Lymph Transport and Immunity

Chapter 33

Overview

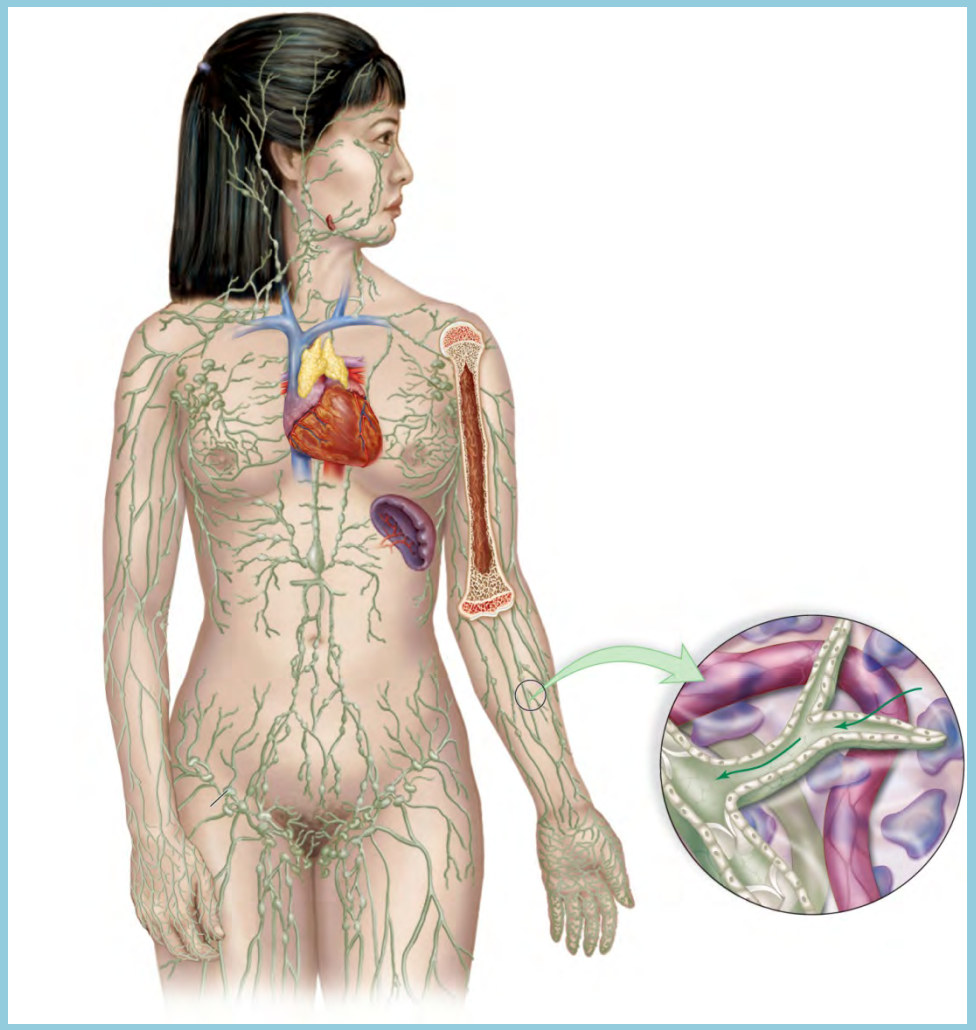
- The Lymphatic System
  - Lymph Vessels
  - Lymphoid Organs
- Nonspecific Defenses
  - Barriers
  - Inflammatory Response
- Specific Defenses
  - B-Cells
  - Antibodies
  - T Cells
- Induced Immunity
  - Active versus Passive Immunity
- Immunity Side Effects
  - Allergies

Lymphatic System - Function

- Lymphatic capillaries take up and return excess fluid to the bloodstream
- Lacteals receive lipoproteins and transport them to the bloodstream
- Contains cells, tissues, and organs responsible for defending the body
- Produces, maintains, distributes **lymphocytes**
  - Lymphocytes= type of white blood cell
  - Resists infection by responding to invading pathogens (e.g., virus/bacteria, abnormal body cells (cancer), foreign particles/toxins).

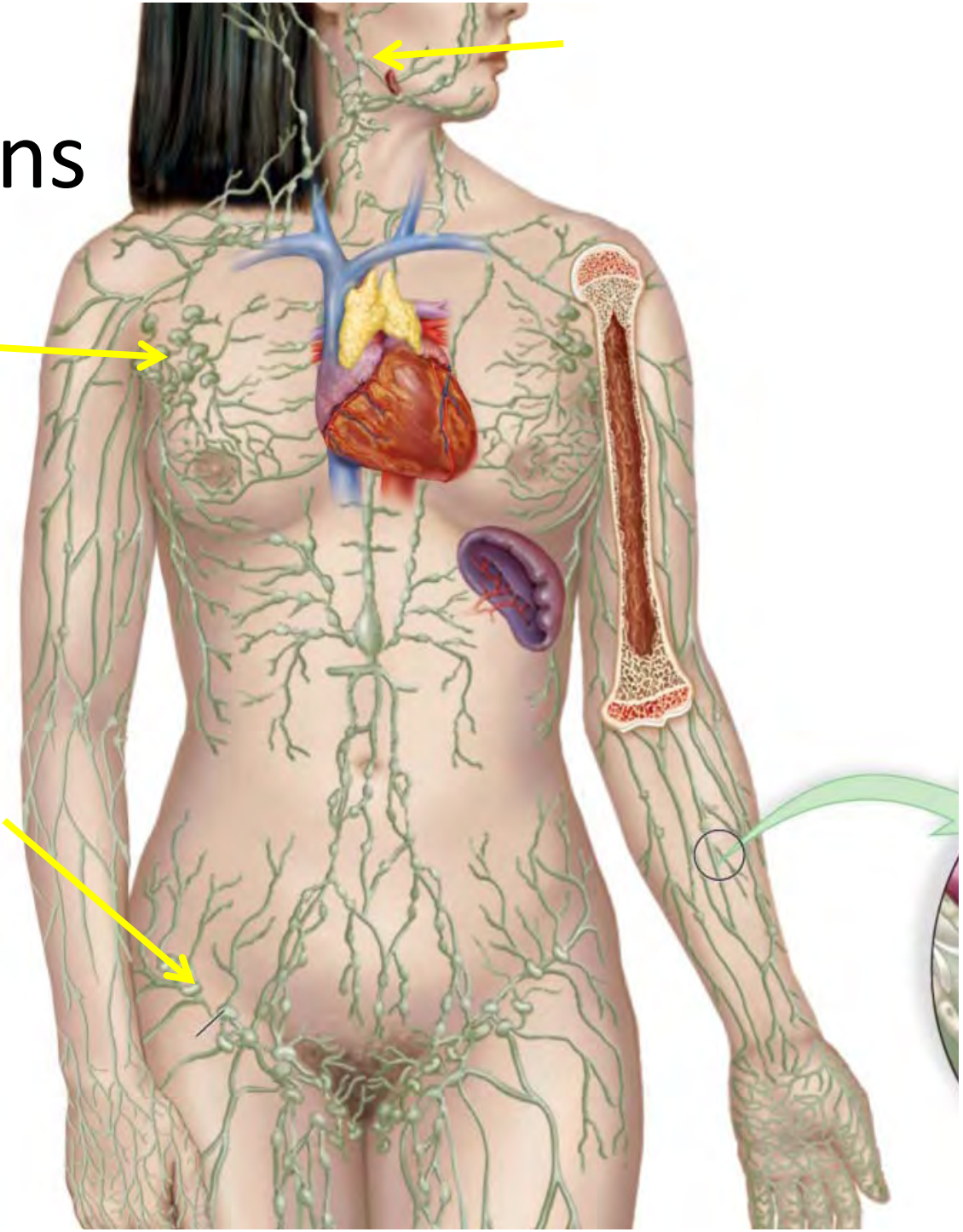
Lymphatic System

- Lymphatic Vessels
  - One-way system
  - Drain excess fluid from tissues
  - Have backflow valves (like veins)
- Lymphoid Organs
  - Lymph Nodes
  - Spleen
  - Thymus Gland
  - Red bone marrow
  - Tonsils



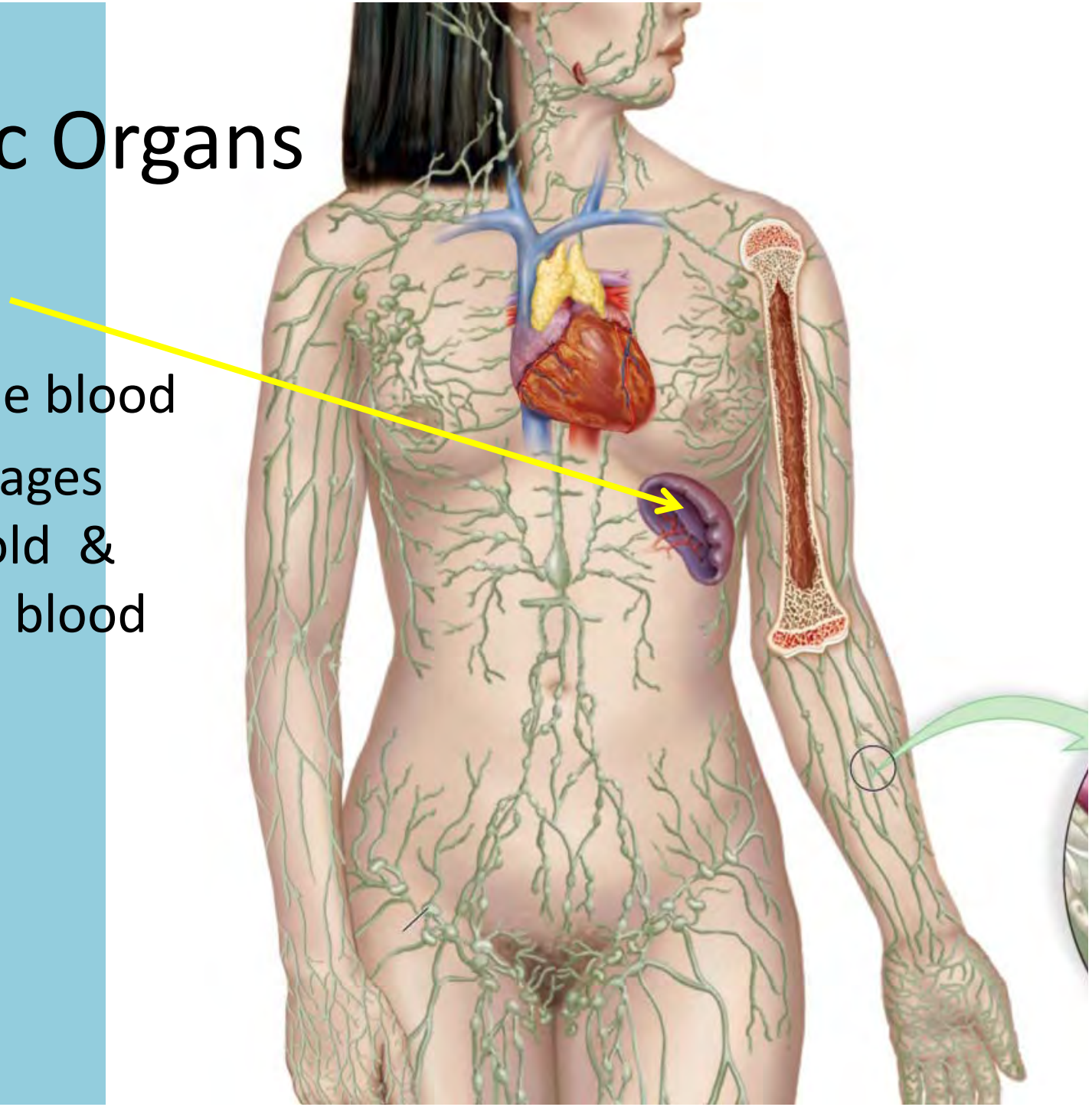
Lymphatic Organs

- Lymph Nodes
  - Cleans the lymph



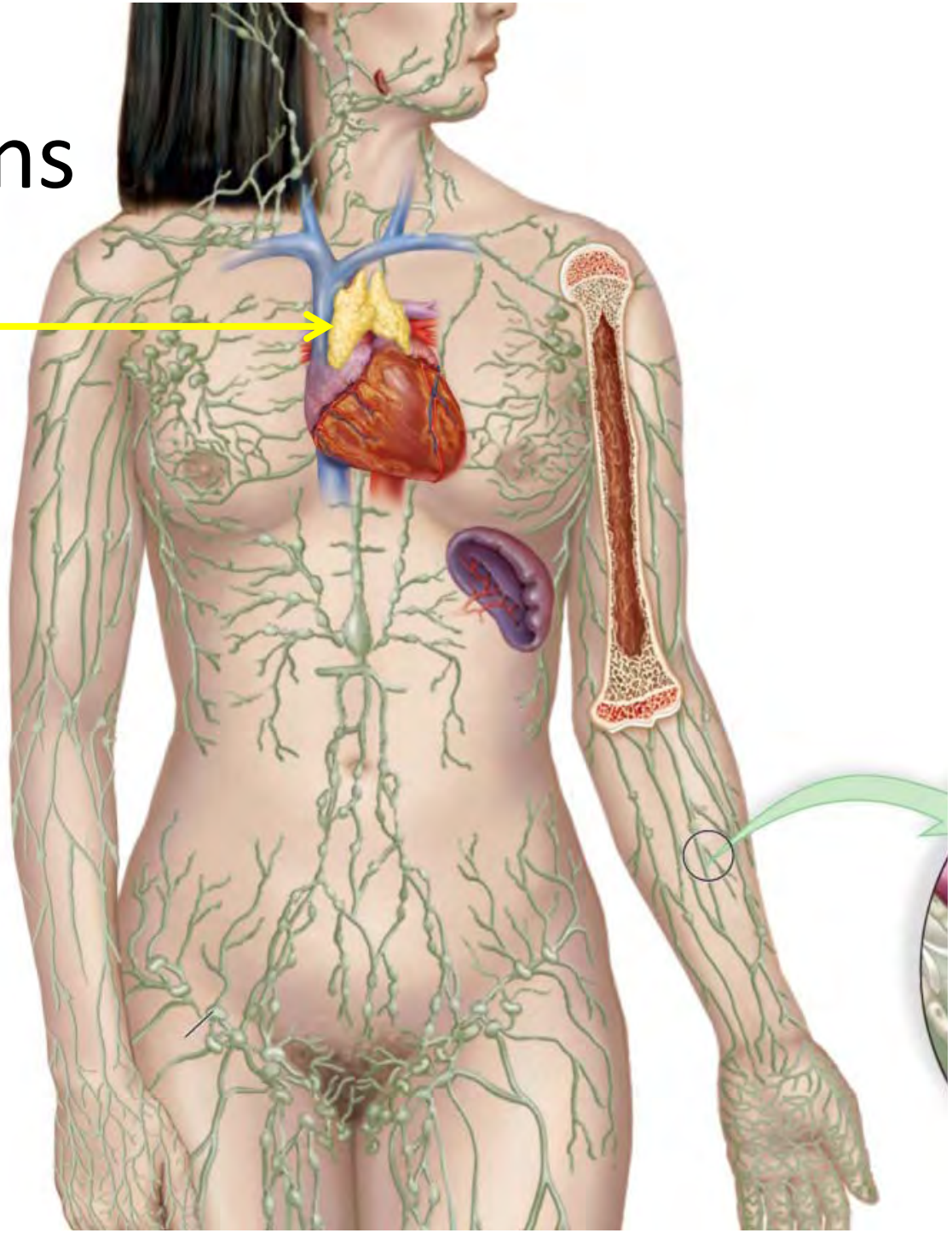
Lymphatic Organs

- Spleen
  - Cleans the blood
  - Macrophages remove old & defective blood cells



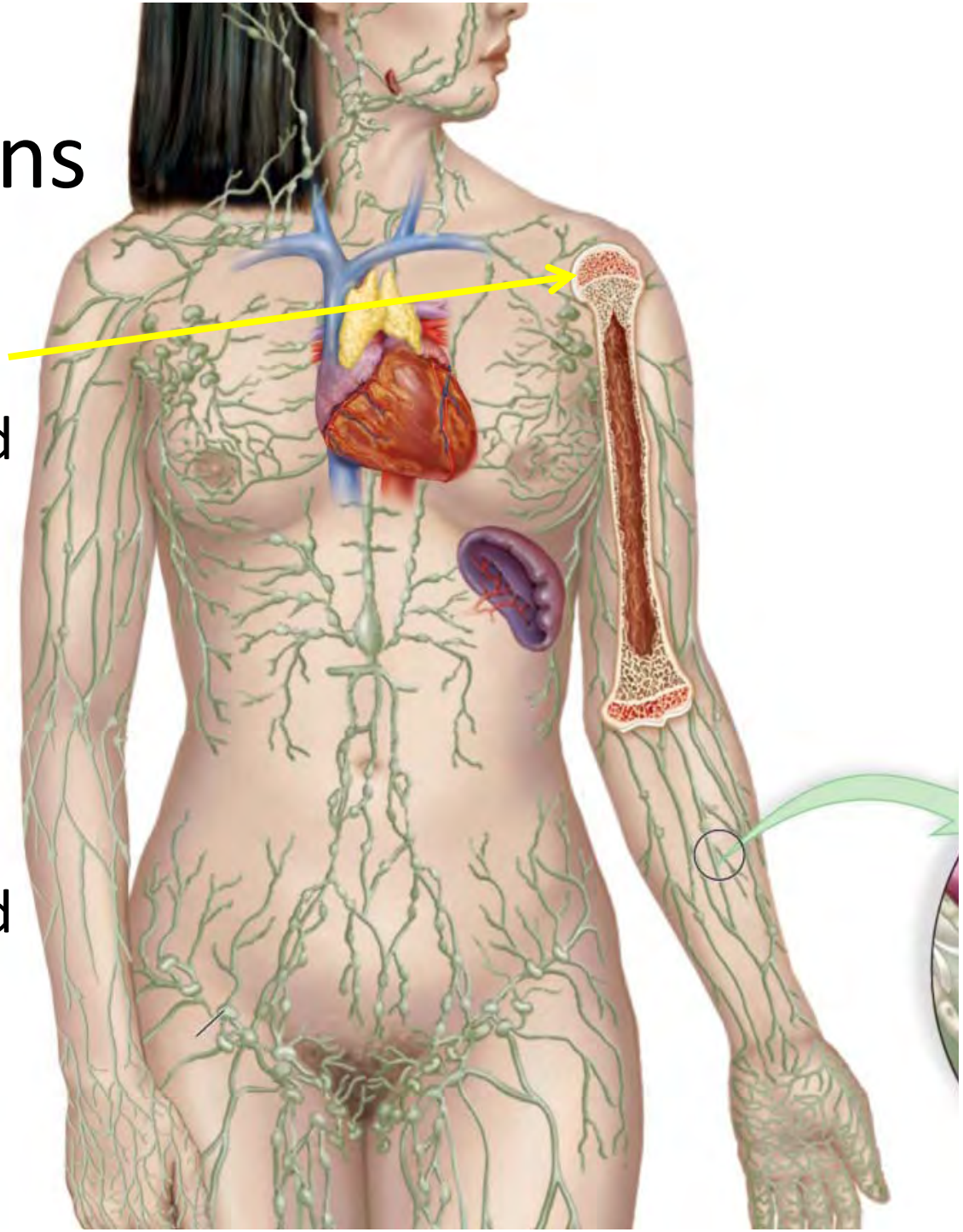
Lymphatic Organs

- Thymus Gland
  - Where T-cells mature (learn to tell “self” from “non-self”)
  - Also produces thymic hormones



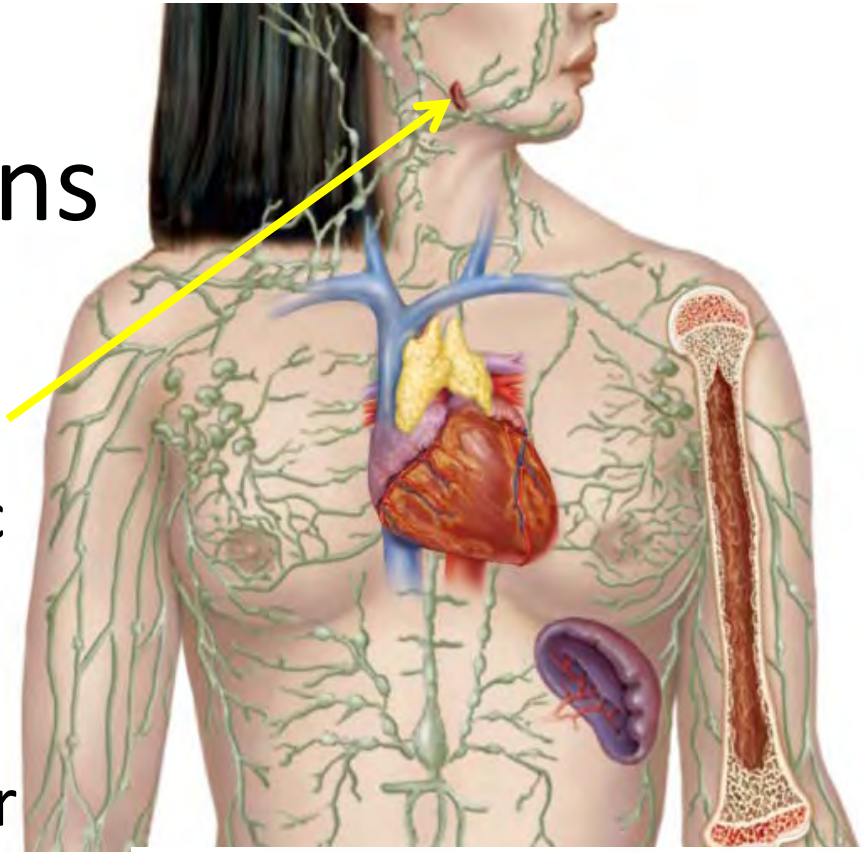
Lymphatic Organs

- Red bone marrow
  - Stem cells divide and produce various types of blood cells, including lymphocytes
  - Immature T-cells move to thymus glad to mature



Lymphatic Organs

- Tonsils
  - Patches of lymphatic tissue
  - First to encounter pathogens that enter via nose and mouth



Non-Specific Defenses

- Do not distinguish one type of threat from another
- Types:
  - Barriers to entry
  - Inflammation
  - Phagocytes & Natural Killer Cells
  - Protective proteins (complement, interferons)

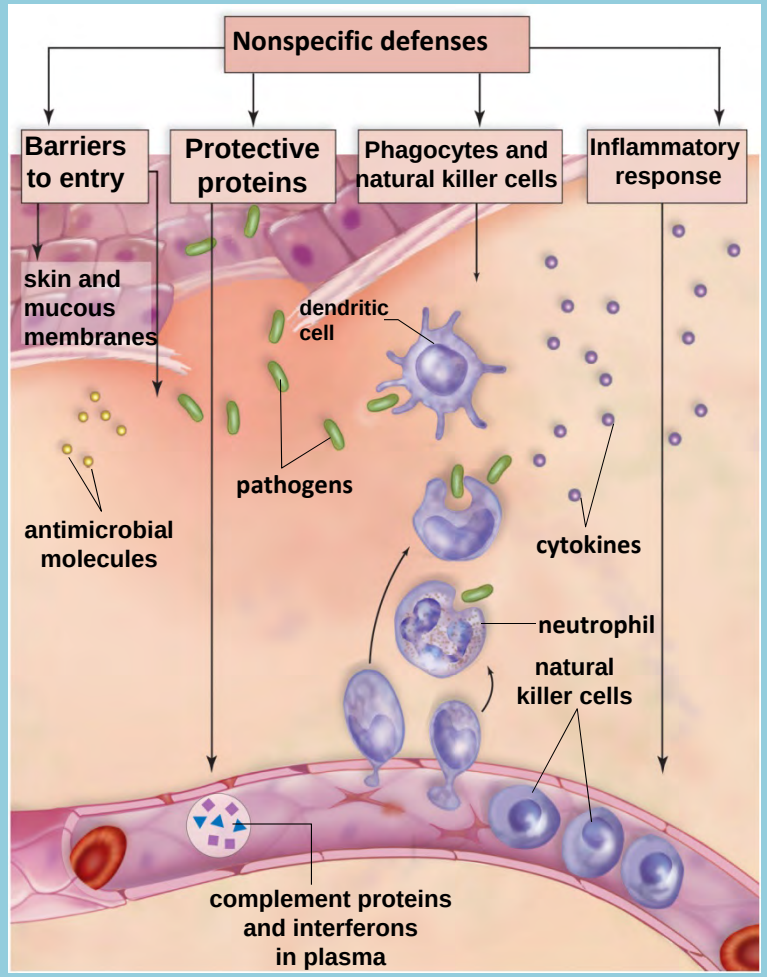
Non-specific Defenses

- Barriers to Entry
  - Skin, mucus, antimicrobial molecules

Non-specific Defenses

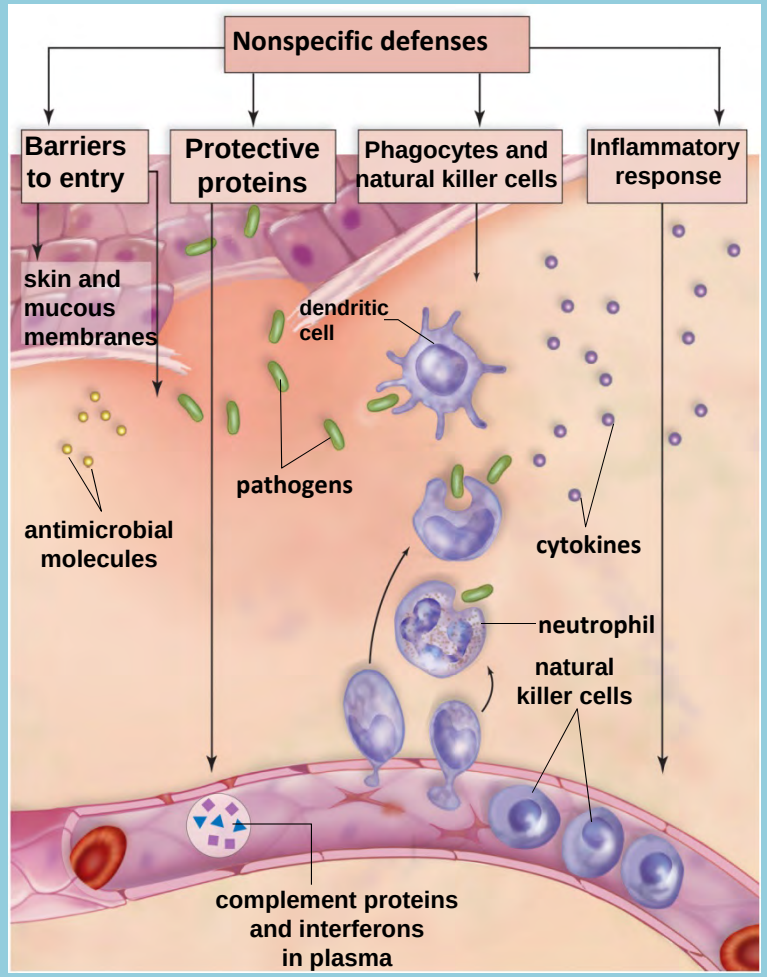
Inflammation

- Signs: redness, swelling, heat, pain
- Damaged tissue releases histamine (a chemical mediator)
  - Capillaries dilate and become more permeable
- Migration of **phagocytes** (**Neutrophils** and **Monocytes)** to area
- Macrophages devour pathogens, release colony stimulating factor (**cytokines**)
- Cytokines stimulate release of white blood cells
- Dead phagocytes and living white blood cells forms pus.



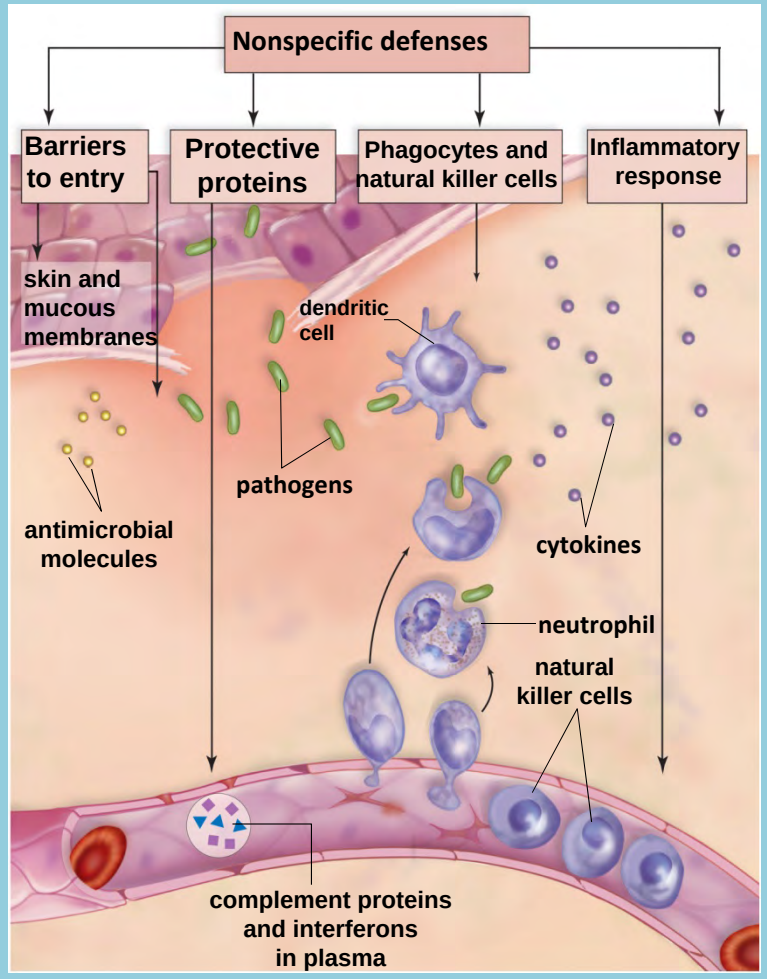
Non-specific Defenses

- Phagocytes
  - Neutrophils
    - Can leave blood stream
    - Phagocytize pathogens in connective tissue
    - Release antimicrobial peptides called defensins
  - Macrophages & Dendritic Cells
    - Two most powerful phagocytic WBCs
    - Dendritic cells engulf, travel to lymph nodes, stimulate Natural Killer cells
  - Natural Killer Cells
    - Lymphocytes that kill virus-infected cells or cancer cells
    - Look for self-protein; if cell has lost self-protein, it is killed.
    - Not specific, no memory.
    - Produce Cytokines
    - Congregate in tonsils, lymph nodes, spleen



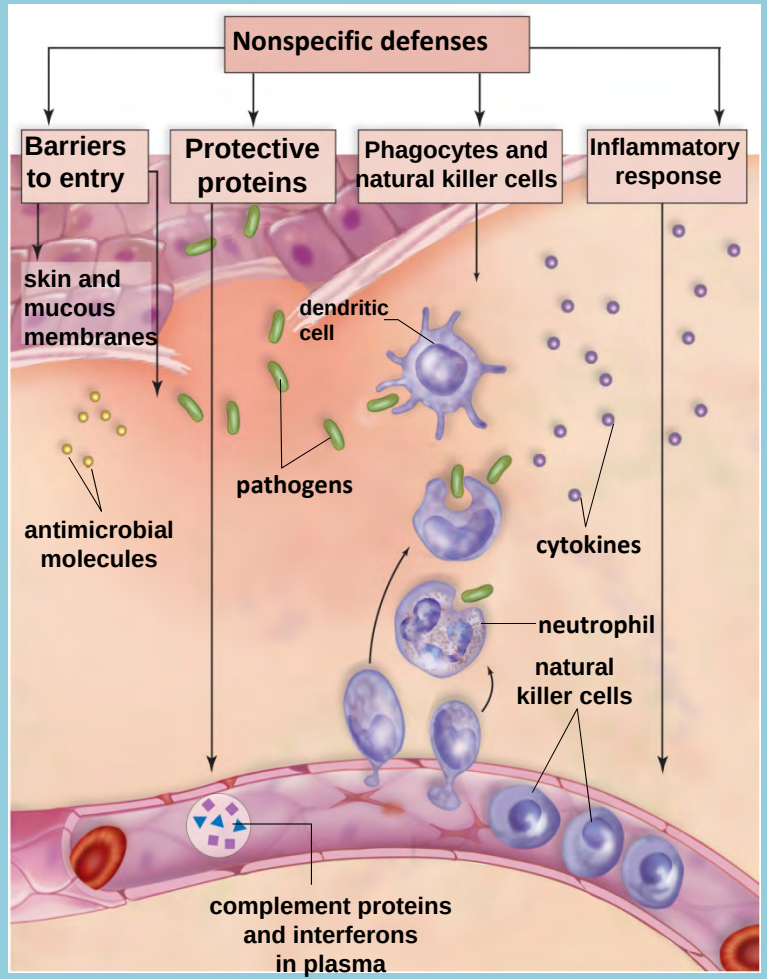
Non-specific Defenses

- Protective Proteins
  -Complement
    - Collection of plasma proteins, complement certain immune responses
    - Continually present in blood plasma, but must be activated
    - Destroys in 3 ways:
      - 1) Enhanced Inflammation
      - 2) Bind to surface of pathogens coated in antibodies to ensure phagocytation by neutrophils or macrophages
      - 3) Form membrane attack complex: makes holes in pathogen membrane so fluids/salts enter or exit and cell bursts.



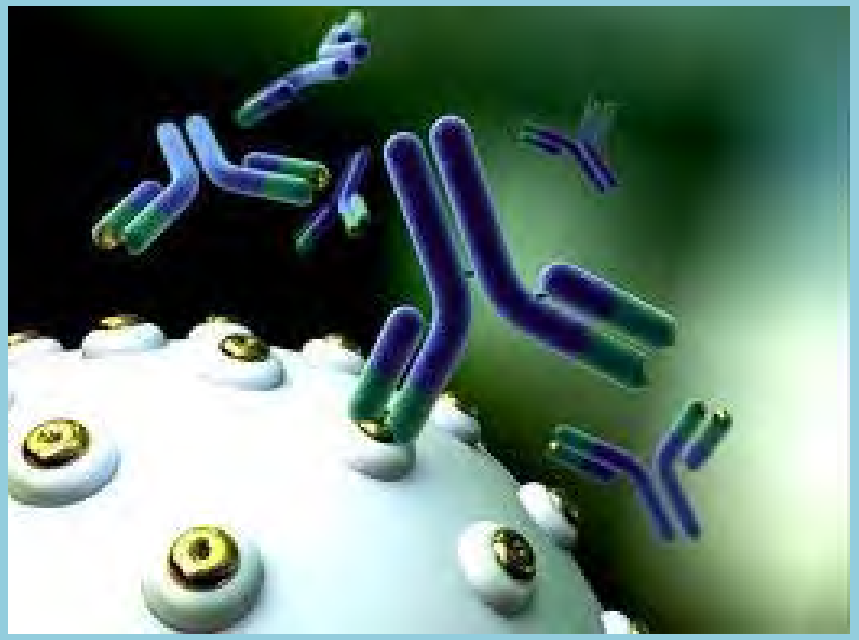
Non-specific Defenses

- Protective Proteins
  - -Interferons
    - Made by virus-infected cells
    - Bind to receptors of non-infected cells, causing them to produce a substance that *interferes* with virus replication
  - – Cytokines
    - Cell-signaling protein
    - Affect the behavior of other cells



Specific Defenses

- Also called *Acquired Immunity*
- Immunity = pathogens unable to cause infection now **or in the future**



Specific Defenses

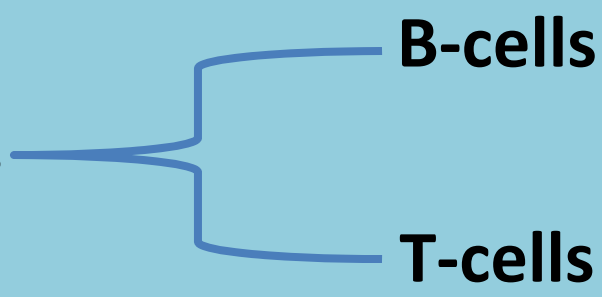
1) Recognition → • Recognition of **antigen** occurs

2) Response → • Usually takes 5-7 days

3) Remember → • Reaction time shorter on 2nd encounter

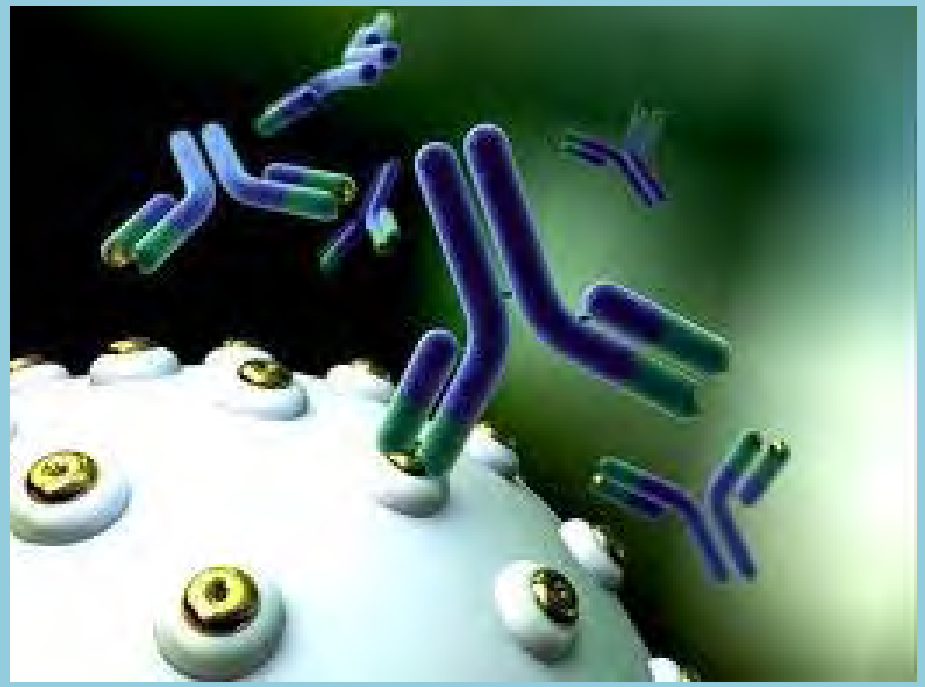
Specific Defenses

- 2 Types of Lymphocytes
  - Both produced in red bone marrow
  - Recognize antigens with **antigen receptors**
  - Each cell has receptors for one antigen
  - BCR, TCR



Specific Defenses – B-Cells

- B-Cells → **Antibody-mediated immunity**



- Combines with antigen right away if BCR recognizes it, then gives rise to **plasma cells** which produce specific antibodies
- Memory B-Cells
  - Persist with a particular BCR in order to recognize future invasions

Specific Defenses – T-Cells

- T-Cells

  1) **Helper T-cells**

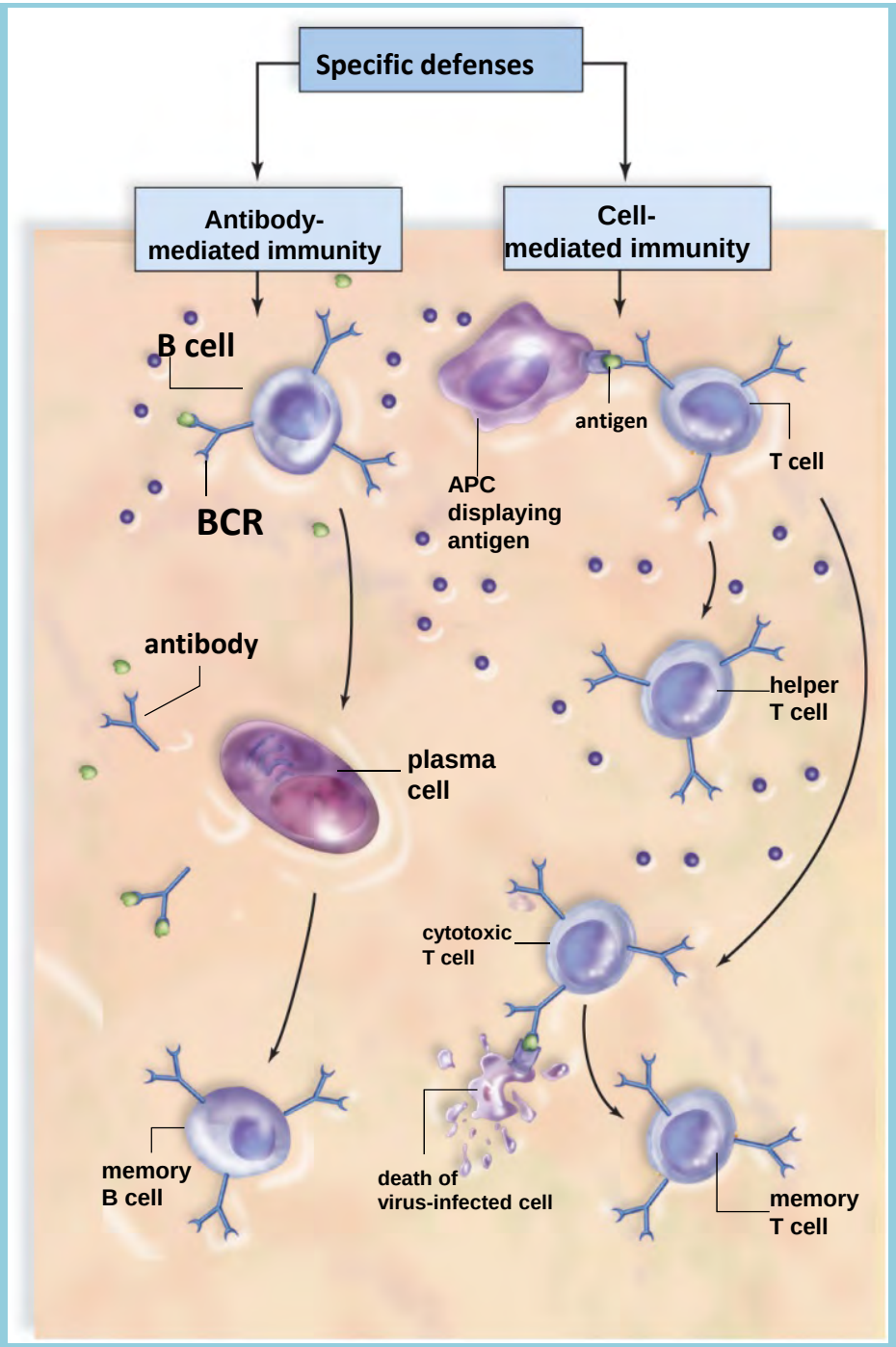
     - When activated, secretes cytokines

  2) **Cytotoxic T-Cells**

     - Destroy antigen-bearing cells
     - Contain Perforins
     - Can become **memory T-cells**

Cell-mediated immunity

- Need **antigen presenting cell (APC)**
  - E.g macrophages + dendritic cells
- Requirements for T cell antigen recognition:
  - Antigen must be presented by an antigen-presenting cell
  - Antigen is first linked to a major histocompatibility complex (MHC) protein in the plasma membrane
  - Cytokines - signaling chemicals that attract neutrophils, natural killer cells and macrophages to pathogens and stimulate clonal expansion of T and B cells.


Specific defenses
Antibody-mediated immunity
Cell-mediated immunity
B cell
BCR
antigen
T cell
APC displaying antigen
antibody
helper T cell
plasma cell
cytotoxic T cell
memory B cell
death of virus-infected cell
memory T cell

Induced Immunity – Active vs. Passive

Active

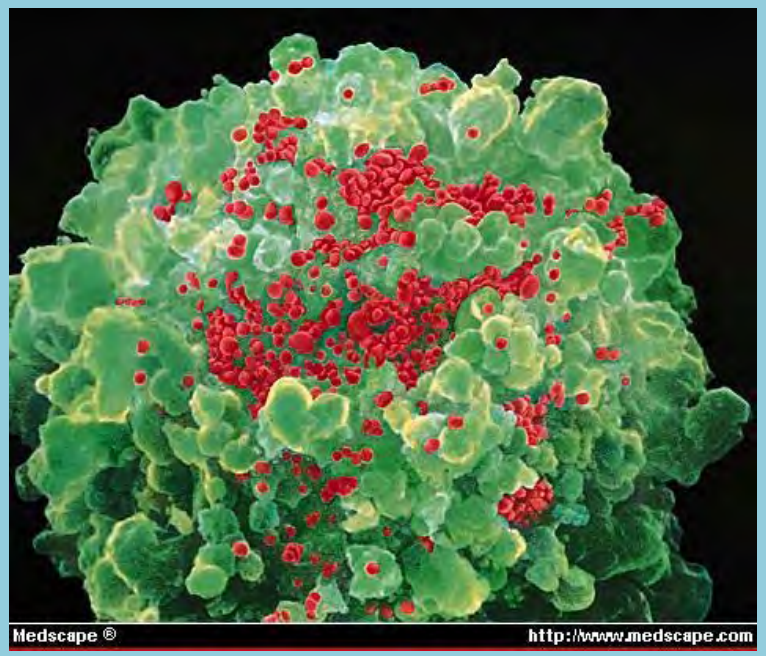
- Individual produces own antibodies
- Immunization= vaccines bring about clonal expansion of B&T Cells
  - Weakened or genetically modified pathogens
  - Raise **Titer** = the amount of antibodies present
- Ex: smallpox, polio, hepatitis B

Passive

- Individual given antibodies to combat disease
- Short lived because antibodies aren't present in the individual's plasma cells
- Ex: Breast feeding, rabies vaccine, **anti-venom**

HIV

- Host for virus is Helper T Cell or macrophages
- Virus reproduces and viruses destroy more Helper T Cells.
- Opportunistic infections



Immunity Side Effects

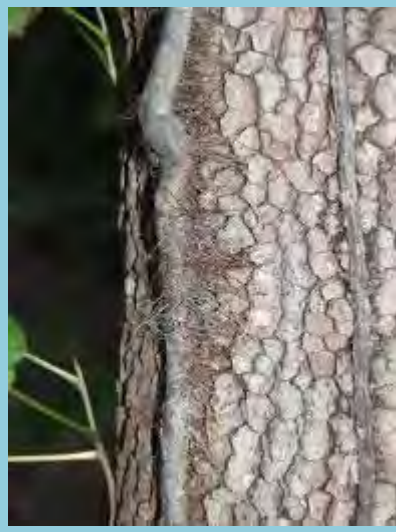
- Tissue Rejection
  - Antibodies and cytotoxic T cells bring about destruction of foreign tissues in the body
  - Immune system is correctly distinguishing between self and nonself

Disorders of the Immune System

- Autoimmune Diseases
  - Cytotoxic T cells or antibodies mistakenly attack the body's own cells
  - Lupus, Rheumatoid arthritis

Allergies

- Hypersensitivities to substances that ordinarily do no harm to the body
- **Immediate allergic response**
  - Occurs within seconds of exposure
  - Caused by antibodies IgE, release histamine to bring about symptoms
- Antihistamines
  - Compete for same receptors that combine with the histamine
  - Only partially effective because of other molecules that cause allergic symptoms
- Anaphylactic shock
- **Delayed allergic response**
  - Initiated by memory T-cells at the site of contact
  - Response regulated by cytokines secreted by T cells and macrophages
  - Example: Poison Ivy, Jewelry, cosmetics
  - Contact dermatitis



Allergies

- Anaphylactic shock
  - Immediate allergic response when allergen has entered the bloodstream
  - Sudden drop in blood pressure due to increased permeability of the capillaries by histamine

Summary

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  - Lymphoid Organs
- Nonspecific Defenses
  - Barriers
  - Inflammatory Response
- Specific Defenses
  - B-Cells = Antibody-mediated immunity
  - T-Cells = Cell-mediated immunity
- Induced Immunity
  - Active versus Passive Immunity
- Immunity Side Effects
  - Allergies