Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

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.

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Write in dark blue or black pen.
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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.

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Section A	
1	
2	
3	
4	
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8	
Section B	
9 or 10	
Total	

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PAPA CAMBRIDGE

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*.

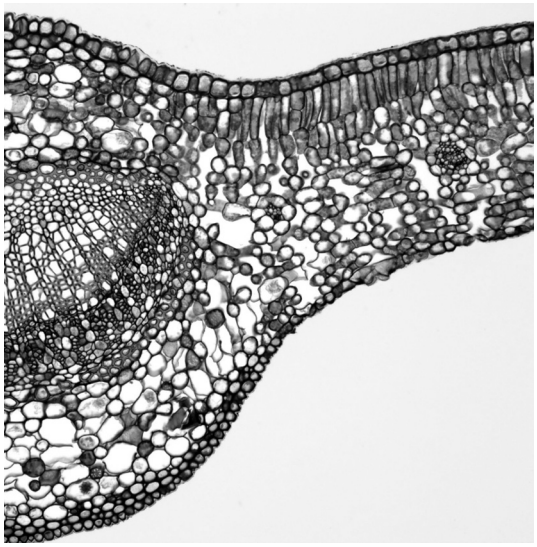


Fig. 1.1

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]

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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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..... [1]

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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]

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(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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PAPA CAMBRIDGE

(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]

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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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PAPA CAMBRIDGE

(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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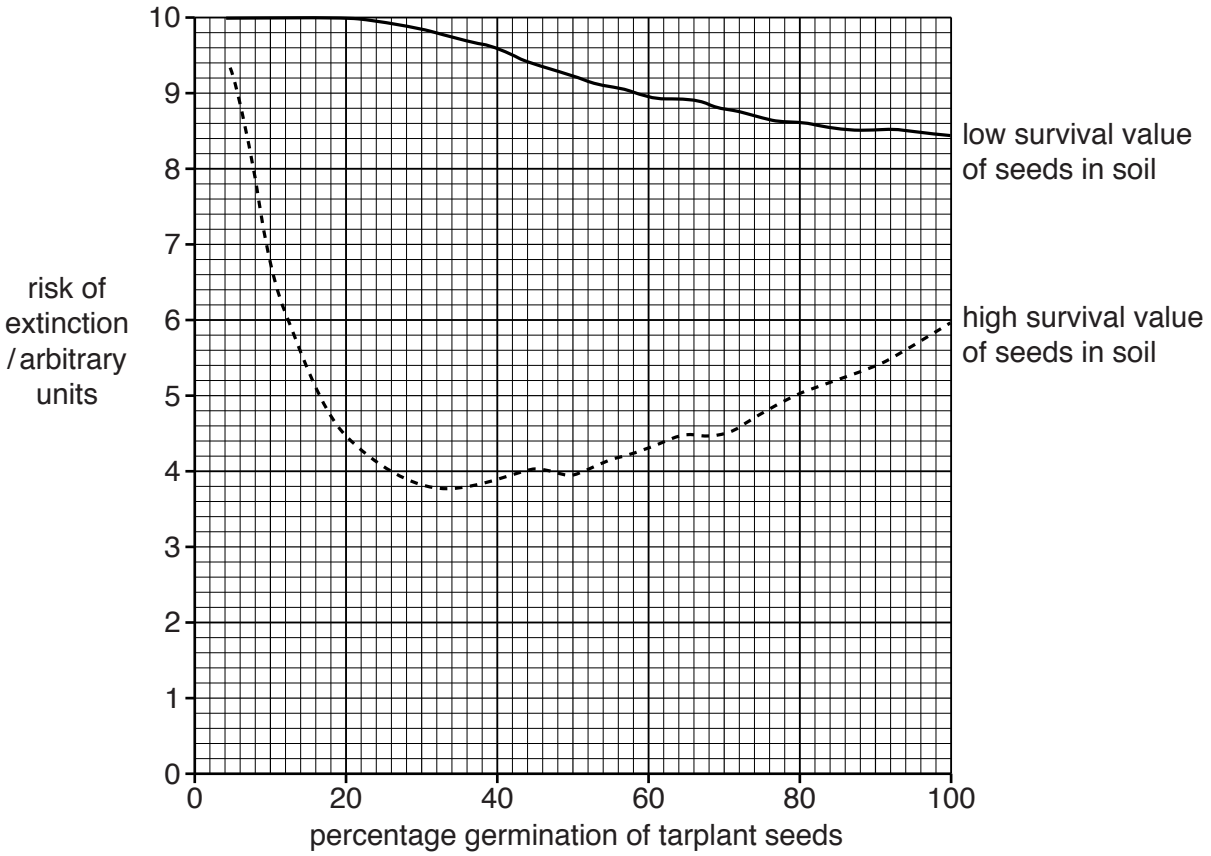


Fig. 4.1

(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]

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Question 5 starts on page 14

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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]

PAPA CAMBRIDGE

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]

PAPA CAMBRIDGE

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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..... [6]

[Total: 15]

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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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[Turn over

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BIOLOGY **9700/42**

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Section A

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows an electronmicrograph of a chloroplast.

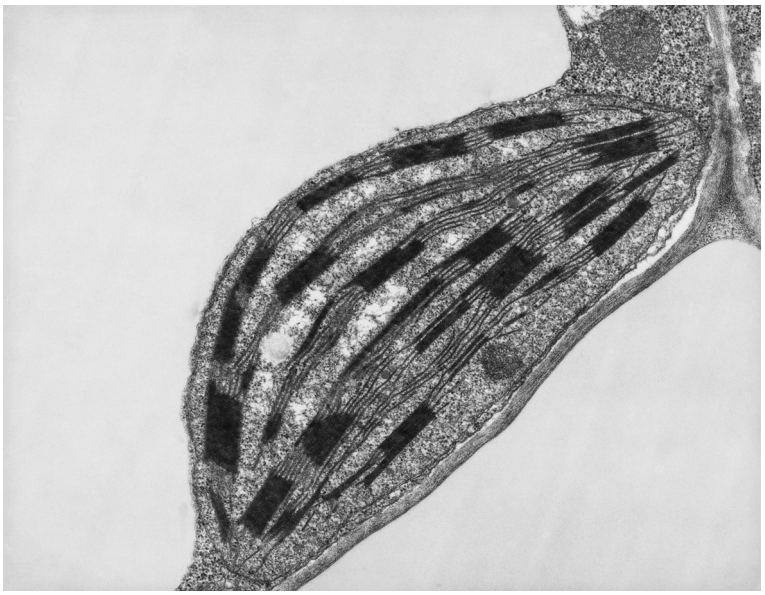


Fig. 1.1

On Fig. 1.1, use label lines and letters to label **one** place where:

L – the light-dependent stage takes place
R – the enzyme rubisco is found.

[2]

(b) Chloroplasts can move within palisade cells.

Suggest **two** advantages of chloroplast movement within palisade cells.

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..... [2]

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(c) Complete the following paragraph by naming the most suitable compounds to fill in the gaps.

Rubisco is involved in the fixation of ..... by RuBP (ribulose bisphosphate) in the Calvin cycle. The resulting six carbon compound immediately splits to give two molecules of glycerate-3-phosphate (GP). GP is converted to triose phosphate (TP) using ..... and ..... produced in the light-dependent stage. Some of the TP produced is used to regenerate ribulose bisphosphate so that the Calvin cycle can continue. The remaining TP may be used to synthesise other compounds including ..... which can directly enter the Krebs cycle.

[4]

[Total: 8]

PAPA CAMBRIDGE

2 Intracytoplasmic sperm injection (ICSI) is a modification of the procedure for in-vitro fertilisation (IVF). A single sperm is injected into an oocyte rather than allowing one of many sperm to fertilise the oocyte.

(a) Suggest **one** problem that may arise from the use of ICSI.

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..... [1]

(b) In preparation for ICSI, infertile women are injected at daily intervals with human follicle stimulating hormone (hFSH) to stimulate the growth and maturation of a number of ovarian follicles. Women may be treated with hFSH extracted from urine (u-hFSH) or with recombinant hFSH (r-hFSH) produced by genetically modified mammalian cells.

Each molecule of hFSH consists of two different polypeptide chains, α and β.
The genes for the α and β chains of hFSH, together with their promoters, have been inserted into mammalian ovary cells.

Explain why promoters need to be transferred with desired genes when producing a genetically modified cell.

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..... [2]

(c) After treatment with hFSH, oocytes are collected from mature ovarian follicles and examined to check that they have reached metaphase II of meiosis.

Describe how an oocyte in metaphase I of meiosis can be distinguished from one in metaphase II of meiosis. You may use labelled diagrams to illustrate your answer.

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[3]

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(d) Two groups of women who were being prepared for ICSI were injected at daily intervals with either r-hFSH or with u-hFSH. The results of their treatment are shown in Table 2.1.

Table 2.1

	group of women receiving r-hFSH	group of women receiving u-hFSH
number of women	63	63
total number of oocytes collected	763	407
number of oocytes in metaphase II of meiosis	634	323

With reference to Table 2.1, compare the effects of treatment with r-hFSH and u-hFSH and suggest an explanation for any differences.

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(e) Whilst the two groups of women described in **(d)** were being injected at daily intervals with FSH, the concentrations of oestrogen in their blood were measured.

The results are shown in Fig. 2.1.

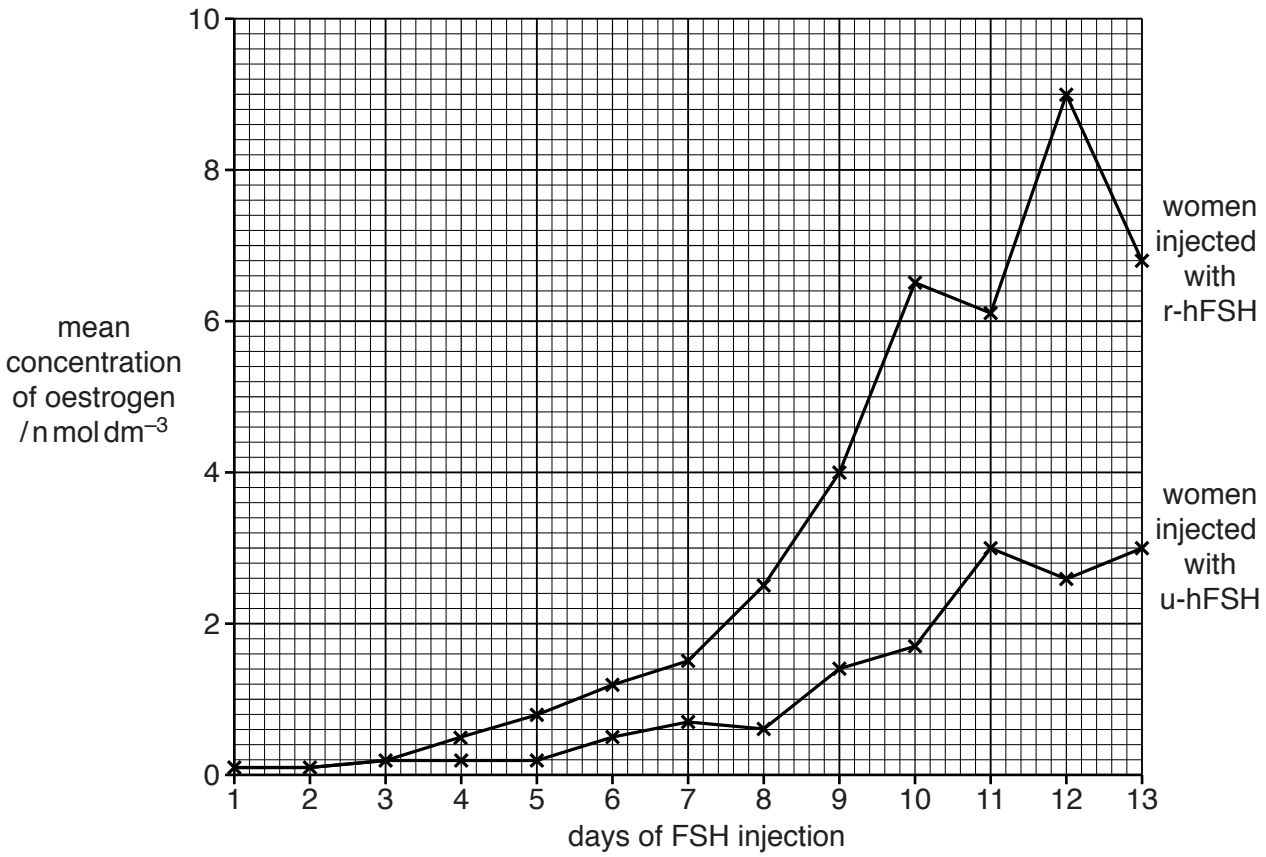


Fig. 2.1

(i) With reference to Fig. 2.1, compare the results for the two groups of women.

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(ii) Describe the role of oestrogen in the preparation of these women to receive an embryo.

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[Total: 14]

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3 *Spartina alterniflora* is a grass that grows in salt marshes. It spreads by means of seeds and by underground stems. On its native east coast of North America it prevents salt marshes from being eroded by the sea and provides a food source for a large number of different species of animals.

Some time after its introduction to the west coast of North America in 1973, *S. alterniflora* hybridised with Californian cord grass, *S. foliosa*. The hybrid now outcompetes the native species.

The hybrid differs from its parent species in a number of ways:
- it is taller
- it produces very large numbers of pollen grains which are dispersed by wind to the other species, producing yet more hybrid plants
- it produces larger numbers of seeds capable of germination
- it can self-pollinate.

(a) State the structural features that are characteristic of a wind-pollinated flower **and** explain how each feature contributes to successful pollination.

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(b) Suggest how self-pollination could help the population of hybrid plants to increase.

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(c) Suggest why the hybrid plant is **not** considered to be a new species of *Spartina*.

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[Total: 9]

PAPA CAMBRIDGE

4 The Italian agile frog, *Rana latastei*, lives in woodlands in northern Italy. The adults breed by laying eggs in water in spring. The eggs hatch into tadpoles, which grow and develop for several weeks, before metamorphosing (changing) into adults and leaving the water. This must take place before cool weather arrives in autumn.

Fig. 4.1 shows an adult agile frog.



Fig. 4.1

This frog is now an endangered species. Many woodlands have been destroyed, leaving only isolated patches in which small populations of the frogs live. In order to try to prevent some of these small populations dying out completely, it has been suggested that tadpoles from larger populations could be introduced into the small populations, in order to increase genetic diversity.

(a) Suggest why increasing genetic diversity could help to conserve populations of Italian agile frogs.

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(b) An argument against introducing individuals from one population into another is that there may be genetic differences between them that have evolved in response to exposure to different selection pressures. These genetic differences could be lost.

An investigation was carried out into the time it takes for tadpoles to develop into frogs in two groups of populations:

- populations living in the cool foothills of mountains
- populations living in the warmer lowlands.

(i) Frogs, like all amphibians, are not able to control their body temperatures. In the wild, tadpoles in the foothills take about one month longer to develop into adult frogs than tadpoles in the lowlands.

Suggest why tadpoles in the foothills take longer to develop into adults than tadpoles in the lowlands.

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PAPA CAMBRIDGE

(ii) The researchers collected eggs from foothill populations and from lowland populations, and kept them in identical conditions in the laboratory. They measured the masses of samples of the tadpoles until they metamorphosed into adult frogs.

The results are shown in Fig. 4.2. The drop in mass towards the end of development shows when the tadpole changes into a frog.

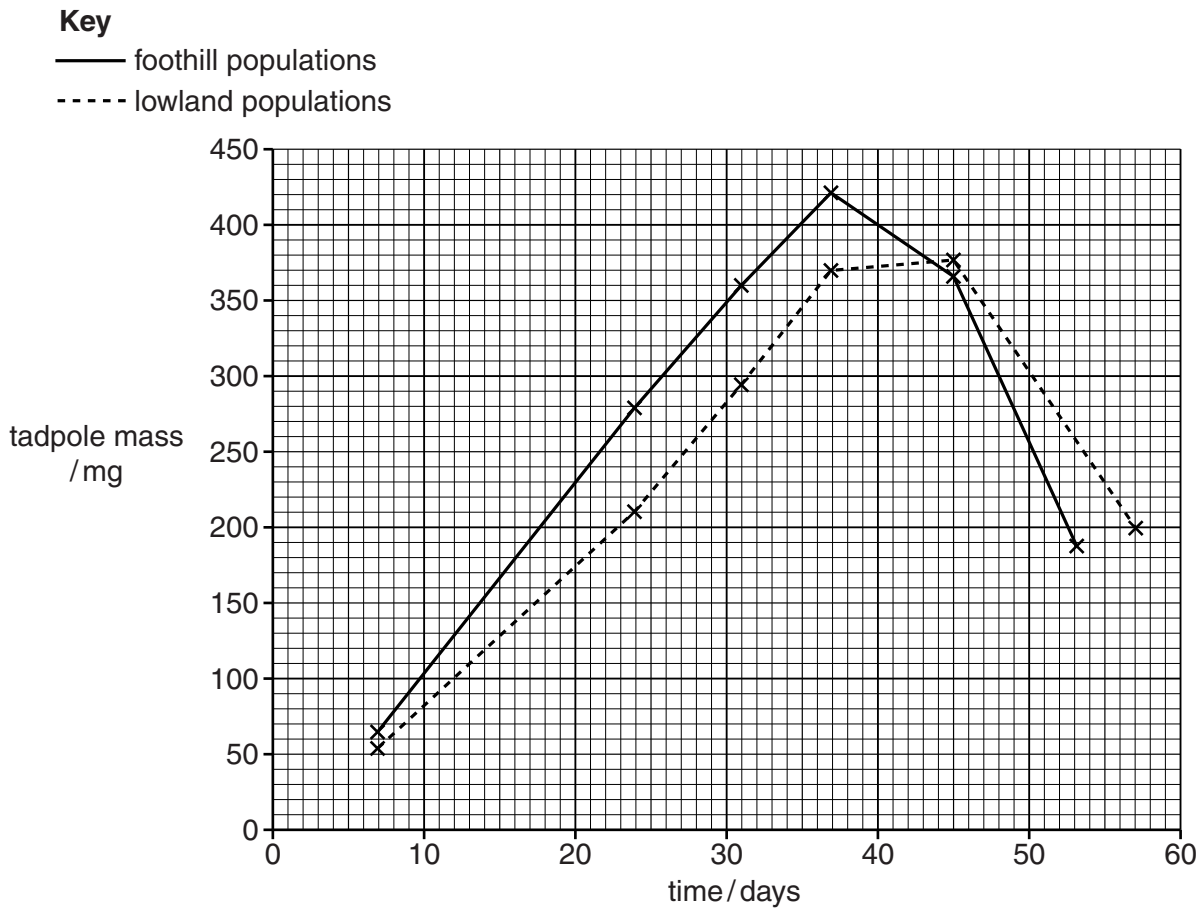


Fig. 4.2

With reference to Fig. 4.2, describe the differences in the growth of tadpoles from foothill and lowland populations.

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PAPA CAMBRIDGE

(iii) Explain how the results shown in Fig. 4.2 suggest that there are **genetic** differences between the foothill populations and the lowland populations of agile frogs.

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(iv) Suggest how these genetic differences may be important in increasing the chances of survival of the foothill populations in their natural habitat.

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(c) With reference to the evidence from this investigation, explain why it may **not** be good conservation policy to introduce tadpoles of agile frogs from lowland populations to foothill populations.

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[Total: 14]

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5 **(a)** Fig. 5.1 shows a type of neurone found in the brain, called a pyramidal cell.

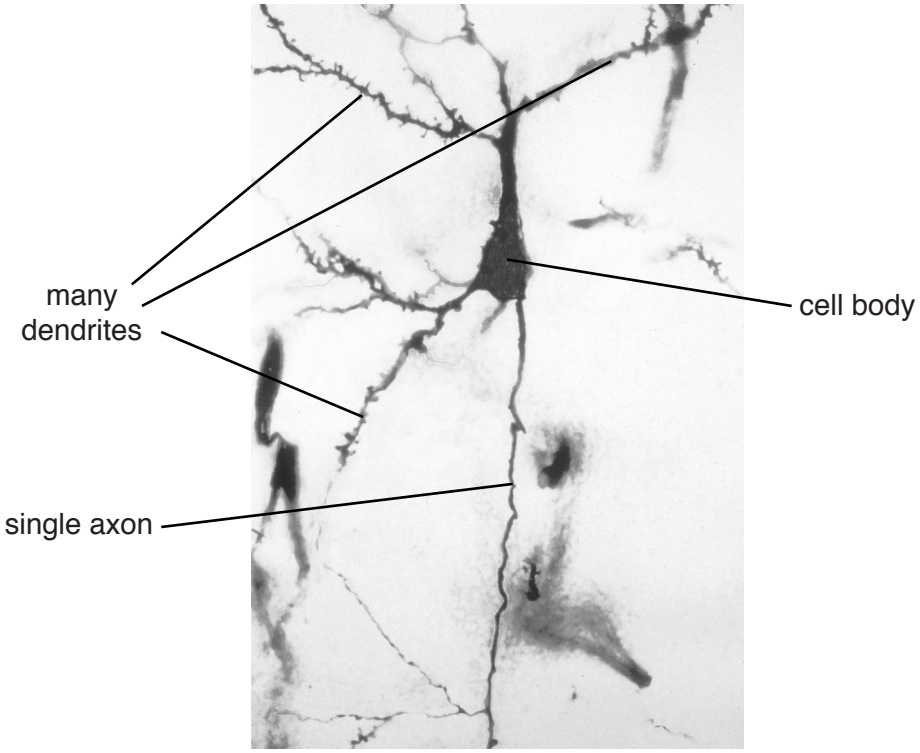


Fig. 5.1

On Fig. 5.1, draw **one** arrow to indicate the direction in which a nerve impulse will travel, as it leaves the cell body of the pyramidal cell. [1]

(b) Fig. 5.2 shows the percentage of energy used for various processes involved in the maintenance of resting potentials and in the reception and transmission of action potentials by a pyramidal cell.

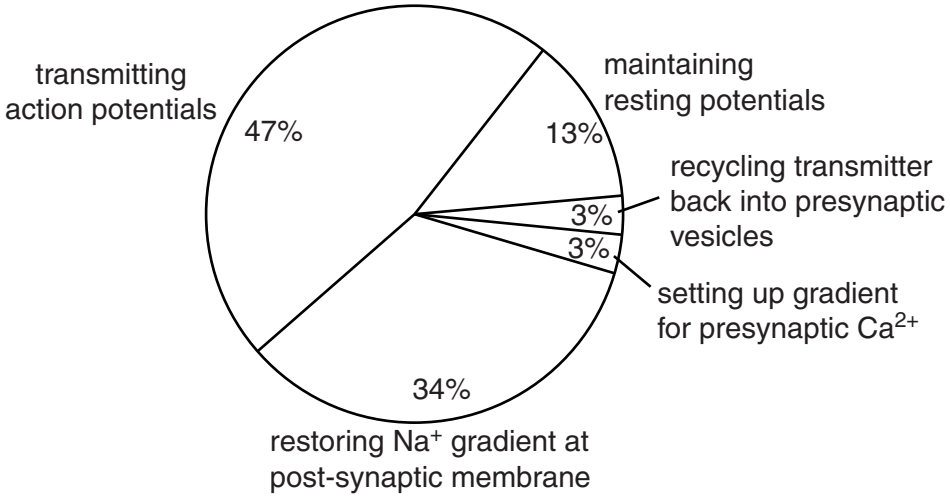


Fig. 5.2

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(i) Explain why maintaining a resting potential requires energy.

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(ii) Outline the role of calcium ions in passing on an impulse from the pyramidal cell to another neurone.

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(iii) Pyramidal cells contain large numbers of mitochondria. There are more mitochondria in each dendrite than in the axon.

With reference to Fig. 5.2, suggest reasons for this distribution of mitochondria.

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..... [2]

[Total: 9]

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6 Artificial selection has been carried out for thousands of years. An example of this is the Santa Gertrudis breed of cattle, which grow fast and tolerate high temperatures and high humidity. This breed was developed from the following two breeds:

- English shorthorn cattle, which grow fast but do not tolerate high temperatures and high humidity.
- Brahman cattle from India, which tolerate high temperatures and high humidity.

(a) Explain how artificial selection has taken place to produce Santa Gertrudis cattle.

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..... [3]

(b) Suggest **two other** characteristics that may be selected for when carrying out artificial selection in cattle.

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..... [2]

(c) Artificial selection can result in inbreeding.

Suggest problems that may result from inbreeding.

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..... [3]

[Total: 8]

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7 **(a)** All cells need ATP for energy-requiring processes in the body.

Fig. 7.1 shows the molecular structure of ATP.

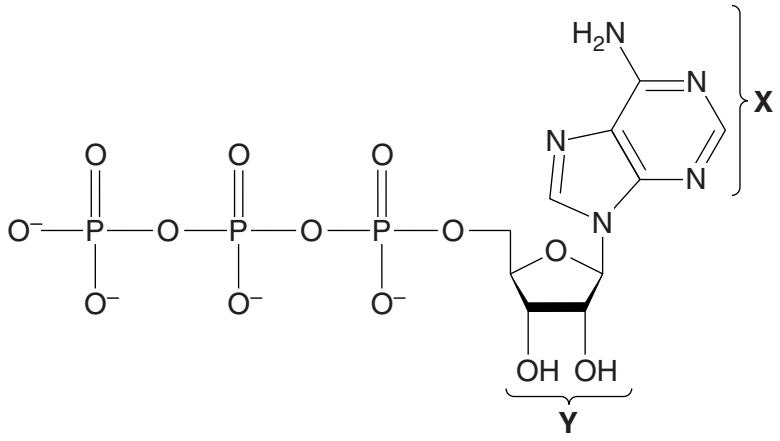


Fig. 7.1

(i) Name the base labelled **X**.

..... [1]

(ii) Name the sugar labelled **Y**.

..... [1]

(b) State **three** reasons why ATP is ideal as an energy currency in all living organisms.

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..... [3]

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(c) ATP is produced in three stages of aerobic respiration.

Complete the table below to show two products of each stage, **other than ATP**.

stage	products
glycolysis	1. ..... 2. .....
Krebs cycle	1. ..... 2. .....
oxidative phosphorylation	1. ..... 2. .....

[3]

(d) Carbohydrates and lipids are both used as respiratory substrates.

Table 7.1 shows the energy values of carbohydrates and lipids.

Table 7.1

respiratory substrate	energy value / kJ g^{-1}
carbohydrate	15.8
lipid	39.4

Explain why lipids have a higher energy value than carbohydrates.

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..... [2]

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(e) Respiration can be investigated by calculating the respiratory quotient (RQ).

(i) State how the RQ is calculated.

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..... [2]

(ii) Give the typical RQ values obtained from the respiration of carbohydrates and lipids.

carbohydrate .....

lipid ..... [2]

(iii) Suggest what happens to the RQ value when respiration in yeast becomes anaerobic.

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..... [1]

[Total: 15]

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[Turn over

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8 An autosomal gene controlling fur colour in cats has three alleles:

- allele $\mathbf{C^B}$ codes for black fur
- allele $\mathbf{C^{CH}}$ codes for chocolate fur
- allele $\mathbf{C^{CM}}$ codes for cinnamon (orange-brown) fur.

Allele $\mathbf{C^B}$ is dominant to both $\mathbf{C^{CH}}$ and $\mathbf{C^{CM}}$.
Allele $\mathbf{C^{CH}}$ is dominant to $\mathbf{C^{CM}}$.

(a) (i) State the name given to the position of a gene on a chromosome.

..... [1]

(ii) A cinnamon-coloured cat must be homozygous.

Explain what is meant by the term *homozygous*.

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..... [1]

(b) Two black cats were crossed. Most of their offspring had black fur and a few had chocolate fur. When they were mature, one of the black offspring was crossed with one of the chocolate offspring. Some of the cats in the second generation had cinnamon fur.

Draw a genetic diagram to show how cats with cinnamon-coloured fur were produced in the second generation.

[6]

[Total: 8]

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Section B

Answer **one** question.

9 **(a)** Describe how electrophoresis is used in genetic fingerprinting. [9]

(b) Explain the advantages of treating diabetic people with human insulin produced by gene technology. [6]

[Total: 15]

10 **(a)** Describe how an enzyme can be immobilised in alginate **and** discuss the advantages of using an immobilised enzyme. [9]

(b) Explain how a dip stick can be used to measure glucose concentration. [6]

[Total: 15]

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CANDIDATE NAME

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7822912989

BIOLOGY **9700/43**

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	

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CAMBRIDGE International Examinations

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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*.

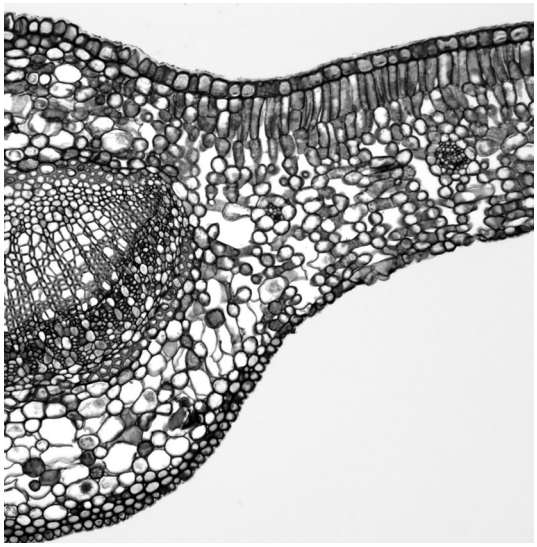


Fig. 1.1

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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..... [2]

(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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..... [3]

[Total: 8]

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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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..... [3]

(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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..... [1]

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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]

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(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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..... [4]

(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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..... [2]

[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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..... [3]

(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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..... [5]

[Total: 9]

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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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..... [2]

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

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2. .....

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3. .....

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..... [3]

PAPA CAMBRIDGE

(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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..... [4]

(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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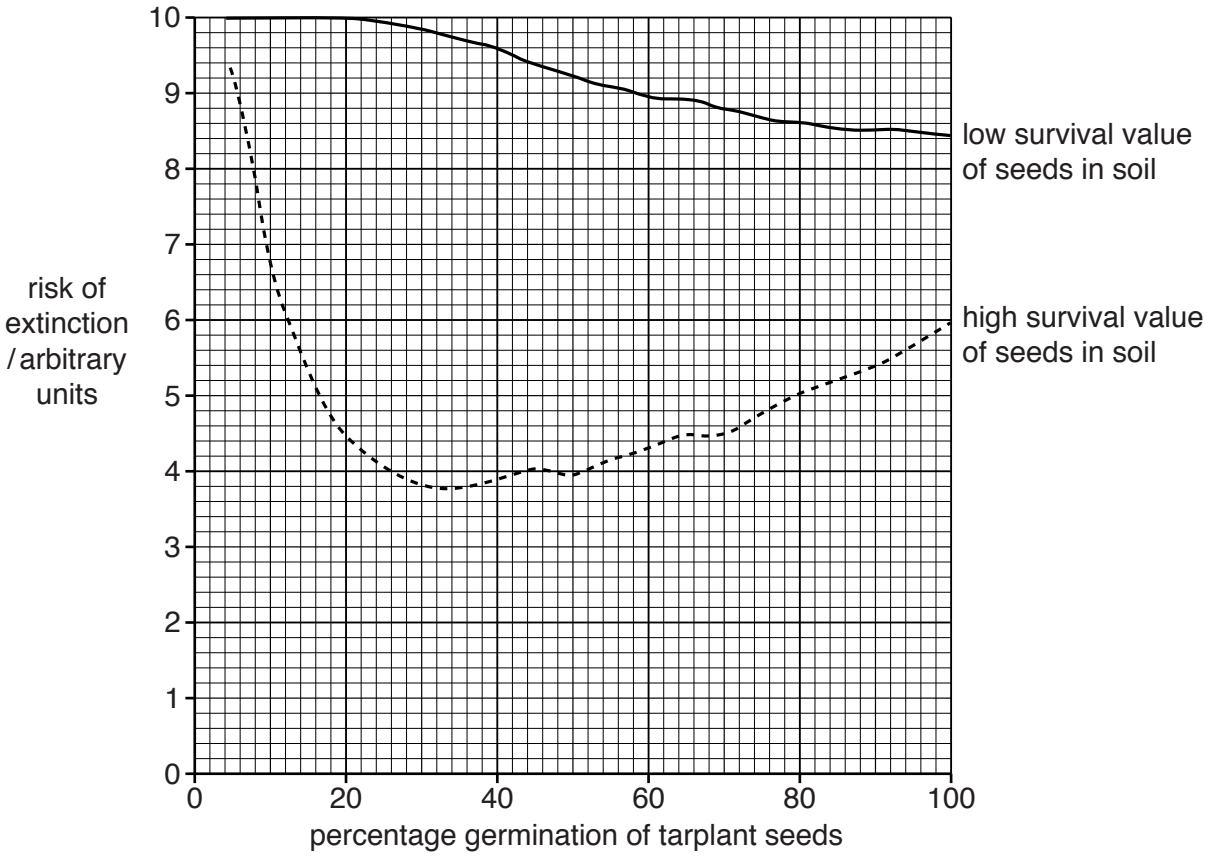


Fig. 4.1

(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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..... [3]

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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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..... [3]

[Total: 15]

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Question 5 starts on page 14

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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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..... [2]

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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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..... [2]

(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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..... [4]

[Total: 8]

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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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..... [3]

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

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..... [3]

(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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..... [2]

[Total: 8]

PAPA CAMBRIDGE

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

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..... [6]

(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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..... [6]

[Total: 15]

PAPA CAMBRIDGE

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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