Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology B

Advanced

Paper 2: Advanced Physiology, Evolution and Ecology

Tuesday 20 June 2017 – Morning
Time: 1 hour 45 minutes

Paper Reference
9BI0/02

You must have:
Calculator, HB pencil, 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.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You may use a scientific calculator.
- In question(s) marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

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.*

Advice

- Read each question carefully before you start to answer it.
- 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 Chemical control in plants is brought about by plant growth substances such as auxins.

Auxins cause elongation of cells.

Auxins weaken the bonds between molecules found in cell walls. Molecules found in cell walls include cellulose and hemicellulose.

(a) (i) Which of the following statements about cellulose molecules is correct?

(1)

☒ **A** they are branched polymers

☒ **B** they contain α-glucose

☒ **C** they are bonded to each other by hydrogen bonds

☒ **D** they contain 1,6 glycosidic bonds

(ii) The following statements relate to calcium pectate:

1. found in the middle lamella
2. holds cell walls together
3. prevents the movement of water

Which of the following is correct for calcium pectate?

(1)

☒ **A** statement 1 and statement 2

☒ **B** statement 1 and statement 3

☒ **C** statement 2 only

☒ **D** statement 3 only

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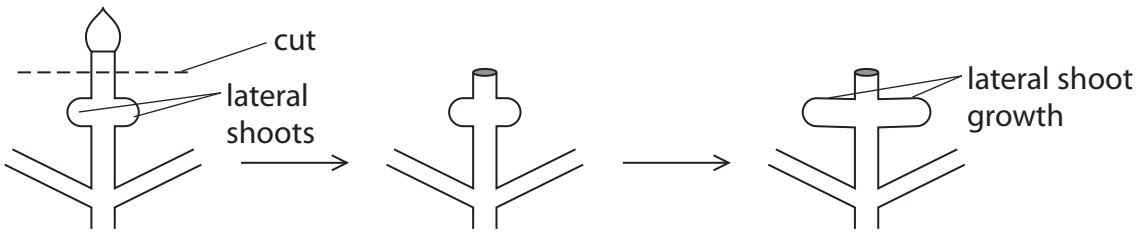
(b) A scientist investigated apical dominance in plants.

In experiment 1, the shoot tips were cut off and the growth of lateral shoots assessed.

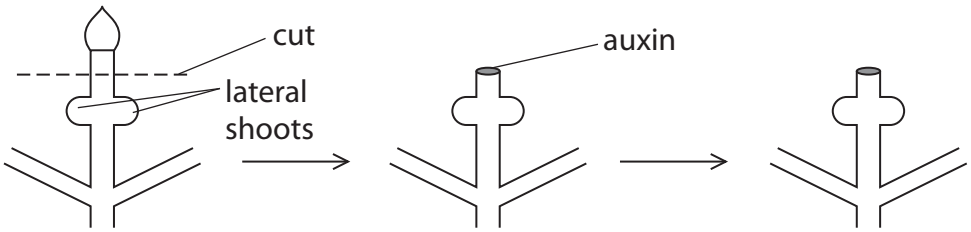
This was repeated in experiment 2, but auxin was placed over the cut end of the tips and the growth of lateral shoots was assessed.

The results are shown in the diagrams.

Experiment 1



Experiment 2



Explain how the interaction between auxins and cytokinins could have produced the results shown in the diagram.

(3)

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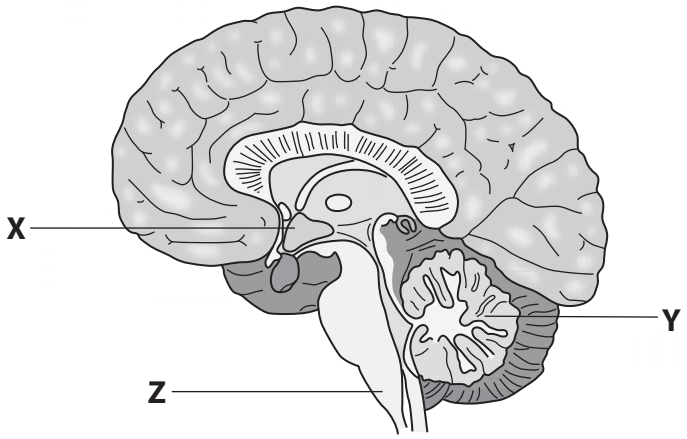
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(Total for Question 1 = 5 marks)

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2 The brain is involved in many homeostatic mechanisms.

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



Which row of the table correctly matches the regions **X**, **Y** and **Z** with their functions?

(1)

	Control of breathing rate	Control of balance	Temperature regulation
☒ **A**	X	Y	Z
☒ **B**	Y	Z	X
☒ **C**	Z	X	Y
☒ **D**	Z	Y	X

(b) An action potential results from the depolarisation of the membrane of a neurone.

Which row of the table shows the correct state of the ion channels during this depolarisation?

(1)

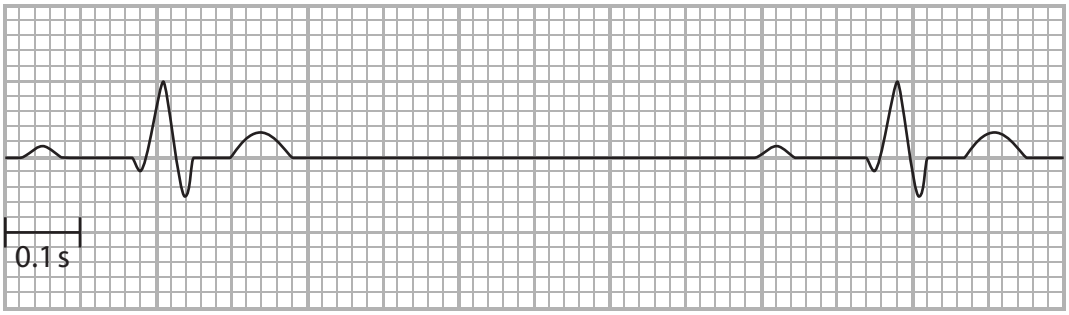
	Na^+ channels	K^+ channels
☒ **A**	closed	closed
☒ **B**	closed	open
☒ **C**	open	closed
☒ **D**	open	open

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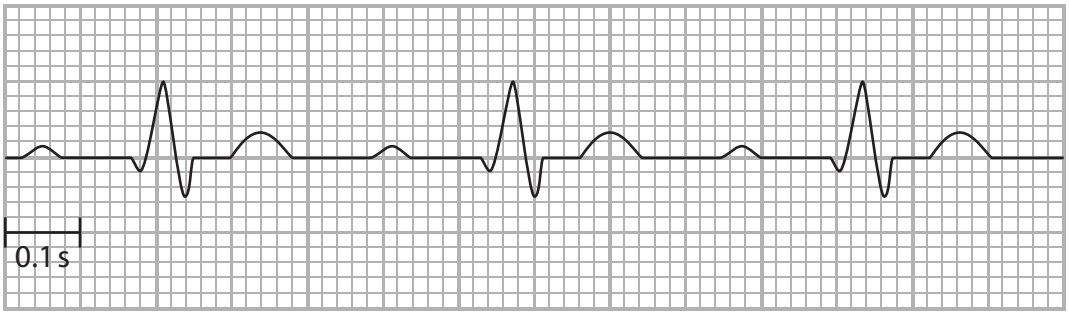
(c) The autonomic nervous system plays a role in regulating heart rate.

The diagram shows an ECG trace from a student before and during exercise.

before exercise



during exercise



(i) Calculate the heart rate of this student during exercise.

(1)

Answer .....

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(ii) Describe how exercise results in an increased heart rate.

(4)

(Total for Question 2 = 7 marks)

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3 In flowering plants, pollen grains grow pollen tubes that are involved in fertilisation, producing a zygote and endosperm.

(a) (i) Which row of the table shows the correct description for these nuclei?

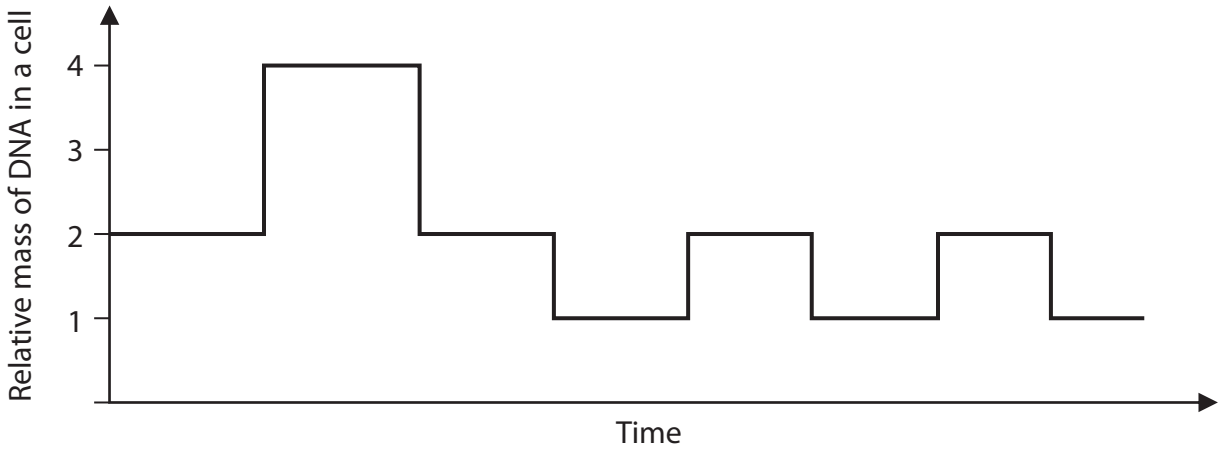
(1)

	Zygote nucleus	Endosperm nucleus	Pollen tube nucleus
☒ **A**	diploid	diploid	haploid
☒ **B**	diploid	triploid	haploid
☒ **C**	diploid	triploid	diploid
☒ **D**	haploid	triploid	diploid

(ii) The production of plant gamete cells involves both mitosis and meiosis.

The graph shows the DNA content of a cell during the production of a pollen grain.

(1)



The order of nuclear divisions shown in the graph is

☒ **A** meiosis, mitosis, mitosis

☒ **B** meiosis, mitosis, meiosis

☒ **C** mitosis, meiosis, meiosis

☒ **D** mitosis, mitosis, meiosis

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(b) A scientist investigated the effects of chemical A and chemical B on pollen tube growth.

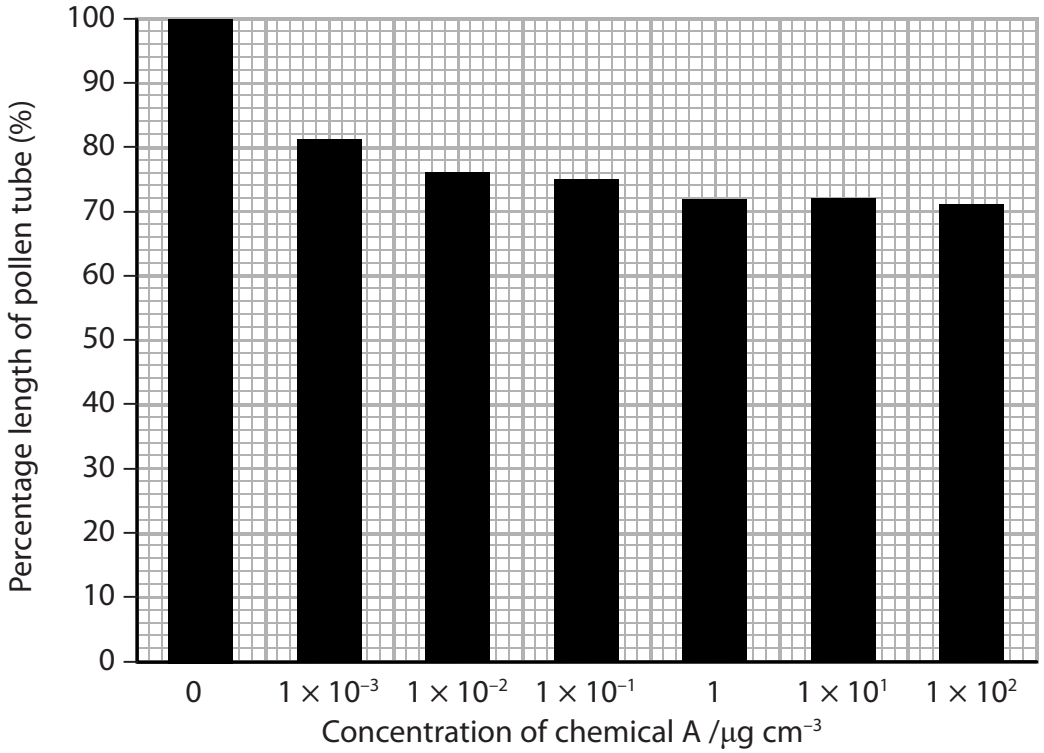
Chemical A prevents transcription.

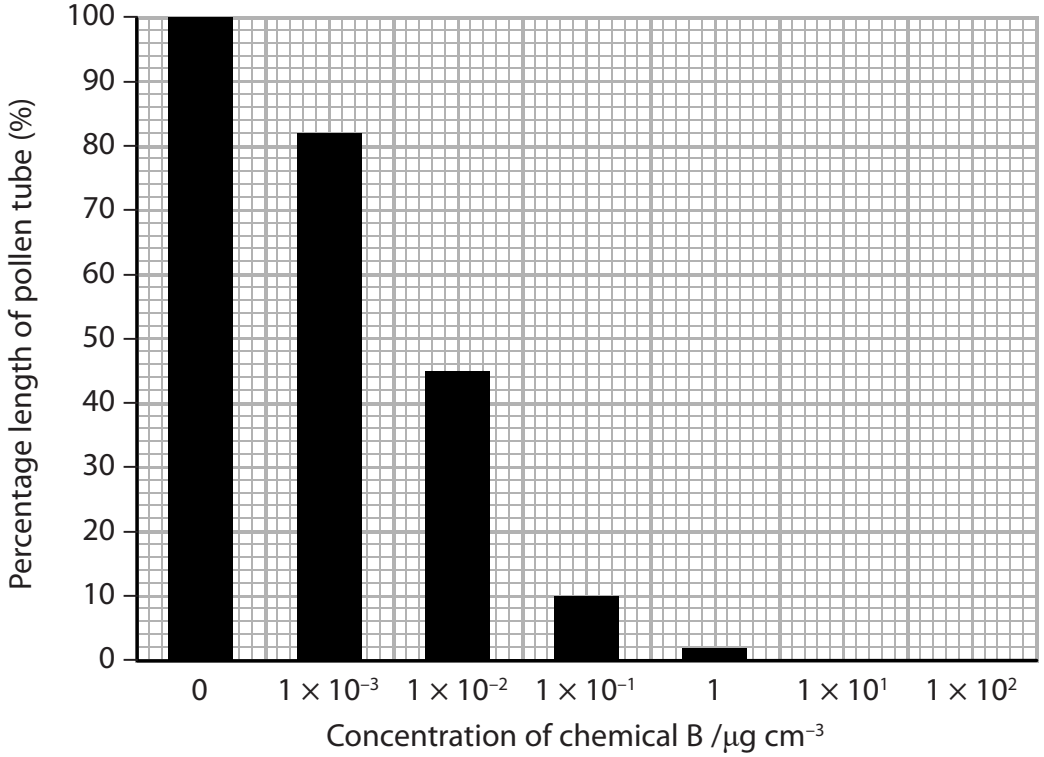
Chemical B prevents translation.

Pollen grains were treated with different concentrations of these two chemicals. The lengths of the pollen tubes they produced were compared with a control group of pollen grains.

The lengths of the pollen tubes were measured and expressed as a percentage of the control group.

The results are shown in the graphs.





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(i) The mean length of the pollen tubes in the control group was 7.5 mm.

Calculate the mean length of the pollen tubes after adding 0.010 μg cm^{-3} of chemical A.

(2)

Answer .....

(ii) Analyse the data to comment on the effects of chemical A and chemical B on the roles of transcription and translation in pollen tube growth.

(4)

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(Total for Question 3 = 8 marks)

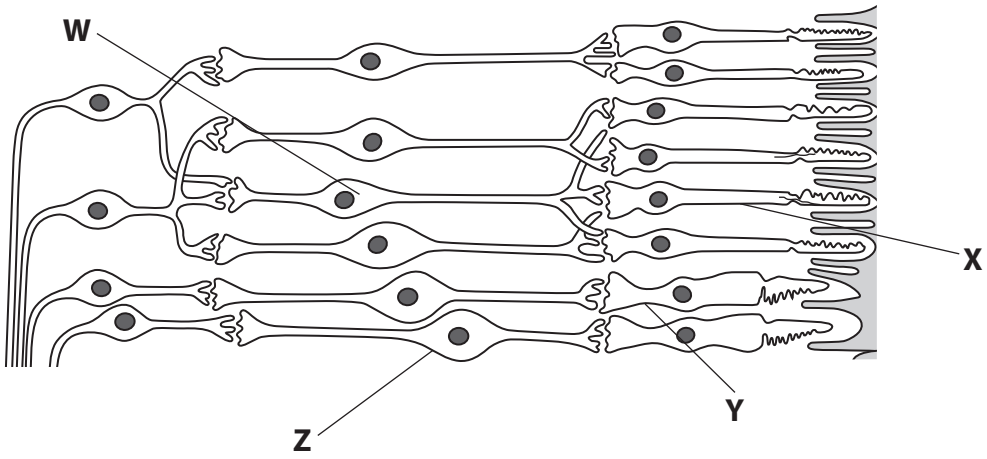
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4 The retina is the light sensitive structure in the eye.

(a) The diagram shows some of the cells in a human retina.



(i) Which row in the table correctly identifies the cells **W**, **X** and **Y**?

(1)

	Cell W	Cell X	Cell Y
☒ **A**	bipolar cell	cone cell	rod cell
☒ **B**	bipolar cell	rod cell	cone cell
☒ **C**	ganglion cell	cone cell	rod cell
☒ **D**	ganglion cell	rod cell	cone cell

(ii) Draw an arrow on the diagram to show the direction of the light passing through the retina.

(1)

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(iii) Explain why a higher light intensity is required to produce an action potential in cell **Z** than in cell **W**.

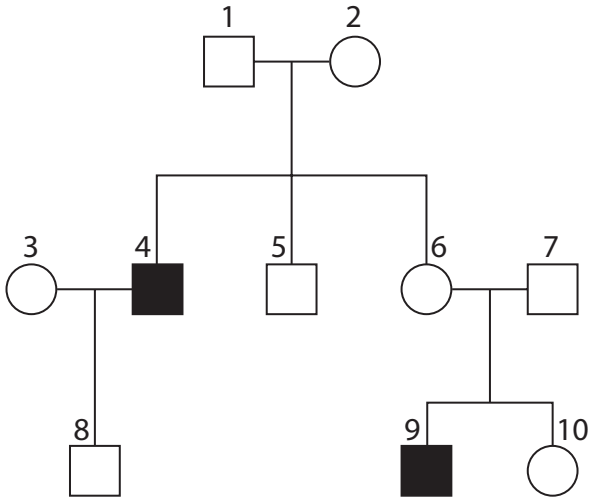
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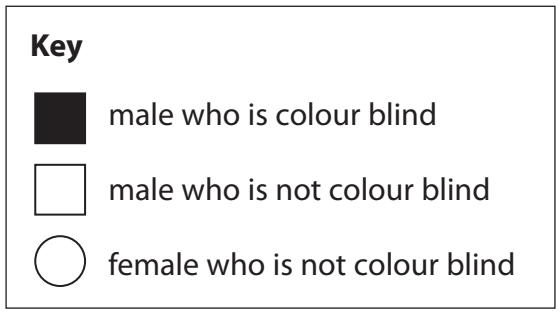
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(b) Red-green colour vision is controlled by a single gene located on the X chromosome.

Colour blindness is caused by a recessive allele for the red-green colour vision gene.

The diagram shows the inheritance pattern of colour blindness for a family.





(i) Explain how the diagram shows that red-green colour blindness is caused by a recessive allele.

(2)

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(ii) Use a genetic diagram to determine the probability that the next child of individuals 6 and 7 is a male who is colour blind.

(3)

Answer .....

(Total for Question 4 = 10 marks)

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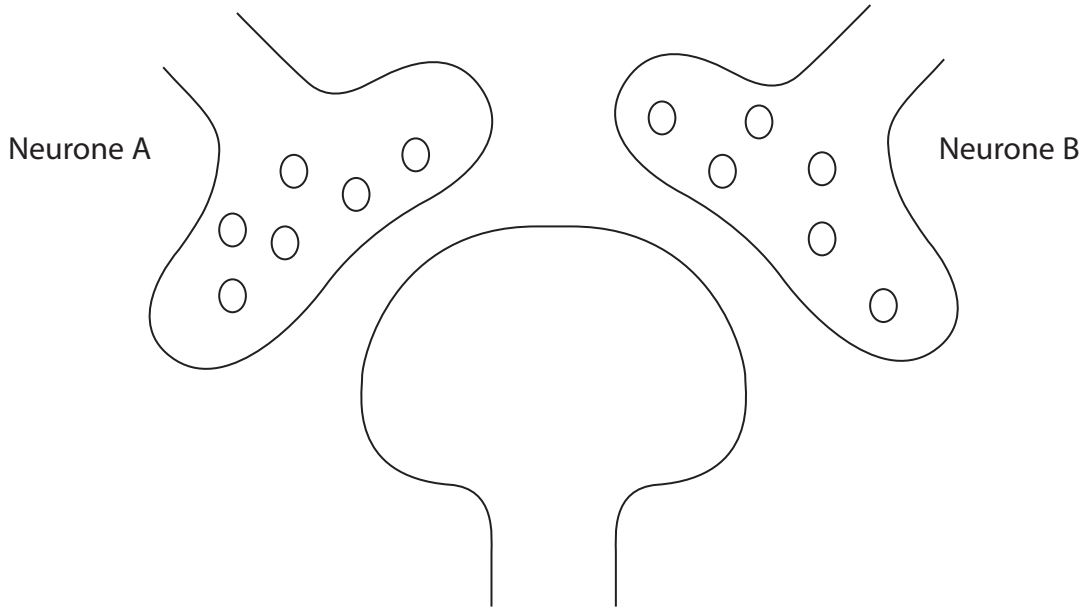
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5 The diagram shows the structure of a synaptic junction between three neurones.

Neurone A releases the excitatory neurotransmitter acetylcholine.

Neurone B releases the inhibitory neurotransmitter glutamate.

Glutamate causes chloride ions to move into the postsynaptic neurone.



Postsynaptic neurone

(a) (i) Describe the sequence of events that leads to an excitatory postsynaptic potential (EPSP) in the postsynaptic neurone after stimulation of neurone A.

(4)

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(ii) Which of the following rows correctly describes the action of each substance on this postsynaptic neurone?

(1)

	Nicotine	Lidocaine	Cobra venom
☒ **A**	excitatory	excitatory	excitatory
☒ **B**	excitatory	inhibitory	inhibitory
☒ **C**	inhibitory	excitatory	excitatory
☒ **D**	inhibitory	inhibitory	inhibitory

(b) A scientist investigated the effect of the intensity of stimulation of neurones A and B on the production of an action potential in the postsynaptic neurone.

High intensity stimulation of neurones A and B causes a high frequency of impulses to arrive at the presynaptic terminals.

The results are shown in the table.

Intensity of stimulation		Production of action potential in postsynaptic neurone
Neurone A	Neurone B	
low	low	no
low	high	no
high	low	yes
high	high	no

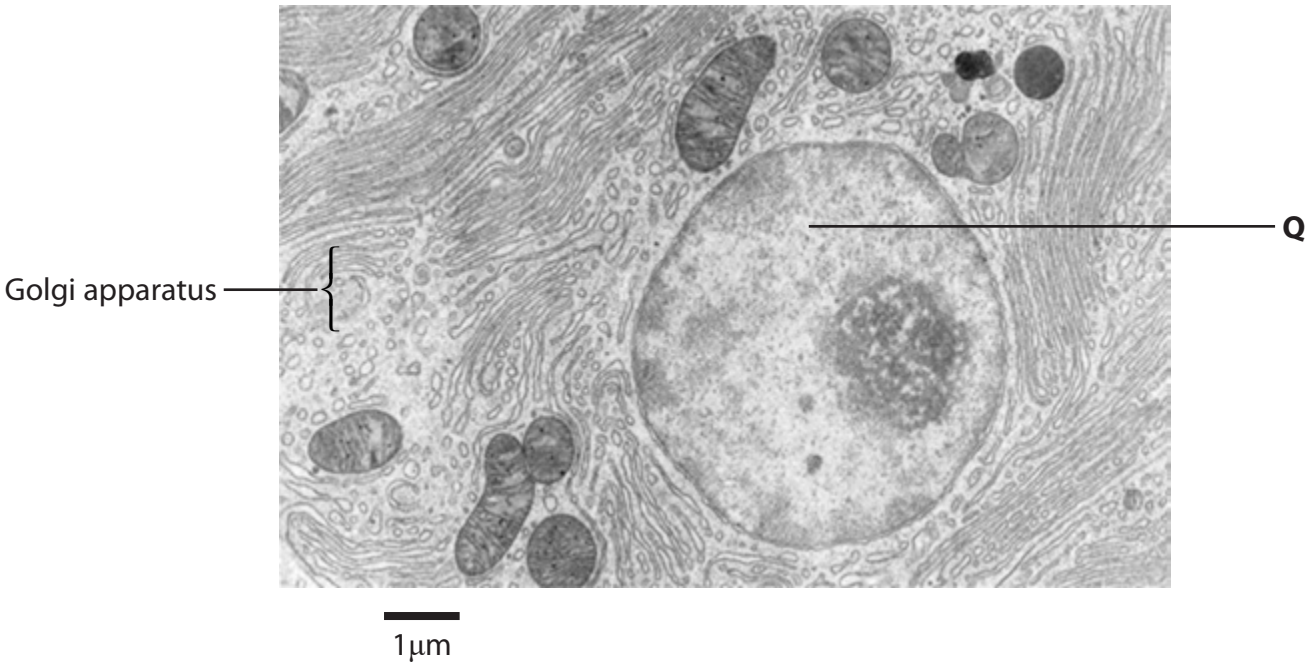
Explain the effect of the intensity of stimulation on the production of an action potential in the postsynaptic neurone.

(3)

(Total for Question 5 = 8 marks)

6 The pancreas is an organ that secretes digestive enzymes.

The electron micrograph shows part of a secretory cell from a human pancreas.



(a) Name organelle **Q**.

(1)

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(b) Calculate the maximum diameter of organelle **Q**.

(2)

Answer .....

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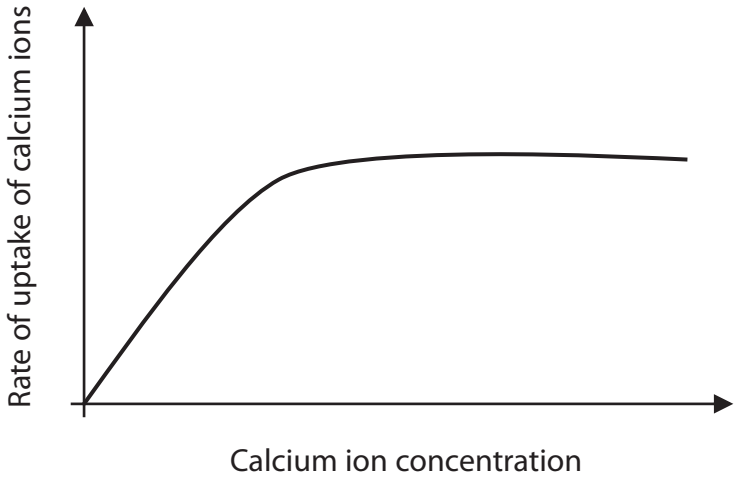
(c) Describe the role of the Golgi apparatus in producing secreted enzymes.

(3)

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(d) Calcium ions are needed for the secretion of enzymes from pancreatic cells.

The graph shows the effect of increasing calcium ion concentration on the uptake of calcium ions by pancreatic cells.



Explain the effects of calcium ion concentration on the rate of uptake of calcium ions through the pancreatic cell membrane.

(3)

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(Total for Question 6 = 9 marks)

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7 The diagram shows four varieties of rabbit.



Brown Chinchilla Himalayan Albino

Fur colour in rabbits is controlled by four different alleles:

- the allele for brown fur, C, is dominant to all other alleles
- the allele for chinchilla fur, c^{ch}, is dominant to the alleles for Himalayan and albino
- the allele for Himalayan fur, c^{h}, is dominant to the allele for albino
- the allele for albino fur, c, is recessive to all other alleles

(a) (i) Describe how new combinations of alleles are produced in meiosis.

(2)

(ii) State all the possible genotypes of a rabbit with brown fur.

(1)

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(iii) Two parent rabbits with brown fur were mated. Two of the F_1 offspring had chinchilla fur.

The F_1 rabbit offspring with chinchilla fur were mated.

The F_2 generation consisted of some rabbits with chinchilla fur and the rest having Himalayan fur.

Use genetic crosses to deduce the genotypes of the two parent rabbits with brown fur.

(3)

Answer .....

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(b) The fur colour of animals can be affected by natural selection.

Compare and contrast stabilising selection with disruptive selection.

(3)

(Total for Question 7 = 9 marks)

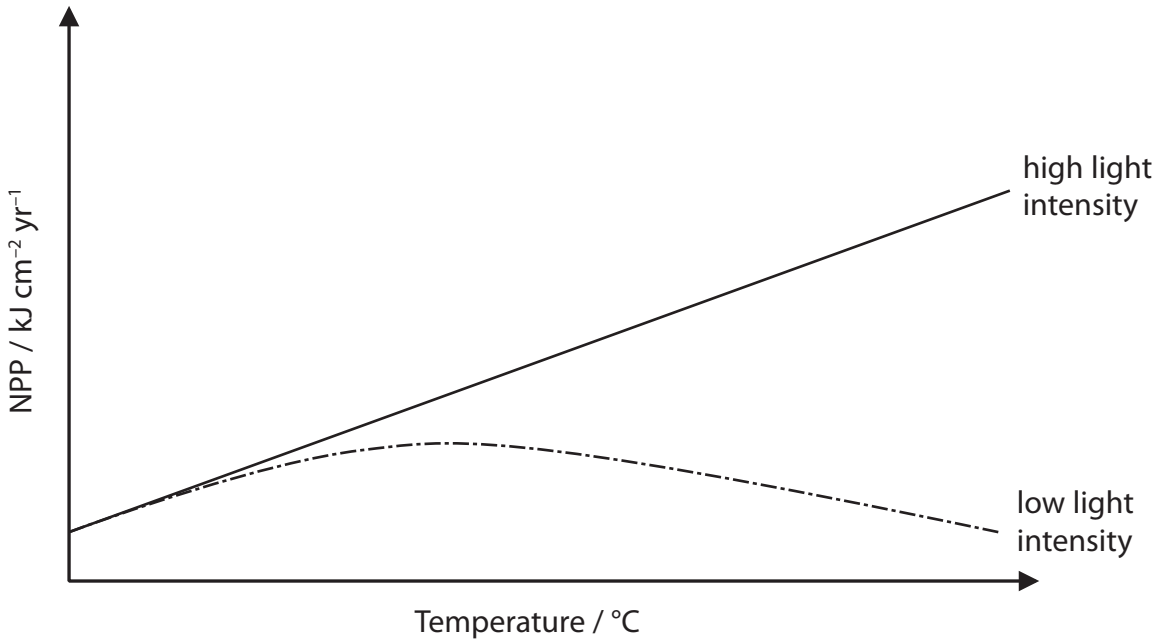
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8 The effects of light intensity and temperature on the net primary productivity (NPP) of young willow trees were investigated.

Young willow trees were grown in two greenhouses: one with high light intensity and one with low light intensity.

In each greenhouse, groups of these willow trees were kept at different temperatures for six months.

The results are shown in the graph.



(a) (i) State what is meant by the term net primary productivity.

(1)

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(ii) Explain why temperature has different effects on NPP at these two light intensities.

(2)

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*(b) In a further investigation, succession was monitored for fifty years in an abandoned field.

The field was originally used to grow crops.

After fifty years, large numbers of coniferous trees were growing in the field.

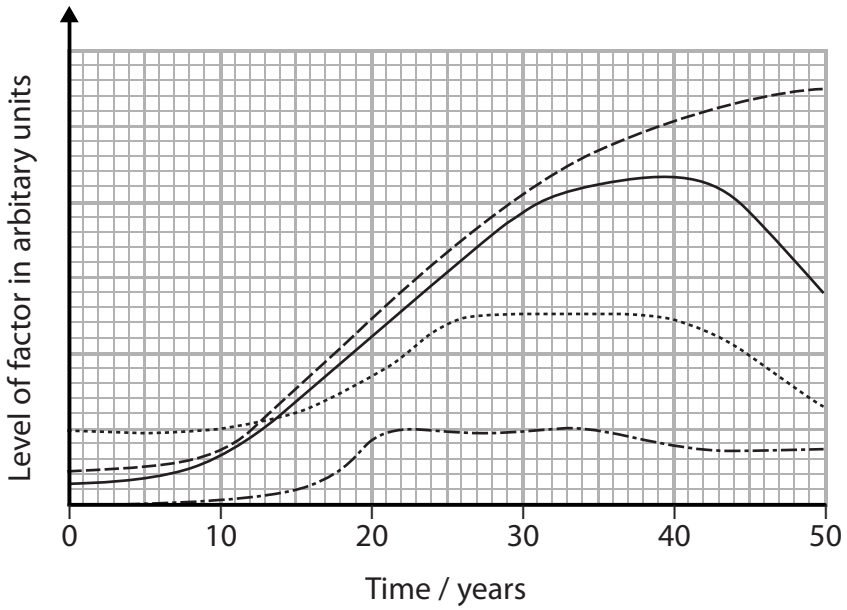
These coniferous trees do not shed many leaves.

When compared with younger trees, older coniferous trees have a much higher proportion of tree stem, branches and roots and a lower proportion of leaves.

The following factors were monitored:

- plant biomass
- NPP
- mineral ion content of soil
- index of diversity of animals

The line graphs show the trends that happened over fifty years for each of the factors.



Key

– – – plant biomass

—— NPP

····· mineral ion content of soil

–·–· index of diversity of animals

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Analyse the data to explain how succession is linked to the changes in this abandoned field.

(6)

(Total for Question 8 = 9 marks)

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9 Polyphenol oxidase is an enzyme found in many plant cells.

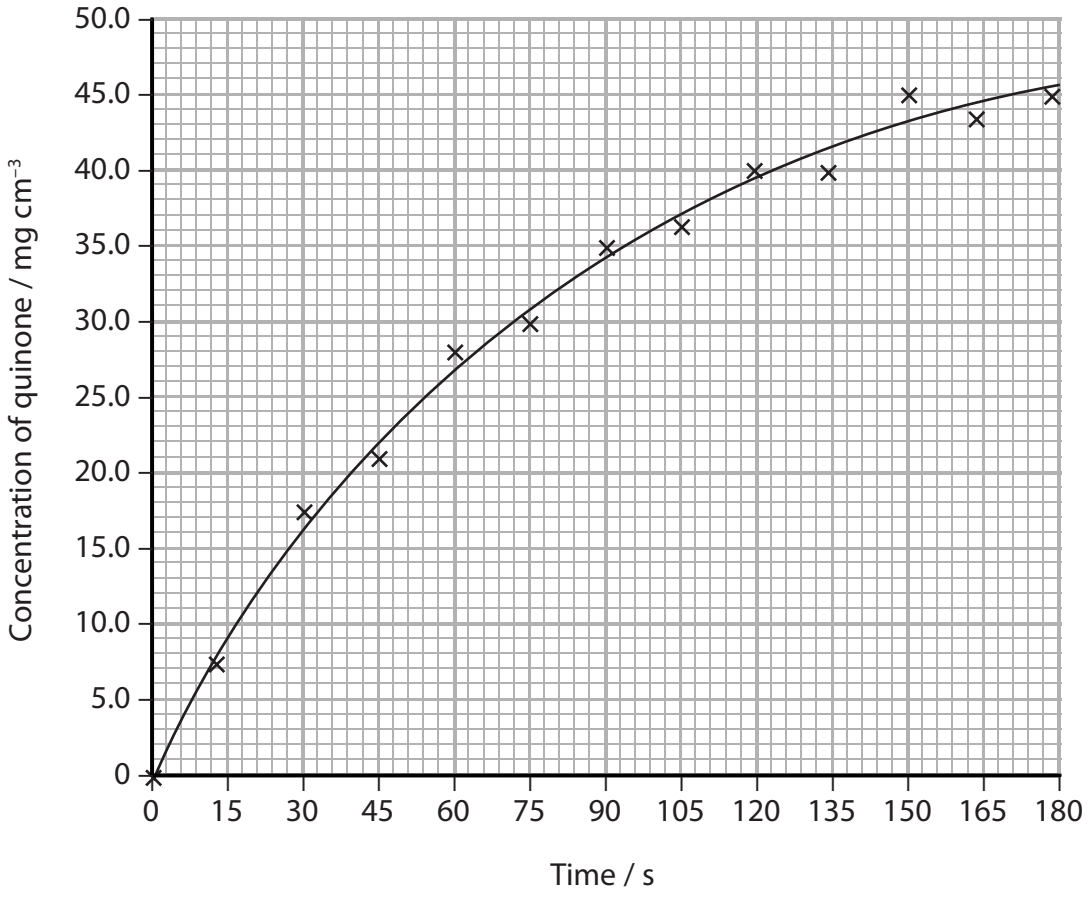
This enzyme catalyses the following reaction

$$\text{monophenol (colourless)} + \text{oxygen} \longrightarrow \text{quinone (brown)}$$

This reaction causes cut fruit to turn brown when exposed to air.

(a) A student carried out an investigation into the rate at which grape juice produced quinone.

The graph shows the results of this investigation.



(i) Calculate the initial rate of this reaction.

(3)

Answer .....

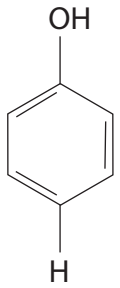
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(ii) Explain why adding citric acid to cut fruit reduces the rate at which the fruit turns brown.

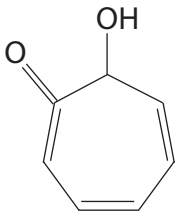
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(iii) The diagram shows the structures of monophenol and a molecule called tropolone.

Tropolone can be added to grape juice to slow the rate at which the juice turns brown.



monophenol



tropolone

Explain how tropolone affects the rate at which the grape juice turns brown.

(2)

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(b) Plant breeders have developed a grape variety that produces inactive polyphenol oxidase.

The bonding in this enzyme is changed and this prevents the juice from turning brown.

(i) Which of the following bonds are used to form the tertiary structure of enzymes?

(1)

☒ **A** hydrogen, glycosidic and ester

☒ **B** hydrogen, ionic and disulfide

☒ **C** ionic, glycosidic and disulfide

☒ **D** ionic, disulfide and ester

(ii) The base sequence of this polyphenol oxidase gene is different in this grape variety.

Explain how this leads to the production of inactive enzyme.

(3)

(Total for Question 9 = 11 marks)

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10 The Northern elephant seal is a mammal found in the Eastern Pacific Ocean.



In the nineteenth century, Northern elephant seals were hunted and this reduced the population to about 20 seals.

The seals were listed as an Appendix II species when CITES was established in the 1970s.

The population has now recovered to over 100 000 individuals.

The seals in this population have developed health problems, including a high mortality rate for newborn pups, deformities and weak immune systems.

(a) (i) Describe the role of treaties such as CITES in maintaining global biodiversity.

(2)

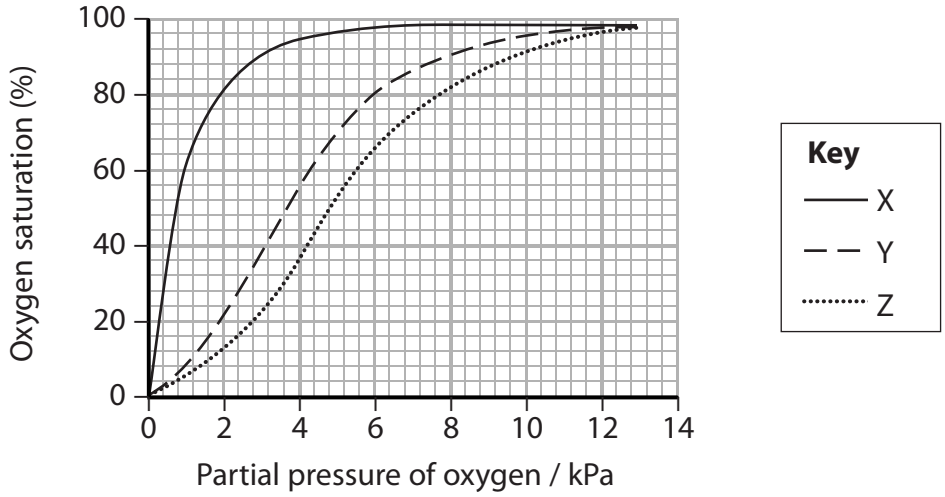
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(ii) Explain why, although the population of seals has recovered, many of the seals have health problems.

(2)

(b) Northern elephant seals have a high concentration of haemoglobin in their blood.

The graph shows the oxygen dissociation curves for myoglobin, adult haemoglobin and fetal haemoglobin.



Which of the rows correctly matches each curve with myoglobin, adult haemoglobin and fetal haemoglobin?

(1)

	Myoglobin	Adult haemoglobin	Fetal haemoglobin
☒ **A**	X	Y	Z
☒ **B**	X	Z	Y
☒ **C**	Y	Z	X
☒ **D**	Z	X	Y

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(c) Northern elephant seals are able to dive to great depths and hold their breath for up to two hours.

The tables show data for four diving mammals.

Species	Maximum time holding breath / min	Maximum diving depth / m	Mass of animal / kg
bottlenose dolphin	5	20	200
harbour seal	17	19	24
Weddell seal	82	400	400
Northern elephant seal	119	437	400

Species	Volume of oxygen in body / $cm^3\ kg^{-1}$	Concentration of haemoglobin in blood / $g\ dm^{-3}$	Total blood volume / $cm^3\ kg^{-1}$	Percentage of stored oxygen in different body tissues		
				lungs	blood	muscle
bottlenose dolphin	36	14	71	34	27	39
harbour seal	57	21	132	13	54	33
Weddell seal	87	210	173	5	66	29
Northern elephant seal	97	216	207	4	71	25

(i) Calculate the total mass of haemoglobin in a Northern elephant seal.

(3)

Answer .....

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*(ii) Analyse the data to explain how marine mammals are adapted for diving.

(6)

(Total for Question 10 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

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