

Biology B
Advanced
PAPER 1: Advanced Biochemistry, Microbiology
and Genetics

| |
|-------------|
| Total Marks |
|-------------|

Time: 1 hour 45 minutes

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

| | | | | | |
|-------------------------|--|--|--|--|--|
| Surname | | | | | |
| Other names | | | | | |
| Centre Number | | | | | |
| Candidate Number | | | | | |

YOU MUST HAVE

Scientific calculator, writing and drawing equipment, ruler

YOU WILL BE GIVEN

Diagram Booklet

INSTRUCTIONS

Answer ALL questions.

Show your working in calculation questions and include units in your answer where appropriate.

Answer the questions in the spaces provided or in the separate Diagram Booklet – there may be more space than you need.

You may use a scientific calculator.

In questions 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.

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.

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 The pathogenic effects of bacteria can be due to the toxins they release.

(a) Endotoxins are released by Gram negative bacteria.

**(i) Name ONE type of Gram negative bacteria that releases endotoxins.
(1 mark)**

(continued on the next page)

1 continued.

- (ii) Give ONE difference between the structure of Gram negative bacteria and Gram positive bacteria.
(1 mark)**

(continued on the next page)

1 continued.

(b) Endotoxins are usually less toxic than exotoxins.

- (i) The LD_{50} value is the mass of the chemical per kg of body mass that would kill half the number of rodent animals.**

The LD_{50} value can be used to indicate how toxic a chemical is.

One endotoxin has an LD_{50} value of 11 ng kg^{-1} .

The mean body mass of a group of rodents is 28 g.

Calculate the mass of endotoxin given to each rodent that would kill half of the rodents in this group.

(1 mark)

Answer _____ ng

(continued on the next page)

Turn over

1 continued.

- (ii) State TWO differences, other than toxicity, between endotoxins and exotoxins.
(2 marks)**

(Total for Question 1 = 5 marks)

2 A zygote is formed when gametes fuse at fertilisation.

(a) Explain how meiosis results in genetic variation in the gametes.

(2 marks)

(continued on the next page)

2 continued.

- (b) Describe how the process of fertilisation results in the formation of a zygote from the gametes in humans.
(3 marks)**

(continued on the next page)

Turn over

2 continued.

(Total for Question 2 = 5 marks)

3 Malaria is a serious and sometimes fatal disease.

Scientists are constantly looking for new ways of controlling this disease.

- (a) Which row of the table shows the name of the pathogen that causes malaria, and its classification group?**
(1 mark)

| | Name of pathogen | Classification group |
|-----------------------------------|-------------------------|-----------------------------|
| <input type="checkbox"/> A | Plasmodium | genus |
| <input type="checkbox"/> B | Plasmodium | species |
| <input type="checkbox"/> C | Puccinia | genus |
| <input type="checkbox"/> D | Puccinia | species |

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3 continued.

- (b) One group of scientists has genetically modified a fungus to produce a spider toxin that kills mosquitoes.**

Describe how a fungus could be genetically modified to produce spider toxin.

(3 marks)

(continued on the next page)

Turn over

3 continued.

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3 continued.

- (c) Another group of scientists has discovered a type of fungus that completely protects mosquitoes from infection by the pathogen that causes malaria.**

This fungus does not kill the mosquitoes.

Explain why this approach is less controversial than the approach used by the scientists who are developing the genetically-modified fungus.

(3 marks)

(continued on the next page)

Turn over

3 continued.

(Total for Question 3 = 7 marks)

4 Bacteria are the host cells for λ (lambda) phage viruses.

**(a) Which is a description of a λ phage?
(1 mark)**

- ☐ **A DNA virus with a complex protein capsid**
- ☐ **B DNA virus with a helical protein capsid**
- ☐ **C RNA virus with a complex protein capsid**
- ☐ **D RNA virus with a helical protein capsid**

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4 continued.

(b) Look at the image for Question 4(b) in the Diagram Booklet. It shows phage viruses attacking a bacterium.

The length of this bacterium is $1.7\text{ }\mu\text{m}$.

Calculate the length of the labelled phage.

**Give your answer in nanometres (nm).
(2 marks)**

Answer _____ nm

(continued on the next page)

4 continued.

(c) Viruses can be cultured and a growth curve can be produced.

The steps below show how this can be done.

Step 1: Grow the host cells of the virus on agar

Step 2: Add the viruses to the host cells

Step 3: View the cells under a microscope and count the number of lysed (burst) cells

Step 4: Repeat counts at regular intervals

Look at the graph for Question 4(c) in the Diagram Booklet. It shows a growth curve for viruses.

**(i) Explain why there was a delay before the number of lysed cells started to increase.
(3 marks)**

4 continued.

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4 continued.

- (ii) Calculate the mean rate of increase in the actual number of lysed cells between 50 minutes and 80 minutes.
(2 marks)**

Answer _____ cells min⁻¹

- (iii) Look at the sketch for Question 4(c)(iii) in the Diagram Booklet. A sketch has been made of this growth curve.**

**Complete this sketch to predict the shape of the growth curve after 120 minutes, assuming there is an excess of host cells.
(2 marks)**

(Total for Question 4 = 10 marks)

- 5 The light-dependent stage and the light-independent stage of photosynthesis both take place in the chloroplast.**

The rate of photosynthesis is affected by a number of different factors, including carbon dioxide concentration and temperature.

(a) Look at the diagram for Question 5(a) in the Diagram Booklet. It shows a chloroplast.

- (i) Where does the light-dependent stage take place?
(1 mark)**

☐ **A Q**

☐ **B T**

☐ **C V**

☐ **D X**

(continued on the next page)

5 continued.

(ii) The light-dependent stage produces hydrogen ions.

**Where do these hydrogen ions accumulate?
(1 mark)**

☐ **A Q**

☐ **B R**

☐ **C S**

☐ **D W**

**(iii) Where does translation take place?
(1 mark)**

☐ **A Q**

☐ **B R**

☐ **C S**

☐ **D U**

(continued on the next page)

Turn over

5 continued.

- (b) Scientists measured the effect of two different concentrations of carbon dioxide on the rate of photosynthesis at different leaf temperatures, in one species of plant.**

Look at the graph for Question 5(b) in the Diagram Booklet. The results are shown in the graph.

- (i) Which units are suitable for measuring the rate of photosynthesis in leaves?
(1 mark)**

☐ **A $\mu\text{mol m}^{-1} \text{sec}^{-1}$**

☐ **B $\mu\text{mol m}^{-1} \text{sec}^{-2}$**

☐ **C $\mu\text{mol m}^{-2} \text{sec}^{-1}$**

☐ **D $\mu\text{mol m}^{-2} \text{sec}^{-2}$**

(continued on the next page)

5 continued.

- (ii) Analyse the data to identify THREE conclusions that can be made from this graph. (3 marks)**

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5 continued.

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5 continued.

(iii) Explain the effects of carbon dioxide concentration and temperature on the rate of formation of GALP.
(4 marks)

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5 continued.

(Total for Question 5 = 11 marks)

6 The lipid content of the cell membranes of prokaryotic organisms changes in response to changes in the environmental temperature.

(a) Phospholipids form a bilayer in the cell membranes of bacteria.

**Describe the structure of a phospholipid.
(2 marks)**

(continued on the next page)

6 continued.

- (b) The cell membranes of most organisms belonging to the domain Archaea are lipid monolayers.**

The lipid that forms this monolayer is a bipolar lipid.

**Explain why a bipolar lipid is a suitable molecule to form the cell membrane.
(2 marks)**

(continued on the next page)

Turn over

6 continued.

- (c) The percentage of branched-chain fatty acids in membranes of bacteria that have different optimum growth temperatures was investigated.**

Look at the graph for Question 6(c) in the Diagram Booklet. It shows the results of this investigation.

- (i) Calculate the mean percentage of branched-chain fatty acids in bacteria whose optimum growth temperature is $<20^{\circ}\text{C}$.
(1 mark)**

Answer _____ %

(continued on the next page)

6 continued.

- (ii) Analyse the data to describe TWO conclusions that can be drawn from this investigation.
(2 marks)**

(continued on the next page)

6 continued.

- (d) A change in temperature can affect the permeability and fluidity of the membrane.**

**Explain why it is important that the lipid composition of the membrane of prokaryotic organisms changes if the temperature changes.
(3 marks)**

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6 continued.

(Total for Question 6 = 10 marks)

7 Macrophages are involved in response to infection.

(a) Macrophages engulf bacteria by surrounding the bacteria with pseudopodia.

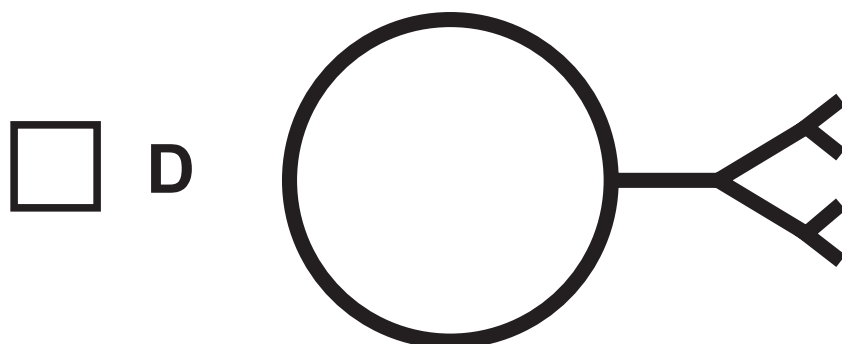
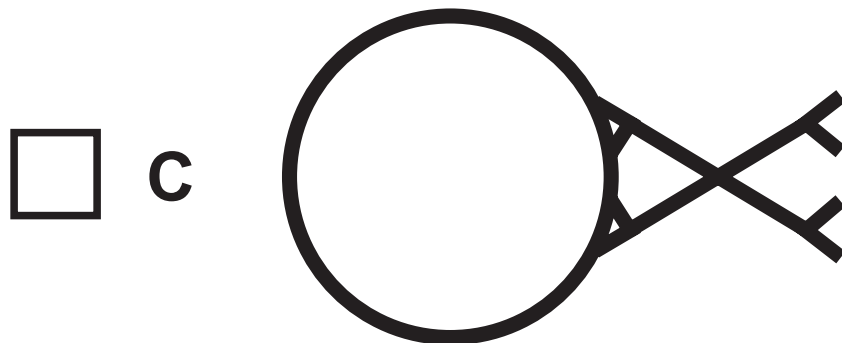
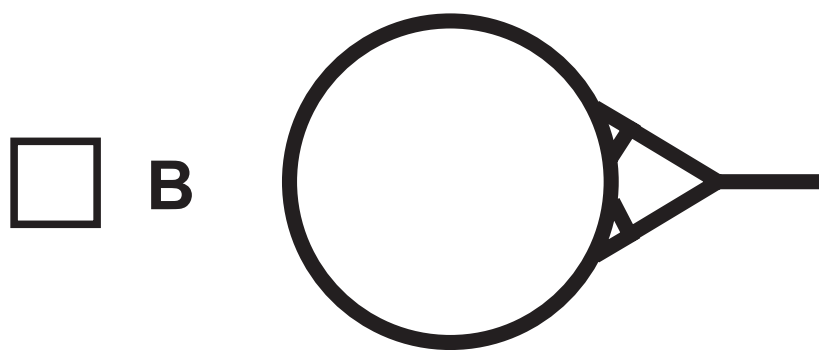
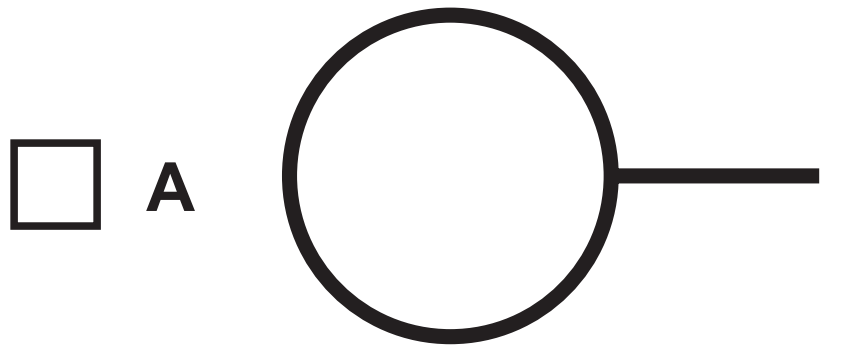
Look at the image for Question 7(a) in the Diagram Booklet. It shows a macrophage forming pseudopodia around some bacteria.

Look at the steps for Question 7(a) in the Diagram Booklet. They show one theory for the formation of pseudopodia.

(continued on the next page)

7 continued.

- (i) Which diagram shows one antibody binding to the surface of a macrophage (STEP 1)?
(1 mark)



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Turn over

7 continued.

(ii) Actin is a fibrous protein.

Which row of the table describes the breakdown of actin (STEP 2)?
(1 mark)

| | monomer formed | process by which bond is broken |
|----------------------------|-------------------|------------------------------------|
| <input type="checkbox"/> A | amino acid | condensation |
| <input type="checkbox"/> B | amino acid | hydrolysis |
| <input type="checkbox"/> C | nucleotide | condensation |
| <input type="checkbox"/> D | nucleotide | hydrolysis |

(continued on the next page)

7 continued.

- (iii) Explain why water flows into the part of the cell where the soluble components are located (STEP 3).
(2 marks)**

(continued on the next page)

7 continued.

- (iv) Describe the events that take place resulting in T helper cell activation, following the formation of pseudopodia by the macrophages (STEP 4).
(3 marks)**

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7 continued.

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7 continued.

***(b) Phagocytosis by macrophages is affected by a number of factors.**

Microorganisms with a fluorescent green dye attached to them were used to measure phagocytosis by macrophages.

The microorganisms were added to the macrophages and incubated. The macrophages were then washed and the extent to which they glowed green was determined.

The extent of the green glow is proportional to the number of microorganisms engulfed by the macrophages.

Look at the four graphs for Question 7(b) in the Diagram Booklet. They show the results of investigations into phagocytosis by macrophages.

**Analyse the data to discuss the factors that affect phagocytosis by macrophages.
(6 marks)**

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7 continued.

(Total for Question 7 = 13 marks)

8 Hypoxia is an inadequate supply of oxygen to tissues and cells that restricts their function.

(a) The normal partial pressures of oxygen vary from tissue to tissue.

Look at the table for Question 8(a) in the Diagram Booklet. It shows the normal partial pressure of oxygen in two tissues.

**(i) Calculate the ratio of the partial pressures of oxygen in these two tissues. Give your answer to one decimal place.
(1 mark)**

Answer _____

(continued on the next page)

8 continued.

- (ii) Explain why the partial pressures of oxygen in these two tissues are different.
(2 marks)**

(continued on the next page)

8 continued.

- (b) The body responds to hypoxia by releasing hypoxia-inducible transcription factors (HIF).**

Investigations have shown that one effect of HIF is an increase in the rate of glycolysis in the affected cells.

- (i) Explain how HIF could result in an increase in the rate of glycolysis.
(2 marks)**

8 continued.

(ii) Explain why cells need to respond to hypoxia with an increase in the rate of glycolysis. (4 marks)

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8 continued.

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8 continued.

(iii) Look at the graph for Question 8(b)(iii) in the Diagram Booklet. It shows the changes in levels of two HIFs, HIF-1 and HIF-2, before and during hypoxia.

**Compare and contrast the changes in the levels of HIF-1 and HIF-2 during hypoxia.
(2 marks)**

(continued on the next page)

Turn over

8 continued.

- (iv) Explain the changes in levels of HIF-1 and HIF-2 during hypoxia.
(2 marks)**

(Total for Question 8 = 13 marks)

9 Plants and animals are adapted for gas exchange.

- (a) (i) Which row of the table describes gas exchange in the root of a plant?
(1 mark)**

| | Net movement of carbon dioxide | Net movement of oxygen |
|-----------------------------------|---------------------------------------|-------------------------------|
| <input type="checkbox"/> A | in only | out only |
| <input type="checkbox"/> B | out only | in only |
| <input type="checkbox"/> C | in and out | in and out |
| <input type="checkbox"/> D | neither in nor out | neither in nor out |

- (ii) Which is the gas exchange surface in the stem of a woody plant?
(1 mark)**

- ☐ **A** lenticel
- ☐ **B** pit
- ☐ **C** plasmodesmata
- ☐ **D** stomata

(continued on the next page)

Turn over

9 continued.

- (b) Spiracles are small openings in the exoskeletons of insects that allow air to enter the respiratory system.**

Water can evaporate out of the spiracles when they are open. The insect can close the spiracles to reduce water loss.

In an investigation, the water loss from insects in air with different humidities was measured.

The insects were kept in air with 80% humidity and then moved into air with a lower humidity. Water loss was then measured.

The investigation was repeated in air high in carbon dioxide to keep the spiracles open.

Look at the table for Question 9(b) in the Diagram Booklet. It shows the results of this investigation.

(continued on the next page)

9 continued.

- (i) State how the water loss could have been measured in this investigation.
(1 mark)**

(continued on the next page)

9 continued.

- (ii) Calculate the percentage increase in water loss from the insects kept in air at 0% humidity compared with those kept at 80% humidity.**

**Give your answer to two decimal places.
(1 mark)**

Answer _____%

(continued on the next page)

9 continued.

- (iii) Explain why the insects were kept in air with 80% humidity at the start of this investigation. (2 marks)**

(continued on the next page)

9 continued.

**(iv) Explain the results of this investigation.
(3 marks)**

(continued on the next page)

Turn over

9 continued.

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9 continued.

(c) The gas exchange surfaces of fish are the gills.

Look at the diagram for Question 9(c) in the Diagram Booklet. It shows part of the structure of a gill.

Fish can be divided into two groups: species of fish that are active and species of fish that are inactive.

Look at the table for Question 9(c) in the Diagram Booklet. It shows some information about some species of fish and their gills.

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9 continued.

- (i) Lamellae are present on both sides of the gill filaments.**

The mean length of a gill filament is 25 mm.

Calculate the total number of lamellae on the gill filaments of *Thunnus*.

**Express your answer in standard form.
(1 mark)**

Answer _____

- *(ii) Analyse the data to explain the relationships between the activity of these fish and the structure of their gills.
(6 marks)**

9 continued.

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9 continued.

(Total for Question 9 = 16 marks)

TOTAL FOR PAPER = 90 MARKS
END OF PAPER