Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

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1437933868

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **October/November 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer paper available on request.

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Write your Centre number, candidate number and name in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the number of the Section B question you have answered in the grid below.

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

Electronic calculators may be used.

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

For Examiner's Use	
Section A	
1	
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6	
7	
8	
Section B	
9 or 10	
Total	

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CAMBRIDGE International Examinations

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Section A

Answer **all** the questions.

1 **(a)** The molecules listed below are all associated with respiration.

ATP synthase	**glucose**	**ATP**	**NAD**
oxaloacetate	**pyruvate**	**citrate**	**oxygen**

From these molecules identify:

a phosphorylated nucleotide .....

a 3-carbon compound .....

a coenzyme .....

an enzyme ..... [4]

(b) A sample of tree sap, rich in sugars, was found to be contaminated with yeast. This sample was tested for the concentration of ethanol at regular intervals.

The results are shown in Fig. 1.1.

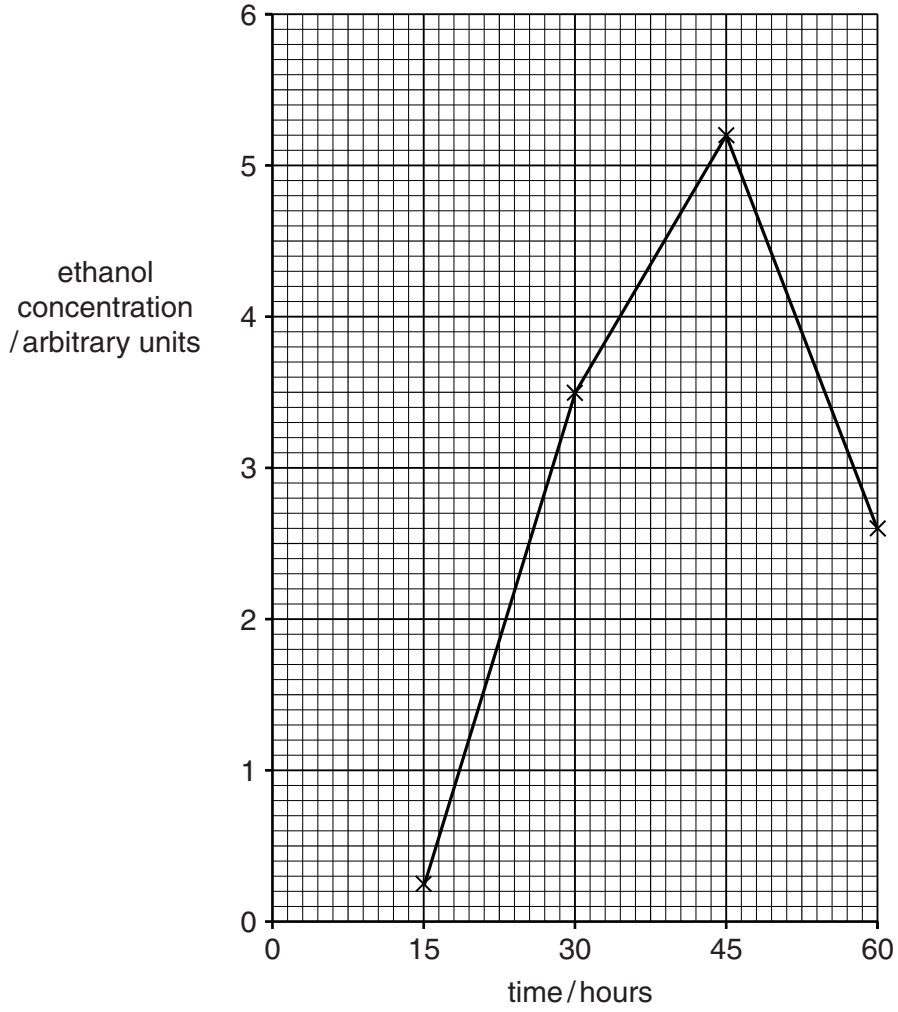


Fig. 1.1

PAPA CAMBRIDGE

(i) Calculate the percentage increase in ethanol concentration between 15 and 45 hours.

Show your working.

answer ..... % [2]

(ii) Suggest why the concentration of ethanol decreased after 45 hours.

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.....[1]

[Total: 7]

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2 Gold ions (Au^{3+}) are toxic to most microorganisms. However, the bacterium *Delftia acidovorans* is frequently found in sticky layers, called biofilms, that form on the surface of gold deposits.

D. acidovorans produces a peptide synthase that catalyses the synthesis of a small peptide called delftibactin. When isolated, delftibactin can precipitate Au^{3+} ions as small particles of metallic gold. Delftibactin is a secondary metabolite.

(a) Name another example of a *secondary metabolite* and explain what is meant by the term.

example .....

explanation .....

.....

.....

.....[3]

(b) A mutant strain of *D. acidovorans* has been identified in which the gene coding for peptide synthase is inactive.

The wild-type (normal) and mutant *D. acidovorans* were grown on agar plates and then flooded with gold chloride solution, which contains Au^{3+} ions. The appearance of such a plate after this treatment is shown in Fig. 2.1.

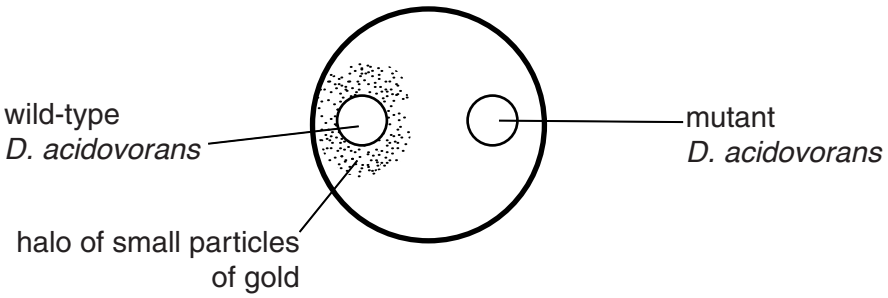


Fig. 2.1

With reference to Fig. 2.1, suggest how delftibactin protects *D. acidovorans* from toxic Au^{3+} ions.

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(c) Wild-type and mutant *D. acidovorans* were grown in standardised conditions:

- wild-type and mutant bacteria were grown in the absence of Au^{3+} ions
- wild type and mutant bacteria were grown in the presence of Au^{3+} ions
- mutant bacteria were grown in the presence of Au^{3+} ions and of delftibactin.

The results are shown in Fig. 2.2.

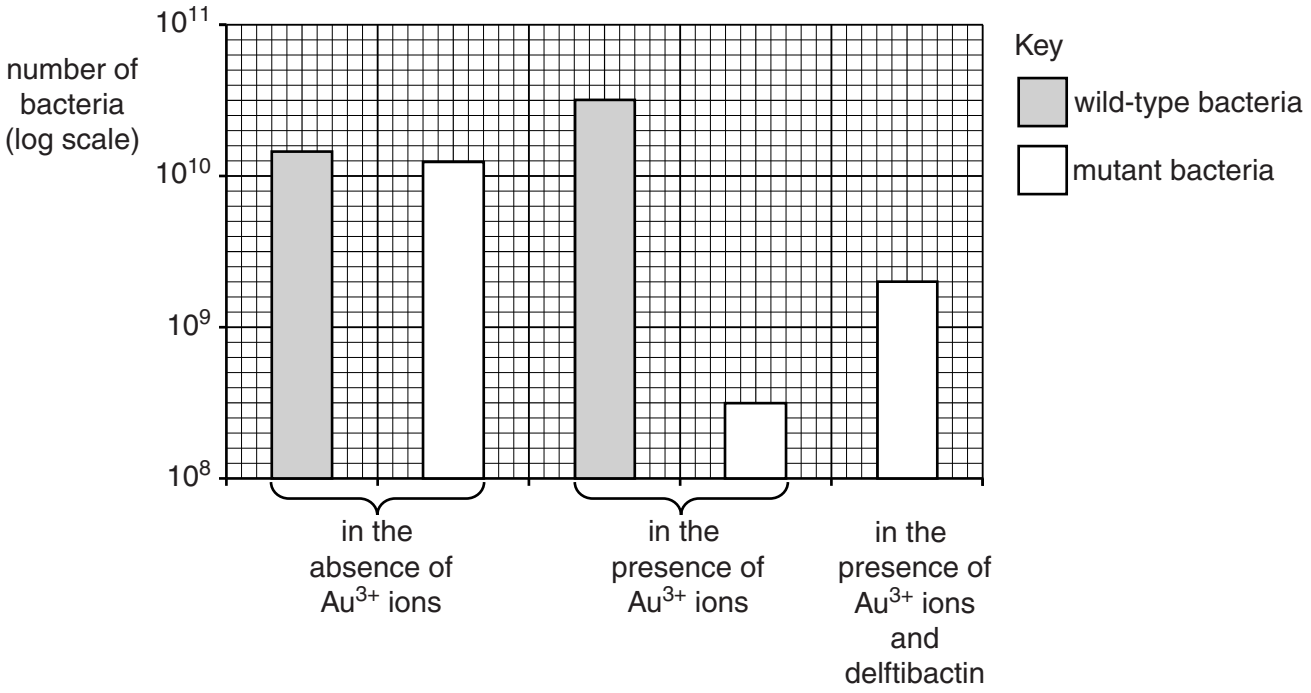


Fig. 2.2

Explain whether or not the results shown in Fig. 2.2 support the idea that delftibactin is protective.

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PAPA CAMBRIDGE

(d) The secondary metabolite, delftibactin, could be used to remove the toxic Au^{3+} ions that are present in the waste produced by gold mining.

Describe how delftibactin could be produced on a large scale.

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[Total: 15]

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3 The blackcap, *Sylvia atricapilla*, is a small song bird. It is a summer visitor to parts of northern Europe, where it breeds.

Many blackcaps spend the winter (overwinter) in southern Europe, particularly in Spain. As a result of many people putting out food for birds in their gardens, some birds can survive the winter in the UK.

Scientists measured the genetic variation between blackcaps from two forest sites in Germany, 800 km apart. Both sites included birds that had overwintered in Spain and in the UK. The measurements were made shortly after the birds returned from their winter feeding grounds.

(a) Explain how DNA sequencing can be used to measure the genetic variation of birds.

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.....[4]

(b) The measurements of genetic variation showed that:

- birds that overwinter in the same country (Spain or the UK) shared many alleles, even though they were living 800 km apart in Germany in the summer
- birds that overwintered in different countries (Spain or the UK) shared fewer alleles, even though they were living in the same forest in Germany in the summer
- the genetic differences between the birds that overwinter in Spain suggest that they no longer breed with those that overwinter in the UK.

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Explain how these blackcaps could evolve into two distinct species.

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[Total: 8]

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4 Bread wheat, *Triticum aestivum*, is a hexaploid that has developed from diploid wild grasses.

(a) Outline the process by which *T. aestivum* has developed from wild grasses.

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.....[4]

(b) Wheat seeds begin to germinate when they are in warm conditions and can take up water.

Fig. 4.1 shows a germinating wheat seedling.

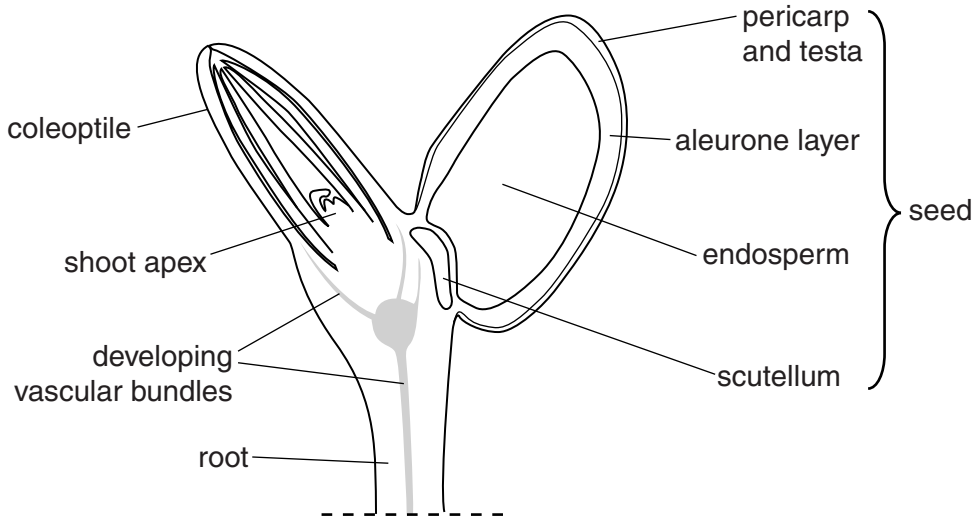


Fig. 4.1

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The endosperm contains starch stores. There are also small quantities of sucrose stored in the aleurone layer.

Water uptake stimulates the production of a plant growth regulator in the seed, which in turn activates the synthesis of enzymes in the aleurone layer. These enzymes hydrolyse starch to maltose and glucose.

Name the plant growth regulator involved in the activation of the synthesis of the enzymes.

.....[1]

(c) An investigation was carried out into the role of a gene, *TaSUT1*, which codes for a sucrose transporter protein, in the germination of wheat seeds.

- Wheat seeds were germinated and left to grow for 3, 7 or 10 days.
- Samples of tissues from the roots, seeds and shoots of the seedlings were tested for the presence of mRNA transcribed from *TaSUT1*.
- The extracted mRNA was mixed with a probe, and then placed on agarose gel across which a voltage was applied.

The results are shown in Fig. 4.2.

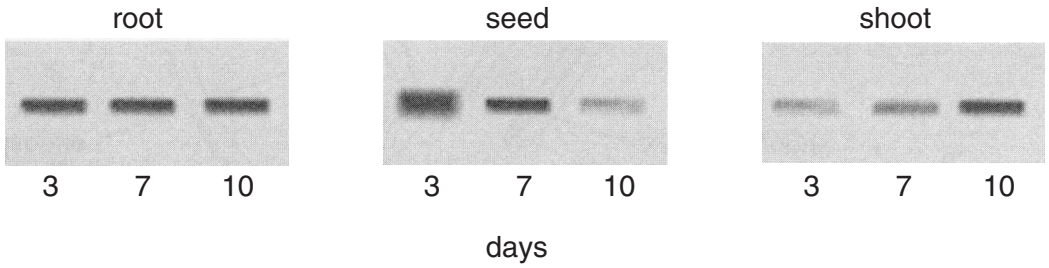


Fig. 4.2

(i) Suggest why the researchers looked for mRNA transcribed from the *TaSUT1* gene, rather than for the gene itself.

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.....[2]

(ii) Explain what the results in Fig. 4.2 indicate about the sequence of activity of *TaSUT1*, from day 3 to day 10, in the root, seed and shoot of a seedling.

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.....[2]

PAPA CAMBRIDGE

(d) *TaSUT1* codes for the sucrose transporter protein, SUT. This protein transports only sucrose.

To investigate where this protein was present in a germinating wheat seedling, a fluorescent antibody for SUT was added to sections of tissues from the seedling.

(i) Suggest how this enabled the researchers to determine the areas where SUT was located.

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.....[2]

(ii) Immediately after germination began, SUT was found in the membranes of cells in the aleurone layer. It was also determined that the most common sugar in the endosperm in the first hours after germination was sucrose.

Explain how these results support the hypothesis that the **first** source of sugar for the embryo during germination is sucrose from the aleurone layer and **not** sugars produced by the hydrolysis of starch.

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.....[2]

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(iii) SUT appeared in the developing phloem tissue within three days of the start of germination.

Outline how sucrose is transported in phloem.

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[Total: 16]

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5 **(a)** Explain the meaning of the term biodiversity.

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(b) The Javan gibbon, *Hylobates moloch*, is an endangered species.

Fig. 5.1 shows a female Javan gibbon with an infant.



Fig. 5.1

Javan gibbons live in fragmented patches of undisturbed forest in western Java, Indonesia. Habitat loss has reduced the population of wild gibbons to around 4500 individuals.

(i) Suggest why the separation of their habitat into small fragments, rather than a single large area, poses a threat to the long-term survival of this species.

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.....[3]

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(ii) Several zoos in Java keep Javan gibbons, but few of these are involved in breeding programmes.

Suggest how, other than through captive breeding programmes, zoos in Java could contribute to the conservation of the Javan gibbon.

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.....[3]

[Total: 8]

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6 Scorpions are predatory arthropods. They have a pair of grasping claws at the front of their bodies and a tail with a stinger. The stinger is used to inject venom into their prey to cause paralysis.

Fig. 6.1 shows a scorpion.



Fig. 6.1

(a) Scorpion venom contains two active components:

- a toxin that affects ion channels at synapses of the nervous system of their prey
- an inhibitor of an enzyme found at these synapses.

For **each** component of the venom, suggest and explain **one** way in which it may stop the correct functioning of the synapse.

toxin .....

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inhibitor .....

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.....[4]

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(b) Scorpions stand very still on the sand. Moving prey will disturb grains of sand, and scorpions are able to detect this movement using sensory organs, known as slit hairs, at the tips of their legs. Some of the cells of a slit hair act as sensory receptors.

(i) State the role of a sensory receptor.

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.....[1]

(ii) When a slit hair is bent by the movement of the sand the potential difference across the cell surface membranes of the slit hair cells becomes more positive inside compared to the outside.

State the name given to the initial change in potential difference that may lead to an action potential.

.....[1]

(iii) Action potentials may then be sent by the cells in the slit hairs to the central nervous system (CNS) of the scorpion.

Explain how the scorpion is able to distinguish between a small and a large movement of sand.

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.....[2]

[Total: 8]

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[Turn over

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7 **(a)** One way to estimate the rate of photosynthesis is to measure the rate of uptake of carbon dioxide.

Fig. 7.1 shows the relationship between light intensity and relative carbon dioxide uptake and production in a dicotyledonous plant.

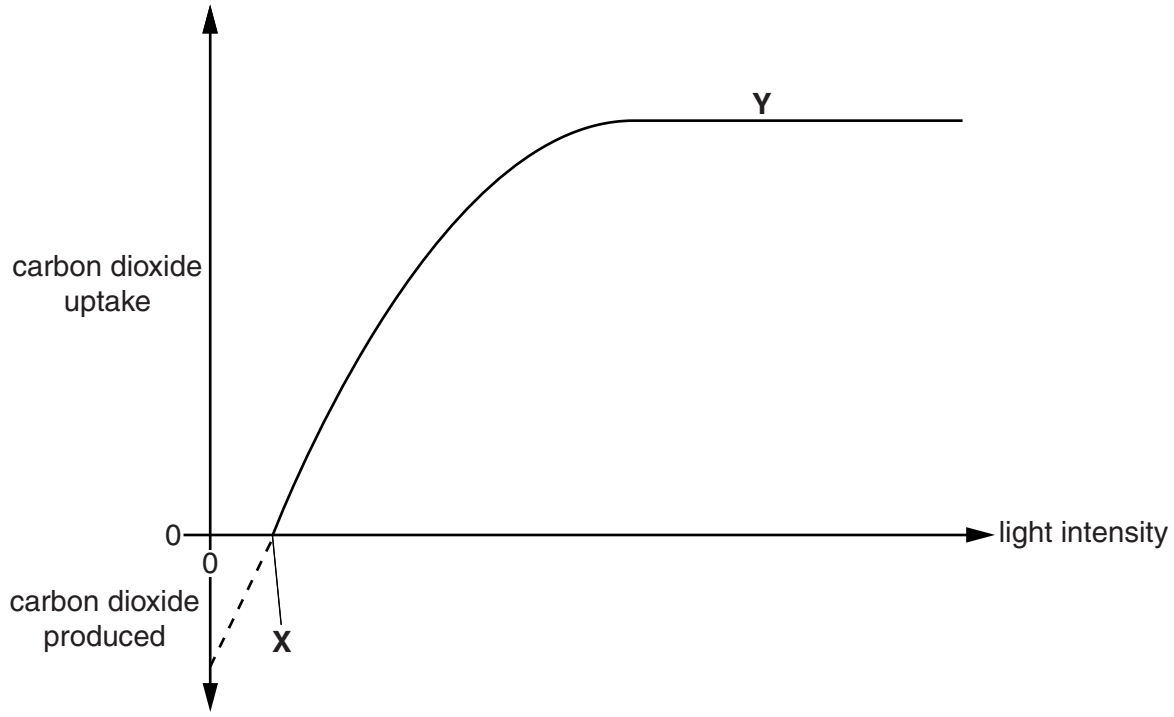


Fig. 7.1

(i) State **one physical factor** that may limit the rate of photosynthesis at **Y**.

.....[1]

(ii) State **two** features of a dicotyledonous leaf that can affect the rate of photosynthesis.

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.....[2]

(iii) Explain the shape of the curve as light intensity increases from **0** to **X**.

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.....[2]

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(b) The uptake of radioactively-labelled carbon dioxide in chloroplasts was investigated.

Three tubes, each containing different components of chloroplasts, were exposed to light.

The results of the investigation are shown in Table 7.1.

Table 7.1

tube	contents	uptake of radioactively-labelled carbon dioxide / counts per minute
A	stroma and grana	96 000
B	stroma, ATP and reduced NADP	97 000
C	stroma	4 000

(i) Name the substance that combines with carbon dioxide in a chloroplast.

.....[1]

(ii) Explain why the results in tube **B** are similar to those in tube **A**.

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.....[2]

(iii) Explain why the uptake in tube **C** was less than the uptake in tube **B**.

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.....[2]

PAPA CAMBRIDGE

(c) Complete the following paragraph by using the most suitable words to fill in the gaps.

In a photosystem, several hundred accessory pigment molecules surround a primary pigment molecule, called ....., in the ..... membrane. The position of the primary pigment is also called the ...... Light energy is absorbed by the accessory pigments and passed on to the primary pigment. Electrons are excited to a higher energy level. They are emitted from the primary pigment and are captured by electron acceptors and eventually pass along the ....., producing ATP. [4]

[Total: 14]

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8 **(a)** In shorthorn cattle, coat colour is controlled by a codominant pair of alleles. Coat colour can be red, white or roan, which is a mixture of red and white.

The presence of horns is controlled by a separate pair of alleles. The allele coding for horns is recessive to the allele coding for hornless cattle.

(i) Choose suitable symbols for the following:

allele for red coat colour .....

allele for white coat colour .....

allele for horns .....

allele for no horns ..... [2]

(ii) Using the symbols you have chosen, write down the genotypes of:

white, hornless cattle .....

roan, horned cattle .....[3]

(b) Some fast-growing breeds of cattle have been produced by artificial selection.

Outline the ways in which artificial selection differs from natural selection.

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.....[4]

[Total: 9]

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Section B

Answer **one** question.

9 **(a)** Outline how the oestrogen/progesterone contraceptive pill works to prevent pregnancy. [6]

(b) Discuss the biological, ethical and social implications of using this contraceptive pill. [9]

[Total: 15]

10 **(a)** Describe and explain the structural features of a wind-pollinated plant. [9]

(b) Discuss the benefits of cross-pollination. [6]

[Total: 15]

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Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

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BIOLOGY **9700/42**

Paper 4 A2 Structured Questions **October/November 2015**

2 hours

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Additional Materials: Answer paper available on request.

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Section A

Answer **all** the questions.

1 **(a)** The molecules listed below are all associated with respiration.

ATP synthase	**glucose**	**ATP**	**NAD**
oxaloacetate	**pyruvate**	**citrate**	**oxygen**

From these molecules identify:

a phosphorylated nucleotide .....

a 3-carbon compound .....

a coenzyme .....

an enzyme ..... [4]

(b) A sample of tree sap, rich in sugars, was found to be contaminated with yeast. This sample was tested for the concentration of ethanol at regular intervals.

The results are shown in Fig. 1.1.

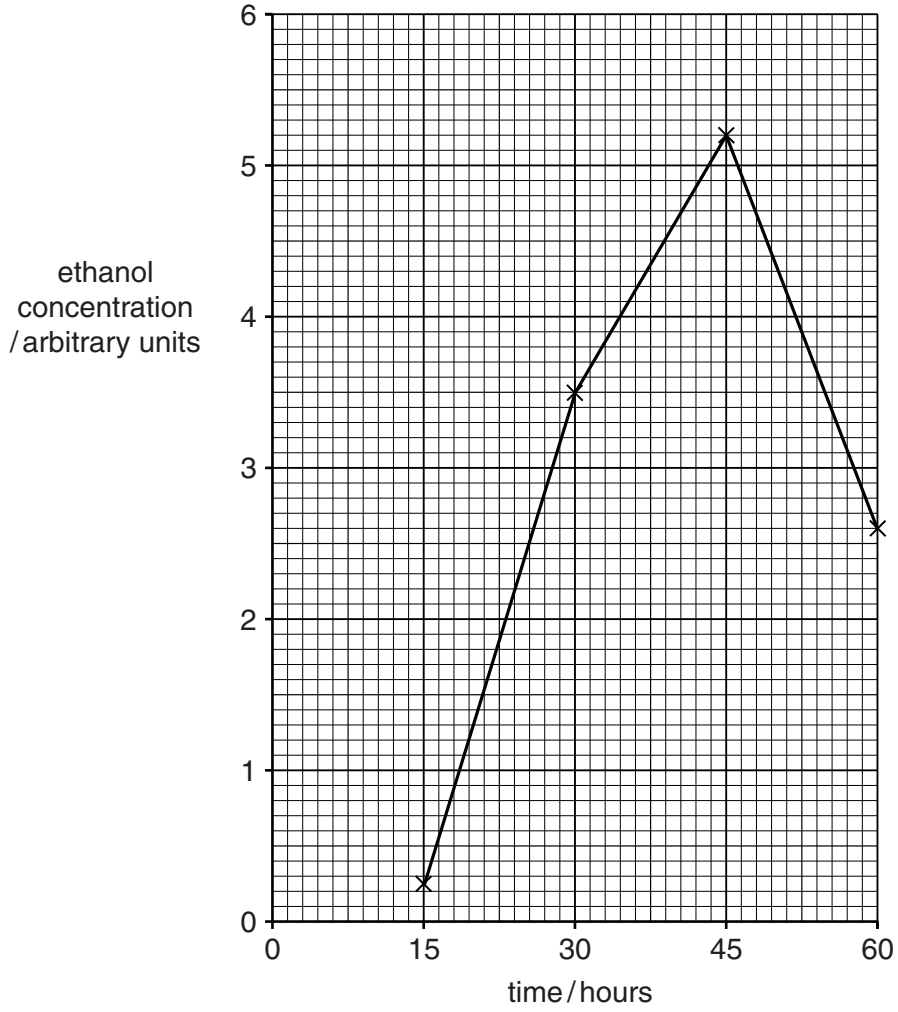


Fig. 1.1

PAPA CAMBRIDGE

(i) Calculate the percentage increase in ethanol concentration between 15 and 45 hours.

Show your working.

answer ..... % [2]

(ii) Suggest why the concentration of ethanol decreased after 45 hours.

.....

.....

.....[1]

[Total: 7]

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2 Gold ions (Au^{3+}) are toxic to most microorganisms. However, the bacterium *Delftia acidovorans* is frequently found in sticky layers, called biofilms, that form on the surface of gold deposits.

D. acidovorans produces a peptide synthase that catalyses the synthesis of a small peptide called delftibactin. When isolated, delftibactin can precipitate Au^{3+} ions as small particles of metallic gold. Delftibactin is a secondary metabolite.

(a) Name another example of a *secondary metabolite* and explain what is meant by the term.

example .....

explanation .....

.....

.....

.....[3]

(b) A mutant strain of *D. acidovorans* has been identified in which the gene coding for peptide synthase is inactive.

The wild-type (normal) and mutant *D. acidovorans* were grown on agar plates and then flooded with gold chloride solution, which contains Au^{3+} ions. The appearance of such a plate after this treatment is shown in Fig. 2.1.

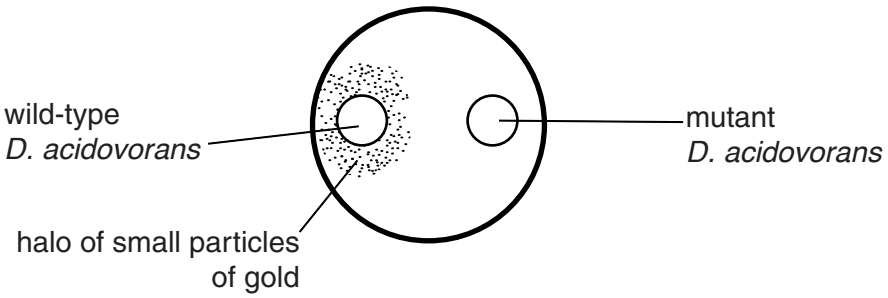


Fig. 2.1

With reference to Fig. 2.1, suggest how delftibactin protects *D. acidovorans* from toxic Au^{3+} ions.

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.....[3]

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(c) Wild-type and mutant *D. acidovorans* were grown in standardised conditions:

- wild-type and mutant bacteria were grown in the absence of Au^{3+} ions
- wild type and mutant bacteria were grown in the presence of Au^{3+} ions
- mutant bacteria were grown in the presence of Au^{3+} ions and of delftibactin.

The results are shown in Fig. 2.2.

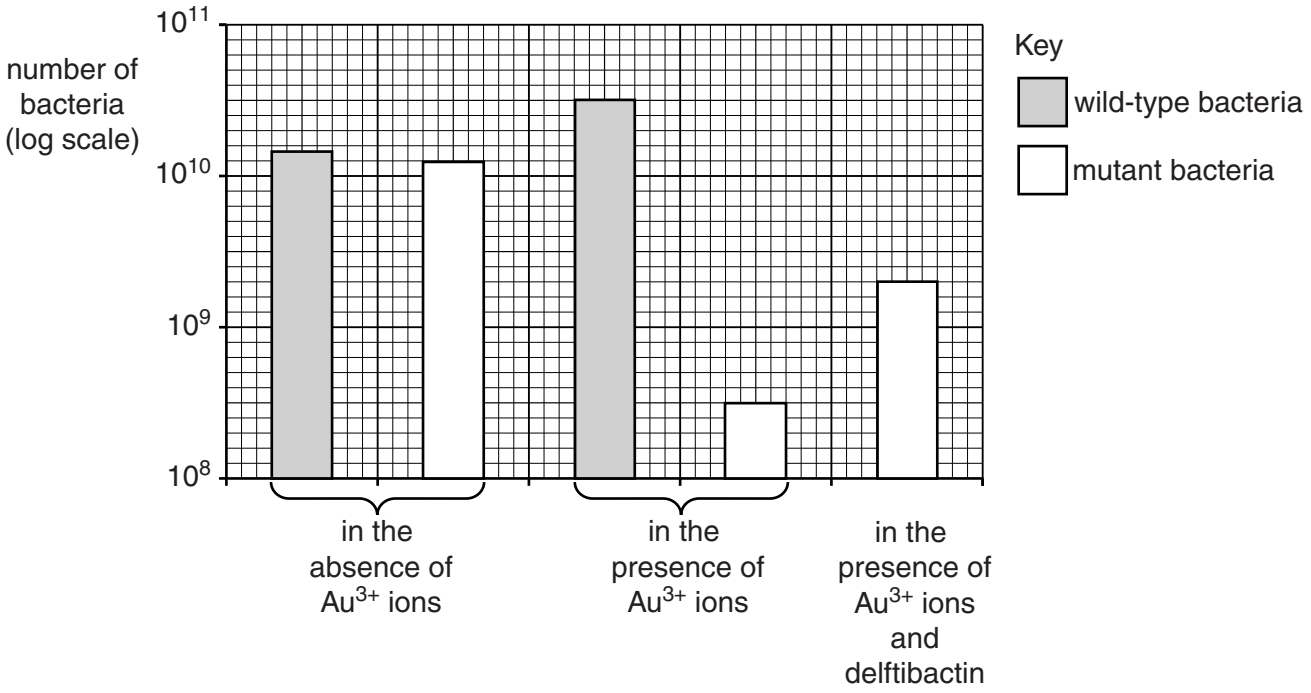


Fig. 2.2

Explain whether or not the results shown in Fig. 2.2 support the idea that delftibactin is protective.

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PAPA CAMBRIDGE

(d) The secondary metabolite, delftibactin, could be used to remove the toxic Au^{3+} ions that are present in the waste produced by gold mining.

Describe how delftibactin could be produced on a large scale.

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.....[5]

[Total: 15]

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3 The blackcap, *Sylvia atricapilla*, is a small song bird. It is a summer visitor to parts of northern Europe, where it breeds.

Many blackcaps spend the winter (overwinter) in southern Europe, particularly in Spain. As a result of many people putting out food for birds in their gardens, some birds can survive the winter in the UK.

Scientists measured the genetic variation between blackcaps from two forest sites in Germany, 800 km apart. Both sites included birds that had overwintered in Spain and in the UK. The measurements were made shortly after the birds returned from their winter feeding grounds.

(a) Explain how DNA sequencing can be used to measure the genetic variation of birds.

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.....[4]

(b) The measurements of genetic variation showed that:

- birds that overwinter in the same country (Spain or the UK) shared many alleles, even though they were living 800 km apart in Germany in the summer
- birds that overwintered in different countries (Spain or the UK) shared fewer alleles, even though they were living in the same forest in Germany in the summer
- the genetic differences between the birds that overwinter in Spain suggest that they no longer breed with those that overwinter in the UK.

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Explain how these blackcaps could evolve into two distinct species.

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.....[4]

[Total: 8]

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4 Bread wheat, *Triticum aestivum*, is a hexaploid that has developed from diploid wild grasses.

(a) Outline the process by which *T. aestivum* has developed from wild grasses.

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.....[4]

(b) Wheat seeds begin to germinate when they are in warm conditions and can take up water.

Fig. 4.1 shows a germinating wheat seedling.

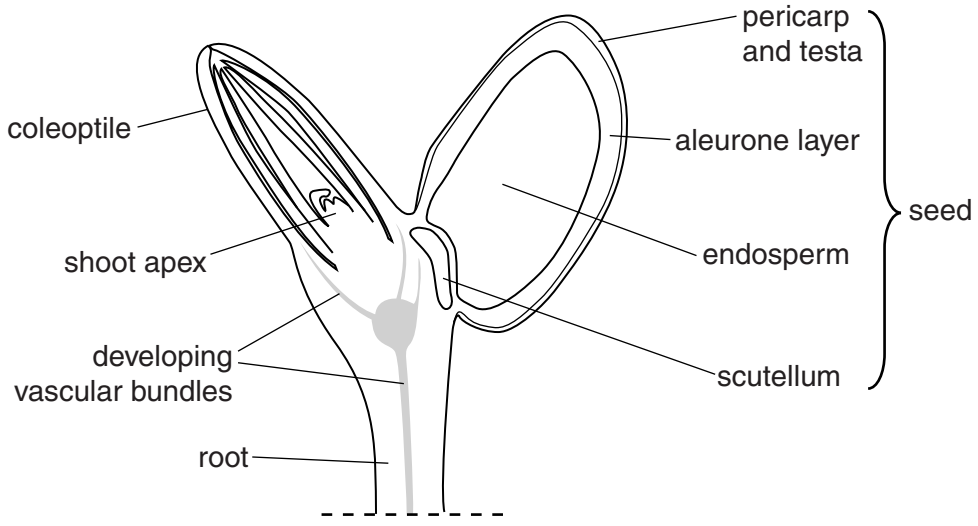


Fig. 4.1

PAPA CAMBRIDGE

The endosperm contains starch stores. There are also small quantities of sucrose stored in the aleurone layer.

Water uptake stimulates the production of a plant growth regulator in the seed, which in turn activates the synthesis of enzymes in the aleurone layer. These enzymes hydrolyse starch to maltose and glucose.

Name the plant growth regulator involved in the activation of the synthesis of the enzymes.

.....[1]

(c) An investigation was carried out into the role of a gene, *TaSUT1*, which codes for a sucrose transporter protein, in the germination of wheat seeds.

- Wheat seeds were germinated and left to grow for 3, 7 or 10 days.
- Samples of tissues from the roots, seeds and shoots of the seedlings were tested for the presence of mRNA transcribed from *TaSUT1*.
- The extracted mRNA was mixed with a probe, and then placed on agarose gel across which a voltage was applied.

The results are shown in Fig. 4.2.

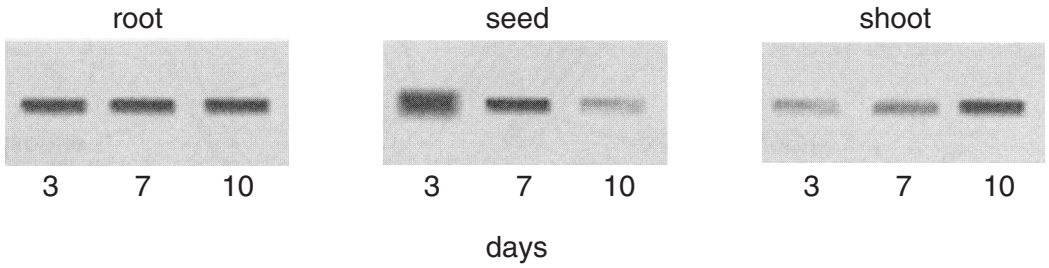


Fig. 4.2

(i) Suggest why the researchers looked for mRNA transcribed from the *TaSUT1* gene, rather than for the gene itself.

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.....[2]

(ii) Explain what the results in Fig. 4.2 indicate about the sequence of activity of *TaSUT1*, from day 3 to day 10, in the root, seed and shoot of a seedling.

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.....[2]

PAPA CAMBRIDGE

(d) *TaSUT1* codes for the sucrose transporter protein, SUT. This protein transports only sucrose.

To investigate where this protein was present in a germinating wheat seedling, a fluorescent antibody for SUT was added to sections of tissues from the seedling.

(i) Suggest how this enabled the researchers to determine the areas where SUT was located.

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.....[2]

(ii) Immediately after germination began, SUT was found in the membranes of cells in the aleurone layer. It was also determined that the most common sugar in the endosperm in the first hours after germination was sucrose.

Explain how these results support the hypothesis that the **first** source of sugar for the embryo during germination is sucrose from the aleurone layer and **not** sugars produced by the hydrolysis of starch.

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.....[2]

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(iii) SUT appeared in the developing phloem tissue within three days of the start of germination.

Outline how sucrose is transported in phloem.

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.....[3]

[Total: 16]

PAPA CAMBRIDGE

5 **(a)** Explain the meaning of the term biodiversity.

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.....[2]

(b) The Javan gibbon, *Hylobates moloch*, is an endangered species.

Fig. 5.1 shows a female Javan gibbon with an infant.



Fig. 5.1

Javan gibbons live in fragmented patches of undisturbed forest in western Java, Indonesia. Habitat loss has reduced the population of wild gibbons to around 4500 individuals.

(i) Suggest why the separation of their habitat into small fragments, rather than a single large area, poses a threat to the long-term survival of this species.

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.....[3]

PAPA CAMBRIDGE

(ii) Several zoos in Java keep Javan gibbons, but few of these are involved in breeding programmes.

Suggest how, other than through captive breeding programmes, zoos in Java could contribute to the conservation of the Javan gibbon.

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.....[3]

[Total: 8]

PAPA CAMBRIDGE

6 Scorpions are predatory arthropods. They have a pair of grasping claws at the front of their bodies and a tail with a stinger. The stinger is used to inject venom into their prey to cause paralysis.

Fig. 6.1 shows a scorpion.



Fig. 6.1

(a) Scorpion venom contains two active components:

- a toxin that affects ion channels at synapses of the nervous system of their prey
- an inhibitor of an enzyme found at these synapses.

For **each** component of the venom, suggest and explain **one** way in which it may stop the correct functioning of the synapse.

toxin .....

.....

.....

.....

.....

inhibitor .....

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.....[4]

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(b) Scorpions stand very still on the sand. Moving prey will disturb grains of sand, and scorpions are able to detect this movement using sensory organs, known as slit hairs, at the tips of their legs. Some of the cells of a slit hair act as sensory receptors.

(i) State the role of a sensory receptor.

.....

.....

.....[1]

(ii) When a slit hair is bent by the movement of the sand the potential difference across the cell surface membranes of the slit hair cells becomes more positive inside compared to the outside.

State the name given to the initial change in potential difference that may lead to an action potential.

.....[1]

(iii) Action potentials may then be sent by the cells in the slit hairs to the central nervous system (CNS) of the scorpion.

Explain how the scorpion is able to distinguish between a small and a large movement of sand.

.....

.....

.....

.....

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.....[2]

[Total: 8]

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[Turn over

PAPA CAMBRIDGE

7 **(a)** One way to estimate the rate of photosynthesis is to measure the rate of uptake of carbon dioxide.

Fig. 7.1 shows the relationship between light intensity and relative carbon dioxide uptake and production in a dicotyledonous plant.

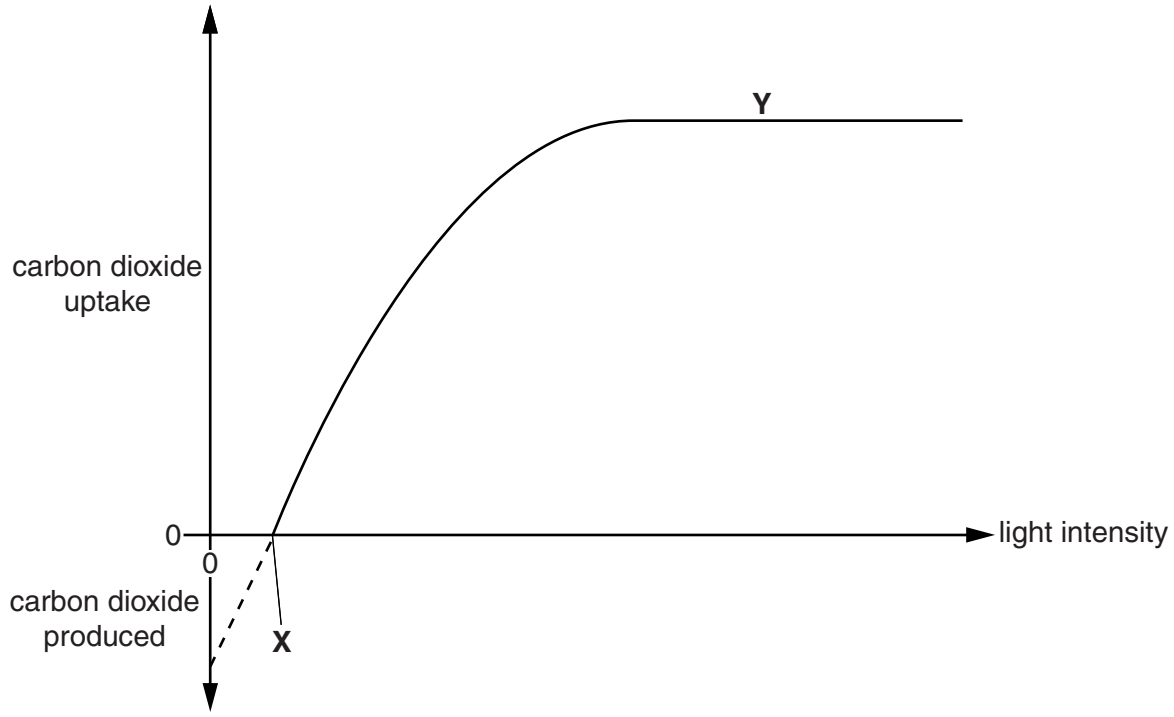


Fig. 7.1

(i) State **one physical factor** that may limit the rate of photosynthesis at **Y**.

.....[1]

(ii) State **two** features of a dicotyledonous leaf that can affect the rate of photosynthesis.

.....

.....[2]

(iii) Explain the shape of the curve as light intensity increases from **0** to **X**.

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.....[2]

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(b) The uptake of radioactively-labelled carbon dioxide in chloroplasts was investigated.

Three tubes, each containing different components of chloroplasts, were exposed to light.

The results of the investigation are shown in Table 7.1.

Table 7.1

tube	contents	uptake of radioactively-labelled carbon dioxide / counts per minute
A	stroma and grana	96 000
B	stroma, ATP and reduced NADP	97 000
C	stroma	4 000

(i) Name the substance that combines with carbon dioxide in a chloroplast.

.....[1]

(ii) Explain why the results in tube **B** are similar to those in tube **A**.

.....

.....

.....

.....

.....[2]

(iii) Explain why the uptake in tube **C** was less than the uptake in tube **B**.

.....

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.....[2]

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[Turn over

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(c) Complete the following paragraph by using the most suitable words to fill in the gaps.

In a photosystem, several hundred accessory pigment molecules surround a primary pigment molecule, called ....., in the ..... membrane. The position of the primary pigment is also called the ...... Light energy is absorbed by the accessory pigments and passed on to the primary pigment. Electrons are excited to a higher energy level. They are emitted from the primary pigment and are captured by electron acceptors and eventually pass along the ....., producing ATP. [4]

[Total: 14]

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8 **(a)** In shorthorn cattle, coat colour is controlled by a codominant pair of alleles. Coat colour can be red, white or roan, which is a mixture of red and white.

The presence of horns is controlled by a separate pair of alleles. The allele coding for horns is recessive to the allele coding for hornless cattle.

(i) Choose suitable symbols for the following:

allele for red coat colour .....

allele for white coat colour .....

allele for horns .....

allele for no horns ..... [2]

(ii) Using the symbols you have chosen, write down the genotypes of:

white, hornless cattle .....

roan, horned cattle .....[3]

(b) Some fast-growing breeds of cattle have been produced by artificial selection.

Outline the ways in which artificial selection differs from natural selection.

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.....[4]

[Total: 9]

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Section B

Answer **one** question.

9 **(a)** Outline how the oestrogen/progesterone contraceptive pill works to prevent pregnancy. [6]

(b) Discuss the biological, ethical and social implications of using this contraceptive pill. [9]

[Total: 15]

10 **(a)** Describe and explain the structural features of a wind-pollinated plant. [9]

(b) Discuss the benefits of cross-pollination. [6]

[Total: 15]

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3316555314

BIOLOGY **9700/43**

Paper 4 A2 Structured Questions **October/November 2015**

2 hours

Candidates answer on the Question Paper.

Additional Materials: Answer paper available on request.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces provided at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the number of the Section B question you have answered in the grid below.

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

Electronic calculators may be used.

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

For Examiner's Use	
Section A	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

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Section A

Answer **all** the questions.

1 **(a)** Yeast cells sometimes carry out anaerobic respiration.

Fig. 1.1 outlines the process of anaerobic respiration in yeast cells.

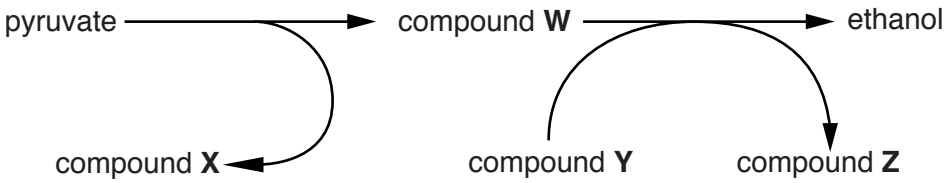


Fig. 1.1

(i) Identify compounds **W**, **X** and **Y**.

W .....

X .....

Y ..... [3]

(ii) State **two** differences between anaerobic respiration in yeast cells and anaerobic respiration in human muscle cells.

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.....

..... [2]

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(b) Dinitrophenol (DNP) is a compound used as a herbicide. DNP inhibits respiration by interfering with the formation of the proton gradient between mitochondrial membranes.

When DNP was added to isolated mitochondria the following observations were made:

- fewer ATP molecules were produced
- more heat energy was released
- the uptake of oxygen remained constant.

Suggest explanations for these observations.

fewer ATP molecules produced .....

.....

.....

more heat energy released .....

.....

.....

constant oxygen uptake.....

.....

.....[3]

[Total: 8]

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2 A vaccine, NicVAX, is being developed to help people stop smoking tobacco. Injection of NicVAX into the body causes production of antibody molecules that bind to nicotine.

(a) Outline the immune response that leads to the production of these anti-nicotine antibodies.

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.....[5]

(b) Mice injected with NicVAX produce B-lymphocytes that mature into cells responsible for the production of antibody (plasma cells).

Outline how these B-lymphocytes can be used to produce monoclonal antibody.

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.....[4]

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(c) Tobacco smoking during pregnancy has adverse side-effects on the developing fetus.

An investigation was carried out to find out whether vaccinating pregnant women with NicVAX might offer some protection for the developing fetus.

Two different monoclonal antibodies, produced in response to NicVAX, were used in this investigation:

- Nic-IgG
- Nic311.

Nicotine, or nicotine plus one of the monoclonal antibodies, was injected into the maternal circulation. The concentrations of nicotine in the fetal circulation were measured at intervals.

The results of the investigation are shown in Fig 2.1.

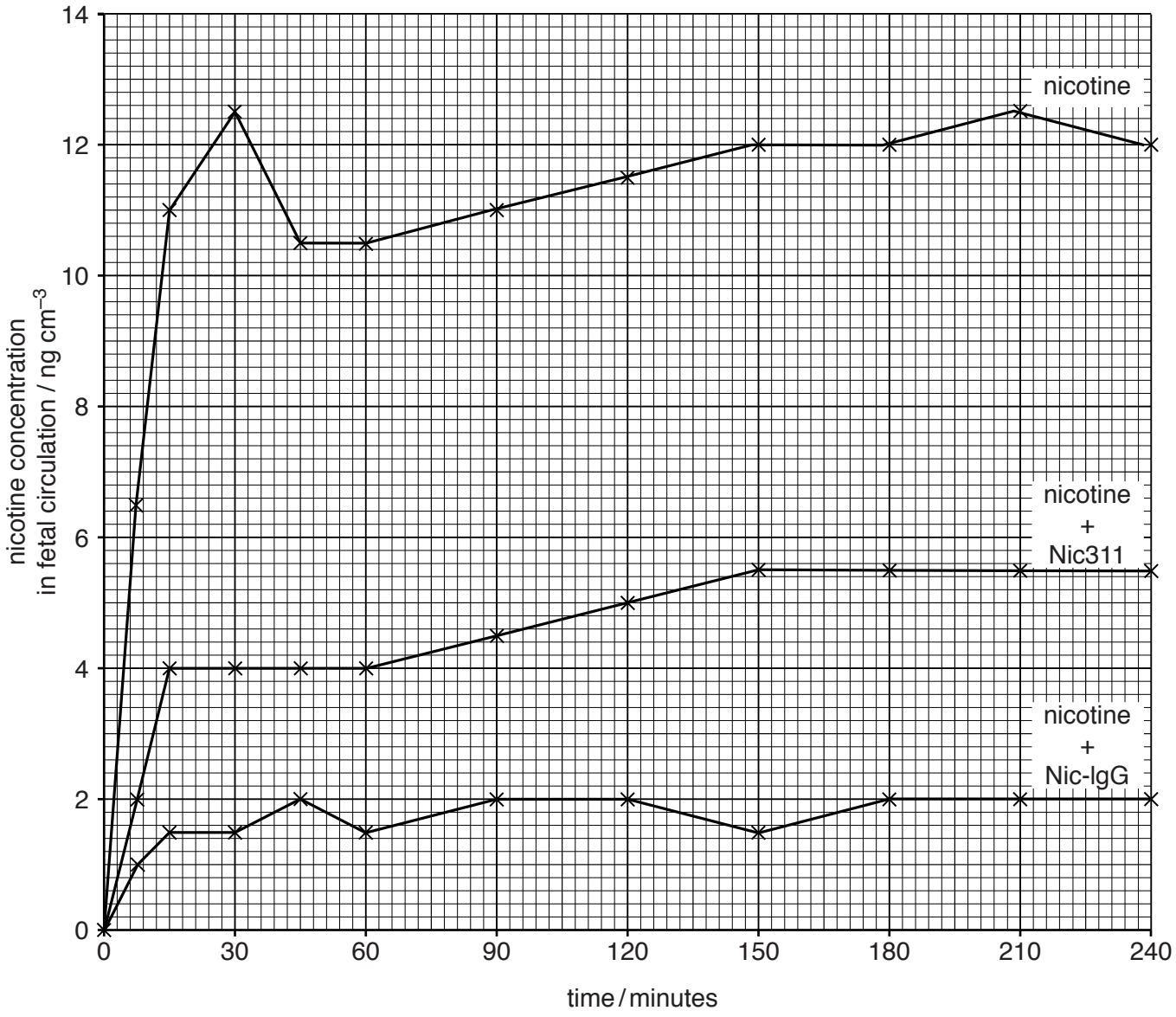


Fig. 2.1

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(i) With reference to Fig. 2.1, describe the results obtained for nicotine only.

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.....[2]

(ii) Discuss the extent to which these results support the idea that vaccination with NicVAX could protect the developing fetus of a woman who smokes tobacco.

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.....[3]

(d) State **one** medical use of monoclonal antibodies, other than their use in producing vaccines.

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.....[1]

[Total: 15]

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3 Atlantic salmon, *Salmo salar*, is one of the most important fish species farmed for human consumption.

Fig. 3.1 shows an Atlantic salmon.

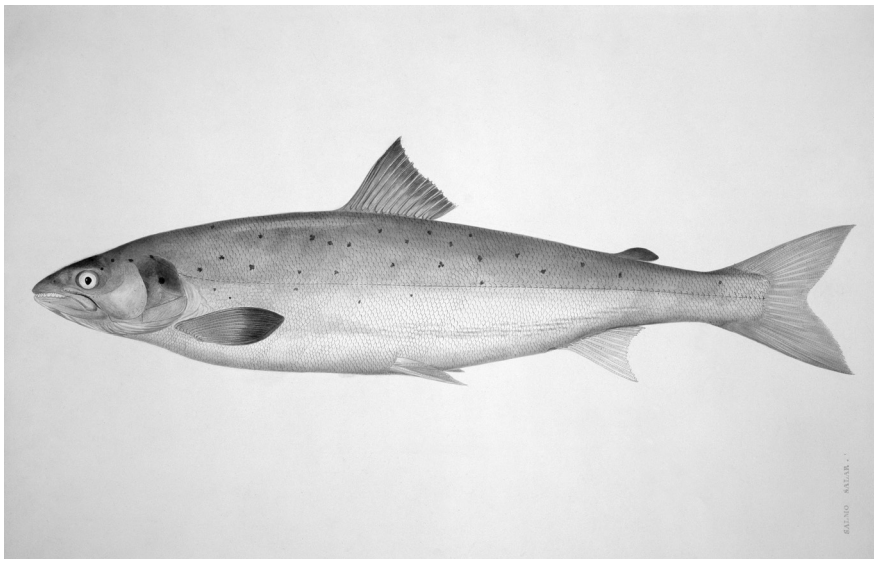


Fig. 3.1

Infectious pancreatic necrosis (IPN) is a serious viral disease currently affecting farmed salmon.

(a) (i) Describe how artificial selection could be used to produce a population of salmon that is resistant to IPN.

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.....[3]

(ii) Suggest problems that may arise from artificial selection.

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.....[2]

PAPA CAMBRIDGE

(b) A laboratory investigation was carried out to compare the artificially selected farmed Atlantic salmon with farmed salmon that had not been artificially selected.

Three groups of young fish were set up in carefully controlled conditions as follows:

- Group **A**: artificially selected salmon
- Group **B**: non-artificially selected salmon
- Group **C**: non-artificially selected salmon.

During this investigation, only groups **A** and **B** were exposed to IPN on day 0.

The percentages of salmon that died (percentage mortality) were calculated and are shown in Fig. 3.2.

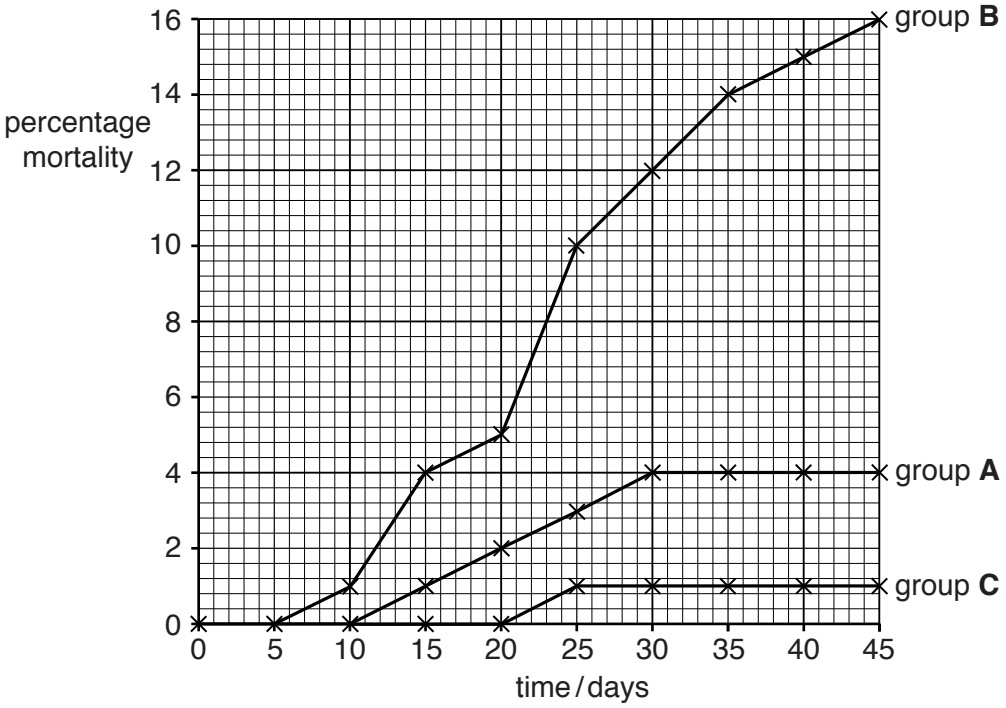


Fig. 3.2

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(i) Describe **and** explain the differences in percentage mortality between groups **A** and **B**.

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.....[4]

(ii) Suggest a reason for the mortality in group **C**.

.....

.....

.....[1]

[Total: 10]

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4 Haemophilia A and haemophilia B are common hereditary disorders of blood clotting.

Haemophilia A is a sex-linked genetic disorder that affects approximately 1 in 20 000 males worldwide. It is caused by a recessive allele of a gene coding for a clotting factor and results in excessive bleeding.

There is currently no cure, but symptoms of haemophilia can be treated with a transfusion of a clotting factor to slow down the bleeding.

(a) State how genetic screening could reduce the number of cases of haemophilia.

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.....[2]

(b) **(i)** Some genetic disorders can be treated with gene therapy.

Outline the aims of gene therapy.

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.....[2]

(ii) Suggest why haemophilia A is a suitable disorder for treatment with gene therapy.

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.....[1]

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(c) Haemophilia A and haemophilia B are caused by mutations in different blood clotting genes, *F8* and *F9* respectively. Both disorders have been treated with gene therapy involving the use of a vector.

(i) Table 4.1 shows the lengths, in kilobases (kb), of the *F8* and *F9* genes.

Table 4.1

haemophilia	gene	gene length / kb
A	*F8*	>8
B	*F9*	1.4

With reference to Table 4.1, suggest why gene therapy using the *F9* gene has been more successful than using the *F8* gene.

.....

.....

.....

.....

.....[2]

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(ii) Two frequently used vectors in gene therapy are compared in Table 4.2.

Table 4.2

feature	**vector**	
	adenovirus	**retrovirus**
genetic material of virus	double-stranded DNA	single-stranded RNA
expression of inserted gene	high gene expression	gene expression in dividing cells only
host immune response to virus	high	low

With reference to Table 4.2, explain the advantages and disadvantages of using adenovirus rather than retrovirus as a vector.

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.....[3]

[Total: 10]

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5 (a) (i) Explain what is meant by the term *biodiversity*.

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.....[2]

(ii) Explain why it is important to ensure that biodiversity is maintained.

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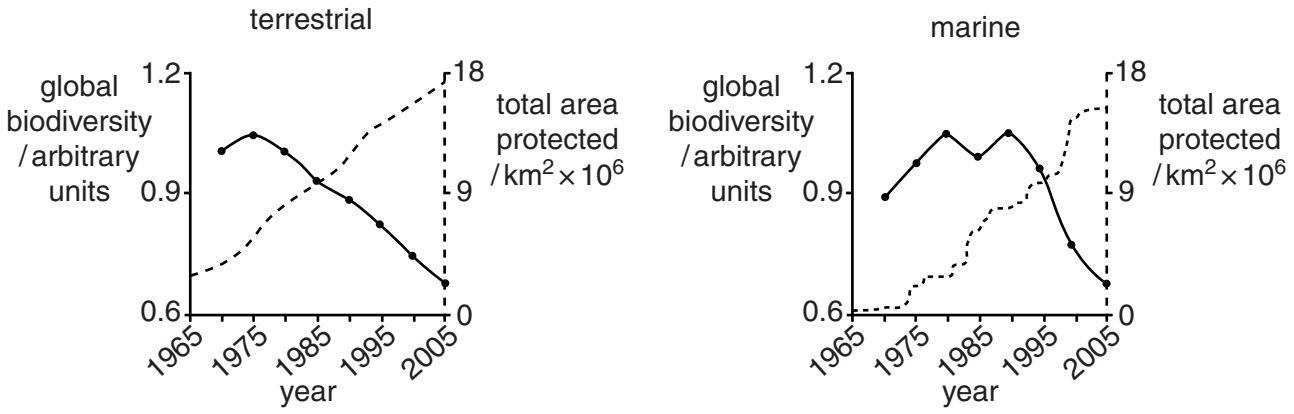
.....

.....[3]

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(b) To reduce the loss of global biodiversity, areas of habitat have been protected.

Fig 5.1 shows the changes in the total area protected and in global biodiversity from 1965 to 2005, in terrestrial and marine habitats.



key:

——— global biodiversity

- - - - - - total area protected

Fig. 5.1

(i) With reference to Fig. 5.1, compare the relationship between total area protected and global biodiversity in terrestrial and marine habitats:

- between 1970 and 1990
- between 1990 and 2005.

between 1970 and 1990 .....

.....

.....

between 1990 and 2005 .....

.....

.....[3]

(ii) Suggest why a smaller area of marine habitats has been protected than of terrestrial habitats.

.....

.....

.....

.....

.....[2]

[Total: 10]

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6 (a) One important function of the kidney nephron is selective reabsorption. This involves the rapid transfer of water across cell surface membranes. The rapid transfer of water requires the presence of protein channels known as aquaporins.

Fig. 6.1 is a diagram of a nephron.

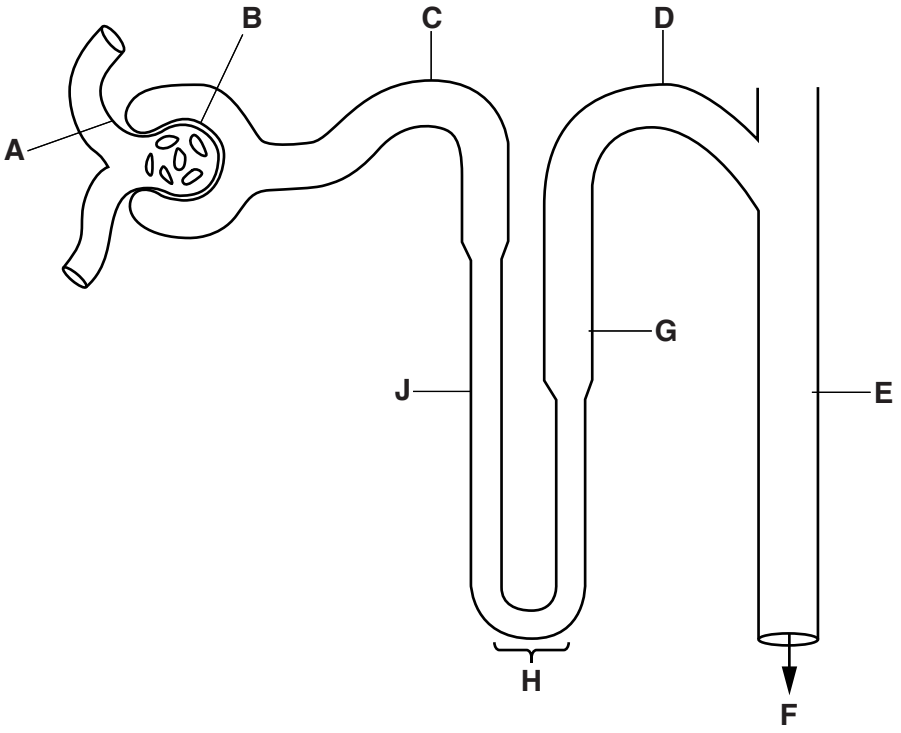


Fig. 6.1

With reference to Fig. 6.1, complete the table by inserting the correct letter for each description.

description of region of nephron	letter
region where no aquaporins are present in the tubule wall cells	
region where aquaporins and glucose transport proteins are present in tubule wall cells	
region where aquaporins are always present in the tubule wall cells but no glucose transport proteins are present	
region where tubule wall cells are modified to produce filtration slits	

[4]

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(b) (i) The urine of people on different types of diet was analysed.

- people on a low protein diet had a mean urea concentration of 2.40 g dm^{-3}
- people on a high protein diet had a mean urea concentration of 14.76 g dm^{-3}.

Calculate the percentage increase in the concentration of urea between the low and high protein diets.

Show your working.

answer ..... % [2]

(ii) Explain why an increase in the quantity of protein in the diet leads to an increase in the concentration of urea in the urine.

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.....[2]

[Total: 8]

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7 **(a)** Fig. 7.1 shows the absorption spectra of chlorophyll a and chlorophyll b and a corresponding action spectrum.

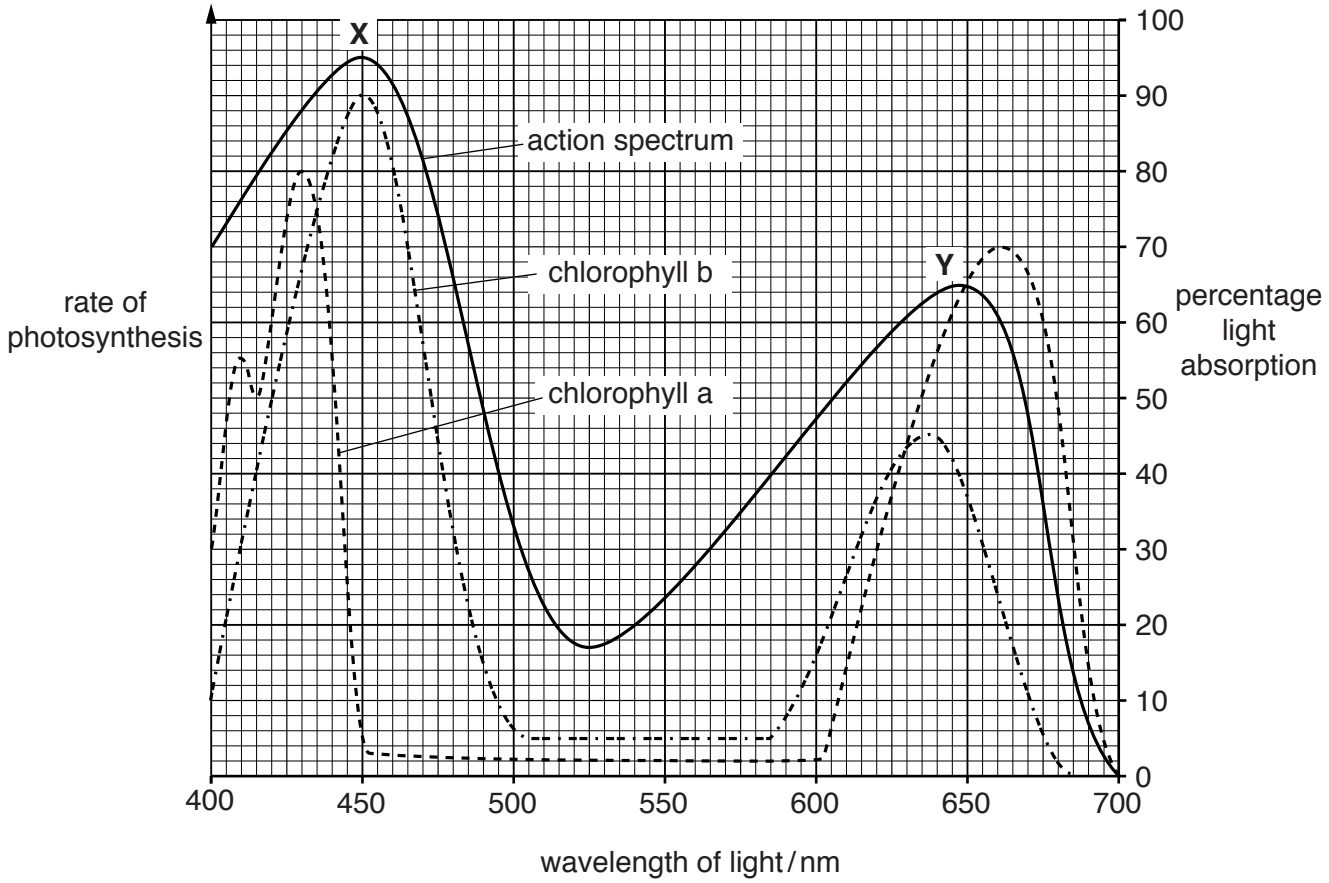


Fig. 7.1

(i) Explain why peak **X** of the **action** spectrum is higher than peak **Y**.

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.....[2]

(ii) Explain why most plants appear green.

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.....[2]

PAPA CAMBRIDGE

(iii) Chlorophyll b is an accessory pigment.

Outline the role played by accessory pigments in the light-dependent stage of photosynthesis.

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.....[2]

(b) Describe the effects on a plant if its environmental temperature rises well above the usual temperature range.

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.....[5]

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(c) Complete the following paragraph by using the most suitable words to fill in the gaps.

A chloroplast is surrounded by two phospholipid membranes. It has an internal ground substance called the stroma which is the site of the Calvin cycle. The stroma contains enzymes such as ..... and also sugars, lipids and starch. A chloroplast has an internal membrane system of fluid-filled sacs called ..... which can be stacked to form grana. Grana membranes hold photosynthetic pigments so that the light-dependent stage of photosynthesis can take place. The stroma contains circular ..... which codes for some of the chloroplast proteins made by its own small .....

[4]

[Total: 15]

8 The fruit fly, *Drosophila melanogaster*, is widely used in genetic research. It has many phenotypic variants in features such as body colour, wing shape and eye colour.

Two variations from the normal-winged, grey-bodied phenotype are:

- vestigial (very short) wings, coded for by the recessive allele of the gene **N/n**
- ebony (black) body colour, coded for by the recessive allele of the gene **G/g**.

(a) Using the symbols given, state the possible genotypes of normal-winged, grey-bodied fruit flies.

.....

.....[2]

(b) Describe how you would determine the genotype of a normal-winged, grey-bodied fly.

.....

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.....[3]

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(c) One of the genes for eye colour is carried on the X chromosome. This gene has different alleles coding for:

- red eyes
- orange eyes
- white eyes.

The allele for red eyes (R) is dominant to the allele for orange eyes (o) and dominant to the allele for white eyes (w). The allele for orange eyes is dominant to that for white eyes.

Using these symbols, draw a genetic diagram to show how a cross between a white-eyed male fruit fly with a red-eyed female fruit fly will produce male and female offspring that are either red-eyed or orange-eyed.

[4]

[Total: 9]

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Section B

Answer **one** question.

9 **(a)** Outline oogenesis in a human female. [9]

(b) Describe and explain the changes to the uterus during the menstrual cycle. [6]

[Total:15]

10 **(a)** Outline how hybridisation leads to polyploidy in wheat **and** how this benefits farmers. [8]

(b) Discuss the detrimental environmental and economic effects of growing genetically modified herbicide-resistant oil seed rape. [7]

[Total: 15]

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