1: Biological molecules – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2017	May/June	21
4	2017	May/June	23
6	2017	May/June	23

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2 Phosphatases are enzymes that catalyse the removal of phosphate groups from organic compounds.

Some students investigated the effect of substrate concentration on the rate of the reaction catalysed by an acid phosphatase (enzyme **A**). The results are shown in Fig. 2.1.

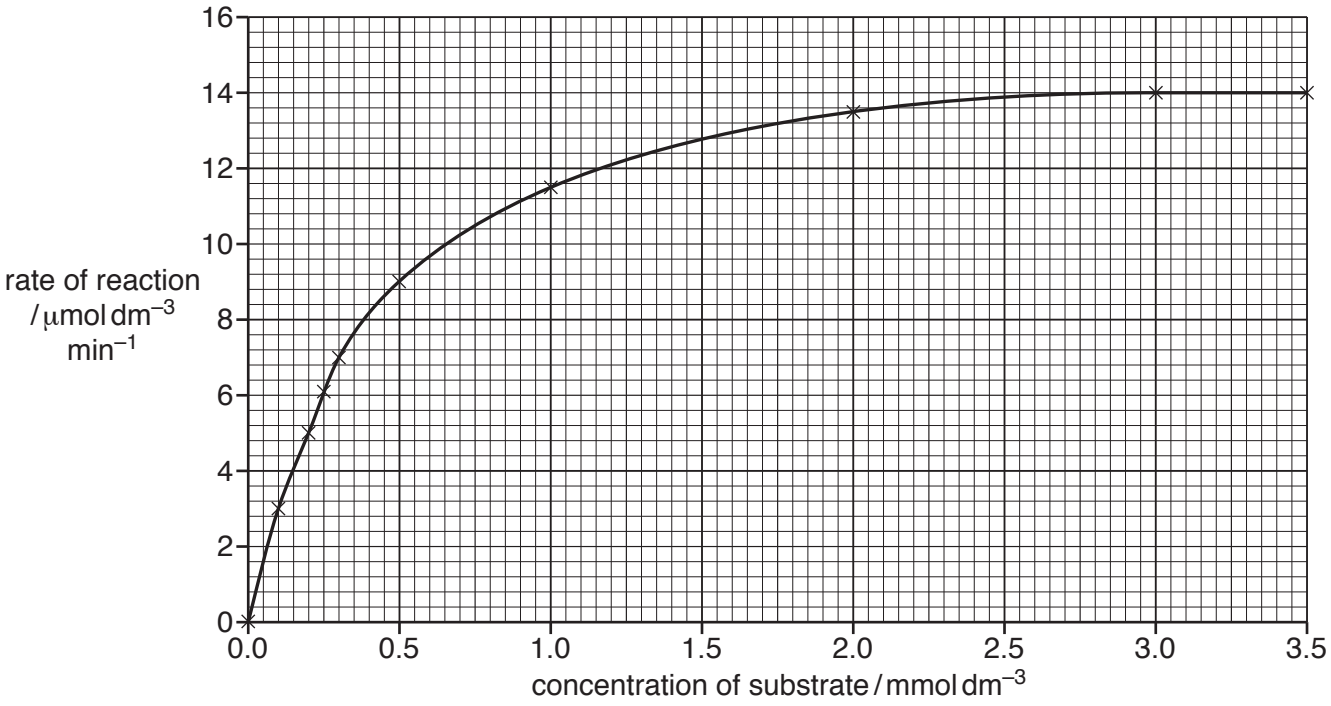

Fig. 2.1

(a) The students used Fig. 2.1 to derive the Michaelis-Menten constant (K_m) for enzyme **A** as 0.3 mmol dm^{-3}.

Explain how they derived K_m.

.....

.....

.....

.....

.....

.....[2]

(b) The students investigated a different phosphatase enzyme (enzyme **B**) and found the value of K_m to be higher than 0.3 mmol dm^{-3}.

Explain the difference between the values of K_m for these two phosphatase enzymes.

.....

.....

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.....[2]

(c) The students repeated their investigation on enzyme **A** with a competitive inhibitor.

They used the same concentrations of substrate as before, but added a competitive inhibitor to each reaction mixture.

They used the same concentration of the inhibitor in each reaction mixture.

The students found that V_{max} was the same as before, but K_m was higher than 0.3 mmol dm^{-3}.

Explain how the addition of the competitive inhibitor results in the same value for V_{max} but a higher value for K_m.

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.....

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.....

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.....

.....

.....[4]

[Total: 8]

4 **(a)** Complete Table 4.1 by using a tick (✓) to indicate which statements apply to each of the molecules. Use a cross (✗) for statements that do **not** apply.

Some of the boxes have been completed for you.

Table 4.1

statement	ATP	cellulose	haemoglobin	phospholipid
contains phosphorus	✓		✗	
found in plants				
contains iron				✗
has a structural role				

[4]

(b) Fig. 4.1 shows two amino acids.

Complete Fig. 4.1 to show how a peptide bond forms between these two amino acids.

Fig. 4.1

[3]

[Turn over

(c) Some glycoproteins in cell surface membranes function as transport proteins.

State two **other** functions of glycoproteins in cell surface membranes.

1 .....

.....

2 .....

.....[2]

[Total: 9]

6 **(a)** In the space below, draw a diagram to show a hydrogen bond between two water molecules.

[3]

(b) **(i)** Movement of water in xylem depends on the force of attraction between water molecules as a result of hydrogen bonding.

State the name given to this force of attraction.

.....[1]

(ii) State the property of water that results in a cooling effect as water evaporates from the surface of organisms.

.....

.....[1]

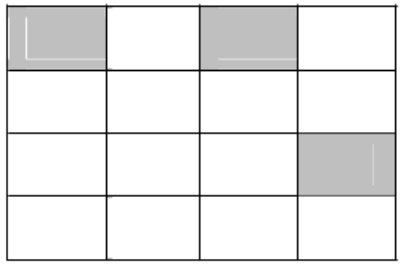
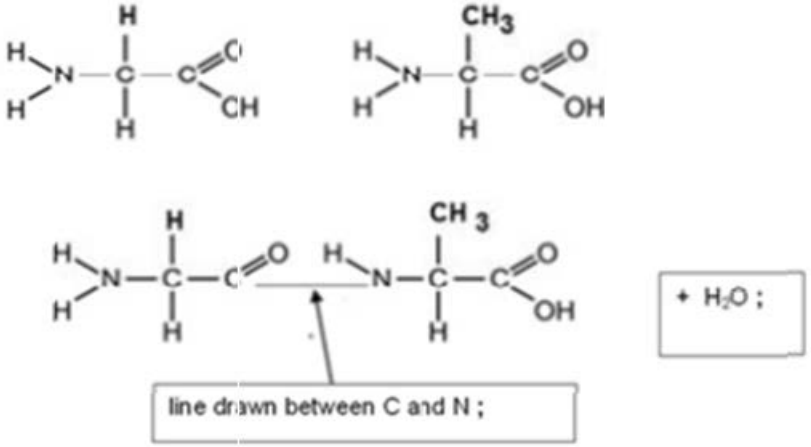
[Total: 5]

Mark scheme abbreviations

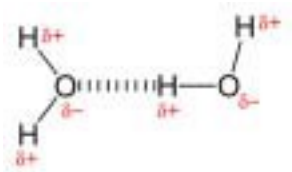
;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answer	Mark
2(a)	half V_{max} / AW, = 7 (µmol dm^{-3} min^{-1}) / take half of V_{max} of 14 (µmol dm^{-3} min^{-1}) **;** **A** description of using the graph to find ½ V_{max} without reference to figures read (substrate concentration) from *x*-axis / AW **;** *alternative* plot 1 / [S] = x	**2**

Question	Answers	Marks
2(b)	***allow*** *phosphate group(s) / organic compound for substrate* *if affinity not used, accept idea of ability to form ESC* *check for* ***ora*** **I** *ref. to* competitive inhibition **1** enzyme **B** has a lower affinity for its substrate (than enzyme **A**) **or** the higher the K_m the lower the affinity of the enzyme for its substrate **;** **R** if substrate has affinity for the enzyme **2** enzyme **B** needs a higher concentration of substrate to reach, V_{max} / ½V_{max} / K_m (than enzyme **A**) **;** **3** AVP **;** e.g. enzyme **B** forms fewer ESC in the same unit of time enzyme **B** active site is a less good fit for substrate *idea that* in normal cell enzyme **A** is saturated (with substrate) so works at a constant rate variations in substrate concentration will have less effect on the rate of formation of product by enzyme **A** **I** *ref. to* turnover number(s)	**max 2**
2(c)	*marks can be taken from a sketch graph* **1** competitive inhibitor, occupies / competes with substrate for / AW, active site (of the enzyme) **;** **2** reduces frequency of collisions (with substrate) / fewer ESCs form **;** **R** no ESCs form **3** reduces reaction rate at low substrate concentrations **;** ***4*** *idea that* curve with inhibitor is to the right of the curve without inhibitor **;** **5** at high substrate concentration / with increasing substrate concentration, the inhibitor has, no / less, effect **;** **A** *idea that* substrate outcompetes inhibitor at high substrate concentration **6** therefore V_{max} is the same as it is determined by the enzyme concentration / AW **;** **A** explanation in terms of active sites, saturated / fully occupied ***7*** *idea of* intercept to curve gives a higher value for K_m **;**	**max 4**
		Total: 8

Question	Answer	Marks
4(a)		**4**
4(b)	*allow diagrams with glycine on right*  bond forms between the C of the carboxyl group and the N of the amino group **;** **A** amine *for amino* water / H_2O, is formed **;** **A** condensation (reaction) **R** hydrolysis amino acid residues correctly drawn **;**	**3**

Question	Answer	Marks
4(c)	receptor(s) / cell signalling **;** cell recognition / antigens **;** cell adhesion **;** form H-bonds with water to stabilise membrane **;** enzyme **;** AVP **;** e.g. *ref. to* role in antigen presentation / MHC	**max 2**
		Total: 9

Question	Answer	Marks
6(a)	two water molecules drawn with correct bonding **; I** Fischer projections partial charges shown as σ+ on at least one H and σ– on at least one O **;** hydrogen bond shown **;** e.g. labelled or as dashed or dotted lines between H of one molecule and O of another **;** 	**3**
6(b)(i)	cohesion **;**	**1**
6(b)(ii)	high / large, latent heat of, vapourisation / evaporation **;** **A** takes a large amount of, heat / energy, to evaporate / turn liquid to water vapour	**1**
		Total: 5

2: Cells as the basic units of life – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

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Question	Year	Series	Paper number
1	2017	May/June	21
3(c)(d)	2017	May/June	22
6	2016	May/June	21

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1 **(a)** Each of the statements **A** to **D** describes a structure found in eukaryotic cells.

Identify the structure that is described in each statement.

A An organelle that contains 70S ribosomes.

.....

B A thread-like structure composed of DNA and histone proteins.

.....

C The organelle that modifies and packages proteins for secretion.

.....

D The structure that synthesises rRNA and combines it with proteins.

.....

[4]

(b) Prokaryotes and plant cells have cell walls.

Outline the composition of the cell wall of a prokaryote **and** the composition of the cell wall of a plant cell to show how they differ.

.....

.....

.....

.....

.....[2]

[Total: 6]

3 Malaria is a disease caused by the protoctist, *Plasmodium*. The organism has a very complex life

Fig. 3.1 is a transmission electron micrograph showing the developing *Plasmodium* cells inside a protective structure known as an oocyst. In this stage of the life cycle the oocysts are found in the mosquito gut. When mature, the *Plasmodium* cells are released and travel to the salivary glands of the mosquito.

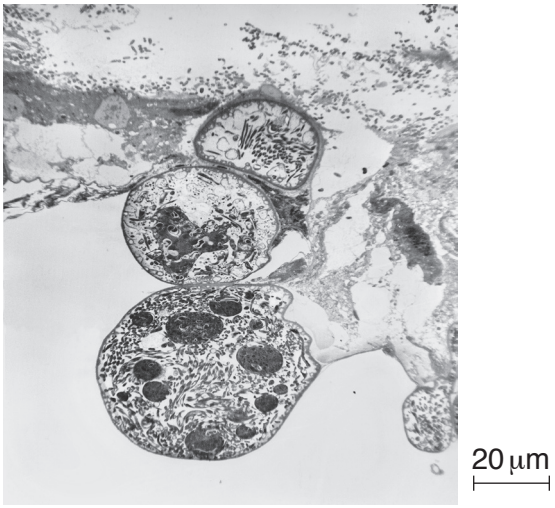

Fig. 3.1

(c) The magnification used in Fig. 3.1 can also be obtained using a light microscope.

Suggest why an electron microscope was used to obtain this image instead of a light microscope.

.....

.....

.....

.....

.....[2]

(d) Use the scale bar to calculate the magnification of the image shown in Fig. 3.1.

Write down the formula and use it to make your calculation. Show your working.

formula

magnification × .....[3]

[Total: 5]

6 Fig. 6.1 shows an incomplete diagram of the fluid mosaic model of membrane structure. The diagram shows the cell surface membrane of a eukaryotic cell.

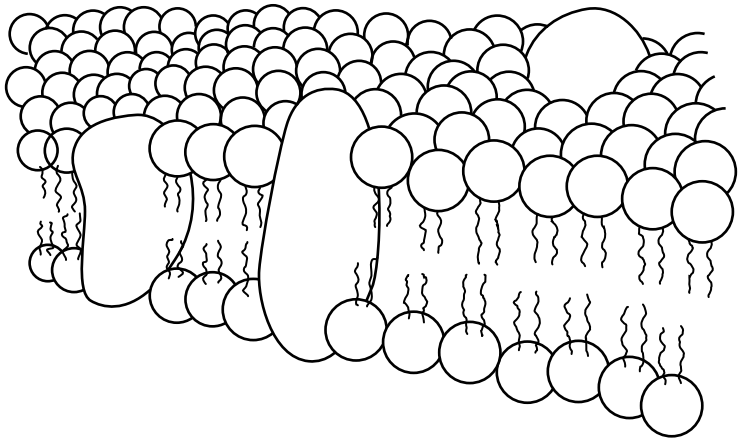

Fig. 6.1

(a) State what is meant by the term fluid mosaic.

.....

.....

.....

.....[2]

(b) State the thickness of a cell surface membrane.

.....[1]

(c) List four features of cell surface membranes of eukaryotic cells that are **not** visible in Fig. 6.1.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....[4]

[Total: 7]

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Question	Answers	Marks
1(a)	**A** chloroplast / mitochondrion **;** **B** chromosome(s) / chromatid / chromatin **;** **C** Golgi (body / apparatus / complex) **;** **D** nucleolus **;**	**4**
1(b)	*max 1 if only written about prokaryote wall or only about plant wall* **1** prokaryote cell wall has, peptidoglycan / murein **;** **2** plant cell wall has, cellulose / polymer of β glucose **; I** lignin **3** AVP **;** e.g. prokaryote wall is made of chains crossed linked by, peptides / amino acids hydrogen bonds between cellulose molecules (within microfibrils) in plant cell wall **A** cellulose chains other components such as pectins / hemicelluloses in plant cell walls	**max 2**
		Total: 6

Question	Answer	Marks
3(c)	*look for ora* **1** higher / better / AW, resolution / resolving power ; **2** { 0.5 nm (**A** 0.2–1 nm) compared to, 200 nm 0.2 µm (**A** range 100–300 nm) **or** electrons have shorter wavelength ; **R** electron microscope has a shorter wavelength **or** *idea that* cell structures too small to interfere with light waves ora } **3** better able to distinguish between two points ; **A** as a definition if mp 1 achieved **4** (can see) more detail ; *treat 'clearer' as neutral* **5** able to make thinner sections / able to see inside (oocyst) ; **6** can continue to obtain higher magnifications and see more detail ;	**max 2**
3(d)	(magnification =) $\frac{\text{image / scale bar (length)}}{\text{actual / object (length)}}$; **A** triangle / letters only (x) 500 ; *using 10 mm as measured length* **A** calculated values for measured length of 9 mm or 11 mm *allow one mark if correct answer given with units* *allow one mark if incorrect answer and* *correct measurement and correct working* *correct measurement and formula but incorrect conversion* *measurement ±2 mm and correct working*	**3**

Question	Answers	Marks
6(a)	fluid phospholipids (and proteins), move / AW ; mosaic proteins / glycoproteins, scattered / AW (in the phospholipid bilayer) ; **A** different types of proteins **I** pattern unqualified	**2**
6(b)	7 nm ; **A** any size or range within 6 nm and 10 nm **A** 7 nanometres	**1**
6(c)	cholesterol ; unsaturated fatty acids ; **A** phospholipid tails carbohydrate chains added to protein(s) / glycoproteins ; **A** oligosaccharides *for carbohydrate chains* carbohydrate chains added to lipids / glycolipids ; glycocalyx ; channel protein(s) / AW ; **A** aquaporin(s) ; carrier proteins / AW ; peripheral / extrinsic, proteins ; attachment to, cytoskeleton / microfilaments ; receptor(s) ; antigen(s) ; AVP ;	**Max 4**
		Total: 7

3: DNA and the mitotic cell cycle – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

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4	2017	May/June	21
5	2017	May/June	23
4	2017	May/June	22

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4 **(a)** Fig. 4.1 shows part of a DNA molecule.

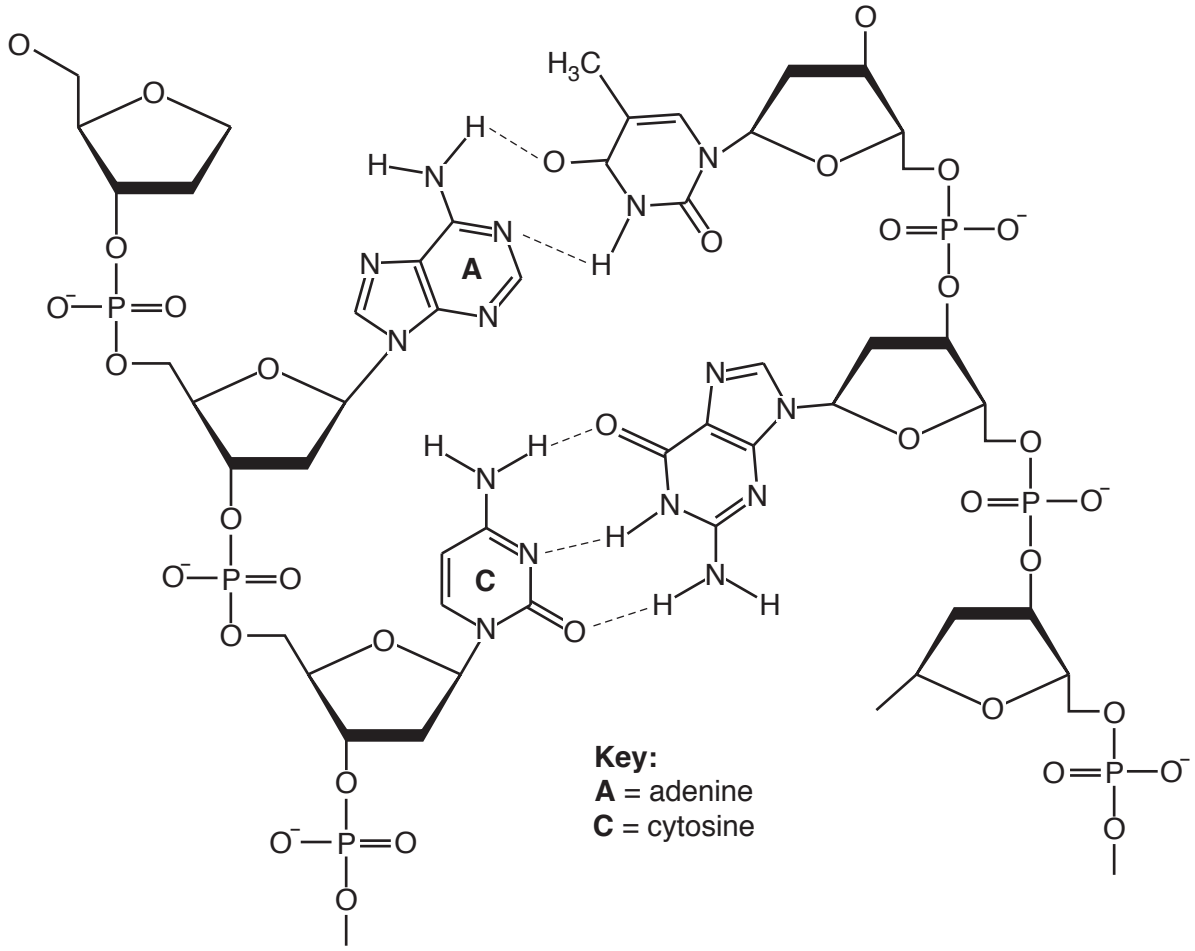

Fig. 4.1

Use Fig. 4.1 to explain how the structure of mRNA differs from the structure of DNA.

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.....[4]

[Turn over

(b) Fig. 4.2 shows:

- the first seven amino acids of the β chain of haemoglobin
- the first amino acid in the sequence is valine (Val)
- the 21 base pairs in the sequence of DNA that code for these seven amino acids.

amino acid sequence	Val	His	Leu	Thr	Pro	Glu	Glu
base sequence in DNA	CAC	GTG	GAC	TGA	GGA	CTC	CTC
	GTG	CAC	CTG	ACT	CCT	GAG	GAG

Fig. 4.2

Table 4.1 shows the triplets of bases that code for seven amino acids.

Using Fig. 4.2 and Table 4.1, state what will happen to the sequence of amino acids in the first part of the β chain of haemoglobin:

(i) if the base pair at position 6 is deleted

.....

.....[1]

(ii) if the three base pairs at positions 7, 8 and 9 are deleted.

.....

.....[1]

Table 4.1

amino acid		DNA triplets
cysteine	(Cys)	TGT TGC
glutamic acid	(Glu)	GAA GAG
histidine	(His)	CAT CAC
leucine	(Leu)	CTT CTC CTA CTG
proline	(Pro)	CCT CCC CCA CCG
threonine	(Thr)	ACT ACC ACA ACG
valine	(Val)	GTT GTC GTA GTG
no amino acid	STOP	TAA TAG TGA

(c) DNA is involved in the processes of replication and transcription.

Complete Table 4.2 by using a tick (✓) to indicate which features apply to each of the processes. Use a cross (✗) for features that do **not** apply.

The first row has been completed for you.

Table 4.2

feature	replication	transcription
a single-stranded molecule is produced	✗	✓
hydrogen bonds are broken		
both strands of DNA act as templates		
phosphodiester bonds are formed		
DNA polymerase is used		

[4]

(d) Telomeres are parts of chromosomes. Describe the function of telomeres.

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.....

.....[2]

(e) Describe the function of ribosomes in protein synthesis.

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.....

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.....[4]

[Turn over

[Total: 16]

5 **(a)** Describe the process of DNA replication.

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.....[5]

(b) State the name of the part of the chromosome that prevents the loss of genes during DNA replication.

.....[1]

(c) During DNA replication, the use of an incorrect base in the newly synthesised strand can lead to a mutation.

(i) A transversion event is where a pyrimidine is used in the newly synthesised strand instead of a purine, or the other way round.

Name the **two** possible bases that could be used instead of cytosine in a transversion event.

.....[1]

(ii) A transition event is where an incorrect purine is used or an incorrect pyrimidine is used.

Suggest why transversion events are **less** likely to occur than transition events.

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.....[2]

(d) Outline how mutations can cause healthy cells to become tumour cells.

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.....[3]

[Total: 12]

4 Meristematic tissue is found in the growing regions of plants, such as root tips.

(a) Fig. 4.1 summarises a cell cycle for a meristematic cell in the root tip. The two phases of this cell cycle are shown:

- interphase, which is divided into the G_1, S and G_2 stages
- cell division, which is divided into stages 1–5.

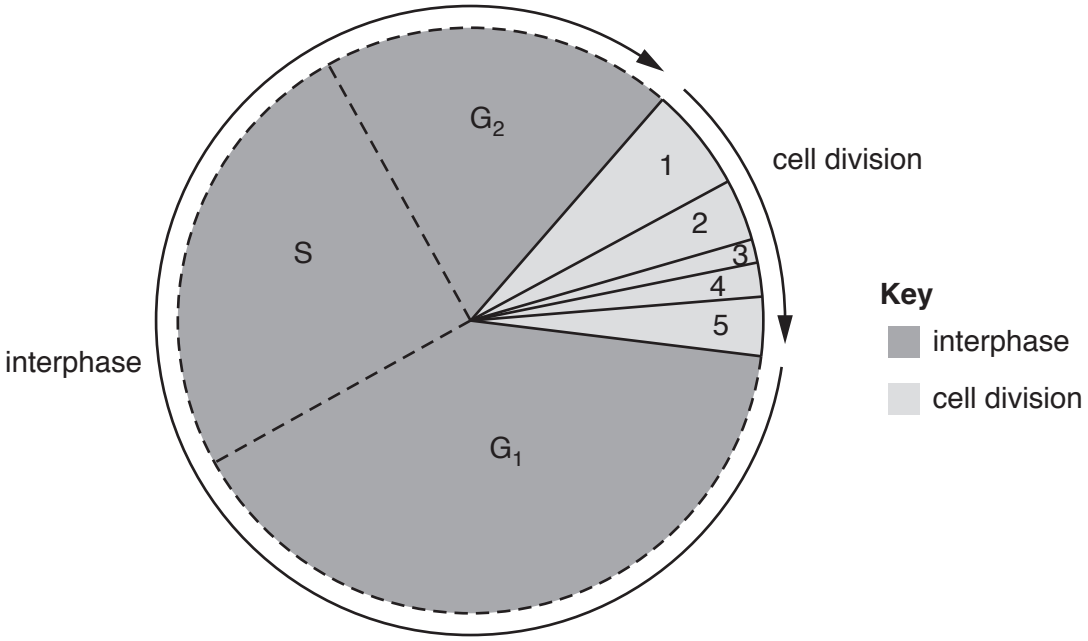

Fig. 4.1

(i) In Fig. 4.1, stage 2 is metaphase.

The stages shown in Fig. 4.1 are listed below. Draw a circle around the stage in the cell cycle that is cytokinesis **and** describe what happens in this stage in the root tip meristematic cell.

1 2 3 4 5 G_1 S G_2

.....

.....

.....

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.....

.....

.....[3]

[Turn over

(ii) The stages shown in Fig. 4.1 are listed below. Draw a circle around the stage in the cell cycle in which the semi-conservative replication of DNA occurs **and** state what is meant by semi-conservative replication.

1 2 3 4 5 G_1 S G_2

.....

.....

.....

.....

.....

.....

.....[3]

(b) Meristematic cells have a similar role to stem cells found in animals.

Suggest the role of a meristematic cell **and** explain the features that help it to carry out its role.

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.....

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.....

.....

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.....

.....[3]

[Turn over

(c) Meristematic regions in the plant can sometimes be described as strong sinks.

(i) State what is meant by a *sink*.

.....

.....

.....[1]

(ii) Suggest what is meant by a **strong** sink.

.....

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.....[1]

[Turn over

(d) Describe **and** explain how sucrose is loaded into phloem sieve tubes.

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.....[4]

[Total: 15]

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max	indicates the maximum number of marks that can be given
ora	or reverse argument
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ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answers	Marks
4(a)	*mRNA* **1** single-stranded **;** **2** no hydrogen bonding / only DNA has hydrogen bonding **;** **3** no base pairs / only DNA has base pairs **;** **4** uracil and not thymine / DNA has thymine instead of uracil **;** *treat as neutral T and U, look for complete term* **5** ribose not deoxyribose **;** **6** detail, e.g. –H and not –OH on C2 **;** **7** short(er) / DNA is longer **; A** smaller / bigger **8** not a helix **;**	**max 4**
4(b)(i)	*third triplet is a stop codon so* only two amino acids are joined by peptide bonds / chain only 2 amino acids long **;** **A** will still have Val-His as the first two amino acids very short molecule is produced / chain stops after His(tidine) **;** **R** frameshift / description of frameshift	**max 1**

<table>
<tr><th>Question</th><th>Answers</th><th>Marks</th></tr>
<tr><td>4(b)(ii)</td><td>a triplet is deleted so
(polypeptide / sequence / β chain) has one less amino acid ;
polypeptide does not have Leu (as the third amino acid) ;
I Leu is not, produced / made / synthesised</td><td>max 1</td></tr>
<tr><td>4(c)</td><td><table>
<tr><th>feature</th><th>DNA replication</th><th>transcription</th></tr>
<tr><td>a single-stranded molecule is produced</td><td>x</td><td></td></tr>
<tr><td>hydrogen bonds are broken</td><td></td><td>✓ ;</td></tr>
<tr><td>both strands of DNA act as templates</td><td></td><td>x ;</td></tr>
<tr><td>phosphodiester bonds are formed</td><td></td><td>✓ ;</td></tr>
<tr><td>DNA polymerase is used</td><td></td><td>x ;</td></tr>
</table></td><td>4</td></tr>
<tr><td>4(d)</td><td>I functions of telomerase
permits continued replication (in stem cells / meristematic cells) ; A ora
prevents loss of, genes / genetic material / DNA ; A ora
A prevents shortening of, chromosomes / DNA
length of telomere determines lifespan of, cells / cell lineage ;
AVP ; e.g. prevents ends of chromosomes attaching to each other prevents apoptosis / cell death / cell destruction</td><td>max 2</td></tr>
</table>

Question	Question	Question
4(e)	**1** translation / construction of polypeptide(s) **;** **2** provide binding site for mRNA / mRNA attaches to ribosome / AW **;** **A** entering ribosome **3** provides binding sites for (two) tRNA molecules **;** **A** entering ribosome **4** two amino acids are held close together **;** **5** formation of peptide bond(s) **; R** dipeptide / polypeptide, bond **6** (allows) assembly of amino acids into, sequence / primary structure **;** **7** AVP **;** e.g. P and A site (and E site) bond between amino acids catalysed by peptidyl transferase	**max 4**
		Total: 16

Question	Answer	Marks
5(a)	**1** DNA (double helix) unwinds **;** **A** uncoils **I** unzips **R** DNA strand unwinds **2** hydrogen bonds break between, base pairs / bases / strands **;** **3** both strands used as templates **;** **4** catalysed by / AW, DNA polymerase **;** **5** *ref. to* (free) activated nucleotides / AW **;** **6** complementary (DNA) nucleotides added **; R** RNA nucleotides **A** described in terms of complementary base pairing **7** step-by-step / sequentially / AW **;** **8** *idea that* process continues, along whole DNA molecule **;** **9** replication bubbles / described **or** *ref. to* Okazaki fragments **;** **10** replication is semi-conservative / each newly formed molecule contains one original and one newly synthesised strand **11** AVP **;** e.g. *ref. to* repair / proofreading *ref. to*, helicase / ligase *in correct context*	**max 5**
5(b)	telomere(s) **;**	**1**
5(c)(i)	adenine <u>and</u> guanine **;**	**1**
5(c)(ii)	*idea that* purines and pyrimidines are different sizes / two rings and one ring **;** purine normally bonds with pyrimidine (to maintain DNA double strand width) **;** *idea that* two purines or two pyrimidines will distort the double helix width (in a transversion event) **; ora** AVP **;** e.g. (transversion event) more likely to be detected by the repair mechanism **ora**	**max 2**

Question	Answer	Marks
5(d)	*idea that* mutation occurs for a gene controlling cell division **;** detail **;** e.g. proto-oncogene to oncogene tumour suppressor gene switched off **;** *ref. to* disruption of cell cycle / shortened interphase **;** (results in) uncontrolled cell division **; I** uncontrolled growth other detail of result of mutation **;** e.g. divide indefinitely / no programmed cell death do not respond to signals to stop dividing loss of, specialisation / function	**max 3**
		Total: 12

Question	Answer	Marks
4(a)(i)	**1** circle round **5 ;** *to max 2 but 4 cells produced = max 1 out of 2* **I** details of telophase leading to cytokinesis **2** cell plate forms (across equator of cell) **or** cell wall / cellulose, laid down **; A** cell wall forms (between the two) **3** (so) cytoplasm divided (into two) **;** **R** cytoplasm constricts / pinches in / cleavage furrow forms / cleavage forms *(i.e. referring to animal cell)* **4** AVP **;** detail of cell plate formation e.g. *ref. to* vesicles transported to equator / involvement of cytoskeletal structures *idea that* organelles shared out	**max 3**

Question	Answer	Marks
4(a)(ii)	circle round **S ;** synthesis of <u>two</u> identical DNA, molecules / double helices (from one) **;** each new molecule consists of one, original / parental, strand, and one, new / newly synthesised, strand **;** AW **A** daughter *for newly synthesised*	**3**
4(b)	*role* **1** form cells that can, differentiate / become specialised **;** **A** can develop into other cell types / totipotent **A** named examples **2** for, cell replacement / tissue repair / growth **; R** for cell growth **I** found in growing region **3** divides to give continuous supply of, meristematic / stem, cells **;** **A** divides to forms more, meristematic / stem, cells *feature* **4** (stem cells are) undifferentiated **; A** not specialised / unspecialised **5** able to divide **;** *must be in context of mitosis* **A** able to undergo mitosis **A** can replicate **I** reproduce **R** uncontrolled division **6** *idea that* genes not switched off **;** ora	**max 3**

Question	Answer	Marks
4(c)(i)	growing / storage, area / region / correct named part of plant **;** *examples of part of plant that stores / growing* root / shoot tip / bud / flower / maturing leaf / tuber / fruit / seed **I** where sucrose, used / used up **I** nutrients unqualified receives, assimilates / sucrose / AW **; A** area where sucrose unloaded *in context of, via phloem / from source / from leaf*	**max 1**
4(c)(ii)	*strong* high requirement for assimilates **;** fast growing / highly active **;** AW e.g. requires a lot of energy	**max 1**

Question	Answer	Marks
4(d)	*accept H^+ / protons, throughout for hydrogen ions* **1** active process / uses ATP / requires energy **;** **2** hydrogen ions, pumped / active transport / move(d), out of companion cells **;** *this also gets mp1 if stated as, pumped / active transport / move by proton pump* **3** into cell wall / apoplast **;** **A** intercellular space **R** pumped into phloem sieve tube **4** hydrogen ion gradient builds up **;** **5** hydrogen ions re-enter companion cell, down gradient / AW **;** **A** facilitated diffusion **6** via, cotransport protein(s) / cotransporter(s) **;** **A** carrier protein(s) '*hydrogen ions diffuse back into companion cell through cotransport protein' is two marks* **7** <u>cotransport</u> sucrose (molecules) **;** **A** secondary active transport **A** idea of bringing sucrose into companion cell if cotransport / er stated for previous mp **R** cotransport if into phloem sieve tube from companion cell **8** transport of sucrose against gradient **;** **9** diffusion of sucrose into phloem sieve tube (element) **;** **R** facilitated diffusion **A** moves from high to low concentration **10** via plasmodesmata **;**	**max 4**
		Total: 15

4: Transport and gas exchange – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
5	2017	May/June	21
1	2017	May/June	23
4	2016	May/June	21

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

5 Sugar molecules enter cells through transport proteins.

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

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.....[2]

Some plant cells convert fructose and glucose into sucrose for transport from sources to sinks. Sucrose is moved into phloem sieve tubes as shown in Fig. 5.1.

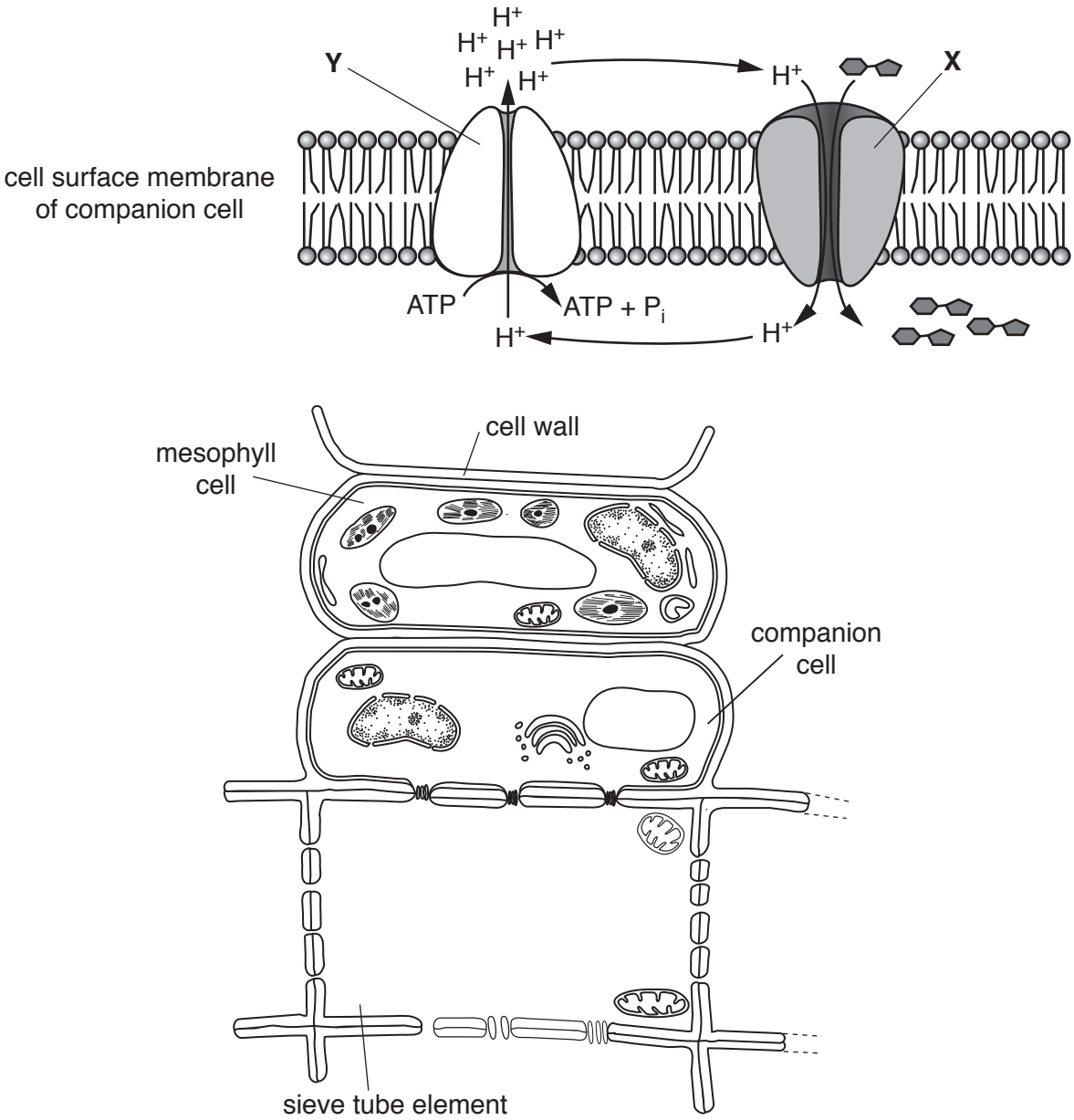

Fig. 5.1 not to scale

(b) Use the information in Fig. 5.1 to explain how sucrose:

- moves into the companion cell
- moves from the companion cell into the sieve tube element.

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.....[5]

(c) Sucrose travels in phloem sieve tubes to sinks.

State two examples of sinks.

1 .....

2 .....[1]

[Total: 8]

1 Mammals have a closed double circulation system.

(a) Explain what is meant by a *closed double circulation*.

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.....[2]

(b) Table 1.1 shows some structures in the mammalian circulatory system.

Complete Table 1.1 to show the sequence of structures through which blood flows, starting with the pulmonary vein.

Use the numbers 2 to 5 to indicate the correct sequence.

Table 1.1

structure	sequence of blood flow
left ventricle	
vena cava	
pulmonary vein	**1**
aorta	
right atrium	

[2]

(c) **(i)** Explain why arteries have thicker walls than veins.

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.....[2]

(ii) Smoking causes carbon monoxide and nicotine to enter the blood.

Describe the short-term effects of each of these substances on the cardiovascular system.

carbon monoxide

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nicotine

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.....[4]

[Total: 10]

4 **(a)** Transpiration is often described as 'an inevitable consequence of gas exchange in leaves'.

Explain what is meant by this description.

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.....[3]

(b) Explain how hydrogen bonding is involved in the movement of water in the xylem.

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.....[3]

Southern beech trees of the genus *Nothofagus* grow in forests in the South Island of New Zealand. Fig. 4.1 shows a small part of a forest.

Most of the trees in the forests form a thick canopy of leaves. These are known as canopy trees. The tallest trees are known as emergent trees. Some trees do not reach the canopy and are known as suppressed trees.

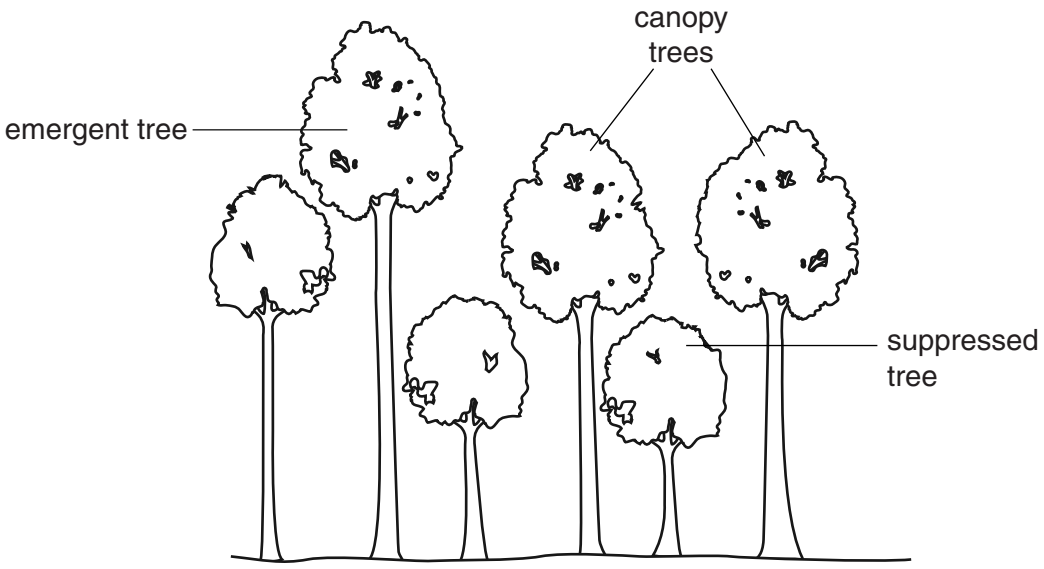

Fig. 4.1

Researchers determined the rates of transpiration of emergent, canopy and suppressed trees in a forest over a 14 hour period from 06.00 until 20.00 on one day in the summer. The results are shown in Fig. 4.2A. They also recorded changes in light intensity above the canopy over the same time period as shown in Fig. 4.2B.

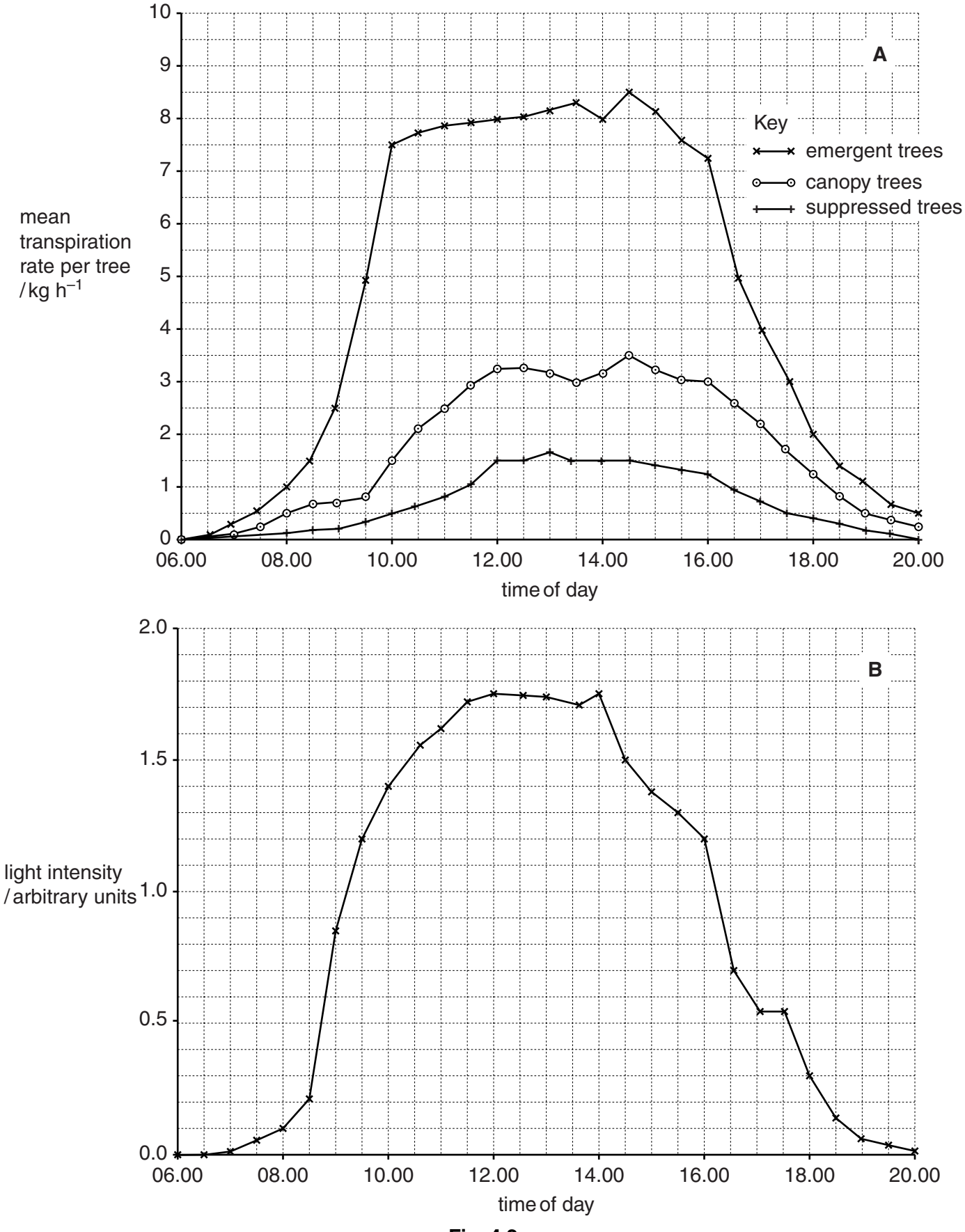

Fig. 4.2

(c) Use Fig. 4.2A to compare the transpiration rates of the emergent, canopy and suppressed trees in the forest over 14 hours.

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.....[4]

(d) The factors that affect transpiration rate vary considerably at different places inside forests.

Use the information in Fig. 4.1 and Fig. 4.2 to suggest reasons for the difference in the transpiration rates of the emergent and suppressed trees.

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.....[4]

[Total: 14]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answers	Marks
5(a)	sugar (molecules) / glucose / fructose, is polar / is water soluble / not lipid soluble / hydrophilic **;** cannot pass through, (phospho)lipid bilayer / hydrophobic core / fatty acid 'tails' / hydrocarbon 'tails' **; A** non-polar regions	**2**
5(b)	*accept H^+ for proton throughout* **1** (*at **Y***) protons, pumped out (of companion cell) / moved out by active transport / move out through proton pump **;** **A** protons are moved out against concentration gradient **2** creates a, proton gradient / electrochemical gradient **;** **3** protons go into the, cell wall / apoplast **; R** mesophyll cell **4** (*at **X***) protons enter cell by facilitated diffusion **;** **5** (**X** is) cotransporter / cotransport protein **;** **6** sucrose transported into (companion) cell together with protons **;** **7** (sucrose enters) against concentration gradient **;** **8** sucrose concentration, increases / maintained, in companion cell **;** **9** sucrose diffuses into sieve tube (element) **;** **10** through plasmodesmata **;** **11** AVP **;** e.g. *ref. to*, secondary / indirect, active transport	**max 5**

Question	Answers	Marks
5(c)	*look for names of plant organs other than leaves, ignore names such as potato, iris, onions* **R** leaves unqualified *any two for max 1* root / root tip stem / stem tip / shoot / shoot tip tubers bulbs corms rhizomes buds flowers fruits seeds young / maturing / developing / infected, leaves AVP	max 1
		Total: 8

Question	Answer	Marks
1(a)	blood contained in (blood) vessels AW **or** blood contained in *any three of* heart, arteries, veins, capillaries **;** systemic and pulmonary, systems / circulation **;** **A** described *if circulations not named* e.g. for each complete circuit (round the body) blood passes through heart twice blood transported from heart to lungs and back, then to (rest of) body and back	**2**
1(b)	 1st and 5th boxes (2 and 5) correct **;** 2nd and 4th boxes (4 and 3) correct **;**	**2**
1(c)(i)	*assume answer refers to arteries unless stated otherwise* withstand / AW, higher pressure (of blood) **;** prevent rupturing / bursting (from high blood pressure) **; I** collapsing *one from* thicker / AW, tunica media **;** more elastic, tissue / fibres, and (smooth) muscle tissue **;** more / AW, elastic, tissue / fibres, to maintain, blood pressure / blood flow **;** more (smooth) muscle to maintain, blood pressure / blood flow **;**	**max 2**
		Total: 6

Question	Answers	Marks
4(a)	*transpiration is an inevitable consequence because* **1** stomata open ; **2** for diffusion in of carbon dioxide / carbon dioxide required for photosynthesis ; **3** water vapour, diffuses out / moves out down the water potential gradient ; **A** description of water potential gradient / high to low water potential **A** vapour pressure gradient / water vapour gradient *allow water vapour if it is clear that evaporation has occurred* **A** water evaporates and diffuses out **R** water evaporates out **I** water (vapour) concentration gradient	3
4(b)	**1** adhesion of water to, cellulose / lining / walls (of xylem vessels) ; **A** adhesive force **2** ref to, hydrophilic / polar, property of cellulose (fibres) ; **A** hydrophilic / polar, parts of lignin **3** cohesion between water molecules ; cohesive force **4** maintains column of water / prevents water column breaking / AW ; **5** *ref.* to transpiration pull / AW ; **I** transpiration *unqualified*	max 3
4(c)	*mp3 – units for rates of transpiration must appear once correctly in the whole answer to award this point* **1** rate (of transpiration) of all trees is 0 at, 06.00 / start ; **A** no transpiration **2** rates (of transpiration) increase and decrease (in all three) ; **A** peaks **3** highest rates: emergent trees at 14.30 at 8.5 kg h^{-1} canopy trees at 14.30 at 3.5 kg h^{-1} suppressed trees at 13.00 at 1.6–1.7 kg h^{-1} ; *must have units at least once* *accept kg / h or kg per hour* **4** emergent trees (always) have highest rate or suppressed trees have lowest rate; **A** emergent trees have higher rate than, canopy and suppressed, trees **5** rate of emergent trees is, much / AW, higher than rates for canopy and suppressed trees ; **6** emergent trees have, steeper / steepest, increase in (transpiration) rate ; **A** emergent trees have, steeper / steepest, decrease in (transpiration) rate	max 4

Question	Answers	Marks
4(d)	*following factors may be given in answers, any three of these factors = 1 mark* light, intensity / wavelength **I** 'more light' humidity temperature wind speed / air movement size of tree / height / area of leaves water availability / depth or length of roots *transpiration rate for emergent trees is higher because … accept **ora** for suppressed trees* *accept vapour pressure gradient / water vapour pressure gradient / water vapour diffusion gradient for water potential gradient* **1** high(er) light intensity for emergent trees increase in stomatal aperture ; ora **A** more sunlight **A** stomata open more **I** more stomata open **2** lower humidity for emergent trees so steeper water potential gradient ; ora **A** description of water potential gradient **3** higher temperature / AW, for emergent trees so higher rate of, evaporation / diffusion ; ora **4** higher wind speed for emergent trees so, steeper water potential gradient / lower humidity ; ora **A** *ref.* to diffusion shells / descriptions of water potential gradient **5** emergent trees have longer roots so take up more water ; **6** emergent trees have more leaves so, greater surface area / more stomata per unit area (of leaf)	max 4
		Total: 14

5: Disease and protection against disease – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2017	May/June	21
6	2017	May/June	21
3	2017	May/June	23

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

3 Fig. 3.1 is a diagram that shows the structure of an antibody molecule.

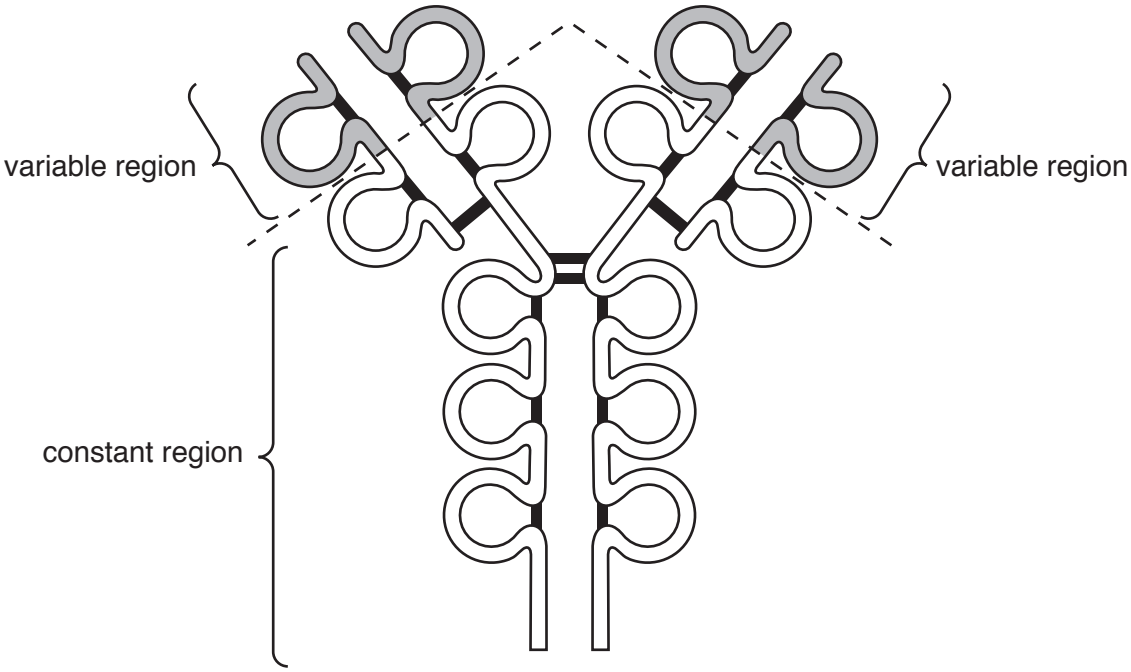

Fig. 3.1

(a) State why the antibody molecule shown in Fig. 3.1 has quaternary structure.

.....

.....[1]

(b) **(i)** Use Fig. 3.1 to explain how the structure of the variable region of an antibody molecule is related to its function.

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.....[3]

(ii) State the role of the constant region of an antibody.

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.....[1]

(c) Monoclonal antibodies are used both in diagnosis and in treatment of disease.

(i) Outline how monoclonal antibodies are produced.

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.....[4]

(ii) Suggest the advantages of using monoclonal antibodies in diagnosis of disease.

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.....[2]

[Total: 11]

6 Cholera bacteria release the toxin, choleragen, when they are in the intestine.

(a) (i) Name the bacterium that is the pathogen of cholera.

.....[1]

(ii) Describe the way in which cholera is transmitted from an infected person to an uninfected person.

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.....[2]

Gangliosides are glycolipids that bind choleragen. These glycolipids are found on many cell surface membranes.

When choleragen is released from the bacteria in the intestine, it binds to gangliosides on epithelial cells and enters these cells as shown in Fig. 6.1.

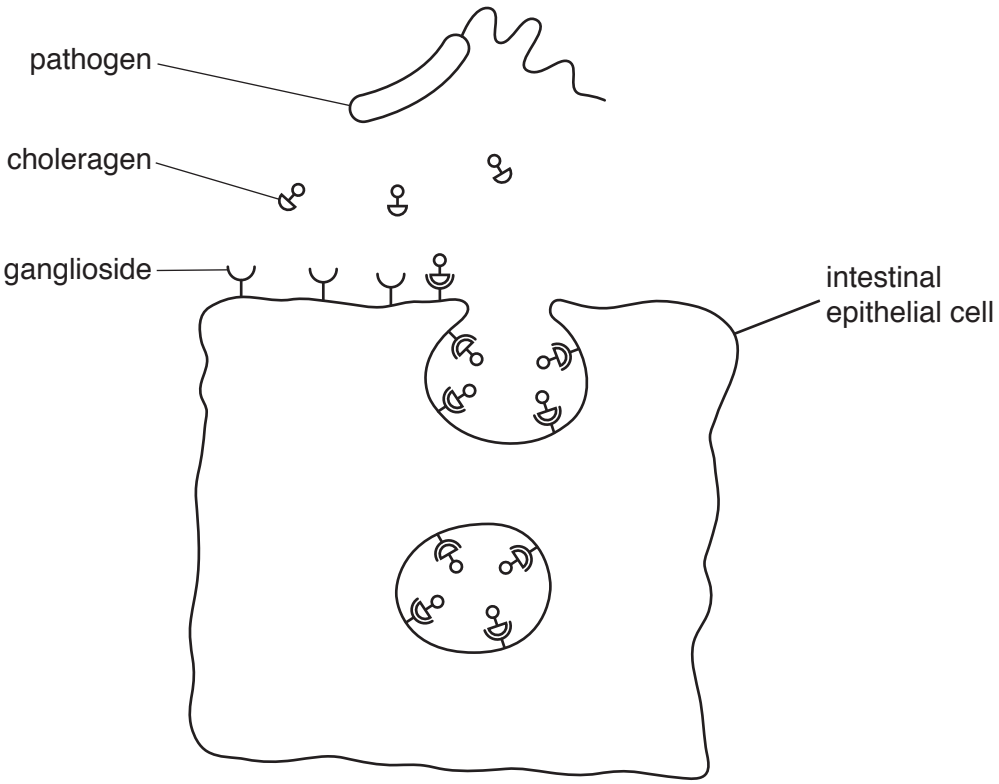

Fig. 6.1 not drawn to scale

(b) Suggest how choleragen interacts with gangliosides on intestinal epithelial cells.

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.....[2]

(c) Name the process by which choleragen enters the intestinal epithelial cell as shown in Fig. 6.1.

.....[1]

Once inside the cells choleragen is activated. One effect is to increase the movement of chloride ions through channel proteins out of cells.

(d) Suggest **and** explain the likely consequences on the intestinal epithelial cells of the loss of chloride ions through the channel proteins.

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.....[2]

(e) Health authorities recommend that antibiotics, such as tetracycline, are **only** to be used for treating people with severe cases of cholera.

Explain why it is recommended that antibiotics should **not** be given to people with mild cases of cholera or to protect people from cholera.

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.....[3]

[Total: 11]

3 **(a)** Name the causative organism of tuberculosis (TB).

.....[1]

(b) Fig. 3.1 shows the number of deaths from TB and the number of new cases of TB from 1925 to 2010 in Canada.

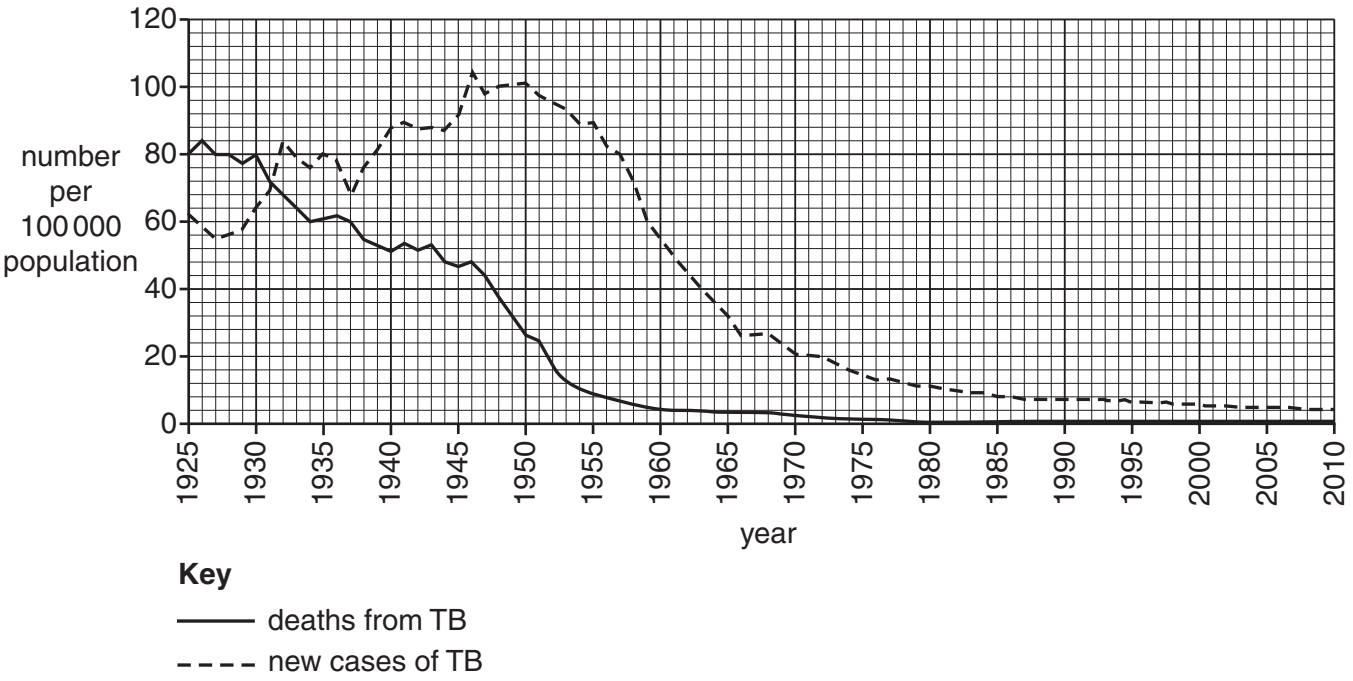

Fig. 3.1

The vaccine for TB was introduced in Canada for widespread use from 1948.

Antibiotics, such as streptomycin, were introduced in Canada from 1940.

Use the information in Fig. 3.1 to comment on the effect of the introduction of the vaccine and antibiotics on the number of new cases and deaths from TB.

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.....[5]

(c) In 2010, Swaziland had one of the highest death rates from TB in the world.

Swaziland also had a high number of new cases of HIV infection in its population in 2010.

People who are infected with HIV are described as HIV+ and people who are **not** infected with HIV are described as HIV–.

Table 3.1 shows the number of deaths from TB in Swaziland in 2010.

Table 3.1

HIV status	number of deaths from TB per 100 000 population
HIV+	400
HIV–	91

Using the information in Table 3.1, suggest why the number of deaths per 100 000 population of people who are HIV+ is much higher than that in people who are HIV–.

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.....[3]

[Total: 9]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answers	Marks
3(a)	(antibody has) more than <u>one polypeptide</u> **;** **A** <u>four polypeptides</u> **R** two / two or more / two types of / many / AW, polypeptides	**1**
3(b)(i)	*allow epitope for antigen* **1** (two) antigen-binding, site(s) / region(s) **;** **A** binds to / AW, antigens **R** active site **2** (shape / structure is) <u>complementary</u> to antigen **;** ***3*** *idea of* specificity / AW **;** **4** *ref. to*, primary structure / sequence of amino acids **;** **5** *ref. to* R-groups / (amino acid) side chains, and interactions with antigen / giving specific shape **;**	**max 3**
3(b)(ii)	binds to (receptors on), phagocytes / macrophages / neutrophils **;** **A** other correct named cell of the immune system AVP **;** e.g. gives class of antibody (e.g. IgM, IgG, IgA, IgE)	**max 1**

Question	Answers	Marks
3(c)(i)	**1** antigen, introduced / AW, into, (small) mammal **; A** named small mammal **2** B-lymphocytes / B cells / plasma cells / splenocytes / antibody-producing lymphocytes, are taken / are isolated (from the spleen / lymph nodes) **;** **3** (these) cells are fused / AW, with, myeloma / cancer, cells **;** **4** hybridoma cells / hybridomas, formed **; R** hybridised cells / hybrid cells **5** hybridoma cell, is cloned / AW **;** **6** screening / testing, for hybridoma that produces desired antibody **;** **7** *ref. to* scaling up / large-scale production / grow in a fermenter **;** **8** AVP **;** e.g. fusion using, fusogen / polyethylene glycol / PEG / electric current (electrofusion) / (Sendai) virus HAT medium, for, hybridoma growth / inhibiting myeloma growth humanisation of monoclonal antibody	**max 4**
3(c)(ii)	**I** *suggestions for treatment* **1** monoclonal antibodies used all have the same specificity **;** **R** 'are specific' unqualified **2** detect only one, antigen / epitope **;** **3** can distinguish between different, pathogens / strains of, pathogens **; A** types of cancer cells **4** can be, labelled / tagged / marked / AW **;** e.g. with fluorescent label **5** monoclonal antibodies can detect location of, tissues expressing antigen / cancer cells / blood clots **; A** *idea of* locating areas of infection **6** fast(er) (diagnosis) **;** **7** can detect antibody levels (e.g. HIV) **;** **8** AVP **;** e.g. some pathogens cannot be cultured **I** *ref. to* cost	**max 2**
		Total: 11

Question	Answers	Marks
6(a)(i)	*Vibrio cholerae* ;	1
6(a)(ii)	faecal-oral route ;; *description of faecal / oral route* *infected person* faeces / sewage / stool, contaminating (drinking) water **R** (human) waste unqualified **or** poor hygiene so transferring, faecal material / sewage, onto utensils / food / AW **or** defaecating / putting sewage, onto vegetable plots ; **or** flies in contact with contaminated faeces landing on food and contaminating / AW *uninfected person* eating contaminated food / using contaminated utensils **or** drinking contaminated water ;	max 2
6(b)	1 ganglioside is the receptor for choleragen ; 2 choleragen is complementary to ganglioside ; 3 any interaction between molecules ; e.g. (hydrogen / ionic) bonding	max 2
6(c)	endocytosis ; **A** phagocytosis / pinocytosis	1
6(d)	1 loss of water / dehydration ; 2 by osmosis ; 3 (water moves out) down water potential gradient / from high to low water potential / high Ψ to low Ψ ; 4 Loss of cations / positively-charged ions (as well as chloride ions) ; 5 change in potential (difference) / change in charge across membrane ; 6 AVP ; e.g. disruption of absorption (of products of digestion / vitamins / mineral ions) disruption of digestion	max 2

Question	Answers	Marks
6(e)	1 rehydration therapy, is effective / can treat cholera / reduces death rate **;** 2 any detail **;** e.g. solution of glucose and salts 3 antibiotic is a selection pressure / described **;** 4 *ref. to*, antibiotic / tetracycline, resistance **;** 5 *ref. to*, vertical transmission / horizontal transmission, of resistance **;** **A** described, **A** transfer for transmission 6 antibiotics will become, ineffective / less effective / AW **;** 7 keep antibiotics for use 'as last resort' **;** AW 8 *ref. to* cost **;** 9 antibiotics kill gut bacteria **;** 10 *idea that* disrupts functions of digestive system **;** 11 AVP **;** e.g. antibiotics going into the environment / food chain antibiotics can cause mutation decreases need to develop new drugs prevents development of active immunity *idea of* transmission between bacterial species plasmids with resistance genes	**max 3**
		Total: 11

Question	Answer	Marks
3(a)	*Mycobacterium tuberculosis* **/** *Mycobacterium bovis* **;** *correct spelling*	**1**
3(b)	**1** deaths decrease to zero **/** new cases fall to 4 per 100 000, (in 2010) **;** **A** other values that confirm decrease *(after introduction of antibiotics*) **2** deaths relatively constant / approx. 52 per 100 000, until 1943–6 (*accept any in range*) **; A** for a few years **A** *idea that* rate of decrease not improved **3** number of new cases initially stops increasing / plateaus **;** **4** (overall) number of new cases increases before decreases **;** **5** data to support mp 3 or 4 **;** e.g. 88–90 per 100 000 (1940–44) rises to / drops from, 104 per 100 000 in 1946 **;** *(after introduction of vaccination)* **6** no change in trend of decrease in deaths / deaths continue to decrease **;** **7** decrease from 36–40 per 100 000 (in 1948) **;** **8** short plateau / 100 per 100 000 (until 1950), in new cases, then decreases **;** **9** antibiotics may not have been in widespread use at first **; ora** **10** vaccine, reduces spread / gives (herd) immunity **;** **11** *ref. to* decrease less steep initially as time needed to build up herd immunity **;** **12** AVP **;** e.g. suggestion why increase in new cases after introduction of antibiotics suggestion why cases have not decreased to zero not possible to tell relative effect of vaccine v antibiotic	**max 5**

Question	Answer	Marks
3(c)(i)	some people who are HIV+ will have developed HIV / AIDS **;** HIV / AIDS weakens immune, system / response **; ora** *allow **ecf** for HIV+ people* detail of why immune response weakened **;** people with HIV / AIDS, prone to opportunistic diseases **;** **A** TB is an opportunistic disease **A** more susceptible to, diseases / TB (Table 3.1 shows that) a greater proportion / AW, people die of TB if they are HIV+ **;** AW e.g. greater chance of dying from TB if HIV+ dormant TB more likely to become the active form in, HIV+ people / people with HIV / AIDS **;** AW AVP **;** a high proportion of deaths from HIV / AIDs is due to TB mortality HIV+ people do not respond well to treatment for life-threatening diseases inability to pay for treatment for all conditions for HIV+ people	**max 3**
		Total: 9

6: The diversity of life – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
8	2017	May/June	41
8	2017	May/June	42
5	2016	May/June	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

8 There is considerable variation in the ecosystems that occur in the continent of North America. These include coniferous forest, prairie grassland, scrub and desert. Large areas of land that once contained natural ecosystems are now used for agriculture.

(a) Explain how the variation in ecosystems in North America contributes to biodiversity.

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..... [4]

(b) The diversity of some beetle species that feed on animal dung (faeces) was investigated at two types of grassland site in North America. The first type of grassland site was grazed by cattle and the second type of site was not grazed.

Dung beetles were collected, identified and counted from two areas of the same total size. Some of the results are shown in Table 8.1.

Table 8.1

beetle species	number of dung beetles on grassland grazed by cattle	number of dung beetles on grassland not grazed
Onthophagus pennsylvanicus	4267	6641
Canthon ebenus	2005	774
Canthon pilularius	353	108
Onthophagus hecate	218	85
total	6843	7608

(i) State the null hypothesis for a statistical test comparing the data from the two types of site.

.....

..... [1]

(ii) State how many genera and how many species of beetle are shown in Table 8.1.

genera ..... species .....
[1]

(iii) Simpson's Index of Diversity for the beetles on the grassland grazed by cattle was calculated as 0.521 using the formula:

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each species present in the sample
N = the total number of all individuals of all species

Calculate Simpson's Index of Diversity for the beetles on the grassland that was not grazed. Complete Table 8.2 to show your working. Show all working to **three** decimal places. Write your final answer on the dotted line.

Table 8.2

species	**number on grassland not grazed**	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
Onthophagus pennsylvanicus	6641		
Canthon ebenus	774		
Canthon pilularius	108		
Onthophagus hecate	85		
total	7608		

Simpson's Index of Diversity = ... [3]

(iv) Describe what the results in Table 8.1 **and** both figures for Simpson's Index of Diversity show about the effect of grazing on the diversity of dung beetles.

.....

.....

.....

.....

..... [2]

[Total: 11]

8 An investigation was carried out in a temperate woodland that contained a number of areas with two different types of ground cover vegetation.

- On higher ground where the soil was drier, the dominant ground cover plant was bracken, *Pteridium aquilinum*.
- On lower ground where the soil was wetter, the dominant ground cover plant was bramble, *Rubus fruticosus*.

(a) Describe how the abundance of the two plant species at higher and lower ground sites could be measured.

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..... [4]

[Turn over

(b) Soil from under bracken and under brambles was collected and placed in two funnels. A bright light was placed over each funnel so that small invertebrate animals moved down the funnels and were collected in two collecting vessels.

The main groups of invertebrates present were identified and counted. Some of the results are shown in Table 8.1.

Table 8.1

invertebrate group	number present in soil under bracken	number present in soil under brambles
pseudoscorpion	49	21
wireworm	22	12
gamasid mite	18	7
springtail	10	1
total	99	41

(i) It was not possible to identify the invertebrates as far as genus or species level, and only the wireworm group could be classified as far as the taxonomic level **above** genus.

Name the taxonomic level represented by the wireworm group.

..... [1]

(ii) State the null hypothesis for a statistical test comparing the data from the two types of site.

.....

.....

..... [1]

(iii) Simpson's Index of Diversity for invertebrates from the soil under bracken was calculated as 0.663 using the formula:

$$D = 1 - \left(\sum\left(\frac{n}{N}\right)^2\right)$$

n = number of individuals of each species present in the sample
N = the total number of all individuals of all species.

Calculate Simpson's Index of Diversity for the invertebrates from the soil under brambles. Complete Table 8.2 and use the space provided to show your working. Show all working to **three** decimal places. Write your final answer on the dotted line.

Table 8.2

animal taxon	**number present in soil under brambles**	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
pseudoscorpion	21		
wireworm	12		
gamasid mite	7		
springtail	1		
total	41		

Simpson's Index of Diversity = ... [3]

(iv) Describe what Table 8.1 and the calculated figures for Simpson's Index of Diversity show about the effect of bracken and bramble vegetation cover on the diversity and abundance of soil invertebrates in the woodland.

.....

.....

.....

.....

[Turn over

..... [2]

[Total: 11]

5 Fig. 5.1 shows a water vole, *Arvicola amphibius*. This species is native to Great Britain.

Fig. 5.1

The numbers of water voles are estimated to have fallen by 94% in the last century.

This is thought to be due to habitat fragmentation and also to extensive predation by mink, *Neovison vison*, shown in Fig. 5.2. Mink originated in North America but were brought to Great Britain for fur farming. Some escaped or were released into the wild, where their numbers rapidly increased.

Fig. 5.2

(a) Name **and** describe a method for estimating the abundance of water voles in a local area.

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..... [4]

(b) Both water voles and mink are classified as class Mammalia, phylum Chordata, kingdom Animalia.

Outline two features of the **cells** of members of the kingdom Animalia that distinguish them from the cells of other multicellular eukaryotes.

1 .....

.....

2 .....

..... [2]

(c) **(i)** Discuss the reasons why alien species should be controlled.

.....

.....

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.....

.....

.....

..... [3]

(ii) Suggest **one** way of controlling mink numbers in Great Britain.

.....

.....

..... [1]

[Total: 10]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
A	accept (for answers correctly cued by the question, or by extra guidance)
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Paper 41

Question	Answer	Marks
8(a)	*max 4 of:* 1 different habitats **;** 2 different niches **;** 3 many (different) species / large variety of species **;** 4 *ref. to* (much) genetic diversity within a species **;** 5 different selection pressures **;** 6 *ref. to* adaptation **;** 7 different, climate / rainfall / temperature / soil / topography / conditions **;**	**4**
8(b)(i)	both sites are the same / no (significant) difference between two sites **;**	**1**
8(b)(ii)	*genera* 2 **and** *species* 4 **;**	**1**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(b)(iii)</td><td>all figures to 3 d.p. to score but only penalise extra d.p. or rounding error associated with extra d.p. once
<table>
<tr><th>species</th><th>number on grassland not grazed</th><th>n / N</th><th>(n / N)^2</th></tr>
<tr><td>Onthophagus pennsylvanicus</td><td>6641</td><td>0.873</td><td>0.762</td></tr>
<tr><td>Canthon ebenus</td><td>774</td><td>0.102</td><td>0.010</td></tr>
<tr><td>Canthon pilularius</td><td>108</td><td>0.014</td><td>0.000</td></tr>
<tr><td>Onthophagus hecate</td><td>85</td><td>0.011</td><td>0.000</td></tr>
<tr><td>total</td><td>7608</td><td></td><td>0.772</td></tr>
</table>
n / N figures correct / numbers of each species divided by total ;
(n / N)^2 calculated and added up ; ecf from incorrect column 1 including figures with fewer / more than 3 d.p.
0.228 ; ecf total figure subtracted from 1</td><td>3</td></tr>
<tr><td>8(b)(iv)</td><td>greater species evenness on grazed grassland ; ora A mostly, one species / O. pennsylvanicus, on not grazed
grazing increases (dung beetle species) (bio)diversity ; ora
if opposite conclusion reached check answer for (iii) and apply ecf for mp2 if D > 0.521</td><td>2</td></tr>
<tr><td></td><td></td><td>Total: 11</td></tr>
</table>

Paper 42

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)</td><td>1. <u>random sampling</u> ;
2. (using) random number generator for coordinates ;
3. in both sites ;
4. measure, percentage cover / (Braun-Blanquet / ACFOR) scale cover ;
5. using (square frame) quadrats ;
6. repeat sampling ;</td><td>max 4</td></tr>
<tr><td>8(b)(i)</td><td>family / sub-family ;</td><td>1</td></tr>
<tr><td>8(b)(ii)</td><td>that there is no significant difference (between the two sites) ;</td><td>1</td></tr>
<tr><td>8(b)(iii)</td><td><table>
<tr><th>animal taxon</th><th>number present in soil under brambles</th><th>$\frac{n}{N}$</th><th>$(n/N)^2$</th></tr>
<tr><td>pseudoscorpion</td><td>21</td><td>0.512</td><td>0.262</td></tr>
<tr><td>wireworm</td><td>12</td><td>0.293</td><td>0.086</td></tr>
<tr><td>gamasid mite</td><td>7</td><td>0.171</td><td>0.029</td></tr>
<tr><td>springtail</td><td>1</td><td>0.024</td><td>0.001</td></tr>
<tr><td>total</td><td>41</td><td></td><td>0.378</td></tr>
</table>
n / N figures correct or numbers of each species divided by total ;
$(n / N)^2$ calculated and added up ;
total figure subtracted from 1 / 1 – 0.378 = 0.622 ; ecf</td><td>3</td></tr>
</table>

Question	Answer	Marks
8(b)(iv)	*apply **ecf** from (iii) if D is very different to 0.663 / 0.622* 1. bracken and bramble / both sites, have similar Simpson's Index of Diversity (D) numbers **;** **or** bracken and bramble / type of vegetation, has little effect on soil organism diversity **;** 2. soil organisms more abundant under bracken **;** ora	**2**
		Total: 11

Question	Answer	Marks
5(a)	1 mark-release-recapture / AW ; **A** catch, mark, return, catch **A** mark-and-recapture *description (max 3)* 2 detail of trapping ; e.g. Longworth / Sherman / live / small mammal 3 detail of marking ; e.g. felt tip pen / clipping fur / not to have adverse effects 4 detail of timing of second trapping ; e.g. not too soon or mixing will not occur / not too long after as migration may occur / after 24 hours / 1 day (any number of days up to two weeks) 5 detail of calculation ; e.g. Lincoln Index / Petersen index **or** number marked time 1 × no. captured time 2 number of marked individuals recaptured time 2 **A** symbols in equation if key is given	[max 4]
5 (b)	glycogen ; centrioles / centrosomes ; (may have) cilia / flagella / microvilli ; no cell wall ; no, large / central / permanent, vacuole ; **A** no tonoplast	[max 2]

Question	Answer	Marks
5(c)(i)	1 reduce, other organisms' abundance / biodiversity ; **A** endanger, rare species / water voles **A** causes extinction 2 alter food, chains / webs ; 3 due to predation ; 4 due to competition ; 5 due to spreading disease ; 6 may change habitat ; e.g. create shade, change soil pH 7 may be toxic / threaten human health ;	[max 3]
5(c)(ii)	culling / hunting / trapping ; contraceptive measures ; biological control disease agent ; **I** introduce new mink-eating predator **I** biological control alone	[max 1]
		Total: 10

7: Genetics, population genetics and evolutionary processes – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
7	2017	May/June	41
7	2017	May/June	42
3	2015	May/June	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

7 **(a)** The stems of raspberry plants have spines.

Fig. 7.1 shows part of a raspberry plant.

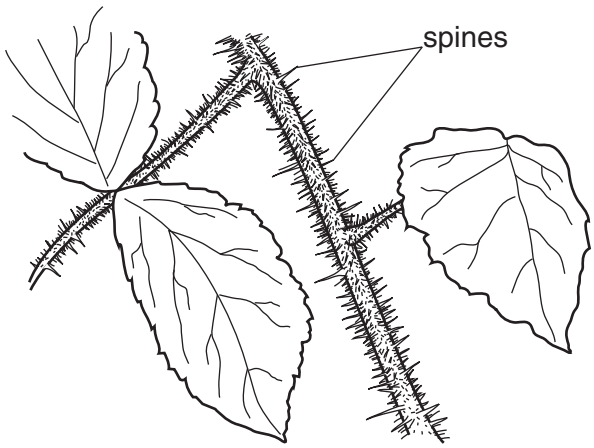

Fig. 7.1

The colour of the spines is controlled by two genes, **A**/**a** and **B**/**b**. The two genes are on different pairs of chromosomes.

- Allele **A** produces a pink anthocyanin pigment in the spines.
- Allele **B** has no effect by itself, but increases the colour produced by allele **A** to give red spines.
- Alleles **a** and **b** have no effect on colour.
- In the absence of anthocyanin, the spines are green.

State the colour of the spines of raspberry plants with the genotypes **Aabb** and **aaBB**.

Aabb .....

aaBB ..... [2]

(b) Plants with the genotype **AaBb** were crossed with plants with the genotype **aabb**. The resulting seeds were sown and the seedlings grown until their stems developed spines.

Use a genetic diagram to show the outcome of this cross, including the ratio of offspring phenotypes.

[5]

(c) Suggest why the ratio you have given in your genetic diagram would be different if the genes **A**/**a** and **B**/**b** were on the same homologous pair of chromosomes.

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.....

..... [2]

[Total: 9]

7 **(a)** Cats with either black fur or white fur are common in Europe, whereas cats with brown fur are less common.

A gene, coding for an enzyme involved in pigment production, has two alleles.

- The dominant allele, **B**, results in black fur.
- The recessive allele, **b**, results in brown fur.

A second gene can affect fur colour.

- The dominant allele, **A**, prevents pigment production, resulting in a cat with white fur.
- The recessive allele, **a**, has no effect on fur colour.

The two genes are on different pairs of autosomes.

Use a genetic diagram to show how a cross between two cats, heterozygous at both loci, can produce offspring with three different colours: white, black and brown.

State the expected ratio of the different coloured offspring.

[6]

(b) Suggest how the presence of allele **A** prevents pigment production.

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.....

.....

..... [3]

[Total: 9]

3 The monkey flower, *Mimulus guttatus*, is cross-pollinated by bumblebees. It does not normally self-pollinate.

Since the number of bumblebees in many parts of the world is falling, an experiment was carried out in Kansas to investigate the effects on these plants of the loss of pollinators.

- 1600 *Mimulus* plants were grown in a field.
- 1600 *Mimulus* plants were grown in a glasshouse which bumblebees could not enter.

Seeds were repeatedly collected and sown for several generations at each site.

At first, the plants in the glasshouse produced few seeds, but after five generations the plants were able to self-pollinate and the number of seeds produced was almost the same as that of the plants in the field.

After five generations, the flowers of the plants in the glasshouse were significantly smaller than those of the plants in the field.

(a) Explain why offspring produced by cross-pollination and self-pollination differ in their genetic variation.

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..... [3]

(b) Suggest how smaller flowers could lead to an increase in self-pollination.

.....

..... [1]

(c) Explain how natural selection produced the smaller flower size of the plants grown for five generations in the glasshouse.

.....

.....

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.....

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.....

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.....

.....

.....

.....

..... [5]

[Total: 9]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
R	reject
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ecf	error carried forward
I	ignore
AVP	alternative valid point

Paper 41

Question	Answer	Marks
7(a)	**Aabb** – pink **;** **aaBB** – green **;**	**2**

Question	Answer	Marks
7(b)	1 parents phenotypes **red** **green ;** 2 gametes **AB** **Ab** **aB** **ab** × **ab ;** 3 offspring genotypes **AaBb** **Aabb** **aaBb** **aabb ;** 4 offspring phenotypes *(must be linked)* red spines pink spines green spines green spines **;** 5 ratio 1 : 1 : 2 **ecf** mp 3 derived from incorrect 2 mp 4 matching incorrect 3 mp 5 matching incorrect 4	**5**
7(c)	*max 2 of:* 1 genes would be, linked / inherited together **;** 2 no independent assortment **;** 3 ratio 1:1 / only two classes (of phenotypes) **; A** red and green **or** pink and green 4 rare cross-over events / recombination (gives small numbers of third phenotype) **;**	**2**
		Total: 9

Paper 42

Question	Answer		Marks
7(a)	*parental genotypes* **AaBb** x **AaBb ;** *gametes* **AB Ab aB ab x AB Ab aB ab ;** *offspring* *m* *max 2 for all offspring correct* *max 1 if one error* *max 0 if more than one error* offspring phenotype correctly linked to genotype **;** *ratio* 12 white : 3 black : 1 brown **;**	**;;**	**6**

	AB	**Ab**	**aB**	**ab**
AB	**AABB** white	**AABb** white	**AaBB** white	**AaBb** white
Ab	**AABb** white	**AAbb** white	**AaBb** white	**Aabb** white
aB	**AaBB** white	**AaBb** white	**aaBB** black	**aaBb** black
ab	**AaBb** white	**Aabb** white	**aaBb** black	**aabb** brown

Question	Answer	Marks
7(b)	1. example of, gene interaction / epistasis **;** 2. *ref. to* blocking (one step in) pathway to pigment production **;** 3. (allele **A**) product / protein, inhibits enzyme (producing pigment) **;** 4. (allele **A**) product / protein, is a repressor **;** **A** allele codes for a repressor 5. (which) blocks transcription / RNA polymerase cannot bind / switches off allele (coding for pigment) **;** 6. (by), binding to / blocking, operator / promoter **;** 7. (allele **A**) product / protein, prevents transcription factor complex formation / AW **;**	**max 3**
		Total: 9

Question	Answer	Marks
3(a)	*self-pollination* ***ora*** *for cross-pollination* 1 gametes / alleles / genes / DNA, come(s) from one parent ; 2 gives, less genetic variation / more genetic uniformity ; 3 results in inbreeding ; 4 increases homozygosity / decreases heterozygosity ;	[max 3]

Question	Answer	Marks
3(b)	anthers and stigma / stamens and carpels, closer together ;	1
3(c)	1 range of flower size in original population ; 2 genetic variation (affecting flower size) in original population ; **I** mutation 3 change in environment / selection pressure, is absence of, bees / insect pollination (in greenhouse) ; 4 plants with small, flowers / petals, are, selected for / reproduce / at a selective advantage ; **ora** 5 alleles for small size passed to offspring ; **ora I** gene 6 frequency of, advantageous / smallness, allele increases ; **ora** 7 directional selection ; 8 temperature / irrigation / space / competition, different in field and glasshouse ; 9 small size explanation linked to factor in mp8 ;	[max 5]
		Total: 9

8: Molecular biology and gene technology – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
3	2017	May/June	41
4	2017	May/June	42
5	2017	May/June	42

The mark scheme for each question is provided at the end of the document.

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3 Oil seed rape (canola), *Brassica napus*, has been genetically modified to be resistant to herbicides containing glufosinate ammonium. The genetically modified (GM) oil seed rape contains the *bar* gene, obtained from a soil bacterium. This gene codes for an enzyme that converts glufosinate ammonium into a non-toxic compound.

(a) Outline the advantages to farmers of growing glufosinate-resistant oil seed rape.

.....

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..... [2]

(b) The *bar* gene was introduced into the oil seed rape using plasmids. The plasmids also contained a promoter taken from thale cress, *Arabidopsis thaliana*.

(i) Outline the structure of a plasmid.

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.....

.....

.....

..... [2]

(ii) Explain how the properties of plasmids make them suitable for use during genetic modification programmes.

.....

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..... [3]

(iii) Describe the role of a promoter in gene expression.

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..... [2]

(c) The pollen of oil seed rape is transferred from one flower to another by insects. After pollination, fertilisation and seed formation can occur. One of the potential problems of growing glufosinate–resistant oil seed rape is that pollen from these plants could be transferred to the flowers of wild relatives, such as wild radish, *Raphanus raphanistrum*. This could result in genetic changes in these wild species.

An experiment was carried out to investigate whether glufosinate–resistant hybrids between GM oil seed rape and wild radish plants are likely to compete successfully with non-hybrid or non-resistant plants in the natural environment.

- Type 1 hybrids were produced by transferring pollen from wild radish (diploid number 18) to glufosinate–resistant oil seed rape (diploid number 38).
- Type 2 hybrids were produced by transferring pollen from glufosinate–resistant oil seed rape to wild radish.

- Each hybrid was then crossed with wild radish over several generations.
- The resulting offspring were then grown in field trials, together with normal wild radish.
- The height of the plants and number of seeds each produced were measured. Then the plants were tested for the *bar* gene.

Table 3.1 shows the results.

Table 3.1

type of plant	number of seeds per plant	mean height /cm	presence of *bar* gene
offspring from type 1 hybrid and wild radish	265	22.3	absent
	99	28.3	present
offspring from type 2 hybrid and wild radish	3958	88.7	absent
	2047	95.0	present
wild radishes	3515	76.5	absent

(i) Predict the diploid number of chromosomes in a hybrid between oil seed rape and wild radish.

..... [1]

(ii) Suggest how the researchers could have determined whether or not the *bar* gene was present in the plants.

.....

.....

..... [1]

(iii) Many varieties of GM oil seed rape are male sterile, meaning that they do not produce pollen.

With reference to Table 3.1, suggest the advantages to the environment of growing male sterile varieties of GM oil seed rape, rather than GM varieties that produce pollen.

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..... [3]

[Total: 14]

4 Weeds reduce crop yields by competing with crop plants for space, light, water and minerals. The modes of action of three different types of herbicide are summarised in Table 4.1.

Table 4.1

type of herbicide	mode of action	year of first widespread use
photosystem II inhibitor	prevents photophosphorylation	1960
ALS inhibitor	prevents synthesis of the amino acids isoleucine, leucine and valine	1980
glyphosate	prevents synthesis of the amino acids phenylalanine, tryptophan and tyrosine	1990

Fig. 4.1 shows the cumulative number of species of weeds that have become resistant to these three types of herbicide since 1960.

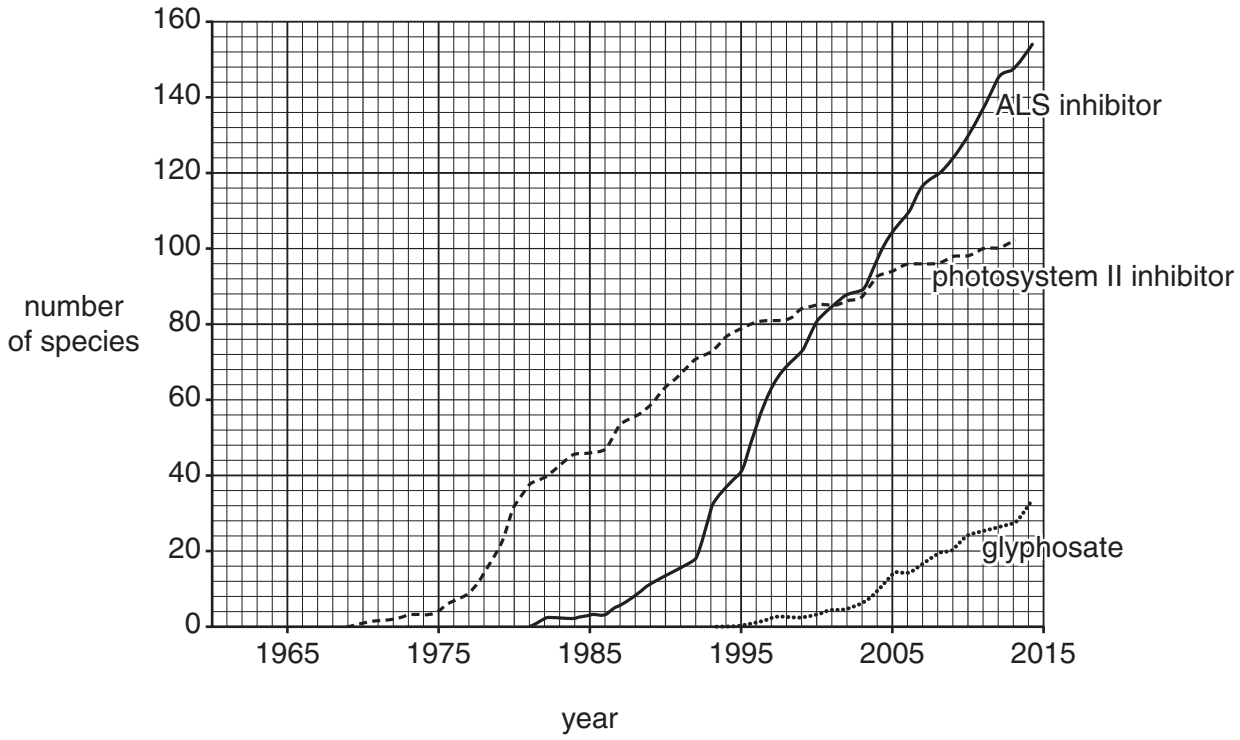

Fig. 4.1

(a) **(i)** Describe how the number of weed species resistant to herbicides has changed since 1960.

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..... [3]

(ii) Explain how a weed species becomes resistant to a herbicide.

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..... [4]

(b) ALS inhibitor herbicides work by binding to an enzyme present in chloroplasts called acetolactate synthetase (ALS). ALS is a globular protein consisting of four identical polypeptides each composed of 668 amino acids.

The primary structure of the ALS polypeptide of each weed species resistant to ALS inhibitor herbicides has been sequenced. Amino acid substitutions at positions as far apart as position 122 and position 574 can result in resistance.

(i) The gene that codes for the ALS polypeptide does not contain any non-coding sections (introns). The first amino acid in the final polypeptide is methionine.

State the number of base pairs in the gene that codes for an ALS polypeptide.

..... [1]

(ii) Explain why resistance to ALS inhibitor herbicide can result from substitutions of amino acids that are **far apart** in the primary sequence.

.....

.....

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..... [2]

(c) Genetic modification is one method used to develop herbicide resistance in crop plants. Other methods include:

method 1: crossing a crop plant with a herbicide-resistant wild plant belonging to the same genus and then applying the herbicide

method 2: causing mutations in the crop plants and then applying the herbicide.

State **two** benefits of using method 1 **and two** benefits of using method 2 to develop herbicide resistance in crop plants.

method 1 .....

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method 2 .....

.....

.....

.....

.....

..... [4]

[Total: 14]

5 Cancer is a disease in which normal controls over cell division are lost and malignant tumours form. An early diagnosis of many types of cancer can result in successful treatment.

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

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

Fig. 5.1 is a pedigree (family tree) showing the occurrence of cancers in four generations of a family. The presence of a faulty *BRCA2* allele was confirmed in person 15. The other individuals with cancer were not tested for the presence of the allele. Individuals 24–30 are all under twelve years old.

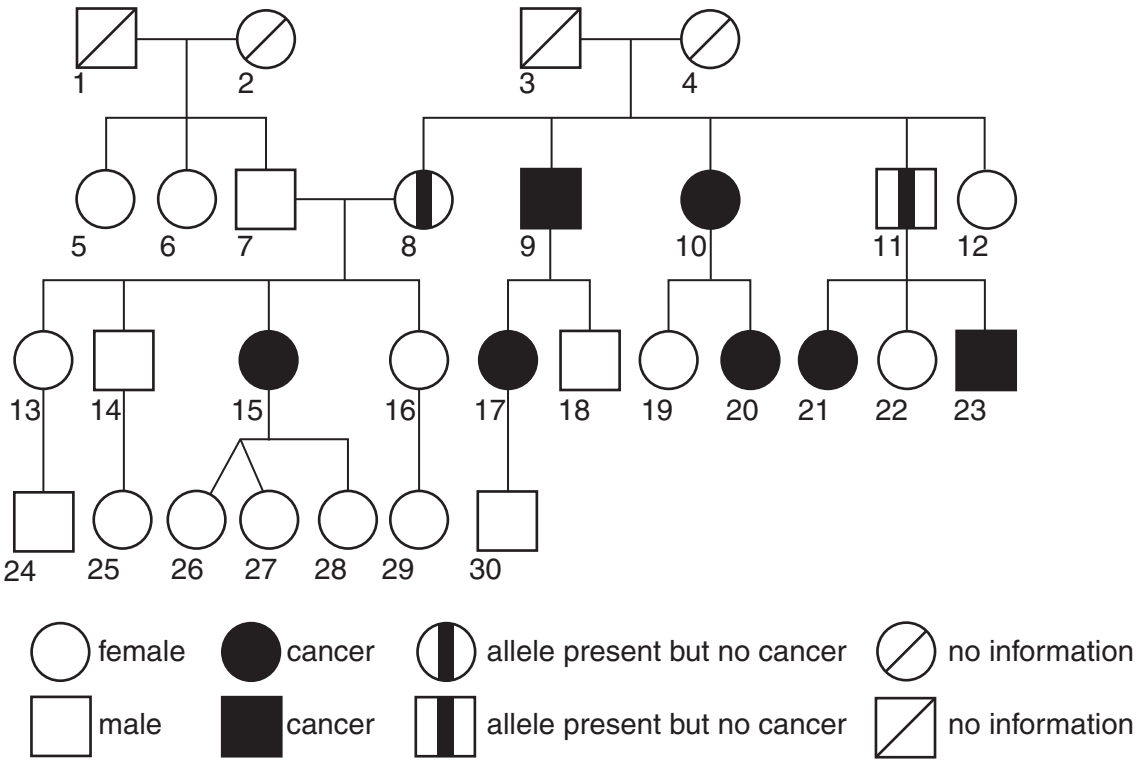

Fig. 5.1

(a) Discuss the extent to which Fig. 5.1 provides evidence that a faulty *BRCA2* allele increases the risk of a person developing cancer.

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..... [4]

(b) People whose families are suspected of having a faulty *BRCA2* allele may choose to be tested for its presence in their own genome.

A company based in the USA sells a microarray containing DNA probes for 20 different alleles that are associated with an increased risk of cancer, including the faulty *BRCA2* alleles. This microarray can be used in a medical facility or research laboratory to test blood samples for the presence of these alleles.

(i) Explain the meaning of the term *genome*.

.....

.....

..... [1]

(ii) Suggest a type of cell from a blood sample that is suitable for testing for the presence of this allele **and** explain your choice.

.....

.....

..... [1]

(iii) Outline how a microarray enables the detection of particular alleles.

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..... [4]

(iv) Suggest **one** advantage and **one** disadvantage of screening for faulty alleles of *BRCA2* before any symptoms occur.

advantage .....

.....

.....

disadvantage .....

.....

..... [2]

[Total: 12]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answers	Marks
3(a)	*max 2 of*: 1 can, kill / control, weeds ; **R** kill, insects / pests 2 reduce competition / increase yield (of rape) ; 3 AVP ; e.g. manual weeding / hoeing, difficult / expensive ref. to glufosinate converted to non-toxic compound	**2**
3(b)(i)	circle of / circular, DNA ; **I** loop **R** single-stranded small / supplementary ;	**2**
3(b)(ii)	*max 3 of:* 1 small so can be taken up by, cells / bacteria ; 2 replicate, independently / fast ; **A** have *ori* / origin of replication / high copy number 3 (DNA) has restriction site(s) / can be cut by restriction enzymes ; **A** have polylinker 4 have, marker genes / genes for resistance (for screening) ; 5 AVP ; e.g. circular so, increased stability / reduced host cell degradation	**3**

3(b)(iii)	*max 2 of:* 1 RNA polymerase binds **;** 2 so, transcription / mRNA synthesis, begins / occurs / allowed **;** 3 AVP **;** e.g. correct / template, strand is transcribed *ref. to* tissue-specific / inducible, expression	**2**
3(c)(i)	28 **;**	**1**
3(c)(ii)	*max 1 of:* spray with herbicide **and**, those that die did not have the *bar* gene / those that survive did have the *bar* gene **;** add gene for fluorescence with *bar* gene and test plants under UV / use PCR with primer complementary to *bar* gene / use (gene) probe (on Southern blot) of electrophoresis gel **;**	**1**
3(c)(iii)	*max 3 of:* *advantage of male sterile GM variety* 1 avoid transferring, *bar* / resistance, gene to wild, radish / relations **; ora** 2 avoid superweeds **; ora** 3 avoid type 2 hybrids **; ora** *disadvantage of* ***type 2 hybrids*** *(from GM variety that produces pollen)* 4 taller (than wild radish) **; A** very tall / 88 cm / 95 cm 5 produce, more / many, seeds (than wild radish) **; A** 3958 / 443 more 6 may (out)compete, wild radish / crops **;**	**3**
		Total: 14

Question	Answers	Marks
4(a)(i)	1. no resistance to any herbicide at start of use **;** 2. resistant to photosystem II inhibitors – increases, to 101–103 **or** from 1969 to 2013 **;** 3. resistant to ALS inhibitors – increase to 153 – 155 **or** from 1981 to 2014 **;** 4. resistant to glyphosate - increase to 32 / 33 **or** from 1993 - 1995 to 2014 **;** 5. comparative point described **;** e.g. ALS steepest gradient / ALS has highest number of species	**max 3**
4(a)(ii)	1. random / spontaneous, mutation **;** 2. herbicide is selection pressure **;** 3. mutant / resistant, individuals, survive / reproduce **;** ora 4. pass on, mutant / resistance, allele **;** ora 5. (mutant / resistance) allele increases in frequency (in population) **;** ora 6. *ref. to* many generations **;**	**max 4**
4(b)(i)	(668 · 3) + 3 (stop codon) = 2007 bp **or** 668 · 3 = 2004 bp **;**	**1**
4(b)(ii)	1. after folding substituted amino acids are close together **;** 2. *ref. to* different bonding **;** 3. (substituted amino acids) causes change to protein, 3D / tertiary / quaternary / globular, structure **;** 4. herbicide / inhibitor, unable to bind to, active / allosteric, site **;**	**max 2**

4(c)	*method 1 benefits max 3* 1. hybrid vigour / reduces inbreeding depression **;** 2. increase in, genetic variation / gene pool / variety of alleles **;** 3. increase in heterozygosity **;** ora 4. *idea that* low tech / easy to do / cheaper **;** *method 2 benefits* 5. no need to find a suitable (wild) plant / can proceed even if no resistant (wild) plant exists **;** 6. will not introduce, unwanted alleles / poor characteristics, from (wild) plant **;** 7. no chance of disease transfer **;**	**max 4**
		Total: 14

Question	Answer	Marks
5(a)	1. individual 8 or 11 has, BRCA2 / allele, but does not have cancer **;** 2. no evidence / unknown, that individuals (apart from 15) with cancer have, *BRCA2* / allele **or** individuals with cancer (apart from 15) may have a different mutation **;** 3. no children of individual 15, (known to) have the allele / have cancer **;** 4. individuals in fourth generation / children of individual 15, may develop cancer later in life **;** 5. individual 15 has cancer and, *BRCA2* / allele **;** 6. (some) individuals with cancer in third generation had a parent with cancer **or** (some) individuals with cancer in third generation had a parent with, *BRCA2* / allele **;** ora 7. individual 3 or 4 may have had the, BRCA2 / allele **or** any individual from 8 to 11 may have inherited, *BRCA2* / allele, from 3 or 4 **;** 8. *idea that* overall data inconclusive **;**	**max 4**
5(b)(i)	all the, DNA / genetic material (in a person's cell) **;**	**1**
5(b)(ii)	(named) white cell, **because** it contains a nucleus **;**	**1**

Question	Answer	Marks
5(b)(iii)	1. *ref. to* probes are (short) lengths of ssDNA **;** 2. complementary to the, alleles / DNA, being tested for **;** 3. many copies of one type of probe placed in each cell (of the microarray) **;** 4. (target), alleles / DNA, made single-stranded **or** single-stranded DNA made from mRNA **;** 5. (target), alleles / DNA, labelled, (with fluorescent 'tags') **;** 6. (target), alleles / DNA, hybridises / binds, with, probes / ssDNA **;** 7. unbound (target), alleles / DNA, washed off **or** bound (target), alleles / DNA, will not be washed off **;** 8. laser / UV light, used to detect presence of, fluorescence / hybridised probes / alleles / DNA **;**	**max 4**
5(b)(iv)	*advantage* max 1 1. if present, enables lifestyle change / early treatment / regular check-ups **;** 2. if not present removes worry **;** 3. preventative treatment may be cheaper than treating disease itself **;** *disadvantage* max 1 4. if present may cause worry **;** 5. if present person may not develop cancer **;** 6. test is expensive **;** 7. may have implications for life insurance / AW **;** 8. may decide to not have children / may be tested after they have children **;**	**max 2**
		Total: 12

9: Respiration – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
4	2017	May/June	41
1	2017	May/June	42
7	2015	May/June	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

4 **(a)** ATP is used or produced at different stages in the respiration of glucose in aerobic conditions.

Complete the table to show whether ATP is used or produced at each stage of respiration.

Write either **YES** or **NO** in each box.

stage of respiration	ATP used	ATP produced
glycolysis		
link reaction		
Krebs cycle		
oxidative phosphorylation		

[2]

(b) An experiment was carried out to investigate the effect of epicatechin on mitochondrial respiration in mice. Epicatechin is a naturally occurring compound in cocoa beans and so is present in chocolate.

Two groups of mice, group **A** and group **B**, were used in this experiment.

- Group **A** was given water containing epicatechin, twice a day for 15 days.
- Group **B** was given water without epicatechin, twice a day for 15 days.

After 15 days, the structure of mitochondria from striated muscle cells in both groups of mice was examined.

The surface area of the inner membrane of the mitochondria was divided by the surface area of the outer membrane to obtain a ratio for each mouse.

Table 4.1 shows the mean ratios for the two groups of mice.

Table 4.1

group	mean ratio
A	2.0 **:** 1
B	1.7 **:** 1

The mice in group **A** were able to exercise longer than the mice in group **B**.

With reference to Table 4.1, explain why the mice in group **A** were able to exercise for longer than the mice in group **B**.

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..... [5]

[Total: 7]

Section A

Answer **all** the questions.

1 **(a)** Fig. 1.1 represents the link reaction.

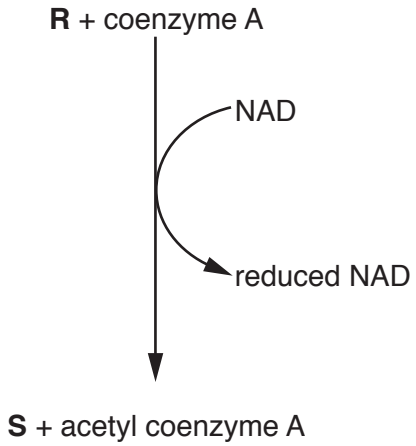

Fig. 1.1

With reference to Fig. 1.1:

(i) name substances **R** and **S**

R .....

S ..... [2]

(ii) explain what happens to the reduced NAD.

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..... [2]

(b) The pH of the blood of an athlete decreases during a race and returns to its normal level after the race. The decrease in the pH of the blood is caused by the presence of waste products that have been excreted by cells during respiration.

Name the waste products that are excreted **and** describe what occurs to these products to help return the pH of the blood back to a normal level.

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[Total: 9]

7 **(a)** Outline the process of glycolysis in a mammalian cell.

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..... [6]

(b) Within a mammalian cell, ATP can be produced in a number of ways, including:

- substrate level phosphorylation during the Krebs cycle
- oxidative phosphorylation.

Table 7.1 compares both processes.

Complete Table 7.1.

Use a tick (✓) if the statement is correct or a cross (✗) if the statement is incorrect.
The first row has been done for you.

Table 7.1

statement	substrate level phosphorylation	oxidative phosphorylation
enzymes are involved	✓	✓
occurs in cytoplasm		
occurs in mitochondria		
channel proteins are involved		

(c) An investigation into the RQ values of germinating maize seeds was carried out.

- A sample of maize seeds was soaked in water for one hour.
- The mean RQ value of some of the seeds was then calculated and the remaining seeds were then planted in soil.
- After 12 hours, the mean RQ value of some of the planted seeds was calculated.
- The remaining seeds were allowed to germinate and grow into seedlings.
- After 21 days, the mean RQ value of some of the seedlings was calculated.

Table 7.2 shows the results of the investigation.

Table 7.2

stage of germination and growth	mean RQ
seeds soaked in water	5.6
seeds after 12 hours in the soil	0.8
seedlings after 21 days	1.0

Suggest an explanation for each of the RQ values shown in Table 7.2.

seeds soaked in water .....

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seeds after 12 hours in the soil .....

.....

.....

.....

seedlings after 21 days .....

.....

.....

..... [6]

[Total: 15]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

<table>
<tr><th>Question</th><th>Answers</th><th>Marks</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th>stage of respiration</th><th>ATP used</th><th>ATP produced</th></tr>
<tr><td>glycolysis</td><td>yes</td><td>yes</td></tr>
<tr><td>link reaction</td><td>no</td><td>no</td></tr>
<tr><td>Krebs cycle</td><td>no</td><td>yes</td></tr>
<tr><td>oxidative phosphorylation</td><td>no</td><td>yes</td></tr>
</table>
;;
4 correct = 2 marks, 2 or 3 rows correct = 1 mark
If ticks and crosses used need all 4 correct for maximum 1 mark
</td><td>2</td></tr>
</table>

4(b)	*max 5 of:* *group **A** (accept ora for group **B** throughout) **accept** 'they' = group **A*** 1 higher <u>ratio</u> **;** 2 larger / more, inner membrane / cristae (than **B**) **;** 3 more, ETCs / cytochromes / ATP synth(et)ase / stalked particles **; I** ATPase 4 oxidative phosphorylation **;** 5 more ATP produced **;** 6 <u>muscles</u> can contract for, longer / more time / without getting tired **; I** exercise longer **I** muscles contract faster 7 AVP **;** e.g. chemiosmosis or detail thereof: H_+ move, down gradient / through ATP synth(et)ase **I** ATPase *If **B** and **A** switched round penalise once only*	**5**
		Total: 7

Question	Answers	Marks
1(a)(i)	**R** – pyruvate **;** **S** – carbon dioxide **;**	**2**
1(a)(ii)	*idea that*, hydrogen(s) / protons **and** electrons, are released **;** **A** (reduced NAD), oxidised / dehydrogenated at ETC / (for) oxidative phosphorylation **;**	**2**
1(b)	1. lactate (produced) **; A** lactic acid 2. (lactate) taken to liver **;** 3. converted to pyruvate **;** 4. (pyruvate) converted to, glucose / glycogen **;** 5. carbon dioxide (produced) **;** 6. *ref. to* carbon dioxide / pH, receptors **;** 7. (carbon dioxide) goes into alveoli **;** 8. increased breathing (rate) **;** 9. *ref. to* haemoglobin acts as a buffer for carbon dioxide **;**	**max 5**
		Total: 9

Question	Answers	Marks
7(a)	1 glucose phosphorylated by ATP ; 2 (forms) hexose / fructose, bisphosphate ; 3 raises energy level of / activates, glucose / sugar **OR** lowers activation energy of reaction ; 4 breaks down to two TP ; 5 6C _ 2 × 3C ; 6 hydrogen (atoms) removed / dehydrogenated / oxidised ; 7 2 reduced NAD formed ; **A** NADH / $NADH_2$ 8 ref. to 4 ATP produced / net gain of 2 ATP ; 9 pyruvate produced ; 10 AVP ; e.g. ref. to substrate level phosphorylation / dehydrogenase / phosphofructokinase / hexokinase	**max 6**

<table>
<tr><td>7(b)</td><td>
<table>
<tr><th></th><th>substrate level phosphorylation</th><th>oxidative phosphorylation</th><th></th></tr>
<tr><td>enzymes are involved</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>occurs in cytoplasm</td><td>✓</td><td>×</td><td>;</td></tr>
<tr><td>occurs in mitochondria</td><td>✓</td><td>✓</td><td>;</td></tr>
<tr><td>channel proteins are involved</td><td>×</td><td>✓</td><td>;</td></tr>
</table>
</td><td>3</td></tr>
<tr><td>7(c)</td><td>seeds soaked in water
1 little / no, oxygen (in water) ;
2 (mostly) anaerobic respiration ;
seeds after 12 hours in the soil
3 (more) aerobic respiration / less anaerobic respiration ;
4 mixture of substrates ; e.g. 2 of carbohydrates, proteins and lipids
seedlings after 21 days
5 aerobic respiration ;
6 substrate is, glucose / carbohydrate ;
7 ref. to presence of leaves / photosynthesis ;</td><td>max 6</td></tr>
<tr><td></td><td></td><td>Total: 15</td></tr>
</table>

10: Mammalian physiology, control and co-ordination – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
1	2017	May/June	41
6	2017	May/June	41
10	2017	May/June	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

1 **(a)** The mammalian kidney is an organ involved in homeostasis.

Explain what is meant by the term *homeostasis.*

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.....

..... [1]

(b) Fig. 1.1 shows a section through a kidney.

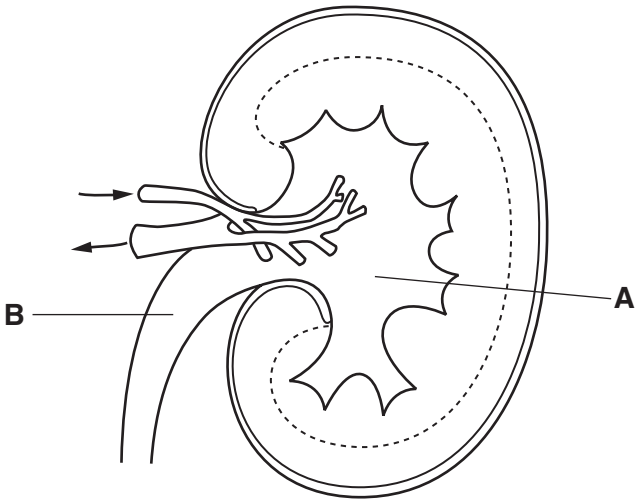

Fig. 1.1

(i) With reference to Fig. 1.1, name structures **A** and **B**.

A .....

B ..... [2]

(ii) On Fig. 1.1, use label lines and letters to label where:

U – ultrafiltration occurs

L – the loop of Henle is found

C – blood urea concentration is low.

[3]

(c) Describe the roles of the hypothalamus and the posterior pituitary in osmoregulation.

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..... [5]

[Total: 11]

6 **(a)** Describe how tropomyosin and myosin are each involved in the sliding filament model of muscle contraction.

(i) *tropomyosin* .....

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..... [2]

(ii) *myosin* .....

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..... [4]

(b) Striated muscle is made up of many specialised muscle cells known as muscle fibres or myocytes.

There are two different types of muscle fibre in striated muscle:

- fast twitch muscle fibres that contract quickly, but rapidly fatigue (get tired)
- slow twitch muscle fibres that contract slowly and continue to contract for a long time.

Table 6.1 shows some features of fast twitch and slow twitch muscle fibres.

Table 6.1

feature	fast twitch fibre	slow twitch fibre
respiration	mainly anaerobic	mainly aerobic
glycogen concentration	high	low
capillaries	few	many

Use the information in Table 6.1 to suggest **and** explain **one** advantage of:

(i) the high glycogen concentration in fast twitch fibres

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..... [2]

(ii) many capillaries supplying slow twitch fibres.

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..... [2]

[Total: 10]

10 **(a)** Compare the endocrine and nervous systems in control and co-ordination in mammals. [8]

(b) Outline the role of a chemoreceptor cell in the human taste bud in detecting stimuli **and** in stimulating the transmission of nerve impulses in sensory neurones. [7]

[Total: 15]

Mark scheme abbreviations

;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answers	Marks
1(a)	maintain / keep / restore, constant / stable / set-point / within narrow limits, internal environment / in body **;**	**1**
1(b)(i)	**A** – pelvis **;** *note if labelled medulla as affects ecf in part (ii)* **B** – ureter **;**	**2**
1(b)(ii)	**A** *full labels instead of letters* *if region **A** (pelvis) was mislabelled as medulla in (i) can apply:* ***ecf** for **L** placed in pelvis* ***ecf U** placed in medulla **only if** word cortex also written by **U** / ultrafiltration* **U** – pointing to the cortex **;** **L** – pointing to the medulla **;** **C** – pointing to the renal vein **;**	**3**

1(c)	*max 5 of:* 1 hypothalamus detects (changes in) water potential (of the blood) **;** 2 osmoreceptors shrink when, low / less, water in blood **; ora** 3 ADH, produced / made, in hypothalamus **;** 4 if low, water / Ψ, ADH secreted from posterior pituitary **; ora** **R** ADH *produced* in posterior pituitary 5 *ref. to* neurosecretory cells **or** impulse / ADH transported, from hypothalamus to posterior pituitary **;** 6 aquaporins **;** 7 ADH increases permeability of, distal convoluted tubule / collecting duct **; ora** 8 ADH causes, more water reabsorption / smaller volume of urine / more concentrated urine **; ora** **A** both with and without ADH compared	**5**
		Total: 11

Question	Answers	Marks
6(a)(i)	*max 2 of:* 1 tropomyosin / it, covers / uncovers, myosin binding sites on actin **;** **R** inhibits **R** active site 2 when calcium ions bind to troponin, tropomyosin / it, moves / changes shape **;** 3 allows myosin to, bind to actin / form cross-bridges **; ora**	**2**
6(a)(ii)	*max 4 of:* 1 ATP hydrolysis / ATP → ADP + Pi **;** 2 (causes myosin) head to, pivot / rotate / tilt / stand up **;** 3 myosin / head, binds to actin / forms cross-bridges with actin **;** **R** active site 4 ADP and Pi detach **;** 5 (myosin) head, swings back / returns to previous position **;** 6 actin is moved / power stroke occurs **;** 7 (new) ATP binds **;** 8 myosin / head, detaches from actin / cross-bridges break **;** ***A*** *mps in any order apart from 1, 4 and 7 which must be linked to correct action*	**4**
6(b)(i)	*max 2 of:* 1 to, supply / provide, (enough / plenty of) glucose **;** 2 for glycolysis **;** 3 as little ATP is produced by anaerobic respiration **;** 4 as few capillaries are present (to supply glucose directly) **;**	**2**
6(b)(ii)	*max 2 of:* 1 to, supply / provide, (enough / plenty of) oxygen **;** 2 aerobic respiration / oxidative phosphorylation **;** 3 to remove, carbon dioxide / lactate **;** **A** lactic acid 4 to, avoid fatigue **or** promote, stamina / endurance (for exercise / work) **;**	**2**
		Total: 10

Question	Answers	Marks
10(a)	*Differences*	**max 8**

		nervous		*endocrine*
1	communication	action potential / impulse	**and**	hormone ;
2	nature of communication	electrical (and chemical)	**and**	chemical ;
3	mode of transmission	neurone / nerve cell	**and**	blood ;
4	response destination	muscle / gland	**and**	target, organs / tissue / cells ;
5	transmission speed	fast(er)	**and**	slow(er) ;
6	effects	specific / localised	**and**	(can be) widespread ;
7	response speed	fast(er)	**and**	slow(er) ;
8	duration	short-lived / temporary	**and**	can be long-lasting / permanent ;
9	receptor location	on cell surface membrane	**and**	either on cell surface membrane or within cell ;

Similarities

10	cell signalling	both involve cell signalling ;
11	detail	both involve signal molecule binding to receptor ;
12	chemicals	both involve chemicals ;

10(b)	1. chemicals act as a stimulus ; 2. *ref. to* specificity of chemoreceptors ; 3. sodium ions diffuse into cell ; 4. via microvilli ; 5. membrane depolarised ; 6. receptor potential / generator potential ; 7. stimulates opening of calcium (ion) channels ; 8. calcium ions enter cell ; 9. causes movement of vesicles containing neurotransmitter ; 10. neurotransmitter released by exocytosis / described ; 11. neurotransmitter stimulates, action potential / impulses, in sensory neurone ; 12. *ref. to* (chemoreceptors are) transducers / description ; 13. AVP ; e.g. threshold / all or nothing law / papilla	**max 7**
		Total: 15

11: Plant physiology and biochemistry – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2017	May/June	41
2	2017	May/June	42
9	2017	May/June	42

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 Corals grow in shallow seawater. Corals consist of colonies of small animals called polyps. These polyps have photosynthetic protoctists called algae inside their cells, which is advantageous both to the coral polyps and to the algae.

The algae that live within the cells of the polyps can also live independently as free-living algae.

(a) The rate of photosynthesis of algae that live within the cells of coral polyps is higher than that of free-living algae.

Suggest **and** explain how living inside the cells of coral polyps increases the rate of photosynthesis in these algae compared to free-living algae.

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..... [2]

(b) The relative abundance of five different chloroplast pigments in the algae of corals was determined. The results are shown in Table 2.1.

Table 2.1

chloroplast pigment	percentage of total
chlorophyll a	39
peridinin	39
chlorophyll c2	13
dinoxanthin	7
β-carotene	2

Outline the method you would use to separate and identify the pigments present in an extract of these algae.

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..... [4]

(c) Table 2.2 shows the light wavelengths at which each algal chloroplast pigment shows its two largest peaks of light absorption.

Table 2.2

chloroplast pigment	peak 1 wavelength /nm	peak 2 wavelength /nm
chlorophyll a	430	662
peridinin	456	485
chlorophyll c2	450	396
dinoxanthin	442	471
β-carotene	454	480

Corals kept in tanks are often illuminated by lamps radiating mostly violet and blue light with wavelengths in the range of 400–490 nm.

With reference to Table 2.1 and Table 2.2, suggest why lamps radiating mostly violet and blue light are expected to increase coral growth.

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[Total: 9]

2 Chloroplasts belong to a group of organelles called plastids. Although different types of plastid have different structures and functions, one type of plastid can change into another type of plastid in response to environmental or developmental signals.

- Example 1: plants grown in the dark have plastids called etioplasts which lack chlorophyll. If these plants are exposed to light, the etioplasts quickly change into chloroplasts.

- Example 2: chloroplasts in surface tissues of tomato fruits change into plastids called chromoplasts as the fruits ripen. Thylakoid membranes break down and chlorophyll synthesis stops. Chromoplasts synthesise and accumulate red lycopene and orange β-carotene pigments.

(a) For each of these examples, explain the effect on the rate of photosynthesis of one type of plastid changing into another type of plastid.

Example 1 .....

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Example 2 .....

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..... [2]

(b) Outline the method you would use to separate and identify the pigments in an extract of tomato chromoplasts.

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(c) Cyanobacteria are prokaryotic organisms. Plastids are thought to have evolved from cyanobacteria that became incorporated into larger cells. Experiments show that free-living cyanobacteria can adapt to environmental signals in the same way as plastids.

Fig. 2.1 shows the absorption spectra of cyanobacteria grown under two different lighting conditions. One group was grown under fluorescent light and the other group was grown under red light.

The range of light wavelengths absorbed by each group of cyanobacteria was then measured under identical lighting conditions.

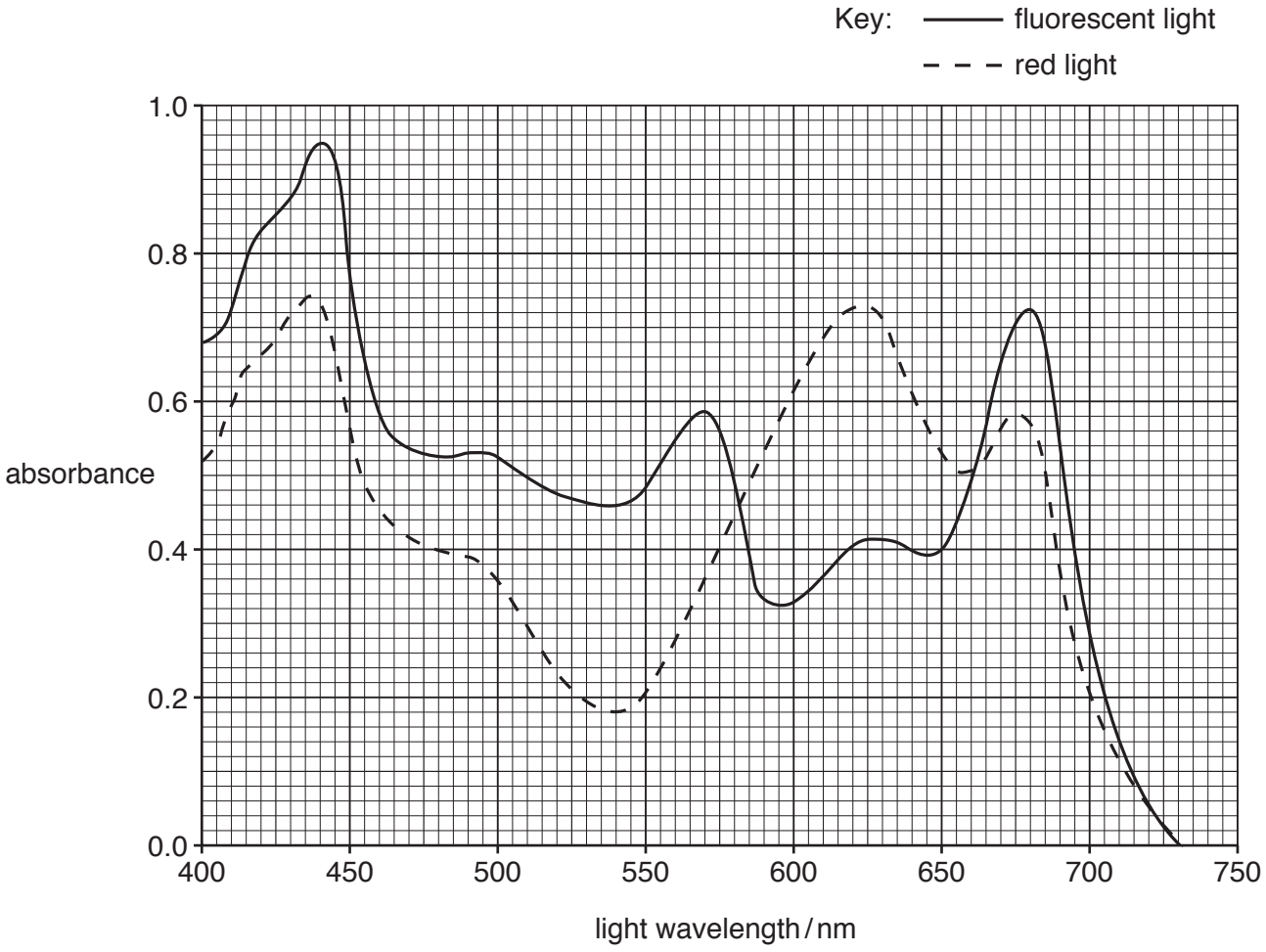

Fig. 2.1

With reference to Fig. 2.1 and the information given on pages 4 and 5, explain the effect of different lighting conditions on the absorption spectra of the two groups of cyanobacteria.

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[Total: 9]

Section B

9 **(a)** Explain the mechanism by which guard cells open stomata. [9]

(b) State the changes in the external environment that lead to stomatal opening and closure. Explain why these stomatal responses are necessary. [6]

[Total: 15]