

Lymphatic System and Immunity

Chapter 27

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Introduction

- Component of the circulatory system
- Lymphatic system
 - Helps maintain fluid balance
 - Supports transport of nutrients within the body
 - Has disease-fighting functions
 - Helps maintain homeostasis

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Anatomy

- Lymph
- Lymphatic vessels
- Lymphatic structures
- Lymphatic (lymphoid-related) tissues
- Lymphatic cells

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Physiology

- Transportation: Specialized lymphatic vessels called *lacteals* assist in the absorption of fats from the digestive tract
- Immune response
- Maintains homeostasis: Collects fluid and returns it to blood circulation

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Lymph

- Lymph: Fluid in lymphatic vessels
- Similar to blood plasma
 - Contains more white blood cells (WBCs), proteins, and fats
- Collected by lymphatic capillaries
- Helps transport fat, lymphocytes, and excess fluids

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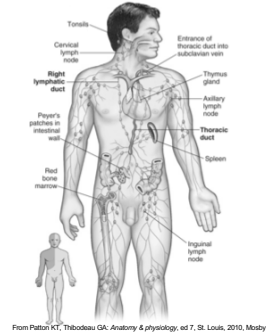
Lymphatic Vessels

- Have thinner walls than blood vessels, contain more valves than veins
- Contain:
 - Lymph capillaries
 - Lymphatic trunks: Converge to form ducts
 - Lymphatic ducts: Right lymphatic duct and the thoracic duct

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Lymphatic System



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Lymphatic Vessels

- Lymphatic vessels
 - Found in intercellular spaces in most areas of the body
 - Join other vessels as they move up the lymphatic chain
- Lymphatic capillaries
 - Found in intercellular spaces throughout most of the body

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Lymphatic Vessels

- Lymphatic trunks
 - Formed by joining lymphatic vessels
- Lymphatic ducts
 - Formed by joining lymphatic trunks
 - Right lymphatic duct
 - Thoracic duct

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Lymphatic Ducts

- Right lymphatic duct
 - Drains from right arm and right side of head and thorax
 - Enters blood circulation at right subclavian vein
- Thoracic duct
 - Drains rest of body
 - Enters blood circulation at left subclavian vein

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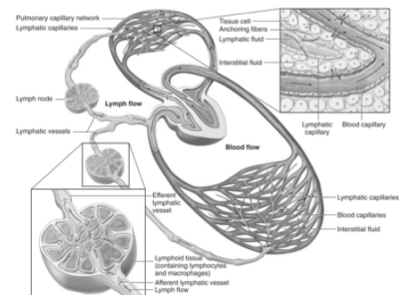
Movement of Lymph

- Starts as interstitial fluid
- Enters lymphatic capillary
- Lymph moves via external forces
 - Skeletal muscle lymphatic pump
 - Respiratory lymphatic pump

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Flow of Lymph

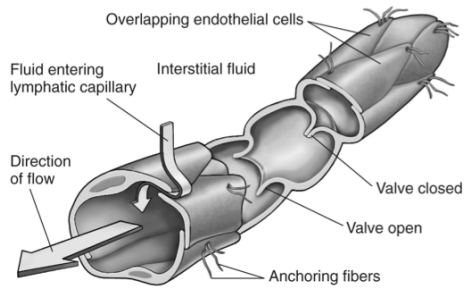


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Lymphatic Capillary



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Primary Lymphatic Organs and Structures

- Produce and mature lymphocytes
 - Lymphocytes are WBCs
- Bone marrow
- Thymus

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Secondary Lymphatic Organs and Structures

- Populated by lymphocytes from primary structures
- Examples:
 - Spleen
 - Lymph nodes
 - Mucosa-associated lymphoid tissue

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Bone Marrow

- Performs hematopoiesis
 - Produces WBCs, red blood cells (RBCs), platelets, and lymphocytes
- Matures B cells

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Thymus

- This is where T cells complete maturation
- Thymus is largest at puberty
- Typically is atrophied by the age of 40

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Spleen

- Largest lymphatic organ
- Stores lymphocytes and releases them during immune response
- Macrophages destroy old RBCs and harmful organisms
- Serves as blood reservoir
 - Releases small amounts of blood during blood loss

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Lymph Nodes

- Bean-shaped
- Located along lymphatic chain
- Filter and clean lymph
- Filter and remove pathogens
- May enlarge during infection

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Lymph Nodes

- Superficial nodes include:
 - Inguinal nodes
 - Groin region
 - Axillary nodes
 - Armpit region
 - Cervical nodes
 - Neck region

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Mucosa-Associated Lymph Tissue

- Small groups of lymph tissue located in:
 - Respiratory tract
 - Digestive tract
- Protects from swallowed pathogens or invaders

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Mucosa-Associated Lymph Tissue

- Tonsils
 - Located in oral cavity and pharynx
- Peyer patches
 - Located in portions of the small intestine
- Vermiform appendix
 - Attached to cecum

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Immunity

- Immunity: Body's ability to recognize and respond to pathogens and harmful agents
- Not an organ system
 - Involves responses from organs, tissues, cells, and migration of specific antibodies
- Major types
 - Nonspecific
 - Specific

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Nonspecific Immunity

- Innate immunity
- Generalized response to invader
- First line of defense includes:
 - Barriers
 - Reflexes
 - Cellular responses

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Barriers and Reflexes

- Skin
 - Glands secrete sweat and sebum (hostile environment for pathogens)
 - Tears contain lysozyme (has antibacterial properties)
 - Cerumen provides barrier to foreign agents in ear canal
- Mouth
 - Sticky mucus and saliva trap organisms
- Stomach
 - Gastric juices destroy pathogens

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Barriers and Reflexes

- Intestines
 - Intestinal flora contributes to normal function
 - Contain numerous MALTs
- Genitourinary tract
 - Urine flow protects against bladder infections
 - Vaginal secretions maintain acidic environment to fight pathogens

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Barriers and Reflexes

- Respiratory tract
 - Nose hairs prevent insects and particles from entering
 - Mucus and cilia move particles to digestive tract
 - Trachea and bronchi have cilia that traps debris
 - Cilia moves mucus away from lungs

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Cellular Responses

- WBCs phagocytize to destroy pathogens
- Mast cells release chemicals that initiate inflammation
- Interferons act as antivirals
- Natural killer cells attack and kill abnormal cells, such as tumor cells
- Complementary proteins found in blood plasma “complement” the ability of antibodies to destroy pathogens
 - Mark pathogens to destroy them later

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Inflammation

- Second line of defense
- Cardinal signs and symptoms are SHARP:
 - **S**welling
 - **H**eat
 - **A** loss of function
 - **R**edness
 - **P**ain

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Specific Immunity

- Uses specialized lymphocytes (B and T cells)
- Activated when pathogens:
 - Travel through lymph to lymph nodes
 - Travel through bloodstream to lymphatic tissue in spleen
 - Come into contact with lymphatic tissues along mucous membranes
- Can be naturally or artificially acquired

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B Cells

- Mature in bone marrow
- Many leave bone marrow and circulate in body fluids
- Provide immune surveillance of pathogens
 - Produce antibodies to attack pathogens

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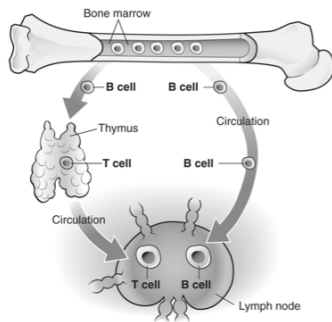
T Cells

- Migrate to thymus to complete maturation
- Travel to spleen lymph nodes and other lymphatic tissues
- Specialized T cells:
 - CD4⁺ cells: Helper T cells activate immune cells
 - CD8⁺ cells: Cytotoxic cells seek out and kill foreign cells

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Development of B and T Cells



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Immunodeficiency

- Failure of immune response to protect body from pathogens
- Some present at birth, but most arise later in life
- Examples include:
 - Acquired immunodeficiency syndrome (AIDS)
 - Diabetes
 - Advanced age
 - Chronic stress

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Hypersensitivity

- Overreaction to usually harmless substances
- Reactions are immediate or delayed
 - Type I encompasses allergic reactions
 - Type II includes tissue-specific reactions
 - Type III is immune complex-mediated reactions
 - Type IV reactions are cell-mediated reactions

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Autoimmune Disease

- Unable to distinguish normal tissues from foreign substances
- Body then attacks normal tissues
- This occurs in:
 - Rheumatoid arthritis
 - Multiple sclerosis
 - Type I diabetes mellitus

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