Cardiovascular System: Vessels and Circulation (Chapter 21)
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Primary Sources for figures and content:
Health Problems with Arteries
- aneurysm: pressure of blood exceeds elastic capacity of wall, causes bulge or weak spot prone to rupture, caused by chronic high BP or arteriosclerosis
- arteriosclerosis: variety of pathological conditions causing changes in walls that decrease elasticity (“thickenings”):
  - focal calcification: smooth muscle degenerates, replaced by calcium salts
- atherosclerosis: lipid deposits

-stroke = cerebrovascular accident (CVA): interruption of arterial supply to portion of brain (embolism, atherosclerosis), brain tissue dies and function is lost

Capillaries (on handout, typed)
- only vessels with thin enough wall structure to allow complete diffusion
- all cells are within 125μm of capillary
- fun fact: 25,000 miles of capillaries

- continuous
- fenestrated
- sinusoid

Vasomotion: cycle of contraction/relaxation
- sphincter relaxed = flow in capillary bed
- sphincter constricted = capillary bed empty, flow through anastomoses
**Veins (on handout, typed)**

- Pressure from heart drives blood flow in arteries, but pressure in veins often too low to oppose gravity
- Skeletal muscle movement required to “squish” blood through veins

**Anastomoses (on handout, typed)**

**Physiology of Circulation**

Blood flow = volume of blood flowing through a vessel in given period (total body flow = CO)

Blood pressure = force per unit area exerted on vessel by blood (mmHg)

Blood flows from high pressure → low

Resistance = opposition to blood flow, friction

↑ blood viscosity = ↑ resistance

↑ vessel length = ↑ resistance

↓ vessel diameter = ↑ resistance

Vasoconstriction = ↓ flow, ↑ BP, ↑ resistance

Vasodilation = ↑ flow, ↓ BP, ↓ resistance

- Blood pressure changes throughout body: greatest in arteries leaving heart, lowest in veins returning to heart
- Person’s BP measured at arteries near heart: systolic pressure / diastolic pressure (from ventricles, squeeze / rest)

“normal” = 110/70 mmHg

**Hypertension**

- Arterial pressure >150/90 mmHg
- Causes ↑ workload for heart
- Untreated = enlarged left ventricle, requires more O₂, heart can fail

As arteries branch, area for blood increases, pressure decreases and becomes constant.

Blood at arteriole ~35 mmHg → capillary → Blood at venule ~18 mmHg

Pressure continues to decline as veins increase diameter
Cardiovascular Response to Hemorrhaging

- Short Term (aimed at ↑BP and ↑flow: blood flow to brain kept constant while other systems adjust, can compensate for ~20% blood loss)
  1. ↑C.O., trigger peripheral vasoconstriction to ↑BP
  2. Venoconstrict to mobilize venous reserve to ↑blood volume
  3. Release NE, ADH, Angiotensin II to ↑BP
- Long Term (aimed at restoring normal blood volume after hemorrhage)
  1. Recall fluid from interstitial spaces
  2. Release ↑ADH for fluid retention at kidney
  3. Increase thirst
  4. Release EPO to ↑RBCs

Shock = low BP and inadequate blood flow

Due to:
- loss of >30% blood volume
- damage to heart
- external pressure on heart
- extensive vasodilation

Results in:
- hypotension, rapid weak pulse
- clammy skin, confusion, ↑heart rate
- ↓urine production, ↓blood pH

Body focuses on supplying blood to brain at expense of other tissues

Circulatory collapse - blood flow stops completely as muscles in vessels no longer contract due to lack of oxygen, no blood flow = death

Capillary Exchange
- functions to feed tissues and remove wastes
- due to filtration and diffusion
- dependent on good blood flow and pressure
  1. Filtration - pressure forces substances through a membrane
  2. Blood hydrostatic pressure in capillaries drives water and solutes out of plasma to tissues, 24 L/day
  3. Most recollected by osmosis (plasma proteins) back into capillary (filtered at arteriole end, absorbed at venule end)
  4. 3.6 L/day flows through interstitial spaces, recollected by lymphatic system:
     - accelerates distribution of nutrients
     - flushes out toxins and pathogens (will be removed/detoxified by immune cells in lymphatic system)

2. Diffusion - movement of substances from an area of high concentration to low
   - small ions transit through endothelial cells (e.g. Na+)
   - large ions & small organics pass between endothelial cells (e.g. glucose, amino acids)
   - lipids pass through endothelial membranes (e.g. steroid hormones)
   - large water soluble compounds diffuse at fenestrated capillaries (e.g. in intestine)
   - large plasma proteins diffuse only at sinusoids (e.g. in liver)

Edema = buildup of fluid in the tissues, due to too much diffusion or filtration, not enough osmosis, or blocked lymphatics

Cardiovascular Regulation (on handout)
- flow, BP, & resistance must be controlled to insure delivery of nutrients and removal of wastes in tissues
Aging and the Cardiovascular System:
- decreased hematocrit
- increased thrombus formation
- venous valves ↓ function, blood pools in legs
- reduction in max CO
- increased arteriosclerosis

*Anatomical locations of individual major blood vessels will be examined in detail in lab!