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 **9BI0/01**

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.
- Show your working in 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.
- In questions 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.

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.*

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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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 pathogenic effects of bacteria can be due to the toxins they release.

(a) Endotoxins are released by Gram negative bacteria.

(i) Name **one** type of Gram negative bacteria that releases endotoxins.

(1)

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(ii) Give **one** difference between the structure of Gram negative bacteria and Gram positive bacteria.

(1)

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(b) Endotoxins are usually less toxic than exotoxins.

(i) The LD_{50} value is the mass of the chemical per kg of body mass that would kill half the number of rodent animals.

The LD_{50} value can be used to indicate how toxic a chemical is.

One endotoxin has an LD_{50} value of 11 ng kg^{-1}.

The mean body mass of a group of rodents is 28 g.

Calculate the mass of endotoxin given to each rodent that would kill half of the rodents in this group.

(1)

Answer ..... ng

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(ii) State **two** differences, other than toxicity, between endotoxins and exotoxins.

(2)

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(Total for Question 1 = 5 marks)

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2 A zygote is formed when gametes fuse at fertilisation.

(a) Explain how meiosis results in genetic variation in the gametes.

(2)

(b) Describe how the process of fertilisation results in the formation of a zygote from the gametes in humans.

(3)

(Total for Question 2 = 5 marks)

3 Malaria is a serious and sometimes fatal disease.

Scientists are constantly looking for new ways of controlling this disease.

(a) Which row of the table shows the name of the pathogen that causes malaria, and its classification group?

(1)

	Name of pathogen	Classification group
☒ **A**	*Plasmodium*	genus
☒ **B**	*Plasmodium*	species
☒ **C**	*Puccinia*	genus
☒ **D**	*Puccinia*	species

(b) One group of scientists has genetically modified a fungus to produce a spider toxin that kills mosquitoes.

Describe how a fungus could be genetically modified to produce spider toxin.

(3)

(c) Another group of scientists has discovered a type of fungus that completely protects mosquitoes from infection by the pathogen that causes malaria.

This fungus does not kill the mosquitoes.

Explain why this approach is less controversial than the approach used by the scientists who are developing the genetically-modified fungus.

(3)

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(Total for Question 3 = 7 marks)

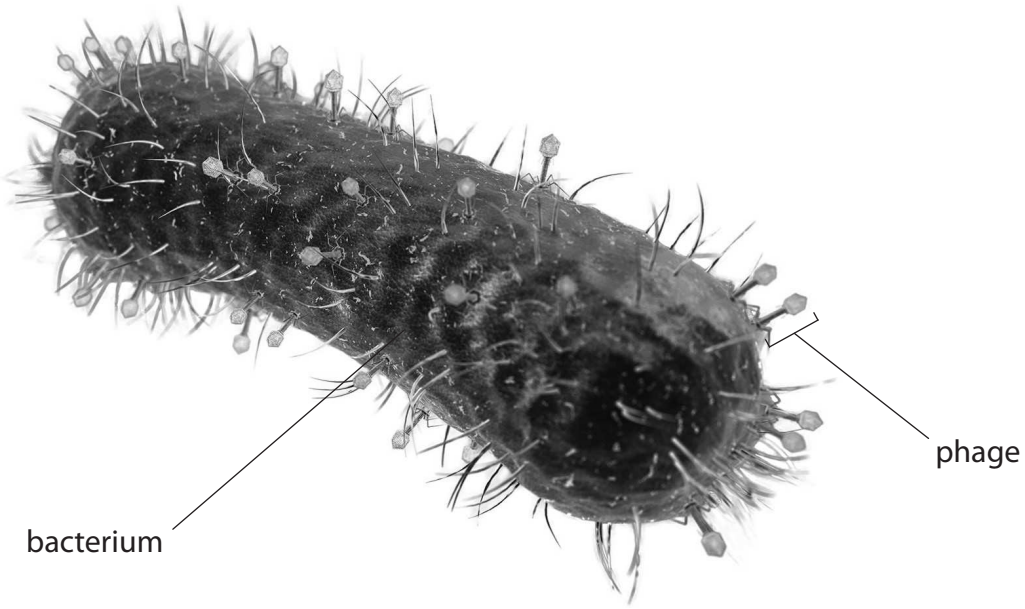
4 Bacteria are the host cells for λ (lambda) phage viruses.

(a) Which is a description of a λ phage?

(1)

- ☒ **A** DNA virus with a complex protein capsid
- ☒ **B** DNA virus with a helical protein capsid
- ☒ **C** RNA virus with a complex protein capsid
- ☒ **D** RNA virus with a helical protein capsid

(b) The image shows phage viruses attacking a bacterium.



(Source: © nobeastsofierce Science/Alamy Stock Photo)

The length of this bacterium is 1.7 µm.

Calculate the length of the labelled phage.

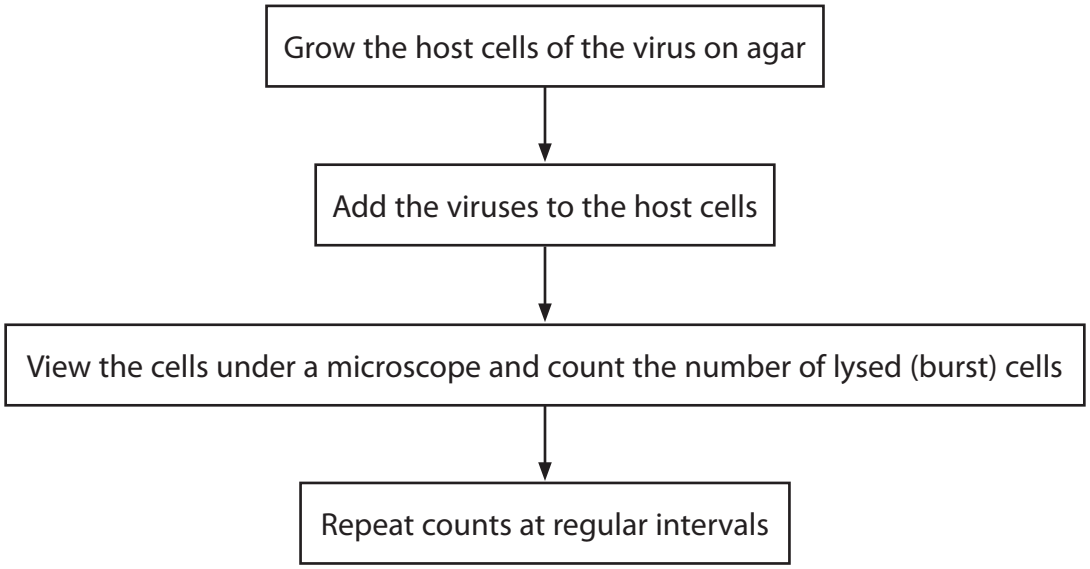
Give your answer in nanometres (nm).

(2)

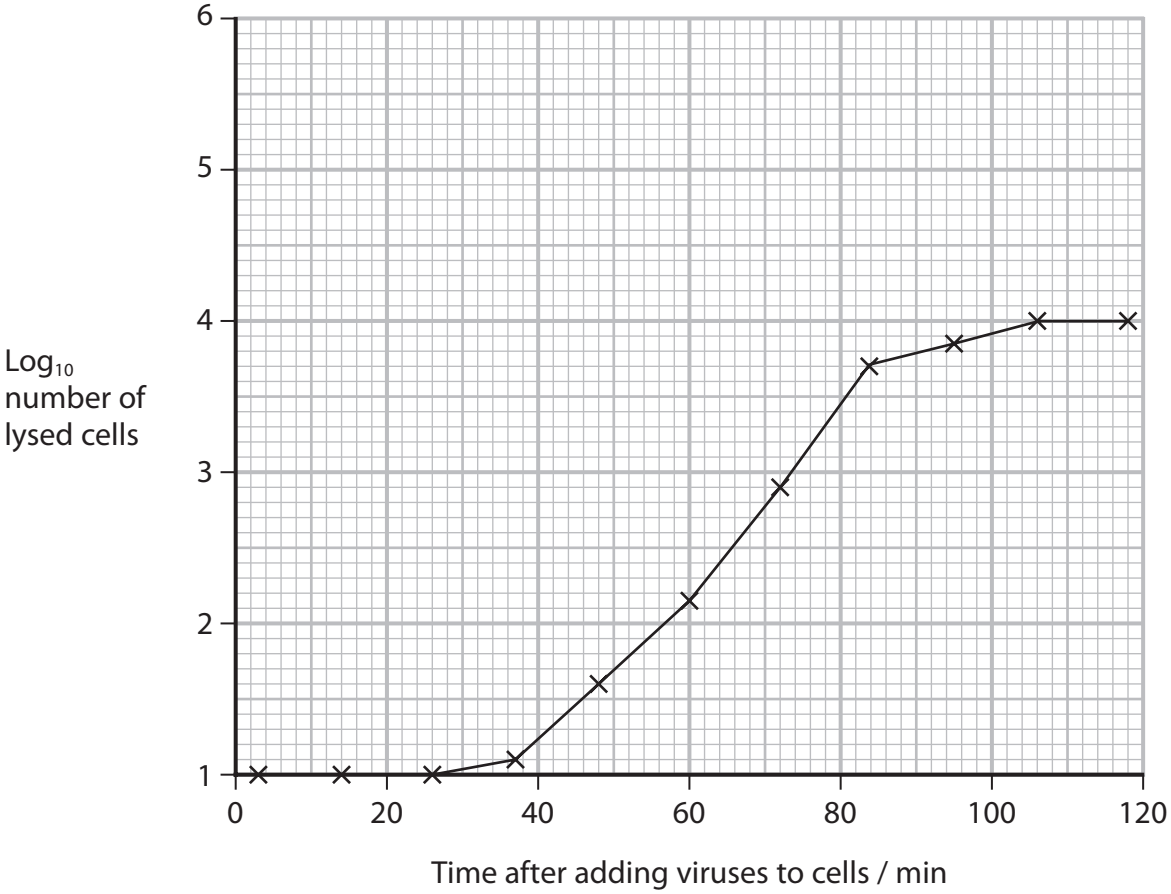
Answer ..... nm

(c) Viruses can be cultured and a growth curve can be produced.

The flow chart shows how this can be done.



The graph shows a growth curve for viruses.



(i) Explain why there was a delay before the number of lysed cells started to increase.

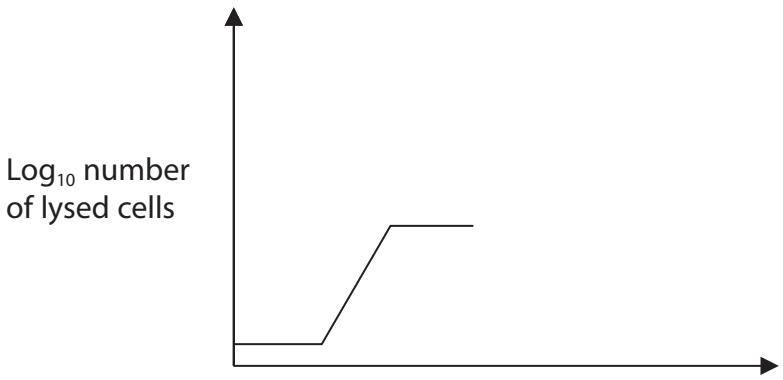
(3)

(ii) Calculate the mean rate of increase in the actual number of lysed cells between 50 minutes and 90 minutes.

(2)

Answer ..... cells min^{-1}

(iii) A sketch has been made of this growth curve.



Complete this sketch to predict the shape of the growth curve after 120 minutes, assuming there is an excess of host cells.

(2)

(Total for Question 4 = 10 marks)

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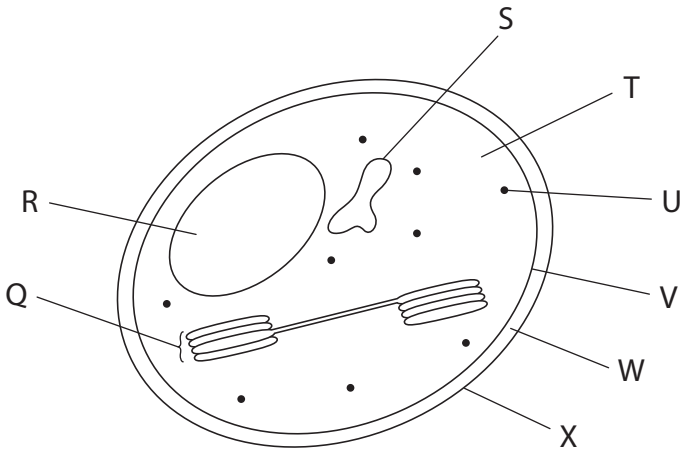
5 The light-dependent stage and the light-independent stage of photosynthesis both take place in the chloroplast.

The rate of photosynthesis is affected by a number of different factors, including carbon dioxide concentration and temperature.

(a) The diagram shows a chloroplast.



(i) Where does the light-dependent stage take place?

(1)

- ☒ **A** Q
- ☒ **B** T
- ☒ **C** V
- ☒ **D** X

(ii) The light-dependent stage produces hydrogen ions.

Where do these hydrogen ions accumulate?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** W

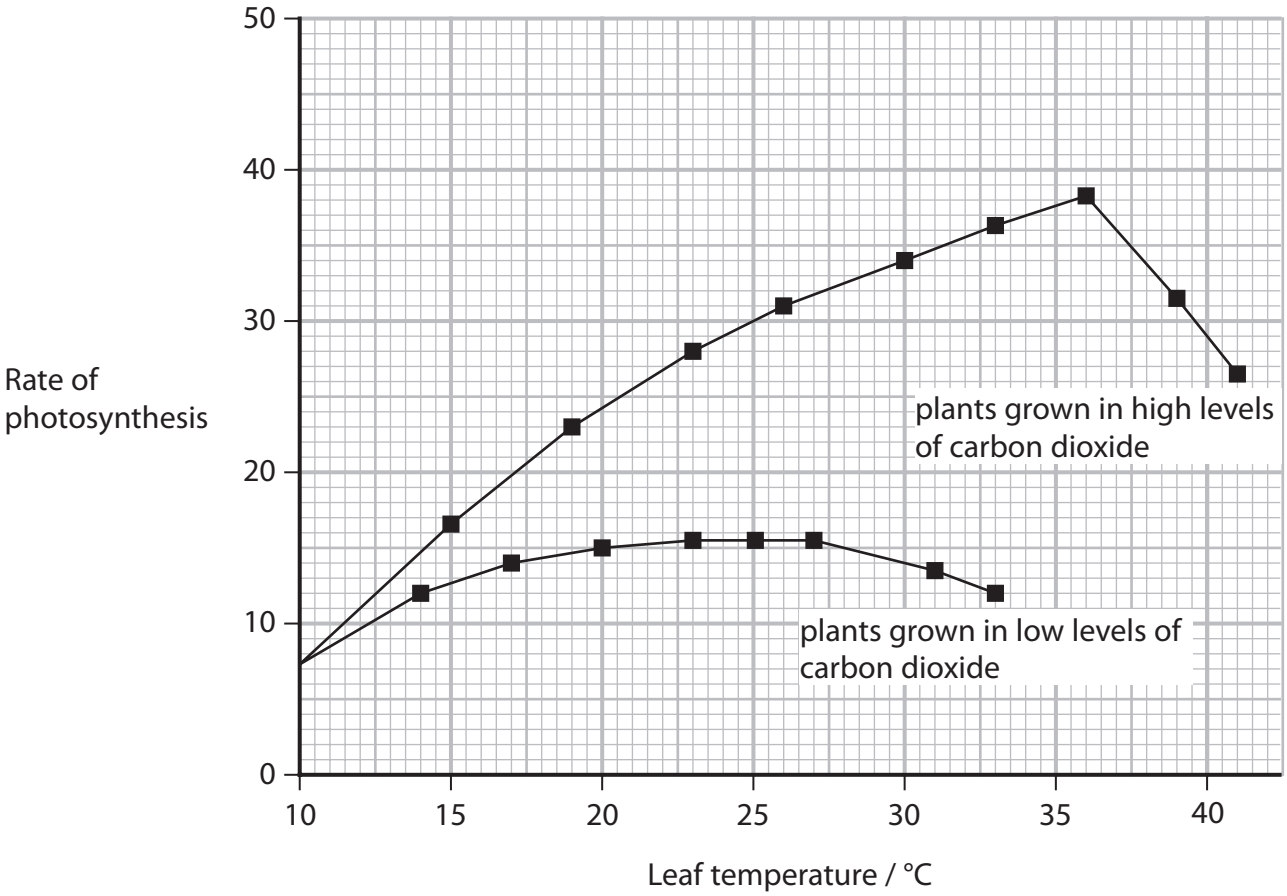
(iii) Where does translation take place?

(1)

- ☒ **A** Q
- ☒ **B** R
- ☒ **C** S
- ☒ **D** U

(b) Scientists measured the effect of two different concentrations of carbon dioxide on the rate of photosynthesis at different leaf temperatures, in one species of plant.

The results are shown in the graph.



(i) Which units are suitable for measuring the rate of photosynthesis in leaves?

(1)

☒ **A** $\mu mol\, m^{-1}\, sec^{-1}$

☒ **B** $\mu mol\, m^{-1}\, sec^{-2}$

☒ **C** $\mu mol\, m^{-2}\, sec^{-1}$

☒ **D** $\mu mol\, m^{-2}\, sec^{-2}$

(ii) Analyse the data to identify **three** conclusions that can be made from this graph.

(3)

(iii) Explain the effects of carbon dioxide concentration and temperature on the rate of formation of GALP.

(4)

(Total for Question 5 = 11 marks)

6 The lipid content of the cell membranes of prokaryotic organisms changes in response to changes in the environmental temperature.

(a) Phospholipids form a bilayer in the cell membranes of bacteria.

Describe the structure of a phospholipid.

(2)

(b) The cell membranes of most organisms belonging to the domain Archaea are lipid monolayers.

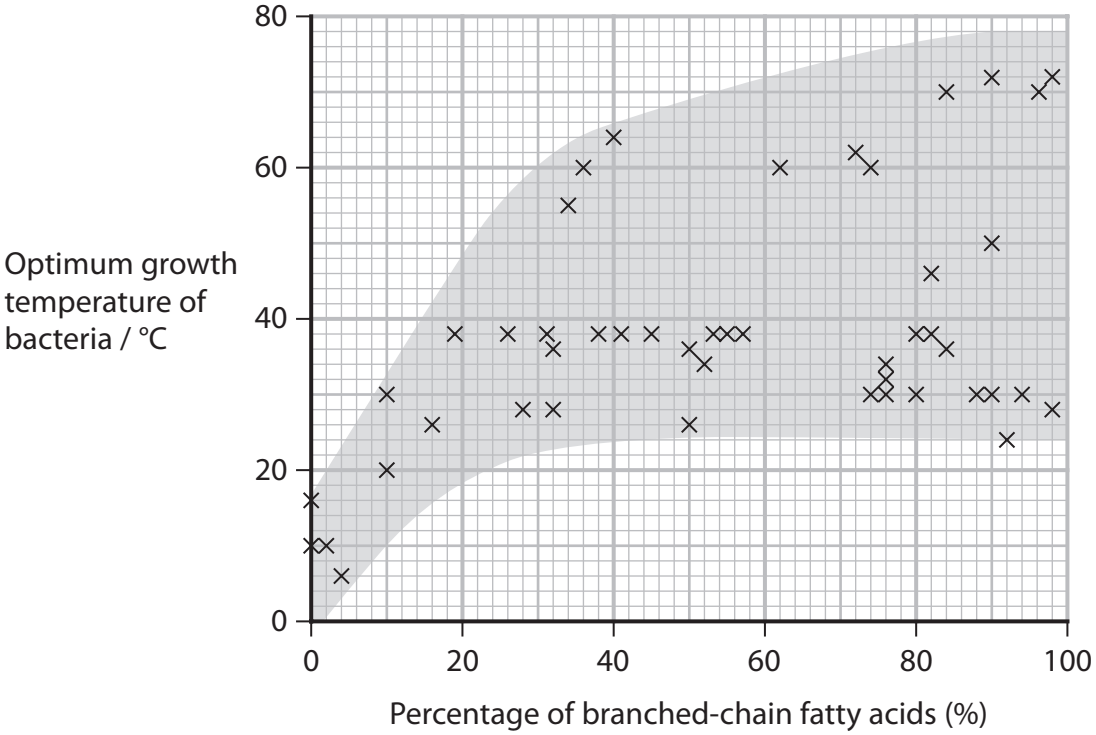
The lipid that forms this monolayer is a bipolar lipid.

Explain why a bipolar lipid is a suitable molecule to form the cell membrane.

(2)

(c) The percentage of branched-chain fatty acids in membranes of bacteria that have different optimum growth temperatures was investigated.

The graph shows the results of this investigation.



(i) Calculate the mean percentage of branched-chain fatty acids in bacteria whose optimum growth temperature is $<20\,°C$.

(1)

Answer ..... %

(ii) Analyse the data to describe **two** conclusions that can be drawn from this investigation.

(2)

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(d) A change in temperature can affect the permeability and fluidity of the membrane.

Explain why it is important that the lipid composition of the membrane of prokaryotic organisms changes if the temperature changes.

(3)

(Total for Question 6 = 10 marks)

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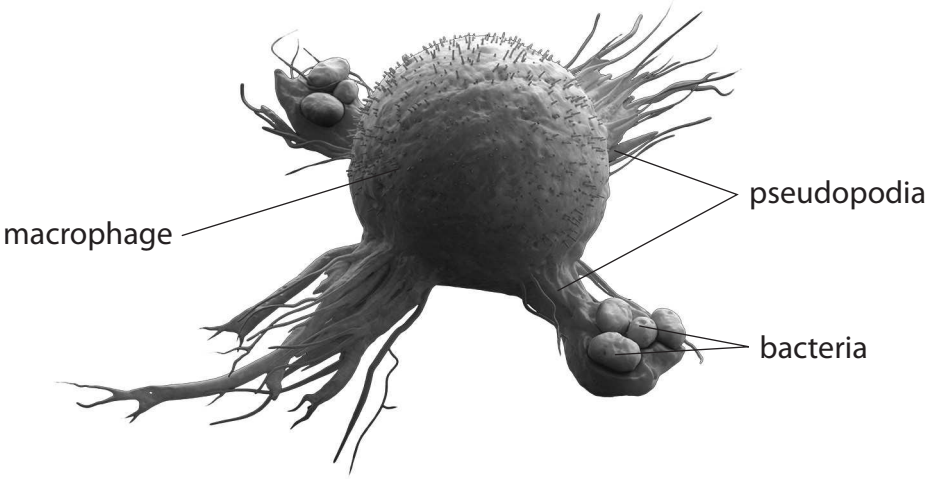
7 Macrophages are involved in response to infection.

(a) Macrophages engulf bacteria by surrounding the bacteria with pseudopodia.

The image shows a macrophage forming pseudopodia around some bacteria.



(Source: © urfin/Shutterstock)

The flow chart shows one theory for the formation of pseudopodia.

Step 1 antibody binds to the cell surface of the macrophage

↓

Step 2 fibrous proteins in the cytoplasm, close to the antibody binding site, break down to form soluble components

↓

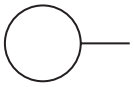
Step 3 water flows into the part of the cell where the soluble components are located

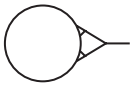
↓

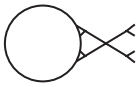
Step 4 pseudopodia start to form around the bacteria

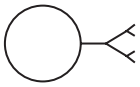
(i) Which diagram shows one antibody binding to the surface of a macrophage (**Step 1**)?

(1)

☒ **A** 

☒ **B** 

☒ **C** 

☒ **D** 

(ii) Actin is a fibrous protein.

Which row of the table describes the breakdown of actin (**Step 2**)?

(1)

		monomer formed	process by which bond is broken
☒	**A**	amino acid	condensation
☒	**B**	amino acid	hydrolysis
☒	**C**	nucleotide	condensation
☒	**D**	nucleotide	hydrolysis

(iii) Explain why water flows into the part of the cell where the soluble components are located (**Step 3**).

(2)

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(iv) Describe the events that take place resulting in T helper cell activation, following the formation of pseudopodia by the macrophages (**Step 4**).

(3)

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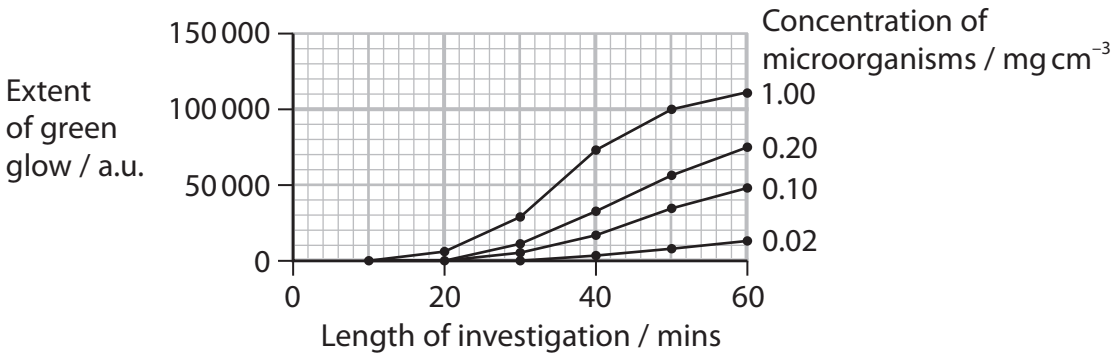
*(b) Phagocytosis by macrophages is affected by a number of factors.

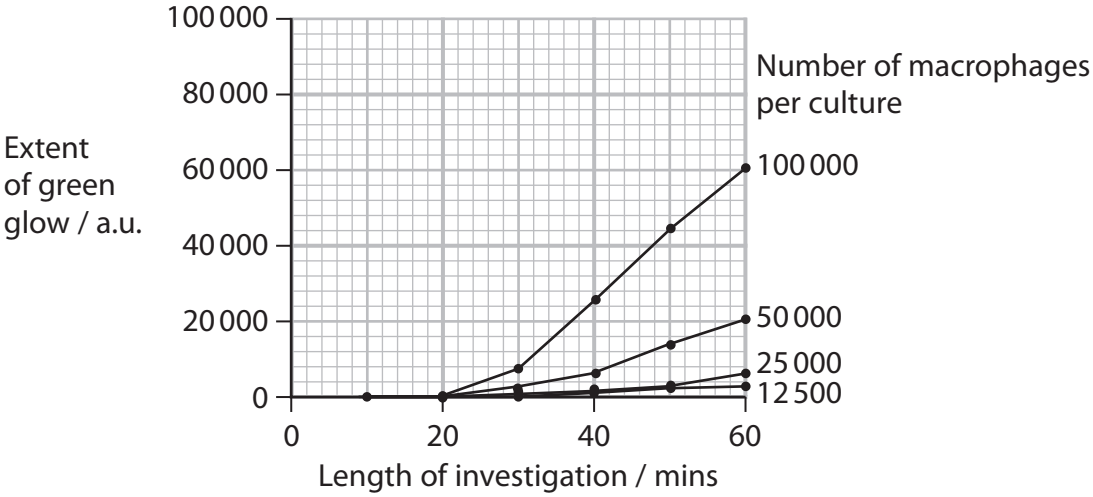
Microorganisms with a fluorescent green dye attached to them were used to measure phagocytosis by macrophages.

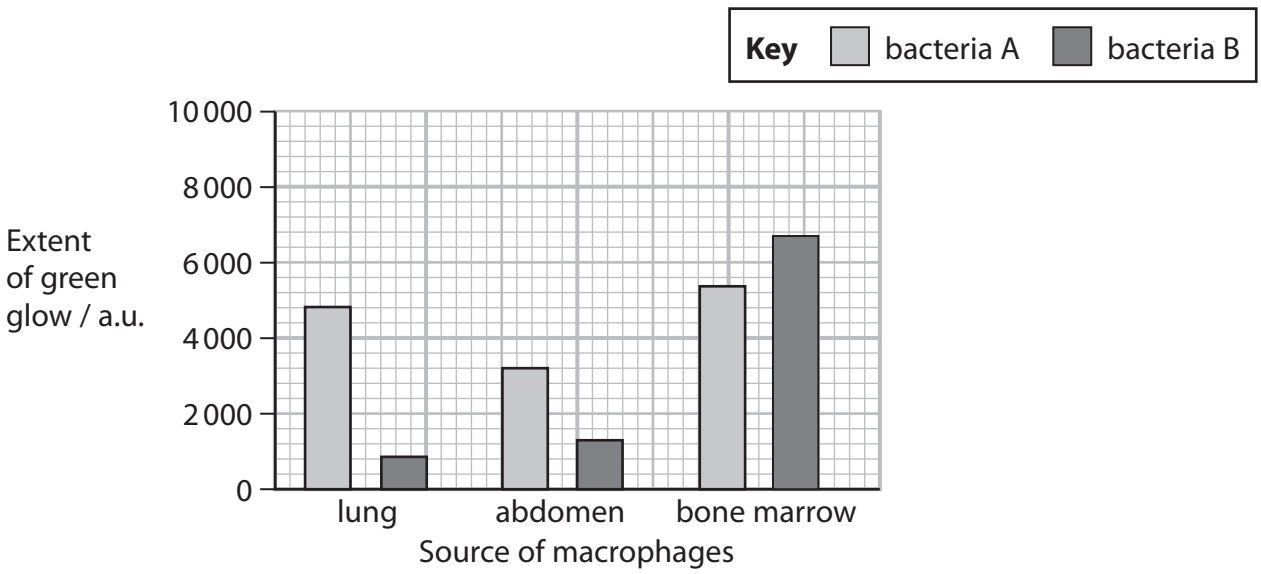
The microorganisms were added to the macrophages and incubated. The macrophages were then washed and the extent to which they glowed green was determined.

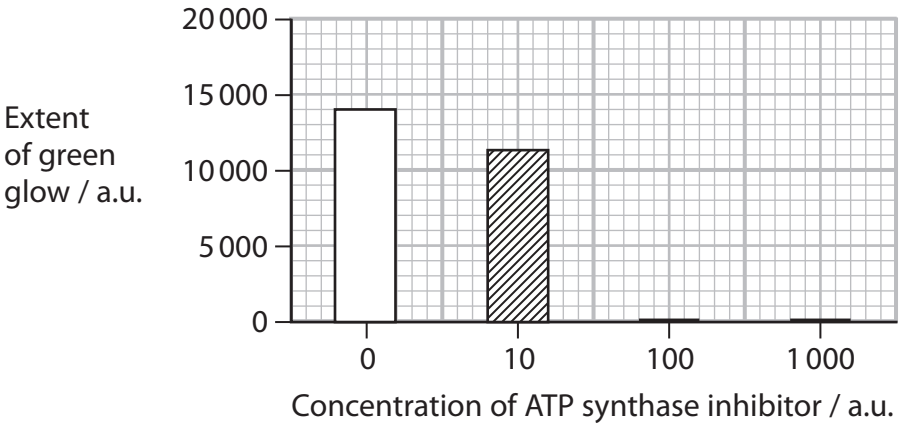
The extent of the green glow is proportional to the number of microorganisms engulfed by the macrophages.

The graphs show the results of investigations into phagocytosis by macrophages.









Analyse the data to discuss the factors that affect phagocytosis by macrophages.

(6)

(Total for Question 7 = 13 marks)

8 Hypoxia is an inadequate supply of oxygen to tissues and cells that restricts their function.

(a) The normal partial pressures of oxygen vary from tissue to tissue.

The table shows the normal partial pressure of oxygen in two tissues.

Tissue	Partial pressure of oxygen / kPa
Pulmonary arterial blood	5.3
Other arterial blood	13.3

(i) Calculate the ratio of the partial pressures of oxygen in these two tissues. Give your answer to one decimal place.

(1)

Answer .....

(ii) Explain why the partial pressures of oxygen in these two tissues are different.

(2)

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(b) The body responds to hypoxia by releasing hypoxia-inducible transcription factors (HIF).

Investigations have shown that one effect of HIF is an increase in the rate of glycolysis in the affected cells.

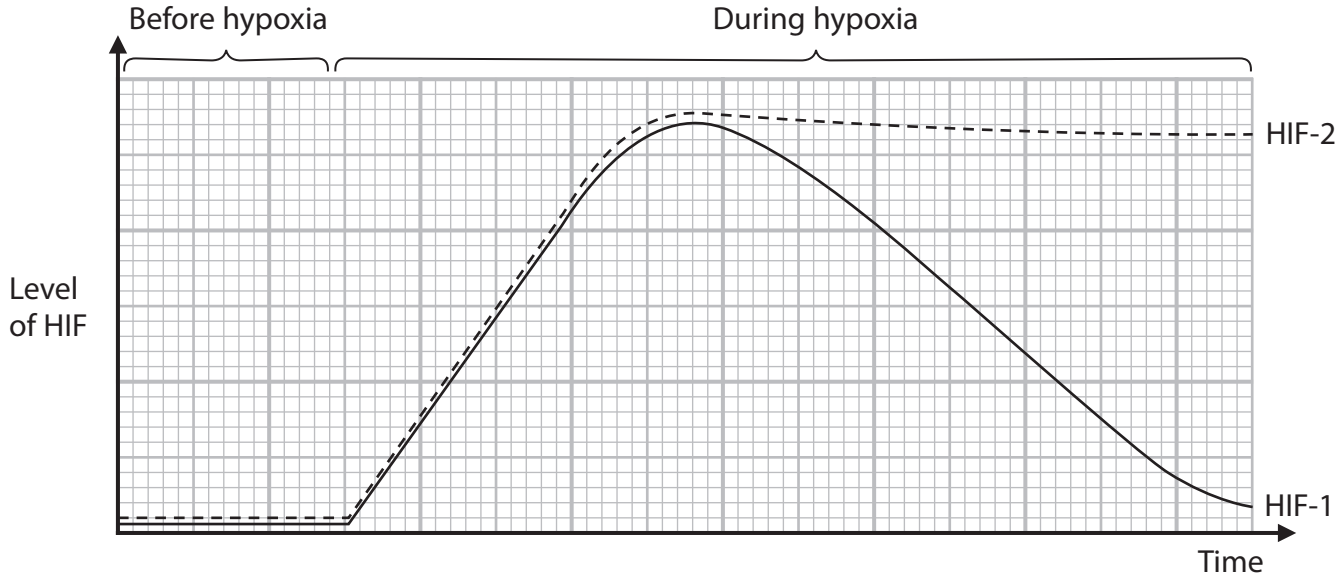
(i) Explain how HIF could result in an increase in the rate of glycolysis.

(2)

(ii) Explain why cells need to respond to hypoxia with an increase in the rate of glycolysis.

(4)

(iii) The graph shows the changes in levels of two HIFs, HIF-1 and HIF-2, before and during hypoxia.



Compare and contrast the changes in the levels of HIF-1 and HIF-2 during hypoxia.

(2)

(iv) Explain the changes in levels of HIF-1 and HIF-2 during hypoxia.

(2)

(Total for Question 8 = 13 marks)

9 Plants and animals are adapted for gas exchange.

(a) (i) Which row of the table describes gas exchange in the root of a plant?

(1)

		Net movement of carbon dioxide	Net movement of oxygen
☒	**A**	in only	out only
☒	**B**	out only	in only
☒	**C**	in and out	in and out
☒	**D**	neither in nor out	neither in nor out

(ii) Which is the gas exchange surface in the stem of a woody plant?

(1)

☒ **A** lenticel

☒ **B** pit

☒ **C** plasmodesmata

☒ **D** stomata

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(b) Spiracles are small openings in the exoskeletons of insects that allow air to enter the respiratory system.

Water can evaporate out of the spiracles when they are open. The insect can close the spiracles to reduce water loss.

In an investigation, the water loss from insects in air with different humidities was measured.

The insects were kept in air with 80% humidity and then moved into air with a lower humidity. Water loss was then measured.

The investigation was repeated in air high in carbon dioxide to keep the spiracles open.

The table shows the results of this investigation.

Percentage humidity (%)	Water loss from insects / mg hr^{-1}	
	Insects in air	Insects in air high in carbon dioxide
0	0.10	0.90
20	0.13	0.68
40	0.15	0.50
60	0.13	0.35
80	0.07	0.07

(i) State how the water loss could have been measured in this investigation.

(1)

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(ii) Calculate the percentage increase in water loss from the insects kept in air at 0% humidity compared with those kept at 80% humidity.

Give your answer to two decimal places.

(1)

Answer ..... %

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(iii) Explain why the insects were kept in air with 80% humidity at the start of this investigation.

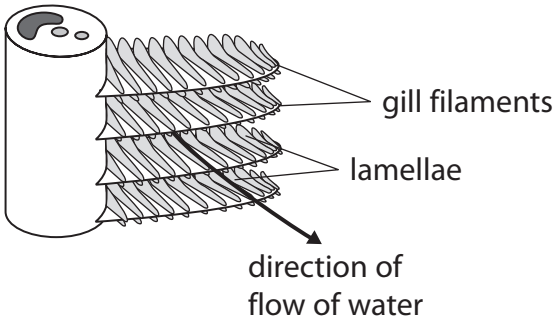
(2)

(iv) Explain the results of this investigation.

(3)

(c) The gas exchange surfaces of fish are the gills.

The diagram shows part of the structure of a gill.



Fish can be divided into two groups: species of fish that are active and species of fish that are inactive.

The table shows some information about some species of fish and their gills.

Species of fish	Mass of fish / g	Total number of gill filaments	Number of lamellae on each side of filament per mm	Surface area of gills / cm^2 per g of fish	Diffusion distance between water and blood / µm
Active species					
Trachurus	26	1665	39	7.8	2.2
Lucioperca	70	1811	15	18.0	no data
Salmo	394	1606	19	2.0	6.4
Katsuwonus	3258	6066	32	13.5	0.6
Thunnus	26600	6480	24	8.9	no data
Inactive species					
Callionymus	39	478	16	2.1	no data
Ictalurus	239	no data	10	1.2	no data
Opsanus	251	660	11	1.9	5.0
Tinca	268	1764	22	1.8	2.5

(i) Lamellae are present on both sides of the gill filaments.

The mean length of a gill filament is 25 mm.

Calculate the total number of lamellae on the gill filaments of *Thunnus*.

Express your answer in standard form.

(1)

Answer .....

*(ii) Analyse the data to explain the relationships between the activity of these fish and the structure of their gills.

(6)

(Total for Question 9 = 16 marks)

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