Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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8325794238

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **May/June 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 on all the work you hand in.
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.

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

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 **21** printed pages and **3** lined pages.

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CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows a section through part of a dicotyledonous leaf of the tea plant *Camellia sinensis*.

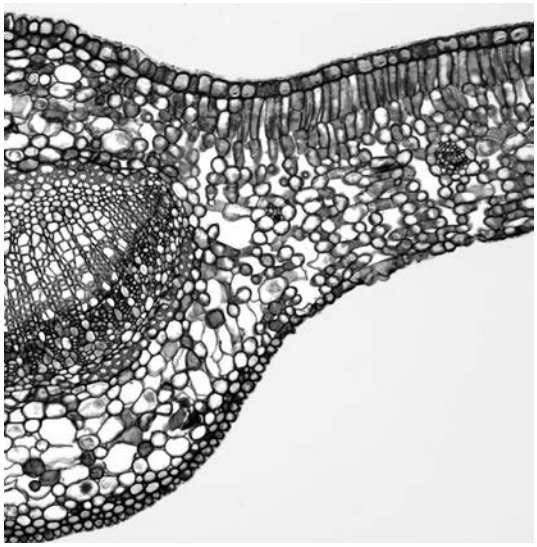


Fig. 1.1

On Fig. 1.1, use label lines and letters to label each of the following parts:

X – xylem tissue
P – palisade mesophyll tissue. [2]

(b) The leaves of *C. sinensis* have a large surface area and are thin.

Explain how each of these two features help the leaf to carry out photosynthesis.

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(c) The lower epidermis contains stomata.

(i) State **one** structural difference between a guard cell and other lower epidermal cells.

..... [1]

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(ii) Abscisic acid has an important role in the closure of a stoma. It promotes the loss of potassium ions from guard cells.

Outline how the loss of potassium ions from guard cells will lead to the closure of a stoma.

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[Total: 8]

2 When preparing infertile women for in-vitro fertilisation (IVF), it is necessary to stimulate the growth and maturation of several ovarian follicles. This is done by giving daily injections of the glycoprotein hormone, follicle stimulating hormone (FSH).

Each molecule of FSH has quaternary structure and consists of two different polypeptide chains, α and β.

(a) Explain what is meant by *quaternary structure*.

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..... [1]

(b) Human FSH can be extracted from women's urine (u-hFSH). A procedure involving the use of monoclonal antibodies is used to produce purified u-hFSH.

Suggest how monoclonal antibodies can be used to obtain purified u-hFSH from urine.

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(c) Recombinant human FSH (r-hFSH) can be produced by adding the genes coding for the α and β polypeptide chains of FSH to mammalian ovary cells.

Suggest why mammalian cells are needed to produce r-hFSH, rather than bacterial cells.

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(d) In IVF treatment, a second hormone, human chorionic gonadotrophin (hCG) is injected when mature ovarian follicles (Graafian follicles) have developed.

Draw a **labelled** diagram to show the structure of a mature ovarian follicle.

[3]

(e) The effectiveness of r-hFSH was compared with that of u-hFSH. Women starting IVF treatment were randomly divided into two groups and given **either** r-hFSH **or** u-hFSH.

The differences between the two groups of women after FSH treatment are shown in Table 2.1.

Table 2.1

	women receiving r-hFSH	women receiving u-hFSH
number of women	119	102
mean number of mature follicles per woman	13	8
concentration of oestrogen in the blood / nmol dm^{-3}	6.55	3.95

(i) With reference to Table 2.1, compare the effects of treatment with r-hFSH and u-hFSH **and** suggest explanations for the differences.

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(ii) The probability of the results for the mean number of mature follicles per woman occurring by chance is < 0.002.

Explain what is meant by this probability.

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[Total: 14]

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3 The monkey flower, *Mimulus guttatus*, is cross-pollinated by bumblebees. It does not normally self-pollinate.

Since the number of bumblebees in many parts of the world is falling, an experiment was carried out in Kansas to investigate the effects on these plants of the loss of pollinators.

- 1600 *Mimulus* plants were grown in a field.
- 1600 *Mimulus* plants were grown in a glasshouse which bumblebees could not enter.

Seeds were repeatedly collected and sown for several generations at each site.

At first, the plants in the glasshouse produced few seeds, but after five generations the plants were able to self-pollinate and the number of seeds produced was almost the same as that of the plants in the field.

After five generations, the flowers of the plants in the glasshouse were significantly smaller than those of the plants in the field.

(a) Explain why offspring produced by cross-pollination and self-pollination differ in their genetic variation.

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(b) Suggest how smaller flowers could lead to an increase in self-pollination.

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(c) Explain how natural selection produced the smaller flower size of the plants grown for five generations in the glasshouse.

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[Total: 9]

4 The Santa Cruz tarplant, *Holocarpha macradenia*, is a tall annual plant that grows only in the coastal grasslands in California. An annual plant is one that grows, flowers, produces seeds and dies in less than one year.

The tarplant used to be widely spread in California, but there are now only nine natural populations. It is listed as an endangered species.

(a) (i) Suggest **two** reasons why the tarplant has become endangered.

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(ii) State three reasons why it is important to conserve species.

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(b) Tarplant seeds can survive in the soil for several years. Dormant seeds can be encouraged to germinate by scraping the soil, which exposes them to light. This stimulates the production of gibberellin in these seeds, which brings about germination.

Explain how gibberellin brings about germination in seeds.

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(c) The long-term survival of tarplant seeds in the soil provides a store of seeds that can help to ensure the future survival of the tarplant.

Little is known about the survival of tarplant seeds in the soil, or what percentage of these seeds is able to germinate. Researchers therefore used computer models to predict how these factors could affect the likelihood that the tarplant might become extinct.

In their models they used:

- high or low survival values of tarplant seeds in the soil
- different germination percentages of tarplant seeds.

The predictions of the models are shown in Fig. 4.1.

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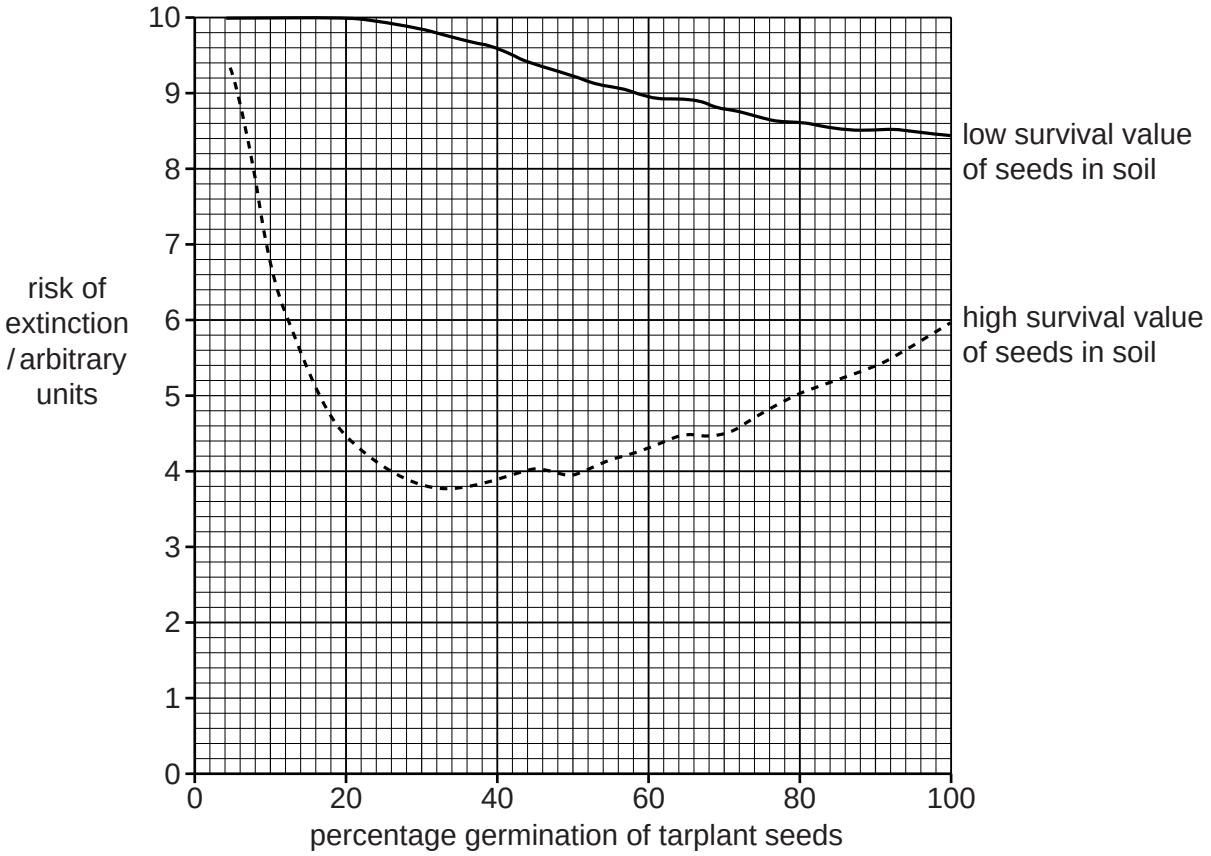


Fig. 4.1

(i) With reference to Fig. 4.1, describe the effect of each of the following on the risk of extinction of the tarplant:

high compared to low survival of the tarplant seeds

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different germination percentages of the tarplant seeds.

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(ii) With reference to Fig. 4.1, discuss whether scraping the soil should be recommended as part of the management strategy to attempt to conserve the tarplant.

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[Total: 15]

Question 5 starts on page 14

5 Mole rats, *Spalax ehrenbergi*, are mammals that live in groups in underground burrows. They are blind, and communicate with each other through sound and scent. Males make a purring call when they are attempting to persuade females to mate with them.

In Israel, the mole rats found in different parts of the country all look identical. However, there are actually four different populations with different chromosome numbers, which live in different climatic regions.

These are shown in Table 5.1.

This table also shows information about the purring calls used by the males in each population. The calls of the males were analysed by measuring the number of sound pulses per second, and also the frequencies of the sounds that they made.

Table 5.1

chromosome number of population		52	54	58	60
climatic region in which population lives		cool and humid	cool and dry	warm and humid	warm and dry
purring call made by males	mean number of pulses per second	21.0	25.3	23.9	23.2
	mean major frequency / kHz	595	555	583	562

(a) Explain why the chromosome number of each of the four populations of mole rats is an even number.

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(b) Researchers investigated how female mole rats from each of the four populations responded to purring calls made by males from the same population, and by males from different populations.
A female was placed midway between two loudspeakers, and recorded calls from two males were played to her simultaneously. The researchers noted which loudspeaker the female moved towards. This was repeated with many different females from each population.
The results are shown in Table 5.2.

Table 5.2

population chromosome number	percentage of females preferring the purring call of males from their own population
52	79
54	77
58	77
60	44

With reference to Table 5.2, describe the extent to which female mole rats show a preference for the purring calls of males from their own population.

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(c) With reference to the data in both Table 5.1 and Table 5.2, discuss whether these four populations of mole rats should be classified as different species.

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[Total: 8]

6 The Indian cobra (*Naja naja*) is a species of venomous snake found in South Asia.

Fig. 6.1 shows an Indian cobra.



Fig. 6.1

(a) The Indian cobra's venom contains a toxin which causes muscle paralysis in mammals bitten by the snake. The toxin acts at cholinergic synapses.

Suggest ways by which the toxin in cobra venom may cause muscle paralysis.

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(b) Describe the role played by calcium ions in synaptic transmission.

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(c) Synapses slow down the rate of transmission of nerve impulses but have an important role in the nervous system.

Outline **two** of the roles of synapses in the nervous system.

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[Total: 8]

7 **(a)** Outline the process of glycolysis in a mammalian cell.

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(b) Within a mammalian cell, ATP can be produced in a number of ways, including:

- substrate level phosphorylation during the Krebs cycle
- oxidative phosphorylation.

Table 7.1 compares both processes.

Complete Table 7.1.

Use a tick (✓) if the statement is correct or a cross (✗) if the statement is incorrect.
The first row has been done for you.

Table 7.1

statement	substrate level phosphorylation	oxidative phosphorylation
enzymes are involved	✓	✓
occurs in cytoplasm		
occurs in mitochondria		
channel proteins are involved		

[3]

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(c) An investigation into the RQ values of germinating maize seeds was carried out.

- A sample of maize seeds was soaked in water for one hour.
- The mean RQ value of some of the seeds was then calculated and the remaining seeds were then planted in soil.
- After 12 hours, the mean RQ value of some of the planted seeds was calculated.
- The remaining seeds were allowed to germinate and grow into seedlings.
- After 21 days, the mean RQ value of some of the seedlings was calculated.

Table 7.2 shows the results of the investigation.

Table 7.2

stage of germination and growth	mean RQ
seeds soaked in water	5.6
seeds after 12 hours in the soil	0.8
seedlings after 21 days	1.0

Suggest an explanation for each of the RQ values shown in Table 7.2.

seeds soaked in water .....

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seeds after 12 hours in the soil .....

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seedlings after 21 days .....

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[Total: 15]

8 In mice, the intensity of pigmentation of the fur is controlled by multiple alleles of a single gene.

The alleles are listed below in order of dominance, with **C** as the most dominant.

- **C** = full colour
- $\mathbf{C^{ch}}$ = chinchilla
- $\mathbf{C^{h}}$ = himalayan
- $\mathbf{C^{p}}$ = platinum
- $\mathbf{C^{a}}$ = albino

(a) Explain how multiple alleles arise.

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..... [2]

(b) Eye colour in mice is controlled by two alleles of a single gene, **B**/**b**:

- allele **B** codes for black eyes
- allele **b** codes for red eyes.

A mouse with full colour fur and black eyes was crossed with a mouse with himalayan fur and black eyes. One of the offspring was albino with red eyes.

Using the symbols above, draw a genetic diagram to show the genotypes and phenotypes of the offspring of this cross.

[6]
[Total: 8]

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Section B

Answer **one** question.

9 **(a)** Describe how the gene coding for human insulin can be obtained and inserted into a plasmid vector. [8]

(b) Explain how bacteria can be genetically modified and then identified using antibiotic resistance genes. [7]

[Total: 15]

10 **(a)** Describe the **advantages** of using batch culture for penicillin production and continuous culture for mycoprotein production. [8]

(b) Outline the hybridoma method for the production of a monoclonal antibody. [7]

[Total: 15]

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