

# THE BODY'S DEFENSES

# Immunity

- Immunity-state of being resistant or not susceptible to a specific disease
- Acquired immunity-any form of immunity NOT present at birth and obtained during life

# Factors That Influence Immune System

- Health
- Age
- Heredity

# The Nature of Disease

- Pathogenic Organisms
- Genetic Disorders
- Toxic Chemicals
- Other Environmental Factors
- Physical Damage to Organs
- Nutritional Disorders

# Types of Pathogenic Organisms

- Viruses
- Bacteria
- Protozoan
- Fungi
- Animal
- Parasites

# Functions of the Immune System

- To protect the entire body from a variety of harmful substances
  - pathogenic microorganisms
  - allergens
  - toxins
  - malignant cells

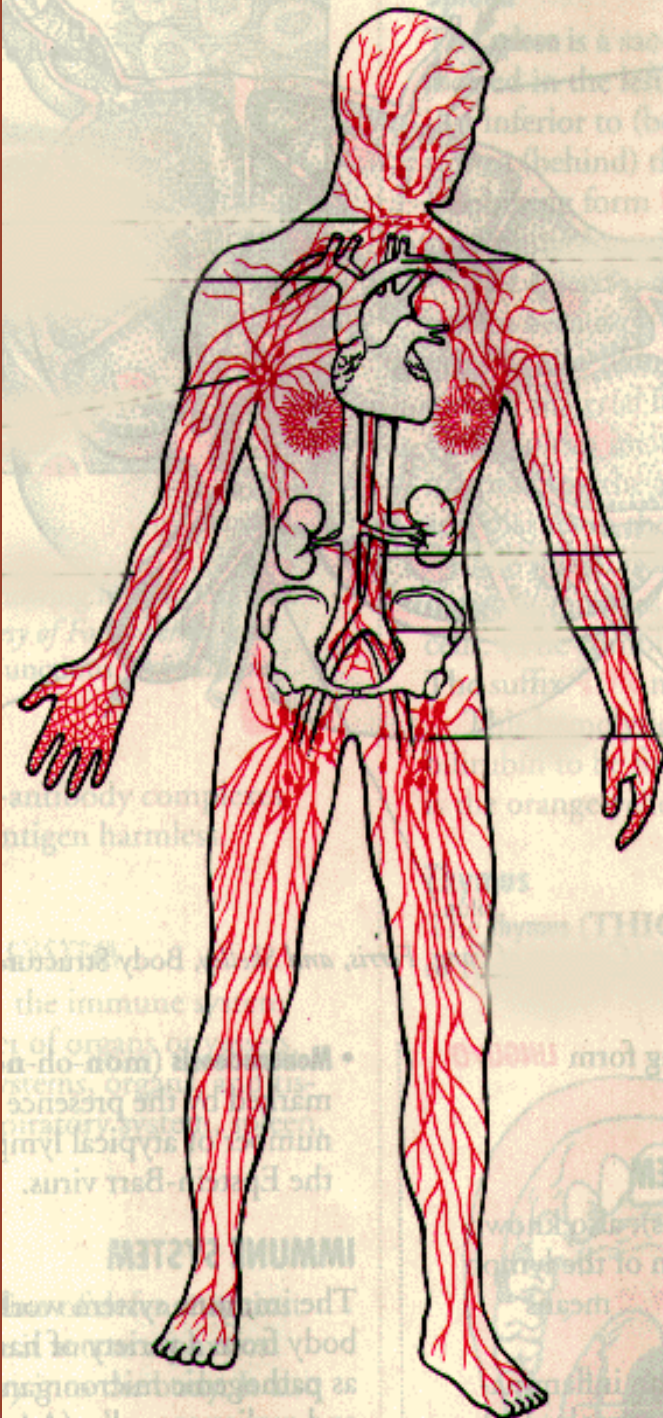
# Structures of the Immune System

- Unlike other body systems, Immune System is NOT contained within a single set of organs or vessels
- Action depends on structures from lymphatic, cardiovascular, and Integumentary systems
- Works primarily through antigen-antibody reaction



# Lymphatic System

- Major structures
  - lymph vessels
  - lymph nodes
  - lymph fluid
  - tonsils
- Also
  - spleen
  - thymus



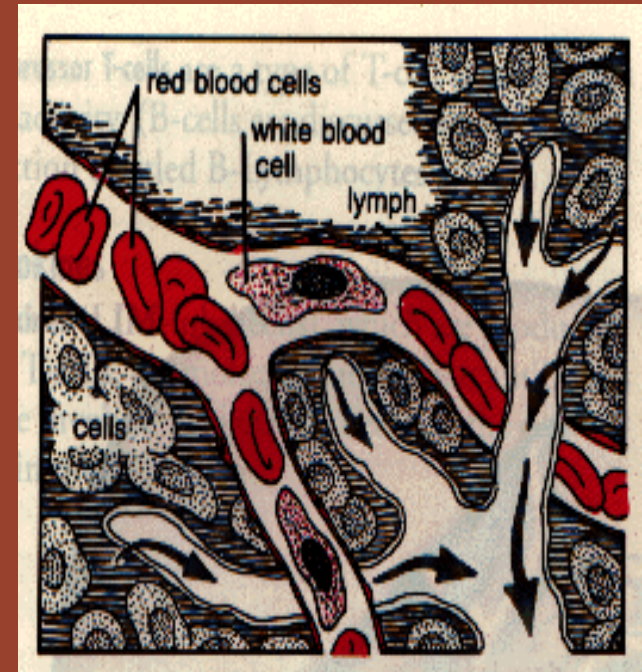


# Functions of the Lymph System

- lymph/o
- drain fluid from tissue spaces and return to it to the blood
- transport materials (nutrients, hormones and oxygen) to body cells
- carry away waste products to the blood
- transport lipids away from digestive system
- control of infection

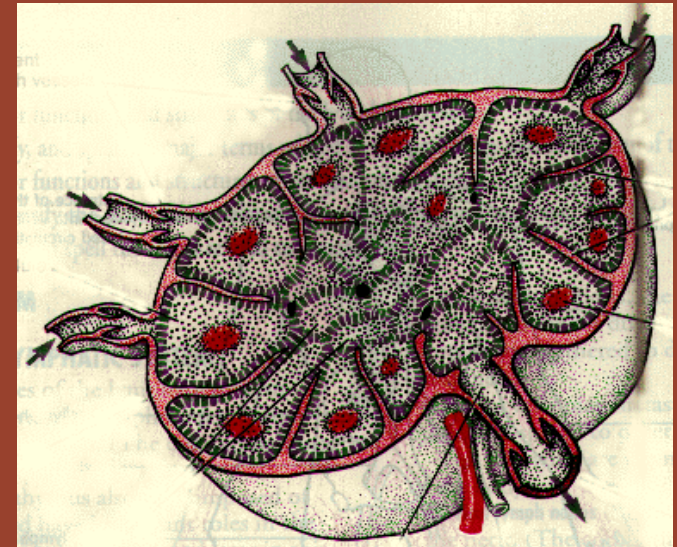
# Lymph System

- Lymph originates in blood plasma
- Interstitial fluid
- cleans and nourishes body tissues
- collects cellular debris, bacteria
- return to blood or lymph capillaries



# Lymph Nodes

- located in lymph vessels
- small round or oval structures (filters)
- depositories for cellular debris
- bacteria and debris phagocytized



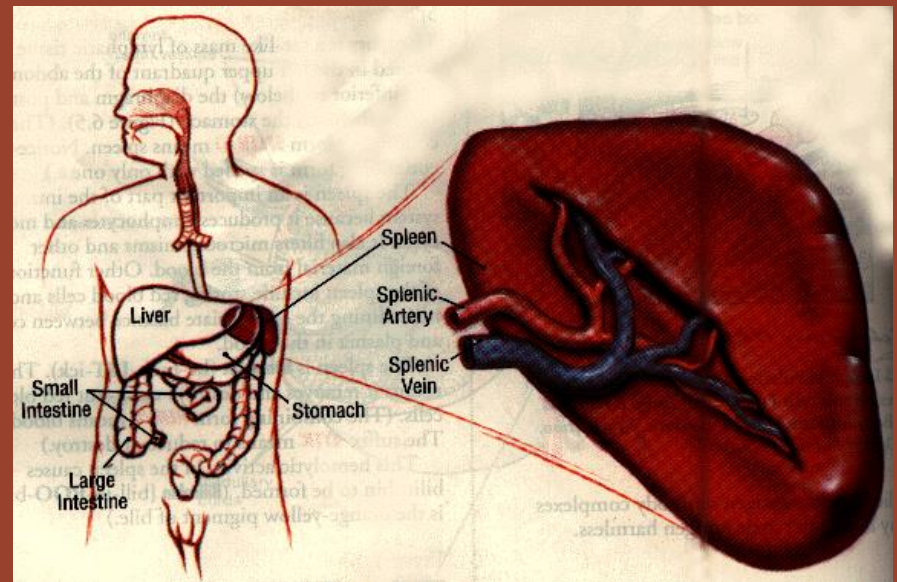
# Lymph Nodes

- inside are masses of tissue which contain WBCs (lymphocytes)
- almost always grouped 2 or 3 to 100
- invading cells destroyed in nodes and often swell as an indicator of the disease process



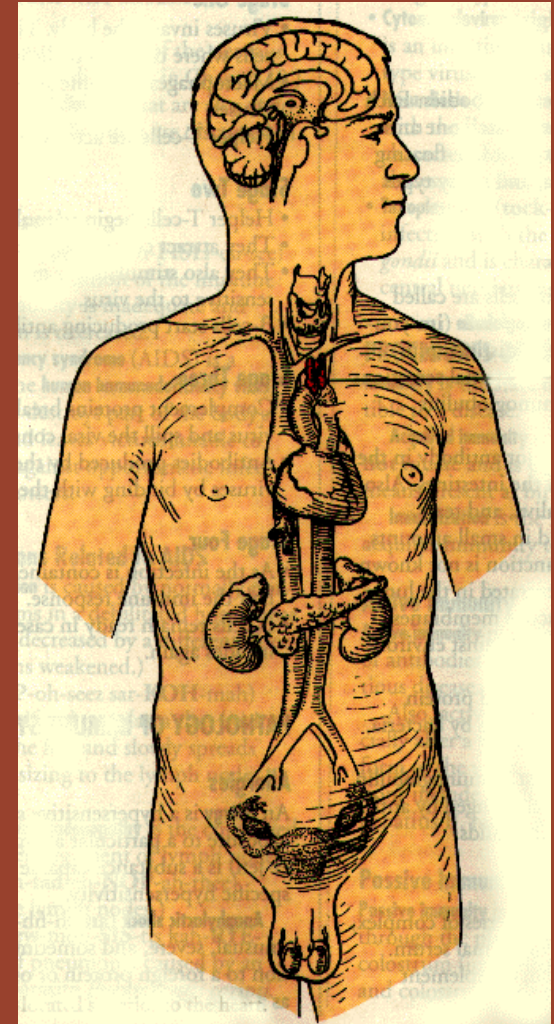
# Spleen

- sac-like mass of lymphatic tissue
- filter for lymph
- phagocytic cells
- hemolytic



# Thymus

- lymphatic tissue
- mediastinum
- primary role: changes lymphocytes to T cells for cellular immunity



# Tonsils

- masses of lymph tissue designed to **filter** tissue fluid, not lymph
- located beneath certain areas of moist epithelium exposed to outside and hence to contamination
- any or all may become so loaded with bacteria that the pathogens gain dominance
- should not be removed unless absolutely necessary.



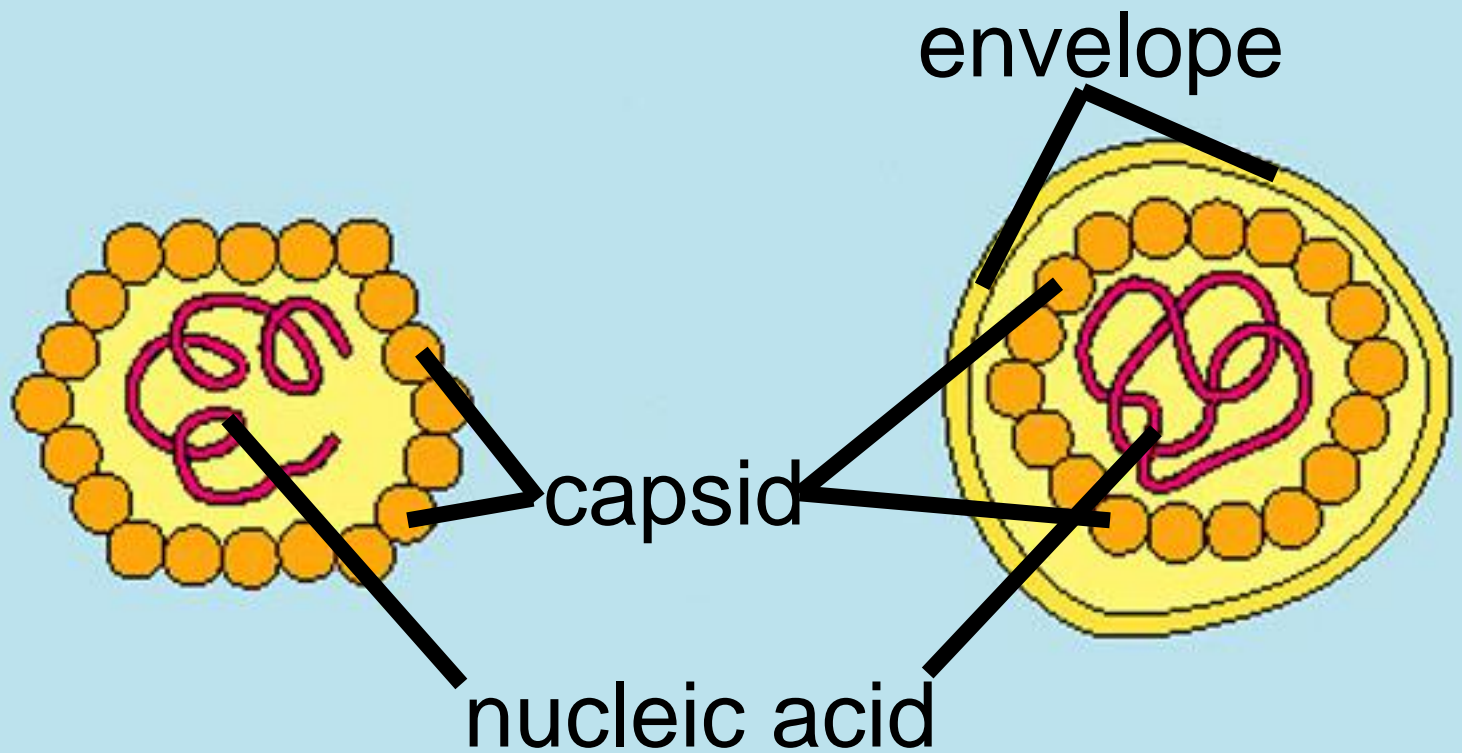
# WBCs for Immune Reactions

- monocytes - type of lymphocytes
  - formed in bone marrow/transported where needed by body
  - become **macrophages**
- macrophage - phagocytic cell that protects body by ingesting invading cells
- lymphocytes - major class of WBCs
  - formed in lymphatic tissue

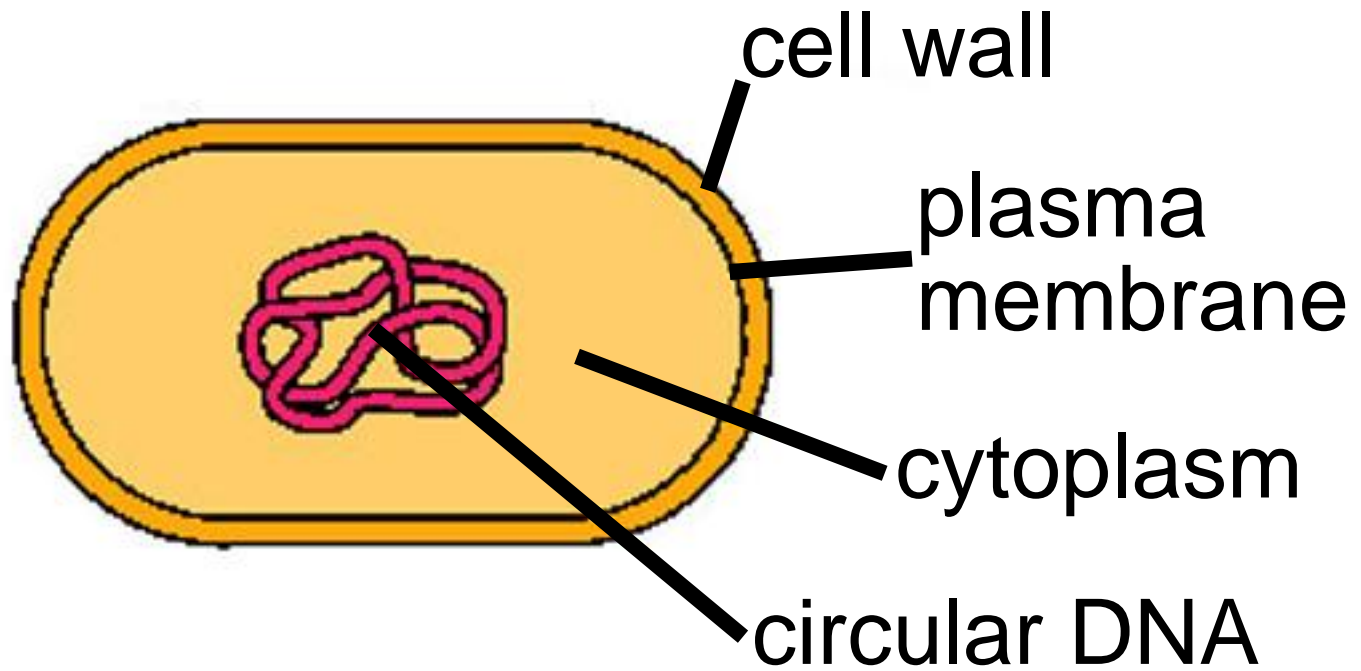
# Mechanisms of Disease by Pathogens

- Utilization of host nutritional resources
- Physical damage to host tissues
- Production of toxic substances
- Chromosomal and gene damage
- Body cells behave abnormally

# Viruses



# Bacteria



# Defense Mechanisms

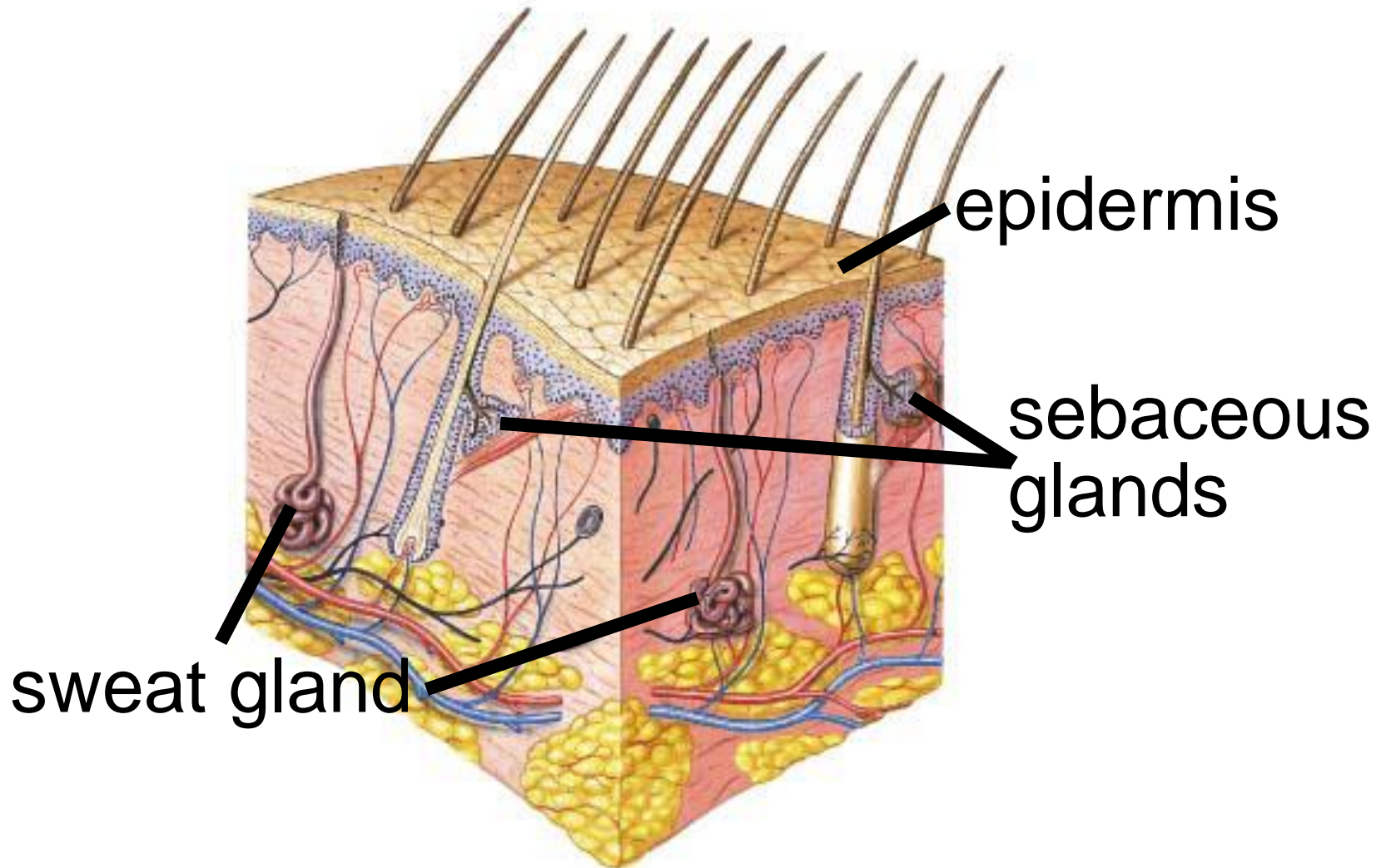
1. External defense
2. Internal Defense
3. Immune Defense

Nonspecific defense mechanisms		Specific defense mechanisms (immune system)
First line of defense	Second line of defense	Third line of defense
<ul style="list-style-type: none"><li>• Skin</li><li>• Mucous membranes</li><li>• Secretions of skin and mucous membranes</li></ul>	<ul style="list-style-type: none"><li>• Phagocytic white blood cells</li><li>• Antimicrobial proteins</li><li>• The inflammatory response</li></ul>	<ul style="list-style-type: none"><li>• Lymphocytes</li><li>• Antibodies</li></ul>

# 1<sup>st</sup> Line of Defense

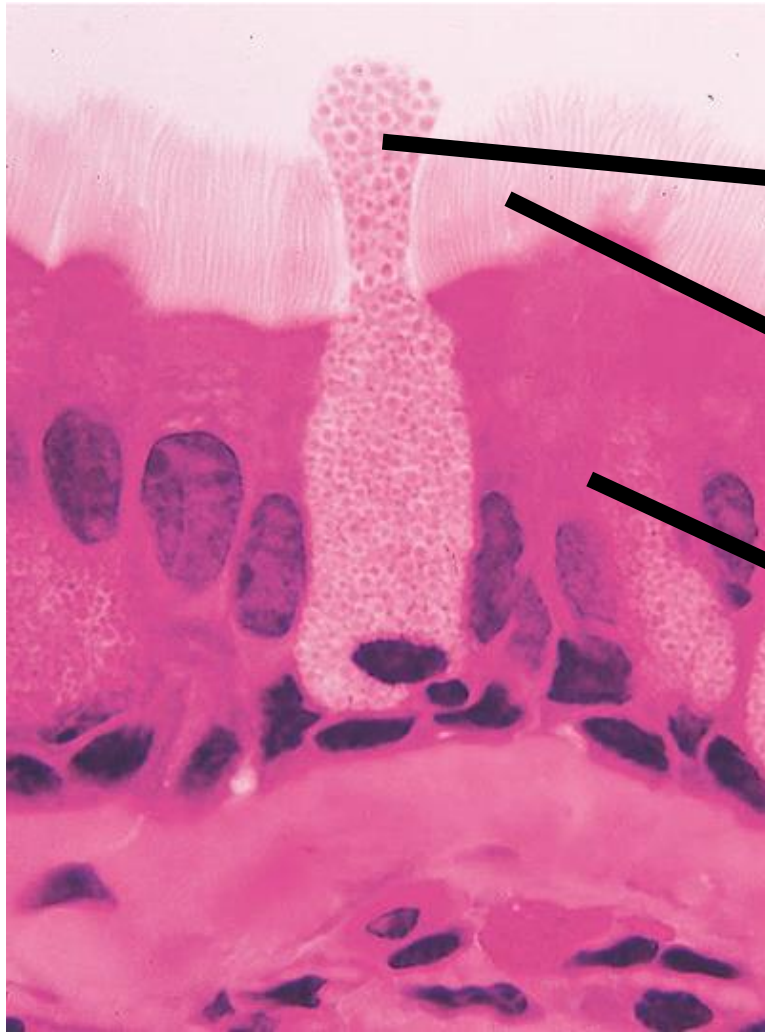
- Skin acts as barrier to microbes and viruses
  - sweat has a low pH
- Mucus traps foreign particles
- Tears
  - Lysozyme has antimicrobial action
- Gastric stomach acid

# Body Coverings: The Skin





# Body Coverings: Mucous Membranes



mucus

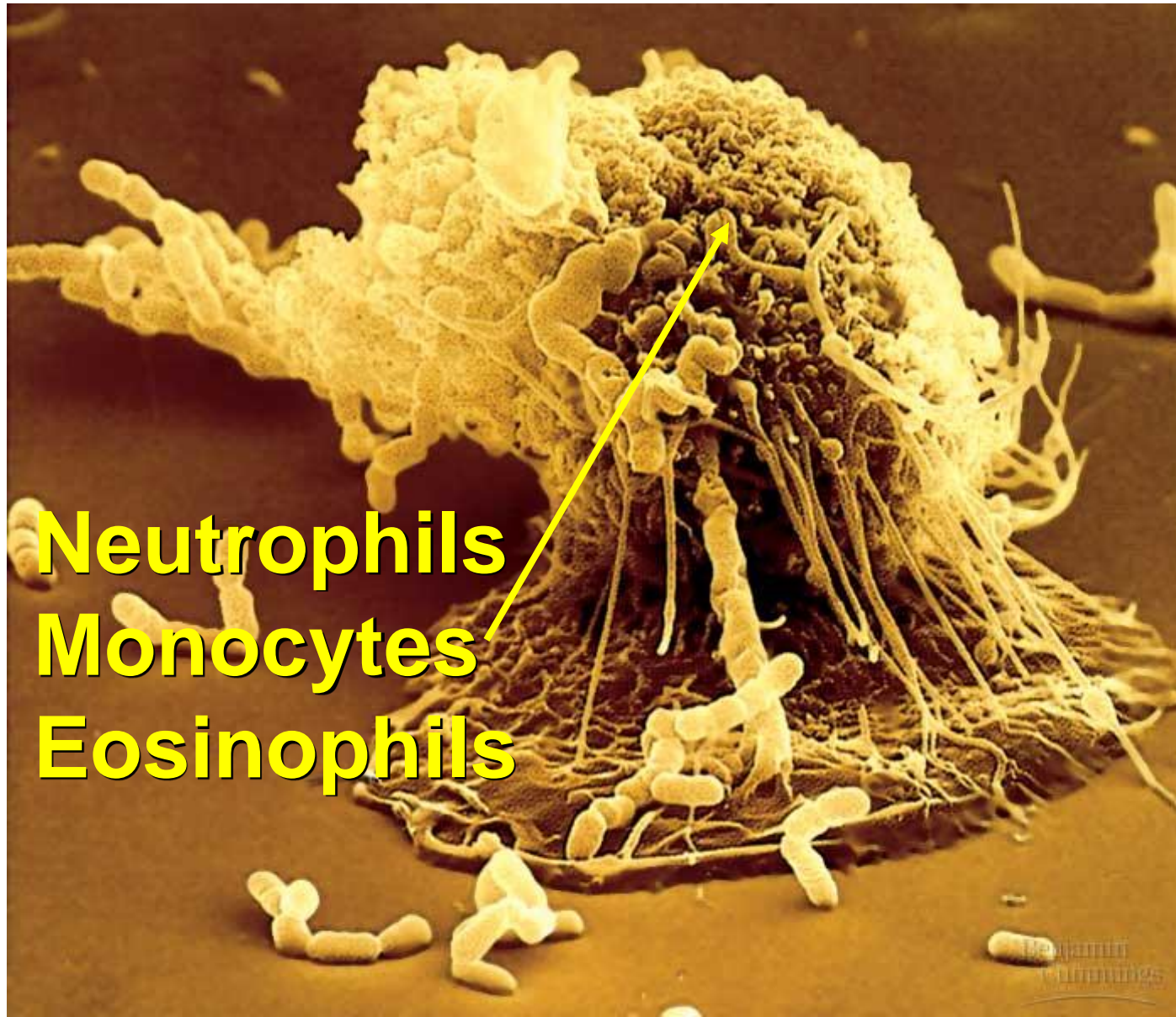
cilia

columnar  
epithelium

# 2<sup>nd</sup> Line of Defense

- Phagocytic cells (WBCs)
  - N    L    M    E    B
  - Natural Killer (NK) Cells: attack virus infected cells
- Inflammatory Response
- Antimicrobial proteins
  - Lysozyme
  - Interferon
  - Antibodies

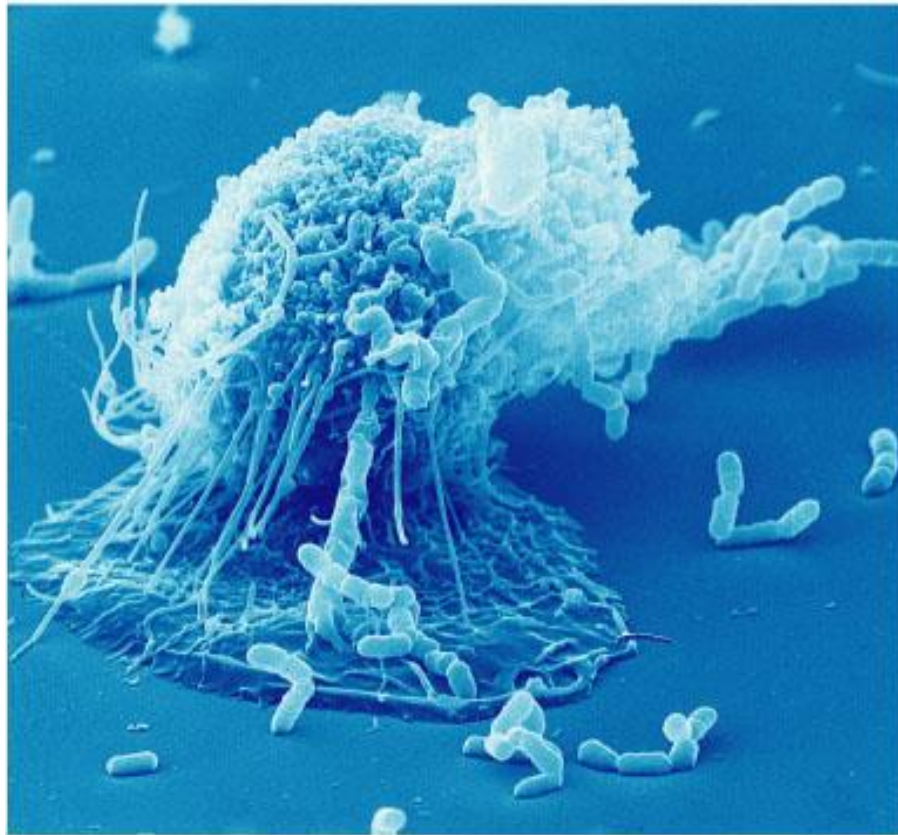
# Nonspecific Phagocytosis



**Neutrophils**  
**Monocytes**  
**Eosinophils**

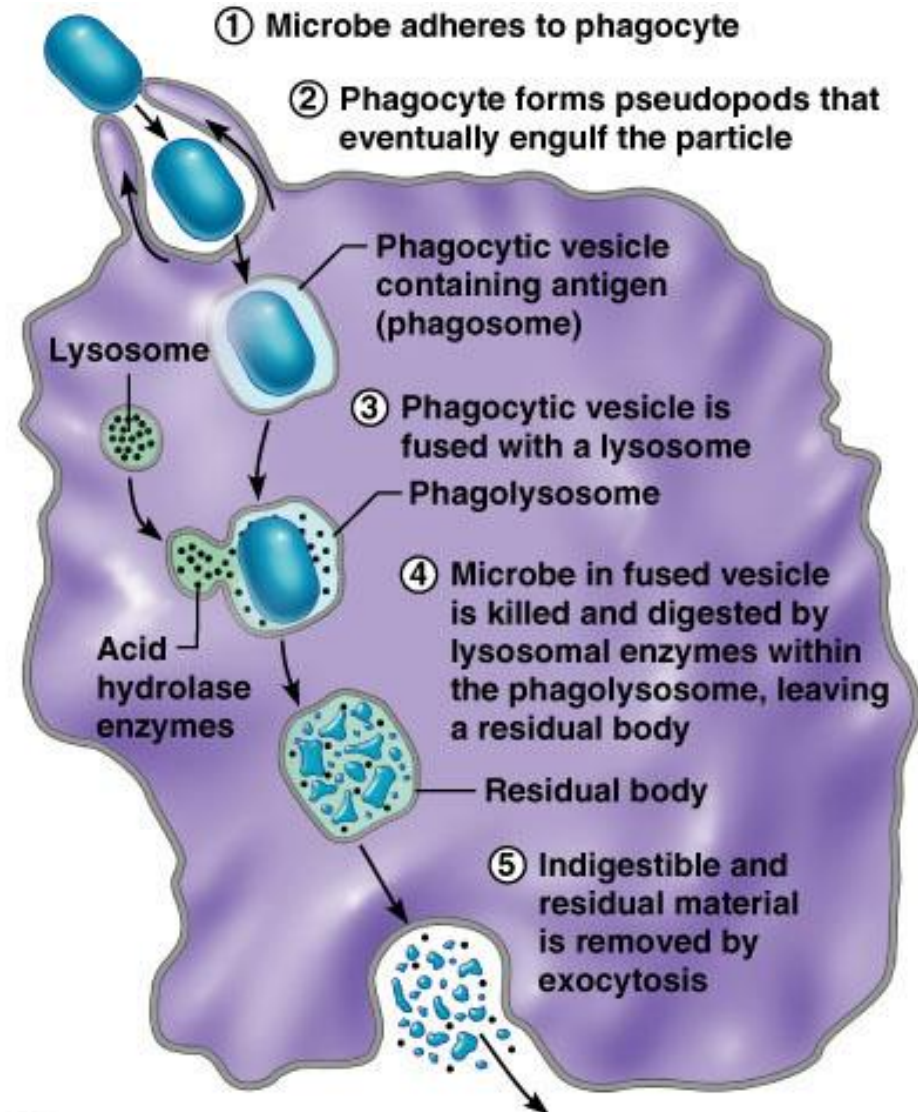


# Mechanism of Phagocytosis



(a)

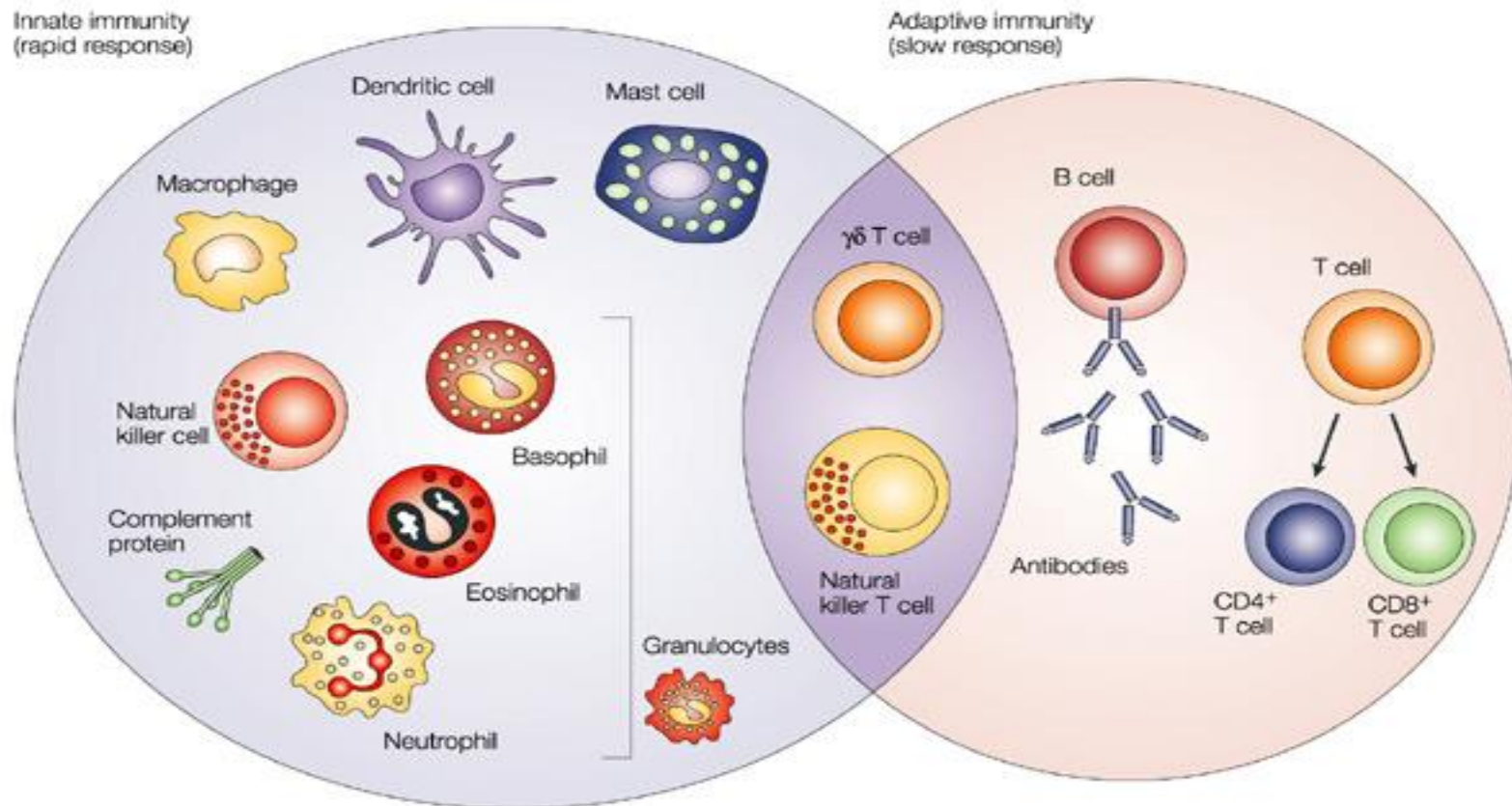
**Macrophage**



(b)

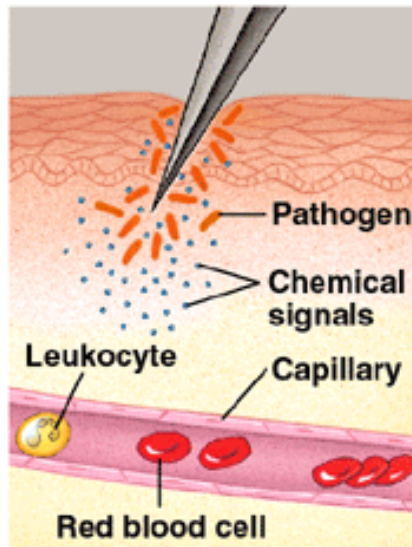
# The Immune System

- The function of the immune system is to fight infection through the production of cells that inactivate foreign substances or cells which is called Immunity



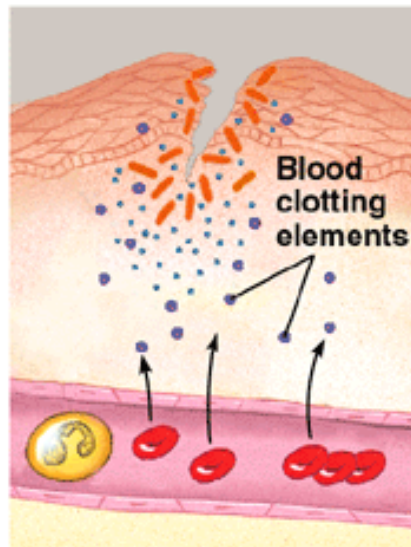


# Inflammatory Response



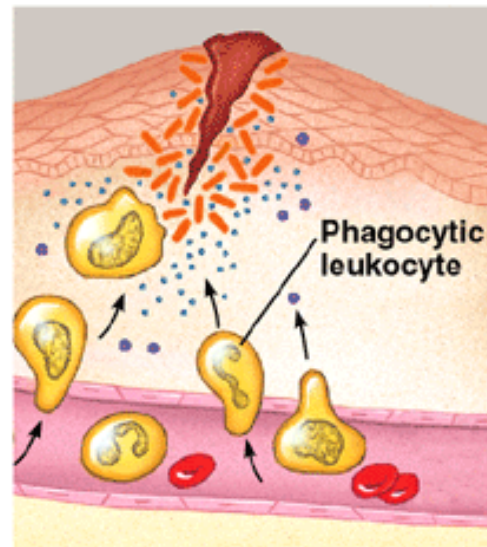
1

Histamine & prostaglandins released



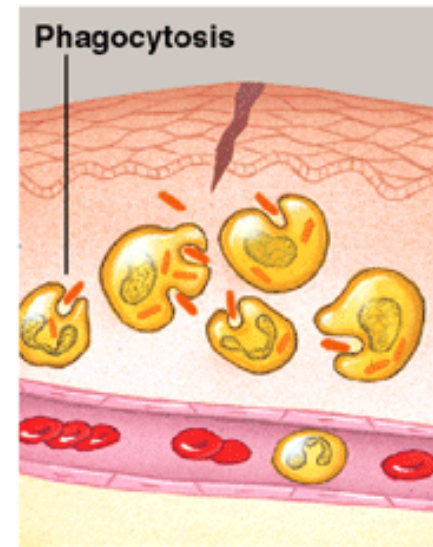
2

Capillaries dilate  
Clotting begins



3

Chemotactic factors attract phagocytic cells



4

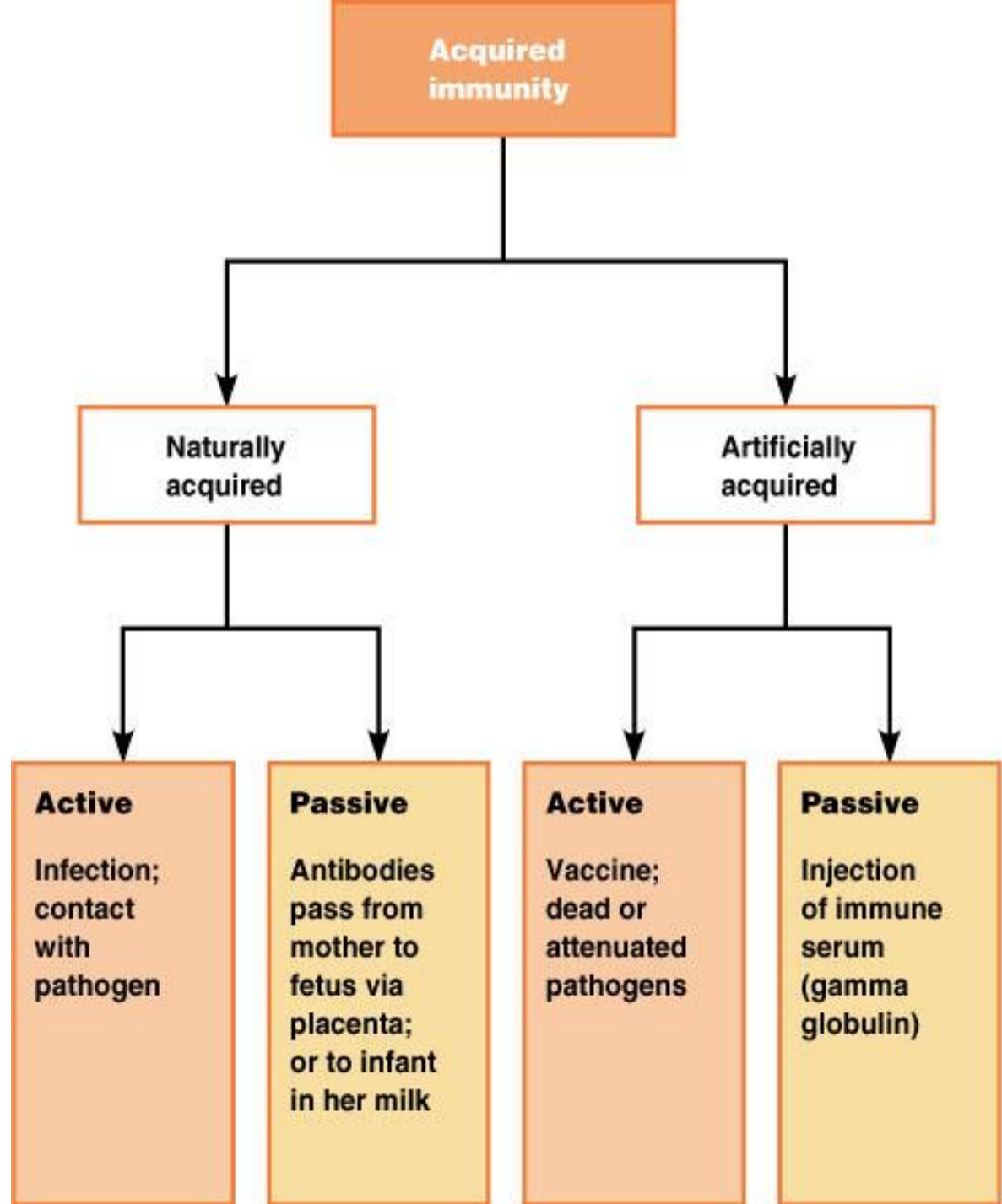
Phagocytes consume pathogens & cell debris

# Types of Immunity

- **Active Immunity**
  - Naturally-Acquired Active Immunity
  - Artificially-Acquired Active Immunity
- **Passive Immunity**
  - Naturally-Acquired Passive Immunity
  - Artificially-Acquired Passive Immunity



# Types of Acquired Immunity



# Active Immunity

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- The production of antibodies against a specific disease by the immune system.
- Naturally acquired through disease
- Artificially acquired through vaccination
  - Vaccines include inactivated toxins, killed microbes, parts of microbes, and viable but weakened microbes.
- Active immunity is usually permanent

- A vaccinated person has a secondary response based on memory cells when encountering the specific pathogen.
  - Routine immunization against infectious diseases such as measles and whooping cough, and has led to the eradication of smallpox, a viral disease.
  - Unfortunately, not all infectious agents are easily managed by vaccination.
    - HIV vaccine in the works

# Passive Immunity

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- **Passive Immunity-** Protection against disease through antibodies produced by another human being or animal.
- Effective, but temporary
- Ex. Maternal antibodies
- Colostrum.

- Passive immunity can be transferred artificially by injecting antibodies from an animal that is already immune to a disease into another animal.
  - Rabies treatment: injection with antibodies against rabies virus that are both **passive immunizations** (the immediate fight) and **active immunizations** (longer term defense).

# Lymphocytes

- T cells or T Lymphocytes
  - mature in thymus gland
  - Cell mediated immunity
- B cells or B Lymphocytes
  - mature in bone marrow
  - antibody-mediated immunity

# T Cell or T Lymphocyte (Cell Mediated Immunity)

- T Cell (cell mediated immunity)
  - circulating lymphocytes
  - produced in bone marrow
  - matures in thymus
  - live for years
  - primary function: coordinate immune defenses and kill organisms



# Lymphocyte: T Cells

- helper T cells - essential to proper functioning of immune system
- Memory cells- remember antigens and stimulate a faster response if same antigen introduced at a later time

# Immune System Response to Antigens

## Humoral Immunity

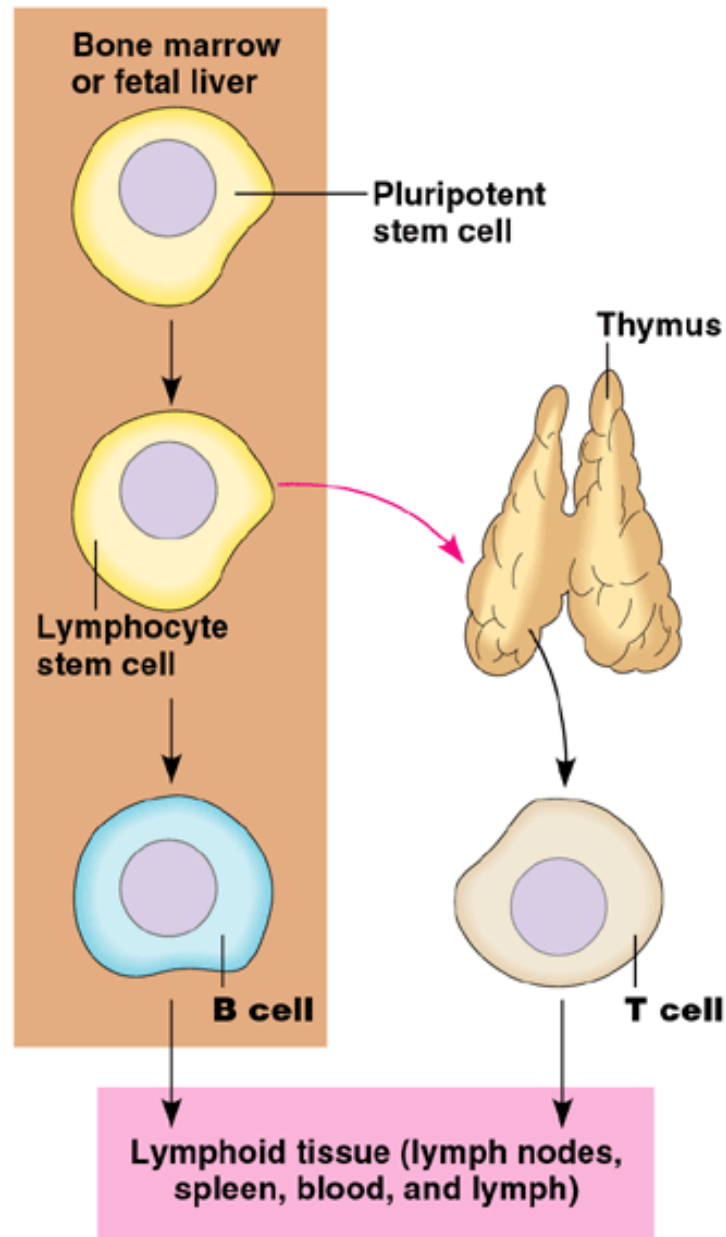
- Involves antibodies (secreted from B cells) dissolved in the blood plasma.
- Demonstrated as a immune response using only the blood serum.
- Defense against bacteria, bacterial toxins, & viruses.

# Immune System Response to Antigens

## **Cell-Mediated Immunity**

- Involves the activities of specific white blood cells (T cells).
- Defense against cancer cells, virus-infected cells, fungi, animal parasites, & foreign cells from transplants.

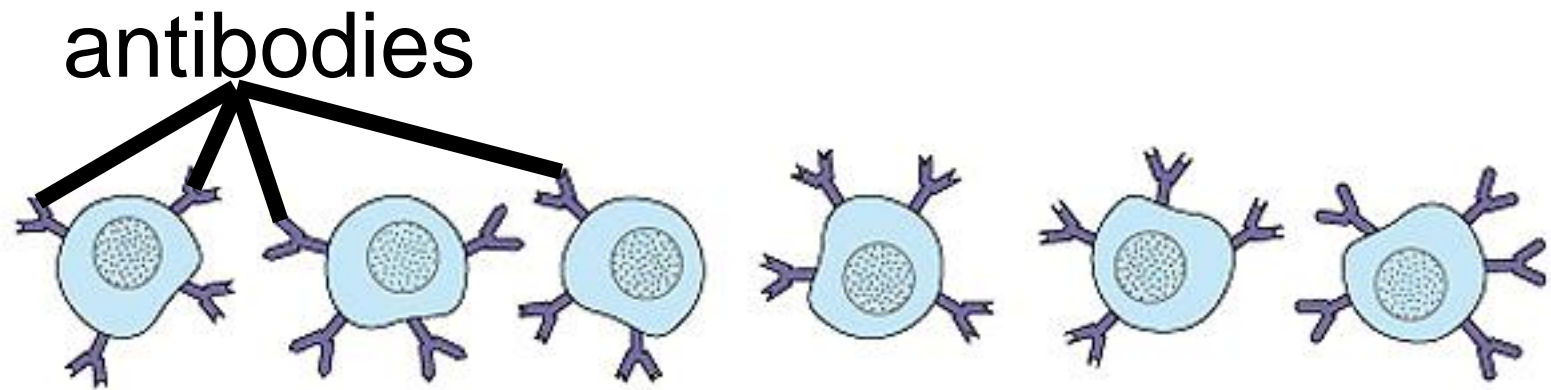
# Lymphocyte Formation



# B Cells

- Mature in bone marrow
- Involved in humoral immunity
- Once activated by antigen, proliferate into two clones of cells: plasma cells that secrete **antibodies** and **memory cells** that may be converted into plasma cells at a later time

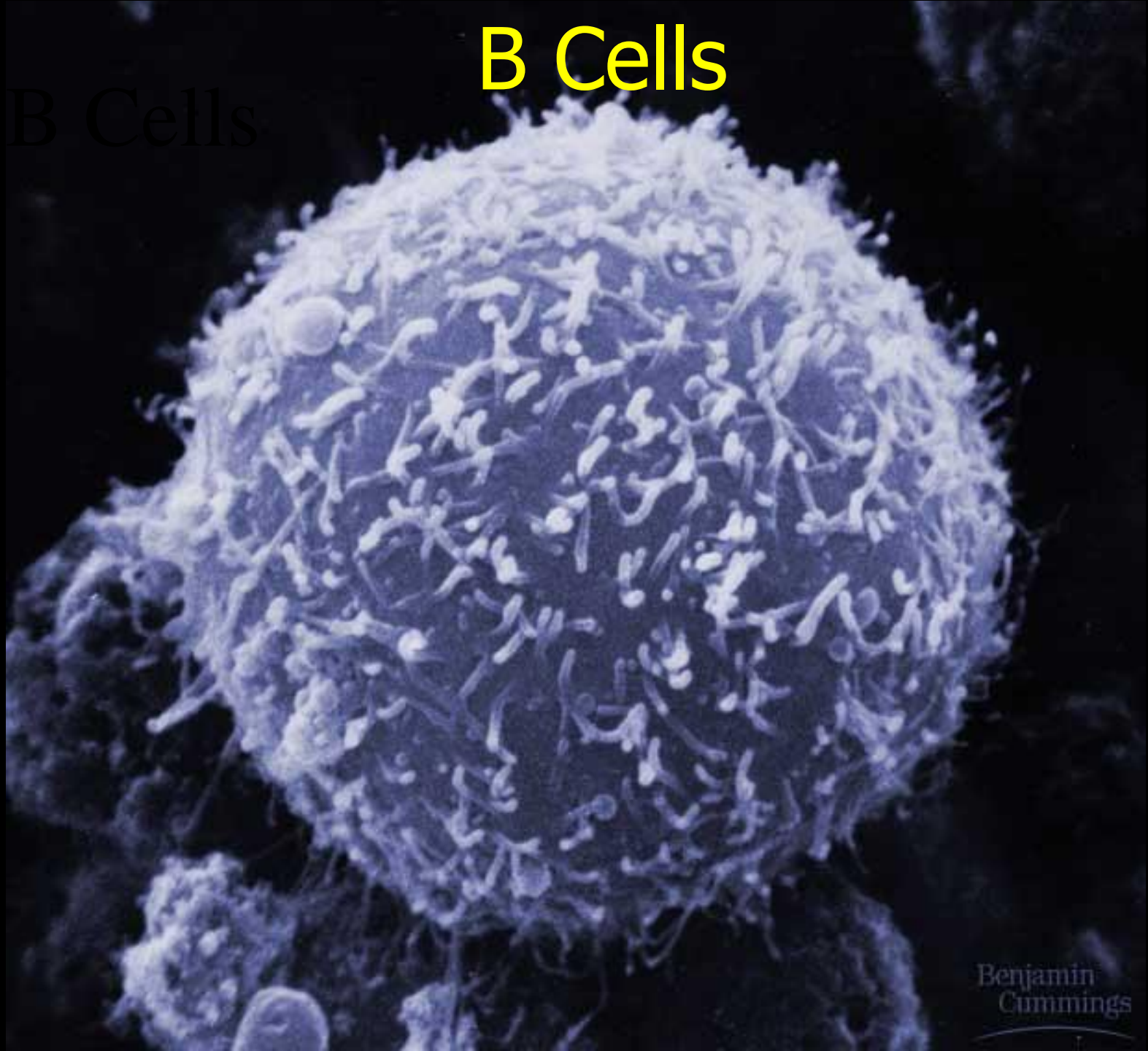
# B Cells





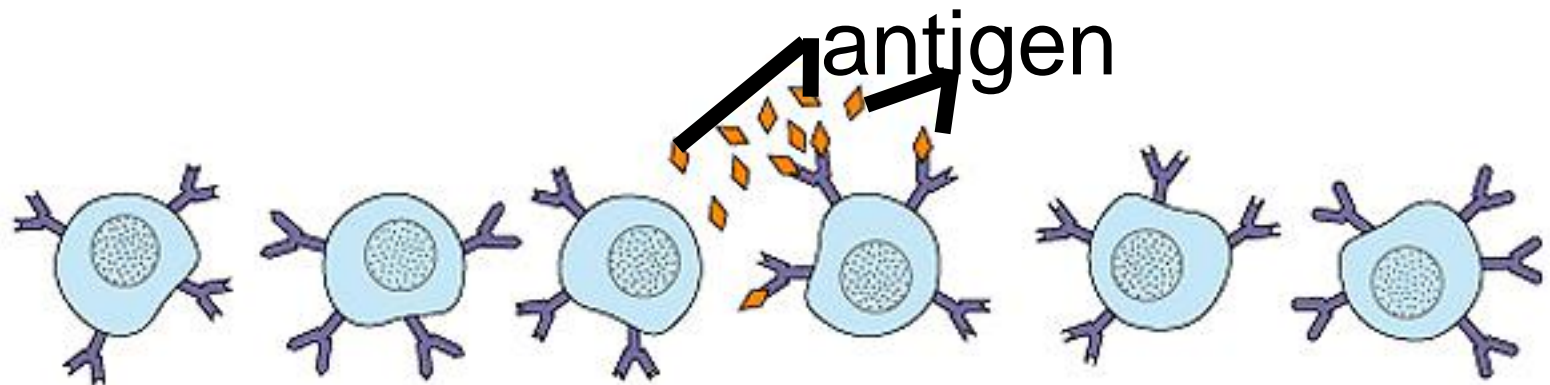
# B Cells

B Cells

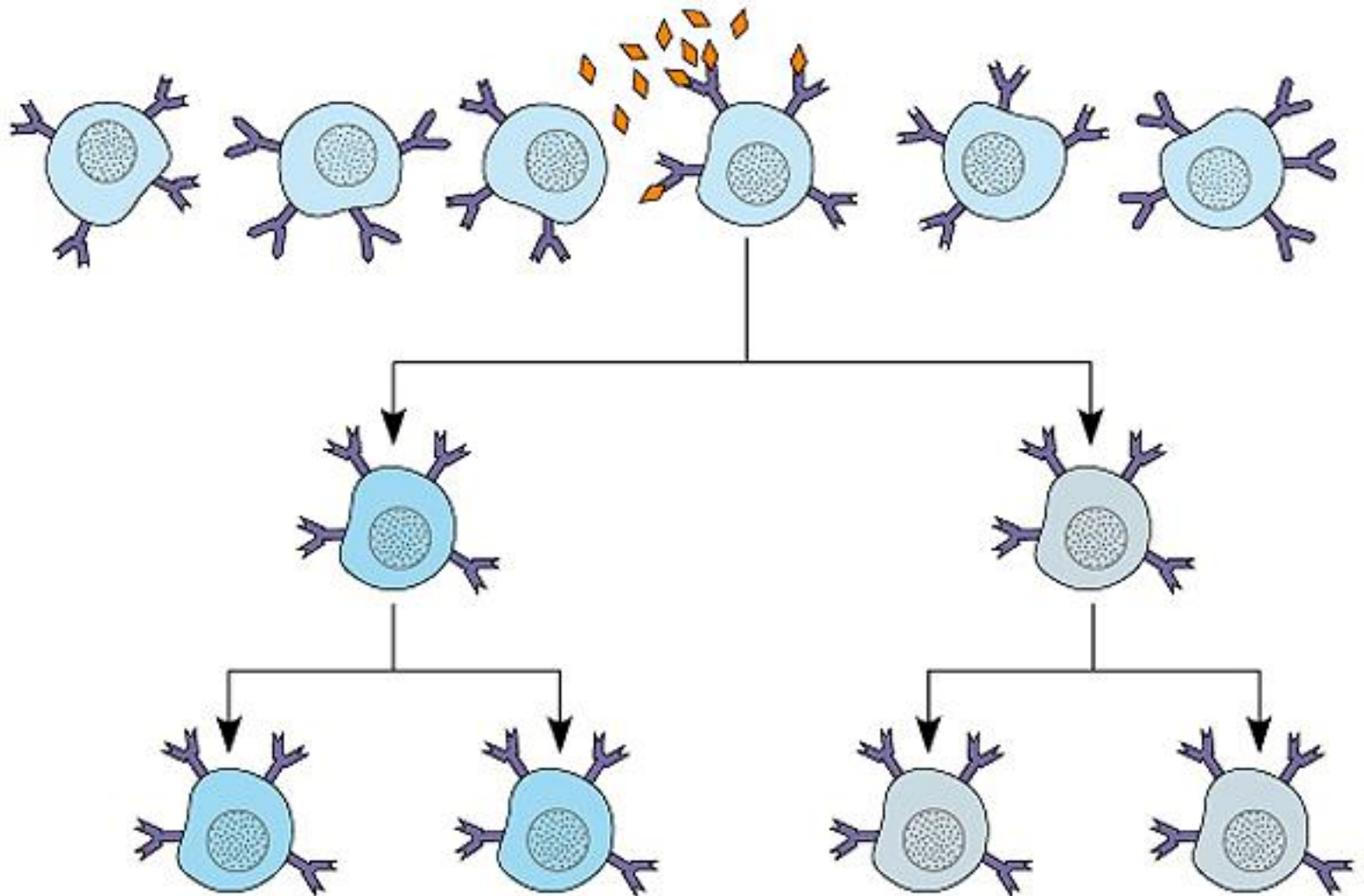


Benjamin  
Cummings

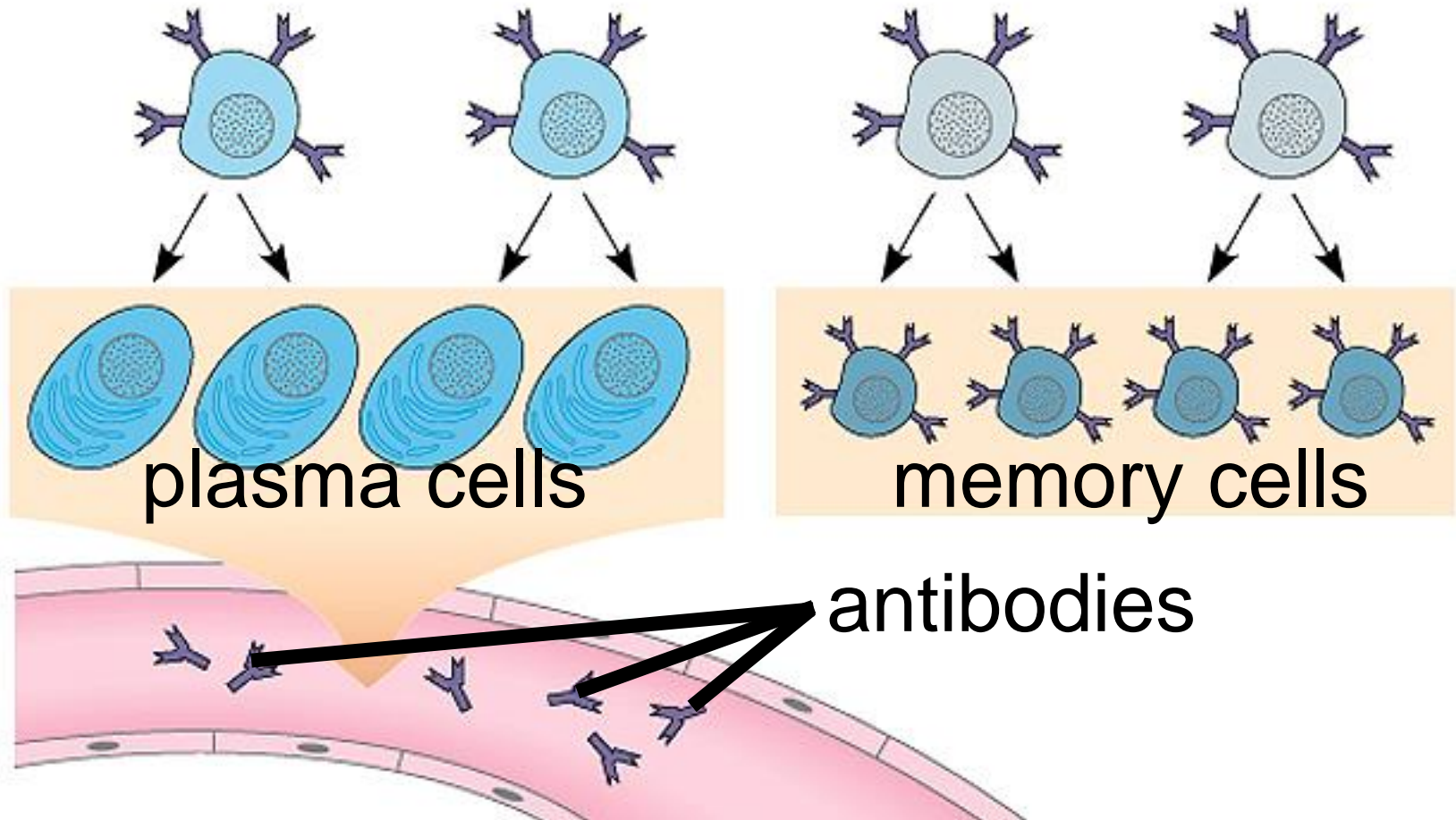
# Activation of B Cells by Antigen



# Clonal Selection



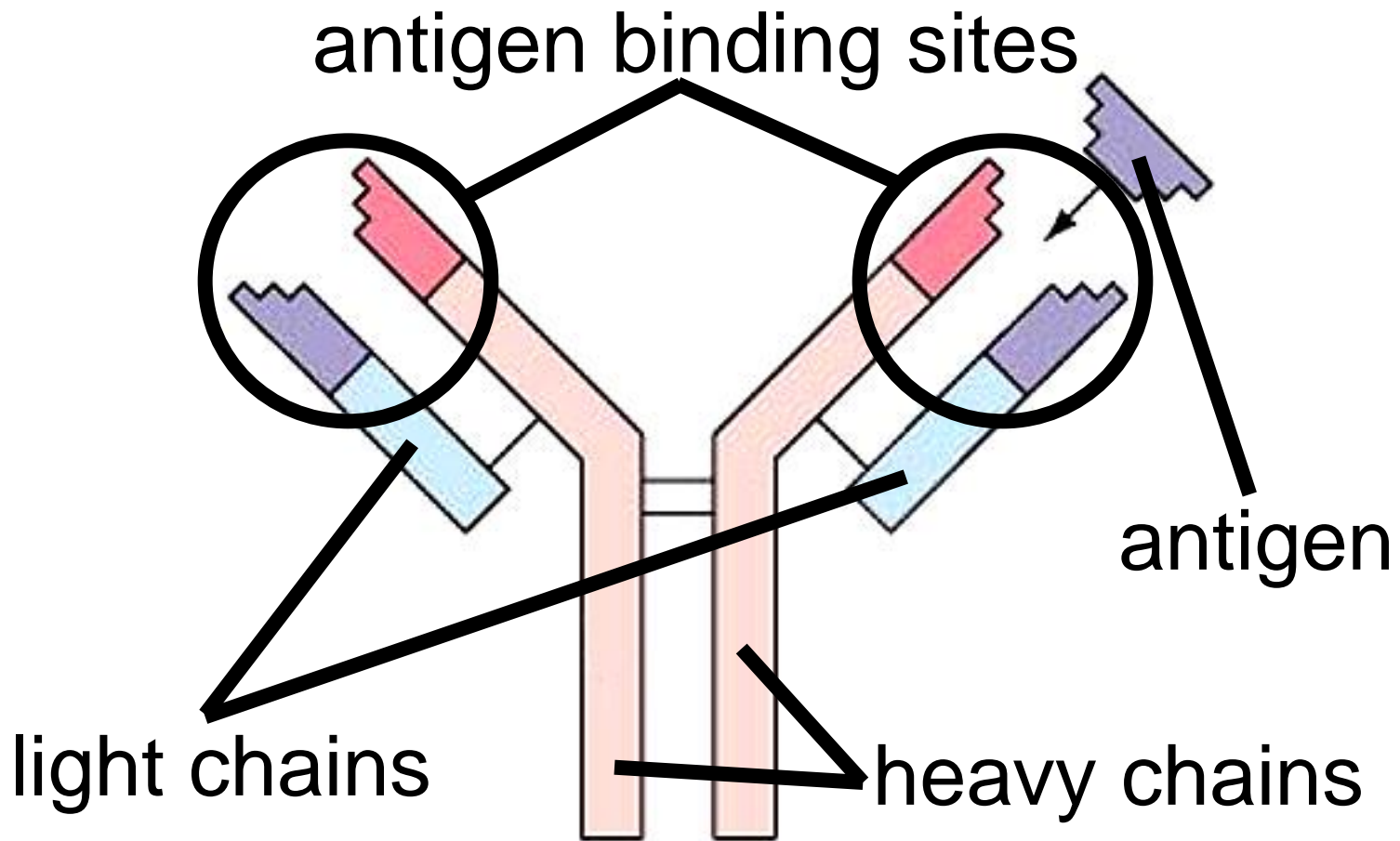
# Clonal Selection



- Antibodies constitute a group of globular serum proteins called **immunoglobins (Igs)**.
  - A typical antibody molecule has two identical antigen-binding sites specific for the epitope that provokes its production.



# Antibody Molecule

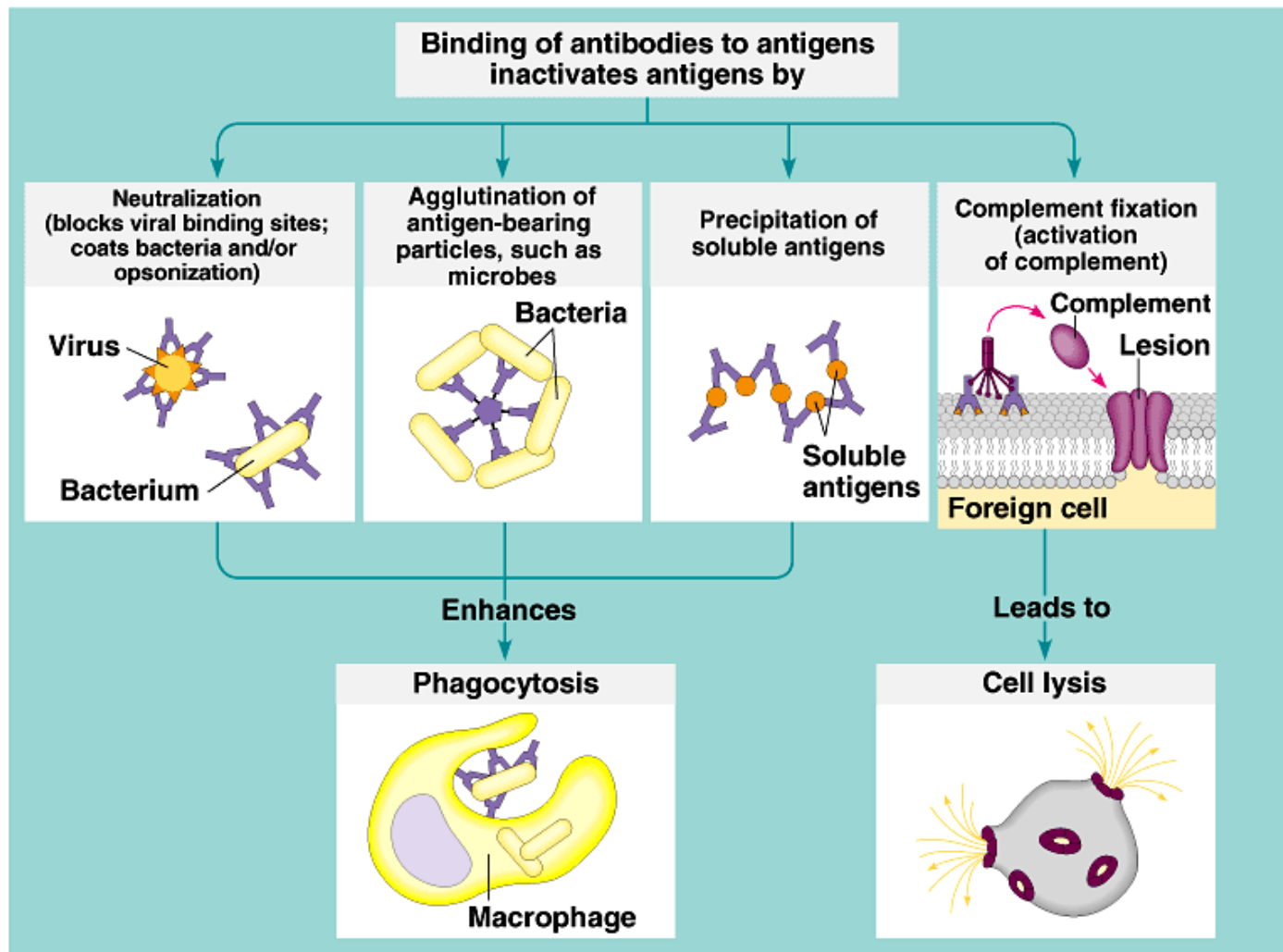




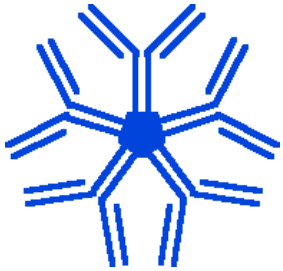
# Mechanisms on Antibody Action

- Precipitation of soluble antigens
- Agglutination of foreign cells
- Neutralization
- Enhanced phagocytosis
- Complement activation leading to cell lysis
- Stimulates inflammation

- The binding of antibodies to antigens to form antigen-antibody complexes is the basis of several antigen disposal mechanisms.



# Immunoglobulin Classes



## IgM

- 1<sup>st</sup> response to antigen
- Effective in agglutination
- Can't cross placenta



## IgD

- B cell activation
- Can't cross placenta



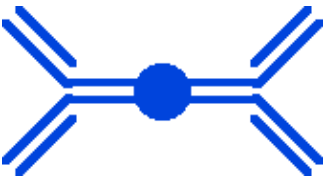
## IgG

- Most common form
- Crosses blood vessels
- Crosses placenta (passive immunity to fetus)



## IgE

- Histamine reactions and allergies



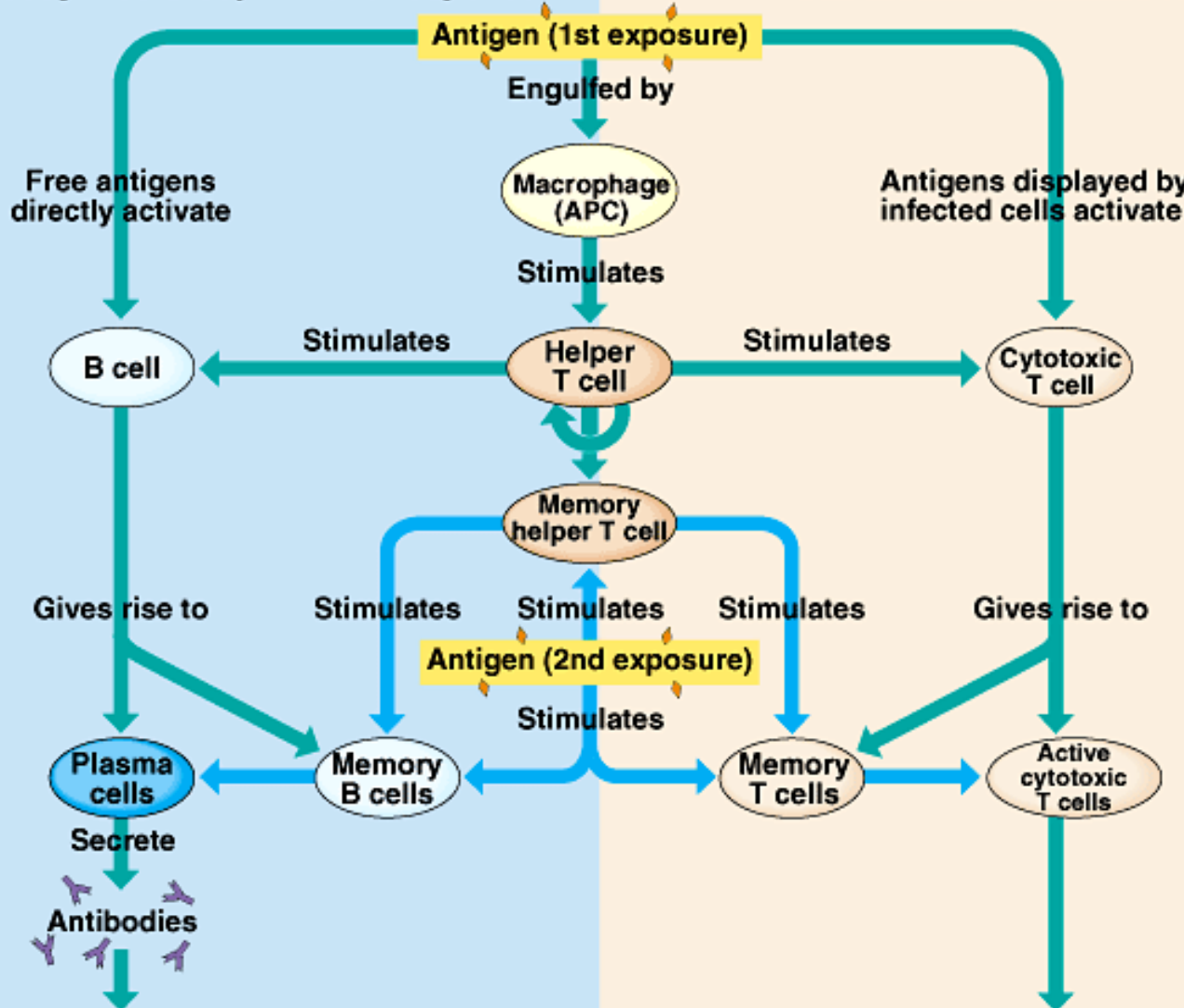
## IgA

- Secreted from mucus membranes
- Prevents attachment of bacteria to epithelial surface
- In colostrum

# Overview of Immune System Responses

## Humoral (antibody-mediated) immune response

## Cell-mediated immune response



Defend against extracellular pathogens by binding to antigens and making the pathogens easier targets for phagocytes and complement.

Defend against intracellular pathogens and cancer by binding to and lysing the infected cells or cancer cells.

# T Cells

- Mature in thymus
- Involved in cell-mediated immunity
- Activated when another cell presents antigen to them
- Several types of T cells: cytotoxic T cells, helper T cells, suppressor T cells, and memory T cells

# T Cells

- There are two main types of T cells, and each responds to one class of MHC molecule.
  - **Cytotoxic T cells ( $T_C$ )** have antigen receptors that bind to protein fragments displayed by the body's class I MHC molecules.
  - **Helper T cells ( $T_H$ )** have receptors that bind to peptides displayed by the body's class II MHC molecules.