Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Friday 14 June 2024

Morning (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.*

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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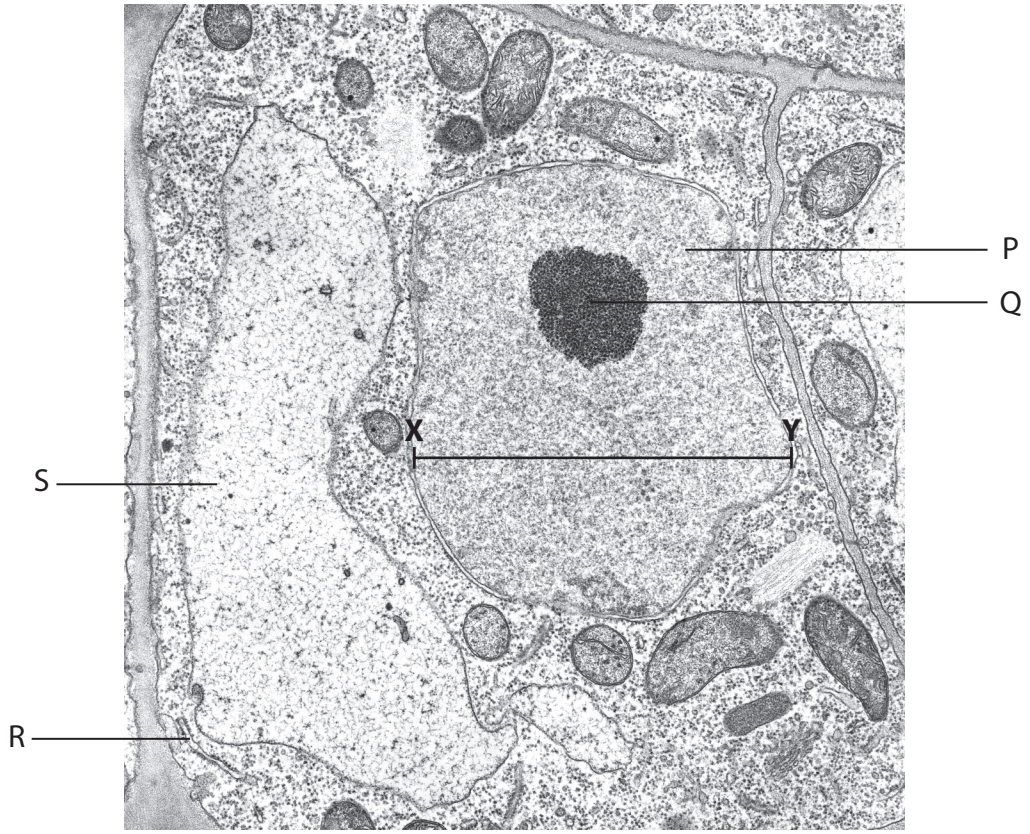
P 7 8 6 6 4 A 0 1 4 0

Pearson

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 The photograph shows part of a root tip cell, as seen with an electron microscope.



(Source: © BIOPHOTO ASSOCIATES / SCIENCE PHOTO LIBRARY)

(a) (i) Which of the following structures is surrounded by a tonoplast?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(ii) In which of the following structures does the process of translation occur?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(iii) How many of the labelled structures in this cell will be present in a cell of an organism in the domain Archaea?

(1)

- ☒ **A** 0
- ☒ **B** 1
- ☒ **C** 2
- ☒ **D** 3

(b) The width of structure P, measured between X and Y, is 36 μm.

Calculate the magnification of this photograph.

Give your answer in **standard form**.

(2)

Answer .....

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(c) Some plants have adaptations that prevent them being eaten by animals.

Sorghum is a plant that stores a substance called dhurrin inside leaf cells in the structures labelled S in the photograph.

Dhurrin is broken down by the enzyme glucosidase to release hydrogen cyanide.

Glucosidase is stored within the chloroplasts of leaf cells.

Hydrogen cyanide inhibits aerobic respiration.

Explain why dhurrin is stored within structure S, and glucosidase is stored separately in the chloroplasts.

(2)

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(Total for Question 1 = 7 marks)

2 The photograph shows tomato flowers.

(Source: © NIGEL CATTLIN / HOLT STUDIOS / SCIENCE PHOTO LIBRARY)

(a) (i) Describe how an embryo sac, containing eight haploid nuclei, is formed inside the ovary of a flower.

(3)

(ii) Which row gives the correct chromosome number in these structures?

(1)

	endosperm cell	generative nucleus of pollen grain	embryo cell
☒ **A**	n	n	2n
☒ **B**	2n	2n	2n
☒ **C**	3n	n	2n
☒ **D**	3n	2n	n

(b) Cereal grains, such as barley, start to germinate after exposure to water.

Which growth substance is released by the embryo during germination to stimulate enzyme production?

(1)

☒ **A** auxin

☒ **B** cytokinin

☒ **C** gibberellin

☒ **D** phytochrome

(c) The colour of tomato fruits is controlled by two genes, each on a different chromosome.

- The flesh colour gene has two alleles, a dominant allele for red flesh (**R**) and a recessive allele for white flesh (**r**).
- The skin colour gene has two alleles, a dominant allele for yellow skin (**T**) and a recessive allele for white skin (**t**).

If a tomato plant has an allele for red flesh (**R**), the tomatoes will always have a red colour regardless of the skin colour.

(i) Which are the possible genotypes for a yellow-coloured tomato?

(1)

☒ **A** **RrTT** only

☒ **B** **rrTt** only

☒ **C** **rrtt** only

☒ **D** **rrTt** and **rrTT**

(ii) A tomato breeder crosses a yellow tomato plant with a red tomato plant that is heterozygous for both genes.

Some of the F1 generation tomatoes are white.

Determine the expected ratios of all the phenotypes of the F1 generation, using a genetic diagram.

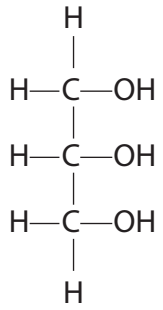
(4)

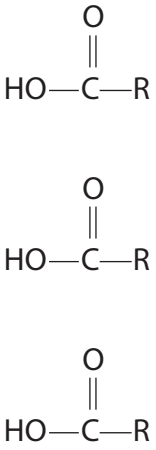
Answer .....

(Total for Question 2 = 10 marks)

3 Fats and oils are lipids synthesised from glycerol and fatty acids.

(a) The diagram shows the structures of glycerol and three fatty acids.





(i) Draw the **triglyceride** that would be produced from these molecules.

(1)

(ii) Which type of reaction produces the triglyceride from these molecules?

(1)

- ☒ **A** condensation, releasing water
- ☒ **B** condensation, using water
- ☒ **C** hydrolysis, releasing water
- ☒ **D** hydrolysis, using water

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(b) The table shows the fatty acid composition of three lipids: almond oil, cocoa butter, and flaxseed oil. These lipids are eaten by humans.

Lipid	Percentage of each fatty acid present (%)				
	Palmitic acid $C_{16}H_{32}O_2$	**Stearic acid $C_{18}H_{36}O_2$**	**Oleic acid $C_{18}H_{34}O_2$**	**Linoleic acid $C_{18}H_{32}O_2$**	**Linolenic acid $C_{18}H_{30}O_2$**
Almond oil	8	1	77	14	0
Cocoa butter	30	36	30	4	0
Flaxseed oil	2	2	18	20	58

(i) Calculate the mass of oleic acid present in 25 g of almond oil.

Give your answer to **two significant figures**.

(1)

Answer ..... g

(ii) Give **one** similarity and **one** difference between the structure of a **saturated** fatty acid and an **unsaturated** fatty acid.

(2)

Similarity

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Difference

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(iii) Analyse the data to comment on which of these lipids are healthier to eat.

(3)

(Total for Question 3 = 8 marks)

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4 Asthma is a condition that causes bronchi (airways) in the lungs to narrow.

Salbutamol is a drug that is often used to treat asthma.

Salbutamol causes muscles to relax to widen the bronchi.

Salbutamol acts by binding to the adrenaline receptors of cells.

(a) Gas exchange in the lungs occurs at the alveoli.

Explain how alveoli are adapted to maximise gas exchange.

(3)

(b) Which of these statements are correct about the action of adrenaline?

1. adrenaline stimulates the release of second messengers inside cells
2. adrenaline binds directly to transcription factors
3. adrenaline causes the activation of enzymes inside the cells

(1)

☒ **A** 1 and 2 only

☒ **B** 1 and 3 only

☒ **C** 1, 2 and 3

☒ **D** 2 and 3 only

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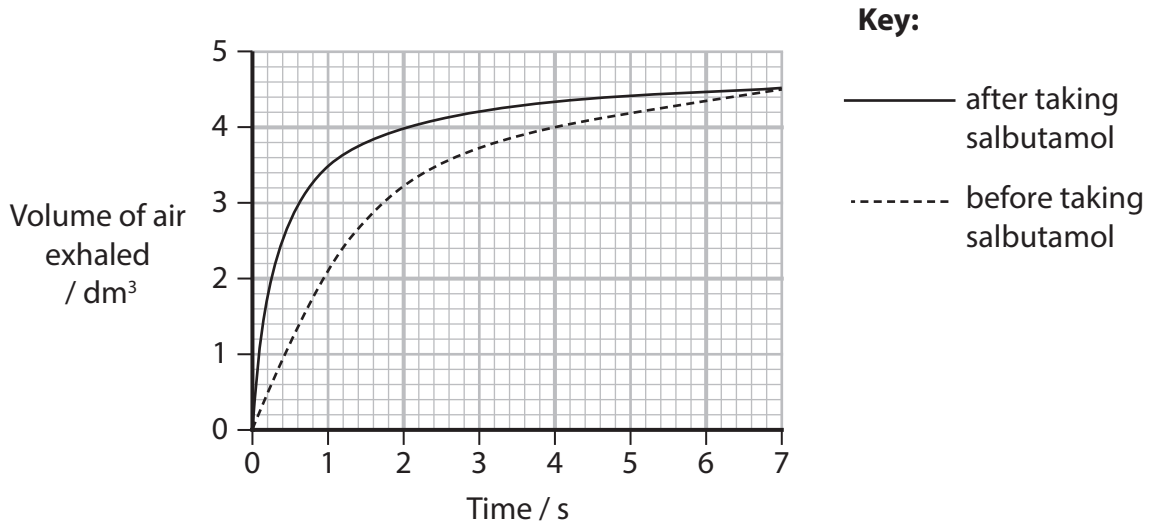
(c) The graph shows the volumes of air breathed out by a person with asthma before taking salbutamol and after taking salbutamol.



(i) Determine the rate of exhalation of air at **one second** after taking salbutamol.

Use a tangent to the curve.

(2)

Answer ..... dm³ per second

(ii) Explain why taking salbutamol increases the concentration of oxygen in the blood compared with not taking salbutamol.

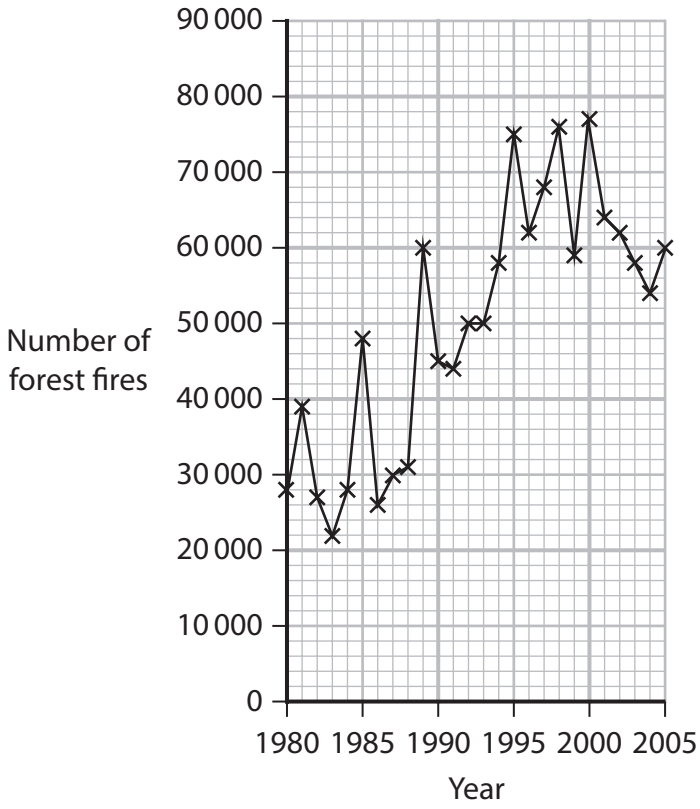
(3)

(Total for Question 4 = 9 marks)

5 Forest fires often occur in areas with old, dry trees.

Graph 1 shows the number of forest fires recorded in Europe from 1980 to 2005.

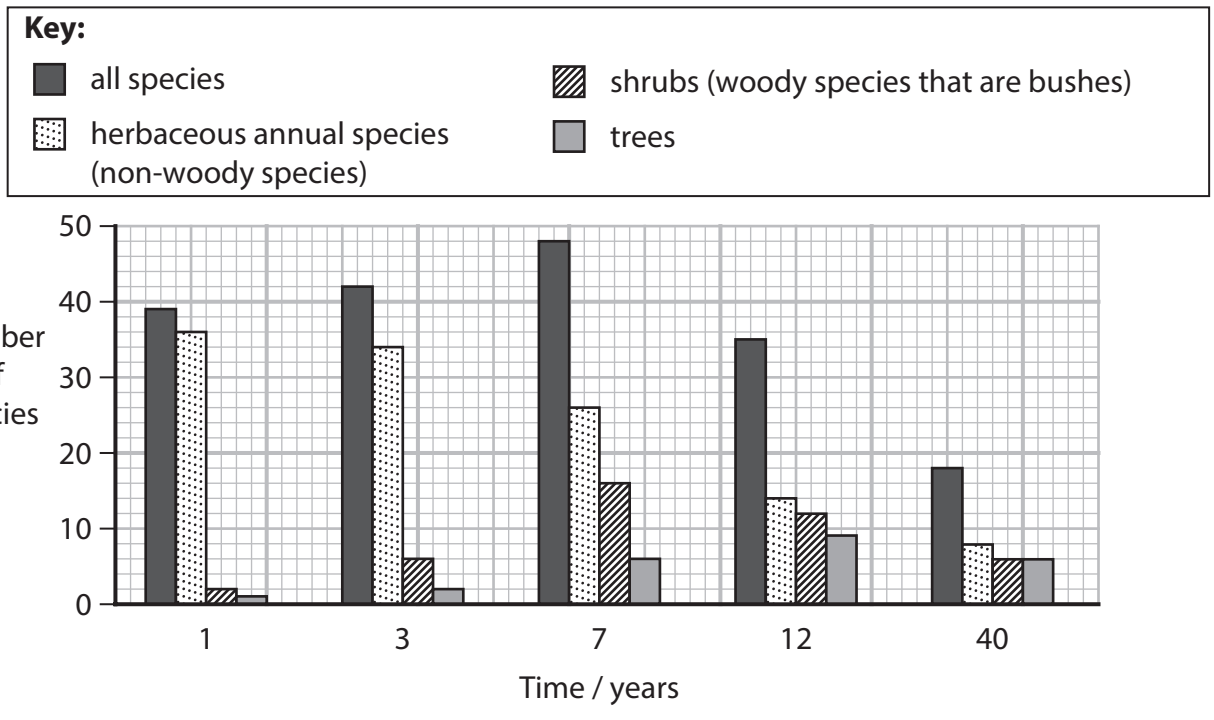
Graph 1



Scientists investigated the changes in plant species for 40 years after a forest fire.

The results are shown in Graph 2.

Graph 2



*(a) Some scientists have stated that the number of forest fires is increasing due to climate change and that measures need to be taken to stop forest fires.

Analyse the data to discuss whether measures to prevent climate change need to be taken to prevent further forest fires.

(6)

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(b) In this investigation, the scientists compared the numbers of different plant species.

The scientists also calculated a diversity index for tree species 40 years after the fire. This index gave a value of 7.33.

The table shows data for an area of forest seven years after the fire.

Tree species	Number of trees
Aleppo pine	45
Silver fir	30
Beech	14
Oak	12
Chestnut	18
Plane	11

(i) Calculate the index of biodiversity (D) for the trees shown in the table for this area of forest.

Use the formula

$$D = \frac{N(N-1)}{\sum n(n-1)}$$

Give your answer to **two decimal places**.

(3)

Answer .....

(ii) State why using the index of diversity is a more valid way of comparing biodiversity of areas than comparing the number of species.

(1)

(iii) Explain why a high species diversity means that an area is more resistant to environmental changes.

(2)

(Total for Question 5 = 12 marks)

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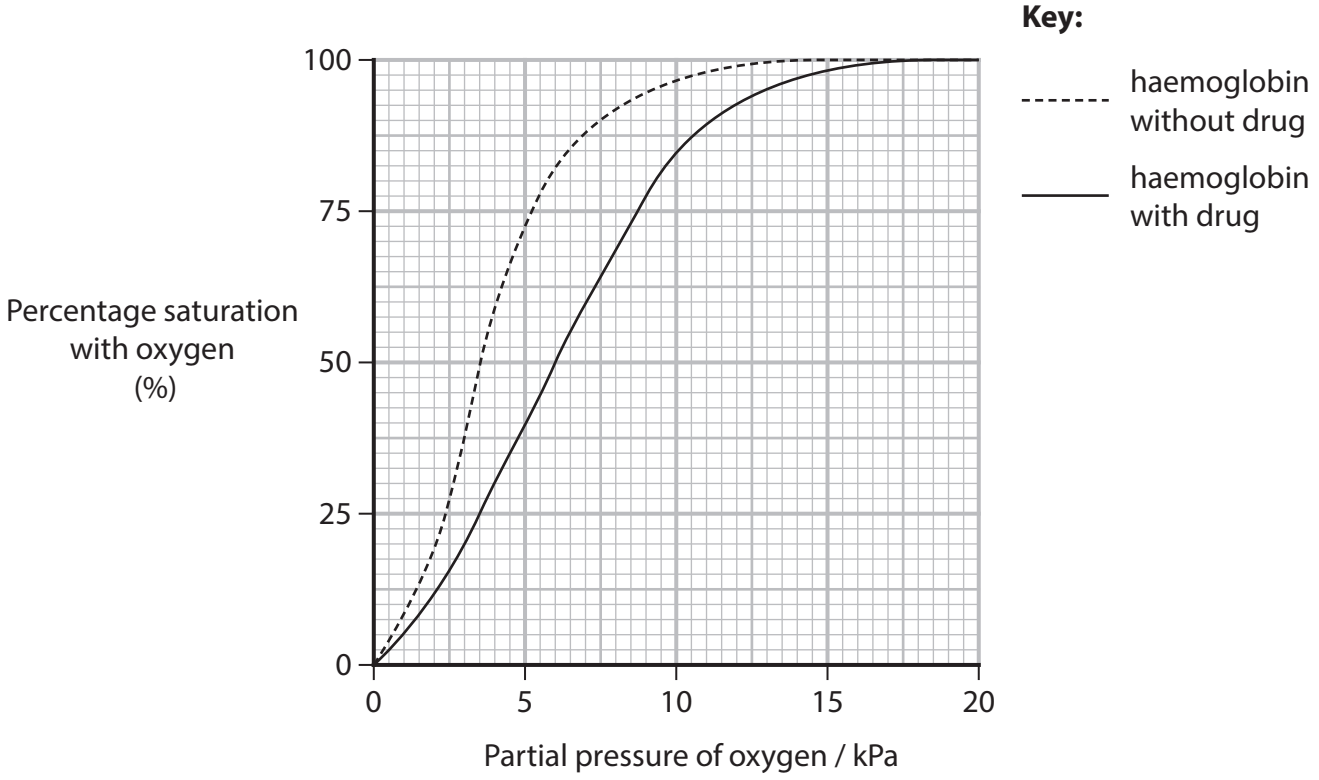
6 Tissue hypoxia is a medical condition that occurs if body tissues cannot get sufficient oxygen from the blood.

Scientists have developed a drug that may help people suffering from tissue hypoxia.

The graph shows the oxygen dissociation curves for haemoglobin from a patient treated with the hypoxia drug and a patient not treated with the drug.



(a) Explain the shape of the haemoglobin dissociation curve without the drug.

(3)

(b) The partial pressure of oxygen in the alveoli is approximately 14 kPa.

Explain why giving a patient the drug is a more effective method of treating tissue hypoxia than increasing the partial pressure of oxygen in the inhaled air.

(3)

(Total for Question 6 = 6 marks)

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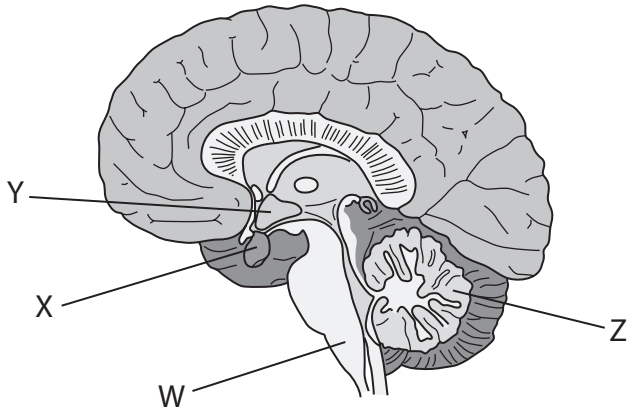
7 Thermoregulation and osmoregulation are examples of homeostasis.

(a) In mammals, the hypothalamus has a role in thermoregulation.

The diagram shows a cross section of a human brain.



Which structure is the hypothalamus?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

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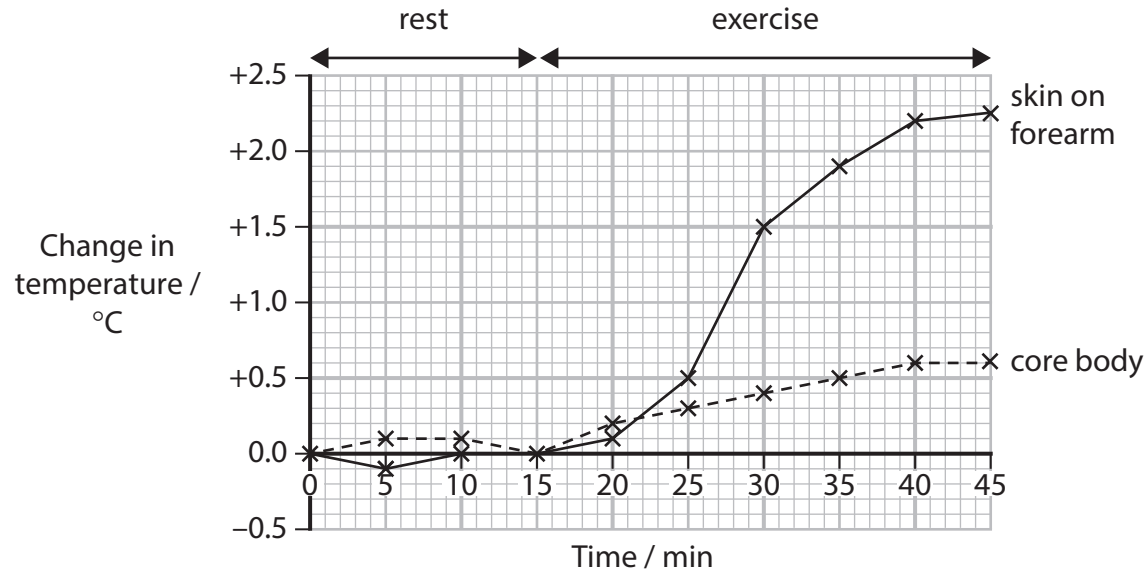
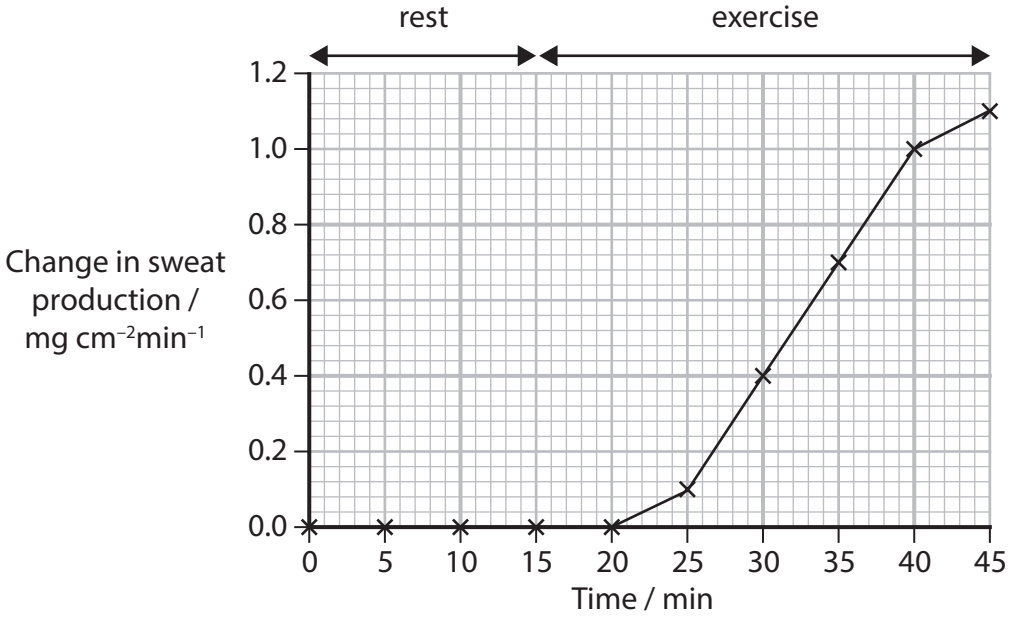
(b) A student investigated the effect of exercise on:

- the change in core body temperature
- the change in skin temperature (on the forearm)
- the change in production of sweat from skin on the chest.

The student monitored these factors every five minutes during 15 minutes of rest, followed by 30 minutes of exercise.

The graphs show the results.





(i) Explain the changes in core body temperature and skin temperature during exercise, using the information in the graphs.

(4)

(ii) Mammals are endotherms.

Give **one** method that **ectotherms**, such as reptiles, can use to thermoregulate.

(1)

(iii) Hypothermia occurs when thermoregulation does not work and the body temperature of a mammal becomes too low.

If the body is unable to thermoregulate, core temperature decreases rapidly.

Explain how **positive feedback** results in a decrease in core body temperature.

(2)

(c) The hypothalamus plays a role in osmoregulation.

Describe how stimulation of the hypothalamus leads to the production of concentrated urine.

(3)

(Total for Question 7 = 11 marks)

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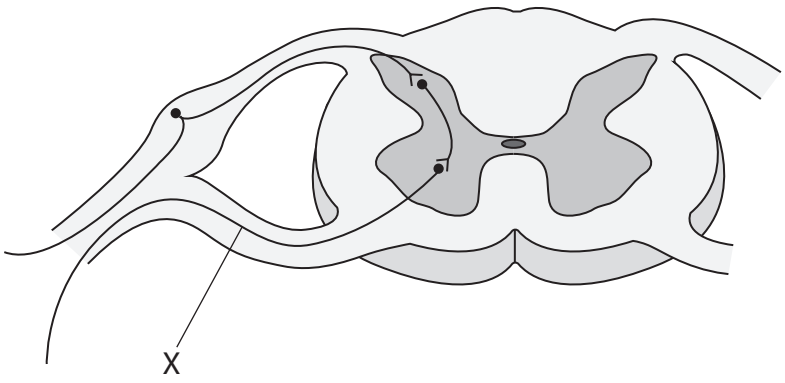
8 Animals use nervous systems to coordinate their behaviour.

(a) The diagram shows a cross section of a spinal cord.



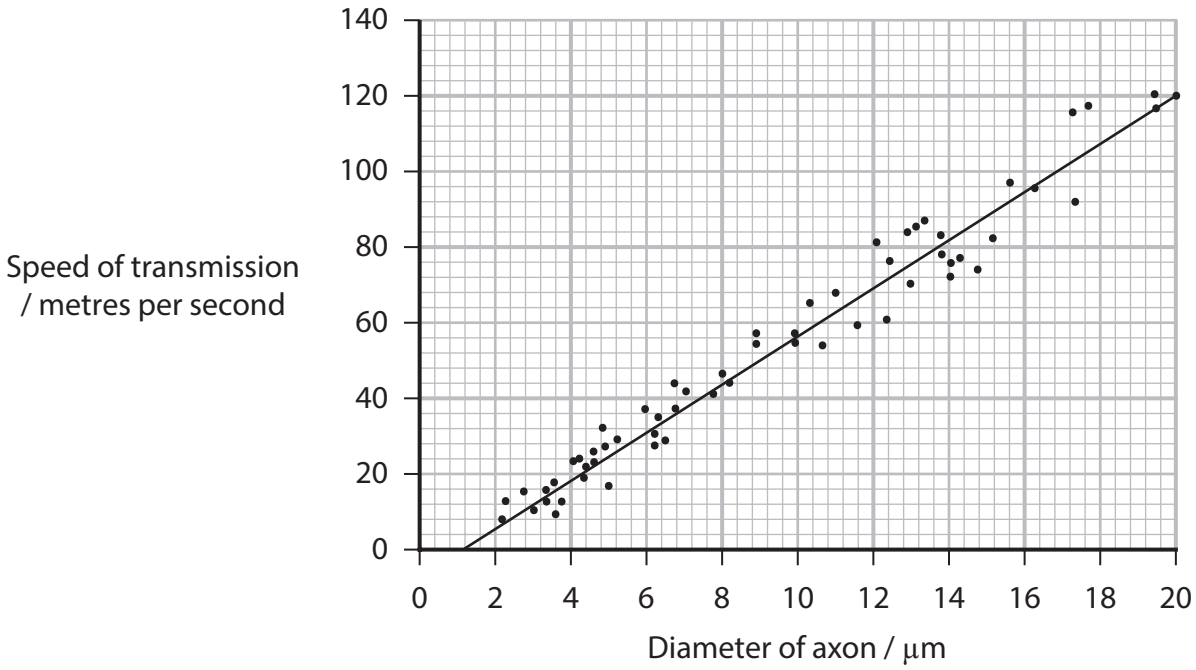
Which of the following are the name and location of the neurone labelled X?

(1)

- ☒ **A** motor neurone in the dorsal root
- ☒ **B** motor neurone in the ventral root
- ☒ **C** sensory neurone in the dorsal root
- ☒ **D** sensory neurone in the ventral root

(b) Most vertebrate neurones are myelinated.

The graph shows the relationship between the speed of transmission of a nerve impulse and the diameter of myelinated axons.



(i) Calculate the distance that an action potential would move in 400 milliseconds along a myelinated axon with a diameter of 12 μm.

Give your answer in metres.

(2)

Answer ..... m

(ii) Some varieties of dog can have delaminating disease when the myelin sheath of neurones is lost.

Explain why dogs with delaminating disease respond more slowly to stimuli.

(2)

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(c) The photograph shows a type of animal called a cone snail.

(Source: © Colin Marshall / Alamy Stock Photo)

Many species of cone snail produce toxins that paralyse their prey.

(i) These toxins are protein molecules held together by disulfide bonds.

Which other types of bond hold together the tertiary structure of a protein?

(1)

☒ **A** hydrogen bonds only

☒ **B** ionic bonds only

☒ **C** hydrogen bonds and ionic bonds only

☒ **D** peptide bonds only

(ii) Describe how the arrival of an action potential at a presynaptic neurone leads to the generation of an inhibitory postsynaptic potential (ipsp) in the postsynaptic neurone.

(4)

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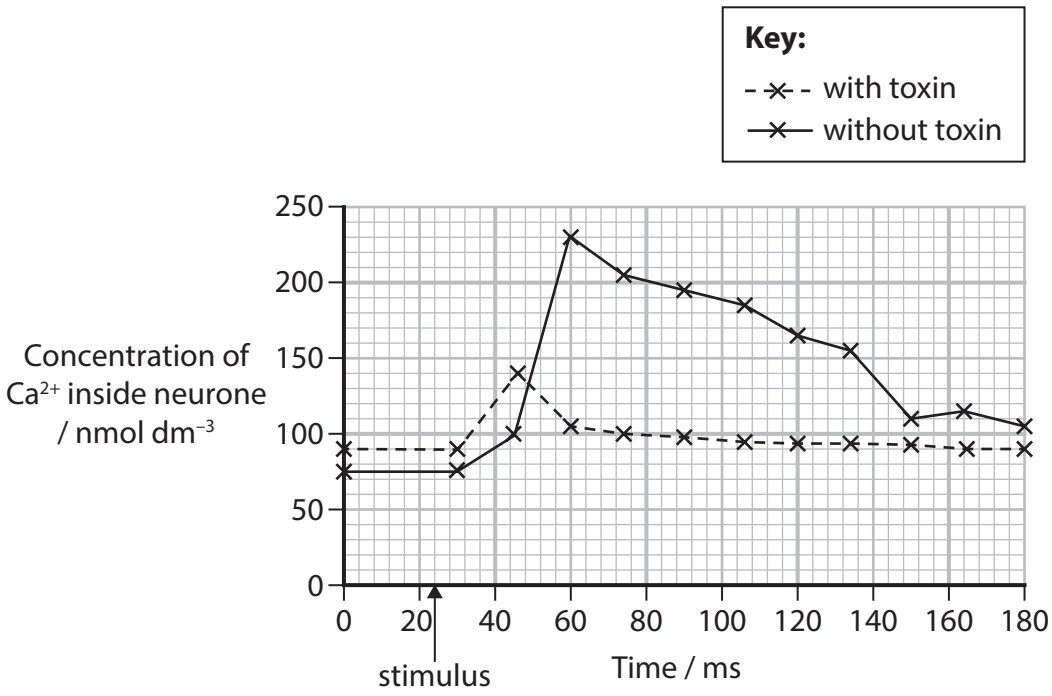
(iii) The graph shows the changes in concentration of calcium ions inside the **presynaptic terminal** of a neurone after stimulation with toxin and without toxin.



Analyse the data to explain why this toxin causes paralysis of prey animals.

(3)

(Total for Question 8 = 13 marks)

9 Asiatic lions are endangered animals. Some of these lions have been kept in zoos for many years.

The photograph shows a group of Asiatic lions.

(Source: © FELIS IMAGES / NATURE PICTURE LIBRARY / SCIENCE PHOTO)

In 2017, a European zoo stated that 392 lions in captivity had died over a period of 14 years. Of these, 80% were less than one year old.

(a) (i) The population of Asiatic lions in the zoo was initially started by breeding from nine lions.

Explain why many of the next generations of lions died before they were one year old.

(2)

(ii) Some of the young lions have a condition of the nervous system caused by a recessive allele.

In wild populations of Asiatic lions, this recessive allele has a frequency of 0.02.

In zoo populations of Asiatic lions, the recessive allele has a frequency of 0.30.

Determine the frequency of heterozygous Asiatic lions in **zoo** populations.

Use the Hardy-Weinberg equation

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

(2)

Answer .....

(iii) State **two** conditions that must occur for allele frequencies to stay constant over several generations.

(2)

1 .....

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2 .....

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(iv) Describe how CITES helps to maintain populations of Asiatic lions in the wild.

(2)

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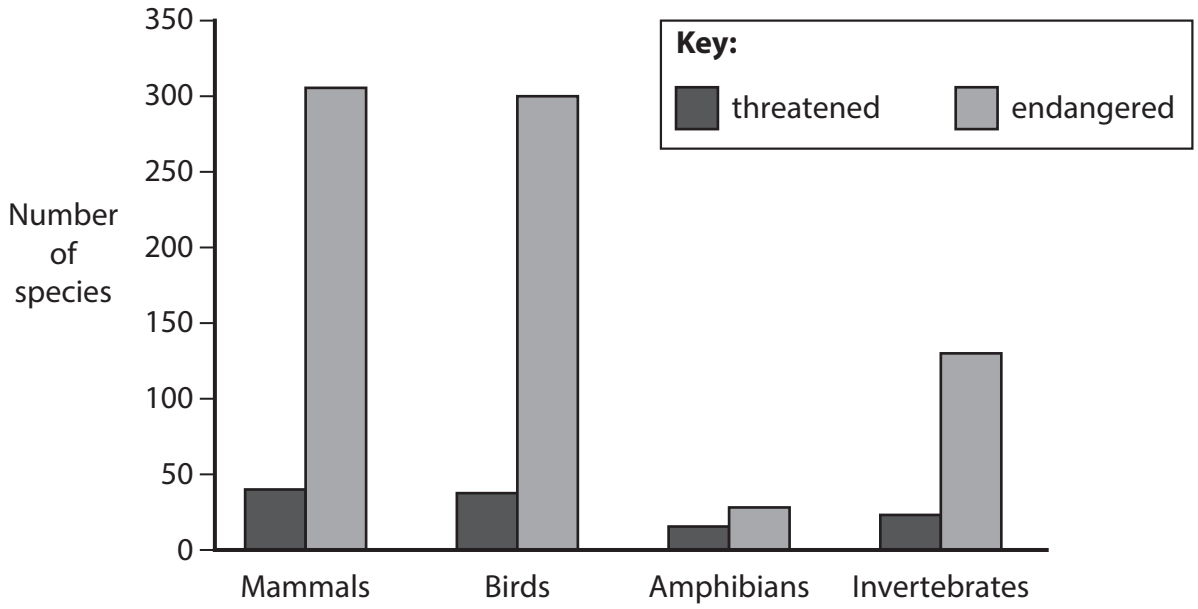
*(b) Zoos keep many species in captivity and also engage in research, ex-situ conservation, and in-situ conservation.

Scientists investigated the roles of zoos in the conservation of different species of mammals, birds, invertebrates, and amphibians.

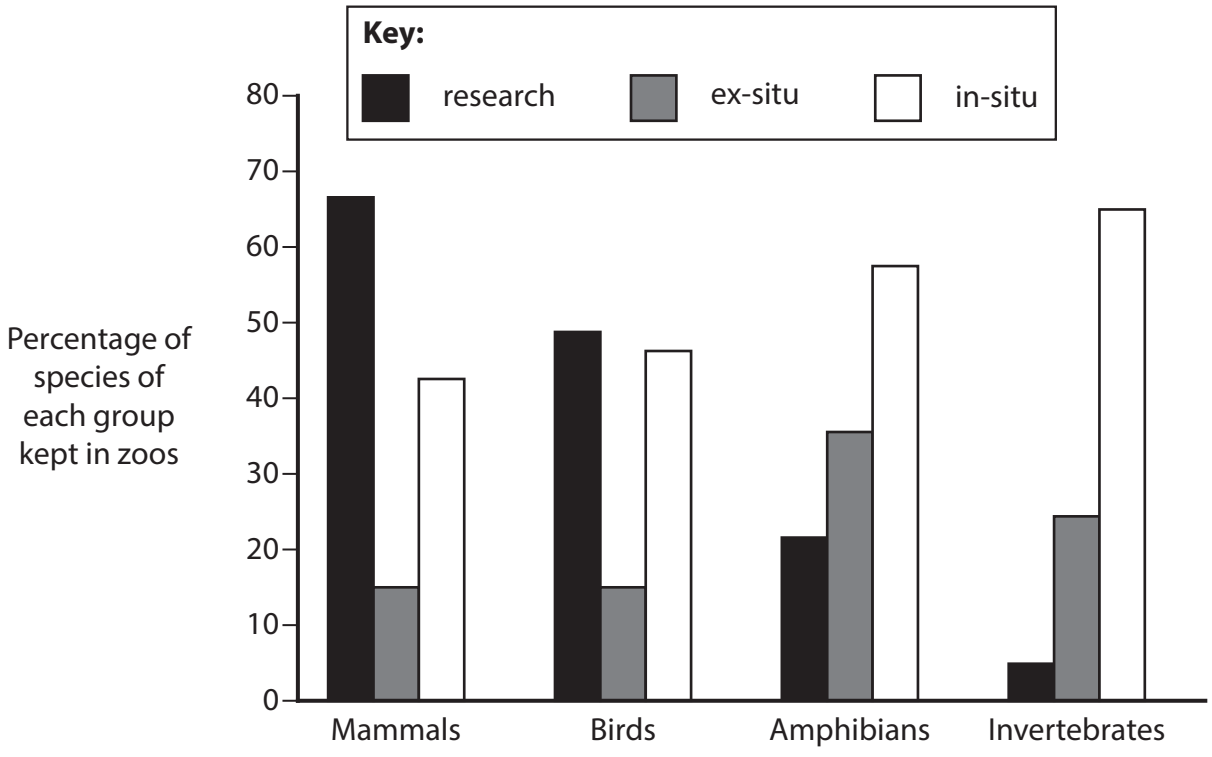
Graph 1 shows the numbers of species of each group that are kept in zoos and listed as being endangered or threatened with becoming endangered.

Graph 2 shows the percentages of species of each group kept in zoos that are used by the zoos for research, for ex-situ conservation, and are overseen for in-situ conservation.

Graph 1



Graph 2



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Analyse the data and use your own knowledge to discuss the effectiveness of zoos as centres for the conservation of animals.

(6)

(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

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