

Paper Reference(s) 9BI0/01
Pearson Edexcel Level 3 GCE

Biology B

Advanced

**PAPER 1: Advanced Biochemistry,
Microbiology and Genetics**

Thursday 5 June 2025 – Afternoon

Time: 1 hour 45 minutes

Question Paper

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

**THIS DOCUMENT MUST BE
RETURNED TO PEARSON AT THE END
OF THE EXAMINATION**

YOU MUST HAVE

**Scientific calculator, writing and
drawing equipment**

YOU WILL BE GIVEN

Diagram Booklet

Turn over

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – 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.**

There may be spare copies of some diagrams.

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.

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 mark)**

- ☐ **A ATP is hydrolysed releasing energy**
- ☐ **B ATP is hydrolysed using energy**
- ☐ **C ATP is phosphorylated
releasing energy**
- ☐ **D ATP is phosphorylated
using energy**

(continued on the next page)

1 continued.

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

(1 mark)

- ☐ **A hydrophilic molecule**
- ☐ **B large hydrophobic molecule**
- ☐ **C small hydrophobic molecule**
- ☐ **D water**

(continued on the next page)

1 continued.

(c) Look at the graph for Question 1(c) in the Diagram Booklet. It 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.**

(2 marks)

Answer space continues on the next page.

Turn over

1(c) continued.

(Total for Question 1 = 4 marks)

2 Look at the diagram for Question 2 in the Diagram Booklet. It shows part of cellular respiration.

(a) Which is molecule X?

(1 mark)

☐ **A glycerate 3-phosphate**

☐ **B glycogen**

☐ **C lactate**

☐ **D pyruvate**

(continued on the next page)

2 continued.

**(b) Look at the table for Question 2(b) in the Diagram Booklet. Which row of the table shows the locations of glycolysis, the link reaction and the Krebs cycle in eukaryotic cells?
(1 mark)**

(continued on the next page)

2 continued.

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

**(i) The oxidation of one glucose
molecule yields 2870 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 marks)

Answer space begins on the next page.

Turn over

2(c)(i) continued.

Answer _____%

(continued on the next page)

2(c) continued.

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

(1 mark)

(Total for Question 2 = 5 marks)

- 3 Viruses can be cultured and isolated in a laboratory.**

Look at the diagram for Question 3 in the Diagram Booklet. It shows the steps involved in culturing and isolating viruses.

(continued on the next page)

3 continued.

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

(continued on the next page)

Turn over

3 continued.

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

Answer space continues on the next page.

Turn over

3(b) continued.

(continued on the next page)

3 continued.

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

(3 marks)

Answer space continues on the next page.

Turn over

3(c) continued.

(Total for Question 3 = 6 marks)

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) Look at the diagrams for Question 4(a) in the Diagram Booklet. They show some of the components of the cell surface membrane.

(continued on the next page)

4(a) continued.

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

	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

(continued on the next page)

Turn over

4(a) continued.

(ii) Look again at the diagrams for Question 4(a) in the Diagram Booklet. Draw on the next page part of a cell surface membrane that has twelve phospholipids, one channel protein and one cholesterol molecule.

Use the components shown in the diagrams.

(2 marks)

Answer space begins on the next page.

4(a)(ii) continued.

4(a) continued.

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

Answer space continues on the next page.

Turn over

4(a)(iii) continued.

(continued on the next page)

4 continued.

(b) Look at the graph for Question 4(b) in the Diagram Booklet. It 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.

(2 marks)

Answer space continues on the next page.

Turn over

4(b)(i) continued.

(continued on the next page)

4(b) continued.

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

(2 marks)

Answer space continues on the next page.

Turn over

4(b)(ii) continued.

(Total for Question 4 = 9 marks)

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.

(continued on the next page)

5 continued.

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

(1 mark)

- ☐ **A non-disjunction leading to monosomy**
- ☐ **B non-disjunction leading to polysomy**
- ☐ **C translocation leading to monosomy**
- ☐ **D translocation leading to polysomy**

(continued on the next page)

Turn over

5 continued.

(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 marks)

Answer space begins on the next page.

5(b) continued.

Answer _____

(continued on the next page)

5 continued.

(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.

(3 marks)

Answer space begins and continues on the next 2 pages.

Turn over

5(c)(i) continued.

Turn over

5(c)(i) continued.

(continued on the next page)

5(c) continued.

**(ii) Look at the table for
Question 5(c)(ii) in the Diagram
Booklet. It shows some of
the physical features of the
two groups of girls.**

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

**Explain which was the
significantly different feature.**

(2 marks)

Answer space continues on the next page.

Turn over

5(c)(ii) continued.

(continued on the next page)

5(c) continued.

**(iii) Look at the table for
Question 5(c)(iii) in the Diagram
Booklet. It shows the levels of
four immunological markers in
the blood of each group of girls.**

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

(2 marks)

Answer space continues on the next page.

Turn over

5(c)(iii) continued.

(continued on the next page)

5(c) continued.

(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.

(continued on the next page)

5(c)(iv) continued.

**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 marks)**

Answer space continues on the next page.

Turn over

5(c)(iv) continued.

(Total for Question 5 = 12 marks)

6 Chlorella are single-celled photosynthetic algae.

(a) Look at the diagram for Question 6(a) in the Diagram Booklet. It shows part of a membrane in a chloroplast from Chlorella.

**(i) Which membrane is shown in this diagram?
(1 mark)**

☐ **A crista**

☐ **B inner**

☐ **C outer**

☐ **D thylakoid**

(continued on the next page)

Turn over

6(a) continued.

(ii) Name reaction A.

(1 mark)

(continued on the next page)

6(a) continued.

(iii) What occurs in reaction B?
(1 mark)

- ☐ **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**

(continued on the next page)

Turn over

6(a) continued.

**(iv) Write the equation for reaction C.
(1 mark)**

(continued on the next page)

6 continued.

(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.

Look at the graph for Question 6(b) in the Diagram Booklet. It shows the growth of *Chlorella* exposed to either natural light or to alternating twelve-hour periods of light and dark.

(continued on the next page)

Turn over

6(b) continued.

- (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 marks)**

Answer space begins on the next page.

6(b)(i) continued.

Answer _____

(continued on the next page)

Turn over

6(b) continued.

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

**Look at the table for
Question 6(b)(ii) in the Diagram
Booklet. It shows the observations.**

Explain these observations.

(5 marks)

Answer space continues on the next 2 pages.

Turn over

6(b)(ii) continued.

Turn over

6(b)(ii) continued.

(continued on the next page)

Turn over

6(b) continued.

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

Look at the graph for Question 6(b)(iii) in the Diagram Booklet. It 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.

(3 marks)

Answer space begins and continues on the next 2 pages.

Turn over

6(b)(iii) continued.

Turn over

6(b)(iii) continued.

(Total for Question 6 = 14 marks)

7 Living organisms have a range of gas exchange systems.

(a) Look at the images for Question 7(a) in the Diagram Booklet. The photograph shows human lung tissue, as seen using a light microscope. An outline version of the photograph has also been provided.

(i) The typical diameter of an adult alveolus is $200\text{ }\mu\text{m}$

There are 300 million alveoli in each lung.

(continued on the next page)

7(a)(i) continued.

**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 m²
(3 marks)**

Answer _____ m²

7(a) continued.

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

(2 marks)

Answer space continues on the next page.

Turn over

7(a)(ii) continued.

(continued on the next page)

7(a) continued.

**(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 marks)

Answer space continues on the next page.

Turn over

7(a)(iii) continued.

(continued on the next page)

7 continued.

(b) Look at the photograph and outline version for Question 7(b) in the Diagram Booklet. They show a marine sponge.

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

Look at the diagram for Question 7(b) in the Diagram Booklet. It shows a section through a sponge.

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

(3 marks)

Answer space begins and continues on the next 2 pages.

Turn over

7(b) continued.

Turn over

7(b) continued.

(continued on the next page)

7 continued.

(c) Look at Graph 1 and Graph 2 for Question 7(c) in the Diagram Booklet. They show changes in gas exchange as a tadpole develops into an adult frog.

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

(4 marks)

Answer space continues on the next 2 pages.

Turn over

7(c) continued.

Turn over

7(c) continued.

(Total for Question 7 = 14 marks)

- 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 mark)

- ☐ **A carbohydrates and lipids**
- ☐ **B lipids and nucleic acids**
- ☐ **C nucleic acids and proteins**
- ☐ **D proteins and carbohydrates**

(continued on the next page)

Turn over

8 continued.

(b) Look at the diagram for Question 8(b) in the Diagram Booklet. It shows a section through a leaf.

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

☐ **A lower epidermal layer**

☐ **B mesophyll layers**

☐ **C stomata**

☐ **D upper epidermal layer**

(continued on the next page)

Turn over

8(b) continued.

***(ii) Look at the table for
Question 8(b)(ii) in the Diagram
Booklet. It shows some effects on
the characteristics of leaves when
plants are grown in low, moderate
and high levels of nitrogen gas.**

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

(6 marks)

Answer space continues on the next 3 pages.

Turn over

8(b)(ii) continued.

Turn over

8(b)(ii) continued.

Turn over

8(b)(ii) continued.

(continued on the next page)

8 continued.

(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.

Look at the chart for Question 8(c) in the Diagram Booklet. It shows the results of this part of the investigation.

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

(continued on the next page)

8(c) continued.

- (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.**

(3 marks)

Answer space continues on the next page.

Turn over

8(c)(i) continued.

(continued on the next page)

Turn over

8(c) continued.

**(ii) Describe how gene expression
can be changed.**

(2 marks)

Answer space continues on the next page.

Turn over

8(c)(ii) continued.

(Total for Question 8 = 13 marks)

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.

(3 marks)

Answer space continues on the next page.

Turn over

9(a) continued.

(continued on the next page)

Turn over

9 continued.

(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.

(4 marks)

Answer space continues on the next 2 pages.

Turn over

9(b) continued.

Turn over

9(b) continued.

(continued on the next page)

9 continued.

***(c) Look at the diagram for Question 9(c) in the Diagram Booklet. It 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).

9(c) continued.

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

Look at Graph 1 and Graph 2 for Question 9(c) in the Diagram Booklet. They show the results of this investigation.

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

(6 marks)

Answer space begins and continues on the next 3 pages.

Turn over

9(c) continued.

Turn over

9(c) continued.

Turn over

9(c) continued.

(Total for Question 9 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

END OF PAPER