X007/13/02

NATIONAL QUALIFICATIONS 2013

WEDNESDAY, 15 MAY
1.00 PM – 3.30 PM

BIOLOGY
ADVANCED HIGHER

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 ink 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 8 contains a choice.

Question 1 is on Pages 10, 11 and 12. Question 2 is on Page 12 and Question 3 is on Page 13. Pages 12 and 13 are fold-out pages.

Section C (20 marks)

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

Read carefully

1 Check that the answer sheet provided is for **Biology Advanced Higher (Section A)**.

2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.

3 Check that the answer sheet you have been given has **your name**, **date of birth**, **SCN** (Scottish Candidate Number) and **Centre Name** printed on it.

Do not change any of these details.

4 If any of this information is wrong, tell the Invigilator immediately.

5 If this information is correct, **print** your name and seat number in the boxes provided.

6 The answer to each question is **either** A, B, C or D. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided (see sample question below).

7 There is **only one correct** answer to each question.

8 Any rough working should be done on the question paper or the rough working sheet, **not** on your answer sheet.

9 At the end of the examination, put the **answer sheet for Section A inside the front cover of the answer book**.

Sample Question

Which of the following molecules contains six carbon atoms?

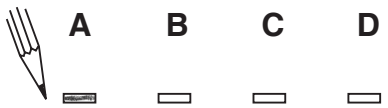
A Glucose

B Pyruvic acid

C Ribulose bisphosphate

D Acetyl coenzyme A

The correct answer is **A**—Glucose. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



Changing an answer

If you decide to change your answer, carefully erase your first answer and using your pencil, fill in the answer you want. The answer below has been changed to **D**.

SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

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

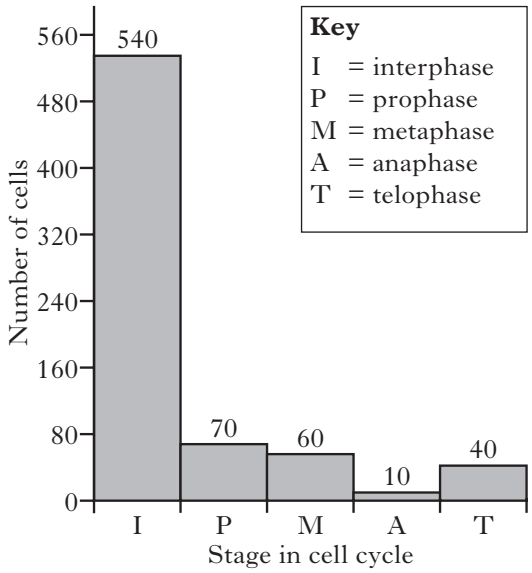
A Ribosomes

B Mitochondria

C Pili

D Centrioles

2. The figure below shows the number of cells in a tissue sample at various stages of the cell cycle.



The mitotic index for this sample is

A 3

B 4

C 25

D 33.

3. Which of the following genes encodes proteins that prevent the development of tumours by restricting cell division?

A Oncogenes

B Regulator genes

C Proto-oncogenes

D Anti-proliferation genes

4. Which line in the table correctly describes the chemical reaction in which two monosaccharides are joined together?

	Type of reaction	*Type of bond formed*
A	hydrolysis	glycosidic
B	condensation	glycosidic
C	hydrolysis	ester
D	condensation	ester

5. An unbranched polysaccharide is made up of glucose monomers joined together by $\beta(1\text{–}4)$ linkages. This polysaccharide could be

A amylopectin

B cellulose

C amylose

D glycogen.

6. Which of the following statements about the sodium-potassium pump is correct?

A The transport protein has an affinity for sodium ions in the cytoplasm.

B It results in a higher concentration of sodium ions inside the cell.

C The transport protein has an affinity for sodium ions in the extracellular fluid.

D It results in a higher concentration of potassium ions outside the cell.

7. The total surface area of a red blood cell is about $136\,\mu m^2$. A single sodium-potassium ATPase molecule takes up an area of $1 \times 10^{-4}\,\mu m^2$. In total these molecules account for 0·5% of the cell surface area.

Approximately how many of these molecules are there on the surface of one red blood cell?

A 13 600

B 6 800

C 3 400

D 680

8. Which of the following describes the structure of thymine?

A A pyrimidine base with a single-ring structure.

B A pyrimidine base with a double-ring structure.

C A purine base with a single-ring structure.

D A purine base with a double-ring structure.

9. The role of the polymerase chain reaction (PCR) is to

A profile DNA

B anneal DNA

C replicate DNA

D sequence DNA.

10. A short stretch of a DNA molecule that could be used as a template for the polymerase chain reaction (PCR) is shown below.

5' ATTCCGGTCGACCGGTAC 3'
top strand

3' TAAGGCCAGCTGGCCATG 5'
bottom strand

Which of the following correctly represents the base sequence of a primer that would bind to the **top** strand of the template DNA?

A 5' TGGCCTTA 3'

B 5' ATTCCGGT 3'

C 5' ACCGGAAT 3'

D 5' TAAGGCCA 3'

11. Enzymes that catalyse the hydrolysis of phosphodiester bonds in genetic material are called

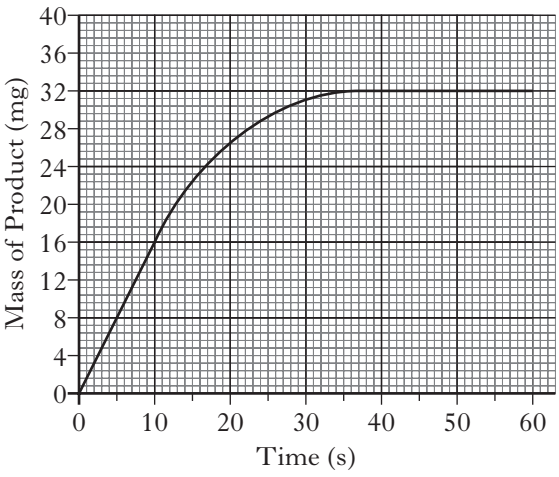
A ligases

B kinases

C nucleases

D polymerases.

12. The graph below shows the mass of product resulting from an enzyme controlled reaction.



What is the initial rate of reaction?

A $0{\cdot}53\ mg\ s^{-1}$

B $0{\cdot}63\ mg\ s^{-1}$

C $0{\cdot}89\ mg\ s^{-1}$

D $1{\cdot}60\ mg\ s^{-1}$

13. A marine food chain is shown below.

phytoplankton ⟶ zooplankton ⟶ fish

The phytoplankton have a lower biomass than the zooplankton. The food chain will remain stable if

A other consumers eat the phytoplankton

B there are larger numbers of phytoplankton than zooplankton

C the fish also feed on other producers

D the phytoplankton have a higher productivity than the zooplankton.

14. The table below shows the areas of four aquatic ecosystems and their contribution to world net primary production.

Ecosystem number	*Description*	*Area* (millions km^2)	*World net primary production* (10^9 tonnes/year)
1	Estuaries	1·4	2·1
2	Upwelling zones	0·4	0·2
3	Lakes and streams	2·0	0·5
4	Continental shelf	26·6	9·6

The order of increasing net primary productivity for these ecosystems is

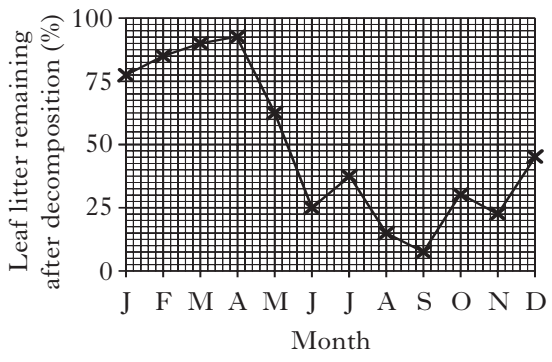
A 3 → 4 → 2 → 1

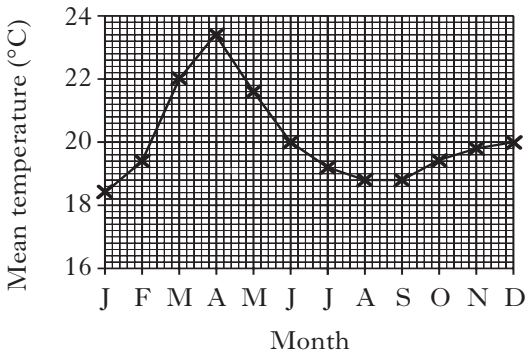
B 3 → 2 → 1 → 4

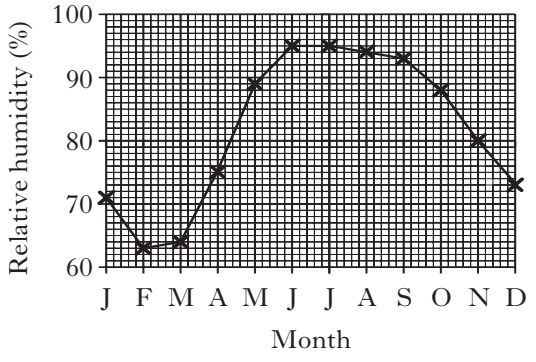
C 4 → 2 → 1 → 3

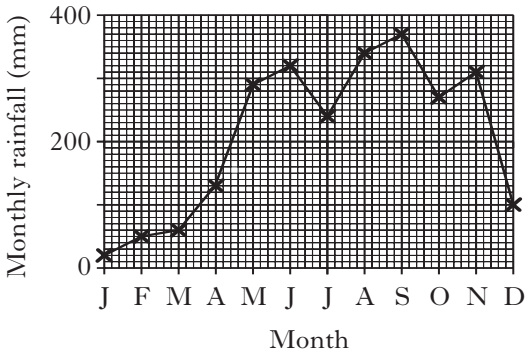
D 1 → 2 → 4 → 3.

15. The decomposition of leaf litter on the floor of a tropical rainforest was studied monthly over a year. The changes in some abiotic factors were also recorded. The graphs below show the results.









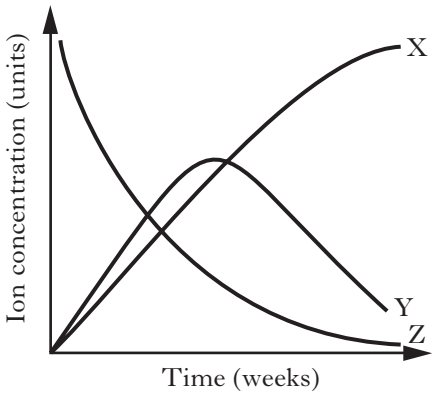
Which row in the table below correctly identifies changes in abiotic factors that **increase** the rate of decomposition?

	Mean temperature	*Relative humidity*	*Monthly rainfall*
A	Higher	Lower	Lower
B	Lower	Higher	Higher
C	Higher	Lower	Higher
D	Lower	Higher	Lower

16. Which line in the table identifies correctly micro-organisms responsible for nitrogen fixation and for nitrification in the soil?

	Micro-organisms	
	Nitrogen fixation	*Nitrification*
A	*Rhizobium*	Cyanobacteria
B	*Nitrobacter*	*Nitrosomonas*
C	*Nitrosomonas*	*Rhizobium*
D	Cyanobacteria	*Nitrobacter*

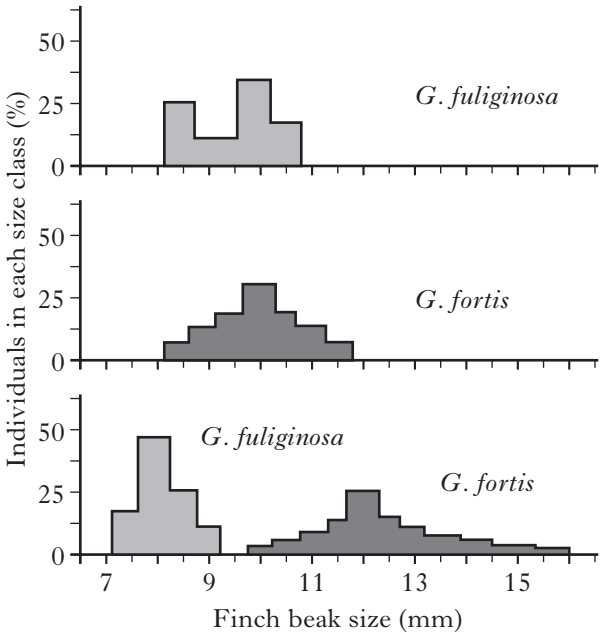
17. A flask containing some soil in a solution of ammonium salts was set up to demonstrate the activity of nitrifying bacteria. The concentrations of ammonium, nitrite and nitrate ions were measured over several weeks and the results are shown in the following graph.



Which line in the table below correctly represents the results obtained?

	X	*Y*	*Z*
A	nitrate	nitrite	ammonium
B	nitrite	nitrate	ammonium
C	ammonium	nitrite	nitrate
D	nitrate	ammonium	nitrite

18. The information below shows the distribution of beak sizes in two species of finches living separately and living together.



The changes in distribution are a result of

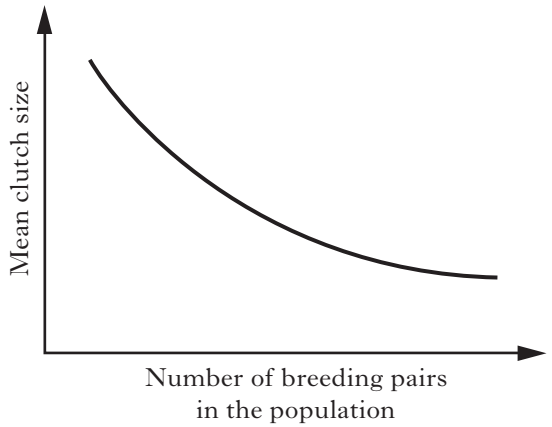
A intraspecific competition

B competitive exclusion

C resource partitioning

D exploitation competition.

19. The graph below shows the relationship between the number of breeding pairs in a songbird population and the mean clutch size (number of eggs in a nest).



The graph shows that clutch size is affected by

A intraspecific competition that is density dependent

B intraspecific competition that is density independent

C interspecific competition that is density dependent

D interspecific competition that is density independent.

20. The gases shown in the table below may contribute to acid rain (AR) and the greenhouse effect (GE). Which line in the table correctly shows the contribution of each gas?

	Gas					
	CFC		*Carbon dioxide*		*Methane*	
	AR	*GE*	*AR*	*GE*	*AR*	*GE*
A	✓	✗	✓	✓	✗	✓
B	✗	✓	✗	✓	✓	✗
C	✓	✓	✓	✗	✓	✓
D	✗	✓	✓	✓	✗	✓

21. Coral bleaching is the result of an increase in

A ultraviolet radiation

B nutrient concentration

C seawater temperature

D populations of zooxanthellae.

22. The following formula can be used to estimate population size from mark and recapture data.

$$N = MC/R$$

Where N = population estimate
M = number first captured, marked and released
C = total number in second capture
R = number marked in second capture

In a survey to estimate a peppered moth population, the following data were obtained:

Moths captured, marked and released = 200
Marked moths in second capture = 60
Unmarked moths in second capture = 240

The estimated population of the moths was

A 500

B 600

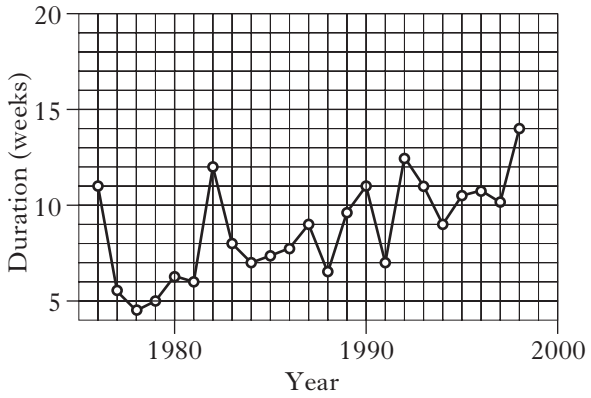
C 800

D 1000.

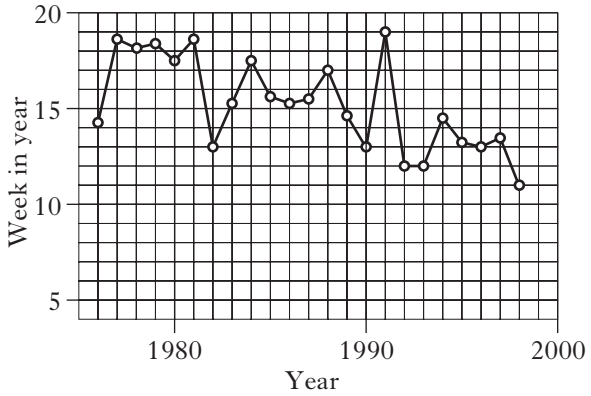
[Turn over

23. For a species of butterfly, the duration of its flight periods and the week of its first sighting were recorded from 1976 to 1998.

Graph 1: Duration of flight period



Graph 2: Week of first sighting



Which line in the table correctly identifies the behaviour trends shown in the graphs?

	Flight period	*First sighting*
A	shorter	earlier
B	longer	earlier
C	longer	later
D	shorter	later

24. The widespread distribution of DDT in the environment is a result of

A toxicity

B persistence

C biotransformation

D biological magnification.

25. In aquatic ecosystems, phosphate enrichment will **not** lead to

A eutrophication

B succession

C algal bloom

D increased biodiversity.

[*END OF SECTION A*]

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

[Turn over for Section B on *Page ten*

SECTION B

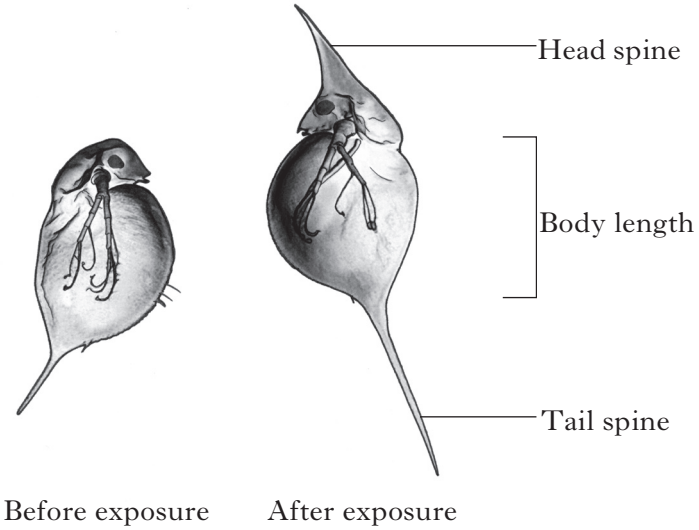
All questions in this section should be attempted.

All answers must be written clearly and legibly in ink.

1. Some species of *Daphnia* (water fleas) are able to develop their head spines and tail spines as structural defences against predators such as fish. These structures can increase in length in response to **kairomones**, chemicals in water where the fish occur.

One species, *Daphnia lumholtzi*, occurs naturally in freshwater habitats in Africa, Asia and Australia. It has now spread throughout North America, first appearing in lakes in the south in 1990 and reaching more northern and western lakes within four years. It is thought to have been introduced when lakes were stocked with African fish species.

Figure 1: Illustration of *Daphnia lumholtzi* before and after exposure to kairomones



The successful spread of *D. lumholtzi* has been attributed to its ability to develop defensive spines. To investigate the relevance of this feature to *Daphnia* survival, laboratory experiments were carried out to compare the population dynamics of *D. lumholtzi* with *Daphnia pulicaria*, the most widely distributed American species.

All the experiments were conducted under standard conditions of temperature (20 °C) and light in identical plastic tanks. The culture medium was based on minerals and phosphate buffer made up in water of a very high purity. *Daphnia* were fed with green algae in quantities that maintained constant food availability. The density of each species was the same at the start and populations were left for several days before sampling began.

Figure 2 shows the population changes observed from the first day of sampling in experiments set up as below:

Experiment A: Single species alone without predators

Experiment B: Two species together without predators

Experiment C: Two species together with fish predators.

Figure 3 shows the results of measuring the lengths of head spines and tail spines for the two species in culture medium either containing or lacking kairomones.

Question 1 (continued)

Figure 2: Population changes in Experiments A, B and C

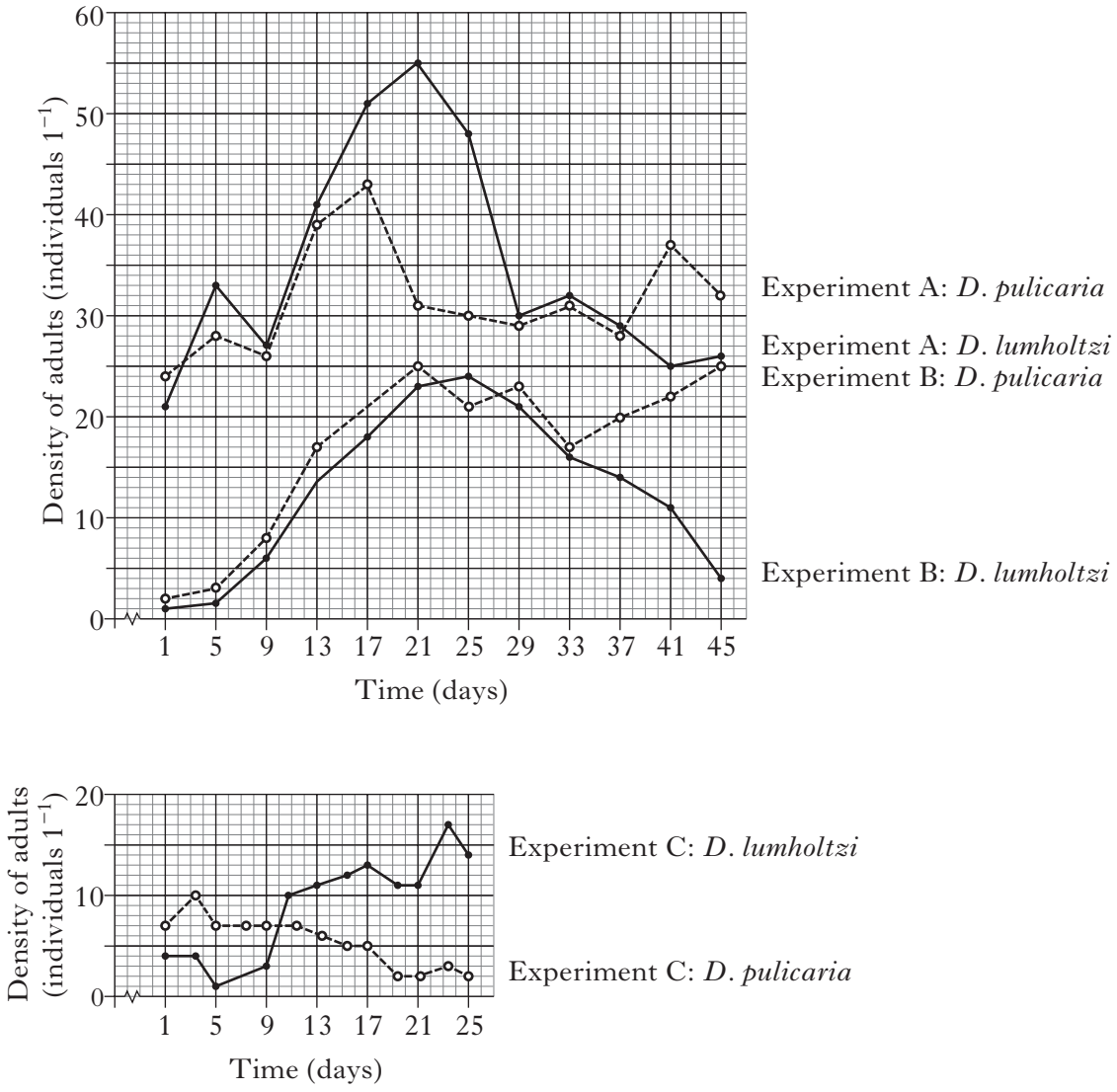
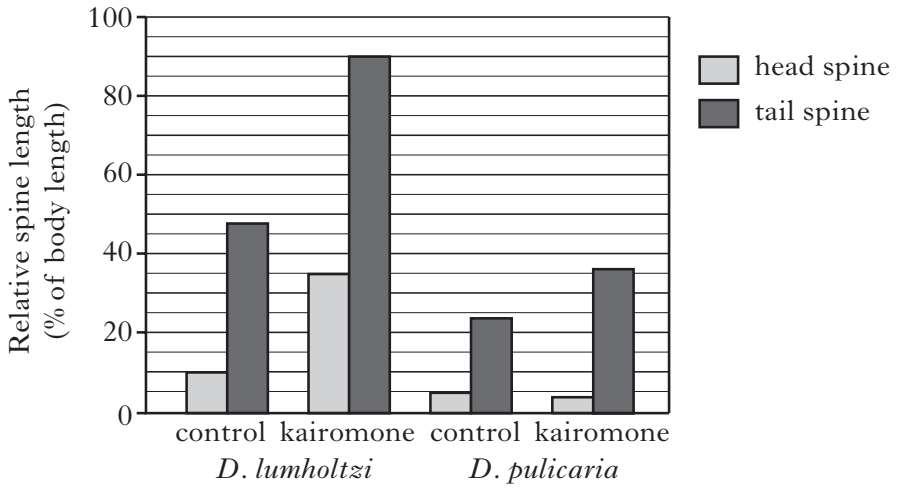


Figure 3: Relative lengths of spines before and after exposure to kairomones



Question 1 (continued)

(*a*) (i) Explain why *D. lumholtzi* can be described as an exotic species. **1**

(ii) State **one** damaging effect of an exotic species on an ecosystem. **1**

(*b*) Refer to Figure 2.

(i) Use the data at Day 41 to demonstrate that competition is a negative interaction for both species. **2**

(ii) What term could be used to describe the fate of *D. lumholtzi* in experiment B, if the trend observed from Day 33 to Day 45 continues? **1**

(iii) What evidence is there that spine formation may be affecting predator behaviour? **1**

(*c*) Refer to Figure 3.

(i) What appears to be the defence of *D. pulicaria* against fish predation? **1**

(ii) Suggest why relative spine lengths were used in Figure 3. **1**

(iii) For *D. lumholtzi* with a mean body length of 1·6 mm, what was the difference in length between the head spines in the control and kairomones cultures? **1**

(iv) Compare the response of the two species to the presence of kairomones. **2**

(*d*) Spine formation is a structural defence against predators. Give **two** defences against predators in which the mechanisms depend on coloration. **2**

(13)

2. Discuss the flow of energy through ecosystems. **(5)**

[Question 3 is on fold-out *Page thirteen*

Marks

3. Much of the heather moorland in Scotland is an unstable, man-made ecosystem. Heather moorland is maintained by sheep grazing and by burning to promote the growth of new heather. If these activities ceased, succession would result in stable woodland communities.

(*a*) What term is used to describe a stable woodland community? **1**

(*b*) Give one reason why stability increases as succession proceeds from heather moorland to woodland. **1**

(*c*) Large areas of heather moorland are under threat from bracken, a type of fern that spreads vigorously by means of underground storage organs called rhizomes. Bracken can shade out neighbouring plants and it produces toxic compounds, some of which can reduce the germination and growth of other plant species. The spread of bracken on many moorland sites has been limited by mechanical control measures (cutting and rolling) and the use of the herbicide *asulam*.

Figure: Heather (*Calluna vulgaris*) being invaded by bracken (*Pteridium aquilinum*)

(i) What aspect of bracken's success can be attributed to interference competition? **1**

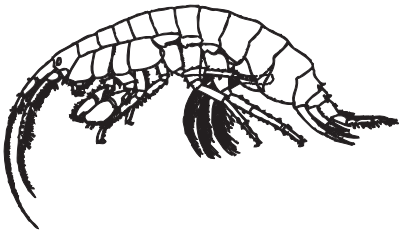
(ii) Why are mechanical control measures by themselves unlikely to be successful? **1**

(iii) An EU ban on the use of *asulam* came into effect at the end of 2011. Suggest **one** reason why such a ban would be imposed. **1**

(5)

Marks

4. Animals that live under polar sea-ice benefit from adaptations that allow them to survive changes in the salinity of their immediate environment as the ice freezes and thaws. The crustacean *Gammarus wilkitzkii* is a dominant species of the Arctic ice community.



3 cm

During the summer, as sea-ice melts, this species experiences low salinity and during sea-ice growth in the winter it is exposed to high salinity.

Figure 1 shows the rate of oxygen consumption of this animal when transferred to water of varying salinity. Figure 2 shows ion concentrations in its body fluids at the higher salinities.

Figure 1

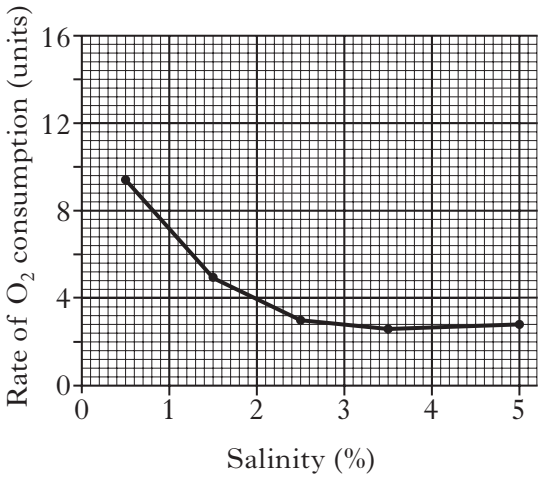
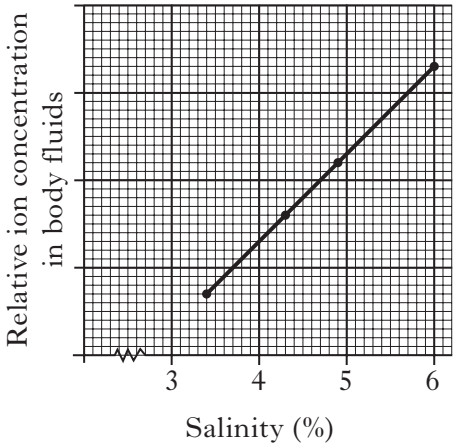


Figure 2



(*a*) Refer to Figure 1. Explain how the data suggest that *Gammarus wilkitzkii* is a regulator in salinities up to 2·5%. **2**

(*b*) Refer to Figure 2.

(i) What term is used to describe an organism that shows this type of physiological response? **1**

(ii) Increasing concentrations of ions in body fluids lower the temperature at which these fluids will freeze. Suggest how the response shown in Figure 2 would aid the survival of *G. wilkitzkii* during winter. **1**

(*c*) Another crustacean, *Parathemisto libellula*, is unable to tolerate or resist salinity variations. How would this affect the habitat range that it could occupy? **1**

(5)

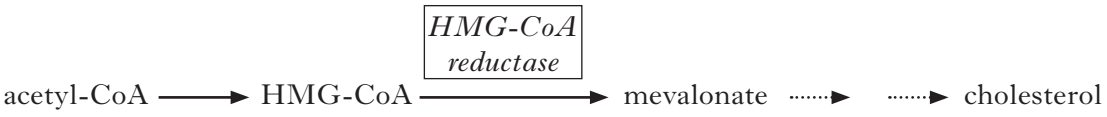
Marks

5. Cholesterol is an important component of cell membranes and a starter molecule in the formation of steroid hormones.

(*a*) Give **one** role of cholesterol in cell membranes. **1**

(*b*) When cholesterol accumulates in the wall of an artery, the plaque that forms reduces the internal diameter of the vessel. Plaque formation (atherosclerosis) is a major cause of heart disease. *Statins* are taken to reduce blood cholesterol and are one of the most commonly prescribed medications.

Cholesterol is synthesised by cells in a sequence of steps starting with acetyl-CoA from the Krebs cycle. The step that limits the rate of production is near the start and is catalysed by the enzyme *HMG-CoA reductase*, as illustrated below.



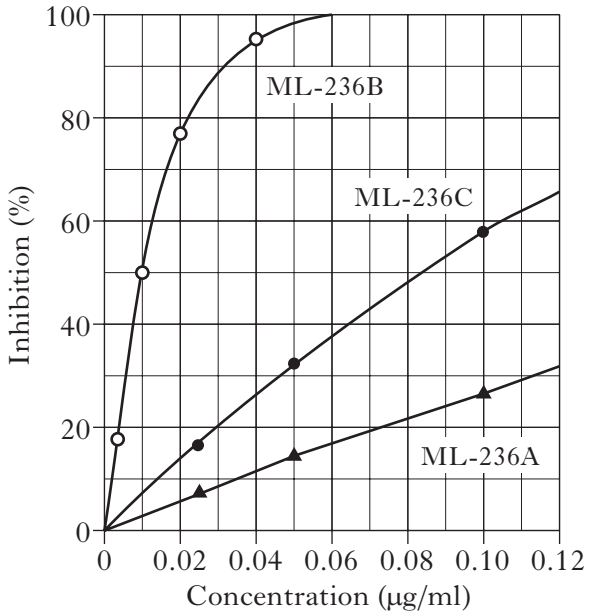
(i) In this pathway, a form of end-product inhibition occurs in which increasing cholesterol promotes the destruction of HMG-CoA reductase.

Describe how end-product inhibition would be achieved if the enzyme was allosteric. **2**

(ii) Statins are *competitive* inhibitors of HMG-CoA reductase.

Explain how they would reduce cholesterol formation. **1**

(iii) The graph below shows results of an experiment done in 1976 on three forms of a substance, ML-236, extracted from a fungal culture. The experiment was assessing how well these substances inhibit cholesterol formation, the key requirement for a potential statin.



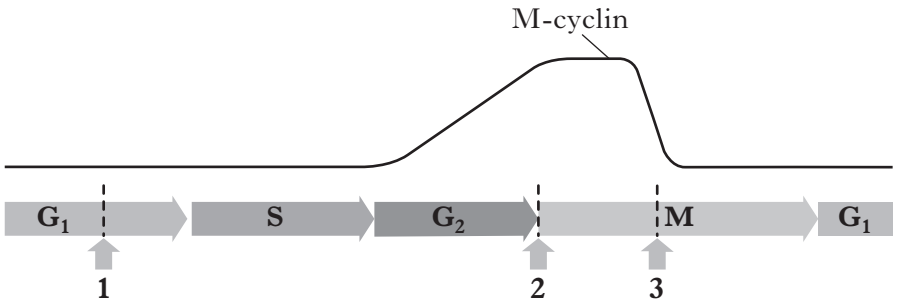
Use data for 50% inhibition to compare the effectiveness of the three molecules as potential statins. **2**

(6)

Marks

6. During the cell cycle, proteins called *cyclins* are made and destroyed in a fixed sequence. As their concentrations change, they activate enzymes that cause the dynamic events of the next stage to proceed.

The diagram below shows how cell cycle phases and checkpoints (1, 2 and 3) relate to changes in the level of one type of cyclin, *M-cyclin*.



(*a*) M-cyclin is part of the protein complex MPF. What is the role of MPF? **1**

(*b*) What is controlled at checkpoint 3 on the diagram? **1**

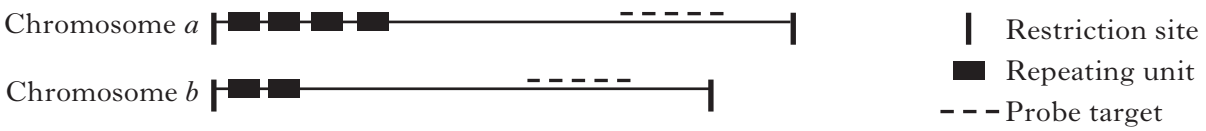
(*c*) Use the diagram to suggest how M-cyclin contributes to the progress of the cell cycle. **1**

(3)

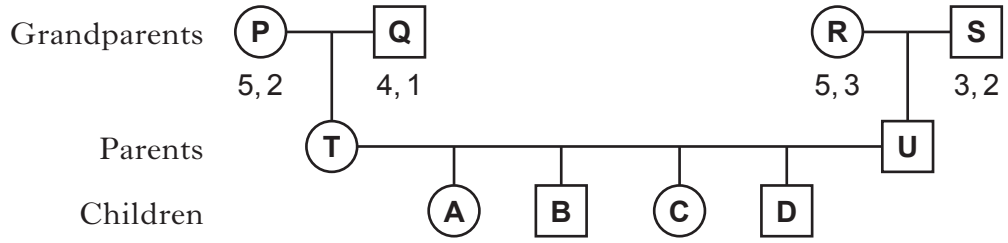
Marks

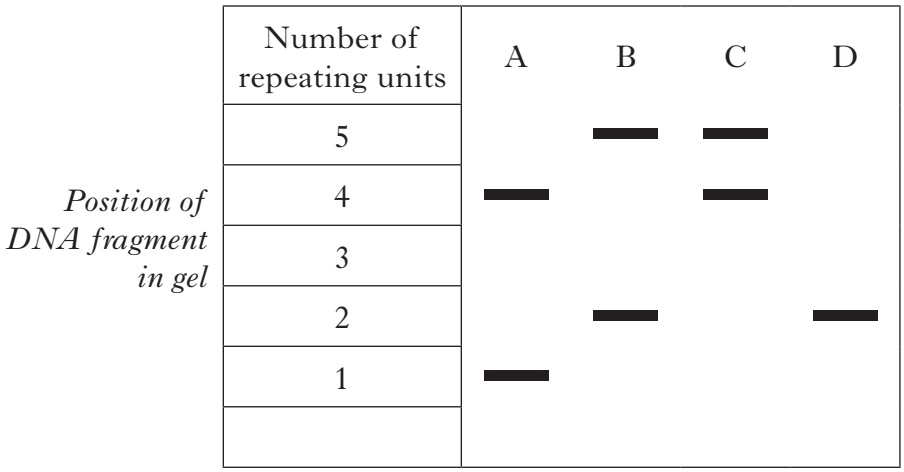
7. Fragments of DNA between restriction sites can vary in length depending on the number of repeating units present. DNA profiling identifies the number of repeating units between the restriction sites on each chromosome.

The diagram below shows fragments from a pair of homologous chromosomes for an individual with four repeating units on one chromosome and two on the other chromosome. The genotype for this individual is described as 4, 2.



(*a*) Orphans (A, B, C, D) from a war zone, believed to be from the same family, were being relocated back to grandparents. DNA profiling was used to check the family tree. The results are shown below.





(i) Explain the result for child D. **1**

(ii) Which child is **not** related to both sets of grandparents? Use the results to justify your answer. **1**

(*b*) Explain the role of probing in the production of a DNA profile. **1**

(3)

[Turn over

Marks

8. Answer **either** A **or** B.

A. Give an account of the procedures involved in producing transgenic plants. Use the following headings:

(*a*) plant production by tissue culture; **5**

(*b*) the use of *Agrobacterium*; **4**

(*c*) modification of plasmids. **6**

(15)

OR

B. Give an account of proteins in the following contexts:

(*a*) membranes; **5**

(*b*) cell signalling; **5**

(*c*) cytoskeleton. **5**

(15)

[*END OF SECTION B*]

[Turn over for Section C on *Page twenty*

Marks

SECTION C

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

The questions on Biotechnology can be found on pages 20–22.

The questions on Animal Behaviour can be found on pages 23–25.

The questions on Physiology, Health and Exercise can be found on pages 26–28.

All answers must be written clearly and legibly in ink.

Labelled diagrams may be used where appropriate.

BIOTECHNOLOGY

1. A study was carried out to investigate the growth rate of the bacterium *Escherichia coli* (*E. coli*) in different growth media. A single colony of bacteria was used to inoculate either complex broth or minimal medium to which was added one of a variety of carbon sources. Cell numbers were estimated using a colorimeter to measure the turbidity of the culture during growth. The generation time for each culture is shown in the table.

Growth medium	*Generation time* (minutes)
complex broth	22
minimal medium + glucose	40
minimal medium + succinate	67
minimal medium + ethanoate	120

(*a*) (i) What is meant by the term *generation time*? **1**

(ii) Give **two** general conclusions about the effects of growth medium on the generation time of *E. coli*. **2**

(*b*) Calculate the growth rate constant for *E. coli* growing in minimal medium containing ethanoate. (ln2 = 0·693) **1**

(*c*) (i) State **one** disadvantage of the method used to estimate cell numbers. **1**

(ii) Name an alternative method for obtaining cell number in bacterial cultures. **1**

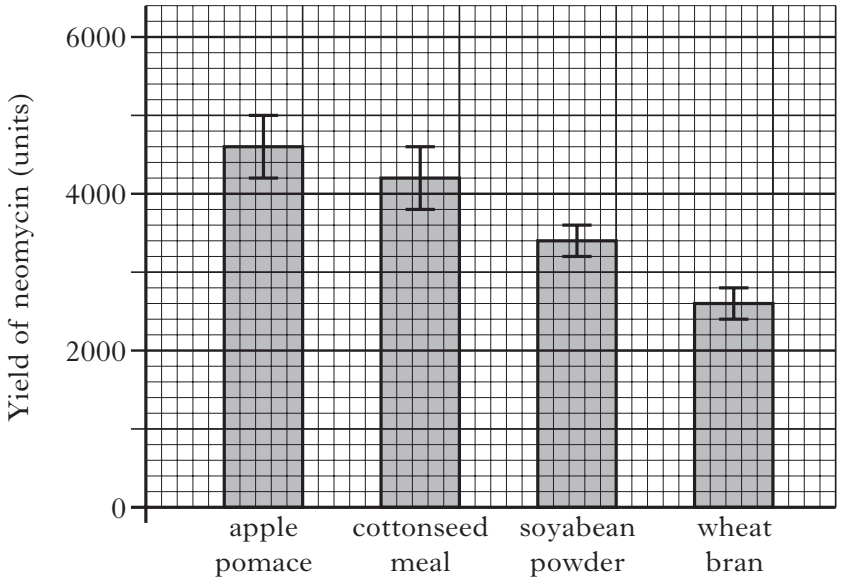
(6)

2. Silage is an important winter feed for cattle. Give an account of the production of silage. **(5)**

***BIOTECHNOLOGY* (continued)**

3. Antibiotics can be produced by growing micro-organisms in culture media made from waste materials. For example, apple *pomace* is a waste left over after juice extraction and it contains peel, seeds and other solid parts. Waste materials are dried and ground into a powder that can be added to culture medium in a fermenter.

(*a*) The graph below shows the yield of the antibiotic *neomycin* produced using media containing a variety of agricultural waste products.



(i) It was concluded that medium containing apple pomace gave a higher yield of neomycin than media containing the other waste products. Comment on the validity of this conclusion. **2**

(ii) This study was carried out in India where it is estimated that one million tonnes of apple pomace is produced each year. Suggest **two** reasons why it is desirable to use this material in the production of antibiotics. **2**

(*b*) Neomycin is a bactericidal antibiotic. Describe how its action would differ from a bacteriostatic antibiotic. **1**

(5)

[Turn over

4. Many enzymes used in biotechnology are produced industrially by fermentation using naturally occurring micro-organisms.

(*a*) Name **one** industrially produced enzyme and the micro-organism used in the fermentation. **1**

(*b*) (i) Describe **two** conditions that need to be controlled during the fermentation process used to produce enzymes. **1**

(ii) Give **one** method used in the recovery of enzymes from the fermentation culture. **1**

(*c*) Explain what is meant when an industrial enzyme is described as a *secondary metabolite*. **1**

(4)

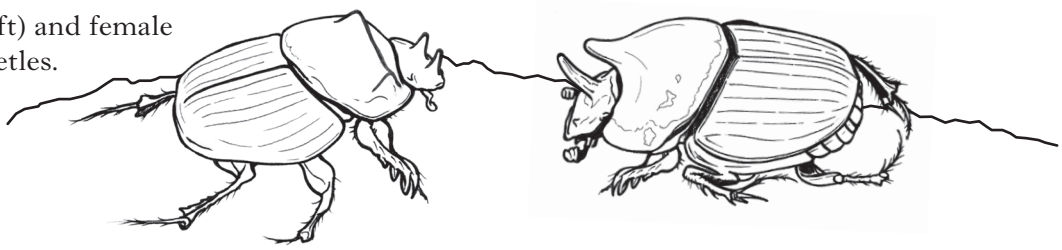
[End of *Biotechnology* questions. *Animal Behaviour* questions start on Page 23]

SECTION C (continued)

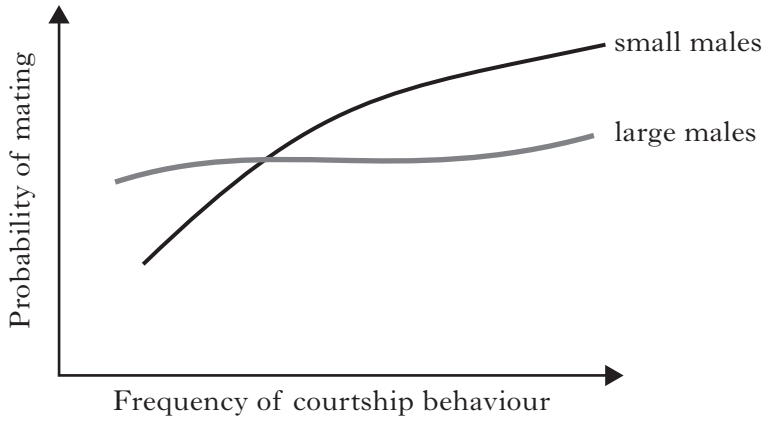
ANIMAL BEHAVIOUR

1. Sexual selection in the dung beetle *Onthophagus sagittarius* was investigated in the laboratory.

Male (left) and female dung beetles.



Beetles were paired by randomly selecting males and females, and the pairs were placed in breeding chambers. Mating success in relation to the frequency of courtship behaviour was recorded for large and small males.



(*a*) From the results, describe how female choice changes in relation to male size. **1**

(*b*) What terms apply to the following measurements during the experiment:

(i) time from introduction until first courtship; **1**

(ii) total time of courtship? **1**

(*c*) Male and female dung beetles can be distinguished by their horns. What term can be used to describe this difference in appearance? **1**

(*d*) Females in many species are relatively inconspicuous. Explain why this is beneficial to them. **2**

(6)

[Turn over

***ANIMAL BEHAVIOUR* (continued)**

2. Most of the behaviour of the fruitfly *Drosophila melanogaster* is determined by "nature" rather than "nurture".

(*a*) Explain why nurture has little influence on the behaviour of an invertebrate such as *Drosophila*. **1**

(*b*) The *Drosophila* period (*per*) gene is an example of a single gene affecting behaviour. Describe the effects of this gene. **2**

(3)

3. Discuss behaviour that maximises net energy intake by predators. **(5)**

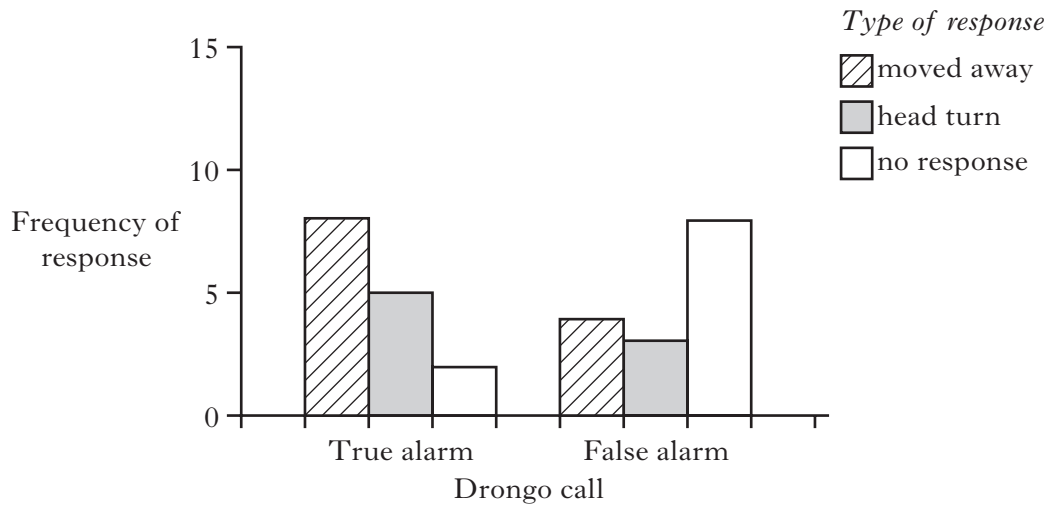
4. Many birds that feed together in mixed-species flocks produce distinctive alarm calls which alert other flock members to the presence of predators. However, some of the flocks may contain birds that produce calls that sound similar to the alarm calls. These calls are emitted when there are no predators present and are referred to as "false alarm" calls.

(*a*) Explain why true alarm calling may be regarded as altruistic behaviour. **2**

(*b*) State why the evolution of true alarm calls **cannot** be the result of kin selection alone. **1**

(*c*) Suggest a benefit to the caller of using false alarm calls. **1**

(*d*) A study investigated true and false alarm calls of the racket-tailed drongo (*Dicrurus paradiseus*). The calls were recorded and played to the orange-billed babbler (*Turdoides rufescens*), a species that regularly feeds in the same flocks. The graph shows the responses of the babblers to both types of call.



From the graph select information to show that babblers are able to distinguish between the false and true alarm calls of the drongos. **1**

(*e*) The study involved wild babblers in their natural habitat. Suggest why the researchers used a method that involved selecting a different individual babbler for each measurement. **1**

(6)

[End of *Animal Behaviour* questions. *Physiology, Health and Exercise* questions start on Page 26]

[Turn over

SECTION C (continued)

PHYSIOLOGY, HEALTH AND EXERCISE

1. Coronary heart disease (CHD) is caused by restriction of blood flow in vessels that supply oxygenated blood to heart muscle.

(*a*) Describe the changes in blood vessel walls that lead to CHD. **2**

(*b*) Give **two** modifiable risk factors for the development of CHD. **1**

(*c*) The table shows the incidence of CHD in two categories of male employees in the 1950s.

	CHD rate per 1000	
Age (years)	*Postmen*	*Office workers*
35–44	0·3	0·4
45–54	2·7	2·9
55–65	4·6	6·5

Give **two** general conclusions about CHD that can be drawn from the data. **2**

(5)

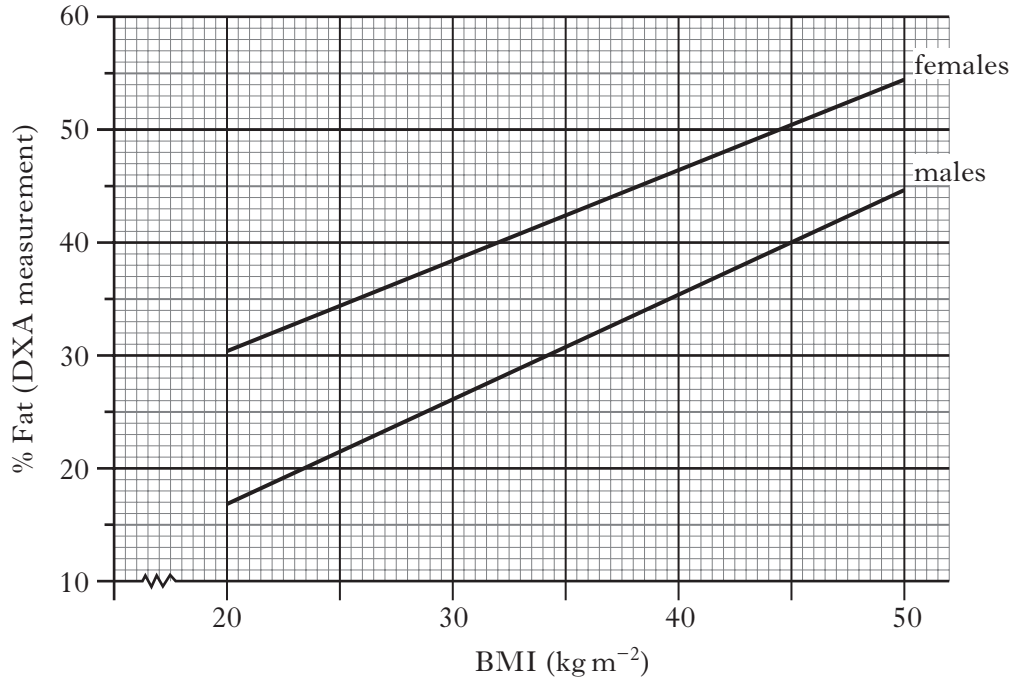
2. Discuss the effects of exercise on the development of osteoporosis. **(4)**

3. (*a*) (i) Give **one** reason for assessing body composition. **1**

(ii) What **two** measurements are required to estimate body composition using densitometry? **1**

(*b*) The BMI value is used routinely in the assessment of an individual's body composition. State **one** limitation of using BMI for this purpose. **1**

(*c*) Percentage body fat can be measured accurately using a method called *dual X-ray absorption* (DXA). The graph shows "best fit" lines when BMI values are correlated with measured % body fat.



(i) What are the BMI values of a man and a woman who both have 40% body fat? **1**

(ii) Recently an improved way of estimating % body fat has been developed. It involves calculating the body adiposity index (BAI) using the formula below. The calculated BAI equals the % body fat.

$$\text{BAI} = \left(\frac{\text{Hip circumference (cm)}}{\text{Height (m)} \times \sqrt{\text{Height (m)}}}\right) - 18$$

A woman with a BMI value of 27 (kg m^{-2}) has a hip circumference 105 cm and height 1·69 m. Compare the predicted value of % body fat obtained using her BMI with that obtained using the more accurate BAI. **2**

(6)

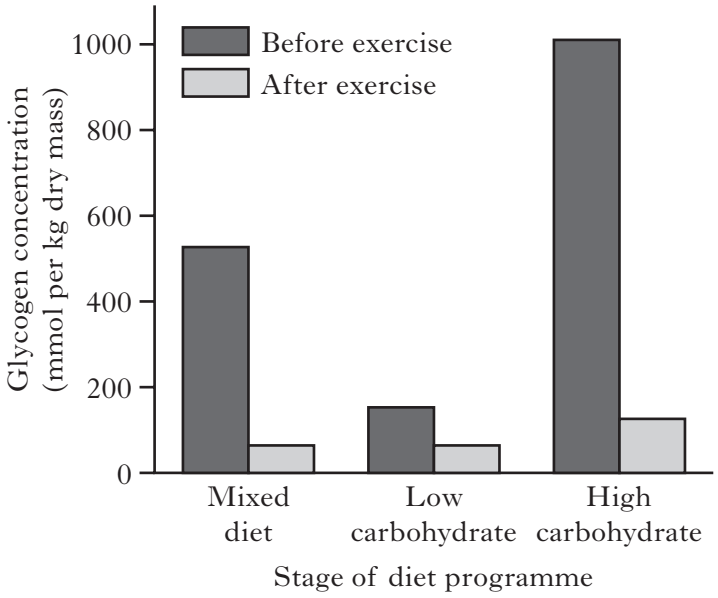
[Turn over for Question 4 on *Page twenty-eight*

4. Elite athletes are interested in ways to improve performance in endurance events.

(*a*) Give **two** changes in the performance of an athlete's heart arising from endurance training. **2**

(*b*) In a study, volunteers ate a mixed diet for three days and then measured endurance by exercising to exhaustion. Over the next three days they ate a low carbohydrate diet and again measured endurance. Over a further three days they ate a high carbohydrate diet and exercised to exhaustion for a third time.

The Figure shows glycogen concentration in skeletal muscle before and after the endurance testing for each stage of the diet programme. The Table shows the time to exhaustion as *exercise duration*.



Stage of diet programme	*Exercise duration* (mins)
Mixed diet	126
Low carbohydrate	59
High carbohydrate	189

(i) What evidence supports the conclusion that increased muscle glycogen improved endurance? **1**

(ii) What term is used for exercise testing that takes athletes to exhaustion? **1**

(iii) Give an example of a situation where it would **not** be appropriate for an individual to exercise to exhaustion. **1**

(5)

[*END OF QUESTION PAPER*]

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