The Lymphatic System, Lymphoid Organs and Tissues

**Lymphatic System**
- Consists of three parts
  1. A network of lymphatic vessels (lymphatics)
  2. Lymph
  3. Lymph nodes

**Lymphatic System: Functions**
- Returns interstitial fluid and leaked plasma proteins back to the blood
  - Once interstitial fluid enters lymphatics, it is called lymph
- Together with lymphoid organs and tissues, provide the structural basis of the immune system

**Lymphatic Vessels**
- One-way system, lymph flows toward the heart
- Lymph vessels (lymphatics) include:
  - Lymphatic capillaries
  - Lymphatic collecting vessels
  - Lymphatic trunks and ducts

**Lymphatic Capillaries**
- Similar to blood capillaries, except
  - Very permeable (take up cell debris, pathogens, and cancer cells)
  - Endothelial cells overlap to form one-way minivalves, and are anchored by collagen filaments, preventing collapse of capillaries

**Lymphatic Capillaries**
- Absent from bones, teeth, bone marrow and the CNS
- Lacteals: specialized lymph capillaries present in intestinal mucosa
  - Absorb digested fat and deliver fatty lymph (chyle) to the blood

**Lymphatic Collecting Vessels**
- Similar to veins, except
  - Have thinner walls, with more internal valves
  - Anastomose more frequently
- Collecting vessels in the skin travel with superficial veins
- Deep vessels travel with arteries
- Nutrients are supplied from branching vasa vasorum
Lymphatic Trunks
• Formed by the union of the largest collecting ducts
  • Paired lumbar
  • Paired bronchomediastinal
  • Paired subclavian
  • Paired jugular trunks
  • A single intestinal trunk

Lymphatic Ducts
• Lymph is delivered into one of two large ducts
  • Right lymphatic duct drains the right upper arm and the right side of the head and thorax
  • Thoracic duct arises from the cisterna chyli and drains the rest of the body
• Each empties lymph into venous circulation at the junction of the internal jugular and subclavian veins on its own side of the body

Lymph Transport
• Lymph is propelled by
  • Pulsations of nearby arteries
  • Contractions of smooth muscle in the walls of the lymphatics

Lymphoid Cells
• Lymphocytes the main warriors of the immune system
• Two main varieties
  • T cells (T lymphocytes)
  • B cells (B lymphocytes)

Lymphocytes
• T cells and B cells protect against antigens
  • Anything the body perceives as foreign
    • Bacteria and their toxins; viruses
    • Mismatched RBCs or cancer cells

Lymphocytes
• T cells
  • Manage the immune response
  • Attack and destroy foreign cells
• B cells
  • Produce plasma cells, which secrete antibodies
**Other Lymphoid Cells**
- Macrophages phagocytize foreign substances and help activate T cells
- Dendritic cells capture antigens and deliver them to lymph nodes
- Reticular cells produce stroma that supports other cells in lymphoid organs

**Lymphoid Tissue**
- Houses and provides a proliferation site for lymphocytes
- Furnishes a surveillance vantage point
- Two main types
  - Diffuse lymphatic tissue
  - Lymphatic follicles

**Lymphoid Tissue**
- Diffuse lymphatic tissue comprises scattered reticular tissue elements in every body organ
  - Larger collections in the lamina propria of mucous membranes and lymphoid organs

**Lymphoid Tissue**
- Lymphatic follicles (nodules) are solid, spherical bodies of tightly packed reticular elements and cells
  - Germinal center composed of dendritic and B cells
  - May form part of larger lymphoid organs

**Lymph Nodes**
- Principal lymphoid organs of the body
- Embedded in connective tissue, in clusters along lymphatic vessels
- Near the body surface in inguinal, axillary, and cervical regions of the body

**Lymph Nodes**
- Functions
  1. Filter lymph—macrophages destroy microorganisms and debris
  2. Immune system—lymphocytes are activated and mount an attack against antigens

**Structure of a Lymph Node**
- Bean shaped
• External fibrous capsule
• Trabeculae extend inward and divide the node into compartments
• Two histologically distinct regions
  • Cortex
  • Medulla

**Structure of a Lymph Node**
• Cortex contains follicles with germinal centers, heavy with dividing B cells
• Dendritic cells nearly encapsulate the follicles
• Deep cortex houses T cells in transit
• T cells circulate continuously among the blood, lymph nodes, and lymphatic stream

**Structure of a Lymph Node**
• Medullary cords extend inward from the cortex and contain B cells, T cells, and plasma cells
• Lymph sinuses contain macrophages

**Circulation in the Lymph Nodes**
• Lymph
  • Enters via afferent lymphatic vessels
  • Travels through large subcapsular sinus and smaller sinuses
  • Exits the node at the hilus via efferent vessels
• Fewer efferent vessels, causing flow of lymph to stagnate, allowing lymphocytes and macrophages time to carry out functions

**Spleen**
• Largest lymphoid organ
• Served by splenic artery and vein, which enter and exit at the hilus
• Functions
  • Site of lymphocyte proliferation and immune surveillance and response
  • Cleanses the blood of aged cells and platelets and debris

**Spleen**
• Stores breakdown products of RBCs (e.g., iron) for later reuse
• Stores blood platelets
• Site of fetal erythrocyte production (normally ceases after birth)
• Has a fibrous capsule and trabeculae
- Contains lymphocytes, macrophages, and huge numbers of erythrocytes

**Structure of the Spleen**
- Two distinct areas
  - White pulp around central arteries
  - Mostly lymphocytes on reticular fibers and involved in immune functions
  - Red pulp in venous sinuses and splenic cords
    - Rich in macrophages for disposal of worn-out RBCs and bloodborne pathogens

**Thymus**
- Size with age
  - In infants, it is found in the inferior neck and extends into the mediastinum, where it partially overlies the heart
  - Increases in size and is most active during childhood
  - Stops growing during adolescence and then gradually atrophies

**Thymus**
- Thymic lobes contain an outer cortex and inner medulla
- Cortex contains densely packed lymphocytes and scattered macrophages
- Medulla contains fewer lymphocytes and thymic (Hassall’s) corpuscles involved in regulatory T cell development

**Thymus**
- Differs from other lymphoid organs in important ways
  - It functions strictly in T lymphocyte maturation
  - It does not directly fight antigens
  - The stroma of the thymus consists of star-shaped epithelial cells (not reticular fibers)
  - These thymocytes provide the environment in which T lymphocytes become immunocompetent

**Tonsils**
- Simplest lymphoid organs
- Form a ring of lymphatic tissue around the pharynx
  - Palatine tonsils—at posterior end of the oral cavity
  - Lingual tonsils—grouped at the base of the tongue
• Pharyngeal tonsil— in posterior wall of the nasopharynx
• Tubal tonsils—surrounding the openings of the auditory tubes into the pharynx

**Tonsils**
• Contain follicles with germinal centers
• Are not fully encapsulated
• Epithelial tissue overlying tonsil masses invaginates, forming tonsillar crypts
• Crypts trap and destroy bacteria and particulate matter

**Aggregates of Lymphoid Follicles**
• Peyer’s patches
  • Clusters of lymphoid follicles
  • In the wall of the distal portion of the small intestine
  • Similar structures are also found in the appendix
• Peyer’s patches and the appendix
  • Destroy bacteria, preventing them from breaching the intestinal wall
  • Generate “memory” lymphocytes

**MALT**
• Mucosa-associated lymphatic tissue, including
  • Peyer’s patches, tonsils, and the appendix (digestive tract)
  • Lymphoid nodules in the walls of the bronchi (respiratory tract)
• Protects the digestive and respiratory systems from foreign matter