UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0962624472

BIOLOGY **9700/41**

Paper 4 A2 Structured Questions **October/November 2012**

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 in the spaces provided at the top of this page.
Write in dark blue or black ink.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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.

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 **23** printed pages and **1** lined page.

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Section A

For Examiner's Use

Answer **all** the questions.

1 (a) Nerve impulses have to cross synapses. The events that enable a nerve impulse to cross a cholinergic synapse are listed in Table 1.1.

The events are **not** listed in the correct order.

Table 1.1

event	description of event
A	Calcium ions enter presynaptic neurone knob.
B	Acetylcholine binds to receptor proteins on postsynaptic membrane.
C	Vesicles fuse with presynaptic membrane and release acetylcholine into synaptic cleft.
D	Postsynaptic membrane becomes depolarised.
E	Nerve impulse reaches presynaptic membrane.
F	Acetylcholine diffuses across cleft.
G	Receptor proteins change shape, channels open and sodium ions enter postsynaptic neurone.
H	Calcium ion channels open in presynaptic membrane.
I	Nerve impulse generated in postsynaptic neurone.
J	Vesicles of acetylcholine move towards presynaptic membrane.

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Complete Table 1.2 to show the events in the correct order.

Two of the events have been done for you.

For Examiner's Use

Table 1.2

correct order	letter of stage
1	**E**
2	
3	
4	
5	
6	**F**
7	
8	
9	
10	

[4]

(b) Synapses have many roles in nervous coordination in mammals.

(i) Explain how synapses ensure one-way transmission of nerve impulses.

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.....[2]

(ii) In a learning activity, it is believed that the number of synapses between brain neurones increases.
Suggest the advantages of this increased number of synapses.

For Examiner's Use

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.....[2]

[Total: 8]

2 **(a)** Penicillin belongs to a group of antibiotics known as β lactams, which all act in the same way on bacteria.

For Examiner's Use

Describe how penicillin kills non-resistant bacteria.

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(b) One of the ways in which a bacterium may be resistant to an antibiotic, such as a β lactam, is by having protein pumps in its cell surface membrane which expel the antibiotic from the bacterium.

The gene coding for such an efflux pump is carried on a plasmid.

Outline how the bacterium produces an efflux pump from a gene on a plasmid.

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.....[3]

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(c) A strain of the bacterium *Pseudomonas aeruginosa*, strain **R**, has a gene coding for an efflux pump and is resistant to a β lactam antibiotic.

For Examiner's Use

The minimum inhibitory concentration (MIC) of the β lactam for strain **R** was determined. The MIC is the lowest concentration of antibiotic that prevents a colony of the bacterium from growing.

The MICs were also determined for two mutant strains derived from strain **R**, mutant strain **1** and mutant strain **2**. Each of these strains differs from strain **R** in the expression of the gene coding for the efflux pump.

The MICs for the three strains of *P. aeruginosa* are shown in Table 2.1.

Table 2.1

strain of *P. aeruginosa*	**MIC of β lactam / μg cm^{-3}**
resistant strain **R**	64
mutant strain **1**	0.5
mutant strain **2**	256

With reference to Table 2.1, suggest:

(i) why the MICs for mutant strains **1** and **2** differ from that for strain **R**

*mutant strain **1*** .....

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*mutant strain **2*** .....

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.....[4]

(ii) how a population of strain **R** of *P. aeruginosa* could be replaced by mutant strain **2**.

For Examiner's Use

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.....[4]

[Total: 15]

3 Green fluorescent protein (GFP) is a small protein that emits bright green fluorescence in blue light. It was first isolated from the jellyfish, *Aequorea victoria*.

For Examiner's Use

The gene coding for GFP can be expressed in bacteria, such as *Escherichia coli*, and so it is often used as a marker to show successful uptake of a gene by the bacterium.

(a) (i) Outline how a gene from another species can be inserted into *E. coli*.

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(ii) Explain how a marker gene, such as the gene for GFP, is used to show successful uptake of a gene for a wanted protein.

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.....[3]

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(b) Genes for enzymes that produce fluorescent substances are often used as markers in gene technology.

For Examiner's Use

GFP is **not** an enzyme.

Suggest **one** disadvantage of using the gene for GFP to produce easily detectable fluorescence, rather than using a gene for an enzyme that produces a fluorescent substance.

Explain your answer.

disadvantage .....

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explanation .....

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.....[2]

[Total: 8]

4 **(a)** Fig. 4.1 shows the stages in spermatogenesis in a mammal.

For Examiner's Use

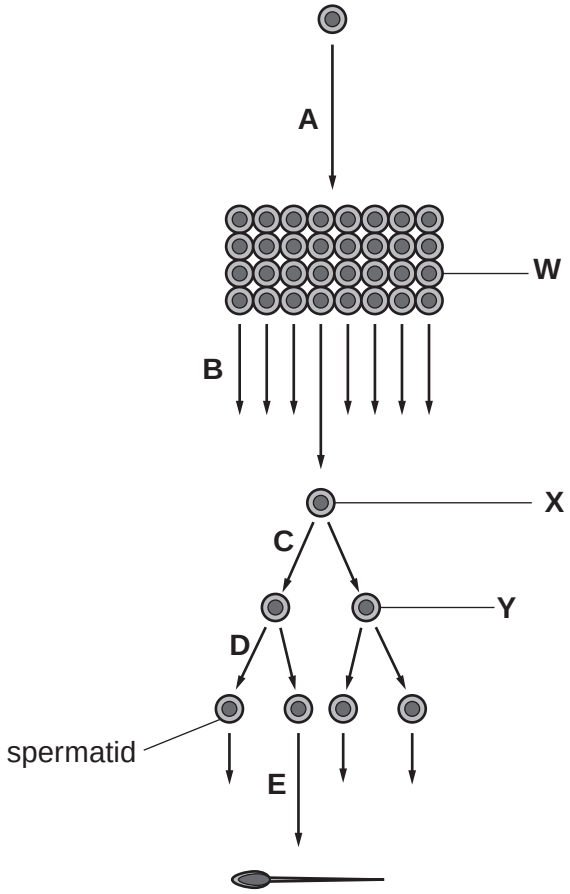


Fig. 4.1

(i) State the letter(s) of the arrow or arrows that represent mitosis.

.....[1]

(ii) Name the cells **W**, **X** and **Y**.

W .....

X .....

Y .....[3]

(b) Fig. 4.2 is a light micrograph of a transverse section through a seminiferous tubule in a mammalian testis.

For Examiner's Use



Fig. 4.2

On the sector indicated on Fig. 4.2, use label lines and letters to label:

G a cell in the germinal epithelium

M a maturing sperm cell

Y an area where spermatids are found.

[3]

For Examiner's Use

(c) In all animals so far studied, the production of fully functional sperm is sensitive to temperature.

In the nematode worm, *Caenorhabditis elegans*, spermatogenesis takes place in a similar way to mammals. Two proteins known as argonaute proteins are important in the development of sperm. They are coded for by the genes *alg-3* and *alg-4*.

Table 4.1 shows the effect of mutations in one or both of these genes on the fertility of male worms, at temperatures of 20 °C and 25 °C.

Fertility was measured as the mean number of offspring produced when the male worms mated with normal females.

Table 4.1

male worms	mean number of offspring produced	
	at 20 °C	at 25 °C
normal at both gene loci	280	150
mutation in *alg-3* only	125	95
mutation in *alg-4* only	220	85
mutations in **both** *alg-3* **and** *alg-4*	90	0

(i) Describe the effect of increased temperature on the fertility of normal male worms.

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.....[2]

(ii) Compare the effect of increased temperature on the fertility of *alg-3* mutant male worms with the effect on fertility of *alg-4* mutant male worms.

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(iii) An investigation showed that at 20 °C the number of spermatids produced in worms with both mutations, in *alg-3* **and** *alg-4*, was the same as in normal worms.

However, at 25 °C, these mutant worms produced 29% fewer spermatids than the normal worms. Microscopic examination of their testes showed that many of the secondary spermatocytes had failed to complete meiosis.

Use this information to state the letter of **one** arrow on Fig. 4.1 that represents a stage of spermatogenesis affected by mutations in **both** the *alg-3* **and** *alg-4* genes.

..... [1]

(iv) Table 4.2 shows the effect of temperature on the percentage of spermatids that developed full motility at 20 °C and 25 °C in normal worms and in worms with mutations in **both** *alg-3* **and** *alg-4*.

Table 4.2

male worms	percentage of sperms with full motility	
	at 20 °C	**at 25 °C**
normal	57	54
mutations in **both** *alg-3* **and** *alg-4*	10	2

With reference to Table 4.2, and the information in **(iii)**, state the cause or causes of reduced fertility in these mutant worms at each temperature.

at 20 °C

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at 25 °C

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.....[2]

[Total: 14]

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[Turn over

5 Flowers are the organs of sexual reproduction in plants. Before fertilisation and seed development can take place, pollination must occur. This can be either self-pollination or cross-pollination, and can be carried out by insects or by wind.

For Examiner's Use

(a) Explain the meaning of the term *self-pollination*.

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.....[2]

(b) Explain why cross-pollination may be more beneficial to a species than self-pollination.

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(c) In maize, wind pollination occurs. An investigation was carried out to find out how the length of time that maize pollen is in the air affects its ability to bring about fertilisation in a female flower.

- Pollen grains were removed from maize flowers and left exposed to the air for varying times.
- The pollen grains were then placed onto groups of female flowers.
- The groups of fertilised flowers developed into 'ears', each containing many seeds. The number of seeds per ear was counted.

The results are shown in Fig. 5.1.

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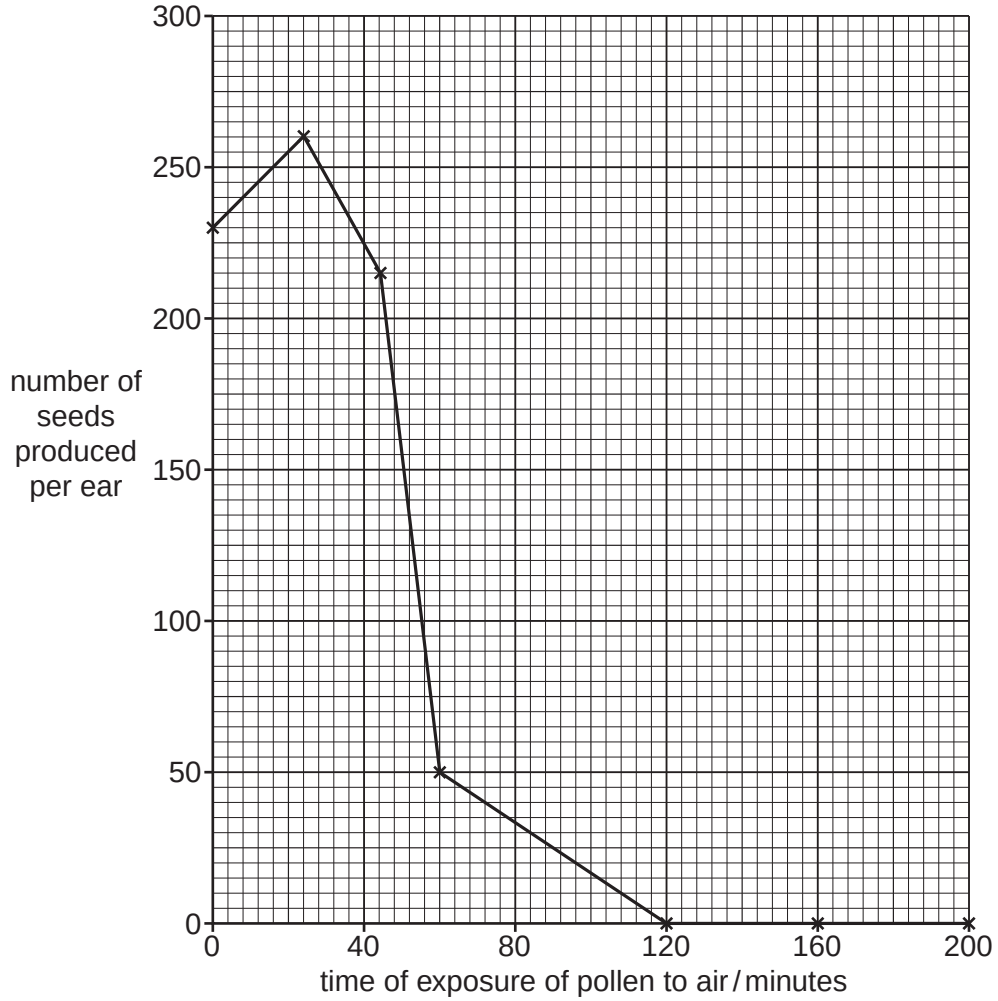


Fig. 5.1

(i) Describe the effect of exposure to the air on maize pollen.

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.....[2]

For Examiner's Use

(ii) A wild relative of maize, called teosinte, grows in Mexico. There are concerns that pollen from genetically-modified maize could pollinate wild teosinte and transfer new genes to it.

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Suggest how the results shown in Fig. 5.1 could be used to devise strategies that would reduce the possibility of this happening.

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.....[2]

[Total: 9]

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6 A group of plants, known as Rapid Cycling Brassicas (RCBs), has been developed for use in schools and colleges for genetics experiments.

For Examiner's Use

When RCB seedlings develop they can have either purple stems or non-purple stems. Their seed leaves can be either green or yellow-green.

Purple stems and green seed leaves are controlled by dominant alleles.

The genes for stem colour and seed-leaf colour are located on separate chromosomes.

(a) Explain what is meant by a *dominant allele.*

allele .....

.....

dominant .....

.....[2]

(b) Draw a genetic diagram to show the likely outcome of a cross between two RCB plants which are heterozygous for **both** stem colour and seed-leaf colour.

Use the symbols **A / a** for stem colour and **B / b** for seed leaf colour.

[6]

[Total: 8]

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[Turn over

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7 Corals are simple marine animals and usually exist in colonies of thousands of individuals.

Fig. 7.1 shows a coral colony.



Fig. 7.1

Corals absorb calcium carbonate from the sea to build their skeletons, which help to form large coral reefs. Coral reefs provide a home for about 25% of known fish species and have the highest biodiversity of any marine ecosystem.

(a) Corals, although they are animals, are sometimes mistaken for members of the plant kingdom.

State **two** ways in which corals differ from plants.

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..... [2]

(b) Outline what is meant by the term *ecosystem.*

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..... [2]

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(c) Coral reefs are at risk of damage due to human activities. All the coral reefs in three regions were classified as being at low, medium or high risk of damage.

Table 7.1 shows the areas of coral reef at risk of damage in these three regions.

Table 7.1

region	area of coral reef at risk of damage / 1000 km^2			percentage of coral reef at high risk of damage
	low	medium	high	
Caribbean Sea	9	8	7	29
Indian Ocean	20	15	10	
Pacific Ocean	60	30	9	

(i) Complete Table 7.1, giving your answers **to the nearest whole number**. [1]

(ii) Suggest how human activities could damage coral reefs.

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[Total: 8]

8 **(a)** Fig. 8.1 is an electronmicrograph of a section through a mitochondrion.

For Examiner's Use

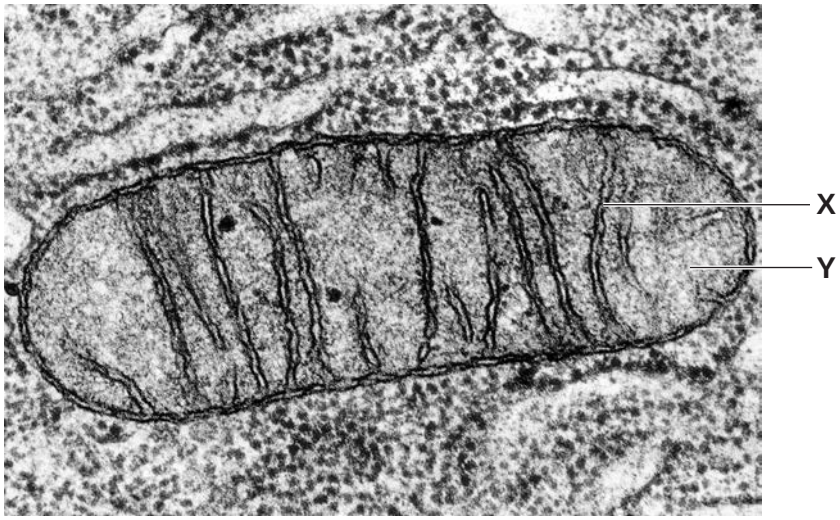


Fig. 8.1

Name **X** and **Y**.

X .....

Y ..... [2]

(b) Fig. 8.2 outlines the early stages of respiration.

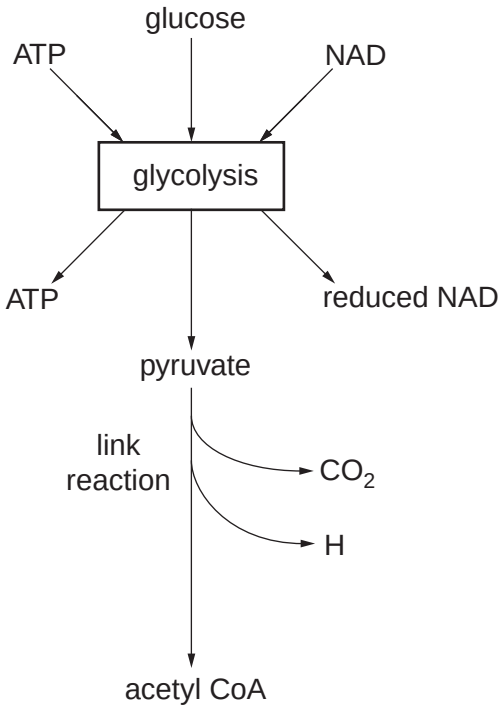


Fig. 8.2

With reference to Fig. 8.2:

For Examiner's Use

(i) explain why ATP is needed at the start of glycolysis

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.....[1]

(ii) state the role of NAD in glycolysis

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.....[1]

(iii) state how many molecules of ATP are produced from one molecule of glucose during glycolysis

.....[1]

(iv) name the two types of reaction that occur during the conversion of pyruvate to acetyl CoA in the link reaction

1. .....

2. .....[2]

(v) name the location, in the mitochondrion, of the link reaction

.....[1]

(vi) describe what happens to the hydrogen released during the link reaction.

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.....[2]

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(c) Explain why ATP is regarded as the universal energy currency in organisms.

For Examiner's Use

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.....[5]

[Total: 15]

Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Describe the **first** division of meiosis (meiosis I) in animal cells. [6]

(b) Discuss the link between the frequency of sickle cell anaemia and the number of cases of malaria. [9]

[Total: 15]

10 **(a)** Describe the arrangement and location of chloroplast pigments **and** discuss their effect on absorption spectra. [8]

(b) Describe the part played by auxins in apical dominance in a plant shoot. [7]

[Total: 15]

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Question 8 Fig. 8.1 © CNRI/SCIENCE PHOTO LIBRARY

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