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Surname

Other names

Pearson Edexcel
International
Advanced Level

Centre Number

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Candidate Number

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Biology

Advanced

Unit 5: Energy, Exercise and Coordination

Wednesday 20 January 2016 – Afternoon

Time: 1 hour 45 minutes

Paper Reference

WBI05/01

You must have:

A copy of the scientific article (enclosed), Calculator, Ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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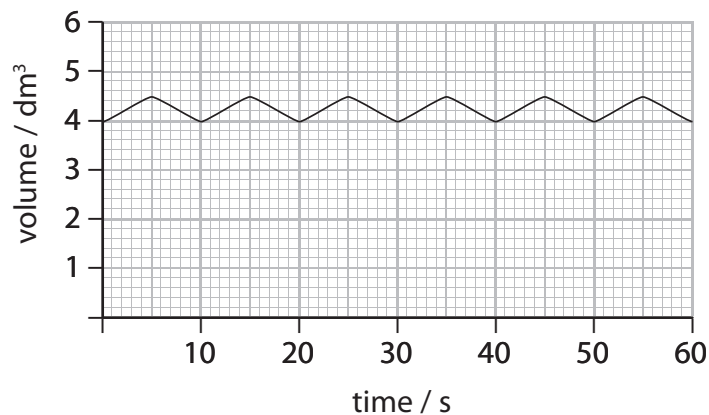
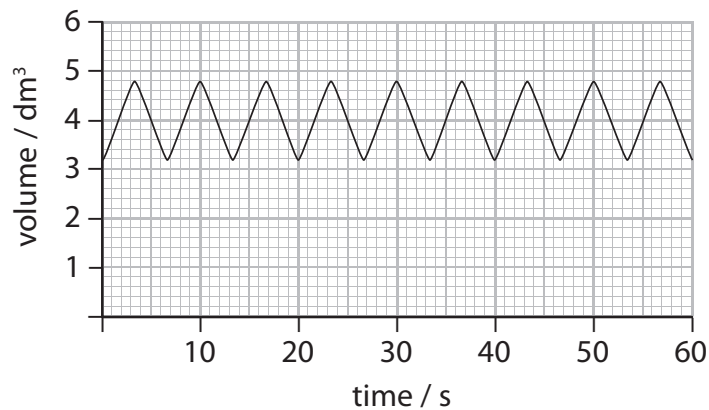
Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 Asthma occurs when the airways in the lungs become narrowed, which makes breathing difficult.

It is thought that the caffeine contained in coffee might help people with asthma by increasing their breathing rate.

- (a) The traces below show the breathing rate of a resting person before and after drinking coffee.

Before drinking coffee**After drinking coffee**

- (i) Place a cross in the box ☒ next to the apparatus used to obtain these traces.

(1)

- A a peak flow meter
- B an ECG
- C a respirometer
- D a spirometer



(ii) Place a cross in the box next to the tidal volume before drinking coffee.

(1)

- A 0.5 dm³
- B 1.0 dm³
- C 6.0 dm³
- D 12.0 dm³

(iii) Place a cross in the box next to the difference in breathing rate before and after drinking coffee.

(1)

- A 3 breaths min⁻¹
- B 6 breaths min⁻¹
- C 12 breaths min⁻¹
- D 15 breaths min⁻¹

(iv) The traces suggest that caffeine affects the sensitivity of the brain to carbon dioxide.

Place a cross in the box next to the statement that describes this sensitivity.

(1)

- A hypothalamus less sensitive to carbon dioxide
- B hypothalamus more sensitive to carbon dioxide
- C ventilation centre less sensitive to carbon dioxide
- D ventilation centre more sensitive to carbon dioxide

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(b) The formula below shows Fick's law.

$$\text{rate of diffusion} = \frac{\text{area of diffusion surface} \times \text{difference in concentration}}{\text{thickness of surface over which diffusion takes place}}$$

Use the information in the formula to explain how the rate of diffusion is affected by asthma.

(2)

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(c) Suggest how drinking hot coffee can cause a change in the production of sweat.

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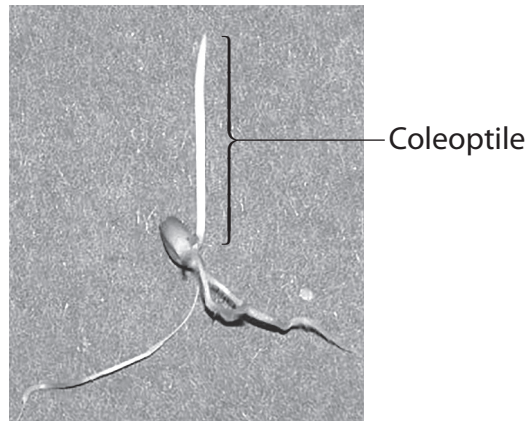
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- 2 The young shoot of a germinating wheat grain is enclosed in a structure called a coleoptile.

Scientists use coleoptiles to investigate the role of IAA (auxin) in the growth responses of plants to light.

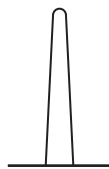
The photograph below shows a germinating wheat grain.



Magnification $\times 1$

In one investigation, a coleoptile was exposed to light from one direction. The diagram below shows the appearance of the coleoptile before and after exposure to light from one direction.

Before exposure



After exposure



- (a) Place a cross in the box next to the correct description of the response of this coleoptile after exposure to light from one direction.

(1)

- A** negative phototropism to light shining from the left
- B** negative phototropism to light shining from the right
- C** positive phototropism to light shining from the left
- D** positive phototropism to light shining from the right



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(b) The response of the coleoptile occurs because IAA (auxin) binds to membrane receptors. This promotes the active transport of hydrogen ions out of the cell cytoplasm.

(i) Explain what is meant by the term **active transport**.

(2)

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(ii) Hydrogen ions provide the optimum pH for enzymes that break the bonds between adjacent cellulose microfibrils.

Name the bonds that are broken by these enzymes.

(1)

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(iii) Suggest what happens to cells in the coleoptile, after the breaking of these bonds, that allows the response to light from one direction.

(2)

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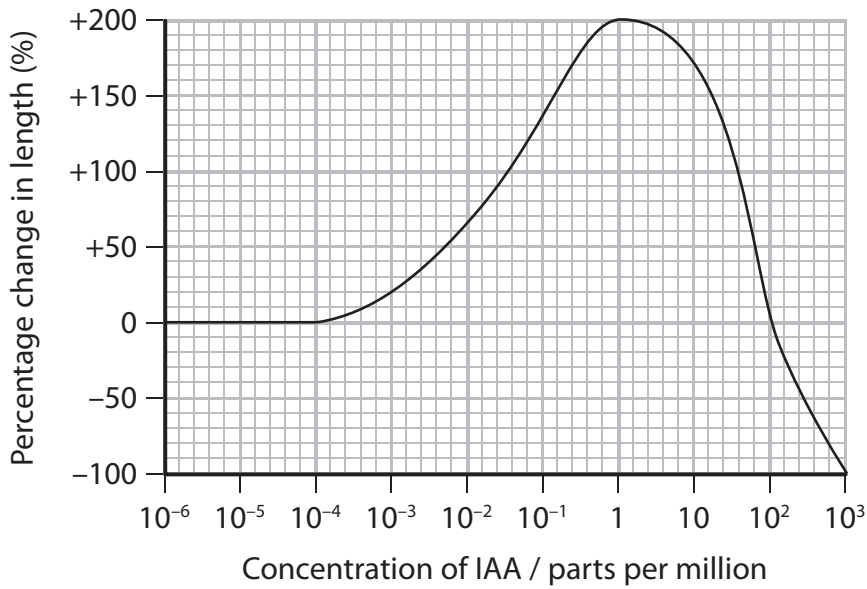
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(c) Scientists also investigated the effect of IAA concentration on the elongation of coleoptiles.

Coleoptile sections of the same length were placed in Petri dishes containing IAA solutions of different concentrations. The change in length was measured.

The graph below shows the percentage change in length when compared to control coleoptile sections placed in water.



(i) Use the information in the graph to describe the effect of IAA concentration on the elongation of coleoptiles.

(3)

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- (ii) The method used by the scientists made sure that a valid comparison could be made from the data collected.

Suggest a method the scientists could use to make a valid comparison of the elongation of coleoptiles at each IAA concentration.

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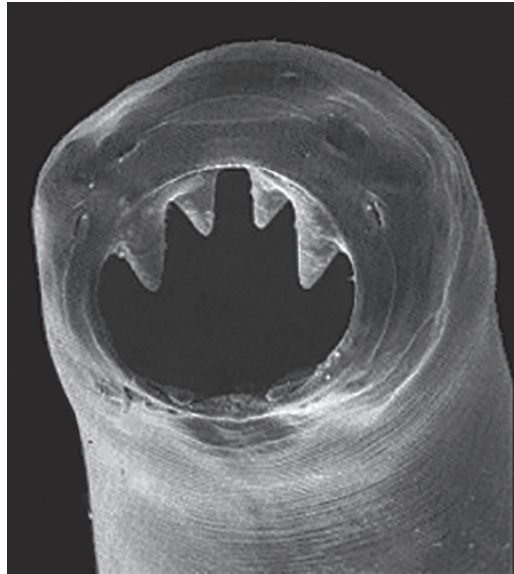
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(Total for Question 2 = 13 marks)



3 Parasitic worms are a major cause of disease and disability worldwide.

The photograph below shows the head of a hookworm, *Ancylostoma duodenale*. This is a parasite of the human gut.



© Washington University School of Medicine

Magnification $\times 100$

Drugs can be used to treat people with gut parasites. These drugs are often highly toxic. Parasites resistant to these drugs have evolved.

(a) Place a cross in the box next to the statement that explains how parasites resistant to these drugs have evolved.

(1)

- A** drugs affect selection of mutations in parasites
- B** good hospital hygiene
- C** mutations in the human gut cells
- D** parasites reproduce rapidly

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(b) An alternative to these drugs could be a protein called Cry5B, normally produced by the bacterium *Bacillus thuringiensis*. Cry5B has been shown to kill parasitic worms in animals. It works by forming protein channels in cell membranes.

In the space below, draw a diagram of a fluid mosaic model of the cell membrane that includes a labelled protein channel.

(2)

(c) Scientists have developed genetically modified (GM) bacteria, *Bacillus subtilis*, containing the gene for Cry5B.

In an investigation, hamsters were infected with hookworms. The hamsters were then given the GM bacteria in their food.

The investigation showed that Cry5B protein released by the GM bacteria reduced the number of hookworms in hamsters by 93%.

(i) Suggest a suitable control for this investigation.

(2)

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(ii) Describe the steps taken by the scientists to enable them to calculate a 93% reduction in the number of hookworms.

(2)

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(d) GM bacteria would have to undergo clinical trials before they could be used to treat hookworm infections in humans.

Suggest **two** reasons why these trials are needed.

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(Total for Question 3 = 9 marks)

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4 Aerobic respiration and anaerobic respiration produce ATP in cells.

(a) It is thought that 38 ATP molecules are produced from one molecule of glucose in aerobic respiration.

Place a cross in the box next to the description of where most of these ATP molecules are produced.

(1)

- A glycolysis in the cytoplasm
- B glycolysis in the mitochondria
- C oxidative phosphorylation in the cytoplasm
- D oxidative phosphorylation in the mitochondria

(b) During anaerobic respiration lactate is produced.

The table below shows the lactate concentration in the blood of a person who is an athlete and in a person who is not an athlete (non-athlete), at increasing levels of exercise.

Level of exercise / arbitrary units	Blood lactate concentration / mmol dm ⁻³	
	Athlete	Non-athlete
0	1.0	1.5
60	1.1	2.2
120	1.4	3.7
180	3.2	6.2
240	6.4	10.0



(i) Explain the change in blood lactate concentration with an increasing level of exercise in the non-athlete.

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(ii) Suggest an explanation for the difference between the blood lactate concentration of the athlete and the non-athlete.

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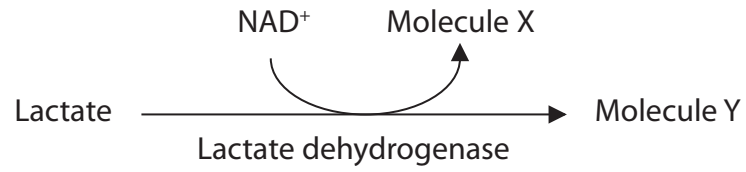
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(c) The diagram below shows the fate of lactate after exercise.



(i) Name molecule X. (1)

(ii) Describe what happens to molecule Y. (2)

(Total for Question 4 = 9 marks)

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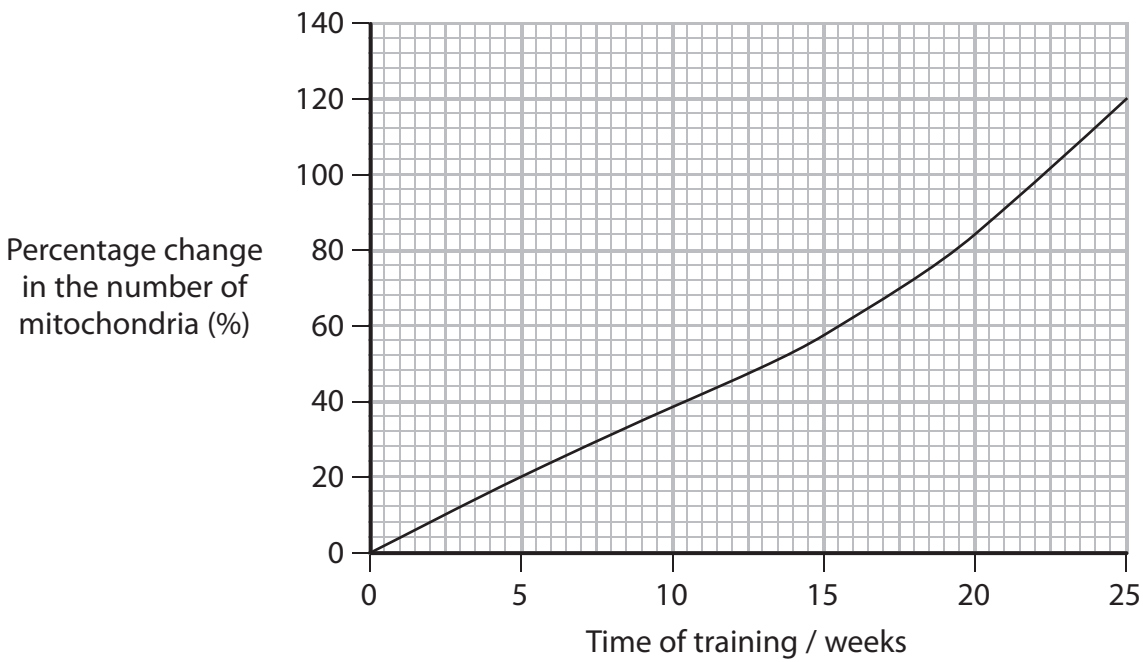
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5 Endurance training changes the number and size of mitochondria in muscle tissue.

The graph below shows the percentage change in the number of mitochondria found in muscle tissue during 25 weeks of endurance training.



(a) Use the graph to describe the changes in the number of mitochondria in muscle tissue during this 25 week training period.

(2)

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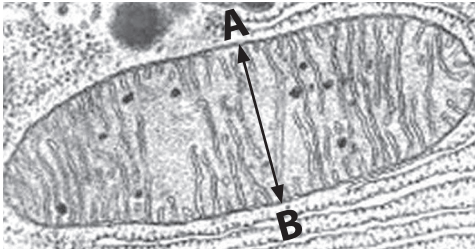
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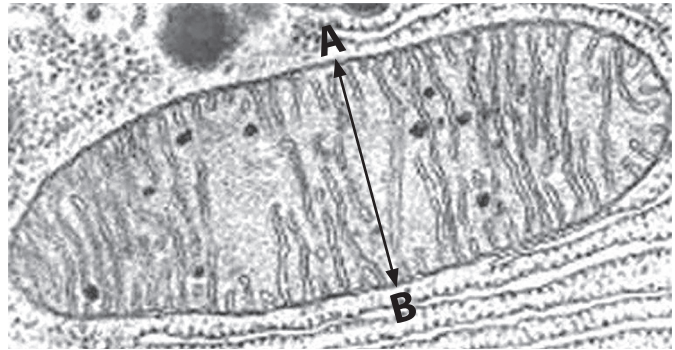


(b) The electron micrographs below show a typical mitochondrion in muscle before and after training.

Before training



After training



Magnification $\times 10000$

(i) The width of each mitochondrion is shown by the line A to B.

Calculate the percentage change in the width of the mitochondrion after training. Show your working.

(2)

Answer %

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*(ii) An increase in the width of mitochondria increases the surface area of membranes inside mitochondria.

Explain how an increase in the surface area of these membranes will affect the synthesis of ATP in the muscle tissue of an athlete.

(6)

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(Total for Question 5 = 10 marks)



6 The anterior cruciate ligament helps to keep the knee joint stable.

(a) (i) Place a cross in the box next to the name of the structure to which the anterior cruciate ligament is attached.

(1)

- A bone
- B cartilage
- C muscle
- D tendon

(ii) Place a cross in the box next to the statement that explains why ligaments are effective at keeping the knee joint stable.

(1)

- A they contain collagen making them elastic
- B they contain collagen making them inelastic
- C they contain myosin making them elastic
- D they contain myosin making them inelastic

(b) Each year in the UK there are about 30 anterior cruciate ligament injuries for every 100 000 people.

Assuming the population in the UK is 65 000 000, calculate the number of anterior cruciate ligament injuries per year.

Show your working.

(2)

Answer

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- (c) A surgeon can use keyhole surgery when repairing a torn cruciate ligament. The torn ligament is repaired by grafting (attaching) new tissue.

The repair often uses tissue from the patient (autograft) or from a donor (allograft).

The table below shows the failure rate of each type of repair carried out by one surgeon.

Type of graft	Failure rate (%)
Autograft	0.7
Allograft	9.7

- (i) Using the information in the table, compare the failure rates of these types of graft. Suggest explanations for the difference.

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(ii) Suggest what additional information would be needed to increase the confidence in a conclusion drawn from these results.

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(iii) Give **two** advantages of using keyhole surgery to repair torn ligaments compared with other types of surgery.

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(Total for Question 6 = 11 marks)

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7 The scientific article you have studied has been adapted from the Scientific American and New Scientist magazines.

Use the information from these articles and your own knowledge to answer the following questions.

(a) Explain how an imbalance in the level of neurotransmitter could contribute to depression (paragraph 2).

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(b) The article describes how a variety of different types of rhodopsin in bacteria are sensitive to light (paragraph 4).

Explain the role of rhodopsin in reducing the permeability of the membrane of a mammalian rod cell.

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(c) Transcranial magnetic stimulation (TMS) (paragraph 10) is a non-invasive method that generates weak electric currents.

Suggest how these weak electric currents could affect neurones in the brain.

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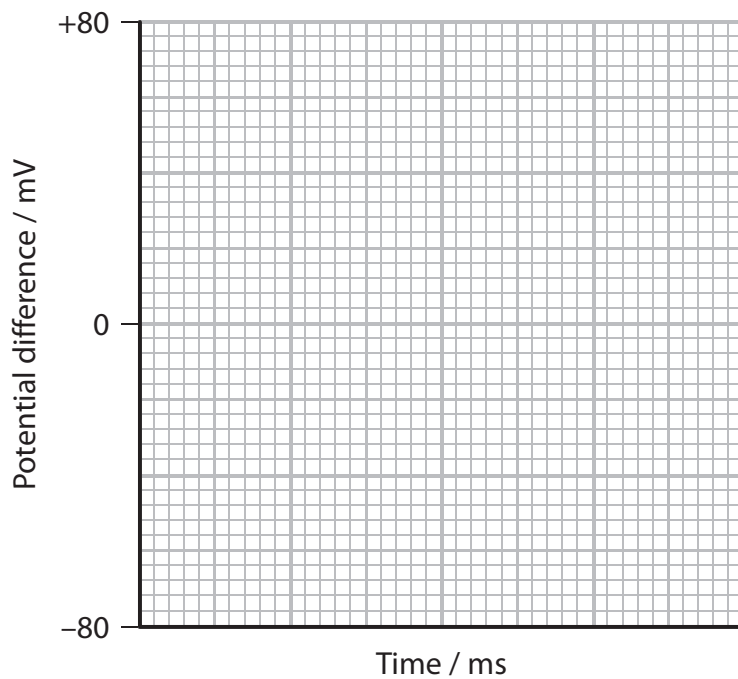
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(d) The experiments enabled scientists to see the 'firing' of an action potential in a neurone (paragraph 17).

On the grid below, draw an action potential for a neurone in a human.

(2)



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(e) Epinephrine is a hormone that acts as a signalling molecule that affects the activity of cells (paragraph 21).

Epinephrine acts in the same way as peptide hormones that affect the activity of cells.

Explain how epinephrine would stimulate a cell to produce proteins.

(3)

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(f) The article states that 'the firing of local excitatory neurons is fully sufficient to trigger the complex signals detected by fMRI scanners' (paragraph 24).

Explain how an increase in the activity of neurones could produce the signals detected by an fMRI scanner.

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(g) Suggest how optogenetics could be used to change the behaviour of the depressed woman so she would enjoy seeing her grandchildren (paragraphs 10 and 25).

(2)

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(h) Suggest how deep-brain stimulation could help someone with Parkinson's disease (paragraph 26).

(2)

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* (i) Explain why the electrical stimulation of muscles leads to people becoming exhausted (paragraph 36).

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(j) Suggest how scientists engineered neurones to manufacture an ion channel protein sensitive to changes in temperature (paragraph 38).

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(Total for Question 7 = 30 marks)

TOTAL FOR PAPER = 90 MARKS



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