

8.2 Bacteria: structure, growth and pathogenesis

Name: _____ Class: _____ Date: _____

Total: 24 marks

KEY WORDS peptidoglycan • lipopolysaccharide • capsule

Objective

Use wall structure and growth arithmetic to predict the disease.

1 Key knowledge and worked examples

■ Two walls

Gram-positive: many peptidoglycan layers + teichoic acids. Gram-negative: thin peptidoglycan + outer membrane with LPS (endotoxin) and porins ✓. Capsule defeats phagocytosis; exotoxins are secreted proteins with named targets.

■ Worked example: the growth clock

$N = N_0 \cdot 2^{t/g}$: a 20-minute doubler makes $2^{30} \approx 10^9$ cells in 10 h; a 20-hour doubler makes half a generation ✓.

2 Practice

2.1 Classify LPS: exotoxin or endotoxin – and why? [3]

2.2 Starting from 5 cells, how many after 3 h at 20-minute doubling? [3]

2.3 What does the clear halo around pneumococci on a stain represent, and what does it DO? [3]

3 Exam-style questions

3.1 A fictional wound swab grows an organism with generation time 25 minutes from a starting inoculum of 40 cells.

Calculate the cell count after 2.5 h (6 generations; $40 \times 2^6 = 2560$). Explain why the patient's symptoms appeared within a day while a second patient infected with an organism of generation time 20 h has a weeks-long illness. [8]

3.2 Two fictional isolates (teaching set): toxin A blocks host protein synthesis; toxin B lyses red cells on a plate.

For each toxin, predict the clinical picture (distant organ failure with little local destruction vs local haemolysis and tissue destruction) and justify from the mechanism. [7]

Solutions

2.1

- Endotoxin – a wall component released at lysis, not a secreted protein ✓.

2.2

- 3 h = 9 doublings: $5 \times 2^9 = 5 \times 512 = 2560$ cells ✓.

2.3

- The capsule (unstained) – it defeats phagocytosis/opsonisation ✓.

3.1

- 2.5 h = 150 min = 6 generations of 25 min.
- $40 \times 2^6 = 40 \times 64 = 2560$ cells ✓.
- Fast doubling reaches large numbers in hours → acute 24-hour disease and cultures positive at 24–48 h.
- 20-hour generation time gives ~half a generation in 10 h → weeks-long illness and weeks-long cultures ✓.

3.2

- Toxin A: blocking protein synthesis kills quietly – distant organ failure with minimal local necrosis ✓.
- Toxin B: membrane lysis destroys locally – haemolysis on the plate mirrors tissue destruction at the wound.
- Mechanism predicts the picture: where the damage happens follows what the toxin chemically attacks ✓.