Systemic Circulation

- Arteries
- Arterioles
- Capillaries
- Venules
- Veins

Role is to direct the flow of blood from the heart to the capillaries, and back to the heart.

Exterior (to the heart) circulation

- Aorta
- Arteries
- Arterioles
- Capillaries
- Venules
- Veins
- Pulmonary Arteries
- Pulmonary Trunk
- Pulmonary Veins

Effect of tube radius

Radius of A ($R_A$) = 2
Radius of B ($R_B$) = 1

Flow

$\frac{dP}{dt}$ = $\frac{1}{R_A}$ = 0.0625
$\frac{dP}{dt}$ = $\frac{1}{R_B}$ = 1.0

Therefore $R_B = 16R_A$

Therefore flow in B = 1/16th of flow in A

Pressures in vascular system

The systemic “blood highway”

- Aorta and arteries
- Arterioles
- Capillaries (venules)
- Veins

Blood Vessels

- Venous Circuit
- Arterial Circuit

Fig. 13.25
**Arteries**

- Elastic arteries:
  - Walls of smooth muscle and elastin.
  - Expand when the pressure of the blood rises.
  - Acts as recoil system when ventricles relax.
- Muscular arteries:
  - Are less elastic and have a thicker layer of smooth muscle.

**Arteries**

- Arterioles:
  - Contain highest % smooth muscle.
  - Greatest pressure drop.
  - Greatest resistance to flow.

**Aterial Blood Pressure and associate definitions.**

- **Compliance** - how easily a structure is stretched.
  - Compliance = Δ volume/Δ pressure
- **Systolic pressure (SP)** - maximum arterial pressure reached during peak ventricular contraction.
- **Diastolic pressure (DP)** - minimum arterial pressure occurring just before ventricular ejection begins.
- **Pulse Pressure** = SP - DP.
- **Mean Arterial Pressure (MAP)** = DP + 1/3 (pulse pressure)

**Factors determining magnitude of the pulse pressure**

- Stroke volume.
- Speed of ejection of stroke volume.
- Arterial compliance.

**Movement of blood/cardiac cycle**

- **Entry from heart**
- **Arteries**
- **Exit via arterioles**

**Arterial pressure**

- Systolic pressure
- Diastolic pressure
- Mean pressure
- Age (years)
- Time

Figure Not in book
**Aterioles**

- In individual organs - responsible for determining relative blood flow to those organs.
- Major factor in determining mean arterial pressure.
- Controlled by
  - Local controls
  - Extrinsic controls.

**Importance of Arterioles to Blood Flow.**

- Differences in flow between organs depends on relative resistances of arterioles in those organs.
- Vasodilation vs. vasoconstriction.

**Capillaries**

- Smallest blood vessels.
- 1 endothelial cell thick.
- Provide direct access to cells.
- Permits exchange of nutrients and wastes.
**Capillaries:**

**Important Points**

- Movement across capillaries
  - Diffusion
  - Vesicle transport
  - Bulk flow
  - Mediated transport (in brain capillaries).

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**Movement of fluid across capillary wall**

- Difference between capillary blood hydrostatic pressure and interstitial-fluid hydrostatic pressure favors filtration out of the capillary.
- Water-concentration difference between plasma and interstitial fluid, which results from differences in protein concentration, favors filtration of interstitial fluid into the capillary.
**Veins**

- **Venules:**
  - Formed when capillaries unite.
  - Very porous.
- **Veins:**
  - Little smooth muscle or elastin.
  - Capacitance vessels (blood reservoirs).
  - Contain 1-way valves ensure blood flow to the heart.

**Skeletal Muscle Pump**

- The rate of venous return is dependent in part on the action of skeletal muscle pumps.
- Skeletal muscles contract, forcing blood out of the veins toward heart.

**Atherosclerosis**

- Most common form of arteriosclerosis (hardening of the arteries).
- Mechanism of plaque production:
  - Begins as a result of damage to endothelial cell wall.
  - Cytokines are secreted by platelets, macrophages and lymphocytes.
  - Attract more monocytes and lymphocytes.
Atherosclerosis

- Macrophages engulf lipids and transform into foamy cells.
- Smooth muscle cells synthesize connective tissue proteins.
- Smooth muscle cells migrate to tunica interna and proliferate forming fibrous plaques.

Cholesterol and Plasma Lipoproteins

- Lipids are carried in the blood attached to protein carriers.
- Cholesterol is carried to the arteries by LDLs (low-density lipoproteins).
  - LDLs are produced in the liver.
- Cells in various organs contain receptors for proteins in LDL.
  - The cell engulfs the LDL and oxidizes it.

Ischemic Heart Disease

- Ischemic:
  - Oxygen supply is deficient.
  - Most common cause is atherosclerosis of coronary arteries.
  - Increased concentrations of lactic acid.
- Referred pain:
  - Substernal pain.
- MI:
  - Myocardial infarction (heart attack).
  - Increased plasma CPK and LDH.

Arrhythmias Detected on ECG

- Arrhythmias:
  - Abnormal heart rhythms.
- Flutter:
  - Extremely rapid rates of excitation and contraction of atria or ventricles.
- Fibrillation:
  - Contraction of different groups of myocardial cells occur at different times.
  - Coordination of pumping impossible.
Arrhythmias Detected on ECG

- First-degree AV nodal block:
  - Rate of impulse conduction through AV node exceeds 0.2 sec.
- Second-degree AV nodal block:
  - AV node is damaged so that only 1 out of 2 – 3 atrial AP can pass to the ventricles.
- Third-degree (complete) AV nodal block:
  - None of the atrial waves can pass through the AV node.
  - Ventricles paced by ectopic pacemaker.

Lymphatic System

- 3 basic functions:
  - Transports interstitial (tissue) fluid back to the blood.
  - Transports absorbed fat from small intestine to the blood.
  - Help provide immunological defenses against pathogens.