

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