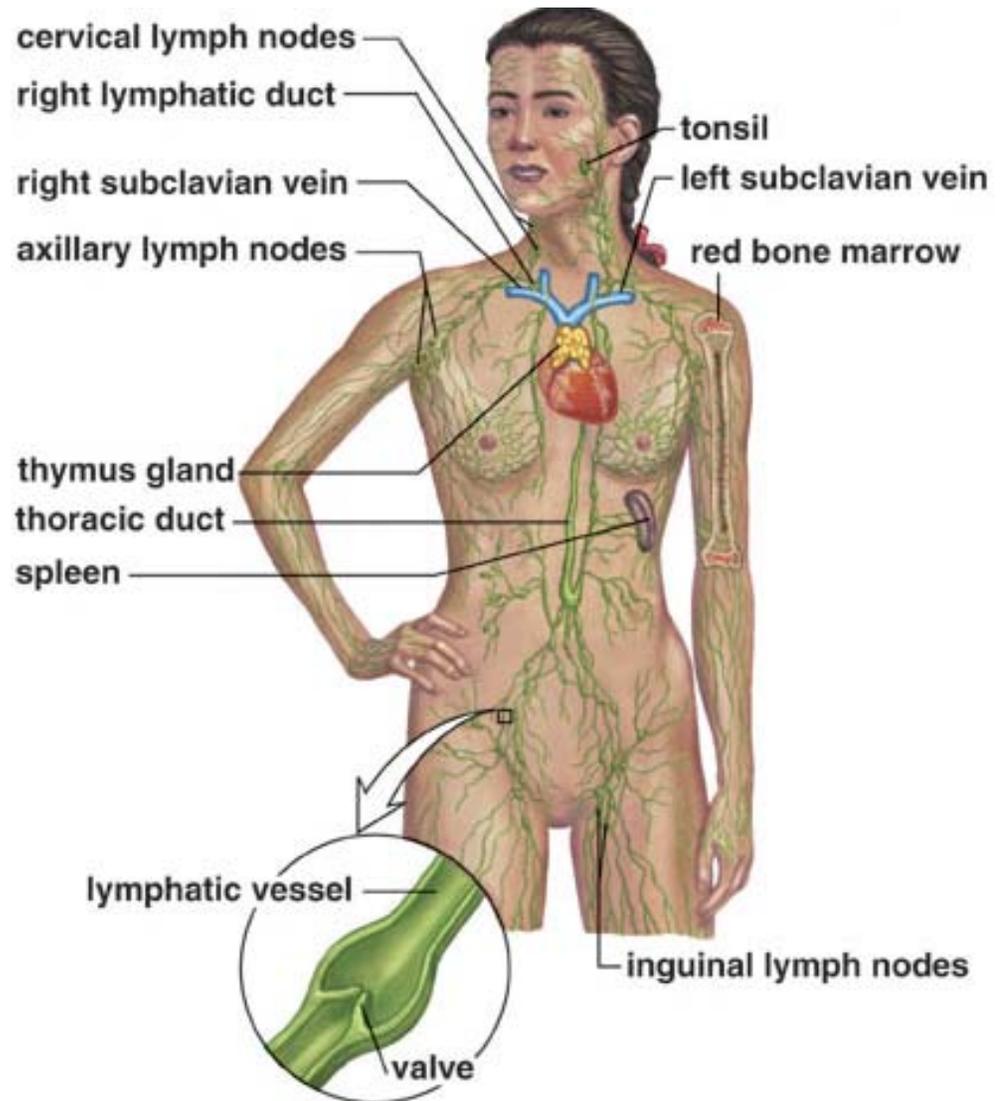


# Chapter 13- The Body's Defense System



# Section 13.1- Lymphatic System

- Consists of lymphatic vessels and organs
- Closely associated with the cardiovascular system



# Lymphatic System- Functions

## 1. Fluid Balance

- takes up and returns excess fluid to bloodstream

## 2. Fat Absorption

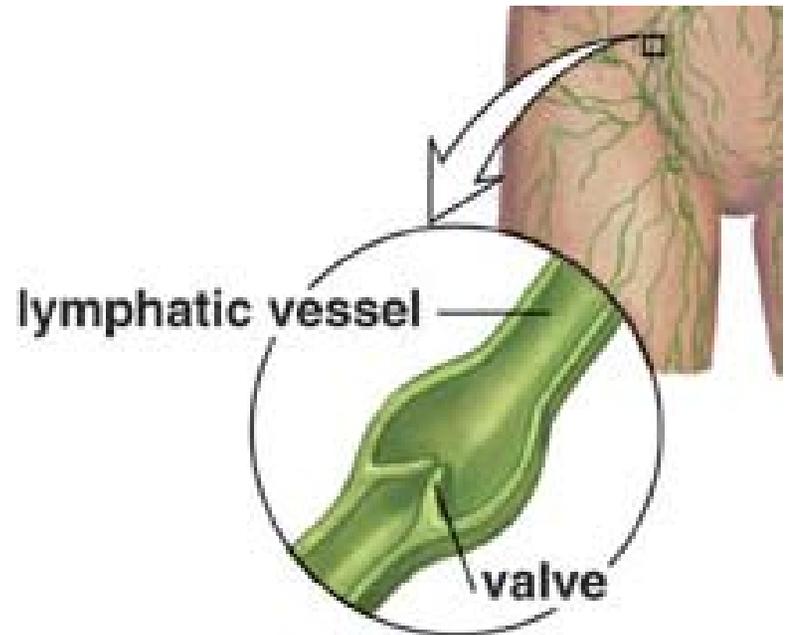
- absorbs fats from digestive tract and transports them to bloodstream

## 3. Defense

- WBC in lymphatic vessels and organs

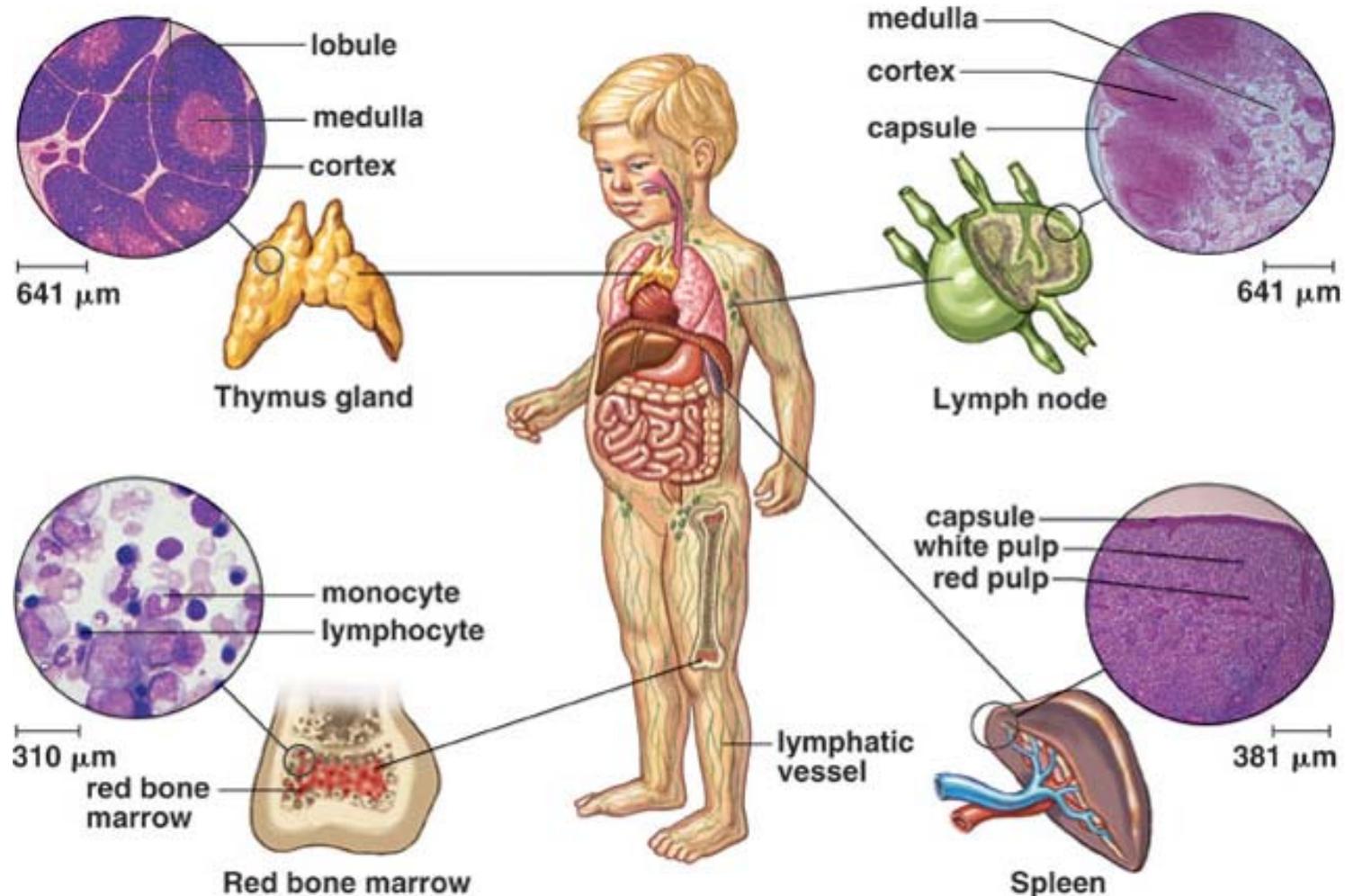
# Lymphatic Vessels

- One-way system
  - Valves
- Returns excess fluid back to bloodstream
- Lymphatic capillaries
- Lymphatic vessels
- Lymphatic ducts
  - Thoracic duct
  - Right lymphatic duct



# Section 13.2- Lymphatic Organs

- Contains large number of lymphocytes



# Lymphatic Organs

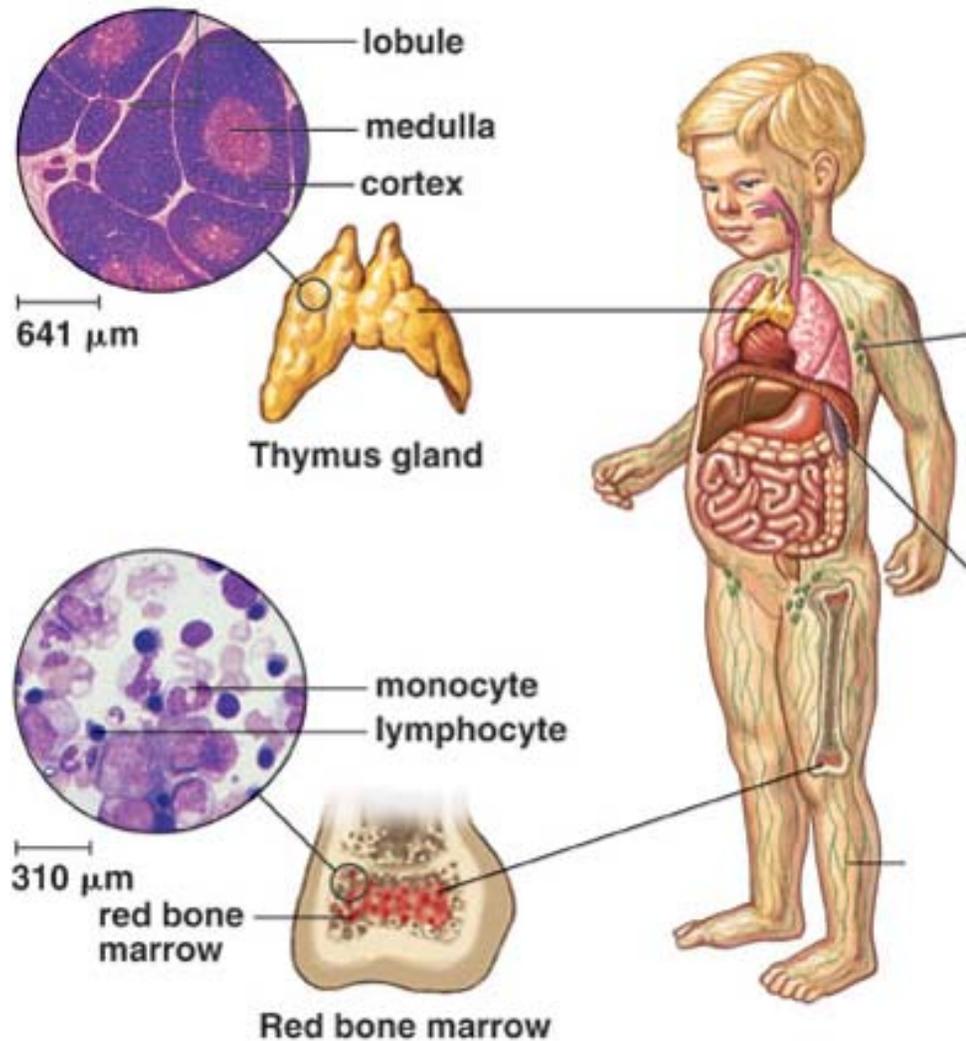
## Primary Organs

### 1. Red Bone Marrow

- Stem cells become lymphocytes

### 2. Thymus

- Gland where T lymphocytes mature



# Lymphatic Organs

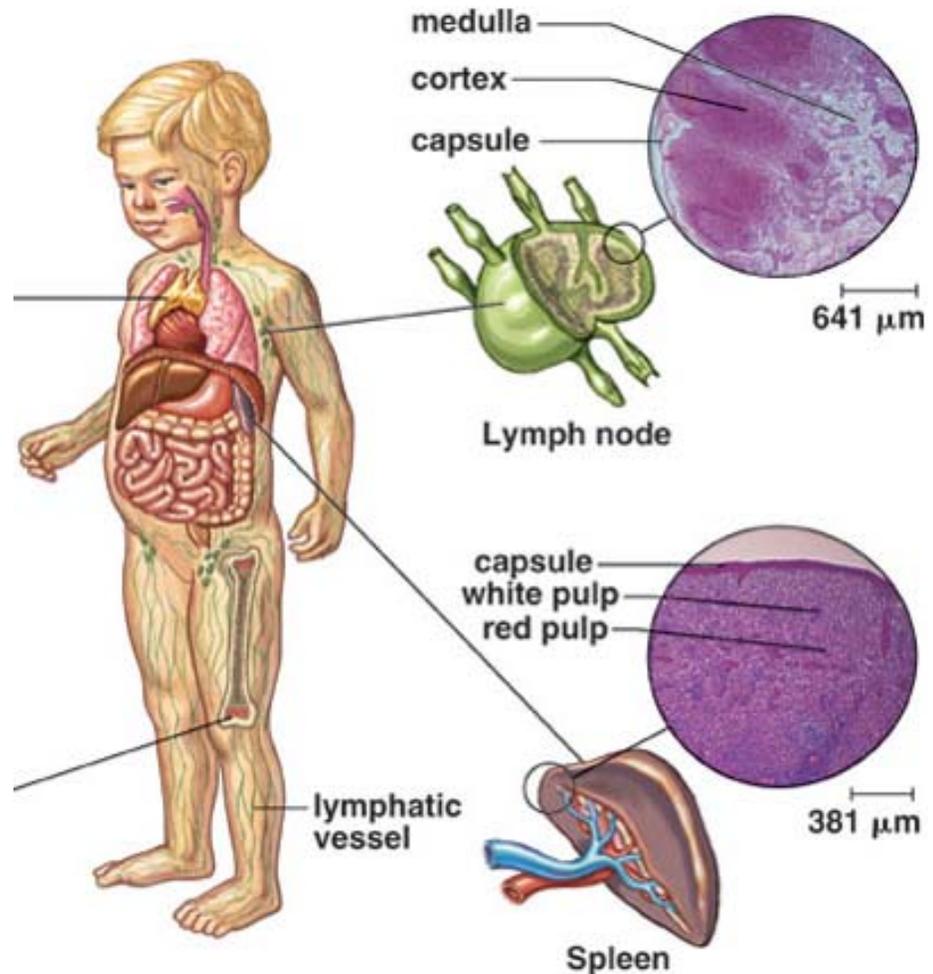
## Secondary Organs

### 1. Spleen

- Filters blood

### 2. Lymph Nodes

- Small oval structures located on lymph vessels
- Packed with lymphocytes
- Filters lymph



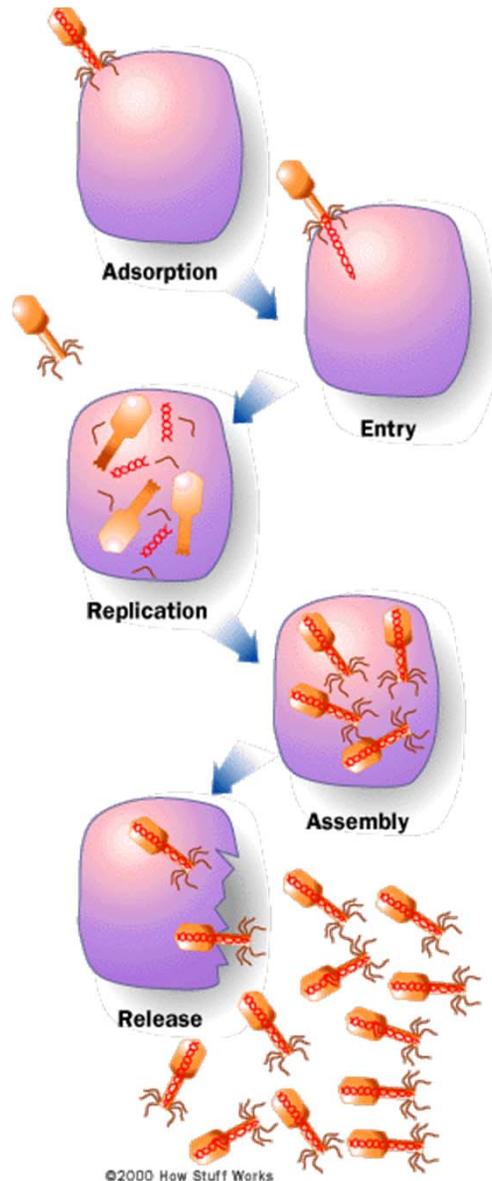
## 13.3- Body's Defenses

### **2 types of Body Defenses**

1. Non-Specific Defenses
2. Specific Defenses

# Non-Specific Defenses

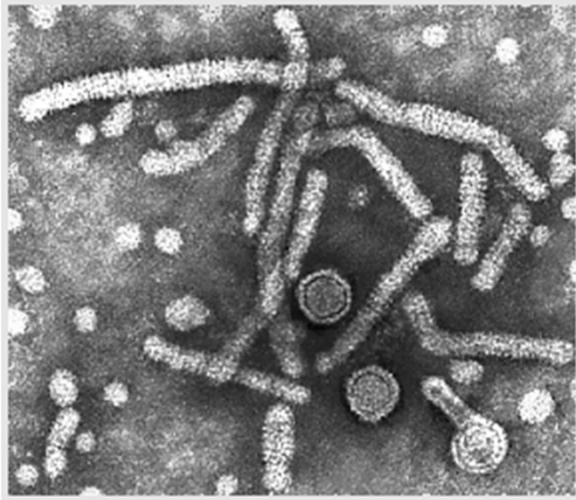
- Infectious diseases are caused by agents invading the body



# Identifying Pathogens

## Pathogen

- Agent (bacteria or virus) that causes disease



**Hepatitis B Virus**



**Herpes Virus**

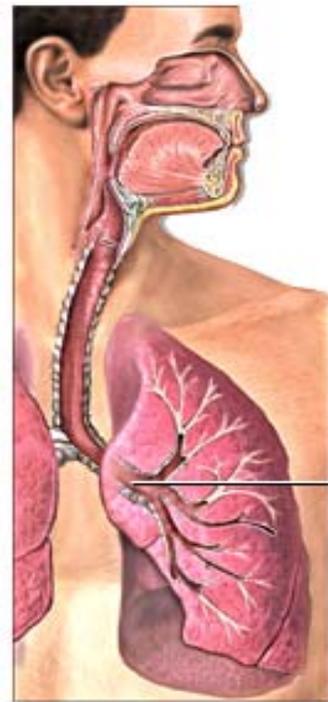
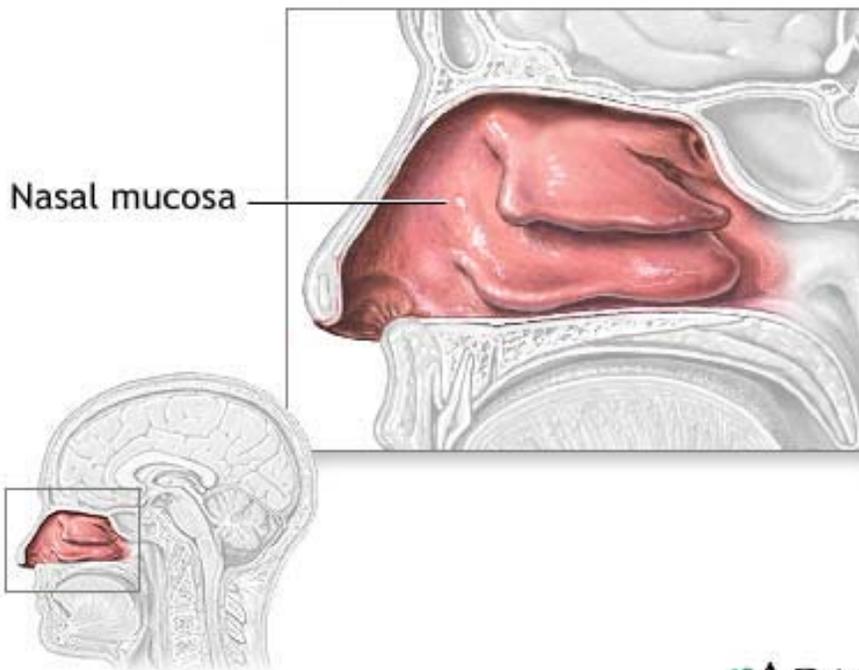
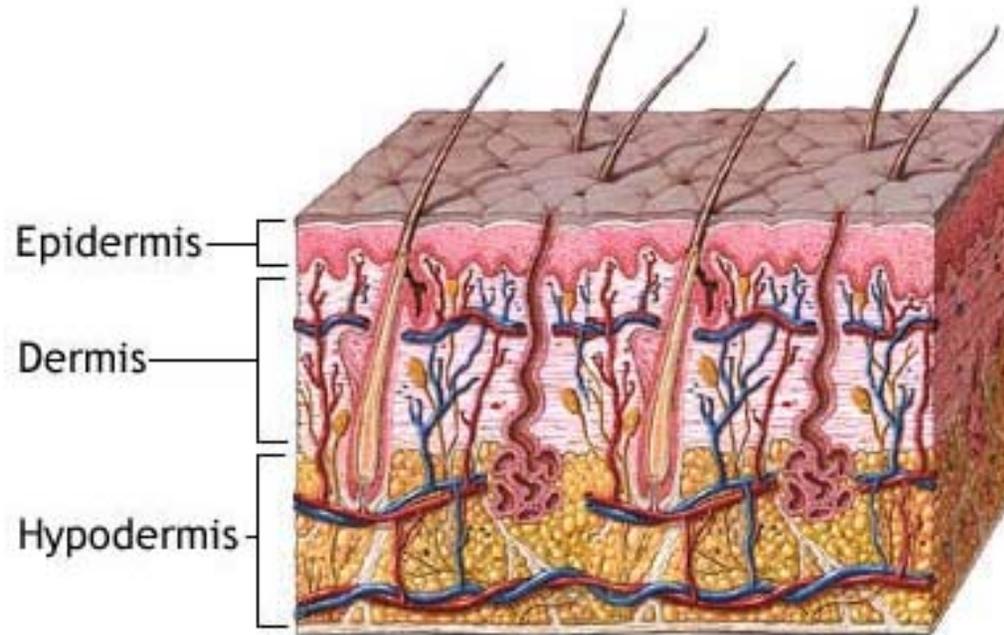
# Non-Specific Defenses

## Non Specific Defenses

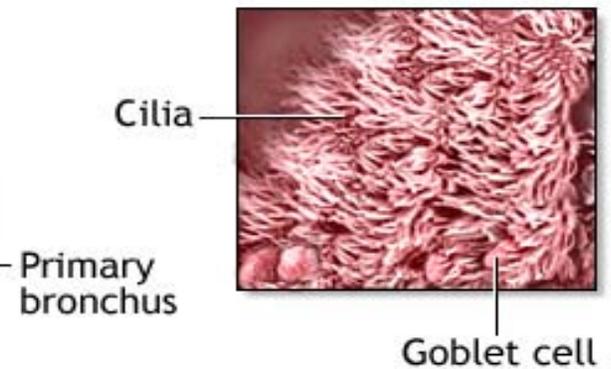
- Protects against any type of pathogen regardless of identity

## First Line of Defense:

- **Barriers**
  - Skin
  - Mucous membranes
    - Mucous, cilia
  - Oil, sweat, wax



Hair-like projections called cilia line the primary bronchus to remove microbes and debris from the interior of the lungs



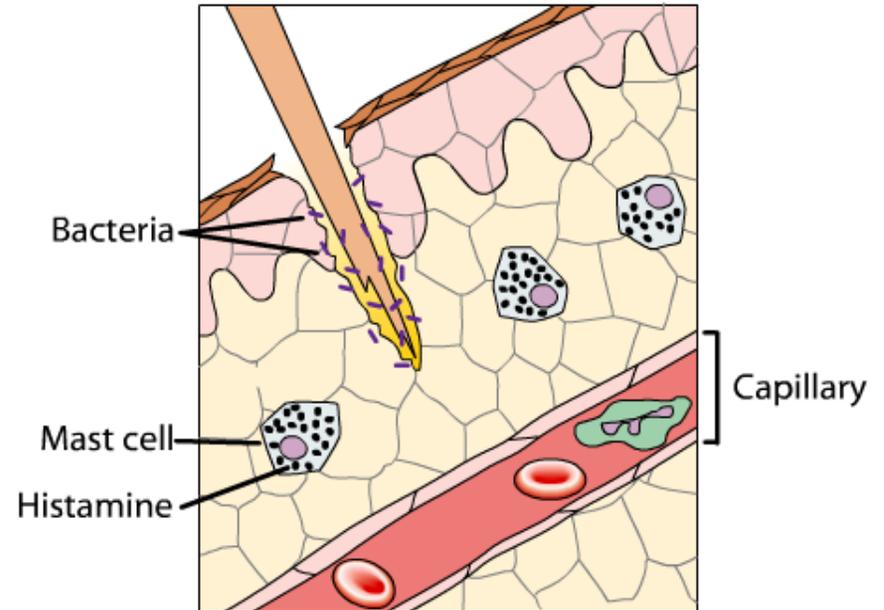
# Non-Specific Defenses

## Second Line of Defense:

- Inflammatory Response
- Natural Killer Cells
- Temperature Response
- Proteins

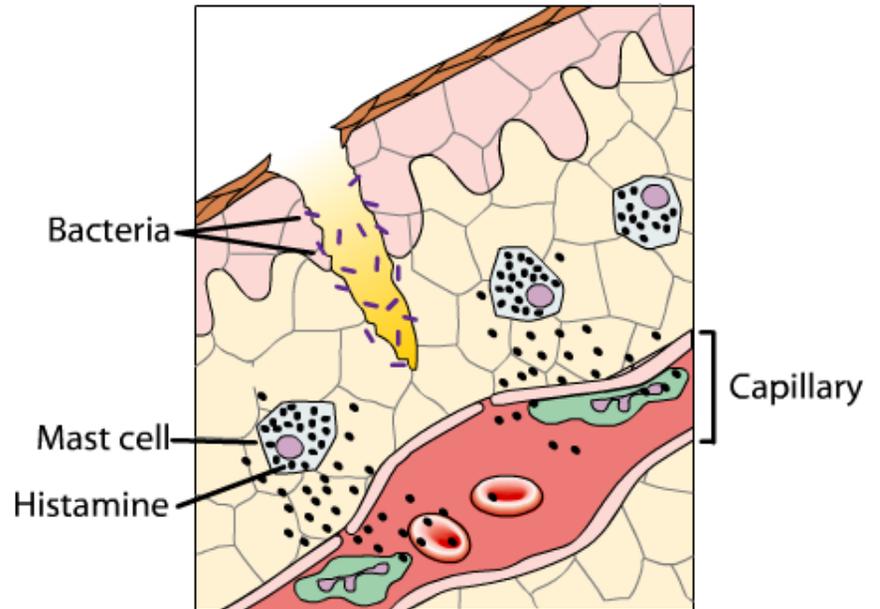
# Inflammatory Response

1. Break in the barrier



2. Mast cells release histamine (vasodilation and increases permeability of capillaries)

- Redness, swelling, warm, pain, clotting



# Inflammatory Response

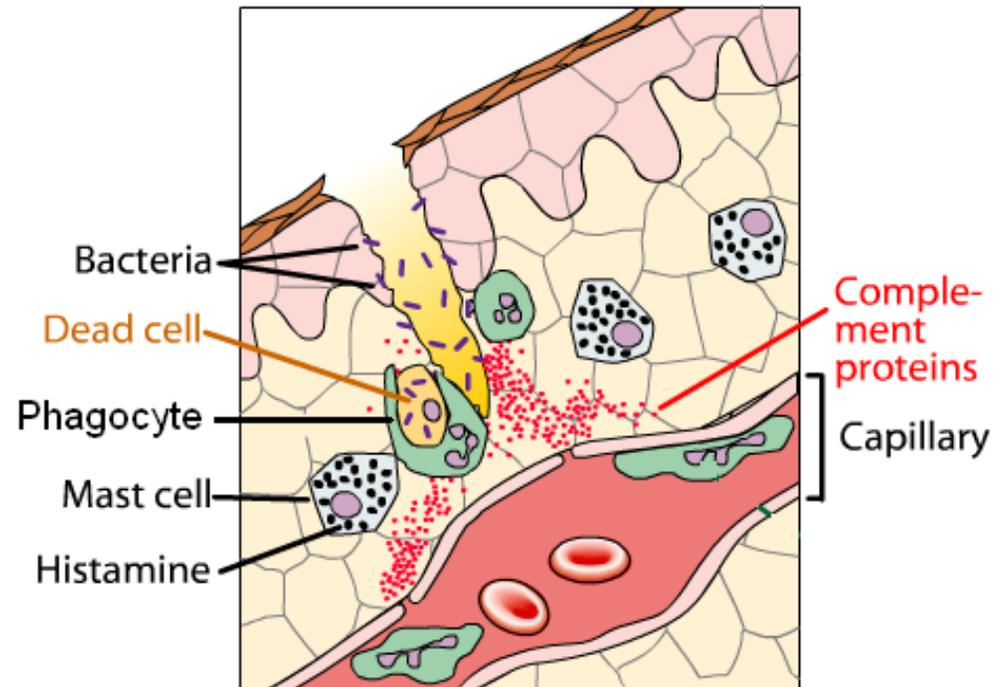
## 3. Phagocytosis

“eating” foreign  
pathogen and dead  
cellular debris

## Phagocytes

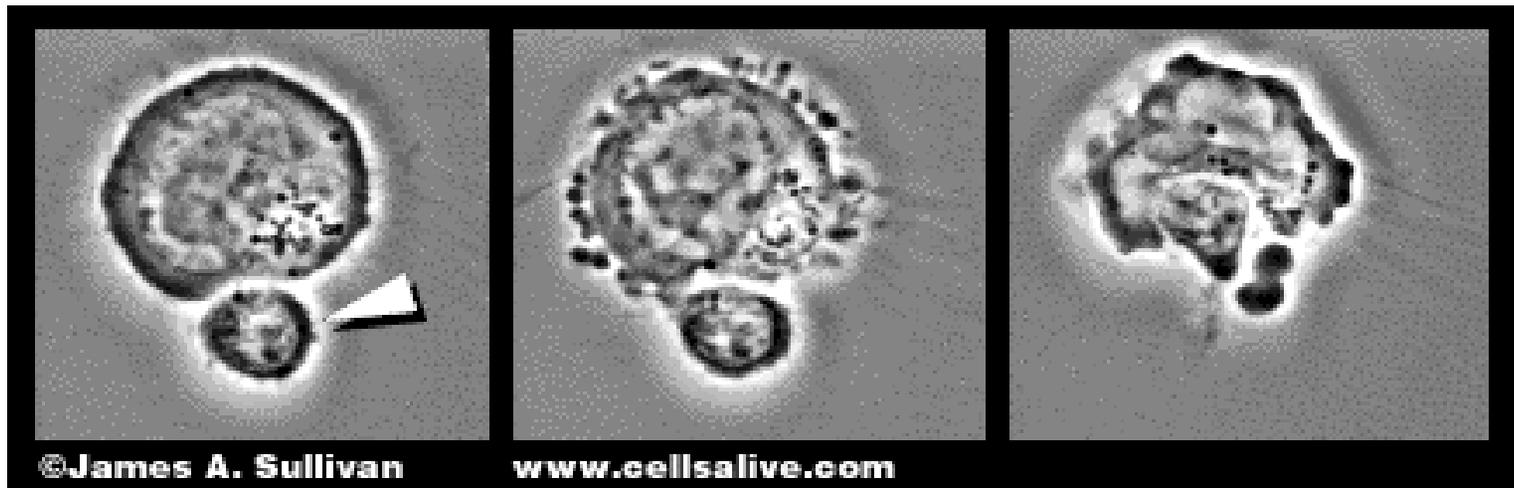
WBC that eat

- Neutrophils
- macrophage



# Natural Killer Cells

- Secretes a chemical mediator called perforin
- Perforin creates a pore in the cell membrane of the pathogen allowing water and salts to enter cell causing it to burst or lyse.



# Temperature Response

**Normal Body Temp.**

**98.6°**

## Fever

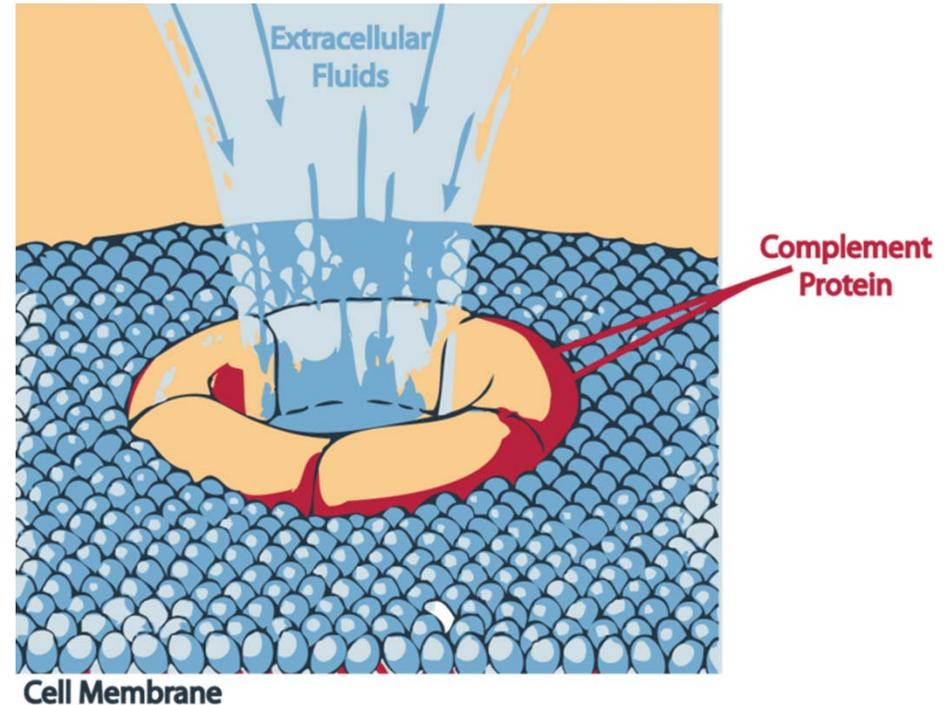
- Elevation of body temp. above 98.6°
- Heat destroys all cells



# Proteins

## Complement System

- Proteins in blood plasma that aid other immune responses

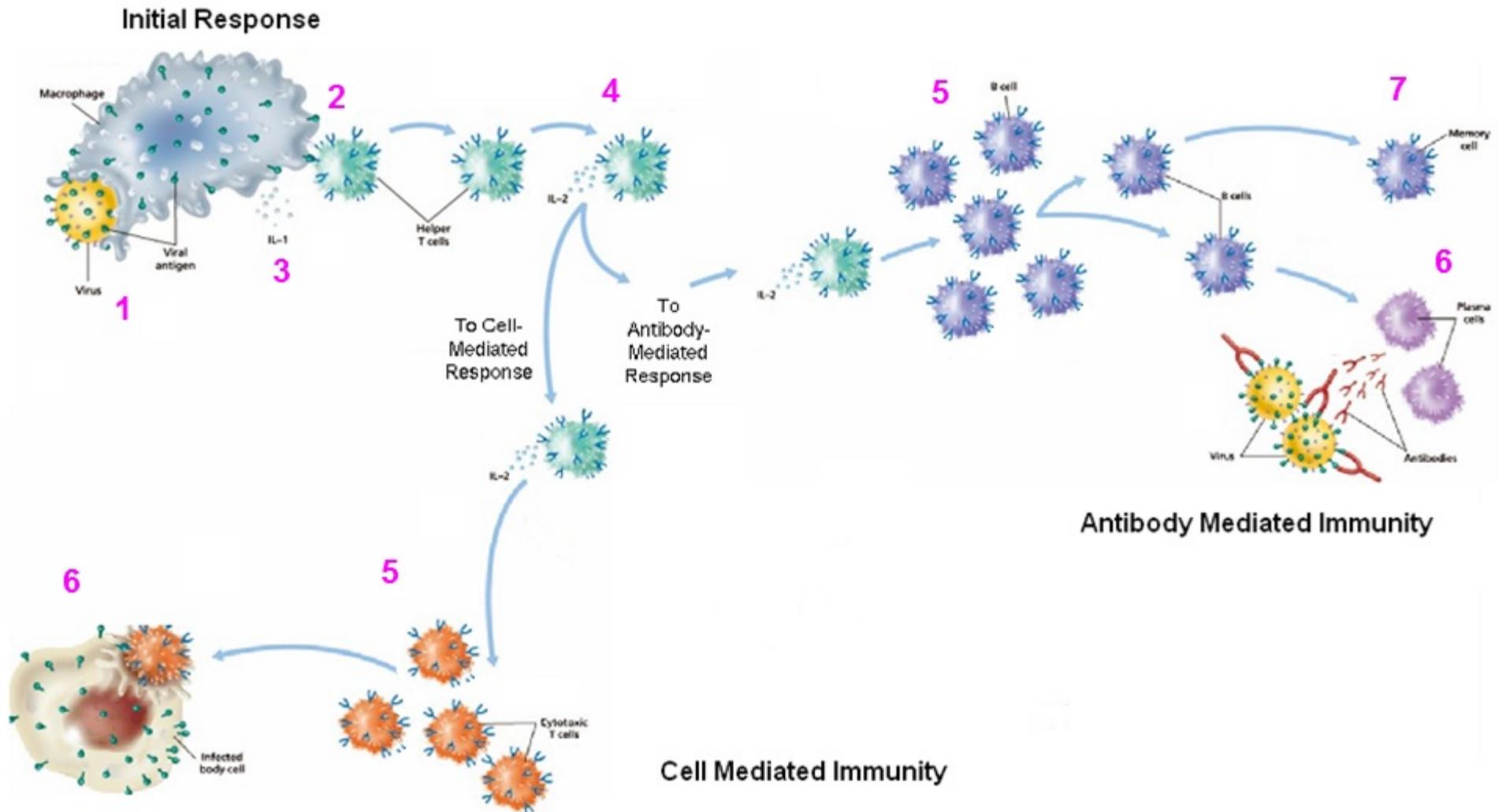


## Interferon

- Protein released by infected cells that causes nearby cells to make a protein to resist infection

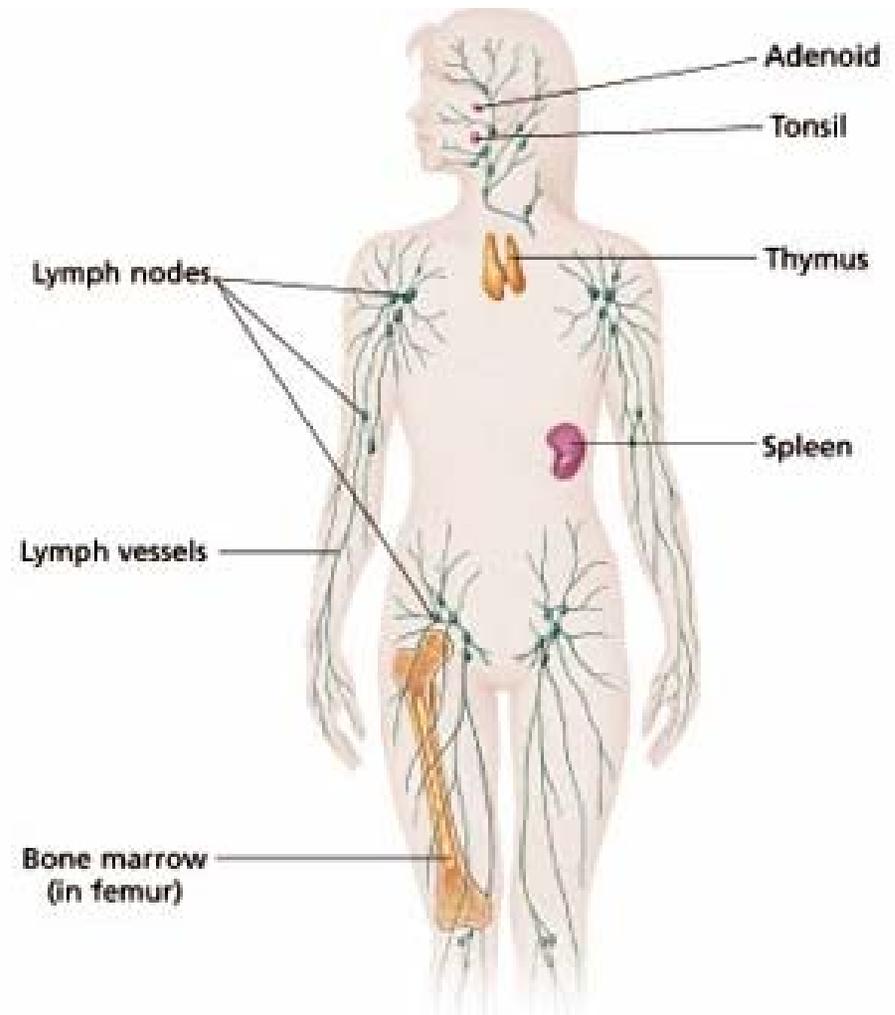


# Specific Defenses



# The Immune System

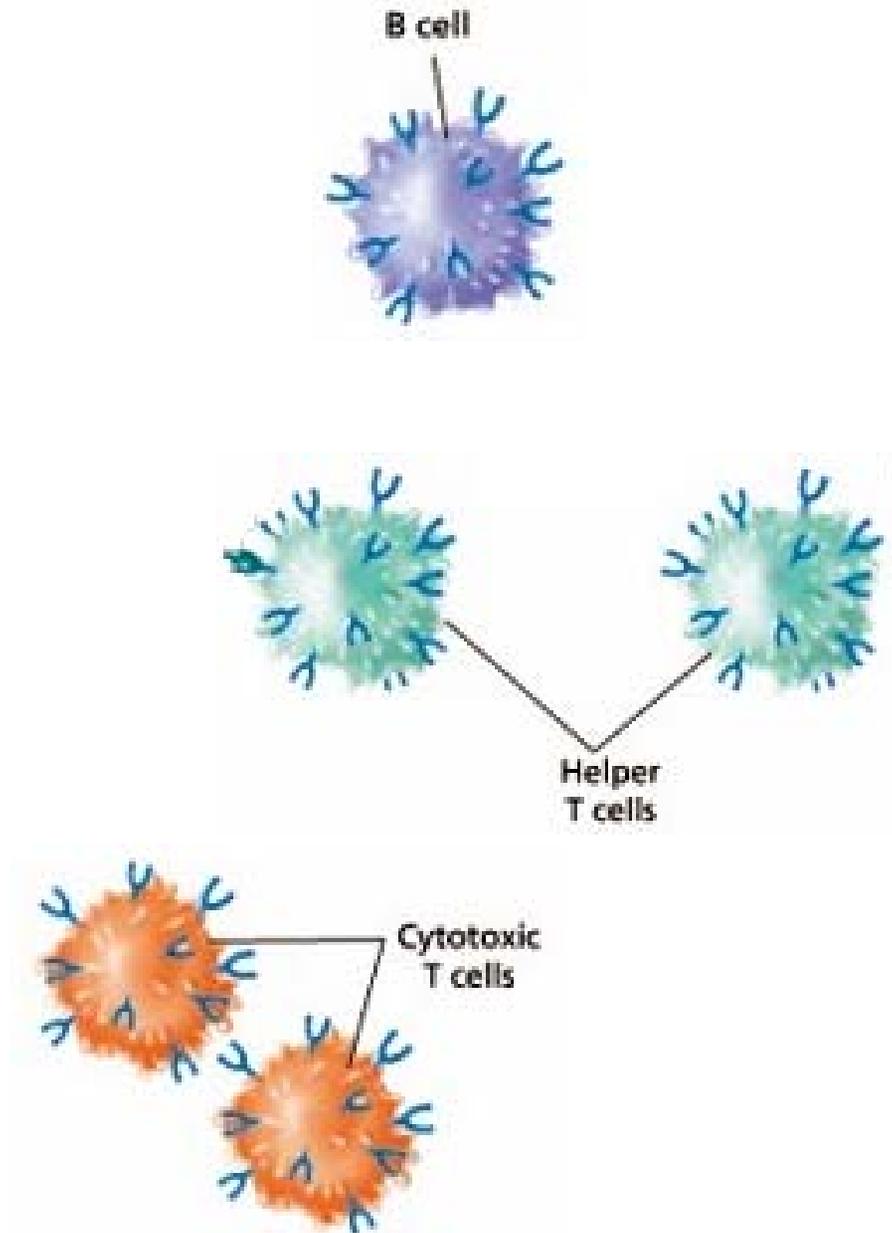
- Cells and tissues that recognize and attack foreign substances in the body
- Provides the body's specific defenses



# Cells of the Immune System

## Lymphocytes

- White blood cells of the immune system
  - **B Cells**
  - **T Cells**
    - **Helper**
    - **Cytotoxic**

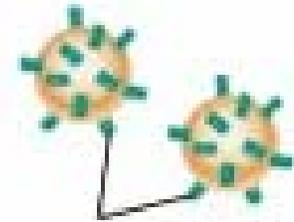


# Recognizing Pathogens

## Antigens

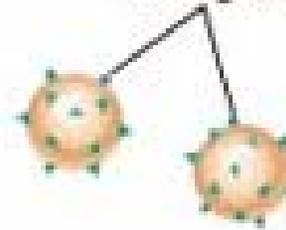
- Surface molecules on pathogens
- Any substance that the body recognizes as “non-self” and will defend against

PATHOGENS



Antigens

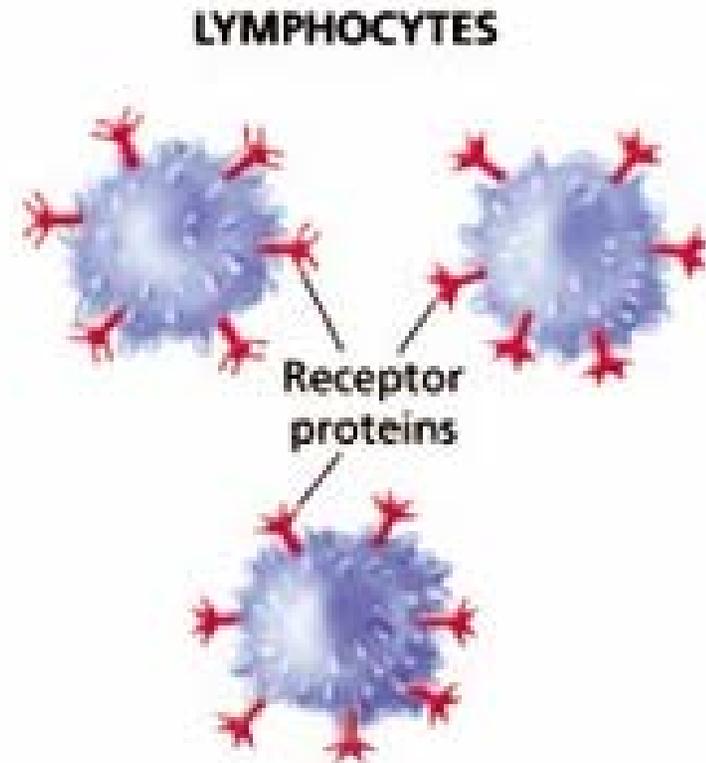
Antigens



# Recognizing Pathogens

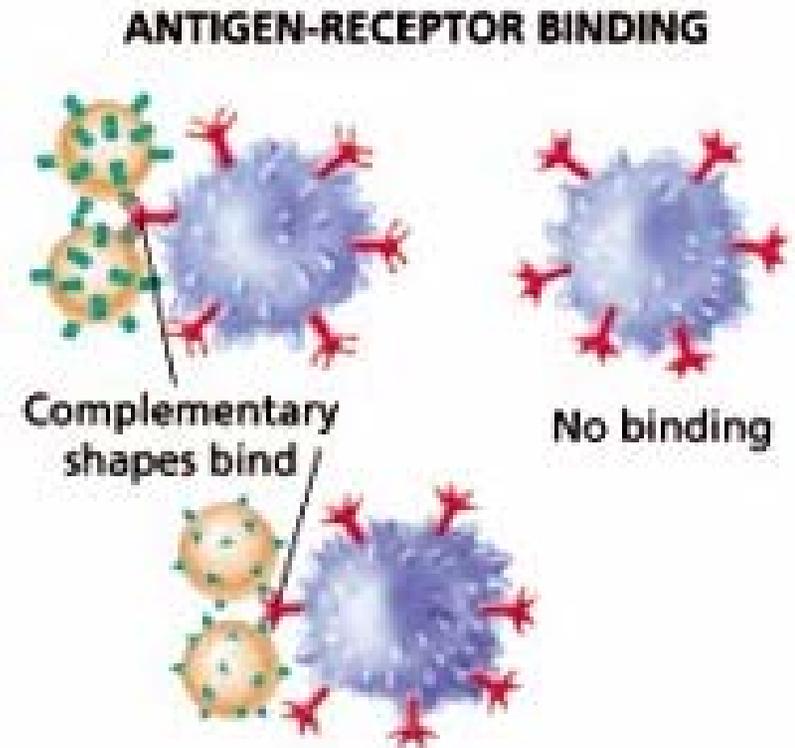
## Lymphocytes

- Contain antigen receptors with a unique binding site shape all over its cell membrane



# Recognizing Pathogens

- Lymphocytes bind to antigens with **specific** matching shape
- Body makes billions of different lymphocytes with unique antigen receptors



# Immune Response

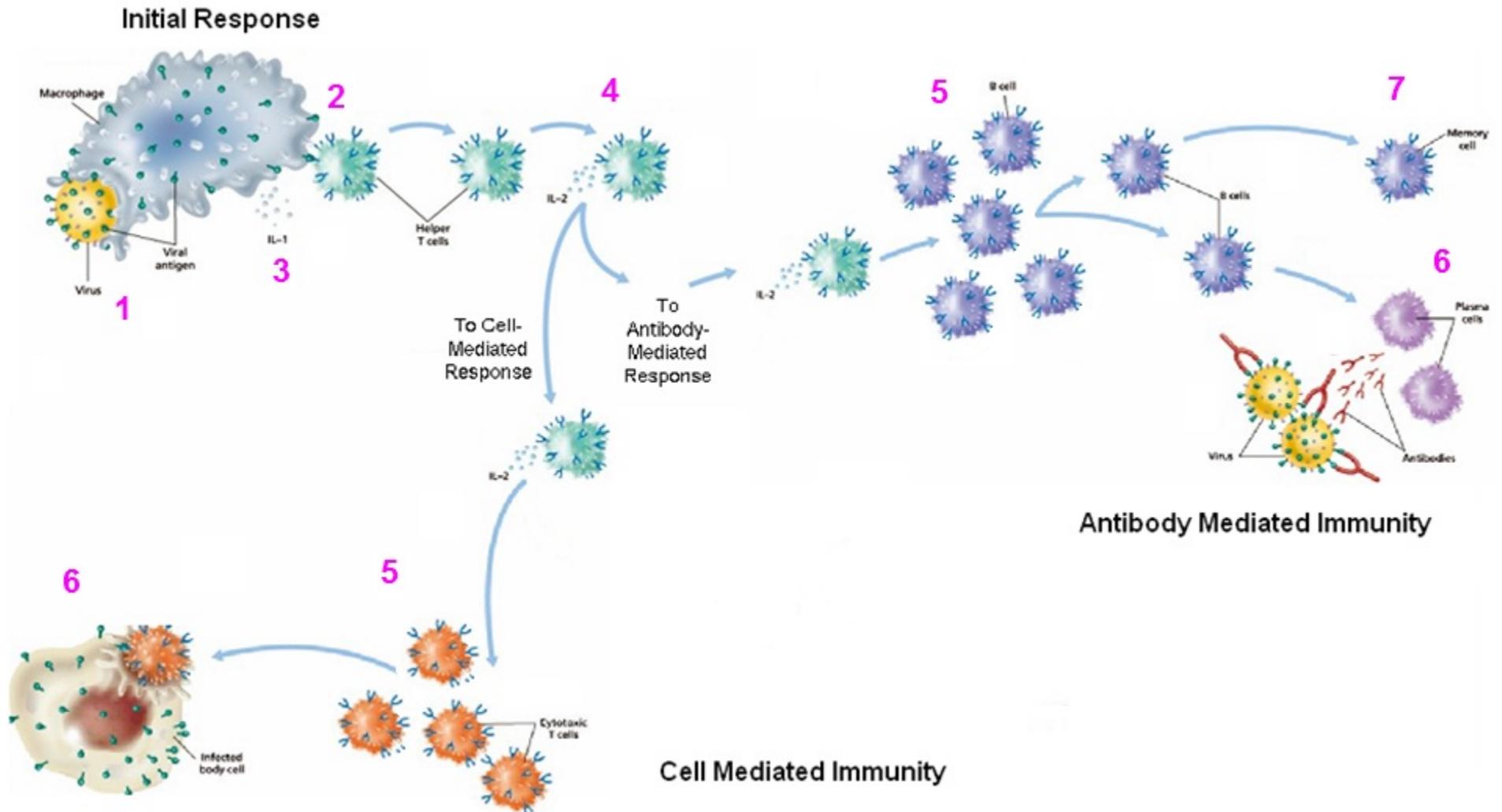
- The reaction by the body against a pathogen

## 2 Parts

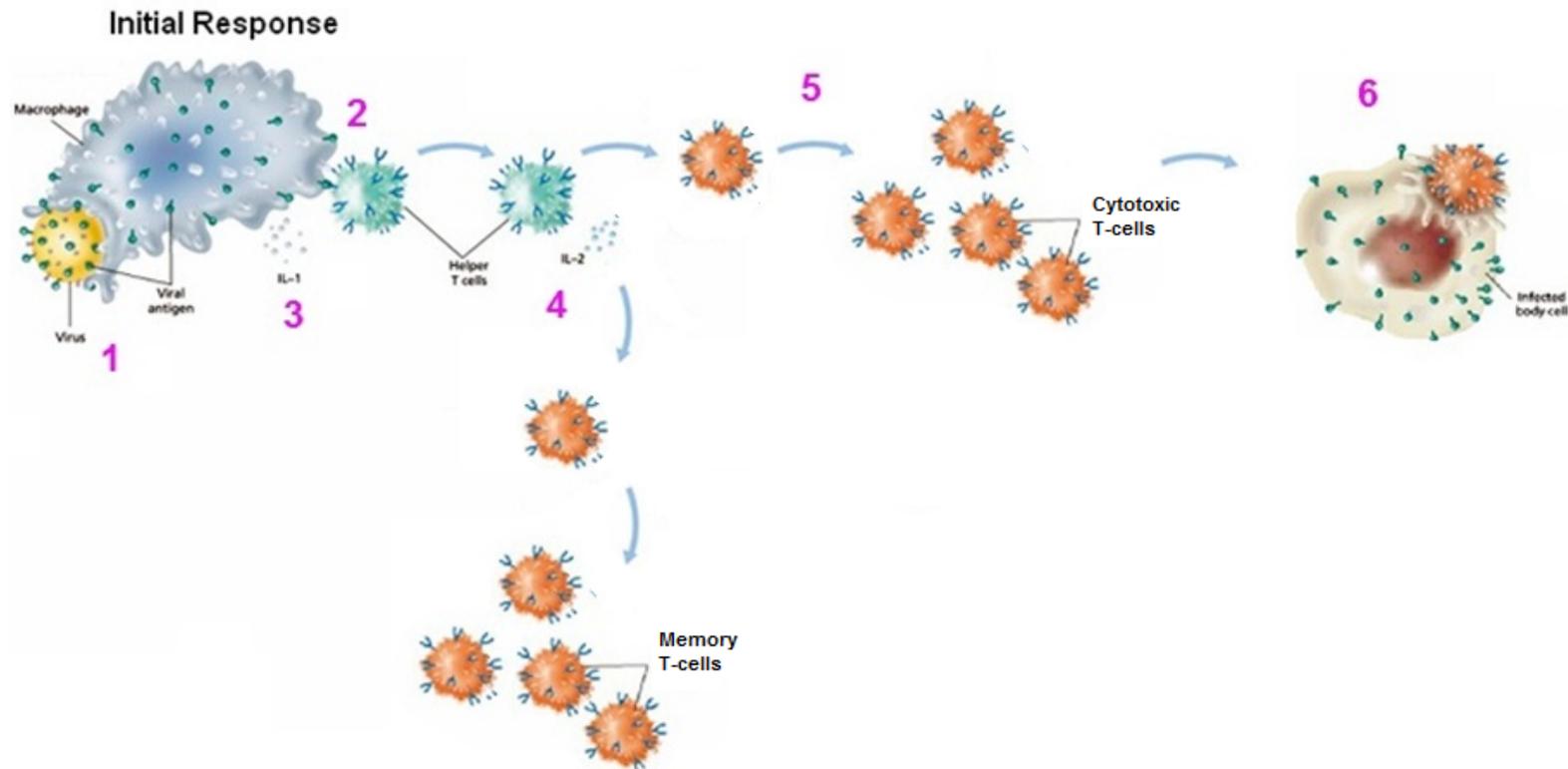
1. Cell-Mediated Immune Response
2. Antibody-Mediated Response



# Types of Specific Immunity



# Cell-Mediated Immunity



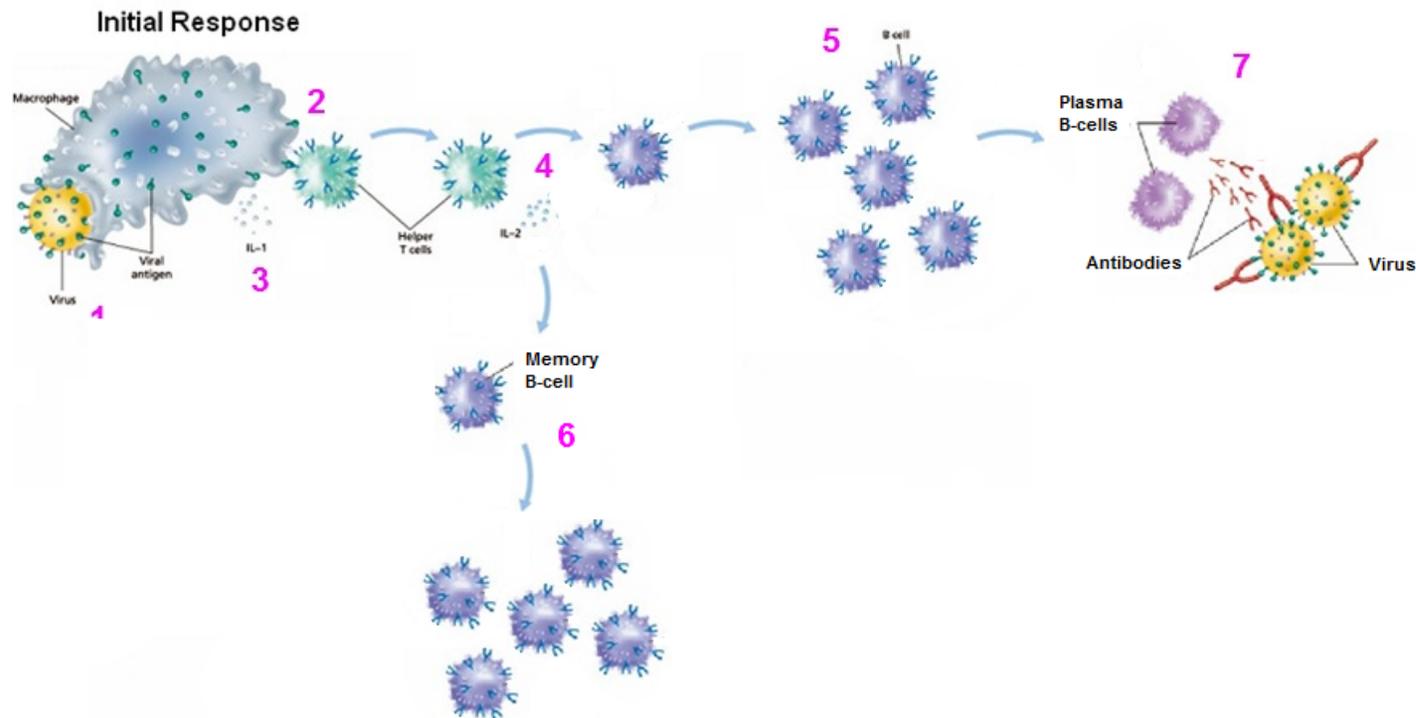
## INITIAL RESPONSE

1. Macrophage engulfs pathogen
2. Macrophage presents antigens of pathogen on a Major Histocompatibility Complex (MHC) molecule. Helper T-cell binds to antigen.
3. Binding of Helper T-cell to MHC molecule stimulates the release of Interleukin-1.
4. Interleukin-1 stimulates the Helper T-cell to release Interleukin-2.

## CELL-MEDIATED IMMUNITY

5. Interleukin-2 stimulates proliferation and activation of Cytotoxic T-cells.
6. Cytotoxic T-cells that are active, secrete perforin, which creates a pore in the cell membrane of the pathogen, allowing water and salts to enter, causing the cell to burst (lysis of the cell). Some Cytotoxic T-cells become Memory T-cells that wait for the next infection by the same pathogen.

# Antibody-Mediated Immunity



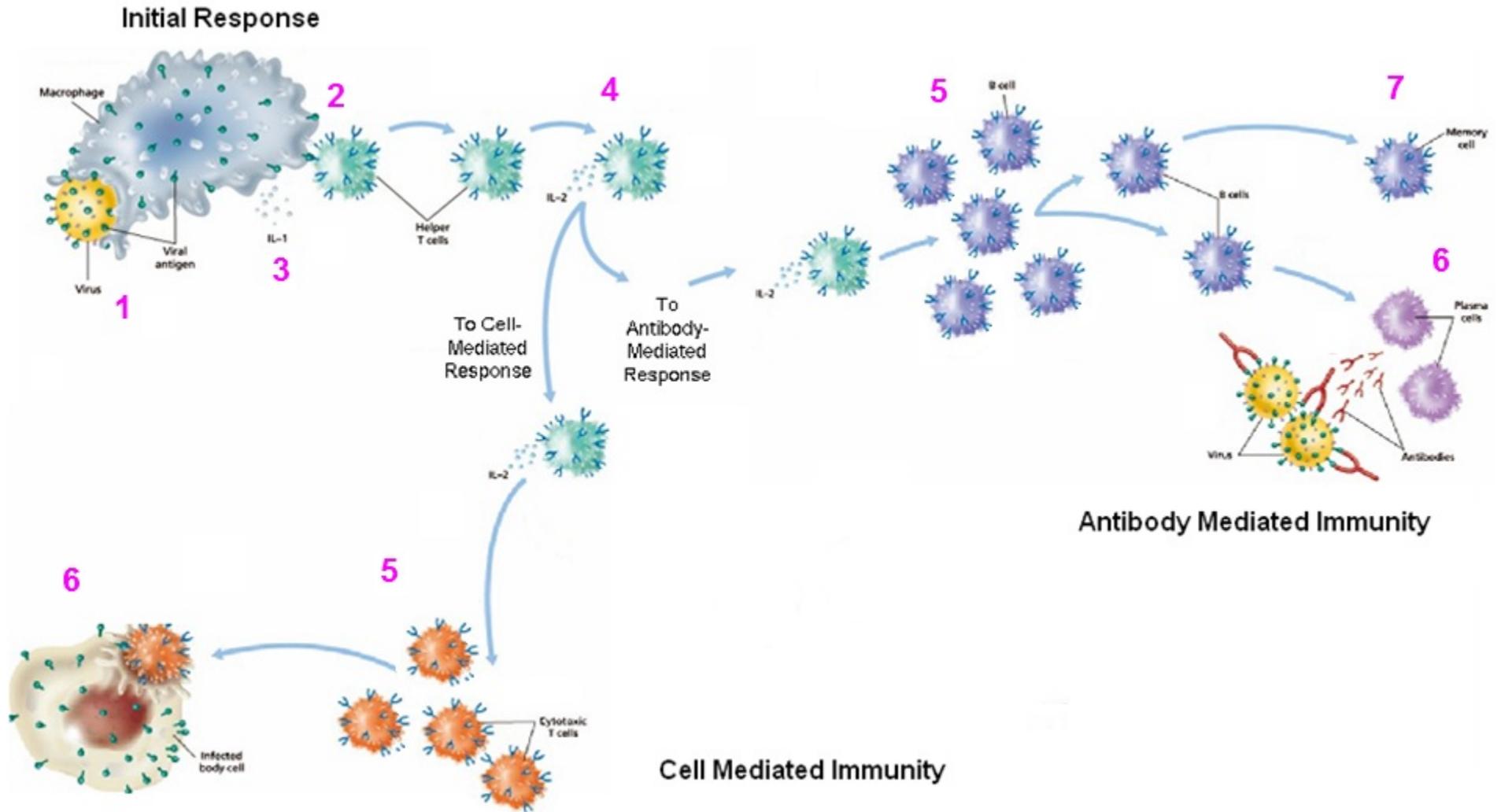
## INITIAL RESPONSE

1. Macrophage engulfs pathogen
2. Macrophage presents antigens of pathogen on a Major Histocompatibility Complex (MHC) molecule called a Human Leukocyte-associated (HLA) antigen. Helper T-cell binds to antigen.
3. Binding of Helper T-cell to HLA antigen stimulates the release of Interleukin-1.
4. Interleukin-1 stimulates the Helper T-cell to release Interleukin-2.

## ANTIBODY-MEDIATED IMMUNITY

5. Interleukin-2 stimulates proliferation and activation of B-cells.
6. Some B-cells become Memory B-cells that wait for the next infection by the same pathogen.
7. Some B-cells become Plasma B-cells which fight pathogens by creating antibodies. Antibodies bind to antigens of pathogens and clump them together or activate complement proteins to initiate the inflammatory response or phagocytosis by macrophages.

# Recap of Types of Specific Immunity



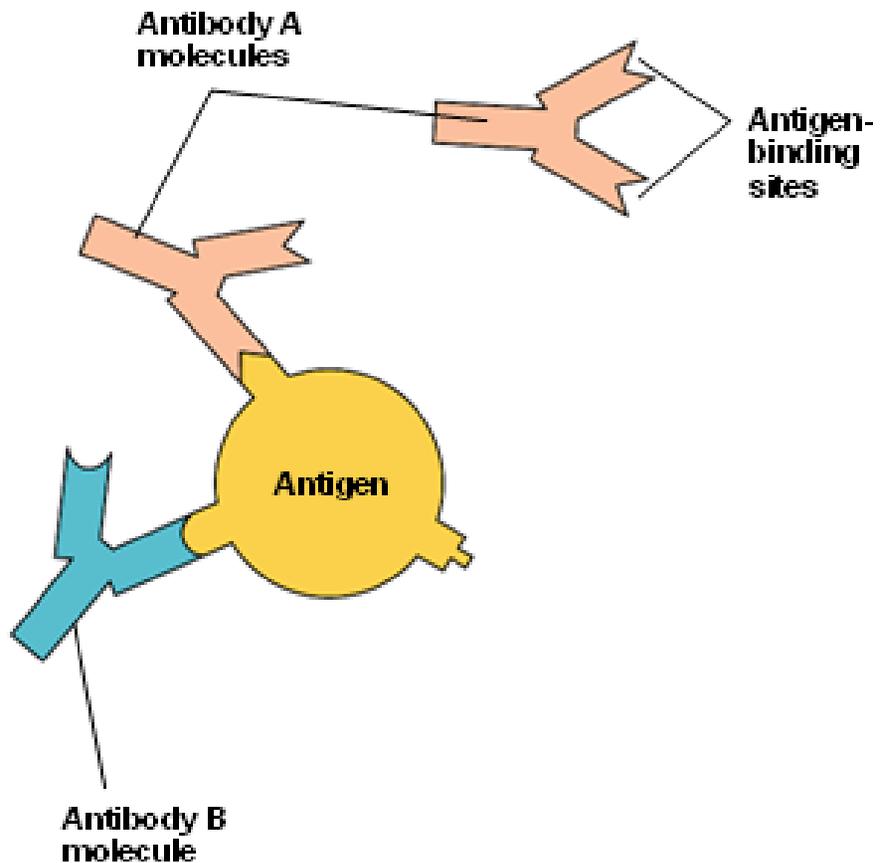
# Primary and Secondary Response

## Primary Response

- First time encounter with antigen

## Secondary Response

- Second encounter with antigen, memory cells change into plasma cells and create antibodies again



# HIV and AIDS

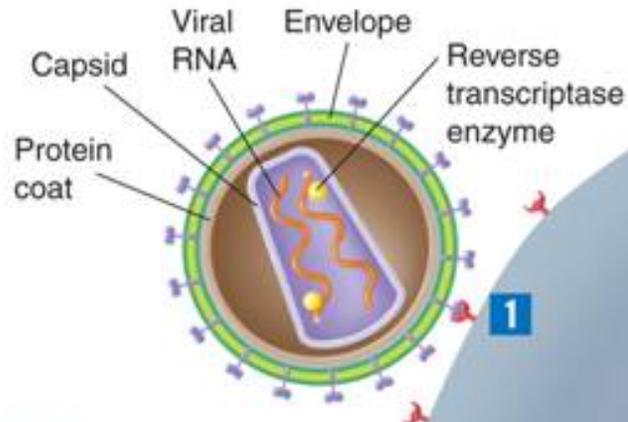
- **How does the immune system work?**
- When an organism gets inside your body white blood cells go to investigate. These white blood cells come in two groups: one group organizes the other, which in turn produces the antibodies to fight the hostile organisms.
- The cells that do the organizing are called T-cells. Some of these have a protein receptor on their surface, called CD4.

# HIV and our immune system

- HIV is dangerous because the virus destroys the very cells of our immune systems that are supposed to be keeping us well: the T- Cells or CD4 cells.
- HIV attaches itself to a CD4 cell and enters. It makes copies of itself inside the CD4 cell. The new HIV viruses burst out of the CD4 cell and go off to find more cells to invade.

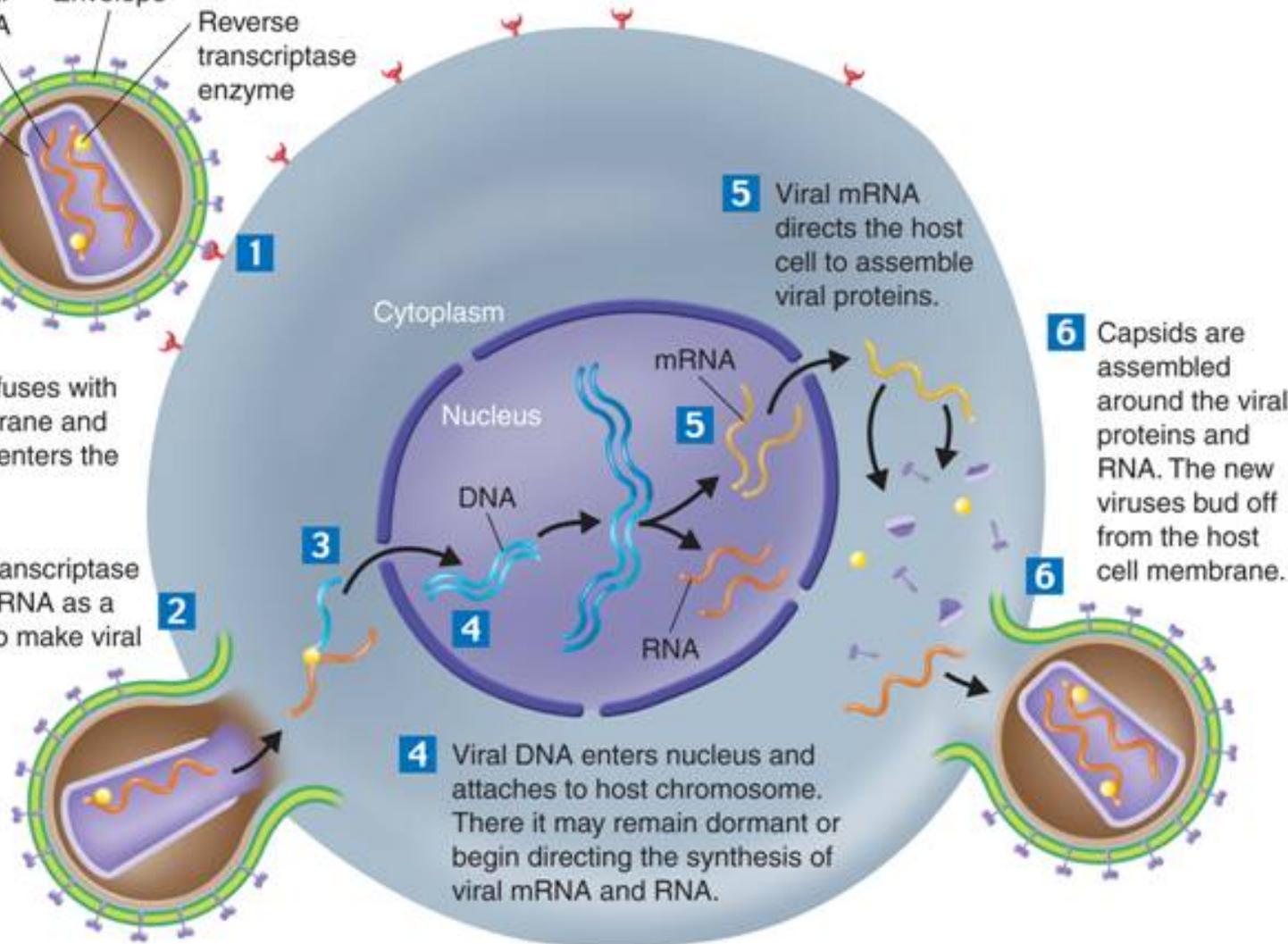
# HIV Life Cycle

- 1** Virus attaches to host cell membrane by recognizing specific molecules on the cell surface.



- 2** Viral coat fuses with cell membrane and viral RNA enters the cell.

- 3** Reverse transcriptase uses viral RNA as a template to make viral DNA.



- 4** Viral DNA enters nucleus and attaches to host chromosome. There it may remain dormant or begin directing the synthesis of viral mRNA and RNA.

# AIDS

- If the number of CD4 cells drops, the immune system has fewer cells to help it defend the body from other organisms. This means we are at greater risk of getting ill.
- The immune system does try to fight HIV infection. It produces antibodies to do this. But they're not very effective without the CD4 cells to organize them.

# Section 13.4- Immunity and Vaccination

## Immunity

- The ability to resist infection

## Active Immunity

### 1. Primary Immune Response

### 2. Vaccination

- Introduction of antigens into the body
  - Vaccine  
weakened pathogen with antigens



# Section 13.4- Immunity and Vaccination

## Passive Immunity

- Individual given prepared antibodies
- Immunity does not last



# Problems of the Immune System

## Allergies

Physical response to an antigen



## Asthma

Respiratory disorder causes bronchioles in lungs to narrow



## Autoimmune Diseases

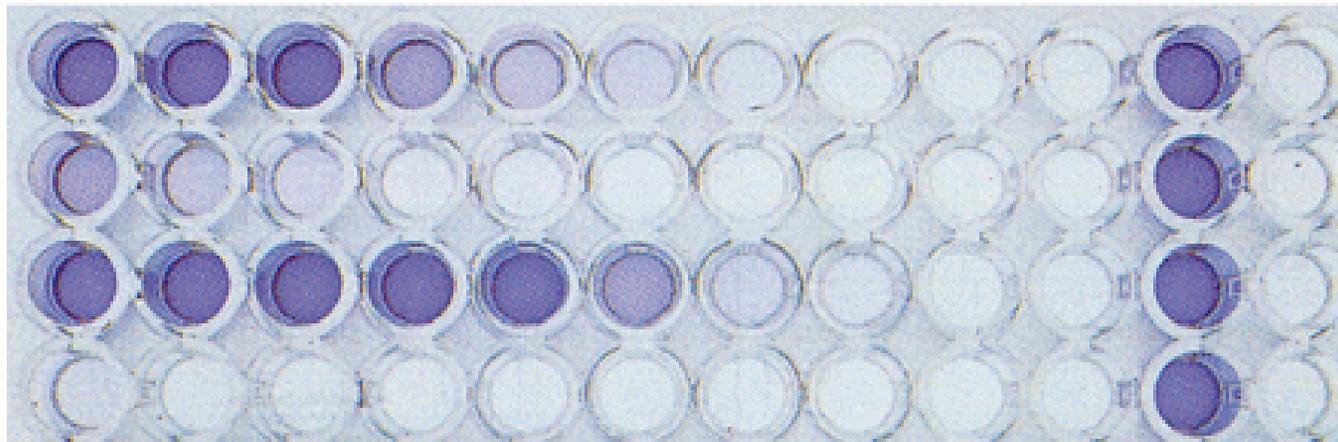
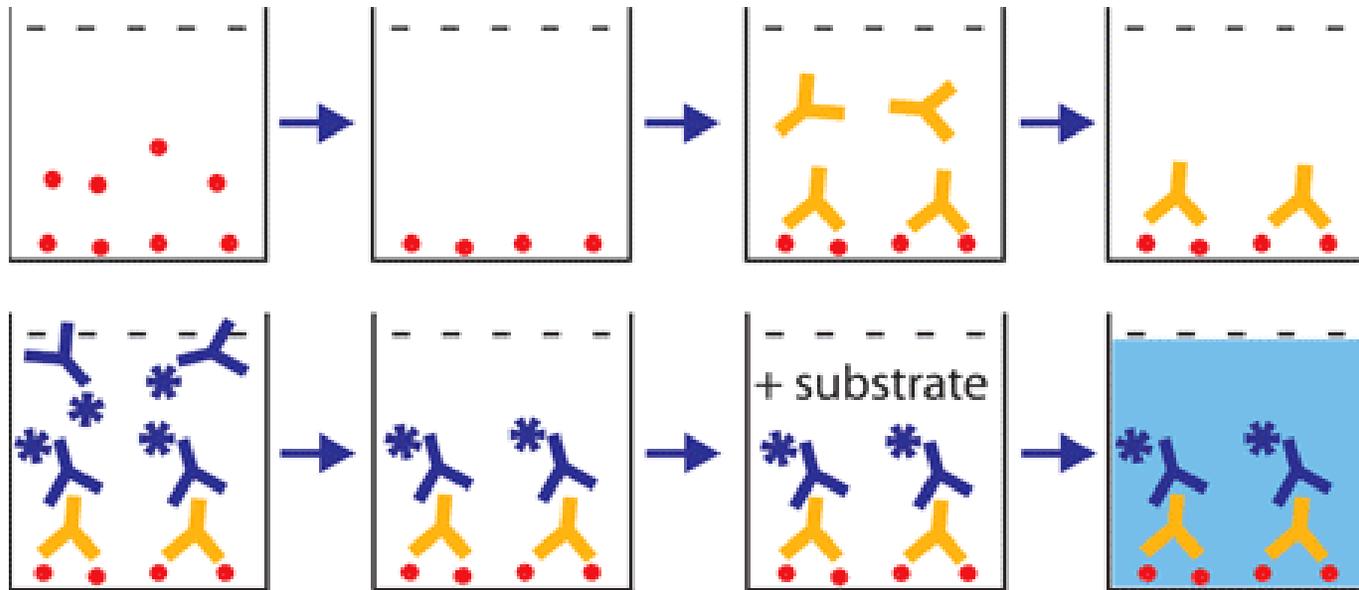
Immune system attacks own cells



# ELISA Test

- **Enzyme-linked immunosorbent assay**, also called **ELISA**, is a biochemical technique used mainly in immunology to detect the presence of an antibody or an antigen in a sample.

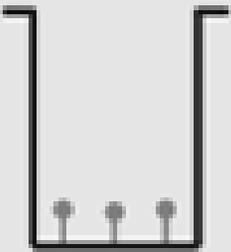
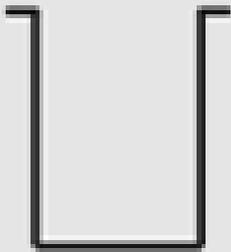
# Results of an ELISA Test



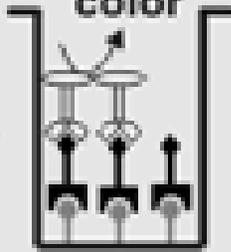
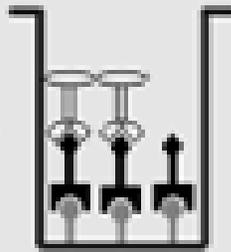
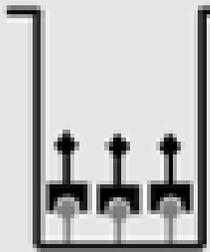
# Illustration of ELISA Test

## Principles of Enzyme Linked ImmunoSorbent Assay (ELISA)

Wells of ELISA plate coated with antigen



Primary antibody reacted with antigen



Reagent added that is converted to colored product by enzyme

Primary antibody bound to antigen detected using secondary antibody that is coupled to an enzyme such as peroxidase

## The ELISA Method



Partially purified, inactivated HIV antigens pre-coated onto an ELISA plate



Patient serum which contains antibodies. If the patient is HIV+, then this serum will contain antibodies to HIV, and those antibodies will bind to the HIV antigens on the plate.

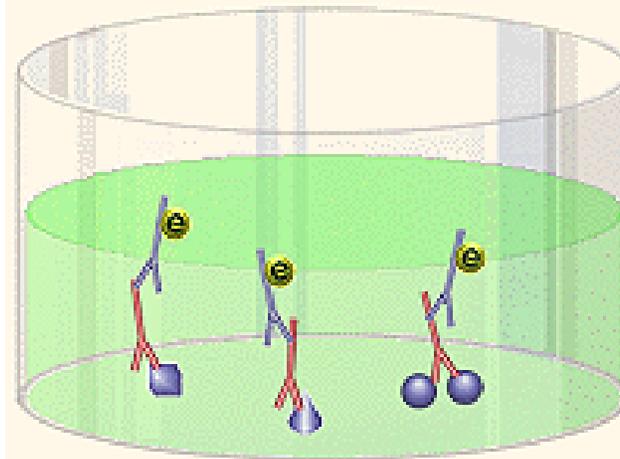


Anti-human immunoglobulin coupled to an enzyme. This is the second antibody, and it binds to human antibodies.



Chromogen or substrate which changes color when cleaved by the enzyme attached to the second antibody.

### Positive ELISA Test



# ELISA Test Animation

- <http://www.sumanasinc.com/webcontent/animations/content/ELISA.html>