Human anatomy

THE LYMPHATIC SYSTEM
The Lymphatic system, is a subsystem of the circulatory system that consists of a complex network of vessels, tissues, and organs.

This network of lymphatic vessels carry a clear fluid called lymph in one direction towards the heart.

The lymphatic system helps maintain Fluid balance in the body by collecting excess fluid and particulate matter from tissues and depositing them in the bloodstream.

It also helps defend the body against infection by supplying disease-fighting cells called Lymphocytes.
LYMPHAHATIC SYSTEM

- Lymphatic comes from the Latin word *lymphaticus*, meaning "connected to water," as lymph is clear.
- This network of vessels & lymph nodes which are located in all major tissues of body.
- Lymphatic system is absent in CNS, Cornea, Superficial layer of skin, Bones, Alveoli of lung.

**CONSIST OF**
- Lymph
- Lymphatic Channels
- Lymph Nodes
- Lymph Organs
When circulating blood reaches the capillaries, part of its fluid passes into surrounding tissues as tissue fluid. Most of the fluid re-enters the capillaries at their venous ends. Some of it returns to the circulation through a separate system, the lymphatic vessels/lymphatics.
The lymph system is not a closed system

- The circulatory system processes an average of 20 litres of blood per day through capillary filtration which removes plasma while leaving the blood cells.
- Roughly 17 litres of the filtered plasma actually get reabsorbed directly into the blood vessels, while the remaining 3 litres are left behind in the interstitial fluid.
- The primary function of the lymph system is to provide an accessory route for these excess 3 litres per day to get returned to the blood.

- Therefore, The Lymph is essentially recycled blood plasma.
The lymphatic functions

- It is responsible for the removal of **interstitial fluid** from tissues
- It absorbs and transports **fatty acids** and **fats** from the digestive system
- It transports **white blood cells** to and from the lymph nodes into the bones
- The lymph transports **antigen-presenting cells** (APCs), such as **dendritic cells**, to the lymph nodes where an immune response is stimulated.
The LYMPHATIC SYSTEMS consists of:

1. Lymphatic vessels

2. Lymphoid tissues and lymphoid organs
Development of lymphatic system

Lymphatic system
  - Lymph
  - Lymphatic Channels
DEVELOPMENT

- Develop at the end of 5th wk of embryonic life
- Lymphatic vessels develop from lymph sacs which arise from developing veins and are derived from mesoderm
- 1st lymph sac to appear are the paired jugular lymph sacs at junction of internal jugular & subclavian veins
JUGULAR LYMPH SAC

- Retains one connection with its Jugular vein
- Spreads lymphatic capillary plexuses to Thorax, upper limbs, head & neck.
- The Left one develops into superior portion of thoracic duct.

RETROPERITONEAL LYMPH SAC

- It is unpaired and develops from primitive vena cava & mesonephric veins.
- Spreads capillary plexuses & lymphatic vessels to abdominal viscera & diaphragm.
- Develops connections with cisterna chyli & loses connections with neighboring veins.
CISTERNA CHYLI
- develops inferior to diaphragm on posterior abdominal wall.
- gives rise to inferior portion of thoracic duct.

POSTERIOR LYMPH SACS
- Develops from iliac veins.
- Gives capillary plexuses & lymphatic vessels to abdominal wall, pelvic region & lower limbs.
- Join cisterna chyli & loose connections with adjacent veins
• Lymph vessels grow out from the lymph sacs, along the major veins.

• Except for the upper portion of the cisterna chyli, which persists, the lymph sacs are transformed into groups of lymph nodes during early fetal life, at about 3 months.
THE LYMPH

- Transudative fluid.
- Transparent & slightly yellowish liquid.
- Alkaline in nature.
- Derived from tissue fluid.
- When blood passes through tissues
  9/10 of fluid - venous end
  1/10 of fluid - lymph capillaries
- “CHYLE” - Lymph from small intestine.
COMPOSITION OF LYMPH

96% water 4% solids

PROTEINS : 2 to 6 % of solids.
Depending upon the part of body from which it is collected
Albumin, globulin, clotting factors (fibrinogen, prothrombin), all
antibodies and enzymes.
LIPIDS : 5-15 % - Mainly chylomicrons and lipoproteins.
CARBOHYDRATES : Sugar - 132 mg per 100 ml (Mainly glucose).
Non protein nitrogenous substances : Urea, A.A & Creatinine.
ELECTROLYTES : Sodium, calcium, potassium, Chloride &
bicarbonate.
CELLULAR CONTENT : Mainly lymphocytes 1000-2000 per cu mm
lymphatic capillaries

Are absent from bone, bone marrow and from the entire central nervous system.

- The excess in nervous tissue fluid drains through the into the cerebrospinal fluid.
- The cerebrospinal fluid then returns this tissue fluid to the blood through the superior sagittal sinus.
- Lymphatic capillaries, called lacteals, has a unique function.
- Located in the villi of the mucosa of the small intestine, lacteals absorb digested fats from the intestine, which causes the lymph draining from the digestive viscera to become milky white.
- This fatty lymph is called chyle, and, like all lymph, it is carried into the bloodstream.
LYMPHATIC CAPILLARIES

- They are lined by a single layer of endothelial cells.
- These are attached to C.T by anchoring filaments.
- The edge of one endothelial cell overlaps the adjacent cell.
- Overlapping edge is free to flap inward minute valve.
- Permits passage of high molecular weight substance.
The structure of lymphatic capillaries

- Lymph flow
- Lymphatic capillary
- Interstitial fluid
- Blood capillary
- Loose connective tissue
- Incomplete or absent basal lamina
- To larger lymphatics
- Overlapping endothelial cells

Sectional view

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(a) Structural relationship between a capillary bed of the blood vascular system and lymphatic capillaries.

(b) Lymphatic capillaries are blind-ended tubes in which adjacent endothelial cells overlap each other, forming flaplike minivalves.
Lymphatic Capillaries

Special lymph capillaries ---

Lacteals

- Lacteals
  - Specialized lymphatic capillaries found in the villi of the small intestine.
  - Absorb fats from the digestive tract.
Flow of Lymph

- Lymph takes the following route from the tissues back to the bloodstream:
  - lymphatic capillaries -> collecting vessels -> six lymphatic trunks -> two collecting ducts -> subclavian veins.

- Thus, there is a continual recycling of fluid from blood to tissue fluid to lymph and back to the blood.
Bulk flow to Lymphatic circulation

- Lymphatic ducts (thoracic duct, right lymphatic duct) empty lymph into the junction of jugular and subclavian veins of the cardiovascular system.
- Lymphatic vessels pass lymph to lymphatic ducts.
- Efferent lymphatic vessels carry lymph from lymph nodes.
- Afferent lymphatic vessels carry lymph from blood capillaries to lymph nodes. Lymph nodes filter lymph and remove foreign substances through filtering, phagocytosis, and immune reactions.
- Blood plasma is filtered from blood capillaries into interstitial spaces to become interstitial fluid.

- Bulk flow creates interstitial fluid which then flows into the lymph and finally returns to the blood vessels.

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LYMPHATIC VESSELS

- Lymph capillaries merge to form lymphatic vessels.
- Resemble veins but ...........
  - Thin walls (Diameter - 0.2 – 0.3 mm)
  - More valves (formed from folds of tunica intima)
- Lymph Nodes are located at interval along its course
  - Have 3 coats (Tunica intima, Tunica media, Tunica adventitia)
  - BEADED in appearance (due to semilunar valves). Collagenous fibers attaches the endothelium to the outer tissues (fibrous sheath of muscle)
Lymph and Lymph Vessels

- In contrast to the blood circulation, which uses the pumping of the heart to circulate its flow, lymph is propelled through the vessels primarily by the rhythmic contractions of tiny muscular units (lymphangions) which form the lymph collectors.
- The lymphatic system has a slow rhythm, low velocity and low pressure.
- Human body has twice as many lymph vessels and capillaries as you have blood vessels and capillaries!
Mechanism of lymphatic flow:

Lymph flows under forces similar to those that govern venous return, except that the lymphatic system has no pump like the heart.

Lymph flows at even lower pressure and speed than venous blood; it is moved primarily by rhythmic contractions of the lymphatic vessels themselves, which contract when stretched by lymph.

The lymphatic vessels, like the veins, are also aided by a skeletal muscle pump that squeezes them and moves the lymph along.

Also like the medium veins, lymphatic vessels have valves that prevent lymph from flowing backward.

Since lymphatic vessels are often wrapped with an artery in a common sheath, arterial pulsation may also rhythmically squeeze the lymphatic vessels and contribute to lymph flow.

A thoracic (respiratory) pump aids the flow of lymph from the abdominal to the thoracic cavity as one inhales, just as it does in venous return.

Finally, at the point where the collecting ducts join the subclavian veins, the rapidly flowing bloodstream draws the lymph into it.

Considering these mechanisms of lymph flow, it should be apparent that physical exercise significantly increases the rate of lymphatic return.
How is fluid moved?

- Contraction of skeletal muscles against lymphatic vessels
- Smooth muscle contraction
- Valves in lymphatic vessels
Lymphatic Trunks

(Paired, except intestinal)

- Lumbar
- Intestinal

Drain into **cisterna chyli**

Receives fatty lymph *(chyle)* absorbed through **lacteals** of intestines

- Broncho-mediastinal
- Subclavian
- Jugular
Lymphatic Flow (cont.)

- **Lymph ducts**
  - **Right lymphatic duct**
    - about ½ inch long
    - drains lymph from upper right side of body (arm & head)
  - **Thoracic (left) duct**
    - main collecting duct of the lymphatic system
    - 38-45 cm long
    - drains 75% of body
    - begins as a dilation known as the **cisterna chyli** located anterior to lumbar disk #2
Thoracic duct (always present) (drain into left subclavian vein)

- 38 – 45 cm long
- Begins as a dilation called cisterna chyli anterior to 2nd lumber vertebra.
- Main duct for return of lymph to blood
- Receives lymph from left side of head, neck, Left upper limb, chest & entire body inferior to ribs
- Joins the venous system at the junction of Left Sub clavian & Left internal jugular veins & drains lymph via Lt subclavian vein.
Origin, course, relations, and termination

- Arises in the abdomen from cisterna chyli under cover of diaphragm.
- Enters the thorax through the aortic opening.
- It continues upward through the posterior mediastinum, on the left, first with the aortic arch and then with the left pleura.
- It enters the root of the neck, where it arches laterally behind the left carotid sheath, to terminate in the upper end of the left innominate vein, in the angle of junction of the internal jugular and subclavian veins.
- Chyle leak.
- Virchows or scalene nodes or signal nodes – supra clavicular nodes.
Right lymphatic duct

- Formed by union of right jugular, subclavian, and bronchomediastinal trunks
- Ends by entering the right venous angle
- Receives lymph from right half of head, neck, thorax and right upper limb
RIGHT LYMPHATIC DUCT

- 1.2 cm long
- 3 lymphatic trunks drain into Rt lymphatic duct
  - Rt Jugular trunk-drains Rt side of head & neck
  - Rt subclavian trunk-Rt upper limb
  - Rt bronchomediastinal trunk-Rt side of thorax, Rt lung,
    Rt side of heart, & part of liver
- Rt lymphatic duct joins the venous system at the junction of Rt Subclavian & Rt internal jugular veins
Lymph Drainage of Lower Limb

Superficial inguinal lymph nodes
- One group parallel and below the inguinal ligament
- Another group along the upper part of great saphenous vein
- They drain all superficial structures in:
  - Buttocks, thigh, leg, foot
  - Anterior abdominal wall below the umbilicus.
  - External genitalia except testis
  - Perineum and lower parts of vagina and anal canal
  - Cornu of uterus
Deep inguinal lymph nodes
- They are located medial to femoral vein
- They drain:
  lymphatic vessels that accompany femoral vessels and from popliteal fossa
  Glans penis and clitoris
  Efferent lymphatics from superficial inguinal lymph nodes
- Efferent lymphatics from this group drain into external lymph nodes
Lymphatic Drainage of the Upper Limb

- Superficial lymphatic vessels from the thumb, index and lateral side of the hand follow the **cephalic vein** to **infraclavicular lymph nodes**

- Superficial lymphatic vessels from the medial side of the hand follow the **basilic vein** to **supratrochlear lymph nodes** then to the **lateral group** of axillary lymph nodes

- Deep lymphatic vessels follow the arteries to the **lateral group** of axillary lymph nodes
Axillary Lymph Nodes

They drain lymph from entire upper limb, lateral part of breast, and superficial lymphatics of skin above the umblicus.

They include the following groups:

- Anterior: deep to pectoralis major at lower border of pectoralis minor drain most of breast
- Posterior: in front of subscapularis muscle
- Lateral: along the axillary vein
- Central: deep in the axilla
- Infraclavicular
- Apical: above the clavicle at the apex of axilla
Lymph Nodes of the Head & Neck

Deep Cervical Lymph Nodes
7. Lateral jugular
8. Anterior jugular
9. Jugulodigastric

Inferior Deep Cervical Lymph Nodes
10. Juguloomohyoid
11. Supraclavicular (scalene)
Deep Lymph Nodes

1. Submental
2. Submandibular (Submaxillary)

Submandibular
- tongue
- lips, mouth
- conjunctivae

Submental
- lower lip
- floor of mouth
- tongue

Postauricular
- external auditory meatus
- pinna

Posterior Cervical
- scalp
- neck
Lymph nodes of the neck

Anterior cervical ln.
- Superficial anterior cervical lymph nodes
- Deep anterior cervical lymph nodes

Lateral cervical ln.
- Superficial lateral cervical ln. lie along the external jugular vein
- Deep lateral cervical ln. extend along the internal jugular vein

Anterior Cervical Lymph Nodes (Deep)
3. Prelaryngeal
4. Thyroid
5. Pretracheal
6. Paratracheal
Deep Cervical Lymph Nodes:
- They drain lymph from the entire head and neck
- Located along the whole length of internal jugular vein
- They are two groups
  - **Upper group** located at the angle between the lower border of mandible and anterior border of sternomastoid
  - **Lower group** located in the angle between the clavicle and sternomastoid
Lymph Drainage of the Thorax

Lymph nodes of the chest wall:
- Parasternal
- Intercostal
- Diaphragmatic

Lymph nodes of the mediastinum:
- Nodes around bifurcation of trachea and main bronchi
- Posterior mediastinal
- Anterior mediastinal
Lymph Node Groups in Abdomen

- They are related to the main arteries of the abdomen
- **Preaortic group:**
  They are related to the main single branches of the aorta
- **Paraaortic group:**
  They are related to the lateral branches of the aorta
Coeliac Nodes

- Located around the stem of the coeliac trunk
- They drain node groups related to the main arteries of the region:
  - Left gastric
  - Splenic
  - Hepatic
  - Gastroduodenal
  - Gastroepiploic
  - Pyloric
Superior and Inferior Mesenteric Lymph Nodes

- Drain the small and large intestines
- Drain the intestines via lymph nodes close to the intestinal wall and intermediate nodes in the mesentery
General Plan of Lymph Drainage from the Abdomen
Lymphatic Drainage of the Pelvis

- Lymph nodes along the external, internal, and common iliac vessels in addition to the sacral vessels
- Lymph nodes between the layers of the broad ligament and in the fascial sheath of the rectum and the urinary bladder