Unit 8

Lymphatic System and Immunity

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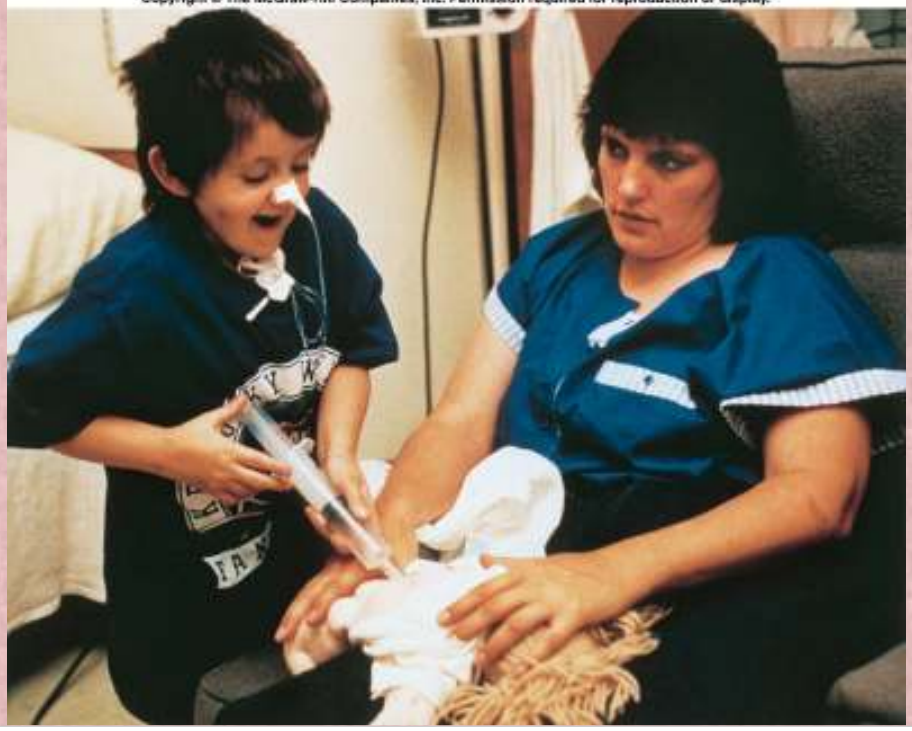

✶ Introduction

A. The **lymphatic system** is comprised of a network of vessels that transport body fluids, the cells and chemicals in those vessels, and the organs and glands that produce them.

B. Lymphatic vessels collect and carry away excess fluid from interstitial spaces and special vessels called lacteals transport fats to the circulatory system.

C. The organs of the lymphatic system help defend against disease.

✶ Lymphatic Pathways

A. Lymphatic pathways start as lymphatic capillaries that merge to form larger vessels that empty into the circulatory system.

B. Lymphatic Capillaries

1. Lymphatic capillaries are tiny, closed-ended tubes that extend into interstitial spaces.

2. They receive tissue fluid through their thin walls; once inside, tissue fluid is called lymph.

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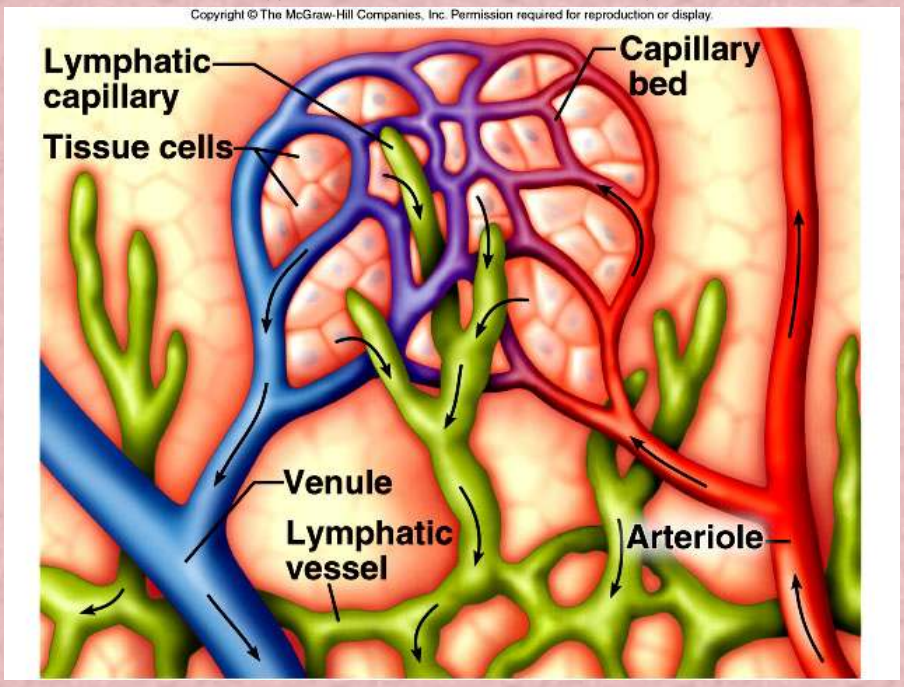
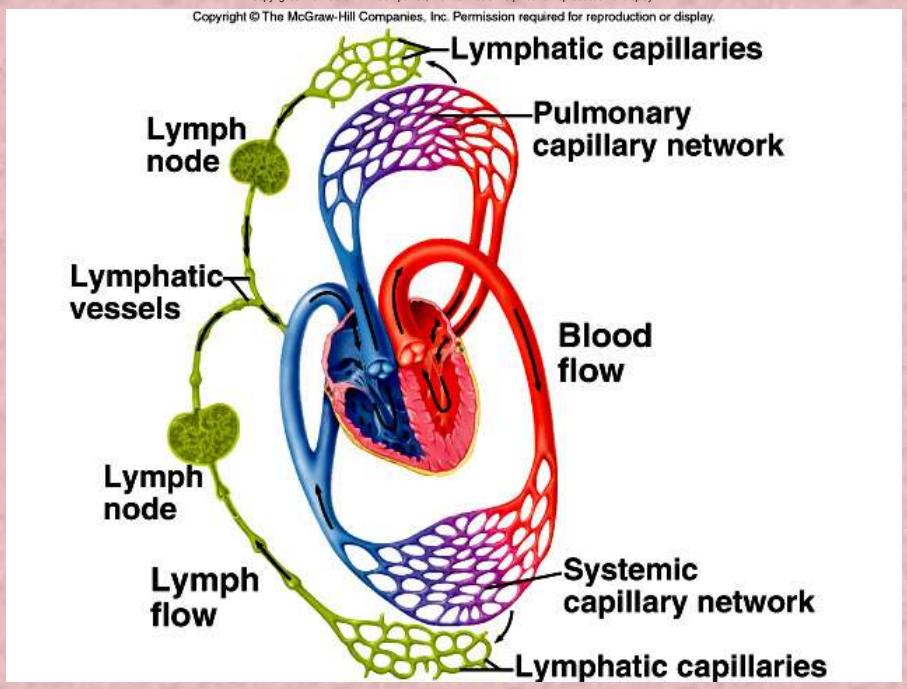


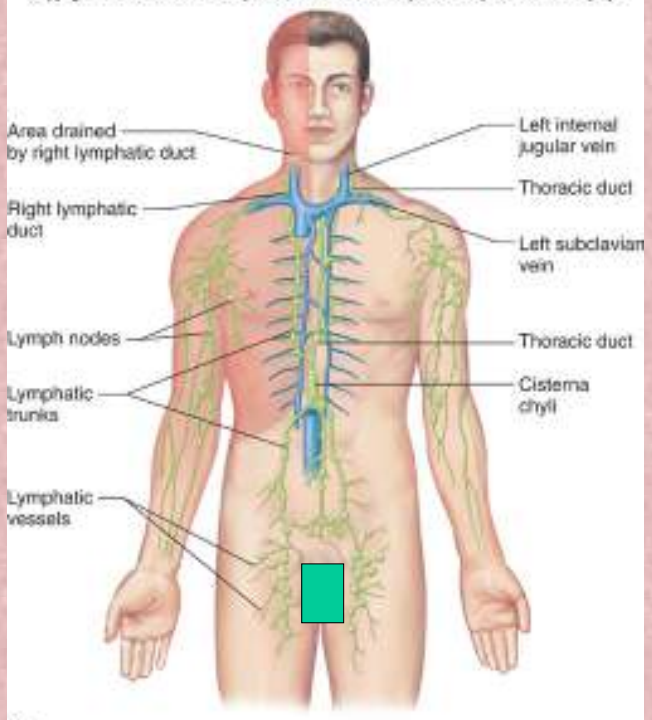
C. Lymphatic Vessels

1. The walls of lymphatic vessels are thinner than those of veins but are constructed with the same three layers with semilunar valves on the inside.
2. Larger lymphatic vessels pass through lymph nodes and merge to form lymphatic trunks.



D. Lymphatic Trunks and Collecting Ducts

1. The lymphatic trunks drain lymph from the body and are named for the regions they drain.
2. These trunks join one of two collecting ducts—either the thoracic duct or right lymphatic duct.
3. The thoracic duct drains into the left subclavian vein, while the right lymphatic duct drains into the right subclavian vein.



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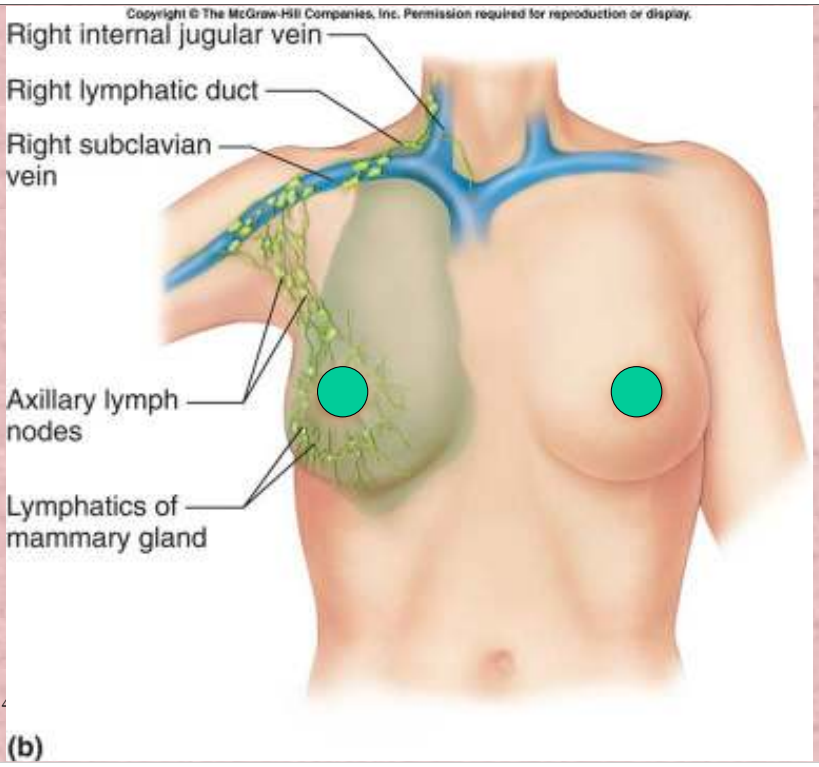


✶ Tissue Fluid and Lymph

A. Tissue fluid becomes lymph once it has entered a lymphatic capillary; lymph formation depends on tissue fluid formation.

B. **Tissue Fluid Formation**

1. Tissue fluid is made up of water and dissolved substances that leave blood capillaries by filtration and diffusion.
2. During filtration, some smaller proteins leak from capillaries into the tissues and are not returned to the bloodstream, thus increasing osmotic pressure within the tissues.

C. **Lymph Formation and Function**

1. Rising osmotic pressure in tissues interferes with the return of fluids to the bloodstream.
2. Increasing interstitial pressure forces some of the fluid into lymphatic capillaries.

✶ Lymph Movement

A. The hydrostatic pressure of tissue fluid drives the entry of lymph into lymphatic capillaries.

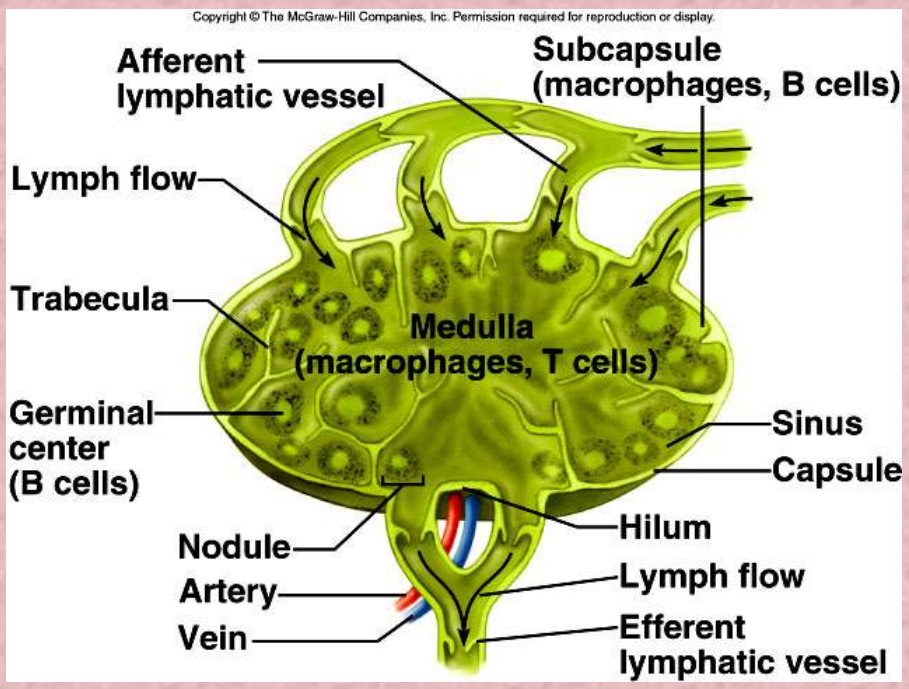
B. Forces that move blood in veins (skeletal muscle contraction, breathing movements, and contraction of smooth muscle in the walls of lymphatic trunks) are the forces that propel lymph through lymphatic vessels.

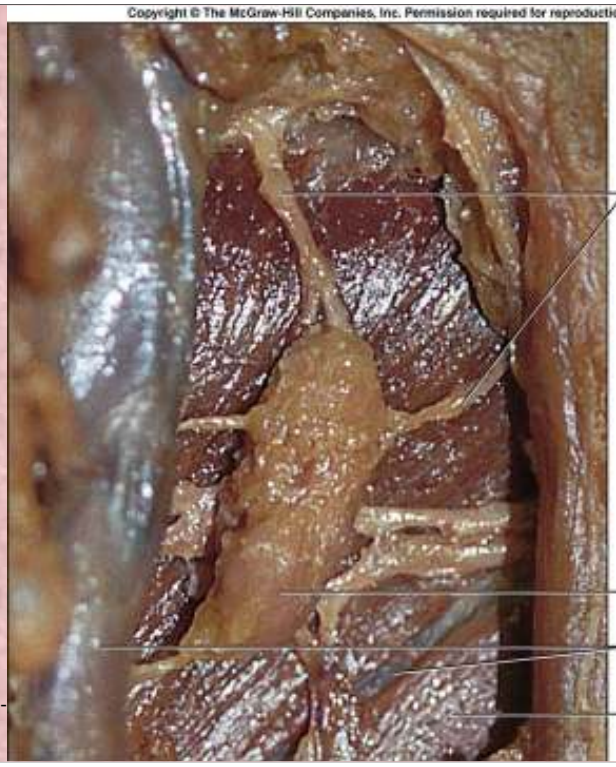
C. A condition that interferes with the flow in lymph will result in edema.

D. During surgery, lymphatic vessels or tissues may be removed or disturbed, resulting in edema.

✶ Lymph Nodes

A. Lymph nodes, which contain lymphocytes and macrophages, are located along lymphatic pathways.





This is a real lymph node

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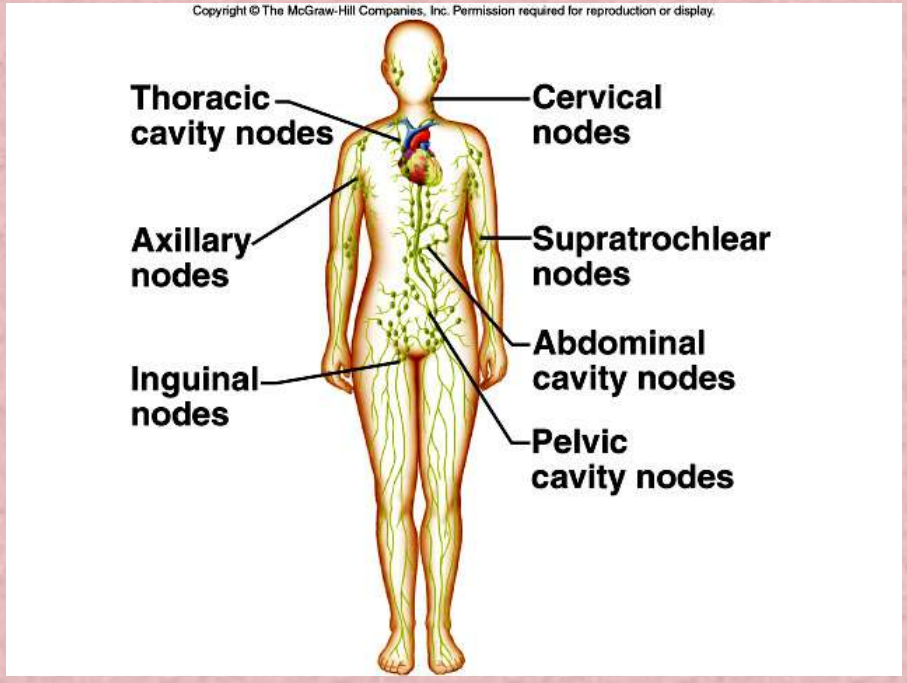
C. Locations of Lymph Nodes

1. The lymph nodes generally occur in chains along the parts of the larger lymphatic vessels.

D. Functions of Lymph Nodes

1. The macrophages and lymphocytes within lymph nodes filter lymph and remove bacteria and cellular debris before lymph is returned to the blood.
2. Lymph nodes are also centers of lymphocyte production; these cells function in immune surveillance.



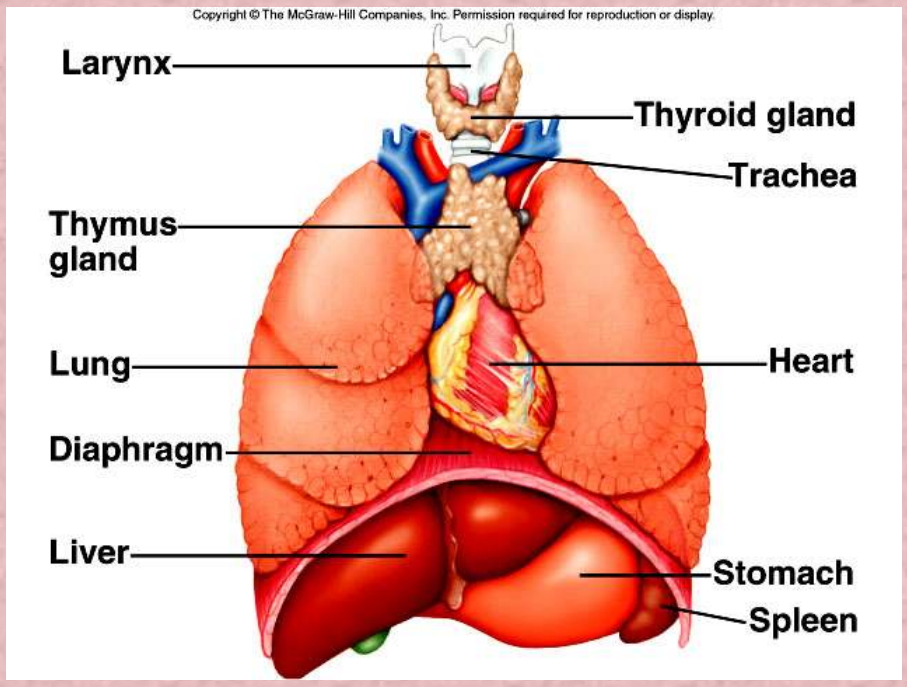
✶ Thymus and Spleen

A. The functions of the thymus and spleen are similar to those of lymph nodes.

B. **Thymus**

1. The thymus is a soft, bi-lobed organ located behind the sternum; it shrinks in size during the lifetime (large in children, microscopic in the elderly).
2. The thymus is surrounded by a connective tissue capsule that extends inside it and divides it into lobules.

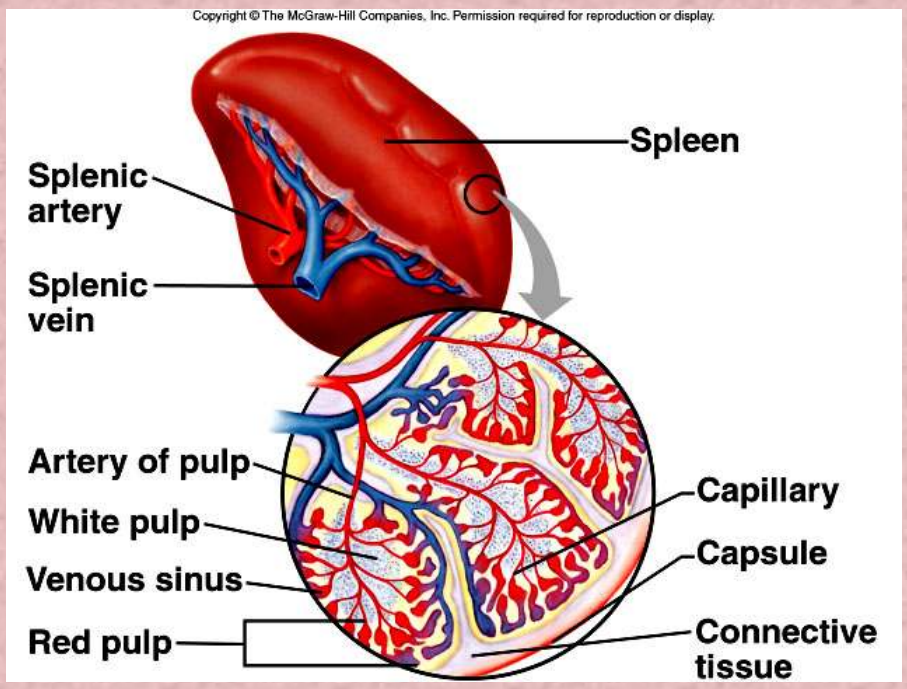
3. Lobules contain lymphocytes, some of which mature into T lymphocytes (T cells) that leave the thymus to provide immunity.
4. The thymus secretes the hormone thymosin, which influences the maturation of T lymphocytes once they leave the thymus.



C. **Spleen**

1. The spleen lies in the upper left abdominal cavity and is the body's largest lymphatic organ.
2. The spleen resembles a large lymph node except that it contains blood instead of lymph.

3. Inside the spleen lies white pulp (containing many lymphocytes) and red pulp (containing red blood cells, macrophages, and lymphocytes).
4. The spleen filters the blood and removes damaged blood cells and bacteria.



✶ Body Defenses Against Infection

A. Disease-causing agents, also called pathogens, can produce infections within the body.

B. The body has two lines of defense against pathogens: **nonspecific defenses** that guard against any pathogen, and **specific defenses** (immunity) that mount a response against a very specific target.

✶ Innate (Nonspecific) Defenses

A. Species Resistance

1. A species is resistant to diseases that affect other species because it has a unique chemical environment or temperature that fails to provide the conditions required by the pathogens of another species.
2. A mother passes on certain immunity agents through breast milk (colostrum).

B. Mechanical Barriers

1. Skin
2. Mucous membranes
3. Cilia
4. Nose Hair
5. Eye Lashes
6. Wax

C. Chemical Barriers

1. Acids (stomach, vagina)
2. Tears (lysozyme)
3. Interferons, hormone-like peptides that serve as antiviral substances, are produced by cells when they are infected with viruses and induce nearby cells to produce antiviral enzymes that protect them from infection.

D. Fever

1. Fever offers powerful protection against infection by interfering with the proper conditions that promote bacterial growth.
   a. During fever, the amount of iron in the blood is reduced, and thus fewer nutrients are available to support the growth of pathogens.
   b. Phagocytic cells attack with greater vigor when the temperature rises.

E. Inflammation

1. Inflammation, a tissue response to a pathogen, is characterized by redness, swelling, heat, and pain.
2. Major actions that occur during an inflammatory response include: dilation of blood vessels; increase of blood volume in affected areas; invasion of white blood cells into the affected area; and appearance of fibroblasts and their production of a sac around the area.

F. Phagocytosis

1. The most active phagocytes are neutrophils and monocytes; these leave the bloodstream at areas of injury by diapedesis.
   a. Neutrophils engulf smaller particles; monocytes attack larger ones.

2. Monocytes give rise to macrophages, which become fixed in various tissues.
3. Monocytes, macrophages, and neutrophils constitute the mononuclear phagocytic system.
4. Phagocytosis also removes foreign particles from the lymph.

✶ Adaptive (Specific) Defenses or Immunity

A. The body's third line of defense, immunity, refers to the response mounted by the body against specific, recognized foreign molecules.

B. **Antigens**

1. Before birth, the body makes an inventory of "self" proteins and other large molecules.
2. Antigens are generally larger molecules that elicit an immune response.

a. Sometimes small molecules called haptens combine with larger molecules and become antigenic.

Bone marrow releasing lymphocytes

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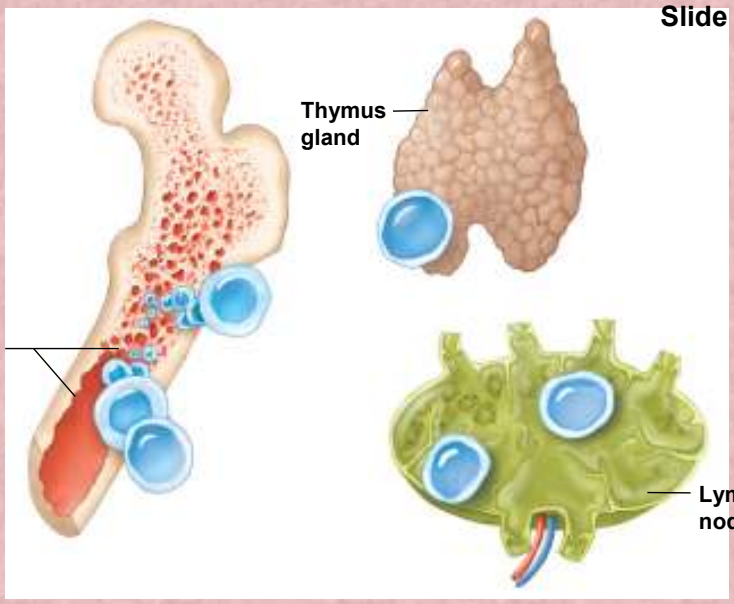

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Bone marrow releasing lymphocytes

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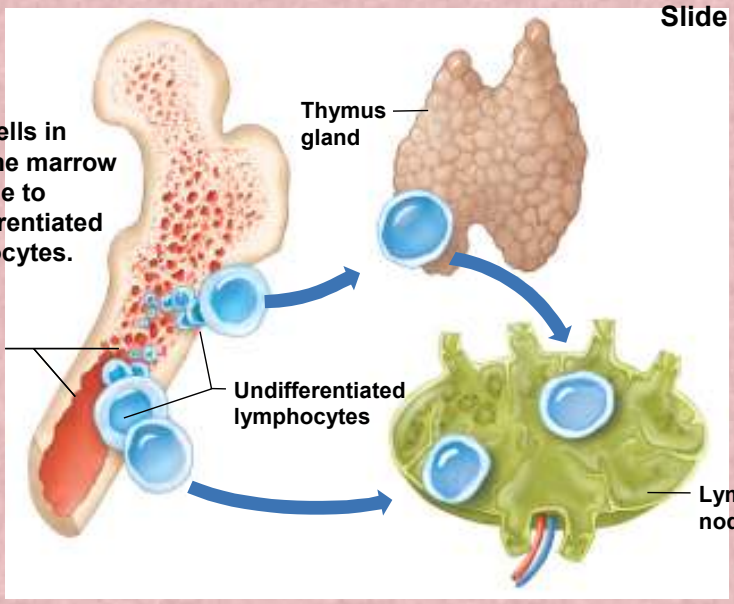

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Bone marrow releasing lymphocytes

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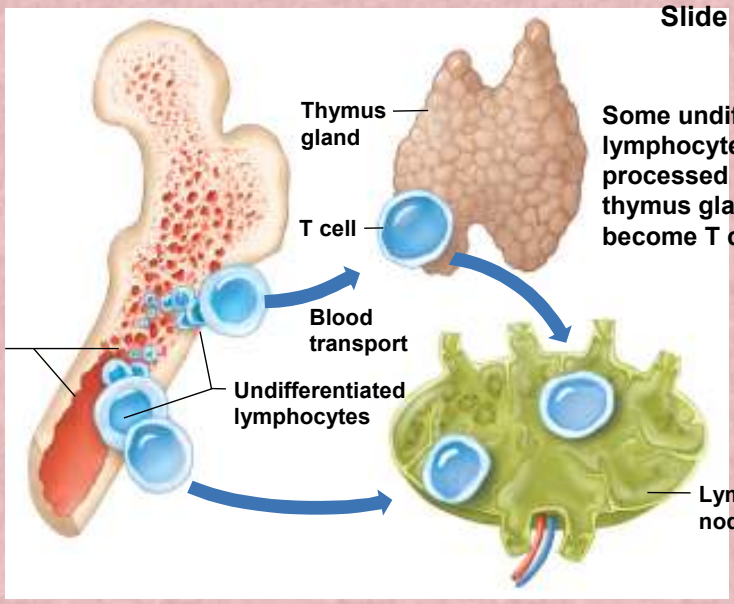

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Bone marrow releasing lymphocytes

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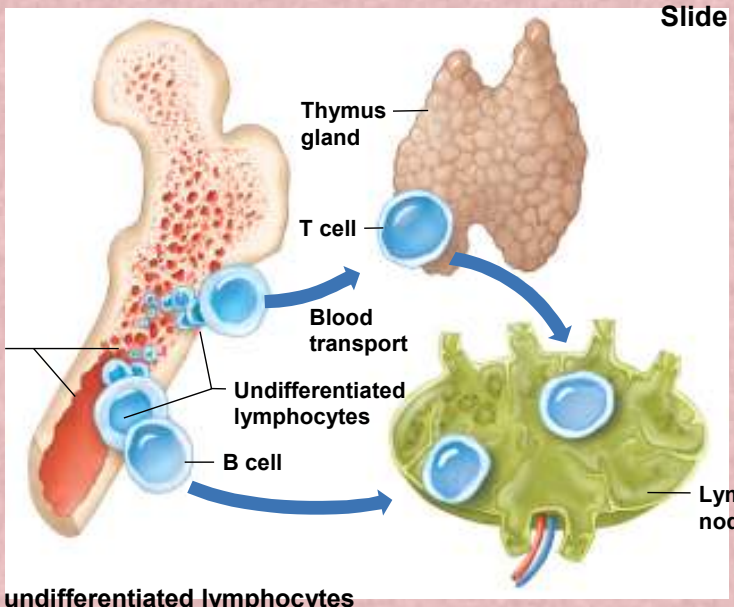

Some undifferentiated lymphocytes are processed, probably within the bone marrow, to become B cells.

Bone marrow releasing lymphocytes

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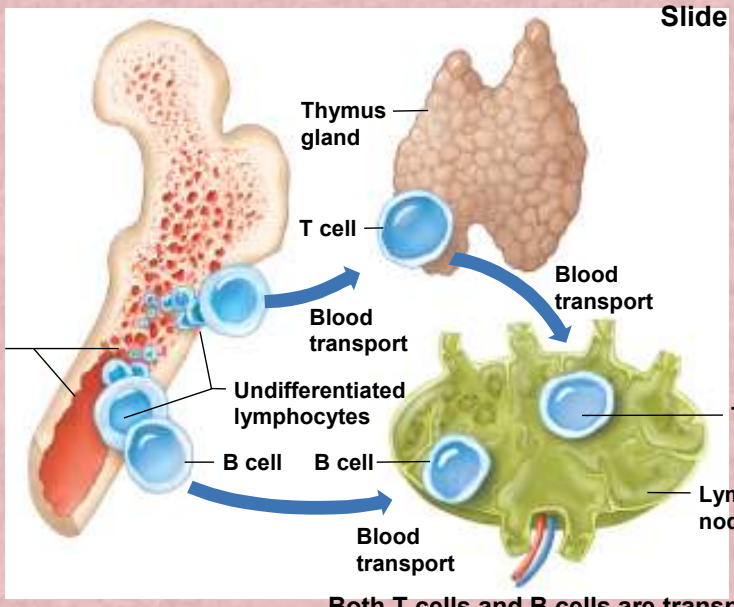

Both T cells and B cells are transported through the blood to lymphatic organs, such as the lymph nodes, ducts, and spleen.

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D. **Lymphocyte Functions**

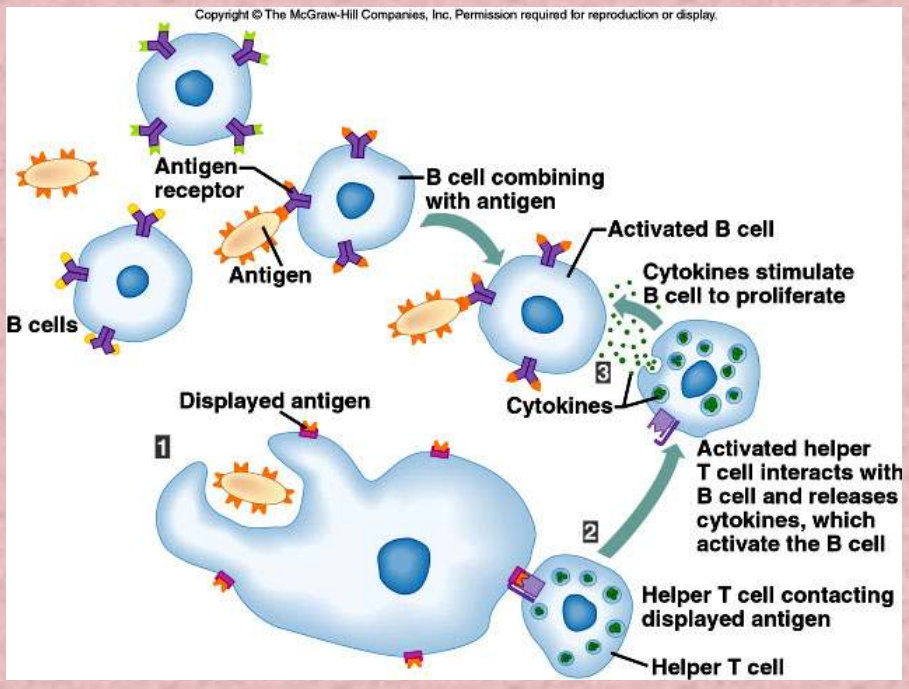
1. T cells attack foreign, antigen-bearing cells, such as bacteria, by direct cell-to-cell contact, providing cell-mediated immunity.
2. T cells also secrete cytokine (lymphokines) that enhance cellular response to antigens.

3. T cells may also secrete toxins that kill target cells, or produce growth-inhibiting factors or interferon to interfere with viruses and tumor cells.
4. B cells attack pathogens by differentiating into plasma cells that secrete antibodies (immunoglobulins).
5. Body fluids attack and destroy specific antigens or antigen-bearing particles through antibody-mediated immunity also called humoral immune response.

E. **T Cells and the Cellular Immune Response**

1. T cell activation requires the presence of an antigen-presenting cell, such as a B cell or macrophage, that has already encountered the antigen.
2. In order for a helper T cell to become activated, it must first encounter a macrophage displaying the antigen on its major histocompatibility complex (MHC) proteins; if the antigen fits the helper T cell's antigen receptor, it becomes activated and stimulates B cells to produce antibodies.

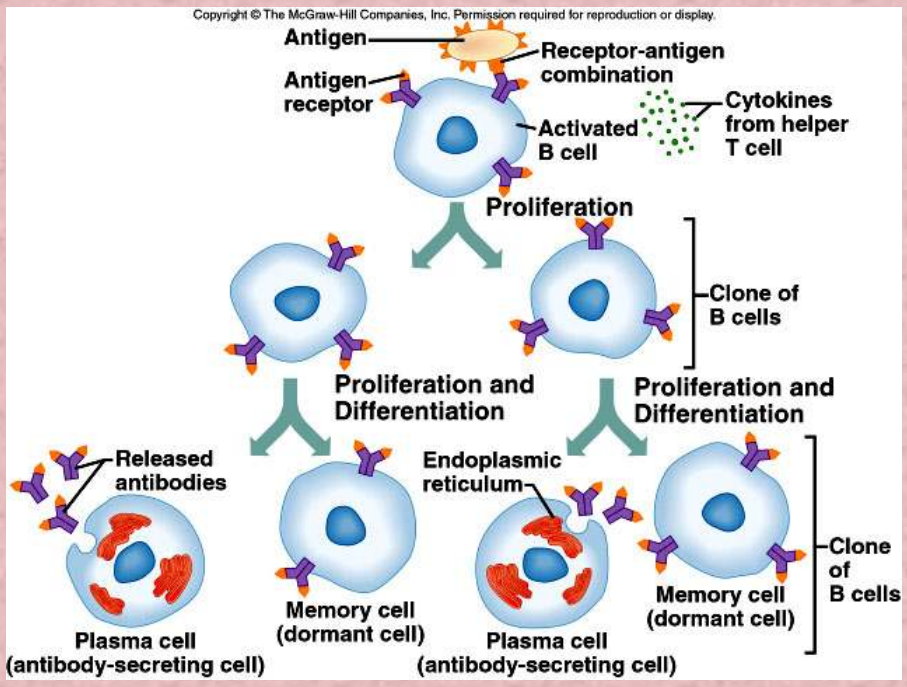
3. Cytotoxic T cells continually monitor the body's cells, recognizing and eliminating tumor cells and virus-infected cells by release of proteins, cutting holes, and by other means.
   a. Cytotoxic T cells become activated when a antigen binds to its receptors.
4. Memory T cells provide a no-delay response to any future exposure to the same antigen.



F. B Cells and the Humoral Immune Response

1. A B cell may become activated and produce a clone of cells when its antigen receptor encounters its matching antigen, but most B cells need helper T cells for activation.
2. When a helper T cell encounters a B cell that has itself encountered an antigen, the helper T cell releases cytokines that activate the B cell so that it can divide and form a clone.

3. Some of the B cells become plasma cells, producing and secreting antibodies.
4. Like T cells, some of the B cells become memory cells to respond to future encounters with the antigen.



G. **Types of Antibodies**

1. There are five major types of antibodies (immunoglobulins) that constitute the gamma globulin fraction of the plasma.
    a. IgA is in exocrine gland secretions (breast milk, saliva, tears) and defends against bacteria and viruses.
    b. IgM is found in plasma and activates complement and reacts with blood cells during transfusions.
    c. IgD is found on the surface of most B lymphocytes and functions in B cell activation.
    d. IgE is found in exocrine gland secretions and promotes allergic reactions.

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H. **Antibody Actions**

1. Antibodies can react to antigens in three ways: direct attack, activation of complement, or stimulation of changes in areas that help prevent the spread of the pathogens.
2. Direct attack methods include agglutination, precipitation, and neutralization of antigens.
3. The activation of complement can produce opsonization, chemotaxis, inflammation, or lysis in target cells or antigens.

I. **Immune Responses**

1. When B or T cells become activated the first time, their actions constitute a primary immune response, after which some cells remain as memory cells.
2. If the same antigen is encountered again, more numerous memory cells can mount a more rapid response, known as the secondary immune response.
    a. The ability to produce a secondary immune response may be long-lasting.

J. **Practical Classification of Immunity**

1. Naturally acquired active immunity occurs after exposure to the antigen itself.
2. Artificially acquired active immunity occurs through the use of vaccines, without the person becoming ill from the disease.

3. Artificially acquired passive immunity involves the injection of gamma globulin containing antibodies and is short-lived.
4. Naturally acquired passive immunity occurs as antibodies are passed from mother to fetus and is short-lived.

K. **Allergic Reactions**

1. Allergic reactions to allergens are excessive immune responses that may lead to tissue damage.
2. Delayed-reaction allergy results from repeated exposure to substances that cause inflammatory reactions in the skin.

3. Immediate-reaction allergy is an inherited ability to overproduce IgE.
4. During allergic reactions, mast cells release histamine and leukotrienes, producing a variety of effects.
5. Allergy mediators sometimes flood the body, resulting in anaphylactic shock, a severe form of immediate-reaction allergy.

L. **Transplantation and Tissue Rejection**

1. A transplant recipient's immune system may react with foreign antigens on the surface of the transplanted tissue, causing a tissue rejection reaction.
2. Close matching of donor and recipient tissues can reduce the chances of tissue rejection, and use of immunosuppressive drugs may reduce rejection, although the individual may be more susceptible to infection.

M. **Autoimmunity**

1. In autoimmune disorders, the immune system manufactures antibodies against some of its own antigens.
2. Autoimmune disorders may result from viral infection, faulty T cell development, or reaction to a nonself antigen that bears close resemblance to a self antigen.

Immunization

The ability of the immune system to respond and activate the immune response quickly during repeated exposure to infectious disease.

Vaccine

- A suspension of parts of microorganisms, inactivated whole microorganisms, or inactivated toxins
- Administered to induce an immune response
- When later exposed to the active form of the disease, the individual already has the antibodies to fight against it
- Common Vaccines:
  - chicken pox - hepatitis A/B - measles
  - mumps - polio -flu - tetanus

AIDS Acquired Immunodeficiency Syndrome

- A disease caused by a virus (HIV)
  - Human Immunodeficiency Virus
- Destroys T-Cells (Helper)
- Results in fatal immunodeficiency
- Victim dies from infection by another opportunistic disease
  - pneumonia - Kaposi's sarcoma
  - dementia - AIDS Wasting Syndrome

AIDS (Cont.)

- A person who is HIV positive is considered a carrier of AIDS
- Blood test to detect for HIV antibodies
- 6 month dormancy period between exposure until you test positive for HIV
- May be HIV positive but not actually develop AIDS until many years later
  - Years ago - positive test - 6 months to 2 - 3 years until you developed AIDS
  - Now - proper treatment - can live for more than 20 years after you have tested positive

AIDS (Cont.)

- Difference between HIV+ and AIDS
  - T-Cell count below 200
    - normally 800 - 1500
  - Two or more opportunistic diseases present
- Once diagnosed with AIDS, death usually occurs within 2 - 3 years
  - This is changing rapidly due to improved drug therapies and lifestyle modifications once diagnosed with the disease

AIDS - Mechanisms

- Selectively destroys Helper T-Cells
- May also destroy other leukocytes after the initial dormant period
- Results in suppressed cell mediated immunity

Transmission and Prevention of AIDS

- spread through the transmission of blood, semen, or vaginal fluids from an infected person to one who is not infected
  - unprotected sexual intercourse
    - homosexual or heterosexual
  - sharing intravenous drug needles
  - infected blood transfusions
  - mother to child during childbirth
  - mother to child during breast feeding

AIDS

- NO vaccine or drug is 100% effective in curing AIDS
- Ways to guarantee you won't get AIDS
- DON'T Use Intravenous DRUGS
- ABSTINENCE From Sexual Intercourse (Mutual Monogamy)

Measles

- A highly communicable disease characterized by fever, general malaise, sneezing, nasal congestion, brassy cough, conjunctivitis, spots on the buccal mucosa, and maculopapular eruptions over the entire body
- Caused by the Rubeola virus

Mumps

- An acute, contagious, febrile disease characterized by inflammation of the parotid and other salivary glands.
- Greatest complication -- infertility

Rubella

- An acute infectious disease resembling both scarlet fever and measles but differing from them in that it has a short course, slight fever, and is free from sequelae.
- Also known as ***German Measles***

Tetanus

- An acute infectious disease due to the toxin *Clostridium Tetani* growing anaerobically at the site of the injury. May cause lockjaw and muscle paralysis.