

X007/13/02

NATIONAL FRIDAY, 16 MAY
QUALIFICATIONS 1.00 PM - 3.30 PM
2014

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

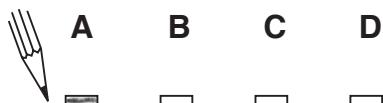
- 1 Check that the answer sheet provided is for **Biology Advanced Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate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

A Cellulose
B Phospholipid
C Polysaccharide
D Peptidoglycan

2. In *E. coli*, DNA in the nucleoid is 1.7 mm long and the cell is typically 2 μm in length. How many times longer is the DNA compared to the cell?

A 0.85
B 1.18
C 850
D 1176

3. The organelles in the list below can be found in a range of cells.

1 Endoplasmic reticulum
2 Golgi apparatus
3 Mitochondria
4 Ribosomes

Which of these organelles would be found in both eukaryotic and prokaryotic cells?

A 4 only
B 1 and 4 only
C 1, 3 and 4 only
D 1, 2, 3 and 4

4. Which of the following occurs during S phase of the cell cycle?

A The cytoplasm divides.
B The DNA replicates.
C Two identical nuclei are formed.
D The nuclear membrane forms.

5. The table below shows the number of cells from a cell culture at different stages in the cell cycle.

Stage	Number of cells
Interphase	2240
Prophase	300
Metaphase	180
Anaphase	40
Telophase	40

The mitotic index for the sample is

A 8%
B 20%
C 25%
D 32%.

6. Which of the following describes the action of oncogenes?

A They cause cell proliferation resulting in tumour formation.
B They encode the proteins that limit cell division.
C They restrict cell division at checkpoints.
D They switch genes on during cell differentiation.

[Turn over

7. The table below shows the results of an investigation to work out the best combination of auxin and cytokinin for promoting organ growth from explants in plant tissue culture.

<i>Concentration of auxin ($\mu\text{mol L}^{-1}$)</i>	<i>Concentration of cytokinin ($\mu\text{mol L}^{-1}$)</i>	<i>Appearance of tissue after incubation</i>	<i>Summary of effect</i>
10	0		No growth
10	0.1		Roots growing
10	1.0		Disorganised growth
10	2.5		Several shoots
10	10.0		A few shoots; considerable growth
10	50.0		Limited, disorganised growth

In the culture medium, what ratio of auxin to cytokinin is most successful for this plant?

- A 1 : 1
- B 4 : 1
- C 10 : 1
- D 100 : 1

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

- A hydrogen bonds
- B peptide bonds
- C ester linkages
- D glycosidic linkages.

9. Which of the following describes the structure of cytosine?

- A A purine base with a single-ring structure
- B A purine base with a double-ring structure
- C A pyrimidine base with a single-ring structure
- D A pyrimidine base with a double-ring structure

10. The genome of a cell contains 3×10^9 base pairs. Only 1.5% of the genome codes for proteins.

How many amino acids are encoded by this genome?

- A 1.5×10^7
- B 4.5×10^7
- C 5.0×10^{10}
- D 4.5×10^{11}

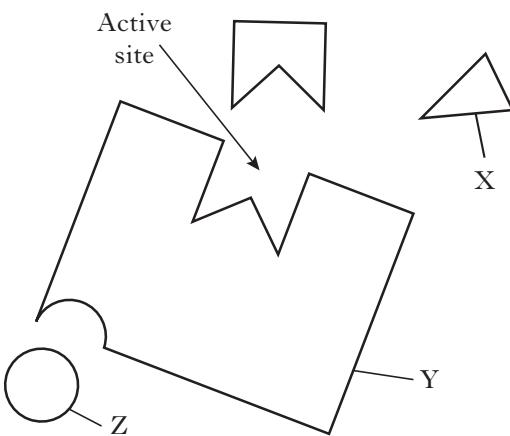
11. The mechanism of action of the sodium-potassium pump includes the following events:

- P membrane protein loses a phosphate group
- Q potassium binds to membrane protein
- R potassium ions are released
- S membrane protein shape is restored.

The correct sequence of these events is

- A P, Q, R, S
- B P, Q, S, R
- C Q, P, R, S
- D Q, P, S, R

12. The diagram below represents the molecules involved in an enzyme reaction.



Which line in the table correctly identifies the molecules?

	X	Y	Z
A	competitive inhibitor	enzyme	non-competitive inhibitor
B	competitive inhibitor	substrate	non-competitive inhibitor
C	non-competitive inhibitor	enzyme	competitive inhibitor
D	non-competitive inhibitor	substrate	competitive inhibitor

13. Which of the following stages in the polymerase chain reaction (PCR) is carried out at 95°C ?

- A Annealing of primers
- B Separation of DNA strands
- C Formation of phosphodiester bonds
- D Complementary base pairing

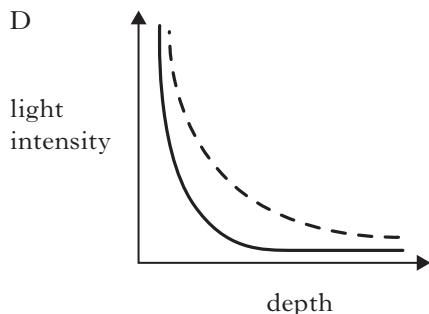
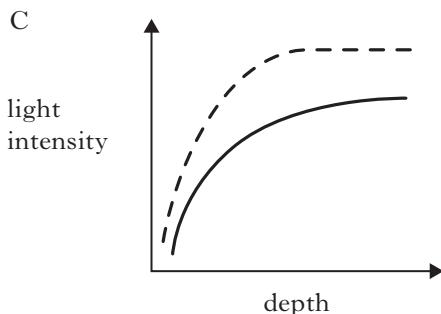
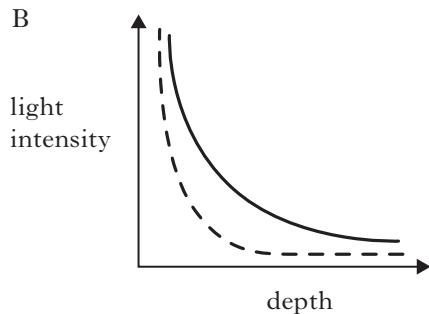
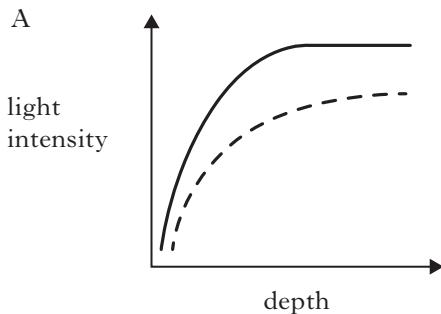
[Turn over

14. In aquatic ecosystems the amount of sunlight absorbed by water increases with depth.

Absorption by seawater is greater than absorption by fresh water.

Which of the following graphs represents the relationship between depth and light intensity in fresh water and seawater?

Key ————— sea water
- - - - - fresh water



15. Detritivores play an important role in the circulation of nutrients in the soil.

Which line in the table below shows the correct classification of detritivores and the product they form in the soil?

	Classification	Product
A	invertebrates	ammonia
B	bacteria	humus
C	invertebrates	humus
D	bacteria	ammonia

16. The following micro-organisms are involved in nitrate formation in ecosystems.

- 1 Cyanobacteria
- 2 *Nitrosomonas*
- 3 *Nitrobacter*
- 4 *Rhizobium*

Which line in the table matches correctly the micro-organisms and their roles?

	Nitrogen fixation	Nitrification
A	1 and 3	2 and 4
B	2 and 3	1 and 4
C	2 and 4	1 and 3
D	1 and 4	2 and 3

17. In the following table “+” indicates a benefit and “-” indicates a cost or negative effect on an organism in a relationship. “0” indicates neither benefit nor cost.

For which of the relationships in the table is the benefit/cost shown **incorrectly**?

	Relationship	Benefit/cost
A	commensalism	+/0
B	competition	+/-
C	parasitism	+/-
D	predation	+/-

18. In Africa, a bird called the honey-guide eats beeswax but can only feed when a honey-badger has broken open a wild bee nest to feed on the honey. The honey-guide locates the bee nest and leads the honey-badger to it.

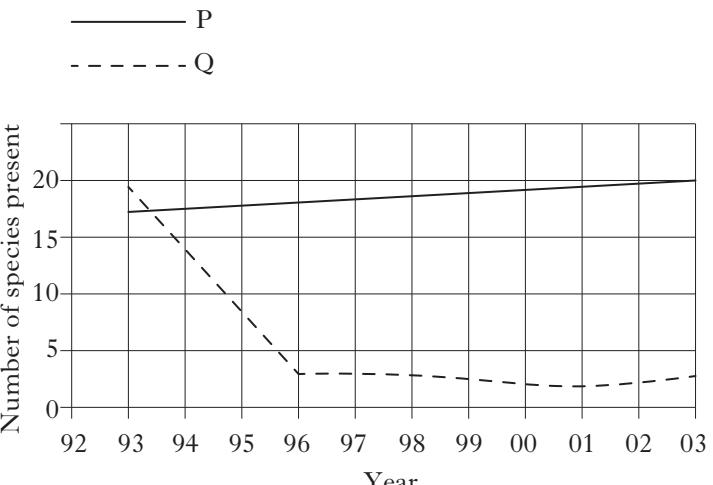
The relationship between the honey-guide and the honey-badger is an example of

- A parasitism
- B competition
- C commensalism
- D mutualism.

19. The production of toxic chemicals by one species of plant to prevent the growth of other plant species is an example of

- A interspecific exploitation competition
- B interspecific interference competition
- C intraspecific exploitation competition
- D intraspecific interference competition.

20. The Sea Star *Pisaster ochraceous* is a key predator of the rocky intertidal zone on the coast of Washington State, USA. It feeds on mussels and other invertebrates in rock pools. One of the lines in the graph below shows the effect of removing *Pisaster* from a rock pool in 1993.

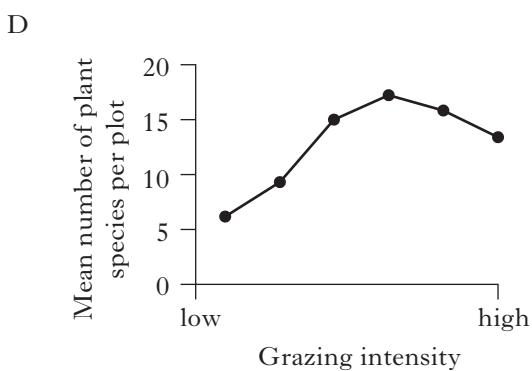
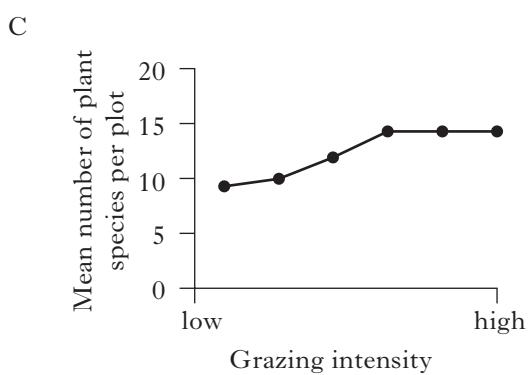
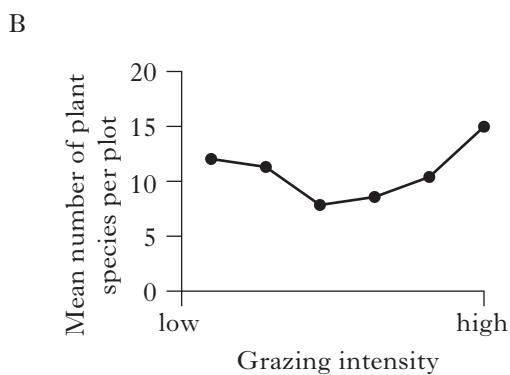
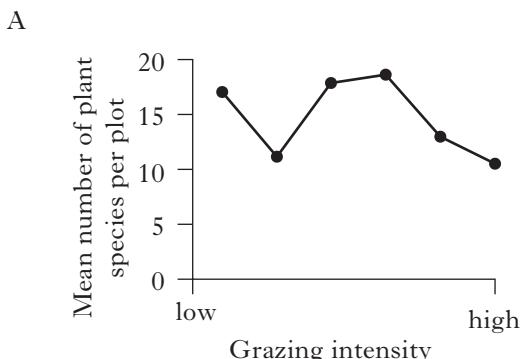


Which line in the table correctly describes the results?

	Line P	Line Q	Role of Pisaster
A	with <i>Pisaster</i>	without <i>Pisaster</i>	decreases species diversity
B	with <i>Pisaster</i>	without <i>Pisaster</i>	increases species diversity
C	without <i>Pisaster</i>	with <i>Pisaster</i>	increases species diversity
D	without <i>Pisaster</i>	with <i>Pisaster</i>	decreases species diversity

[Turn over

21. Which of the graphs below represents the relationship between the intensity of rabbit grazing and the diversity of plant species in a series of grassland plots?



22. Diagram A shows three burrowing animals that live at different depths in Scottish beaches. They are eaten by various wading birds such as those illustrated in Diagram B.

Diagram A

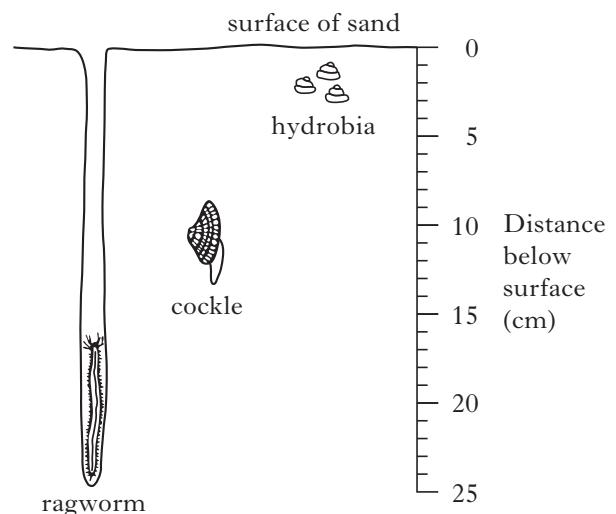
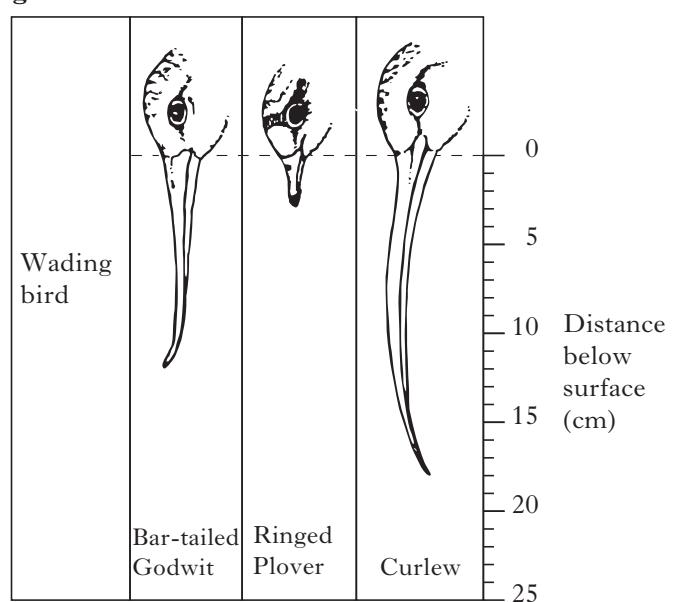


Diagram B



Which of the following is a consequence of the different lengths of the waders' beaks?

- A Resource partitioning
- B Competitive exclusion
- C Exploitation competition
- D Interspecific competition

23. The table below shows the results of a population survey of *Hydrobia* snails using a quadrat in five random positions on a muddy beach.

Quadrat	1	2	3	4	5
Number of snails	1800	2600	2100	1900	1600

The quadrat measured 50 cm × 50 cm.

What was the average density of *Hydrobia* per square metre?

- A 2000
- B 4000
- C 8000
- D 10 000

24. Scarlet kingsnakes are non-venomous and live in the same area as the venomous eastern coral snakes. Both species have red, yellow and black ring markings.

Which line in the table correctly describes the relationship between these two species?

	<i>Model</i>	<i>Mimic</i>	<i>Type of mimicry</i>
A	coral snake	scarlet kingsnake	Batesian
B	scarlet kingsnake	coral snake	Batesian
C	coral snake	scarlet kingsnake	Mullerian
D	scarlet kingsnake	coral snake	Mullerian

25. Suspended development of insects in response to the adverse environmental conditions of winter is a form of

- A predictive dormancy called hibernation
- B predictive dormancy called diapause
- C consequential dormancy called diapause
- D consequential dormancy called hibernation.

[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.

- Two types of muscle, red and white, can be distinguished by their colour in samples of fresh tissue and can be easily separated. Red muscle cells obtain energy mainly using aerobic respiration: they have many large mitochondria and a good supply of oxygen. White muscle cells obtain energy mainly by anaerobic respiration: they have fewer mitochondria and a poorer oxygen supply. In both muscle types, glucose is the substrate for respiration. It is widely thought that the mechanism of glucose transport into these cells is the step that limits their ability to use glucose, and it is considered that red muscle cells have a greater capacity for glucose transport than white muscle cells.

Glucose diffuses into cells through glucose transporters (GLUTs), which are protein molecules embedded in cell membranes. There are several types of GLUT. GLUT1 is responsible for glucose uptake in all cells; the membranes of muscle and fat cells also contain GLUT4.

The study below investigated the contribution of these two GLUTs to glucose uptake in red and white muscle cells, before and after exposure to insulin. Figure 1 shows the effect of insulin on glucose transport in the two types of muscle.

An extract of membranes from the muscle cells was centrifuged to separate it into two portions, plasma membrane (PM) and the internal membranes (IM) from the cytoplasm. The protein components of the membranes were separated by gel electrophoresis and blotted. The blots were exposed to radioactively-labelled antibodies specific for each of the two GLUT proteins, to allow identification and quantification.

Figure 2 shows the percentage change in total GLUT level in the two membrane fractions following the insulin treatment. In Figure 3, the blots indicate the changing abundances of the two GLUTs. Figure 4 shows the relative amount of GLUT4 in the two muscle types in response to insulin. Error bars show *standard error*.

Figure 1: Glucose transport with and without insulin

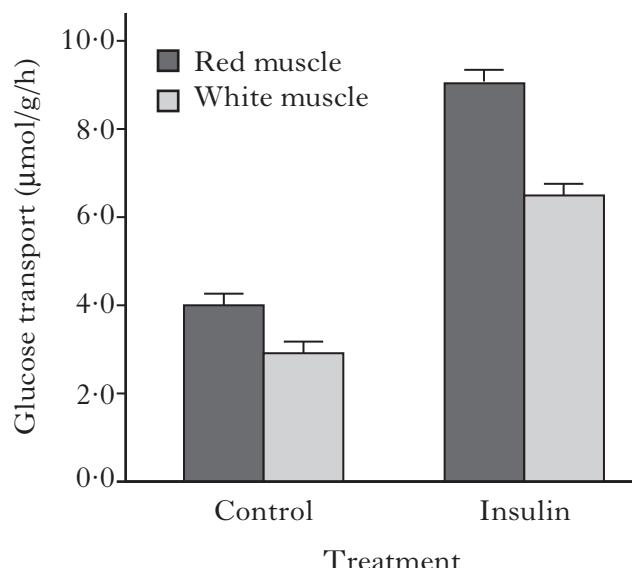
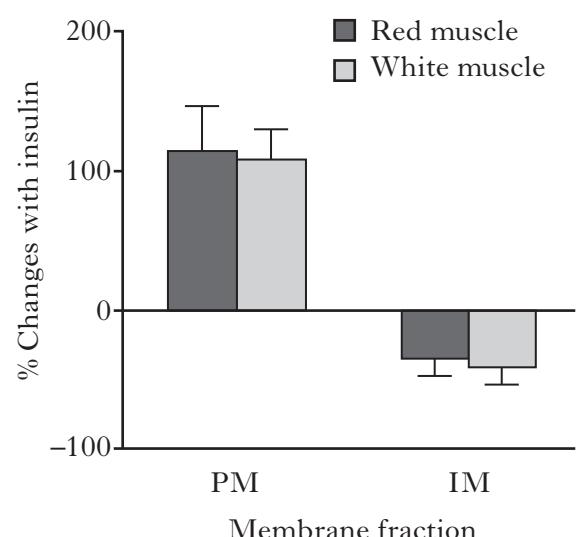


Figure 2: Effect of insulin on total GLUT levels



Question 1 (continued)

Figure 3: Blots showing the effect of insulin on the distribution of GLUTs 1 and 4

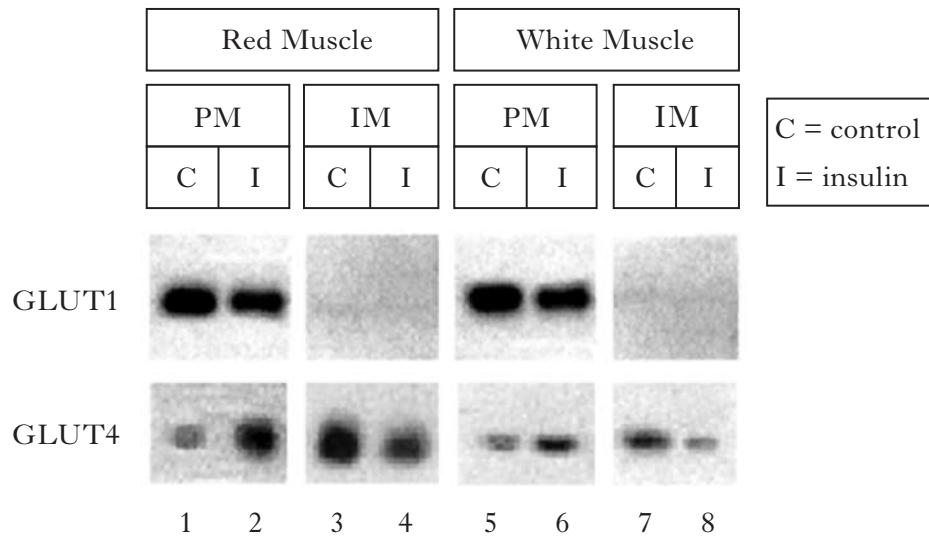
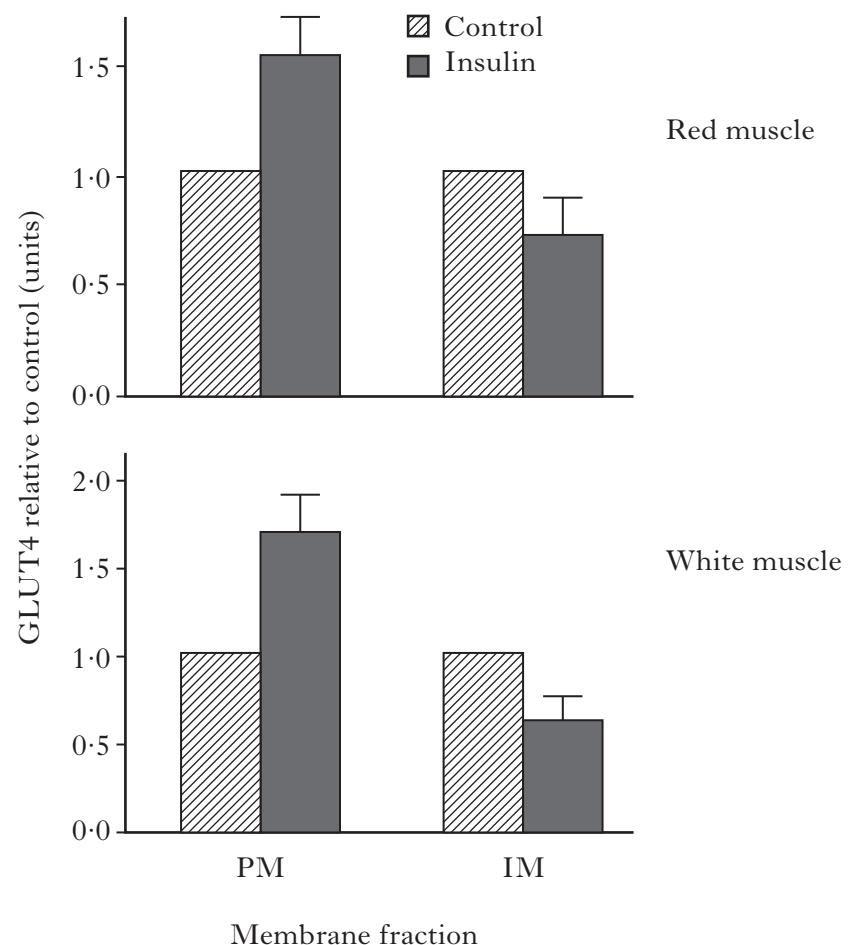


Figure 4: Relative amounts of GLUT4 quantified from several blots



Question 1 (continued)

(a) Use data from Figure 1 to support the statement that “red muscle cells have a greater capacity for glucose transport than white muscle cells”. 2

(b) Figure 2 shows that GLUT increases in the PM fraction and decreases in the IM fraction after insulin treatment.

- (i) Why is *percentage change* being used here to present the results? 1
- (ii) It was concluded that both muscle types have the same underlying GLUT response to insulin. Explain how the error bars confirm this conclusion is valid. 1

(c) Refer to Figure 3.

- (i) Describe the distribution of GLUT1 in muscle cells before insulin treatment. 1
- (ii) Give **one** conclusion about the effect of insulin treatment on GLUT1. 1
- (iii) What evidence is there that the effect of insulin on the distribution of GLUT4 is the same in both types of muscle? 1

(d) It was hypothesised that insulin triggers the transport of additional GLUT4 to the plasma membrane from storage on membranes in cytoplasm, and that this ‘recruitment’ mechanism is greater in red muscle cells.

Explain how the results from Figures 3 and 4 support this hypothesis. 2

(e) (i) Insulin is a hydrophilic signalling molecule. Explain why some cells are not targets in this type of signalling. 2

(ii) Explain why the effect of insulin on GLUT4 is an example of signal transduction. 1

(f) Glucose taken up by different cell types in response to insulin can have different fates, for example muscle cells can convert glucose to glycogen.

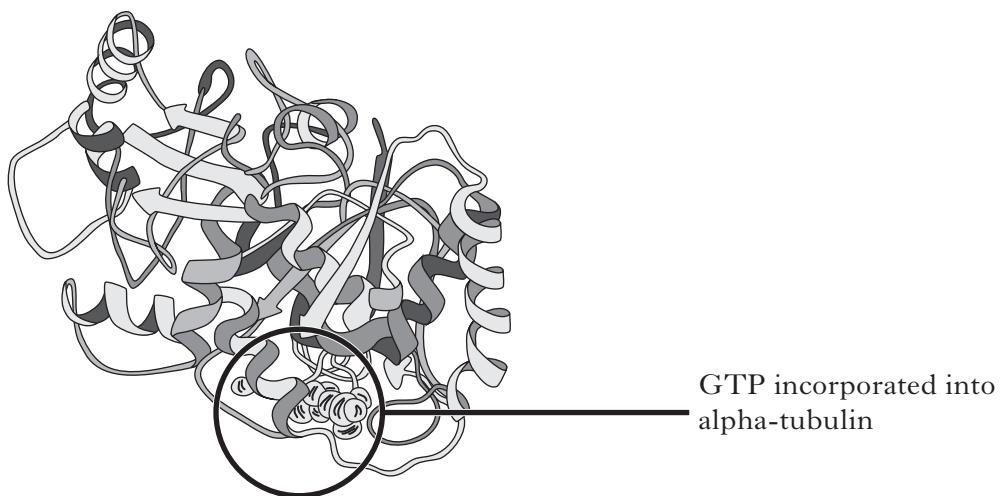
- (i) State the role of glycogen in cells. 1
- (ii) Give **two** features of the structure of glycogen. 1

(14)

2. Transgenic plants can be grown from modified protoplasts. Describe how plasmids from *Agrobacterium* are engineered and used to produce modified protoplasts. (4)

[Question 3 is on fold-out Page thirteen]

3. Tubulin is described as a *dimer* because it is made of two polypeptide subunits, alpha-tubulin and beta-tubulin. Both subunits contain GTP, a molecule that is similar to ATP but has the base guanine instead of adenine. A representation of alpha-tubulin is shown below.



Microtubules are made of assembled tubulin. Microtubules can extend at one end by the addition of tubulin dimers provided there are enough present.

(a) What term is used to describe a component, such as GTP, embedded in a polypeptide? 1

(b) During mitosis:

- (i) to which structures do the two ends of a spindle fibre normally attach? 1
- (ii) what is the role of spindle microtubules in anaphase? 1

(c) (i) A new drug, *eribulin*, has recently been approved as a treatment for some advanced cancers. Eribulin, introduced into the bloodstream, appears to have two effects in dividing cells: it blocks the growing ends of microtubules and it binds to available tubulin dimers.

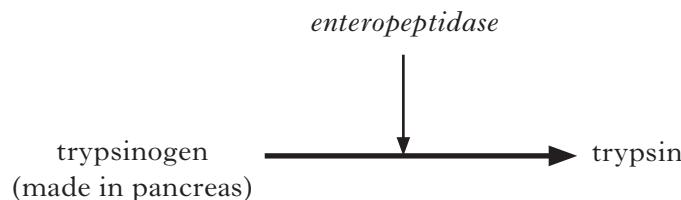
Suggest why cells treated with eribulin might fail the M checkpoint in the cell cycle. 1

(ii) Suggest **one** disadvantage of treating tumours with drugs that target cell division. 1

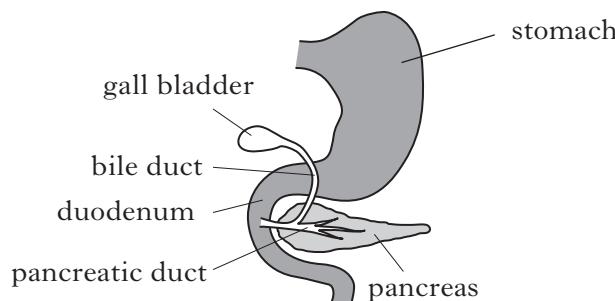
(5)

4. The enzyme *enteropeptidase* brings about the conversion of trypsinogen to trypsin.

Marks



Enteropeptidase is made in cells lining the duodenum but only after partially digested food has moved on from the stomach and when pancreatic juice has entered the gut. This key enzyme is not free to move; it remains bound to plasma membranes of the cells that make it. A powerful trypsin inhibitor is present in pancreatic juice, even though no trypsin is present.



(a) What term describes the activation carried out by enteropeptidase? 1

(b) Name the type of reaction carried out on a peptide bond by a protease such as trypsin. 1

(c) Why is it important that active trypsin is produced only after trypsinogen has left the pancreas? 1

(d) Enteropeptidase cuts trypsinogen after the amino acid lysine, in a unique position where it is bonded to isoleucine. Trypsin attacks points in any polypeptide where either of the amino acids lysine or arginine appear.

Explain why trypsin formation accelerates once trypsin production has started.

1

(4)

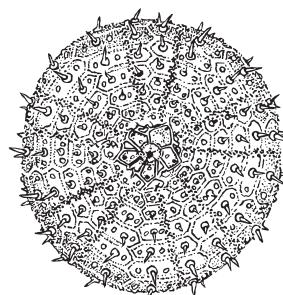
5. (a) Mammals and birds are homeotherms; they maintain a constant body temperature. For this adaptation, give

- one cost;
- one benefit.

2

(b) The body fluids of sea urchins are isotonic with seawater, that is, they have the same solute concentration as their surroundings.

What term is used to describe an organism that has this type of interaction with the environment?



1

(3)

6. Pesticides are widely used in intensive food production.

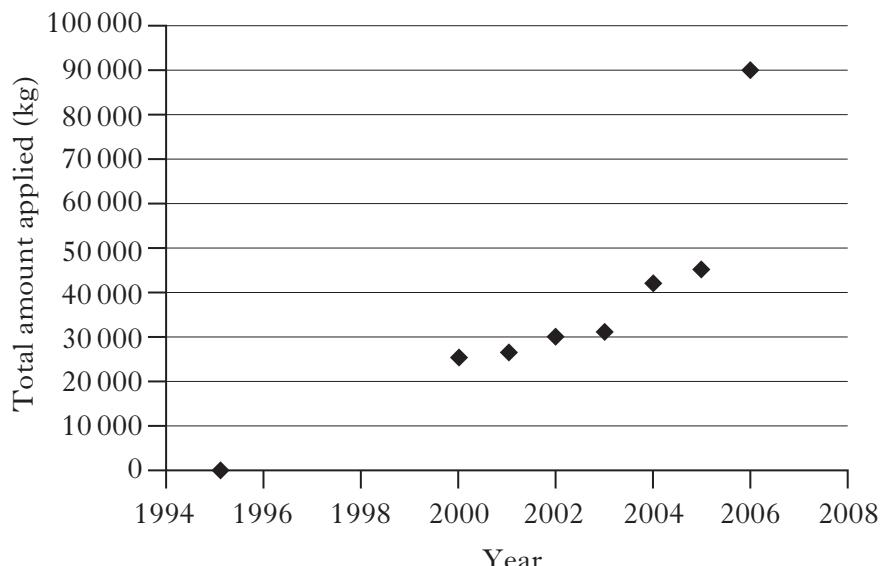
(a) Explain the role of pesticides in intensive crop production. 1

(b) Give **one** feature of a pesticide that can help to reduce undesirable effects on the environment. 1

(c) Bumble-bees (*Bombus* species) are important pollinators of crop plants and wild flowers. Since 2006 there have been increasing numbers of reports of bee colonies suddenly dying off with a condition referred to as *colony collapse disorder*.

(i) Colony collapse disorder has been linked to the widespread use of *neonicotinoid* insecticides.

The graph below shows the changes in usage of neonicotinoids since their introduction into the UK in 1995.



Calculate the percentage increase in neonicotinoid usage between 2002 and 2006. 1

(ii) Bee behaviour, however, may also contribute to colony loss. Bumble-bee colonies contain up to 100 individuals and the bees forage no more than a few hundred metres from their nests. Most of their food (pollen and nectar) is used immediately and very little is stored.

Suggest **one** way intensive crop production could be planned to improve the conservation of bumble-bees. Explain your suggestion. 2

(5)

[Turn over

7. As global warming proceeds, gradual changes in community composition of ecosystems are expected to occur.

(a) Explain how a gradual increase in sea temperature leads to coral bleaching. 2

(b) Recently it has been proposed that global warming is increasing the frequency of *extreme weather events*, such as droughts and heatwaves. It is not known if these intense, localised conditions have any significant impact on ecosystems.

The community composition of coral reefs was monitored over several years in Jurien Bay on the west coast of Australia. During 2011, warmer seawater moved from the tropical north into cooler, southern areas.

Figure 1 shows the mean water temperature recorded each week in 2011 and the mean for the five preceding years. Figure 2 shows the abundance of seaweed species that form a floating canopy and those that cover the seabed as 'turf'.

Figure 1: Sea temperatures

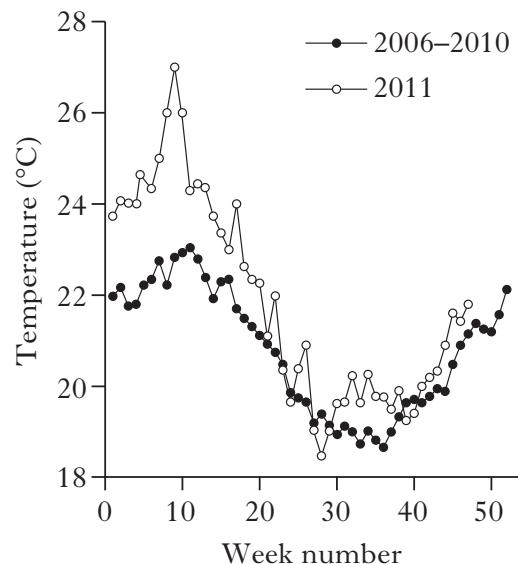
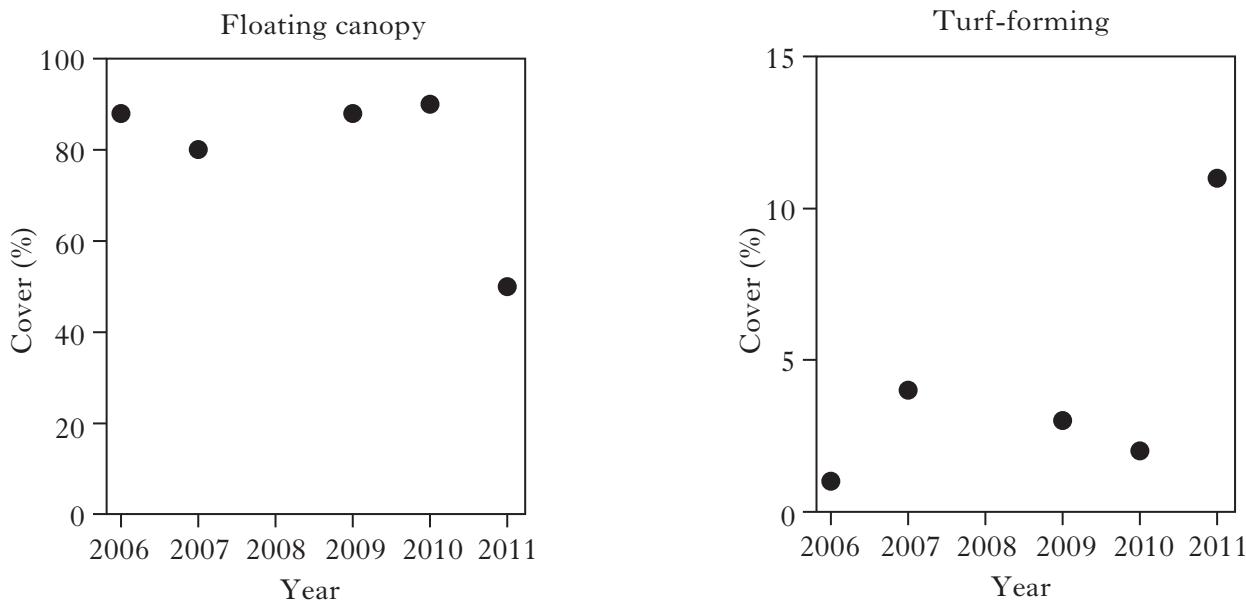


Figure 2: Abundance of Seaweeds



7. (b) (continued)

(i) Using the data, show that there was a sea temperature “spike” in 2011. 1

(ii) What impact does the sea temperature spike appear to have had on the plant community in Jurien Bay? 1

(c) A permanent change in an external factor such as temperature can result in the formation of a new climax community. What term describes this outcome? 1

(5)

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

A. Give an account of energy in ecosystems under the following headings:

(i) energy fixation; 6

(ii) flow of energy through trophic levels. 9

(15)

OR

B. Give an account of the pollution of fresh-water ecosystems arising from the:

(i) use of fossil fuels; 5

(ii) release of toxic pollutants; 5

(iii) release of biodegradable organic pollutants. 5

(15)

[END OF SECTION B]

[Turn over for SECTION C on Page eighteen]

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 22–24.

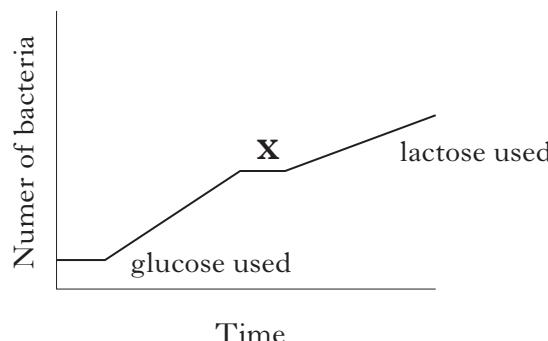
The questions on Physiology, Health and Exercise can be found on pages 25–27.

All answers must be written clearly and legibly in ink.

Labelled diagrams may be used where appropriate.

BIOTECHNOLOGY

1. The bacterium *Escherichia coli* (*E. coli*) can use a variety of different sugars as an energy source during growth. The graph shows the typical growth curve obtained when *E. coli* is cultured in a medium containing both glucose and lactose.



(a) Give **one** method that could be used to determine cell numbers in the production of a bacterial growth curve. 1

(b) What term describes the two-phase pattern of growth shown? 1

(c) The two-phase growth results from the effects of two regulatory proteins, *lac* repressor and CAP, on the lac operon. Explain the role of these proteins in producing the second phase of growth:

- (i) *lac* repressor; 2
- (ii) CAP. 2

(d) Suggest an explanation for the shape of the graph at position X. 1

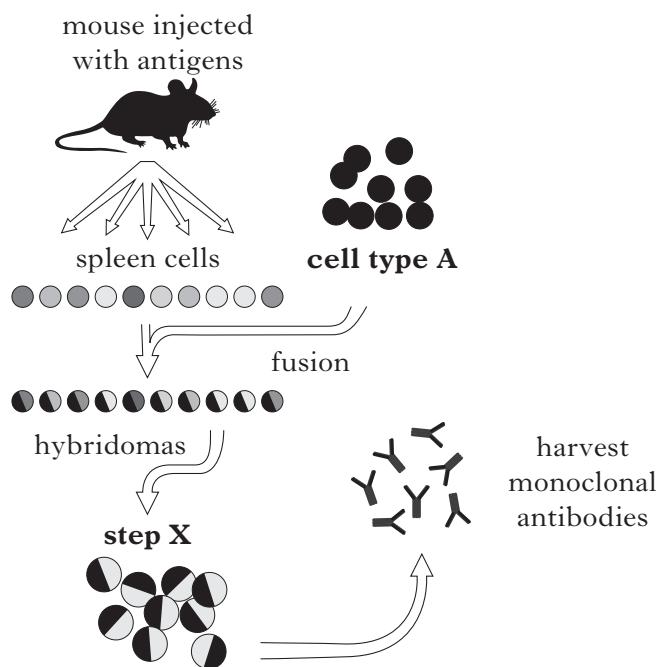
(5)

2. Describe how micro-organisms are manipulated and grown in the industrial production of the enzyme chymosin. (5)

BIOTECHNOLOGY (continued)

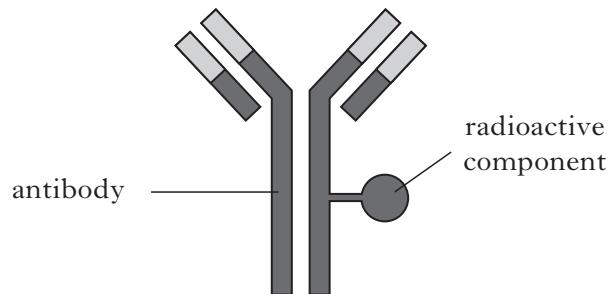
3. Figure 1 shows steps in the production of a monoclonal antibody.

Figure 1



In the treatment of disease, monoclonal antibodies can be attached to toxic components to create “magic bullets”. One example of this, shown in Figure 2, uses a component that emits damaging radiation.

Figure 2



(a) (i) Name cell type A and explain the role of these cells in the production of monoclonal antibodies.

2

(ii) How are unfused Type A cells eliminated at step X?

1

(b) Explain how this magic bullet would work in the treatment of a tumour.

2

(5)

[Turn over

BIOTECHNOLOGY (continued)

4. Yeast autolysis is a process in which yeast biomass undergoes degradation by internal enzymes. The autolysate produced can have a variety of uses, including the production of flavourings for foods.

Ribonucleic acid (RNA) is degraded by autolysis in the production of the flavour-enhancing molecules IMP and GMP, as shown in the flow chart below. However, autolysis must be carefully controlled to prevent the RNA being degraded too far.



The table below shows the results of a study into the effects of different heat treatments on the autolysis process in the yeast *Kluyveromyces marxianus*.

Treatment of cells		Soluble protein in autolysate (g per litre)	Partially degraded RNA in autolysate (mg per litre)
Temperature (°C)	Time (hours)		
35	15	19.4 ± 0.4	not detected
	30	18.8 ± 1.0	not detected
50	15	18.8 ± 0.5	285 ± 30
	30	18.4 ± 0.2	430 ± 10

(a) How do the data support the conclusion that increasing the temperature from 35°C to 50°C had no effect on the release of protein during autolysis? 1

(b) (i) What evidence is there that some treatments have totally degraded the RNA molecules? 1

(ii) Which treatment would be best for maximising the production of GMP and IMP? Explain your choice. 2

(c) Give **one** factor, other than heat treatment, that can affect the characteristics of yeast autolysate. 1

1

1

2

1

(5)

[End of Biotechnology questions.]

[Turn over for *ANIMAL BEHAVIOUR* questions on *Page twenty-two*

SECTION C (continued)

ANIMAL BEHAVIOUR

1. Some species show a tendency to remain in their home area after birth or hatching. Staying in a familiar environment for breeding can be advantageous since the risks and costs of exploring new habitats are avoided. However, the encounter rate of related individuals is high and can increase the risk of inbreeding. A mechanism to avoid inbreeding is likely to be favoured by natural selection.

A study was carried out on European storm petrels (*Hydrobates pelagicus*), Figure 1, to see if these birds are able to distinguish between kin and non-kin individuals by odour.

Birds were captured from their burrows and rubbed with cotton swabs to collect individual odours. A cotton swab from a related bird (kin) was placed in one 'goal' arm in a Y-maze.

A swab from an unrelated bird (non-kin) was placed in the other goal arm. Birds placed in the entrance to the maze were allowed to make a choice by walking into one goal arm or the other. Some birds did not move from the entrance, so did not make a choice. Results for forty birds tested are shown in Figure 3.

Figure 1: European storm petrel

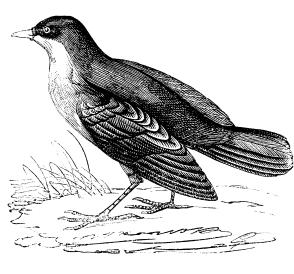


Figure 2: Y-maze

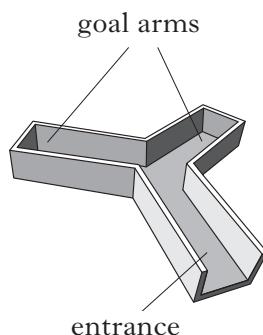
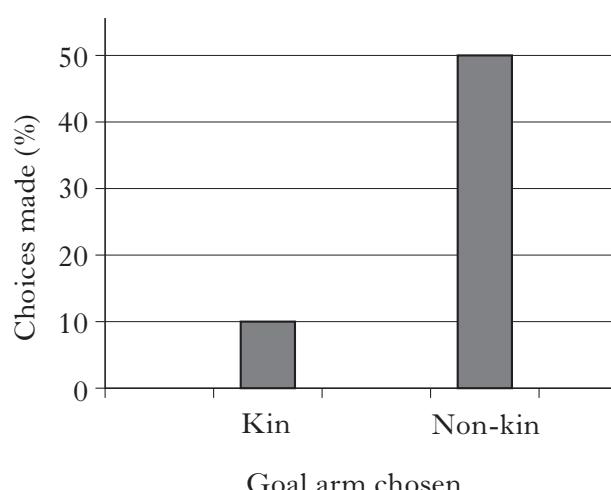


Figure 3: Results of the Y-maze experiments



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

<p>(a) (i) What conclusion can be drawn from these results? 1</p> <p>(ii) Calculate the number of birds that made no choice. 1</p> <p>(b) Suggest one precaution that should be carried out in the conduct of such an experiment. 1</p> <p>(c) Why is avoidance of inbreeding likely to be favoured by natural selection? 2</p> <p>(d) Describe a different strategy for avoiding inbreeding that may be observed in polygamous social mammals, such as lions. 1</p>
(6)

2. Using examples, discuss the responses of intrinsically adaptable species to human activity. (5)

3. Each of the following titles refers to original research articles that have appeared in the journal *Animal Behaviour*.

For each of the titles, explain the meaning of the term in **bold**.

<p>(a) “Fish cleaning symbiosis: proximate causes of host behaviour” 1</p> <p>(b) “Response latency as a function of the amount of reinforcement” 1</p> <p>(c) “Worker nutrition and division of labour in honey bees” 1</p>
(3)

[Turn over

4. Imprinting is an important process involved in a variety of different behaviours in many species.

(a) (i) Drugs that inhibit memory processes have been shown to disrupt imprinting. Explain how this supports the view that imprinting is a form of learning. 1

(ii) State **one** other feature of imprinting. 1

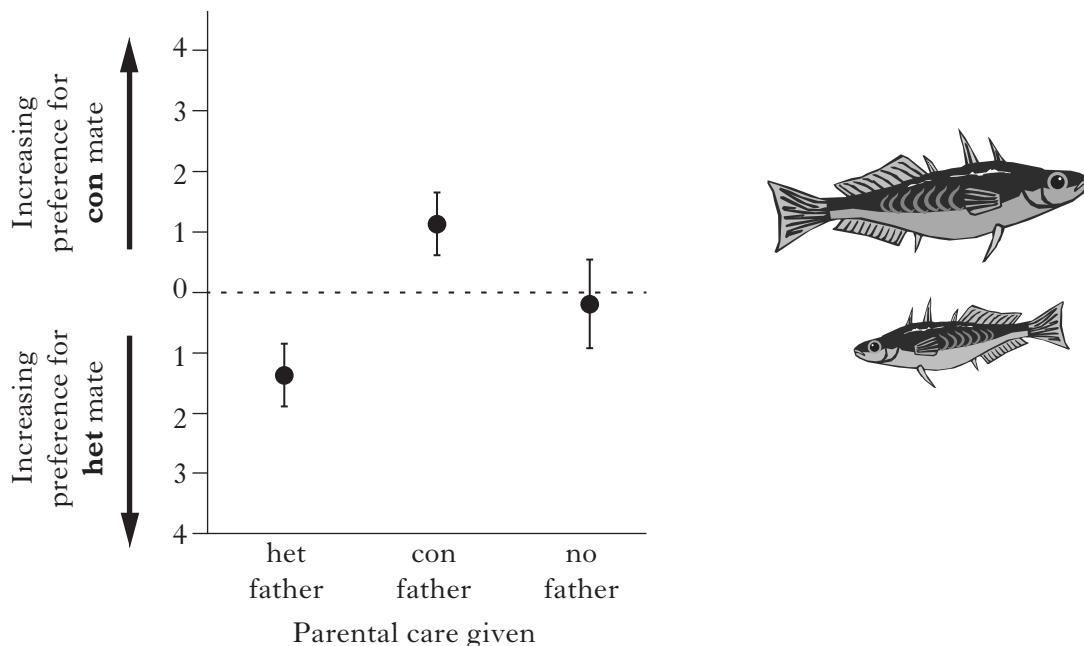
(iii) Explain how imprinting can increase the protection of young members of a species. 1

(b) In Paxton Lake, Canada, there are two species of three-spined sticklebacks (*Gasterosteus* spp.), illustrated below. An investigation was carried out to examine the possible role of imprinting in maintaining reproductive isolation in these species. In sticklebacks, males provide all of the parental care.

Offspring were raised in three groups as follows:

- 1 cross-fostered by father of the other species – “het” father
- 2 fostered by father of the same species – “con” father
- 3 no father.

When sexually mature, female offspring of the three groups were scored for degree of preference for mates of either species (“het” or “con” mates). The results are shown in the graph below.



- (i) What evidence is there that females in the “no father” group had no preference for species of mate? 1
- (ii) What do the results suggest about the mate preference of cross-fostered females? 1
- (iii) Stickleback males have an elaborate courtship display. Give one signal in the display that can stimulate a fixed action pattern. 1

(6)

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

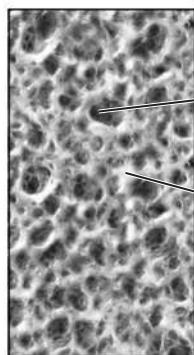
SECTION C (continued)

PHYSIOLOGY, HEALTH AND EXERCISE

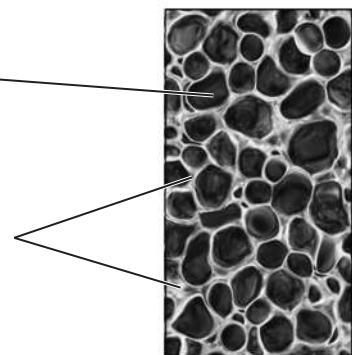
1. Discuss the importance of exercise in reducing the risk of cardiovascular disease. (5)

2. (a) (i) What aspect of body composition is measured using bioelectrical impedance analysis (BIA)? 1
 (ii) Give **one** limitation of BIA. 1

(b) The images below show sections of vertebrae from two females; one shows normal bone and one is from a female recently diagnosed with osteoporosis.



Normal bone



Bone from female with osteoporosis

(i) With reference to the images above, describe the changes in bone structure as osteoporosis develops. 1
 (ii) What action can be taken to delay the onset of osteoporosis? 1
 (iii) Why does osteoporosis develop more quickly in females than in males? 1

(5)

[Turn over

PHYSIOLOGY, HEALTH AND EXERCISE (continued)

3. The thermic effect of food (TE) is the energy expended in digesting and processing nutrients. Some substances in foods, however, can activate other processes that increase thermogenesis and thus influence total energy expenditure.

(a) Total energy expenditure (EE) can be calculated using measured values in the following formula:

$$\boxed{EE = TE + A + B}$$

Identify components A and B.

1

(b) Total energy expenditure can be determined in a laboratory using data recorded during respiratory gas analysis.

(i) What **two** aspects of gas exchange must be measured during this analysis?

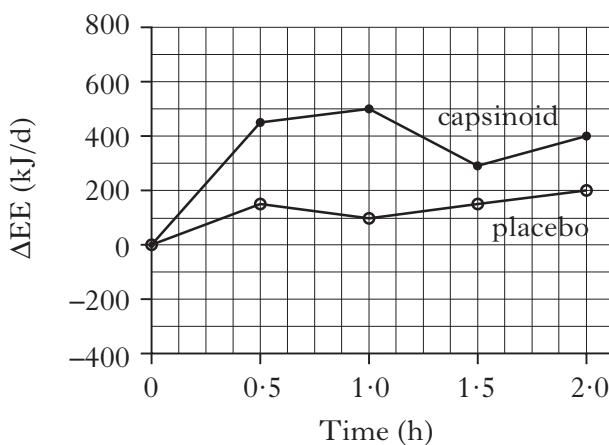
1

(ii) Explain why this procedure is referred to as indirect calorimetry.

1

(c) *Capsinoids*, a group of substances found in a type of red pepper, are known to increase energy expenditure through thermogenesis. A study examined the effect of capsinoids on energy expenditure in healthy adult males. Subjects were given capsules of capsinoid or placebo (no capsinoid).

The graph below shows changes in total EE (Δ EE) for individuals following treatment.



(i) Calculate the thermogenic effect of the capsinoid at 1.0 h.

1

(ii) The study used a 'single-blind' procedure. In this procedure, the subjects were not told which capsule they were receiving.

Suggest how this aspect of the study improves its validity.

1

(5)

PHYSIOLOGY, HEALTH AND EXERCISE (continued)

4. (a) Individuals with high $VO_{2\text{max}}$ have greater aerobic fitness. $VO_{2\text{max}}$ can be determined by maximal or sub-maximal testing.

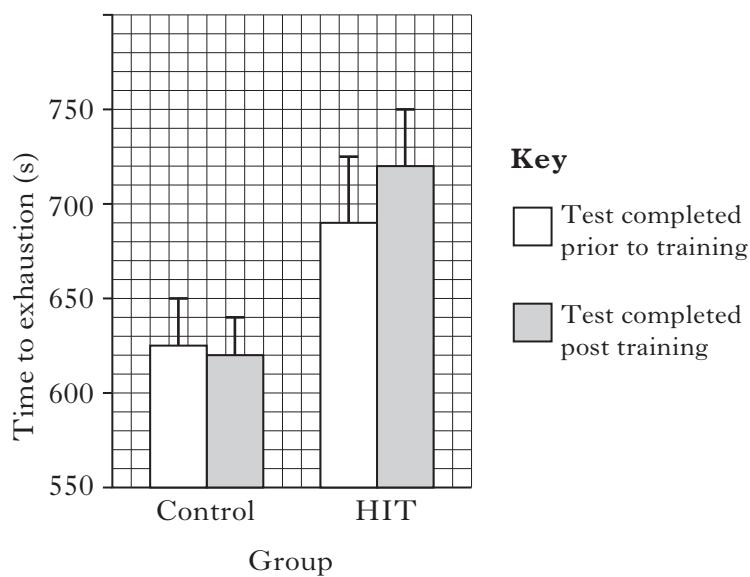
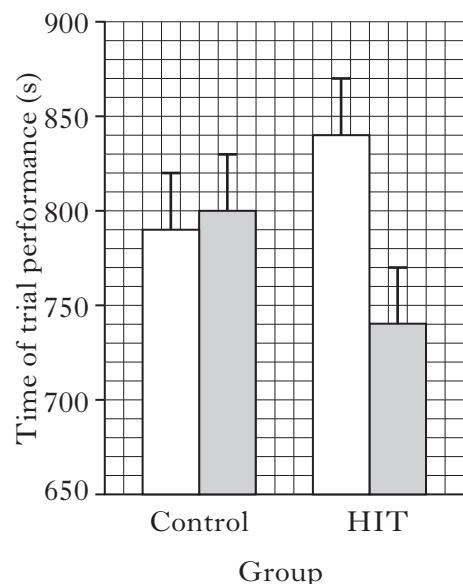
(i) What is meant by sub-maximal testing? 1

(ii) In maximal testing, what **two** factors are measured to determine $VO_{2\text{max}}$? 1

(b) There is recent evidence that short periods of high-intensity training (HIT) can be used to help athletes reach peak aerobic fitness. In the study below, HIT involved six training sessions over two weeks. Each session consisted of ten repeats of cycling all-out for six seconds, with a one-minute rest between repeats.

Two teams of racing cyclists took part in the study; one group did the HIT training, the other followed its normal training routines.

The results of two tests are shown below. Figure 1 shows the time to exhaustion when participants performed a cycle test that gradually increases demand. Figure 2 shows the time taken to complete a 10 km cycling time trial.

Figure 1: Time to exhaustion**Figure 2: Time for 10 km trial**

(i) Refer to Figure 1. How does the evidence support the conclusions that:

A: “Members of the HIT group were fitter than the control group” and
 B: “Members of the HIT group did not improve their $VO_{2\text{max}}$ ”? 2

(ii) What evidence is there that HIT has improved performance? 1

(5)

[END OF QUESTION PAPER]

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