Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A LEVEL – NEW

2400U10-1

S17-2400U10-1

BIOLOGY – AS unit 1
Basic Biochemistry and Cell Organisation

THURSDAY, 25 MAY 2017 – AFTERNOON

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**9**	
2.	**13**	
3.	**10**	
4.	**15**	
5.	**14**	
6.	**10**	
7.	**9**	
Total	**80**	

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01

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the continuation pages at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question 7.

The quality of written communication will affect the awarding of marks.

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Answer **all** *questions.*

1. The images below show a longitudinal section through a tissue found lining the trachea of humans and a highly magnified image of the surface of this tissue.

Image **1**

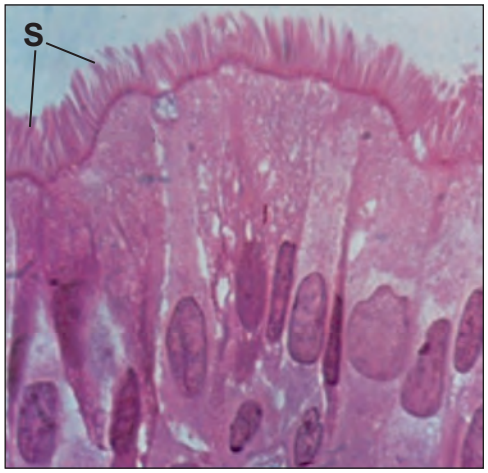
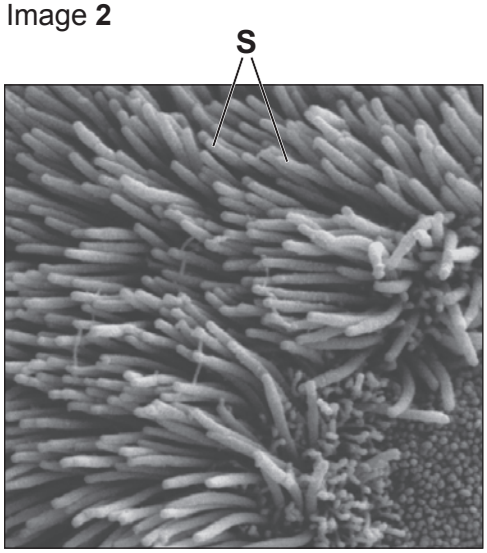


Image **2**



(a) (i) Name the structures labelled **S** and suggest their function in the human respiratory system. [2]

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(ii) Explain why Image **1** is referred to as a tissue rather than an organ. [1]

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The photo electron micrograph below shows two mitochondria found in this tissue.

(b) (i) One reason for the different appearance of the mitochondria is that they have been cut in different planes. Suggest **one** *other* reason that could account for the difference in their appearance. [1]

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(ii) Calculate the actual size of mitochondrion **T** along the line shown on the image. Give your answer in micrometres. [3]

Length of organelle = ... µm

(iii) State and explain **one** way in which mitochondria are adapted to perform their function. [2]

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2. Meselson and Stahl investigated the replication of DNA prior to cell division.

In their experiments, bacteria were cultured in a medium containing only the ^{15}N isotope (heavy nitrogen). The bacteria were then transferred to ^{14}N (light nitrogen) culture medium and allowed to divide. Following each generation, samples of DNA were taken, separated using an ultracentrifuge and analysed.

(a) Identify **three** variables which would need to be controlled during centrifugation of the samples. [2]

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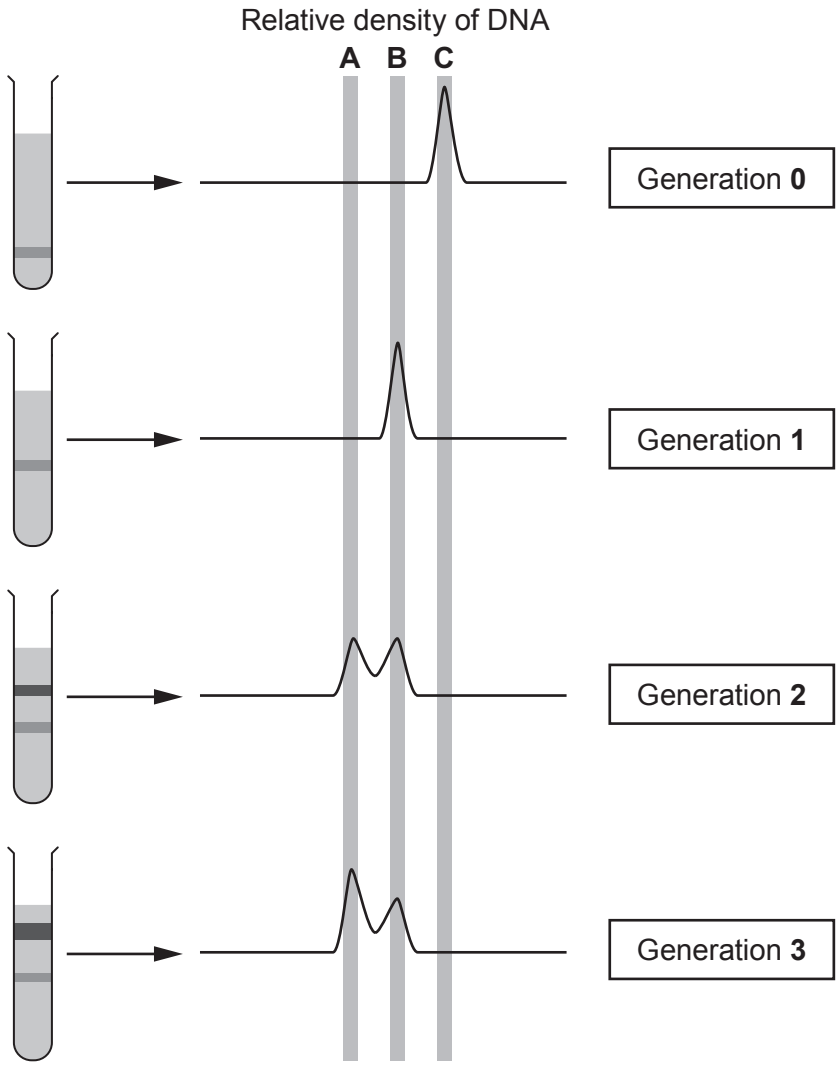
Photographs were taken of the extracted bands of DNA. The relative density of each band was scanned and measured; the more dense the DNA, the higher the reading. Shown below are some of their experimental results.



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(b) (i) State which isotopes of nitrogen would be found in the DNA at **A**, **B** and **C** in the scans. [1]

A .....

B .....

C .....

(ii) Explain how the results in generations **0** and **1** support the theory of semi-conservative replication. [3]

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(iii) Explain the height of the peaks in the scans for generations **2** and **3**. [4]

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(iv) Name **two** enzymes now known to be involved in DNA replication and explain their functions. [3]

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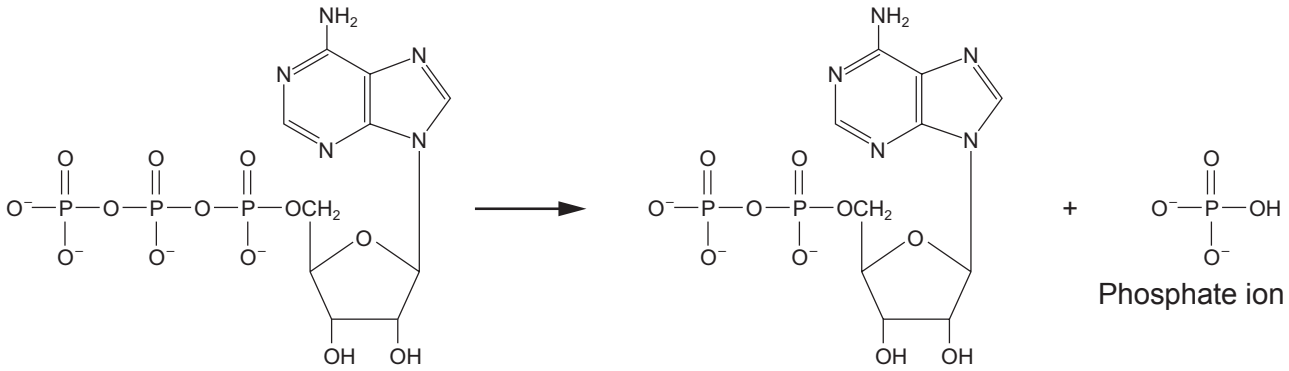
3. Adenosine triphosphate (ATP) belongs to a group of molecules that are made from nucleotides. ATP is an unstable molecule which possesses two high energy phosphate bonds and is often referred to as the universal energy currency. The diagram below shows the conversion of ATP into ADP.



Adenosine triphosphate (ATP) Adenosine diphosphate (ADP)

(a) (i) State the parts of the molecule that are common to DNA, RNA and ATP nucleotides. [1]

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(ii) State what is meant by the term *universal energy currency*. [1]

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(iii) State whether the reaction shown above is exergonic or endergonic. Explain your answer. [2]

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(b) It is estimated that the mass of ATP that is found within a resting human at any one time is approximately 5 g, yet a human uses an estimated 50 kg of ATP each day. Calculate the percentage of the total ATP used per day that is available at any one time. [2]

Percentage of the total ATP available = ... %

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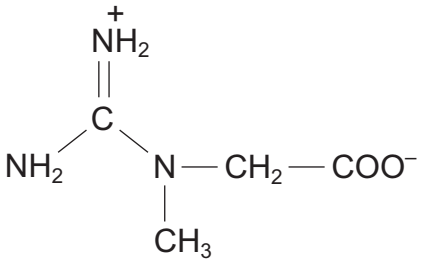
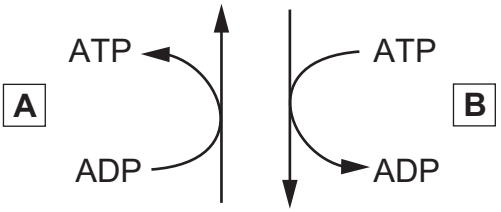
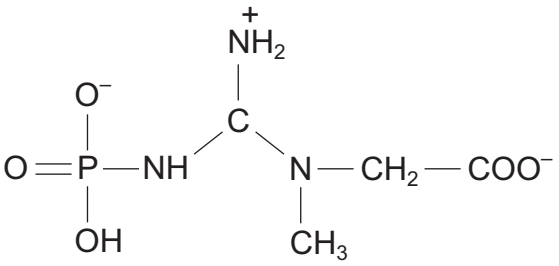
Creatine phosphate is a naturally occurring chemical that works in partnership with ATP to increase the ability of muscle tissue to perform. It is not an energy source itself, but is used to increase the availability of ATP. It is stored inside muscle tissue.



CREATINE





CREATINE PHOSPHATE

(c) Under what circumstances would each of the reactions **A** and **B** take place? Explain your answer. [4]

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4. Lipases are involved in diverse biological processes, including the hydrolysis of triglycerides. Some lipases act in specific compartments inside cells, while others work in extracellular spaces.

(a) State the term given to enzymes which work within specific compartments inside cells. [1]

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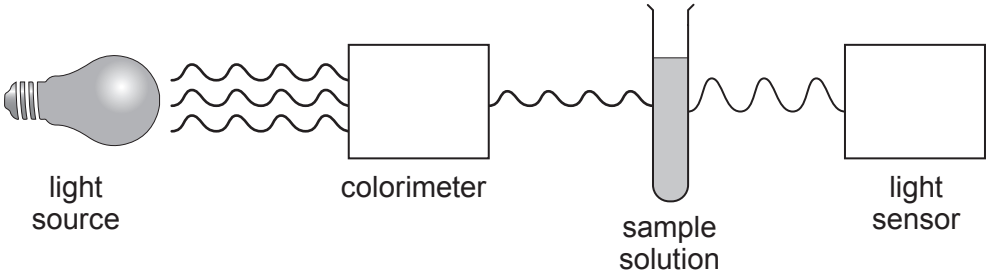
Triacetin is a colourless triglyceride and can be hydrolysed by bacterial lipase. When an indicator is added to alkaline triacetin solution a coloured solution is produced. A colorimeter can then be used to monitor the progress of the reaction. When the triacetin is completely digested, the solution will change from coloured to colourless, allowing more light to pass through, and produce an absorbance reading of zero.



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The effect of temperature on the hydrolysis of triacetin was investigated.

The experiment was performed as follows:

1. 2 cm^3 of triacetin was mixed with 3 cm^3 of sodium hydrogen carbonate (pH10) in a test tube and 5 drops of indicator added.
2. 1 cm^3 of lipase was placed in a separate test tube.
3. Both test tubes were placed in a water bath (20 °C) for 5 minutes.
4. The contents of the tubes were combined, mixed thoroughly and 2 cm^3 transferred to a cuvette.
5. The time taken for the absorbance to reach zero was measured.
6. The experiment was repeated to give a total of three readings.
7. Steps 1-6 were repeated at 25, 35, 45, and 50 °C.

(b) (i) Identify the independent and dependent variables in this investigation. [2]

independent .....

dependent .....

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(ii) Explain why the solutions were left in the water bath for 5 minutes before combining and mixing. [1]

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(iii) Explain why it would be inappropriate to use a buffer solution in this experiment. [3]

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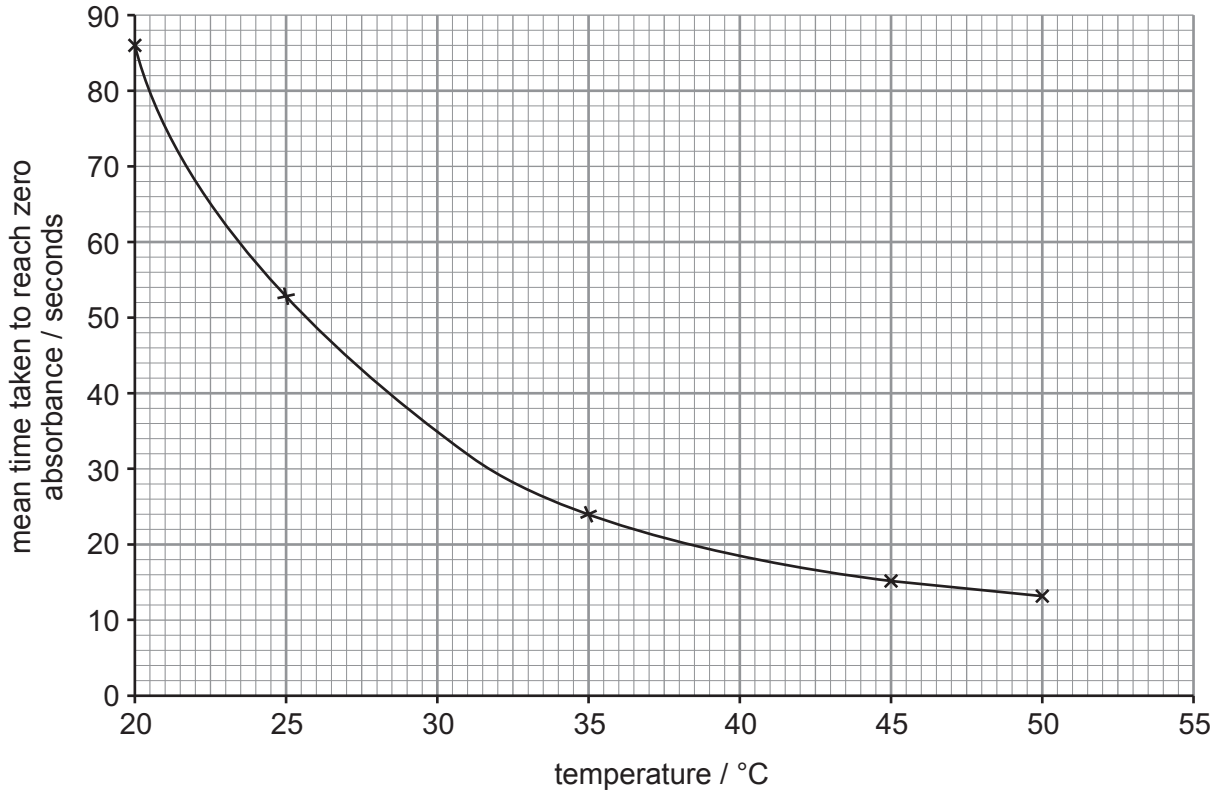
The results of the investigation are shown below.



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(c) (i) In this experiment, $2\,cm^3$ of $0.25\,g\,cm^{-3}$ triacetin was used. Calculate the rate of digestion per second at 40°C.

Give your answer in standard form. [3]

Rate = ... $g\,s^{-1}$

(ii) Suggest **one** source of inaccuracy in this experimental method. [1]

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(iii) It was not possible to determine the optimum temperature for this enzyme in this experiment. Explain why and suggest how the design might be improved. [4]

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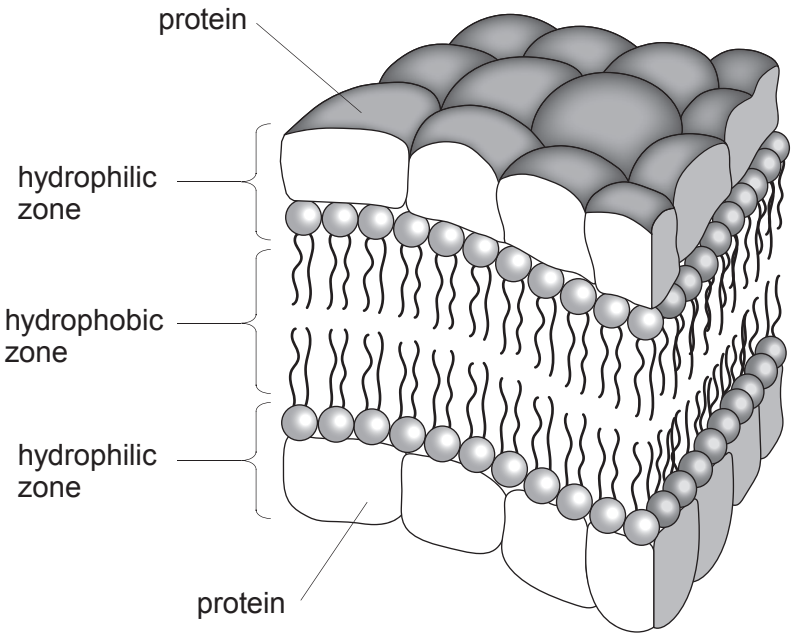
5. In 1935, Hugh Davson and James Danielli proposed a model of the arrangement of molecules in the plasma membrane of a cell.



(a) Compare Davson-Danielli's model shown in the diagram to the currently accepted fluid mosaic model of the plasma membrane. [4]

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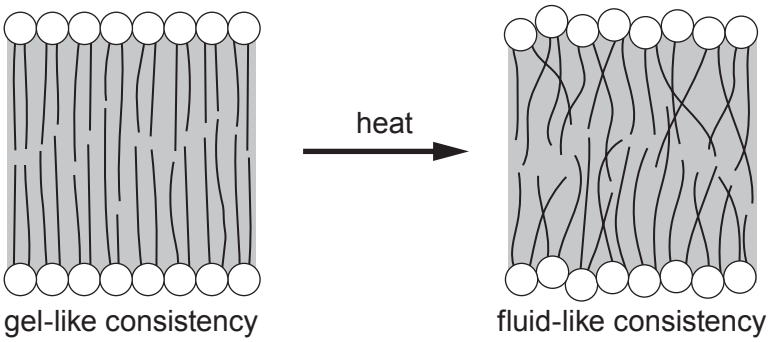
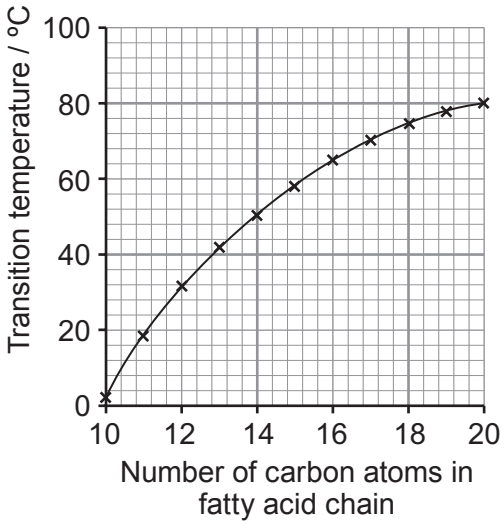
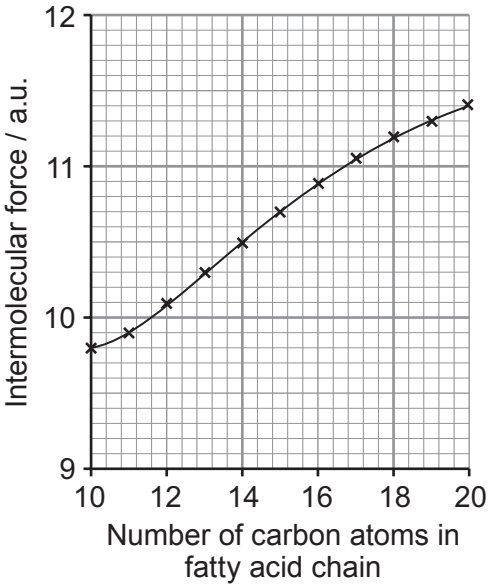
Fluidity of the plasma membrane is due to the lateral movement of phospholipids. Increased fluidity occurs when the phospholipid bilayer changes from a more fixed gel-like consistency to a fluid-like consistency. Heating the molecules can result in increased fluidity.



The transition temperature, is the temperature at which the phospholipid bilayer changes from a gel like consistency to a fluid like consistency. This can also be affected by the length of the fatty acid chains which affect the strength of the intermolecular forces. These relationships are shown in the graphs below.





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(b) (i) With reference to the graphs, describe the relationship between fatty acid chain length and the temperature at which the phospholipid bilayer becomes fluid. Explain your answer. [3]

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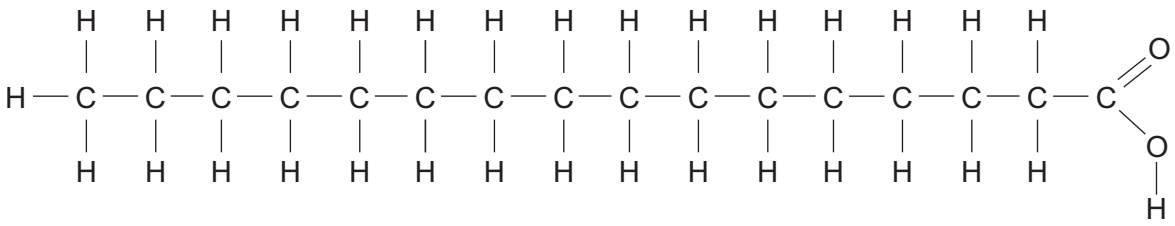
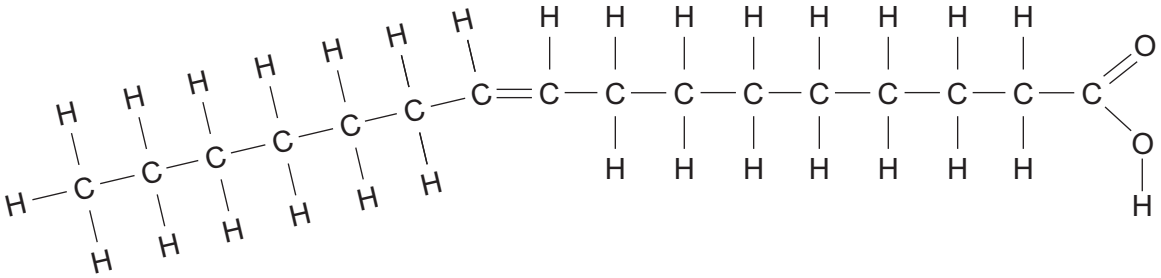
The packing of hydrocarbons also plays a significant role in affecting fluidity.
Two examples of fatty acids that can be found in phospholipids are shown below.

Saturated Fatty Acid



Unsaturated Fatty Acid



(ii) Suggest why the presence of unsaturated fatty acids in the phospholipid would increase fluidity of the membrane. [4]

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Cholesterol is a non-polar substance that is produced in the body and obtained from foods that come from animals (particularly egg yolks, meat, poultry, fish, and dairy products). The body needs this substance to build cell membranes. However, too much cholesterol increases a person's risk of developing heart disease.

(iii) Suggest the position of cholesterol molecules within the plasma membrane. [1]

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(iv) State how a diet high in animal products and cholesterol can lead to a person developing heart disease. [2]

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6. The cell surface membranes of root cells are responsible for differences in the concentration of ions in the roots when compared to those found in the surrounding soil solution.
Inorganic ions are essential for cell metabolism in plants.

(a) Describe the role of magnesium, calcium, and phosphate ions in plant cells and tissues. [3]

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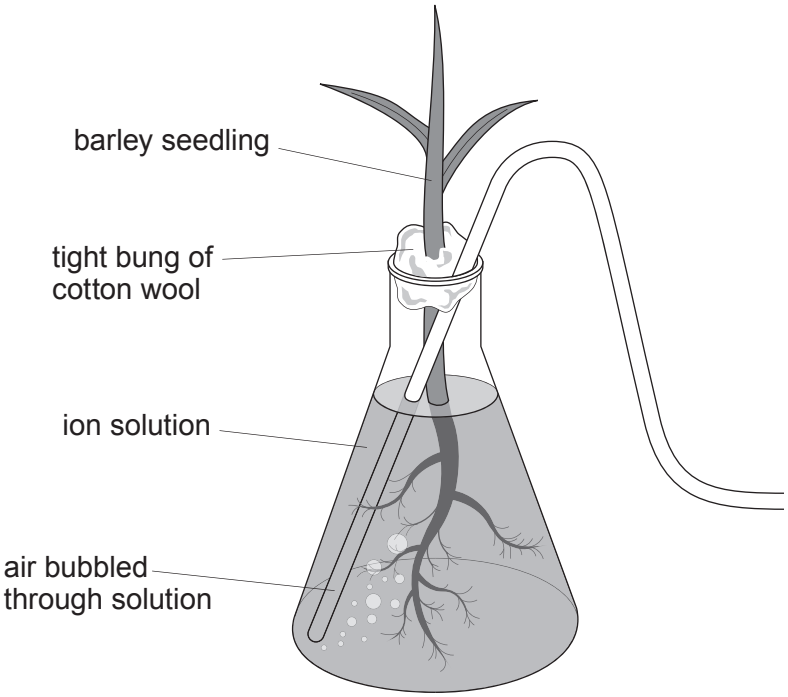
To investigate the uptake of mineral ions by plants, barley seedlings were grown with their roots in a solution of mineral ions for four days. Air was bubbled through the solution. The concentration of the ions in the solution and the root tissue were determined.



ion	ion concentration / mmol dm^{-3}	
	surrounding solution	root tissue
calcium (Ca^{2+})	1.0	57.0
magnesium (Mg^{2+})	0.3	33.0
phosphate (PO_4^{3-})	0.9	1.6

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(b) (i) With reference to the data, explain the relative concentrations in the surrounding solution and the root tissue after four days. [3]

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(ii) Explain why the growth of a barley seedling may be reduced if the solution did not have air bubbled through it. [4]

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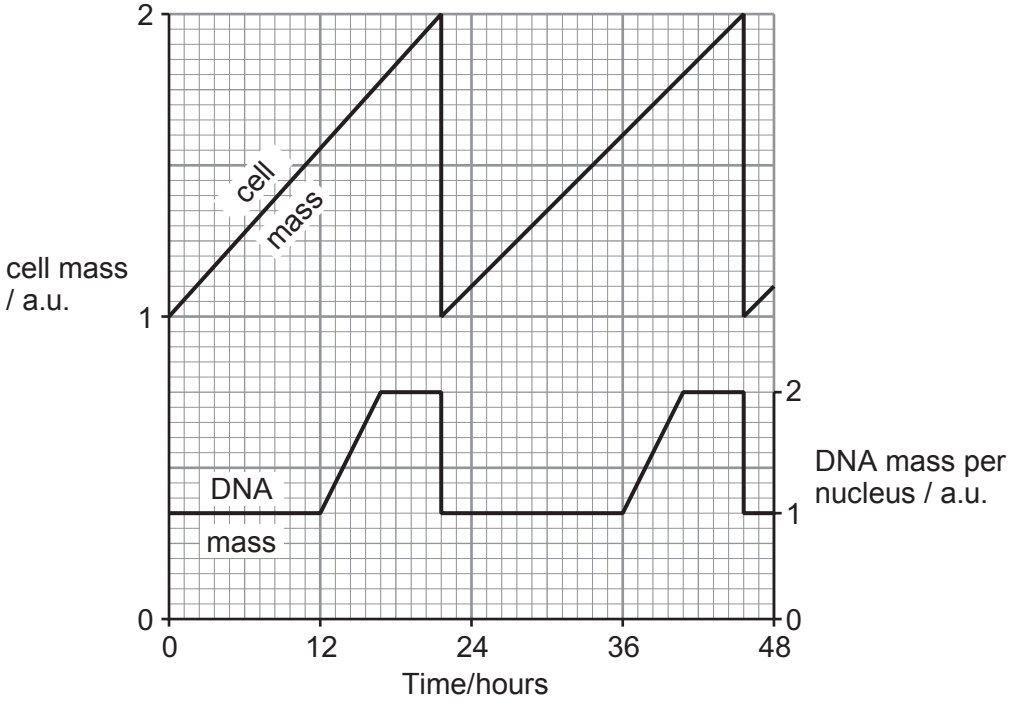
7. Cells can be grown under laboratory conditions and used in the development of drugs to treat cancer. The graph below shows a model of the general changes in cell mass and changes in mass of DNA in two cell cycles.



Identify the type of cell division shown above and explain the changes in cell mass and mass of DNA per nucleus in one cell cycle. [9 QER]

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