UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Level 3 Pre-U Certificate
Principal Subject

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

7905524261

BIOLOGY **9790/02**

Paper 2 Structured **May/June 2011**

1 hour 45 minutes

Candidates answer on the Question Paper.

Additional materials: ruler

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen in the spaces provided.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

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	
1	
2	
3	
4	
5	
6	
7	
Total	

This document consists of **18** printed pages and **2** blank pages.

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1 Fig. 1.1 is a transmission electronmicrograph of a cell.

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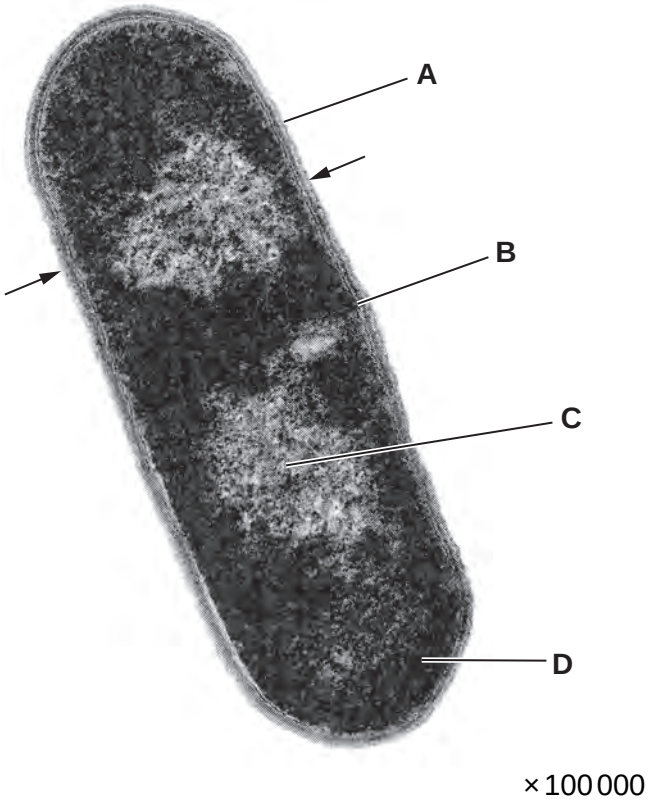

Fig. 1.1

(a) With reference to Fig. 1.1:

(i) identify the type of cell shown;

..... [1]

(ii) name structures **A**, **B** and **C**;

A .....

B .....

C ..... [3]

(iii) name an organelle that would be found in region **D**;

..... [1]

(iv) calculate the actual width of the cell between the arrows. Show your working.

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width ..... [2]

(b) Cells like the one shown in Fig. 1.1 turn blue or purple when stained with the Gram stain.

Explain why the Gram staining procedure gives this result with some, but not all, of these types of cells.

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..... [4]

[Total: 11]

2 Monosaccharides may be used to build a wide variety of biological structures.

For Examiner's Use

Fig. 2.1 shows two simplified β-glucose molecules.

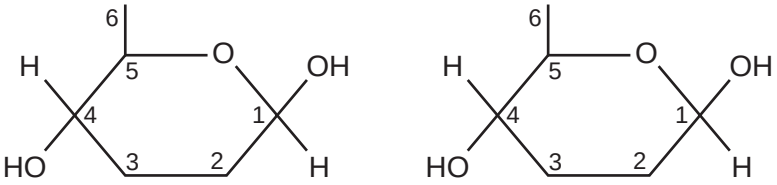

Fig. 2.1

(a) **(i)** Draw a diagram in the space below to show how these molecules can bond together.

[2]

(ii) State the name of the bond you have drawn.

..... [1]

(b) State two similarities and one difference between the structure of ribose and the structure of β-glucose.

similarities

1. .....

2. .....

difference

1. ..... [3]

(c) Another form of glucose is α-glucose.

For Examiner's Use

(i) Describe the advantages to a plant of condensing α-glucose molecules into starch.

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(ii) Suggest why mammals store α-glucose as glycogen rather than as starch.

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..... [1]

[Total: 11]

3 Lack of vitamin A in the diet is a major problem in the rice-based societies of south-east Asia. Rice plants produce the precursor of vitamin A, β-carotene, in their green tissues, but not in the edible endosperms of their seeds.

Rice seeds lack the enzymes for two steps of the pathway for β-carotene production. The genes for these two enzymes have been inserted into rice embryos by genetic engineering, giving rise to Golden Rice™. This rice produces seeds containing β-carotene.

The added genes were:

- the *psy* gene from daffodil plants,
- the *crt* 1 gene from the bacterium *Erwinia uredovora*.

(a) Explain why it is possible for rice plants to express genes from a bacterium.

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..... [1]

(b) The following steps were taken to produce Golden Rice™:

- **step 1** – a length of DNA was made including a rice endosperm-specific promoter + *psy* + *crt* 1,
- **step 2** – copies of this length of DNA were inserted into plasmids from the bacterium *Agrobacterium tumefaciens*,
- **step 3** – *A. tumefaciens* containing the plasmids were mixed with rice embryos in tissue culture,
- **step 4** – the embryos were grown into plantlets and then plants.

(i) Describe the role of the rice endosperm-specific promoter that was added to *psy* and *crt* 1 in **step 1**.

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..... [2]

(ii) Explain how a length of DNA can be inserted into a plasmid in **step 2**.

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..... [3]

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(iii) Suggest why *A. tumefaciens* containing plasmids were used in **step 3**.

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..... [2]

(iv) State **one** method that is commonly used to insert DNA into cells of monocotyledonous plants.

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..... [1]

(c) The concentration of β-carotene in the seeds from the field trial of the original strain of Golden Rice™ in 2004 was only about $6\,\mu g\,g^{-1}$. The rate-limiting step in the production of β-carotene was found to be the activity of the enzyme encoded by the *psy* gene.

Suggest what is meant by a *rate-limiting step* in a metabolic pathway.

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..... [2]

(d) The concentration of β-carotene was increased by breeding with other varieties of rice and by further genetic engineering. More recent strains, such as Golden Rice 2™, contain about $31\,\mu g\,g^{-1}$ of β-carotene in the endosperm of its seeds.

Suggest what further genetic engineering was carried out to increase the concentration of β-carotene in rice seeds.

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..... [2]

(e) Field trials of genetically engineered crops, such as Golden Rice™, hope to identify any risks to the environment or to human health of growing and eating the crops.

For Examiner's Use

Suggest:

(i) one possible risk to the environment of growing a genetically engineered crop;

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..... [1]

(ii) one possible risk to human health of eating a genetically engineered crop.

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..... [1]

[Total: 15]

4 **(a)** About one third of the injuries to racehorses involve tendon damage. In 2006, bone marrow stem cells were taken from injured racehorses and cultured so that they divided many times by mitosis. Each horse's cells were then injected into its damaged tendons. 80% of the treated horses returned to racing, compared with 30% of those treated conventionally.

(i) Adult stem cells such as these are described as multipotent.

Explain what is meant by the term *multipotent*.

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..... [1]

(ii) Describe how the rate of mitosis is controlled.

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(iii) Suggest how it is possible that bone marrow stem cells could differentiate into the range of cell types needed for repairing injuries.

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A biopsy was taken from the muscle of a healthy racehorse.

For Examiner's Use

Fig. 4.1 shows drawings made from three different transverse sections of the muscle as seen with a transmission electron microscope.

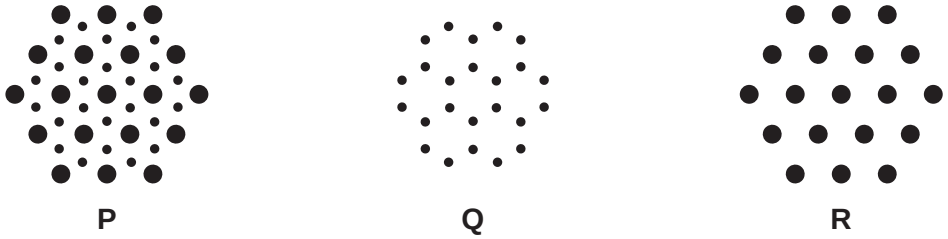

Fig. 4.1

(b) With reference to Fig. 4.1, explain the differences between sections **P**, **Q** and **R**. You may draw a diagram to illustrate your answer.

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..... [4]

(c) The coordination of muscular contraction is essential in successful racehorses. Muscle weakness in racehorses may sometimes be related to a deficiency of calcium.

For Examiner's Use

Outline the roles of calcium ions in the coordination of muscle contraction.

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..... [5]

[Total: 16]

5 The takahē, *Porphyrio hochstetteri*, is a flightless bird that is restricted to a small area of the South Island of New Zealand. It is one of only two remaining species of large, flightless, herbivorous birds from New Zealand. All the other species are extinct. The takahē was thought to be extinct, but a small population was discovered in 1948 in remote mountains of the South Island.

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The takahē is a grassland specialist and lives in alpine grassland dominated by tussock grasses.

In order to conserve the takahē, some birds were transferred to four islands where the habitat is different from that in the mountains where they were found, but where there were fewer threats to their survival. Some ecologists argued that the takahē would not survive on these islands as their niche did not exist because the islands have pasture grasses rather than tussock grasses. The takahē populations on these four islands have survived, but have not thrived as well as those in the mountains.

(a) Explain why it has been possible for flightless birds, such as the takahē, to evolve in New Zealand.

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(b) Outline the threats to the remaining species of flightless birds of New Zealand.

For Examiner's Use

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(c) Ecologists differentiate between *fundamental* and *realised* niches. The fundamental niche provides the conditions under which a species can in theory exist; the realised niche is the actual set of conditions under which it does exist.

Explain how knowledge of the fundamental niche and the realised niche of an endangered species, such as the takahē, may be used in making decisions about its conservation.

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[Total: 11]

6 Fig. 6.1 is a scanning electronmicrograph of xylem vessels.

For Examiner's Use

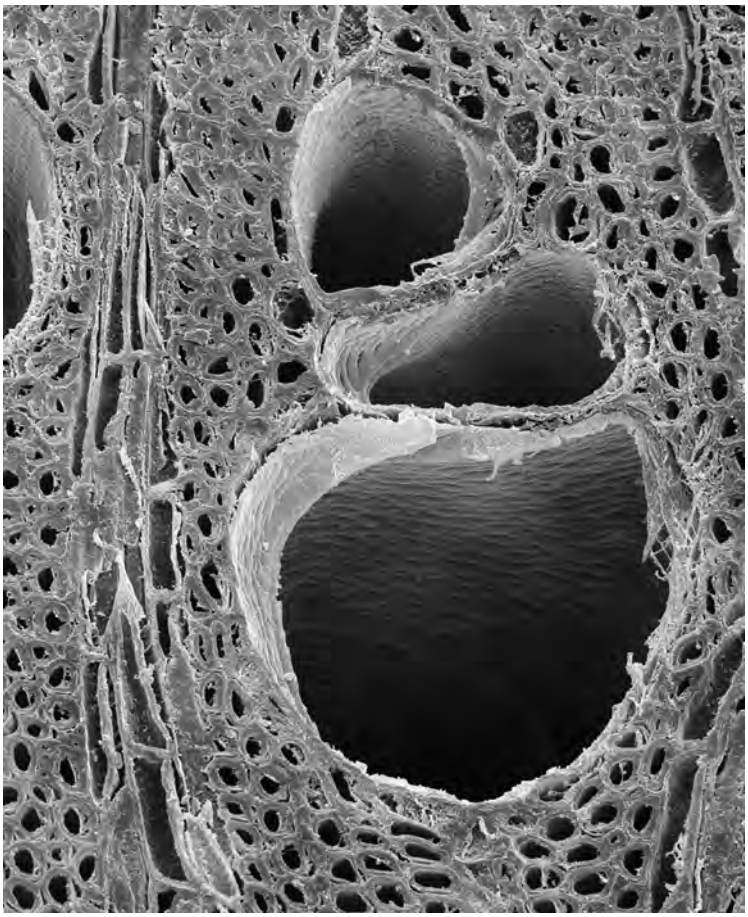

Fig. 6.1

(a) Describe how xylem vessels, such as those shown in Fig. 6.1, are adapted to their functions.

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Question 6 continues on page 16

Fig. 6.2 shows the masses of water transpired and the masses of water absorbed by loblolly pine, *Pinus taeda*, and prickly pear cactus, *Opuntia ficus-indica*, over a 24 hour period.

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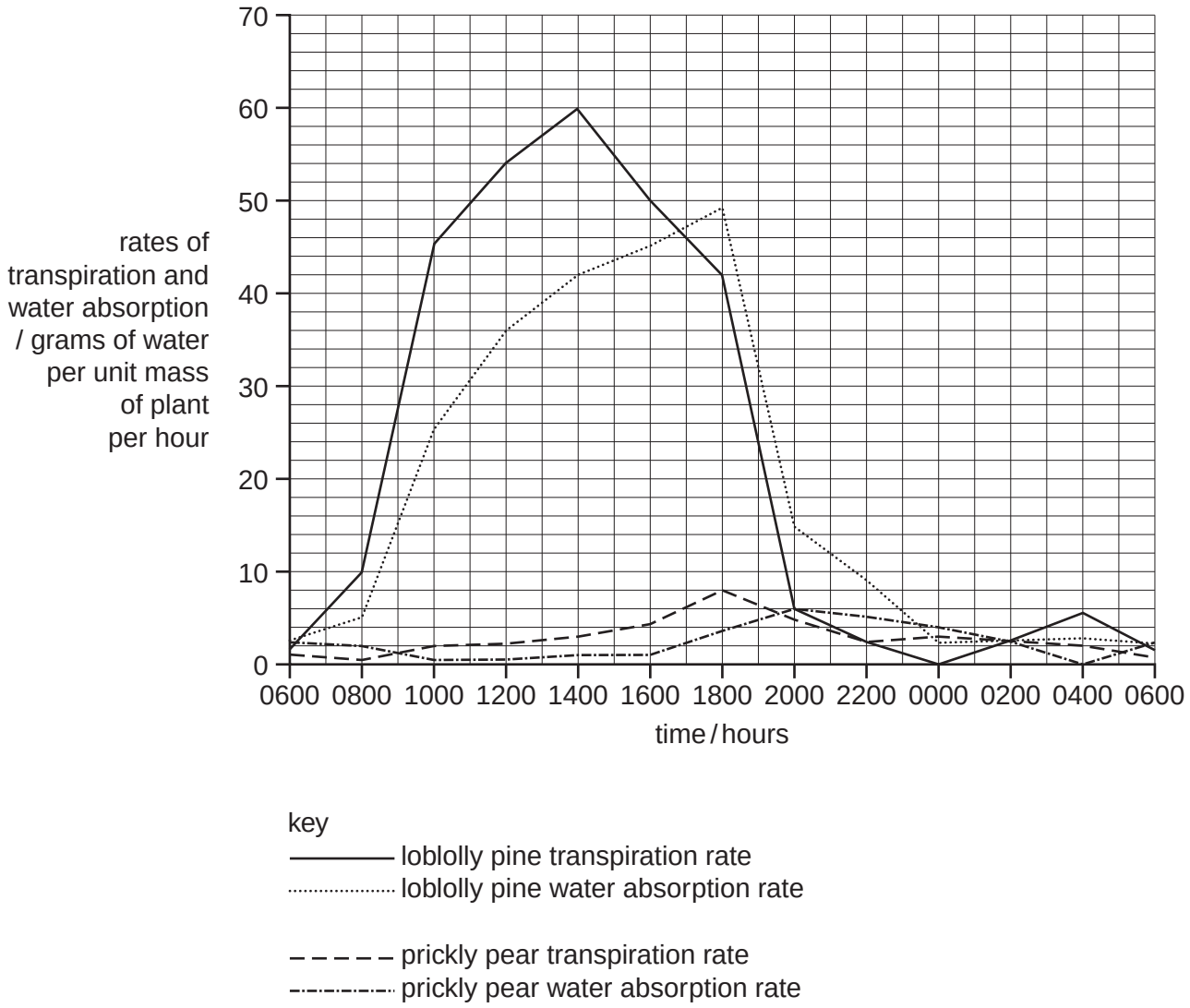

Fig. 6.2

(b) (i) Describe **and** explain the patterns of transpiration and water absorption in loblolly pine.

For Examiner's Use

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(ii) Suggest why the patterns of transpiration and water absorption for prickly pear are **not** the same as for loblolly pine.

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..... [3]

[Total: 11]

7 17β-oestradiol is the main oestrogen in humans.

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Fig. 7.1 shows the concentration of 17β-oestradiol during the first half of the menstrual cycle.

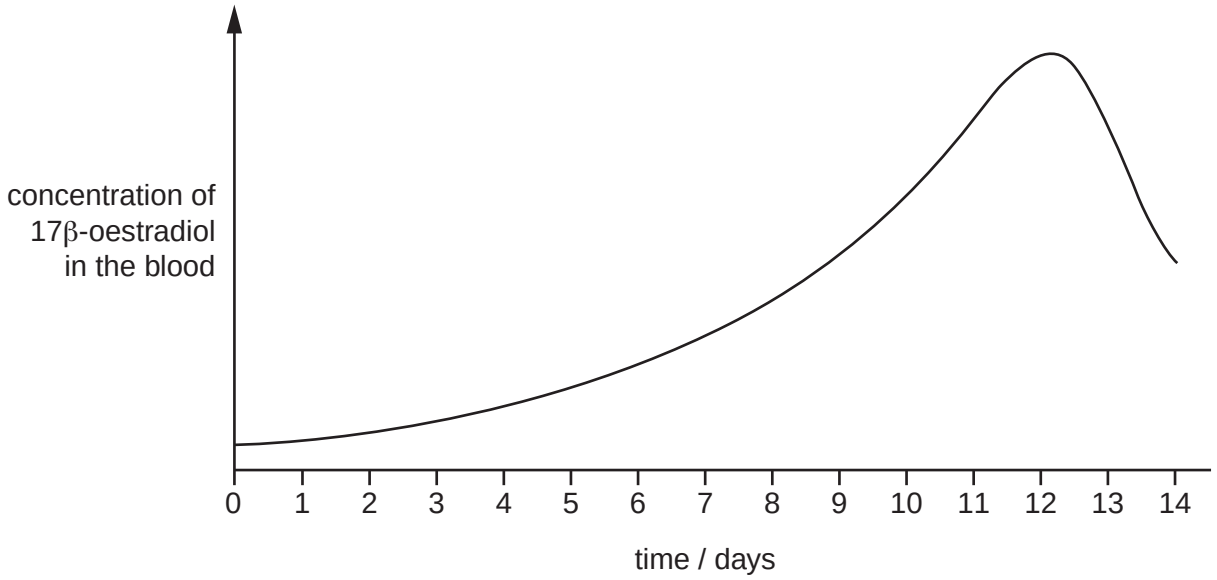

Fig. 7.1

(a) (i) Name a source of oestrogen, such as 17β-oestradiol, during the first part of the menstrual cycle.

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(ii) With reference to Fig. 7.1, describe the effects of oestrogen secretion on the uterus during the first half of the menstrual cycle.

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(b) The combined contraceptive pill contains oestrogens and progesterones.

Describe how these hormones act to prevent conception.

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For Examiner's Use

(c) The drug clomiphene is used in infertility treatments for women.

Describe the mode of action of clomiphene.

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[Total: 10]

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