Surname	Centre Number	Candidate Number
Other Names		2

GCE AS – NEW

B400U10-1

S17-B400U10-1

BIOLOGY – AS component 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.	**15**	
2.	**13**	
3.	**8**	
4.	**16**	
5.	**14**	
6.	**9**	
Total	**75**	

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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 **6**.

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

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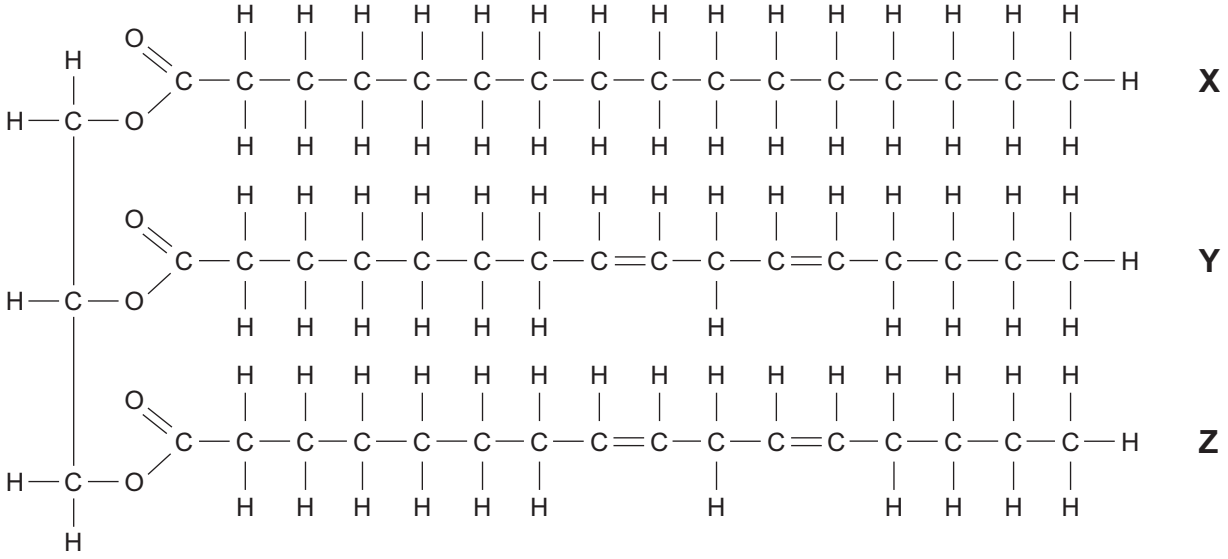
Answer **all** *questions.*

1. Lipids are important biological chemicals that play many different roles in cells and organisms.

(a) The diagram below shows one type of lipid found in the human body.



(i) Name this type of lipid and describe **two** uses of this type of molecule in organisms. [3]

Type of lipid

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Uses

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(ii) Describe how you would test for the presence of lipid in a tissue extract. [2]

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(iii) Describe how components **Y** and **Z** in the lipid differ from component **X** and explain why it is recommended that humans eat a higher proportion of lipids containing **Y** and **Z**. [3]

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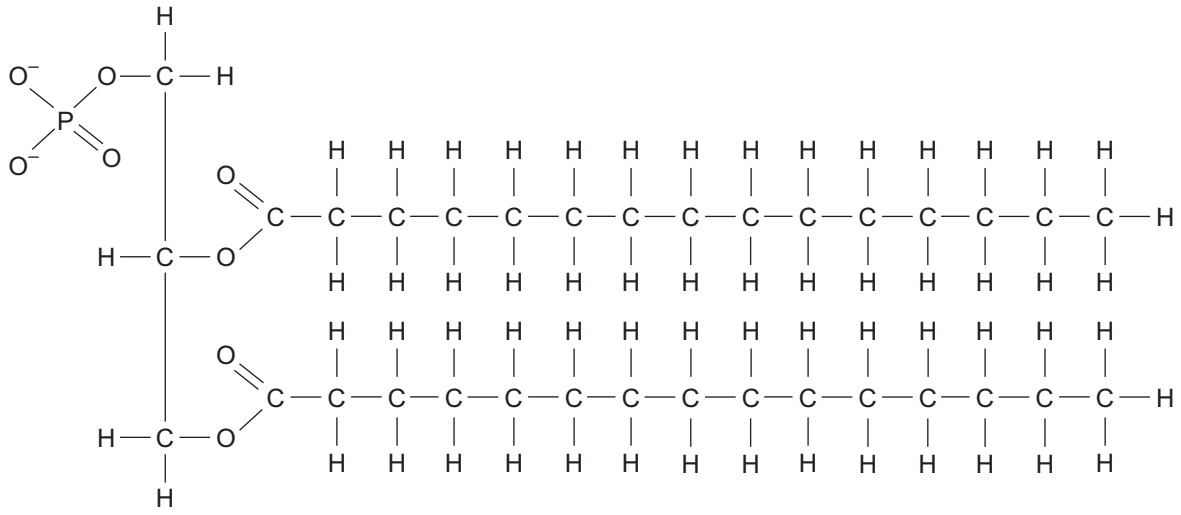
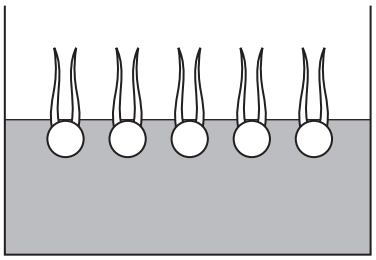
(b) The diagram below shows a different type of lipid. It is the main component of cell membranes.



When these lipid molecules are extracted from the plasma membranes of cells, they arrange themselves on the surface of water as shown in the diagram below.



(i) Explain why they arrange themselves in this way. [2]

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(ii) The plasma membrane of a single human red blood cell has a surface area of approximately 140 μm^2. Calculate the area of water covered by the lipids extracted from the plasma membrane of a single red blood cell. [1]

Area = ... μm^2

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(iii) Explain how you calculated this value. [1]

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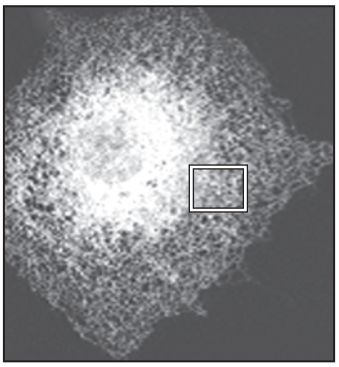
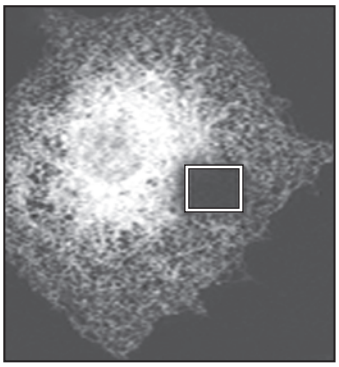
(c) A human cell was genetically engineered to produce plasma membrane proteins that fluoresced when exposed to UV light. These proteins permanently lose their ability to fluoresce if exposed to a laser beam.

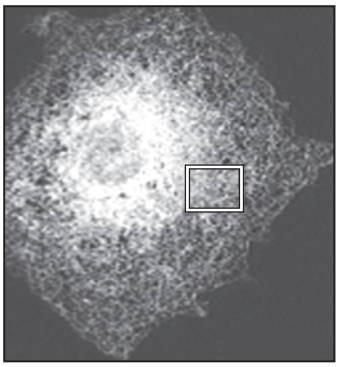
The images below show part of a cell before and after exposure to a laser beam. The white square shows the area exposed to the laser.



1. appearance of cell **before** exposure to a laser beam



2. appearance of cell **immediately after** exposure to a laser beam



3. appearance of cell **five minutes** after exposure to a laser beam

Explain how these images provide evidence for the currently accepted model of the plasma membrane. [3]

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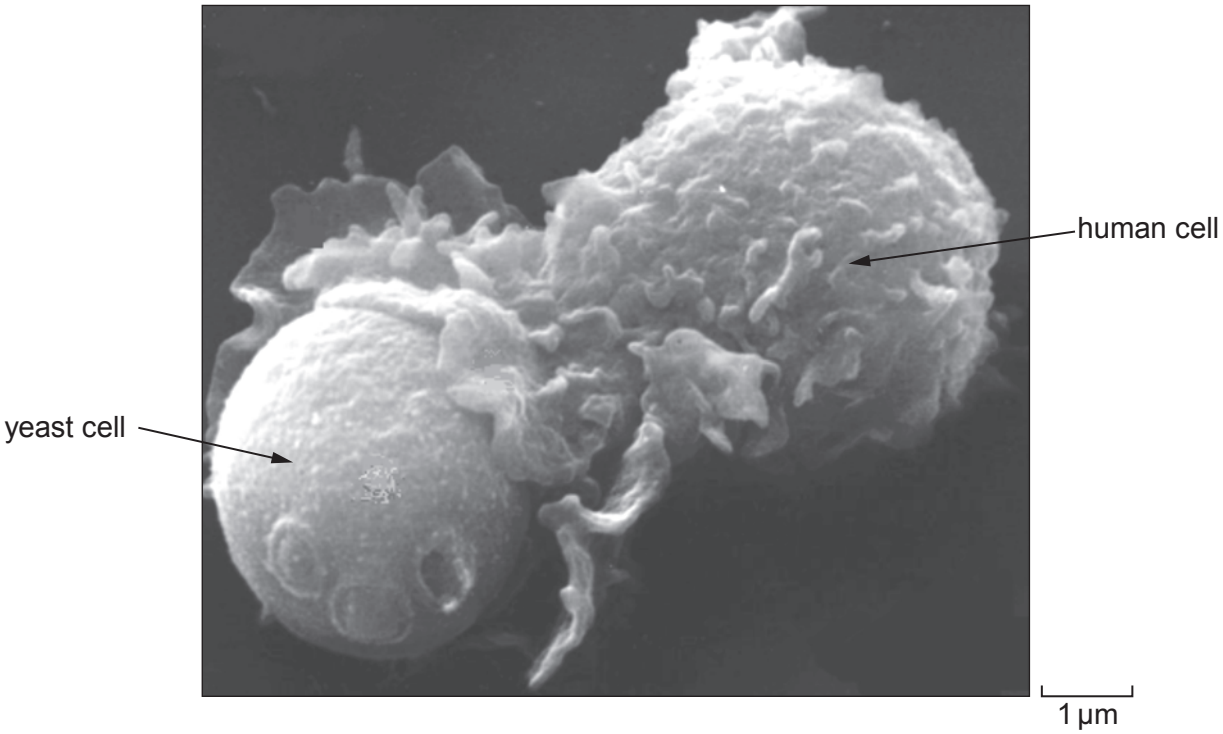
2. Classification of organisms into different kingdoms is based largely on cell structure and, increasingly, on biochemical analysis.

(a) The electron micrograph below shows a human cell ingesting a yeast cell. Both cells have the same basic cell type but are classified into different kingdoms.



(i) Complete the table below. [3]

	Human	Yeast
Domain		
Kingdom		
Cellular basis for classification into different kingdoms		

(ii) Calculate the magnification of the electron micrograph above. Show your working. [2]

Magnification = × .....

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(iii) I. Explain why the process shown in the electron micrograph is an example of holozoic nutrition. [1]

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II. Describe the digestion of the yeast cell, including the role of the Golgi body. [2]

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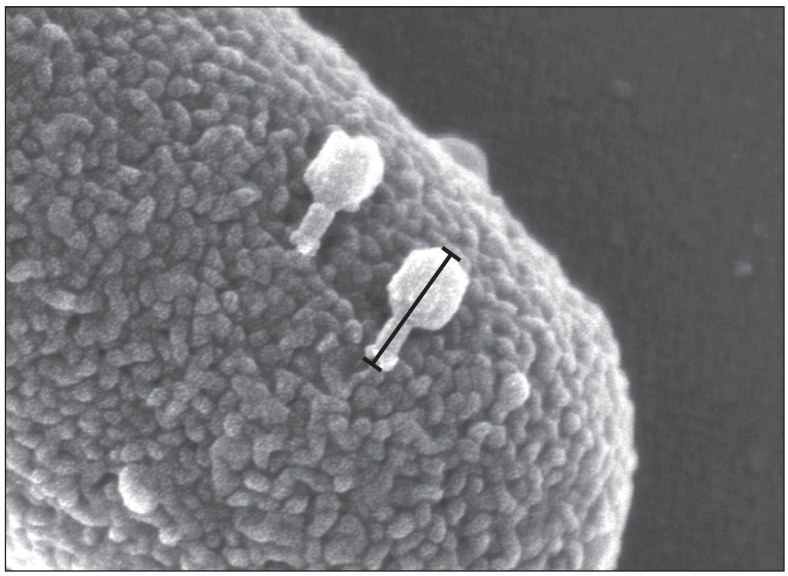
(b) Viruses are similar to other organisms in that they contain nucleic acid and can reproduce, although not on their own. They are not considered to be cells and many scientists believe that they are non-living.

The electron micrograph below shows two bacteriophages (a type of virus) infecting a bacterium.



(magnification × 135 000)

(i) Describe the structure of a virus and explain why it is not considered to be a cell. [2]

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(ii) Calculate the actual length of the bacteriophage along the line shown in the electron micrograph. Show your working and express your answer to two significant figures using suitable units. [3]

Actual length of bacteriophage = ...

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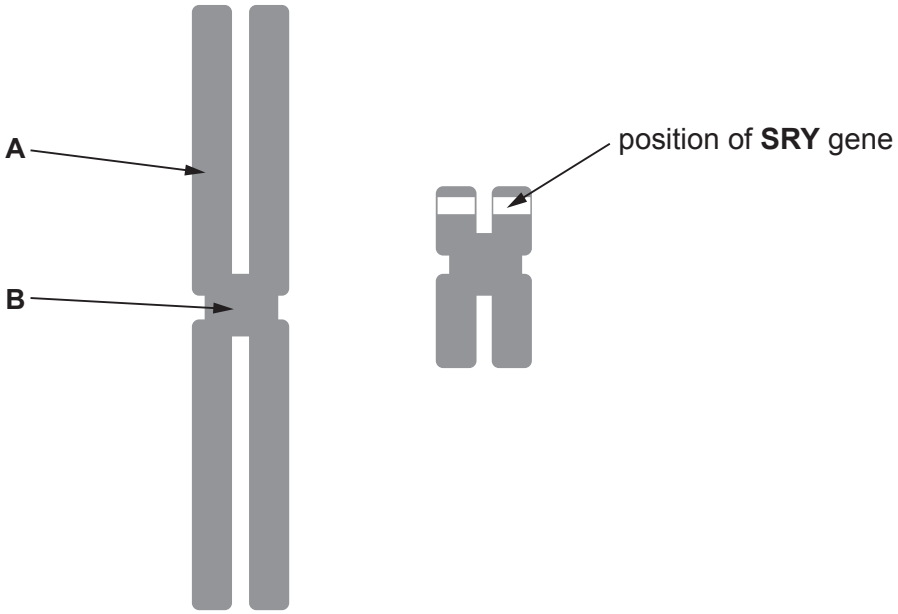
3. The SRY gene on the human **Y** chromosome codes for a protein involved in the development of testicular tissue in the developing foetus. As a result, male hormones are produced. The diagrams below show maps of the **X** and **Y** chromosomes of a normal male.

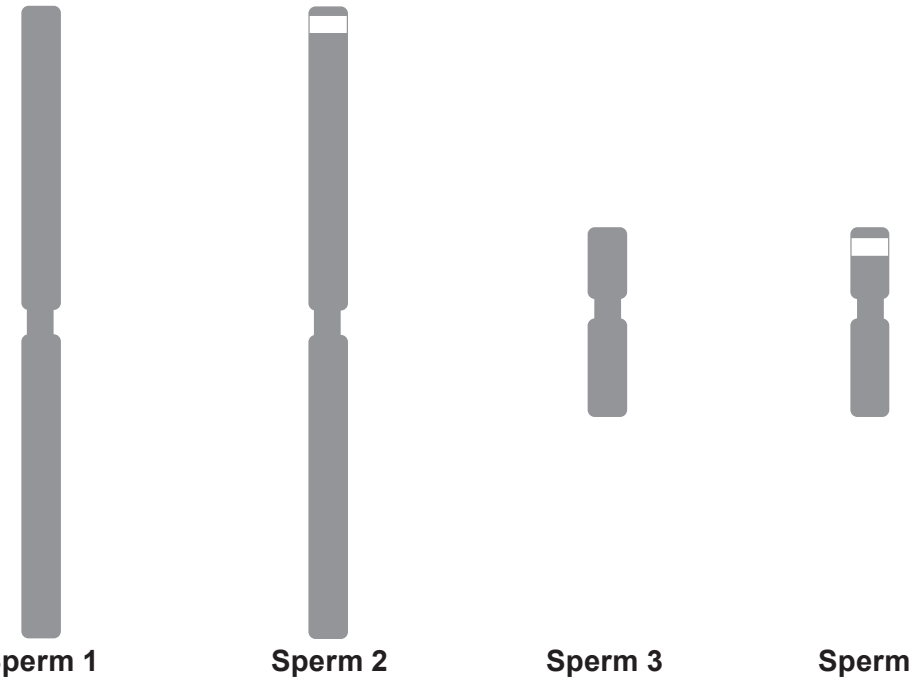


(a) Identify structures **A** and **B** labelled on the diagram. [2]

A .....

B .....

(b) During meiosis, four different sperm can be produced with the following sex chromosomes.



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(i) Explain how the SRY gene can be transferred from a **Y** chromosome to an **X** chromosome. [2]

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(ii) Explain how four **different** haploid sperm are produced at the end of meiosis. [2]

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(iii) The presence of the SRY gene was used to check the gender of athletes competing in the 1996 Olympics. Only eight of 3387 female athletes (0.23%) possessed the SRY gene.
With reference to the diagrams given and using your knowledge of meiosis, suggest why this figure is so low. [2]

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Turn over.

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4. Chromosomes are not usually visible in cells during most of the cell cycle. However, during mitosis, chromosomes can be observed at different stages of nuclear division.

(a) What must be done to the tissues to enable chromosomes to be seen more clearly? [1]

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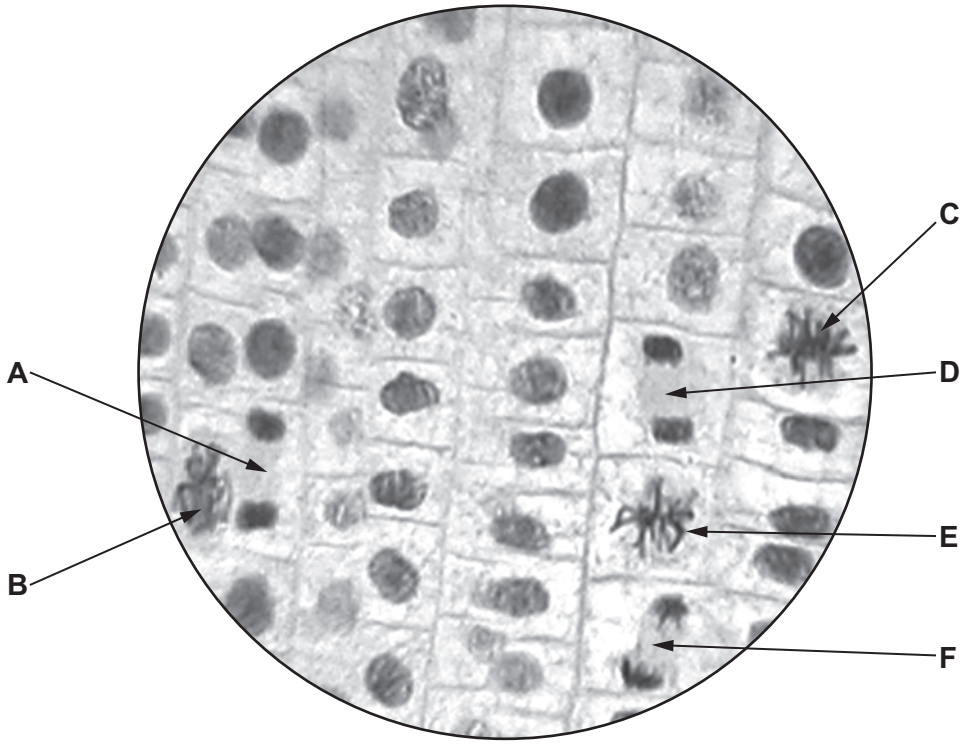
(b) An investigation was carried out to determine the region of maximum growth in the root tips of garlic *(Allium sativum)*. Longitudinal sections of garlic root tips were examined using a light microscope. The numbers of cells at different stages of mitosis were counted in a field of view at ×400 magnification. The total number of cells in the field of view was also counted. The process was repeated at increasing distances from the root tip.

The image below shows the field of view at 0.2 mm from the root tip.



Using **all** the letters from the image identify the stages of mitosis shown in the image. [3]

Prophase .....

Metaphase .....

Anaphase .....

Telophase .....

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The percentage of cells undergoing mitosis at any one time is called the mitotic index and can be used to assess the growth rate of that tissue.

(c) The results of the investigation are shown in the table below.

(i) Calculate the mitotic index for 0.2 mm from the root tip. **Write your answer in the table below**. [2]

	distance from root tip /mm				
	0.2	**0.5**	**0.8**	**1.3**	**1.8**
Total number of cells undergoing mitosis in field of view	6	3	2	1	0
Total number of cells in field of view	47	45	41	35	31
mitotic index %	.....	6.7	4.9	2.9	0.0

(ii) With reference to the mitotic index, what conclusion regarding growth rate can be drawn from the data in the table? [2]

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(iii) Describe how you could improve the reliability of the data. [1]

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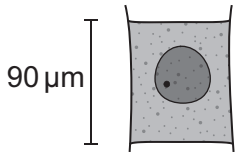
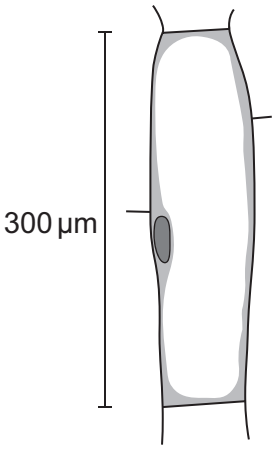
(d) The drawings below show the appearance and average length of cells at 0.2 mm and 1.8 mm from the root tip at the same magnification.

0.2 mm



1.8 mm



Using **all** the information provided, explain why the mitotic index does not fully explain the **overall** growth of garlic roots. [4]

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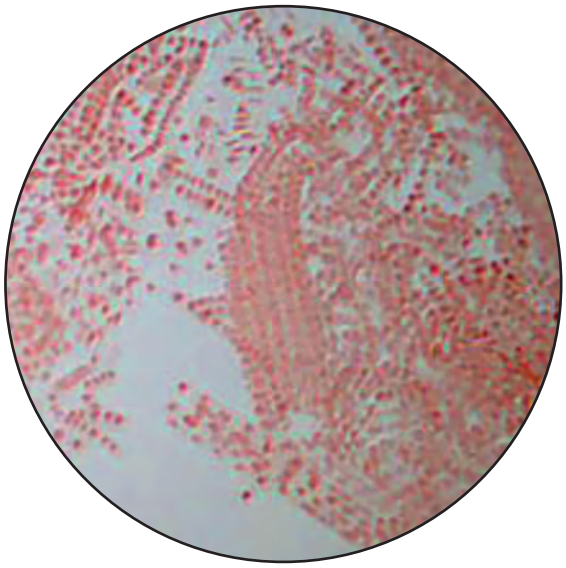
(e) A student attempted to find the mitotic index of garlic roots using the root tip squash technique in the school laboratory. An image of the slide is shown below.



Using your knowledge of the method used, explain why it would be difficult for the student to calculate a valid mitotic index from the image shown even if a higher magnification was used. [3]

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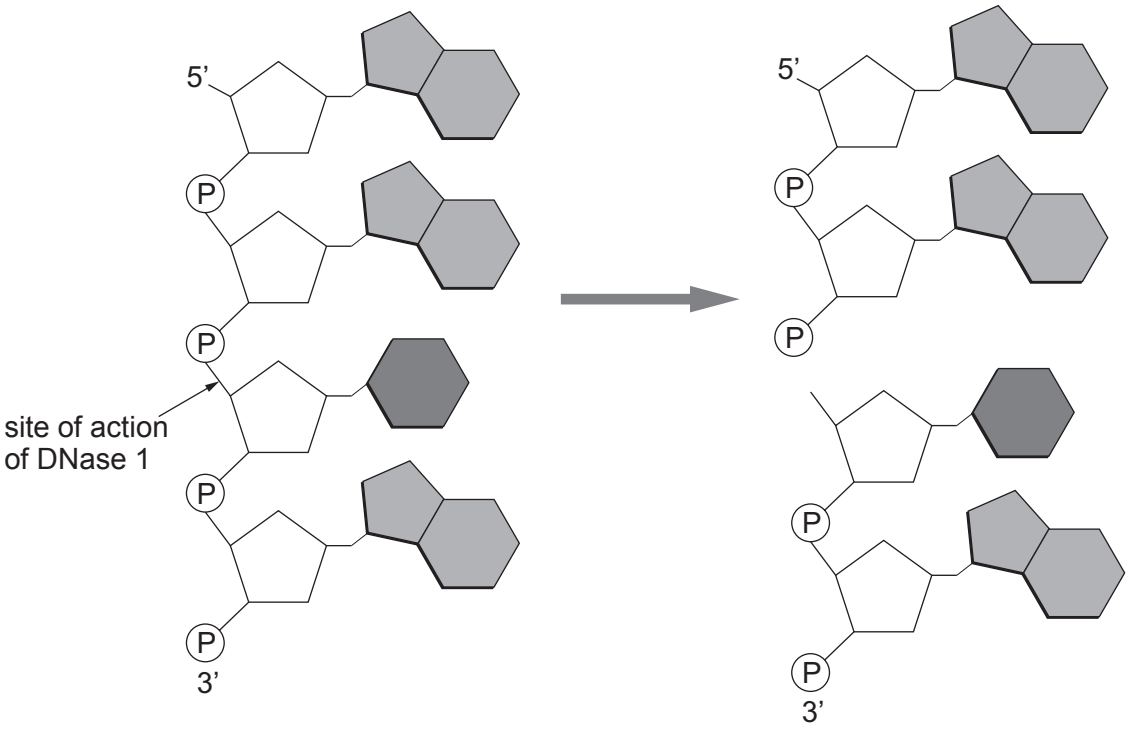
5. In some lung conditions, the DNA from dead cells in the alveoli and bronchioles makes mucus less fluid and difficult to remove from the lungs.

Deoxyribonuclease 1 (DNase 1) is an *endonuclease* enzyme and works in a similar way to an endopeptidase. It digests DNA into fragments ranging from one to four base pairs in length.

It has been suggested that DNase 1 could be used to break down the DNA in mucus. This would make the mucus more fluid and easier for cilia to move from the lungs.

The enzyme causes *hydrolysis* of the bond between a phosphate group attached to carbon atom 5 of a deoxyribose which has a pyrimidine base attached to carbon atom 1. The digestion of a short length of DNA by DNase 1 is shown in the diagram below.



(a) (i) What is meant by the term *hydrolysis*? [1]

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(ii) Explain why DNase 1 is called an *endonuclease*. [1]

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(iii) The diagram shows a short length of single stranded DNA that was mixed with a sample of the enzyme DNase 1.

Identify the fragments that would be produced by hydrolysis of this length of DNA by DNase 1 by drawing vertical lines between each fragment on the sequence above. Explain why you chose these positions. [3]

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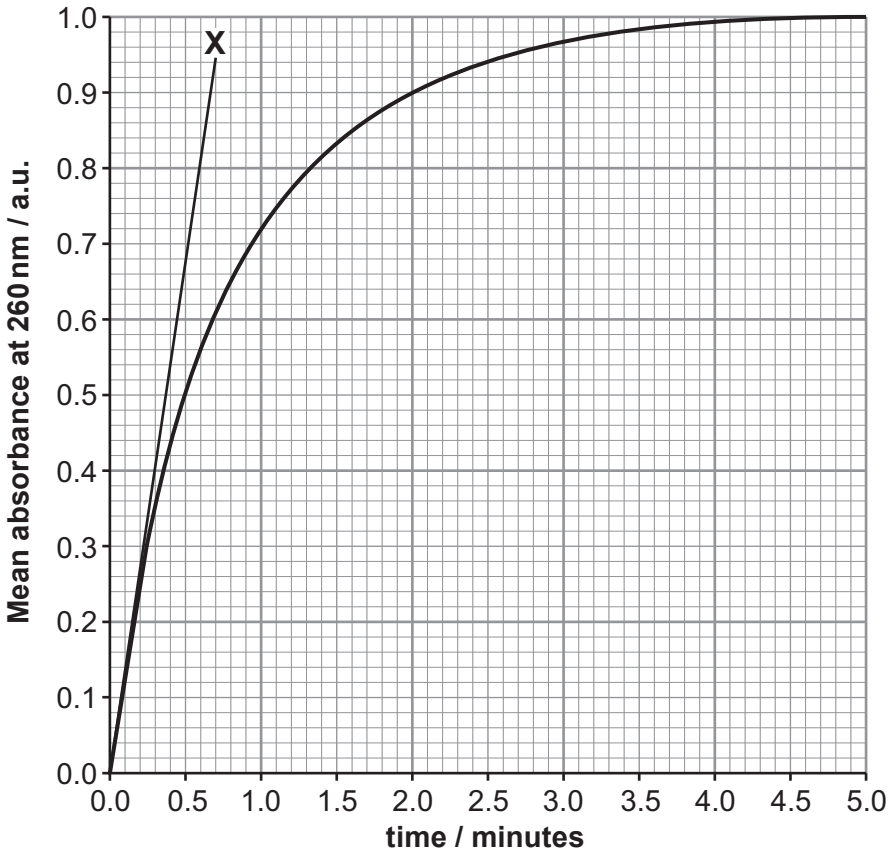
(b) The rate of digestion of DNA can be determined using a colorimeter. As DNA is digested it absorbs more light at a wavelength of 260 nm.

To determine the rate of reaction of DNase 1, 0.2 cm^3 of DNase 1 at 50 $ng\,cm^{-3}$ concentration were mixed with 1.8 cm^3 of synthetic single stranded DNA at a concentration of 200 $\mu g\,cm^{-3}$ in a cuvette. The absorbance of light at 260 nm was recorded at intervals for a period of five minutes. The experiment was repeated to give five results. The mean results are plotted on the graph below.



(i) The rate of reaction between 0 and 0.5 minutes was calculated as 1.0 a.u. $minute^{-1}$. Using the tangent drawn at **X**, calculate the initial rate for this reaction. [1]

Initial rate = ... a.u. $minute^{-1}$

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(ii) Explain the difference between the initial rate and the rate between 0 and 0.5 minutes. [2]

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(iii) In addition to the control variables described, identify **two** *other* variables that should have been controlled in this experiment to produce valid results. Explain your answer. [3]

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(c) Explain why the results of this experiment may not provide the evidence needed to reach a valid conclusion on the use of DNase 1 in treating human lung conditions. [3]

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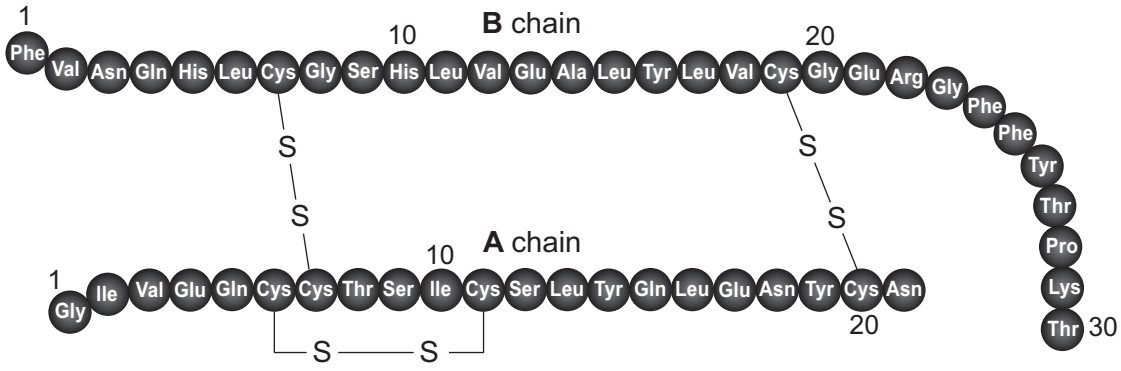
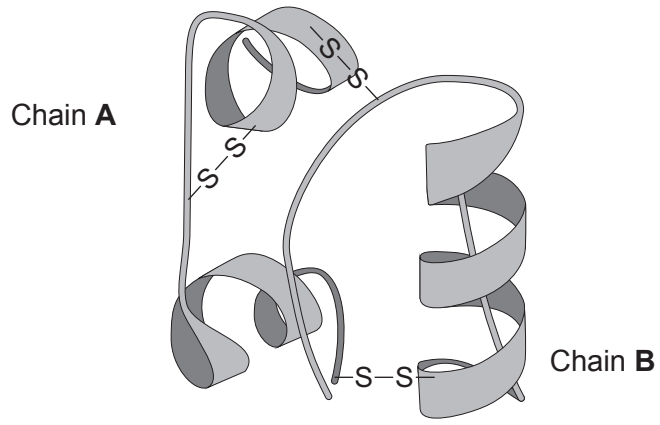
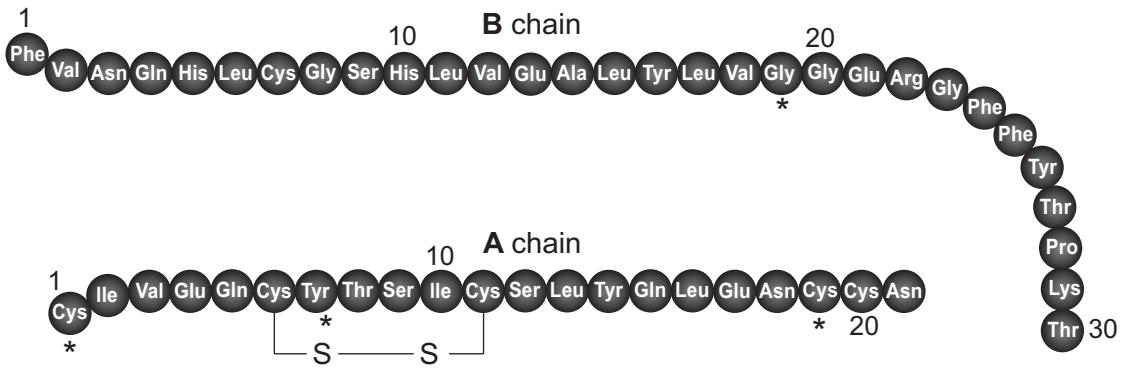
6. Insulin is a protein composed of polypeptide chains **A** and **B** and is involved in the control of blood glucose levels. It binds to receptors in the cell membranes of cells causing them to absorb more glucose from the plasma.

The diagrams below show the amino sequence of a fully functional insulin molecule and a ribbon drawing to show its three dimensional structure.





Some types of diabetes result from changes to the structure of the insulin molecule caused by mutations. The amino acid sequences of mutated **A** and **B** chains are shown below. Mutations are marked with an asterisk (*).



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Explain how these changes could affect **each level of protein structure** of insulin. Suggest how this may make the hormone non-functional.
You should use all the information provided and your own knowledge of protein structure and function in your answer. [9 QER]

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