PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



EXAM QUESTION PACK

UNIT 5: COORDINATION, RESPONSE AND GENE TECHNOLOGY

SCORE	PERCENTAGE
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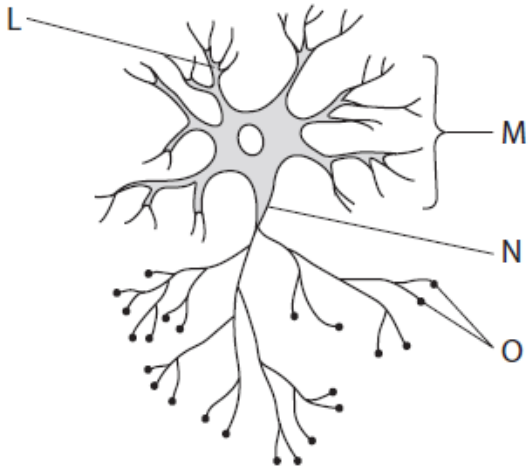
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Q1.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows a relay neurone.



(a) (i) Complete the table by filling in the names of each labelled part.

(2)

Label	Part
L	
M	
N	
O	

(ii) Lidocaine is a drug that is used as a local anaesthetic.

Lidocaine works by

(1)

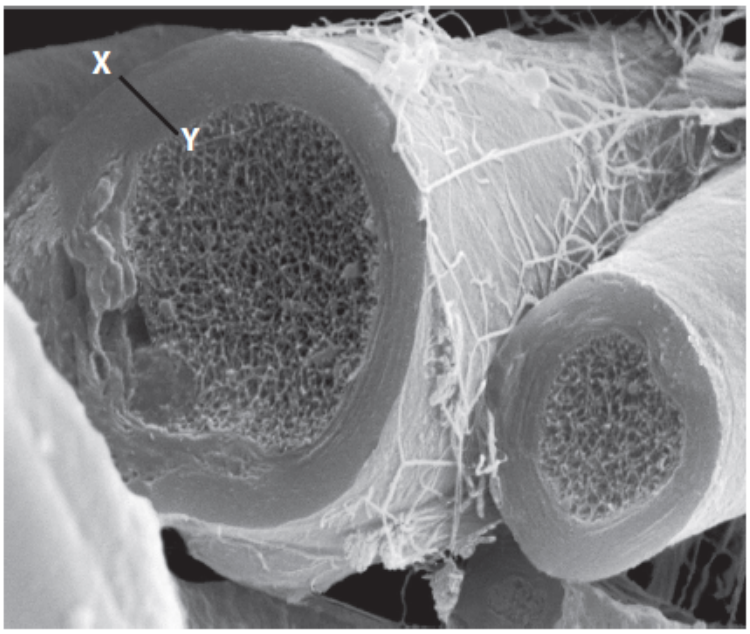
☒ **A** blocking the binding of acetylcholine to its receptor

☒ **B** blocking the release of acetylcholine

☒ **C** inhibiting potassium ion channels

☒ **D** inhibiting sodium ion channels

(b) The photograph shows a nerve with an outer layer of connective tissue.



(Source: © Science Photo Library/Alamy Stock Photo)

Magnification × 3300

(i) State the type of microscope used to produce this image.

(1)

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(ii) Calculate the thickness of the connective tissue layer between the points X and Y.

Give your answer in micrometres (µm).

(2)

Answer ..... µm

(iii) The nerve shown in the photograph contains many myelinated neurones.

Explain why a myelinated neurone conducts an impulse faster than a non-myelinated neurone of the same diameter.

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(Total for question = 9 marks)

Q2.

Alpha-1 antitrypsin (AAT) deficiency is an inherited disease that can affect different organ systems.

Alpha-1 antitrypsin (AAT) is a protein produced in the liver.

(a) Investigation of the breathing of a patient with AAT deficiency found that the:

- resting tidal volume (V_T) was 500 cm^3
- dead space (DS) was 150 cm^3
- resting respiratory rate (RR) was 12 breaths per minute.

Calculate the volume of air that enters the alveoli (A_V) **each hour**.

$$A_V = (V_T - DS) \times RR$$

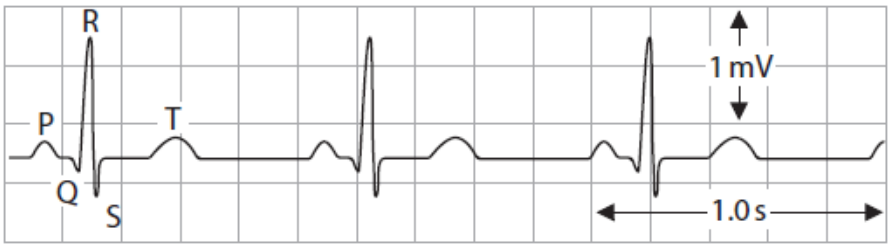
Give your answer to 2 significant figures with appropriate units.

(3)

Answer .....

(b) Activity of the heart was investigated in the same patient.

The trace shows a normal electrocardiogram (ECG).

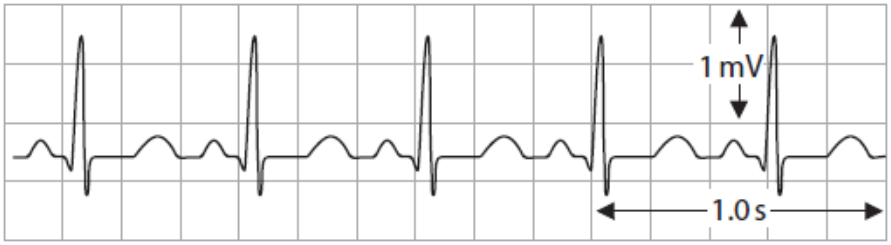


(i) Name the stage of the cardiac cycle at T on this ECG.

(1)

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(ii) The ECG of the patient with AAT is shown in the trace.



Calculate the mean heart rate shown in this ECG trace.

(1)

Answer .....

(iii) Compare and contrast the ECG trace of this patient with the normal ECG trace.

(3)

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(c) One potential treatment for AAT deficiency uses adenoviruses to genetically modify cells in an affected person.

Adenoviruses contain double-stranded DNA.

Explain how adenoviruses can be used to treat AAT deficiency in a person.

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(Total for question = 12 marks)

Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Animals and plants can detect and respond to light.

(a) Rod cells respond to light by producing action potentials in the optic nerve.

(i) In which structure are rod cells located?

(1)

☒ **A** iris

☒ **B** pupil

☒ **C** retina

☒ **D** spinal cord

(ii) Describe the role of rhodopsin in rod cells.

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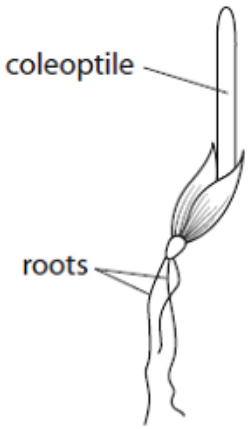
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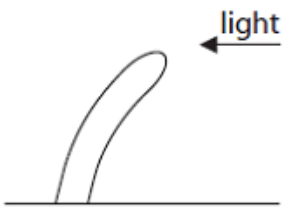
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*(b) The drawing shows the results of some experiments investigating phototropisms.

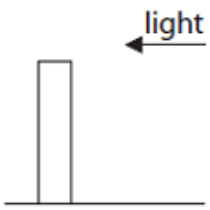
The diagram shows a coleoptile of a seedling.



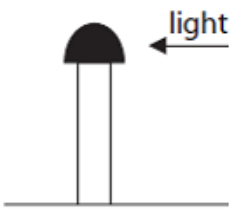
Experiment 1:



intact coleoptile illuminated from one side

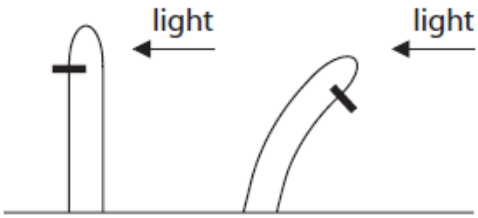


tip of coleoptile removed and remaining coleoptile illuminated from one side



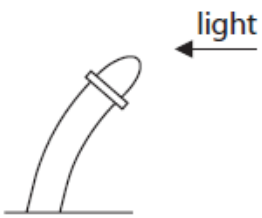
black cap placed on tip of coleoptile and coleoptile illuminated from one side

Experiment 2a:



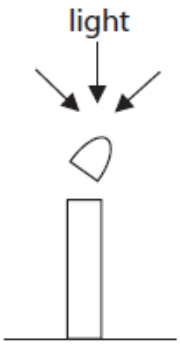
plastic sheet inserted below the tip of the coleoptile and the coleoptile illuminated from one side

Experiment 2b:



gel layer placed below the tip of the coleoptile and the coleoptile illuminated from one side

Experiment 3:



coleoptile illuminated and the tip removed



tip replaced on one side of the remaining coleoptile that is then kept in the dark

Scientists concluded that these results suggest a plant growth substance is involved in regulating the phototropic response.

Discuss how the results of these experiments support the role of a plant growth substance in the phototropic response of plants.

Use the information for these experiments and your own knowledge to support your answer.

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(Total for question = 10 marks)

Q4.

Animals and plants can respond to light.

(a) The photograph shows the front of a human eye.



(Source: © SCIENCE PHOTO LIBRARY)

(i) The size of the pupil changes when moving from dim to very bright light.

Explain how this change occurs.

(3)

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(ii) Describe the role of rhodopsin in causing changes in the polarisation of rod cells.

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*(b) Exposure to light controls the germination of seeds and the direction of growth of plants.

In an investigation the seeds of plantains were exposed to light.

The seeds were first exposed to red light and then to far-red light.

The percentage of seeds that germinated when exposed to different periods of red and far-red light was recorded.

The results are shown in the table.

Exposure to red light / min	Percentage germination (%)						
	Exposure to far-red light /seconds						
	1	5	10	15	30	60	960
32	100	20	14	6	4	6	10
16	92	30	40	28	30	33	20
8	100	62	50	57	44	47	56
4	100	67	60	57	40	37	92

Comment on the effect of red and far-red light on the germination of these seeds and the processes that occur in their cells.

Use the information in the table to support your answer.

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(Total for question = 13 marks)

Q5.

Parkinson's disease is caused by a loss of neurones in part of the brain called the substantia nigra.

Co-beneldopa is used to treat Parkinson's disease.

Co-beneldopa is a mixture of L-dopa and a drug that prevents the conversion of L-dopa into dopamine in the blood.

(a) Explain why using Co-beneldopa will be more effective than using L-dopa alone to treat Parkinson's disease.

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(b) In an investigation, tomato plants were genetically modified to convert the amino acid tyrosine into L-dopa.

Three genes were used in this investigation:

- a control gene that is not involved in the production of L-dopa
- MYB12, a plant gene that produces a transcription factor
- CYP76, a gene found in beetroot that codes for an enzyme that converts tyrosine into L-dopa.

The table shows the concentration of L-dopa in the tomato fruit from genetically modified plants.

Genes used to modify the tomato plants	Concentration of L-dopa in the tomato fruit / mg 100 g^{-1}
none	1.2
control gene	1.2
MYB12	1.5
CYP76	10.2
CYP76 and MYB12	14.6

(i) Explain the effects of these three genes in this investigation.

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(ii) Describe how tomato plants could be genetically modified to make the enzyme that converts tyrosine to L-dopa.

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(Total for question = 10 marks)

Q6.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

(a) The body length of the medicinal leech decreases when touched.



(Source: © Mit Kapevski/Shutterstock)

The body length of the leech decreases less each time the leech is touched.

(i) What is the name of this effect?

(1)

☒ **A** absorption

☒ **B** adaptation

☒ **C** habituation

☒ **D** sensitivity

(ii) Why is it an advantage for the leech to respond in this way?

(1)

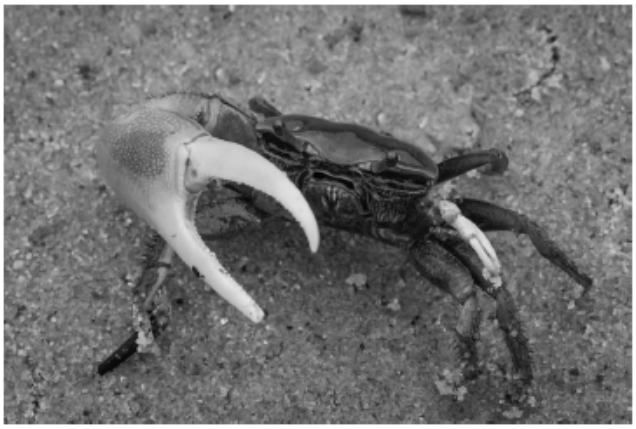
☒ **A** it filters out what is important and what is not important to react to

☒ **B** it enables the animal to react more quickly to the stimulus

☒ **C** it keeps the habitat of the animal protected

☒ **D** it helps the animal find food more easily

(b) The photograph shows a fiddler crab.



(Source: © Jay Gao/Shutterstock)

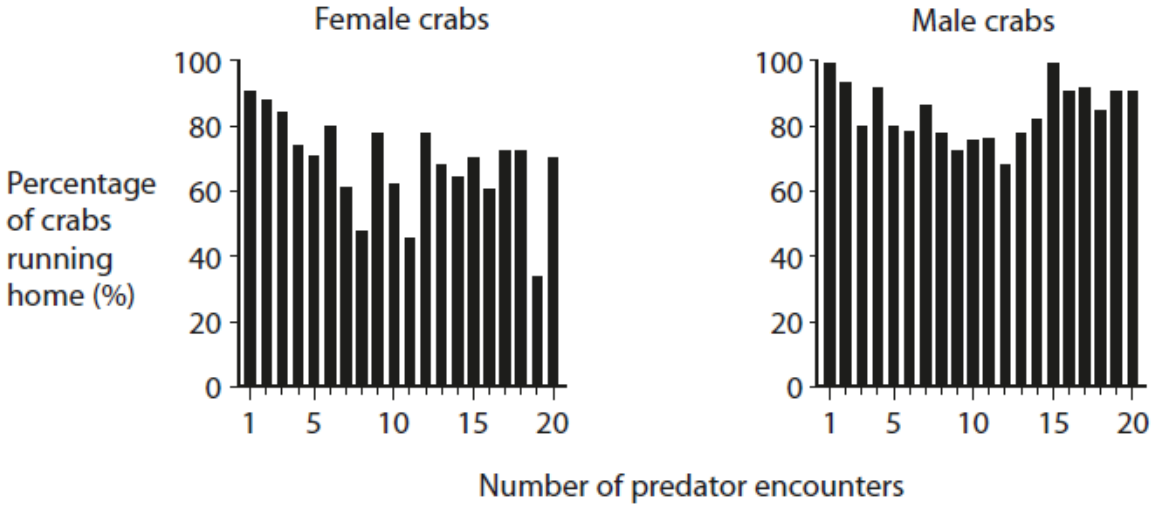
In an experiment, the fiddler crab was used to investigate responses to a predator. The responses by females and males were compared.

A predator approached a group of female crabs from one direction.

The percentage of crabs running home was recorded. This was repeated 20 times.

This experiment was repeated with a group of male crabs.

The graphs show the percentage of crabs running home for both groups of crabs against the total number of times each group of crabs encountered a predator.



(i) Comment on the results of this experiment.

(3)

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(ii) Which statistical test would be used to analyse the effect of the increase in the number of predator encounters on the percentage of crabs running home?

(1)

☒ **A** correlation coefficient

☒ **B** Hardy-Weinberg

☒ **C** index of diversity

☒ **D** Student's t-test

(Total for question = 6 marks)

Q7.

Many neurones in the human nervous system are myelinated.

(a) A myelinated axon conducts impulses faster than a non-myelinated axon of the same diameter.

Explain this difference.

(3)

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(b) Polyneuropathy is a disorder that damages the myelin sheath of neurones throughout the body.

One symptom is muscle weakness. Muscle weakness is the reduced strength in one or more muscles.

Suggest how damage to the myelin sheaths of neurones can lead to muscle weakness.

(2)

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(c) Dementia is a condition associated with the ongoing decline of brain functioning. There are many types of dementia.

The relationship between myelin in brain tissue and types of dementia has been investigated.

The mean quantity of myelin in samples of brain tissue from groups of people with types of dementia and from a control group was measured.

The table shows the results of this investigation.

Group	Mean quantity of myelin in a brain tissue sample / a.u.	Standard deviation
Control (no dementia)	52	± 3.2
Patients with vascular dementia	25	± 5.9
Patients with Alzheimer's dementia	32	± 4.1
Patients with Lewy Body dementia	42	± 5.0

A student concluded that there was a relationship between the quantity of myelin in the brain of a person and whether or not they had dementia.

Comment on the validity of this conclusion.

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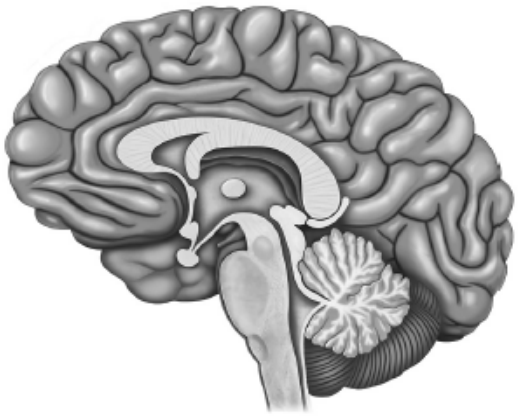
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(Total for question = 7 marks)

Q8.

The brain is made up of more than 1×10^{11} neurones.

(a) The diagram shows a section through the human brain.



(Source: © ilusmedical/Shutterstock)

Label the diagram to show the location of the following:

- pituitary gland
- medulla oblongata
- cerebral hemisphere (cerebrum)

(3)

(b) Complete the table to show the parts of the brain and their functions.

(2)

Part of the brain	Function
cerebellum	
	control of heart rate
cerebral hemisphere (cerebrum)	

(Total for question = 5 marks)

Q9.

The scientific document you have studied is adapted from articles in *StatPearls: Anatomy, Autonomic Nervous System, British Journal of Cardiology: Postural Orthostatic Tachycardia Syndrome (POTS) and Cellular and Molecular Life Sciences: The enteric nervous system in gastrointestinal disease etiology*.

Use the information from the scientific document and your own knowledge to answer the following questions.

(a) The autonomic nervous system regulates aspects of respiration (paragraph 1).

Describe how the autonomic nervous system regulates the breathing rate when a person is resting.

(4)

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(b) Explain how neurones can respond to different neurotransmitter substances (paragraph 4).

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(c) Suggest how the activity of the sympathetic nervous system in immune organs could

regulate
inflammation (paragraph 7).

(2)

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(d) Explain how an electrocardiogram could be used to show that a person has postural orthostatic tachycardia syndrome (POTS) (Box 1).

(2)

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(e) Explain how reflex circuits in the gut cause a bolus to move (paragraphs 10 and 11).

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(f) State what is meant by the term ischemia (paragraph 12).

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(g) Suggest why embryological ENS cells may fail to colonise the bowel in a developing embryo (paragraph 13).

(1)

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(h) Explain how the interaction of microbial and other factors could result in gastrointestinal inflammation such as IBD (Box 2).

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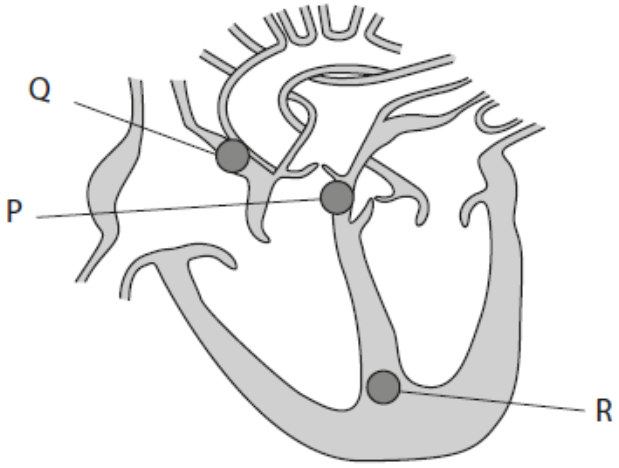
(Total for question = 20 marks)

Q10.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

In humans the sinoatrial node, atrioventricular node and bundle of His are involved in regulation and coordination of the cardiac cycle.

(a) The diagram shows a human heart.



(i) Which **one** of the following statements is correct?

(1)

☒ **A** Q is the sinoatrial node (SAN) and R is the atrioventricular node (AVN)

☒ **B** Q is the sinoatrial node (SAN) and P is the atrioventricular node (AVN)

☒ **C** Q is the bundle of His and R is the sinoatrial node (SAN)

☒ **D** R is the sinoatrial node (SAN) and P is the Purkinje fibres

(ii) The electrical impulse that initiates the cardiac cycle begins without the need for a nerve impulse.

What is the term for this process?

(1)

☒ **A** diastole

☒ **B** myogenic

☒ **C** polarisation

☒ **D** systole

(b) A football player undertook regular exercise as part of a training programme.

During exercise there is a change in the duration of the cardiac cycle.

(i) Explain why there is a change in the cardiac cycle during this exercise.

(3)

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(ii) The table shows the effect of the training programme on the cardiac output and resting heart rate of this football player.

When measurements were made	Cardiac output / $cm^3 min^{-1}$	Resting heart rate / bpm
Before training	4500	72
After training	4500	51

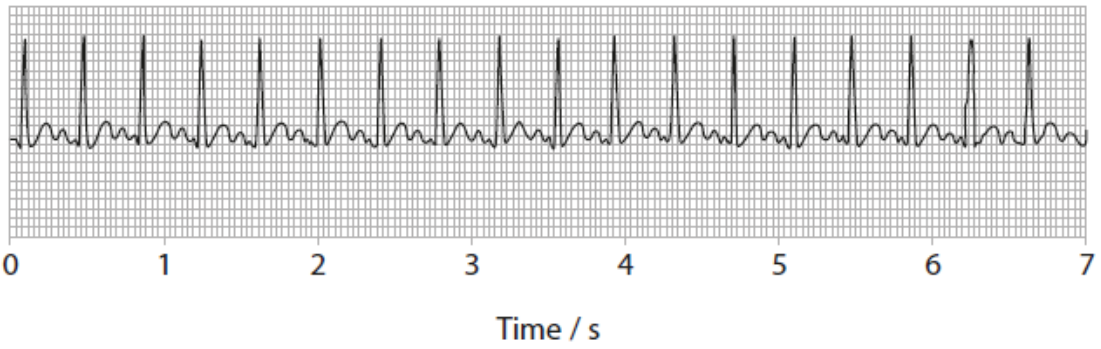
Calculate the stroke volume of this football player, after training.

(1)

Answer ..... cm^3

(iii) After training, the footballer had an ECG.

This ECG trace is shown in the diagram.

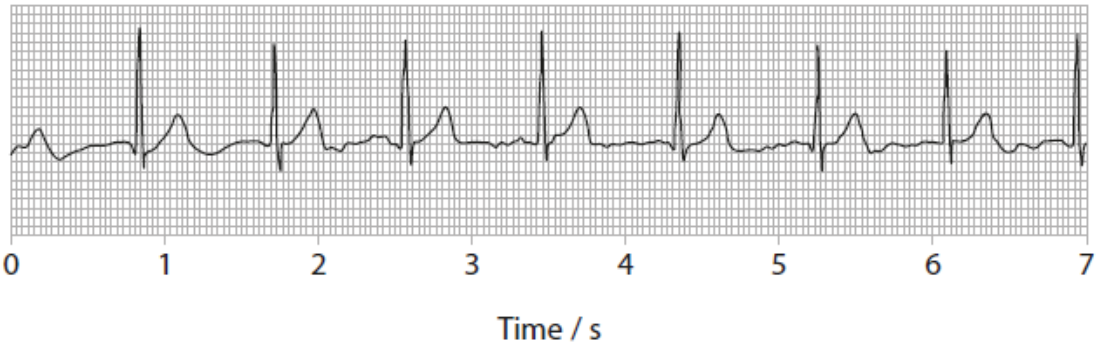


Calculate the heart rate of the footballer using the ECG in this diagram.

(1)

Answer .....

(iv) Two hours later a second ECG was recorded.



Comment on the changes that have occurred in the activity of the heart as shown in these two ECG traces.

(3)

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(Total for question = 10 marks)

Q11.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The nervous system enables an organism to respond to environmental stimuli.

(a) Several types of neurone are found in the nervous system.

(i) Which term describes the space between a sensory neurone and a relay neurone?

(1)

☒ **A** axon

☒ **B** cell body

☒ **C** postsynaptic membrane

☒ **D** synaptic cleft

(ii) Compare and contrast the function of a sensory neurone and a motor neurone.

(3)

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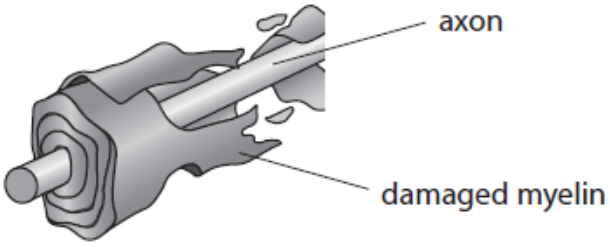
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(b) Guillain-Barré syndrome is a disorder of the nervous system.

The immune system damages the myelin sheath surrounding the axons of individuals with Guillain-Barré syndrome.



Symptoms of this disorder include:

- inability to maintain steadiness when walking
- inability to feel any sensations in the limbs
- loss of reflexes such as knee jerk.

Suggest why a person with Guillain-Barré syndrome will suffer from the symptoms of this condition.

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(c) Mutations in the genes coding for voltage-gated calcium ion channels have been linked to neurological conditions.

Explain how these mutations might cause these neurological conditions.

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(Total for question = 11 marks)

Q12.

A number of insects can transmit disease when they bite their hosts.

The photograph shows *Rhodnius prolixus*, a blood-sucking insect that transmits Chagas disease between humans.

This insect feeds on blood by extending its proboscis and pushing it through the skin of a person. It is thought to do this when it detects body warmth.



© Oxford Scientific/Getty Images

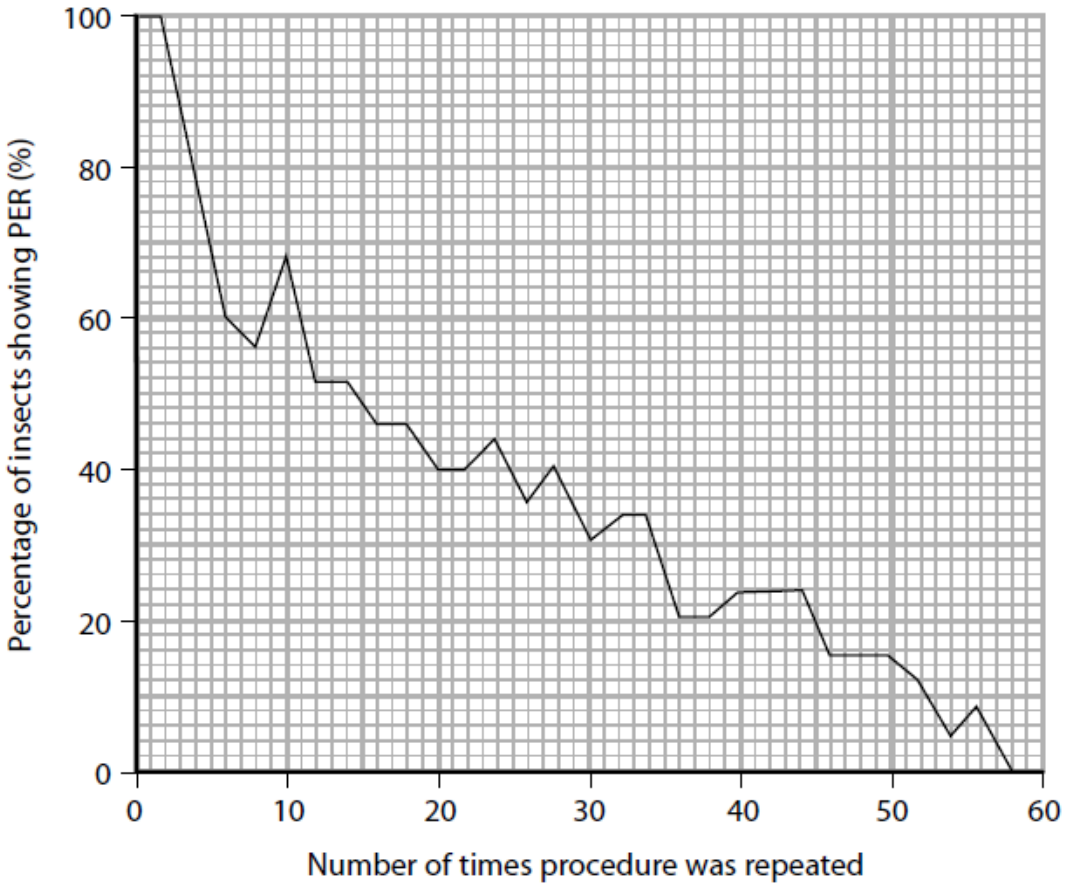
An investigation was carried out to study the effect of a heat stimulus on the proboscis extension response (PER).

Insects were kept in a temperature-controlled container with a heat pad placed in front of them. The heat pad could be touched by the proboscis when fully extended.

The heat pad was initially set at 25 °C. It was then heated up to 35 °C and the number of insects with a fully-extended proboscis were counted. It was then returned to a temperature of 25 °C.

This procedure was repeated a number of times.

The graph shows the results of this investigation.



(a) In this investigation, 350 insects were used.

Calculate the mean decrease in the number of insects showing PER each time the procedure was repeated.

(3)

Answer .....

(b) Explain the results of this investigation.

(3)

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(c) Suggest why a drop in PER to a heat stimulus could be an advantage to these insects.

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(Total for question = 8 marks)

Q13.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Plants respond to external stimuli.

(a) Phytochrome molecules are found in plants.

Phytochrome exists in two forms, Pr (P_{660}) and Pfr (P_{730}).

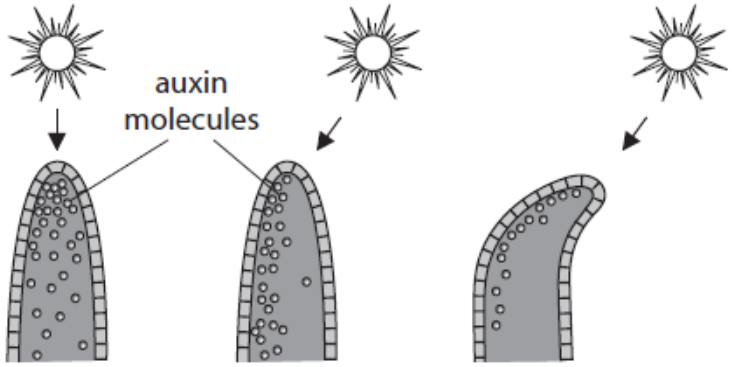
Which row shows the action of these two forms of phytochrome?

(1)

		Absorbs far red light	Breaks down in the dark
☒	**A**	Pfr	Pfr
☒	**B**	Pfr	Pr
☒	**C**	Pr	Pfr
☒	**D**	Pr	Pr

(b) Auxins (IAA) are plant growth substances.

The diagram shows auxin molecules producing a phototropic response in a shoot.



Explain the role of auxins in this phototropic response.

Use the information in the diagram to support your answer.

(3)

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(c) Seeds contain starch. This starch is used to supply energy when the seed germinates.

Gibberellins are a group of naturally occurring plant growth substances.

Gibberellins regulate starch hydrolysis in the seed.

Explain how gibberellins can produce this effect on the seed.

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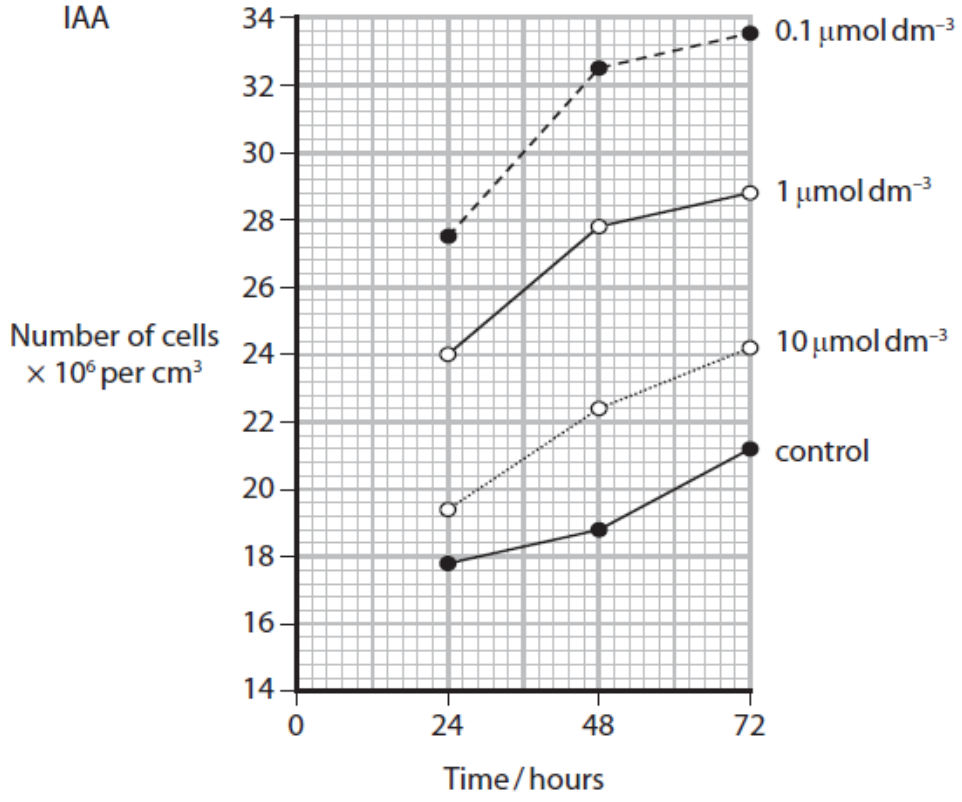
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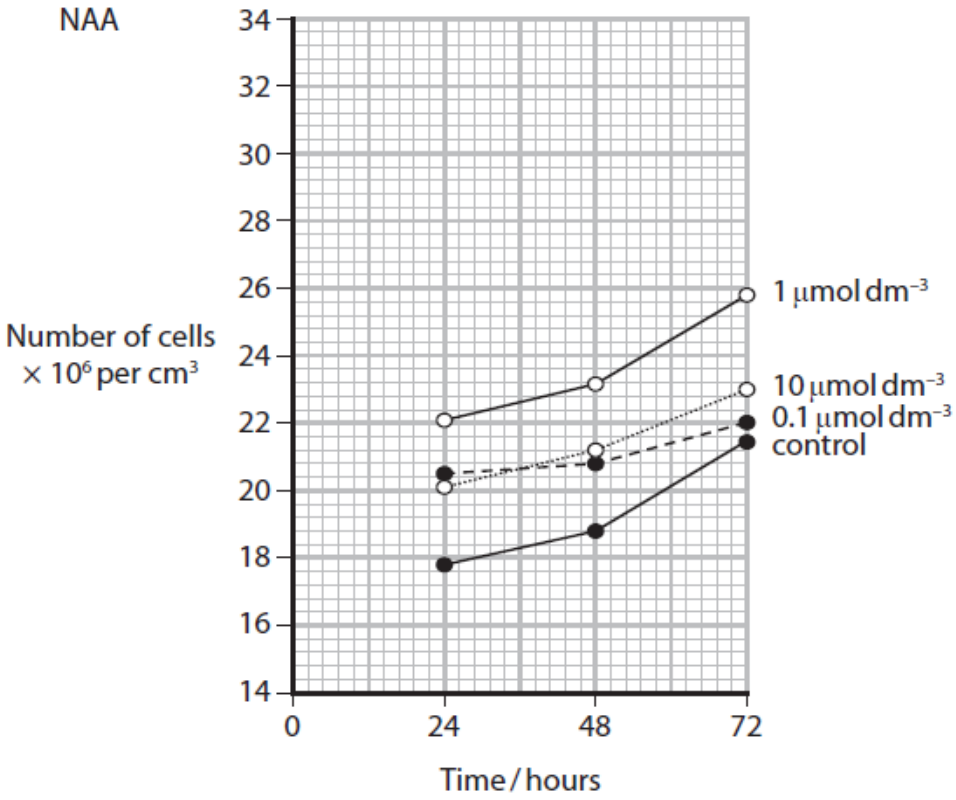
(d) Indole acetic acid (IAA) is a natural plant auxin. 1-Naphthaleneacetic acid (NAA) is a synthetic auxin.

The effects of these two auxins on the growth of *Chlorella* was investigated.

Chlorella is a single-celled photosynthetic organism.

The graphs show the effect of different concentrations of the auxins on the growth of *Chlorella*.





Comment on the effect of these auxins on the growth of *Chlorella*.

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(Total for question = 12 marks)

Q14.

Vitamin A is an essential component of the human diet.

Rice is a staple food in parts of the world where a lot of people have vitamin A deficiency.

Rice contains no β-carotene or vitamin A.

Cells in the human intestine can convert β-carotene from the diet to vitamin A.

Some soil bacteria can produce large quantities of β-carotene.

(a) Describe how genetic engineering could be used to produce rice that contains β-carotene.

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(b) (i) Describe the possible risks of growing genetically modified rice plants.

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(ii) Suggest how one of these risks could be reduced.

(1)

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(Total for question = 8 marks)

Q15.

The scientific article you have studied is adapted from *Rethinking Alzheimer's* in *New Scientist* (February 2019).

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Memory and cognitive function are two processes that occur in the brain (paragraphs 2 and 13).

Different parts of the brain are responsible for specific functions.

Complete the table showing which parts of the brain are responsible for different functions.

(2)

Part of brain	Function
cerebellum	
	interpretation of information from the retina
medulla oblongata	
	secretion of ADH

(b) Some forms of dementia can be diagnosed using brain scans.

Compare and contrast the use of functional magnetic resonance imaging (fMRI) and computed tomography (CT) scans to identify structures like plaques in the brain (paragraph 6).

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(c) Suggest how the amyloid protein may prevent bacterial infection in the brain (paragraphs 7 and 22).

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(d) Explain how the bacterium *Porphyromonas gingivalis* that causes gum disease may invade the brain and cause inflammation in brain regions affected by Alzheimer's disease (paragraphs 10, 20 and 21).

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(e) Suggest how gingipains may have a degrading effect on the memory of a person suffering from Alzheimer's disease (paragraph 12).

(3)

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(f) The team found genetic material from *P. gingivalis* in the cerebral cortex (paragraph 13).

Describe how the team could show that this genetic material is active.

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(Total for question = 20 marks)

Q16.

Animals and plants can be genetically modified.

(a) Recombinant human erythropoietin (rHE) is a protein drug that can be given to patients with low haemoglobin concentrations.

(i) Sheep have been genetically modified to produce rHE in their milk.

Explain how a sheep could be genetically modified to produce rHE in its milk.

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(ii) In a clinical study, 4382 patients were treated with rHE. They showed a mean increase in blood haemoglobin from 80 g dm^{-3} to 142 g dm^{-3}.

Calculate the percentage increase in the mean blood haemoglobin concentration as a result of rHE treatment.

(1)

Answer ..... %

(iii) Some patients receiving rHE develop anti-rHE antibodies.

Describe how these antibodies may be produced.

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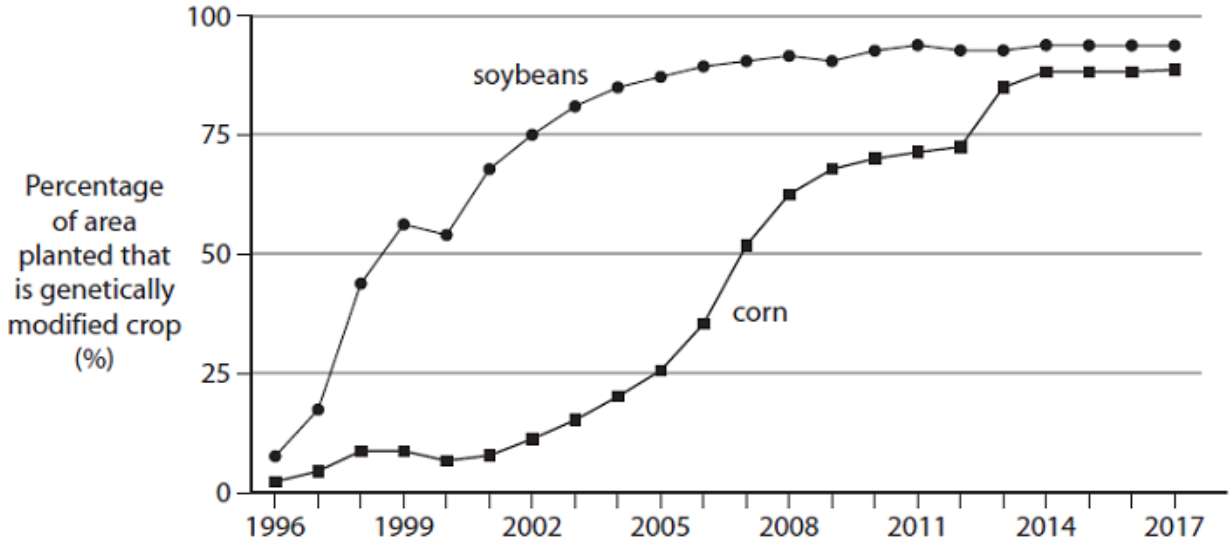
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(b) Advances in genetic engineering have allowed for precise control of the genetic changes introduced into plants.

The table describes some examples of the use of genetic modification in plants.

Trait	Plant	Details
herbicide tolerance	soybean	glycophosphate herbicide tolerance using a gene from the bacterium *A. tumefaciens*
insect resistance	corn	resistance to European corn borer using a gene from *B. thuringiensis*

The graph shows the increase in the use of genetically modified crops in the United States from 1996 to 2017.



Discuss the risks and benefits of genetic modification in valuable agricultural plants.

Use all the data and your own knowledge to support your answer.

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(Total for question = 15 marks)

Q17.

Answer the question with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Whales are large mammals.

The photograph shows a beluga whale and a human diver.



(Source: © Andrey Nekrasov/Alamy Stock Photo)

(a) (i) A beluga whale can become habituated to human divers.

How many of the following statements about habituation are correct?

(1)

- habituation is an example of anatomical adaptation
- habituation is only observed in mammals
- habituation only occurs after repeated exposure to the same stimulus

☒ **A** 0

☒ **B** 1

☒ **C** 2

☒ **D** 3

(ii) A beluga whale can respond to a stimulus using a spinal reflex arc.

Which row is correct?

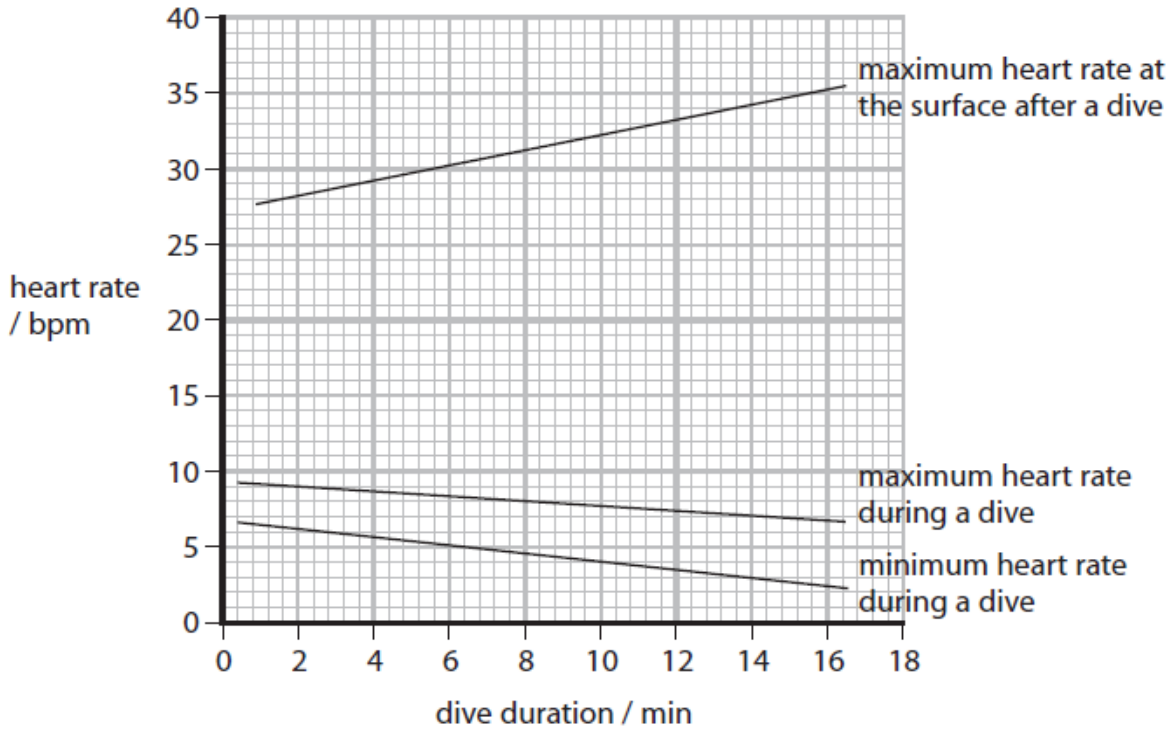
(1)

	Location of relay neurone	Location of cell body on the sensory neurone
☒ **A**	grey matter of spinal cord	at the end of the axon
☒ **B**	grey matter of spinal cord	in the middle of the axon
☒ **C**	white matter of spinal cord	at the end of the axon
☒ **D**	white matter of spinal cord	in the middle of the axon

(b) The heart rate of a whale changes when it is diving.

The graph shows the changes in heart rate that occur during dives of different durations.

The maximum heart rate at the surface is when the whale returns to the surface after a dive.



(i) Comment on the changes in heart rate of the whale when diving.

(3)

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(ii) Explain how the changes in heart rate are controlled when the whale returns to the surface immediately after the dive.

(3)

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(Total for question = 8 marks)

Q18.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Chemicals are used to regulate responses in both plants and animals.

(a) In mammals antidiuretic hormone (ADH) is involved in regulating plasma concentration and blood volume.

(i) Which of the following produces ADH?

(1)

☐ **A** adrenal gland

☐ **B** hypothalamus

☐ **C** medulla oblongata

☐ **D** pituitary gland

(ii) Which structures does ADH act on?

(1)

☐ **A** capillaries

☐ **B** collecting ducts

☐ **C** proximal tubules

☒ **D** ureters

(iii) The control of plasma concentration and blood volume in the body is an example of which type of process?

(1)

☒ **A** countercurrent multiplier

☒ **B** habituation

☒ **C** negative feedback

☒ **D** positive feedback

(iv) Name the type of receptor in the body that detects changes in the plasma concentration.

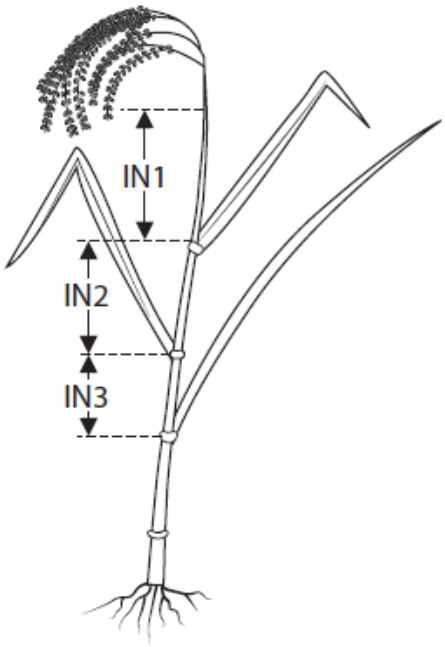
(1)

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(b) The effect of a gibberellin on the growth of cereal plants was investigated.

Different concentrations of the gibberellin were sprayed on cereal plants.

The lengths of the first, second and third internodes (IN1, IN2, IN3) were measured, as shown in the diagram.



The table shows the effect of the gibberellin on the mean lengths of the first, second and third internodes.

Concentration of the gibberellin / ppm	Mean length / cm		
	first internode	second internode	third internode
0	36	19	14
10	36	19	14
100	41	21	14
1000	52	22	15
2500	56	22	15

(i) Comment on the effect of the gibberellin on the growth of cereal plants.

(2)

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(ii) Suggest how the gibberellin causes this effect.

(3)

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(Total for question = 9 marks)

Q19.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

The mammalian retina is a tissue that detects light.

(a) Rod cells and bipolar neurones are cell types found in the retina.

(i) What is the name of the chemical formed when light is absorbed by the photopigment found in rod cells?

(1)

☒ **A** cis-retinal

☒ **B** phytochrome

☒ **C** rhodopsin

☒ **D** trans-retinal

(ii) Which row in the table shows the effects of light absorption on cells in the retina?

(1)

		Rod cell	Bipolar neurone
☒	**A**	hyperpolarised	hyperpolarised
☒	**B**	hyperpolarised	depolarised
☒	**C**	depolarised	hyperpolarised
☒	**D**	depolarised	depolarised

(b) An investigation studied the effects of light intensity on the mammalian retina.

Samples of retina were exposed to different light intensities and the mean potential difference of the bipolar neurones was recorded.

The results are shown in the table.

Light intensity / a.u.	Mean potential difference / mV
2	11
4	17
8	19
12	20
16	20
20	20

(i) Describe the effect of light intensity on the mean potential difference of bipolar neurones.

(2)

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(ii) Calculate the percentage change in the mean potential difference when the light intensity increases from 4 to 12 a.u.

(2)

Answer .....

(iii) Give **two** reasons why some people might have objections to the use of mammalian retinas in this investigation.

(2)

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(c) Which statement describes the response of the muscles in the iris to increasing light

intensity?

(1)

☒ **A** circular and radial muscles contract

☒ **B** circular and radial muscles relax

☒ **C** circular muscles contract and radial muscles relax

☒ **D** circular muscles relax and radial muscles contract

(Total for question = 9 marks)

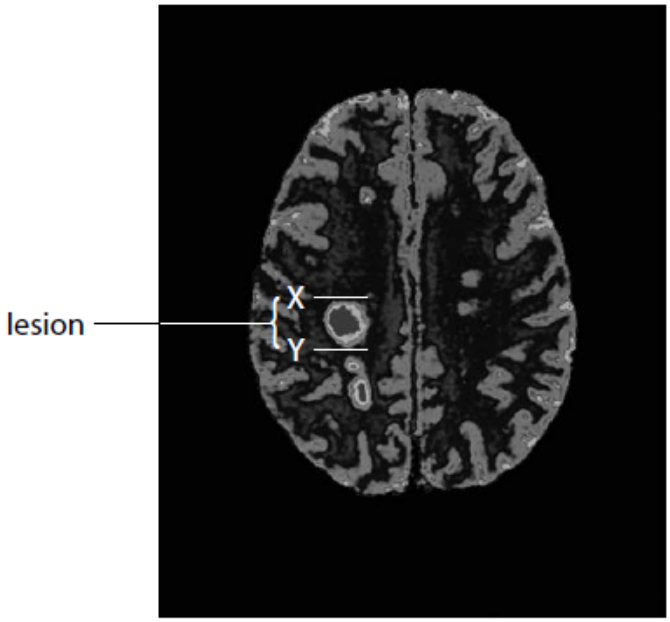
Q20.

Multiple sclerosis (MS) is a disease that causes the destruction of the myelin sheaths around neurones.

This destruction is caused by the person's own immune system.

Lesions form in the brain where myelin is destroyed.

(a) The photograph shows lesions in the brain of a person with MS, as seen using magnetic resonance imaging (MRI).



© M210/0087 SGI/Science Photo Library

The actual length of this brain is 15 cm.

Calculate the actual diameter, in mm, of the lesion between X and Y.

(2)

Answer ..... mm

(b) The table shows the speed of conduction of an impulse along non-myelinated and myelinated neurones with axons of different diameters.

Type of neurone	Diameter of axon / μm	Speed of conduction of impulse / m s^{-1}
non-myelinated	1	2.3
non-myelinated	2	3.1
non-myelinated	4	4.2
myelinated	1	2.6
myelinated	2	8.5

(i) Show that the effect of diameter on the speed of conduction of an impulse is six times greater in a myelinated neurone than in a non-myelinated neurone.

(2)

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(ii) Explain the effect of the myelin sheath and the diameter of the axon on the speed of conduction of an impulse.

(4)

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(iii) Symptoms of MS can include blindness in one eye and lack of coordination.

Suggest why a person with MS could have these symptoms.

(3)

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(Total for question = 11 marks)

Q21.

The scientific document you have studied is adapted from an article in nature.com: *Microgravity elicits reproducible alterations in cytoskeletal and metabolic gene and protein expression in space-flown Caenorhabditis elegans*.

Use the information from the scientific document and your own knowledge to answer the following questions.

(a) Suggest why the authors of this article have named the species of nematode used in this study (paragraph 2).

(1)

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(b) State **one** ethical issue of using nematodes in this study.

(1)

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(c) Describe how microgravity can cause changes in gene expression in these nematodes (paragraph 4).

(3)

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(d) Suggest why there was a lower fat accumulation and shorter body length in nematodes grown in microgravity (paragraph 4).

(3)

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(e) Explain why there were reduced levels of a number of metabolic proteins in nematodes grown in microgravity (paragraph 6).

(4)

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(f) Explain why microarrays could be used to show that mitochondrial electron transport genes are downregulated, whereas the sirtuin gene was upregulated (paragraph 7).

(3)

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(g) Explain why Sudan Black was used in this study (paragraph 8).

(2)

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(h) Comment on the reliability of the data presented in Table 1 (paragraph 9).

(3)

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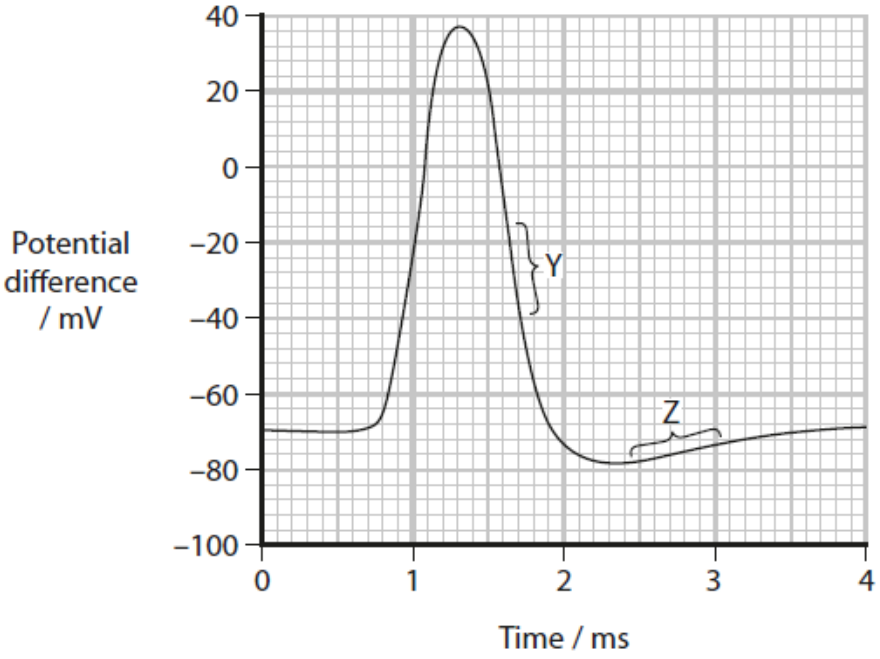
(Total for question = 20 marks)

Q22.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Nerve impulses travel along axons as action potentials.

(a) The graph shows an oscilloscope trace for an action potential in an axon.



(i) Which is the resting potential for this axon?

(1)

☒ **A** –70 mV

☒ **B** –78 mV

☒ **C** 38 mV

☒ **D** 108 mV

(ii) Both voltage-gated sodium and voltage-gated potassium ion channels are involved in generating an action potential.

Which of these voltage-gated channels are open at Y?

(1)

☒ **A** no voltage-gated ion channels are open

☒ **B** voltage-gated sodium ion channels only

☒ **C** voltage-gated potassium ion channels only

☒ **D** both sodium and potassium voltage-gated ion channels

(iii) Which is the state of polarisation of the membrane at Z?

(1)

☒ **A** depolarised

☒ **B** hyperpolarised

☒ **C** hypopolarised

☒ **D** unpolarised

(iv) How many of the following statements are correct?

- the magnitude of the action potential is proportional to the strength of stimulus that generates the action potential
- action potentials spread out in both directions along the axon
- following an action potential, there is a refractory period during which it is not possible to generate a new action potential

(1)

☒ **A** none

☒ **B** one

☒ **C** two

☒ **D** three

(b) Explain why maintaining a resting potential requires ATP.

(3)

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(Total for question = 7 marks)