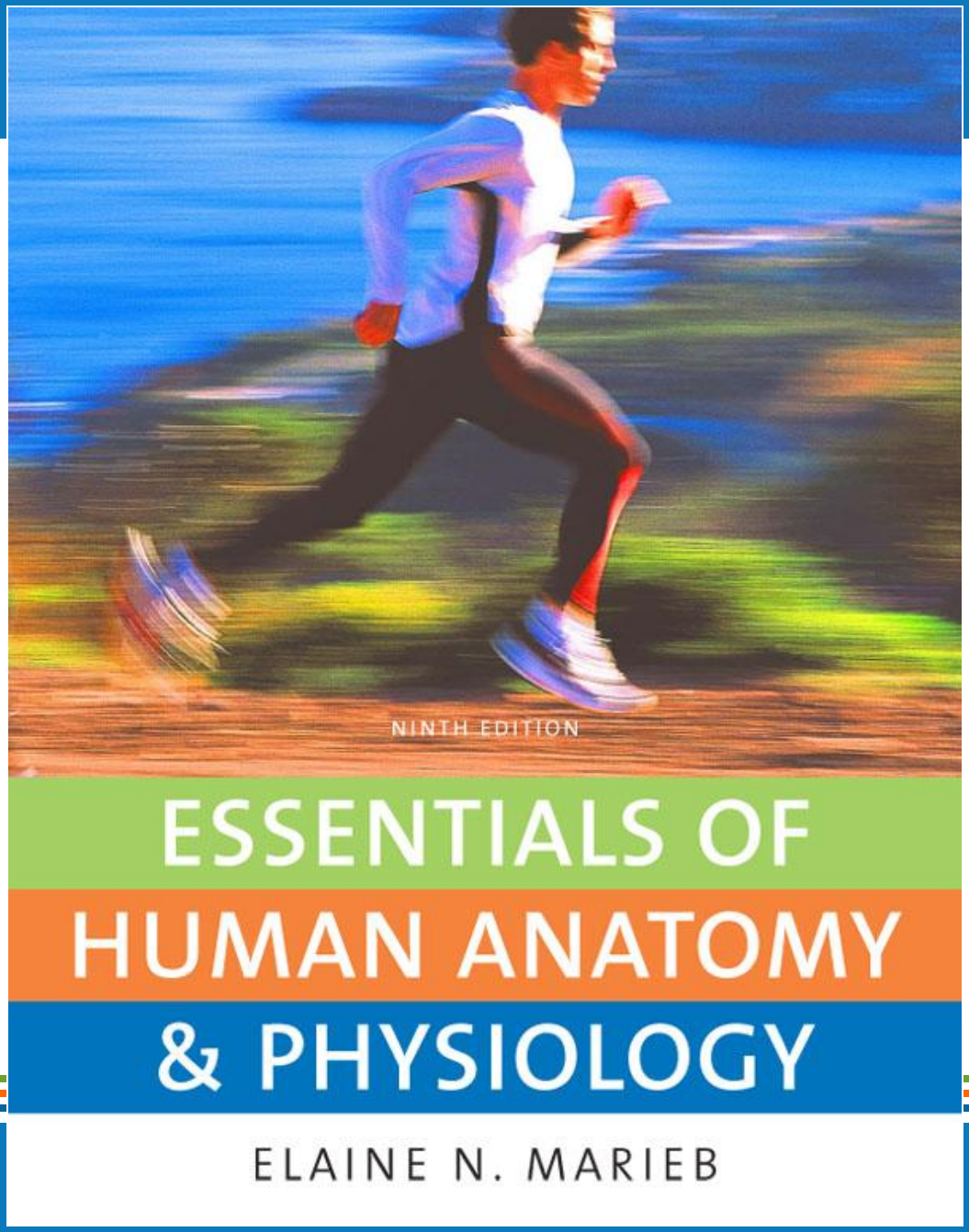

PowerPoint® Lecture Slide Presentation
by Patty Bostwick-Taylor,
Florence-Darlington Technical College

The Lymphatic System and Body Defenses

12 PART A

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The Lymphatic System

- Consists of two semi-independent parts
  - Lymphatic vessels
  - Lymphoid tissues and organs
- Lymphatic system functions
  - Transports escaped fluids back to the blood
  - Plays essential roles in body defense and resistance to disease

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Lymphatic Characteristics

- Lymph—excess tissue fluid carried by lymphatic vessels
- Properties of lymphatic vessels
  - One way system toward the heart
  - No pump
  - Lymph moves toward the heart
    - Milking action of skeletal muscle
    - Rhythmic contraction of smooth muscle in vessel walls

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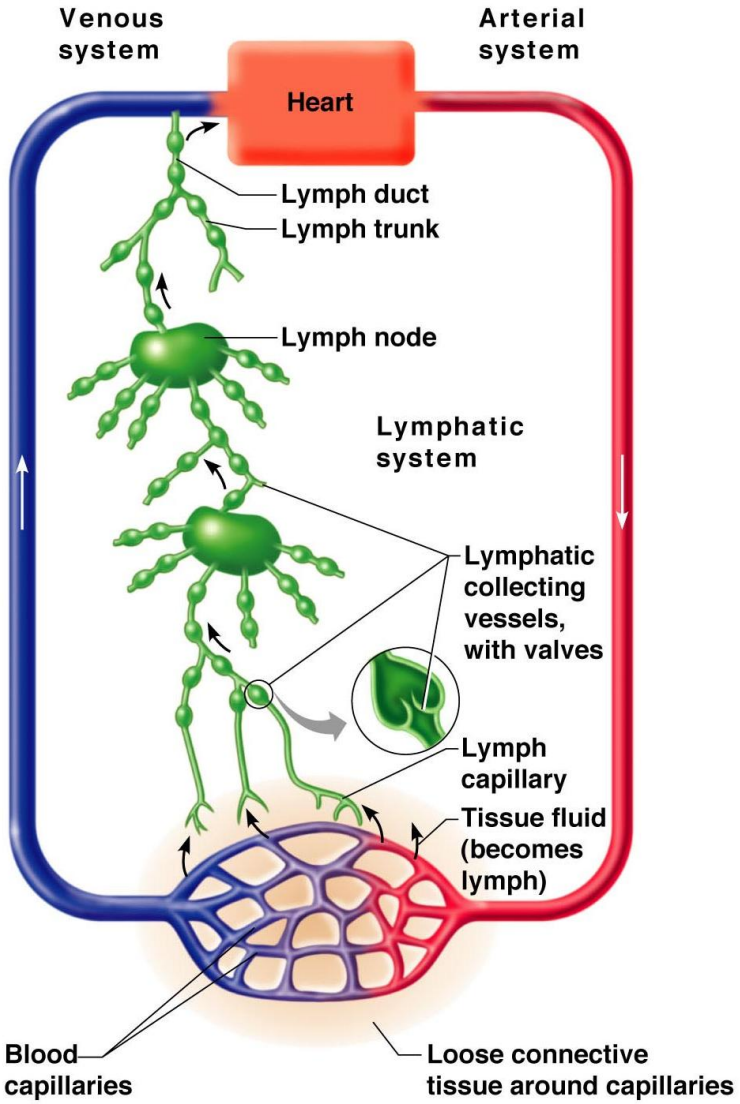
Relationship of Lymphatic Vessels to Blood Vessels



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Lymphatic Vessels

- Lymphatic collecting vessels
  - Collect lymph from lymph capillaries
  - Carry lymph to lymph nodes and away from them
  - Lymph is returned to blood into veins near the heart via 2 channels:
    - Right lymphatic duct
    - Thoracic duct

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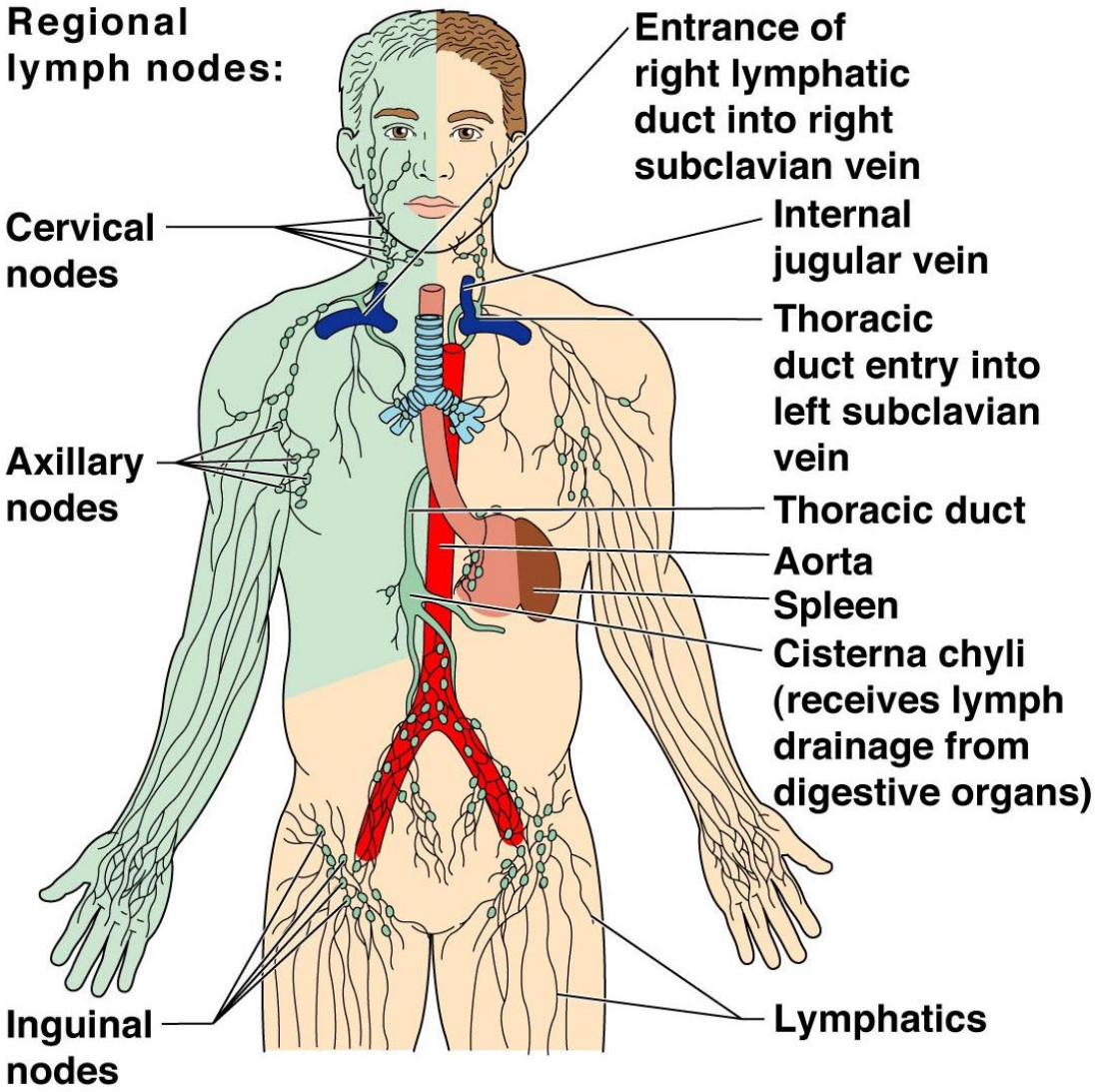
Lymphatic Vessels: Drainage areas



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Lymph

- Harmful materials that enter lymph vessels
  - Bacteria
  - Viruses
  - Cancer cells
  - Cell debris

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Lymph Nodes

- Filter lymph before it is returned to the blood
  - All lymph is filtered by at least one node before returning to blood
- Defense cells within lymph nodes
  - Macrophages—engulf and destroy foreign substances
  - Lymphocytes—provide immune response to antigens

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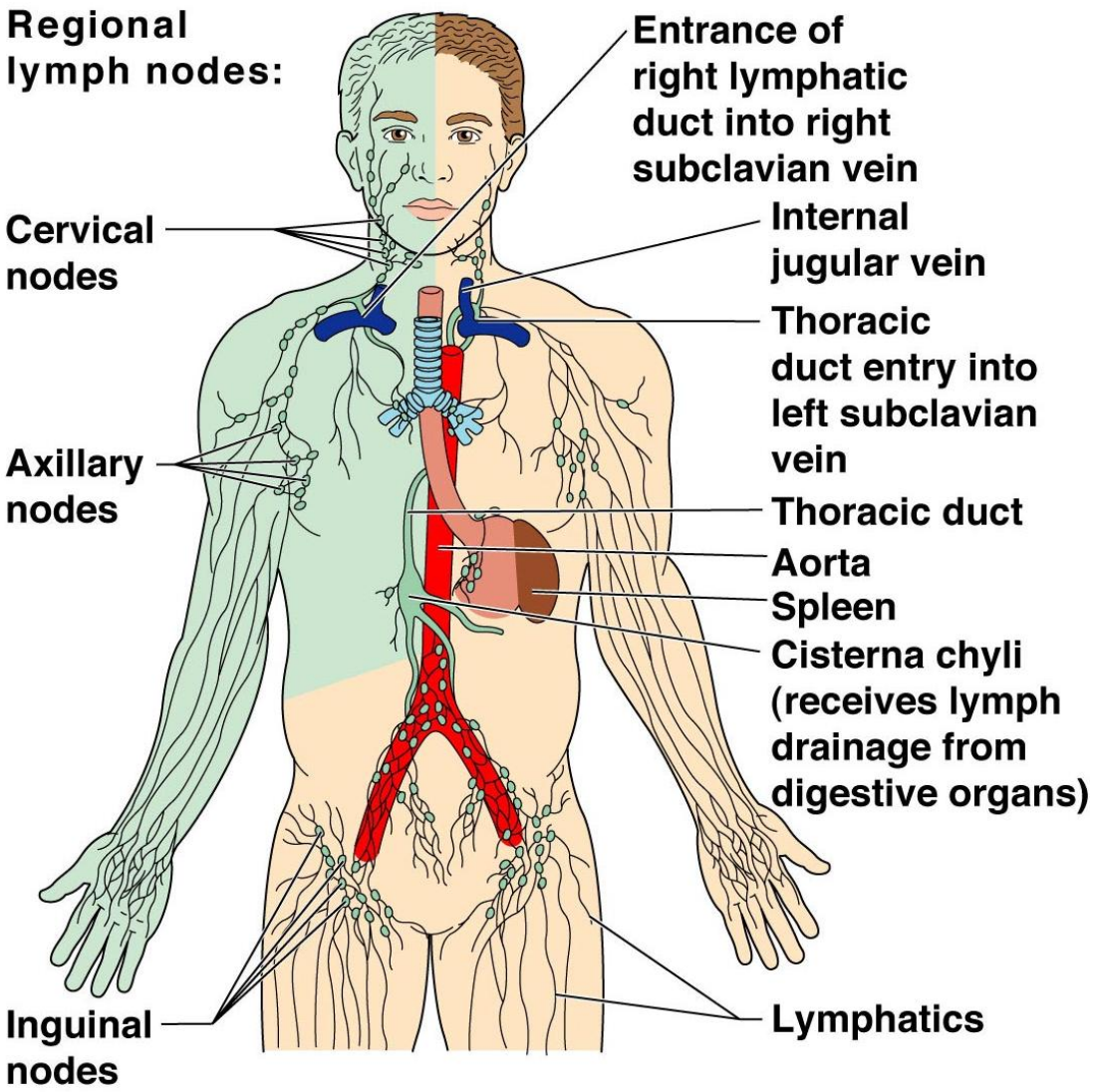
Lymph Nodes



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Other Lymphoid Organs

- Several other organs contribute to lymphatic function
  - Spleen
  - Thymus
  - Tonsils
  - Peyer's patches, appendix, etc.

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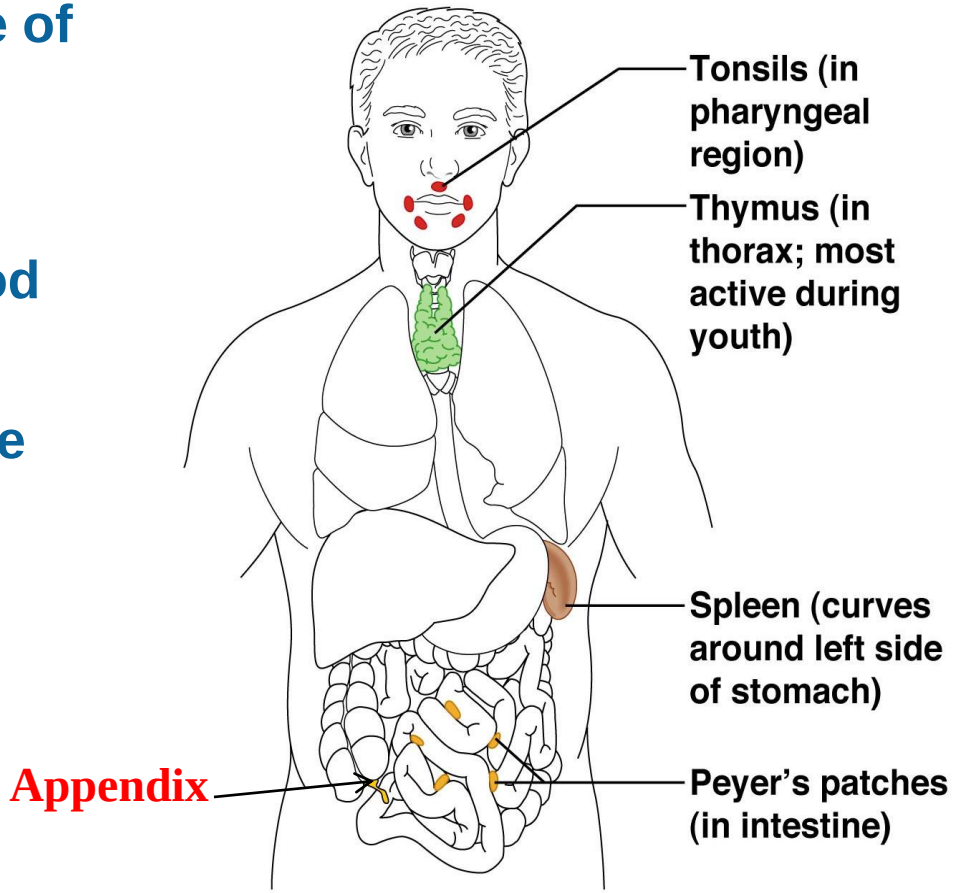
Spleen

- Located on the left side of the abdomen
- Filters blood
- Destroys worn out blood cells
- Forms blood cells in the fetus



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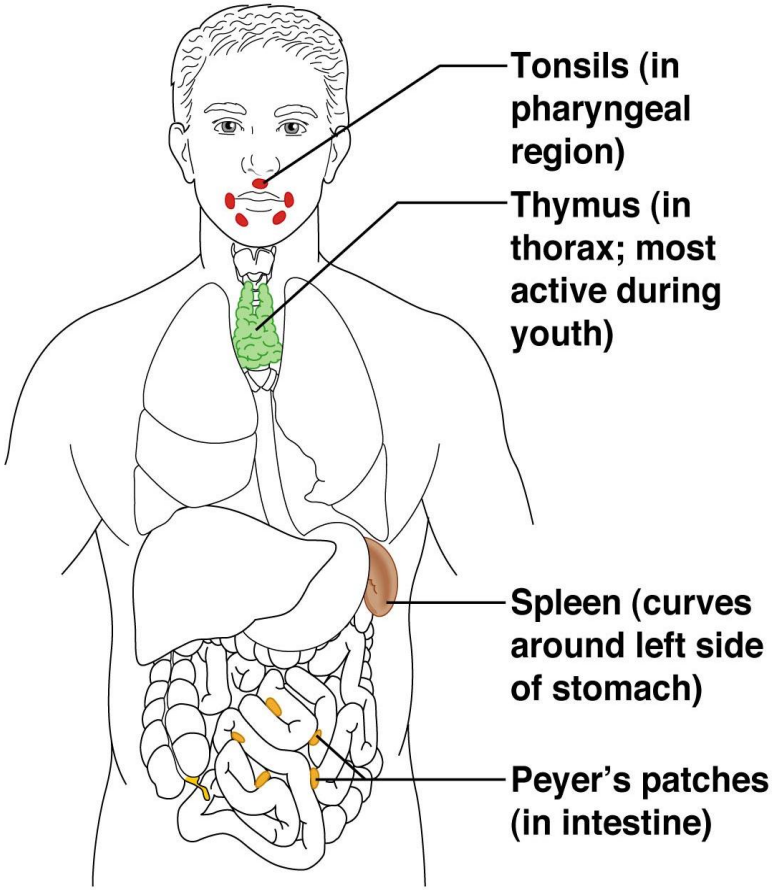
Thymus Gland

- Located in the thorax, overlying the heart
- Functions at peak levels only during childhood; then regresses
- Produces hormones (thymosin) to program lymphocytes



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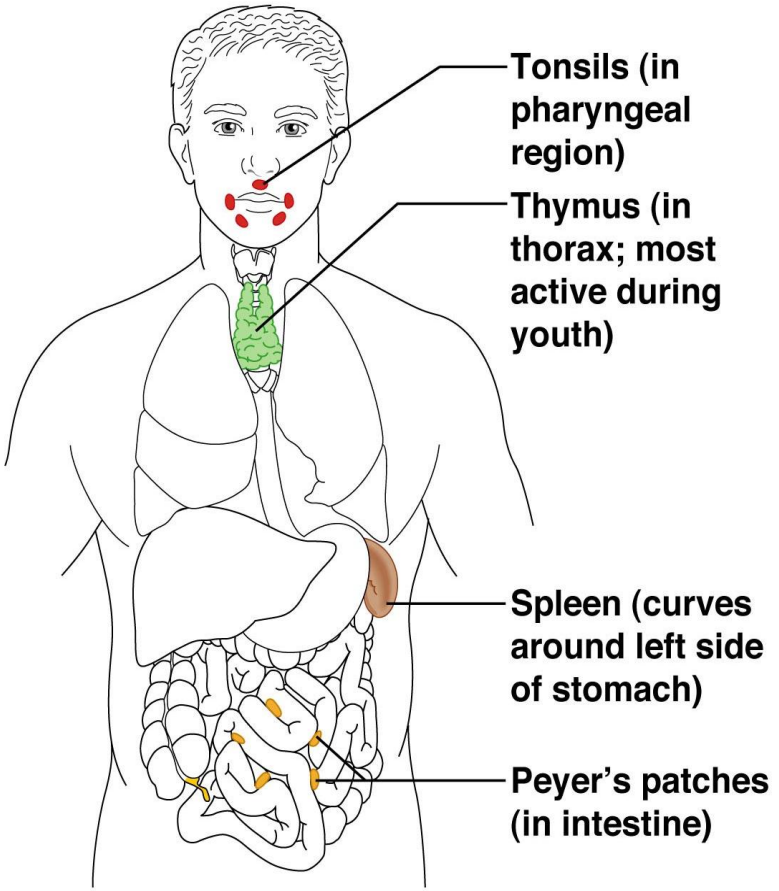
Mucosa-Associated Lymphatic Tissue (MALT)

- Acts as a sentinel to protect respiratory and digestive tracts
- Includes
  - Peyer's patches
  - Tonsils
  - Appendix
  - Other small accumulations of lymphoid tissue



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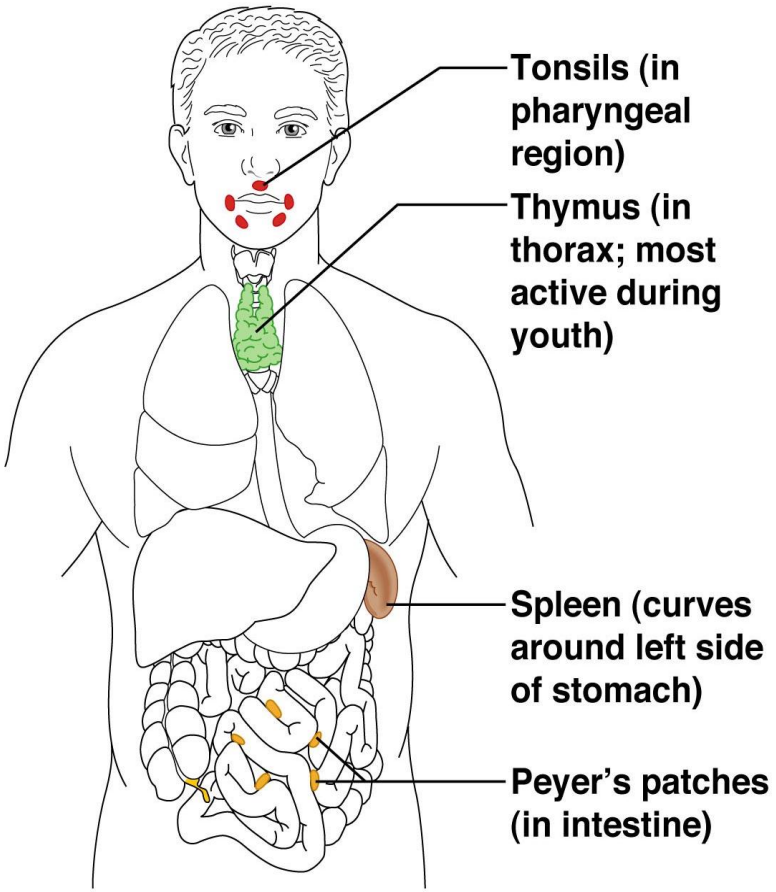
Tonsils

- Small masses of lymphoid tissue around the pharynx
- Trap and remove bacteria and other foreign materials
- Tonsillitis is caused by congestion with bacteria
- 3 sets: palatine, lingual, pharyngeal (adenoids)
- Tonsillectomy removes palatine and pharyngeal tonsils



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Body Defenses

- The body is constantly in contact with bacteria, fungi, and viruses
- The body has two defense systems for foreign materials
  - Innate (nonspecific) defense system
  - Adaptive (specific) defense system
- Immunity—specific resistance to disease

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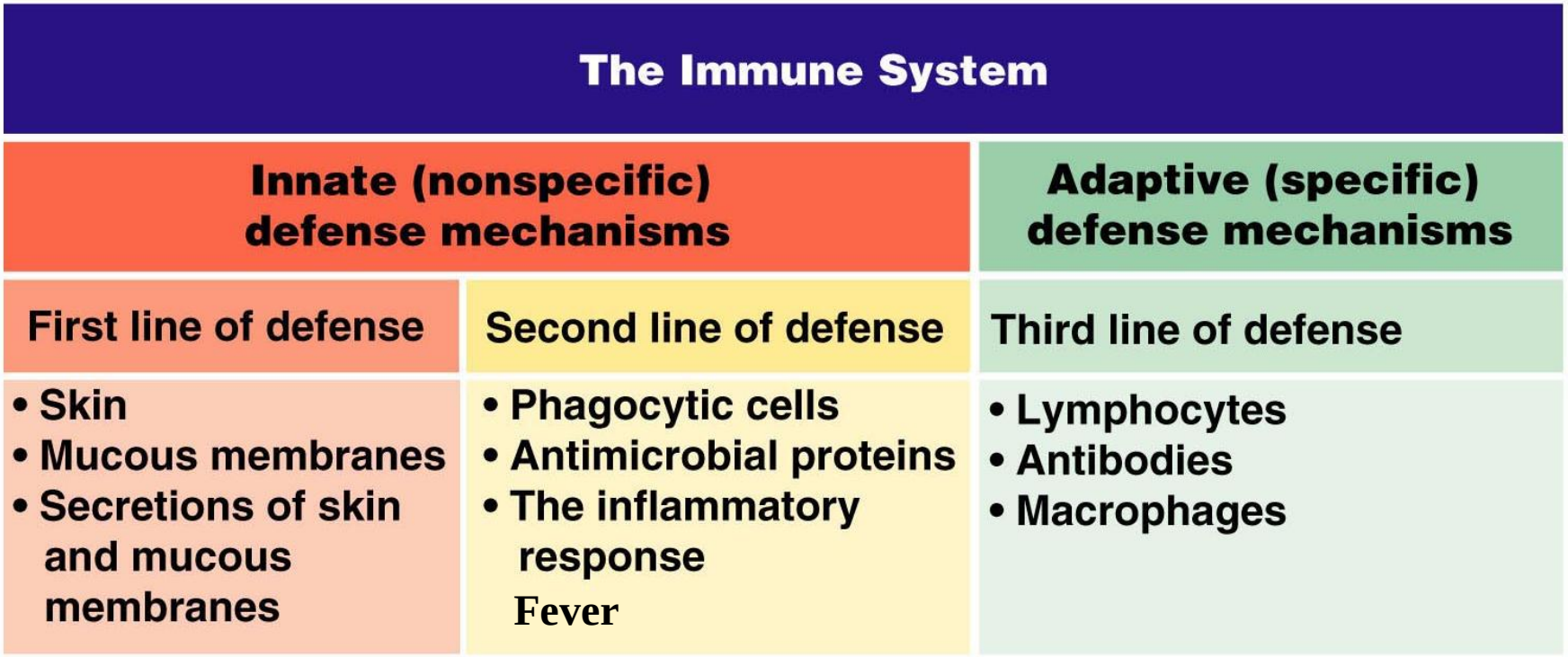
Immune System



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Body Defenses

- Innate defense system (nonspecific defense system)
  - Mechanisms protect against a variety of invaders
  - Responds immediately to protect body from foreign materials
- Adaptive defense system (specific defense system)
  - Specific defense is required for each type of invader

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Innate Body Defenses

- Innate body defenses are mechanical barriers to pathogens such as
  - Body surface coverings
    - Intact skin
    - Mucous membranes
  - Specialized human cells
  - Chemicals produced by the body

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Surface Membrane Barriers: First Line of Defense

- Skin and mucous membranes
  - Physical barrier to foreign materials
  - Also provide protective secretions
    - pH of the skin is acidic to inhibit bacterial growth
    - Sebum is toxic to bacteria
    - Vaginal secretions are very acidic

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Surface Membrane Barriers: First Line of Defense

- Stomach mucosa
  - Secretes hydrochloric acid
  - Has protein-digesting enzymes
- **Saliva and tears** contain lysozymes, an enzyme that destroy bacteria
- **Mucus** traps microogranisms in digestive and respiratory pathways

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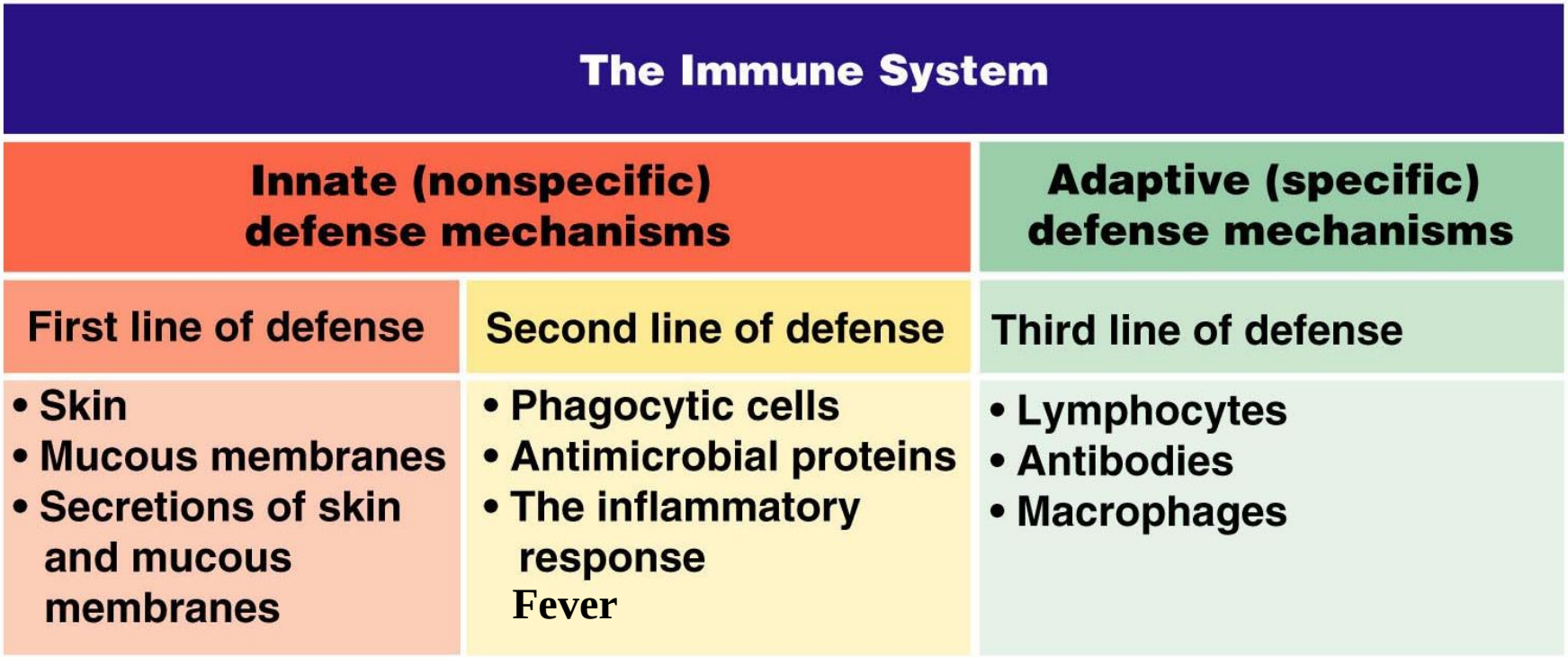
Immune System



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Cells and Chemicals: Second Line of Defense

- Phagocytes
- Natural killer cells
- Inflammatory response
- Antimicrobial proteins
- Fever

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Cells and Chemicals: Second Line of Defense

- Phagocytes
  - Cells such as neutrophils and macrophages
  - Engulf foreign material into a vacuole within cell; vacuole merges with lysosome
  - Enzymes from lysosomes digest the material

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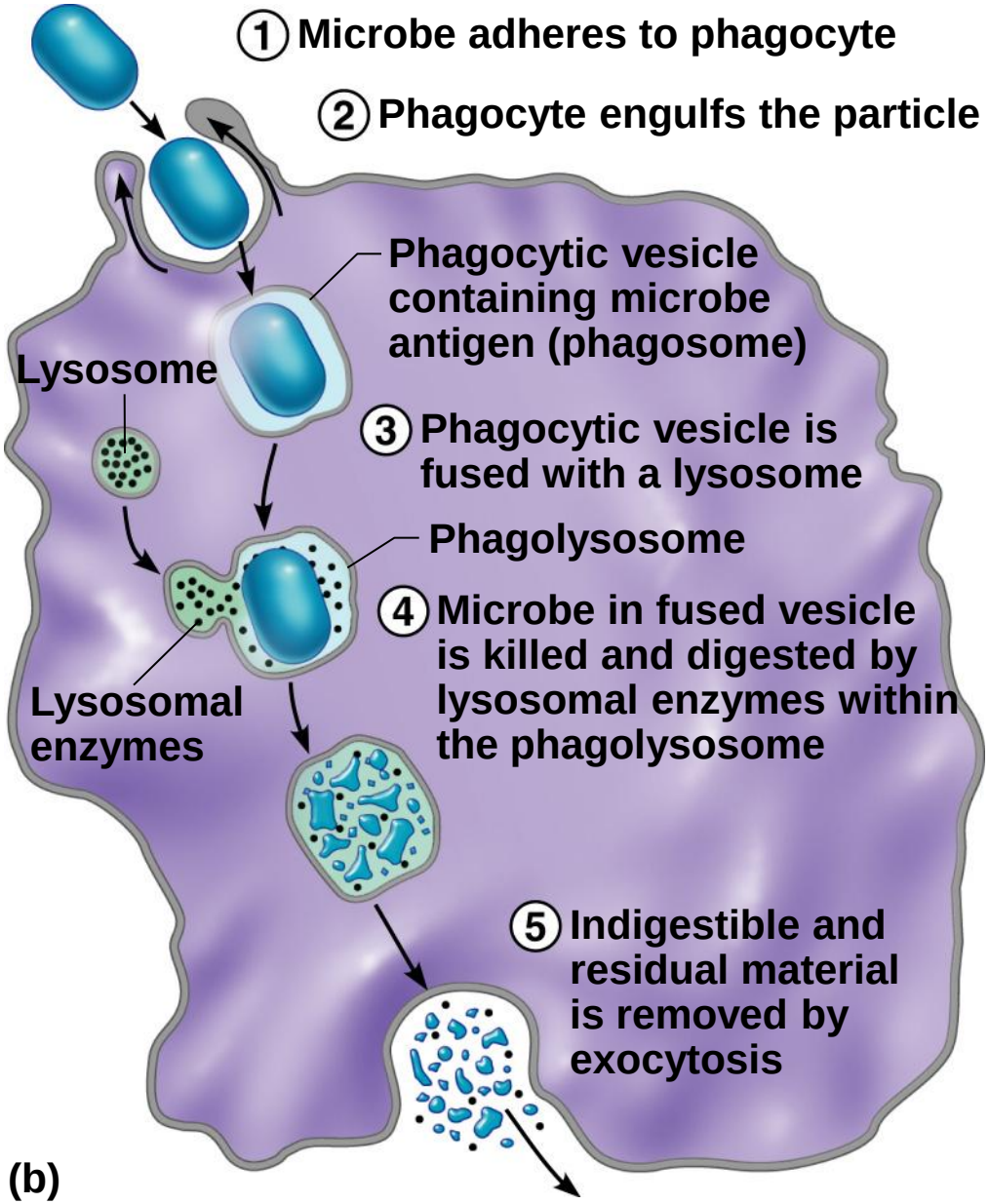

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Internal Innate Defenses: Cells and Chemicals

- **Natural killer (NK) cells**
  - **Can lyse (disintegrate or dissolve) and kill cancer cells**
  - **Can destroy virus-infected cells**

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Cells and Chemicals: Second Line of Defense

- Inflammatory response
  - Triggered when body tissues are injured
  - Four most common indicators of acute inflammation
    - Redness
    - Heat
    - Swelling
    - Pain
  - Results in a chain of events leading to protection and healing

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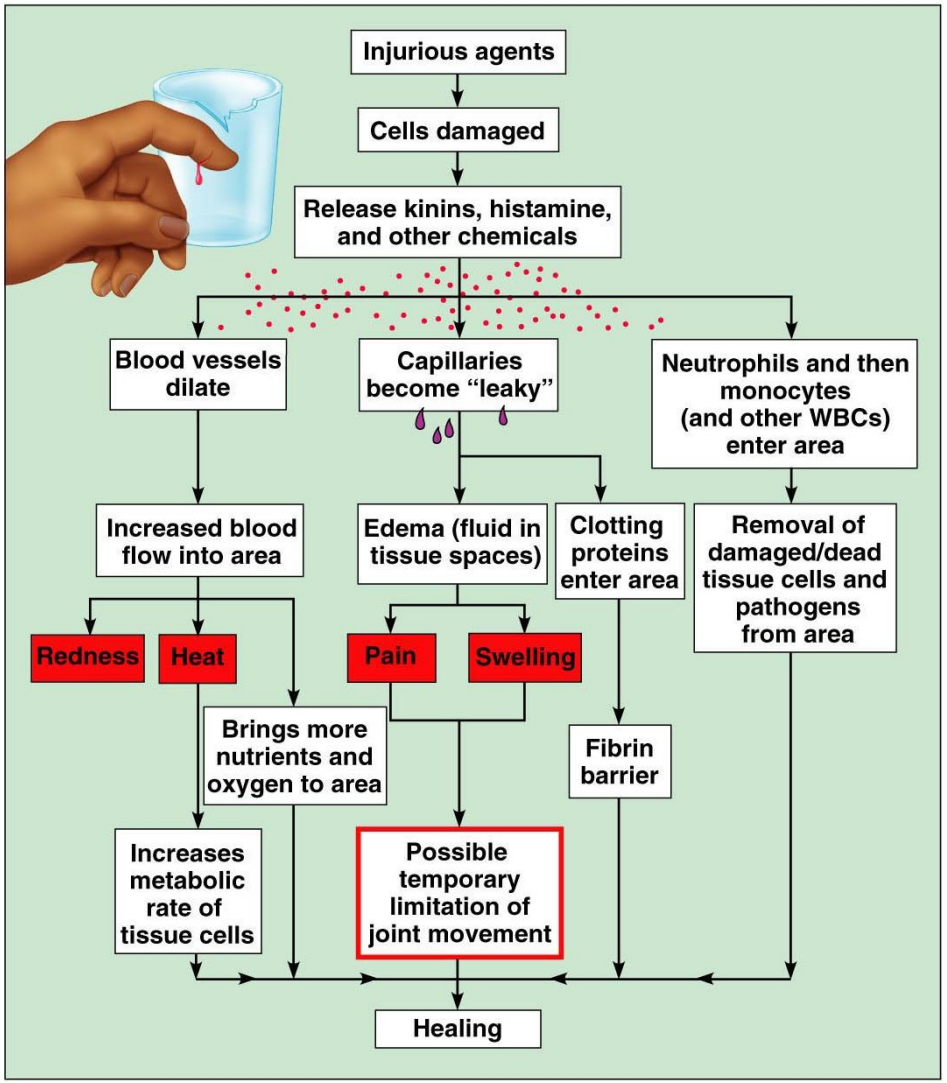
Flowchart of Inflammatory Events



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Cells and Chemicals: Second Line of Defense

- **Functions of the inflammatory response**
  - **Prevents spread of damaging agents**
  - **Disposes of cell debris and pathogens through phagocytosis**
  - **Sets the stage for repair**

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Cells and Chemicals: Second Line of Defense

- **Phagocytosis**
  - **Neutrophils move by diapedesis to clean up damaged tissue and/or pathogens**
  - **Monocytes become macrophages and complete disposal of cell debris**

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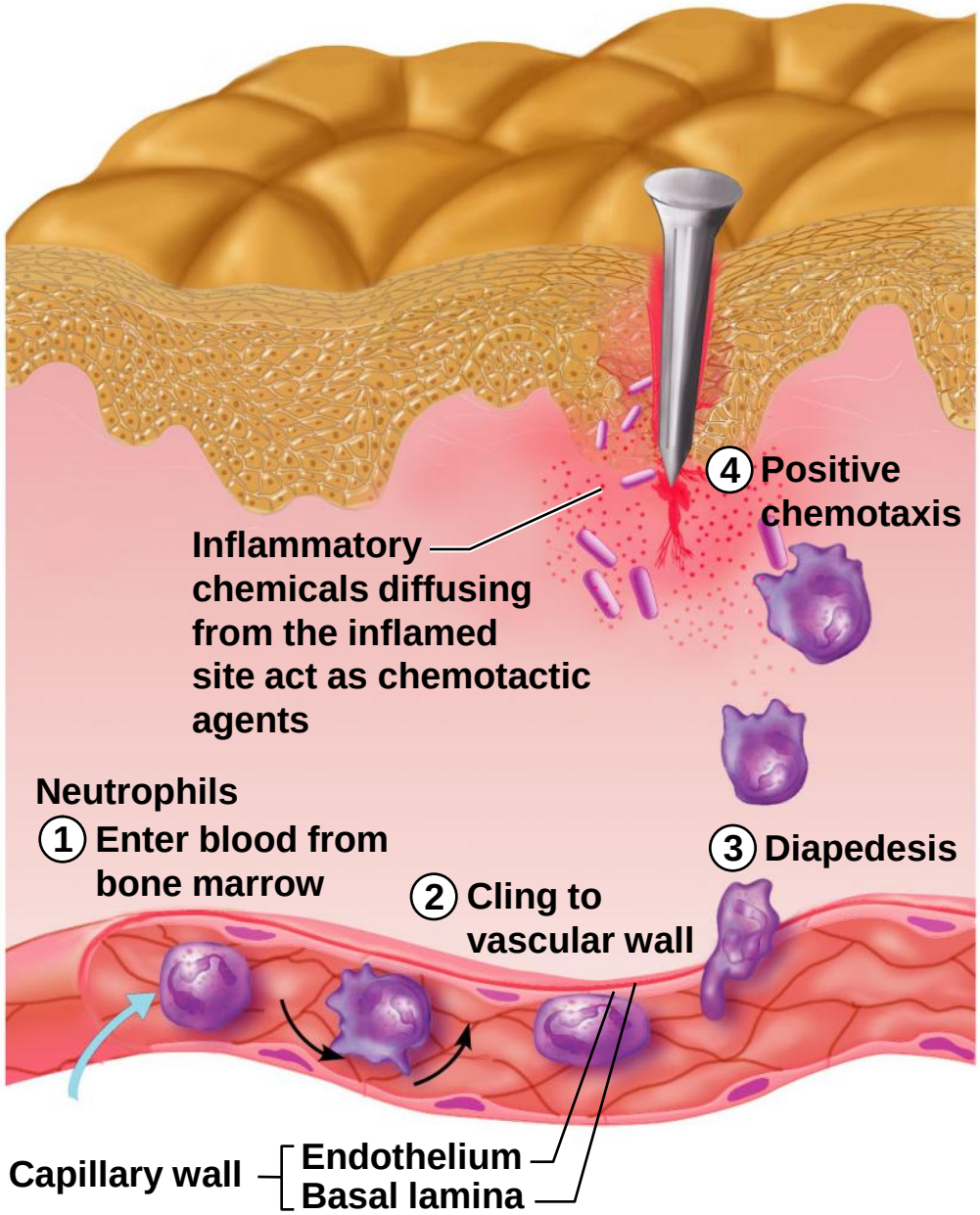

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Cells and Chemicals: Second Line of Defense

- Antimicrobial proteins
  - Attack microorganisms
  - Hinder reproduction of microorganisms
- Most important
  - Complement proteins
  - Interferon

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Cells and Chemicals: Second Line of Defense

- Complement proteins
  - A group of at least 20 plasma proteins
  - Activated when they encounter and attach to cells (complement fixation)
  - Damage foreign cell surfaces
  - Release vasodilators and chemotaxis chemicals, cause opsonization
- Interferon
  - Proteins secreted by virus-infected cells
  - Bind to healthy cell surfaces to interfere with the ability of viruses to multiply

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Cells and Chemicals: Second Line of Defense

- **Fever**
  - **Abnormally high body temperature**
  - **Hypothalamus heat regulation can be reset by pyrogens (secreted by white blood cells)**
  - **High temperatures inhibit the release of iron and zinc from the liver and spleen needed by bacteria**
  - **Fever also increases the speed of tissue repair**

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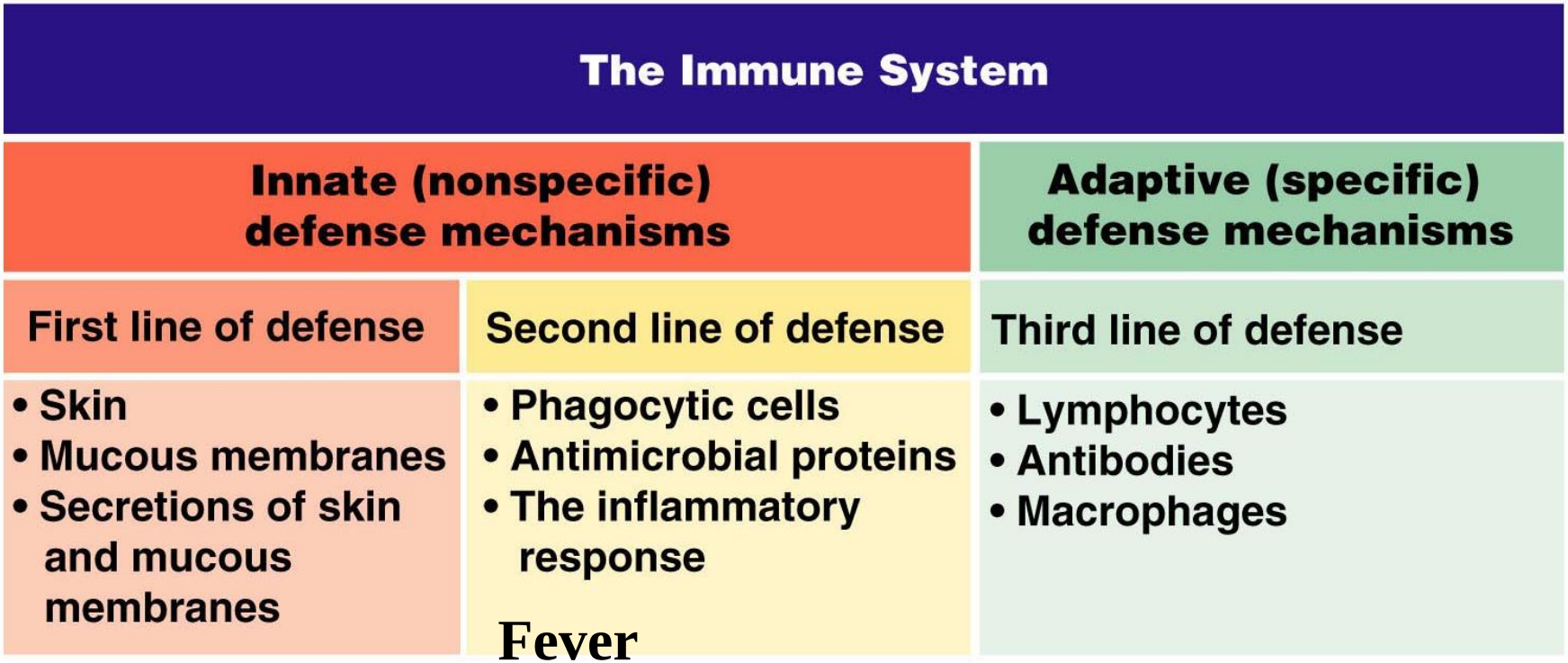
Immune System



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Adaptive Defense System: Third Line of Defense

- **Immune response is the immune system's response to a threat**
- **Immunology is the study of immunity**
- **Antibodies are proteins that protect from pathogens**

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Adaptive Defense System: Third Line of Defense

- Three aspects of adaptive defense
  - Antigen specific—recognizes and acts against particular foreign substances
  - Systemic—not restricted to the initial infection site
  - Memory—recognizes and mounts a stronger attack on previously encountered pathogens

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Adaptive Defense System: Third Line of Defense

- Types of Immunity
  - Humoral immunity = antibody-mediated immunity
    - Provided by antibodies present in body fluids
  - Cellular immunity = cell-mediated immunity
    - Targets virus-infected cells, cancer cells, and cells of foreign grafts

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Adaptive Defense System: Third Line of Defense

- Antigens (nonself)
  - Any substance capable of exciting the immune system and provoking an immune response
  - Examples of common antigens
    - Foreign proteins (strongest)
    - Nucleic acids
    - Large carbohydrates
    - Some lipids
    - Pollen grains
    - Microorganisms

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Adaptive Defense System: Third Line of Defense

- Self-antigens
  - Human cells have many surface proteins
  - Our immune cells do not attack our own proteins
  - Our cells in another person's body can trigger an immune response because they are foreign
    - Restricts donors for transplants

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Adaptive Defense System: Third Line of Defense

- **Allergies**
  - **Many small molecules (called haptens or incomplete antigens) are not antigenic, but link up with our own proteins**
  - **The immune system may recognize and respond to a protein-hapten combination**
  - **The immune response is harmful rather than protective because it attacks our own cells**

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Adaptive Defense System: Third Line of Defense

- Cells of the adaptive defense system
  - Lymphocytes respond to specific antigens
    - B lymphocytes (B cells)
    - T lymphocytes (T cells)
  - Macrophages and other cells help lymphocytes

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Adaptive Defense System: Third Line of Defense

- **Immunocompetent—cell becomes capable of responding to a specific antigen by binding to it**
- **Cells of the adaptive defense system**
  - **Lymphocytes from lymphoid stem cells**
    - **Originate from hemocytoblasts in the red bone marrow**
    - **B lymphocytes become immunocompetent in the bone marrow (*remember **B** for **B**one marrow*)**
    - **T lymphocytes become immunocompetent in the thymus (*remember **T** for **T**hymus*)**

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Adaptive Defense System: Third Line of Defense

- Cells of the adaptive defense system (continued)
  - Macrophages
    - Arise from monocytes
    - Become widely distributed in lymphoid organs
    - Some tend to remain fixed in the lymphoid organs

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Humoral (Antibody-Mediated) Immune Response

- B lymphocytes with specific receptors bind to a specific antigen
- The binding event activates the lymphocyte to undergo clonal selection (mitosis)
- A large number of clones are produced (primary humoral response) (repeated mitoses to create large numbers of the same cell; think “Clone Wars” in Star Wars)

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Humoral Immune Response

- Most B cells become plasma cells
  - Produce antibodies to destroy antigens
  - Activity lasts for 4 or 5 days
- Some B cells become long-lived memory cells (secondary humoral response)
- Secondary humoral responses
  - Memory cells are long-lived
  - A second exposure causes a rapid response
  - The secondary response is stronger and longer lasting

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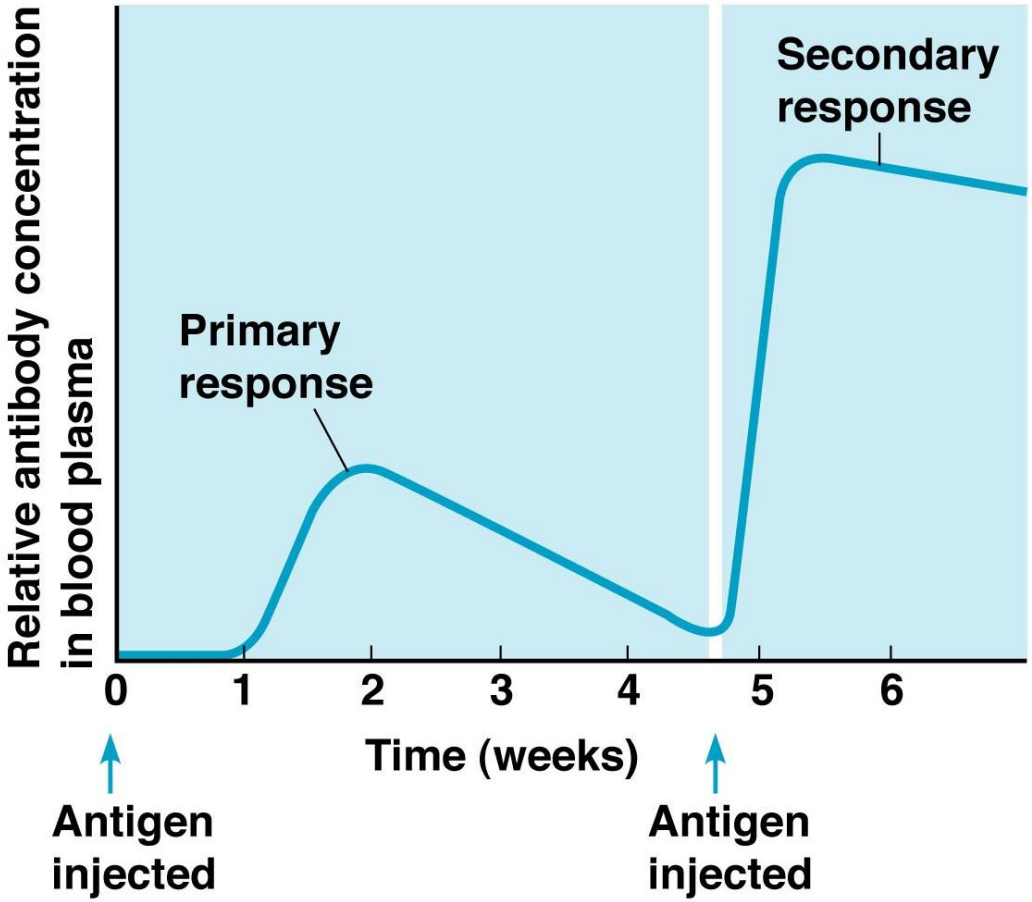
Humoral Immune Response



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Active Immunity

- Occurs when B cells encounter antigens and produce antibodies
- Active immunity can be
  - Naturally acquired during bacterial and viral infections
  - Artificially acquired from vaccines

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Passive Immunity

- Occurs when antibodies are obtained from elsewhere, not internally generated
  - Conferred naturally from a mother to her fetus (*naturally acquired*)
  - Conferred artificially from immune serum or gamma globulin (*artificially acquired*)
- Immunological memory does not occur
- Protection provided by “borrowed antibodies”; short-term

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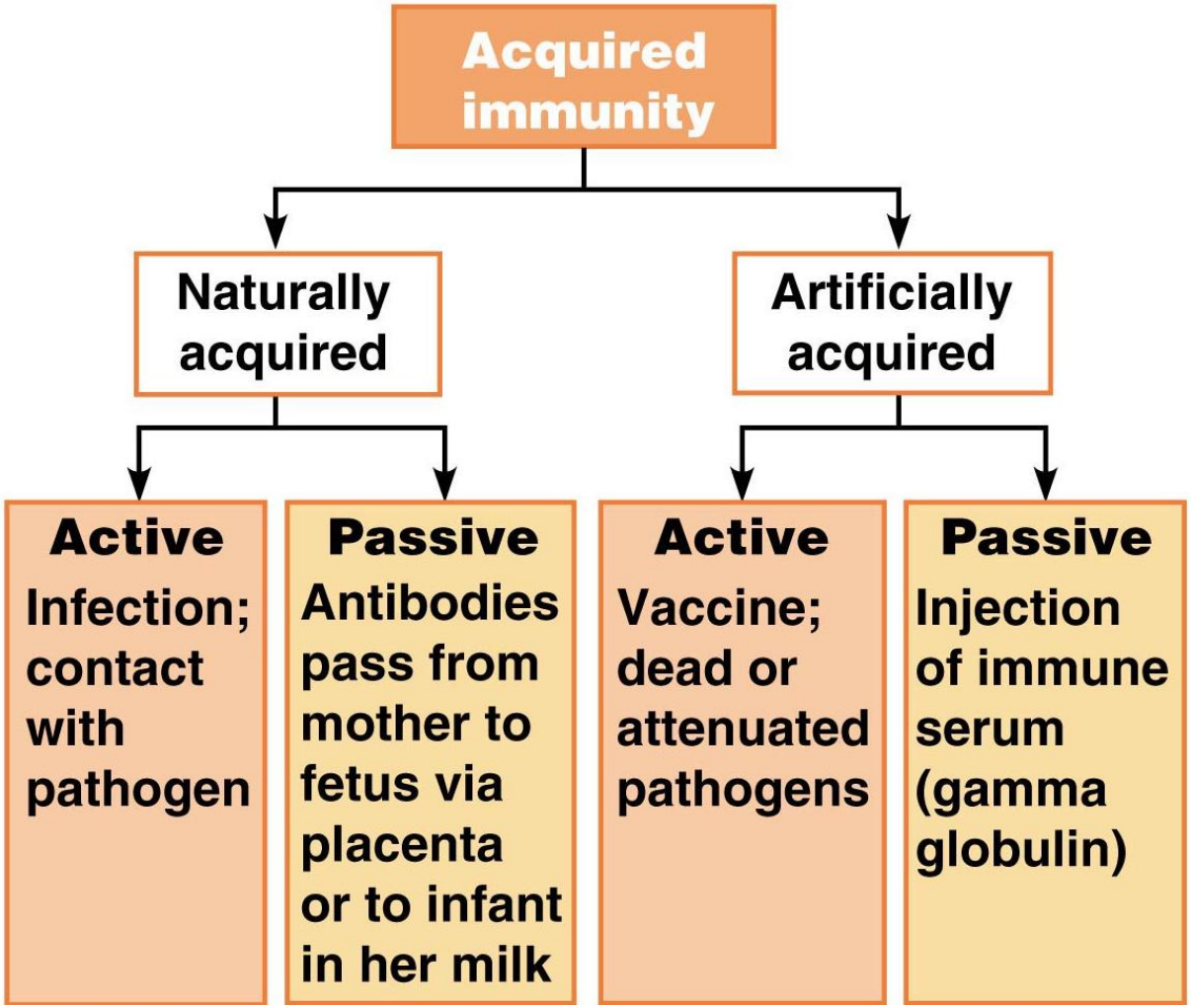
Types of Acquired Immunity



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Antibodies (Immunoglobulins or Igs)

- Soluble proteins secreted by B cells (plasma cells)
- Carried in blood plasma and found in tissue fluids
- Capable of binding specifically to an antigen

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Antibodies

- Antibody classes
  - Antibodies of each class have slightly different roles
  - Five major immunoglobulin classes (MADGE)
    - IgM—can fix complement
    - IgA—found mainly in mucus, breast milk
    - IgD—important in activation of B cell
    - IgG—can cross the placental barrier and fix complement; most abundant
    - IgE—involved in allergies

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Antibodies

- Antibody function
  - Antibodies inactivate antigens in a number of ways
    - Complement fixation
    - Neutralization
    - Agglutination
    - Precipitation

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Cellular (Cell-Mediated) Immune Response

- Antigens must be presented by macrophages to an immunocompetent T cell (antigen presentation)
- T cells must recognize nonself and self (double recognition)
- After antigen binding, clones form as with B cells, but different classes of cells are produced

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Cellular (Cell-Mediated) Immune Response

- T cell clones
  - Cytotoxic (killer) T cells
    - Specialize in killing infected cells
    - Insert a toxic chemical (perforin)
  - Helper T cells
    - Recruit other cells to fight the invaders
    - Interact directly with B cells

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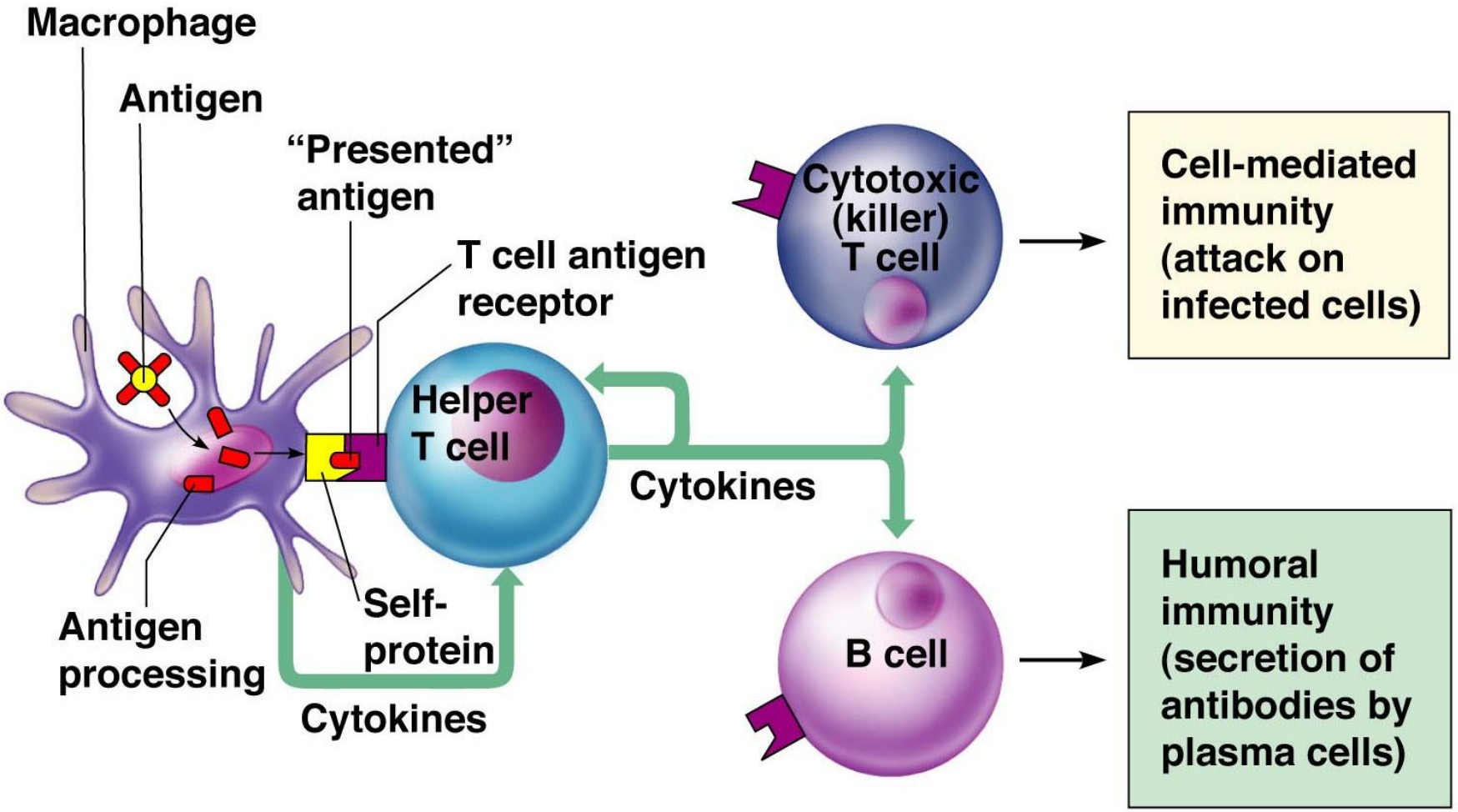
Cellular (Cell-Mediated) Immune Response



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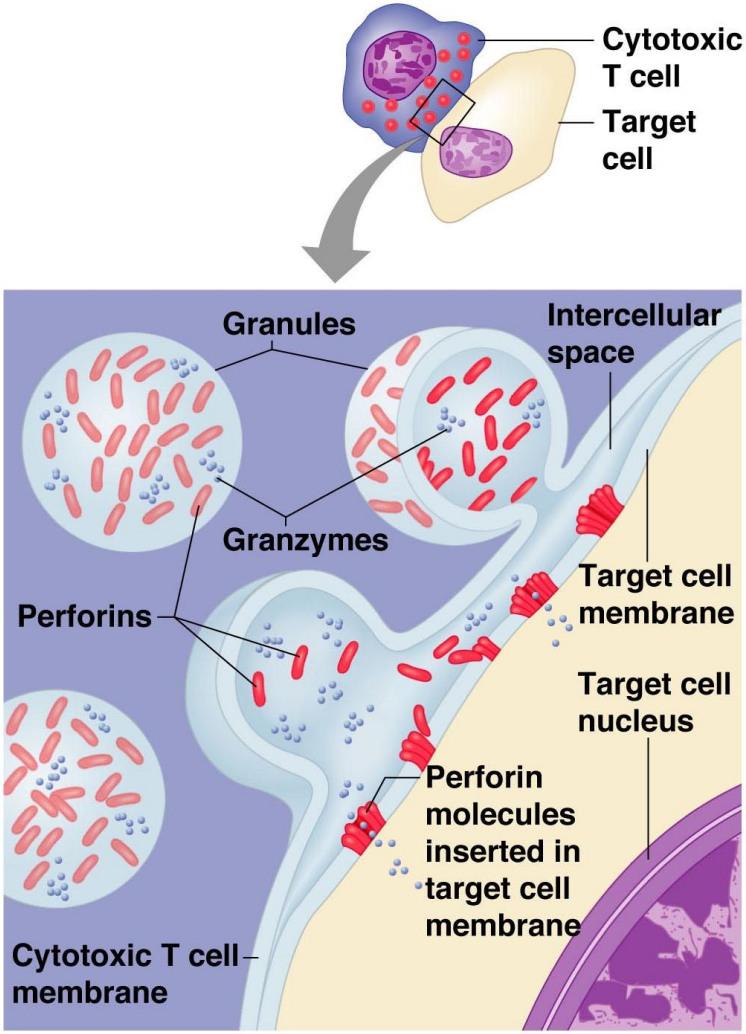
Cellular (Cell-Mediated) Immune Response



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Cellular (Cell-Mediated) Immune Response

- T cell clones (continued)
  - Regulatory T cells
    - Release chemicals to suppress the activity of T and B cells
    - Stop the immune response to prevent uncontrolled activity
  - Memory cells

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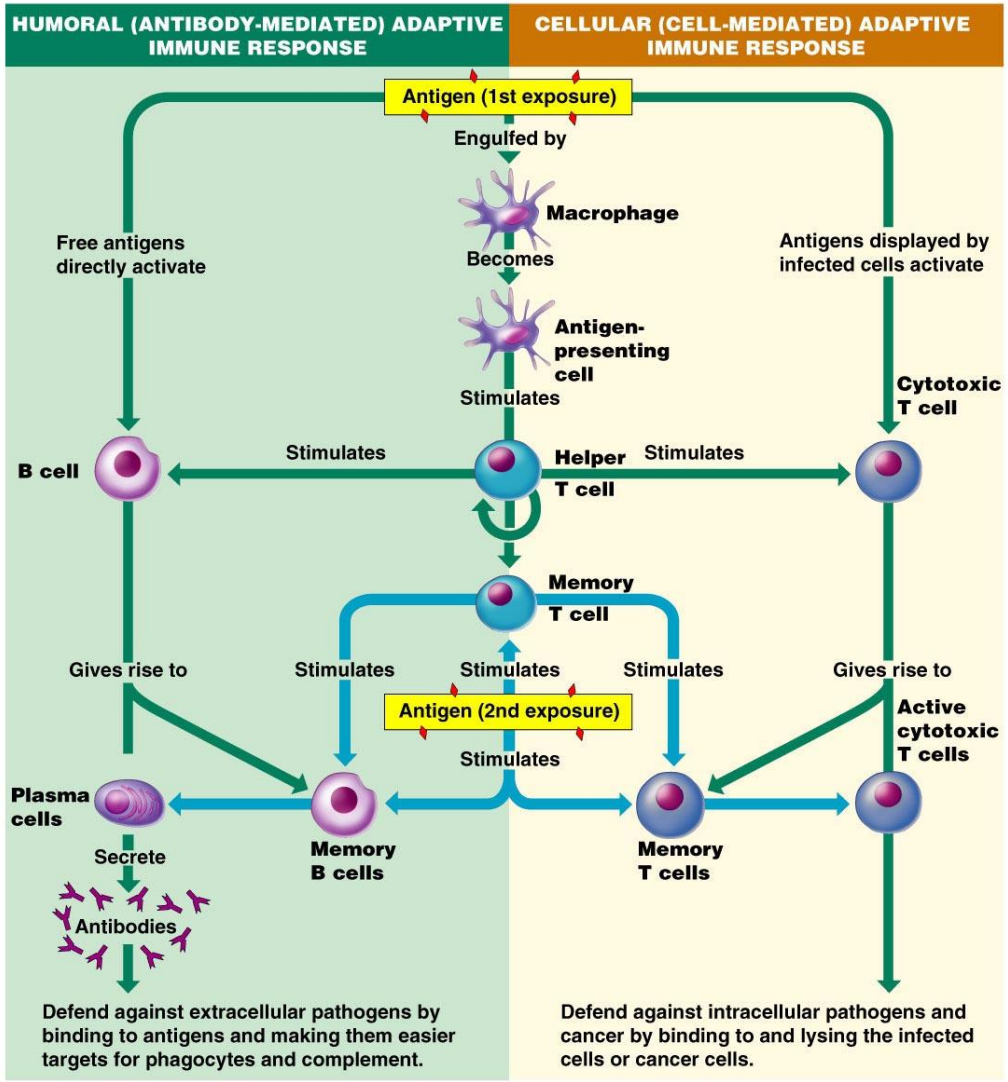
Summary of Adaptive Immune Response



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Disorders of Immunity: Allergies (Hypersensitivity)

- Abnormal, vigorous immune responses
- Types of allergies
  - Immediate hypersensitivity
    - Triggered by release of histamine from IgE binding to mast cells
    - Reactions begin within seconds of contact with allergen
    - Anaphylactic shock—dangerous, systemic response

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Disorders of Immunity: Allergies (Hypersensitivity)

- Types of allergies (continued)
  - Delayed hypersensitivity
    - Triggered by the release of lymphokines from activated helper T cells
    - Symptoms usually appear 1–3 days after contact with antigen
    - Example: poison oak/ivy

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Disorders of Immunity: Immunodeficiencies

- Production or function of immune cells or complement is abnormal
- May be congenital or acquired
- Includes AIDS (Acquired Immune Deficiency Syndrome)

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Disorders of Immunity: Autoimmune Diseases

- The immune system does not distinguish between self and nonself
- The body produces antibodies and sensitized T lymphocytes that attack its own tissues

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Autoimmune Disease: Self Tolerance Breakdown

- Inefficient lymphocyte programming
- Appearance of self-proteins in the circulation that have not been exposed to the immune system
  - Eggs
  - Sperm
  - Eye lens
  - Proteins in the thyroid gland

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Disorders of Immunity: Autoimmune Diseases

- Examples of autoimmune diseases
  - Multiple sclerosis—white matter of brain and spinal cord are destroyed
  - Myasthenia gravis—impairs communication between nerves and skeletal muscles
  - Type I diabetes mellitus—destroys pancreatic beta cells that produce insulin
  - Rheumatoid arthritis—destroys joints
  - Systemic lupus erythematosus (SLE)
    - Affects kidney, heart, lung and skin
  - Glomerulonephritis—impairment of renal function

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