



Tikrit University
College of Veterinary Medicine

Lecture: Introduction to Immunology

Subject name: Immunology
(Theoretical)

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Lecturers link

Lecture 1
Introduction to Immunology
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What is Immunology?

Immunology is the study of the immune system — a complex network of **cells, tissues, organs, and molecules** that defends the body against pathogens such as bacteria, viruses, fungi, and parasites. The immune system also eliminates abnormal cells like cancer cells and helps maintain overall body homeostasis. Understanding immunology is crucial in fields like medicine, microbiology, biotechnology, and pharmacology. It provides the foundation for **vaccine development, autoimmune disease therapy, allergy management, and cancer immunotherapy**.

1. Types of Immunity

Innate Immunity (Non-specific)

- Present from birth.
- Provides **immediate, generalized defense** against invaders.
- Includes barriers like skin and mucous membranes, phagocytic cells (macrophages, neutrophils), and chemical defenses (stomach acid, lysozymes).
- Does **not** improve with repeated exposure — no memory.

Adaptive Immunity (Specific)

- Develops over time after exposure to specific pathogens.
- Involves **B cells** (antibody production) and **T cells** (cell-mediated immunity).
- Has **memory**, allowing faster, stronger responses upon re-exposure.
- Basis of vaccination.

Thinking Question:

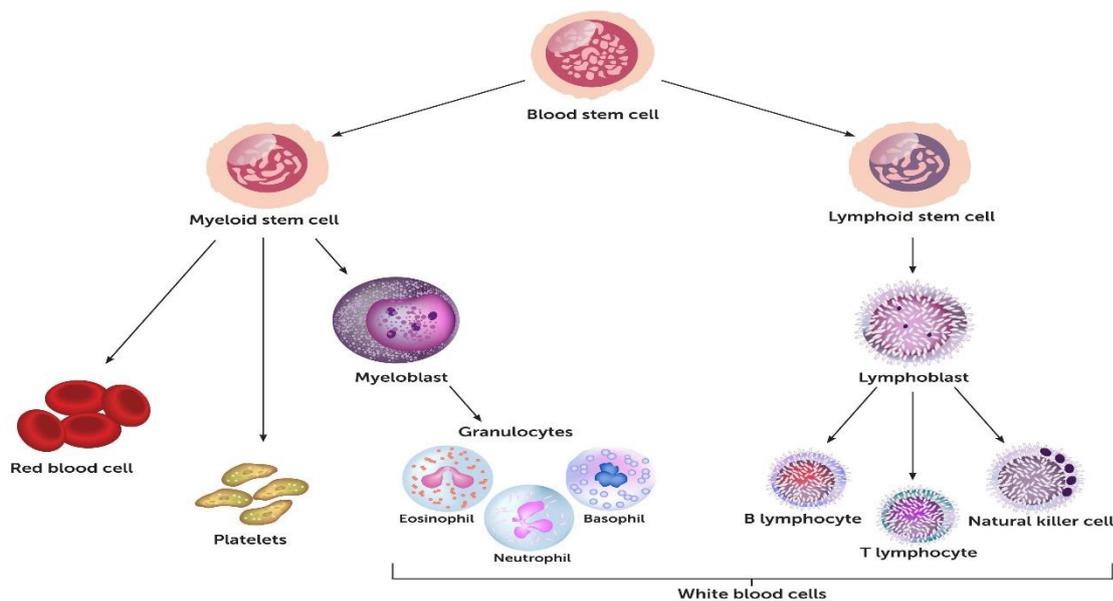
If innate immunity responds faster, why does the body still need adaptive immunity?

2. Components of the Immune System

A. Cells

- **Lymphocytes**
 - **B Cells:** Produce antibodies targeting specific antigens.
 - **T Cells:**
 - *Helper T cells (CD4+):* Coordinate immune responses.
 - *Cytotoxic T cells (CD8+):* Kill infected or cancerous cells.

- **Phagocytes**
 - *Macrophages*: Engulf and digest pathogens.
 - *Neutrophils*: Fast responders at infection sites.
 - *Dendritic Cells*: Present antigens to T cells (bridge between innate and adaptive systems).
- **Other Cells**
 - *Mast Cells & Basophils*: Release histamine; involved in allergies.
 - *Eosinophils*: Target parasites.
 - *NK (Natural Killer) Cells*: Destroy virus-infected and tumor cells.
 - *Innate Lymphoid Cells (ILCs)*: Regulate inflammation and tissue repair.



B. Organs and Tissues

- **Primary Lymphoid Organs:**
 - *Bone Marrow*: Produces all blood and immune cells.
 - *Thymus*: Maturation site for T cells.
- **Secondary Lymphoid Organs:**
 - *Lymph Nodes*: Filter lymph and activate lymphocytes.
 - *Spleen*: Filters blood and combats systemic infections.
 - *MALT (Mucosa-Associated Lymphoid Tissue)*: Includes tonsils, Peyer's patches; defends mucosal surfaces.

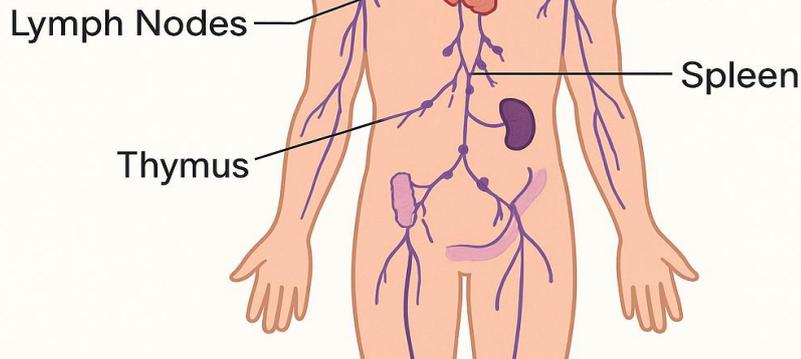
Organs and Tissues

A. Primary lymphoid organs:

- Bone Marrow
- Thymus

B. Secondary lymphoid organs:

- Lymph Nodes
- Spleen
- Mucosal-associated lymphoid tissue



C. Molecules

- **Antibodies (Immunoglobulins):** Recognize and neutralize antigens.
- **Cytokines:** Chemical messengers that regulate immunity and inflammation.
- **Complement Proteins:** Enhance antibody and phagocyte action.

D. Physical and Chemical Barriers

- **Skin:** Physical blockade.
- **Mucous Membranes:** Trap microbes.
- **Secretions:** Tears, saliva, and gastric acid contain antimicrobial compounds.

Thinking Question:

Why does damage to the skin or mucous membranes increase infection risk?

3. Innate vs. Adaptive Immunity — How They Work Together

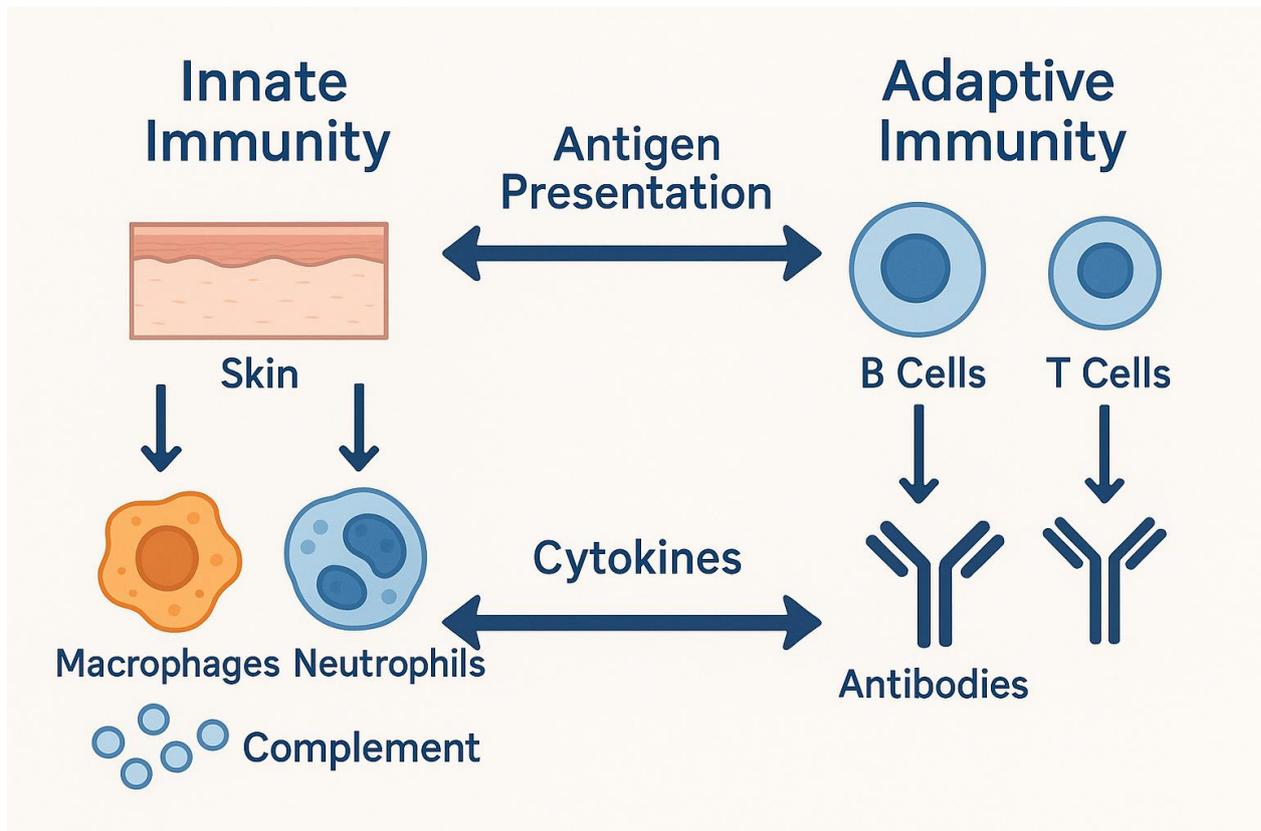
Innate System: First responder — recognizes broad pathogen patterns.

Adaptive System: Arrives later but targets the invader precisely.

When innate immune cells detect a pathogen, they **signal and activate** adaptive cells. Dendritic cells act as a bridge, carrying information (antigens) to T and B cells to shape a targeted response.

Defects in either system can cause disease:

- Weak innate response → recurrent infections.
- Overactive adaptive response → allergies or autoimmunity.



Thinking Question:

If the innate system acts first, why does it sometimes fail to prevent infection?

4. Immune Response Steps

1. **Recognition:** Immune cells detect antigens using surface receptors.
2. **Activation:** Immune cells multiply and differentiate.
3. **Response:** Pathogens are neutralized or destroyed.
4. **Memory Formation:** Adaptive system “remembers” the pathogen for faster future responses.

Thinking Question:

How might a vaccine mimic natural infection to train this memory?

A vaccine works like a biological rehearsal for your immune system. Instead of fighting a real infection that could cause harm, your body is safely exposed to something that resembles the pathogen — often a weakened, inactivated, or fragmentary version of it. This “practice run” lets your adaptive immune system learn to recognize the invader’s antigens (the unique molecular signatures on its surface).

5. Autoimmunity and Allergies

- **Autoimmunity:** Immune system attacks the body's own tissues (e.g., Type 1 Diabetes, Lupus).
- **Allergies:** Hypersensitivity to harmless substances like pollen or food proteins.

Thinking Question:

How does a normal immune system distinguish between self and non-self — and what happens when this fails?

6. Clinical Importance

- Understanding immune mechanisms enables:
 - Vaccine design (COVID-19, influenza).
 - Cancer immunotherapy (checkpoint inhibitors, CAR-T cells).
 - Autoimmune disease management (immunosuppressants).
 - Allergy treatments (desensitization therapy).

Checkpoint Inhibitors

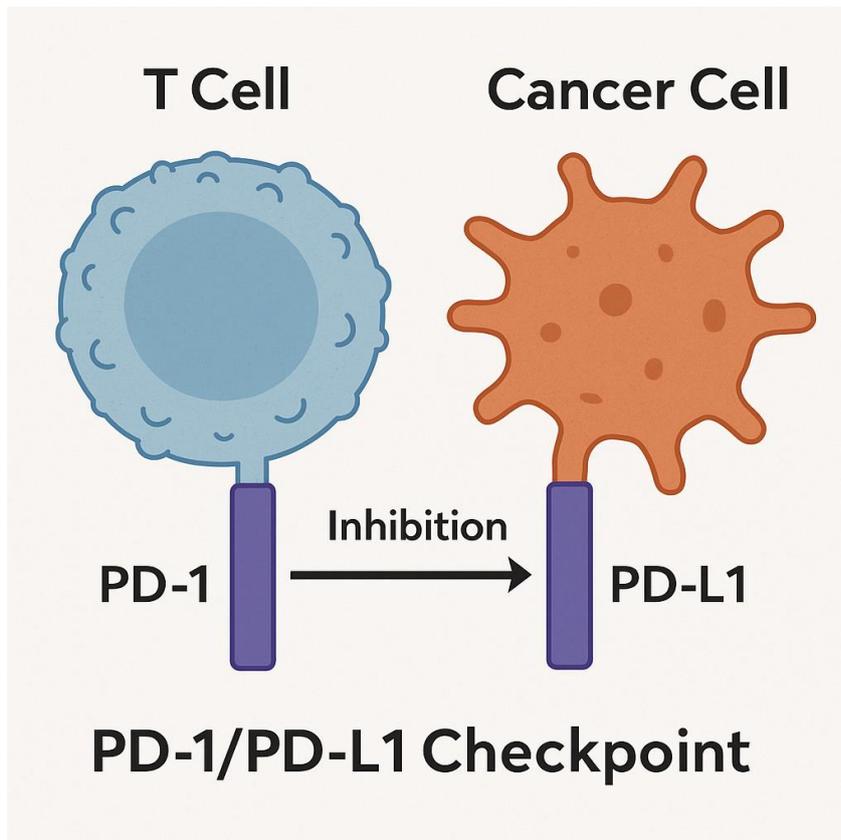
Your immune system has built-in “brakes” called **immune checkpoints** — molecules on T cells that prevent them from attacking healthy tissue. Tumors often exploit these brakes to hide from immune attack.

Checkpoint inhibitors are drugs that block these brakes, effectively taking the foot off the pedal so the T cells can attack the cancer.

Common checkpoint targets:

- **PD-1 / PD-L1:** These proteins dampen T-cell activity. Blocking them (with drugs like *nivolumab* or *pembrolizumab*) reactivates the immune response against tumors.
- **CTLA-4:** Another inhibitory receptor on T cells; blocking it (with *ipilimumab*) can boost the immune system's ability to fight melanoma and other cancers.

Think of it like cutting the rope that holds back a guard dog — suddenly the immune system lunges at the intruder.



CAR-T Cell Therapy (Chimeric Antigen Receptor T Cells)

This is an advanced form of personalized immunotherapy. Scientists **genetically engineer a patient's own T cells** to express special receptors (CARs) that specifically recognize proteins on cancer cells.

Once infused back into the patient, these “supercharged” T cells hunt and destroy the cancer with incredible precision.

For example:

- **CD19 CAR-T therapy** is used to treat certain leukemias and lymphomas.
- These cells act like custom-programmed assassins — trained to find one target and eliminate it.

Desensitization Therapy (Allergen Immunotherapy)

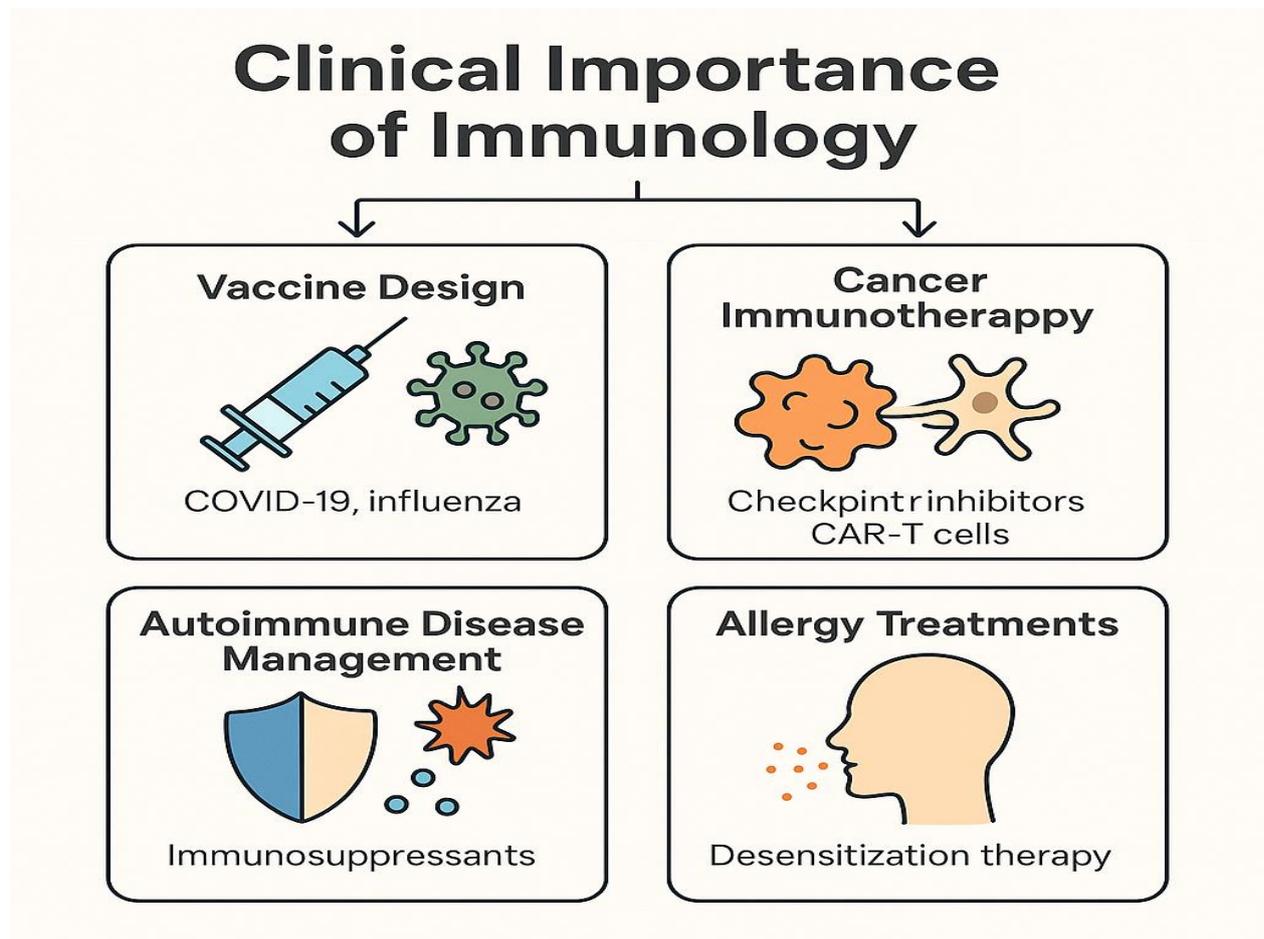
Allergies occur when the immune system overreacts to harmless substances (like pollen or peanuts).

Desensitization therapy aims to “teach” the immune system tolerance through **gradual exposure** to the allergen.

How it works:

- The allergen is introduced in **tiny, increasing doses** (either through shots or sublingual drops).
- Over time, the immune system shifts from a strong **IgE-mediated allergic response** to a calmer, **tolerant state**, involving more regulatory T cells and IgG antibodies.

It's like retraining a jumpy guard dog to recognize that the mail carrier isn't a threat.



7. Summary

The immune system:

- Is a **multi-layered defense system** combining innate and adaptive elements.
- Functions through a coordinated network of **cells, organs, and molecules**.
- Learns, remembers, and adapts — keeping you alive in a world filled with microbial threats.

Discussion Questions:

1. How does the concept of “immune memory” challenge the idea that immunity is purely passive defense?
2. What ethical issues might arise from manipulating the immune system through biotechnology?
3. How might immunology guide personalized medicine in the future?