Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 3 GCE

Thursday 5 June 2025

Afternoon (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.
- Answer the questions in the spaces provided – *there may be more space than you need.*

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.*
- In question(s) 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.

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 Active transport is one type of cell transport mechanism.

(a) What happens during active transport?

(1)

☐ **A** ATP is hydrolysed releasing energy

☐ **B** ATP is hydrolysed using energy

☐ **C** ATP is phosphorylated releasing energy

☐ **D** ATP is phosphorylated using energy

(b) Which substance is transported against a concentration gradient by active transport?

(1)

☐ **A** hydrophilic molecule

☐ **B** large hydrophobic molecule

☐ **C** small hydrophobic molecule

☐ **D** water

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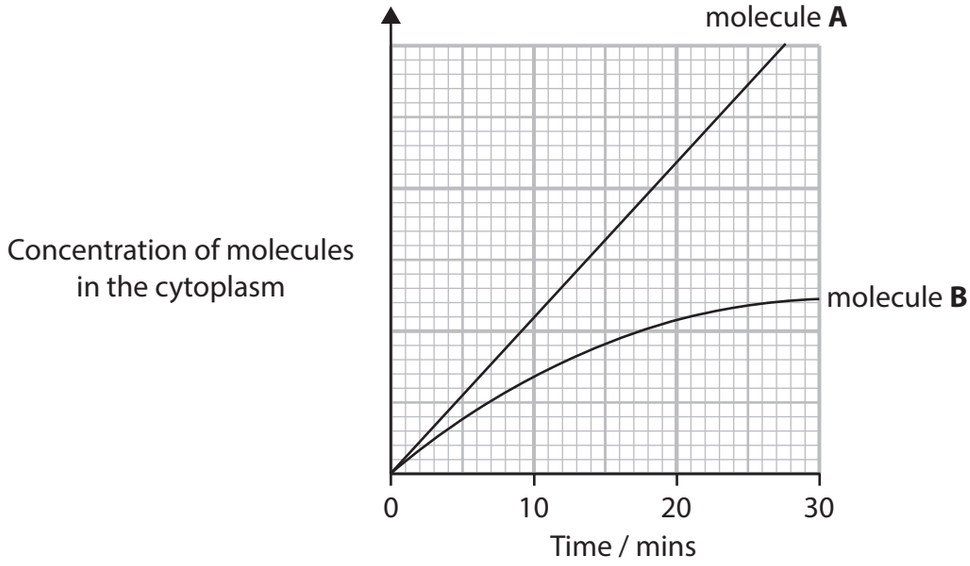
(c) The graph shows the change in concentration of molecule **A** and molecule **B**, as they are transported into the cytoplasm of a cell.



Explain the differences in the changes in concentration of molecule **A** and molecule **B** between 0 and 10 minutes and between 20 and 30 minutes.

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(Total for Question 1 = 4 marks)

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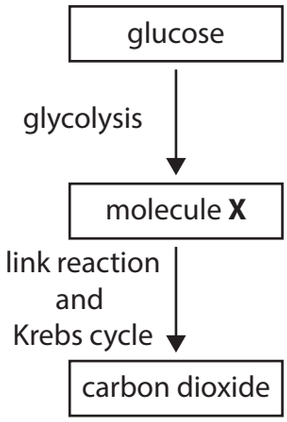
2 The diagram shows part of cellular respiration.



(a) Which is molecule **X**?

(1)

☒ **A** glycerate 3-phosphate

☒ **B** glycogen

☒ **C** lactate

☒ **D** pyruvate

(b) Which row of the table shows the locations of glycolysis, the link reaction and the Krebs cycle in eukaryotic cells?

(1)

	Glycolysis	Link reaction	Krebs cycle
☒ **A**	cytoplasm	cytoplasm	cytoplasm
☒ **B**	cytoplasm	mitochondria	mitochondria
☒ **C**	mitochondria	cytoplasm	cytoplasm
☒ **D**	mitochondria	mitochondria	mitochondria

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(c) Cellular respiration yields 36 molecules of ATP per molecule of glucose.

(i) The oxidation of one glucose molecule yields 2 870 224 Joules.

The free energy stored in one ATP molecule is 30 566 Joules.

Calculate the efficiency of energy transfer in the formation of ATP.

Give your answer to **two decimal places**.

(2)

Answer ..... %

(ii) State why this process is not 100 % efficient.

(1)

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(Total for Question 2 = 5 marks)

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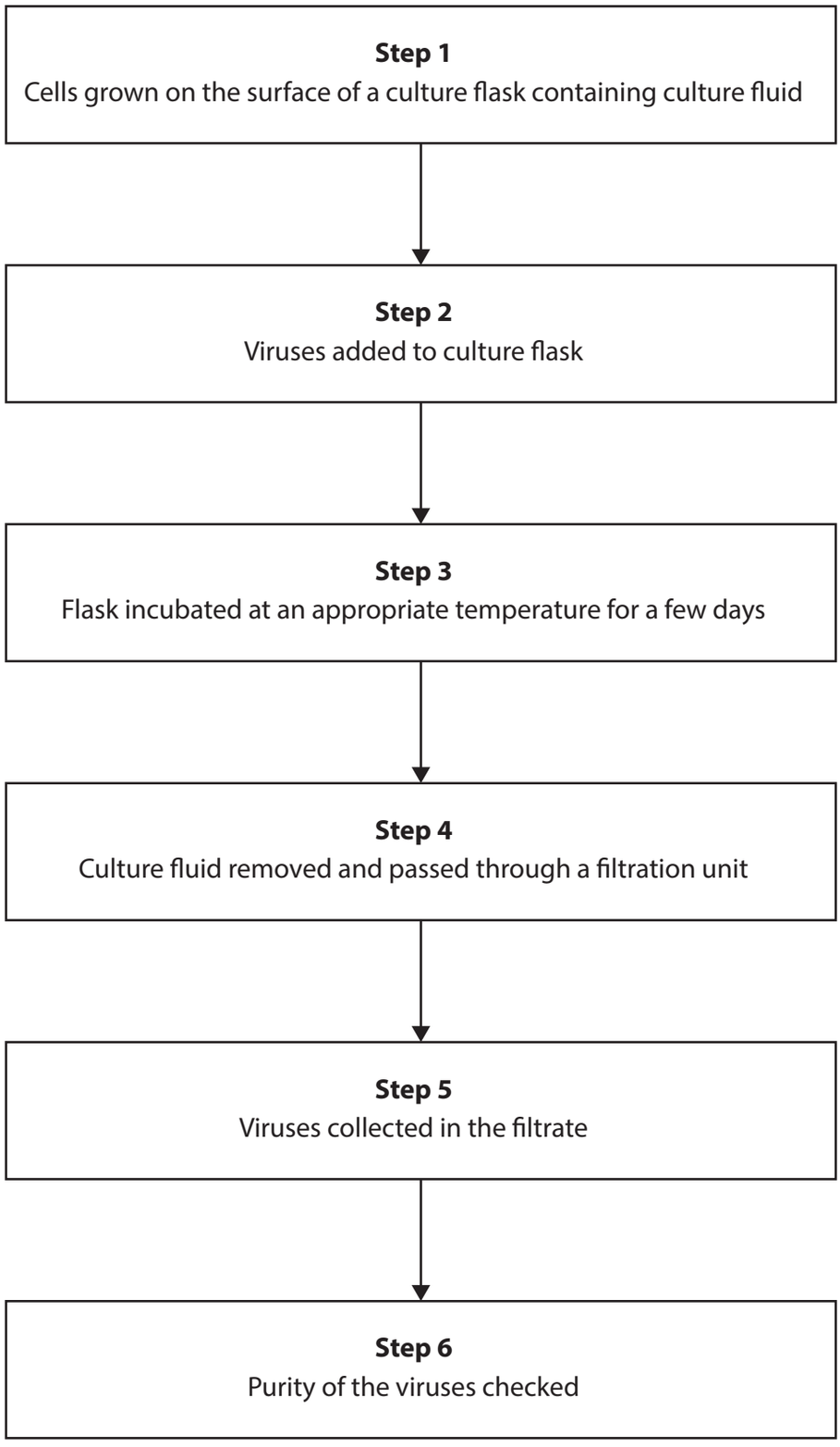
3 Viruses can be cultured and isolated in a laboratory.

The diagram shows the steps involved in culturing and isolating viruses.



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(a) State why specifically-selected cell types have to be grown in **Step 1**.

(1)

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(b) Explain why the flask has to be incubated at an appropriate temperature for a few days in **Step 3**.

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(c) Explain why the viruses and not the cells will be present in the filtrate in **Step 5**.

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(Total for Question 3 = 6 marks)

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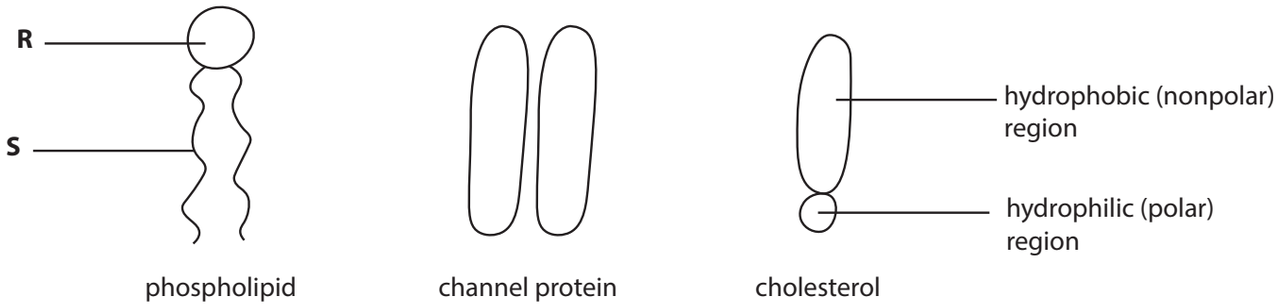
4 The permeability of the cell surface membrane to a particular molecule depends on a number of factors, including the properties of the membrane and the properties of the molecule moving through it.

(a) The diagram shows some of the components of the cell surface membrane.



(i) Which row in the table describes parts R and S of the phospholipid?

(1)

		Part R	Part S
☒	**A**	hydrophilic fatty acid	hydrophobic phosphate
☒	**B**	hydrophilic phosphate	hydrophobic fatty acid
☒	**C**	hydrophobic fatty acid	hydrophilic phosphate
☒	**D**	hydrophobic phosphate	hydrophilic fatty acid

(ii) Draw part of a cell surface membrane that has twelve phospholipids, one channel protein and one cholesterol molecule.

Use the components shown in the diagram.

(2)

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(iii) Describe the role of channel proteins in cell transport.

(2)

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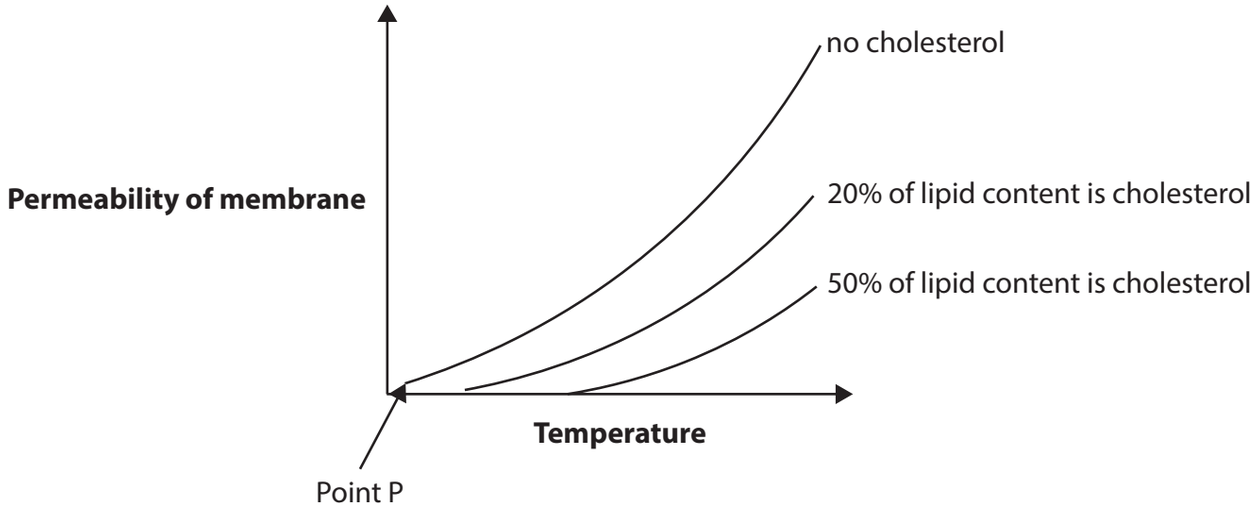
(b) The graph shows the effect on the permeability of membranes of temperature and the proportion of cholesterol in the membrane.



(i) Analyse the data to give **two** conclusions that can be made from this graph.

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(ii) Explain the effect of temperature on membrane permeability at point P.

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(Total for Question 4 = 9 marks)

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5 Turner's syndrome (TS) results from a chromosome mutation.

People with TS are at a higher risk of developing autoimmune disorders than people without TS.

An autoimmune disorder results when a person's immune system attacks their own body.

(a) Which of the following describes the chromosome mutation that causes TS?

(1)

☒ **A** non-disjunction leading to monosomy

☒ **B** non-disjunction leading to polysomy

☒ **C** translocation leading to monosomy

☒ **D** translocation leading to polysomy

(b) There were 613 936 babies born in the UK in 2020.

The ratio of baby boys to baby girls is 1.05 : 1.

The incidence of TS is between 1 in 2 000 and 1 in 2 500 in baby girls.

Calculate the **minimum** number of baby girls born with TS in the UK in 2020.

(2)

Answer .....

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(c) Scientists studied a group of girls with TS and a group of girls without TS.

They recorded physical features and immunological markers such as antibodies and lymphocytes.

(i) Girls who had recently been vaccinated were excluded from this study.

Explain why these girls were excluded.

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(ii) The table shows some of the physical features of the two groups of girls.

Physical features	Mean value ± SD for each group of girls	
	With TS	Without TS
Age / years	11.9 ± 4.1	12.5 ± 4.0
Mass / kg	36.7 ± 14.8	45.2 ± 19.3
Height / cm	134.8 ± 20.0	146.3 ± 21.3
Standardised height score	–2.16 ± 0.95	–0.41 ± 0.50
Body mass index (BMI)	19.2 ± 3.3	19.7 ± 4.6

Only one of these features was significantly different between the two groups of girls.

Explain which was the significantly different feature.

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(iii) The table shows the levels of four immunological markers in the blood of each group of girls.

Immunological marker	Mean value ± SD for each group of girls	
	With TS	Without TS
IgA antibody / g dm^{-3}	1.08 ± 0.39	1.15 ± 0.42
IgG antibody / g dm^{-3}	9.14 ± 2.10	11.15 ± 3.29
CD4 lymphocytes / cells per µl	656.3 ± 227.3	817.3 ± 350.1
CD8 lymphocytes / cells per µl	597.6 ± 272.6	494.8 ± 188.3

Analyse the data to describe the conclusions that can be made about the immunological markers in girls with TS.

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(iv) The scientists also determined the number of a type of cell called T regulatory cells in the blood of these two groups of girls.

They found that the numbers of these cells were very similar.

People with autoimmune diseases have been shown to have a decreased number of T regulatory cells.

Explain how this study could be modified to show that a decreased number of T regulatory cells is linked to the risk of autoimmune disease in girls with TS.

(2)

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(Total for Question 5 = 12 marks)

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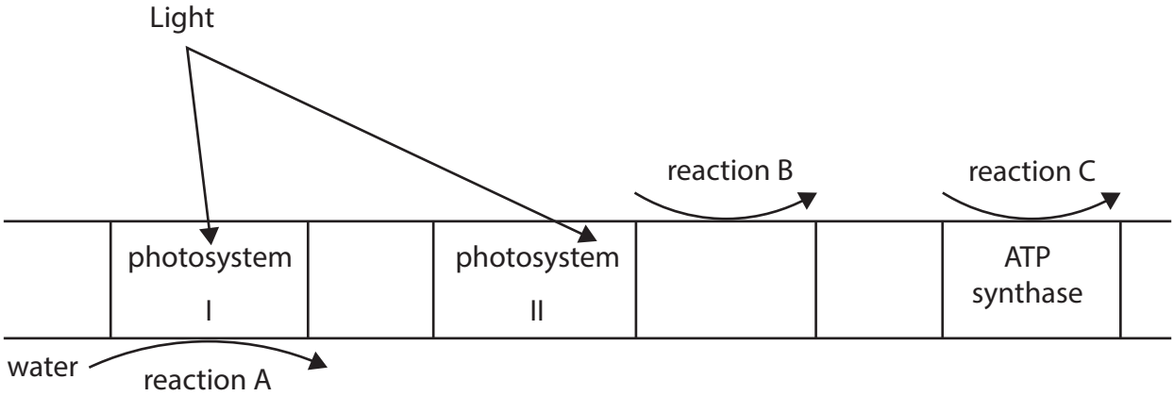
6 *Chlorella* are single-celled photosynthetic algae.

(a) The diagram shows part of a membrane in a chloroplast from *Chlorella*.



(i) Which membrane is shown in this diagram?

(1)

☒ **A** crista

☒ **B** inner

☒ **C** outer

☒ **D** thylakoid

(ii) Name reaction A.

(1)

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(iii) What occurs in reaction B?

(1)

☒ **A** reduced NADP is broken down by gaining an electron

☒ **B** reduced NADP is broken down by losing an electron

☒ **C** reduced NADP is produced by gaining an electron

☒ **D** reduced NADP is produced by losing an electron

(iv) Write the equation for reaction C.

(1)

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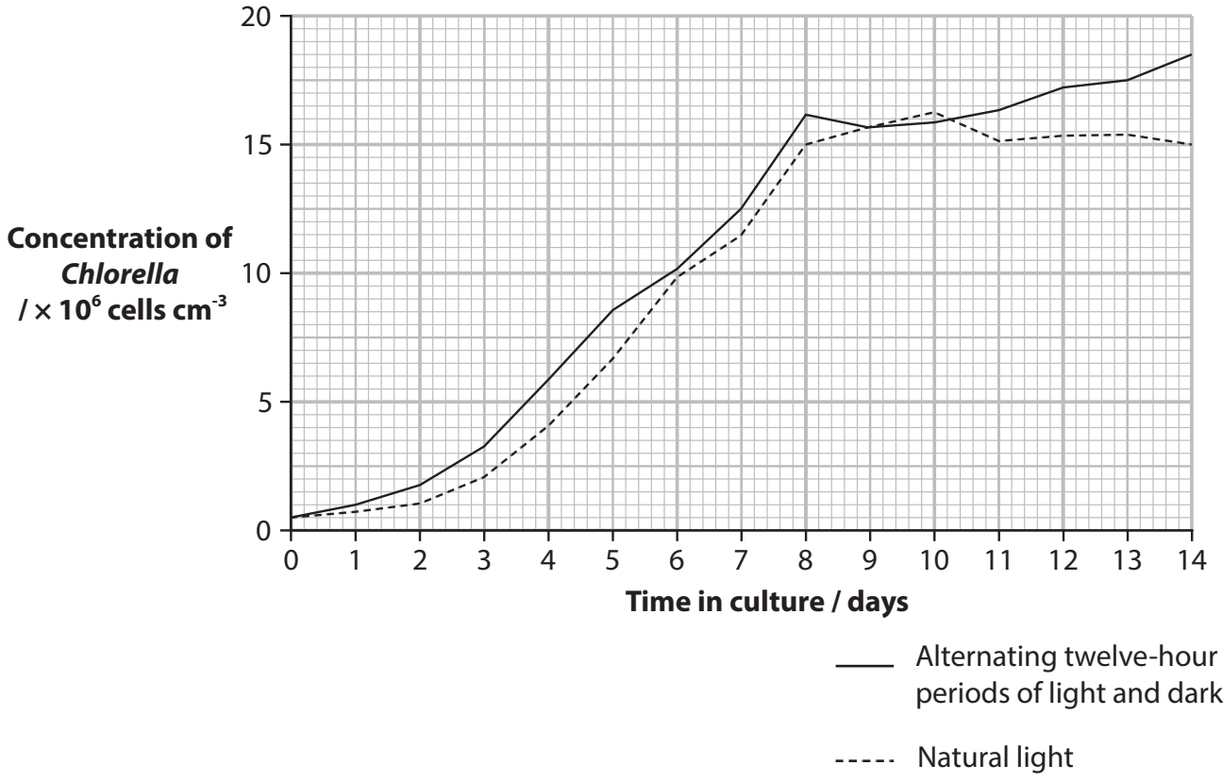
(b) Scientists are developing solar cells that contain photosynthetic pigments derived from *Chlorella*.

Solar cells absorb light and generate electricity.

The scientists cultured *Chlorella* under two different lighting conditions.

The graph shows the growth of *Chlorella* exposed to either natural light or to alternating twelve-hour periods of light and dark.



(i) The mean growth rate for *Chlorella* grown in natural light during the fourteen-day period was 1.04×10^6 cells per day.

Calculate how many times faster *Chlorella* grew in alternating periods of light and dark.

Give your answer to **two significant figures**.

(2)

Answer .....

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(ii) The cultures were observed for a further four days.

The table shows the observations.

Time in culture / days	Observation	
	***Chlorella* grown in alternating periods of light and dark**	***Chlorella* grown in natural light**
17	Dark green cells The number of cells had not increased since the previous day	Light green cells The number of cells had increased since the previous day
18	Cells had entered the death phase	Cells had not entered the death phase

Explain these observations.

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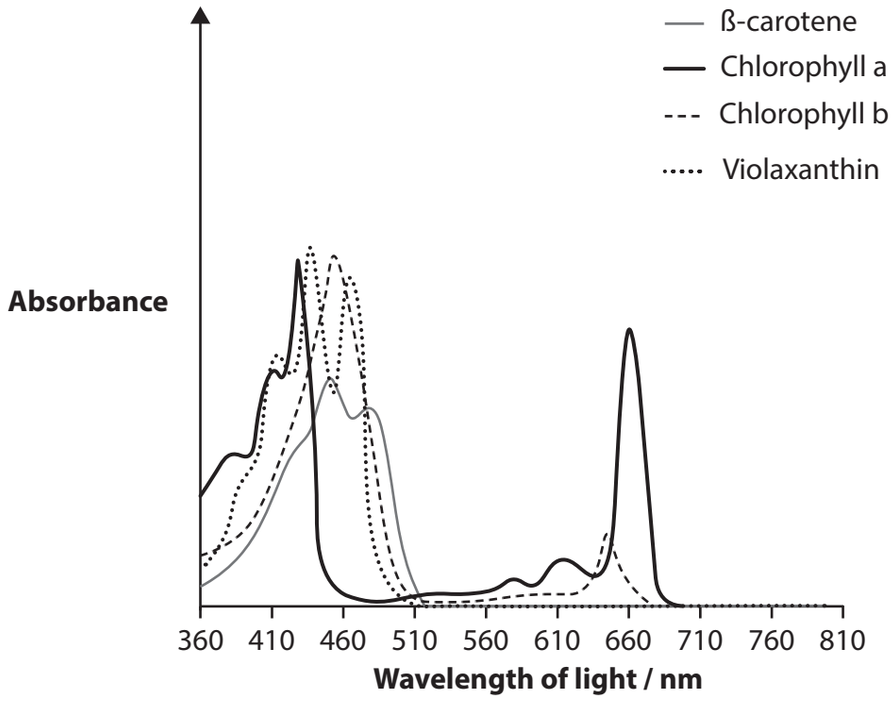
(iii) The scientists chose to use *Chlorella* as a source of photosynthetic pigments for solar cells.

The graph shows the absorption spectra of four photosynthetic pigments found in *Chlorella*.



Explain why *Chlorella* cells are a suitable source of photosynthetic pigments for use in a solar cell.

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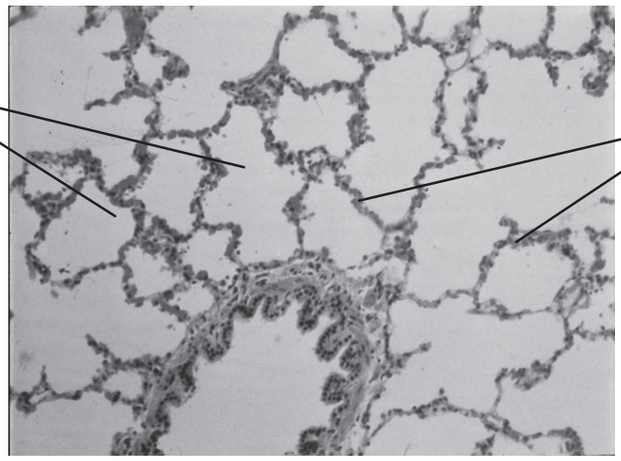
7 Living organisms have a range of gas exchange systems.

(a) The photograph shows human lung tissue, as seen using a light microscope.



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(i) The typical diameter of an adult alveolus is 200 μm.

There are 300 million alveoli in each lung.

Calculate the total surface area of a pair of adult lungs, using the formula:

$$\text{surface area of one alveolus} = 4\pi r^2$$

Give your answer in m^2.

(3)

Answer ..... m^2

(ii) Explain the importance of a large surface area in a gas exchange system.

(2)

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(iii) Fluid passes out of the capillaries into the spaces around the alveoli.

Some of this fluid passes into the alveoli.

Explain the importance of having fluid inside the alveoli.

(2)

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(b) The photograph shows a marine sponge.

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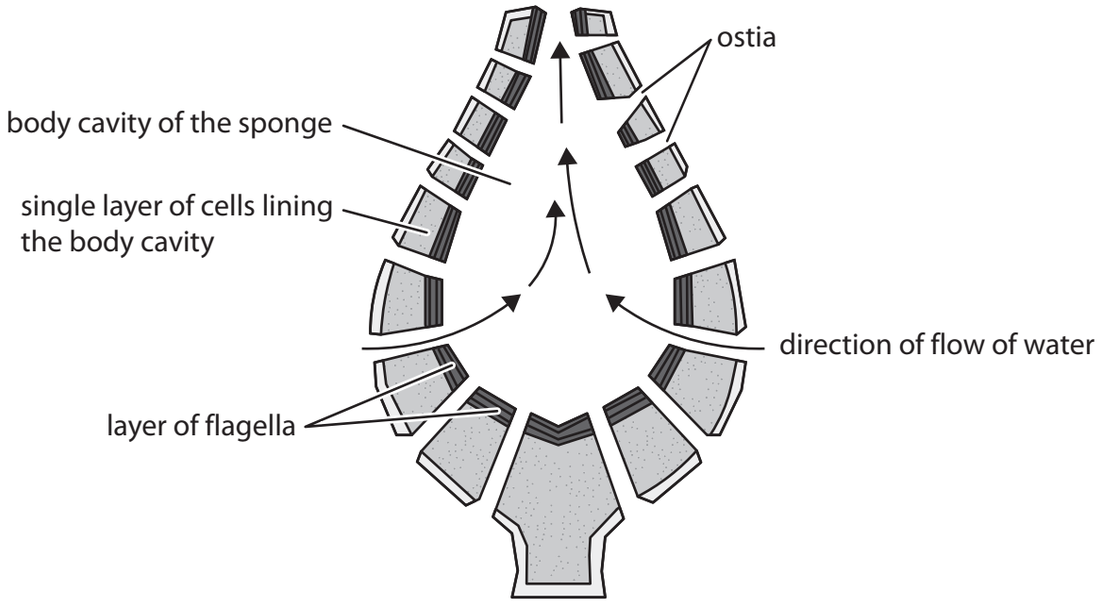
Sponges are aquatic animals that are covered in pores called ostia.

The diagram shows a section through a sponge.



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Analyse the information in the diagram to explain how this sponge is adapted for gas exchange.

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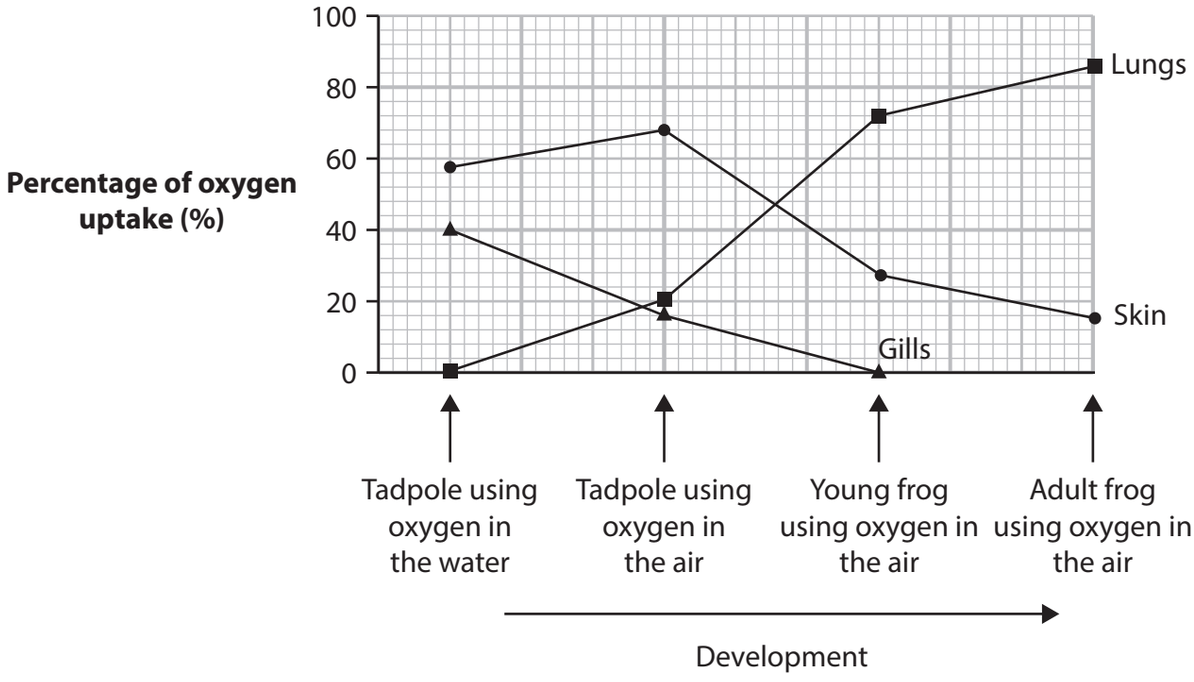
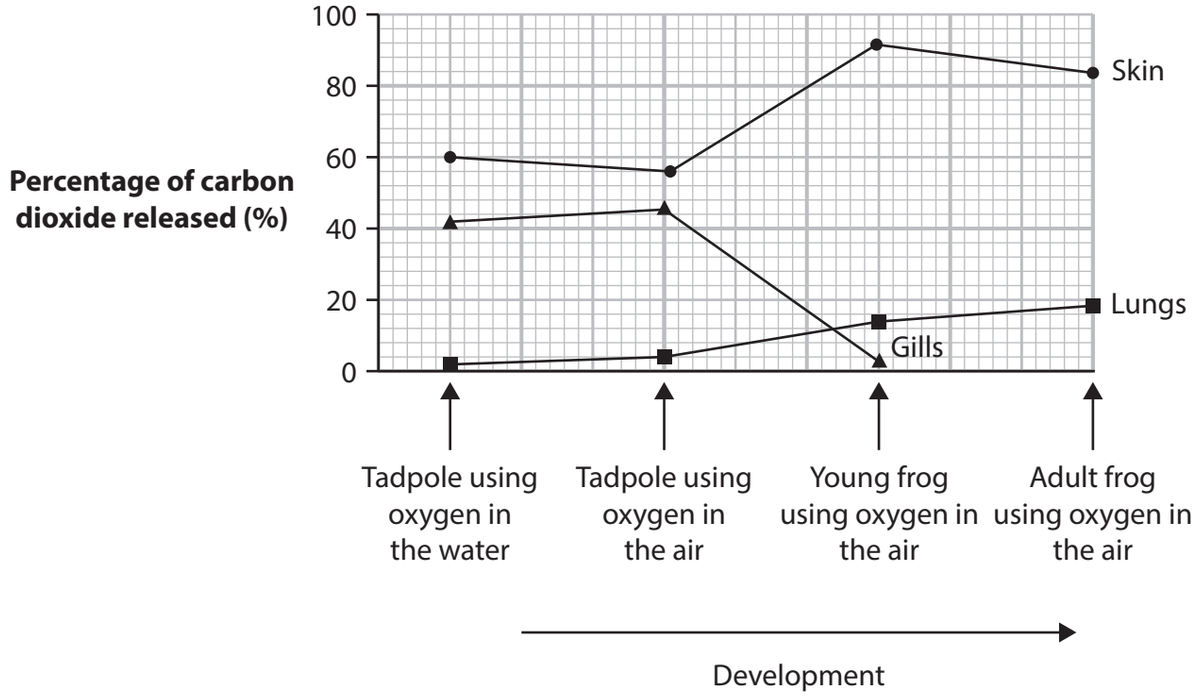
(c) The graphs show changes in gas exchange as a tadpole develops into an adult frog.





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Analyse the data to explain the role of the gills, lungs and skin in gas exchange as a tadpole develops into a frog.

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8 The rate of photosynthesis in some plants can be affected by the level of nitrogen gas in the air.

The effects of low, moderate and high nitrogen levels on leaf structure and molecules present in the leaves were investigated.

(a) Which pair of molecules contains nitrogen atoms?

(1)

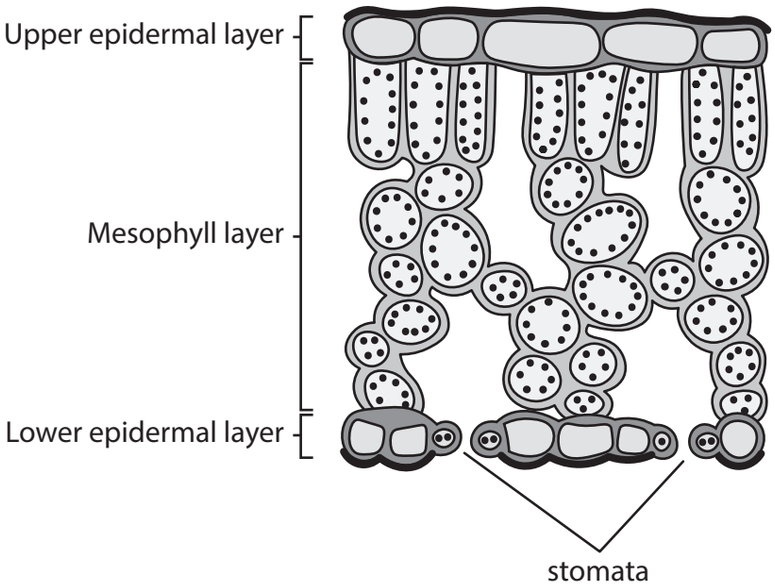
☒ **A** carbohydrates and lipids

☒ **B** lipids and nucleic acids

☒ **C** nucleic acids and proteins

☒ **D** proteins and carbohydrates

(b) The diagram shows a section through a leaf.



(i) Which is the main gas exchange surface in a leaf?

(1)

☒ **A** lower epidermal layer

☒ **B** mesophyll layers

☒ **C** stomata

☒ **D** upper epidermal layer

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*(ii) The table shows some effects on the characteristics of leaves when plants are grown in low, moderate and high levels of nitrogen gas.

Characteristic	Effect compared with plants grown in moderate levels of nitrogen gas	
	Plants grown in low levels of nitrogen gas	Plants grown in high levels of nitrogen gas
Thickness of layers	smaller	larger
Size of chloroplasts	smaller	larger
Surface area of chloroplasts exposed to intercellular air space	lower	higher
RUBISCO activity	lower	lower

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Discuss how growing plants in low levels and high levels of nitrogen gas affects the rate of photosynthesis.

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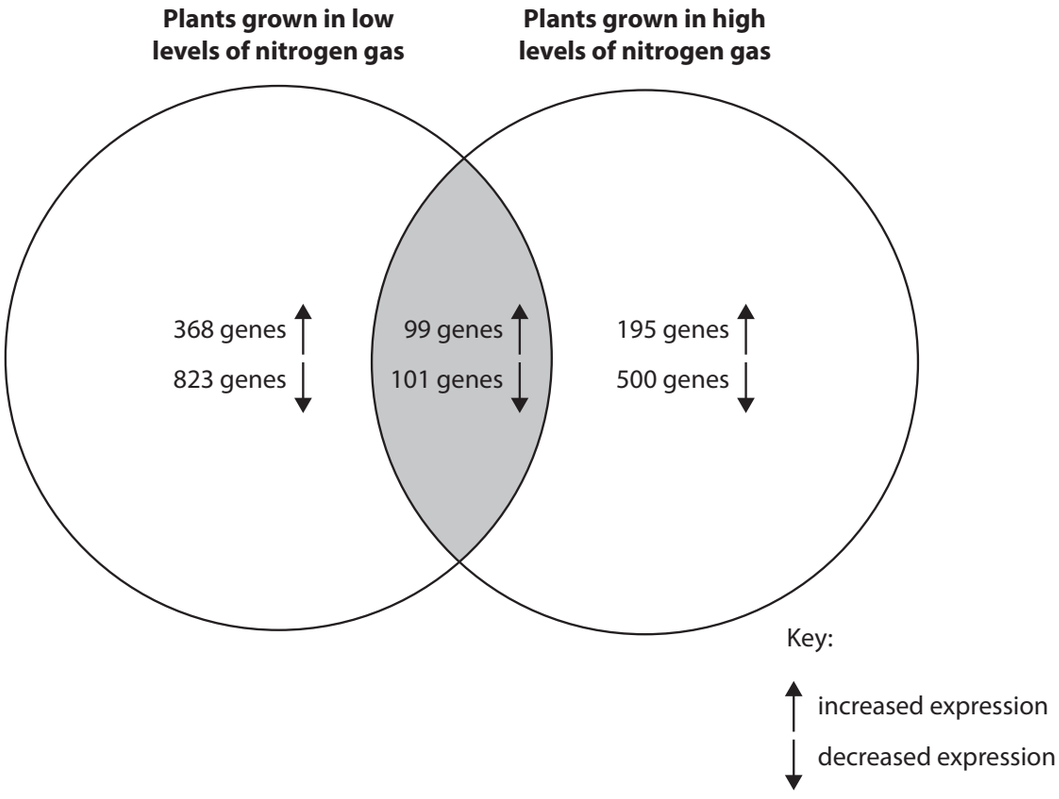
(c) This investigation also studied changes in gene expression in the plants grown in low levels and high levels of nitrogen gas compared with those grown in moderate levels.

The chart shows the results of this part of the investigation.

The shaded area shows the genes that were affected in both groups of plants.



(i) Determine the effect of growing plants in low levels of nitrogen gas and in high levels of nitrogen gas on the changes in gene expression.

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(ii) Describe how gene expression can be changed.

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9 Aptamers are single-stranded DNA or RNA sequences that fold into specific three-dimensional structures.

Aptamers bind tightly to targets such as proteins and viruses.

(a) Compare and contrast the structure of single-stranded DNA with that of single-stranded RNA.

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(b) Aptamers can be amplified using PCR.

To amplify an RNA aptamer, reverse transcription-PCR (RT-PCR) must be used.

Describe how RT-PCR can be used to amplify RNA aptamers.

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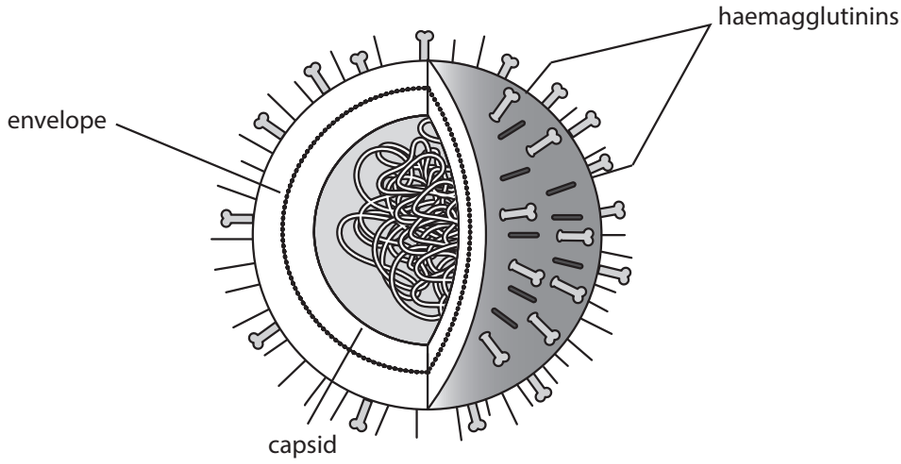
*(c) The diagram shows the structure of the influenza virus.

Haemagglutinin is a glycoprotein that binds to molecules on the cell membranes of the host cells of this virus.

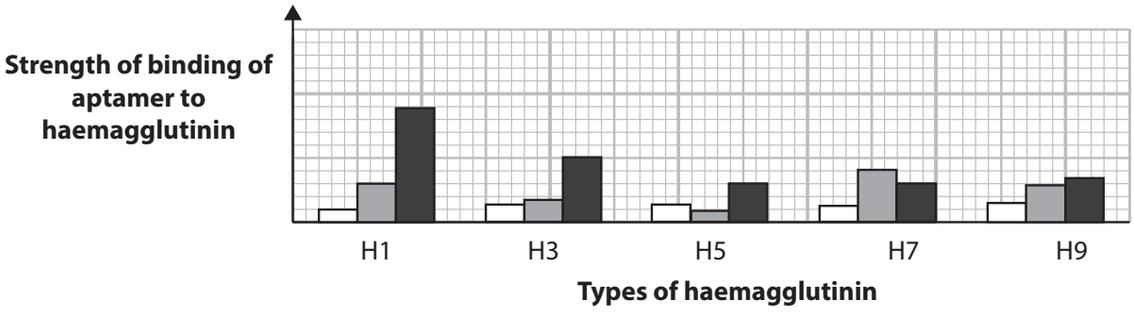
Strains of influenza virus have evolved that have haemagglutinins on their surface, with different antigenic properties.

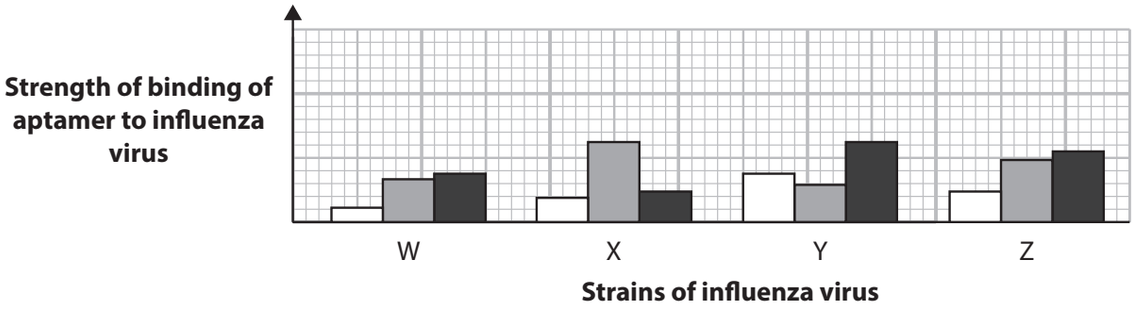


Aptamers (AT1, AT2 and AT3) have been developed that bind to haemagglutinins (H1, H3, H5, H7 and H9).

The strength of binding of these aptamers to the haemagglutinins and to four strains of influenza virus (W, X, Y and Z) was investigated.

The graphs show the results of this investigation.





Key

AT1 AT2 AT3

P 7 4 4 5 9 R A 0 3 4 3 6

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Discuss the advantages and disadvantages of using aptamers to prevent infection with the influenza virus.

(6)

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(Total for Question 9 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

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