C007/SQP251

Biology
Advanced Higher
Specimen Question Paper
for use in and after 2005

Time: 2 hours 30 minutes

NATIONAL QUALIFICATIONS

SECTION A—Questions 1–25 (25 marks)

Instructions for completion of Section A are given on *Page two*.

SECTIONS B AND C

The answer to each question should be written in the answer book provided. Any additional paper (if used) should be placed inside the front cover of the answer book.

Rough work should be scored through.

Section B (55 marks)

All questions should be attempted. Candidates should note that Question 7 contains a choice.

Section C (20 marks)

Candidates should attempt the questions in one unit **either** Biotechnology **or** Animal Behaviour **or** Physiology, Health and Exercise.

SCOTTISH QUALIFICATIONS AUTHORITY

SECTION A

Read carefully

1. Check that the answer sheet provided is for Biology Advanced Higher (Section A).
2. Fill in the details required on the answer sheet.
3. In this section a question is answered by indicating the choice A, B, C or D by a stroke made in **ink** in the appropriate place on the answer sheet—see the sample question below.
4. For each question there is only **one** correct answer.
5. Rough working, if required, should be done only on this question paper or on the rough working sheet provided—**not** on the answer sheet.
6. At the end of the examination the answer sheet for Section A **must** be placed inside the front cover of the answer book.

SAMPLE QUESTION

Which of the following molecules contains six carbon atoms?

A Pyruvic acid

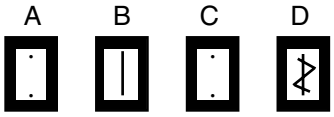
B Glucose

C Ribulose bisphosphate

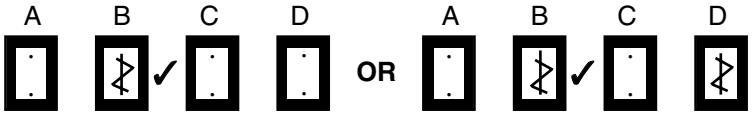
D Acetyl coenzyme A

The correct answer is **B**—Glucose. A **heavy** vertical line should be drawn joining the two dots in the appropriate box in the column headed **B** as shown **in the example on the answer sheet**.

If, after you have recorded your answer, you decide that you have made an error and wish to make a change, you should cancel the original answer and put a vertical stroke in the box you now consider to be correct. Thus, if you want to change an answer **D** to an answer **B**, your answer sheet would look like this:



If you want to change back to an answer which has already been scored out, you should **enter a tick (✓)** to the RIGHT of the box of your choice, thus:



SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

1. The function of flagella in prokaryotes is

A motility

B active transport

C adhesion

D DNA transfer.

2. Which of the following structures is present in both eukaryotic and prokaryotic cells?

A Mitochondrion

B Chloroplast

C Ribosome

D Nucleoid

3. The key below can be used to identify carbohydrates.

1.	Sugars	go to (2)
	Polysaccharides	go to (4)
2.	Monosaccharides	A
	Disaccharides	go to (3)
3.	Contains only one type of monomer ..	B
	Contains two types of monomer ...	sucrose
4.	Storage function	go to (5)
	Structural function in plants	C
5.	Storage function in animals	D
	Storage function in plants	starch

Which substance could be maltose?

4. Fatty acids and glycerol are joined in a triglyceride by

A hydrogen bonds

B ester linkages

C glycosidic linkages

D peptide bonds.

5. Which of the following is responsible for cell–cell recognition?

A Phospholipid

B Glycoprotein

C Cholesterol

D Peptidoglycan

6. The following reaction occurs in glycolysis.

fructose 6–phosphate → fructose 1,6–bisphosphate

Which type of enzyme would catalyse this reaction?

A Protease

B Polymerase

C ATPase

D Kinase

7. Not all cells respond to testosterone because

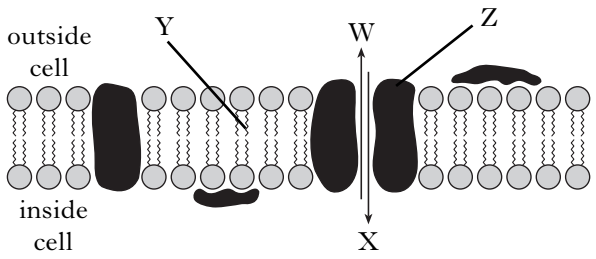
A the hormone crosses the plasma membrane of target cells only

B the hormone directly inhibits the transcription of certain genes

C only target cells possess the necessary regulatory proteins

D only target cells possess the genes necessary for the response.

Questions **8** and **9** refer to the following diagram of the sodium–potassium pump.



8. Which line in the table correctly identifies the labels?

	W	X	Y	Z
A	Sodium ions	Potassium ions	Protein	Phospholipid
B	Potassium ions	Sodium ions	Protein	Phospholipid
C	Sodium ions	Potassium ions	Phospholipid	Protein
D	Potassium ions	Sodium ions	Phospholipid	Protein

9. This pump moves ions in the ratio 3 sodium: 2 potassium.

5000 of these ions are pumped across the membrane every ten seconds. The number of potassium ions moved across in one second is

A 200

B 500

C 2000

D 3000.

Questions **10** and **11** refer to the following information.

ONPG is a colourless substrate for the enzyme β–galactosidase.

$$\text{ONPG} \xrightarrow[\beta\text{–galactosidase}]{} \text{galactose + ONP (yellow)}$$

The table shows the results of an investigation into the effect of inhibitor X and inhibitor Y on β–galactosidase at different substrate concentrations.

The greater the absorbance, the more active the enzyme.

ONPG concentration (%)	*Absorbance*	
	Inhibitor X	*Inhibitor Y*
0·25	0·17	0·05
0·50	0·25	0·05
0·75	0·34	0·04
1·00	0·50	0·06

10. Which of the following conclusions can be drawn from the results for inhibitor X?

A An increase in enzyme concentration increases enzyme activity.

B An increase in inhibitor concentration decreases enzyme activity.

C A three-fold increase in substrate concentration doubles the enzyme activity.

D Doubling the substrate concentration gives a three-fold increase in enzyme activity.

11. The results suggest that the inhibition by

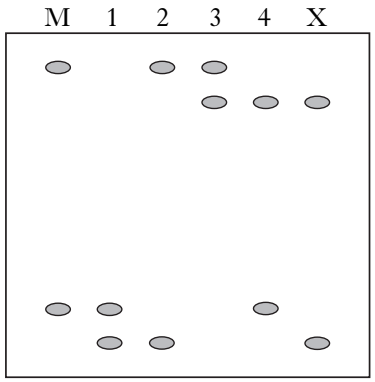
A inhibitor X is competitive and reversible

B inhibitor Y is competitive and reversible

C both inhibitors are non-competitive and non-reversible

D both inhibitors are competitive.

12. The DNA profile shown below was prepared using a single locus probe to determine if man X was the father of all four children. The samples shown are for the mother (M), four children (1–4) and man (X).



Which of the children have a different father?

A 1 and 2

B 2 and 3

C 3 and 4

D None of them

13. Net primary productivity in an ecosystem is the result of the activities of

A autotrophs

B heterotrophs

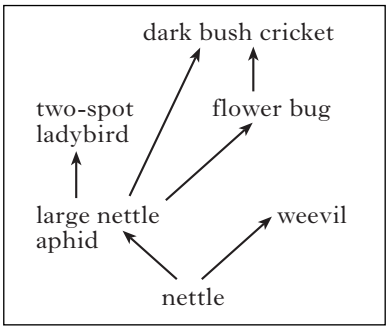
C detritivores

D decomposers.

Questions **14**, **15** and **16** refer to the following information.

The diagram shows a food web in a heathland ecosystem.

The table shows data obtained from an investigation into the mass and population density of the organisms in the food web.



Species	*Mean mass of organism* (g)	*Population density* (number m^{-2})
dark bush cricket	0·10	4
two-spot ladybird	0·03	20
flower bug	0·04	50
large nettle aphid	0·002	5420
weevil	0·005	3250
nettle	40·0	25

14. Which of the following populations in the food web has the largest biomass?

A Dark bush cricket

B Two-spot ladybird

C Weevil

D Large nettle aphid

15. The biomass of the primary consumer level is

A 5·41 g m^{-2}

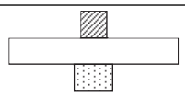
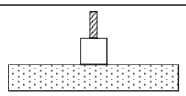
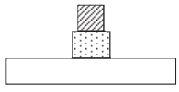
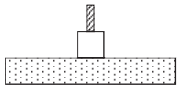
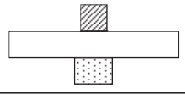
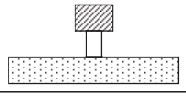
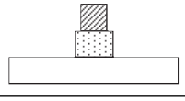
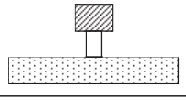
B 10·84 g m^{-2}

C 16·25 g m^{-2}

D 27·09 g m^{-2}.

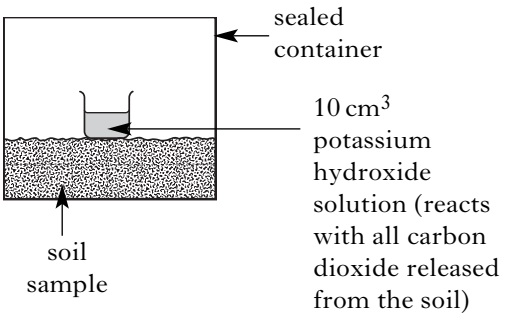
16. Which pair of diagrams in the table below correctly identifies the pyramids of number and biomass for the following food chain? (Pyramids not drawn to scale.)

nettle → large nettle aphid → two-spot ladybird

	Pyramid Type	
	Number	*Biomass*
A		
B		
C		
D		

Key: large nettle aphid; nettle; two-spot ladybird

17. The apparatus below was set up to compare the rates of respiration by decomposers in four soil samples.



After one day, the volume of hydrochloric acid needed to neutralise any potassium hydroxide left over was measured.

When the experiment was repeated with a fifth soil sample, it was found that **all** the potassium hydroxide had reacted with carbon dioxide released from the soil.

Before a valid calculation of respiration rate in this soil could be made, the experiment would have to be repeated

A at a higher temperature

B with a smaller mass of soil

C with a more dilute potassium hydroxide solution

D over a long period of time.

18. Which of the following is a density-independent effect?

A An increase in competitors decreasing the yield of a crop species

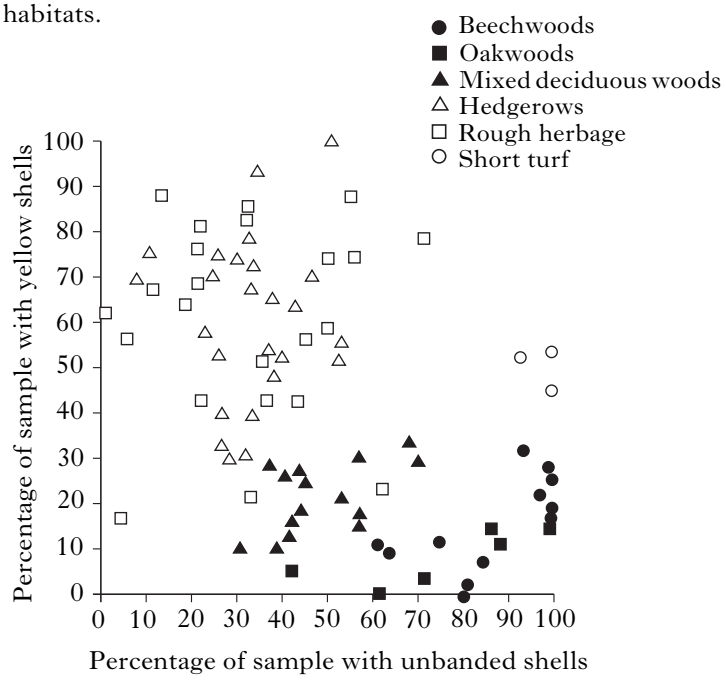
B An increase in food supply increasing the abundance of a herbivore

C A decrease in predators increasing the abundance of a prey species

D A decrease in temperature increasing the abundance of a tree species

Questions **19, 20** and **21** are based on the scattergram below which shows the distribution of different forms (morphs) of the snail *Cepaea nemoralis* in different habitats.

Cepaea has shells which may be either yellow or brown and may have either a banded or unbanded pattern. The scattergram shows frequencies of different colours and banding patterns in different habitats.



19. The habitat most favourable to brown, unbanded snails appears to be

A beechwoods

B hedgerows

C mixed deciduous woods

D short turf.

20. Which of the following pairs of habitats supports similar distributions of snail morphs?

A Hedgerows and beechwoods

B Rough herbage and short turf

C Oakwoods and mixed deciduous woods

D Hedgerows and rough herbage

21. Samples show that there are often good matches between the snails and the backgrounds of the different soils and vegetation. The snails' markings and colouration are showing

A aposematic colouration

B Mullerian mimicry

C crypsis

D Batesian mimicry.

22. Tiny crustaceans called copepods live inside the tentacles of a tropical sea anemone. These crustaceans feed on nutrients within the anemone but do it no harm.

This is an example of

A commensalism

B competition

C parasitism

D mutualism.

23. Which of the following types of succession will never lead to a climax community?

A Allogenic

B Autogenic

C Secondary

D Degradative

24. Which of the following is a problem associated with phosphate enrichment?

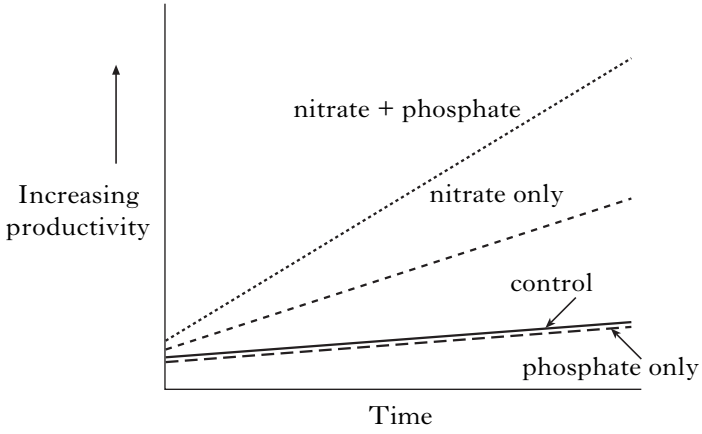
A Bioaccumulation

B Algal bloom

C Coral bleaching

D Biological magnification

25. The graph shows how productivity in a marsh was affected by the experimental addition of nitrate and phosphate. Neither was added in the control experiment.



Which statement is supported by the graph?

A Productivity in the control is limited by both nitrate and phosphate.

B Phosphate can limit productivity if enough nitrate is available.

C Phosphate limits productivity in the control experiment.

D Productivity in the marsh is never limited by phosphate.

[*END OF SECTION A*]

Candidates are reminded that the answer sheet MUST be returned INSIDE the front cover of the answer book.

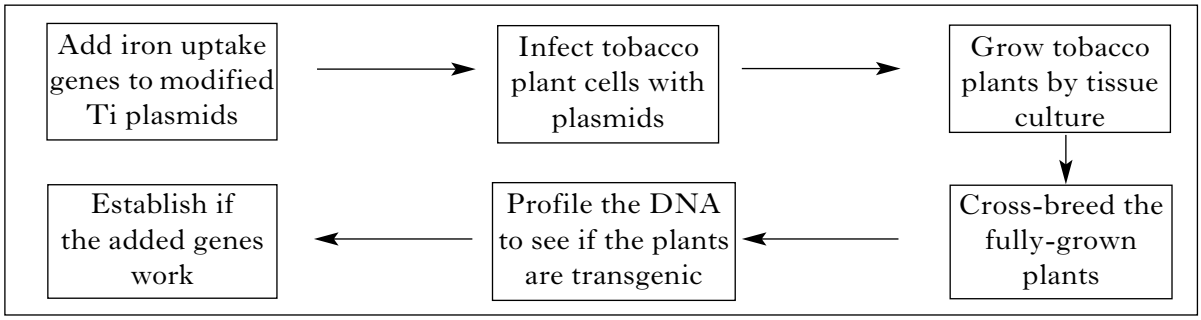
SECTION B

All questions in this section should be attempted.

1. *Agrobacterium tumefaciens* is a type of bacterium that causes a disease of plants resulting in tumour-like growths at the stem base. These abnormal growths in infected plants are caused by the tumour inducing or **Ti plasmid** of the bacterium. Genes from the plasmid are inserted into a chromosome in the infected plant cells. Ti plasmids have now been modified for laboratory use so that they no longer cause the disease but can still be used to insert genes of commercial interest into a plant's genome.

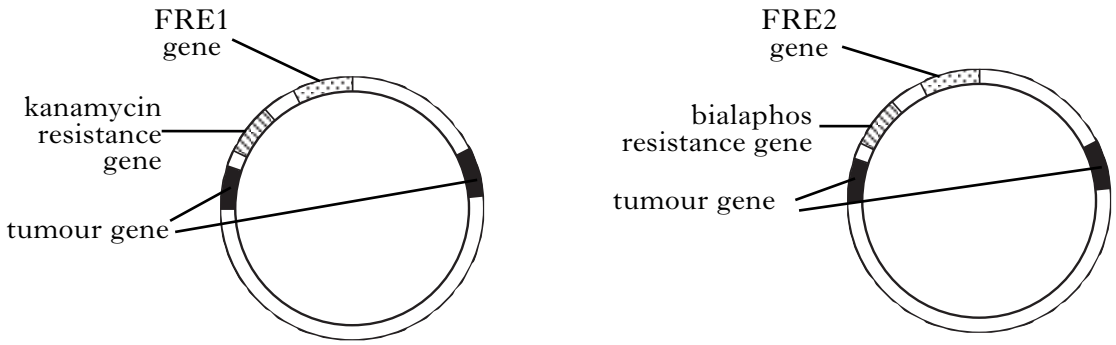
The aim of the research outlined below was to create transgenic tobacco plants with an increased ability to absorb iron from the soil. Modified Ti plasmids were used to transfer the iron uptake genes found in yeast cells into tobacco plants. Iron is an important nutrient for plants; it is absorbed in the roots and transported to the leaves where it is essential for the formation of chlorophyll. The study had several steps, shown as a flow diagram in Figure 1.

Figure 1: Steps in the production of transgenic tobacco plants.



FRE1 and FRE2 are two genes in yeast cells that code for proteins responsible for the absorption of iron across the plasma membrane. The FRE genes were isolated and inserted into separate Ti plasmids, each alongside a different toxin-resistance gene to act as a **marker** gene. FRE1 was linked to the gene for resistance to the toxin kanamycin. FRE 2 was linked to the gene for resistance to the toxin bialaphos. Diagrams of the plasmids are shown in Figure 2. These modified plasmids were returned to *Agrobacterium tumefaciens* cells, which were then cultured to produce two strains of the bacteria.

Figure 2: Modified Ti plasmids.



Tobacco plant tissue was incubated with each strain of bacterium and then transferred to tissue culture media to which the appropriate toxins had been added. Plants surviving the toxins were grown on in pots.

Question 1 (continued)

Two groups of plants were produced to begin with, one resistant to kanamycin (group KA) and the other resistant to bialaphos (group BI). These plants were then cross-bred to produce a third group of plants resistant to both toxins (group KA+BI). Plants from all three groups were tested for the presence of FRE genes and for the effects of the genes on iron absorption. Control plants were tested at the same time. DNA profiles, shown in Figure 3, proved that the genes were now present in the plants.

Figure 3: Profiling gels of tobacco plant DNA.

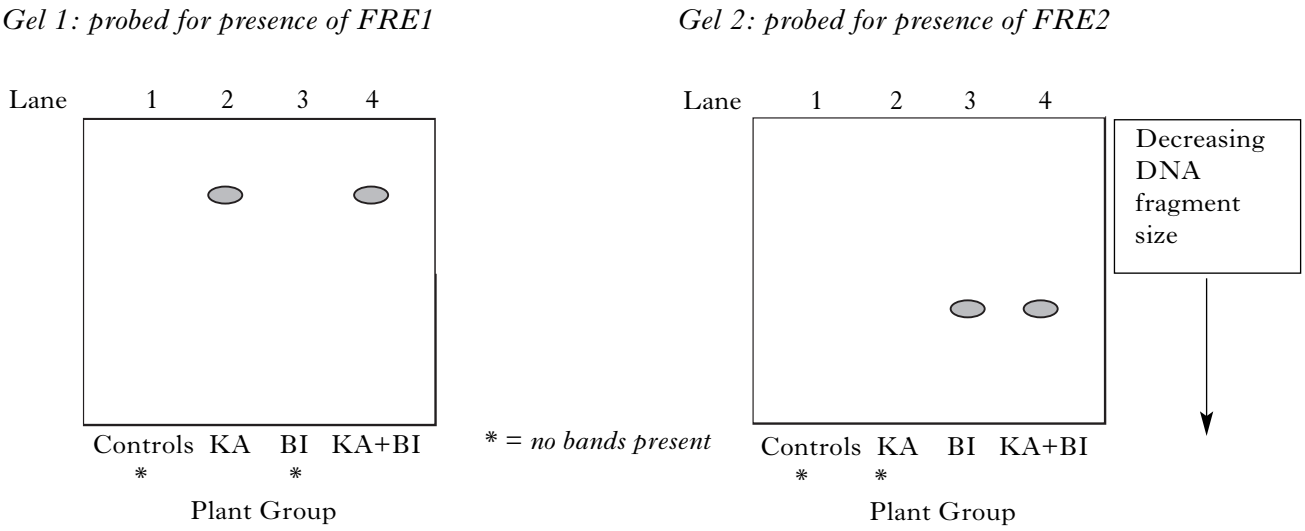


Figure 4 shows iron absorption by root samples from the different plant groups grown in conditions where iron is easily absorbed ("high" iron). Figure 5 compares the iron content of leaves after the plants were grown in "high" iron and "low" (difficult to absorb) iron conditions.

Figure 4: Iron absorption by roots of plants grown in "high" iron conditions.

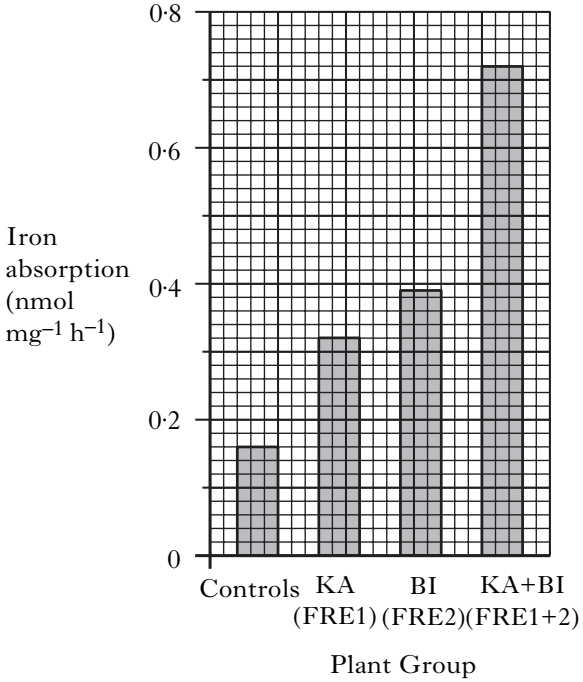


Figure 5: Iron content of leaf tissue of plants in "high" iron and "low" iron conditions.

	Iron concentration (µg/g dry mass)	
Plant Group	*"High" Iron*	*"Low" Iron*
Controls	129	26
KA (FRE1)	154	31
BI (FRE2)	199	43
KA+BI (FRE1+2)	223	41

[Question 1 continues on *Page ten*

Question 1 (continued)

(*a*) What are plasmids? **1**

(*b*) FRE1 and FRE2 code for proteins present in the plasma membrane of yeast cells.

Give **two** functions of membrane proteins. **2**

(*c*) (i) DNA extracted from all the groups of plants for profiling was digested by the same two enzymes, EcoRV and XbaI.

What term is used to describe enzymes such as EcoRV and XbaI? **1**

(ii) Name the procedure used to separate the DNA fragments in the gels. **1**

(iii) Which process could be used to amplify DNA fragments? **1**

(*d*) Control plants were used to ensure the validity of the study.

Suggest **one** way in which the control plants would have been different from the experimental plants. **1**

(*e*) Explain how the DNA profiles confirm:

(i) that plants selected for toxin resistance are also transgenic for FRE genes; **2**

(ii) that the cross-breeding of KA resistant and BI resistant plants has successfully combined both FRE genes into the plant genome. **1**

(*f*) (i) Draw **one** conclusion from the information in Figure 4. **1**

(ii) Use data in Figure 4 to justify your answer. **1**

(*g*) Refer to the data in Figure 5.

(i) For plants grown in "high" iron conditions, calculate the percentage increase in iron concentration of leaves when both FRE1 and FRE2 are present. **1**

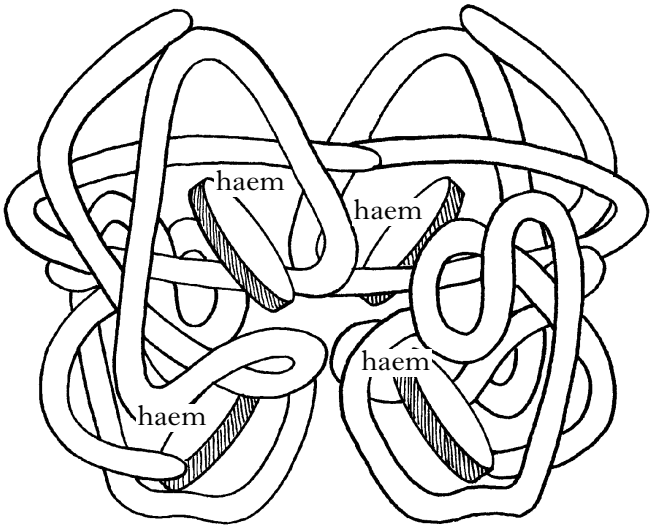
(ii) Use the data to compare the impact of the FRE2 gene on plants grown in the two iron conditions. **1**

(*h*) A critic of the study claims that "to boost leaf iron concentration it would be better to alter the soil than to engineer the plants".

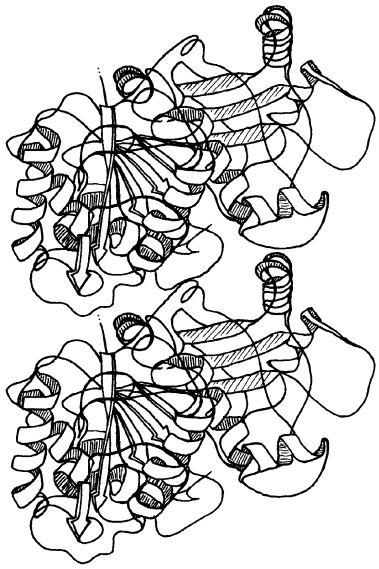
How can data in Figure 5 be used to support this position? **1**

(15)

2. The diagrams below represent the molecular structure of haemoglobin and tubulin.



Haemoglobin



Tubulin

(*a*) What aspects of secondary, tertiary or quaternary structure of proteins are shown in the diagrams of (i) haemoglobin and (ii) tubulin? **3**

(*b*) The secondary structure of a protein can be altered more easily than the primary structure. Explain this in terms of the bonds involved. **2**

(*c*) Tubulin is involved in the construction of microtubules.

(i) Where in the cell do microtubules originate? **1**

(ii) Describe the role of microtubules in M phase of the cell cycle. **1**

(*d*) Discuss the location and purpose of checkpoints in the cell cycle. **3**

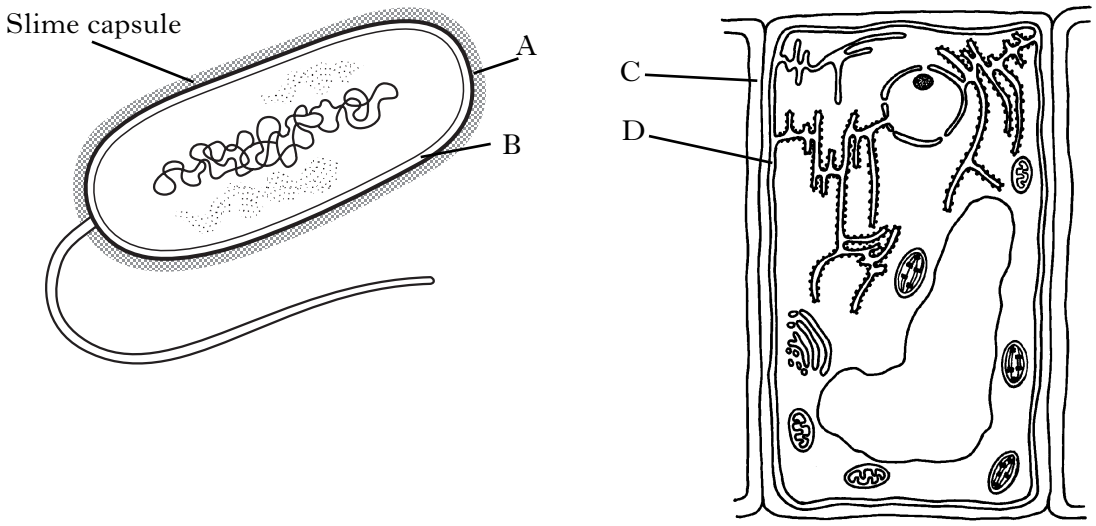
(10)

Marks

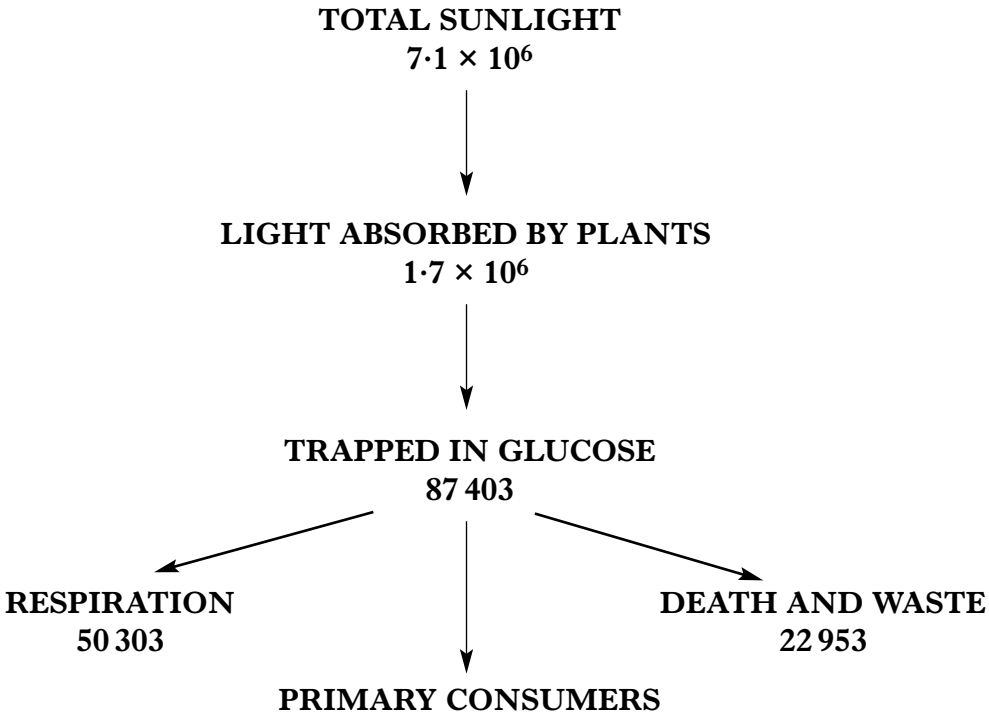
3. The diagrams below represents a bacterial cell and a plant cell.

Compare the composition of the outer layers labelled A, B, C and D on the diagrams. **2**

(2)



4. The diagram below shows energy flow through a freshwater ecosystem in Florida. Units are kJ m^{-2} yr^{-1}.



(*a*) How much energy is transferred annually to primary consumers in this ecosystem? **1**

(*b*) How much energy is fixed as a result of gross primary productivity? **1**

(*c*) What happens to the energy associated with respiration in the diagram? **1**

(3)

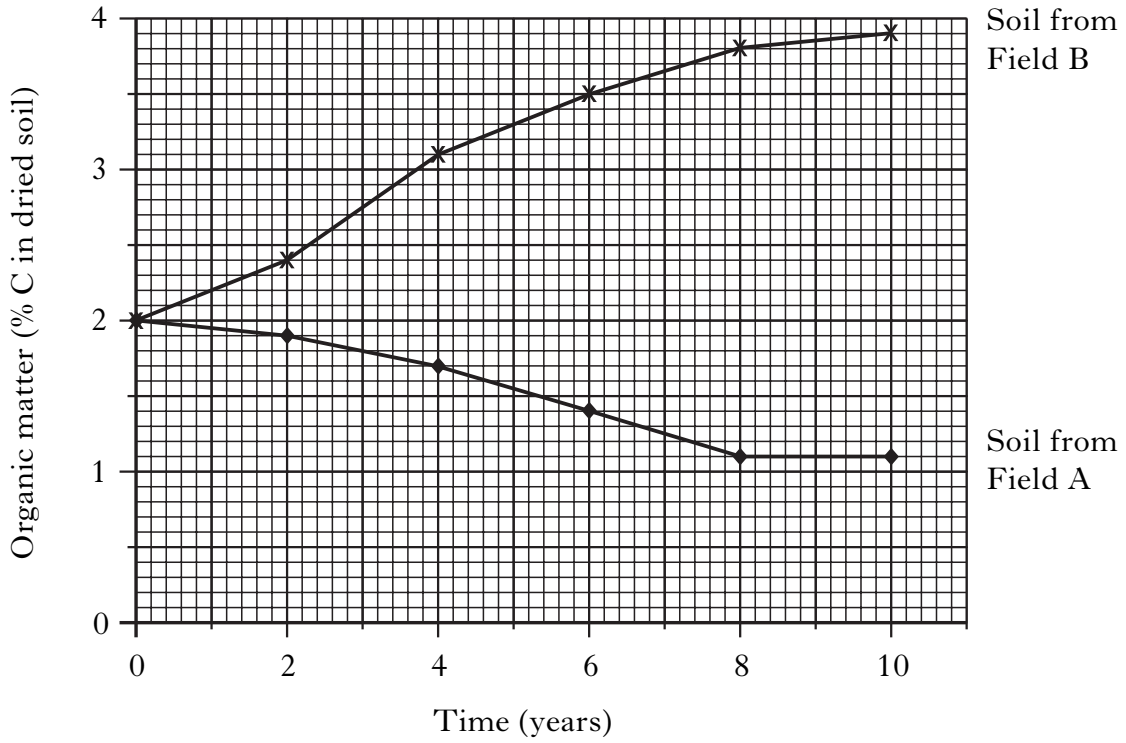
Marks

5. A piece of uncultivated land was divided into two fields which were treated as follows.

Field A – arable monoculture/ploughed annually

Field B – permanent pasture/grazed; not ploughed

The graph below shows changes occurring in the organic matter content of soils in the two fields.



(*a*) What is meant by monoculture? **1**

(*b*) Calculate the percentage change in carbon content for the soil in Field B after 8 years. **1**

(*c*) Suggest explanations to account for the changes shown in the two soils. **2**

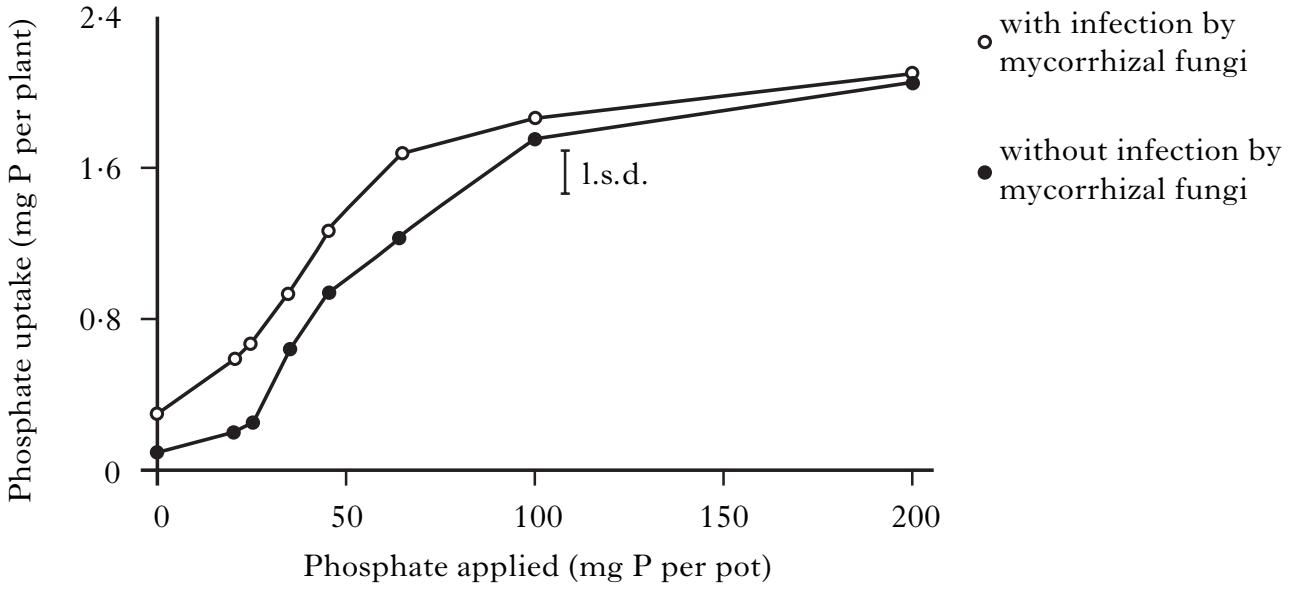
(4)

Marks

6. The root systems of many plants can interact with specialised fungi to form mutualistic relationships called mycorrhizae.

The graph shows the phosphorus (P) content of plants grown in pots of soil with various amounts of phosphate added, and with or without infection by mycorrhizal fungi.

The vertical bar shows the smallest difference considered to be significant (l.s.d.).



(*a*) Describe **two** characteristics of the relationship between plant roots and mycorrhizal fungi signified by the term "mutualistic". **2**

(*b*) From the graph, describe the effects of infection by mycorrhizal fungi. **2**

(*c*) Mycorrhizae are very important in the nutrition of forest trees, many of which are difficult to grow in the absence of fungi.

Use evidence in the graph to explain how forest trees might be cultivated more successfully in the absence of mycorrhizal fungi. **2**

(6)

7. Answer either A or B.

A Discuss the circulation of nutrients in ecosystems under the following headings:

(i) decomposition of organic matter; **5**

(ii) the role of bacteria in chemical transformations in the nitrogen cycle. **10**

(15)

OR

B Discuss the efffects of intensive food production on ecosystems. **(15)**

[*END OF SECTION B*]

SECTION C

Candidates should attempt questions on <u>one</u> unit, <u>either</u> Biotechnology <u>or</u> Animal Behaviour <u>or</u> Physiology, Health and Exercise.

The questions on Animal Behaviour can be found on pages 17–18.

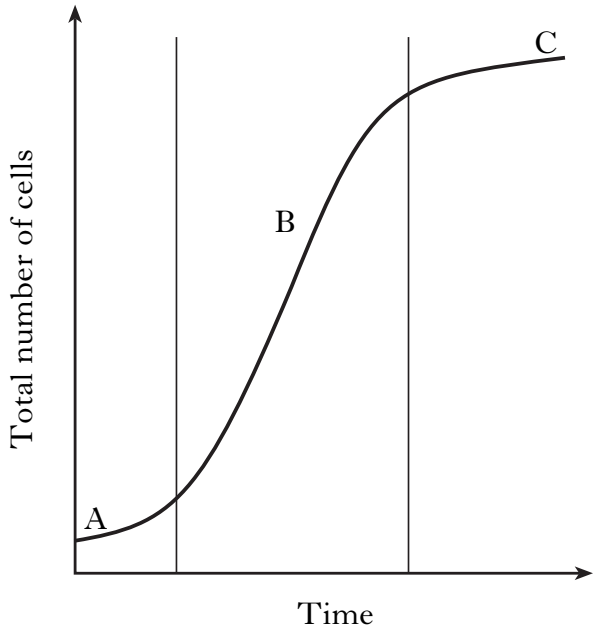
The questions on Physiology, Health and Exercise can be found on pages 19–20.

Labelled diagrams may be used where appropriate.

Marks

Biotechnology

1. The graph below shows the stages of growth in a microbial fermentation.



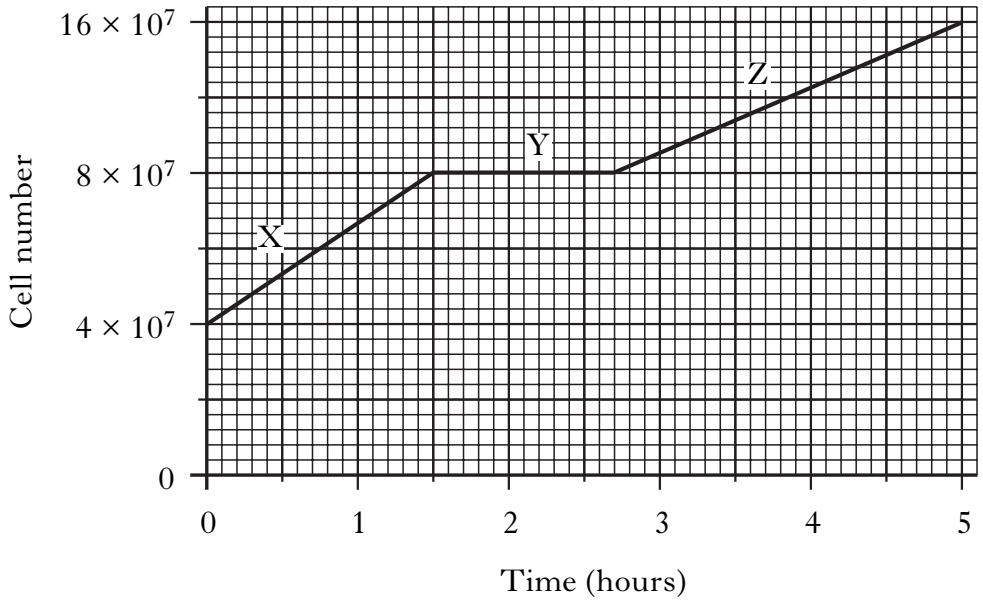
(*a*) State one reason why initial growth in stage A is slow. **1**

(*b*) (i) During which stage are secondary metabolites most likely to be produced? **1**

(ii) Name a secondary metabolite manufactured in a microbial fermentation. **1**

2. Describe the health benefits of probiotic food. **5**

3. The graph below shows the growth of *E. coli* when introduced into a culture medium containing glucose and lactose.



(*a*) What name is given to this pattern of growth? **1**

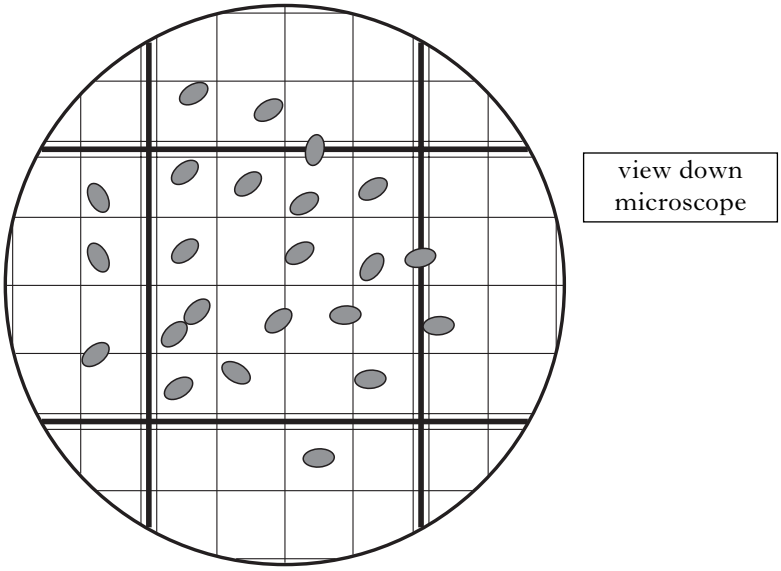
(*b*) The growth rate constant for phase X is 0·46. Calculate the growth rate constant for phase Z. **2**

(*c*) Explain why no growth occurs during phase Y. **3**

(*d*) The cell numbers in the fermentation were estimated using turbidometry. Describe the key features of this method. **2**

(*e*) Describe another technique which could be used to determine the number of viable cells. **2**

(*f*) The diagram below shows part of a haemocytometer grid being used to estimate the number of bacteria in a sample.



(i) Identify a possible source of error shown in the diagram. **1**

(ii) Suggest how the effects of this error could be minimised. **1**

[End of *Biotechnology* questions. *Animal Behaviour* questions start on page 17] **(20)**

SECTION C (continued)

Animal Behaviour

1. Brown hyenas are large carnivores living in the drier parts of Africa such as the Kalahari Desert in Botswana. The animals are solitary hunters and scavenge from the kills of other predators such as lions. In the dry season, when lions expand their territories, these hyenas switch to smaller prey such as reptiles, eggs, rodents and birds.

The hyenas live in small clans and are organised into dominance hierarchies. Researchers have found that the position of a female in a hierarchy is strongly associated with the time that she spends feeding on carcasses in the area.

(*a*) What are the main features of a dominance hierarchy? **2**

(*b*) Explain why dominant females were found to have significantly more cubs survive to maturity (36 months) than subordinate females. **2**

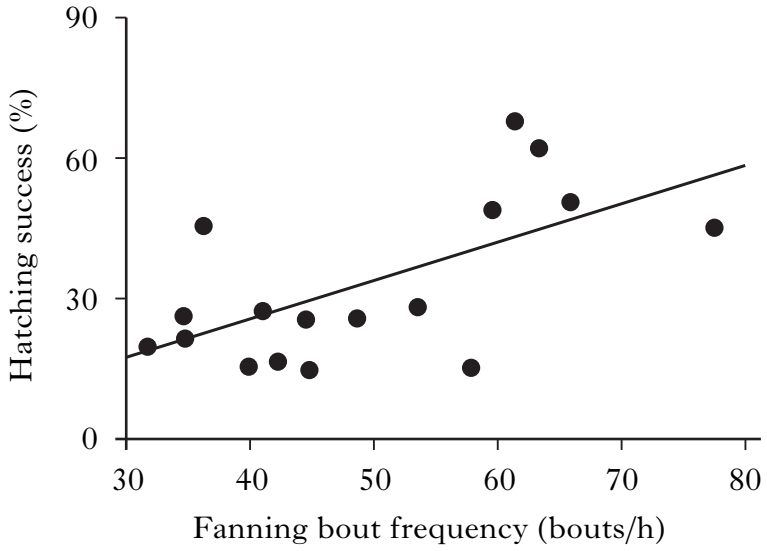
(*c*) Why do lions find it necessary to expand their territories in the dry season? **1**

(*d*) Not all hyenas are solitary hunters; some species often hunt in groups.

State **one** advantage and **one** disadvantage of group hunting. **2**

2. In spring, a male fifteen-spined stickleback builds a nest and then attempts to attract a female to lay eggs in it. Only the male looks after the young, "fanning" the nest to increase the flow of oxygenated water through it. Female choice of males seems to be based on the behaviour of the male after he has built his nest, particularly the time spent fanning which begins as soon as the nest is completed.

The scattergram below shows the relationship between the number of fanning bouts per hour and hatching success.



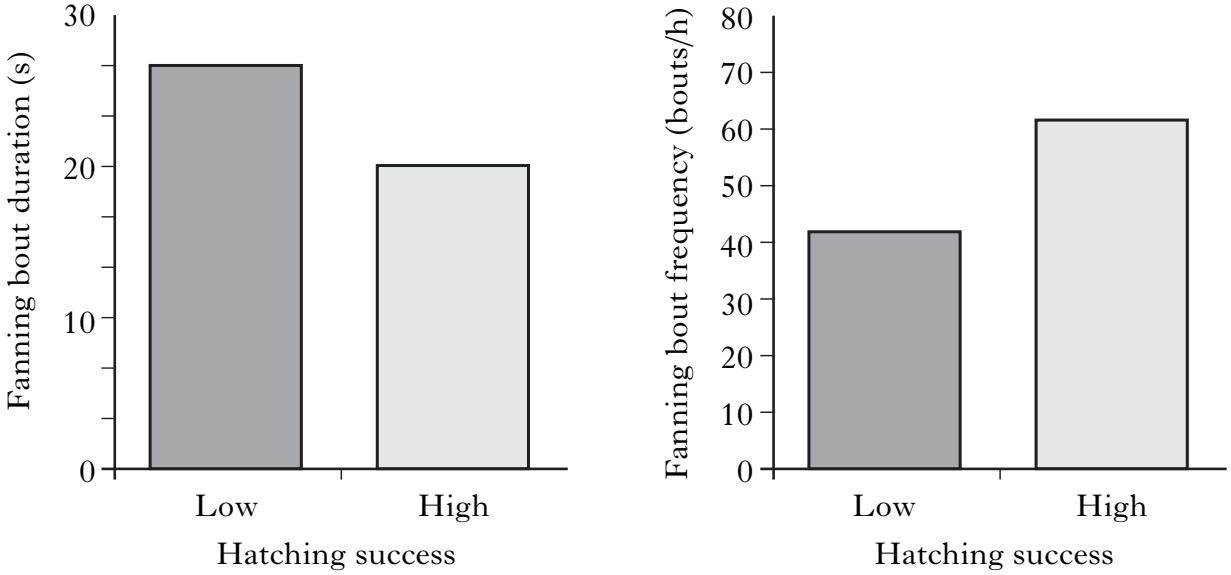
(*a*) Identify the independent and dependent variables in this study. **1**

(*b*) Explain the relationship shown in the scattergram. **2**

Marks

2. (continued)

The charts below compare the fanning behaviour of males that had a low or high hatching success.



(*c*) Discuss the best strategy for males to adopt in order to increase the hatching success of their eggs. **2**

(*d*) Female choice in these animals is mainly determined by the fanning ability of the male. Why should this be a reliable signal for a female to use? **2**

(*e*) Using a named example of a different animal species, describe a characteristic of males used by females to choose their mate. **1**

3. Give an account of reciprocal altruism. **5**

(20)

[End of *Animal Behaviour* questions.

***Physiology, Health and Exercise* questions start on page 19]**

SECTION C (continued)

Physiology, Health and Exercise

1. (*a*) What is meant by systole in the cardiac cycle? **1**

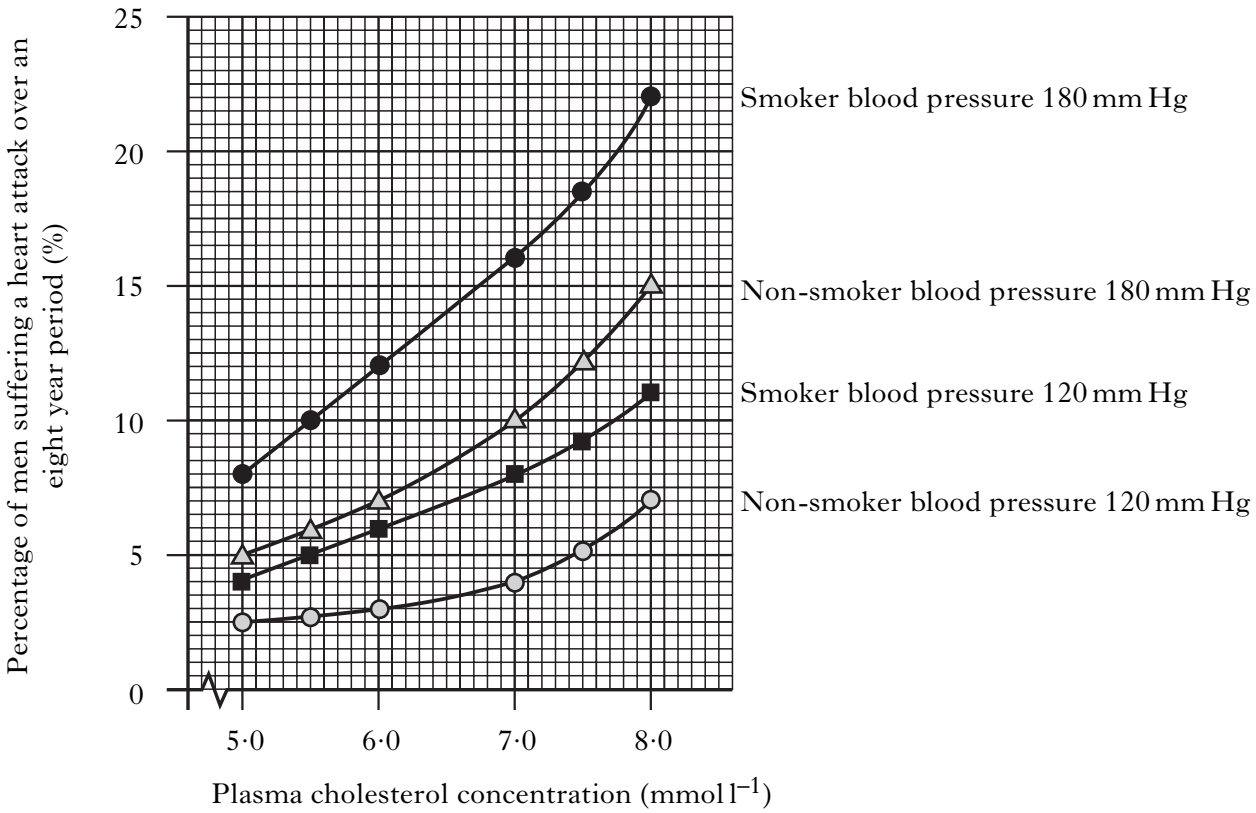
(*b*) The values $\frac{125}{75}$ mm Hg refer to the measurement of blood pressure.

Explain how the two values relate to the cardiac cycle. **2**

2. (*a*) Explain how atherosclerosis contributes to hypertension. **3**

(*b*) Describe the sequence of events that leads from atherosclerosis to myocardial infarction (MI). **3**

(*c*) The results shown in the figure below are from a long-term study into the impact of different factors on the risk of MI.



(i) From the data for non-smokers, draw two conclusions about the risk of MI. **1**

(ii) Express to the nearest whole number ratio, the relative risk of MI faced by a smoker having BP of 180 mm Hg and cholesterol of 8·0 mmol l^{-1} with a non-smoker having a BP of 120 mm Hg and cholesterol of 5·0 mmol l^{-1} . **1**

(iii) It is possible to conclude from the data that "raised BP has more impact on the risk of MI in smokers than non-smokers".

Use data from the graph to:

(A) support this conclusion;

(B) reject this conclusion. **2**

3. Discuss the effects of exercise on weight control. **4**

4. The table below presents the relationship between *body mass index* (BMI) and weight classification.

BMI	*Weight class*
less than 20	under weight
20 to 25	ideal weight
25 to 30	over weight
above 30	clinically obese

(*a*) Show how to work out the weight class of a person with a body mass of 90 kilograms and a height of 1·7 m. **2**

(*b*) Why might this method of classification be inappropriate for measuring the body composition of an athlete? **1**

(20)

[*END OF SPECIMEN QUESTION PAPER*]

C007/SQP251

Biology
Advanced Higher
Specimen Marking Instructions
for use in and after 2005

NATIONAL
QUALIFICATIONS

SCOTTISH
QUALIFICATIONS
AUTHORITY

Section A

1	A
2	C
3	B
4	B
5	B
6	D
7	C
8	C
9	A
10	C
11	A
12	D
13	A
14	C
15	D
16	A
17	B
18	D
19	A
20	D
21	C
22	A
23	D
24	B
25	B

Section B				
Question	**Acceptable Answer**	**Mark**	**Unacceptable Answer**	**Negates**
1 (*a*)	additional/ring/circular piece of DNA/genetic information in bacteria/prokaryote	1		– nucleus – found in animal/plant cell
(*b*)	receptors, enzymes, channels, carriers, attachment, junctions, recognition, transport, antigen, cell adhesion, control passage of substances *any 2* (1 mark each)	2		
(*c*) (i)	restriction (enzymes)/endonucleases	1	nuclease; restrictive enzyme	
(ii)	electrophoresis	1		
(iii)	Polymerase chain reaction/PCR	1	letters in wrong order	
(*d*)	no plasmids added/not given Ti plasmid (= wild type plants) no FRE1/no FRE2/no KA gene/no BI gene no <u>additional</u> iron uptake no toxin/KA/BI resistance given plasmids lacking FRE genes not exposed to Agrobacterium *any 1*	1	no alteration to DNA DNA unchanged no genes inserted	
(*e*) (i)	(probes indicate that) KA plants have (yeast) FRE1 (probes indicate that) BI plants have (yeast) FRE2 control plants do not have the FRE (gene) *any 2* (1 mark each)	2		– reference to KA or BI as disease resistant
(ii)	<u>Probes</u> for FRE1 and FRE2 show that both genes are present in the same plant OR (DNA from the) cross-bred/KA + BI plants reacts with both <u>probes</u>	1		

Section B	Acceptable Answer	Mark	Unacceptable Answer	Negates
1 (*f*) (i)	addition of FRE genes increases iron uptake OR statement about uptake relative to control (eg absorption is higher than control if FRE1 is present) OR treatments relative to each other *(eg absorption is higher with FRE2 inserted than if FRE1 is present)*	1		
(ii)	correct quantification (for answer (i)) (eg FRE1 at 0·32 units and control 0·16 units/0·16>control) (eg FRE2 at 0·39 units and FRE1 at 0·32 units/FRE2>FRE1 by 0·07 (eg FRE1+2 at 0·72 is 0·33>FRE2 alone or 0·40>FRE1 alone)	1	Correct units nmol $mg^{-1} h^{-1}$ must appear at least once Can accept no units if statement refers to absorption being 4 ×that of the control	
(*g*) (i)	72·868/72·87/72·9/73 (94/129 = 72·87)	1	72·86 or 72·00	
(ii)	FRE2 gives greater (percentage) improvement in low iron High 199 – 129 = 70 70/129 × 100 = 54·26% Low 43 – 26 = 17 17/26 × 100 = 65·4%	1		
(*h*)	the iron content of leaves of genetically modified tobacco in low iron is much less than the unaltered plants/control (129 units) when iron is easy to absorb OR growing control/normal tobacco in high iron gives (about three times) more iron in leaves than the best achieved by modified plants in low iron mark for correct observation; quantification not required *129/31 OR 129/43 OR 129/41 are OK*	1	Comparison of two controls is not enough reference to 154 or 199 or 223	

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
2 (*a*) (i)	present: haem prosthetic group, (four) sub-units	3		
(ii)	present: (two) sub-units, alpha helices, beta sheets *four correct 3 marks, two or three correct 2 marks, 1 correct 1 mark*			
(*b*)	bonds in primary are strong and covalent *both* **OR** peptide in secondary they are weak and hydrogen *both*	1 1		
(*c*) (i)	MTOC/microtubule organising centre	1		
(ii)	they are spindle fibres for separating chromatids (or equivalent terms eg chromosomes, kinetochores)	1		
(*d*)	checkpoint locations in G1, in G2 and in Metaphase of mitosis purpose of checkpoints G1 checks cell size G2 checks DNA replication is correct M checks chromosome alignment *any three*	3		
3	B and D are (both) phospholipid bilayer with protein OR annotated diagram of structure A and C (both are walls) A is made of peptidoglycan B is made of cellulose	1 1		
4 (*a*)	14147 $kJm^{-2}yr^{-1}$	1		
(*b*)	87403 $kJm^{-2}yr^{-1}$	1		
(*c*)	lost as heat	1		
5 (*a*)	cultivation of a single species over a large area	1		
(*b*)	90% increase	1		
(*c*)	A – decomposing organic matter not replaced, decreasing C% B – grazing animals' egesta incorporated into soil, increasing C%	1 1		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
6(*a*)	both species derive benefit OR structures are complementary OR metabolites are exchanged *any two*	2		
(*b*)	in low P soils/up to 100 mg added, mycorrhizae significantly increase P uptake in high P soils/100 – 200 mg added, mycorrhizae make no (significant) difference to P uptake	1 1		
(*c*)	grow trees in enriched/high P soils because mycorrhizae do not improve uptake in high P soils	1 1		

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
7A (i)	1 breakdown of organic matter to release (inorganic) nutrients/minerals 2 which are available for uptake by plants/primary producers 3 eg (organic matter) – animal waste/droppings/dead remains of plants/animals/microbes etc 4 eg (organic molecule) – cellulose/chitin/protein/urea etc 5 decomposers/saprotrophs are bacteria and fungi 6 detritivores are invertebrates/named example such as woodlice, earthworm, millipede 7 decomposers carry out breakdown by external (enzymatic) digestion 8 detritivores fragment detritus to produce humus 9 gives increased surface area for decomposers to work on 10 nitrogen fixation is nitrogen → ammonia/ammonium	Maximum 5		
(ii)	11 nitrogenase required 12 anaerobic conditions necessary/inhibited by oxygen 13 leghaemoglobin (produced due to plant and bacterial genes) absorbs/removes/binds excess oxygen (within *Rhizobium* cell) 14 oxygen released slowly for aerobic respiration 15 provides large amount of energy/ATP required by nitrogenase 16 carried out by free-living cyanobacteria/photosynthetic bacteria/*Nostoc*/*Azotobacter* 17 or by symbiotic bacteria/*Rhizobium* in root nodules/legumes 18 nitrification is ammonia/ammonium → nitrate 19 ammonium → nitrite by *Nitrosomonas*/*Nitrococcus* 20 nitrite → nitrate by *Nitrobacter* 21 denitrification is nitrate → nitrogen gas 22 by *Pseudomonas* OR denitrifiers are free-living 23 anaerobic conditions required 24 ammonification/decomposition by bacteria releases ammonia from dead organisms/animal waste	Maximum 10	Wrong bacterium linked to stage	

Question	Acceptable Answer	Mark	Unacceptable Answer	Negates
7B	1 monoculture is cultivation of single species 2 large area is more economical/suitable for mechanisation 3 hedgerows cleared/habitats destroyed (to increase in field size) 4 (monoculture) leads to reduction in species diversity 5 (monoculture) leads to loss of stability/change in populations/increase in pest numbers or species 6 (monoculture) adversely affects soil structure/soil condition/crumb structure/organic content 7 erosion more likely 8 pesticides (any type) reduce species diversity 9 substances used may be toxic/polluting 10 may be persistent/non-degradable/may accumulate 11 concentration increased with each trophic transfer is biomagnification 12 consequence of (biomagnification) eg populations of top predator birds decreased 13 due to high concentrations being lethal OR causing loss of eggs due to shell-thinning 14 use of <u>chemical</u> fertilisers (to increase yield/promote growth); chemical = artificial = inorganic 15 loss of nutrients through leaching/cropping 16 nitrates/phosphate leak into aquatic ecosystem (in run-off) 17 nutrient enrichment/eutrophication occurs 18 leads to large populations of algae/algal blooms 19 sunlight blocked out and aquatic plants die 20 death of algae/plants leads to large bacterial population 21 high BOD/low levels of oxygen/oxygen depletion 22 aquatic animals/fish die	Maximum 15		

Section C *Option: Biotechnology*				
Question	**Acceptable Answer**	**Mark**	**Unacceptable Answer**	**Negates**
1 (*a*)	Time needed for adaptation/repair of damage/replace metabolites	1		
(*b*) (i)	stage C/stationary phase	1		
(ii)	antibiotic/named example, eg penicillin	1		
2	1 probiotics contain live bacteria 2 health benefits beyond basic nutrition 3 control pathogens in the gut 4 inactive toxins produced by pathogens 5 anti-cancer activity 6 reduce blood cholesterol 7 improve lactose intolerance	5		
3 (*a*)	diauxic	1		
(*b*)	growth rate constant (k) = 0·693/g where g is doubling time at stage Z k = 0·693/2·3 = 0·30	1 1		
(*c*)	glucose is preferentially metabolised and is now exhausted enzymes that act on lactose no longer repressed induction of these enzymes by lactose results in lag	1 1 1		
(*d*)	measure absorbance in colorimeter/equivalent instrument compare against standard/calibration curve	1 1		
(*e*)	dilution series, poured plates, grow bacteria, count colonies *four correct for 2 marks, two or three correct for 1 mark*	2		
(*f*) (i)	whether or not to count bacteria on boundaries	1		
(ii)	count as "in" on 2/4 pre-determined sides, eg N and S	1		

Section C *Option: Animal Behaviour*				
Question	**Acceptable Answer**	**Mark**	**Unacceptable Answer**	**Negates**
1 (*a*)	system of social ranking established through fighting/based on threat of physical violence rank determines right to resources/mates *any two*	2		
(*b*)	dominant animals feed longer at kills/eat more food cubs are better nourished and have greater survival chances	1 1		
(*c*)	they have to disperse further in search of scarcer food	1		
(*d*)	advantage – can hunt larger prey species disadvantage – food obtained has to be shared	1 1		
2 (*a*)	independent = fanning frequency; dependent = % hatching success	1		
(*b*)	as fanning bout frequency increases, % hatching success increases fanning improves oxygen supply/gas exchange	1 1		
(*c*)	males should fan frequently and in short bursts this offsets the decrease in oxygen level in water round eggs	1 1		
(*d*)	rate of fanning is indication of male "fitness" fitter/healthier males will increase survival of young in their care	1 1		
(*e*)	any correct example of conspicuous marking, structures, behaviours etc to attract females, eg peacock tail feathers	1		
3	1 altruistic behaviour improves survival chances of others 2 decreases own chance of survival/has costs, eg time/energy/risk 3 reciprocal altruism is intraspecific 4 mutual benefits outweigh costs 5 involves helping others and being repaid later 6 cooperators leave more offspring than non-cooperators 7 example of behaviour, eg blood meal sharing by vampire bats 8 example of benefit, eg bats are more likely to feed others that have fed them previously	5		

Section C *Option: Physiology, Health and Exercise*				
Question	**Acceptable Answer**	**Mark**	**Unacceptable Answer**	**Negates**
1 (*a*)	(ventricular) contraction	1		
(*b*)	systolic pressure over diastolic pressure (measured in mm Hg) OR upper value is systole/the pressure of ventricular contraction lower value is diastole/pressure at ventricular relaxation	 1 1		
2 (*a*)	deposition of atheroma/fatty plaque/cholesterol beneath inner lining of arteries arteries made narrower/narrower lumen increases resistance arteries lose their elasticity as the walls thicken blood pressure increases to overcome the increased resistance	 1 1 1		
(*b*)	platelets gather on rough surface of plaque clotting factors cause red cells to clump/form thrombus thrombus breaks off/enters circulation and gets trapped in coronary artery *four points for 3 marks, three points for 2, one or two points for 1*	 3		
(*c*)(i)	as cholesterol level increases risk of MI increases elevated BP increases risk of MI (at all cholesterol levels) *both*	 1		
(ii)	22:2 = 11:1	1		
(iii)	(A) support at cholesterol levels 6·0, 7·0 and 8·0, smokers show greater difference in numerical values of risk as blood pressure increases eg cholesterol 8·0: risk increases by 11 (11 → 22) for smokers but 8 (7 → 15) for non-smokers; 6·0 risk increases by 6 (6 → 12) for smokers but 4 for non-smokers (3 → 7) (B) reject however if the initial risk is compared (number of times the risk is increased) then non-smokers have greater increase eg cholesterol 8·0, 7·0 and 6·0 risk is increased 2·0 times for smokers (22/11, 16/8, 12/6) but more for non-smokers (2·13, 2·5, 2·3)	 1 1	no quantification	

Section C	*Option: Physiology, Health and Exercise*			
Question	**Acceptable Answer**	**Mark**	**Unacceptable Answer**	**Negates**
3	1 exercise increases energy deficit/difference between intake and expenditure per day/ increases output relative to input energy 2 exercise increases fat loss and preserves lean tissue/increases body mass index/helps prevent obesity 3 low energy/reduced food intake causes fall in BMR 4 (drop in BMR) prevented by exercise/exercise increases BMR 5 aerobic exercise is more effective 6 (exercise should be) of moderate intensity/of long duration/done frequently	4		
4 (*a*)	BMI formula BMI = mass(kg) / (height(m))^2 this individual is 90/2·89 = 31 which is slightly overweight in the table *both*	1 1		
(*b*)	method is intended to estimate body fat **and** athlete may be heavy for his height because of large muscle bulk, not fat	1		

[*END OF SPECIMEN MARKING INSTRUCTIONS*]