

- Lecture 37

## **Introduction to Circulation**

- **BY DR QAZI IMTIAZ RASOOL**

- OBJECTIVES
- Functions of the Heart
- Generating blood pressure
- Routing blood: separates pulmonary and systemic circulations
- Ensuring one-way blood flow: valves
- Regulating blood supply
  - 1.Changes in contraction rate and force match blood delivery to changing metabolic needs
- Circulatory System Function

Move circulatory fluid (blood) around body

  - Gas Transport
  - Nutrient Transport
  - Excretory Product Transport

- Cell Signal Transport
- Distribute secretions of endocrine glands,
- Production/Synthesis
- Hydraulic Force
- Heat Conductance
- Immunity
- Overview of the Cardiovascular System
- Heart- circulates blood through vessels
- Vascular System /Blood vessels
  - . Arteries- away from heart
  - . Veins- towards heart
  - . Capillaries- location of internal respiration, are tiny, thin-walled blood vessels that connect arteries to veins and are located in all body tissues.
    - in diameter that blood cells pass through in a single file.

### 3. Blood- transport medium

- Path of Blood

#### Pulmonary Circuit

Blood flow between the lungs and heart

Supplied by the *Right* side of the heart

#### Systemic Circuit

Blood flow between the rest of the body and heart

Supplied by the *Left* side of the heart

- Venous return

is aided by both structural modifications and functional adaptations.

#### 1. Structural

- Large lumen

- Valves - present mostly in extremities,  
none in ventral body cavity

## 2. Functional

- Respiratory Pump
- Muscular Pump
- Smooth muscle layer under sympathetic control

- **Systemic Blood Pressure**

- **Functional Anatomy of the Heart**

### Chambers

- 4 chambers
  - 2 Atria
  - 2 Ventricles
- 2 systems
  - Pulmonary
  - Systemic

- **Functional Anatomy of the Heart**

### Cardiac Muscle

- Characteristics
  - Striated
  - Short branched cells
  - Uninucleate
  - Intercalated discs
  - T-tubules larger and over z-discs
- **Functional Anatomy of the Heart**
  - Valves
    - Function is to prevent backflow
      - Atrioventricular Valves
        - Prevent backflow to the atria
        - Prolapse is prevented by the chordae tendinae
          - Tensioned by the papillary muscles
      - Semilunar Valves
        - Prevent backflow into ventricles

- # The Conduction System of the Heart

- ## Conduction pathways

- Depolarization spreads throughout the heart very rapidly facilitating a coordinated contraction pattern
- Intercalated disks
  - Form junctions between adjacent cardiac muscle fibers
  - Contain a high concentration of *gap junctions* for rapid transmission of the action potential

- ## Myocardial Physiology

- ### Contractile Cells

- Plateau phase prevents summation due to the elongated refractory period
- No summation capacity = no tetanus (Which would be fatal)

- **Myocardial Physiology**

Autorhythmic Cells (Pacemaker Cells)

- **Altering Activity of Pacemaker Cells**

- **Sympathetic activity**

- NE and E increase  $I_f$  channel activity
  - Binds to  $\beta_1$  adrenergic receptors which activate cAMP and increase  $I_f$  channel open time
  - Causes more rapid pacemaker potential and faster rate of action potentials

- **Myocardial Physiology**

Autorhythmic Cells (Pacemaker Cells)

- **Altering Activity of Pacemaker Cells**

- **Parasympathetic activity**

- ACh binds to muscarinic receptors
  - Increases  $K^+$  permeability and decreases  $Ca^{2+}$  permeability = hyperpolarizing the membrane
    - Longer time to threshold = slower rate of action potentials

- **Aging and the CVS**

Changes occur in the blood, heart, and  
BVs

- Blood changes — HCT; thrombi and emboli form more easily; blood pools in leg
- Heart changes — efficiency and elasticity; atherosclerosis of coronary vessels; scar tissue forms
- Blood vessel changes — loss of elasticity; calcium deposits damage vessel walls
- Gradual changes in heart function, minor under resting condition, more significant during exercise
- Hypertrophy of L ventricle
- Maximum heart rate decreases
- tendency for valves to function abnormally and arrhythmias to occur



- $O_2$  consumption required to pump same amount of blood