These notes explain the **why** behind every concept, not just the what. They include **analogies**, **real-life examples**, and explanations of **common mistakes**. Use these alongside your revision notes for full understanding.

Topic 5 Health and Disease — Why We Get Ill and How We Fight Back

Disease is not simply bad luck — pathogens have evolved sophisticated mechanisms to infect and exploit host organisms. Understanding these mechanisms helps us design effective treatments and preventions.

HIV — How a Virus Destroys the Immune System

HIV (Human Immunodeficiency Virus) is particularly dangerous because it attacks the very cells needed to fight infection — CD4+ T helper lymphocytes. As HIV destroys these cells, the immune system gradually fails. When the CD4+ cell count falls below a critical level, the patient develops AIDS (Acquired Immunodeficiency Syndrome) and becomes vulnerable to "opportunistic infections" — pathogens that a healthy immune system would normally control easily.

■ **Why does this happen?** Why is HIV so difficult to cure? HIV is a retrovirus — it converts its RNA genome into DNA and inserts it permanently into the host cell's chromosomes. It becomes part of the cell's own DNA. Any latently infected cell becomes a reservoir, and current drugs cannot find or destroy it. This is why people with HIV must take antiretroviral drugs for life.

Antibiotic Resistance — An Evolutionary Arms Race

Bacteria reproduce in 20 minutes under ideal conditions — 72 generations per day. With billions of bacteria reproducing this fast, mutations arise constantly. A mutation that helps a bacterium survive antibiotic exposure will be strongly selected for. The more antibiotics are used, the stronger the selection pressure, and the faster resistance spreads.

■ **Real-life example:** In 1940, penicillin cured virtually all Staphylococcus aureus infections. By 1945, some strains were already resistant. Today, MRSA is resistant to nearly all standard antibiotics. The WHO has warned that without action, we could reach a post-antibiotic era where routine operations become life-threatening again.

Monoclonal Antibodies — Precision Medicine

Because monoclonal antibodies bind to a single specific antigen, they can be designed to target molecules found on cancer cells but not normal cells. A cancer drug attached to a monoclonal antibody (an "immunoconjugate" or "magic bullet") will therefore deliver its toxic payload only to cancer cells, reducing side effects dramatically compared to conventional chemotherapy.

Communicable disease	Disease caused by a pathogen that can spread between hosts
Non-communicable disease	Disease that cannot be transmitted between people — e.g. heart disease, cancer
Immune system	The body's defence system — includes physical barriers, phagocytes and lymphocytes

Monoclonal antibody	Identical antibody molecules produced from a single lymphocyte clone — highly specific
Antibiotic resistance	Ability of bacteria to survive antibiotic treatment — evolved through natural selection
Clinical trial	Systematic testing of a new treatment on human volunteers — ensures safety and effectiveness