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.

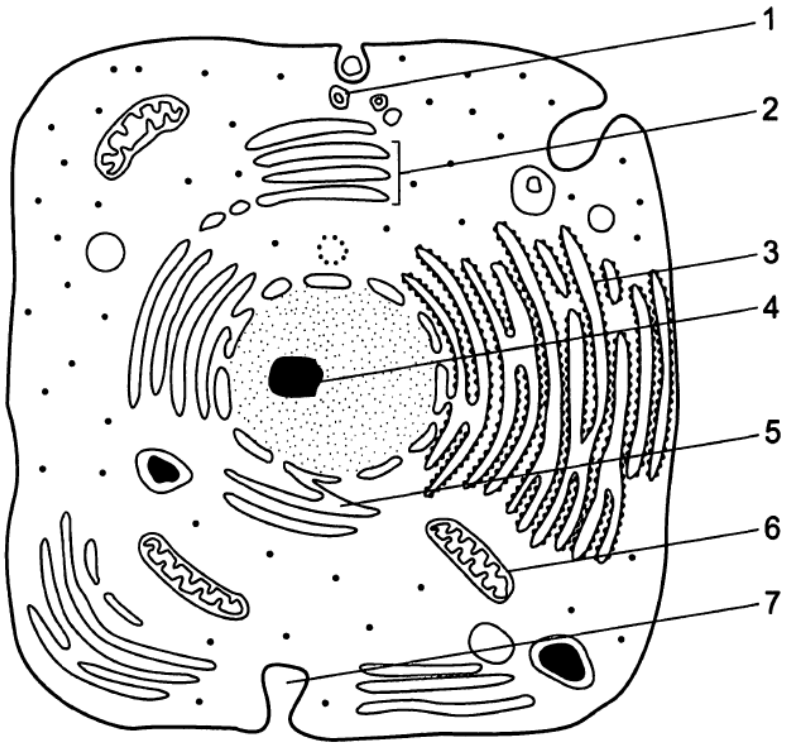
Read the instructions on the Answer Sheet very carefully.

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.

[Turn over

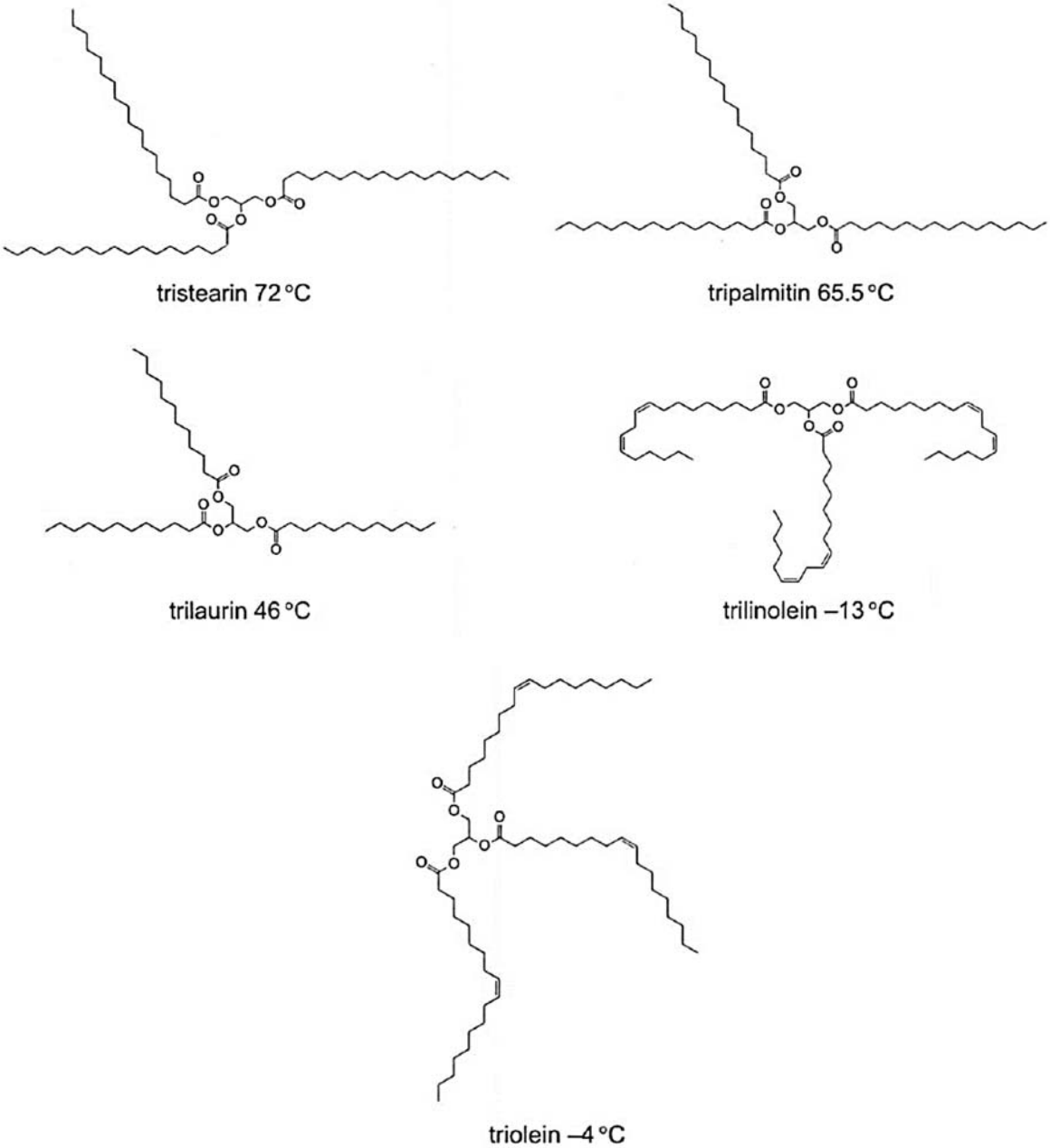
1 The diagram shows a section of a generalised animal cell as seen under the electron microscope.



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

2 The formulae and melting points of five triglycerides are shown in the diagram. Each triglyceride contains three identical fatty acids.

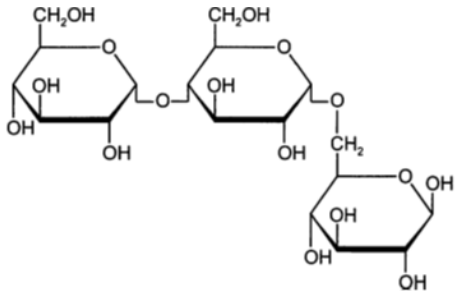


Which two structural features of the molecules make the melting point higher?

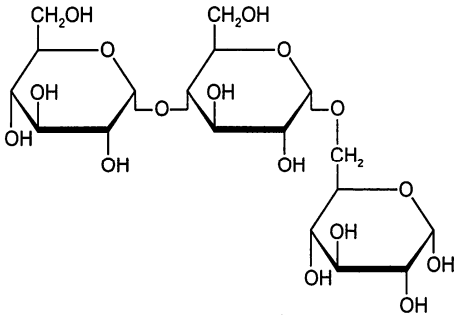
	number of double bonds	length of fatty acid chains
A	fewer	shorter
B	fewer	longer
C	more	longer
D	more	shorter

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?

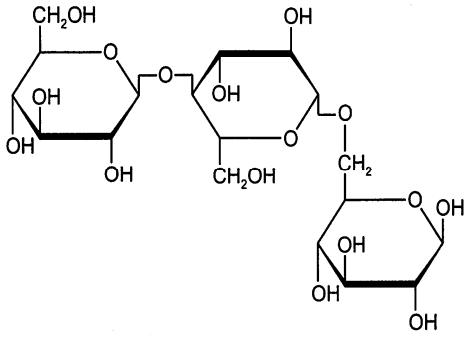
A



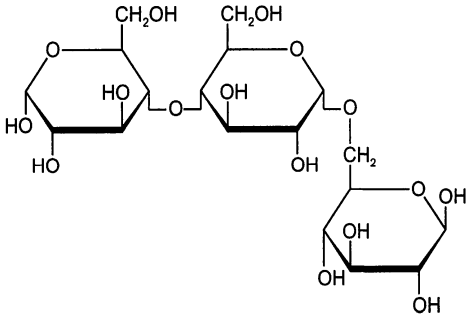
B



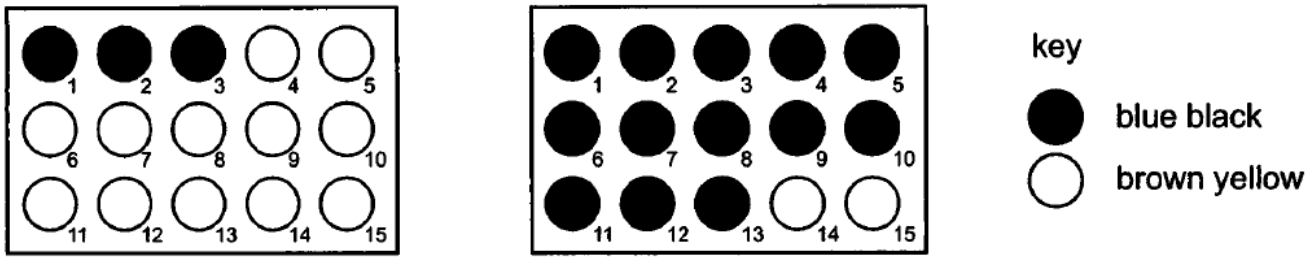
C



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?

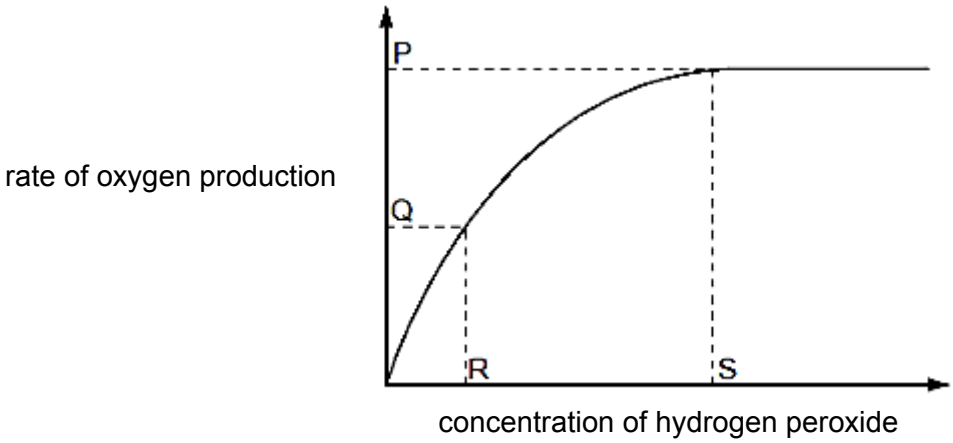
	temperature / °C	time / s
A	10 30	0.45 3.15
B	10 30	195 45
C	10 30	45 195
D	10 30	3.15 0.45

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.

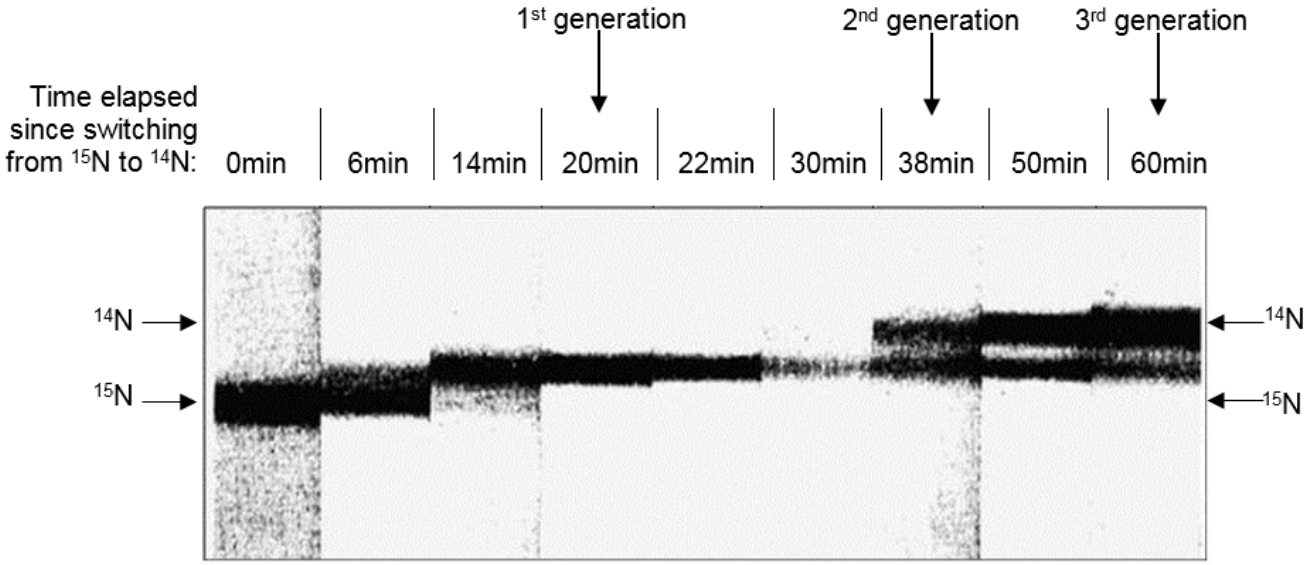
B Pluripotent embryonic stem cells differentiate into multipotent blood stem cells and then into rbcs.

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.

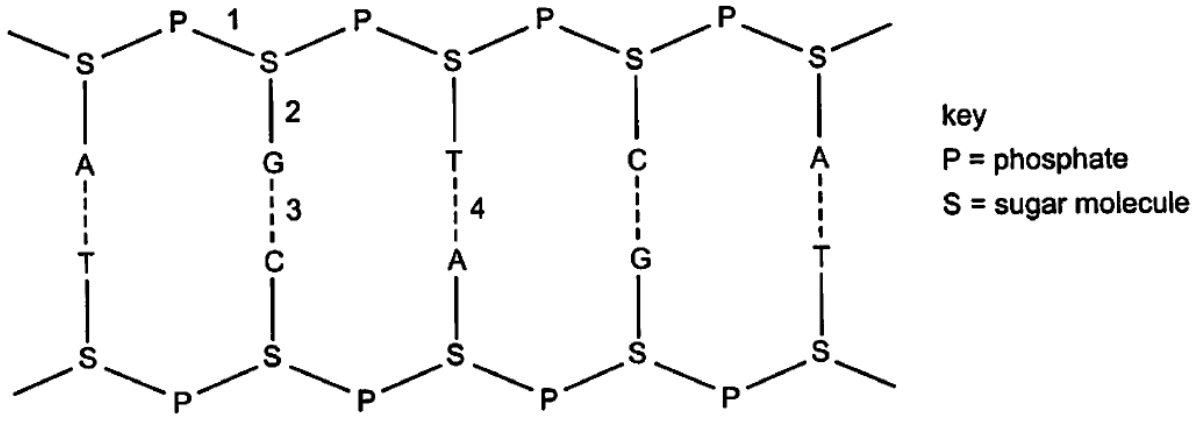
A 1 and 2

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.

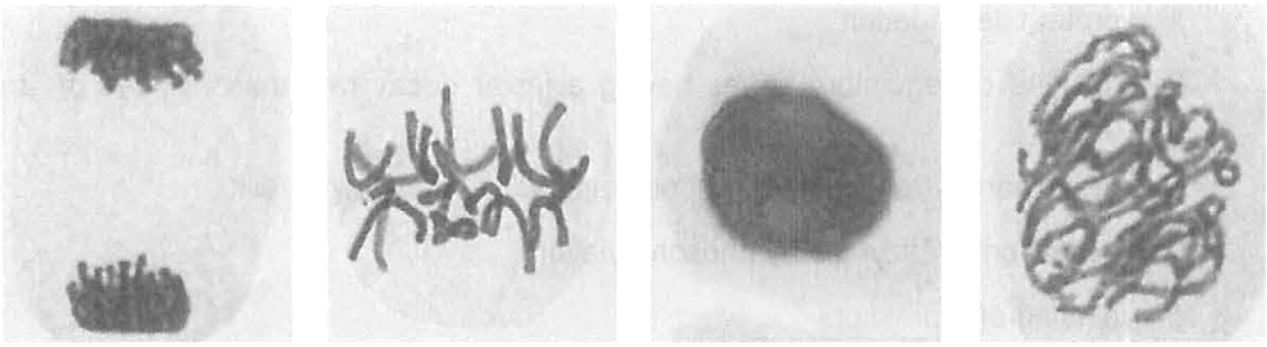
A 1 and 2

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.



1 2 3 4

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**.

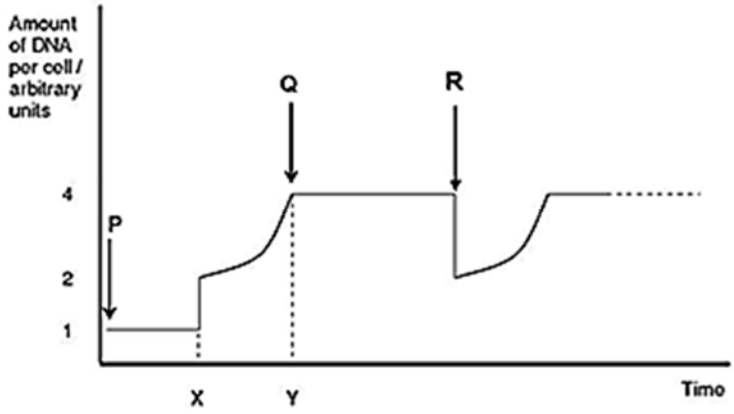
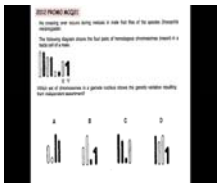


Fig. 14.1

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

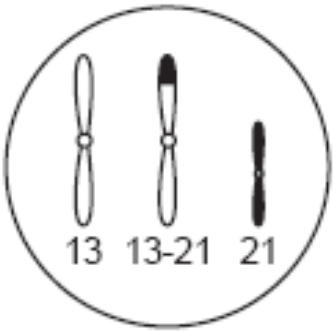
D replication of centromeres

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.



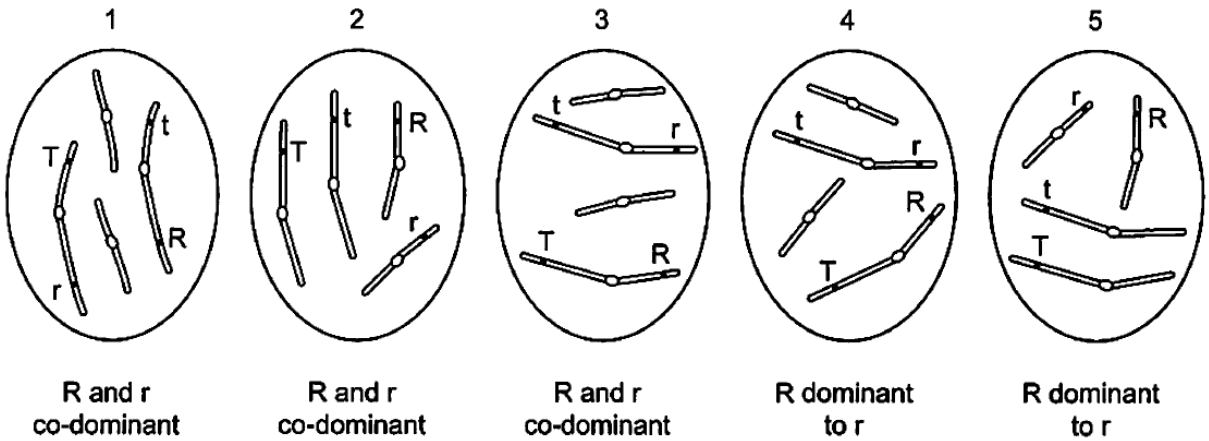
Which is **not** a likely outcome of fertilisation of normal oocytes by sperm from this male?

	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?

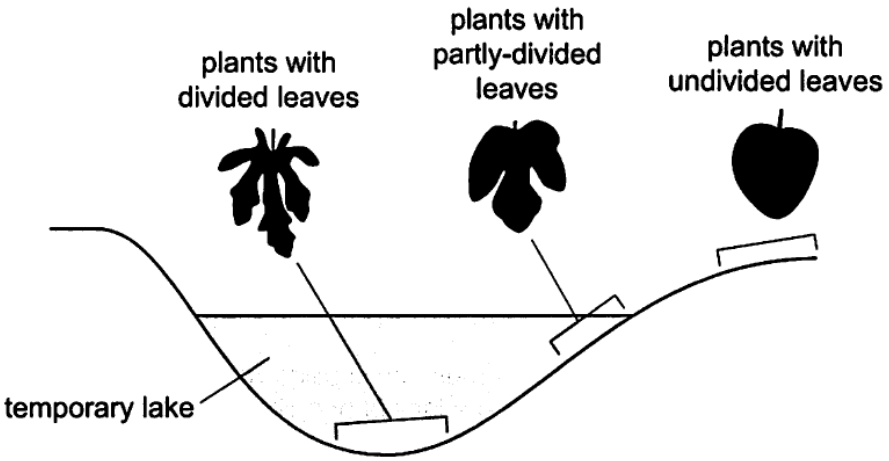
A The dominant and recessive phenotypes can be explained by the transcription of different nucleotide sequences to produce two different mRNA molecules, which produce a functional and a non-functional protein.

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?

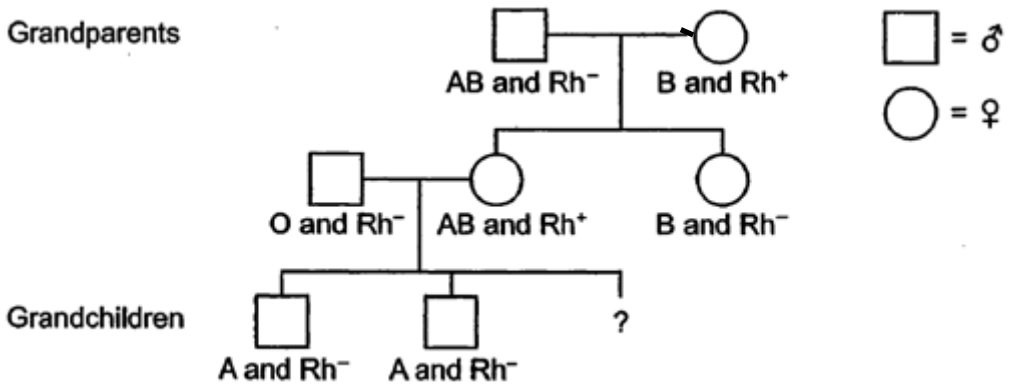
A changes in gene expression dependent on the soil water content

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?

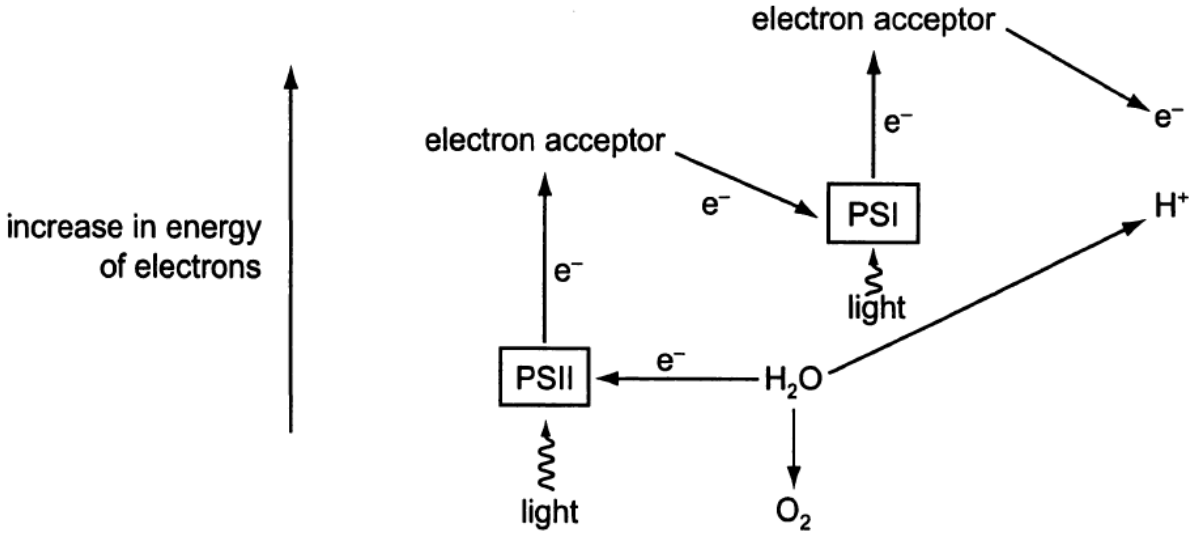
A cell vacuole

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

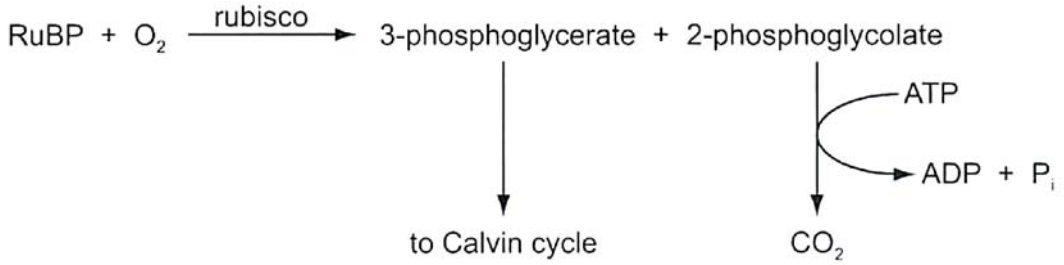
B ATP from ADP and reduced NADP from NADP

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

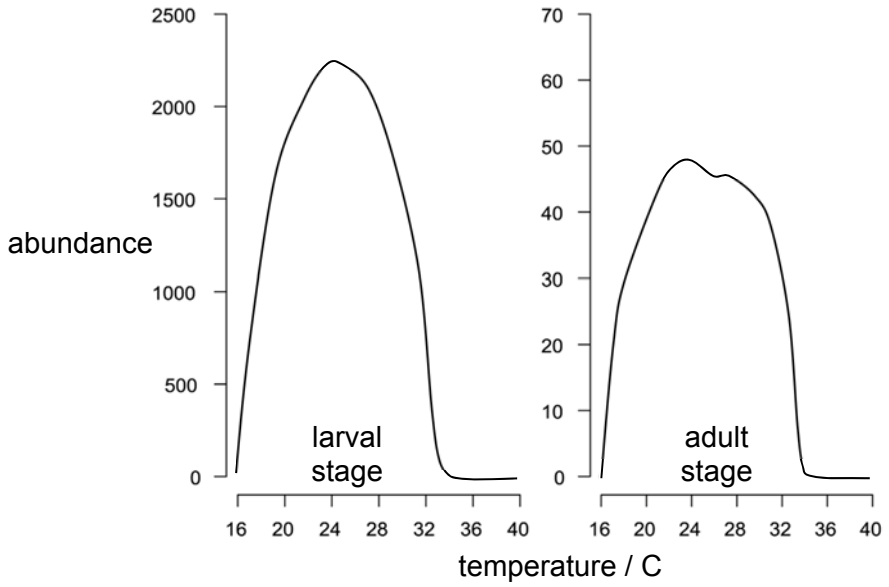
D 1, 2 and 4 only

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

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Answers

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Paper 1 Multiple Choice

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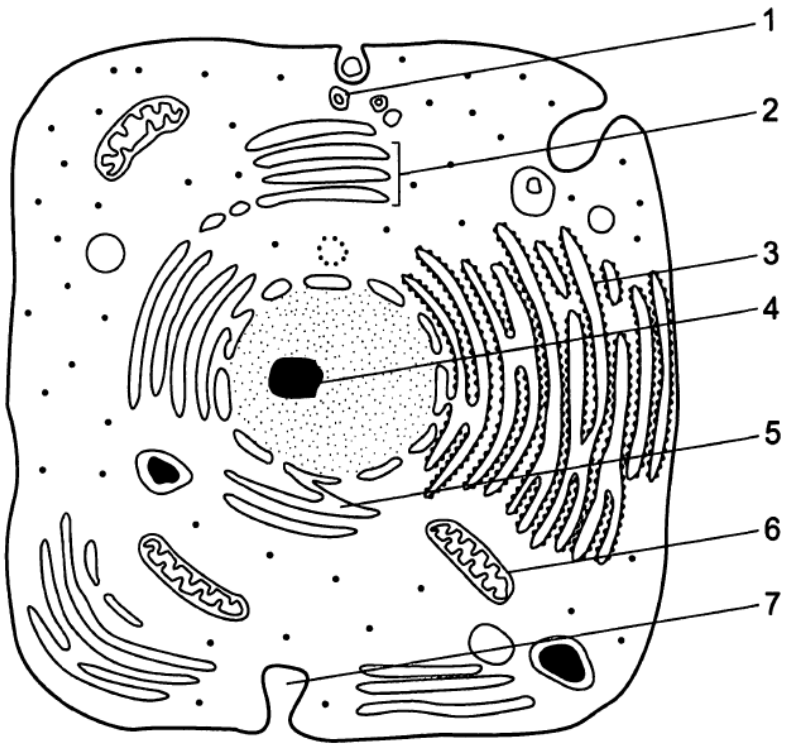
The use of an approved scientific calculator is expected, where appropriate.

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]

[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

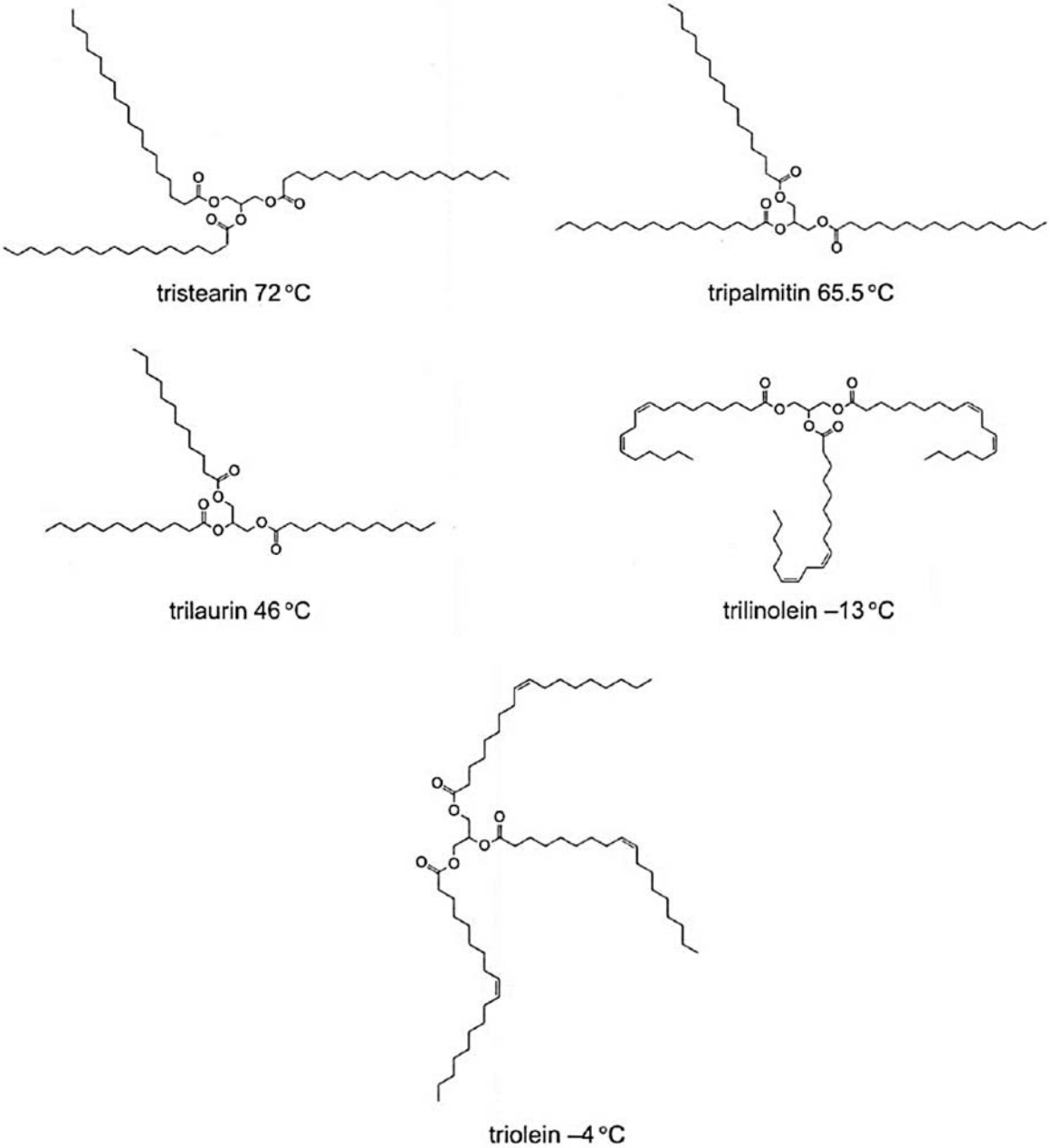
ANS A [L1] (H2 ALevel/2009/P1/Q1)

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)

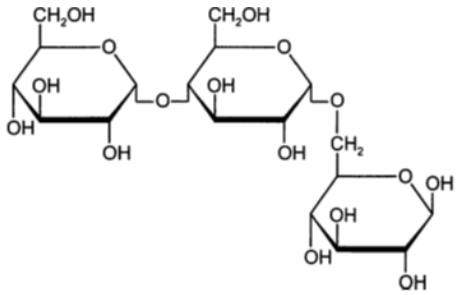
SC: structural features **melting point higher**

OR: **more saturated (C-C)❷ higher melting points; less saturated (more C=C)❷ lower melting points**

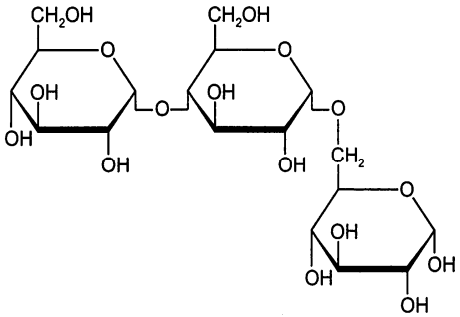
longer chains ❷ higher melting points; shorter chains ❷ lower melting points

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?

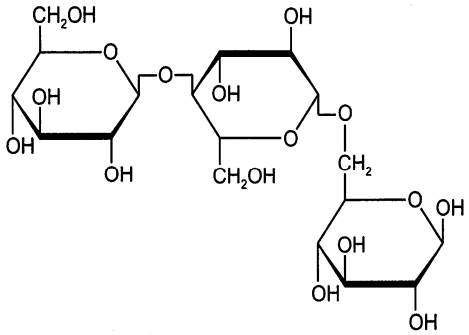
A



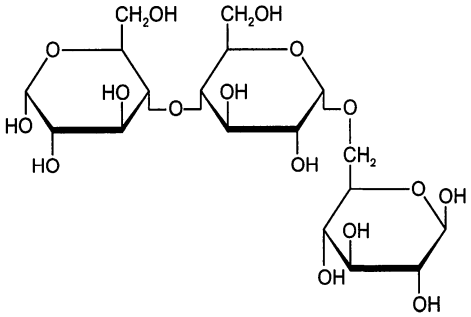
B



C



D

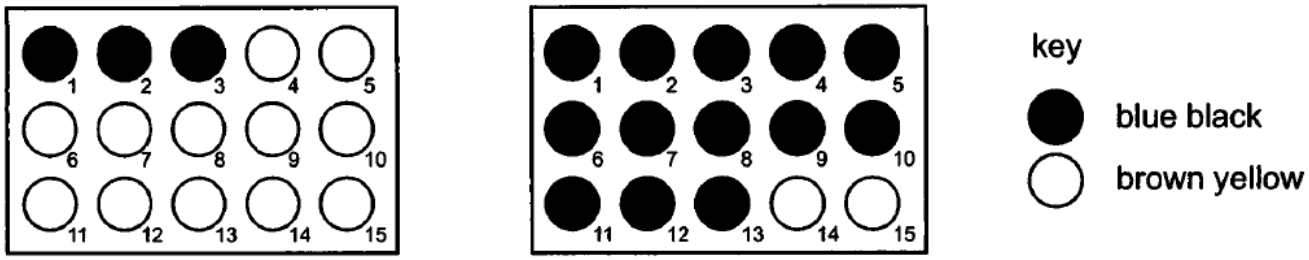


ANS A [L2] (H2 Alevel/2017/P1/Q3)

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

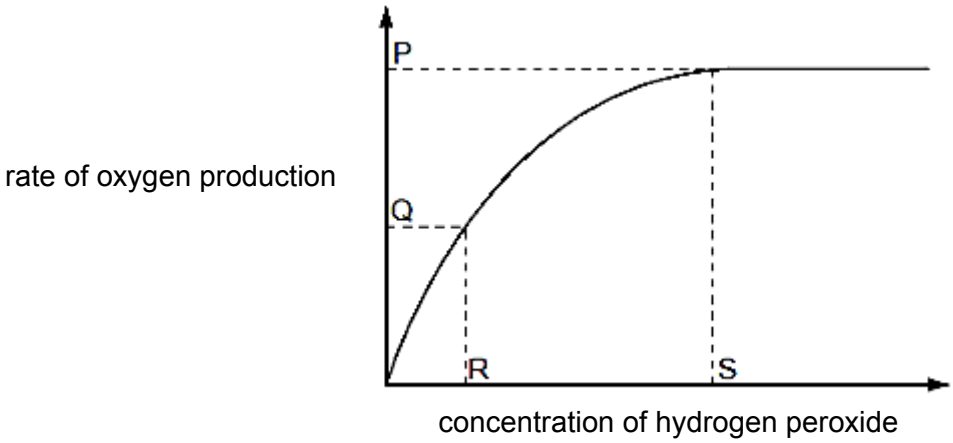
ANS B [L2] (H2 ALevel/2007/P/Q3)
SC: temperature time complete digestion
OR: increase temperature ➊ need less time for digestion [Trend]; faster decolourisation (blue black ➊ colourless)

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 ➐ 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 ➐ 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.

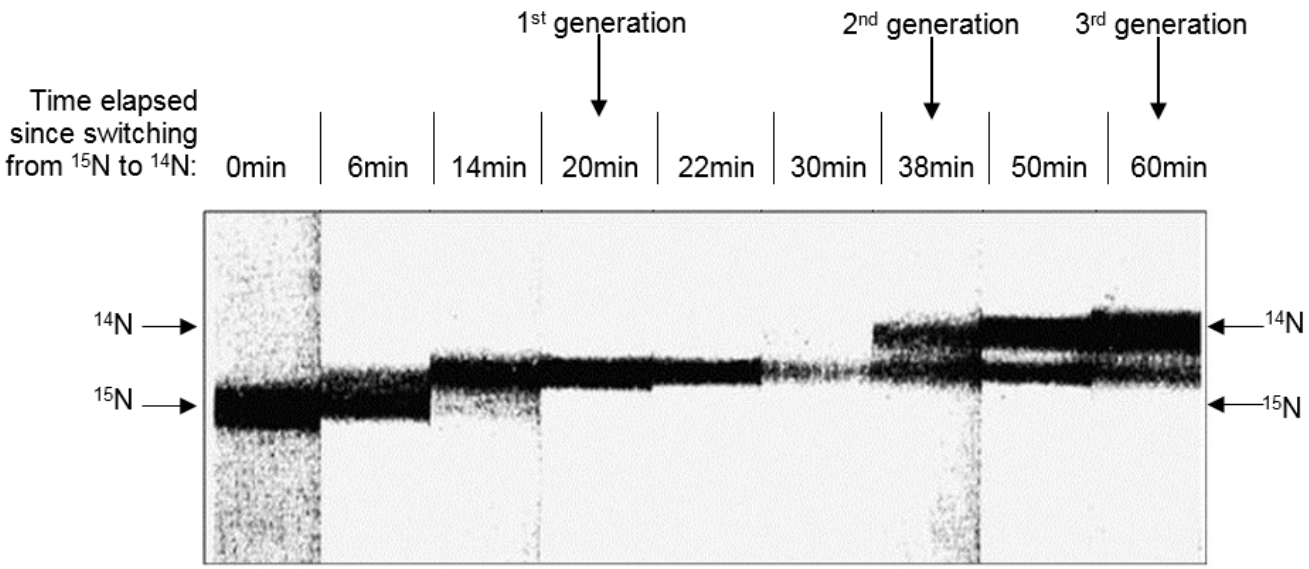
C Totipotent embryonic stem cells differentiate into multipotent blood stem cells and then into rbcs.

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 ➐ pluripotent; blood SC ➐ 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

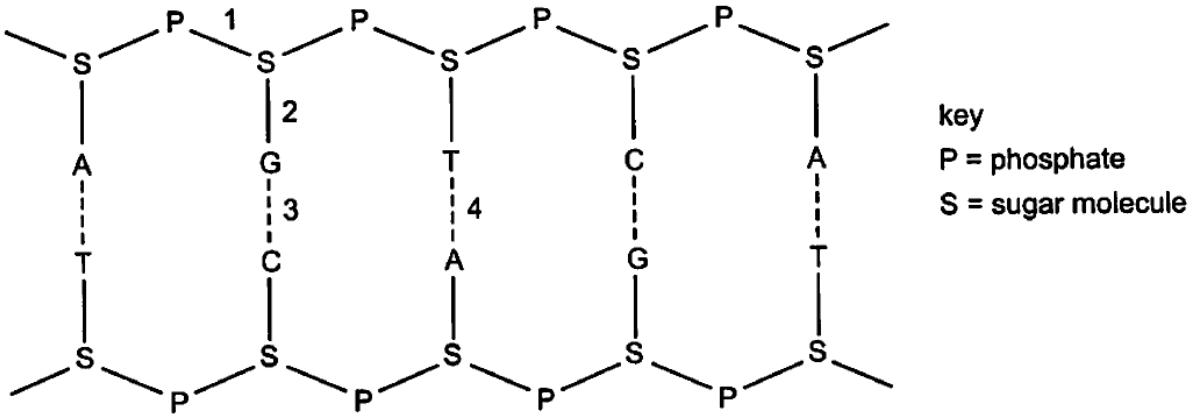
C 2, 3 and 4

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

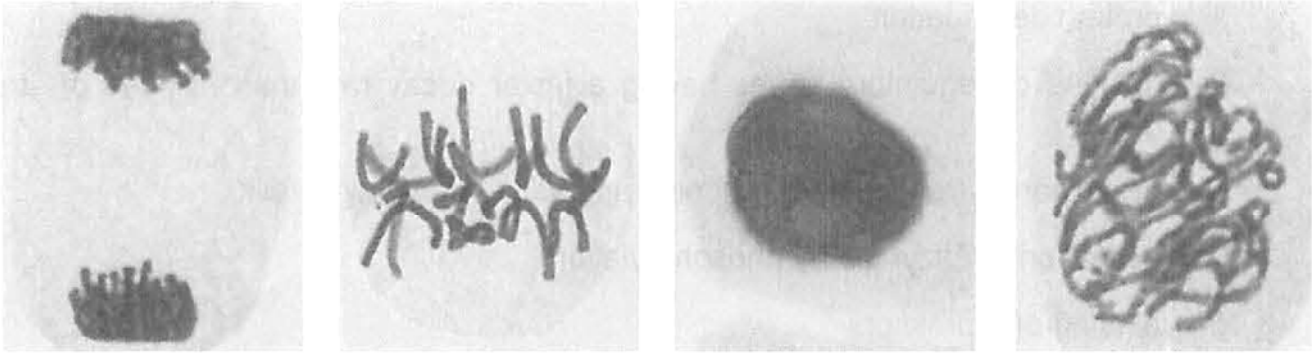
C 3 and 4

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.



1 2 3 4

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**.

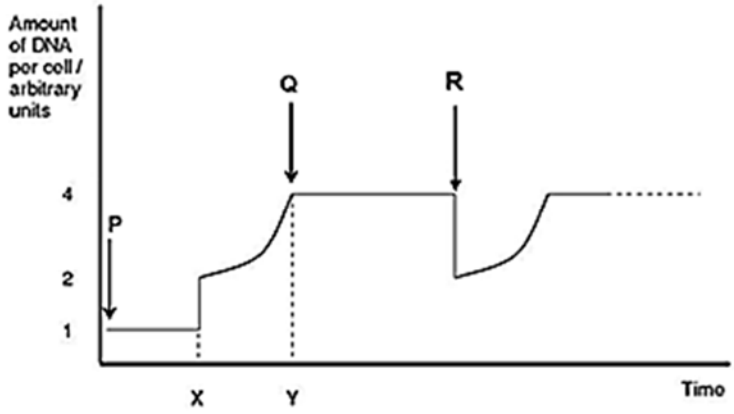
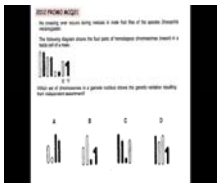


Fig. 14.1

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

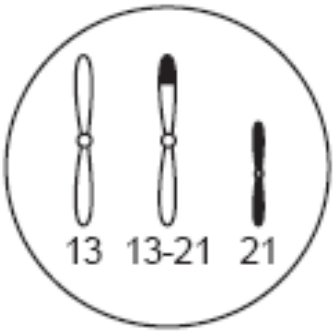
16 Which set of terms matches the definitions in the table?

	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)

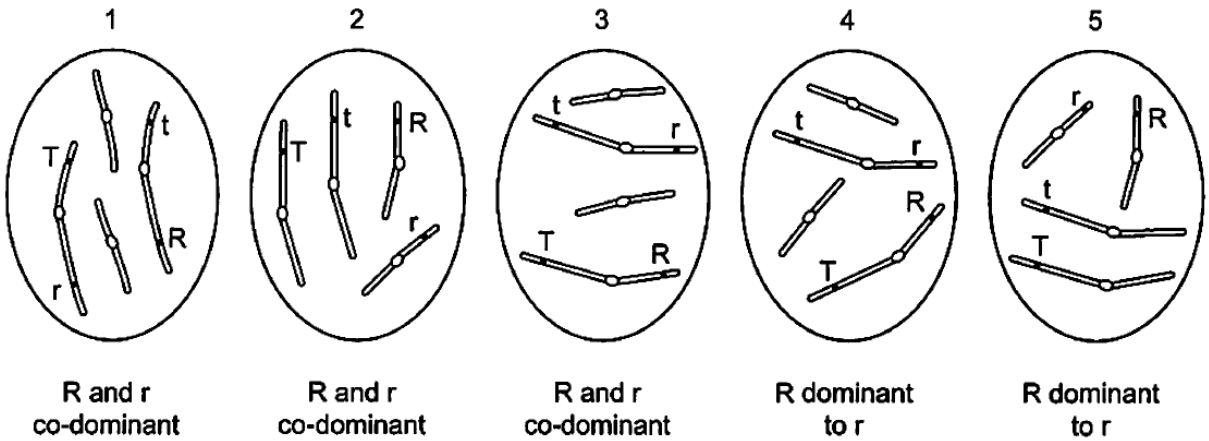
SC: NOT likely outcome **normal oocytes**
OR: potential male gametes: 13, 13-21, 21 **from females with chromosome 13 and 21**

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.

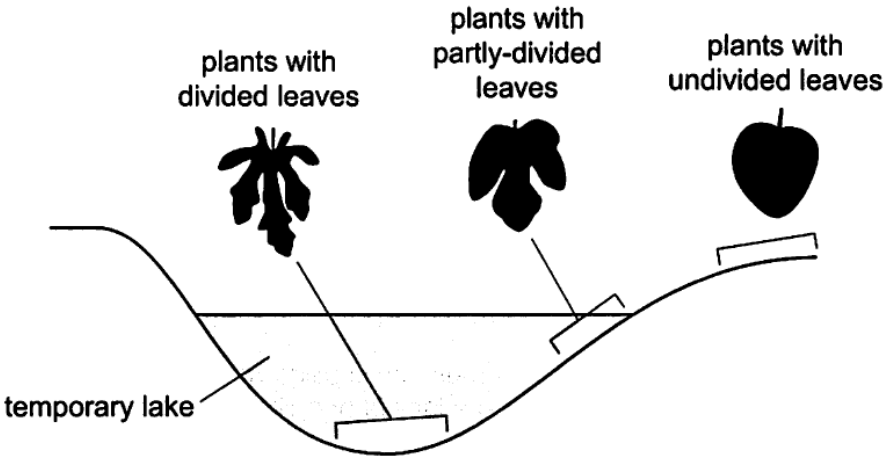
C The nucleotide sequences of the alleles occurring at different loci leads to the production of active and inactive enzymes, so that the heterozygous phenotype only has half of the enzyme concentration of the homozygous dominant phenotype.

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

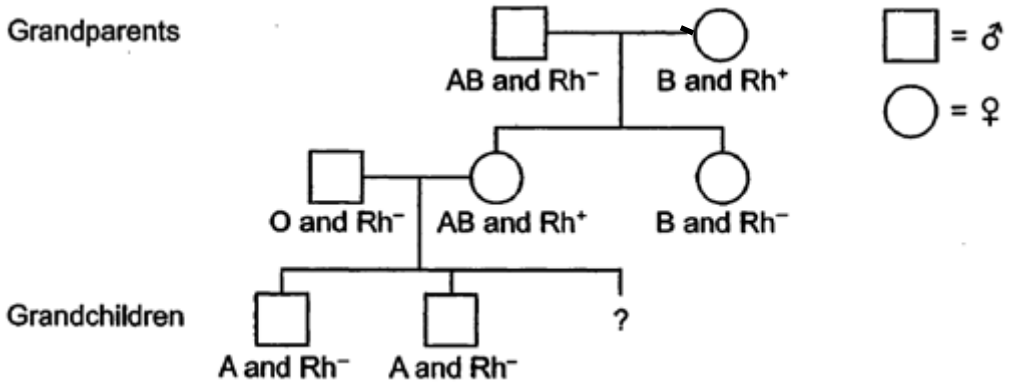
C random assortment of alleles in the plant population

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 ❼ 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

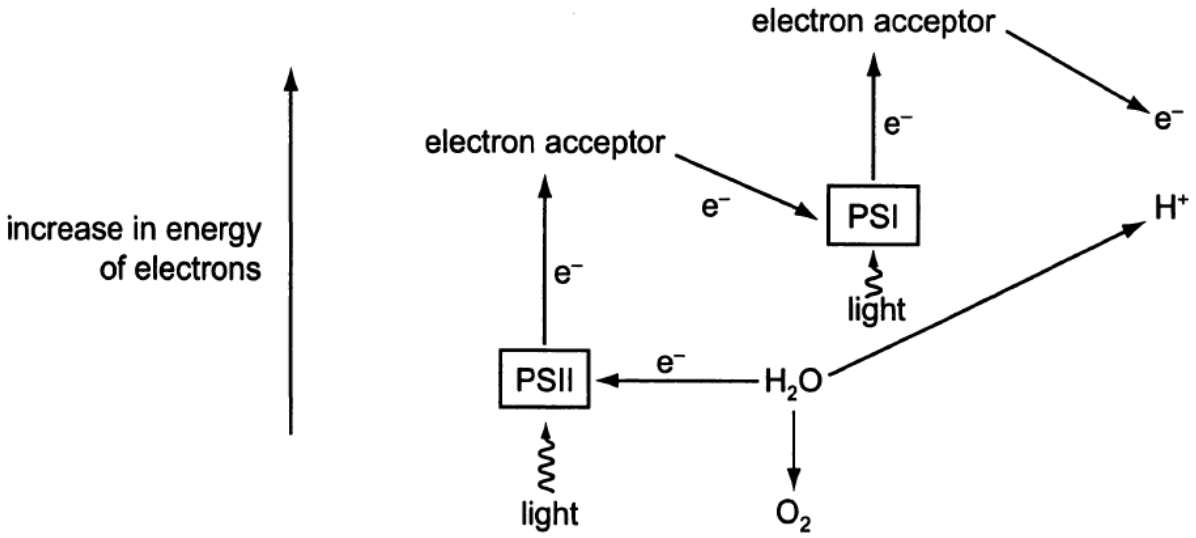
B cytoplasm

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

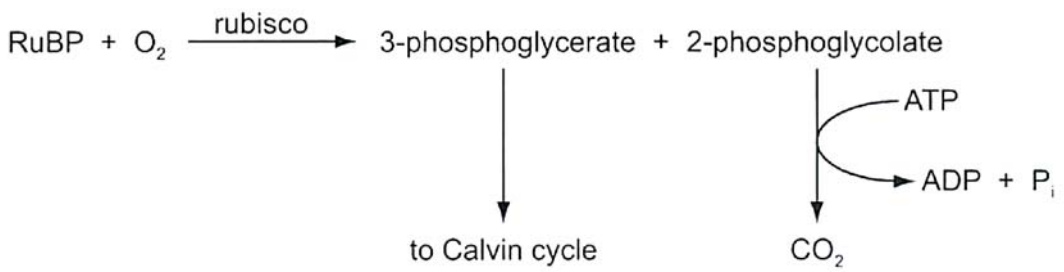
C glycerate 3-phosphate from glyceraldehyde 3-phosphate

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

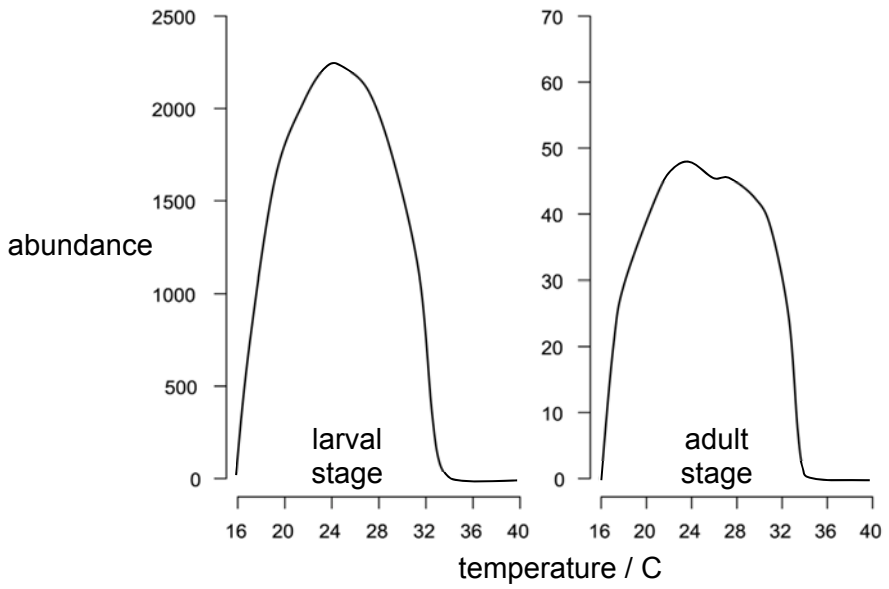
D	Increased	Unaffected	Increased

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

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.

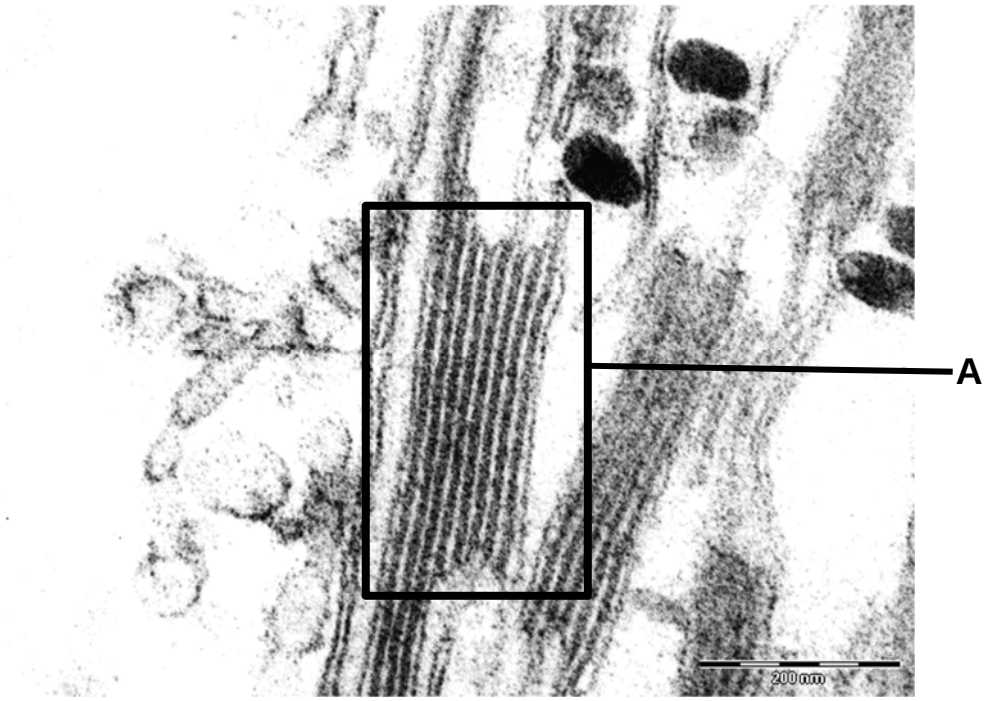


Fig. 1.1

(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.

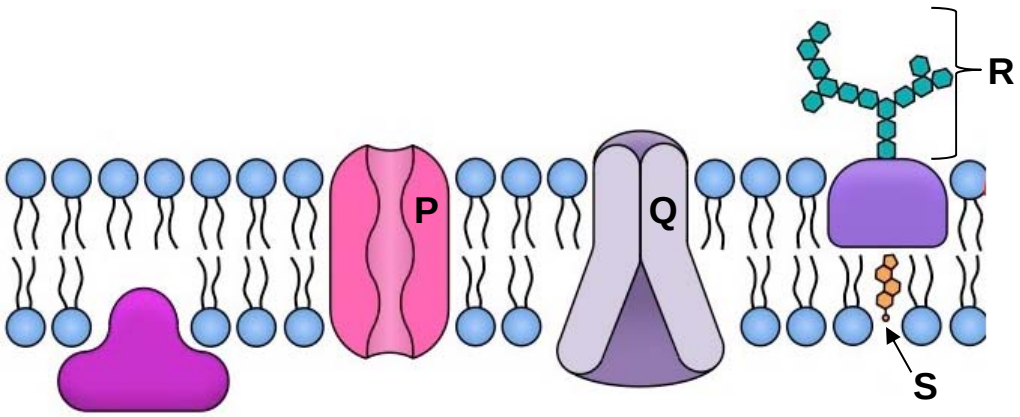


Fig. 1.2

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.

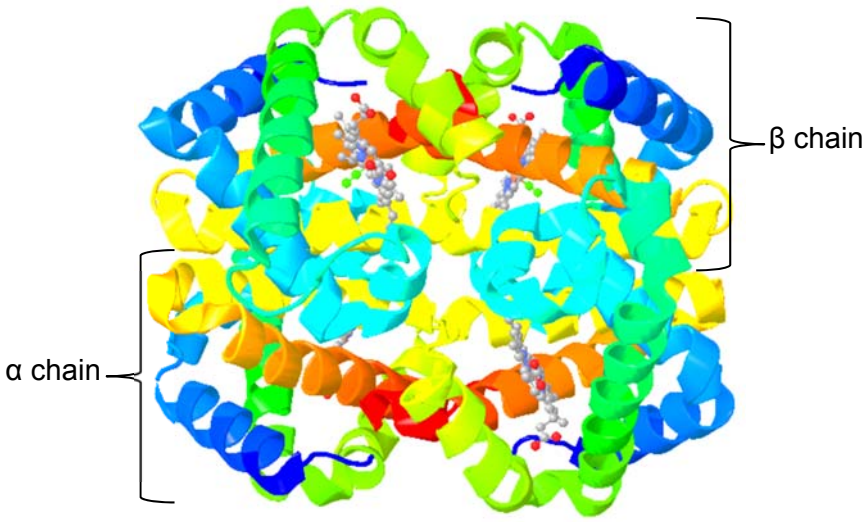


Fig. 2.1

(i) With reference to Fig. 2.1, explain how the structure of HbA is related to its function.

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……

……

……[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.

……

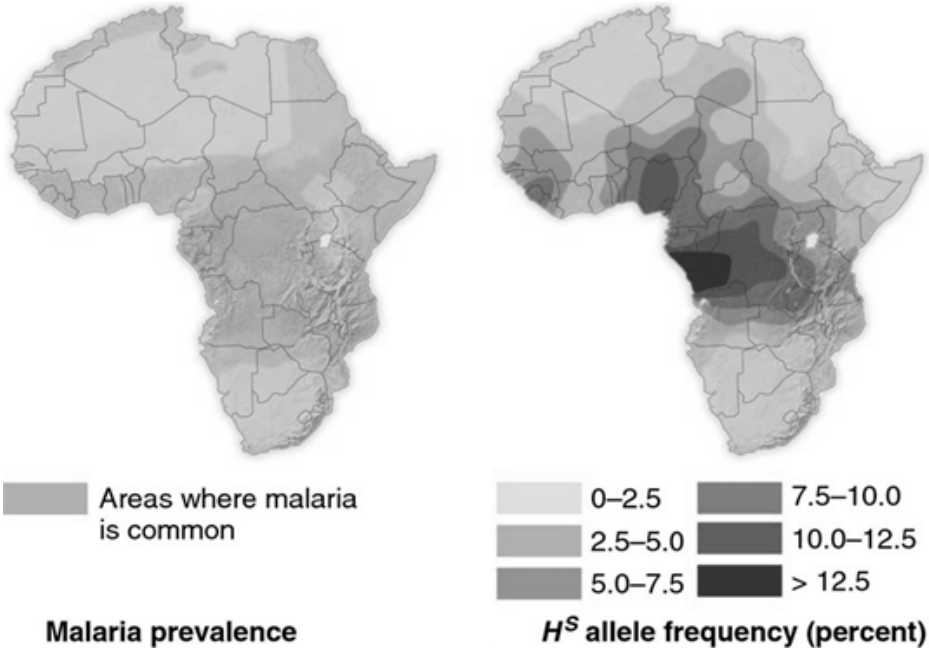
……

……

……[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.

……

……

……

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……

……[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.

……

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……[2]

(ii) Explain why treatment using HSC from allogeneic sources may pose some risks to the patient.

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……[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.

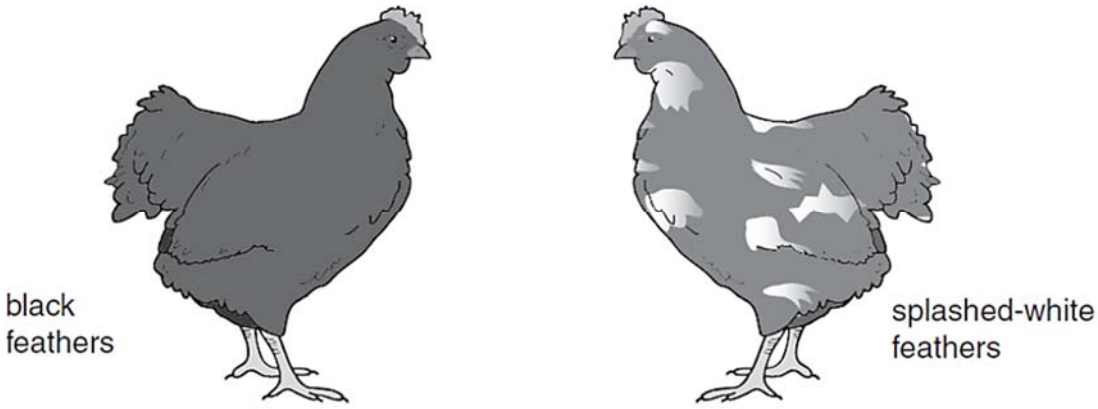

Fig. 3.1

(a) The blue feathers is the result of codominance.

Explain what is meant by ‘codominance’.

……

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……[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 (**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.

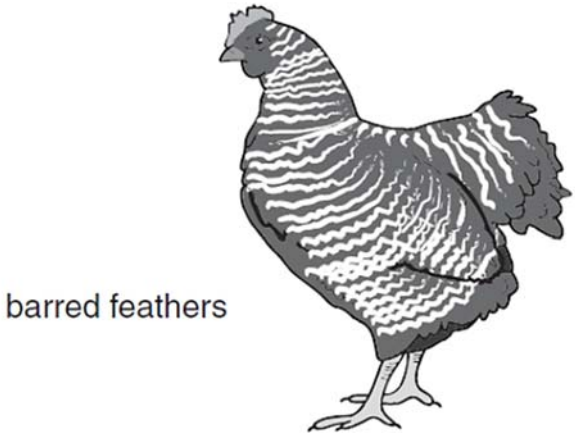

Fig. 3.2

(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.

[3]

(c) Explain how a farmer could use a breeding programme to find out the genotype of a male chicken with blue, barred feathers.

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……[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.

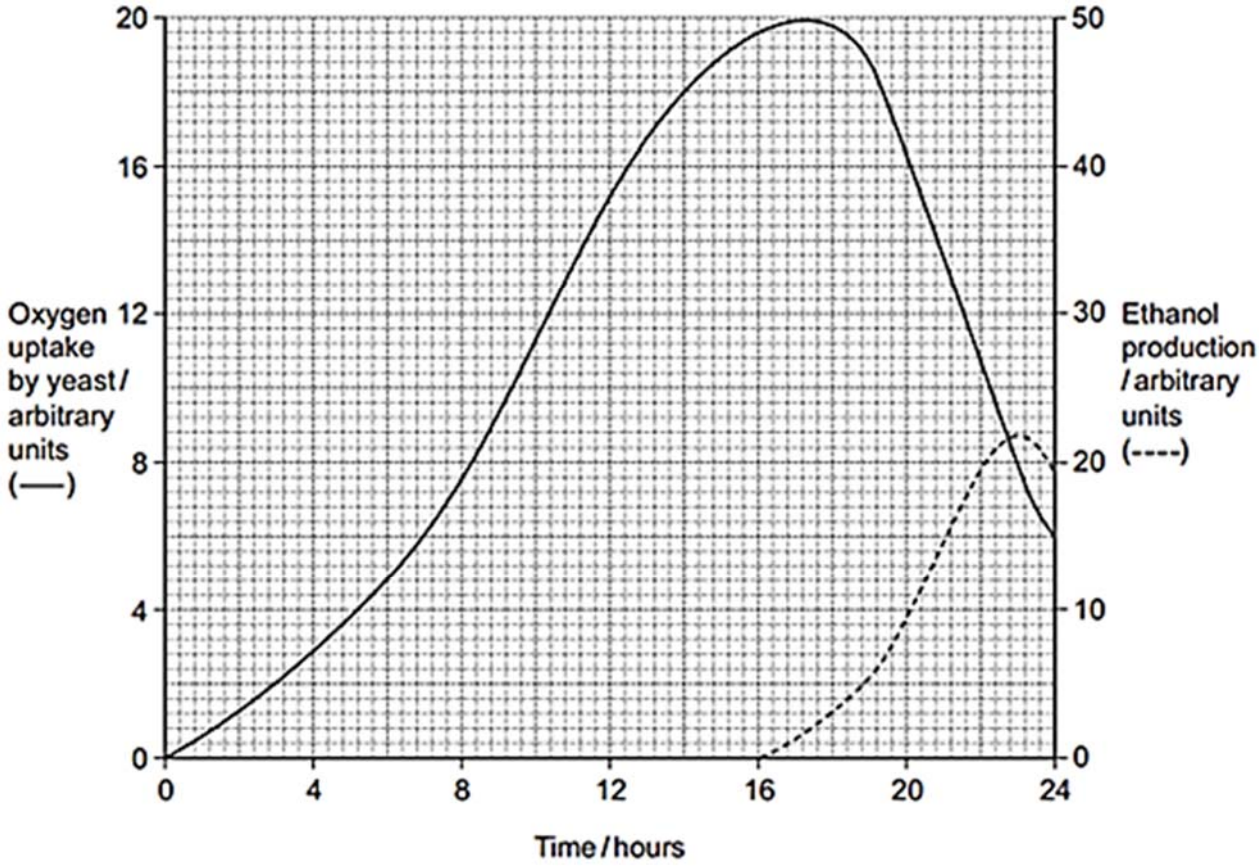

Fig. 4.1

(a) With reference to Fig. 4.1, explain the changes in the ethanol production by yeast during this investigation.

……

……

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……

……[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.

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……[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.

……

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……

……[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.

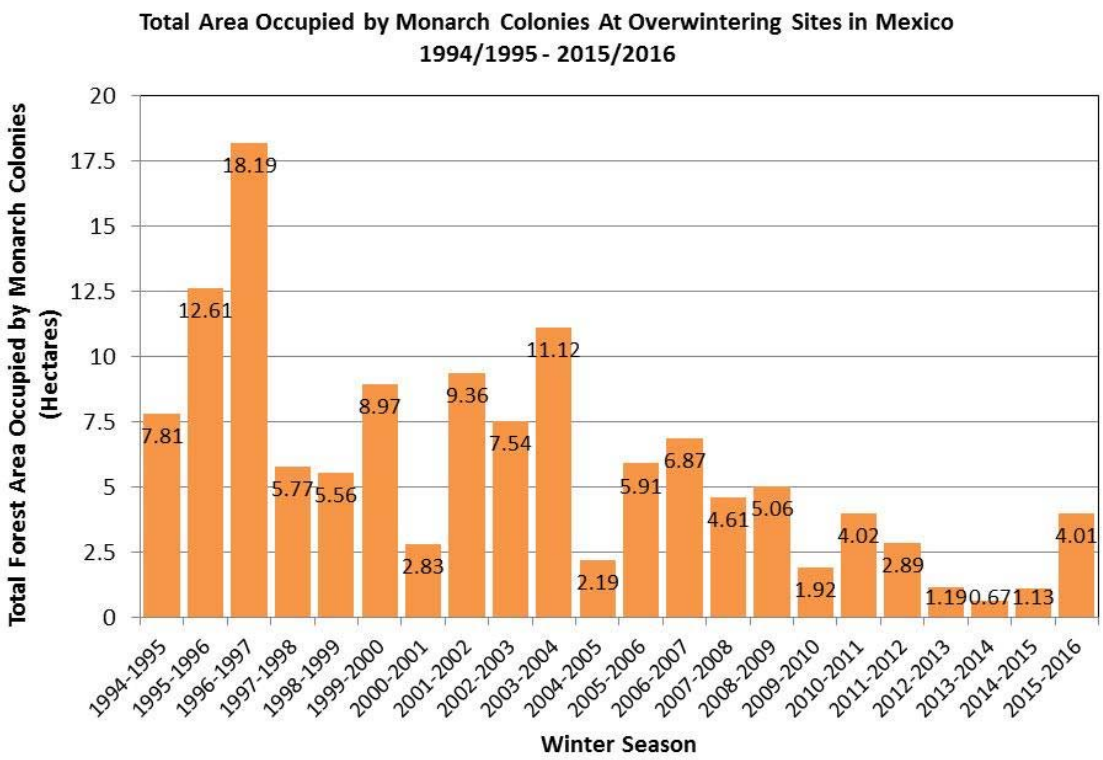
……

……

……

……[2]

Fig 5.2 below shows data of monarch butterflies arriving at Mexico during winter.



Data from 1994-2003 were collected by personnel of the Monarch Butterfly Biosphere Reserve (MBBR) of the National Commission of Protected Natural Areas (CONANP) in Mexico. Data from 2004-2016 were collected by the WWF-Telcel Alliance, in coordination with the Directorate of the MBBR.

Fig. 5.2

(ii) Explain why monarch butterflies would be highly sensitive to climate change.

……

……

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……[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

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

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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.

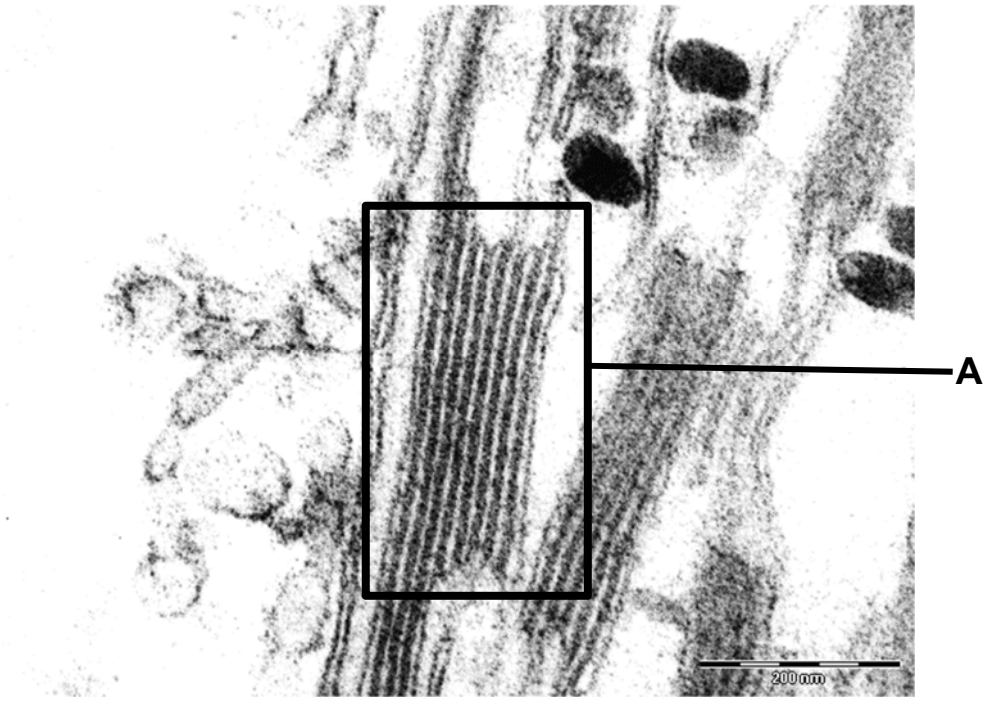


Fig. 1.1

(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]

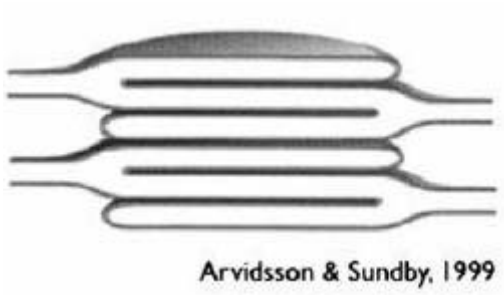
ANS [L2] Novel [2]

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.

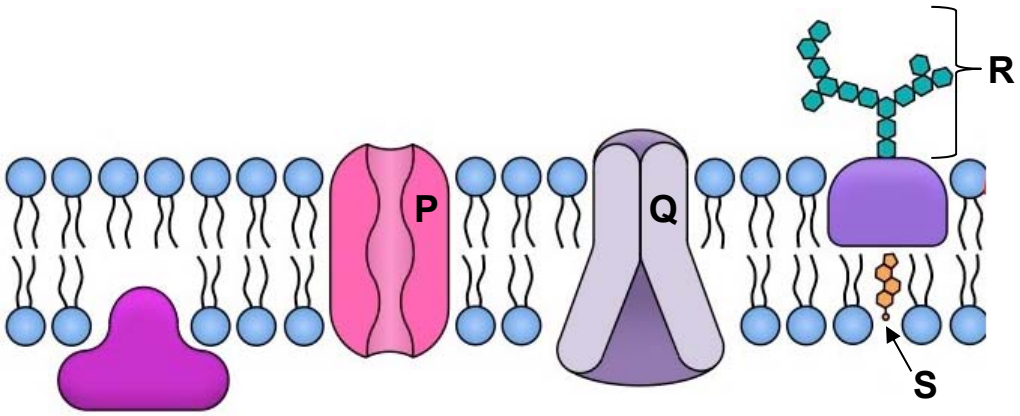


Fig. 1.2

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.

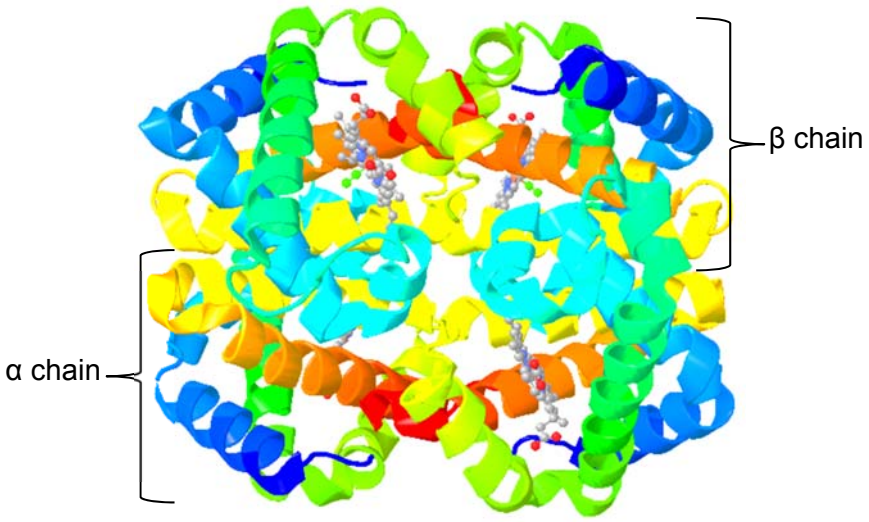


Fig. 2.1

(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]

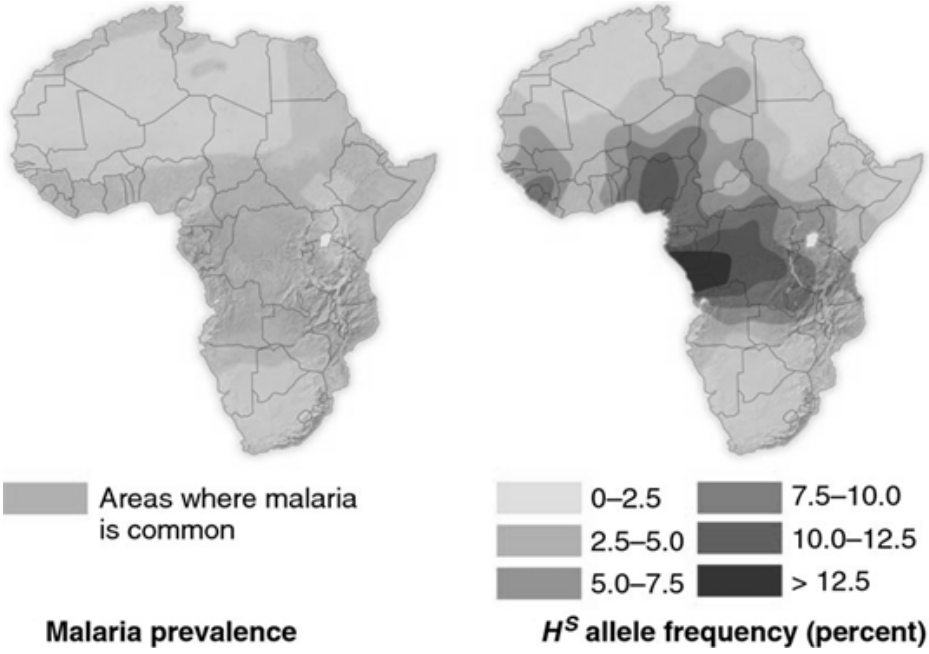
SC: Explain how affect structure of haemoglobin mol.
OR:
1. single-base substitution; T ➐ A and mRNA codon from GAG ➐ GUG
2. Glu (hydrophilic/polar) ➐ Val (hydrophobic/nonpolar) ➐ change 3D conf. ➐sickle shaped rbc

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.

.....

.....

.....

.....

.....

.....

.....[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
- **Diploidy➊ HbS: recessive allele➊exist 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 ➊ HbS allele is selected for (for malaria parasite can't develop in sickle cells➊ X infection)**
- **need to survive from SCA ➊ 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 ➋ 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.

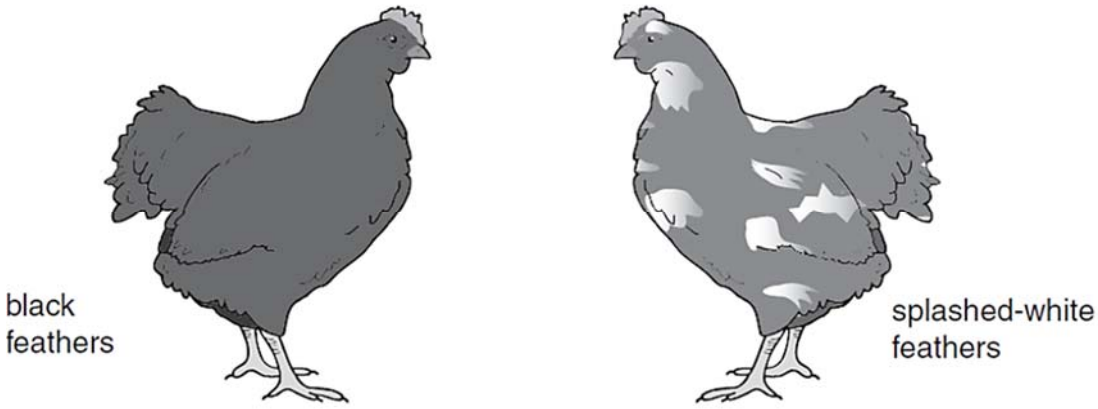


Fig. 3.1

(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: heterozygotes ❷ 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.

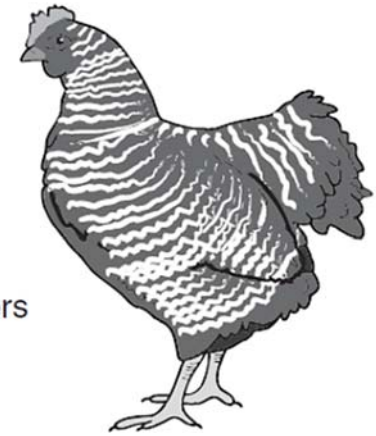

Fig. 3.2

(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	$C^WX^AX^a$ C^B		[1]
phenotypes	male, blue, barred feathers.	female, blue, non-barred feathers.	

ANS [L2] (H2 NYJC/2017/P2/Q7) [3]

[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.

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……[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.

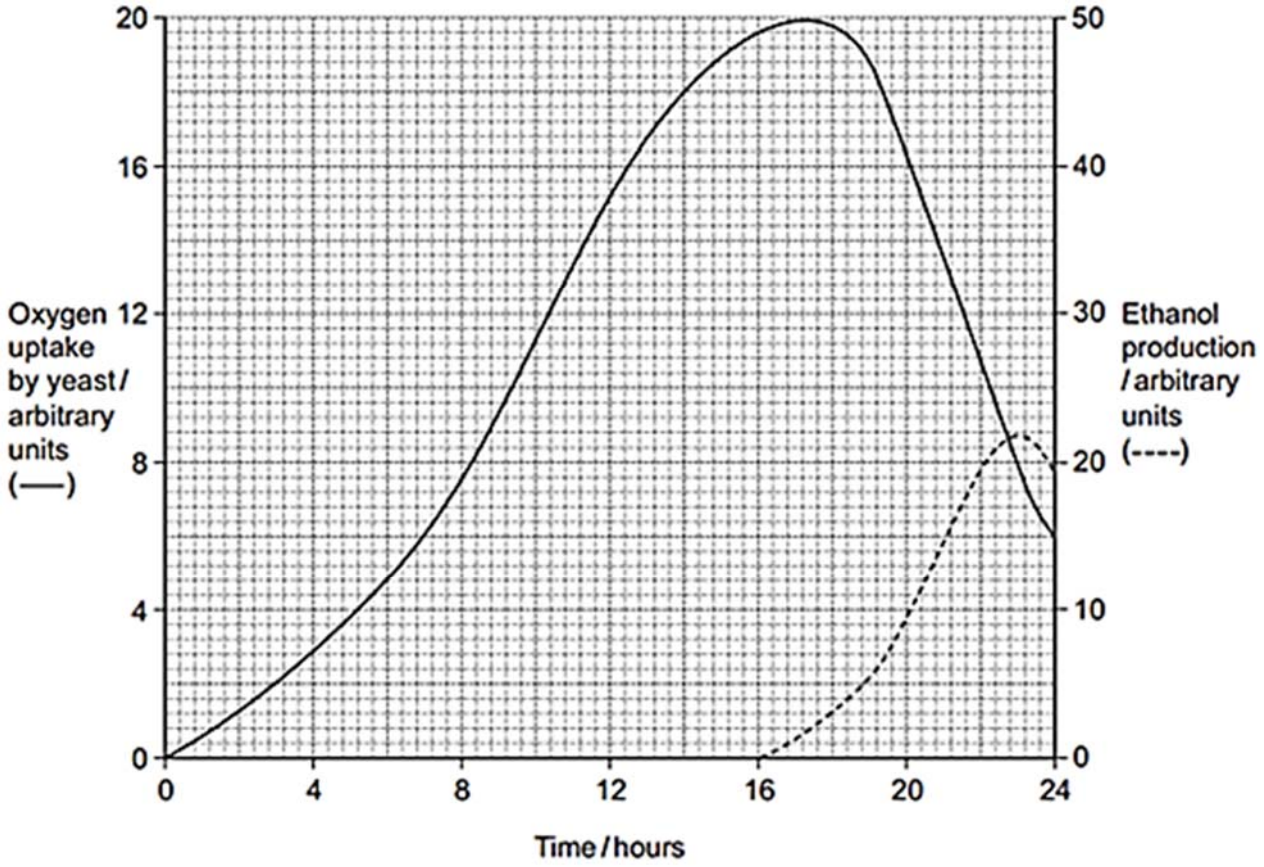

Fig. 4.1

(a) With reference to Fig. 4.1, explain the changes in the ethanol production by yeast during this investigation.

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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.

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ANS [L3] (H2 NJC/2017/P2/Q7) [2]

SC: **Suggest** **& Explain how** **sodium azide** **affect oxygen uptake**

OR: **oxygen uptake ↓es / stopped ➔ final e acceptor**
ethanol pdtn starts
switch from aerobic ➔ 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.

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……[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.

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……[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.

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.....[2]

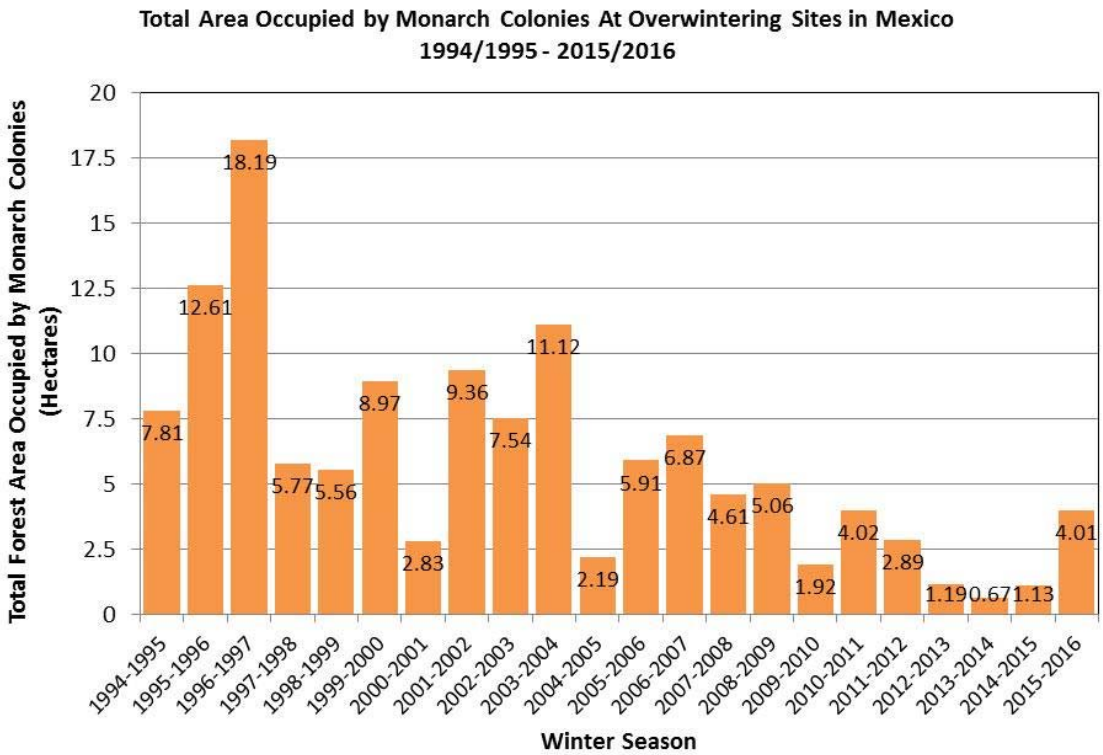
ANS [L1] (H1 Novel) [2]

SC: State	**Q_{10} theory**	**Describe correlation**
OR:	**For every 10°C ↑ 2-fold ↑ in E rxn**	**impact on insect physiology; ↑ temp ➊ life cycle faster; mature faster 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.



Data from 1994-2003 were collected by personnel of the Monarch Butterfly Biosphere Reserve (MBBR) of the National Commission of Protected Natural Areas (CONANP) in Mexico. Data from 2004-2016 were collected by the WWF-Telcel Alliance, in coordination with the Directorate of the MBBR.

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'-OH** 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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