PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



EXAM QUESTION PACK

TOPIC 4: EXCHANGE AND TRANSPORT

CELL TRANSPORT MECHANISMS

SCORE	PERCENTAGE
/145	%

STEMUP

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Q1.

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

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.

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(Total for question = 2 marks)

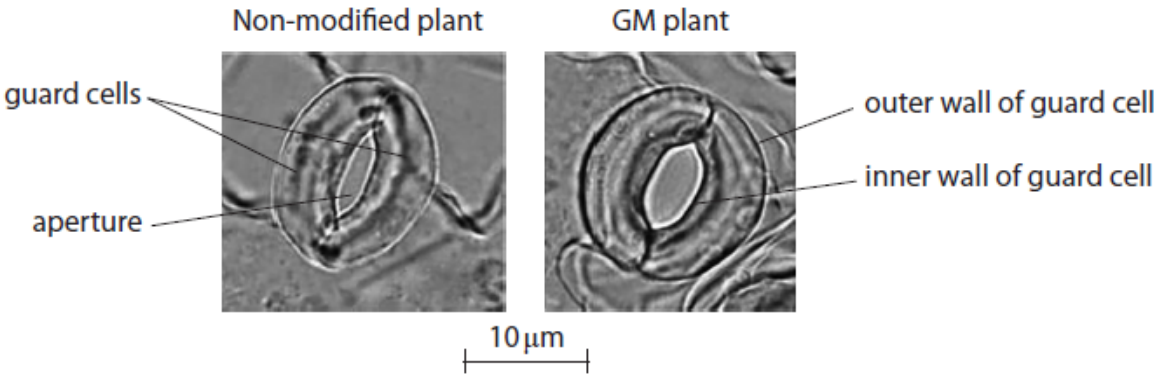
Q2.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Genetically modified (GM) crop plants have been produced that have stomata with a wider aperture than non-modified crop plants.

This difference in the width of the aperture is only evident in daylight.

The photographs show the appearance of each type of stoma in daylight.



Sourced from: http://www.aip.nagoya-u.ac.jp/en/public/nu_research/images/Wang_f1.jpg

The flow chart shows some of the steps involved in opening the aperture of a stoma.

Hydrogen ions actively transported out of the guard cells

↓

Potassium ions diffuse into the guard cells

↓

Starch broken down into malate

↓

Water moves into the guard cells

↓

Aperture of the stoma widens

(i) What happens when hydrogen ions are actively transported out of the guard cells?

(1)

☒ **A** ADP and phosphate ions are converted into ATP by a hydrolysis reaction

☒ **B** ADP and phosphate ions are converted into ATP by a condensation reaction

☒ **C** ATP is broken down into ADP and phosphate ions by a condensation reaction

☒ **D** ATP is broken down into ADP and phosphate ions by a hydrolysis reaction

(ii) Which of the following explains why water moves into the guard cells?

(1)

☒ **A** malate lowers the water potential of the cytoplasm

☒ **B** malate raises the water potential of the cytoplasm

☒ **C** starch lowers the water potential of the cytoplasm

☒ **D** starch raises the water potential of the cytoplasm

(iii) Which of the following explains why the aperture of the stoma widens?

(1)

☒ **A** The guard cells become smaller and the inner wall of the guard cell is more flexible than the outer wall

☒ **B** The guard cells become smaller and the inner wall of the guard cell is less flexible than the outer wall

☒ **C** The guard cells become larger and the inner wall of the guard cell is more flexible than the outer wall

☒ **D** The guard cells become larger and the inner wall of the guard cell is less flexible than the outer wall

(Total for question = 3 marks)

Q3.

(a) A student investigated the effect of ethanol on plant cell membranes.

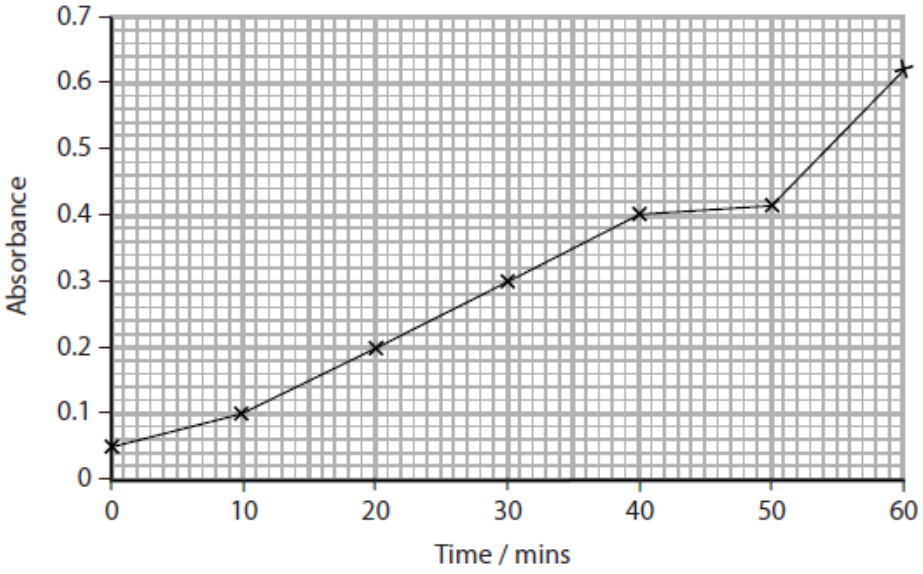
Step 1: The student cut leaf discs from leaves, using a cork borer.

Step 2: These leaf discs were then added to a boiling tube containing 10 cm^3 of 40% ethanol solution. The pigments in the leaf discs dissolved in the ethanol, producing a green solution.

Step 3: The boiling tube was shaken and the amount of red light absorbed by this solution (absorbance) was measured at the start.

Step 4: The absorbance was measured every 10 minutes, for an hour.

The graph shows the results of this investigation.



(i) Explain why red light was used in this investigation.

(2)

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(ii) Explain the absorbance value at 0 minutes.

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(iii) Explain the effect of ethanol on plant cell membranes.

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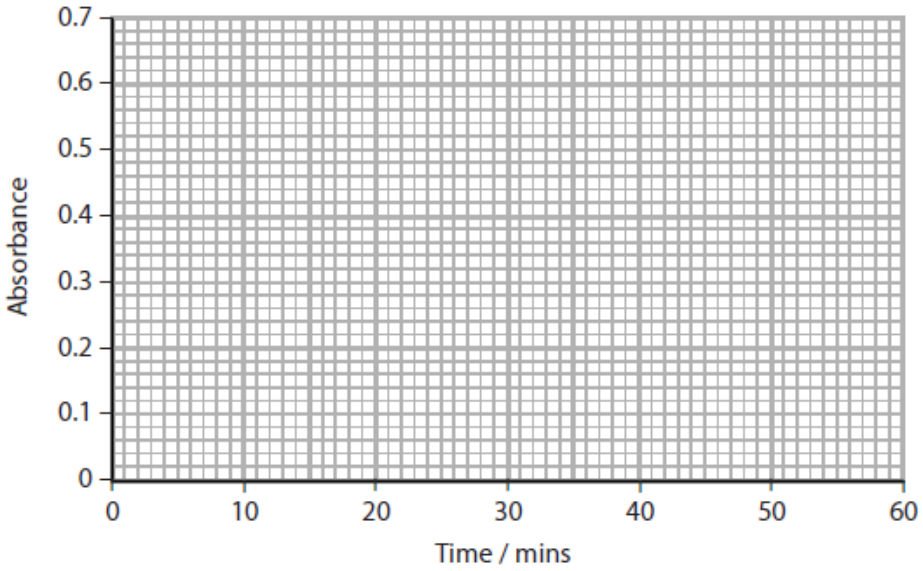
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(b) The student also carried out a control, using water instead of 40% ethanol.

Draw a line on the graph to show the results for this control.

(2)



(c) The student then investigated the effect of ethanol concentration on leaves from different plant species.

Justify the modifications to the procedure in part (a) that will be required to obtain valid data.

(5)

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(Total for question = 13 marks)

Q4.

Compare and contrast the way in which ATP is synthesised in mitochondria and in chloroplasts.

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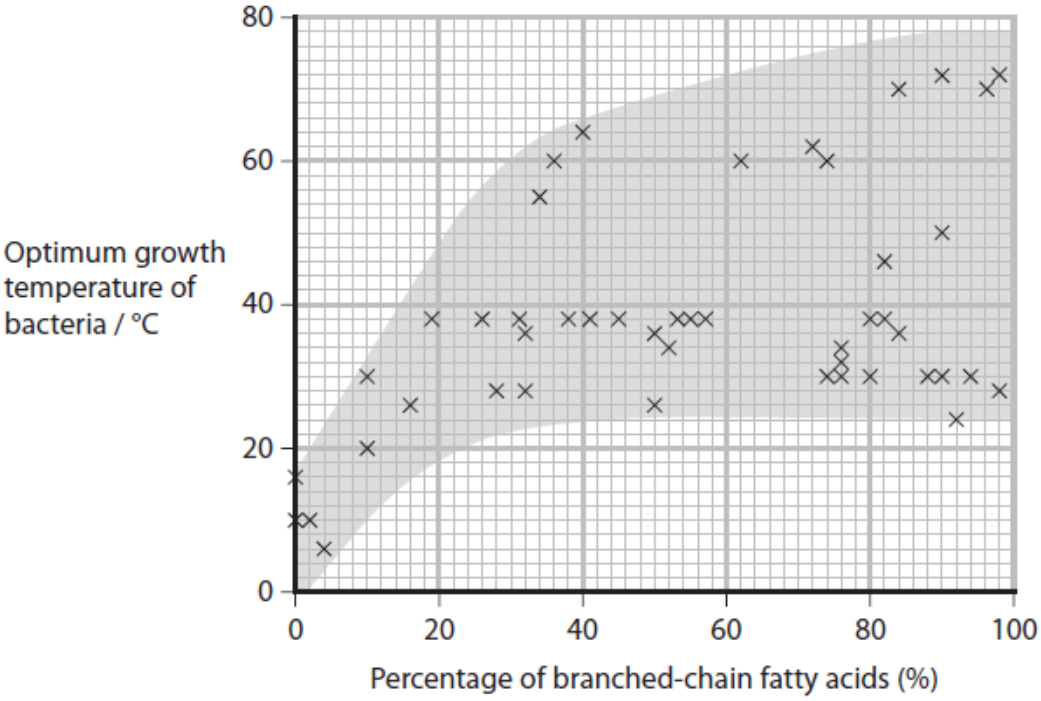
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Q5.

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

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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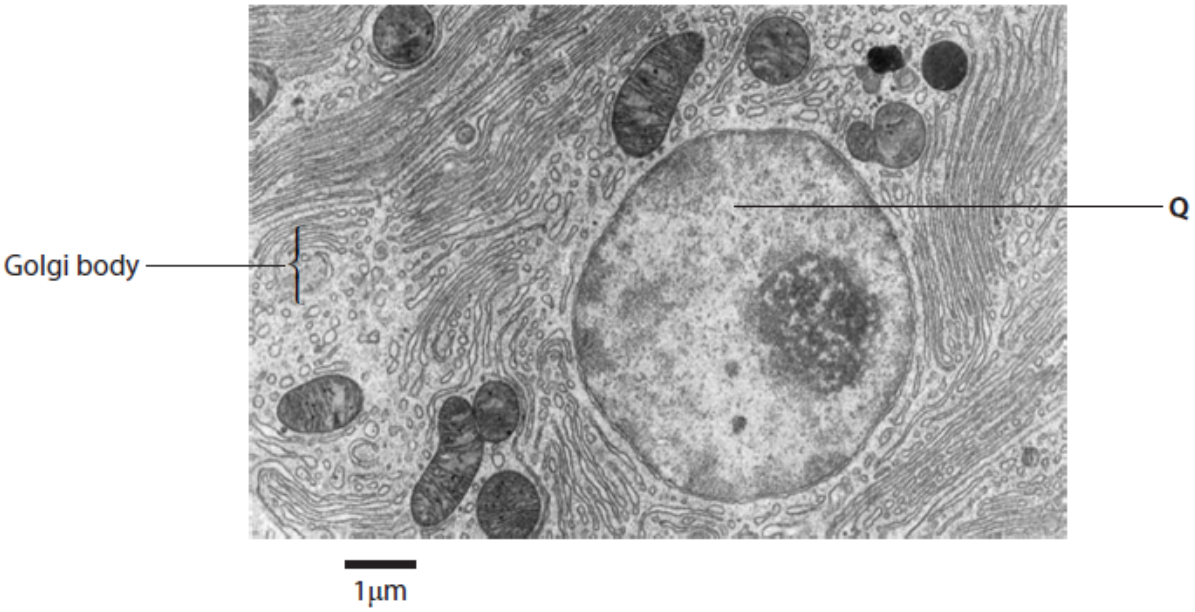
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(Total for question = 3 marks)

Q6.

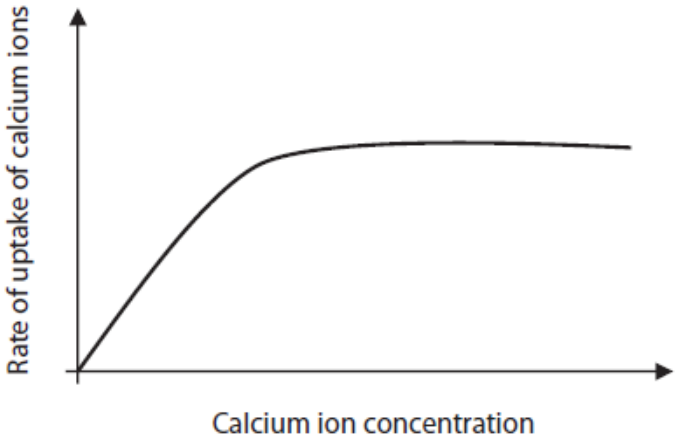
The pancreas is an organ that secretes digestive enzymes.

The electron micrograph shows part of a secretory cell from a human pancreas.



Calcium ions are needed for the secretion of enzymes from pancreatic cells.

The graph shows the effect of increasing calcium ion concentration on the uptake of calcium ions by pancreatic cells.



Explain the effects of calcium ion concentration on the rate of uptake of calcium ions through the pancreatic cell membrane.

(3)

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(Total for question = 3 marks)

Q7.

ATP is involved in a wide variety of biological processes such as active transport and muscle contraction.

A typical adult human body has a mass of 62 kg.

It contains approximately 250 g of ATP and has approximately 3.7×10^{13} cells.

(i) Calculate the mean mass of ATP in one cell of a typical human.

Express your answer in standard form.

(2)

Answer ..... g

(ii) Explain why this calculation does **not** give an accurate estimate of the mass of ATP in a nerve cell.

(2)

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Q8.

Scientists have calculated that a typical person synthesises their own body mass in ATP every 24 hours.

(i) Calculate the mean rate of ATP production in grams per second in a person with a body mass of 62 kg.

(2)

Answer .....

(ii) Explain why people do not double their body mass in 24 hours due to ATP production.

(2)

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Q9.

Auxins and cytokinins are plant growth regulators that control apical dominance and cell elongation.

Auxin is an uncharged molecule when it diffuses through the cell surface membrane.
When inside the cytoplasm, auxin develops a negative charge. Auxin leaves cells by facilitated diffusion.

Explain how the structure of the cell membrane affects the transport of auxin.

(2)

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(Total for question = 2 marks)

Q10.

The structure of a lipid relates to its role in living organisms.

Cell membranes contain lipids that have a phosphate group attached to the glycerol, instead of one of the fatty acids.

Explain the importance of the phosphate group in these lipids.

(2)

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(Total for question = 2 marks)

Q11.

A student investigated the effect of the concentration of sodium chloride solution on blood.

The student set up six test tubes, each with a different concentration of sodium chloride solution.

Five drops of blood were added to each test tube.

The appearance of the solutions was then recorded.

Samples of each solution were observed using a light microscope.

The table shows the results of this investigation.

Concentration of sodium chloride (%)	Appearance of solution after blood was added	Observation with light microscope
3.0	very cloudy	cells seen with shrunken edges
1.0	very cloudy	cells seen
0.9	very cloudy	cells seen
0.7	slightly cloudy	cells seen
0.5	cloudy at first, then went clear	no cells seen
0.3	clear	no cells seen

Analyse the data to comment on the effect of the concentration of sodium chloride solution on blood.

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(Total for question = 4 marks)

Q12.

A student investigated the effect of the concentration of sodium chloride solution on blood.

The student set up six test tubes, each with a different concentration of sodium chloride solution.

Five drops of blood were added to each test tube.

The appearance of the solutions was then recorded.

Samples of each solution were observed using a light microscope.

The table shows the results of this investigation.

Concentration of sodium chloride (%)	Appearance of solution after blood was added	Observation with light microscope
3.0	very cloudy	cells seen with shrunken edges
1.0	very cloudy	cells seen
0.9	very cloudy	cells seen
0.7	slightly cloudy	cells seen
0.5	cloudy at first, then went clear	no cells seen
0.3	clear	no cells seen

The student then investigated the effect of using glucose solutions and sucrose solutions, instead of sodium chloride solutions.

The appearance of the solutions was recorded and samples were observed using a light microscope.

When the concentration of glucose solution was below 3%, the solution was clear and no blood cells could be seen. When the concentration of glucose solution was above 3%, the solution was cloudy and blood cells could be seen.

When the concentration of sucrose solution was below 6%, the solution was also clear and no blood cells could be seen. When the concentration of sucrose solution was above 6%, the solution was cloudy and blood cells could be seen.

Explain the differences in the effects of the solutions of glucose and sucrose.

(3)

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(Total for question = 3 marks)

Q13.

The photograph shows *Salicornia*, a plant growing on salt marshes close to the sea. *Salicornia* colonises bare mud containing seawater.



A student sampled *Salicornia* plants at the river mouth by the sea and at different distances upstream. Samples of the water in the mud were also taken.

The salt concentration of the plants and the water in the mud were measured.

The results are shown in the table.

Distance upstream from sea / km	Salt concentration / arbitrary units	
	Salicornia plants	Water in the mud
0.0	60.0	2.8
1.6	60.0	1.1
4.8	55.0	0.6
8.0	75.0	0.2

Analyse the data to explain how *Salicornia* is adapted to life in salt marshes.

(3)

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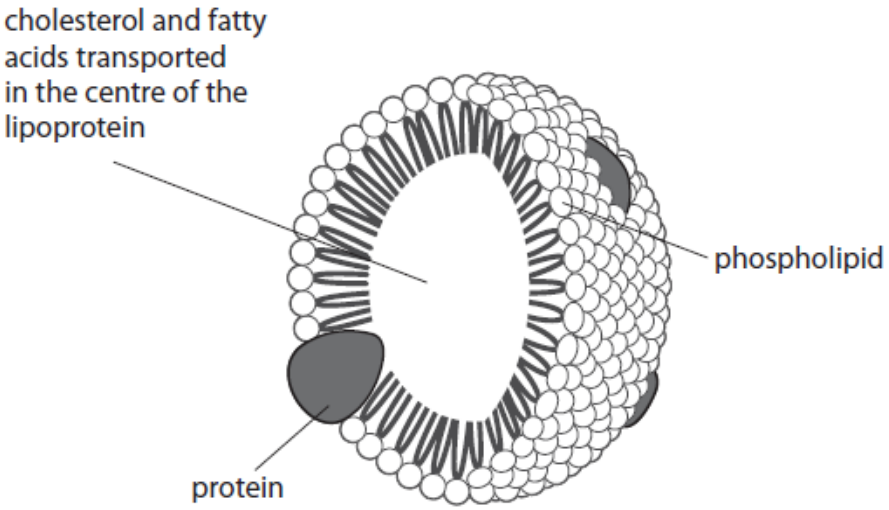
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(Total for question = 3 marks)

Q14.

High density and low density lipoproteins are spherical structures that transport cholesterol and fatty acids in the bloodstream.

The diagram shows a lipoprotein.



Explain why the properties of lipoproteins enable cholesterol and fatty acids to be transported in the bloodstream.

(3)

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(Total for question = 3 marks)

Q15.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

(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

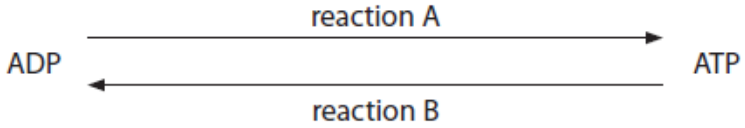
☒ **D** increased permeability of the collecting duct to water, producing more dilute urine

(Total for question = 2 marks)

Q16.

Phagocytosis requires a source of energy in the form of ATP.

The diagram below shows the relationship between ATP and ADP.



Place a cross ☒ in the box next to the name of reaction A and reaction B.

(2)

Reaction	Name of reaction				
	autolysis	decarboxylation	hydrolysis	phosphorylation	polymerisation
A	☐	☐	☐	☐	☐
B	☐	☐	☐	☐	☐

Q17.

White clover plants provide a rich source of nitrogen for cattle when grown with grass plants in fields.

The photograph shows a clover plant growing in a field of grass.



Clover plants have bacteria living in root nodules.

These bacteria convert atmospheric nitrogen (N_2) to ammonia (NH_3) using the enzyme nitrogenase.

(i) State one organic molecule containing nitrogen atoms which is found in plant cells.

(1)

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(ii) Nitrogen is a relatively unreactive gas that forms 80% of the atmosphere.

The enzyme nitrogenase catalyses the reaction shown:

$$N_2 + 8H^+ + 16\ ATP \rightarrow 2NH_3 + H_2 + 16\ ADP + 16\ Pi$$

The activation energy for this reaction is very high.

Analyse the information to explain how the enzyme nitrogenase is involved in the energy changes required for this reaction.

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(Total for question = 5 marks)

Q18.

The photograph shows a glacier that is melting. As the glacier gradually melts, it leaves behind bare rock.



(Source: © CHARLES D. WINTERS/SCIENCE PHOTO LIBRARY)

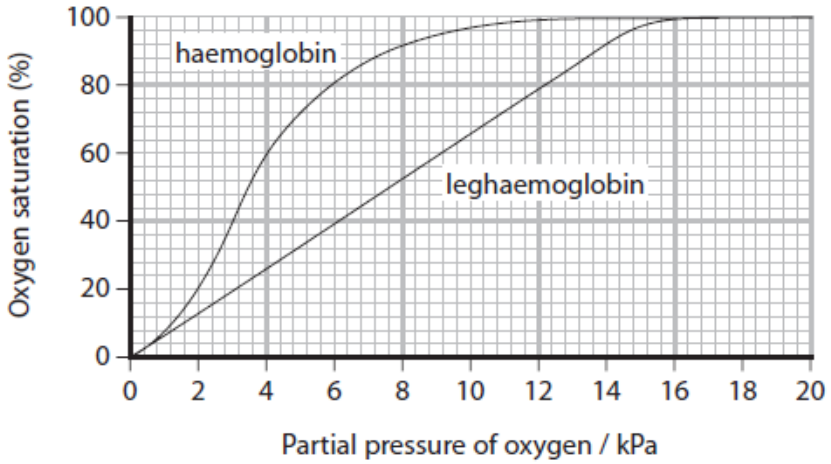
Scientists sampled the soil from areas that had been uncovered for different lengths of time after the glacier ice had melted.

The table shows the results from the samples.

Length of time since glacier melted / years	Soil depth / cm	Mass of nitrate in soil / mg m^{-2}	Mass of leaf litter that falls to ground each year / g m^{-2} yr^{-1}
5	5.2	3.8	1.5
15	6.4	4.1	1.7
40	7.0	5.3	12.8
100	9.2	21.8	277.0
150	10.8	35.4	335.0
200	15.1	53.3	277.0
250	16.2	61.4	261.0

The roots of some of the plants growing around the glacier were found to contain an oxygen binding protein called leghaemoglobin.

The graph shows the oxygen dissociation curve for leghaemoglobin and the oxygen dissociation for haemoglobin.



(i) Leghaemoglobin is a protein that is similar in structure to myoglobin. Both of these proteins have one subunit.

Explain how the oxygen dissociation curve shows that the structure of leghaemoglobin is more similar to myoglobin than to haemoglobin.

(3)

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(ii) Explain how leghaemoglobin enables these plants to grow in waterlogged and compact soils.

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(Total for question = 6 marks)

Q19.

Macrophages are involved in response to infection.

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

↓

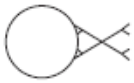
Step 4 pseudopodia start to form around the bacteria

(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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(Total for question = 7 marks)

Q20.

Plants require mineral ions from the soil for healthy growth.

(i) Describe how mineral (inorganic) ions are taken up by active transport.

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(ii) Describe the function of a named mineral ion that is vital for the growth of plants.

(2)

Mineral ions

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Function

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(Total for question = 5 marks)

Q21. The scientific article you have studied is adapted from several sources.

Use the information from the article and your own knowledge to answer the following questions.

(a) The sweet potato eaten by naked mole rats (paragraph 3) is very rich in starch. Starch can be a combination of amylose and amylopectin.

Give **two** structural differences between amylose and amylopectin.

(2)

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(b) Explain why a colony of naked mole rats is considered 'a eusocial society' (paragraph 4).

(2)

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(c) Naked mole rats show evidence of poikilothermy (paragraph 5).

(i) Explain what is meant by the term **poikilothermic**.

(1)

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(ii) Suggest how each of the following 'contribute to poikilothermic responses to changing temperature of this mammal'.

(2)

'Lack of an insulating layer'

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'A marked reduction in sweat glands'

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(d) Suggest a mechanism that could have been used to genetically modify cells from mice with cancer-causing genes (paragraph 13).

(2)

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*(e) Whilst naked mole rats are 'impervious to chemical pain' they do feel 'acute pain such as cuts and burns' (paragraph 31).

Touching something hot, which could lead to a burn, can cause nerve impulses to travel along myelinated sensory neurones very rapidly.

Explain how myelination increases the speed of transmission of nerve impulses in a sensory neurone.

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(f) Explain how a heart attack can temporarily reduce the oxygen concentration in brain tissue (paragraph 36).

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(g) Using the information in paragraph 48, name **one** hormone **and** state its function.

(1)

Hormone:

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Function:

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(h) Suggest how a change in the mid region of the sperm may make it non-motile (paragraph 48).

(2)

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(i) Disperser naked mole rats 'are laden with fat' (paragraph 50).

Suggest why it may be advantageous for disperser naked mole rats to have high levels of fat.

(3)

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(j) Explain the statement that 'a preference by reproductively active females for unfamiliar males is interpreted as inbreeding avoidance' (paragraph 52).

(2)

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(k) 'The naked mole rat hasn't yet had its genome sequenced' (paragraph 53).

Explain what is meant by the term **genome sequenced**.

(1)

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(l) 'With so much to offer science, it is no surprise that naked mole rats are becoming more common in labs' (paragraph 53).

Using information from the article, describe **two** adaptations of naked mole rats. For each adaptation, explain why it could be of interest in a medical research laboratory.

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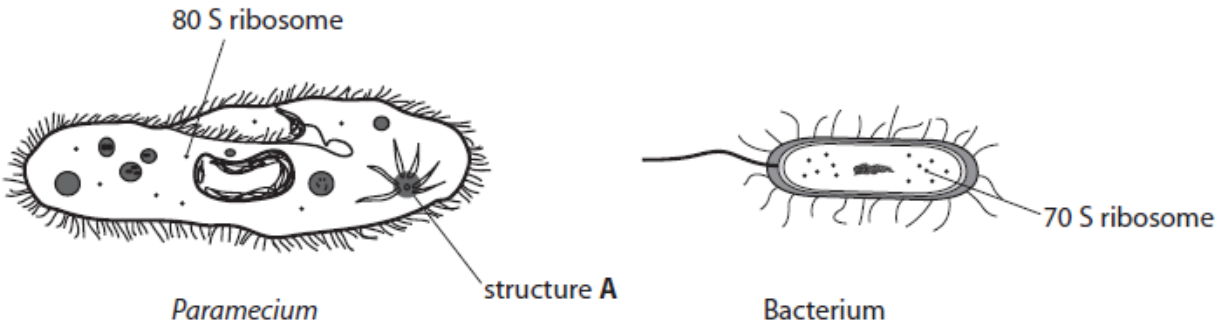
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(Total for Question = 30 marks)

Q22.

The drawings show two single-celled organisms that live in ponds, *Paramecium* and a bacterium.



Paramecium
Magnification ×200

Bacterium
Magnification ×5000

Structure **A** is a contractile vacuole. This removes water from the *Paramecium*.

Explain why the *Paramecium* needs to remove water.

(3)

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Q23.

A student investigated the rate of uptake of nitrate ions (NO_3^-) into plant cells.

Discs of carrot were cut and half of them were immersed in a solution containing 10 µmol dm^{-3} nitrate ions. The other half were placed in the same nitrate ion solution to which 2,4-dinitrophenol (DNP) was added.

DNP inhibits the process of oxidative phosphorylation.

The nitrate ion concentration of the discs was determined every five minutes.

The student failed to pre-treat the carrot discs before placing them in the solution.

(a) Explain how the carrot discs should be pre-treated.

(3)

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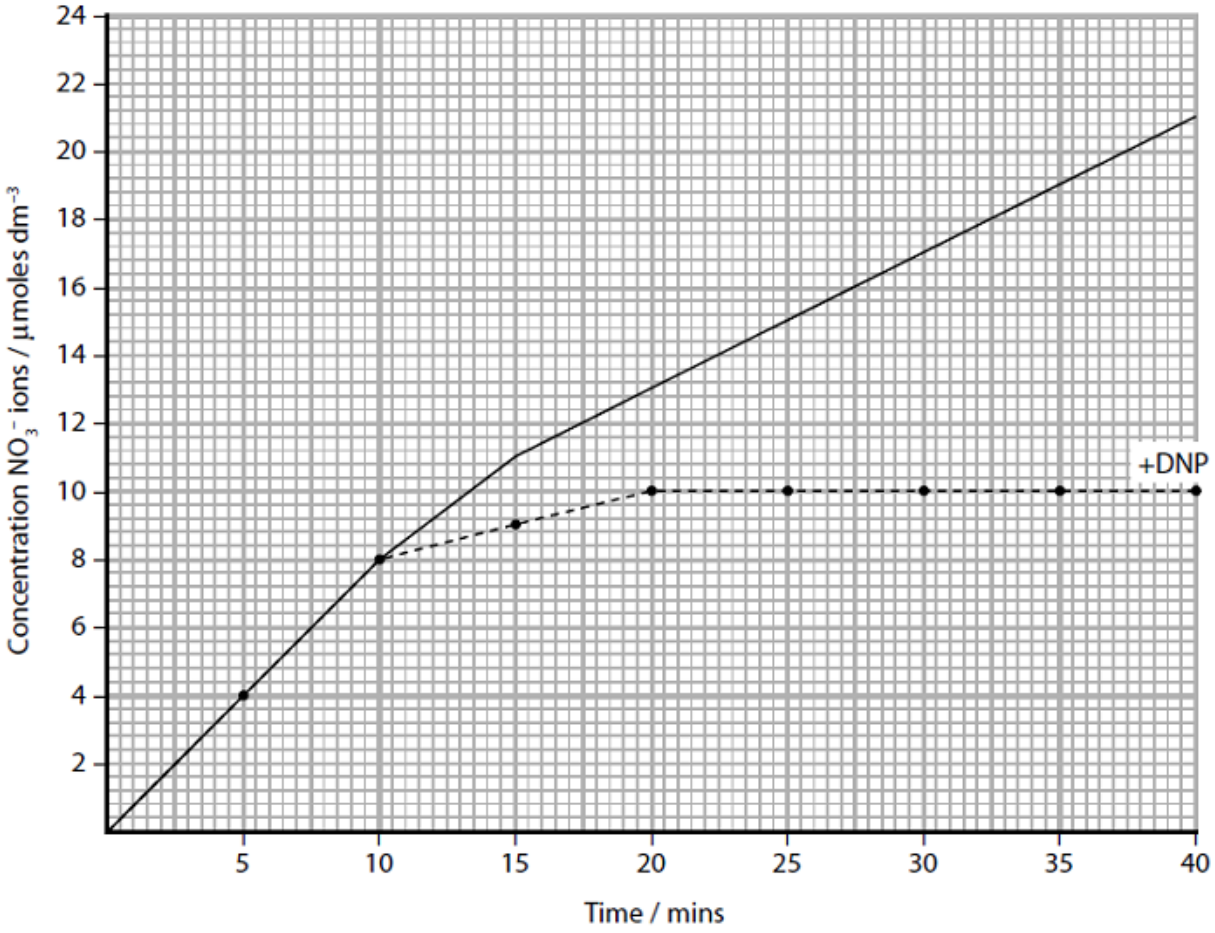
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The graph below shows the results of this investigation after the carrot discs were pre-treated.



(b) Calculate the mean rate of nitrate ion uptake of the carrot discs placed in the nitrate ion solution without DNP between 5 and 10 minutes.

(3)

Answer .....

(c) Analyse the data to explain the effect of DNP on the nitrate ion uptake of the carrot tissue between 0 to 10 minutes and 20 to 30 minutes.

(3)

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(d) DNP acts by rapidly transferring protons (H^+ ions) across biological membranes.

Explain how this action will bring about the effect of DNP on oxidative phosphorylation.

(3)

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(Total for question = 12 marks)

Q24.

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

Phospholipids form a bilayer in the cell membranes of bacteria.

Describe the structure of a phospholipid.

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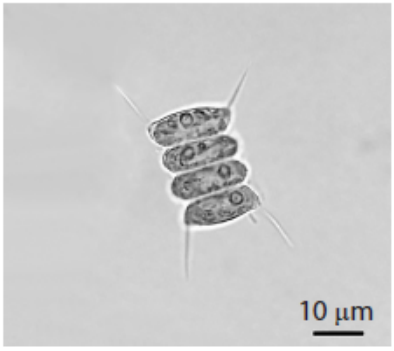
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(Total for question = 2 marks)

Q25.

The green alga, *Scenedesmus quadricauda*, lives in fresh water.
Each cell has a single chloroplast.

The photograph shows some *Scenedesmus* cells.



Photosynthesis can be measured if these algae are placed in a solution containing hydrogen carbonate indicator.

When the carbon dioxide concentration is the same as that of atmospheric air, the hydrogen carbonate indicator is red.

As the carbon dioxide concentration decreases, the hydrogen carbonate indicator changes colour from red to pink and then to purple.

Explain why the carbon dioxide concentration of the solution decreases when the algae carry out photosynthesis.

(2)

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Q26.

Water is needed for the transport of mineral ions through a plant.

Farmyard manure contains many mineral ions.

(i) Calcium ions in manure promote the growth of plants by increasing

(1)

☒ **A** amino acid synthesis

☒ **B** the production of chlorophyll

☒ **C** the strength of the middle lamella between cells

☒ **D** water loss by the leaves

(ii) Which of the following is the mechanism by which these calcium ions are transported from soil water into plants?

(1)

☒ **A** active transport

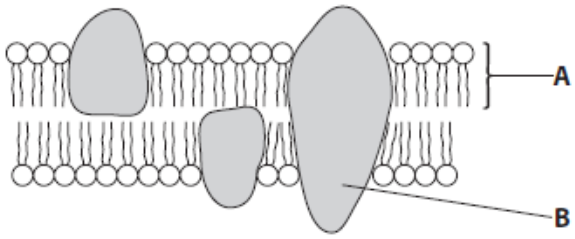
☒ **B** exocytosis

☒ **C** osmosis

☒ **D** transpiration

Q27.

The diagram shows the structure of a cell membrane.



Name the parts labelled **A** and **B**.

(1)

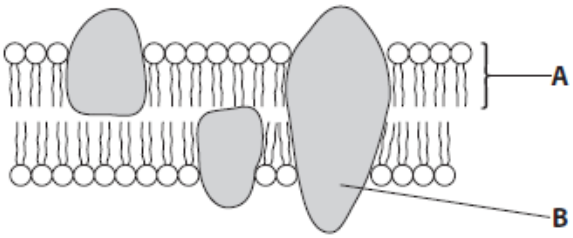
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(Total for question = 1 mark)

Q28.

The diagram shows the structure of a cell membrane.



Explain how the structure of the membrane controls the transport of polar molecules.

(4)

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(Total for question = 4 marks)

Q29.

The velocity of the conduction of nerve impulses along an axon can be studied.

Describe the structure of the cell surface membrane of an axon.

(4)

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(Total for question = 4 marks)

Q30.

Cystic fibrosis is a recessive inherited condition where the cells in the lungs produce sticky mucus. This mucus builds up in the airways, causing breathlessness and chest infections.

People with cystic fibrosis often need treatments such as physiotherapy and antibiotics.

Australian scientists observed that people with cystic fibrosis who went surfing had fewer symptoms than people with cystic fibrosis who did not go surfing.

The scientists carried out a trial on 164 people with cystic fibrosis.

These people were placed at random into either the experimental group or the control group.

The experimental group inhaled a fine spray of 7.0% salt solution and the control group inhaled a fine spray of 0.9% salt solution.

The scientists found that the mucus in the experimental group contained more water and became less sticky than the mucus in the control group.

(i) Explain why only the fine spray of 7.0% salt solution resulted in mucus that contained more water.

(2)

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(ii) Explain why the control group inhaled a fine spray of 0.9% salt solution, rather than a fine spray of pure water.

(2)

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(Total for question = 4 marks)

		condensation reactions form bonds	