*This is the **Higher Combined** version — includes Higher Tier content. Some Separate-only details are omitted.*

Vaccination protects individuals and communities from infectious disease by training the immune system without causing the disease itself.

- A vaccine contains dead, weakened, or harmless fragments (antigens) of a pathogen — or a piece of genetic code that causes cells to produce a pathogen protein.
- The immune system responds by producing antibodies and memory cells — without the person becoming ill.
- If the real pathogen is encountered later, memory cells enable a rapid, large antibody response — the infection is destroyed before symptoms develop.
- Herd immunity: when a large enough proportion of a population is vaccinated, the pathogen cannot spread easily — even unvaccinated individuals are protected.

★ **HT** For herd immunity, the required vaccination rate depends on the pathogen's infectivity. For measles (highly infectious): ~95% vaccination needed.

★ **HT** Vaccines must be regularly updated for viruses that mutate rapidly (e.g. influenza vaccines change each year).

- Concerns about vaccines: side effects, religious/philosophical objections, misinformation — all reduce uptake and can break herd immunity.

Key Terms

Vaccine	A preparation containing harmless antigens that trains the immune system without causing disease
Herd immunity	Protection of unvaccinated individuals because enough of the population is immune to prevent pathogen spread
Memory cell	B lymphocyte retained after initial immune response — enables faster antibody production on re-exposure

■ **Exam Tip:** Vaccines do NOT contain the live, active pathogen — they contain a HARMLESS VERSION. A common error is stating vaccines contain the disease. Also, vaccines create MEMORY CELLS, not just antibodies — memory cells are what give long-term protection.