

Section 1 — Multiple Choice Answers

Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	6	B	11	A	16	A
2	B	7	A	12	C	17	C
3	B	8	B	13	B	18	B
4	A	9	A	14	C	19	A
5	C	10	B	15	C	20	C

Section 2 — Short Response

Question 21 — Sample response (4 marks)

Oxygen will diffuse from the systemic blood (89 kPa) into body cells (40 kPa), moving down its partial pressure (concentration) gradient.

Carbon dioxide will diffuse from body cells (46 kPa) into the systemic blood (44 kPa), moving down its partial pressure gradient.

Marking criteria:

- Identifies oxygen will diffuse from blood into body cells. [1 mark]
- Uses supporting data (89 kPa vs 40 kPa). [1 mark]
- Identifies carbon dioxide will diffuse from body cells into blood. [1 mark]
- Uses supporting data (46 kPa vs 44 kPa). [1 mark]
- OWTTE (or words to that effect).

Question 22 — Sample response (3 marks)

Mast cells and neutrophils act rapidly and non-specifically against any pathogen, without needing to recognise a specific antigen, and do not confer future immunological memory — this makes them part of the innate immune response.

B cells and T cells, in contrast, recognise specific antigens via unique receptors and produce a targeted response (e.g. antibody production, cytotoxic action), and generate memory cells that allow a faster response on re-exposure — this makes them part of the adaptive immune response.

Marking criteria:

- Describes innate response of mast cells/neutrophils as rapid and non-specific, with no memory. [1 mark]
- Describes adaptive response of B cells as antigen-specific (e.g. antibody production). [1 mark]
- Describes adaptive response of T cells as antigen-specific and/or notes immunological memory. [1 mark]

Question 23 — Sample response (4 marks)

(i) $6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$

(ii) See completed table below.

Marking criteria:

- Correct balanced word or chemical equation for photosynthesis. [1 mark]
- Correctly identifies location of light-dependent reactions as the thylakoid membrane. [1 mark]
- Correctly identifies inputs of the Calvin cycle: CO_2 , ATP, NADPH (all three correct). [1 mark]
- Correctly identifies remaining outputs/inputs consistent with the cycle (accept chemical formula or words). [1 mark]

Stage	Location	Inputs	Outputs
Light-dependent reactions	Thylakoid membrane	Light energy, water, NADP^+ , $\text{ADP} + \text{P}_i$	Oxygen, ATP, NADPH
Calvin cycle	Stroma	CO_2 , ATP, NADPH	G3P/glucose, $\text{ADP} + \text{P}_i$, NADP^+

Question 24 — Sample response (3 marks)

The optimum pH for this enzyme is approximately pH 4.5, as this is where the relative rate of reaction is highest (100).

As pH moves further away from 4.5 in either direction, the rate decreases because the hydrogen ion concentration disrupts the ionic and hydrogen bonds maintaining the enzyme's tertiary structure. This alters the shape of the active site, reducing substrate binding, and at extreme pH values causes denaturation so the enzyme can no longer function.

Marking criteria:

- Identifies pH 4.5 as the optimum, using the data. [1 mark]
- Explains that further from optimum pH, bonds maintaining enzyme (tertiary) structure are disrupted / active site shape changes. [1 mark]
- Links this to reduced substrate binding and/or denaturation at extreme pH. [1 mark]

Question 25 — Sample response (4 marks)

1. Adherence factors These allow a pathogen to attach to a specific tissue type, which is necessary for it to survive and begin an infection. They are often called adhesins. An example is pili (small hair-like structures), which bind to receptors on the surface of epithelial cells, anchoring the pathogen in place so it isn't washed away or dislodged.

2. Invasion factors These allow bacteria to enter host cells and tissues, helping the pathogen colonise the body. They are often enzymes that break down the extracellular matrix (the structural material between cells), allowing the pathogen to spread through tissue that would otherwise act as a barrier.

3. Capsules These are large, well-organised polysaccharide (sugar-based) gel layers that surround the pathogen. They inhibit phagocytosis by immune cells like neutrophils and macrophages, essentially acting as a physical shield that protects the bacteria from being engulfed and destroyed.

4. Toxins These manipulate host cell functions and disrupt normal biological processes. They come in two main types:

- Endotoxins — lipid-based molecules (part of the bacterial cell wall) that cause fever, changes in blood pressure, inflammation, and in severe cases, lethal shock.
- Exotoxins — protein-based molecules secreted by the bacteria, which can include cytotoxins, neurotoxins, and enterotoxins. They diffuse rapidly into tissue and inhibit normal metabolic function.

Marking criteria (4 marks total):

- Identifies two correct virulence factors: adherence factors / invasion factors / capsules / toxins. [1 mark each, total 2 marks]
- Explains how each identified virulence factor affects pathogenesis. [1 mark each, total 2 marks]
- Accept any reasonable explanation.

Question 26 — Sample response (2 marks)

When the body is dehydrated, ADH is released and increases the permeability of the collecting duct (and distal tubule) to water.

This increases water reabsorption back into the blood, producing more concentrated urine and helping to restore blood osmolality/water balance.

Marking criteria:

- Describes ADH increasing permeability of the collecting duct/distal tubule to water. [1 mark]

- Links this to increased water reabsorption, reducing blood osmolality / producing concentrated urine. Accept converse. [1 mark]