

**Biology**  
**Standard level**  
**Paper 3**

Thursday 16 November 2017 (morning)

Candidate session number

1 hour

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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 **[35 marks]**.

Section A	Questions
Answer all questions.	1 – 3

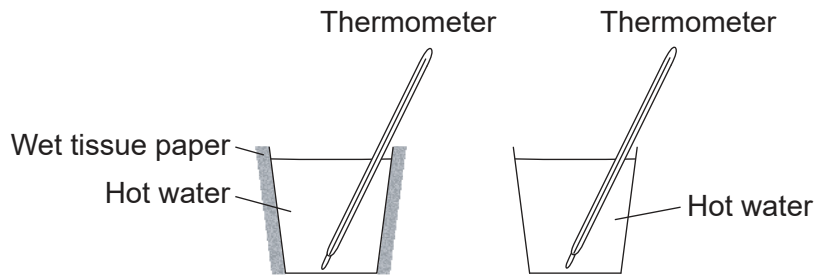
Section B	Questions
Answer all of the questions from one of the options.	
Option A — Neurobiology and behaviour	4 – 7
Option B — Biotechnology and bioinformatics	8 – 11
Option C — Ecology and conservation	12 – 15
Option D — Human physiology	16 – 19



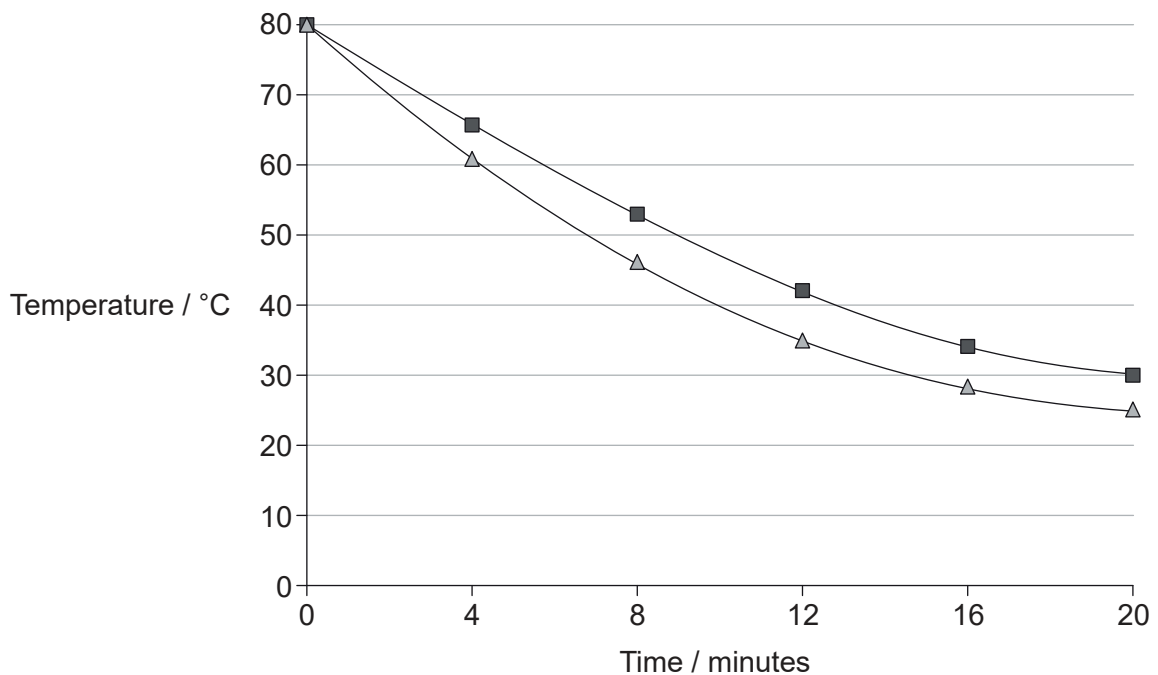
### Section A

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

- To investigate the thermal properties of water, students placed hot water in two thin plastic cups and measured their rate of cooling. The sides of one cup were covered with tissue paper soaked in hot water; the other cup was left uncovered. The temperature was recorded with a thermometer every 4 minutes for 20 minutes. The temperature in the laboratory was 18 °C.



[Source: © International Baccalaureate Organization 2017]



**Key:** ■ uncovered    ▲ covered with wet tissue paper

[Source: © International Baccalaureate Organization 2017]

- (a) Calculate the change in temperature in each cup after 20 minutes. [1]

Uncovered: .....

Covered with wet tissue paper: .....

(This question continues on the following page)



36EP02

**(Question 1 continued)**

(b) State **two** conditions that must be the same for each cup at the start of the experiment. [2]

1. ....
2. ....

(c) Predict the temperature of the water in the cups after 3 hours. [1]

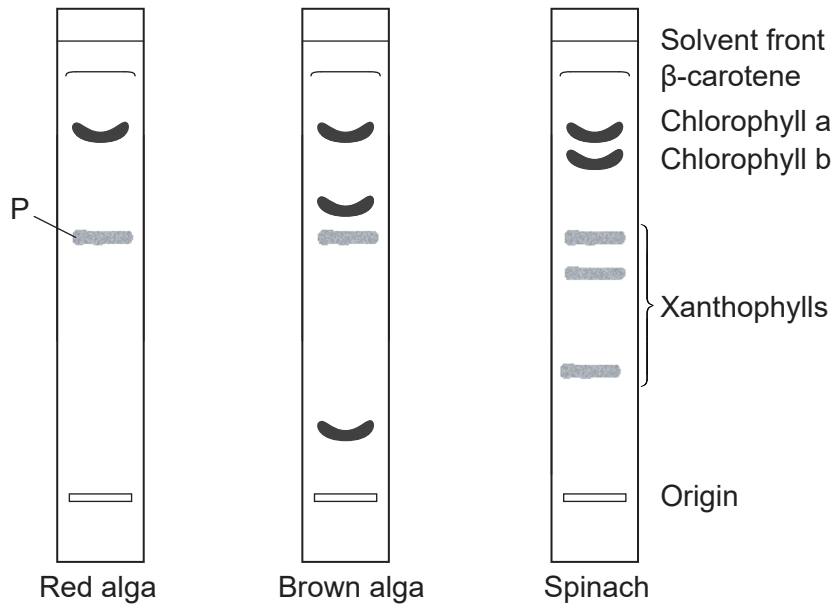
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(d) Explain, with reference to the thermal properties of water, how this experiment helps demonstrate how humans respond to overheating. [3]

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2. Thin-layer chromatography was carried out on red and brown algae to discover what photosynthetic pigments they contained. The results were compared with the known pigments found in spinach leaves.



- (a) Identify pigment labelled P. [1]

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- (b) State a suitable solvent for extracting photosynthetic pigments from plant tissue. [1]

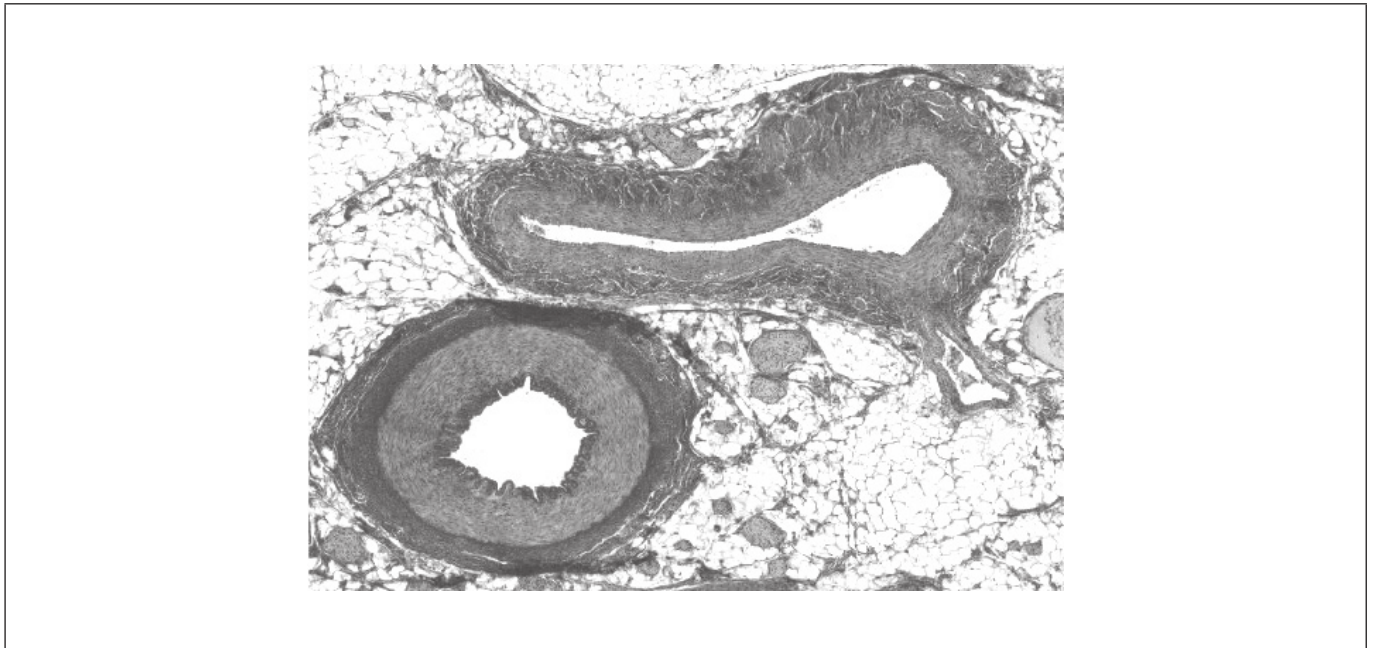
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- (c) Explain how the pigments in the chromatogram of spinach are identified. [3]

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3. The micrograph shows a transverse section through blood vessels of a mammal.



[Source: This book was originally published by OpenStax College, released under the CC-BY license: <https://creativecommons.org> The eBook was adapted by Frank Lee.]

- (a) Identify the vein by labelling it with the letter V. [1]
- (b) Distinguish between the vein and the artery with reference to structures visible in the micrograph. [2]

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36EP05

Turn over

### 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 a cross section of the left eye viewed from above. Light entering the eye stimulates the receptor cells. The graph shows the number and type of receptor cells at different points of the retina measured in degrees relative to a point at the back of the eye.



- (a) Using the eye diagram, identify the part labelled X, giving evidence from the graph. [1]

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(Option A continues on the following page)



**(Option A, question 4 continued)**

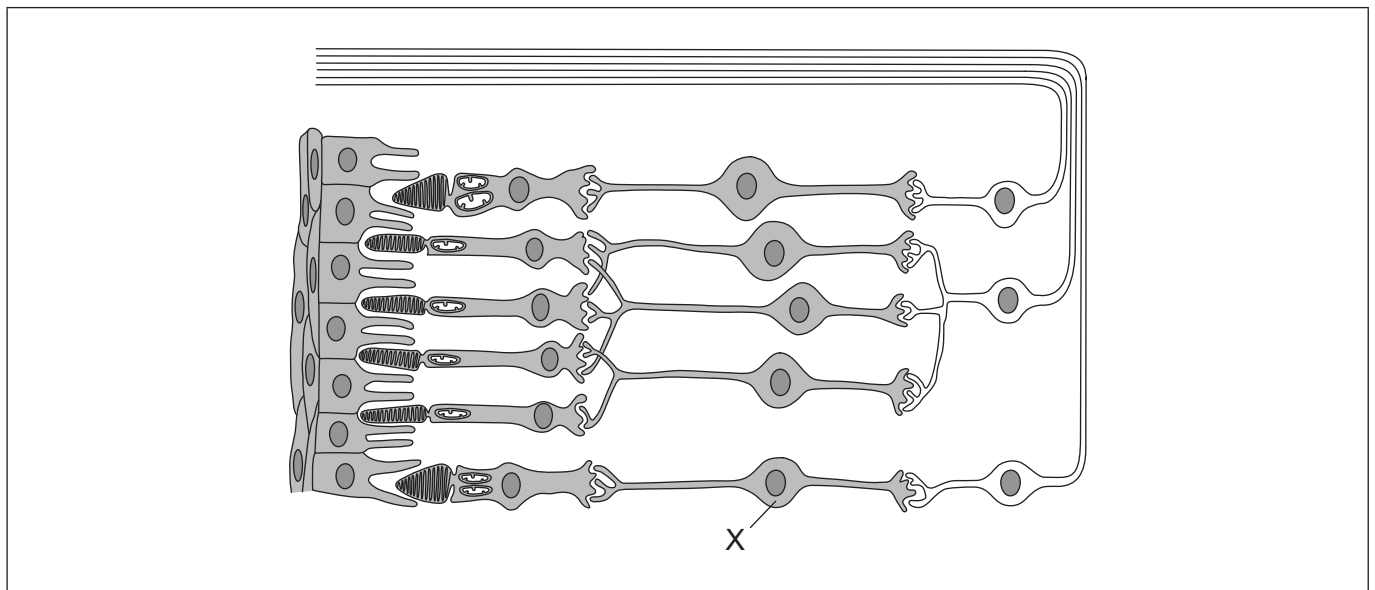
- (b) Using the graph, outline why there are no receptor cells at the part labelled Y. [2]

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- (c) Using the eye diagram, state which part of the visual cortex receives impulses from the area of the visual field labelled Z. [1]

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- (d) The diagram shows part of a retina.



[Source: C. J. Clegg, *Introduction to Advanced Biology*, 2000, p. 285. Reproduced by permission of Hodder Education.]

- (i) Identify the cell labelled X. [1]

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- (ii) Draw an arrow to show the direction of light through the retina. [1]

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

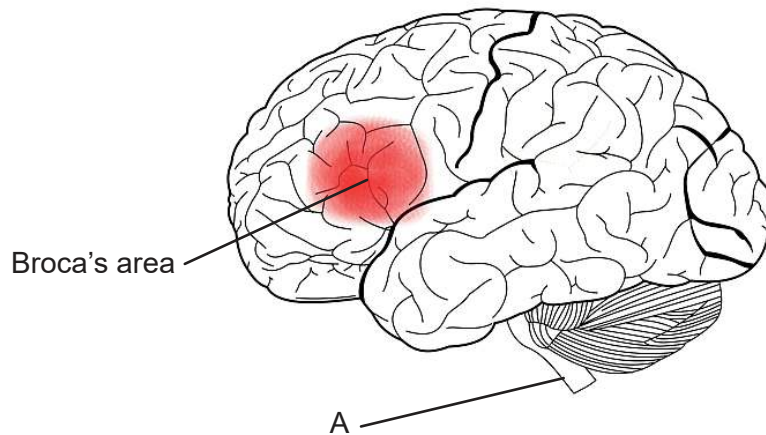


36EP07

Turn over

**(Option A continued)**

5. The diagram shows the human brain.



[Source: By charlyzon (Own work) [CC BY-SA 3.0 (<https://creativecommons.org/licenses/by-sa/3.0/>)], via Wikimedia Commons.]

(a) (i) Identify the structure labelled A. [1]

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(ii) List **two** functions of the structure labelled A. [2]

1. ....  
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2. ....  
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(b) Outline the reason that Broca's area is more developed in humans than other primates. [1]

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



36EP08



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

(c) Suggest how an injury to the brain can help in understanding brain function. [1]

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

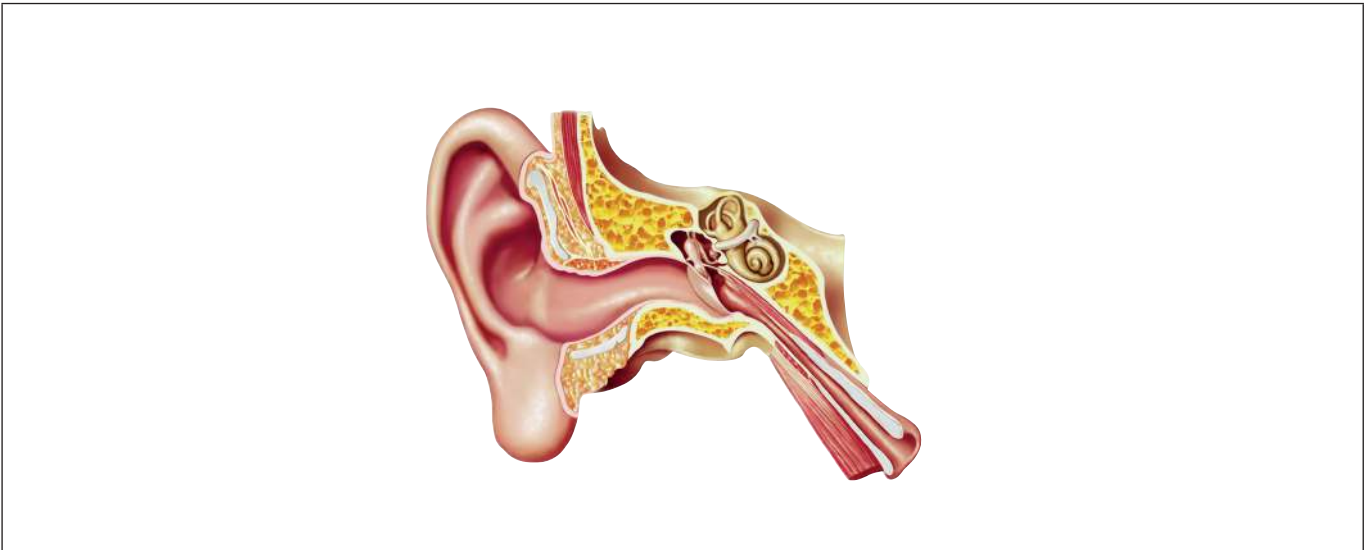


36EP09

Turn over

**(Option A continued)**

6. The image shows a human ear.



[Source: Leonello/iStock]

- (a) (i) Using the letter M, label the structures which detect movement of the head. [1]
- (ii) Using the letter A, label where sound is amplified. [1]
- (b) Explain the function of the cochlea in hearing. [2]

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



36EP10

**(Option A, question 6 continued)**

(c) Outline how the hearing of a deaf or partially deaf person could be improved. [1]

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**(Option A continues on page 13)**



36EP11

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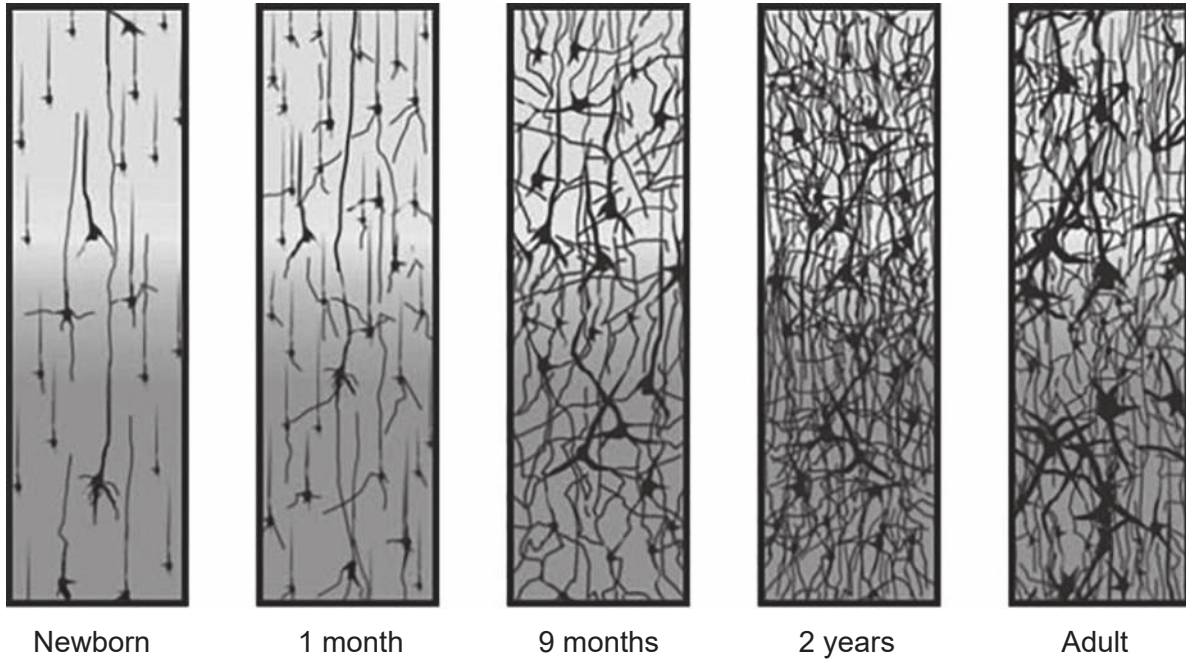
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36EP12

(Option A continued from page 11)

7. The diagrams illustrate changes in synapse density of the cerebral cortex from newborn to adult.



[Source: THE POSTNATAL DEVELOPMENT OF THE HUMAN CEREBRAL CORTEX, VOLUMES IVIII, by Jesse LeRoy Conel, Cambridge, Mass.: Harvard University Press, Copyright © 1939, 1941, 1947, 1951, 1955, 1959, 1963, 1967 by the President and Fellows of Harvard College. Copyright © renewed 1967, 1969, 1975, 1979, 1983, 1987, 1991.]

Explain the processes illustrated by the diagrams.

[4]

A large rectangular area containing horizontal dotted lines for writing the answer.

End of Option A

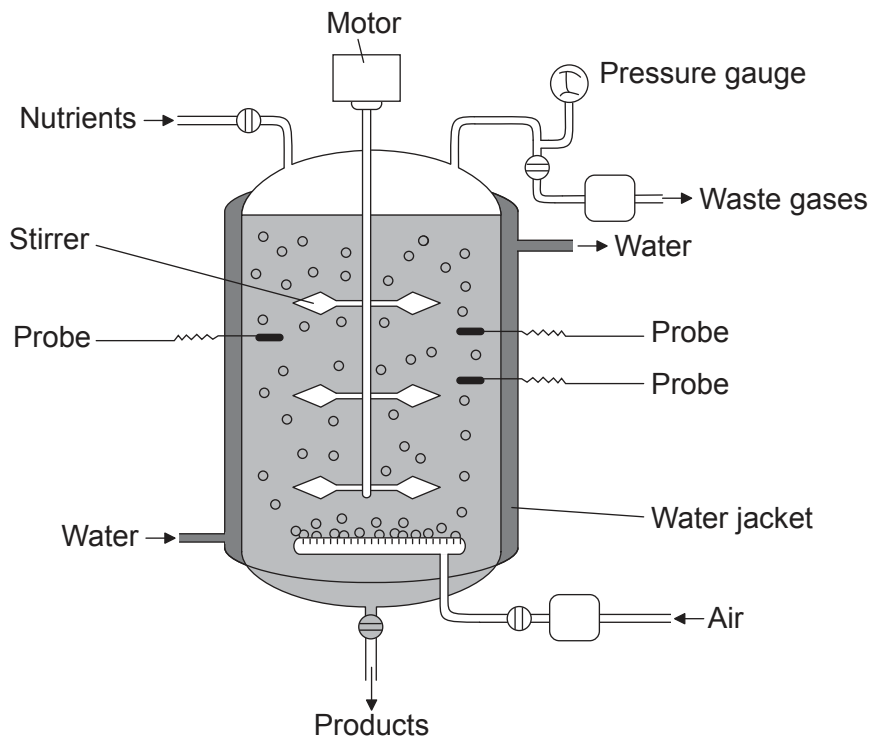


36EP13

Turn over

**Option B — Biotechnology and bioinformatics**

8. The diagram shows a simplified fermenter used in the production of penicillin.



[Source: Valero, F, del Rio, JL, Poch, M and Sola, C (John Wiley and Sons, 1992).  
Studies on Lipase Production by *Candida rugosa* Using On-line Enzymatic Analysis.  
*Annals of the New York Academy of Sciences*, 665, pp. 334–344.  
doi: 10.1111/j.1749-6632.1992.tb42596.x]

(a) State **two** conditions in the fermenter that would be monitored by the probes. [1]

1. ....
2. ....

(b) Suggest a reason that the fermenter is surrounded by a water jacket. [1]

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(Option B continues on the following page)



36EP14

**(Option B, question 8 continued)**

(c) Identify the waste gas produced.

[1]

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(d) Explain the process of penicillin production in the fermenter.

[3]

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**(Option B continues on page 17)**



36EP15

Turn over

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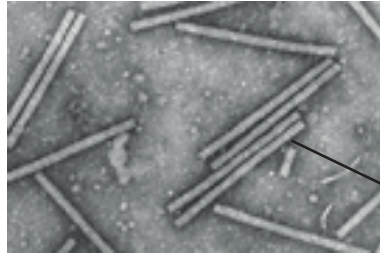


36EP16



**(Option B continued from page 15)**

- 9. Tobacco mosaic virus (TMV) was used as a vector in the development of a new process for Hepatitis B vaccine production.



Tobacco mosaic virus

[Source: Scholthof, K-B.G. 2000. Tobacco mosaic virus. The Plant Health Instructor.  
 DOI: 10.1094/PHI-I-2000-1010-01. Updated 2005.  
 © 2018 The American Phytopathological Society. All rights reserved.]

- (a) State the role of a vector in biotechnology. [1]

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- (b) Explain how the Hepatitis B vaccine is produced using TMV. [3]

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- (c) State the importance of marker genes in genetic modification. [1]

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

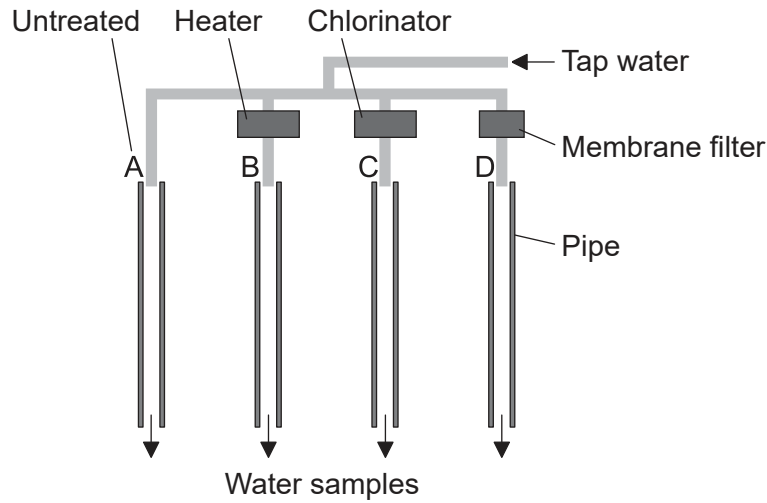


36EP17

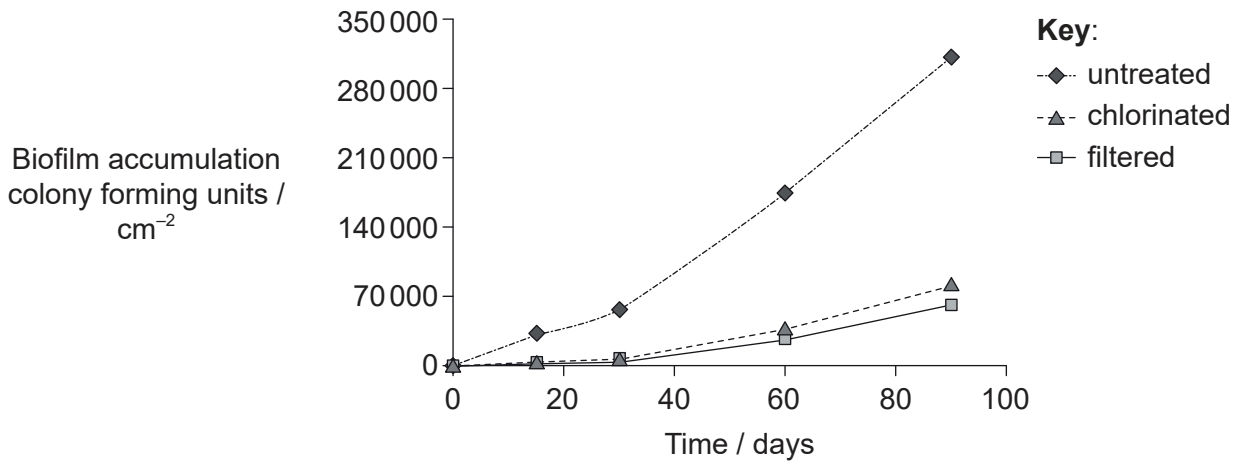
Turn over

(Option B continued)

- 10. Researchers in Korea set up an experiment to measure how accumulation of biofilm changes in water pipes under different conditions.



The graph shows the accumulation of biofilm in steel pipes when the water was untreated, treated with chlorine and filtered through a membrane.



[Source: adapted from Yoonjin Lee, (2013), *Journal of Environmental Research Public Health* 2013, **10** (9), pages 4143–4160]

- (a) State the effect chlorination has on the accumulation of biofilm in the pipe. [1]

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(Option B continues on the following page)



**(Option B, question 10 continued)**

- (b) Suggest why membrane filtration may be more suitable than chlorination in purifying the water. [1]

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- (c) Identify which **two** pipes would be required to study the effect of heat on biofilm accumulation. [1]

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- (d) Explain how quorum sensing benefits the bacteria within the steel pipes. [2]

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**(Option B continues on page 21)**



36EP19

Turn over

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36EP20

**(Option B continued from page 19)**

11. The picture shows workers cleaning up a polluted stretch of coastline in Alaska after oil was leaked from a tanker.



[Source: <https://commons.wikimedia.org/wiki/File:OilCleanupAfterValdezSpill.jpg>]

Explain how oil pollution can be treated by bioremediation.

[4]

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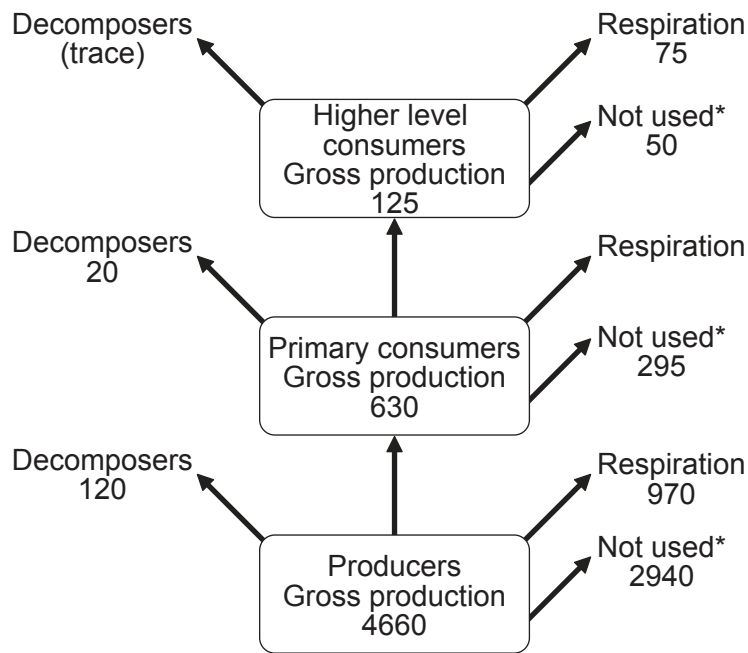


36EP21

Turn over

**Option C — Ecology and conservation**

12. The diagram shows both production and losses of energy in three trophic levels of a freshwater lake over the period of one year. All values are expressed in  $\text{kJ m}^{-2} \text{y}^{-1}$ .



\* not used: this refers to organic material sinking to the lake bottom, becoming unavailable to other trophic levels

(a) Calculate the energy loss due to respiration in primary consumers. [1]

.....  $\text{kJ m}^{-2} \text{y}^{-1}$

(b) Outline why a year is more suitable than a month for the measurement of energy flow. [1]

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(Option C continues on the following page)



36EP22

**(Option C, question 12 continued)**

(c) Explain how pesticides may undergo biomagnification in the lake.

[2]

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



36EP23

Turn over

(Option C continued)

13. The sea snail *Nucella ostrina* and the sea star *Pisaster ochraceus* are predators of the mussel *Mytilus trossulus*. The mussels live on rocks at the edge of the sea and feed on phytoplankton and zooplankton. The zooplankton feed on the phytoplankton.



*Nucella ostrina*

[Source: Photograph ©Kelly Fretwell, www.centralcoastbiodiversity.org]



*Pisaster ochraceus*

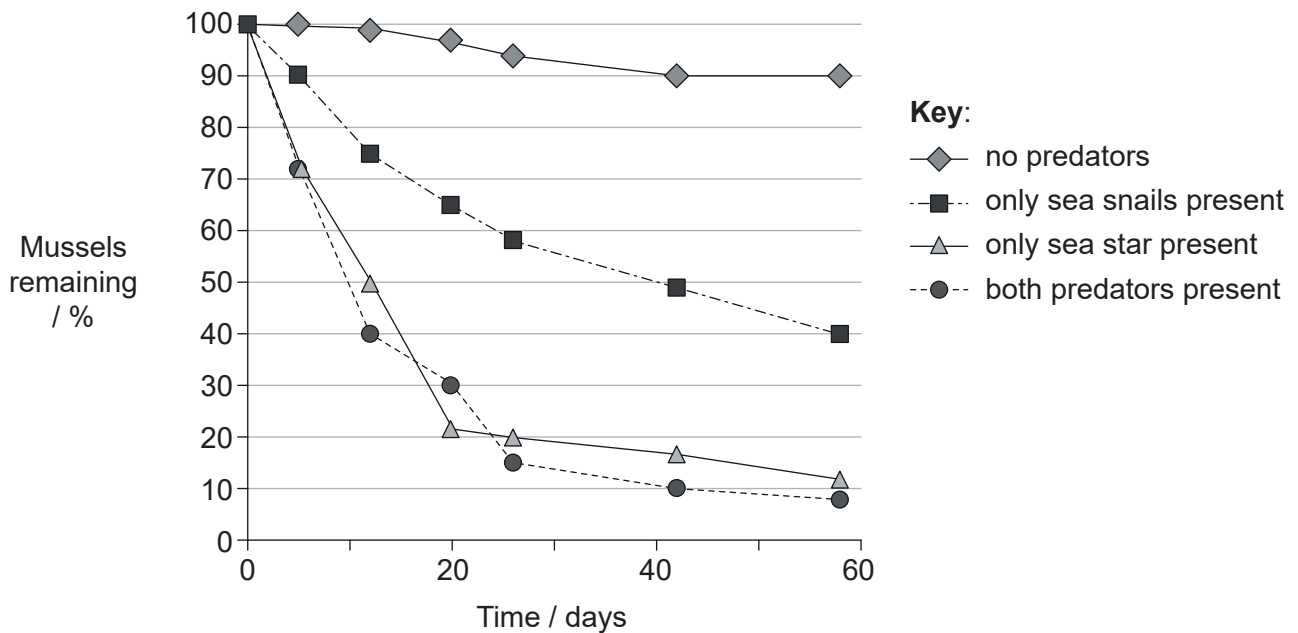
[Source: D. Gordon E. Robertson. https://en.wikipedia.org/wiki/Pisaster\_ochraceus#/media/File:Ochre\_sea\_star.jpg]



*Mytilus trossulus*

[Source: NNehring/iStock]

Groups of 50 mussels were transplanted to an experimental area and protected from predation until the start of the experiment. Researchers then investigated the effect of the predators on the population of the mussels over a period of 60 days.



[Source: Republished with permission of John Wiley and Sons, from Navarrete, S. A. and Menge, B. A. (1996), Keystone Predation and Interaction Strength: Interactive Effects of Predators on Their Main Prey. *Ecological Monographs*, 66: 409–429. doi:10.2307/2963488; permission conveyed through Copyright Clearance Center, Inc.]

(Option C continues on the following page)



36EP24



**(Option C, question 13 continued)**

- (a) Compare and contrast the effects of the predators on the population of the mussels. [2]

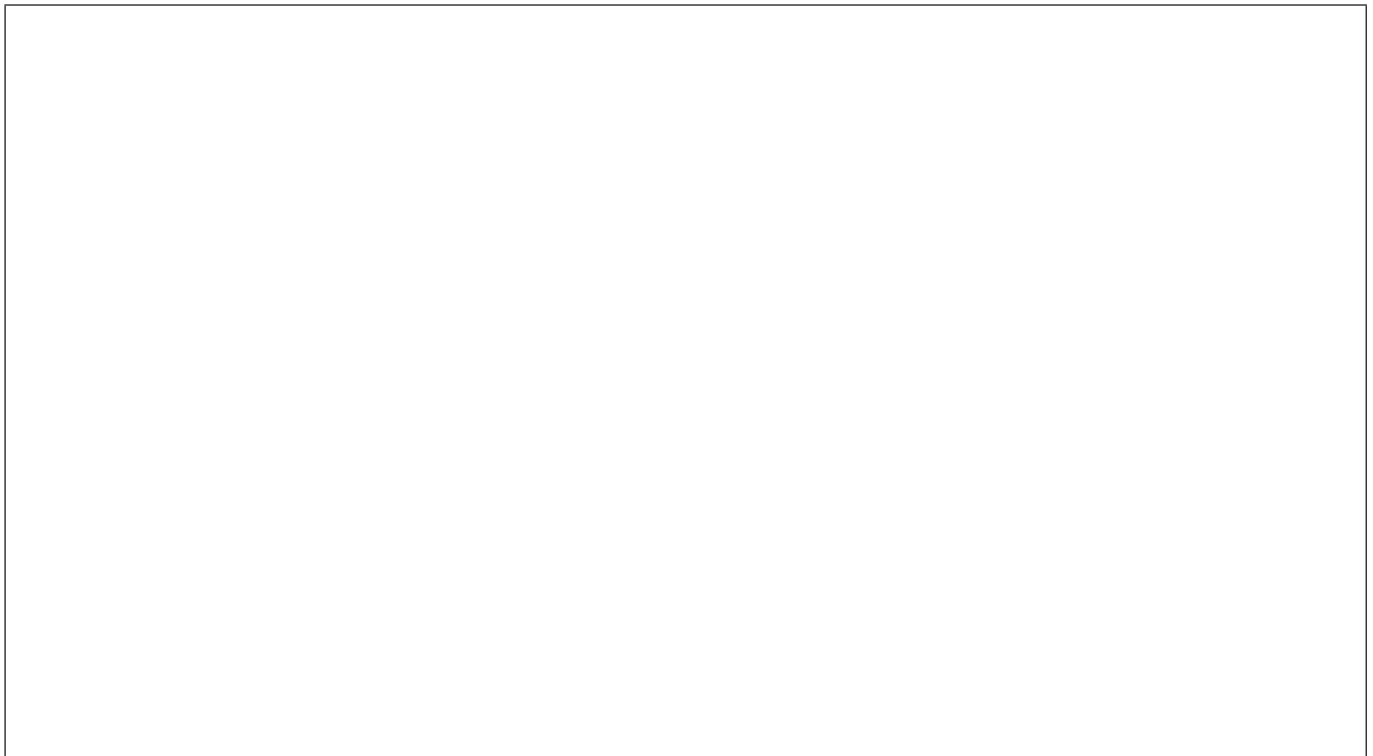
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- (b) The sea star also eats the sea snails. Construct a food web to show the feeding relationships between these five organisms in the ecosystem. [2]



**(Option C continues on page 27)**



36EP25

Turn over

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36EP26

**(Option C, question 13 continued from page 25)**

- (c) The chart shows the effect the presence of the sea star has on the total number of species found in the ecosystem.

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Evaluate the evidence that the sea star is a keystone species in the ecosystem.

[2]

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- (d) Sea stars along the pacific coast of the US are dying from “sea star wasting syndrome”. Suggest the effect this will have on the ecosystem.

[1]

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

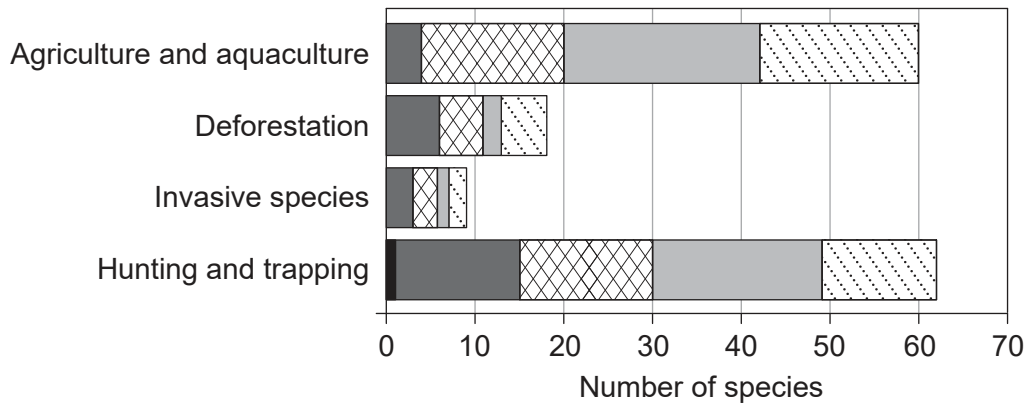


36EP27

Turn over

(Option C continued)

14. Data from the International Union for Conservation of Nature (IUCN) indicates that the population numbers of many mammal species are decreasing. The chart shows reasons for the decrease and the number of species in each category of danger.



Key:

- extinct in the wild
- critically endangered
- ▨ endangered
- vulnerable
- ▨ threatened

[Source: Michael Hoffmann *et al.* 2011. The changing fates of the world's mammals. *Philosophical Transactions of the Royal Society B*, Volume 366, issue 1578. DOI: 10.1098/rstb.2011.0116. By permission of the Royal Society.]

(a) Calculate how many species are classified as endangered due to hunting and trapping. [1]

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(b) State **one** reason mammals can continue to survive even if they are extinct in the wild. [1]

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(Option C continues on the following page)



36EP28

**(Option C, question 14 continued)**

- (c) Outline how deforestation can affect the richness of biodiversity in an ecosystem. [1]

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- (d) Explain the impact of plastic waste on Laysan albatrosses (*Phoebastria immutabilis*). [2]

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- 15.** Explain reasons for differences in the realized niche and fundamental niche of an organism. [4]

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**End of Option C**

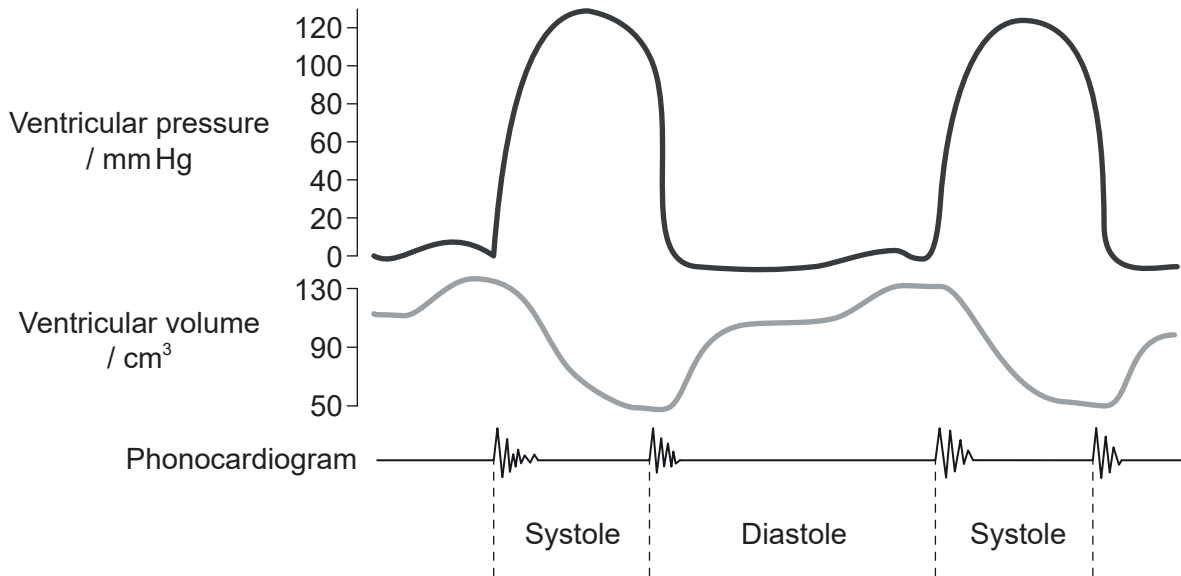


36EP29

Turn over

**Option D – Human physiology**

16. The diagram shows changes in the pressure and volume of the left ventricle during normal heartbeat. The phonocardiogram records heart sounds during the cardiac cycle.



[Source: Wiggers, Carl J. 1923. *Modern Aspects of the Circulation in Health and Disease*, 2nd ed. Philadelphia: Lea & Febiger, p. 97.]

(a) State the relationship between pressure and volume in the left ventricle. [1]

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(b) Explain the events that cause the sound shown on the phonocardiogram at the start of systole. [2]

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(Option D continues on the following page)



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

(c) Outline reasons for fitting an artificial cardiac pacemaker.

[2]

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

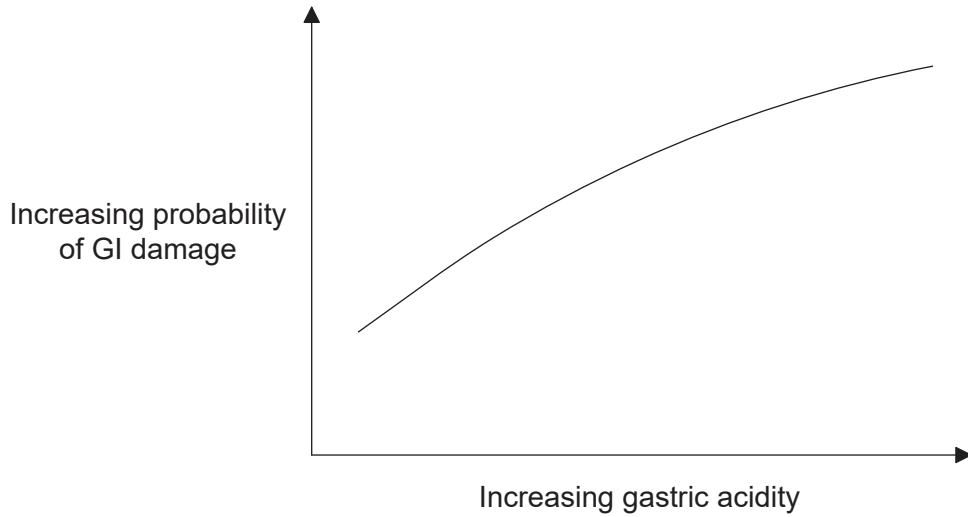


36EP31

Turn over

**(Option D continued)**

17. The graph shows the relationship between gastrointestinal (GI) damage and gastric acidity in 37 healthy human volunteers.



[Source: Republished with permission of Elsevier Science and Technology Journals, from 'Integrated gastric acidity can predict the prevention of naproxen-induced gastroduodenal pathology in normal subjects', John Plachetka, Gaetano Morelli, Carolyn Hines, Julie Borland, Alison Lyke, Diane Littlefield, Jerry D. Gardner *Gastroenterology*, Vol. 124, Issue 4, 2003; permission conveyed through Copyright Clearance Center, Inc.]

- (a) State the relationship between gastric acidity and GI damage. [1]

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- (b) GI damage can include ulcers. Outline the treatment of stomach ulcers. [3]

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



36EP32



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

(c) Other than gastric acidity, state a primary cause of stomach ulcers.

[1]

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

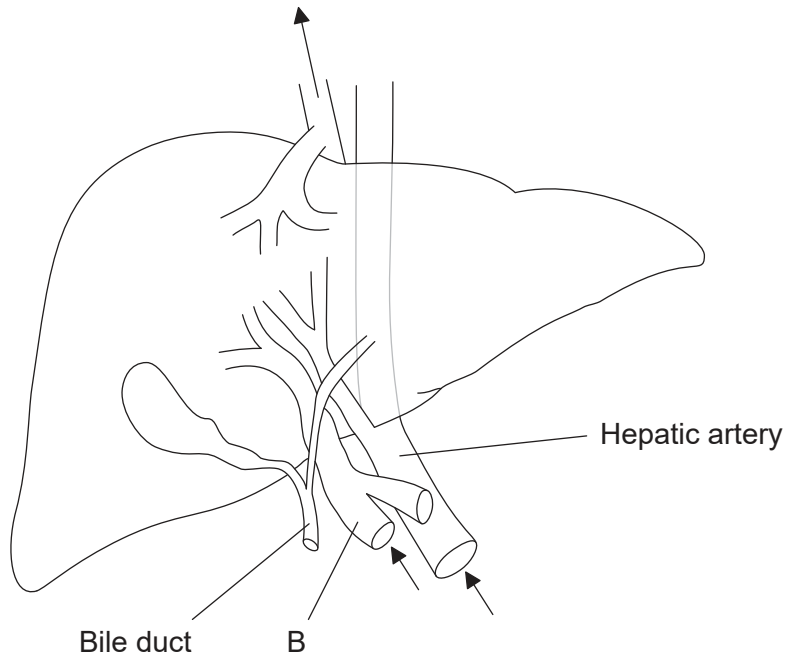


36EP33

Turn over

**(Option D continued)**

**18.** The diagram shows the liver. The arrows show the direction of blood flow into and out of the liver.



[Source: © International Baccalaureate Organization 2017]

(a) (i) Identify the blood vessel labelled B. [1]

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(ii) Outline the function of the blood vessel labelled B. [3]

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



36EP34

**(Option D, question 18 continued)**

(b) Distinguish between the structure of liver sinusoids and capillaries.

[2]

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**19.** Explain the possible health risks of being overweight.

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**End of Option D**



36EP35

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36EP36