

Biology
Standard level
Paper 3

Tuesday 2 May 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 – 12
Option C — Ecology and conservation	13 – 16
Option D — Human physiology	17 – 21



Section A

Answer **all** questions. Write your answers in the boxes provided.

- 1. Urease is an enzyme that breaks down urea into ammonia and carbon dioxide. The ammonia produced causes the pH of the solution to rise. This reaction can be followed using a pH indicator or a pH probe.

In an experiment conducted by a student the time taken for the pH indicator, thymol blue, to change from yellow to blue was recorded at different temperatures.

Temperature / °C ± 1	Time / s ± 1						
	Trials					Mean	Standard deviation
	1	2	3	4	5		
30	109	62	79	59	65	75	21
40	54	46	38	42	43	45	6
50	31	30	31	34	27	31	3
60	23	18	19	21	18	20	2
70	19	29	29	31	36	29	6

[Source: © International Baccalaureate Organization 2017]

- (a) Outline what the standard deviations reveal about the data from this experiment. [2]

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- (b) One result in this experiment can be classified as an outlier as its value is very distant from those of the other values.

Explain an appropriate procedure for dealing with outliers. [2]

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(Question 1 continued)

(c) Outline the effect of temperature on the activity of urease enzyme. [2]

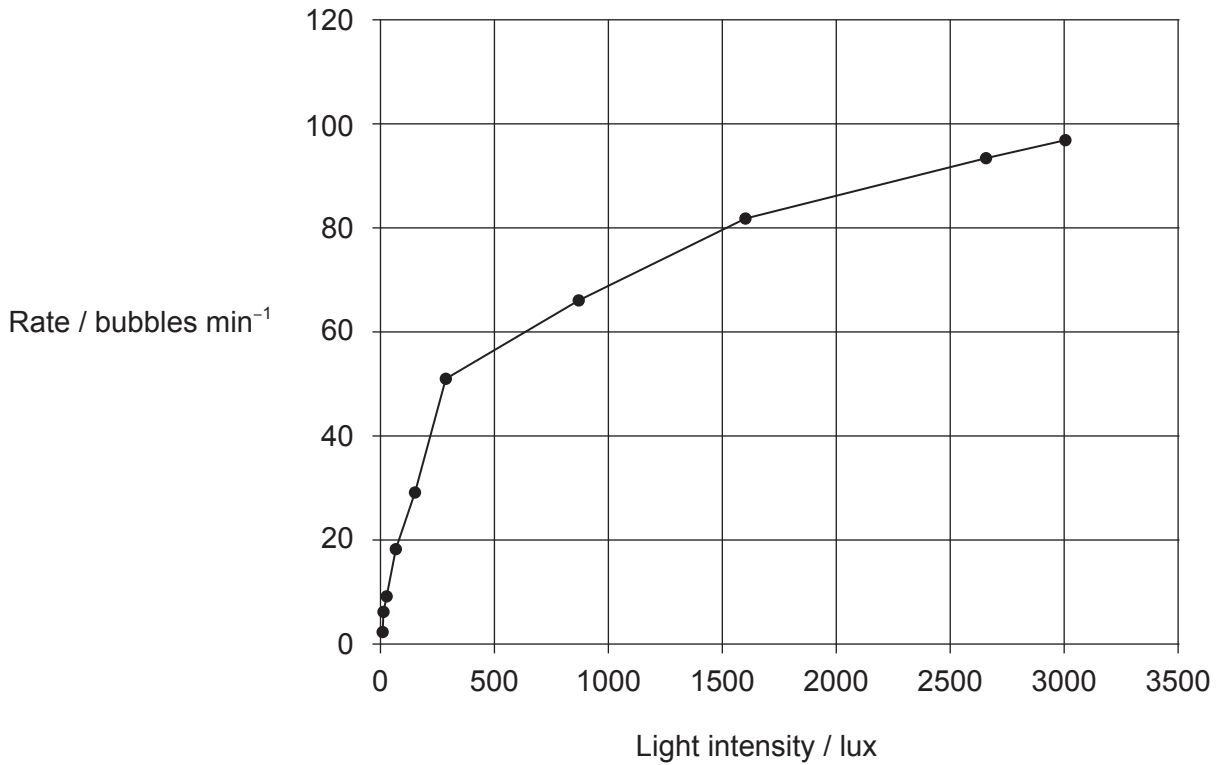
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(d) State **one** factor that would need to be controlled in this experiment. [1]

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2. Students exposed the water plant *Cabomba caroliniana* to different light intensities. The bubbles of oxygen gas released by the plant were counted each minute.



- (a) Compare and contrast the experimental results for the effect of light intensity on the rate of photosynthesis of a green plant with the expected trend line.

[2]

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C. caroliniana can grow well in water at 27°C. This experiment was carried out at 25°C.

- (b) Describe the effect of carrying out the same experiment at 15°C.

[1]

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(Question 2 continued)

- (c) This experiment measured the quantity of oxygen gas released by the water plant.
State **one** other way of measuring the rate of photosynthesis.

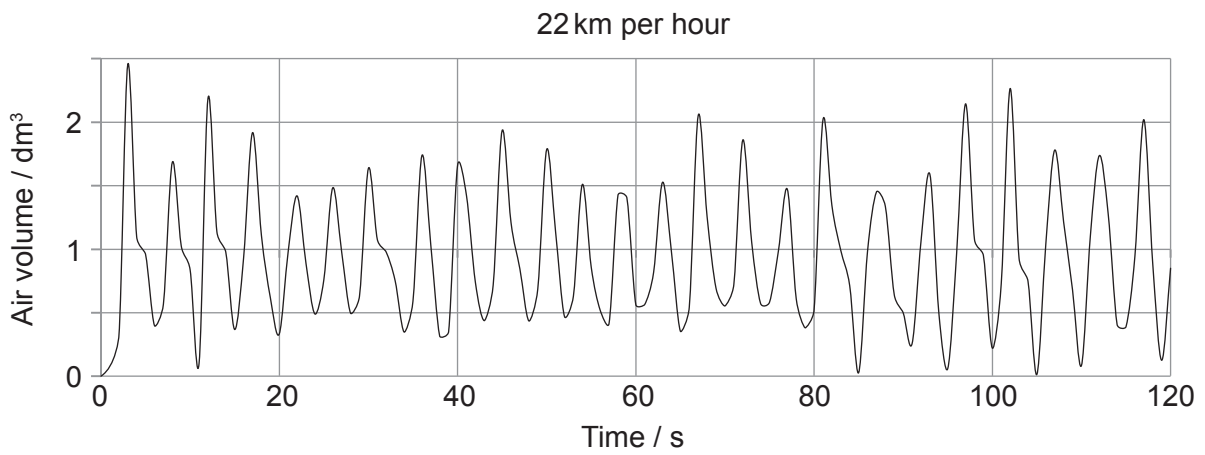
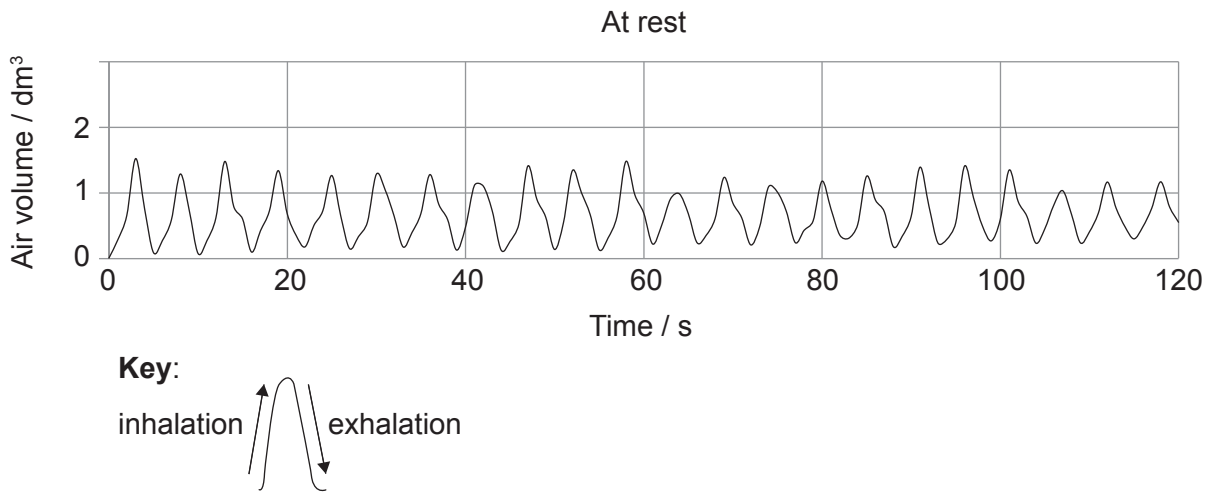
[1]

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3. A spirometer was used to measure the ventilation rate of a person at rest and pedaling at 22 km per hour on an exercise bike.



- (a) Calculate the difference in ventilation rate between resting and exercising. [1]

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(Question 3 continued)

(b) Explain the change in the tidal volume during exercise.

[3]

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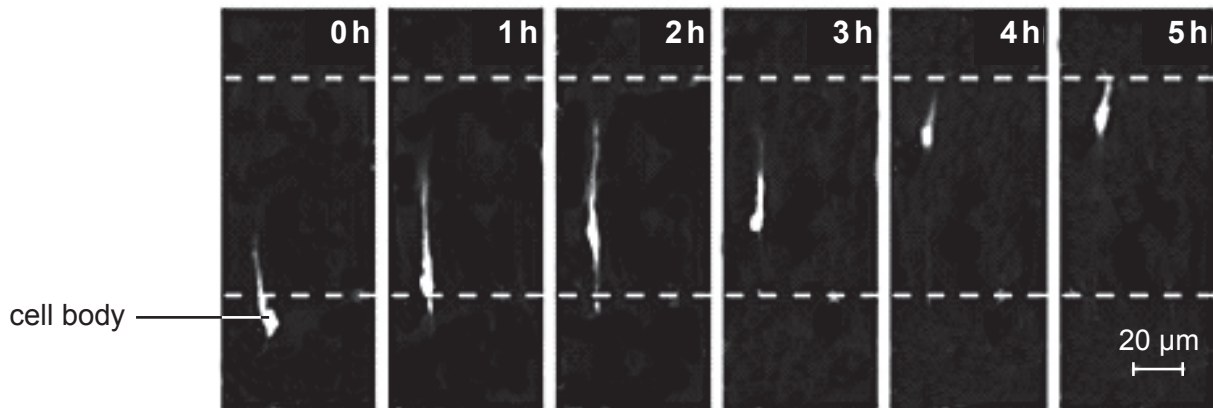


Section B

Answer **all** of the questions from **one** of the options. Write your answers in the boxes provided.

Option A — Neurobiology and behaviour

4. The photomicrographs below show time lapse images of a migrating neuron in the grey matter of the cerebrum of an embryo. The time lapse images were taken at one hour intervals. The cell body is the rounded bright area towards the rear of the migrating neuron.



[Source: Reprinted from C. Gil-Sanz et al. (2013) *Neuron*, 79, pages 461–477, with permission from Elsevier.]

- (a) Calculate the rate of movement of the neuron cell body between 0 and 5 h. Working should be shown, giving the units. [2]

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- (b) Suggest a reason for the migration of neurons in the embryonic nervous system. [1]

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(Option A continues on the following page)



(Option A, question 4 continued)

(c) Outline neural pruning.

[2]

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(Option A continues on the following page)

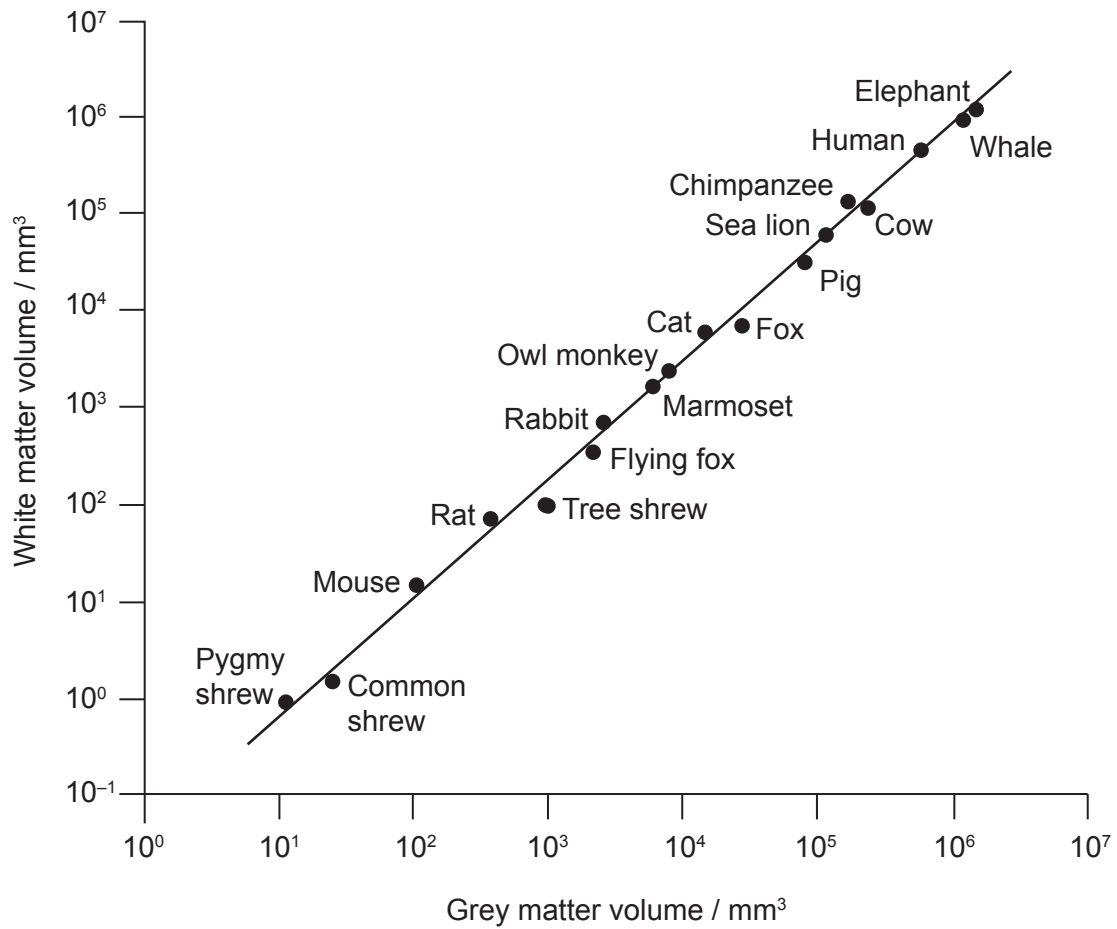


36EP09

Turn over

(Option A continued)

5. In a study of brain organization, several factors were investigated. The relationship between the volumes of grey and white matter across mammalian species was compared.



[Source: E. Bullmore and O. Sporns (2012) *Nature Reviews, Neuroscience* Vol. 3, pages 336–349. Reprinted by permission from Macmillan Publishers Ltd. <http://www.nature.com/nrn/index.html>]

- (a) Describe the relationship between the volume of white matter and grey matter.

[1]

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(Option A continues on the following page)



(Option A, question 5 continued)

- (b) Outline the organization of the human cerebral cortex with regard to structure and function.

[3]

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- (c) Outline **one** reason for the large energy requirement of the brain.

[1]

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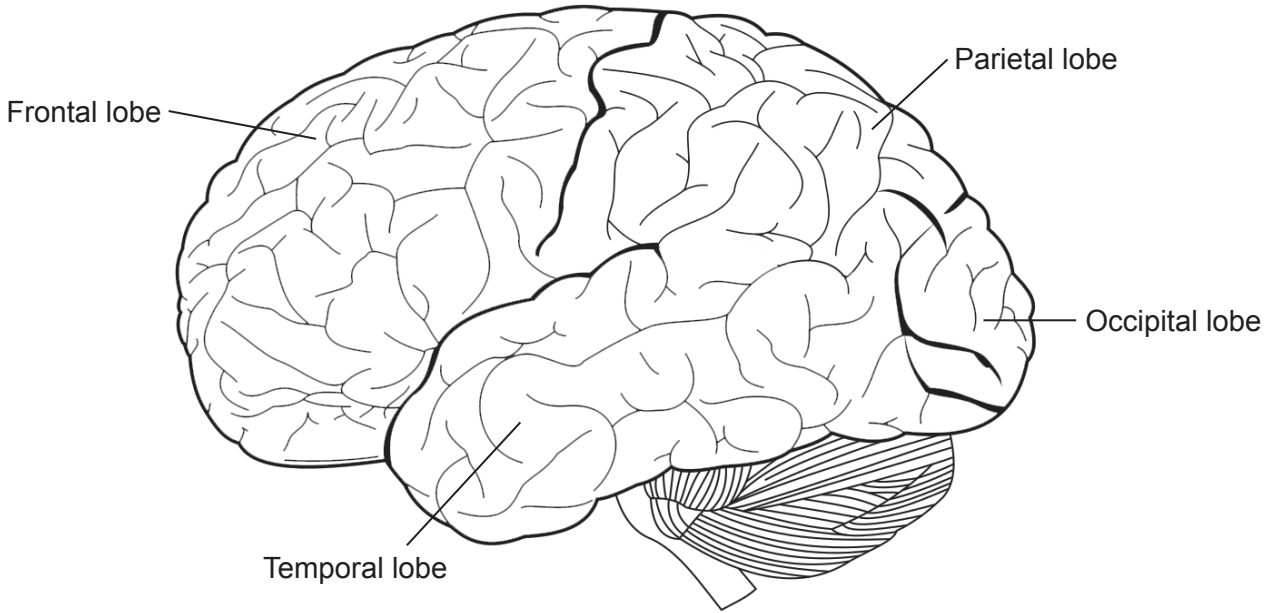
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(Option A continues on the following page)



(Option A continued)

6. The cortex of the brain consists of several regions.



[Source: http://i0.wp.com/buquad.com/wp-content/uploads/2010/11/800px-Brain_Surface_Gyri.SVG_.png]

(a) State whether this view of the brain shows the left side or the right side. [1]

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(b) Outline the function of Broca's area. [2]

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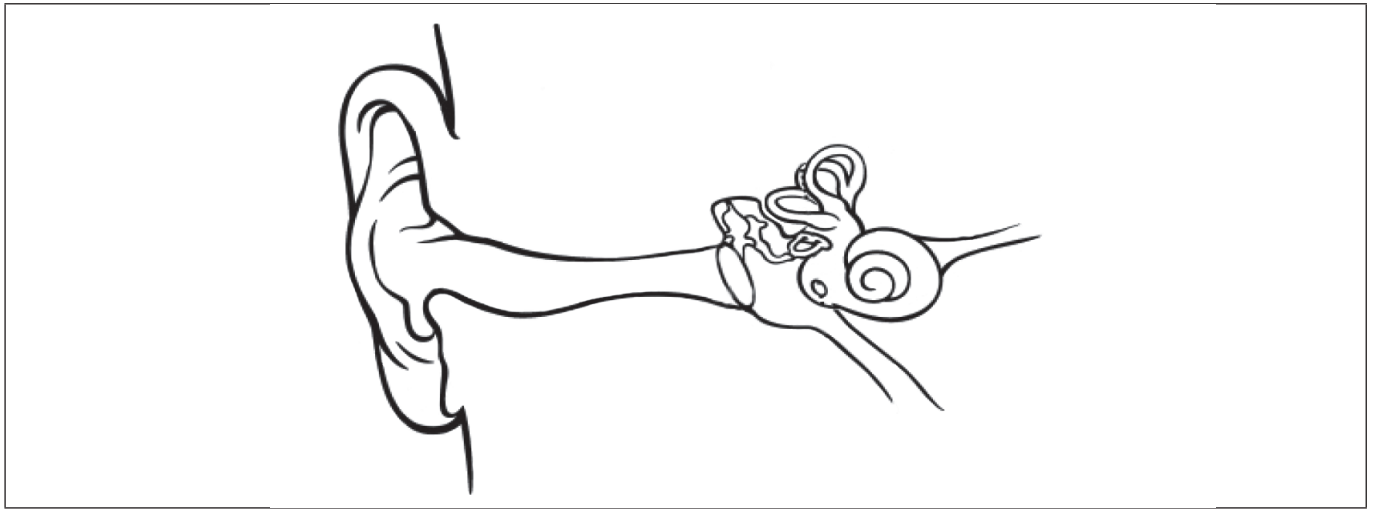
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(Option A continues on the following page)



(Option A continued)

7. The diagram shows the anatomy of the human ear.



(a) Label the cochlea on the diagram. [1]

(b) Explain the structure of the semicircular canals in relation to their functions. [4]

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(c) Explain the role of ganglion cells in the eye. [2]

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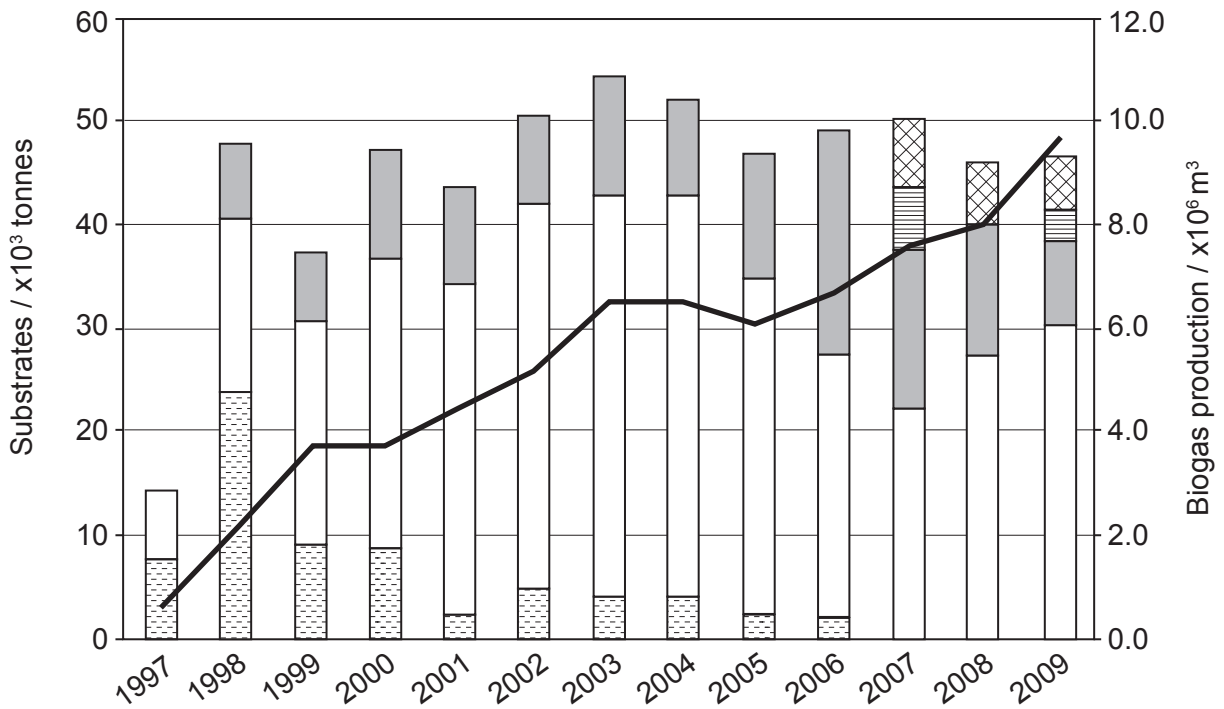
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End of Option A



Option B — Biotechnology and bioinformatics

8. The graph shows the development of biogas production and substrate utilization at Svensk Biogas (Sweden) from 1997 to 2009.



Key:

— Biogas production

Types of substrates:

Manure

Slaughterhouse waste

Other

Residue from ethanol production

Food industry

[Source: L Vallin, (2012), Svensk Biogas AB]

(a) (i) Biogas production in a fermenter requires a substrate. State another requirement for this process.

[1]

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(Option B continues on the following page)



36EP14

(Option B, question 8 continued)

(ii) Suggest reasons based on the data in the graph for increases in biogas production at Svensk Biogas.

[2]

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(b) Outline the principles of fermentation by continuous culture.

[3]

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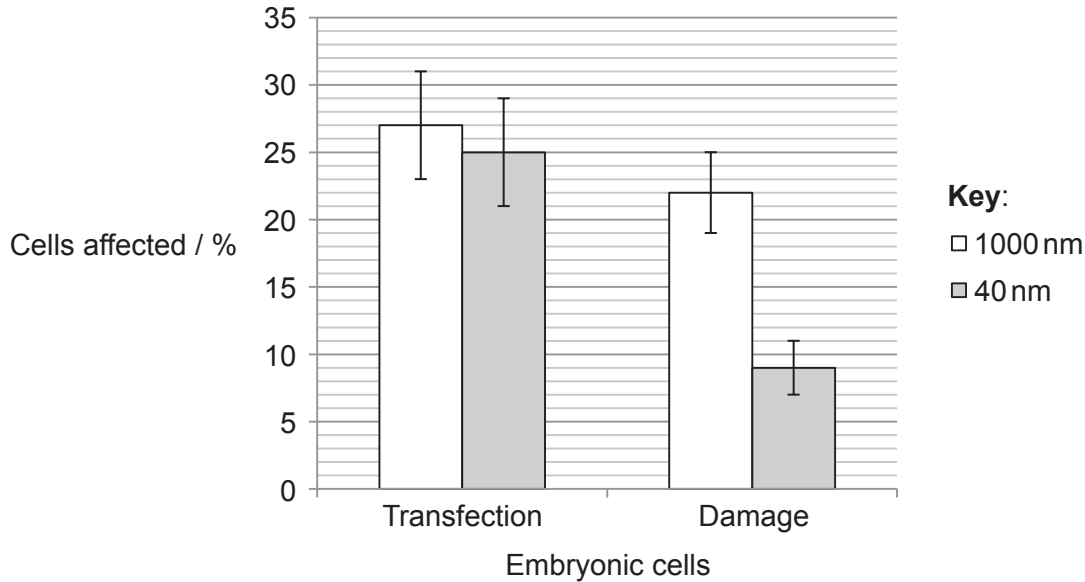
36EP15

Turn over

(Option B continued)

- 9. Usually the size of particles used in biolistics with plant cells is 1000 nm. Researchers tested the effect of using smaller sized particles (40 nm) in the biolistic treatment of animal cells.

The degree of transfection by DNA and the damage to embryonic kidney cells was assessed using particles of the two different sizes. The amount of DNA attached to each particle, whether large or small, was the same.



[Source: John A O'Brien and Sarah C. R. Lummis (2011) 'Nano-biolistics: a method of biolistic transfection of cells and tissues using a gene gun with novel nanometer-sized projectiles.' *BMC Biotechnology*, 11: p. 66.]

- (a) Describe the effect of the different sized particles on the treatment of these animal cells.

[2]

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- (b) State **one** other physical method used to introduce DNA into plants.

[1]

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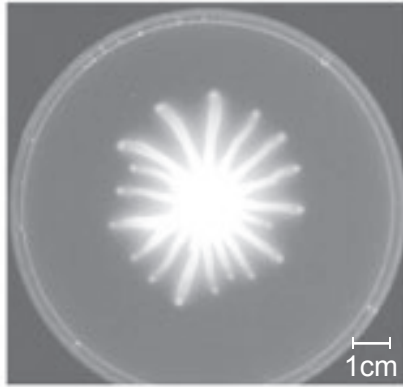
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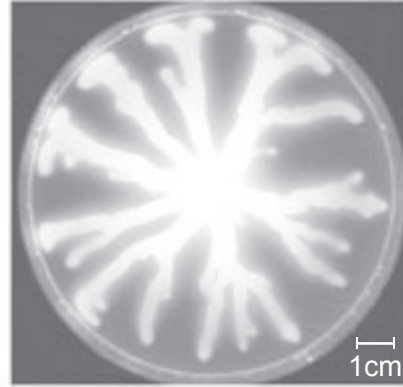


(Option B continued)

10. Korean microbiologists tested the effect of ginger root (*Zingiber officinale*) extracts on biofilm formation by the bacterium *Pseudomonas aeruginosa*. Formation of a biofilm prevents the bacteria from spreading. These bacteria were cultured on plates of agar and the results after 24 hours of growth are shown in the photographs below.



Control



1% ginger root extract

[Source: Han-Shin Kim and Hee-Deung Park (2013) Ginger Extract Inhibits Biofilm Formation by *Pseudomonas aeruginosa* PA14. *PLOS ONE*, September, 8(9). <https://doi.org/10.1371/journal.pone.0076106>.]

(a) Evaluate the effect of 1 % ginger root extract on biofilm formation. [3]

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(b) Outline the importance of avoiding biofilm formation in pipes carrying drinking water. [2]

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(Option B continues on the following page)



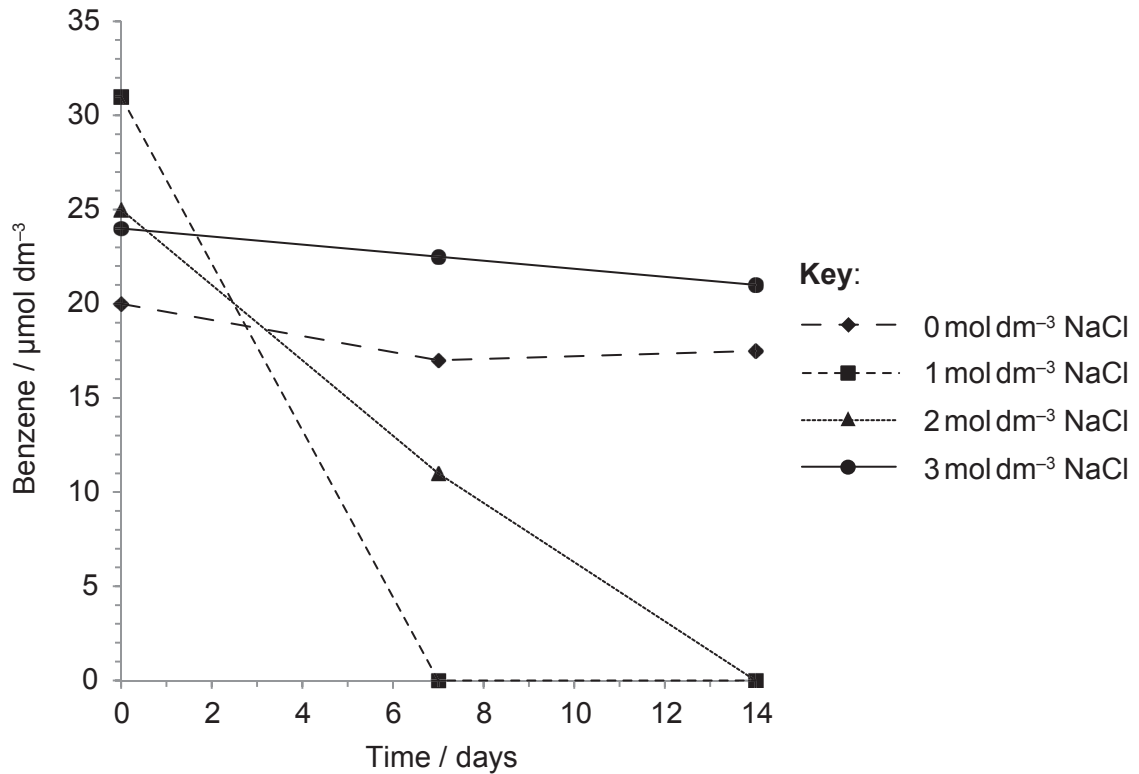
36EP17

Turn over

(Option B continued)

11. Benzene is a cancer-causing component of crude oil. Some halophilic bacteria degrade benzene. Using a culture of bacteria obtained from an oil field in the US, degradation of benzene was studied by microbiologists.

The microbiologists cultured the bacteria at different concentrations of sodium chloride (NaCl) and measured the amount of benzene left at different times.



[Source: C A Nicholson and B Z Fathepure, (2004), *Applied and Environmental Microbiology*, pages 1222–1225]

(a) Determine the optimum concentration of sodium chloride for benzene degradation. [1]

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(b) State the genus of halophilic bacteria in the soil that could be degrading the benzene. [1]

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(Option B continues on the following page)



(Option B continued)

12. Discuss the environmental risks of the cultivation of genetically modified crops. **[4]**

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End of Option B

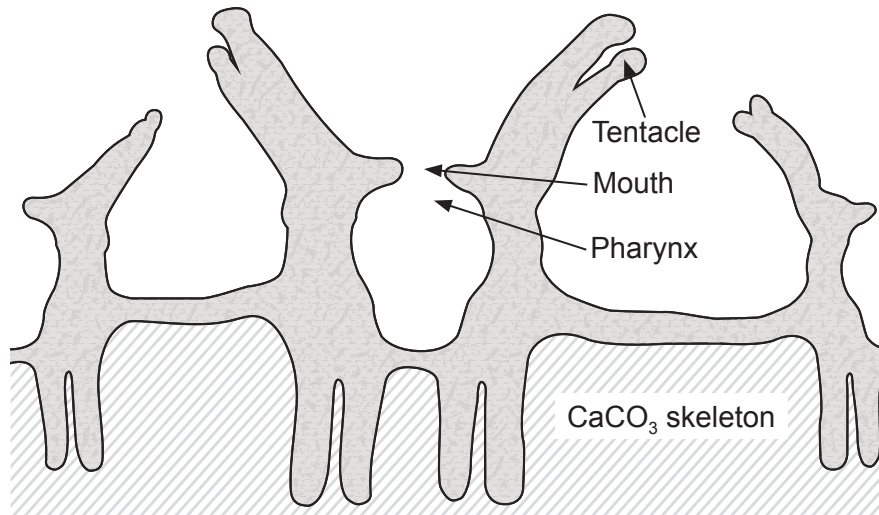


36EP19

Turn over

Option C — Ecology and conservation

13. Reef-building corals are an association between two organisms: coral polyps and *Zooxanthellae*.



[Source: © International Baccalaureate Organization 2017]

- (a) State the relationship between *Zooxanthellae* and coral reef species. [1]

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- (b) Describe the exchange of materials between the coral's polyps and *Zooxanthellae*. [2]

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- (c) State **one** limiting factor on *Zooxanthellae* which affects coral reef formation. [1]

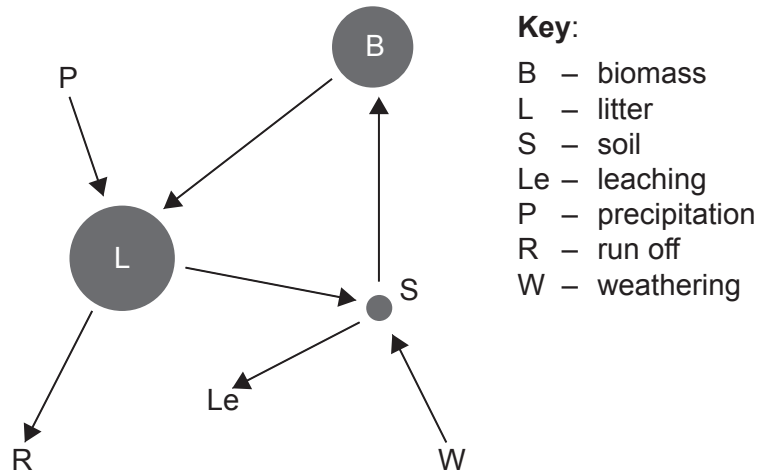
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(Option C continues on the following page)



(Option C continued)

14. The Gersmehl diagram below shows the movement and storage of nutrients in a taiga ecosystem.



[Source: Adapted from: <http://www.slideshare.net/ecumene/ecosystems-3-nutrient-cycle-presentation>]

Predict the possible effect of global warming on the nutrient flow in a taiga ecosystem.

[2]

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(Option C continues on the following page)



36EP21

Turn over

(Option C continued)

15. (a) Outline **one** consequence of introducing an alien species into an ecosystem. [2]

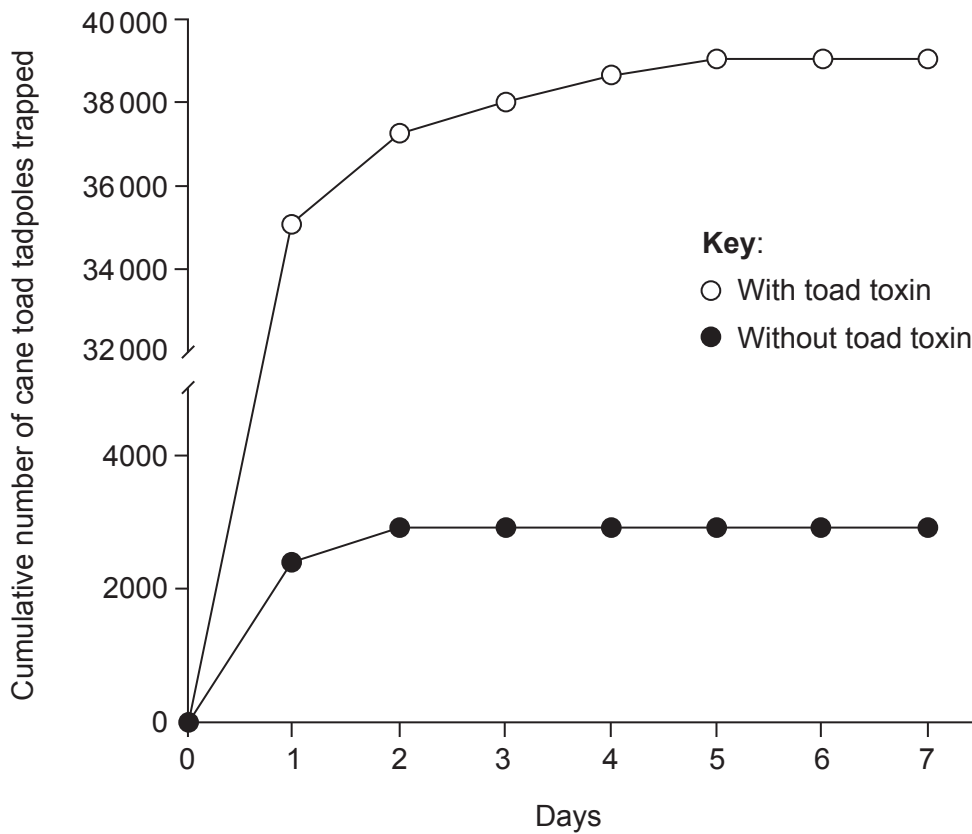
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After their introduction cane toads (*Rhinella marina*) have become a serious pest in many parts of Australia. In an attempt to control them scientists set traps to which they added toxins produced by native species of toad to capture cane toad tadpoles. The toad toxin attracts the cane toad tadpoles without killing them.



[Source: Michael R. Crossland, Takashi Haramura, Angela A. Salim, Robert J. Capon and Richard Shine (2012) 'Exploiting intraspecific competitive mechanisms to control invasive cane toads (*Rhinella marina*).' *Proceedings of the Royal Society B: Biological Sciences*, 279(1742): 3436–3442. DOI: 10.1098/rspb.2012.0821.]

(Option C continues on the following page)



(Option C, question 15 continued)

(b) State the origin of cane toads.

[1]

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(c) Evaluate the use of traps containing toxin as a means of cane toad control.

[3]

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(Option C continues on the following page)



36EP23

Turn over

(Option C continued)

- 16. Freshwater invertebrates were sampled by students at three sites along a river in central France. The animals were identified and counted. The diversity of each site can be compared using Simpson’s reciprocal index.

Species	Number of animals in the sample		
	Site A	Site B	Site C
<i>Baetis rhodani</i>	0	30	7
<i>Ecdyonurus dispar</i>	1	0	9
<i>Ephemerella ignita</i>	4	0	0
<i>Limnephilus lunatus</i>	0	0	2
<i>Brachycentrus subnubilus</i>	2	1	0
<i>Polycentropus flavomaculatus</i>	0	1	0
<i>Rhyacophila obliterata</i>	1	0	0
<i>Gammarus pulex</i>	0	1	0
<i>Asellus aquaticus</i>	8	0	0
<i>Simulium equinum</i>	17	0	0
<i>Dexia</i>	0	5	0
<i>Chironomus annularis</i>	0	0	1
<i>Hirudinea</i>	0	4	2
Simpson’s reciprocal index	3.09	1.91	

[Source: © International Baccalaureate Organization 2017]

Simpson’s reciprocal index is given by the following formula:

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

- (a) Calculate the diversity of site C. Working should be shown.

[2]

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(Option C continues on the following page)



(Option C, question 16 continued)

- (b) Site A has a higher Simpson's reciprocal index than Site B showing that its diversity is higher.

Explain the reason that ecologists consider Site A to have a higher diversity than Site B, despite both sites having six different species present.

[2]

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- (c) Discuss the advantages and disadvantages of *in situ* conservation methods.

[4]

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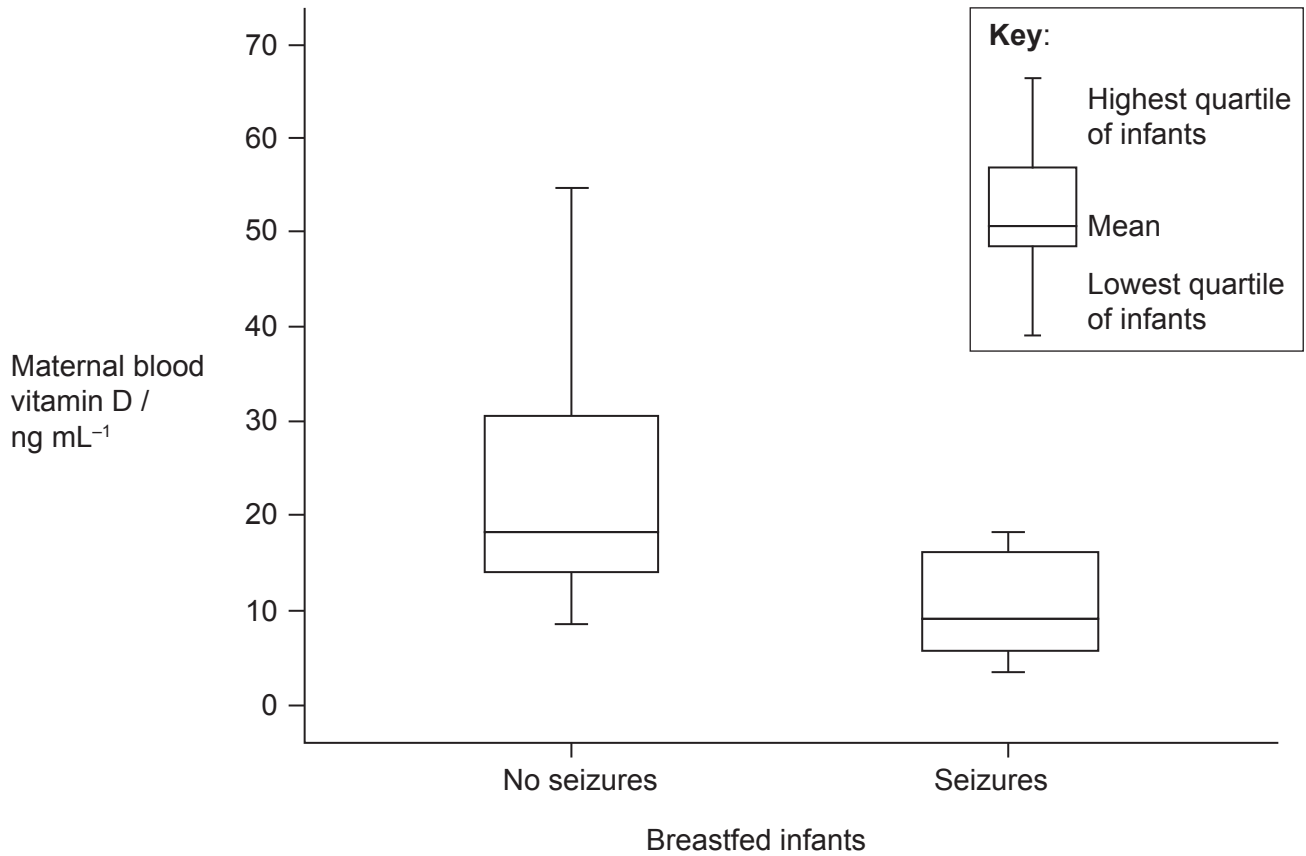


36EP25

Turn over

Option D — Human physiology

17. Breastfed infants with rickets sometimes have seizures due to low blood calcium levels. A study was carried out to investigate the relationship between maternal blood vitamin D levels and the incidence of these infant seizures.



[Source: M M Salam and A S El-Sakka, (2010), *Pakistan Journal of Biological Sciences*, 13(9), pages 437–472]

- (a) (i) Describe the relationship between the maternal blood vitamin D levels and the incidence of seizures. [1]

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- (ii) Deduce the reason for rickets in these infants. [1]

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(Option D continues on the following page)



(Option D, question 17 continued)

(b) Identify the reason for vitamin D not being considered to be a typical vitamin. [1]

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(c) Outline the reason for some amino acids being classified as essential amino acids. [1]

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(Option D continues on the following page)



36EP27

Turn over

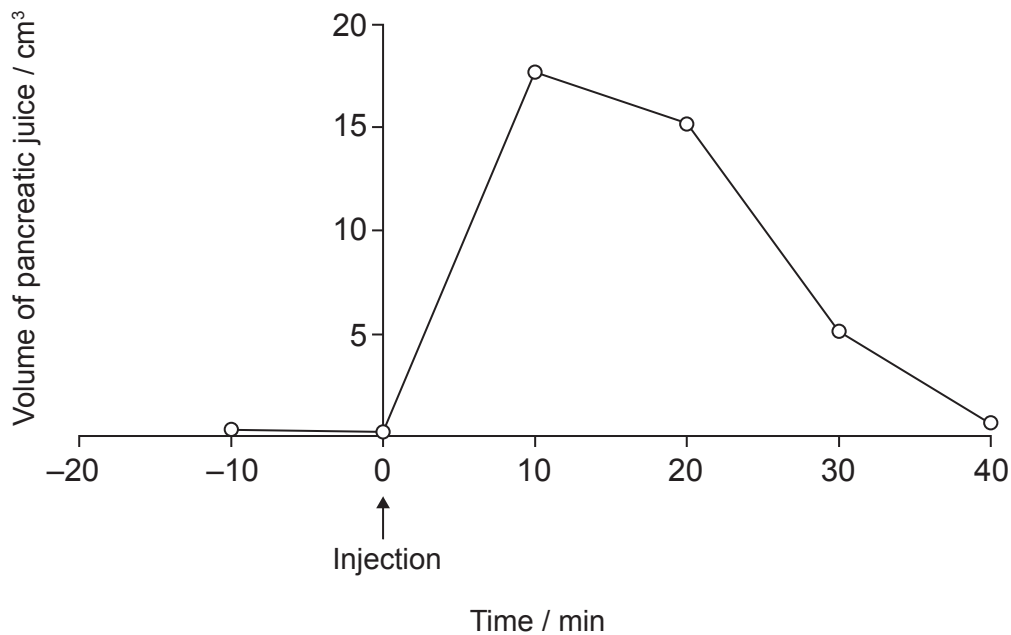
(Option D continued)

18. (a) State **two** roles of hydrochloric acid in gastric juice. [2]

Role 1:
Role 2:

Pancreatic juice is secreted into the pancreatic duct which carries these secretions to the small intestine.

The hormone secretin is released by the small intestine when hydrochloric acid enters it from the stomach. The data below show the volume of pancreatic juice released after an injection of secretin.



[Source: K E Barrett *et al.* (2010) *Ganong's review of medical physiology*, page 438, © McGraw Hill Education.]

(Option D continues on the following page)



(Option D, question 18 continued)

(b) Pancreatic secretions contain sodium hydrogen carbonate, making them basic.

Deduce the significance of the response by the pancreas to secretin. [3]

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(c) State **one** cause of stomach ulcers. [1]

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(Option D continues on page 33)



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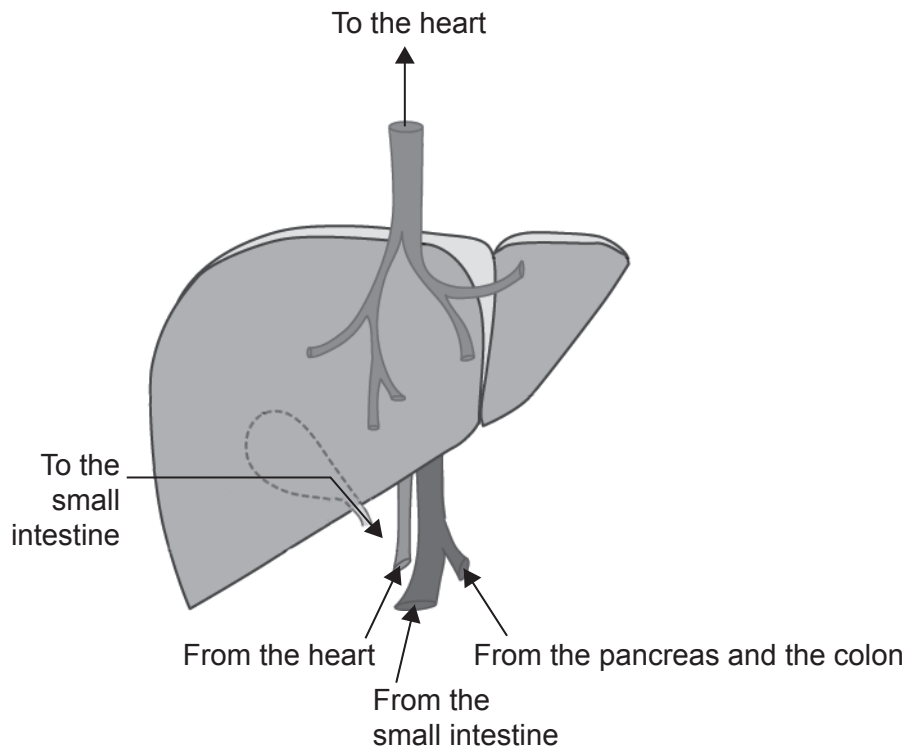
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36EP30

(Option D continued from page 31)

19. The diagram below shows the liver and main vessels associated with it.



[Source: Adapted with permission of the Canadian Cancer Society, Liver Cancer: The Liver, <http://www.cancer.ca/en/cancer-information/cancer-type/liver/anatomy-and-physiology/?region=nb>, accessed 14 July 2017]

Suggest advantages of the blood supply from the pancreas passing directly into the liver. [2]

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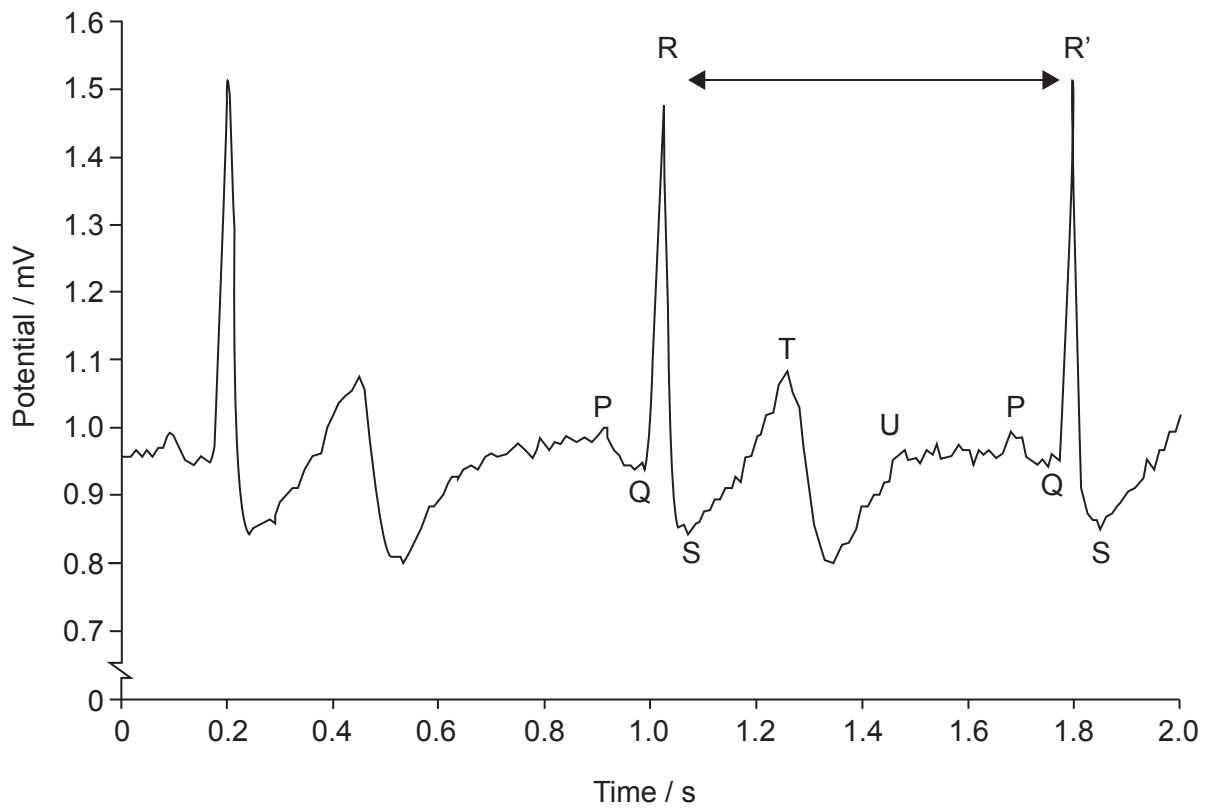


36EP31

Turn over

(Option D continued)

20. The graph below shows a normal electrocardiogram (ECG) trace.



(a) Using the letters provided, identify the parts of the ECG where the ventricle muscles are contracting.

[1]

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(b) State what is represented by the period between the points R and R'.

[1]

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(Option D continues on the following page)



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