

Name:		Centre/Index Number:		Class:	
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DUNMAN HIGH SCHOOL

Preliminary Examination

Year 6

H2 BIOLOGY

9744/02

Paper 2 Structured Questions (**PART 1 of 2**)

17 September 2025

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST:

Write your name, centre number, index number and class at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

This exam consists of **two parts: Part 1 and Part 2.**

You must complete both Part 1 and Part 2.

This is Part 1.

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

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

You may lose marks if you do not show your working or if you do not use appropriate units.

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

For Examiner's Use	
1	11
2	9
3	11
4	11
5	8

This document consists of **32** printed pages and **4** blank pages.

Answer **all** questions.

- 1 Fig. 1.1 is a transmission electron micrograph of a cell from the stem of sago pondweed, *Stuckenia pectinata*.



Fig. 1.1

- (a) (i) State the evidence from Fig. 1.1 that shows that the cell is from the stem of *S. pectinata* and not from the mesophyll of a leaf.

[1]

- (ii) Complete each row in Table 1.1 to identify a cell structure shown in Fig. 1.1 that carries out the function listed.

Table 1.1

function	name of cell structure	letter on Fig. 1.1
gas exchange		
production of subunits of ribosomes		
active transport of ions		
aerobic respiration		

[4]

- (b) Plant vacuoles develop when vesicles fuse together. The vacuoles increase in size as more vesicles fuse.

Fig. 1.2 shows the movement of vesicles within a plant cell during the development of a vacuole.

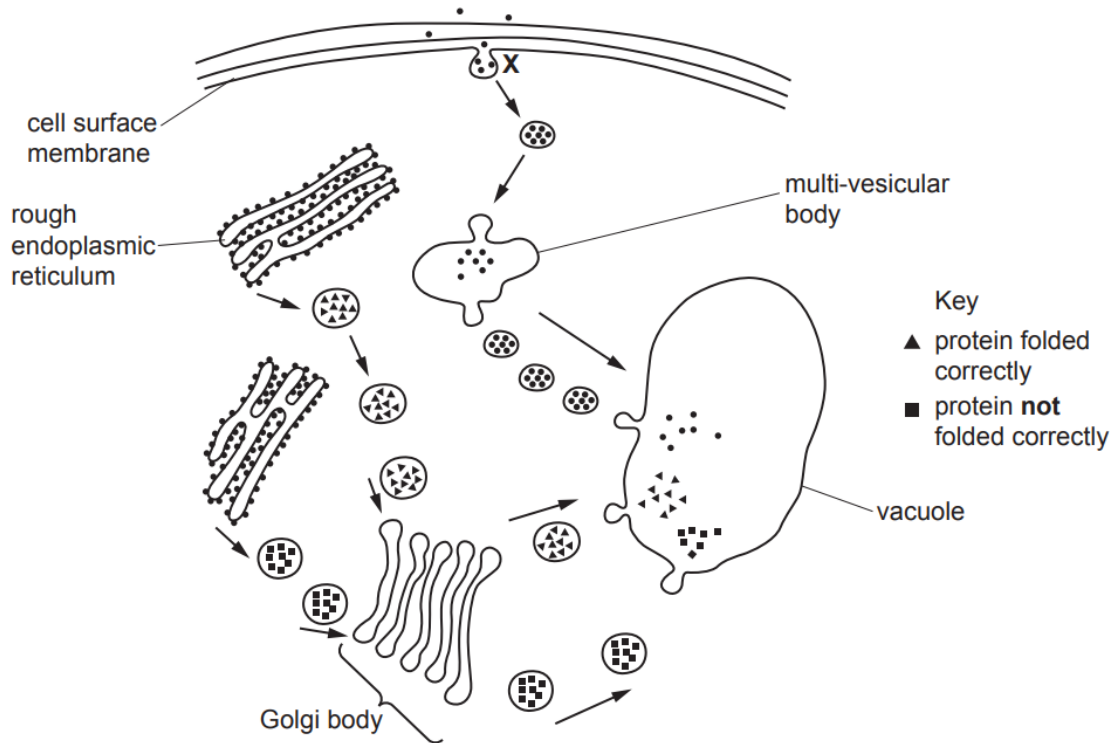


Fig. 1.2

- (i) Name the process that is occurring at **X**.

[1]

- (ii) Some of the vesicles formed by the Golgi body fuse with the vacuole. These vesicles contain both proteins that have been folded correctly and incorrectly.

Explain how proteins that have not been folded correctly are broken down in the vacuole.

[3]

- (c) Small vacuoles in *S. pectinata* may have roles similar to lysosomes in animal cells.

Describe the role of lysosomes in animal cells in defence against pathogens.

[2]

Total: [11]

Question 2 starts on page 6.

- 2 Glycogen and cellulose are polymers. Fig. 2.1 shows small, representative regions of a glycogen molecule and a cellulose molecule.

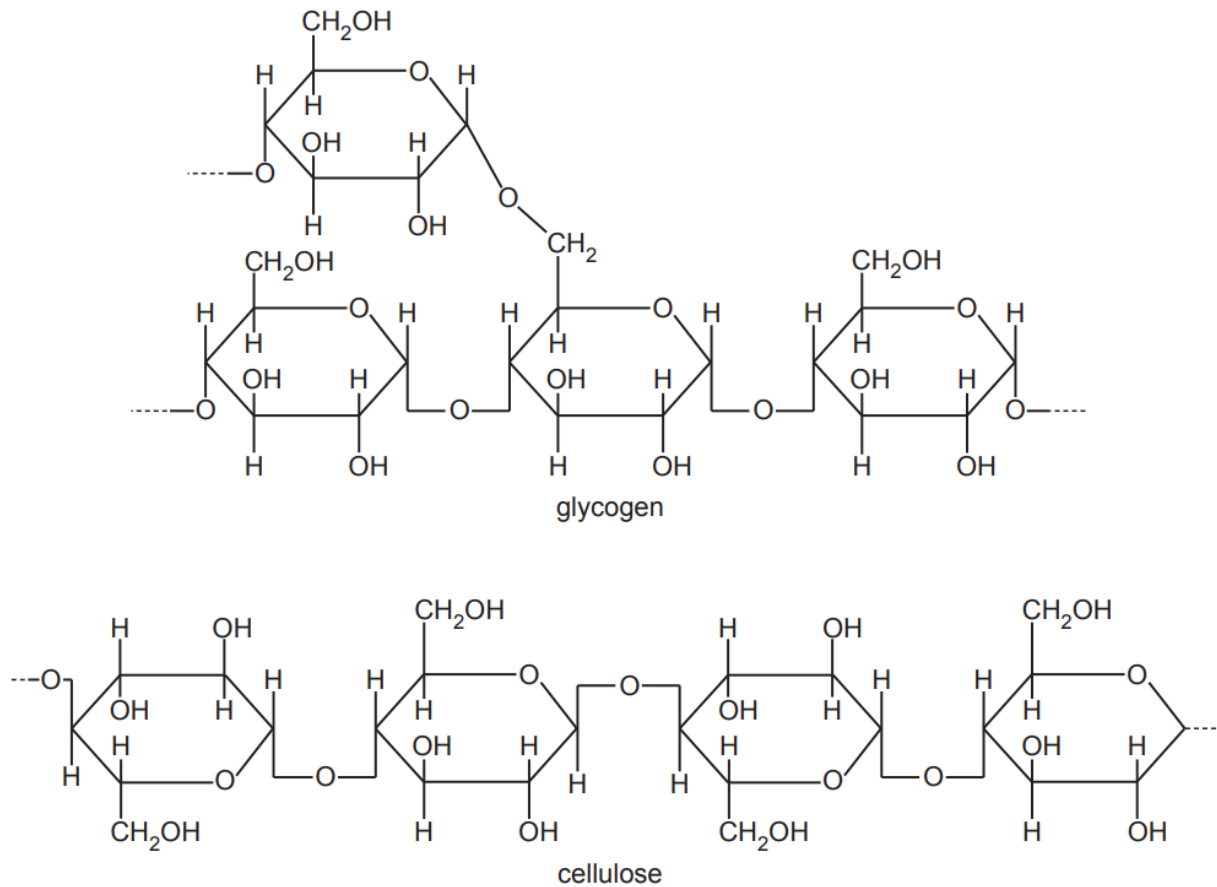


Fig. 2.1

- (a) Describe **three** ways, **visible in Fig. 2.1**, in which the molecule of glycogen differs from the molecule of cellulose.

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[3]

- (b) Glycogen is found in the form of granules in mammalian liver and muscle cells. Fig. 2.2 is a diagram of part of a molecule of glycogen isolated from a glycogen granule.

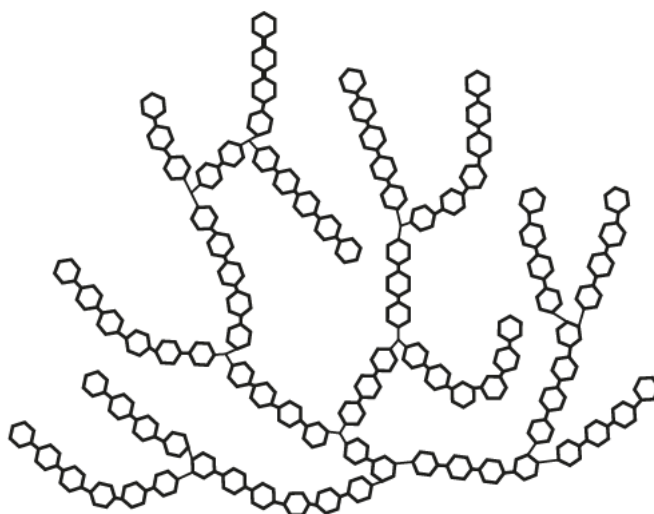


Fig. 2.2

Explain how the structure of glycogen is related to its function in cells.

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..... [3]

- (c) Explain how the arrangement of cellulose molecules in plant cell walls is related to their function.

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..... [3]

Total: [9]

3 Phosphate ions have a number of uses in organisms. These include:

- involvement in cell signalling responses
- involvement in energy transfer processes
- component of phospholipids
- component of nucleotides.

Phosphatase enzymes remove phosphate groups from organic compounds, while kinase enzymes add phosphate groups.

(a) Read the following passage:

Some hormones circulating in the blood are able to trigger transcription within a cell, even though they are unable to enter the cell. Phosphatases and kinases then take part in cell activities that eventually result in genes switching on and transcription beginning.

(i) Suggest why the hormones, referred to in the passage, are unable to enter the cell.

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..... [2]

(ii) Use the information in the passage to outline the process of cell signalling.

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..... [3]

- (b) The activity of a phosphatase enzyme was measured at different values of pH by using nine different buffer solutions. The temperature was kept constant at 30 °C.

The results are shown in Fig. 3.1.

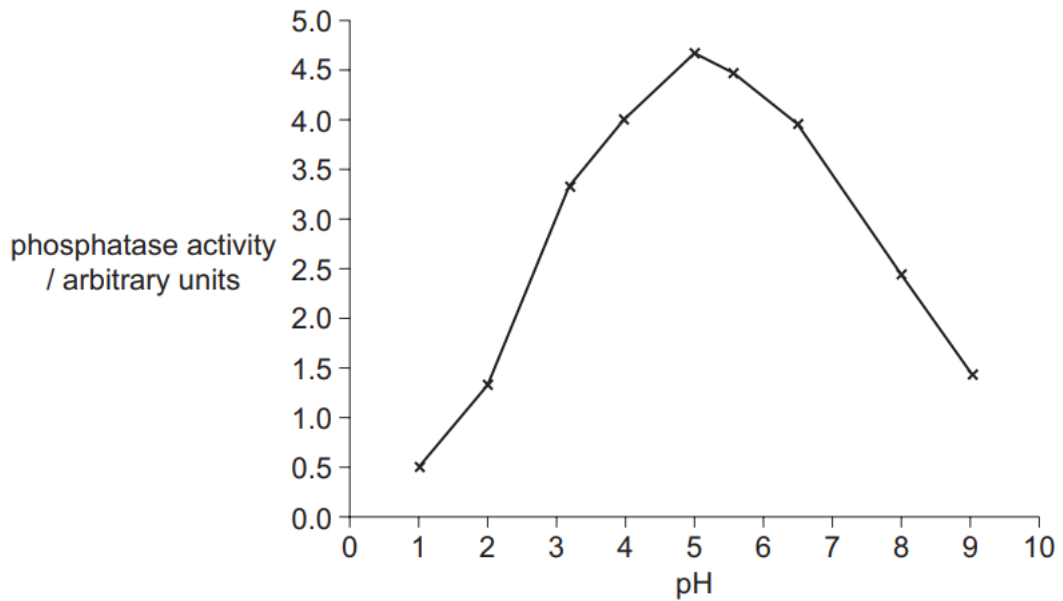


Fig. 3.1

- (i) With reference to Fig. 3.1, describe the effect of pH on the activity of phosphatase.

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..... [3]

- (ii) Explain why the activity of phosphatase at pH 1 is very low.

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Total: [11]

(b) Fig. 4.2 shows two main stages of protein synthesis.

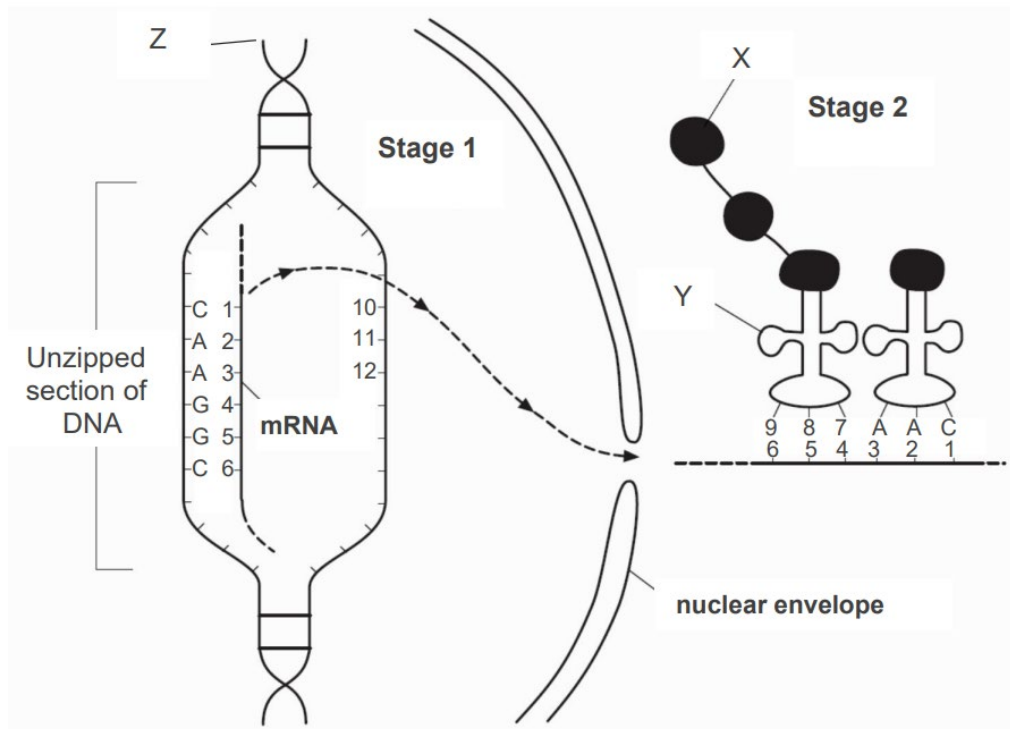


Fig. 4.2

(i) Name the nitrogenous bases 9 and 12.

Base 9 : Base 12 : [1]

(ii) State the terminus of the amino acid chain, as indicated by X.

..... [1]

(iii) State if Z indicates 5' or 3' end of the molecule in **Stage 1**.

..... [1]

(iv) Describe the role of hydrogen bonds in molecule Y.

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 [2]

Total: [11]

- 5 Arabinose is a monosaccharide containing five carbon atoms. The arabinose operon, which is also known as the *araBAD* operon, is an operon required for the breakdown of arabinose in the bacteria, *Escherichia coli*.

The *araBAD* operon contains three structural genes: *araB*, *araA*, *araD*, which code for three different enzymes that are required for the breakdown of arabinose. Other than the promoter of the structural genes, there are other regulatory regions of the operon including the CAP binding site and the operator, as shown in Fig. 5.1.

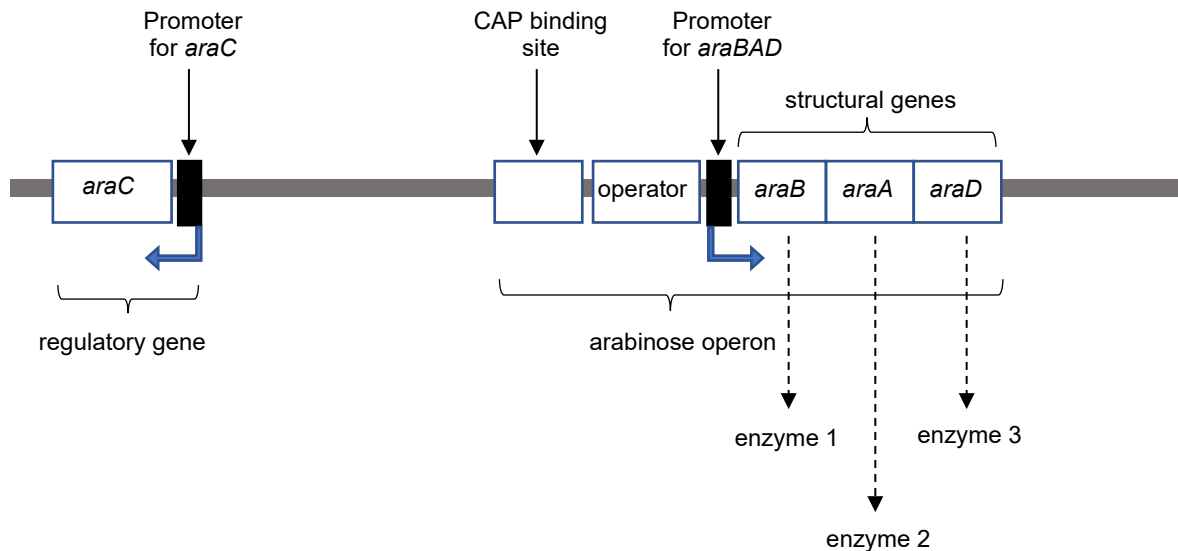


Fig. 5.1

When the cell is starved of glucose, the CAP-cAMP complex binds to the CAP binding site resulting in positive regulation of the *araBAD* operon.

The regulatory protein, araC protein, is coded for by the regulatory gene, *araC*. In the presence of arabinose, arabinose will bind to the araC protein forming the arabinose-araC protein complex. The arabinose-araC protein complex will then bind to the operator of *araBAD* operon, recruiting RNA polymerase to the *araBAD* promoter. When there is no arabinose, araC protein binds to the operator of *araBAD* operon in a manner that prevents RNA polymerase from binding to the *araBAD* promoter.

With reference to the *araBAD* operon in Fig. 5.1,

- (a) explain the term 'operon',

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[3]

(b) explain if the operon is an inducible or a repressible operon,

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..... [2]

(c) describe the positive regulation of gene expression in the *araBAD* operon.

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..... [3]

Total: [8]

Question 6 starts on page 18.

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Name:		Centre/Index Number:		Class:	
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H2 BIOLOGY

9744/02

Paper 2 Structured Questions (**PART 2 of 2**)

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For Examiner's Use	
6	14
7	8
8	8
9	8
10	7
11	5
Total	100

- 6** Table 6.1 shows the number of chromosomes present in nuclei of females and males of some species.

Table 6.1

Species	Number of chromosomes per nucleus	
	Female	Male
red king crab	208	208
maize	20	20
koala	16	16
jack jumper ant	2	1

Nuclear division by meiosis produces gametes which show genetic variation.

- (a)** With reference to processes in meiosis, explain how more genetic variation can be achieved in red king crab gametes, compared with koala gametes.

[4]

The process of reproduction in jack jumper ants is unusual. A fertilised egg develops into a female, whereas an unfertilised egg develops into a male.

- (b)** Using the information in Table 6.1, suggest why cells from male jack jumper ants cannot undergo meiosis.

A scientist prepared maize root samples to observe cells undergoing mitosis. He determined the mean mitotic index at 50 μm intervals away from the root tip in 10 young maize roots.

Mitotic index is the proportion of cells undergoing mitosis in a given cell population. A higher mitotic index indicates that more cells are actively dividing.

Fig. 6.1 shows the scientist's results.

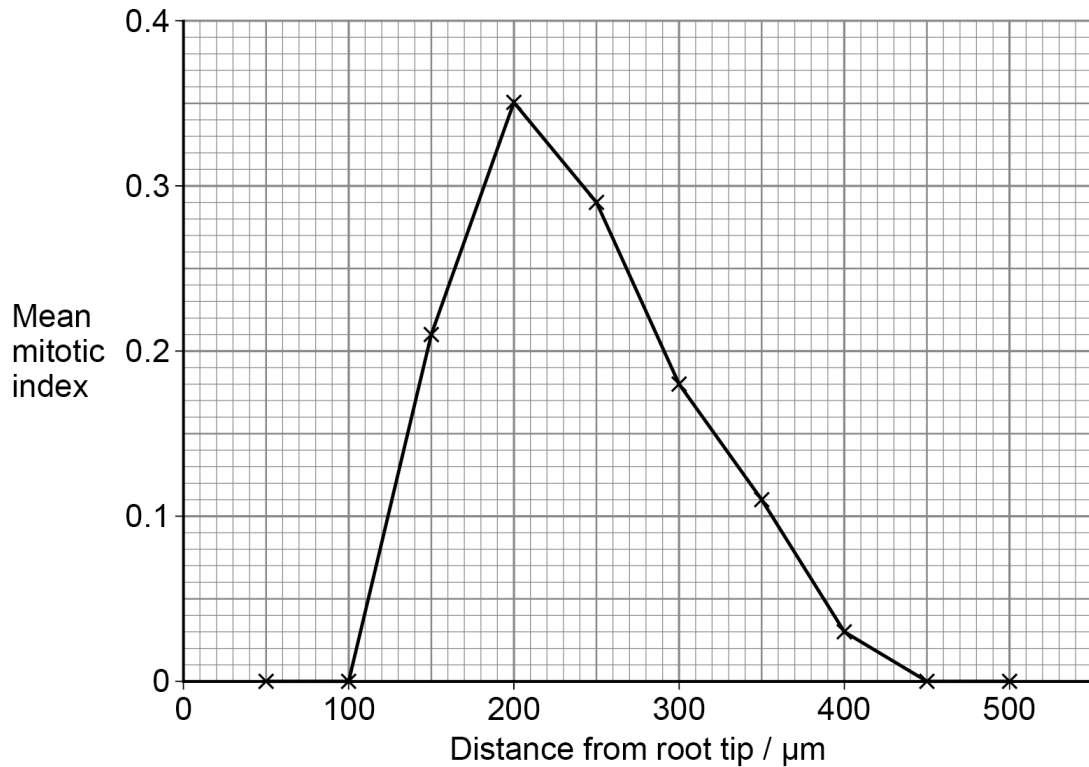


Fig. 6.1

- (c) (i) Name the statistical test needed to determine whether the difference between the mean mitotic index at 200 μm and at 300 μm is significant.

[1]

- (ii) State the null hypothesis for this investigation.

[1]

Cell division was observed under the light microscope. The photomicrograph in Fig. 6.2 shows cells of the root tip at 400X magnification.

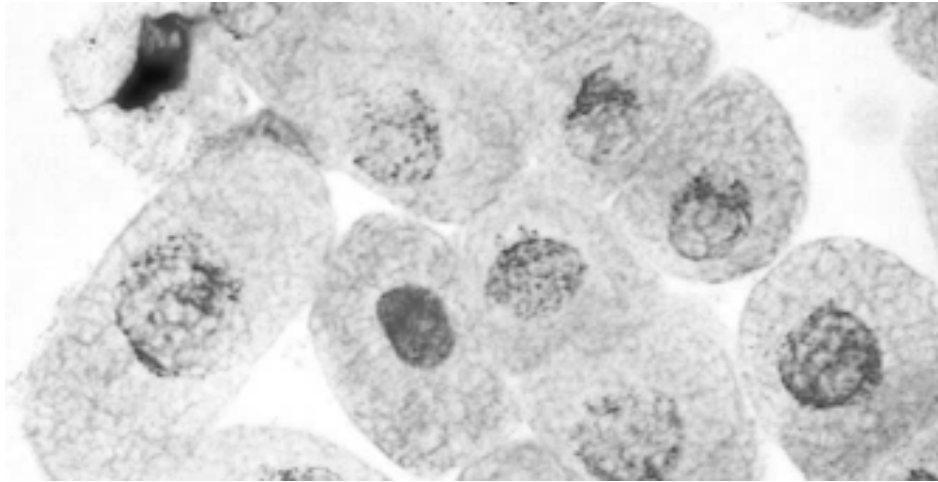


Fig. 6.2

(d) Suggest three reasons why chromosomes cannot be seen in all cells in Fig. 6.2.

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[3]

The scientist also measured the mitotic indices of red king crab, koala and jack jumper ant.

The bar graph in Fig. 6.3 shows the mean mitotic index expressed in percentage and the line graph shows the number of p53 gene mutations per 1000 cells in all four species.

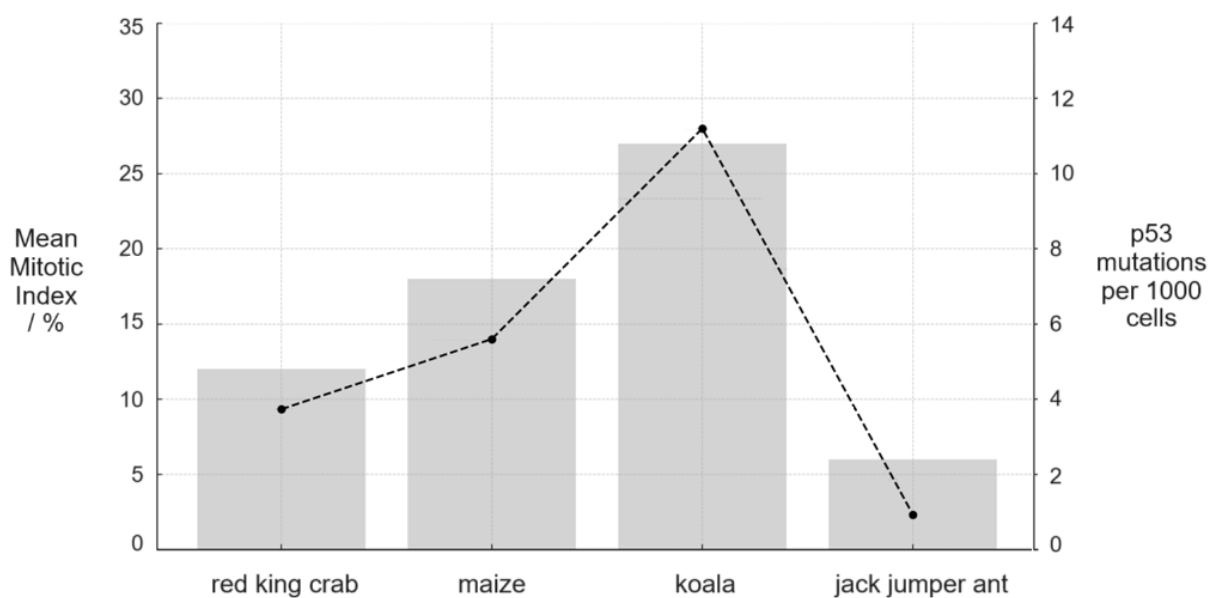


Fig. 6.3

- (e) With reference to Fig. 6.3, explain why the koala has the highest risk of developing a tumour.

[4]

Total: [14]

- 7 In the pea plant, *Pisum sativum*, the timing of flowering is controlled by multiple alleles. Investigators have found evidence for four different alleles at this flowering locus that can exert temporal control of flowering:

- F^V – very early flowering
- F^E – early flowering
- F^M – mid flowering
- F^L – late flowering

Another **A/a** gene locus on a different chromosome codes for the colour of the flower which is either purple or white.

Table 7.1 shows the results of crosses between a mid flowering plant with purple flowers with three other different plants.

Table 7.1

cross	parents	offspring
1	mid flowering, purple flowers x early flowering, purple flowers	50% mid flowering 25% early flowering 25% very early flowering all purple flowers
2	mid flowering, purple flowers x mid flowering, white flowers	75% mid flowering 25% early flowering 50% purple flowers 50% white flowers
3	mid flowering, purple flowers x late flowering, purple flowers	50% late flowering 25% mid flowering 25% early flowering 75% purple flowers 25% white flowers

- (a) (i) Determine the relative dominance of the alleles F^V , F^E , F^M and F^L .

[1]

- (ii) State the genotype of the mid flowering parent plant with purple flowers.

[1]

(iii) Draw a genetic diagram to explain the results of cross 3.

[4]

(b) Contrast between inheritance caused by multiple alleles and polygenic inheritance for a characteristic.

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..... [2]

Total: [8]

- 8 Most terrestrial plants use chlorophylls *a* and *b* to construct pigment-protein complexes which harvest light.

Fig. 8.1 shows an absorption spectrum for a terrestrial plant and Fig. 8.2 shows the corresponding action spectrum.

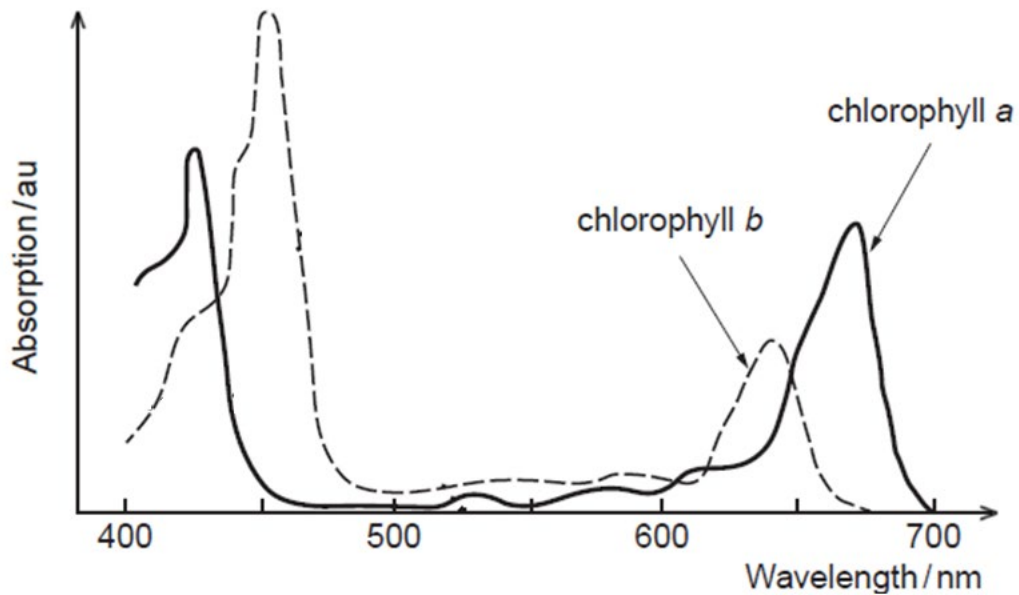


Fig. 8.1

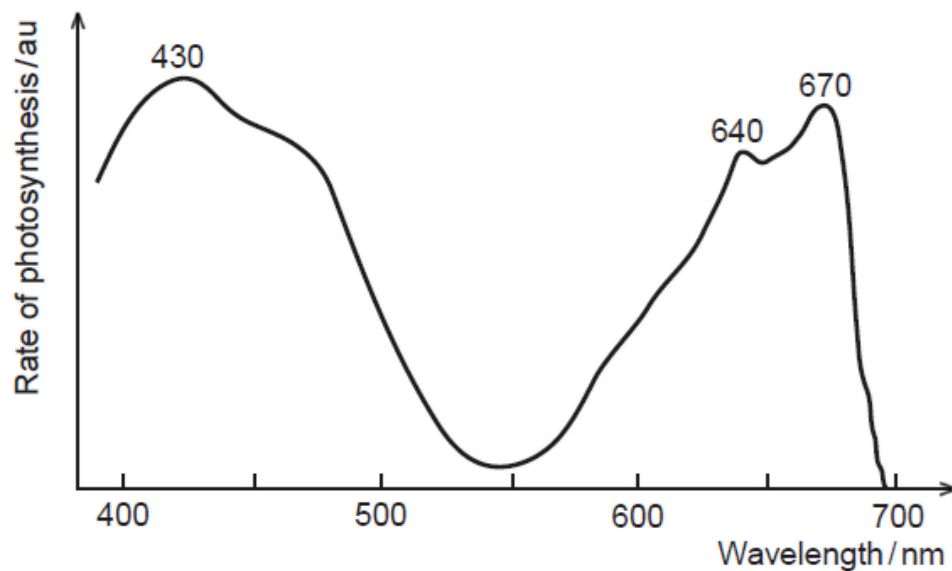


Fig. 8.2

Different taxa contain different photosynthetic pigments.

Diatoms are photosynthetic microscopic algae. Their chloroplasts contain chlorophyll *a*, but instead of chlorophyll *b*, they contain chlorophyll *c*.

Fig. 8.3 shows the absorption spectrum of chlorophyll *c*.

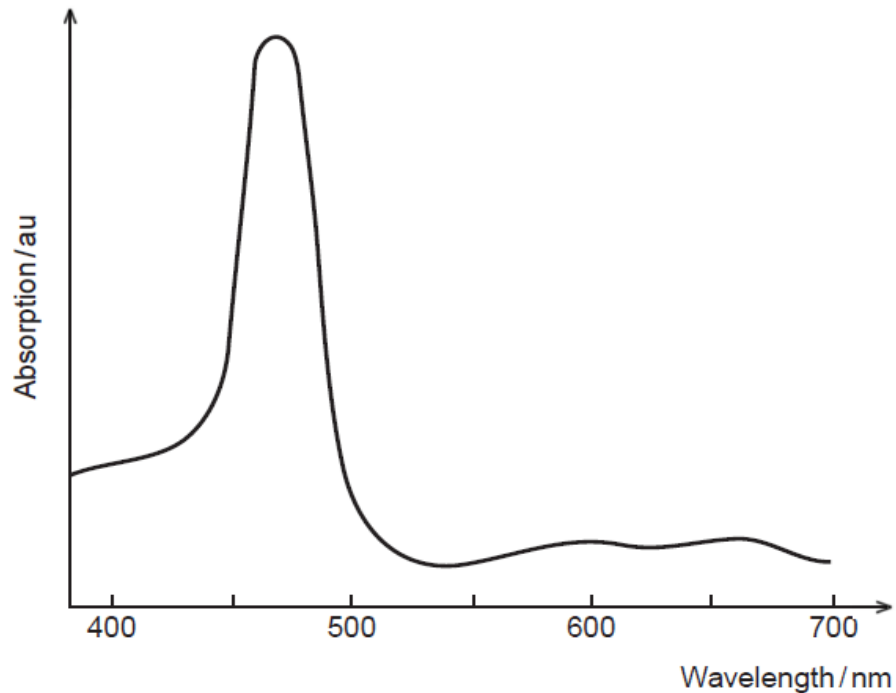


Fig. 8.3

(a) Compare the absorption spectrum for chlorophyll *b* and chlorophyll *c*.

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[3]

(b) With reference to the peaks labelled on the action spectrum in Fig. 8.2, predict how the action spectrum for diatoms would differ from that of terrestrial plants.

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[1]

Fig. 8.4 shows diagrammatic representations of membranes found in organelle A, where ATP synthesis takes place.

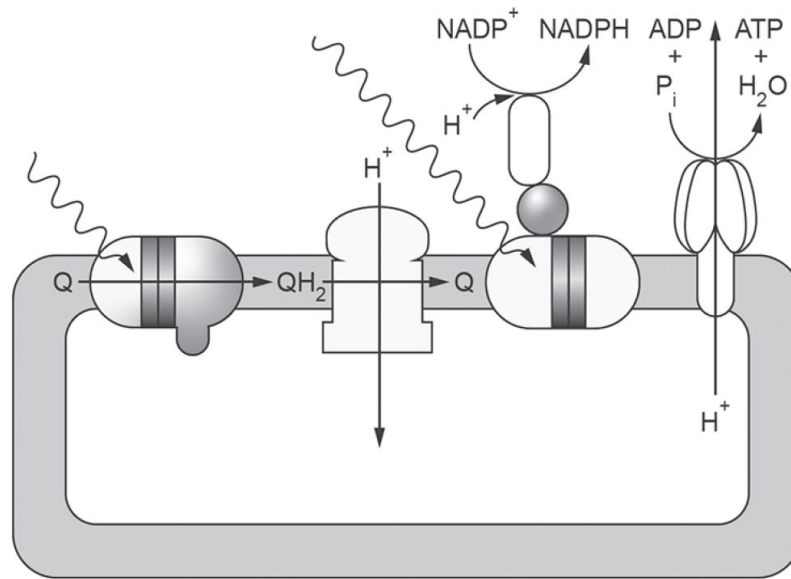


Fig. 8.4

The experiment shown in Fig. 8.5 is evidence supporting the chemiosmotic hypothesis. It was carried out on membranes isolated from the organelle A shown in Fig. 8.4 and made into vesicles. The isolated membranes were placed in buffer solutions.

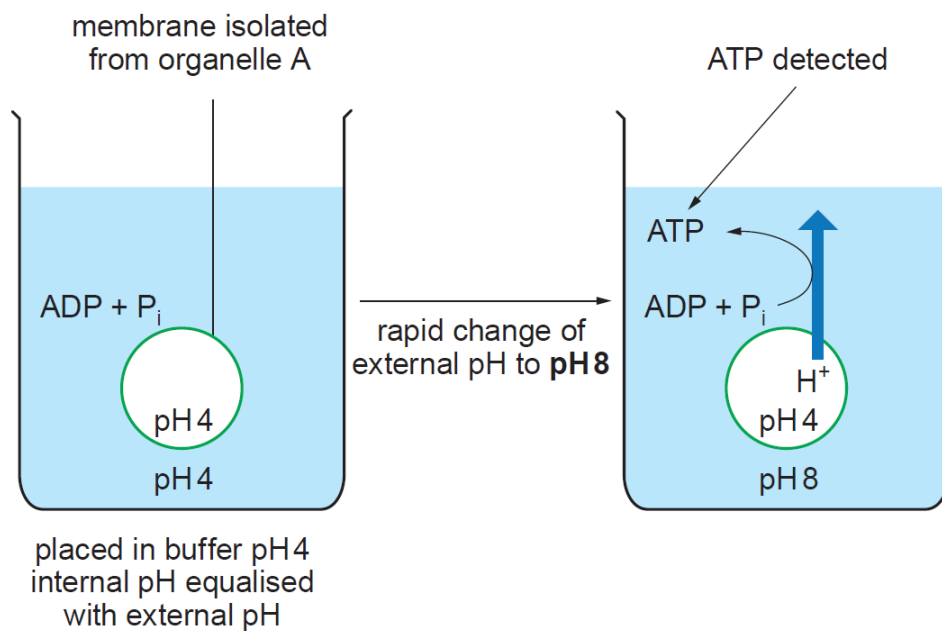


Fig. 8.5

(c) Explain why the experiment shown in Fig. 8.5 supports the chemiosmotic theory.

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..... [4]

Total: [8]

- 9 The international trade of ivory has been banned since 1989. However, as many as 50 000 African elephants are killed each year for their ivory tusks out of a population of less than 400 000.

Researchers collected elephant dung samples containing DNA from epithelial cells from many locations across Africa. They analysed the DNA and created a map of genetic profiles of different elephant populations. Fig. 9.1 shows the distribution of these locations. Each location was known to contain one population of elephants. The different patterned dots (★ ■ ●) indicate where closely matching genetic profiles were found by researchers.

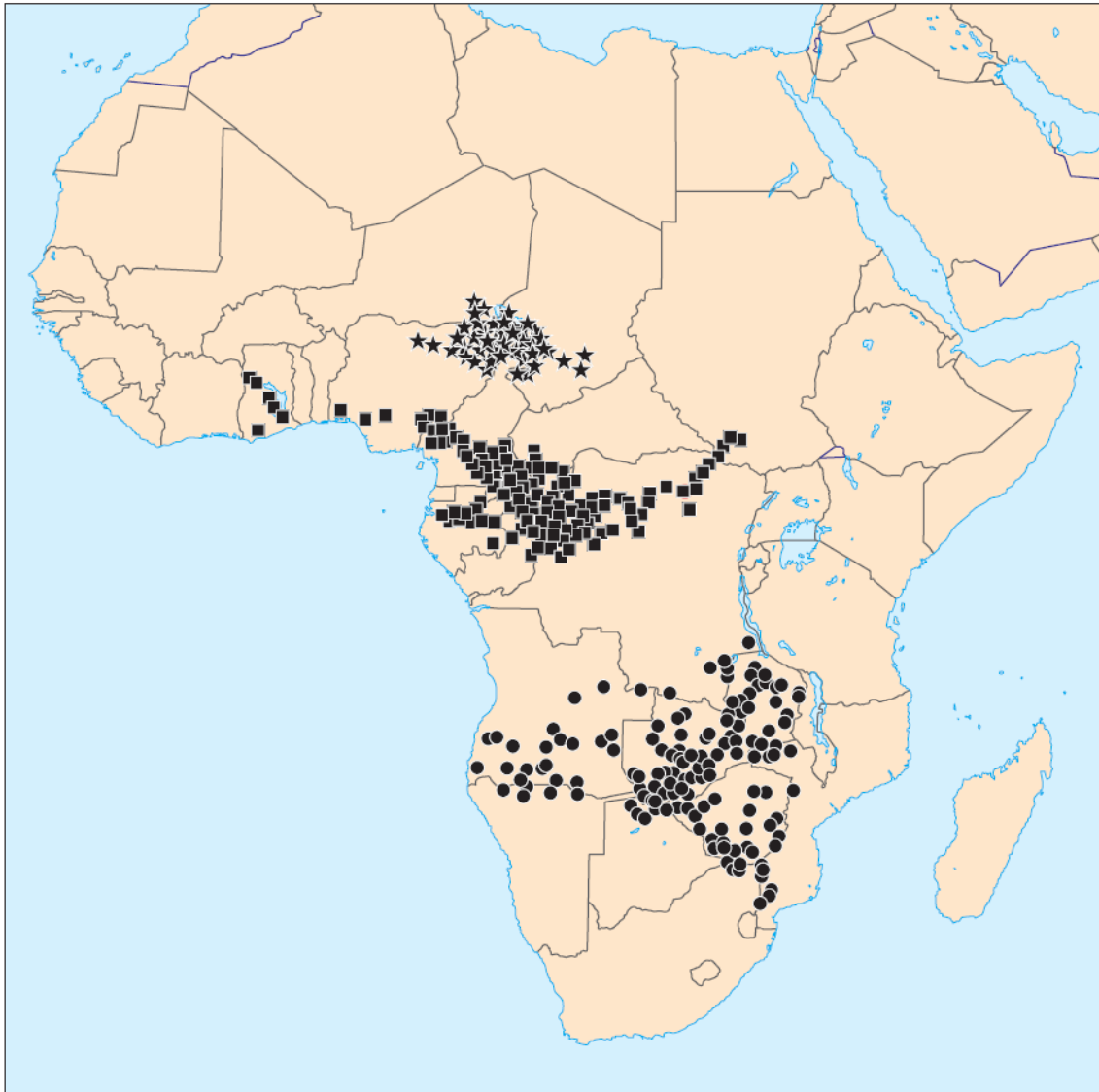


Fig. 9.1

- (a) Explain the distribution of the genetic profiles of the different elephant populations.

[2]

Most female African elephants have tusks, but typically about 6% of females in a population will never grow tusks.

However, in Gorongosa National Park in Mozambique:

- elephants with large tusks are targeted and killed by poachers for the illegal ivory trade,
- 33% of females between 10 and 20 years old do not have tusks,
- 50% of females over 20 years old do not have tusks.

(b) Explain the high incidence of elephants without tusks in the Gorongosa elephant population.

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..... [3]

(c) Describe and explain how the trend towards increased lack of tusks in a population will affect African elephant population sizes in the future.

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..... [2]

(d) Suggest how the data on the DNA profiles of populations could help with combatting poaching.

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..... [1]

Total: [8]

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- 10 Some hospital patients suffer from diarrhoea caused by infection with the bacterium *Clostridium difficile*. The *C. difficile* bacteria release toxins. These toxins cause the diarrhoea.

The toxins damage the cells lining the ileum, causing them to lose their microvilli. The damage to the cells reduces the absorption of the products of digestion and water, resulting in diarrhoea.

- (a) Explain why the damage to the cells lining the ileum reduces absorption of the products of digestion **and** why this reduces absorption of water.

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..... [2]

Not all patients in hospital with *C. difficile* develop diarrhoea.

Scientists measured the anti-toxin antibody concentration in hospital patients with and without *C. difficile* infection.

They measured the anti-toxin antibody concentration four times:

- on admission to hospital (day 0)
- on day 3
- on day 6
- on the day the patient left the hospital

Fig. 10.1 shows the scientists' results.

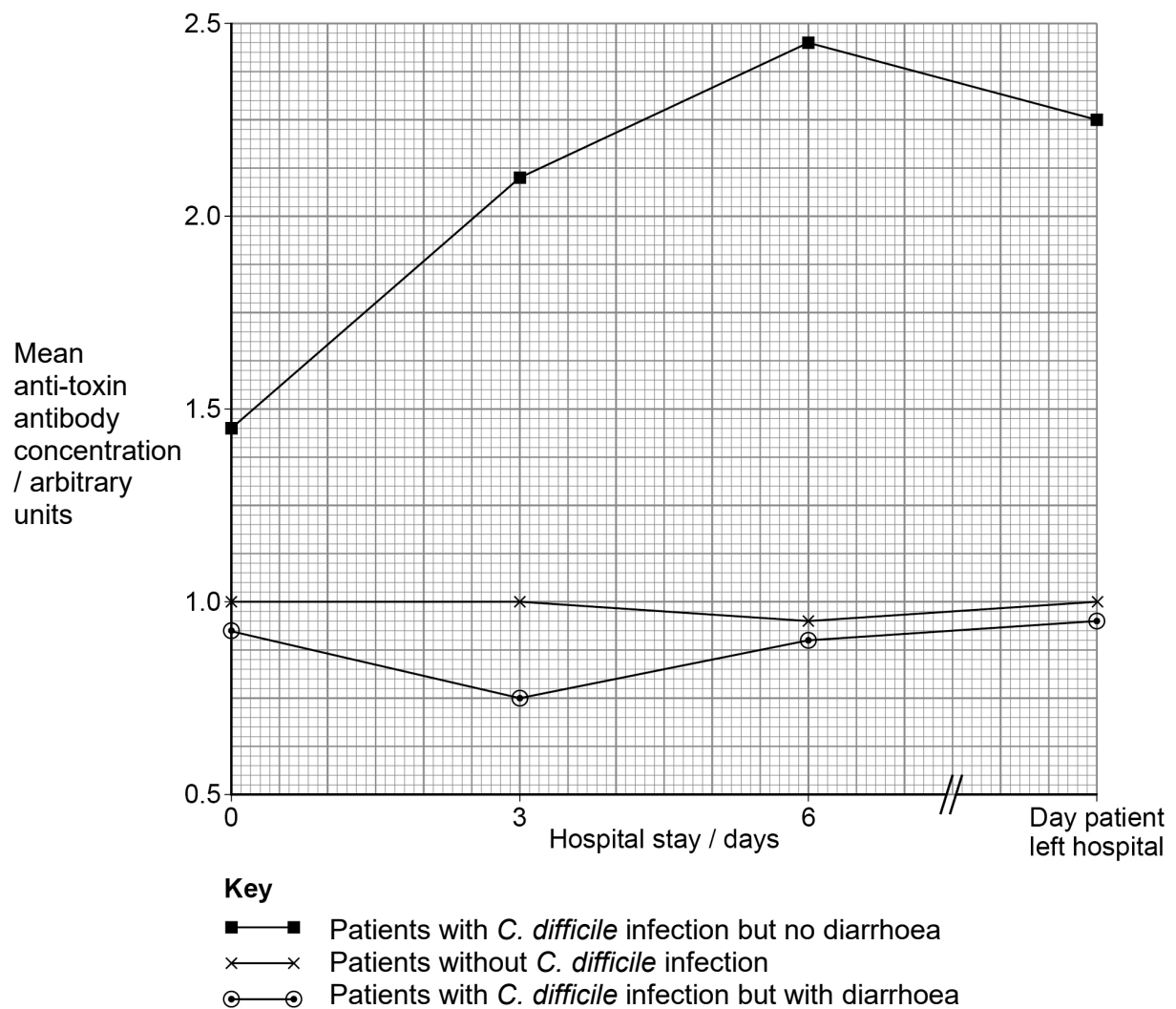


Fig. 10.1

The scientists suggest that the anti-toxin antibody could be given to some patients as a form of passive immunity.

- (b) With reference to Fig. 10.1 and your knowledge of the immune system, suggest which patients should be offered this anti-toxin antibody and explain how this passive immunity would work.

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..... [3]

- (c) Explain how somatic hypermutation can lead to affinity maturation.

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..... [2]

Total: [7]

- 11 Scientists carried out a study of the effect of temperature on three populations of the mosquito *Aedes aegypti*, each found in a different city in Brazil. All conditions, other than temperature, were kept the same.

Table 11.1 shows the mean length of time taken in days for the mosquitoes to develop from eggs to adults at different experimental temperatures.

Table 11.1

temperature / °C	mean total length of time to develop from egg to adult / days		
	city 1	city 2	city 3
16	38.8	31.4	36.3
22	23.4	24.8	20.9
28	13.1	11.6	12.5
33	13.2	11.9	11.4
36	9.3	10.1	10.7

Table 11.2 shows the mean length of time the adult females live at each of the five experimental temperatures.

Table 11.2

temperature / °C	mean length of time adult females live / days		
	city 1	city 2	city 3
16	14.8	10.2	12.9
22	34.7	26.6	25.4
28	30.1	27.4	23.3
33	22.2	22.6	15.0
36	10.5	9.5	7.2

Table 11.3 shows the mean number of eggs laid per adult female at each of the five experimental temperatures.

Table 11.3

temperature / °C	mean number of eggs laid per adult female		
	city 1	city 2	city 3
16	2.7	1.5	3.5
22	161.5	126.0	79.2
28	262.3	181.3	64.6
33	51.3	52.9	40.4
36	30.6	22.3	16.1

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Paper 2 Suggested Answers

- 1 (a)(i) no chloroplasts (present) ;
presence of (many) small vacuoles / no large vacuole / no central vacuole ;
central nucleus / nucleus not located at the, edge / periphery ;

Max 1

(ii)	name of cell structure	letter on Fig. 1.1
	cell surface membrane Ignore phospholipid bilayer	A
	mitochondrial membrane(s)	E
	nucleolus	C
	cell surface membrane ecf for cell membrane	A
	or tonoplast / vacuolar membrane	F
	or mitochondrial membrane(s)	E
	or nuclear envelope Accept nuclear membrane(s)	B
	mitochondrion / mitochondria	E

- (b)(i) endocytosis / pinocytosis ; **Reject** phagocytosis

- (b)(ii) (action of) **protease(s)** / peptidases / proteolytic enzyme(s) ;

hydrolysis / use water to break **peptide bonds**;

to form, peptides / **amino acids** ;

- (c) **formation of phagolysosomes** which **break down** / digest **pathogen** ;

one pt from below:

(by) **two named enzymes** ; e.g. lysozyme, protease, lipase, carbohydrase, nuclease

any **two named substrates that are hydrolysed** ; e.g. polysaccharides, peptidoglycans, proteins, lipids, glycogen, nucleic acid(s)

2 (a) glycogen **branched** vs cellulose **unbranched** ;

monomer is / made of alpha / **α -glucose** vs cellulose monomer is **β -glucose** ;

$\alpha(1\rightarrow4)$ and $\alpha(1\rightarrow6)$ glycosidic bonds vs cellulose **$\beta(1\rightarrow4)$ glycosidic bonds** ;

alternate, monomers / glucose residues / 1,4-(glycosidic) bonds, **are not, rotated 180°** / inverted / flipped / Alternative Wording ; or reverse argument

Max 3

- (b)
1. Glycogen is able to **store large amounts of energy** as it composed of several hundred / thousands of **glucose monomers** linked together by glycosidic bonds ;
 2. **$\alpha(1\rightarrow4)$ glycosidic bonds** are **easily hydrolysed** by glycogen phosphorylase to release glucose, as respiratory substrate ;
 3. **$\alpha(1\rightarrow6)$ glycosidic bonds** are **easily hydrolysed by debranching enzyme**, which speeds up digestion;
 4. Due to extensive intrachain hydrogen bonding, glycogen has **no free $-OH$ groups** available for bonding with water, making it **insoluble**, hence **osmotically inactive** and ideal as storage molecule. ;
 5. **coil helically / branched structure of glycogen**, making the molecule compact for storage;

Max 3

- (c)
1. Cellulose consist thousands of **β glucose monomers linked by $\beta(1\rightarrow4)$ glycosidic bonds, with 180° rotation of alternate β glucose residues**, resulting in **long straight chains** of cellulose. ;
 2. This allows the cellulose chains to **lie parallel** with each other and **extensive hydrogen bonds are formed between the $-OH$ groups** that project outwards. ;
 3. Such extensive hydrogen cross-linkages contributed to its **high tensile strength** in the cell wall necessary to resist mechanical damage to the plant cells. ;
 4. Furthermore, due to extensive hydrogen bonding to form microfibrils, cellulose has **no free $-OH$ groups to hydrogen bond with water, hence cellulose is insoluble**. This allows it to be a structural polyepitope in the plant cell wall. ;
 5. With many cellulose chains **associating to form microfibrils and twisting of microfibrils to form fibrils and macrofibrils**, the tensile strength of cellulose fibres in the cell wall is greatly increased. ;
 6. **Spaces between the cellulose macrofibrils** in the cell wall allows the cell wall to remain **fully permeable to substances** that needs to be transported in or out of the cell. ;

Max 3

- 3 (a)(i) **Hormone molecule is hydrophilic and too large** to cross membrane ;
unable to pass through hydrophobic core of phospholipid bilayer ;
- (a)(ii) **Hormones** are **ligands** that bind complementarily in shape to the cell surface receptor ; ;
kinases and phosphatases within the cell lead to specific response / **phosphorylation cascade** ;
 (cellular response) **transcription / production of mRNA** ;
- (b)(i) as pH increases from pH 1 to pH 5, phosphatase activity increases from 0.5 a.u. to 4.5 a.u. ;
 as pH increases pH 5 to pH 9, phosphatase activity decreases from 4.5 a.u to 1.5 a.u ;
 Optimum pH is pH 5;
- (b)(ii) low pH equivalent to **high H^+ concentration**. **H^+ disrupts hydrogen and ionic bonds**;
active site shape changed / no longer complementary to substrate , **enzyme 3D conformation changed**, and **enzymes are denatured** ;
decreases frequency of effective collisions and **fewer enzyme-substrate complexes** formed;

- 4 (a)(i) Similarities
Both form **phosphodiester bonds between adjacent deoxyribonucleotides** ;
Both require an existing DNA strand ;
- Differences
DNA polymerase **add deoxyribonucleotides to complementary strands**, but DNA ligase does not / **seal the nick**;
DNA polymerase requires a template strand, but DNA ligase does not ;
DNA polymerase works in 5' to 3' direction, but DNA ligase has no directionality ;
DNA polymerase has **proofreading ability**, but DNA ligase does not;
- Max 5
- (a)(ii) S phase / synthesis phase ;
- (b)(i) Base **9**: Cytosine Base **12**: Thymine ; (both must spell in full and correctly)
- (b)(ii) Amino / N
- (b)(iii) 3'
- (b)(iv) Hydrogen bonds take place **between complementary base pairs** along the tRNA;
form a **3D L-shape structure / 2D clover-leaf shape**;
has correct shape for recognition by aminoacyl-tRNA synthetase or binding to **ribosome** ;
- Max 2
- 5 (a) *araBAD* operon contains ***araB*, *araA* and *araD***, **which** have **related functions** for the **breakdown of arabinose** ;
under the **control of the same promoter and operator** ;
product is a single **polycistronic mRNA** coding for **enzymes 1, 2 and 3** ;
- (b) **inducible** operon;
enzymes coded by the operon are involved in **catabolic** reaction/**breakdown** of arabinose ;
operon is **normally “off”** and **only switched “on” in the presence of arabinose** ;
- Max 2
- (c) 1 In the **absence of glucose**/when glucose levels are **low**, **cAMP is high** and binds to allosteric site of the CAP protein, activating CAP;
2 Active CAP/**CAP-cAMP complex binds to CAP binding site, increasing the affinity of RNA polymerase for the *araBAD* promoter** ; (Accept: increase binding affinity of arabinose-*araC* complex to the operator);
3 In the presence of arabinose, this upregulates transcription/expression of *araB*, *araA*, and *araD*/structural genes;

- 6 (a) Red king crab has **104 pairs of chromosomes** per cell, which is **more** than that of koala with only **8 pairs of chromosomes** per cell.;

This allows for a **greater number of possible chromosome combinations.**;

During **crossing over in Prophase I.**;

And during **independent assortment and random segregation of homologous chromosomes** during **Metaphase I and Anaphase I.**;

- (b) Males only have **1 chromosome per cell**, hence meiosis cannot occur since there are **no homologous chromosomes** / paired chromosomes.;

- (c)(i) **t-test;**

- (c)(ii) There is **no significant difference** between the **mitotic index at 200 μm and 300 μm .**;

- (d) The cells are in **interphase** where chromosomes are **not condensed** yet.;
The cells have **finished cell division** where chromosomes are **decondensed.**;
Chromosomes are at a **different plane** / depends on where the section is cut.;
Chromosomes **have not taken up the stain** / enough stain.;

Max 3

- (e) Koala has the **highest mitotic index at 27%**, compared to **12%, 18% and 6% in red king crab, maize and jack jumper ant.** Koala also has the **highest** number of p53 gene mutations at **11 mutations per 1000 cells**, compared to **4, 5.5 and 1 mutations per 1000 cells in red king crab, maize and jack jumper ant;**

The highest mitotic index shows that the **greatest proportion** of its cells are **actively dividing.**;

p53 is a **tumour suppressor gene** and the **loss-of-function mutation of p53 gene** causes cells with damaged DNA to continue to divide.;

Together, these increase the chances of **uncontrolled cell division and tumour formation.**;

- 7 (a)(i) $F^V < F^E < F^M < F^L$;
 (a)(ii) $F^M F^V Aa$;
 (a)(iii) Cannot ECF from ii.

Parental phenotype: mid flowering, purple flowers x late flowering, purple flowers

Parental genotype: $F^M F^V Aa$ x $F^L F^E Aa$

Gametes:



Punnett square:

Gamete	$F^L A$	$F^L a$	$F^E A$	$F^E a$
$F^M A$	$F^L F^M AA$ late flowering, purple flowers	$F^L F^M Aa$ late flowering, purple flowers	$F^M F^E AA$ mid flowering, purple flowers	$F^M F^E Aa$ mid flowering, purple flowers
$F^M a$	$F^L F^M Aa$ late flowering, purple flowers	$F^L F^M aa$ late flowering, white flowers	$F^M F^E Aa$ mid flowering, purple flowers	$F^M F^E aa$ mid flowering, white flowers
$F^V A$	$F^L F^V AA$ late flowering, purple flowers	$F^L F^V Aa$ late flowering, purple flowers	$F^E F^V AA$ early flowering, purple flowers	$F^E F^V Aa$ early flowering, purple flowers
$F^V a$	$F^L F^V Aa$ late flowering, purple flowers	$F^L F^V aa$ late flowering, white flowers	$F^E F^V Aa$ early flowering, purple flowers	$F^E F^V aa$ early flowering, white flowers

Phenotypic ratio:

6	: 2	: 3	: 1	: 3	: 1
late flowering purple flowers	late flowering white flowers	mid flowering purple flowers	mid flowering white flowers	early flowering purple flowers	early flowering white flowers

Correct parental genotype;

Correct gametes;

Correct punnet square / offspring genotype;

Correct offspring genotype matched with phenotypic ratio;

- (b) In inheritance caused by multiple alleles, **one gene** is involved in determining the characteristic whereas in polygenic inheritance, **several genes** are involved in determining the same characteristic;

In inheritance caused by multiple alleles, **each allele** of the gene **have a qualitative effect** whereas in polygenic inheritance, each allele having an **additive / quantitative effect**;

In inheritance caused by multiple alleles, the **phenotypes show discontinuous variation** / fall into discrete classes without intermediates whereas in polygenic inheritance, the phenotypes show **continuous variation** / a range of values from 1 extreme to another;

Max 2

8 (a)

Similarity

Both chlorophylls *b* and *c* have a **peak at about 460 - 470nm.**;

Differences

Chlorophyll *c* has **one peak** whereas chlorophyll *b* has **two peaks.**;

Chlorophyll *b* has a **peak at 640nm** but chlorophyll *c* does not / chlorophyll *b* absorbs more light at 640nm.;

- (b) **No peak** / lower rate of photosynthesis at **640nm.**;
Narrower peak at **670nm.**;

Max 1

- (c) In the buffer solution of **pH 4**, there is **no proton gradient** thus **no ATP produced.**;

When the pH of buffer solution is raised to **pH 8**, a **proton gradient** is produced.;

Protons move out of the vesicles through the **ATP synthase.**;

Proton motive force results in the **synthesis of ATP.**;

- 9 (a) Populations are **geographically isolated**, with each location having a **different selection pressure**.;
- Populations **evolve independently** as there is **no gene flow** between the populations.;
- In each area, individuals can **interbreed** and remain **genetically similar**.;
- Max 2
- (b) There is a selection pressure due to **poaching / predation**.;
- Elephants **without tusks** are at **selective advantage** as they have higher chance of **survival and reproduction**, **passing down alleles** to their offspring.;
- Alleles coding for no tusks will increase in frequency** in the gene pool of population.;
- (c) **Increased** population size.;
- Tusk-less elephants are **not poached for ivory**.;
- OR
- Decreased** population size.;
- Tusk-less elephants **cannot defend against predators / feed as well**.;
- (d) Data can be used to **identify where the ivory came from** to identify recent illegal activity.;
- Ref to **any anti-poaching action** targeting populations at risk.;
- 10 (a) Max 1
- Damaged to the cell lining the ileum leads to reduction in **surface area / fewer transport proteins**. Thus, solute concentration in cells decreases ;
- Hence **water potential, of cells lining the ileum increases** / lumen decreases
+ less water molecules moves from **lumen into cells** lining the ileum / more water molecules move out of the cells into lumen
+ via osmosis ;
- (b) **Patients with *C. difficile* infection and diarrhoea**.;
- Patients with *C. difficile* and diarrhoea have the **lowest concentration** of anti-toxin antibody throughout the duration in the hospital + **quote any 1 set of data (infected ones) on any 1 day**.;
- Anti-toxin antibody causes **neutralisation, agglutination and phagocytosis (any 2 functions of antibody)**, thereby **treating diarrhoea**.;
- (c) Somatic hypermutation introduces **random point mutations in the V, D or J segments** at a **high rate**, allowing B cells to produce antibodies with altered V region.;
- Clonal selection** then occurs where **B cells that produce antibodies with higher affinity receive more signals to proliferate more**, thereby resulting in an increase in average affinity of the antibodies to antigen (affinity maturation).;

- 11 (a) The student's conclusion is accurate to some extent (no mark).

Accurate:

From 22°C / 28°C to 33°C, the **mean total length of time to develop from egg to adult generally decreases + quote any 1 set of data from 1 city.**;
Shorter life cycles mean **shorter time of exposure to adverse environmental conditions**, thereby **increasing reproductive success of these mosquito vectors** and the incidence of viral dengue disease.;

Inaccurate:

From 22°C / 28°C to 33°C, the **mean length of time adult females live decreases + quote any 1 set of data from 1 city.**;
This **reduces the total blood meals and bites, decreasing the number of people** the mosquitoes can infect in its lifetime, thereby **reducing** the incidence of viral dengue disease.;

From 22°C / 28°C to 33°C, the **mean number of eggs laid per adult female decreases + quote any 1 set of data from 1 city.**;
This reduces the number of mosquitoes in the next generation and **less adult females emerge, reducing** the incidence of viral dengue disease.;

Max 5