

## 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

#### a. Lymphatic Capillaries

originate in tissues as tiny blind ended sacs

lie side by side with blood capillaries

single layer of endothelial cells like blood capillaries

but much more permeable to solvents, and large solutes and whole cells

#### b. Lymphatic Vessels

these small lymphatic capillaries merge with others to form larger lymphatic vessels

lymphatic vessels resemble veins in structure:

a. three layers – but much thinner

b. 1-way valves – but many more (every few mm or so)

c. also has lymph nodes at intervals along its course

#### Lymph Nodes

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 subclavian veins the rapid flow of blood also draws lymph in

### Major Accessory Lymphatic Organs

#### 1. Tonsils

masses of lymphoid 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 <1minute)

also, helps stabilize blood volume by transferring  
excess plasma from blood to lymphatic system

## 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 1<sup>st</sup> 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 comon

more widespread distribution in body with higher  
mortality rate

### Ruptured Spleen

one of most common consequences of blows to left  
thoracic or abdominal wall

it bleeds profusely if damaged, may cause fatal  
hemorrhaging

removal of spleen usually not serious since functions  
are shared with liver and bone marrow