The Lymphatic System

network of tissues, organs and vessels that help to maintain the body’s fluid balance & protect it from pathogens.

like the circulatory system, the lymphatic system consists of "pumps", a series of vessels, and a fluid called lymph.

unlike the circulatory system it is a 1-way system

→ lymph doesn’t "circulate" around in a loop like blood
→ lymph is collected from the tissues and delivered to the blood.

lymphatic system is directly connected to the circulatory system.

it helps the circulatory system to do its job.

without it neither the circulatory system nor the immune system would function.

can be thought of as an accessory to the circulatory system.

General Functions of Lymphatic System:

1. Returns Fluid from Tissues to Blood
   ~85% of fluids that leak out of blood returns to blood via blood capillaries.
   ~15% returns via lymph capillaries.
   in 24 hrs lymphatics return fluid equivalent to entire blood volume.
   if lymphatic system becomes blocked → edema

2. Returns Large Molecules to Blood
   ~25-50% of blood proteins leak out of capillaries each day.
   they cannot get back into capillaries.
   instead lymphatic capillaries pick them up and return them to the blood.
   if lymphatics are blocked blood protein decreases leading to fluid imbalances in body.

3. Absorb and Transport Fats
   Special lymphatic capillaries (= lacteals) in villi of small intestine absorb all lipids and fat soluble vitamins from digested food.
   bypasses liver.
   much goes straight to adipose tissues.

4. Hemopoiesis

   some WBC’s (lymphocytes, monocytes) are made in lymphatic tissues (not bone marrow).
   including body’s main supply of lymphocytes.

5. Body Defense/Immunity

   lymphoid tissue is an important component of the Immune System (forms a diffuse surveillance defense system in all body tissues and organs).
   the major role of WBC’s is in body defense.
   lymphatic system screens body fluids and removes pathogens and damaged cells.

Lymph

lymphatic system contains a fluid derived from plasma = lymph.

Lymph is a clear watery fluid that resembles blood plasma but:

→ has fewer proteins
→ its composition varies depending on organs that it drains.

the lymphatic system handles 125 ml/hr (2.5-2.8 liters /day)

~1/2 of this from the liver and small intestine alone.

lymph contains white blood cells

(esp lymphocytes and macrophages [monocytes]).

Lymphatic Vessels

scattered along the lymphatic vessels are lymph nodes, also called lymph glands.
oval, vary in size from pinhead to lima bean
most numerous of the lymphatic organs (100’s)

**Functions of Lymph Nodes:**
- cleanse lymph: remove dead cells and microorganisms
- alert immune system to pathogens
- formation of white blood cells

lymph moves into nodes by way of several **afferent lymphatic vessels**

moves through **sinus channels** lined with **phagocytic cells** (reticuloendothelial cells or macrophages)

exits via 1-3 **efferent lymph vessels**

fewer efferent vessels creates a bottleneck and slows flow as lymph is “screened”

the macrophages and reticular cells in each node remove ~99% of impurities

→ as lymph passes from node to node virtually all impurities are normally removed

lymph nodes are widespread in body but most occur in groups or clusters:

- **eg. submental & submaxillary lymph nodes**
  - floor of mouth;
  - drain nose, lips teeth

- **eg. cervical lymph nodes**
  - neck
  - drain neck and head

- **eg. axillary lymph nodes**
  - armpit (axilla) and upper chest
  - drains arm and upper thorax including breasts

- **eg. inguinal lymph nodes**
  - in groin area
  - drain legs and genitals

as lymphatic vessels converge they become larger and larger

c. **Lymphatic Ducts**

these lymphatic trunks merge together to form two major **Lymphatic Ducts** equivalent to major vessels of circulatory system but more like veins than arteries

**Two major Lymphatic Ducts:**

**Right Lymphatic Duct**
- very short
- drains upper right quadrant of body
- drains into right subclavian vein at jct with jugular V

**Thoracic Duct**
- much larger and longer
- drains the rest of body (3/4ths):
  - all of body below diaphragm and left arm and left side of head, neck and thorax
- begins just below the diaphragm, anterior to vertebral column
- lumbar trunks and intestinal trunk join to form saclike **cysterna chyli**
- drains into left subclavian vein

**Lymphatic Pumps:**

fluid pressure in lymphatic system is very low, as in veins

vessels contract rhythmically

→ direction of flow is maintained by 1-way valves

also body movements and pulsing of arteries help to move lymph along

→ many vessels are wrapped in connective tissue with arteries: the pulsing of the arteries also helps move lymph along

as lymph drains into subclavias veins the rapid flow of blood also draws lymph in

**Major Accessory Lymphatic Organs**

1. **Tonsils**

masses of lymphoidal tissue embedded in mucous membranes of pharynx

covered by epithelium, with deep pits (=crypts)

crypts often contain food debris, bacteria, dead wbc’s etc

three main sets of tonsils:

- **pharyngeal tonsils** (=adenoids)
  - on wall of pharynx behind nasal cavity
- **palatine tonsils**
  - at post margin of oral cavity
  - largest and most often infected = tonsillitis usually Streptococcus
today usually treated with antibiotics
- **lingual tonsils**
on each side of root of tongue

2. Spleen

- largest of the lymphatic organs
- located below diaphragm in left hypochondriac region
- spleen performs several functions:
  1. defense
      - helps screen blood and removes pathogens and bacteria
  2. hemopoiesis
      - monocytes and lymphocytes are made here
      - (before birth, RBC’s also made here)
  3. erythrocyte and platelet destruction
      - spleen is “erythrocyte graveyard”
      - iron is salvaged from RBC’s
  4. blood reservoir
      - able to store blood (~350ml)
      - can constrict and pump blood into circulatory system if hemorrhaging
      - = self transfusion (can squirt 200 ml into blood in <1 minute)

3. Thymus

- is single unpaired organ in mediastinum and neck region
- plays vital role in initial set up of body’s immune system
  - source of lymphocytes before birth which circulate to spleen, nodes and vessels
  - soon after birth it secretes a hormone that causes lymphocytes to develop into plasma cells
- once this job is done it degenerates
  - seems to complete its essential job by end of childhood
  - largest when young, esp puberty
  - then gets smaller and is replaced with fat

4. Lacteals

- specialized lymphatic capillaries in the villi of the intestine
- used to absorb fats and oils after digestion

Diseases of Lymphatic System

Edema

- any disruption of lymphatic flow can lead to edema
  - excessive accumulation of interstitial fluid
- results from injury, inflammation, surgery, or parasitic infections

Metastatic Cancers

- metastasis is when cancer cells break free of original tumor and travel to other sites in the body
- lymph nodes are common sites of metastatic cancer
- since lymphatic capillaries are so permeable, cancer cells can easily enter and travel in the lymph
- tend to lodge in 1st node they enter and enlarge and destroy the node = lymphoma
- once lymphoma is established cells travel from their to other nodes

Hodgkin Disease

- lymph node malignancy
- early symptoms: enlarged, painful nodes, esp in neck; fever, anorexia, weight loss, night sweats, severe itching
- often progresses to neighboring lymph nodes

Non-Hodgkin Lymphoma

- lymphoma similar to above but more common
- also, helps stabilize blood volume by transferring excess plasma from blood to lymphatic system