Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel Level 3 GCE**

Centre Number | | | | | |

Candidate Number | | | | |

# Thursday 11 June 2020

Morning (Time: 1 hour 45 minutes) | Paper Reference **9BI0/02**

# Biology B

## Advanced

## Paper 2: Advanced Physiology, Evolution and Ecology

**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.

## 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.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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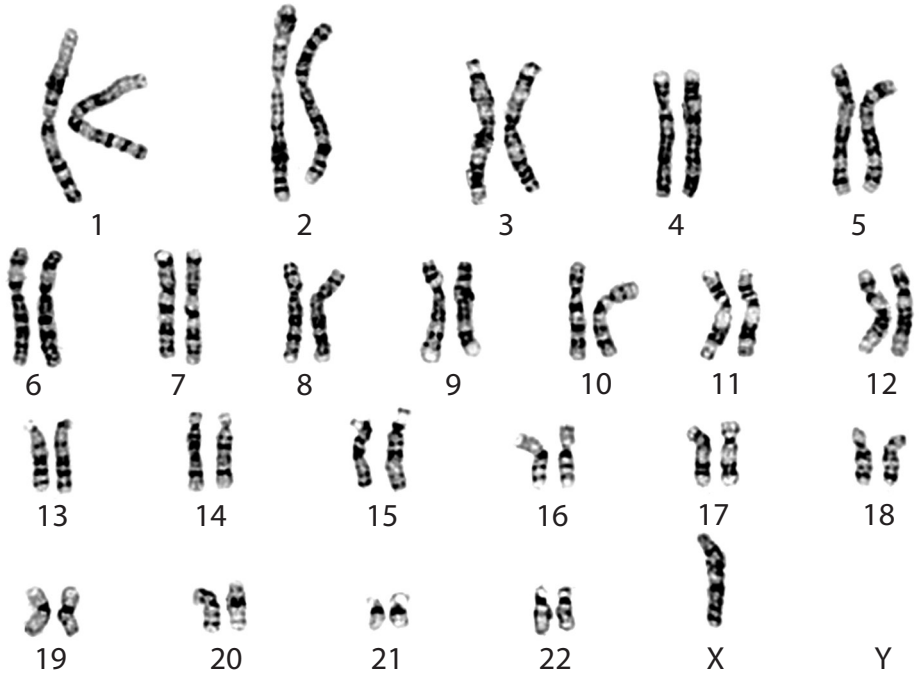
**Answer ALL questions.**

**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** A karyotype shows the chromosomes found in the cells of an individual.

The photograph shows a karyotype from a child with a genetic condition.




(Source: © Dept. of Clinical Cytogenetics, Addenbrookes Hospital / Science Photo Library)

(a) (i) Which of the following identifies the genetic condition shown in the photograph?

**(1)**

☒ **A** Down's syndrome due to monosomy

☒ **B** Down's syndrome due to polysomy

☒ **C** Turner's syndrome due to monosomy

☒ **D** Turner's syndrome due to polysomy

(ii) Which process would have caused the genetic condition shown by this karyotype?

**(1)**

☒ **A** base insertion

☒ **B** base substitution

☒ **C** non-disjunction

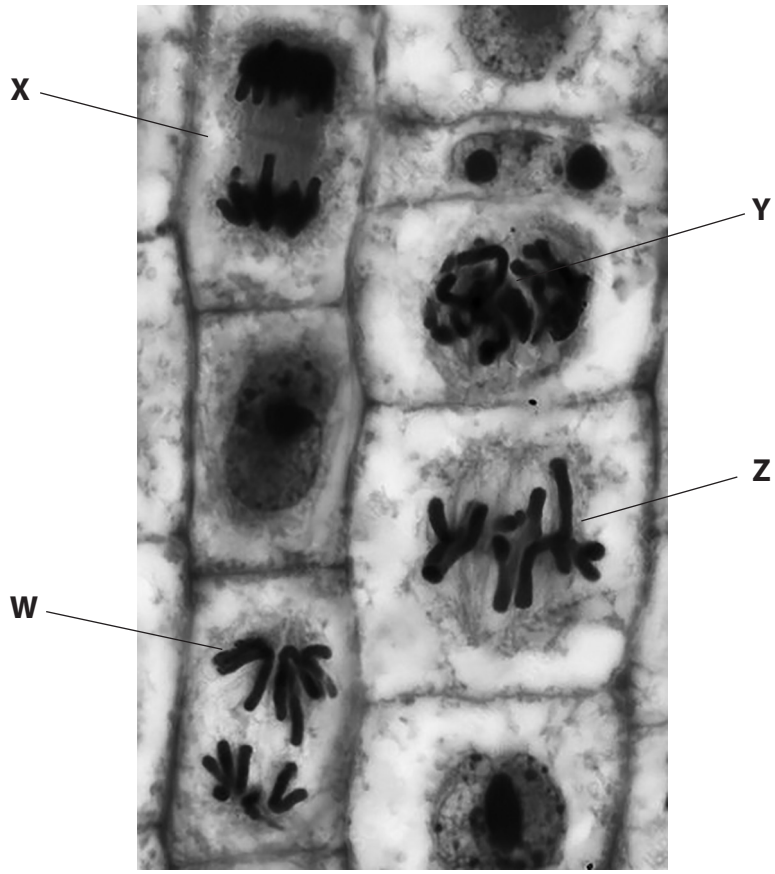
☒ **D** translocation

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(b) The photograph shows cells in different stages of mitosis.




(Source: © STEVE GSCHMEISSNER / Science Photo Library)

(i) Which of the following correctly identifies the stages shown in the photograph?

**(1)**

| | W | X | Y | Z |
|---|---|---|---|---|
| ☒ **A** | anaphase | telophase | prophase | metaphase |
| ☒ **B** | anaphase | prophase | telophase | metaphase |
| ☒ **C** | prophase | anaphase | metaphase | telophase |
| ☒ **D** | telophase | metaphase | anaphase | prophase |

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(ii) Colchicine is a chemical that inhibits mitosis.

A student investigated the effect of colchicine on mitosis.

Two sets of genetically identical cells were grown in culture. Colchicine was added to one culture of cells but not to the other culture of cells.

Six hours after treatment, the mean percentages of cells in each stage of mitosis were determined.

The results are shown in the table.

| Mitosis stage | Mean percentage of cells in stage ± Standard Deviation | |
|---|---|---|
| | cells cultured without colchicine | cells cultured with colchicine |
| interphase | 84.8 ± 4.2 | 82.8 ± 3.2 |
| prophase | 10.2 ± 2.2 | 16.3 ± 3.1 |
| metaphase | 1.8 ± 0.4 | 0.8 ± 0.2 |
| anaphase | 1.8 ± 0.2 | 0.7 ± 0.1 |
| telophase | 1.4 ± 0.3 | 0.4 ± 0.1 |

Analyse the data to comment on how colchicine affects mitosis.

**(4)**

**(Total for Question 1 = 7 marks)**

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**2** Acetylcholine is a neurotransmitter produced by the parasympathetic nervous system.

(a) Describe the process by which acetylcholine is released from a synapse.

**(4)**

(b) Some chemical pesticides, such as diisopropyl fluorophosphate (DFP), affect the activity of synapses.

This pesticide acts by binding irreversibly to the R group of an amino acid in the active site of acetylcholinesterase.

(i) Explain why DFP inhibits the activity of acetylcholinesterase.

**(2)**

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(ii) Explain why a person poisoned with DFP has a slower heart rate.

**(3)**

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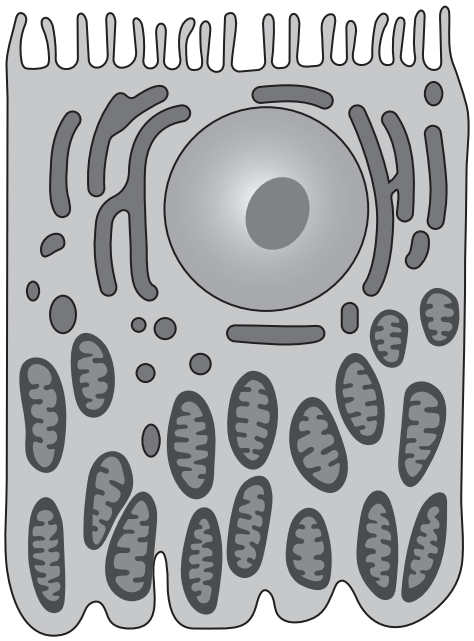
**(Total for Question 2 = 9 marks)**

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**3** (a) The diagram shows a cell from the proximal convoluted tubule of the nephron.



Explain how the features shown in the diagram enable this cell to carry out its function.

**(4)**

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(b) (i) Which of the following statements about facilitated diffusion are correct?

**(1)**

1. substances move through membrane proteins
2. substances move against a concentration gradient
3. substances move down a concentration gradient
4. substances move between phospholipids

☒ **A** 1 and 2

☒ **B** 1 and 3

☒ **C** 2 and 3

☒ **D** 2 and 4

(ii) The collecting duct is also part of the nephron.

Which of the following are the effects of increased release of antidiuretic hormone (ADH)?

**(1)**

☒ **A** decreased permeability of the collecting duct to water, producing more concentrated urine

☒ **B** decreased permeability of the collecting duct to water, producing more dilute urine

☒ **C** increased permeability of the collecting duct to water, producing more concentrated urine

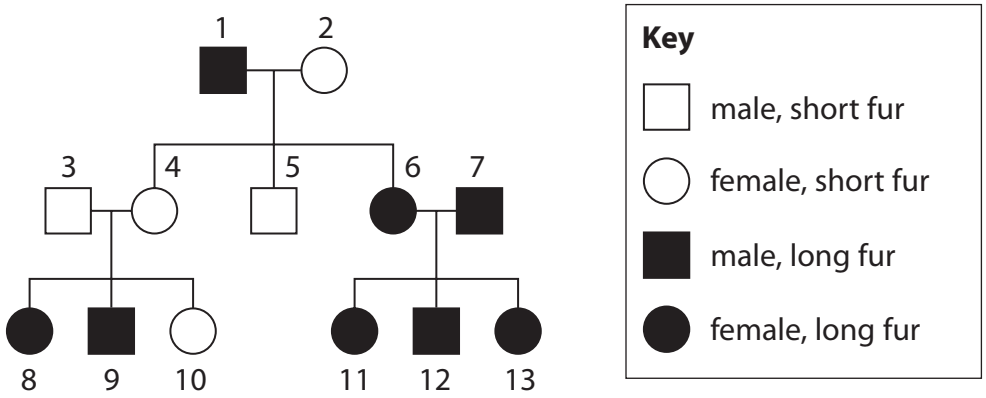
☒ **D** increased permeability of the collecting duct to water, producing more dilute urine

**(Total for Question 3 = 6 marks)**

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**4** In cats, the gene for fur length is not located on the X chromosome. The allele for short fur (F) is dominant to the allele for long fur (f).

The pedigree diagram shows the inheritance of fur length in a family of cats.




(a) Explain how one piece of evidence from the diagram shows that the allele for short fur is dominant to the allele for long fur.

**(2)**

(b) A gene for fur colour in cats is located on the X chromosome.

The alleles for black fur ($X^B$) and orange fur ($X^o$) are codominant.

Tortoiseshell cats have areas of black and orange fur.

(i) Give all the possible genotypes of a male, black cat with short fur.

**(1)**

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(ii) Explain why all tortoiseshell cats are female.

**(2)**

(iii) In a genetic cross, a tortoiseshell cat with long fur was mated with an orange male cat, heterozygous for fur length.

Deduce the probability of producing a tortoiseshell cat with long fur from this cross.

Use a genetic diagram to support your answer.

**(4)**

**(Total for Question 4 = 9 marks)**

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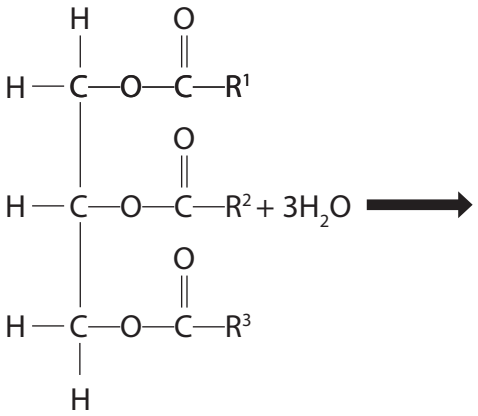
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**5** Palm plants and cocoa plants are used to produce lipids for the food industry.

Palm oil is produced from palm plants. Cocoa butter is produced from cocoa plants.

(a) Palm oil and cocoa butter are made of triglycerides composed of different fatty acids.

The diagram shows a triglyceride.




Complete the diagram to show the products of hydrolysis of this triglyceride.

**(2)**

(b) The fatty acid compositions of palm oil and cocoa butter are shown in the table.

| Fatty acid | Chemical formula of fatty acid | Percentage of fatty acid found in palm oil and cocoa butter (%) | |
|---|---|---|---|
| | | Palm oil | Cocoa butter |
| palmitic acid | $C_{16}H_{32}O_2$ | 45 | 27 |
| oleic acid | $C_{18}H_{34}O_2$ | 40 | 31 |
| linoleic acid | $C_{18}H_{32}O_2$ | 10 | 3 |
| myristic acid | $C_{14}H_{28}O_2$ | 1 | 1 |
| stearic acid | $C_{18}H_{36}O_2$ | 4 | 38 |

(i) How many of the named fatty acids shown in the table are saturated?

**(1)**

☒ **A** 1

☒ **B** 2

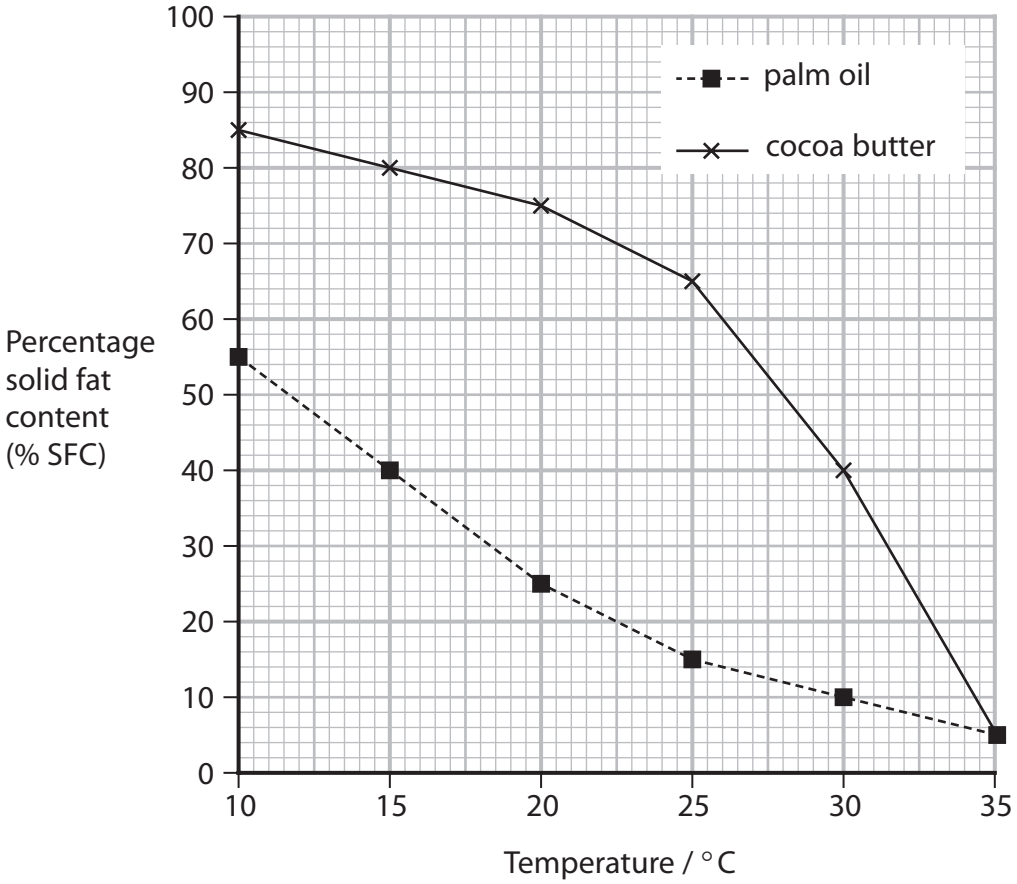
☒ **C** 3

☒ **D** 4

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(ii) The percentage solid fat content (% SFC) is a measure of how much of a lipid is solid at different temperatures.

The graph shows the effect of temperature on the % SFC for palm oil and for cocoa butter.




Comment on the effect of temperature on the % SFC of palm oil and of cocoa butter.

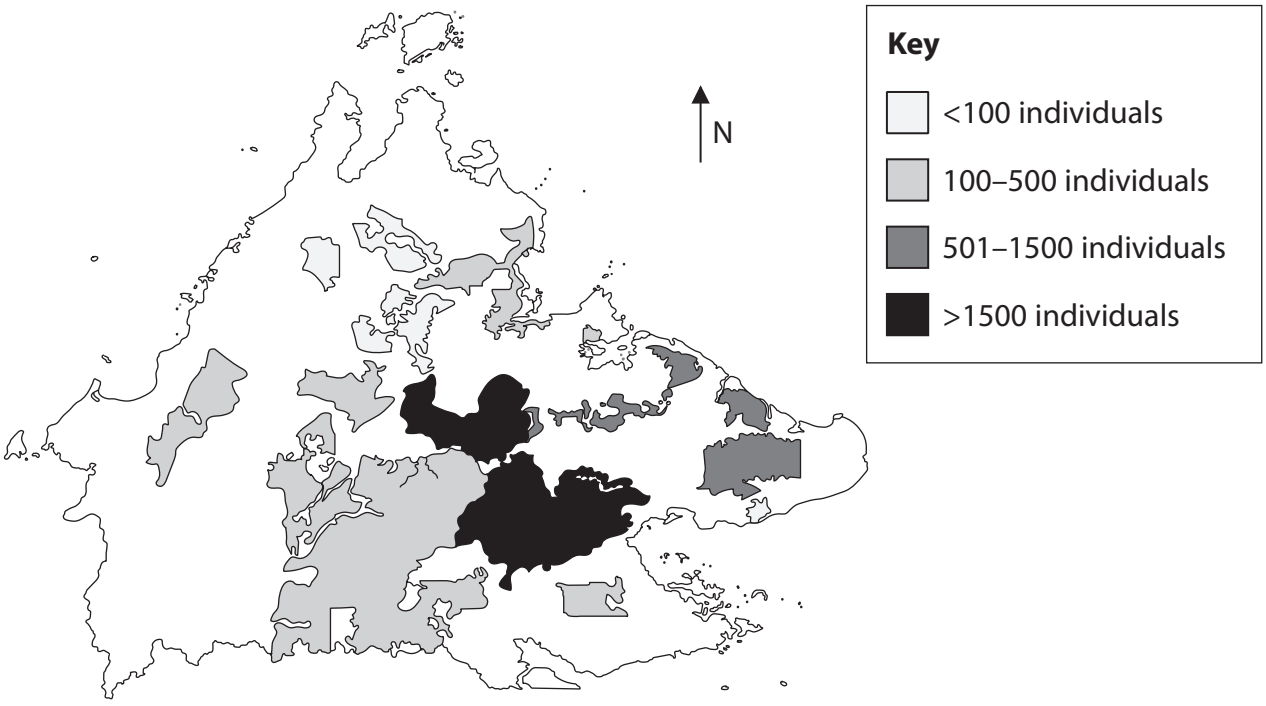
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(c) Some forests in Borneo have been cleared to grow these plants.

Orangutans used to live in forests throughout this island but now they are found in small areas of forest.

The map shows the distribution of orangutans in parts of Borneo.




(i) Explain why in areas with low populations of orangutans, many of the orangutans have deformities and health problems.

**(2)**

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(ii) The Malaysian government is paying local people to create and maintain 'land-bridges' of forest to link areas of forest together.

Explain why these payments will help to develop palm oil production and support conservation of orangutans.

**(3)**

(iii) State how treaties such as CITES help conserve orangutans.

**(1)**

**(Total for Question 5 = 13 marks)**

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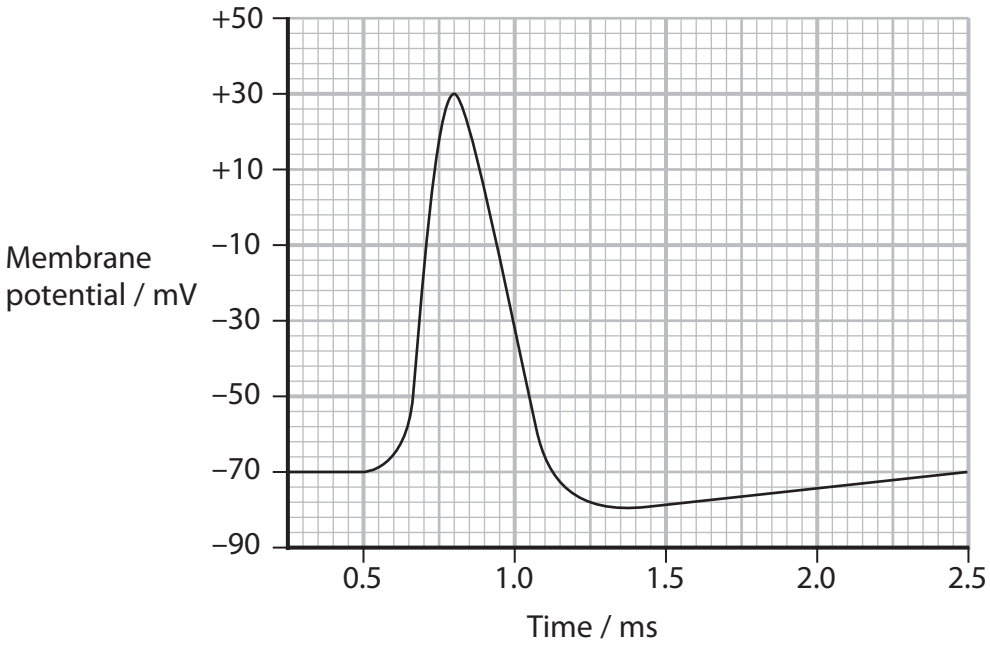
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**6** The speed of a nerve impulse along a neurone depends on the diameter and the presence or absence of myelin.

(a) The graph shows an action potential in a neurone.



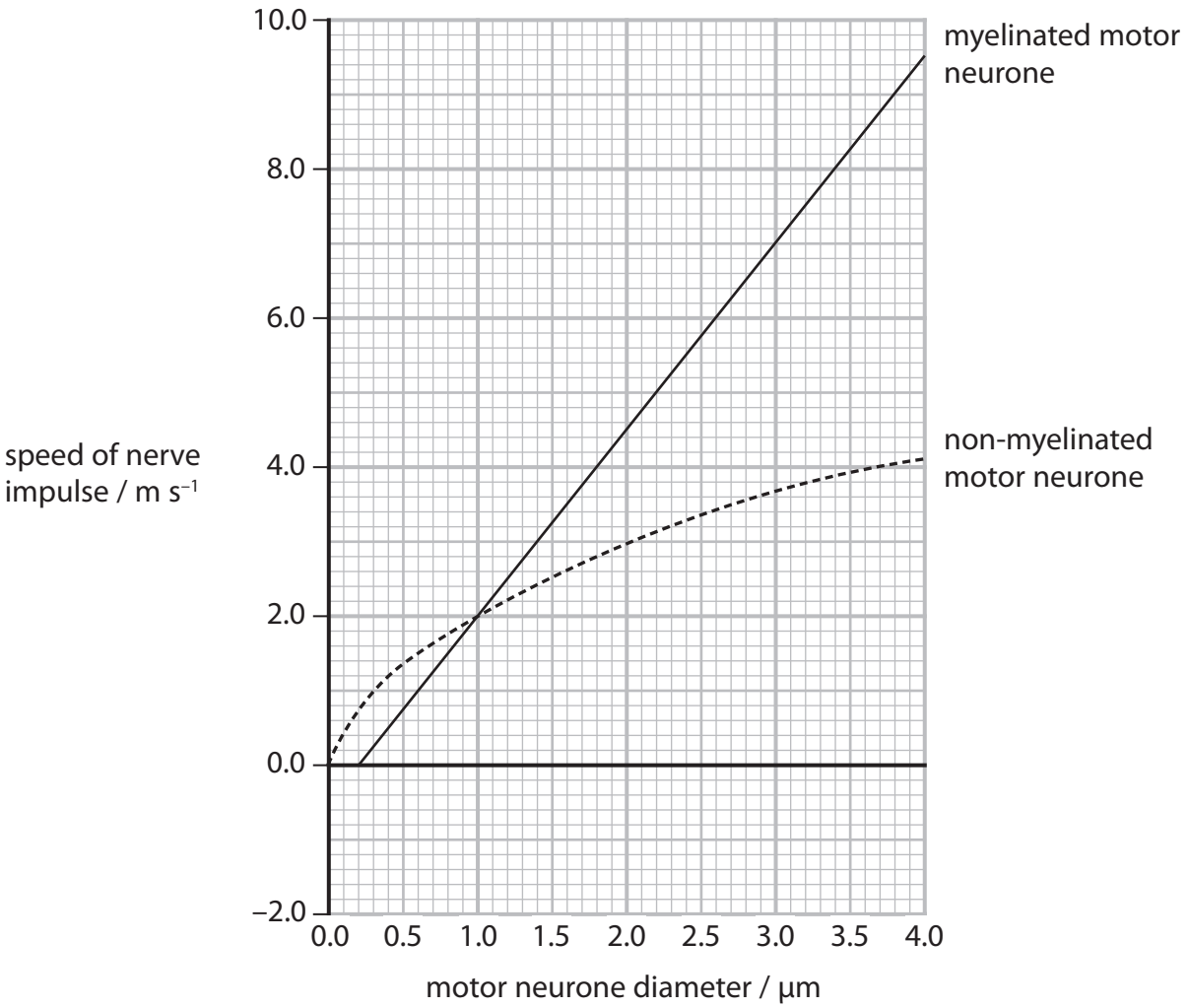

When are voltage-gated sodium channels open?

**(1)**

- ☒ **A** 0.25 ms
- ☒ **B** 0.75 ms
- ☒ **C** 1.00 ms
- ☒ **D** 1.25 ms

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(b) The graph shows the relationship between the diameter of the neurone and the speed of nerve impulses along myelinated and non-myelinated motor neurones.




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(i) Compare and contrast the effect of diameter on the speed of an impulse in myelinated and non-myelinated motor neurones.

**(4)**

(ii) Determine the speed of a nerve impulse along a myelinated motor neurone with a diameter of 5 µm.

The equation for a linear relationship is $y = mx + c$

**(3)**

Answer .....

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(iii) Multiple sclerosis (MS) is a disease that results in the loss of myelin around motor neurones.

Explain why the speed of nerve impulses along axons is slower in people with MS.

**(3)**

**(Total for Question 6 = 11 marks)**

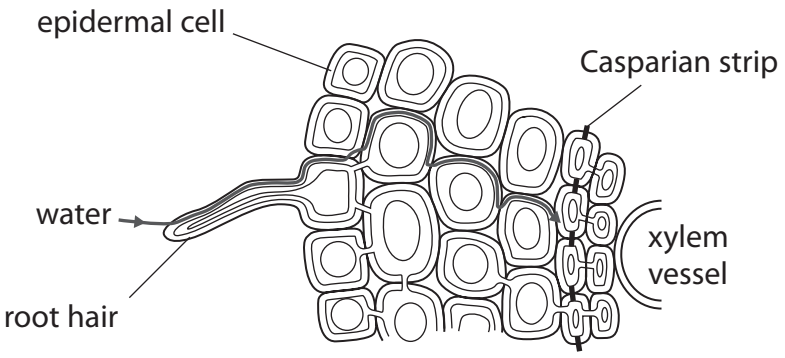
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**7** The primary productivity of plants depends on their ability to synthesise carbohydrates and transport solutes to cells.

(a) The diagram shows the movement of water across a root.




What is the name of the water movement pathway shown in the diagram?

**(1)**

- ☒ **A** apoplastic pathway
- ☒ **B** diffusion pathway
- ☒ **C** osmotic pathway
- ☒ **D** symplastic pathway

(b) Explain how the mass-flow hypothesis accounts for the movement of sugars from leaves to roots.

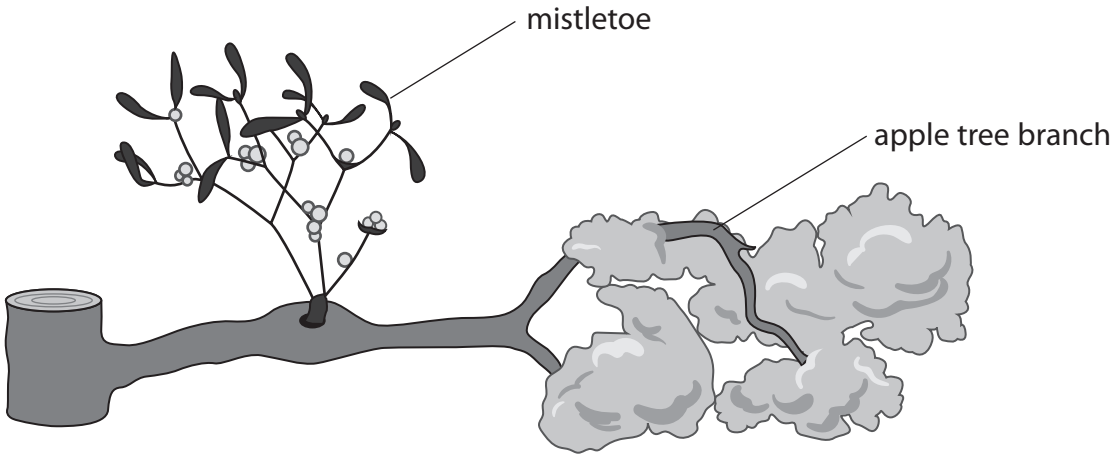
**(4)**

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*(c) Mistletoe is a plant that is a parasite on trees.

Mistletoe has green leaves. Mistletoe also has a modified root that grows into the xylem of a tree.

The diagram shows mistletoe growing on an apple tree branch.




The effect of mistletoe on the growth of apple trees was investigated.

Every year for 20 years, scientists selected apple trees infected with mistletoe and measured the:

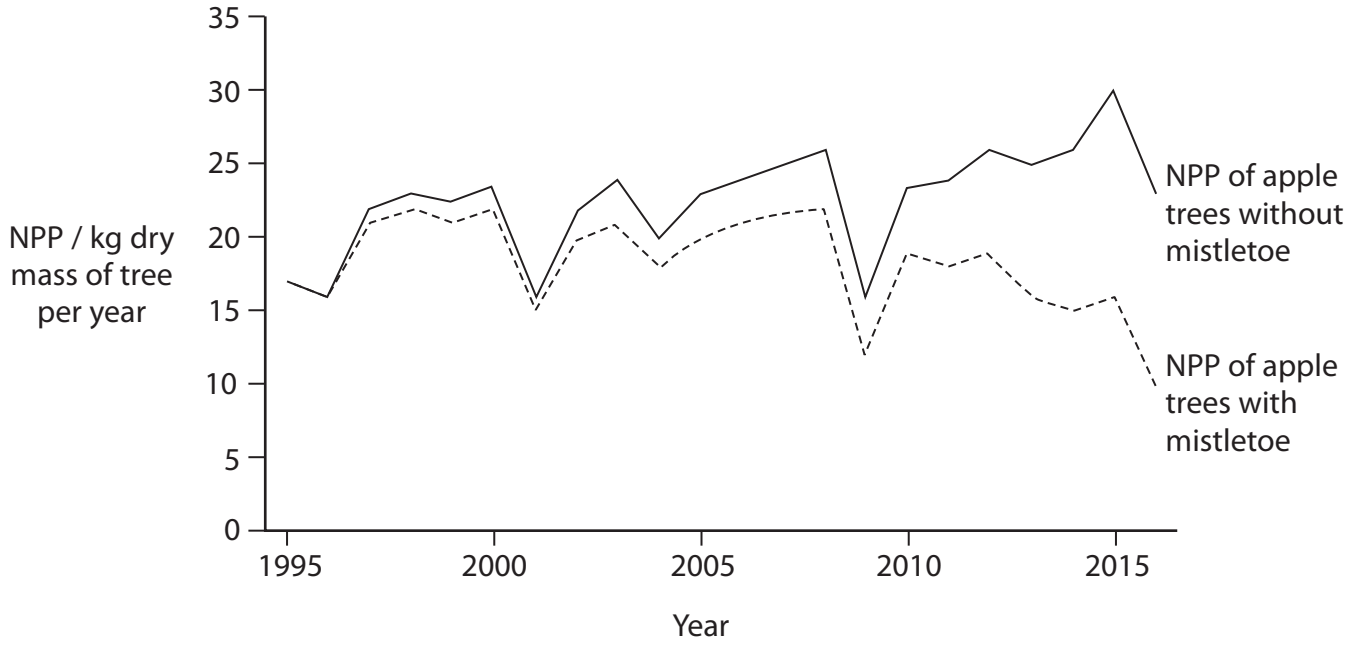
- mean net primary productivity (NPP) of the apple trees
- transpiration rate of the apple trees
- transpiration rate of the mistletoe branches on the apple trees

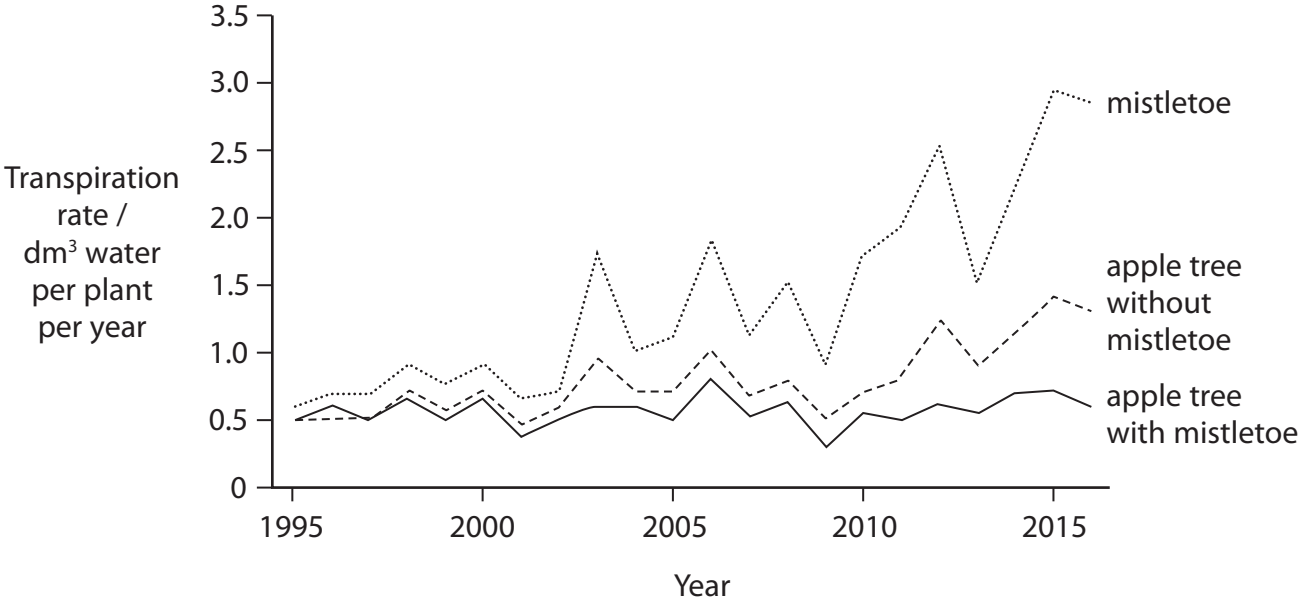
They also determined the mineral content of the apple tree leaves after 20 years.

A control group of apple trees not infected with mistletoe was included in this investigation.

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The graphs and table show the results of the investigation.




| Apple tree leaves from | Nitrogen content / mg per g of leaf | Calcium content / mg per g of leaf |
|---|---|---|
| trees infected with mistletoe | 8.50 | 6.45 |
| trees not infected with mistletoe | 10.60 | 8.90 |

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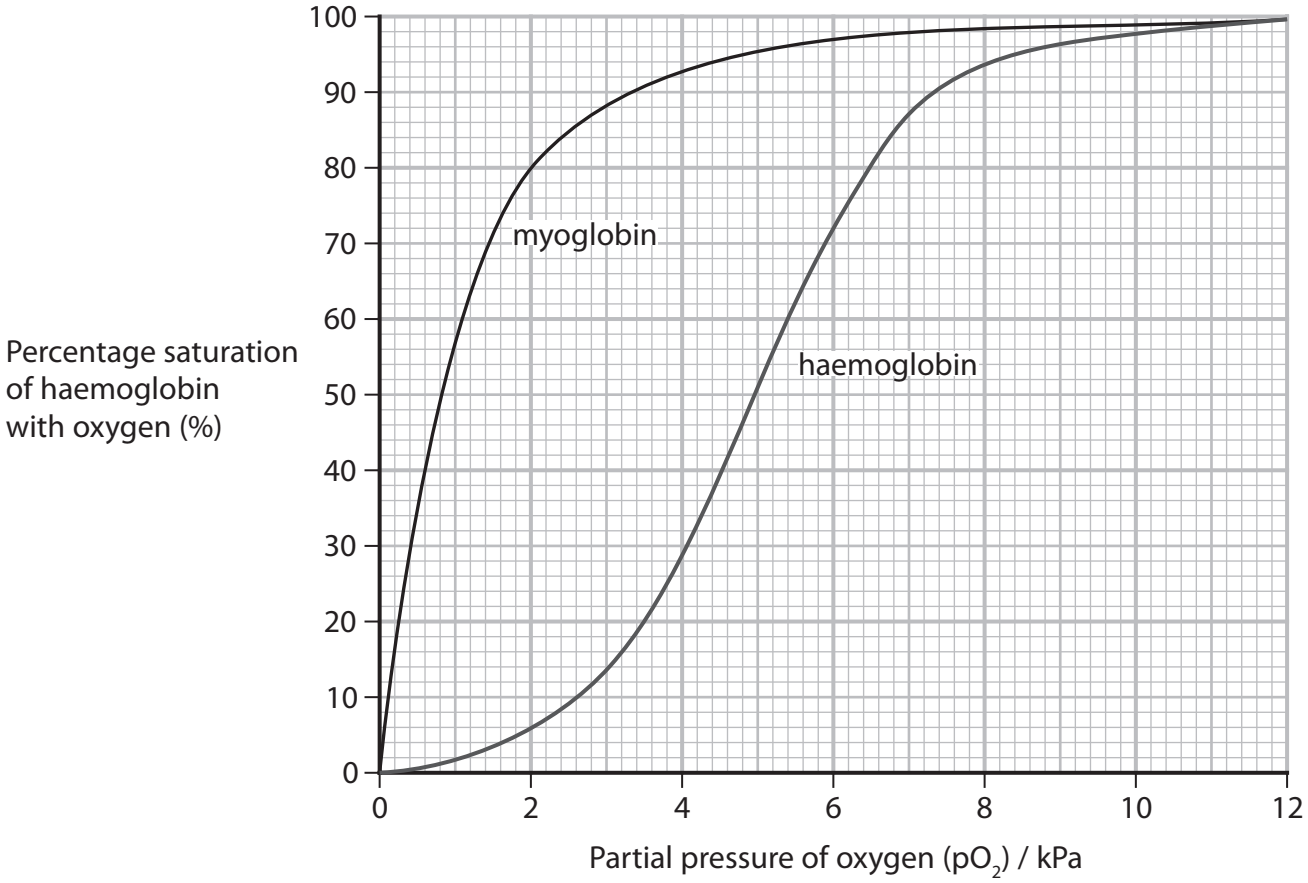
Analyse the data to explain the effect of mistletoe on the NPP of apple trees.

**(6)**

**(Total for Question 7 = 11 marks)**

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**8** The graph shows the oxygen dissociation curves of human haemoglobin and human myoglobin.




(a) (i) Calculate the volume of oxygen bound to haemoglobin at a partial pressure of oxygen of 6 kPa in 100 $cm^3$ blood.

The concentration of haemoglobin is 15 g per $dm^3$ blood.

When fully saturated, there is 1.36 $cm^3$ oxygen per g of haemoglobin.

**(3)**

Answer .....

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(ii) Explain why the oxygen dissociation curves for haemoglobin and myoglobin are different.

**(4)**

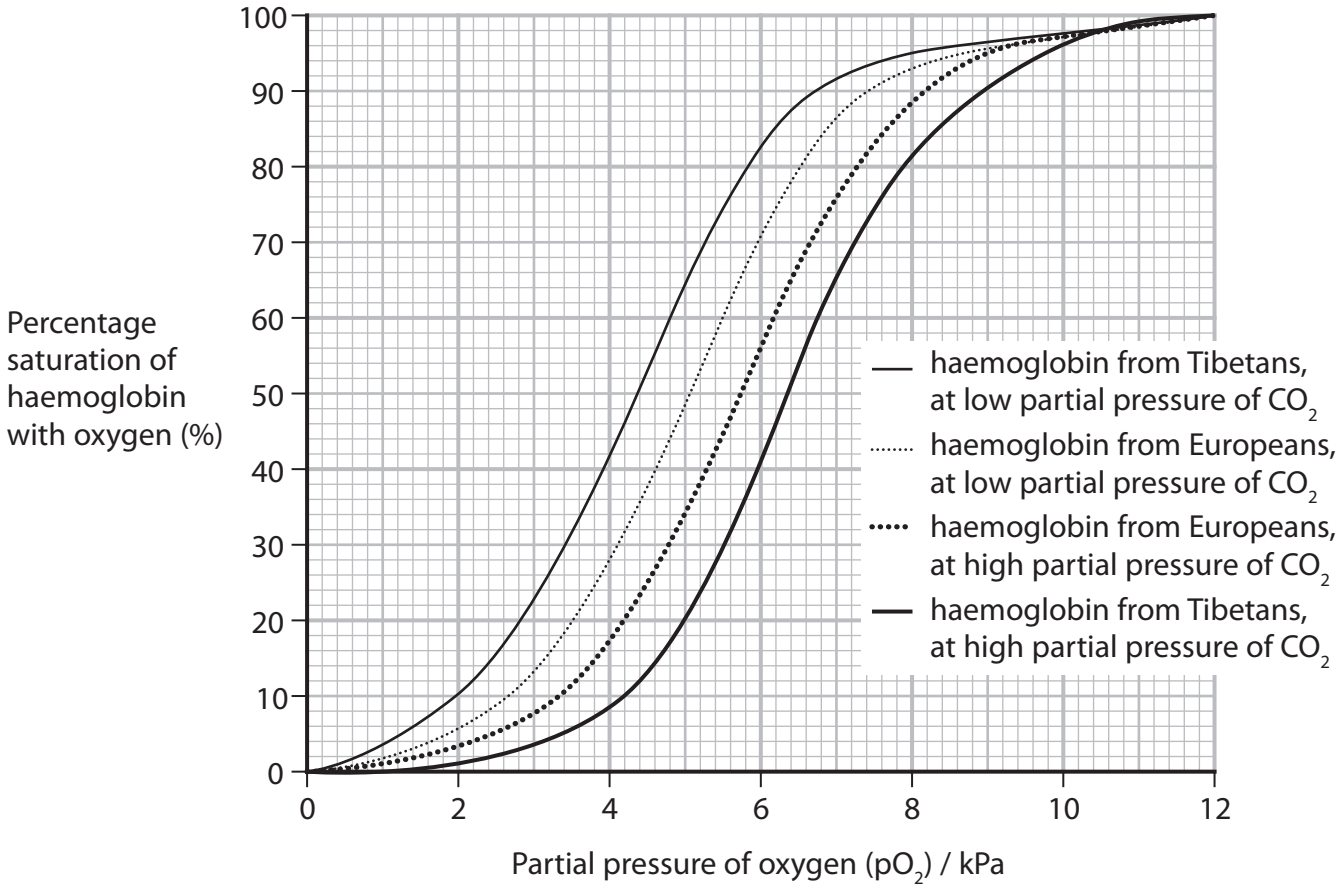
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(b) In an investigation, the oxygen dissociation of haemoglobin from Tibetan people and European people was compared.

The Tibetan people were living at high altitude.

The European people were living at low altitude.

The graph shows the results of this investigation.




Comment on the oxygen dissociation curves of the Tibetan people.

**(4)**

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(c) Tibetan populations have a recessive allele that helps them to survive at high altitude.

In a village in Tibet, 1950 people out of a population of 2500 people carry two copies of this allele.

(i) Calculate the number of heterozygous people in the village.

Use the Hardy-Weinberg equation

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

**(3)**

Answer .....

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(ii) This allele is currently found only in human populations in Tibet.

The allele has also been found in the fossil bones of an extinct form of modern humans called the Denisovans.

Fossils of Denisovans have been found in Tibet.

Explain why scientists think that the Denisovans belonged to the same species as modern humans.

**(2)**

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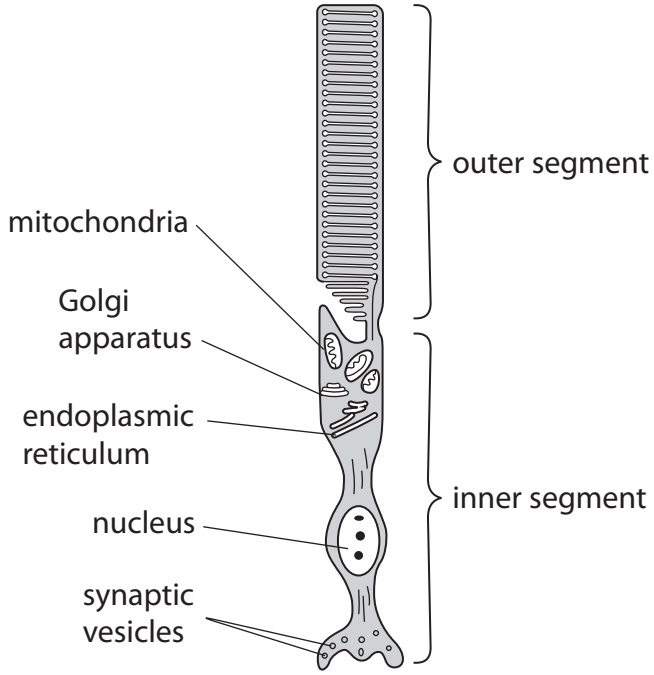
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**(Total for Question 8 = 16 marks)**

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**9** The diagram shows the structure of a rod cell.




(a) (i) How many of the labelled organelles have a double membrane?

**(1)**

☒ **A** 0

☒ **B** 1

☒ **C** 2

☒ **D** 3

(ii) Which of the following statements about the effect of light on rod cells are correct?

**(1)**

1. rhodopsin breaks down into opsin and trans-retinal
2. voltage-gated sodium channels open in the membrane
3. more neurotransmitter is released from the presynaptic terminal

☒ **A** 1 only

☒ **B** 1 and 2

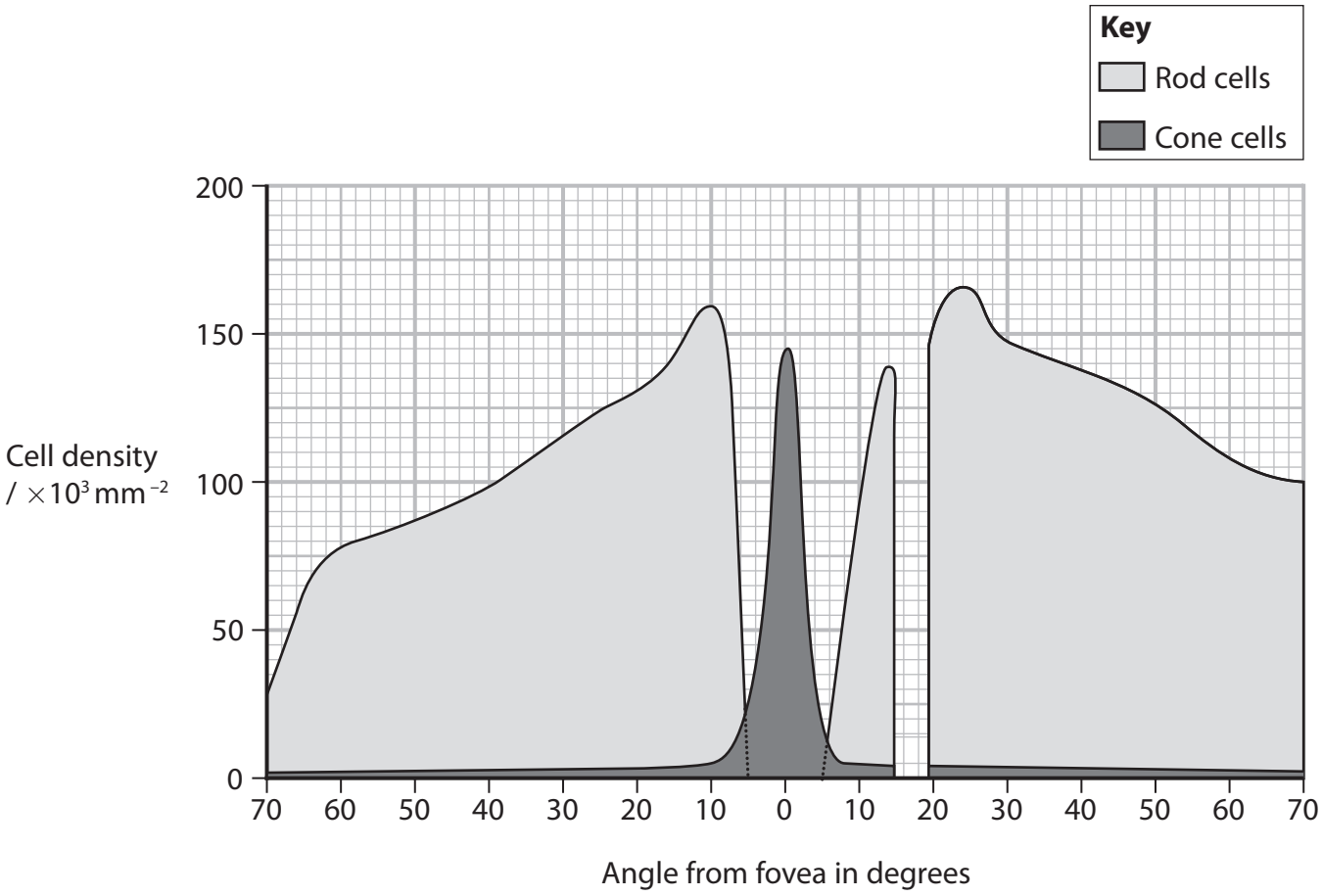
☒ **C** 1 and 3

☒ **D** 2 and 3

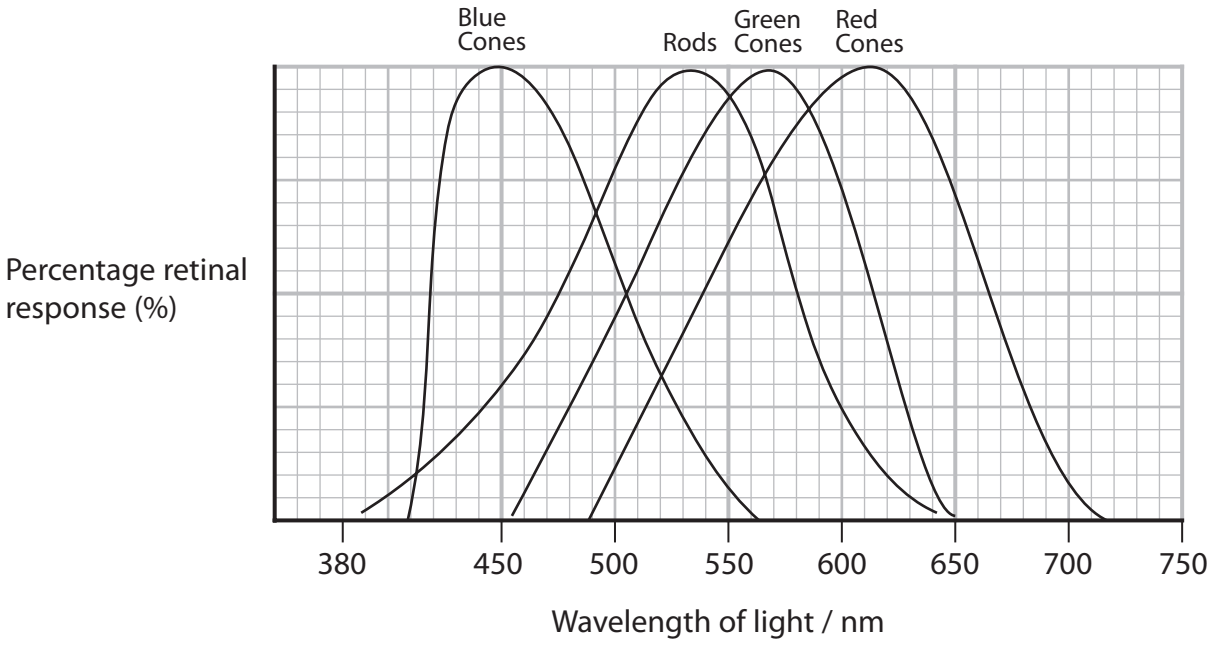
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*(b) Graph 1 shows the distribution of photoreceptors across the retina.

Graph 2 shows the sensitivity of rod cells and cone cells to light of different wavelengths.




**Graph 1**




**Graph 2**

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Students investigated the ability to detect beams of light of different colours and intensities.

A student covered one eye and a bright red light (wavelength 670 nm) was placed at different angles in the field of vision of the other eye. The student stated if they could detect the red light.

This was repeated with a dim red light.

This was then repeated with a bright green light and a dim green light (wavelength 525 nm).

The table shows the results of this investigation.

| Angle from fovea in degrees | Light detected (Yes/No) | | | |
|---|---|---|---|---|
| | Bright light Red | Dim light Red | Bright light Green | Dim light Green |
| 60 | N | N | Y | Y |
| 30 | N | N | Y | Y |
| 15 | N | N | Y | Y |
| 10 | N | N | Y | Y |
| 5 | Y | N | Y | N |
| 0 | Y | N | Y | N |
| 5 | Y | N | Y | N |
| 10 | N | N | Y | Y |
| 15 | N | N | N | N |
| 30 | N | N | Y | Y |
| 60 | N | N | Y | Y |

Analyse the data to explain the results of this investigation.

**(6)**

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**(Total for Question 9 = 8 marks)**

**TOTAL FOR PAPER = 90 MARKS**

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