

4.7 Pathogens, infection routes and TB/HIV

Name: _____ Class: _____ Date: _____

Total: 20 marks

KEY WORDS capsid • plasmid • lysozyme • vector

Objective

Practise statements 6.5-6.7: the structures of bacteria and viruses, the major routes pathogens take into the body, the barriers that meet them, and how tuberculosis and HIV attack.

1 Key knowledge and worked examples

■ Two designs of parasite

Bacterium: cell wall, plasma membrane, single circular DNA, plasmids, 70S ribosomes, sometimes capsule and flagellum – a living cell. Virus: nucleic acid (DNA or RNA) in a protein **capsid**, sometimes a lipid envelope with glycoproteins – no organelles, no independent metabolism.

■ Routes and barriers

Routes: respiratory (inhaled droplets), digestive (contaminated food/water), sexual contact, through wounds, via vectors (insects). Barriers: intact skin; mucus trapping pathogens with cilia sweeping them; stomach acid; lysozyme in tears and saliva; blood clotting sealing breaks. Fever and inflammation follow if they fail.

■ The pair the exam returns to

Mycobacterium tuberculosis is inhaled in droplets, taken up by macrophages, and survives inside them – the immune system walls them off (tubercles), but they persist and reactivate when immunity drops. **HIV** infects T helper cells via the CD4 receptor, replicates, and gradually destroys them; untreated infection can severely weaken immune coordination and progress to AIDS. This increases the risk of active TB, including reactivation of a latent infection; reactivation is not inevitable.

■ **Worked example: why HIV makes TB worse**

T helper cells activate macrophages and drive antibody production; loss of their function weakens the immune response that helps contain TB bacteria. TB infection can remain latent; HIV-associated immune damage increases the risk of progression to active disease.

2 Practice

2.1 Give two structures a bacterial cell has that a virus does not. [2]

2.2 Name two barriers to infection in the respiratory tract. [2]

2.3 State which cell type HIV destroys and one consequence. [2]

3 Exam-style questions

3.1 Compare the structure of a bacterium and a virus under the headings: genetic material, external covering, and organelles. [5]

3.2 Cholera bacteria enter through contaminated water. Name the route, describe two barriers that such bacteria must survive before reaching the gut, and explain how the acidic stomach usually destroys them. [4]

3.3 Explain why a patient with advanced HIV infection may develop several opportunistic infections at once, naming the immune cell affected and two of its normal roles. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Any two: cell wall, plasma membrane, ribosomes, plasmids, flagellum.

2.2 Mucus (traps); cilia (sweep the mucus upward).

2.3 T helper cells; immune coordination collapses – poor antibody response and poor macrophage activation, so infections take hold.

3.1 Genetic material: bacterium – DNA free in the cytoplasm as a single circular molecule plus plasmids; virus – DNA or RNA inside the capsid. Covering: bacterium – cell wall with (sometimes) a capsule; virus – protein capsid, some with a lipid envelope. Organelles: bacteria have ribosomes (70S); viruses have no organelles at all.

3.2 The digestive (ingestion) route. Barriers: mucus and cilia of the airway if droplet-borne (not here) – for water: saliva's lysozyme and the stomach. Stomach acid at about pH 2 denatures bacterial enzymes and membrane proteins, killing most cells before they reach the intestine.

3.3 HIV destroys T helper cells. T helpers normally activate B cells to make antibodies and release cytokines that activate macrophages and T killer cells. Without them, responses to new antigens are slow or absent, so normally harmless organisms – Pneumocystis, candida, reactivating TB – all establish at once.