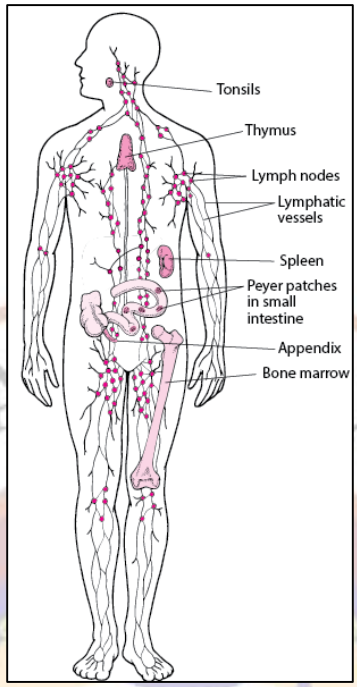
Lymph



- A lymph is clear, watery fluid.
- Identical in composition to:
  - Interstitial fluid
  - Plasma
- Differs from plasma by having **less protein**

Composition of Lymph

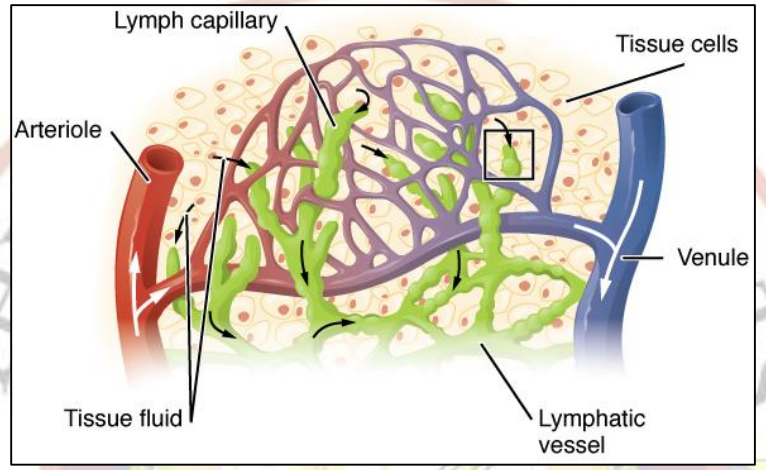
- Similar mineral content as plasma
- Consists of:
  - Less calcium
  - High glucose concentration
  - Few blood proteins
  - Less phosphorus
  - Globulin proteins (actual antibodies)
  - Organic substances
  - Inorganic substances

Functions of Lymph

- Transports plasma proteins that seep out of capillary beds back to bloodstream
- Carries away larger particles such as:
  - Bacteria
  - Cell debris from damaged tissues
- These particles are filtered out and destroyed in lymph nodes

- Contains lymphocytes:
  - Circulate in lymphatic system
  - Patrol different regions of the body
- **Lacteals of small intestine**:
  - Lymph vessels responsible for absorbing fat
  - Fat-absorbed lymph is called **chyle**
  - Chyle gives lymph a **milky appearance**

Lymph Capillaries



- Originate as **blind-ended tubes** in interstitial spaces
- Structure similar to blood capillaries:
  - Single layer of endothelial cells
- Walls are **more permeable** than blood capillaries
- Allow passage of:
  - Cell debris
  - Proteins
- Tiny lymph capillaries join to form larger lymph vessels

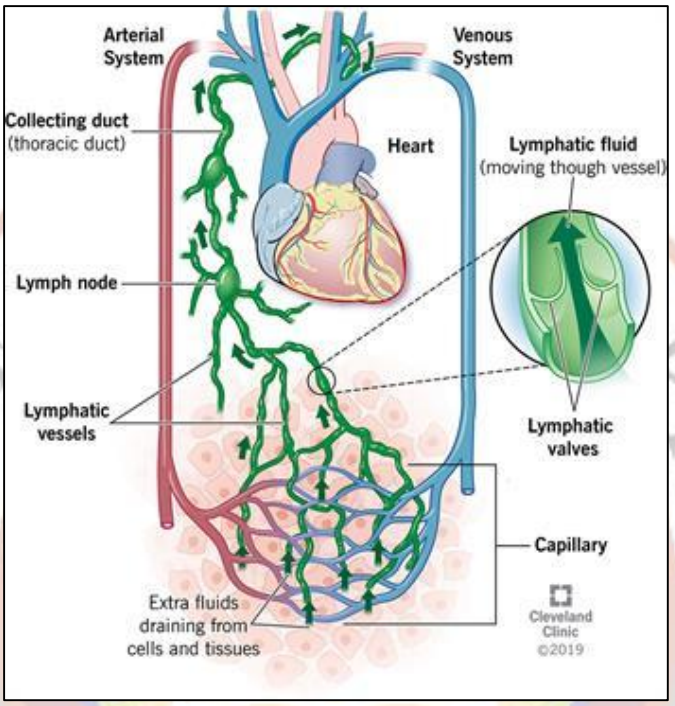
Tissues Without Lymphatic Vessels

- Central nervous system (CNS)
- Cornea of eye
- Bones
- Most superficial layers of skin

Larger Lymph Vessels

- Run alongside arteries and veins
- Walls similar to small veins:
  - Outer fibrous covering
  - Middle smooth muscle and elastic tissue
  - Inner endothelium

- Contain numerous **cup-shaped valves**
- Ensure **one-way flow towards thorax**
- Vessels unite to form two large ducts:
    - Thoracic duct (left)
    - Right lymphatic duct (right)
- Both ducts empty into **subclavian veins**



Thoracic Duct

- Begins at **cisterna chyli**
- Cisterna chyli:
    - Dilated lymph channel
    - Situated in front of first two lumbar vertebrae
- Length: **40 cm**
- Opens into **left subclavian vein**
- Drains lymph from:
    - Both legs
    - Pelvic cavity
    - Abdominal cavity
    - Left half of thorax
    - Left half of head and neck
    - Left arm

Right Lymphatic Duct

- Dilated lymph vessel

- Lies in root of neck
- Opens into **right subclavian vein**
- Drains lymph from:
    - Right half of thorax
    - Right half of head and neck
    - Right arm

Circulation of Lymph

- No central pump
- Movement occurs due to:
    - Muscle layer in vessel walls
    - Intrinsic rhythmic contractions (lymphatic pump)
    - Compression by adjacent muscle contraction
    - Pulsation of large arteries
    - Changes in thoracic pressure during respiration

Lymphatic Organs & Tissues

Lymph Nodes

- Oval or bean-shaped organs
- Located along lymph vessels
- Often arranged in groups
- Lymph passes through **8–10 nodes** before entering venous circulation
- Size ranges from:
    - Pinhead
    - Almond

Structure of Lymph Node

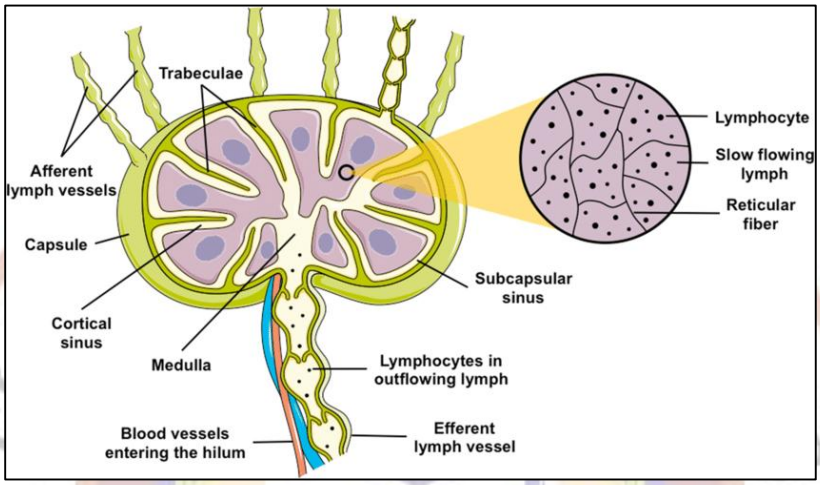
- Outer fibrous capsule
- Capsule forms partitions called **trabeculae**
- Main substance:
    - Reticular tissue
    - Lymphatic tissue

Cells

- Reticular cells:
    - Form fiber network
    - Provide internal framework
- Lymphatic tissue:
    - Packed with immune cells:
        - Lymphocytes
        - Macrophages

Vessels

- 4–5 afferent lymph vessels enter node
- Only 1 efferent vessel leaves node
- Concave surface called **hilum**
    - Artery enters
    - Vein and efferent lymph vessel leave



Location of Lymph Nodes

- Arranged in superficial and deep groups
- Commonly located where major blood vessels meet

Major Groups

- Cervical nodes: Drain lymph from head and neck
- Axillary nodes: Drain upper limbs and breast
- Submandibular nodes: Beneath mandible, Drain cheeks, lips, side of nose, tongue
- Mediastinal nodes: Drain thoracic organs
- Intestinal, iliac, deep nodes: Drain abdominal and pelvic cavities
- Popliteal nodes: Knee
- Inguinal nodes: Groin, Drain lower limbs

Functions of Lymph Nodes

Defence

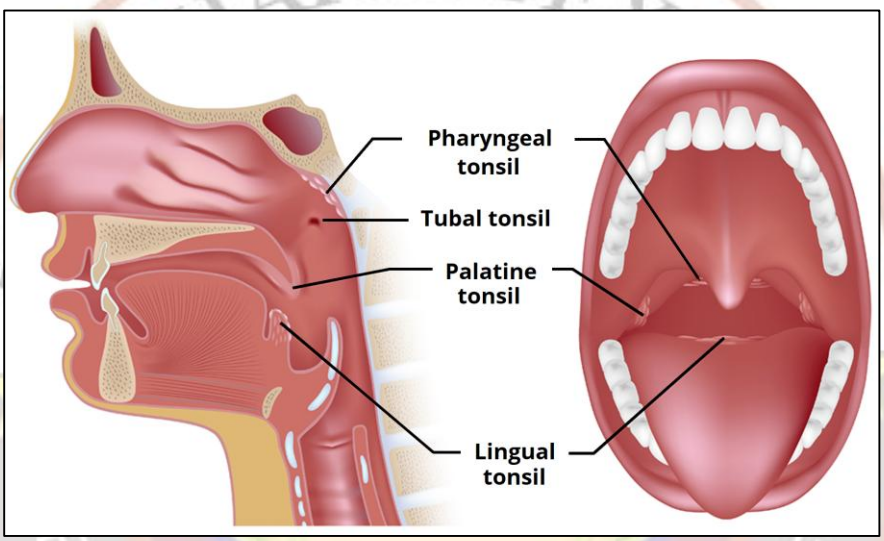
- Lymph filtered by reticular and lymphatic tissue
- Destroy:
    - Bacteria
    - Malignant cells
    - Damaged cells

    - Phagocytes with ingested bacteria
- Inorganic inhaled material not destroyed
- Material not destroyed in one node passes to next

Lymphocyte Maturation

- Some lymphocytes complete maturation here
- Activated T and B cells multiply
- Antibodies pass from:
    - Lymph → node → blood

Tonsils



- Uncapsulated collections of lymphoid tissue
- Located in back of mouth and throat
- Trap swallowed or inhaled antigens
- Largest in childhood
- Regress with age

Three Main Groups

Pharyngeal Tonsils (Adenoids)

- Located on upper posterior wall of pharynx
- Swell during childhood respiratory infections
- May obstruct nasal passages
- Removed by tonsillectomy if enlarged

Palatine Tonsils

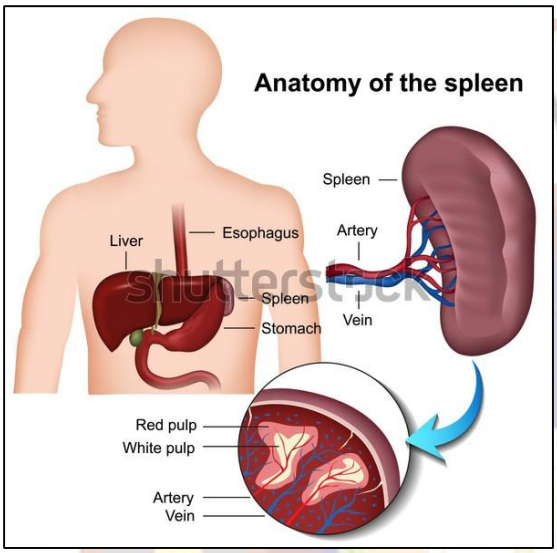
- Located on pharyngeal wall at back of mouth

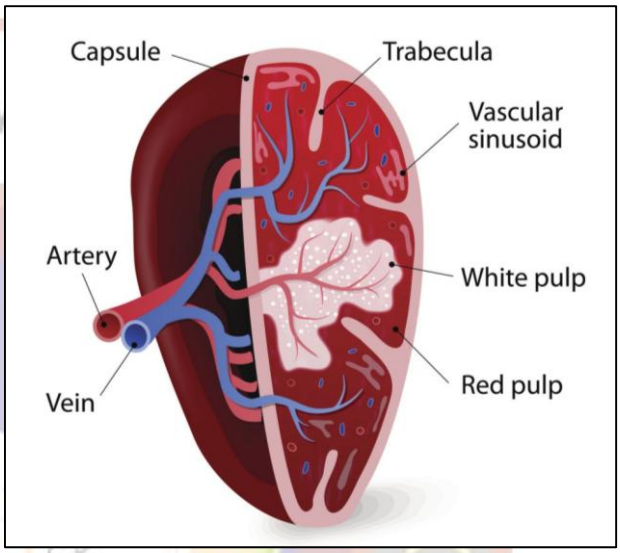
- Can swell and obstruct airway
- May require removal

Lingual Tonsils

- Located at back and sides of tongue

Spleen





- Largest lymphatic organ
- Contains reticular and lymphatic tissue
- Located between:
  - Fundus of stomach
  - Diaphragm
- Purple in colour
- Dimensions:
  - 11 cm long
  - 7 cm wide
  - 2.5 cm thick
- Weight: **200 g**

Structure

- Oval shaped
- Covered by peritoneum
- Capsule:
  - Fibroelastic tissue
  - Forms trabeculae
- Splenic pulp:
  - Red pulp – blood filled

- White pulp – lymphatic tissue

Blood Supply

- Splenic artery – branch of coeliac artery
- Splenic vein – branch of portal vein
- Sinusoids:
  - Have pores
  - Remove aged RBCs

Functions of Spleen

Phagocytosis

- Destroys old and abnormal RBCs
- Phagocytosis of:
  - Leukocytes
  - Platelets
  - Bacteria

Blood Storage

- Stores up to **350 ml blood**
- During hemorrhage:
  - Sympathetic stimulation releases stored blood

Immune Response

- Contains T and B cells
- Activated during infections
- Enlargement causes **splenomegaly**

Erythropoiesis

- Blood formation in fetus
- In adults during emergencies

Thymus Gland

- Located in upper mediastinum behind sternum
- Grows until puberty
- Gradually atrophies afterward

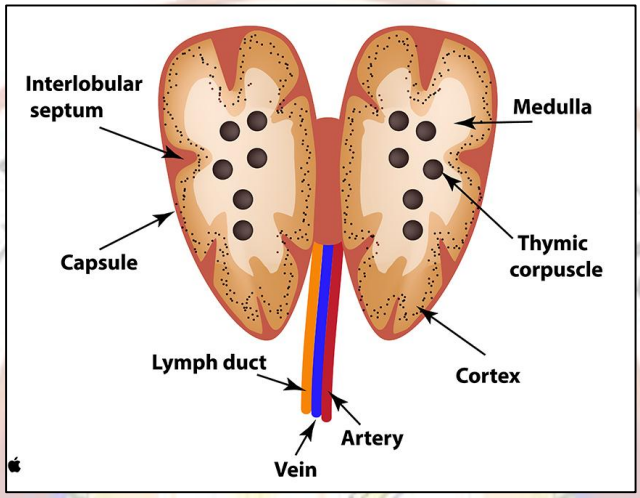
Relations

- Anterior: sternum

- Posterior: trachea
- Lateral: lungs
- Superior & inferior: heart

Structure

- Two lobes joined by areolar tissue
- Fibrous capsule divides into lobules
- Contains epithelial cells and lymphocytes



Functions

- Maturation of T-lymphocytes
- T cells learn to:
  - Recognize self
  - Respond to only one specific antigen
- Thymosin hormone:
  - Secreted by epithelial cells
  - Aids T-cell maturation

Mucosa-Associated Lymphoid Tissue (MALT)

- Non-encapsulated lymphoid tissue
- Located in:
  - GIT
  - Respiratory tract
  - Genitourinary tract
- Contains T and B lymphocytes
- Important for early detection of invaders

Main Groups

- Tonsils
- Peyer's patches (small intestine)

Lymph Nodules

- Small localized collections of lymphoid tissue
- Located beneath wet epithelial membranes
- Found in:
  - Digestive system
  - Respiratory system
  - Urinary bladder
- Differ from lymph nodes:
  - Smaller
  - No capsule
  - Not filters
  - Not along lymph vessels
- Often contain **germinal centers**
- Peyer's patches:
  - Collections of lymph nodules
- Tonsils:
  - Fused lymph nodules

Functions of Lymphatic System

Fluid Balance

- Returns excess fluid and proteins to blood

Absorption

- Assists fat absorption
- Removes excess tissue fluid

Immunity

- Protects body from microorganisms
- Essential in defense against infections