

X007/701

NATIONAL
QUALIFICATIONS
2011

WEDNESDAY, 1 JUNE
1.00 PM – 3.30 PM

BIOLOGY
ADVANCED HIGHER

SECTION A—Questions 1–25 (25 marks)

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

SECTIONS B AND C

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

Rough work should be scored through.

Section B (55 marks)

All questions should be attempted. Candidates should note that Question 8 contains a choice.

Question 1 is on Pages 10, 11 and 12. Question 2 is on Page 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

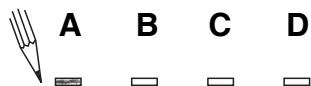
- 1 Check that the answer sheet provided is for **Biology Advanced Higher (Section A)**.
- 2 For this section of the examination you must use an **HB pencil** and, where necessary, an eraser.
- 3 Check that the answer sheet you have been given has **your name, date of birth, SCN** (Scottish Candidate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

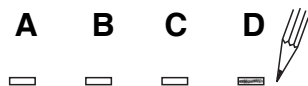
- A Glucose
- B Pyruvic acid
- C Ribulose biphosphate
- D Acetyl coenzyme A

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**.



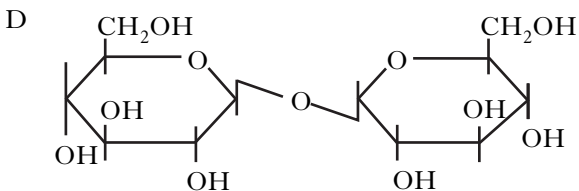
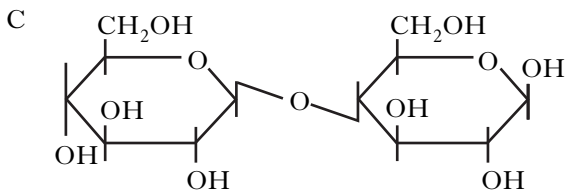
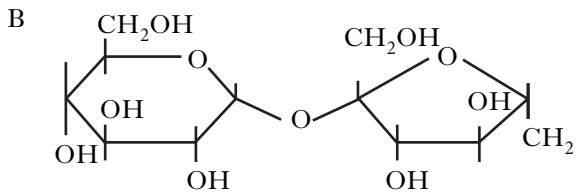
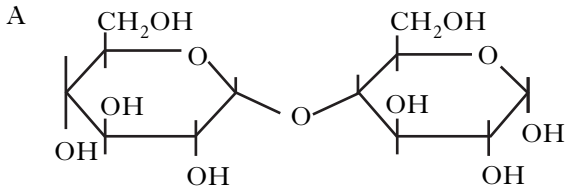
SECTION A

All questions in this section should be attempted.

Answers should be given on the separate answer sheet provided.

1. Cellobiose is a disaccharide with glucose monomers joined by a β 1, 4 bond.

Which of the following represents cellobiose?



2. The following stages occur during the culture of mammalian cells.

- W Cells flatten
- X Cells divide
- Y Cells become confluent
- Z Cells adhere to surface

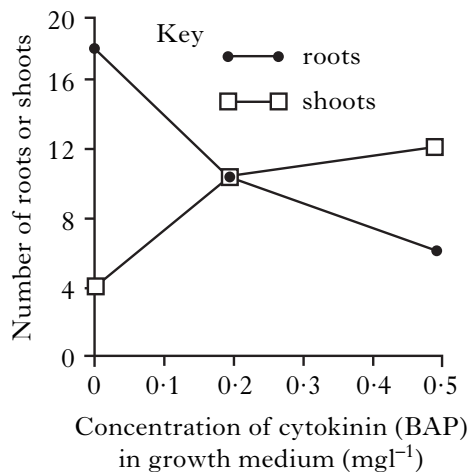
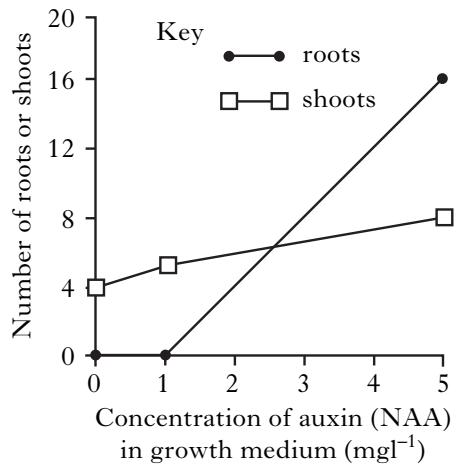
Which line below shows the correct sequence of stages?

- A X → W → Y → Z
- B Z → W → X → Y
- C Z → Y → W → X
- D X → Y → Z → W

3. A piece of plant tissue prepared for growth under tissue culture conditions is known as

- A a callus
- B an explant
- C a protoplast
- D a hybrid.

4. The graphs below show the effect of plant growth substances on the development of roots and shoots in plant tissue culture.



Which of the following treatments produces a root : shoot ratio of 2 : 1?

- A 0.2 mg l⁻¹ BAP
- B 0.5 mg l⁻¹ BAP
- C 2 mg l⁻¹ NAA
- D 5 mg l⁻¹ NAA

5. In the formation of fats, which type of linkage is formed by the dehydration (condensation) reaction between glycerol and a fatty acid?

- A Phosphodiester
- B Glycosidic
- C Peptide
- D Ester

6. Which of the following describes the structure of guanine?

- 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

7. An average diploid human cell contains 6×10^9 base pairs of genetic code. Only 1.5% of this may be coding for protein.

How many base pairs code for protein in a human gamete?

- A 4.5×10^7
- B 9.0×10^7
- C 4.5×10^8
- D 9.0×10^8

8. Which of the following is responsible for cell-cell recognition?

- A Glycoprotein
- B Phospholipid
- C Hormones
- D Peptidoglycan

9. The sodium–potassium pump spans the plasma membrane. Various processes involved in the active transport of sodium and potassium ions take place either inside the cell (intracellular) or outside the cell (extracellular).

Which line in the table correctly applies to the transport of potassium ions?

	<i>Binding location of potassium ions</i>	<i>Conformation of transport protein</i>
A	intracellular	not phosphorylated
B	extracellular	phosphorylated
C	intracellular	phosphorylated
D	extracellular	not phosphorylated

10. Covalent modification can be used to regulate enzyme activity.

Which of the following is an example of covalent modification?

- A Allosteric modulation
- B End product inhibition
- C Binding of an inhibitor to the active site
- D Addition of a phosphate group by a kinase enzyme

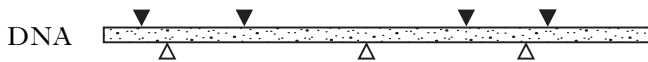
11. The table below shows the results of an investigation into the effects of varying substrate concentration on the activity of the enzyme phosphatase in the presence of inhibitors. The greater the absorbance the more active the enzyme.

Substrate concentration (%)	Absorbance		
	Inhibitor X	Inhibitor Y	Inhibitor Z
0.1	0.03	0.12	0.06
0.25	0.06	0.17	0.06
0.5	0.14	0.21	0.06
1.0	0.30	0.36	0.06

What valid conclusion can be drawn from the results?

- A An increase in substrate concentration reduces the effect of all three inhibitors.
- B All three inhibitors are competitive inhibitors.
- C Inhibitor Z has least effect on enzyme activity.
- D Inhibitor Y has least effect on enzyme activity.
12. A length of DNA is cut into fragments by the restriction enzymes BamHI and EcoRI.

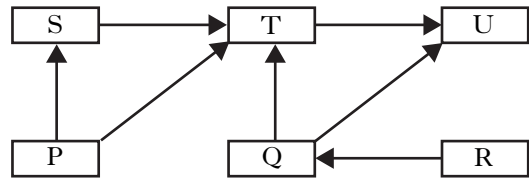
BamHI cut site ▼ EcoRI cut site △



Which of the following gives the correct number of DNA fragments obtained?

	DNA cut by BamHI only	DNA cut by EcoRI only	DNA cut by both BamHI and EcoRI
A	5	4	8
B	4	5	8
C	5	4	9
D	4	5	9

13. The following diagram represents a food web.



Which line in the table below correctly describes the organisms?

	Producer	Herbivore	Omnivore	Carnivore
A	P	Q	U	S
B	Q	R	S	T
C	R	S	T	U
D	P	U	T	Q

14. A river ecosystem receives about $6000000 \text{ kJm}^{-2}\text{year}^{-1}$ of solar energy. Of this energy 98% is **not** used in photosynthesis.

Which of the following shows the amount of energy ($\text{kJm}^{-2}\text{year}^{-1}$) captured by the producers in this ecosystem?

- A 120000
- B 588000
- C 1200000
- D 5880000

15. The percentage of energy transferred from one trophic level to the next describes

- A ecological efficiency
- B growth
- C consumption
- D productivity.

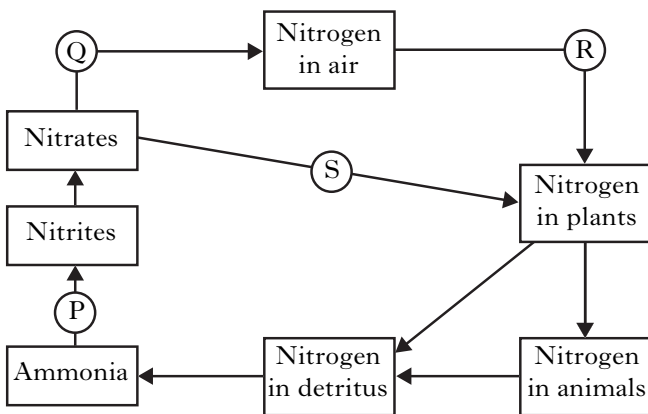
[Turn over

16. The Alcon blue butterfly (*Maculinea alcon*) spends most of its life cycle as a caterpillar associated with usually only one species of red ant (*Myrmica* species). Once the caterpillar chews its way out of the flower where the butterfly laid its eggs, it will die unless ants find it. Ants respond to the caterpillar's secretions and adopt it, taking it into their nest. The caterpillar is fed by worker ants and grows quickly, occasionally eating ant larvae.

Which of the following represents the association between the butterfly species and the ant species?

- A Commensal
- B Mutualistic
- C Parasitic
- D Predatory

17. The diagram below represents part of the nitrogen cycle.



Which of the following stages is likely to involve activity of the enzyme nitrogenase?

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

18. The function of leghaemoglobin is to

- A allow oxygen to react with fixed nitrogen
- B remove oxygen from nitrogen compounds
- C trap nitrogen for use in forming plant proteins
- D trap oxygen to protect bacterial enzymes.

19. The low nitrate content of a marshland soil could result from the activity of

- A *Rhizobium*
- B *Nitrobacter*
- C *Pseudomonas*
- D *Nitrosomonas*.

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

- A An increase in disease decreasing the yield in a crop species
- B An increase in prey numbers increasing the abundance of predators
- C A decrease in grazing increasing the abundance of a plant species
- D A decrease in rainfall increasing the abundance of a plant species

21. The figure below shows two species of butterfly which are bright orange with black markings.

Only the monarch (*Danaus plexippus*) is unpalatable to its predators.

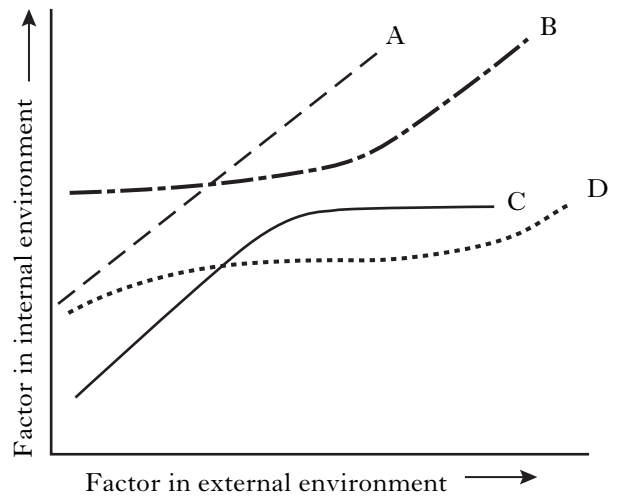


Which type of mimicry is involved and which species is the mimic?

	Type of mimicry	Mimic
A	Batesian	Monarch
B	Müllerian	Monarch
C	Batesian	Viceroy
D	Müllerian	Viceroy

22. Some insects have a period of dormancy in which a stage of the life cycle is inactive. This type of dormancy is known as
- A hibernation
 - B diapause
 - C aestivation
 - D symbiosis.

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



Which animal could occupy the widest range of habitats?

24. Which of the following correctly describes eutrophication?
- A Addition of artificial fertiliser to farmland
 - B Nutrient enrichment in ponds
 - C Loss of complexity in rivers
 - D Algal bloom in lochs

[Turn over

25. Cultivation of soya beans is carried out in areas where hedgerows have been cleared to make large open fields.

The crop is regularly treated with herbicides to which soya bean plants are resistant.

Which line in the table below shows changes that would be expected to occur in an ecosystem when a soya bean farm is set up?

	<i>Soil erosion</i>	<i>Species diversity</i>	<i>Density of insect pest species</i>
A	increase	increase	decrease
B	increase	decrease	increase
C	decrease	decrease	decrease
D	decrease	increase	increase

[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*

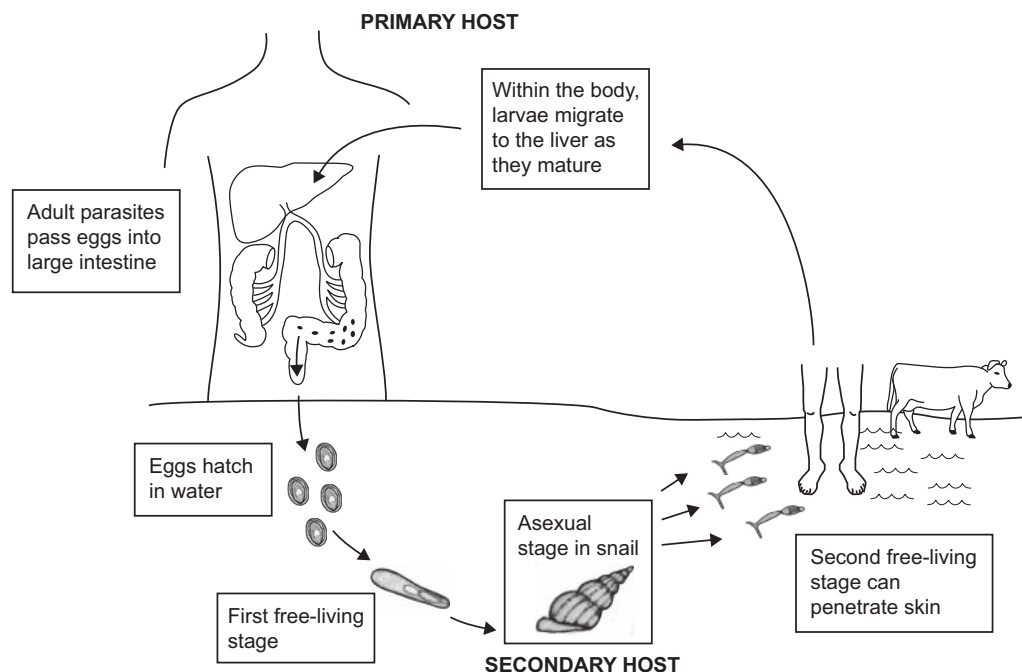
SECTION B

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

1. *Schistosoma* is a parasitic flatworm found in tropical areas throughout the world. The flatworm can live for many years within a host. In humans, if untreated, it causes the disease schistosomiasis (bilharzia), which can be fatal.

Schistosoma japonicum is found in East Asia; its life cycle is shown in Figure 1. The parasite's eggs hatch in fresh water, releasing a free-living stage that infects a species of freshwater snail. The parasite multiplies asexually within this secondary host before being released into the water as a second free-living stage. This stage is capable of penetrating the skin of humans and other mammals when they are in fresh water. Inside the liver of the mammal, the flatworms develop into sexually mature adults that disperse eggs via the host's large intestine.

Figure 1: Life cycle of *Schistosoma japonicum*



Successful control of *Schistosoma* is very difficult. Drugs can kill flatworms inside the body but they cannot prevent re-infection. The following factors contribute to high re-infection rates: the parasite has free-living stages; the secondary host can reach high population densities very quickly; untreated, unhygienic humans act as “superspreaders”.

A trial to control *S. japonicum* near a freshwater lake in China compared two pairs of villages given different treatment programmes. Inhabitants of Ximiao and Zhuxi continued to receive the routine annual dose of a drug that kills adult flatworms. Those living in Aiguo and Xinhe were given a programme of intervention that combined the same routine annual drug treatment with the following additional strategies: relevant health education, sanitation, clean bathing water and restrictions on the access of cattle to the lakeside.

The methods used to evaluate the effectiveness of the intervention programme are shown in the Table and the major findings are shown in Figure 2. The target set for the successful control of *Schistosoma* was to reduce infection in villagers to 1% of the population.

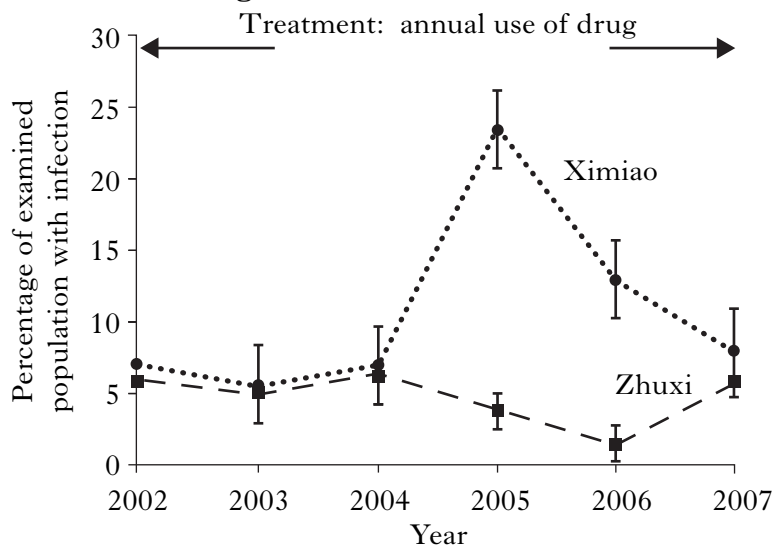
Question 1 (continued)

Table: Methods used to detect *Schistosoma* stages

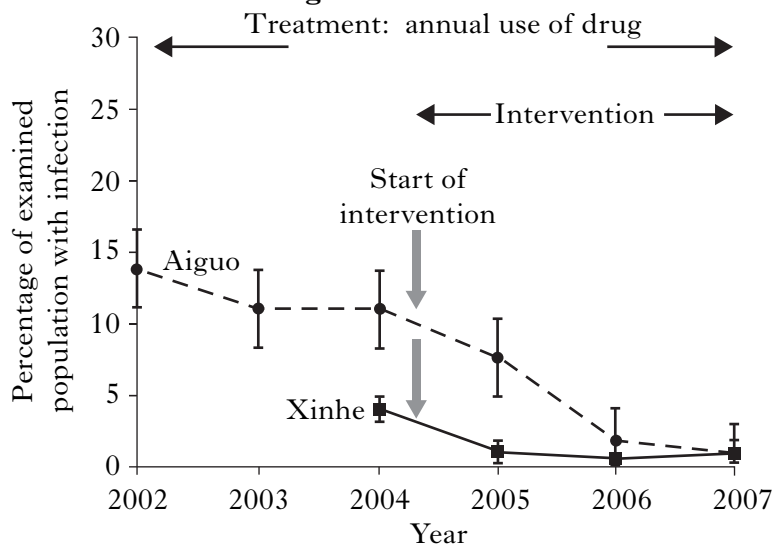
<i>Stage in life cycle</i>	<i>Detection method for stage</i>
Asexual stage in snail	Dissection of snail samples
Second free-living stage	Dissection of mice exposed in laboratory to samples of lake water
Adult	Non-invasive assessment of human infestation

Figure 2: Infection rates in control and intervention villages

A Control Villages



B Intervention Villages



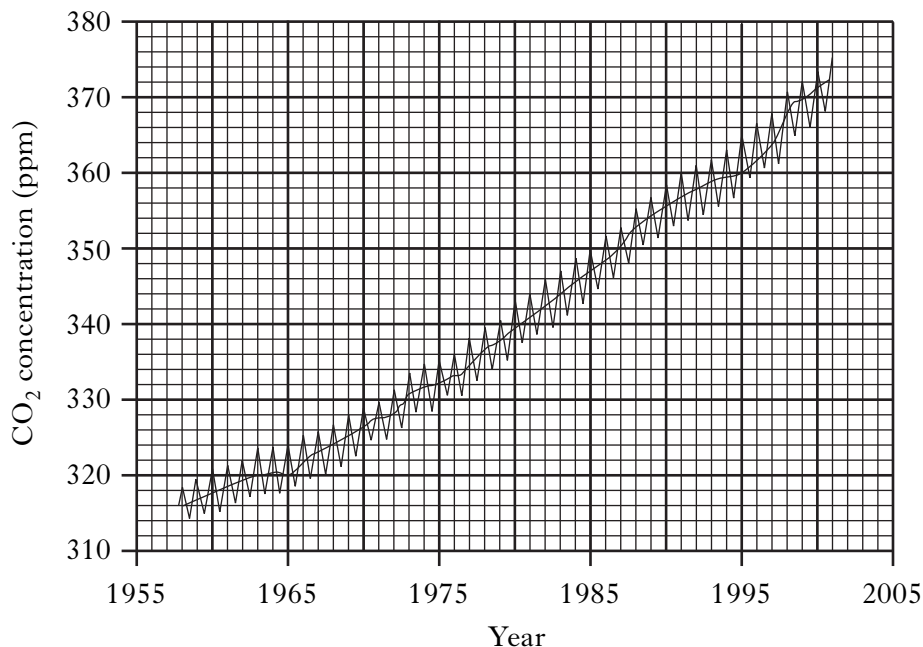
[Question 1 continues on Page twelve]

Question 1 (continued)

- | | | | |
|-----|------|---|-------------|
| (a) | (i) | Explain what is meant by the term parasitism. | 2 |
| | (ii) | <i>Schistosoma</i> has free-living stages but can only feed or reproduce when in contact with a host. What term is used to describe this form of parasitism? | 1 |
| (b) | | One of the keys to the successful control of <i>Schistosoma</i> is to reduce the number of “superspreaders”. | |
| | (i) | Suggest a “non-invasive assessment” for identifying superspreaders. | 1 |
| | (ii) | Give two aspects of the intervention designed to tackle superspreaders. | 2 |
| (c) | (i) | Use the data from the trial to show that the intervention is needed to achieve the 1% target for infection. | 2 |
| | (ii) | Comment on the reliability of the results. | 1 |
| (d) | | Attempts have been made to control <i>Schistosoma</i> through the use of molluscicides to kill the secondary host. Using the information, suggest why this method of control is unlikely to be successful with reference to | |
| | (i) | the secondary host; | 1 |
| | (ii) | the parasite. | 1 |
| (e) | | Explain how the broad host specificity of <i>S. japonicum</i> has influenced both the design of the intervention programme and the methods for measuring its effectiveness. | 3 |
| | | | (14) |

[Question 2 is on fold-out Page thirteen

2. The graph below shows variation in global atmospheric carbon dioxide concentration during a fifty year period. Seasonal variation occurs because there is much more green plant biomass in the northern hemisphere than in the southern hemisphere. The underlying trend, however, reveals an increase in concentration.



- (a) Which **two** cellular processes are responsible for the seasonal variation in carbon dioxide concentration of the atmosphere? **1**
- (b) Using the trend line, calculate the percentage increase in the carbon dioxide concentration between 1965 and 1995. **1**
- (c) The increasing carbon dioxide concentration contributes to the enhanced greenhouse effect.
- (i) Explain what is meant by the term *enhanced* in relation to the greenhouse effect. **1**
- (ii) Name a gas, other than carbon dioxide, that contributes to the enhanced greenhouse effect. **1**
- (4)**

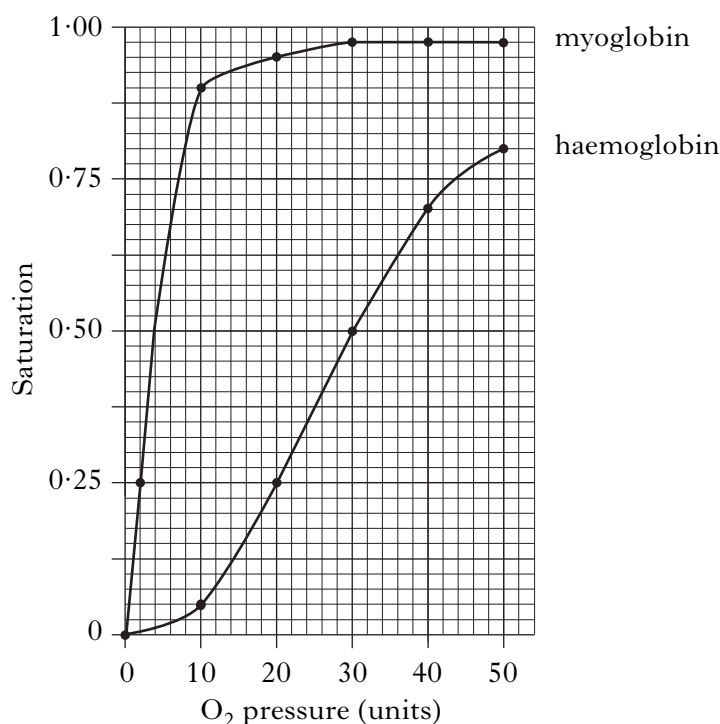
3. Soils that have developed from serpentine rocks have a naturally low abundance of minerals such as calcium, nitrogen, phosphorus and potassium, and a high abundance of potentially toxic metals such as nickel. The succession of serpentine plant communities shows little facilitation and is limited by the regular input of toxic minerals from the erosion of the rock. The climax vegetation that develops tends to be sparse and species present have unusual adaptations to cope with the high concentrations of metal in the soil.
- (a) (i) What is meant by facilitation in succession? **1**
- (ii) What term describes a succession influenced by external factors such as erosion? **1**
- (b) The flowering herb *Alyssum bertolonii* is favoured in serpentine soils because it can isolate absorbed nickel into specialised leaf hair cells. As a result, its dry mass can be as high as 3% nickel. Most other species are susceptible to nickel poisoning at much lower concentrations.
- (i) What term describes the increasing levels of nickel found in *A. bertolonii*? **1**
- (ii) Explain why a serpentine climax community is unlikely to have many trophic levels. **1**
- (iii) Suggest why *A. bertolonii* could be used as an indicator species. **1**
- (5)**
4. Discuss the concept of niche with reference to the competitive exclusion principle. **(4)**

5. Myoglobin and haemoglobin are oxygen-carrying proteins. Myoglobin has one polypeptide chain and is found in muscle. Haemoglobin has four polypeptide chains and is found in red blood cells. The tertiary structures of the myoglobin and the haemoglobin chains are very similar. Each chain has one binding site for oxygen.

The proportion of binding sites occupied by oxygen is known as *saturation*.

$$\text{Saturation} = \frac{\text{number of oxygen binding sites occupied}}{\text{total number of oxygen binding sites}}$$

The graph shows the binding of oxygen to haemoglobin and myoglobin as the available oxygen is increased.



- (a) (i) Use data to compare the saturation of myoglobin and haemoglobin between 0 and 30 units. 1
- (ii) Explain how the information shows that quaternary structure affects the binding of oxygen to haemoglobin. 2
- (b) Use the formula to calculate the change in the number of oxygen molecules bound to haemoglobin as the oxygen pressure is reduced from 30 to 20 units. 1
- (c) Haem groups are an example of non-polypeptide components present in proteins. What term describes such components? 1
- (5)**

[Turn over

6. Gamma-aminobutyric acid (GABA) is a neurotransmitter that functions as a signalling molecule in the central nervous system. GABA binds to a receptor protein located in the plasma membrane of target cells as shown in Figure 1. Binding of a GABA molecule opens a channel that allows chloride ions (Cl^-) to enter the cell.

Figure 1

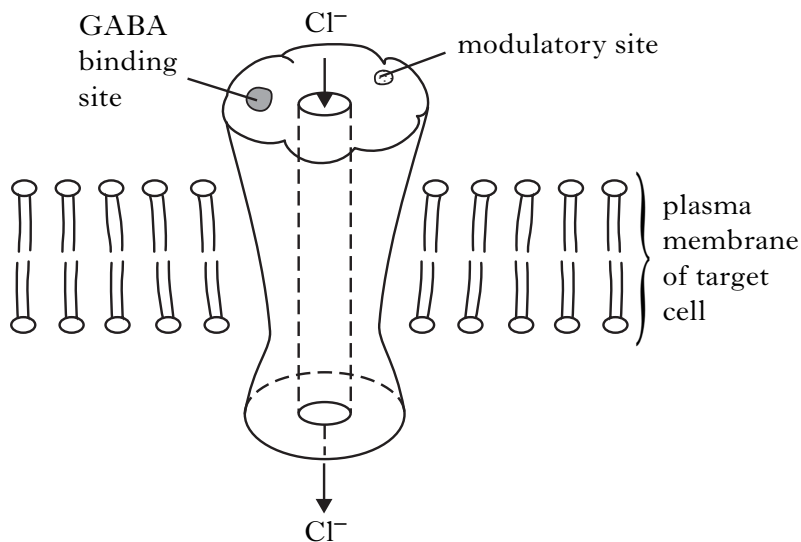
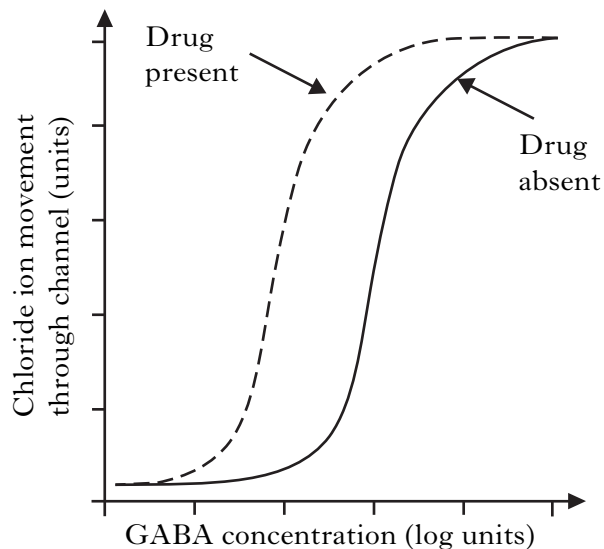


Figure 2



Benzodiazepines are sedative drugs that bind to the receptor protein and increase its affinity for GABA. These drugs act as allosteric modulators by binding at a site that is distinct from the GABA-binding site. Figure 2 above shows the movement of chloride ions through the channel as GABA is increased with and without the drug being present.

- (a) (i) State why neurotransmitters such as GABA cannot cross the membrane. 1
- (ii) What term describes the action of membrane receptors in which signal binding triggers an event in the cytoplasm that alters the behaviour of the cell? 1
- (b) (i) How does the information in Figure 2 show that the affinity of the receptor for GABA has been increased by the drug? 1
- (ii) How might the binding of benzodiazepine to the modulatory site increase the affinity of the receptor for GABA? 1
- (4)**

7. Cystic fibrosis is caused by mutation within the gene encoding the CFTR protein. The most common mutation in this gene is a three base-pair deletion that results in the loss of one amino acid from the CFTR protein. This deletion, $\Delta F508$, accounts for about 70% of mutations in cystic fibrosis.
- A screening test for cystic fibrosis uses the polymerase chain reaction (PCR) to amplify part of the *CFTR* gene containing the mutation.
- (a) Describe the features of primers used in PCR. 2
- (b) Give **one** technique that could be used in the detection of the mutation following PCR. 1
- (c) What information should be given to someone during counselling, following a negative screening result for $\Delta F508$? 1
- (4)**
8. Answer **either A or B**.
- A.** Compare prokaryotic and eukaryotic cells under the following headings:
- (i) organisation of genetic material; 5
- (ii) ultrastructure and other features. 10
- OR** **(15)**
- B.** Write notes on the cell cycle and its control under the following headings:
- (i) interphase; 5
- (ii) mitosis; 5
- (iii) mutations. 5
- (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.

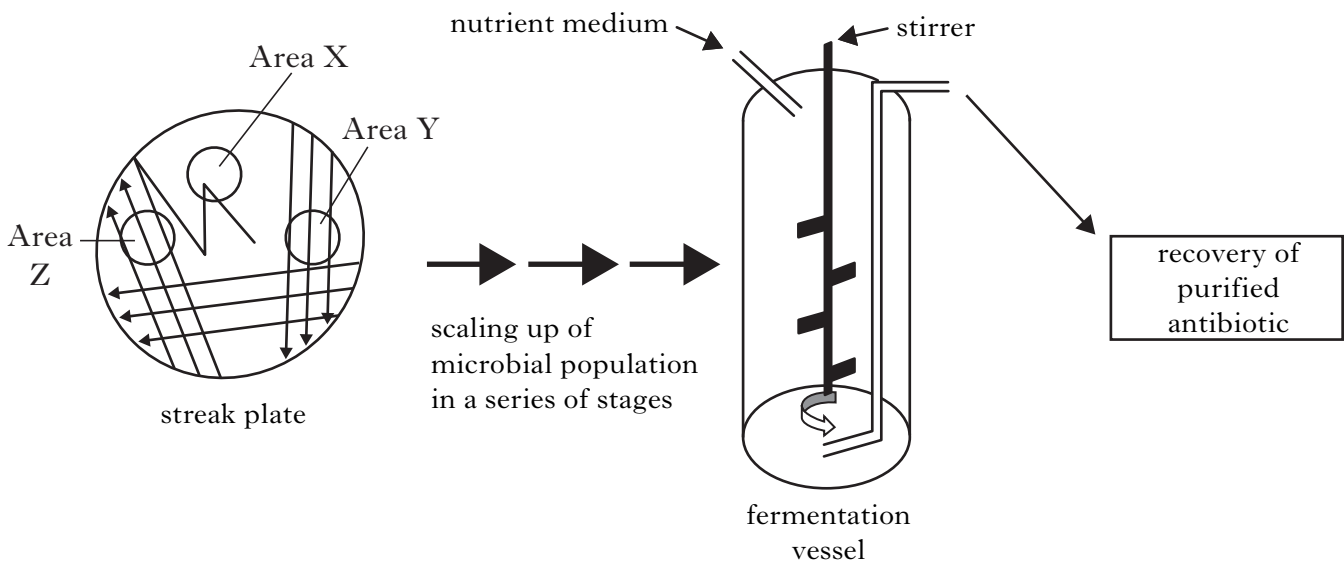
All answers must be written clearly and legibly in ink.

Labelled diagrams may be used where appropriate.

BIOTECHNOLOGY

Marks

1. The figure shows stages involved in the commercial production of an antibiotic.

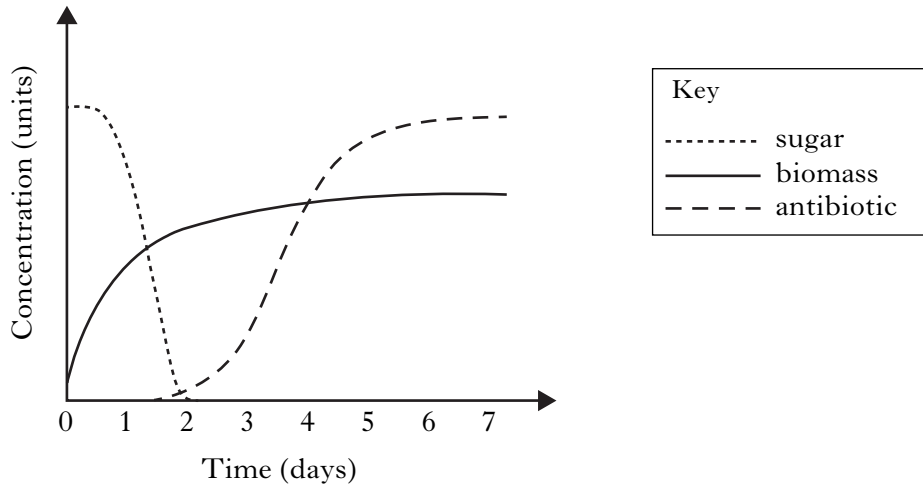


- (a) Name a commercially produced antibiotic and the type of micro-organism used in its production. 1
- (b) The scaling up process above is started using cells from a single isolated colony.
- (i) Explain why it is necessary to use a single colony isolate. 1
- (ii) Which one of the labelled areas on the streak plate would be most likely to have such a colony? 1
- (c) Give **one** reason why the culture in the fermentation vessel is stirred. 1
- (d) Give **one** process involved in the recovery of the antibiotic. 1

BIOTECHNOLOGY (continued)

1. (continued)

- (e) The figure shows changes in the culture medium during the production of an antibiotic in a fermentation vessel.



From the figure, give **two** pieces of evidence to indicate that this antibiotic is a secondary metabolite.

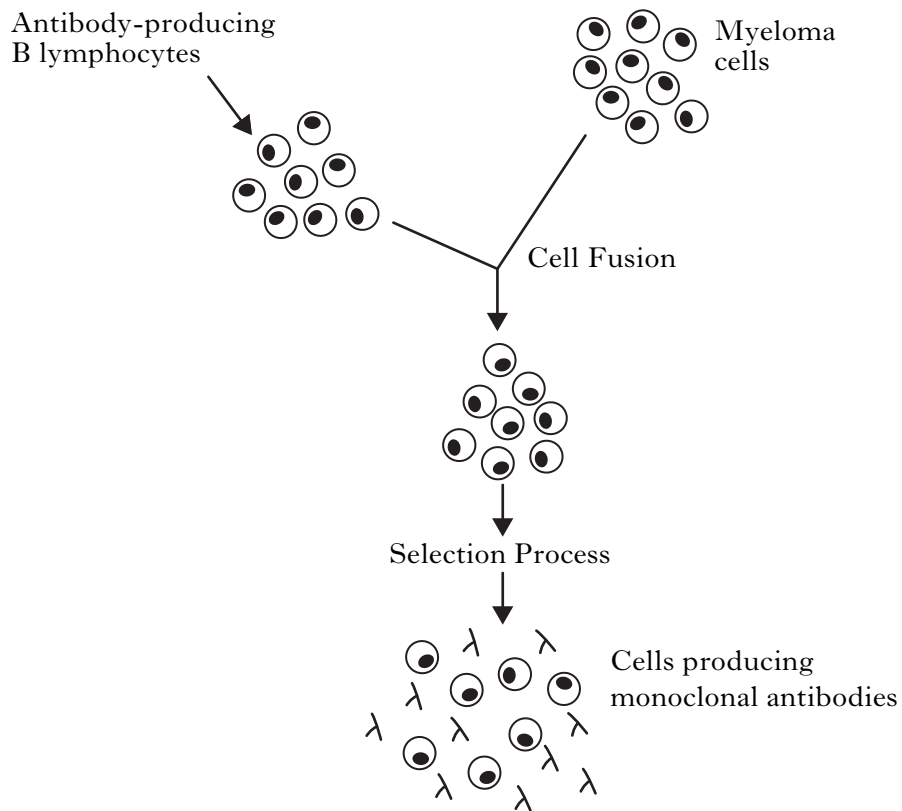
2

(7)

[Turn over

BIOTECHNOLOGY (continued)

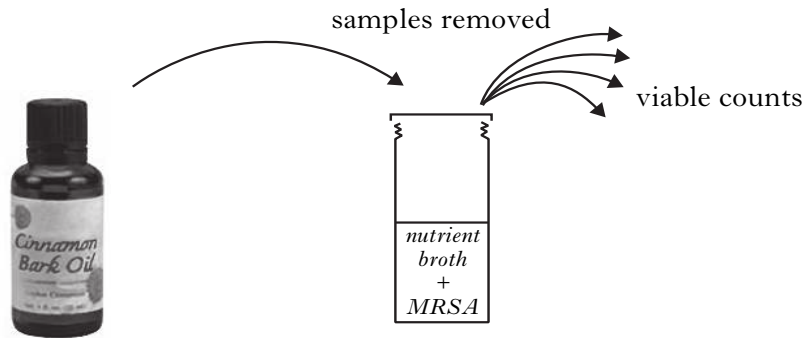
2. The diagram shows stages in the production of monoclonal antibodies.



- (a) Describe how the B lymphocytes shown above would have been produced. 2
 - (b) Name the chemical used to bring about the fusion of B lymphocytes and myeloma cells. 1
 - (c) Give **one** use of monoclonal antibodies in the **treatment** of disease. 1
- (4)**

3. The chemical composition of plant cell walls causes problems in the commercial production of fruit juices. Identify the problems and outline how enzymes are used to overcome them. (5)

4. Several studies have demonstrated the antimicrobial activity of oils extracted from plants. One such study investigated the bactericidal activity of an oil from cinnamon bark on the bacterium, methicillin-resistant *Staphylococcus aureus* (MRSA). The oil was added to broth containing an inoculum of MRSA.

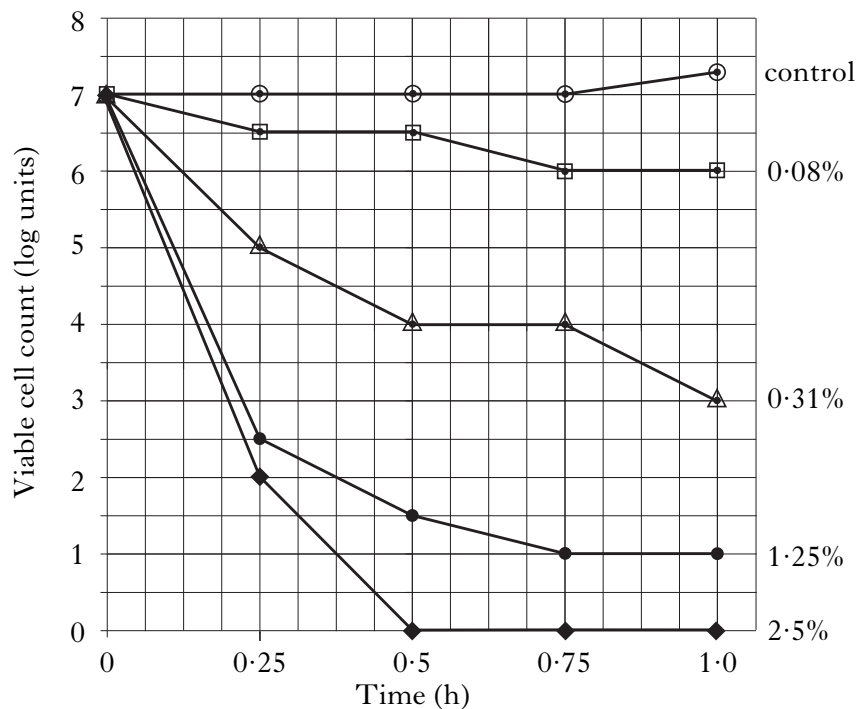


- (a) Viable counts were made at intervals over a one hour period.

What is meant by a viable count?

1

- (b) The graph below shows data for different concentrations of the cinnamon bark oil and a control with no oil. Log units are powers of ten.



- (i) In this study a bactericidal effect was defined as a reduction, over a one hour period, of 5 log units from the initial viable count.
Identify which of the oil treatments are bactericidal.
- (ii) What aspect of the procedure was necessary to ensure that a valid comparison was made between the control and the treatments with essential oil?
- (iii) By how many cells has the starting population been reduced in the 0.08% treatment after the first hour?

1

1

1

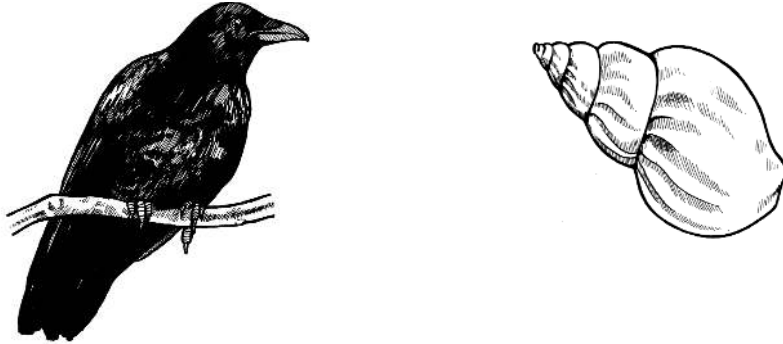
[End of Biotechnology questions. Animal Behaviour questions start on Page 22]

SECTION C (continued)

ANIMAL BEHAVIOUR

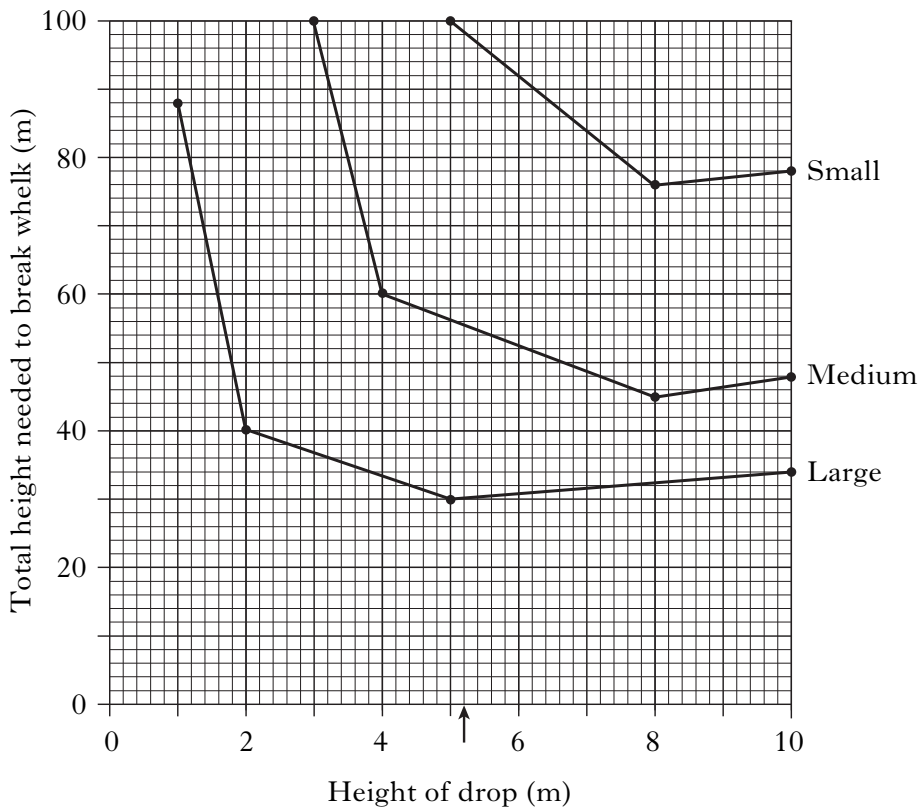
1. Northwestern crows (*Corvus caurinus*) can be observed feeding on the beaches of British Columbia in Canada. They search mainly for whelks (*Thais lamellosa*).

Northwestern crow and whelk prey (not to scale)



The crows search only for the largest whelks. After finding a whelk, they take off with it and fly vertically upwards before dropping it onto a rock. This is repeated until the whelk's shell is broken. Steep ascending flight of this kind is energetically expensive. The crows are very persistent and may drop a single whelk up to 20 times before the shell breaks.

- (a) The graph below shows the results of an experiment in which **researchers** dropped small, medium and large whelks from different heights. In the graph, "Total height" is obtained by combining the number of drops at each height required to break the whelk. The arrow on the X axis indicates the mean height of drop actually observed when **crows** drop whelks.



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

- (i) On average, how many times would a medium-sized whelk need to be dropped from a height of 4 m in order to break? **1**
- (ii) From the information provided, suggest why crows take only the largest whelks. **1**
- (b) Use the concept of optimal foraging to explain the observation that crows drop whelks from an average height of 5.2 m. **2**
- (c) Apart from energy content and handling time, what other aspect of foraging behaviour is likely to be of significance in determining a predator's choice of prey? **1**
- (5)**

2. "All development depends on both nature and nurture." (R. Hinde)

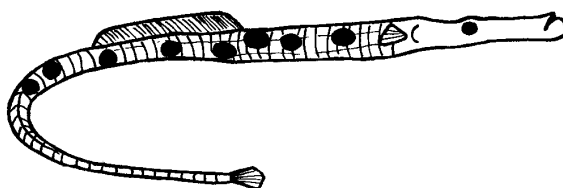
- With reference to life span, compare the roles of nature and nurture in the behavioural development of adult invertebrates and primates. **(5)**

[Turn over

ANIMAL BEHAVIOUR (continued)

3. The broad-nosed pipefish (*Syngnathus typhle*) can be found along many coasts and estuaries in the British Isles. In this species, “normal” sex roles are reversed: females compete with each other for males and it is the males that are selective. During mating, the female transfers her eggs into a brood pouch in the male where they are then fertilised and nourished. The males provide parental care for the young.

All pipefish are susceptible to infestation by a parasite that induces the formation of visible black spots on the skin.

Figure: Pipefish showing signs of parasite infestation

When females are infected, egg production decreases as the parasite load increases. High intensity infections may kill the fish host.

Experiments were carried out to discover male responses to spotted females that were either naturally infected or had been artificially tattooed using ink dissolved in a solvent. In both situations, it was found that males selected females with fewer or no black spots. Behavioural interactions between males, however, were not influenced by the presence or absence of spots on the males.

- (a) During mating, the fish are more vulnerable to predators.
- (i) Explain how the male’s preference for healthy females allows him to maximise his reproductive fitness. 2
- (ii) Explain why the genes controlling this behaviour might be described as “selfish”. 1
- (b) Give **one** aspect of behaviour that contributes to the high level of parental investment shown by the male pipefish. 1
- (c) The parasite cannot be transmitted directly from one fish to another.
Which aspect of pipefish behaviour is consistent with this observation? 1
- (d) Suggest a control that should be used in the experiment involving tattooed spots. 1
- (e) In the experiments, fish were arranged so that males could see females but females could not see males. Explain why this would strengthen the conclusion that males select against parasitised females using visual stimuli. 1
- (7)**

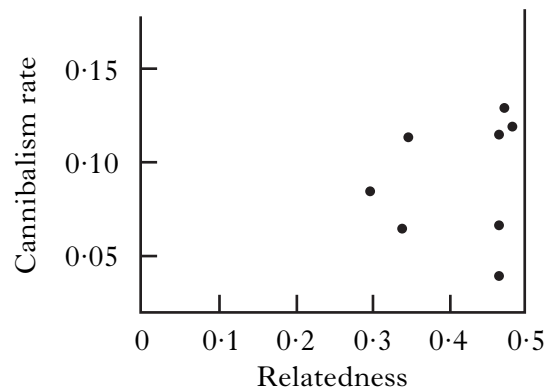
ANIMAL BEHAVIOUR (continued)

4. Cannibalism occurs when animals eat other animals of their own species. Willow leaf beetles, *Plagioderia versicolora*, lay eggs in clutches (groups). Females may have mated once or several times so clutches contain a mixture of half and full siblings. This means that the coefficient of relatedness, r , varies between 0.25 and 0.5.

Larvae that hatch first eat unhatched eggs from the same clutch. 24 hours after hatching, cannibals are 30% heavier than non-cannibals.

The scatterplot shows cannibalism rate and clutch relatedness for a number of populations.

Figure: Cannibalism rate versus average clutch relatedness for each of eight populations



- (a) Why do full siblings have a coefficient of relatedness of 0.5? 1
- (b) A hypothesis from Hamilton's rule would be that cannibalistic larvae should not eat close relatives.
- (i) What is meant by Hamilton's rule? 1
- (ii) What evidence from the graph contradicts the hypothesis? 1
- (3)**
- (20)**

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

[Turn over

SECTION C (continued)

Marks

PHYSIOLOGY, HEALTH AND EXERCISE

1. Describe how atherosclerosis can lead to myocardial infarction. **(4)**

2. (a) To reduce the risk of cardiovascular disease, individuals are encouraged to improve the ratio of high-density lipoprotein (HDL) to low-density lipoprotein (LDL).

Give **two** lifestyle factors that can be changed to improve the ratio of HDL:LDL. **2**

(b) Cholesterol in the blood is associated with HDL, LDL and triglycerides. Treatment with *statin* medication aims to improve the ratio of HDL to LDL by reducing cholesterol production.

The data below show the blood lipid profiles of a patient before and after two years of statin medication, and the normal range of values for a healthy individual.

<i>Blood lipid</i>	<i>Concentration (mmol/l)</i>		
	<i>Before treatment</i>	<i>After treatment</i>	<i>Normal range values</i>
Total cholesterol	8.5	5.5	3.0 – 5.0
HDL	1.9	1.8	1.0 – 2.2
LDL		2.9	2.0 – 3.4
Triglycerides	1.5	1.7	0.3 – 2.5
Total cholesterol/HDL	4.5	3.1	about 3.0

(i) LDL is not measured directly, it is calculated from other values using the formula below.

$$\text{LDL} = (\text{Total} - \text{HDL}) - (\text{Triglycerides} / 2.2)$$

Calculate the LDL value before treatment. **1**

(ii) Select **two** pieces of evidence to show that statin treatment has reduced the risk of cardiovascular disease. **2**

(iii) The aim for statin treatment is to increase the proportion of HDL to over 30% of the total. Use the data to show that this has been achieved. **1**

(6)

PHYSIOLOGY, HEALTH AND EXERCISE (continued)

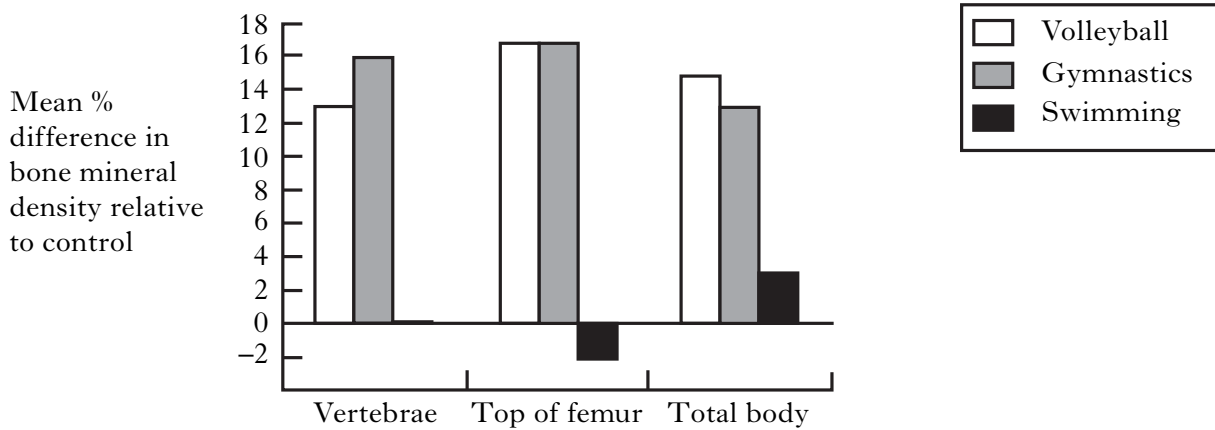
3. (a) Blood glucose concentration increases after a meal.
Describe the events that bring blood glucose concentration back to normal. **2**
- (b) In an *oral glucose tolerance test*, an individual has “impaired glucose tolerance” when results are in the range 7.8 to 11.0 mmol/l. A result in this range is referred to as *pre-diabetic*. If untreated, pre-diabetes leads to Type 2 diabetes (NIDDM).
The underlying cause of impaired glucose tolerance is insulin resistance.
- (i) Explain why cells become less sensitive to insulin in individuals with insulin resistance. **1**
- (ii) For people with pre-diabetes, explain why there would be a long-term benefit from reducing a high waist to hip ratio. **2**
- (5)**

[Turn over for Question 4 on Page twenty-eight

PHYSIOLOGY, HEALTH AND EXERCISE (continued)

4. (a) Why does taking part in sporting activities during adolescence reduce the risk of osteoporosis-related fractures in later life? 2

(b) The figure below shows the results of a study comparing bone mineral density of groups of women involved in different types of sport. The values show mean percentage difference in bone mineral density between the athletes and a control group who have an inactive lifestyle.



- (i) Suggest why the study focuses on bone mineral density of vertebrae and the top of the femur (thigh). 1
- (ii) Explain why swimmers are included in the study. 1
- (iii) The data suggest that swimming has a negative effect on bone mineral density at the top of the femur. What other information would be required to judge if the results are statistically significant? 1

(5)
(20)

[END OF QUESTION PAPER]

[BLANK PAGE]

[BLANK PAGE]