

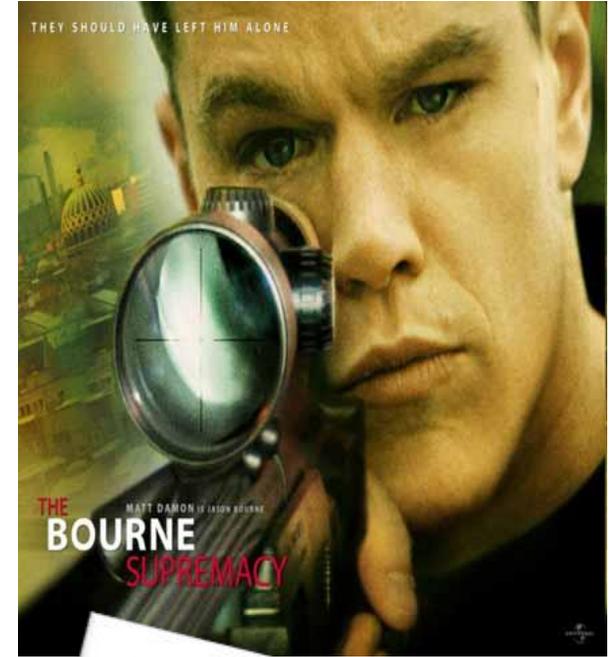
Lesson 22 – Basic immunology: The third line of defense



Acquired (specific) immunity – the third line of defense (TLD)

The body's ability to recognize and defend itself against **distinct invaders**

- Is a “smart” system
 - Also called **specific** and/or **adaptive** immunity
 - “Memory” allows it to respond rapidly to additional encounters with a pathogen
 - If nonspecific immune system has *warriors*, then acquired immunity has more sophisticated *special agents* and *assassins*
- Two types of specific immunity
 - **Naturally acquired** = immune response against **antigens** encountered in daily life
 - **Artificially acquired** = response to antigens introduced via vaccines

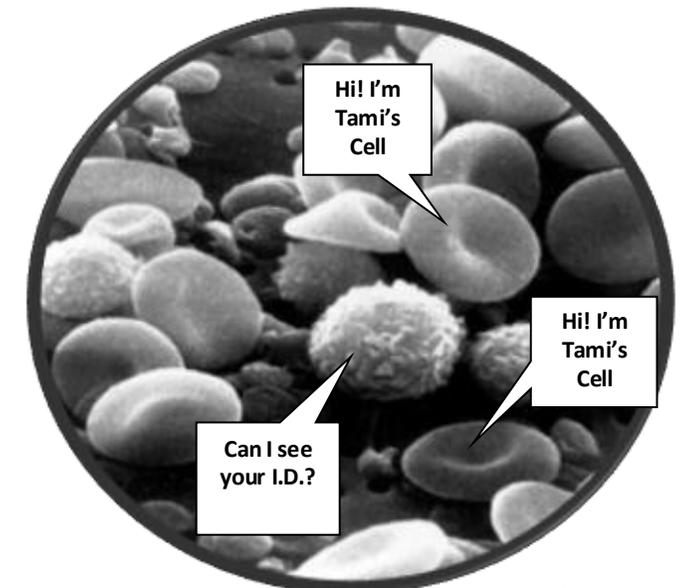


Antigens

- Body does not direct immune response against **whole** bacteria, fungi, protozoa or viruses
- **Foreign molecules (antigens) trigger a specific immune response**
 - Include components of bacterial cell walls, capsules, pili, and flagella, as well as proteins of viruses, fungi and protozoa
- Food and dust can also contain antigenic particles
- Enter the body by various methods
 - Through breaks in skin and mucous membranes
 - Direct injection, as with a bite or needle
 - Through organ transplants and skin grafts

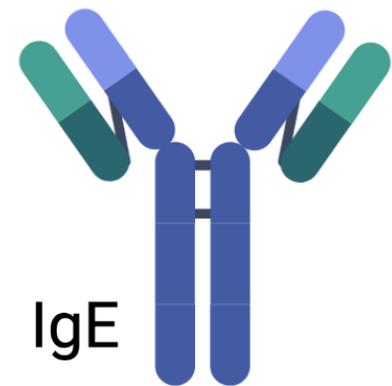
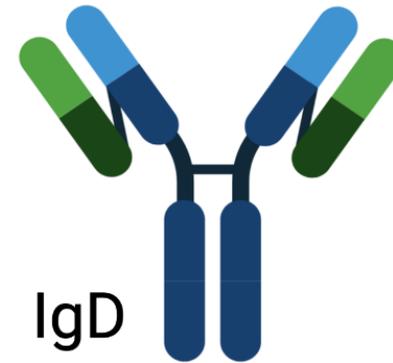
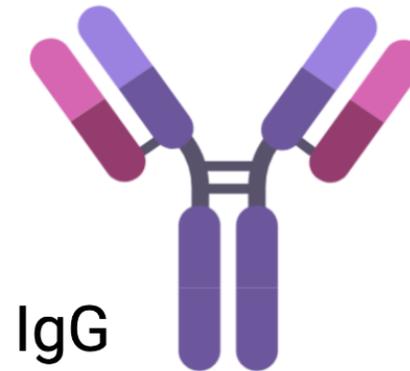
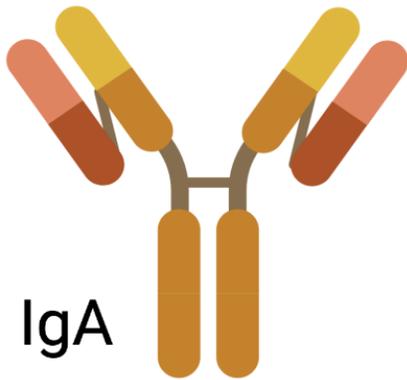
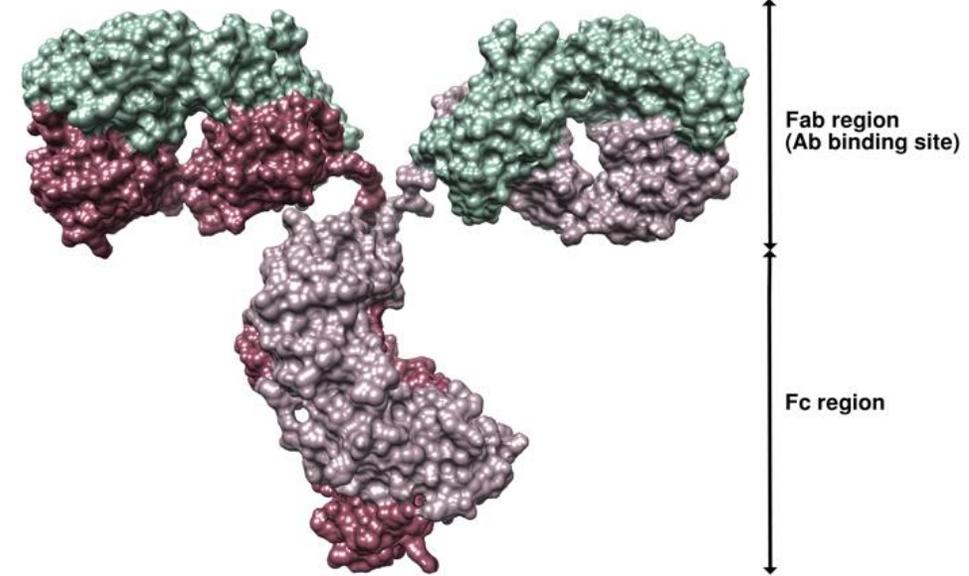
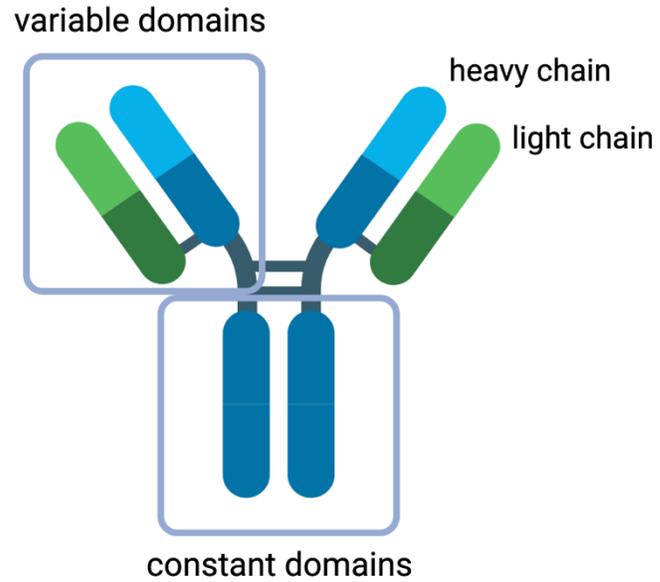
HELLO
my name is

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

- Also called immunoglobulins (Igs)



The 5 Antibody All-Stars: A Guide to Immunoglobulin Isotypes

The immune system produces five main classes of antibodies (isotypes). Each is a Y-shaped protein with a specialized role, from fighting initial infections to protecting mucosal surfaces and triggering allergies.

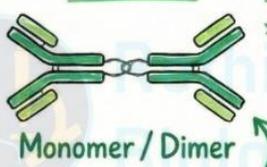
IgG: The Long-Term Protector



Monomer

- Comprising ~75% of serum antibodies, provides lasting immunity. Can cross the placenta.
- Primary Function: Long-term immunity; crosses placenta.

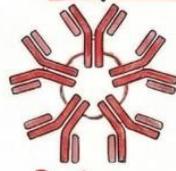
IgA: The Mucosal Guardian



Monomer / Dimer

- Found in saliva, tears, & breast milk. Protects body surfaces from pathogens.
- Primary Function: Mucosal immunity (linings, saliva, tears).

IgM: The First Responder



Pentamer

- The first and largest antibody produced during an initial infection.
- Primary Function: First antibody in a primary immune response.

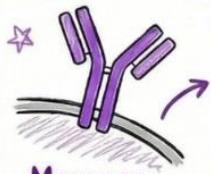
IgE: The Allergy & Parasite Defender



Monomer

- Triggers allergic reactions by activating mast cells. Helps defend against parasites.
- Primary Function: Allergic reactions and defense against parasites.

IgD: The B-Cell Activator



Monomer

- Found on the surface of B-cells. Plays a role in activating the immune response.
- Primary Function: Found on B-cells; role in B-cell activation.

Y TYPES OF ANTIBODIES



IgG: Major defender against invading pathogens & the most common type of antibody. It also crosses the placenta = protects the baby

IgM: First to be produced (before IgG) & mostly found on B-cell surface. Works best to activate the complement system

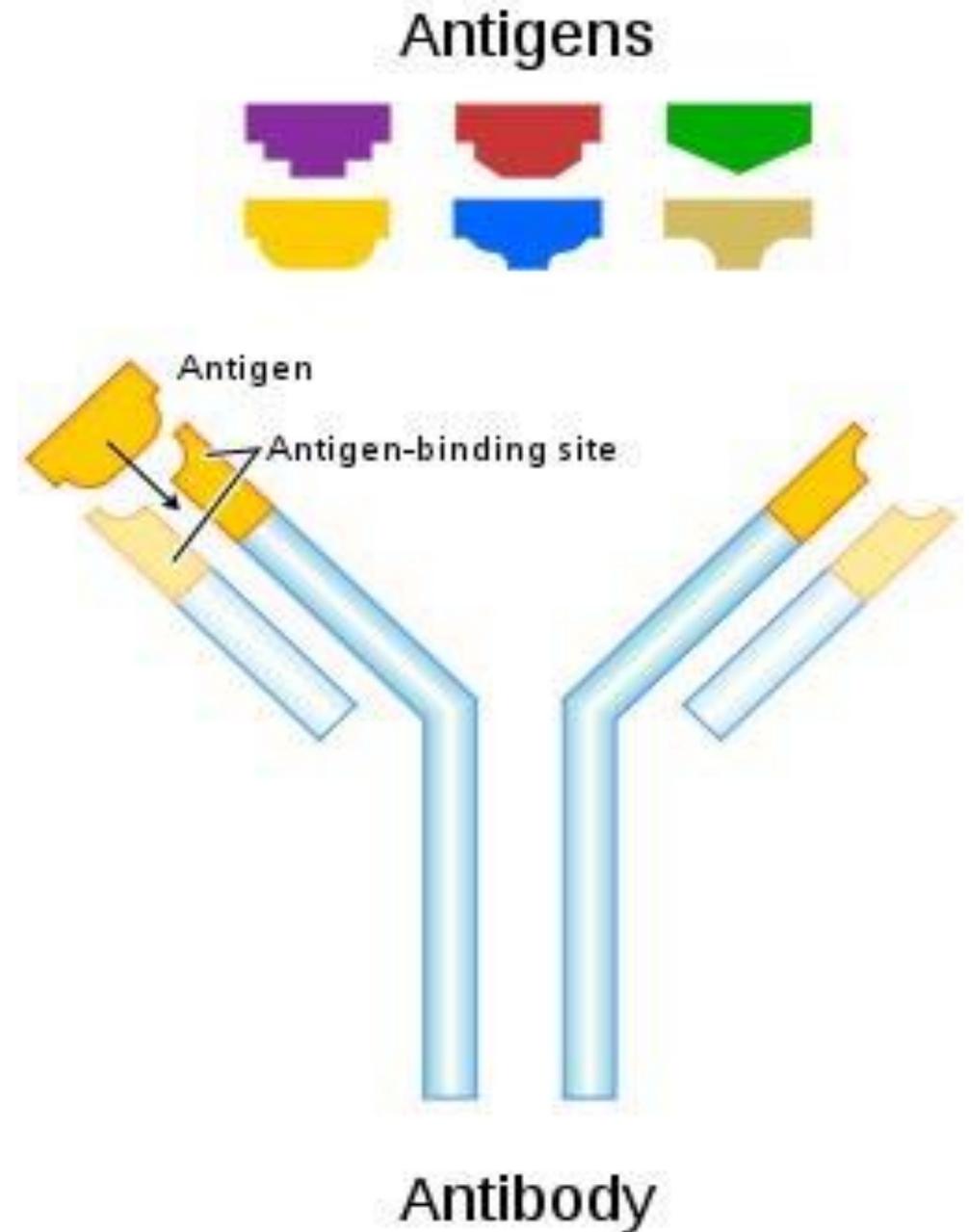
IgA: Lines respiratory track, gut & urogenital track. It is part of our innate immunity and also found in breast milk

IgE: Found on the surface of basophils & mast cells, which initiates the inflammatory & allergic reactions. They bind to allergens & parasitic worms.

IgD: Found on naive B-cells and functions to stimulate B cell differentiation (No antigen exposure)

Antibodies

- Also called immunoglobulins (Igs)
- Proteins that bind **antigens** at the antigen-binding site



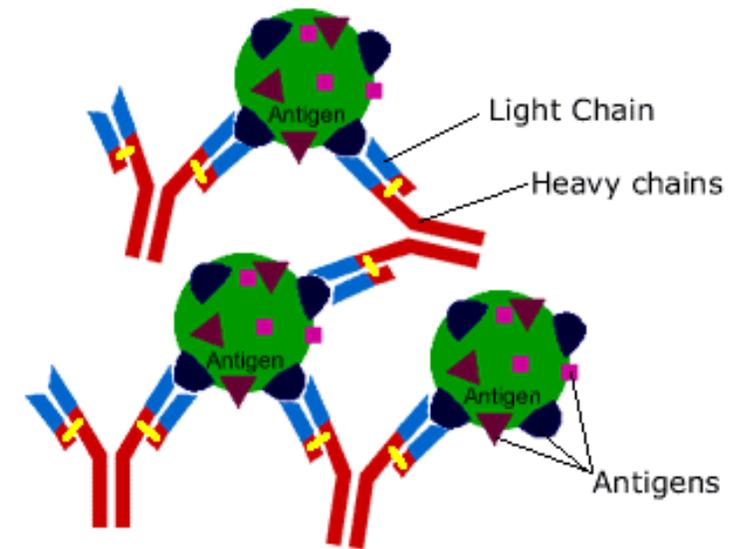
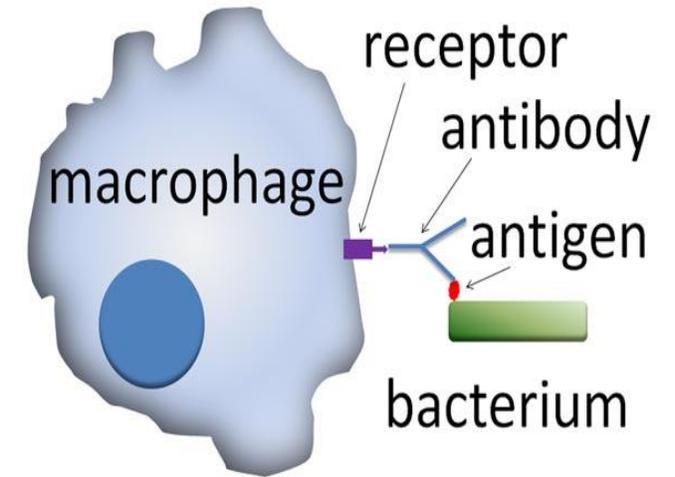
Antibodies

Some act as **opsonins**, markers to identify antigens for phagocytes and stimulate phagocytosis

Some work as **antitoxins** (*i.e.*, they neutralize toxins *e.g.* those causing diphtheria and tetanus)

Some attach to bacterial flagella making them less active and easier for phagocytes to engulf

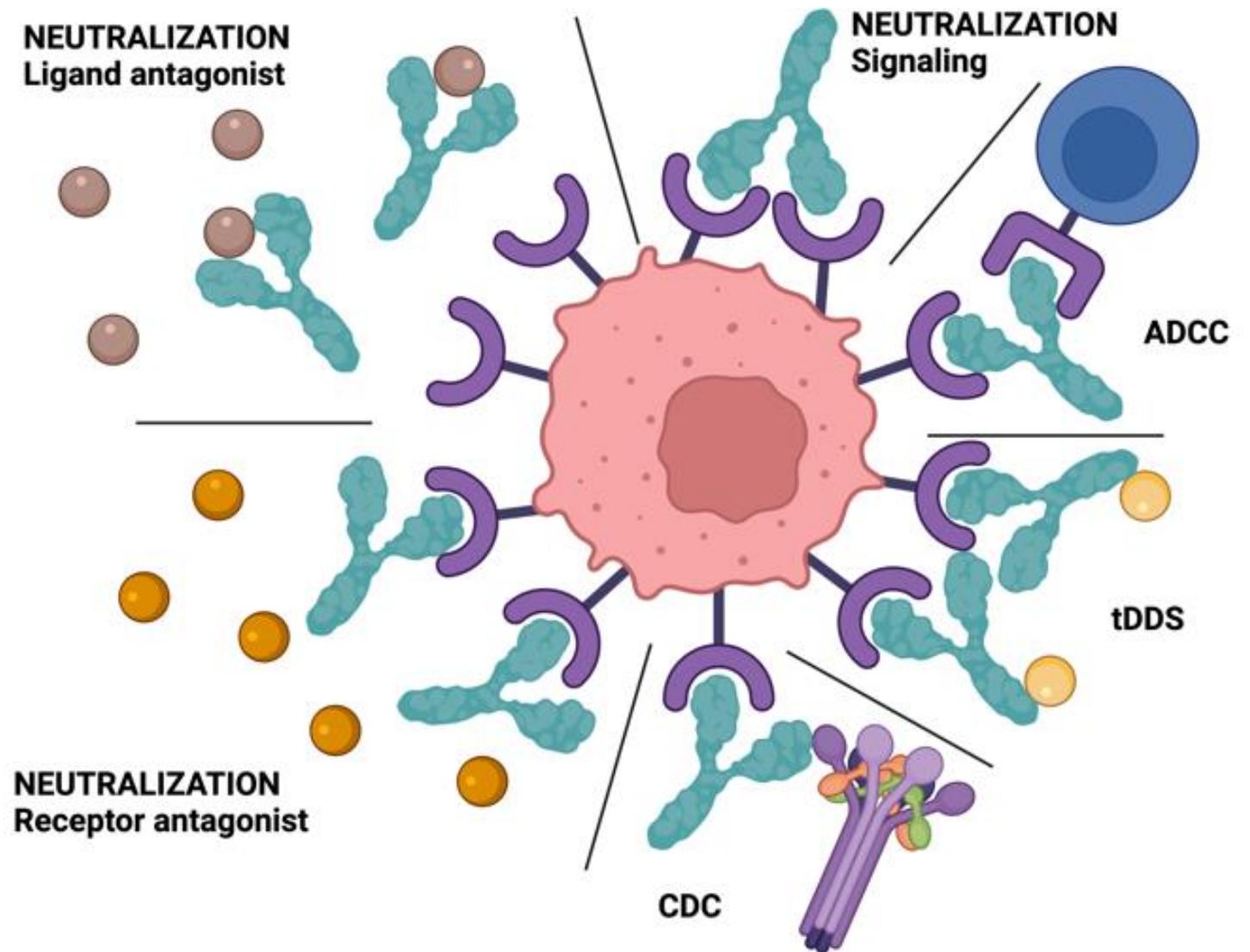
Some cause **agglutination** (clumping together) of bacteria making them less likely to spread



Antibodies

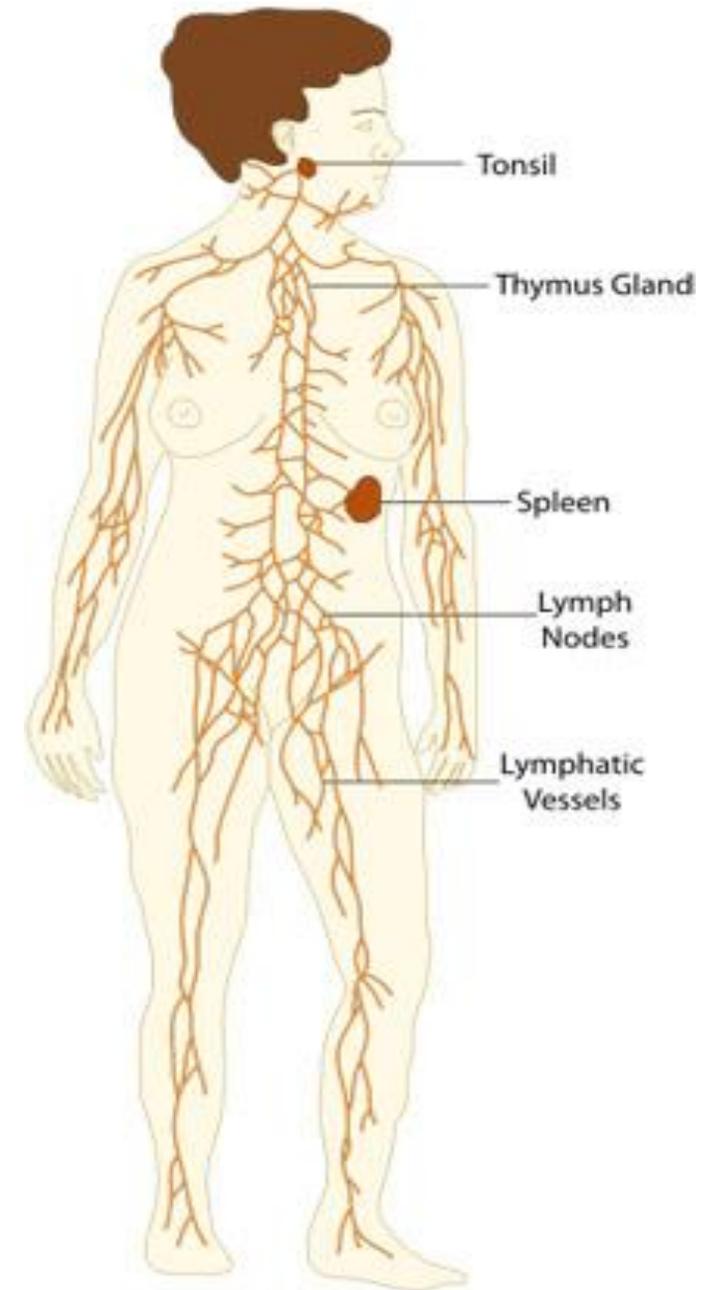
And much more...

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



The lymphatic system

- Screens tissues of the body for foreign antigens
- Composed of lymphatic vessels and lymphatic cells
- One-way system that conducts lymph from local tissues and returns it to the circulatory system
- Lymph is a liquid with similar composition to blood plasma
- Lymph nodes house **lymphocytes** that recognize and attack foreign antigens present in lymph



* What Are Lymph Nodes?

- Small, bean-shaped immune organs found along lymphatic vessels.
- Act as filters for lymph fluid and trap pathogens.
- Contain lymphocytes that help fight infections.

* Functions

■ Filtration of lymph

- ▲ Removes bacteria, viruses, and debris

■ Immune activation

- ▲ Lymphocytes get activated upon detecting antigens

■ Production of immune cells

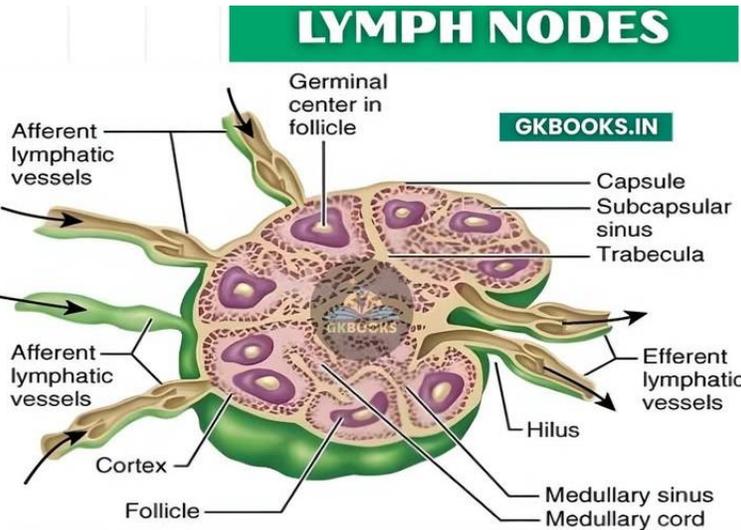
- ◆ B-cells & T-cells proliferate during infections

■ Transport of nutrients & waste

- ▲ Supports body fluid balance

● Major Locations

- Cervical nodes – neck region
- Axillary nodes – armpits
- Inguinal nodes – groin
- Thoracic nodes – chest
- Abdominal nodes – around organs
- Mesenteric nodes – along intestines



* Structure of a Lymph Node

■ Capsule

- ◆ Outer protective covering

■ Cortex

- ▲ Houses B-cells & germinal centers

■ Paracortex

- ◆ Rich in T-cells

■ Medulla

- ▲ Contains macrophages & medullary cords

■ Afferent vessels – bring lymph in

■ Efferent vessel – carries filtered lymph out

* Common Clinical Conditions

■ Lymphadenopathy – enlarged nodes

- ▲ Often due to infections, autoimmune issues

■ Lymphadenitis – inflamed lymph nodes

■ Metastatic spread

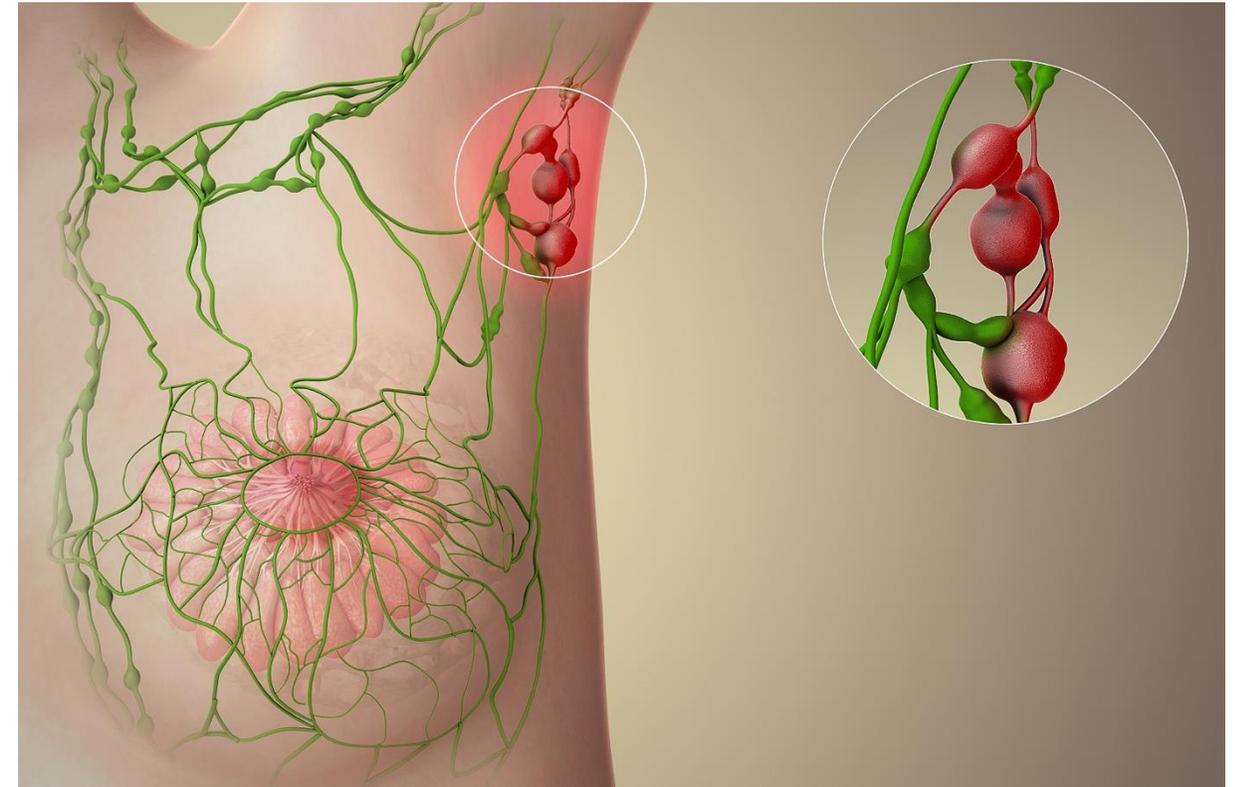
- ◆ Cancer cells frequently travel via lymph nodes

■ Lymphoma

- ▲ Cancer of lymphatic tissue

● Exam Key Points

- Largest lymph nodes: **Cervical & axillary**
- Largest lymphoid organ (not a node): **Spleen**
- **Sentinel lymph node:**
 - ◆ First node to receive drainage from a cancer site
- Lymph **flows unidirectionally** due to valves
- **Swollen nodes** indicate **active immune response**



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



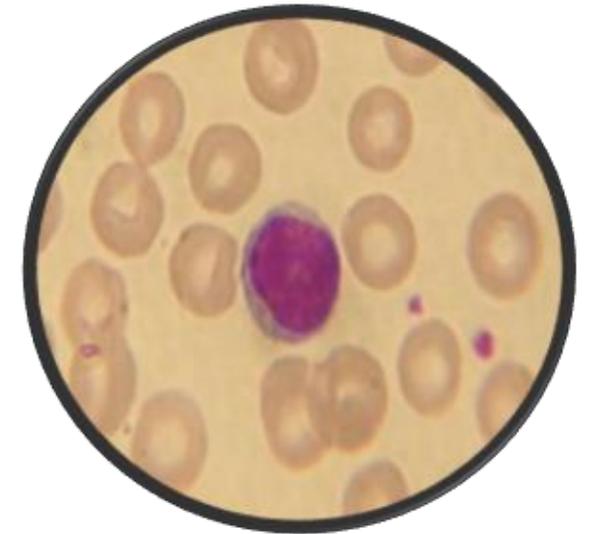
• Category of **WBCs** characterized by the **absence of granules** in their cytoplasm

• 2 types:

- **Lymphocytes**



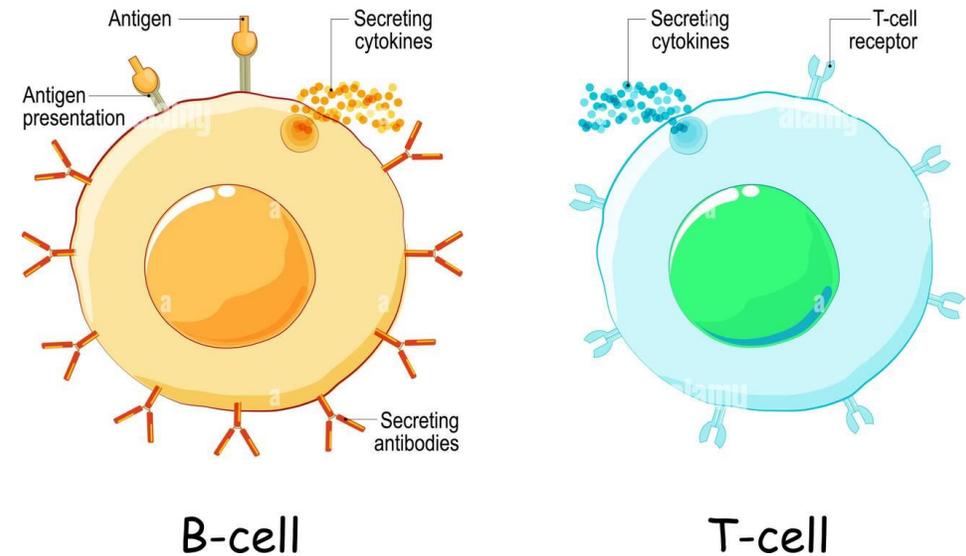
- most involved in the **SPECIFIC IMMUNITY** (3rd line of immune defense - TLD)



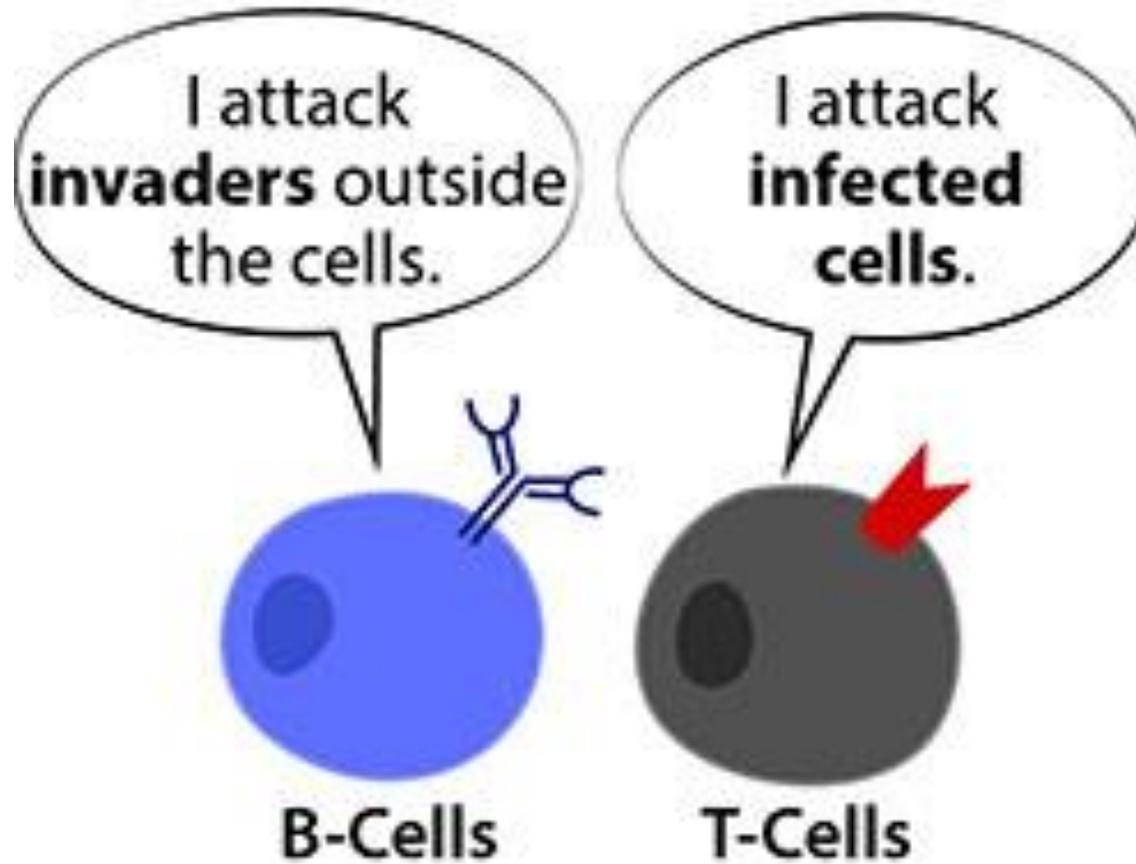
The lymphocytes

- WBCs of specific immunity
- Smallest leukocytes
 - Have huge nucleus surrounded by thin rim of cytoplasm
 - Produced from blood stem cells in the red bone marrow
- Two main types
- **B-cells**
 - mature in bone marrow, then concentrate in lymph nodes and spleen
- **T-cells**
 - mature in thymus
- B and T cells mature then circulate in the blood and lymph
- Circulation ensures they come into contact with pathogens and each other

Cells of the adaptive immune system

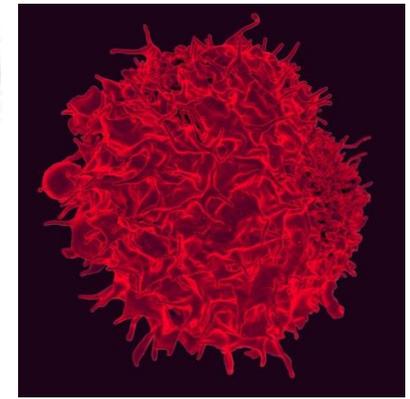
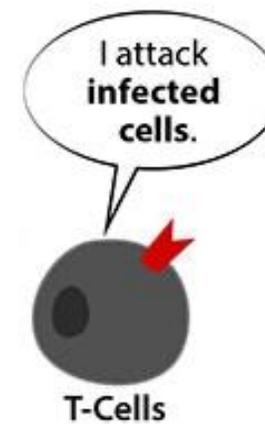


B- vs. T-lymphocytes



T-cells (or T-lymphocytes)

- Produced in red bone marrow and mature in thymus
- Circulate in the lymph and blood and migrate to the lymph nodes (and other areas of the lymph system)
- Part of the **cellular immune response** (aka cell-mediated immune response) because **these cells act directly against various antigens**
 - Intracellular pathogens (inside the body's cells)
 - **Abnormal body cells such as cancer cells**



T-cells (or T-lymphocytes)

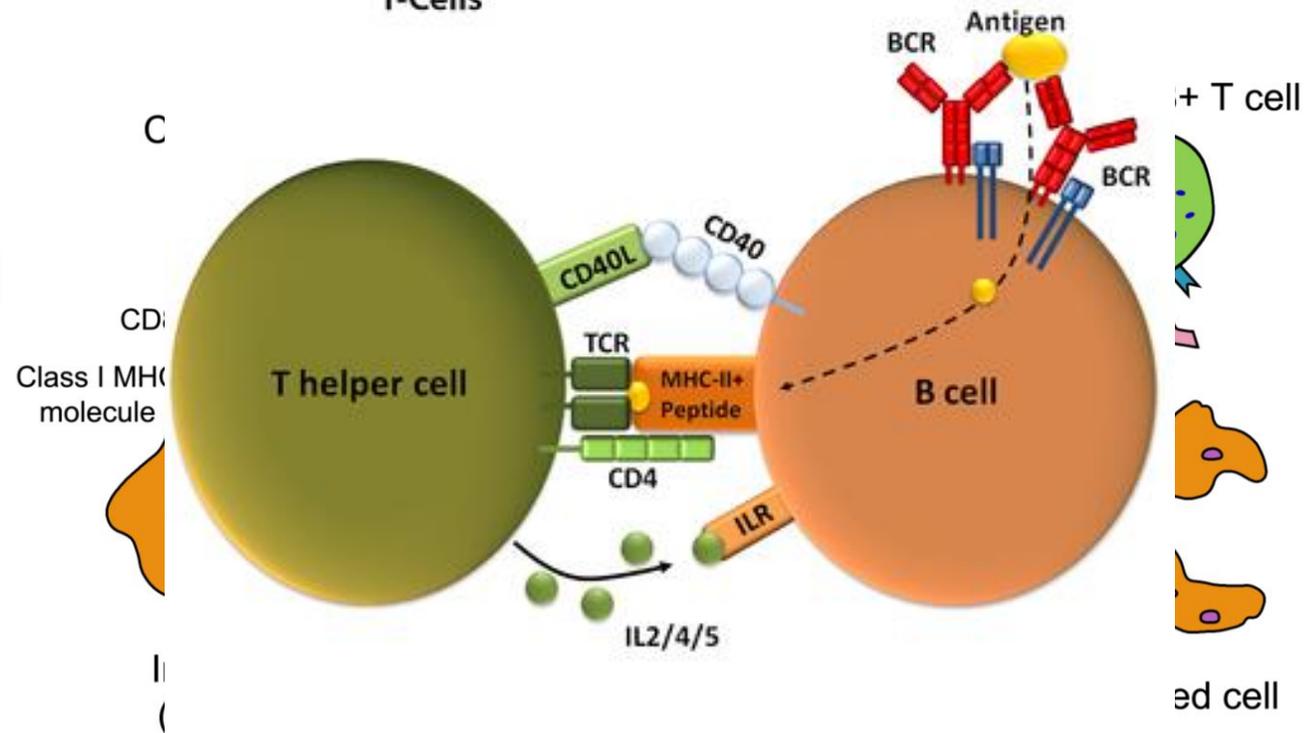
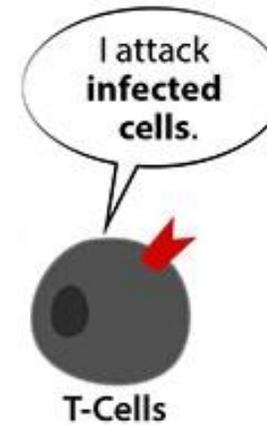
2 main types

- **cytotoxic or killer T cells** (T_c)

- Destroy compromised body cells (e.g., cancer cells)

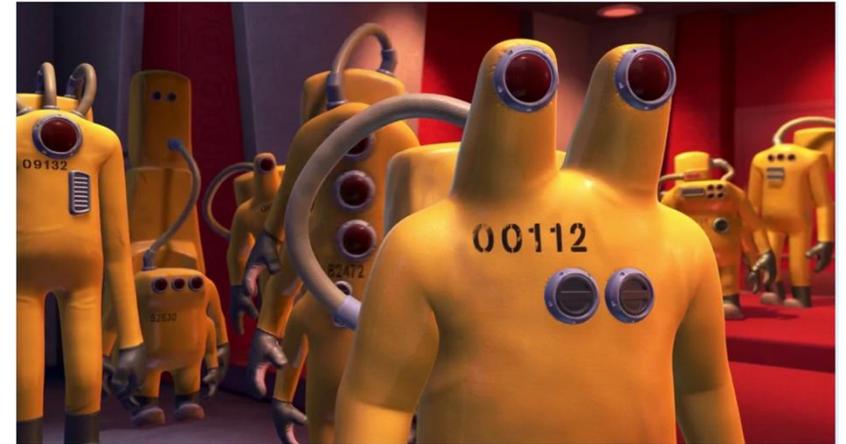
- **helper T cells** (T_H)

- Activate B-cells



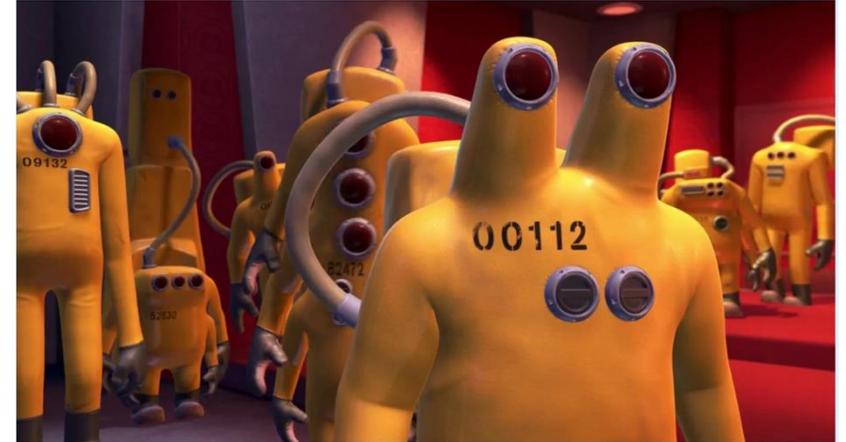
B-cells (or B-lymphocytes) – the APCs

- Consider your WBCs a **security patrol** for your body and
- any non-self antigens as **the bad guys**



The antigen presenting cells (APCs)

- Consider your WBCs a **security patrol** for your body and
- any non-self antigens as **the bad guys**
- The larger the patrol, the more likely one of the officers will run into a bad guy and help the body apprehend it
- **Any WBC that can grab and present an antigen to another immune cell, is called an antigen presenting cell (APC)**



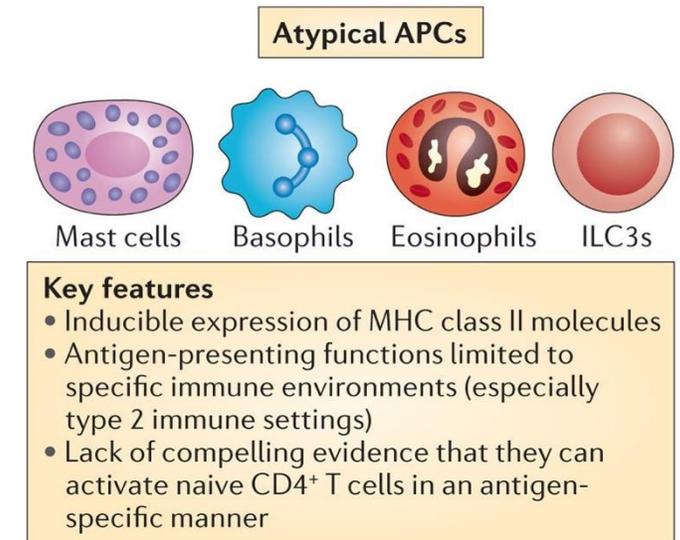
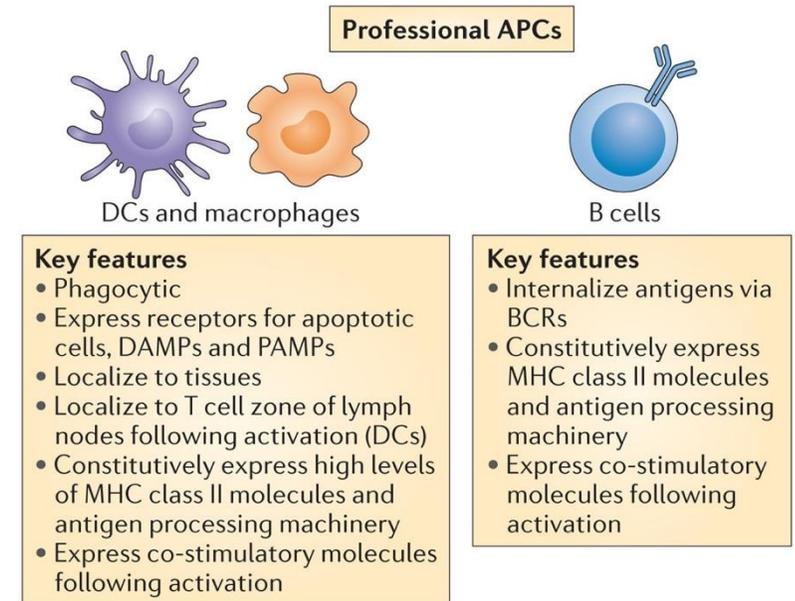
The APCs

- Antigen-presenting cells (APCs) are **a heterogeneous group of immune cells that mediate the cellular immune response by processing and presenting antigens for recognition by certain lymphocytes such as T and B cells and macrophages**



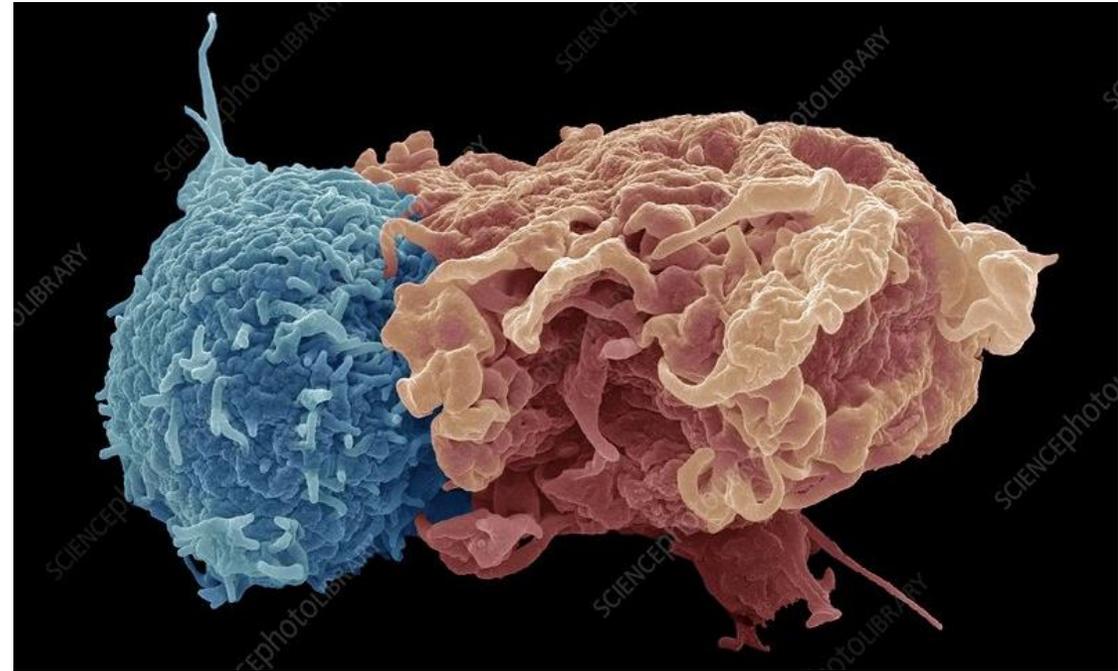
The APCs

- Antigen-presenting cells (APCs) are a heterogeneous group of immune cells that mediate the cellular immune response by processing and presenting antigens for recognition by certain lymphocytes such as T cells
- **APCs are classified as**
 - **Professional APCs**
 - include **dendritic cells, macrophages, Langerhans cells and B- cells**
 - **Atypical APCs**
 - Include basophils, eosinophils, some skin cells (like fibroblasts and some epithelial and endothelial cells) and glial cells (brain) among others



Antigen presentation

- Macrophages (red) are antigen-presenting cells (APCs)
- They present antigens (fragments on the surface of pathogens or foreign objects) to T-helper-lymphocytes (Th, blue), activating them
- Each Th lymphocyte recognizes and binds to a specific antigen
- Binding of the Th cell to the antigen presented by the macrophage activates the Th cell
- This leads to its proliferation and the activation of other immune cells that eliminate the antigen

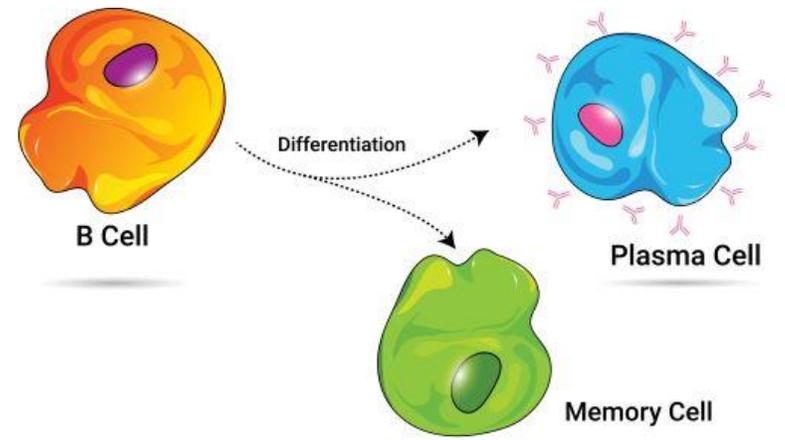


B-cells (or B-lymphocytes)

Activated B-lymphocytes produce either:

- **Plasma cells**
 - make antibodies to a pathogen
- **Memory cells**
 - remember the same pathogen for faster antibody production in future infections

Answer to question in slide 7



B Cell Differentiation

Naive B cells before encountering a pathogen:

