Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

2568923076

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **October/November 2014**

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, graphs or rough working.
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.

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	

This document consists of **20** printed pages and **2** blank pages and **2** lined pages.

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Section A

Answer **all** the questions.

1 **(a)** All modern breeds of dog belong to the same species and are thought to have originated from 14 ancient breeds by the process of artificial selection. The golden retriever is a modern breed that is often used as a guide dog for people who are blind or visually impaired.

Fig. 1.1 shows a golden retriever.



Fig. 1.1

Explain how the principles of artificial selection would have been used to produce golden retrievers with the characteristics required for a guide dog.

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.....[4]

(b) The domestic dog, *Canis familiaris*, is found worldwide. It is able to breed with all other members of the genus to form fertile hybrids.

The distribution of some of the species belonging to the genus *Canis* is shown in Fig. 1.2.

The dingo and the grey wolf species have distinct ranges but the ranges of three species of jackal overlap in East Africa.

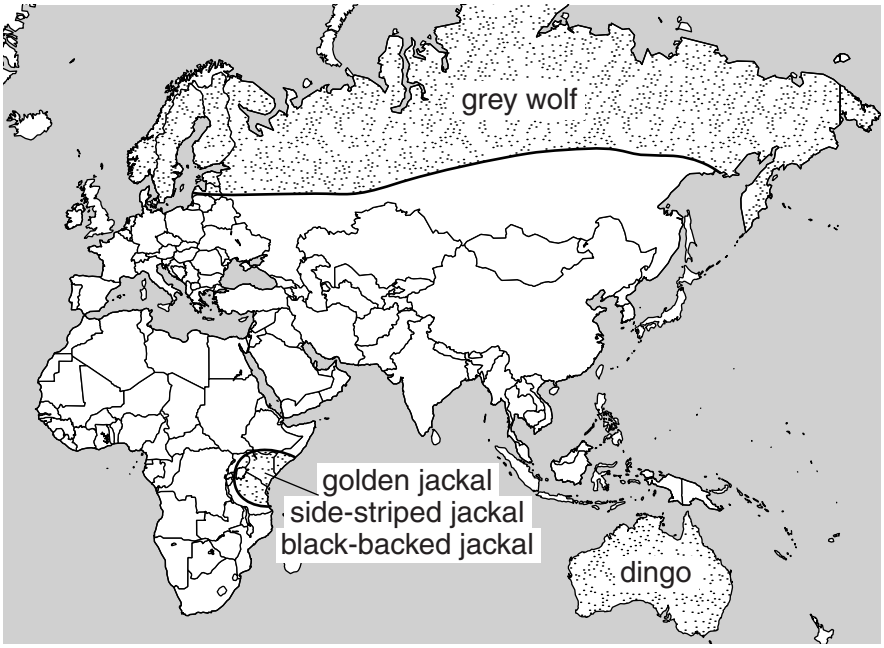


Fig. 1.2

Table 1.1 shows whether members of different species of the genus *Canis* are able to breed with each other.

Table 1.1

key: ✓ = able to interbreed ✗ = unable to interbreed **?** = interbreeding unknown

	dingo	**grey wolf**	**golden jackal**	**side-striped jackal**	**black-backed jackal**	**domestic dog**
dingo	✓	?	?	?	?	✓
grey wolf	?	✓	?	?	?	✓
golden jackal	?	?	✓	✗	✗	✓
side-striped jackal	?	?	✗	✓	✗	✓
black-backed jackal	?	?	✗	✗	✓	✓
domestic dog	✓	✓	✓	✓	✓	✓

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(i) Suggest the type of isolating mechanism **preventing**:

- the three species of jackal interbreeding

.....

- the dingo mating with all the other members of the genus *Canis* apart from the domestic dog.

.....[2]

(ii) Using the information in Fig. 1.2 and Table 1.1, state:

- **one** reason why the members of the genus *Canis* could be described as one species

.....

.....

.....

- **one** reason why they should be described as separate species.

.....

.....

.....[2]

[Total: 8]

2 Many tumours release a protein growth factor called VEGF. This is a chemical signal that causes nearby blood vessels to grow new branches into the tumour.

The monoclonal antibody, bevacizumab (Avastin®), specifically binds to VEGF.

(a) Suggest how Avastin® can prevent the growth and spread of a tumour.

.....

.....

.....

.....

.....

.....[2]

(b) Avastin® is made by the hybridoma method.

State:

(i) the antigen that is injected into a mouse to produce this monoclonal antibody

.....[1]

(ii) what is meant by a *hybridoma*.

.....

.....

.....[1]

(c) The monoclonal antibody made by the hybridoma method is modified to obtain humanised mouse antibody. This type of antibody molecule resembles those produced by humans.

Suggest advantages of using humanised mouse antibody rather than mouse antibody.

.....

.....

.....

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.....[3]

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(d) A second monoclonal antibody, ranibizumab (Lucentis®) is used to treat eye diseases. Lucentis® is a fragment of Avastin® and is shown in Fig. 2.1.

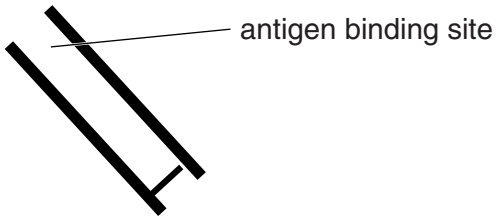


Fig. 2.1

Complete Fig. 2.1 to show a molecule of Avastin®.

Labels are **not** required. [2]

[Total: 9]

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3 Human insulin can be synthesised in a laboratory strain of *Escherichia coli* using recombinant DNA (rDNA) technology.

The starting point for the process is mRNA coding for insulin, isolated from human pancreas cells.

Four enzymes are needed:
- reverse transcriptase
- DNA polymerase
- restriction enzyme
- DNA ligase.

(a) (i) State the role of each of these enzymes in producing rDNA carrying the gene for human insulin.

reverse transcriptase

.....

.....

DNA polymerase

.....

.....

restriction enzyme

.....

.....

DNA ligase

.....

.....[4]

(ii) Outline the role of insulin in a healthy human.

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.....[3]

(iii) Describe and explain **one** advantage of treating diabetics with human insulin produced by rDNA technology.

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.....[2]

(b) It is possible to use rDNA technology to produce insulin with a slightly different structure from that of human insulin. The effect of the changed structure can then be investigated.

The activities of equal quantities of two insulins, both produced by *E. coli*, were compared in healthy, non-diabetic subjects:

- human insulin
- insulin **X**, in which the positions of two amino acids, lysine and proline, were exchanged. Lysine has a hydrophilic R group and proline has a hydrophobic R group.

The results of the investigation are shown in Fig. 3.1.

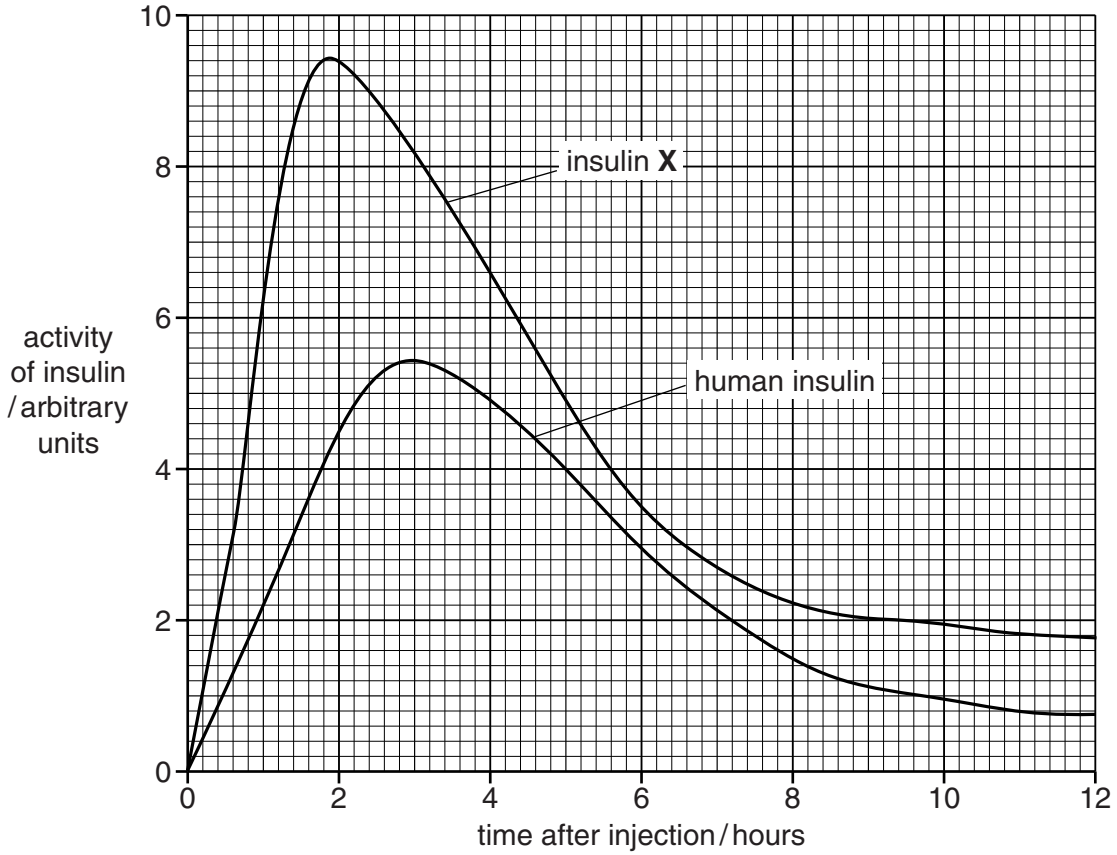


Fig. 3.1

(i) With reference to Fig. 3.1 describe the differences in activity between human insulin and insulin **X**.

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.....[4]

(ii) Suggest how exchanging the position of two amino acids in the insulin molecule can result in differences in activity.

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.....[2]

[Total: 15]

4 **(a)** List three reasons why it is important to conserve endangered plant species.

1. .....

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2. .....

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3. .....

.....[3]

(b) The tree *Vatica guangxiensis* is an endangered species. Only three wild populations exist, all in south-western China. Conservation of this species began in the 1980s. Conservation methods included attempts to preserve the habitat of the wild populations and the establishment of a fourth population in the Xishuangbanna Tropical Botanical Garden.

In 2002, the genetic diversity of each of the four populations was assessed. This was done by testing samples of DNA from a number of individuals.

- Twenty different regions of DNA were investigated, using electrophoresis.
- For each population, the percentage of samples that showed differences in the DNA structure, shown by different bands on the DNA 'fingerprint', was calculated.
- This figure was recorded as the percentage of polymorphic bands.

The greater the percentage of polymorphic bands, the greater the genetic diversity in the population.

Table 4.1 shows the results.

Table 4.1

population	**number of individual plants sampled**	**percentage of polymorphic bands**
wild population **A**	27	38.53
wild population **B**	30	31.60
wild population **C**	10	27.27
population in the botanic garden	28	30.74

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(i) With reference to Table 4.1, compare the genetic diversity of the population of *V. guangxiensis* in the botanic garden with the genetic diversity of the three wild populations.

.....

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.....[2]

(ii) Suggest explanations for the relatively low percentage of polymorphic bands recorded in wild population **C**.

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.....[2]

(iii) Explain why high genetic diversity is important for a species.

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.....[2]

(iv) The Xishuangbanna Tropical Botanical Garden is located only tens of kilometres from the habitats of the wild populations of *V. guangxiensis*.
Suggest how this may help with the long-term conservation of this species.

.....

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.....[2]

(c) Seed banks also have an important role in the conservation of endangered plant species.

(i) Explain why storing seeds may be a more successful method of conservation than maintaining a population of growing plants.

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.....[2]

(ii) Suggest why a sample of each type of seed stored in a seed bank is germinated every few years.

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[Total: 15]

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5 **(a)** Fig. 5.1 shows the structure of an ATP molecule.

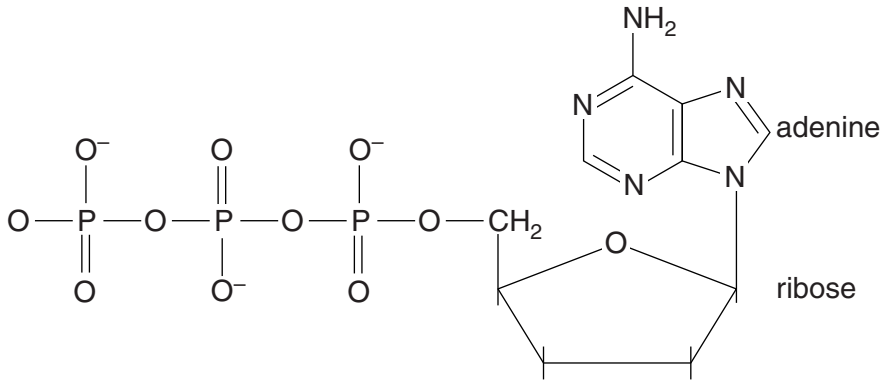


Fig. 5.1

State two ways in which the structure of ATP differs from the structure of an adenine nucleotide in a DNA molecule.

1. .....

.....

2. .....

.....[2]

(b) In respiration, energy from various substrates is used to synthesise ATP.

(i) Explain why less ATP can be synthesised from the same mass of glucose in anaerobic respiration than in aerobic respiration.

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.....[3]

(ii) Explain why more ATP can be synthesised in aerobic respiration from one gram of lipid than from one gram of glucose.

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.....[3]

[Total: 8]

6 (a) Neurones transmit impulses from one part of a mammal's body to another.

The table contains statements that refer to motor and sensory neurones.

Complete the table, indicating with the letters **M**, **S** or **B**, whether each statement applies to:

- motor neurones only (**M**)
- sensory neurones only (**S**)
- both motor and sensory neurones (**B**).

The first one has been done for you.

statement	letter
is myelinated	**B**
may form a synapse with an intermediate (relay) neurone	.....
cell body lies within the CNS	.....
dendron is usually longer than axon	.....
cell body lies within spinal nerve	.....
has many dendrites	.....

[3]

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(b) A synapse is a junction between two or more neurones.

Describe how an action potential arriving at a presynaptic membrane of a neurone can result in the depolarisation of the membrane of a post-synaptic neurone.

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(c) Acetylcholinesterase is an enzyme found in the synaptic cleft.

Outline the role of acetylcholinesterase.

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[Total: 10]

7 Phenylketonuria (PKU) is a genetic disease which results in a raised concentration of the amino acid phenylalanine in the blood. If left untreated in a newborn baby, it can lead to brain damage. For this reason, babies may be tested for PKU soon after birth.

Usually, excess phenylalanine is converted to the amino acid tyrosine by the enzyme phenylalanine hydroxylase (PAH). PKU can be the result of a recessive mutation of the gene coding for PAH.

(a) Explain what is meant by a *recessive mutation*.

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.....[2]

(b) Using appropriate symbols, complete the diagram below to show how two parents who do not have PKU can have children with, or without, PKU.

key to symbols

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parental phenotypes	without PKU	without PKU
parental genotypes		
gametes		
offspring genotypes		
offspring phenotypes		

[3]

(c) PKU can be caused when a short length of the RNA produced during transcription of the gene coding for PAH is lost.

Suggest what effect this would have on the protein that is subsequently produced.

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[Total: 8]

8 **(a)** Fig. 8.1 shows some of the reactions that take place inside a palisade mesophyll cell.

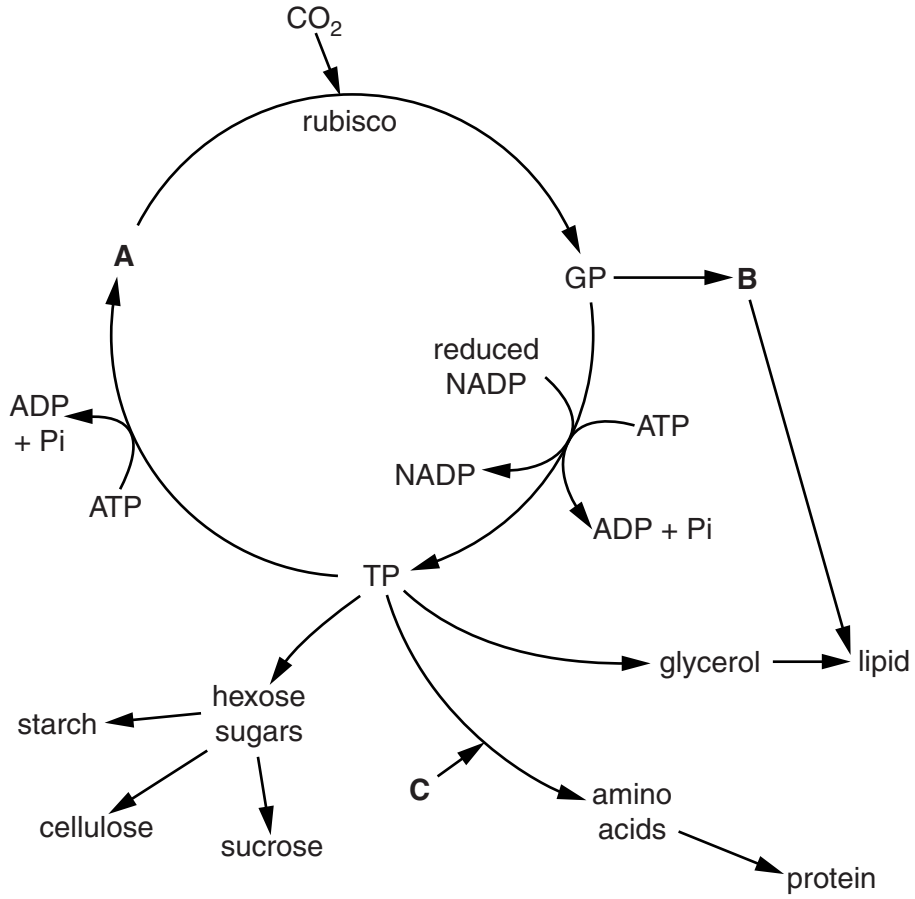


Fig. 8.1

(i) Identify substances **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) Name precisely the process that produces reduced NADP.

.....[1]

(iii) Name the type of reaction that takes place to produce starch from hexose sugars **and** name the type of bonds formed.

reaction .....

bond .....[2]

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(iv) Describe how carbon dioxide reaches the inside of a palisade mesophyll cell from the external atmosphere.

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(b) The optimum pH for the activity of rubisco is pH8.

Explain why the illumination of chloroplasts leads to optimum pH conditions for rubisco.

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[Total: 12]

Section B

Answer **one** question.

9 **(a)** Explain the significance of cereal crops in the human diet. [8]

(b) Describe and explain how gibberellins are involved in the germination of wheat or barley seeds. [7]

[Total: 15]

10 **(a)** Describe the role of hormones in the maintenance of the human menstrual cycle. [9]

(b) Explain the principles of homeostasis in humans. [6]

[Total: 15]

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[Turn over

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Fig. 1.1 A. Bennett

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Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

6098897919 4

BIOLOGY **9700/42**

Paper 4 A2 Structured Questions **October/November 2014**

2 hours

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Total	

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Section A

Answer **all** the questions.

1 **(a)** All modern breeds of dog belong to the same species and are thought to have originated from 14 ancient breeds by the process of artificial selection. The golden retriever is a modern breed that is often used as a guide dog for people who are blind or visually impaired.

Fig. 1.1 shows a golden retriever.



Fig. 1.1

Explain how the principles of artificial selection would have been used to produce golden retrievers with the characteristics required for a guide dog.

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.....[4]

(b) The domestic dog, *Canis familiaris*, is found worldwide. It is able to breed with all other members of the genus to form fertile hybrids.

The distribution of some of the species belonging to the genus *Canis* is shown in Fig. 1.2.

The dingo and the grey wolf species have distinct ranges but the ranges of three species of jackal overlap in East Africa.

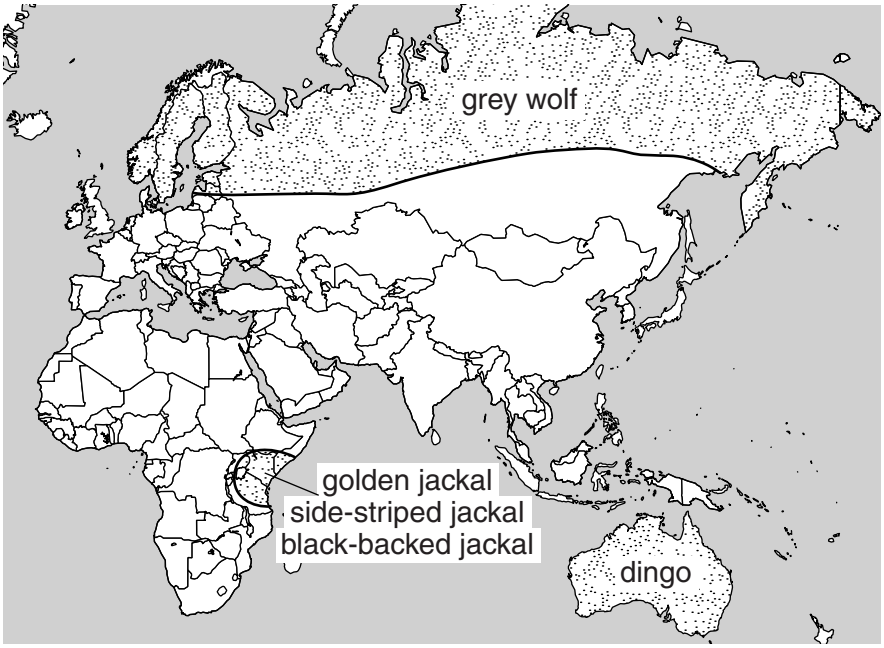


Fig. 1.2

Table 1.1 shows whether members of different species of the genus *Canis* are able to breed with each other.

Table 1.1

key: ✓ = able to interbreed ✗ = unable to interbreed **?** = interbreeding unknown

	dingo	**grey wolf**	**golden jackal**	**side-striped jackal**	**black-backed jackal**	**domestic dog**
dingo	✓	?	?	?	?	✓
grey wolf	?	✓	?	?	?	✓
golden jackal	?	?	✓	✗	✗	✓
side-striped jackal	?	?	✗	✓	✗	✓
black-backed jackal	?	?	✗	✗	✓	✓
domestic dog	✓	✓	✓	✓	✓	✓

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(i) Suggest the type of isolating mechanism **preventing**:

- the three species of jackal interbreeding

.....

- the dingo mating with all the other members of the genus *Canis* apart from the domestic dog.

.....[2]

(ii) Using the information in Fig. 1.2 and Table 1.1, state:

- **one** reason why the members of the genus *Canis* could be described as one species

.....

.....

.....

- **one** reason why they should be described as separate species.

.....

.....

.....[2]

[Total: 8]

2 Many tumours release a protein growth factor called VEGF. This is a chemical signal that causes nearby blood vessels to grow new branches into the tumour.

The monoclonal antibody, bevacizumab (Avastin®), specifically binds to VEGF.

(a) Suggest how Avastin® can prevent the growth and spread of a tumour.

.....

.....

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.....

.....

.....[2]

(b) Avastin® is made by the hybridoma method.

State:

(i) the antigen that is injected into a mouse to produce this monoclonal antibody

.....[1]

(ii) what is meant by a *hybridoma*.

.....

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.....[1]

(c) The monoclonal antibody made by the hybridoma method is modified to obtain humanised mouse antibody. This type of antibody molecule resembles those produced by humans.

Suggest advantages of using humanised mouse antibody rather than mouse antibody.

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(d) A second monoclonal antibody, ranibizumab (Lucentis®) is used to treat eye diseases. Lucentis® is a fragment of Avastin® and is shown in Fig. 2.1.

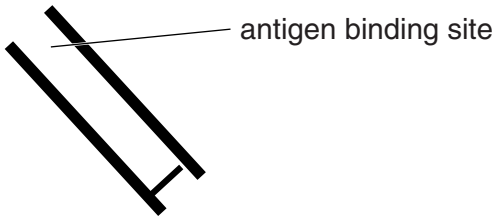


Fig. 2.1

Complete Fig. 2.1 to show a molecule of Avastin®.

Labels are **not** required. [2]

[Total: 9]

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3 Human insulin can be synthesised in a laboratory strain of *Escherichia coli* using recombinant DNA (rDNA) technology.

The starting point for the process is mRNA coding for insulin, isolated from human pancreas cells.

Four enzymes are needed:
- reverse transcriptase
- DNA polymerase
- restriction enzyme
- DNA ligase.

(a) (i) State the role of each of these enzymes in producing rDNA carrying the gene for human insulin.

reverse transcriptase

.....

.....

DNA polymerase

.....

.....

restriction enzyme

.....

.....

DNA ligase

.....

.....[4]

(ii) Outline the role of insulin in a healthy human.

.....

.....

.....

.....

.....

.....[3]

(iii) Describe and explain **one** advantage of treating diabetics with human insulin produced by rDNA technology.

.....

.....

.....

.....[2]

(b) It is possible to use rDNA technology to produce insulin with a slightly different structure from that of human insulin. The effect of the changed structure can then be investigated.

The activities of equal quantities of two insulins, both produced by *E. coli*, were compared in healthy, non-diabetic subjects:

- human insulin
- insulin **X**, in which the positions of two amino acids, lysine and proline, were exchanged. Lysine has a hydrophilic R group and proline has a hydrophobic R group.

The results of the investigation are shown in Fig. 3.1.

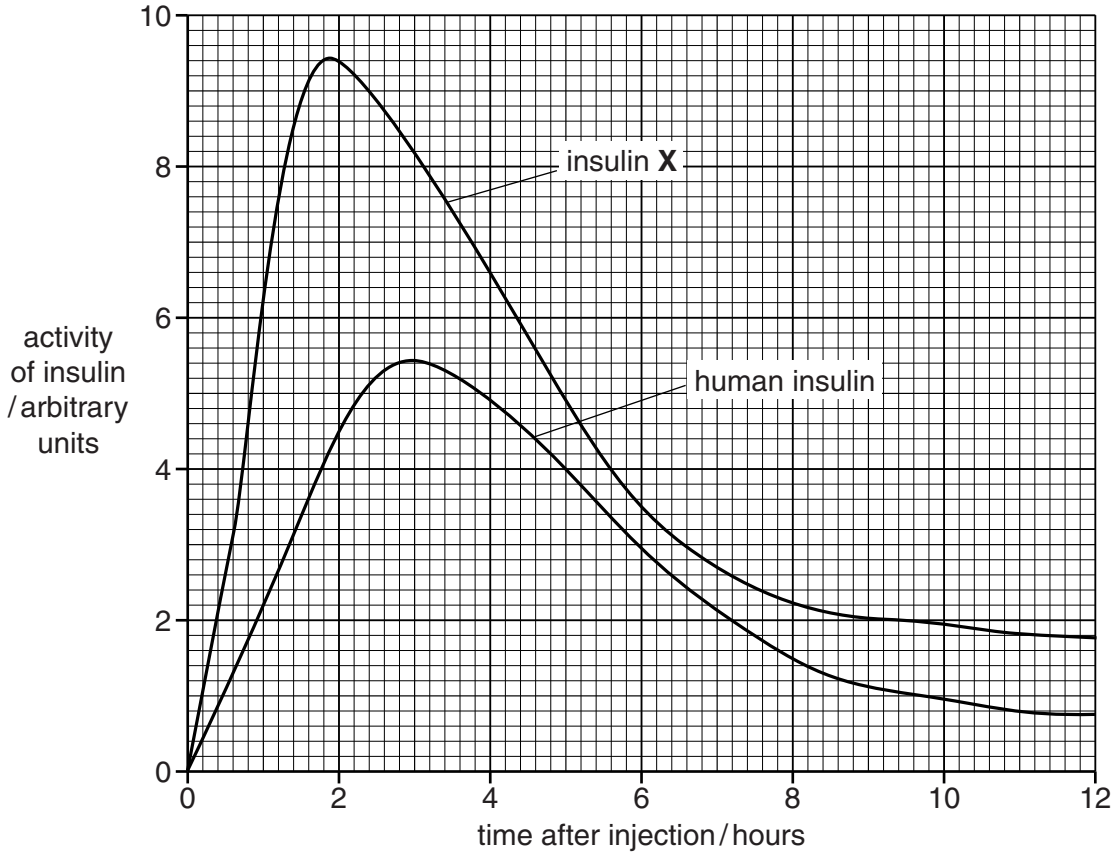


Fig. 3.1

(i) With reference to Fig. 3.1 describe the differences in activity between human insulin and insulin **X**.

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.....[4]

(ii) Suggest how exchanging the position of two amino acids in the insulin molecule can result in differences in activity.

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[Total: 15]

4 **(a)** List three reasons why it is important to conserve endangered plant species.

1. .....

.....

2. .....

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3. .....

.....[3]

(b) The tree *Vatica guangxiensis* is an endangered species. Only three wild populations exist, all in south-western China. Conservation of this species began in the 1980s. Conservation methods included attempts to preserve the habitat of the wild populations and the establishment of a fourth population in the Xishuangbanna Tropical Botanical Garden.

In 2002, the genetic diversity of each of the four populations was assessed. This was done by testing samples of DNA from a number of individuals.

- Twenty different regions of DNA were investigated, using electrophoresis.
- For each population, the percentage of samples that showed differences in the DNA structure, shown by different bands on the DNA 'fingerprint', was calculated.
- This figure was recorded as the percentage of polymorphic bands.

The greater the percentage of polymorphic bands, the greater the genetic diversity in the population.

Table 4.1 shows the results.

Table 4.1

population	**number of individual plants sampled**	**percentage of polymorphic bands**
wild population **A**	27	38.53
wild population **B**	30	31.60
wild population **C**	10	27.27
population in the botanic garden	28	30.74

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(i) With reference to Table 4.1, compare the genetic diversity of the population of *V. guangxiensis* in the botanic garden with the genetic diversity of the three wild populations.

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.....[2]

(ii) Suggest explanations for the relatively low percentage of polymorphic bands recorded in wild population **C**.

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.....[2]

(iii) Explain why high genetic diversity is important for a species.

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.....[2]

(iv) The Xishuangbanna Tropical Botanical Garden is located only tens of kilometres from the habitats of the wild populations of *V. guangxiensis*.
Suggest how this may help with the long-term conservation of this species.

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.....[2]

(c) Seed banks also have an important role in the conservation of endangered plant species.

(i) Explain why storing seeds may be a more successful method of conservation than maintaining a population of growing plants.

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.....[2]

(ii) Suggest why a sample of each type of seed stored in a seed bank is germinated every few years.

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.....[2]

[Total: 15]

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5 **(a)** Fig. 5.1 shows the structure of an ATP molecule.

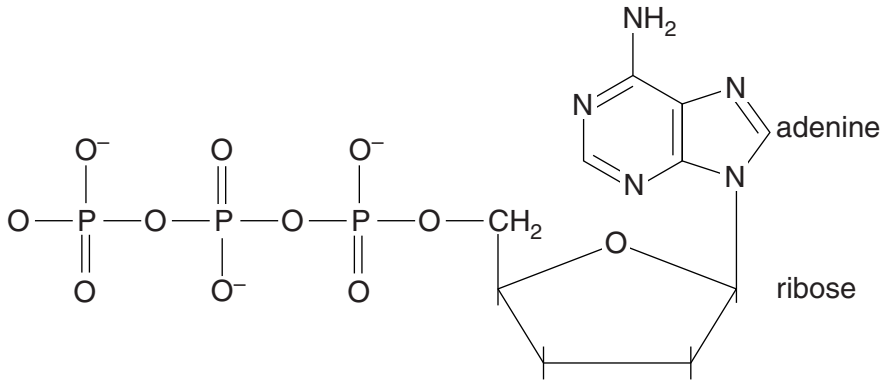


Fig. 5.1

State two ways in which the structure of ATP differs from the structure of an adenine nucleotide in a DNA molecule.

1. .....

.....

2. .....

.....[2]

(b) In respiration, energy from various substrates is used to synthesise ATP.

(i) Explain why less ATP can be synthesised from the same mass of glucose in anaerobic respiration than in aerobic respiration.

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.....[3]

(ii) Explain why more ATP can be synthesised in aerobic respiration from one gram of lipid than from one gram of glucose.

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.....[3]

[Total: 8]

6 (a) Neurones transmit impulses from one part of a mammal's body to another.

The table contains statements that refer to motor and sensory neurones.

Complete the table, indicating with the letters **M**, **S** or **B**, whether each statement applies to:

- motor neurones only (**M**)
- sensory neurones only (**S**)
- both motor and sensory neurones (**B**).

The first one has been done for you.

statement	letter
is myelinated	**B**
may form a synapse with an intermediate (relay) neurone	.....
cell body lies within the CNS	.....
dendron is usually longer than axon	.....
cell body lies within spinal nerve	.....
has many dendrites	.....

[3]

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(b) A synapse is a junction between two or more neurones.

Describe how an action potential arriving at a presynaptic membrane of a neurone can result in the depolarisation of the membrane of a post-synaptic neurone.

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(c) Acetylcholinesterase is an enzyme found in the synaptic cleft.

Outline the role of acetylcholinesterase.

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.....[2]

[Total: 10]

7 Phenylketonuria (PKU) is a genetic disease which results in a raised concentration of the amino acid phenylalanine in the blood. If left untreated in a newborn baby, it can lead to brain damage. For this reason, babies may be tested for PKU soon after birth.

Usually, excess phenylalanine is converted to the amino acid tyrosine by the enzyme phenylalanine hydroxylase (PAH). PKU can be the result of a recessive mutation of the gene coding for PAH.

(a) Explain what is meant by a *recessive mutation*.

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.....[2]

(b) Using appropriate symbols, complete the diagram below to show how two parents who do not have PKU can have children with, or without, PKU.

key to symbols

.....

.....

parental phenotypes	without PKU	without PKU
parental genotypes		
gametes		
offspring genotypes		
offspring phenotypes		

[3]

(c) PKU can be caused when a short length of the RNA produced during transcription of the gene coding for PAH is lost.

Suggest what effect this would have on the protein that is subsequently produced.

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.....[3]

[Total: 8]

8 **(a)** Fig. 8.1 shows some of the reactions that take place inside a palisade mesophyll cell.

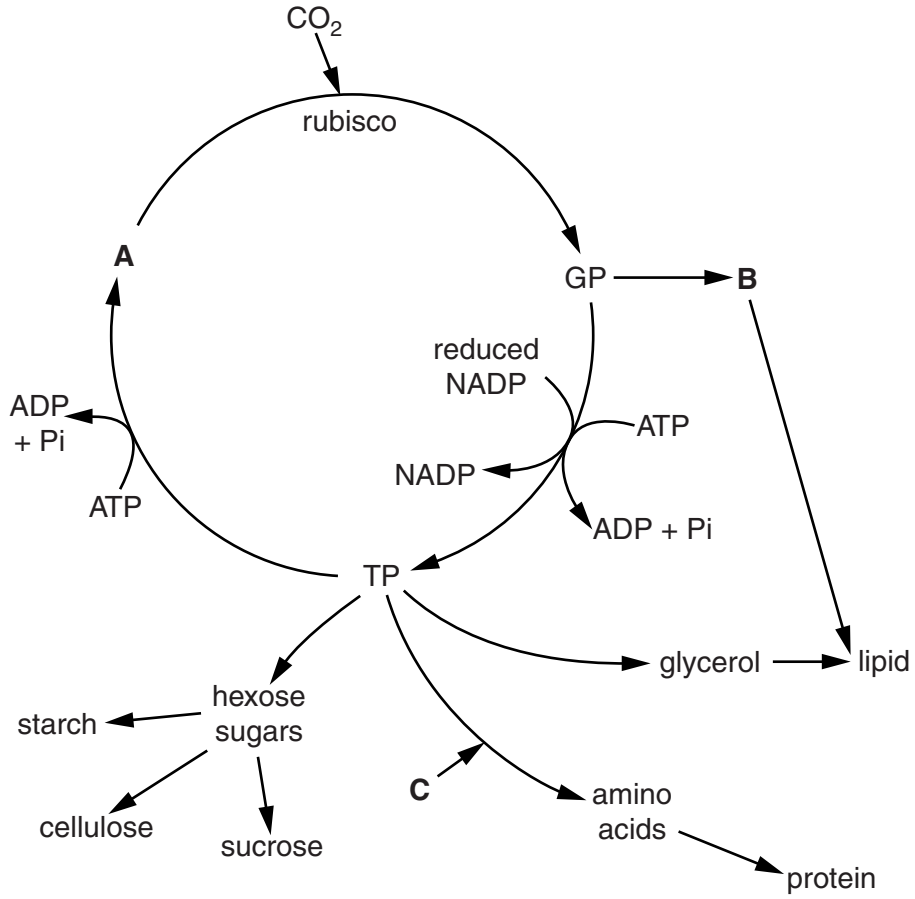


Fig. 8.1

(i) Identify substances **A**, **B** and **C**.

A .....

B .....

C ..... [3]

(ii) Name precisely the process that produces reduced NADP.

.....[1]

(iii) Name the type of reaction that takes place to produce starch from hexose sugars **and** name the type of bonds formed.

reaction .....

bond .....[2]

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(iv) Describe how carbon dioxide reaches the inside of a palisade mesophyll cell from the external atmosphere.

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.....[3]

(b) The optimum pH for the activity of rubisco is pH8.

Explain why the illumination of chloroplasts leads to optimum pH conditions for rubisco.

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.....[3]

[Total: 12]

Section B

Answer **one** question.

9 **(a)** Explain the significance of cereal crops in the human diet. [8]

(b) Describe and explain how gibberellins are involved in the germination of wheat or barley seeds. [7]

[Total: 15]

10 **(a)** Describe the role of hormones in the maintenance of the human menstrual cycle. [9]

(b) Explain the principles of homeostasis in humans. [6]

[Total: 15]

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Fig. 1.1 A. Bennett

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6782071751

BIOLOGY **9700/43**

Paper 4 A2 Structured Questions **October/November 2014**

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, graphs or rough working.
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.

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	

This document consists of **22** printed pages and **2** lined pages.

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CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

1 Phenylketonuria (PKU) is a genetic disease which results in a raised concentration of the amino acid phenylalanine in the blood. If left untreated in a newborn baby, it can lead to brain damage. For this reason, babies may be tested for PKU soon after birth.

(a) (i) In people without PKU, excess phenylalanine is converted to the amino acid tyrosine by the enzyme phenylalanine hydroxylase (PAH). One of the mutations that can lead to PKU is caused by a base substitution in the gene coding for PAH. This results in the replacement of the amino acid arginine by the amino acid glutamine.

Table 1.1 shows the triplet base codes for arginine and glutamine.

Table 1.1

amino acid	DNA triplet
arginine	GCA
	GCG
	GCT
	GCC
	TCT
	TCC
glutamine	GTT
	GTC

Using the information in Table 1.1, explain how a single base substitution can replace arginine with glutamine in PAH.

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.....[2]

(ii) Suggest the consequence to the structure of PAH as a result of a single base substitution in its gene.

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.....

.....[1]

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(b) For some genetic diseases, the proportion of individuals that have the disease can vary in different parts of the world. Sometimes this is due to different environmental conditions. The number of cases of PKU is approximately ten times higher in Europe than in Sub-Saharan Africa.

- Individuals who are carriers of the recessive allele for PKU are more resistant to ochratoxin A, produced by a fungus found on contaminated grain products.
- Ochratoxin A has been linked to a form of renal cancer.
- The fungi that produce ochratoxin A are less common in dry regions such as Sub-Saharan Africa.

Suggest **and** explain the mechanism which has resulted in the different number of cases of PKU in European and Sub-Saharan populations.

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.....[5]

[Total: 8]

2 The endangered Californian condor, *Gymnogyps californianus*, is the largest flying bird in North America. Condors feed on dead bodies of large mammals, such as cattle and deer. Fig. 2.1 shows the Californian condor.



Fig. 2.1

The population of these condors fell to just 22 in 1982 and this led to the California Condor Recovery Program (CCRP), a captive breeding programme, being set up in different zoos in the United States and Mexico.

Owing to the success of the captive breeding programme there are now over 300 condors. Many of these have been released as part of the programme.

(a) Outline the advantages of captive breeding programmes such as CCRP.

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.....[4]

(b) Suggest why animals in captive breeding programmes may not always breed successfully.

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.....[2]

(c) When animals that have been bred in captivity are released, their survival rate is low.

Suggest **two** reasons why many of these animals are unable to survive in the wild.

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.....[2]

(d) Bullets containing lead are commonly used by hunters. Hunting for pleasure means that hunters often leave the killed animals, such as deer, bears and antelopes, in the area where they have been shot.

Suggest why this is a threat, rather than an advantage, to the Californian condor.

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.....[1]

[Total: 9]

3 **(a)** The diagram outlines how a gene coding for human insulin is produced by genetic engineering techniques.

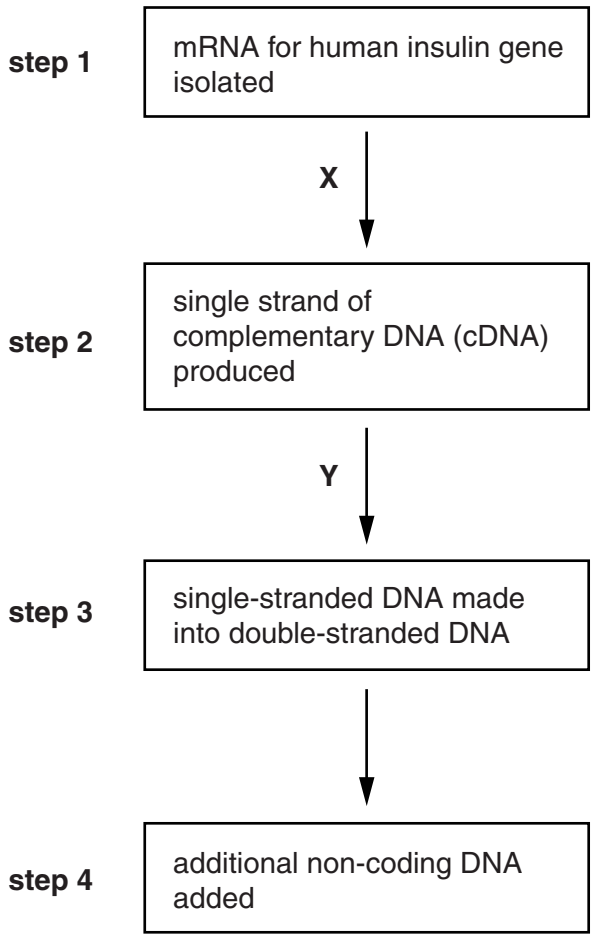


Fig. 3.1

(i) Name the enzymes **X** and **Y**.

X .....

Y ..... [2]

(ii) Explain why the starting point in this procedure is mRNA.

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.....

.....[2]

(b) Suggest why some methods of manufacturing genetically engineered insulin use eukaryotic yeast cells rather than prokaryotic bacterial cells.

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.....[2]

(c) State **three** advantages of using human insulin produced by genetic engineering.

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.....[3]

[Total: 9]

4 **(a)** All living organisms require a continuous supply of energy.

Outline the need for energy in living organisms.

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.....[2]

(b) Fig. 4.1 is a diagram of ATP.

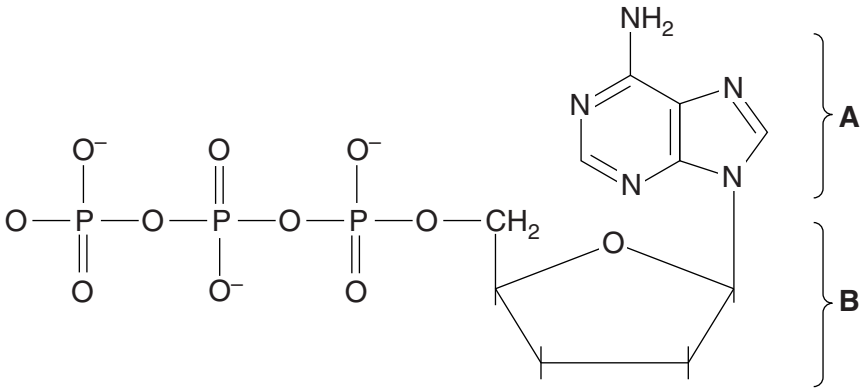


Fig. 4.1

(i) Name **A** and **B**.

A .....

B ..... [1]

(ii) Describe how the structure of ATP is related to its role as energy currency.

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.....[3]

(c) *Thermus thermophilus* is a bacterium found in geothermal environments, such as hot springs. The bacterium respires **aerobically**, even though at high temperatures the solubility of oxygen in water is low.

(i) Explain how **aerobic** respiration may be affected by a decrease in oxygen availability.

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.....[2]

(ii) One strain of *T. thermophilus*, HB8, has an enzyme, nitrate reductase, which allows nitrate to be used as the final electron acceptor in the electron transport chain (ETC).

Suggest an advantage to the bacterium of this adaptation.

.....

.....[1]

(d) A mutant strain of HB8 (HB8 mutant) was made by adding an insertion mutation to the gene that codes for the enzyme nitrate reductase.

An investigation was carried out into population growth of HB8 and of HB8 mutant in aerobic and in anaerobic conditions. In each experiment, a flask containing bacterial culture medium was incubated. Table 4.1 shows how the flasks were set up.

The number of bacteria of each strain per cm^3 was calculated after 20 hours.

Table 4.1

flask	bacteria	conditions
1	HB8	aerobic
2	HB8 mutant	aerobic
3	HB8 and HB8 mutant	aerobic
4	HB8	anaerobic
5	HB8 mutant	anaerobic
6	HB8 and HB8 mutant	anaerobic

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The results are shown in Fig. 4.2.

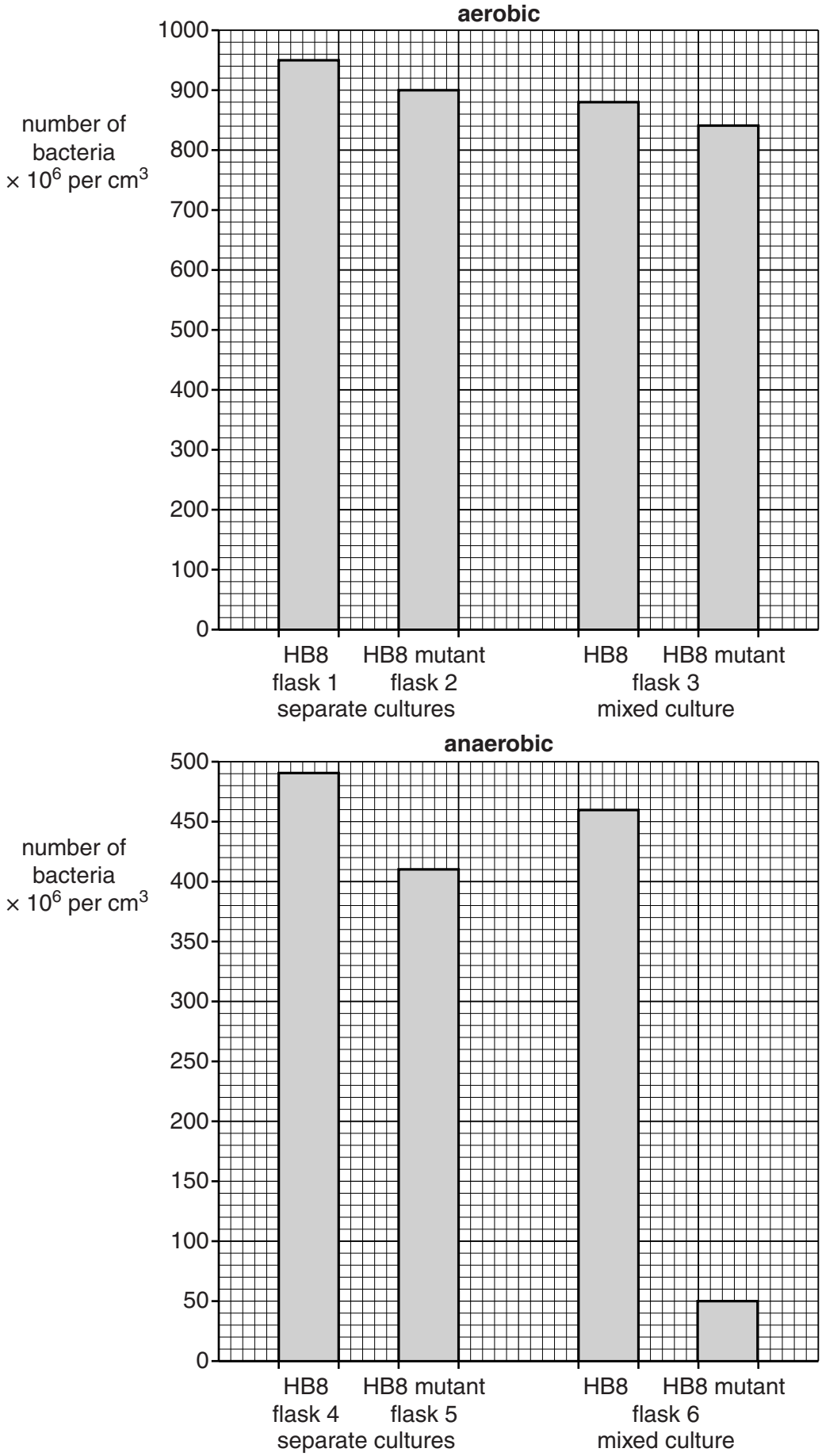


Fig. 4.2

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(i) Compare the growth of the two strains of bacteria in aerobic and anaerobic conditions in **separate** cultures.

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.....

.....[2]

(ii) Compare the growth of the two strains of bacteria in aerobic and anaerobic conditions in **mixed** cultures.

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.....[2]

(iii) Suggest an explanation for the results shown in flask 6.

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.....[1]

[Total: 14]

5 **(a)** The pollutants in waste water from the textile industry may include azo-dyes, which give colour to textiles. Azo-dyes are organic pollutants that can be carcinogenic.

White-rot fungi are useful for the treatment of environmental pollution as they produce extracellular enzymes that are able to break down a number of organic pollutants, such as azo-dyes.

The extracellular enzymes produced by white-rot fungi are primary metabolites that are mass produced by continuous culture.

(i) Outline the main operating conditions of continuous culture.

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.....[2]

(ii) State **three** advantages of using continuous culture and not batch culture, for the mass production of these enzymes.

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.....[3]

(b) (i) The ability of the white-rot fungi to break down azo-dyes was investigated. A suspension of the intact fungal cells was added to water contaminated with various concentrations of an azo-dye.

The results are shown in Table 5.1.

Table 5.1

	percentage breakdown of azo-dye	
azo-dye concentration / mg dm^{-3}	**after 7 days**	**after 10 days**
50	21.9	100.0
100	53.1	93.7
150	61.7	89.6
200	51.0	87.3

Describe the results shown in Table 5.1.

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.....[4]

(ii) When a similar experiment was performed using the free enzymes from the white-rot fungal cells, all concentrations of azo-dye shown in Table 5.1 were broken down within 12 hours.

Suggest why free enzymes break down the azo-dye more quickly than intact white-rot fungal cells.

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.....[2]

(c) These extracellular enzymes may be immobilised on an inert support.

Outline the advantages of using immobilised enzymes in the treatment of textile waste water.

.....

.....

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.....

.....[3]

[Total: 14]

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6 Asparagus, *Asparagus officinalis*, is a green vegetable plant grown in many parts of the world.

Fig. 6.1 shows some asparagus shoots.



Fig. 6.1

(a) The shoots are usually cooked and then eaten hot or cold. Asparagus contains many mineral ions which have important roles in the bodies of mammals.

Complete Table 6.1 to summarise some of these roles.

Table 6.1

ion	role	type of cell
Fe^{2+}	....	red blood cell
Na^{+}	co-transport in the kidney	....
Ca^{+}	....	neurone

[3]

(b) When asparagus is digested, some of the compounds produced pass quickly into the urine to give a characteristic odour that only 22% of people can detect. The compounds bind to specific chemoreceptors in the nasal cavities of these people.

Complete the sentence below by using the most appropriate scientific term.

The chemoreceptors will send impulses to the brain only if the ..... potential is reached. [1]

(c) Outline how molecules, such as the compounds from the digestion of asparagus, pass from the blood to become part of the glomerular filtrate.

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.....[4]

[Total: 8]

7 The ABO blood grouping system in humans is determined by a single gene with three alleles: I^A, I^B and I^o.

(a) Distinguish between the terms *gene* and *allele*.

gene .....

.....

.....

allele .....

.....

.....[4]

(b) Fig. 7.1 shows a pedigree diagram of the inheritance of the ABO blood group system. The blood group of some of the individuals is given in the pedigree.

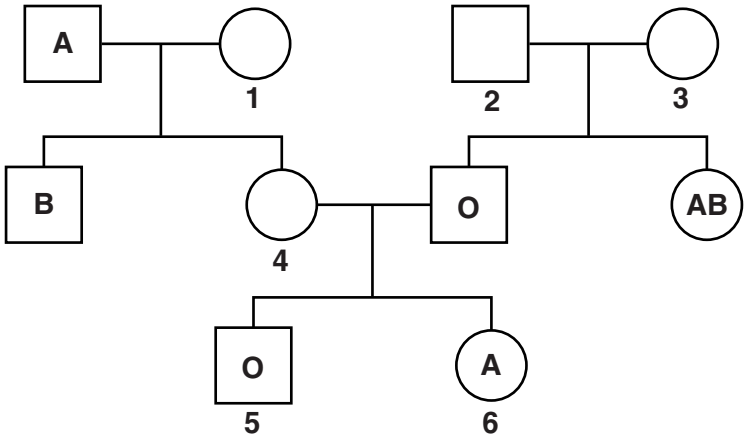


Fig. 7.1

Use the information in Fig. 7.1 and the genetic symbols I^A, I^B and I^o, to complete the table.

individual	phenotype	genotype
1		
2		
3		
4		

[4]

[Total: 8]

8 **(a)** Fig. 8.1 is a diagram of a palisade cell from a leaf.

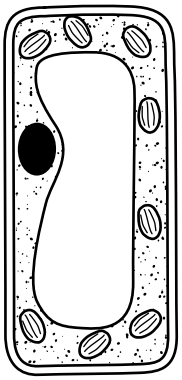


Fig. 8.1

Using label lines and the letters **X**, **Y** and **Z**, identify a structure in Fig. 8.1 that:

- contains RuBP – **X**
- is fully permeable – **Y**
- is made mainly of phospholipids – **Z** [3]

(b) An experiment was carried out to investigate the effect of light intensity on the rate of photosynthesis in an aquatic plant using the apparatus shown in Fig. 8.2.

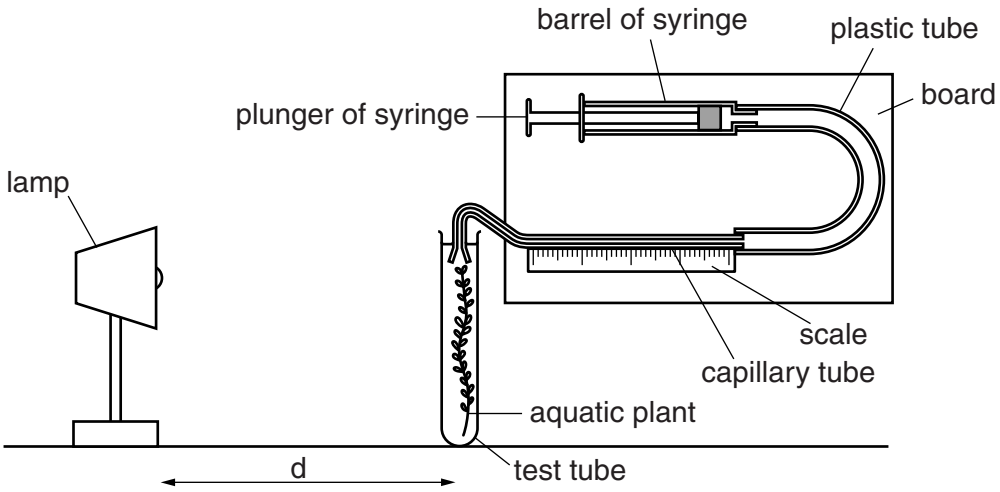


Fig. 8.2

As photosynthesis took place, the oxygen produced formed a bubble of gas which moved along the scale in the capillary tube. The distance moved by the bubble in a fixed period of time was used to calculate the rate of photosynthesis.

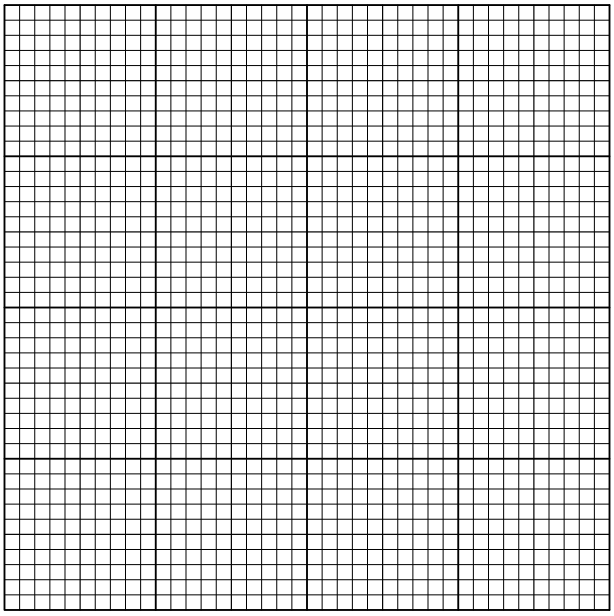
The light intensity was varied by altering the distance, d, between the lamp and the photosynthesising plant.

The results are shown in Table 8.1.

Table 8.1

light intensity / arbitrary units	rate of photosynthesis / arbitrary units
50	50
100	100
125	110
150	115
200	120
300	120

(i) Using the data in Table 8.1, draw a graph to show the relationship between light intensity and the rate of photosynthesis.



[3]

(ii) **Explain** the shape of the graph you have drawn, with reference to limiting factors.

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.....[3]

(c) Fig. 8.3 shows the absorption spectra of the photosynthetic pigments of a flowering plant.

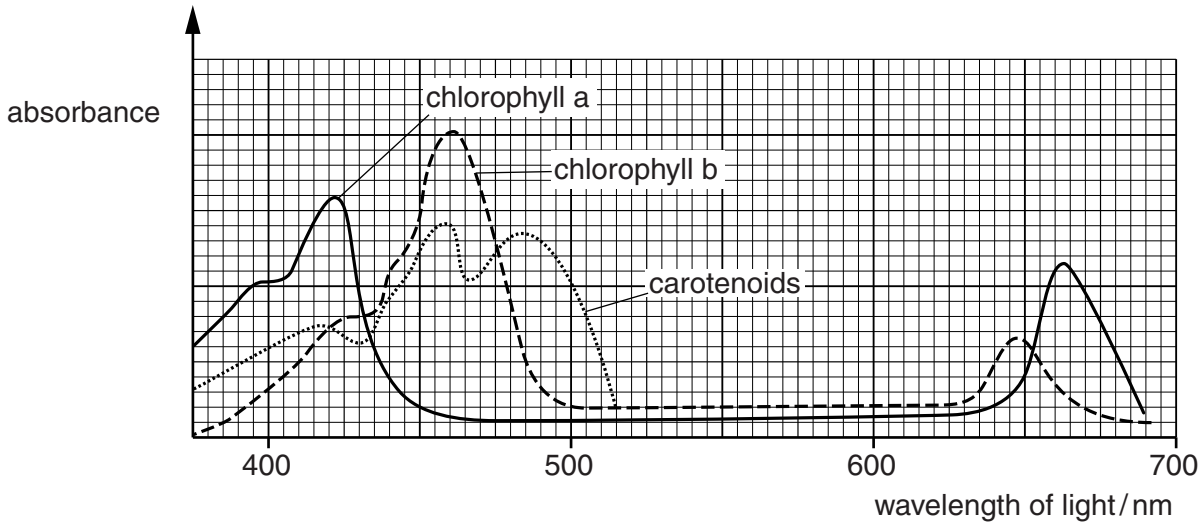


Fig. 8.3

(i) Name the accessory pigment(s) shown in Fig. 8.3.

.....

.....[1]

(ii) Outline the role of the accessory pigments in photosynthesis.

.....

.....

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.....[3]

(iii) Very little light of wavelength 550 nm is absorbed by the photosynthetic pigments.

State what happens to most of this light.

.....

.....[1]

(iv) A graph can also be drawn to show the relationship between the wavelength of light and the rate of photosynthesis.

State the name of this type of graph.

.....[1]

[Total: 15]

Section B

Answer **one** question.

9 **(a)** Describe how the vitamin A content of rice can be enhanced by genetic modification. [8]

(b) Outline the disadvantages of using plants that have been genetically modified. [7]

[Total: 15]

10 **(a)** Outline the technique of in-vitro fertilisation (IVF). [8]

(b) Discuss the ethical implications of IVF. [7]

[Total: 15]

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[Turn over

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Fig. 2.1 Yva Momatiuk & John Eastcott / Getty Images
Fig. 6.1 J. R. Bale / Alamy

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