

## Area of study 2 – Detecting and responding

### Section A (Multiple-choice questions)

Coordination and regulation at the cellular level

#### Question 2.1

A signalling molecule triggering a cellular response is an example of

- A. stimulus response.
- B. negative feedback.
- C. signal transduction.
- D. a reflex arc.

#### Question 2.2

Testosterone

- A. is a protein-based hormone.
- B. binds to an intracellular receptor.
- C. is transduced by G proteins.
- D. passes through protein channels.

#### Question 2.3

The signal for apoptosis

- A. is genetically determined.
- B. is external to the cell.
- C. is external to the organism.
- D. comes from within the cell.

#### Question 2.4

Cancer sufferers, where a tumour grows,

- A. the growth is due to the high rate of apoptosis.
- B. the rate of cells produced by meiosis exceeds those removed by apoptosis.
- C. there is no apoptosis occurring.
- D. more cells are produced than are removed by apoptosis.

#### Question 2.5

A signalling molecule of the immune system is

- A. cytokines.
- B. cytokinins.
- C. interferon.
- D. antibodies.

Use the following information to answer Questions 2.6 to 2.8.

An investigation was carried out to determine the effect of exercise on blood flow through the tissues of various organs. Various degrees of exercise were performed on an exercise bicycle. The work done was measured in arbitrary units and ranged from 0 (rest) to 50 units (severe exercise).

The results are given in the table below.

| Work done<br>(arbitrary<br>units) | Volume of blood in cm <sup>3</sup> per minute |                            |       |                                 |               |
|-----------------------------------|-----------------------------------------------|----------------------------|-------|---------------------------------|---------------|
|                                   | Brain                                         | Coronary<br>(heart) muscle | Liver | Skeletal muscle<br>(e.g. thigh) | Other tissues |
| 0                                 | 700                                           | 200                        | 1650  | 750                             | 1700          |
| 10                                | 840                                           | 300                        | 1500  | 1500                            | 1860          |
| 20                                | 1200                                          | 480                        | 1600  | 3200                            | 1520          |
| 30                                | 1650                                          | 770                        | 1650  | 5500                            | 1430          |
| 40                                | 2250                                          | 1200                       | 1650  | 9000                            | 900           |
| 50                                | 3000                                          | 1800                       | 1800  | 12 400                          | 1000          |

### Question 2.6

The primary homeostatic function of increased blood flow during exercise is to maintain

- A. core temperature.
- B. blood glucose concentration.
- C. blood carbon dioxide concentration and blood oxygen concentration.
- D. blood oxygen concentration only.

### Question 2.7

The blood-sucking insect *Rhodinus* grows and moults after a blood meal. If its head is removed straight after a blood meal, it will not moult. If its head is removed one week after a blood meal, it will moult. It is capable of living up to a year without its head if it has just had a blood meal.

Two *Rhodinus* insects had their heads removed after a blood meal: one straight after and the other a week after. The two headless bodies were joined by a glass tube. Both moulted within the next few days. Chemical examination of both bodies showed the presence of a substance known as ecdysone. It was later demonstrated that ecdysone was released from the prothoracic region of the brain.

Ecdysone would best be described as

- A. a neurotransmitter.
- B. an enzyme.
- C. a hormone.
- D. a cofactor.

### Question 2.8

Sea anemones produce an organic compound called anthopleurine. When eaten by sea slugs, the chemical is released from the sea slug, warning other anemones that a predator is approaching.

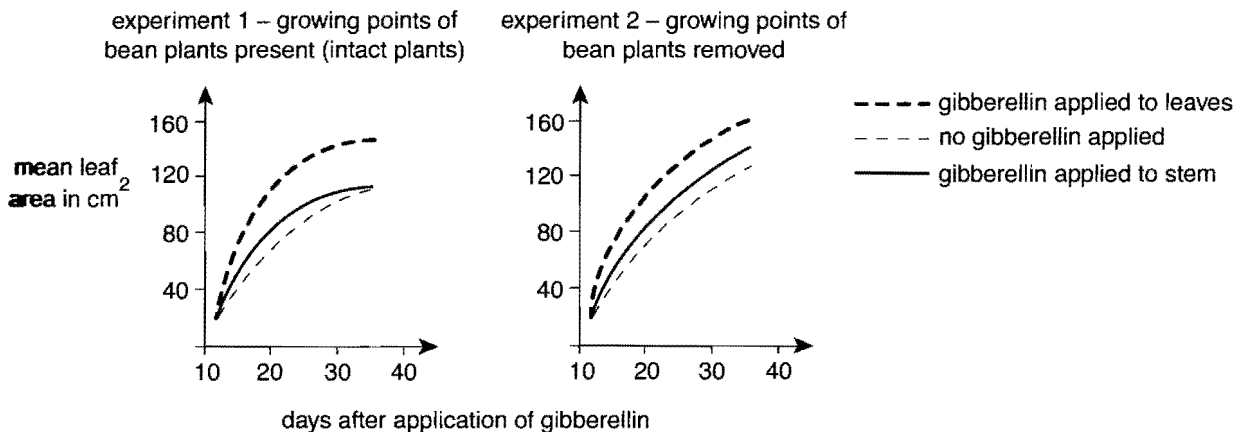
Anthopleurine would best be described as a

- A. hormone.
- B. pheromone.
- C. trigger substance.
- D. neurotransmitter.

## Plant growth regulators

Use the following information to answer Questions 2.9 and 2.10.

An investigation was carried out into the effect of gibberellin on the growth of leaves in dwarf bean plants. Equal amounts of the hormone were applied either to the stem or to the first leaves produced by the plants. In one experiment the plants were left intact, but in a second experiment the growing point (apex) of each plant was removed when gibberellin was applied.



## Question 2.9

- effect on leaf growth of removal of growing points from the bean plants when no gibberellin is applied is
- increased leaf growth when compared to an intact plant.
  - decreased leaf growth when compared to an intact plant.
  - the same leaf growth.
  - no leaf growth.

## Question 2.10

- the reason why removal of the growing point had the effect as illustrated by the graph is that
- an intact growing point produces a substance which stimulates the growth of leaves further down.
  - an intact growing point produces a substance which inhibits the growth of leaves further down.
  - leaves further down act independently of the growing point above.
  - nutrients from the roots are used more readily by leaves closer to the source than the growing point.

## Question 2.11

- citric acid is involved in
- flowering.
  - ripening of fruit.
  - the dropping off of fruit.
  - growth of cells.

## Question 2.12

- auxellins are involved in
- flowering.
  - ripening of fruit.
  - the dropping off of fruit.
  - growth of cells.

**Question 2.13**

Ethylene is involved in

- A. flowering.
- B. ripening of fruit.
- C. the dropping off of fruit.
- D. growth of cells.

**Question 2.14**

ABA refers to the plant growth regulator substance

- A. auxin.
- B. cytokinin.
- C. abscisic acid.
- D. gibberellin.

Disease, pathogens and the human immune system

**Question 2.15**

Food poisoning is due to the ingestion of large numbers of microorganisms or of toxins produced by microorganisms.

From the above information and your knowledge, it would be correct that

- A. cooking food destroys all microorganisms and their toxins.
- B. high concentrations of salt or sugar prevent and/or reduce multiplication of microorganisms.
- C. spoilage of food does not occur if food is refrigerated.
- D. viruses produce toxins responsible for food poisoning.

**Question 2.16**

The protein produced by the body in response to infection is

- A. antigen.
- B. antibody.
- C. antibiotic.
- D. histamine.

**Question 2.17**

If a disease is caused by prions, which of the following sets of results would be obtained for the characteristics tested? (✓ positive, ✗ negative)

|    | Test      |         |              |
|----|-----------|---------|--------------|
|    | Cell wall | Protein | Nucleic acid |
| A. | ✓         | ✓       | ✓            |
| B. | ✓         | ✓       | ✗            |
| C. | ✗         | ✓       | ✗            |
| D. | ✗         | ✓       | ✓            |

**Question 2.18****Mast cells**

- A.** detect allergens.
- B.** produce histamines.
- C.** produce antihistamines.
- D.** detect antigens.

**Question 2.19****Histamines**

- A.** produce an allergic response.
- B.** render allergens harmless.
- C.** inactivate allergens.
- D.** reduce the effect of conditions such as hay fever.

**Question 2.20****Natural killer cells**

- A.** engulf cells and destroy cell contents.
- B.** destroy cancer and are cytotoxic, not antigen specific.
- C.** act to destroy eukaryotic cells such as virally infected cells or cells from transplanted tissue.
- D.** are stimulated by specific antigens to produce antibodies.

**Question 2.21****B cells**

- A.** engulf cells and destroy cell contents.
- B.** destroy cancer and are cytotoxic, not antigen specific.
- C.** act to destroy eukaryotic cells such as virally infected cells or cells from transplanted tissue.
- D.** are stimulated by specific antigens to produce antibodies.

**Question 2.22****T cells**

- A.** engulf cells and destroy cell contents.
- B.** destroy cancer and are cytotoxic, not antigen specific.
- C.** act to destroy eukaryotic cells such as virally infected cells or cells from transplanted tissue.
- D.** are stimulated by specific antigens to produce antibodies.

**Question 2.23****Macrophages**

- A.** engulf cells and destroy cell contents.
- B.** destroy cancer and are cytotoxic, not antigen specific.
- C.** act to destroy eukaryotic cells such as virally infected cells or cells from transplanted tissue.
- D.** are stimulated by specific antigens to produce antibodies.

**Question 2.24****Infants, which has antibodies that have passed from its mother via the placenta, is said to have**

- A.** naturally acquired active immunity.
- B.** naturally acquired passive immunity.
- C.** artificially acquired active immunity.
- D.** artificially acquired passive immunity.

**Question 2.25**

An example of passive artificial immunity is

- A. a baby gaining antibodies from its mother's milk.
- B. contracting a disease and recovering from it and not contracting the disease when re-exposed.
- C. when a person is vaccinated against a particular disease.
- D. when antibodies are injected into the body.

**Question 2.26**

An attenuated vaccine contains

- A. live microorganisms, which are altered so as to be less harmful.
- B. dead pathogens, so they can't reproduce.
- C. antibodies.
- D. antitoxins.

**Question 2.27**

The humoral response depends on

- A. mast cells.
- B.  $T_h$  cells.
- C.  $T_c$  cells.
- D. NK cells.

**Question 2.28**

The cells involved directly in the rejection of a transplanted organ, such as a heart, are

- A. B cells.
- B.  $T_h$  cells.
- C.  $T_c$  cells.
- D. macrophages.

**Question 2.29**

Facultative parasites

- A. can only live in a live host.
- B. can only live in nutrient media.
- C. can live in live hosts or nutrient media.
- D. can change their requirements to suit their environment.

**Question 2.30**

An opportunistic pathogen

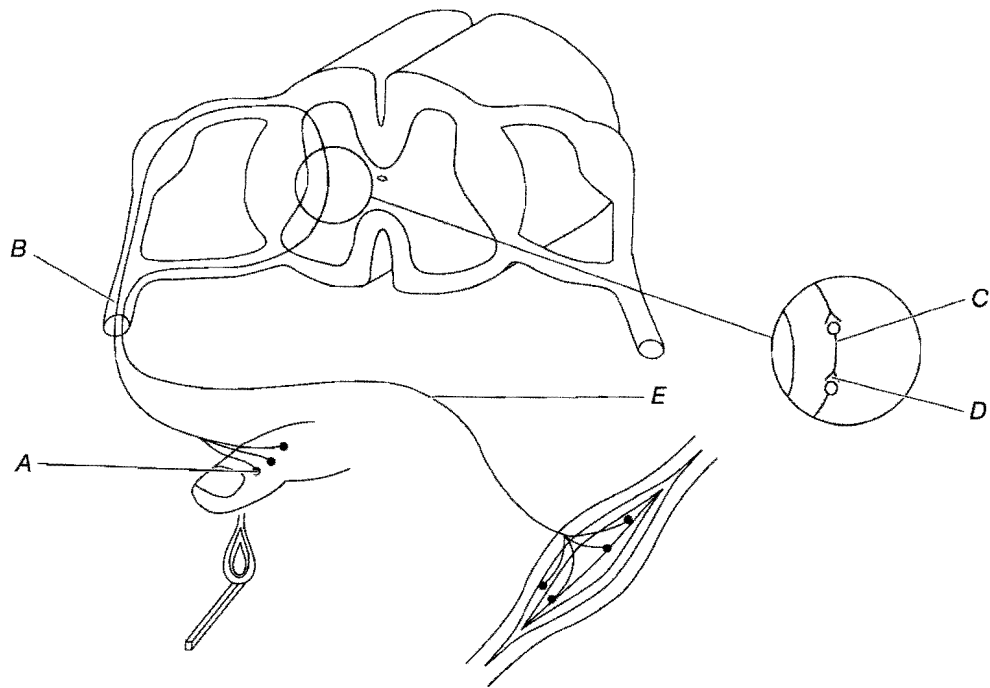
- A. causes disease when a host's defences are reduced.
- B. always has a variety of hosts.
- C. reproduces when conditions are suitable.
- D. infects both plants and animals.

## Section B (Short-answer questions)

### Coordination and regulation at the cellular level

#### Question 2.1

The following diagram shows the structures involved in a reflex action that occurs when a finger comes in contact with a flame.



Name the parts labelled A–E above.

5 marks

What is the advantage of this type of response to the individual?

1 mark

How does the action potential move across D?

1 mark

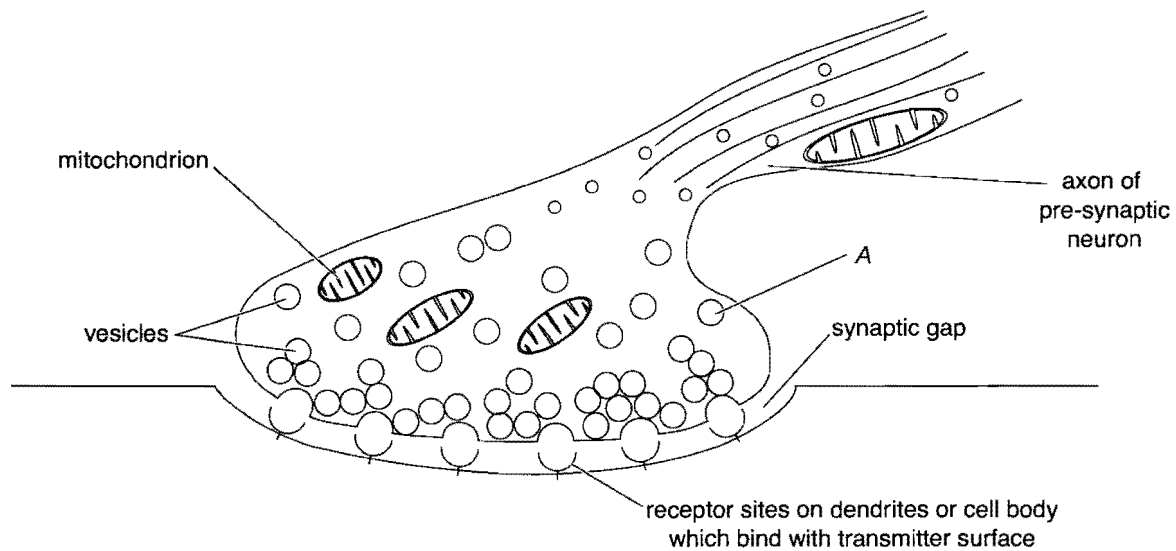
How does the reflex action differ from the stimulus-response action?

1 mark

Total 8 marks

**Question 2.2**

There are a number of different ways that cells and organisms communicate with each other.



- a. i. What is the general name given to the compound X that is secreted from A?  
 ii. Complete the following table to show how compound X differs from a hormone in its action (answer by placing a yes or no in each cell of the table).

|                   | Effect is sustained | Needed in high concentration at its site of action |
|-------------------|---------------------|----------------------------------------------------|
| <b>Hormone</b>    |                     |                                                    |
| <b>Compound X</b> |                     |                                                    |

1 + 2 = 3 marks

- b. i. In which organelle would compound X be synthesised?  
 ii. Prior to secretion, compound X was modified. In what organelle did this occur?

1 + 1 = 2 marks

- c. i. By what process does compound X leave the axon?  
 ii. Once in the synaptic gap, what process moves compound X to the dendrite?  
 iii. Define the process named in c.ii.

1 + 1 + 1 = 3 marks

- d. From your knowledge and the diagram, explain two ways the transmission of an action potential across the synaptic gap could be reduced or stopped.

4 marks

Total 12 marks



**Question 2.3**

Two recent findings regarding male fertility have raised concerns for scientists. Firstly, it has been shown that the sperm production by men in industrialised countries is declining. The second discovery has shown that male rats, when exposed to a chemical that mimics oestrogen, can become infertile within two months. This particular chemical is found in many rivers.

- i. Oestrogen is an example of which group of compounds produced in the body?
- ii. List **two** general features of this type of compound.

1 + 2 = 3 marks

Testosterone levels are under homeostatic control.

Define homeostasis.

2 marks

The oestrogen mimic is found in drinking water.

Describe how scientists in the laboratory may determine that this chemical is responsible for declining male fertility.

3 marks

Total 8 marks

**Signalling molecules****Question 2.4**

1 diabetics suffer from a lack of insulin, a hormone produced by the pancreas that stimulates cells to up glucose from the blood.

What is a hormone?

2 marks

What type of hormone is insulin?

1 mark

Describe how insulin initiates the uptake of glucose from the blood.

2 marks

Total 5 marks

**Question 2.5**

Epinephrine and adrenalin are water-soluble hormones called peptide hormones. Once the hormones have done their job it is important they are removed so that the effect they produce will cease.

What is the specific substance the cells must produce to break down these molecules?

1 mark

Total 1 mark

**Question 2.6**

Define what a pheromone is and describe an example.

3 marks

What advantages do pheromones have over verbal or visual communications?

What disadvantages do they have?

4 marks

Total 7 marks

**Question 2.7**

Neurotransmitters, such as acetylcholine and dopamine, are involved in signal transmission in nerves.

- a. Where in the presynaptic cell are neurotransmitters released? 1 mark
- b. Prior to being released, what are neurotransmitters contained in? 1 mark
- c.
  - i. By what process are neurotransmitters released from the presynaptic cells?
  - ii. Describe this process.1 + 2 = 3 marks
- d. By what process does the neurotransmitter move across the synaptic cleft? 1 mark
- e. What feature must postsynaptic cells possess if they are to respond to the neurotransmitter? 1 mark

Total 7 marks

**Plant growth regulators****Question 2.8**

Plants may show tropisms in response to their environment.

- a. What is a tropism? 1 mark
- b. Name two environmental stimuli that cause tropisms. 2 marks
- c. Auxin is involved in some tropic responses. What is its role? 1 mark

Total 4 marks

**Question 2.9**

The following table shows whether plants of an angiosperm species flowered during a particular treatment schedule. The schedule included exposure to 8 hours of high-intensity light and differing lengths of exposure to low-intensity light and darkness. The plants were grown in continuous light before and after the indicated treatment.

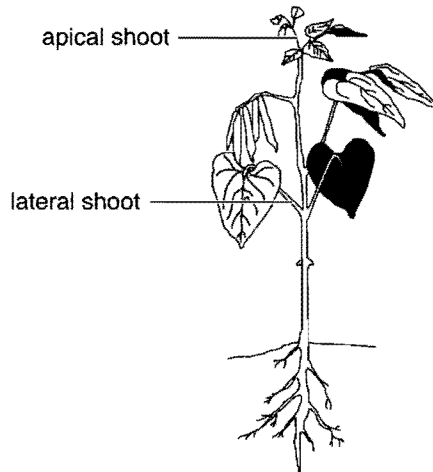
| Plant treatment                          | 1  | 2  | 3  | 4   | 5   | 6   | 7   | 8   |
|------------------------------------------|----|----|----|-----|-----|-----|-----|-----|
| Duration of high-intensity light (hours) | 8  | 8  | 8  | 8   | 8   | 8   | 8   | 8   |
| Duration of low-intensity light (hours)  | 8  | 7  | 6  | 5   | 4   | 3   | 2   | 1   |
| Duration of darkness (hours)             | 8  | 9  | 10 | 11  | 12  | 13  | 14  | 15  |
| Did flowering occur?                     | no | no | no | yes | yes | yes | yes | yes |

- a. What is the general term given to the response seen by these plants? 1 mark
- b. Classify this species of plant on the basis of the above information. 1 mark
- c. Design a controlled experiment to determine if flowering is related to environmental temperature. 3 marks

Total 5 marks

## Question 2.10

A group of bean plants were used to investigate the control of apical dominance in angiosperms. Apical dominance can be quantified by measuring the length of lateral shoots in the plants. A high degree of apical dominance inhibits the growth of these lateral shoots.



Groups of bean plants were treated as follows.

| Group | Treatment                                                   |
|-------|-------------------------------------------------------------|
| 1     | plants left intact                                          |
| 2     | plants with apical bud removed                              |
| 3     | apical bud removed and gibberellic acid applied to cut apex |
| 4     | apical bud removed and auxin applied to cut apex            |

Each day, after treatment, the lengths of the lateral shoots were measured and averaged for each group. The results are shown in the table below.

| Day | Average lateral shoot length per bean plant (mm) |         |         |         |
|-----|--------------------------------------------------|---------|---------|---------|
|     | Group 1                                          | Group 2 | Group 3 | Group 4 |
| 0   | 5                                                | 5       | 5       | 5       |
| 1   | 5                                                | 10      | 12      | 5       |
| 2   | 5                                                | 22      | 28      | 5       |
| 3   | 5                                                | 36      | 40      | 5       |
| 4   | 5                                                | 52      | 58      | 6       |
| 5   | 5                                                | 70      | 76      | 6       |
| 6   | 5                                                | 88      | 99      | 6       |
| 7   | 5                                                | 97      | 126     | 6       |

What survival advantage is there for a plant to exhibit apical dominance?

1 mark

What do the results indicate about the role of auxin in maintaining apical dominance in bean plants?

Explain your answer.

2 marks

What do the results indicate about the effect of gibberellic acid on the growth of bean plants?

Explain your answer.

2 marks

Which region of the plant is auxin probably produced? What evidence supports your suggestion?

2 marks

How are gibberellic acid and auxin transported in the plant?

1 mark

Total 8 marks

**Question 2.11**

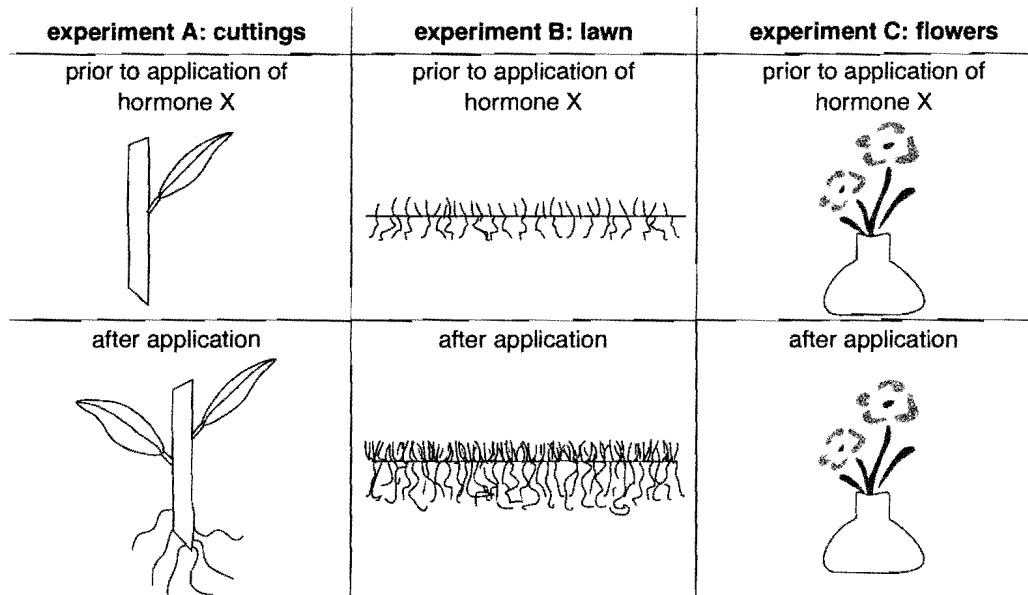
A single plant hormone, hormone X, was tested to determine its effect on a range of plant conditions.

experiment A: Cuttings from a geranium were soaked in hormone X overnight.

experiment B: Bowling green lawns were sprayed monthly with hormone X.

experiment C: Some of hormone X was added to a vase prior to arranging some cut flowers.

The following diagrams show the various plants prior to and after prolonged use of hormone X.



a. Define 'plant hormone'.

1 mark

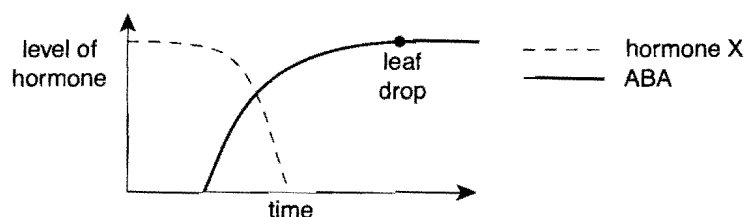
b. What type of plant hormone is hormone X?

1 mark

c. Through what part of the plant would hormone X mainly travel?

1 mark

Hormone X concentration was measured against the concentration of abscisic acid (ABA) in a deciduous plant during autumn, prior to leaf drop. The following graph shows the changes in concentrations of the two hormones (X and ABA) over this time.



d. Using the information provided in the graph, describe the role the two hormones appear to play in leaf drop.

2 marks

e. ABA appears to play a similar role in fruit drop as it does in leaf drop.

How might apple growers use this information in controlling apple picking seasons in orchards?

1 mark

f. ABA also has an important role to play for leaves in times of stress due to high temperatures and low moisture content in soils.

Describe the role of ABA and how it helps plants to overcome the problems associated with low moisture.

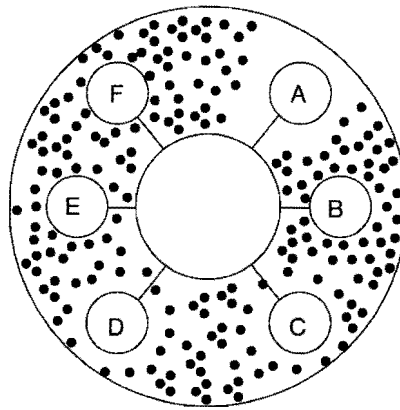
1 mark

Total 7 marks

## Disease, pathogens and the human immune system

## Question 2.12

The resistance of bacteria to various antibiotics can be tested using a 'multidisc' – a paper disc with extensions soaked in the antibiotics under investigation. The disc is placed on an agar plate that has been inoculated with the bacterium being tested. The plate is then incubated at 37°C for a few days and the bacterial growth noted. A typical result is shown in the diagram below. The plate has been inoculated with 0.5 mL of *Escherichia coli*.



To which antibiotic is *E. coli* most

- resistant?
- sensitive?

1 + 1 = 2 marks

Why are the clear zones around some of the extensions circular?

1 mark

Would it be possible to investigate viral growth using this method? Explain your answer.

2 marks

Would you expect the same results if a different bacterial strain, such as *Staphylococcus albus*, had been used to inoculate the agar plate? Explain your answer.

2 marks

How should the agar plates be safely disposed of?

2 marks

Total 9 marks

## Question 2.13

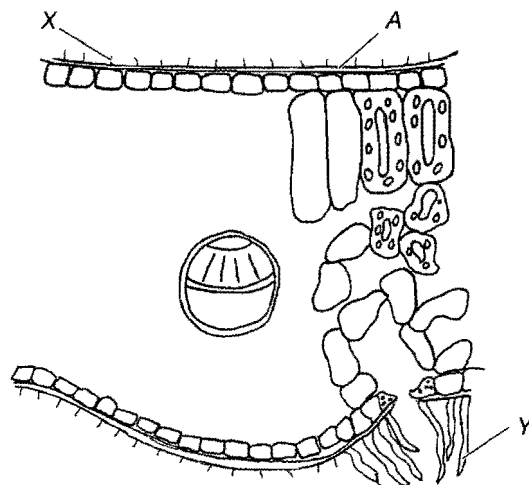
Some fungi and some bacteria are all capable of inducing disease in organisms.

Complete the table below that outlines the differences between these three types of pathogens.

| Structure                 | Bacteria | Fungus  | Virus |
|---------------------------|----------|---------|-------|
| Cell wall                 |          | present |       |
| Genetic material          | DNA      |         |       |
| Membrane-bound organelles |          | present |       |

3 marks

Examine the diagram of a transverse section of a typical angiosperm leaf below.



- b. Plants have a number of ways of restricting pathogens. Hairs labelled *X*, for example, can stop aphids biting the plant.  
How does this stop the spread of disease?
- c. What other purpose might the hairs labelled *Y* serve?
- d. Name **two** functions of *A*.
- e. Mark with an *F* on the diagram where the most likely point of entry would be for most fungi.
- f. Some fungi, which are parasitic on plants, can make enzymes that dissolve waxes.  
What advantage is this to the fungi?

1 mark

1 mark

2 marks

1 mark

1 mark

Total 9 marks

**Question 2.14**

Dutch elm disease is a fungal disease that has wiped out many millions of elm trees around the world. The fungus contains a poisonous chemical which causes the xylem of the elm tree to swell. This blocks the xylem vessels. A vaccine has been developed to prevent this disease.

- a. What is a vaccine?

2 marks

The vaccine uses a protein from a related fungus. The tree responds as if it is under attack from the fungus and so a cascade of defence reactions is triggered.

What is the general term given to any substance which triggers such a reaction?

1 mark

The tree produces substances which, by attacking its mitochondria, are lethal to the fungus.

- i. Why would such a substance be lethal for a fungus?
- ii. Would bacteria be affected in a similar way? Explain.

1 + 1 = 2 marks

One of the symptoms of Dutch elm disease is leaf die-back. This greatly reduces the rate of photosynthesis.

Give a balanced equation for this process.

2 marks

In humans, a different type of substance is produced as a result of vaccination.

- i. What are these substances?
- ii. How do these substances protect us against a specific disease?
- iii. Why does the polio vaccine not protect us against whooping cough? Explain.

1 + 1 + 1 = 3 marks

Total 10 marks

**Question 2.15**

Car tick bites cause the death of about one million cattle a year in eastern and southern Africa. The bite does not cause the deaths, rather the tick carries a parasite called *Theileria parva*. This parasite causes East Coast fever. A new and risky form of immunisation is being used to try to control the outbreaks of this disease. Vets are simultaneously injecting cattle with antibiotics and small doses of live, virulent *Theileria parva*.

Which of the organisms mentioned is the vector for this disease?

1 mark

Why are antibiotics given at the same time as the vaccination?

1 mark

There is a relatively new virus, the RHD (haemorrhagic disease) virus which kills rabbits quickly. Scientists realised that the virus is only spread by direct contact between rabbits. Before its release, scientists were experimenting with the virus on an island near the mainland of Australia. Several months later the virus was found on the mainland.

State one way it may have reached the mainland if the scientists' hypothesis was correct and one way it may have reached the mainland if the hypothesis was incorrect.

2 marks

Total 4 marks

**Question 2.16**

While picking a rose for his date for the school formal, a Year 12 boy receives a deep puncture wound. Very little bleeding occurs. The area becomes inflamed, very sore and throbs.

- a. Explain the benefit of these responses to the body. 1 mark
- b. As a precaution he sought medical advice and the doctor asked how long it had been since he had received a tetanus injection. As the last injection was given in Year 7 the doctor thought it advisable that she give him a booster.
  - i. Why is it important to be given a booster shot some time after the initial immunisation?
  - ii. Name **two** cell types involved in the immune response and state their function.

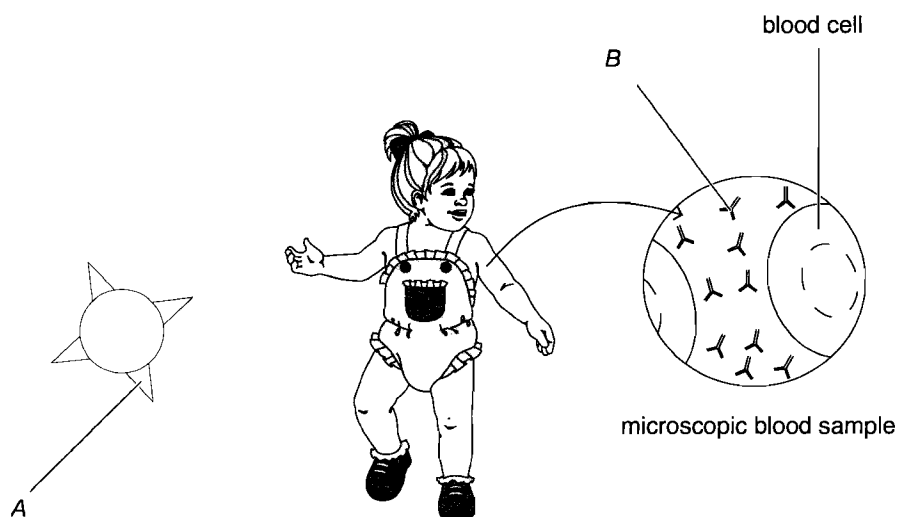
2 + 4 = 6 marks

Total 7 marks

**Question 2.17**

A recent study has indicated that isolating young children from pathogens can lead to more severe infections when exposed to the pathogen at a later date.

- a. Explain how exposure to pathogens can protect the body from later infections. 2 marks
- b. What is this type of resistance called? 1 mark
- c. i. Name the parts labelled A and B in the diagram below.



- ii. Describe the chemical nature of A and B.
- iii. What is the advantage of the shape of B to help its function? Use a labelled diagram to support your explanation. 2 + 2 + 2 = 6 marks
- d. i. Bacteria and viruses are both examples of pathogens. Give **two** structural differences between these pathogens.
- ii. Why are antibiotics prescribed for bacterial infections but not viral infections?

2 + 2 = 4 marks

Total 13 marks



**Question 2.18**

The bacterium *Hylobacteria pyloria* has recently been attributed with being the chief cause of peptic ulcers, gastritis and some stomach cancers. Scientists are developing a new vaccine that may help future infections and disease in patients, but may also be useful in helping to get rid of the bacterium in already infected individuals.

This vaccine can be taken orally and includes two proteins found on the surface of *H. pyloria* cells.

- a. Suggest one way that a human may become infected with *H. pyloria* initially. 1 mark
- b. What type of cells of the human immune system would be responsible for producing the antibodies necessary to fight an infection by *H. pyloria*? 1 mark
- c. Describe briefly how a vaccine that includes two of the proteins found on the surface of this bacterium can help prevent an individual developing symptoms of their disease again. 3 marks
- d. There has been a suggestion that the government legislate that all children be vaccinated. Discuss an issue which could be put forward as to why this is inappropriate. 1 mark

Total 6 marks

**Question 2.19**

Explain what is meant by the following terms.

- a. antigen 1 mark
  - b. antibody 1 mark
  - c. lymphocyte 1 mark
  - d. B plasma cell 1 mark
  - e. interferon 1 mark
- Total 5 marks

**Question 2.20**

Our immune system protects us from invasion by disease-causing organisms. It is often divided into two specific and non-specific defences.

The respiratory and digestive systems, as well as our skin, are all involved with providing a non-specific form of defence against disease by providing a physical or chemical barrier to invading organisms.

Describe and explain two non-specific barriers involved in these systems.

- a. What kind of cells provide a second line of defence if these mechanical and chemical barriers have not been effective? 2 marks
- b. What is 'immunity' and how is it acquired naturally? 1 mark
- c. How can long-term immunity be acquired artificially? Explain your answer. 2 marks
- d. What is 'passive immunity' and when is it more useful in curing a disease than the method in d. above? 1 mark

Total 8 marks

**Question 2.21**

- a. Complete the following table.

| Cell type     | Function                                           |
|---------------|----------------------------------------------------|
| B cell        |                                                    |
| B memory cell |                                                    |
|               | activate B cells and T <sub>C</sub> cells          |
|               | stimulated by antigen, rapidly produces antibodies |
|               | destroys eukaryotic cells                          |
| macrophage    |                                                    |

6 marks

- b. Draw and describe an antibody.

3 marks

- c. For the following pathogens, complete the table.

| Pathogen | Example of disease | Distinguishing feature | Treatment |
|----------|--------------------|------------------------|-----------|
| prion    |                    |                        |           |
| fungus   |                    |                        |           |
| virus    |                    |                        |           |
| bacteria |                    |                        |           |

12 marks

Total 21 marks