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 13 June 2025

Morning (Time: 2 hours)

Paper reference **9BN0/02**

Biology A (Salters Nuffield)

Advanced

PAPER 2: Energy, Exercise and Coordination

You must have:
Scientific calculator, 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.*

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- 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.

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 5 8 A 0 1 3 2

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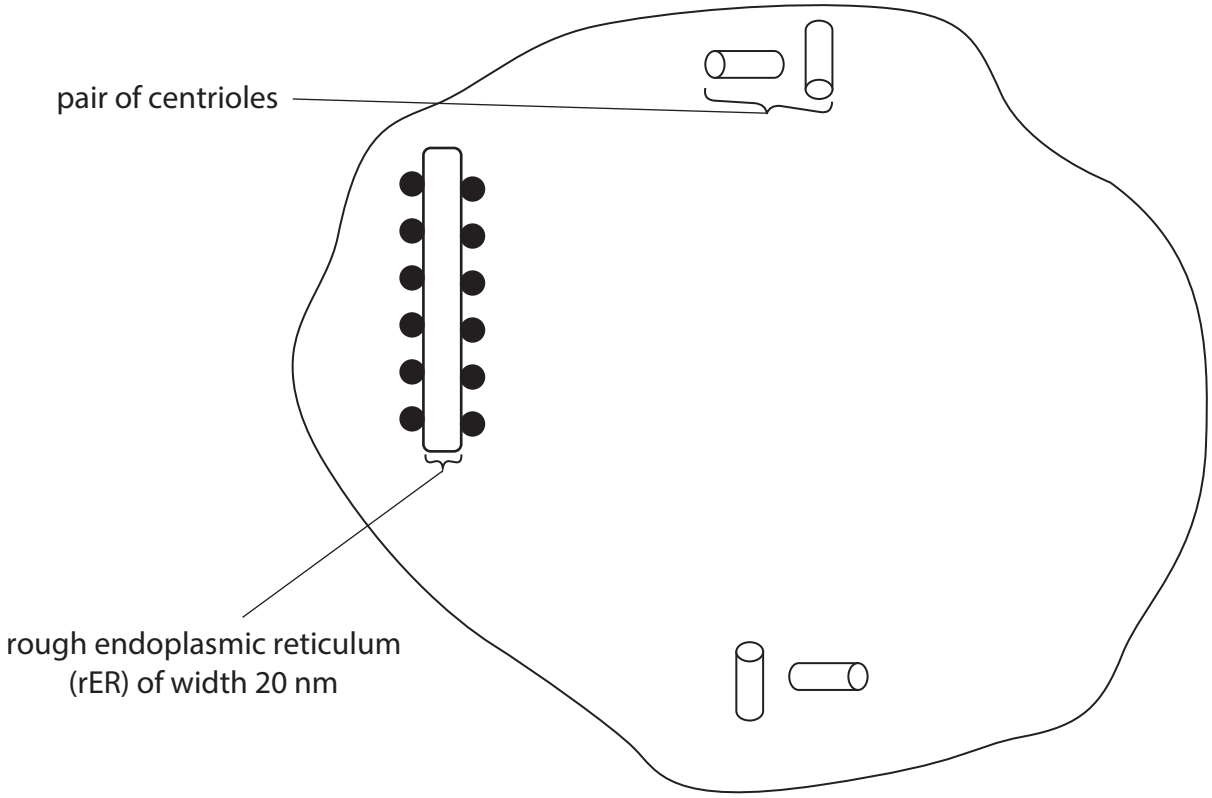
Answer ALL questions. Write your answers in the spaces provided.

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 pancreas is an organ found in the human body.

The pancreas is made up of a number of different cell types including beta cells and acinar cells.

(a) The diagram shows a beta cell from a human pancreas.



(i) Calculate the magnification of this diagram.

(2)

Answer .....

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(ii) A student viewed the diagram and stated that the cell was undergoing mitosis.

Give **two** reasons why this statement is correct.

(2)

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(b) Acinar cells produce the digestive enzyme elastase. Elastase is secreted from the acinar cells as a glycoprotein.

The polypeptide chain for elastase is formed on the ribosomes of the rER.

Describe how this polypeptide is processed to form a glycoprotein and then released from the cell.

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(Total for Question 1 = 8 marks)

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2 A spirometer can produce a trace used to study breathing.

(a) When using a spirometer, the same air is repeatedly inhaled and exhaled. Before the air is inhaled from the spirometer, it passes through soda lime to remove carbon dioxide.

Explain the effect on breathing if the inhaled air is **not** passed through soda lime.

(3)

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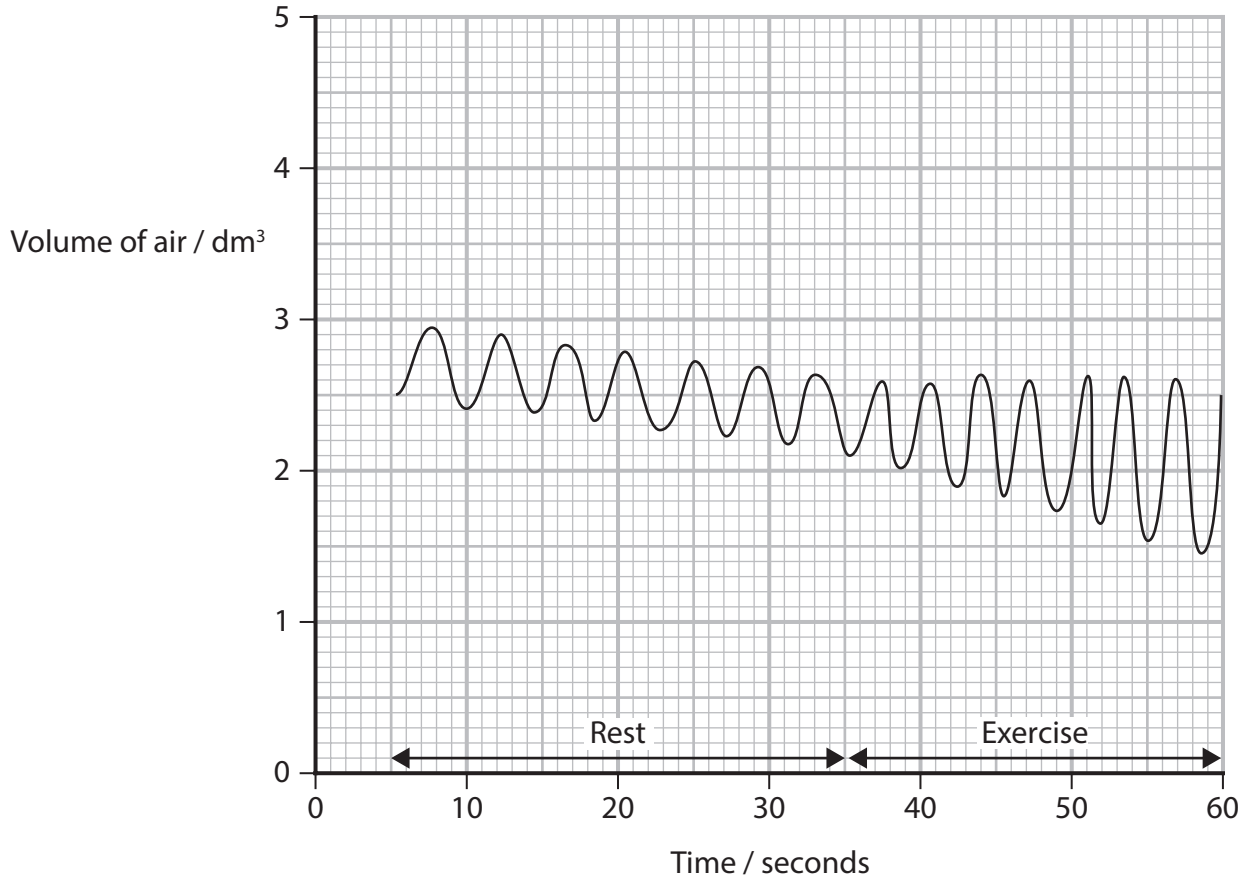
(b) A person at rest used a spirometer for 30 seconds. The person then exercised whilst using the same spirometer.

The results are shown in the trace.



(i) Which is the breathing rate at rest for this person?

(1)

☒ **A** 6 breaths per minute

☒ **B** 7 breaths per minute

☒ **C** 14 breaths per minute

☒ **D** 16 breaths per minute

(ii) The resting respiratory minute ventilation can be calculated using this trace, and the equation:

Resting respiratory minute volume = resting breathing rate (in breaths per minute) × Q

Which is the value of Q?

(1)

☒ **A** 0.5

☒ **B** 1.1

☒ **C** 14

☒ **D** 60

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(iii) Devise an investigation, using a spirometer, to find the change in the rate of oxygen uptake of a person during exercise compared with at rest.

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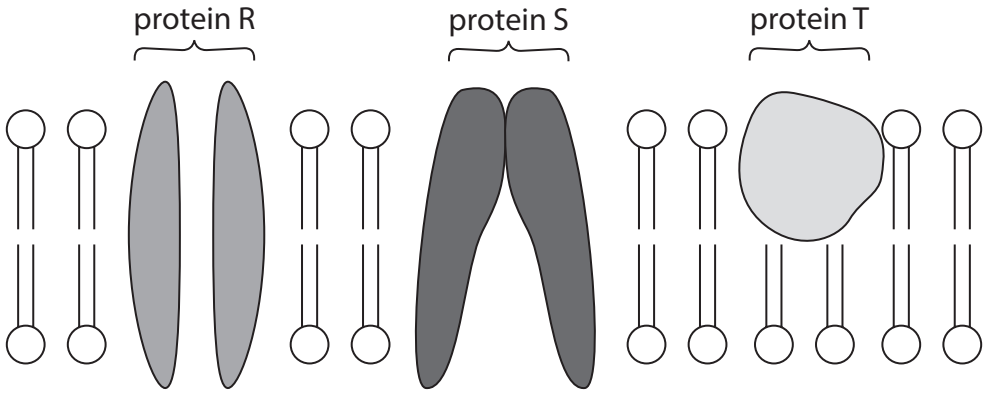
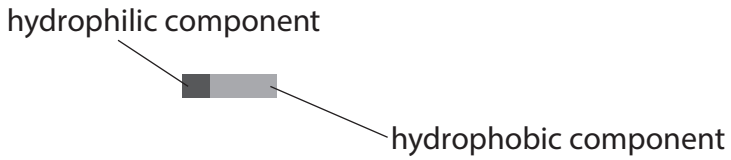
3 All cells have a cell surface membrane that allows some ions to move across.

The diagram shows the fluid mosaic model for the cell surface membrane.



(a) The cell surface membrane also contains cholesterol.

This diagram represents cholesterol.



Describe how the cholesterol is positioned within the phospholipid bilayer.

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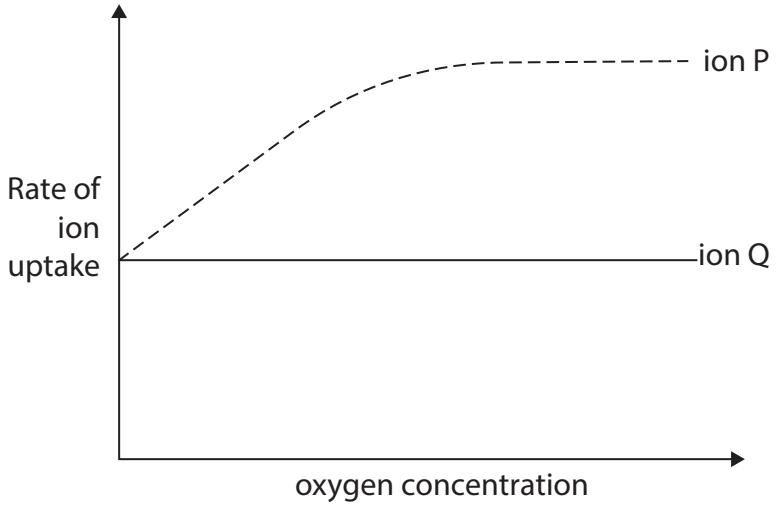
(b) An animal cell, containing proteins R, S and T in its cell surface membrane, was placed in a solution containing two ions, P and Q.

The rate of uptake of both ions was measured as the cell was supplied with an increasing concentration of oxygen.

The results are shown in the graph.



Only one of the proteins labelled R, S and T on the diagram on page 8 allows the uptake of ion P.

This protein changes shape to move ion P.

Explain which protein allows the uptake of ion P.

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(Total for Question 3 = 6 marks)

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4 The human eye can detect both images and a change in light intensity.

(a) Describe the pathway taken by nerve impulses from sensory cells in the eye to the part of the brain that forms the images.

(3)

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(b) The fovea is part of the retina.

In one study, the mean density of photosensitive cells in the fovea was found to be 164 000 ± 24 000 per mm^2.

The mean radius of the fovea is 0.8 mm.

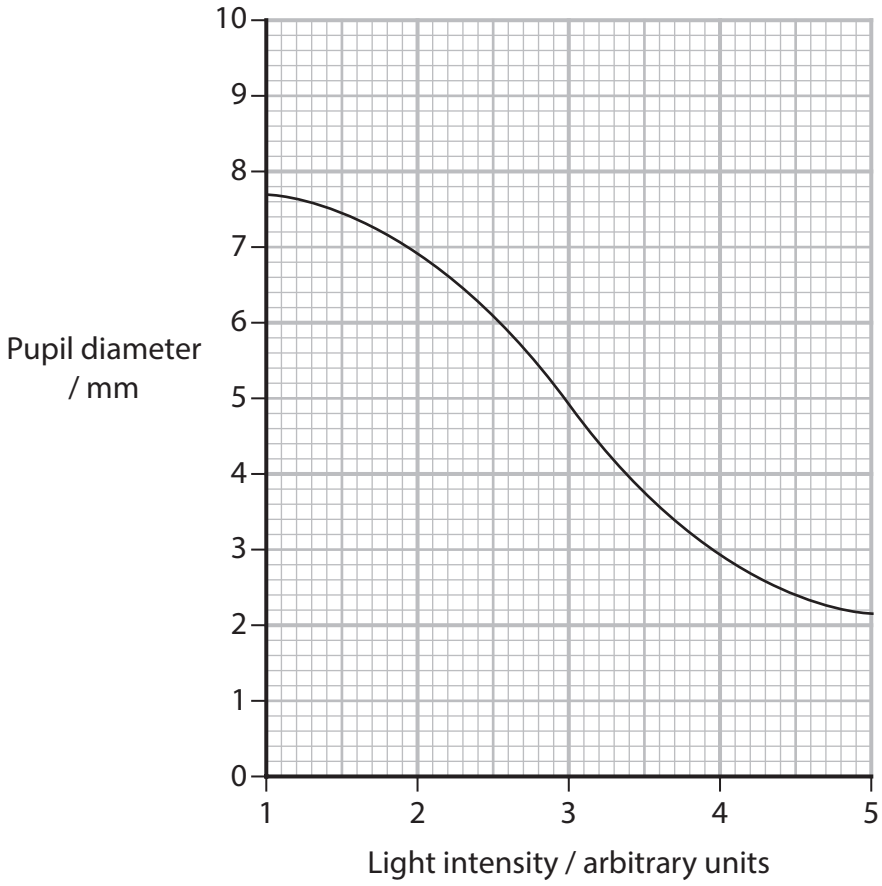
Calculate the maximum number of photosensitive cells present in the fovea.

Give your answer to 3 significant figures.

(3)

Answer .....

(c) The graph shows the relationship between light intensity and pupil diameter.



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Explain the relationship shown in the graph.

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(Total for Question 4 = 10 marks)

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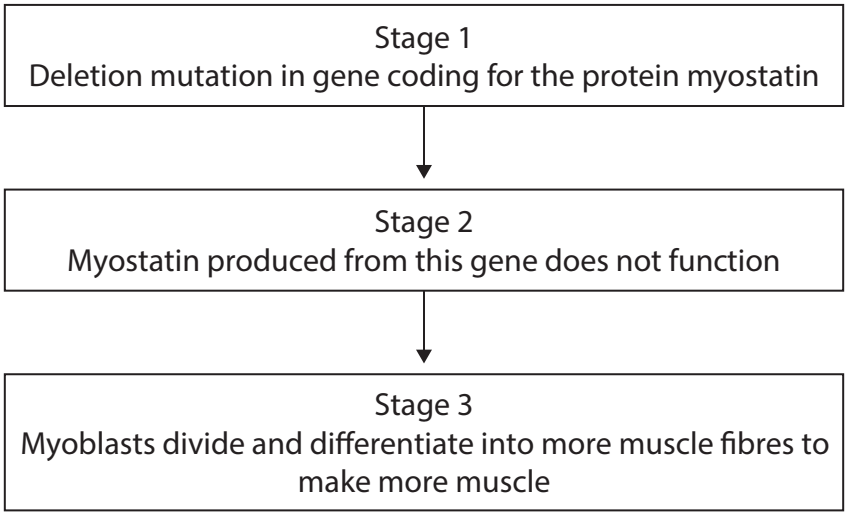
5 The Belgian Blue is a breed of cattle that contains a lot of muscle due to a mutation. The mutation affects cells called myoblasts.

The flow diagram shows some stages that lead to the production of excess muscle.



(a) The base sequence shows 21 bases in one DNA strand of part of the myostatin gene.

T	G	T	G	A	T	G	A	A	C	A	C	T	C	C	A	C	A	G	A	A

(i) Which is the **maximum** number of **different** codons that there would be on the mRNA transcribed from this part of the gene?

(1)

☒ **A** 6

☒ **B** 7

☒ **C** 10

☒ **D** 21

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(ii) The bases shaded are deleted from one strand in the mutated gene (Stage 1).

T	G	T	G	A	T	G	A	A	C	A	C	T	C	C	A	C	A	G	A	A

The two strands of DNA are held together by hydrogen bonds.

There are two hydrogen bonds between adenine (A) and its complementary base and three between the other pair of bases.

Calculate the percentage reduction in the number of hydrogen bonds in this part of the myostatin gene due to the mutation.

Give your answer to one decimal place.

(3)

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(b) Explain why myostatin produced from the mutated gene does not function (Stage 2).

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(c) Mitosis is involved in Stage 3.

Mitosis also has a number of other functions.

Which row is correct?

(1)

		Function	
		asexual reproduction	**repair of cells**
☒	**A**	✓	✓
☒	**B**	✓	✗
☒	**C**	✗	✓
☒	**D**	✗	✗

Key

✗ = is not a function of mitosis

✓ = is a function of mitosis

(d) Each muscle fibre (Stage 3) is a cell.

Which statement identifies a muscle fibre as a cell?

(1)

☒ **A** it contains cytoplasm in which organelles may be present

☒ **B** it has a cell wall containing actin

☒ **C** it has a nucleus that disappears in interphase

☒ **D** it has genetic material

(Total for Question 5 = 9 marks)

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6 Antagonistic muscles interact to control the movement of the legs.

Sprinters need to respond rapidly to the starting signal in a race.

In an investigation, the response time for a group of athletes was studied.

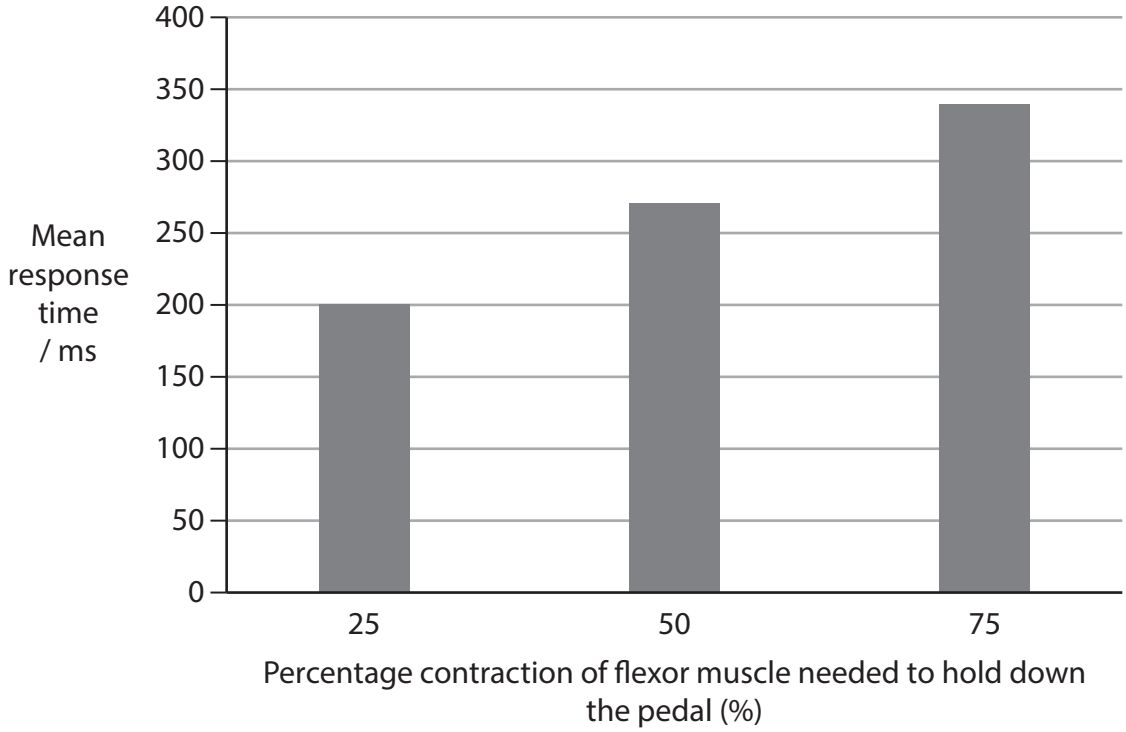
Each athlete contracted a flexor muscle in the leg to hold a pedal down.

When a light was switched off, the athlete released the pedal.

The response time for the flexor muscle to fully relax was recorded.

The investigation was repeated except the percentage muscle contraction needed to hold the pedal down was changed.

The results are shown in the graph.



(a) State the type of muscle that works antagonistically with a flexor muscle.

(1)

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(b) The difference in the mean response time for the 25% contraction and the 50% contraction was significant at the 0.05 level.

Explain what is meant by this difference being significant at the 0.05 level.

(2)

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(c) Which is the relationship between the percentage muscle contraction needed to hold down the pedal and the response time?

(1)

☒ **A** exponential

☒ **B** linear

☒ **C** logarithmic

☒ **D** proportional

*(d) When the investigation was carried out, it took time between the athlete seeing the light switch off and the flexor muscle being fully relaxed.

Explain why there was a delay between the light being switched off and full relaxation of the flexor muscle in this investigation.

Use the results of the investigation and your own knowledge to answer this question.

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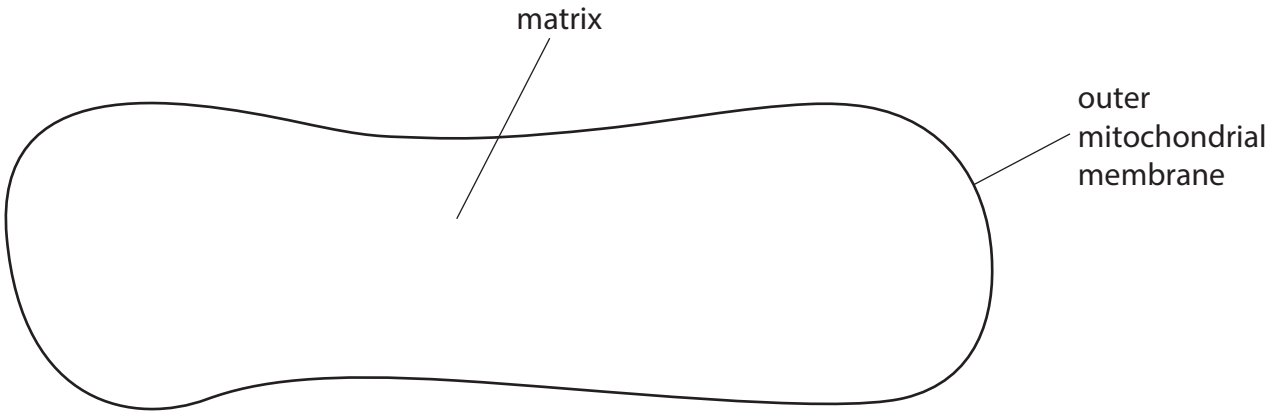
(Total for Question 6 = 10 marks)

7 Aerobic respiration in eukaryotic cells occurs in mitochondria.

(a) Complete the diagram of a mitochondrion to show the internal structure.
Label each structure that is added.

(3)



(b) The matrix of a mitochondrion contains a range of enzymes.

Describe the role of enzymes in the link reaction.

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(c) Proton pumps are found in mitochondria.

Explain the role of proton pumps in aerobic respiration.

(5)

(Total for Question 7 = 12 marks)

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8 *Arabidopsis thaliana* is a plant that uses phytochromes and auxin to respond to changes in the environment.

(a) (i) State **two** ways that the active form of phytochrome (P_{FR}) can be converted to the inactive form (P_R).

(2)

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(ii) *Arabidopsis* is known as a long-day plant.

Explain why *Arabidopsis* will flower when each day has 16 hours of light.

(3)

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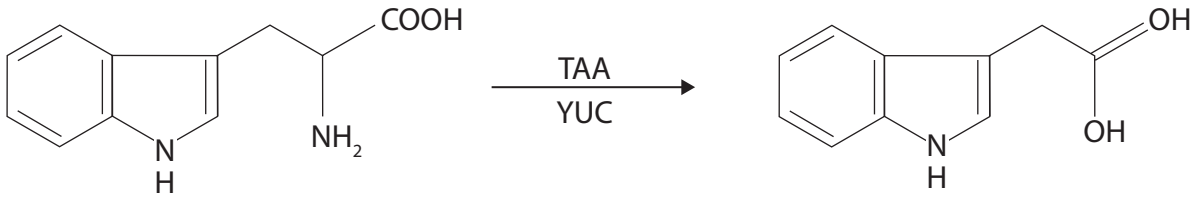
(b) Auxin is made by *Arabidopsis* using molecule Q and the enzymes TAA and YUC, as shown in the diagram.



Molecule Q

Auxin (IAA)

(i) Which type of molecule is Q?

(1)

☒ **A** amino acid

☒ **B** nucleic acid

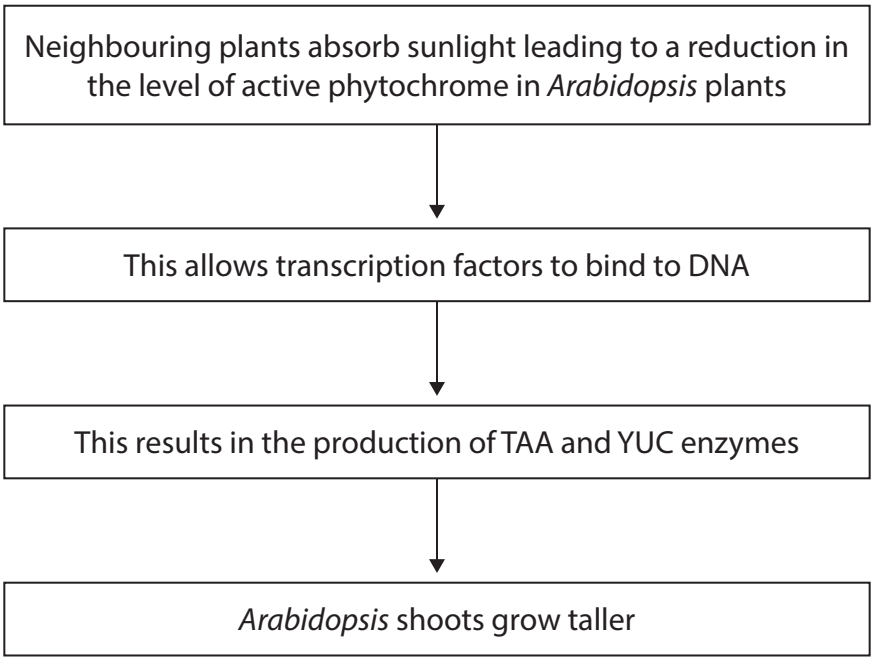
☒ **C** nucleotide

☒ **D** protein

*(ii) Phytochromes and auxin are involved in the response of *Arabidopsis* plants to the presence of other plants growing nearby.

Arabidopsis plants grow taller if there are many neighbouring plants competing for sunlight.

The diagram shows some of the stages in this response.



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Explain how neighbouring plants competing for light result in *Arabidopsis* plants growing taller.

Use the information provided and your own knowledge to answer the question.

(6)

(Total for Question 8 = 12 marks)

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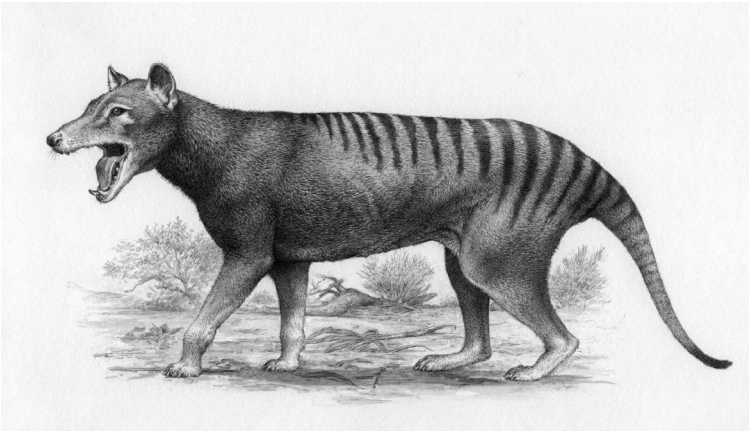
9 The picture shows a thylacine (Tasmanian tiger), a mammal believed to have become extinct during the twentieth century.



(Source: © JOHN SIBBICK/SCIENCE PHOTO LIBRARY)

Some scientists are hoping to produce living thylacines. The scientists are planning to use preserved thylacine DNA, stem cells from closely-related species and gene technology.

(a) (i) Describe how stem cells can be made to differentiate into different specialised cells.

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(ii) Explain why the scientists plan to use stem cells from closely-related species.

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(iii) Explain **one** reason for using stem cells from more than one individual of the same species to produce a population of thylacines that can survive for a long time.

(2)

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(b) Gene technology uses restriction enzymes and ligases.

(i) Which type of bond is hydrolysed by a restriction enzyme during gene technology?

(1)

☒ **A** ester

☒ **B** hydrogen

☒ **C** peptide

☒ **D** phosphodiester

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(ii) Determine the number of condensation reactions that occur when ligase joins a single gene to a bacterial plasmid.

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10 Angina is a painful condition caused by a narrowing of the coronary arteries that supply heart muscle with oxygen.

This narrowing can be caused by atheroma partially blocking the artery lumen.

(a) (i) Which structure supplies the coronary artery with oxygenated blood?

(1)

☒ **A** aorta

☒ **B** left atrium

☒ **C** pulmonary artery

☒ **D** right ventricle

(ii) Explain why angina is likely to be more painful during exercise than when at rest.

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(iii) Describe the events that occur in a coronary artery that lead to the formation of an atheroma.

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(b) Angina can lead to a raised heart rate.

A substance found in a plant, Roselle (*Hibiscus sabdariffa*), has been shown to reduce heart rate in humans.

In humans, this substance was effective at a dose of 15 mg kg^{-1} of human body mass.

(Source : © K JAYARAM/SCIENCE PHOTO LIBRARY)

Roselle (*Hibiscus sabdariffa*)

(i) Why was the substance given at a dose of 15 mg kg^{-1} of human body mass and not just at 15 mg?

(1)

☒ **A** so each person is given the same mass of substance

☒ **B** so the data is more precise

☒ **C** to allow a valid comparison between humans

☒ **D** to control the dependent variable

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(ii) Devise an investigation to find the mean minimum concentration of this substance that will lower the heart rate in *Daphnia*.

(5)

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS

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