Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

*7777700630*

**BIOLOGY** **9700/41**

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 part of a cell in a growing region of a plant.

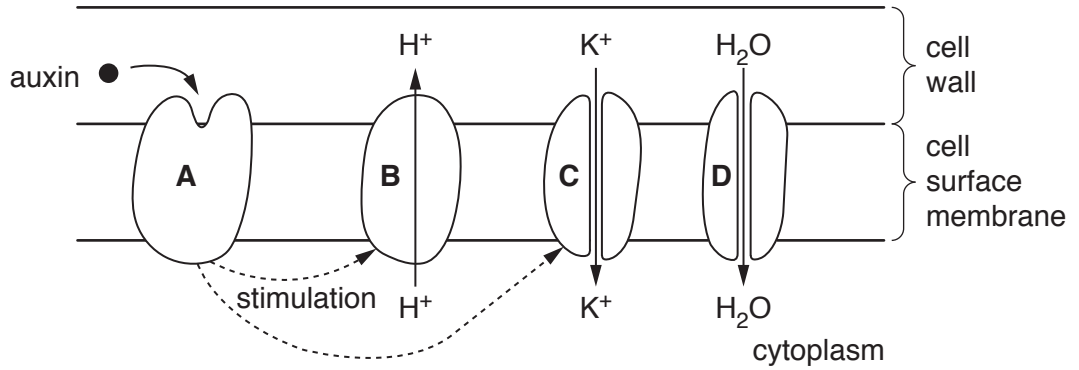



**Fig. 1.1**

**(i)** State the **type** of protein represented by **A**.

..... [1]

**(ii)** Proteins **B**, **C** and **D** are transport proteins.

Identify proteins **B**, **C** and **D**.

**B** .....

**C** .....

**D** .....

[3]

**(b)** Describe the effects on the cell wall of many hydrogen ions moving into the cell wall.

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..... [3]

**(c)** Explain the consequences of an influx of potassium ions into the cell.

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..... [2]

[Total: 9]

**2** The interpupillary distance (IPD) is the distance in millimetres between the centres of the pupils of the eyes. Fig. 2.1 shows how IPD is measured.

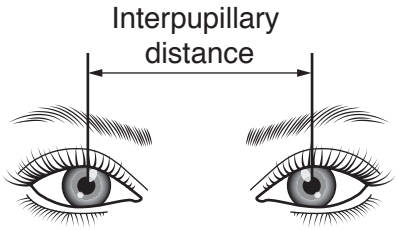



**Fig. 2.1**

IPD is one example of a characteristic of human facial structure that shows variation.

Fig. 2.2 shows the pattern of variation in IPD in a large sample of adults.

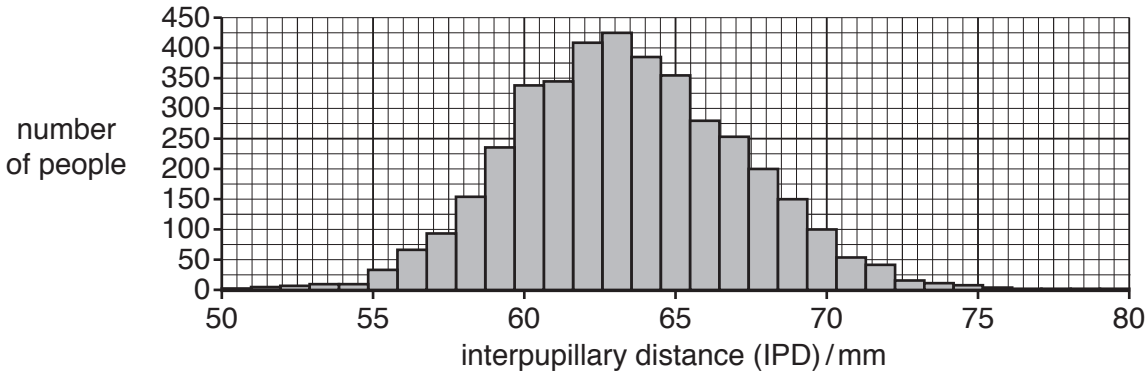



**Fig. 2.2**

**(a) (i)** Name the type of variation shown in Fig. 2.2.

..... [1]

**(ii)** Suggest **and** explain how genes and the environment contribute to variation in IPD in humans.

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..... [3]

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**(b)** Individuals with an IPD of 70 mm or more have a mutation in the *PAX3* gene that results in less PAX3 protein being made.

The normal role of the PAX3 protein is to increase the expression of many other genes involved in embryonic development. These genes affect a range of phenotypic features such as facial structure, hearing and eye colour.

**(i)** State the term that is used to describe a gene, such as *PAX3*, that controls the expression of other genes **and** suggest how the PAX3 protein controls the expression of other genes.

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..... [3]

**(ii)** Describe how microarray analysis could be used to identify the genes switched on by PAX3 in embryonic cells.

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..... [5]

**(iii)** The chimpanzee, *Pan troglodytes*, has DNA that is 98.5% similar to humans, including possession of the *PAX3* gene. Investigations show that chimpanzees express higher levels of the PAX3 protein during embryonic development than humans.

Fig. 2.3 shows a chimpanzee, *Pan troglodytes*.



**Fig. 2.3**

Suggest how knowledge of the *PAX3* gene helps scientists explain how humans and chimpanzees are very different in facial structure, even though they have very similar DNA.

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..... [3]

[Total: 15]

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**3** Some neurones in the brain produce a neurotransmitter known as dopamine. Parkinson's disease occurs when the neurones that produce dopamine die. A person with the disease may experience difficulty in coordinating movement, often seen as tremors (shaking) in different parts of the body.

Parkinson's disease typically occurs in people older than 55 years. Younger people with these symptoms are said to have early onset Parkinson's disease (EOPD).

Recessive mutations in a gene known as *PINK1*, located on chromosome 1, an autosome, are believed to be one cause of EOPD. A person with this form of EOPD has a homozygous recessive genotype.

**(a)** Draw a genetic diagram of a cross between two individuals who are heterozygous at the *PINK1* gene locus.

*key to symbols used for alleles*

.....

.....

*parental genotypes*

*gametes*

*offspring genotypes*

*ratio of offspring phenotypes*

[4]

**(b)** *PINK1* codes for a protein kinase enzyme that is important in the functioning of mitochondria in neurones.

Most recessive *PINK1* mutations are base substitutions which lead to the production of a non-functioning protein kinase enzyme.

Explain how a base substitution mutation can lead to the production of a non-functioning protein kinase.

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..... [5]

**(c)** One rare, dominant mutation of the *PINK1* gene codes for a product that inhibits the normal protein kinase.

Explain how this mutation causes EOPD in a heterozygote.

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..... [2]

[Total: 11]

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**Question 4 starts on page 10**

**4 (a)** The link reaction and Krebs cycle take place in the mitochondrion.

The main stages of the link reaction and Krebs cycle are listed in Table 4.1.

They are **not** listed in the correct order.

**Table 4.1**

| stage | description of stage |
|---|---|
| **A** | acetyl group combines with coenzyme A to form acetyl CoA |
| **B** | citrate is formed |
| **C** | hydrogen atoms are accepted by NAD and FAD |
| **D** | oxaloacetate is regenerated |
| **E** | pyruvate enters the mitochondrial matrix |
| **F** | acetyl group is formed |
| **G** | acetyl CoA enters Krebs cycle |
| **H** | ATP is made by substrate-linked phosphorylation |
| **I** | pyruvate is decarboxylated and dehydrogenated |
| **J** | acetyl CoA combines with oxaloacetate |
| **K** | citrate is decarboxylated and dehydrogenated |

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Complete Table 4.2 to show the correct order of the stages.

Three of the stages have been done for you.

**Table 4.2**

| correct order | letter of stage |
|---|---|
| 1 | **E** |
| 2 | ..... |
| 3 | ..... |
| 4 | ..... |
| 5 | ..... |
| 6 | **J** |
| 7 | ..... |
| 8 | ..... |
| 9 | ..... |
| 10 | ..... |
| 11 | **D** |

[4]

**(b)** Outline the role of NAD in respiration in aerobic conditions.

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..... [4]

**(c)** Carbon dioxide is removed from compounds in the link reaction and Krebs cycle by decarboxylation.

**(i)** State the total number of molecules of carbon dioxide removed in the link reaction and Krebs cycle for each molecule of glucose respired.

..... [1]

**(ii)** In a mammal, carbon dioxide diffuses from cells into the blood to be transported to the lungs.

Suggest why carbon dioxide is transported in the blood mainly as hydrogen carbonate ions and not as carbonic acid.

..... [1]

[Total: 10]

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**5** Researchers investigated the extent to which the founder effect and natural selection affected evolutionary change.

Fig. 5.1 shows the brown anole lizard, *Anolis sagrei*. These lizards live on a number of Caribbean islands and feed on a variety of invertebrates and other small animals.

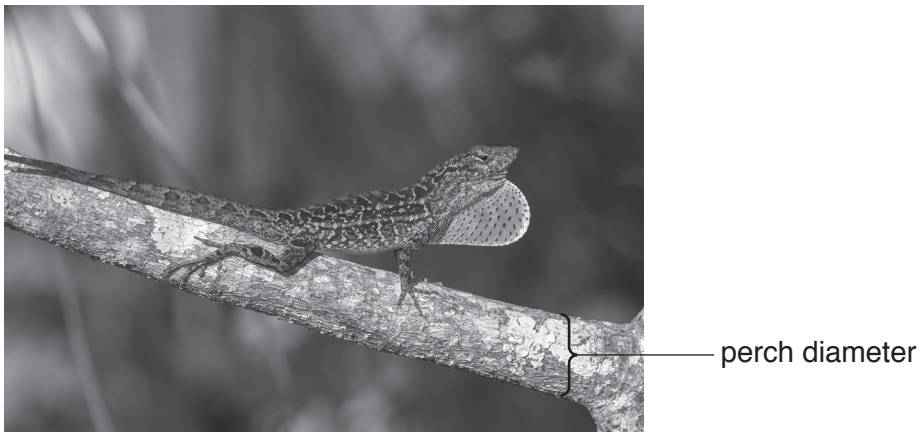



**Fig. 5.1**

*A. sagrei* spends a lot of time perching (resting) on, or moving along, branches of shrubs and trees. The width of the branch that *A. sagrei* perches on is known as the perch diameter, as labelled in Fig. 5.1.

There is a positive correlation between perch diameter and hind limb length of *A. sagrei*.
- Longer hind limbs allow *A. sagrei* to run faster on vegetation with a larger diameter.
- Shorter hind limbs are needed to provide stability on vegetation of a smaller diameter.

In 2004, a hurricane caused the death of all the *A. sagrei* lizards on seven islands.

In 2005, the researchers randomly collected seven male and seven female lizards from a source population on a nearby island. For each of the seven islands affected by the hurricane, a male and female lizard were mated and placed on each island. These islands formed the experimental founder islands where new populations of *A. sagrei* were successfully established from each founding pair.

Fig. 5.2 shows the difference in vegetation between the source island and the seven experimental founder islands.




**Fig. 5.2**

**(a) (i)** Predict the effect of natural selection on mean hind limb length of *A. sagrei* on the seven experimental founder islands.

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..... [1]

**(ii)** Predict how collecting individuals **at random** for the seven founding pairs affects the mean hind limb length of *A. sagrei* on the different islands.

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..... [1]

**(b)** Many generations of *A. sagrei* were produced over the four years after the introduction of the founding pairs.

Fig. 5.3 shows how the mean hind limb length of *A. sagrei* changed on the seven experimental islands and on the source island.

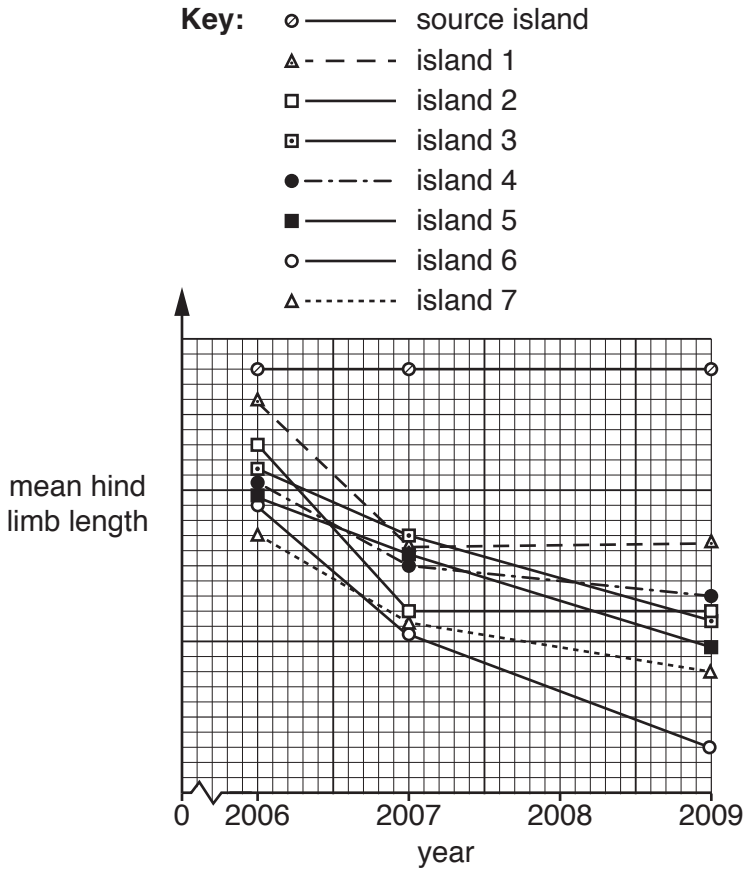



**Fig. 5.3**

With reference to Fig. 5.2 and Fig. 5.3, describe **and** suggest explanations for the results for the islands.

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..... [5]

**(c)** In the investigation, one population of *A. sagrei* was established on each experimental founder island.

Outline how speciation may occur on the seven experimental founder islands.

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..... [3]

**(d)** Speciation is one possible outcome for the experimental founder populations, but there is also a high risk that they may become extinct.

Explain why the experimental founder populations are at high risk of extinction.

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..... [3]

[Total: 13]

**6** Maize, *Zea mays*, is an important food crop for human consumption and for feeding to animals.

Two varieties of maize are MON810 and Justina. Justina has been developed in the traditional way by selective breeding (artificial selection) and MON810 is an example of a genetically modified (GM) organism.

**(a)** MON810 produces a chemical that is toxic to insect pests. It is described as insect-resistant.

Outline how genetic engineering gave MON810 the trait of insect resistance.

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..... [4]

**(b)** Countries vary in the extent to which they grow GM varieties such as MON810, instead of traditional varieties such as Justina.

- In the USA, 88% of the total maize that is grown is GM.
- In most European countries, 0% of the maize that is grown is GM.

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

- a global ban that reduces the cultivation of GM maize to 0% everywhere
- all countries increasing the cultivation of GM maize to the 88% level of the USA.

Table 6.1 shows the results of this modelling for four countries.

**Table 6.1**

| country | percentage change in yield of maize | |
|---|---|---|
| | decrease GM maize cultivation to 0% of total | increase GM maize cultivation to 88% of total |
| Argentina | –8.86 | +2.90 |
| Honduras | –1.26 | +16.75 |
| Spain | –3.82 | +5.39 |
| USA | –7.63 | 0.00 |

Explain what the data in Table 6.1 suggests about the social and ethical implications of growing GM maize.

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..... [4]

[Total:8]

**7** **(a)** Some people have a condition called diabetes. In type 1 diabetes the pancreas does not produce enough insulin.

Fig. 7.1 shows the blood glucose concentrations of a type 1 diabetic person and a non-diabetic person, at regular intervals after drinking a glucose drink.

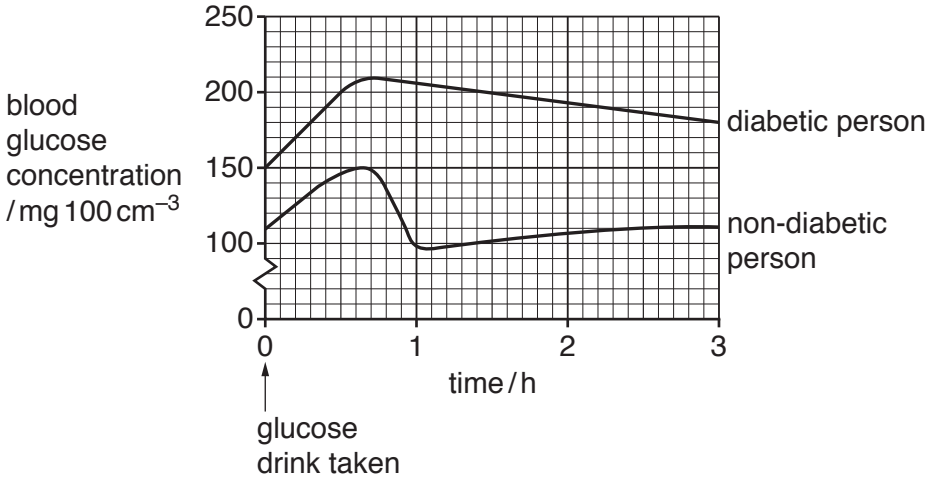



**Fig. 7.1**

**(i)** Describe the results shown in Fig. 7.1.

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..... [3]

**(ii)** Name the location of the receptors in a non-diabetic person that detect a change in blood glucose concentration.

..... [1]

**(iii)** Name the homeostatic mechanism by which blood glucose concentration is maintained.

..... [1]

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**(b)** The urine of a non-diabetic person does not contain glucose. A person with type 1 diabetes will excrete glucose in urine.

A reading of the concentration of glucose in the urine can be estimated using a dipstick.

Fig. 7.2 outlines how a dipstick works.

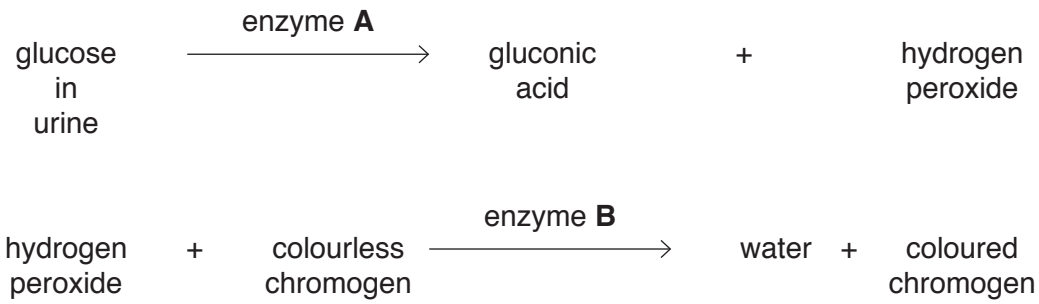



**Fig. 7.2**

The higher the concentration of glucose in the urine, the darker the colour on the dipstick.

**(i)** Name enzymes **A** and **B**.

**A** .....

**B** .....

[2]

**(ii)** An electronic biosensor can be used to measure the glucose concentration in a drop of blood.

Suggest **one** advantage of using a biosensor and **one** advantage of using a dipstick to measure glucose concentration.

*biosensor* .....

.....

*dipstick* .....

.....

[2]

**(c)** Describe the role played by insulin in the control of blood glucose concentration.

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..... [5]

[Total: 14]

**8** Table 8.1 shows the total number of plant species, the total number of insect species and the number of habitats in three areas, **A**, **B** and **C**.

**Table 8.1**

| area | total number of plant species | total number of insect species | number of habitats |
|---|---|---|---|
| **A** | 6 | 5 | 1 |
| **B** | 15 | 23 | 4 |
| **C** | 362 | 70 | 12 |

**(a)** Identify the area with the highest biodiversity.

Give reasons for your choice of area.

*area* .....

*reasons* .....

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.....

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..... [3]

**(b)** Identify the area that is likely to be affected the most if the environment changes.

Give a reason for your choice of area.

*area* .....

*reason* .....

.....

[1]

**(c)** State **one** reason why it is important to conserve biodiversity in **all** three areas.

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..... [1]

[Total: 5]

## Section B

Answer **one** question.

**9** **(a)** Explain what is meant by the term limiting factor **and** explain how knowledge of limiting factors is used to increase crop yields in glasshouses. [7]

**(b)** Describe the behaviour of chromosomes during meiosis. [8]

[Total: 15]

**10** **(a)** Explain how a cholinergic synapse functions. [7]

**(b)** Describe how you would carry out an investigation into the effect of wavelength of light on the rate of photosynthesis of a plant, using a redox indicator such as DCPIP. [8]

[Total: 15]

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