

This is the **Higher Separate** version — includes all Higher Tier content (marked ★) and all Separate Science content.

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

<b>Vaccine</b>	A preparation containing harmless antigens that trains the immune system without causing disease
<b>Herd immunity</b>	Protection of unvaccinated individuals because enough of the population is immune to prevent pathogen spread
<b>Memory cell</b>	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.