Cambridge International **A Level**

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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BIOLOGY **9700/42**

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.

CAMBRIDGE International Examinations

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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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(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.

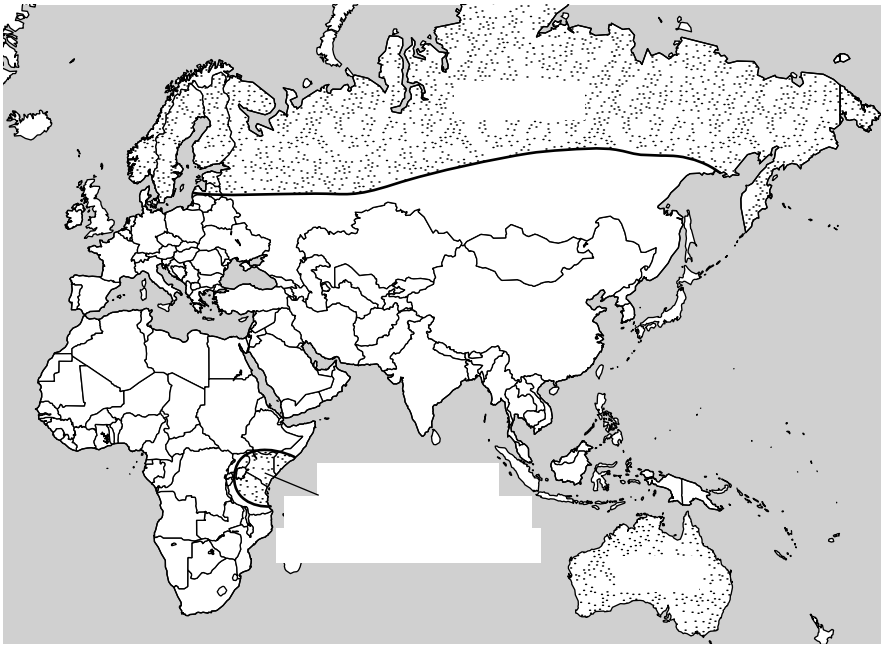

Fig. 1.2

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	✓	✓	✓	✓	✓	

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

- the three species of jackal interbreeding

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- 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

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

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.....[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.

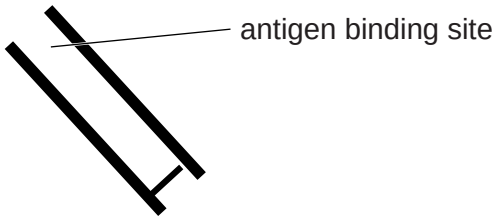

Fig. 2.1

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

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DNA polymerase

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restriction enzyme

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DNA ligase

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.....[4]

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

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(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.

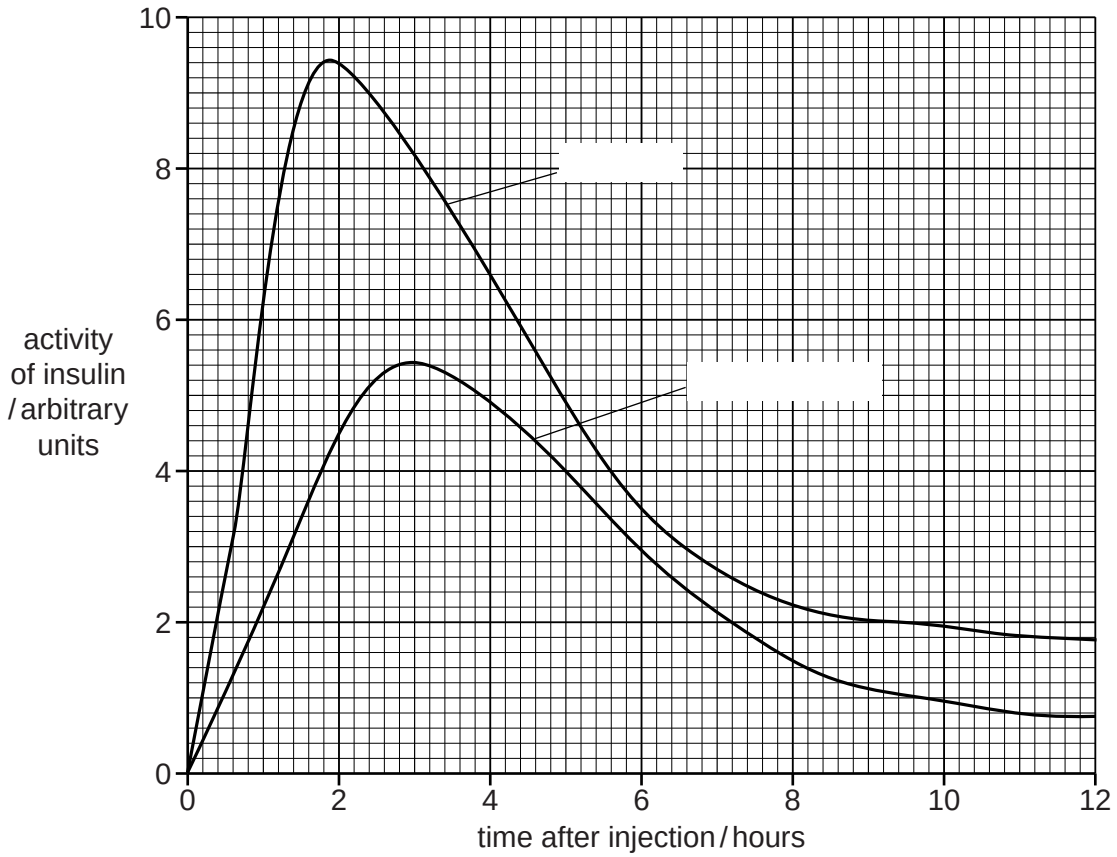

Fig. 3.1

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

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(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. .....

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2. .....

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3. .....

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(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

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

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

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(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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(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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(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]

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

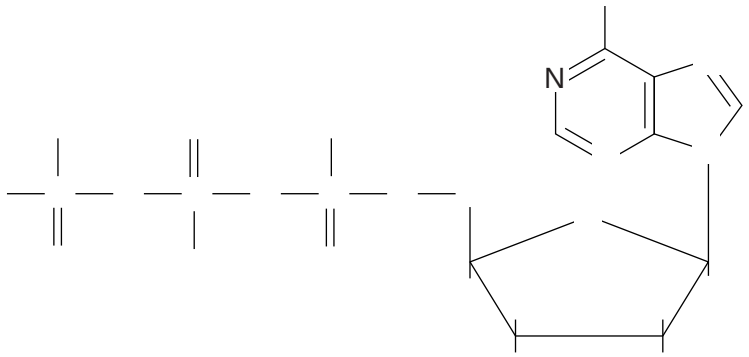

Fig. 5.1

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

1. .....

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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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(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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[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	.....

(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.

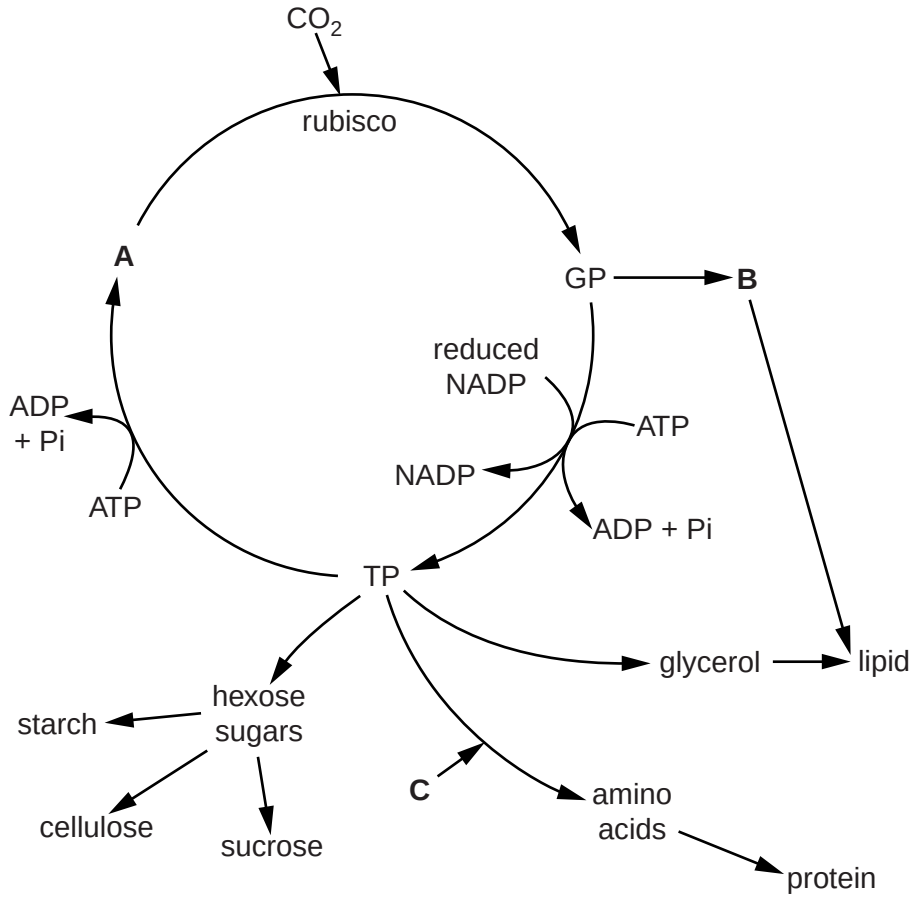

Fig. 8.1

(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]

(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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