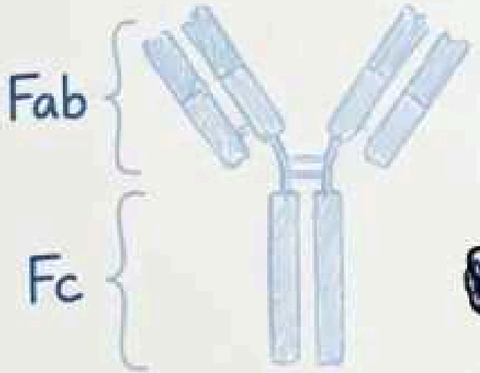
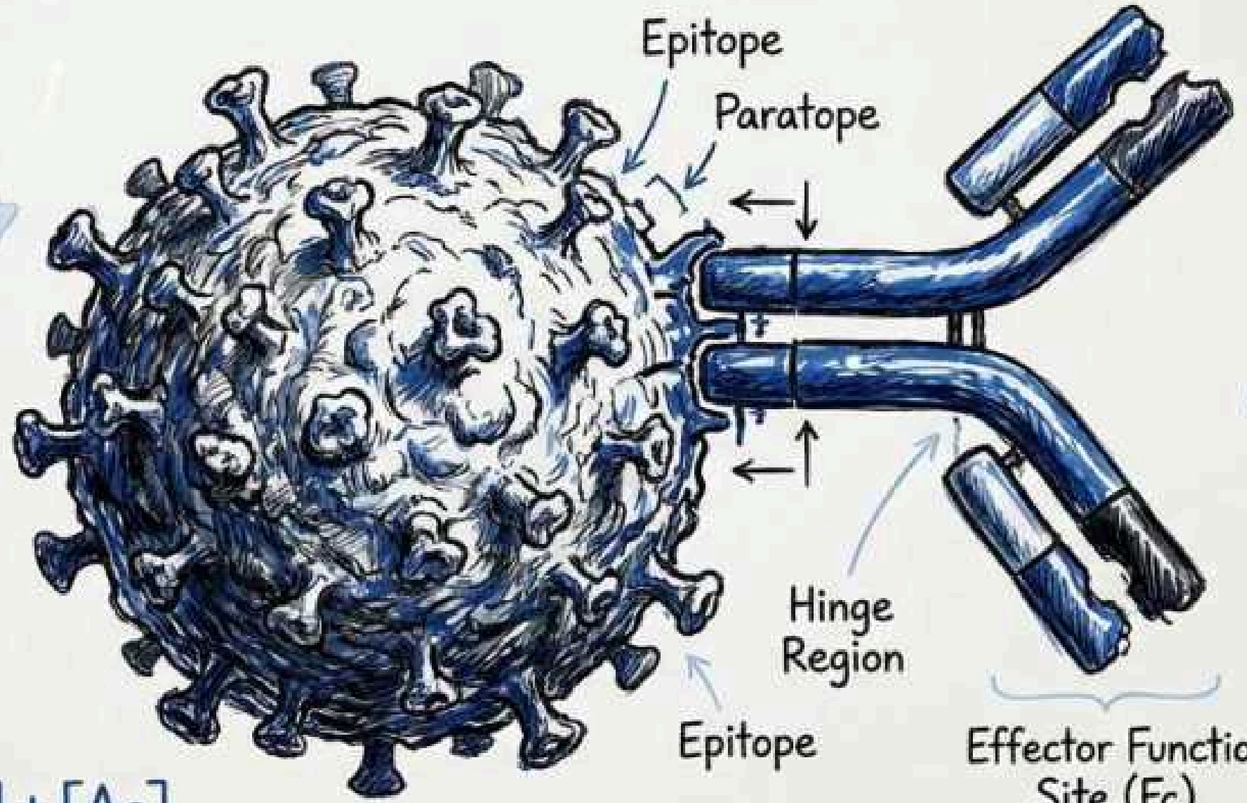
MED 504 B Lecture 5: Immunological Memory and Vaccines

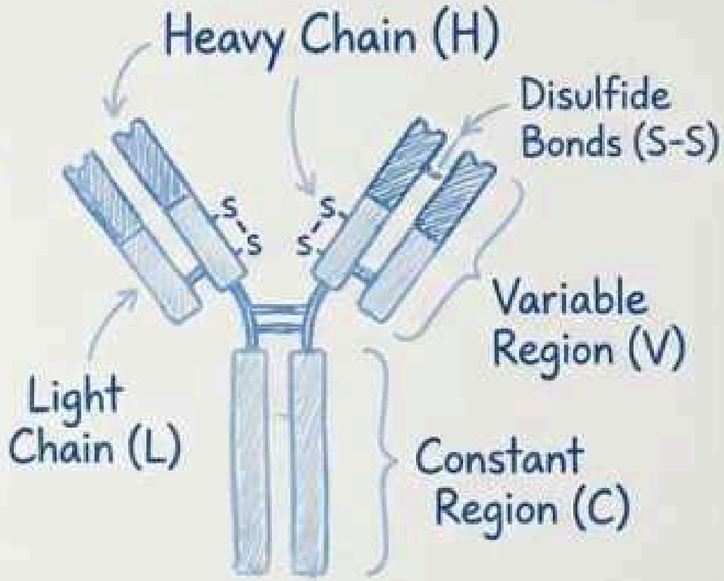
Instructor: Gary Anderson

MW ≈ 150 kDa

IgG structure







$$K_d = \frac{[Ab][Ag]}{[Ab\text{-}Ag]}$$

$$[Ab\text{-}Ag] \rightleftharpoons [Ab] + [Ag]$$

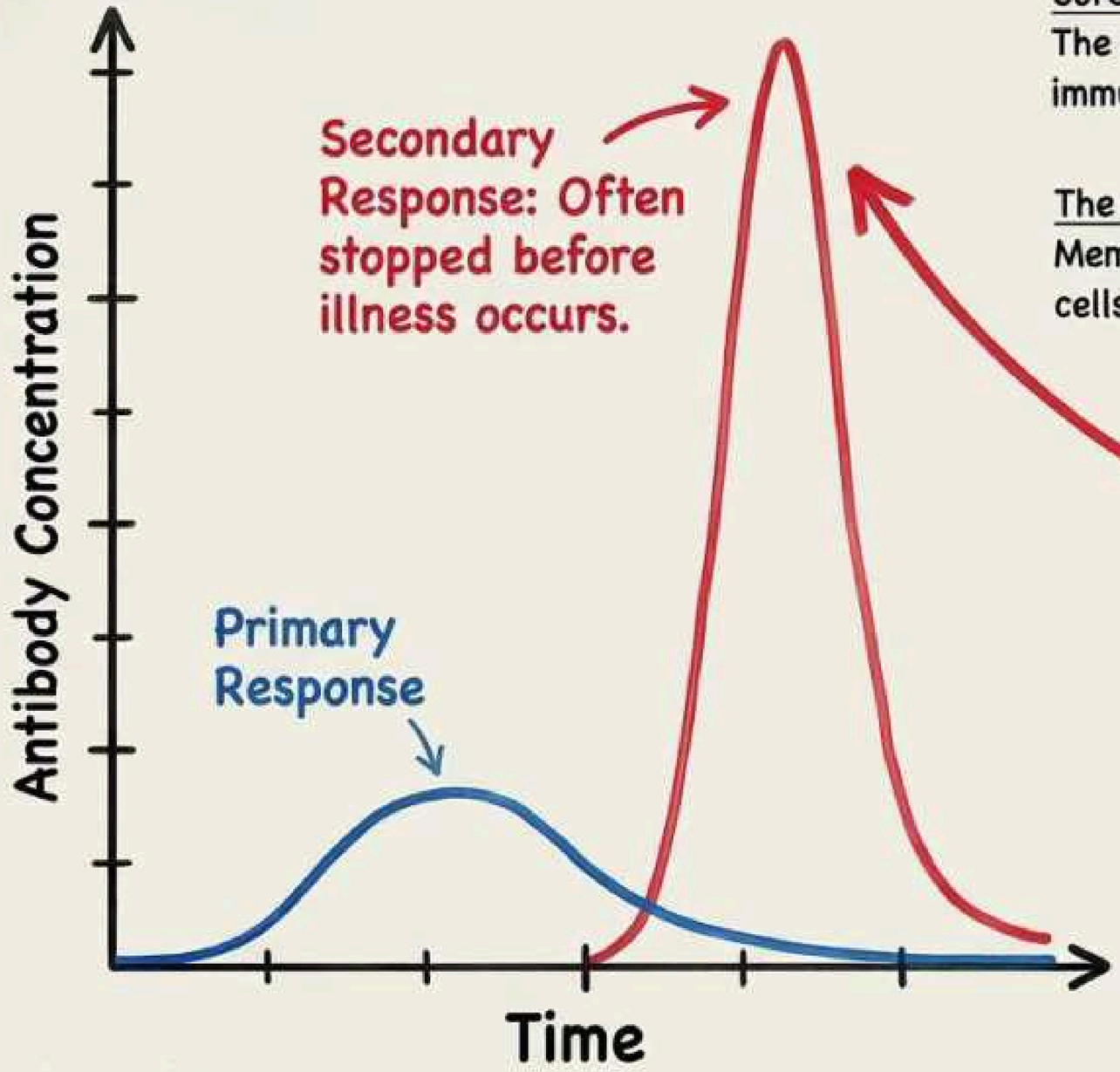
$$K_a = \frac{k_{on}}{k_{off}} \ (M^{-1})$$

Affinity vs. Avidity concepts

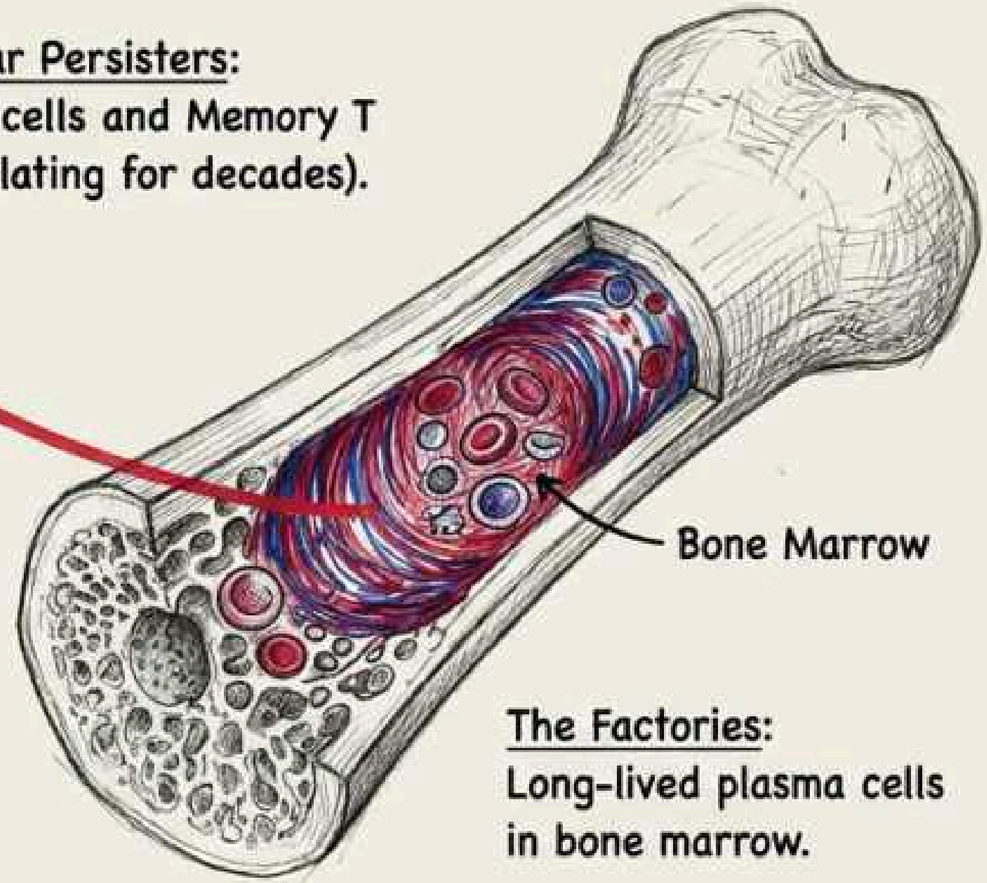
Anderson Academy · Questions: garyanderson@mail.grokbot.com · X: @garyanderson

¶ 5.1

Core Principle:
The defining power of adaptive immunity is memory.



The Cellular Persisters:
Memory B cells and Memory T cells (circulating for decades).



The Factories:
Long-lived plasma cells in bone marrow.

Outcome: Childhood infections are typically caught only once.

¶5.2

Natural Infection



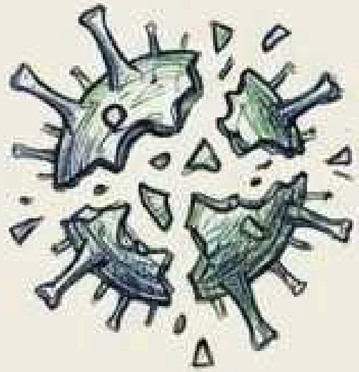


Illness/Survival Required



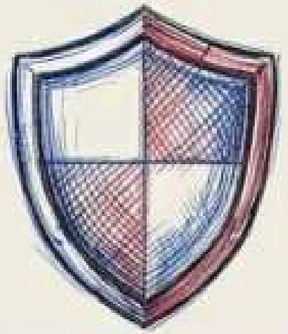
Immunological Memory

The Rehearsal (Vaccination)





No Disease Pathogenesis



Immunological Memory

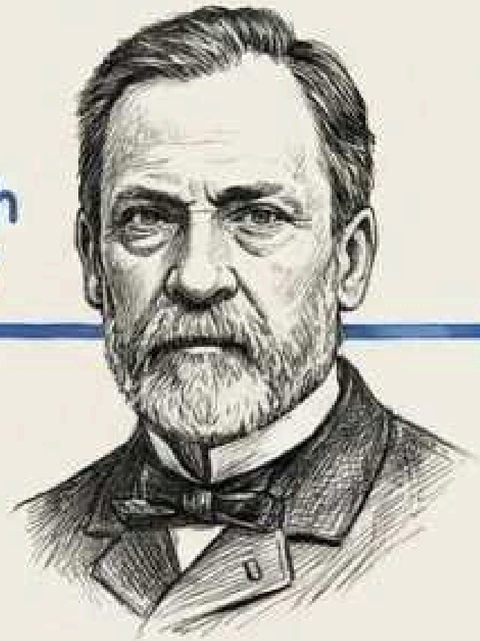
- Vaccines deliberately exploit memory.
- The immune system is exposed to a microbe's antigen in a non-disease-causing form.
- When the real microbe arrives, the body responds as if they have already met.

¶5.3



Vacca = Latin for cow
(origin of the term "vaccine").





Pre-1796

Variolation:
Deliberate exposure to smallpox sores for milder infection.

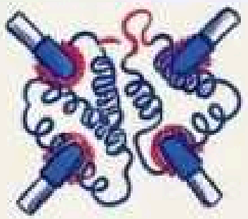
1796

Edward Jenner:
Used milder cowpox to protect against smallpox.

Late 19th Century

Louis Pasteur: Developed vaccines for chicken cholera and rabies, expanding the term to all such preparations.

¶5.4

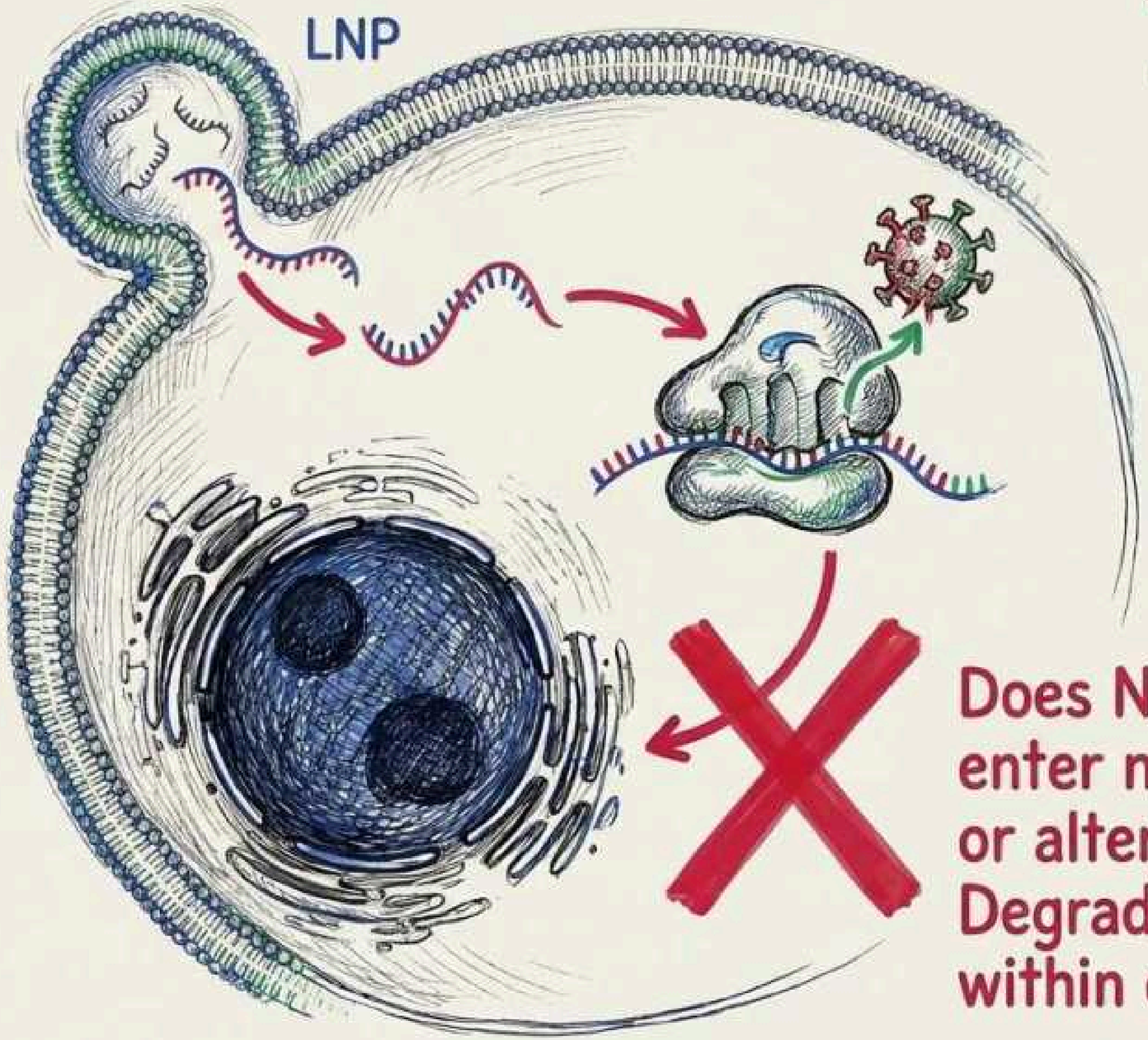
Vaccine Type	Mechanism / Contents	Clinical Examples
Live Attenuated	Weakened microbe; multiplies slightly, no disease. 	Measles, Mumps, Rubella (MMR)
Inactivated	Killed microbes. 	Various
Subunit	Selected microbe pieces (e.g., single protein). 	Hepatitis B
Toxoid	Inactivated form of the disease-causing toxin. 	Tetanus, Diphtheria

¶5.5

Newer vaccines deliver instructions, not antigens.

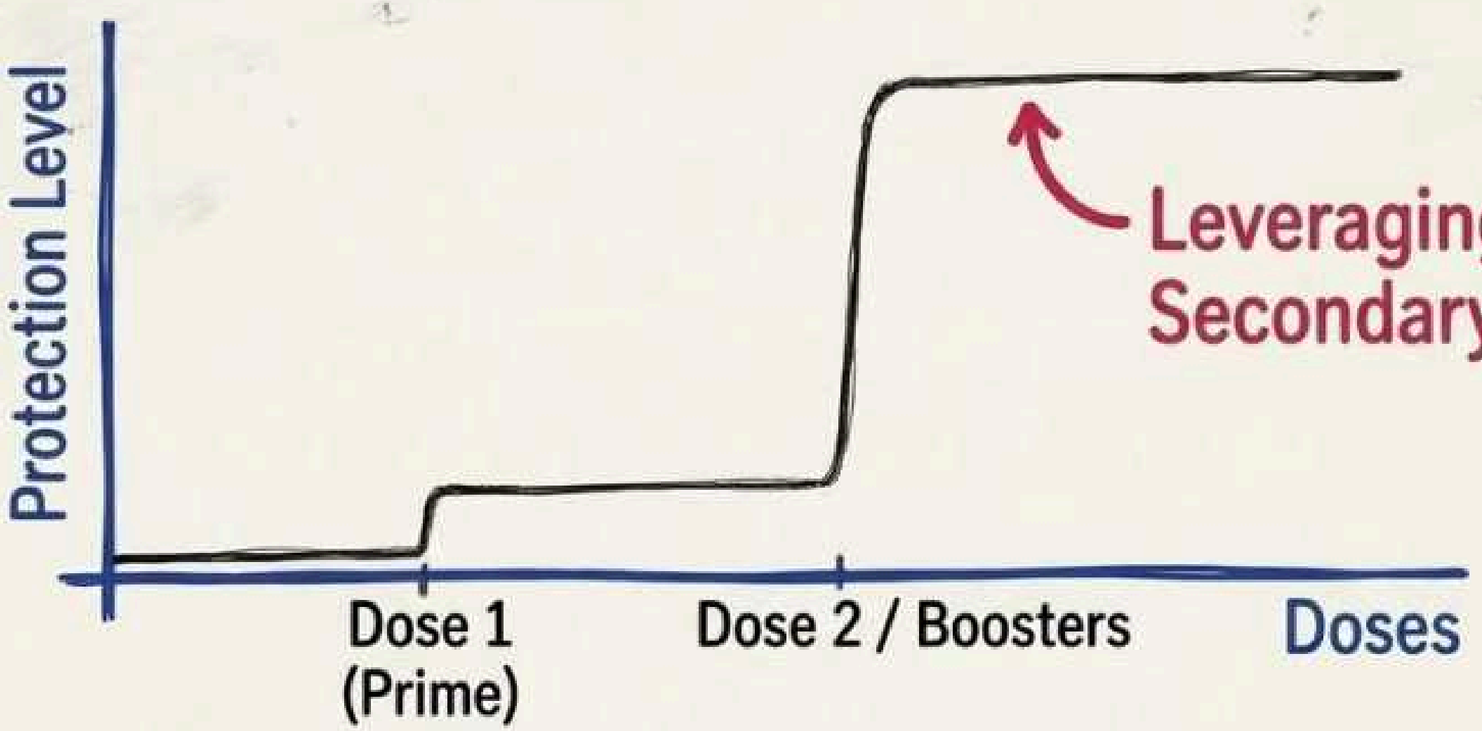
Viral Vectors:
Use a harmless virus for instruction delivery.

Clinical Application:
Both widely deployed against COVID-19 (late 2020).



Does NOT enter nucleus or alter DNA. Degrades within days.

¶5.6



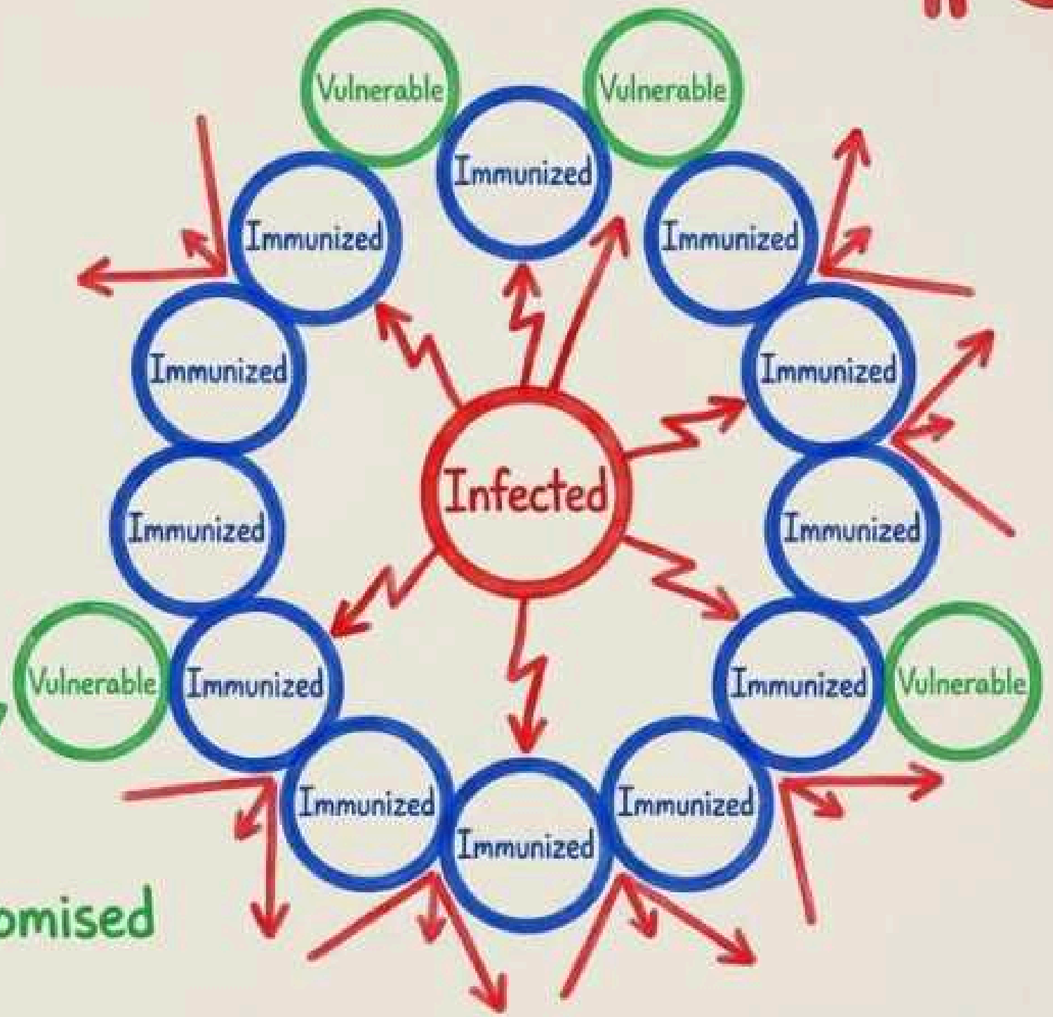
Antigen + Adjuvant → Adaptive Co-stimulation

- Adjuvants: Substances that stimulate the innate immune system.
- They provide the crucial "danger signal" necessary to fully activate the adaptive response.

¶ 5.7

$$V_c = 1 - \left(\frac{1}{R_0}\right)$$

Because measles is highly contagious (huge R_0), the critical vaccination threshold is ~95%.



Vulnerable: Newborns, Immunocompromised

- Herd / Community Immunity: Microbes are starved of new hosts.
- Protects those who cannot be vaccinated themselves.

¶ 5.8

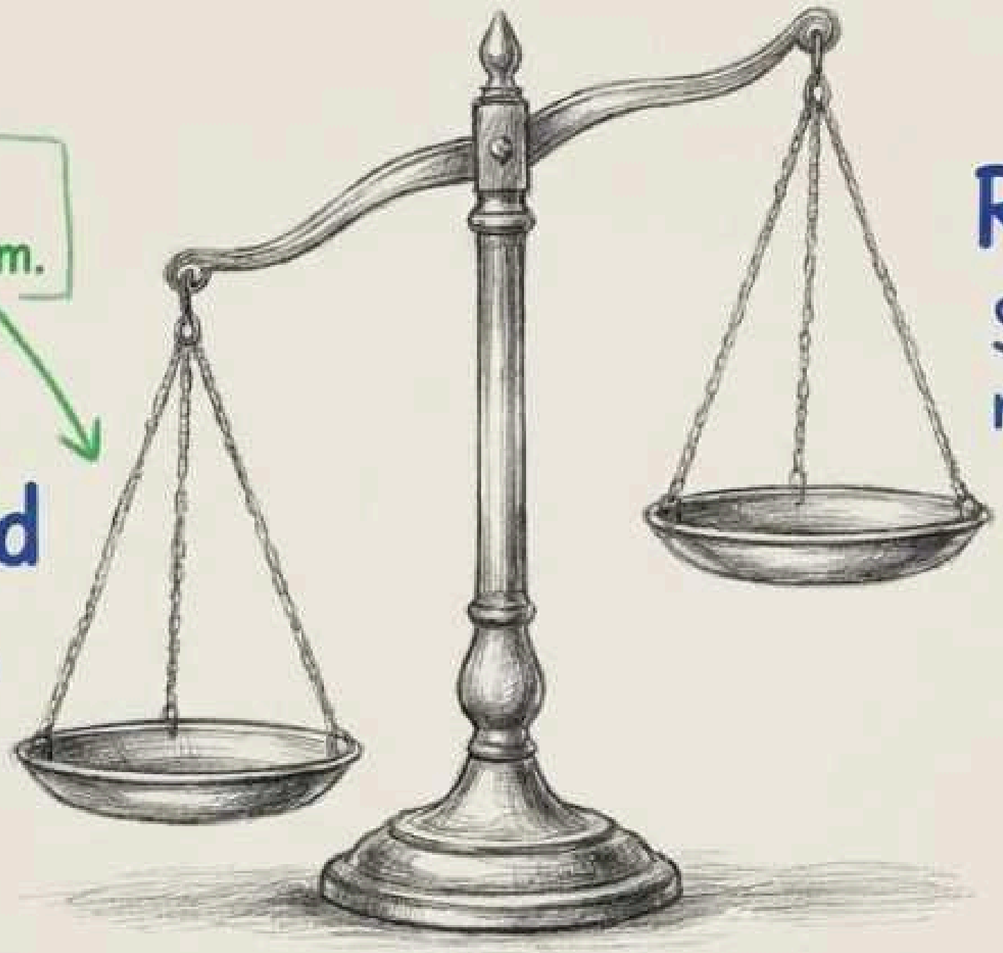


Eradication & Elimination

1. Smallpox: Eradicated in 1980 by the WHO. Halted a disease that killed hundreds of millions in the 20th century.
2. Polio: Eliminated from most of the world.
3. Childhood Killers: Diphtheria, tetanus, and measles rendered rare wherever widespread vaccination exists.

¶ 5.9

Expected signs of a working immune system.



Common & Mild

Sore arm, tiredness, slight fever.

Rare & Severe

Severe allergic reactions (anaphylaxis).

Monitored meticulously by national safety systems.

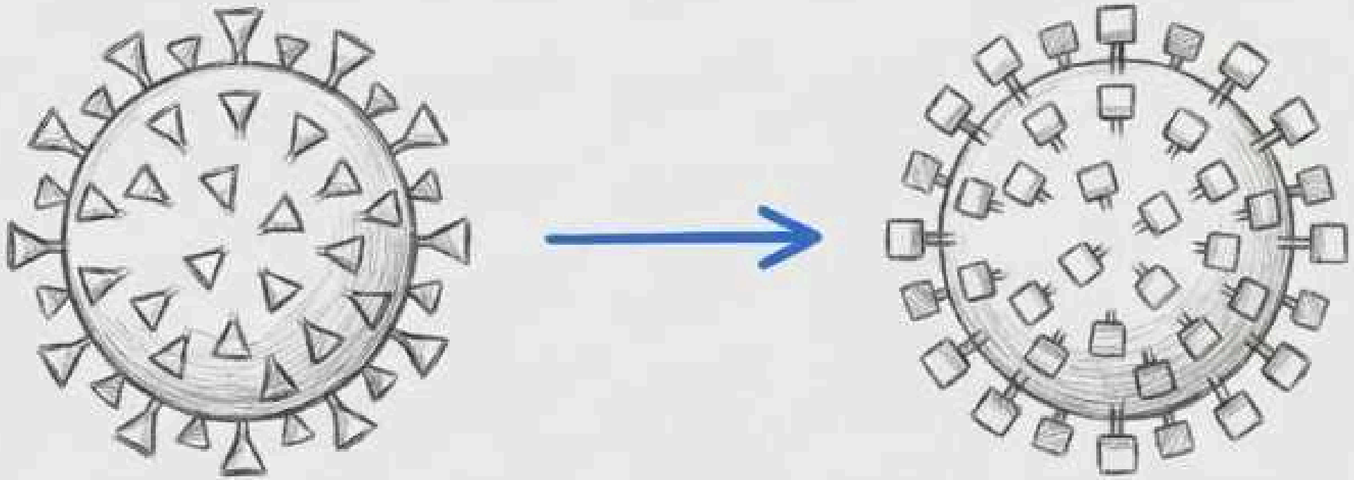
Brief post-vaccination observation periods are standard to catch rare allergic reactions.

Decisions should be made between patient and doctor, guided by national recommendations.

Not every infection produces lasting memory; therefore, not every vaccine is equally durable.

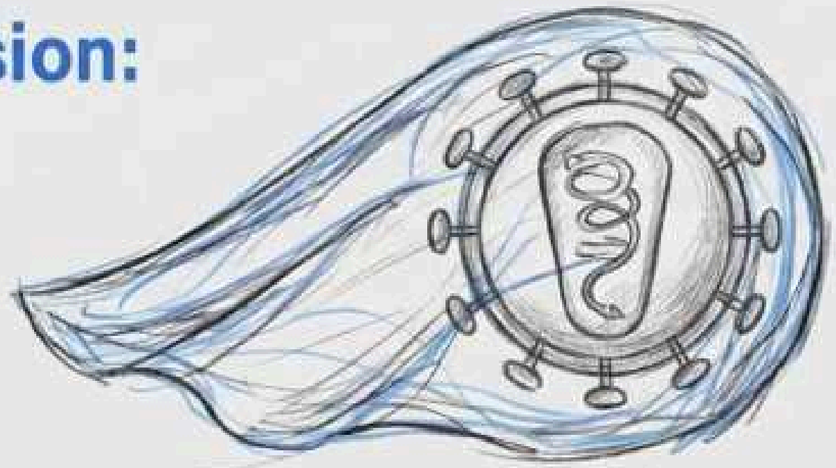
¶ 5.10

Antigenic Variation:



Influenza: Surface proteins change year by year, requiring updated vaccines.

Immune Evasion:



HIV: Hides from the immune system and mutates rapidly. No fully effective vaccine exists despite decades of effort.

¶ 5.11

Slide 2
(Memory Kinetics)

Slide 8
(Transmission
Blockade)

The Lecture Question:

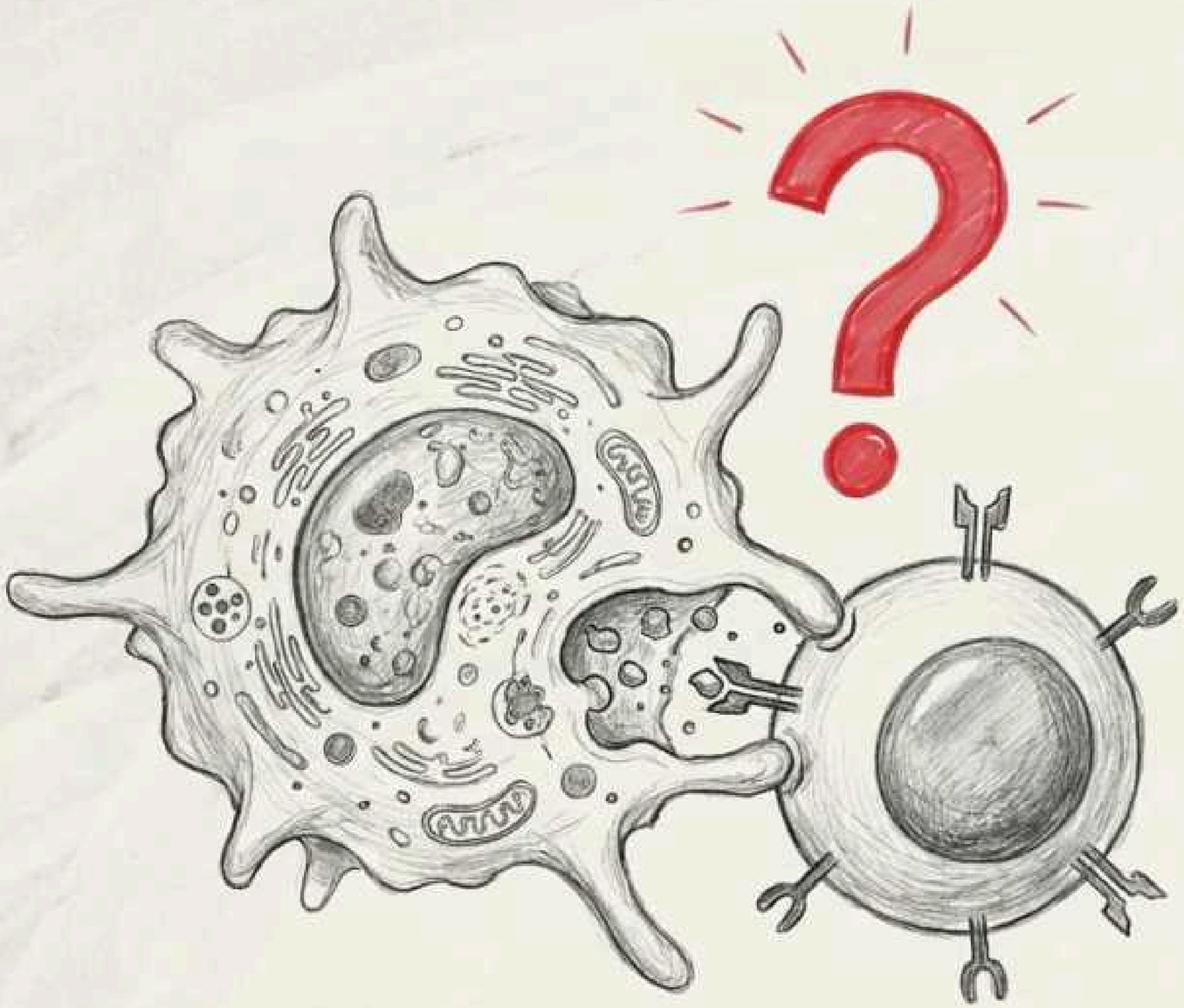
Explain why a vaccinated person won't fall ill to measles, and how unvaccinated babies are protected.

Part 1 (Individual Level):

Memory B & T cells + Long-lived plasma cells mount a secondary response so fast the measles virus is neutralized before pathogenesis.

Part 2 (Population Level):

Because 95% of the community is vaccinated, transmission vectors are blocked, shielding vulnerable unvaccinated babies via Herd Immunity.



Next Topic: Lecture 6 - When the System Fails.

A look at what happens when the immune system goes wrong (autoimmunity, hypersensitivity) and how modern medicine harnesses these mechanisms.

End of Lecture 5.