Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Wednesday 7 June 2023

Afternoon (Time: 1 hour 45 minutes)

Paper reference **9BI0/01**

Biology B

Advanced

PAPER 1: Advanced Biochemistry, Microbiology and Genetics

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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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 Plants take up inorganic ions from the soil.

These ions include calcium, phosphate and potassium.

(a) (i) Name the molecule that contains calcium ions in the cell walls of a plant.

(1)

.....

(ii) How many of the following statements are correct?

(1)

- phosphate ions are used to make DNA and RNA
- phosphate ions are used in the structure of the cell membrane
- the element potassium is part of a peptide bond

☒ **A** none

☒ **B** one only

☒ **C** two only

☒ **D** three

(b) The uptake of potassium ions by plant seedlings in anaerobic and aerobic conditions was investigated.

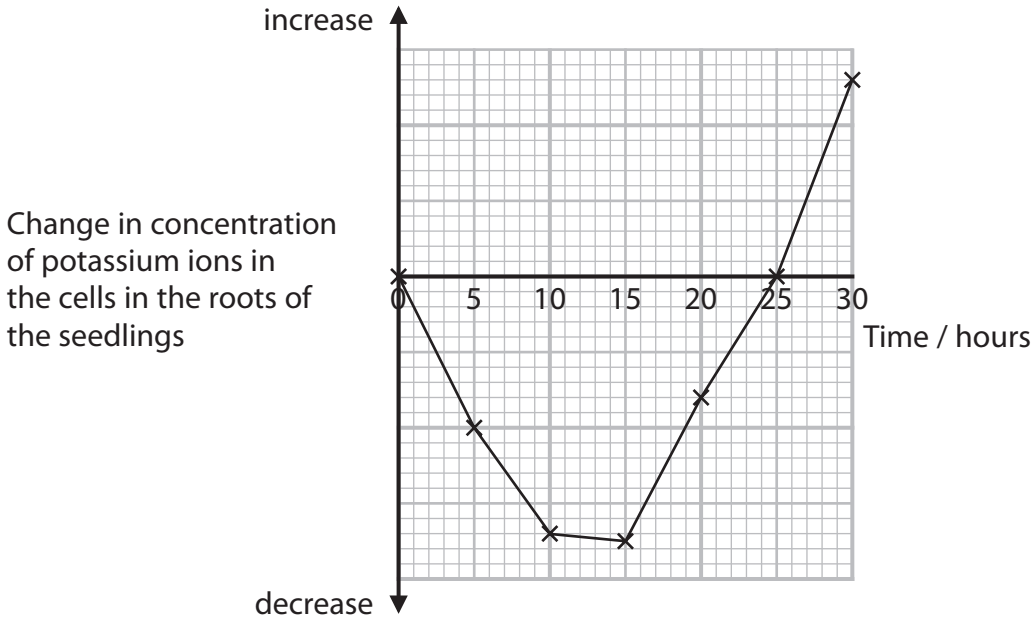
The seedlings were grown in a mineral ion solution containing a low concentration of potassium ions for 30 hours. The conditions were anaerobic for the first 15 hours and aerobic for the second 15 hours.

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The graph shows the results of this investigation.



Explain the changes in the concentration of potassium ions in the cells in the roots of the seedlings during this investigation.

(4)

(Total for Question 1 = 6 marks)

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2 Living organisms are divided into three domains: Archaea, Bacteria and Eukaryota.

(a) The table shows some characteristics of organisms in the domain Archaea.

Characteristic	Organisms in the domain Archaea
membrane-enclosed nucleus	absent
peptidoglycan in cell wall	absent
ribosomes	70S

Explain why these organisms have **not** been classified in either of the other two domains.

(2)

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(b) Some Archaea have the enzyme adenylate kinase (AK).

This enzyme is similar to AK enzymes found in humans.

There are two types of this enzyme in humans, AK1 and AK3.

The table gives some information about these two enzymes.

Enzyme	Location in the cell	Substrate	Role of enzyme
AK1	cytoplasm	adenosine triphosphate (ATP)	transfers phosphate
AK3	mitochondria	guanosine triphosphate (GTP)	transfers phosphate

(i) The tertiary structures of AK1 and AK3 are very similar but not identical.

Analyse the information to deduce why there are two AK enzymes.

(3)

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(ii) Some types of Archaea have only one type of AK enzyme.

This enzyme can catalyse both the reactions shown in the table.

The tertiary structure of this enzyme is different from AK1 and AK3.

Explain why Archaea have a different type of AK enzyme.

(2)

(Total for Question 2 = 7 marks)

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3 Xylem and phloem tissues transport molecules and ions through plants.

(a) Give the meaning of the term **tissue**.

(1)

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(b) The table gives some information about the structures of xylem and phloem tissues.

For each statement, put **one** cross ☒ in the appropriate box, in each row, to show whether these statements are true for both types of tissue, xylem tissue only, phloem tissue only or neither type of tissue.

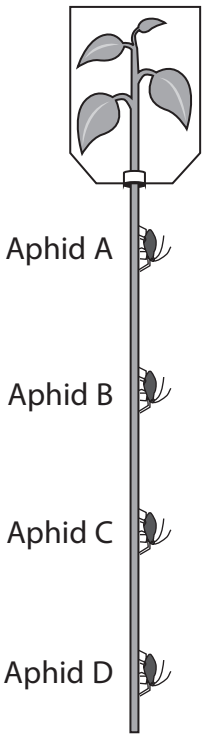
(3)

Statement	Type of tissue			
	both xylem and phloem	**xylem only**	**phloem only**	**neither xylem nor phloem**
Contain sieve plates	☒	☒	☒	☒
Have cellulose in the cell walls	☒	☒	☒	☒
Have mitochondria	☒	☒	☒	☒

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(c) Aphids are insects that can be used to study the transport of sugars in the phloem.

The diagram shows how this is done.



1. The leaves of a plant are covered with a glass chamber containing radioactive carbon dioxide.
2. The plant produces radioactive sugars by photosynthesis.
3. Aphids, A, B, C and D are attached to the stem and allowed to feed on the contents of the phloem.
4. The aphids are analysed to determine the time at which radioactivity first appeared in their bodies.

(i) Which disaccharide is transported in the phloem?

(1)

- ☒ **A** fructose
- ☒ **B** glucose
- ☒ **C** lactose
- ☒ **D** sucrose

(ii) In an experiment, the time between radioactivity appearing in aphid A and aphid D was 210 minutes.

The distance between these two aphids was 50 cm.

Calculate the rate of flow of phloem contents between these two aphids, in cm hour^{-1}.

(1)

Answer ..... cm hour^{-1}

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(iii) Describe how sugars are transported through the phloem.

(3)

(Total for Question 3 = 9 marks)

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4 Influenza is an infectious disease caused by a virus.

(a) The influenza virus is an RNA virus and has an envelope.

Which pair of viruses also have RNA and an envelope?

(1)

- ☒ **A** Ebola and human immunodeficiency virus
- ☒ **B** Ebola and tobacco mosaic virus
- ☒ **C** human immunodeficiency virus and λ phage
- ☒ **D** tobacco mosaic virus and λ phage

(b) Which of the following is the predominant method of transmission of the influenza virus?

(1)

- ☒ **A** contaminated surfaces
- ☒ **B** contaminated food
- ☒ **C** respiratory droplets
- ☒ **D** insect vectors

(c) Symptoms of influenza appear some time after a person is infected with the virus.

Explain why there is a time delay between infection and the symptoms appearing.

(3)

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(d) In some countries, people take antibiotics without a prescription.

In a survey, 77% of people who had taken antibiotics had taken them without a prescription.

Some of the people who took antibiotics without a prescription had influenza.

(i) Calculate the ratio of the number of people who took antibiotics without a prescription to the number of people who took antibiotics with a prescription.

Give your answer to two decimal places.

(1)

Answer .....

(ii) Explain why antibiotics should not be taken by people with viral infections.

(2)

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(Total for Question 4 = 8 marks)

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5 Some forms of infertility are due to the female producing antibodies to sperm cells.

Contraceptives are being developed that use these antibodies.

(a) Antibodies can be injected into a person to give immunity.

Which type of immunity develops from the injection of antibodies?

(1)

- ☒ **A** artificial active
- ☒ **B** artificial passive
- ☒ **C** natural active
- ☒ **D** natural passive

(b) In the development of these contraceptives, an agglutination assay was performed.

Antibodies were mixed with sperm cells and the time taken for 100% of the sperm cells to agglutinate was recorded.

Different concentrations of antibody were tested.

The number of sperm cells that escaped from the sperm cell agglutinates, at each concentration of antibody, was also recorded.

(i) Each test used 2 μl of a sperm cell suspension at a concentration of 3.0×10^6 cells per cm^3.

$1\ \mu l = 10^{-6}\ dm^3$

Calculate the number of sperm cells used in each test.

(1)

Answer .....

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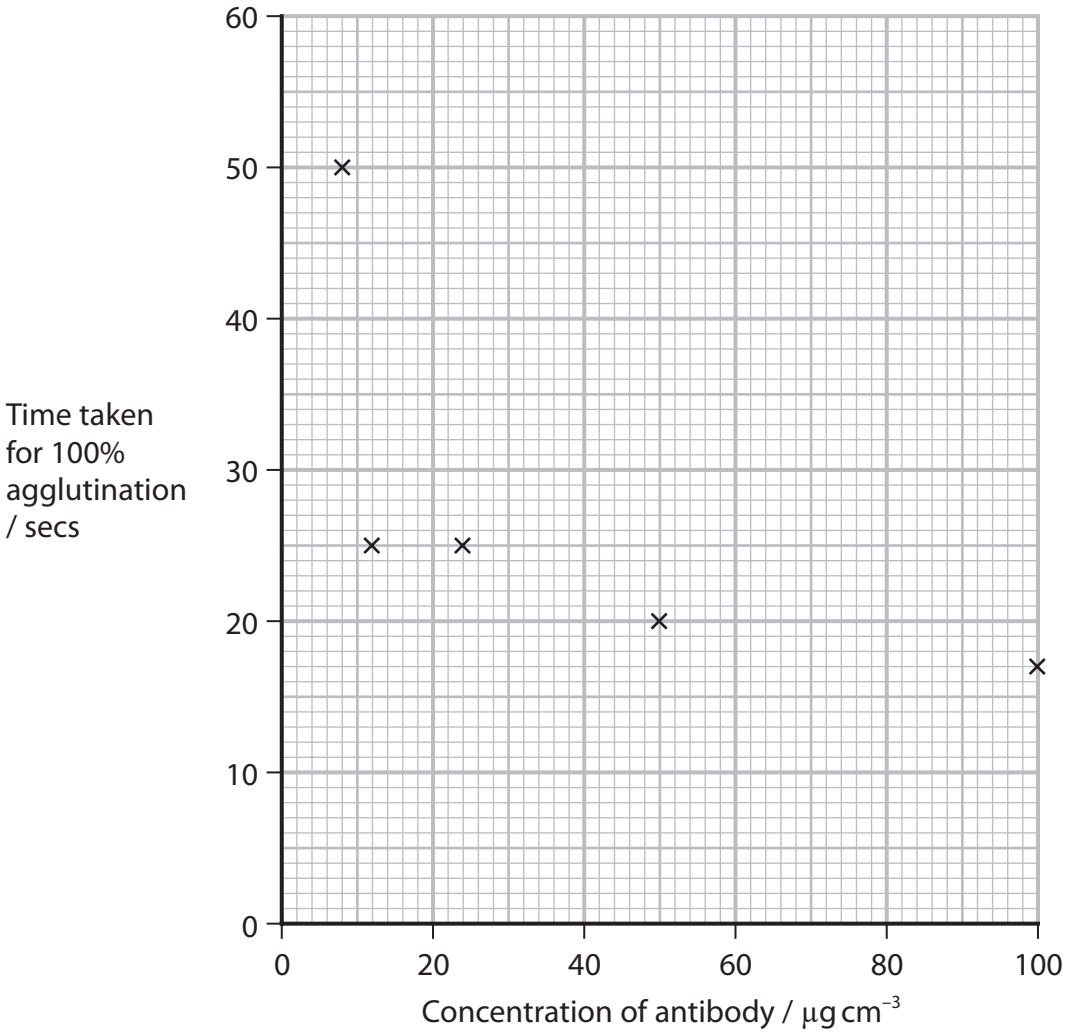
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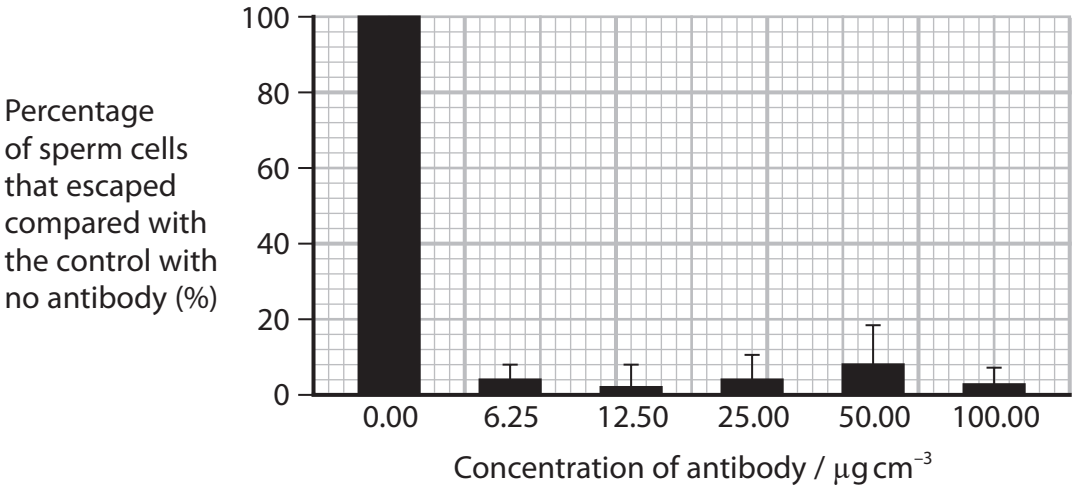
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(ii) The graphs show the results of this assay.





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Analyse the data to comment on these results.

(3)

(iii) Observation of the sperm cells agglutinated by these antibodies showed that some were joined head to head, some head to flagellum and some flagellum to flagellum.

Explain these observations.

(3)

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(c) In the development of these contraceptives, the effect of the concentration of sperm cells on the time taken to agglutinate was also investigated.

Explain why agglutination could take longer at low and at high concentrations of sperm cells.

(2)

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(Total for Question 5 = 10 marks)

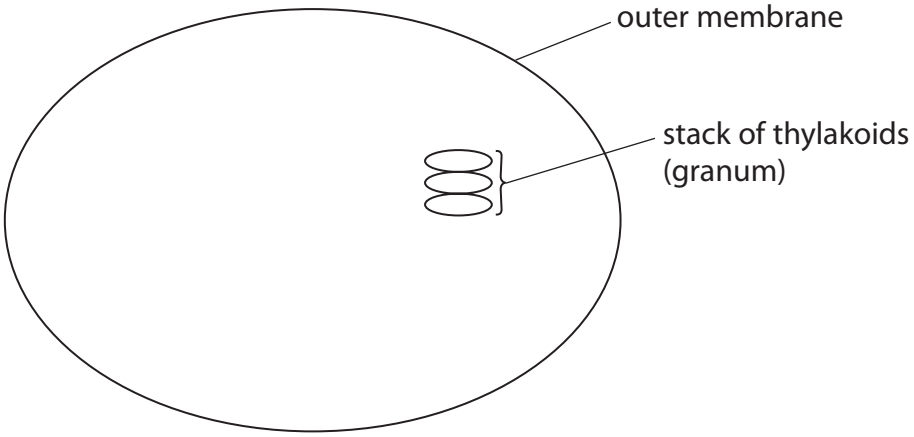
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6 Scientists have removed thylakoids from chloroplasts to make artificial chloroplasts.

(a) The diagram shows part of a chloroplast.



(i) Draw and label **three** other structures found in a chloroplast.

(3)

(ii) Chloroplasts can be 3 μm in length.

Calculate the magnification of this diagram for a chloroplast that is 3 μm in length.

Give your answer to two significant figures.

(2)

Answer .....

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(b) Explain the importance of the thylakoid membranes in the light-dependent stage of photosynthesis.

(4)

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(c) The artificial chloroplasts made by the scientists consisted of thylakoids removed from spinach leaves, and enzymes involved in carbon fixation.

These components were put into water, forming a suspension.

This suspension was dropped into a medium containing oil.

The suspension formed cell-sized droplets of water containing the thylakoids and the enzymes.

(i) Name the enzyme that fixes carbon dioxide in the light-independent stage of photosynthesis.

(1)

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(ii) Explain why it is necessary to keep the thylakoids and enzymes together within droplets.

(2)

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(Total for Question 6 = 12 marks)

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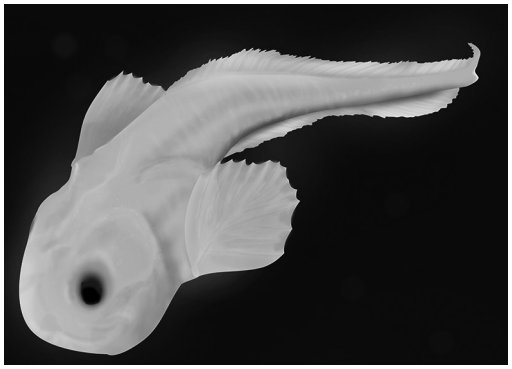
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7 The Yap Trench is an area of very deep water in the Pacific Ocean.

In 2017, a new species of fish was caught in the Yap Trench. This was named the Yap hadal snailfish.

The photograph shows a different species of snailfish, the Mariana hadal snailfish.



(Source: © Adisha Pramod/Alamy Stock Photo)

(a) The Yap hadal snailfish was caught in a deep sea trench, at a depth of 7 000 m below sea level.

Hydrostatic pressure increases 100 kPa with every 10 m of depth.

Calculate the hydrostatic pressure at 7 000 m.

Give your answer in standard form.

(1)

Answer ..... kPa

(b) Analysis of the genome of the Yap hadal snailfish and the Mariana hadal snailfish showed that they were closely related.

(i) The DNA from the Yap hadal snailfish contained 725 608 564 bases and 204 202 736 of these bases were adenines.

Calculate the number of guanine bases in the DNA of this fish.

(2)

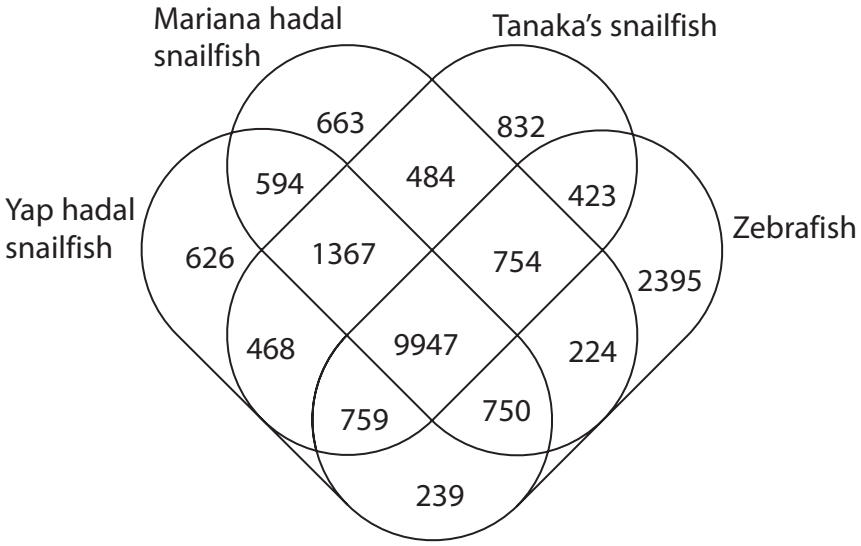
Answer .....

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(ii) The Venn diagram shows unique and shared gene families in the genomes of three species of snailfish and a zebrafish.



Calculate the percentage of gene families in the Yap hadal snailfish that are shared with the Mariana hadal snailfish.

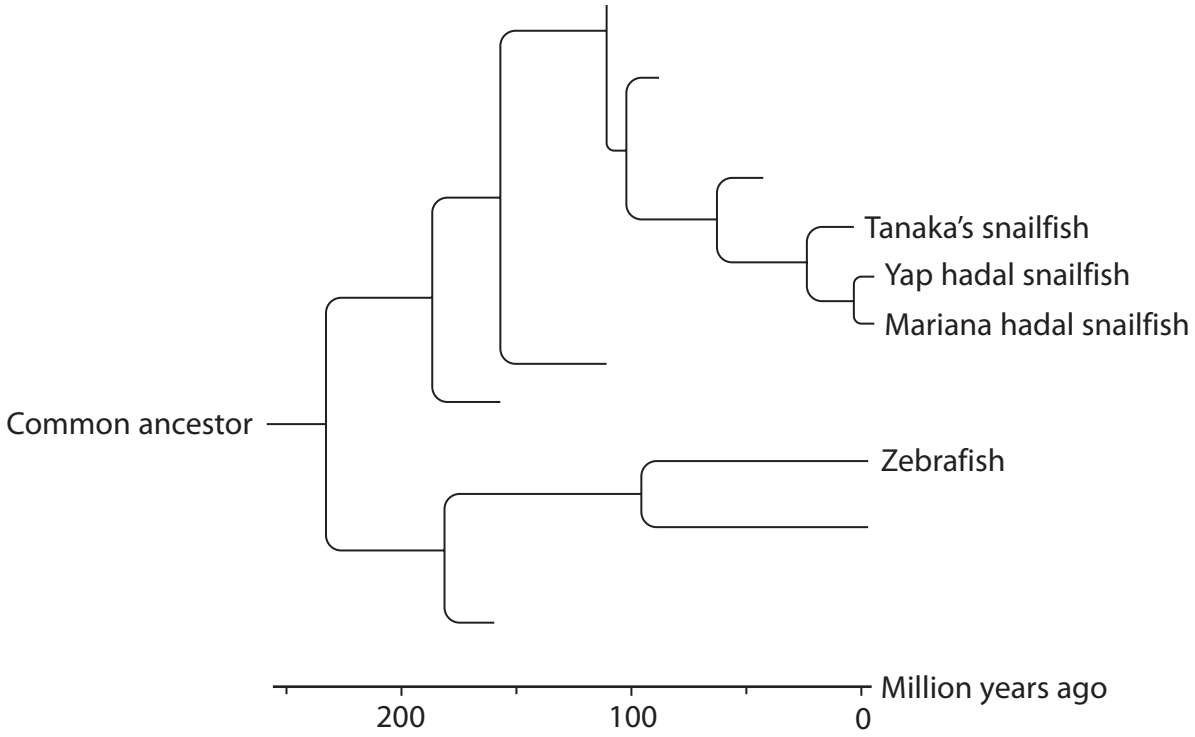
Give your answer to one decimal place.

(2)

Answer .....%

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(iii) The diagram shows the evolutionary relationship between three species of snailfish and a zebrafish.



Analyse the diagram to describe the evolutionary relationship between these four species of fish.

(3)

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*(iv) The Mariana hadal snailfish and the Yap hadal snailfish were caught in separate trenches hundreds of kilometres apart.

Explain how these fish evolved to become separate species.

(6)

(Total for Question 7 = 14 marks)

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8 Vaccines are being developed to stimulate the immune response to destroy cancer cells.

Some of these vaccines contain mRNA that codes for specific antigens found on cancer cells.

(a) These vaccines deliver the mRNA into antigen presenting cells, such as macrophages.

Describe how the delivery of mRNA into macrophages results in antigen presentation by these cells.

(4)

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(b) Antigen presentation results in the stimulation of both the humoral immune response and the cell-mediated immune response.

Compare and contrast the humoral immune response with the cell-mediated immune response.

(4)

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(c) These vaccines stimulate both the humoral immune response and the cell-mediated immune response.

Explain how the products of these responses result in the destruction of cancer cells.

(4)

(Total for Question 8 = 12 marks)

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9 The photograph shows a shortfin molly.



(Source: © WILDLIFE GmbH/Alamy Stock Photo)

This fish has adapted to survive in environments where levels of hydrogen sulfide (H_2S) are toxic to other organisms.

(a) Hydrogen sulfide can interrupt mitochondrial respiration by inactivating cytochrome c oxidase, one of the proteins in the electron transport chain.

(i) Where is the electron transport chain located in mitochondria?

(1)

☒ **A** inner membrane

☒ **B** intermembrane space

☒ **C** matrix

☒ **D** outer membrane

(ii) Explain why inactivating cytochrome c oxidase could be fatal.

(3)

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(b) The adaptation of these fish to H_2S in their environment is thought to be due to epigenetic modification by DNA methylation.

(i) State the meaning of the term epigenetic modification.

(1)

.....

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(ii) Which of the following is another type of **epigenetic** modification?

(1)

☒ **A** deletion mutation

☒ **B** histone modification

☒ **C** translation

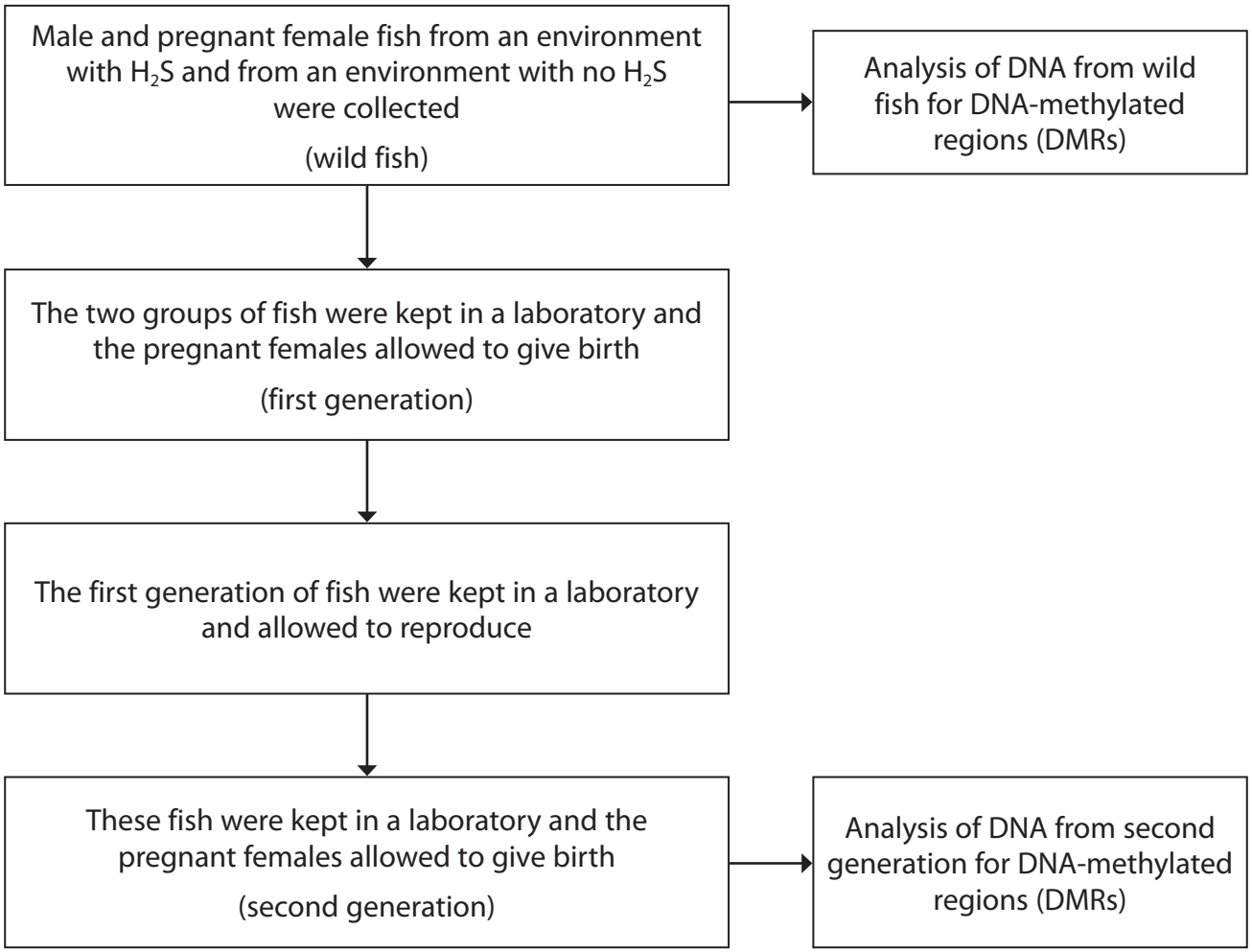
☒ **D** translocation

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*(c) The effect of hydrogen sulfide (H_2S) on DNA methylation in these fish was investigated.

The flow diagram shows part of the method used in this investigation.

All the fish kept in the laboratory were in water with no H_2S.



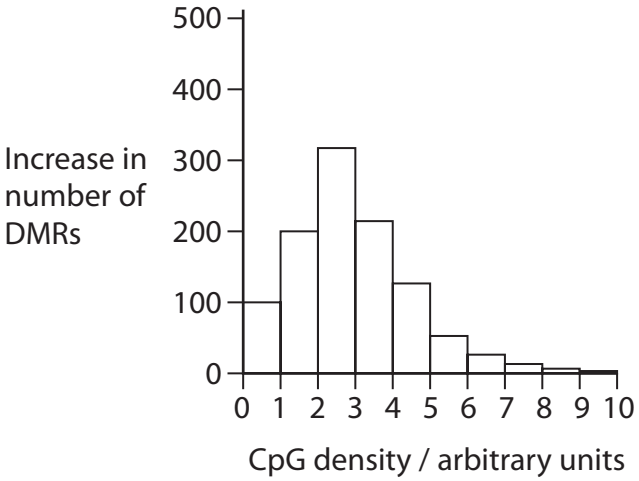
A CpG site is a region of DNA where a cytosine nucleotide is followed by a guanine nucleotide on the sense strand.

The DNA was analysed for the number of DNA-methylated regions (DMRs) at areas of DNA with different CpG densities. The numbers of DMRs for each group of fish were then compared.

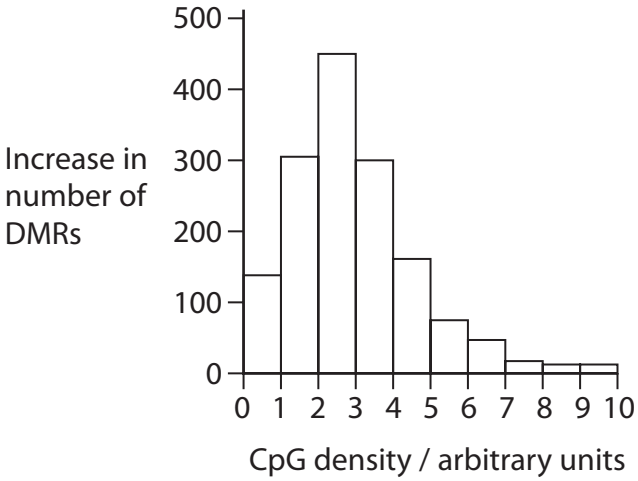
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The graphs show the increase in the number of DNA-methylated regions (DMRs) in each group of fish.

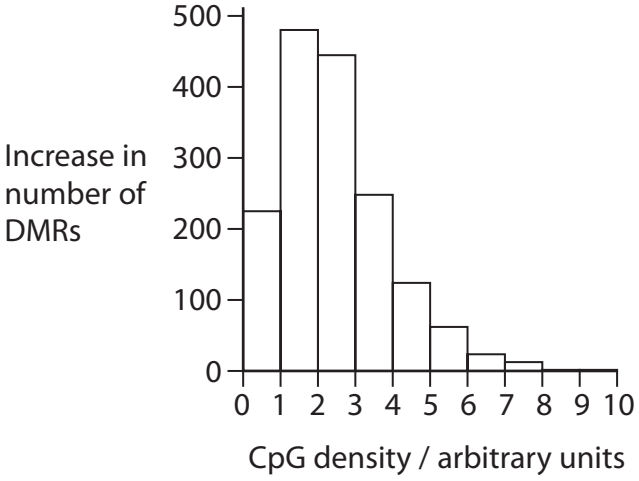
Graph 1: Wild male fish
fish from environment with H_2S compared with fish from environment with no H_2S



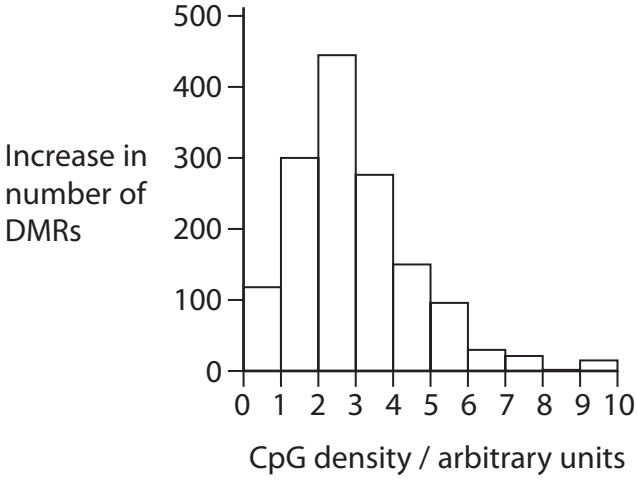
Graph 2: Wild female fish
fish from environment with H_2S compared with fish from environment with no H_2S



Graph 3: Second generation male fish
fish from environment with H_2S compared with fish from environment with no H_2S



Graph 4: Second generation female fish
fish from environment with H_2S compared with fish from environment with no H_2S



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Discuss the results of this investigation.

(6)

(Total for Question 9 = 12 marks)

TOTAL FOR PAPER = 90 MARKS

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