Cambridge Assessment International Education

Cambridge Pre-U

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0123456789

BIOLOGY **9790/01**

Paper 1 Structured **For examination from 2020**

SPECIMEN PAPER **2 hours 30 minutes**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 100.
- The number of marks for each question or part question is shown in brackets [ ].

This specimen paper has been updated for assessments from 2020. The specimen questions and mark schemes remain the same. The layout and wording of the front covers have been updated to reflect the new Cambridge International branding and to make instructions clearer for candidates.

For Examiner's Use	
Section A	
21	
22	
23	
24	
25	
26	
Total	

This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document has **30** pages. Blank pages are indicated.

Section A

Answer **all** the questions.

You are advised to spend no more than 30 minutes on this section.

1 The resolving power of a microscope depends on the wavelength used by the system. Table 1.1 shows the wavelengths and resolving powers of three types of microscope.

Table 1.1

type of microscope	wavelength / μm	resolving power / μm
light microscope	0.8	0.4
ultra-violet microscope	0.2	0.1
electron microscope	0.005	0.0025

Table 1.2 gives details of three biological structures that are investigated using microscopes. The ticks (✓) and crosses (×) indicate whether or not each structure can be clearly seen with each microscope.

Table 1.2

	Escherichia coli bacterium, length 2 μm	ribosome, diameter 25 nm	plasma membrane, thickness 10 nm
light microscope	✓	×	×
ultra-violet microscope			
electron microscope	✓	✓	✓

Which row correctly completes Table 1.2 to show which structures can be clearly seen with an **ultra-violet** microscope?

	Escherichia coli bacterium, length 2 μm	ribosome, diameter 25 nm	plasma membrane, thickness 10 nm
A	✓	✓	✓
B	✓	✓	×
C	✓	×	×
D	×	×	×

answer ..... [1]

2 Which description of telomeres and telomerase reverse transcriptase (TERT) is correct?

	telomeres	telomerase reverse transcriptase (TERT)
A	present in eukaryotes	uses RNA as a template to make single-stranded DNA
B	present in eukaryotes	inhibits the loss of telomeres from DNA during semi-conservative replication
C	present in prokaryotes	inhibits the loss of telomeres from DNA during semi-conservative replication
D	present in prokaryotes	uses RNA as a template to make single-stranded DNA

answer ..... [1]

3 The enzyme phosphofructokinase is involved in the phosphorylation of hexose phosphate sugars during glycolysis. It is involved in the control of the rate of glycolysis, and thus respiration, by end-product inhibition.

Deduce which of the following is a description of this enzyme.

	shape of binding site(s)	substrate	products
A	no allosteric site, active site complementary to ATP and hexose	hexose	hexose phosphate
B	allosteric site complementary to glucose, active site complementary to hexose phosphate	hexose phosphate	hexose phosphate
C	allosteric site complementary to ATP, active site complementary to ATP and hexose phosphate	hexose phosphate	hexose bisphosphate
D	no allosteric site, active site complementary to hexose bisphosphate	hexose bisphosphate	two triose phosphate

answer ..... [1]

4 An action potential arrives at the synaptic knob increasing the permeability of the membranes to ...**1**..., which diffuse in and cause vesicles to move to the pre-synaptic membrane and fuse with it.

...**2**... occurs and acetylcholine moves across the synaptic cleft by ...**3**... and attaches to receptors on the post-synaptic membrane, causing ...**4**... channels to open and a post-synaptic potential to be generated.

Which words correctly complete the numbered gaps?

	1	2	3	4
A	sodium ions	endocytosis	active transport	calcium ion
B	calcium ions	exocytosis	diffusion	sodium ion
C	calcium ions	exocytosis	active transport	sodium ion
D	sodium ions	endocytosis	diffusion	calcium ion

answer ..... [1]

5 The diagram represents a length of DNA from a prokaryote that includes a structural gene.

Parts of the length of DNA are labelled W, X and Y. They have different functions in the control of transcription of the structural gene.

Fig. 5.1

What identifies the functions of parts W, X and Y?

	W	X	Y
A	operator	regulator	regulator
B	promoter	regulator	operator
C	regulator	promoter	operator
D	promoter	operator	promoter

answer ..... [1]

6 Small samples from crime scenes can be genetically profiled (DNA fingerprinted).

Which is a possible combination of crime scene sample and methods for a successful genetic profiling process?

	crime scene sample	PCR	ethidium bromide and X-rays
A	red blood cells	✓	✓
B	saliva	×	✓
C	semen	✓	×
D	skin cells	✓	✓

key

✓ = used
× = not used

answer ..... [1]

7 A symbiont may be defined as a species in which individuals live in a long-term, intimate and beneficial relationship with hosts of a different species. As the name suggests, endosymbionts live within their hosts.

Which statement provides the strongest evidence that mitochondria and chloroplasts in eukaryotes originated as prokaryotic endosymbionts?

A Proteins encoded by the nucleus are exported to these organelles.

B Their inner membrane has a different structure from other intracellular membranes.

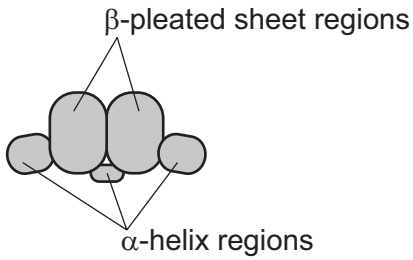
C They are surrounded by a double membrane.

D They contain their own DNA and have 70S, rather than 80S, ribosomes.

answer ..... [1]

8 Approximately half of the total protein in a pea seed consists of the storage protein vicilin.

- Each molecule of vicilin is made up of three identical polypeptides.
- Each polypeptide is made up of two β-pleated sheet regions with linking α-helix regions, folded into the shape shown to the right.



- This allows the three polypeptides to pack together into a compact, flat storage molecule, as shown below.

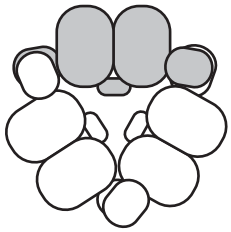


Fig. 8.1

Which row correctly describes the structure of vicilin?

	primary structure	secondary structure	tertiary structure	quaternary structure
A	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	association of three polypeptides	folding of each polypeptide
B	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	folding of each polypeptide	association of three polypeptides
C	association of three polypeptides	amino acid sequence of one polypeptide	α-helix and β-pleated sheet regions of each polypeptide	folding of each polypeptide
D	association of three polypeptides	amino acid sequence of one polypeptide	folding of each polypeptide	α-helix and β-pleated sheet regions of each polypeptide

answer ..... [1]

9 Which statements are correct interpretations of Darwinian evolutionary theory?

1 Advantageous behaviour acquired during the lifetime of an individual is likely to be inherited.

2 In competition for survival, the more aggressive animals are more likely to survive.

3 Species living in a stable environment will not evolve any further.

4 Variation between individuals of a species is essential for evolutionary change.

A 1, 2 and 4 only

B 2 and 3 only

C 3 and 4 only

D 4 only

answer ..... [1]

10 Curve **X** shows the oxygen dissociation curve for human haemoglobin. Under certain conditions this curve becomes displaced to the right. This is termed the Bohr effect and is shown by curve **Y**.

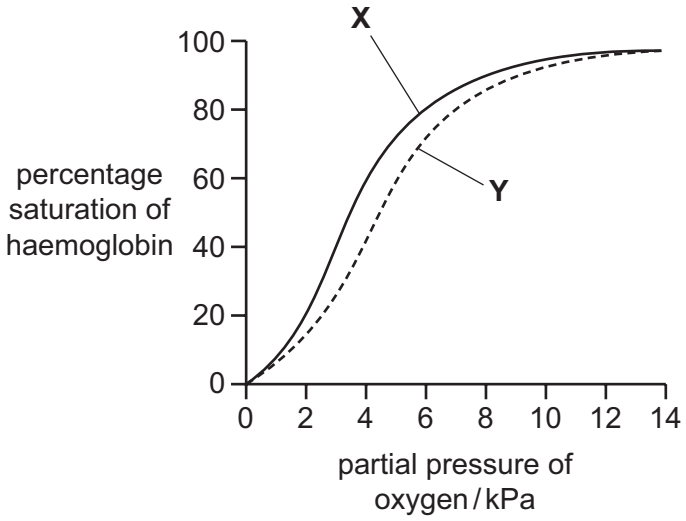


Fig. 10.1

Which change is responsible for the Bohr effect?

A a decrease in the partial pressure of oxygen

B a decrease in the temperature of the blood

C an increase in pH of the blood

D an increase in the partial pressure of carbon dioxide

answer ..... [1]

11 Sometimes scientists need to isolate organelles. This can be achieved by taking a number of cells and breaking their cell surface membranes to release the contents of the cells into a buffer solution.

In zonal centrifugation, the suspension of cell contents is placed on top of a sucrose density gradient. The tube is then placed in a centrifuge and spun at high speed. The heavier particles will move towards the bottom of the tube faster than lighter particles, as shown below.

If a sample of intact prokaryotes had been added to a suspension of eukaryotic cell contents, where would you expect them to be found?

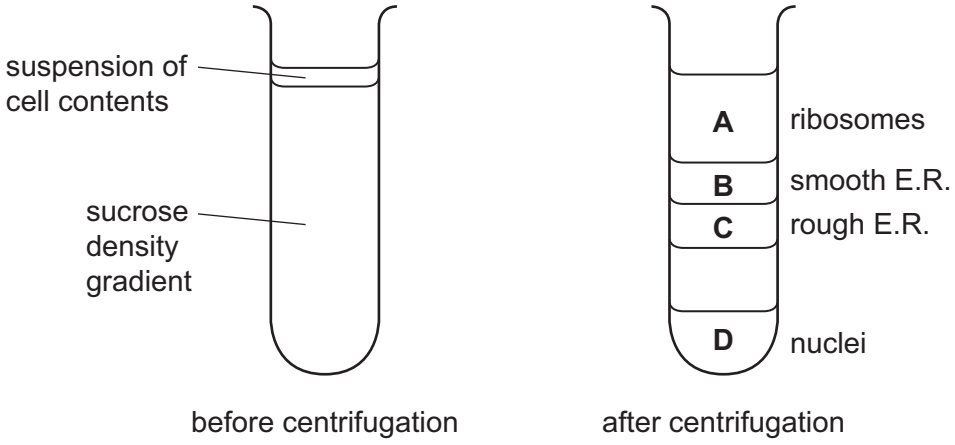


Fig. 11.1

answer ..... [1]

12 A particular snake venom causes death by leading to paralysis of muscles. It exerts its effect at synapses.

The statements below were put forward as possible explanations for the effects of this venom.

1 It interferes with the binding of neurotransmitter vesicles to the membranes.

2 It binds with neurotransmitter receptor sites.

3 It blocks calcium and sodium channels.

4 It destroys the myelin sheath of the neurone.

5 It binds with neurotransmitter.

Which statements should be investigated further?

A 1, 2, 3 and 5 only

B 2, 4 and 5 only

C 4 only

D 1, 2, 3, 4 and 5

answer ..... [1]

13 What happens during the light-dependent reactions of photosynthesis?

1 ADP is hydrolysed.

2 ADP is phosphorylated.

3 ATP is hydrolysed.

4 ATP is phosphorylated.

5 NADP is oxidised.

6 NADP is reduced.

A 1 and 5 only

B 2 and 6 only

C 1, 4 and 5 only

D 2, 3 and 6 only

answer ..... [1]

14 One of the many recessive mutations of the *CFTR* gene changes one amino acid in the region of the CFTR protein that binds ATP. The graph shows the effect of different concentrations of ATP on normal and mutant CFTR proteins.

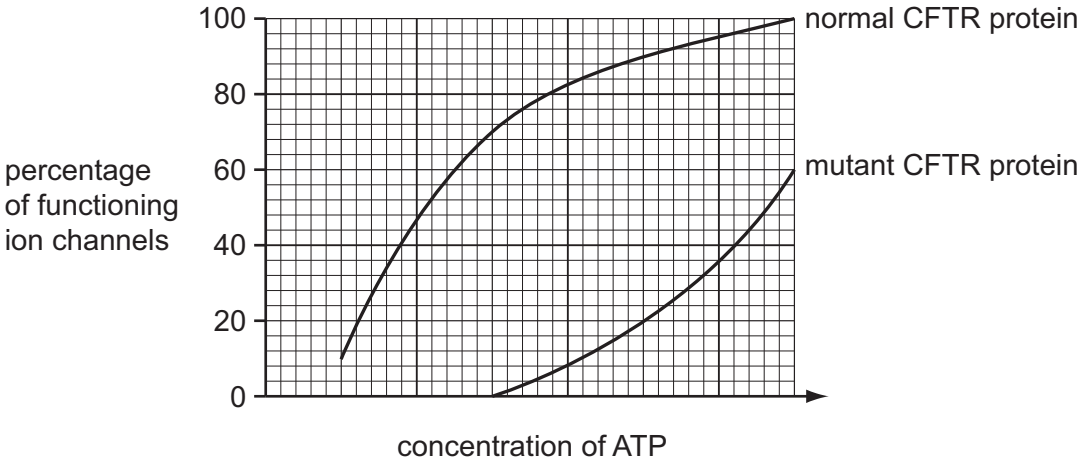


Fig. 14.1

Which correctly describes individuals who are homozygous for this mutation?

1 Their CFTR protein cannot bind ATP and cannot act as an ion channel.

2 Their CFTR protein binds ATP less readily than normal CFTR protein.

3 They produce CFTR protein that must bind ATP to function as an ion channel.

4 They produce a mixture of normal and mutant CFTR protein, both of which can act as an ion channel.

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

answer ..... [1]

15 Many plants cannot be fertilised by pollen from their own flowers. This is known as self-incompatibility. In some species one or two S genes are responsible, each of which may have many different alleles.

If a pollen grain has an S allele which matches an allele in the genotype of the stigma then the pollen grain fails to germinate or the pollen tube fails to grow through the style.

Which pollen grains would germinate on the stigma of a flower that only included alleles S_3 and S_4 of the S gene?

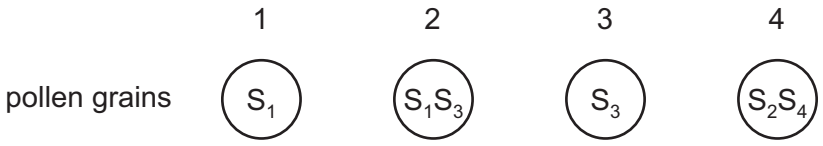


Fig. 15.1

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

answer ..... [1]

16 Molecules can be transported in several ways.

1 cohesion/tension

2 diffusion

3 mass flow

4 osmosis

Which row shows a correct method of transport for each situation?

	into capillaries	in phloem	out of stomata	in xylem
A	1	2	3	4
B	2	1	4	3
C	3	4	1	2
D	4	3	2	1

answer ..... [1]

Questions 17, 18, 19 and 20

The graphs on the opposite page show features of the survival and reproductive success of adult males and females of three different species:

A barnacle goose

B Bewick's swan

C dwarf mongoose

D red deer

In all of these species, equal numbers of male and female offspring are produced.

Column 1 shows the age-specific survival, which is the probability that adult animals of different ages will survive for a further year.

Column 2 shows survivorship curves. A survivorship curve shows the proportion of a population that survives to different ages.

Column 3 shows the mean annual reproductive success which is the number of offspring produced by adult males and females of different ages.

Study the graphs and then identify which one gives the best match to each of the statements in questions 17 to 20. Record your answer to each question by using a letter for the appropriate species and a number for the appropriate graph, e.g. A1, B2, C3, etc.

17 A species with a higher proportion of females than males in the oldest age groups.

answer ..... [1]

18 A species with a mortality rate above 60% during the first three years of life.

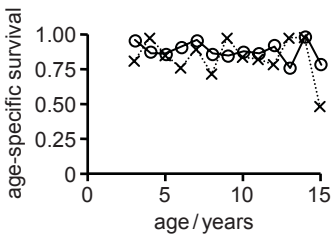
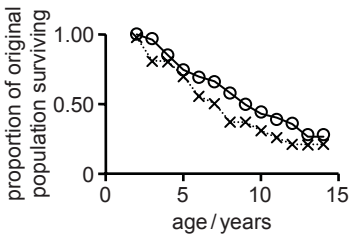
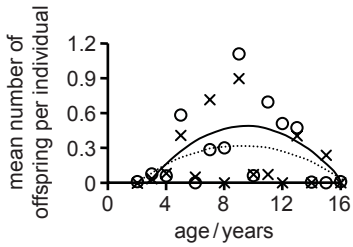
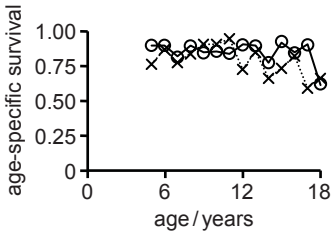
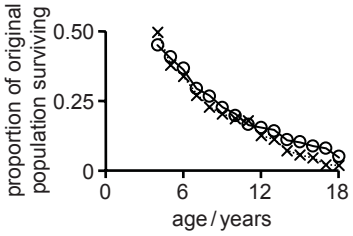
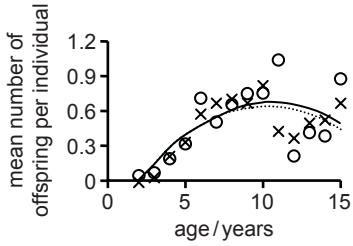
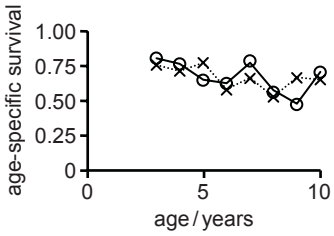
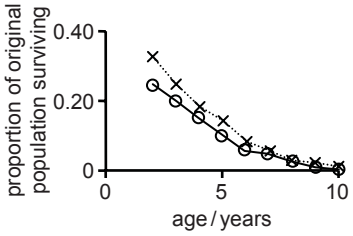
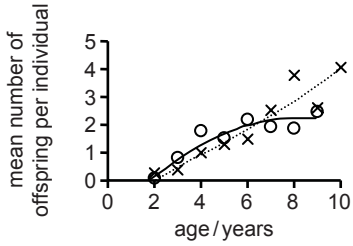
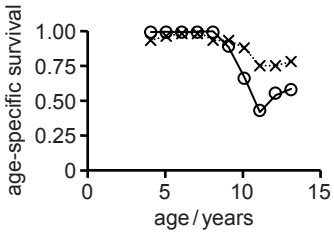
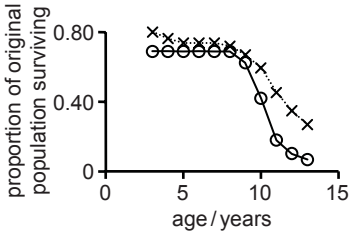
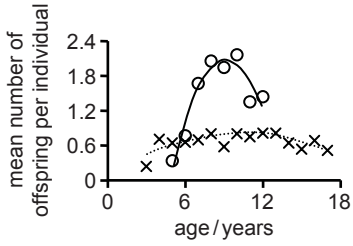
answer ..... [1]

19 A species in which, for every year that data was collected, both males and females are more likely to survive than they are to die.

answer ..... [1]

20 A species that is likely to be polygynous (males mate with more than one female).

answer ..... [1]

species	1 age-specific survival	2 survivorship	3 mean annual reproductive success
A barnacle goose			
B Bewick's swan			
C dwarf mongoose			
D red deer			

key

×·····× = females

o—o = males

Section B

Answer **all** the questions.

You are advised to spend no more than 2 hours on this section.

21 ATP is a nucleotide that performs many essential roles in prokaryotic and eukaryotic cells. It is considered to be the major 'energy currency' of cells.

Fig. 21.1 shows the structure of ATP.

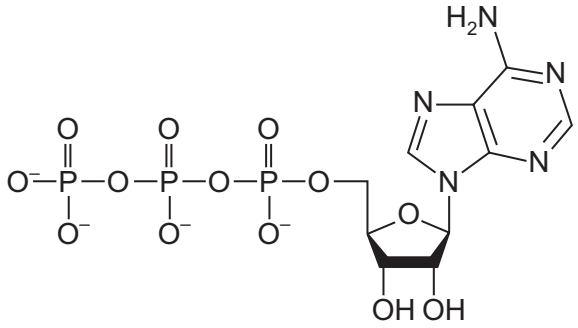


Fig. 21.1

(a) (i) Explain why ATP is said to be an 'energy currency' and describe the features of a molecule of ATP that make it suitable for its role.

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..... [4]

(ii) Describe an example of ATP acting as an 'energy currency'.

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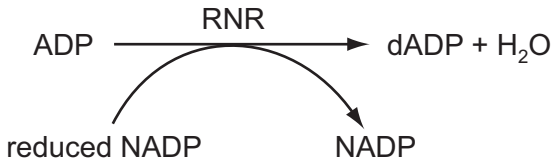
..... [2]

(b) The enzyme ribonucleotide reductase (RNR) is needed for DNA synthesis. The enzyme catalyses the reaction in which adenosine diphosphate is converted to deoxyadenosine diphosphate (dADP).



(i) State how adenosine diphosphate differs from deoxyadenosine diphosphate.

.....

..... [1]

(ii) Suggest how dADP is used in the synthesis of DNA.

.....

.....

.....

..... [2]

(c) Excess adenosine is deaminated to deoxyinosinol in a reaction catalysed by the enzyme, adenosine deaminase (ADA), which consists of one polypeptide.

Fig. 21.2 shows a ribbon model of ADA.

Fig. 21.2

Describe the structure of the enzyme, ADA, as shown in Fig. 21.2. You may add labels to the diagram to help your answer if you wish.

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.....

..... [3]

A deficiency of ADA is a cause of severe combined immunodeficiency syndrome (SCID).

Children with non-functional adenosine deaminase are at risk of infections as a toxic product builds up inside T lymphocytes (T cells) and kills these cells.

(d) Outline the roles of named T lymphocytes in the immune system.

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..... [3]

(e) Gene therapy has been used to treat SCID.

Explain the problems encountered in using gene therapy as a treatment for genetic diseases, such as SCID.

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..... [4]

[Total: 19]

22 Skin cancer cells may be grown in culture and examined using the technique of immunofluorescence in which antibodies are used to attach fluorescent dyes to specific molecules within the cells.

Fig. 22.1 is an immunofluorescent light micrograph of skin cancer cells. The DNA in the large cell nuclei is stained blue. These nuclei are typical of cells undergoing division in cancer. Proteins in the cytoplasm are stained green.

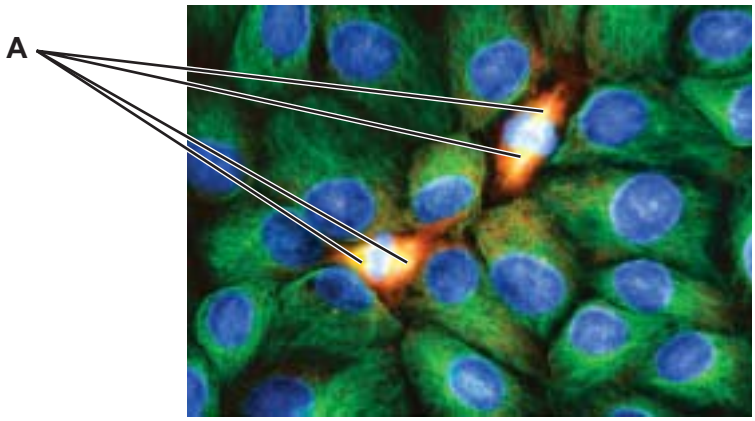

Fig. 22.1

(a) (i) Suggest why proteins in the cytoplasm of the non-dividing cells in Fig. 22.1 are not evenly distributed.

.....

..... [1]

(ii) There are two cells in the process of dividing. Each of these cells has two areas stained bright yellow, labelled **A** on Fig. 22.1.

Suggest the identity of these two areas and outline their function.

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..... [3]

(b) Before the skin cancer cells could be stained with antibodies, the cells had to be fixed and treated with a mild detergent to increase the permeability of the cell surface membranes.

(i) State why it is necessary to increase the permeability of the cell surface membranes before staining cells using the technique of immunofluorescence.

.....

..... [1]

(ii) State **and** explain two advantages of using immunofluorescence in studying the changes that occur in cells during cell division.

advantage 1 .....

.....

.....

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.....

advantage 2 .....

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..... [4]

[Total: 9]

23 Fig. 23.1 is a photomicrograph of the lower epidermis of the leaf of an oleander, *Nerium oleander*. Fig. 23.2 is a photomicrograph of the lower epidermis of the leaf of a privet, *Ligustrum vulgare*. Both photomicrographs are to the same scale.

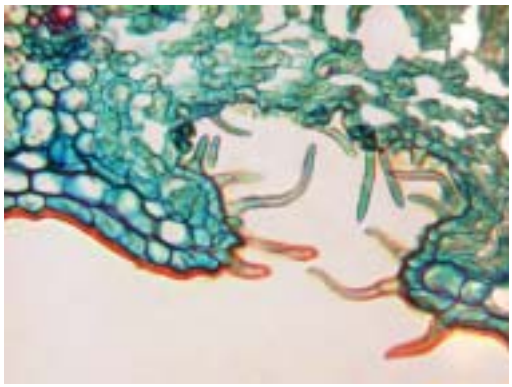

Fig. 23.1

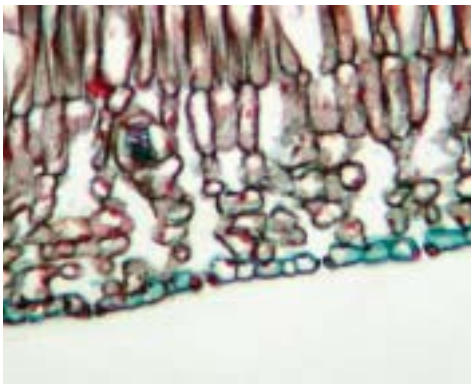

Fig. 23.2

(a) State two ways, visible in Fig. 23.1 and Fig. 23.2, in which the epidermis of oleander differs from the epidermis of privet. In each case explain how oleander is adapted to survive severe drought conditions.

1 .....

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.....

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2 .....

.....

.....

..... [4]

The concentration of three ions, potassium, chloride and phosphate, were determined in guard cells of closed and open stomata. Fig. 23.3 shows these concentrations measured in arbitrary units, which are the same for all three ions.

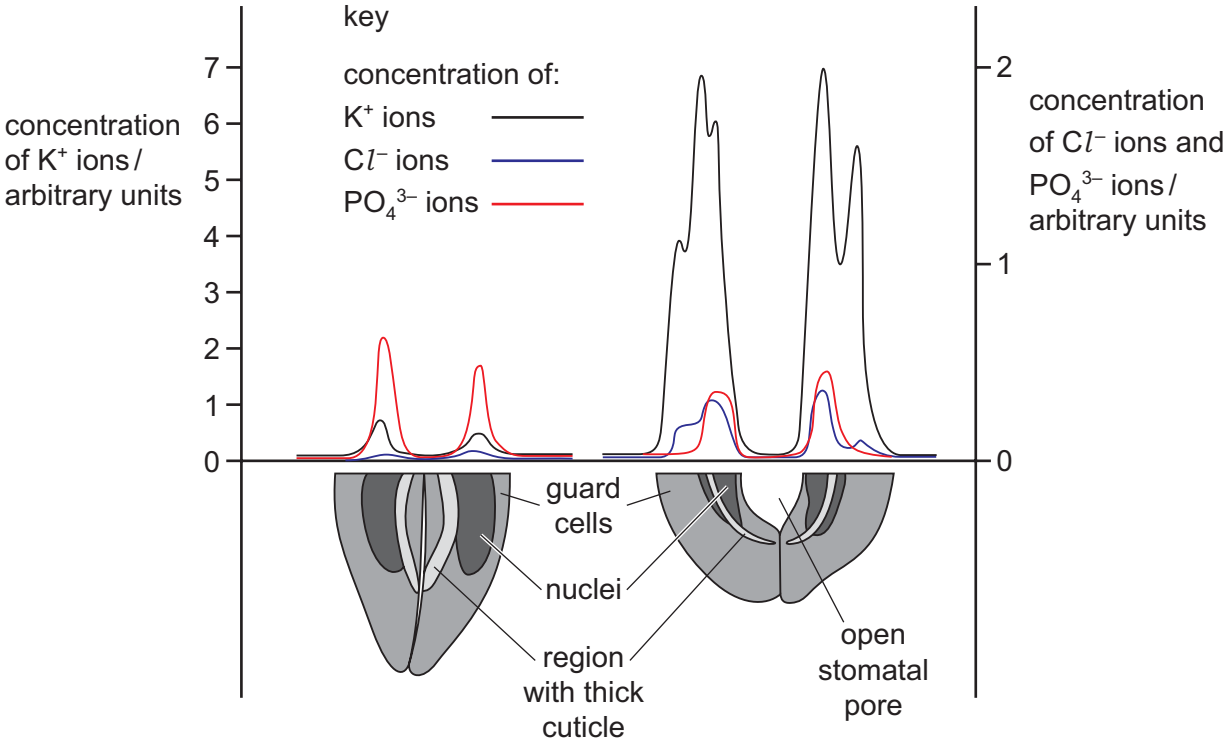

Fig. 23.3

(b) Suggest a possible mechanism, that can be supported by the data in Fig. 23.3, to account for the changes in stomatal aperture.

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..... [4]

(c) Many plant cells have cytoplasmic connections (plasmodesmata) between neighbouring cells, but these are absent from guard cells.

Explain how this helps guard cells function efficiently.

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..... [2]

[Total: 10]

24 Fig. 24.1 summarises the reactions which occur in the Calvin cycle.

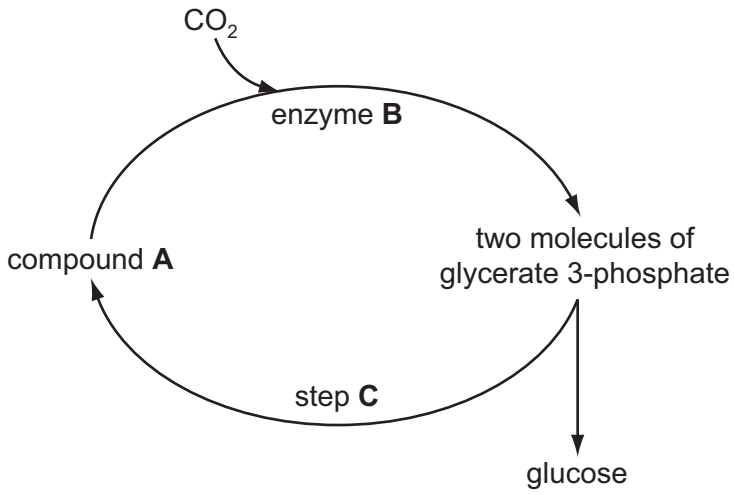

Fig. 24.1

(a) Where, precisely, in a plant cell do the reactions shown in Fig. 24.1 take place?

..... [1]

(b) Name

(i) compound **A**

..... [1]

(ii) enzyme **B**

..... [1]

(c) Calculate the proportion of carbon atoms from glycerate 3-phosphate molecules which are incorporated into glucose. Show your working.

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..... [2]

(d) Some biologists describe enzyme **B** as 'the most important enzyme in our biosphere'. Explain why they might hold this opinion.

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(e) The Calvin cycle is part of the light-independent reactions of photosynthesis. These reactions continue when a plant is moved from light conditions to dark conditions, but only for a very short time.

With reference to Fig. 24.1, explain why this is the case.

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(f) Evidence suggests that the earliest eukaryotic cells did not carry out photosynthesis.

Explain how some eukaryotic cells are thought to have become photosynthetic.

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[Total: 15]

25 Fig. 25.1 shows a European starling, *Sturnus vulgaris*.

Fig. 25.1

(a) Outline the aspects of the biology of *S. vulgaris* that must be considered when describing the niche of this species.

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The relative contribution of individual species to the biodiversity of communities has been investigated for particular species. Fig. 25.2 shows the effect of different densities of the gastropod mollusc, *Littorina littorea*, on the number of species of algae in tidal rock pools on the Eastern seaboard of the USA. *L. littorea* grazes on algae.

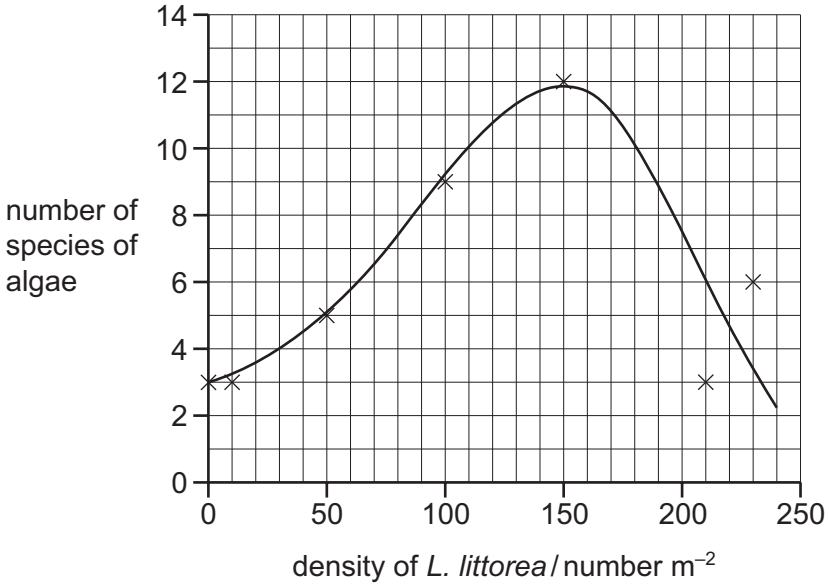

Fig. 25.2

(b) Describe the results shown in Fig. 25.2 and suggest how they could be explained.

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The effects of removing all the individuals of a species of predatory starfish on a rocky shore community were investigated. Fig. 25.3 is part of a food web for this community and shows the changes that occurred. The minus symbol (–) indicates that the numbers of individuals in the species concerned decreased; the plus symbol (+) indicates that the numbers of individuals in the species concerned increased.

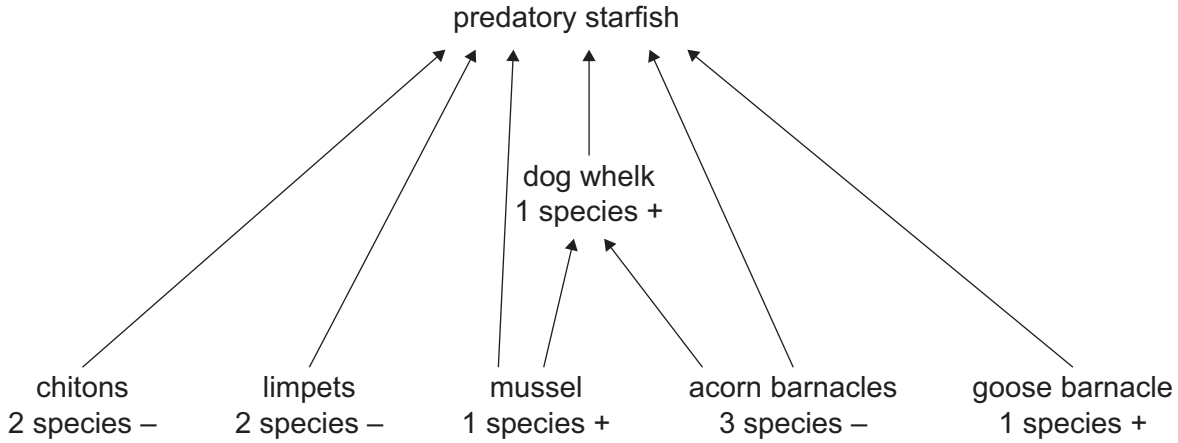

Fig. 25.3

(c) Explain how the results of the study support the idea that the predatory starfish is a keystone species.

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[Total: 12]

26 The gene for colour vision in humans is sex-linked and has two alleles, **Ch** and **ch**. The recessive allele, **ch**, causes red-green colour blindness.

The gene for the ABO blood group system is on chromosome 9. There are three alleles:

$\mathbf{I^A}$ – leads to A antigens on red blood cells

$\mathbf{I^B}$ – leads to B antigens on red blood cells

$\mathbf{I^o}$ – leads to neither A nor B antigens on red blood cells.

These three alleles give four possible phenotypes:

- blood group A (A antigens on red blood cells)
- blood group B (B antigens on red blood cells)
- blood group AB (A and B antigens on red blood cells)
- blood group O (neither A nor B antigens on red blood cells)

Fig. 26.1 shows the inheritance of these two genes in a family.

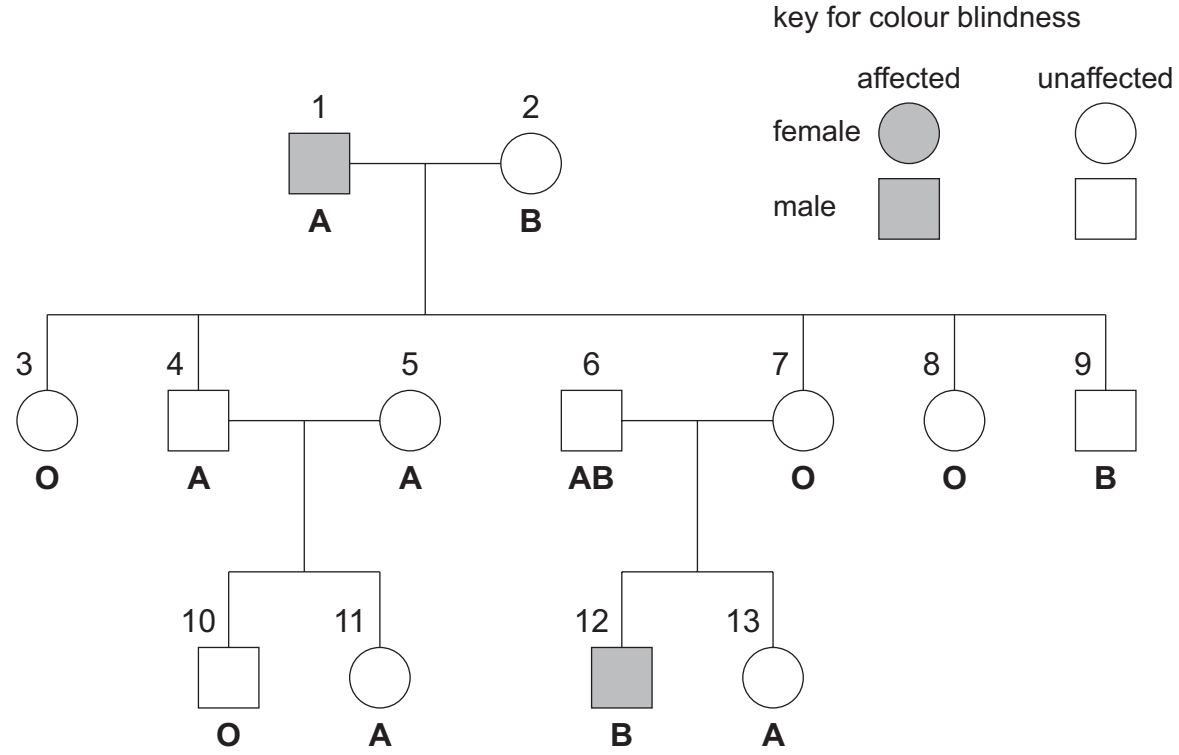

Fig. 26.1

(a) State a possible genotype for each of the following people in the family shown in Fig. 26.1.

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3 .....

9 .....

[3]

(b) With reference to Fig. 26.1, explain why

(i) the grandfather (1) is colour blind, but neither of his sons is colour blind

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(ii) one grandson (12) has inherited colour blindness but the other (10) has not

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(iii) there are four phenotypes in the ABO blood group system.

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Nail-patella syndrome is a rare autosomal dominant trait that affects fingernails, toenails, elbows and kneecaps. The locus of the gene for nail-patella syndrome, **Np**/**np**, is 10 map units from the ABO locus on chromosome 9.

A man with nail-patella syndrome and blood group AB has a family of five children with his wife who does not have the syndrome and is blood group O.

Three children do not have the nail-patella syndrome and are blood group A.

Two children have nail-patella syndrome and are blood group B.

(c) State the genotypes of the father and the mother.

father .....

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mother .....

..... [3]

(d) Explain why there is a small probability of these parents having a child with both blood group A and nail-patella syndrome.

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[Total: 15]