

**Biology**  
**Higher level**  
**Paper 3**

Tuesday 15 May 2018 (morning)

Candidate session number

1 hour 15 minutes

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**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 **[45 marks]**.

Section A	Questions
Answer all questions.	1 – 3

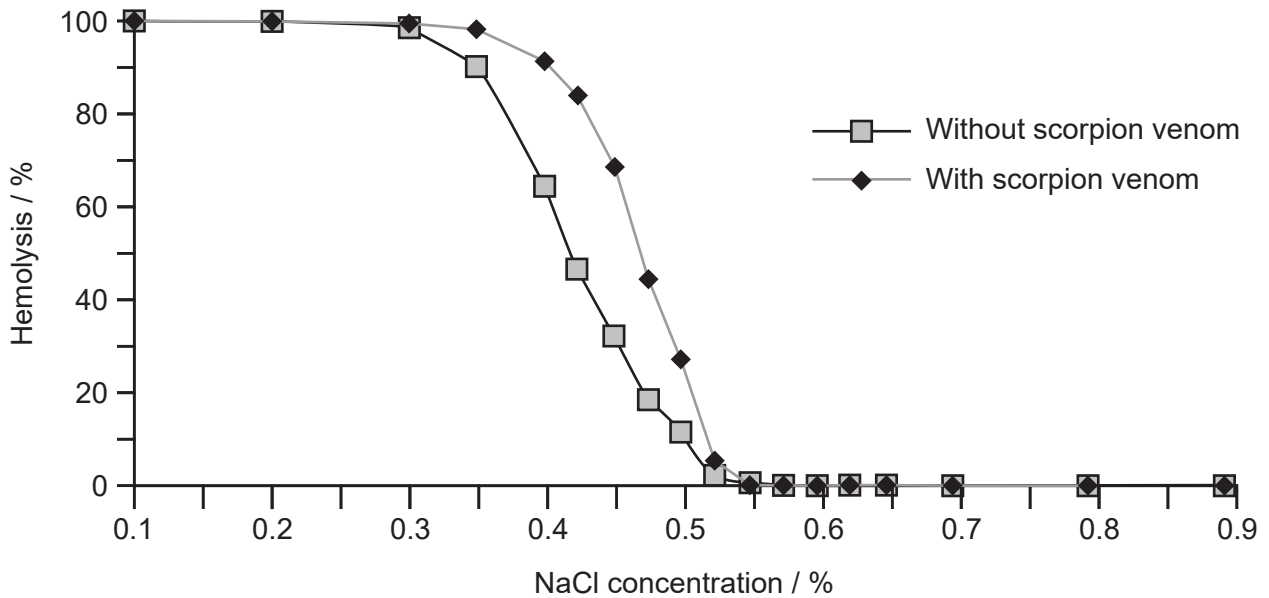
Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 8
Option B — Biotechnology and bioinformatics	9 – 13
Option C — Ecology and conservation	14 – 18
Option D — Human physiology	19 – 22



### Section A

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

1. Data was collected on rabbit red blood cells that were exposed to sodium chloride (NaCl) and scorpion venom. Under some osmotic conditions red blood cells swell and burst, releasing hemoglobin (hemolysis). The graph shows the response of red blood cells to different concentrations of sodium chloride, with and without scorpion venom.



[Source: Adapted from Mirakabadi A Z, *et al.*, (2006), *J. Venom. Anim. Toxins incl. Trop. Dis.*, 12 (1), pages 67–77 (London: BioMed Central)]

- (a) Outline the effect of the venom on the hemolysis of red blood cells. [2]

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**(Question 1 continued)**

- (b) Describe how the variables would be controlled in an experiment to estimate the osmolarity of plant tissue.

[3]

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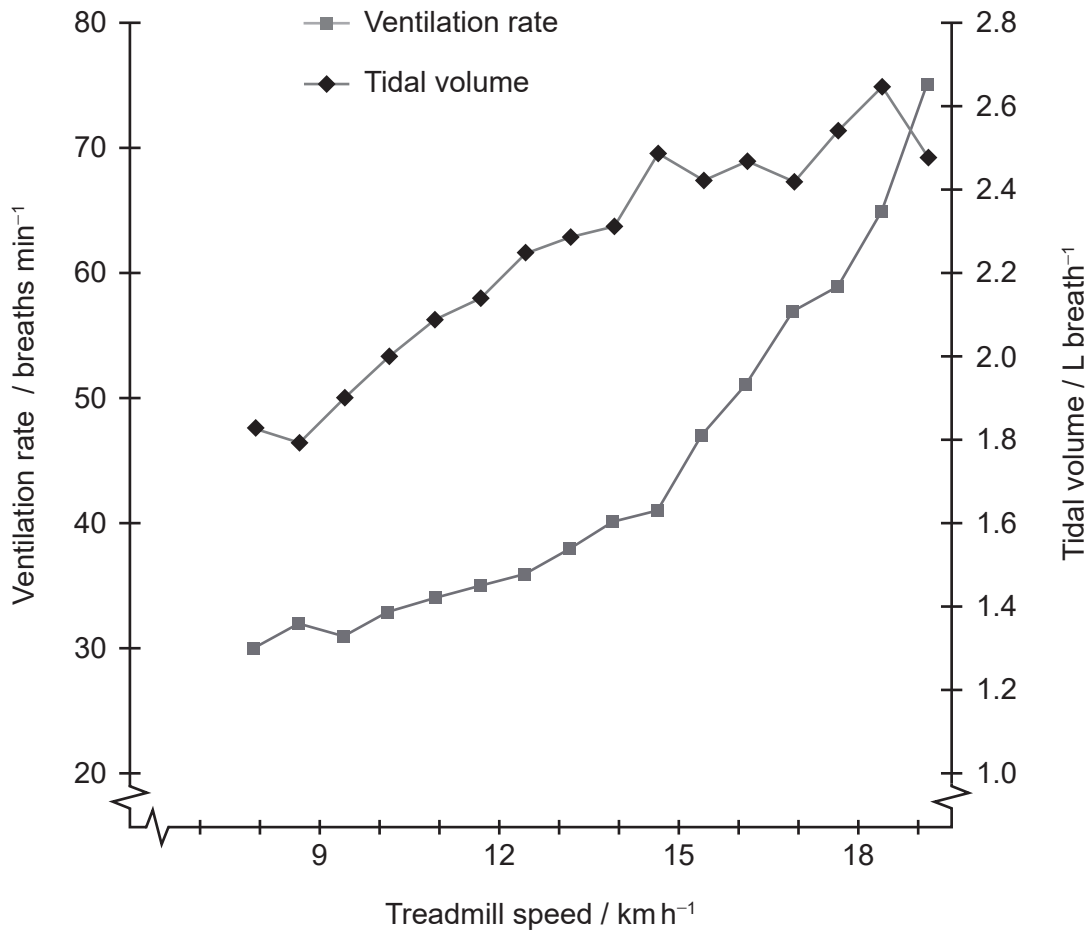
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2. The graph shows the ventilation rate and tidal volume of a well-trained runner during exercise on a treadmill. The tidal volume is the volume of air being moved in and out of the lungs in each breath.



[Source: The Editor In Chief of the Journal of Exercise Physiology online grants permission to publish the article by Amonette W E and Dupler T L, which was published in *JEPonline* 2002;5(2):29-35 issue.]

- (a) State the apparatus used to measure the tidal volume.

[1]

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(This question continues on the following page)



**(Question 2 continued)**

- (b) Calculate the total volume of air inhaled during one minute during the highest velocity of the treadmill in this test, giving the units. [2]

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- (c) Compare and contrast the effect of increasing treadmill speed on the ventilation rate and tidal volume in this runner. [2]

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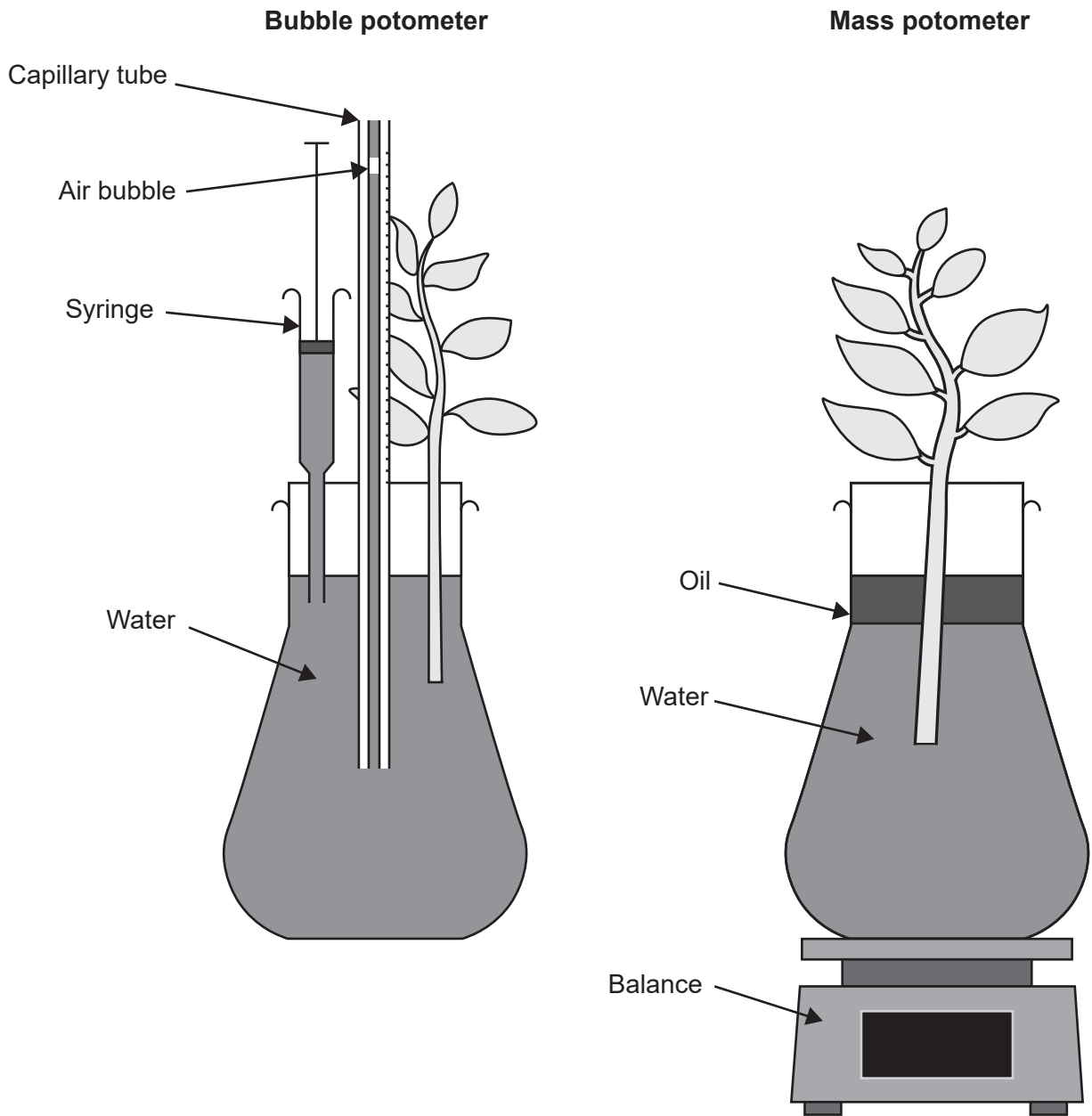
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3. Transpiration in plants can be measured using a bubble potometer or a mass potometer.



[Source: © International Baccalaureate Organization 2018]

(a) Suggest a possible research question that could be investigated using a potometer. [2]

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**(Question 3 continued)**

(b) Evaluate the limitations of using a potometer in the investigation you suggested in (a). [3]

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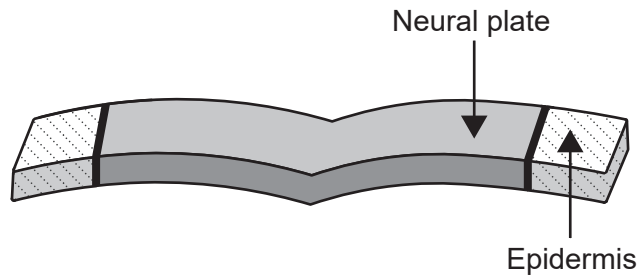


### Section B

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 diagram shows one of the stages in neurulation.



[Source: [https://en.wikipedia.org/wiki/Neural\\_tube#/media/File:Neural\\_crest.svg](https://en.wikipedia.org/wiki/Neural_tube#/media/File:Neural_crest.svg)]

(a) Describe what happens next in neurulation. [2]

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(b) Explain the causes of spina bifida in vertebrates. [2]

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(c) Explain the process of neural pruning. [2]

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(Option A continues on the following page)





**(Option A continued)**

5. The table shows cerebral cortex mass, body mass and neuron count of different animals.

Removed for copyright reasons

(a) (i) State **one** function of the cerebral hemispheres. [1]

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(ii) Discuss briefly the claim that humans are more intelligent than elephants, using only the data in the table. [2]

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**(Option A continues on the following page)**



**(Option A, question 5 continued)**

(b) The brain requires a large energy input. Suggest **one** reason for this. [1]

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(c) Outline the functional magnetic resonance imaging (fMRI) technique for brain research. [2]

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**(Option A continues on the following page)**



**(Option A continued)**

6. The table shows the typical sound intensity of different sources.

Source	Sound intensity / dB
Soft whisper	20
Quiet library	40
Normal conversation	60
Busy traffic	80
Underground train	100
Jet plane taking off or loud rock concert	120

(a) (i) State the type of sensory receptors that detect sound. [1]

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(ii) Suggest **one** reason for hearing loss caused by extended exposure to high intensity sound. [1]

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

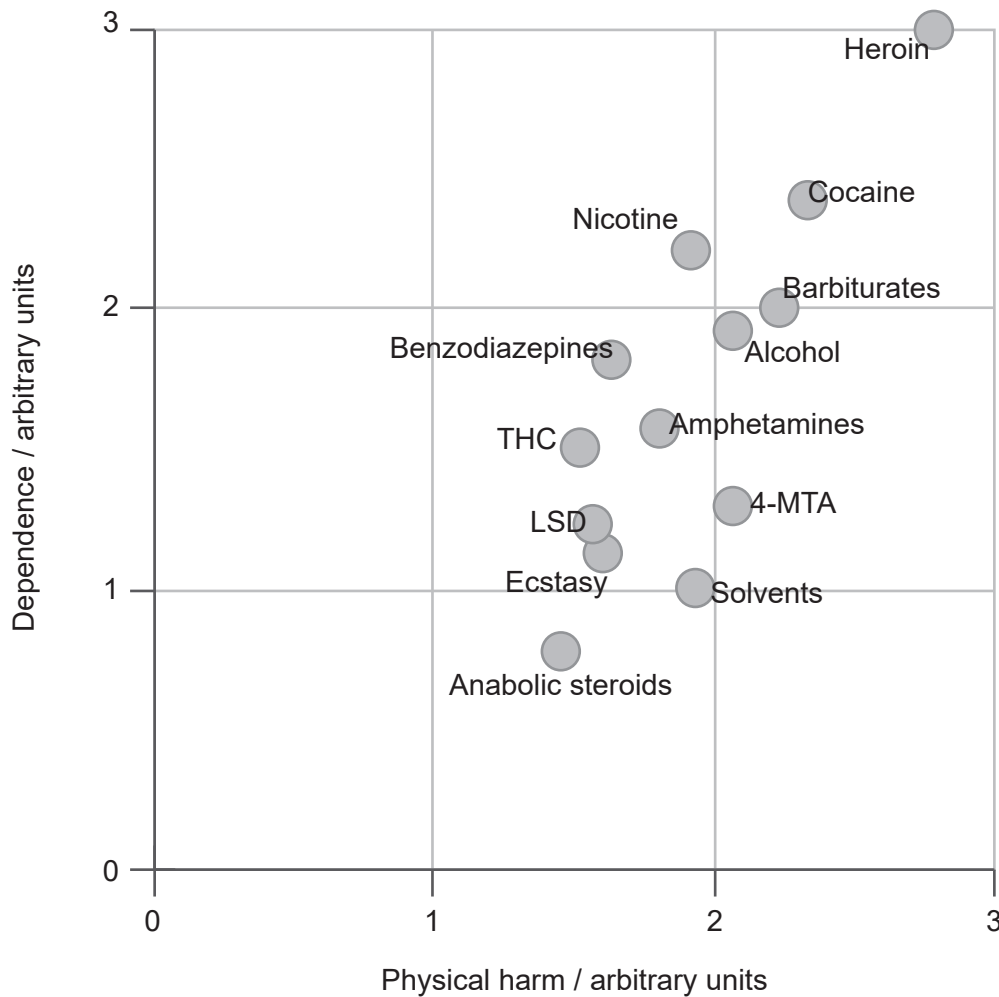
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**(Option A continues on the following page)**



(Option A continued)

7. Drug misuse and abuse are major health problems in the world. The diagram shows the correlation between physical harm and dependence for various psychoactive drugs.



[Source: Adapted from [https://commons.wikimedia.org/wiki/File:Rational\\_scale\\_to\\_assess\\_the\\_harm\\_of\\_drugs\\_\(mean\\_physical\\_harm\\_and\\_mean\\_dependence\).svg](https://commons.wikimedia.org/wiki/File:Rational_scale_to_assess_the_harm_of_drugs_(mean_physical_harm_and_mean_dependence).svg)]

- (a) Identify an example of inhibitory drug shown in the diagram.

[1]

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(Option A continues on the following page)



**(Option A, question 7 continued)**

- (b) Addiction may be affected by social environment. Outline **one other named** factor that can affect addiction to drugs. [2]

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- (c) Distinguish between innate behaviour and learned behaviour in the development of birdsong. [3]

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- (d) Outline an example of a change in animal behaviour as a result of natural selection. [2]

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**(Option A continues on page 15)**



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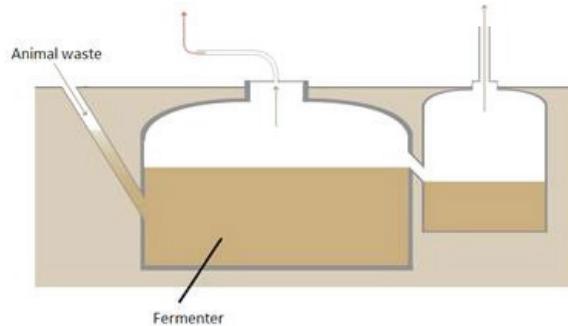
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**Option B — Biotechnology and bioinformatics**

9. The diagram shows an industrial anaerobic fermenter.



[Source: Adapted from Tilley, E., Ulrich, L., Lüthi, C., Reymond, Ph., Zurbrügg, C. - *Compendium of Sanitation Systems and Technologies* - (2nd Revised Edition). Swiss Federal Institute of Aquatic Science and Technology (Eawag), Duebendorf, Switzerland.]

(a) (i) State **one** fuel that can be produced in this fermenter. [1]

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(ii) Outline **one** variable that must be controlled in an industrial fermenter. [1]

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(b) Explain factors that affect the rate of activity of microorganisms in fermenters. [3]

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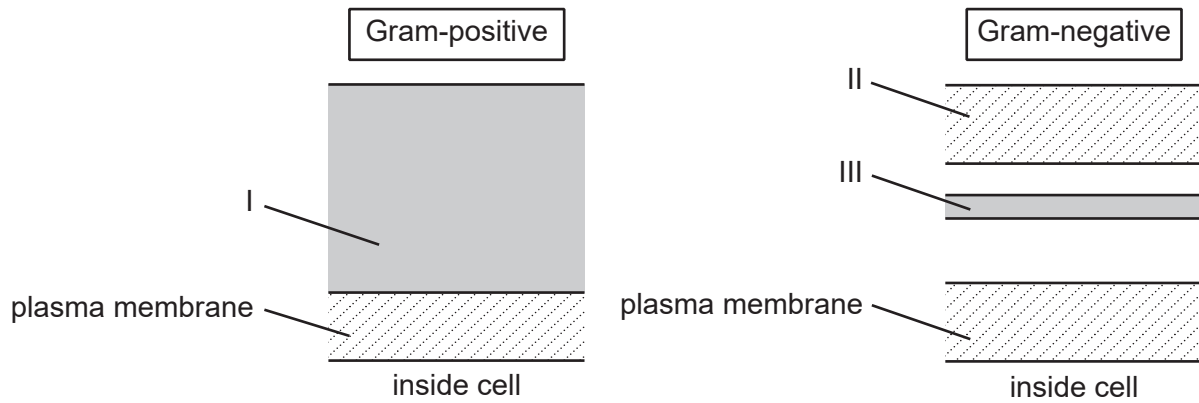
(Option B continues on the following page)





**(Option B, question 9 continued)**

The diagram represents the cell walls of Gram-positive and Gram-negative bacteria.



[Source: © International Baccalaureate Organization 2018]

(c) Label the layers I, II and III.

[3]

I:	.....
II:	.....
III:	.....

**(Option B continues on page 19)**



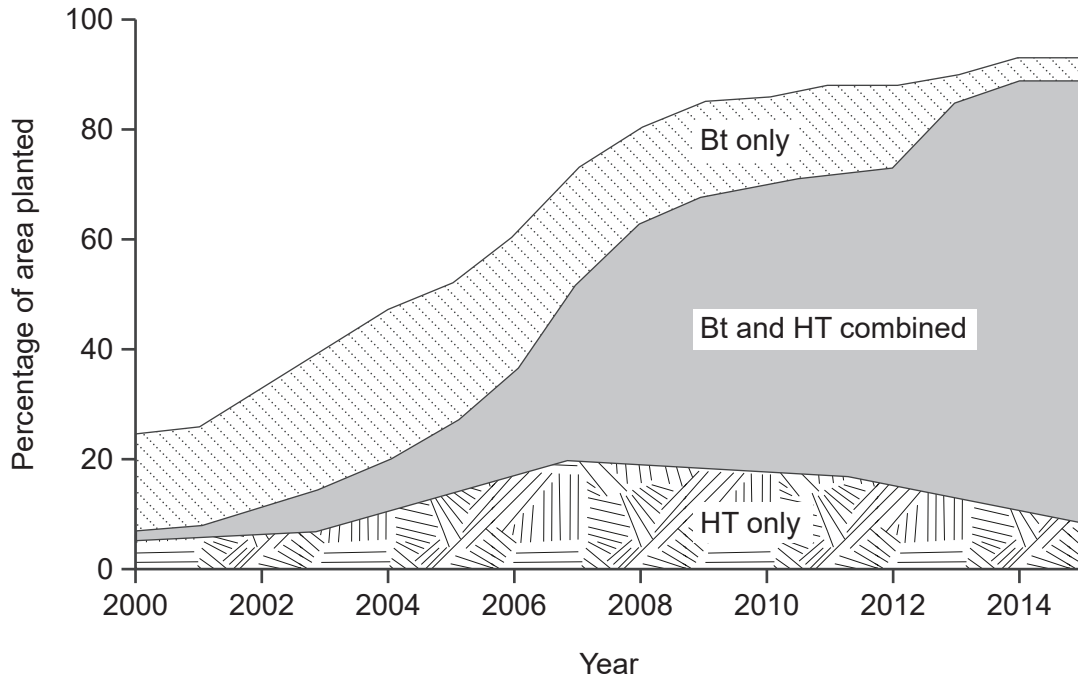
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**(Option B continued)**

10. The graph shows the trends of the use of genetically modified corn in the United States (USA) from 2000 to 2015, including herbicide tolerant varieties (HT), insect resistant varieties (Bt) and varieties with both traits combined.



[Source: Adoption of Genetically Engineered Crops in the U.S. [Online]. US Department of Agriculture – Economic Research Service, Washington, DC (2017). Available: <https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption/> [13 June 2017].]

- (a) Compare and contrast the use of genetically modified corn in the USA in the years 2000 and 2015. [2]

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- (b) Explain how the Bt and HT combined crop was produced. [2]

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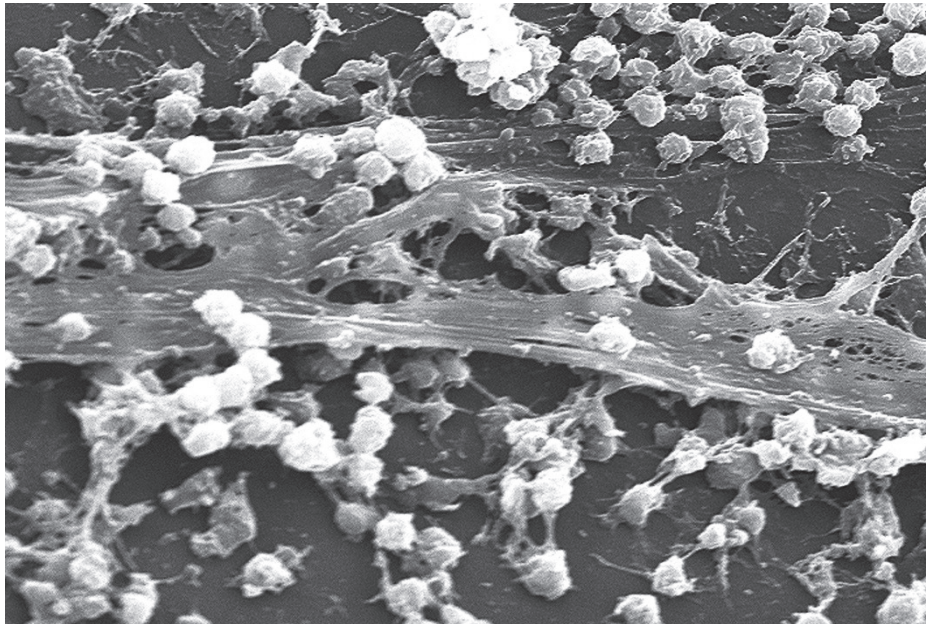
**(Option B continues on the following page)**



Turn over

**(Option B continued)**

11. Some microorganisms can form a biofilm on living or non-living surfaces. The image shows a *Staphylococcus aureus* biofilm inside a medical catheter.



[Source: [https://en.wikipedia.org/wiki/Biofilm#/media/File:Staphylococcus\\_aureus\\_biofilm\\_01.jpg](https://en.wikipedia.org/wiki/Biofilm#/media/File:Staphylococcus_aureus_biofilm_01.jpg), CDC/ Rodney M. Donlan, Ph.D.; Janice Carr (PHIL #7488), 2005]

- (a) (i) Define biofilm.

[1]

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- (ii) Explain the difficulties of treating microorganisms growing in biofilms.

[3]

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**(Option B continues on the following page)**



**(Option B, question 11 continued)**

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

[3]

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**(Option B continues on the following page)**

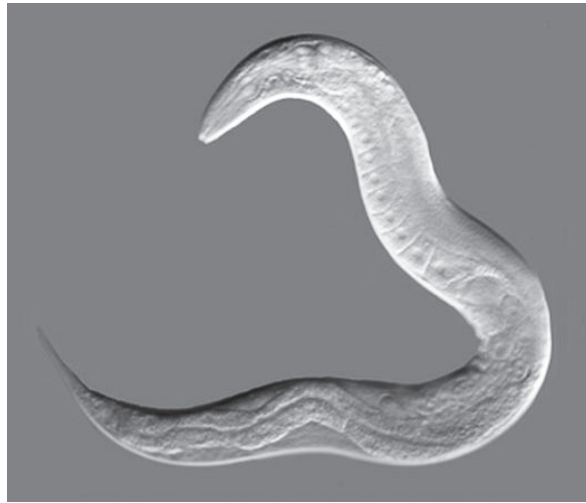


40EP21

**Turn over**

**(Option B continued)**

12. *Caenorhabditis elegans*, a nematode, was the first multicellular organism whose genome was completely sequenced.



[Source: [https://en.wikipedia.org/wiki/Caenorhabditis\\_elegans#/media/File:CelegansGoldsteinLabUNC.jpg](https://en.wikipedia.org/wiki/Caenorhabditis_elegans#/media/File:CelegansGoldsteinLabUNC.jpg) by Bob Goldstein]

- (a) Outline the benefits of using model organisms for studying gene function. [2]

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- (b) Describe how BLAST can be used to establish phylogenetic relationships between several organisms. [3]

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**(Option B continues on the following page)**





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**Option C — Ecology and conservation**

14. The sea star *Pisaster ochraceus* is identified as a keystone species in the Pacific Ocean.



*Pisaster ochraceus*

[Source: [https://en.wikipedia.org/wiki/Pisaster\\_ochraceus#/media/File:Ochre\\_sea\\_star.jpg](https://en.wikipedia.org/wiki/Pisaster_ochraceus#/media/File:Ochre_sea_star.jpg) by D. Gordon E. Robertson]

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

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(b) Outline **one** example of mutualism. [2]

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

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(Option C continues on the following page)

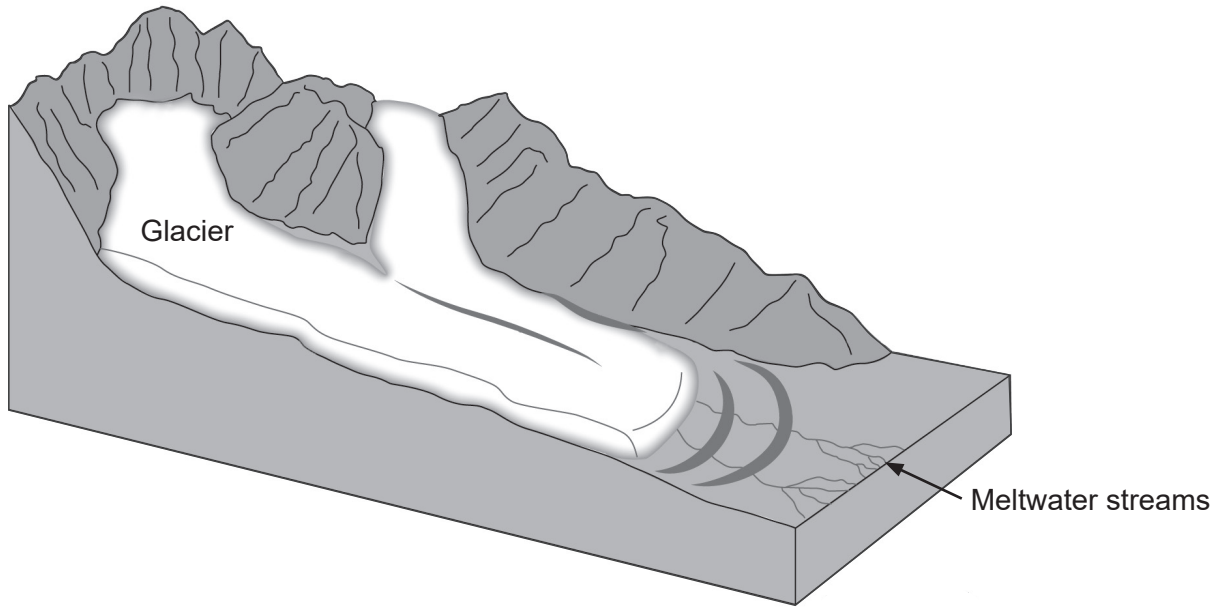


40EP25

Turn over

(Option C continued)

15. 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) State **one** abiotic factor that will determine the type of ecosystem in a succession. [1]

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- (b) 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 15 continued)**

(c) Compare and contrast food chains and food webs.

[2]

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**(Option C continues on the following page)**

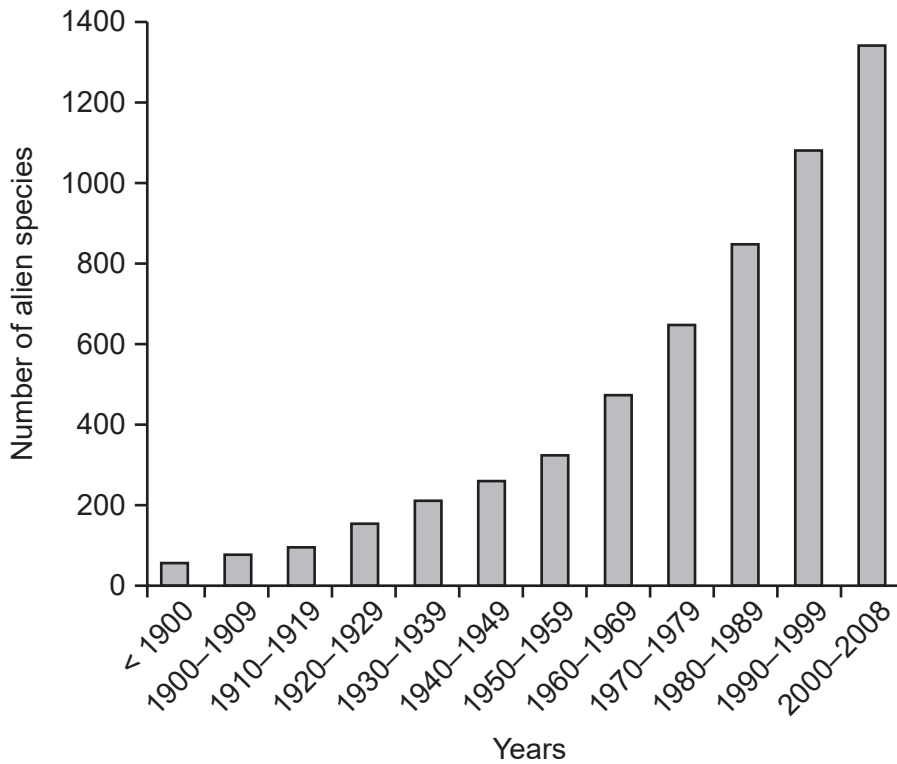


40EP27

**Turn over**

**(Option C continued)**

16. The graph shows the total number of alien species in marine ecosystems estimated by the European Environment Agency.



[Source: Data from NOBANIS. Available from <http://www.NOBANIS.org>. Date of access 08/2008]

- (a) Define invasive alien species.

[1]

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**(Option C continues on the following page)**



**(Option C, question 16 continued)**

(b) Discuss the global impacts of invasive alien species. [3]

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(c) Using **one** example, outline biological control of an invasive alien species. [2]

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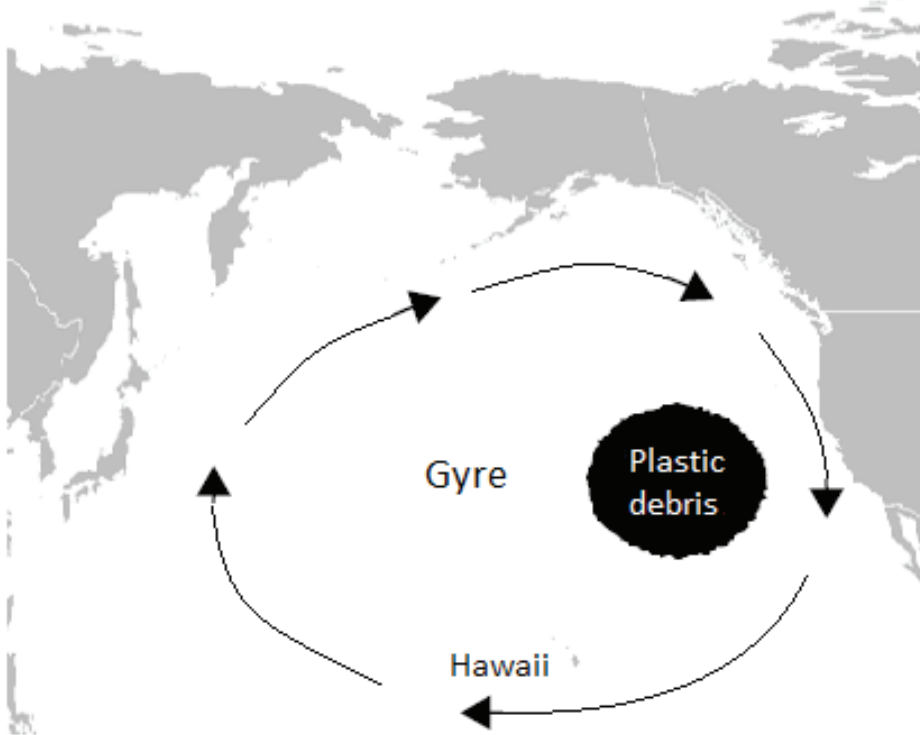
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**(Option C continues on the following page)**



(Option C, question 16 continued)

The map shows an area of the Pacific Ocean characterized by exceptionally high concentrations of plastics and other debris that have been trapped by the currents of the North Pacific Gyre.



[Source: Spry895

[https://commons.wikimedia.org/wiki/Category:Maps\\_of\\_the\\_Pacific\\_Ocean#/media/File:Pacific-centric-map.png](https://commons.wikimedia.org/wiki/Category:Maps_of_the_Pacific_Ocean#/media/File:Pacific-centric-map.png)]

(d) Outline **one** consequence of marine plastic pollution. [1]

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(e) Explain the consequences of biomagnification. [2]

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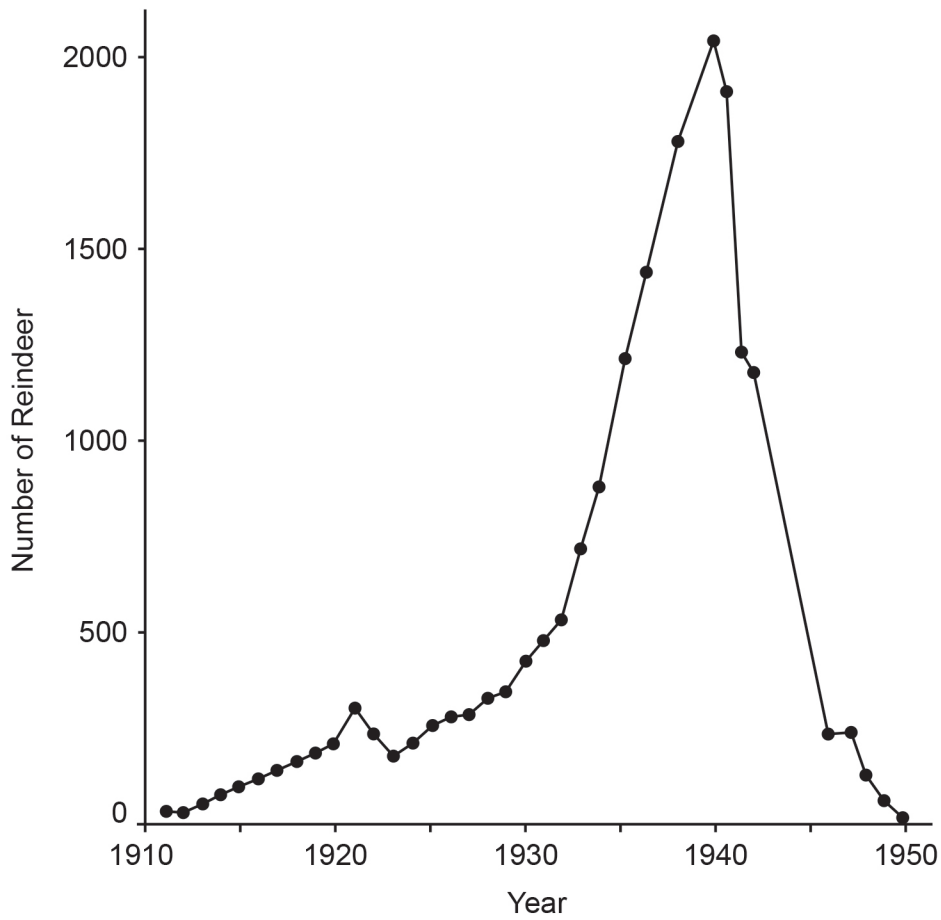
(Option C continues on the following page)



40EP30

(Option C continued)

17. In 1911, twenty-five reindeer (*Rangifer tarandus*) were introduced onto Saint Paul Island in Alaska and the population was recorded for 40 years.



[Source: From V B Scheffer, "The Rise and Fall of a Reindeer Herd", *The Scientific Monthly*, Vol. 73, No. 6 (Dec., 1951), pp. 356-362. Reprinted with permission from AAAS.]

- (a) (i) State the type of growth of this population up to 1940. [1]

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- (ii) Suggest **one** possible cause for the decrease of the number of animals after 1940. [1]

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(Option C continues on the following page)



40EP32



**(Option C, question 17 continued)**

(b) Explain biogeographic factors that increase the effectiveness of nature reserves. [3]

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**(Option C continues on the following page)**



40EP33

**Turn over**



Option D — Human physiology

19. The image shows an example of a label showing nutritional information.

<b>Nutrition Facts</b>	
Serving Size 2/3 cup (55g)	
Servings Per Container About 8	
<b>Amount Per Serving</b>	
<b>Calories</b> 230	Calories from Fat 72
<b>% Daily Value*</b>	
<b>Total Fat</b> 8g	<b>12%</b>
Saturated Fat 1g	<b>5%</b>
<i>Trans</i> Fat 0g	
<b>Cholesterol</b> 0mg	<b>0%</b>
<b>Sodium</b> 160mg	<b>7%</b>
<b>Total Carbohydrate</b> 37g	<b>12%</b>
Dietary Fiber 4g	<b>16%</b>
Sugars 1g	
<b>Protein</b> 3g	
Vitamin A	10%
Vitamin C	8%
Calcium	20%
Iron	45%

[Source: U.S. Food and Drug Administration]

(a) (i) State the importance of including vitamins in our diet. [1]

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(ii) Suggest **one** limitation of the information about vitamins shown on this label. [1]

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(Option D continues on the following page)



Turn over

(Option D, question 19 continued)

- (b) Distinguish between gastric juice and pancreatic juice using the table. [3]

Gastric juice	Pancreatic juice

- (c) Describe the mode of action of steroid hormones. [3]

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- (d) Many animals, including humans, maintain strongly acidic conditions in part of their digestive systems. Explain **two** benefits of this to the animal. [2]

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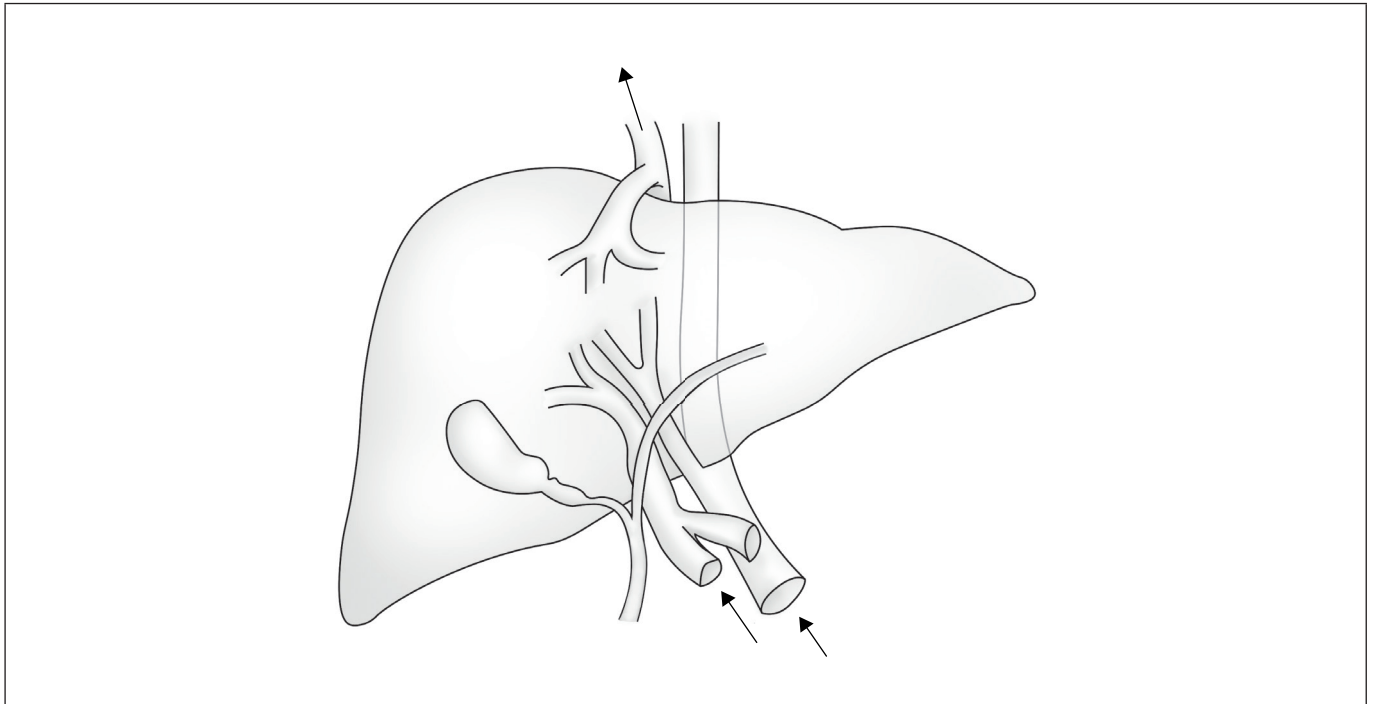
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(Option D continued)

20. The diagram shows the liver and its main blood vessels.



[Source: VectorStock]

- (a) (i) Label the hepatic portal vein bringing blood to the liver. [1]
- (ii) Outline the circulation of blood through liver tissue. [3]

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(Option D continues on the following page)



**(Option D, question 20 continued)**

(b) Explain the breakdown of hemoglobin in the liver.

[3]

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**(Option D continued)**

**21. (a)** Outline the role of the sinoatrial node in the contraction of the heart. [2]

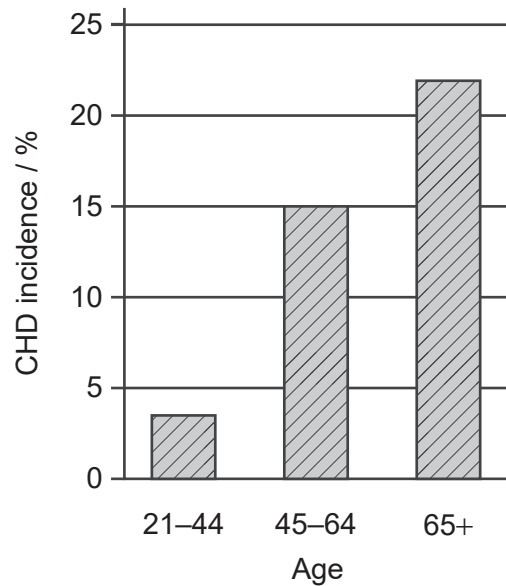
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The graph shows the results of a study of the incidence of coronary heart disease (CHD) in different age groups of men participating in a study carried out by the National Heart, Blood and Lung Institute.



[Source: © International Baccalaureate Organization 2018]

**(b) (i)** Comment on the claim that the bar chart proves that old age causes CHD. [1]

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**(Option D continues on the following page)**



**Turn over**

**(Option D, question 21 continued)**

- (ii) Suggest **one** factor other than age and hypertension that is correlated with the incidence of CHD.

[1]

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- (c) Hypertension has been suggested as a possible cause of CHD. Explain the possible causes of hypertension.

[3]

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**(Option D continues on the following page)**





