



The Immune System

Chapter 48



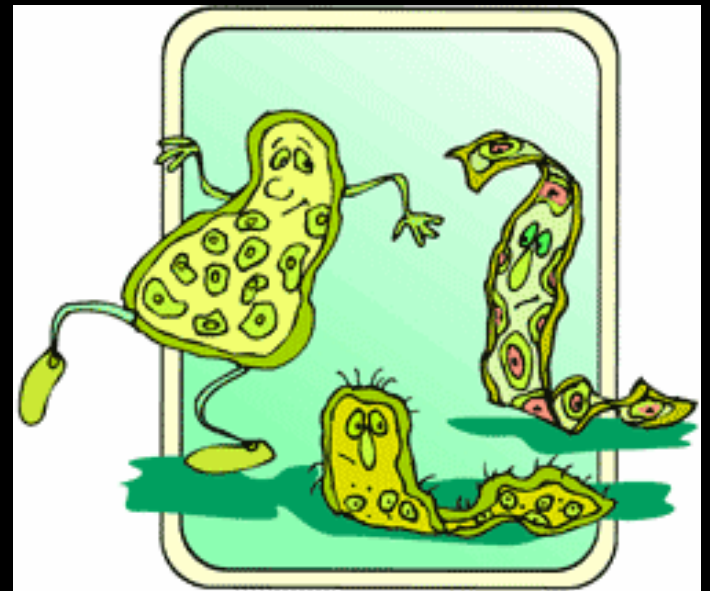
Standard 10

- A. Students know the role of the skin in providing nonspecific defenses against infection.

- f.* Students know the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.

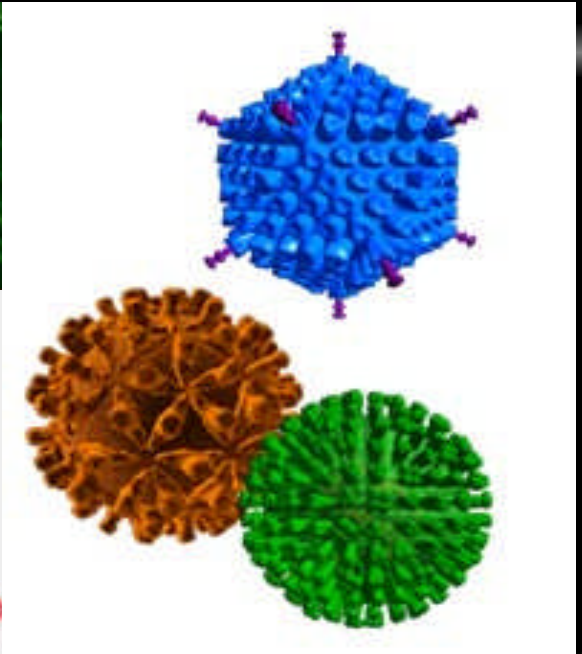
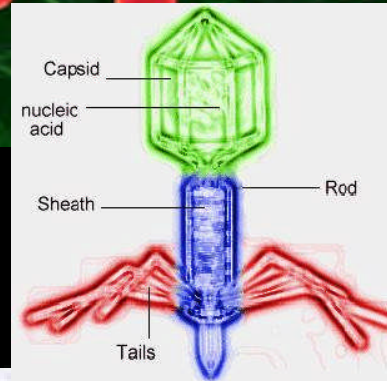
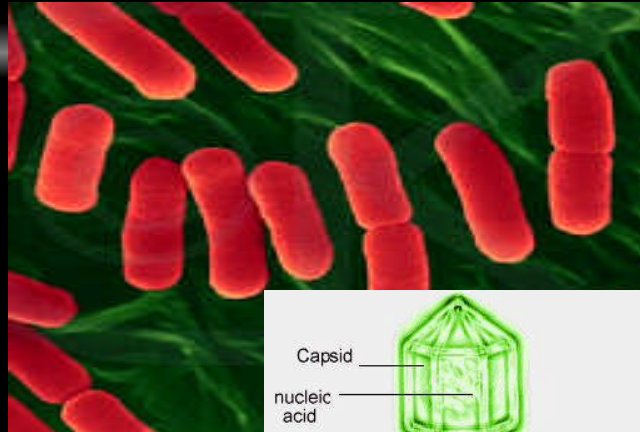
What is a pathogen?

- Pathogen: disease causing agents
- They are harmful to living things



Examples of Pathogens?

- Bacteria
- Viruses
- Parasites such as fungi, protista, & worms



How are Pathogens Spread?

- Soil
- Water
- Infected animals
 - Consumption (food)
 - Vectors-mosquitoes-West Nile Virus, ticks-Lyme Disease, fleas-Bubonic plague, flies
- Person-to-person contact
- Yourself...
 - always wash your hands





Q: How do bacteria cause damage to host cells?

A: By releasing poisonous substances called toxins.

- Did you know? ...the Tetanus bacteria is found in soil and one drop of the toxin, the size of a period, can kill 30 people.



The Immune System

- ∞ Immune System: the body system that fights off invading pathogens
- ∞ The body has two types of defense against infection:
 - Nonspecific Defense – a general response to any pathogen (1st line of defense)
 - Specific Defense – a specific counter-assault against a particular pathogen that your body can recognize





1st line of Defense: Types of Non-specific Defense

∞ Skin: a physical barrier to pathogens

- Any break in the skin allows entry
- releases sweat, oils, and waxes that contain chemicals toxic to bacteria

∞ Mucous membranes: tissues that line internal body surfaces that are in contact with the environment

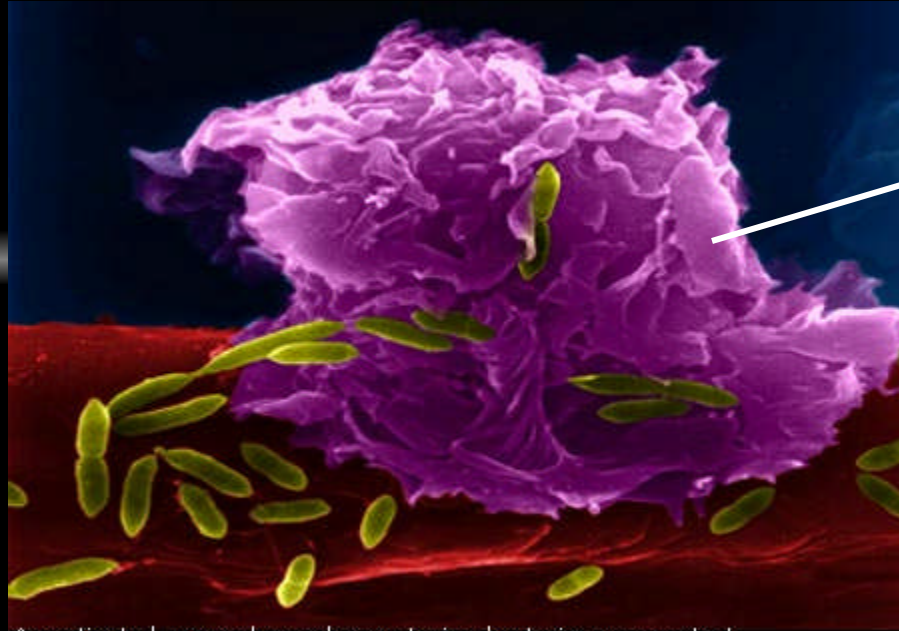
- Mucous: sticky fluid that traps pathogens



1st line of Defense: Types of Non-specific Defense

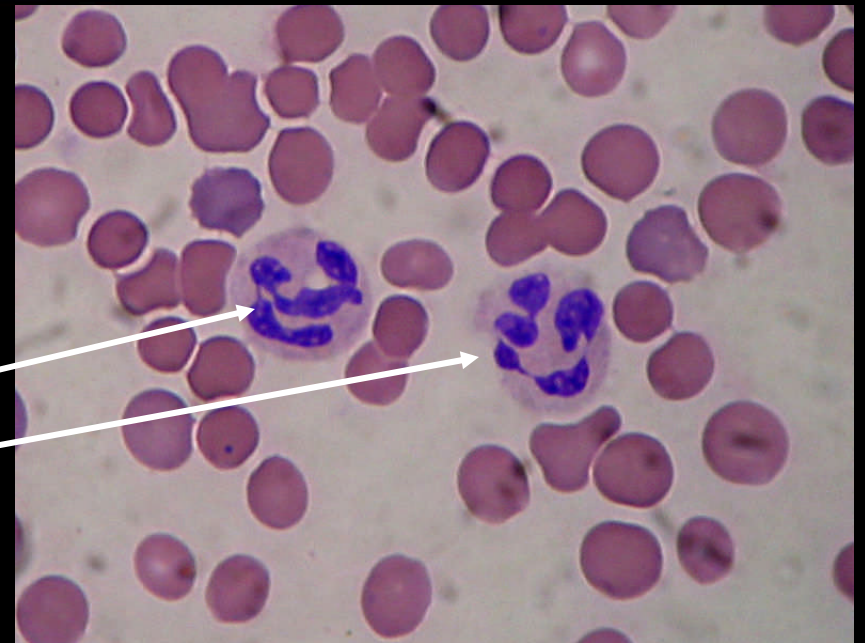
- ∞ **Stomach**: has acid that destroys potential pathogens that are swallowed
- ∞ **Phagocytes**: WBC's that "eat" pathogens
 - **Macrophages** – ingest and destroy pathogens
 - **Neutrophils** – secrete toxic chemicals that kill bacteria

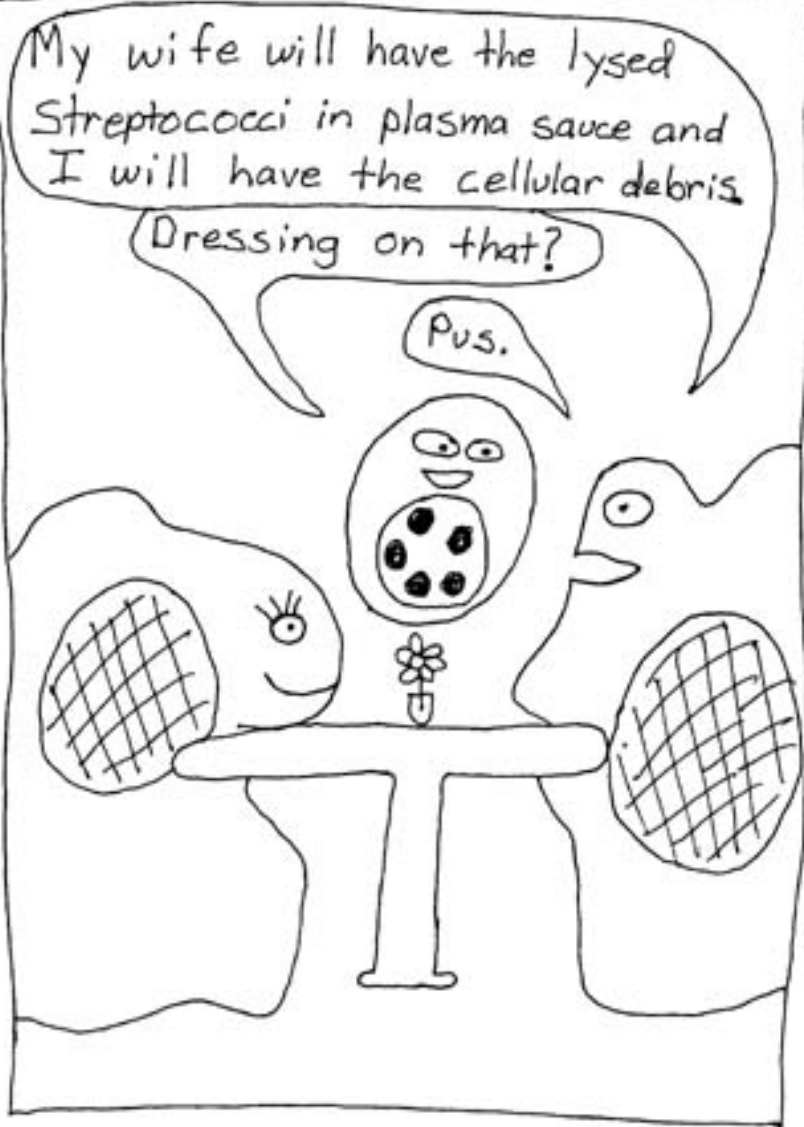
Macrophage



An activated macrophage phagocytosing bacteria upon contact
Photo: courtesy of Dennis Kunkel

Neutrophils





Macrophage restaurants.



1st line of Defense: Types of Non-specific Defense

- ⌚ Moderate Fevers (< 103° F): inhibit the growth of pathogens and stimulate macrophage action
- ⌚ Inflammatory Response: response in which WBC's engulf foreign substances and body temperature rises



The Inflammatory Response (Inflammation)

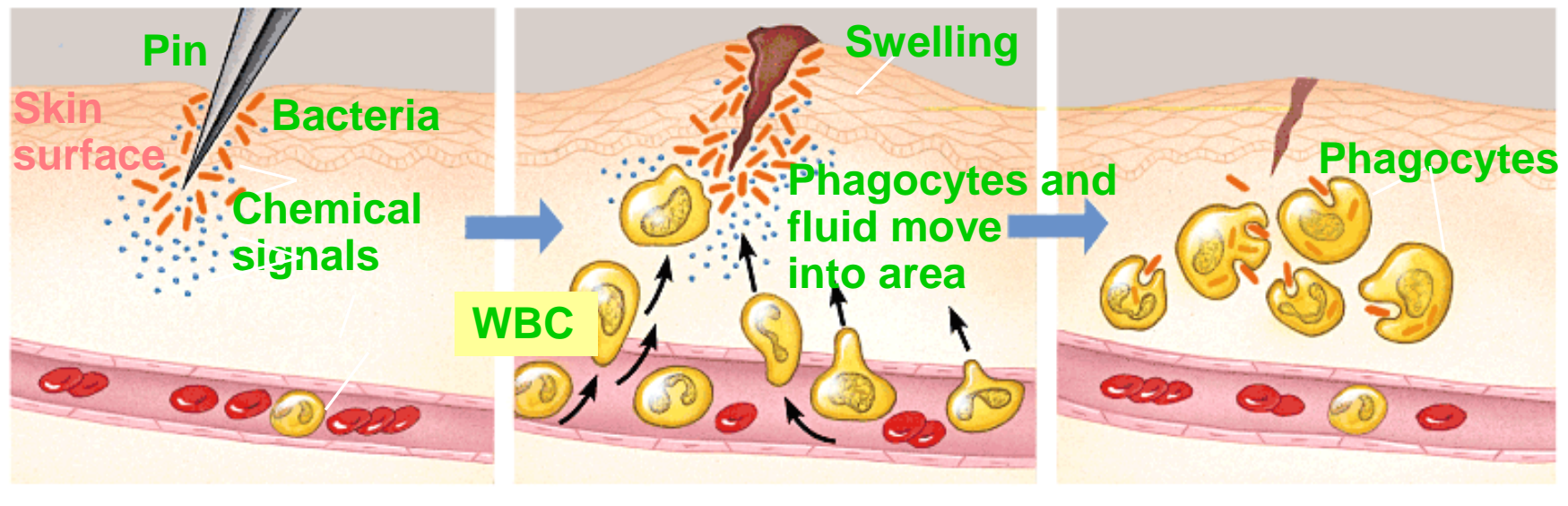
- Stimulated when pathogen gets past the skin and mucous membranes
- **Step 1:** injury occurs (cut or splinter)
- **Step 2:** damaged cells release a chemical messenger (histamine)
- **Step 3:** histamine increases blood flow to the injured area – results in redness, swelling, warmth, and pain

Continued...

- **Step 4:** blood clotting process begins
- **Step 5:** WBC attracted by chemical messenger engulf the pathogens



Inflamed hand fighting infection on left, regular hand on right.




1 Tissue injury; release of chemical signals such as histamine

2 Dilation and increased leakiness of local blood vessels; migration of phagocytes to the area

3 Phagocytes (macrophages and neutrophils) consume bacteria and cell debris; tissue heals




Figure 24.2



What are the four symptoms of inflammation? (FYI)

- Redness
- Swelling
- Pain
- Heat

Self Check

- Ω **What is a pathogen?** 
- Ω **How are diseases transmitted?** 
- Ω **What are two categories of the body's defense?** 
- Ω **How do the skin and mucous membranes protect the body?**



Standard 10

- Ω b. *Students know* the role of antibodies in the body's response to infection.**
- c. *Students know* how vaccination protects an individual from infectious diseases.**
- d. *Students know* there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.**
- Ω e. *Students know* why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.**



Specific Defense: The Immune System

Ω Organs of the Immune System:

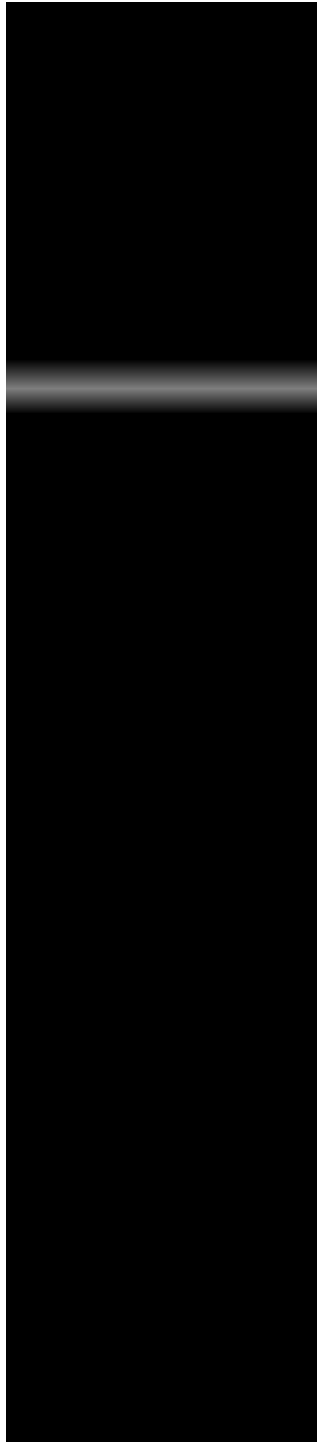
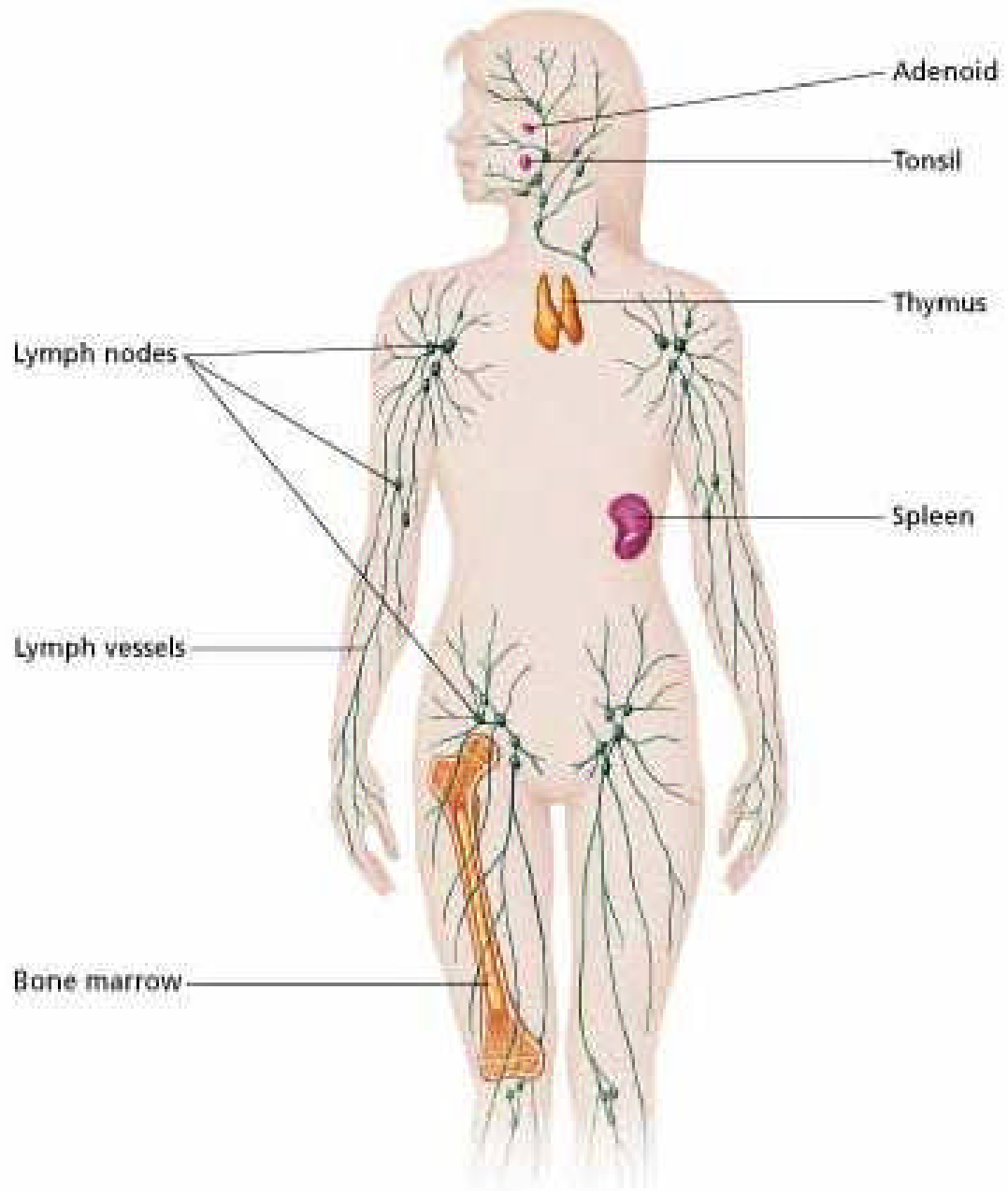
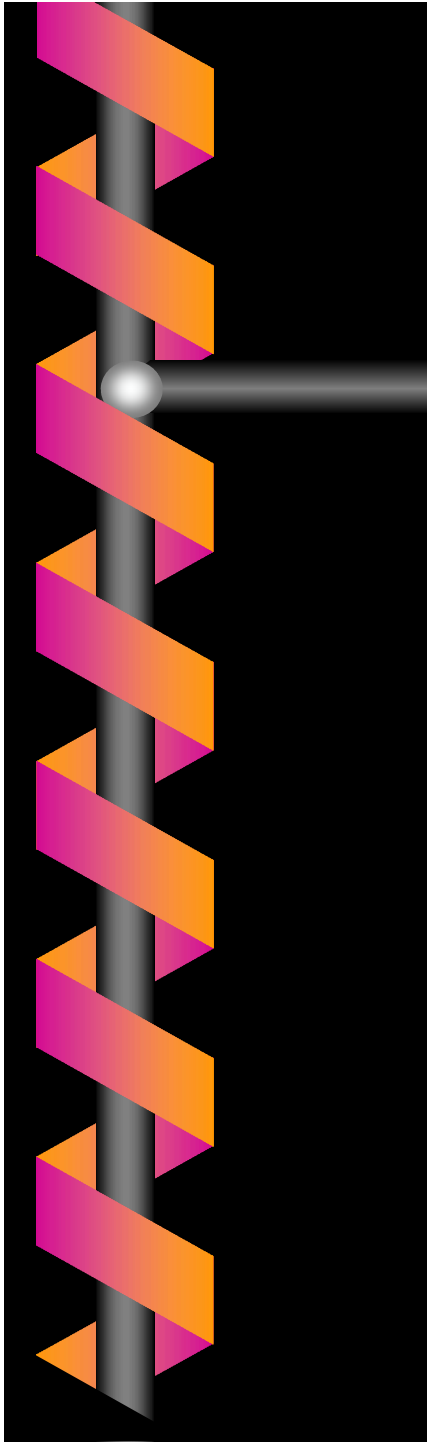
- Bone Marrow: makes WBC
- Thymus: where T cells mature
- Lymph nodes: contain lots of WBC
- Spleen: removes pathogens from blood



Ω **Cells of the Specific Immune System:**
Lymphocytes

- B Lymphocytes: Makes antibodies
- T Lymphocytes: helps stimulate an immune response

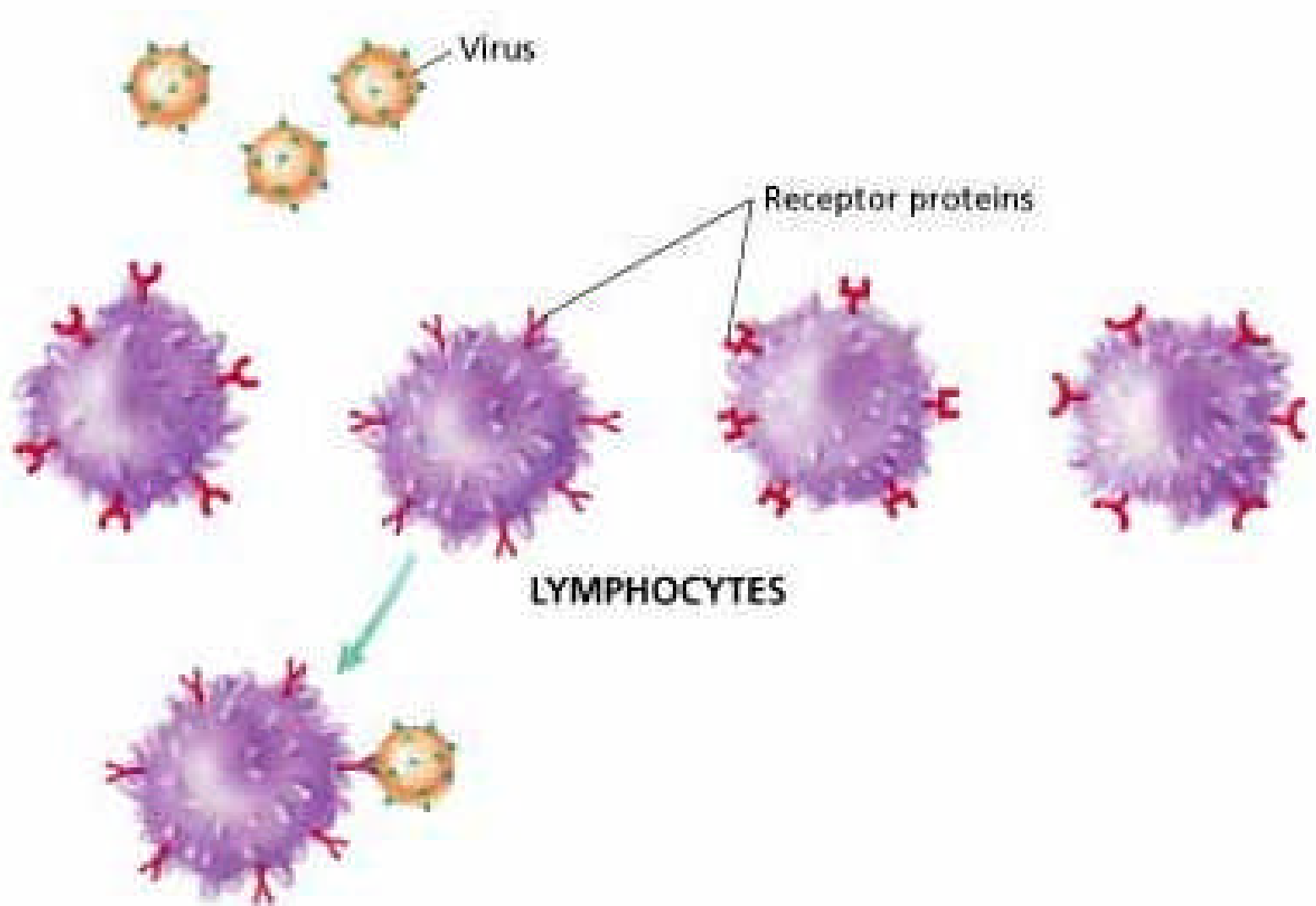
You can call them B-cells and T-cells for short!





Specific Defense: Recognizing Pathogens

- ∞ **Immune Response**: process of lymphocytes attacking and removing pathogens
- ∞ **Antigen**: protein found on the surface of microorganisms or pollen that provokes an immune response
- ∞ **Recognition:**
 - Lymphocytes have receptor proteins all over them
 - Receptor proteins recognize and bind to antigens that match the receptor
- ∞ **Immune system makes millions of lymphocytes with different receptors**





Specific Defense: Types of Immune Responses

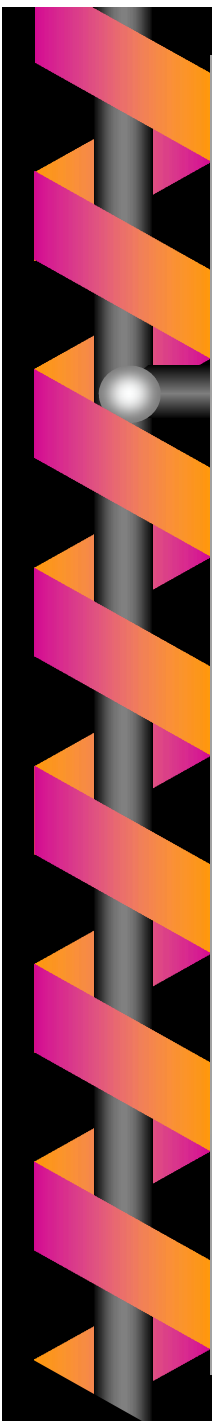
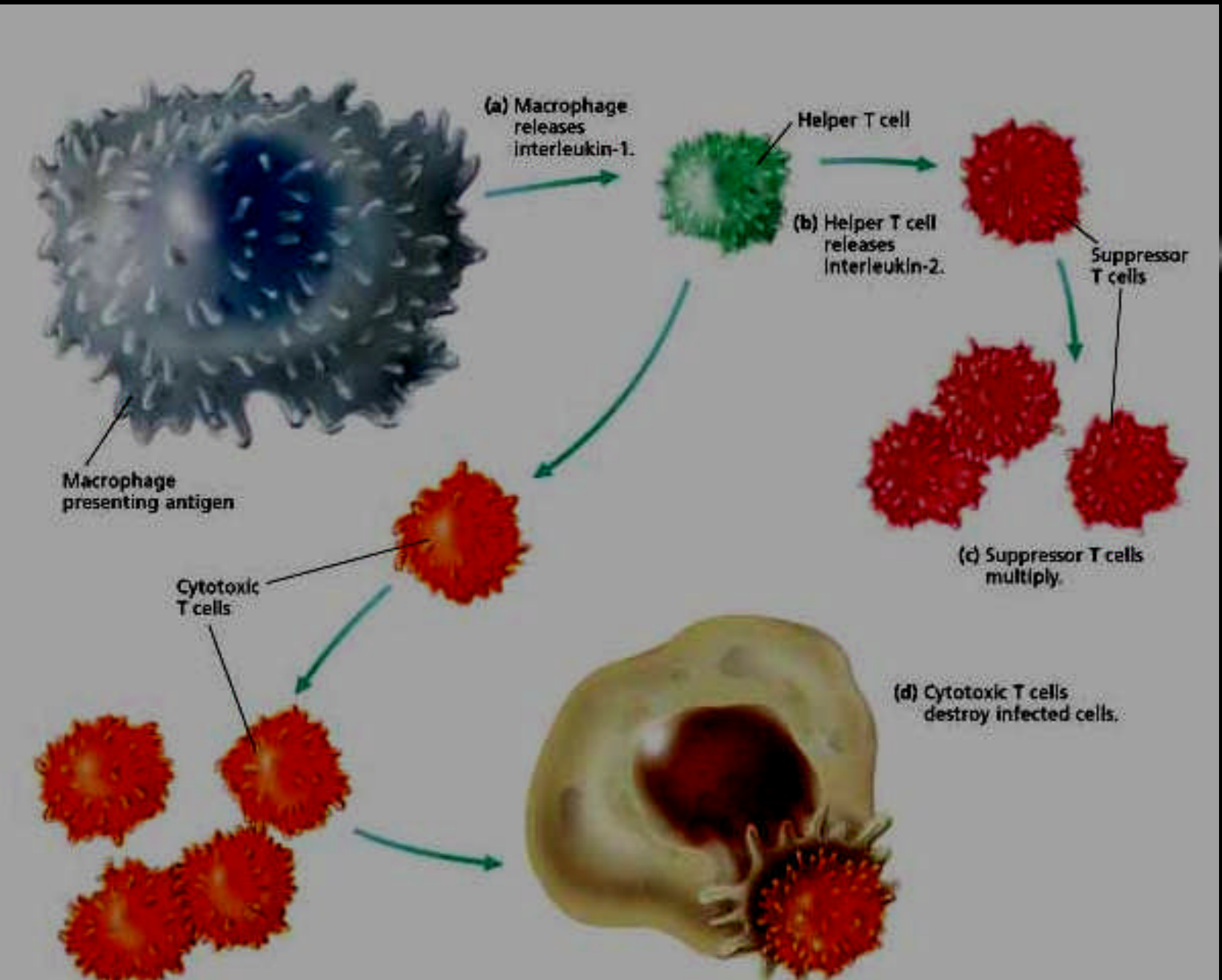
- 1. Humoral**
- 2. Cell Mediated**



Specific Defense: Cell-Mediated Immune Response

∞ Involves mainly T cells

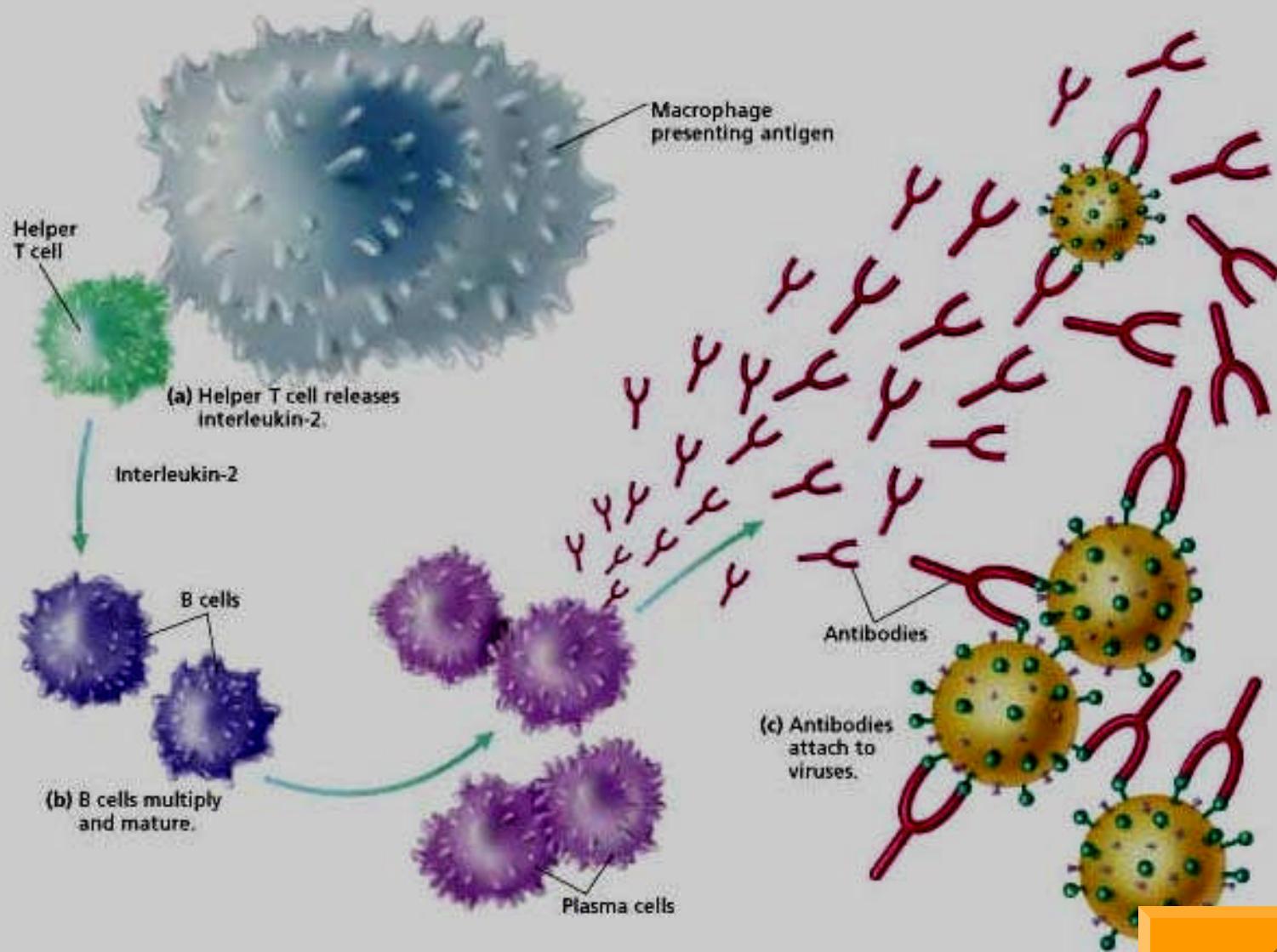
1. Macrophage eats a pathogen and puts fragments of its antigen on its surface
2. T-helper cell comes along
3. Macrophage releases a signal (Interleukin-1) to T-helper cell
4. T-helper cell recognizes signal and releases another signal (Interleukin-2)
5. T-cytotoxic cell recognizes signal and comes to kill infected cells
6. T-suppressor cells come to shut down immune response when pathogen is defeated





Specific Defense: Humoral Immune Response

- ∞ Involves mainly B cells
- 1. T-helper cells stimulate B cells to divide and form plasma cells
- 2. Plasma cells make and release antibodies
- 3. Antibodies: Y-shaped molecules that bind to specific pathogens and inactivate them or trigger their destruction – they help destroy microbes that invade the body
- 4. When the battle is won, B-cells patrol the body for years as Memory Cells





Immune Response gets stronger over time

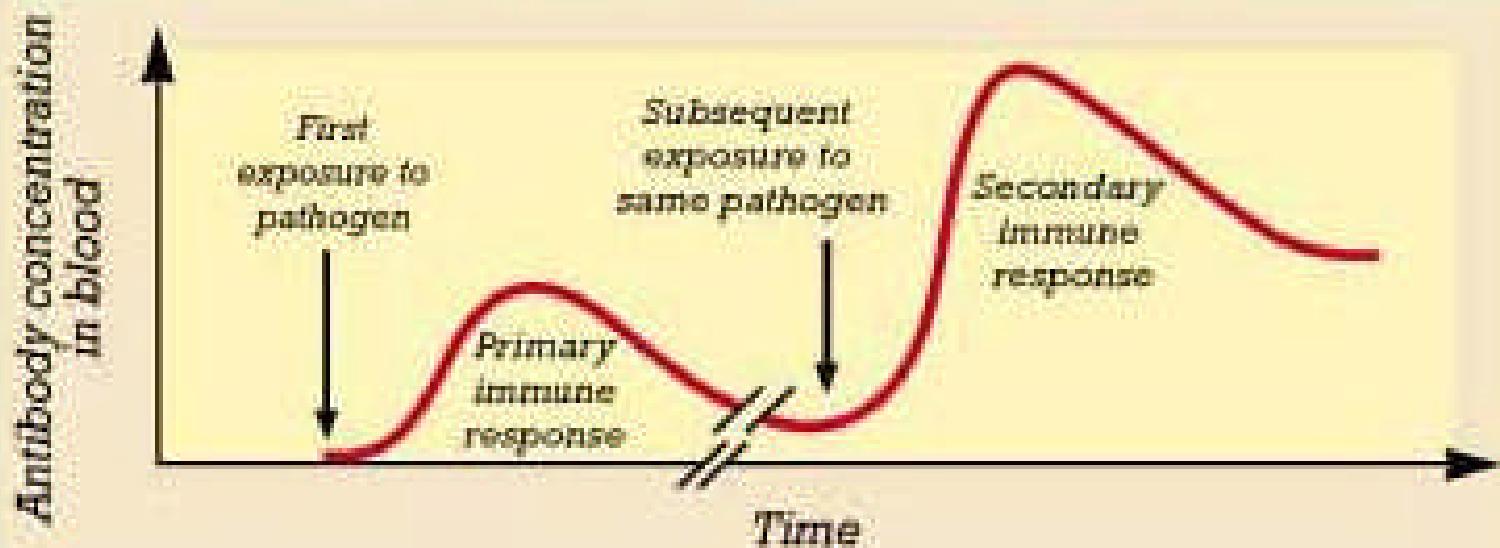
- Ω **Primary Immune Response:** 1st time a certain antigen is encountered by the body
- Immune response takes place
 - After infection, most B and T cells die, but some stay alive for life as Memory cells
 - Memory Cells will divide to fight pathogens if they ever meet again



A decorative vertical bar on the left side of the slide. It features a grey sphere at the top, with a series of overlapping, colorful rectangular segments (pink, orange, and purple) that spiral downwards. The background is black with a horizontal grey gradient line.

Ω **Secondary Immune Response:** a later exposure to the same pathogen

- Response is faster and stronger because the memory cells are already familiar with the pathogen and know how to fight it

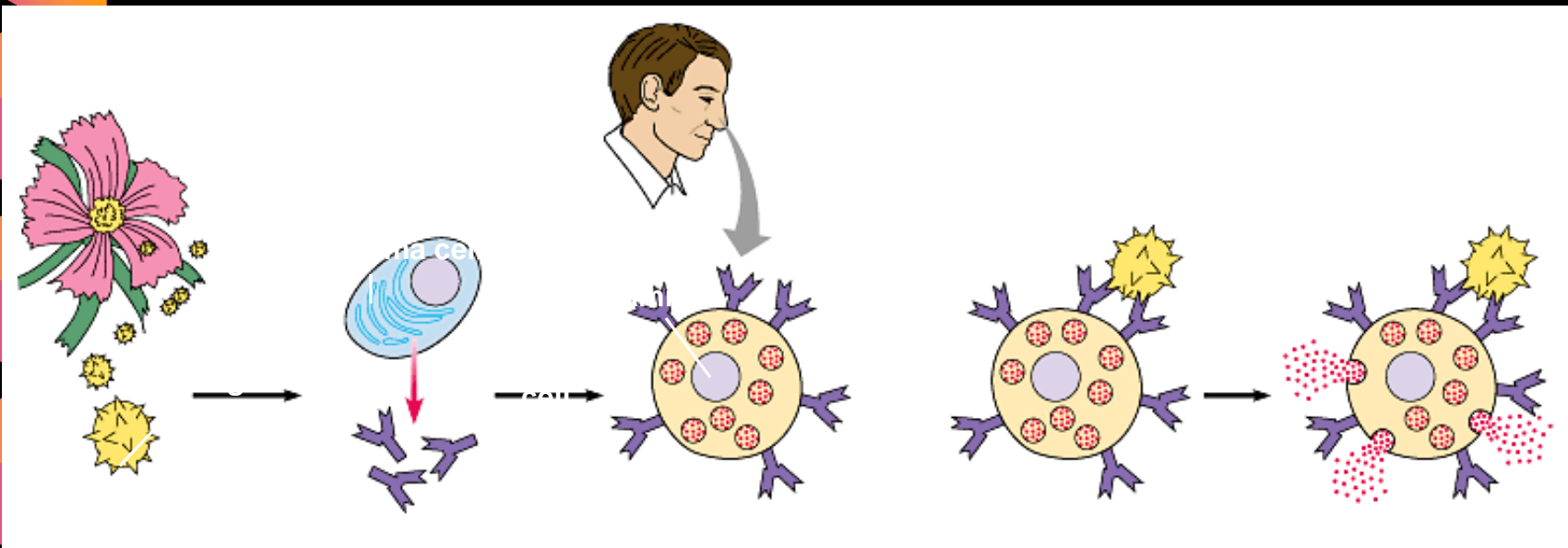
Primary and Secondary Immune Responses



- 
- ⌚ When were the first antibodies produced?**
 - ⌚ When was the most rapid division of B cells?**
- 

Allergies

Ω Allergies: misdirected immune response against harmless antigens



Allergen
(pollen grain)

B cells make
antibodies

Antibodies
attach to
mast cell

Allergen binds to
antibodies on
mast cell

Histamine is
released, causing
allergy symptoms

SENSITIZATION: Initial exposure to allergen

LATER EXPOSURE TO SAME ALLERGEN

Figure 24.17



Ω Allergies involve the release of Histamine which:

- Causes nearby capillaries to swell
- Causes increased secretion by mucous membranes





Immunity and Vaccination

- ∞ **Immunity**: resistance to a specific pathogen
 - Can get immunity by having the disease and surviving (chicken pox)
 - Can get immunity by getting a vaccination
- ∞ **Vaccine**: solution containing a harmless version of a pathogen
 - They are produced from killed or weakened pathogens
 - They trigger antibody formation

Ω Vaccination



Figure 24.4x



Bacteria vs. Virus

Ω Structure

- **Bacteria:** have both a cell membrane and cell wall
- **Virus:** have a protein coat and a nucleic acid core



Bacteria vs. Virus

∞ Growth and Replication

- **Bacteria:** divide by binary fission, require food source, warmth
- **Virus:** reproduce by taking over host cell, require a host cell
 - **Are NOT alive because:**
 - They are NOT cells
 - They can't make proteins
 - They can't use energy



Bacteria vs. Virus

∞ Body's Primary Defense

- **Bacteria:** nonspecific immune response followed by specific immune response
- **Virus:** specific immune response

Bacteria vs. Virus

∞ Treatments

- **Bacteria:** antibiotics
- **Virus:** vaccination
 - antibiotics are ineffective against viruses because antibiotics kill bacteria





Compromised Immune System

- ⌚ **Compromised Immune System:** immune system is weakened and loses its ability to fight off pathogens
- Results in the person becoming vulnerable to infections that a healthy immune system normally defeat





Ex) HIV

- HIV attacks and cripples the immune system
- HIV invades macrophages and T-helper cells
- HIV kills a large number of T-helper cells

A person infected with HIV may:






- Develop AIDS
- Have viruses reproducing from T-helper cells
- Be more susceptible to a variety of pathogens, even benign ones

Autoimmune Disease

- Ω Autoimmune Disease: a disease in which the immune system attacks the organism's own cells
- The body makes “anti-self” antibodies



Self Check

- ❧ Describe the humoral immune response 
- ❧ Compare the first exposure to a pathogen to the second (response time?) 
- ❧ What is an autoimmune disease? 
- ❧ Contrast bacteria and viruses 
- ❧ Why does someone with a compromised immune system more likely to be infected by something that would not affect someone with a healthy immune system? 



The End