3.2 Defences, vaccination and drugs

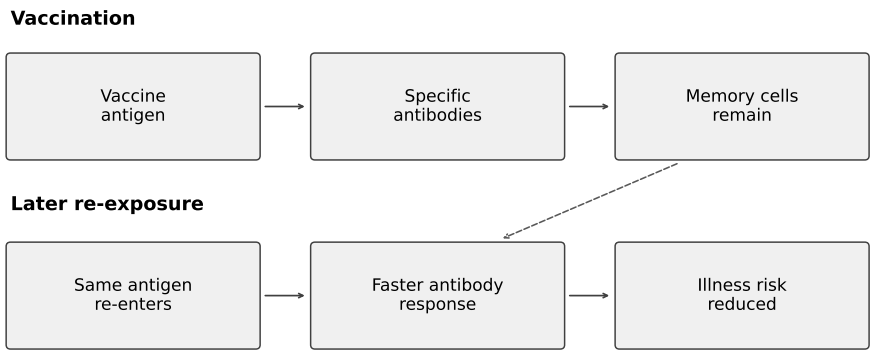
Name: _____ Class: _____ Date: _____ **Total: 21 marks**

KEY WORDS phagocytosis • antibody production • antitoxin production • Vaccination • Antibiotics

Objective

Describe the defence systems, white blood cell actions, vaccination and drug development, and distinguish antibiotics from painkillers. Original questions for spec statements 4.3.1.6–4.3.1.9.

1 Key knowledge and worked examples



Teacher sequence model, not measured response data.

Non-specific defences: skin forms a physical barrier; scabs seal wounds. Nose hairs/mucus trap inhaled pathogens. Airway mucus traps pathogens; cilia move it towards the throat to be swallowed. Stomach hydrochloric acid kills many swallowed pathogens.

White blood cells defend by **phagocytosis** (engulf/digest), **antibody production** (antibodies complementary to a specific antigen), and **antitoxin production** (neutralising toxins). An antigen is the target recognised by an antibody; antitoxins are not antibiotics.

Worked vaccination (sheet Q3.1 [4]): small amounts of dead/inactive pathogen supply antigens → white cells make specific antibodies → memory cells remain → later exposure produces correct antibodies quickly, reducing illness risk. This is the syllabus vaccine model, not a claim that every vaccine has the same manufacture or guarantees zero infection.

Population protection (original 2025 Q01.5 [2]; sheet Q3.2 [3]): fewer susceptible/infected hosts → fewer opportunities to pass on the pathogen → unvaccinated people are less likely to encounter it. "Herd immunity" alone does not supply the mechanism. Vaccination reduces infection and transmission risk; protection is not absolute.

Original 2025 Figure 1: percentages refer to the entire surveyed sample, not to the vaccinated or unvaccinated group alone.

Severity	Vaccinated	Unvaccinated
Mild	15%	37%
Severe	3%	45%

Worked number (Q01.6 [3]): 240 surveyed children; severe/unvaccinated bar = 45%.

$$N = \frac{p}{100} \times N_{\text{total}}$$

$$N = \frac{45}{100} \times 240 \text{ children}$$

$$N = 108 \text{ children}$$

Evidence (Q01.7 [2]): severe cases represent 3% vaccinated versus 45% unvaccinated in the whole sample. This supports reduced severity; vaccinated infected children are still present. Do not silently change the denominator or label these raw percentages as vaccine efficacy.

Animal-to-human chain (2023 Q03.2 [4]): specific antibodies in vaccinated animals → rapid response to later Salmonella infection → fewer bacteria in animal products → fewer bacteria ingested by humans, reducing infection/toxin production. The original level-two requirement links the animal immune response to human food poisoning.

Antibiotics kill susceptible infective bacteria; they do not kill viruses. The cold is viral, so antibiotics do not cure it (sheet Q1.3 [2]). **Painkillers** relieve symptoms without killing pathogens. Viruses reproduce in host cells, making antiviral development difficult; this does not mean antiviral treatment is impossible.

Sources: digitalis–foxglove (heart); aspirin–willow (painkiller; 2025 Q01.3); penicillin–Penicillium mould (Fleming). Modern synthesis can start from plant chemicals.

Testing questions (2023 Q01.7 [2]): toxicity (harm/side effects), efficacy (does it work?), dose (how much?). Choose distinct reasons.

Worked testing sequence (sheet Q3.3 [5]): preclinical cells/tissues/live animals investigate toxicity and potential efficacy → healthy volunteers start at very low dose for safety → patients test efficacy/optimum dose → appropriate controlled double-blind comparison → peer review scrutinises methods/results. Original 2024 Q08.6 [1] identifies testing live tissues in a laboratory as preclinical; volunteers/patients are clinical.

Placebo and blinding: placebo lacks the active drug and helps account for expectation effects. In a double-blind comparison neither participants nor outcome assessors know allocation, reducing bias. Comparator choice depends on the trial; not every trial uses placebo. Peer review is scrutiny, not a guarantee of success. Original 2023 Q01.8 [1]: company financial gain or competitor loss can motivate bias; Q01.9 [1]: peer review scrutinises claims.

2 Practice

2.1 List the four non-specific defence systems with their mechanisms. [4]

2.2 Name the three ways white blood cells defend the body. [3]

2.3 Explain why antibiotics do not cure the common cold. [2]

3 Exam-style questions

3.1 Explain how vaccination prevents illness in an individual. [4]

3.2 Explain why vaccinating a large proportion of the population protects those not vaccinated. [3]

3.3 Describe how a new drug is tested before it can be used. [5]

Solutions

2.1 Skin – physical barrier and scab formation; nose – hairs and mucus trap pathogens; trachea/bronchi – mucus traps and cilia waft it away; stomach – hydrochloric acid kills swallowed pathogens.

2.2 Phagocytosis, antibody production, antitoxin production.

2.3 The cold is caused by a virus; antibiotics target bacteria, not viral pathogens.

3.1 Small quantities of dead or inactive pathogen are introduced; white blood cells are stimulated to produce antibodies specific to its antigens; memory cells remain; if the live pathogen re-enters, correct antibodies are produced rapidly, reducing illness risk.

3.2 Fewer people are susceptible to or develop infection after vaccination; fewer infectious hosts mean fewer transmission opportunities; unvaccinated people are less likely to encounter the pathogen. Protection reduces risk; it is not an absolute guarantee.

3.3 Preclinical testing on cells, tissues and live animals checks toxicity and potential effectiveness; clinical trials then give the drug to healthy volunteers at a low dose to check safety; then to patients to find the optimum dose and test effectiveness; an appropriate controlled double-blind comparison reduces expectation and assessment bias; the results are peer-reviewed before publication and use.