

# X007/13/02

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NATIONAL  
QUALIFICATIONS  
2012

WEDNESDAY, 23 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

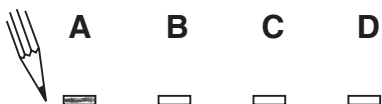
- 1 Check that the answer sheet provided is for **Biology Advanced Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate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

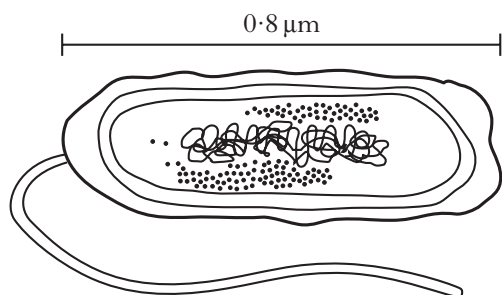
All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

1. Which line in the table below correctly represents the organelles in a prokaryotic cell?

	<i>Chloroplast</i>	<i>Mitochondria</i>	<i>Ribosomes</i>
A	Present	Absent	Absent
B	Absent	Absent	Present
C	Absent	Present	Absent
D	Present	Present	Present

2. The following diagram shows a bacterial cell.



The length of this cell in millimetres (mm) is

- A 800  
 B 80  
 C 0.008  
 D 0.0008.
3. In which of the following do both copies of the gene require a mutation for cancer to develop?
- A Oncogenes  
 B Proto-oncogenes  
 C Proliferation genes  
 D Anti-proliferation genes

4. Which of the following is the correct sequence of stages in the production of plants by tissue culture? (PGR = plant growth regulators)

- A callus → explant  $\xrightarrow{\text{PGR}}$  plantlet  
 B explant  $\xrightarrow{\text{PGR}}$  callus  $\xrightarrow{\text{PGR}}$  plantlet  
 C callus  $\xrightarrow{\text{PGR}}$  explant  $\xrightarrow{\text{PGR}}$  plantlet  
 D explant → callus  $\xrightarrow{\text{PGR}}$  plantlet

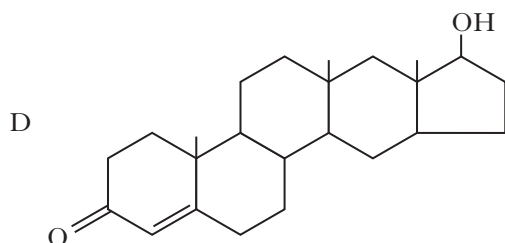
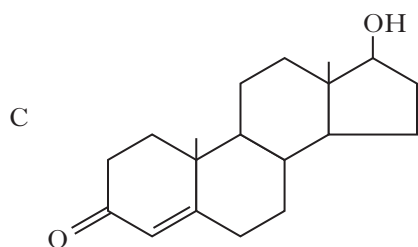
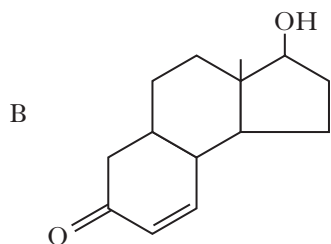
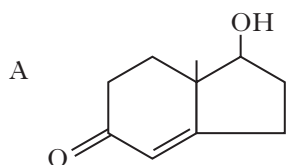
5. The key below can be used to identify carbohydrates.

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

Using the key, which letter would represent amylopectin?

**[Turn over**

6. Which of the diagrams below represents correctly a molecule of the steroid testosterone?



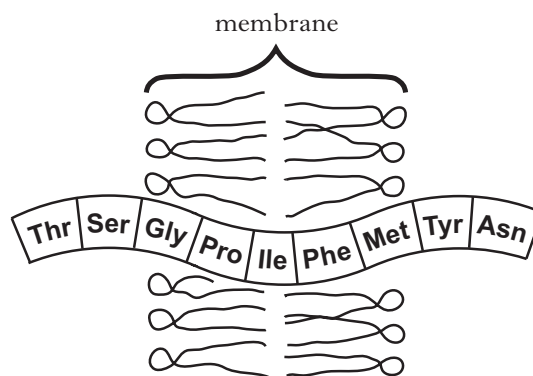
7. Which of the following is correct for a purine base?

	Ring structure	Example of base
A	double	adenine
B	double	thymine
C	single	adenine
D	single	thymine

8. A section of a double stranded DNA molecule contains 80 bases. 24 of these are thymine. The percentage of cytosine bases in the molecule is

- A 12  
B 16  
C 20  
D 30.

9. The diagram below shows a small polypeptide integrated into a membrane.



Which line in the table below correctly classifies amino acids in this polypeptide?

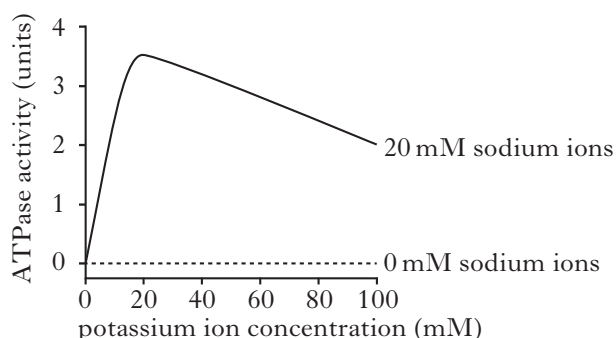
	Polar	Non-polar
A	Thr	Pro
B	Ile	Tyr
C	Asn	Ser
D	Phe	Gly

10. The mechanism of action of the sodium-potassium pump involves the following stages:

P membrane protein is phosphorylated  
 Q sodium ions bind to membrane protein  
 R sodium ions are released  
 S membrane protein changes conformation

The correct sequence is

- A P, Q, R, S  
 B Q, P, S, R  
 C Q, P, R, S  
 D P, Q, S, R
11. The figure below shows how the ATPase activity of the sodium-potassium pump is affected by the concentrations of sodium and potassium ions.



What valid conclusion can be drawn from this information?

- A The presence of potassium ions inhibits ATPase activity.  
 B The optimal concentration of sodium ions for ATPase activity is 20 mM.  
 C ATPase activity requires the presence of both sodium and potassium ions.  
 D ATPase activity requires the presence of sodium ions only.

12. The DNA sequences of the normal and mutated versions of a gene are shown below.

**Normal** DNA sequence

GAGAATCCTTGAGCTCTTAAGCTTATT

**Mutated** DNA sequence

GAGAATCCTTGAGGTCTTAAGCTTATT

The table below gives the recognition sequences of four restriction endonucleases.

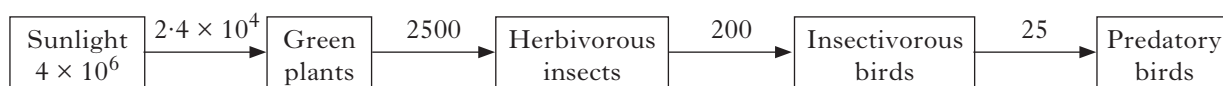
Restriction endonuclease	Recognition sequence
<i>Bam</i> H1	GGATCC
<i>Eco</i> R1	GAATTC
<i>Hind</i> III	AAGCTT
<i>Sac</i> I	GAGCTC

Which of the restriction endonucleases would produce different numbers of fragments when used to digest normal and mutant DNA?

- A *Bam*H1  
 B *Eco*R1  
 C *Hind*III  
 D *Sac*I
13. During the production of transgenic tomato plants, plasmids can be used to transfer recombinant DNA from
- A *Rhizobium* to plant cell protoplasts  
 B *Rhizobium* to differentiated plant cells  
 C *Agrobacterium* to plant cell protoplasts  
 D *Agrobacterium* to differentiated plant cells.
14. When a caterpillar consumes a plant leaf containing 200 kJ of energy, it passes 100 kJ of energy in its faeces, uses 67 kJ of energy for cellular respiration and uses 33 kJ of energy for new growth.
- The amount of energy lost from the woodland ecosystem in this process is:

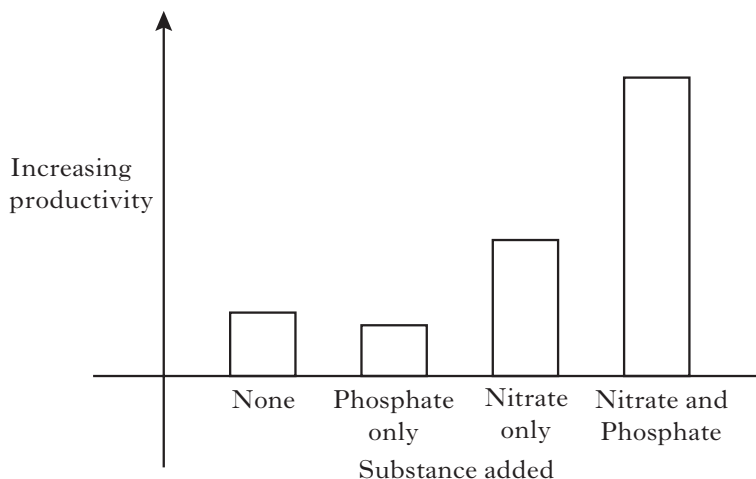
- A 67 kJ  
 B 100 kJ  
 C 167 kJ  
 D 200 kJ

Questions 15 and 16 refer to the following diagram which shows the annual flow of energy through a terrestrial ecosystem. The units are  $\text{kJ m}^{-2}$ .



15. The organisms at trophic level 2 are
- A producers
  - B primary consumers
  - C secondary consumers
  - D tertiary consumers.
16. Gross primary productivity (in  $\text{kJ m}^{-2}$ ) for this ecosystem is
- A  $2.4 \times 10^4$
  - B  $2.5 \times 10^3$
  - C  $4.0 \times 10^6$
  - D  $21.5 \times 10^3$ .

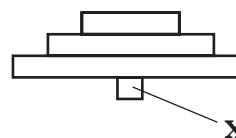
17. The graph shows how productivity in a marsh was affected **after a time** by the experimental addition of nitrate and phosphate. Neither was added in the control experiment.



Which statement is supported by the graph?

- A Productivity in the control is limited by both nitrate and phosphate.
- B Phosphate can limit productivity if enough nitrate is available.
- C Phosphate limits productivity in the control experiment.
- D Productivity in the marsh is never limited by phosphate.

18. The pyramid below represents organisms in a food chain.



The part labelled **X** could represent

- A phytoplankton in a pyramid of productivity
  - B oak trees in a pyramid of biomass
  - C phytoplankton in a pyramid of biomass
  - D oak trees in a pyramid of productivity.
19. Which of the following is an example of Batesian mimicry?
- A Two harmful species of wasps that look like each other.
  - B A butterfly with large eyespots on its wings.
  - C A stick insect which looks like a twig.
  - D A harmless snake which resembles a poisonous species.

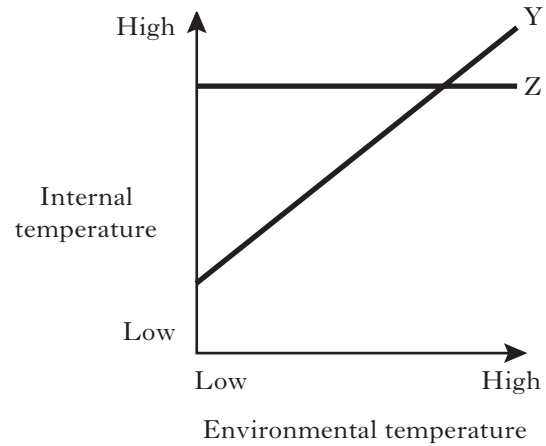
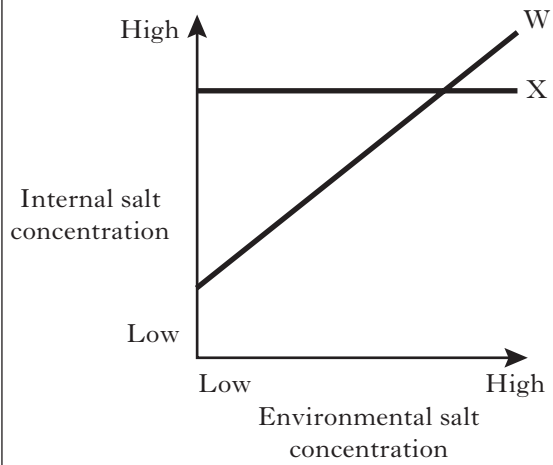
20. An experiment was carried out to investigate the density-dependent spread of a fungal disease of plants. Soil samples were taken near an infected plant. Half of the samples were sterilised.

The samples were then used to grow seedlings of the same species of plant at low or high density.

Which line in the table below would result in the highest percentage survival of the seedlings?

	<i>Seedling density</i>	<i>Soil sterilised</i>
A	low	no
B	high	no
C	low	yes
D	high	yes

21. The graphs below show how environmental changes can affect the internal conditions in aquatic organisms W, X, Y and Z.



Which line in the table correctly identifies the osmoconformer and the homeotherm?

	<i>Osmoconformer</i>	<i>Homeotherm</i>
A	W	Y
B	W	Z
C	X	Y
D	X	Z

[Turn over

22. The table below shows information about plants in fenced and unfenced grassland plots after 2 years. The plots were fenced to exclude voles which feed mainly on annual grasses.

	<i>Relative biomass (units)</i>		<i>Number of plant species</i>	
	<i>Fenced plots</i>	<i>Unfenced plots</i>	<i>Fenced plots</i>	<i>Unfenced plots</i>
Annual grasses	120	40	6	6
Other plants	40	80	12	24

Which line of the table below best summarises the effects of grazing on the grassland?

	<i>Plant growth (biomass units)</i>	<i>Plant diversity (number of species)</i>
A	increased	increased
B	increased	decreased
C	decreased	decreased
D	decreased	increased

23. Which of the following does **not** result in loss of complexity in ecosystems?

- A Predation
- B Monoculture
- C Eutrophication
- D Toxic pollution

24. Bleaching of coral occurs because

- A pollution prevents them producing coloured pigments
- B toxic chemicals kill zooxanthellae in the corals
- C their symbiotic partners are sensitive to increasing temperature
- D zooxanthellae in the corals are sensitive to UV light.

25. Allogenic succession takes place

- A as a result of climatic change
- B after clearing of agricultural land
- C when more sand is deposited on a beach
- D during decomposition.

[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

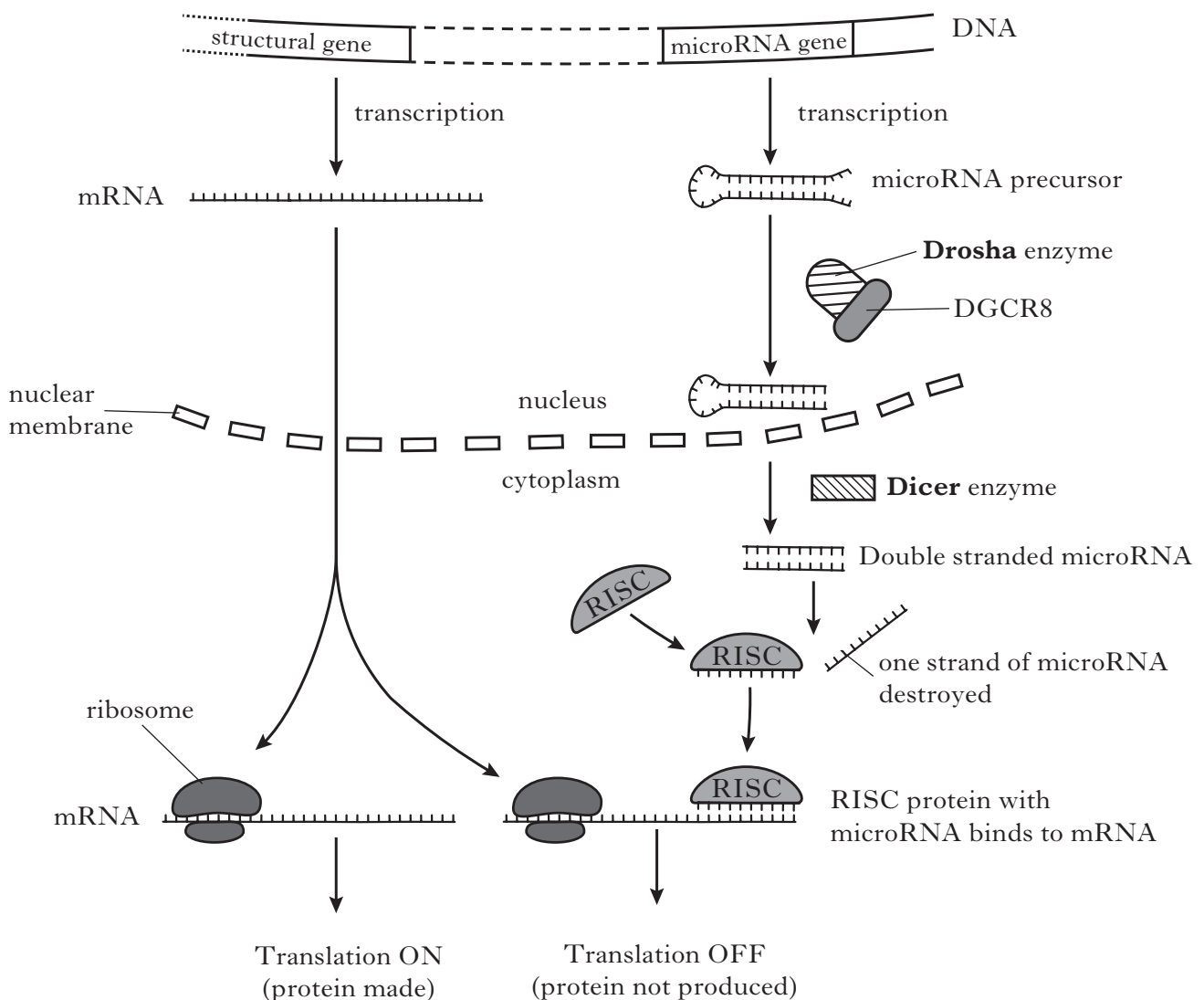
All questions in this section should be attempted.

All answers must be written clearly and legibly in ink.

1. Recently a new class of RNA, called **microRNA**, has been discovered. These small RNA molecules have an important role in controlling the translation of mRNA. This type of control is called *RNA interference*.

A microRNA is formed from a *precursor* RNA molecule that folds into a double-stranded “hairpin” structure. The hairpin is then processed to give a shorter molecule by the enzymes “Drosha” and “Dicer”. One strand of this short molecule attaches to RISC proteins; the resulting complex binds to target mRNA molecules and prevents translation. (Figure 1)

**Figure 1: Control of gene expression by RNA interference**

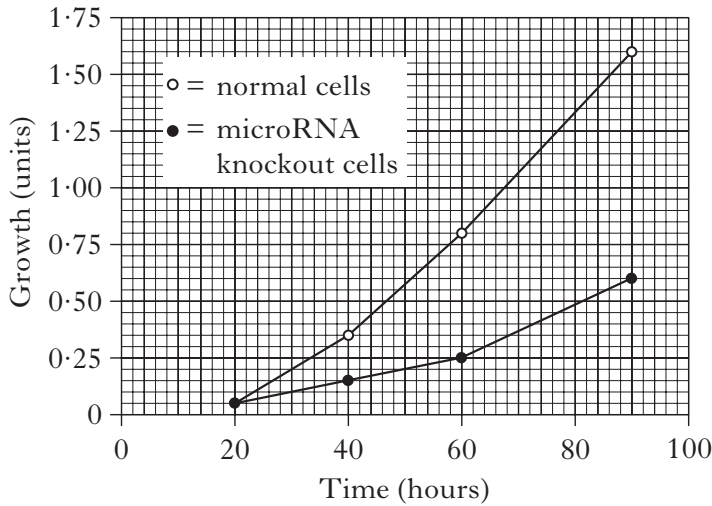


Recent research has investigated the importance of microRNA in controlling the fate of stem cells. Stem cells can either divide rapidly to make more stem cells, a process called **self-renewal**, or differentiate into specialised cell types. To determine the role of microRNAs in these processes, stem cells were modified to “knock out” microRNA production. These microRNA *knockout cells* lack the protein DGCR8, an activator of Drosha. Figures 2A and 2B compare growth rate and cell-cycle progression in knockout and normal cells.

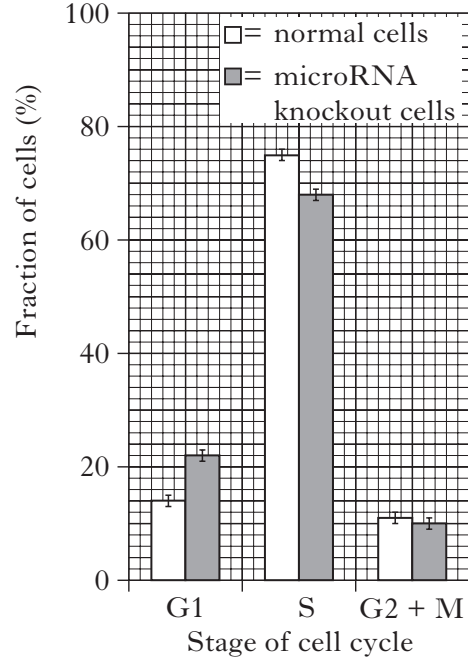
**Question 1 (continued)**

In further work, the differentiation of knockout and normal cells was studied by inducing the cells to differentiate. Analysis was carried out on the levels of specific marker molecules whose presence is associated with either self-renewal or differentiation. Results are shown in Figures 3A and 3B.

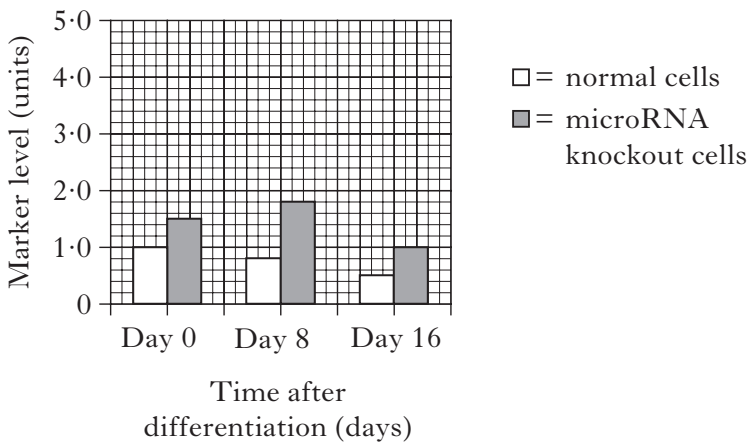
**Figure 2A: Effect of knockout on growth rate**



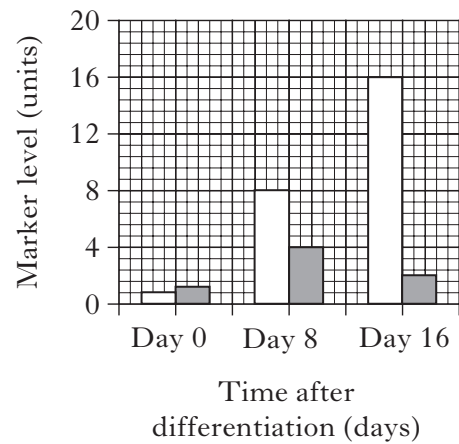
**Figure 2B: Effect of knockout on cell cycle**



**Figure 3A: Level of self-renewal marker**



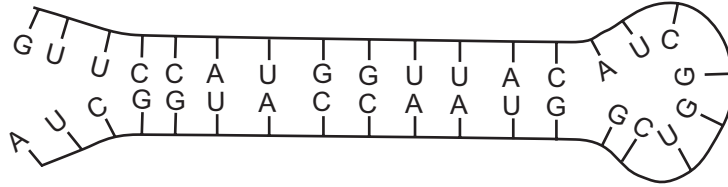
**Figure 3B: Level of differentiation marker**



[Question 1 continues on Page twelve]

**Question 1 (continued)**

- (a) During the formation of microRNAs, single-stranded RNA molecules form hairpin structures as shown in the diagram below.

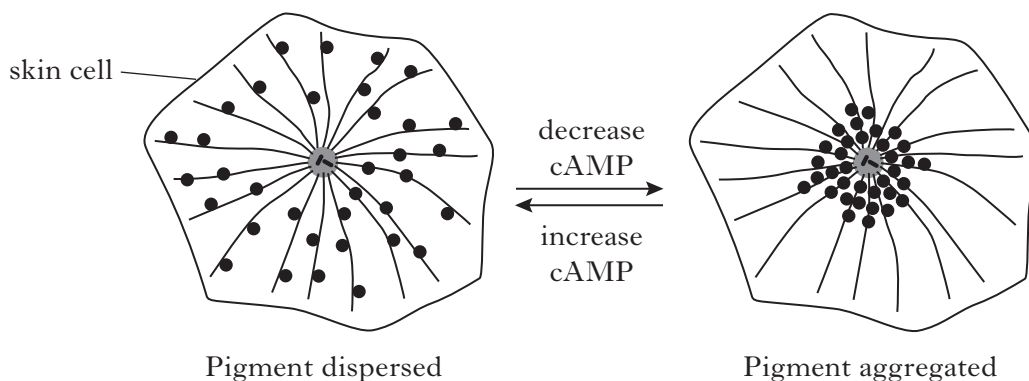


- (i) Which covalent bonds join nucleotides in RNA molecules? 1
- (ii) What is the role of hydrogen bonding in maintaining the hairpin shape? 1
- (b) Describe how the knockout of DGCR8 affects RNA interference. 2
- (c) (i) Refer to Figure 2A. Calculate the percentage reduction in growth at 90 hours caused by the microRNA knockout. 1
- (ii) The authors concluded that microRNA knockout cells do not progress normally through the cell cycle. How do the results in Figure 2B support this conclusion? 2
- (d) Refer to Figures 3A and 3B.
- (i) Comparing normal and knockout cells, give **two** general conclusions about the expression of the differentiation marker. 2
- (ii) What evidence is there that self-renewal is switched off as differentiation proceeds and that the interaction of these two processes is abnormal in knockout cells? 2
- (e) MicroRNAs inhibit *translation*. Describe how the *transcription* of  $\beta$ -galactosidase in prokaryotes is switched off. 2
- (13)**

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

2. Some fish species can change the colour of their skin by moving pigment granules within skin cells. The granules are attached to microtubules and can either aggregate in the centre of the cell or disperse throughout the cytoplasm.

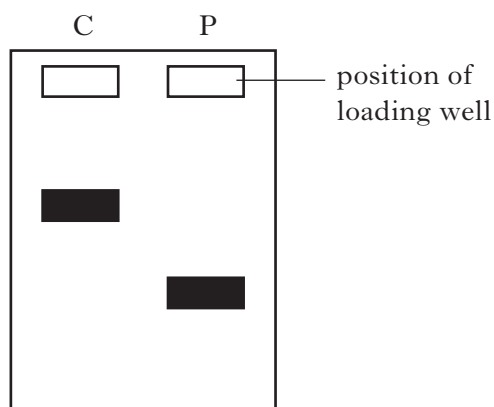
Movement of granules along microtubules is controlled by hydrophilic signalling molecules that alter the concentration of the intracellular signalling molecule cyclic AMP (cAMP).



- (a) (i) Explain why the control of pigment movement by hormones is an example of signal transduction. 2
- (ii) Suggest how the movement of pigments to alter skin colour could function in defence against predation. 1
- (b) (i) Microtubules have a role in governing the location of cell components. Give **one** other function of the cytoskeleton. 1
- (ii) Name the protein component of microtubules. 1
- (iii) From which structure do microtubules radiate? 1
- (6)**
3. Describe the control of enzyme activity by competitive and non-competitive inhibitors. **(5)**

4. Duchenne muscular dystrophy (DMD) is an inherited condition resulting from a deletion mutation within the dystrophin gene of the X-chromosome.

A sample of DNA from an individual (P) suspected of having DMD was isolated and digested with a restriction endonuclease. A corresponding control sample (C) was treated in the same way. The resulting fragments were separated using gel electrophoresis. The outcome is shown in the diagram below.



- (a) How are specific gene fragments identified in this procedure? 1
- (b) State whether or not the results confirm a diagnosis of DMD and explain your answer. 2
- (c) An alternative method of genetic screening for DMD involves the amplification of regions of the dystrophin gene. Name the technique used to amplify DNA. 1

**(4)**

5. The gannet (*Morus bassanus*) is a fish-eating seabird that breeds on barren, rocky offshore islands in the North Atlantic. A study from 1963 to 1976 investigated the negative impact of DDE on gannet breeding success. DDE, a residue from DDT breakdown, causes thinning of egg shells.

- (a) What term is used to describe the increase in DDE concentration shown in the table below?

1

<i>Gannet age class</i>	<i>DDE concentration in muscle tissue (ppm)</i>
1 year	0.08
2 years	0.50
3–4 years	0.96
Adult	2.17

- (b) The table below shows aspects of breeding success in two different island colonies.

<i>Island colony</i>	<i>Egg hatching success (%)</i>	<i>Chick survival (%)</i>
Ailsa Craig, Scotland	81	92
Bonaventure, Canada	38	78

- (i) At Ailsa Craig, 75% of eggs laid resulted in the survival of a chick.  
Use the data to calculate the corresponding survival rate for eggs laid at Bonaventure.
- (ii) DDT was sprayed to protect hillside forests in mainland Canada from severe caterpillar outbreaks.  
Explain how the pollutant came to be present in the gannets at Bonaventure.

1

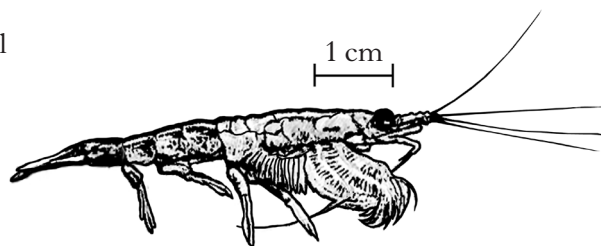
2

(4)

[Turn over

6. The Antarctic krill (*Euphausia superba*) is the major primary consumer in the marine food web of the Southern Ocean. They feed on algae, the producers. The ecological efficiency of krill is low.

Antarctic krill

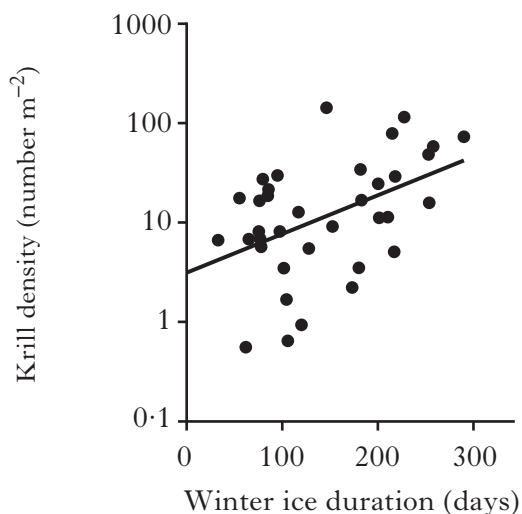


- (a) Ecological efficiency is the energy in one trophic level as a percentage of energy in the level below. Give **one** reason for a low ecological efficiency. 1

- (b) Young krill scrape algae from below the ice sheets that form during winter. Once the ice melts, the krill must feed on algae in open water. At this time, they become the main food source of many Antarctic species including penguins, seals and whales.

Long-term studies have monitored krill density in relation to winter ice duration.

The results below suggest that as winter ice duration increases the population density of krill increases.



- (i) Suggest an explanation for the trend shown in the graph. 1
- (ii) Krill have the highest total biomass of any species of animal. Their faeces fall to the deep ocean floor where decomposition rates are so low that there is no significant recycling of carbon dioxide back to the atmosphere.

With reference to krill faeces, explain how a rise in sea temperature in Antarctica caused by global warming could lead to a further increase in global warming. 2

(4)



7. The rose-grain aphid (*Metopolophium dirhodum*) is a herbivorous insect that requires two different types of plant to complete its lifecycle. It spends the winter as an egg in diapause on wild roses found in hedgerows. In spring, its numbers build up and it migrates to feed on nearby wheat crops. The rose-grain aphid is an important vector for major plant viruses that reduce grain yields.
- (a) What is meant by the term diapause? **1**
- (b) Suggest why the increased field sizes associated with intensive wheat cultivation may help to reduce crop losses due to rose-grain aphid outbreaks. **2**
- (c) What is meant by the biological term “vector”? **1**
- (4)**
8. Answer **either A or B**.
- A.** Write notes on niche and competition. Use examples as appropriate. **(15)**
- OR**
- B.** Give an account of the circulation of nutrients under the following headings:
- (i) decomposition;
- (ii) nutrient cycling. **(15)**

[END OF SECTION B]

[Turn over for Section C]

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 18–21.

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

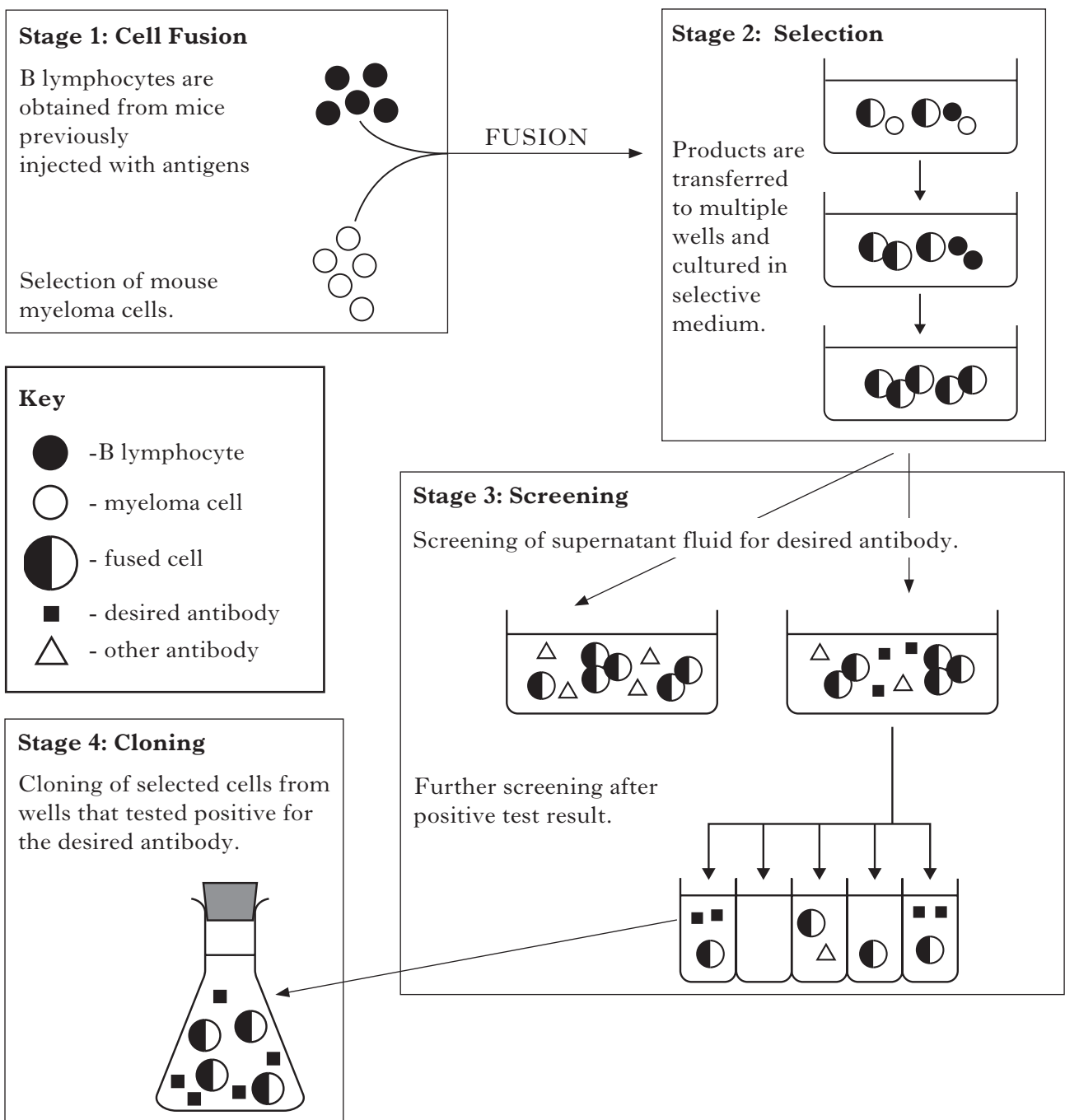
The questions on Physiology, Health and Exercise can be found on pages 26–28.

All answers must be written clearly and legibly in ink.

Labelled diagrams may be used where appropriate.

**BIOTECHNOLOGY**

1. The diagram shows stages in the production of a monoclonal antibody.



**BIOTECHNOLOGY (continued)****1. (continued)**

- (a) Which organ in the mouse is used as a source of B lymphocytes? **1**
- (b) Why are the mouse B lymphocytes fused with myeloma cells? **1**
- (c) Refer to Stage 2 on the diagram.
- (i) Explain why unfused myeloma cells do not progress to Stage 3. **1**
- (ii) Explain why B lymphocytes do not progress to Stage 3. **1**
- (d) With reference to Stage 3, explain the need for screening to occur in two steps. **2**
- (6)**
2. Describe how the *growth rate constant* of a bacterial culture can be determined.  
What is its relevance when culturing bacteria for enzyme production? **(5)**

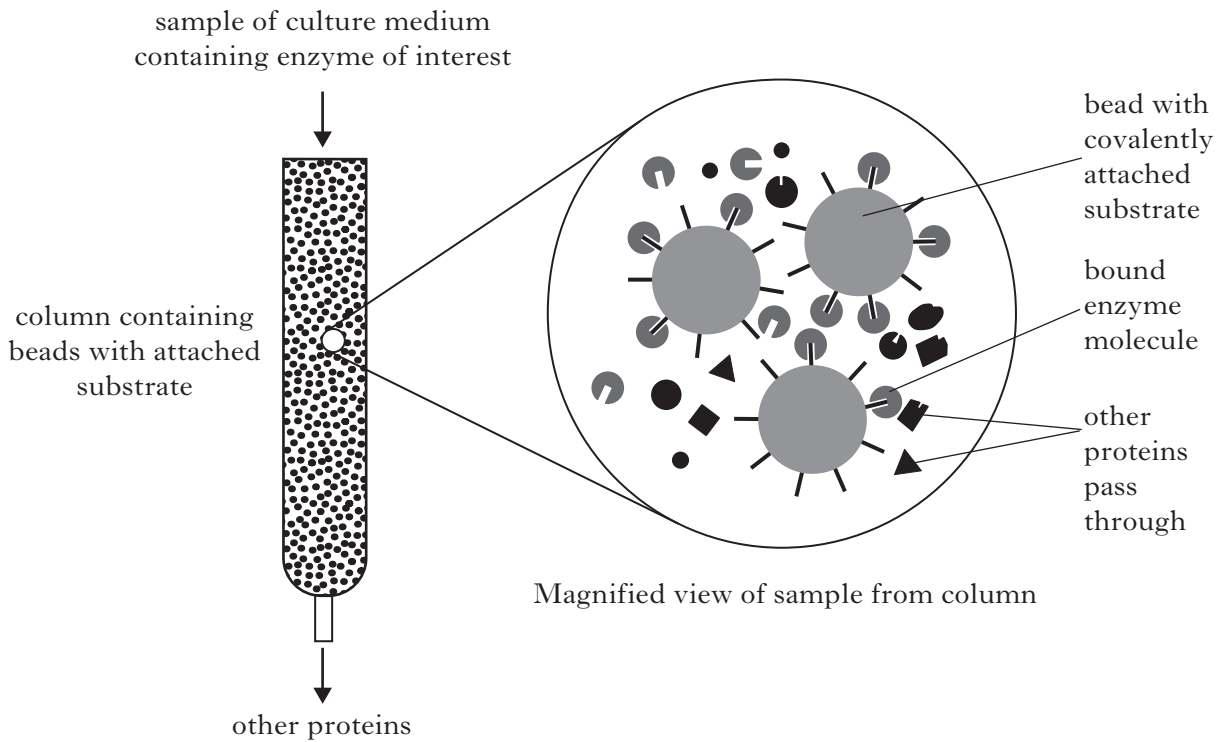
**[Turn over**

**BIOTECHNOLOGY (continued)**

3. (a) Various enzymes are used in fruit juice production.

- (i) Name an enzyme used to decrease viscosity during extraction. 1
- (ii) Why might arabanase be added to the extracted product? 1

(b) The diagram illustrates a technique used to purify an enzyme secreted by a culture of microbial cells in a fermenter.



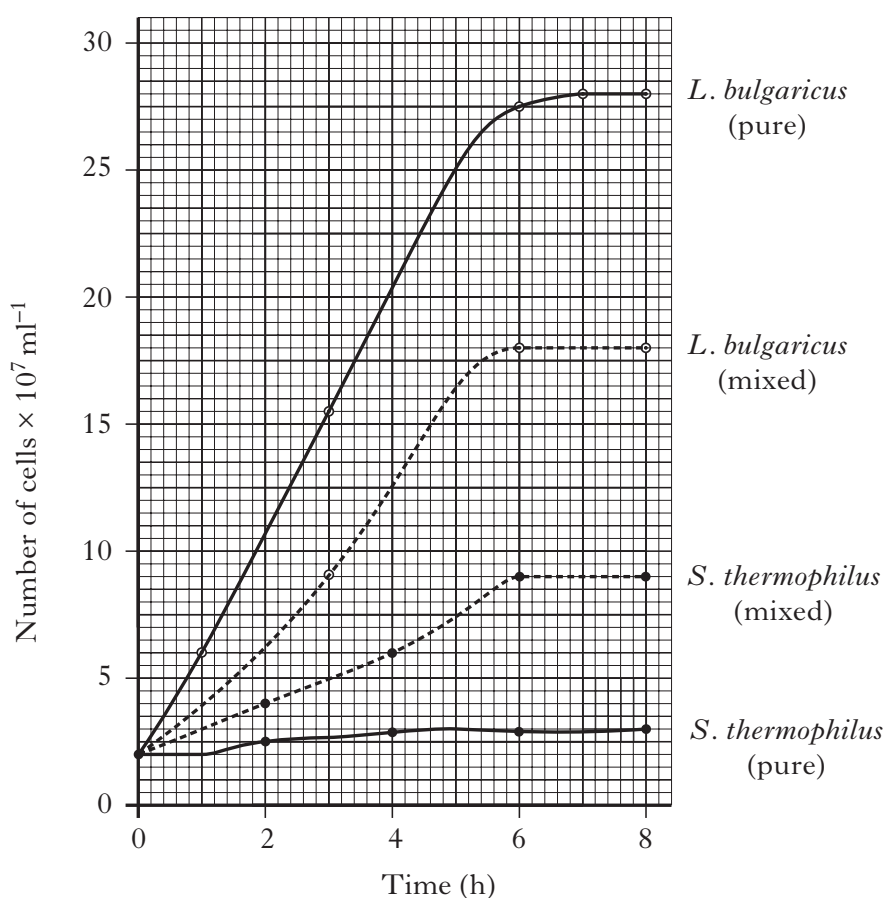
- (i) What general term is given to the purification technique shown above? 1
- (ii) What feature of the enzyme molecule allows it to be separated from the other proteins as the sample passes through the column? 1

**(4)**

**BIOTECHNOLOGY (continued)**

4. To make yoghurt, milk is pasteurised and then inoculated with bacteria that allow fermentation to occur. Two species commonly used together in the inoculum are *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

- (a) What is the purpose of pasteurisation? 1
- (b) The fermentation is a two-stage process.
  - (i) State the chemical conversion taking place in the first stage. 1
  - (ii) What is the role of the second stage? 1
- (c) The graph shows the growth of *L. bulgaricus* and *S. thermophilus* in both pure and mixed culture.



- (i) Calculate the reduction in growth of *L. bulgaricus* at 8 hours as a result of being in the mixed culture. 1
  - (ii) Scientists have suggested that *S. thermophilus* receives a growth promoting substance in this mixed culture. How do the data support that conclusion? 1
- (5)**

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

SECTION C (continued)

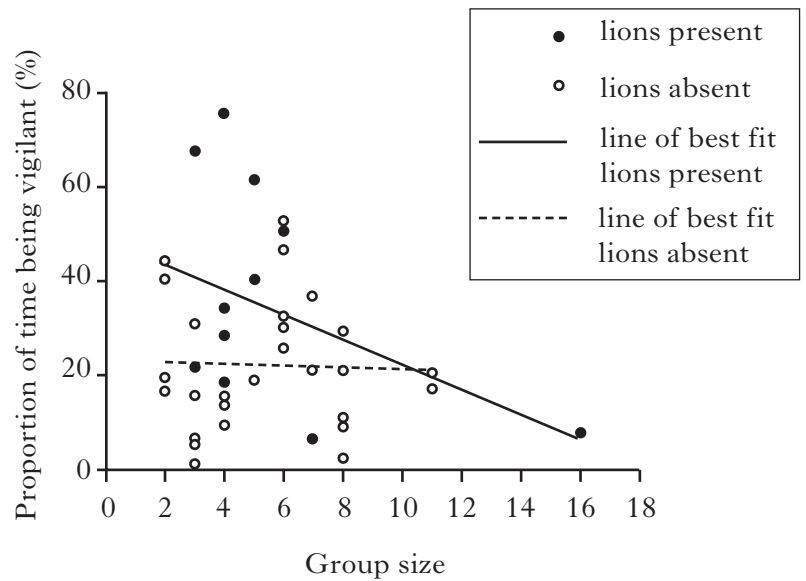
ANIMAL BEHAVIOUR

- The proportion of time that individual prey animals spend being vigilant may be affected by both the risk of predation and group size. Kudu (Figure 1) are a frequent prey of lions, with most attacks occurring by ambush within two kilometres of water holes. The vigilance behaviour of kudu at water holes has been studied in Hwange National Park, Zimbabwe.

Figure 1: Kudu



Figure 2: Effect of presence of lions and kudu group size on vigilance

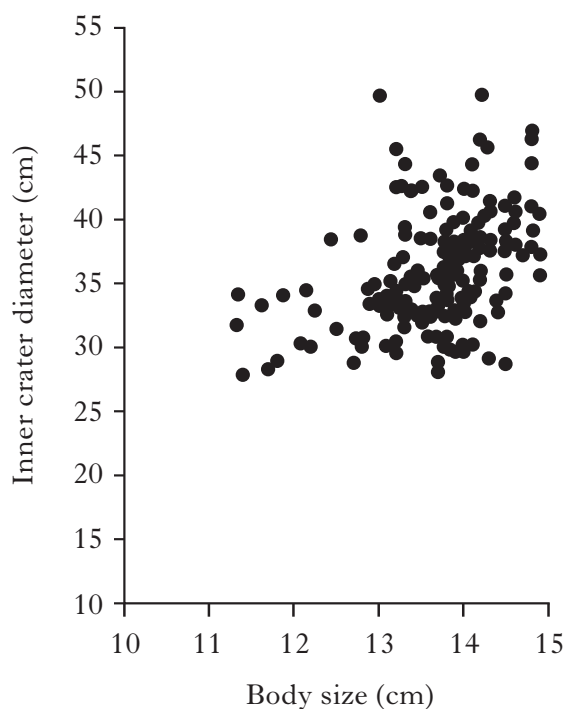
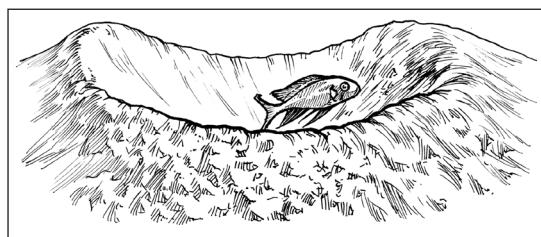


- Describe what vigilance behaviour would look like in an animal such as a kudu. 1
  - Figure 2 shows the proportion of time individual kudu spend being vigilant during drinking, when in different group sizes and when lions are present or absent.
    - Suggest **one** strategy that should be used in the observation and recording of kudu vigilance behaviour. 1
    - The researchers hypothesised that individual vigilance would decrease as group size increased, and increase in the presence of lions. Use the results to evaluate these hypotheses. 2
    - Comment on the reliability of the data recorded when lions were present. 1
- (5)**

**ANIMAL BEHAVIOUR (continued)**

2. Figure 1 shows the cichlid fish *Cyathopharynx furcifer* found in Lake Tanganyika in Africa. Sexually active males build the sandy substrate into crater-like structures (mating craters). The male fish display around these spawning sites with intense colour. The crater itself has no role in the rearing of the brood produced after fertilisation. Figure 2 shows the results of an investigation into male body size and crater diameter.

**Figure 1: Male cichlid in mating crater**      **Figure 2: Male body size and crater diameter**



- (a) Describe the relationship between body size and crater size shown in Figure 2. 1
- (b) When crater sizes were either enlarged or reduced by researchers, within a day the males rebuilt the craters to their original sizes, even the enlarged ones.
- (i) Explain why the researchers concluded that mating craters in *C. furcifer* are extended phenotypes. 1
- (ii) Give another example of an extended phenotype in a species. 1
- (c) State **one** feature of a male cichlid that is likely to have evolved as a result of sexual selection. 1
- (4)**

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### **ANIMAL BEHAVIOUR (continued)**

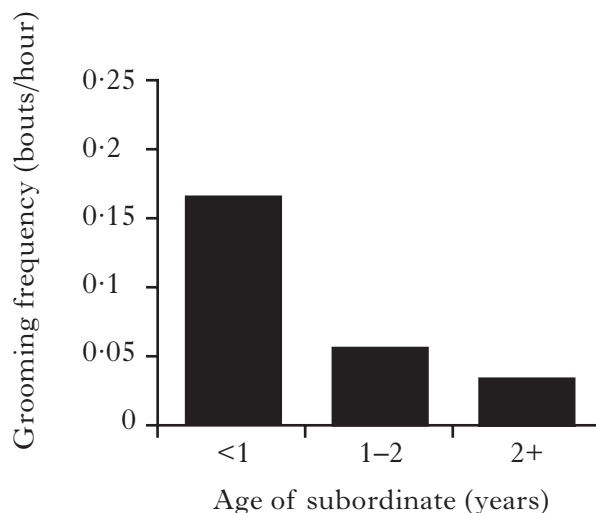
3. Meerkats (*Suricata suricatta*) are social mammals living in the Kalahari Desert. They show co-operative breeding in which a dominant male and dominant female monopolise reproduction. Subordinate animals rarely reproduce but help to rear the offspring of the dominant pair. They are not necessarily closely related to the young animals that they help to rear.

**Figure 1: Meerkats**



As in the dominance hierarchies of many primate groups, grooming behaviour can be frequently observed in meerkats. Figure 2 shows the frequency of grooming between dominant females and young, subordinate animals.

**Figure 2: Grooming of juveniles by dominant females**





**ANIMAL BEHAVIOUR (continued)****3. (continued)**

- (a) (i) Use Figure 2 to support the hypothesis that one function of meerkat grooming is concerned with parental care. **1**
- (ii) State an aspect of grooming behaviour, other than frequency, that could be observed and recorded. **1**
- (b) State **two** other functions of grooming in social mammals such as primates. **2**
- (c) Select a statement from the information given about meerkats that may seem to be at odds with the concept of the “selfish” gene. Justify your answer. **2**
- (6)**
4. Discuss the characteristics of sign stimuli and fixed action patterns. How do they interact in the feeding of young birds by their parents? **(5)**

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

**[Turn over**

## SECTION C (continued)

**PHYSIOLOGY, HEALTH AND EXERCISE**

1. In the cardiac cycle, ventricles contract and force blood into the arteries during systole; during diastole the chambers are relaxed and the ventricles fill with blood.

(a) What do the values 120/70 represent in a normal blood pressure reading? **1**

(b) Explain how plaque formation in artery walls can lead to raised blood pressure. **2**

(c) The most widespread cardiovascular disease in western countries is atherosclerosis in coronary arteries. The most common symptom is angina pectoris, chest pain that develops from oxygen shortage in the myocardial circulation during exertion.

Oxygen is delivered to heart muscle during diastole as ventricles relax. When heart rate changes, the durations of systole and diastole change, as shown in the table below.

<i>Heart rate</i> (bpm)	<i>Duration of</i> <i>systole</i> (s)	<i>Duration of</i> <i>diastole</i> (s)
65	0.27	0.65
75	0.27	0.53
200	0.16	0.14

(i) Calculate the % decrease in duration of systole when heart rate increases from 65 to 200 bpm. **1**

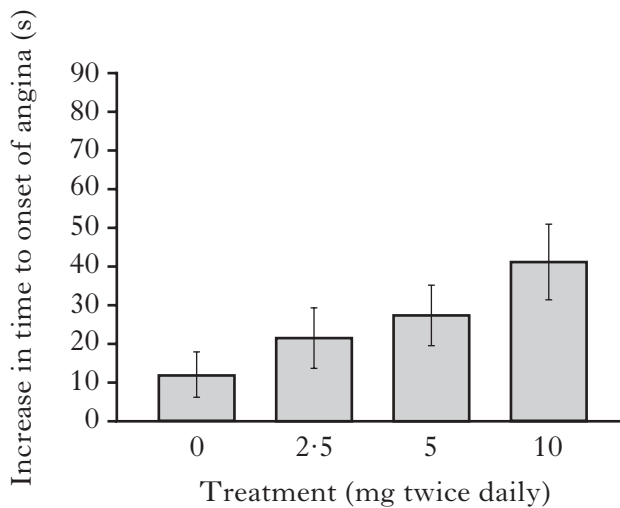
(ii) Use information provided to explain why, in individuals with atherosclerosis, exertion can cause angina. **2**

(d) Most of the treatments to relieve angina aim to dilate the coronary arteries. However, a relatively new drug, *ivabradine*, has been successful in the treatment of angina by only reducing heart rate.

**PHYSIOLOGY, HEALTH AND EXERCISE (continued)**

**1. (d) (continued)**

The figure below shows the effect of exercise tolerance tests on angina patients, exercised until the onset of chest pain. Patients were given tablets containing a dose of *ivabradine* or a placebo (where the tablet contained no drug). The change in response is calculated from each individual's result before and after taking the tablets.



What evidence is there that the medication is effective?

1  
(7)

2. Obesity is defined as a body mass index (BMI) greater than 30 (kg/m<sup>2</sup>). BMI is not a measure of body composition. Other methods are used to determine percentage body fat, such as densitometry and bioelectrical impedance analysis.

(a) Is an individual with a height of 1.82 m and mass of 90 kg obese?

Justify your answer.

1

(b) (i) What **two** measurements are required in densitometry?

1

(ii) How is the density value used to obtain percentage body fat?

1

(c) What is the drawback of using bioelectrical impedance analysis with obese individuals?

1

(4)

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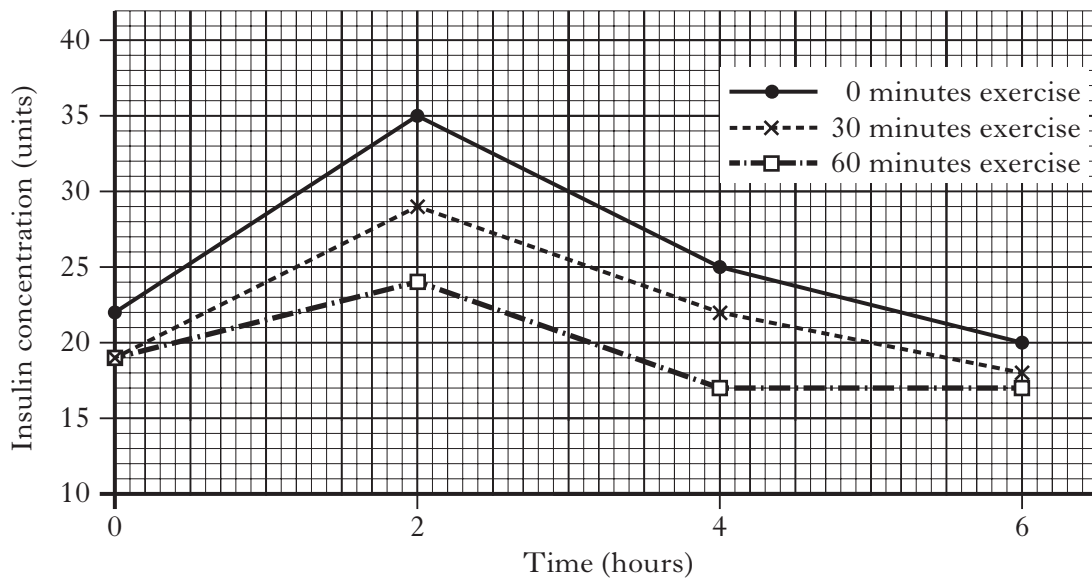
**PHYSIOLOGY, HEALTH AND EXERCISE (continued)**

3. Medical scientists are increasingly focusing research on “*metabolic syndrome*”, a group of risk factors that apply to both Type 2 diabetes (NIDDM) and cardiovascular diseases. Risk factors include increased insulin concentrations, increased fasting glucose, increased blood triglycerides and decreased HDL. The underlying concern is their common link to *insulin resistance*, a loss of sensitivity to insulin.

(a) What effect does exercise have on the lipid profile of blood? 1

(b) Explain how exercise reduces blood glucose in Type 2 diabetes. 2

(c) In an investigation, volunteers with metabolic syndrome were monitored following different periods of jogging on a treadmill at 60% of their  $VO_{2max}$ . They fasted for 12 hours after the exercise period then consumed a high-energy drink and remained at rest. Blood samples were taken following the high-energy drink and at two-hour intervals. Results for insulin concentration are shown below.



Give **one** conclusion that can be drawn from the experiment about the possible role of exercise in the control of metabolic syndrome. Use data to support your answer. 2

(5)

4. Discuss the contribution of exercise to a weight-control programme. (4)

[END OF QUESTION PAPER]

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