The Lymphatic System

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

lymphatic vessels, lymph nodes, spleen, thymus, tonsils, etc

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

can be thought of as an accessory to the circulatory system

it helps the circulatory system to do its job

the two systems are directly connected together

it consists of fluid derived from plasma =**lymph**

and **white blood cells** (esp lymphocytes and macrophages (monocytes))

the lymph travels in only one direction
→ it doesn't circulate

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 (2500-2800 ml of lymph/day)
~1/2 of this from the liver and small intestine alone

Lymphatic Vessels (=lymphatics):

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

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

as they converge they become larger and larger

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

<u>Flow of Lymph:</u>

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

<u>Lymph Nodes</u>

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:

1. cleanse lymph
   → as lymph flows through sinuses of node it slows down and microorganisms and foreign matter are removed
2. alert immune system to pathogens
3. important in hemopoiesis
   → lymphocytes and monocytes are made here

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

moves through **sinus channels** lined with **phagocytic white blood cells**

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

the WBC's 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

breasts contains 2 sets of lymphatics:
(NOT mammary glands)
those that drain the skin over breast excluding the areola and nipple
those that originate in and drain deeper portions of breast and skin of areola and nipple

numerous connections join the lymphatic systems of the breast with:
the other breast
axillary nodes (85% of lymph from breast enters them)

abdominal nodes

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

Major Accessory Lymphatic Organs

1. Tonsils

masses of lymphoidal tissue ebedded 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 = tonsilitis
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

ovoid in shape

inside is a network of interlacing fibers:
red pulp → packed with RBC's
white pulp → crowded with lymphocytes, monocytes, and neutrophils

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

<u>General Functions of Lymphatic System:</u>

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)

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

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: elarged, 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