

## 12.1 COMPONENTS OF THE CIRCULATORY SYSTEM

### A. major components of cardiovascular system

#### 1. blood (circulating elements)

- a. **formed elements:** cells and cell fragments
- b. **erythrocytes:** red blood cells; 99% of blood cells
- c. **leukocytes:** white blood cells; fight infection and cancer
- d. **platelets:** function in clotting
- e. **plasma:** liquid portion of blood that contains dissolved nutrients, ions, wastes, gases, and other substances
- f. average volume: 5.5 L

#### 2. heart (pump)

- a. two chambers: upper (atrium) and lower (ventricle)
- b. **atria:** chambers through which blood flows from veins to ventricles
  - atrial contraction adds to ventricular filling but is not essential for it
- c. **ventricles:** chambers whose contractions produce the pressures that drive blood through the pulmonary and systematic vascular systems and back to the heart
- d. **pulmonary circulation:** right ventricle → lungs → left atrium
  - blood leaves via **pulmonary trunk**
  - divides into 2 pulmonary arteries; one for each lung
  - leaves lungs via pulmonary veins
- e. **systematic circulation:** left ventricle → aorta → all organs and tissues in body → right atrium
  - closed system
  - inferior vena cava, superior vena cava
  - veins converge in IVC and SVC

#### 3. vascular system (blood vessels- conduits)

- a. **bulk flow:** rapid flow of blood throughout the body; produced by pressures created by the pumping action of the heart
- b. **arteries:** vessels carrying blood away from heart ; low resistance tubes
- c. **veins:** carrying blood from organs/tissues back to heart
- d. **arterioles:** smallest arteries; responsible for the pattern of blood-flow distribution to the various organs; participate in the regulation of arterial blood pressure
- e. **capillaries:** very small vessels; major sites of nutrient, metabolic end product, and fluid exchange between blood and tissues
- f. **venules:** made up of capillaries;
- g. **veins:** made up of venules in systematic circulation
- h. **inferior vena cava:** collects blood from below the heart
- i. **superior vena cava:** collects blood from above the heart
  - both return blood to right atrium

### B. components of a closed circulatory system: characteristics of vessel types

1. hearts (pump) through left ventricle
  - a. 120/0 mm Hg - pressure varies
2. aorta and large arteries
  - a. high elasticity - pressure reservoir
  - b. 120/80 mm Hg - pressure never goes to 0 - would be dead
3. arterioles:
  - a. thick smooth muscle layer, high sympathetic NS innervations; regulation of blood flow/pressure
4. capillaries: single cells layer
  - a. exchange vessels; waste products/CO<sub>2</sub> picked up
  - b. will go next to either:
    - interstitial fluid
      - cells → lymphatic vessels → veins
    - veins
5. veins: high compliance; volume reservoir

## 12.2: PRESSURE, FLOW, RESISTANCE

### A. hemodynamics

1. includes blood pressure (P), blood flow (F), and the resistance to blood flow(R)

### B. blood flow

1. always from a region of higher pressure to lower pressure
2. blood flow = difference in pressure / resistance
3. proportional to the PRESSURE gradient between 2 points
  - a.  $F = P/R$  ;  $p_1 = 100$  mmHg and  $p_2 = 10$ mmHg  
then pressure is 90 mmHg
4. inversely proportional to the resistance

### C. blood pressure

1. **hydrostatic pressure:** pressure exerted by any fluid
2. force exerted by blood; generated in the blood by the contraction of the heart
3. not the absolute pressure at any point in the cardiovascular system that determines the flow rate - rather the difference in pressure between the relevant points

### D. resistance

1. how difficult it is for blood to flow between 2 points at any given pressure difference ; measure of friction the impedes flow
2. cannot be measured directly
3. **viscosity:** function of the friction between molecules of a flowing fluid
  - a. greater friction, greater viscosity
  - b. increases as hematocrit increases
4. also effected by length and radius of tube (most important)
5. more resistance, more viscosity, more vessel length, less vessel radius

## 12.3: ANATOMY

### A. overview

1. layers around the heart:

- a. **pericardium**: protective fibrous sac around heart
  - space filled with watery fluid- lubricant ---
- b. **epicardium**: fibrous layer on the heart
- 2. **myocardium**: wall of the heart; composed primarily of cardiac muscle cells
- 3. **endothelial cells/endothelium**: lines the inner surface of cardiac chambers and blood vessels
- 4. **interventricular septum**: separates 2 ventricles
- 5. **atrioventricular valves (AV)**: located between atrium and ventricle
  - a. **tricuspid valve**: right AV
  - b. **bicuspid valve**: left AV; aka mitral valve
  - c. heart valves open and close passively by chamber pressure gradient:
    - function is to prevent backflow; securing unidirectional flow
    - results in pressure differences across the valves; when pressure in ventricle is greater than that in atrium: valve closes
- 6. **pulmonary semilunar valve**: between right ventricle and pulmonary trunk
- 7. **aortic semilunar valve**: between left ventricle and aorta
- \* heart valves
  - offer little resistance to flow, so very small pressure differences across them suffice to produce large flows

#### B. summary of circulatory plan

Left atrium → left AV valve → left ventricle → aortic valve → aorta → arteries  
 → arterioles → capillaries → venules → veins → venae cavae → right atrium → right AV valve  
 → right ventricle → pulmonary valve → pulmonary trunk → pulmonary arteries → capillaries  
 of lungs → pulmonary veins → left atrium ....

#### C. cardiac muscle

##### 1. conducting system

- a. 1% do not function in contraction - specialized features that are essential for normal heart excitation
- b. cells are in electrical contact with the cardiac muscles via gap junctions
- c. initiates heartbeat and helps spread an action potential rapidly throughout the heart

##### 2. Innervation

- a. effects of ANS on heart function
  - parasympathetic 'rest or digest'
    - . vagus nerve: acetylcholine
    - .atria - muscarinic-type ACh receptors
    - . Reduces heart rate, blood pressure, respiration, Activates intestinal activity, contractility, conduction rate
  - sympathetic 'fight or flight'
    - .thoracic spinal nerves: norepinephrine