Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8366615273

BIOLOGY **9700/42**

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.

Cambridge Assessment International Education

Section A

Answer **all** questions.

1 **(a)** Fig. 1.1 is an electron micrograph showing a cross-section of a myelinated neurone.

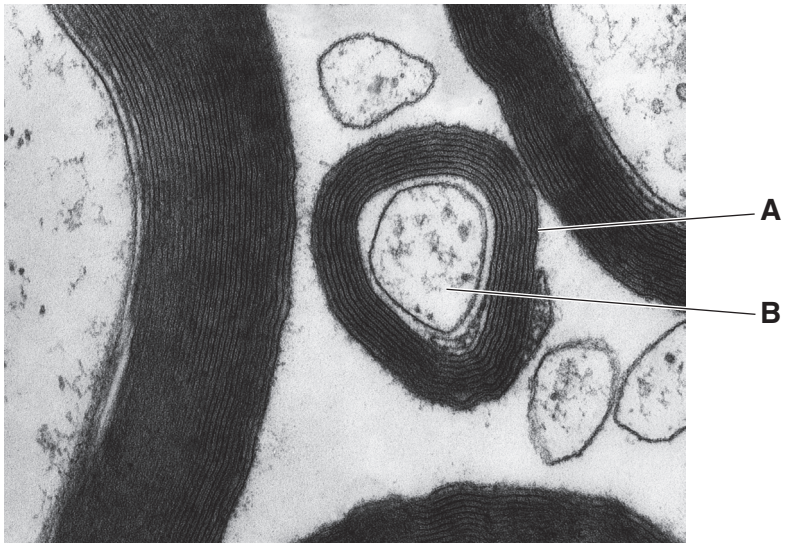

Fig. 1.1

Name **A** and **B**.

A .....

B .....
[2]

(b) Explain what is meant by saltatory conduction **and** describe its effect on the transmission of a nerve impulse.

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..... [3]

(c) A type of sea snail, *Conus purpurascens*, produces a toxin that blocks calcium ion channels in the presynaptic knob of a cholinergic synapse. The presence of this toxin results in no action potentials in the postsynaptic neurone.

Explain why the presence of this toxin results in **no** action potentials in the postsynaptic neurone.

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..... [5]

[Total: 10]

2 Steelhead trout, *Oncorhynchus mykiss*, are fish that live in streams in North America.

To increase the number of steelhead trout, captive breeding has occurred since 1992. Fish eggs and sperm are mixed and the young fish grow in large tanks of aerated water for the first year of their lives. Most are then released into the wild, however a few male and female fish are kept to become the parents of the next generation of captive-bred fish.

Each tank may hold up to 50 000 fish. The young captive fish are fed processed food. Some young fish are unable to survive these conditions and a proportion die. Death is usually the result of poor wound-healing after accidents due to overcrowding and due to the spread of diseases.

(a) (i) Name the expected pattern of variation in wound-healing ability in a population of fish.

..... [1]

(ii) Name the process that results in improved survival of captive fish in second, third and subsequent generations of captive-bred fish.

..... [1]

(b) Suggest **and** explain **three** ways in which the tank environment may make the phenotype of a captive fish different from a wild fish.

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Two groups of fish were bred and grown in the **same** environment and were then compared to see if they showed differences in gene expression.

The two groups of fish came from:

- eggs and sperm from parent fish that had always lived in the wild
- eggs and sperm from parent fish that had been bred in captivity.

Results from microarray analysis showed that the offspring of the wild and captive-bred fish differed in the expression of over 700 genes.

(c) (i) Describe how microarray analysis can detect differences in the expression of many genes when comparing two samples, such as the offspring of wild and captive-bred fish.

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(ii) Explain how gene expression is controlled in eukaryotes such as fish.

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(d) Many of the differences in gene expression between the offspring of the wild and captive-bred fish were in genes coding for proteins involved in the immune response and in genes coding for proteins involved in wound healing. The fish from captive-bred parents expressed these genes to a greater degree.

The researchers concluded that the differences were inherited and adaptive.

Explain why the researchers concluded that the differences in gene expression between the two groups of fish were:

(i) inherited

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..... [1]

(ii) adaptive.

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..... [1]

[Total: 16]

3 Soybean, *Glycine max*, is an important food crop for human consumption and for feeding to animals.

Two varieties of soybean are Vinton 81 and GTS 40-3-2.

Vinton 81 has been developed in the traditional way by selective breeding (artificial selection) and GTS 40-3-2 is an example of a genetically modified (GM) organism.

(a) GTS 40-3-2 is described as herbicide-resistant, as it can withstand the application of glyphosate herbicide. Glyphosate is sprayed on the crop to kill weeds.

Outline how genetic engineering gave GTS 40-3-2 the trait of herbicide resistance.

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(b) Countries vary in the extent to which they grow GM varieties, such as GTS 40-3-2, instead of traditional varieties such as Vinton 81.

- In the USA, 94% of soybeans grown are GM.
- In Europe, 0% of soybeans grown are GM.

Scientists used computer models to predict the effect of two different changes in agricultural practice on soybean crop yields:

- a global ban that reduces the cultivation of GM soybeans to 0% everywhere
- all countries increasing the cultivation of GM soybeans to the 94% level of the USA.

Table 3.1 shows the results of this modelling for four countries.

Table 3.1

country	percentage change in yield of soybeans	
	decrease GM soybean cultivation to 0% of total	increase GM soybean cultivation to 94% of total
Argentina	0.00	+6.23
Bolivia	–10.82	0.00
Brazil	0.00	+6.23
USA	–5.87	0.00

Explain what the data in Table 3.1 suggests about the social and ethical implications of growing GM soybeans.

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[Total: 9]

4 Oculocutaneous albinism (OCA) is a type of albinism. There are many different forms of OCA.

OCA1A is one form of OCA, caused by a recessive mutation in the autosomal gene, *TYR*, coding for the enzyme tyrosinase. This enzyme is involved in the biosynthetic pathway that results in the production of melanin, the pigment responsible for the colour of hair, skin and eyes.

A person with OCA1A has white hair, very pale skin and pink eye colour.

(a) Draw a genetic diagram to show the probability of a child having OCA1A, if both parents are carriers.

Use the symbols **A** and **a** for the alleles.

parental genotypes

gametes

offspring genotypes

offspring phenotypes

probability

[4]

(b) Fig. 4.1 shows the biosynthetic pathway involving tyrosinase.

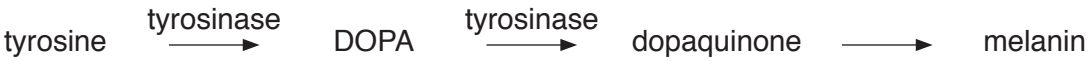

Fig. 4.1

There are a number of different mutations of the *TYR* gene that can result in an absence of melanin and cause OCA1A. These include:

- a missense mutation, caused by a base substitution, is most common
- a nonsense mutation, caused by a base substitution, is less common
- an insertion mutation, which is extremely rare.

(i) A missense mutation results in a complete polypeptide chain that does not fold properly to form the functioning enzyme.

A nonsense mutation results in a shortened polypeptide.

Explain why a missense mutation results in a different product from a nonsense mutation.

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(ii) Explain how an insertion mutation in *TYR* can lead to a lack of melanin in a person with OCA1A.

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(c) Worldwide, 1 in 17 000 people are born with OCA. This compares with 1 in 165 people among the Guna people of Panama. The Guna people of Panama have a small population and mostly live on many small islands off the coast of Panama.

Suggest reasons why the Guna population of Panama has a relatively high number of cases of OCA.

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[Total: 12]

5 **(a)** Fig. 5.1 is a photomicrograph of part of the cortex of a kidney.

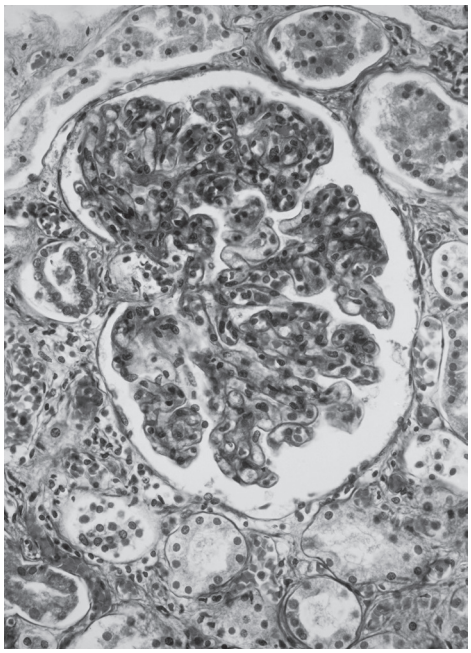

Fig. 5.1

(i) On Fig. 5.1, use label lines and letters to label:

G – the glomerulus

L – the lumen of the Bowman's (renal) capsule.

[2]

(ii) During ultrafiltration, components of blood in the glomerulus with a relative molecular mass greater than 68 000 are prevented from passing into the Bowman's capsule.

Name the structure that acts as this filtration barrier.

..... [1]

(b) The glomerular filtration rate (GFR) is the rate of flow of filtered fluid through the kidneys per unit time.

The afferent arterioles supply blood to the glomerulus of each nephron within the kidney and the efferent arterioles take blood away from each glomerulus. The lumen diameters of the afferent and efferent arterioles have a large effect on the GFR. Normally the lumen diameters of the afferent and efferent arterioles are different, but they can change to increase or decrease the normal GFR in response to changing conditions.

Complete Table 5.1 to indicate whether the GFR is normal, increased, or decreased for each combination of arteriole diameters shown.

The first row has been completed for you.

Table 5.1

afferent arteriole lumen diameter	efferent arteriole lumen diameter	GFR
normal	normal	normal
decreased	normal	.....
normal	increased	.....

[2]

(c) After leaving the Bowman's capsule, the glomerular filtrate passes through the proximal convoluted tubule, where selective reabsorption occurs.

Describe **and** explain how all of the glucose in the glomerular filtrate is reabsorbed back into the blood.

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(d) State **and** explain **three** features of a proximal convoluted tubule cell that adapt it to its function.

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[Total: 13]

6 **(a)** State the general theory of evolution.

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(b) Different types of organism have evolved different structures containing light receptors. Eyes are organs containing light receptors.

Fig. 6.1 describes the light receptors of several types of organism.

Euglena (a single-celled eukaryote) has a simple eyespot that can only detect the intensity and direction of light.
Turbellarian flatworms have cup-shaped eyes, each with a layer of light receptor cells. They can detect the intensity and direction of light better than *Euglena*. They also detect movement.
The mollusc *Nautilus* has eyes with deeper cups and narrower openings for light to enter. They can form a rough image, see shapes and detect the direction of light better than turbellarian flatworms.
The mollusc *Nucella* has eyes with lenses made of jelly. They can form a more detailed image than the eyes of *Nautilus* and can focus light to a small degree.
Mammals have eyes that are more complex than *Nucella*. They have a fixed lens (the cornea) that bends light and a lens that can change shape to focus on objects at different distances. The lenses focus light onto a deeply cup-shaped layer of light receptor cells. The eyes form a very detailed image.

Fig. 6.1

Using the information in Fig. 6.1, suggest how a complex eye such as that of mammals could have evolved in successive stages.

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(c) Octopuses are molluscs that have eyes very similar to those of mammals.

Octopuses and mammals are not closely related.

Octopuses and mammals have lenses that can change shape to focus on objects at different distances.

Suggest reasons why octopuses and mammals have evolved similar eye structures.

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..... [2]

(d) Molecular evidence is used to investigate evolution. One study involved a marine worm, *Platynereis dumerilii*, that still has characteristics similar to its ancestors from 600 million years ago.

Researchers sequenced all the proteins in light receptor cells of *P. dumerilii* and humans. The results showed that there are many similarities between the protein sequences of *P. dumerilii* and humans, particularly in the light-detecting protein opsin.

(i) State what this molecular evidence indicates about the evolutionary origins of *P. dumerilii* and humans.

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..... [1]

(ii) Explain how amino acid sequences indicate how close the relationship is between two species.

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[Total: 10]

7 **(a)** Define the term *ecosystem*.

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(b) State the term used to describe:

the functional role of a species within an ecosystem

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a reproductively isolated group of organisms that interbreed to produce fertile offspring

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physical factors in the environment such as temperature and soil pH.

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[3]

[Total: 6]

8 (a) Oxidative phosphorylation takes place in the mitochondrion.

Table 8.1 shows the different stages of oxidative phosphorylation.

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

Table 8.1

stage	description of stage
Q	protons diffuse through the membrane proteins into the matrix
R	a proton gradient is set up across the crista membrane
S	hydrogen atoms split into protons and electrons
T	protons combine with electrons and oxygen atoms to form water
U	electrons are passed from carrier to carrier
V	reduced NAD releases hydrogen atoms to cytochrome carriers
W	energy from electron transfer is used to pump protons into the intermembrane space
X	ATP synthase produces ATP

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

Two of the stages have been completed for you.

Table 8.2

correct order	letter of stage
1	**V**
2	.....
3	.....
4	.....
5	**R**
6	.....
7	.....
8	.....

[4]

(b) State the precise location in a mitochondrion of each of the following.

ATP synthase .....

Krebs cycle .....

electron transport chain .....

coenzyme A .....

pyruvate .....

[5]

[Total: 9]

Section B

Answer **one** question.

9 **(a)** Describe how you would carry out an investigation into the effect of temperature on the rate of photosynthesis of an aquatic plant. [8]

(b) Outline how degraded habitats may be restored, with reference to named examples. [7]

[Total: 15]

10 **(a)** Outline the biological basis of contraceptive pills containing oestrogen and progesterone. [8]

(b) Explain how speciation may occur as a result of geographical separation. [7]

[Total: 15]

[Turn over

[Turn over