Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level

2400U10-1 – **NEW AS**

S16-2400U10-1

BIOLOGY – Unit 1

Basic Biochemistry and Cell Organisation

P.M. THURSDAY, 26 May 2016

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**16**	
3.	**11**	
4.	**19**	
5.	**17**	
6.	**9**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this paper you will require 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.

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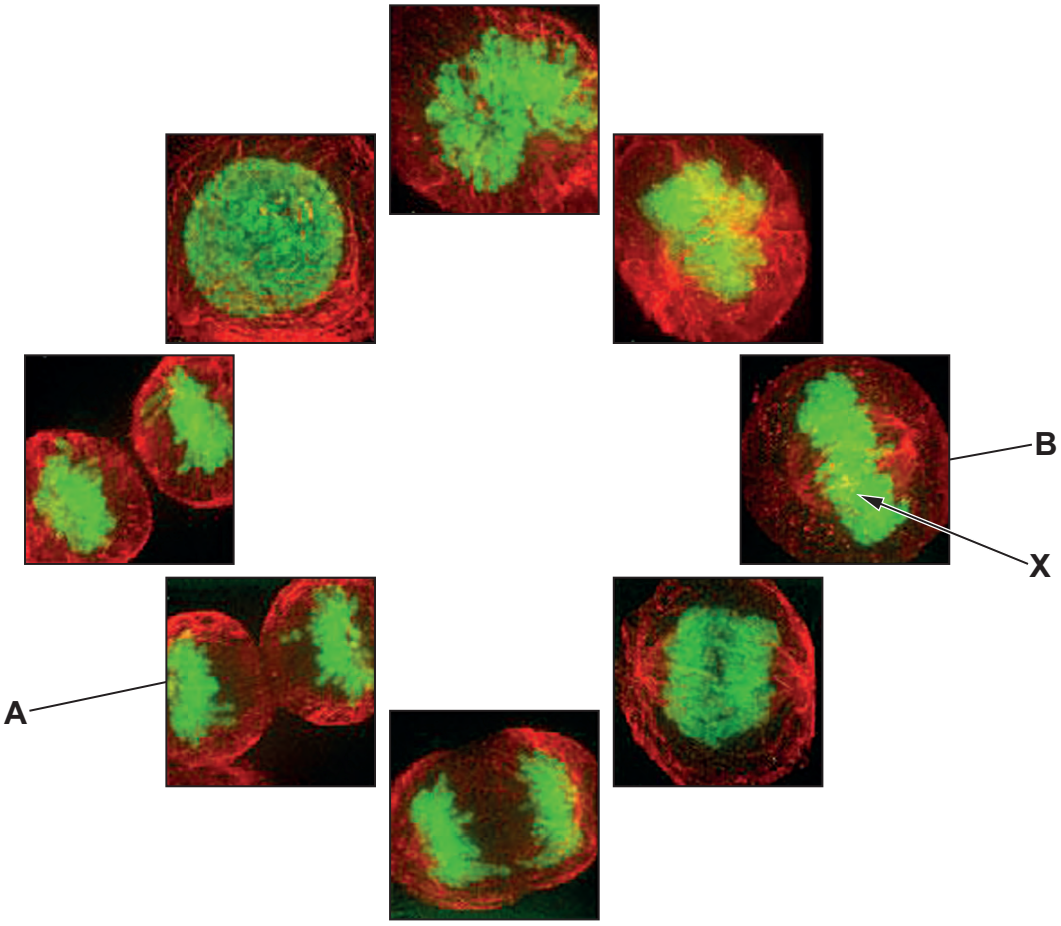
Answer **all** *questions.*

1. In 1951, Henrietta Lacks died of cervical cancer. A research scientist called George Gey, grew a sample of her tumour. He found that these cells multiplied rapidly and could be grown indefinitely in culture. They became the first immortal human cell line, which he named HeLa. HeLa cells are now grown in research laboratories in many different countries.

(a) The photomicrographs below show images of HeLa cells during different stages of the cell cycle. The cells have been stained with a dye, which causes the DNA to be visible.



(i) Name the stages shown in **A** and **B**. [2]

Stage **A**: .....

Stage **B**: .....

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(ii) Name the structures, labelled **X**, that can be seen in the photomicrograph. [1]

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(iii) Explain why some stain would be seen in other parts of the cell. [2]

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(b) A biotechnology company that supplies HeLa cells to laboratories states that the number of HeLa cells double every 19 hours. They suggest that the starting culture of cells should have a density of 30 000 cells cm^{-3} and that the cells should be sub-cultured every 4 days.

Calculate the density of the cells that would be present after 4 days; give your answer in cells cm^{-3} in standard form. [3]

Cell density = ... cm^{-3}

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2. Influenza, commonly known as "the flu", is an infectious disease caused by the influenza virus, which infects the epithelial cells of the upper respiratory tract. The virus is composed of a protein capsid which surrounds the enzyme, RNA polymerase and its genetic material, RNA.

(a) Describe the differences between the genetic material of the Influenza virus and the genetic material found within the nucleus of the epithelial cell it infects. [4]

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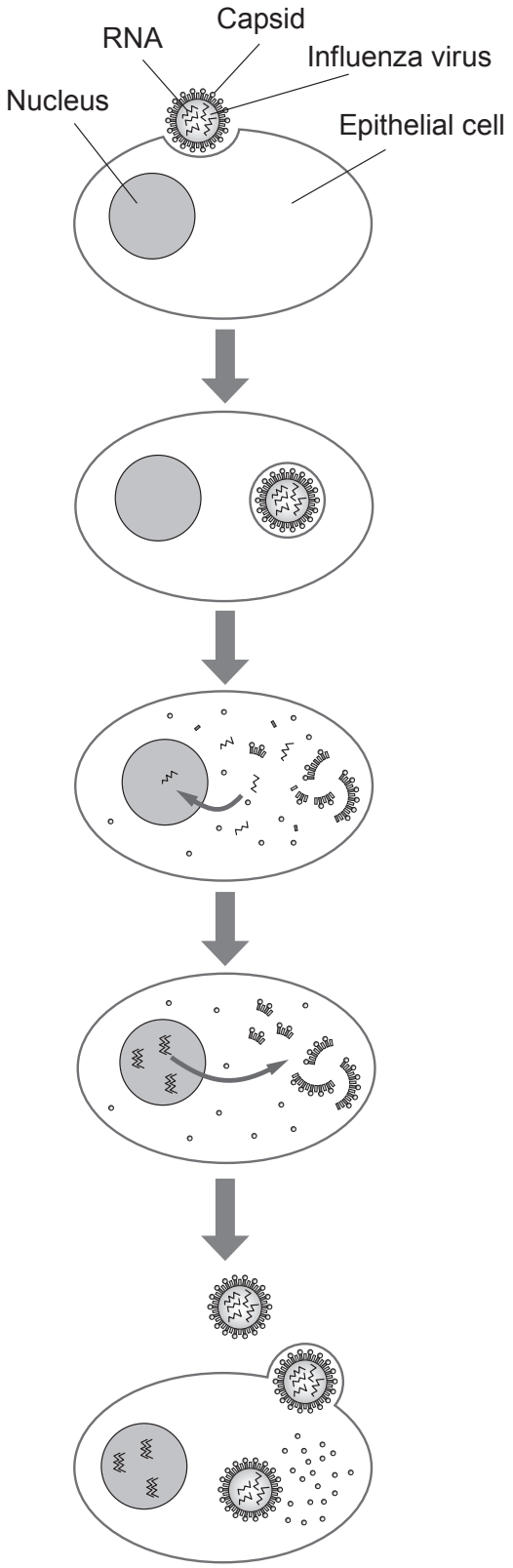
(b) The virus can only replicate in living (host) cells, where it utilises nutrients and organelles within the cell to multiply quickly. The diagram below shows the stages in the replication of the virus.



1 Influenza virus becomes attached to a target epithelial cell.

2 The cell engulfs the virus.

3 Viral contents are released. Viral RNA enters the nucleus where it is replicated by the viral RNA polymerase.

4 Viral mRNA is used to make viral proteins.

5 New viral particles are made and released into the extracellular fluid. The cell, which is not killed in the process, continues to make a new virus.

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(i) State the name of the process occurring between stages 1 and 2. [1]

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(ii) In stage 3, the capsid has broken down and the viral RNA and RNA polymerase enter the nucleus, where the viral RNA is replicated. Apply your knowledge of RNA polymerase to describe how the viral RNA is replicated. [4]

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(iii) To complete the replication of the virus, capsids need to be produced (stage 4). Describe how the proteins in the capsid are produced. [5]

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(iv) Explain why the virus is unable to synthesise its own capsid. [2]

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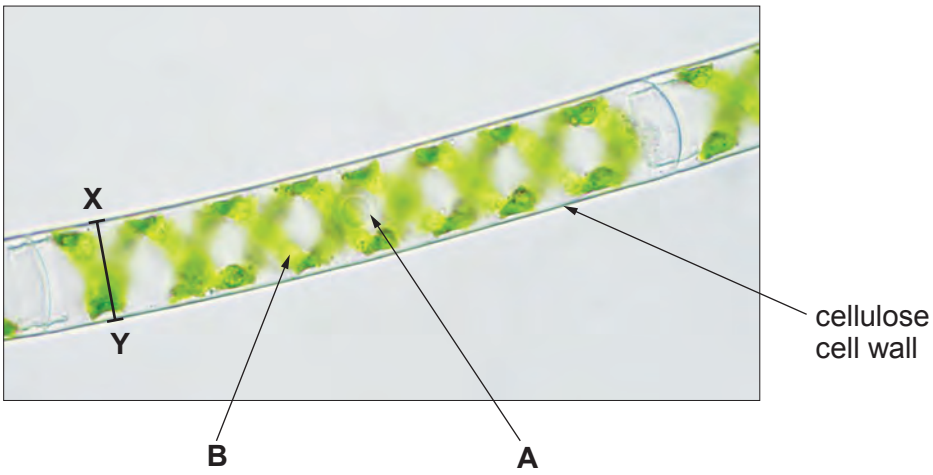
3. The photomicrograph below is of *Spirogyra*; an autotrophic organism that inhabits fresh water ponds and ditches.



(a) Identify the organelles labelled **A** and **B**. [2]

A: .....

B: .....

(b) The actual width of the cell between points **X – Y** was 32.3 µm. Calculate the magnification that was used to take the photomicrograph. [2]

magnification = ...

(c) During the day the concentration of solutes in the pond water changes due to evaporation. However, the length of the spirogyra cells remain almost constant. What can you conclude about how the structure of the cell wall enables *Spirogyra* to survive in different solute concentrations? [4]

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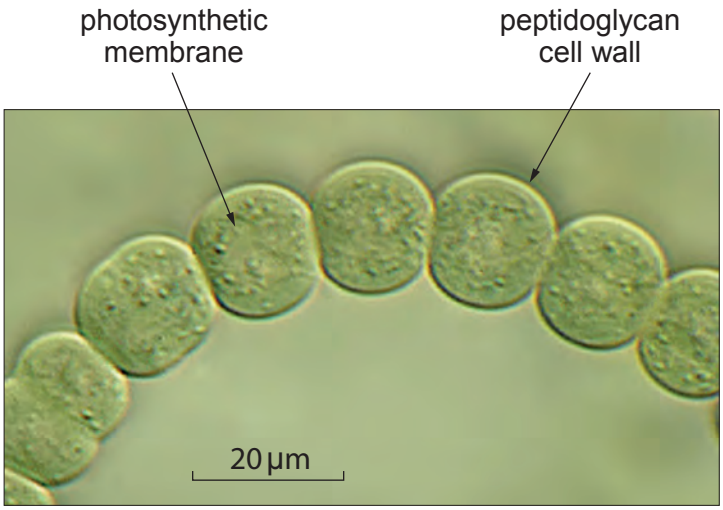
(d) Below is a photomicrograph of the bacteria *Nostoc*, which also inhabits fresh water ponds and ditches. They were once thought to belong to the same group of organisms as *Spirogyra* and thought to have the same cellular structure. Evidence from electron microscopy has now grouped these two separately.

Conclude what cell types are present in *Spirogyra* and *Nostoc*. Identify **two** differences and **one** similarity (not labelled in the photomicrographs) between these two species that would be revealed by electron microscopy. [3]



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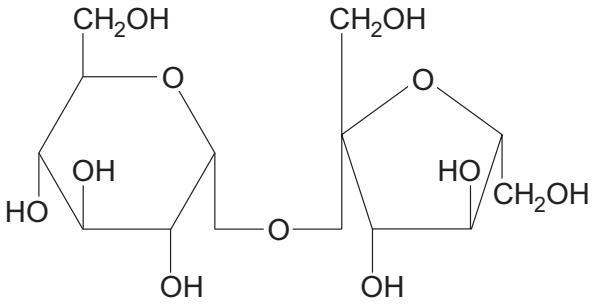
4. Sucrose is a disaccharide of glucose and fructose. The enzyme sucrase, catalyses the hydrolysis of sucrose into its monosaccharides. A colorimeter can be used to record absorbance values, which can then be used to determine the rate of hydrolysis.

(a) (i) Complete the diagram to show the hydrolysis of sucrose including the products formed. [2]



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(ii) State the name of the bond broken during the reaction. [1]

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(iii) Explain why glucose and fructose are referred to as structural isomers. [1]

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(iv) A student was provided with two beakers, one containing sucrose and the other containing sucrase. Describe **one** biochemical test that the student could have carried out to distinguish between the two solutions. [2]

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(b) A student wanted to investigate the hypothesis that sucrase catalyses the hydrolysis of sucrose fastest at a neutral pH. She was provided with the following method:

- Add 5 cm^3 of buffer solution to a test tube
- Add 5 cm^3 of sucrose solution to the test tube
- Add 1 cm^3 of sucrase solution to the test tube and mix
- After 20 minutes add 1 cm^3 of dinitrosalicylic acid (DNS)
- Pipette 5 cm^3 of the mixture into a cuvette and place into a colorimeter and record the absorbance of light passing through the solution.

Dinitrosalicylic acid (DNS) will react with monosaccharides to produce amino-nitrosalicylic acid (ANS). ANS causes a colour change to occur which can be detected by a colorimeter. The greater the concentration of ANS the greater the absorbance of light.

(i) State **two** additional variables that the student should control to ensure that the results recorded would be repeatable. [2]

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(ii) The results are shown in the table below.

pH of sucrose and sucrase solution	Absorbance of light (au)			
	trial 1	trial 2	trial 3	mean
3	0.84	0.63	0.76	0.74
4	0.89	0.95	0.76	0.87
5	0.85	0.91	0.72	0.83
7	0.27	0.34	0.29	0.30
9	0.13	0.11	0.12	0.12
10	0.05	0.04	0.06	0.05

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Plot the mean data on the graph below. [4]

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(iii) What conclusions can be drawn from the data regarding the hypothesis being tested? [3]

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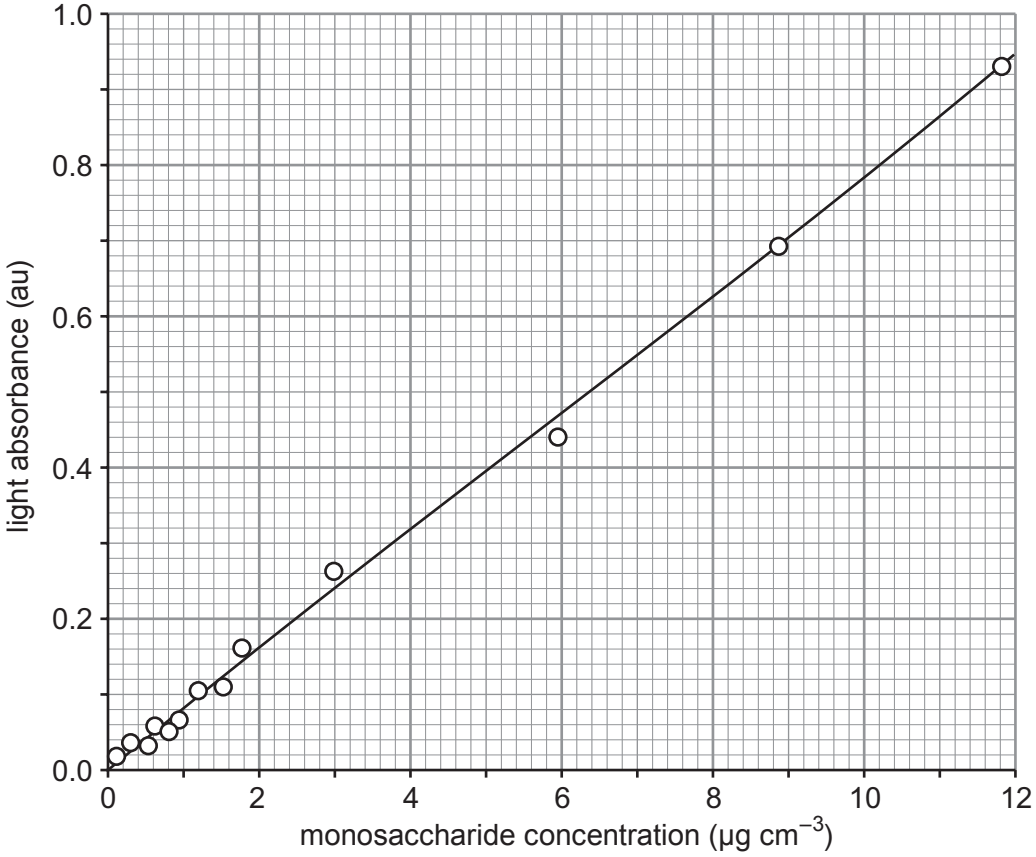
(iv) The student was also provided with the calibration curve below in order to calculate the concentration of glucose produced during the investigation.

The colour change, caused by ANS, is dependent on the concentration of monosaccharides, the greater the concentration the greater the absorbance value recorded.



Determine the maximum concentration of glucose produced during the investigation at pH 7. [2]

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(c) With reference to the data explain how, and why, you would modify the method to determine the optimum pH more accurately. [2]

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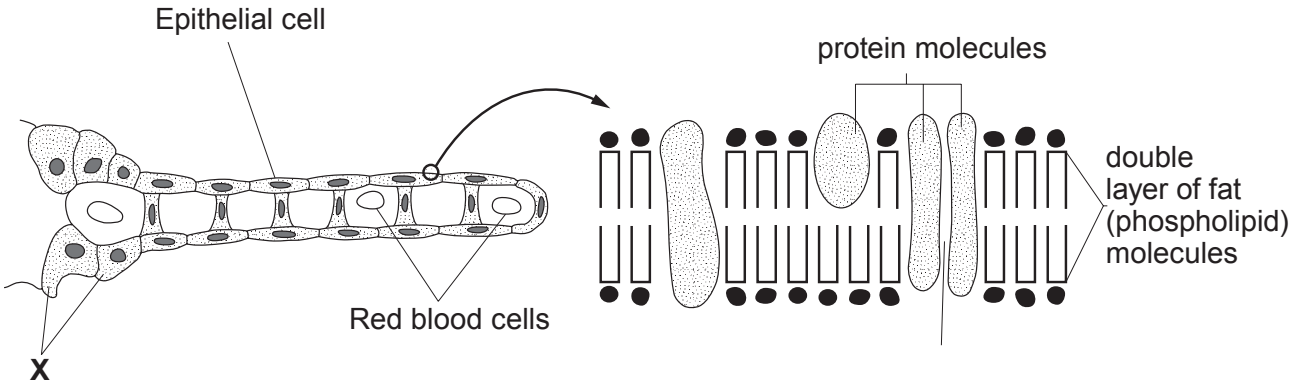
5. The primary role of the gills of fish is gas exchange. Oxygen, a non-polar molecule, passes from the surrounding water into the blood of the gills. The gills are also permeable to water and solutes, such as sodium ions and chloride ions.



(a) Use the information provided to describe how oxygen and sodium ions cross the membrane. [4]

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(b) The data below shows the percentage ion composition of different aquatic habitats and of the blood plasma of two different fish.

		Percentage ion composition	
Fish	Habitat	Blood plasma of fish	Habitat
Flounder	Sea water	1.1	3.5
Carp	Fresh water	0.9	<0.1

Explain why it is important for the survival of the carp to produce large volumes of dilute urine. [4]

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(c) (i) Specialised cells, labelled **X** on the diagram, are located in the epithelium of the gills. They are important in maintaining the ion composition of the blood plasma. Use the data to explain why this is necessary in the flounder. [3]

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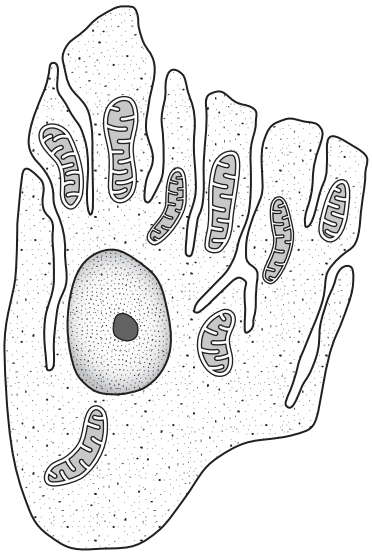
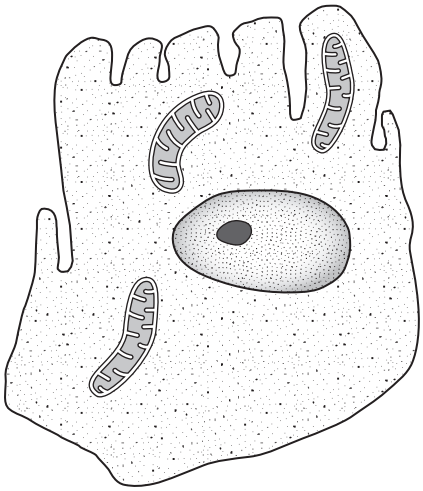
(ii) Salmon spend the majority of their lives in sea water. In order to reproduce salmon must migrate into fresh water rivers. During these migrations these specialised cells undergo structural changes.

The diagrams below are of these cells, taken from the salmon in the two different habitats. Giving reasons for your answer, suggest which cell was taken from the salmon in fresh water, and which was taken from the salmon whilst in sea water. [2]



Cell 1



Cell 2

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(d) Acidification of fresh-water lakes, due to acid rain, has been linked to the death of fish such as carp. Scientists concluded that one of the causes of death in these animals is their inability to maintain blood plasma ion concentrations. Use the information to explain how they arrived at this conclusion. [4]

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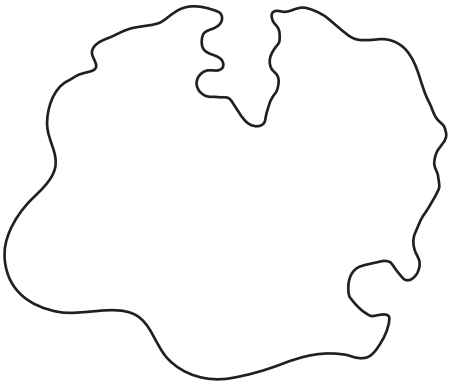
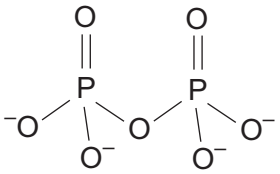
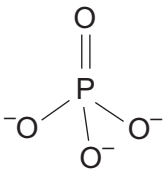
6. Pyrophosphatase is an enzyme found inside the nucleus of cells and is involved in DNA replication. The enzyme catalyses the conversion of a molecule of pyrophosphate to two phosphate ions. The diagrams below show the enzyme pyrophosphatase and its substrate pyrophosphate. Molecules of phenylalanine (an amino acid) and phosphate are also shown; both of these molecules are known to inhibit pyrophosphatase. (Drawings are not to the same scale).



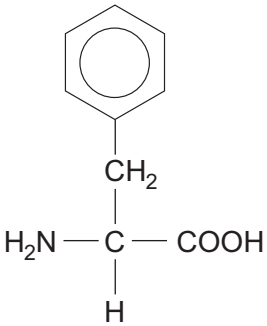
pyrophosphatase



pyrophosphate



phosphate



phenylalanine

Describe and explain why pyrophosphatase can only hydrolyse pyrophosphate and the mechanism by which phenylalanine and phosphate inhibit pyrophosphatase. [9 QER]

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