Blood Vessels, Pressure & Composition

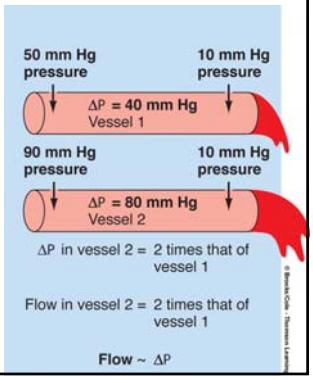
Hemodynamics

- Flow of blood through the circulatory system
- Based on interrelationships between:
  - Pressure
  - Resistance
  - Flow rate

$$F = \Delta P/R$$

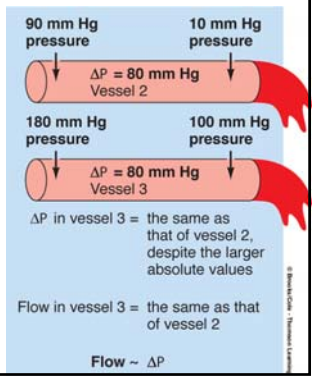
Hemodynamics: Pressure & Resistance

- Pressure
  - Blood flows from high → low pressure



Hemodynamics: Pressure & Resistance

- Pressure
  - Blood flows from high → low pressure

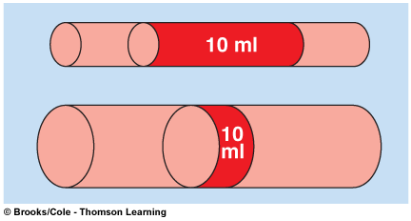


Hemodynamics: Pressure & Resistance

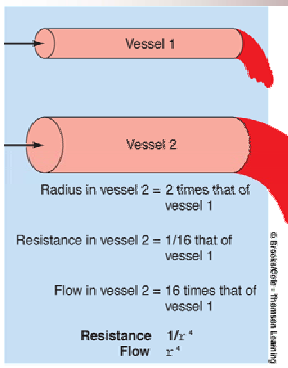
- Resistance
  - Length of the vessel
  - Viscosity of the blood
  - Radius of the vessel
    - ✓A small change in vessel diameter can have a dramatic impact on resistance!

$$\text{Resistance} = \frac{\text{Length} \times \text{viscosity}}{\text{Radius}^4}$$

Hemodynamics: Pressure & Resistance



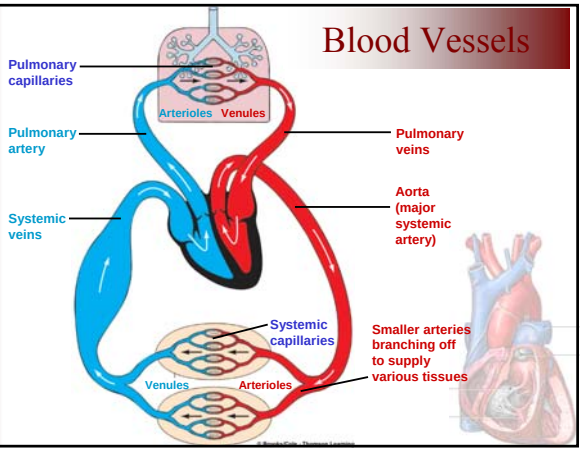
Hemodynamics: Pressure & Resistance



Poiseuille's Law

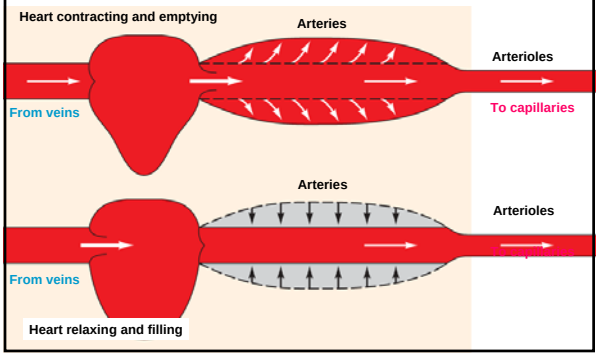
$$F = \pi \Delta P r^4 / 8 \eta L$$

Blood Vessels



Arteries

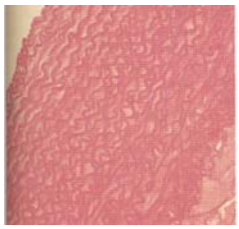
Rapid transit system & pressure reservoir



Arteries *(cont.)*

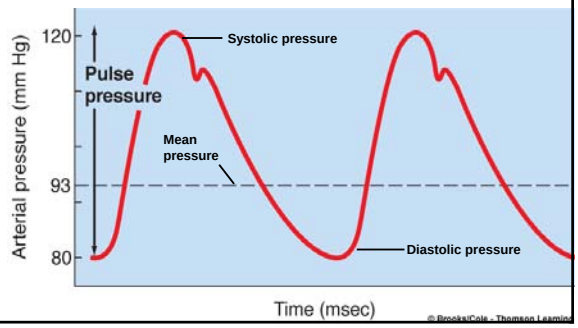
- 2 types of connective tissue:
  - Collagen fibers & Elastin fibers

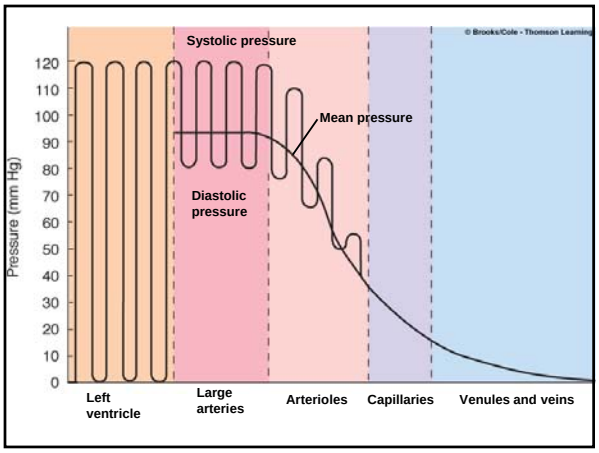
Allow for <u>strength</u> & <u>elasticity</u>



Arteries *(cont.)*

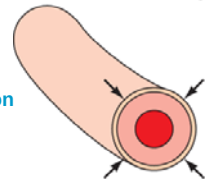
- Blood pressure & pulse pressure





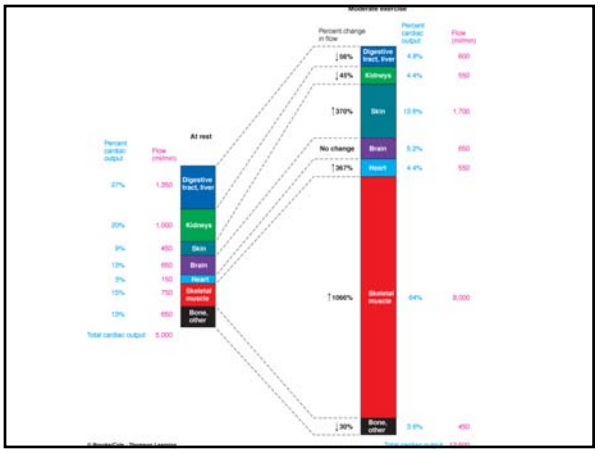
Arterioles

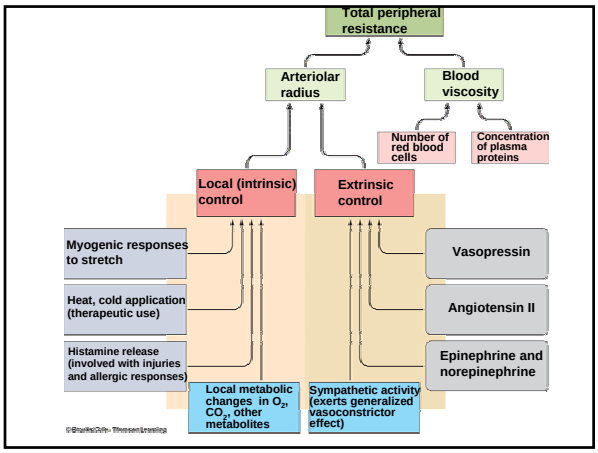
- Major source of resistance
- Little elastic tissue
- Primarily smooth muscle
  - Heavily innervated by sympathetic nerve fibers
  - Promotes ***vascular tone***
    - ✓Ability to vasoconstrict and vasodilate



Vasoconstriction

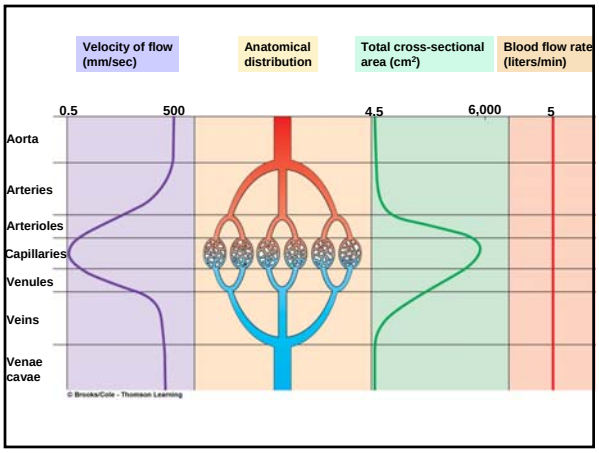
Caused by:
- ↑ **Myogenic activity**
- ↑ **Oxygen (O_2)**
- ↓ **Carbon dioxide (CO_2) and other metabolites**
- ↑ **Endothelin**
- ↑ **Sympathetic stimulation**
  Vasopressin; angiotensin II
  Cold



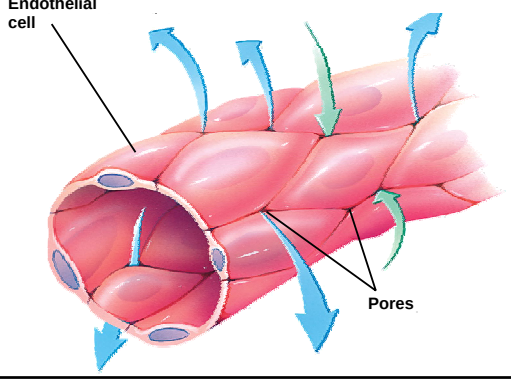


Capillaries

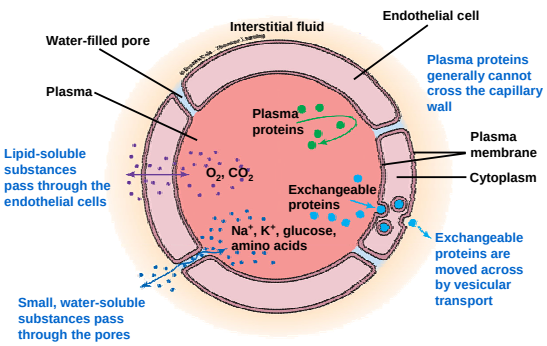
- Exchange of materials between blood & tissues
- High rates of diffusion
  - Short distance
  - Thin
  - Narrow
  - Extensive network



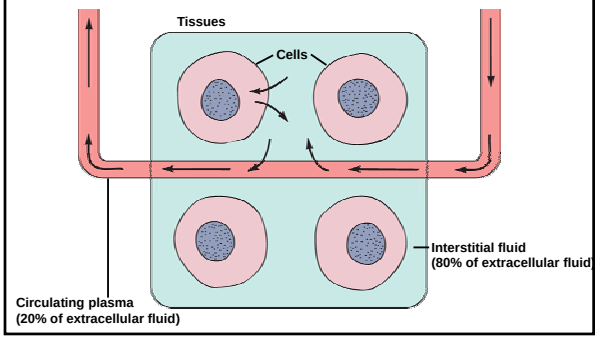
Capillary permeability

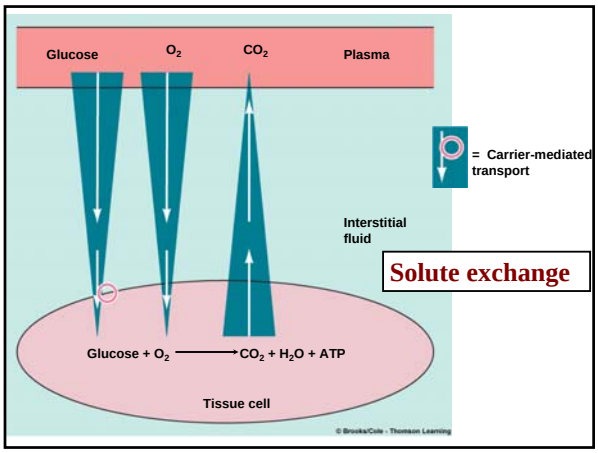


Transport across capillary wall



Capillary to Tissue Exchange

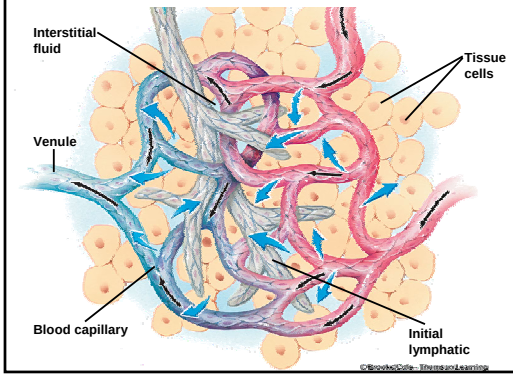




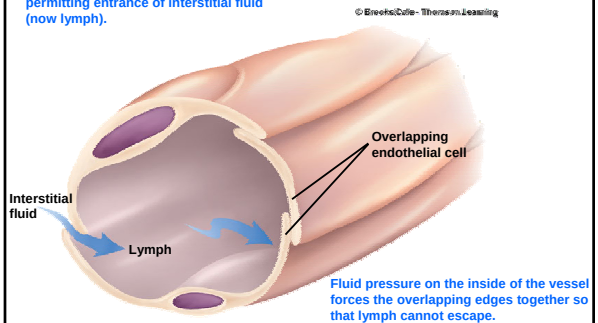
Bulk Flow

1. Capillary blood pressure
2. Plasma-colloid osmotic pressure (proteins)
3. Interstitial fluid hydrostatic pressure
4. Interstitial fluid-colloid osmotic pressure (proteins)

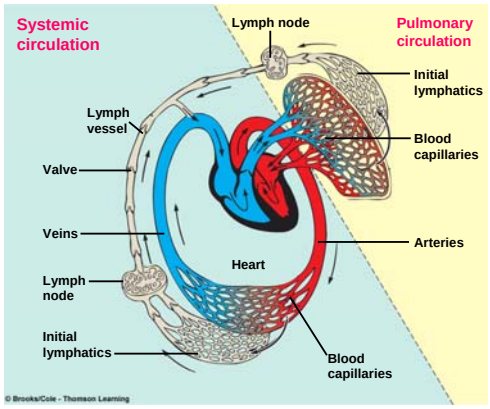
Lymphatic System



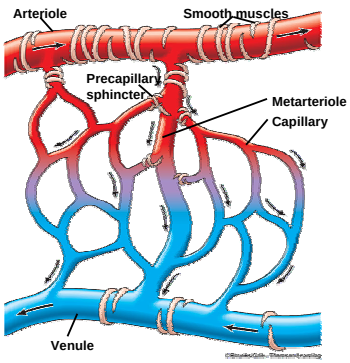
Fluid pressure on the outside of the vessel pushes the endothelial cell's free edge inward, permitting entrance of interstitial fluid (now lymph).



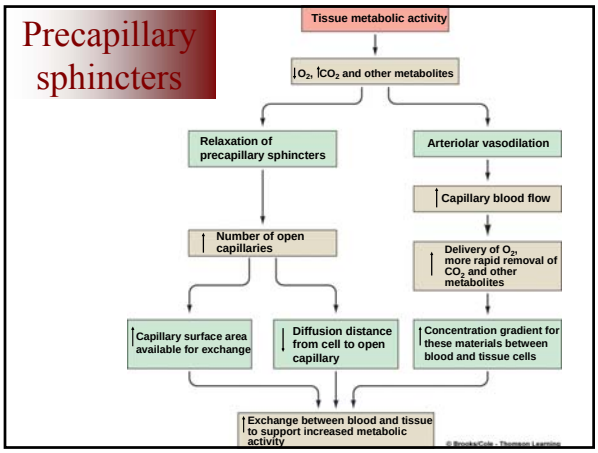
Fluid pressure on the inside of the vessel forces the overlapping edges together so that lymph cannot escape.

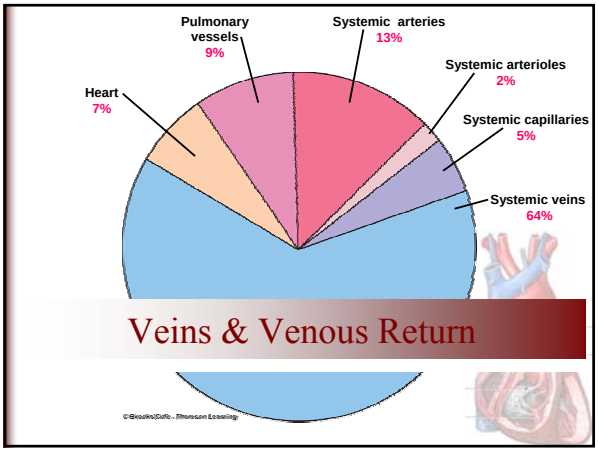


Precapillary sphincters

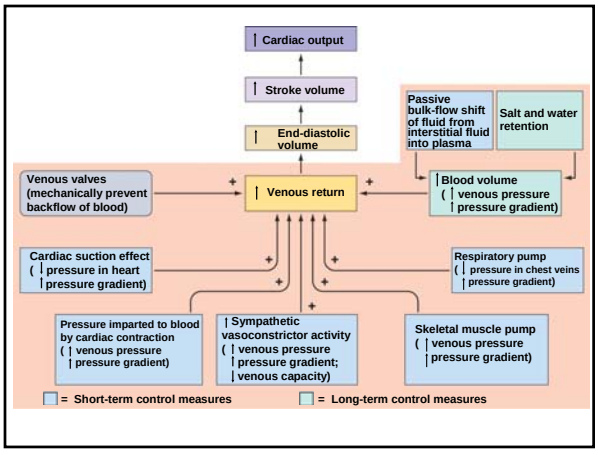


Precapillary sphincters





Veins & Venous Return

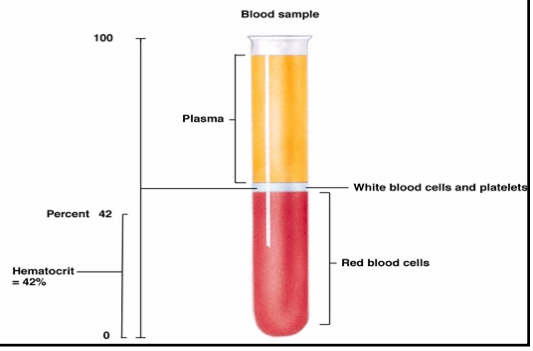


Blood

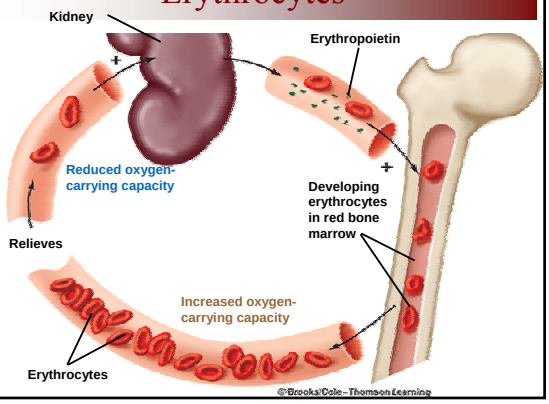
1. Plasma
   - Liquid portion of blood
   - Contains ions, proteins, hormones
2. Cells
   - Red blood cells (Erythrocytes)
     - ✓ Contain hemoglobin to carry oxygen
   - White blood cells (Leukocytes)
   - Platelets
     - ✓ Important in blood clotting

Blood

Is a high or low HEMATOCRIT a problem?



Erythrocytes

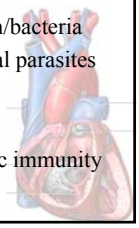


Blood terms associated w/ RBCs

- Hematocrit
  - Percent of blood composed of cells
- Polycythemia
  - Excess production of red blood cells causing an abnormal increase in red blood cells
- Anemia
  - Abnormally low red blood cell count

Leukocytes

- Primary function: ***defense***
- White Blood Cells (WBCs)
- Individual functions:
  1. Neutrophils (~60-70%): follow infection/bacteria
  2. Eosinophils (~1-4%): allergies & internal parasites
  3. Basophils (0.25-0.5%): mast cells
  4. Monocytes (2-6%): macrophages
  5. Lymphocytes (25-33%): provide specific immunity



Platelets