

AP2, Lab 4 - Blood Vessels, BF, BP, & Lymphatic System

1) Functions and Types of Blood Vessels

Your 60,000 miles of blood vessels perform 3 primary functions:

(1) to serve as “pipelines” for the transport of nutrients to tissues and wastes away from tissues.

(2) to control the distribution of blood. There’s not enough blood to fill all your vessels at the same time.

By constriction of ARTERIOLES and PRECAPILLARY SPHINCTERS blood flow can be diverted away from certain capillary beds towards others.

By dilation of ARTERIOLES and PRECAPILLARY SPHINCTERS blood flow can be directed into capillary beds of the more active tissues.

(3) To help control blood pressure (BP) by adjusting PR. Vasoconstriction ↑BP. Vasodilation ↓BP.

TYPES OF VESSELS (see images p. 717, 721, 726 / 697, 700, 706)

ARTERIES

- Elastic Arteries & Muscular Arteries both serve as transport pathways to tissues
- Due to their elasticity a “pulse” can be felt in many of these vessels with each beat of the heart.
- Pressures here are typically 100 - 200 mmHg
- Walls contain visceral (smooth) muscle controlled involuntarily by the ANS via the vasomotor center in the medulla oblongata
- Muscular arteries can be stimulated by sympathetic nerves to constrict to raise BP

ARTERIOLES

- are much smaller (but still muscular) vessels where most of the vasoconstriction or vasodilation takes place adjusting PR and therefore BP
- Vasoconstriction and dilation also helps control distribution of blood. Blood can be diverted from tissues that need the least to tissues that need the most.

CAPILLARIES

- pressures typically 20-30 mmHg
- are the very smallest, microscopic vessels where the exchange of nutrients and wastes with surrounding tissues actually takes place
- walls consist of a single layer of endothelial cells only. These cells are loosely joined to each other thus facilitating FILTRATION of fluids OUT and OSMOSIS of fluids IN as well as the DIFFUSION of nutrients outward to the tissue cells and diffusion of wastes inward from tissue cells. Average pressure = 20-30 mmHg
- PRECAPILLARY SPHINCTERS – circular rings of muscle that "shut down" or "open up" capillary beds as necessary to control distribution of blood. Blood can be ‘shunted’ away from tissues where demand for blood is low to tissues where demand is higher.

VENULES

- Are the smallest veins collecting blood from the capillary beds.
- Venules merge together to form increasingly larger and larger VEINS.

VEINS

- Are large pipelines transporting blood from the tissues back to the heart.
- Many veins are superficial and visible just under your skin.
- Pressures here are typically < 20 mmHg. To compensate for these low pressures veins of the arms and legs have abundant VENOUS VALVES to insure the upward movement of the blood toward the heart.

2) BLOOD VESSELS IDENTIFICATION Use diagrams on p. 747-766 / 725-744 to identify the following vessels on the arm, leg or torso models. All these vessels are ARTERIES unless otherwise noted. With a few exceptions, there are usually corresponding veins beside them with identical names.

Group I: On the HUMAN TORSO find:

AORTIC ARCH - the abrupt turn posteriorly of the aorta immediately after exiting the LV

BRACHIOCEPHALIC - the first branch off the aortic arch. It soon splits to become the **R common carotid** supplying the R side of the head and neck and the **R subclavian** supplying the R arm. (These are best viewed on p. 751 / 729)

L COMMON CAROTID - 2nd branch off the aortic arch; supplies the L side of head and neck

L SUBCLAVIAN - 3rd branch off the aortic arch; supplies the L arm

THORACIC AORTA (remove the heart to see the continuation of the aortic arch down through the thoracic cavity along the spinal column but above the diaphragm)

ABDOMINAL AORTA (remove the small and large intestines and mesentery to see the continuation of the thoracic aorta below the diaphragm into the abdominal cavity.) Both the thoracic and abdominal aortas are sometimes referred to together as the '**descending**' aorta.

INTERCOSTAL ARTERIES – On the larger and darker torso, remove the lung entirely to expose the **posterior intercostal arteries**. Look on the inferior border of each rib. Look on the inner surface of the anterior chest wall to see the anterior intercostal arteries. Note that they always run along the inferior border of each rib. This is why when you insert a needle through the chest wall to do a 'needle decompression' of a tension pneumothorax you always insert the needle on the superior border of a rib.

INFERIOR PHRENIC - On the larger and darker torso, look on the inferior surface of the diaphragm. This artery will seem to 'sprawl' across the diaphragm.

R & L RENAL ARTERIES - supplies kidneys

INFERIOR MESENTERIC - supplies the descending portion of the large intestine. The **SUPERIOR MESENTERIC** supplies the small intestine as well as the ascending colon and transverse colon. These are best seen in the **mesentery** which supports the Lg. I. On the larger, darker torso models the pale plastic attached to the medial edges of the large intestine represents connective tissue called **mesentery**. On the lighter colored torso models these are visible on the posterior side of the large and small intestines. The many branches of the inferior mesenteric are readily visible.

R & L COMMON ILIACS - the abdominal aorta forks to become R & L common iliacs. Each common iliac then forks to become an internal and external iliac. (seen only on our larger, darker, torso models)

R & L INTERNAL ILIACS – first branches of common iliac which travel toward the sacral region (seen only on our larger, darker, torso models)

R & L EXTERNAL ILIACS – continuation of common iliac on toward the leg (seen only on our larger, darker, torso models)

INTERNAL THORACIC - descends vertically along the inner side of the **anterior** thoracic wall (seen only on our larger, darker, torso models)

SUPERIOR and INFERIOR VENA CAVA VEINS – well duhhh

L INTERNAL JUGULAR VEIN and STUB OF L EXTERNAL JUGULAR VEIN. (seen only on our larger, darker, torso models) The ext. jugular is significant clinically because IV lines can be started here when BP is too low to start an IV elsewhere.

L Cephalic vein –from the arm to the L subclavian in the groove between the deltoid and pectoral muscles (seen only on our larger, darker, torso models)

Group II: On the ARM MODEL find:

AXILLARY - in the arm pit / shoulder joint area

BRACHIAL - parallel to the humerus

RADIAL – next to the radius; a pulse is often taken here to measure HR

ULNAR – next to the ulna

On the LEG MODEL remove muscles as necessary to see:

FEMORAL - runs along medial side of femur; is the continuation of the external iliac

POPLITEAL - the continuation of the femoral *behind* knee

POSTERIOR TIBIAL – the continuation of the popliteal behind the tibia

ANTERIOR TIBIAL – a branch to the front of the tibia

DORSALIS PEDIS – The anterior tibial artery continues across the dorsal surface of the foot. (The models really don't show it – use your imagination.) A distal pulse can be palpated here to confirm whether or not circulation is reaching the feet. After splinting a broken leg or applying a tourniquet you always check for a pulse here.

On the HUMAN TORSO HEAD find:

FACIAL ARTERY – (seen best on the larger, darker torsos)

- ascends up the lateral side of face about midway along mandible

TEMPORAL ARTERY - (seen best on the larger, darker torsos)

- lateral side of temporal bone just anterior to ear. You can feel this pulse on yourself with light finger pressure placed vertically just in front of your ear canal.

On p. 763 / 741 find:

L & R CEPHALIC VEINS, L & R BRACHIOCEPHALIC VEINS, SUPERIOR & INFERIOR VENA CAVA

3) THE LYMPHATIC SYSTEM

The lymphatic system consists of lymph nodes and vessels similar to veins. They begin as lymphatic capillaries in the tissues and then merge to form larger lymphatic vessels that ultimately return lymph back to the blood by draining it into the subclavian veins.

FUNCTIONS OF THE LYMPHATIC SYSTEM

1. **To maintain fluid balance (prevent edema) by:**
 - collecting and returning excess ISF from the tissues to the blood.
 - collecting and returning small proteins that “escaped” from blood capillaries. If these proteins were not removed from the ISF they would attract water to the ISF and cause **edema**.
2. **To assist with defense by:**
 - collecting foreign particles such as bacteria, viruses, and cancerous cells and delivering them to lymph nodes for “processing” by the numerous macrophages and lymphocytes found there.
3. **To absorb lipids from the small intestine.**
 - lymphatic vessels called **LACTEALS** in the villi of the small intestine absorb lipids and transport them to venous blood which then carries them to the liver for processing.

LYMPHATIC CAPILLARIES AND VESSELS

LYMPHATIC CAPILLARIES

- are most abundant in superficial tissues such as dermis and hypodermis. Lesser #s are found deep in almost all tissues of the body except CNS, bone marrow, and avascular tissues.
- are similar to blood capillaries in that walls of lymphatic capillaries are made of thin, loosely joined cells... but they **differ from blood capillaries in two important ways:**
 1. **more permeable.** Nothing in the ISF is excluded from entering lymphatic capillaries. Even whole cells such as WBCs, bacteria, and cancer cells may enter and become part of the lymph.
 2. **passage between the cells of the walls is typically “one-way.”** What enters the lymphatic capillaries from the ISF is “milked” away into larger lymphatic vessels. It does not go back and forth between the ISF and lymph.

LYMPHATIC VESSELS

- lymphatic **capillaries** join to form slightly larger lymphatic vessels with numerous lymph nodes found along the way. The lymph must flow through these nodes.
- small **vessels** join to form larger lymphatic **ducts** that ultimately drain the lymph back into circulating blood at the **subclavian veins**

LYMPHATIC ORGANS

LYMPH NODES:

- act as “residence halls” for lymphocytes known as B-CELLS & T-CELLS, and for MACROPHAGES
- B-cells and T-cells multiply here by mitotic cloning
- Are where many foreign “visitors” usually first meet B cells, T cells, and macrophages.
- become inflamed and swollen during peak activity.
- **sites of antibody production** by B-lymphocytes known as PLASMA cells.

LYMPH NODULES: dense clusters of lymphoid tissues not as well defined as nodes.

(e.g. Peyer's patches on Sm. I.) Act similar to lymph nodes.

TONSILS: groups of lymph nodules just under mucous membrane of oral cavity and pharynx. Act similar to lymph nodes. (e.g. PALATINE tonsils are the most obvious and easily palpated.)

SPLEEN:

- is located in L HYPOCHONDRIAC region.
- acts like a giant lymph node but *for the blood* rather than lymph
- is highly vascular, ruptures easily, and bleeds profusely

THYMUS GLAND:

- is located in mediastinum anterior to large vessels at base of heart
- is where T-cells are 'programmed' to become immunocompetent
- is large and active until puberty then diminishes in both size and activity with age.

OYO: Explain the connection between the spread of cancer in the body and the lymphatic system.

Which component of the lymphatic system do they often remove and examine in order to see if a patient's cancer has spread?

FLOW OF LYMPH:

- 125 ml/hr at rest. Calculate liters/day: _____ How does this compare to blood flow?
- **Factors assisting the flow of lymph:**
 1. contractions of surrounding skeletal muscles
 2. one-way valves similar to those in veins
 3. respirations causing alternating pressures in thoracic and abdominal cavities help to "milk" the lymphatic vessels of these regions.
 4. rhythmic contractions of smooth muscles in the walls of larger lymphatic trunks and ducts
- Rate of flow increases with exercise.

CLINICAL APPLICATIONS

1. If flow of lymph were obstructed due to vessel compression, node damage, or surgical removal of nodes, what would happen to ISF? _____, a condition called _____ or _____.
2. Following surgical removal of nodes, (e.g. after radical mastectomy) new lymphatic vessels usually eventually form over a period of weeks or months.
3. First aid treatment for poisonous snake bite includes immobilizing the bitten limb and positioning it lower than the heart. This slows the flow of lymph from the bitten area and thereby slows the rate at which the venom enters the bloodstream to have more systemic effects.