Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

4400228029

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **May/June 2018**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

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.

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

DC (LK/FC) 147453/3

CAMBRIDGE International Examinations

[Turn over

Section A

Answer **all** questions.

1 The Sulawesi macaque, *Macaca nigra*, is found on the large island of Sulawesi in Indonesia. The Sulawesi macaque is also found on other smaller islands close to Sulawesi, such as the island of Bacan.

Fig. 1.1 shows a Sulawesi macaque.

Fig. 1.1

(a) The International Union for Conservation of Nature (IUCN) is the world's largest global environmental organisation. The IUCN Red List of Threatened Species™ evaluates the conservation status of plant and animal species. The Sulawesi macaque is categorised as critically endangered on the IUCN Red List.

Table 1.1 shows the numbers of humans and the numbers of Sulawesi macaques on Sulawesi and Bacan.

Table 1.1

island	area / km^2	number of humans	number of humans per km^2	number of macaques	number of macaques per km^2
Sulawesi	174 600	17 360 000	99.43	5200	....
Bacan	1900	60 741	31.97	90 000	47.37

(i) Calculate the number of macaques per km^2 for Sulawesi.

Write your answer in Table 1.1. [1]

(ii) Comment on the data shown in Table 1.1 **and** suggest reasons for the pattern shown.

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(b) Suggest ways of protecting the Sulawesi macaque.

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[Total: 8]

2 **(a)** In the fruit fly, *Drosophila melanogaster*, eye colour and wing shape are controlled by genes.

- **E/e** are alleles of a gene involved in eye colour.
- **E** results in red eyes, **e** results in purple eyes.

- **N/n** are alleles of a gene involved in wing shape.
- **N** results in normal (functional) wings, **n** results in vestigial (short, non-functional) wings.

These genes are **both** autosomal.

A dihybrid cross was carried out between a fly with red eyes and normal wings and a fly with purple eyes and vestigial wings. Both parents were homozygous for both genes. The offspring from the F1 generation were crossed to obtain the F2 offspring.

The results are shown in Table 2.1.

Table 2.1

F2 offspring phenotype	expected number of individuals	expected F2 ratio	observed number of individuals	observed F2 ratio
red eye, normal wing	225	....	287	22.1
red eye, vestigial wing	....	3	13	1.0
purple eye, normal wing	75	....	17	1.3
purple eye, vestigial wing	....	1	83	6.4

(i) Complete the missing expected number of individuals and the expected F2 ratio in Table 2.1.

[2]

(ii) A chi-squared test showed that the results for the F2 generation in Table 2.1 were significantly different from those expected.

To investigate this, test crosses were carried out using flies taken from the **F1 generation** and flies that were homozygous recessive for both genes.
The investigator assumed that the genes were **unlinked** and expected a ratio of 1:1:1:1.

Draw a genetic diagram of this test cross. Use the symbols **E/e** and **N/n**.

[4]

(b) The results of the test crosses described in **(a)(ii)** are shown in Table 2.2.

Table 2.2

offspring phenotype	number of individuals
red eye, normal wing	196
red eye, vestigial wing	22
purple eye, normal wing	23
purple eye, vestigial wing	175

(i) Flies with red eye, vestigial wing and flies with purple eye, normal wing phenotypes are described as recombinant.

Name the stage of meiosis when these recombinants are produced **and** state how this occurs.

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(ii) Explain why the results in Table 2.2 are different from the expected ratio of 1:1:1:1.

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[Total: 10]

3 **(a)** Meiosis is described as reduction division.

Explain why meiosis is necessary in the life cycle of a sexually reproducing organism.

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(b) Plants need mineral ions to grow and develop. For example, plants need phosphates and a deficiency inhibits cell division and root growth.

Mutations in individuals of some plant populations allow them to survive in mineral-deficient soils.

(i) Name **two** examples of environmental conditions that affect plant phenotype, **other than** mineral deficiency.

For **each** example, describe how it affects the phenotype.

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(ii) Explain why mutations are important in selection.

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(c) A study compared root growth of thale cress, *Arabidopsis thaliana*, in two different soil types:

- full nutrient
- low phosphate.

Two different populations of thale cress were used:

- thale cress with a functional enzyme **X**
- thale cress, with a non-functional enzyme **X**.

30 seedlings from each population were placed in each type of soil and left to grow for seven days. At the start all seedlings had a root of the same length. After seven days, the length of this root was measured again for each seedling.

The mean final root length and standard deviation was calculated for each population of thale cress.

The mean final root lengths are shown in Fig. 3.1.

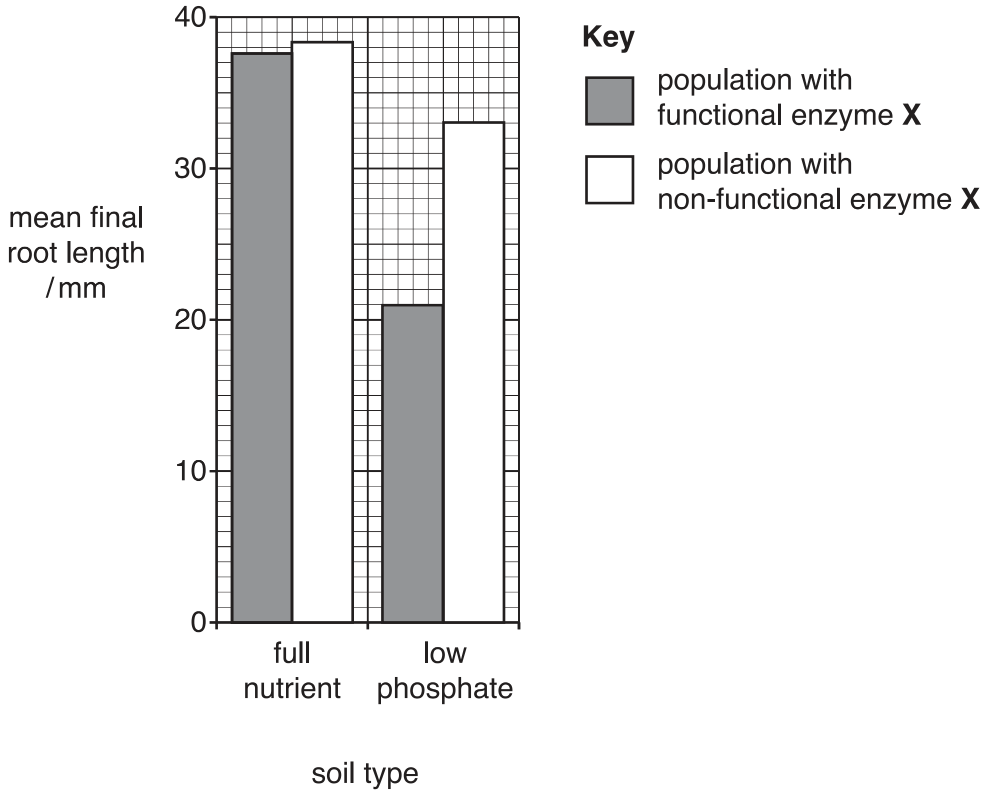

Fig. 3.1

With reference to Fig. 3.1, describe the effect of the low phosphate soil type compared to the full nutrient soil type on root growth, for both populations of thale cress.

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(d) The null hypothesis states there is no significant difference between the mean final root lengths of the two populations of thale cress grown in low phosphate soil type.

A *t*-test can be carried out to compare these two means. The critical value for *t* at the $p = 0.05$ significance level is 2.00.

Table 3.1

population grown in low phosphate soil type	mean final root length / mm	standard deviation
functional enzyme **X**	21	0.5
non-functional enzyme **X**	33	0.8

(i) Fig. 3.2 shows the formula for calculating the value of *t*.

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)}}$$

$\bar{x}$ = mean
s = standard deviation
n = sample size (number of measurements)

Fig. 3.2

Use the formula in Fig. 3.2 to calculate the value of *t*.

Show your working.

t = ... [2]

(ii) Use your calculated value of *t* to explain whether the null hypothesis should be accepted or rejected.

accept or reject ....

explanation ....

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[Total: 13]

4 **(a)** A study was carried out to investigate natural selection in the plant evening primrose, *Oenothera biennis*.

Physiological changes associated with resistance to grazing by herbivorous insects were measured over 5 years in 16 experimental populations of evening primrose. For 8 of the experimental populations the plants were regularly sprayed with chemical insecticide, and the other 8 experimental populations were not sprayed.

In each of the 5 years some older plants died after producing seeds and some new plants grew from seed.
Observations after the study were:

- sprayed populations:
    - The length of time that the plants produced flowers (flowering period) became longer.
    - Flowering started earlier in each generation.
    - The mean concentration of natural insect-deterring chemicals in the plants was relatively low.

- non-sprayed populations:
    - The flowering period remained the same over the 5 years.
    - The mean concentration of natural insect-deterring chemicals in the plants increased.

Analysis showed that genetic differences were responsible for the differences in flowering time and concentration of natural insect-deterring chemicals in the plants. The researchers concluded that natural selection was acting on both groups of plants.

Explain how natural selection acted in the **non-sprayed** populations to cause the mean concentration of natural insect-deterring chemicals to increase.

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(b) **(i)** Identify the type of natural selection that caused an increase in the mean concentration of insect-deterring chemicals in the non-sprayed populations.

....[1]

(ii) Identify the type of natural selection that caused the flowering period to remain the same in the non-sprayed populations.

....[1]

(c) The same trends in results were recorded in all of the non-sprayed populations.

Explain how this supports the researchers' conclusion that natural selection caused the trends and **not** genetic drift.

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[Total: 8]

5 **(a)** People with Alzheimer's disease (AD) lose their ability to form new memories. One form of Alzheimer's disease, called familial Alzheimer's disease, is caused by an autosomal dominant allele of the *APP* gene.

To study Alzheimer's disease, identical genetically modified mice containing the dominant human *APP* allele have been produced. These mice are known as AD mice and are used as mouse models of Alzheimer's disease.

When these AD mice are trained to swim through a water maze, they perform poorly and cannot learn as well as normal mice.

(i) Suggest what steps will be needed to make identical genetically modified AD mice.

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(ii) Suggest why it is useful to have an animal model of a human disease.

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(b) Researchers wanted to know if changes in gene expression were important in the inability of the AD mice to learn.

Groups of normal mice and AD mice either received training to allow them to learn how to swim a water maze, or they received no training. The mice in the four groups then had mRNA extracted from the memory-forming areas of their brains.

Reverse transcription of the mRNA of individuals in each group was carried out and the resulting cDNA was labelled with fluorescent nucleotides. This was then used for DNA microarray analysis using slides containing DNA sequences from **33696** mouse genes.

Explain the principles of this type of DNA microarray analysis.

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(c) Table 5.1 summarises the microarray analysis of differences in gene expression for:

- an untrained AD mouse compared to an untrained normal mouse
- a trained AD mouse compared to a trained normal mouse.

Table 5.1

training received	number of genes expressed in AD mouse but not in normal mouse	number of genes expressed in normal mouse but not in AD mouse	total number of genes showing a difference in expression between the normal mouse and AD mouse
no	17	11	28
yes	112	820	932

(i) Calculate the percentage of mouse genes whose expression has been shown to be affected by training.

Show your working.

percentage = ... % [2]

(ii) State what the results in Table 5.1 show about the effect of training and learning on gene expression in brain cells.

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....[1]

(d) The genes which are expressed in the brains of normal mice undergoing training and learning code for proteins important in synapse and memory formation. A large number of these genes are under the control of one transcription factor, a protein called Crtc1.

To try to improve learning in AD mice, researchers caused over-expression of the *Crtc1* gene in the brains of AD mice, by delivering the gene to mouse brain cells using a virus vector.

(i) State the name given to this type of treatment.

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(ii) Suggest the effects of over-expression in the brain of the *Crtc1* gene on AD mice.

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[Total: 15]

6 **(a)** Fig. 6.1 is a diagram of part of a mitochondrion showing some of the events occurring in oxidative phosphorylation.

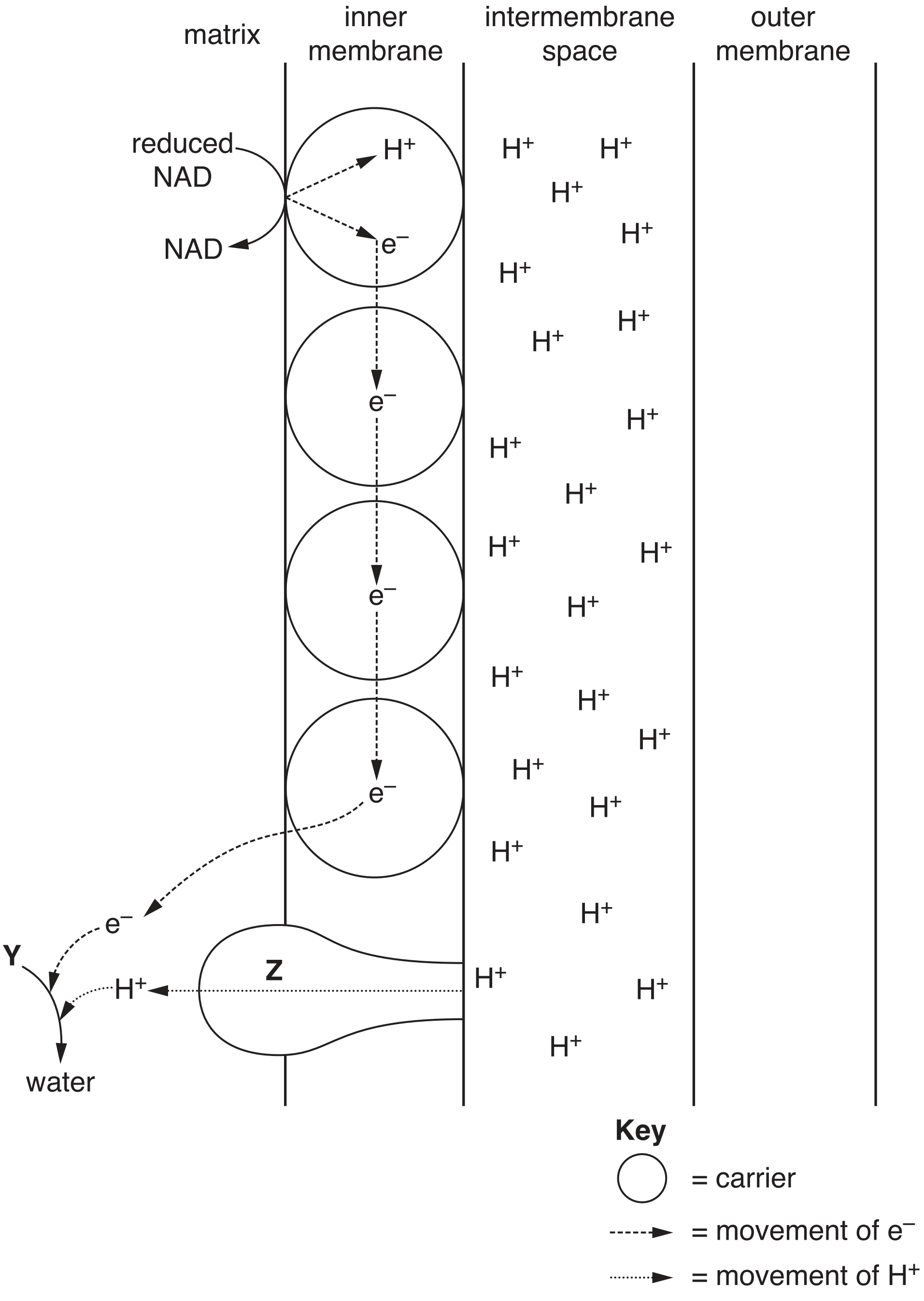

Fig. 6.1

(i) State two sources of the reduced NAD in Fig. 6.1.

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....[2]

(ii) With reference to Fig. 6.1, outline the role of carriers in the inner membrane.

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....[2]

(iii) With reference to Fig. 6.1, name **Y** and **Z**.

Y ....

Z ....[2]

(b) Explain why it is an advantage to the cell for the inner membrane of the mitochondrion to be folded.

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[Total: 8]

7 (a) Fig. 7.1 is a transmission electron micrograph of part of a chloroplast of a leaf cell from maize.

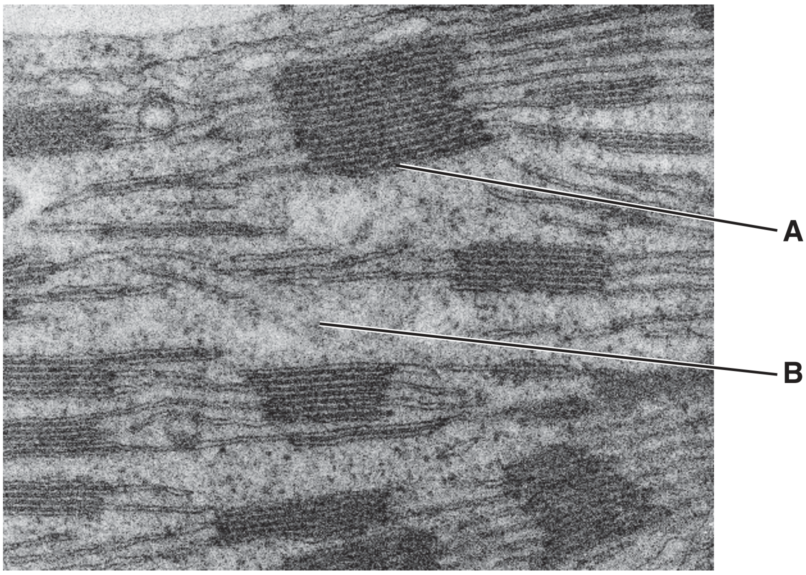

Fig. 7.1

Table 7.1 shows some substrates and products involved in photosynthesis.

Use letter **A** or letter **B** from Fig. 7.1 to complete Table 7.1 to show the location where the substrates or products are used or produced.

Table 7.1

substrate or product	location
oxygen produced	....
carbon dioxide used	....
reduced NADP used	....
ATP produced	....
hexose produced	....

[3]

(b) Chloroplasts isolated from leaf palisade cells can still function if they are suspended in a buffer solution. The buffer solution has the same water potential as the chloroplasts.

The dye DCPIP is a hydrogen acceptor that changes colour from blue to colourless when it becomes reduced.

Three test tubes were set up as shown in Table 7.2 and left for 20 minutes to allow any colour change to occur. The results are also shown in Table 7.2.

Table 7.2

test-tube	**contents**	**conditions**	**colour change**
1	buffer solution + DCPIP	light	no
2	chloroplast suspension + DCPIP	light	yes
3	chloroplast suspension + DCPIP	dark	no

(i) Explain the results for test-tube 2.

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(ii) Test-tube 1 is a control tube. Explain why test-tube 1 was included in the investigation.

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(iii) Suggest **and** explain what would happen to the chloroplasts if they were suspended in distilled water.

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(c) The rate of photosynthesis in green plants can be limited by factors such as light intensity, temperature and carbon dioxide concentration.

State which factor would have **no** effect on the reducing ability of a chloroplast suspension. Give a reason for your answer.

factor ....

reason ....

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....[2]

[Total: 10]

8 **(a)** Striated muscle is made of many fibres. Each fibre is composed of myofibrils.

The striated appearance of the muscle fibre is due to the arrangement of two types of protein filaments, thick filaments and thin filaments, within the sarcomeres of the myofibril.

Describe the main structural features of thick filaments and thin filaments in the sarcomere.

thick filaments ....

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thin filaments ....

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(b) Describe the role of calcium ions in the contraction of striated muscle.

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(c) Muscle cells sometimes have to carry out respiration in anaerobic conditions.

Describe how respiration occurs in anaerobic conditions in a muscle cell **and** state why it is important that this process occurs.

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[Total: 13]

Section B

Answer **one** question.

9 **(a)** Outline the characteristic features of organisms in the domain Eukarya. [8]

(b) Discuss the use of assisted reproduction techniques in the conservation of endangered mammal species. [7]

[Total: 15]

10 **(a)** Describe the effect of a high blood concentration of ADH on the kidney. [8]

(b) Explain how glucagon brings about a rise in blood glucose concentration. [7]

[Total: 15]

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