distance measurements taken from metaphase of mitosis onwards. The graphs are to scale when compared to one another.



Which row correctly identifies the distance measurement for each graph?

	X	Y	Z
A	distance between poles of spindle	distance between sister chromatids	distance of centromeres from poles of spindle
B	distance between poles of spindle	distance of centromeres from poles of spindle	distance between sister chromatids
C	distance of centromeres from poles of spindle	distance between poles of spindle	distance between sister chromatids
D	distance of centromeres from poles of spindle	distance between sister chromatids	distance between poles of spindle

QUESTION 12
Which molecules are found in both cytoplasm and the nucleus of a typical eukaryotic cell?

1 DNA nucleotides

2 DNA polymerase

3 RNA nucleotides

4 RNA polymerase

A 1, 2, 3 and 4 **B** 1, 2 and 4 only **C** 2, 3 and 4 only **D** 3 and 4 only

QUESTION 13
Two polynucleotide strands make up a DNA molecule.

What is a correct description?

A The percentage of cytosine is 50% of that of guanine in the whole molecule.

B The percentage of cytosine is the same as that of guanine in each strand.

C The percentage of cytosine is the same as that of guanine in the whole molecule.

D The percentage of cytosine is the same in each strand of the molecule.

QUESTION 14
Which of the following statements explain the difference in the direction in which the two strands of a DNA molecule are synthesised?

1 The replication of DNA is semi-conservative.

2 DNA polymerase can only add deoxyribonucleotides to the 3'OH group.

3 Each DNA molecule consists of two anti-parallel polynucleotides.

4 The synthesis of the lagging strand requires many more RNA primers.

A 1 and 2 only **B** 2 and 3 only **C** 1, 2 and 4 only **D** 2, 3 and 4 only

QUESTION 15
Scientists have made a nucleic acid (HNA) that has a sugar with the same number of carbon atoms as glucose instead of deoxyribose. Although genetic information can be stored by HNA, naturally occurring DNA polymerase cannot replicate HNA.

Which statements could explain why naturally occurring DNA polymerase cannot replicate HNA?

1 DNA polymerase cannot form bonds between the sugars of two HNA nucleotides.

2 DNA polymerase cannot form hydrogen bonds between two HNA nucleotides.

3 HNA nucleotides do not fit into the active site of naturally occurring DNA polymerase.

4 The shape of an HNA nucleotide is slightly larger than that of a DNA nucleotide.

A 3 and 4 only **B** 1 and 4 only **C** 2 and 3 only **D** 1, 2, 3 and 4

QUESTION 16
Some RNA molecules, called ribozymes, can catalyse reactions in a similar way to protein enzymes.

Most of these ribozymes have other RNA molecules as their substrates and catalyse reactions that break specific sugar phosphate bonds in the substrate molecules.

Which statements about these ribozymes are correct?

1 Hydrogen, ionic and disulfide bonds will be involved in the ribozyme structure.

2 The active site of a ribozyme is formed from a specific sequence of nucleotides.

3 Ribozymes can be formed because RNA can have a specific three-dimensional conformation.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

QUESTION 17
The codons UGU and UGC code for the amino acid cysteine, which can form disulfide bonds in a polypeptide.

The codon UGG codes for the amino acid tryptophan, which does not contain a sulfur atom.

The codon UGA is a stop signal.

The DNA triplet code for the 10th amino acid in a particular polypeptide is ACA.

Which single base substitutions in this triplet code will result in **no** disulfide bond being formed with the 10th amino acid in the polypeptide?

A ACC and ACG

B ACG and ACT

C ACT and ACC

D ACT only

QUESTION 18
Exceptions to the universal genetic code are found in mammalian mitochondria, as shown in the table.

mRNA codon	in mammalian cytoplasm, codes for	in mammalian mitochondria, codes for
AGA	arginine	stop
AGG	arginine	stop
AUA	isoleucine	methionine
UGA	stop	tryptophan

A short length of DNA triplet code with the following base sequence was transcribed.

TATTCTTCCACT

How many peptide bonds would be formed by ribosomes during translation in mammalian cell cytoplasm and in mammalian mitochondria?

	mammalian cell cytoplasm	mammalian mitochondria
A	2	1
B	2	0
C	3	0
D	3	1

QUESTION 19
Which statement(s) describe(s) how a gene mutation can lead to the production of a non-functional protein?

1 During transcription an incorrect nucleotide is added to a DNA molecule.

2 A codon in the mRNA transcribed from the mutated gene is changed.

3 The order of the bases in an anticodon on tRNA is altered during translation.

4 The sequence of nucleotides in the promoter of the gene is altered.

A 2 only **B** 1 and 2 only **C** 2 and 4 only **D** 2, 3 and 4 only

QUESTION 20
The following discoveries were made about myostatin, a protein that is produced in mammalian skeletal muscle cells.

- Myostatin circulates in the blood and acts on muscle tissue to slow down further differentiation and growth of muscle cell precursors called myoblasts.
- In racehorses that were bred true, a mutation involving the substitution of a single nucleotide has been identified in the *MSTN* gene which codes for myostatin.
- At the site of this mutation, the DNA nucleotide has either a cytosine (C) base or a thymine (T) base, giving race horses three possible genotypes for this mutation: CC, CT or TT.
- At two years of age, racehorses with the *MSTN* CC genotype have greater muscle mass than those with the TT genotype.

Which of the following statements may be best concluded from the above?

A Racehorses with the CC genotype contain hyperactive myostatin protein in their muscle tissue.

B In racehorses with the CC genotype, there is a change in the reading frame of the mRNA codon from the site of the mutation.

C All racehorses with the CC genotype are able to run faster than those with the CT and TT genotype.

D Racehorses with the TT genotype develop more muscles later in life.

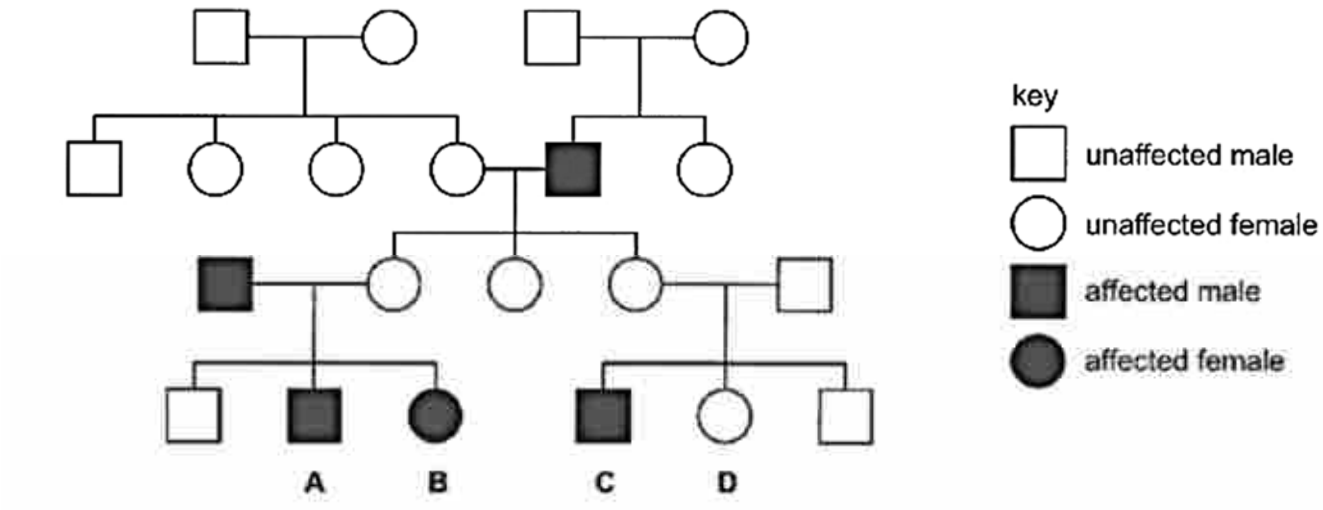
QUESTION 21
The Himalayan variety of rabbits has white hair on the body and black hair on the feet, tail, ears and face. The allele for the Himalayan rabbit pigment pattern, c^h, is recessive to the alleles for normal colour (all hair agouti), C, as well as dark chinchilla (all dark grey hair), c^{chd}, and is dominant to the allele for albino (all white hair, no pigment production), c. All of the alleles of this gene produce different versions of the same enzyme involved in pigment production.

A patch of white fur was removed from a Himalayan rabbit and an ice pack secured to the skin. The fur that grew back on the patch was black.

Which of the following statements is correct?

	Genotypes of Himalayan rabbits	**Explanation for pigment pattern in Himalayan rabbits**
A	c^hc^h only	The enzyme is denatured at the high skin temperatures found on the rabbits' bodies
B	cc only	The enzyme becomes inactive at the low skin temperatures found on the rabbits' feet, tail, ears and face
C	c^hc^h and c^hc only	The enzyme is denatured at the high skin temperatures found on the rabbits' bodies
D	c^hc^h and c^hc only	The enzyme becomes inactive at the low skin temperatures found on the rabbits' feet, tail, ears and face

QUESTION 22
The pedigree diagram shows the inheritance of an X-linked recessive trait in humans.
If the recessive allele is r, which individual possesses the genotype rr?



QUESTION 23
Uncontrolled cell division can form tumours.

Which statement is correct for tumour cells **only**?

A Metaphase does not take place.

B Cytokinesis does not occur.

C Interphase takes less time.

D They have mutated DNA.

QUESTION 24
What are the products of glycolysis?

1 pyruvate

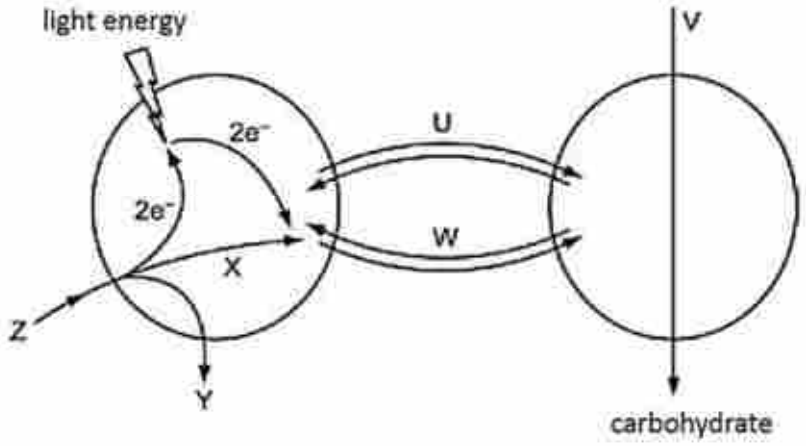
2 reduced FAD

3 reduced NAD

4 reduced NADP

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

QUESTION 25
The diagram summarises the reactions of photosynthesis in a plant.



Which of the following correctly identifies the substances involved?

	CO_2	reduced NADP	H_2O	ADP	2H	O_2
A	U	W	Y	V	Z	X
B	U	X	Z	W	Y	Z
C	V	U	Z	W	X	Y
D	V	W	Y	U	X	Z

QUESTION 26
Some apples can be stored in controlled atmospheric conditions for up to a year. Taste and texture are maintained by using conditions that reduce the production of a fruit-ripening plant hormone while limiting the build-up of ethanol. Ethanol damages the fruit.

The storage conditions needed include low temperature (1˚C), high carbon dioxide concentration (1.2%) and low oxygen concentration (0.9%).

Why are these conditions needed?

1 Low oxygen concentration favours anaerobic respiration.

2 Enzyme activity is reduced.

3 Conversion of sugar to ethanol is minimised.

4 High carbon dioxide concentration promotes photosynthesis.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 2 and 3 only **D** 3 and 4 only

QUESTION 27
Which of the following describe processes that lead to an increase in variation?

1 breaking and re-joining in homologous chromosomes during prophase I of meiosis

2 random distribution of homologous chromosomes to the cell poles during anaphase I of meiosis

3 random variation in allele frequency with time that may result in alleles becoming more common

4 the production of new alleles by substitution of one base for another in DNA

A 1 and 4 only **B** 2 and 3 only **C** 1, 2 and 4 only **D** 1, 3 and 4 only

QUESTION 28
The skin of a small amphibian contains a substance, tetrodotoxin (TTX), that is deadly to all predators except the common garter snake. TTX acts by blocking membrane ion channels involved in muscular movement. Some of the garter snakes slow down for a few hours after eating the amphibian, but are not otherwise harmed.

Some variants of the amphibian have higher toxicity because of higher TTX production, while some variants of the garter snake have higher resistance. Where snakes have not been exposed to TTX, the snake variants with higher resistance have been observed to move more slowly than those with normal resistance.

From the information provided above, what is **not** a valid suggestion concerning natural selection and evolution in the amphibian and the garter snake?

A A selection pressure acting against the garter snake with higher resistance is the amphibian variant with normal toxicity.

B Locations with the most toxic amphibian variants are likely to have the most resistant garter snake variants.

C Predation by garter snakes is the selection pressure for increasing toxicity of the prey; the selection pressure acting against the most resistant garter snakes is predation.

D TTX resistance is likely to involve a mutation in the gene coding for the membrane ion channels.

QUESTION 29
By which mechanism do greenhouse gases contribute to global warming?

A Their higher concentration absorbs more long wave radiation coming from the sun.

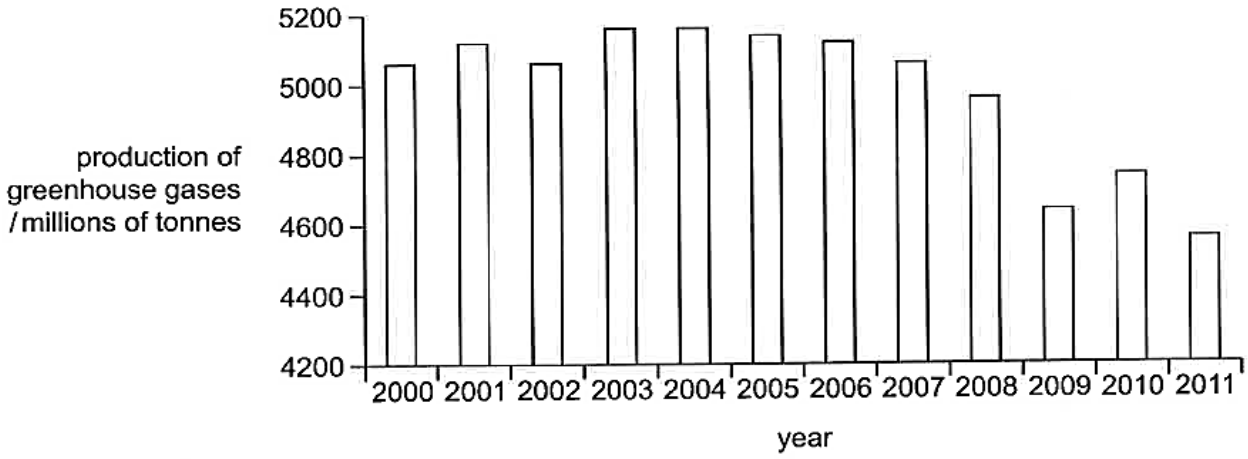
B Short wave radiation emitted from the Earth's surface increases with their concentration.

C They absorb higher amounts of long wave radiation emitted from the Earth's surface as their concentration increases.

D They absorb higher amounts of short wave radiation caused by increased combustion of fossilized organic matter.

QUESTION 30

The bar chart shows the production of greenhouse gases (carbon dioxide and methane) from agriculture in the European Union (EU) from 2000 to 2011, measured in millions of tonnes.



Which of the following could contribute to the trend seen between 2003 and 2009?

A conversion of intensive farmland into woodland reserves

B greater use of agricultural machinery for harvesting

C increased consumption of meat-based products

D increased import and export of crops between EU countries

End of Paper

H1 Biology Prelim Paper 1 Answers

1. C	**6. B**	**11. C**	**16. D**	**21. C**	**26. C**
2. D	**7. A**	**12. A**	**17. C**	**22. B**	**27. C**
3. D	**8. C**	**13. C**	**18. B**	**23. C**	**28. A**
4. C	**9. B**	**14. B**	**19. A**	**24. B**	**29. C**
5. D	**10. C**	**15. A**	**20. D**	**25. C**	**30. A**

MERIDIAN JUNIOR COLLEGE
JC2 Preliminary Examination 2018
Higher 1

CANDIDATE NAME	

CIVICS GROUP	1	7				

INDEX NUMBER		

H1 BIOLOGY 8876/02

Paper 2

12 September 2018
2 hours

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, civics group and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **ONE** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/ 9
2	/ 10
3	/ 11
4	/ 15
Section B	
5 or 6	/ 15
Total	/ 60

This document consists of **14** printed pages

[Turn over]

Section A

Answer **all** questions in this section

QUESTION 1

(a) Distinguish the processes of facilitated diffusion and active transport. [3]

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(b) A group of students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

- Group **A** plants had a substance that inhibited respiration added to the solution.
- Group **B** did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in Fig. 1.1.

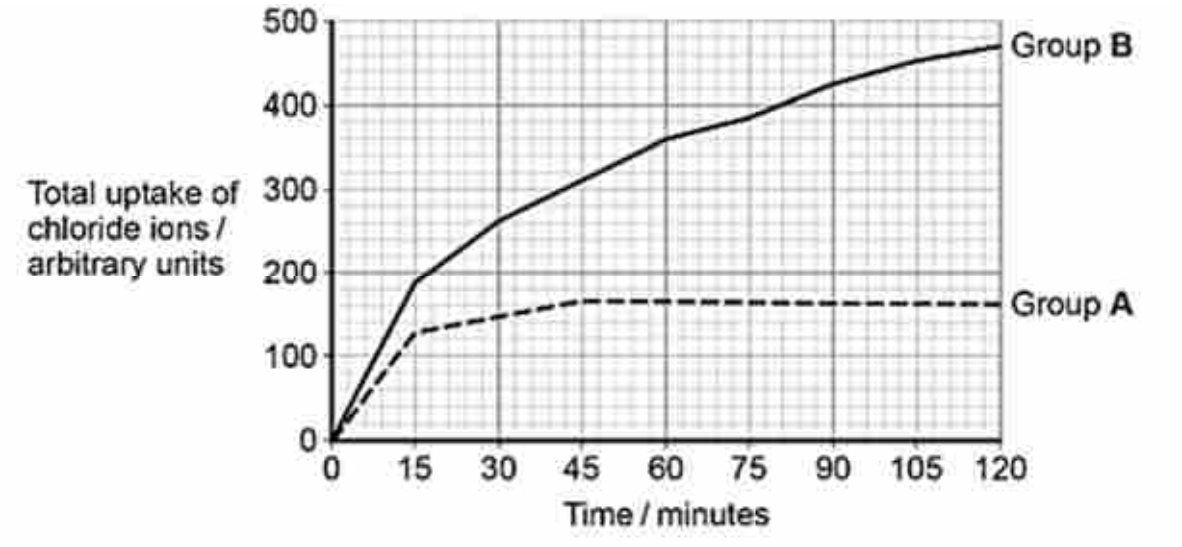

Fig. 1.1

(i) Calculate the ratio of the **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants. [2]

(ii) Explain the results shown in Fig 1.1. [4]

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[Total: 9]

QUESTION 2

Bone marrow contains many stem cells. Some of these stem cells are responsible for the replacement of white blood cells.

Fig. 2.1 shows the production of a white blood cell from one of these stem cells.

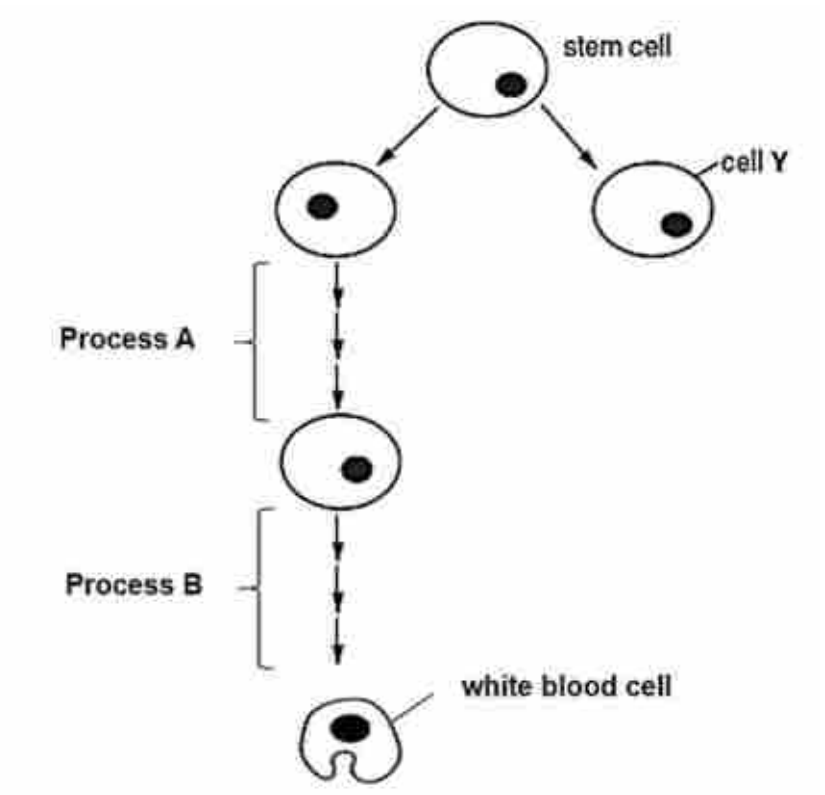

Fig. 2.1

(a) (i) State the potency of the stem cells found in the bone marrow. [1]

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(ii) Name the processes **A** and **B**. [2]

A ……

B ……

(iii) Suggest what may happen to cell **Y**. [1]

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The human induced pluripotent stem cells (HiPS cells) can be derived from fully differentiated adult somatic cells such as white blood cells. This has been hailed as an effective replacement for human embryonic stem cells for its usefulness in regenerative medicine.

Recent research shows that abnormal reprogramming can occur during the induction of HiPS cells and tumours could be generated.

(b) (i) Compare the embryonic stem cell and HiPS cell. [3]

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(ii) Comment on the ethical issues involved in the use of HiPS cells. [3]

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[Total: 10]

QUESTION 3

In mice, fur colour is controlled by a gene with multiple alleles. These alleles are listed below in no particular order.

black and tan = C^{bt}	yellow = C^{y}
agouti = C^{a}	black = C^{b}

(a) Explain the term *multiple alleles*. [2]

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(b) Crosses between heterozygous parents with the genotype $C^{y}C^{b}$ always produce a ratio of two yellow mice to one black mouse. Explain the observation using a genetic diagram. [3]

(c) Suggest explanations for the results of the following crosses between mice.

(i) Mice with agouti fur crossed with mice with black fur may produce all agouti offspring **or** some agouti and some black offspring. [2]

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(ii) Mice with yellow fur crossed with mice with black fur will produce one of the following outcomes:

- some yellow offspring and some agouti offspring
- some yellow offspring and some black and tan offspring
- some yellow offspring and some black offspring. [2]

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(d) A test cross is used to determine the genotype of an organism.

Describe how you would carry out a test cross to determine the genotype of a black and tan mouse. [2]

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[Total: 11]

QUESTION 4

Malaria is a mosquito-borne infectious disease caused by the malarial parasites, *Plasmodium falciparum*, which is transmitted among humans by the female mosquito vectors *Anopheles*.

(a) Outline the general life cycle of a mosquito. [3]

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Malaria was common in Italy, a European country situated in the Northern Hemisphere. Widespread land drainage together with the use of the insecticide DDT and the drug chloroquine eradicated both the mosquito vectors and the malarial parasites in the 1950s. Due to the success of these measures, they were later discontinued as they were no longer necessary.

Articles in the scientific literature more recently show that malarial mosquitoes are returning to Italy and increasing their numbers and their northerly range, with some cases of malaria being reported. In general, winters are milder and summers are hotter in the south of the country, with temperatures decreasing to the north, especially in the winters.

(b) Discuss whether the return of malaria to Italy can be attributed to climate change. [4]

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(c) Chloroquine-resistant (CQR) malarial parasites, *P. falciparum,* were first reported in 1950s and are now widespread. The resistance is caused by mutations of a gene known as *pfcrt*.

(i) Explain why CQR *P. falciparum* are now widespread. [3]

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Analysis of *pfcrt* in CQR *P. falciparum* from different parts of the world shows differences in one section of the gene only. The amino acid sequences coded for by this section are shown in Table 4.1, together with the amino acid sequence coded for by the allele found in parasites that are still susceptible to chloroquine (non-CQR). The amino acid sequence coded for by the rest of the gene is the same in all cases.

Table 4.1

allele of *pfcrt* gene	amino acid sequence coded for by allele of *pfcrt* gene
non-CQR	—Cys—Met—Asn—Lys—His—Ala—Glu—Asn—Ile —Met—
CQR from Africa	—Cys—Ile —Glu—Thr—His—Ser—Glu—Ser—Ile —Ile —
CQR from Asia	—Cys—Ile —Glu—Thr—His—Ser—Glu—Ser—Thr—Ile —
CQR from Peru and Brazil	—Ser—Met—Asn—Thr—His—Ser—Gln—Asp—Leu—Arg—
CQR from Colombia	—Cys—Met—Glu—Thr—Gln—Ser—Gln—Asn—Ile —Thr—

(ii) With reference to Table 4.1, calculate the mean number of different amino acids coded for by CQR alleles in comparison with the non-CQR allele. Show your working. [2]

mean number of different amino acids ……..

In the non-CQR *P. falciparum*, chloroquine accumulates in the digestive vacuole of *P. falciparum* and interferes with the detoxification of haem in the host red blood cell. This results in parasite death.

Research shows that there is a point mutation in the *pfcrt* gene of CQR *P. falciparum* which leads to the formation of a chloroquine-resistance transporter located in the digestive vacuole membrane of CQR *P. falciparum*.

This mutation changes the amino acid from lysine to threonine at the binding site of the chloroquine-resistance transporter.

(iii) Using the information provided, suggest how this mutation of *pfcrt* gene increases the chloroquine resistance in *P. falciparum*. [3]

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[Total: 15]

Section B

Answer **ONE** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.
Your answers should be illustrated by large, clearly labelled diagrams, were appropriate.
Your answers must be in continuous prose, where appropriate.
You answers must be set out in parts **(a)**, **(b)**, etc., as indicated in the question.

QUESTION 5

(a) Following cytokinesis, one of the daughter cells may not have a nucleolus. This cell is able to divide once more and then the new daughter cells die.

Explain how the cell is able to survive for one more cell division and suggest why the new daughter cells then die. [7]

(b) The same parents may produce offspring that are different in appearance. Discuss how this is brought about. [8]

[Total: 15]

QUESTION 6

(a) All cells, from bacteria to humans, express their genetic information via the central dogma of molecular biology which depicts the flow of genetic information from DNA to protein.

Outline the processes involved in the central dogma of molecular biology, and explain, using an example, why the central dogma may not always hold true. [7]

(b) The expression of genes gives rise to proteins that affect the biochemical reactions and other processes in organisms.

Discuss, with examples, the importance of specific shapes of proteins in organisms. [8]

[Total: 15]

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End of Paper

MERIDIAN JUNIOR COLLEGE
JC2 Preliminary Examination 2018
Higher 1

CANDIDATE NAME	

CIVICS GROUP	1	7				

INDEX NUMBER		

H1 BIOLOGY

Paper 2

ANSWER SCHEME

8876

12 September 2018
2 hours

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Section A	
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Section B	
5 or 6	/ 15
Total	/ 60

This document consists of **14** printed pages

[Turn over]

Section A

Answer **all** questions in this section

QUESTION 1

(a) Distinguish the processes of facilitated diffusion and active transport. [3]

- Facilitated diffusion involves transport of substances **down a concentration gradient** whereas active transport occurs **against a concentration gradient**.
- Facilitated diffusion **does not require ATP** whereas active transport **requires ATP**.
- Facilitated diffusion involves **channel or carrier proteins** whereas active transport only involves **protein pump**.
- .

(b) A group of students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

- Group **A** plants had a substance that inhibited respiration added to the solution.
- Group **B** did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in Fig. 1.1

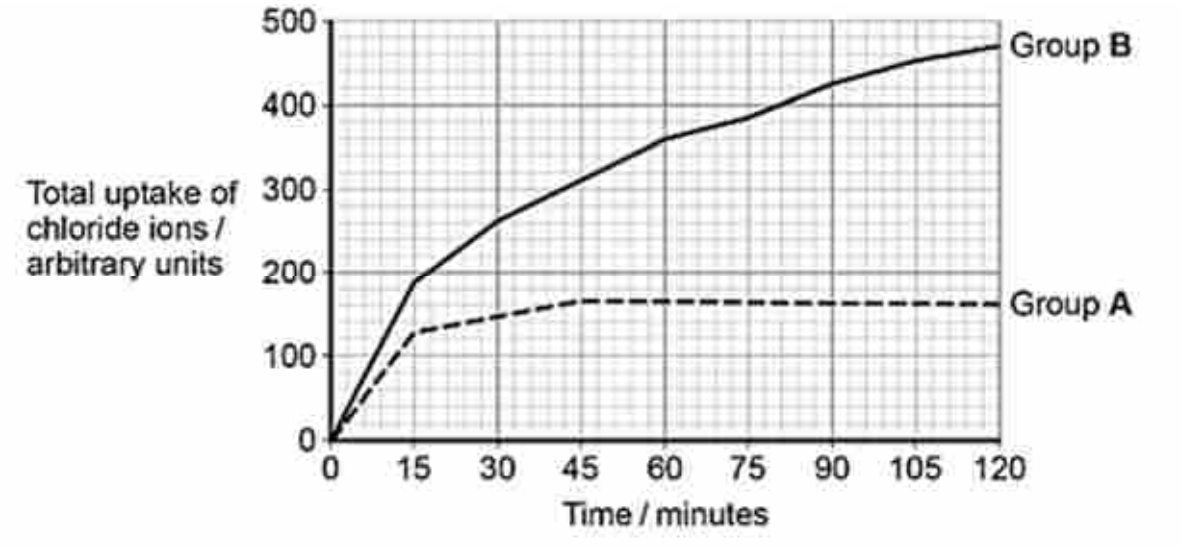


Fig. 1.1

(i) Calculate the ratio of the **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants. [2]

rate of uptake in the first hour = $\frac{360 - 0}{60}$

= 6 au min^{-1}

rate of uptake in the second hour = $\frac{470-360}{60}$

= 1.83 au min^{-1}

Ratio = 6/ 1.83 = **3.3 : 1**

(ii) Explain the results shown in Fig 1.1 [4]

- In Group A, **from 0-15 mins**, the initial rate of uptake of chloride ions is slower as only **facilitated diffusion** occurred.
- In Group A, **from 45-120 mins**, the total uptake of chloride ions **levels off/plateaus** because the concentrations of chloride ions inside cells and outside cells is the **same/reached equilibrium**.
- In Group B, **from 0-15 mins**, the initial rate of uptake of chloride ions is faster as both **facilitated diffusion** and **active transport** occurred.
- In Group B, **from 15-120 mins,** the total uptake of chloride ions continued to increase because the uptake of chloride ions is **against concentration/did not reach an equilibrium**.
- In Group B, **from 15-120 mins**, the rate of uptake **slows down** as **fewer chloride ions in external solution/ respiratory substrate is used up**.

[Total: 9]

QUESTION 2

Bone marrow contains many stem cells. Some of these stem cells are responsible for the replacement of white blood cells.

Fig. 2.1 shows the production of a white blood cell from one of these stem cells.

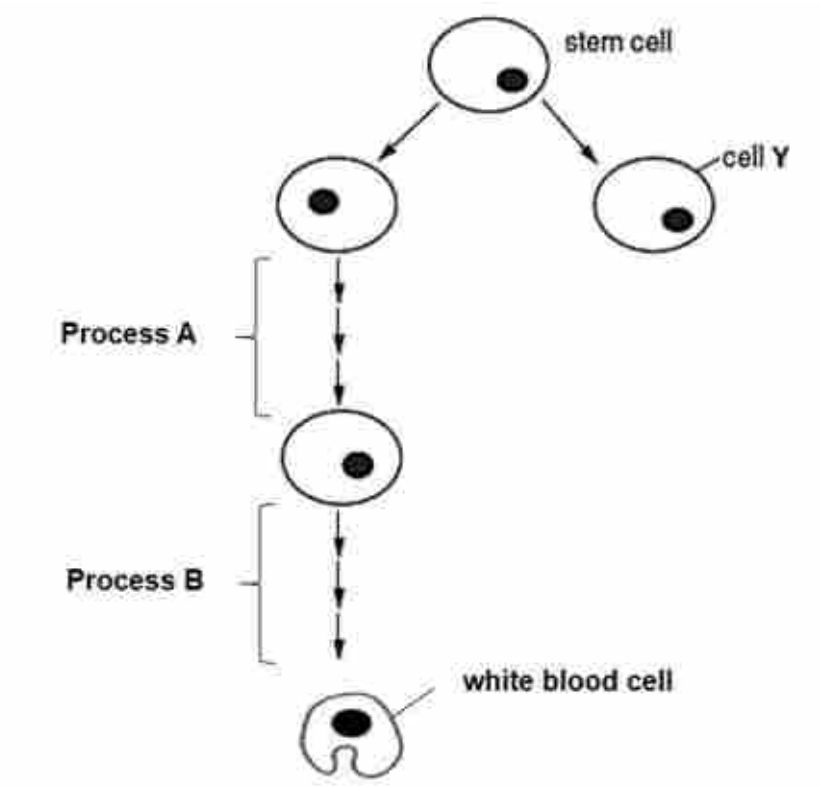


Fig. 2.1

(a) **(i)** State the potency of the stem cells found in the bone marrow. [1]

- Multipotent

(ii) Name the processes **A** and **B**. [2]

- **Process A – Mitosis**
- **Process B – Differentiation**

(iii) Suggest what may happen to cell **Y**. [1]

- Remains as a stem cell
- Undergoes cell division/mitosis
- Undergoes differentiation to become specialised cells

The human induced pluripotent stem cells (HiPS cells) can be derived from fully differentiated adult somatic cells such as white blood cells. This has been hailed as an effective replacement for human embryonic stem cells for its usefulness in regenerative medicine.

Recent research shows that abnormal reprogramming can occur during the induction of HiPS cells and tumours could be generated.

(b) (i) Compare the embryonic stem cell and HiPS cell. [3]

Difference

- Embryonic stem cell is obtained from **Inner cell mass of blastocyst** / **embryos** whereas HiPS cells are obtained from **differentiated somatic cell**

Similarities [any 2]

- Both are pluripotent /have the potential to become any cell type in the adult body but not those of the extra-embryonic membranes
- Both have **self-renewing capabilities** / can **divide continually**
- Both are **unspecialised/undifferentiated**

(ii) Comment on the ethical issues involved in the use of HiPS cells. [3]

- Overcome ethical issue of using embryonic stem cells for treatment as it does not involve killing of embryo.
- No tissue rejection involved as the HiPS cells are derived from the patient
- [idea of] Treatment to benefit patients/ alleviate the suffering of many people
- [idea of] Safety concerns on the use of HiPS cells.
- Potential to develop into a human embryo/ to clone human being/produce germ cells

[Total: 10]

QUESTION 3

In mice, fur colour is controlled by a gene with multiple alleles. These alleles are listed below in no particular order.

black and tan = C^{bt}	yellow = C^{y}
agouti = C^{a}	black = C^{b}

(a) Explain the term *multiple alleles*. [2]

- Gene that exists in **more than two allelic forms** in a given population
- **only two** of which can be present in a **diploid** organism

(b) Crosses between heterozygous parents with the genotype $C^{y}C^{b}$ always produce a ratio of two yellow mice to one black mouse. Explain the observation using a genetic diagram. [3]

Parental phenotype:	Yellow mouse	x	Yellow mouse		**[1]**
Parental genotype (2n):	C^{y} C^{b}	x	C^{y} C^{b}		
Gametes (n):	C^{y} C^{b}	x	C^{y} C^{b}		**[1]**
F_1 genotype (2n):	C^{y} C^{y}	C^{y} C^{b}	C^{y} C^{b}	C^{b} C^{b}	
F_1 phenotype:	mouse dies	yellow fur	yellow fur	black fur	**[1]**
F_1 phenotypic ratio:	yellow fur : black fur 2 : 1				

(c) Suggest explanations for the results of the following crosses between mice.

(i) Mice with agouti fur crossed with mice with black fur may produce all agouti offspring **or** some agouti and some black offspring. [2]

- Agouti allele (C^{a}) is **dominant** to black allele (C^{b})
- Parents with agouti fur has genotype of $\mathbf{C^{a}\ C^{a}}$ or $\mathbf{C^{a}\ C^{b}}$
- Parents with black fur has genotype of $\mathbf{C^{b}\ C^{b}}$

(ii) Mice with yellow fur crossed with mice with black fur will produce one of the following outcomes:

- some yellow offspring and some agouti offspring
- some yellow offspring and some black and tan offspring
- some yellow offspring and some black offspring. [2]

- yellow allele (C^{y}) is dominant to all alleles (C^{a}, C^{bt}, C^{b})
- Agouti allele (C^{a}) and black and tan allele are dominant to black allele (C^{b}) OR black allele is recessive to all other alleles
- Yellow mice is heterozygous at the gene locus

(d) A test cross is used to determine the genotype of an organism.

Describe how you would carry out a test cross to determine the genotype of a black and tan mouse. [2]

- Cross black and tan mouse with black mouse (C^b C^b)
- If **all** offspring is black and tan, then parent is homozygous (C^{bt} C^{bt})
- If some offspring are black and some are black and tan, then parent is heterozygous (C^{bt} _)

[Total: 11]

QUESTION 4

Malaria is a mosquito-borne infectious disease caused by the malarial parasites, *Plasmodium falciparum*, which is transmitted among humans by the female mosquito vectors *Anopheles*.

(a) Outline the general life cycle of a mosquito. [3]

- The female mosquitoes lay **eggs** in stagnant **water**
- develop as **larvae and pupae in water** [sequence must be correct]
- mature/develop into an **adult mosquito**.

Malaria was common in Italy, a European country situated in the Northern Hemisphere. Widespread land drainage together with the use of the insecticide DDT and the drug chloroquine eradicated both the mosquito vectors and the malarial parasites in the 1950s. Due to the success of these measures, they were later discontinued as they were no longer necessary.

Articles in the scientific literature more recently show that malarial mosquitoes are returning to Italy and increasing their numbers and their northerly range, with some cases of malaria being reported. In general, winters are milder and summers are hotter in the south of the country, with temperatures decreasing to the north, especially in the winters.

(b) Discuss whether the return of malaria to Italy can be attributed to climate change. [4]

[Yes]

- Range extending further north may relate to **warmer temperatures**
- [idea of] higher temperature lead to increase in number of mosquitoes due to e.g. hasten the life cycle of mosquitoes due to increased metabolism
- Climate change leads to **increase in rainfall** may result in **more flooded areas for mosquitoes to breed**

[No]

- Return of malaria was due to the **discontinued use of DDT**
- [idea of] Mosquitos could be introduced into Italy from the surrounding countries
- [idea of] The parasite thrive and spend most of their life cycle in host body temperature (37°C) hence ambient temperature has hardly any effect on their survival

(c) Chloroquine-resistant (CQR) malarial parasites, *P. falciparum,* were first reported in 1950s and are now widespread. The resistance is caused by mutations of a gene known as *pfcrt*.

(i) Explain why CQR *P. falciparum* are now widespread. [3]

- **Variation** in the population of *P. falciparum* due to random **mutations**
- Use of chloroquine acts as **selection pressure** on the *P. falciparum* population
- Chloroquine-resistant *P. falciparum* are at **selective advantage** and are likely to survive to reproduce
- ..and pass their **CQR allele/ mutated *pfcrt* allele** to their **fertile and viable offspring**
- **Allele frequency** for **CQR allele/ mutated *pfcrt* increases** over **many generations** within the *P. falciparum* population.

Analysis of *pfcrt* in CQR *P. falciparum* from different parts of the world shows differences in one section of the gene only. The amino acid sequences coded for by this section are shown in Table 4.1, together with the amino acid sequence coded for by the allele found in parasites that are still susceptible to chloroquine (non-CQR). The amino acid sequence coded for by the rest of the gene is the same in all cases.

Table 4.1

allele of *pfcrt* gene	amino acid sequence coded for by allele of *pfcrt* gene
non-CQR	—Cys—Met—Asn—Lys—His—Ala—Glu—Asn—Ile —Met—
CQR from Africa	—Cys—Ile —Glu—Thr—His—Ser—Glu—Ser—Ile —Ile —
CQR from Asia	—Cys—Ile —Glu—Thr—His—Ser—Glu—Ser—Thr—Ile —
CQR from Peru and Brazil	—Ser—Met—Asn—Thr—His—Ser—Gln—Asp—Leu—Arg—
CQR from Colombia	—Cys—Met—Glu—Thr—Gln—Ser—Gln—Asn—Ile —Thr—

(ii) With reference to Table 4.1, calculate the mean number of different amino acids coded for by CQR alleles in comparison with the non-CQR allele. Show your working. [2]

$\frac{6 + 7 + 7 + 6}{4}$ [1]

= **6.5** [1]

mean number of different amino acids ……..

In the non-CQR *P. falciparum*, chloroquine accumulates in the digestive vacuole of *P. falciparum* and interferes with the detoxification of haem in the host red blood cell. This results in parasite death.

Research shows that there is a point mutation in the *pfcrt* gene of CQR *P. falciparum* which leads to the formation of a chloroquine-resistance transporter located in the digestive vacuole membrane of CQR *P. falciparum*.

This mutation changes the amino acid from lysine to threonine at the binding site of the chloroquine-resistance transporter.

(iii) Using the information provided, suggest how this mutation of *pfcrt* gene increases the chloroquine resistance *in P. falciparum*. [3]

- **Base-pair substitution of a nucleotide at the 1st or 2nd nucleotide of the triplet** in the *pfcrt* gene of CQR *P. falciparum*
- ..**change in mRNA codon** that **codes for threonine** instead of **lysine**
- ..alters the **shape of the** **binding site** of pfcrt protein to become **complementary to chloroquine /** change the **charge of the binding site** in pfcrt protein to allow **binding to chloroquine**
- ..chloroquine are **transported out** of the digestive vacuole.

[Total: 15]

Section B

Answer **ONE** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.
Your answers should be illustrated by large, clearly labelled diagrams, were appropriate.
Your answers must be in continuous prose, where appropriate.
You answers must be set out in parts **(a)**, **(b)**, etc., as indicated in the question.

QUESTION 5

(a) Following cytokinesis, one of the daughter cells may not have a nucleolus. This cell is able to divide once more and then the new daughter cells die.

Explain how the cell is able to survive for one more cell division and suggest why the new daughter cells then die. [7]

[Function of nucleolus]

1. The nucleolus is a site where **rRNA genes** are located and **transcribed** to produce **rRNA**.

2. The nucleolus is also the **site of assembly** of rRNA and ribosomal proteins to form the large and small **subunits of the ribosomes**.

3. Cells **without nucleolus** are **unable to synthesize ribosomes** that are required for translation to take place.

[How the cell without a nucleolus is able to survive for one more cell division]

4. Though this daughter cell has no nucleolus, it **contains sufficient ribosomes** derived **from the parental cell** during cell division, but is unable to produce new ribosomes.

5. Hence this cell is still able to use the ribosomes to **make proteins** to carry out **cellular activities**, allowing it to undergo cell division once more.

[Why the new daughter cells then die]

6. The new daughter cells produced have **no nucleoli**.

7. [idea of] The amount of ribosomes derived from the parental cell is insufficient to meet the demand of the cell (new daughter cells have half the original number of ribosomes present in the abnormal daughter cell).

8. As **insufficient ribosomes** cannot synthesize sufficient proteins to drive cellular processes/meet cellular demands (e.g. respiration), the new daughter cells die.

QWC [1]
Processes communicated accurately with no ambiguity.

(b) The same parents may produce offspring that are different in appearance. Discuss how this is brought about. [8]

1. [Definition of a gene] A **gene** is a **discrete unit of hereditary information** consisting of **specific nucleotide sequence in DNA**

2. Genetic information is encoded in gene which **determines the phenotype**

Different gametes produced by same parents due to:

Germline mutation

3. Mutations occur in **germ cells** of the parents which produce gametes that can be **inherited by the offspring** during fertilization to produce different phenotype.

Meiosis

4. During **prophase I**, **crossing-over between non-sister chromatids of homologous chromosomes** occur. This results in exchange of alleles between corresponding gene loci.

5. During **metaphase I** and **anaphase I**, there is **independent assortment and segregation of homologous chromosomes** respectively. The resulting daughter cells are different as each has only one of the two homologous chromosomes.

6. During **metaphase II** and **anaphase II,** there is **independent assortment and segregation of non-identical sister chromatids respectively**.

7. These processes give rise to a large number of **different chromosome combinations** in the **gametes.**

Random fertilisation of gametes

8. **The random fusion of gametes** from two different parents during **fertilization** adds variation to the offspring/ results in different appearance in the offspring

Phenotypic variation due to environment

9. **Genes can interact with the environment** to give rise to phenotypic variation /different appearance of the offspring

QUESTION 6

(a) All cells, from bacteria to humans, express their genetic information via the central dogma of molecular biology which depicts the flow of genetic information from DNA to protein.

Outline the processes involved in the central dogma of molecular biology, and explain, using an example, why the central dogma may not always hold true. [7]

[Transcription] max 3

1. **General transcription factors** and **RNA polymerase** bind to the **promoter**

2. **One** of the DNA strands is used as the **template** to synthesize **mRNA**

3. Template read from **3' to 5'**, mRNA synthesized from **5' to 3'**

4. RNA polymerase add ribonucleotides by **complementary base pairing** via **hydrogen bonds**

5. Catalyzes formation of **phosphodiester bonds** between adjacent ribonucleotides.

[Translation] max 3

6. **Mature mRNA** used as a **template** to synthesize **polypeptide**

7. mRNA read from **5' to 3'**, three bases (**codon**) at a time

8. Ribosome peptidyl transferase catalyses **peptide bond** between adjacent amino acids

9. **Each codon** codes for **one amino acid**

10. Punctuated: **AUG start**, **UAA/UGA/UAG stop**

[Why central dogma is not always true] – any 1

11. Flow may be reverse, from **RNA to DNA**
    Ref. to HIV: (+)ssRNA reverse transcribed to ssDNA

12. Flow may **end at RNA**
    Ref. to tRNA / rRNA

QWC [1]

Central Dogma processes communicated accurately and to include one specific example

(b) The expression of genes gives rise to proteins that affect the biochemical reactions and other processes in organisms.

Discuss, with examples, the importance of specific shapes of proteins in organisms.

[8]

1. Active site of enzyme has specific shape that substrate can fit into
2. Via lock and key mechanism
3. *[Importance]* To form enzyme-substrate complex/ products important for metabolic pathways / increase the rate of reaction
4. *[Example]* any *enzyme and substrate*

5. DNA to fit into binding site of proteins (point 6-9, 16-19)
6. *[Importance]* Ref. to **DNA replication**
7. *[Example]* DNA polymerase binds to 3'OH group of existing nucleotide/ helicase binds to origin of replication/ topoisomerase binds to DNA to unzip the double-stranded
8. *[Importance]* Ref. to **transcription**
9. *[Example]* **transcription factor** binding to DNA / **RNA polymerase** binds to promoter

10. Binding of substances to transport proteins
11. *[Importance]* Allows for movement of substances across cell membrane
12. *[Example]* transmembrane protein e.g. Na+ channel, Na+K+ pump, glucose transporter etc

13. *[Example]* Haemoglobin is made up of **4 polypeptides** and their **haem groups** to form a specific conformation
14. *[Importance]* allows it to **bind to oxygen molecules** to form oxyhaemoglobin/ transport oxygen to all parts of the body
15. Reference to **cooperative binding**

16. *[Importance]* Ref. to **separation of sister chromatids during anaphase**
17. E.g. kinetochore to bind to centromere via complementary shape

18. *[Importance]* Ref. to **amino acid activation**
19. E.g. tRNA anticodon bind to the anticodon attachment site of amino-acyl tRNA synthetase

QWC [1]
Importance of specific shapes communicated accurately and to include at least two examples

End of Paper

Name	Index Number	CTG

YISHUN JUNIOR COLLEGE
JC 2 SEMESTRAL EXAMINATION 2018

BIOLOGY **8876/01**

HIGHER 1 **14th SEPTEMBER 2018**
Fri 0800 – 0900

1 hour

Paper 1 Multiple Choice

Additional material: Optical Mark Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your NRIC number, name and CTG on the Optical Mark Sheet in the spaces provided.

There are **twenty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet.

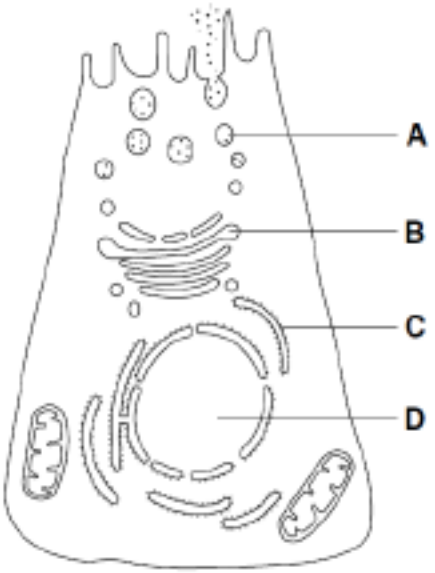
Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of 9 printed pages and 1 blank page.

1 The diagram is taken from an electron micrograph of a cell which secretes digestive enzymes.

Where are these enzymes made?

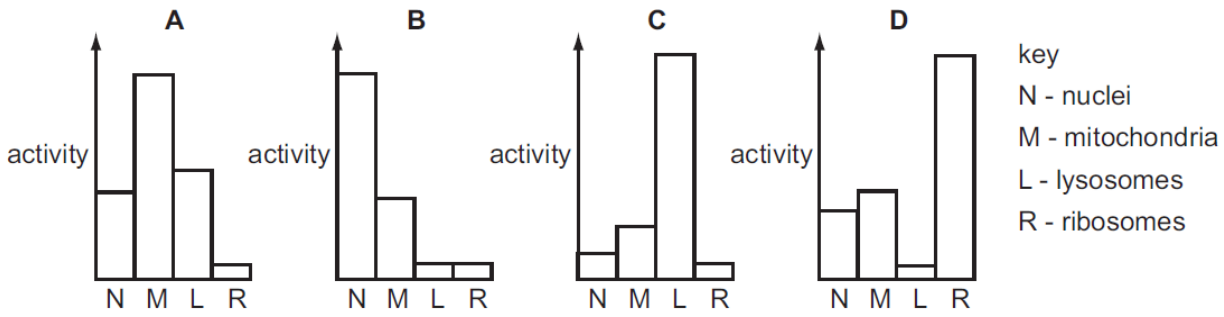


2 What is the order of size of cell components?

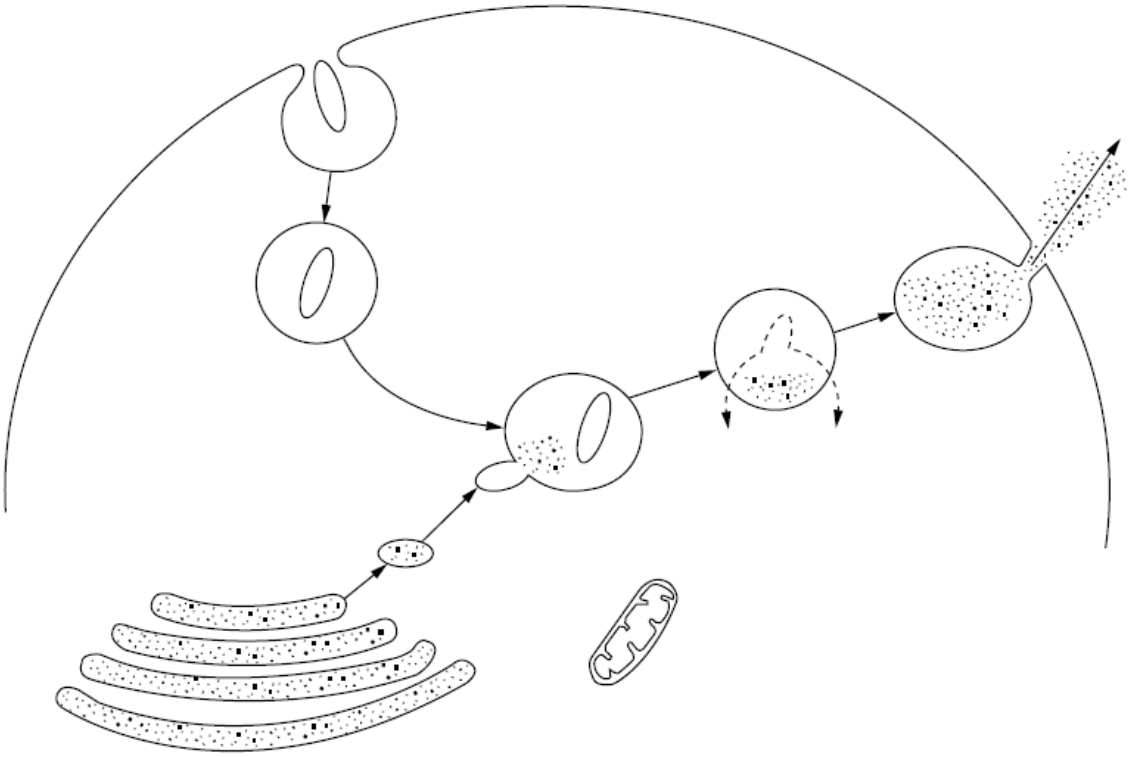
	Largest →			Smallest
A	Mitochondria	Ribosomes	Starch grains	Nuclei
B	Nuclei	Chloroplasts	Mitochondria	Ribosomes
C	Ribosomes	Mitochondria	Chloroplasts	Starch grains
D	Starch grains	Mitochondria	Chloroplasts	Ribosomes

3 A piece of mammalian tissue was homogenised and subjected to differential centrifugation to yield four subcellular fractions. The activity within each fraction, of four different types of enzyme, **A**, **B**, **C** and **D**, was investigated.

Which bar chart shows the results of investigating hydrolytic enzyme activity?



4 The diagram shows several processes taking place in a cell.



Which processes are shown in the diagram and involve the cell surface membrane of the cell?

A active transport and diffusion

B diffusion and osmosis

C endocytosis and exocytosis

D endocytosis and osmosis

5 A plant cell is placed in a solution with a less negative (higher) water potential than the cell contents.

Which change occurs in the cell and what causes the change?

	change	cause
A	cell becomes more flaccid	solution diffuses out of the cell
B	cell becomes more flaccid	water diffuses out of the cell
C	cell becomes more turgid	solution diffuses into cell
D	cell becomes more turgid	water diffuses into cell

6 Beetroot cells contain a water-soluble red pigment. Two test tubes were set up as described in the table.

tube 1	Pieces of washed raw beetroot in water
tube 2	Pieces of washed raw beetroot in water containing 3 drops of cyanide, a respiratory inhibitor.

After 30 minutes, the water in tube 2 contained a red pigment but the water in tube 1 did not.

Which of the following statements are false for tube 2?

1 Pigment molecules passed out and were replaced by cyanide.

2 The cell membrane was unable to retain the red pigment.

3 Water entered the tissue by osmosis and caused the cells to burst.

4 Water passed out of the cells by osmosis and carried the soluble pigment with it.

5 The same result will occur if ethanol was used instead of cyanide.

A 1 and 3 only

B 3 and 4 only

C 2 and 5 only

D 1, 3 and 4 only

7 Some features of haemoglobin are listed.

1 They are made up of a protein component called globin and a non-protein component called haem group.

2 There are two types of polypeptide chains: the α-helix globin chain and the β-globin chain.

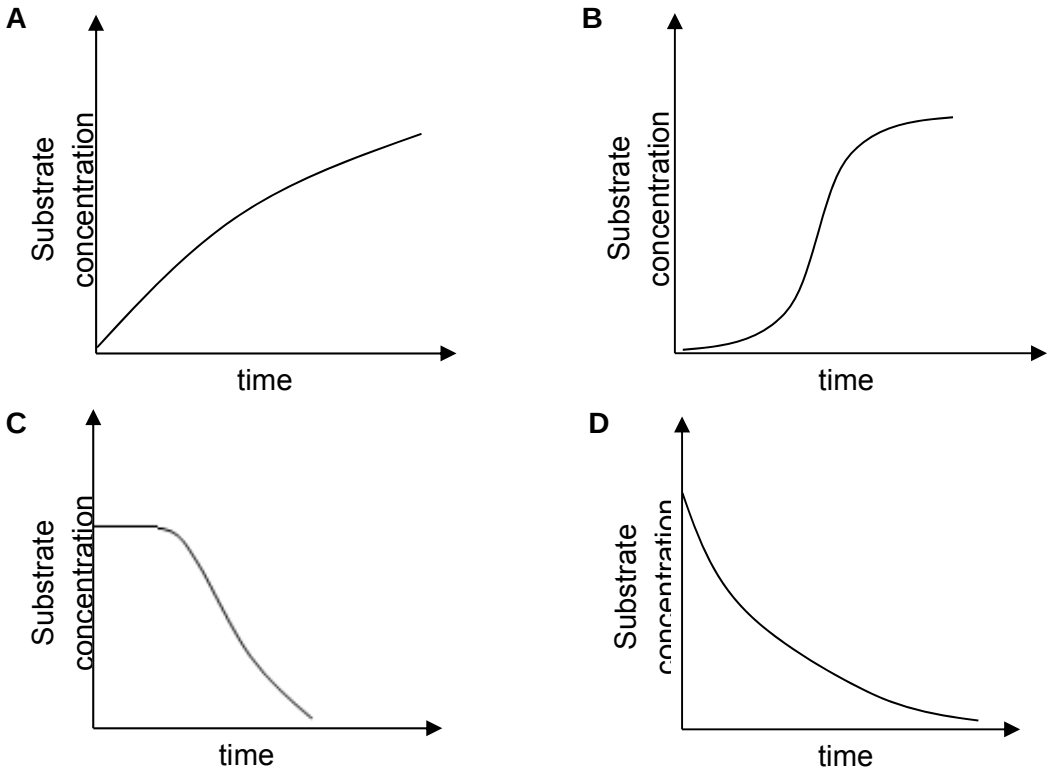
3 Each polypeptide chain is held by hydrophobic interactions, hydrogen and ionic bonds and disulfide bonds.

4 Most of its hydrophilic polar amino acid residues are on the external surface of the globular structure.

Which are these statements are true ?

A 1 and 3 **B** 1 and 2 **C** 1, 2 and 4 **D** 1 and 4

8 Which graph represents the changes in substrate concentration during the course of an enzyme catalysed reaction?



9 Which is a correct statement about obtaining human embryonic stem cells for research?

A Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.

B The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.

C The cells must be removed within a day following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.

D The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

10 Mesenchymal stem cells can differentiate into several types of cells belonging to our skeletal tissue, such as cartilage, bone and fat.

Which statement correctly describes mesenchymal stem cells?

A They are specialised cells that can give rise to a variety of cell types.

B They can be stimulated by chemical signals to express certain genes.

C They lose genetic information as they differentiate.

D They occur in large numbers in the bone marrow.

11 Which statements about ribosomal RNA(rRNA) is true?

1 rRNA is involved in the binding of mRNA and not tRNA.

2 rRNA with associated proteins, fold into complex tertiary structures within the ribosome.

3 The 3′ terminus of rRNA in prokaryotes is known to interact with the initiation region of mRNA via the Shine–Dalgarno sequence.

4 Nucleolus is the site of rRNA transcription and processing, and of ribosome assembly.

A 1 and 3 **B** 1, 2 and 3 **C** 2 and 4 **D** 2, 3 and 4

12 What is the basis for the difference in the synthesis of the leading and lagging strands of DNA molecules?

1 The anti-parallel arrangement of the DNA strands.

2 The RNA primers are required to initiate DNA elongation.

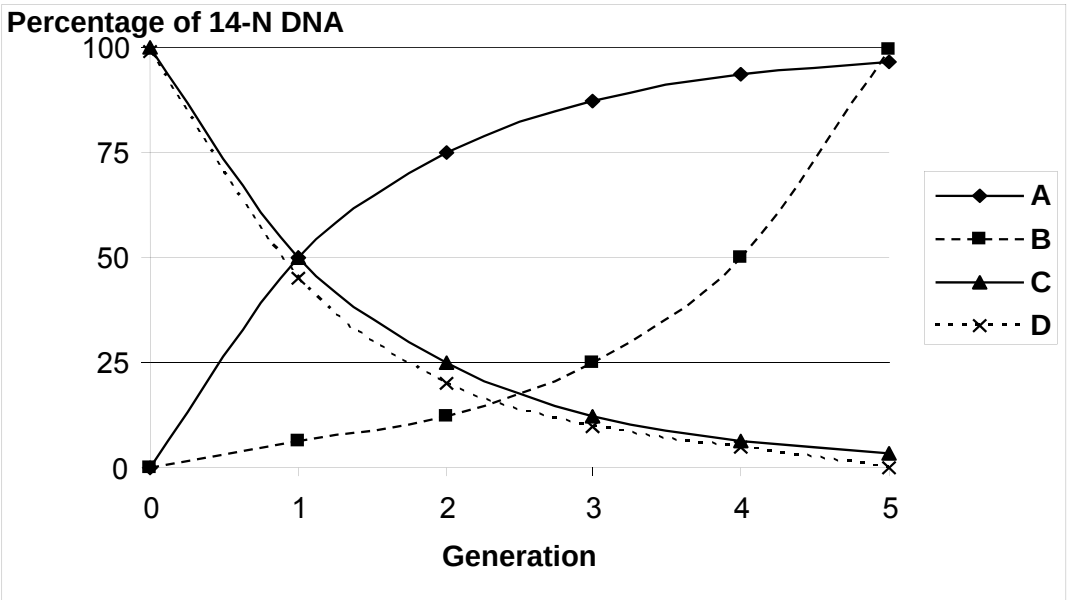
3 DNA polymerase can join new nucleotides to the 3' end of the growing strand.

4 Helicase and single-stranded binding proteins work at the 5'end of the DNA strand.

A 2 and 4 **B** 1 and 3 **C** 1 and 4 **D** 2 and 3

13 Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all DNA was labelled. These bacteria were then grown in a medium containing only normal nitrogen (^{14}N) for 5 generations. The percentage of ^{14}N DNA strands in each generation was estimated.

Which curve provides evidence that DNA replication is semi-conservative?



14 A new form of life is discovered. It has a genetic code much like that of organisms on Earth except that there are five different DNA bases instead of four and the base sequences are translated as doublets instead of triplets. How many different amino acids could be accommodated by this genetic code?

A 25

B 32

C 10

D 64

15 What do chromosomal aberrations and gene mutations have in common and how are they different?

	Similarity	**Difference**
A	Both may involve addition of nucleotides.	Gene mutations always produce dominant alleles but not chromosomal aberrations.
B	Both cause changes in number of chromosomes.	Gene mutations do not involve inversions but inversion of segments of chromosomes do occur.
C	Both affect DNA sequence.	Gene mutations occur within a chromosome but chromosomal aberrations may occur across chromosomes.
D	Both may not result in a difference in protein expression.	Chromosomal aberrations are more harmful than gene mutations.

16 The table shows the DNA triplet codes for some amino acids from the strand complementary to mRNA.

Amino acid	DNA triplet code
Glycine	CCA, CCG, CCT, CCC
Leucine	AAT, AAC, GAA, GAG, GAT, GAC
Lysine	TTT, TTC
Methionine	TAC
Proline	GGA, GGG, GGT, GGC
Threonine	TGA, TGG, TGT, TGC

The sequence of DNA triplets from the strand complementary to mRNA form part of a gene is shown.

…TAC TTT AAT GGC CCT GAG GGC TAC TGT …

Which mutated DNA sequences of this part of a gene would result in the same amino acid sequences as the original gene sequences ?

A …TAC TTT AAT GGC CCT GAG GGT CCA TGT

B …TAC TTC GAT GGC CCT GAG GGC TAC TGT

C …TAC TTT AAT GGC CCG GAG TGA TAC TGT

D TAC TTT AAT GGC CCT GAG GGC TTC TGT

17 Which environmental factor is associated with the development of melanomas (a type of skin cancer)?

A alcohol

B tar

C ultraviolet light

D X-radiation

18 Cancer research has found that gene amplification is involved in the development of cancer. This research has identified one type of sequence that causes a break in DNA before gene amplification.

How might the findings of this research be used?

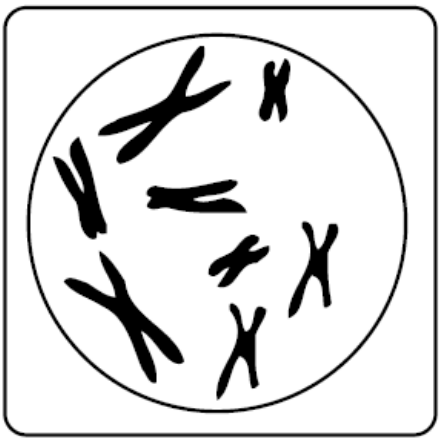
A to identify people at risk of developing cancer

B to prevent cancer from developing in 'at-risk' people

C to repair DNA breaks from amplification occurs

D to use restriction endonuclease to remove DNA

19 The diagram shows a diploid cell during mitosis.



Which stage of mitosis is shown?

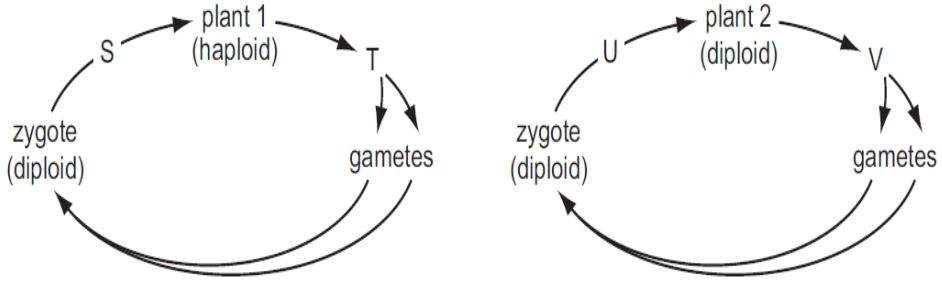
A anaphase

B metaphase

C prophase

D telophase

20 The diagram shows the life-cycles of two types of simple plant.



Where will reduction divisions occur in the life cycles?

A at S and U

B at S and V

C at T and U

D at T and V

21 In corn, the colour of the stem can be either wild type, which is dark green, or virescent, which is pale green.

Cross	Phenotype of parents	Temperature at which raised	Offspring
1	virescent X virescent	20°C	virescent
2	virescent X virescent	37°C	wild type
3	wild type X wild type	20°C	3 wild type: 1virescent
4	wild type X wild type	37°C	wild type

The parents of crosses 1 and 2 had the same genotypes. The parents of crosses 3 and 4 had the same genotypes.

Which of the following can be deduced from the data?

1 Wild type is dominant.

2 The wild type parents are heterozygotes.

3 Virescent is the recessive phenotype but the characteristic will only be expressed at lower temperature.

4 The parents of cross 1 are only recessive at 20°C.

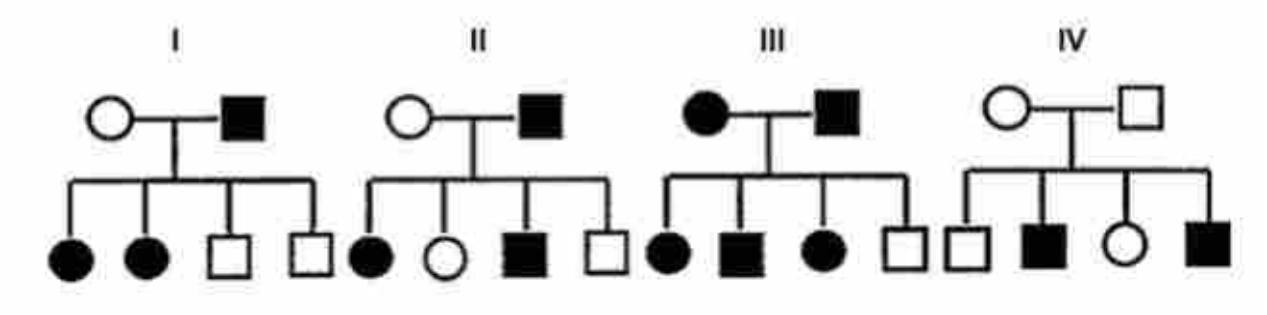
A 2 only

B 1 and 3 only

C 1, 2 and 3 only

D all of the above

22 The figure below shows 4 pedigrees. A shaded circle represents an affected female while a shaded square represents an affected male.



Which pedigree(s) show(s) a sex-linked dominant trait in humans?

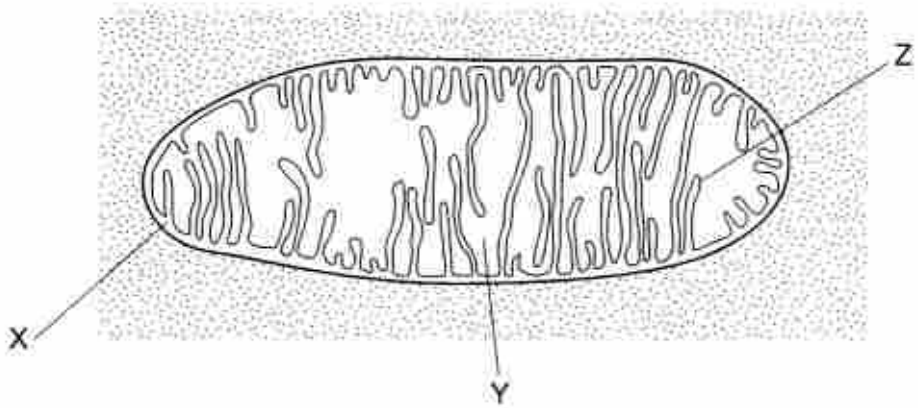
A I only

B I and III

C II and III

D III and IV

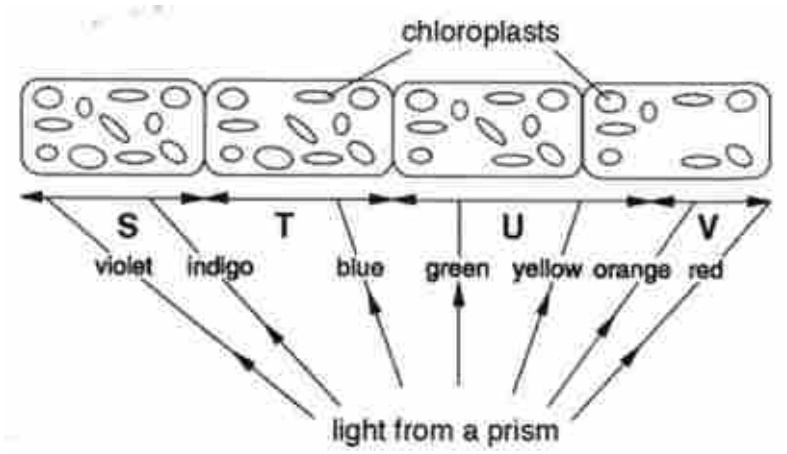
23 The electron micrograph shows an organelle found in a plant cell.



Which row shows the correct location of each named biological molecule?

	DNA	oxaloacetate	ATP
A	absent	Y	Z
B	Y	Z	Y
C	Y	Y	X
D	Y	Y	Y

24 A filament of the alga *Cladophora* was illuminated as shown in the diagram. Motile, aerobic bacteria were placed in the water with the alga and their position was determined by microscopic examination after 10 minutes.



In which two regions will the number of bacteria be highest?

A S and T

B S and U

C T and V

D U and V

25 The copying of DNA is not always accurate, resulting in occasional, random changes to its base sequence. For example, scientists have calculated that one amino acid in vertebrate haemoglobin protein is changed every 10 million years.

Which statement about this process is correct?

A A single amino acid change in a protein may be affected by natural selection.

B All changes in the base sequence of DNA are affected by natural selection.

C Natural selection can cause some of the amino acid changes in proteins.

D The variability of DNA in a population will be less than the variability of its proteins.

26 In 1954, copper waste in the Finniss River killed numerous fish. This caused various species in the area to die out. However, one species, the black-banded rainbow fish, increased in numbers. The black-banded rainbow fish have modified gills that enable the fish to filter and remove the copper before it enters their body.

With respect to the black-banded rainbow fish it is reasonable to conclude that

A a mutation occurred in their population in 1954.

B the ability of their gills to remove copper already existed in 1954

C the high levels of copper in the water changed the structure of their modified gills

D their genomes are identical with those of the other species of fish that existed in 1954.

27 Climate change has led to increasing temperature. The environments where birds, fishes, and other marine species live have become warmer. What is not an effect of climate change on these organisms?

A Certain fish species migrate in response to seasonal temperature changes, moving northward or to deeper, cooler waters in the summer and migrating back during the winter.

B The birds are moving north to feed and breed in the summer, then moving further south to spend the winter in warmer areas.

C The birds follow a regular seasonal migration pattern during wintering periods.

D As smaller marine prey species shift their habitats, larger predator species may follow them.

28 Other than melting land-based ice sheets, which of these factors has made the largest contribution to the rise in sea level over the past 100 years?

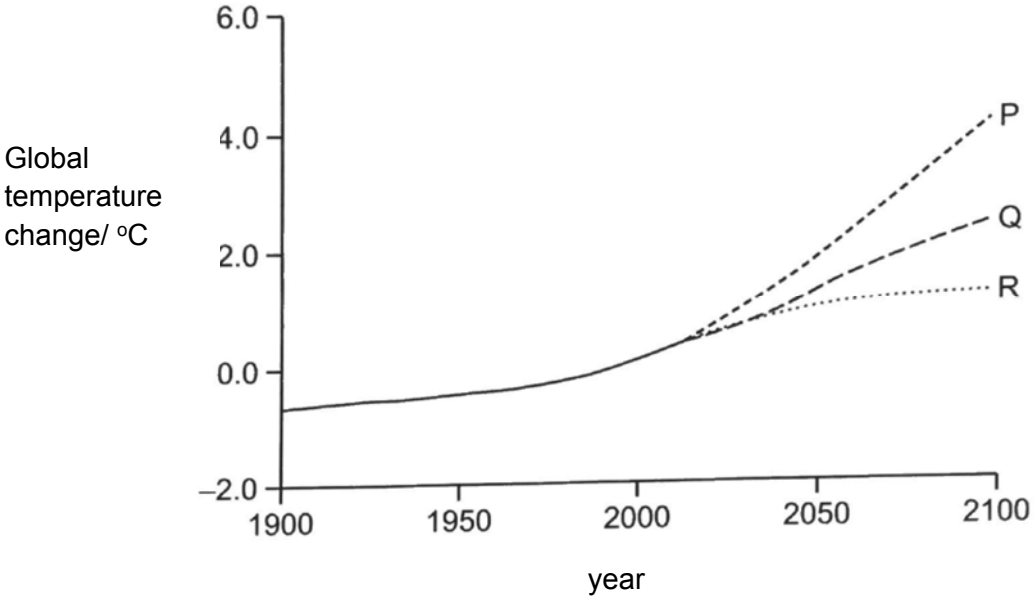
A Warming of ocean surface water

B Melting sea ice

C Increased river runoff

D Increased reflection of infrared radiation

29 The graph shows the predicted changes in global temperatures using three different models, P, Q and R. Model Q assumes that no new factors act to influence the rate of climate change.



The predictions based on models P and R can be explained using some of the following statements.

1 An increased global temperature and reduced rainfall will lead to an increase in forest fires.

2 Permanently frozen soil and sediment in the Artic will begin to thaw as global temperature increase.

3 Rising sea temperature will cause increase growth of photosynthetic algae.

4 Rising sea temperatures will reduce the solubility of greenhouse gases in the oceans.

Which of these statements support predictions P and R?

	statements that support prediction P	statements that support prediction R
A	1, 2 and 4	3
B	1 and 3	2 and 4
C	2	1, 3 and 4
D	3 and 4	1 and 2

30 Corals are among the first indicators of climate change. When ocean temperatures get too hot for too long, corals undergo a process called bleaching. Which statements are true about this process?

1 Increased levels of sediment in seawater, the zooxanthellae may lose substantial amounts of their photosynthetic pigmentation, which decreases rates of photosynthesis produces bleaching.

2 Bleaching occurs when abnormally high sea temperatures cause corals to expel the zooxanthellae living in them.

3 Zooxanthellae are able to use the oxygen and waste materials of the host, supplying carbon dioxide and food substances in return.

4 With high sea temperatures and decreasing planktons, corals use the zooxanthellae as their food source

A 1 and 2

B 1 and 4

C 2 and 4

D 2 and 3

Parent's signature

Name	Index Number	CTG

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2018

BIOLOGY **8876/02**

HIGHER 1 **29 AUGUST 2018**

Paper 2 Structured and Free-response Questions **Wed 1400 - 1600**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and CTG in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen only.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question paper.

Section B
Write your answers in the spaces provided on the Question Paper.

At the end of the examination, fasten all your work securely together.

This question paper consists of **20** printed pages.

FOR EXAMINER'S USE	
Paper 1	/ 30
Paper 2	
Section A	
Q1	/14
Q2	/10
Q3	/ 6
Q4	/ 5
Q5	/ 10
Section B	
Q6 OR 7	/ 15
Total	/ 60
Overall	/ 90

Section A

Answer **all** questions in this section.

1 In an experiment to study the effect of heat treatment on the digestibility of protein substrate and the effect of raw bean extract on protease activity, various reaction mixtures were prepared and were incubated for 30 minutes.

The protein concentration of each reaction mixture at the beginning and at the end of the incubation period was determined by the colorimetric method which measures colour intensity of these reaction mixtures. The results were shown in Table 1.1.

Table 1.1

Incubation period /min	**Colour intensity of the reaction mixture / arbitrary unit**		
	Tube A	**Tube B**	**Tube C**
	Protease + heated protein substrate	**Protease + unheated protein substrate**	**Protease + unheated protein substrate + raw bean extract**
0	10	10	10
30	4	7	9

Fig. 1.1 shows a standard graph obtained by using colorimetric method for determining concentration of protein solutions.

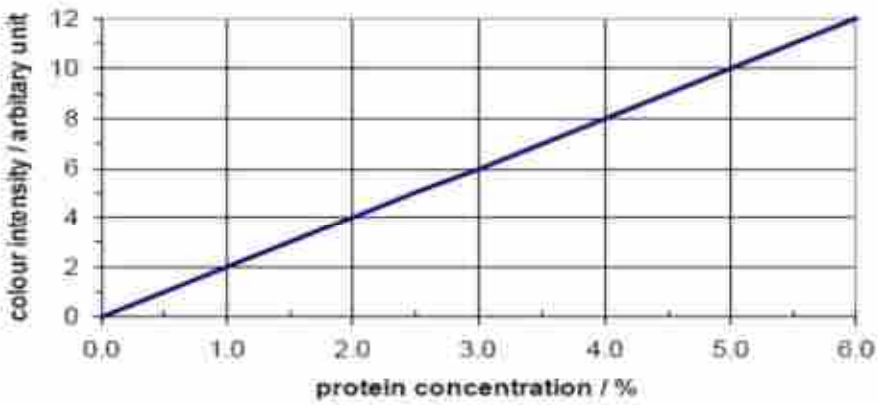


Fig. 1.1

(a) With reference to Table 1.1 and Fig 1.1,

(i) Determine the protein concentration of the three tubes at time 0 min.

…… [1]

(ii) Explain which protein substrate is more digestible by protease.

……...

……...

……...

…… [2]

(b) Based on your knowledge of protein structure, explain the effect of heat treatment on the digestibility of this protein substrate.

……

……

……

……

……

…… [3]

(c) Suggest the effect of raw bean extract on protease activity.

…… [1]

(d) Dextrin is a generic term applied to a variety of products obtained by heating starch in the presence of small amounts of moisture and an acid. Dextrins can be made from starch and is a polysaccharide similar to amylopectin.

Describe the differences in molecular structure between cellulose and dextrins.

……

……

……

…… [2]

Fig. 1.2 shows the structure of a triglyceride. Fig. 1.3 shows the structure of a glycolipid.

Fig. 1.2

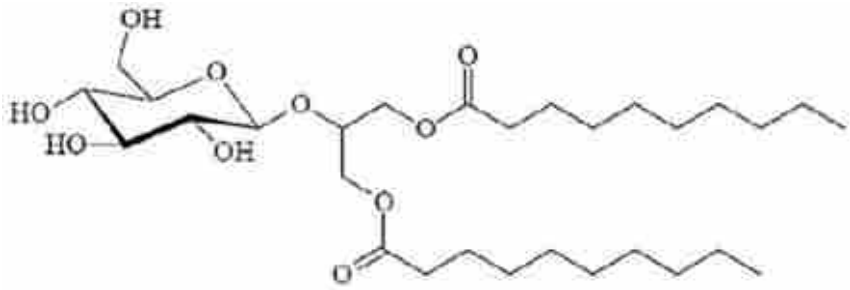


Fig. 1.3

(e) Explain the difference in solubility between triglycerides and the products of their hydrolysis.

……

……

……

……

……

…… [3]

(f) Describe the roles of triglycerides and glycolipids in relation to the differences in their molecular structures.

……

……

……

…… [2]

[Total: 14]

2 Fig. 2.1 shows two pairs of homologous chromosome carrying alleles **F/f and G/g** respectively.

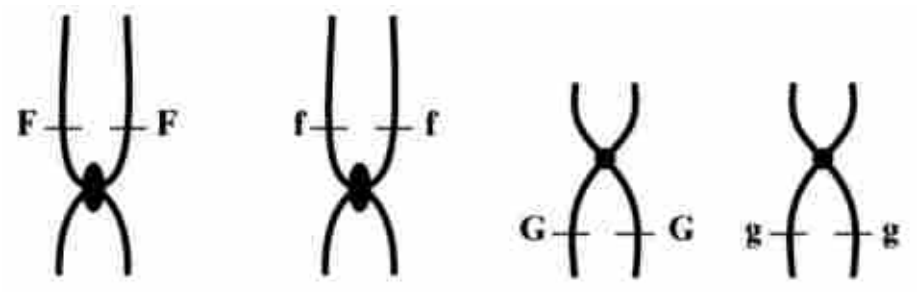


Fig. 2.1

(a) State the genotype of this cell.

…… [1]

(b) Explain why there are two copies of each allele for each gene present on the chromosomes in Fig. 2.1, before the start of nuclear division.

……

……

……

…… [2]

Fig. 2.2 shows a molecule of tRNA and the enzyme that attaches the correct amino acid to it.

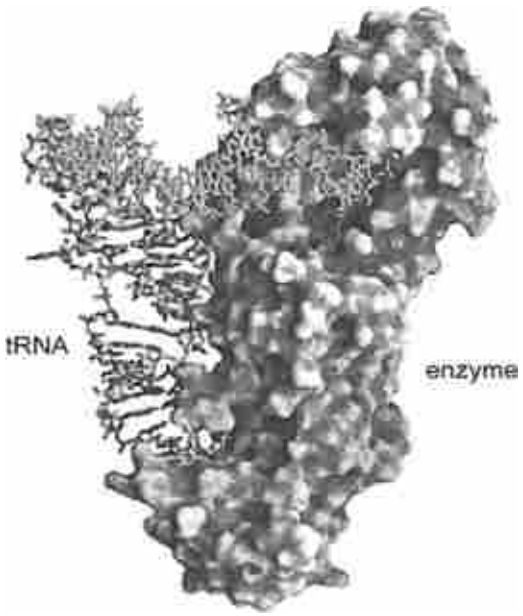


Fig. 2.2

(c) Describe **two** structural features which adapt tRNA to its role in translation.

.....

.....

.....

..... [2]

(d) Explain how the enzyme in Fig. 2.2 is suited to its function.

.....

.....

.....

.....

.....

..... [3]

(e) Fig. 2.3 below shows the base sequence on a length of mRNA and the amino acids represented by the respective codons.

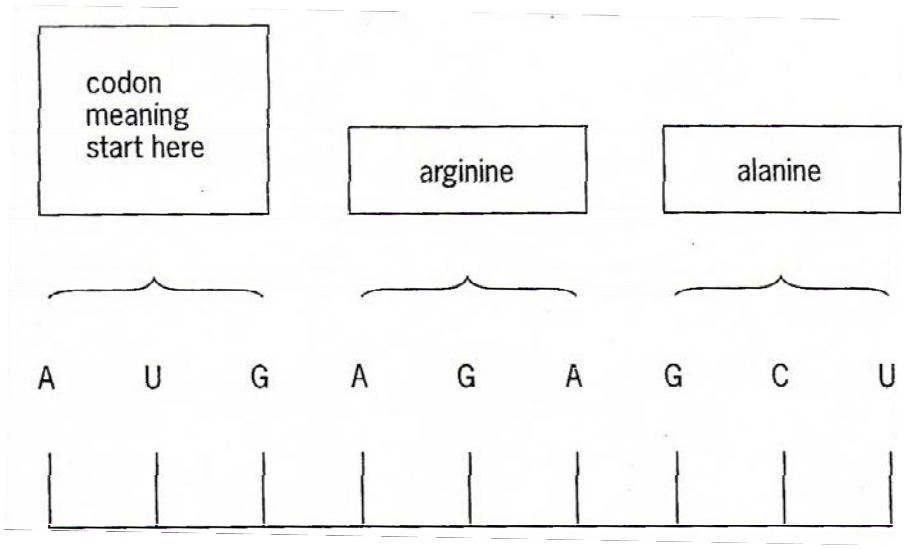


Fig. 2.3

The codon AGA codes for the amino acid arginine. However, arginine can also be represented by the codon AGG.

(i) Explain why the substitution of A by G in this case does not affect the amino acid represented.

……

…….. [1]

(ii) The codons in the mRNA sequence do not overlap. Suggest one advantage of this.

……

…….. [1]

[Total: 10]

3 An inbred variety of maize, **A**, with finely striped leaves was found to be resistant to the fungus that causes the disease, corn leaf blight.

Plants of variety **A** were crossed with another inbred variety of maize, **B**, which had entirely green leaves and low resistance to the fungus. All the F_1 generation had entirely green leaves and low resistance.

(a) Using appropriate symbols and indicating what they represent, state the genotype of **A**.

…… [1]

The above F_1 generation was back-crossed to variety **A**.

(b) Draw a genetic diagram to explain the expected results of the F_2 generation from this cross.

[5]

[Total: 6]

4 Dengue fever is an infectious disease transmitted by a vector.

(a) **(i)** State the name of the pathogen that causes dengue fever.

…….. [1]

(ii) State the name of the vector that transmits the pathogen.

…….. [1]

In 2002, the World Health Organization estimates that there might be 50 million cases of dengue infection worldwide every year. In Singapore, dengue fever is endemic with year-round transmission. Fig 4.1 shows the incidences of dengue fever from 1985 to 3 September 2005.

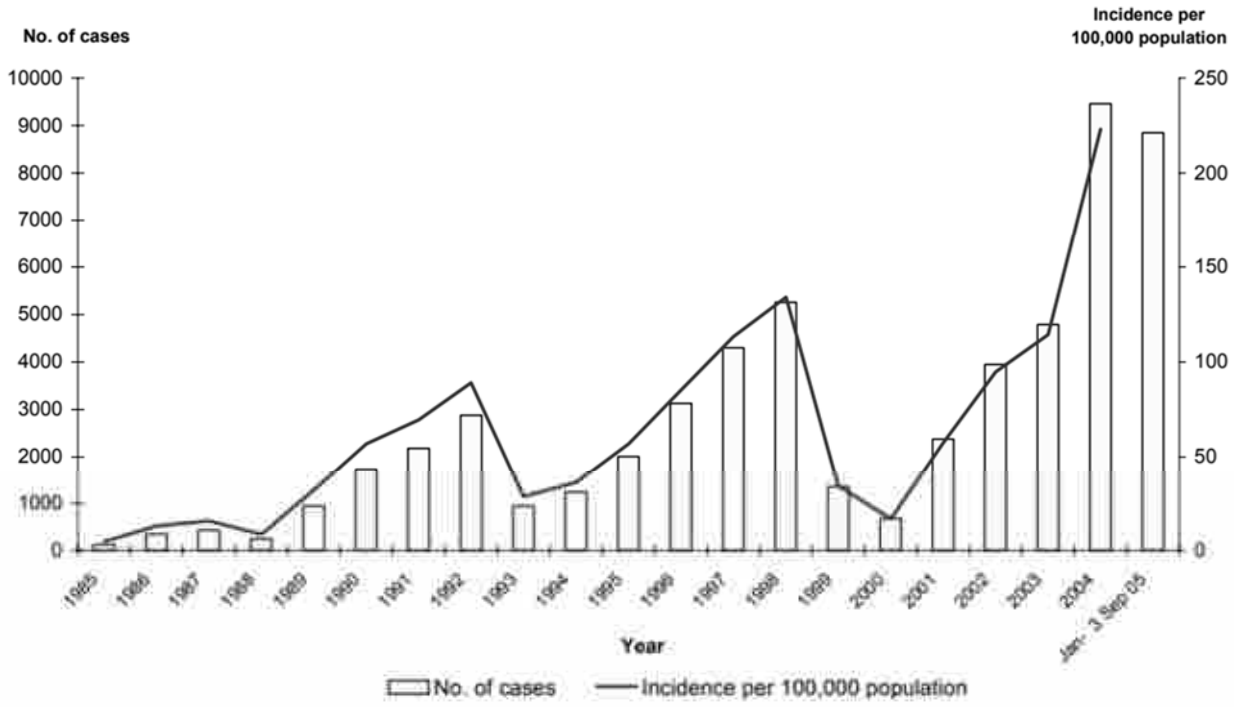


Fig. 4.1

(b) Suggest **two** reasons why the number of cases of dengue fever decreased in 1993 and 2000.

…….

…….

…….

…… [2]

(c) Dengue fever is very difficult to control even though there has been improved understanding of the disease.

Explain why dengue fever is very difficult to control.

……

…… [1]

[Total: 5]

5 Fig. 5.1 shows the Calvin cycle which takes place inside a plant cell.

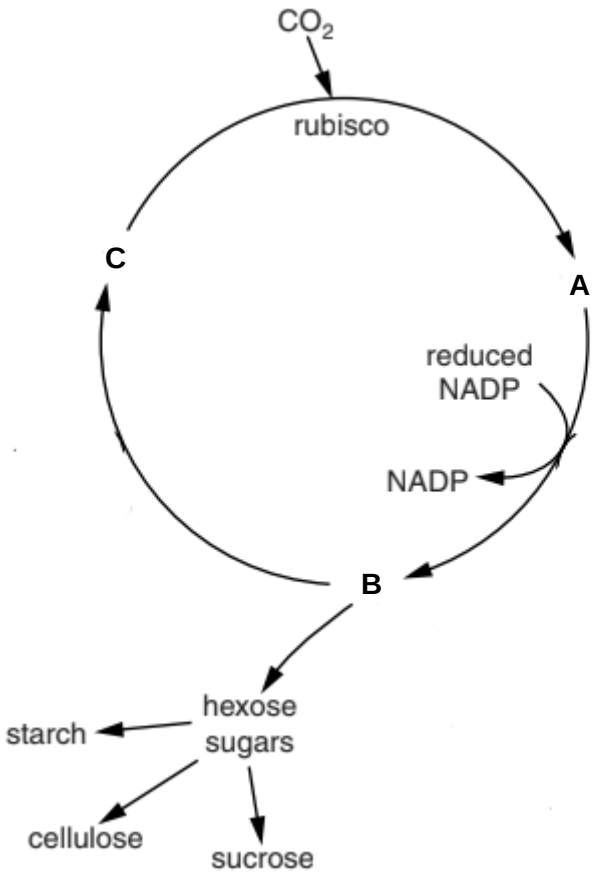


Fig. 5.1

(a) Identify substances **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(b) Describe the role of NADP in linking the light dependent reactions to the Calvin cycle in shown in Fig. 5.1.

.....

.....

.....

..... [2]

(c) In aerobic respiration and photosynthesis, ATP is synthesised via chemiosmosis in oxidative phosphorylation and photophosphorylation.

(i) Outline the role of stalked particles in chemiosmosis in oxidative phosphorylation.

……...

……...

……...

……...

……...

…… [2]

(ii) Explain why less ATP is synthesised from the same mass of glucose in anaerobic respiration compared to aerobic respiration.

……...

……...

……...

……...

……...

…… [3]

[Total: 10]

Section B

Answer **one** question in this section.

Write your answers on the lined papers provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where applicable.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6 **(a)** Discuss the role of complementarity in cellular mechanisms. [6]

(b) Red blood cells are replaced every 3 to 4 months.

Explain how haemoglobin is synthesised when haematopoietic stem cells form red blood cells. [9]

[Total: 15]

7 **(a)** With reference to named examples, describe the range of roles performed by ATP in living organisms. [6]

(b) Cytochrome *c* is primarily known as an electron-carrying mitochondrial protein. The amino acid sequence is highly conserved in eukaryotes, differing by a few residues.

Cytochrome *c* amino acid sequence in humans is more similar to that of chimpanzees but differs more from that of horses.

Explain how cytochrome *c* was conserved over time in eukaryotes. [9]

[Total: 15]

Name	Index Number	CTG

YISHUN JUNIOR COLLEGE
JC 2 SEMESTRAL EXAMINATION 2018

BIOLOGY **8876/01**

HIGHER 1 **14th SEPTEMBER 2018**
Fri 0800 – 0900

1 hour

Paper 1 Multiple Choice

Additional material: Optical Mark Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your NRIC number, name and CTG on the Optical Mark Sheet in the spaces provided.

There are **twenty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Optical Mark Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This question paper consists of 9 printed pages and 1 blank page.

1 The diagram is taken from an electron micrograph of a cell which secretes digestive enzymes.

Where are these enzymes made? **Ans: C**

Explanation: digestive enzymes are proteins. Proteins are translated by 80S ribosomes bounded to ER (RER).

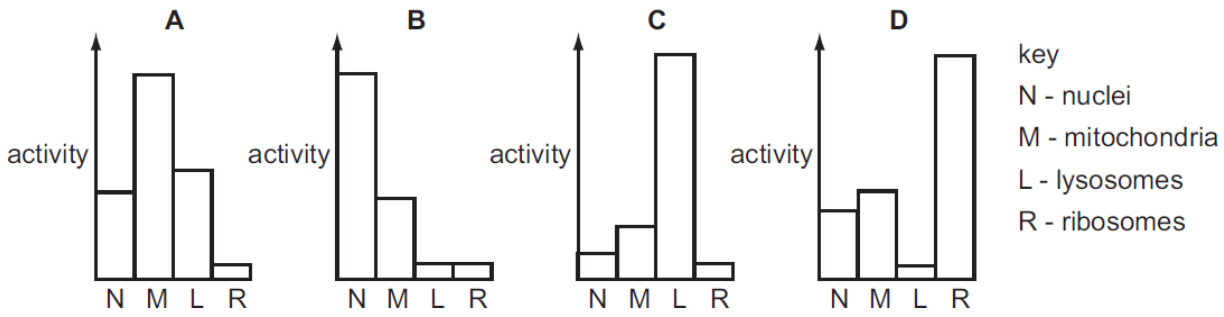
2 What is the order of size of cell components?

	Largest →			Smallest
A	Mitochondria	Ribosomes	Starch grains	Nuclei
B	Nuclei	Chloroplasts	Mitochondria	Ribosomes
C	Ribosomes	Mitochondria	Chloroplasts	Starch grains
D	Starch grains	Mitochondria	Chloroplasts	Ribosomes

Explanation: Nucleus has the largest molecular weight while ribosomes have the smallest molecular weight.

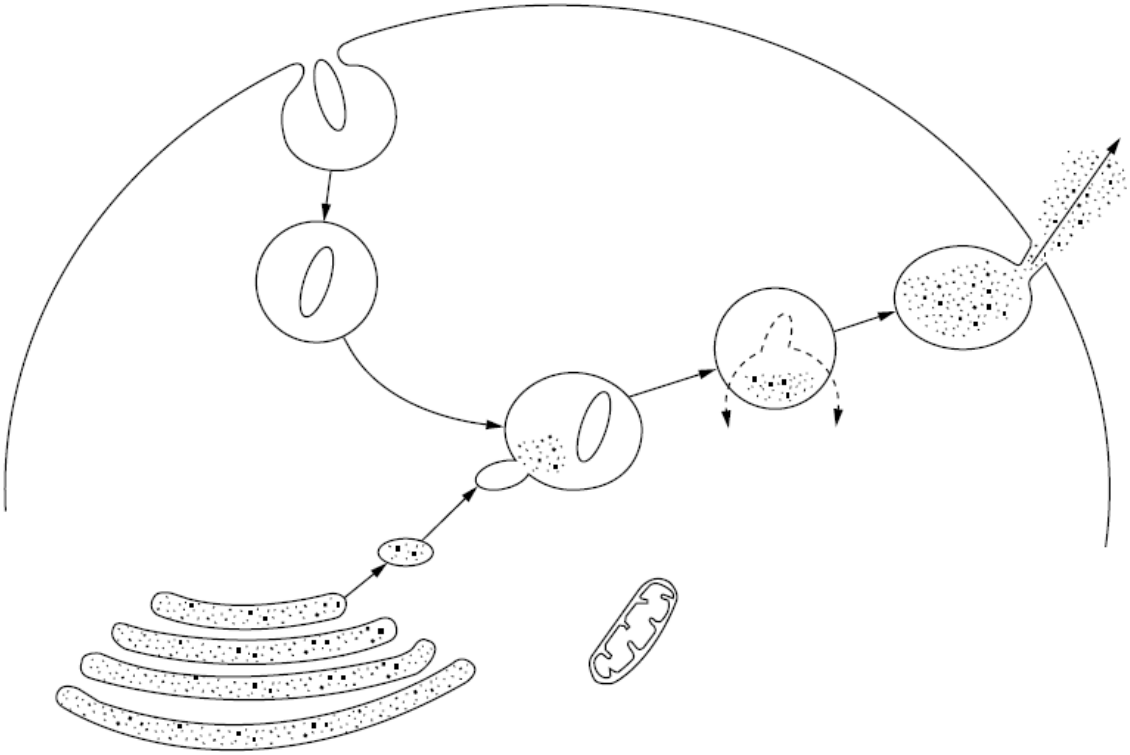
3 A piece of mammalian tissue was homogenised and subjected to differential centrifugation to yield four subcellular fractions. The activity within each fraction, of four different types of enzyme, **A**, **B**, **C** and **D**, was investigated.

Which bar chart shows the results of investigating hydrolytic enzyme activity?



Explanation: hydrolytic enzymes are found in the lysosomes. Therefore, the bar with the highest activity for lysosomes should reflect the investigative outcome for hydrolytic enzymes.

4 The diagram shows several processes taking place in a cell.



Which processes are shown in the diagram and involve the cell surface membrane of the cell?

A active transport and diffusion

B diffusion and osmosis

C endocytosis and exocytosis

D endocytosis and osmosis

Explanation: Endocytosis is in the intake of materials into the cell via the formation of the pseudopods and engulfment of materials in an endosome. Exocytosis is the discharge of materials via the fusion of endosome with the cell surface membrane.

5 A plant cell is placed in a solution with a less negative (higher) water potential than the cell contents.

Which change occurs in the cell and what causes the change?

	change	cause
A	cell becomes more flaccid	solution diffuses out of the cell
B	cell becomes more flaccid	water diffuses out of the cell
C	cell becomes more turgid	solution diffuses into cell
D	cell becomes more turgid	water diffuses into cell

Explanation: If solution water potential is higher than cell content, water will diffuse into the cell via osmosis causing the cells to become turgid.

6 Beetroot cells contain a water-soluble red pigment. Two test tubes were set up as described in the table.

tube 1	Pieces of washed raw beetroot in water
tube 2	Pieces of washed raw beetroot in water containing 3 drops of cyanide, a respiratory inhibitor.

After 30 minutes, the water in tube 2 contained a red pigment but the water in tube 1 did not.

Which of the following statements are false for tube 2?

1 Pigment molecules passed out and were replaced by cyanide.

2 The cell membrane was unable to retain the red pigment.

3 Water entered the tissue by osmosis and caused the cells to burst.

4 Water passed out of the cells by osmosis and carried the soluble pigment with it.

5 The same result will occur if ethanol was used instead of cyanide.

A 1 and 3 only

B 3 and 4 only

C 2 and 5 only

D 1, 3 and 4 only

Explanation: deduce what is true – the reason why tube 2 is red is because the red pigments leak out of the cell due to the disruption of the cell membrane (#1 and #5). Beetroot cells are plant cells; plant cells have cell wall; therefore, osmosis should not cause the cells to burst (contradict #3). Cyanide disrupts the membrane and do not replace the red pigments (contradict #1). Red pigments are too big to diffuse across the membrane (contradict #4).

7 Some features of haemoglobin are listed.

1 They are made up of a protein component called globin and a non-protein component called haem group.

2 There are two types of polypeptide chains: the α-helix globin chain and the β-globin chain.

3 Each polypeptide chain is held by hydrophobic interactions, hydrogen and ionic bonds and disulfide bonds.

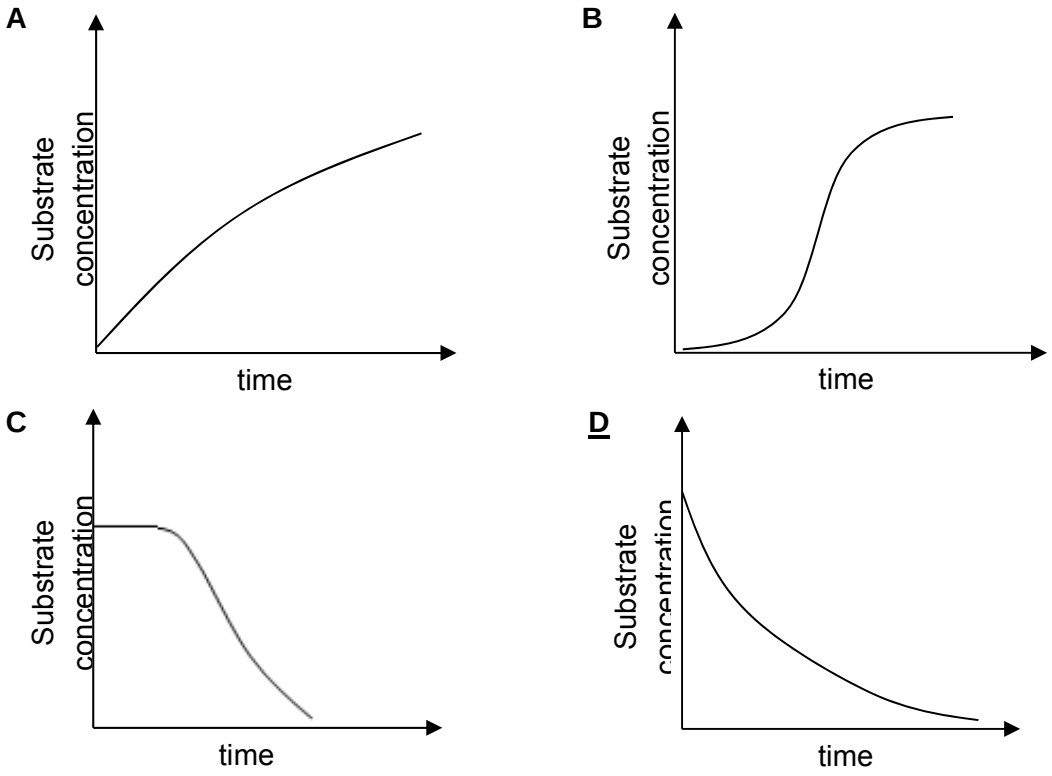
4 Most of its hydrophilic polar amino acid residues are on the external surface of the globular structure.

Which are these statements are true ?

A 1 and 3 **B** 1 and 2 **C** 1, 2 and 4 **D** 1 and 4

Comments : there are no disulphide bonds and polypeptide is α-globin chain

8 Which graph represents the changes in substrate concentration during the course of an enzyme catalysed reaction?



9 Which is a correct statement about obtaining human embryonic stem cells for research?

A Removal of these cells is considered to be ethically acceptable as normal development of the embryo is not inhibited.

B The cells must be removed at an early stage of development from a region of the blastocyst known as the inner cell mass.

C The cells must be removed within a day following the successful fertilisation of the ovum by the sperm, and after checking for normal mitotic division.

D The region of the blastocyst from where the cells are removed is an area that develops at a later stage into the placenta.

Explanation: A is not correct because it is not ethically accepted to remove ESCs from blastocyst as the blastocyst is deemed as a potential life. C is not correct because the cells removed within a day following successful fertilisation are zygotic stem cells. D is not correct because it is the trophoblast that will develop into a placenta, not the inner cell mass.

10 Mesenchymal stem cells can differentiate into several types of cells belonging to our skeletal tissue, such as cartilage, bone and fat.

Which statement correctly describes mesenchymal stem cells?

A They are specialised cells that can give rise to a variety of cell types.

B They can be stimulated by chemical signals to express certain genes.

C They lose genetic information as they differentiate.

D They occur in large numbers in the bone marrow.

Explanation: A is false because stem cells are not specialised cells. C is false because genetic information is condensed, not lost. D is false because haematopoietic stem cells are found in bone marrow.

11 Which statements about ribosomal RNA(rRNA) is true?

1 rRNA is involved in the binding of mRNA and not tRNA.

2 rRNA with associated proteins, fold into complex tertiary structures within the ribosome.

3 The 3′ terminus of rRNA in prokaryotes is known to interact with the initiation region of mRNA via the Shine–Dalgarno sequence.

4 Nucleolus is the site of rRNA transcription and processing, and of ribosome assembly.

A 1 and 3 **B** 1, 2 and 3 **C** 2 and 4 **D** 2, 3 and 4

Explanation: 1 is false because tRNA anticodon is complementary to the codon of the mRNA, not rRNA. 2 is true because rRNA is a component of ribosome. 3 is true because the rRNA in the small ribosomal subunit binds to the initiation region of the mRNA. 4 is true because rRNA is transcribed in nucleolus.

12 What is the basis for the difference in the synthesis of the leading and lagging strands of DNA molecules?

1 The anti-parallel arrangement of the DNA strands.

2 The RNA primers are required to initiate DNA elongation.

3 DNA polymerase can join new nucleotides to the 3' end of the growing strand.

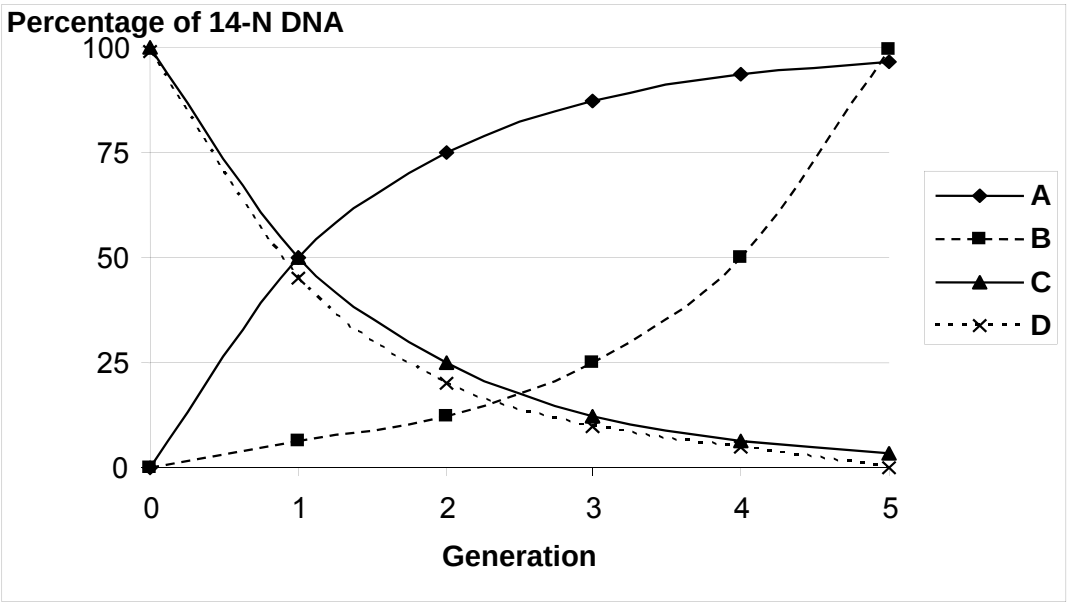
4 Helicase and single-stranded binding proteins work at the 5'end of the DNA strand.

A 2 and **B** 1 and 3 **C** 1 and 4 **D** 2 and 3

Explanation: 2 is false because both leading and lagging strands require primers to initiate DNA elongation. 4 is false because helicase and ssbp work on the 3' end of the DNA strand because daughter strand is elongated from 5' → 3'

13 Bacteria were cultured in a medium containing heavy nitrogen (^{15}N) until all DNA was labelled. These bacteria were then grown in a medium containing only normal nitrogen (^{14}N) for 5 generations. The percentage of ^{14}N DNA strands in each generation was estimated.

Which curve provides evidence that DNA replication is semi-conservative?



Answer A

14N DNA increases. Between A or B . first generation – 50 % (2 molecules of 14N : 15N)
Second generation : 2 molecules of 14N15N and 2 molecules of 14N14N) 6/8 = 75% etc

14 A new form of life is discovered. It has a genetic code much like that of organisms on Earth except that there are five different DNA bases instead of four and the base sequences are translated as doublets instead of triplets. How many different amino acids could be accommodated by this genetic code?

A 10

B 25

C 32

D 64

Explanation: $5^2 = 25$

15 What do chromosomal aberrations and gene mutations have in common and how are they different?

	Similarity	Difference
A	Both may involve addition of nucleotides.	Gene mutations always produce dominant alleles but not chromosomal aberrations.
B	Both cause changes in number of chromosomes.	Gene mutations do not involve inversions but inversion of segments of chromosomes do occur.
C	Both affect DNA sequence.	Gene mutations occur within a chromosome but chromosomal aberrations may occur across chromosomes.
D	Both may not result in a difference in protein expression.	Chromosomal aberrations are more harmful than gene mutations.

Option A : Gene mutations do not always produce dominant alleles. Option B : Gene mutation does not cause changes to the total number of chromosomes in an organism.

16 Which environmental factor is associated with the development of melanomas (a type of skin cancer)?

A alcohol

B tar

C ultraviolet light

D X-radiation

Explanation: melanomas are skin cancer, therefore, only UV aggravate the risk of cancer.

17 The table shows the DNA triplet codes for some amino acids from the strand complementary to mRNA.

Amino acid	DNA triplet code
Glycine	CCA, CCG, CCT, CCC
Leucine	AAT, AAC, GAA, GAG, GAT, GAC
Lysine	TTT, TTC
Methionine	TAC
Proline	GGA, GGG, GGT, GGC
Threonine	TGA, TGG, TGT, TGC

The sequence of DNA triplets from the strand complementary to mRNA form part of a gene is shown.

…TAC TTT AAT GGC CCT GAG GGC TAC TGT …

Which mutated DNA sequences of this part of a gene would result in the same amino acid sequences as the original gene sequences ?

A …TAC TTT AAT GGC CCT GAG GGT CCA TGT

B …TAC TTC GAT GGC CCT GAG GGC TAC TGT

C …TAC TTT AAT GGC CCG GAG TGA TAC TGT

D TAC TTT AAT GGC CCT GAG GGC TTC TGT

Explanation: no change in amino acid sequence → implies silent mutation

18 Cancer research has found that gene amplification is involved in the development of cancer. This research has identified one type of sequence that causes a break in DNA before gene amplification.

How might the findings of this research be used?

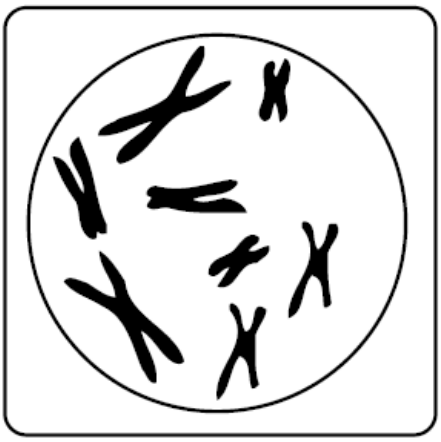
A to identify people at risk of developing cancer

B to prevent cancer from developing in 'at-risk' people

C to repair DNA breaks from amplification occurs

D to use restriction endonuclease to remove DNA

19 The diagram shows a diploid cell during mitosis.



Which stage of mitosis is shown?

A anaphase

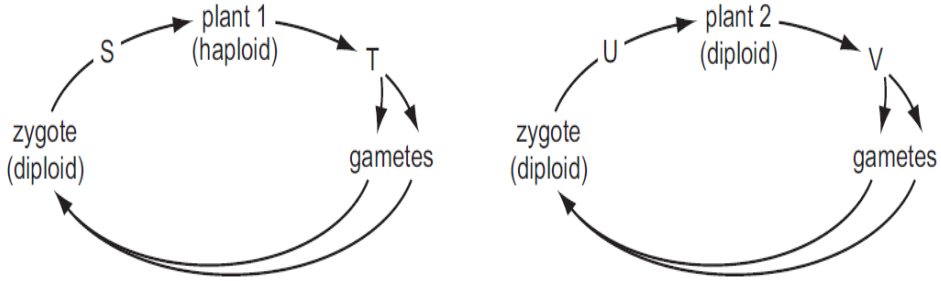
B metaphase

C prophase

D telophase

Explanation: Recall the behaviour of the chromosomes in the different stages of mitosis.

20 The diagram shows the life-cycles of two types of simple plant.



Where will reduction divisions occur in the life cycles?

A at S and U

B at S and V

C at T and U

D at T and V

Explanation: reductive divisions occur when there is a need reduced number of chromosomes from diploid to haploid.

21 In corn, the colour of the stem can be either wild type, which is dark green, or virescent, which is pale green.

Cross	Phenotype of parents	Temperature at which raised	Offspring
1	virescent X virescent	20°C	virescent
2	virescent X virescent	37°C	wild type
3	wild type X wild type	20°C	3 wild type: 1virescent
4	wild type X wild type	37°C	wild type

The parents of crosses 1 and 2 had the same genotypes. The parents of crosses 3 and 4 had the same genotypes.

Which of the following can be deduced from the data?

1 Wild type is dominant.

2 The wild type parents are heterozygotes.

3 Virescent is the recessive phenotype but the characteristic will only be expressed at lower temperature.

4 The parents of cross 1 are only recessive at 20°C.

A 2 only

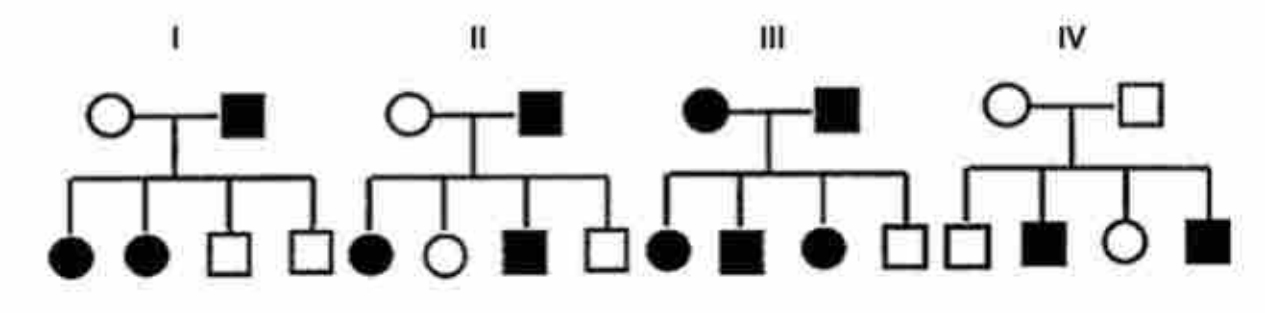
B 1 and 3 only

C 1, 2 and 3 only

D all of the above

Comments cross 3 has offspring virescent at lower temperature and not at 37ºC even though genotypes are the same. Statement 4 is incorrect as dominant or recessive not affected by temperature but rather the expression is affected

22 The figure below shows 4 pedigrees. A shaded circle represents an affected female while a shaded square represents an affected male.



Which pedigree(s) show(s) a sex-linked dominant trait in humans?

A I only

B I and III

C II and III

D III and IV

Sex linked dominant :

I : shaded square male X^D Y → pass one X^D to female and diseased . Male not diseased

If diseased is recessive, X^d Y x X^D X^D female, then females should not be affected.

II : X^D Y or X^d Yshaded male. If dominant X^D Y → female diseased .

But male affected. Can be because of recessive allele from mother X^d X^d

Option III ;

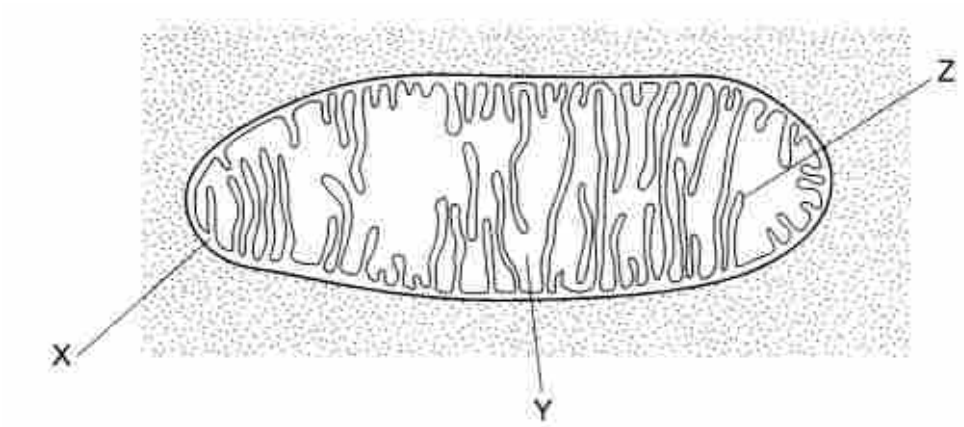
X^d X^d x X^d Y→ all males affected , But see one male unaffected

X^D X^D x X^D Y → all sexes affected

X^D X^d x X^D Y → females affected , males affected and males unaffected

Option IV : If dominant, at least one parents should be shaded

23 The electron micrograph shows an organelle found in a plant cell.

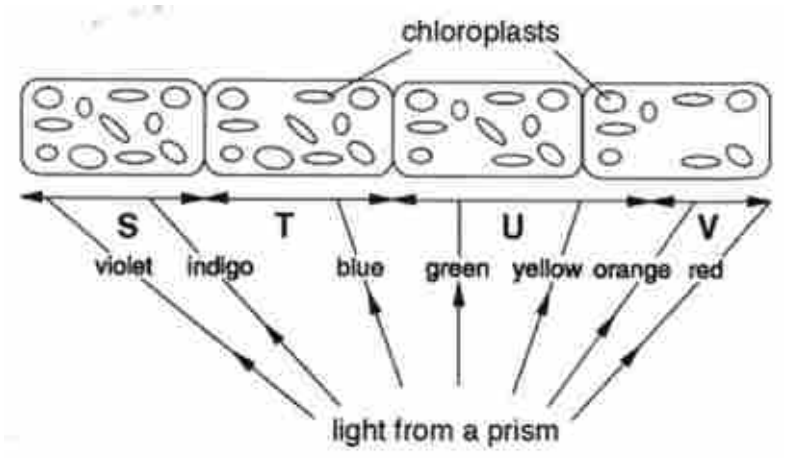


Which row shows the correct location of each named biological molecule?

	DNA	oxaloacetate	ATP
A	absent	Y	Z
B	Y	Z	Y
C	Y	Y	X
D	Y	Y	Y

Explanation: DNA is found as circular DNA in the matrix. Oxaloacetate is a substrate that is part of the Krebs cycle. ATP is produced during chemiosmosis into matrix.

24 A filament of the alga *Cladophora* was illuminated as shown in the diagram. Motile, aerobic bacteria were placed in the water with the alga and their position was determined by microscopic examination after 10 minutes.



In which two regions will the number of bacteria be highest?

A S and T

B S and U

C T and V

D U and V

Explanation: High light absorption in blue and red wavelengths → implies highest rate of photosynthesis → more bacteria

25 The copying of DNA is not always accurate, resulting in occasional, random changes to its base sequence. For example, scientists have calculated that one amino acid in vertebrate haemoglobin protein is changed every 10 million years.

Which statement about this process is correct?

A A single amino acid change in a protein may be affected by natural selection.

B All changes in the base sequence of DNA are affected by natural selection.

C Natural selection can cause some of the amino acid changes in proteins.

D The variability of DNA in a population will be less than the variability of its proteins.

Comments
A- One aa subject to NS to select for the haemoglobin protein
B – change in base sequence due to mutation, Silent mutation not affected by NS
C - change in aa due to mutation
D – no link to the process

26 In 1954, copper waste in the Finniss River killed numerous fish. This caused various species in the area to die out. However, one species, the black-banded rainbow fish, increased in numbers. The black-banded rainbow fish have modified gills that enable the fish to filter and remove the copper before it enters their body.

With respect to the black-banded rainbow fish it is reasonable to conclude that

A a mutation occurred in their population in 1954.

B the ability of their gills to remove copper already existed in 1954

C the high levels of copper in the water changed the structure of their modified gills

D their genomes are identical with those of the other species of fish that existed in 1954.

Comments : there existed the black banded rainbow fish that has the ability to remove copper within the population already. Mutation occurred prior to change in environment

27 Climate change has led to increasing temperature. The environments where birds, fishes, and other marine species live have become warmer. What is not an effect of climate change on these organisms?

A Certain fish species migrate in response to seasonal temperature changes, moving northward or to deeper, cooler waters in the summer and migrating back during the winter.

B The birds are moving north to feed and breed in the summer, then moving further south to spend the winter in warmer areas.

C The birds follow a regular seasonal migration pattern during wintering periods.

D As smaller marine prey species shift their habitats, larger predator species may follow them.

Comments
A, B and D are effect and consequences from an increase in temperature . Option C is the habit of birds and not an effect

28 Other than melting land-based ice sheets, which of these factors has made the largest contribution to the rise in sea level over the past 100 years?

A Warming of ocean surface water

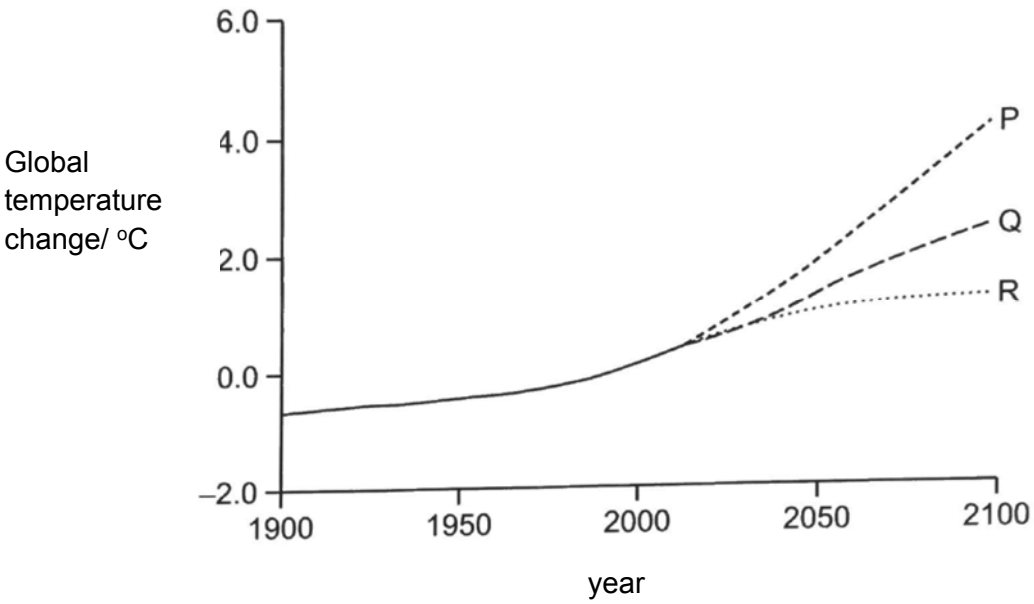
B Melting sea ice

C Increased river runoff

D Increased reflection of infrared radiation

Explanation: sea ice is formed from sea water, therefore melting of sea ice will not rise sea level.

29 The graph shows the predicted changes in global temperatures using three different models, P, Q and R. Model Q assumes that no new factors act to influence the rate of climate change.



The predictions based on models P and R can be explained using some of the following statements.

1 An increased global temperature and reduced rainfall will lead to an increase in forest fires.

2 Permanently frozen soil and sediment in the Artic will begin to thaw as global temperature increase.

3 Rising sea temperature will cause increase growth of photosynthetic algae.

4 Rising sea temperatures will reduce the solubility of greenhouse gases in the oceans.

Which of these statements support predictions P and R?

	statements that support prediction P	statements that support prediction R
A	1, 2 and 4	3
B	1 and 3	2 and 4
C	2	1, 3 and 4
D	3 and 4	1 and 2

Comments: Curve P shows a higher increase in global temperature. Statements 1, 2 and 4 lead to sharp increase in global temperature. Algal blooms absorb sunlight, making water even warmer and promoting more blooms.

30 Corals are among the first indicators of climate change. When ocean temperatures get too hot for too long, corals undergo a process called bleaching. Which statements are true about this process?

1 Increased levels of sediment in seawater, the zooxanthellae may lose substantial amounts of their photosynthetic pigmentation, which decreases rates of photosynthesis produces bleaching.

2 Bleaching occurs when abnormally high sea temperatures cause corals to expel the zooxanthellae living in them.

3 zooxanthellae unable to use the oxygen and waste materials of the host, supplying carbon dioxide and food substances in return.

4 With high sea temperatures and decreasing planktons, corals use the zooxanthellae as their food source

A 1 and 2

B 1 and 4

C 2 and 4

D 2 and 3

Statement 3 is wrong as zooxanthellae supply oxygen (from photosynthesis) to the corals and coral supply carbon dioxide to zooxnthellae.
Statement 4 is wrong as zooxanthellae is expelled out.

Parent's signature		
Name	**Index Number**	**CTG**

YISHUN JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION 2018

BIOLOGY **8876/02**

HIGHER 1 **29 AUGUST 2018**

Paper 2 Structured and Free-response Questions **Wed 1400 - 1600**

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and CTG in the spaces at the top of this page and on all separate answer paper used.

Write in dark blue or black pen only.

You may use a soft pencil for any diagrams, graphs or rough working.

Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question paper.

Section B
Write your answers in the spaces provided on the Question Paper.

At the end of the examination, fasten all your work securely together.

This question paper consists of **20** printed pages.

FOR EXAMINER'S USE	
Paper 1	/ 30
Paper 2	
Section A	
Q1	/14
Q2	/10
Q3	/ 6
Q4	/ 5
Q5	/ 10
Section B	
Q6 OR 7	/ 15
Total	/ 60
Overall	/ 90

Section A

Answer **all** questions in this section.

1 In an experiment to study the effect of heat treatment on the digestibility of protein substrate and the effect of raw bean extract on protease activity, various reaction mixtures were prepared and were incubated for 30 minutes.

The protein concentration of each reaction mixture at the beginning and at the end of the incubation period was determined by the colorimetric method which measures colour intensity of these reaction mixtures. The results were shown in Table 1.1.

Table 1.1

Incubation period /min	**Colour intensity of the reaction mixture / arbitrary unit**		
	Tube A	**Tube B**	**Tube C**
	Protease + heated protein substrate	**Protease + unheated protein substrate**	**Protease + unheated protein substrate + raw bean extract**
0	10	10	10
30	4	7	9

Fig. 1.1 shows a standard graph obtained by using colorimetric method for determining concentration of protein solutions.

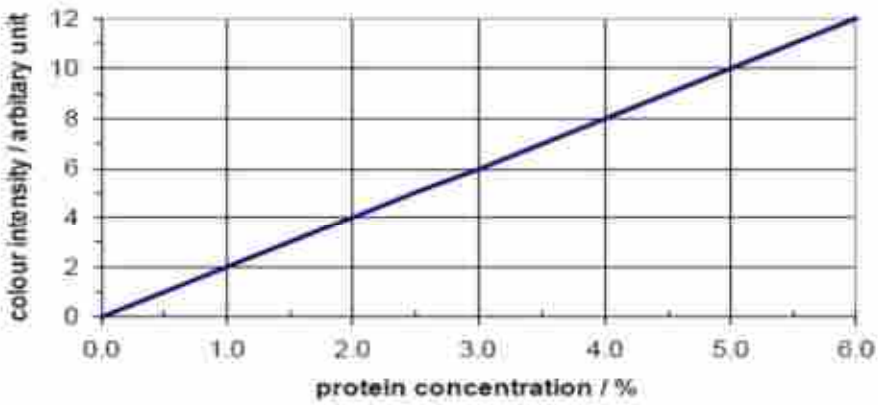


Fig. 1.1

(a) With reference to Table 1.1 and Fig 1.1,

(i) Determine the protein concentration of the three tubes at time 0 min.

5% protein concentration [1]

(ii) Explain which protein substrate is more digestible by protease.

1. **heated protein more digestible by protease;**
2. **less protein remained after incubation with protease / lowest colour intensity**
3. **unheated vs heated = 3% decreases** [2]

(b) Based on your knowledge of protein structure, explain the effect of heat treatment on the digestibility of this protein substrate.

1. **heating increases the digestibility of this protein substrate / digest more quickly / easier to digest;**
2. **heating causes protein substrate denaturation/ loss of 3D configuration;**
3. **breaking of bonds – H, hydrophobic, ionic, disulphide (name at least 2);**
4. **increase in surface area of substrate for protease action/ easier access of enzyme(s' active site) to substrate/peptide bonds;** [3]

(c) Suggest the effect of raw bean extract on protease activity.

inhibits protease activity [1]

(d) Dextrin is a generic term applied to a variety of products obtained by heating starch in the presence of small amounts of moisture and an acid. Dextrins can be made from starch and is a polysaccharide similar to amylopectin.

Describe the differences in molecular structure between cellulose and dextrins.

1. **Cellulose** is a polymer of around 10,000 **β-glucose molecules while d**extrin is a polymer of **α glucose molecules**,
2. Dextrin joined by **α (1→4) and α (1→6) glycosidic bonds at the branch points** while **cellulose** joined by **β (1→4) glycosidic bonds**,
3. In cellulose, **alternate β glucose molecules rotate 180^0** while α glucose molecules of dextrin are at the **same orientation** (i.e. do not rotate)
4. Dextrin is a **branched** chain of α glucose units, and **coiled into a helix while cellulose chains are long unbranched chains with a**djacent cellulose chains form hydrogen bonds / cross bridges between the chains to form **microfibrils.** [2]

Fig. 1.2 shows the structure of a triglyceride. Fig. 1.3 shows the structure of a glycolipid.

Fig. 1.2

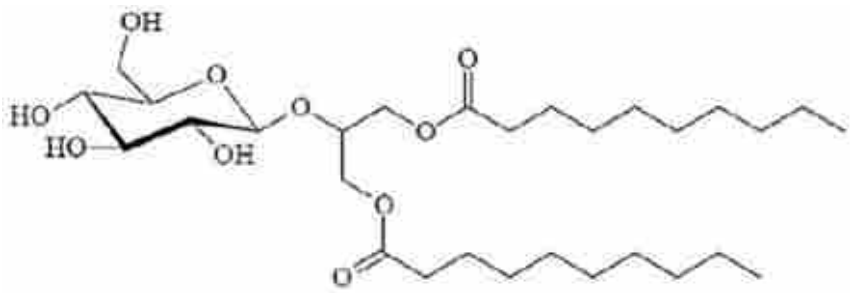


Fig. 1.3

(e) Explain the difference in solubility between triglycerides and the products of their hydrolysis.

1. Triglycerides are **non-polar molecules** that are **insoluble in water**. This is due to their incapability of forming hydrogen bonds with water molecules.
2. **Glycerol and fatty acids** are the **products of triglyceride hydrolysis**.
3. **Glycerol is an alcohol** that is **soluble** due to its ability (-OH groups in glycerol) to form hydrogen bonds with water, but **fatty acids** are **insoluble** due to their **long hydrocarbon tails** that are **non-polar** and **hydrophobic.** [3]

(f) Describe the roles of triglycerides and glycolipids in relation to the differences in their molecular structures.

1. **Has long hydrocarbon chains, acting as energy store that yield more energy** (38kJ per gram) than same mass of carbohydrates (17 kJ per g)
2. Releases **more metabolic water** during fat oxidation/ respiration.
3. Lipid molecule with a carbohydrate component and act as a recognition site for cell adhesion [2]

[Total: 14]

2 Fig. 2.1 shows two pairs of homologous chromosome carrying alleles **F/f and G/g** respectively.

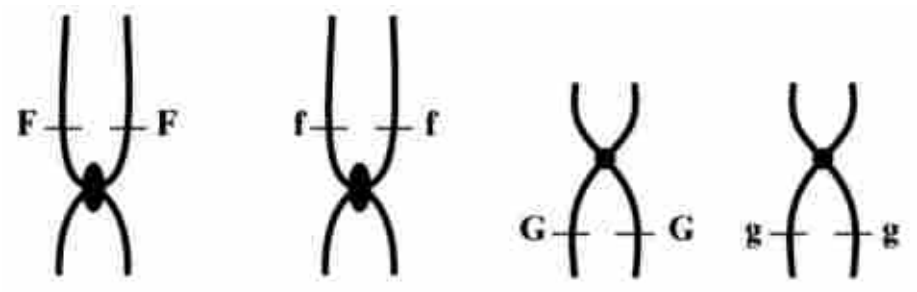


Fig. 2.1

(a) State the genotype of this cell.

FfGg [1]

(b) Explain why there are two copies of each allele for each gene present on the chromosomes in Fig. 2.1, before the start of nuclear division. [2]

1. DNA replication has occurred;
2. During interphase / S-phase of interphase before mitosis;
3. Giving rise to two chromatids;
4. With two copies of the allele, one on each chromatid;

Fig. 2.2 shows a molecule of tRNA and the enzyme that attaches the correct amino acid to it.

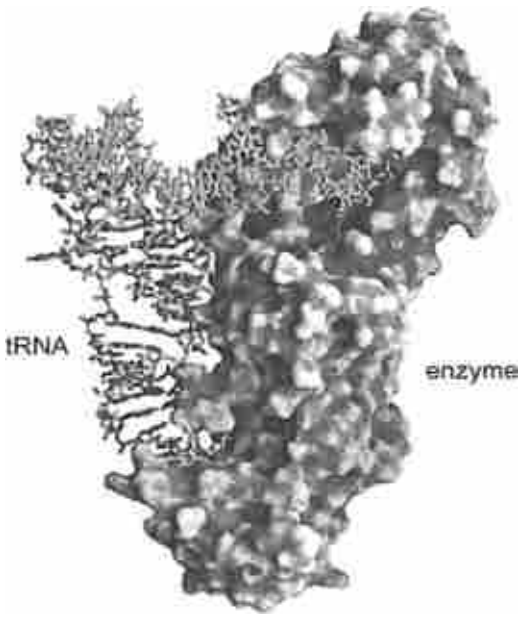


Fig. 2.2

(c) Describe **two** structural features which adapt tRNA to its role in translation.

1 3' / (CCA end) = allows specific amino acid molecule binds to the tRNA

2 loop with anticodon /region has specific triplet base sequence - complementary to a codon on mRNA. [2]

(d) Explain how the enzyme in Fig. 2.2 is suited to its function.

1) Identify the enzyme as aminoacyl-tRNA synthetase
2) has recognition/active site for both amino acid
3) and tRNA with specific anticodon;
4) with site being complementary in shape and charge to the substrates
5) able to catalyse formation of covalent bond between tRNA and amino acid
6) twenty different aminoacyl-tRNAase enzymes for each amino acid to ensure specificity in binding

[3]

(e) Fig. 2.3 below shows the base sequence on a length of mRNA and the amino acids represented by the respective codons.

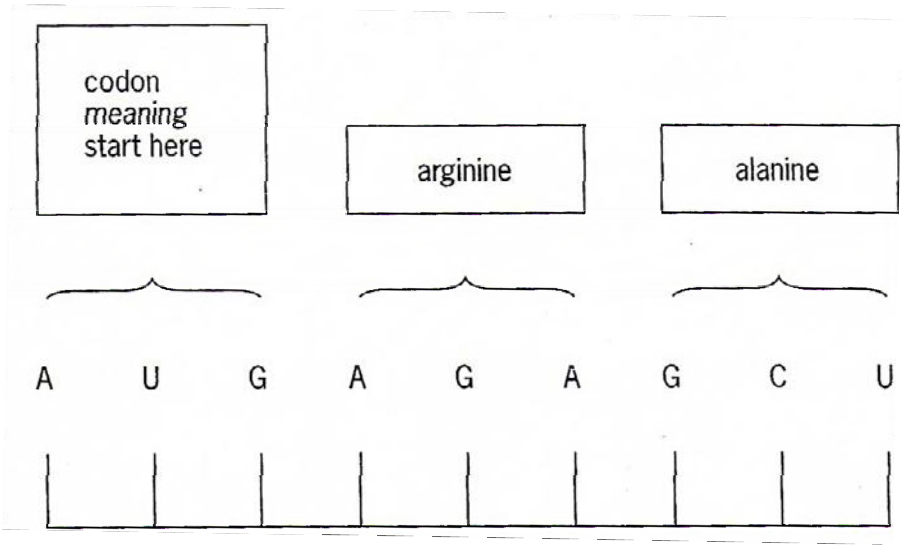


Fig. 2.3

The codon AGA codes for the amino acid arginine. However, arginine can also be represented by the codon AGG.

(i) Explain why the substitution of A by G in this case does not affect the amino acid represented.

1. Genetic code is degenerate/redundancy in genetic code;
2. 1 amino acid can be coded by more than 1 codon;
3. First two bases are most important in determining which amino acid is attached;
4. The third base is a wobble base/not as important;
5. It is a form of silent mutation [1]

(ii) The codons in the mRNA sequence do not overlap. Suggest one advantage of this.

1. Substitution of a base will only change one amino acid instead of two;;
2. Overlapping can cause difficulties in translation when the tRNA comes into the P site as it would be blocked by the previous tRNA;;
3. There is less restriction on the order of amino acids since the overlapped base of one codon has no effect on the next codon;; [1]

[Total: 10]

3 An inbred variety of maize, **A**, with finely striped leaves was found to be resistant to the fungus that causes the disease, corn leaf blight.

Plants of variety **A** were crossed with another inbred variety of maize, **B**, which had entirely green leaves and low resistance to the fungus. All the F_1 generation had entirely green leaves and low resistance.

(a) Using appropriate symbols and indicating what they represent, state the genotype of **A**.

G - entirely green leaf, R – low resistance
genotype of A: ggrr; [1]

The above F_1 generation was back-crossed to variety **A**.

(b) Draw a genetic diagram to explain the expected results of the F_2 generation from this cross.

Phenotype	***entirely green, low resistance***	***x***	***striped resistant***	***leaves, [1]***
[Genotype	***GgRr***	***x***	***ggrr***	***[2]***
Meiosis				
Gametes	***GR Gr gR gr***		***gr***	***[3]***
Fertilisation				
Using Punnett Square				

	GR	***gR***	***Gr***	***gr***
gr	***GgRr***	***ggRr***	***Ggrr***	***ggrr***

F_2 genotype	***GgRr***	***ggRr***	***Ggrr***	***ggrr***	***[4]***
F_2 phenotype (offspring)	***entirely green, low resistance***	***striped leaves, low resistance***	***entirely green, resistant***	***striped leaves, resistant***	***[5]***
F_2 phenotypic ratio	***1 :***	***1 :***	***1 :***	***1***	

[5]

[Total: 6]

4 Dengue fever is an infectious disease transmitted by a vector.

(a) **(i)** State the name of the pathogen that causes dengue fever.

Dengue virus; **A** DENV [1]

(ii) State the name of the vector that transmits the pathogen.

Aedes aegypti **R** mosquito, aedes, *A. aegypti* [1]
R genus and species are not underlined separately

In 2002, the World Health Organization estimates that there might be 50 million cases of dengue infection worldwide every year. In Singapore, dengue fever is endemic with year-round transmission. Fig 4.1 shows the incidences of dengue fever from 1985 to 3 September 2005.

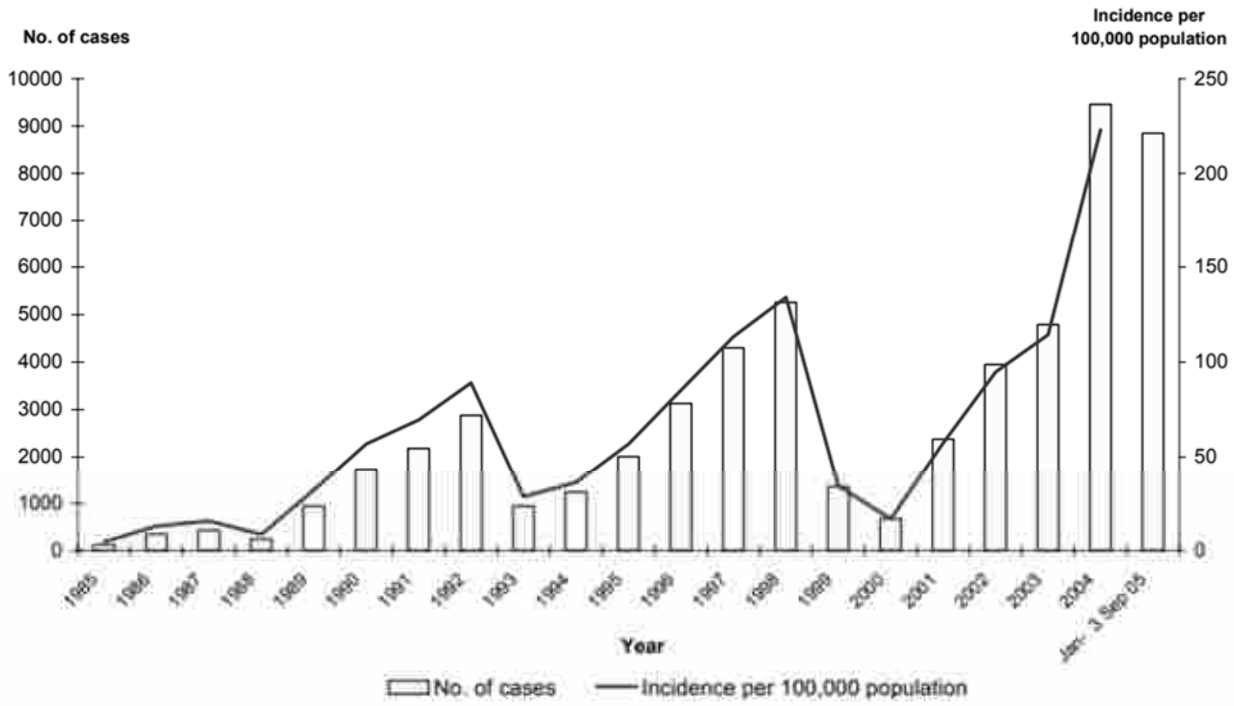


Fig. 4.1

(b) Suggest **two** reasons why the number of cases of dengue fever decreased in 1993 and 2000.

Give example of control of breeding of mosquitoes;
e.g. drainage of stagnant water / sterile males / aerial spraying of insecticide / applying oil on water / breeding of fishes in water

example of reduction of contact between mosquitoes and human;
e.g. use of bed nets / insect repellents

Improve in surveillance (by NEA);

Improve awareness of / education about, transmission / control methods;

AVP e.g. drop in ambience temperature → not suitable for breeding of mosquitoes

[Any 2] [2]

(c) Dengue fever is very difficult to control even though there has been improved understanding of the disease.

Explain why dengue fever is very difficult to control.

1 no vaccine **;** **A** no effective vaccine
2 any problem in developing a vaccine **;**
e.g. 4 serotypes of dengue viruses / antibody dependent enhancement of dengue virus infection
3 insecticide resistance in *Aedes* **;**
any example, e.g. DDT / dieldrin / pyrethroids **;**
4 *ref. to* conditions for breeding of *Aedes* **;**
5 problems with, funding research / AW **;**
6 cost of, drugs / insecticides, to government / health authorities / individuals **;**
7 people with HIV / AIDS are at high(er) risk than others **;**
8 lack of knowledge / lack of education / 'fatalism' / AW **;**
9 inaccessibility of some regions to healthcare **;**
10 infected people not, identified / diagnosed **;**
11 AVP **;**
e.g. migration of people with dengue fever to places without malaria; global warming promoting the growth and development of mosquitoes;

[Any 1] [1]

[Total: 5]

5 Fig. 5.1 shows the Calvin cycle which takes place inside a plant cell.

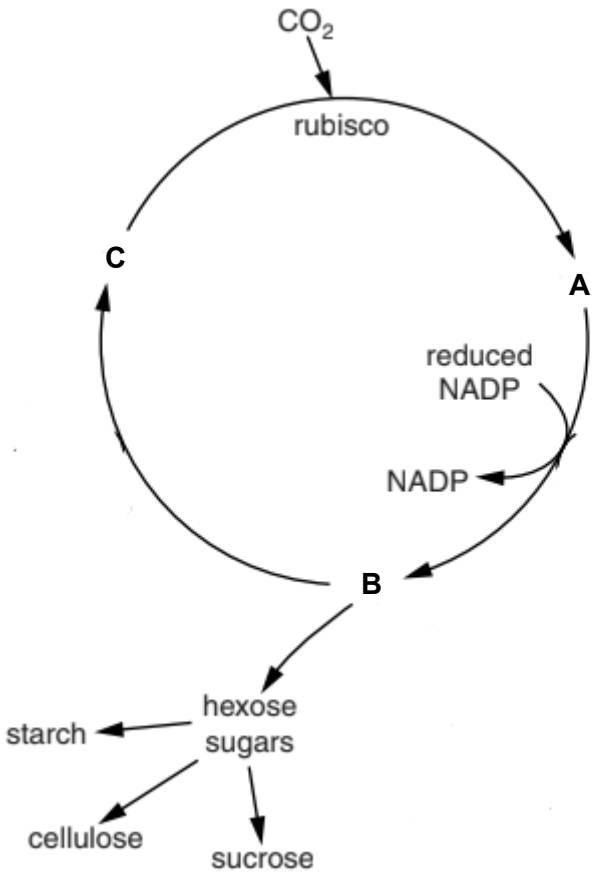


Fig. 5.1

(a) Identify substances **A**, **B** and **C**.

A – glycerate-3-phosphate / 3-phosphoglycerate (R! G3P, 3PG)

B – glyceraldehyde-3-phosphate / triose phosphate (R! G3P, TP)

C – ribulose bisphosphate / RuBP [3]

(b) Describe the role of NADP in linking the light dependent reactions to the Calvin cycle as shown in Fig. 5.1.

NADP is the final electron acceptor of the non-cyclic photophosphorylation, reduced to NADPH;

NADPH is required to reduced glycerate-3-phosphate (A! if student wrote 1,3-bisphosphoglycerate) to glyceraldehyde-3-phosphate; [2]

(c) In aerobic respiration and photosynthesis, ATP is synthesised via chemiosmosis in oxidative phosphorylation and photophosphorylation.

(i) Outline the role of stalked particles in chemiosmosis in oxidative phosphorylation.

Protons diffuse from intermembrane space back to matrix via the stalked particles, results in proton motive force;

Proton motive force drives ATP synthase to catalyse the formation of ATP from ADP and free phosphate; [2]

(ii) Explain why less ATP is synthesised from the same mass of glucose in anaerobic respiration compared to aerobic respiration.

anaerobic – accept ora for aerobic
1 idea that glucose not completely, broken down/oxidised
or
only glycolysis occurs;
or
pyruvate/lactate/ethanol, still contains energy;

2 ETC stops (because) no oxygen to act as (final) electron acceptor;

3 (so) no, Krebs cycle/link reaction/oxidative phosphorylation / chemiosmosis; [3]

[Total: 10]

Section B

Answer **one** question in this section.

Write your answers on the lined papers provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where applicable.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6 **(a)** Discuss the role of complementarity in cellular mechanisms. [6]

<u>Complementary shape (max 2)</u>

1. Substrate(s) fit into the active site of enzyme;
2. via lock and key hypothesis;
3. And induced fit hypothesis;
4. To form enzyme-substrate complex;

5. DNA to fit into binding site of proteins
6. To regulate replication;
7. And gene expression;

8. Binding of substances to transport proteins;
9. Allows for movement of substances across cell membrane;
10. and viral entry;

<u>Complementary interaction (max 2)</u>

11. H bonds between polar groups;
12. Hydrophobic interaction between non-polar groups;
13. Ionic bonds between oppositely charged groups;
14. Allows for folding of polypeptide into 3D shape;
15. Stability of biomolecules;

<u>Complementary base pair (max 2)</u>

16. A-T (A-U) and C-G;
17. Allows for stability of DNA double helix;
18. Allows for replication of DNA;
19. Allows for the synthesis of mRNA/transcription;
20. allows for the binding of (anticodon on) tRNA to (codon on) mRNA;

(b) Red blood cells are replaced every 3 to 4 months.

Explain how haemoglobin is synthesised when haematopoietic stem cells form red blood cells. [9]

cells and organelles: max 2

1. haemoglobin a- and b- genes in DNA, DNA in nucleus;
2. transcription of haemoglobin a- and b- gene in nucleus by RNA polymerase;
3. export of mature mRNAs into cytoplasm via nuclear pores;
4. free 80S ribosomes bind to each mRNA, translation of each mRNA to form a-chain and b-chain separately;
5. each chain fold into the tertiary structure of a-globin and b-globin;

proteins: max 2

6. haemoglobin - quaternary structure, 4 polypeptide chains; 2 a- and 2 b-;
7. maintained by 3 types of intermolecular bonds;
8. ref to the primary, secondary, tertiary structure of globin;

stem cells: max 2

9. Hematopioetic stem cells multipotent;
10. can differentiate into myeloid progenitor, myleoid progenitor cell give rise to RBC;
11. ref to internal and external signals to stimulate differentiation;

DNA & genomics: max 2

12. ref to transcription mechanism;
13. ref to translation mechanism;
14. primary RNA from transcription needs to be processed (post-transcriptional modification) to form mature mRNA;
15. removal of introns by RNA excision; splicing of exons;
16. additional of 5'-methylguanosine cap;
17. additional of 3'-poly 'A' tail;

Energetics: max 1

18. idea that aerobic respiration releases energy (ATP) to support the various stages of immunoglobin production;

QWC (1m) points communicated clearly without ambiguity and with relevant connections as to how haemoglobin (protein) is expressed as HSC differentiate to form RBC

[Total: 15]

7 **(a)** With reference to named examples, describe the range of roles performed by ATP in living organisms. [6]

1. ATP – adenosine triphosphate, an energy currency in the cell produced by phosphorylation of ADP + P_i ;

2. when hydrolysed into ADP + P_i, releases a lot of energy to fuel many anabolic reactions within the cell ;;

3. In cellular/aerobic respiration: Activation of glucose to glucose-6-phosphate via phosphorylation using ATP during the energy investment phase of glycolysis.

OR

- ATP is required for the phosphorylation of fructose-6-phosphate to fructose-1,6-bisphosphate catalysed by phosphofructokinase ;
- ATP also serves as an allosteric inhibitor to the phosphofructokinase enzyme ;

4 needed in the endomembrane system i.e. to supply energy needed to power the migration of vesicles (transport / secretory) between organelles for protein / lipid trafficking ;;

5 Active transport of molecules against concentration gradient across the cell surface membrane via the action of a specific carrier proteins called "pump" which use ATP to change its conformation. E.g. is sodium-potassium pump ;

6 required for active transport processes i.e. to move large substances against concentration gradient through carrier proteins / in bulk transport processes, endocytosis and exocytosis ;;

7 synthesis of large biomolecules (proteins, carbohydrates) through formation of bonds between monomers (peptide bonds, glycosidic bonds / amino acids, monosaccharides) requires energy ;;

8 ATP required for amino acid activation prior to translation for the covalent attachment of the amino acid to the 3' acceptor stem of the corresponding tRNA, catalysed by amino acyl tRNA synthetase;

In photosynthesis:

8. energy from ATP is required in the convert glycerate-3-phosphate (GP) to glyceraldehyde-3-phosphate (GALP) in Calvin cycle, as well as in the regeneration of RuBP during light independent stage ;;
9. Energy from hydrolysis of ATP is also needed to regenerate ribulose bisphosphate in Calvin cycle ;

Role of ATP as a nucleotide:

10. ATP is a ribonucleotide and is incorporated into mRNA acid during transcription ;

Others

I. phosphorylation of proteins, where a phosphate group from ATP is added to proteins → activating / inactivating proteins by triggering a 3D conformational change → e.g. kinases in cell cycle /signal transduction pathways ;;

II. polymerisation of microtubules during cell division requires ATP → MTs can then be attached to kinetochores of chromosomes to align them at the metaphase plate / elongation of the cell ;;

III. act as an allosteric inhibitor in respiration i.e. high ATP inhibits glycolysis (phosphofructokinase enzyme) / Krebs cycle ;;

IV. ATP/AMP ratio acts as a biosensor in bacteria → low levels of ATP corresponding to high levels of AMP triggers increased transcriptional rates of the *lac* operon ;;

QWC (2m) points communicated clearly <u>without ambiguity</u> and with <u>relevant examples</u> as to how ATP is useful in living organisms (plants, animals, prokaryotes)

[Total: 6]

(b) Cytochrome *c* is primarily known as an electron-carrying mitochondrial protein. The amino acid sequence is highly conserved in eukaryotes, differing by a few residues.

Cytochrome *c* amino acid sequence in humans is more similar to that of chimpanzees but differs more from that of horses.

Explain how cytochrome *c* was conserved over time in eukaryotes. [9]

[Total: 15]

1 Cytochrome c important protein as participates in electron transfer as part of the mitochondrial electron transport chain (ETC)

2 is thus an indispensable part of the energy production process ATP in oxidative phosphorylation

3 eukaryotes : all have mitochondria in their cells for respiration

4. The variations in the amino acid sequences for cytochrome c are due to mutations in ancestral populations

5. There are different selection pressures that will select for advantageous alleles that express out functional cytochrome c

6 these advantageous alleles passed on to offsprings who survive to sexual maturity and reproduce

7 Increase in frequency of alleles expressing functional cyc c accumulate in the population

8 As new species evolved by the process of natural selection ,

9 any mutation that lead to non functional cytochrome c will lead to that variant not able to survive as unable to undergo respiration

10 because 3D conformation of protein disrupted

11 Due to ionic bonds or hydrogen bonds not formed between the R groups of the amino acids

12 The humans, horses could have mutations that occurred in the different eukaryotes : silent mutations

13 Mutation that are on non essential genes

14 Cyc c still functional and conserved in eukaryotes

[Total: 9]

QWC (1m) points communicated clearly

JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2018

CANDIDATE NAME	
CLASS	

BIOLOGY 8876/01

Paper 1 Multiple Choice **14 September 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **21** printed pages and **1** blank page.

1 A severe inherited condition arises from the failure to produce an enzyme that breaks down glycoproteins in cells. The condition can be diagnosed from an electron micrograph of a patient's cells.

Which abnormality would be observed in these cells?

A an incomplete chromosome due to lack of a gene

B larger lysosomes due to accumulation of glycoprotein

C less endoplasmic reticulum due to a reduction in protein synthesis

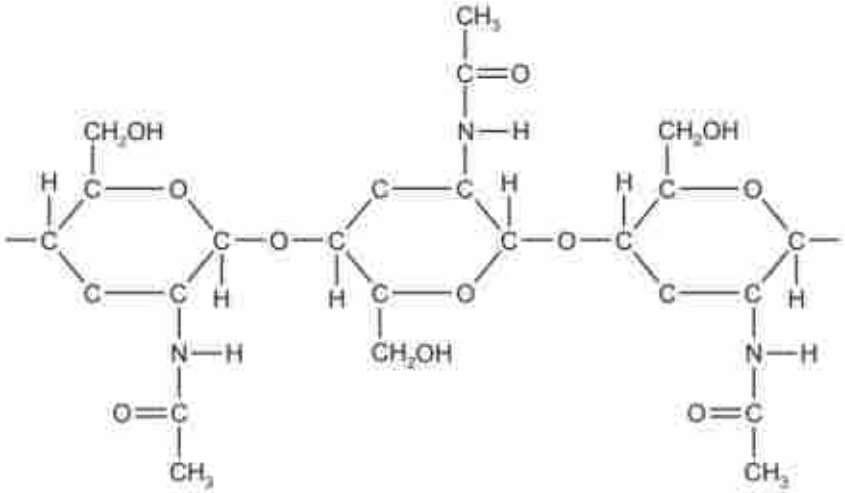
D thinner cell surface membrane due to lack of glycoprotein

2 The table shows a comparison between three features of a prokaryotic cell and a eukaryotic cell.

Which row is correct?

	chromosome structure		ribosome		presence of introns	
	prokaryote	eukaryote	prokaryote	eukaryote	prokaryote	eukaryote
A	circular	linear	80S	70S	rare	common
B	circular	linear	70S	80S	rare	always
C	linear	circular	80S	70S	common	always
D	linear	circular	70S	80S	always	never

3 The diagram shows the structure of the polysaccharide chitin which is found in the cell wall of fungi.



Which statements are correct for chitin and for cellulose?

1 The monomers are joined by 1, 4 glycosidic bonds.

2 Every second monosaccharide in the polysaccharide chain is rotated by 180°.

3 The polysaccharide contains the elements carbon, hydrogen, oxygen and nitrogen.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 only

4 Which statements about triglycerides and phospholipids are correct?

1 Triglycerides and phospholipids both have a hydrophobic region.

2 Triglycerides are non-polar molecules and phospholipids are polar.

3 Fatty acids in a triglyceride may be saturated or unsaturated but in a phospholipid they are always saturated.

A 1 and 2

B 1 and 3

C 2 only

D 3 only

5 The cells in the roots of beetroot plants contain a red pigment.

When pieces of root tissue are soaked in cold water, some of the red pigment leaks out of the cells into the water.

An experiment was carried out to investigate the effect of temperature on the loss of red pigment from the root cells. It was found that the higher the temperature of the water, the higher the rate of loss of red pigment from the root cells.

Which of these statements could explain this trend?

1 Enzymes in the cells denature as the temperature increases, so the pigment can no longer be used for reactions inside the cells and diffuses out.

2 As the temperature increases, the tertiary structure of protein molecules in the cell surface membrane changes, increasing the permeability of the membrane.

3 Phospholipid molecules gain kinetic energy as temperature rises, increasing the fluidity of the phospholipid bilayer and allowing pigment molecules to diffuse out more easily.

A 1 and 2

B 2 and 3

C 2 only

D 3 only

6 High concentrations of urea break all bonds except covalent bonds in protein molecules. Which level of protein structure would remain unchanged when keratin is treated with urea?

A primary

B secondary

C tertiary

D quaternary

7 Which feature of haemoglobin makes it a globular protein?

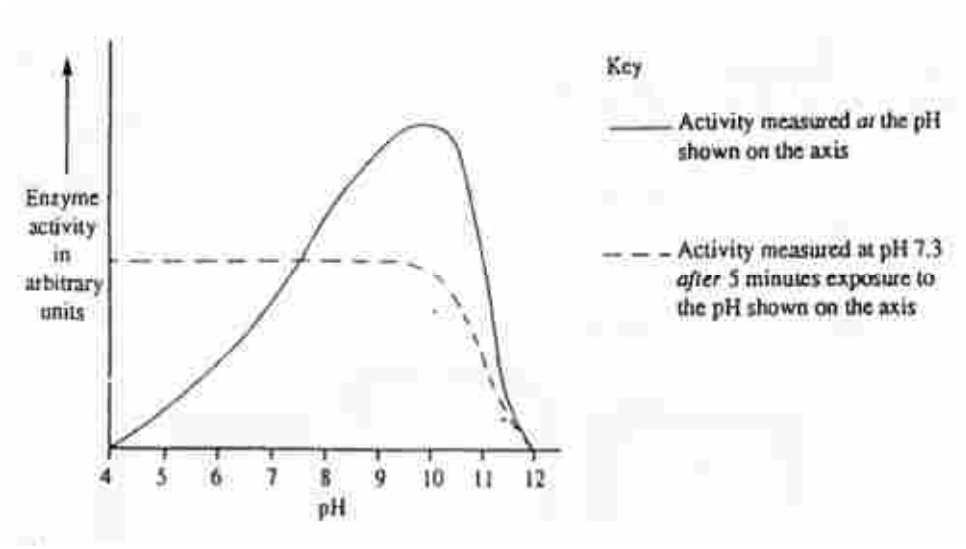
A It has four cross-linked polypeptide chains forming a quaternary structure.

B It has hydrophobic groups on the inside and hydrophilic groups on the outside.

C It has hydrophobic interactions and is insoluble in water.

D It has polypeptide chains which are cross-linked to form sheets.

8 The graph shows the effects of pH on the activity of the enzyme monoamine oxidase, as measured by two different methods.



Which hypothesis is not supported by these results?

A Both acid and strong alkali denature the enzyme.

B The optimum pH is alkaline.

C Strong alkali causes a reversible change in the tertiary structure of the enzyme.

D The change in the catalytic properties of the enzyme caused by acid is reversible.

9 There are two hypotheses to explain how enzymes interact with a substrate.

1 In the lock-and-key hypothesis, enzyme active sites and substrate molecules have complementary shapes.

2 In the induced-fit hypothesis, the substrate causes the active site to become a complementary shape.

What is true only of the induced-fit hypothesis?

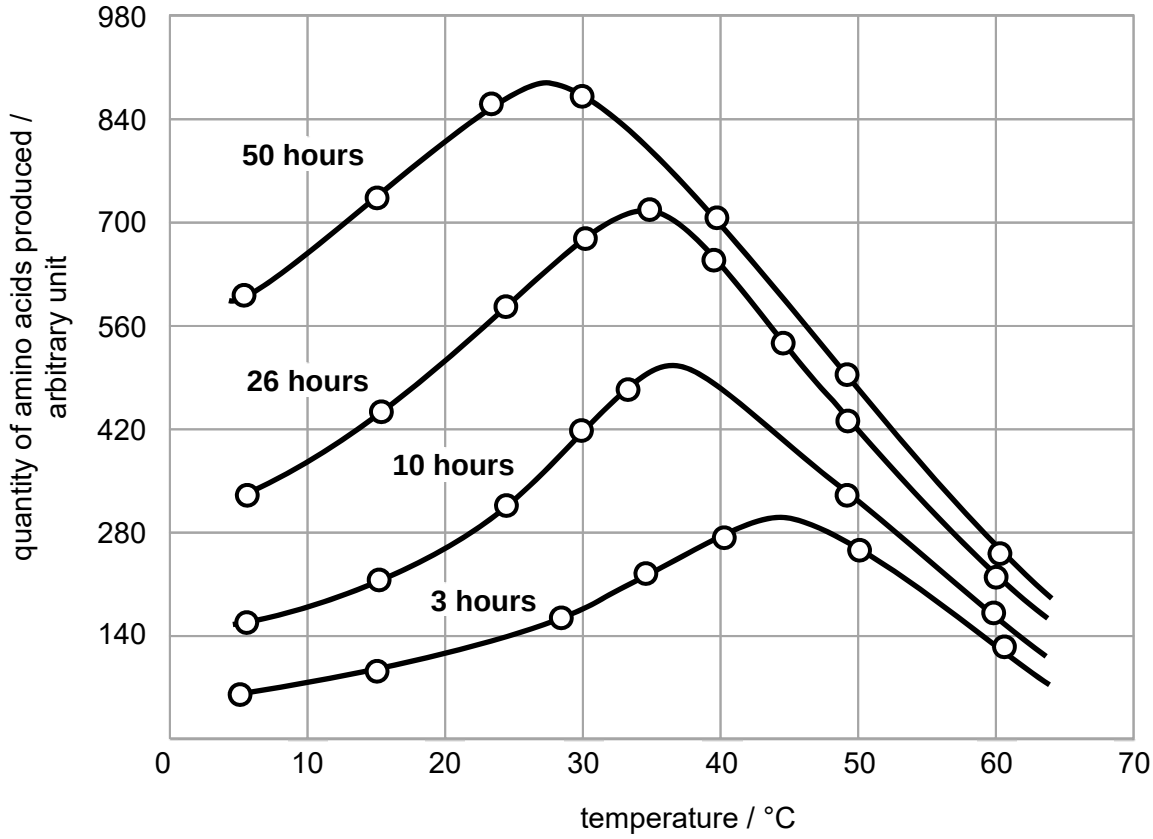
A Adding an excess of substrate does not increase the number of enzyme-substrate complexes.

B An enzyme lowers the activation energy, causing more enzyme-substrate complexes to form.

C An enzyme undergoes a conformational change as it forms enzyme-substrate complexes.

D An increase in enzyme concentration may increase the number of enzyme-substrate complexes.

10 The graph below shows the variation in the effect of a proteolytic enzyme with temperature over time.



Which of the following conditions can be deduced from the graph?

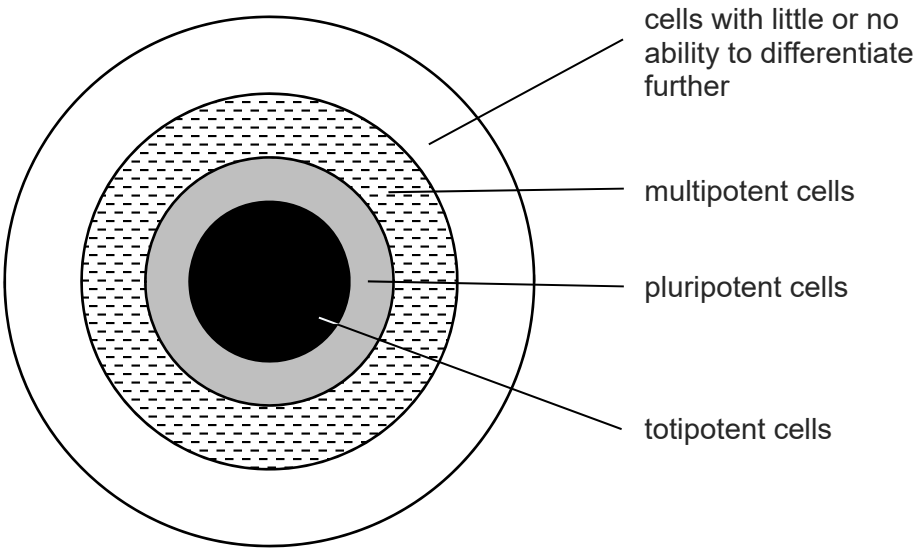
A The optimum temperature for the enzyme is 27 °C.

B The optimum temperature for the enzyme increases as the substrate is hydrolysed.

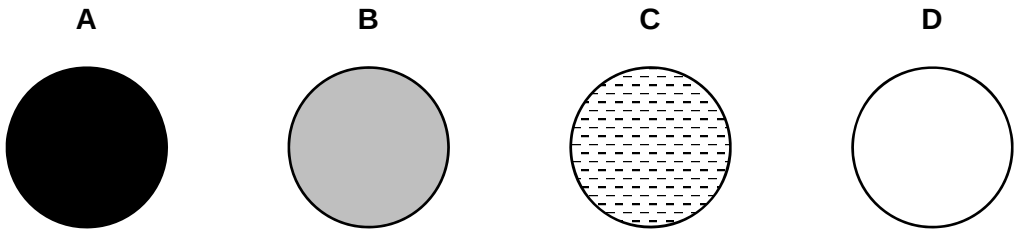
C The optimum temperature increases causing the experiment to last longer.

D The optimum temperature of the enzyme decreases over the duration of the experiment.

11 The diagram represents all human cell types. Each shaded region represents cells with varying degrees of ability to differentiate into different cell types.



Which shaded region includes blood stem cells?



12 Anti-cancer therapy that targets dividing cells can reduce the numbers of the different blood cell types in a person's body.

Which statement about blood stem cells is correct?

A As blood stem cells are totipotent, all the blood cell types can be produced to restore circulating differentiated blood cells to their normal numbers.

B As blood stem cells are undifferentiated, they are unaffected by anti-cancer therapy and will continue to renew themselves to gradually bring numbers of blood cells back to normal.

C Blood stem cells that are collected from a person before anti-cancer therapy and are then put back into the same person after therapy are able to produce new blood cells.

D Blood stem cells removed from the bone marrow, if transplanted to the site where the cancer is located, will differentiate into the cell types of the new location.

13 Which statements concerning DNA and RNA are correct?

1 Adenine and guanine are bases that have a double ring structure; cytosine, thymine and uracil are bases with a single ring structure.

2 An adenine nucleotide from DNA is the same as an adenine nucleotide from RNA; DNA adenine pairs with thymine and RNA adenine pairs with uracil.

3 The base pairing that occurs in a double DNA helix and when RNA is synthesised during transcription is always according to the rule that a purine pairs with a pyrimidine.

4 The two polynucleotides on a DNA molecule run in opposite directions so that the double helix formed has two strands that are parallel to each other.

A 1, 2 and 3

B 1, 2 and 4

C 1, 3 and 4

D 2, 3 and 4

14 Which row shows the correct functions of the three different proteins involved in DNA replication?

	helicase	single-strand binding protein	DNA polymerase
A	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	make strands available as templates	prevents original strands reforming complementary base pairs
B	prevents original strands reforming complementary base pairs	adds DNA nucleotides to the 3' end of a growing polynucleotide strand	make strands available as templates
C	prevents original strands reforming complementary base pairs	make strands available as templates	adds DNA nucleotides to the 3' end of a growing polynucleotide strand
D	make strands available as templates	prevents original strands reforming complementary base pairs	adds DNA nucleotides to the 3' end of a growing polynucleotide strand

15 The table compares the structure and function of some elements involved in transcription.

	made of protein	interacts with protein	codes for protein
RNA polymerase	1	2	3
promoter	4	5	6
terminator	7	8	9
gene	10	11	12

Which combination of numbers link the four elements listed to their structures and functions?

A 1, 5, 6, 9 and 12

B 1, 5, 8, 11 and 12

C 2, 6, 7, 8 and 11

D 3, 4, 8, 10 and 12

16 Two enzymes, X and Y, are each encoded by different alleles of the same gene. The amino acid sequences of the two enzymes differ between positions 87 and 91 of the polypeptide.

The amino acid sequences of enzymes X and Y, and the corresponding DNA sequence of enzyme X from position 86 to position 93 of the polypeptides, are shown in the table below.

	←N terminal end amino acid position C terminal end→							
	86	87	88	89	90	91	92	93
DNA triplet codes for enzyme X	TTT	TCA	GGT	AGT	GAA	TTA	CGA	CGA
amino acid sequence of enzyme X	lys	ser	pro	ser	leu	asn	ala	ala
amino acid sequence of enzyme Y	lys	val	his	his	leu	met	ala	ala

The actual mRNA codons for the amino acids in these positions for enzymes X and Y, are shown in the table below.

amino acid	Lys	Ser	Pro	Leu	Asn	Ala	Val	His	Met
mRNA codon(s)	AAA	AGU UCA	CCA	CUU UUA	AAU	GCU	GUC	CAU CAC	AUG

What could account for the difference in amino acid sequence of enzymes X and Y?

A A single frame shift by deletion in the DNA code at position 87.

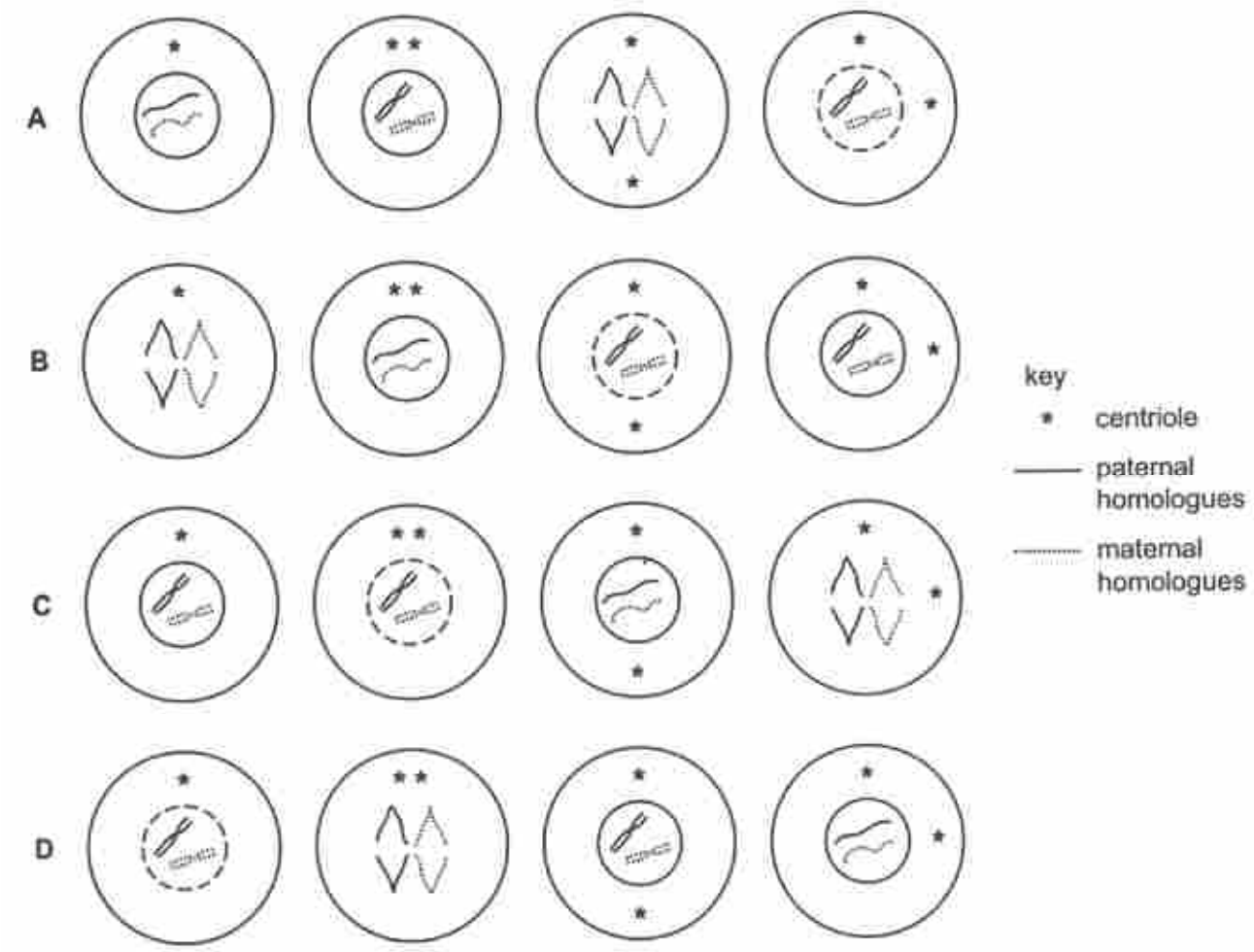
B Frame shift mutations in the DNA codes at position 87 and position 90.

C A change in the sequences of the second and third nucleotides at positions 87 and 88 of the DNA codes and frameshifts at positions 89 and 91

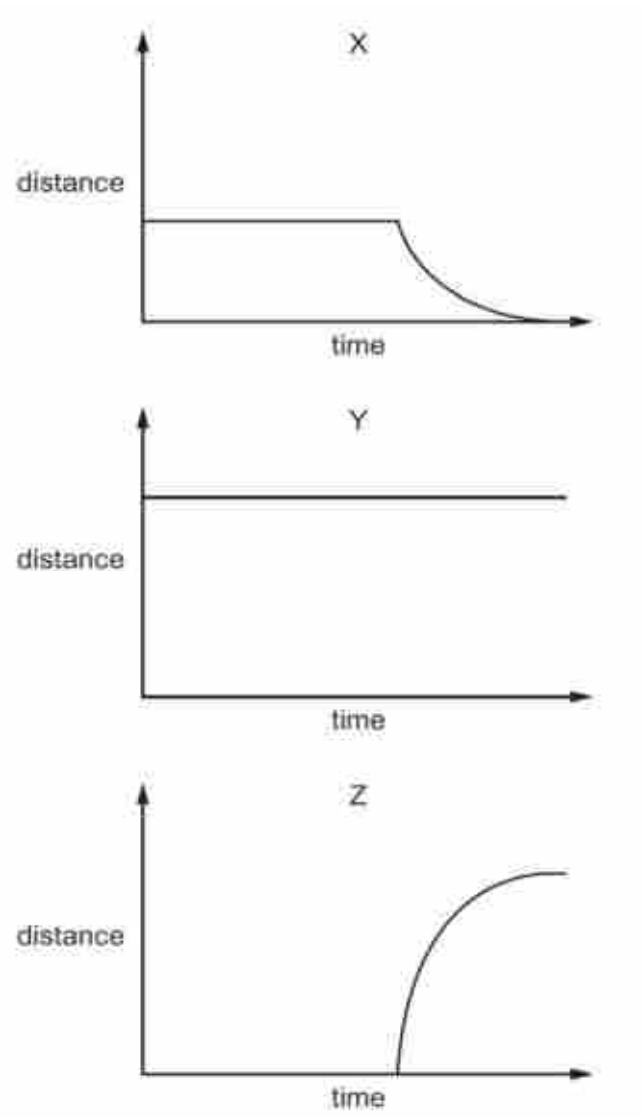
D A deletion in the DNA code at position 87 and an insertion into the DNA code at position 92.

17 The diagram shows cells in the mitotic cell cycle.

In which row does the appearance of the chromosomes match the appearance of the nuclear envelopes and the positions of the centrioles in all four cells?



18 The graphs show various distance measurements taken from metaphase of mitosis onwards. The graphs are to scale when compared to one another.



Which row correctly identifies the distance measurement for each graph?

	X	Y	Z
A	distance between poles of spindle	distance between sister chromatids	distance of centromeres from poles of spindle
B	distance between poles of spindle	distance of centromeres from poles of spindle	distance between sister chromatids
C	distance of centromeres from poles of spindle	distance between poles of spindle	distance between sister chromatids
D	distance of centromeres from poles of spindle	distance between sister chromatids	distance between poles of spindle

19 It has been suggested that breast cancer cells produce high levels of hydrogen peroxide. This causes connective tissue cells near the cancer cells to digest some of their mitochondria, releasing nutrients which feed the cancer cells.

Which observations made on breast cancer cells and connective tissue cells growing in tissue culture support this view?

1 Breast cancer cells grown alone produce hydrogen peroxide.

2 Treating breast cancer cells with hydrogen peroxide causes apoptosis.

3 Connective tissue cells grown with breast cancer cells have reduced mitochondrial activity.

4 Treating breast cancer cells with peroxidases increases cancer cell death.

A 1, 2, 3 and 4

B 1, 3 and 4 only

C 1 and 4 only

D 2 and 3 only

20 Which are correct statements about the need for a reduction division?

1 Reduction division needs to occur so that a parent will contribute to the zygote one set of chromosomes that are similar in size and number to the set contributed by the other parent and contain the same genes, but not necessarily the same alleles.

2 There is a requirement to reduce the diploid number of chromosomes, characteristic of the species, to produce cells with a haploid number in preparation for fertilisation and the subsequent restoration of the original diploid number.

3 Without reduction division occurring, the fusion of two gametes, each with a diploid number, would give rise to a chromosome aberration and cells that would have more than two copies of any one gene.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

21 In a monohybrid, sex-linked genetic cross involving dominant and recessive alleles, different phenotypes are observed.

Which statement correctly explains these different phenotypes?

A Expression of the recessive allele only occurs in males, because the Y chromosome lacks the relevant gene.

B The nucleotide sequences of the two alleles each produces a different mRNA molecule, only one of which is translated into a functional protein.

C The recessive allele present in the male is unlikely to be transcribed and translated, as the male does not have a corresponding nucleotide sequence on the shorter Y chromosome.

D Transcription of alleles at different loci leads to transcription and translation of active and inactive enzymes.

22 The feather colour of a certain breed of chicken is controlled by codominant alleles. A cross between a homozygous black-feathered chicken and a homozygous white-feathered chicken produces all speckled chickens. What phenotypic ratios would be expected from a cross between two speckled chickens?

A all speckled

B 1 black feathers : 1 white feathers

C speckled, black feathers and white feathers in equal numbers

D 1 black feathers : 2 speckled feathers : 1 white feathers

23 A student carried out an investigation into the effect of light intensity on photosynthesis. Several groups of spinach leaf discs were placed in test tubes of water. The discs all sank to the bottoms of the tubes. Each tube was placed at a measured distance from a lamp.

As photosynthesis occurs, the build-up of oxygen gas in the leaf discs causes them to rise from the bottom of the tube upwards. The results are shown in the table below.

tube number	distance from lamp / mm	time taken for five discs to float / s
1	50	125
2	100	210
3	150	360
4	200	600
5	250	none floated in the time available

Which of these statements are true?

1 The compensation point occurs between 200 and 250 mm.

2 A variable which is controlled is the distance of the tube from the light source.

3 The time taken for the discs to rise is directly proportional to the distance from the lamp.

A 1, 2 and 3

B 1 and 2 only

C 1 only

D 2 and 3 only

24 What happens in both respiration and photosynthesis?

1 ADP is phosphorylated.

2 ATP is hydrolysed.

3 Electrons pass through ATP synthase.

4 NADP is reduced.

5 Protons pass through ATP synthase.

6 Triose phosphates are decarboxylated.

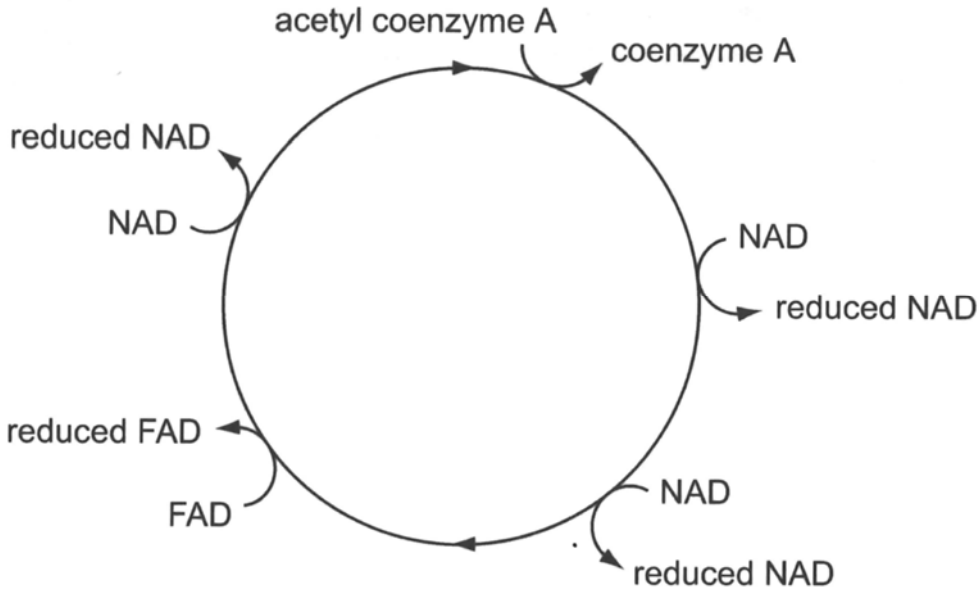
A 1, 4 and 5

B 1 and 5 only

C 2, 4 and 6

D 3 and 6

25 The diagram shows the reactions of the hydrogen carriers in the Krebs cycle.



The average yield of ATP, in oxidative phosphorylation, is 2.5 molecules from each molecule of reduced NAD and 1.5 molecules from each molecule of reduced FAD.

What is the average yield of ATP from the hydrogen carriers reduced in the Krebs cycle from one molecule of glucose?

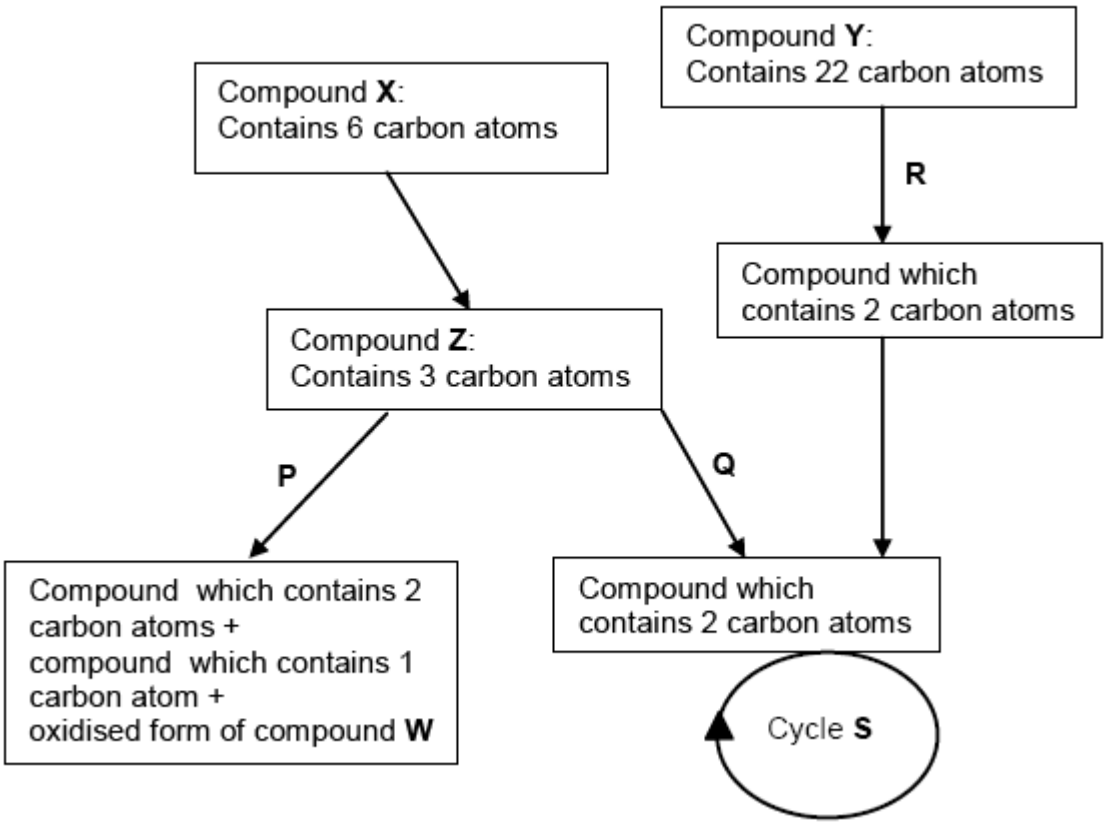
A 9

B 18

C 28

D 32

26 The diagram shows the flow of carbon atoms in cellular respiration in a plant cell, where processes **P**, **Q** and **R** are key stages.



Which statements are correct?

1 Process P involves the formation of lactic acid and regeneration of the oxidised form of compound W.

2 Compound Y is starch which hydrolyses into acetyl-CoA.

3 In process Q, compound Z undergoes oxidative decarboxylation.

4 Cycle S produces large amounts of reduced coenzymes for oxidative phosphorylation.

4 One molecule of compound X yields 36-38 ATP molecules when completely oxidised.

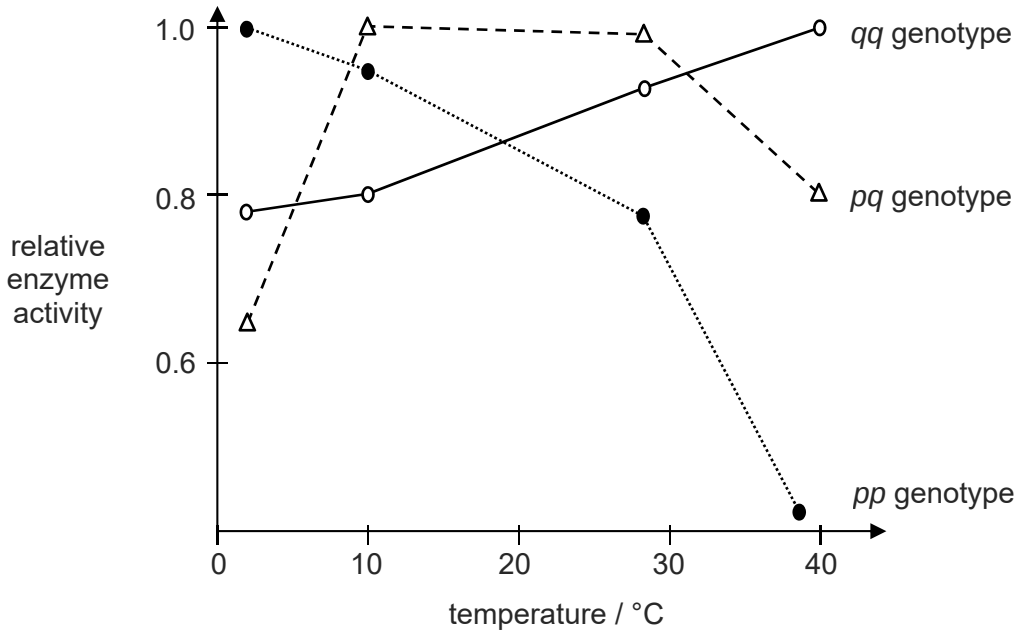
A 1, 2 and 4

B 1 and 3

C 2 and 5

D 3, 4 and 5

27 In the North America catfish *Catostomus clarki*, two alleles, represented by *p* and *q*, control the synthesis of a vital enzyme. The three possible genotypes (*pp*, *pq*, *qq*) lead to the synthesis of variations of the same enzyme with different temperature optima as shown in the graph below.



When the mean annual temperature is 5 °C, which is correct?

A Allele *p* will be positively selected for.

B Allele *p* will become dominant and *q* recessive.

C The heterozygotes will have a selective advantage over the homozygotes.

D No genotype will have a selective advantage over another.

28 Animals with horizontal stripes are bitten less frequently by tsetse flies. The flies carry diseases that infect zebras.

Which explains how zebras might evolve to have more horizontal stripes?

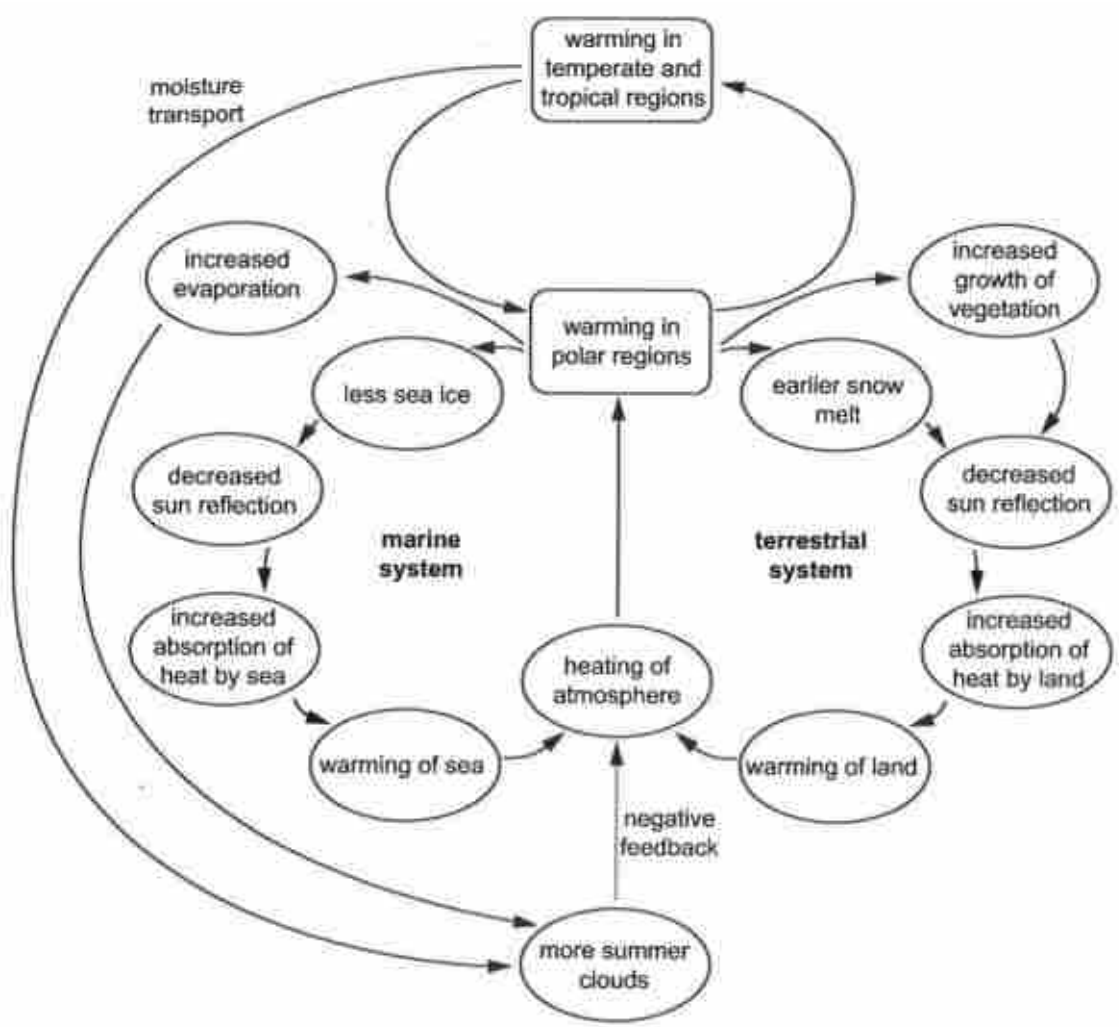
A Bites from tsetse flies cause mutations. If a zebra has a mutation it will die and not pass its genes to its offspring which will not have more horizontal stripes.

B If two zebras with horizontal stripes mate, their offspring will have more horizontal stripes. Horizontal stripes will become dominant. This is natural selection.

C Tsetse flies are a selection pressure. The zebras would gradually develop more horizontal stripes and pass them on to their offspring so they are not bitten by flies.

D Zebras with more horizontal stripes get fewer diseases from tsetse flies. These zebras live longer and breed more, passing the allele for more horizontal stripes to their offspring.

29 The diagram shows the effect of increasing temperatures on the ice and snow cover at the polar regions.



Which effect of higher temperatures in the polar regions could increase global warming?

A Increased evaporation leads to more rainfall, which absorbs heat from the land and the sea.

B Melting of ice and snow results in less reflection of sunlight and more heat absorption by the Earth.

C Melting of sea ice caused more cloud formation, which increases absorption of heat in the atmosphere.

D Earlier melting of snow allows vegetation cover to increase faster, reducing loss of heat from the surface of the Earth.

30 Increases in global temperatures have been linked in some species to changes in their distribution or to the timing of stages in their life-cycles. Examples in North America include:

- earlier nesting of several species of birds
- earlier migration of birds from southern winter habitats to northern breeding habitats
- movement of warm water fish into rivers inhabited by cold water species
- an increase in the range of boreal (coniferous) forest as it moves north and invades tundra grassland.

If global temperatures continue to increase, which consequences are likely to occur in North America as a result of these changes?

1 mismatch between the timing of breeding seasons and maximum food availability

2 decrease in populations of all species

3 reduction in the area of tundra grassland

4 decrease in available habitat for cold water species of fish

A 1, 2, 3 and 4

B 1, 3 and 4 only

C 1 and 2 only

D 3 and 4 only

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JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2018

CANDIDATE NAME	

CLASS		INDEX NUMBER				

BIOLOGY 8876/02

Paper 2 Structured Questions and Free-response Questions **23 August 2018**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
Section B	
Total	

This document consists of **20** printed pages.

Section A

Answer **all** the questions in this section.

1 Fig. 1.1 shows an electron micrograph of mitochondria cross-sections.

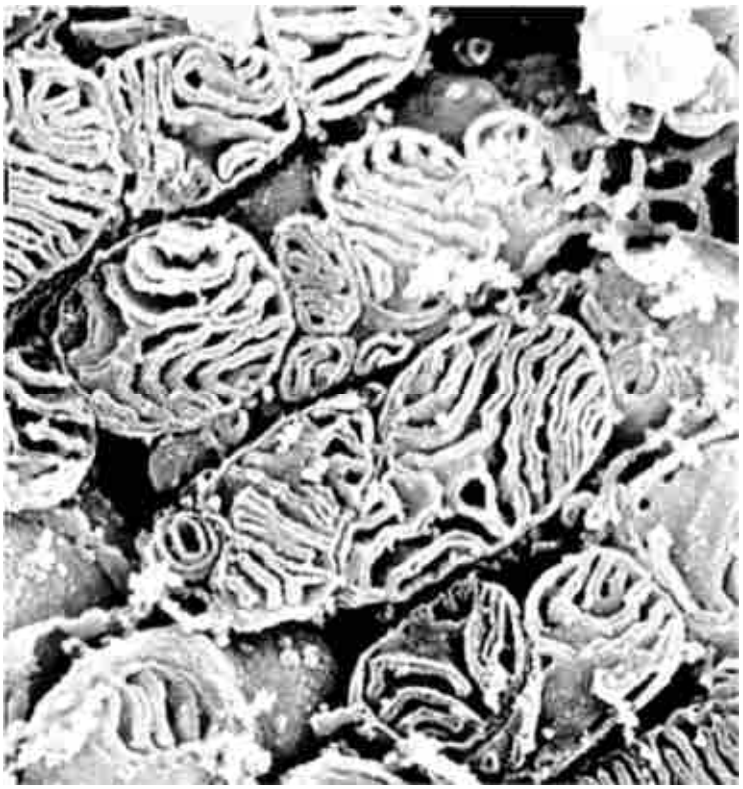

Fig. 1.1

(a) With reference to Fig. 1.1, state one visible feature of the mitochondrion and explain how this feature is adapted for the mitochondrion's function. [3]

_____

_____

_____

_____

_____

_____

Fig. 1.2 shows the molecular structure of carbonyl cyanide-4-(trifluoromethoxy) phenylhydrazone (FCCP). FCCP is a respiratory poison that binds protons and transports them across the phospholipid bilayer of the inner mitochondrial membrane. Protons alone are unable to diffuse freely in this manner.

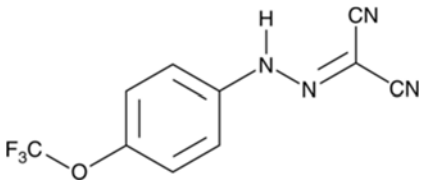

Fig. 1.2

(b) Explain, in relation to their properties, why FCCP readily diffuses across the phospholipid bilayer while protons do not. [2]

_____

_____

_____

_____

In the presence of FCCP, the rate of ATP synthesis during respiration is significantly diminished. The rate is further reduced if oxygen becomes unavailable. In such conditions where oxygen is depleted, cells continue to oxidise glucose to form pyruvate and sustain ATP synthesis.

(c) **(i)** Identify the key stages where ATP synthesis occurs via substrate level phosphorylation. [1]

_____

(ii) State the location where the biochemical pathway enabling the continual oxidation of glucose to form pyruvate occurs. [1]

_____

(iii) Explain how ATP synthesis can be sustained in the absence of oxygen in yeast cells. [3]

_____

_____

_____

_____

_____

_____

[Total: 10]

2 Fig. 2.1 shows a representation of a starch molecule. Starch is made up of amylose and amylopectin.

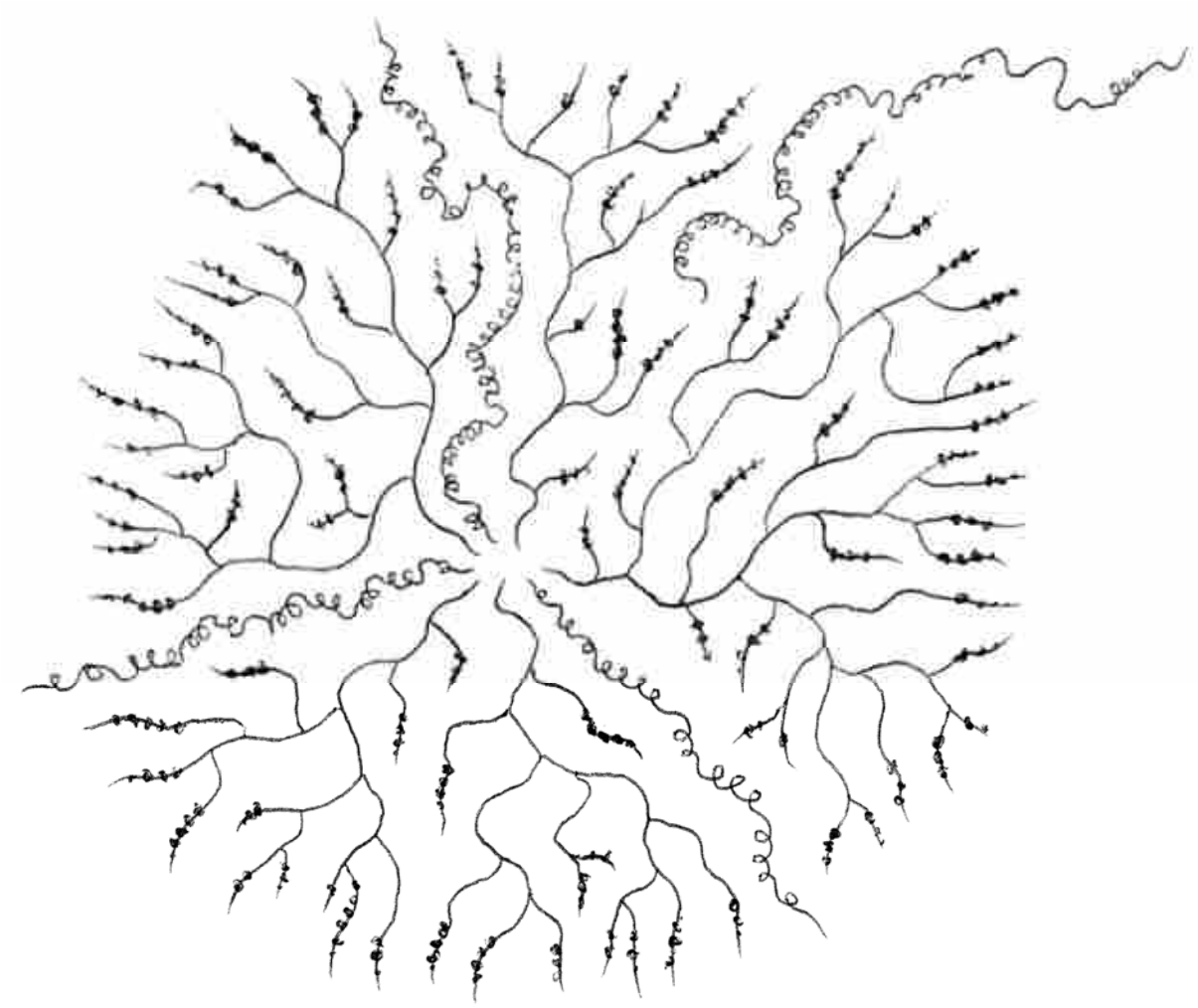

Fig. 2.1

(a) On Fig. 2.1, label amylose and amylopectin. [2]

(b) Explain how the structure of amylopectin is related to its role in living organisms. [2]

_____

_____

_____

_____

_____

_____

(c) Describe one structural difference between cellulose and amylopectin. [1]

_____

_____

_____

[Total: 5]

3 Fig. 3.1 shows the origin and development of a B cell (a type of white blood cell) from a stem cell.

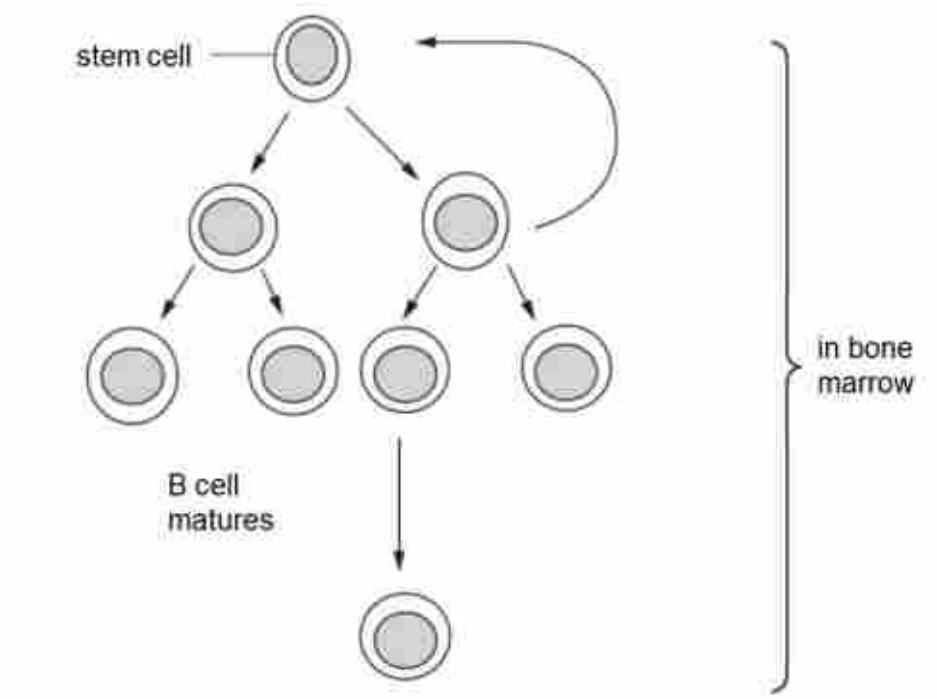

Fig. 3.1

(a) Explain what is meant by a *stem cell*. [2]

_____

_____

_____

_____

Turn over for the remainder of Question 3

During B cell development, specific cell surface proteins known as CD proteins are produced and incorporated into the cell surface membrane.

Fig. 3.2 shows the stages involved in the synthesis of a CD protein in a B cell.

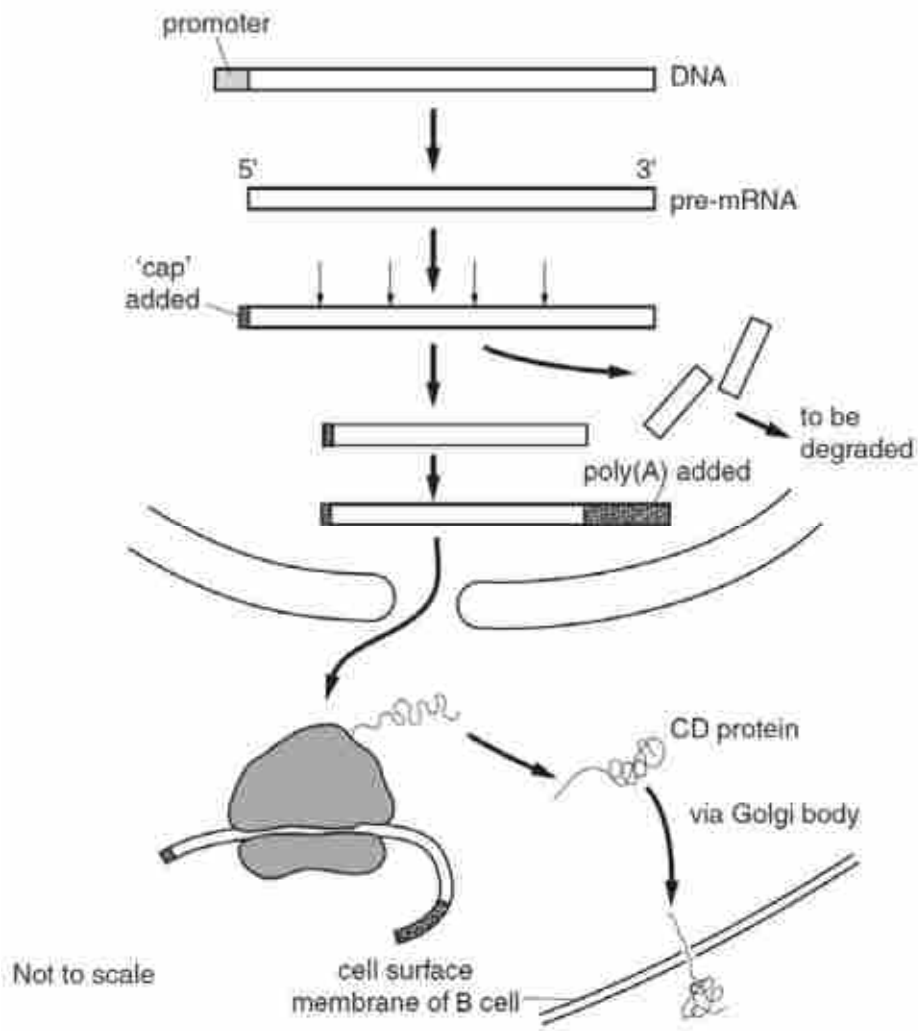

Fig. 3.2

(b) With reference to Fig. 3.2, outline the process:

(i) occurring in the nucleus of the B cell to produce pre-mRNA [3]

_____

_____

_____

_____

_____

_____

(ii) in forming the translation initiation complex. [3]

_____

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_____

(c) Burkitt's lymphoma is a cancer of B cells. It is caused by a mutation that usually involves chromosome 8.

(i) Name one causative agent of mutation in chromosome 8 of Burkitt's lymphoma. [1]

_____

(ii) Describe the key changes of two types of genes and their effects on cancer development. [2]

_____

_____

_____

_____

[Total: 11]

4 Galactosaemia is a rare genetic disease in which the build-up of the monosaccharide galactose can result in an enlarged liver, kidney failure and brain damage. Galactose is produced in the body from the digestion of the sugar lactose, found in milk.

Galactosaemia is caused by a recessive mutation of the *GALT* gene. The normal dominant allele codes for an enzyme which converts galactose to glucose.

(a) **(i)** Suggest how a person with galactosaemia can minimise damage to the liver, kidney and brain. [1]

_____

(ii) Explain how a mutation in the *GALT* gene could result in a change in the enzyme responsible for the metabolism of galactose. [4]

_____

_____

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_____

(b) If the phenotypes of parents are known, the probabilities of having a child with galactosaemia, an unaffected child (healthy, not a carrier) or a child who is a carrier can be calculated.

Complete Table 4.1 to show the results of these calculations. [2]

Table 4.1

parent 1	parent 2	percentage probability of having a child with galactosaemia	percentage probability of having an unaffected child	percentage probability of having a child who is a carrier
unaffected	carrier	0	50	50
carrier	carrier	.....	.....	.....
unaffected	has galactosaemia	.....	.....	.....
carrier	has galactosaemia	50	0	50

[Total: 7]

5 Silvereyes (*Zosterops lateralis*) are a species of Australian songbirds that can be found in both rural and urban environments. These birds produce contact calls to inform one another of danger or newly discovered food sources. The pitches and speed (measured in number of syllables per second) of Silvereyes' contact calls were identified to be genetically associated.

Studies on Silvereyes living in increasingly denser Australian cities have revealed that the birds made contact calls with much higher mean pitches and slower mean speeds with longer pauses between calls over the years.

When measured in the past, the mean pitch of the Silvereye call overlapped significantly with the pitches of road and air traffic making the calls indistinguishable from urban noise. Sound-reflecting buildings also diminished the clarity of the bird calls.

Fig. 5.1 shows a Silvereye.

Fig. 5.1

(a) Explain how natural selection may have led to a change in the mean pitch and speed of the Silvereye calls in the city. [5]

(b) An analysis of ice cores from the Arctic and Antarctic can provide information about the composition of the Earth's atmosphere over thousands of years.

Fig. 5.1 shows the concentrations of carbon dioxide measured in ice cores, dated between 1000 and 2000 AD.

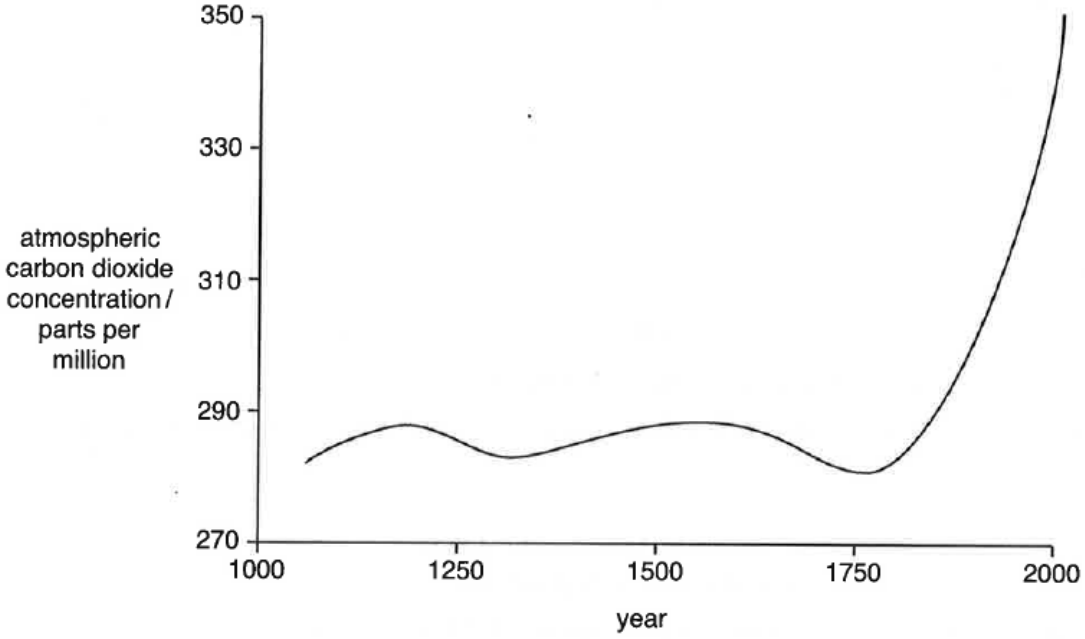


Fig. 5.1

(i) Describe the trend in Fig. 5.1. [2]

_____

_____

_____

_____

(ii) Atmospheric carbon dioxide concentrations show regular annual variations. Suggest one reason for this. [1]

_____

_____

(c) Fig. 5.2 shows that, over the same period of time, the average surface temperature of the Earth has shown a similar pattern of change. The increasing concentrations of carbon dioxide is thought to be responsible for the increase in temperature over the last 100 years. This is referred to as the enhanced greenhouse effect.

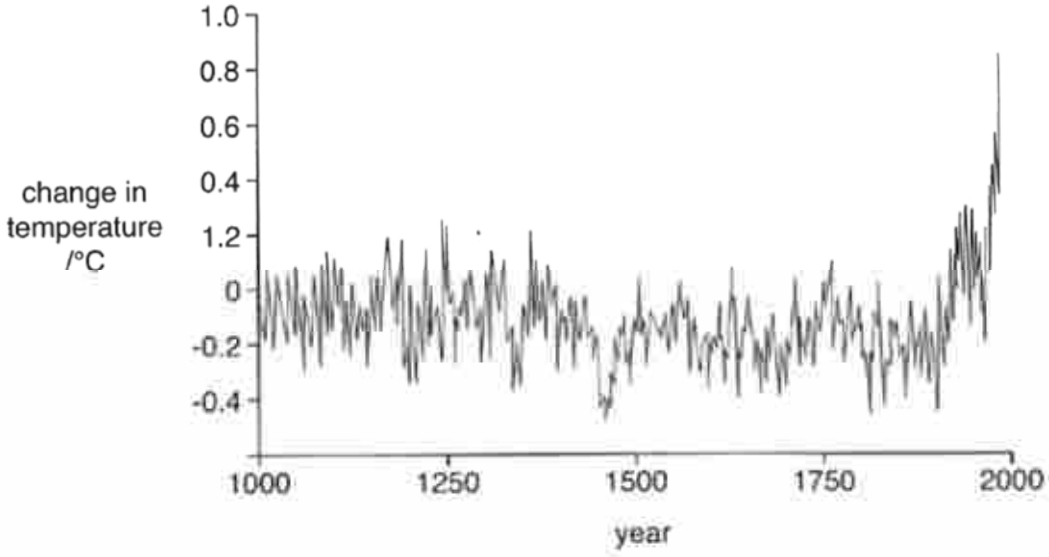


Fig. 5.2

(i) Describe one way in which the data in Fig. 5.2 resembles the data in Fig. 5.1 and one way in which it is different. [2]

Similarity _____

_____

Difference _____

_____

(ii) Explain the human activities that have contributed to the enhanced greenhouse effect. [2]

_____

_____

_____

_____

[Total: 12]

Section B starts on page 16

[Turn over]

Section B

Answer **one** question in this section

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6 **(a)** The organelles of the endomembrane system in animal cells are related through direct contact or by the transfer of membrane segments as vesicles.

Outline the functions of the organelles of the endomembrane system and state the structural similarities between these organelles. [9]

(b) A 75 kg human consists of ten times more prokaryotic cells than eukaryotic cells, with a total prokaryote mass of at least 1 kg. This assembly of prokaryotic cells is known as the human prokaryotic microbiome community.

Outline the differences between typical prokaryotic and eukaryotic cells and state the methods by which these differences can be shown. [6]

[Total: 15]

7 **(a)** Variation exists in individuals of the same species in a population due to a number of different reasons. Describe what causes variation and why it is important in natural selection. [9]

(b) Discuss, using known examples, how limiting factors can influence the rate of various biological processes. [6]

[Total: 15]

JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2018

CANDIDATE NAME	**Answers**
CLASS	

BIOLOGY 8876/01

Paper 1 Multiple Choice **14 September 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **21** printed pages and **1** blank page.

Qn	Ans
1	B
2	B
3	B
4	A
5	B
6	A
7	B
8	C
9	C
10	D

Qn	Ans
11	C
12	C
13	C
14	D
15	B
16	D
17	A
18	C
19	B
20	A

Qn	Ans
21	B
22	D
23	C
24	B
25	B
26	D
27	A
28	D
29	B
30	B

JURONG JUNIOR COLLEGE
JC2 Preliminary Examination 2018

CANDIDATE NAME	Teacher's copy		
CLASS		INDEX NUMBER	

BIOLOGY 8876/02

Paper 2 Structured Questions and Free-response Questions **23 August 2018**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
Section B	
Total	

This document consists of **24** printed pages and **1** blank page.

Section A

Answer **all** the questions in this section

1 Fig. 1.1 shows an electron micrograph of mitochondria cross-sections.

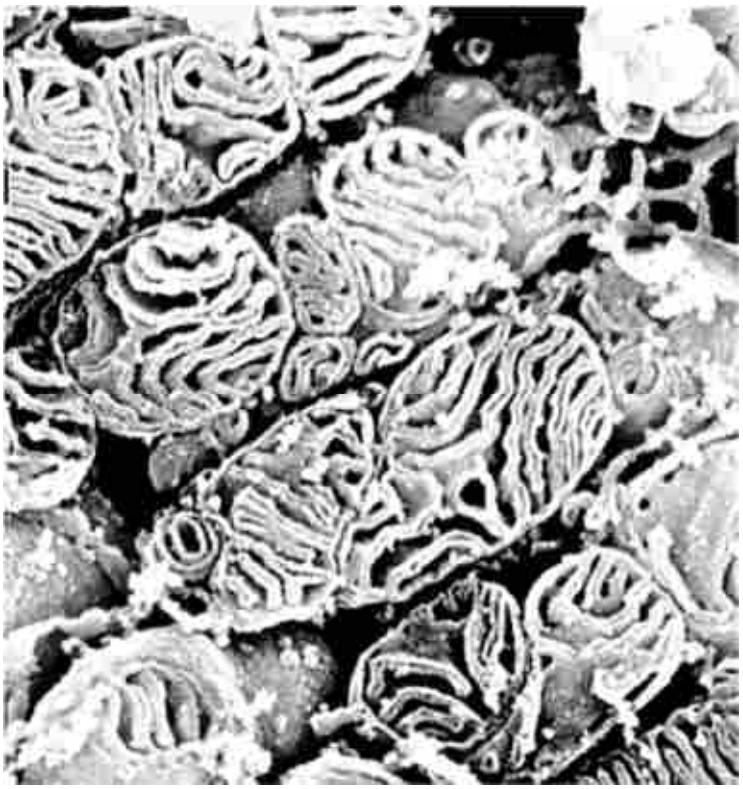


Fig. 1.1

(a) With reference to Fig. 1.1, state one visible feature of the mitochondrion and explain how this feature is adapted for the mitochondrion's function. [3]

Visible feature:
1. **The mitochondrion has a <u>highly folded inner mitochondrial membrane</u> / has <u>numerous infoldings/cristae</u> ;**

Adaptation:
2. **which provides a (large) surface (area) for the <u>attachment of enzymes / electron transport chains / electron carriers / ATP synthase</u> ; [Reject: for H^+ diffusion]**
3. **involved in oxidative phosphorylation <u>for ATP synthesis</u>. ;**

OR

Visible feature:
4. **The mitochondrion has a <u>narrow intermembrane space</u> / <u>Compartmentalisation</u> of the mitochondrion <u>by the inner mitochondrial membrane</u> into regions like the intermembrane space ;**

Adaptation:
5. **facilitates the <u>accumulation / concentration of H^+</u> leading to the (rapid) establishing of a (steep) electrochemical / proton gradient required to ;**
6. **drive <u>ATP synthesis</u>. ;**

[must make correct match between Visible Feature and Adaptation]

Fig. 1.2 shows the molecular structure of carbonyl cyanide-4-(trifluoromethoxy) phenylhydrazone (FCCP). FCCP is a respiratory poison that binds protons and transports them across the phospholipid bilayer of the inner mitochondrial membrane. Protons alone are unable to diffuse freely in this manner.

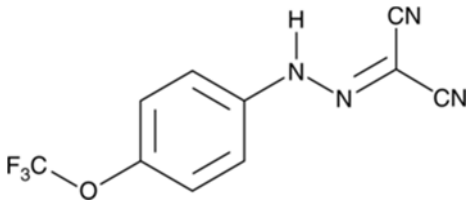


Fig. 1.2

(b) Explain, in relation to their properties, why FCCP readily diffuses across the phospholipid bilayer while protons do not. [2]

1. **FCCP is a small, hydrophobic <u>non-polar</u> molecule and readily <u>diffuses across</u> the <u>hydrophobic core</u> of the phospholipids bilayer. FCCP is hence soluble in lipids. (all subjects required) ;**
2. **Protons are <u>charged</u> and are <u>repelled by</u> the <u>hydrophobic core</u> of the phospholipid bilayer of the inner mitochondrial membrane. Thus, protons cannot diffuse readily. ;**
   [Mark once for *"hydrophobic core"*]

In the presence of FCCP, the rate of ATP synthesis during respiration is significantly diminished. The rate is further reduced if oxygen becomes unavailable. In such conditions where oxygen is depleted, cells continue to oxidise glucose to form pyruvate and sustain ATP synthesis.

(c) (i) Identify the key stages where ATP synthesis occurs via substrate level phosphorylation. [1]

glycolysis and Krebs cycle ;

(ii) State the location where the biochemical pathway enabling the continual oxidation of glucose to form pyruvate occurs. [1]

Cytosol / cytoplasm ;

(iii) Explain how ATP synthesis can be sustained in the absence of oxygen in yeast cells. [3]

1. **ATP in yeast can be sustained through anaerobic respiration, where <u>glycolysis</u> occurs followed by <u>alcoholic fermentation</u>. ;**
2. **<u>Regeneration of NAD</u> (during alcoholic fermentation) <u>allows glycolysis to continue</u> ;**
3. **resulting in a <u>net gain of 2 ATP per molecule of glucose</u> via <u>substrate level phosphorylation</u>. ;**

[Total: 10]

2 Fig. 2.1 shows a representation of a starch molecule. Starch is made up of amylose and amylopectin.

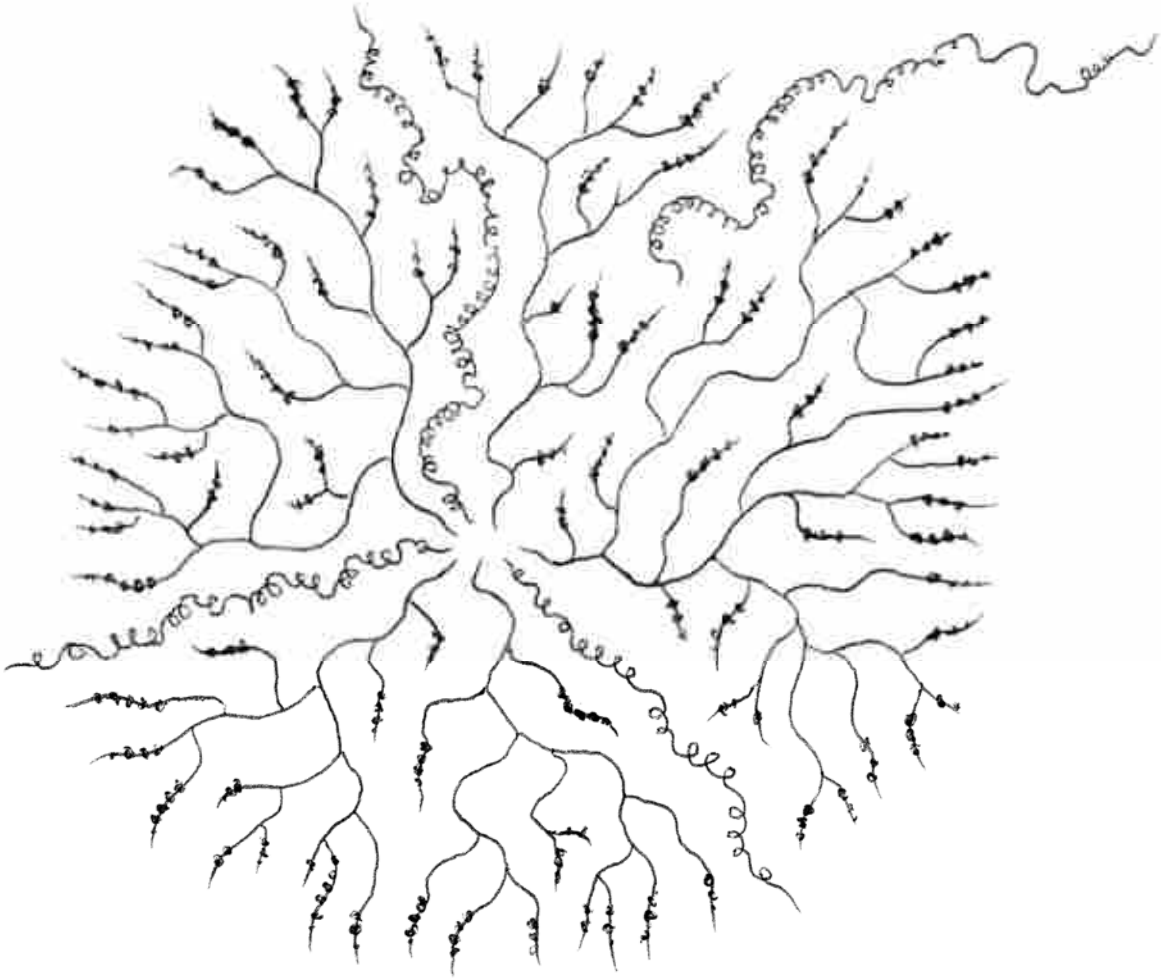


Fig. 2.1

(a) On Fig. 2.1, label amylose and amylopectin. [2]

(b) Explain how the structure of amylopectin is related to its role in living organisms. [2]

1. **Amylopectin is highly branched / many side chains formed by α-1, 6 glycosidic bonds, hence there are more branched ends / sites for hydrolytic enzymes to act on at any one time / can be hydrolysed by hydrolytic enzymes more efficiently; hence amylopectin acts as an accessible source of glucose**
2. **The glycosidic bonds (between monomers) in amylopectin can be hydrolysed easily, resulting in the release of a large number of glucose monomers; hence amylopectin acts as an accessible source of glucose**
3. **Amylopectin is a large (polysaccharide) / long chain (of glucose residues), which makes it insoluble in water; making amylopectin a suitable energy storage molecule within the cell**
4. **Insoluble nature of amylopectin prevents its diffusion out of the cell, hence it does not affect/AW the water potential / has no osmotic effect (within the cell); making amylopectin a suitable energy storage molecule within the cell**
5. **Due to the compact structure / packing of many glucose molecules per unit volume, amylopectin serves as a good storage molecule (TEACH) / good energy source in animals; as a lot of energy in the form of ATP is released when amylopectin is hydrolysed**

(c) Describe one structural difference between cellulose and amylopectin. [1]

1. **a polymer of β-glucose vs a polymer of α-glucose;**
2. **successive β-glucose residues are rotated 180° with respect to its adjacent residue vs successive α-glucose residues are not rotated 180° with respect to its adjacent residue;**
3. **consists of (a long chain of) β-glucose residues joined by β-1,4 glycosidic bonds vs (a backbone of) α-glucose residues held together by α-1,4 glycosidic bonds, and is highly branched/with side chains formed by α-1,6 glycosidic bonds;**
4. **unbranched/linear vs branched;**
5. **hydrogen bonds are formed between the –OH groups of neighbouring cellulose chains lying in parallel (resulting in cross-linking) vs most of the –OH groups are projected into the interior of the helix, hence there are no free –OH groups to form hydrogen bonds with between neighbouring amylopectin;**
6. **hydrogen bonds / cross-linking are formed between neighbouring cellulose chains (lying in parallel) vs hydrogen bonds are not form / no cross linking between neighbouring amylopectin;**
7. **In cellulose, –OH groups projecting outwards from each cellulose chain in all directions vs in amylopectin, most of the –OH groups are projected into the interior of the helix;**

[Total: 5]

3 Fig. 3.1 shows the origin and development of a B cell (a type of white blood cell) from a stem cell.

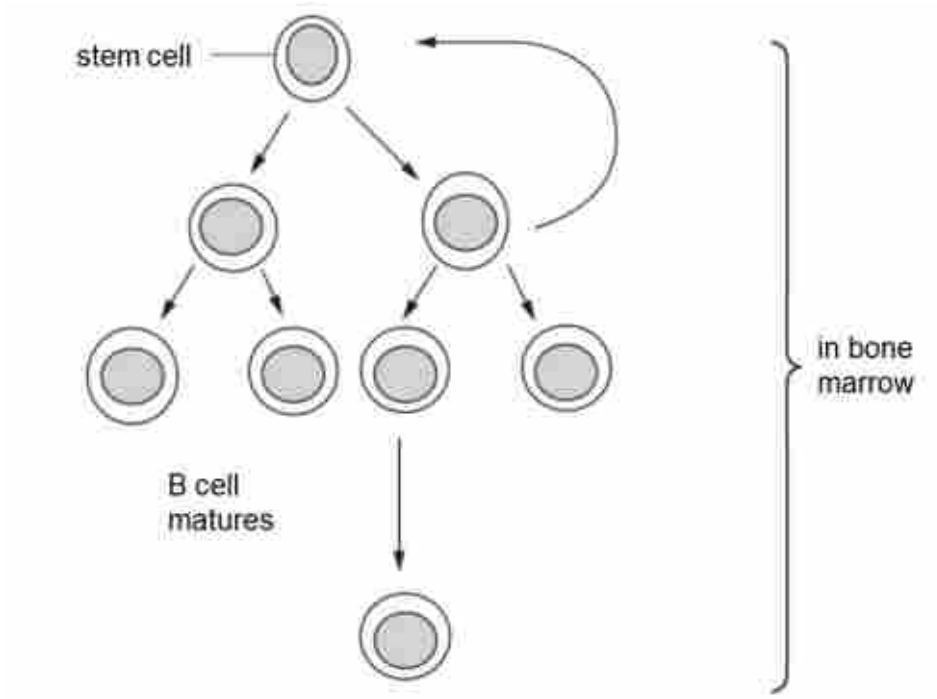


Fig. 3.1

(a) Explain what is meant by a *stem cell*. [2]

1. **Stem cells are capable of <u>remaining undifferentiated</u> (and unspecialised) for a long time ;**
2. **Stem cells are capable of <u>dividing indefinitely</u>/<u>renewing itself many times</u> by <u>mitosis</u> ;**
3. **Stem cells can <u>undergo differentiation</u>, giving rise to <u>specialised cell types</u> (upon receiving appropriate molecular signals) ;**

During B cell development, specific cell surface proteins known as CD proteins are produced and incorporated into the cell surface membrane.

Fig. 3.2 shows the stages involved in the synthesis of a CD protein in a B cell.

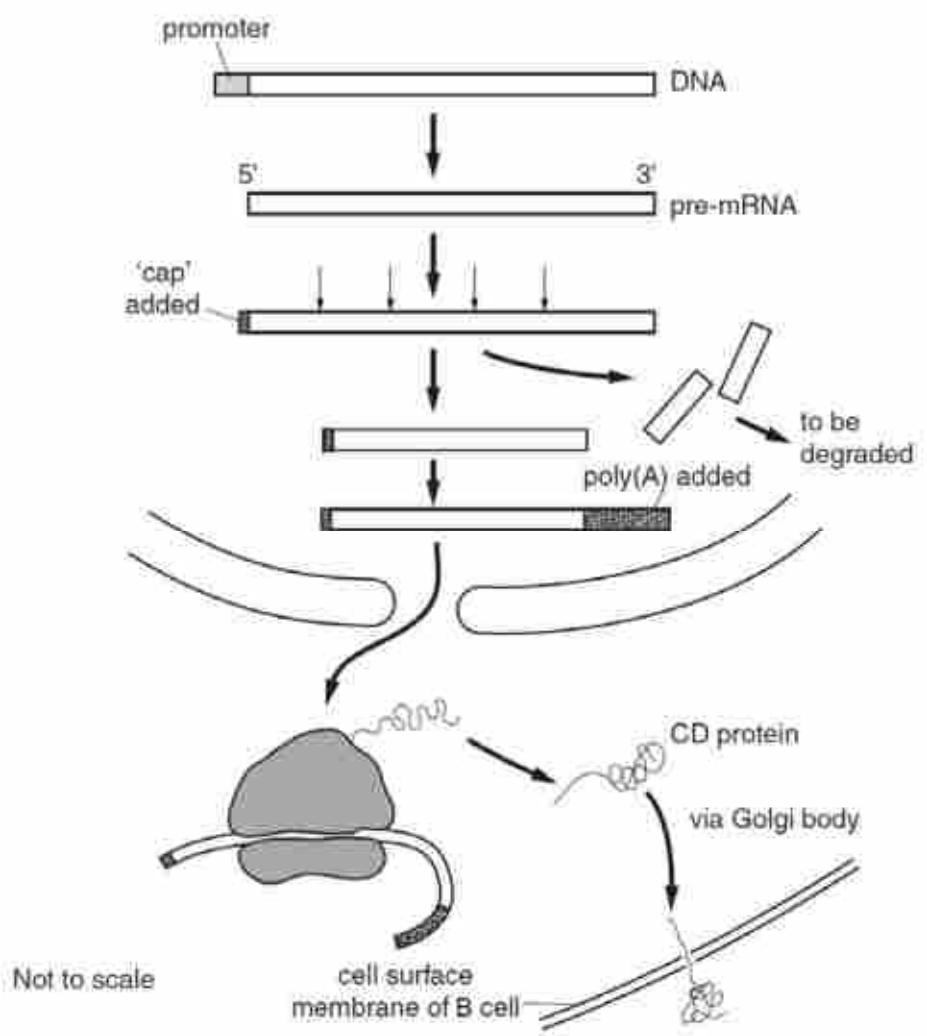


Fig. 3.2

(b) With reference to Fig. 3.2, outline the process:

(i) occurring in the nucleus of the B cell to produce pre-mRNA [3]

1. **<u>Transcription</u> is the synthesis of an RNA molecule with a base sequence complementary to a section of DNA in the nucleus ;**
2. **<u>RNA polymerase</u> recognises and binds to the (core) promoter, forming a transcription initiation complex together with general transcription factors ;**
3. **<u>Free RNA nucleotides</u> align opposite the template strand via <u>complementary base-pairing</u> ;**
4. **(base-pairing) Cytosine pairs with guanine, guanine with cytosine, thymine with adenine and adenine with uracil, forming hydrogen bonds with complementary DNA bases ; (any 2)**
5. **RNA polymerase joins these RNA nucleotides together by catalysing the formation of a <u>phosphodiester bond between RNA nucleotides</u> ;**

(ii) in forming the translation initiation complex. [3]

1. **A small ribosomal subunit recognises and binds to the 5' end of the mRNA and travels along the mRNA until it reaches the first AUG / start codon;**
2. **A special initiator tRNA carrying the amino acid methionine (Met) / anticodon UAC, binds to the start codon AUG on the mRNA;**
3. **The union of mRNA, initiator tRNA, and a small ribosomal subunit is followed by the attachment of a large ribosomal subunit, completing a translation initiation complex;**
4. **Proteins called initiation factors and GTP are required to bring all these components together;**

(c) Burkitt's lymphoma is a cancer of B cells. It is caused by a mutation that usually involves chromosome 8.

(i) Name one causative agent of mutation in chromosome 8 of Burkitt's lymphoma. [1]

5. **(Exposure to) ionising radiation, e.g. X-rays / gamma rays / UV radiation /** nuclear radiation;
6. **(Exposure to) chemical carcinogens, e.g. tobacco/tar in cigarettes;**
7. **Infection by viruses, e.g. human papilloma virus (HPV);**

(ii) Describe the key changes of two types of genes and their effects on cancer development. [2]

1. **Gain-of-function mutation in (one copy of) proto-oncogenes results in overstimulation of cell cycle/uncontrolled cell division ;**
2. **Loss-of function mutation in (both copies of) tumour suppressor genes results in inappropriate cell cycle progression/cell cycle not being arrested ;**
3. **Mutation in genes which control regulatory checkpoints of the cell cycle results in inappropriate cell cycle progression ;**
4. **Mutation in the genes involved in apoptosis causes cells to evade programmed cell death (even when the DNA of the cells are irreparably damaged) ;**
5. **Up-regulation/Activation of genes coding for telomerase prevents the progressive shortening of telomeres with each round of DNA replication, such that cancer cells (have limitless replicative potential and) can divide indefinitely ;**

[Total: 11]

4 Galactosaemia is a rare genetic disease in which the build-up of the monosaccharide galactose can result in an enlarged liver, kidney failure and brain damage. Galactose is produced in the body from the digestion of the sugar lactose, found in milk.

Galactosaemia is caused by a recessive mutation of the *GALT* gene. The normal dominant allele codes for an enzyme which converts galactose to glucose.

(a) **(i)** Suggest how a person with galactosaemia can minimise damage to the liver, kidney and brain. [1]

- **consume, less / no, milk / lactose / (named) dairy products;**

(ii) Explain how a mutation in the *GALT* gene could result in a change in the enzyme responsible for the metabolism of galactose. [4]

1. **Single base pair substitution has occurred in the DNA / gene;**
2. **Different codon is coded for in the mRNA, resulting in a missense mutation;**
3. **(resulting in a change in amino acids with different properties due to different R groups and) a change in polypeptide sequence/ primary structure;**
4. **change in specific 3D conformation of protein;**
5. **change in allosteric site / active site;**
6. **resulting in a non-functional enzyme / does not convert galactose (to glucose);**

(b) If the phenotypes of parents are known, the probabilities of having a child with galactosaemia, an unaffected child (healthy, not a carrier) or a child who is a carrier can be calculated.

Complete Table 4.1 to show the results of these calculations. [2]

Table 4.1

parent 1	parent 2	percentage probability of having a child with galactosaemia	percentage probability of having an unaffected child	percentage probability of having a child who is a carrier
unaffected	carrier	0	50	50
carrier	carrier	.....	.....	.....
unaffected	has galactosaemia	.....	.....	.....
carrier	has galactosaemia	50	0	50

carrier	carrier	25	25	50	;
unaffected	has galactosaemia	0	0	100	;

[Total: 7]

5 Silvereyes (*Zosterops lateralis*) are a species of Australian songbirds that can be found in both rural and urban environments. These birds produce contact calls to inform one another of danger or newly discovered food sources. The pitches and speed (measured in number of syllables per second) of Silvereyes' contact calls were identified to be genetically associated.

Studies on Silvereyes living in increasingly denser Australian cities have revealed that the birds made contact calls with much higher mean pitches and slower mean speeds with longer pauses between calls over the years.

When measured in the past, the mean pitch of the Silvereye call overlapped significantly with the pitches of road and air traffic making the calls indistinguishable from urban noise. Sound-reflecting buildings also diminished the clarity of the bird calls.

Fig. 5.1 shows a Silvereye.

Fig. 5.1

(a) Explain how natural selection may have led to a change in the mean pitch and speed of the Silvereye calls in the city. [5]

1. **<u>Spontaneous mutation results in genetic variation</u> (in alleles coding for Silvereye contact call pitch and speed) within the population of Silvereyes living in the city ;**
2. **Birds that do not make clearer calls hence <u>die from predation / lack of food</u>. ;**
   - **Selection Pressure: Urban noises such as road and air traffic and sound-reflective buildings muffled the Silvereye contact call, diminishing the success of birds communicating danger and newly discovered food sources among themselves.**
3. **On the other hand, Silvereyes that made calls at a <u>higher pitch and slower speed</u> are at <u>selective advantage</u>. ;**
4. **Silvereyes selected for these advantageous traits <u>survive to maturity</u>, <u>mate/reproduce</u> and <u>passed down favourable alleles (that code for higher-pitched and slower contact calls) to their offspring</u> / ORA. ;**
5. **Over time, there is a <u>change in the allele frequencies in the population</u> for contact call pitch and speed, leading to evolution of a higher mean pitch and slower speed with pauses in Silvereye calls. ;**

(b) An analysis of ice cores from the Arctic and Antarctic can provide information about the composition of the Earth's atmosphere over thousands of years.

Fig. 5.1 shows the concentrations of carbon dioxide measured in ice cores, dated between 1000 and 2000 AD.

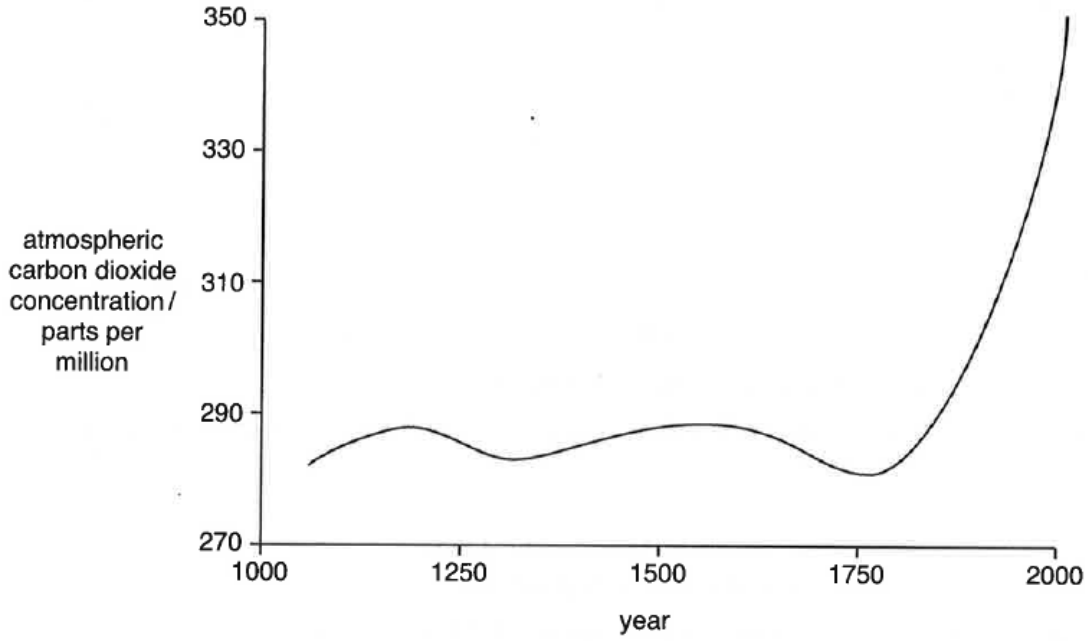


Fig. 5.1

(i) Describe the trend in Fig. 5.1. [2]

1. **The atmospheric carbon dioxide concentration stayed relatively <u>constant</u> at around 285 parts per million in year 1060 and <u>increased exponentially/sharply</u> in year 1750 to reach 350 parts per million in year 2000;**

   1m for constant, increased sharply
   1m for pair of figures

(ii) Atmospheric carbon dioxide concentrations show regular annual variations. Suggest one reason for this. [1]

1. **There are (four) seasons/seasonal changes in a year / atmospheric carbon dioxide concentrations is lower in summer and higher in winter;**

(c) Fig. 5.2 shows that, over the same period of time, the average surface temperature of the Earth has shown a similar pattern of change. The increasing concentrations of carbon dioxide is thought to be responsible for the increase in temperature over the last 100 years. This is referred to as the enhanced greenhouse effect.

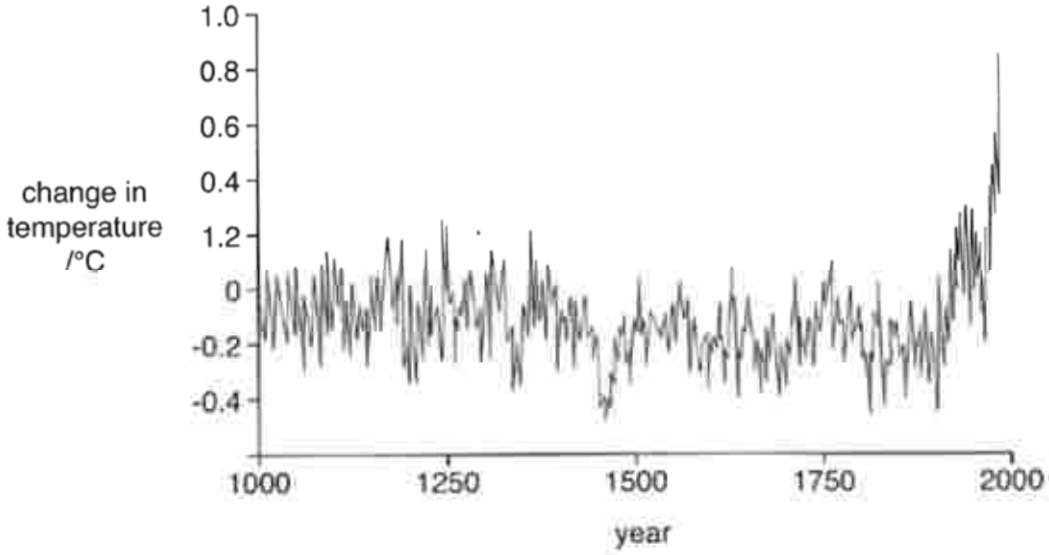


Fig. 5.2

(i) Describe one way in which the data in Fig. 5.2 resembles the data in Fig. 5.1 and one way in which it is different. [2]

1. **Similarity: The change in temperature stayed relatively constant before increasing exponentially/sharply**

2. **Difference: there are more variations/fluctuations in the changes in temperature and less variations/fluctuations in atmospheric carbon dioxide concentrations;**

(ii) Explain the human activities that have contributed to the enhanced greenhouse effect. [2]

1. **<u>Burning of fossil fuels due to increasing energy usage releases large amounts of stored carbon into the atmosphere</u> as carbon dioxide (CO_2) and is the major source of CO_2 emission;**
2. **<u>Deforestation</u> causes a net <u>reduction in carbon storage</u> as forested areas act as carbon sinks and results in <u>CO_2 emission when forests are burnt</u>, increasing the level of CO_2 in the atmosphere;**

[Total: 12]

Section B

Answer **one** question in this section

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6 **(a)** The organelles of the endomembrane system in animal cells are related through direct contact or by the transfer of membrane segments as vesicles.

Outline the functions of the organelles of the endomembrane system and state the structural similarities between these organelles. [9]

(Max 7 from pt 1 – 14)

Functions of the rough ER

1. **<u>sites of protein synthesis</u>;**
2. **<u>biochemical modification</u> takes place in cisternal space / proteins may be modified by enzymes in the cisternal space of ER that add carbohydrate chains (or lipids) to them – <u>glycosylation</u>;**
3. **serves as the <u>intracellular transport system</u> which transports the synthesised/modified proteins to other compartments within the cell by transport vesicles budding off from the ER membrane;**
4. **The membrane of transport vesicles (formed from rough ER membrane) also replenishes the membrane of Golgi body.;**

Functions of the smooth ER

5. **responsible for the synthesis of lipids (e.g. phospholipids and steroid hormones);**
6. **involved in carbohydrate metabolism in the liver (glycogenolysis);**
7. **detoxification of drugs and other toxic substances in the liver;**
8. **storage of calcium ions necessary for muscle contraction;**

Function of Golgi body

9. **<u>Further modify, sort and package proteins / products</u> of ER into vesicles before transporting to other parts of the cell and/or out of the cell / targeted for other destinations;;**
10. **<u>Formation of secretory vesicles containing matured proteins</u> which move to the cell surface and fuse with the plasma membrane, releasing their contents out of the cell via the process of exocytosis;;**
11. **Formation of lysosomes containing hydrolytic enzymes (e.g. proteases, nucleases, lipases);;**

Function of Lysosomes

12. **Intracellular digestion – to digest material which the cell consumes from the environment through phagocytosis;**
13. **Autophagy – to digest parts of the cell such as damaged or worn-out organelles;**
14. **Autolysis – self-destruction of a cell by releasing the hydrolytic enzymes of all lysosomes within the cell.;**

Structural similarities

15. **Presence of (single) membrane / phospholipids bilayer;**
16. **Presence of proteins/enzymes within organelles;**
17. **Presence of fluid-filled space;**
18. **Association with cytoskeleton;**

QWC:
Good spread of knowledge communicated without ambiguity to include:
At least 2 organelles' functions and at least 1 MP on the structural similarities.

(b) A 75kg human consists of ten times more prokaryotic cells than eukaryotic cells, with a total prokaryote mass of at least 1kg. This assembly of prokaryotic cells is known as the human prokaryotic microbiome community.

Outline the differences between typical prokaryotic and eukaryotic cells and state the methods by which these differences can be shown. [6]

Differences (max 5)

Features	Eukaryotes	Prokaryotes
1. Size	**Large, 10-100µm**	**Small/<1 µm**
2. Nucleus/nuclear envelope	**Present**	**Absent**
3. Cell wall	**Absent in animal cell**	**Present in prokaryotic cell**
4. Membrane bound organelles	**Present**	**Absent**
5. Ribosomes	**80S/large/22nm**	**70S/small/18nm**
6. DNA conformation	**Linear**	**Circular**
7. Introns	**Present**	**Absent**
8. Origin of replication *(ori)*	**Many**	**Few**
9. Compaction of DNA	**Highly condensed**	**Less condensed**
10. Size of genome	**Large**	**Small**
11. Histones	**Present**	**Absent**
12. Component in cell wall	**Cellulose in plant cell**	**Peptidoglycan in bacterial cell**
13. Peptidoglycan	**Absent**	**Present**

Pt 12 & 13: award once

Methods:

14. Light microscope;
15. Use of stain;
16. Electron microscope;
17. Centrifugation;
18. Chemical analysis;
19. DNA analysis/PCR/DNA sequencing/electrophoresis;
20. Other valid methods;

7 (a) Variation exists in individuals of the same species in a population due to a number of different reasons. Describe what causes variation and why it is important in natural selection. [9]

Causes of Variation (Max 7)

1. **Variation is due to mutation, meiosis and sexual reproduction ;**

Gene Mutation

2. **Gene mutations are defined as changes in the sequence of DNA nucleotides in the gene;**
3. **Due to exposure to chemical carcinogens such as tobacco in cigarette smoke / ionising radiation such as UV-rays, X-ray / viruses / errors during DNA replication or repair etc.;**
4. **Base pair substitution / addition / deletion may occur, resulting in nonsense / silent / missense / frameshift mutation; (max 1)**

5. **Base-pair substitution – replacement of one nucleotide base pair with another base-pair in a gene, resulting in missense mutation/nonsense mutation/significant change in the encoded protein OR silent mutation/no/little effect on the encoded protein;**

6. **Base-pair addition – insertion of one or more nucleotide base pairs in a gene, resulting in frameshift mutation, whereby the reading frame is altered / nucleotides downstream from the mutation are improperly grouped into incorrect codons and read in different sets of threes;**
   OR
7. **Base-pair deletion – loss of one or more nucleotide base pairs in a gene, resulting in frameshift mutation, whereby the reading frame is altered / nucleotides downstream from the mutation are improperly grouped into incorrect codons and read in different sets of threes;**

Max 2 for MP 4-7

Chromosomal aberration

8. **Chromosomal aberration can be categorised as numerical aberration (the change in chromosome number) or structural aberration to chromosomes;**

9. **Translocation – a section of chromosome breaks off from one chromosome and becomes attached to another chromosome;**
10. **Duplication – a section of a chromosome replicates such that a set of gene loci is repeated;**
11. **Deletion – a chromosome breaks at two points, the middle portion is displaced with the two ends joining together;**
12. **Inversion – a chromosome breaks at two locations and the middle portion flips through 180° before rejoining;**

13. **Aneuploidy is a condition in the nucleus where there are one or several chromosomes more than or less than the diploid number of chromosomes;**
14. **Aneuploidy can result from non-disjunction during anaphase / when a haploid gamete fuses with a gamete carrying n-2, n-1, n+1 or n+2 chromosomes;**
15. **Polyploidy is a condition of the nucleus where there are three or more times the haploid number of chromosomes, e.g. 3n, 4n and 5n;**
16. **It can result from non-disjunction, the fusion of a diploid gamete with a normal haploid gamete giving a triploid nucleus;**

Meiosis

17. In meiosis, crossing over between non-sister chromatids of homologous chromosomes occurs during prophase I;
18. Independent assortment of homologous chromosomes during metaphase I and chromatids during metaphase II;
19. Results in new combination of alleles;

Sexual reproduction

20. Random fusion of gametes during sexual reproduction;
21. Results in new combination of alleles (award once);

Importance in Natural Selection

22. Variation describes the differences in characteristics / means the presence of different characteristics;
23. due to presence of different alleles in the different individuals;
24. resulting in differential reproductive success / different survival rates;
25. Variations in characteristics are subjected to selection pressure from the environment;
26. ~~There can be continuous / discontinuous variation;~~
27. Due to interaction of genotype and environment;
28. variants with favourable characteristics will survive to maturity, reproduce and pass down their favourable alleles to their offspring;
29. Those with unfavourable characteristics die and fail to do so;

QWC:
Good spread of knowledge communicated without ambiguity to include:
At least 2 causes of variation and at least 1 MP on the importance.

[Turn over

(b) Discuss, using known examples, how limiting factors can influence the rate of various biological processes. [6]

Definition

1. **A limiting factor is that factor which directly affects/determines the rate of reaction/process if its quantity is changed / when the factor is in lowest/shortest/scarcest supply. ;**

Biological Processes

2. **Biological Process: Enzyme-catalysed Reactions ;**

Factor	How Factor Influences Rate	
3. Substrate concentration	+ illustrate how factor influence rate	;
4. Enzyme concentration		;
5. Temperature		;
6. pH		;

[Max 3]

REJECT: Concentration of competitive or non-competitive inhibitors as limiting factors.

7. **Biological Process: Facilitated Diffusion ;**

Factor	How Factor Influences Rate	
8. (Steepness of) concentration gradient / difference in concentrations of transported substance across a cell / biological membrane	+ illustrate how factor influence rate	;
9. Density of channel/carrier proteins on the membrane		;

10. **Biological Process: Photosynthesis ;**

Factor	How Factor Influences Rate	
11. Light intensity	+ illustrate how factor influence rate	;
12. Temperature		;
13. Carbon dioxide concentration		;

14. **Biological Process: Aerobic Respiration ;**

Factor	How Factor Influences Rate	
15. Glucose / hexose sugars concentration	+ illustrate how factor influence rate	;
16. Oxygen availability		;
17. Temperature		;
18. NAD^+ / FAD^+ / mobile electron carriers availability		;

[Max 3]

19. Biological Process: Population Growth / Bacteria Colony Growth ;

Factor	How Factor Influences Rate	
20. Nutrient availability	**+ illustrate how factor influence rate**	**;**
21. Water availability		**;**
22. Temperature		**;**
23. Competition for resources / Predation / AVP		**;**

[Max 3]

REJECT: Signal Reception / Ligand-Receptor Interactions as a form of biological process that is influenced by limiting factors. Any limits on rates of signal propagation and hence response efficacy is overcome by signal amplification.

QWC:
Clearly communicates limiting factors of 2 different biological processes

[Total: 6]

INNOVA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME	

CG						INDEX NUMBER				

BIOLOGY 8876/01

Paper 1 Multiple Choice **13 September 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, CG and index number in the spaces at the top of this page.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, CG and index number on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

1 Which part of the cell is often continuous with the rough endoplasmic reticulum?

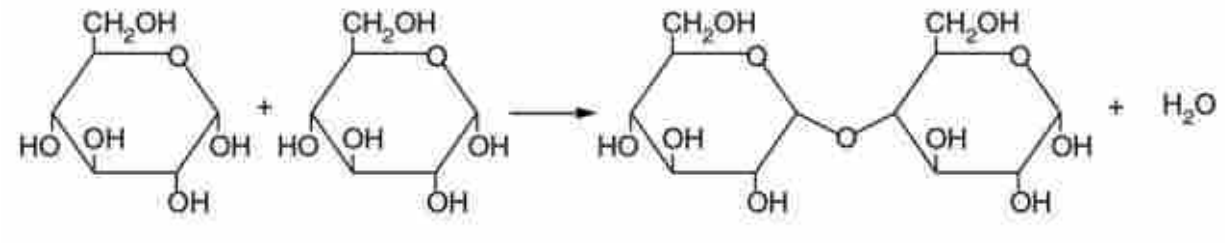
A cell surface membrane
B Golgi apparatus
C mitochondrion
D nuclear envelope

2 Which structures are found in eukaryotic cells?

1 70S ribosomes
2 80S ribosomes
3 circular DNA
4 linear DNA

A 1 and 2
B 1 and 3
C 2 and 4
D 1, 2, 3, and 4

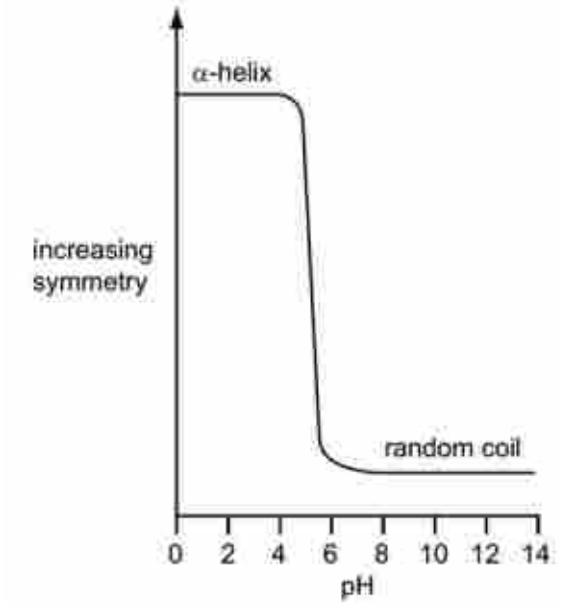
3 The diagram shows a reaction resulting in the formation of a bond between two molecules.



Which bond is formed and what is the type of reaction?

	bond formed	type of reaction
A	glycosidic	condensation
B	glycosidic	hydrolysis
C	peptide	condensation
D	peptide	hydrolysis

4 The graph shows the effect of pH on the structure of a protein which consists entirely of repeating residues of one amino acid.



Which statement is true?

A At pH2, the protein has lost its secondary structure.

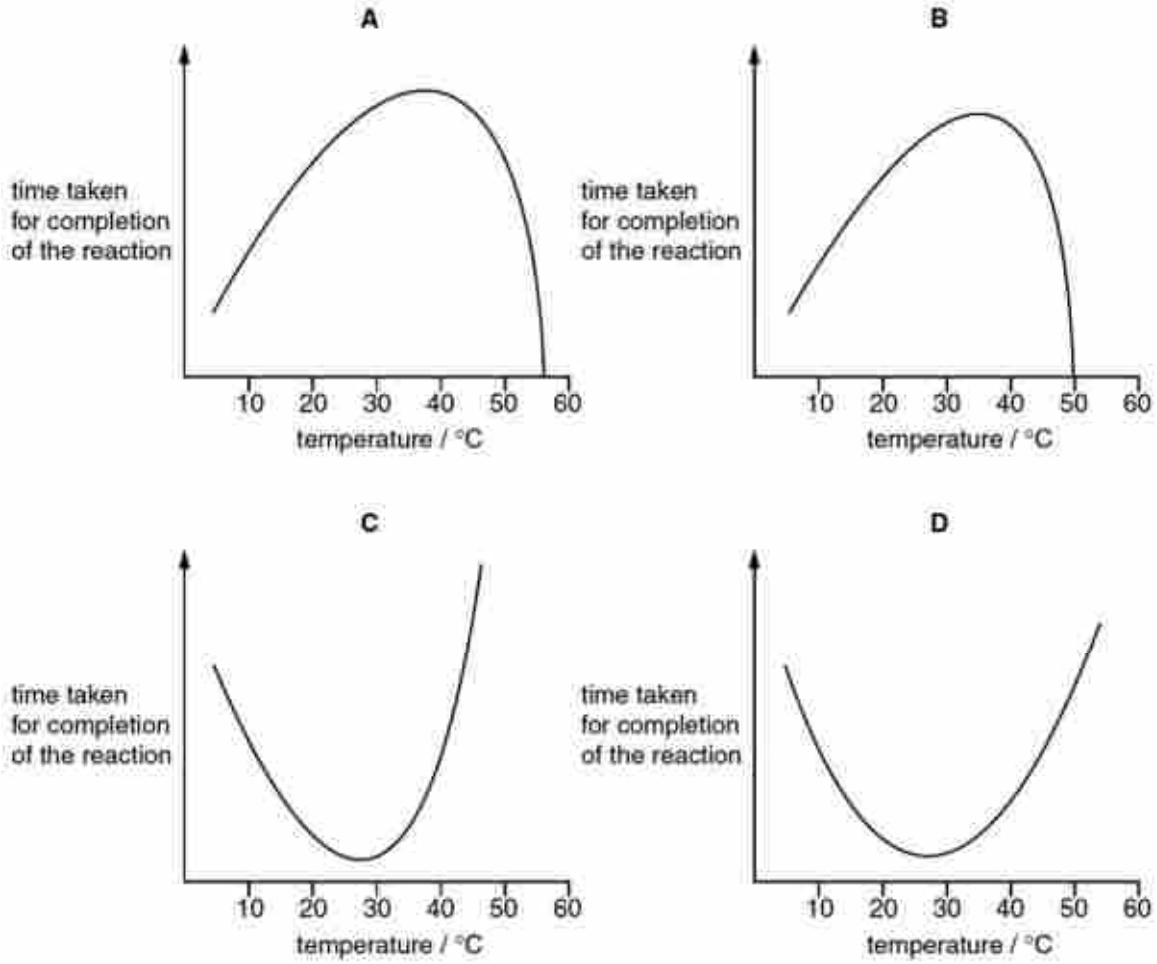
B At pH2, the protein has lost its tertiary structure.

C At pH10, the protein has lost its primary structure.

D At pH10, the protein has lost its secondary structure.

5 An enzyme is completely denatured at 50 °C. A fixed concentration of this enzyme is added to a fixed concentration of its substrate. The time taken for completion of the reaction is measured at different temperatures.

Which graph shows the results?



6 Which bonds are the last to break when an enzyme is heated?

A disulfide

B hydrogen

C hydrophobic interactions

D ionic

7 Increasing which type of bond helps to increase the fluidity of the cell surface membrane?

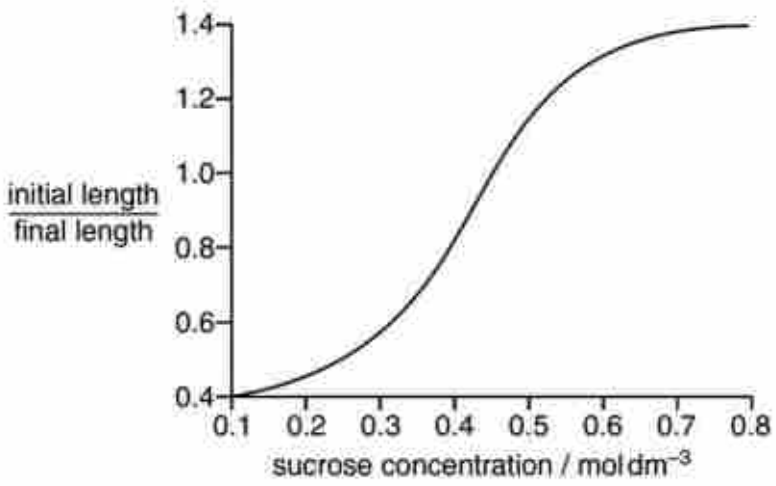
A C — O — C

B C — C

C C = C

D hydrogen

8 Strips of plant tissue were immersed in a range of sucrose solutions of different concentrations. Their lengths were measured before immersion and after 30 minutes in the different solutions. The graph shows the ratio of initial length to final length.



Which concentration of sucrose solution, in moldm^{-3}, has the same water potential as the cell sap before immersion?

A 0.1

B 0.25

C 0.45

D 0.8

9 Which of the following best illustrates totipotency of stem cells?

A A somatic cell isolated from a root tip develops into a normal adult plant.

B Stem cells are able to divide indefinitely.

C Mesenchymal stem cells can differentiate into an extensive range of cell types, including bone cells, cartilage cells, muscle cells and fat cells.

D The replacement of the nucleus of an unfertilised egg with that of a pancreatic cell converts the egg into a pancreatic cell.

10 RNA is involved in the process of protein synthesis.

Which of the following descriptions is true about RNA in eukaryotes?

A rRNA, which is coded by genes found in nucleolus, associates with ribosomal proteins in the cytoplasm to form ribosomal subunits.

B Functional mRNA is formed as a result of post-transcriptional modifications of primary RNA transcript in the nucleus.

C The ribonucleotide sequence of tRNA molecules allows extensive folding and inter-strand complementarity to generate a three-dimensional structure.

D RNA is synthesised in the nucleus only.

11 The mechanism of action of four drugs that inhibit DNA replication is stated below:

- Drug 1 inhibits the action of DNA ligase.
- Drug 2 resembles the shape of a DNA nucleotide.
- Drug 3 attaches irreversibly to the DNA molecule.
- Drug 4 binds irreversibly to the active site of DNA polymerase.

Which option correctly matches the drug(s) to the effect on DNA replication?

	Daughter strands of varying lengths are synthesized.	Only fragments are synthesized at the end of replication process.	Phosphodiester bonds cannot be formed.	Template strand becomes inaccessible by the enzyme.
A	4	3	2	1
B	2	4	3	1
C	2	1	4	3
D	3	2	1	4

12 Which of the following statement(s) is/are **not** true of the translation process in all eukaryotes?

1 Polypeptides are only synthesised in the cytosol.

2 Amino acids are linked by the formation of peptide bonds catalysed by a ribozyme.

3 Ribosomes contain an amino-acyl tRNA site that is occupied by the initiator tRNA attached to methionine.

4 Amino-acyl tRNA synthetase attaches an amino acid to the 5’ end of a tRNA molecule.

A 1, 3 and 4 only

B 2, 3 and 4 only

C 2 and 4 only

D 1 only

13 In 1985, it was discovered that a bacterium, *Mycoplasma capricolum*, used a deviant genetic code. The codon UGA resulted in the addition of tryptophan to the growing polypeptide chain.

A short sequence of nucleotides was synthesised with the following base sequence:

3' CTGGCAACTATTTCAACTCATATC 5'

How many peptide bonds would be formed by ribosomes when this sequence undergoes transcription and translation in *Mycoplasma capricolum* and a human liver cell?

	Mycoplasma capricolum	Human liver cell
A	1	0
B	2	1
C	3	2
D	4	3

14 The RNA triplet UAG acts as a stop codon terminating the synthesis of a polypeptide. The diagram shows a strand of DNA which codes for four amino acids.

Where would a mutation, introducing a thymine nucleotide, result in the termination of translation?

T C C A C T C G A T G C

↑ A ↑ B ↑ C ↑ D

15 Which of the following describes aneuploidy?

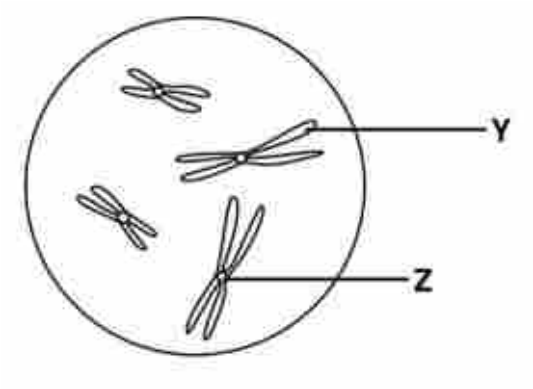
A nonsense mutation

B single base substitution

C translocation

D trisomy 21 i.e. Down's syndrome

16 The diagram shows chromosomes in a nucleus.



What are **Y** and **Z**?

	Y	Z
A	centromere	centriole
B	centromere	chromatid
C	chromatid	centriole
D	chromatid	centromere

17 Gene mutations in either the *BRCA1* or the *BRCA2* genes are responsible for the majority of hereditary breast cancer in humans.

The proteins produced by the two genes migrate to the nucleus where they interact with other proteins, such as those produced by the tumour suppressor gene, *p53*, and the DNA repair gene, *RAD51*.

Which combination of gene activity is most likely to result in breast cancer?

key:

✓ = gene produces normal protein × = gene produces abnormal protein or no protein

	gene		
	BRCA1 or BRCA2	*p53*	*RAD51*
A	✓	✓	✓
B	✓	✓	×
C	✓	×	✓
D	×	×	×

18 The table shows the results of a series of crosses in a species of small mammal.

coat colour phenotype		
male parent	female parent	offspring
dark grey	light grey	dark grey, light grey, albino
light grey	albino	light grey, white with black patches
dark grey	white with black patches	dark grey, light grey
light grey	dark grey	dark grey, light grey, white with black patches

What explains the inheritance of the range of phenotypes shown by these crosses?

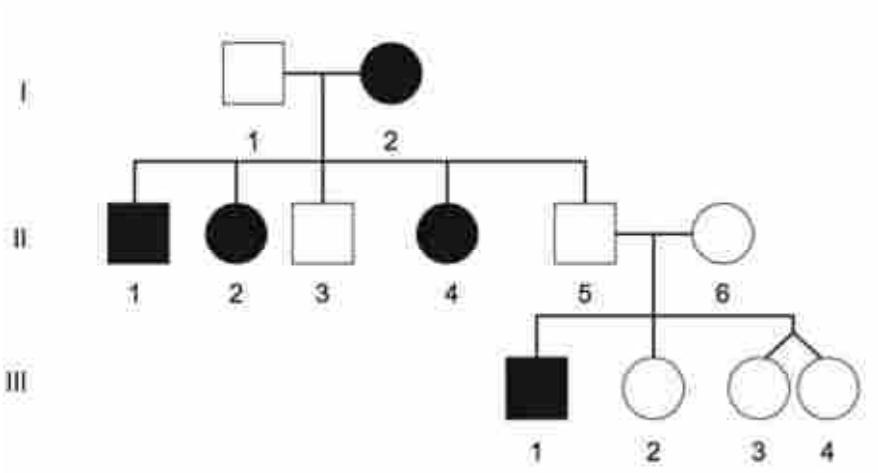
A one gene with a pair of co-dominant alleles

B one gene with multiple alleles

C sex linkage of the allele for grey coat colour

D two genes, each with a dominant and recessive allele

19 The pedigree below showed that the mode of inheritance of this disease is …… as supported by …….



A autosomal dominant, individuals I-2 with offspring II-1, II-2 and II-4

B autosomal recessive, individuals I-1, I-2 with offspring II-3 and II-5

C autosomal recessive, individuals II-5, II-6 with offspring III-1

D sex-linked dominant, offspring II-2 and II-4

20 Fruit flies (*Drosophila*), homozygous for long wings, were crossed with fruit flies homozygous for vestigial wings. The F_1 and F_2 generations were raised at three different temperatures.

At each temperature, the F_1 generation all had long wings.

The table shows the results in the F_2 generation.

temperature / °C	result
21	¾ long wings, ¼ vestigial wings
26	¾ long wings, ¼ intermediate wing length
31	all long wings

Which statement explains these results?

A Heterozygous flies have vestigial wings only at 21°C or below but have long wings at 31°C or above.

B Long wing and vestigial wing illustrate codominance at 26°C.

C Long wing is dominant at higher temperatures but vestigial wing is dominant at lower temperatures.

D Vestigial wing is recessive but causes a vestigial wing phenotype only at lower temperatures.

21 In respiration, the enzyme hexokinase uses ATP to transfer a phosphate group to glucose to form glucose-6-phosphate.

If a cell only has glucose available for energy and the activity of hexokinase is suddenly inhibited in this cell, which of the following will occur?

1 The cell will not be able to produce pyruvate through glycolysis.

2 Respiratory processes in the mitochondria would not proceed.

3 The use of oxygen by the cell will decrease.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

22 Which of the following statements explains the mechanism for chemiosmosis in the synthesis of ATP?

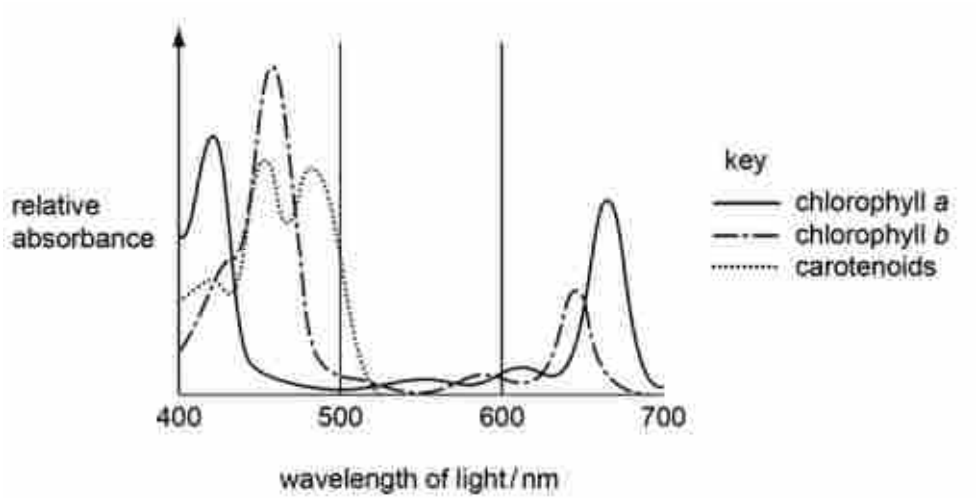
A The energy released by the reduction and subsequent oxidation of components of the electron transport chain is transferred to ATP synthase for the synthesis of ATP.

B Phosphorylation of ADP is linked to the proton gradient established by the electron transport chain.

C The difference in pH between the intermembrane space and the cytosol drives the formation of ATP.

D The flow of H^+ through ATP synthase into the intermembrane space drives the synthesis of ATP.

23 The graph shows the absorption spectra of some pigments found in chloroplasts.



Which statements are correct?

1 Having several pigments, rather than one, increases the efficiency of photosynthesis.

2 Most leaves are green as chlorophyll absorbs light in the blue and red regions of the spectrum.

3 Photosynthesis will be fastest in light at the red end of the spectrum, as red light has higher energy than blue light.

4 Prior to leaf fall, chlorophyll is broken down, leaving carotenoids which makes leaves look yellow or red.

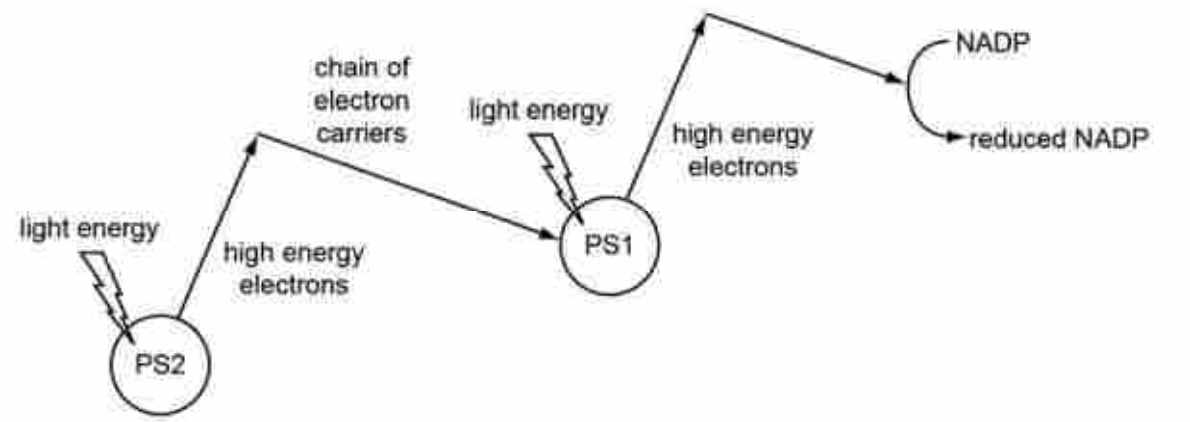
A 1 and 2 only

B 1 and 3 only

C 1, 2 and 4 only

D 2 and 4 only

24 The diagram shows some of the processes in the light-dependent stage of photosynthesis.



For the light-dependent stage to continue, photosystem two (PS2) must gain electrons. Where do these electrons come from?

A electron carriers

B reduced NADP

C photolysis of water

D the formation of ATP

25 Which statements are true about Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.

2 In competition for survival, the more aggressive animals are more likely to survive.

3 Species perfectly adapted to a stable environment will continue to evolve.

4 Variation between individuals of a species is essential for evolutionary change.

A 1, 2 and 4 only

B 2 and 3 only

C 3 and 4 only

D 4 only

26 The Galapagos Islands are a group of volcanic islands in the eastern Pacific Ocean, about 1000km from South America. Thirteen species of finch are found on the islands; they resemble each other closely but differ in their feeding habits and in shape of their beaks.

Assuming that an ancestral stock of finches came from the mainland, what is the most likely explanation for the existence of similar but distinct species of Galapagos finches?

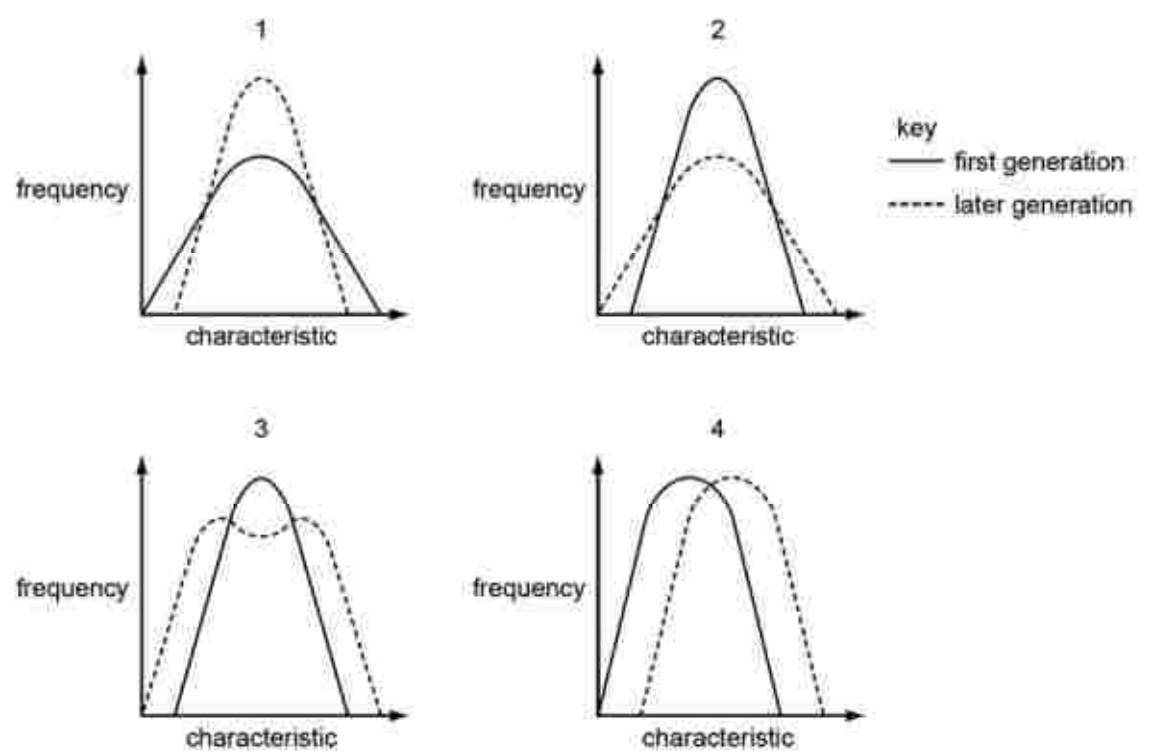
A Finches developed different kinds of beaks in order to feed on different kinds of food.

B Finches evolved separately according to the habitat in which they settled.

C Finches from the mainland bred with population of a related species on the island to produce new genotypes.

D Finches in similar habitats face similar selection pressures thus evolve to become very similar species.

27 The graphs show frequency against a measured characteristic in the first and later generation of an organism.



Which graph represents each type of natural selection?

	directional	disruptive	stabilising
A	1	2	3
B	2	3	4
C	3	1	2
D	4	3	1

28 What is the impact of global warming on plants?

A In colder regions, a warmer climate may allow people to grow new crops.

B Global warming beyond optimal growth temperatures encourages plant growth.

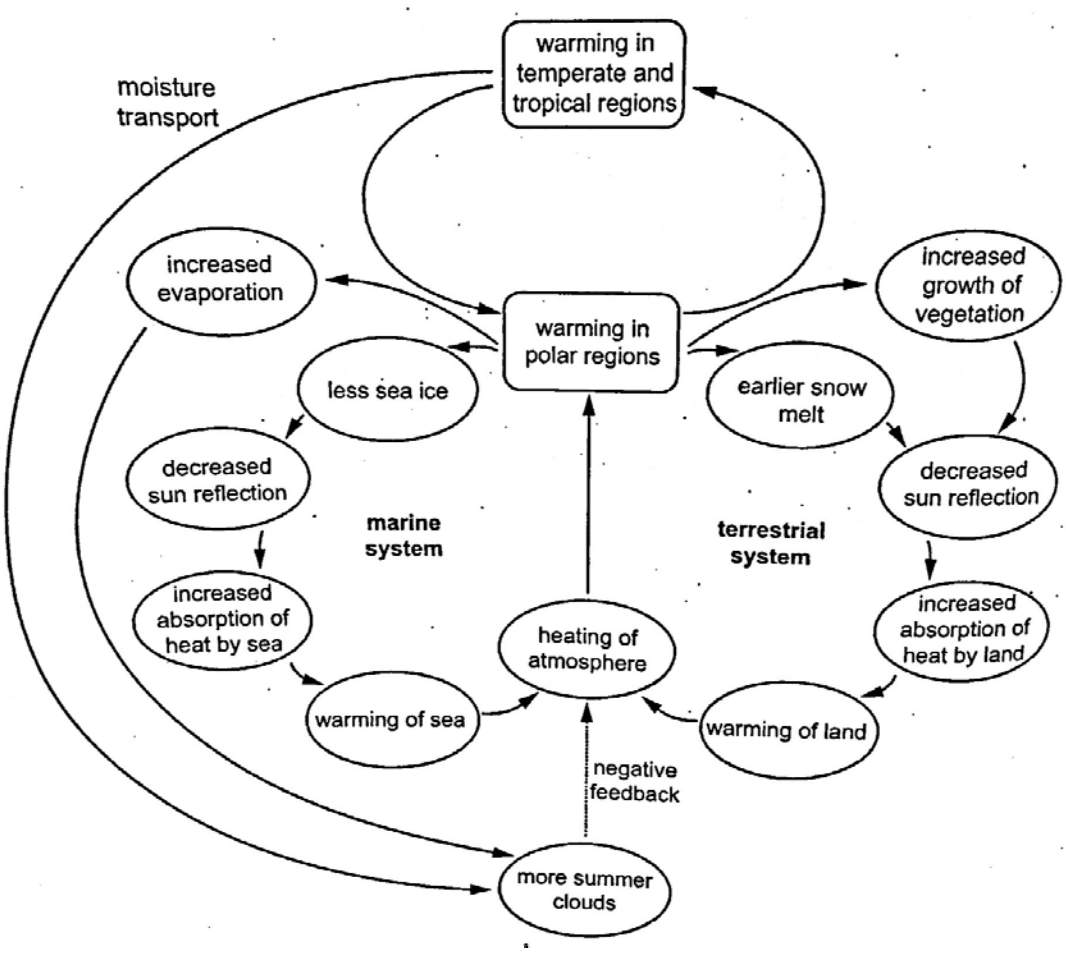
C Temperate plants will shift to tropical regions.

D Production of all crops are higher due to higher temperatures.

29 Which of the following correctly shows the effects of climate change on coral reefs and associated ecosystems?

	Average number of zooxanthellae in each polyp	Mass of basal plate of hard corals	Diversity of catch from nearby fisheries
A	Decreased	Decreased	Decreased
B	Decreased	Unaffected	Increased
C	Increased	Decreased	Decreased
D	Increased	Unaffected	Increased

30 The diagram shows the effect of increasing temperatures on the ice and snow cover at the polar regions.



Which effect of higher temperatures in the polar regions could increase global warming?

A Melting of ice and snow results in less reflection of sunlight and more heat absorption by the Earth.

B Increased evaporation leads to more rainfall, which absorbs heat from the land and the sea.

C Melting sea ice causes more cloud formation, which increases absorption of heat in the atmosphere.

D Earlier melting of snow allows vegetation cover to increase faster, reducing loss of heat from the surface of the Earth.

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Higher 1

CANDIDATE NAME

CG | | | | | | INDEX NUMBER | | | | |

BIOLOGY 8876/02

Paper 2 Structured and Free-response Questions

28 August 2018

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, CG and index number on page 1, 7 and 11 in the spaces provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided on the Question Paper.

Section B
Answer any **one** question in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	/10
2	/14
3	/13
4	/8
5 or 6	/15
Total	/60

This document consists of **16** printed pages.

Section A

Answer **all** the questions in this section.

1 Fig. 1.1 shows part of a eukaryotic cell.

Fig. 1.1

(a) **(i)** Outline the role of organelle labelled **A**.

.....

.....

.....

.....

.....

..... [3]

(ii) Identify **one** molecule with different modes of transport across the membrane of **A** and explain their modes of transport.

.....

.....

.....

.....

.....

..... [2]

(b) **(i)** Explain the significance of glycolysis in aerobic respiration.

.....

.....

.....

.....

.....

..... [3]

An experiment was carried out to investigate the effect of temperature on respiration in isolated mitochondria extracted from a worm. Respiratory substrate was provided and oxygen consumption was monitored at 15°C, 25°C and 35°C.

Fig. 1.2 shows the temperature coefficients, Q_{10}, when temperature is increased from 15°C to 25°C and from 25°C to 35°C.

Q_{10} measures the ratio of the rate of respiration when the temperature increases by 10°C.

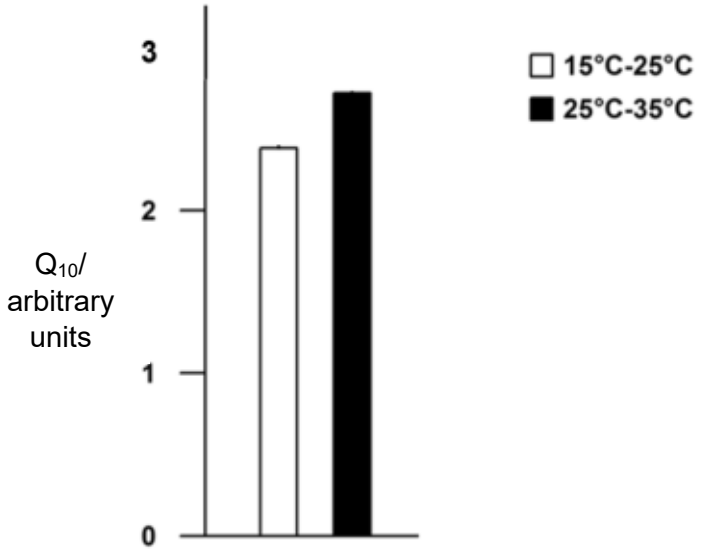

Fig. 1.2

(ii) Describe and explain the effect of temperature on the Q_{10} of mitochondria respiration.

.....

.....

.....

..... [2]

[Total: 10]

2 Fig. 2.1 is a photomicrograph of plant root cells near the growing top. Some of the cells are undergoing mitosis.

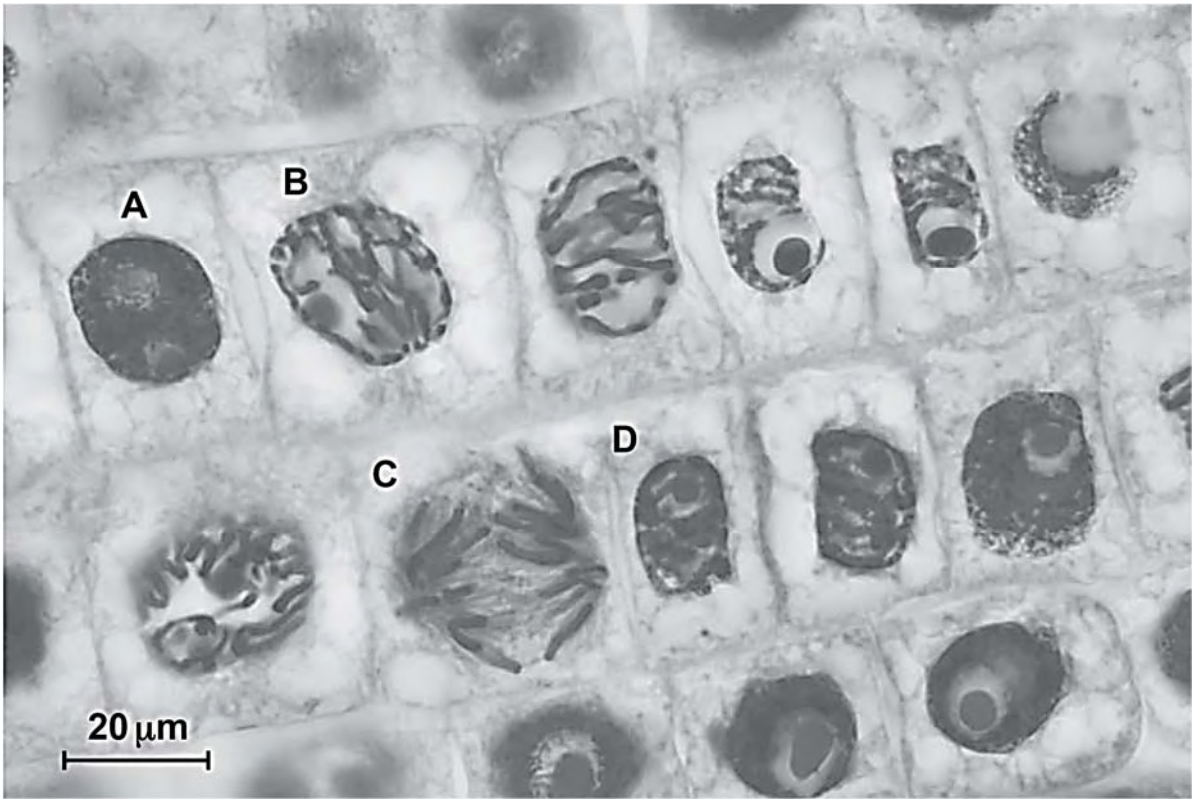

Fig. 2.1

(a) State **one** feature, visible in Fig. 2.1, which indicates that the section is taken from a plant tissue and not animal tissue.

..... [1]

(b) State the letter, **A** to **D**, of the cell in Fig. 2.1 which is in:

(i) prophase .....

(ii) anaphase ..... [2]

(c) Explain why the growth of roots involves mitosis and not meiosis.

.....

.....

.....

.....

.....

..... [3]

(d) Fig. 2.2 represents one complete cell cycle for the plant root cells.

(i) Complete Fig. 2.2 by naming the stages represented by **J**, **K** and **L**.

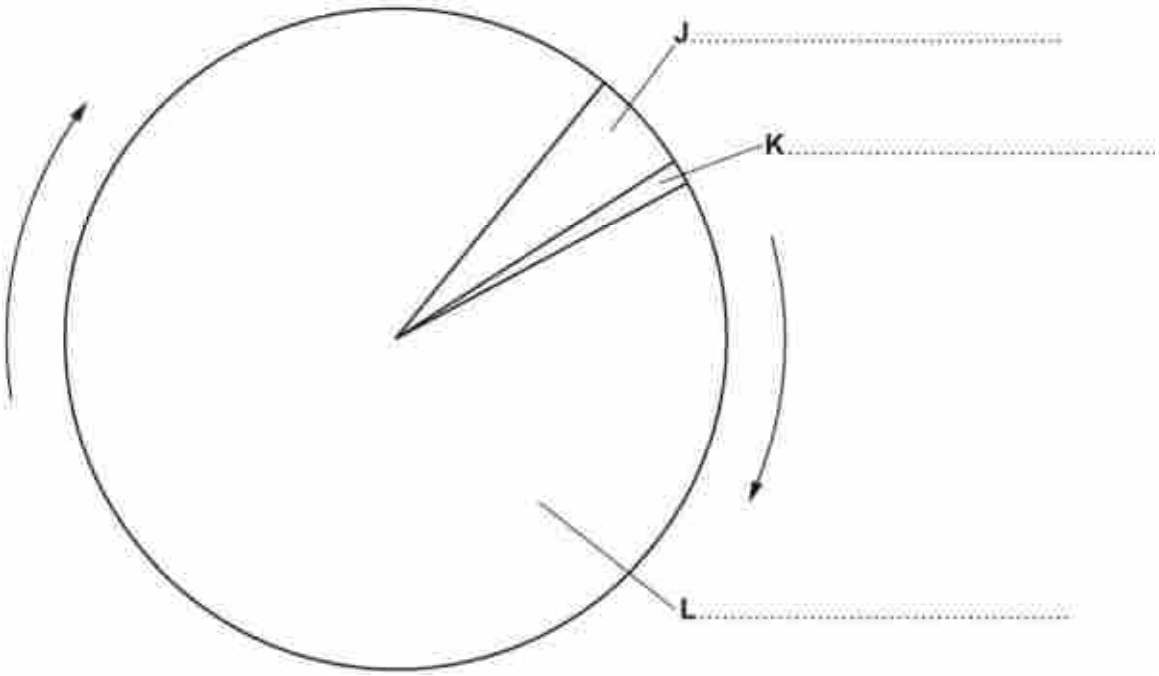

Fig. 2.2 [3]

(ii) Some bacteria infect the plant to result in tumour formation at the infected tissues as shown in Fig. 2.3.

Research on the tumour formation processes revealed that there was an unusual excessive production of auxin, an important plant growth hormone. Auxin has been found to regulate gene expression resulting in cell division, expansion, differentiation and specialisation.

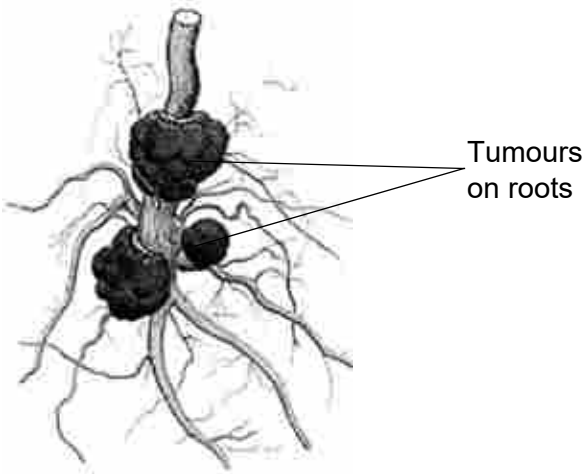

Fig. 2.3

Suggest how the bacteria infection resulted in tumour formation.

.....

.....

.....

.....

.....

..... [3]

(iii) Suggest why plants with these tumours if left untreated will eventually die.

.....

.....

.....

..... [2]

[Total: 14]

Name: _____

Index No.: _____ CG: 17____

3 In sickle cell anaemia the recessive allele Hb^S replaces the normal allele Hb^A.

- The frequency of Hb^S is much higher in West Africa than in most parts of the world.
- The frequency of Hb^S corresponds with the distribution of malaria.

(a) Explain what is meant by the term *allele*.

.....

..... [1]

(b) State whether the likely life expectancy is high or low in West Africa for individuals with the following genotypes. In each case give a reason for your answer.

Hb^AHb^A .....

..... [1]

Hb^AHb^S .....

..... [1]

Hb^SHb^S .....

..... [1]

(c) Suggest why the frequency of Hb^S allele corresponds to the distribution of malaria.

.....

.....

.....

.....

.....

..... [3]

(d) Describe how the Hb^S allele came about.

.....

.....

.....

..... [2]

(e) A man with sickle-cell anaemia marries a woman without sickle-cell anaemia whose mother also has sickle-cell anaemia. Using a genetic diagram, find the probability that the couple would give birth to a son with sickle-cell anaemia.

[4]

[Total: 13]

4 Reef-building corals are marine invertebrates found in shallow, clear, tropical oceans. The corals secrete an exoskeleton of calcium carbonate that becomes the underlying structure of the coral reef ecosystem.

Zooxanthellae are a group of unicellular algae from the genus *Symbiodinium* that live within the cells of reef-building corals. The relationship has been described as mutualistic since it is beneficial to both coral and zooxanthellae.

(a) Evidence shows that the mutualistic relationship between zooxanthellae and reef-building corals has evolved by free-living algae invading corals that did not contain algae.

(i) Corals that do not need zooxanthellae can live at a greater depth than reef-building corals.

Explain why this is so.

.....

.....

.....

..... [2]

(ii) Suggest **two** benefits **to the zooxanthellae** of their association with the corals.

.....

.....

.....

.....

.....

..... [2]

(b) Under conditions of stress the relationship between the reef-building corals and the zooxanthellae can break down. Loss of zooxanthellae and the subsequent whitening that occurs, shown in Fig. 4.1, is known as coral bleaching. Coral bleaching can lead to death of the coral.

Fig. 4.1

(i) Suggest **two** reasons why permanent loss of zooxanthellae can lead to the death of the coral.

.....

.....

.....

..... [2]

(ii) Increased sea temperature associated with global climate change is known to be an environmental stress that can cause coral bleaching. The temperature range for healthy survival of reef-building coral is 25°C to 29°C.

Explain why the areas of sea containing coral reefs are susceptible to increased temperature resulting from global climate change.

.....

.....

.....

..... [2]

[Total: 8]

Name: _____

Index No.: _____ CG: 17____

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a), (b) a**s indicated in the question.

Either

5 **(a)** Stem cells research offers a great number of potential benefits to humans and has helped scientists to understand many cellular processes naturally involved in the growth and development of organisms.

Describe the role of stem cells in humans and discuss the ethical issues that arise from stem cells research. [8]

(b) Outline how genes found on the DNA are expressed to result in the phenotype of an organism. [7]

[Total: 15]

Or

6 **(a)** Proteins play important roles in the metabolic processes of both plants and animals. In particular, enzymes assist in the catalysis of key activities in the production of organic matter in plants using carbon dioxide as its raw material.

Describe the roles of enzymes in photosynthesis. [9]

(b) Membranes of organelles in photosynthesis are key in the light dependent stage of photosynthesis. Metabolic poisons are known to disrupt key events in the light dependent stage.

Explain the possible ways metabolic poisons can inhibit light dependent reaction in photosynthesis. [6]

[Total: 15]

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CANDIDATE NAME	

CG						INDEX NUMBER				

BIOLOGY 8876/01

Paper 1 Multiple Choice **13 September 2018**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

1 Which part of the cell is often continuous with the rough endoplasmic reticulum?

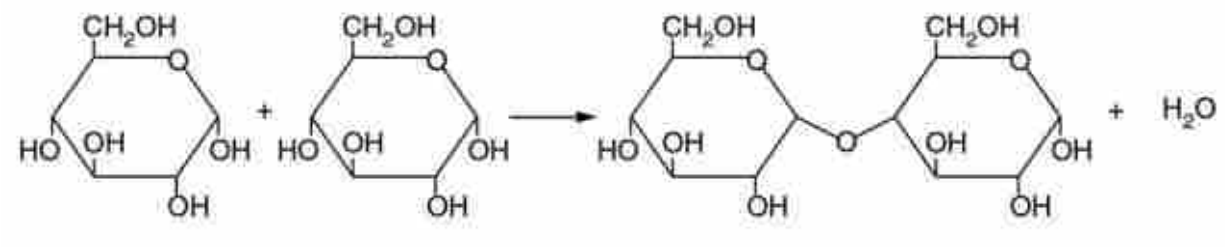
A cell surface membrane
B Golgi apparatus
C mitochondrion
D nuclear envelope

2 Which structures are found in eukaryotic cells?

1 70S ribosomes
2 80S ribosomes
3 circular DNA
4 linear DNA

A 1 and 2
B 1 and 3
C 2 and 4
D 1, 2, 3, and 4

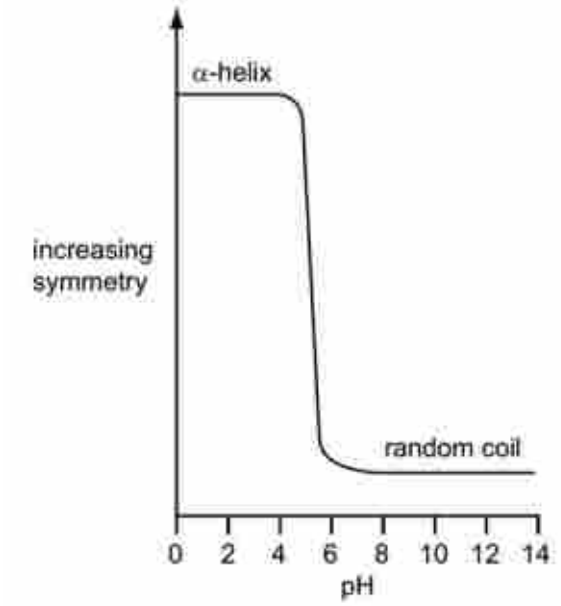
3 The diagram shows a reaction resulting in the formation of a bond between two molecules.



Which bond is formed and what is the type of reaction?

	bond formed	type of reaction
A	glycosidic	condensation
B	glycosidic	hydrolysis
C	peptide	condensation
D	peptide	hydrolysis

4 The graph shows the effect of pH on the structure of a protein which consists entirely of repeating residues of one amino acid.



Which statement is true?

A At pH2 the protein has lost its secondary structure.

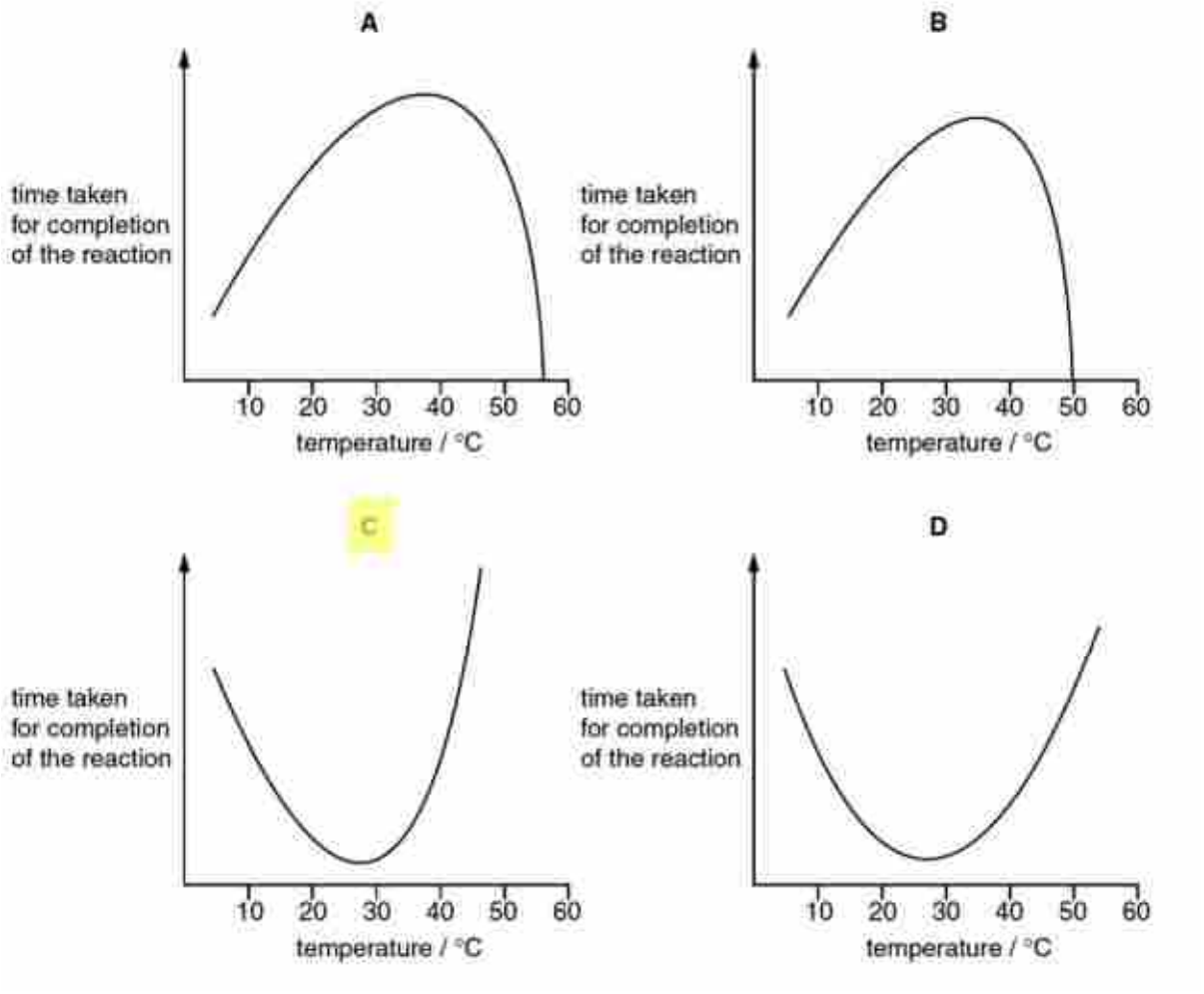
B At pH2 the protein has lost its tertiary structure.

C At pH10 the protein has lost its primary structure.

D At pH10 the protein has lost its secondary structure.

5 An enzyme is completely denatured at 50 °C. A fixed concentration of this enzyme is added to a fixed concentration of its substrate. The time taken for completion of the reaction is measured at different temperatures.

Which graph shows the results?



6 Which bonds are the last to break when an enzyme is heated?

A disulfide

B hydrogen

C hydrophobic interactions

D ionic

7 Increasing which type of bond helps to increase the fluidity of the cell surface membrane?

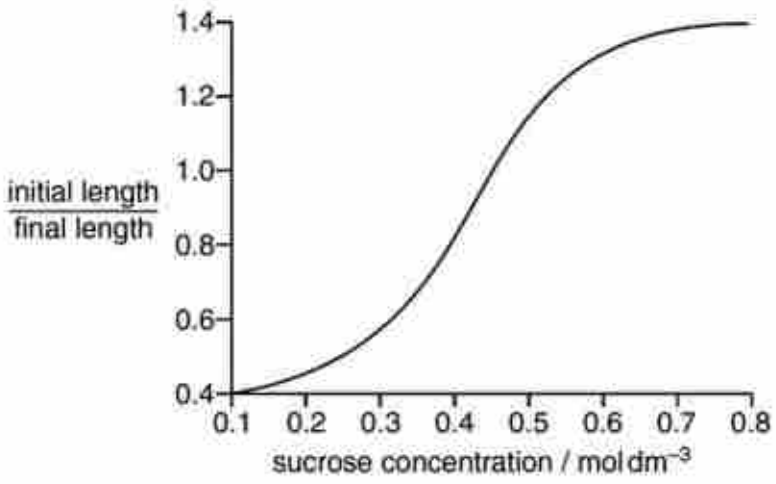
A C — O — C

B C — C

C C = C

D hydrogen

8 Strips of plant tissue were immersed in a range of sucrose solutions of different concentrations. Their lengths were measured before immersion and after 30 minutes in the different solutions. The graph shows the ratio of initial length to final length.



Which concentration of sucrose solution, in moldm^{-3}, has the same water potential as the cell sap before immersion?

A 0.1

B 0.25

C 0.45

D 0.8

9 Which of the following best illustrates totipotency of stem cells?

A A somatic cell isolated from a root tip develops into a normal adult plant.

B Stem cells are able to divide indefinitely.

C Mesenchymal stem cells can differentiate into an extensive range of cell types, including bone cells, cartilage cells, muscle cells and fat cells.

D The replacement of the nucleus of an unfertilised egg with that of a pancreatic cell converts the egg into a pancreatic cell.

10 RNA is involved in the process of protein synthesis.

Which of the following descriptions is true about RNA in eukaryotes?

A rRNA, which is coded by genes found in nucleolus, associates with ribosomal proteins in the cytoplasm to form ribosomal subunits.

B Functional mRNA is formed as a result of post-transcriptional modifications of primary RNA transcript in the nucleus.

C The ribonucleotide sequence of tRNA molecules allows extensive folding and inter-strand complementarity to generate a three-dimensional structure.

D RNA is synthesised in the nucleus only.

11 The mechanism of action of four drugs that inhibit DNA replication is stated below:

- Drug 1 inhibits the action of DNA ligase.
- Drug 2 resembles the shape of a DNA nucleotide.
- Drug 3 attaches irreversibly to the DNA molecule.
- Drug 4 binds irreversibly to the active site of DNA polymerase.

Which option correctly matches the drug(s) to the effect on DNA replication?

	Daughter strands of varying lengths are synthesized.	Only fragments are synthesized at the end of replication process.	Phosphodiester bonds cannot be formed.	Template strand becomes inaccessible by the enzyme.
A	4	3	2	1
B	2	4	3	1
C	2	1	4	3
D	3	2	1	4

12 Which of the following statement(s) is/are **not** true of the translation process in all eukaryotes?

1 Polypeptides are only synthesised in the cytosol.

2 Amino acids are linked by the formation of peptide bonds catalysed by a ribozyme.

3 Ribosomes contain an amino-acyl tRNA site that is occupied by the initiator tRNA attached to methionine.

4 Amino-acyl tRNA synthetase attaches an amino acid to the 5' end of a tRNA molecule.

A 1, 3 and 4 only

B 2, 3 and 4 only

C 2 and 4 only

D 1 only

13 In 1985, it was discovered that a bacterium, *Mycoplasma capricolum*, used a deviant genetic code. The codon UGA resulted in the addition of tryptophan to the growing polypeptide chain.

A short sequence of nucleotides was synthesised with the following base sequence:

3' CTGGCAACTATTTCAACTCATATC 5'

How many peptide bonds would be formed by ribosomes when this sequence undergoes transcription and translation in *Mycoplasma capricolum* and a human liver cell?

	Mycoplasma capricolum	Human liver cell
A	1	0
B	2	1
C	3	2
D	4	3

14 The RNA triplet UAG acts as a stop codon terminating the synthesis of a polypeptide. The diagram shows a strand of DNA which codes for four amino acids.

Where would a mutation, introducing a thymine nucleotide, result in the termination of translation?

T C C A C T C G A T G C

↑ A ↑ B ↑ C ↑ D

15 Which of the following describes aneuploidy?

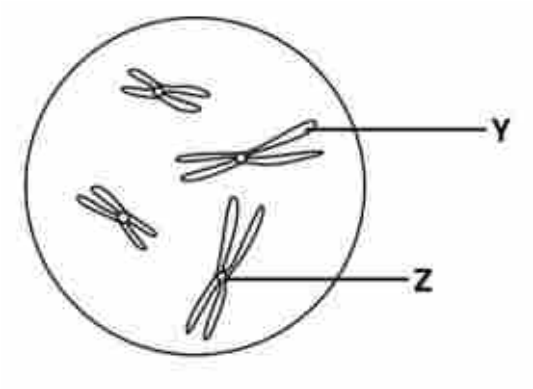
A nonsense mutation

B single base substitution

C translocation

D trisomy 21 i.e. Down's syndrome

16 The diagram shows chromosomes in a nucleus.



What are **Y** and **Z**?

	Y	Z
A	centromere	centriole
B	centromere	chromatid
C	chromatid	centriole
D	chromatid	centromere

17 Gene mutations in either the *BRCA1* or the *BRCA2* genes are responsible for the majority of hereditary breast cancer in humans.

The proteins produced by the two genes migrate to the nucleus where they interact with other proteins, such as those produced by the tumour suppressor gene, *p53*, and the DNA repair gene, *RAD51*.

Which combination of gene activity is most likely to result in breast cancer?

key:

✓ = gene produces normal protein × = gene produces abnormal protein or no protein

	gene		
	BRCA1 or BRCA2	*p53*	*RAD51*
A	✓	✓	✓
B	✓	✓	×
C	✓	×	✓
D	×	×	×

18 The table shows the results of a series of crosses in a species of small mammal.

coat colour phenotype		
male parent	female parent	offspring
dark grey	light grey	dark grey, light grey, albino
light grey	albino	light grey, white with black patches
dark grey	white with black patches	dark grey, light grey
light grey	dark grey	dark grey, light grey, white with black patches

What explains the inheritance of the range of phenotypes shown by these crosses?

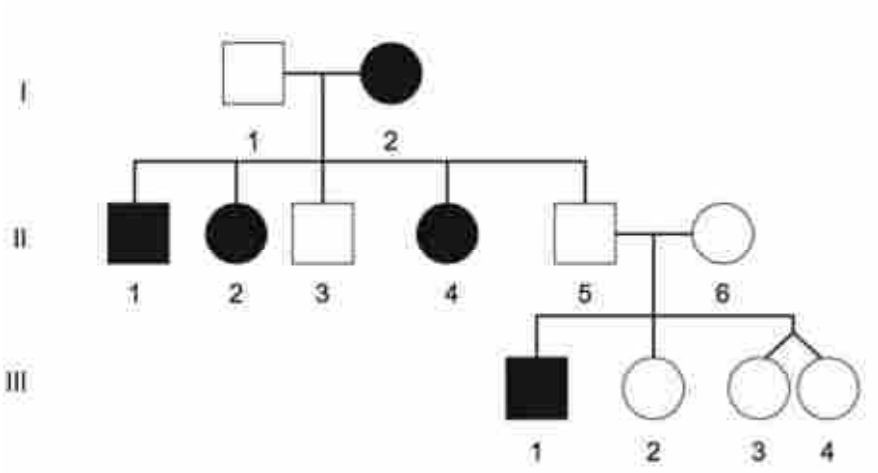
A one gene with a pair of co-dominant alleles

B one gene with multiple alleles

C sex linkage of the allele for grey coat colour

D two genes, each with a dominant and recessive allele

19 The pedigree below showed that the mode of inheritance of this disease is …… as supported by …….



A autosomal dominant, individuals I-2 with offspring II-1, II-2 and II-4

B autosomal recessive, individuals I-1, I-2 with offspring II-3 and II-5

C autosomal recessive, individuals II-5, II-6 with offspring III-1

D sex-linked dominant, offspring II-2 and II-4

20 Fruit flies (*Drosophila*), homozygous for long wings, were crossed with fruit flies homozygous for vestigial wings. The F_1 and F_2 generations were raised at three different temperatures.

At each temperature, the F_1 generation all had long wings.

The table shows the results in the F_2 generation.

temperature / °C	result
21	¾ long wings, ¼ vestigial wings
26	¾ long wings, ¼ intermediate wing length
31	all long wings

Which statement explains these results?

A Heterozygous flies have vestigial wings only at 21°C or below but have long wings at 31°C or above.

B Long wing and vestigial wing illustrate codominance at 26°C.

C Long wing is dominant at higher temperatures but vestigial wing is dominant at lower temperatures.

D Vestigial wing is recessive but causes a vestigial wing phenotype only at lower temperatures.

21 In respiration, the enzyme hexokinase uses ATP to transfer a phosphate group to glucose to form glucose-6-phosphate.

If a cell only has glucose available for energy and the activity of hexokinase is suddenly inhibited in this cell, which of the following will occur?

1 The cell will not be able to produce pyruvate through glycolysis.

2 Respiratory processes in the mitochondria would not proceed.

3 The use of oxygen by the cell will decrease.

A 1, 2 and 3

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

22 Which of the following statements explains the mechanism for chemiosmosis in the synthesis of ATP?

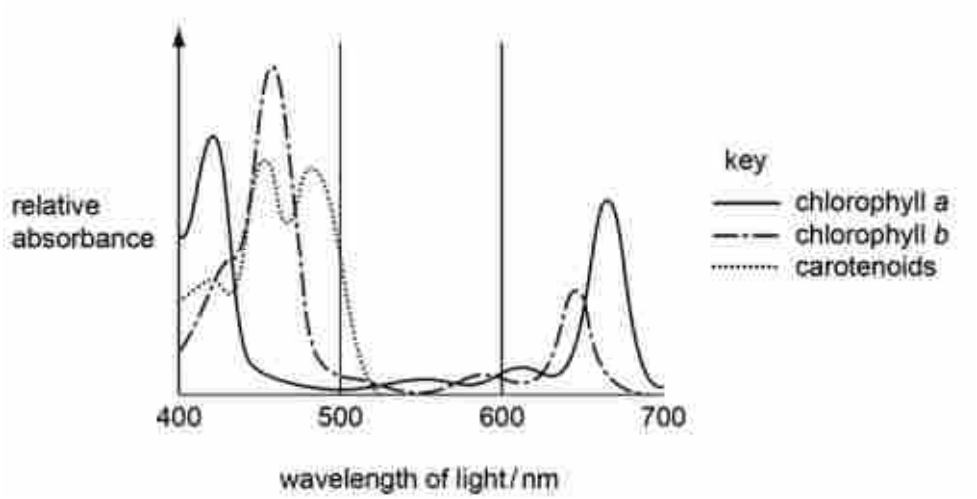
A The energy released by the reduction and subsequent oxidation of components of the electron transport chain is transferred to ATP synthase for the synthesis of ATP.

B Phosphorylation of ADP is linked to the proton gradient established by the electron transport chain.

C The difference in pH between the intermembrane space and the cytosol drives the formation of ATP.

D The flow of H^+ through ATP synthase into the intermembrane space drives the synthesis of ATP.

23 The graph shows the absorption spectra of some pigments found in chloroplasts.



Which statements are correct?

1 Having several pigments, rather than one, increases the efficiency of photosynthesis.

2 Most leaves are green as chlorophyll absorbs light in the blue and red regions of the spectrum.

3 Photosynthesis will be fastest in light at the red end of the spectrum, as red light has higher energy than blue light.

4 Prior to leaf fall, chlorophyll is broken down, leaving carotenoids which makes leaves look yellow or red.

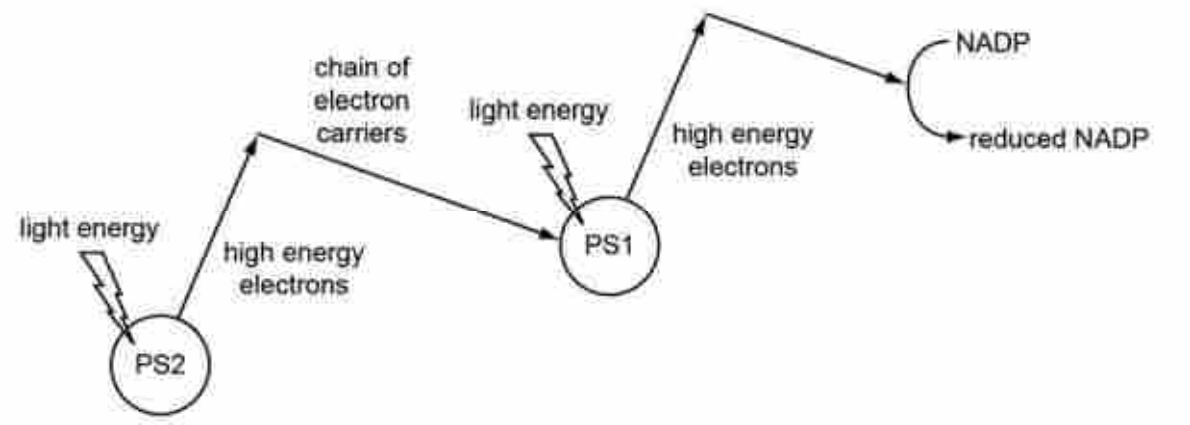
A 1 and 2 only

B 1 and 3 only

C 1, 2 and 4 only

D 2 and 4 only

24 The diagram shows some of the processes in the light-dependent stage of photosynthesis.



For the light-dependent stage to continue, photosystem two (PS2) must gain electrons. Where do these electrons come from?

A electron carriers

B reduced NADP

C photolysis of water

D the formation of ATP

25 Which statements are true about Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.

2 In competition for survival, the more aggressive animals are more likely to survive.

3 Species perfectly adapted to a stable environment will continue to evolve.

4 Variation between individuals of a species is essential for evolutionary change.

A 1, 2 and 4 only

B 2 and 3 only

C 3 and 4 only

D 4 only

26 The Galapagos Islands are a group of volcanic islands in the eastern Pacific Ocean, about 1000 km from South America. Thirteen species of finch are found on the islands; they resemble each other closely but differ in their feeding habits and in shape of their beaks.

Assuming that an ancestral stock of finches came from the mainland, what is the most likely explanation for the existence of similar but distinct species of Galapagos finches?

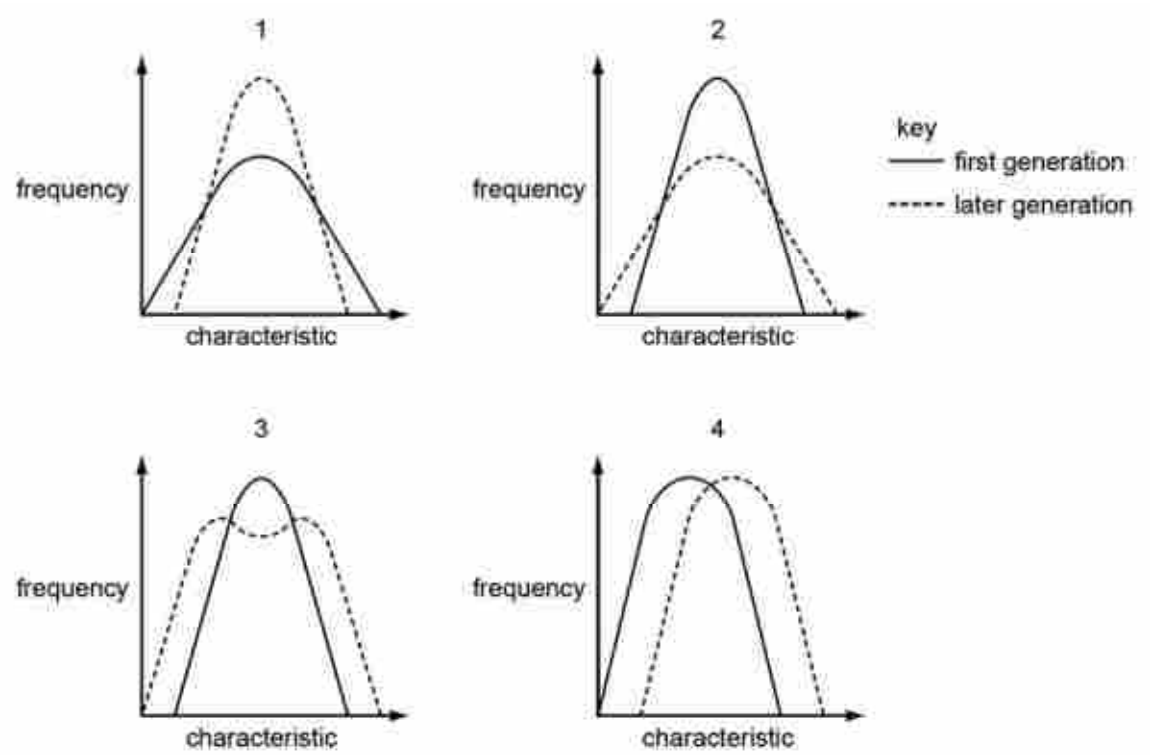
A Finches developed different kinds of beaks in order to feed on different kinds of food.

B Finches evolved separately according to the habitat in which they settled.

C Finches from the mainland bred with population of a related species on the island to produce new genotypes.

D Finches in similar habitats face similar selection pressures thus evolve to become very similar species.

27 The graphs show frequency against a measured characteristic in the first and later generation of an organism.



Which graph represents each type of natural selection?

	directional	disruptive	stabilising
A	1	2	3
B	2	3	4
C	3	1	2
D	4	3	1

28 What is the impact of global warming on plants?

A In colder regions, a warmer climate may allow people to grow new crops.

B Global warming beyond optimal growth temperatures encourages plant growth.

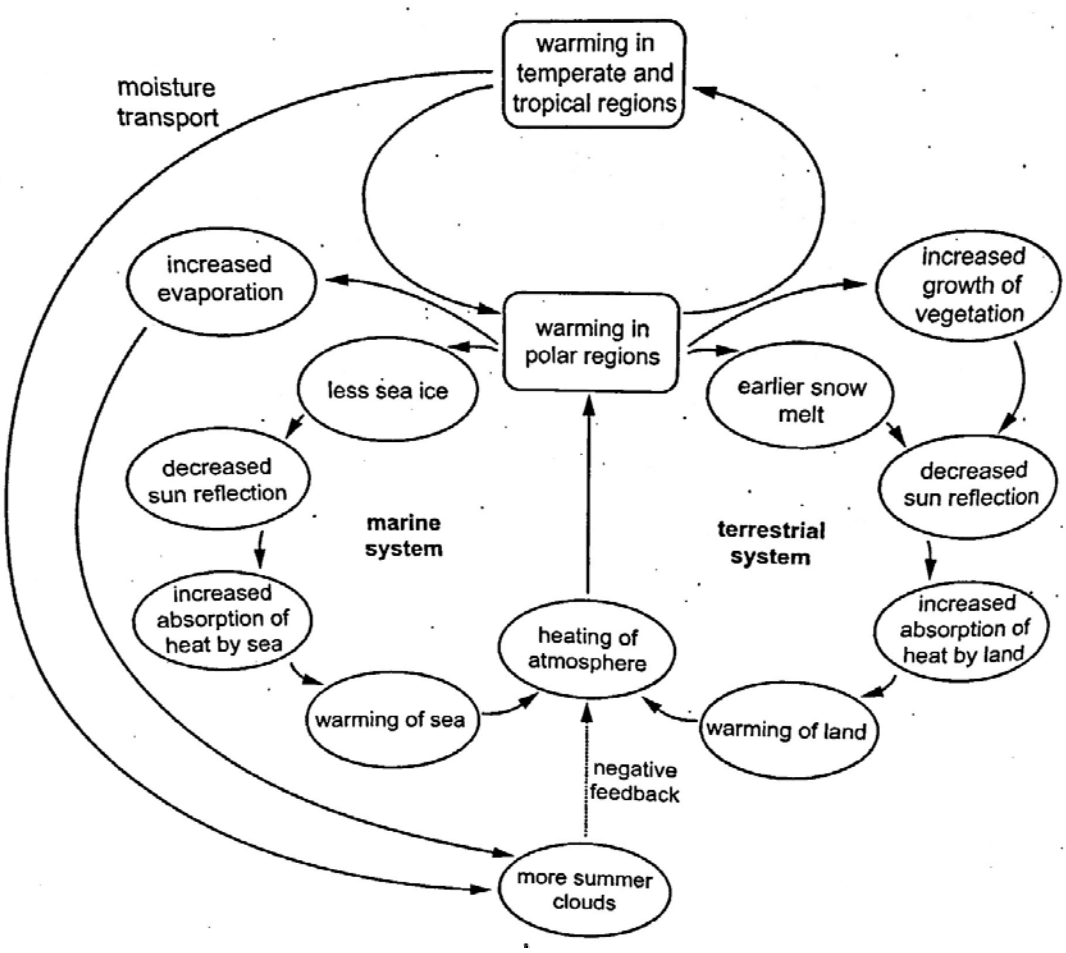
C Temperate plants will shift to tropical regions.

D Production of all crops are higher due to higher temperatures.

29 Which of the following correctly shows the effects of climate change on coral reefs and associated ecosystems?

	Average number of zooxanthellae in each polyp	Mass of basal plate of hard corals	Diversity of catch from nearby fisheries
A	Decreased	Decreased	Decreased
B	Decreased	Unaffected	Increased
C	Increased	Decreased	Decreased
D	Increased	Unaffected	Increased

30 The diagram shows the effect of increasing temperatures on the ice and snow cover at the polar regions.



Which effect of higher temperatures in the polar regions could increase global warming?

A Melting of ice and snow results in less reflection of sunlight and more heat absorption by the Earth.

B Increased evaporation leads to more rainfall, which absorbs heat from the land and the sea.

C Melting sea ice causes more cloud formation, which increases absorption of heat in the atmosphere.

D Earlier melting of snow allows vegetation cover to increase faster, reducing loss of heat from the surface of the Earth.

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2018 JC2 H1 BIO P2 PRELIM EXAM ANSWER SCHEME

Section A

Answer **all** the questions in this section.

1 Fig. 1.1 shows part of a eukaryotic cell.

Fig. 1.1

(a) **(i)** Outline the role of organelle labelled **A**.

1. link rxn in matrix

pdc CO_2 & NADH where pyruvate undergoes oxidative decarboxylation;

2. Krebs cycle in matrix

pdc CO_2 & NADH where acetyl-coA undergoes oxidative decarboxylation;

3. oxidative phosphorylation on inner memb

pdc ATP via chemiosmosis; [3]

(ii) Identify **one** molecule with different mode of transport across the membrane of **A** and explain the mode of transport.

1. CO_2/ O_2;

tpted across memb via simple diffusion down conc. grad due to its small size & uncharged mol; OR

2. ATP/ ADP;

tpted across memb via facilitated diffusion as it is large in size & charged which is repelled by hydrophobic core of phospholipid bilayer; OR

3. pyruvate;

tpted across memb via facilitated diffusion as it is large in size & charged which is repelled by hydrophobic core of phospholipid bilayer; [2]

(b) **(i)** Explain the significance of glycolysis in aerobic respiration.

1. oxidation of glucose into pyruvate

via substrate level phosphorylation producing ATP;

2. NAD is reduced into NADH

NADH is supplied to inner memb of mito for oxidation phosphorylation;

3. pyruvate enters into matrix of mito undergoes oxidative decarboxylation

converted into acetyl coA for subsequent Krebs cycle to take place; [3]

An experiment was carried out to investigate the effect of temperature on respiration in isolated mitochondria extracted from a worm. Respiratory substrate was provided and oxygen consumption was monitored at 15°C, 25°C and 35°C.

Fig. 1.2 shows the temperature coefficients, Q_{10}, when temperature is increased from 15°C to 25°C and from 25°C to 35°C.

Q_{10} measures the ratio of the rate of respiration when the temperature increases by 10°C.

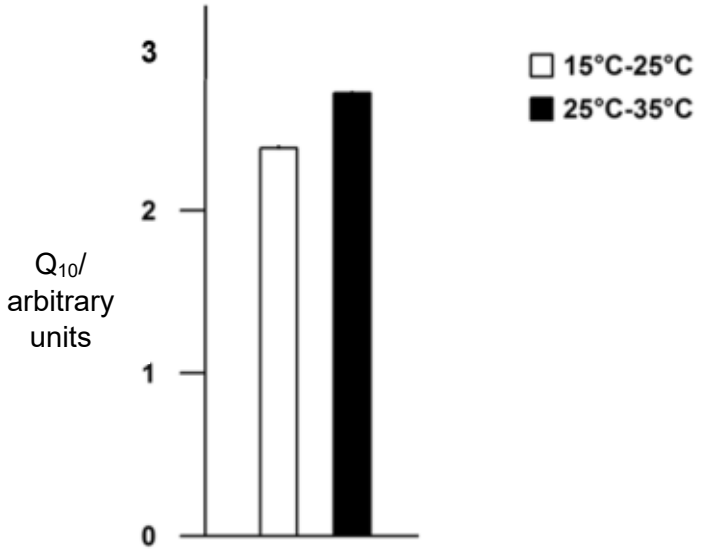


Fig. 1.2

(ii) Describe and explain the effect of temperature on the Q_{10} of mitochondria respiration.

1. increase in Q_{10} is higher for increase in temp from 25-35°C c.f. to 15-25°C

2.4 arbitrary units for 15-25°C compared to 2.7 arbitrary units for 25-35°C;

2. KE of both respiratory enz & substrate increases causing higher freq of effective collisions b/w them

more ES complexes formed, increasing rate of respiration; [2]

[Total: 10]

2 Fig. 2.1 is a photomicrograph of plant root cells near the growing top. Some of the cells are undergoing mitosis.

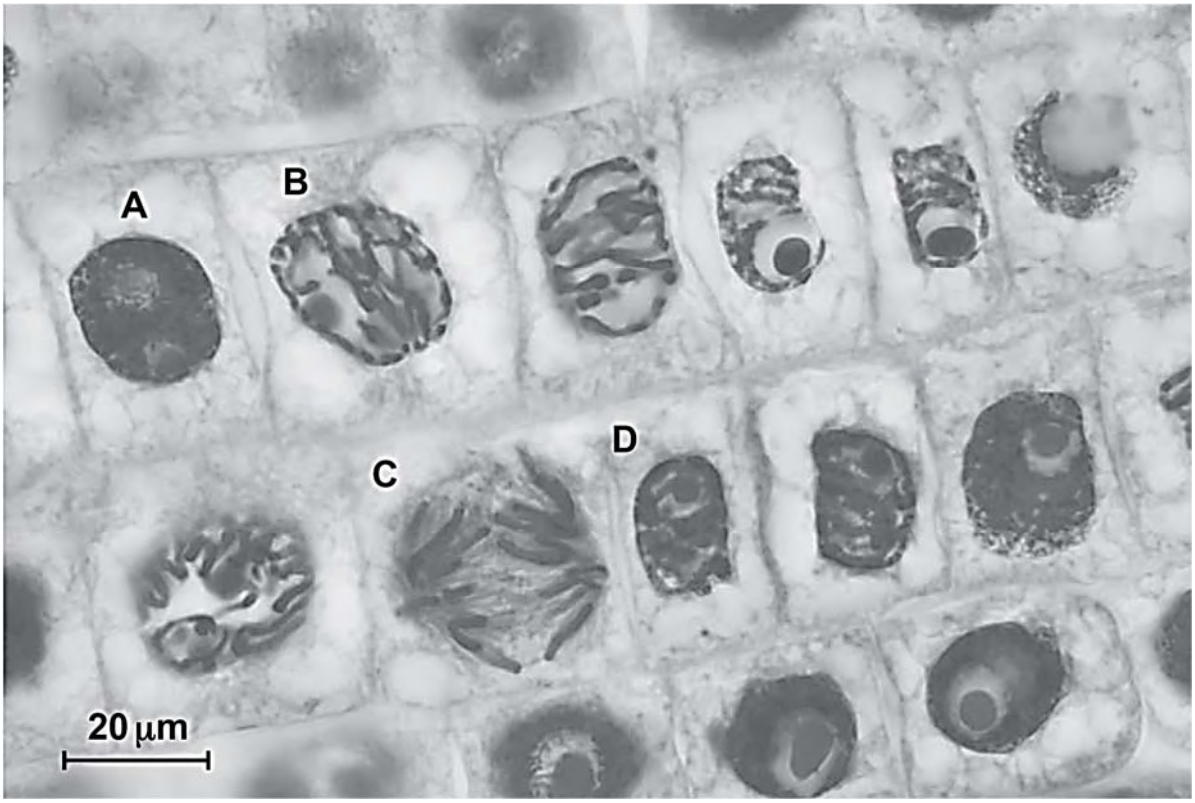


Fig. 2.1

(a) State **one** feature, visible in Fig. 2.1, which indicates that the section is taken from a plant tissue and not animal tissue.

presence of cell walls/ rectangular cells; [1]

(b) State the letter, **A** to **D**, of the cell in Fig. 2.1 which is in:

(i) prophase ***B;***

(ii) anaphase ***C;*** [2]

(c) Explain why the growth of roots involves mitosis and not meiosis.

1. mitosis maintain diploidy & pdc genetically identical daughter cells

results in genetic stability;

2. meiosis results in haploid cells & pdc genetically non-identical daughter cells

results in genetic variation;

3. growth of tissue requires similar cells to be grouped together

to perform same fn; [3]

(d) Fig. 2.2 represents one complete cell cycle for the plant root cells.

(i) Complete Fig. 2.2 by naming the stages represented by **J**, **K** and **L**.

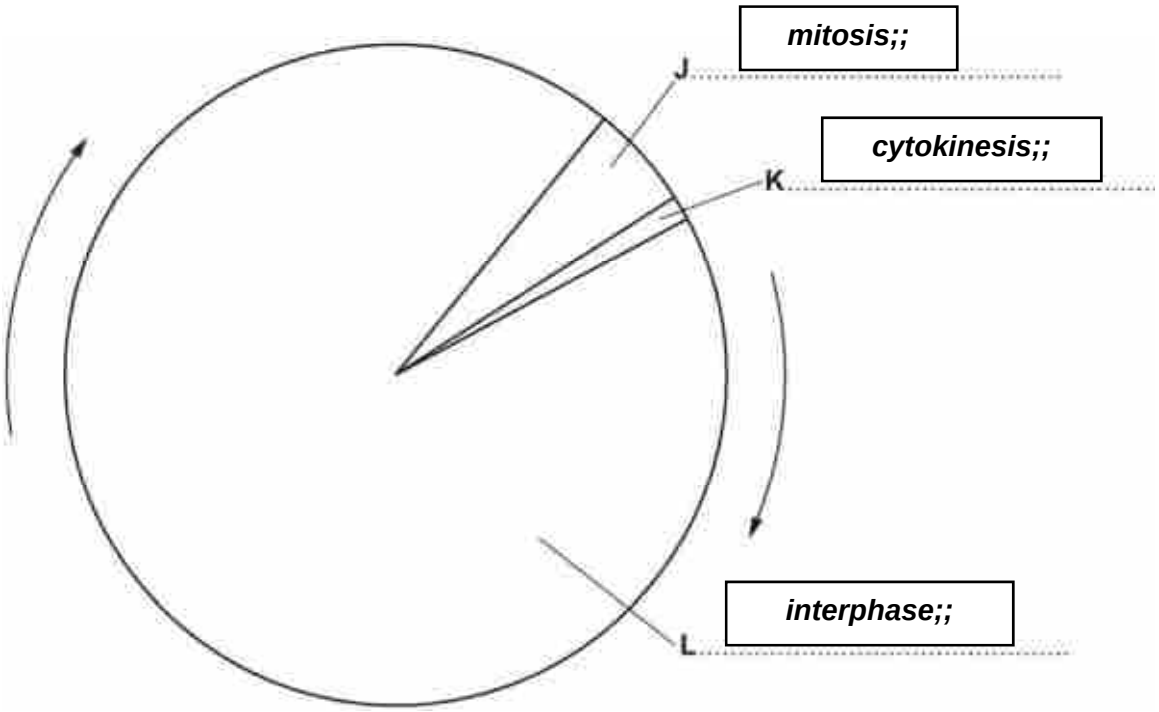


Fig. 2.2 [3]

(ii) Some bacteria infect the plant to result in tumour formation at the infected tissues as shown in Fig. 2.3.

Research on the tumour formation processes revealed that there was an unusual excessive production of auxin, an important plant growth hormone. Auxin has been found to regulate gene expression resulting in cell division, expansion, differentiation and specialisation.

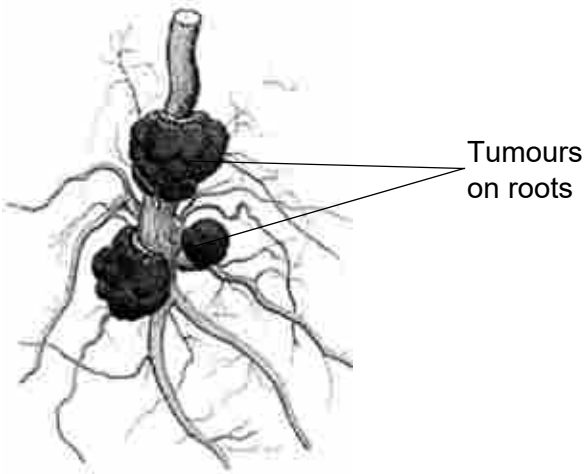


Fig. 2.3

Suggest how the bacteria infection resulted in tumour formation.

1. ***affects G1 checkpt in interphase***

checks for presence of growth factors;

2. ***auxin regulates gene expression***

overpdtn of auxin results in overpdtn of CDKs / cyclins / enz involved in ctrl of cell cycle;

3. ***auxin activates telomerase***

plant cells divide indefinitely;

4. ***auxin prevents programmed cell death / apoptosis***

decreasing activities of prots involved in cell death; [3]

(iii) Suggest why plants with these tumours if left untreated will eventually die.

1. ***tumours are disorganised tissue with no specialised fns;***

2. ***leading to disruption of normal tpt of essential resources (e.g. sugar / water) for survival;*** [2]

[Total: 14]

3 In sickle cell anaemia the recessive allele Hb^S replaces the normal allele Hb^A.

- The frequency of Hb^S is much higher in West Africa than in most parts of the world.
- The frequency of Hb^S corresponds with the distribution of malaria.

(a) Explain what is meant by the term *allele*.

1. ***alternative form of a gene (located at the same gene locus);***

2. ***may be dominant, recessive or codominant;*** [1]

(b) State whether the likely life expectancy is high or low in West Africa for individuals with the following genotypes. In each case give a reason for your answer.

Hb^AHb^A ***low***

susceptible to / die from, malaria; [1]

Hb^AHb^S ***high***

no / only have traits of sickle cell anaemia, not susceptible to malaria; [1]

Hb^SHb^S ***low***

susceptible to / die from sickle cell anaemia; [1]

(c) Suggest why the frequency of Hb^S allele corresponds to the distribution of malaria.

1. presence of malaria act as selection pressure

selects for indv with favourable phenotype i.e. resistant to malaria;

2. indv with Hb^S allele has (Hb that polymerises thus) shorter RBC lifespan

disrupts life cycle of / kills malaria parasite;

3. Hb^S is a recessive allele

thus heterozygotes do not suffer from effects of SCA & is able to pass down Hb^S allele to offspring (increasing its freq in gene pool); [3]

(d) Describe how the Hb^S allele came about.

1. (spontaneous) gene / point mutation

in β-globin gene;

2. single base sub

of T → A in DNA template strand / GAA → GUA in 6th codon / glu → val; [2]

(e) A man with sickle-cell anaemia marries a woman without sickle-cell anaemia whose mother also has sickle-cell anaemia. Using a genetic diagram, find the probability that the couple would give birth to a son with sickle-cell anaemia.

parent phenotype	***man with sickle cell anaemia***		***woman without sickle cell anaemia***
parent genotype ;	***$XY\ Hb^SHb^S$***	***x***	***$XX\ Hb^AHb^S$***
gametes ;	***XHb^S YHb^S***		***XHb^A XHb^S***

Punnett Sq ;

genotypic ratio	***$XXHb^AHb^S$***	***: $XXHb^SHb^S$***	***: $XYHb^AHb^S$***	***: $XYHb^SHb^S$***
phenotypic ratio	***1 female normal***	***: 1 female SCA***	***: 1 male normal***	***: 1 male SCA***

Probability = 0.25 ;

[4]

[Total: 13]

4 Reef-building corals are marine invertebrates found in shallow, clear, tropical oceans. The corals secrete an exoskeleton of calcium carbonate that becomes the underlying structure of the coral reef ecosystem.

Zooxanthellae are a group of unicellular algae from the genus *Symbiodinium* that live within the cells of reef-building corals. The relationship has been described as mutualistic since it is beneficial to both coral and zooxanthellae.

(a) Evidence shows that the mutualistic relationship between zooxanthellae and reef-building corals has evolved by free-living algae invading corals that did not contain algae.

(i) Corals that do not need zooxanthellae can live at a greater depth than reef-building corals.

Explain why this is so.

1. corals with no zooxanthellae thus no need light for photosyn

can live at greater depths where less light can penetrate / reach;

2. such corals able to acquire sufficient nutrients thro' own feeding

due to diff feeding method / bcos ocean has more nutrient at greater depths; [2]

(ii) Suggest **two** benefits **to the zooxanthellae** of their association with the corals.

1. corals respire produce CO_2

for zooxanthellae to use in photosynthesis;

2. corals pdc nitrogenous waste / phosphate

as nutrients for zooxanthellae growth / metabolism;

3. corals provide structural support

for zooxanthellae to absorb as much light as possible;

4. provide protection

against predators / harsh environmental conditions; [2]

(b) Under conditions of stress the relationship between the reef-building corals and the zooxanthellae can break down. Loss of zooxanthellae and the subsequent whitening that occurs, shown in Fig. 4.1, is known as coral bleaching. Coral bleaching can lead to death of the coral.

Fig. 4.1

(i) Suggest **two** reasons why permanent loss of zooxanthellae can lead to the death of the coral.

1. decreased source of food / nutrients for corals (pdc by zooxanthellae via photosynthesis)

coral die from starvation / malnutrition;

2. loss of protective algal layer

from harmful effects of direct sunlight; [2]

(ii) Increased sea temperature associated with global climate change is known to be an environmental stress that can cause coral bleaching. The temperature range for healthy survival of reef-building coral is 25°C to 29°C.

Explain why the areas of sea containing coral reefs are susceptible to increased temperature resulting from global climate change.

1. areas of sea where corals are found are usually shallow waters

such areas has larger amts of light & heat penetrating waters → ↑ temp easily (c.f. to deeper waters where less light penetrates);

2. shallow waters also has less water vol

thus absorption of small amts of heat can lead to sig ↑ in temp c.f. to deeper areas; [2]

[Total: 8]

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a), (b) a**s indicated in the question.

Either

5 (a) Stem cells research offers a great number of potential benefits to humans and has helped scientists to understand many cellular processes naturally involved in the growth and development of organisms.

Describe the role of stem cells in humans and discuss the ethical issues that arise from stem cells research. [8]

Role of stem cells

1. ***stem cells have unlimited cell renewal capacity***
   can dy/dx into any specialised cell type;
2. ***zygotic / morula stem cells are totipotent***
   can dy/dx into any cell types including cells of placenta;
3. ***embryonic stem cells (ESCs) are pluripotent***
   can dy/dx into any cell types except cells of placenta;
4. ***ESCs dy/dx into cells of 3 germ layers***
   endoderm, ectoderm, mesoderm;
5. ***adult stem cells are multipotent***
   can dy/dx into specific cell lineages;
6. ***haematopoietic stem cells (HSCs) dy/dx into blood cell components***
   blood cells & platelets;
7. ***HSCs gives rise to white blood cells***
   giving rise to immunity;
8. ***HSCs gives rise to red blood cells***
   tpt gases around the body;

(Max 6m)

Ethical issues

9. ***use of ESCs raises issues of potential loss of a life as embryo destroyed in process & hence denied the chance of developing into a human being;***
10. ***issue of informed consent & relinquished rights by donor over donated tissue e.g. frozen embryos from infertility treatment / gametes;***
11. ***issue of whether tissue was donated based on free choice & implications with paid tissue donation;***
12. ***issue of medical complications in gamete retrieval if donation of gametes (oocytes) occur solely for research purposes;***

13. ***issue of protecting reproductive rights for women involved in infertility treatments, where oocyte of highest quality should be used for reproductive treatment instead of research;***
14. ***confidentiality of donor info could be compromised, resulting in inconveniences / harassment by companies involved in stem cell research;***

(Max 3m)

(b) Outline how genes found on the DNA are expressed to result in the phenotype of an organism. [7]

1. ***genes are nucleotides seq***

   coding for polypeptides / prots / RNA;
2. ***transcription of genes into mRNAs***

   occurs in nucleus;
3. ***RNA pol binds to promoters of specific genes***

   in presence of basal TFs in nucleus;
4. ***(post-transcriptional) modification of mRNA via addition of 5' methylated guanosine cap, poly A tail;***
5. ***(post-transcriptional) modification of mRNA via splicing (by spliceosome) where introns removed & exons joined together into mature mRNA;***
6. ***mRNA translated in cytoplasm***

   results in polypeptide pdtn;
7. ***initiation of translation involves initiator tRNA with met***

   binds to start codon AUG on mRNA;
8. ***ribosome subunits bind to mRNA***

   placing initiator tRNA at P site;
9. ***peptidyl transferase forms peptide bonds***

   b/w amino acids (aas) carried by tRNA on A site & P site;
10. ***1° seq of aas results in polypeptide folding***

    specific 3D config to perform its specific f^n;
11. ***e.g. of phenotype e.g. sickle cell anaemia;***

[Total: 15]

6 **(a)** Proteins play important roles in the metabolic processes of both plants and animals. In particular, enzymes assist in the catalysis of key activities in the production of organic matter in plants using carbon dioxide as its raw material.

Describe the roles of enzymes in photosynthesis. [9]

(A) light dependent rxn

1. ***<u>Mn-containing enz</u> (H_2O splitting enz) catalyses photolysis of H_2O into H^+, O_2 & e^-;***
2. ***H^+ released into stroma for active tpt across thylakoid memb/ contributes to H^+ grad across thylakoid memb;***
3. ***O_2 evolved as by-pdt;***
4. ***e^- replace e^- deficit in P680 (PSII) to allow non-cyclic photophosphorylation to continue;***
5. ***<u>NADP reductase</u> catalyses reduction of NADP to NADPH (reduced NADP);***
6. ***H^+ from photolysis of H_2O, e^- from ETC;***
7. ***NADPH involved in carbon reduction stage in Calvin cycle;***
8. ***<u>ATP synthase</u> catalyses phosphorylation of ADP with P_i to ATP;***
9. ***with diffusion of H^+ via chemiosmosis;***
10. ***from thylakoid space into stroma;***

(B) Light independent rxn

11. ***<u>Rubisco</u> (RUBP carboxylase-oxygenase) catalyses carbon fixation stage in Calvin cycle;***
12. ***1 mol of CO_2 (1C) is added to 1 mol RUBP (5C);***
13. ***form 6C intermediate then splitted into 2 mols of 3C phosphoglycerate/ glycerate phosphate (PGA);***

Max 3 points per enz. Need to include at least 1 enz from each category

(b) Membranes of organelles in photosynthesis are key in the light dependent stage of photosynthesis. Metabolic poisons are known to disrupt key events in the light dependent stage.

Explain the possible ways metabolic poisons can inhibit light dependent reaction in photosynthesis. [6]

metabolic poisons can block/ prevent activity of prots & enz involved in light dependent rxn

1. ***blocks role of <u>Mn-containing enz</u> (H_2O splitting enz);***
2. ***prevents photolysis of H_2O into H^+, O_2 & e^-;***
3. ***O_2 not released as by-pdt;***
4. ***H^+ not available for reduction of NADP at end of ETC/ no contribution for H^+ grad;***
5. ***e^- not replaced in deficit P680 (PSII);***
6. ***blocks role of <u>pump prot;</u>***
7. ***prevents active tpt of H^+ across thylakoid memb;***

8. ***from stroma into thylakoid space;***
9. ***no generation of H^+ grad for chemiosmosis to take place;***
10. ***blocks role of <u>e^- carriers</u> in ETC;***
11. ***e^- not tpted down energy level;***
12. ***energy not dissipated hence not provided for pumping of H^+ across thylakoid memb;***
13. ***NADP not reduced to NADPH as no e^- supplied by ETC;***
14. ***blocks role of <u>ATP synthase</u>;***
15. ***prevents diffusion of H^+ via chemiosmosis from thylakoid space into stroma;***
16. ***prevents phosphorylation of ADP + P_i into ATP;***

Max 3 points per prot/ enz activity affected. Only need to mention how 2 prot/ enz affected.

[Total: 15]

EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examination 2018
General Certificate of Education Advanced Level
Higher 1

H1 Biology

8876/01

Paper 1 Multiple Choice

20 September 2018

60 minutes

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use paper clips, glue or correction fluid.
Write your name, civics group and registration number on the Answer Sheet in the spaces provided.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **23** printed pages and **1** blank pages.

- BLANK PAGE-

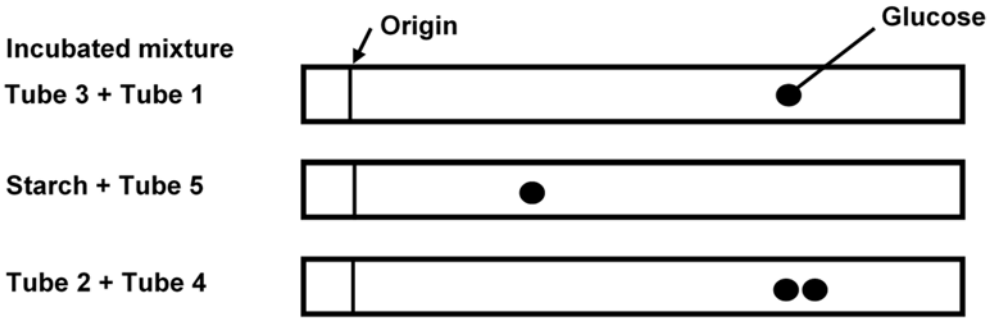
1 A lab technician has 5 tubes containing unknown compounds. However, he knows that each tube contains only either a carbohydrate or enzyme. To determine the identities of the compounds in the 5 tubes, the lab technician conducted various tests and he made the following observations.

I Sample in tube 2 is soluble in water. Sample in tube 3 was insoluble in water.

II Tube 5 tested positive with Biuret's test.

III Contents of all 5 samples tested negative with Benedict's test.

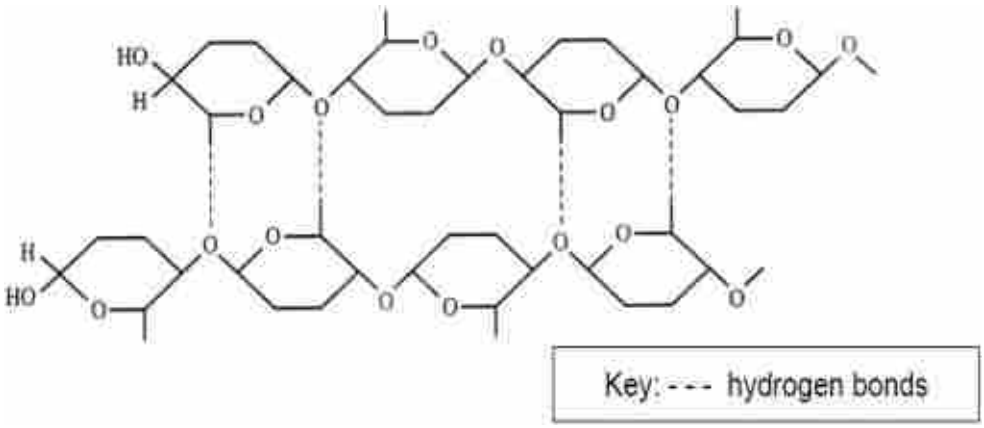
IV However, after he mixed and incubated the contents of certain tubes together, a positive result was obtained for Benedict's test. The mixtures were also subjected to paper chromatography, and the results were shown below.



Which of the following correctly shows the contents of each tube?

	tube 1	tube 2	tube 3	tube 4	tube 5
A	amylase	cellulose	sucrose	cellulase	sucrose
B	cellulase	sucrose	cellulose	sucrase	amylase
C	cellulose	sucrose	cellulose	sucrase	amylase
D	sucrose	cellulose	sucrase	amylase	cellulase

2 The figure below shows part of the molecular structure of a polysaccharide.

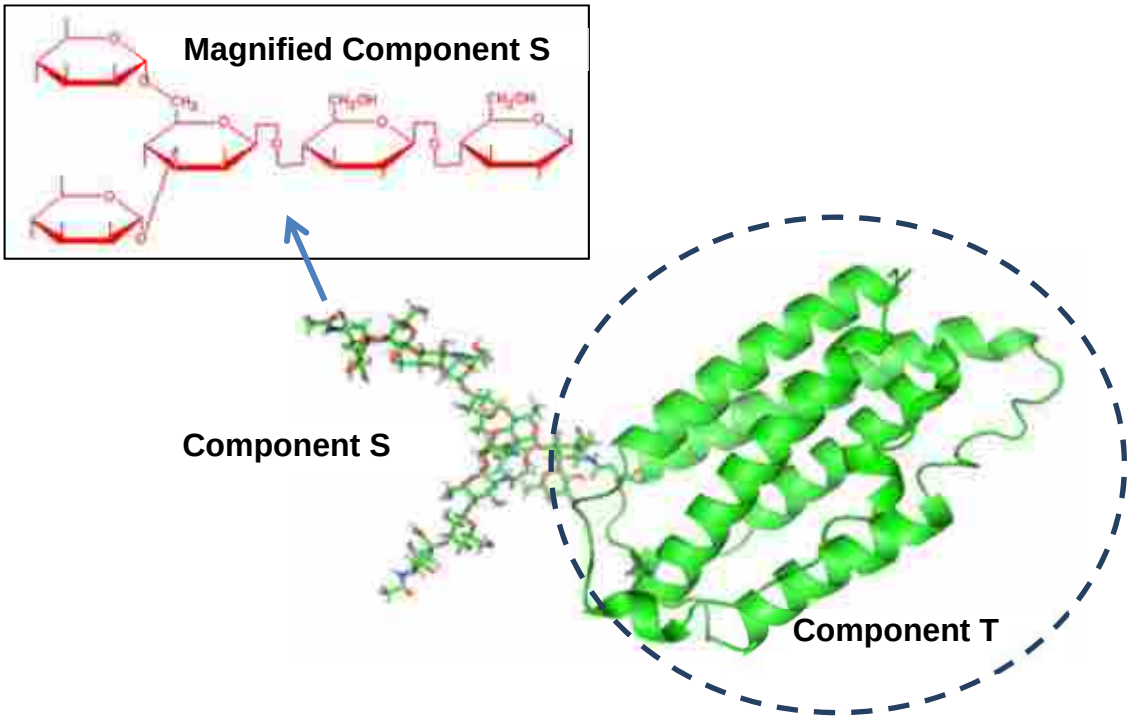


Which of the following statements are true?

I The hydrogen bonds maintain the double-helical structure of the molecule.
II The subunits of each chain are β-glucose.
III Water is needed in the formation of bonds between the subunits.
IV The chains formed by the subunits are unbranched.

A I and II
B II and IV
C III and IV
D All of the above

3 The figure below shows the structure of a biomolecule extracted from a cell. It is made up of two components, **S** and **T**. The boxed region shows a **magnified** portion of component **S**. The circled region shows component **T**, of the same molecule.

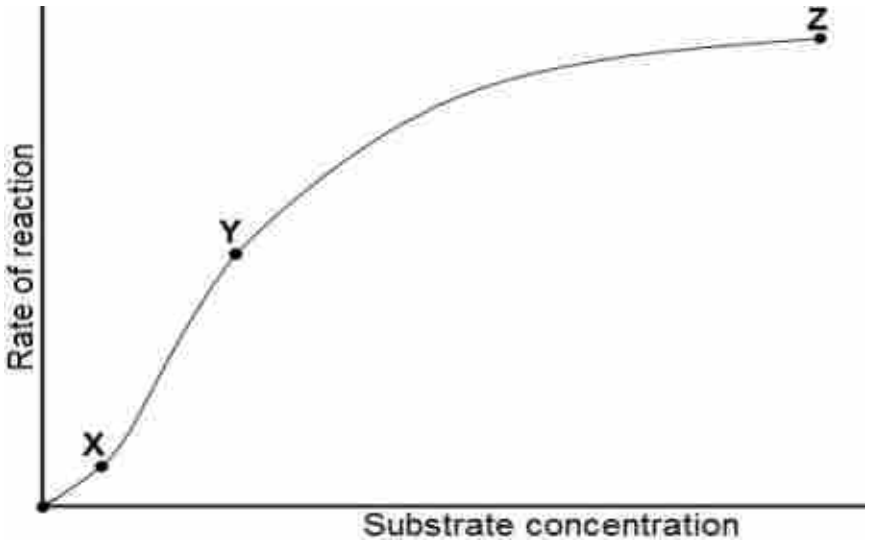


Below are some statements regarding the structure, property and function of the biomolecule extracted from the cell as shown in the figure above. Which of these statements are true?

I The biomolecule has both hydrophilic and hydrophobic properties.
II It is important for cell to cell adhesion.
III The synthesis of this molecule requires only the rough endoplasmic reticulum.
IV When completely hydrolysed, all the monomers of this molecule are soluble in water.

A I and III
B II and IV
C I, II and IV
D II, III and IV

4 The graph below shows the effect of increasing substrate concentrations on the activity of an allosteric enzyme under optimum conditions.



Which of the following statements is correct?

A There is low kinetic energy at **X** to overcome the activation energy, thus resulting in a low rate of reaction.

B Rate of reaction increases at a faster rate at **Y** as the allosteric activator outcompetes the allosteric inhibitor to bind to the allosteric site.

C At **Z**, enzyme molecules are in the active state and active sites are saturated.

D Substrate concentration is the limiting factor at **X** and **Y** but temperature is the limiting factor at **Z**.

5 The four acids shown below form part of an enzyme-catalysed sequence of reactions. The addition of malonic acid results in no change in the concentration of oxoglutaric acid, an accumulation of succinic acid, and a near absence of both fumaric acid and malic acid. Further addition of fumaric acid results in the formation of malic acid. What does this information indicate about malonic acid?

A It is an inhibitor of enzyme 1.

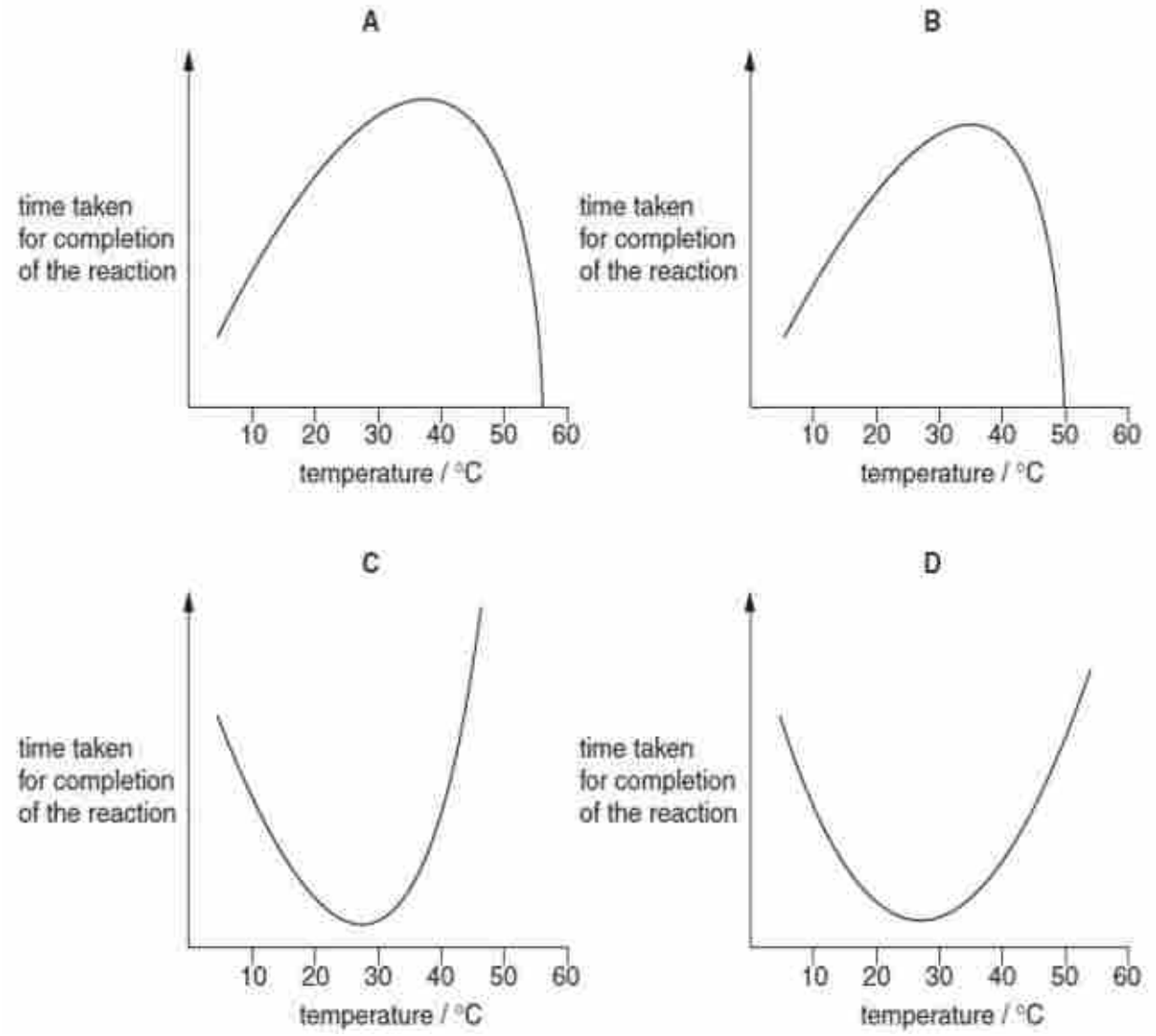
B It is an inhibitor of enzyme 2.

C It reactions with fumaric acid.

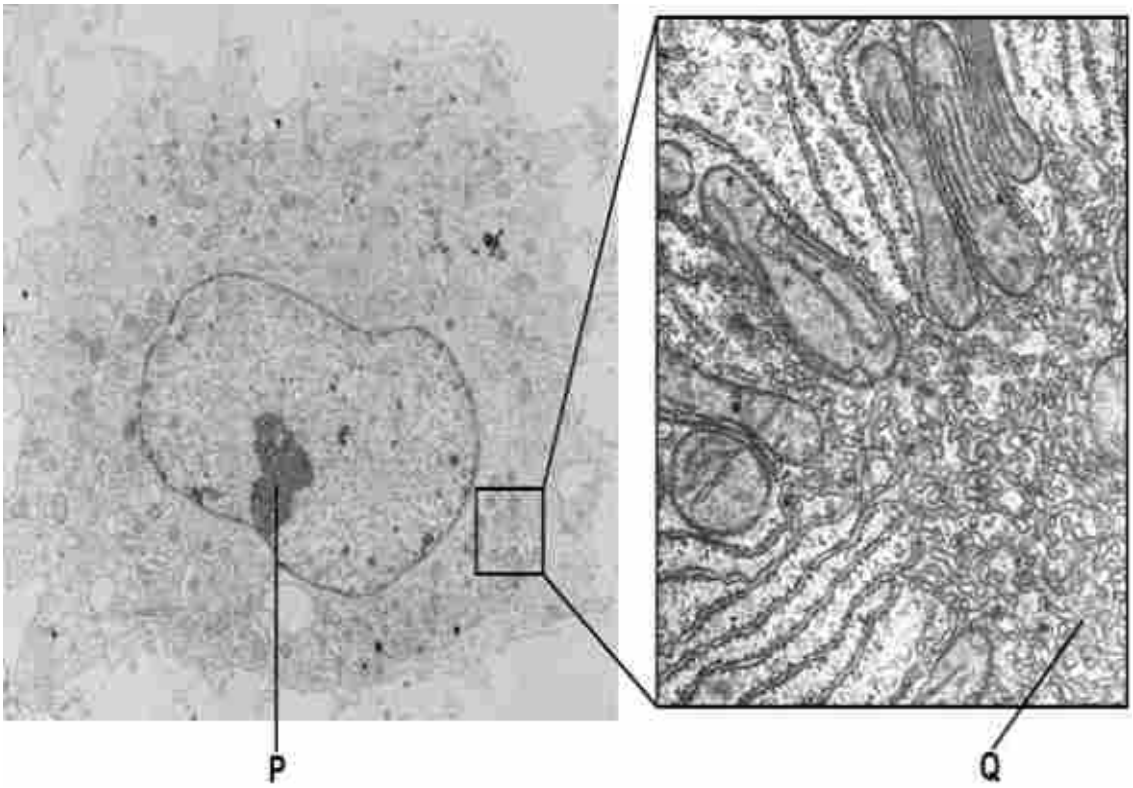
D It catalyses the formation of succinic acid.

6 An enzyme is completely denatured at 50°C. A fixed concentration of this enzyme is added to a fixed concentration of its substrate. The time taken for completion of the reaction is measured at different temperatures.

Which graph shows the results?



7 The diagram on the left below shows the electron-micrograph of a cell found in a healthy individual. A region of the cell, indicated by the box, is magnified and shown in the diagram on the right.



Which of the following shows the correct identities and functions of **P** and **Q**?

	Identity of P	**Function of P**	**Identity of Q**	**Function of Q**
A	Nucleosome	Transcription of rRNA	Smooth ER	Detoxification
B	Nucleosome	Assembly of ribosomal subunits	Secretary vesicles	Storage of Ca^{2+}
C	Nucleolus	Assembly of ribosomal subunits	Smooth ER	Synthesis of lipids
D	Nucleolus	Transcription of rRNA	Secretary vesicles	Modification of protein

8 Most wild plants contain toxins that deter animals from eating them. A scientist discovered that a toxin produced by a certain plant was also toxic to the same plant if it is applied to the roots of the plant.

As the first step on finding out why the plant was not normally killed by its own toxin, he fractionated some plant cells and found that the toxin was in the fraction that contained the largest cell organelle. He also found that the toxin was no longer toxic after it was heated.

Which of the following statements are consistent with the scientist's observations?

I The toxin was stored in the central vacuole.
II The toxin cannot cross the membrane of the organelle in which it is stored.
III The toxin was stored in the chloroplast.
IV The toxin is likely to be lipid soluble.
V The toxin may be an enzyme.

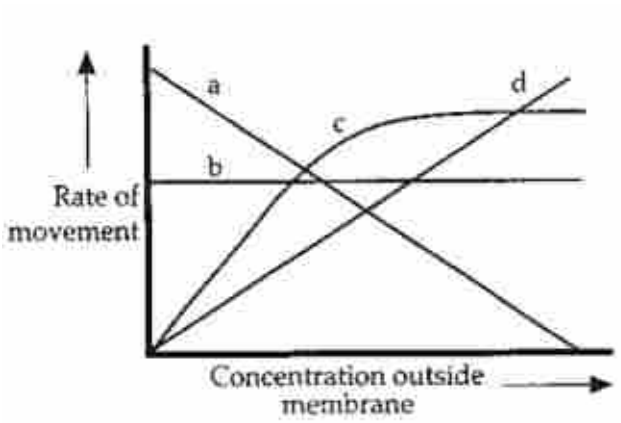
A **I**, **II** and **V**

B **I**, **IV** and **V**

C **II**, **III** and **IV**

D **III**, **IV** and **V**

9 Which of the following curves best represent the movement of substances by simple diffusion and facilitated diffusion?



	simple diffusion	facilitated diffusion
A	d	b
B	d	c
C	c	a
D	c	d

10 The table describes some molecules found in a cell surface membrane.

Which of the following is correct?

	cholesterol	**glycolipid**	**glycoprotein**	**phospholipid**	**protein**
A	is a precursor of certain hormones	involved in active transport	transports substances across the membrane	is amphipathic in nature	involved in DNA replication
B	regulates membrane fluidity at different temperatures	involved in cell-cell recognition	increases membrane fluidity at high temperature	involved in DNA replication	limits the permeability of the membrane
C	decreases membrane fluidity at high temperature	involved in cell-cell recognition	acts as a signal binding site during cell signaling	limits the permeability of the membrane	can change in conformation when phosphorylate d by ATP
D	has a four ring structure	involved in active transport	acts as a ligand binding site	is amphoteric in nature	limits the permeability of the membrane

11 The figures below show the complete karyotypes of 2 rodents of the same species. In this species of rodents, males are heterogametic.

Rodent A (Male)

Rodent B (Female)

Which of the following observations is not true?

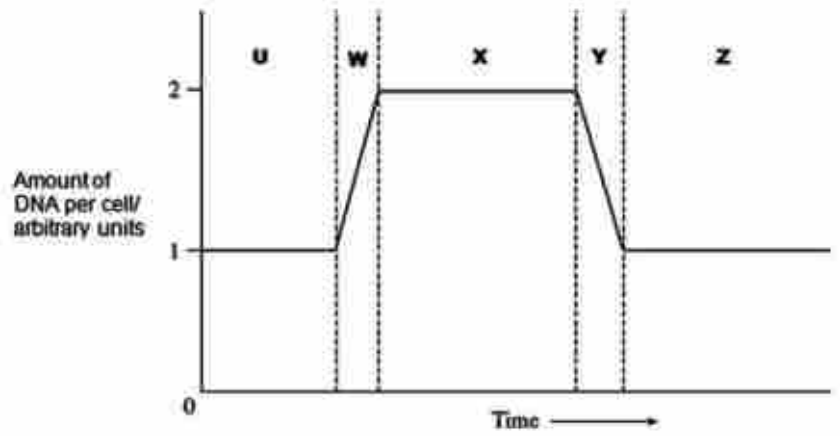
A A chromosomal aberration occurred in the ovary of the mother of rodent **B**.

B Rodent **A** is diploid and 2n = 16.

C Rodent **B** has 1 missing X chromosome.

D Non-disjunction of autosomes occurred in rodent **B**.

12 The graph shows changes in the amount of DNA in a cell during one cell cycle. The letters U – Z marks out the different phases in the cell cycle.



Many drugs that are used to treat cancer work at different time periods during the cell cycle.

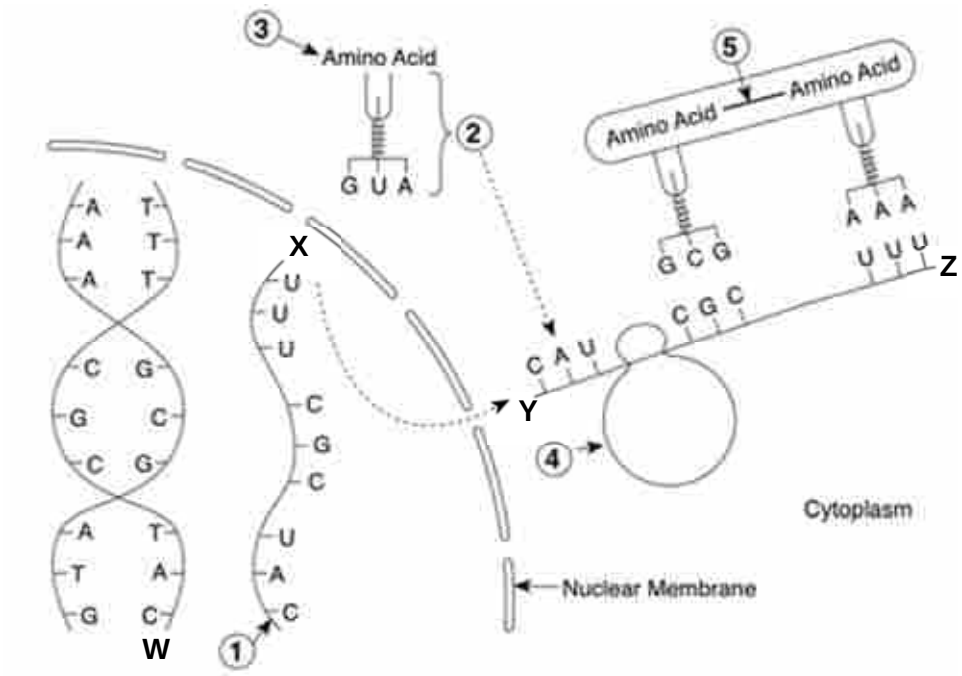
I One of the drugs, Cisplatin, binds to DNA and stops free DNA nucleotides from joining together.

II Another drug, B, stops spindle fibres from shortening.

With reference to the cell cycle above, determine where these 2 drugs work.

	Cisplatin	Drug B
A	W	X
B	W	Y
C	U	X
D	U	Z

13 The diagram below represents some biochemical reactions involved in protein synthesis.



Which is correct?

	Entire molecule coded directly from DNA is represented by	5' end of molecule	Enzyme involved in catalysing bond 5
A	1 and 2	**Z**	peptidyl transferase
B	1 and 2	**Y**	aminoacyl tRNA synthethase
C	1, 2 and 3	**X**	aminoacyl tRNA synthethase
D	1, 2 and 4	**W**	peptidyl transferase

14 A mutation of a gene coding for an ion pump in cell surface membranes results in the substitution of one amino acid, arginine, by another, histidine.

The DNA triplet codes for the two amino acids are shown.

Arginine	GCA	Histidine	GTA
	GCG		GTG
	GCT		
	GCC		
	TCT		
	TCC		

Which mutation has occurred in the DNA?

A Addition of an extra nucleotide

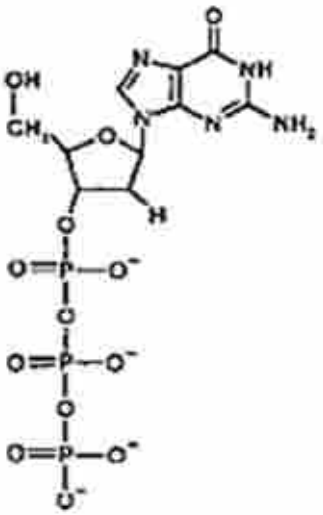
B Replacement of a nucleotide with a purine base by one with a different purine base

C Replacement of a nucleotide with a purine base by one with a pyrimidine base

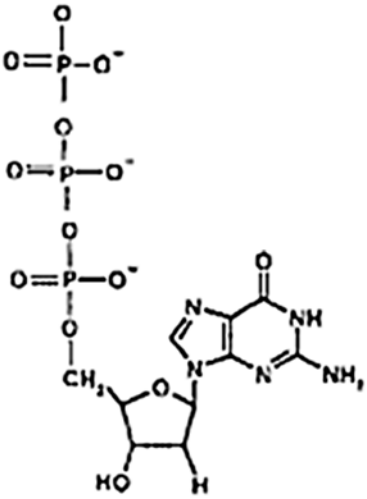
D Replacement of a nucleotide with a pyrimidine base by one with a different pyrimidine base

15 Which of the following is the correct physiological substrate for DNA polymerase?

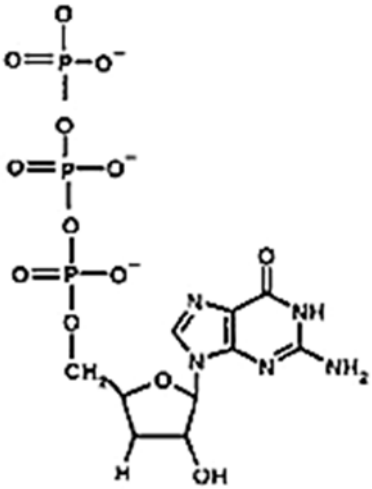
A



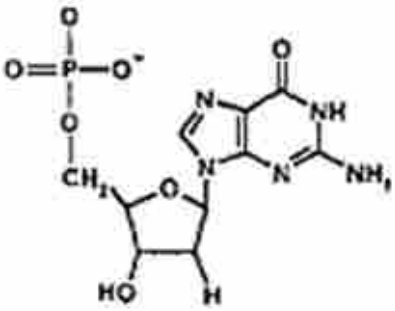
B



C



D



16 The following events occur during transcription.

1 Bonds break between complementary bases.
2 Bonds form between complementary bases.
3 Sugar-phosphate bonds form.
4 Free nucleotides pair with complementary nucleotides.

Before the mRNA leaves the nucleus, which events will have occurred twice?

A 1 and 2 only

B 1, 3 and 4 only

C 2, 3 and 4 only

D 1, 2, 3 and 4

17 The coding region of a gene is 105 nucleotides long, including both the start and stop codons. Which would be the most likely effect of a single nucleotide deletion at position 76 in the coding region?

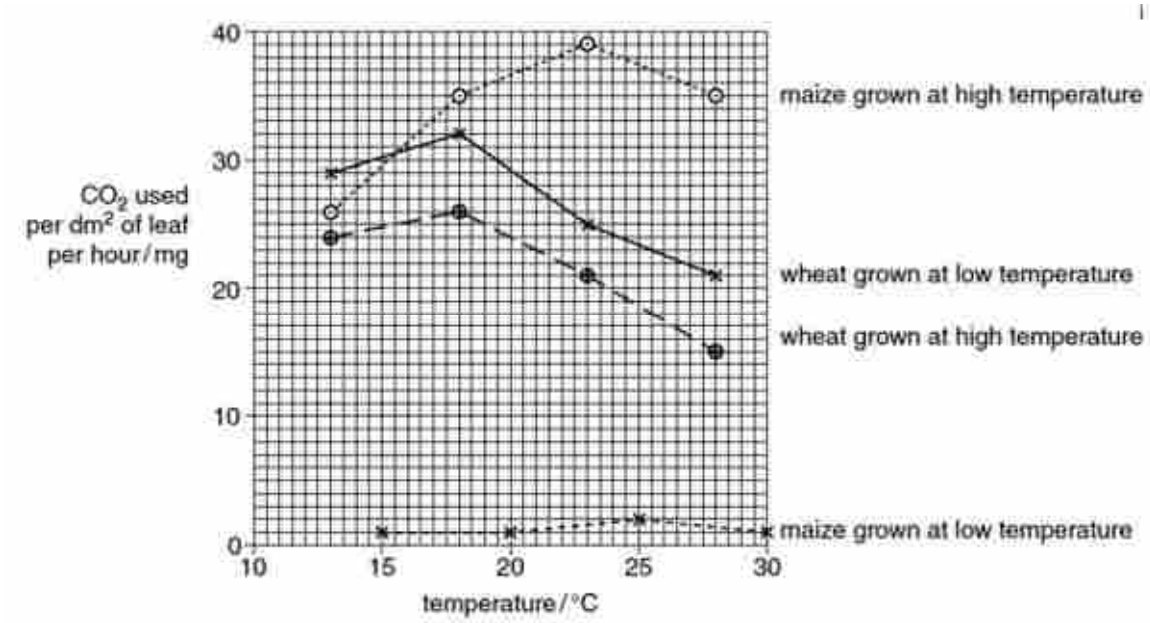
A Only the active site would be affected.

B The entire amino acid sequence of the polypeptide would change.

C There would be changes in only the first 25 amino acids.

D There would be changes in only the last 9 amino acids.

18 Young maize and wheat plants were grown to maturity at high and low temperatures. The rate of photosynthesis in each of these mature plants was measured at different temperatures. The rate of photosynthesis was measured as the amount of CO_2 used per dm^2 of leaf per hour. The results are shown in the graph below.



What information can be concluded from the graph above?

1 For plants grown at high temperature, the rate of photosynthesis is optimum at 25°C in maize and 18°C in wheat.

2 For plants grown at high temperature, maize had a greater increase in rate of photosynthesis compared to wheat until optimum temperature was reached.

3 The rate of photosynthesis was affected more significantly in maize plants than in wheat plants grown at low temperatures.

4 Low temperatures slowed down the formation of membranes in maize plants but not in wheat plants.

A 1 and 4 only

B 2 only

C 2 and 3 only

D 3 and 4 only

19 The blue dye DCPIP can be converted to colourless DCPIP as shown below:

DCPIP (blue) → reduced DCPIP (colourless)

A suspension of chloroplasts was made by grinding fresh leaves in buffer solution and centrifuging the mixture. Tubes were then prepared and treated in the following ways.

tube	contents	treatment	colour	
			at start	after 20 minutes
1	1 cm^3 chloroplast suspension + 5 cm^3 DCPIP	illuminated strongly	blue green	green
2	1 cm^3 buffer solution + 5 cm^3 DCPIP	illuminated strongly	blue	blue
3	1 cm^3 chloroplast suspension + 5 cm^3 DCPIP	left in the dark	blue green	blue green

Which statement is a possible conclusion for the observation above?

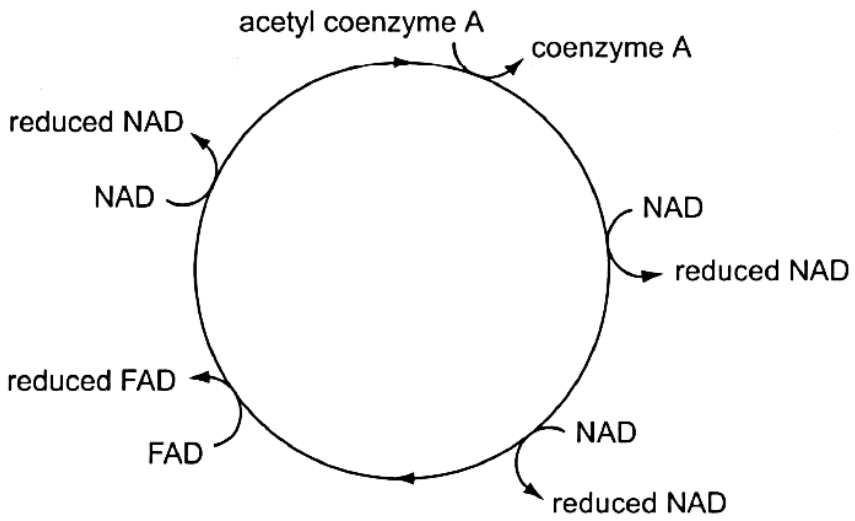
A Electron transfer from reduced NAD to DCPIP causes the decolourisation of DCPIP.

B NADP was oxidised and the electron was used to decolourise DCPIP.

C Light dependent reaction which occurs in the chloroplasts yield free electrons which reduced DCPIP.

D Either strong illumination or the buffer solution used in the extraction of chloroplasts could oxidise DCPIP.

20 The diagram shows the reactions of the hydrogen carriers in the Krebs cycle.



The average yield of ATP, in oxidative phosphorylation, is 3 molecules from each molecule of reduced NAD and 2 molecules from each molecule of reduced FAD.

What is the average yield of ATP, in oxidative phosphorylation, from the hydrogen carriers reduced in the Kreb's cycle, from one molecule of glucose?

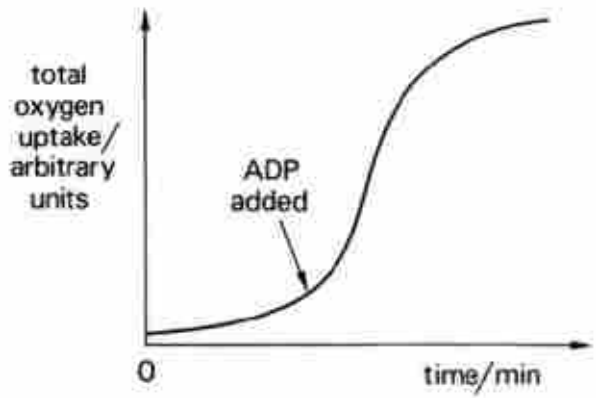
A 11

B 22

C 34

D 36

21 The graph shows the total oxygen uptake by a sample of homogenised liver tissue over a period of time.



Which statement explains the sharp rise in oxygen uptake after the addition of ADP?

A Electron transport is coupled to the phosphorylation of ADP.

B More protons move directly across the phospholipid bilayer of the cristae, generating the proton pool in the intermembrane space.

C Slower utilisation of reduced NAD and FAD causes molecular oxygen to be reduced to water.

D Oxidative phosphorylation occurs as protons are pumped back into the matrix through ATP synthase, phosphorylating ADP.

22 A plant is known to be heterozygous at two gene loci. The pollen grains from this plant are used to fertilise another plant of the same genotype.

What is the probability that an embryo will be homozygous dominant at one locus?

A 1 in 4

B 3 in 8

C 5 in 8

D 1 in 16

23 Fruit flies (*Drosophila*), homozygous for long wings, were crossed with fruit flies homozygous for vestigial wings. The F_1 and F_2 generations were raised at three different temperatures.

At each temperature, the F_1 generation all had long wings.

The table shows the results in the F_2 generation.

temperature / °C	result
21	¾ long wings, ¼ vestigial wings
26	¾ long wings, ¼ intermediate wing length
31	all long wings

Which statement explains these results?

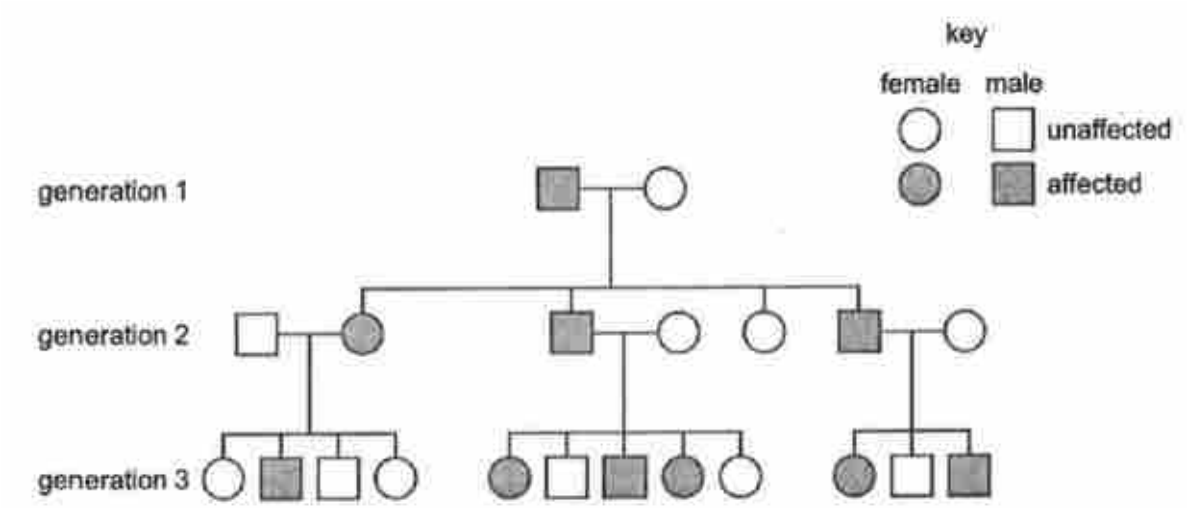
A Heterozygous flies have vestigial wings only at 21°C or below but have long wings at 31°C or above.

B Long wing and vestigial wing illustrate codominance at 26°C.

C Long wing is dominant at higher temperatures but vestigial wing is dominant at lower temperatures.

D Vestigial wing is recessive but causes a vestigial wing phenotype only at lower temperatures.

24 The pedigree shows the inheritance of a genetic condition in a family for three generations.



Which evidence indicates that this genetic condition is autosomal?

A Affected females always have affected sons.

B Affected males do not pass it on to their sons.

C Affected parents always have affected offspring.

D Males and females are equally affected.

25 A strain of mice have been genetically modified so that they display symptoms of a recessive sex-linked trait that causes death before the mice are able to breed.

In these mice, 33% of the alleles of this gene were recessive.

In multiple crossings of carrier females and normal males, it was found that 50% of the males died but no females.

What percentage of the alleles of this gene in the surviving offspring would be recessive?

A 0 %

B 17 %

C 20 %

D 33 %

26 Healthy, embryonic stem cells offer great promise to the cure of many diseases because _____.

I They are totipotent.
II They are more readily available than other cells.
III They can be easily cultured *in vitro*.
IV They will differentiate in the presence of appropriate molecular signals and produce cells which are normal.

Which of the above statement(s) is/are true?

A II, III and IV

B I, III and IV

C I and IV

D IV only

27 Animals with horizontal stripes are bitten less frequently by tsetse flies. The flies carry diseases that infect zebras.

Which explains how zebras might evolve to have more horizontal stripes?

A Bites from tsetse flies cause mutations. If a zebra has a mutation it will die and not pass its genes onto its offspring which will not have more horizontal stripes.

B If two zebras with horizontal stripes mate, their offspring will have more horizontal stripes. Horizontal stripes will become dominant. This is natural selection.

C Tsetse flies are a selection pressure. The zebras would gradually develop more horizontal stripes and pass them on to their offspring so that are not bitten by flies.

D Zebras with more horizontal stripes get fewer diseases from tsetse flies. These zebras live longer and breed more, passing the allele for more horizontal stripes to their offspring.

28 Bacteria in the genus *Wolbachia* infect many butterfly species. They are passed from one generation to the next in eggs, but not in sperm, and they selectively kill developing male embryos.

In Samoa in the 1960s, the proportion of male blue moon butterflies fell to less than 1% of the population. However, by 2006, the proportion of males was almost 50% of the population.

Resistance to *Wolbachia* is the result of the dominant allele of a suppressor gene.

Which statements correctly describe the evolution of resistance to *Wolbachia* in the blue moon butterfly population?

I *Wolbachia* acts as a selective agent.
II The selective killing of male embryos is an example of artificial selection.
III When infected with *Wolbachia*, male embryos that are homozygous for the recessive allele of the suppressor gene die.
IV All male embryos that carry the dominant allele of the suppressor gene pass that allele to their offspring.
V The frequency of the dominant allele of the suppressor gene rises in the butterfly population.

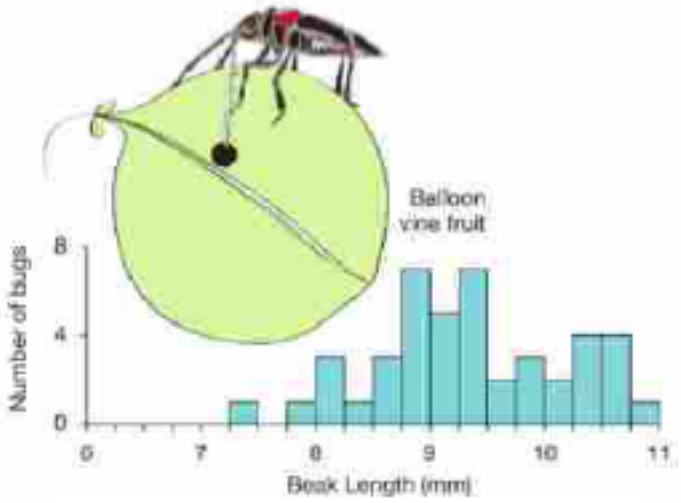
A I and IV

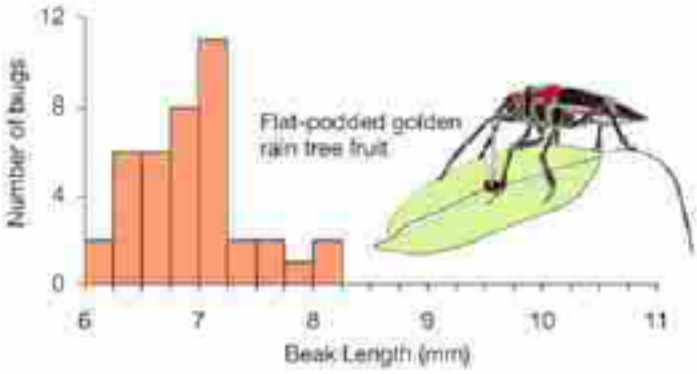
B I, III and V

C II and III

D II, IV and V

29 Soapberry bugs in Florida originally fed on the native balloon vine, using their sharp beaks to penetrate the fruits to reach the seeds. In the 1920s, the flat-podded golden rain tree was introduced from Asia to mainland central Florida. This has thinner-skinned fruit, and correspondingly, soapberry bugs evolved shorter beaks after they switched completely to feed on this new host plant.





What best describes the type of evolutionary process depicted above?

The soapberry bugs are undergoing

A stabilizing selection.

B genetic drift.

C natural selection.

D directional selection.

30 Which of the following about global warming is correct?

A growing of crops → burning of trees to clear land → increased methane production → global warming

B global warming → melting of permafrost → emergence of deadly diseases → possibility of increased mortality

C global warming → metabolism of insects in the tropics increases → size of insects increases → amount of pesticides required to kill insect pests increases

D global warming → calcium carbonate uptake by corals increases → coral bleaching → disruption of food web in ocean

- END OF PAPER -

1	B	**6**	C	**11**	D	**16**	A	**21**	A	**26**	D
2	B	**7**	C	**12**	A	**17**	D	**22**	B	**27**	D
3	C	**8**	A	**13**	A	**18**	B	**23**	D	**28**	B
4	C	**9**	B	**14**	D	**19**	C	**24**	D	**29**	D
5	B	**10**	C	**15**	B	**20**	B	**25**	C	**30**	B

EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examinations 2018
General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME	

CIVICS GROUP	1	7	-			REGISTRATION NUMBER		

H1 Biology 8876/02

Paper 2 Structured Questions

14 September 2018

2 hours

Candidates answer **Section A** on the Question Paper and **Section B** on separate writing paper.
Additional Materials: Writing Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Write your answer to each part of the question on a fresh sheet of paper.

The use of an approved scientific calculator is expected, where appropriate.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
Section B	
7 or 8	
Total	/60

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For Examiner's Use

Section A

Answer **all** the questions in this section.

1 The synthesis of collagen is shown in Fig. 1.1.

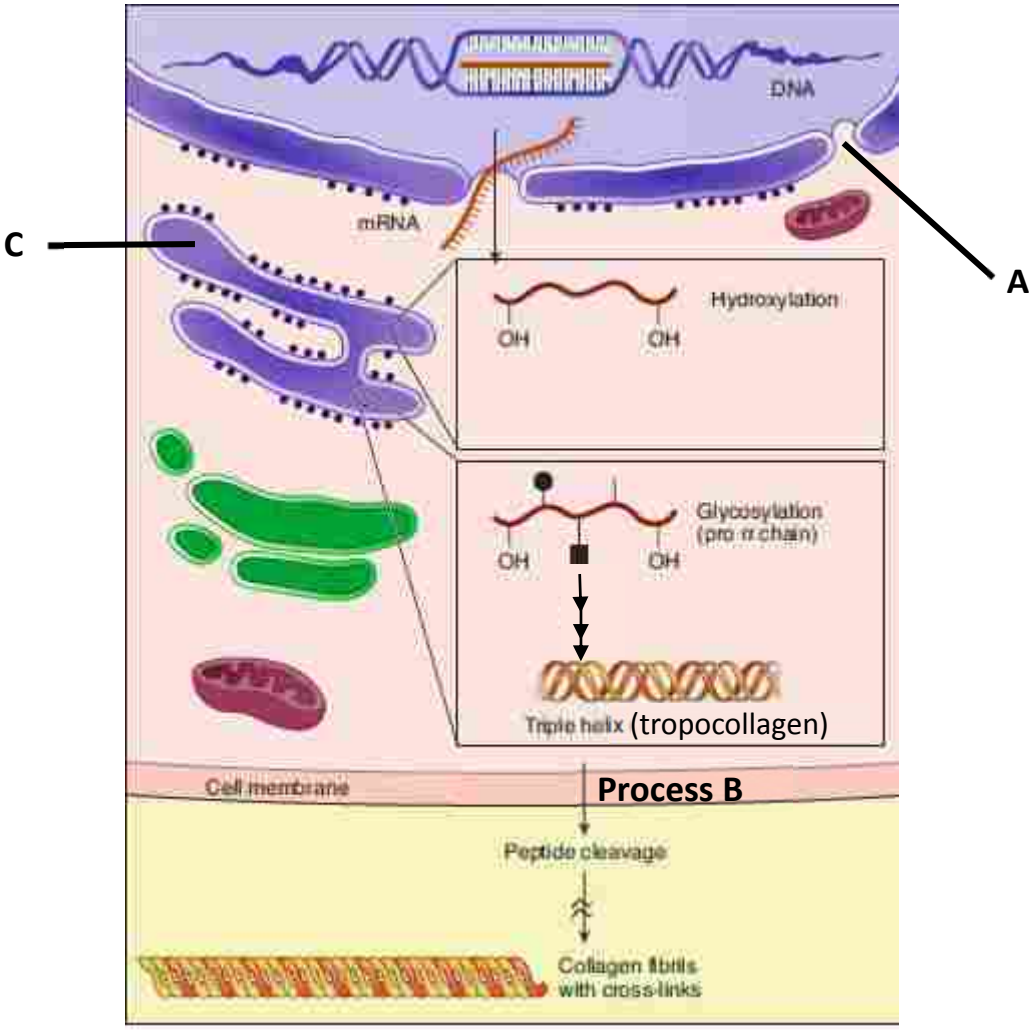

Fig. 1.1

(a) **(i)** Describe two important functions of structure **A** in the synthesis of collagen.

……

……

……

……[2]

(ii) Tropocollagen leaves the cell to be assembled to form collagen fibrils via **Process B**. Outline **Process B**.

……

……

……

……

……

……[3]

Fig. 1.2 shows two electron micrographs. One of the electron micrograph shows part of a normal cell while the other electron micrograph shows part of a cancer cell. The white arrows point to an organelle within the cell. The appearance of this organelle in both cell types were visibly different. The cancer cell had a higher activity than the normal cell.

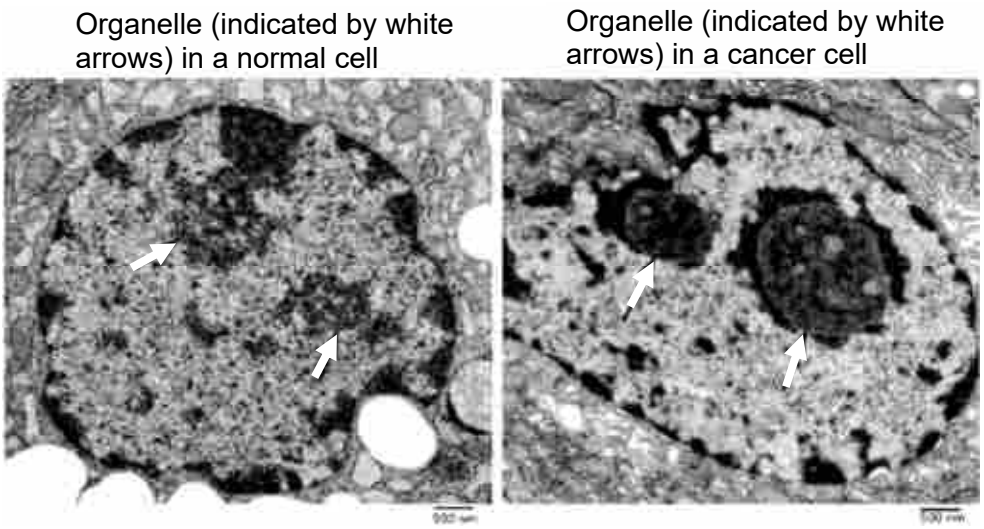

Fig. 1.2

(c) **(i)** Describe the visible difference between the organelle indicated by the white arrows in Fig. 1.2, between the cancer cell and the normal cell.

……

……[1]

(ii) Account for the higher activity of the cancer cell.

……

……

……

……[2]

[Total: 8]

For Examiner's Use

2 Bone marrow contains stem cells that divide by mitosis to form blood cells. The fate of a stem cell was tracked and it was recorded that during the observed duration the stem cell divided asymmetrically each time.

Fig. 2.1 shows changes in the mass of DNA in a human stem cell from bone marrow during three cell cycles.

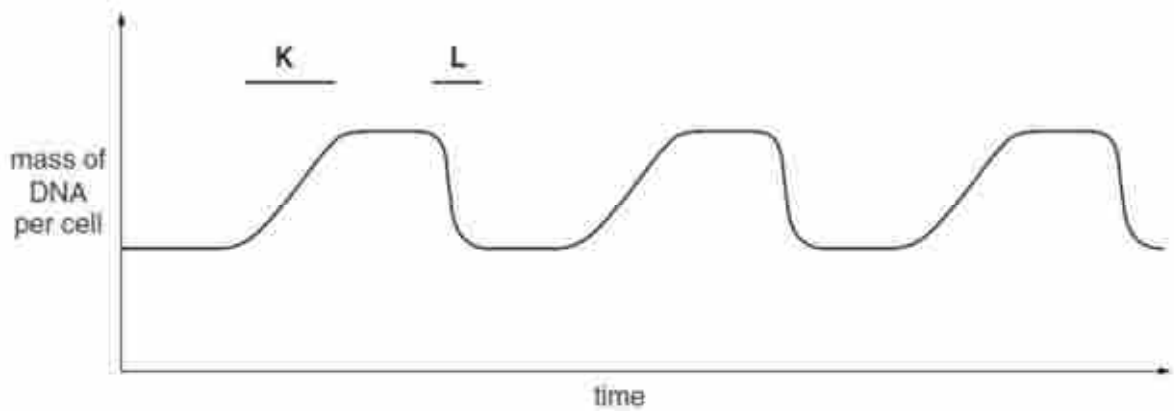

Fig. 2.1

(a) With reference to the information provided above,

(i) Describe what happens to bring about the changes in the mass of DNA per cell at time period **K** and at time period **L**.

K ……

……

L ……

……[2]

(ii) State one function of these stem cells undergoing the above type of cell division.

……

……[1]

(iii) The process of meiosis is significant to natural selection in evolution.

Explain this significance.

……

……

……

……[2]

The use of embryonic stem cells (ESCs) for stem cell therapy and research is controversial and considered by many people as unethical. Scientists have circumvented this issue through the use of induced pluripotent stem cells (iPSCs) as an alternative to ESCs.

Fig. 2.2 summarises the procedure for obtaining iPSCs and its use.

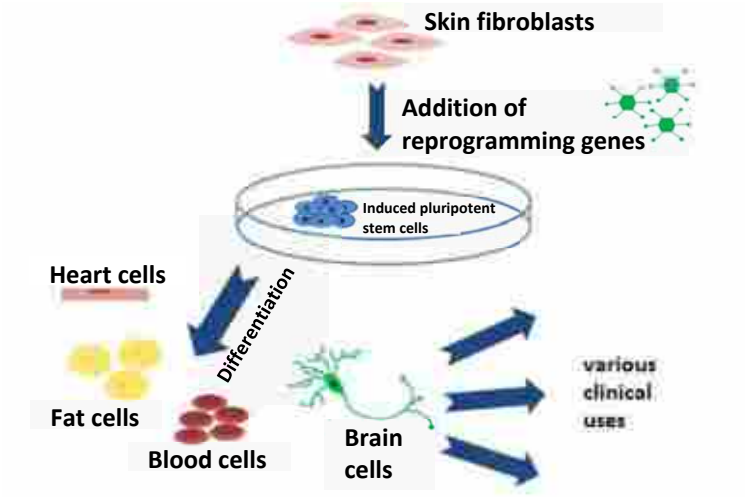

Fig. 2.2

(b) Explain why the use of iPSCs is preferred over ESCs.

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……..[2]

[Total: 7]

For Examiner's Use

3 Fig. 3.1 shows part of a DNA molecule.

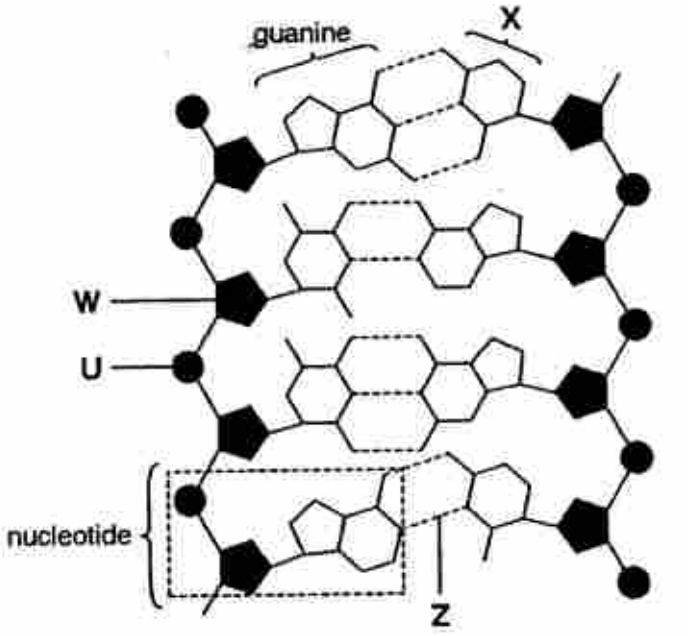

Fig. 3.1

(a) **(i)** Name **W** to **Z**. [1]

W ……

U ……

X ……

Z ……

(ii) Give **one** advantage of DNA having two strands.

……

……[1]

(b) Fig. 3.2 shows a linear chromosome undergoing the first round of DNA replication.

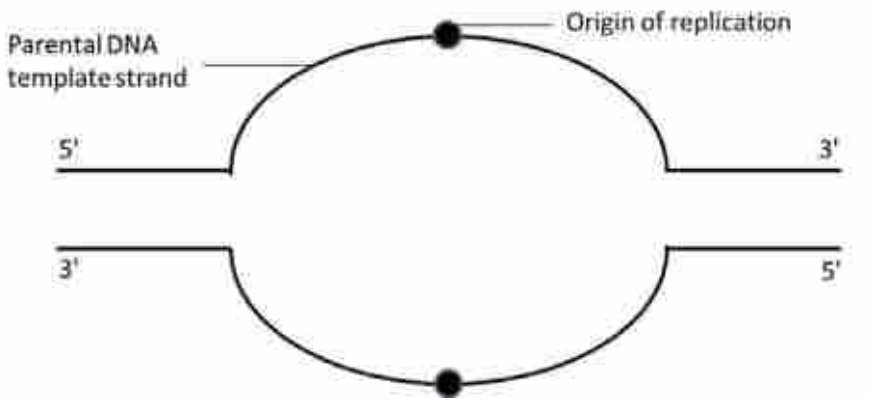

Fig. 3.2

(i) On Fig. 3.2, draw the direction of DNA synthesis for the leading strands using solid arrows (→) and for the lagging strands using dashed arrows (- - - >). [1]

(ii) State **two** ways DNA replication is different from transcription.

……

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……[2]

(c) Fig. 3.3 is an electron micrograph showing the transcription of genes for ribosomal RNAs at adjacent positions along the chromosome in a eukaryotic cell.

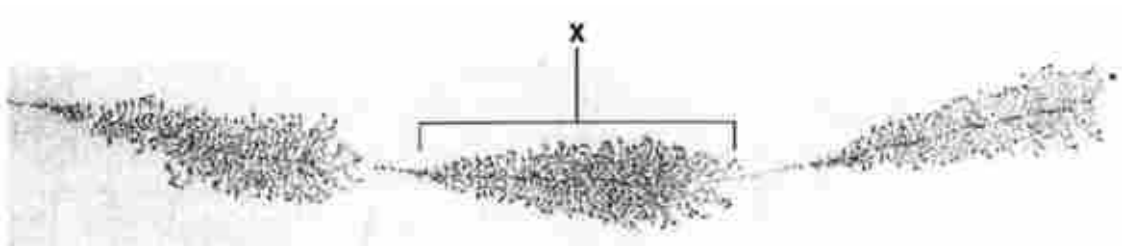

Fig. 3.3

Describe and explain the pattern of transcription visible on the part of the DNA coding for ribosomal RNA, labelled **X** in Fig. 3.3.

……

……

……

……[2]

[Total:7]

For Examiner's Use

4 Fig. 4.1 shows the pedigree of a family. Several members have the condition called albinism where there is a lack of normal pigment in the body.

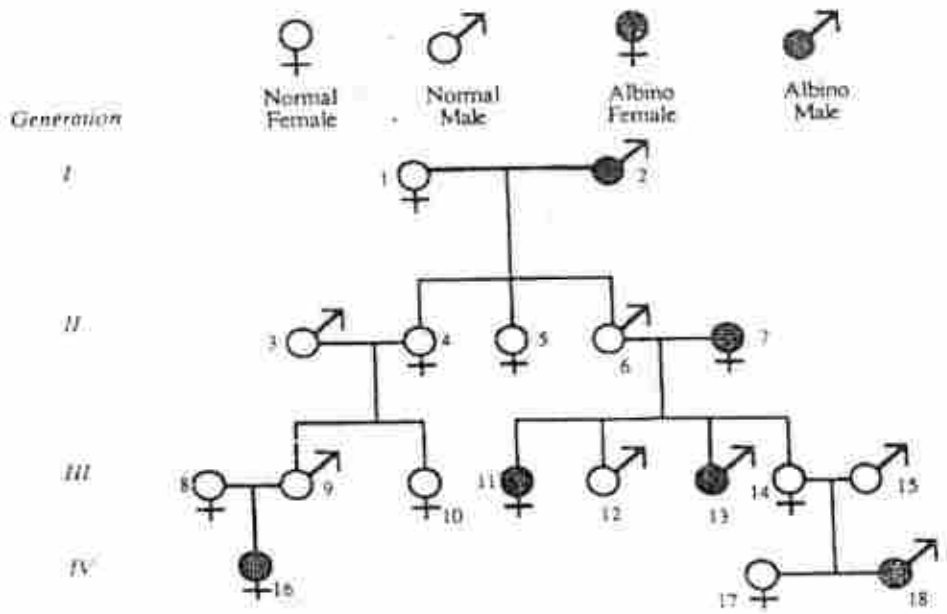

Fig. 4.1

(a) Skin colour is determined by an autosomal gene. Individuals who are not albino possess allele A which codes for an enzyme that synthesizes pigment. Allele a, on the other hand, codes for a non-functional enzyme.

What are all the possible genotypes of the following members of the family tree? [1]

individual 3 in generation II: _____

individual 14 in generation III: _____

For Examiner's Use

(b) The same family was also tested for colour blindness, a recessive sex-linked condition.

Individual 12 from generation III married a female with the same genotype as him at the A/a gene locus. Both of them are not colour blind, but one of their child is colour blind.

Use a genetic diagram to show the offspring phenotypic ratio of the mating between two such individuals.

[4]

[Total: 5]

5 A student carried out an investigation on yeast respiration using the following setup shown in Fig. 5.1. She put 5 grams of yeast into a glucose solution and put a layer of oil on top of the mixture. This layer of oil is impermeable to oxygen but not to carbon dioxide. The total volume of gas was recorded every 10 minutes for 1 hour and the results are shown in Table 5.1.

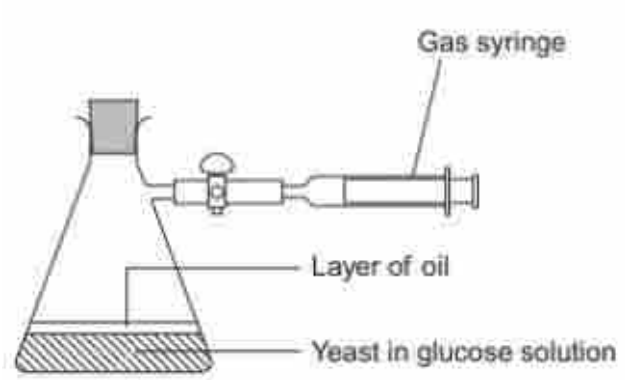

Fig. 5.1

Table 5.1

Time / minutes	Total volume of gas collected / cm^3
10	0.3
20	0.9
30	1.9
40	3.1
50	5.0
60	5.2

(a) **(i)** Calculate the rate of gas production in $cm^3\ g^{-1}\ min^{-1}$ during the first 40 minutes of this investigation. Show your working clearly. [1]

Answer = ... $cm^3\ g^{-1}\ min^{-1}$

For Examiner's Use

(ii) Suggest why the rate of gas production decreased between 50 and 60 minutes.

……

……[1]

(b) The Respiratory Quotient (RQ) is defined as the ratio of carbon dioxide produced to oxygen consumed per unit time by an organism and the formula is as follows:

$$RQ = \frac{\text{volume of } CO_2 \text{ produced}}{\text{volume of } O_2 \text{ consumed}} \text{ per unit time}$$

Given that the rate of carbon dioxide produced equals to the rate of oxygen used for aerobic respiration, suggest and explain the RQ value for the setup shown in Fig. 5.1.

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……

……[2]

(c) To show that the presence of oil has an effect on yeast respiration, the student also created another similar setup as the one shown in Fig. 5.1. All variables were kept constant in this second setup except that no oil was used.

Explain if there is any difference in the amount of ATP produced between both setups.

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……[3]

In another experiment, the student investigated the effect of temperature on the rate of oxygen consumption of the lizard, *Sauromalus hispidus*. The body temperature of a lizard varies with environmental temperature.

Several baby lizards were fitted with small, airtight masks that covered their heads. Air was supplied inside the mask through one tube, and collected through another. The differences between oxygen concentrations in the air supplied for inhalation and the exhaled air enabled the researchers to measure the rate of oxygen consumption of the lizards.

The rate of oxygen consumption of each baby lizard was measured at different temperatures ranging from 15 °C to 40 °C and the average measurements were computed. The results are shown in Fig. 5.2.

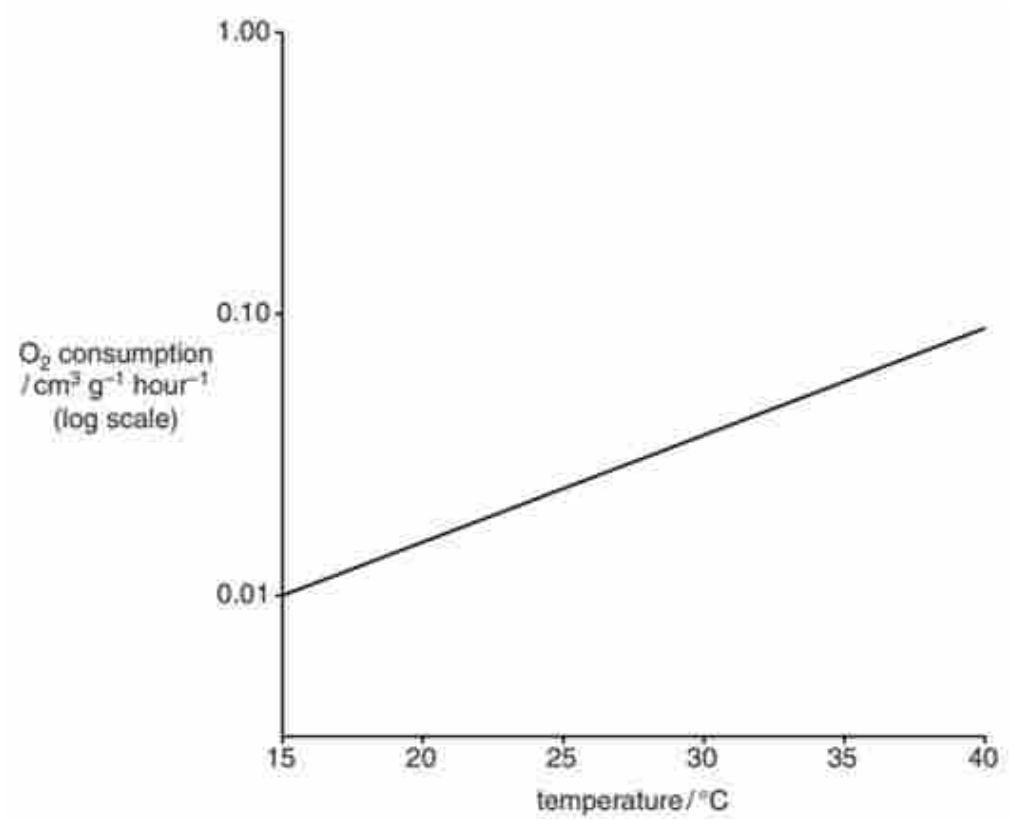

Fig. 5.2

(d) Using Fig. 5.2, suggest and explain how temperature influences the development of baby lizards.

……

……

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……

……

……[3]

[Total: 10]

For Examiner's Use

6 The theory of continental drift was proposed over 90 years ago by Alfred Wegener and is now a widely accepted theory of how the continents were formed.

The supercontinent Gondwana is shown in Fig. 6.1. The land that was to form New Zealand began to break away from the supercontinent, Gondwana around 80 million years ago and broke away totally around 65 million years ago (Fig. 6.2). Ever since, New Zealand is now composed of North Island and South Island (Fig. 6.3).

The separation of New Zealand from Gondwana has led to some species like the New Zealand kiwi bird being distantly related to the rhea (South America), ostrich (Africa) and cassowary (Australia).

Fig. 6.1

Fig. 6.2

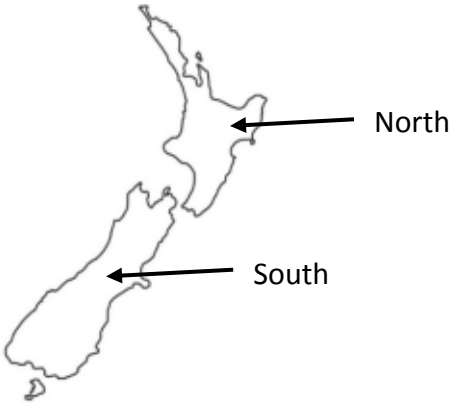

Fig. 6.3

For reasons that are not apparent, New Zealand was not inhabited by many mammals. Instead, its fauna became dominated by birds and insects. Birds became the predators, the scavengers, the herbivores and the insectivores. They lived everywhere from the highest mountains to the sea. Some have lost the ability to fly and became ground dwellers.

The kakapo, kea and kaka are parrots that are currently found in New Zealand (Fig. 6.4).

The kakapo (*Stringops habroptila*) is found only in New Zealand and is flightless. Highly endangered, they were relocated to several islands in New Zealand during the 1980s and 1990s.

The kea (*Nestor notabilis)* is the world's only alpine parrot, it can be found living near forested mountain habitats - Southern Alps on South Island. Kea are not found on North Island now.

Kaka (*Nestor meridionalis)* can be found on South Island and the sub-species of Kaka (*Nestor meridionalis septentrionalis*) is found on North Island. All Kaka live in the lowlands and mid-altitude regions.

kakapo

kea

kaka

Fig. 6.4

(a) Suggest a possible factor causing birds like the kakapo to become flightless early in their evolutionary history.

……

……[1]

Fig. 6.5 shows the phylogenetic relationships between the kakapo, kea and kaka derived from mtDNA evidence, together with the geological changes that shape the landscape of New Zealand.

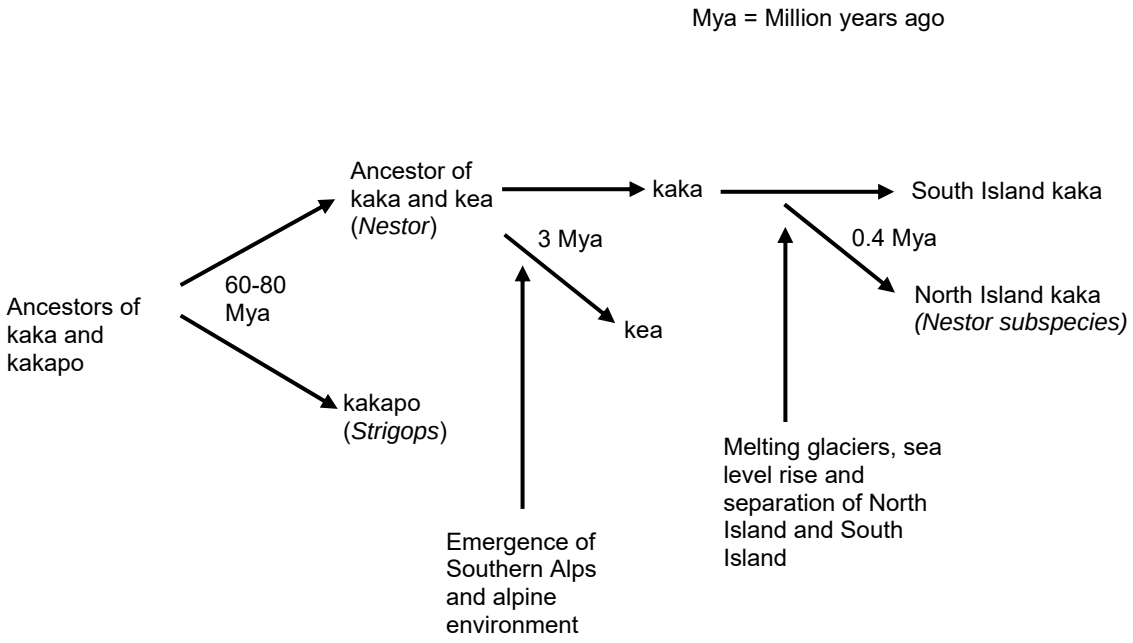

Fig. 6.5

(b) With reference to Fig. 6.5, explain the distribution and evolution of the kea.

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.....[5]

(c) With reference to Fig. 6.5, suggest a possible reason for the emergence of a sub-species of kaka on North Island.

……

……

……

……[2]

[Total:8]

For Examiner's Use

Section B

Answer either Q7 or Q8.

Write your answers for **Q7** or **Q8** on separate pieces of the answer paper provided.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

Question 7

a) Discuss the importance of shapes fitting together in cells. [7]

b) Using named examples, describe the function of cycles in Biology. [8]

Question 8

a) Using examples, discuss the importance of movement in cellular processes. [7]

b) Polymers have different structures and functions. Describe how such structures are related to functions. [8]

- END OF PAPER -

EUNOIA JUNIOR COLLEGE
JC2 Preliminary Examinations 2018
General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME	

CIVICS GROUP	1	7	-			REGISTRATION NUMBER		

H1 Biology 8876/02

Paper 2 Structured Questions

14 September 2018

2 hours

Candidates are to **answer all questions** in this question booklet.

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and registration number on all the work you hand in.

Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
Section B	
7	
8	
Total	/60

This document consists of **17** printed pages and **1** blank page.

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For Examiner's Use

Section A

Answer **all** the questions in this section.

1 The synthesis of collagen is shown in Fig. 1.1.

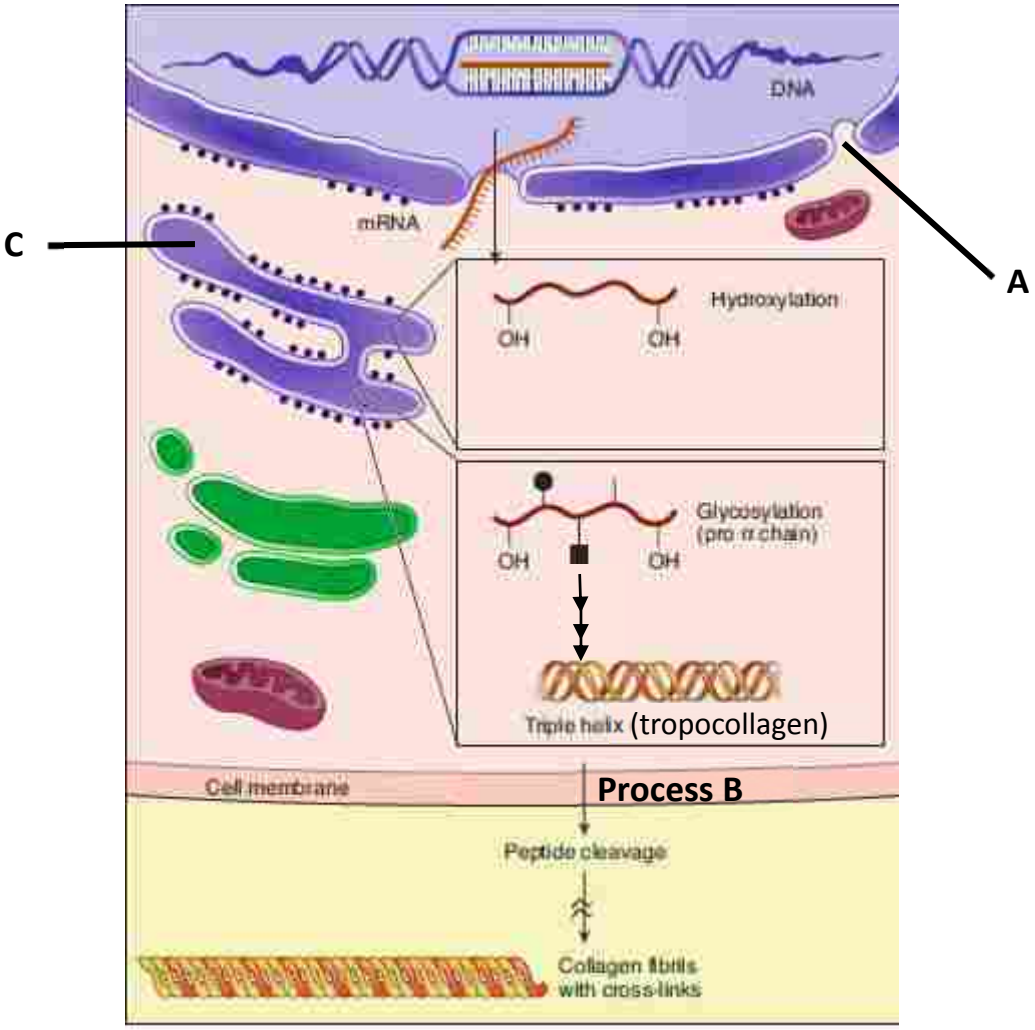

Fig. 1.1

(a) **(i)** Describe two important functions of structure **A** in the synthesis of collagen.

.....

.....

.....

.....[2]

Structure A is the nuclear pore;

1. **Allows mature mRNA to leave nucleus and enter cytosol for translation into collagen by ribosome;**
2. **Allows RNA polymerase/ ribonucleotides to enter nucleus to synthesise mRNA/tRNA during transcription of collagen gene;**
3. **Allows exit of mRNA to ribosomes to be translated;**

4. **Allows tRNA to leave nucleus for amino acid activation/ amino acid attachment for use in translation during collagen synthesis;**
   (any 2)

(ii) Tropocollagen leaves the cell to be assembled to form collagen fibrils via **Process B**. Outline **Process B**.

.....

.....

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.....[3]

1. **Process B is exocytosis;**
2. **Secretory vesicle containing tropocollagen is transported to cell surface membrane and fuses with the cell surface membrane to release tropocollagen extracellularly;**
3. **This process requires ATP;**

Fig. 1.2 shows two electron micrographs. One of the electron micrograph shows part of a normal cell while the other electron micrograph shows part of a cancer cell. The white arrows point to an organelle within the cell. The appearance of this organelle in both cell types were visibly different. The cancer cell had a higher activity than the normal cell.

Organelle (indicated by white arrows) in a normal cell

Organelle (indicated by white arrows) in a cancer cell

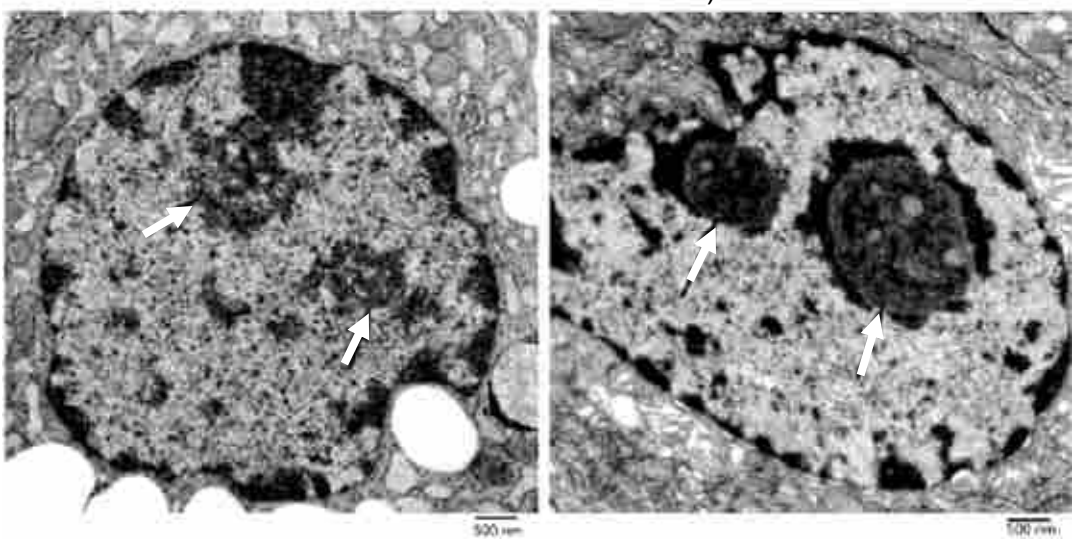


Fig. 1.2

(b) **(i)** Describe the visible difference between the organelle indicated by the white arrows in Fig. 1.2, between the cancer cell and the normal cell.

.....

.....[1]

For Examiner's Use

1. **Nucleoli in the cancer cell were denser/darker/more darkly stained and larger;**

(ii) Account for the higher activity of the cancer cell.

.....

.....

.....

.....[2]

1. **Nucleoli are the sites for rRNA synthesis which are key components of ribosomes required for translation;**
2. **Larger and denser nucleoli in cancer cells due to increased rRNA enable cancer cell to achieve higher rates of protein synthesis to enable excessive proliferation/growth;**

[Total: 8]

2 Bone marrow contains stem cells that divide by mitosis to form blood cells. The fate of a stem cell was tracked and it was recorded that during the observed duration the stem cell divided asymmetrically each time.

Fig. 2.1 shows changes in the mass of DNA in a human stem cell from bone marrow during three cell cycles.

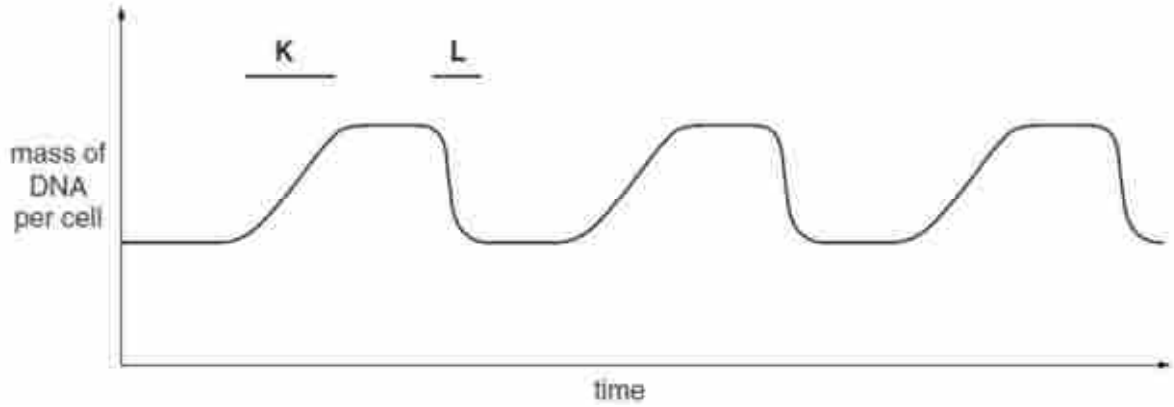


Fig. 2.1

(a) With reference to the information provided above,

(i) Describe what happens to bring about the changes in the mass of DNA per cell at time period **K** and at time period **L**.

K .....

For Examiner's Use

……

L ……

……[2]

5. **K: DNA replication/ synthesis during S phase of interphase;**
6. **L : cytoplasmic division during cytokinesis;**

(ii) State one function of these stem cells undergoing the above type of cell division.

……

……[1]

1. **To replace blood cells that die due to injury/ wear and tear/ disease;**

(iii) The process of meiosis is significant to natural selection in evolution.

Explain this significance.

……

……

……

……[2]

1. **Meiosis gives rise to genetically different haploid gametes;**
2. **During Prophase I of meiosis, crossing over between chromatids of homologous chromosomes would give rise to different combinations of alleles**

   OR

   During Metaphase I and Anaphase I, independent assortment and separation of homologous chromosomes would give rise to different combinations of maternal and paternal chromosomes;

3. **Resulting in genetic variation in diploid organisms leading to different phenotypes/ variation in phenotypes;**

4. **those with advantageous phenotypes are selected for, resulting in change in allele frequency in the population over time;**

   (1 and 2 + 3 / 4 OR 1+ 3 and 4)

For Examiner's Use

The use of embryonic stem cells (ESCs) for stem cell therapy and research is controversial and considered by many people as unethical. Scientists have circumvented this issue through the use of induced pluripotent stem cells (iPSCs) as an alternative to ESCs.

Fig. 2.2 summarises the procedure for obtaining iPSCs and its use.

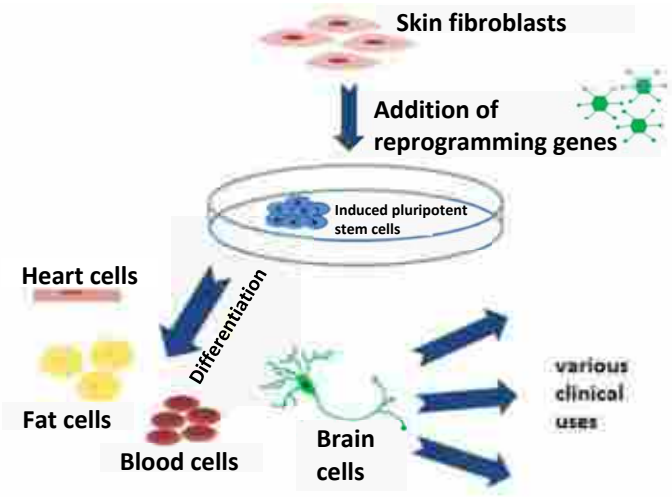


Fig. 2.2

(b) Explain the use of iPSCs is preferred over ESCs.

.....

.....

.....

.....[2]

1. **Since iPSCs can be derived directly from adult tissues/specialised somatic cell/ skin cells, it does not destroy any human embryos unlike ESCs;**
2. **iPSCs from adult/specialised somatic cell/ skin cell can be easily obtained without risk to the donor, whereas obtaining the embryo to isolate ESCs is more invasive; (R: easy vs difficult because no elaboration)**
3. **In contrast to ES cells extracted from human embryos, iPSCs derived from a patient's own cells would open the possibility of generating patient-specific cells, which will not be rejected by the immune system upon transplantation; (A: idea of iPSCs obtained from self vs embryos not from self thus contain antigens that will be rejected by immune system);**
4. **Sources of obtaining iPSCs is more easily accessible compared to the source of obtaining ESCs/ obtaining the embryo; (any one, answer must make comparison with ESCs)**

[Total: 7]

For Examiner's Use

3 Fig. 3.1 shows part of a DNA molecule.

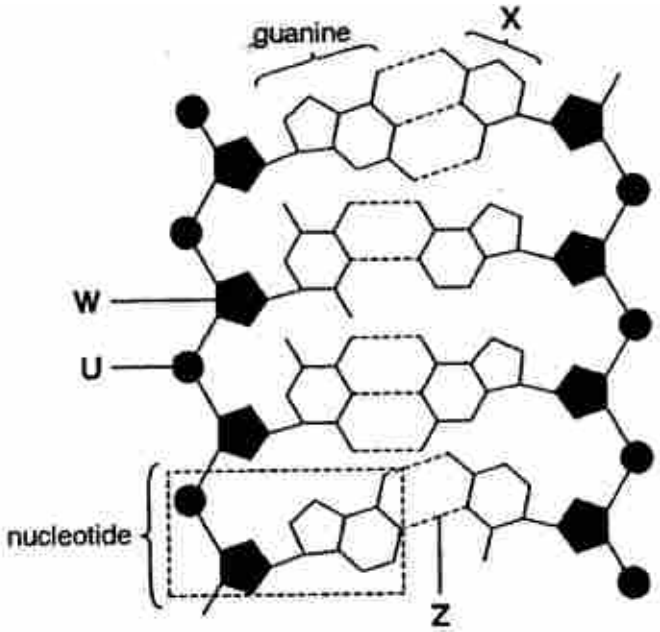


Fig. 3.1

(a) **(i)** Name **W** to **Z**. [2]

W .....

U .....

X .....

Z .....

1. **W = Deoxyribose (R: sugar, ribose, pentose)**
2. **U = Phosphate group (R: phosphate head)**
3. **X = Cytosine (R: nitrogenous base, pyrimidine)**
4. **Z = Hydrogen bond**

4 correct = 2 marks, 2-3 correct = 1 mark, less than 2 correct = 0 marks

(ii) Give **one** advantage of DNA having two strands.

.....

.....[1]

1. **Collective/numerous hydrogen bonds between the complementary base pairs stabilise the double helical structure/molecule;**
2. **One strand act as a template for repair during DNA replication;**
3. **Protects / shields the hydrophobic nitrogenous bases from the hydrophilic medium;**

For Examiner's Use

(b) Fig. 3.2 shows a linear chromosome undergoing the first round of DNA replication.

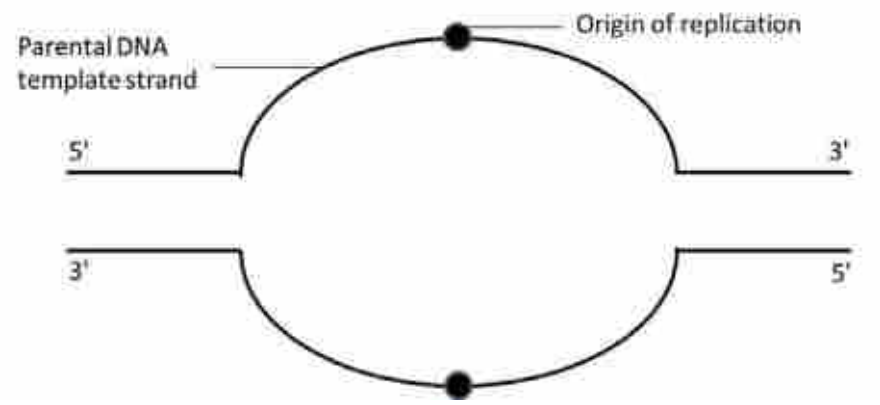
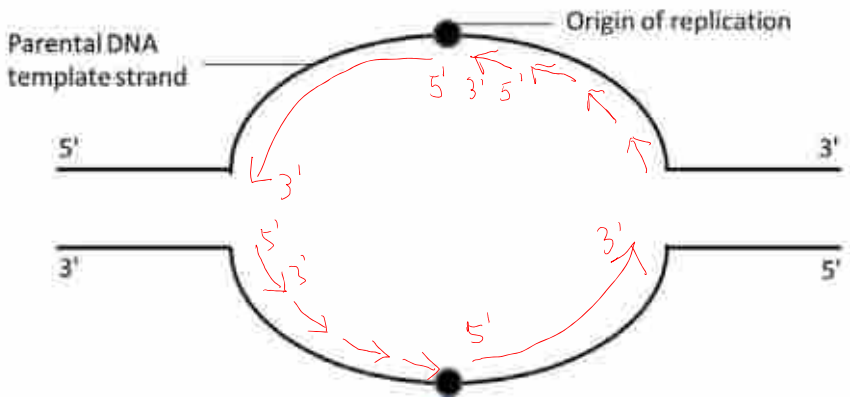


Fig. 3.2

(i) On Fig. 3.2, draw the direction of DNA synthesis for the leading strands using solid arrows (→) and for the lagging strands using dashed arrows (- - - >).

[1]



1. All directions of leading and lagging strands (Okazaki fragments) correctly indicated;
2. Lagging strands must show several Okazaki fragments in correct directions;

Points 1 and 2 must be present for full credit. Not marking for 5'/ 3' labels, but arrow head needed.

(ii) State **two** ways DNA replication is different from transcription.

.....

.....

.....

.....[2]

DNA Replication	Transcription
DNA polymerase used to polymerise nucleotides/synthesize new strands;	RNA polymerase used to polymerise nucleotides/synthesize new strands
Helicase used to unzip DNA strands;	RNA polymerase unzip DNA strands
Both parental strands used as templates;	Only one strand used as template
DNA strands produced;	mRNA/tRNA/rRNA strand produced
Deoyribonucleotide monomers;	Ribonucleotide monomers
Daughter DNA molecule double-stranded;	mRNA molecule single stranded
AVP;	AVP

(c) Fig. 3.3 is an electronmicrograph showing the transcription of genes for ribosomal RNAs at adjacent positions along the chromosome in a eukaryotic cell.

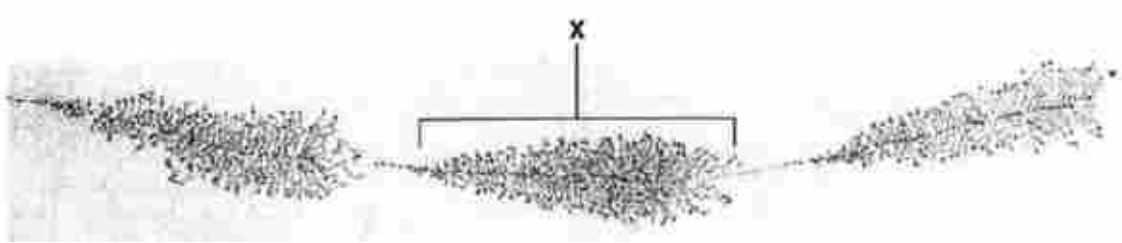


Fig. 3.3

Describe and explain the pattern of transcription visible on the part of the DNA coding for ribosomal RNA, labelled **X** in Fig. 3.3.

……

……

……

……[2]

1. **The pattern shows shorter strands of rRNA emerging on the left and with longer strands of rRNA seen on the right;**

2. **This is because RNA polymerase transcribes DNA from 3' to 5' direction/ synthesises rRNA from 5' to 3' direction, hence the rRNA strands on the right (near 5' end of DNA template) were the longest (transcription started earlier); (ora)**

[Total:7]

For Examiner's Use

4 Fig. 4.1 shows the pedigree of a family. Several members have the condition called albinism where there is a lack of normal pigment in the body.

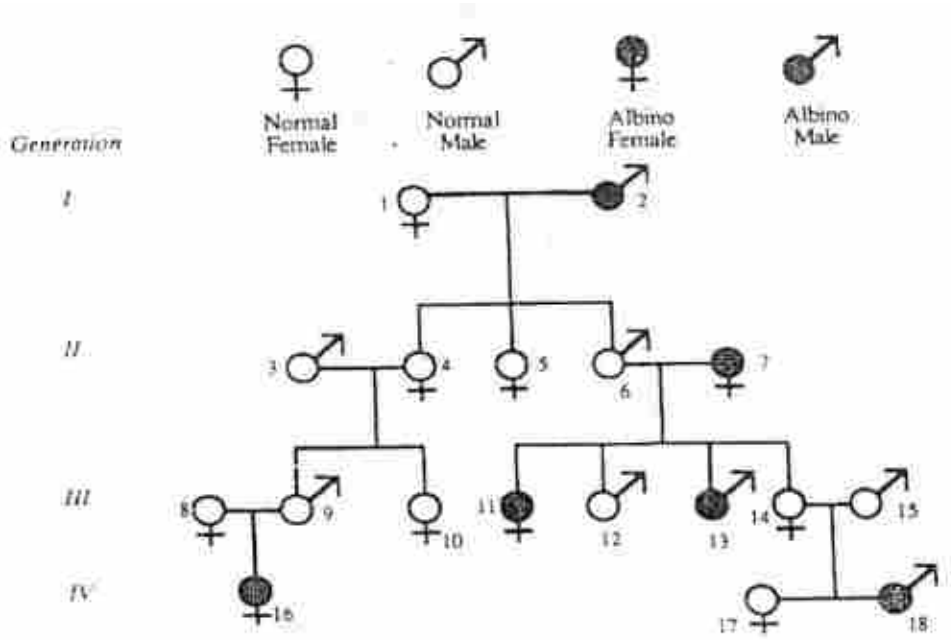


Fig. 4.1

(a) Skin colour is determined by an autosomal gene. Individuals who are not albino possess allele A which codes for an enzyme that synthesizes pigment. Allele a, on the other hand, codes for a non-functional enzyme.

What are all the possible genotypes of the following members of the family tree? [1]

individual 3 in generation II: _____ (**Aa, AA**)

individual 14 in generation III: _____ (**Aa**)

(b) The same family was also tested for colour blindness, a recessive sex-linked condition.

Individual 12 from generation III married a female with the same genotype as him at the A/a gene locus. Both of them are not colour blind, but one of their child is colour blind. Use a genetic diagram to show the offspring phenotypic ratio of the mating between two such individuals.

Let X^B represent the X chromosome with the dominant B allele for normal colour vision.
Let X^B represent the X chromosome with the dominant B allele for red-green colour blindness.

Let X^B represent the X chromosome with the dominant B allele for normal colour vision.
Let X^B represent the X chromosome with the dominant B allele for red-green colour blindness.

Parental phenotype	Normal pigmentation, normal colour vision female	x	Normal pigmentation, normal colour vision male	1m
Parental genotype	AaX^BX^b		AaX^BY	
Gametes	AX^B AX^b aX^B aX^b	x	AX^B AY aX^B aY	1m

For Examiner's Use

Fertilisation	Gametes	AX^B	AX^b	aX^B	aX^b	1m
	AX^B	AAX^BX^B normal pigmentation, normal colour vision female	AAX^BX^b normal pigmentation, normal colour vision female	AaX^BX^B normal pigmentation, normal colour vision female	AaX^BX^b normal pigmentation, normal colour vision female	
	aX^B	AaX^BX^B normal pigmentation, normal colour vision female	AaX^BX^b normal pigmentation, normal colour vision female	aaX^BX^B albino, normal colour vision female	aaX^BX^b albino, normal colour vision female	
	AY	AAX^BY normal pigmentation, normal colour vision male	AAX^bY normal pigmentation, colour blind male	AaX^BY normal pigmentation, normal colour vision male	AaX^bY normal pigmentation, colour blind male	
	aY	AaX^BY normal pigmentation, normal colour vision male	AaX^bY normal pigmentation, colour blind male	aaX^BY albino, normal colour vision male	aaX^bY albino, colour blind male	

Offspring genotypic ratio	6 A_X^B_ :	2 aa X^B_ :	3 A_ X^BY :	3 A_ X^bY :	1aa X^BY :	1aa X^bY	1m
Offspring phenotypic ratio	6 normal pigmentation, normal colour vision female :	2 albino, normal colour vision female :	3 normal pigmentation, normal colour vision male :	3 normal pigmentation, colour blind male :	1 albino normal colour vision male :	1 albino colour blind male	

[Total: 5m]

For Examiner's Use

5 A student carried out an investigation on yeast respiration using the following setup shown in Fig. 5.1. She put 5 grams of yeast into a glucose solution and put a layer of oil on top of the mixture. This layer of oil is impermeable to oxygen but not to carbon dioxide. The total volume of gas was recorded every 10 minutes for 1 hour and the results are shown in Table 5.1.

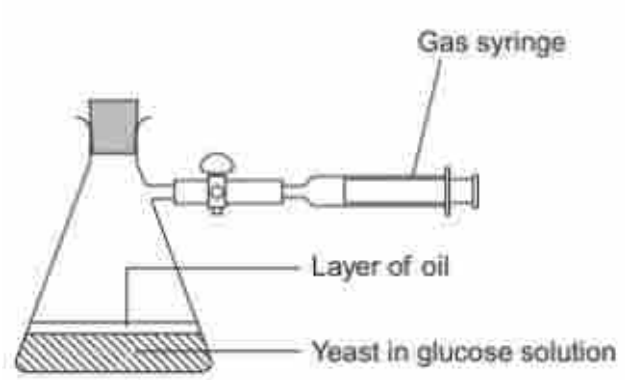


Fig. 5.1

Table 5.1

Time / minutes	Total volume of gas collected / cm^3
10	0.3
20	0.9
30	1.9
40	3.1
50	5.0
60	5.2

(a) **(i)** Calculate the rate of gas production in $cm^3\ g^{-1}\ min^{-1}$ during the first 40 minutes of this investigation. Show your working clearly. [1]

Answer = ... $cm^3\ g^{-1}\ min^{-1}$

3.1 cm^3 / 5g / 40min = 0.0155 OR 0.016

For Examiner's Use

(ii) Suggest why the rate of gas production decreased between 50 and 60 minutes.

.....

.....[1]

1. **Glucose becomes a limiting factor;**
   OR
2. **increase in ethanol / toxins build up causing yeast/cells to die;**
   (Note: ethanol disrupts yeast cell membrane causing cell death)

(b) The Respiratory Quotient (RQ) is defined as the ratio of carbon dioxide produced to oxygen consumed per unit time by an organism and the formula is as follows:

$$RQ = \frac{\text{volume of } CO_2 \text{ produced}}{\text{volume of } O_2 \text{ consumed}} \text{ per unit time}$$

Given that the rate of carbon dioxide produced equals to the rate of oxygen used for aerobic respiration, suggest and explain the RQ value for the setup shown in Fig. 6.1.

.....

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.....[2]

1. RQ value **more than 1** / **higher** than RQ value for aerobic respiration;
2. **Oxygen** is **not consumed** during **anaerobic respiration** but **carbon dioxide** is **evolved** during **alcohol fermentation** by yeast;

(c) To show that the presence of oil has an effect on yeast respiration, the student also created another similar setup as the one shown in Fig. 6.1. All variables were kept constant in this second setup except that no oil was used.

Explain if there is any the difference in the amount of ATP produced between both setups.

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.....[3]

1. **With oil: only 2 net ATP produced per glucose molecule, whereas without oil: 34/ 36/ 38 ATP produced per glucose molecule / about 17/ 18/ 19x more ATP produced for setup without oil as compared with setup with oil;**

2. **With oil, oxygen not present as the final electron acceptor (mark once), only glycolysis occurs to produce ATP;**
3. **without oil, oxygen is present as final electron acceptor (mark once), hence Krebs cycle and oxidative phosphorylation can occur to produce more ATP as well;**

In another experiment, the student investigated the effect of temperature on the rate of oxygen consumption of the lizard, *Sauromalus hispidus*. The body temperature of a lizard varies with environmental temperature.

Several baby lizards were fitted with small, airtight masks that covered their heads. Air was supplied inside the mask through one tube, and collected through another. The differences between oxygen concentrations in the air supplied for inhalation and the exhaled air enabled the researchers to measure the rate of oxygen consumption of the lizards.

The rate of oxygen consumption of each baby lizard was measured at different temperatures ranging from 15 °C to 40 °C and the average measurements were computed. The results are shown in Fig. 5.2.

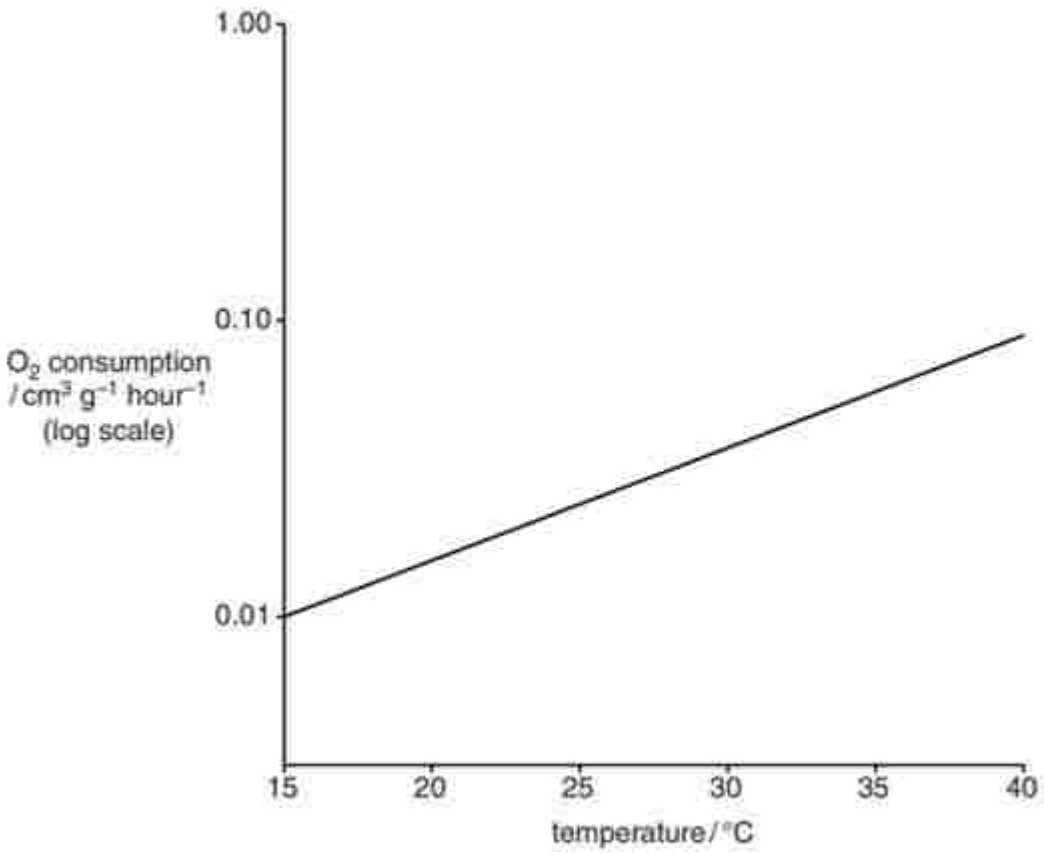

Fig. 5.2

For Examiner's Use

(d) Using Fig. 6.2, suggest and explain how temperature influences the development of baby lizards.

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.....[3]

1. **As temperature increase from 15 °C to 40 °C, the rate of oxygen consumption increased from 0.01 cm^{-3} g^{-1} $hour^{-1}$ to 0.09 cm^{-3} g^{-1} $hour^{-1}$;**
2. **because increase in temperature, increases kinetic energy of respiratory enzymes and substrates, leading to increased rate of effective collisions between enzyme and substrate / increased rate of formation of enzyme-substrate complexes;**
3. **Hence, with an increase in respiration rate, thus providing more ATP for growth, hence rate of development of baby lizards will increase;**

[Total: 10]

For Examiner's Use

6 The theory of continental drift was proposed over 90 years ago by Alfred Wegener and is now a widely accepted theory of how the continents were formed.

The supercontinent Gondwana is shown in Fig. 6.1. The land that was to form New Zealand began to break away from the supercontinent, Gondwana around 80 million years ago and broke away totally around 65 million years ago (Fig. 6.2). Ever since, New Zealand is now composed of North Island and South Island (Fig. 6.3).

The separation of New Zealand from Gondwana has led to some species like the New Zealand kiwi bird being distantly related to the rhea (South America), ostrich (Africa) and cassowary (Australia).

Fig. 6.1

Fig. 6.2

For Examiner's Use

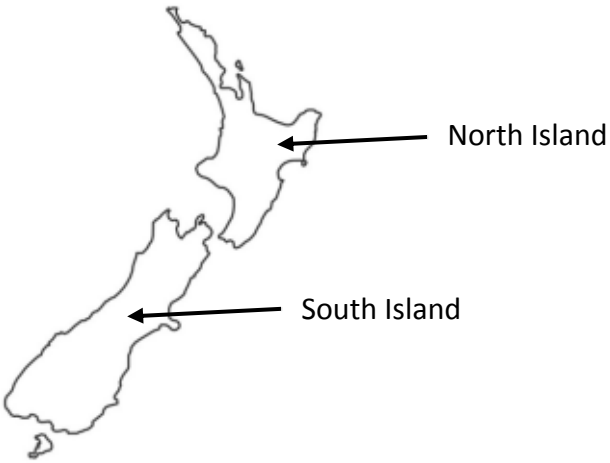

Fig. 6.3

For reasons that are not apparent, New Zealand was not inhabited by many mammals. Instead, its fauna became dominated by birds and insects. Birds became the predators, the scavengers, the herbivores and the insectivores. They lived everywhere from the highest mountains to the sea. Some have lost the ability to fly and became ground dwellers.

The kakapo, kea and kaka are parrots that are currently found in New Zealand (Fig. 6.4).

The kakapo (*Stringops habroptila*) is found only in New Zealand and is flightless. Highly endangered, they were relocated to several islands in New Zealand during the 1980s and 1990s.

The kea (*Nestor notabilis)* is the world's only alpine parrot, it can be found living near forested mountain habitats - Southern Alps on South Island. Kea are not found on North Island now.

Kaka (*Nestor meridionalis)* can be found on South Island and the sub-species of Kaka (*Nestor meridionalis septentrionalis*) is found on North Island. All Kaka live in the lowlands and mid-altitude regions.

kakapo

kea

kaka

Fig. 6.4

For Examiner's Use

(a) Suggest a possible factor causing birds like the kakapo to become flightless early in their evolutionary history.

.....

.....[1]

1. Lack of predators / mammals that hunted the kakapo for food;
2. AVP;

Fig. 6.5 shows the phylogenetic relationships between the kakapo, kea and kaka derived from mtDNA evidence, together with the geological changes that shape the landscape of New Zealand.

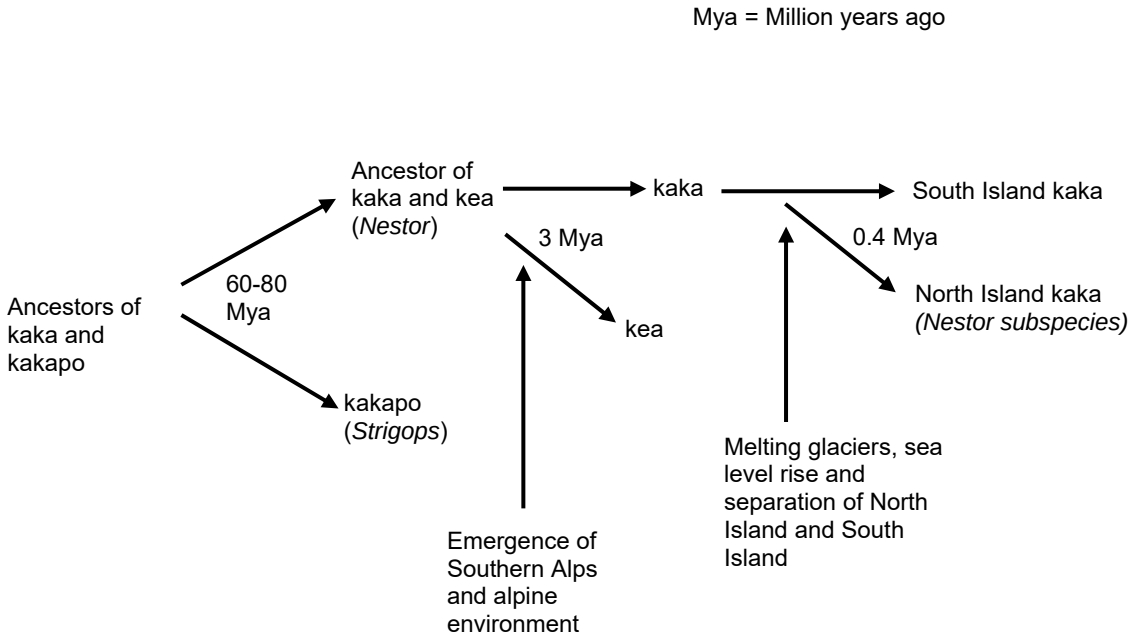

Fig. 6.5

(b) With reference to Fig. 6.5, explain the distribution and evolution of the kea.

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……[5]

1. **Emergence of Southern Alps / alpine environment, 3 million years ago, provided opportunity for a founder population / ancestors of the kea to exploit this habitat / niche;**
2. **This sub-population was exposed to a different environment with different selection pressures compared to original population;**
3. **There is existing variation in this sub-population, those birds with favourable traits / adaptations for alpine environment have a selective advantage to the local conditions and will be selected for,**
4. **and will survive, reproduce and pass on their alleles to the next generation, thus increasing the frequency of favourable alleles;**
5. **Those best adapted to alpine environment remain in the alps, thus gene flow is disrupted.**
6. **As this sub-population evolved independently from other subpopulation, / accumulated different genetic mutations, allele frequencies changed due to genetic drift and natural selection;**
7. **Over hundreds and thousands of generations, the alpine population became reproductively isolated, no longer *interbreed* to produce *viable, fertile* offspring;**

(c) With reference to Fig. 6.5, suggest a possible reason for the emergence of a sub-species of kaka on North Island.

……

……

……

……[2]

1. **North and South Island become separated due to the land being covered by sea during melting of glaciers 0.4 million years ago;**
2. **Geographical isolation and independent evolution into a sub-species occurring in isolated North island kaka sub-population;**

OR

3. **Only a sub-species because 0.4 million years ago is insufficient time for complete (WTTE) speciation / reproductive isolation to take place;**
4. **Both North and South Island kaka can interbreed and produce fertile offspring if brought together;**

[Total: 8]

For Examiner's Use

Section B

Answer either Question 7 or 8.

Write your answers for **Q7** or **Q8** on separate pieces of the answer paper provided.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

7 **(a)** Discuss the importance of shapes fitting together in cells. [7]

1. Enzyme + substrate (max 3)
   (a) **Enzyme** has an **active site** with complementary shape to **substrate**;
   (b) enzymes are **specific** to the substrate(s) they act on; (importance)
   (c) Allows for formation of **enzyme-substrate complex** whereby **bonds** in substrate are **strained** (any of one e.g. of how activation energy can be lowered),
   (d) allowing for **activation energy** of reaction to be **lowered** such that biochemical reactions can occur in cells; (importance)
   (e) E.g. of enzyme catalysed reaction, e.g. aminoacyl-tRNA synthethase, rubisco, cytochrome c oxidase, peptidyl transferase (importance)

2. Cell transport (max 3)
   (a) **Carrier protein** has a **binding site** complementary in shape to **molecule to be transported**;
   (b) Specific carrier proteins can only bind / transport specific molecules; **(importance –idea of specificity)**
   (c) **Bind**ing of molecule to be transported to carrier protein **induces a conformational change** in carrier protein;
   (d) This allows for molecule to be **transported across cell membrane**; (importance)

   (OR pumps + ATP)

3. Protein structure (max 3)
   (a) **Haemoglobin** is composed of **four subunits**;
   (b) Each subunit is complementary in shape to a haem group and **binds to a haem group**;
   (c) When one subunit binds to an oxygen, **conformational change** results and other subunits are able to **bind oxygen** with **higher affinity** – **cooperative binding**;
   (d) Allows for **efficient loading** of haemoglobin with oxygen (cooperative binding) / **transport** of oxygen (presence of haem group); (importance)

   OR
   Polymerisation of tubulin / ribosomal subunits (or E, P, A sites)

4. **QWC** – at least **two different examples** of shapes fitting together in cells

For Examiner's Use

(b) Using named examples, describe the function of cycles in Biology. [8]

1. Krebs cycle;
   (a) **Acetyl-coA** combines with **OAA** to produce **citrate/6C compound**, followed by **regeneration of OAA**;
   (b) To result in the **continual** **production of NADH** and **$FADH_2$** via a series of redox reactions; (fn)
   (c) as well as **continual** **synthesis of ATP** via substrate-level phosphorylation; (fn)

2. Calvin cycle / light-independent reaction;
   (a) Carbon dioxide combines with RuBP / **carbon fixation**, followed by the **reduction** of **glycerate-3-phosphate** to **glyceraldehyde-3-phosphate** and then **regeneration of RuBP**;
   (b) To allow for **continual** formation of **glucose** / formation of **large amounts** of glucose;
   (c) which is used for **synthesis of ATP** via **respiration** / for building of cellular components such as **cellulose cell wall**;

3. Cyclic photophosphorylation
   (a) Photo-excited **electrons** from **PS I** are transferred to the **ETC** before returning to PS I;
   (b) Allows for the **synthesis of ATP** via **chemiosmosis** for **Calvin cycle** to **continue**;

4. Electron transport
   (a) **Cyclical reduction** of **NAD, FAD** / **electron carriers of ETC**, and **oxidation** of **NADH, $FADH_2$** and **reduced electron carriers of ETC**; (must have)
   (b) To allow for **continual oxidation** of respiratory substrate **glucose**, for the **synthesis of ATP**; (fn)
   OR
   (c) **Cyclical reduction** of **$NADP^+$** and **oxidation** of **NADPH**; (must have)
   (d) To allow for **light-dependent reaction / Calvin cycle** to **continue** to produce **glucose**; (fn)

5. Mitotic cell cycle;
   (a) Involves **interphase** followed by **mitosis** then **cytokinesis**;
   (b) **DNA is replicated** during **S phase of interphase**, doubling the amount of DNA for cell division;
   (c) **Sister chromatids separate** during **anaphase** of **mitosis**, **DNA amount** is **halved** after **cytokinesis**; (Note: mark only once for "mitosis" in point a or c)
   (d) Results in production of **genetically identical** daughter cells, for **growth** / **asexual reproduction**;

OR

6. Meiotic cell cycle
   (a) Involves **interphase** followed by **2 rounds of meiotic / reduction division**;
   (b) At the end of **meiosis I**, **haploid** condition is attained;
   (c) During **fertilisation**, **fusion** of haploid **gametes** restores the **diploid condition**;
   (d) Allowing for **chromosome number** to be **maintained from generation to generation**;

7. **QWC** – at least **two to three** different cycles

For Examiner's Use

8 (a) Using examples, discuss the importance of movement in cellular processes. [7]

1. Movement of chromosomes during mitosis / meiosis
   (a) During **metaphase** of **mitosis**, **chromosomes** align singly along the **metaphase plate**;
   (b) Following which, during **anaphase** of **mitosis**, centromeres divide and **sister chromatids separate**, each becoming a **chromosome** and are **pulled to opposite poles**;
   (c) The proper separation allows the formation of **genetically identical cells** at the end of mitosis; (importance)

2. Transport processes (simple diffusion / facilitated diffusion / active transport)
   (a) When **electrons** move down the **ETC**, **energy released** is used to **pump protons** from **mitochondrial matrix** into **intermembrane space** / across **inner mitochondrial membrane**;
   OR
   When **electrons** move down the **ETC**, **energy released** is used to **pump protons** from **stroma** into **thylakoid space** / across **thylakoid membrane**;
   (b) During **chemiosmosis**, **protons** **move** from **intermembrane space** to **mitochondrial matrix** / across **inner mitochondrial membrane** through **ATP synthase**;
   OR
   During **chemiosmosis**, **protons** **move** from **thylakoid space** to **stroma** through **ATP synthase** / across **thylakoid membrane**;
   (c) allowing ATP synthase to **synthesise ATP**; (importance)

3. Electron transport during respiration / photosynthesis
   (a) **Electrons** move down the **electron transport chain** during **oxidative phosphorylation**;
   (b) This allows a **large amount of ATP** to be **synthesised per glucose molecule**; (importance)
   (c) **Electrons** also move down the **electron transport chain** during **photophosphorylation**;
   (d) This allows for **ATP** and **NADPH** to be synthesised for **Calvin cycle** to proceed; (importance)

4. DNA replication / transcription / translation (reading of template, directionality)
   (a) **Enzyme** has an
   (b) ;

5. QWC – at least **2 to 3** examples;

   NOTE: max 3m if no importance highlighted in answer throughout;

For Examiner's Use

(b) Polymers have different structures and functions. Describe how such structures are related to functions. [8]

1. Storage molecules (ctrl of blood glucose, **starch**)
   - **(a)** **Starch** is made up of **many** **α glucose** joined together by **α (1, 4) glycosidic bonds**;
   - **(b)** Starch is **large** and therefore **insoluble in water**, and **does not affect the water potential** of cells;
   - **(c)** Amylose is **helical** which makes starch a **compact** molecule
     OR
     Amylopectin is **helical** and **branched**, making it a **compact** molecule;
   - **(d)** Amylopectin has **many branch points** where **amylase** can act on to **release glucose quickly**;
   - **(e)** Starch is therefore a good **storage** molecule;

2. Structural molecules (**cellulose**)
   - **(a)** **Cellulose** made up of **many** **β glucose** joined together by **β(1, 4) glycosidic bonds**;
   - **(b)** Each **β glucose** is **inverted 180° with respect to one another**, giving rise to **linear/straight** cellulose chain;
   - **(c)** **Intermolecular H-bonds** form between –OH groups that project out of each cellulose chain, forming **fibrils**;
   - **(d)** **Fibrils** associate to form **fibres**, giving rise to **high tensile strength** of cellulose;
   - **(e)** **Intermolecular H-bonds** form between **–OH groups** that project out of each cellulose chain, thus **unable to form H-bonds with water**, making it **insoluble in water**;
   - **(f)** The **large** size of cellulose also makes it **insoluble in water**;
   - **(g)** Cellulose is therefore a good **structural** molecule;

3. Informational molecules (**enzymes**, **RNA, DNA**)
   - **(a)** **Enzymes** are made up of **a specific number and sequence of amino acids** joined together by **peptide bonds**;
   - **(b)** Amino acids with **hydrophobic R groups** are buried in the **interior** while amino acids with **hydrophilic R groups** are exposed on the **exterior** of enzymes;
   - **(c)** giving rise to a **globular** enzyme which is **soluble in water**;
   - **(d)** **H-bonds**, **hydrophobic interactions**, **ionic bonds** and disulfide bonds form between **R groups** of amino acids,
   - **(e)** giving rise to a **specific** 3D **conformation** of **active site** which can only **bind** to **specific substrates** / catalyse **specific reactions** in the cell;
   - **(f)** **DNA** strand is made up of a specific sequence of **nucleotides** joined together by **phosphodiester bond**;
   - **(g)** DNA contains **genes** which code for specific **proteins**;
   - **(h)** Presence of **H-bonds** between **complementary base pairs** in a **double stranded** DNA molecule gives rise to a **stable** molecule;
   - **(i)** **Doubled stranded** nature of DNA allows one strand to serve as a **backup strand** for **DNA repair**;
   - **(j)** Both strands of DNA serve as **templates** for the synthesis of **complementary** DNA strand, giving rise to **identical daughter DNA molecules** via semi-conservative DNA replication;
   - **(k)** This makes DNA a good **storage** molecule of **genetic information**;

4. **QWC** – at least two named examples.

Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H1 BIOLOGY

8876/01

Paper 1 Multiple Choice Questions **25 September 2018**

1 hour

Additional Material: OTAS sheet

INSTRUCTIONS TO CANDIDATES:

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE TOLD TO DO SO.

READ THESE NOTES CAREFULLY.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

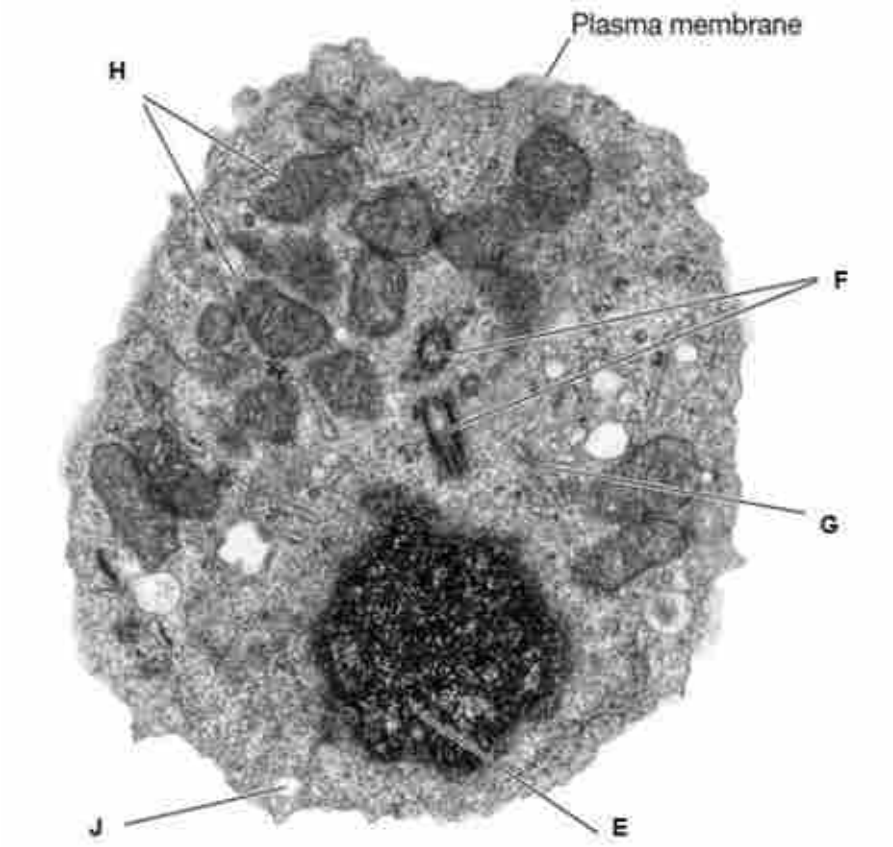
Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This document consists of **25** printed pages and 1 blank page.

[Turn over

Multiple Choice Questions (30 marks)
Answer **all** questions in this section.

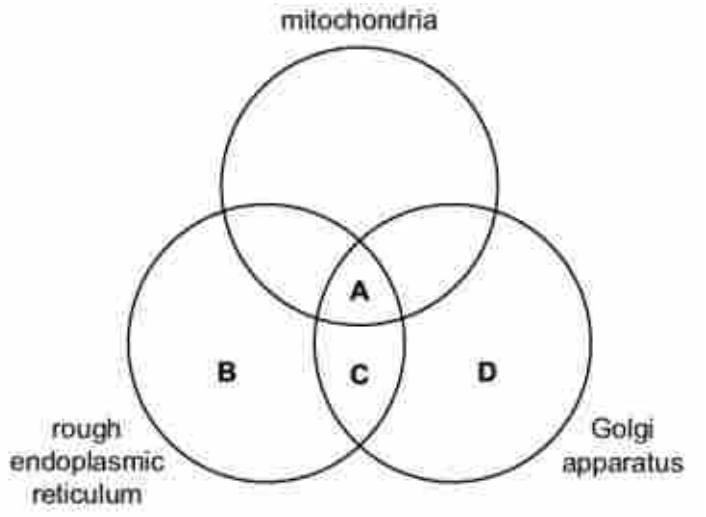
1 An electron micrograph of a cell is shown below.



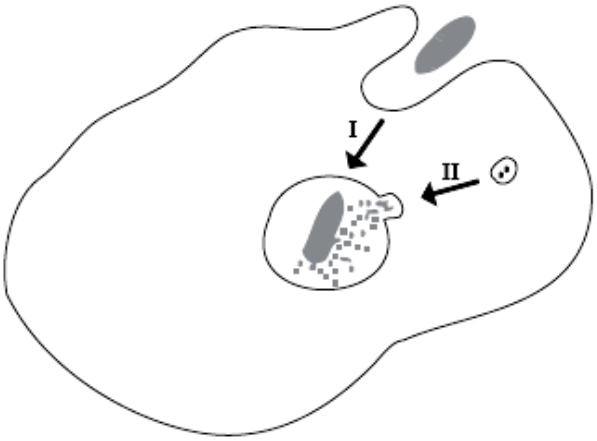
Match the organelles **E, F, G, H** and **J** associated with the cellular processes listed.

	E	F	G	H	J
A	DNA replication	Digestion of material	Organizes the spindle	Oxidative phosphorylation	Packaging of secretory products
B	Oxidative phosphorylation	Organizes the spindle	Digestion of material	DNA replication	Packaging of secretory products
C	Organizes the spindle	Digestion of material	Oxidative phosphorylation	Packaging of secretory products	DNA replication
D	DNA replication	Organizes the spindle	Packaging of secretory products	Oxidative phosphorylation	Digestion of material

2 Which organelle(s) is / are required for the formation of the hydrolytic enzymes found in lysosomes?

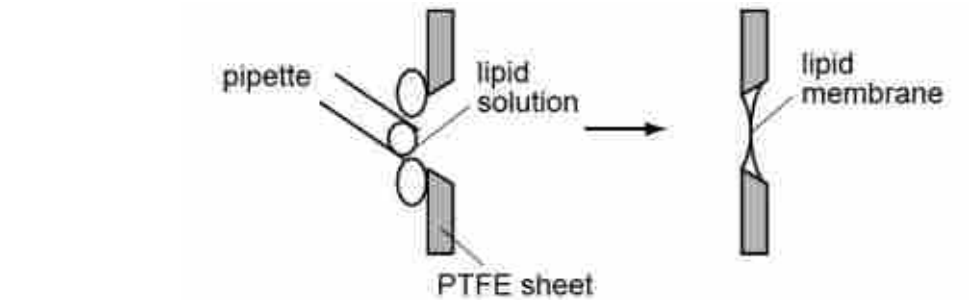


3 Which processes are represented by the labels in the diagram below?



	I	II
A	A phagocyte ingesting a microbe by exocytosis	Digestion of the microbe with the help of the Golgi apparatus
B	A phagocyte ingesting a microbe by endocytosis	Digestion of the microbe with the help of the lysosome
C	A phagocyte ingesting a microbe by exocytosis	Digestion of the microbe with the help of the lysosome
D	A phagocyte ingesting a microbe by endocytosis	Digestion of the microbe with the help of the Golgi apparatus

4 Lipid membranes can be formed in the laboratory by painting phospholipids over a support (PTFE sheet) with a hole in it.



Such a lipid membrane is impermeable to water-soluble materials including charged ions such as Na^+ or K^+. In one experiment with Na^+ ions, no current flowed across the membrane until a substance called gramicidin was added.

Which statement is consistent with this information and your knowledge of membrane structure?

Gramicidin becomes incorporated into the membrane and is _____.

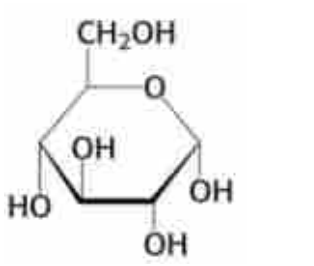
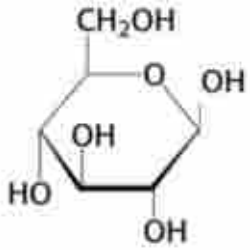
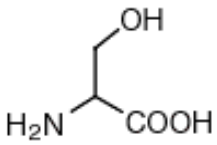
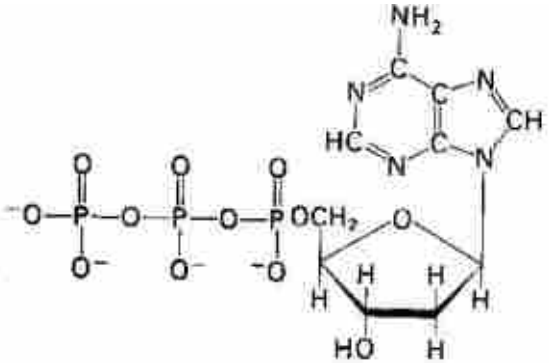
A a carbohydrate molecule found only on the outside of the membrane.

B a non-polar lipid which passes all the way through the membrane.

C a protein molecule with both hydrophilic and hydrophobic regions.

D a protein molecule which has only hydrophobic regions.

5 The diagram below shows the structure of 4 monomers.

 **U**	 **X**
 **Y**	 **Z**

Which of the following combination of polymer, monomer and bond formed between monomers is ***CORRECT***?

	starch	***cellulose***	***polypeptide***	***polynucleotide***
A	**X**, β-1,4 glycosidic bond	**U**, α-1,4 glycosidic bond	**Z**, ester linkage	**Y**, disulphide linkage
B	**U**, α-1,4 glycosidic bond	**X**, β-1,4 glycosidic bond	**Y**, peptide bond	**Z**, phosphoester linkage
C	**Z**, peptide bond	**X**, hydrogen bond	**Y**, ionic bond	**U**, hydrogen bond
D	**X**, ionic bonds	**Y**, peptide bond	**U**, hydrogen bond	**Z**, α-1,6 glycosidic bond

6 Which of the following is / are ***TRUE*** of triglycerides and phospholipids?

1 Both contain glycerol.

2 Both are not amphipathic.

3 Triglycerides have a higher carbon content than phospholipids for storage purposes.

4 Phospholipids have hydrophilic regions to interact with cell cytoplasm unlike triglycerides.

5 Triglycerides are formed from glycerol and fatty acids but phospholipids are formed from glycerol and phosphoric acid only.

A 1, 3 and 5

B 1, 2 and 3

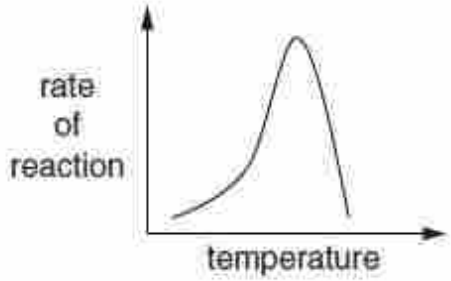
C 1, 3 and 4

D 2, 3 and 4

7 Which set of statements correctly describes haemoglobin?

A	Four polypeptide chains, each containing a prosthetic group	Iron ions can associate with oxygen forming oxyhaemoglobin	In each chain, hydrophobic R groups of amino acids point towards the centre of the molecule	At 50% saturation, two oxygen molecules are transported by the molecule
B	Polypeptide chains interact to produce a globular chain	Each chain contains a prosthetic group of amino acids surrounding an iron ion	Two identical alpha chains and two identical beta chains	Each chain can transport an oxygen molecule
C	Polypeptide chains interact to produce an almost spherical molecule	An iron ion is present within each haem group	Quaternary structure of two alpha chains and two beta chains	Each molecule can transport a total of four oxygen atoms
D	Polypeptide chains produce a loose helical shape, which curls to form a spherical molecule	Iron ions in the molecule can bind reversibly with oxygen	In each chain, hydrophobic R groups of amino acids surround the iron ion	Each molecule can transport a total of eight oxygen atoms

8 The graph below shows how the rate of an enzyme reaction varies with temperature.



Which ***TWO*** statements, taken together, explain why the graph has this shape?

I Enzymes speed up reactions.

II Increasing temperature increases the effective collisions between enzyme and substrate.

III The optimum temperature is the only temperature at which the enzyme works.

IV At high temperatures the enzyme is denatured.

V At high temperatures the rate of reaction falls sharply.

A **I** and **IV**

B **III** and **IV**

C **II** and **IV**

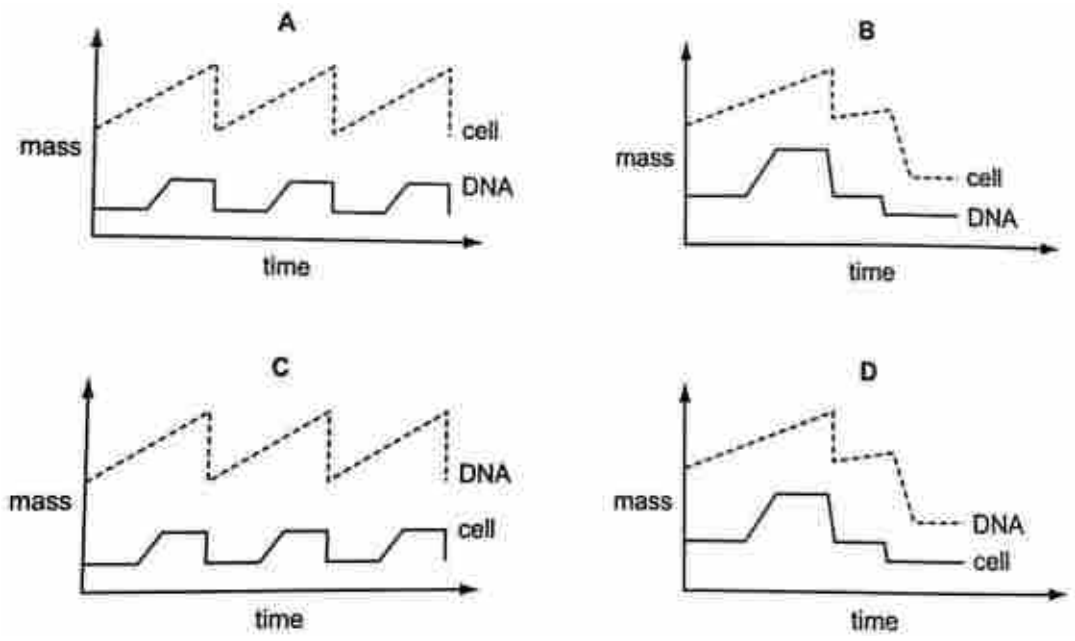
D **II** and **V**

9 What are the conditions in a human cell just before the cell enters prophase?

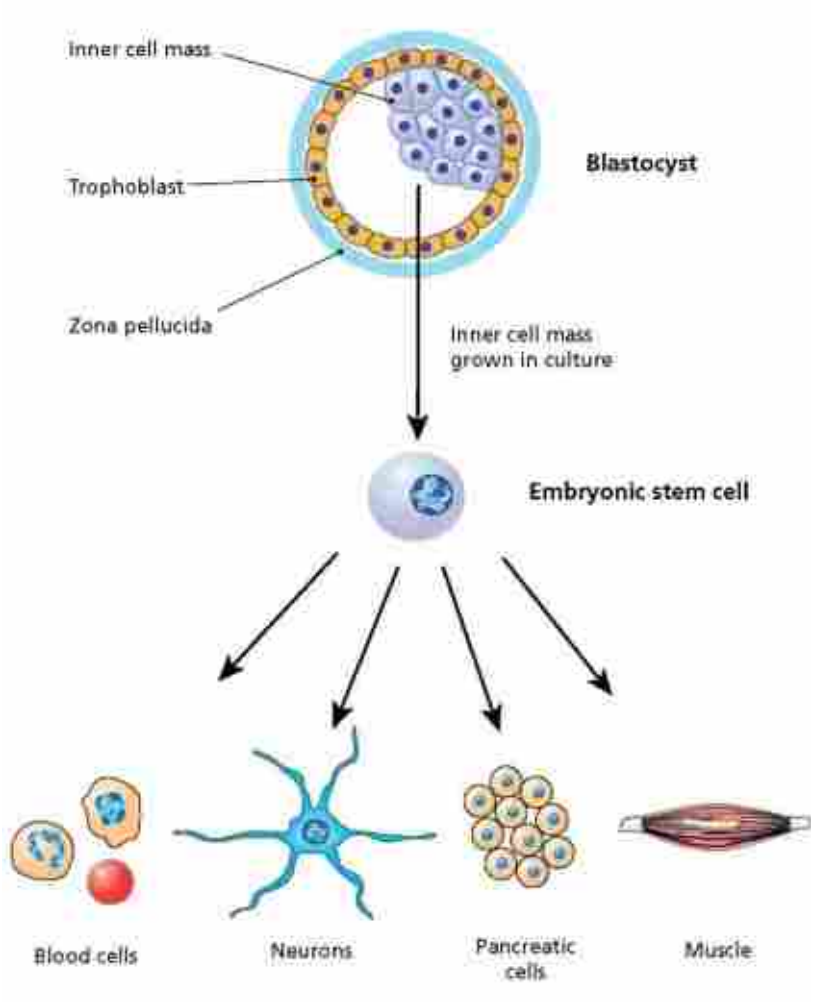
	number of chromatids	**number of molecules of DNA in nucleus**	**spindle present**	**nuclear envelope present**
A	46	46	yes	no
B	92	46	no	no
C	46	92	yes	yes
D	92	92	no	yes

10 Cell division is the means of almost all growth and reproduction.

Which graph correctly represents a form of cell division that maintains genetic stability at expense of variation?



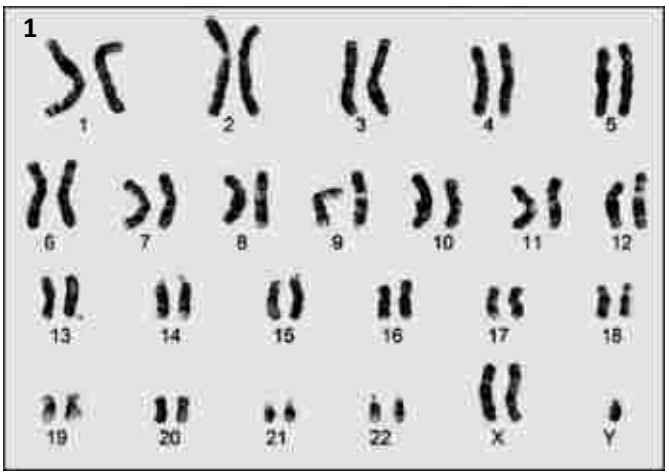
11 Which of the following features of the embryonic stem cells and specialized cells shown in the diagram are ***TRUE***?



	Embryonic stem cells	**Specialized cells**
A	Embryonic stem cells display greater plasticity when grown in culture than when in blastocyst.	The blood cells are genetically different from the embryonic stem cells but have shorter telomeres.
B	Embryonic stem cells are totipotent and are capable of differentiating into many different cell types.	The pancreatic cells are genetically identical to the embryonic stem cells but with a different set of genes expressed.
C	Embryonic stem cells are multipotent and are capable of differentiating into limited range of cell types.	The blood cells are genetically different from the embryonic stem cells because different genes are expressed.
D	Embryonic stem cells are pluripotent and are capable of differentiating into many different cells types.	The pancreatic cells are genetically identical to the embryonic stem cells but have shorter telomeres.

12 Which of the following diagrams, **1** – **3**, shows gene mutation?

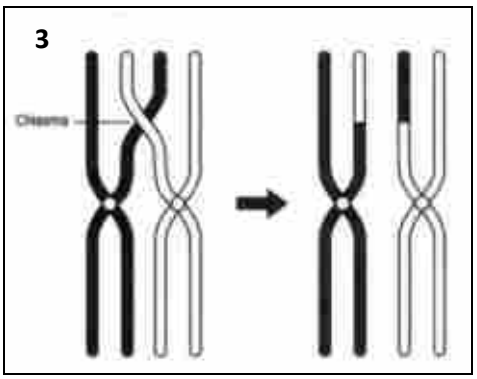
1



2

Normal allele	...A C T C C T G A G G A G...
Mutated allele	...A C T C C T G T G G A G...

3



A 2 only

B 3 only

C 2 and 3

D 1, 2 and 3

13 Two genes involved in coat colour of goats are at loci on different chromosomes.

The colour gene C causes the hairs to have uniform colour and has three alleles.

- C^{DB} giving dark brown hairs
- C^{B} giving black hairs
- C^{MB} giving medium brown hairs

A dominant allele of the agouti gene (A^{G}) causes the development of white hairs between the coloured hairs giving the coat a shaded appearance.

The table shows the results of crosses between a male goat and two female goats.

parents	**offspring**
black agouti male x uniformly dark brown female	50% uniform, 50% agouti; 50% dark brown, 50% black
black agouti male x medium brown agouti female	all agouti; 50% black, 50% medium brown

Which row shows the possible genotypes of the male and female goats?

	black agouti male	uniformly dark brown female	medium brown agouti female
A	$C^{B}C^{MB}A^{G}A^{G}$	$C^{B}C^{DB}A^{G}A^{g}$	$C^{MB}C^{MB}A^{G}A^{G}$
B	$C^{B}C^{MB}A^{G}A^{g}$	$C^{B}C^{DB}A^{g}A^{g}$	$C^{B}C^{MB}A^{G}A^{G}$
C	$C^{B}C^{DB}A^{G}A^{G}$	$C^{DB}C^{MB}A^{G}A^{g}$	$C^{B}C^{DB}A^{G}A^{g}$
D	$C^{B}C^{MB}A^{G}A^{g}$	$C^{B}C^{DB}A^{g}A^{g}$	$C^{MB}C^{MB}A^{G}A^{G}$

14 In rats, the allele of a gene for 'mottled' coat (M) and the recessive allele (m) for 'normal' coat are sex linked. The allele of a gene for 'long' whiskers (W) and the recessive allele (w) for 'short' whiskers are autosomal.

A male rat with a normal coat and short whiskers was mated on several occasions to the same female. The offspring showed the following phenotypes in equal proportions.

- Mottled females and males with long whiskers
- Mottle females and males with short whiskers
- Normal females and males with long whiskers
- Normal females and males with short whiskers

What are the genotypes of the parents?

A $X^{M}Yww$ and $X^{M}X^{M}WW$

B $X^{m}Yww$ and $X^{M}X^{M}Ww$

C $X^{m}Yww$ and $X^{M}X^{m}WW$

D $X^{m}Yww$ and $X^{M}X^{m}Ww$

15 Which statement(s) about RNA is / are ***CORRECT***?

1 It is less stable than DNA as it contains a ribose sugar that lacks a 2' OH group.

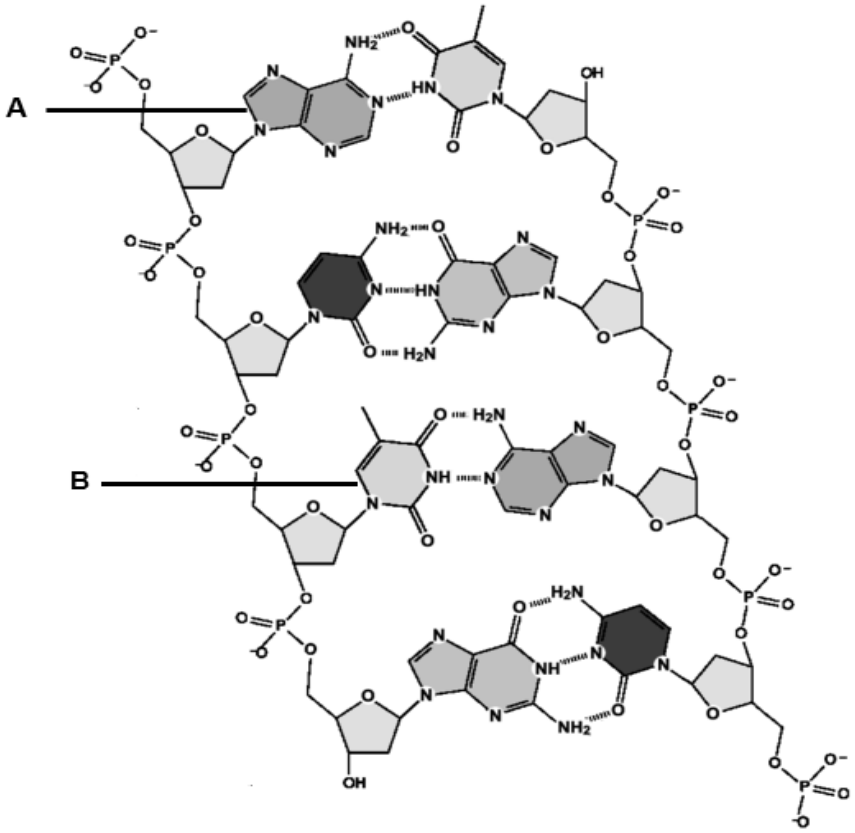
2 It is able to form double-stranded regions with some areas of base pairing.

3 It is a polymer of pyrimidine joined by phosphodiester bonds.

4 It is synthesised in the 5' to 3' direction where the 5'-phosphate group of the growing RNA strand is joined to the 3'-hydroxyl group of an incoming nucleotide.

A 2 **B** 1 and 4 **C** 2 and 3 **D** 1, 3 and 4

16 The figure below shows a DNA molecule.



Which statement(s) ***CORRECTLY*** describe the polynucleotide?

1	The structure labelled A corresponds to that of a purine, while the structure labelled B corresponds to that of a pyrimidine.
2	The antiparallel nature of DNA double helix allows phosphodiester bonds to form between the nitrogenous bases of opposite strands.
3	Width of DNA double helix is 2μm.
4	The wound DNA double helix consists of alternating major grooves and minor grooves along its axis.

A 1 only

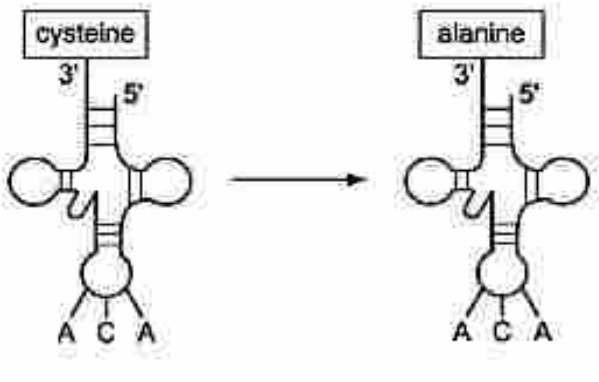
B 1 and 4 only

C 2 and 3 only

D 1, 3 and 4 only

17 Transfer RNA combined with an amino acid is called amino-acyl tRNA. It is possible to chemically convert the amino acid cysteine into the amino acid alanine whilst it is still attached to its tRNA.

The altered amino-acyl tRNA still binds to UGU triplets on messenger RNA (mRNA), but now incorporates alanine into the resulting polypeptide instead of cysteine.



Which statement is ***CORRECT***?

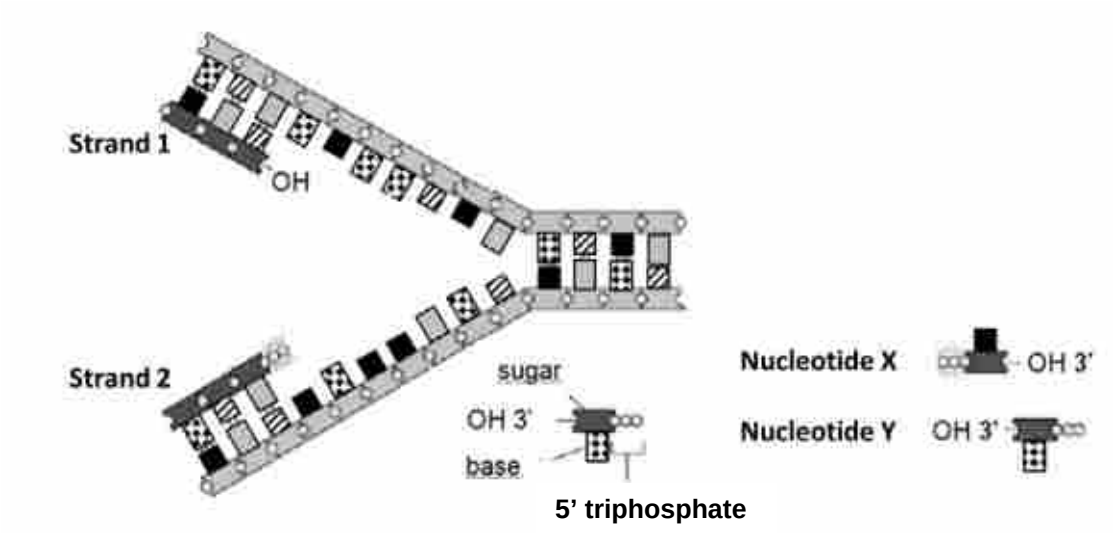
A A codon on the amino-acyl tRNA determines its specificity.

B Both the amino acid and the anticodon of an amino-acyl tRNA affect where it binds to mRNA.

C The amino acid of an amino-acyl tRNA does not influence its binding to mRNA.

D The codon-anticodon interaction is influenced by the amino acid on an amino-acyl tRNA.

18 DNA replication is illustrated in the following figure.



Which of the following correctly describes the addition of the next nucleotide(s) in the DNA strands undergoing replication?

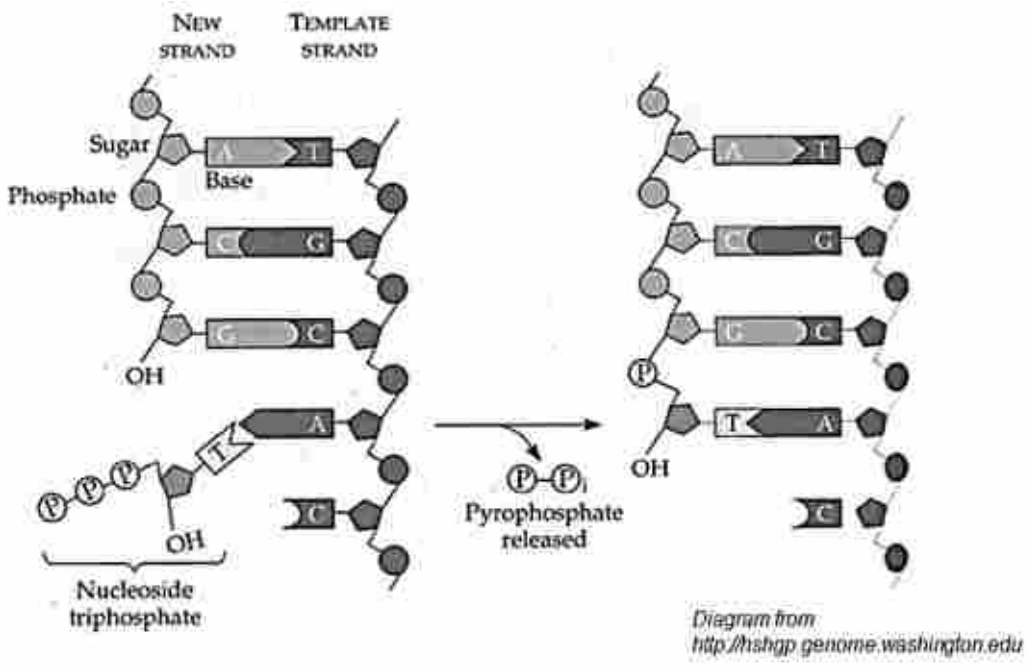
A Nucleotide **X** will be added to the leading strand, which is strand 1.

B Nucleotide **Y** will be added to the leading strand, which is strand 1.

C Nucleotide **X** will be added to the lagging strand, which is strand 1.

D Nucleotide **Y** will be added to the leading strand, which is strand 2.

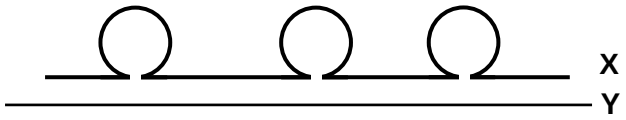
19 The diagram below shows the synthesis of a new strand of DNA during interphase.



Which of the following shows the ***CORRECT*** combination of bond(s) that need to be formed and the kind of reaction that is involved in order for the nucleotide to be added to the DNA chain?

	Bond(s) to be formed	**Reaction(s) involved**
A	Phosphodiester	Condensation and dephosphorylation
B	Phosphodiester	Condensation and hydrolysis
C	Phosphoester and hydrogen	Condensation and hydrolysis
D	Phosphoester and hydrogen	Condensation

20 The diagram below shows the result of hybridizing mature mRNA of ovalbumin to the ovalbumin gene.



Which of the following statement is ***CORRECT***?

	X	**Y**	Number of exons	Number of introns
A	Mature mRNA	DNA	3	4
B	Mature mRNA	DNA	4	3
C	DNA	Mature mRNA	3	4
D	DNA	Mature mRNA	4	3

21 The following statements illustrate the processes that occur during translation.

1 The large subunit of the ribosome binds and forms the translation initiation complex.

2 The second amino acyl-tRNA complex now binds to mRNA at the “A” site of the ribosome.

3 The small ribosomal subunit, with initiator tRNA bound, binds to the 5’ cap of the mRNA and scans for the first start codon.

4 Soluble protein called release factor recognises the stop codon and binds at the “A” site.

5 Formation of a peptide bond between the first and the second amino acids by peptidyl transferase.

6 The second amino acyl-tRNA complex moves from the “A” site to the “P” site.

Which of the following shows the ***CORRECT*** order?

A 3 → 1 → 2 → 5 → 6 → 4

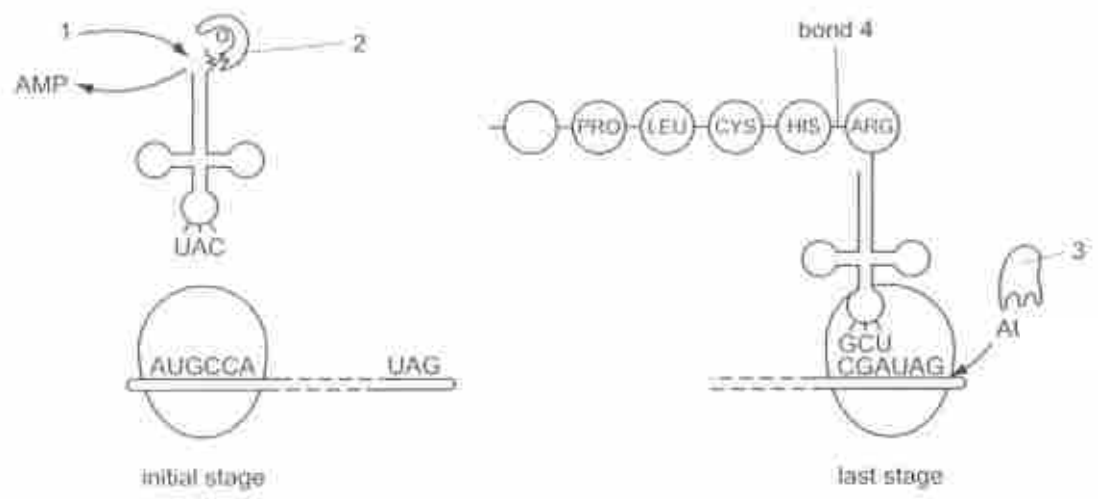
B 1 → 5 → 2 → 3 → 4 → 6

C 3 → 5 → 2 → 1 → 4 → 6

D 1 → 5 → 2 → 3 → 4 → 6

22 A number of molecules other than tRNA and mRNA are involved during translation.

The diagram below shows some of these molecules and some of the nucleotides in the codon and anticodon positions.



Which of the following ***CORRECTLY*** label 1 – 4?

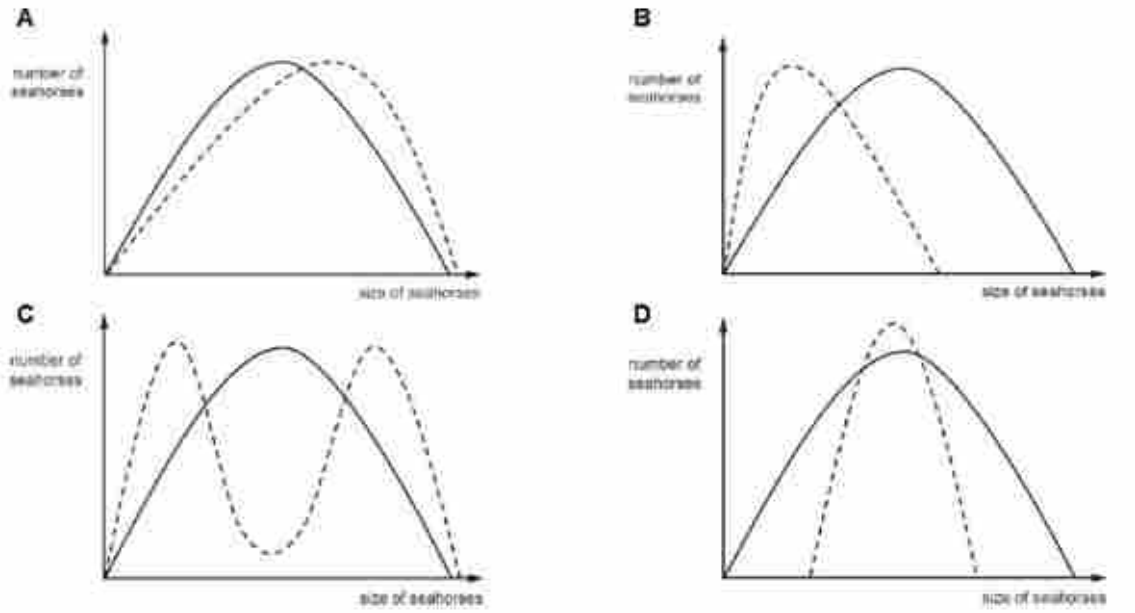
	1	2	3	4
A	ADP	Aminoacyl tRNA synthetase	Amino acid	Hydrogen bond
B	ADP	Amino acid	Translation releasing factor	Hydrogen bond
C	ATP	Amino acid	Aminoacyl tRNA	Peptide bond
D	ATP	Aminoacyl tRNA synthetase	Releasing factor	Peptide bond

23 The seahorse, *Hippocampus,* is an unusual small fish. It gives birth to live young and it is the male rather than the female that becomes pregnant.

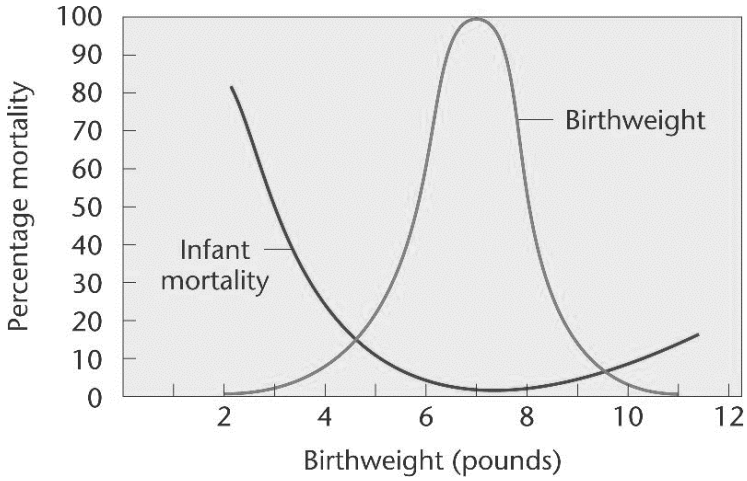
In one species of seahorse, large females within a population mate with large males and small females mate small males. Few medium-sized individuals are produced and they have a low survival rate.

Which graph shows the effect of natural selection on size of seahorses after a fixed period of time?

Legend: ━━━ Original population - - - after selection



24 The graph below shows the relationship between birthweight and infant mortality in humans.



What type of selection is demonstrated above?

A Directional selection

B Disruptive selection

C Stabilising selection

D Artificial selection

25 2,6-dichlorophenolindophenol (DCPIP) is a blue dye that can be converted to colourless reduced DCPIP by accepting electrons, as shown as follows.

In an experiment, green chloroplast extract was first mixed with DCPIP and the extract turned blue-green. After exposure to 2 hours of light in the presence of fixed volumes of carbon dioxide and water, the extract became completely green again.

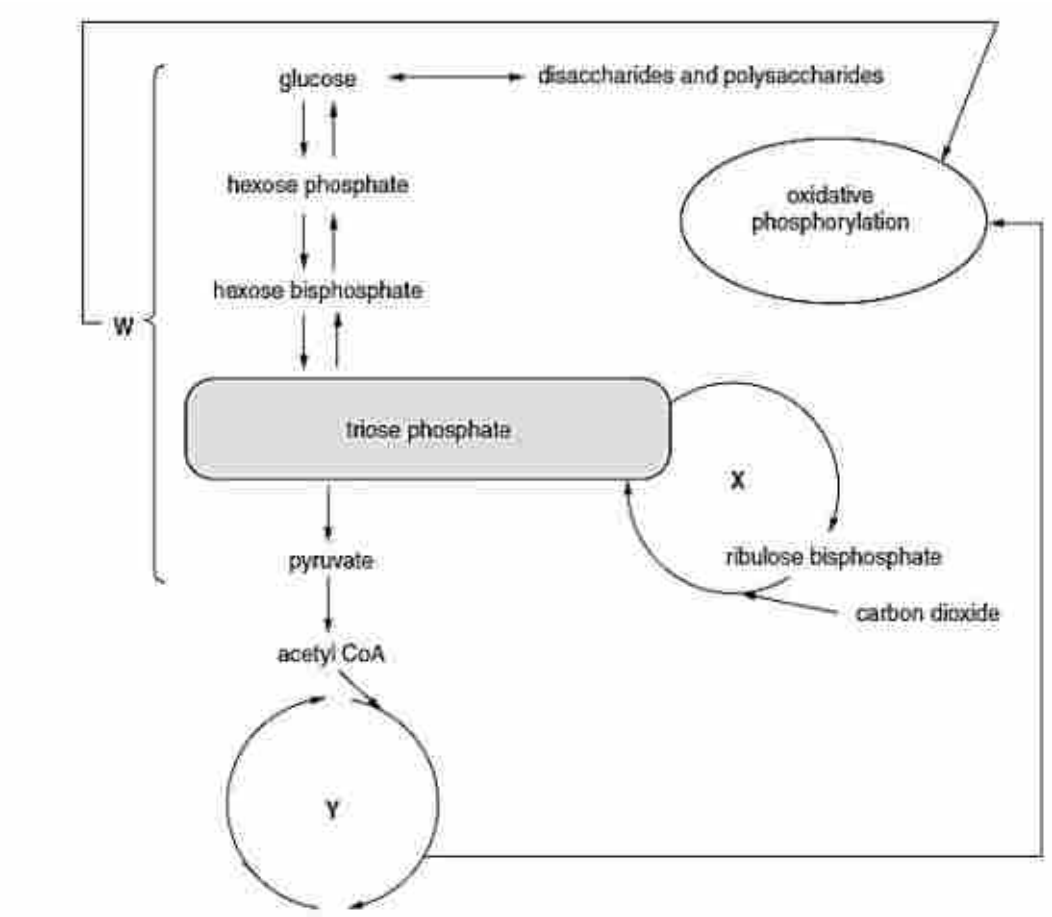
Which of the following shows a likely combination of products that was being formed towards the end of the experiment?

	O_2	ATP	reduced NADP
A	+	+	–
B	+	+	+
C	–	–	–
D	–	–	+

26 Which row shows the correct locations of some stages of aerobic respiration occurring in a eukaryotic cell?

	Link reaction	Oxidative phosphorylation
A	inner mitochondrial membrane	mitochondrial intermembrane space
B	mitochondrial matrix	inner mitochondrial membrane
C	mitochondrial matrix	mitochondrial matrix
D	outer mitochondrial membrane	inner mitochondrial membrane

27 The diagram represents some of the reactions that take place in a leaf cell.



Which statement explains why the three reaction pathways, W, X and Y, are able to work concurrently in the same leaf cell?

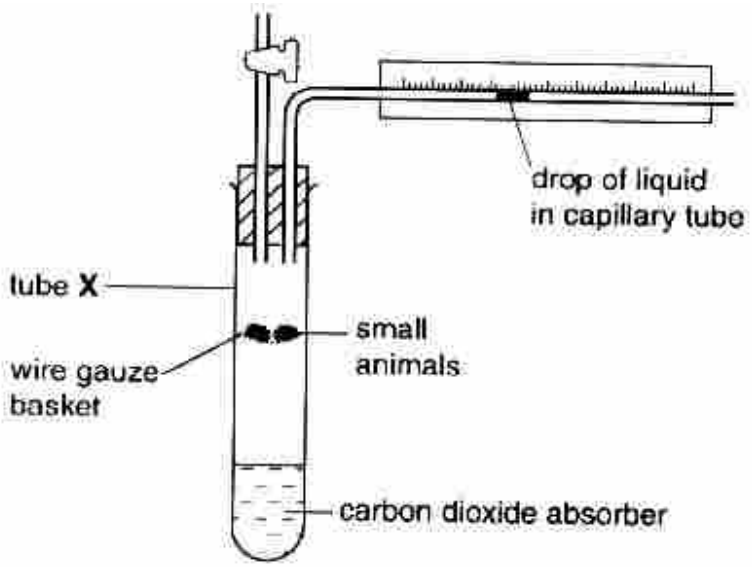
A Only X and Y can take place in the absence of oxygen.

B W, X and Y are separated by membranes, allowing for the formation of separate proton gradients to synthesise ATP.

C W, X and Y are separated by membranes, allowing for the maintenance of different conditions for enzymes to function.

D X occurs independently of light unlike W and Y.

28 The diagram shows a simple respirometer.



The changes in gas volume in the tube are measured at intervals.

Time (minutes)	Gas volume with carbon dioxide absorber (cm^3)	Gas volume without carbon dioxide absorber (cm^3)
0	0.0	0.0
10	-0.4	-0.1
20	-0.8	-0.2
30	-1.2	-0.3

Tube **X** contains 2 g of small animals.

What is the carbon dioxide output per g per hour for these organisms?

A 0.9 cm^3

B 1.8 cm^3

C 2.4 cm^3

D 4.8 cm^3

29 Rice crops in Japan are damaged by the green rice leafhopper *(Nephotettix cincticeps),* a pest that reduces crop yield.

In a study of the effect of climate change on crop damage by the green rice leafhopper, it was found that an increase in winter temperatures caused an increase in crop damage, while an increase in summer temperatures caused a decrease in crop damage.

Which of the following are possible explanations for these findings?

1 Increased temperatures in the summer disrupt metabolic reactions in pests.

2 Increased temperatures in the summer cause a rise in the pests' metabolic rate that results shorter life cycle.

3 Increased temperatures in the winter disrupt the pests' life cycle and result in fewer being able to reproduce.

4 Increased temperatures in the winter allow more pests to survive and results in an increase in the pest population.

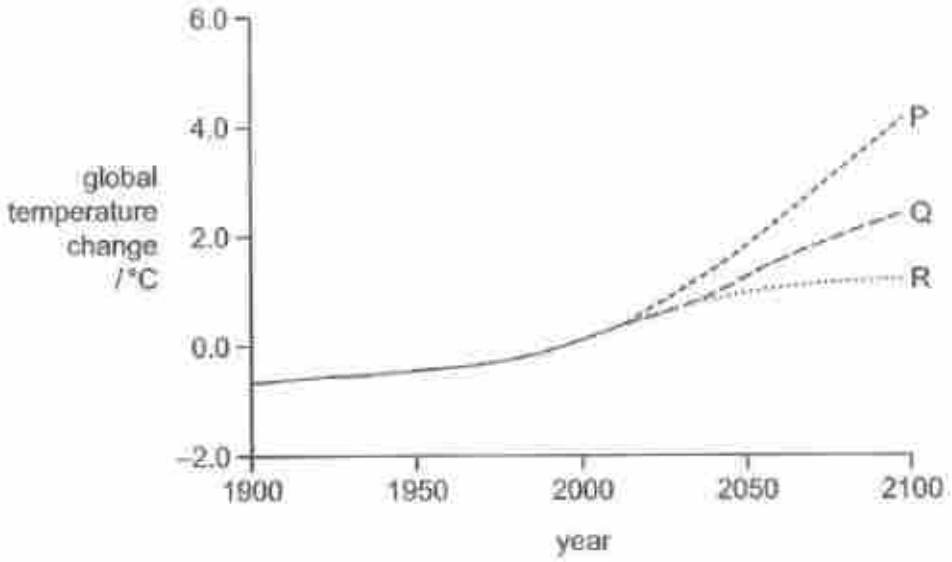
A 1 and 3 only

B 1 and 4 only

C 2 and 3 only

D 2 and 4 only

30 The graph shows the predicted change in global temperatures using three different models, P, Q and R. Model Q assumes that no new factors act to influence the rate of climate change.



The predictions of models P and R can be explained using some of the following statements.

1 Expansion of rainforest.

2 Increase in frequency of forest fires.

3 Permanently frozen soil and sediment in the Arctic begin to thaw.

4 Rising sea temperatures will reduce the solubility of greenhouse gases in the oceans.

Which of these statements support prediction of models P and R?

	Statements that support prediction P	**Statements that support prediction R**
A	2, 3 and 4	1
B	1 and 3	2 and 4
C	2	1, 3 and 4
D	3 and 4	1 and 2

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2018 Y6 Preliminary Exam H1

MCQ Answer Scheme

1	**D**	16	**B**
2	**A**	17	**C**
3	**B**	18	**A**
4	**C**	19	**D**
5	**B**	20	**D**
6	**C**	21	**A**
7	**A**	22	**D**
8	**C**	23	**C**
9	**D**	24	**C**
10	**A**	25	**A**
11	**D**	26	**B**
12	**A**	27	**C**
13	**D**	28	**A**
14	**D**	29	**B**
15	**A**	30	**A**

Name:		Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H1 BIOLOGY 8876/02

Paper 2 Structured Questions **14 September 2018**

2 hours

INSTRUCTIONS TO CANDIDATES:

DO NOT TURN THIS PAGE OVER UNTIL YOU ARE TOLD TO DO SO.

READ THESE NOTES CAREFULLY.

Answer **all** questions.

Write your answers on space provided in the Question Paper.

INFORMATION FOR CANDIDATES

Essential working must be shown.

The intended marks for questions or parts of questions are given in brackets [ ].

For Examiner's Use	
Section A	
1	**/ 10**
2	**/ 5**
3	**/ 7**
4	**/ 8**
5	**/ 6**
6	**/ 9**
Section B	
1 / 2	**/ 15**
Total [60]	

This document consists of **15** printed pages and **1** blank page.

[Turn over

For Examiner's use

Section A: Structured Questions (45 marks)

Answer **all** questions in this section.

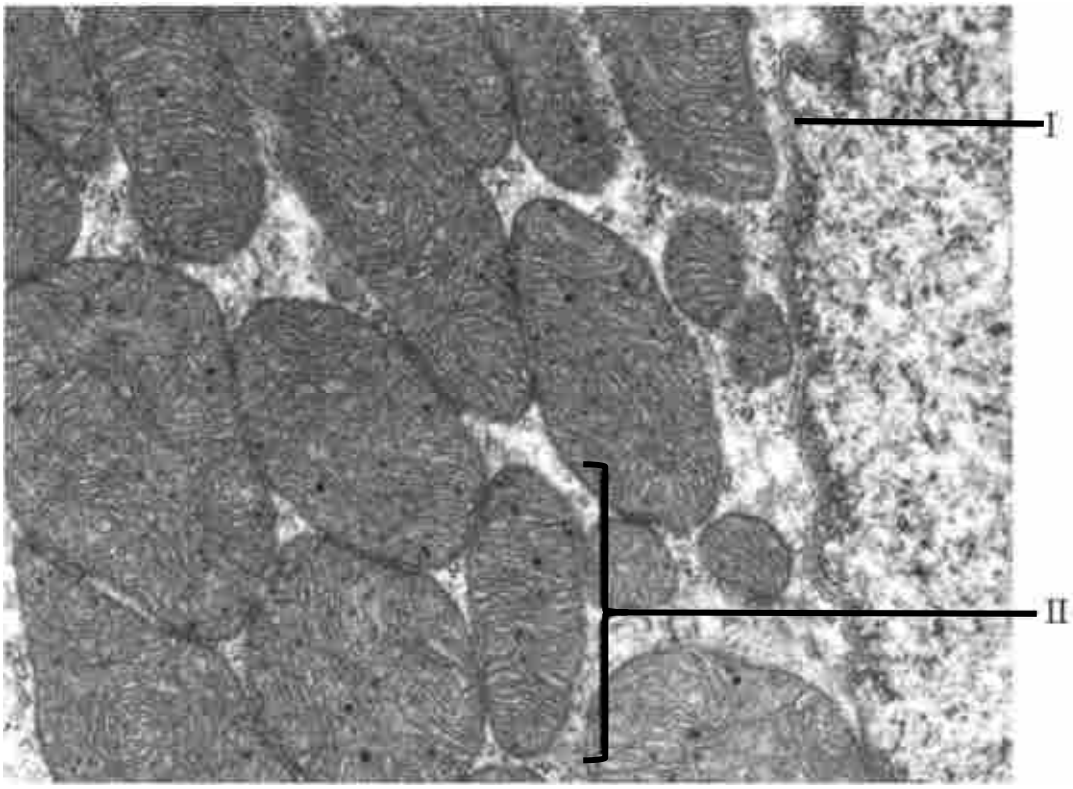
Question 1

(a) Distinguish between the terms "***resolution***" and "***magnification***". [1]

.....

.....

The electron micrograph below shows part of a cell.



(b) **(i)** Identify the structures labelled **I** and **II**. [2]

I : .....

II : .....

(ii) State one function of structure **I**. [1]

.....

.....

For Examiner's use

(iii) State one function of structure **II**. [1]

(iv) Deduce, with a reason, whether this cell is eukaryotic or prokaryotic. [1]

(c) RNAs are synthesised in nucleus and transported out into the cytoplasm for use in protein synthesis. Describe the roles of mRNA and rRNA in protein synthesis. [4]

mRNA: .....

.....

.....

.....

rRNA: .....

.....

.....

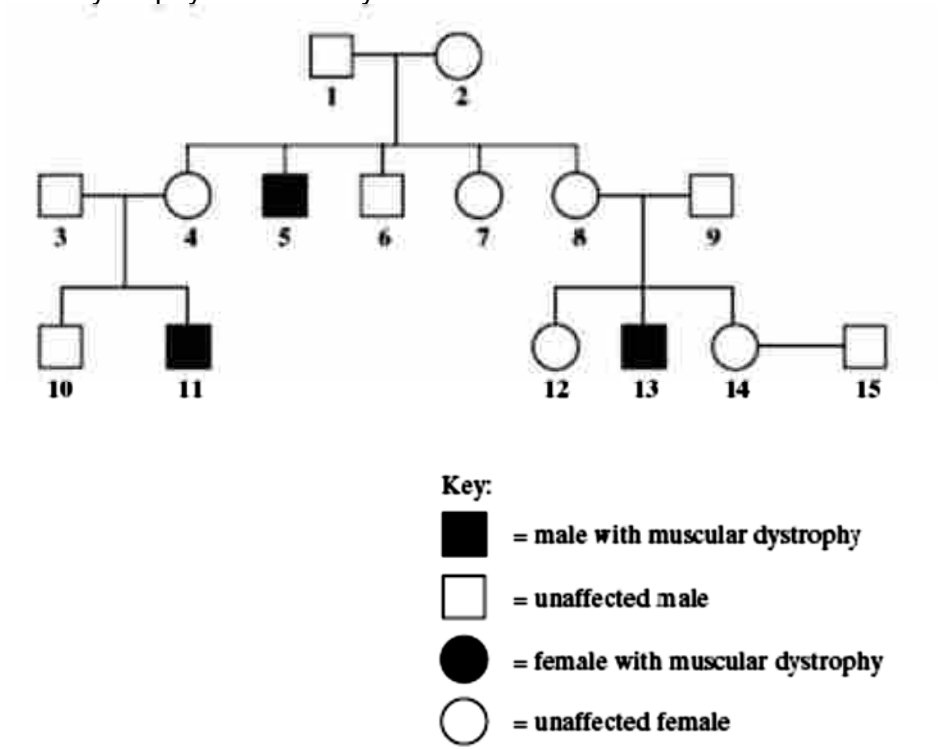
.....

Total: [10]

Question 2

For Examiner's use

Duchenne muscular dystrophy is a sex-linked inherited condition which causes degeneration of muscle tissue. It is caused by a recessive allele. The diagram shows the inheritance of muscular dystrophy in one family.



(a) Give evidence from the diagram which suggests that muscular dystrophy is:

(i) sex-linked. [1]

.....

.....

(ii) caused by a recessive allele. [1]

.....

.....

For Examiner's use

(b) Using the following symbols:

X^D= an X chromosome carrying the normal allele
X^d= an X chromosome carrying the allele for muscular dystrophy
Y = a Y chromosome

Give **ALL** the possible genotypes of each of the following persons. [2]

5:

6:

7:

8:

(c) A blood test shows that person **14** is a carrier of muscular dystrophy. Person **15** has recently married person **14** but as yet they have had no children.

What is the probability that their first child will be a male who develops muscular dystrophy? [1]

Total: [5]

Question 3

For Examiner's use

(a) The *APP* gene provides instructions for making a protein called amyloid precursor protein. This protein is found in many tissues and organs, including the brain and spinal cord. The most common mutation on the *APP* gene involves one codon being changed from GCC to GUC. Fig. 3.1 shows the genetic code.

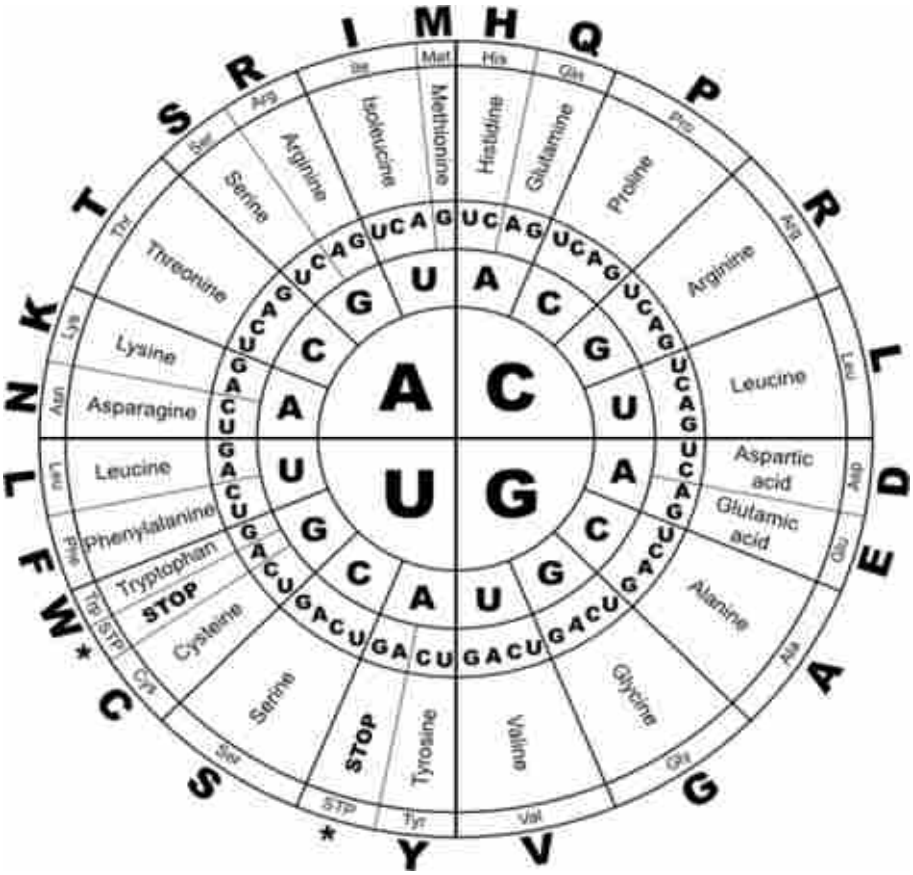


Fig. 3.1

Explain the significance of codon in translation. [3]

For Examiner's use

(b) With reference to Fig. 3.1, describe the mutation that has occurred. [2]

(c) Amyloid precursor protein is cut by enzymes to create smaller fragments, some of which are released outside the cell. Two of these fragments are called soluble amyloid precursor protein (sAPP) and amyloid beta (β) peptide. This mutation in the *APP* gene can lead to the production of a "stickier" form of the β peptide. When these protein fragments are released from the cell, they can accumulate in the brain and form clumps called amyloid plaques. These plaques are characteristic of Alzheimer disease.

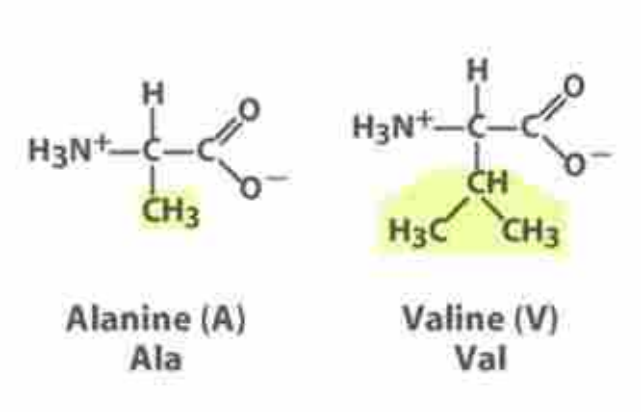


Fig. 3.2

Fig. 3.2 shows the structures of alanine and valine. Both amino acids contains non-polar R group. Suggest how a change from alanine to valine can result in a mutated amyloid precursor protein which then give rise to amyloid plaques. [2]

Total:[7]

For Examiner's use

Question 4

Dengue is the most rapidly spreading mosquito-borne viral disease in the world. In the last 50 years, incidence has increased 30-fold with increasing geographic expansion to new countries and, in the present decade, from urban to rural settings. An estimated 50 million dengue infections occur annually and approximately 2.5 billion people live in dengue endemic countries.

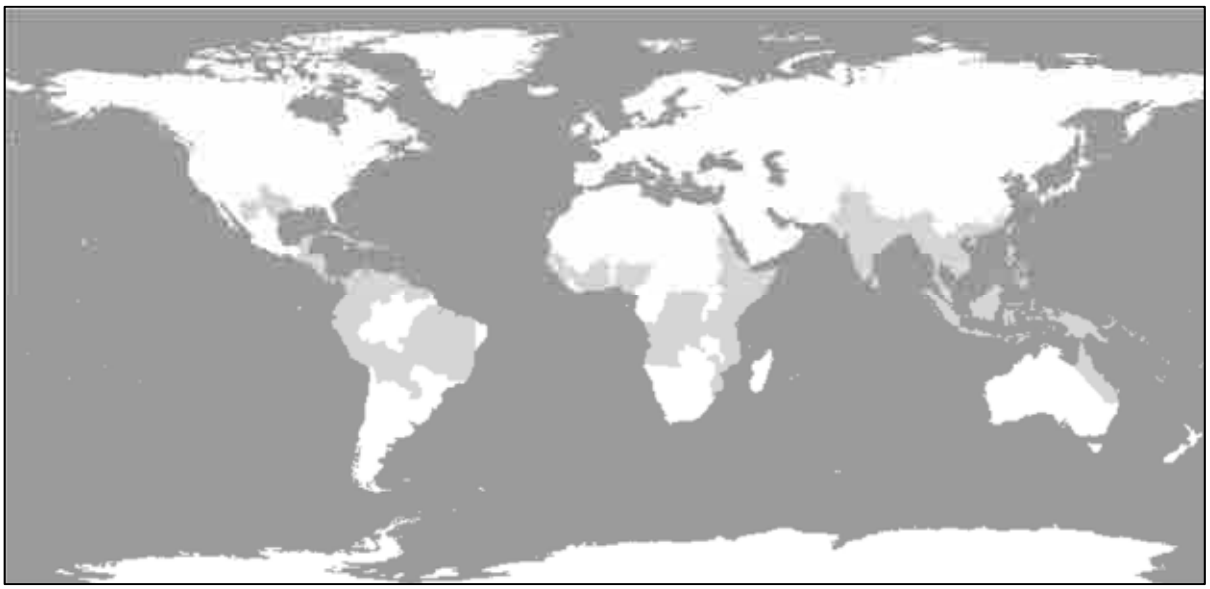


Fig. 4

Shaded areas in Fig. 4 represents countries at risk of dengue fever due to presence of Aedes mosquito, as of 2008.

(a) Outline the developmental stages in the life cycle of the Aedes mosquito. [4]

For Examiner's use

(b) Explain why the growing area of influence of dengue fever overlaps with that of the Aedes mosquito. [3]

(c) To some extent the range of the Aedes mosquito has also followed human expansion. Explain how this may be true. [1]

Total:[8]

Question 5

For Examiner's use

Cranes are large birds. One of the earliest methods of classifying cranes was based on the calls they make during the breeding season.

(a) Suggest why biologists could use calls to investigate relationships between different species of crane. [2]

The bone protein, osteocalcin, has been extracted from fossil Neanderthal skulls found in Shanidar Cave, Iraq. The skulls were estimated to be approximately 75 000 years old.

Using mass spectrometry, the amino acids of this Neanderthal osteocalcin have been sequenced. This sequence has been compared with that in osteocalcin from *Homo sapiens* and other modern primates.

The sequences of the first 20 amino acids in the primary structure of osteocalcin from this study are shown below in Fig. 5. Amino acids are represented by capital letters.

	1									10										20
Modern human	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	R	R
Neanderthal	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	R	R
Chimpanzee	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	R	R
Orang-utan	Y	L	Y	Q	W	L	G	A	P	V	P	Y	P	D	P	L	E	P	K	R
Gorilla	Y	L	Y	Q	W	L	G	A	O	V	P	Y	P	D	P	L	E	P	K	R
Monkey	Y	L	Y	Q	W	L	G	A	O	A	P	Y	P	D	P	L	E	P	K	R

Fig. 5

(b) Suggest what the data indicate about the relationships between Neanderthals and modern primates. Give reasons for your answer. [4]

Total: [6]

For Examiner's use

Question 6

The following experiment was carried out to investigate the effect of light intensity on the rate of photosynthesis of a water plant, *Elodea*.

- *Elodea* was cut into three pieces, each 10 cm long.
- Each piece of *Elodea* was placed in a glass tube, containing 0.5% sodium hydrogen carbonate solution, which was then sealed with a bung.
- Tube **A** was placed 10 cm away from a lamp.
- Tube **B** was placed 5 cm away from a lamp.
- Tube **C** was placed in a dark room.
- An oxygen sensor was used to measure the percentage of oxygen in the solutions at the start of the experiment and again at 5, 10 and 20 minutes.

The results are shown in Fig. 6.1.

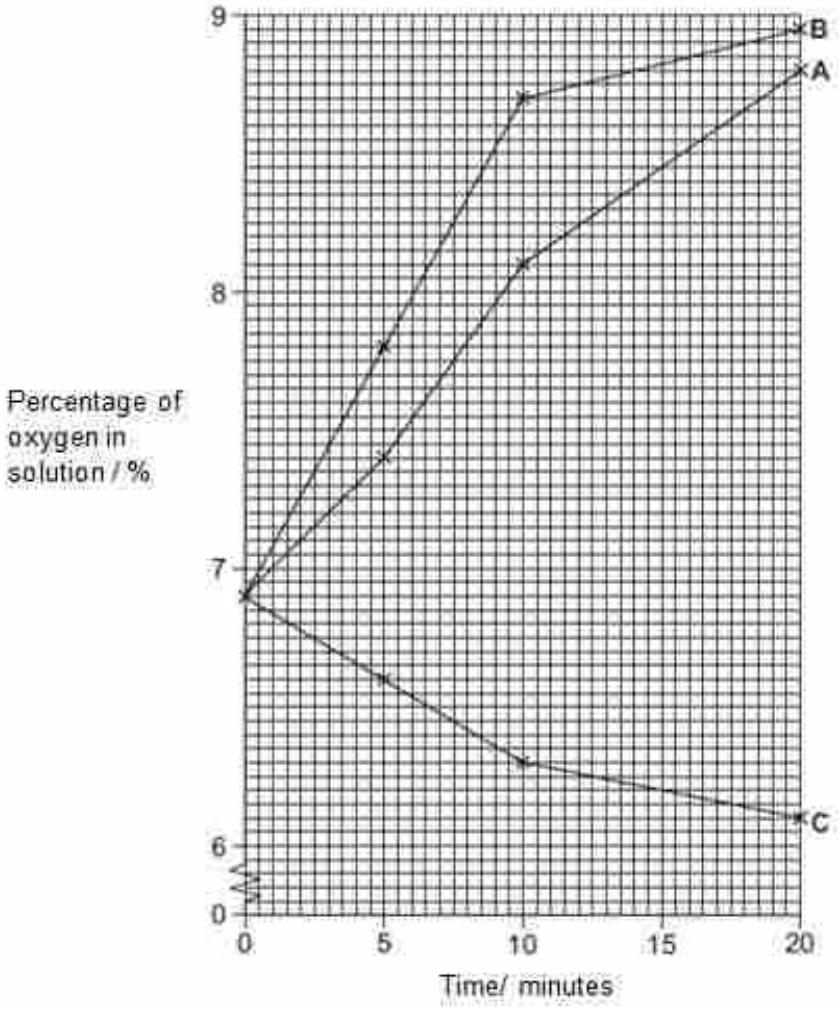


Fig. 6.1

For Examiner's use

(a) With reference to Fig. 6.1,

(i) Calculate the rate of oxygen production for tube **A** for the 20 minutes of the experiment. Give your answer to two decimal places. Show your working. [1]

(ii) Compare the results for tubes **A** and **B**. [2]

.....

.....

.....

.....

(iii) Explain the results for tube **C**. [2]

.....

.....

.....

.....

For Examiner's use

Fig. 6.2 outlines the early stages of respiration in yeast cells in the presence of oxygen.

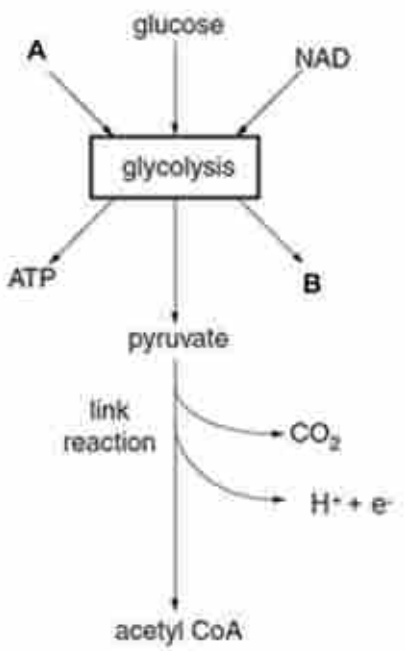


Fig. 6.2

(b) With reference to Fig. 6.2,

(i) Identify molecules **A** and **B**. [2]

A: .....

B: .....

(ii) Explain what would happen to pyruvate in the absence of oxygen. [2]

.....

.....

.....

.....

Total: [9]

Section B: Free-Response Question (15 marks)

Answer only **one** question.
Write your answers on the writing paper provided.
Answer each part (a) and (b) on a fresh piece of writing paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.
A **NIL RETURN** is required.

Question 1

(a) Describe the role of proteins in the structure of the cell surface membrane. [5]

(b) Describe ATP synthesis in various cellular processes. [10]

Total: [15]

OR

Question 2

(a) Describe the structure of DNA and explain how its stability is maintained. [5]

(b) Describe how cancer occurs and outline the factors that increase the chances of cancerous growth. [10]

Total: [15]

END OF PAPER

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DUNMAN HIGH SCHOOL
PRELIMINARY EXAMINATION 2018
YEAR SIX
H1 BIOLOGY (8876)

Suggested Answers

Question 1
(a)
Resolution refers to the degree of details that can be seen whilst magnification refers to the number of times a specimen can be enlarged

(b)(i)
I : nuclear envelope
II : mitochondrion

(ii)
I :
Contain nuclear pores to allow for RNA to leaves nucleus and nucleotides and enzymes to enter nucleus

(iii)
II : Involved in cellular (aerobic) respiration that result in the formation of ATP

(iv)
Eukaryotic cell due to presence of membrane bound organelles namely mitochondria and nucleus

(c)
mRNA
sequence of codons determine the sequence of amino acids in polypeptide
direct the initiation and termination of translation by the start and stop codon

rRNA
rRNA is a component of ribosome
rRNA component interacts with mRNA and tRNA by bringing them to correct orientation during proteins synthesis

Question 2
(a)(i)
Only seen in males / not in females

(a)(ii)
Unaffected parents/mother → child with M.D. / (1 x)2 → 5 / (3 x) 4 → 11 / 8 (x 9) → 13

(b)
5 X^dY
6 X^DY
7 X^DX^d AND X^DX^D
8 X^DX^d

All 4 correct = 2 marks
2 or 3 correct = 1 mark

(c)
¼ / 0.25 / 25% / 1:3 / 1 in 4; (NOT '1:4')

Question 3
(a)
- A codon is three nucleotides/bases on mRNA that specify an amino acid
- It is where the corresponding tRNA anticodon will complementary base-pairs
- signals the start of translation
- signals the termination of translation

(b)
- Single base pair substitution mutation from guanine to adenine on DNA template strand
- Results in the substitution/replacement of an amino acid from alanine to valine

(c)
- Ref. alanine and valine gives rise to different extent of hydrophobic interaction
- more extensive hydrophobic interaction between β peptides and thus forming amyloid plaques

Question 4
(a)
- Eggs are laid on damp surfaces/ surface of stagnant water
- Larvae hatch from eggs upon being submerged in water
- larvae feed on microorganisms and particulate organic matter, shedding their skins three times to be able to grow from first to fourth **instars**
- When the larva has acquired enough energy and size and is in the fourth instar, metamorphosis is triggered, changing the larva into a pupa
- Pupae do not feed, they just change in form until the body of the adult, flying mosquito is formed and emerged

(b)
- *Aedes aegypti* is a mosquito vector
- In the last 50 year, as climate change to warmer and wetter in more countries, mosquito also thrives in these new places
- therefore where the vector thrives so does the dengue virus

(c)
- ref. human activity provide viable habitats e.g. stagnant water for Aedes to thrive
- In colder latitudes or altitudes, urbanisation / large cities provide a warmer habitat

<u>1 Max</u>

Question 5
(a)
the calls made by cranes are species specific

the greater the similarity in calls, the closer the relationship between different species is likely to be

(b)
- Neanderthals, modern human and chimpanzee are the most closely related
- because the first 20 amino acid sequences for all three organisms are identical
- subsequent relatedness to Neanderthal is in the order of orang-utan, gorilla and monkey
- because orang-utan has 1 amino acid difference from Neanderthals, gorilla 2 differences and monkey 3 differences
- at least one difference described in detail e.g. orang-utan has 1 amino acid difference from Neanderthals at amino acid 19, a change from R to K in orang-utan

4 max

Question 6
(a)(i)
(8.8% - 6.9%) / 20 = 0.10 % per minute

(a)(ii)
1 mark for quoting appropriate pair of values with units
1 mark for describing appropriate difference (using comparative terms) between solutions A and B

E.g.
- From 0-20mins, percentage O_2 in solution **B** increased from **6.9% to 8.95%** but percentage O_2 in solution A increased from **6.9% to 8.8%**.

- From 0-10min, percentage O_2 in solution **B increased more steeply** from **6.9% to 8.7%** but percentage O_2 in solution **A** increased from **6.9% to 8.1%.**

OR
- From 0-10min, percentage of O_2 in solution **B has a higher increase of 1.8%** but O_2 increase in solution **A increased by only 1.2%**.

- From 10-20min, percentage O_2 in solution **B increased less steeply** from **8.7% to 8.95%** but percentage O_2 in solution A **increased more steeply from 8.1% to 8.8%**.

OR
- From 10-20min, percentage of O_2 in solution **B has a lower increase of 0.25%** but O_2 increase in solution **A** has a **higher increase of 0.7%**.

(a)(iii)
(quote values and describe trend) From 0 – 20 mins, percentage of O_2 in solution C decreased from 6.9% to 6.1%

In the absence of light, no photolysis of water, hence, no oxygen released

As oxygen is used up in respiration
2 max

(b)(i)
A: ATP / ADP
B: reduced NAD / NADH

(b)(ii)
Anaerobic respiration / lactic acid fermentation;
Pyruvate will be used in anaerobic respiration / alcohol fermentation;

to form ethanol and CO_2 instead of undergoing link reaction to form acetyl CoA;

Essay Answers

1(a)

1. channel proteins with hydrophilic pores found within intrinsic protein molecules
2. Conformation change in carrier protein allows selective passage of molecules across the plasma membrane
3. for facilitated diffusion of ions, large and polar molecules/ for osmosis / water molecules diffuse across the membrane
4. for active transport to pumps to move solutes against concentration gradients
5. receptor proteins for binding of antigens / hormones / external signal molecules
6. to allow an external signal to trigger or initiate reactions within a cell
7. Glycoprotein function in cell-cell adhesion / function in cell junctions / cell-cell recognition

1(b)

1. ATP is synthesized by substrate level photophosphorylation, oxidative phosphorylation and photophosphorylation.
2. ATP is synthesized during glycolysis, in the cytoplasm, and during Kreb cycle in the mitochondrial matrix. ;
3. 4 ATP / 2 nett ATP is synthesized per glucose molecule during glycolysis. ;
4. In anaerobic respiration, ATP is synthesized only by substrate level phosphorylation in glycolysis. ;
5. In the Kreb cycle, 2 ATP is synthesized per glucose when succinyl-CoA is converted to succinate. ;
6. NAD and FAD are reduced during glycolysis, link reaction and Kreb cycle. ;
7. Reduced NAD and FAD donates electrons to the electron transport chain on the inner mitochondrial membrane. ;
8. As electrons are transported along a series of electron carriers of progressively lower energy levels, some energy is used to pump H^+ from the matrix to the intermembrane space, against its concentration gradient ;
9. This creates a proton gradient across the inner mitochondrial membrane, driving protons to diffuse down its concentration gradient via ATP synthase on the inner mitochondrial membrane. ;
10. ATP synthase harness the proton motive force for phosphorylation of ADP to ATP, in the mitochondria matrix. ;
11. O_2 is the final electron carrier of the electron transport chain. ;
12. 3 ATP is synthesized per reduced NAD and 2 ATP per reduced FAD. ;
13. ATP is produced during non-cyclic photophosphorylation and cyclic photophosphorylation;
14. During non-cyclic photophosphorylation, photolysis of water donates electrons to the electron transport chain on the thylakoid membrane;
15. Light energy is harvested by photosynthetic pigments and the energy is passed on to the reaction centre chlorophyll;
16. Electron at reaction centre chlorophyll a is excited to a higher energy level;
17. As electrons are transported along a series of electron carriers of progressively lower energy levels, some energy is used to pump H^+ from the stroma to the thylakoid lumen, against its concentration gradient ;
18. This creates a proton gradient across the thylakoid membrane, driving protons to diffuse down its concentration gradient via ATP synthase on the thylakoid membrane. ;

QWC: at least 2 points each from substrate level photophosphorylation, oxidative phosphorylation and photophosphorylation

2(a)

2(b)

1. Cancer arises from uncontrolled cell division / loss of normal control of cell division
2. Due to mutations which alter the genes that control cell division
3. This causes the rate of cell division to exceed the rate of cell differentiation and cell loss
4. And leads to tumour formation / tumourigenesis
5. Which invades / infiltrates into surrounding tissues and disrupts its normal organisation
6. Cancer cells can metastasise / spread *via* blood or lymph vessels to other organs
7. Exposure to chemical carcinogens that are alkylating agents and electrophiles
8. Such as mustard gas, asbestos, polycyclic hydrocarbons, various pesticides and herbicides, carbon monoxide in cigarette smoke / OVA
9. High energy beams / wavelengths such as ultraviolet radiation / X-rays / gamma rays
10. Some viruses can also cause cancer by causing genetic changes in the cells that will make them cancerous
11. Some people also possess genetic predisposition to cancers, where genes involved in regulating cell division such as proto-oncogenes or tumour suppressor genes become defective
12. A compromised immune system could also lead to abnormal proteins on cancer cells to not be targeted and removed
13. As a person ages, cells are more likely to have accumulated enough changes to the genes / mutations to turn into cancerous cells

<u>9 Max + QWC</u>

QWC: Includes 2 points each for characteristics of cancer and factors that increases chances of cancerous growth

NAME: _____ CLASS: _____ INDEX: _____

CATHOLIC JUNIOR COLLEGE

JC2 PRELIM EXAMINATION

Higher 1

BIOLOGY

8876/01

Paper 1 Multiple Choice

28 AUGUST 2018

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write and/or shade your name, NRIC / FIN number and HT group on the Answer Sheet in the spaces provided unless this has been done for you.

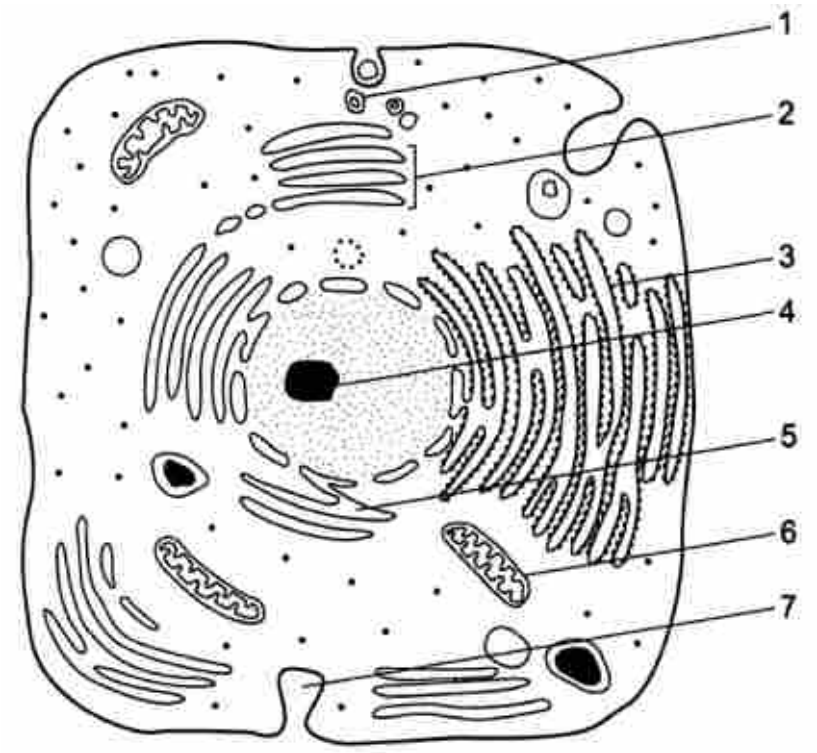
There are **thirty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft 2B pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **18** printed pages and **0** blank page.

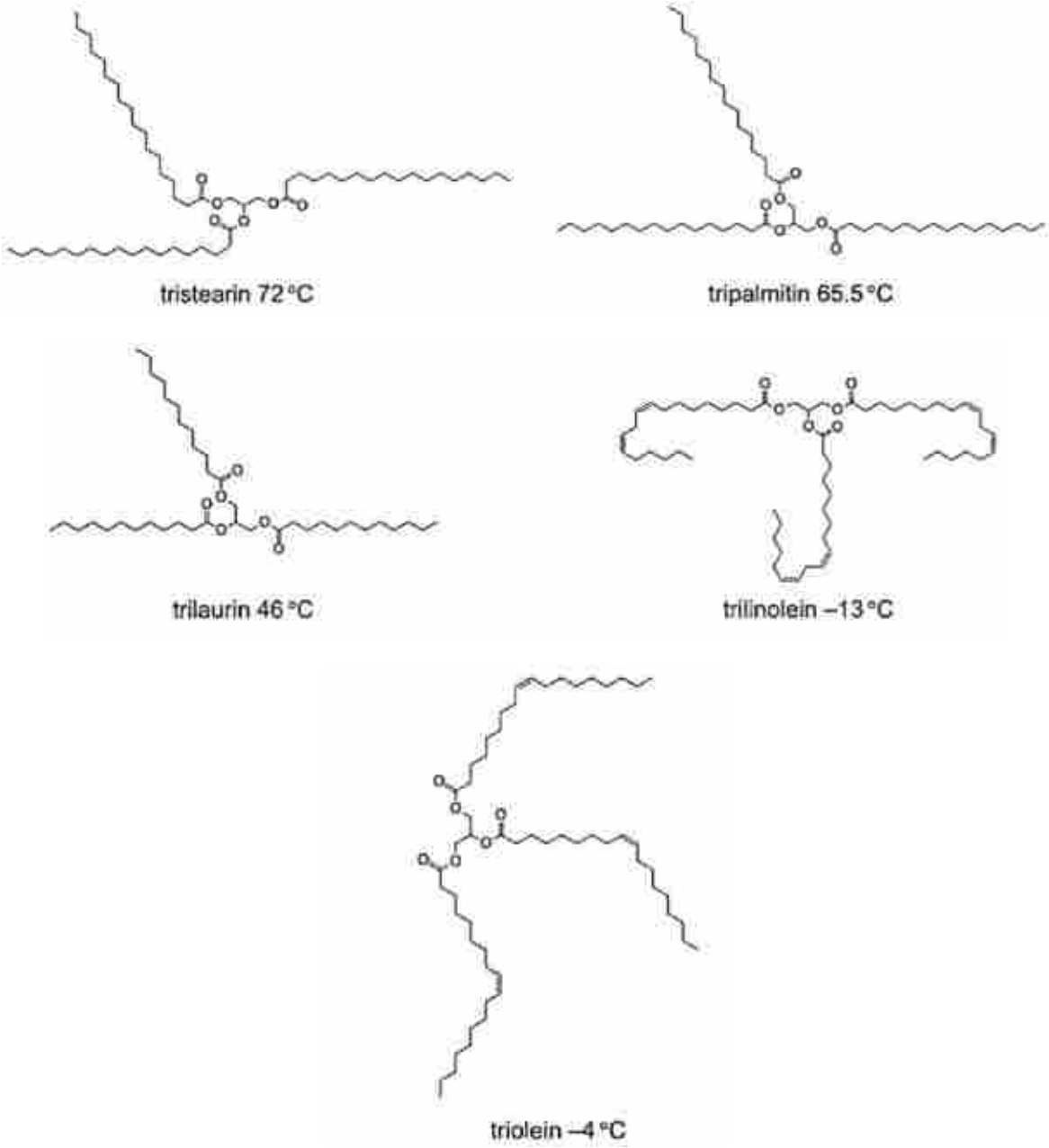
1 The diagram shows a section of a generalised animal cell as seen under the electron microscope.



Where are the proteins and lipids synthesised and transported, packaged and secreted?

	synthesised and transport		packaged	secreted
	proteins	lipid	proteins and lipids	proteins and lipids
A	3	5	2	1
B	4	6	3	7
C	5	3	4	7
D	6	1	2	5

2 The formulae and melting points of five triglycerides are shown in the diagram. Each triglyceride contains three identical fatty acids.

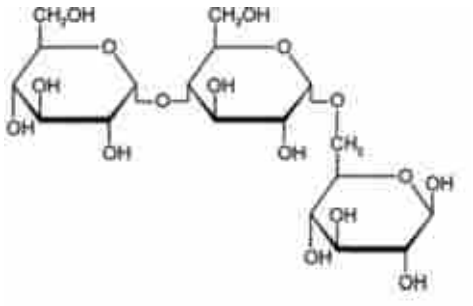


Which two structural features of the molecules make the melting point higher?

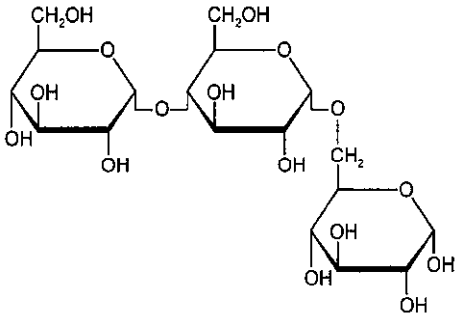
	number of double bonds	length of fatty acid chains
A	fewer	shorter
B	fewer	longer
C	more	longer
D	more	shorter

3 Which diagram correctly shows a trisaccharide containing both 1,4-glycosidic and 1,6-glycosidic bonds, and formed from both α-glucose and β-glucose molecules?

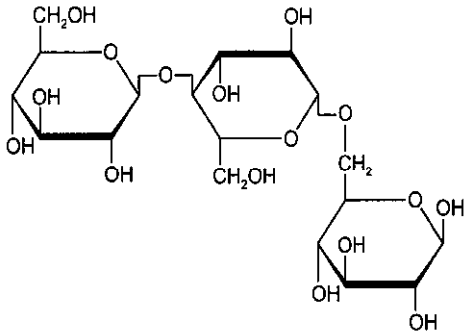
A



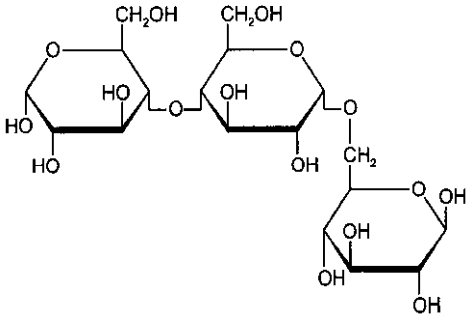
B



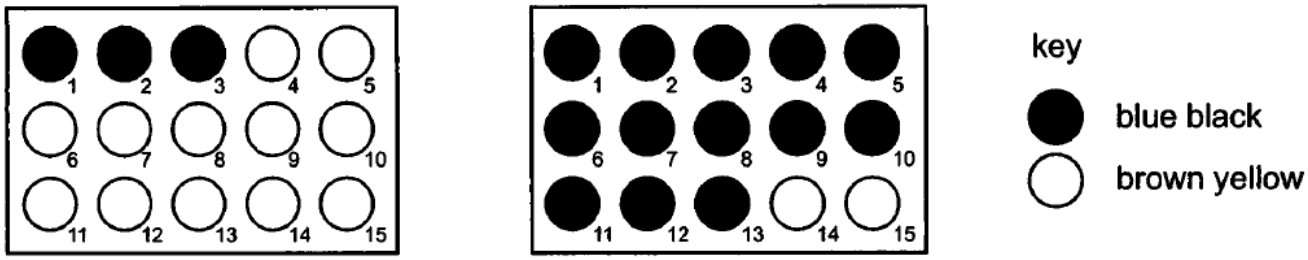
C



D



4 An experiment was carried out to investigate the digestion of starch using amylase at two different temperatures. A sample was removed from each mixture at 15 second intervals and placed onto a spotting tile well containing two drops of iodine in KI solution. The results are shown in the diagram.



Which shows the correct temperatures and times for the complete digestion of starch?

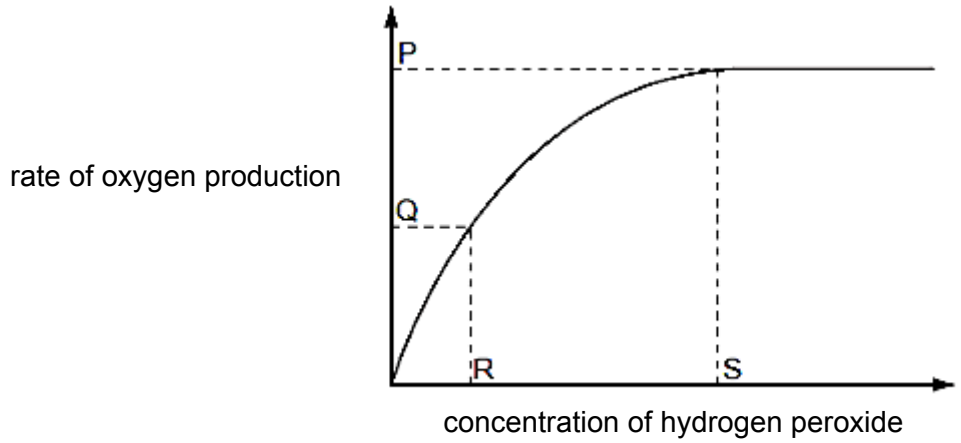
	temperature / °C	time / s
A	10 30	0.45 3.15
B	10 30	195 45
C	10 30	45 195
D	10 30	3.15 0.45

5 The diagram shows the action of a liver enzyme called catalase, which breaks down hydrogen peroxide into water and oxygen.

$$2\,H_2O_2 \xrightarrow{\text{catalase}} 2\,H_2O + O_2$$

The rate of this reaction can be determined by measuring the volume of oxygen produced in a given length of time. Students added small cubes of fresh liver tissue to hydrogen peroxide solution of varying concentrations and measured the volume of oxygen produced.

The graph shows how the concentration of hydrogen peroxide affected the rate of oxygen production.



Which statements are correct?

1 At P, the rate of reaction me.

2 At Q, all of the enzyme a olecules.

3 At Q, the rate of reaction is limited by the concentration of the substrate.

4 At S, all of the enzyme active sites are occupied by substrate molecules.

A 1 and 4

B 2 and 4

C 1, 2 and 3

D 1, 3 and 4

6 The concentration of glucose is higher in the blood plasma.

By which process does glucose move into red blood cells from the blood plasma?

A active transport

B endocytosis

C facilitated diffusion

D osmosis

7 It has been found that stem cells transferred from the intestinal lining to the bone marrow produce all of the different types of blood cell instead of intestinal cells.

Which statement explains this?

A All stem cells are totipotent.

B Environmental factors change the expression of specific genes.

C Specific genes are destroyed by endonucleases.

D Specific genes are hidden by condensation of some chromosomes.

8 Blood transfusion laboratories around the world are hoping to produce large numbers of red blood cells (rbcs) from 'spare' human embryos produced during *in vitro* fertilisation procedures.

Embryonic stem cells are removed from an embryo and cultured in a growth medium that stimulates their differentiation into rbcs.

Which statement correctly describes this differentiation?

A Multipotent embryonic stem cells differentiate into pluripotent blood stem cells and then into rbcs.

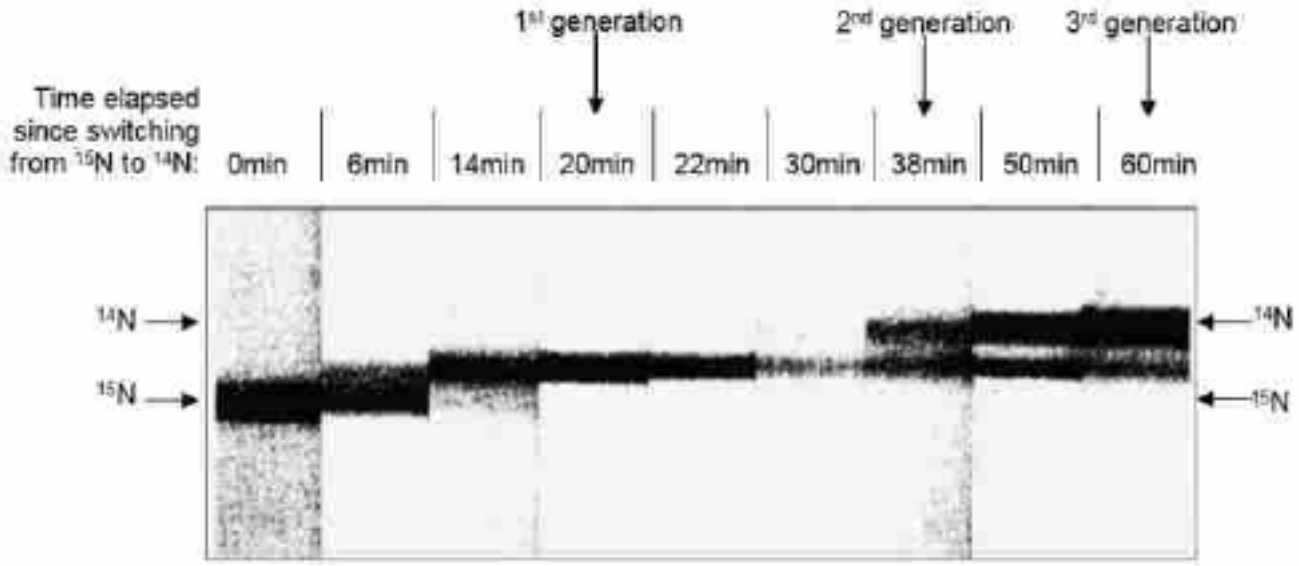
B Pluripotent embryonic stem cells differentiate into multipotent blood stem cells and then into rbcs.

C Totipotent embryonic stem cells differentiate into multipotent blood stem cells and then into rbcs.

D Totipotent embryonic stem cells differentiate into pluripotent blood stem cells and then into rbcs.

9 In the classic paper that demonstrated the semi-conservative replication of DNA, scientists Meselson and Stahl began by showing that DNA itself will form a band when subjected to density gradient centrifugation.

Escherichia coli grown in ^{15}N DNA were switched to ^{14}N and then harvested at eight different time points. The DNA was centrifuged resulting in the banding pattern shown.



Which statements correctly explain the results?

1 At 20 min, the entire DNA of *E. coli* exists as hybrid with 100% ^{15}N DNA.

2 At 20 min, DNA of *E. coli* is 50% hybrid with 50% ^{15}N DNA.

3 At 38 min, there are two bands consisting of 50% hybrid DNA and 50% light DNA.

4 At 60 min, there is 25% hybrid DNA and 75% light DNA.

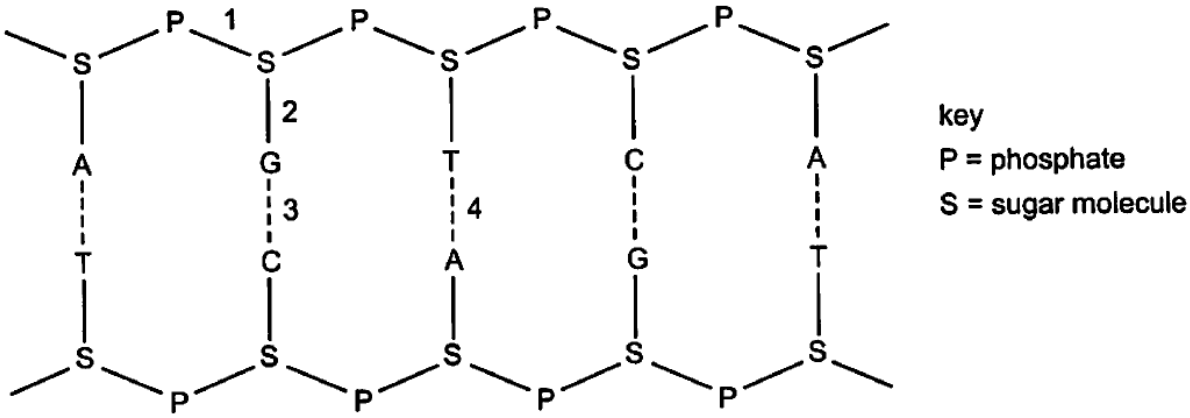
A 1 and 2

B 3 and 4

C 2, 3 and 4

D 1, 2, 3 and 4

10 The diagram shows part of a nucleic acid.



Which row correctly describes the bonds shown in the diagram at positions 1, 2, 3 and 4?

	is formed by condensation	forms a di-ester	occurs during transcription	involves attraction between polar molecules
A	1	2	1, 2 and 3	3
B	1 and 2	1	3 and 4	3 and 4
C	2, 3 and 4	1	3 and 4	1, 3 and 4
D	2	.3	1, 3 and 4	4

11 The same length of DNA in a eukaryote can code for more than one protein.

When are different introns removed in order to allow the production of different mRNAs?

A at transcription

B before transcription

C before translation

D during translation

12 The active messenger RNAs (active mRNAs) in tissue cells can be isolated by passing the homogenised cell contents through a fractionating column. The column has short lengths of uracil nucleotides attached to a solid supporting material. Most molecules of mRNA that pass through the column quickly break up into small pieces and cannot be translated

The active mRNAs that attach to the column can be separated again by appropriate treatment.

Which statements correctly describe active mRNA?

1 Active mRNAs are held to the fractionating column by bonds between adenine and uracil bases.

2 Active mRNAs can be released from fractionating column by breaking hydrogen bonds.

3 Only mRNAs with polyadenine tailing can be translated.

4 Polyadenine tailing stabilizes mRNA and prevents it from being broken up.

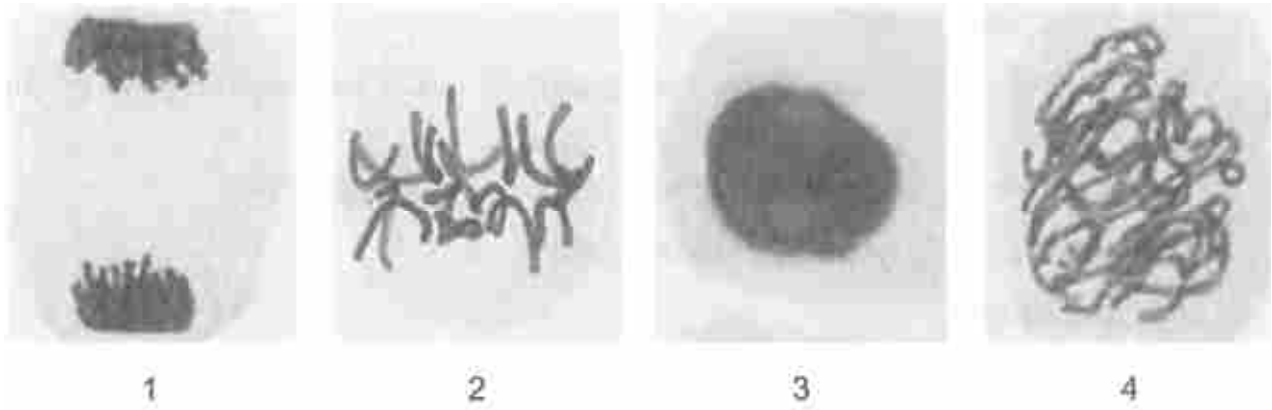
A 1 and 2

B 1, 2 and 3

C 3 and 4

D 1, 2, 3 and 4

13 The photomicrographs show different stages of the mitotic cell cycle.



Which row matches the name of a stage, a description of some of the events happening at this stage and a photomicrograph of a stage of the mitotic cell cycle?

	name of stage	description	photomicrograph
A	anaphase	Centromeres bind to spindle microtubules between centrioles. Chromosomes are pulled into position.	1
B	metaphase	Chromosomes align at equator of cell. Microtubules begin to pull the two parts of each chromosome in opposite directions.	2
C	prophase	Chromatin condenses. Nuclear envelope disperses. Nucleolus no longer visible.	3
D	telophase	Chromosomes become less condensed. Spindle microtubules disperse.	4

14 Fig. 14.1 represents the changes in the quantity of DNA in two types of cell divisions that occur in different types of cells of an organism. Fig. 14.2 shows the entire set of homologous chromosomes in a diploid cell of this organism before it undergoes the type of nuclear division that leads to **P**.

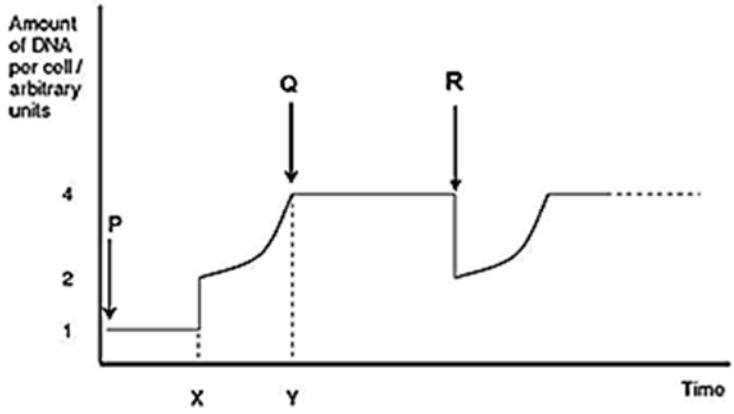
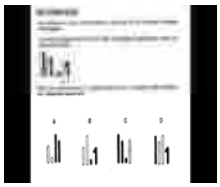


Fig. 14.1

Fig. 14.2

Identify the correct combination of outcomes within a cell in this organism at **P**, **Q** and **R**.

	At **P**	At **Q**	At **R**
A		Diploid set of homologous chromosomes, each with identical sister chromatids.	Diploid set of homologous chromosomes, each a single DNA molecule.
B		Diploid set of homologous chromosomes, each with identical sister chromatids.	Haploid set of chromosomes, each a single DNA molecule.
C		Diploid set of homologous chromosomes, each a single DNA molecule.	Haploid set of chromosomes, each a single DNA molecule.
D		Tetraploid sets of homologous chromosomes, each a single DNA molecule.	Diploid set of homologous chromosomes, each a single DNA molecule.

15 A toxic chemical causes malfunction of the centrioles in animal cells.

Which process in meiosis is likely to be directly affected by the chemical?

A crossing over between homologous chromosomes

B migration of chromosomes to opposite poles of the cell

C pairing of homologous chromosomes

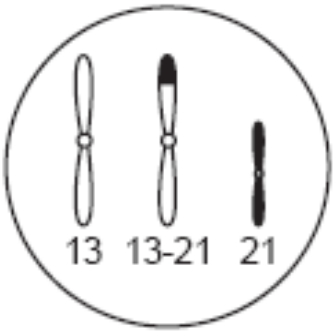
D replication of centromeres

16 Which set of terms matches the definitions in the table?

	definition			
	the structure that replicates in the S phase	in animal cells, the 'pinching in' process that divides the cytoplasm	the cell structure that disassembles to allow chromosome attachment to the spindle	the phase of the cell cycle immediately prior to entering mitosis
A	centriole	cytokinesis	nuclear envelope	S phase
B	centriole	late telophase	nucleolus	S phase
C	chromatid	cytokinesis	nuclear envelope	G_2 phase
D	chromatid	late telophase	nucleolus	G_2 phase

17 Down's syndrome can be caused by a trisomy of chromosome 21, but can also result from the translocation of chromosome 21 into chromosome 13, forming a single chromosome 13-21.

The diagram shows chromosomes 13 and 21 in the nucleus of a diploid (2n) testis cell from a phenotypically normal male carrier of a 13-21 translocation. This cell has a chromosome number of 45.



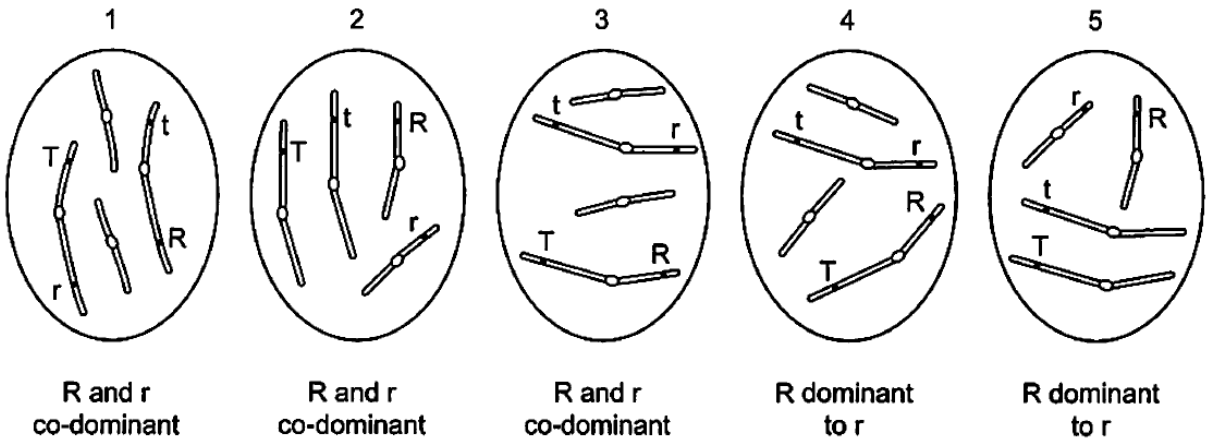
Which is **not** a likely outcome of fertilisation of normal oocytes by sperm from this male?

	chromosomes in sperm	embryo
A	13 and 21	2n =46 normal phenotype
B	13-21	2n =45 normal phenotype
C	13-21 and 21	2n =46 Down's syndrome
D	13-21 and 21	2n =47 Down's syndrome

18 In a family of flowering plants, height is controlled by a pair of alleles. The allele for tall (T) is always dominant to the allele for short (t). The flower colour is also controlled by a pair of alleles.

In some species, the allele for red (R) is dominant to the allele for white (r). In other species the colour alleles are co-dominant. (For simplicity, the symbols R and r are used for the co-dominant alleles.)

The diagram shows the chromosome arrangement and information about the height alleles and the flower colour allele in five species of this family of plants.



Each of the plants 1, 2, 3, 4 and 5 was test crossed.

Assuming there is no crossing over, which plants would produce offspring with the phenotypes short with white flowers and tall with red flowers?

A 1,3 and 4

B 2,4 and 5

C 2 and 5 only

D 4 and 5 only

19 In a monohybrid, X-linked (sex-linked) genetic cross involving two alleles, dominance and recessiveness is observed in the phenotypes obtained. The link between genotype and phenotype is not always obvious when the parental and offspring phenotypes are recorded.

What is the best explanation of this observation?

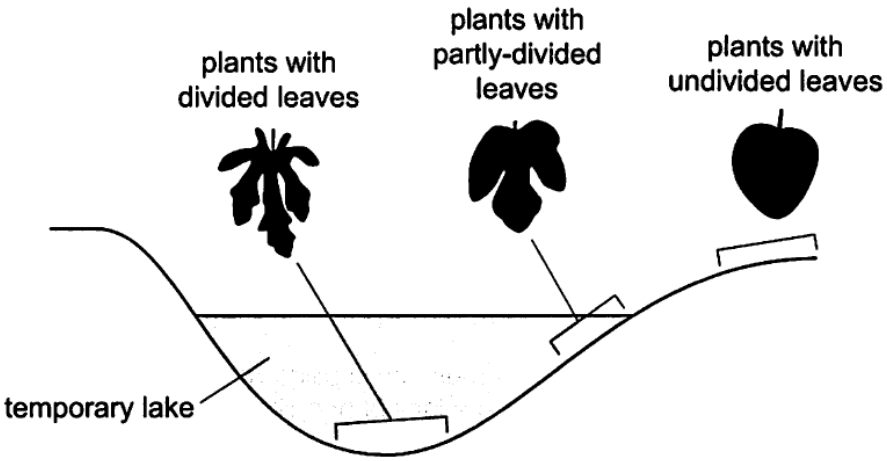
A The dominant and recessive phenotypes can be explained by the transcription of different nucleotide sequences to produce two different mRNA molecules, which produce a functional and a non-functional protein.

B The expression of the recessive allele only occurs when it is in the male, because the Y chromosome is lacking the entire sequence of nucleotides corresponding to the production of a different protein.

C The nucleotide sequences of the alleles occurring at different loci leads to the production of active and inactive enzymes, so that the heterozygous phenotype only has half of the enzyme concentration of the homozygous dominant phenotype.

D The recessive allele present in the male is unlikely to be expressed in the same way as it would if it occurred in the female heterozygote, as the male does not possess a corresponding nucleotide sequence on the X chromosome.

20 The diagram shows the distribution of plants with different leaf shapes in an area where flooding has caused the development of a temporary lake. The plants are all of the same species. When there is no flooding, all the leaves are undivided.



What could explain these differences in leaf shape during flooding?

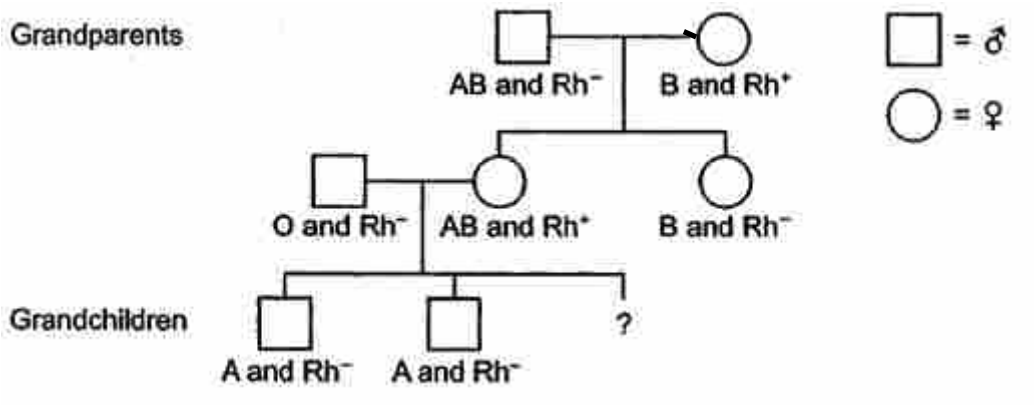
A changes in gene expression dependent on the soil water content

B cross-fertilisation between plants with different leaf shapes

C random assortment of alleles in the plant population

D self-fertilisation allowing adaptation to the local environment

21 The diagram shows a family tree.



What is the probability that the third grandchild will be a boy with blood group B and Rh positive blood?

A 0.0625 (1 in 16)

B 0.125 (1 in 8)

C 0.25 (1 in 4)

D 0.5 (1 in 2)

22 What describes oxidative phosphorylation?

A addition of phosphate to ADP using energy gained by transferring electrons along a chain of carriers

B addition of phosphate to ADP using energy gained by transferring electrons between chlorophyll molecules

C addition of phosphate to glucose in the first step of glycolysis

D removal of phosphate from ATP with the release of energy for work within the cell

23 Where does ethanol formation occur in a yeast cell?

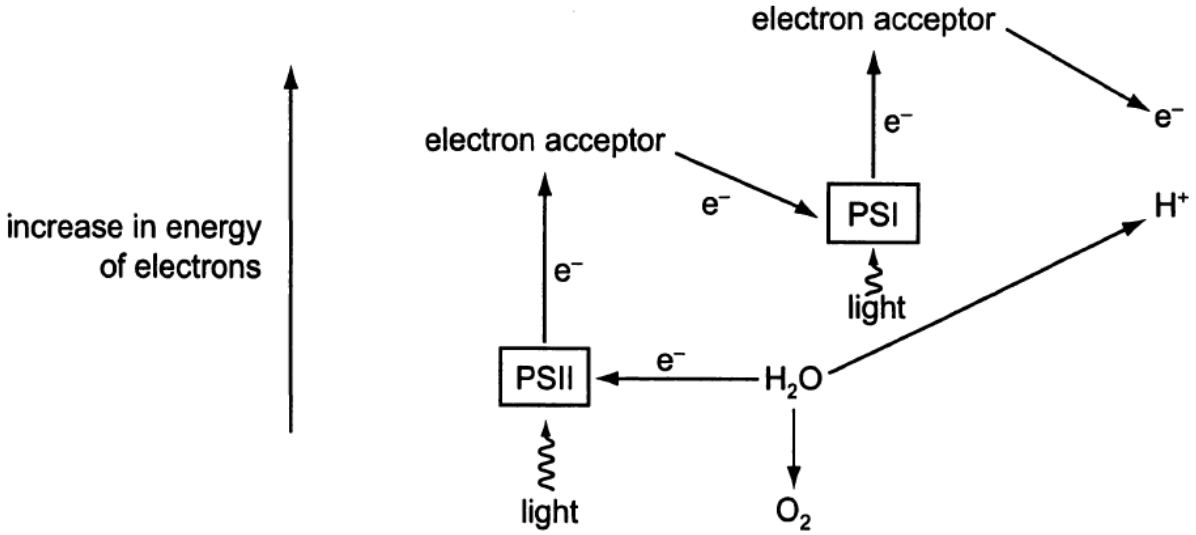
A cell vacuole

B cytoplasm

C Golgi apparatus

D mitochondrion

24 The diagram shows the path taken by electrons and the formation of hydrogen ions in the light-dependent stages of photosynthesis.



What are the electrons and hydrogen ions used to produce?

A ATP from ADP

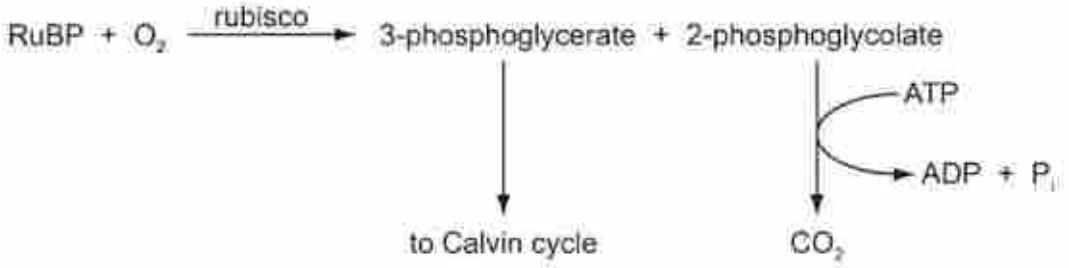
B ATP from ADP and reduced NADP from NADP

C glycerate 3-phosphate from glyceraldehyde 3-phosphate

D reduced NADP from NADP

25 Rubisco is the carbon dioxide-fixing enzyme. One rubisco molecule has eight active sites where carbon dioxide fixation occurs, with each active site catalysing only three reduction reactions per second.

The enzyme also catalyses, at the same active sites, the addition of oxygen to ribulose bisphosphate (RuBP). This reaction is favoured when oxygen concentrations in the leaf are high and carbon dioxide concentrations are low.



Which of the facts is paired with a correct explanation?

	fact	explanation
A	On very hot, dry days stomata close to prevent water loss.	This reduces the availability of oxygen, increasing the production of 3-phosphoglycerate.
B	Plants synthesise large volumes of rubisco.	This may be an adaptive response to compensate for low concentrations of oxygen.
C	Processing 2-phosphoglycolate will eventually release carbon dioxide.	This will increase the rate of reduction and increase the rate of RuBP regeneration, increasing the rate of photosynthesis.
D	Rubisco is an inefficient photosynthetic enzyme.	This is because the rate of carbon dioxide reduction can be decreased by competitive binding of oxygen molecules to the active site

26 Which statements are acceptable parts of Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.

2 In competition for survival, the more aggressive animals are more likely to survive.

3 Species perfectly adapted to a stable environment will continue to evolve.

4 Variation between individuals of a species is essential for evolutionary change.

A 1, 2 and 4 only

B 2 and 3 only

C 3 and 4 only

D 4 only

27 When organochlorine insecticides such as DDT were in widespread use, mosquitoes in malarial regions developed resistance more rapidly than did houseflies in Britain.

What could account for the difference in the rates of the development of resistance?

A Houseflies produce more generations a year.

B More insecticides was used in Britain.

C More insecticides was used in malarial regions.

D Mosquitoes show fewer random mutations per generation.

28 Human activity often results in habitat loss. The remaining habitat in an area become fragmented forming smaller patches of habitat, through for example, construction of new roads and deforestation.

Which statements describe how a small habitat patch differs from a larger patch of the same habitat?

1 biodiversity decreases

2 competition from surrounding habitats increases

3 gene pool increases

4 populations of large animals decrease

A 1 and 2 only

B 2 and 3 only

C 3 and 4 only

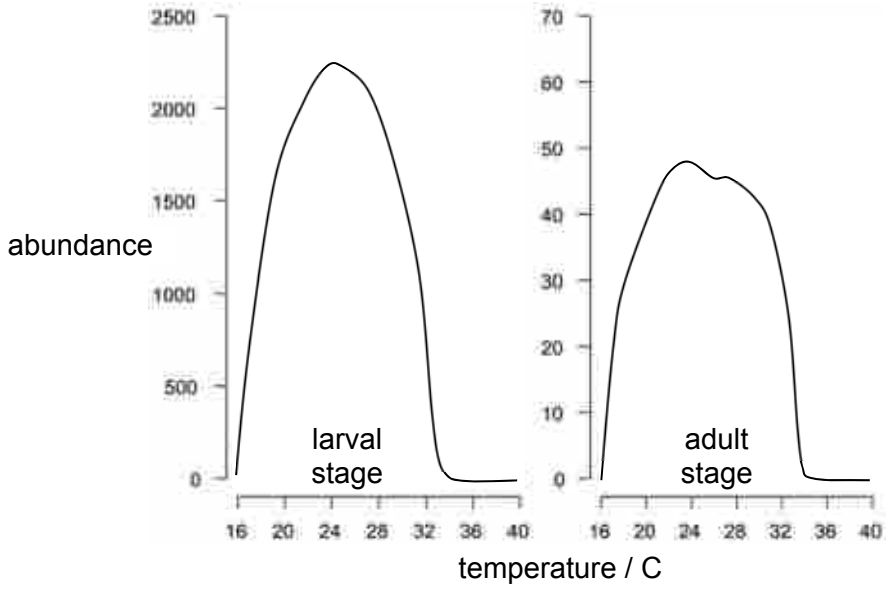
D 1, 2 and 4 only

29 Which of the following correctly shows the effects of climate change on coral reefs and associated ecosystems?

	Average number of zooxanthellae in each polyp	Mass of basal plate of hard corals	Diversity of catch from nearby fisheries
A	Decreased	Decreased	Decreased
B	Decreased	Unaffected	Increased
C	Increased	Decreased	Decreased
D	Increased	Unaffected	Increased

30 Malaria is caused by the protozoan parasite, *Plasmodium falciparum* (*P. falciparum*). Female *Anopheles* mosquitoes pick up *P. falciparum* in a blood meal taken from an infectious person. *P. falciparum* then go through several developmental stages before they migrate to the mosquito salivary glands. Once in the salivary glands, the parasites can be transmitted to a susceptible human host when the mosquito takes another blood meal. The time spent for the parasite to develop in the mosquito is determined by temperature.

Both *Anopheles* and *P. falciparum* are sensitive to temperature. Each stage in the life cycle of *Anopheles* mosquitoes (i.e. egg, larva, pupa and adult) is dependent on temperature, examples of which are illustrated in the following graphs.



Investigations into the effect of global warming on malaria transmission often focused on the blood meal-egg laying stage in adult females.

Which row shows the reason for and limitation use for the research?

	reason for the use	limitation of the use
A	Temperature-dependencies are not the same across the different developmental stages of the *Anopheles* mosquitoes.	Increased temperature increased larval mortality and decreased developmental speed.
B	*P. falciparum* is transmitted by adult females.	um temperature for *P. falciparum* growth does not necessarily correspond to the vector's optimum temperature.
C	*P. falciparum* is transmitted by adult females.	Temperature-dependencies are not the same across the different developmental stages of the *Anopheles* mosquitoes.
D	Optimum temperature for *P. falciparum* growth does not necessarily correspond to the vector's optimum.	Increased temperature increased larval mortality and decreased developmental speed.

END OF PAPER

CATHOLIC JUNIOR COLLEGE
JC2 PRELIM EXAMINATION
Higher 1

CANDIDATE NAME	
CLASS	**2T**
INDEX NUMBER	

BIOLOGY
8876/02

Paper 2 STRUCTURED & FREE RESPONSE QUESTIONS
20 AUGUST 2018
2 hours

Candidates answer on the Question Paper.
Additional Materials: Writing Paper

READ THESE INSTRUCTIONS FIRST
Write your Centre number, index number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer all questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together as follows:
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1 [8]	
2 [12]	
3 [8]	
4 [5]	
5 [12]	
6 or 7 [15]	
TOTAL P2	**60**

This document consists of **16** printed pages and **0** blank page.

[Turn over

Section A

Answer **all** questions in this section

1 **(a)** Fig. 1.1 is an electron micrograph showing part of an organelle present in a mature plant cell.

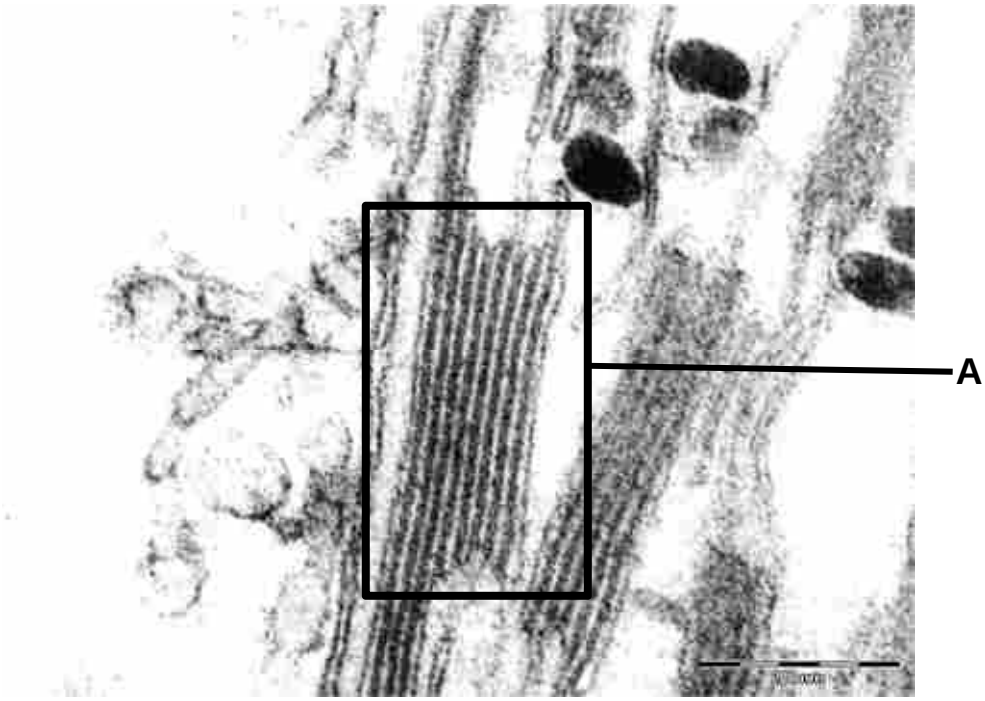


Fig. 1.1

(i) Identify the organelle in which structure **A** resides.

……[1]

(ii) Explain the significance of the flattened stack arrangement in structure **A**.

……

……

……

……[2]

(b) Fig. 1.2 shows the structure of a cell surface membrane.

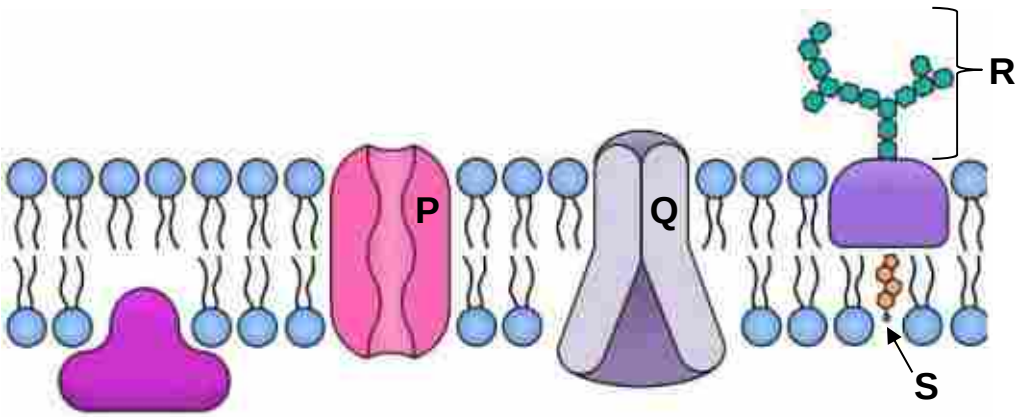


Fig. 1.2

With reference to Fig. 1.2,

(i) explain how the structure of **Q** allows it to be embedded in the cell surface membrane.

……

……[1]

(ii) explain how structure **P** functions differently compared to structure **Q**.

……

……[1]

(iii) explain why structure **S** is amphipathic.

……

……[1]

An immune response is triggered when the body recognises and defends itself against any substances that appear foreign to the body.

(iv) Suggest why a change in R may cause an immunological response.

……

……[2]

[Total: 8 marks]

2 **(a)** Fig.2.1 shows the structure of an adult haemoglobin molecule, HbA.

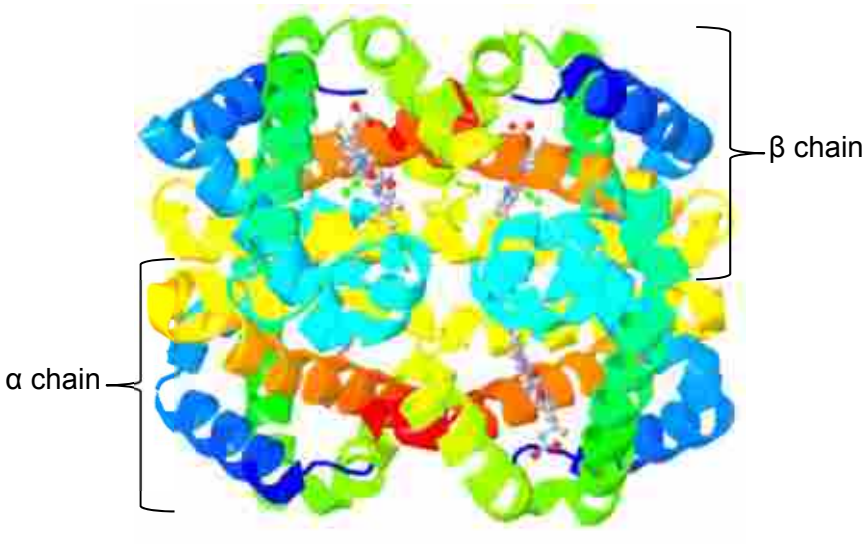


Fig. 2.1

(i) With reference to Fig. 2.1, explain how the structure of HbA is related to its function.

……

……

……

……[2]

Sickle cell anaemia is an inherited disease due to a mutation in the allele that codes for β-globin polypeptide chain. This mutant HbS allele results in the production of haemoglobin variant HbS.
Figure 2.2 shows the blast sequence of both the normal adult haemoglobin variant, HbA, as well as the mutant adult haemoglobin variant, HbS.

Beta globin sequence in normal adult haemoglobin (HbA)

nucleotide base	C T G A C T C C T G A G G A G A A G T C T
amino acid	Leu – Thr – Pro – Glu – Glu – Lys – Ser

Beta globin sequence in mutant adult haemoglobin (HbS)

nucleotide base	C T G A C T C C T G T G G A G A A G T C T
amino acid	Leu – Thr – Pro – Val – Glu – Lys – Ser

Fig. 2.2

(ii) With reference to Fig. 2.1 and Fig. 2.2, explain how this mutation affects the structure of the haemoglobin molecule.

……

……

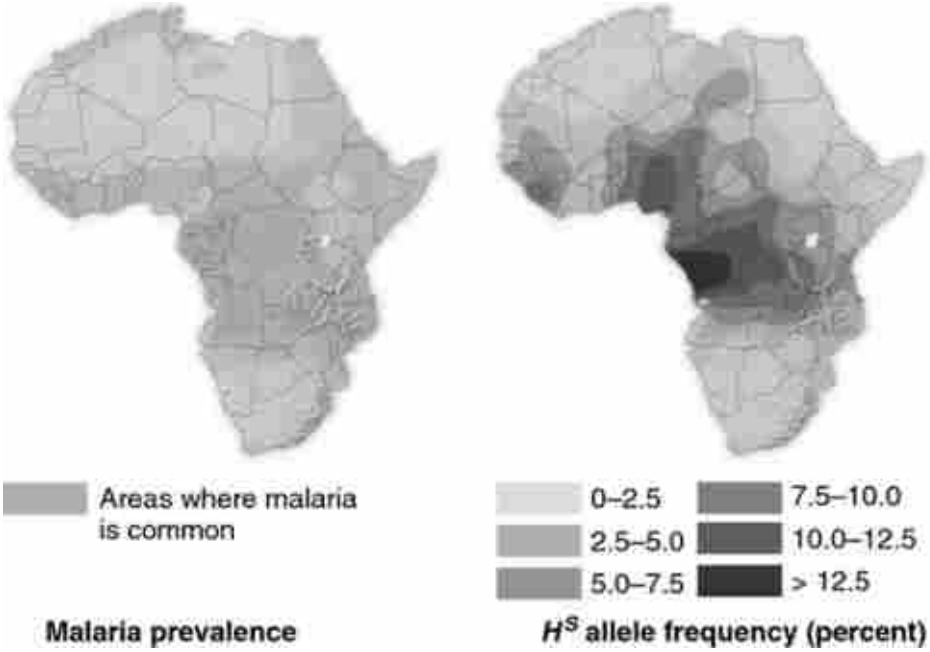
……

……[2]

Sickle cell disease has its highest occurrence in sub-Saharan Africa. Despite the survival disadvantage of the allele HbS, HbS allele persists at more than 12.5 % in the population.

Fig. 2.3 shows regions where sickle cell anaemia is most common, which coincide with regions where malaria is. Malaria-causing parasites are introduced into the blood by mosquitos.

Fig. 2.3



(iii) With reference to Fig. 2.3, explain why HbS allele is still preserved within the population and suggest why it occurs at an unusually high frequency in Africa.

……

……

……

……

……

……

……[4]

(b) Haematopoietic stem cell (HSC), usually derived from bone marrow, peripheral blood or umbilical cord blood have shown great promise in the treatment of sickle cell disease recently.

Sources of such stem cells may be autologous (i.e. using the patient's own stem cells), allogeneic (i.e. using stem cells derived from a donor) or syngeneic (i.e. using stem cells from an identical twin).

After extraction, researchers cultivate these stem cells before injecting them back into the patient. Such haematopoietic stem cell transplantation (HSCT) therapy could potentially give new hope to patients with sickle cell anaemia, although the treatment comes with its own risk towards the patients.

(i) Explain how extracted haematopoietic stem cells are cultivated before they are injected back to the patient.

……

……

……

……[2]

(ii) Explain why treatment using HSC from allogeneic sources may pose some risks to the patient.

……

……

……

……[2]

[Total: 12]

3 Fig. 3.1 shows chickens with two different feather colours in which the gene for feather colour is carried on an autosome. The gene has two alleles, one that codes for black and the other for splashed-white. When a male chicken with black feathers is mated with a female chicken with splashed-white feathers, all the offspring have blue feathers. This also occurs when a male chicken with splashed-white feathers is crossed with a female with black feathers.

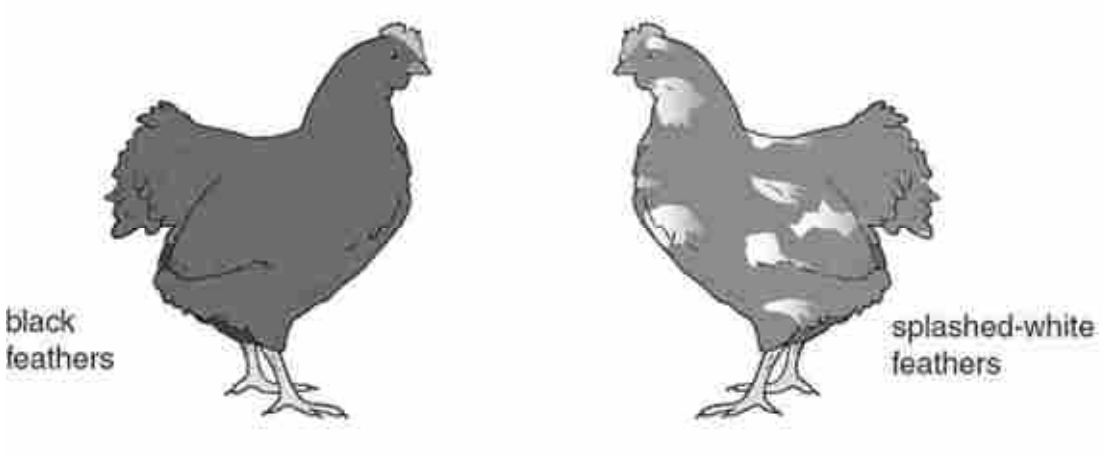


Fig. 3.1

(a) The blue feathers is the result of codominance.

Explain what is meant by ‘codominance’.

……

……

……

……[2]

Another gene may cause stripes on feathers (barred feathers), as shown in Fig. 3.2. This gene is carried on the X chromosome. The allele for barred feathers ($\mathbf{X^A}$) is dominant over the allele for non-barred feathers ($\mathbf{X^a}$).

In chickens, the male is homogametic and has two X chromosomes while the female is heterogametic and has one X chromosome and one Y chromosome.

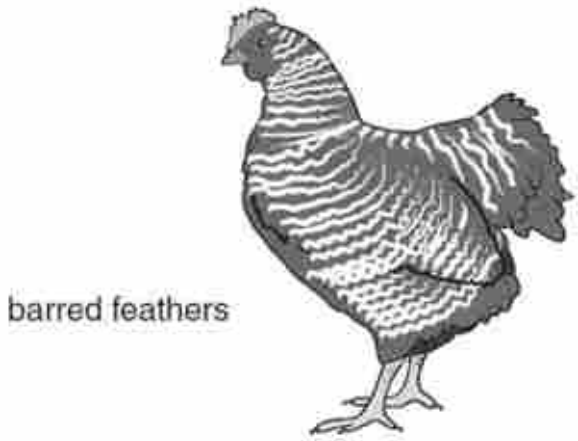


Fig. 3.2

(b) A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers. All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given above draw a genetic diagram to show this cross.

[3]

(c) Explain how a farmer could use a breeding programme to find out the genotype of a male chicken with blue, barred feathers.

……

……

……

……

……

……[3]

[Total: 8]

4 A student investigated respiration in a population of yeast growing in a sealed container.

Fig. 4.1 shows the results of his investigation.

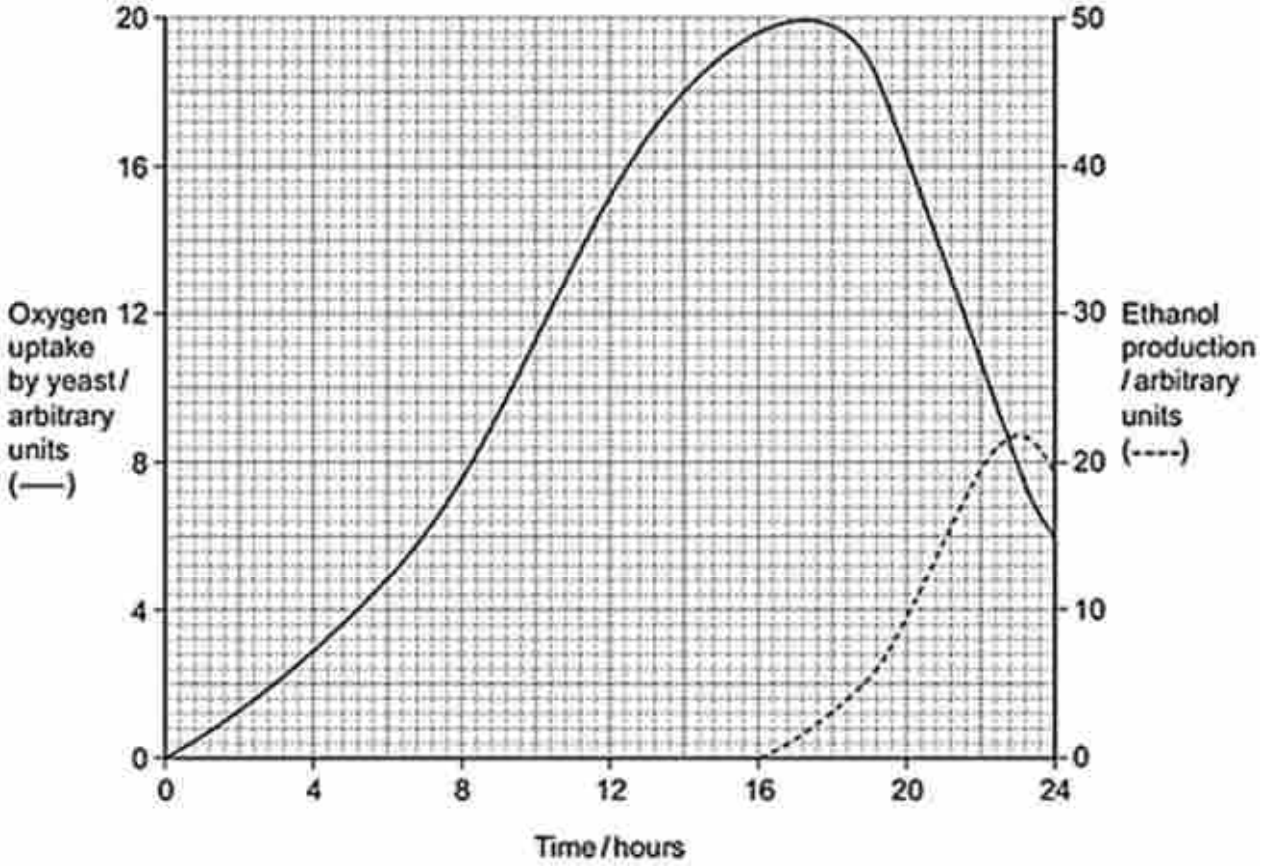


Fig. 4.1

(a) With reference to Fig. 4.1, explain the changes in the ethanol production by yeast during this investigation.

……

……

……

……

……

……[3]

(b) Sodium azide is a substance that inhibits the electron transport chain in respiration. The student repeated the investigation but added sodium azide after 4 hours.

Suggest how the addition of sodium azide would affect oxygen uptake and ethanol production by yeast.

……

……

……

……

……[2]

[Total: 5]

5 Monarch butterflies are one of the largest migrating butterflies in the world. They have recently come under the spotlight in research due to how global warming is affecting their populations.

Monarch butterflies, shown in Fig. 5.1, are obligate feeders on a specific species of milkweed plant for both adults and caterpillars, and lay their eggs on these plants as well. These plants also secrete a toxin called cardenolides that deter most vertebrate herbivores that the monarchs are tolerant to. The monarchs even accumulate these toxins in their bodies that make them taste bad for their predators.

Fig. 5.1

(a) Based on the information above, identify two selection pressures for the monarch butterflies.

……

……

……

……[2]

(b) Explain how monarch butterflies and caterpillars have evolved to have a defense against their predators.

……

……

……

……

……

……[3]

(c) Monarch butterflies, like most insects, are highly sensitive to weather and climate. Based on Q_{10} theory, they depend on environmental cues, temperature in particular, to trigger reproduction, migration, and hibernation.

(i) State the meaning of Q_{10} theory and describe the correlation of this theory on insect physiology.

……

……

……

……[2]

Fig 5.2 below shows data of monarch butterflies arriving at Mexico during winter.

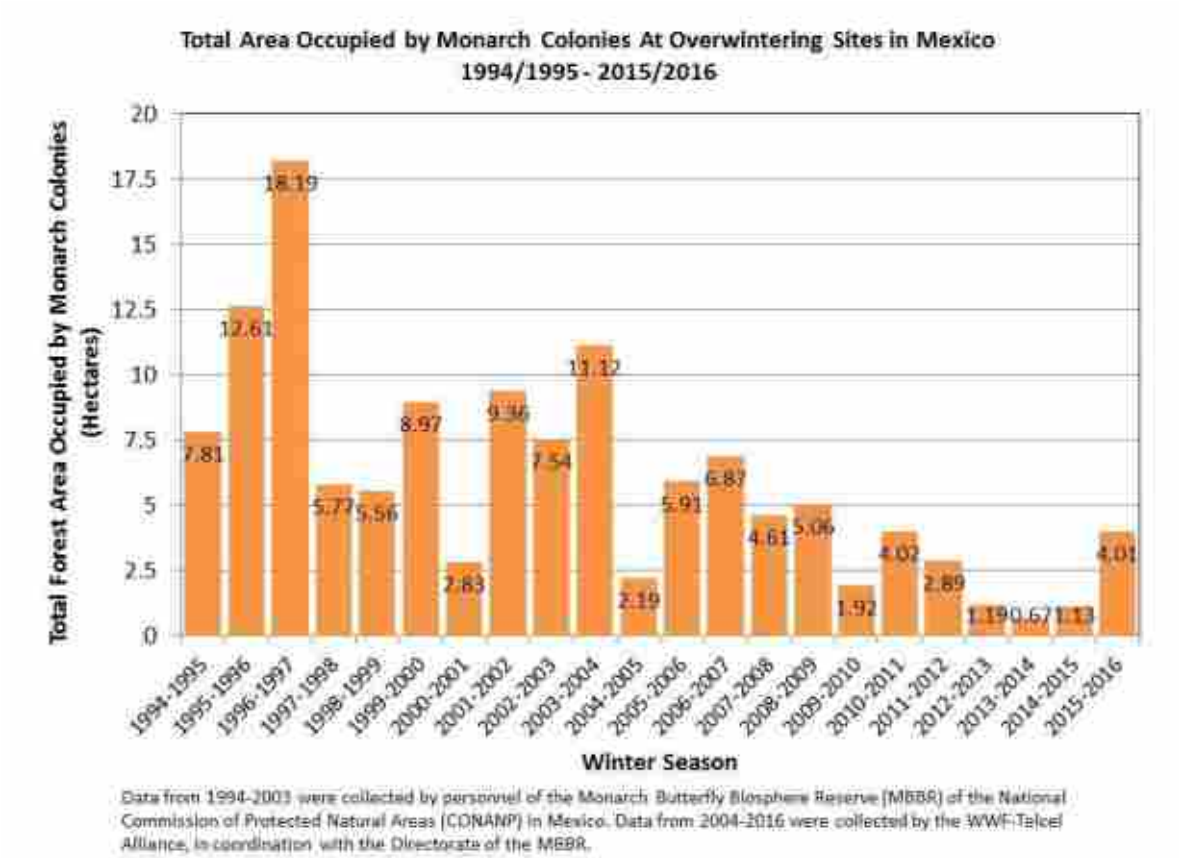


Fig. 5.2

(ii) Explain why monarch butterflies would be highly sensitive to climate change.

……

……

……

……[2]

(iii) Based on recent research, it has been found that increasing temperature can cause milkweeds to secrete a significantly higher level of cardenolides than normal.

With reference to Fig. 5.2 and this information, suggest how climate change is likely going to affect the monarch butterflies.

……

……

……

……

……

……[3]

[Total: 12]

Section B
Answer EITHER 6 OR 7.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

6 In photosynthesis, glyceraldehyde 3-phosphate (3-carbon sugar) is produced in the stroma of chloroplast during Calvin cycle.

(a) Outline this process and how the glyceraldehyde 3-phosphate is converted into starch and discuss the suitability of starch as a storage compound in plants. [8]

(b) Compare the processes of Calvin cycle to that of the Krebs cycle. [7]

[Total: 15]

7 **(a)** Outline the process of DNA replication and discuss the suitability of DNA as a hereditary material. [8]

(b) Compare the processes of DNA transcription to that of DNA translation. [7]

[Total: 15]

END OF PAPER

NAME: _____ CLASS: _____ INDEX: _____

CATHOLIC JUNIOR COLLEGE
JC2 PRELIM EXAMINATION
Higher 1

Answers

BIOLOGY
8876/01

Paper 1 Multiple Choice

28 AUGUST 2018
1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write and/or shade your name, NRIC / FIN number and HT group on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question, there are four possible answers, **A, B, C** and **D**.
Choose the **one** you consider correct and record your choice in **soft 2B pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

1	A [L1]	2	B [L1]	3	A [L2]	4	B [L2]	5	D [L3]
6	C [L1]	7	B [L2]	8	B [L1]	9	B [L3]	10	B [L2]
11	C [L1]	12	D [L3]	13	B [L2]	14	A [L3]	15	B [L2]
16	C [L1]	17	D [L3]	18	D [L3]	19	A [L2]	20	A [L2]
21	B [L3]	22	A [L1]	23	B [L1]	24	B [L1]	25	D [L3]
26	D [L2]	27	C [L2]	28	D [L2]	29	A [L2]	30	B [L3]

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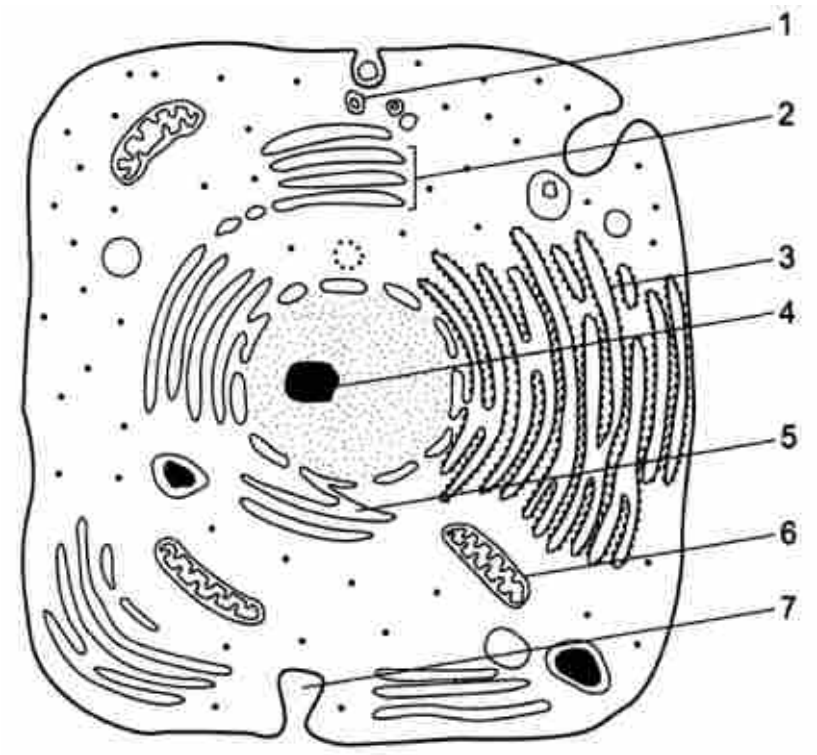
[Turn over

1 The diagram shows a section of a generalised animal cell as seen under the electron microscope.



Where are the proteins and lipids synthesised and transported, packaged and secreted?

	synthesised and transport		packaged	secreted
	proteins	lipid	proteins and lipids	proteins and lipids
A	3	5	2	1
B	4	6	3	7
C	5	3	4	7
D	6	1	2	5

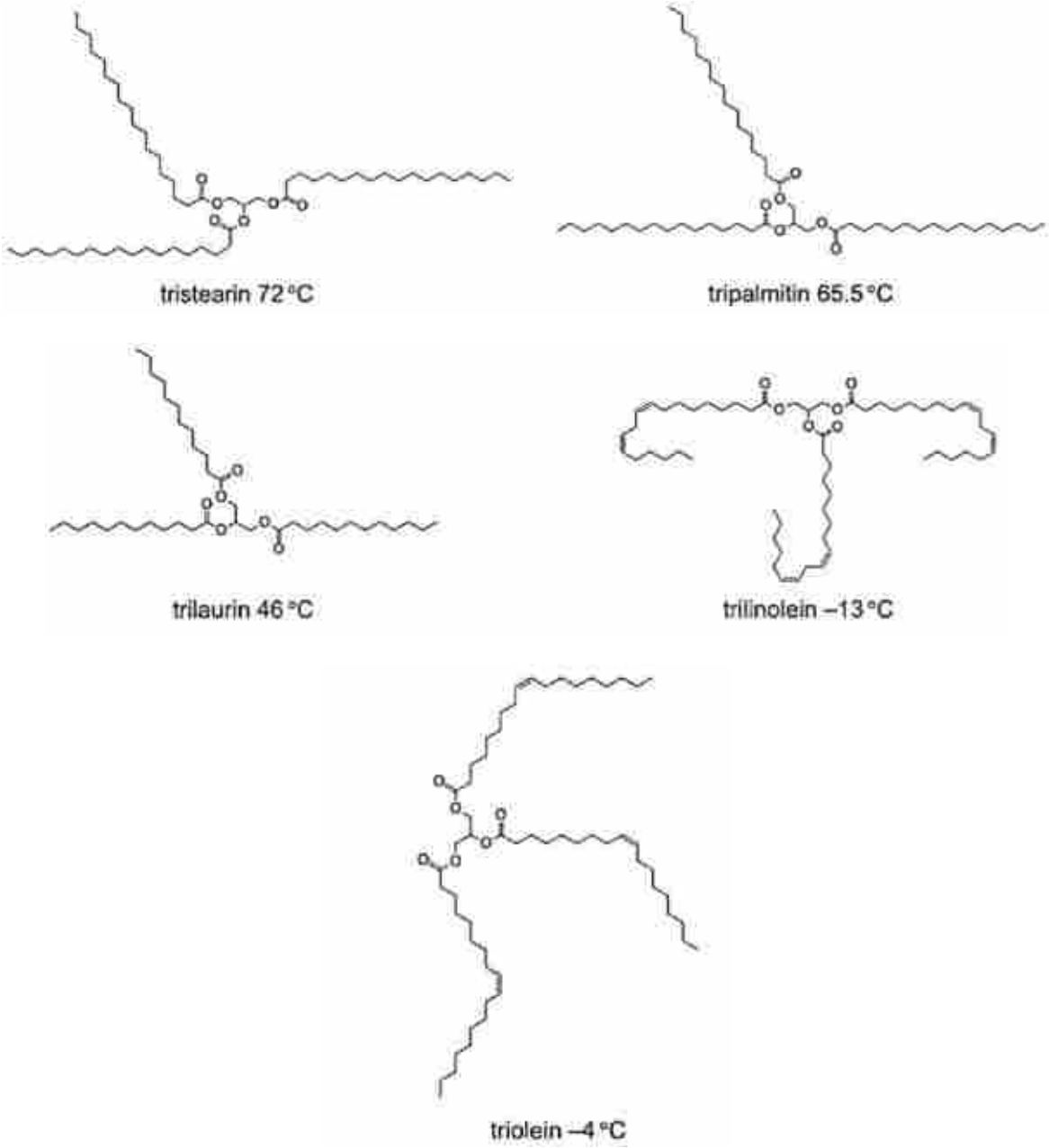
ANS A [L1] (H2 ALevel/2009/P1/Q1)

SC:

OR:

	Structure	Function	Macromolecule (location)
1	Vesicle	Secretion	Proteins / lipids
2	GA	Sorting and packaged	Proteins / lipids
3	ribosomes	Protein synthesis	Protein
4	nucleolus	rRNA synthesis	RNA
5	SER	Lipid synthesis	Lipids
6	Mitochondrion	ATP synthesis	-
7	Invagination made by CM	Bulk transport	Any substances

2 The formulae and melting points of five triglycerides are shown in the diagram. Each triglyceride contains three identical fatty acids.



Which two structural features of the molecules make the melting point higher?

	number of double bonds	length of fatty acid chains
A	fewer	shorter
B	fewer	longer
C	more	longer
D	more	shorter

ANS B [L1] (H1 Alevel/2012/P1/Q3)

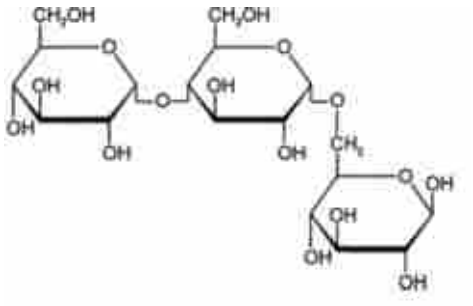
SC: structural features **melting point higher**

OR: **more saturated (C-C)➊ higher melting points; less saturated (more C=C))➊ lower melting points**

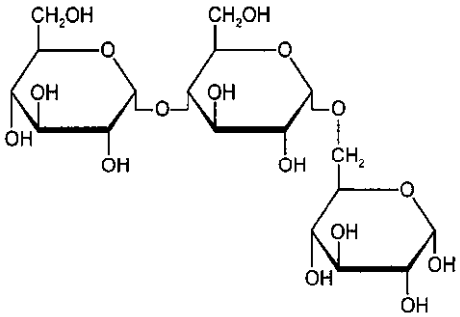
longer chains ➊ higher melting points; shorter chains ➊ lower melting points

3 Which diagram correctly shows a trisaccharide containing both 1,4-glycosidic and 1,6-glycosidic bonds, and formed from both α-glucose and β-glucose molecules?

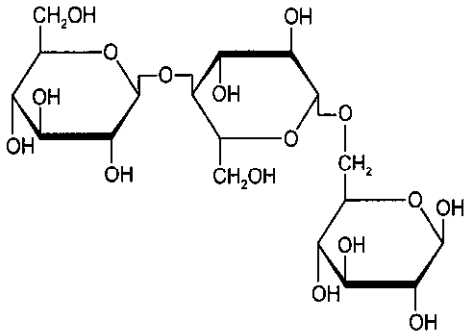
A



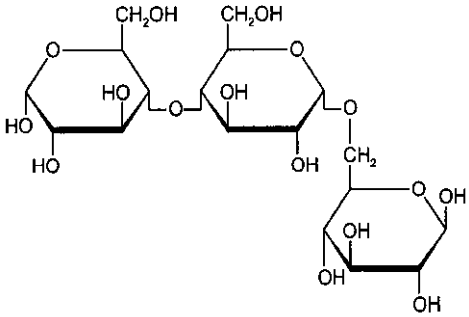
B



C



D

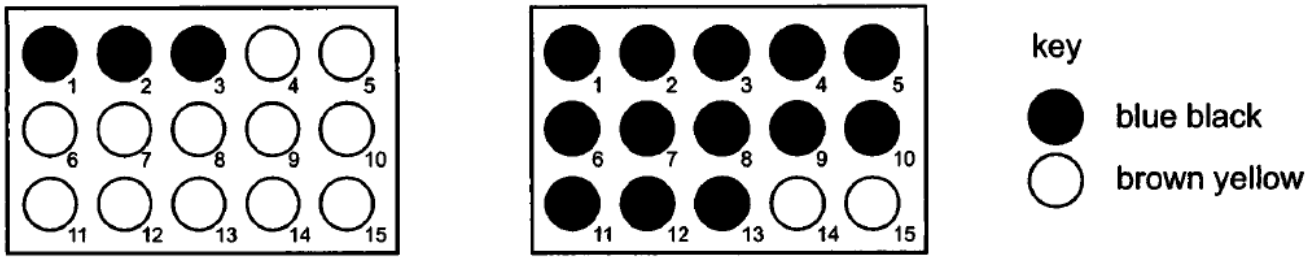


ANS A [L2] (H2 Alevel/2017/P1/Q3)

SC: 1, 4 glycosidic bonds (between alpha glucose) and 1,6 glycosidic bonds (between alpha and beta glucose)

OR: Type of glucose (alpha glucose where –OH group below the plane of the ring; beta glucose where –OH group above plane of ring

4 An experiment was carried out to investigate the digestion of starch using amylase at two different temperatures. A sample was removed from each mixture at 15 second intervals and placed onto a spotting tile well containing two drops of iodine in KI solution. The results are shown in the diagram.



Which shows the correct temperatures and times for the complete digestion of starch?

	temperature / °C	time / s
A	10 30	0.45 3.15
B	10 30	195 45
C	10 30	45 195
D	10 30	3.15 0.45

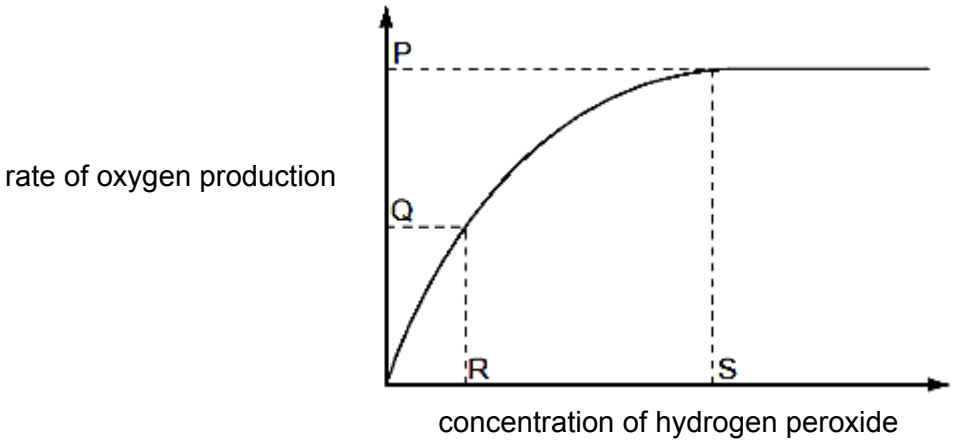
ANS B [L2] (H2 ALevel/2007/P/Q3)
SC: temperature time complete digestion
OR: increase temperature ➲ need less time for digestion [Trend]; faster decolourisation (blue black ➲ colourless)

5 The diagram shows the action of a liver enzyme called catalase, which breaks down hydrogen peroxide into water and oxygen.

$$2\,H_2O_2 \xrightarrow{\text{catalase}} 2\,H_2O + O_2$$

The rate of this reaction can be determined by measuring the volume of oxygen produced in a given length of time. Students added small cubes of fresh liver tissue to hydrogen peroxide solution of varying concentrations and measured the volume of oxygen produced.

The graph shows how the concentration of hydrogen peroxide affected the rate of oxygen production.



Which statements are correct?

1 At P, the rate of reaction me.

2 At Q, all of the enzyme a olecules.

3 At Q, the rate of reaction is limited by the concentration of the substrate.

4 At S, all of the enzyme active sites are occupied by substrate molecules.

A 1 and 4

B 2 and 4

C 1, 2 and 3

D 1, 3 and 4

ANS D [L3] (H2 NJC/2017/P1/Q5)
SC: statements; correct
OR:

1	True
2	False. not all E active sites are occupied
3	True
4	True. E is saturated to form ES complex under high [S]

6 The concentration of glucose is higher in the blood plasma.

By which process does glucose move into red blood cells from the blood plasma?

A active transport

B endocytosis

C facilitated diffusion

D osmosis

ANS C [L1] (modified H2 ALevel/2006/P1/Q3)
SC: Glucose; move into
OR: Glucose is polar ➊ need protein transport

7 It has been found that stem cells transferred from the intestinal lining to the bone marrow produce all of the different types of blood cell instead of intestinal cells.

Which statement explains this?

A All stem cells are totipotent.

B Environmental factors change the expression of specific genes.

C Specific genes are destroyed by endonucleases.

D Specific genes are hidden by condensation of some chromosomes.

ANS B [L2] (H2 ALevel/2010/P1/Q29)
SC: statement explains bone marrow ➊ gives rise to blood cells but not intestinal cells
OR: genes being silenced /genes changes its expression / OWTTE

8 Blood transfusion laboratories around the world are hoping to produce large numbers of red blood cells (rbcs) from 'spare' human embryos produced during *in vitro* fertilisation procedures.

Embryonic stem cells are removed from an embryo and cultured in a growth medium that stimulates their differentiation into rbcs.

Which statement correctly describes this differentiation?

A Multipotent embryonic stem cells differentiate into pluripotent blood stem cells and then into rbcs.

B Pluripotent embryonic stem cells differentiate into multipotent blood stem cells and then into rbcs.

C Totipotent embryonic stem cells differentiate into multipotent blood stem cells and then into rbcs.

D Totipotent embryonic stem cells differentiate into pluripotent blood stem cells and then into rbcs.

ANS B [L1] (H1 Alevel/2013/P1/Q29)
SC: statement describe differentiation
OR: ES cells ➊ pluripotent; blood SC ➊ multipotent

9 In the classic paper that demonstrated the semi-conservative replication of DNA, scientists Meselson and Stahl began by showing that DNA itself will form a band when subjected to density gradient centrifugation.

Escherichia coli grown in ^{15}N DNA were switched to ^{14}N and then harvested at eight different time points. The DNA was centrifuged resulting in the banding pattern shown.

Which statements correctly explain the results?

1 At 20 min, the entire DNA of *E. coli* exists as hybrid with 100% ^{15}N DNA.

2 At 20 min, DNA of *E. coli* is 50% hybrid with 50% ^{15}N DNA.

3 At 38 min, there are two bands consisting of 50% hybrid DNA and 50% light DNA.

4 At 60 min, there is 25% hybrid DNA and 75% light DNA.

A 1 and 2

B 3 and 4

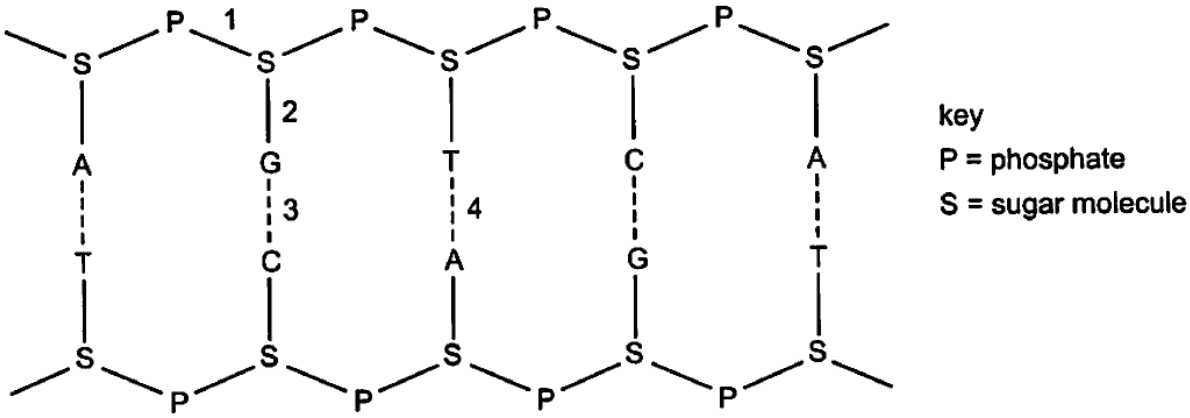
C 2, 3 and 4

D 1, 2, 3 and 4

ANS B [L3] (H2 HCI/2017/P1/Q8)
SC:
OR:

1	False (hybrid with 100% ^{15}N DNA doesn't make sense as hybrids consists of both ^{14}N and ^{15}N strands)
2	False (the bands do not fall in either ^{14}N or ^{15}N)
3	True
4	True

10 The diagram shows part of a nucleic acid.



Which row correctly describes the bonds shown in the diagram at positions 1, 2, 3 and 4?

	is formed by condensation	forms a di-ester	occurs during transcription	involves attraction between polar molecules
A	1	2	1, 2 and 3	3
B	1 and 2	1	3 and 4	3 and 4
C	2, 3 and 4	1	3 and 4	1, 3 and 4
D	2	.3	1, 3 and 4	4

ANS B [L2] (H1 Alevel/2010/P1/Q7)
SC:
OR:

1	Phosphodiester bond; occurs during DNA replication; via condensation rxn
2	Via condensation rxn
3	H bonds; complementary base pairing for transcription; attraction between polar mol.;
4	H bonds; complementary base pairing for transcription; attraction between polar mol.

11 The same length of DNA in a eukaryote can code for more than one protein.

When are different introns removed in order to allow the production of different mRNAs?

A at transcription

B before transcription

C before translation

D during translation

ANS C [L1] (H1 Alevel/2014/P1/Q11)
SC: removal of introns
OR: post transcriptional modification; before translation

12 The active messenger RNAs (active mRNAs) in tissue cells can be isolated by passing the homogenised cell contents through a fractionating column. The column has short lengths of uracil nucleotides attached to a solid supporting material. Most molecules of mRNA that pass through the column quickly break up into small pieces and cannot be translated

The active mRNAs that attach to the column can be separated again by appropriate treatment.

Which statements correctly describe active mRNA?

1 Active mRNAs are held to the fractionating column by bonds between adenine and uracil bases.

2 Active mRNAs can be released from fractionating column by breaking hydrogen bonds.

3 Only mRNAs with polyadenine tailing can be translated.

4 Polyadenine tailing stabilizes mRNA and prevents it from being broken up.

A 1 and 2

B 1, 2 and 3

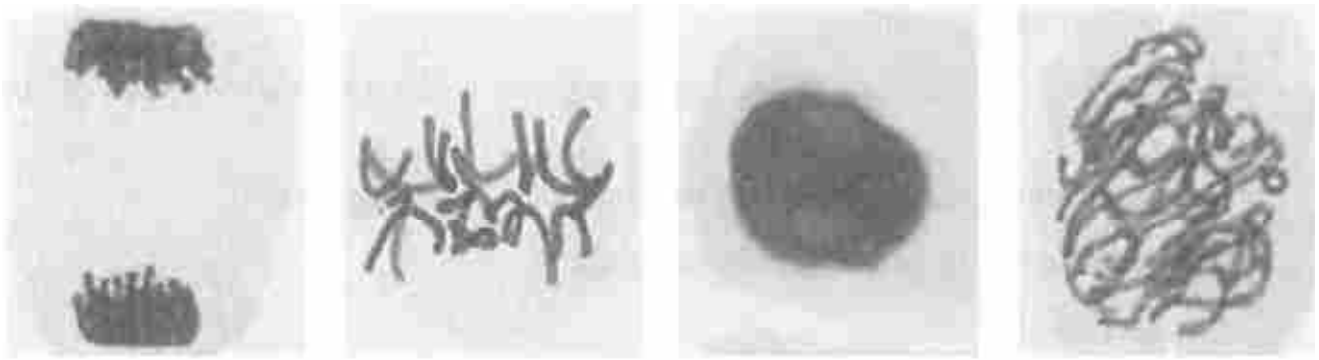
C 3 and 4

D 1, 2, 3 and 4

ANS D [L3] (H2 Alevel/2010/P1/Q17)
SC: statements describe active mRNA
OR:

1	True (polyA tail will H bonds with uracil bases)
2	True (H bonds held these A and U tgt)
3	True (part of post translational mod.; mRNAs w/o polyA tails normally subjected to degradation)
4	True

13 The photomicrographs show different stages of the mitotic cell cycle.



Which row matches the name of a stage, a description of some of the events happening at this stage and a photomicrograph of a stage of the mitotic cell cycle?

	name of stage	description	photomicrograph
A	anaphase	Centromeres bind to spindle microtubules between centrioles. Chromosomes are pulled into position.	1
B	metaphase	Chromosomes align at equator of cell. Microtubules begin to pull the two parts of each chromosome in opposite directions.	2
C	prophase	Chromatin condenses. Nuclear envelope disperses. Nucleolus no longer visible.	3
D	telophase	Chromosomes become less condensed. Spindle microtubules disperse.	4

ANS B [L2] (H2 Alevel/2017/P2/Q16)

SC: row matches

OR:

Photomicrograph	stage	description
√ 1	√ Anaphase	X (description fits for metaphase stage)
√ 2	√ Metaphase	√
X 3	X (Resting state)	X (no condensed chromosomes seen)
X 4	X (Prophase)	X (condensed chromosomes seen)

14 Fig. 14.1 represents the changes in the quantity of DNA in two types of cell divisions that occur in different types of cells of an organism. Fig. 14.2 shows the entire set of homologous chromosomes in a diploid cell of this organism before it undergoes the type of nuclear division that leads to **P**.

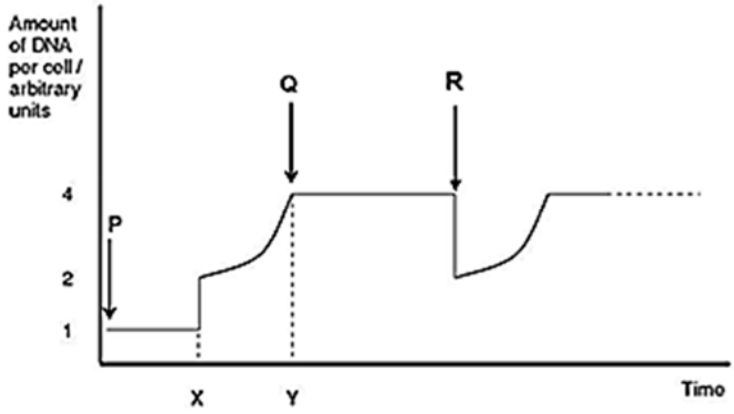
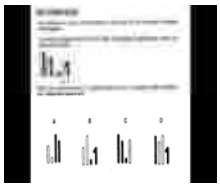


Fig. 14.1

Fig. 14.2

Identify the correct combination of outcomes within a cell in this organism at **P**, **Q** and **R**.

	At **P**	At **Q**	At **R**
A		Diploid set of homologous chromosomes, each with identical sister chromatids.	Diploid set of homologous chromosomes, each a single DNA molecule.
B		Diploid set of homologous chromosomes, each with identical sister chromatids.	Haploid set of chromosomes, each a single DNA molecule.
C		Diploid set of homologous chromosomes, each a single DNA molecule.	Haploid set of chromosomes, each a single DNA molecule.
D		Tetraploid sets of homologous chromosomes, each a single DNA molecule.	Diploid set of homologous chromosomes, each a single DNA molecule.

ANS A [L3] (H2 VJC/2017/P1/Q14)
SC: identify correct combination
OR: P: Haploid number in a gamete (before fusion); Q: Diploid set after fusion of gametes (after S phase where DNA replication took place); R: Diploid set after mitosis

15 A toxic chemical causes malfunction of the centrioles in animal cells.

Which process in meiosis is likely to be directly affected by the chemical?

A crossing over between homologous chromosomes

B migration of chromosomes to opposite poles of the cell

C pairing of homologous chromosomes

D replication of centromeres

ANS B [L2] (H2 Alevel/2005/P1/Q13)
SC: chemical ❷ affect centrioles process meiosis directly affected
OR: responsible in MT production ❷ affecting spindle formation ❷ migration of chromosomes is a problem

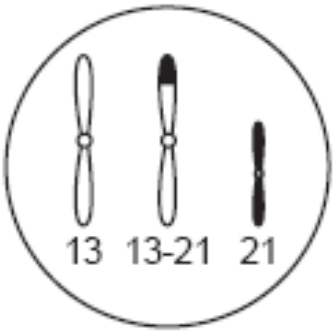
16 Which set of terms matches the definitions in the table?

	definition			
	the structure that replicates in the S phase	in animal cells, the 'pinching in' process that divides the cytoplasm	the cell structure that disassembles to allow chromosome attachment to the spindle	the phase of the cell cycle immediately prior to entering mitosis
A	centriole	cytokinesis	nuclear envelope	S phase
B	centriole	late telophase	nucleolus	S phase
C	chromatid	cytokinesis	nuclear envelope	G_2 phase
D	chromatid	late telophase	nucleolus	G_2 phase

ANS C [L1] (H1 Alevel/2014/P1/Q7)
SC: Definition
OR: As above (content regurgitation)

17 Down's syndrome can be caused by a trisomy of chromosome 21, but can also result from the translocation of chromosome 21 into chromosome 13, forming a single chromosome 13-21.

The diagram shows chromosomes 13 and 21 in the nucleus of a diploid (2n) testis cell from a phenotypically normal male carrier of a 13-21 translocation. This cell has a chromosome number of 45.



Which is **not** a likely outcome of fertilisation of normal oocytes by sperm from this male?

	chromosomes in sperm	embryo
A	13 and 21	2n =46 normal phenotype
B	13-21	2n =45 normal phenotype
C	13-21 and 21	2n =46 Down's syndrome
D	13-21 and 21	2n =47 Down's syndrome

ANS D [L3] (H2 JJC/2017/P1/Q17)

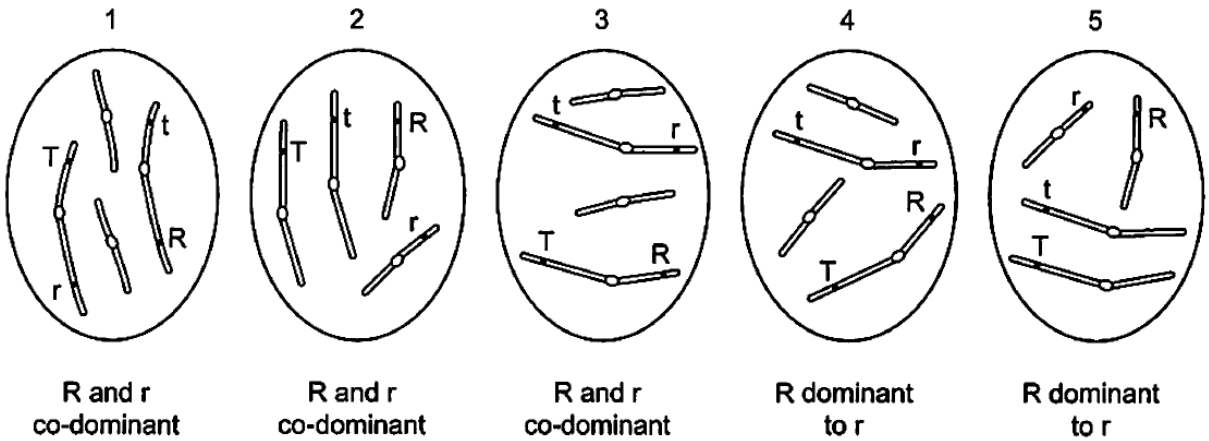
SC: NOT likely outcome **normal oocytes**
OR: potential male gametes: 13, 13-21, 21 **from females with chromosome 13 and 21**

A	√ (paired between M(13) with F(13) as well as M(21) with F(21))
B	√ (one less chromosome; M(13-21) with F(13) but F(21) with male no pairing)
C	√ (paired between M(13-21) with F(13) as well as M(21) with F(21))
D	X (C is true; no additional chromosome seen)

18 In a family of flowering plants, height is controlled by a pair of alleles. The allele for tall (T) is always dominant to the allele for short (t). The flower colour is also controlled by a pair of alleles.

In some species, the allele for red (R) is dominant to the allele for white (r). In other species the colour alleles are co-dominant. (For simplicity, the symbols R and r are used for the co-dominant alleles.)

The diagram shows the chromosome arrangement and information about the height alleles and the flower colour allele in five species of this family of plants.



Each of the plants 1, 2, 3, 4 and 5 was test crossed.

Assuming there is no crossing over, which plants would produce offspring with the phenotypes short with white flowers and tall with red flowers?

A 1,3 and 4

B 2,4 and 5

C 2 and 5 only

D 4 and 5 only

ANS D [L3] (H2 Alevel/2011/P1/Q22)
SC: no crossing over; 2 genes ➊ 2 characters; short and white flowers (ttrr)
OR: R and T are independently assorted ➊ not linked and these genes are found on separate chromosomes
For test cross, unknown genotype will be crossed with a homozygous recessive plant genotype (R_T_ X rrtt)

19 In a monohybrid, X-linked (sex-linked) genetic cross involving two alleles, dominance and recessiveness is observed in the phenotypes obtained. The link between genotype and phenotype is not always obvious when the parental and offspring phenotypes are recorded.

What is the best explanation of this observation?

A The dominant and recessive phenotypes can be explained by the transcription of different nucleotide sequences to produce two different mRNA molecules, which produce a functional and a non-functional protein.

B The expression of the recessive allele only occurs when it is in the male, because the Y chromosome is lacking the entire sequence of nucleotides corresponding to the production of a different protein.

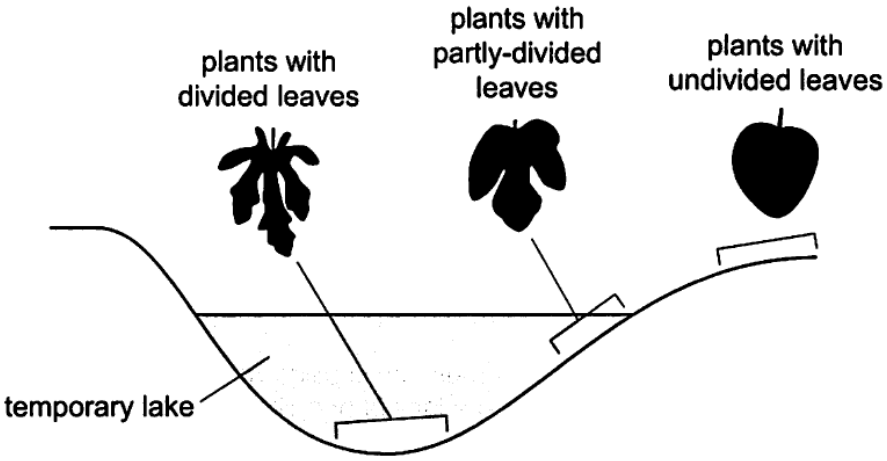
C The nucleotide sequences of the alleles occurring at different loci leads to the production of active and inactive enzymes, so that the heterozygous phenotype only has half of the enzyme concentration of the homozygous dominant phenotype.

D The recessive allele present in the male is unlikely to be expressed in the same way as it would if it occurred in the female heterozygote, as the male does not possess a corresponding nucleotide sequence on the X chromosome.

ANS A [L2] (H2 Alevel/2012/P2/Q23)
SC: best explanation
OR:

A	√ (different alleles of the same gene have different nucleotides that codes for the diff. mRNA)
B	X (not a different protein ❺ Y chromosomes did not carry the allele for that character)
C	X (homozygous dominant phenotype and heterozygous phenotype carries the same amount of E)
D	X (it does; the nucleotide sequence are present on its X chromosome)

20 The diagram shows the distribution of plants with different leaf shapes in an area where flooding has caused the development of a temporary lake. The plants are all of the same species. When there is no flooding, all the leaves are undivided.



What could explain these differences in leaf shape during flooding?

A changes in gene expression dependent on the soil water content

B cross-fertilisation between plants with different leaf shapes

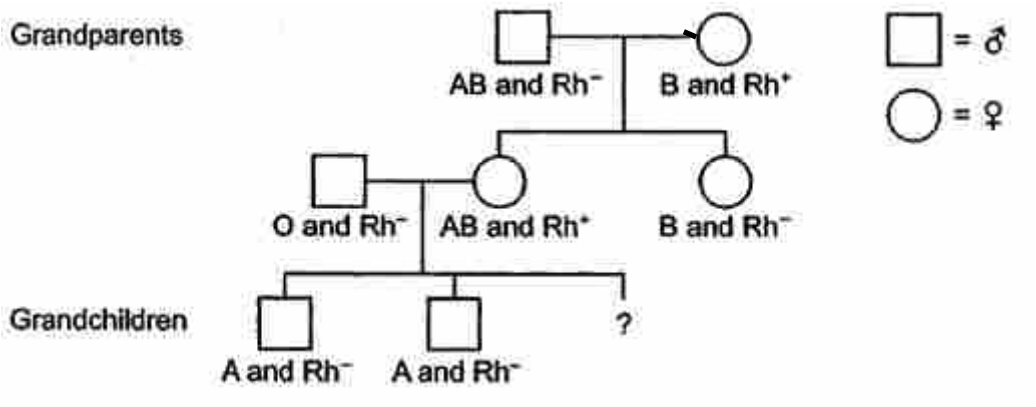
C random assortment of alleles in the plant population

D self-fertilisation allowing adaptation to the local environment

ANS A [L2] (H2 ALevel/2015/P1/Q21)

SC: differences in leaf shape **flooding**
OR:

21 The diagram shows a family tree.



What is the probability that the third grandchild will be a boy with blood group B and Rh positive blood?

A 0.0625 (1 in 16)

B 0.125 (1 in 8)

C 0.25 (1 in 4)

D 0.5 (1 in 2)

ANS B [L3] (H1 Alevel/2007/P1/Q18)

SC: third grandchild	**boy**		
OR:			
Parents	**ii Rh⁻Rh⁻**	**X**	**I^AI^B Rh⁺Rh⁻**
Possible offspring	I^Ai Rh⁺Rh⁻	I^Bi Rh⁺Rh⁻	
	I^Ai Rh⁻Rh⁻	I^Ai Rh⁻Rh⁻	

Probability: For a child to be B blood group = ¼
For a child to a boy = ¼

Hence ❷ 1/8

22 What describes oxidative phosphorylation?

A addition of phosphate to ADP using energy gained by transferring electrons along a chain of carriers

B addition of phosphate to ADP using energy gained by transferring electrons between chlorophyll molecules

C addition of phosphate to glucose in the first step of glycolysis

D removal of phosphate from ATP with the release of energy for work within the cell

ANS A [L1] (H1 Alevel/2008/P1/Q21)
SC: Oxidative phosphorylation
OR: addition of phosphate at ETC

23 Where does ethanol formation occur in a yeast cell?

A cell vacuole

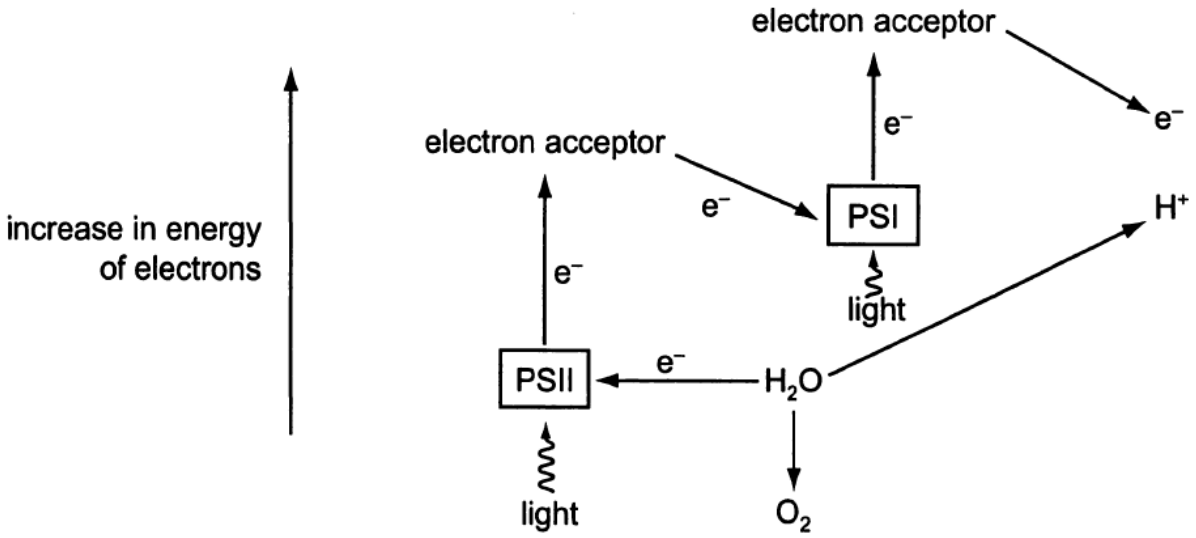
B cytoplasm

C Golgi apparatus

D mitochondrion

ANS B [L1] (H2 ALevel/2002/P1/Q24)
SC: ethanol formation
OR: in cytoplasm

24 The diagram shows the path taken by electrons and the formation of hydrogen ions in the light-dependent stages of photosynthesis.



What are the electrons and hydrogen ions used to produce?

A ATP from ADP

B ATP from ADP and reduced NADP from NADP

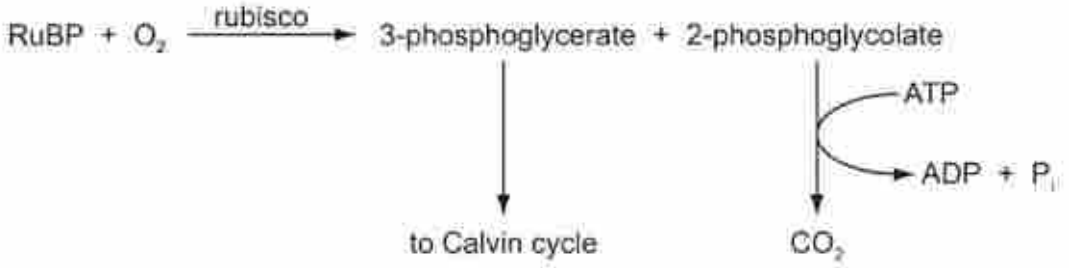
C glycerate 3-phosphate from glyceraldehyde 3-phosphate

D reduced NADP from NADP

ANS B [L1] (H2 Alevel/2009/P1/Q27)
SC: electrons H + ions light dependent rxns
OR: Products ➊ ATP and reduced NADPH

25 Rubisco is the carbon dioxide-fixing enzyme. One rubisco molecule has eight active sites where carbon dioxide fixation occurs, with each active site catalysing only three reduction reactions per second.

The enzyme also catalyses, at the same active sites, the addition of oxygen to ribulose bisphosphate (RuBP). This reaction is favoured when oxygen concentrations in the leaf are high and carbon dioxide concentrations are low.



Which of the facts is paired with a correct explanation?

	fact	explanation
A	On very hot, dry days stomata close to prevent water loss.	This reduces the availability of oxygen, increasing the production of 3-phosphoglycerate.
B	Plants synthesise large volumes of rubisco.	This may be an adaptive response to compensate for low concentrations of oxygen.
C	Processing 2-phosphoglycolate will eventually release carbon dioxide.	This will increase the rate of reduction and increase the rate of RuBP regeneration, increasing the rate of photosynthesis.
D	Rubisco is an inefficient photosynthetic enzyme.	This is because the rate of carbon dioxide reduction can be decreased by competitive binding of oxygen molecules to the active site

ANS D [L3] (H1 Alevel/2012/P1/Q17)
SC: RUBISCO binds to both CO2 and O2 bound to O2 if O2 is high @active site
OR: competitive inhibition

A	X does not explain equation
B	X waste of resource; does not explain context
C	X waste of resource; does not explain context
D	√ photorespiration takes place where RUBISCO binds to oxygen instead of carbon dioxide

26 Which statements are acceptable parts of Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.

2 In competition for survival, the more aggressive animals are more likely to survive.

3 Species perfectly adapted to a stable environment will continue to evolve.

4 Variation between individuals of a species is essential for evolutionary change.

A 1, 2 and 4 only

B 2 and 3 only

C 3 and 4 only

D 4 only

ANS D [L2] (H2 JJC/2017/P1/Q26)
SC: statements acceptable Darwin evolutionary theory
OR:

1	X (anything acquired during lifetime is not inherited)
2	X (survival of fittest does not depend on how strong the organism is)
3	X (not continue to evolve if organism is in a stable environment)
4	√ (variation is the raw material for natural selection to takes place)

27 When organochlorine insecticides such as DDT were in widespread use, mosquitoes in malarial regions developed resistance more rapidly than did houseflies in Britain.

What could account for the difference in the rates of the development of resistance?

A Houseflies produce more generations a year.

B More insecticides was used in Britain.

C More insecticides was used in malarial regions.

D Mosquitoes show fewer random mutations per generation.

ANS C [L2] (H2 ALevel/2002/P1/Q18)
SC: difference in rates of resistance development
OR: selection pressure: insecticides
❷ Mosquitoes subjected to insecticides more often ❼ selects those who are resistant to it

28 Human activity often results in habitat loss. The remaining habitat in an area become fragmented forming smaller patches of habitat, through for example, construction of new roads and deforestation.

Which statements describe how a small habitat patch differs from a larger patch of the same habitat?

1 biodiversity decreases
2 competition from surrounding habitats increases
3 gene pool increases
4 populations of large animals decrease

A 1 and 2 only

B 2 and 3 only

C 3 and 4 only

D 1, 2 and 4 only

ANS D [L2] (H2 MJC/2017/P1/Q25)
SC: statement small patch vs. large patch
OR: all is correct except point 3 (gene pool should be decreasing)

29 Which of the following correctly shows the effects of climate change on coral reefs and associated ecosystems?

	Average number of zooxanthellae in each polyp	Mass of basal plate of hard corals	Diversity of catch from nearby fisheries
A	Decreased	Decreased	Decreased
B	Decreased	Unaffected	Increased
C	Increased	Decreased	Decreased

D	Increased	Unaffected	Increased

ANS A [L2] (H2 SAJC/2017/P1/Q14)

SC: effects of climate change **coral reefs** **associated ecosystems**

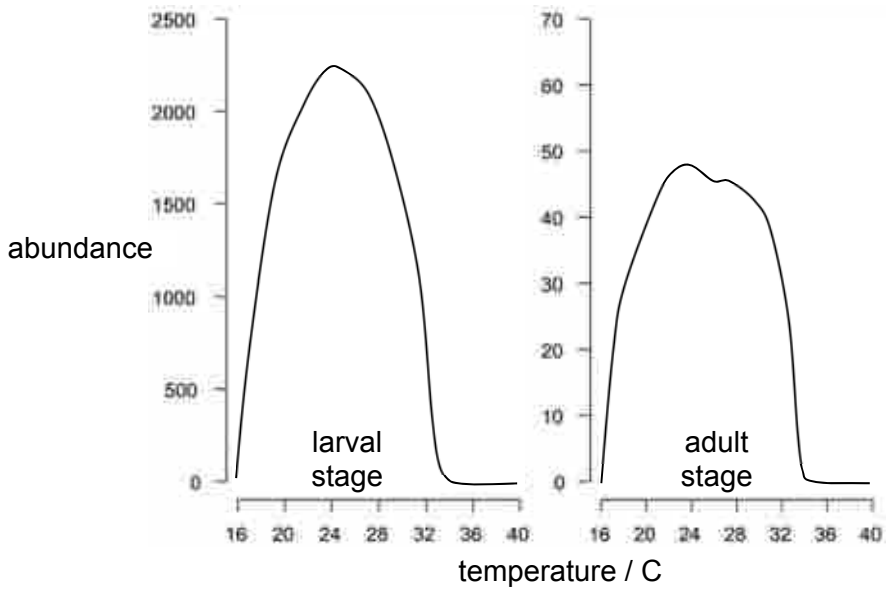
OR: **decrease zooxanthellae (coral bleaching)**

decrease coral (due to ocean acidification and coral cant established themselves)

decrease fishes (loss in keystone species; decrease in organisms in the habitat)

30 Malaria is caused by the protozoan parasite, *Plasmodium falciparum* (*P. falciparum*). Female *Anopheles* mosquitoes pick up *P. falciparum* in a blood meal taken from an infectious person. *P. falciparum* then go through several developmental stages before they migrate to the mosquito salivary glands. Once in the salivary glands, the parasites can be transmitted to a susceptible human host when the mosquito takes another blood meal. The time spent for the parasite to develop in the mosquito is determined by temperature.

Both *Anopheles* and *P. falciparum* are sensitive to temperature. Each stage in the life cycle of *Anopheles* mosquitoes (i.e. egg, larva, pupa and adult) is dependent on temperature, examples of which are illustrated in the following graphs.



Investigations into the effect of global warming on malaria transmission often focused on the blood meal-egg laying stage in adult females.

Which row shows the reason for and limitation use for the research?

	reason for the use	limitation of the use
A	Temperature-dependencies are not the same across the different developmental stages of the *Anopheles* mosquitoes.	Increased temperature increased larval mortality and decreased developmental speed.
B	*P. falciparum* is transmitted by adult females.	um temperature for *P. falciparum* growth does not necessarily correspond to the vector's optimum temperature.
C	*P. falciparum* is transmitted by adult females.	Temperature-dependencies are not the same across the different developmental stages of the *Anopheles* mosquitoes.
D	Optimum temperature for *P. falciparum* growth does not necessarily correspond to the vector's optimum.	Increased temperature increased larval mortality and decreased developmental speed.

ANS B [L3] (H2 HCI/2017/P1/Q29)
SC: reasons limitation
OR: parasite is transmitted by female mosquitoes (reason); Parasite and mosquitoes optimum temperature is not the same

END OF PAPER

CATHOLIC JUNIOR COLLEGE
JC2 PRELIM EXAMINATION
Higher 1

Answers

CANDIDATE NAME	
CLASS	**2T**
INDEX NUMBER	

BIOLOGY

8876/02

Paper 2 STRUCTURED & FREE RESPONSE QUESTIONS

20 AUGUST 2018
2 hours

Candidates answer on the Question Paper.
Additional Materials: Writing Paper

READ THESE INSTRUCTIONS FIRST

Write your Centre number, index number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer all questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together as follows:
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1 [8]	
2 [12]	
3 [8]	
4 [5]	
5 [12]	
6 or 7 [15]	
TOTAL P2	**60**

This document consists of **25** printed pages and **1** blank page.

[Turn over

Section A

Answer **all** questions in this section

1 **(a)** Fig. 1.1 is an electron micrograph showing part of an organelle present in a mature plant cell.

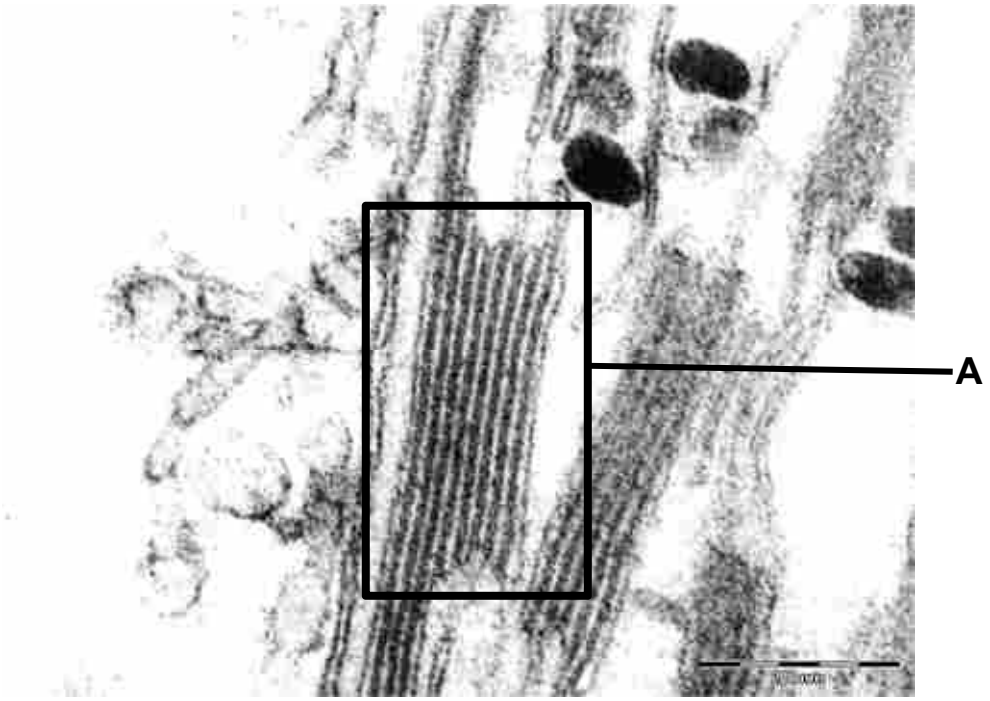


Fig. 1.1

(i) Identify the organelle in which structure **A** resides.

.....[1]

ANS [L1] Novel [1]

SC: Identify **organelle** **cell structure A**
OR: **Chloroplast**

1. Chloroplast

(ii) Explain the significance of the flattened stack arrangement in structure **A**.

.....

.....

.....

.....[2]

ANS [L2] Novel [2]

SC: explain **significance** **flattened stacks** **A**
OR:Give reasons **importance** **1] increase SA; maximise attachment of photosynthetic pigments** **max light absorption**
2] increase thylakoid space ➊ build up proton grad

The thylakoids are arranged in flattened sacs in stacks

1. is to provide **large surface area** to maximize the **attachment of** (photosynthetic elements) / electron protein carriers, ATP synthases and **photosynthetic pigments** for **maximum light absorption**;

2. is to **increase** thylakoid **space** for the **building up of proton gradient** needed for ATP synthesis via chemiosmosis**;**

(b) Fig. 1.2 shows the structure of a cell surface membrane.

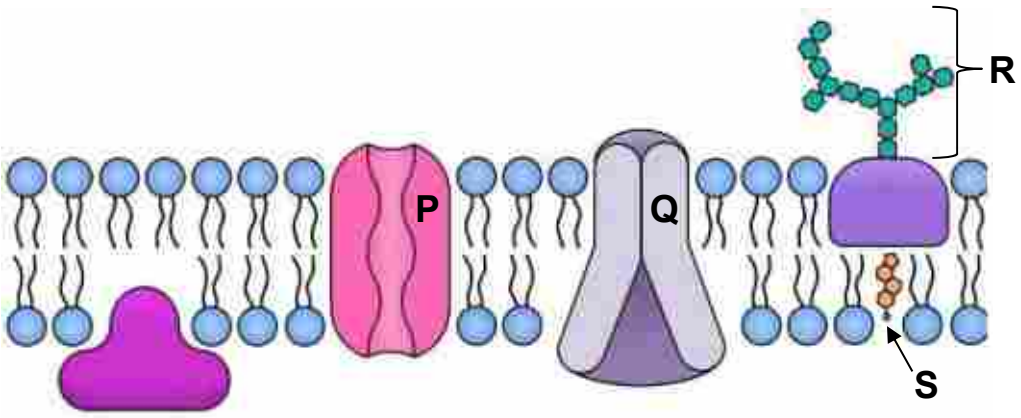


Fig. 1.2

With reference to Fig. 1.2,

(i) explain how the structure of **Q** allows it to be embedded in the cell surface membrane.

.....

.....[1]

ANS [L1] Novel [1]

SC: Explain how **structure Q** **embedded**
OR: **made up of both hydrophilic and hydrophobic R-groups A.A**

1. Structure Q / Carrier protein Q / Q has 3D conformation shape that are made up of **both hydrophilic and hydrophobic amino acids** that folds and anchored on the cell membrane where it can form hydrophilic and hydrophobic interactions with the phospholipid bilayer respectively / OWTTE

(ii) explain how structure **P** functions differently compared to structure **Q**.

.....

.....[1]

ANS [L2] Novel [1]

SC: explain how **P** **Q** **function differently**
OR: **(channel)** **(carrier)**

1. P allows substances to pass through cell membrane via **facilitated diffusion** only whereas Q allows both **facilitated diffusion and active transport**.

(iii) explain why structure **S** is amphipathic.

……

……[1]

ANS [L2] Novel [1]

SC: Explain why structure S amphipathic
OR: S: cholesterol: 4 fused rings + hydrocarbon tails ➊ hydrophobic; -OH group ➊ hydrophilic

1. **S / cholesterol** contains both a **hydrophilic –OH group** and a **hydrophobic 4 fused C rings** that wedged neatly between the phospholipid bilayer.

An immune response is triggered when the body recognises and defends itself against any substances that appear foreign to the body.

(iv) Suggest why a change in R may cause an immunological response.

……

……[2]

ANS [L3] Novel [2]

SC: suggest why a change in R immunological response
OR: R: R ➊ function for cell recognition
Change/Mutated glycoprotein R ➊ changes on CBH chains ➊ cannot recognise as self / see as foreign ➊ trigger immune response

1. **Glycoprotein R** plays an important role for **cell-to-cell recognition** / **serve as identification tags**
2. With **mutated/changes** in **glycoprotein R**, this **changes** the types of sugar residues that make up the **carbohydrate chains** on glycoprotein R which is **considered foreign / cannot recognise as self** thus triggering an immune response.

[Total: 8 marks]

2 **(a)** Fig.2.1 shows the structure of an adult haemoglobin molecule, HbA.

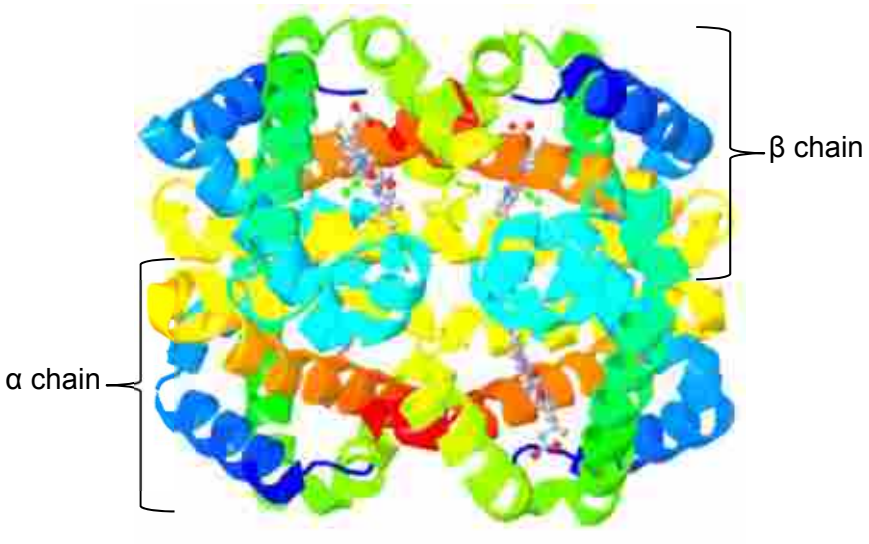


Fig. 2.1

(i) With reference to Fig. 2.1, explain how the structure of HbA is related to its function.

.....

.....

.....

.....[2]

ANS [L1] (Novel) [2]
SC: Explain how **structure of HbA** **function**
OR:

	STRUCTURE	**FUNCTION**
1	HbA molecule has an **overall globular shape** that allows **compact packing**	Allows **many HbA molecules to be packed into a red blood cell** for transport of oxygen.
2	**4 subunits in each haemoglobin molecule**. **Each subunit in haemoglobin consisting of a protein (globin) and a prosthetic (non-protein) haem group component.**	This allows haemoglobin to bind to four oxygen molecules, which greatly **facilitates the transport of oxygen** by haemoglobin.
4	Four subunits in each haemoglobin molecule, **each consisting of a protein (globin) and a non-protein (haem group) component.**	This is the haem binding site. It **is lined with hydrophobic amino acid residues** to provide a hydrophobic environment for the haem group, which is largely hydrophobic.
5	The haem group consists of a porphyrin ring and an iron ion (Fe^{2+}).	**Allowing the release of oxygen in metabolically active tissues such as muscle**.
6	Within haemoglobin, **each polypeptide (α subunit and β subunit)** consists of **both hydrophilic and hydrophobic amino acid residues**. The bulk of **the hydrophobic amino acid residues are buried in the interior of the globular structure** while the **hydrophilic amino acid residues are on the outside**.	This makes the haemoglobin **soluble** in aqueous medium allowing haemoglobin to be a **good transport protein for oxygen** in blood.

Max 2

Sickle cell anaemia is an inherited disease due to a mutation in the allele that codes for β-globin polypeptide chain. This mutant HbS allele results in the production of haemoglobin variant HbS.

Figure 2.2 shows the blast sequence of both the normal adult haemoglobin variant, HbA, as well as the mutant adult haemoglobin variant, HbS.

Beta globin sequence in normal adult haemoglobin (HbA)

nucleotide base	C T G A C T C C T G A G G A G A A G T C T
amino acid	Leu – Thr – Pro – Glu – Glu – Lys – Ser

Beta globin sequence in mutant adult haemoglobin (HbS)

nucleotide base	C T G A C T C C T G T G G A G A A G T C T
amino acid	Leu – Thr – Pro – Val – Glu – Lys – Ser

Fig. 2.2

(ii) With reference to Fig.2.1 and Fig. 2.2, explain how this mutation affects the structure of the haemoglobin molecule.

……

……

……

……[2]

ANS [L2] (Novel) [2]

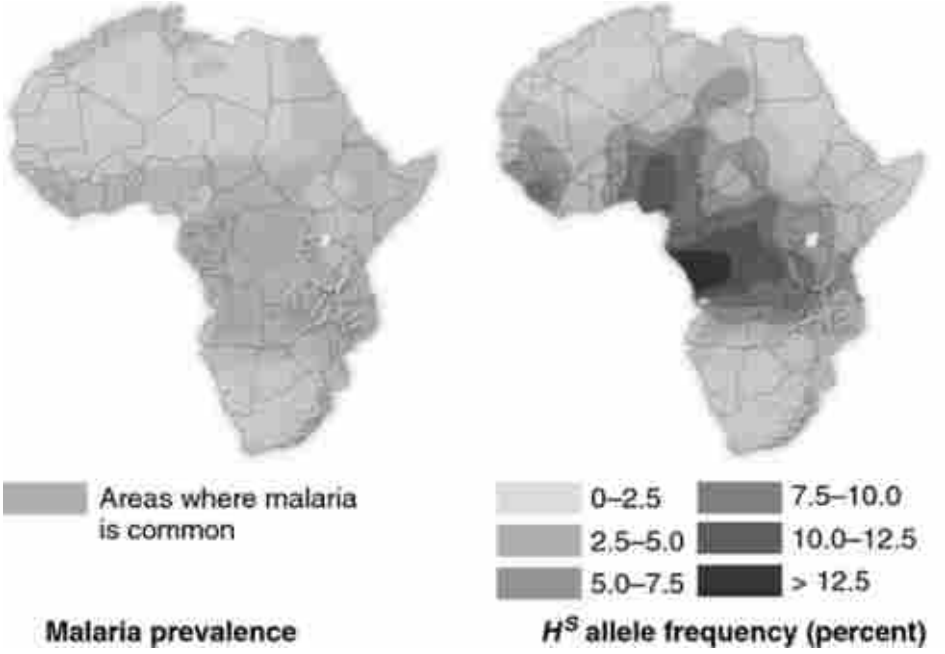
SC: Explain how affect structure of haemoglobin mol.
OR:
1. single-base substitution; T ➐ A and mRNA codon from GAG ➐ GUG
2. Glu (hydrophilic/polar) ➐ Val (hydrophobic/nonpolar) ➐ change 3D conf. ➐sickle shaped rbc

1. Due to **single-base substitution, thymine** in **normal** DNA sequence is **replaced** with **Adenine** in the **mutant** DNA sequence, **mRNA codon change** from **GAG** to **GUG**
2. **Glutamic acid** which is **hydrophilic / polar** in normal HbA protein is being replaced to **valine** which is a **hydrophobic/non-polar** amino acid in mutant HbS protein, resulting in a different **3D conformation shape** resulting in **sickled red blood cells**

Sickle cell disease has its highest occurrence in sub-Saharan Africa. Despite the survival disadvantage of the allele HbS, HbS allele persists at more than 12.5 % in the population.

Fig. 2.3 shows regions where sickle cell anaemia is most common, which coincide with regions where malaria is. Malaria-causing parasites are introduced into the blood by mosquitos.

Fig. 2.3



(iii) With reference to Fig. 2.3, explain why HbS allele is still preserved within the population and suggest why it occurs at an unusually high frequency in Africa.

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.....[4]

ANS [L2/L3] (Novel) [4]

SC: With reference to Fig.1.6 1. explain how HbS frequency preserved
2. suggest why these alleles highest

OR:

1. Explain why
- **Diploidy❷ HbS: recessive allele❷exist in carriers (Hb^AHb^S) and passed down thru generations**
- **hence maintain pool of HbS in the population**

2. Suggest why
- **selection pressure (malaria) is the greatest; heterozygous individuals (selective adv)**
- **need to survive malaria ❷ HbS allele is selected for (for malaria parasite can't develop in sickle cells❷ X infection)**
- **need to survive from SCA ❷ HBA allele is selected for (for efficient O_2 transport at low [O_2] levels)**

[Explain why]

1. Due to diploidy, recessive alleles such as HbS are **hidden / masked over** by the **dominant allele** HbA.
2. Thus, it always existed **in carriers** (Hb^AHb^S) and passed down through generations, **maintaining the gene pool of HbS in the population**

(2 marks for points 1 & 2)

[Suggest why]

3. **Selection pressure** to survive from **malaria** is greatest (shown in Fig.1.6), thus **heterozygous** individuals are at **selectively advantage**.
4. There is a need to survive from malaria where **HbS is selected** for as **malaria parasite cannot developed in sickle cells**.
5. There is also a need to survive from sickle cell anaemia (SCA) where **HbA is selected** to allow **efficient oxygen transport** around the body, especially **at low oxygen concentrations**.

(Max 2 marks for points 3 - 5)

(b) Haematopoietic stem cell (HSC), usually derived from bone marrow, peripheral blood or umbilical cord blood have shown great promise in the treatment of sickle cell disease recently. Sources of such stem cells may be autologous (i.e. using the patient's own stem cells), allogeneic (i.e. using stem cells derived from a donor) or syngeneic (i.e. using stem cells from an identical twin).

After extraction, researchers cultivate these stem cells before injecting them back into the patient. Such haematopoietic stem cell transplantation (HSCT) therapy could potentially give new hope to patients with sickle cell anaemia, although the treatment comes with its own risk towards the patients.

(i) Explain how extracted haematopoietic stem cells are cultivated before they are injected back to the patient.

……

……

……

……[2]

ANS [L1] (Novel) [2]

SC: extracted SC **cultivate & injected back to patient** **explain how (process)**
OR: bone marrow (diff. source) ❼ induction for proliferation ❼ in need of growth factors / inducers ❼ differentiate into blood cells

1. Obtain / extract of **blood stem cells / haematopoietic stem cells** from the **bone marrow (or any other sources named from context given)** which is then grow them in culture dish / chambers in order to alter the surface of culture chambers to **induce** cells to undergo **proliferation.**

2. Provide the necessary **growth factors** / **change the chemical composition** of the culture medium, in addition to the nutrients in the culture medium to **induce** them to become / **differentiate** into **blood cells**

OWTTE

(ii) Explain why treatment using HSC from allogeneic sources may pose some risks to the patient.

……

……

……

……[2]

ANS [L2] (Novel) [2]

SC: Explain why HSCT treatment pose risk to patient
OR: Tissue rejection by recipient patient
Graft-vs-Host disease ➊ WBC from donor cells 'attack' recipients' host cells (new info.)

Either

1. Recipient host cells considers **donor stem cells as foreign** and
2. **rejects** by host's immune system, which then **destroy the transplanted tissue/cells**. / **OWTTE**

Or (more accurately)

1. White blood cells from donor's immune system remain within donated cells/tissues cells **recognise the recipient as foreign** and
2. **attack** the recipient's body cells, which leads to graft-vs-host disease / OWTTE

[Total: 12]

3 Fig. 3.1 shows chickens with two different feather colours in which the gene for feather colour is carried on an autosome. The gene has two alleles, one that codes for black and the other for splashed-white. When a male chicken with black feathers is mated with a female chicken with splashed-white feathers, all the offspring have blue feathers. This also occurs when a male chicken with splashed-white feathers is crossed with a female with black feathers.

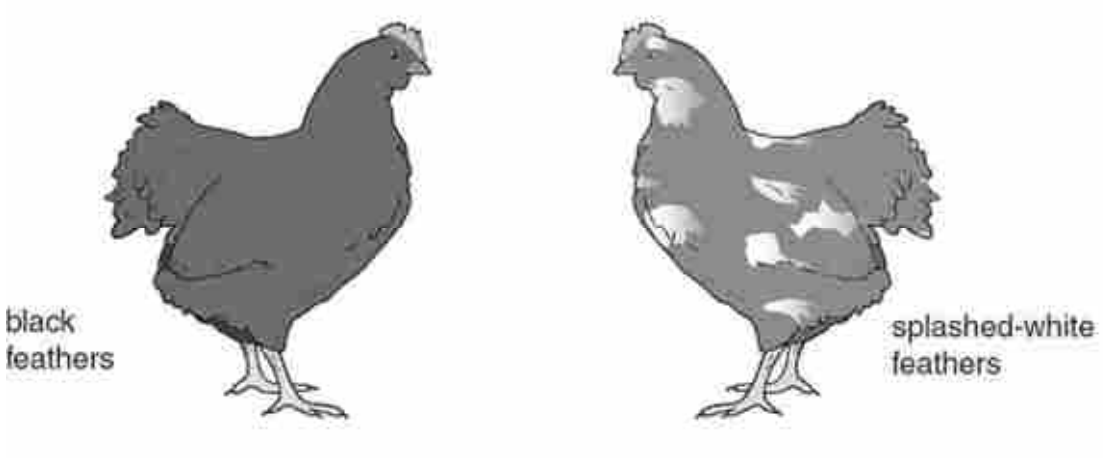

Fig. 3.1

(a) The blue feathers is the result of codominance.

Explain what is meant by 'codominance'.

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.....[2]

ANS [L2] (Novel) [2]

SC: Explain what meant by codominance in this context
OR: heterozygotes❷ C^BC^W (no allele exert dominance over each other both alleles are expressed

1. In heterozygote chickens, genotype **C^BC^W, neither allele exert dominance over the other**
2. **Both** alleles **C^B and C^W are expressed** to give the **blue colouration** on the chicken feathers.

Another gene may cause stripes on feathers (barred feathers), as shown in Fig. 3.2. This gene is carried on the X chromosome. The allele for barred feathers (**X^A**) is dominant over the allele for non-barred feathers (**X^a**).

In chickens, the male is homogametic and has two X chromosomes while the female is heterogametic and has one X chromosome and one Y chromosome.

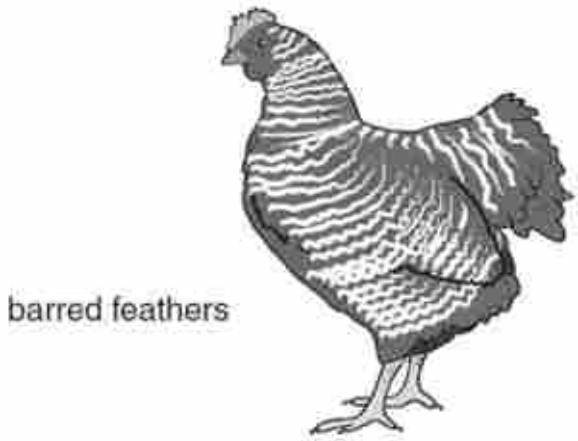

Fig. 3.2

(b) A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers. All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given above draw a genetic diagram to show this cross.

parents' phenotype	male, black, non-barred feathers.	female, splashed-white, barred feathers.	
genotype	$C^BC^BX^aX$	$C^WC^WX^A$	[1]
gametes	C^BX^a C^BX^a	C^WX^A C^WY	[1]
offspring genotypes	$C^BC^WX^AX^a$		[1]
phenotypes	male, blue, barred feathers.	female, blue, non-barred feathers.	[3]

ANS [L2] (H2 NYJC/2017/P2/Q7)

[1] for parental genotype;
[1] for gametes;
[1] for offspring genotype and matching;

(c) Explain how a farmer could use a breeding programme to find out the genotype of a male chicken with blue, barred feathers.

……

……

……

……

……

……[3]

ANS [L2] (H2 NYJC/2017/P2/Q7) [3]

SC: Explain how **genotype of male chicken** **blue barred feathers**
OR: **do test cross with female (non-barred)**

1. Carry out a **Test cross** with female with recessive trait, i.e. **non barred** feathers _ _ X^aY
2. if **all** offspring **barred** feathers, the male parent must be $\mathbf{X^AX^A}$ / **homozygous** ;
3. if **some** offspring **non-barred** features, the male parent must be $\mathbf{X^AX^a}$ **/ heterozygous** ;

4 A student investigated respiration in a population of yeast growing in a sealed container.

Fig. 4.1 shows the results of his investigation.

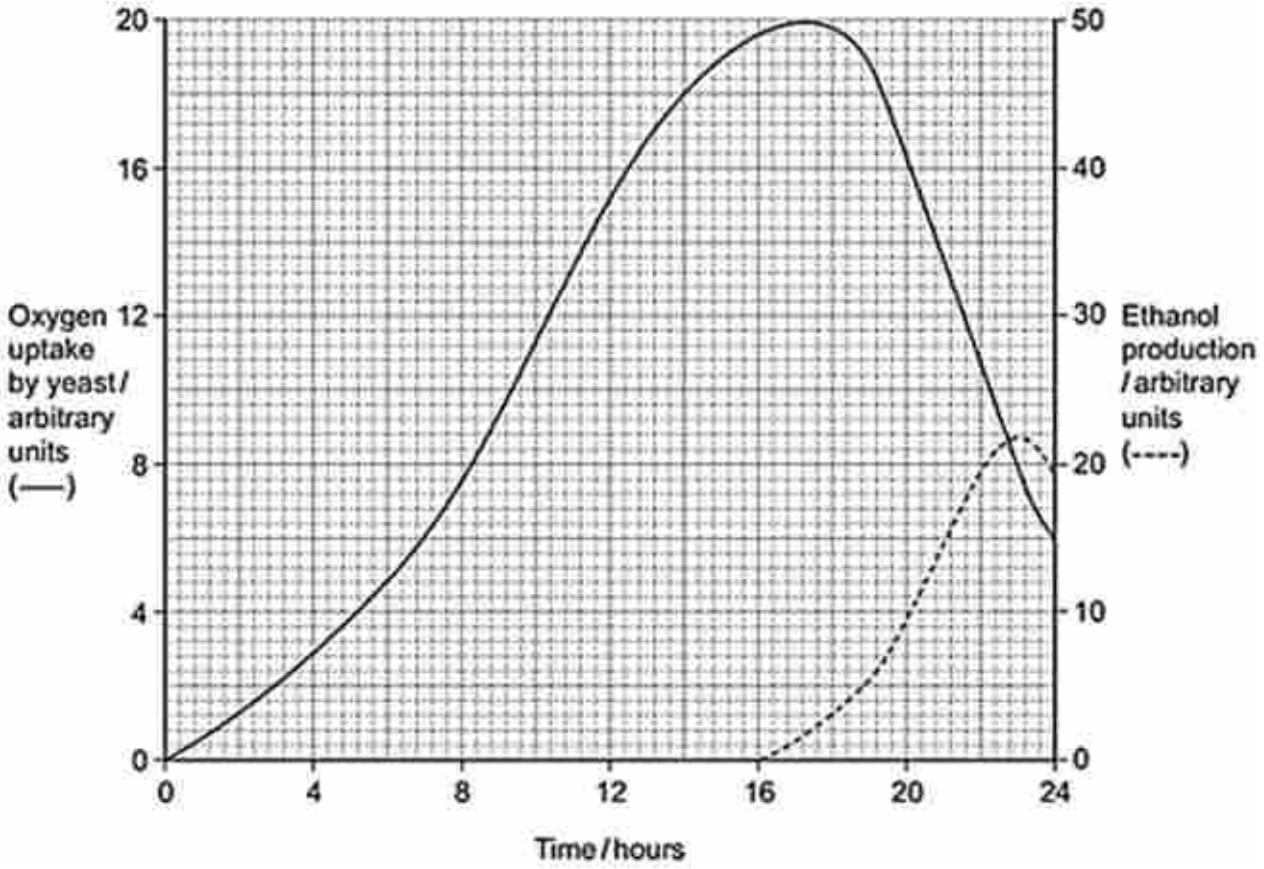

Fig. 4.1

(a) With reference to Fig. 4.1, explain the changes in the ethanol production by yeast during this investigation.

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.....

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.....

.....[3]

ANS [L2] (H2 NJC/2017/P2/Q7) [3]

SC: **With ref. Fig. 3.3** **explain changes** **ethanol production from 16h-24h**

OR:

[Trend]: As time ↑ from 16h to 23h, Ethanol pdtn↑ from 0-22a.u. & oxygen ↓ from 19-9a.u.

[Explain]: convert from aerobic to anaerobic respiration / ethanol or alcohol fermentation from 23h-24h

[Trend]:As time ↑ from 23h-24h, ethanol pdtn ↓ from 22-20 a.u.

[Explain]: [glucose] ↓ / becomes limiting / ethanol reaches toxic levels

1. [*Describe*] As time **increases** from **16h to 23h**, ethanol production **increases from 0 a.u. to 22 a.u**. while oxygen concentration continue to decrease from 19 a.u. to 9 a.u.

2. [*Explain*] Yeast has convert from aerobic respiration to **anaerobic respiration** OR **ethanol / alcohol fermentation**
3. [*Describe*] As time further **increases** from **23h to 24h**, ethanol production **decreases from 22 a.u to 20 a.u.**
4. [*Explain*] This is due to **glucose concentration become limiting / decreases** OR **ethanol levels has reach toxic enough to kill the cells**

Max 3: 1 mark for describe and 2 marks for both explanation

(b) Sodium azide is a substance that inhibits the electron transport chain in respiration. The student repeated the investigation but added sodium azide after 4 hours.

Suggest how the addition of sodium azide would affect oxygen uptake and ethanol production by yeast.

……

……

……

……

……[2]

ANS [L3] (H2 NJC/2017/P2/Q7) [2]

SC: **Suggest** **& Explain how** **sodium azide** **affect oxygen uptake**

OR: **oxygen uptake ↓es / stopped ➊ final e acceptor**
ethanol pdtn starts
switch from aerobic ➊ anaerobic / ethanol fermentation

1. Addition of sodium azide **decreases the oxygen uptake** / **causes oxygen uptake to cease / stop** since it is the **final electron acceptor** of the electron transport chain (ETC) / OWTTE

2. **Ethanol production** starts earlier as yeast switches from **aerobic respiration to anaerobic respiration / ethanol fermentation / alcohol fermentation**.

5 Monarch butterflies are one of the largest migrating butterflies in the world. They have recently come under the spotlight in research due to how global warming is affecting their populations.

Monarch butterflies, shown in Fig. 5.1, are obligate feeders on a specific species of milkweed plant for both adults and caterpillars, and lay their eggs on these plants as well. These plants also secrete a toxin called cardenolides that deter most vertebrate herbivores that the monarchs are tolerant to. The monarchs even accumulate these toxins in their bodies that make them taste bad for their predators.

Fig. 5.1

(a) Based on the information above, identify two selection pressures for the monarch butterflies.

……

……

……

……[2]

ANS [L1] (H1 Novel) [2]
SC: identify 2 selection pressures
OR:predation on larvae; toxins in milkweed; temperature

Any two;

1. Predation on larvae; difficulty in feeding on milkweed; toxins in milkweed; accept: temperature;

(b) Explain how monarch butterflies and caterpillars have evolved to have a defense against their predators.

……

……

……

……

……

……[3]

ANS [L2] (H1 Novel) [3]

SC: Explain how monarch butterfly/caterpillars evolved defense against predators
OR:
1. genetic variation
2. tolerant /sequester cardenolides ➊ selective adv
3. survive & reproduce similar offsprings + ↑allele freq

1. There is **genetic variation** within the population of monarch butterflies where some are less and some are more tolerant to cardenolides.
2. Those that are **more tolerant to and are able to sequester cardenolides** are at a **selective advantage** over those that are less tolerant to and/or those unable to sequester cardenolides.
3. **Over time**, these selective advantageous individuals **survive and reproduce similar offspring** and **alleles** that confer tolerance and ability to sequester cardenolides **increase in frequency**.

(c) Monarch butterflies, like most insects, are highly sensitive to weather and climate. Based on Q_{10} theory, they depend on environmental cues, temperature in particular, to trigger reproduction, migration, and hibernation.

(i) State the meaning of Q_{10} theory and describe the correlation of this theory on insect physiology.

.....

.....

.....

.....[2]

ANS [L1] (H1 Novel) [2]

SC: State	**Q_{10} theory**	**Describe correlation**	
OR:	**For every 10°C ↑**	**impact on insect physiology; ↑ temp●**	**life cycle faster; mature faster**
	2-fold ↑ in E rxn		**multiply faster**

1. The Q_{10} theory of enzyme states that for **every 10°C increase in temperature**, there will be **2 fold increase in the enzyme reaction / OWTTE**

2. This has an impact in insect physiology as their **lifecycle gets shorter / shorter instars**, gaining maturation stage **faster** as well as **multiply faster / breed more**. / **OWTTE**

Fig 5.2 below shows data of monarch butterflies arriving at Mexico during winter.

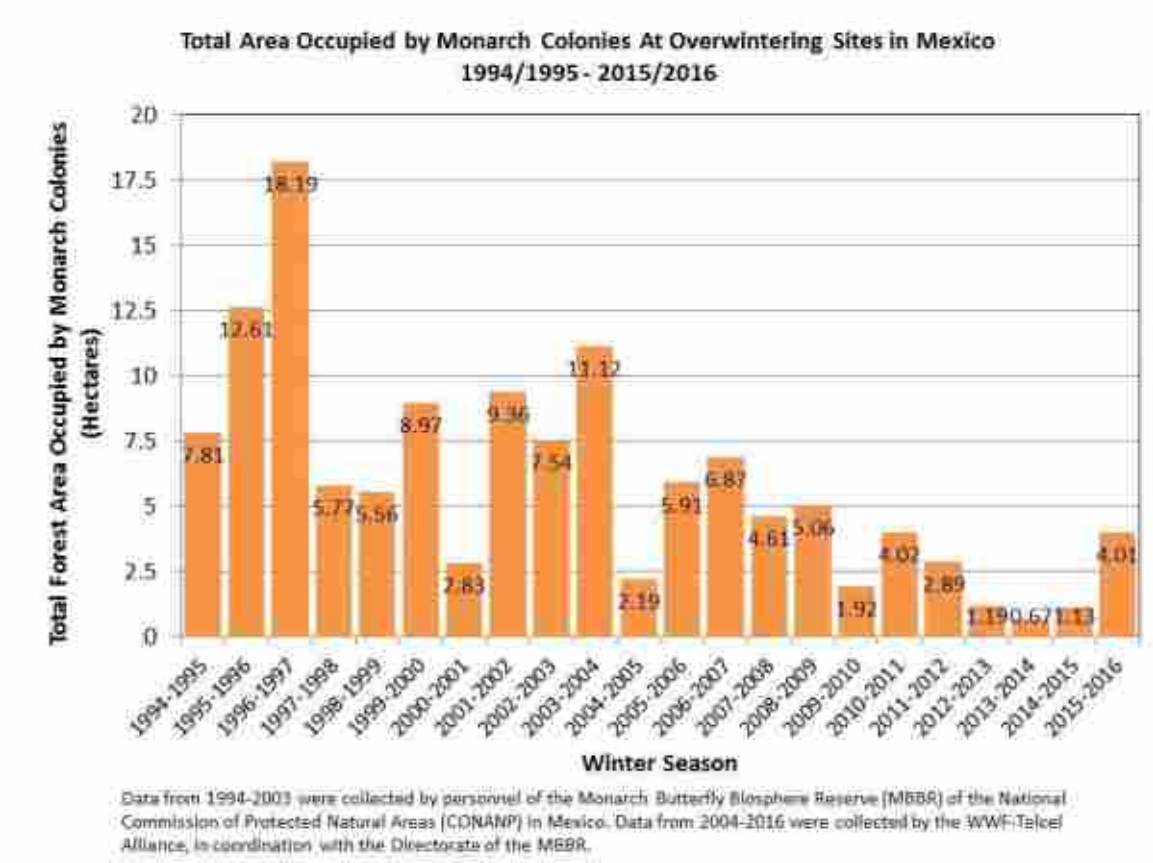

Fig. 5.2

(ii) Explain why monarch butterflies would be highly sensitive to climate change.

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……

……[2]

ANS [L2] (H1 Novel) [2]

SC: Explain why monarch butterflies highly sensitive
OR:
1. not able to regulate temp. / depend on ambient temp
2. small size ● temperature diff affect them (even at small changes)
3. dependent on temp as signal to reproduce, migrate, hibernate
4. any changes in temp (esp. ↑temp due to temp) would change the cue

1. Monarch butterflies, like most insects, are cold-blooded animals; they are **unable to regulate their temperature** and **depend on ambient temperature**
2. They are **small sized**, hence **small fluctuations in temperature affect them** more than other animals in terms of metabolism
3. They depend on a **particular temperature** as a signal / cue for reproducing, migrating and hibernate, hence **global warming would change the cue** for them to carry out such crucial processes
4. **AVP**

Max 2

(iii) Based on recent research, it has been found that increasing temperature can cause milkweeds to secrete a significantly higher level of cardenolides than normal.

With reference to Fig. 5.2 and this information, suggest how climate change is likely going to affect the monarch butterflies.

……

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……

……

……[3]

ANS [L3] (H1 Novel) [3]

SC: with reference to Fig. 4.2 + info suggest how climate change ● affect monarch butterfly
OR: **[cause] [effect]**

1. Increase in temperature will affect the **timing of their migration**, evident by the number arriving at Mexico as **changes in temperature affects the cue to when they start migrating**;
2. Climate change will **shift the migration range of monarch butterflies** more north and higher due to increasing temperature;

3. **but the milkweed which they depend on may not be able to redistribute as quickly** since they are plants, hence resulting in loss of food;

4. Increase in temperature due to global warming may also cause the **milkweed plants to produce more toxins faster than the monarch butterfly population can adapt / evolve,** killing off some of them;

AVP (1m max)

5. Global warming **may also directly kill off** monarch butterflies due to their **narrow physiological tolerance** range to temperature

6. **AVP**

[Total: 12]

Section B
Answer EITHER 5 OR 6.

Write your answers on the separate answer paper provided.
Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answers must be in continuous prose, where appropriate.
Your answers must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

6 In photosynthesis, glyceraldehyde 3-phosphate (3-carbon sugar) is produced in the stroma of chloroplast during Calvin cycle.

(a) Outline this process and how the glyceraldehyde 3-phosphate is converted into starch and discuss the suitability of starch as a storage compound in plants. [8]

(b) Compare the processes of Calvin cycle to that of the Krebs cycle. [7]

[Total: 15]

7 **(a)** Outline the process of DNA replication and discuss the suitability of DNA as a hereditary material. [8]

(b) Compare the processes of DNA transcription to that of DNA translation. [7]

[Total: 15]

6 In photosynthesis, glyceraldehyde 3-phosphate (3-carbon sugar) is produced in the stroma of chloroplast during Calvin cycle.

(a) Outline this process and how the glyceraldehyde 3-phosphate is converted into starch and discuss the suitability of starch as a storage compound in plants.
[8]

ANS [L1/L3] (H1 Alevel/2009/P2/Q5c)
SC: 1. outline GALP made 2. GALP ➊ Starch 3. Discuss suitability of starch (as storage cpd)
OR:

Outline how Glyceraldehyde 3-phosphate is made in Calvin cycle:

1. In carbon fixation, **one molecule** of **carbon dioxide** is incorporated to a **5C ribulose bisphosphate** (RuBP) to give a **6C** intermediate,
2. This is **catalysed by** the enzyme **ribulose bisphosphate carboxylase oxygenase** / **RUBISCO**
3. This **6C** intermediate is **unstable**; hence it is broken down to give two molecules of **3C glycerate-3-phosphate** (**GP / PGA**).
4. In carbon reduction, **glycerate-3-phosphate** (GP) in the presence of **ATP** and **reduced NADP** / **NADPH** (both from the light dependent stage) is **reduced** to **Glyceraldehyde-3-phosphate** (**TP / GALP**).

Outline how Glyceraldehyde 3-phosphate is made in Calvin cycle and converted to starch:

5. **Glyceraldehyde-3-phosphate** (GALP) can be **combined** and **rearranged to form glucose**,
6. **Glucose monomers** undergo **condensation** to form **amylose** via **α1-4 glycosidic bond** and **amylopectin** via **α1-4 and α1-6 glycosidic bond**
7. **AVP**

Discuss starch suitability as a storage compound in plants

8. Starch has **compact shape** where **many glucose residues** can be stored in a **small volume** within the cell.
9. **Insoluble** in water therefore is a useful storage material because it has little effect on the **water potential** of cellular fluid.
10. **AVP**

All 3 components must be present for full marks

(b) Compare the processes of Calvin cycle to that of the Krebs cycle. [7]

ANS [L2] (H2 Alevel/2008/P2/Q8)
SC: compare Calvin vs. Krebs
OR: similarities & differences

[Max 4 for either similarities or differences]

	Features	**Calvin cycle**	**Krebs cycle**
	Similarities		
S1	Both processes require **enzymes** to drive / catalyse substrate based reactions		
S2	Both processes requires **electron carriers**		
S3	Both processes requires a **regeneration of starting material**		
S4	Both processes needed a **substrate** to start the cycle process		
S5	**AVP**		
	Differences		
D1	Location	Occurs at the **stroma** of chloroplast	Occurs at the **mitochondrial matrix**
D2	Starting material	**Ribulose bisphosphate** (RuBP) is the starting material of the cycle and eventually regenerated	**Oxaloacetate** is the starting material of the cycle and eventually regenerated
D3	Substrate	**Carbon dioxide** is used as the substrate	**Acetyl-CoA** is used as the substrate
D4	Role of CO_2	**Carbon dioxide is needed for carbon fixation.** It converts RuBP to form unstable compound 6C which eventually breaks down to glycerate-3-phosphate (GP)	**Carbon dioxide is released** as a result of decarboxylation reactions
D5	Electron carriers	**NADPH** is needed to reduce glycerate-3-phosphate (GP) to triose phosphate (TP) / glyceraldehyde-3-phosphate by serving as electron donors	**NAD+ and FAD** are required for oxidation of intermediates of the cycle by serving as electron acceptors
D6	ATP	Needed energy through **hydrolysis of ATP**	**ATP synthesis** through **substrate level phosphorylation**
D7	Products	For **every 3 molecules of CO_2, one GP** is made	Each cycle gives rise to **2 ATP, 6 NADH, 2 $FADH_2$**
D8	Process type	**Anabolic** due to synthesis of hexose sugar phosphates and eventually energy storage polysaccharide	**Catabolic** due to oxidation of Acetyl-CoA through series of decarboxylation and dehydrogenation
D9	**AVP**		

7 **(a)** Outline the process of DNA replication and discuss the suitability of DNA as a hereditary material. [8]

ANS [L1/L3] (Novel)
SC: 1. outline DNA replication process **2. Discuss suitability of DNA (as a hereditary material)**
OR:

Outline DNA replication process (Max 4):

1. **Helicase unwinds DNA double helix** and **unzips** by **breaking hydrogen bonds between complementary base pairs** to produce two template strands where **single stranded binding proteins** keep the **template strands apart;**
2. **Primase binds** to template at **3'ends** of template strand and **synthesize primers** and provide **free 3'OH for initiation of replication** by DNA polymerase;
3. **DNA polymerase III** carries out DNA **elongation** in **5' to 3'** direction, **catalysing** formation of **phosphodiester bonds** between incoming DNA nucleotides;
4. **DNA nucleoside triphosphates added** to the template strand by **complementary base pairing**
5. **Continuous replication** on **leading strand**;
6. **Discontinuous replication** on **lagging strand** in the form of **Okazaki fragments;**
7. **DNA polymerase I removes RNA primers** and **replaces them with DNA nucleoside triphosphates;**
8. **DNA ligase** formed **phosphodiester bonds between DNA nucleotides** of Okazaki fragments**.**

DNA molecule for role as a stable molecule for inheritance (Max 4)

9. **Strong covalent phosphodiester bonds** between adjacent **nucleotides** of the same DNA strand / within each strand;
10. **Hydrophobic interactions between** the **stacked bases**;
11. **Hydrogen bonds** between **complementary base pairs** in the **double helix / complementary nitrogenous bases** of adjacent **DNA strands;**
12. **Purine always pairs with pyrimidine**
13. **Ensures width of DNA /** between the **2 sugar phosphate backbones is constant**
14. **Stabilises** the **structure of the double helix** and **maintains** the **integrity** of the **DNA sequence.**

DNA molecule in relation to accurate DNA replication

15. The **sequence of bases on the two strands are complementary** / nitrogenous bases allow for highly specific **base-pairing** to occur between **complementary bases**;
16. **Adenine** pairs with **Thymine & Guanine** pairs with **Cytosine**;
17. **Each parental strand can act as a template to which a complementary set of deoxyribonucleotides** will attach by base pairing / synthesize a new daughter strand;
18. Therefore each original / parental **DNA molecule** can give rise to **2 copies** which are **identical** in structure and base sequence;
19. Allow for **accurate replication** to occur; for transmission to daughter cells / next generation

In terms of DNA repair

20. **The sequence of bases on the two strands are complementary / As nitrogenous bases allow for highly specific base-pairing to occur between complementary bases;**
21. **Adenine** pairs with **Thymine; Guanine** pairs with **Cytosine**
22. Intact / existing **complementary strand** can be used as a **template** to guide **DNA repair**;
23. **Repair mechanisms ensure** that the **integrity of the DNA sequence remains intact;**

[Note: to credit only once for the same marking point.]

(b) Compare the processes of DNA transcription to that of DNA translation. [7]

ANS [L2] (Novel)
SC: compare DNA transcription Vs. DNA translation
OR: similarities & differences

[Max 4 for either similarities or differences]

	Features	**Transcription**	**Translation**
	Similarities		
S1	Both processes require a **template**		
S2	Both processes are **catalyzed by enzymes**		
S3	Both processes involve **complementary base-pairing**		
S4	Both processes **requires energy for bond formation during elongation**.		
S5	Both processes **form polymers as product**.		
S6	**AVP**		
	Differences		
D1	Location	In **nucleus**	At **Ribosomes**
D2	Template	**DNA** template/coding strand	**mRNA**
D3	Key enzyme	**RNA polymerase** catalyses formation of phosphodiester bond between adjacent ribonucleotides	**Peptidyl transferase** catalyzes the formation of peptide bond
D4	Bond between monomers	**Phosphodiester bond** is formed **between the 5'-phosphate group** of one nucleotide **and 3'-ÓH** of ribose of the next nucleotide	**Peptide bond is formed between carboxyl group** of one amino acid **and the amino group** of the next amino acid
D5	Monomers (substrate)	**Ribonucleoside triphosphate**	**Amino acids** attached to tRNA
D6	Product(s)	**mRNA, rRNA and tRNA**	**Polypeptide**
D7	Fate of product(s)	products **exit nucleus and migrate to the cytoplasm**	Polypeptide chain **remain in the cytoplasm or secreted out of the cell**
D8	**AVP**		

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H1

ANDERSON JUNIOR COLLEGE
HIGHER 1

2018 JC2 PRELIMINARY EXAMINATIONS

H1 BIOLOGY **8876/01**

Paper 1 Multiple Choice **18 SEPT 2018 TUESDAY**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, PDG and identification number on the Answer Sheet.

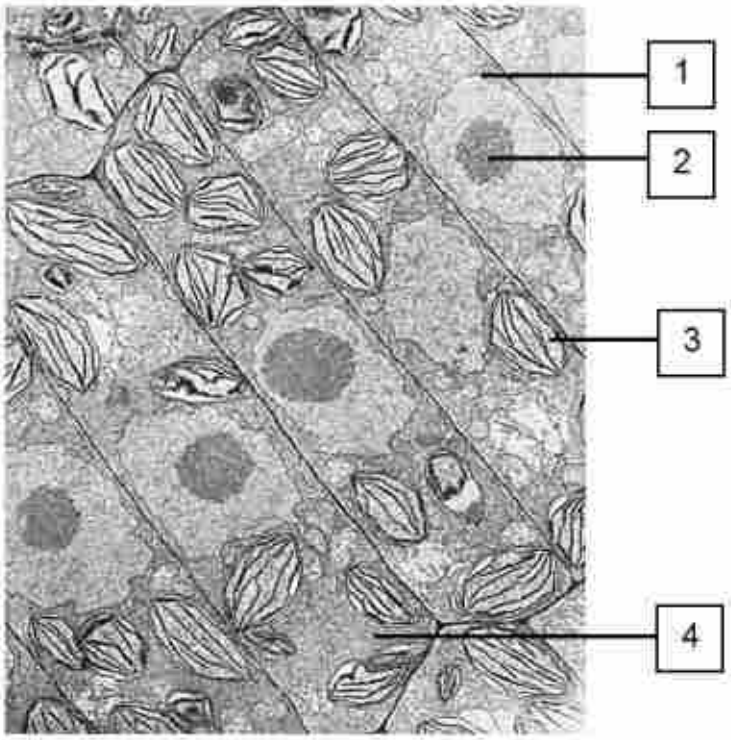
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

The use of scientific calculators is expected, where appropriate.

This document consists of **20** printed pages

1 The electron micrograph shows cells from an aquatic plant.

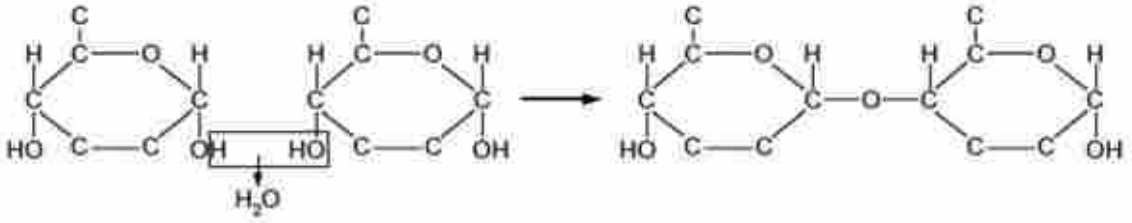


Which of the following about structures 1 to 4 is correct?

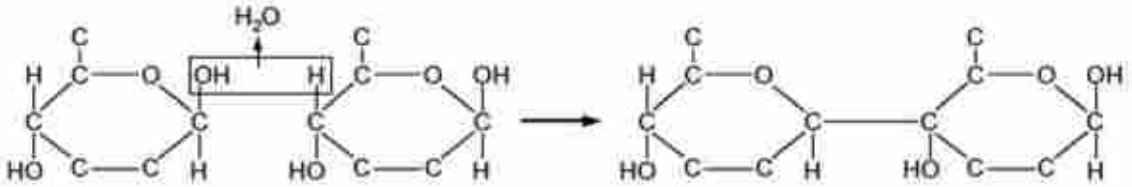
	contains DNA	contains rRNA	contains tRNA	contains proteins
A	1,2	2	2,3,4	1,4
B	3,4	2,3	2,4	3,4
C	2,3	2,3,4	3,4	1,2,3,4
D	2	3,4	1,3	1,2

2 Which diagram shows the linking of two monomers together to form cellulose?

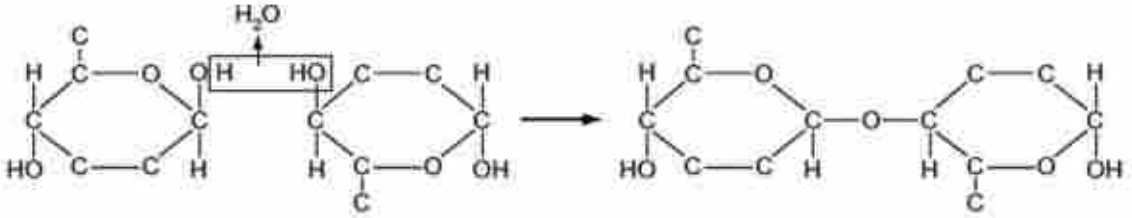
A



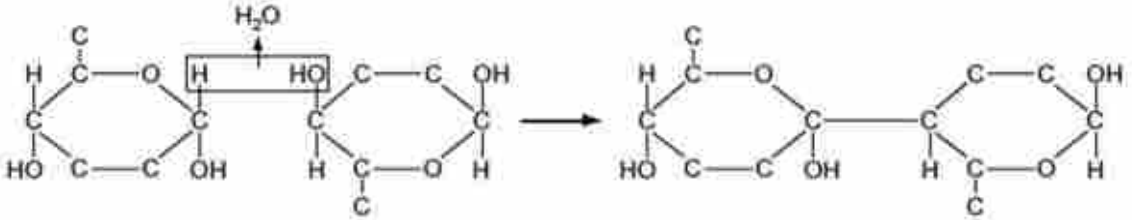
B



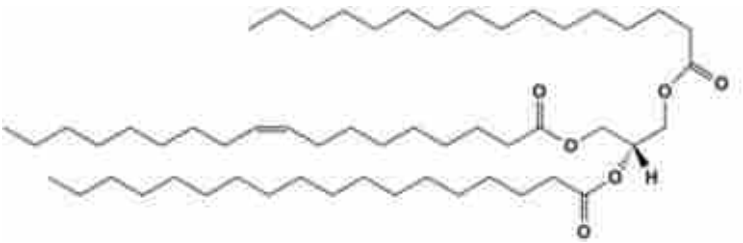
C



D



3 The diagram shows the structure of a lipid molecule.



Which statements are **not** correct?

1 There are 3 fatty acid chains found in the lipid molecule.

2 More ATP can be obtained from the lipid molecule than equal mass of starch.

3 The molecule is able to dissolve in an aqueous medium due to the presence of polar bonds.

4 The molecule increases fluidity of membranes as it contains a kink.

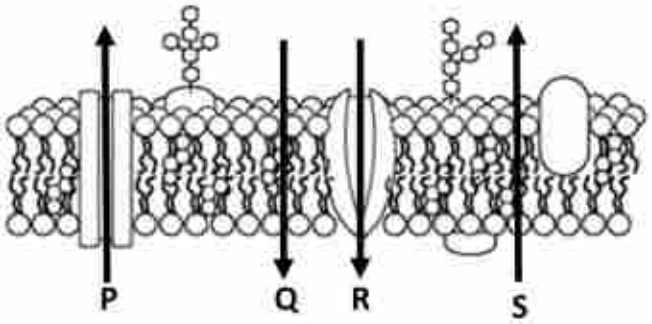
A 1 and 4

B 2 and 3

C 3 and 4

D 1, 3 and 4

4 The diagram shows the cell surface membrane of an actively respiring liver cell placed in a solution of glucose with a lower water potential than that of the tissue cells. Arrows **P**, **Q**, **R** and **S** show the movement of various particles across the cell surface membrane.

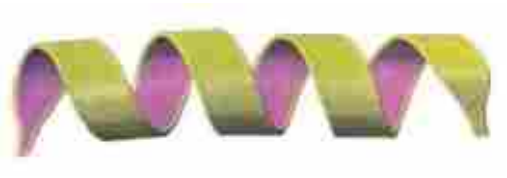


Which arrows correctly reflect the movements of oxygen, carbon dioxide, glucose and water across the surface membrane of this cell?

	Oxygen	Carbon dioxide	Glucose	Water
A	P	Q	R	S
B	Q	S	R	S
C	Q	S	P	P
D	R	S	P	R

5 Human hair is made up from bundles of a fibrous protein called keratin, which is similar to collagen.

The diagram shows the folded structure of keratin polypeptide chain, which forms the basic unit of hair fibre structure.



When hair is wet, it can lengthen temporarily due to the breaking of bonds in the folded keratin polypeptide chain. When it dries, the hair gradually returns to its original length.

What are broken to produce this length of the keratin chain structure?

A peptide bonds

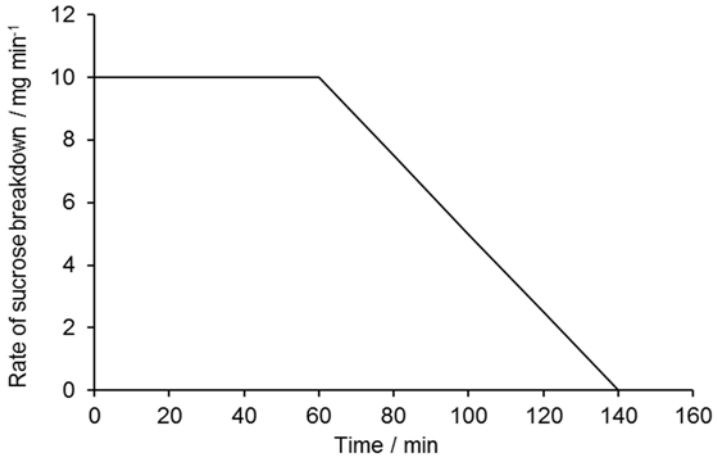
B disulphide bonds

C hydrophobic interactions

D hydrogen bonds

6 The graph shows the results of an investigation using invertase, an enzyme that breaks down sucrose into glucose and fructose.

1 g of sucrose was dissolved in 100 cm^3 of water and 2 cm^3 of a 1% invertase solution was added.



Which conclusion can be drawn from this information?

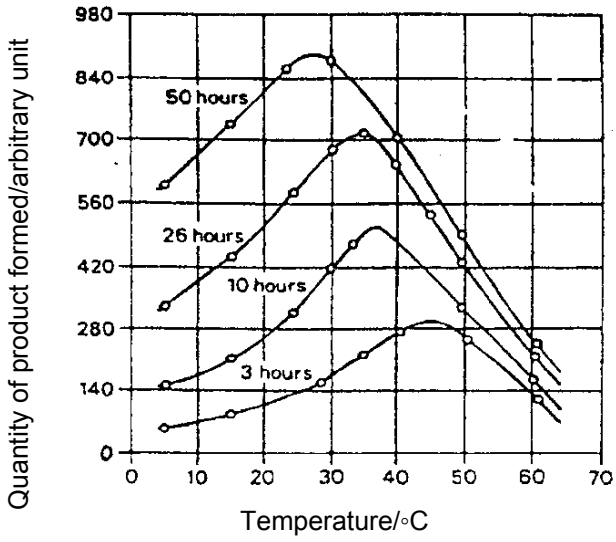
A Between 0 and 60 min, the concentration of the substrate remains constant.

B After 60 min, the concentration of enzymes becomes the limiting factor.

C At 140 min, some of the enzyme molecules are denatured.

D Between 60 and 140 min, the concentration of the substrate is the limiting factor.

7 The graph below shows the quantity of the product formed when samples containing the same concentration of enzyme and substrate were kept at different temperature for four different durations.



Which statement best explain why the optimum temperature is lowered if the duration of incubation is increased?

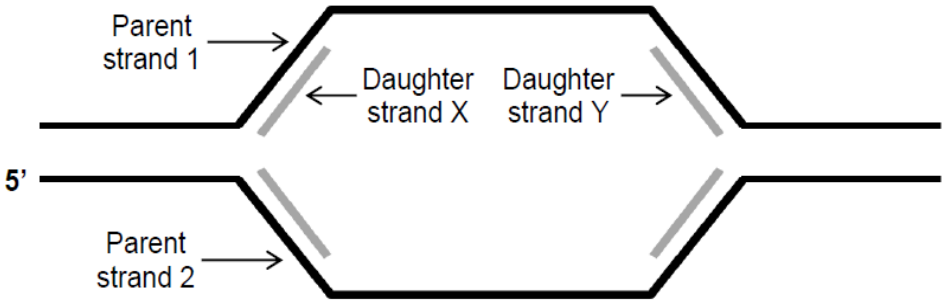
A There is an increase in the denaturation of enzymes if the duration of incubation is increased.

B The activation energy of the reaction is lowered at high temperature.

C There is an increase in the kinetic energy of enzymes and substrate if the duration of incubation is increased.

D Cooperativity between subunits of the enzyme changes shape of active sites to enhance substrate binding.

8 A simplified representation of a replication bubble is shown in the figure below. Parental strands 1 and 2 and the growing daughter strands **X** and **Y** are indicated.



Which of the following statements about the synthesis of daughter strands **X** and **Y** is correct?

A Daughter strands **X** and **Y** are synthesised away from their respective replication forks.

B Daughter strand **X** is synthesised continuously while daughter strand **Y** is synthesised in the form of Okazaki fragments.

C Daughter strand **X** is synthesised in the 5' → 3' direction while daughter strand **Y** is synthesised in the 3' → 5' direction.

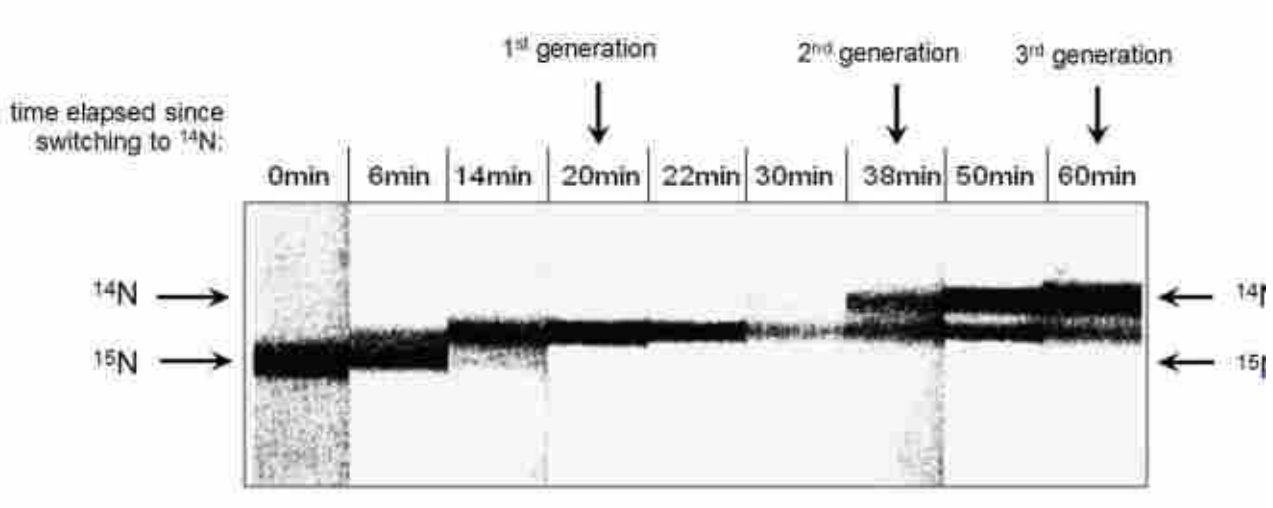
D To synthesise daughter strands **X** and **Y**, both parental strands 1 and 2 are read in the 3' to 5' direction.

9 In an investigation to study the mode of DNA replication, *Escherichia coli* (*E. coli*) cells were grown in a nutrient medium containing heavy isotope of nitrogen (^{15}N) for an extended period of time until all the DNA was labelled.

These *E. coli* cells were then transferred to a nutrient medium containing only light isotope of nitrogen (^{14}N) and were allowed to multiply over three generations. The DNA of the *E. coli* cells was then harvested at nine different time intervals.

Subsequently, density gradient centrifugation of these *E. coli* DNA using caesium chloride was performed.

The diagram shows the results obtained.



Which statements are consistent with the results observed?

1 The generation time for *E.coli* is about 20 minutes.

2 In the 1st generation, only hybrid $^{14}N/^{15}N$ DNA was produced.

3 In the 3rd generation, 75% hybrid $^{14}N/^{15}N$ DNA and 25% light $^{14}N/^{14}N$ DNA were produced.

4 In the subsequent 4th generation, only light $^{14}N/^{14}N$ DNA would be produced.

A 1 and 2

B 2 and 3

C 1 and 4

D 1, 3 and 4

10 The table shows the relative amounts of the bases adenine, thymine, guanine and cytosine in DNA from different organisms.

source	adenine	thymine	guanine	cytosine
bacterium	23.8	23.1	26.8	26.3
maize	26.8	27.2	22.8	23.2
fruit fly	30.7	29.5	19.6	20.2
chicken	28.0	28.4	22.0	21.6
human	29.3	30.0	20.7	20.0

Which statements account for the importance of the ratios of A to T and G to C to the structure of DNA?

1 Complementary base pairing can occur.
2 Mutation will occur when pairing ratio is lost.
3 Semi-conservative DNA replication can occur to copy DNA strands.
4 Phosphodiester bonds helps to hold two strands together.
5 Purines and pyrimidines have different sizes and shapes.

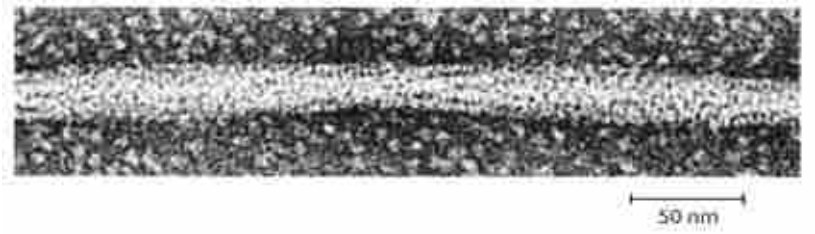
A 1 and 3
B 1, 2, 3 and 5
C 2, 3, 4 and 5
D 1, 2, 3, 4 and 5

11 The coding strand of part of a DNA molecule has the sequence 5' GAATTA 3'

Which row is correct for this part of the corresponding template, mRNA and tRNA?

	the sequence of the template (non-coding DNA sequence)	the sequence of the mRNA molecule	the anticodons of tRNA used in translation
A	5' TAATTC 3'	5' CUUAUU 3'	5' CUU 3' and 5' AAU 3'
B	5' TAATTC 3'	5' GAAUUA 3'	5' UAA 3' and 5' UUC 3'
C	5' CTTAAT 3'	5' CUUAUU 3'	5' CUU 3' and 5' AAU 3'
D	5' CTTAAT 3'	5' GAAUUA 3'	5' UAA 3' and 5' UUC 3'

12 An electron micrograph of a stained fiber of deoxyhemoglobin S (HbS) is shown below.



Which of the following statements is true?

A Mutation in the red blood cell results in the production of hydrophobic HbS molecules which sickled under low oxygen concentration.

B The HbS molecule is insoluble due to its large molecular size and this results in the sickling of red blood cells.

C The aggregration of HbS molecules, under low oxygen concentration, causes the fiber to be precipitated out of solution, resulting in the sickling of red blood cells.

D Under low oxygen concentration, HbS molecules form a triplex helix structure, causing the cell membrane of the red blood cells to be more rigid and hence they sickled.

13 Tay-Sachs disease is a fatal neurodegenerative disease which is caused by a mutation in the hexosaminidase A (Hex A) gene located on chromosome 15.

Part of the sequence of the non-template (coding) DNA strand of the normal Hex A allele and the mutated Tay-Sachs allele are shown below. The sequences are the same as the mRNA sequence of both alleles.

DNA sequences of normal Hex A allele:

Amino acid position		424	425	426	427	428	429	430	431	
Non-template DNA	5'…	CGT	ATA	TCC	TAT	GGC	CCT	GAC	TGT	…3'

DNA sequences of mutated Tay-Sachs allele:

Amino acid position		424	425	426	427	428	429	430	431	
Non-template DNA	5'…	CGT	ATA	TCT	ATC	CTA	TGG	CCC	TGA	…3'

For both alleles, 9 different amino acids are encoded for by the DNA triplets:

Amino acid	DNA triplet
Arg	CGT
Asp	GAC
Cys	TGG, TGT
Gly	GGC
Ile	ATA, ATC

Amino acid	DNA triplet
Leu	CTA
Pro	CCC, CCT
Ser	TCC, TCT
Tyr	TAT
Stop codon	TAG, TAA, TGA

Which statement is true?

A The disease is caused by the deletion of one DNA nucleotide.

B The Hex A protein encoded for by the Tay-Sachs allele is non-functional due to a frameshift mutation.

C The polypeptide encoded for by the Tay-Sachs allele has the same number of amino acids as that encoded by the normal Hex A allele.

D At amino acid position 431, there is a silent mutation.

14 Edwards syndrome is a common autosomal disorder caused by chromosome aberration.

- Edward syndrome is a trisomy of chromosome 18 that affects all cells.
- The extra chromosome is most often of maternal origin.
- In approximately more than 50% of individuals diagnosed with the syndrome, two of the three chromosomes 18 present are found to be nearly genetically identical.

What can be correctly concluded from this information?

A Non-disjunction of chromosome 18 commonly occurs during gamete formation in females.

B Non-disjunction of chromosome 18 occurs more frequently during meiosis I than in meiosis II.

C Non-disjunction of chromosome 18 occurs most commonly in female embryos.

D Two of the three chromosomes 18 are nearly genetically identical due to uneven crossing over resulting in chromosomal translocation.

15 Each of these descriptions of a stage in mitosis in an animal cell is incomplete.

1 centromeres divide and move to the poles of the cell.

2 chromatin condenses, centrioles migrate to the poles of the cell.

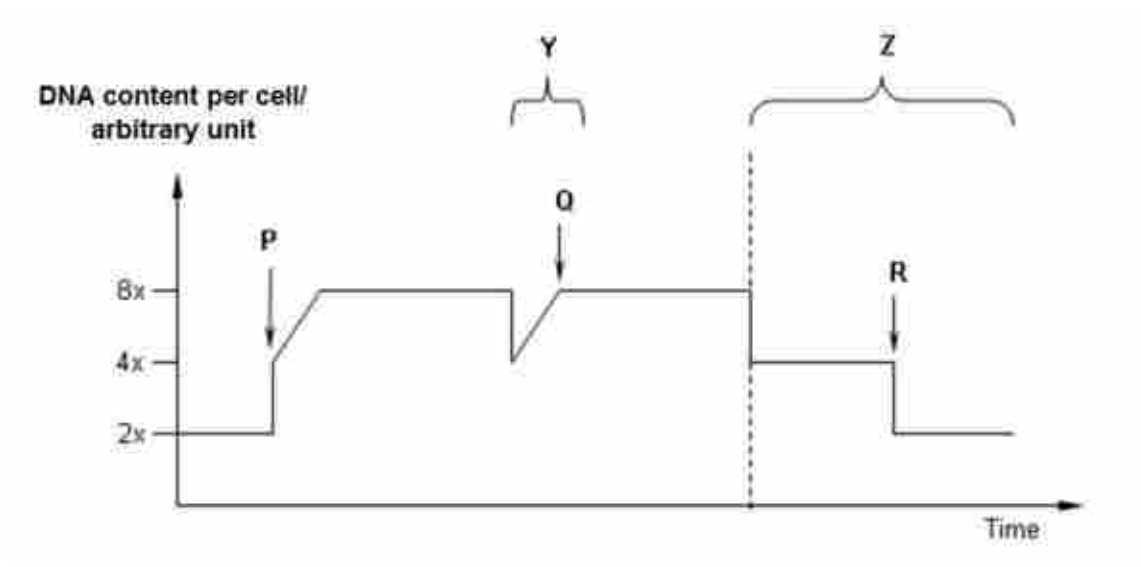
3 chromosomes become less condensed.

4 sister chromatids joined by centromeres align at the equator of the cell.

Which row completes the description of each mitotic stage?

	1	2	3	4
A	Nuclear envelope and nucleolus reforms	Sister chromatids are pulled apart by shortening of spindle microtubules.	Spindle microtubules bind to centromeres.	Spindle microtubules appear between centrioles and nuclear envelope disintegrates.
B	Spindle microtubules bind to centromeres.	Nuclear envelope and nucleolus reforms	Spindle microtubules appear between centrioles and nuclear envelope disintegrates.	Sister chromatids are pulled apart by shortening of spindle microtubules.
C	Spindle microtubules appear between centrioles and nuclear envelope disintegrates.	Spindle microtubules bind to centromeres.	Sister chromatids are pulled apart by shortening of spindle microtubules.	Nuclear envelope and nucleolus reforms
D	Sister chromatids are pulled apart by shortening of spindle microtubules.	Spindle microtubules appear between centrioles and nuclear envelope disintegrates.	Nuclear envelope and nucleolus reforms	Spindle microtubules bind to centromeres.

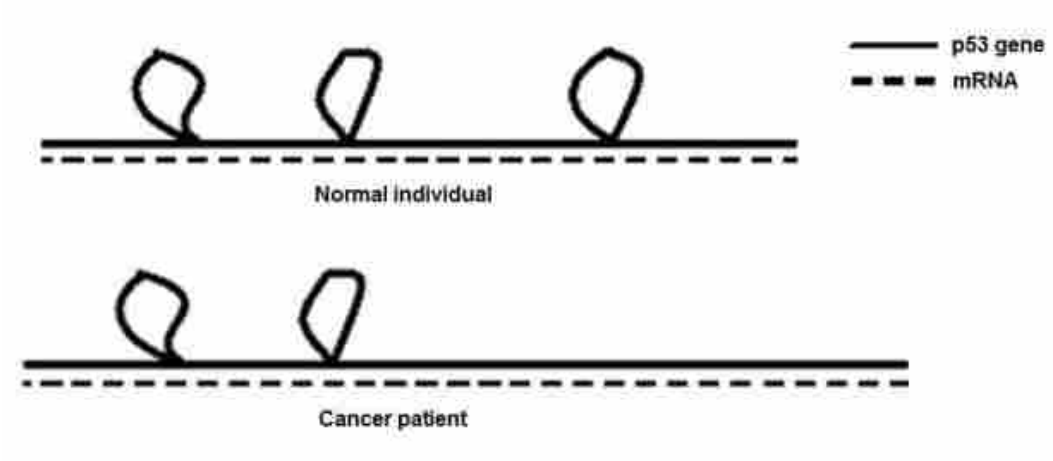
16 The graph represents the changes in the DNA content within a cell.



Name the events occurring at **P**, **Q**, **R** and identify the stage where meiosis is occurring.

	P	**Q**	**R**	**Meiosis occurring at**
A	S phase	fertilisation	cytokinesis	Y
B	fertilisation	interphase	cytokinesis	Z
C	S phase	prophase	telophase	Y
D	fertilisation	metaphase	Telophase	Z

17 mRNA was isolated from a normal individual and a patient suffering from cancer. The mRNA was allowed to hybridise with the *p53* DNA gene sequence. *p53* is a tumour suppressor gene. The schematic diagram shows the results of the hybridisation process under the electron microscope.



Which of the following could be a possible explanation why the patient is suffering from cancer?

A A point mutation had occurred in the intron leading to the failure to excise one intron, resulting in a longer dysfunctional protein being produced.

B Gene amplification had occurred leading to the multiple copies of a trinucleotide repeat in an intron, hence causing splice site to be misread due to frameshift mutation, resulting in a longer dysfunctional protein being produced.

C A point mutation had occurred in the intron leading to the failure to excise one exon, resulting in a hyperactive protein being produced.

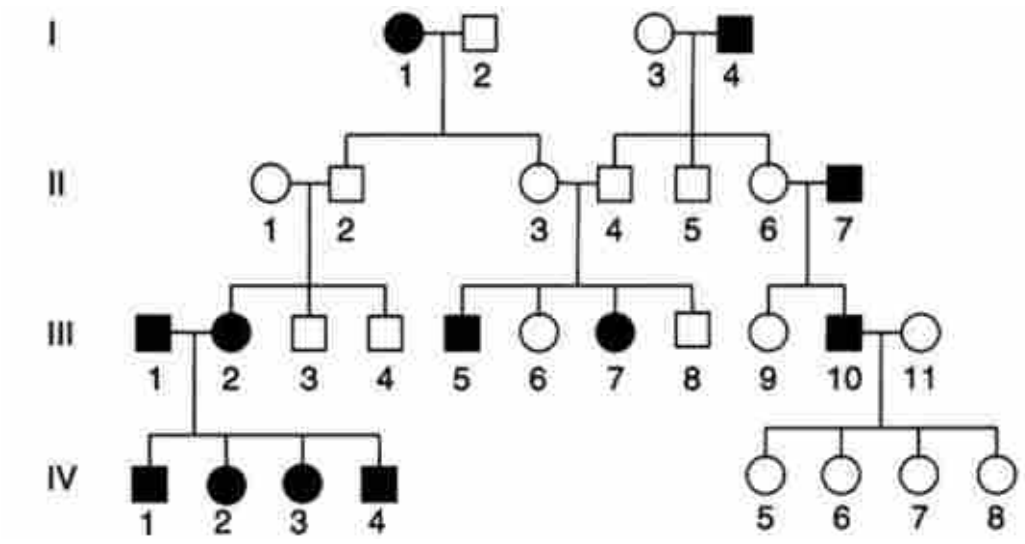
D A point mutation had occurred leading to the failure of spliceosome to recognise splice sites, causing the excision of the wrong intron, resulting in a degradation-resistant protein being produced

18 Which of the following contribute towards cancer progression?

1 Activation of genes that causes cell death.
2 Inactivation of genes that slow down the cell cycle.
3 Activation of genes that result in growth of new blood vessels.
4 Inactivation of genes involved in cell-cell adhesion.

A 2 only
B 1 and 3
C 1 and 4
D 2,3 and 4

19 In the pedigree chart below, the characteristic, adherent earlobes, were studied.



Which row shows the correct genotype (s) of III-3 and III-6, and the inheritance pattern?

	Genotype (s) of III-3 and III-6	Inheritance pattern
A	X^AY, X^AX^a or X^AX^A	Sex-linked recessive
B	Aa	Autosomal dominant
C	X^aY, X^aX^a	Sex-linked dominant
D	AA or Aa	Autosomal recessive

20 The table shows the results of a series of crosses in a species of small mammal.

coat colour phenotype		
male parent	female parent	offspring
dark grey	light grey	dark grey, light grey, albino
light grey	albino	light grey, white with black patches
dark grey	white with black patches	dark grey, light grey
light grey	dark grey	dark grey, light grey, white with black patches

What explains the inheritance of the range of phenotypes shown by these crosses?

A One gene with a pair of co-dominant alleles.

B One gene with multiple alleles.

C Sex-linkage of the allele for grey coat colour.

D Two genes, each with a dominant and recessive allele.

21 Which statement concerning chrysanthemum plants, of the genus *Dendranthema,* is a valid example of how the environment may affect the phenotype?

A Anthocyanins and anthoxanthins are vacuolar pigments, whereas xanthophylls and carotenes are pigments found in membrane-bound organelles known as plastids. These, together with molecules known as co-pigments, are responsible for the variation observed in petal colour in *Dendranthema.*

B Identical genetic crosses performed between varieties of *Dendranthema* result in a greater proportion of offspring plants with plastids exhibiting a yellow colour when grown in a field and a greater proportion of offspring plants with colourless plastids when grown in a glasshouse.

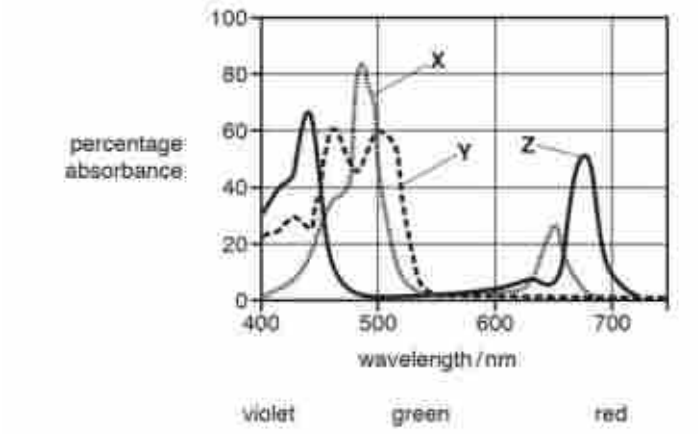
C The seeds of a cross between *Dendranthema weyrichii* and *Dendranthema grandiflora* produce plants that are far more frost-tolerant and exhibit an extended flowering season compared with both parents.

D The seeds of a cross between *Dendranthema weyrichii* (height varying between 12.5 – 15.0 cm) and *Dendranthema grandiflora* (height varying between 8.0 – 25.0 cm) produce plants, when grown in natural day light, of a height varying between 55.0 – 71.0 cm.

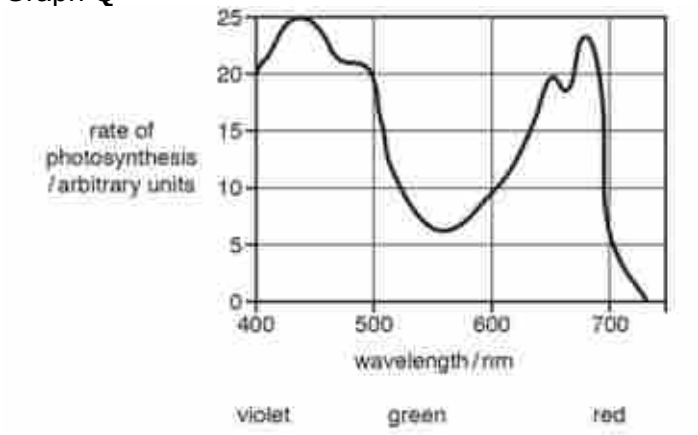
22 Graph **P** shows the absorption spectra of three types of photosynthetic pigment, **X**, **Y** and **Z**, extracted from the leaves of a flowering plant. **X** is chlorophyll b.

Graph **Q** shows the action spectrum for photosynthesis for the same plant.

Graph **P**



Graph **Q**



Four students were asked to relate the information shown in graphs **P** and **Q** to their knowledge and understanding of the light-dependent stage of photosynthesis.

student	comment
1	The high absorption of blue light by chlorophyll b provides evidence that this is the primary electron donor of photosystem I.
2	The low rate of photosynthesis in green light suggests that more green light is reflected than absorbed by the three pigments.
3	The presence of pigment **Y** extends the ability of the plant to absorb light in the blue-green part of the spectrum but not the yellow-green part of the spectrum.
4	Non-cyclic photophosphorylation occurs at a wavelength of 700 nm, indicating that pigment **Y** is more likely to be chlorophyll a than pigment **Z**.

Which students made biologically correct comments?

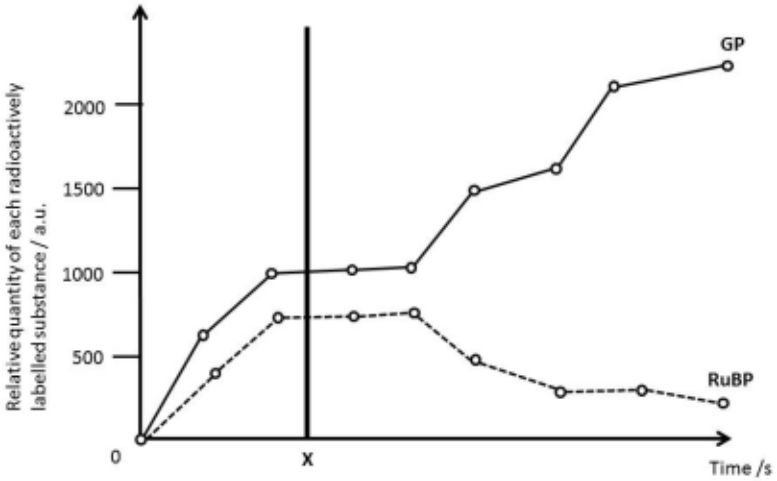
A 1 and 3 **B** 1 and 4

C 2 and 3 **D** 2 and 4

23 Many chemicals are used as herbicides as they are able to inhibit photosynthesis in plants. Diquat, a herbicide, inhibits Photosystem I by intercepting electrons from a an electron carrier.

To investigate the effect of Diquat on light-independent reactions, an illuminated suspension of photosynthesizing algae *Chlorella* was treated with carbon dioxide containing a heavy isotope of carbon, ^{14}C. The levels of Ribulose bisphosphate (RuBP) and Glycerate-3-phosphate (GP) were subsequently measured.

The figure shows the results of the experiment. Point **X** indicates the point at which Diquat was added to the *Chlorella* suspension.



Which row correctly explains why the level of GP increases and RuBP decreases after point **X** ?

	ATP and NADPH production	Carbon fixation	Carbon reduction	RuBP regeneration
A	X	✓	✓	X
B	✓	X	X	✓
C	X	✓	X	X
D	✓	✓	X	✓

24 Both glucose and appropriate enzymes are necessary for the process of glycolysis to begin.

Which additional compound must also be present?

A acetyl coenzyme A

B ATP

C pyruvate

D reduced NAD

25 Below are some statements about anaerobic respiration in animal and yeast cells.

1 Carbon dioxide is produced.
2 Oxidation of reduced coenzyme occurs.
3 A two-carbon compound is generated.

Which statements apply to animal cells and yeast cells?

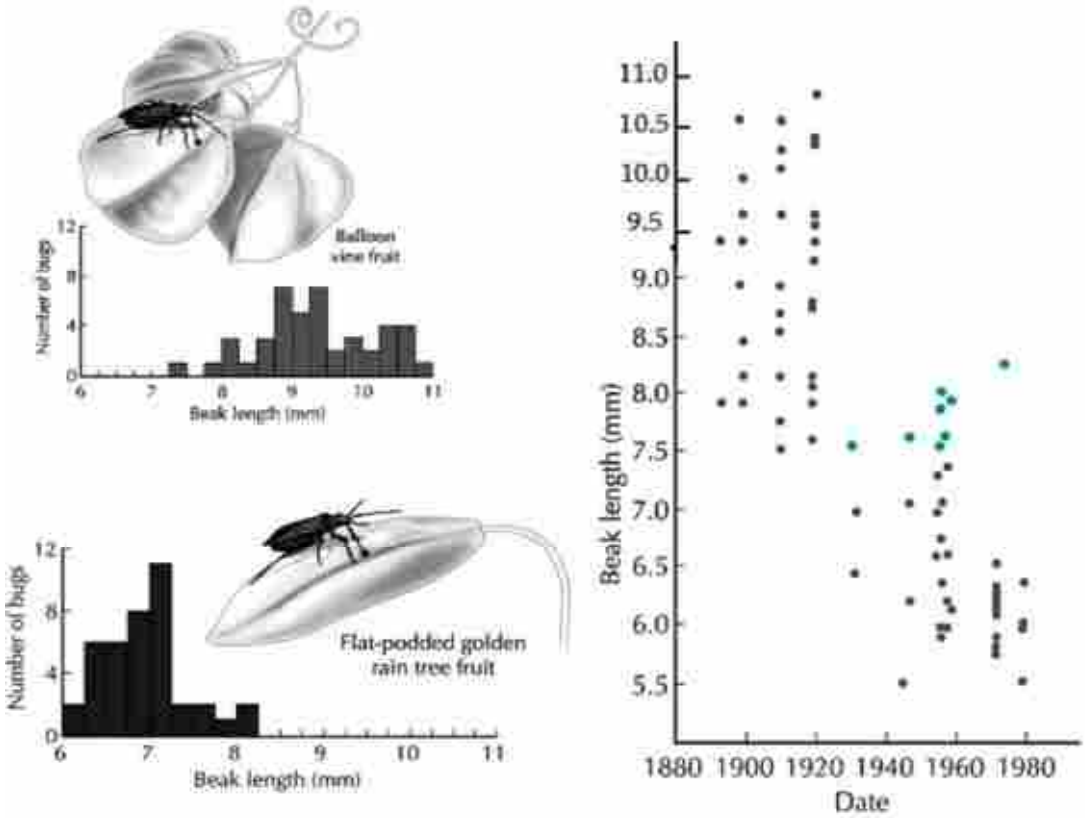
	Animal cells	Yeast cells
A	3	1
B	1 and 2	2 and 3
C	2	1,2,3
D	1,2,3	1,2,3

26 Which statements are **not** acceptable parts of Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.
2 In competition for suvival, the more aggressive animals are more likely to survive.
3 Variation between individuals of a species is essential for evolutionary change.

A 2 only
B 3 only
C 1 and 2
D 1 and 3

27 Soapberry bugs in America originally fed on the native balloon vine using their sharp beaks to penetrate the fruit. In the 1920s, the flat-podded golden rain tree was introduced from Asia. This tree produces thinner-skinned fruit. In the scatter plot, each dot represents the beak length of an individual bug in the sample population.



What can you conclude from the data presented above?

1 The selection pressure is the limited availability of food for soapberry bugs.

2 Soapberry bugs with shorter beaks are being selected for.

3 Soapberry bugs developed shorter beaks after they switched to feed on the flat-podded fruit.

4 The allele encoding for short beaks first appeared in the gene pool in 1930.

A 1 and 2

B 1 and 3

C 2 and 4

D 1,2 and 4

28 The allele Hb^N codes for the synthesis of normal haemoglobin. The Hb^S allele codes for the synthesis of an abnormal form of haemoglobin. The presence of this allele gives resistance to malaria. Individuals homozygous for this allele have a form of anaemia which causes early death.

What explains the increase in frequency of the Hb^SHb^N genotype in an area where there are mosquitos that carry malaria.

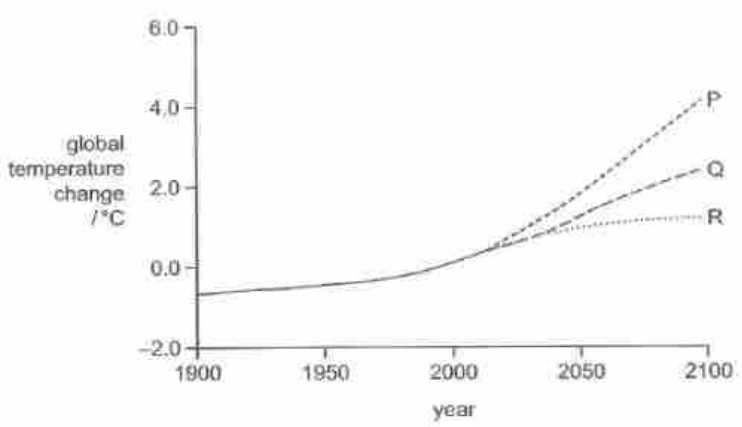
A More individuals with the genotype Hb^SHb^S reproduce with each other.

B More individuals with the genotype Hb^SHb^N survive to reproduce with each other.

C Individuals with the genotype Hb^NHb^N and Hb^SHb^S reproduce with each other.

D Individuals with the genotype Hb^SHb^N and Hb^NHb^N reproduce with each other.

29 The graph shows the predicted change in global temperature using three different models, **P**, **Q** and **R**. Model **Q** assumes that no new factors act to influence the rate of climate change.



The predictions based on models **P** and **R** can be explained using some of the following statements.

1 An increased global temperature and reduced rainfall will lead to an increase in forest fires.

2 Permanently frozen soil and sediment in the Artic will begin to thaw as global temperatures increase.

3 Rising sea temperatures will cause increased growth of photosynthetic algae.

4 Rising sea temperatures will reduce the solubility of greenhouse gases in the oceans.

Which of these statements support predictions **P** and **R**?

	statements that support prediction **P**	statements that support prediction **R**
A	1, 2 and 4	3
B	1 and 3	2 and 4
C	2	1, 3 and 4
D	3 and 4	1 and 2

30 Which statements about dengue disease are correct?

1 Due to global warming, there is an increase in vector types beyond mosquitoes that can contribute to the spread of dengue.

2 The dengue virus develops resistance to drug rapidly due to the lack of RNA polymerase proof reading activity.

3 People who are exposed to a different dengue serotype a second time have an increased risk of dengue shock syndrome compared with those who were not previously exposed due to antibody enhancement.

4 Human-to-human viral transmission is highly possible especially in high density living condition.

A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

Paper 1 Answer Scheme

Qns	Ans	Qns	Ans
1	C	16	B
2	C	17	A
3	C	18	D
4	B	19	D
5	D	20	B
6	D	21	B
7	A	22	C
8	D	23	C
9	A	24	B
10	B	25	C
11	B	26	C
12	C	27	A
13	B	28	B
14	A	29	A
15	D	30	C

H1

ANDERSON JUNIOR COLLEGE
HIGHER 1

2018 JC2 PRELIMINARY EXAMINATIONS

CANDIDATE NAME	

PDG					INDEX NUMBER		

H1 BIOLOGY 8876/02

Paper 2 Structured and Free-Response Questions

11 SEPT 2018
TUESDAY

2 hours

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graph
Do not use paper clips, highlighters, glue or correction fluid.

Answer all questions in the space provided on the Question Paper.

Section A
Answer **all** questions

Section B
Answer any **one** question

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The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	/13
2	/7
3	/10
4	/11
5	/4
6/7	/15
	/60

This document consists of **16** printed pages

Answer **all** questions

1 Fig. 1.1 shows the production of all blood cells from Cell **X**.

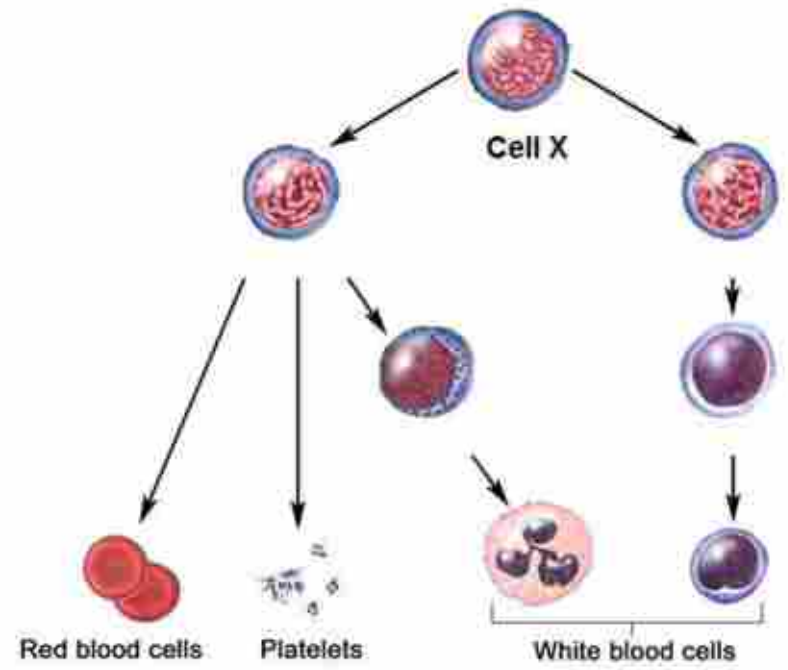

Fig. 1.1

(a) Identify Cell **X** and explain why, as shown in Fig. 1.1, it must have the characteristic of a stem cell.

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..... [4]

(b) Fig 1.2 is an electron micrograph of a type of white blood cell known as plasma cell, in the process of producing antibodies. Antibodies are proteins secreted by plasma cells.

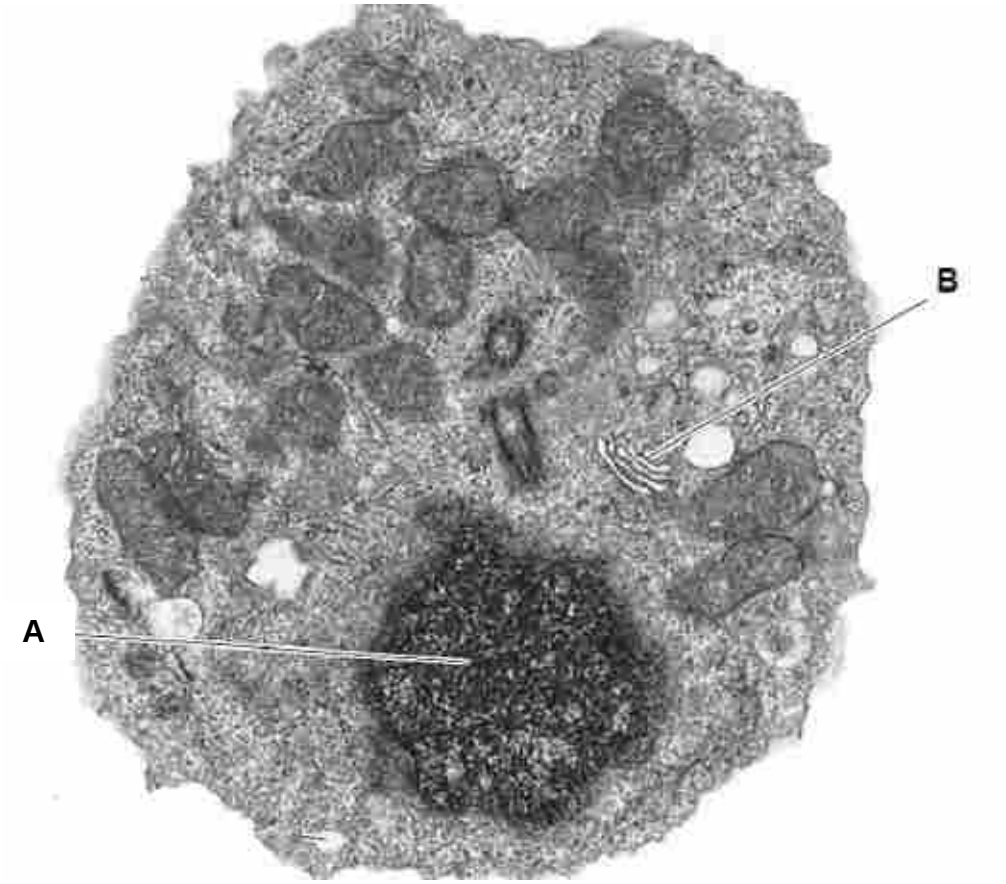

Fig. 1.1

Describe the role of the following organelles in the production of antibodies.

A ……..

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B……..

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…… [4]

(c) Macrophage is another type of white blood cell which is involved in recognising foreign particles and undergoing phagocytosis.

(i) Describe the process of phagocytosis.

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…… [3]

(ii) Suggest how a macrophage recognises specific foreign particles.

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…… [2]

[Total: 13]

2 Fig. 2.1 shows translation occurring on a eukaryotic mRNA.

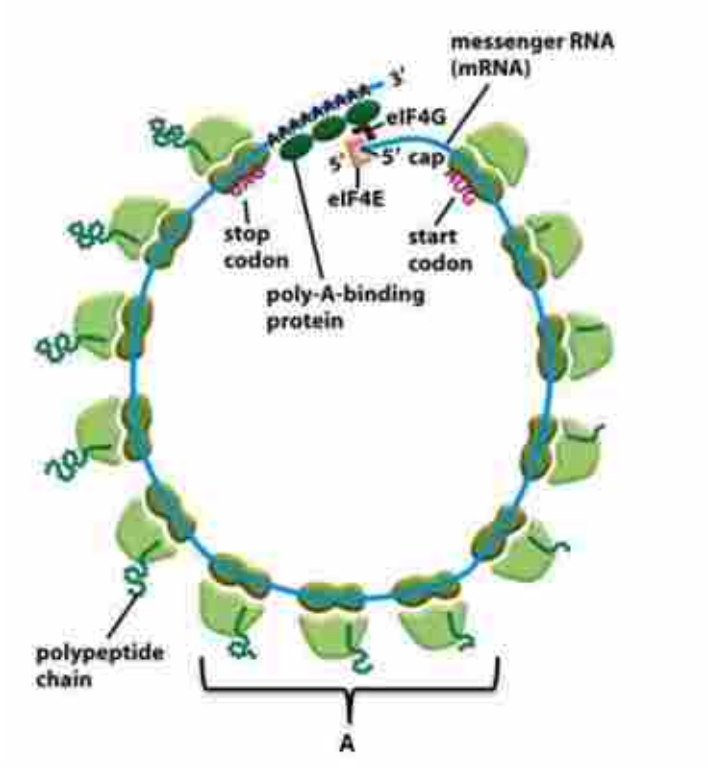

Fig. 2.1

(a) **(i)** Explain the significance of the pattern of translation, labelled **A** in Fig. 2.1.

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…… [2]

(ii) During initiation of translation, the poly-A tail and 5'cap on the mRNA, together with initiation factors like eIF4E and eIF4G form part of a complex which aid in recruiting ribosomal subunits to mRNA.

With reference to Fig. 2.1, describe the role of poly-A tail and 5' cap in the assembly of ribosomes.

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…… [2]

(b) Describe **three** differences between the process of translation and transcription.

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…… [3]

[Total:7]

3 The ABO blood group system in humans is controlled by a gene with alleles, I^A, I^B and I^o. Each allele lead to production of different antigens (proteins) on the surface of red blood cells.

- Allele I^A, leads to the production of antigen A.
- Allele I^B, leads to the production of antigen B.
- Allele I^O, does not lead to the production of either antigen.

Alleles I^A and I^B are codominant and I^o is recessive to both.

(a) With reference to the ABO blood group, explain what is meant by

(i) codominance.

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…… [2]

(ii) multiple alleles.

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…… [1]

(b) In humans, a gene that codes for the production of a protein, called factor VIII, is located on the X chromosome. The dominant allele for this gene produces factor VIII, but the recessive allele does not produce factor VIII.

A person who is unable to make factor VIII has haemophilia in which the blood fails to clot properly.

Explain why a man with haemophilia cannot pass haemophilia to his son but may pass haemophilia to his grandson.

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…… [3]

(c) A gene for feather colour in chickens is carried on an autosome. This gene has two alleles, black ($\mathbf{C^B}$) and splashed-white ($\mathbf{C^W}$). When a male chicken with black feathers is mated with a female chicken with splashed-white feathers as shown in Fig. 3.1, all the offspring have blue feathers. This also occurs when a male chicken with splashed-white feathers is crossed with a female with black feathers.

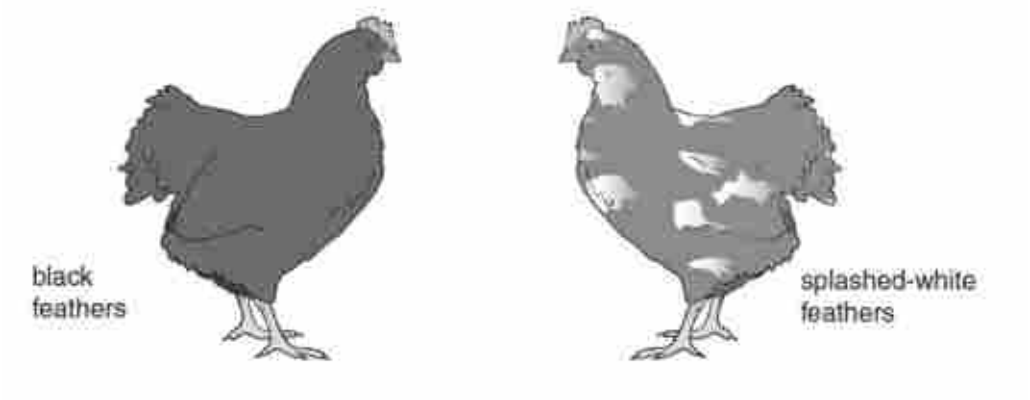

Fig. 3.1

Another gene may cause stripes on feathers (barred feathers), shown in Fig. 3.2. This gene is carried on the X chromosome. The allele for barred feathers ($\mathbf{X^A}$) is dominant to the allele for non-barred feathers ($\mathbf{X^a}$).

Fig. 3.2

In chickens, the male is homogametic and has two X chromosomes while the female is heterogametic and has one X chromosome and one Y chromosome.

A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers. All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given above, draw a genetic diagram to show this cross.

[4]

[Total: 10]

4 To protect crops against insects, many crops such as maize and cotton are genetically modified to contain a gene (Bt) from a bacterium, *Bacillius thuringiensis*. The Bt gene codes for a toxin, which inserts into the insect gut cell membrane, paralyzing the digestive tract and killing the insects which eat the crop. When these genetically modified (GM) crops first became available it was predicted that insect pests would develop resistance to these toxins.

(a) Explain how Bt resistance may arise and spread in an insect population.

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..... [4]

(b) The extent of Bt resistance in insect pest species was surveyed in 2005 and in 2011. The level of resistance in each species was classified according to the highest percentage of resistant individuals recorded in any population anywhere in the world. Three levels of resistance were identified:

- <1%
- 1–6%
- >50%

There were no reports of populations of insect pests having between 6% and 50% of resistant individuals.

The results of the surveys are shown in Table 4.1.

Table 4.1

year	total number of insect pest species surveyed	number of insect pest species susceptible to Bt toxins	number of insect pest species with reported levels of resistance		
			<1%	1–6%	>50%
2005	9	8	0	0	1
2011	13	4	3	1	5

(i) Discuss whether the data provided can support the hypothesis that rise in Bt resistance is due to introduction of GM crop, including limitations of the data provided.

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…… [4]

(ii) Justify the prediction that both insect-caused and non-insect-caused damages to Bt crops will increase with climate change.

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…… [3]

[Total: 11]

5 An analysis of ice cores from the Artic and Antarctic can provide information about the composition of the Earth's atmosphere over thousands of years.

Fig. 5.1 shows the concentrations of carbon dioxide and methane measured in ice cores, dated between 1000 and 2000 AD.

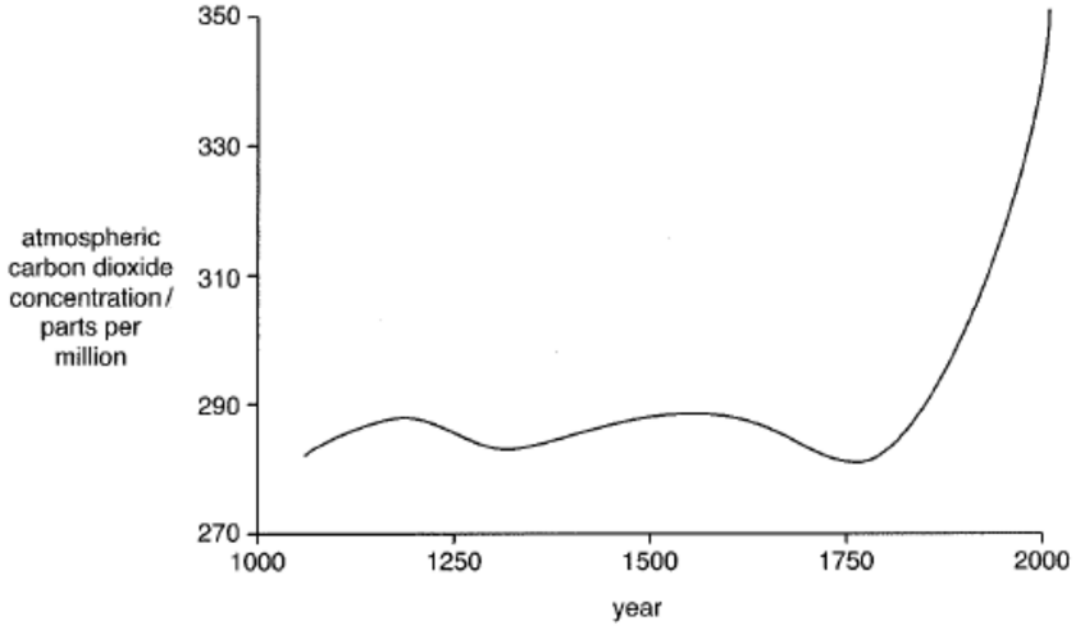

Fig.5.1

(a) Describe and explain the data in Fig. 5.1 from 1750 AD onwards.

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..... [2]

(b) Explain how increasing concentrations of gases, such as carbon dioxide and methane, are thought to cause global warming.

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..... [2]

[Total: 4]

Section B

Answer **one** question in this section

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answer must be set out in parts **(a)**, **(b),** etc., as indicated in the question.

6 **(a)** Explain how fluidity of biological membranes can be maintained and the importance of fluidity to membrane function. [8]

(b) A human body can synthesise more than 90,000 different types of proteins. The complete set of proteins present in the various cells of an individual is known as the proteome.

A human's genome is constant, whereas the proteome of a human is constantly changing.' Discuss this statement. [7]

[Total: 15]

7 **(a)** Discuss the inter-relationships of membranous organelles in eukaryotic cells and suggest the implications of absence of membranous organelles in prokaryotic cells. [8]

(b) Explain why more energy is released from the oxidation of triglycerides as compared to the same unit mass of glucose and outline the problems of using triglycerides as the main respiratory substrate instead of glucose in animals. [7]

[Total: 15]

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H1

ANDERSON JUNIOR COLLEGE
HIGHER 1
ANSWERS

2018 JC2 PRELIMINARY EXAMINATIONS

CANDIDATE NAME	

PDG					INDEX NUMBER		

H1 BIOLOGY 8876/02

Paper 2 Structured and Free-Response Questions

11 SEPT 2018
TUESDAY

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4	/11
5	/4
6/7	/15
	/60

This document consists of **13** printed pages and **1** blank page

Answer **all** questions

1 Fig. 1.1 shows the production of all blood cells from Cell **X**.

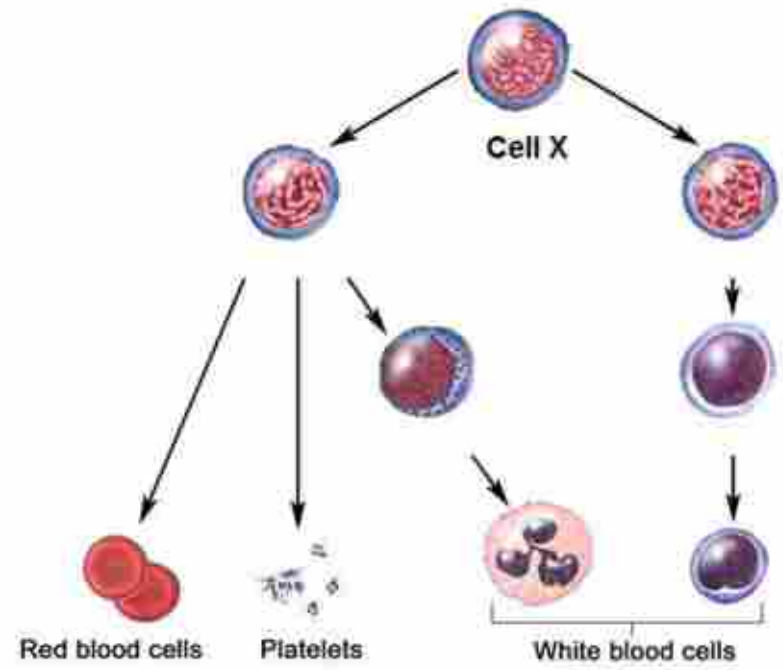


Fig. 1.1

(a) Identify Cell **X** and explain why, as shown in Fig. 1.1, it must have the characteristic of a stem cell.

- Cell X: **haematopoietic stem cell / blood stem cell;**
- must be **unspecialized /** no specialised cell structure and function <u>and</u> **multipotent**
- so that it can **differentiate** into specialized cells such as red blood cells
- must be able to divide by **mitosis / self renew**
- to give rise to more cells which can replace worn-out / damaged blood cells; [4]

(b) Fig 1.2 is an electron micrograph of a type of white blood cell known as plasma cell, in the process of producing antibodies. Antibodies are proteins secreted by plasma cells.

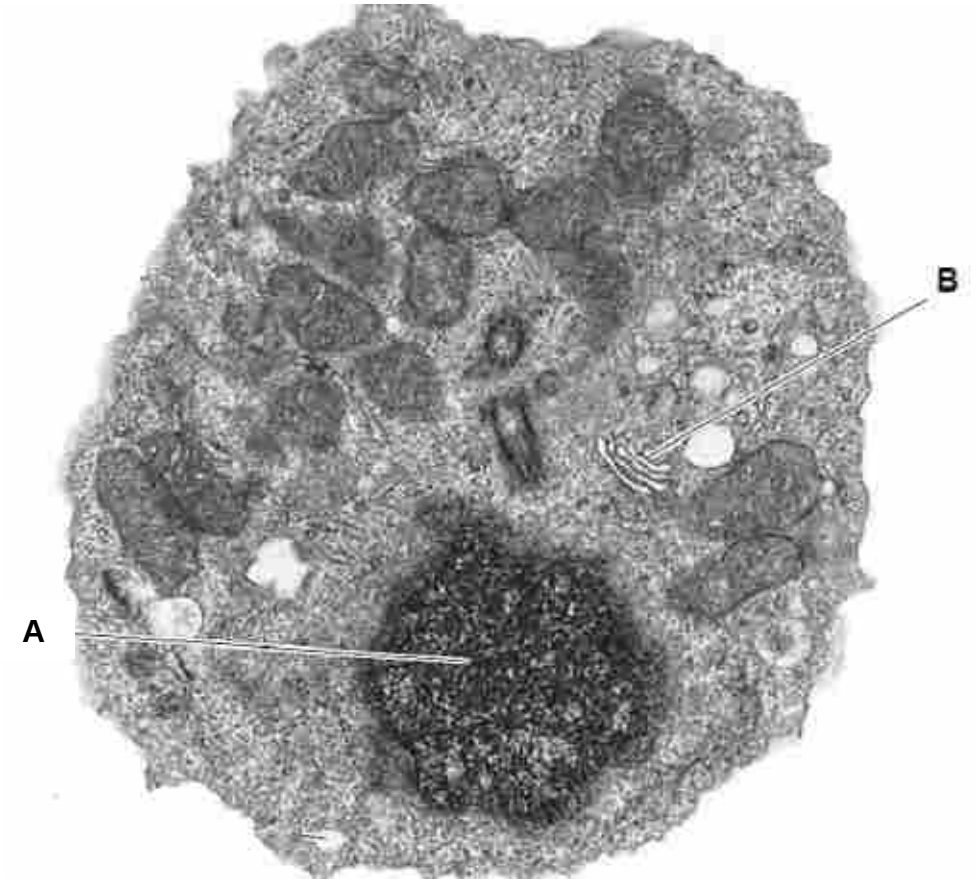


Fig. 1.1

Describe the role of the following organelles in the production of antibodies.

A:
- **Gene** encoding for antibody is found on **DNA** in the **nucleus**
- which is **transcribed** into **mRNA** in the **nucleus**

B:
- proteins are **modified**, **sorted** and **packaged**
- into **secretory vesicles** which **bud/ pinch off** from Golgi body. [4]

(c) Macrophage is another type of white blood cell which is involved in recognising foreign particles and undergoing phagocytosis.

(i) Describe the process of phagocytosis.

- (When particles bind to the cell surface membrane), **the cell surface membrane** **<u>form pseudopodia</u>** (singular form: pseudopodium) to **engulf** the particle.
- This process **requires energy** in the form of ATP.
- The tips of the pseudopodia **fuse** and **pinch** off to form phagocytic vacuole./ vesicle [3]

(ii) Suggest how a macrophage recognises specific foreign particles.

- **receptors/ proteins** on the **cell surface membrane** of macrophages
- are **complementary in shape** to (part of) foreign particles , hence **bind** to the foreign particle [2]

[Total: 13]

2 Fig. 2.1 shows translation occurring on a eukaryotic mRNA.

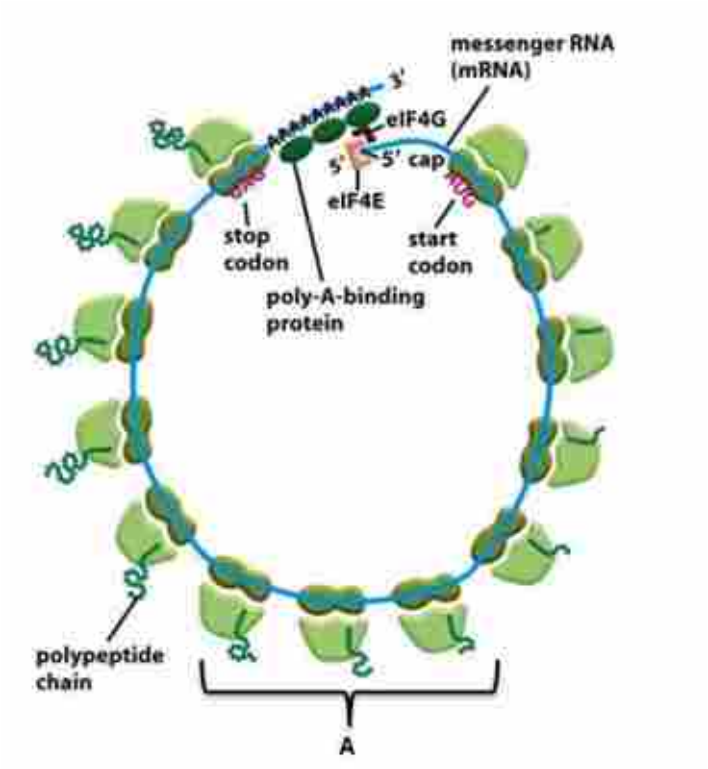


Fig. 2.1

(a) **(i)** Explain the significance of the pattern of translation, labelled **A** in Fig. 2.1.

- Polyribosomes / **multiple ribosomes** work on translating **one** messenger RNA
- **single** mature mRNA is used to make **many copies of the same type of polypeptide simultaneously /** enables a cell to synthesise **many copies of the same type of polypeptide very quickly** [2]

(ii) During initiation of translation, the poly-A tail and 5'cap on the mRNA, together with initiation factors like eIF4E and eIF4G form part of a complex which aid in recruiting ribosomal subunits to mRNA.

With reference to Fig. 2.1, describe the role of poly-A tail and 5' cap in the assembly of ribosomes.

- **poly-A binding protein** binds to the **poly-A tail** which in turn recruit/ attract **eIF4G** to bind
- **eIF4E** binds to **5'cap** which **binds** to **eIF4G** **(**to assemble into **translation initiation complex)**

(together forming a complex which aid in recruiting ribosomal subunits to mRNA) [3]

(b) Describe **three** differences between the process of translation and transcription.

	Transcription	Translation
Monomers	**RNA nucleotides**	**Amino acid**
Bonds formed between monomers	**Phosphodiester bonds**	**Peptide bonds**
Enzyme involved in synthesis the bond between monomers	**RNA polymerase**	**Peptidyl transferase**
Template	**DNA strand**	**mRNA strand**

[3]

[Total:7]

3 The ABO blood group system in humans is controlled by a gene with alleles, I^A, I^B and I^o. Each allele lead to production of different antigens (proteins) on the surface of red blood cells.

- Allele I^A, leads to the production of antigen A.
- Allele I^B, leads to the production of antigen B.
- Allele I^O, does not lead to the production of either antigen.

Alleles I^A and I^B are codominant and I^o is recessive to both.

(a) With reference to the ABO blood group, explain what is meant by

(i) codominance.

- Both alleles I^A and I^B are **separately** manifested/ expressed / influence blood group (distinctly)
- An individual with alleles I^A and I^B (at the gene locus controlling blood group) will have blood group AB.

[2]

(ii) multiple alleles.

- (single characteristic) Blood group is controlled by 3 or more/more than 2 alleles, I^A, I^B and I^o of the same gene/ occupying the same gene locus [1]

(b) In humans, a gene that codes for the production of a protein, called factor VIII, is located on the X chromosome. The dominant allele for this gene produces factor VIII, but the recessive allele does not produce factor VIII.

A person who is unable to make factor VIII has haemophilia in which the blood fails to clot properly.

Explain why a man with haemophilia cannot pass haemophilia to his son but may pass haemophilia to his grandson.

- Son only inherits Y chromosome (which does not have the mutant allele) from father / do not receive X chromosome (carrying the mutant allele) from father

*Some students thought the grandson mentioned in the question is the man's son's son rather than the man's daughter's son. So they talked about the man's son mating with an affected female to cause their son to have hemophilia. However this is not what the question wants since question already says " **man…pass haemphilia** to his grandson". The question wants you to explain the case **on how the man's X-chromosome carrying the mutant allele can be passed to his grandson,*** rather the grandson getting the disease because of inheritance from the female that the man's son marries.

[3]

- Father will pass X chromosome carrying the mutant allele to daughters
- Daughter may pass mutant allele on X-chromosome to her son / his grandson

Reject mutated X-chromosome/ recessive X-chromosome - should be X chromosome carrying mutant allele
Reject merely saying passing down alleles without reference to X-chromosome - Must have idea of passing down X-chromosome carrying mutant allele.
Reject merely saying carrier/heterozygous without reference to X-chromosome

(c) A gene for feather colour in chickens is carried on an autosome. This gene has two alleles, black (**C^B**) and splashed-white (**C^W**). When a male chicken with black feathers is mated with a female chicken with splashed-white feathers as shown in Fig. 3.1, all the offspring have blue feathers. This also occurs when a male chicken with splashed-white feathers is crossed with a female with black feathers.

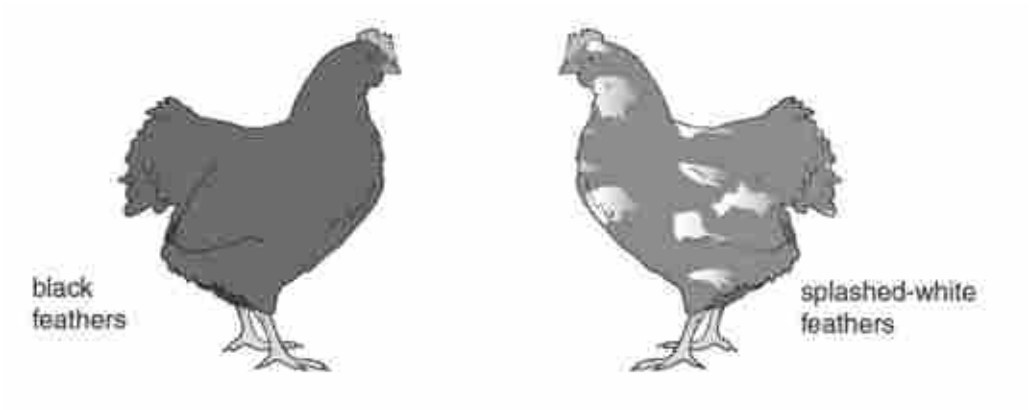


Fig. 3.1

Another gene may cause stripes on feathers (barred feathers), shown in Fig. 3.2. This gene is carried on the X chromosome. The allele for barred feathers (**X^A**) is dominant to the allele for nonbarred feathers (**X^a**).

In chickens the male is homogametic and has two X chromosomes while the female isheterogametic and has one X chromosome and one Y chromosome.

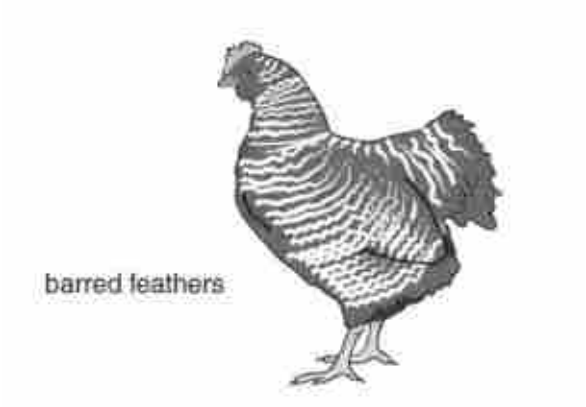


Fig. 3.2

A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers. All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given above ,draw a genetic diagram to show this cross.

(male) $C^BC^BX^aX^a$; x (female) $C^WC^WX^AY$;

(gametes) C^BX^a C^WX^A or C^WY ;

$C^BC^WX^AX^a$; (male, blue, barred)

$C^BC^WX^aY$; (female, blue, non-barred)

[4]

[Total: 10]

4 To protect crops against insects, many crops such as maize and cotton are genetically modified to contain a gene (Bt) from a bacterium, *Bacillius thuringiensis*. The Bt gene codes for a toxin, which inserts into the insect gut cell membrane, paralyzing the digestive tract and killing the insects which eat the crop. When these genetically modified (GM) crops first became available it was predicted that insect pests would develop resistance to these toxins.

(a) Explain how Bt resistance may arise and spread in an insect population.

- Bt resistance arise as a result of: **random mutations** in the gene that encode proteins in the cell surface membrane / gene that encodes for protein that can bind to Bt to prevent it from inserting into the cell membrane / AVP in the insects

Any 2

- Presence of Bt toxin creates a **selection pressure** during **natural selection**
- Insects with resistance to Bt toxin/ not killed by Bt toxins are at a **selective advantage** / will be selected for
- can **survive, reproduce** and **pass** on **alleles** that confer Bt resistance to their **offspring / next generation**

[4]

(b) The extent of Bt resistance in insect pest species was surveyed in 2005 and in 2011. The level of resistance in each species was classified according to the highest percentage of resistant individuals recorded in any population anywhere in the world. Three levels of resistance were identified:

- <1%
- 1–6%
- >50%

There were no reports of populations of insect pests having between 6% and 50% of resistant individuals.

The results of the surveys are shown in Table 4.1.

Table 4.1

year	total number of insect pest species surveyed	number of insect pest species susceptible to Bt toxins	number of insect pest species with reported levels of resistance		
			<1%	1–6%	>50%
2005	9	8	0	0	1
2011	13	4	3	1	5

(i) Discuss whether the data provided can support the hypothesis that rise in Bt resistance is due to introduction of GM crop, including limitations of the data provided.

2 marks on data analysis

From 2005 to 2011,

- percentage of insect pest species susceptible to Bt toxins decreased from 89% to 31%

AND

- Percentage of insect pests with high level of resistance/ >50% resistance increased from 11% to 38.5%

OR

- Number of insects pests with low level of resistance / < 1% resistance increased from 0% to 23% OR Number of insects pests with low level of resistance / 1-6% resistance increased from 0% to 7%

(reject merely quoting raw values since the total number of insect pests surveyed is different- must convert to percentage)

2 marks on limitations

- Small sample size
- Survey only done in two years
- the damage done by the insect pests surveyed ;
- the number of reports of resistance for each species ;
- the proportion of populations with the highest percentage of resistant individuals ;
- the effect on the crops concerned of pest resistance at the levels given (<1%, etc.) ;e.g. the losses in yield
- the geographical spread of the insect pest species that show resistance [4]

(ii) Justify the prediction that both insect-caused and non-insect-caused damages to Bt crops will increase with climate change.

- Extreme weather conditions- must give example e.g. drought / water logging / flood decreased growth of crops
- Increasing temperature degrade Bt toxin → Bt toxin n longer effective against insects
- Increasing temperature will increase metabolism of insects/ shorter maturation/life cycle/ reproduce in a shorten span of time → More insects to feed on crops
- increase in reproduction rate of insects , increase the development of resistance to Bt toxin

[3]

[Total: 11]

5 An analysis of ice cores from the Artic and Antarctic can provide information about the composition of the Earth's atmosphere over thousands of years.

Fig. 5.1 shows the concentrations of carbon dioxide and methane measured in ice cores, dated between 1000 and 2000 AD.

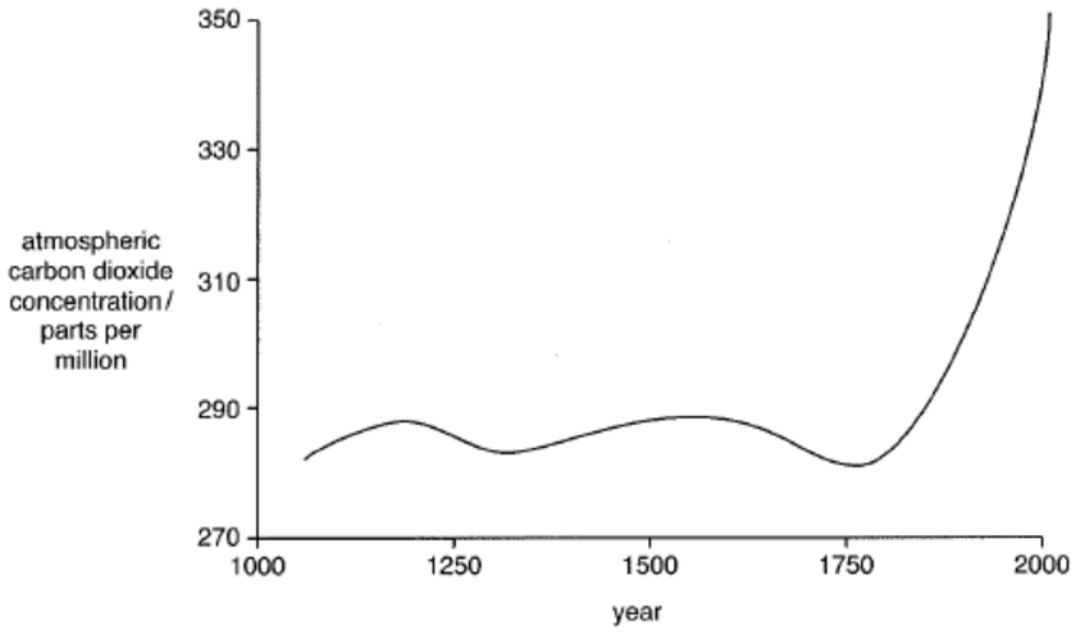


Fig.5.1

(a) Describe and explain the data in Fig. 5.1 from 1750 AD onwards. [2]

- (Describe data trend and quote) Atmospheric carbon dioxide concentration **increase sharply** from 280 to 350 parts per million from 1750 to 2000AD;
- (explain) Rise of both atmospheric carbon dioxide and methane concentration after 1750 is due to industrial revolution, rise in human population, rise in human activities, rise in demand of energy consumption, deforestation for other land uses and meat consumption;

(b) Explain how increasing concentrations of gases, such as carbon dioxide and methane, are thought to cause global warming. [2]

- Blanket of carbon dioxide and methane around the Earth;
- Allows high energy/ short wavelength rays from the Sun to enter Earth's atmosphere;
- When these are reflected from the surface of the Earth;
- They lose energy;
- And the longer wavelength/ lower energy/ infra-red/ heat rays cannot escape through the carbon dioxide blanket;(causes global warming)

[Total: 4]

Section B

Answer **one** question in this section

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

Your answers must be in continuous prose, where appropriate.

Your answer must be set out in parts **(a)**, **(b),** etc., as indicated in the question.

6 **(a)** Explain how fluidity of biological membranes can be maintained and the importance of fluidity to membrane function. [8]

How fluidity is maintained:

- Definition of fluidity: phospholipids and proteins free to move within layer / transversely;
- Membrane fluidity can be regulated by regulating the level of cholesterol and phospholipids with unsaturated hydrocarbon tails in the membrane;
- Membranes freeze at a lower temperature if it has a higher proportion of phospholipids with unsaturated hydrocarbon tails and cholesterol; (Accept reverse argument)
- Unsaturated hydrocarbon tails have kinks that keep the phospholipid molecules in the membrane from packing close together at lower temperatures, enhancing membrane fluidity; (Accept reverse argument)
- Cholesterol prevents close packing of phospholipids in the membrane, preventing membrane from freezing at lower temperatures;
- Membrane prevented from being overly fluid / integrity of the membrane is maintained at higher temperature as cholesterol restricts phospholipid movement through its interactions with phospholipids;
- Stabilising the lipid bilayer through hydrophobic interactions;

[max 4m]

Importance:

- ref. to need for invagination / pinching in of the membrane during cytokinesis / cell division;
- ref. to invagination of the membrane during phagocytosis / pinocytosis / endocytosis;
- ref. to formation of vesicles for the transport / trafficking of proteins from rough ER to Golgi apparatus / other membrane-bound organelles;
- ref. to formation of vesicles from *trans* face of the Golgi apparatus during protein sorting;
- ref. to fusion of vesicles from endoplasmic reticulum / containing proteins to

form cis-face of the Golgi apparatus for protein modification;

- ref. to fusion of vesicles with cell surface membrane to release secretory molecules from the cell / exocytosis;
- ref. to fusion of endocytotic vesicles with lysosomes;
- ref. membrane fluidity to allow locomotion of unicellular organisms e.g. amoeba;
- ref. diffusion of small or non-polar molecules through the membrane, e.g. water / oxygen / carbon dioxide (at least one named example);
- ref. to transmembrane transport proteins changing conformation, such as sodium-potassium pump / ligand-gated sodium ion channel / voltage-gated sodium ion channel (at least one named example);

[max 4m]

Examiners' comments:
There were many answers which incorrectly described fatty acid chains instead of fatty acid tails of phospholipids. Many students also confused phospholipids with cholesterol, describing cholesterol as have kinks or being unsaturated or saturated. There were also students who describe fatty acid chains which were branched.

Many answers included general statements about membrane functions in cells instead of relating fluidity to these functions. The general statements were not credited. Also, merely mentioning that 'membrane fluidity is important for endocytosis or exocytosis' is insufficient. It is important to explain clearly what the membrane fluidity was critical to, i.e. 'membrane fluidity is important for the invagination of the membrane during endocytosis' or 'membrane fluidity is essential for the secretory vesicles to fuse with the cell membrane during exocytosis' would be clearer answers which will gain credit.

(b) A human body can synthesise more than 90,000 different types of proteins. The complete set of proteins present in the various cells of an individual is known as the proteome.

A human's genome is constant, whereas the proteome of a human is constantly changing.' Discuss this statement. [7]

(discuss for human's genome is constant) due to nature of genes being DNA

1. How **semi-conservative DNA replication** before cell division takes place accurately/ described
2. ***complementary base pairing*** *(A=T, C≡G)*
3. ***DNA polymerase*** *with* ***proofreading function***
4. Specific sequences have specific functions → important that the functions are maintained (Examples introns, exons, promoters, distal control elements (enhancer/ silencer), centromeres, telomeres)
5. one gene, one protein hypothesis
6. How mitosis ensures genetic stability/ nuclei of daughter cells are genetically identical or receive the same number and type of chromosomes as the original parent nucleus,
7. Function/ why mitosis is important: stem cells during growth of human and renewal and repair: replace dead or damaged cells by new cells which are genetically identical to original cells so that cells (used in growth/ renewal/repair) can carry out the same function;

(discuss for human's proteome is constantly changing)

8. need for changing protein expression as cells grow and specialise
9. upregulation/ down regulation of enzymes
10. temporal expression e.g. according to human developmental phase (fetal haemoglobin)/ respond to environment changes (growth factors)
11. spatial expression (different cell types requires different proteins to form different structure to perform different functions)
12. Why there is protein variety, classification of proteins/different class of protein for different functions/purpose (Examples: Transport/ enzymatic activity/ cell-to-cell recognition/ receptor binding/ cell signalling/intercellular joining/ stabilizing proteins/ respiration)
13. environmental factors (e.g. exposure to sun, increase melanin production)
14. post translational modification → alternative splicing → different mRNA (also nucleic acid) formed (support variety of proteome)

(discuss against human's genome is constant)

15. Exposure to radiation / chemical carcinogens causes structural damage to DNA/induce mutation + *cite an example below*
    - e.g. UV light (causes thymine dimer formation)
    - e.g. chemicals (such as nitrous acid chemically reacts with base)
    - e.g. ethidium bromide (intercalates into DNA)
16. **DNA replication is not always perfect** → Spontaneous mutation – DNA polymerase adds the wrong base, and is not being rectified.
17. (nature of damage) Such structural damage causes wrong nucleotide(s) / extra nucleotide(s) / missing nucleotide(s)/ change in chromosomal structure e.g. chromosomal translocation

18. Gametic cells: Generation of gametic variation as a result of meiosis (not all cells in the same human body have same genome)
19. Process that generate variation: crossing over, independent assortment of homologous chromosomes
20. Errors in mitosis leading errors in number of chromosomes e.g. aneuploidy/ mosaic Down syndrome

21. (link between genome and proteome) Proteins are derived from protein synthesis. Their unique amino acid sequences (coded for by the DNA sequence of their genes) determine their folding thus their tertiary, quaternary structure which enables them to perform their unique functions.

(discuss against human's proteome is constantly changing)

22. the need for constancy in the proteome for the proteins involved in fundamental life processes, such as respiration idea of conserved proteins/ housekeeping proteins (no matter the time/ space in a human)
23. QWC (address all sections)

Examiners' comments

Those candidates who appreciated the meaning of 'proteome' were able to engage effectively with this title and make links to a range of topic areas with which they were familiar. Stronger candidates used a clear line of explanation and argumentation to form the bulk of the essay content.

Relevant issues for consideration included the significance of mutation, the generation of variation during meiosis, various forms of genetic modification and a discussion of the possible consequences of these changes to the genome. For the proteome, candidates could have discussed the need for changing protein expression as cells grow and specialise. A small number of candidates discussed

the need for constancy in the proteome for the proteins involved in fundamental life processes, such as respiration. A discussion of conserved proteins would have improved the quality of responses of some candidates.

A few candidates misread the question and answered it in terms of 'the human genome and proteome' instead of 'a human's genome and proteome'. Although many relevant issues were still explored, it meant that the essay had an emphasis on evolutionary change in a population as opposed to the uniqueness of the individual (examiner's interpretation).

Reference to **transport**
Hydrophilic channels involved in facilitated diffusion;
For specific ions and polar molecules to pass through;
Channel proteins have fixed shape/ carrier proteins can undergo rapid changes
In shape in oprder to transport specific sunstances;
Na^+ and K^+ pumps involved in active transport;
Actively pumps $2K^+$ into cell and $3Na^+$ out of cell against concentration gradient;

Reference to **enzymatic activity**
Enzyme embedded in membrane with its active site exposed to substances;
E.g. inner membrane of mitochondria contains ATP synthase;
For the synthesis of ATP/ in oxidative phosphorylation;

Reference to **cell to cell recognition**
Glycoproteins serve as identification tags;
Antigens serve as markers;
To recognize specific cells fo development of tissues and organs;
Reference to antibody-antigen binding
Antigens act as cell identity markers
Foreign antigens can be recognized and attacked by immune system;

Reference to **receptor binding**
Chemically signally between cells;
Protein receptors that have binding site with specific shape;
Binds to a transmitter (hormone or neurotransmitter);
Causes conformational change to the protein;
That relays message to the inside of the cell
E.g. receptor on post-synaptic membrane/ receptors for cyclic AMP/ receptors for signal transduction pathway/ receptors for hormonal regulation (insulin receptors);
protein phosphorylation cascade in cell signalling

Reference to **intercellular joining**
Proteins in adjacent cells are hooked together in various kinds of junctions;
Tight junction: membrane fused to prevent leakage of fluid;
Anchoring junction: fasten cells together into strong sheets;
Gap junctions: provide channels between cells for passage of ions and small molecules;

Reference **to stabilizing proteins**
Carbohydrates chains of glycoproteins and glycolipids projects into aqueous environment surrounding cell;
Form hydrogen bonds with water molecules which stabilize the membrane

7 **(a)** Explain why more energy is released from the oxidation of triglycerides as compared to the same unit mass of glucose and outline the problems of using triglycerides as the main respiratory substrate instead of glucose in animals. [7]

- triglycerides contain **two times more hydrogen atoms** / **greater ratio of hydrogen to oxygen atoms** / **more C-H bonds** as compared to the same mass of glucose;
- Can be used to generate **greater** number of **NADH** and **FADH** during **Kreb's cycle** / **dehydrogenation reactions**;
- Release **more** high energy **electrons** to the electron transport chain;
- Generate more ATP by **oxidative phosphorylation**;

- Glucose is **polar / hydrophilic** due to presence of many hydroxyl groups;
- Glucose is therefore soluble in aqueous medium, can easily be transported in blood and cellular cytoplasm;
- Small molecule so can diffuse through blood vessels / across the cell surface membrane through the glucose carrier proteins / via facilitated diffusion;

- Triglycerides are **non-polar / hydrophobic** due to the fatty chains / hydrocarbon chains;
- Triglycerides are insoluble in aqueous medium, cannot be easily transported in aqueous medium / needs to form lipoprotein complexes with proteins to be transported in blood;
- Cannot easily cross the cell surface membrane / needs to enter the cell via **receptor-mediated endocytosis**;

- AVP;

QWC (one point from each section);

(b) Discuss the inter-relationships of membranous organelles in eukaryotic cells and suggest the implications of absence of membranous organelles in prokaryotic cells. [8]

<u>Protein synthesis and secretion</u>

- **Nucleus** : site of **transcription** (of DNA to form RNA)
- Using **RNA nucleotides/ RNA polymerase** and **DNA template** found in the nucleus
- RNA (accept merely mention mRNA?) formed leave via **nuclear pores** to enter **cytoplasm**

Ignore reference to free ribosomes

- **Ribosomes** found on **rough endoplasmic reticulum** carry out **translation** of proteins of the endomembrane system OR proteins to be secreted from the cell

- Route from protein: Proteins are then packaged into **transport vesicles** → **Golgi body**

- Within the Golgi body, proteins from RER are further **modified**, **sorted** and **packaged**

- **Lipids** from **smooth ER** are also **modified**, **sorted** and **packaged**

- From Golgi body to **cell surface membrane** via **secretory vesicles** / to other parts of the cell via the **Golgi vesicles**

- *Award once only* for **pinching off/ budding** of vesicles from organelles + **fusion** of membrane of vesicles with the destination organelle

  E.g. Membrane of transport vesicles fuse with the membrane (of the *cis* face) of the Golgi body and deposit their proteins within the lumen of the Golgi body OR secretory vesicles which bud/ pinch off from (the *trans* face of the) Golgi body to fuse with CSM

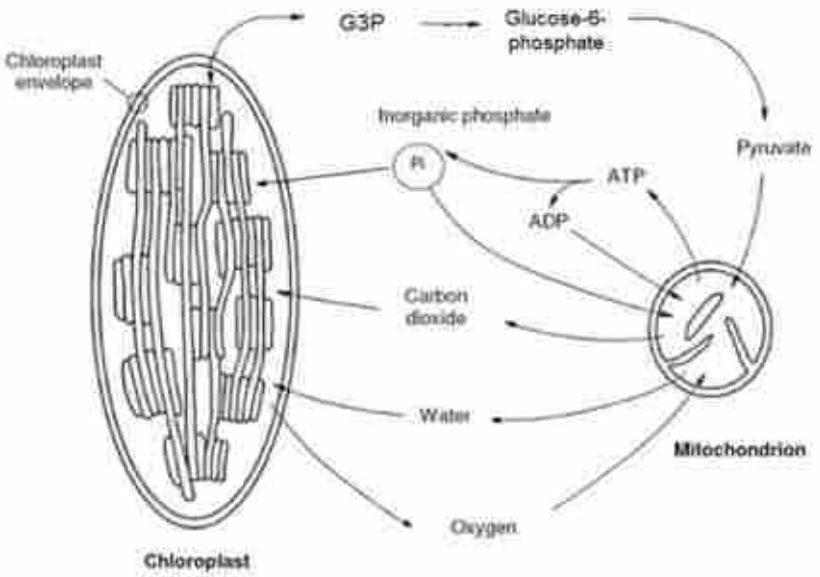
- *award once only for movement of vesicles :* With the aid of **microtubules,** the secretory vesicles will move to the cell surface membrane

Mitochondria / chloroplast with RER (TYS)

- mitochondrion **produces ATP** for rough endoplasmic reticulum for protein synthesis/translation

- RER synthesises proteins/ enzymes which are required for respiratory reactions in mitochondria/ photosynthesis in chloroplast

Mitochondria and chloroplast (2013 Promos) in plant cells



- **G3P** formed in **chloroplast** due to **light-independent reaction/ Calvin cycle** (converted to glucose)
- **pyruvate** (accept glucose?) **undergo aerobic respiration** / the **link reaction, Krebs cycle and oxidative phosphorylation** to **be broken down for ATP production in mitochondria**
- Oxygen is formed (In thylakoid space) as a **product of** the **photolysis** of **water** during **light-dependent reaction**
- Oxygen (diffuses out of the chloroplast and into the mitochondrial matrix) acts as the **final electron acceptor** (in the electron transport chain to produce water) in oxidative phosphorylation
- Carbon dioxide **produced** in aerobic respiration during **Krebs cycle** and **link reaction** / by oxidative decarboxylation
- (Diffuses into the stroma of the chloroplast) for **carbon fixation** in the **light independent reaction/Calvin cycle**;

Lysosomes

- Vesicles containing **digestive/ hydrolytic enzymes**
- Which **bud off / pinch off** from the **Golgi apparatus**
- **Phagocytosis**: Substances taken in by the cell in a vacuole/ **phagocytic vesicles** are fused with lysosomes
- **Autophagy**: A damaged organelles or small amount of cytosol becomes surrounded by a membrane, which then fuses with lysosome to form a vacuole in which the unwanted materials are digested.

Implication of absence of membranous organelles in prokaryotes

- DNA **not enclosed** by **nuclear membrane**
- This allows **transcription** and **translatio**n to take place **simultaneously**
- No RNA processing (since transcription and translation occurs simultaneously)
  → no **post-transcriptional control** of gene expression
- **Fewer genes / smaller genome**: since there is no need to encode transport proteins/ signaling proteins/ etc on membranes of organelles
- Protein secretion (no exocytosis/ endocytosis) can only occur through **channel proteins / facilitated diffusion**
- Stalked particles / respiration / photosynthesis (for cyanobacteria) occurs only on **cell surface membrane**

ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2018

BIOLOGY **8876/01**

HIGHER 1 **28 August 2018**

Paper 1 Multiple Choice **1 hour**

Additional Material: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, pencil clips, highlighters, glue or correction fluid.
Write your name, centre number and index number on the Answer Sheet provided.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

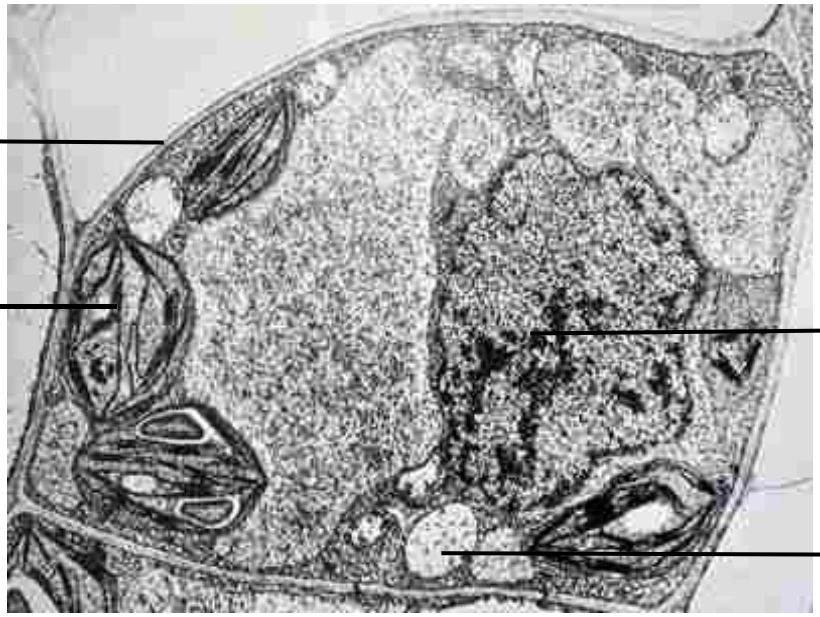
Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.

Calculators may be used.

This question paper consists of **19** printed pages.

1 The electron micrographs show two different types of cells (not shown to scale).



Cell A

Cell B

Which row matches the structures to their correct function?

	Structure in cell A	Structure in cell B	Function
A	3	7	Provide energy for the cells
B	1	5	Maintain the shape of the cells
C	2	6	Photosynthesize
D	4	6	Secrete proteins

2 The plasma membrane is the cell's protective barrier as it prevents foreign molecules from entering the cell. However, in drug research experiments, foreign molecules such as drugs or short DNA fragments need to be transported into the cell.

Electroporation is a technique used to increase the permeability of the membrane transiently by treating the cell with short electrical pulses.

Which statement most likely explains how electroporation works?

A The short electrical pulses denature the membrane proteins, allowing foreign molecules to pass through.

B The short electrical pulses cause the foreign molecules to be attracted to the surface of the membrane.

C Electricity increases the hydrophobic nature of foreign molecules, allowing them to pass through the hydrophobic core of the phospholipid membrane.

D Electroporation causes the phospholipids to move apart to create pores for foreign molecules to pass through.

3 Some students came up with possible explanations of how proteins are secreted out of a prokaryotic cell.

Which is the best explanation?

A Proteins diffuse through the plasma membrane out of the cell.

B Protein channels allow proteins to pass through the plasma membrane.

C Exocytosis occurs when vesicles within the cell fuse with the plasma membrane.

D Prokaryotic cells lyse in order to release proteins into the environment.

4 Which row matches the descriptions of biological molecules to where they are found?

1 Polymer of glucose molecules linked by β-1,4 glycosidic bonds to form a straight chain
2 An unbranched and helical polymer of glucose molecules linked by α-1,4 glycosidic bonds
3 An amphipathic, phosphate-containing molecule

	1	2	3
A	Cell wall of eukaryotes only	Storage granules in animal cells	Plasma membrane of prokaryotes and eukaryotes
B	Cell wall of prokaryotes and eukaryotes	Storage granules in plant cells	Plasma membrane of eukaryotes only
C	Cell wall of prokaryotes and eukaryotes	Storage granules in animal cells	Plasma membrane of prokaryotes only
D	Cell wall of eukaryotes only	Storage granules in plant cells	Plasma membrane of prokaryotes and eukaryotes

5 How many of the following descriptions correctly relates the structure of a globular protein to its property?

1 Monomers are linked by peptide bonds to prevent the protein from denaturing
2 Amino acid residues with hydrophilic R groups face the exterior of the protein, allowing it to be soluble in water
3 Many hydrogen bonds present allow the protein to have high tensile strength
4 Bonds between the subunits of the protein allow it to be stored easily

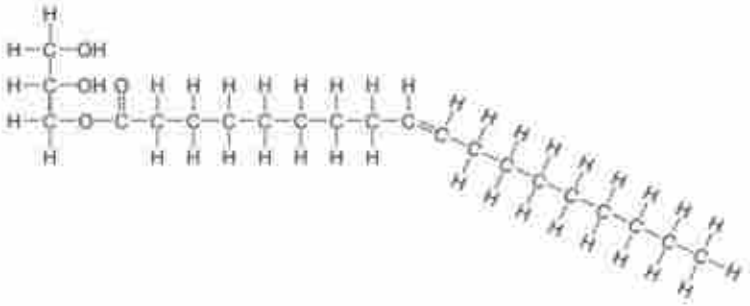
A 0

B 1

C 2

D 3

6 The diagram shows a molecule that has been partially broken down.



This molecule was then completely digested in a further reaction.

Which row correctly matches the products to the reaction?

	Reaction	Products
A	Condensation reaction involving the addition of a water molecule	Glycerol, saturated fatty acid
B	Condensation reaction involving the removal of a water molecule	Glycine, unsaturated fatty acid
C	Hydrolysis reaction involving the addition of a water molecule	Glycerol, unsaturated fatty acid
D	Hydrolysis reaction involving the removal of a water molecule	Glycine, saturated fatty acid

7 Which statement is correct regarding the enzymatic activity of catalase under the following conditions?

1 Addition of a non-competitive inhibitor

2 Addition of pH13 buffer solution

3 Incubation at 10°C

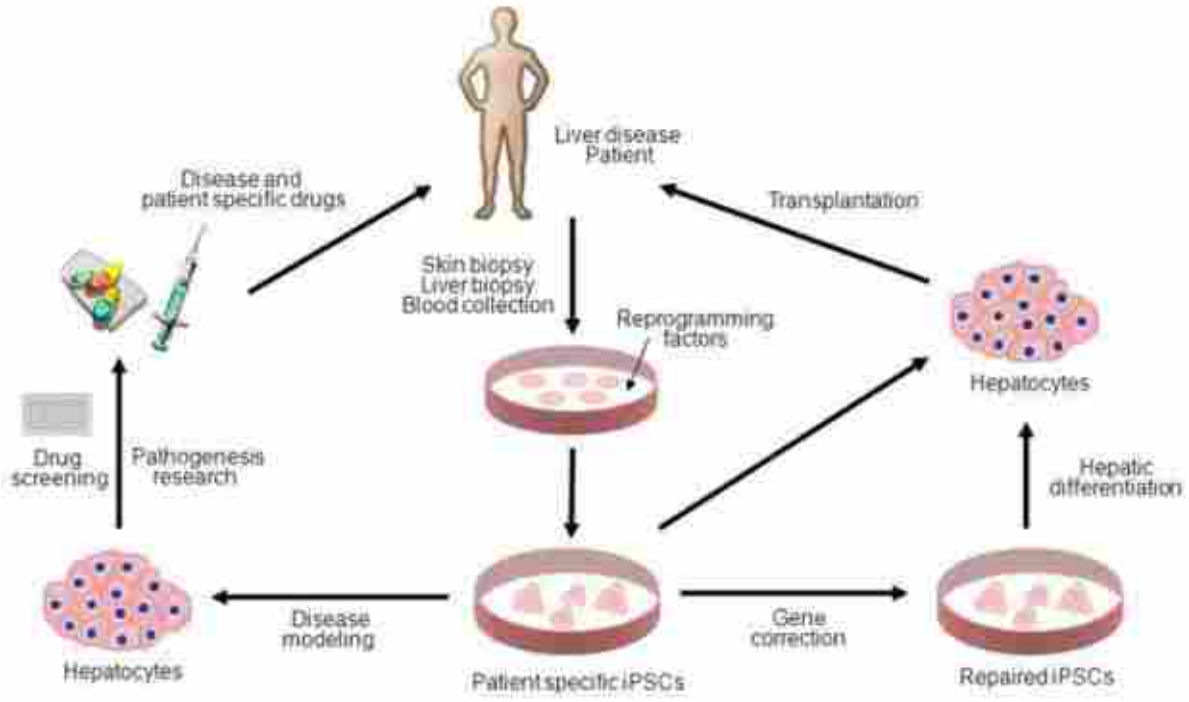
A The hydrogen and ionic bonds between R groups of residues are broken in conditions 2 and 3, hence the rate of reaction decreases.

B The catalytic and binding residues in all active sites are affected in condition 1, hence the rate of reaction decreases.

C The chances of effective collisions to form enzyme-substrate complexes are low in condition 3, hence the rate of reaction decreases.

D The changes in the 3D conformation of enzymes are irreversible in conditions 1, 2 and 3, hence the rate of reaction decreases.

8 Induced pluripotent stem cells (iPSCs) are useful in regenerative medicine as they act as an effective replacement for human embryonic stem cells. The figure shows the potential applications of human iPSCs for liver diseases, such as disease modelling, drug discovery and cell replacement therapy.



Which statement could be concluded from the information provided?

A As iPSCs are obtained and reprogrammed from somatic cells of the patient, the patient-specific iPSCs are genetically identical to the somatic cells.

B The drawback of using iPSCs is that somatic DNA mutations remain in the original differentiated cells and these may potentially affect cellular function.

C It is easier to obtain iPSCs compared to embryonic stem cells as iPSCs can be obtained from any differentiated somatic cell while embryonic stem cells can only be obtained from the inner cell mass of the blastocyst.

D The reprogramming factors used to obtain patient specific iPSCs are transcription factors that induce the patient's cells to express genes that are characteristic of pluripotent stem cells.

9 Which statements regarding stem cells are true?

1 Researchers can induce embryonic stem cells to differentiate into various cells and tissue types to repair damaged tissue.

2 The use of embryonic stem cells for research can be an ethical challenge as the continued destruction of embryos could desensitise medical communities to the destruction of life.

3 One of the normal functions of blood stem cells in a living organism is the transplantation of such stem cells from normal healthy bone marrow donors to leukemia patients for treatment.

4 Blood stem cells can potentially differentiate into neurones under appropriate chemical signals.

A 1, 2 and 3 **B** 1, 2 and 4 **C** 1 and 3 only **D** 2 and 4 only

10 Which statement(s) about DNA polymerases and RNA polymerases is/ are correct?

1 They read the DNA template in the 3’ to 5’ direction.

3 They unwind and unzip double-stranded DNA.

3 They read the terminator sequence and stop adding nucleotides to nucleic acid chains.

4 They bind to the same specific sequences to start their processes.

A 1 and 3 **B** 2 and 3 **C** 1 only **D** 4 only

11 The following steps describe a method to study the structure and localisation of protein kinase c in yeast cells.

- tRNAs with anticodon AAG were isolated and chemically modified to carry their specific fluorescent amino acids.
- During translation, chemically modified amino-acyl tRNAs bind to the large ribosomal subunit.
- Fluorescent amino acids are incorporated into the elongating polypeptide chain.
- After translation, the polypeptide chain folds into its native conformation and the positions of the fluorescent amino acids can be detected and studied.

Which of the following describes a condition which will allow the above method to be carried out?

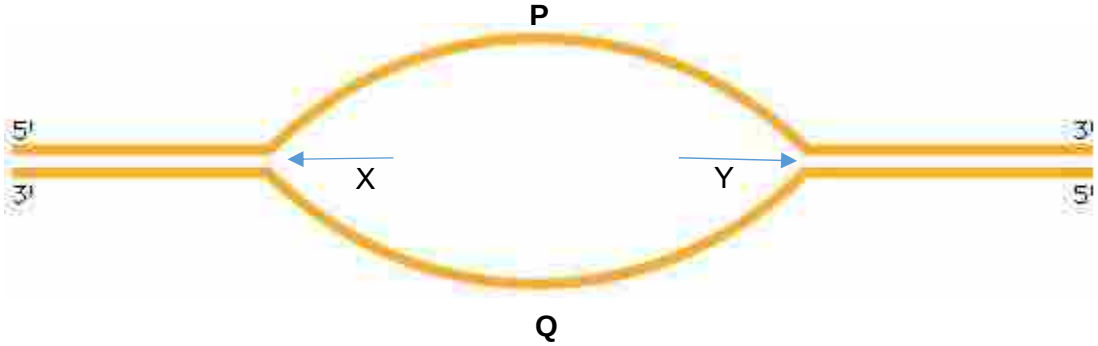
A Peptidyl transferase is specific to the fluorescent amino acid and the elongating polypeptide chain in order to catalyse the formation of a peptide bond.

B Synthetic amino-acyl tRNA synthetase is specific to the fluorescent amino acid and chemically modified tRNA in order to form modified amino-acyl tRNA.

C The ribosome is specific to the mRNA sequence in order to synthesise protein kinase c.

D Chemically modified amino-acyl tRNA is specific to the P site of a large ribosomal subunit in order to add the fluorescent amino acid to the elongating polypeptide chain.

12 Which statement describes the process shown?



A Both DNA template strands P and Q are used to synthesise leading strands towards direction X.

B Both DNA template strands P and Q are used to synthesise leading strand and lagging strand respectively towards direction X.

C The DNA daughter strand synthesised using template strand P has only one primer while the daughter strand synthesised using DNA template strand Q has multiple primers.

D As the replication fork opens towards direction Y, more Okazaki fragments are synthesised using DNA template strand Q.

13 The following table shows the codons and their corresponding amino acids.

	U	C	A	G	
U	UUU Phe UUC UUA Leu UUG	UCU Ser UCC UCA UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU Leu CUC CUA CUG	CCU Pro CCC CCA CCG	CAU His CAC CAA Gln CAG	CGU Arg CGC CGA CGG	U C A G
A	AUU Ile AUC AUA AUG	ACU Thr ACC ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU Val GUC GUA GUG	GCU Ala GCC GCA GCG	GAU Asp GAC GAA Glu GAG	GGU Gly GGC GGA GGG	U C A G

The DNA sequence is taken from part of a gene:

…TAC GTT AAT AAC CCT GAG GGC TAA TGT…

Which of the following mutations will result in the same phenotype as the original sequence?

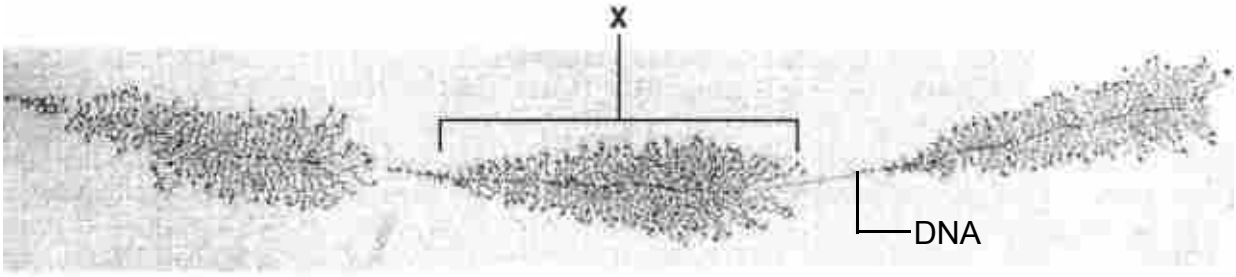
A …TAC GTG ATT AAC CCT GAG GGC TAA TGT…

B …TAT GTT AAT AAC CCT GAG GGC TAA TGT…

C …TAC GTT AAT AAC CCT GAG GGC TAA TTT…

D …TAC GTC AAT AAC CCT GAG GGC TAA TGT…

14 A process known as DNA amplification increases the number of rRNA genes in frog eggs before fertilisation. The figure shows the transcription of the genes coding for rRNAs at adjacent positions along the chromosome.



Which of the following statements could **not** account for structure X?

1 Elongating polypeptide chains form structure X as ribosomes read the mRNA strand.

2 Structure X is thicker on the right side as RNA polymerase reads the template strand from left to right.

3 There are multiple pre-mRNAs synthesized simultaneously in structure X as there are many promoters.

4 Structure X is highly condensed heterochromatin.

A 1, 3 and 4 **B** 2, 3 and 4 **C** 1 and 4 only **D** 2 and 3 only

15 Elephants have been found to be resistant, though not immune, to cancer. They are four times less likely to develop cancer as compared to humans. Elephants have 40 copies of the *p53* gene while humans only have two. In addition, three genes which code for DNA repair proteins have been found to be very active.

What do these observations suggest?

A All DNA mutations in the elephant are repaired.

B When elephants develop cancer, it is due to environmental causative factors such as excessive exposure to UV light.

C The occurrence of cancer is due to the *p53* oncogene, which stimulates the cell to divide rapidly, bypassing the cell cycle checkpoints.

D There is large amount of p53 proteins in an elephant cell which prevent cells with mutations from moving past the cell cycle checkpoints.

16 A species of lizards, Whiptail lizards, reproduce only by parthenogenesis. This mode of asexual reproduction allows females to produce offspring alone, without the genetic contribution of a male.

Scientists are worried that this species may become endangered as a result of climate change.

Which statements support the scientists' concerns?

1 Offspring of parthenogenetic species are genetically identical.
2 Parthenogenesis produces too few offspring for a viable population.
3 Genetic contribution of a male is required in order for the offspring to survive.
4 In asexual reproduction, meiosis does not occur to produce genetically different gametes.

A 1, 2, 3 and 4 **B** 1, 2 and 4 **C** 2 and 3 only **D** 1 and 4 only

17 A student examined a slide of an onion root tip and obtained the following results.

Stage	Number of cells
Interphase	886
Prophase	73
Metaphase	16
Anaphase	14
Telophase	11

What percentage of the cells contain chromosomes that do not appear as sister chromatids?

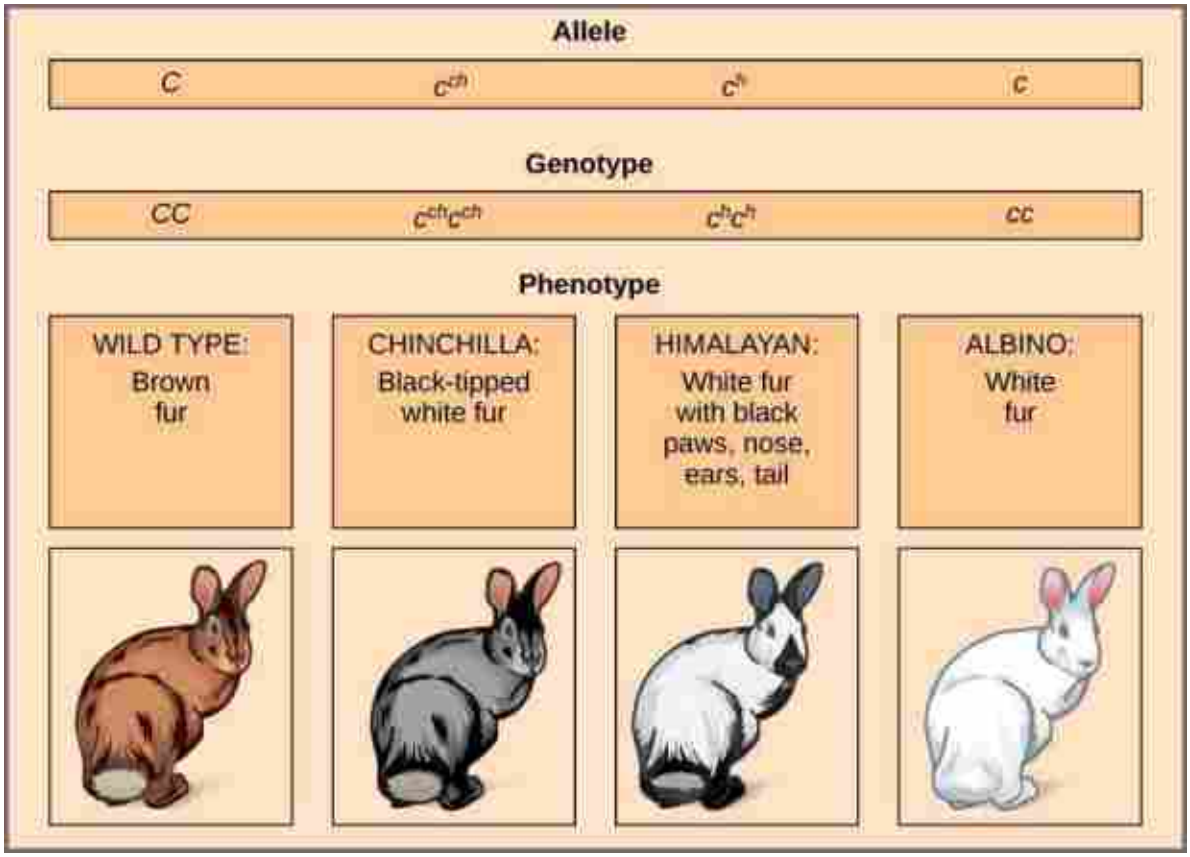
A 95.9%

B 91.1%

C 88.6%

D 2.5%

18 Rabbits carry the *C* gene which is required for the development of pigments in their fur. The alleles show a hierarchy of dominance when present in heterozygous individuals as shown in the figure. The order of dominance of these alleles, in descending order, is C, c^{ch}, c^{h}, c.



A scientist observed that the fur on the paws, noses and ears of Himalayan rabbits tends to be black while the rest of its body tends to be white. The scientist extracted a section of skin from the ear of a Himalayan rabbit and cultured the follicle cells. He discovered that when the cells are exposed to temperatures between 15°C and 25°C, they synthesise certain pigments. However, at temperatures beyond 35°C, these pigments are not synthesised.

Which statement best explains the results of the scientist's experiments?

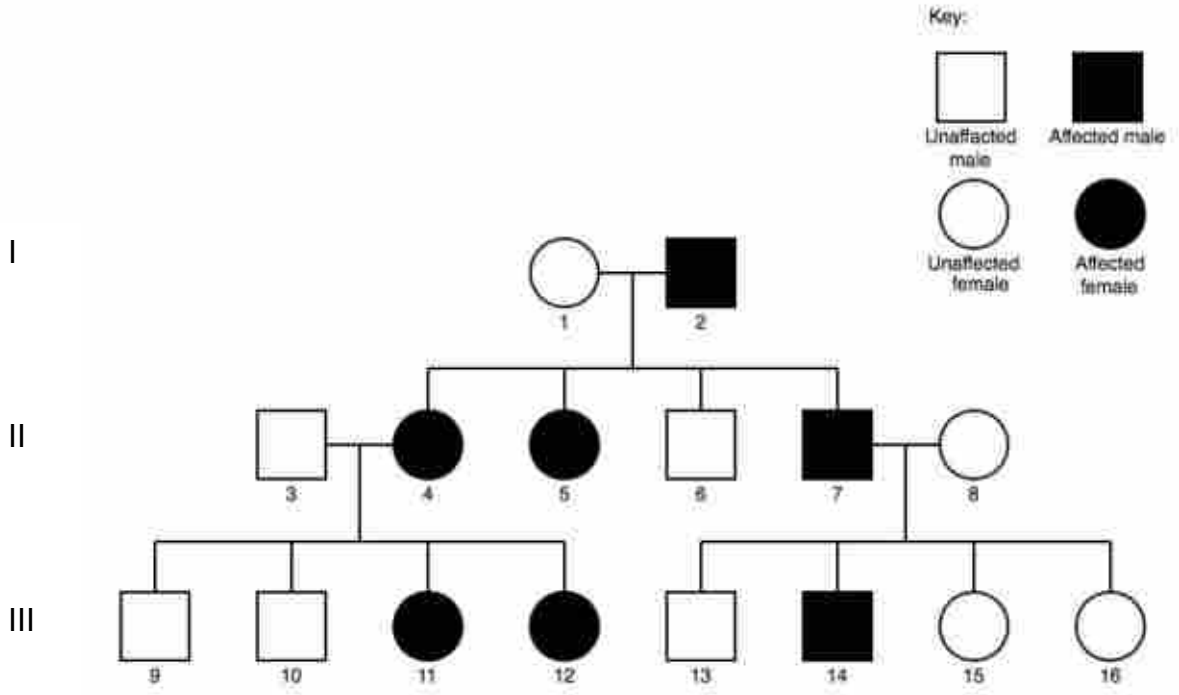
A Temperatures beyond 35°C alter the structure of the pigments produced by the skin cells, hence the rest of the Himalayan rabbit's body tends to be white.

B The Himalayan phenotype is a result of the c^{h} allele that produces a temperature-sensitive gene product which controls the production of the pigments.

C Multiple alleles of the *C* gene can give rise to white fur with black patches or white fur under different temperatures.

D The Himalayan phenotype is an example of incomplete dominance where it is an intermediate of the chinchilla ($c^{ch}c^{ch}$) and albino (cc) genotypes.

19 The diagram shows the pedigree for the inheritance of polycystic kidney disease which is hereditary.



Assuming that the letters R and r denote dominant and recessive alleles respectively, what is the mode of inheritance for this disease and the possible genotype of individual 11?

	Mode of inheritance	Genotype of individual 11
A	Autosomal dominant	RR
B	Autosomal recessive	rr
C	X-linked dominant	$X^R X^r$
D	X-linked recessive	$X^r X^r$

20 An organism is heterozygous at four gene loci on different chromosomes. Its genotype is AaBbCcDd.

What is the chance that a particular gamete from this organism has the genotype abcd?

A 1 in 2

B 1 in 4

C 1 in 8

D 1 in 16

21 The electron micrograph shows structures found in a cell.

Which row matches the events occurring at the labelled structures?

	X	Y	Z
A	ADP + Pi → ATP	ADP + Pi → ATP	NADPH → $NADP^+ + H^+ + 2e^-$
B	ATP → ADP + Pi	ATP → ADP + Pi	$NADP^+ + H^+ + 2e^-$ → NADPH
C	$NAD^+ + H^+ + 2e^-$ → NADH	H_2O → $2H^+ + 2e^- + ½ O_2$	CO_2 + RuBP → 2PGA
D	FAD + $2H^+ + 2e^-$ → $FADH_2$	$2H^+ + 2e^- + ½ O_2$ → H_2O	Acetyl CoA + Oxaloacetate → Citrate

22 Photophosphorylation in the chloroplasts of plant cells results in the synthesis of ATP. Which processes require the use of ATP formed from photophosphorylation?

1 Formation of triose phosphate sugars for the biosynthesis of glucose.
2 Activation of glucose in glycolysis, so that it can be used in further reactions.
3 Regeneration of RuBP, the starting compound of the Calvin cycle.
4 Secretion of cellulose which makes up the plant cell wall.

A 1, 2, 3 and 4 **B** 1, 2 and 4 only **C** 1 and 3 only **D** 3 and 4 only

23 Through a series of energy transfers, chemiosmosis results in the generation of ATP during aerobic respiration and photosynthesis.

Which of the following describe the conditions necessary for the chemiosmotic synthesis of ATP in both processes?

1 The transport of a lipid-soluble molecule against its concentration gradient.
2 The presence of oxygen as a final electron and proton acceptor.
3 The impermeability of the phospholipid bilayer to substances which are polar or charged.
4 The transmembrane nature of electron carrier proteins.
5 The provision of a pore which allows the facilitated diffusion of molecules.

A 1, 3 and 5 **B** 2, 4 and 5 **C** 2, 3 and 4 **D** 3, 4 and 5

24 During an investigation on the process of cellular respiration, scientists isolated different components of a cell and placed them into different tubes as follows:

Tube 1: Cytoplasm only
Tube 2: Intact mitochondria only
Tube 3: Mitochondrial matrix only
Tube 4: Cytoplasm and intact mitochondria

Excess glucose is added to each of the tubes and incubated for one hour. Which of the tubes would have a continuous production of ATP during the incubation period?

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

25 Due to various human activities, there are many species that have become endangered. As these species face a reduction in population size, they are at risk of becoming extinct. It is found that the endangered species lose their genetic variation as the population size is reduced. Should the endangered population size increase, the genetic variation will not increase much within the next hundred years.

Which of the following statements is **not** true?

A A population would need to accumulate many heritable mutations over many generations in order to increase its genetic variation.

B As the population size of the endangered species is reduced, there will be a loss of alleles due to the death of the individual organisms.

C Epidemics could kill the endangered species easily as the population has low genetic variation, increasing their chance of extinction.

D As the population size is reduced, sexual reproduction with random mating within the endangered species will increase heterozygosity, resulting in higher relative fitness in the population.

26 Which of the following statement(s) explain(s) why population is the smallest unit that can evolve?

1 Selection pressures at a particular location where the population is living in, will result in the survival of the fittest.

2 An individual may accumulate genetic changes within its lifetime.

3 Natural selection changes the frequency of alleles within a population.

4 Natural selection will induce mutations in the individual so as to allow adaptation.

A 1, 2, 3 and 4 **B** 1 and 3 **C** 2 and 3 **D** 1 only

27 A population of green anole lizards (*Anolis carolinensis*) is native to the trees in Florida in the United States of America (USA). They tend to occupy the lower branches of the trees which are thicker, instead of the higher branches which are thinner and snap more easily.

In the 1950s, the brown anole lizards (*Anolis porcatus*) from Cuba were introduced into Florida. These lizards are larger and heavier than the green anole lizards and also prefer the lower branches. Both the green and brown anole lizards feed on flying insects that fly around the branches. The adults of both species also tend to feed on the hatchlings of the other species.

Studies have shown that after 20 years, the green anole lizards have occupied the higher branches. Their toe pads are also larger than before, with sticky scales so that they can perch on the higher branches.

Which statement best explains how the evolution of the green anole lizard in Florida has occurred?

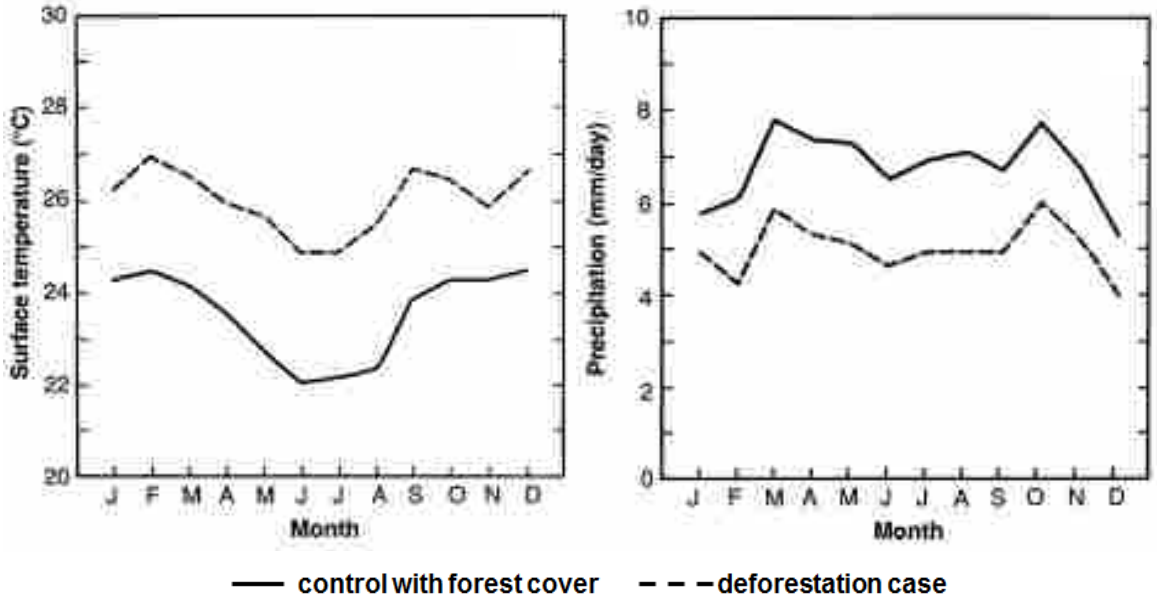
A Mating between the green and brown anole lizards during the 20 years results in the green anole lizards having larger toe pads and sticky scales, on which natural selection could act upon.

B Within the original green anole lizard population, there were some individuals that already had larger toe pads and sticky scales, on which natural selection could act.

C Green anole lizards climbed onto higher branches as the brown anole lizards could not do so.

D Green anole lizards which live longer usually leave more offspring since they have more reproductive opportunities.

28 Scientists created a simulation of the effects of Amazon deforestation on the climate. In the simulation, an area of the tropical forest was replaced by a pasture of grass. The simulation provided monthly data on the temperature of the ground surface (surface temperature) and rainfall (precipitation) over a year-long period.



Which statements could explain these data?

1 Grass is a more effective carbon sink than trees.

2 The removal of forest cover disturbed the soil layers and resulted in carbon emissions.

3 Without the trees, the reduced transpiration rate resulted in less water vapour released into the atmosphere.

4 Increase in surface temperature could lead to increase in the rate of evaporation.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

29 Which row correctly matches the human activity to its corresponding effect due to climate change?

	Human activities	**Effects**
A	Over-hunting of animals	Reduction in biodiversity
B	Usage of more cars	More wild animals killed on the expressways
C	Burning of forests in West Sumatra, Indonesia	Heavy rains and heat waves in different parts of the world
D	Pollution from toxic runoff from factories	Bleaching of coral reefs

30 Which of the following consequences resulted from an increase in global temperatures?

1 Many populations of the European butterfly species moved northwards by 35 – 240km.

2 *Aedes aegypti*, previously limited to low-lying areas, is observed at 2200m above sea level in Colombia.

3 Malaria is a growing public health threat to residents in the highlands.

4 Insect species in the higher latitudes increased their reproductive rate.

A 1, 2, 3 and 4 **B** 1 and 2 **C** 2 and 3 **D** 1 only

Name	Subject Class	Class	Candidate Number
	2BIX01		

ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2018

BIOLOGY **8876/02**
17 AUGUST 2018
HIGHER 1 **2 hours**

Paper 2 Structured & Free-response Questions

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the top of this page.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, glue or correction fluid.

Answer **all** questions in the spaces provided on the Question Paper.
No additional materials are required.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6 or 7	
Total	/ **60**

This question paper consists of **16** printed pages.

For examiner's use

Section A

Answer **all** the questions in this section.

1 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions. Cholesterol is then transported to the Golgi apparatus where they are packaged into vesicles and subsequently released into a membrane-bound duct of the liver.

Fig. 1.1 is an electron micrograph of a section of a liver tissue.

Fig. 1.1

(a) Name structure **T** in Fig. 1.1 and describe its role in liver cells.

_____

_____

_____

_____ [2]

For examiner's use

(b) Both prokaryotes and structure **T** have membrane proteins to help them perform the role described in (a). Suggest how prokaryotes perform this role.

[3]

(c) Explain how prokaryotes illustrate the cell theory.

[3]

[Total: 8]

For examiner's use

2 Fig. 2.1 shows the stages involved in the synthesis of a protein in a eukaryotic cell.

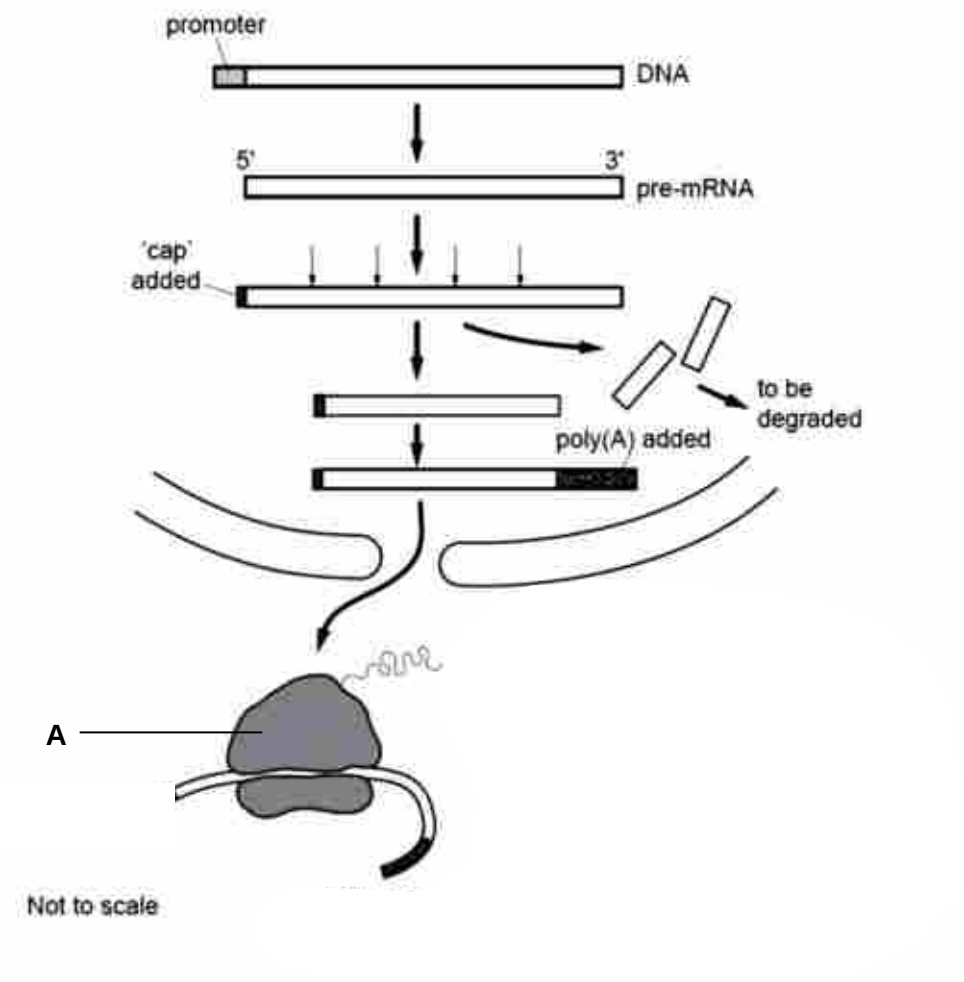


Fig. 2.1

(a) Describe the differences between the processes of protein synthesis in prokaryotes with that shown in Fig. 2.1.

_____

_____

_____

_____ [2]

For examiner's use

(b) Explain how the structure of organelle A is related to its function.

[4]

(c) Describe the formation of a bond found in both DNA & pre-mRNA.

[2]

[Total: 8]

For examiner's use

3 A study reported on the change in beetle sizes in a population due to climate change. Larger beetles are affected when compared to smaller beetles. This could be because larger beetles are less likely to get enough oxygen to sustain a higher metabolic rate caused by higher atmospheric temperatures. Fig. 3.1 shows the effect of a 2°C temperature rise on the size of larger and smaller beetles in a population over 100 generations.

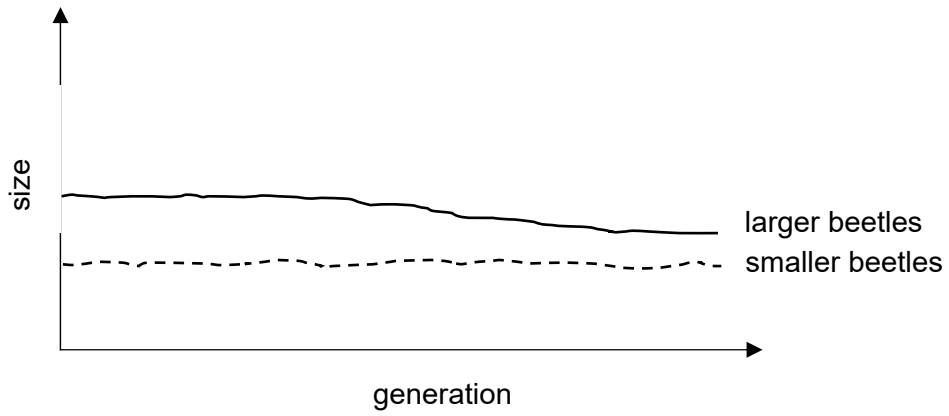


Fig. 3.1

(a) Define a 'population' of beetles.

[2]

(b) Explain how a temperature rise of 2°C in may cause a change in the gene pool of a population of beetles.

[4]

For examiner's use

(c) Comment on whether the alleles for large size in beetles will disappear from the population over time if temperature continues to increase as a result of climate change.

[2]

(d) Explain the consequences of a decrease in beetle size on the ecosystem.

[2]

[Total: 10]

For examiner's use

4 Radish can have two different shapes – elongated or round. The colour of radish can be red, white or purple. These two traits are determined by two genes found on different chromosomes.

When a true-breeding plant with elongated and red radish was cross-fertilised with a true-breeding plant with round and white radish, all the resulting plants have elongated and purple radish.

(a) (i) Using appropriate symbols, construct a genetic diagram to show the expected F2 phenotypic ratio when the plants with elongated and purple radish are self-fertilised.

[5]

For examiner's use

(ii) Each of the genes has only two allelic forms. Explain why the F2 phenotypic ratio does not follow the expected Mendelian ratio of 9:3:3:1.

.....

.....

.....

_____ [2]

(b) Suggest how the environment may affect the development of the colour of the radish.

.....

.....

.....

_____ [2]

[Total: 9]

For examiner's use

5 Table 5.1 shows the range of optimal temperatures for the growth of some major crops in the state of Iowa, USA. These crops are generally grown in April and harvested in October where average temperatures are between 16ºC and 28ºC.

Table 5.1

Type of crop	Temperature/ ºC		
	Optimal	Minimum	Maximum
Corn	22 - 25	20	32 - 34
Wheat	20 - 25	5	38
Soybean	25 - 28	10 -14	37 - 40

(a) (i) With reference to Table. 5.1 and your knowledge of enzymes, explain why Iowa is suitable for the growth of these crops.

.....

.....

.....

[2]

(ii) Suggest why corn productivity may be threatened by climate change.

.....

.....

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.....

.....

[3]

The level of H_2O_2 is high in crops which are under environmental stress. Catalase is an enzyme found in crops which protect the cells from oxidative damage by breaking down hydrogen peroxide (H_2O_2) into water and oxygen. Fig. 5.1 shows the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

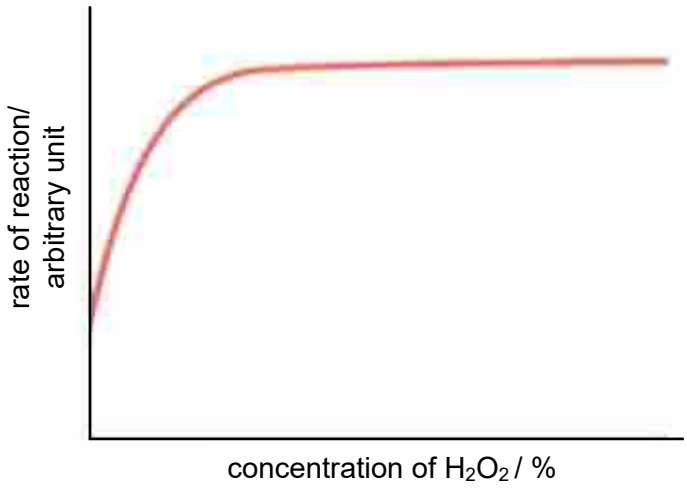

Fig. 5.1

(b) (i) With reference to Fig. 5.1, describe and explain the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

.....

.....

.....

..... [2]

(ii) With reference to the information provided, suggest why the cells in soybean suffer from oxidative damage when the temperature reaches 38ºC.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

For examiner's use

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

You answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6 **(a)** Outline the processes resulting in chromosomal aberrations. [6]

(b) Discuss how the structures of biomolecules can account for their roles in plants. [9]

[Total: 15]

7 **(a)** Discuss the significance of the movement of substances across membranes to photosynthesis. [6]

(b) Outline the key features of stem cells which make them useful for research and medical applications, and discuss the ethical implications which may arise from these applications. [9]

[Total: 15]

For examiner's use

For examiner's use

For examiner's use

For examiner's use

H1

1	B	11	B	21	A
2	D	12	B	22	C
3	B	13	D	23	D
4	D	14	A	24	B
5	B	15	D	25	D
6	C	16	D	26	B
7	C	17	B	27	B
8	A	18	B	28	C
9	B	19	B	29	C
10	C	20	D	30	A

Name	Subject Class	Class	Candidate Number
	2BIX01		

ANGLO-CHINESE JUNIOR COLLEGE
Preliminary Examination 2018

BIOLOGY **8876/02**
17 AUGUST 2018
HIGHER 1 **2 hours**

Paper 2 Structured & Free-response Questions

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the top of this page.
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No additional materials are required.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6 or 7	
Total	60

This question paper consists of **16** printed pages.

For examiner's use

Section A

Answer **all** the questions in this section.

1 Cholesterol is synthesised in the smooth endoplasmic reticulum (SER) in liver cells by a series of enzyme-catalysed reactions. Cholesterol is then transported to the Golgi apparatus where they are packaged into vesicles and subsequently released into a membrane-bound duct of the liver.

Fig. 1.1 is an electron micrograph of a section of a liver tissue.

Fig. 1.1

(a) Name structure **T** in Fig. 1.1 and describe its role in liver cells.

1. **Structure T is the mitochondrion;**

2. **Site of ATP synthesis for synthesis of cholesterol/glycogen/proteins**

OR intracellular movement of vesicles
OR secretion of lipoproteins via exocytosis
A! endocytosis/ active transport

[2]

For examiner's use

(b) Both prokaryotes and structure **T** have membrane proteins to help them perform the role described in (a). Suggest how prokaryotes perform this role.

1. **Presence of electron carriers and ATP synthase;**
2. **Electron carriers use the energy from the transport of the electrons to pump H^+ across the membrane, generating a proton gradient;**
3. **ATP synthase which uses the energy of the proton gradient/proton motive force for chemiosmotic synthesis of ATP;**

[3]

(c) Explain how prokaryotes illustrate the cell theory.

Features of prokaryote	Cell theory
1. **Prokaryotes are single-celled / unicellular;**	2. **Cell theory states that all living things consist of cells;** 3. **The cell is the smallest basic unit of life;**
4. **Prokaryote undergoes binary fission/cell division/reproduction to give rise to more cells;**	5. **All cells come from pre-existing cells**

[3]

[Total: 8]

For examiner's use

2 Fig. 2.1 shows the stages involved in the synthesis of a protein in a eukaryotic cell.

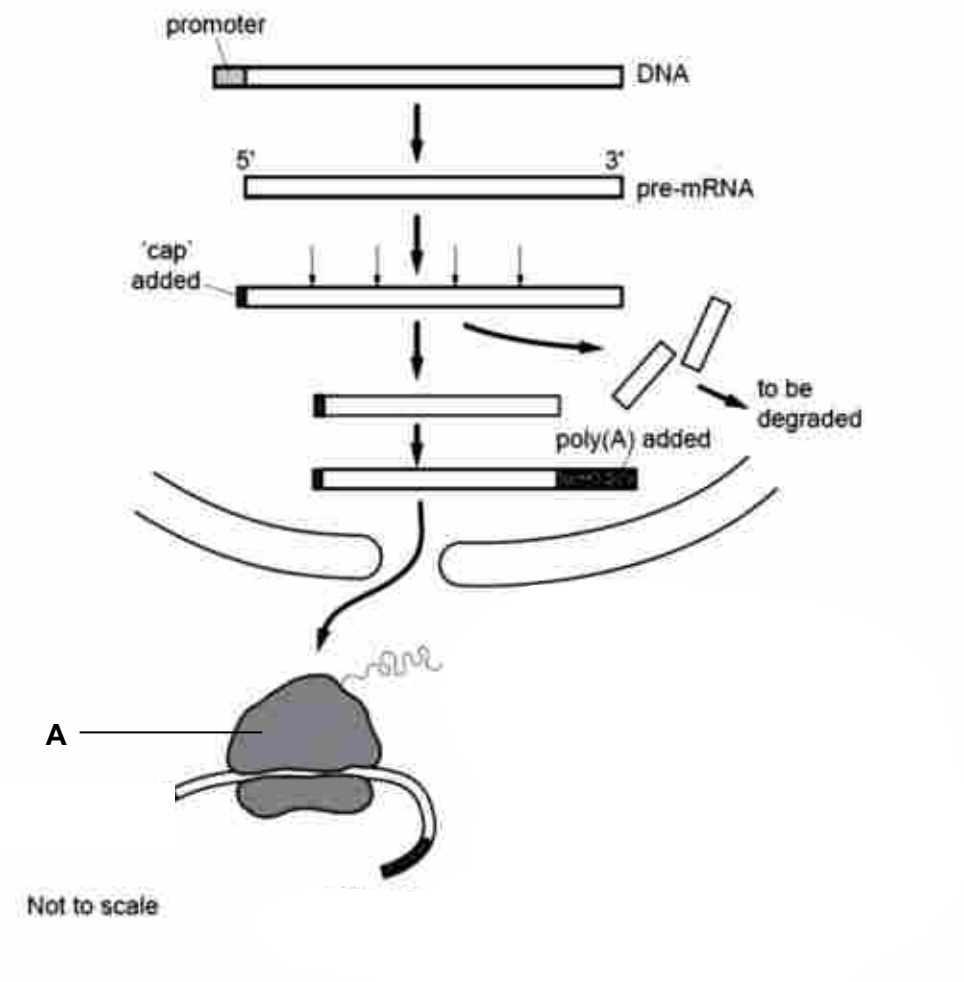

Fig. 2.1

(a) Describe the differences between the processes of protein synthesis in prokaryotes with that shown in Fig. 2.1.

1. **In Fig 2.1, transcription occurs in the nucleus and translation occurs in the cytoplasm while in prokaryotes, both processes occur simultaneously in the cytoplasm;**
2. **ref to post-transcriptional modification (at least 1 e.g.);**
   e.g. In Fig 2.1, introns in the pre-mRNA are excised during RNA splicing to produce a mature mRNA while in prokaryotes, there is no RNA splicing.
   e.g. In Fig 2.1, poly(A) tail/ 5' guanosine cap is added to pre-mRNA while in prokaryotes, no poly(A) tail/ 5' guanosine cap is added; [2]

For examiner's use

(b) Explain how the structure of organelle A is related to its function.

1. **The small subunit has a specific groove/ site that allows for mRNA to bind and be held in positioned during translation / align mRNA with tRNA;**
2. **The large subunit contains the A, P, E sites for aminoacyl-tRNA to be held in position;**
3. **Allowing anti-codon on tRNA to undergo complementary base pairing with the corresponding codons on the mRNA during translation;**
4. **Large ribosomal subunit / rRNA contains peptidyl transferase which catalyses the formation of peptide bond between adjacent amino acids during translation;**

[4]

(c) Describe the formation of a bond found in both DNA & pre-mRNA.

1. **Phosphate group at C5 of ribose forms a bond with OH group at C3 of the ribose of the next nucleotide;**
2. **Via a condensation reaction with the release of a water molecule;**
3. **Catalysed by an enzyme (polymerase);**

[2]

[Total: 8]

For examiner's use

3 A study reported on the change in beetle sizes in a population due to climate change. Larger beetles appear to be affected when compared to smaller beetles. This could be because larger beetles are less likely to get enough oxygen to sustain a higher metabolic rate caused by higher atmospheric temperatures. Fig. 3.1 shows the effect of a 2°C temperature rise on the size of larger and smaller beetles in a population over 100 generations.

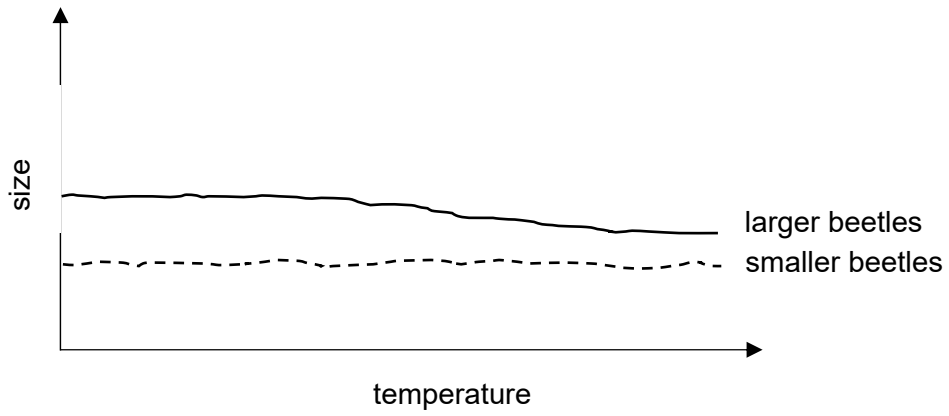

Fig. 3.1

(a) Define a 'population' of beetles.

1. **Population refers to a group of beetles living in the same area;**
2. **Belonging to same species (which can interbreed naturally to give viable, fertile offspring);**

[2]

(b) Explain how a temperature rise of 2°C in may cause a change in the gene pool of a population of beetles.

1. **Genetic variation in population expressed as phenotypic variation, i.e. range of sizes;**
2. **Higher temperature is the selection pressure;**
3. **Smaller beetles are selected for, resulting in more of these surviving and reproducing and passing on alleles coding for small size to their offspring;**
4. **Over time, gene pool changes where there is a higher frequency of alleles coding for smaller sizes in the population;**

[4]

For examiner's use

(c) Comment on whether the alleles for large size in beetles will disappear from the population over time if temperature continues to increase as a result of climate change.

1. **It will not as these alleles for large size may be recessive, and diploidy allows these alleles to exist in a heterozygote which is masked by a dominant allele**;
2. **It will not, as despite temperature rise, large size may still be selected for as such individuals may have a selective advantage during mating/ when foraging for food/preying on other beetles;**
3. **It will as allele for large size may be dominant and hence its phenotype will be expressed and subjected to natural selection, and be selected against;** [2]

(d) Explain the consequences of a decrease in beetle size on the ecosystem.

1. **Beetles are preyed upon, so less food for animals higher up in food chain;**
2. **Beetles act as dentritivores, smaller beetles mean slower rate of decomposition and hence recycling of nutrients;**
3. **Beetles can be pollinators of plants, so lower rate of pollination leads to reduction in certain plant populations/loss of certain plant species;**
4. **AVP;**

[2]

[Total: 10]

For examiner's use

4 Radish can have two different shapes – elongated or round. The colour of radish can be red, white or purple. These two traits are determined by two genes found on different chromosomes.

When a true-breeding plant with elongated and red radish was cross-fertilised with a true-breeding plant with round and white radish, all the resulting plants have elongated and purple radish.

(a) (i) Using appropriate symbols, construct a genetic diagram to show the expected F2 phenotypic ratio when the plants with elongated and purple radish are self-fertilised.

Appropriate symbols given:

Let L denotes the dominant allele coding for elongated shape
l denotes the recessive allele coding for round shape
C^R denotes the incompletely dominant allele coding for red colour
C^W denotes the incompletely dominant allele coding for white colour ;

F_1 phenotype: **elongated and purple radish**

F_1 genotype: **LlC^RC^W x LlC^RC^W ;**

F_1 gametes **LC^R LC^W lC^R lC^W LC^R LC^W lC^R lC^W ;**

Punnett Square:

	LC^R	LC^W	lC^R	lC^W
LC^R	LLC^RC^R Elongated and red	LLC^RC^W Elongated and purple	LlC^RC^R Elongated and red	LlC^RC^W Elongated and purple
LC^W	LLC^RC^W Elongated and purple	LLC^WC^W Elongated and white	LlC^RC^W Elongated and purple	LlC^WC^W Elongated and white
lC^R	LlC^RC^R Elongated and red	LlC^RC^W Elongated and purple	llC^RC^R Round and red	llC^RC^W Round and purple
lC^W	LlC^RC^W Elongated and purple	LlC^WC^W Elongated and white	llC^RC^W Round and purple	llC^WC^W Round and white

;

F_2 phenotypic ratio - **3 elongated and red :**
6 elongated and purple :
3 elongated and white :
1 round and red :
2 round and purple :
1 round and white ;

[5]

For examiner's use

(ii) Each of the genes has only two allelic forms. Explain why the F2 phenotypic ratio does not follow the expected Mendelian ratio of 9:3:3:1.

1. **The alleles for the radish colour display incomplete dominance, where there is an intermediate phenotype of purple colour;**
2. **This gives rise to more phenotypic combinations / Mendelian crosses are based on traits determined by genes that have alleles that display complete dominance;**

[2]

(b) Suggest how the environment may affect the development of the colour of the radish.

1. **Citing an environmental factor: Insufficient nutrients / sunlight;**
2. **Linking to an effect: insufficient pigments which results in pale / white radish even though it should be red or purple;**

[2]

[Total: 9]

For examiner's use

5 Table 5.1 shows the range of optimal temperatures for the growth of some major crops in the state of Iowa, USA. These crops are generally grown in April and harvested in October where average temperatures are between 16ºC and 28ºC.

Table 5.1

Type of crop	Temperature/ ºC		
	Optimal	Minimum	Maximum
Corn	22 - 25	20	32 - 34
Wheat	20 - 25	5	38
Soybean	25 - 28	10 - 14	37 - 40

(a) (i) With reference to Table. 5.1 and your knowledge of enzymes, explain why Iowa is suitable for the growth of these crops.

1. **Data: Optimal temperatures of crops (corn is between 22 – 25ºC; wheat is between 20 – 25ºC, soybean is between 25 – 28ºC) fall in the temperature range of Iowa between 16ºC – 28ºC;**
2. **High enzymatic reactions at optimal temperatures and hence maximum growth/ yield of crops;**

[2]

(ii) Suggest why corn productivity may be threatened by climate change.

1. **Increased temperatures beyond the optimal temperatures for enzyme activity leading to denaturation of enzymes and hence, corn production drops;**
2. **Extreme weather events such as heatwaves/ droughts could lead to corn crops wilting;**
3. **High precipitation in the form of rainfall can cause nutrient leaching/ waterlogged soil/ plant decay;**

[3]

For examiner's use

The level of H_2O_2 is high in crops which are under environmental stress. Catalase is an enzyme found in crops which protect the cells from oxidative damage by breaking down hydrogen peroxide (H_2O_2) into water and oxygen. Fig. 5.1 shows the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

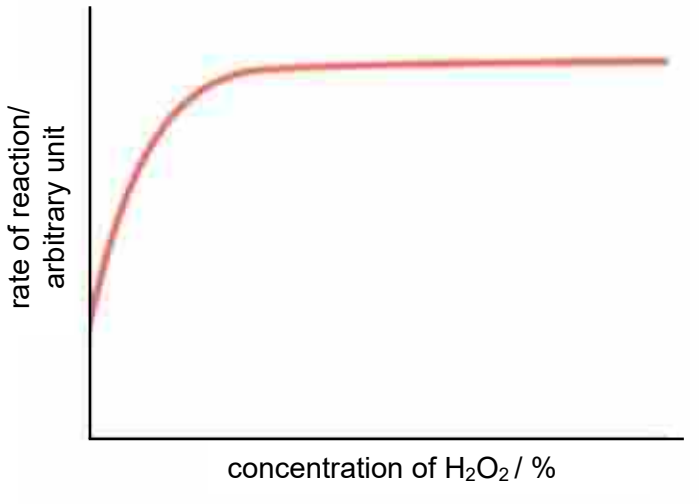

Fig. 5.1

(b) (i) With reference to Fig. 5.1, describe and explain the effect of increasing H_2O_2 concentration on the rate of reaction of catalase.

1. **At low substrate concentrations, many of the available enzymes will have their active sites empty/unoccupied;**
2. **Hence, increasing substrate concentration increases the rate of reaction;**
3. **At high concentrations of substrate, the active sites are saturated/ not available with substrates, hence maximum rate of reaction;**

[2]

(ii) With reference to the information provided, suggest why the cells in soybean suffer from oxidative damage when the temperature reaches 38ºC.

1. **Temperatures of 38ºC at maximum temperature range of soybean (37 – 40ºC);**
2. **Some enzymes denature/ and (remaining) catalase activity at maximum;**
3. **Resulting in high concentrations of H_2O_2 which continue to cause cell damage;**

[3]

[Total: 10]

For examiner's use

Section B

Answer **one** question in this section.

Write your answers on the lined paper provided at the end of this Question Paper.

Your answers should be illustrated by large, clearly labelled diagrams, where appropriate.

You answers must be in continuous prose, where appropriate.

Your answers must be set out in sections **(a)** and **(b)**, as indicated in the question.

6 **(a)** Outline the processes resulting in chromosomal aberrations. [6]

(b) Discuss how the structures of biomolecules can account for their roles in plants. [9]

[Total: 15]

7 **(a)** Discuss the significance of the movement of substances across membranes to photosynthesis. [6]

(b) Outline the key features of stem cells which make them useful for research and medical applications, and discuss the ethical implications which may arise from these applications. [9]

[Total: 15]

For examiner's use

6a)

1. **A chromosomal mutation can be due to change in the structure of a chromosome;**
2. **Can be brought about by deletion where breaks occur at two points along the length of a chromosome and the middle portion of the chromosome is lost;**
3. **inversion where breaks occur at two points along the length of a chromosome and the middle portion of the chromosome rotates through 180° before rejoining;**
4. **Translocation where a section of a chromosome breaks off and attaches to a non-homologous chromosome;**
5. **Duplication where a section of a chromosome replicates such that a set of gene loci is repeated;**

@ max 4

6. **A chromosomal mutation can be due to a change in the number of chromosomes;**
7. **Occurs due to spindle fibres not forming and attaching to kinetochore complex of chromosomes;**
8. **Non-disjunction during mitosis results in the daughter cells having one or more missing or extra chromosome(s)/ aneuploidy;**
9. **Sister chromatids of one or few chromosomes fail to separate during anaphase;**
10. **Non-disjunction in germ cells during meiosis results in the gametes having one or more missing or extra chromosome(s)/ aneuploidy;**
11. **One or several pairs of homologous chromosomes fail to separate during anaphase I/ chromatids of one or few chromosomes fail to separate during anaphase II;**
12. **Non-disjunction can occur on all the chromosomes within a nucleus during mitosis;**
13. **Non-disjunction of *all* the homologous pairs during anaphase I, or non-disjunction of chromatids of *all* the chromosomes during anaphase II/ polyploidy;**

@ max 4

14. **Give an example of a factor resulting in chromosomal aberration and explain why;**

QWC: Addresses both chromosomal structure and number aberrations.

For examiner's use

6b)

	Structure	Property	Role
PROTEINS			
A	**1. Amino acids exist as zwitterions in neutral aqueous solutions**	**2. act as buffers in solution**	**keep pH in cells constant so cellular activities occur at optimum rate**
B	**3. A polypeptide is folded such that the bulk of the hydrophobic R-groups of amino acids/residues are buried in the interior while the hydrophilic R-groups pf amino acids/residues are on the outside, resulting in a globular shape**	**4. Soluble in water**	**Enzymes found in aqueous environment of cells to catalyse metabolic reactions**
C	**5. A polypeptide is folded such that the bulk of the hydrophobic R-groups of amino acids/residues are on the outside, allowing it to form hydrophobic interactions with hydrophobic hydrocarbon core in the phospholipid bilayer of the cell surface membrane** **OR** **A pore in the protein is lined with hydrophilic R-groups of amino acids/residues**	**6. Embedded in membrane** **OR** **Allows hydrophilic substances to pass through**	**Transmembrane protein allows transport of substances needed for cell process it e.g. water, ions to enter, and to leave, e.g. sucrose**
CARBOHYDRATES			
D	**7. Monosaccharides, i.e. glucose are small with many polar OH groups**	**8. Soluble in water**	**Glucose is a respiratory substrate of cellular respiration**
E	**9. Disaccharides, ie. sucrose are small with many polar OH groups**	**10. Soluble in water**	**Sucrose can be transported to different parts of plant via phloem**
F	**11. Each cellulose molecule contains about 10,000 residues, which make it a large molecule** **OR** **Most of the hydrophilic OH groups of the glucose residues are involved in forming cross-links with adjacent chains**	**12. Insoluble in water**	**Cellulose has a structural role as a component of cell wall, maintaining (any 1 pf the following) shape of cell/ allows turgidity to develop/ prevent osmotic lysis**
G	**13. Alternate β-glucose molecules are rotated 180° to form a straight chain, allowing cross-link of chains via hydrogen bonds between their OH groups, which are projected outwards on both sides of each chain** **OR**	**14. Increases compactness within the cellulose, resulting in tremendous tensile strength**	

For examiner's use

	Cellulose chains are bundled to form microfibrils, which are further arranged in larger bundles to form macrofibrils OR Macrofibrils are arranged in several layers in cell walls in a glue-like matrix made up of other polysaccharides		
H	15. The layers of cellulose are fully permeable to water and dissolved solutes and the gaps between layers of cellulose form channels, (and these channels can be filled with lignin)	16. allows for the passage of water and dissolved solutes (Lignified cellulose cell wall provides extra tensile strength e.g. in walls of xylem vessels)	Transport of substances through cell wall is important for the functioning of plant cells
I	17. Starch is composed of several hundreds or thousands of glucose molecules linked by glycosidic bonds	18. Upon hydrolysis, a large number of glucose molecules, which are the main respiratory substrates, are released to produce energy	Starch is a storage molecule
J	19. Starch is composed of several hundreds or thousands of glucose molecules linked by glycosidic bonds, so it is a large molecule OR For each molecule, most of the hydrophilic OH groups of the glucose residues project into the interior of the helices and form hydrogen bonds with one another	20. Insoluble in water OR They can be stored in large quantities without affecting the osmotic potential of cells / do not easily diffuse out of cells	
K	21. Starch is helical in structure, result in extensive coiling and entangling OR Amylopectin is highly branched	22. Allows molecules to be compacted, enabling more molecules to be stored in a given space, so greater amount of carbohydrates can be stored	

For examiner's use

		per unit volume OR Allows many enzymes to act on it at any one time, so they can be hydrolysed to release glucose quickly, so that rate of respiration (i.e. ATP production) is increased	
LIPIDS			
L	23. Phospholipids: Two fatty acids + one phosphate group + one glycerol joined by ester bonds, and fatty acids may be saturated or unsaturated	24. Amphipathic nature allows formation of cell membranes (and glycolipids) OR Degree of saturation in fatty acid chains regulates fluidity of cell membrane	Phospholipid bilayer of cell membranes, allowing transport of selective substances OR Allows endocytosis/ exocytosis to take place
M	25. Triglycerides: Three fatty acids + one glycerol joined by ester bonds / linkages	26. Hydrophobic, thus insoluble in water	Energy storage
N	27. Carbon skeleton with four fused rings and hydroxyl group at one end	28. Hydrophobic and can be wedged between phospholipid molecules OR Regulates fluidity of cell membrane	
NUCLEIC ACIDS			
O	29. In DNA double helix, the complementary bases are held together by hydrogen bonds / the adjacent nucleotides within each strand are held together by strong covalent bonds, known as phosphodiester bonds, which are not easily broken / hydrophobic interactions between the stacked nitrogenous bases	30. Stabilise the structure of the double helix	Stores genetic information / template for reading of genetic information
P	31. Complementary base pairing, i.e. A to T/U, and C to G, via	32. Ensure accuracy/fidelit	

For examiner's use

	hydrogen bonds	y in synthesising molecules with complementary sequences in semi-conservative replication OR transcription OR translation (anti-codon-codon binding)	
Q	33. 4 bases, ATCG (AUCG)	34. Allows diversity of nucleotide sequences resulting in different proteins/products formed	
R	35. AVP		

QWC: covers at least 2 biomolecules

7a)

1. **thylakoid membrane contains the electron transport chain, which is made up of electron carriers;**
2. **Energy from light raises energy level of electron (from special pair of chlorophyll a);**
3. **As it travels from one electron carrier to the next, the energy released is coupled to the pumping of H^+ through electron carriers via active transport;**
4. **from stroma to thylakoid space, hence creating a proton gradient across the membrane;**
5. **As H^+ flow down its gradient through ATP synthase via facilitated diffusion;**
6. **ADP is phosphorylated to form ATP in the stroma;**
7. **Which is required in the Calvin cycle for the reduction of PGA to form GALP;**
8. **GALP is converted to other forms of carbohydrates which the plant needs e.g. cellulose, sucrose etc and release into cytoplasm via facilitated diffusion;**
9. **Water transported into stroma via facilitated diffusion for photolysis;**
10. **Oxygen moved out of chloroplast via double membrane via diffusion to be removed;**

QWC: at least 1 example of how transport across membrane is linked to its significance

For examiner's use

7b)

Key features of stem cells	Usefulness for research and medical applications
1. They are unspecialised/ undifferentiated cells; 2. They are capable of dividing and renewing themselves for long periods via mitotic cell division / self-renewing;	3. Stem cells have been used to generate replacement of tissues and organs for transplant;
4. They can differentiate into specialised cell types under presence of appropriate chemical signals.	5. Stem cell research has enabled scientists to treat genetic disorders using somatic gene therapy;

pt 1-5 (max 3m)

6. **Most ethical issue arises from the derivation of stem cells especially ES cells;**

7. **Procedure of harvesting of ES cells is invasive and is akin to taking a human life;**
8. **An increased social tolerance to loss of life may pave the way for society to agree with controversial practises involving the termination of life;**
9. **Intentional creation of embryos with the intention of using them for research and destroying them in that process violates respect for nascent human life;**

10. **Medical risk of oocyte retrieval from the women / reducing the number and possibly the quality of remaining oocyte for future reproductive purposes;**
11. **Women may face an increasing risk of exploitation for research and commercial benefits;**

12. **Creation of ES cells using nonhuman oocytes may give rise to chimeras that appear part human and part animal and have characteristics of both humans and animals;**

13. **Informed consent of donors of surplus ES cell lines from frozen embryos from IVF may not be obtained or donors may not fully understand the implications of the donation / confidentiality of the donor may not be protected/ Patient may not fully understand the moral issue arising from the use of stem cell for their consent;**
14. **ES cells from donor may exhibit unknown long term effects that range from incompatibility to tumor formation in recipient and recipient may not fully understand the implications;**

15. **The implant of human stem cell into animals during experimentation may cause development of human part on animals;**

pt 6-15 (max 5m)

16. **QWC: Addresses both parts of the questions;**