
NATIONAL
QUALIFICATIONS
2010

THURSDAY, 27 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. Questions 2 and 3 are 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

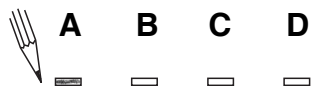
- 1 Check that the answer sheet provided is for **Biology Advanced Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate 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 biphosphate
- 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**.

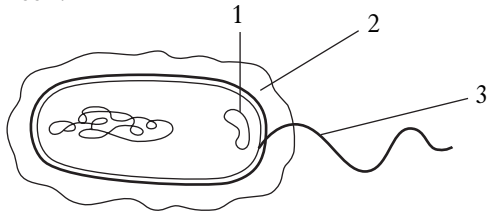


SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

1. The following diagram represents a bacterial cell.



Which **one** of the following correctly identifies the structures labelled 1, 2 and 3?

	1	2	3
A	plasmid	flagellum	capsule
B	flagellum	capsule	plasmid
C	plasmid	capsule	flagellum
D	capsule	plasmid	flagellum

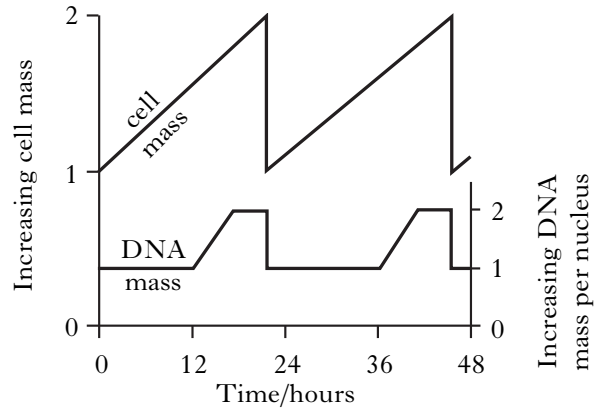
2. Plasmodesmata are structures that link
- A cell walls in adjacent prokaryotic cells
 - B cell walls in adjacent eukaryotic cells
 - C cell cytoplasm in adjacent prokaryotic cells
 - D cell cytoplasm in adjacent eukaryotic cells.

3. The key below shows features of biological molecules.

- 1 Soluble in water.....go to 2
 Insoluble in water.....go to 3
- 2 Extracellular.....A
 Hydrolytic.....B
- 3 Storage.....C
 Structural.....D

Which letter could be both triglycerides and glycogen?

4. The diagram below shows the changes in cell mass and DNA mass during two cell cycles.



What valid conclusion could be made from the graph?

During the cell cycle

- A interphase is the longest phase
- B mitosis is divided into four phases
- C replication takes place between 0 and 12 hours
- D cytokinesis takes place at 12 and 36 hours.

5. Which line in the table below correctly describes adenine and thymine and the bonding between them in a DNA molecule?

	<i>Adenine</i>	<i>Number of hydrogen bonds</i>	<i>Thymine</i>
A	purine	two	pyrimidine
B	pyrimidine	three	purine
C	pyrimidine	two	purine
D	purine	three	pyrimidine

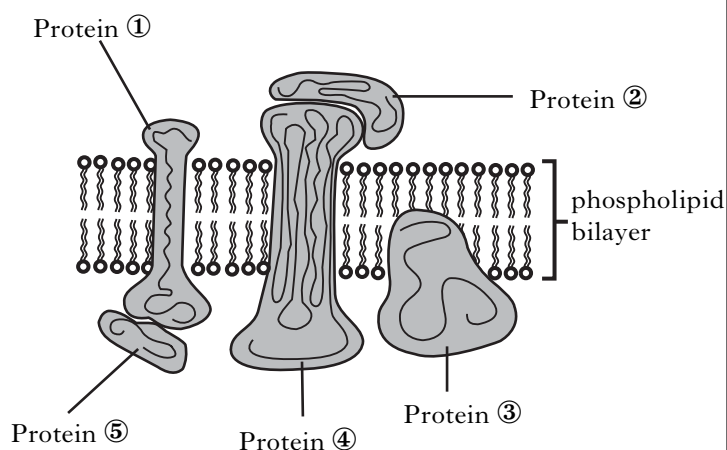
[Turn over

6. One cause of cystic fibrosis is a mutation in the CFTR gene which codes for 1480 amino acids. The most common mutation results in the deletion of one amino acid.

Which line in the table below shows correctly the number of nucleotides in the mutated gene and the number of amino acids in the protein that is synthesised?

	<i>Number of nucleotides encoding the mutated gene</i>	<i>Number of amino acids in the protein synthesised</i>
A	4431	1477
B	4439	1480
C	4437	1479
D	4439	1479

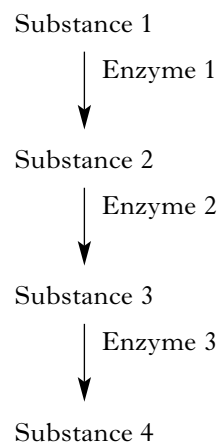
7. The diagram below shows the distribution of protein molecules in a cell membrane.



Which line in the table below correctly identifies a peripheral and an integral membrane protein?

	<i>Peripheral membrane protein</i>	<i>Integral membrane protein</i>
A	1	5
B	2	1
C	3	4
D	5	2

8. The diagram below shows a metabolic pathway that is controlled by end product inhibition.



For Substance 4 to bring about end product inhibition, which of the following will it interact with?

- A Substance 1
 B Substance 3
 C Enzyme 1
 D Enzyme 3
9. Covalent modification of enzymes is used to control their activity.
- Which of the following processes involves the covalent modification of an enzyme?
- A The conversion of trypsinogen into trypsin.
 B The end-product inhibition of phosphatase.
 C The allosteric inhibition of glycogen phosphorylase.
 D The conversion of sucrose into glucose and fructose.

10. Which of the following acts as a hydrophobic extracellular signalling molecule?

- A Insulin
 B Testosterone
 C Acetylcholine
 D Cholesterol

11. The following stages are involved in amplifying DNA fragments using the polymerase chain reaction (PCR).

- V DNA denatures
- W Primers bind
- X Complementary DNA strands replicated
- Y Temperature changed to about 75 °C
- Z Temperature changed to about 55 °C

After heating the fragments to about 95 °C, which of the following sequences occurs?

- A X, Z, V, Y, W
- B Z, V, W, Y, X
- C V, X, Z, W, Y
- D V, Z, W, Y, X

12. A piece of DNA 20 kilobase pairs (kbp) long was digested using different restriction enzymes. BamHI, EcoRI and PstI. The results are shown in the table below.

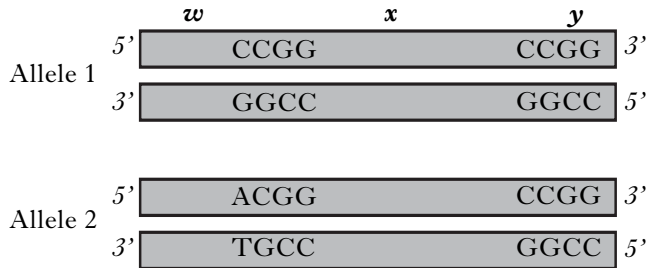
	Restriction enzyme used			
	PstI	BamHI	EcoRI	BamHI PstI
Lengths of DNA fragments (kbp)	15 5	17 3	12 8	12 5 3

Which of the following set of fragments would result if all three enzymes were used together?

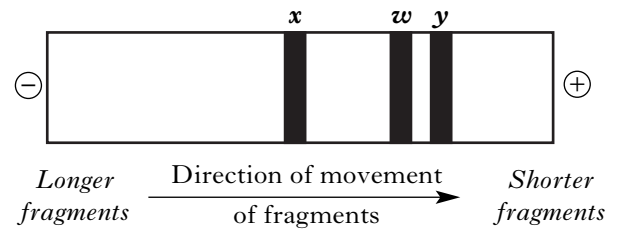
- A 7, 5, 3, 2
- B 8, 7, 3, 2
- C 12, 3, 2
- D 9, 5, 3, 3

13. A certain restriction enzyme will only cut a DNA strand between two Cs when the base sequence CCGG is present.

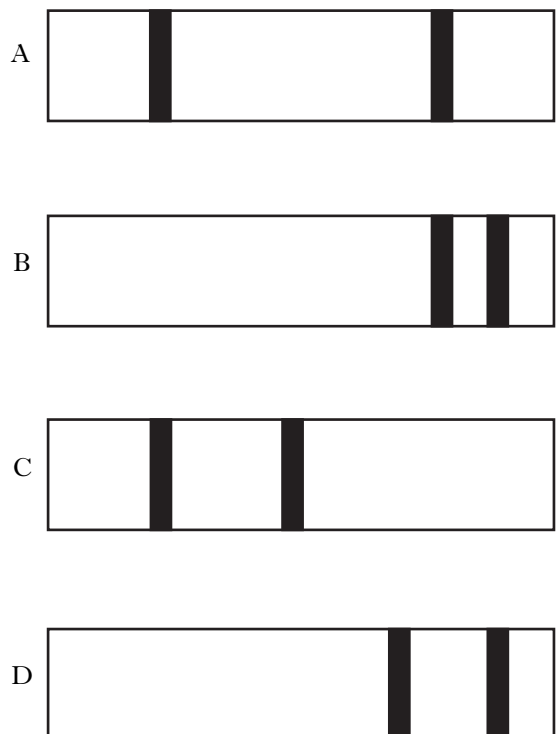
Two homologous segments of DNA that carry different alleles of a gene are shown below. Allele 2 has a single base-pair difference.



Allele 1 was treated with the restriction enzyme and the fragments *w*, *x* and *y* were obtained and separated by gel electrophoresis. The resulting band pattern for allele 1 is shown below.



Which of the following band patterns would result when the procedure was repeated using allele 2?



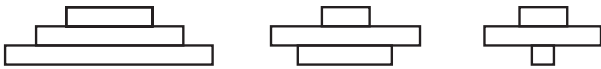
14. Several species of bacteria have been found deep under the Pacific Ocean, where hot water escapes from the sea bed.

In these marine ecosystems, the bacteria can use hydrogen sulphide as an energy source to fix carbon dioxide into organic molecules. When the bacteria break down, organic material is released, which filter feeders consume.

This information indicates that the bacteria are

- A heterotrophs
- B detritivores
- C autotrophs
- D decomposers.

15. Three pyramids of numbers are shown below.



Which of the following food chains **cannot** be represented by any of these pyramids?

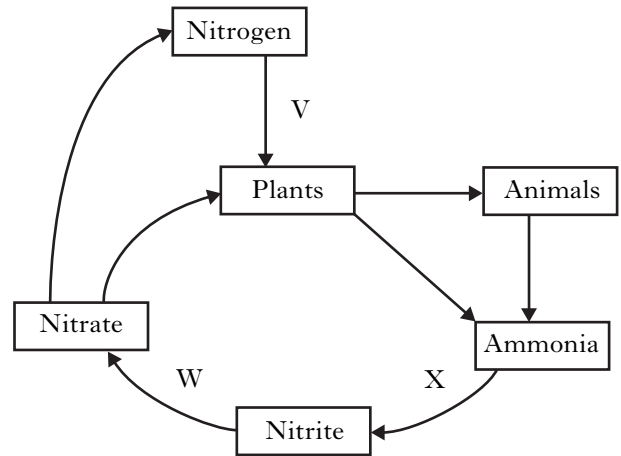
- A Oak tree → leaf miner → tree warbler
- B Algae → pond snail → nematode parasite
- C Grass plants → rabbit → stoat
- D Phytoplankton → zooplankton → herring

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

Which line in the table shows correctly the species with the highest biomass per square metre?

	<i>Species</i>	<i>Mean mass of organism (g)</i>	<i>Population density (numbers m⁻²)</i>
A	cricket	0.10	4
B	ladybird	0.03	20
C	aphid	0.002	5420
D	weevil	0.005	3250

17. The diagram below shows the nitrogen cycle.



Which line in the table below correctly identifies the micro-organisms involved at the stages shown?

	<i>V</i>	<i>W</i>	<i>X</i>
A	<i>Nitrosomonas</i>	<i>Nitrobacter</i>	<i>Rhizobium</i>
B	<i>Rhizobium</i>	<i>Nitrobacter</i>	<i>Nitrosomonas</i>
C	<i>Nitrobacter</i>	<i>Rhizobium</i>	<i>Nitrosomonas</i>
D	<i>Rhizobium</i>	<i>Nitrosomonas</i>	<i>Nitrobacter</i>

18. The table below shows four examples of interactions between species.

Which column in the table shows correctly the benefits (+) or costs (-) which result from each interaction?

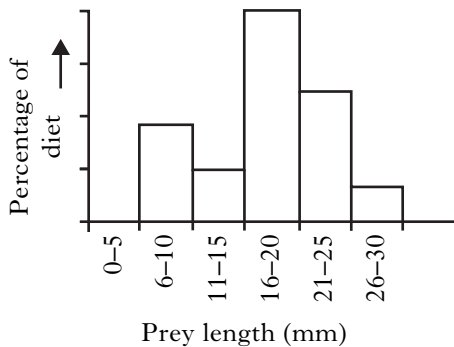
<i>Interaction</i>	A	B	C	D
Sheep grazing in a field of grass	+/-	+/-	+/+	+/-
Owls and foxes hunting for the same food	+/-	-/-	-/-	+/-
Corals acting as hosts for zooxanthellae	+/-	+/+	+/+	+/+
“Cleaner fish” feeding on parasites which they remove from other fish	+/+	+/+	+/-	+/+

19. Anolis lizards are found on Caribbean islands. They feed on prey of various sizes.

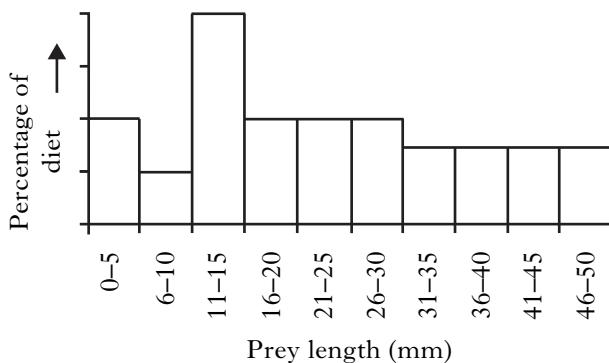
Histogram 1 shows the range of prey length eaten by *Anolis marmoratus* on the island of Jarabacoa, where there are five other Anolis species.

Histogram 2 shows the range of prey length eaten by *Anolis marmoratus* on the island of Marie Galante, where it is the only Anolis species.

Histogram 1: Jarabacoa Island



Histogram 2: Marie Galante Island



Which of the following statements could explain the different range of prey sizes eaten by *Anolis marmoratus* on the two islands?

- A Larger numbers of prey are found on Marie Galante.
- B *Anolis marmoratus* occupies its fundamental niche on Jarabacoa.
- C *Anolis marmoratus* occupies its realised niche on Marie Galante.
- D Resource partitioning takes place on Jarabacoa.

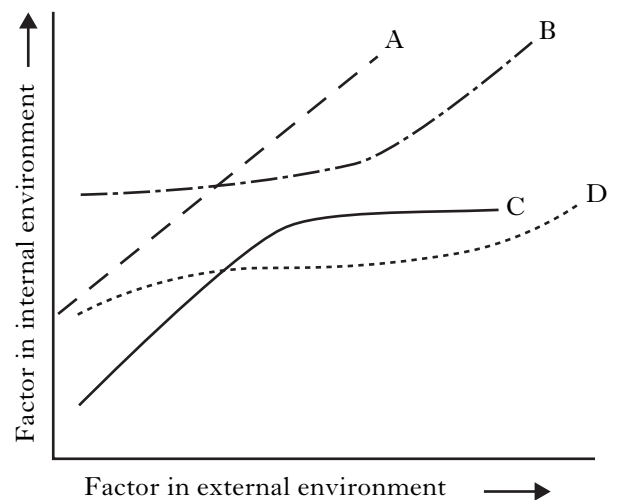
20. Each statement below applies to either conformation or regulation.

- 1 A wide range of habitats can be occupied
- 2 A restricted range of habitats can be occupied
- 3 There is a high energy cost
- 4 There is no energy cost

Which statements apply to conformation?

- A 1 and 4
- B 1 and 3
- C 2 and 4
- D 2 and 3

21. The figure below shows the general relationships between the internal environment and variation in the external environment of four animals.



Which animal is the most effective regulator?

[Turn over

22. Eutrophication can result from agricultural activity.

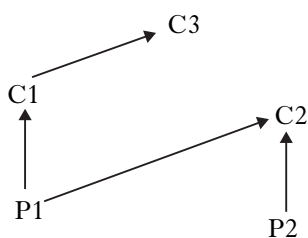
Which of the following defines eutrophication?

- A Algal bloom
- B Increased BOD
- C Loss of diversity
- D Nutrient enrichment

23. The figure below represents part of an aquatic food web.

P1 and P2 are producers.

C1, C2 and C3 are consumers.



Analysis of a persistent organic pesticide in this ecosystem produced the following results:

Result 1 P1 has a higher concentration of the pesticide in its tissues than is present in the surrounding water.

Result 2 C2 converts the pesticide into a more toxic chemical in its tissues.

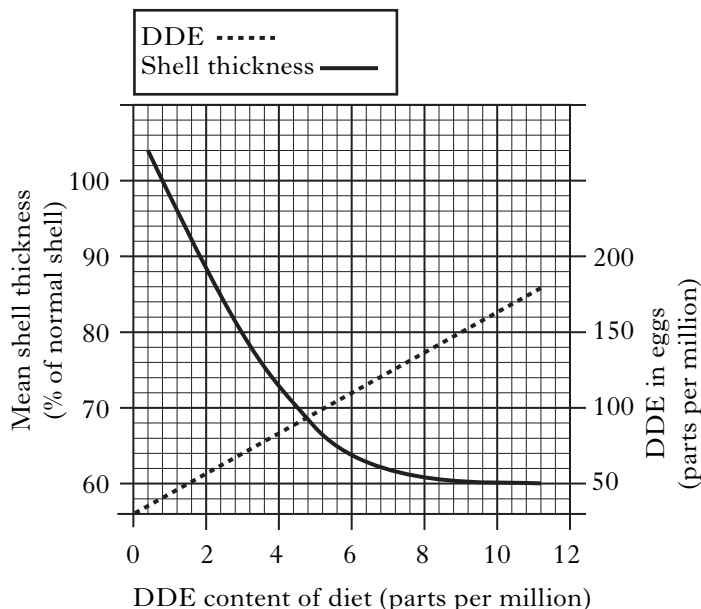
Result 3 The concentration of the pesticide in P1 is lower than that in C1 which, in turn, is lower than that in C3.

Which row in the table shows the processes responsible for Results 1, 2 and 3?

	<i>Result 1</i>	<i>Result 2</i>	<i>Result 3</i>
A	bioaccumulation	biotransformation	biomagnification
B	biomagnification	biotransformation	bioaccumulation
C	biotransformation	bioaccumulation	biomagnification
D	bioaccumulation	biomagnification	biotransformation

24. The insecticide DDT is metabolised in birds to DDE. The level of DDE in eggs affects the shell thickness. Premature egg breakage begins when mean shell thickness is 80% of normal.

The graph below shows how DDE content of the diet affects DDE content of eggs and mean shell thickness.



What would be the minimum DDE concentration to cause the start of premature egg breakage?

- A 150 parts per million
- B 70 parts per million
- C 9 parts per million
- D 3 parts per million

25. Succession which follows the clearing of long-established farm land is described as

- A allogenic
- B secondary
- C degradative
- D primary.

[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*

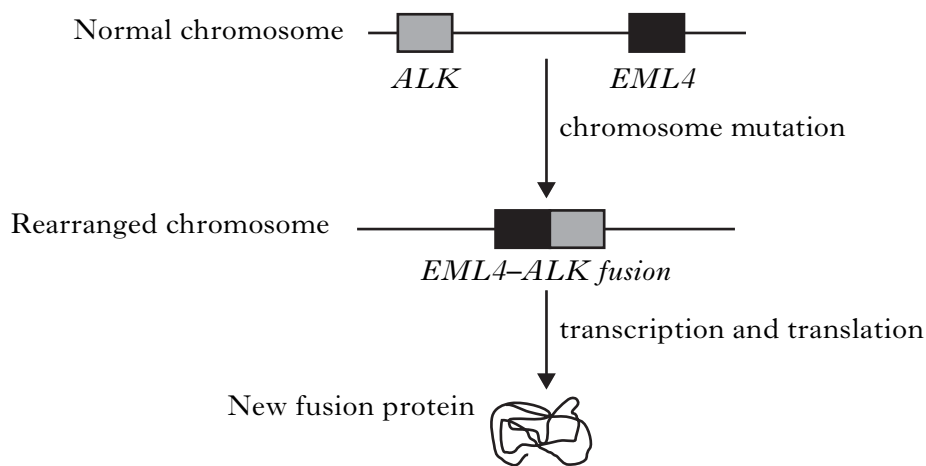
SECTION B

All questions in this section should be attempted.
All answers must be written clearly and legibly in ink.

1. Proto-oncogenes code for proteins that stimulate cell division. When these genes mutate they can become oncogenes and cause the excessive cell proliferation associated with tumour formation.

A recent study investigated a chromosome mutation discovered in lung tumour cells. The mutation is a rearrangement of two genes on the same chromosome, resulting in the fusion of the two genes (Figure 1). The genes are *EML4*, which is involved in microtubule formation, and *ALK* which codes for a kinase enzyme. As a result of this fusion, a new protein is formed that has uncontrolled kinase activity inside the cell.

Figure 1 : Formation of the EML4–ALK fusion gene



Part of the study aimed to find out if normal cells are transformed to divide abnormally after treatment with the fusion gene. In the treatments, genes were introduced into normal cells that were then cultured in a flat dish containing a suitable growth medium. Abnormal cell division is indicated by the transformed cells stacking up in multiple layers called *foci*.

The four gene treatments used are shown in the Table. In the fourth, the *EML4-ALK* fusion gene was modified so that the kinase produced was inactive.

Table: Results of cell transformation study

<i>Gene treatment</i>	<i>Formation of foci</i>
<i>ALK</i> alone	no
<i>EML4</i> alone	no
<i>EML4-ALK</i> fusion	yes
<i>EML4-ALK</i> fusion modified	no

Question 1 (continued)

The study also investigated the possibility that kinase inhibitors could be used to treat tumours arising from the fusion gene. The growth of normal and transformed cells suspended in liquid culture was monitored in the presence and absence of a kinase inhibitor. The results are shown in Figures 2 and 3.

Figure 2: Effect of kinase inhibitor on normal cells

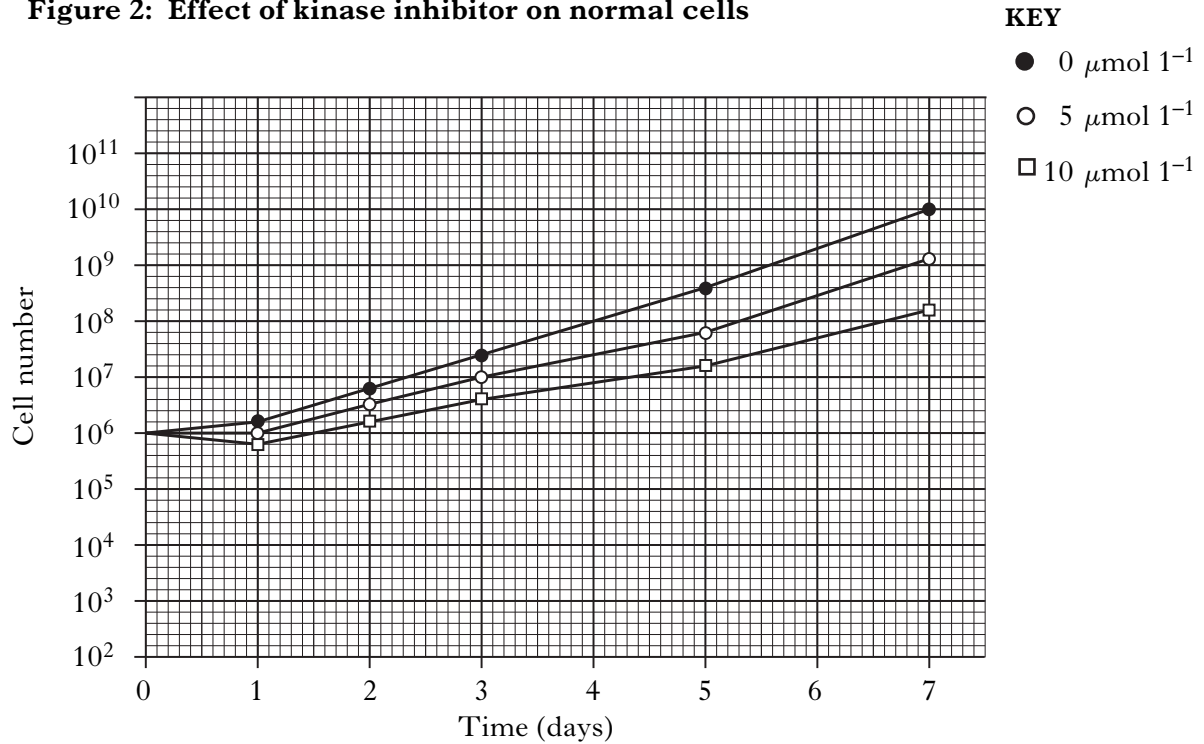
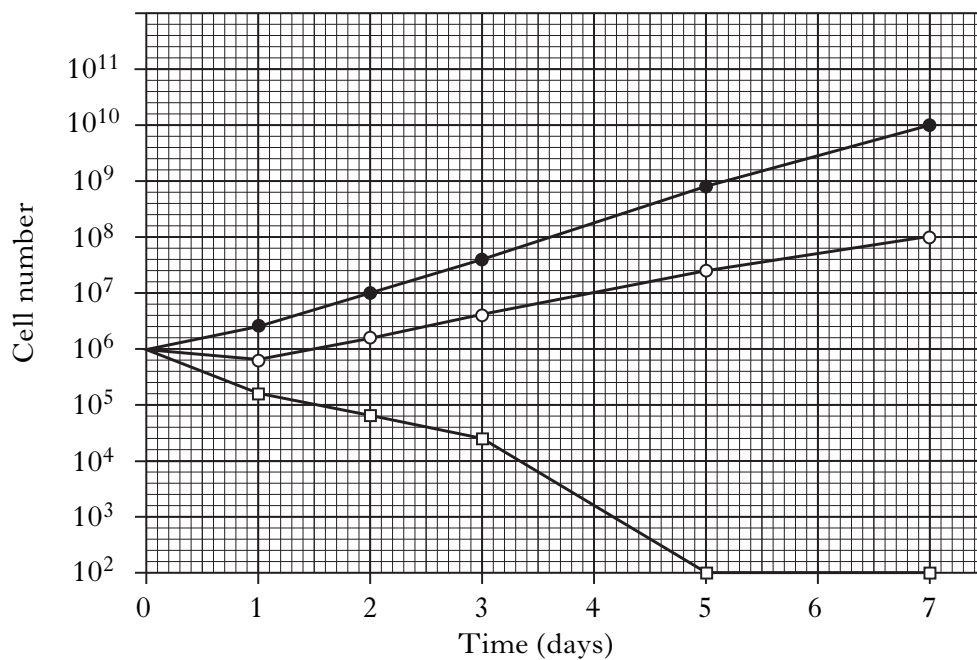


Figure 3: Effect of kinase inhibitor on cells transformed with *EML4-ALK*

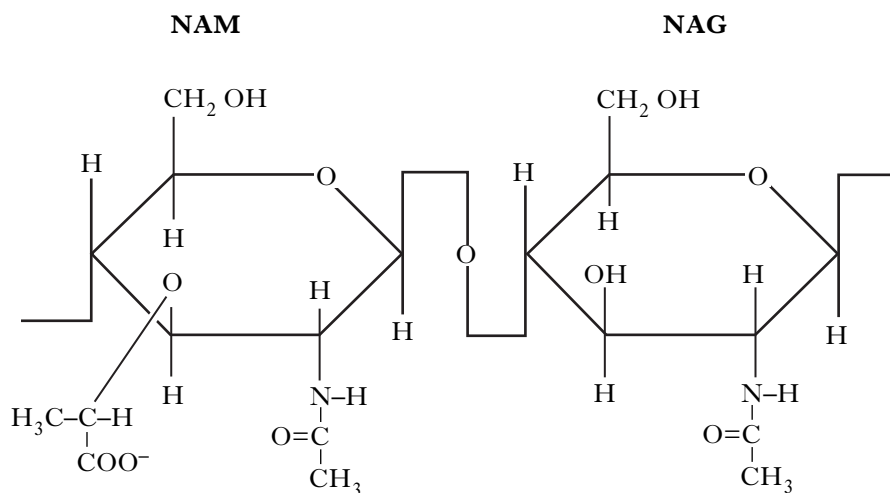


Question 1 (continued)

- (a) State why abnormal proliferation of cells can occur when only one copy of an oncogene is present. **1**
- (b) (i) In the study, abnormal cells formed *foci*. Describe the appearance of a culture of normal animal cells that have stopped dividing. **2**
- (ii) Give a reason for adding fetal bovine serum to cell culture medium. **1**
- (c) Refer to the table. Explain how the results show that:
- (i) the chromosome rearrangement created an oncogene; **1**
- (ii) the effect of the fusion gene is uncontrolled kinase activity. **2**
- (d) Use data from Figures 2 and 3 to show that normal and transformed cells are capable of dividing at the same rate. **1**
- (e) Refer to Figures 2 and 3.
- (i) Show that the $10\ \mu\text{mol l}^{-1}$ inhibitor concentration reduces the proliferation of normal cells by a factor of 100. **1**
- (ii) What general trend is observed for the growth of cells when the concentration of inhibitor is varied? **1**
- (iii) Use data from the $5\ \mu\text{mol l}^{-1}$ concentration to show that transformed cells are more sensitive to the presence of the inhibitor than normal cells. **1**
- (f) The study aimed to find a possible therapy for tumours caused by fusion mutation. How do the results suggest that $10\ \mu\text{mol l}^{-1}$ of inhibitor would be the most useful to test on patients? **2**
- (13)**

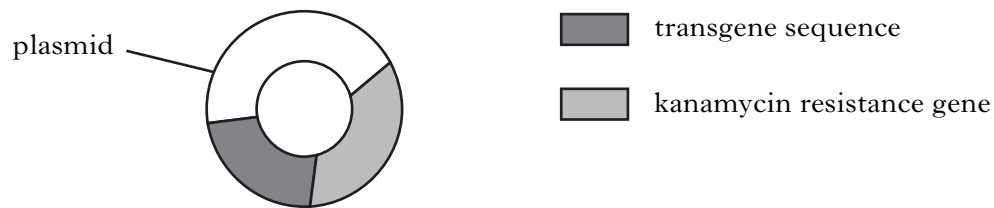
[Questions 2 and 3 are on fold-out Page thirteen

2. The cell wall of the prokaryote *E. coli* is made of a substance that consists of polysaccharide chains cross-linked by short chains of amino acids. The polysaccharide is made up of two kinds of sugar: N-acetylmuramate (NAM) and N-acetylglucosamine (NAG). NAM and NAG alternate along the chain and differ from glucose only at the C2 and C3 positions.



- (a) Name the substance that makes up the cell wall of *E. coli*. 1
- (b) NAM and NAG are joined by a glycosidic bond.
- (i) Explain why this bond is described as $\beta(1-4)$. 2
- (ii) The enzyme lysozyme damages bacterial cell walls by breaking the bonds between NAM and NAG.
- What type of reaction is catalysed by lysozyme? 1
- (4)**
3. Describe the transport of sodium and potassium ions across the plasma membrane. **(5)**

4. Transgenic plants can be produced using genetically engineered plasmids. The plasmids are obtained from bacteria that naturally infect plant cells. A modified plasmid is shown in the diagram below.



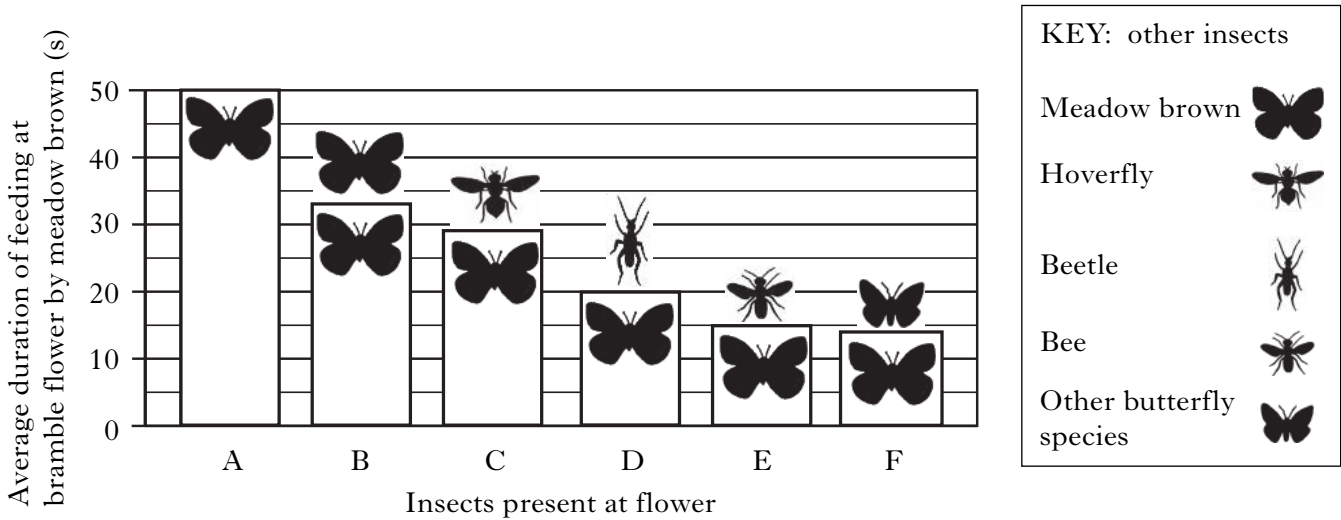
Bacterial cells containing the modified plasmid are incubated with plant cells. The plant cells are then cultured in a growth medium containing kanamycin.

- (a) What is meant by the term transgenic? 1
- (b) Name the bacterial source of these plasmids. 1
- (c) Explain the role of kanamycin in the production of transgenic plants. 2
- (d) Give **one** example of the use of this transgenic technology. 1

(5)

5. Bramble plants (*Rubus fruticosus*) are pollinated by a variety of nectar-feeding insects, such as the meadow brown butterfly (*Maniola jurtina*). Bramble flowers are one of many nectar sources for this species.

A study focused on competitive interactions occurring between meadow browns and other insects at bramble flowers. The average time a meadow brown spent feeding when not disturbed by another insect is shown in the bar graph at A. The other bars show its feeding duration when another insect was also present.



- (a) Explain why intraspecific competition is expected to be more intense than interspecific. 1
- (b) (i) Which bar represents intraspecific competition? 1
- (ii) Give **one** general conclusion that can be drawn from these data about competitive interactions at bramble flowers? 1
- (c) From the information provided, state why the relationship between meadow brown butterflies and bramble plants is not an example of mutualism even though there are benefits to both species. 1
- (4)**

[Turn over

6. A laboratory experiment investigated the decomposition of beech (*Fagus sylvatica*) leaves following four different treatments. Fresh leaves were either left to form leaf litter or were fed to herbivorous caterpillars to form caterpillar faeces. The mass losses of these samples were then compared with and without the detritivore activity of woodlice.

Figure 1 shows the four treatments carried out. Figure 2 shows the mass loss of the four samples produced over a twelve week period.

Figure 1

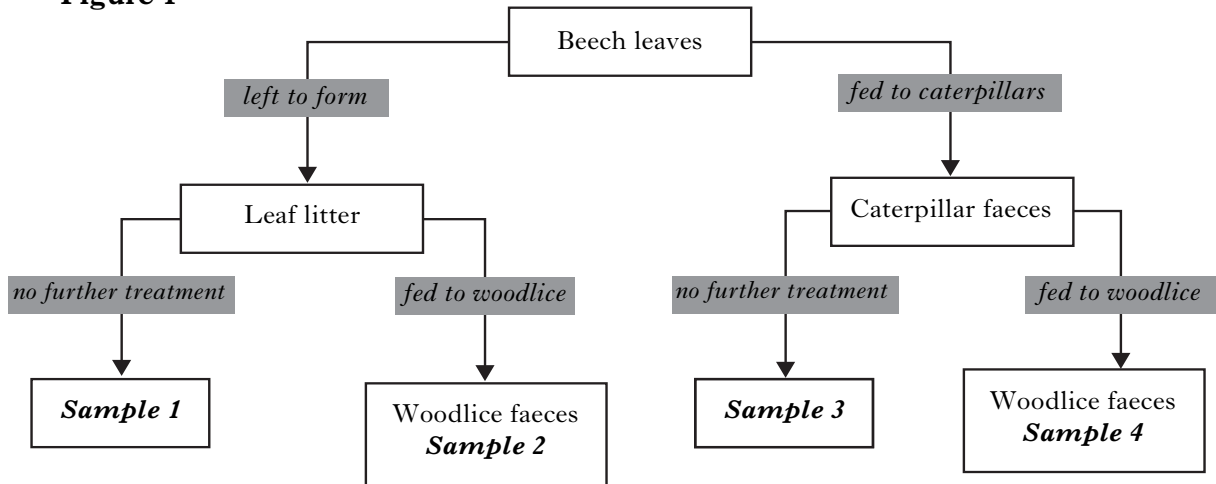
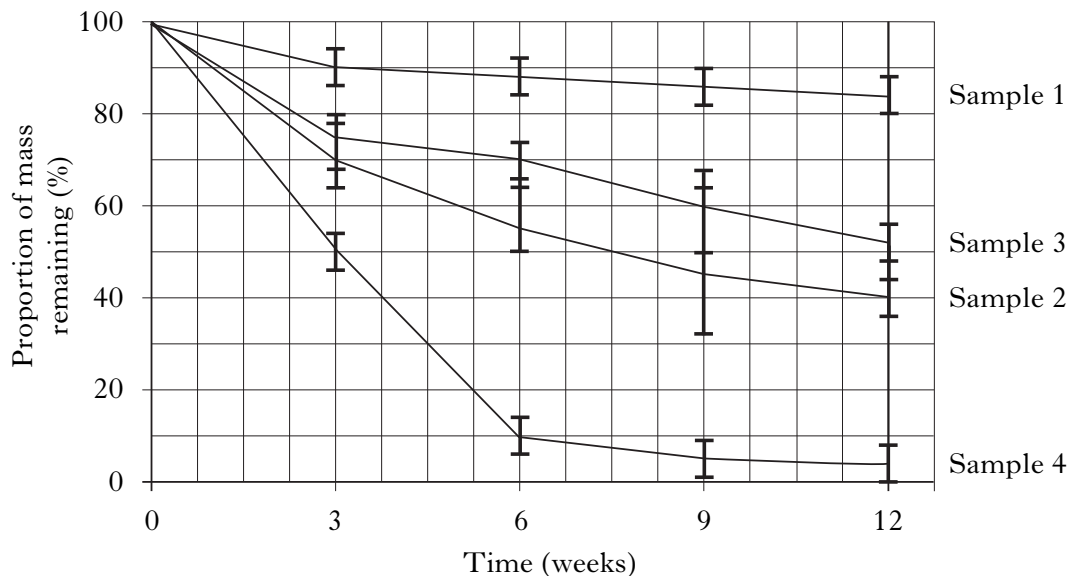


Figure 2



- (a) How do the diets of herbivores and detritivores differ? 1
- (b) Refer to Figure 2.
- (i) What evidence is there that leaves passing through the guts of two invertebrates decompose more than seven times faster than leaves allowed to form leaf litter? 2
- (ii) Use the error bars to comment on the results obtained for Samples 2 and 3 after 9 weeks. 1
- (iii) Explain why Sample 4 shows the most rapid loss in mass. 1
- (5)**

7. (a) Explain how the level of pollution in an ecosystem could be monitored using changes in population. 2
- (b) The widespread use of the drug diclofenac to treat cattle in the Indian subcontinent has led to a rapid decline in the populations of various species of vulture. For example, in 2008 the population of the oriental white-backed vulture (*Gyps bengalensis*) was estimated to be 11 000, a decline of 99.9% since 1992. Although diclofenac has low persistence and generally it has low toxicity, vultures are now known to be unusually susceptible to it.
- (i) What was the population of *Gyps bengalensis* in 1992? 1
- (ii) Explain why the effect on the vulture populations is greatest when they feed on carcasses of cattle treated with diclofenac shortly before their death. 1
- (4)**
8. Answer **either A or B**.
- A.** Increasing the rate of food production to meet global demands is challenging. Discuss the management of the environment for intensive food production with reference to:
- (i) control of species that reduce yield; 7
- (ii) monoculture. 8
- (15)**
- OR**
- B.** Plants are increasingly being cultivated for biomass as an alternative source of energy to fossil fuels. Discuss:
- (i) energy fixation and primary productivity; 5
- (ii) fossil fuels and air pollution. 10
- (15)**

[END OF SECTION B]

[Turn over

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 18–20.

The questions on Animal Behaviour can be found on pages 22–25.

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

All answers must be written clearly and legibly in ink.

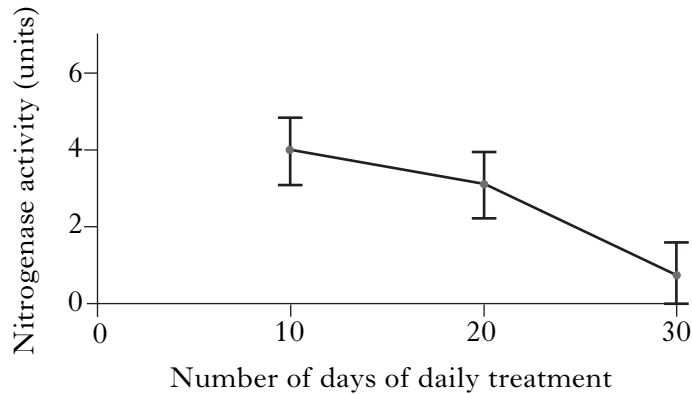
Labelled diagrams may be used where appropriate.

BIOTECHNOLOGY

Marks

1. (a) Legumes interact with bacteria to produce nitrogenase.
- (i) Name the genes responsible for the synthesis of nitrogenase. **1**
- (ii) What chemical transformation is catalysed by nitrogenase? **1**
- (b) Sea buckthorn (*Hippophae rhamnoides*) produces fruit that has potential as a food and medicinal crop. Although not a legume, it has a symbiotic relationship in which nitrogenase is synthesised and the plant receives nitrate. When it is grown as a crop, nitrogen fertiliser is required to produce a high yield of fruit.

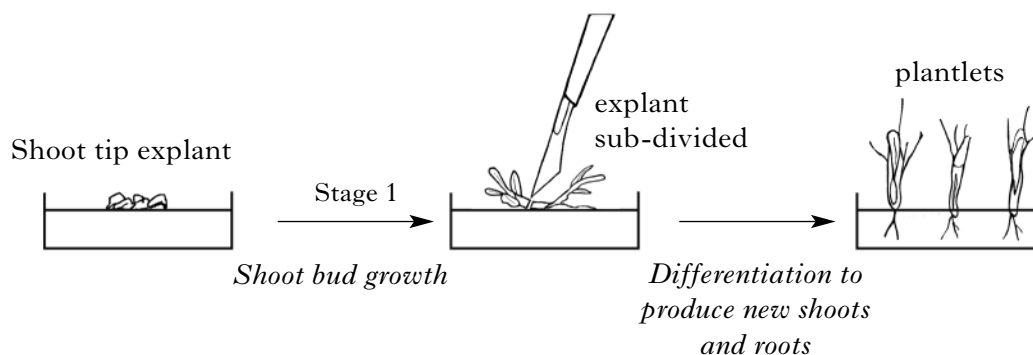
The Figure below shows the effect of daily nitrate fertiliser application on nitrogenase activity in sea buckthorn root nodules over a period of 30 days.



- Describe the effect of nitrate application on nitrogenase activity. **2**
- (4)**
2. Describe how B lymphocytes respond to foreign antigens. How is this response applied in the preparation of polyclonal sera? **(5)**

BIOTECHNOLOGY (continued)

3. Bananas are important as a crop but the planting material required is often in short supply. Scientists have developed a micropropagation system as shown in the flow chart.



- (a) Suggest **two** advantages of propagating banana plants using this system. 2
- (b) State **two** environmental conditions that need to be controlled during the development of the plantlets. 1
- (c) The effect of plant growth regulators on shoot regeneration in Stage 1 is shown in the table.

MS medium + growth regulators (mg l^{-1})		Explants differentiated (%)	Mean number of shoots per explant
+ IAA	+Kinetin		
0	0	29	2
0.1	1.0	42	4
0.1	2.5	46	8
0.1	5.0	58	8
0.5	1.0	54	12
0.5	2.5	66	20
0.5	5.0	58	28

- (i) What evidence is there that growth regulators benefit propagation? 1
- (ii) Use the data to explain why a growth regulator combination of 0.5 mg l^{-1} IAA + 5.0 mg l^{-1} kinetin is recommended. 1

(5)**[Turn over**

BIOTECHNOLOGY (continued)

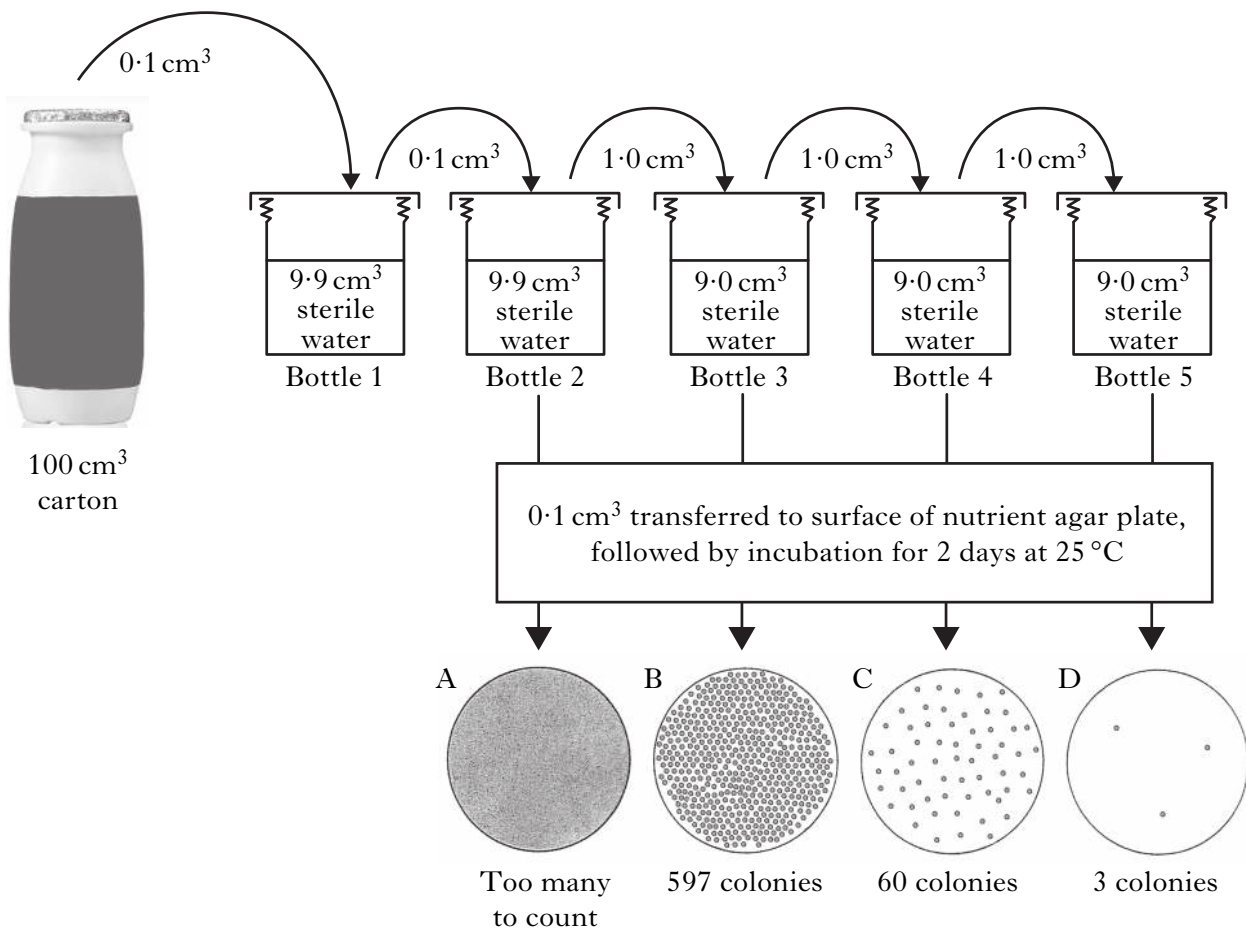
4. (a) Probiotics are produced by the dairy industry to provide health benefits beyond basic nutrition.

Describe **one** such health benefit.

1

- (b) A company that produces a probiotic yoghurt drink claims there is a measurable beneficial effect when there are at least 10^{10} viable cells of *Lactobacillus casei* per 100 cm^3 carton.

The Figure shows how a biotechnologist used dilution plating to check the number of bacteria in a 100 cm^3 carton of the drink.



- (i) Explain why dilution plating was used to check the number of bacteria rather than a direct count under the microscope.
- (ii) Explain why sterile water was used throughout the dilution steps.
- (iii) Explain why plate C would be selected to check the number of bacteria in the drink.
- (iv) Use the information to show that more than 10^{10} viable cells were present in the carton.

1

1

1

2

(6)

(20)

[End of Biotechnology questions. Animal Behaviour questions start on Page 22]

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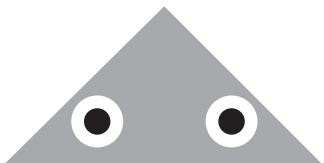

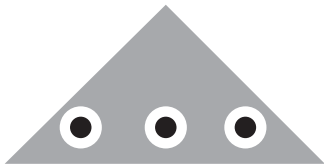
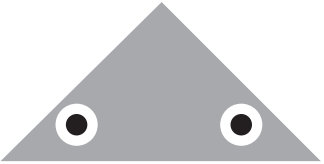
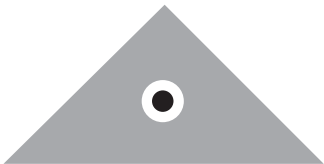
SECTION C (continued)

ANIMAL BEHAVIOUR

1. Many animals use colours and patterns to avoid predation. Some butterflies and moths, for example, have paired circular patterns on their wings.

It has often been assumed that these wing spots are effective deterrents because they resemble the eyes of the predator's own enemies—the *eye mimicry hypothesis*. An alternative explanation suggests that the off-putting effect arises from visual contrast—the *conspicuous signal hypothesis*.

In a recent experiment to test these hypotheses, targets made from triangular pieces of card were printed with the following patterns.

A 	B 	C 
Uniform grey control	Two medium spots. Overall area equal to 3 spots in D	One large spot. Overall area equal to 3 spots in D
D 	E 	F 
Three small spots	Two small spots	One small spot

Each target had a mealworm attached to it. The targets were pinned to trees in woodland containing a variety of predatory bird species. They were checked for predation after 3, 24 and 48 hours. The survival of the mealworms indicated how successful the target patterns had been.

- (a) Suggest a variable that should be controlled in the placement of the targets. 1
- (b) With which target would there be least predation if the eye mimicry hypothesis is correct? 1

ANIMAL BEHAVIOUR (continued)**1. (continued)**

(c) The table below shows mealworm survival for each target following bird predation.

<i>Target</i>	<i>Survival (%)</i>		
	<i>At 3 hours</i>	<i>At 24 hours</i>	<i>At 48 hours</i>
A	65	8	2
B	95	45	21
C	97	48	20
D	93	35	12
E	88	30	8
F	90	25	6

Explain how the results support the conspicuous signal hypothesis.

2

(d) Name **one** other defence strategy where colour or pattern are used to avoid predation.

1

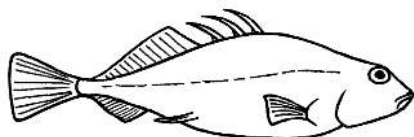
(5)

2. Describe the benefits obtained by primates living in hierarchical groups.

(4)**[Turn over**

ANIMAL BEHAVIOUR (continued)

3. Three-spined sticklebacks (*Gasterosteus aculeatus*) are fish widely distributed in rivers, lakes, ponds and estuaries throughout the British Isles. During the breeding season, from March to July, the male's throat and belly become a brilliant orange-red and his eyes electric-blue.



- (a) In observations of breeding sticklebacks, a checklist of different actions may be used to help in the analysis of their behaviour.

What name is given to such a checklist?

1

- (b) The breeding coloration of red throat and blue eye is found in male sticklebacks but not in females.

(i) What term is used to describe this difference between males and females?

1

(ii) State why the male's coloration is important in courtship.

1

- (c) A wild, outbred population of sticklebacks was captured and inbred for two generations. The table below shows the effects of inbreeding on some aspects of reproduction in these sticklebacks.

<i>Population</i>	<i>Fertilisation rate (%)</i>	<i>Hatching rate (%)</i>
Wild/no inbreeding	98	94
One generation inbred	95	90
Two generations inbred	84	78

(i) Describe briefly how an inbred population could be produced.

1

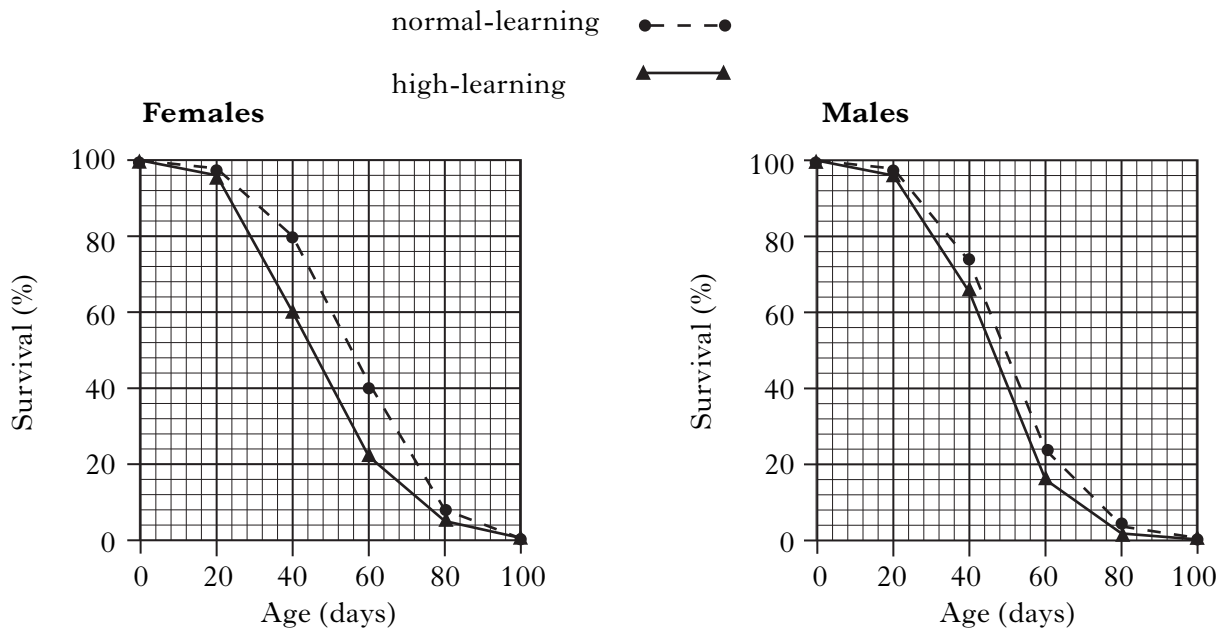
(ii) How can these results be explained?

2

(6)

ANIMAL BEHAVIOUR (continued)

4. (a) The graphs below show survival of fruit flies (*Drosophila melanogaster*) from a normal-learning strain and a high-learning strain produced by artificial selection.



- (i) Explain how these results suggest that learning in this species has a “cost”. 1
 - (ii) State **one** other conclusion that can be drawn from the results. 1
 - (iii) Why is such a cost unlikely to be observed in animals such as primates? 1
- (b) Describe **two** features of the learning process known as imprinting. 2

(5)
(20)

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

[Turn over

SECTION C (continued)

PHYSIOLOGY, HEALTH AND EXERCISE

1. The Figures below show cardiac data for men between 18 and 34 years old who undertake different periods of sports training per week.

Figure 1

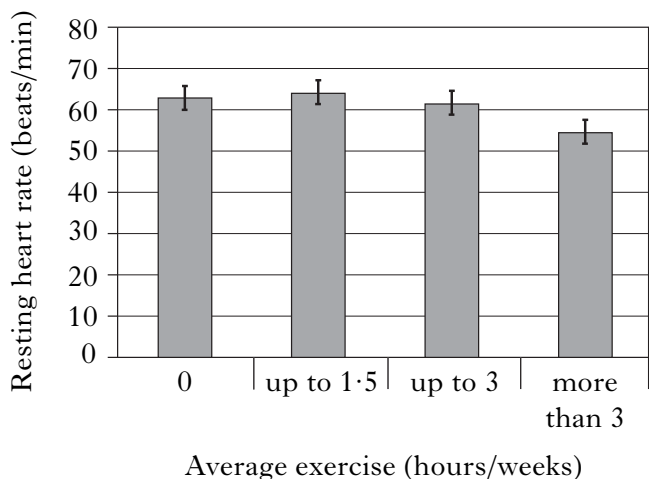
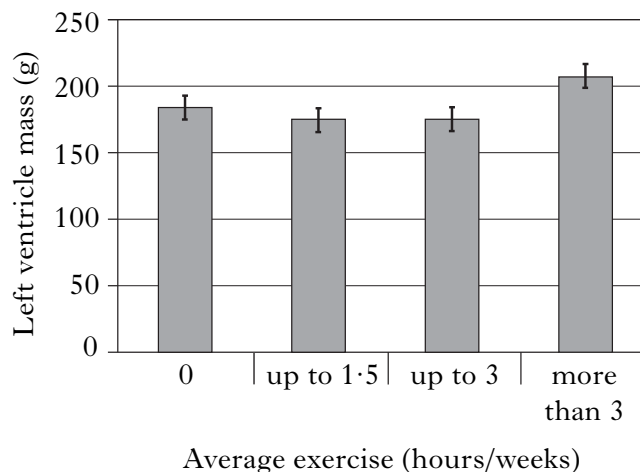


Figure 2



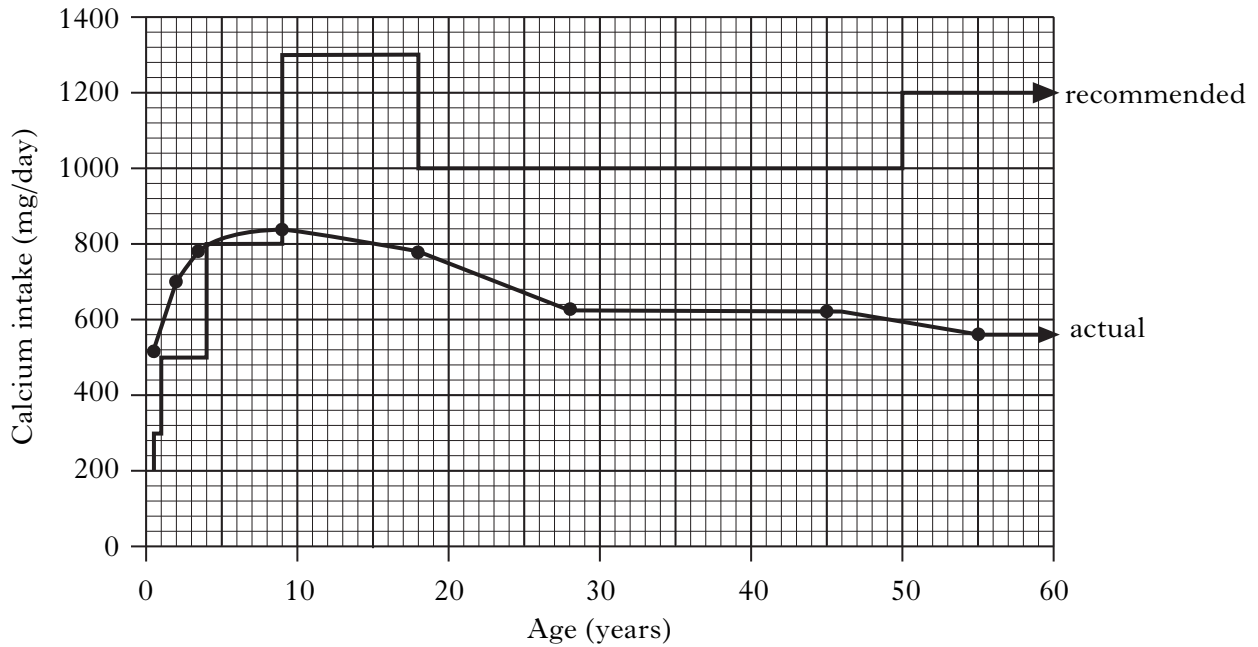
- (a) Use information from both Figures to show that the “athletic heart” is an effect of prolonged training. 2
- (b) What other information would be required to determine cardiac output? 1
- (c) What is meant by the term *cardiac hypertrophy*? 1
- (d) Give **one** example of a cardiovascular health benefit that could arise from exercising for less than three hours per week. 1

(5)

2. Describe the role of insulin in maintaining glucose balance and explain how non-insulin dependent diabetes mellitus (NIDDM) arises. (5)

PHYSIOLOGY, HEALTH AND EXERCISE (continued)

3. The daily intake of calcium for different age groups of females was compared with the recommended intake level. The results shown in the Figure below indicate that actual intake exceeds the recommended level only up to the age of eight.



Explain why a high level of calcium intake is recommended for:

- (a) the 9 to 18 age range;
- (b) the over 50s.

1
2
(3)

[Turn over for Question 4 on Page twenty-eight

PHYSIOLOGY, HEALTH AND EXERCISE (continued)

4. (a) Direct calorimetry is an accurate but expensive way to measure human energy output.

Indirect calorimetry uses measurements of oxygen consumption to estimate energy expenditure.

(i) Describe how energy expenditure is measured by direct calorimetry. **2**

(ii) What **two** aspects of breathing must be measured during indirect calorimetry? **2**

- (b) It is assumed that a person on a “mixed food” or average diet will release 20·20 kJ of energy for one litre of oxygen used. This energy value is described as the *energy equivalent of oxygen*.

(i) A typical individual uses 41·5 litres of oxygen walking slowly for an hour.

How much energy does this activity expend? **1**

(ii) The “average diet” has been worked out so that the energy equivalent of oxygen value it gives is reasonably accurate whatever a person’s diet contains.

The table below lists values for the energy equivalent of oxygen when the diet is made up of a single food.

<i>Food</i>	<i>Energy equivalent of oxygen (kJ)</i>
Starch	21·18
Glucose	20·97
Fat	19·67
Protein	19·25

Use the data to show that the value for an average diet is accurate to within 5% of any diet based on a single food. **2**

(7)

(20)

[END OF QUESTION PAPER]

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