Lesson 22 – Basic immunology: The third line of defense

Immunity as a Security System

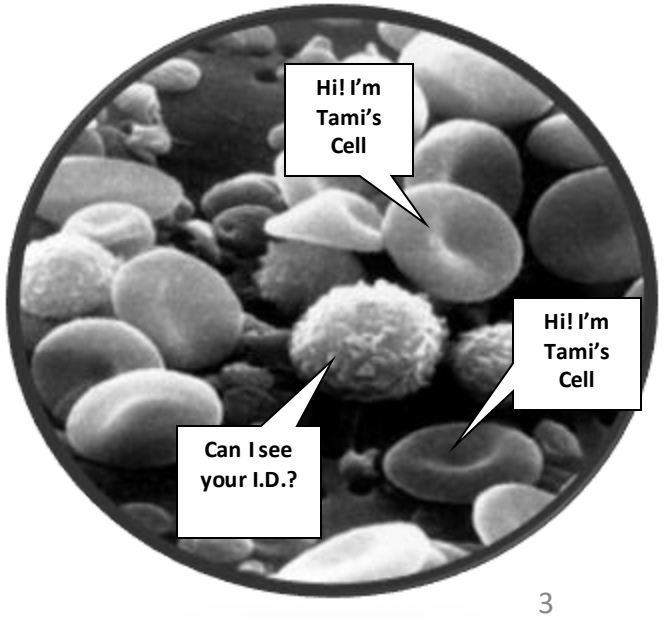
- If the first line of defense (skin & mucous membranes) is like a firewall blocking entry
- And the second line of defense (innate immunity) is like antivirus software scanning for generic threats
- Then the third line of defense, known as **acquired immunity**, works like a self-learning AI-driven security system that remembers past threats, responds more efficiently over time and creates customized solutions for each new attack
- Two types of specific immunity
  - **Naturally acquired** = immune response against **antigens** encountered in daily life
  - **Artificially acquired** = response to antigens introduced via vaccines

Antigens:
The Hackers Trying to Breach the System

- Your body does not react to an entire virus or bacterium, but to specific **antigenic markers** found on them
  - Think of antigens as **unique fingerprints or malware signatures** that your immune system recognizes as **unauthorized access attempts**
- These markers are like **security badges** - only "approved" cells have the right ID
- Foreign antigens can come from bacteria, viruses, fungi, or even non-living particles like pollen or dust
- Antigens enter the body in various ways, such as **breaks in the skin, injections (like a needle), or organ transplants**

Antigens Are Like Name Tags

Antigenic particles are often associated with a specific characteristic of an organism, so are detected as foreign when they get inside another organism that doesn't have that characteristic

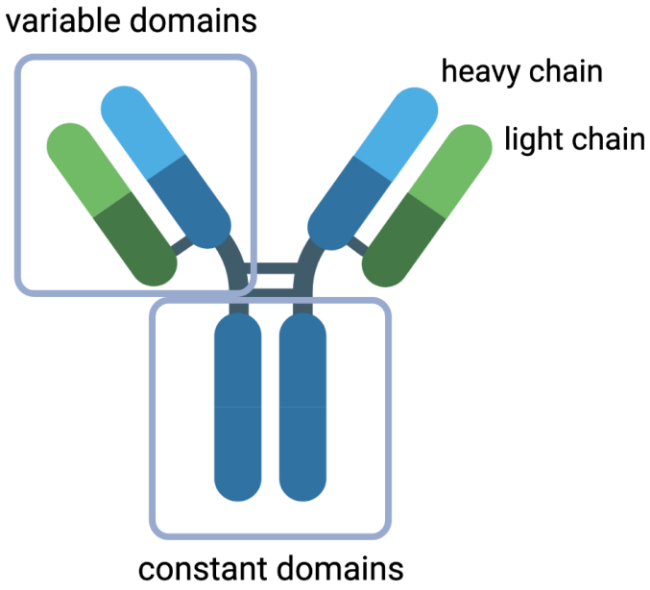


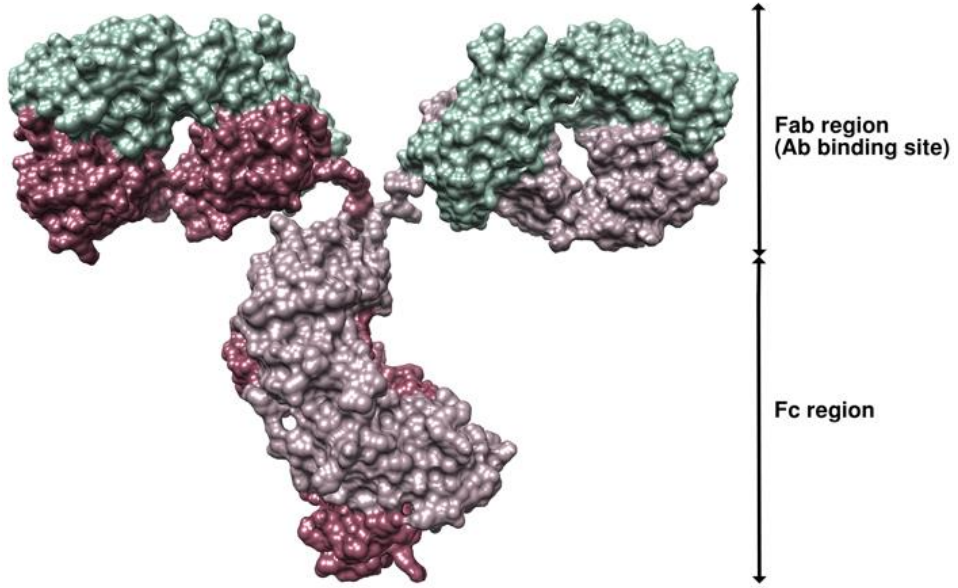
Antibodies: The Custom-Built Security Patches

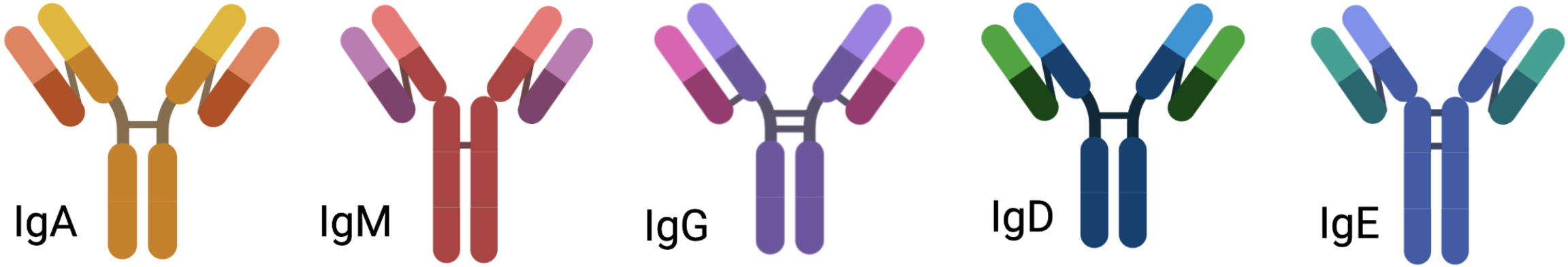
- Antibodies are **customized defense tools** your body produces to **neutralize** specific threats
- Think of antibodies as "**custom-built security patches**" that are designed to **detect and neutralize** a specific type of antigen (hacker)

Antibodies

- Also called immunoglobulins (Igs)



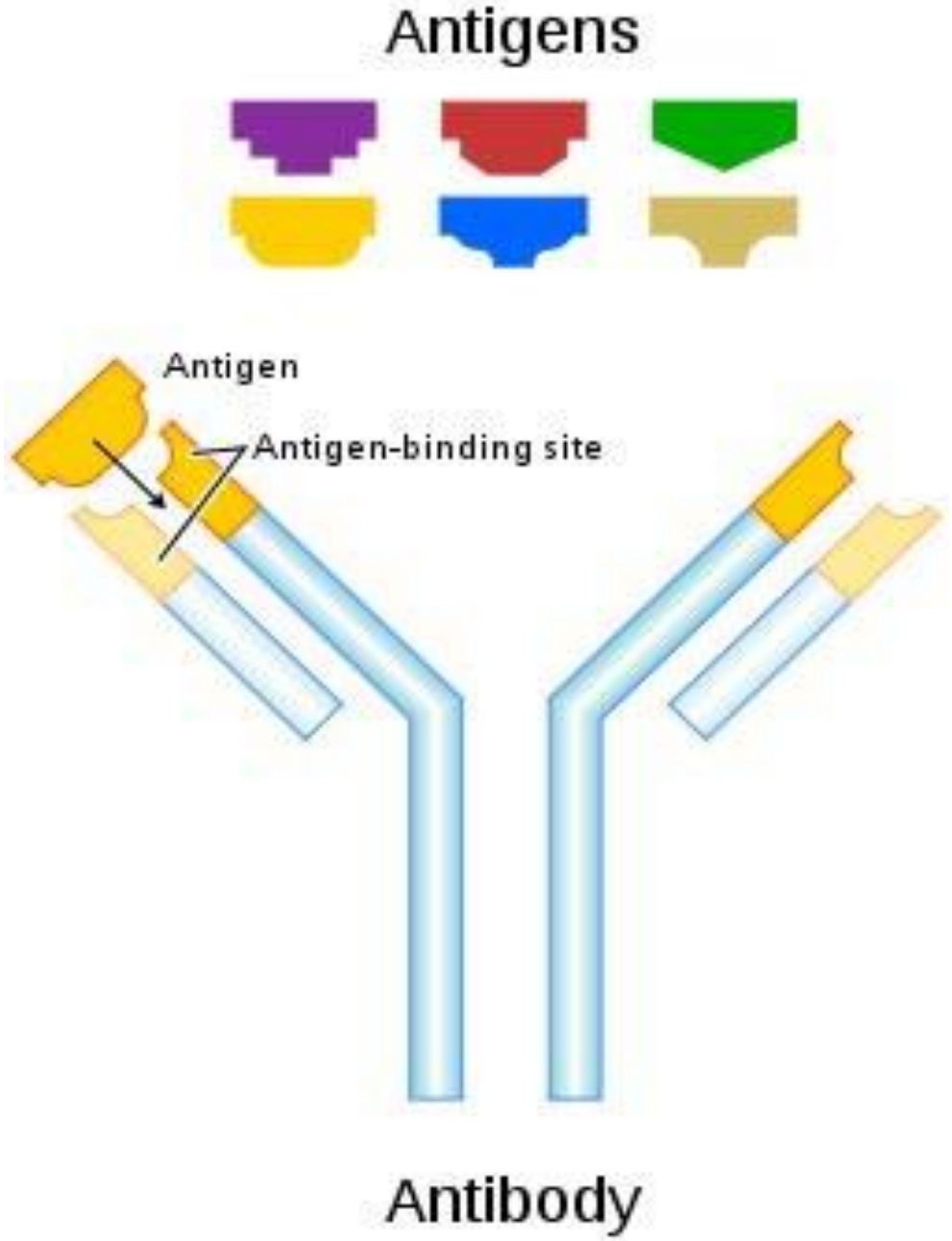




Antibodies

- Also called immunoglobulins (Igs)

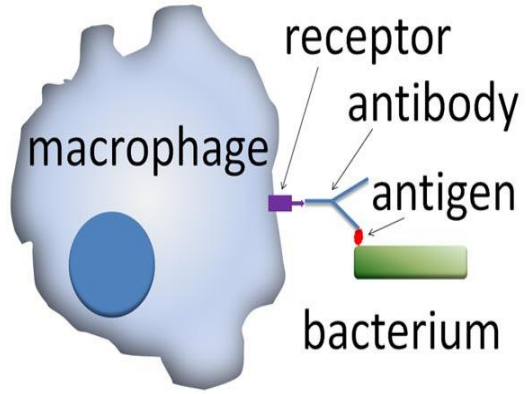
- Proteins that bind **antigens** at the antigen-binding site

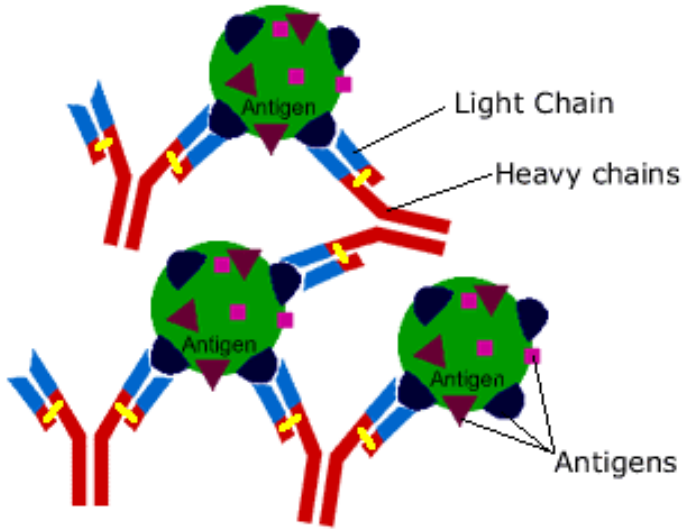


Antibodies: The Custom-Built Security Patches

- Antibodies are **customized defense tools** your body produces to **neutralize** specific threats
- Think of antibodies as **"custom-built security patches"** that are designed to **detect and neutralize** a specific type of antigen (hacker)

- They are produced by **B-cells** (a type of white blood cell)
- Different types of antibodies have specialized roles:
  - **Opsonins** → Tag threats for elimination (like marking suspicious files for deletion)
  - **Antitoxins** → Neutralize toxins (like blocking malware before it spreads)
  - **Agglutination** → Clump invaders together, making them easier to eliminate (like isolating a virus-infected server)

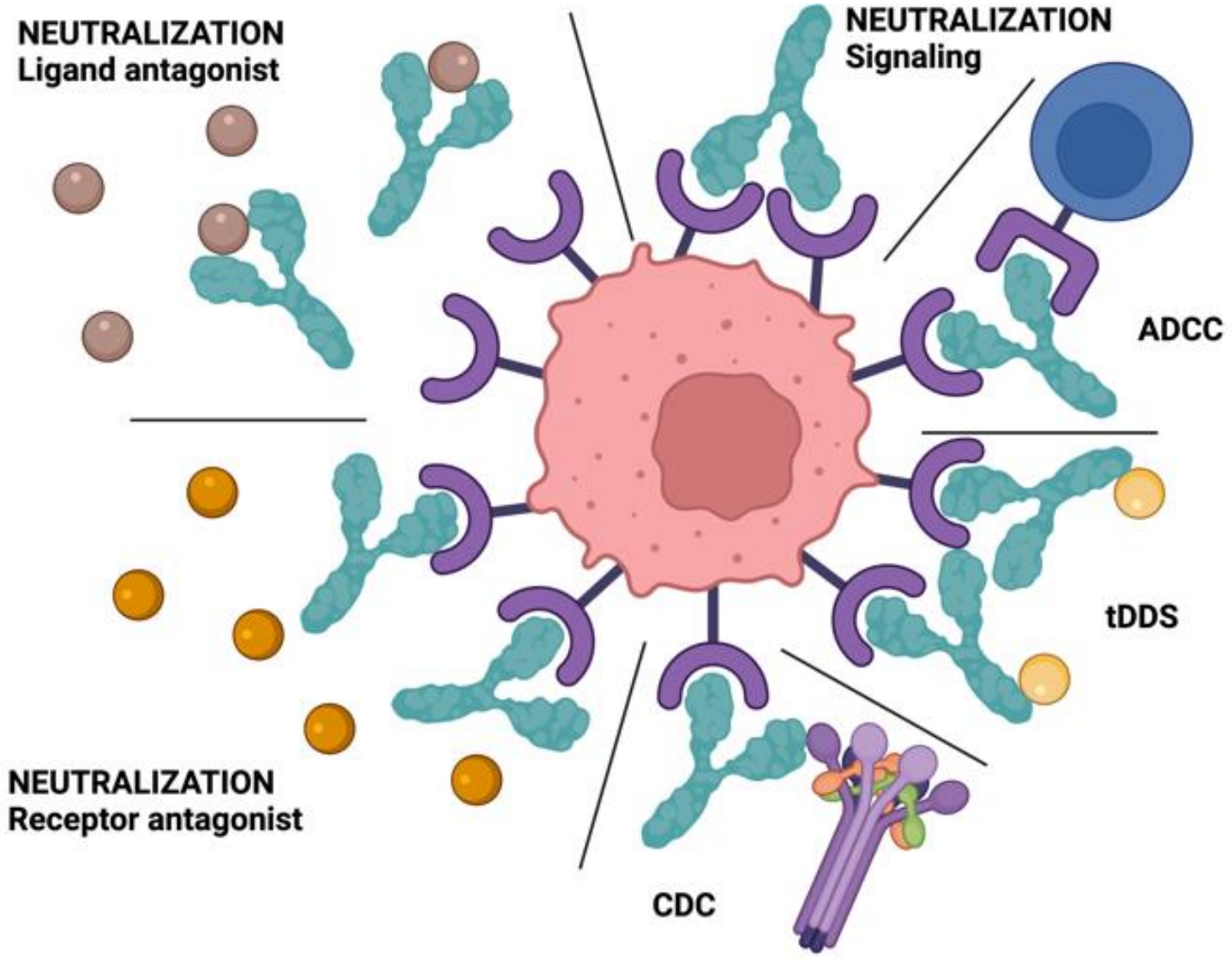




Antibodies

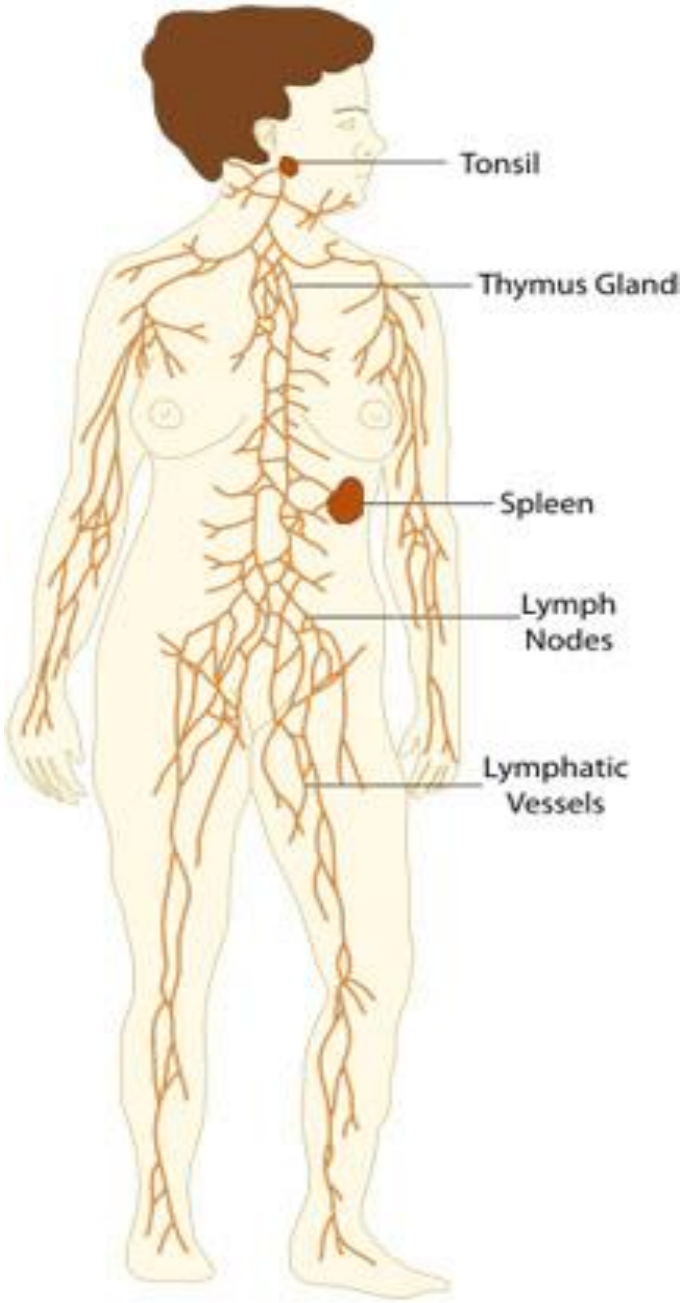
And much more…

Q. Where are antibodies produced?.. Stay tuned..



The Lymphatic System: A Network of Sensors

- The **lymphatic system** acts as a surveillance network that screens tissues for threats
- It consists of **lymphatic vessels** (data highways) and lymph nodes (security checkpoints).
- It transports **lymph**, a liquid similar to blood plasma, which carries immune cells throughout the body
- Lymph nodes house **lymphocytes** (**T-cells and B-cells**), which inspect passing lymph for signs of infection

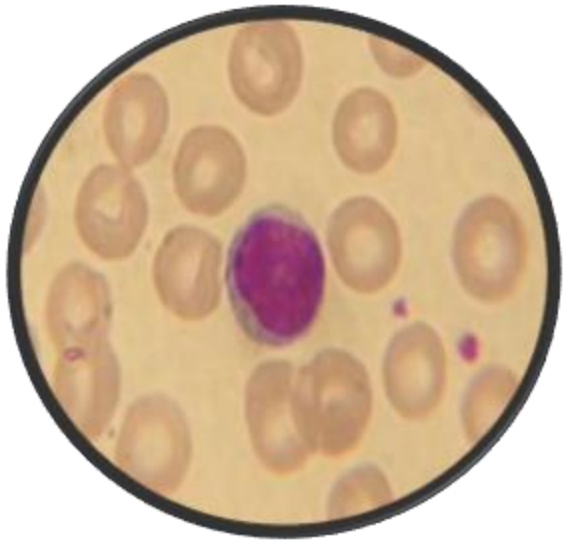


The lymphocytes

- WBCs of specific immunity (Lesson 21, slide #6)
- Smallest leukocytes
  - Have huge nucleus surrounded by thin rim of cytoplasm
  - Produced from blood stem cells in the red bone marrow

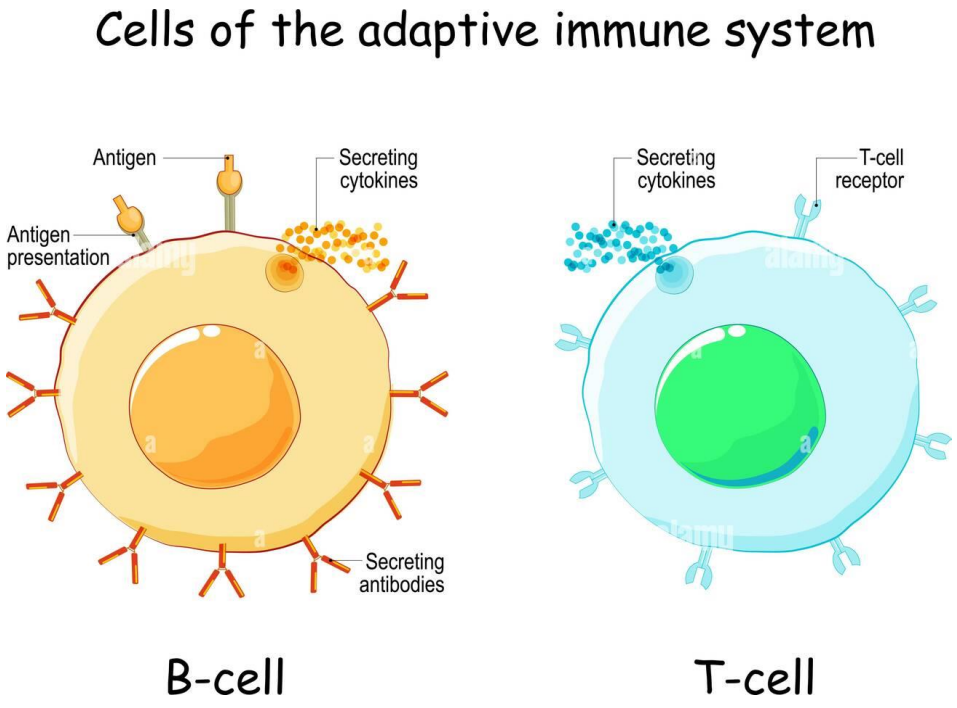
Leukocytes - agranulocytes

- Category of **WBCs** characterized by the absence of **granules** in their cytoplasm
- 2 types:
  - **Lymphocytes** 
    - most involved in the **SPECIFIC IMMUNITY** (3rd line of immune defense - TLD)



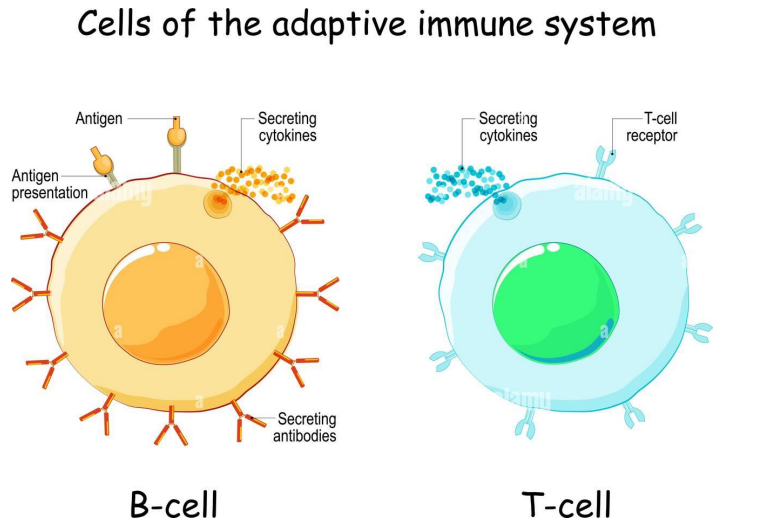
The lymphocytes

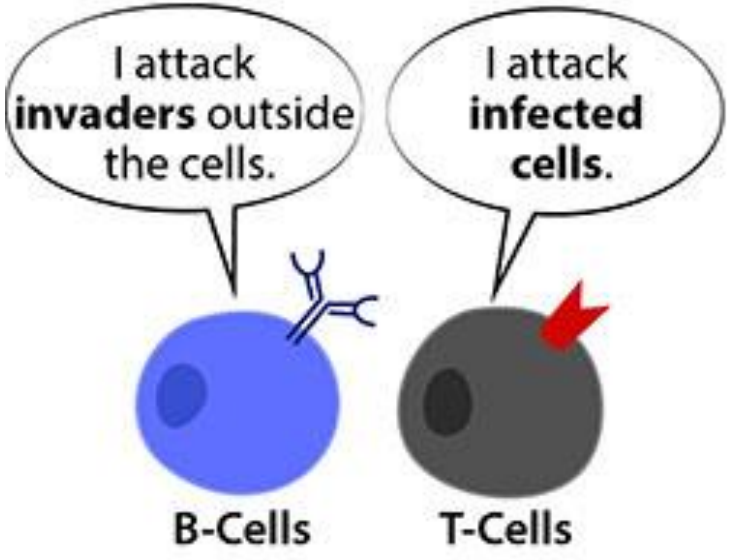
- Both **T-cells** and **B-cells** are specialized immune agents, working like a cybersecurity team with different roles
- **T-cells: The "Security Guards"**
  - **Cytotoxic (Killer) T-cells** → Identify and destroy compromised cells (like shutting down hacked computers)
  - **Helper T-cells** → Coordinate the immune response by activating B-cells (like an IT help desk directing fixes)



The lymphocytes

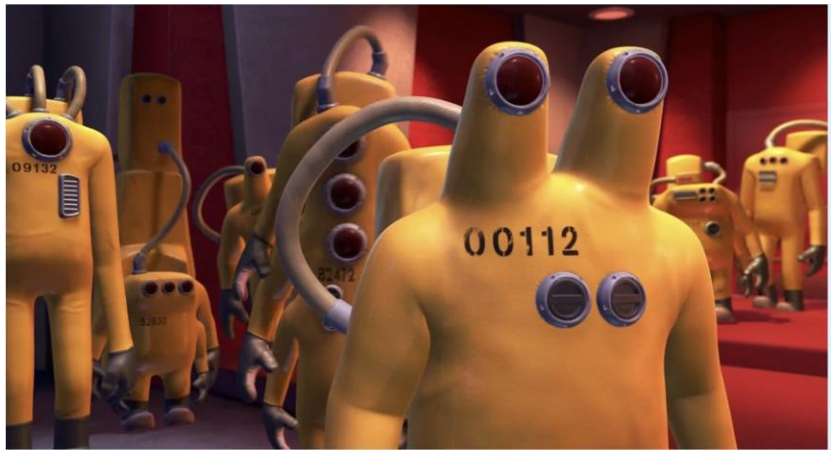
- **B-cells: The "Database of Known Threats"**
  - **Plasma cells** → Produce antibodies to fight the current infection (like deploying a software patch)
  - **Memory cells** → Store information about past infections for faster response in the future (like an AI learning from previous cyberattacks)
- Mature B and T cells circulate in the blood and lymph, and concentrate in lymph nosed and spleen
- Circulation ensures they come into contact with pathogens and each other





Antigen-Presenting Cells (APCs): The Security Analysts of the Immune System

- APCs are like cybersecurity analysts in a network defense system
- They detect intruders (pathogens), capture their 'fingerprints' (antigens), and alert the immune system
- APCs process antigens and present them to T-cells, triggering a targeted immune response (like updating firewall rules for new malware threats)



Antigen-Presenting Cells (APCs): The Security Analysts of the Immune System

- Key APCs include:
  - **Professional APCs**
    - Dendritic Cells → The most efficient, acting like high-tech surveillance cameras
    - Macrophages → The first responders, engulfing threats and sending alerts
    - B-Cells → Specialized analysts that recognize returning threats
  - **Atypical APCs**
    - Include basophils, eosinophils, some skin cells l(ike fibroblasts and some epithelial and endothelial cells cells) and glial cells (brain) among others