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Biology
Standard level
Paper 3

22 October 2024

Zone A afternoon | Zone B afternoon | Zone C afternoon

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 – 17
Option D — Human physiology	18 – 21



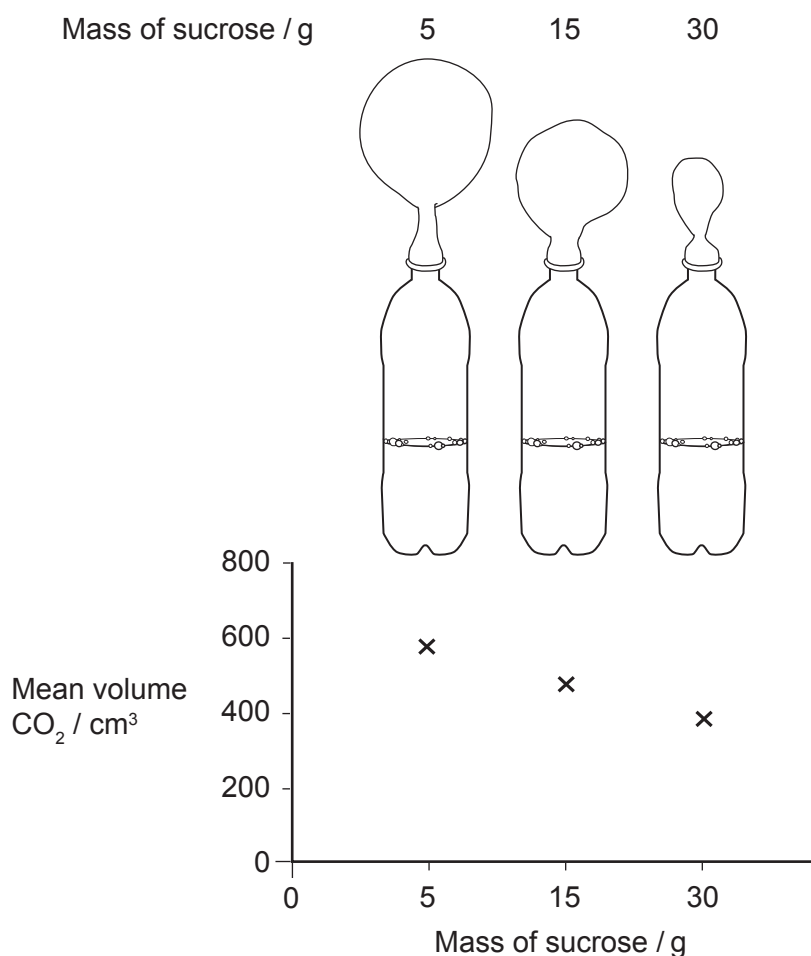
Section A

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

1. A student carried out an investigation to test cell respiration in yeast (*Saccharomyces cerevisiae*). Bottles were filled with 5 g of yeast and 80 cm³ of water maintained at 40 °C. A different mass of sucrose was added to each bottle: 5, 15 and 30 g respectively.

Bottles were left for 15 minutes before attaching a standard balloon to the opening of each bottle. After 45 minutes, the circumference of each balloon was measured using a string. The volume of CO₂ was calculated. Three trials per treatment were performed.

The diagram shows one trial, and the graph shows the mean of three trials.



(This question continues on the following page)



(Question 1 continued)

(a) State the independent variable. [1]

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(b) Suggest a reason for waiting 15 minutes before attaching the balloons. [1]

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(c) Outline a reason for keeping the temperature at 40 °C. [1]

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(d) Suggest a conclusion of this experiment. [1]

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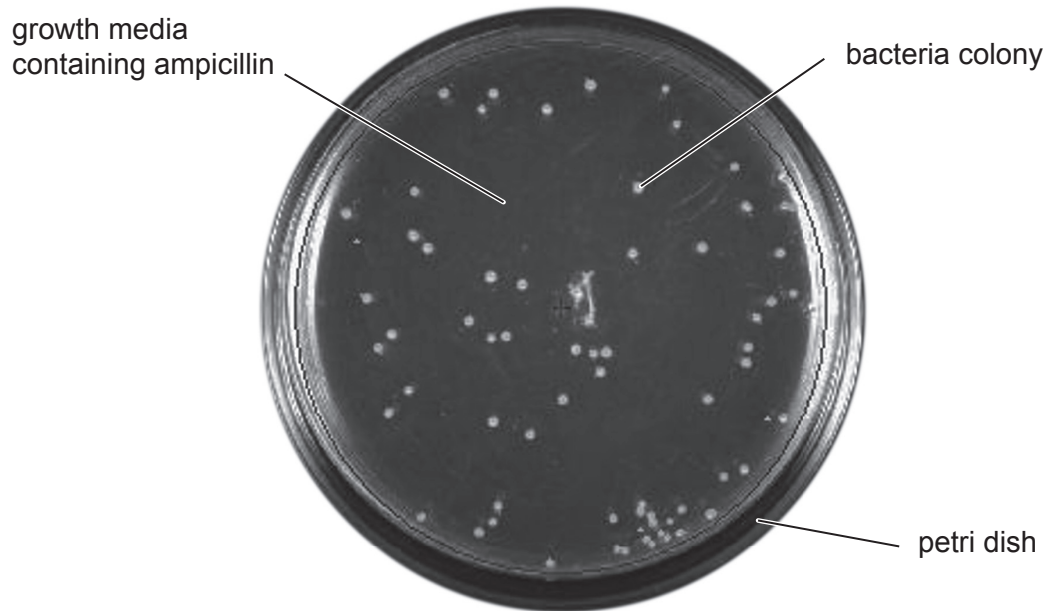
(e) Explain how the method could have been carried out more effectively by the student. [2]

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2. The growth of non-pathogenic *Escherichia coli* bacteria were studied in a microbiology laboratory at different temperatures with the antibiotic ampicillin. The number of bacterial colonies that grew were counted, and the mean and standard deviations calculated for five replicates per temperature.

At 25 °C, the mean number of colonies counted was 70 ± 8 . The Petri dish shows the results obtained in one of the replicates at this temperature.



(This question continues on the following page)



(Question 2 continued)

(a) State the dependent variable in this experiment. [1]

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(b) Explain the need for replicates in this experiment. [2]

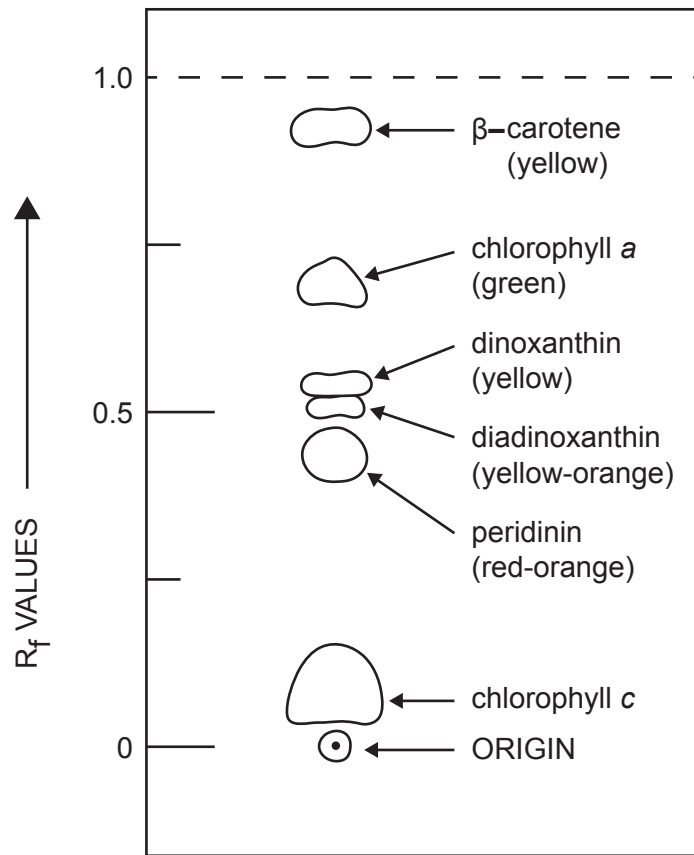
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(c) Suggest **one** reason for the presence of bacterial colonies despite the use of the antibiotic ampicillin. [1]

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3. The diagram represents the pigment fractions in a thin layer chromatography of the alga *Gambierdiscus toxicus*.



- (a) Identify the pigment that is most soluble in the solvent used in the chromatography.

[1]

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(This question continues on the following page)



(Question 3 continued)

(b) Describe the process used to obtain this chromatogram.

[3]

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(c) State the equation used to obtain an R_f value.

[1]

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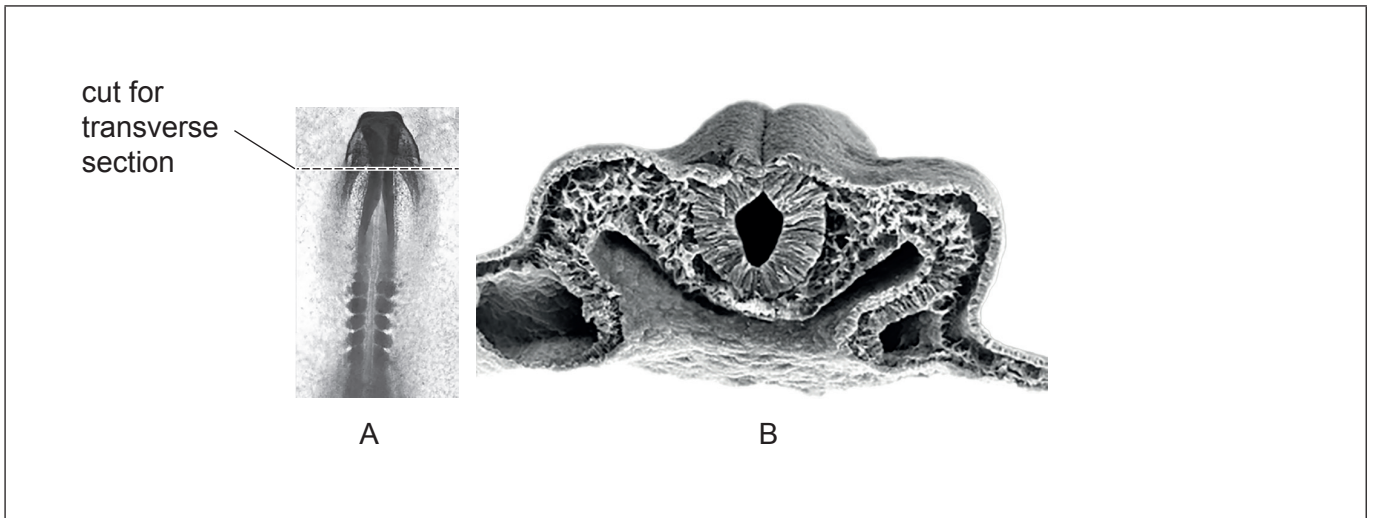


Section B

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. Image A shows a stage of neurulation in a chick embryo, and image B is a scanning electron micrograph (SEM) of a transverse section through the level indicated by the line in image A.



- (a) On image B, label
- (i) the neural tube; [1]
 - (ii) the ectoderm. [1]
- (b) Describe the formation of neurons. [2]

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- (c) Explain neural plasticity. [2]

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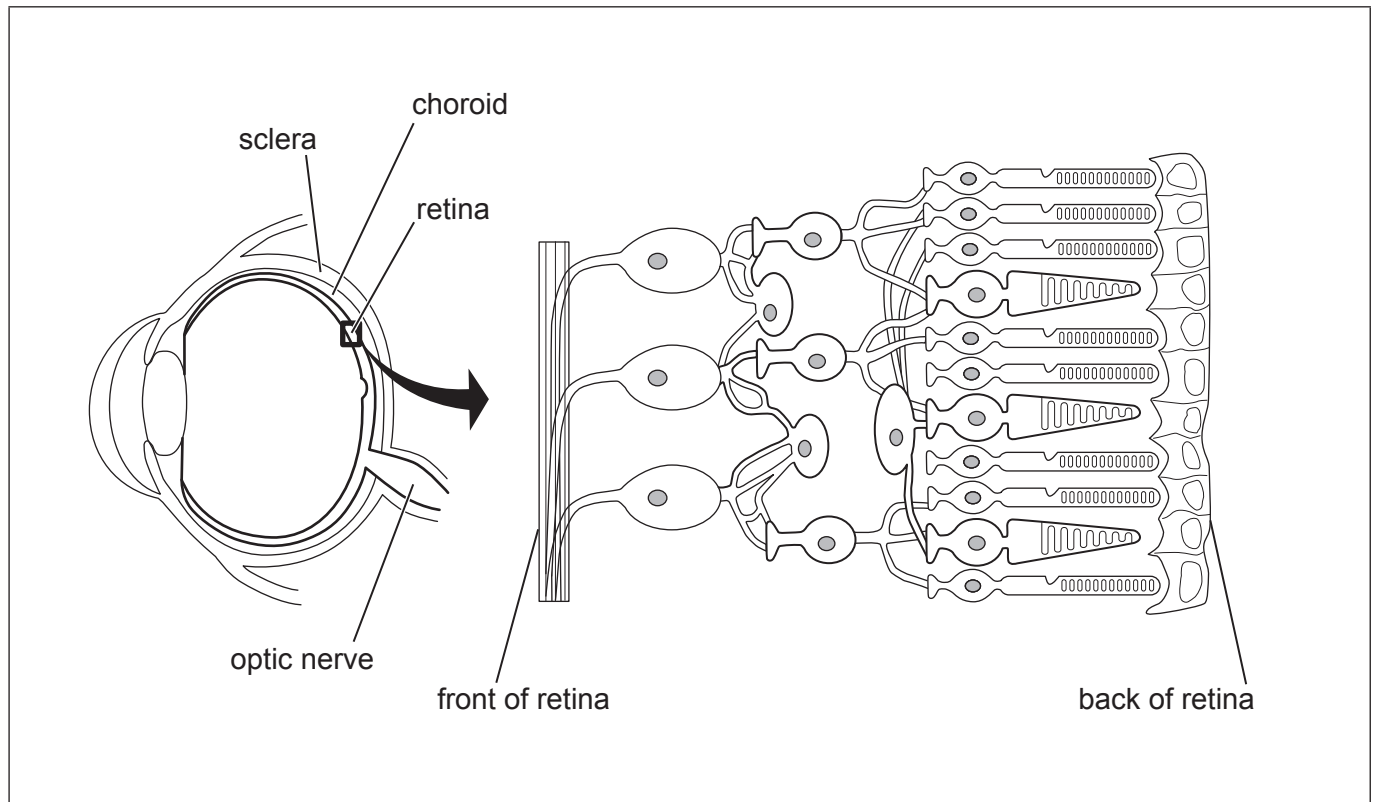
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(Option A continues on the following page)



(Option A continued)

5. The diagram shows the location of the retina within the eye and the location of the photoreceptors in the retina.



(a) On the diagram, label

(i) a rod;

[1]

(ii) a ganglion cell.

[1]

(b) Distinguish between rods and cones.

[2]

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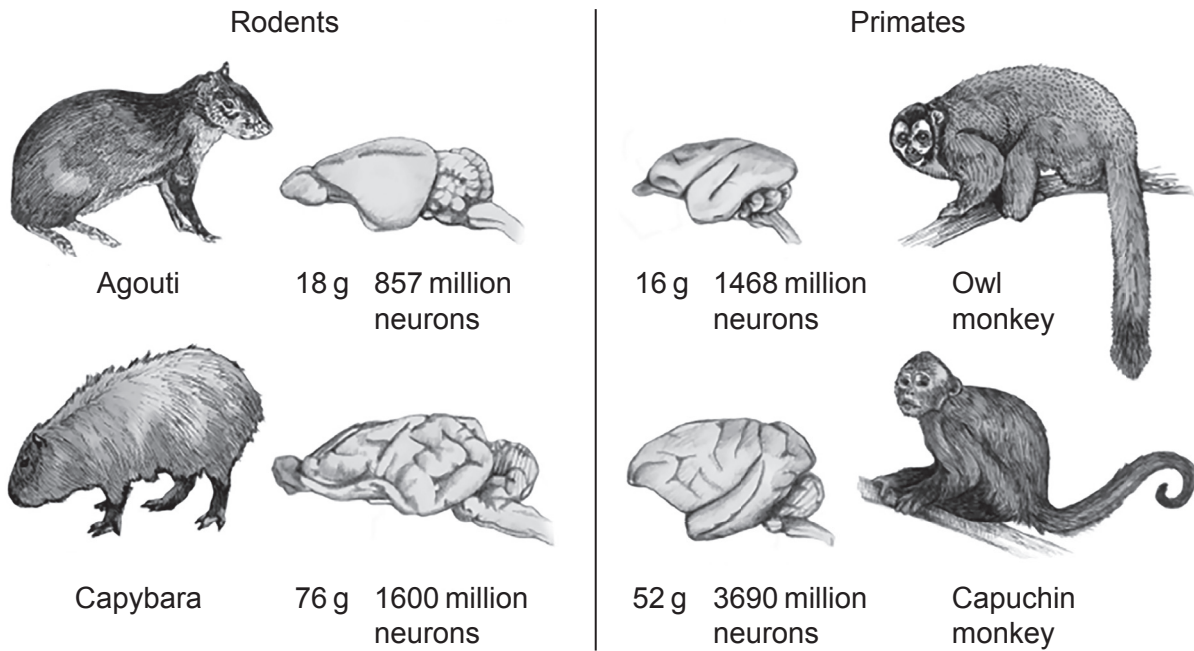
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(Option A continues on the following page)



(Option A continued)

6. The diagram shows the brain mass and number of neurons in two rodents (agouti and capybara) and two primates (owl and capuchin monkeys).



(a) Discuss whether the mass of the brain is proportional to the number of neurons. [2]

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(b) Outline how the cerebral cortex is adapted to allow for large numbers of neurons. [2]

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(Option A continues on the following page)



(Option A, question 6 continued)

(c) State a function of

(i) Broca's area;

[1]

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(ii) the medulla oblongata.

[1]

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(Option A continues on the following page)

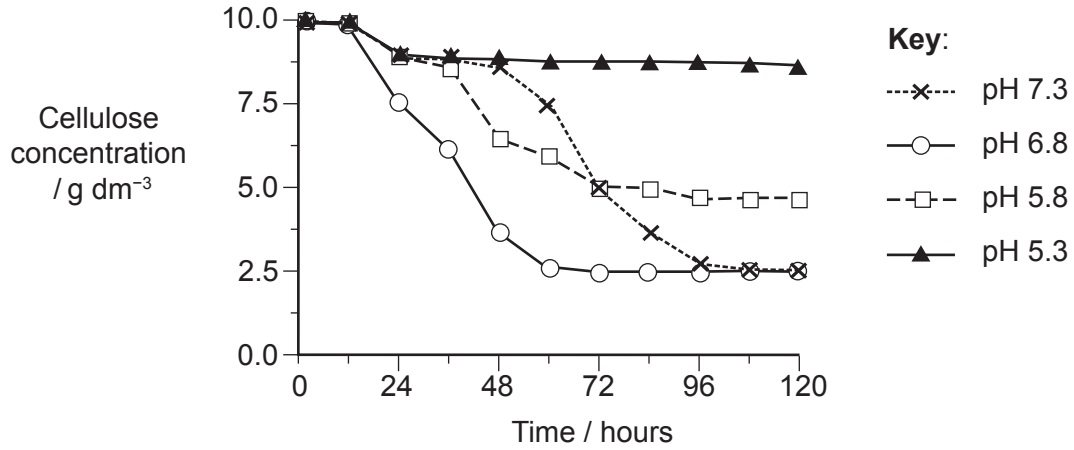


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Option B — Biotechnology and bioinformatics

8. Batch anaerobic fermentation experiments were performed to investigate the hydrolysis of cellulose into reducing sugars by bacteria and fungi found in the stomach of goats. The graph shows the results obtained at a range of pH values from 5.3 to 7.3.



(a) Suggest conclusions that the investigators drew from this data about the effect of pH on the cellulose hydrolysis rate. [2]

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(b) Suggest **one** advantage of using microorganisms in this type of fermentation. [1]

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(c) Distinguish between batch and continuous fermentation. [1]

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(Option B continues on the following page)



(Option B continued)

9. The table shows the steps, timeline and efficiency for the production of fertile transgenic corn (*Zea mays*). Immature corn embryos were transformed with *Agrobacterium tumefaciens* to obtain resistance to bialaphos, a chemical herbicide.

Step	Action	Day	Efficiency / Number produced
1	Infect embryos with <i>A. tumefaciens</i>	1	100 immature embryos
2	Transfer embryos to resting medium	3	
3	Transfer embryos to selection medium with bialaphos	10	
4	Pick independent transgenic organisms (calluses)	52	5 transgenic organisms
5	Regenerate transgenic organisms in the dark	68	
6	Germinate transgenic organisms in the light	82	
7	Transplant to soil	89	4 plants
8	Pollinate	154	3 plants
9	Harvest seeds	194	50 seeds

(a) Describe the use of *A. tumefaciens* as a vector in the production of transgenic corn. [2]

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(b) Calculate the efficiency in the production of transgenic corn, assuming all transgenic seeds germinated. [1]

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(c) State another example of the use of *A. tumefaciens* in herbicide resistance. [1]

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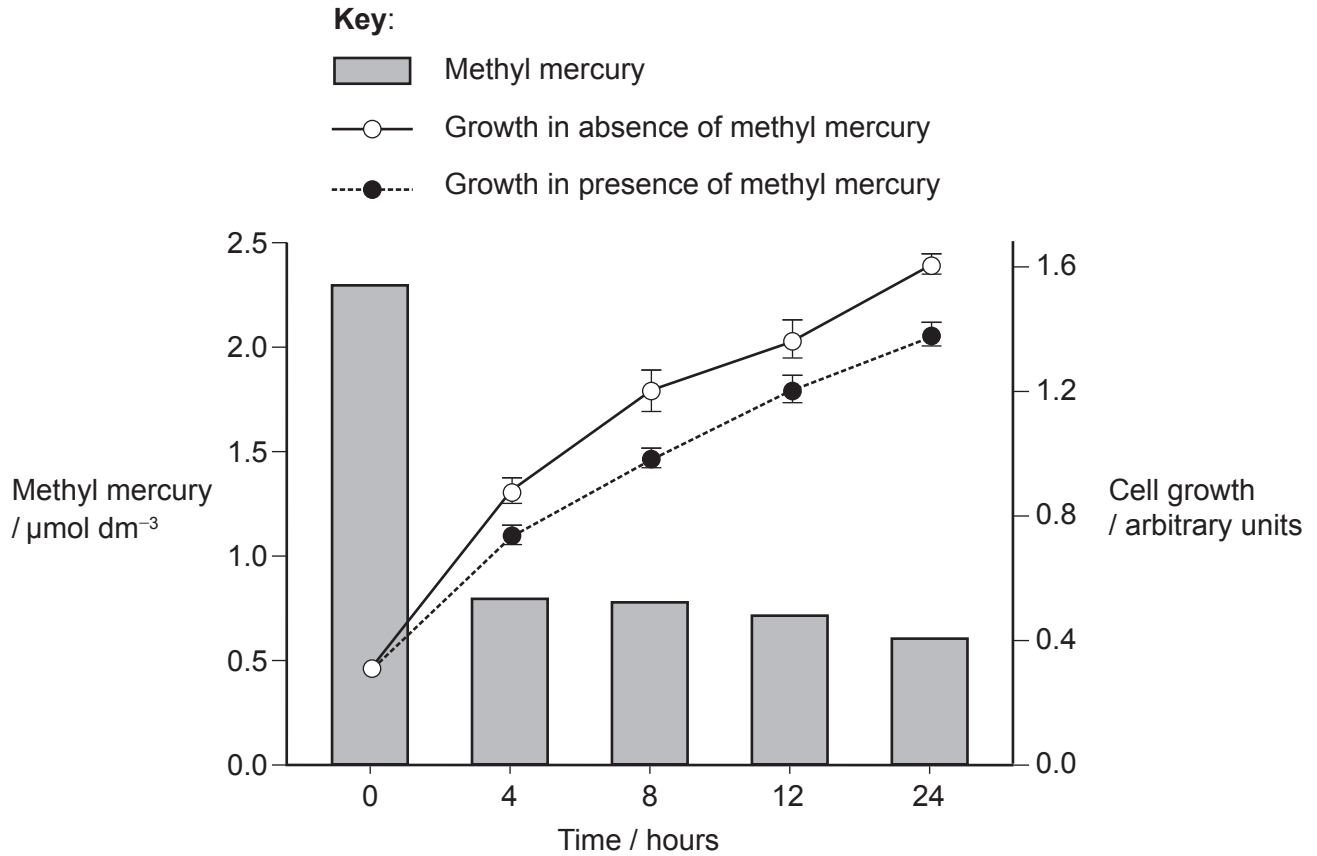
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(Option B continues on the following page)



(Option B continued)

10. The graph shows the concentration of methyl mercury during degradation by *Pseudomonas putida* in experimental tubes after 0, 4, 8, 12 and 24 hours of incubation. It also shows the growth of *P. putida* in the presence and absence of methyl mercury.



(a) State **one** chemical other than mercury produced in the degradation of methyl mercury by *P. putida*. [1]

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(b) Using the data, evaluate whether *P. putida* is an effective microorganism for methyl mercury bioremediation. [2]

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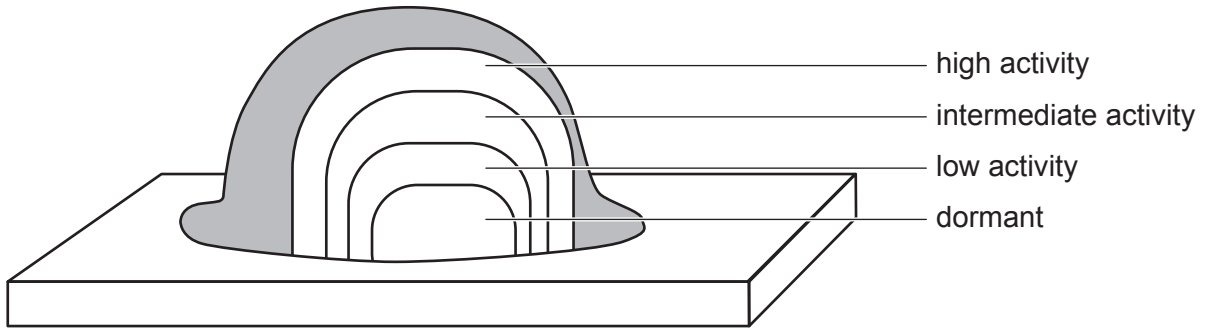
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(Option B continued)

11. The diagram shows the results of a study of metabolic activity within biofilm cell clusters, using fluorescent tags for specific metabolic markers.



(a) Define biofilm.

[1]

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(b) List **two** examples of problems caused by biofilms.

[2]

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(c) Using the diagram, suggest **two** factors affecting the action of antibiotics on this biofilm.

[2]

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(Option B continues on the following page)



(Option B continued)

12. The Amflora potato (*Solanum tuberosum*) is a transgenic organism used in paper and adhesive industries. It is genetically modified to contain a gene for high amylopectin starch. Explain how the open reading frame (ORF) for high amylopectin starch gene is identified. [4]

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End of Option B



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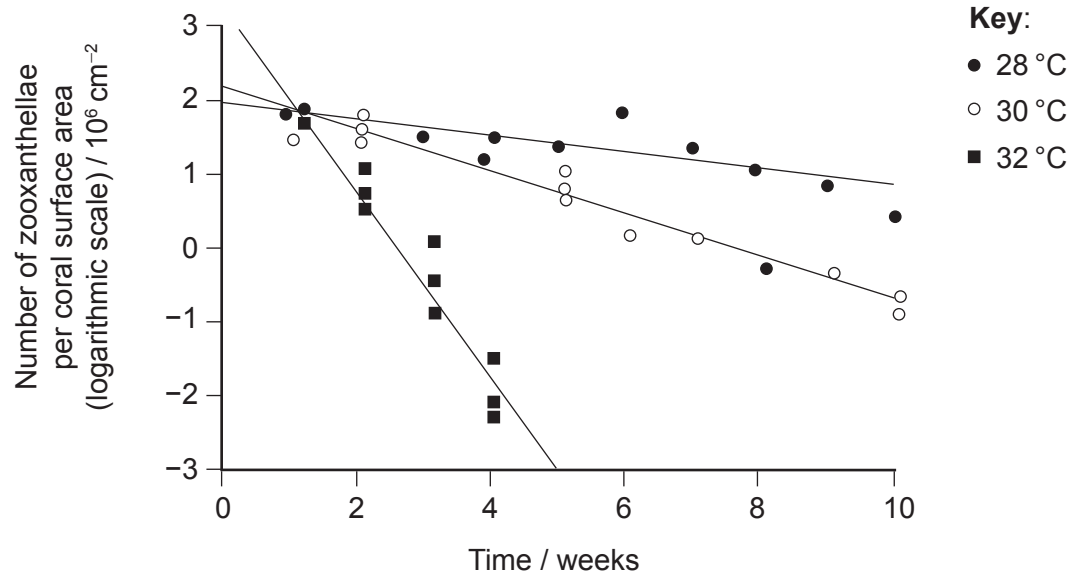
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Option C — Ecology and conservation

13. High-temperature tolerance experiments were performed on *Pocillopora damicornis*, a coral in the tropical eastern Pacific, in the Gulf of Panama. The scattergraph shows the zooxanthellae densities at three temperature treatments over a 10-week period.



Using the data, explain the effect of temperature on coral bleaching in the Gulf of Panama. [2]

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(Option C continues on the following page)



(Option C continued)

14. The table shows the numbers of five different species of algae growing in the River Trent in the United Kingdom from May to October 1939, at different distances from where untreated sewage had entered the river.

Distance from source of pollution / km	Number of algae per mm ²				
	<i>Stigeoclonium tenue</i>	<i>Nitzschia palea</i>	<i>Gomphonema parvulum</i>	<i>Stigeoclonium farctum</i>	<i>Cocconeis placentula</i>
-1	0	0	0	0	820
3	30	130	20	0	0
5	190	680	130	0	0
8	1620	2380	600	0	0
13	15300	5250	3390	20	0
16	50	620	690	1880	0
21	45	420	660	270	0
27	180	250	3000	300	0
35	30	100	1950	120	0
39	210	620	1950	3240	1930
44	190	1720	9170	70	1330
48	240	8000	4200	110	3500
56	220	150	1280	210	1480

(a) State the species with the greatest growth rate between 13 and 16 kilometres from the source of pollution in the River Trent.

[1]

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(Option C continues on the following page)



(Option C, question 14 continued)

- (b) Describe **one** method that could have been used to record the number of algae along the River Trent. [2]

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- (c) (i) Outline the use of indicator species to calculate the biotic index. [1]

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- (ii) Using the data, deduce with a reason which species of alga could be used as an indicator of pollution in the River Trent. [2]

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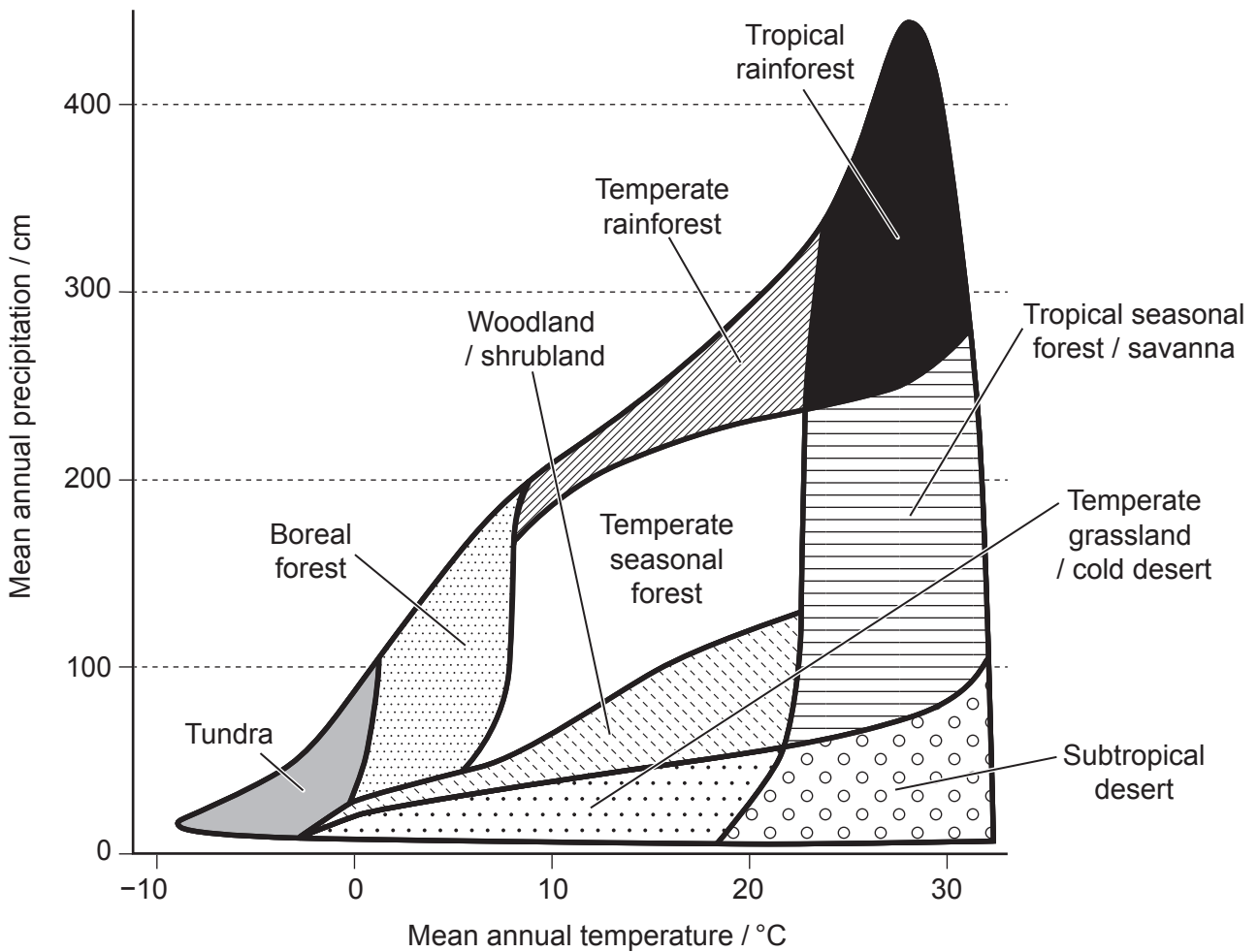
(Option C continues on the following page)



(Option C continued)

15. Each biome has unique characteristics in terms of organisms, weather, nutrient flow and stores.

(a) The model shows world biomes in relation to mean annual precipitation and mean annual temperature.



(i) State the mean annual temperature range in deserts. [1]

.....°C

(ii) State the mean annual precipitation range in tropical rainforests. [1]

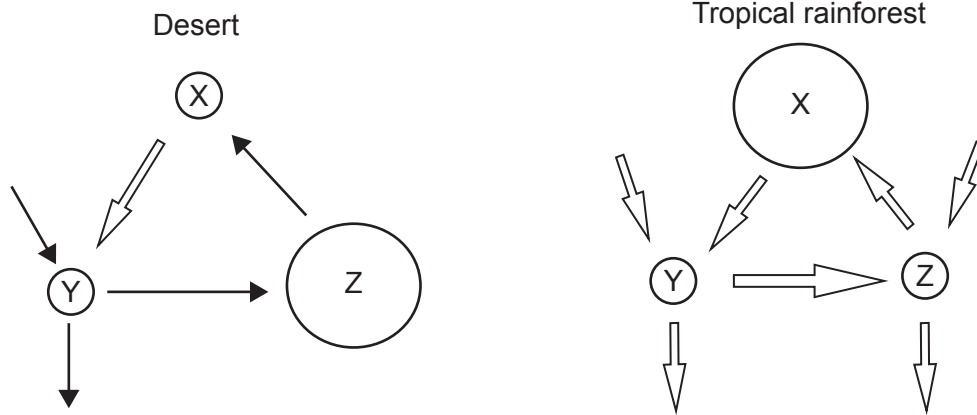
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(Option C continues on the following page)



(Option C, question 15 continued)

- (b) The Gersmehl diagrams show the inter-relationships between nutrient flows and stores in desert and tropical rainforest.



Deduce with a reason the nutrient store labelled Z.

[1]

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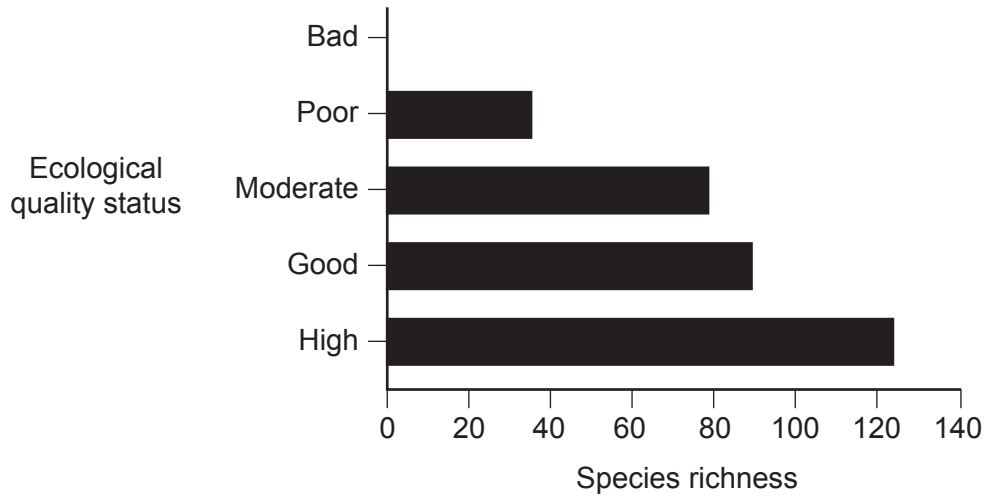
(Option C continues on the following page)



(Option C continued)

16. The sinking of the tanker Eurobulker off the coast of Greece in September 2000 resulted in a spill of 700 tonnes of crude oil. The sands in the oil spill region were categorized according to the level of pollution and the presence of indicator species.

The graph shows the trends in richness of all species in the five ecological quality status categories in sands after the oil spill.



- (a) Analyse the data to show that pollution affects biodiversity. [2]

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- (b) Outline how the biomagnification of chemicals from crude oil could occur in marine food chains. [3]

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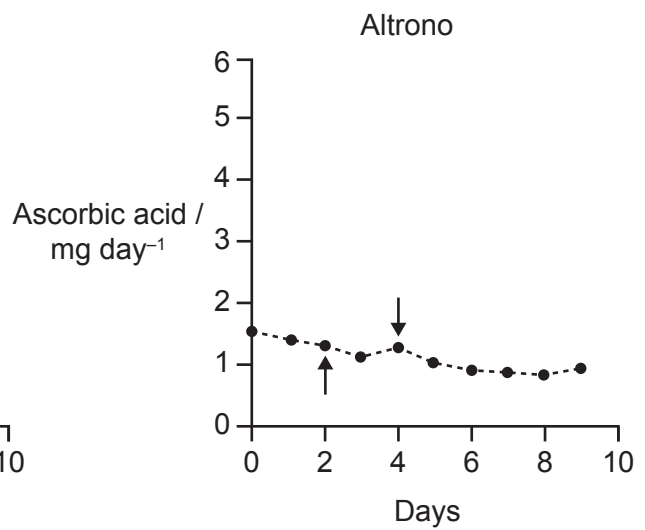
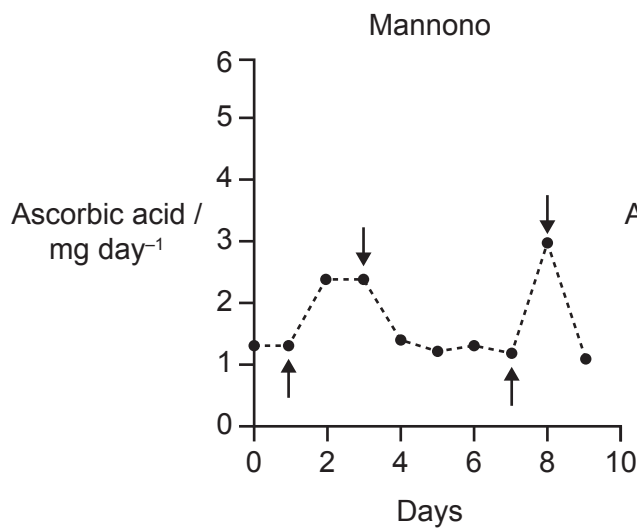
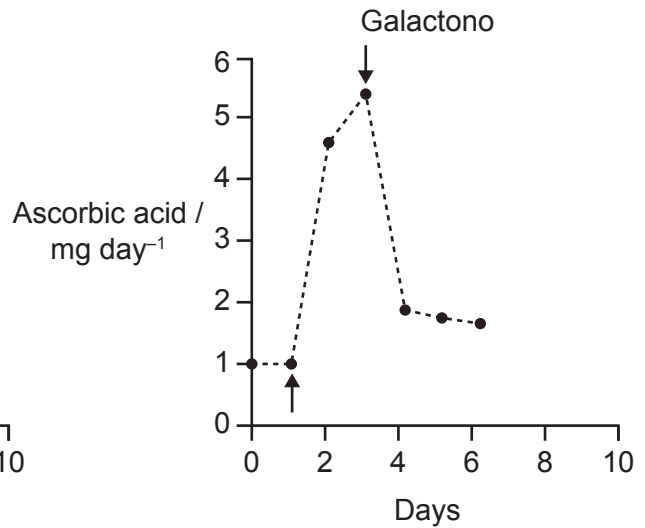
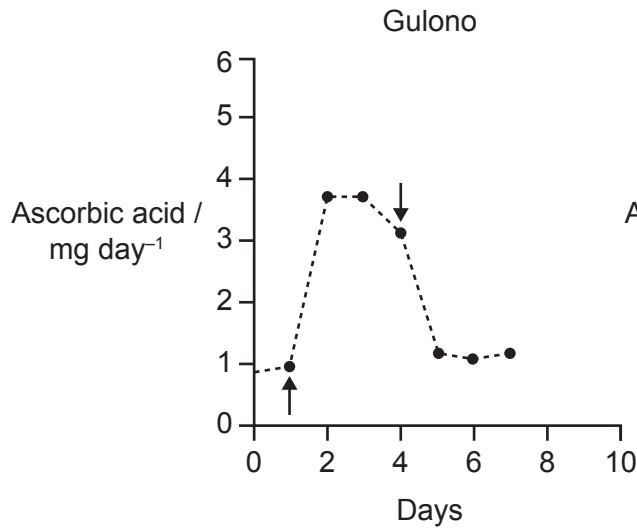
Option D — Human physiology

18. Many animals have a gene that codes for L-gulonolactone oxidase (GULO), a key enzyme in the biosynthesis of ascorbic acid (vitamin C). The graphs show the presence of ascorbic acid in rats' urine after the injection of the lactones gulono, galactono, mannono and altrono.

Key:

↑ lactone injected

↓ lactone no longer injected



(Option D continues on the following page)



(Option D, question 18 continued)

- (a) Determine with a reason which lactone **cannot** be used in the synthesis of ascorbic acid in rats. [2]

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- (b) Explain the need in humans to include ascorbic acid in the diet. [2]

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(Option D continues on the following page)



(Option D continued)

19. Iron can be found in different parts of the body.

(a) Outline the breakdown of red blood cells (erythrocytes) in the liver. [2]

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(b) Outline the function of iron in bone marrow. [2]

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(c) (i) State **one** nutrient other than iron that is stored in the liver. [1]

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(ii) Outline the formation of bile salts in the liver. [1]

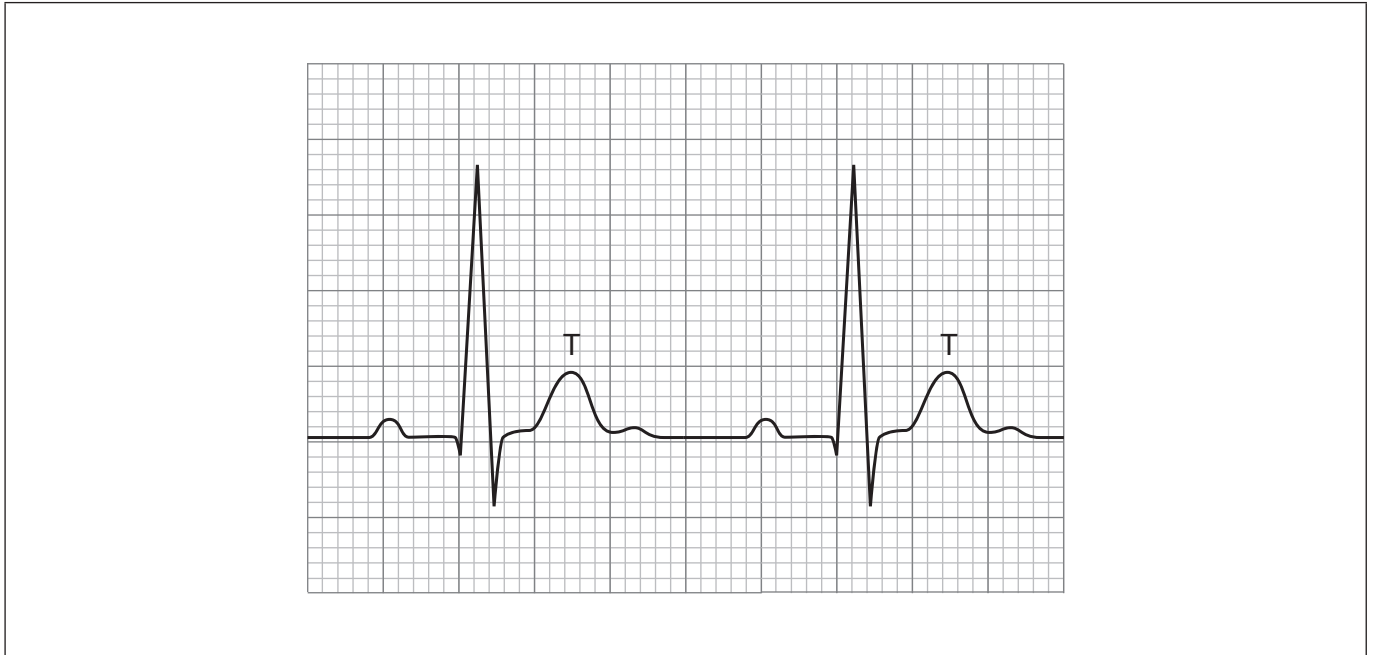
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(Option D continues on the following page)



(Option D continued)

20. The diagram of a normal electrocardiogram (ECG) trace shows two cardiac cycles.



- (a) Annotate the diagram to show the wave produced by
 - (i) the contraction of the atria; [1]
 - (ii) the contraction of the ventricles. [1]
- (b) State the stage of the cardiac cycle shown at T. [1]

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- (c) Explain how the structure of cardiac muscle cells is adapted to their function. [3]

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(Option D continues on the following page)



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32EP32