

## THE CIRCULATORY SYSTEM

The Circulatory System is composed of two systems:

- ✓ The Cardiovascular system:
  - Composed of the heart, blood vessels and blood
- ✓ The Lymphatic system
  - Composed of lymphatic ducts, lymphatic vessels, lymph

### The Cardiovascular System:

#### Heart Anatomy

- Approximately the size of a fist
- Location
  - In the mediastinum between second rib and fifth intercostal space
  - On the superior surface of diaphragm
  - Two-thirds to the left of the midsternal line
  - Anterior to the vertebral column, posterior to the sternum
- Enclosed in pericardium, a double-walled sac

#### Pericardium

- Superficial fibrous pericardium
  - Protects, anchors, and prevents overfilling

#### Pericardium

- Deep two-layered serous pericardium
  - Parietal layer lines the internal surface of the fibrous pericardium
  - Visceral layer (epicardium) on external surface of the heart
  - Separated by fluid-filled pericardial cavity (decreases friction)

#### Layers of the Heart Wall

1. Epicardium—visceral layer of the serous pericardium

#### Layers of the Heart Wall

2. Myocardium

- Spiral bundles of cardiac muscle cells
- Fibrous skeleton of the heart: crisscrossing, interlacing layer of connective tissue
  - Anchors cardiac muscle fibers
  - Supports great vessels and valves

- Limits spread of action potentials to specific paths

## **Layers of the Heart Wall**

3. Endocardium is continuous with endothelial lining of blood vessels

## **Chambers**

- Four chambers
  - Two atria
    - Separated internally by the interatrial septum
    - Coronary sulcus (atrioventricular groove) encircles the junction of the atria and ventricles
  - Auricles increase atrial volume

## **Chambers**

- Two ventricles
  - Separated by the interventricular septum
  - Anterior and posterior interventricular sulci mark the position of the septum externally

## **Atria: The Receiving Chambers**

- Walls are ridged by pectinate muscles
- Vessels entering right atrium
  - Superior vena cava
  - Inferior vena cava
  - Coronary sinus
- Vessels entering left atrium
  - Right and left pulmonary veins

## **Ventricles: The Discharging Chambers**

- Walls are ridged by trabeculae carneae
- Papillary muscles project into the ventricular cavities
- Vessel leaving the right ventricle
  - Pulmonary trunk
- Vessel leaving the left ventricle
  - Aorta

## **Pathway of Blood Through the Heart**

- The heart is two side-by-side pumps
  - Right side is the pump for the pulmonary circuit

- Vessels that carry blood to and from the lungs
- Left side is the pump for the systemic circuit
- Vessels that carry the blood to and from all body tissues

### **Pathway of Blood Through the Heart**

- Right atrium → tricuspid valve → right ventricle
- Right ventricle → pulmonary semilunar valve → pulmonary trunk → pulmonary arteries → lungs

### **Pathway of Blood Through the Heart**

- Lungs → pulmonary veins → left atrium
- Left atrium → bicuspid valve → left ventricle
- Left ventricle → aortic semilunar valve → aorta
- Aorta → systemic circulation

### **Pathway of Blood Through the Heart**

- Equal volumes of blood are pumped to the pulmonary and systemic circuits
- Pulmonary circuit is a short, low-pressure circulation
- Systemic circuit blood encounters much resistance in the long pathways
- Anatomy of the ventricles reflects these differences

Pulmonary circulation:

- ✓ The blood vessels that carry blood to and from the lungs form the pulmonary circuit.
- ✓ This serves gaseous exchange
- ✓ The right side of the heart is the pulmonary circuit pump
- ✓

Systemic circulation:

- ✓ The blood vessels that carry the functional blood supply to and from all body tissues constitute the systemic circuit.
- ✓ The left side of the heart is the systemic circuit pump

### **Coronary Circulation**

- The functional blood supply to the heart muscle itself
- Arterial supply varies considerably and contains many anastomoses (junctions) among branches

- Collateral routes provide additional routes for blood delivery

### **Coronary Circulation**

- Arteries
  - Right and left coronary (in atrioventricular groove), marginal, circumflex, and anterior interventricular arteries
- Veins
  - Small cardiac, anterior cardiac, and great cardiac veins
  - Areas of cell death are repaired with noncontractile scar tissue

### **Heart Valves**

- Ensure unidirectional blood flow through the heart
- Atrioventricular (AV) valves
  - Prevent backflow into the atria when ventricles contract
  - Tricuspid valve (right)
  - Mitral valve (left)
- Chordae tendineae anchor AV valve cusps to papillary muscles

### **Heart Valves**

- Semilunar (SL) valves
  - Prevent backflow into the ventricles when ventricles relax
  - Aortic semilunar valve
  - Pulmonary semilunar valve

### **Microscopic Anatomy of Cardiac Muscle**

- Cardiac muscle cells are striated, short, fat, branched, and interconnected
- Connective tissue matrix (endomysium) connects to the fibrous skeleton
- T tubules are wide but less numerous; SR is simpler than in skeletal muscle
- Numerous large mitochondria (25–35% of cell volume)

### **Microscopic Anatomy of Cardiac Muscle**

- Intercalated discs: junctions between cells anchor cardiac cells
  - Desmosomes prevent cells from separating during contraction
  - Gap junctions allow ions to pass; electrically couple adjacent cells
- Heart muscle behaves as a functional syncytium

### **Conducting System of the Heart**

- Intrinsic cardiac conduction system
  - A network of noncontractile (autorhythmic) cells that initiate and distribute impulses to coordinate the depolarization and contraction of the heart

1. Sinoatrial (SA) node (pacemaker)

2. Atrioventricular (AV) node

3. Atrioventricular (AV) bundle (bundle of His)

- Only electrical connection between the atria and ventricles

4. Right and left bundle branches

- Two pathways in the interventricular septum that carry the impulses toward the apex of the heart

### **Heart Physiology: Sequence of Excitation**

5. Purkinje fibers

- Complete the pathway into the apex and ventricular walls

For all of the following:

- ✓ Arterial branches of Ascending Aorta and Aorta arch
- ✓ Arterial pathways that supply upper extremity and lower extremity
- ✓ Major arteries serving the thorax, abdomen
- ✓ Venous drainage of thorax, lower extremities and abdominal region

See pages 722 – 743 of the class text: Human Anatomy & Physiology 8<sup>th</sup> edition by Marieb and Hoehn