Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8784479278

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **May/June 2019**

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 **24** printed pages.

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Section A

Answer **all** questions.

1 (a) Fig. 1.1 shows a cholinergic synapse.

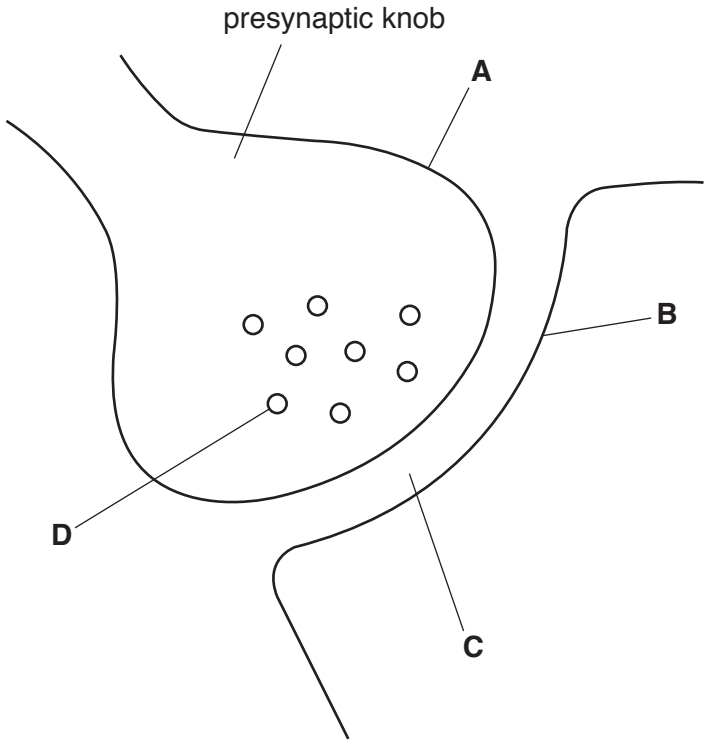


Fig. 1.1

Complete Table 1.1, using the letters **A**, **B**, **C** or **D** from Fig. 1.1, to show the location of compounds and structures associated with a cholinergic synapse.

You may use **A**, **B**, **C** and **D** once, more than once, or not at all.

Table 1.1

compound or structure	location
acetylcholine	.....
voltage-gated channel	.....
receptor protein	.....
acetylcholinesterase	.....

[4]

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(b) Explain what is meant by a voltage-gated channel.

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..... [2]

(c) Explain the role of acetylcholinesterase in a synapse.

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..... [3]

(d) Outline the roles of synapses in the nervous system.

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..... [2]

[Total: 11]

2 Albinism is a condition that results from disruption of a biosynthetic pathway involving the enzyme tyrosinase. It is estimated that 1 in 17 000 people in the world has albinism.

(a) A recessive mutation in the *TYR* gene, which codes for the enzyme tyrosinase, is one cause of albinism. Individuals with this form of albinism are homozygous recessive.

Describe the phenotype of a person with albinism.

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..... [2]

(b) A recessive mutation in a different gene causes a type of albinism that mainly affects the eyes (ocular albinism). A person with this condition has reduced clarity of vision and involuntary eye movements.

Fig. 2.1 shows the pattern of inheritance of ocular albinism in one family. The pattern indicates sex-linked inheritance.

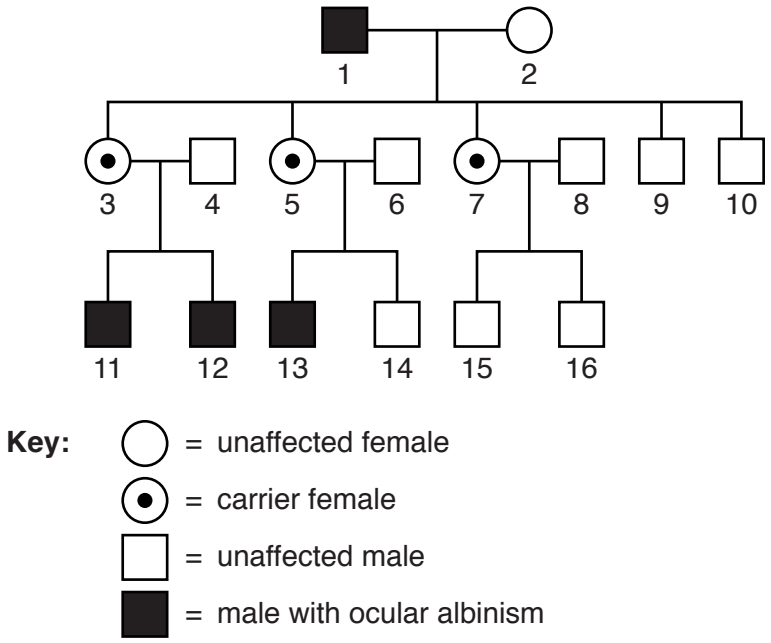


Fig. 2.1

(i) Explain why Fig. 2.1 supports sex-linked inheritance of ocular albinism.

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..... [3]

(ii) Draw a genetic diagram to show how individuals 1 and 2 **cannot** have a child with ocular albinism.

key to symbols

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parental genotypes

gametes

offspring genotypes

offspring phenotypes

[4]

(iii) Ocular albinism may be caused by a base deletion mutation. This mutation results in a non-functional protein.

Explain how a base deletion mutation can result in a non-functional protein.

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..... [2]

(iv) Ocular albinism is a non-progressive disorder and clarity of vision remains stable throughout life.

A female has a family history of ocular albinism but she does not have any symptoms. A test to find out if she has the mutant allele is available.

Suggest **one** reason for taking this test and **one** reason against taking this test.

for .....

.....

against .....

.....

[2]

[Total: 13]

3 The cilia of ciliated epithelial cells show variation in length, within an individual and between different individuals.

Samples of ciliated epithelial tissue were removed from the airways of healthy people and the mean cilia length for each individual was calculated.

The people in the study formed two groups:

- people who were exposed to a harmful environmental factor
- people who were **not** exposed to a harmful environmental factor.

The results are shown in Fig. 3.1.

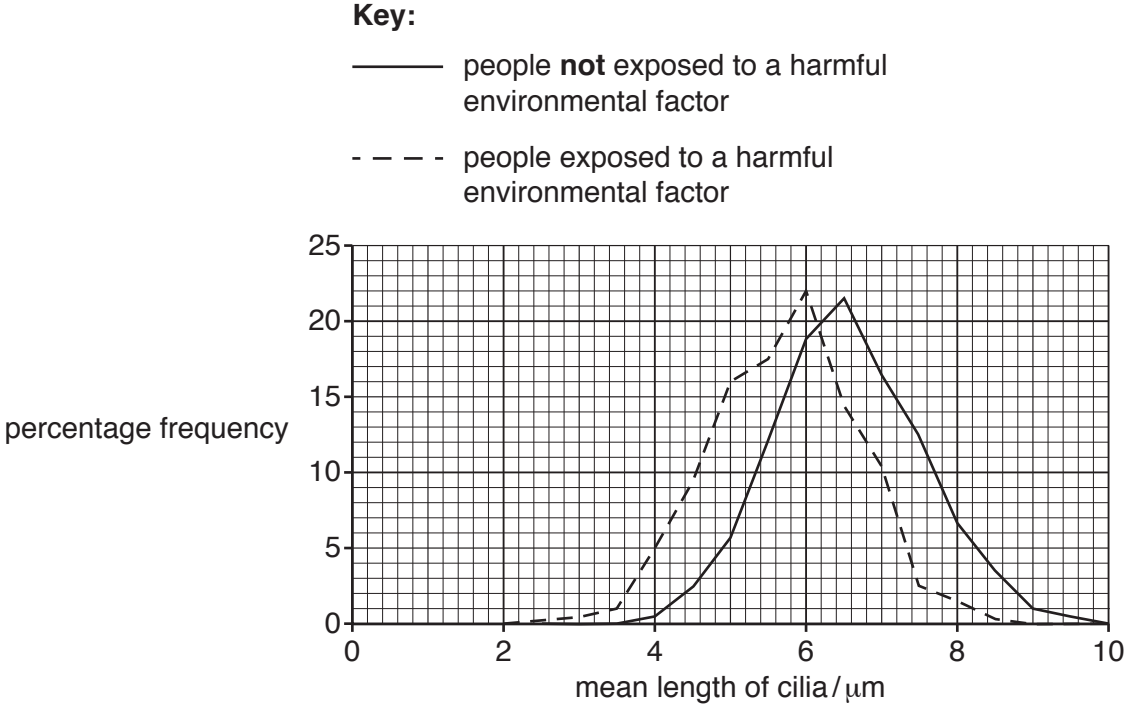


Fig. 3.1

(a) (i) Name the type of variation shown for mean cilia length in each group of people in Fig. 3.1.

..... [1]

(ii) Suggest **two** harmful environmental factors that people might have been exposed to that could explain the difference between the two curves in Fig. 3.1.

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..... [2]

(b) The development and final length of cilia of epithelial cells is controlled by many genes.

Fig. 3.2 summarises the interactions of some of these genes. The arrows represent the genes being switched on.

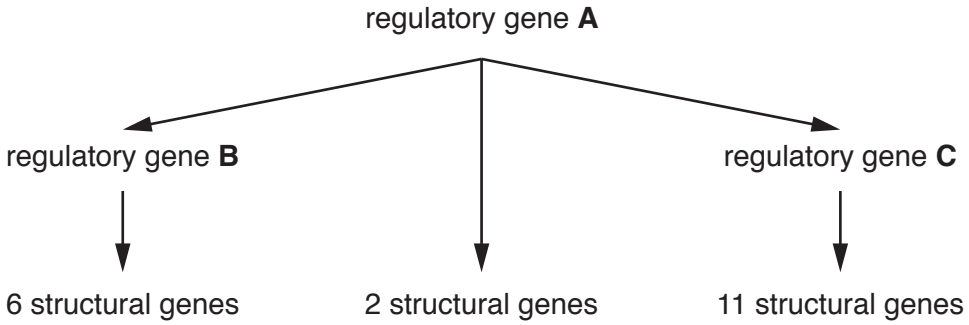


Fig. 3.2

(i) With reference to Fig. 3.2, explain how genes such as **A**, **B** and **C** are able to switch on other genes.

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..... [4]

(ii) Describe how microarray analysis can be used to identify the genes switched on by the product of gene **C**.

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..... [5]

(c) Microarray analysis has shown that ciliated epithelial cells and other epithelial cells in the airways express genes that code for receptor proteins on cell surface membranes. These receptor proteins detect specific chemicals.

When the receptor proteins bind to specific chemicals, this causes coughing, constriction of the airways and an increase in cilia activity. In people who have asthma, the response can be severe and life-threatening.

Suggest how knowledge of the genes for these receptor proteins could help in the treatment of asthma.

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..... [3]

[Total: 15]

4 Rice, *Oryza sativa*, is an important food crop for human consumption.

Two varieties of rice are T2A-1 and Shanyou 2.

Shanyou 2 has been developed in the traditional way by selective breeding (artificial selection) and T2A-1 is an example of a genetically modified (GM) organism.

(a) T2A-1 rice is described as insect-resistant as it produces a chemical that is toxic to insect pests.

Outline how genetic engineering gave T2A-1 rice the trait of insect resistance.

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..... [4]

(b) Countries vary in the extent to which they grow GM varieties instead of traditional crop varieties.

- The USA, Canada and countries in South America plant GM varieties on a large proportion of their crop-growing land, reaching 94% for soybeans in the USA.
- In most European countries, 0% of the crop-growing land is planted with GM varieties.

Scientists used computer models to predict the effects of a global ban that reduced the cultivation of GM crops to 0% everywhere.

Table 4.1 shows the results of this modelling on world crop yields and the purchase price of each crop.

Table 4.1

crop	percentage change in crop yield	percentage change in purchase price
rapeseed	–0.14	+1.96
rice	–0.12	+1.58
soybeans	–1.40	+4.05

(i) Explain what the data in Table 4.1 show about the **social** implications of growing GM crops.

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..... [2]

(ii) A worldwide ban on growing GM crop varieties would mean that more land would be needed to grow traditional crops, such as Shanyou 2. This would involve converting forest and grassland to crop-growing land.

Table 4.2 shows the predicted changes in carbon dioxide emissions associated with this change in use of land.

Table 4.2

change in use of land	change in carbon dioxide emissions / million kg CO_2
forest to crop-growing land	+ 608 726
grassland to crop-growing land	+ 276 042

Discuss what the data in Table 4.2 indicate about the environmental implications of growing GM crops.

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..... [2]

[Total: 8]

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5 **(a)** Fig. 5.1 is a photograph of a section through a kidney.



Fig. 5.1

On Fig 5.1, use label lines and letters to label the regions of the kidney where the following are located:

L – loop of Henlé

D – distal convoluted tubule

P – podocyte cells.

[3]

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[Turn over

(b) In a cold environment, people urinate more frequently. This condition is called cold diuresis.

In a cold environment, homeostatic mechanisms keep heat loss to a minimum. Blood is diverted away from the skin so that more blood circulates around the main body organs, including the kidney.

Suggest **and** explain why cold diuresis occurs.

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..... [4]

(c) The water potential of the blood is maintained at a constant level by a mechanism called negative feedback.

With reference to the maintenance of the water potential of the blood, explain what is meant by negative feedback.

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..... [5]

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(d) ADH affects the number of water channel proteins, aquaporins, in the cell surface membranes of the cells of the distal convoluted tubule.

State what happens to the water potential **and** volume of the urine if cells in the distal convoluted tubule have more aquaporins in their cell surface membranes.

water potential .....

volume of urine .....

[1]

[Total: 13]

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[Turn over

6 (a) Regressive evolution is a change in a population over time that involves the **loss** of certain phenotypic characteristics. It is thought to be caused by either genetic drift or natural selection.

An example of regressive evolution is the loss of eyes in one form of the Mexican cavefish, *Astyanax mexicanus*. These eyeless cavefish live in caves that are in total darkness.

There are three theories to explain how the loss of eyes in the cavefish has occurred.

Theory A
There is no advantage to having eyes in a cave that is in total darkness, where energy sources are scarce. Having eyes is a disadvantage as there may be an energy cost.

Theory B
A mutation has occurred in a single gene. This mutation has two effects:

- a lack of eye development
- an increase in the number of chemoreceptors on the skin.

Theory C
Various mutations occurred in the genes responsible for eye development over a period of time. By chance, these mutations increased in frequency in small isolated populations. Eventually this produced a population of eyeless cavefish.

(i) State **one** theory, **A**, **B** or **C**, which describes genetic drift as the cause of loss of eyes.

..... [1]

(ii) State **and** explain which theory or theories are based on natural selection as the cause of loss of eyes.

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..... [4]

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(b) There are several separate populations of eyeless *A. mexicanus* in different caves.

There are populations of *A. mexicanus* that spend time in areas with light and the fish in these populations have eyes.

The mitochondrial DNA (mtDNA) of eyeless *A. mexicanus* was compared to the mtDNA of *A. mexicanus* with eyes.

(i) Suggest how DNA evidence can help find out whether the eyeless *A. mexicanus* and the *A. mexicanus* with eyes are the same species or different species.

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..... [2]

(ii) Suggest why mtDNA is used instead of nuclear DNA when studying the closeness of the relationship between populations.

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..... [3]

[Total: 10]

7 The passage below outlines one method used by a student to estimate the population size of an animal species.

Complete the passage by using the most appropriate scientific term or terms.

A student estimated the population size of an animal species using the mark-release-..... technique. This can only be used for ..... animals such as mice.

The student caught a sample of mice using humane traps. The student then marked the mice in a way that did not ..... them. For example, the mark did not make them more visible to potential ..... . The student released the marked mice and left enough time for them to randomly ..... with the population.

The student then caught a second sample of mice and noted the numbers of marked and unmarked mice.

The student estimated the population size by multiplying the number of mice in the first sample by the number in the second sample, then dividing by the number of ..... mice in the second sample.

[6]

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8 **(a)** Table 8.1 shows some of the stages of glycolysis and respiration in anaerobic conditions in yeast.

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

Table 8.1

stage	description of stage
A	triose phosphate is dehydrogenated by NAD
B	pyruvate is decarboxylated
C	ethanal is formed
D	ethanol is formed
E	glucose is phosphorylated by ATP
F	pyruvate is formed
G	ethanal is reduced by alcohol dehydrogenase
H	fructose bisphosphate is formed
I	ATP is made by substrate-linked phosphorylation

Complete Table 8.2 to show the correct order of the stages.

One stage has been completed for you.

Table 8.2

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

[4]

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[Turn over

(b) Yeast respires glucose in aerobic and anaerobic conditions.

Explain why less ATP is produced when yeast respires in anaerobic conditions compared to when yeast respires in aerobic conditions.

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..... [5]

[Total: 9]

Section B

Answer **one** question.

9 **(a)** Describe how the structure of a chloroplast is related to its functions. [8]

(b) Describe how you would separate chloroplast pigments using chromatography. [7]

[Total: 15]

10 **(a)** Describe how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe how you would carry out an investigation, using a simple respirometer, to measure the effect of temperature on the respiration rate of insect larvae. [7]

[Total: 15]

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[Turn over

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