Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Standard level
Paper 3

Tuesday 15 May 2018 (morning)

1 hour

Candidate session number

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[35 marks]**.

Section A	Questions
Answer all questions.	1 – 3

Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 7
Option B — Biotechnology and bioinformatics	8 – 11
Option C — Ecology and conservation	12 – 15
Option D — Human physiology	16 – 19

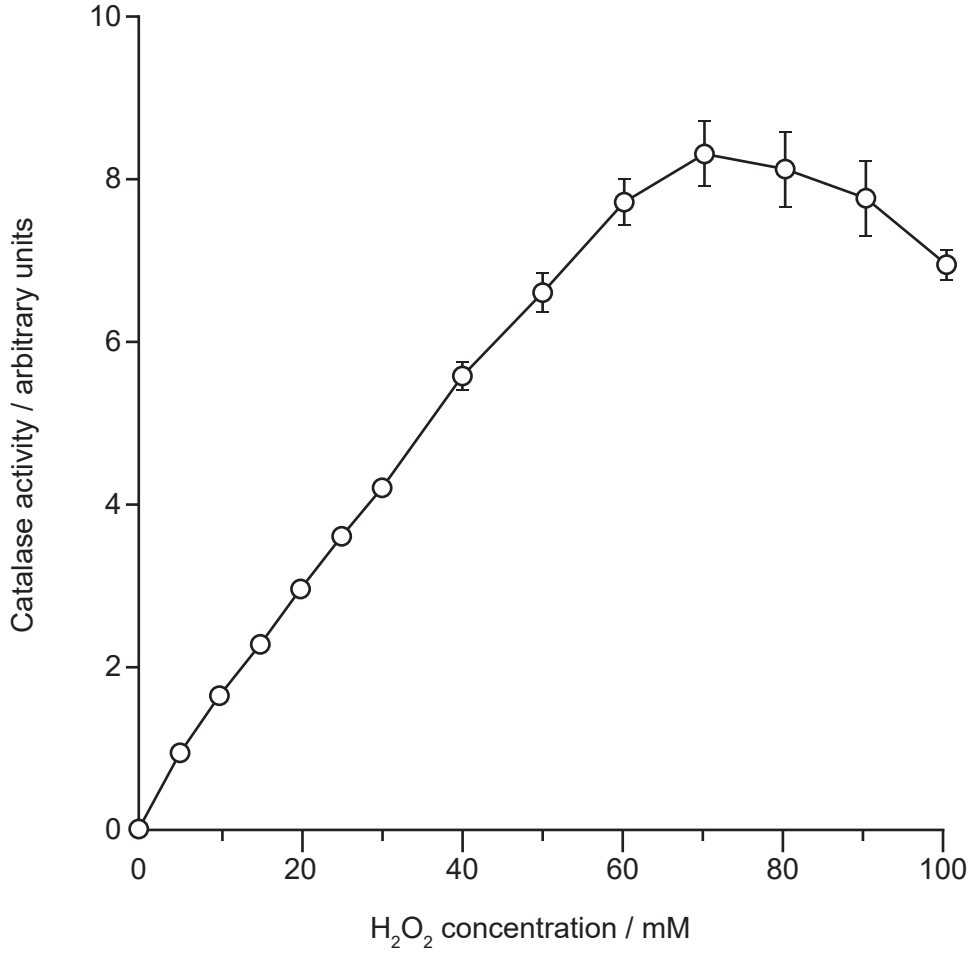
2218–6012

30 pages

Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. A study was carried out on the activity of catalase in bacteria living in extreme environments. Catalase decomposes hydrogen peroxide (H_2O_2). The data were obtained for a strain of bacteria called *Vibrio rumoiensis* which exhibits high catalase activity.



[Source: *Journal of Bacteriology*, 2000, 182, 1903-9, amended with permission from American Society for Microbiology.]

(a) Describe the relationship between increasing H_2O_2 concentration and catalase activity. [2]

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(This question continues on the following page)

(Question 1 continued)

(b) Identify **two** factors that would need to be controlled in generating these data. [1]

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(c) Evaluate the claim that, based on the data, the optimum H_2O_2 concentration for catalase is 70 mM. [2]

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2. The mesocosms shown were placed in a freshwater lake to investigate the impact of water mixing on the biomass of zooplankton (microscopic consumers). Each mesocosm is filled with lake water, sealed at the bottom and sides, and open to the air at the top. The water in each mesocosm was mixed either by moving a flat disc up and down or by bubbling air through the water. In the control there was no active mixing.

Removed for copyright reasons

(a) Based only on the data in the graph, outline the effect of different mixing methods on the biomass of zooplankton. [2]

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(This question continues on the following page)

(Question 2 continued)

(b) Outline the advantages of using mesocosms to study ecological relationships. [2]

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(c) State **one** possible error that could affect a mesocosm experiment of this type. [1]

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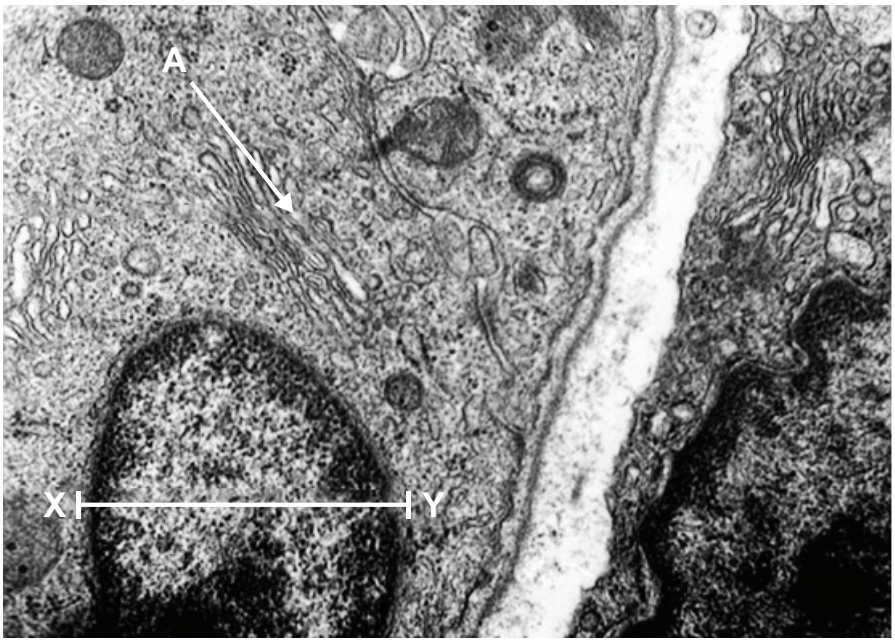
3. The image is a transmission electron micrograph of part of two adjacent pancreatic cells.



[Source: https://commons.wikimedia.org/wiki/File:Pancreatic_cells_-_TEM.jpg]

(a) Using the scale bar, determine the diameter of the nucleus of the cell on the left, giving the units. [2]

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(b) Deduce the magnification of the image. [2]

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(This question continues on the following page)

(Question 3 continued)

(c) Identify the structure labelled A. [1]

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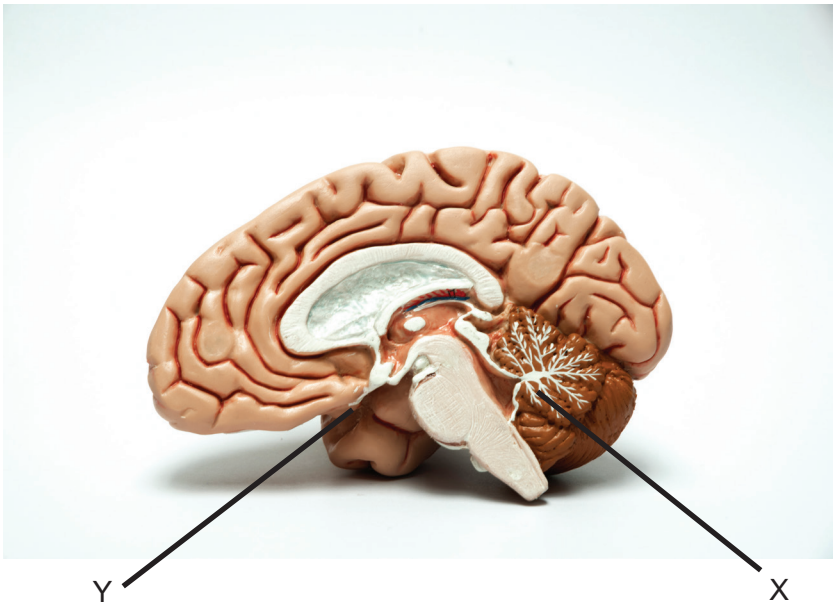
Section B

Answer **all** of the questions from **one** of the options. Answers must be written within the answer boxes provided.

Option A — Neurobiology and behaviour

4. The image shows a normal human brain in vertical section.



[Source: By undefined undefined/iStockphoto]

(a) Identify the parts of the brain labelled X and Y. [2]

X: . . . . . .

Y: . . . . . .

(Option A continues on the following page)

(Option A, question 4 continued)

(b) Outline the function of the nucleus accumbens. [1]

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(c) Compare and contrast the sensory and motor functions of the left and right cerebral hemispheres of the brain. [3]

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(Option A continues on page 11)

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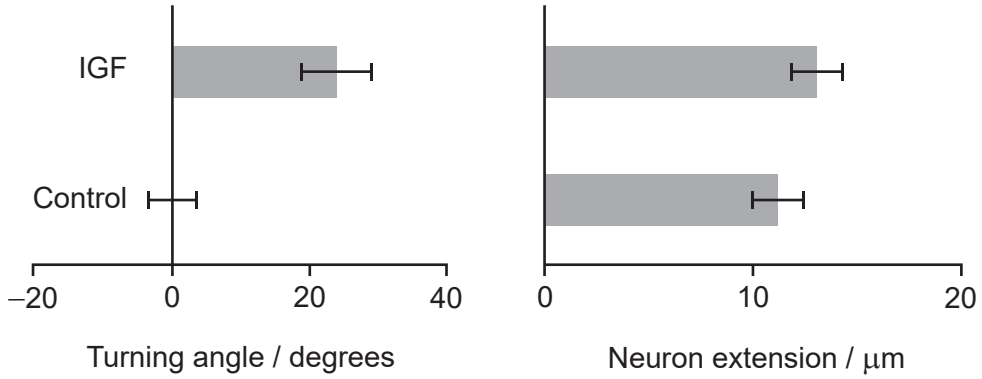
will not be marked.

(Option A continued)

5. Cells destined to become neurons differentiate in the neural tube. They grow and mature under the influence of chemical and other signals. The influence of insulin-like growth factor (IGF) was investigated in vitro using olfactory sensory neurons. The turning angle (direction) and extension of growth of these neurons were measured.



[Source: Reprinted from *Neuron*, 57, J A Scolnick *et al*, Role of IGF Signaling in Olfactory Sensory Map Formation and Axon Guidance, 847, Copyright (2008), with permission from Elsevier]

(a) Evaluate the claim that IGF influences turning angle and neuron extension. [2]

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(b) Outline the development of neurons from when they are first formed in the neural tube. [3]

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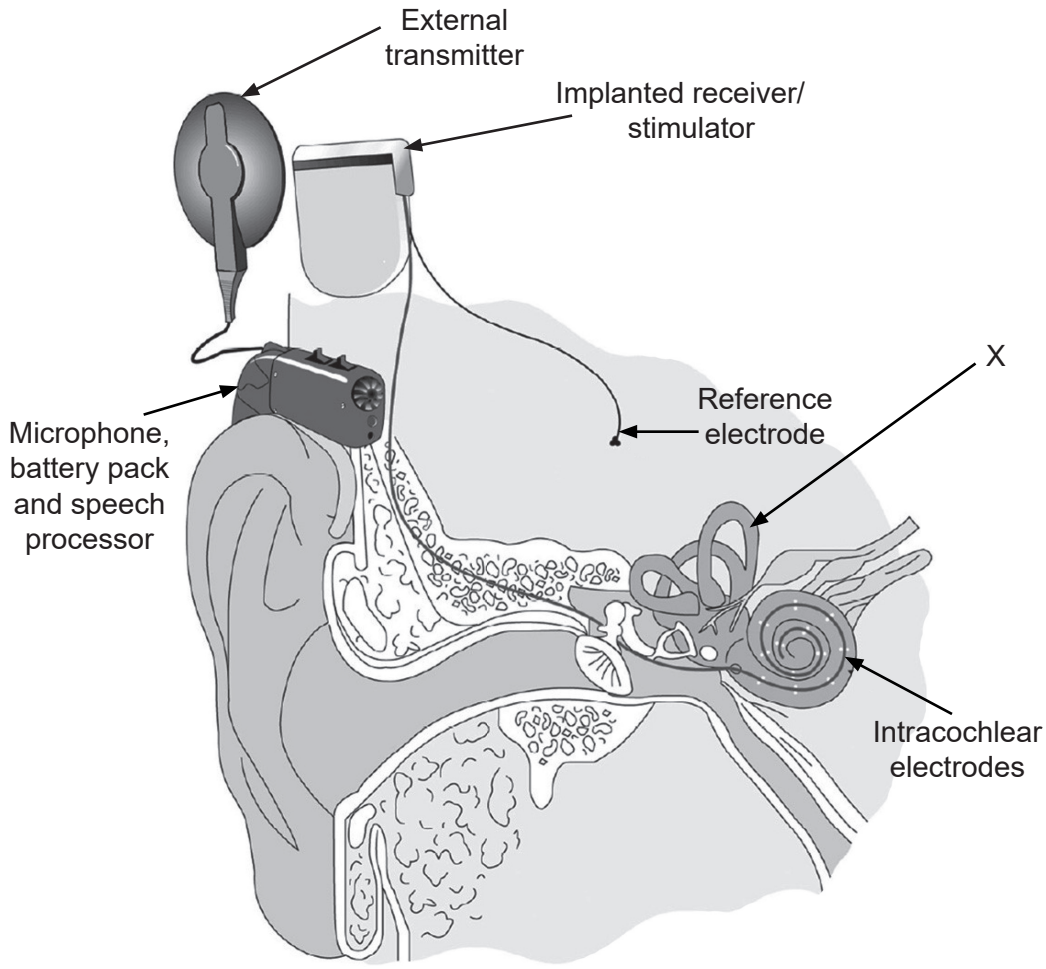
(Option A continues on the following page)

(Option A continued)

6. The diagram shows the components of a cochlear implant system.



[Source: Reprinted from *Hearing Research*, 242, Blake S. Wilson and Michael F. Dorman, Cochlear implants: A remarkable past and a brilliant future, 3-21, Copyright 2008, with permission from Elsevier]

(a) Identify the part of the ear labelled X. [1]

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(Option A continues on the following page)

(Option A, question 6 continued)

(b) Compare and contrast the mechanisms involved in hearing sounds in individuals with and without cochlear implants. [2]

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(c) Outline the role of the ear in balance perception. [2]

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(Option A continues on page 15)

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will not be marked.

(Option A continued)

7. Discuss the methods used to identify the role of specific parts of the brain. [4]

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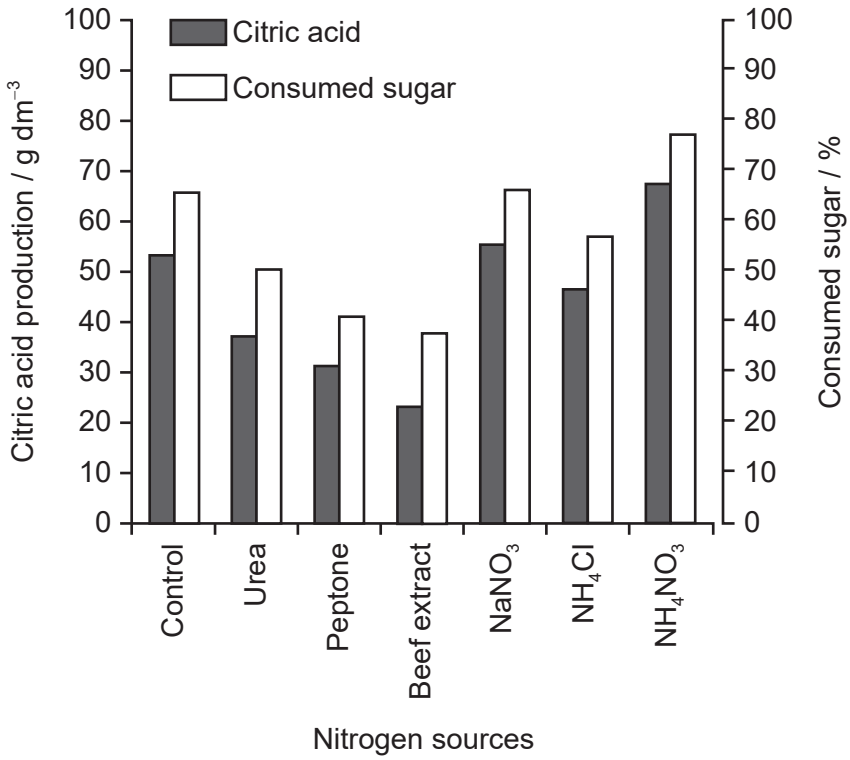
End of Option A

Option B — Biotechnology and bioinformatics

8. Citric acid is produced industrially from sugars in continuous fermenters using the fungus *Aspergillus niger* and with date syrup as a growth medium. Citric acid is a byproduct of the metabolism of this fungus. The fungus requires a nitrogen source for optimal growth and the impact of different nitrogen sources on citric acid production was investigated. The control received no additional nitrogen.



[Source: Reprinted from *Saudi Journal of Biological Sciences*, 19, Y S Mostafa and S A Alamri, Optimization of date syrup for enhancement of the production of citric acid using immobilized cells of Aspergillus niger, 241, Copyright (2012), with permission from Elsevier]

(a) Identify the nitrogen source that results in the highest yield of citric acid. [1]

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(b) State **two** uses for industrially produced citric acid. [1]

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(Option B continues on the following page)

(Option B, question 8 continued)

(c) Citric acid can be produced by either batch fermentation or continuous fermentation. Distinguish between these two methods. [2]

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(d) Explain the significance of pathway engineering in the industrial use of microorganisms. [2]

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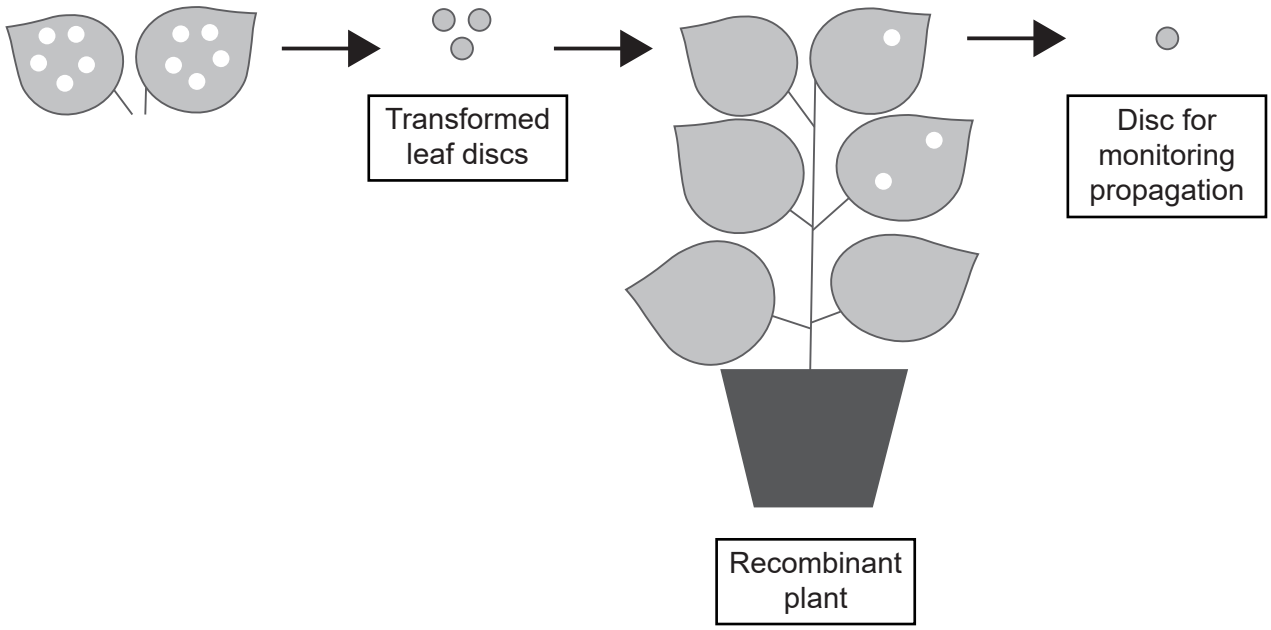
(Option B continues on the following page)

(Option B continued)

9. Transformed leaf discs containing recombinant DNA can be used to grow genetically modified crop plants. Discs taken from the new plant can be used to monitor successful uptake of the recombinant DNA.



[Source: Adapted from Within leaf variation is the largest source of variation in agroinfiltration of Nicotiana benthamiana, Bashandy, *et al.*, (2015), *Plant Methods*, 11, page 47. http://creativecommons.org/licenses/by/4.0/]

(a) State **one** other method by which recombinant DNA can be introduced into a plant. [1]

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(b) Outline the role of bioinformatics in the genetic modification of plants. [2]

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(Option B continues on the following page)

(Option B, question 9 continued)

(c) Outline the potential advantages of genetically modified plants. [3]

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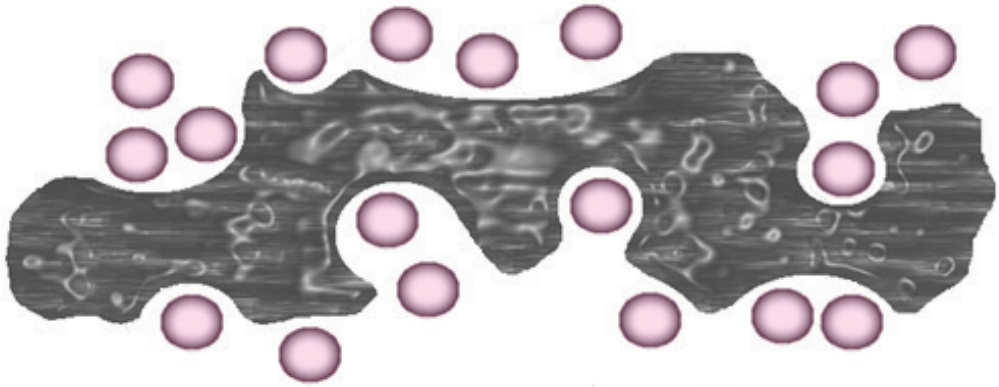
(Option B continues on the following page)

(Option B continued)

10. Microorganisms can be used in bioremediation of pollution, including oil spills at sea.



[Source: © International Baccalaureate Organization 2018]

(a) State the role of microorganisms in bioremediation. [1]

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(b) Explain the use of a **named** bacterium in bioremediation. [3]

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(Option B continues on the following page)

(Option B continued)

11. Explain the difficulties of treating microorganisms growing in biofilms. [4]

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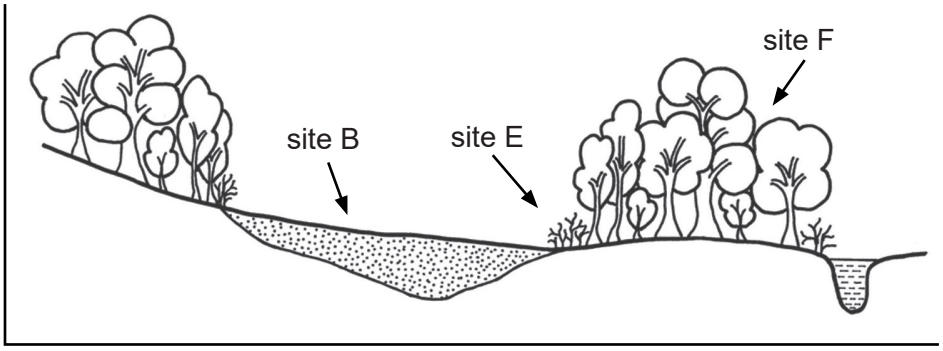
End of Option B

Option C — Ecology and conservation

12. Isopods are a group of organisms belonging to the arthropods and include woodlice (slaters) and other species, some of which live on land and others in water. A study was carried out on the diversity of isopod species living in a bog (site B), the edge zone separating the bog and forest (site E) and adjacent forest (site F).



[Source: Reproduced from Ivan Antonović, Andreja Brigić, Zorana Sedlar, Jana Bedek and Renata Šoštarić 2012 Terrestrial isopod community as indicator of succession in a peat bog, *Zookeys*, 176, 171-188]

Data collected for the three sites are summarized in the table:

	Site B	**Site E**	**Site F**
Number of isopod species	6	7	7
Number of isopod individuals	63	146	180
Simpson reciprocal diversity index	1.43	1.33	4.59

(a) Outline what is meant by the edge effect. [2]

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(Option C continues on the following page)

(Option C, question 12 continued)

(b) Analyse the differences in biodiversity seen in the three sites. [3]

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(c) State **one** method that could be used to estimate the isopod population size. [1]

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13. (a) Distinguish between fundamental niche and realized niche. [1]

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(b) Outline the impact of competition on the niche of an organism. [2]

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(c) Outline the characteristics of keystone species in an ecosystem. [1]

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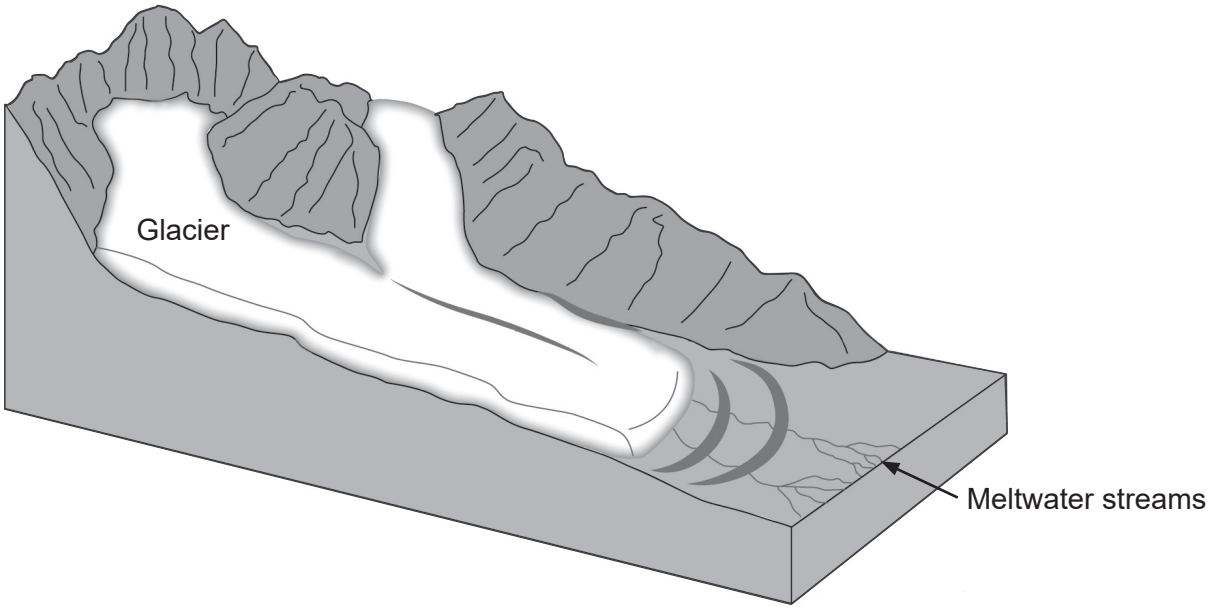
(Option C continues on the following page)

(Option C continued)

14. A retreating glacier leaves an environment of lifeless glacial deposits, including sands and gravels. Retreating glaciers often offer suitable sites for primary succession.



[Source: climatica.org.uk]

(a) Predict the process of succession that takes place on exposed bare ground as the glacier retreats. [3]

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(Option C continues on the following page)

(Option C, question 14 continued)

(b) Suggest how human activities could impact the development of an ecosystem on exposed bare ground. [3]

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15. Discuss how abiotic factors can affect the distribution of species in an ecosystem. [4]

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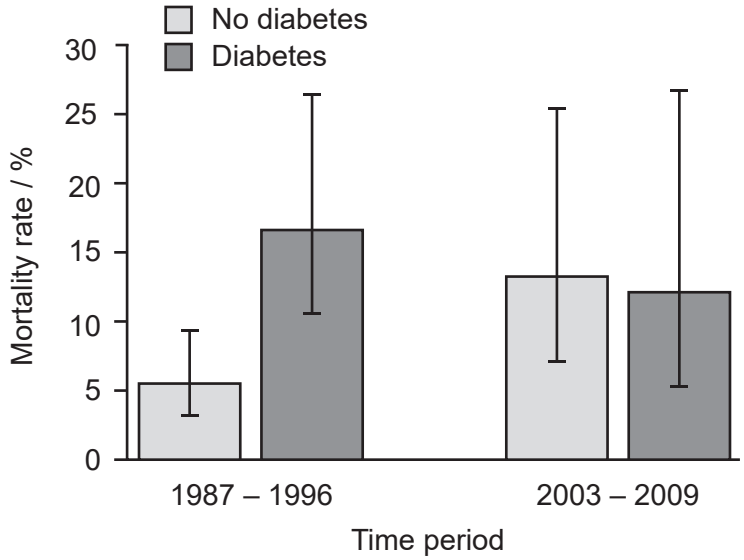
End of Option C

Option D – Human physiology

16. A study was carried out to monitor mortality rates resulting from coronary heart disease (CHD) in people with and without diabetes. The data show the coronary heart disease mortality rates for two time periods.



[Source: Reprinted from *Annals of Epidemiology*, 24, A P Carson *et al*, Declines in coronary heart disease incidence and mortality among middle-aged adults with and without diabetes, 581, Copyright (2014), with permission from Elsevier]

(a) Compare and contrast the data for the two time periods. [2]

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(b) Using the data, evaluate the claim that patients with diabetes have a higher risk of mortality from CHD. [2]

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(Option D continues on the following page)

(Option D, question 16 continued)

(c) Outline **two** factors that are related to increased risk of developing CHD. [2]

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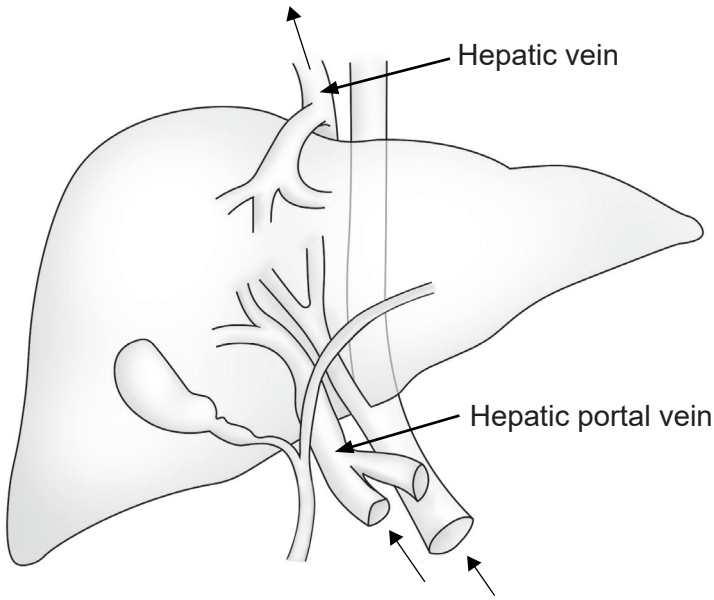
(Option D continues on the following page)

(Option D continued)

17. The liver receives blood from the digestive system via the hepatic portal vein as shown.



[Source: VectorStock]

(a) Compare and contrast the composition of the blood in the hepatic portal vein with the composition of the blood in the hepatic vein. [2]

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(b) Outline how the liver recycles the components of red blood cells. [3]

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(Option D continues on the following page)

(Option D continued)

18. (a) State **one** role of fibre in the diet. [1]

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(b) Outline control of digestive juice secretion so that digestive juices are only secreted into the gut when there is food present. [2]

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(c) Outline the role of intestinal villi. [2]

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(Option D continues on the following page)

(Option D continued)

19. Discuss the causes and consequences of malnutrition in humans. [4]

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End of Option D

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