Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Time 1 hour 45 minutes

Paper reference **9BI0/02**

Biology B

Advanced

PAPER 2: Advanced Physiology, Evolution and Ecology

You must have:
Scientific 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.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.

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.*
- 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.

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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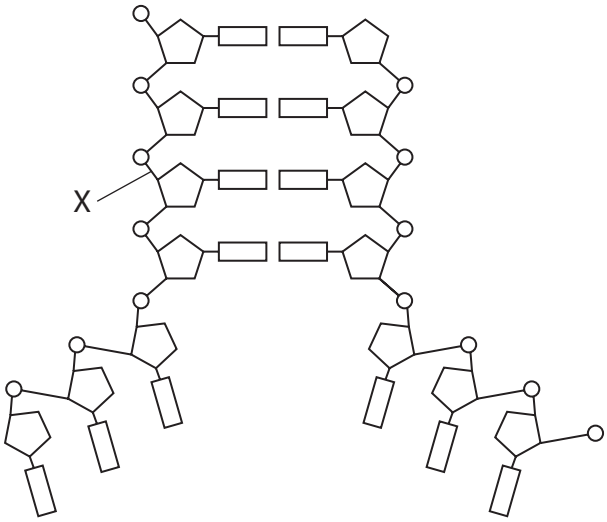
Answer ALL questions. Write your answers in the spaces provided.

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 The diagram shows DNA replication.



(a) Which of the following is the name of the bond labelled X on the diagram?

(1)

☐ **A** ester

☐ **B** glycosidic

☐ **C** hydrogen

☐ **D** phosphodiester

(b) Describe the roles of three named enzymes involved in DNA replication.

(3)

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(c) A section of double-stranded DNA has a total number of 10 000 nucleotides.

Adenine makes up 35% of the nucleotides in this section of double-stranded DNA.

Calculate the total number of cytosine nucleotides found in this section of DNA.

(2)

Answer .....

(Total for Question 1 = 6 marks)

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2 Plant growth substances and phytochromes are chemicals that affect the growth of plants.

(a) (i) Which row of the table shows the concentrations required for the fastest growth of lateral buds?

(1)

		Auxin concentration	Cytokinin concentration
☒	**A**	high	high
☒	**B**	high	low
☒	**C**	low	high
☒	**D**	low	low

(ii) Some types of auxin affect the activity of cells in the same way as hormones such as oestrogen affect human cells.

These auxins pass through the cell membrane and affect the synthesis of enzymes.

Explain how these auxins affect the synthesis of enzymes.

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(b) Phytochrome is involved in the germination of seeds.

The effect of red (R) light and far-red (FR) light on the germination of lettuce seeds was investigated.

A scientist exposed five groups of 50 seeds to red light for one minute.

The seeds were planted and the mean number that germinated was calculated.

Another five groups each of 50 seeds were then exposed to red light for one minute, followed by far-red light for four minutes.

These seeds were planted and the mean number that germinated was calculated.

The experiment was repeated with different combinations of red light and far-red light.

The results are shown in the table.

Sequence of red (R) and far-red (FR) light	Mean number of seeds that germinated	Standard deviation (SD)
R	45	±4
R, FR	5	±2
R, FR, R	45	±5
R, FR, R, FR	10	±4
R, FR, R, FR, R	40	±9

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Analyse the data to comment on the effect of red (R) and far-red (FR) light on the germination of lettuce seeds.

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(Total for Question 2 = 8 marks)

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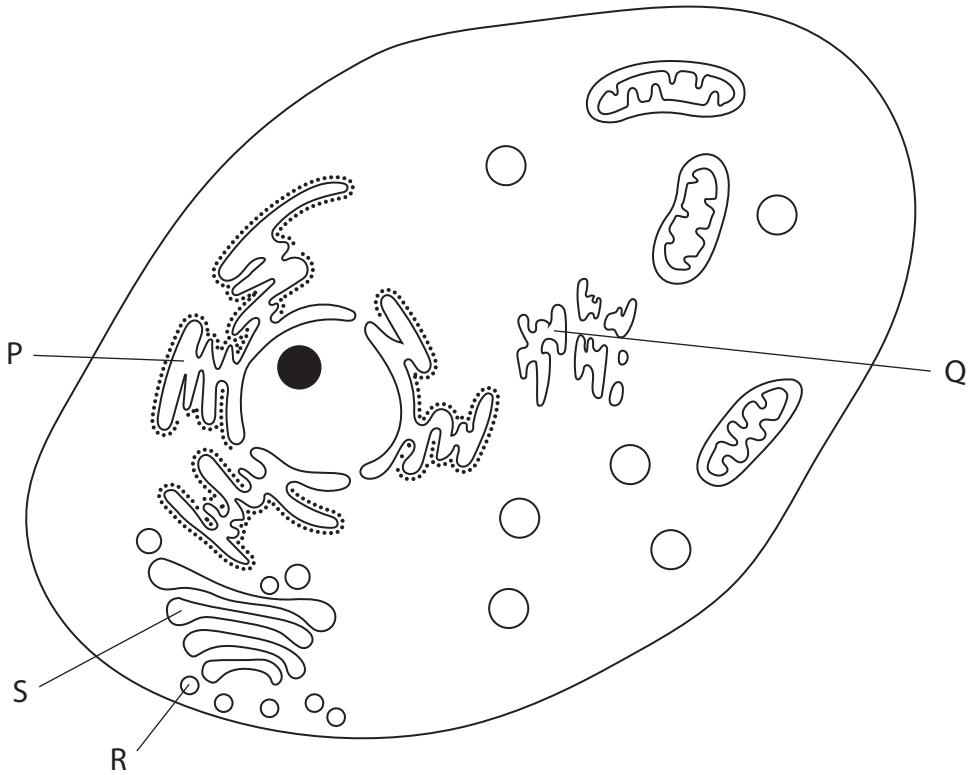
3 The diagram shows the structure of an animal cell.



(a) (i) Which of the following is the name of the structure labelled Q?

(1)

☒ **A** centriole

☒ **B** nucleus

☒ **C** rough endoplasmic reticulum

☒ **D** smooth endoplasmic reticulum

(ii) These cells were cultured in radioactively-labelled amino acids.

In which sequence would the cell structures in the diagram become radioactive during protein synthesis?

(1)

☒ **A** Q S R

☒ **B** S P R

☒ **C** P R Q

☒ **D** P S R

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(iii) Explain one function of lysosomes.

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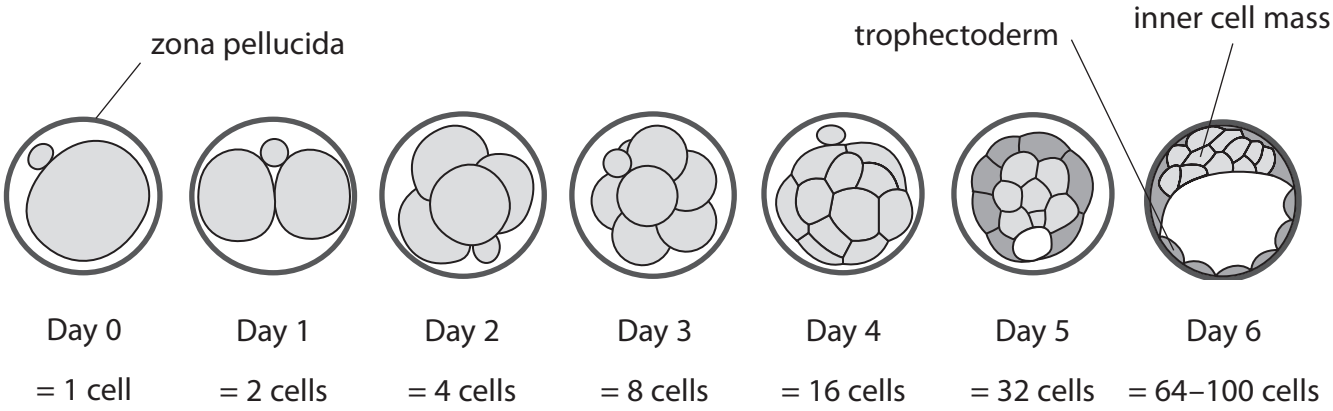
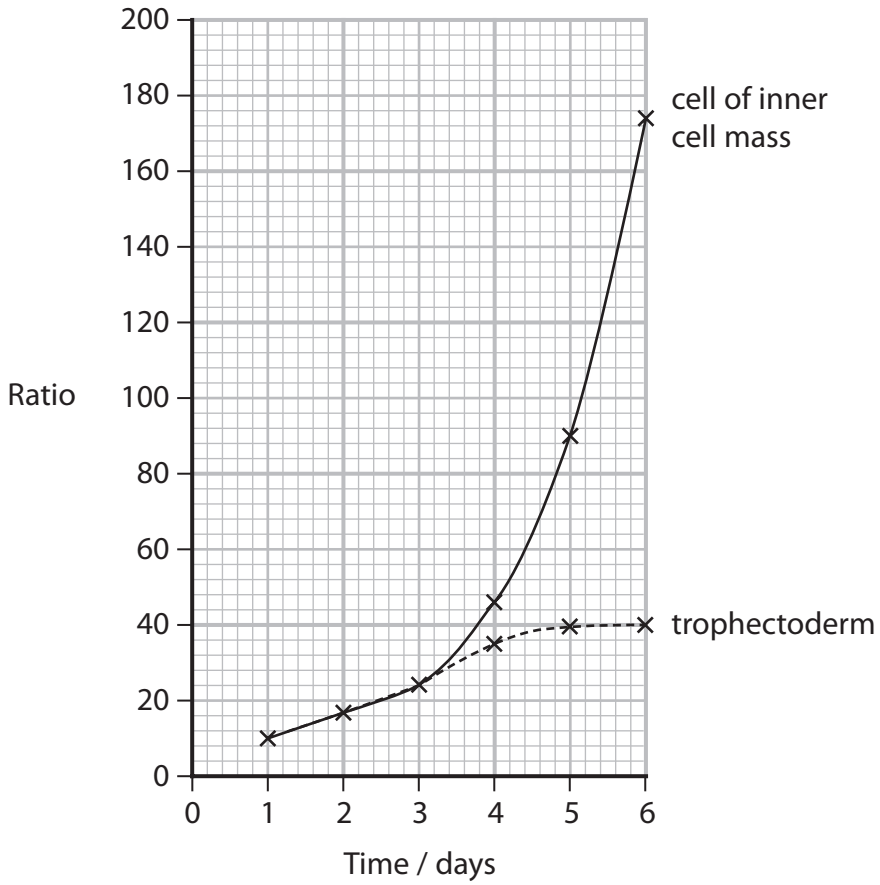
(b) The diagram shows the development of a zygote into a blastocyst.



The graph shows how the ratio of the volume of the nucleus to the volume of the cytoplasm of each embryonic cell changes as the blastocyst develops.



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(i) The ratio shown in the graph can be calculated using the formula

$$\text{ratio} = \frac{\text{volume of nucleus}}{\text{total volume of cell} - \text{volume of nucleus}}$$

On day 2, the volume of the cell nucleus was 900 μm^3.

Calculate the total volume of this cell on day 2.

Give your answer to two significant figures.

(3)

Answer ..... μm^3

(ii) Comment on the changes in the ratios as the zygote develops into a blastocyst.

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(Total for Question 3 = 10 marks)

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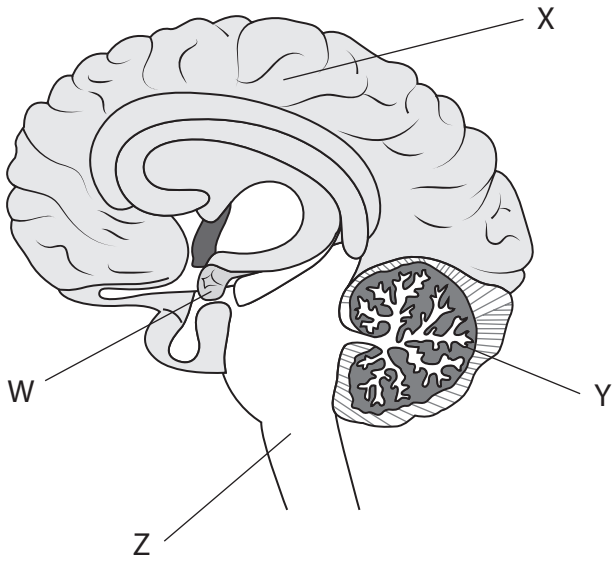
4 The autonomic nervous system controls the heart rate.

(a) The diagram shows a human brain.



(i) Which region of the brain controls the heart rate?

(1)

☒ **A** W

☒ **B** X

☒ **C** Y

☒ **D** Z

(ii) Which one of the following would lead to an increase in heart rate?

(1)

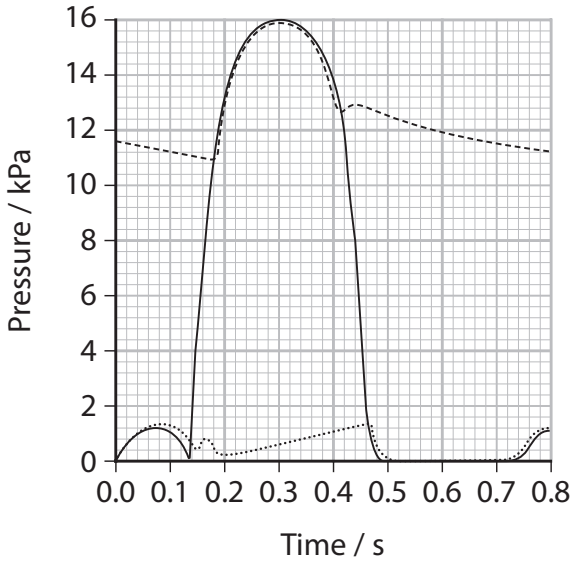
☒ **A** release of acetylcholine by the sympathetic nervous system

☒ **B** release of acetylcholine by the parasympathetic nervous system

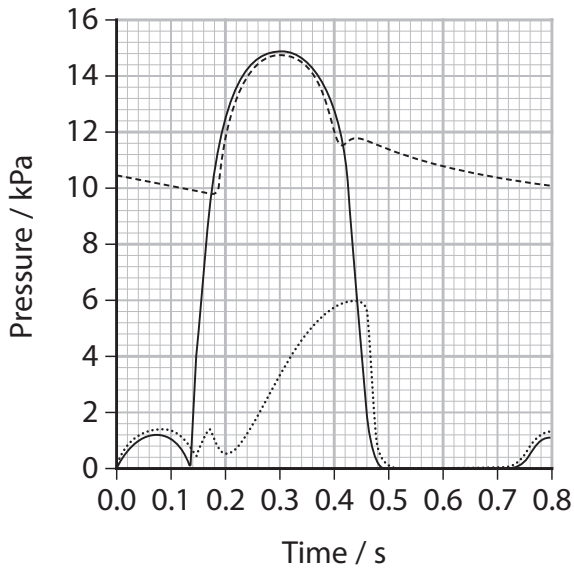
☒ **C** release of noradrenaline by the sympathetic nervous system

☒ **D** release of noradrenaline by the parasympathetic nervous system

(b) The graphs show the pressure changes that occur in a healthy heart and the pressure changes that occur in a heart with an atrioventricular valve that leaks.



Healthy heart



Heart with an atrioventricular valve that leaks

Key

—— left ventricle

- - - - - aorta

····· left atrium

(i) An atrioventricular valve in the healthy heart has a surface area of 3.5 cm^2.

Determine the force that is applied to this atrioventricular valve when it closes.

Use the formula

$$\text{Pressure in kPa} = \frac{\text{Force in newtons}}{\text{Area in m}^2}$$

(3)

Answer ..... newtons

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(ii) Explain why people with an atrioventricular valve that leaks find exercise difficult.

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(Total for Question 4 = 9 marks)

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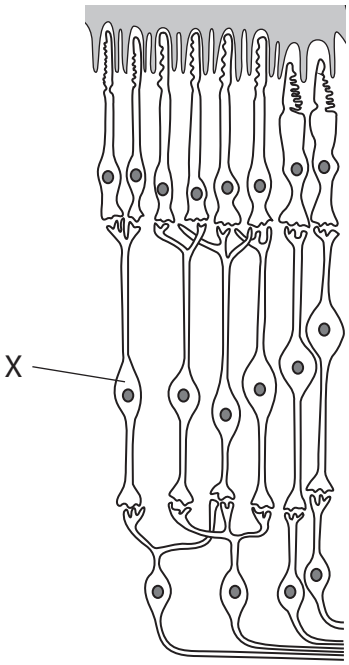
5 The diagram shows a section of a human retina.



(a) Which of the following is the name of the cell labelled X?

(1)

☒ **A** bipolar neurone

☒ **B** ganglion neurone

☒ **C** motor neurone

☒ **D** optic neurone

(b) Explain the role of rhodopsin in the generation of a nerve impulse in cell X when light falls on the retina.

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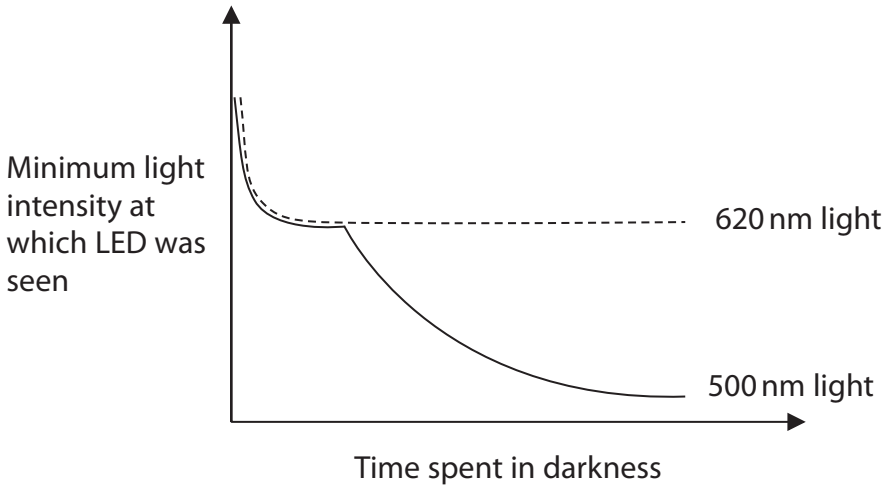
*(c) A scientist investigated the effect of how the length of time a volunteer spent in darkness affected the sensitivity of their retina to light.

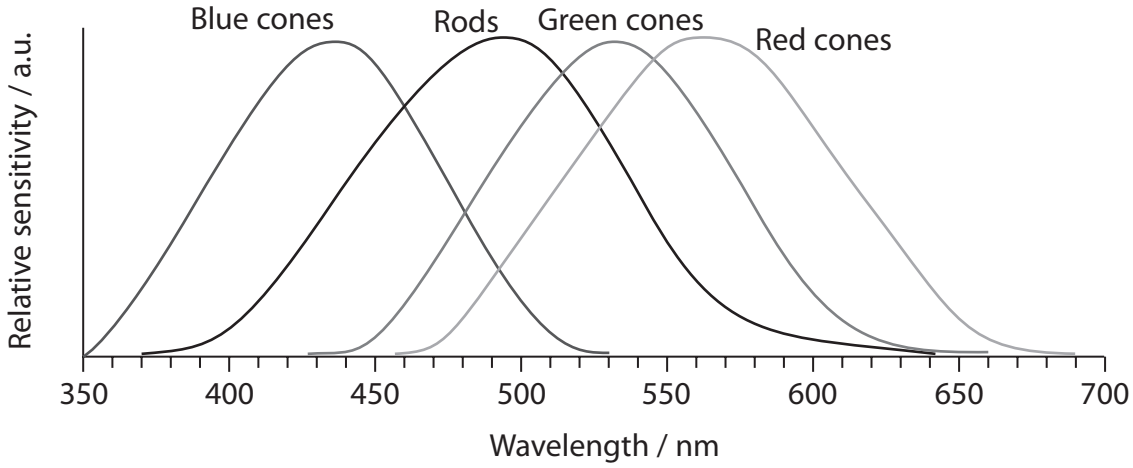
This is the method used:

- the volunteer sat in a room illuminated with white light for twenty minutes
- the lights were switched off and the room was placed into total darkness for one minute
- an LED emitting light of wavelength 500 nm at low light intensity was switched on
- the light intensity was gradually increased until the volunteer was able to see the LED and this minimum light intensity was recorded
- this was repeated with increasing lengths of time that the volunteer was kept in total darkness
- the investigation was then repeated with an LED that emitted red light with a wavelength of 620 nm.

The graph shows the results of this investigation.



The graph shows the relative sensitivity of rods and three types of cone to light of different wavelengths.



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Analyse the graphs to explain the results of this investigation.

(6)

(Total for Question 5 = 10 marks)

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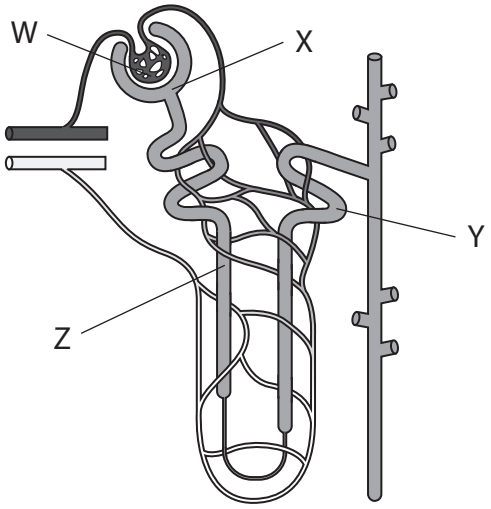
6 The diagram shows a nephron.



(a) Which labelled parts of this nephron would normally contain glucose?

(1)

☒ **A** W only

☒ **B** W and X

☒ **C** W, X, and Y

☒ **D** W, X, Y, and Z

(b) Oedema is an accumulation of tissue fluid. This is due to less tissue fluid being returned to the blood capillaries.

(i) Explain how tissue fluid is returned to capillaries.

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(ii) Furosemides are drugs that are used to reduce oedema. They are diuretics that increase urine production.

Furosemides reduce the active transport of sodium ions by the loop of Henle.

Explain how furosemides cause an increase in urine production.

(4)

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(Total for Question 6 = 8 marks)

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7 The photograph shows a tawny owl. These owls live in areas close to the Arctic Circle.

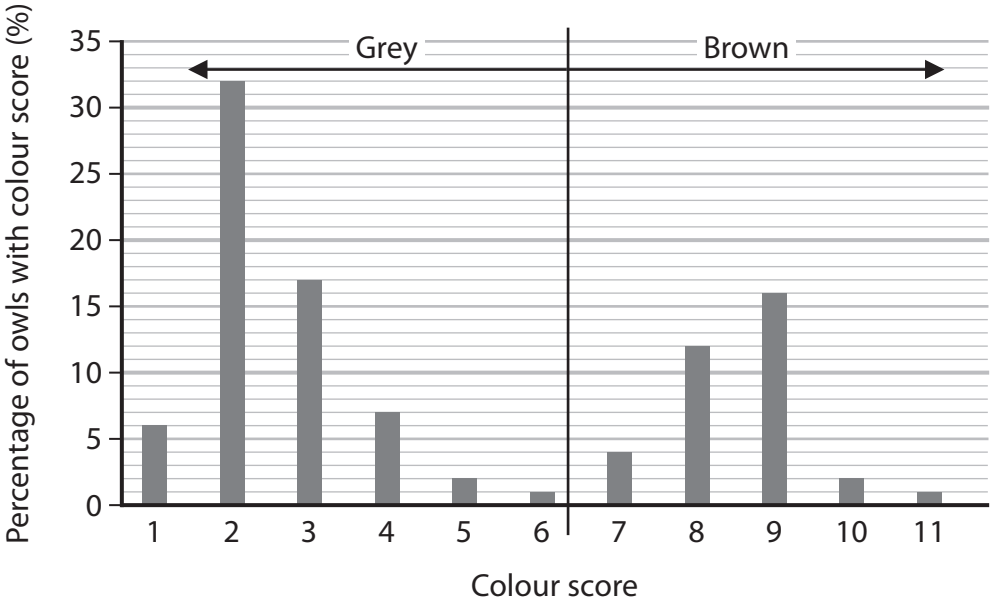
(Source: © LINDA WRIGHT/SCIENCE PHOTO LIBRARY)

Scientists investigated the feather colours of a population of tawny owls. Feather colours of the owls were scored on a scale of 1 to 11, according to how grey or brown they were.

Grey feathered owls were given a score between 6 and 1, with 1 being the most grey.

Brown feathered owls were given a score between 7 and 11, with 11 being the most brown.

The graph shows the percentages of owls in the population with each of the colour scores.



(a) The scientists concluded that feather colour in owls is controlled by a single genetic locus. The brown allele is dominant to the grey allele.

(i) State what is meant by a dominant allele.

(1)

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(ii) Explain the range of feather colours, shown in the graph, in this population of owls.

(2)

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(iii) In this population of 120 owls, 84 of them were grey.

Calculate the number of owls that are heterozygous for feather colour.

Use the Hardy-Weinberg equation

$$p^2 + 2pq + q^2 = 1$$

(3)

Answer .....

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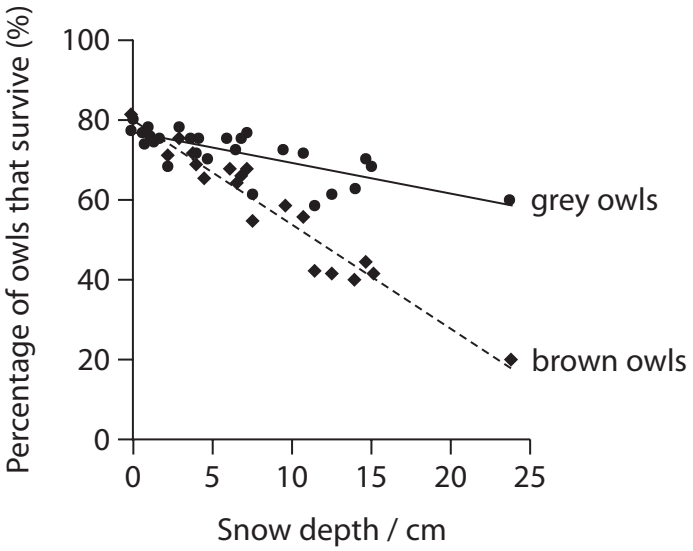
*(b) The scientists investigated the effect of climate change on the frequencies of these two alleles for feather colour in populations of tawny owls.

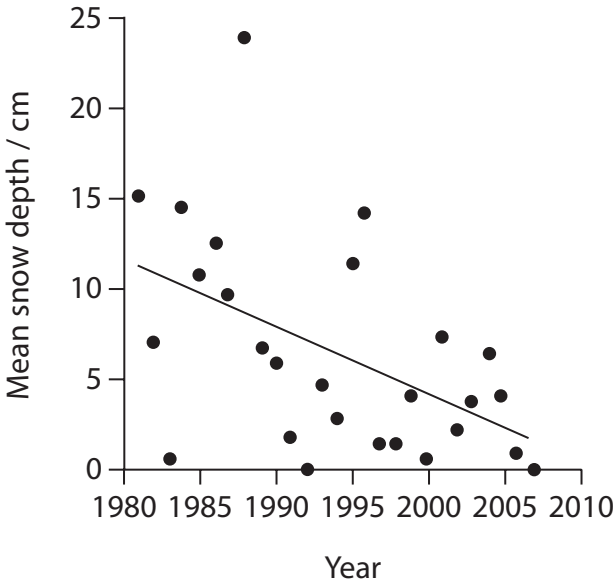
The percentage survival rates of both colours of owl were measured when there were different depths of snow.

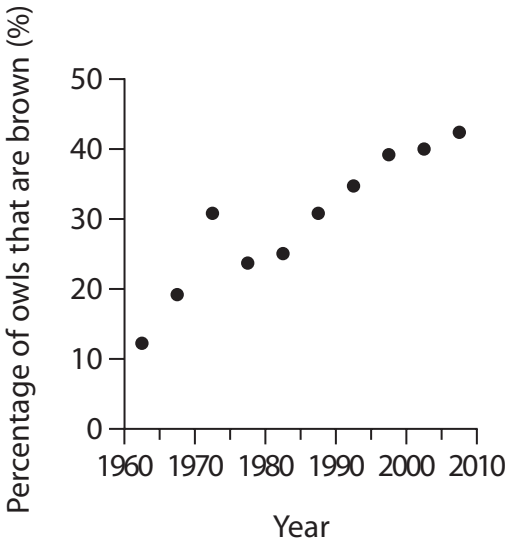
The mean depth of snow was recorded each year between 1980 and 2007.

The percentage of owls that were coloured brown between 1960 and 2007 was also recorded.

The graphs show the results.







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The scientists concluded that increased greenhouse gases from human activity are resulting in an increase in the frequency of the brown allele.

Analyse the data to evaluate this conclusion.

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8 The photograph shows a glacier that is melting. As the glacier gradually melts, it leaves behind bare rock.

(Source: © CHARLES D. WINTERS/SCIENCE PHOTO LIBRARY)

Scientists sampled the soil from areas that had been uncovered for different lengths of time after the glacier ice had melted.

The table shows the results from the samples.

Length of time since glacier melted / years	Soil depth / cm	Mass of nitrate in soil / mg m^{-2}	Mass of leaf litter that falls to ground each year / g m^{-2} yr^{-1}
5	5.2	3.8	1.5
15	6.4	4.1	1.7
40	7.0	5.3	12.8
100	9.2	21.8	277.0
150	10.8	35.4	335.0
200	15.1	53.3	277.0
250	16.2	61.4	261.0

(a) Which of the following should be used to determine if there is an association between length of time since the glacial ice has melted and soil depth?

(1)

☒ **A** chi squared

☒ **B** correlation coefficient

☒ **C** standard deviation

☒ **D** t-test

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(b) Explain how succession brings about the changes in the soil during this period of time.

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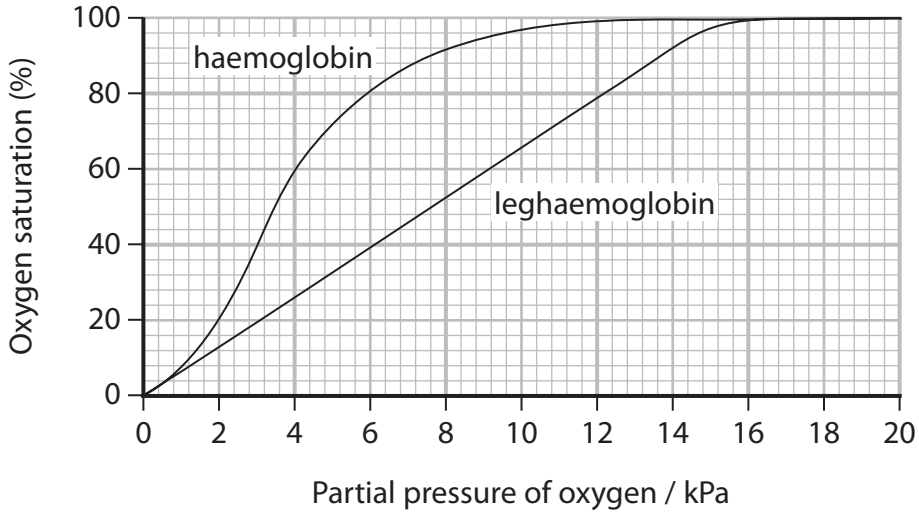
(c) The roots of some of the plants growing around the glacier were found to contain an oxygen binding protein called leghaemoglobin.

The graph shows the oxygen dissociation curve for leghaemoglobin and the oxygen dissociation for haemoglobin.



(i) Leghaemoglobin is a protein that is similar in structure to myoglobin. Both of these proteins have one subunit.

Explain how the oxygen dissociation curve shows that the structure of leghaemoglobin is more similar to myoglobin than to haemoglobin.

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(ii) Explain how leghaemoglobin enables these plants to grow in waterlogged and compact soils.

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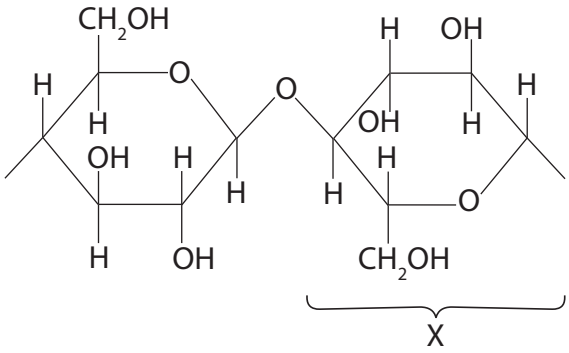
9 In Kenya, an in-situ conservation project has been set up to make paper from elephant dung.

This project aims to help conserve elephant populations, conserve biodiversity and help local communities.

(a) Paper is produced from cellulose molecules present in elephant dung.

The diagram shows part of a cellulose molecule.



(i) Which of the following is the name of the monomer labelled X on the diagram?

(1)

☒ **A** α glucose

☒ **B** β glucose

☒ **C** α ribose

☒ **D** β ribose

(ii) Draw one of the products of the hydrolysis of this part of the cellulose molecule.

(2)

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(iii) Explain how the structure of cellulose is adapted for its function in plant cell walls.

(3)

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(b) Elephant conservation often involves the setting up of protected areas to stop poaching. Local people are banned from entering these areas.

This method of elephant conservation sometimes causes conflict with local people, as elephants can trample and eat crops in nearby farmland. Farmers sometimes burn areas of grassland and forest to stop elephants destroying their farmland.

The new paper conservation project encourages local people to make paper from elephant dung they collect from the conservation area. The paper they make is sold at a high price.

Conservationists measured the effect of the new paper project on the index of diversity of the area over two years. They also measured the effect of a protected conservation area where local people were banned from entering on the index of diversity. The results are shown in the table.

Area	**Index of diversity**	
	At start of project	**After two years**
Conservation area with paper project	2.8	3.6
Conservation area where local people are banned from entering	2.4	2.2

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(i) State why calculating an index of diversity is a better measure of biodiversity than counting the number of different species.

(1)

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(ii) Give two advantages of in-situ conservation of elephants compared with ex-situ conservation of elephants.

(2)

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(iii) Explain the effect of the new paper project on biodiversity compared with the protected area where local people were banned.

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(c) Describe the limitations of CITES in the conservation of organisms such as elephants.

(2)

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(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

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