THE CARDIOVASCULAR SYSTEM

Part 1
CARDIOVASCULAR SYSTEM

- Blood
- Heart
- Blood vessels

- What is the function of this system?
- What other systems does it affect?
CARDIOVASCULAR SYSTEM

- **Functions**
  - Transport gases, wastes, food, hormones, blood cells

- **Systems affected**
  - Respiratory
  - Urinary
  - Digestive
  - Musculoskeletal
  - Immune system
THE HEART

- Four separate chambers in humans
- Double pump → two closed circuits
- 5 L/minute
Two Complete and Separate Circuits

Pulmonary Circuit
Blood flows through lungs for gas exchange

Systemic Circuit
Blood flows to organs to deliver oxygenated blood and carries deoxygenated blood back to heart.

Lungs

Pump

Blood vessels, organs and tissues
Figure 18.5

- Oxygen-rich, CO₂-poor blood
- Oxygen-poor, CO₂-rich blood

Capillary beds of lungs where gas exchange occurs
Capillary beds of all body tissues where gas exchange occurs

Pulmonary Circuit
- Pulmonary arteries
- Venae cavae
- Right atrium
- Right ventricle
- Pulmonary veins
- Aorta and branches
- Left atrium
- Left ventricle

Systemic Circuit
- Heart
Located within mediastinum

- Midsternal line
- 2nd rib
- Diaphragm
- Sternum
- Point of maximal intensity (PMI)
- Membrane surrounding and protecting the heart
  - Confines while still allowing free movement
PERICARDIUM

- Double walled organ
  - Fibrous pericardium
    - Fibrous connective tissue
    - Prevents overstretching, protection, anchorage
  - Serous pericardium
    - Serous epithelium
    - Double layer
      - Parietal layer fused to fibrous pericardium
      - Visceral layer also called epicardium
- Pericardial cavity
  - Between visceral and parietal serous pericardium
  - Scant amount of serous fluid
- Pericarditis
Figure 18.2

Fibrous pericardium
Parietal layer of serous pericardium
Pericardial cavity
Epicardium (visceral layer of serous pericardium)

Heart wall
Myocardium
Endocardium
Heart chamber

Pericardium
Myocardium
Pulmonary trunk
Three layers
- Epicardium
  - Also called the ...
- Myocardium
- Endocardium
Figure 18.2

- Fibrous pericardium
- Parietal layer of serous pericardium
- Pericardial cavity
- Epicardium (visceral layer of serous pericardium)
- Myocardium
- Endocardium
- Heart chamber

Pericardium

Myocardium

Pulmonary trunk
Epicardium
MUSCULAR WALL OF THE HEART

- Myocardium
  - Muscle and connective tissue
  - Bulk of heart
Myocardium

Cardiac muscle bundles
MUSCULAR WALL OF THE HEART

- Endocardium
  - Endocarditis
Chambers

- Right Atrium
- Left Atrium
- Left Ventricle
- Right Ventricle
**ANATOMY OF THE HEART**

- **Chambers**
  - Right and left atria
    - Separated by interatrial septum
    - Coronary sulcus (atrioventricular groove) encircles the junction of the atria and ventricles
    - Auricles increase atrial volume
ANATOMY OF THE HEART

- Chambers
  - Right and left ventricles
    - Separated by interventricular septum
Schematic of Heart Anatomy

- In pipes = veins
- Out pipes = arteries
- Heart has 4 chambers – 2 atria & 2 ventricles
Major Vessels of the Heart

- Brachiocephalic trunk
- Superior vena cava
- Right pulmonary artery
- Ascending aorta
- Pulmonary trunk
- Right pulmonary veins
- Right atrium
  - Right coronary artery (in coronary sulcus)
  - Anterior cardiac vein
- Right ventricle
  - Right marginal artery
  - Small cardiac vein
- Inferior vena cava

- Left common carotid artery
- Left subclavian artery
- Aortic arch
- Ligamentum arteriosum
- Left pulmonary artery
- Left pulmonary veins
- Auricle of left atrium
- Circumflex artery
- Left coronary artery (in coronary sulcus)
- Left ventricle
  - Great cardiac vein
  - Anterior interventricular artery (in anterior interventricular sulcus)
- Apex

(b) Anterior view
ATRIA
THE RECEIVING CHAMBERS

- **Vessels entering right atrium**
  - Superior vena cava
  - Inferior vena cava
  - Coronary arteries and veins

- **Vessels entering left atrium**
  - Right and left pulmonary veins
Superior vena cava
Right pulmonary artery
Pulmonary trunk
Right atrium
Right pulmonary veins
Fossa ovalis
Pectinate muscles
Tricuspid valve
Right ventricle
Chordae tendineae
Trabeculae carneae
Inferior vena cava

Aorta
Left pulmonary artery
Left atrium
Left pulmonary veins
Mitral (bicuspid) valve
Aortic valve
Pulmonary valve
Left ventricle
Papillary muscle
Interventricular septum
Epicardium
Myocardium
Endocardium

(e) Frontal section

Figure 18.4e
VENTRICLES
THE DISCHARGING CHAMBERS

- Vessel leaving the right ventricle
  - Pulmonary trunk
- Vessel leaving the left ventricle
  - Aorta
Figure 18.4e

(e) Frontal section

- Aorta
- Left pulmonary artery
- Left atrium
- Left pulmonary veins
- Mitral (bicuspid) valve
- Aortic valve
- Pulmonary valve
- Right atrium
- Right pulmonary veins
- Fossa ovalis
- Pectinate muscles
- Tricuspid valve
- Right ventricle
- Chordae tendineae
- Trabeculae carneae
- Inferior vena cava
- Superior vena cava
- Right pulmonary artery
- Pulmonary trunk
- Epicardium
- Myocardium
- Endocardium
HEART VALVES

- Atrioventricular (AV) valves
  - Prevent backflow into the atria when ventricles contract
  - Chordae tendineae anchor AV valve cusps to papillary muscles

- Semilunar valves
  - Prevent backflow into the ventricles when ventricles relax

Unidirectional blood flow through the heart
Chordae tendineae attached to tricuspid valve flap (c)
HEART VALVES

- **Atrioventricular**
  - Separate atria from ventricles
    - Tricuspid
      - Right side
    - Bicuspid (mitral)
      - Left side

- **Semilunar**
  - Separate ventricles from great arteries
    - Pulmonary semilunar
    - Aortic semilunar
The heart is two side-by-side pumps

- Right side = pulmonary circuit
  - Vessels that carry blood to and from the lungs
- Left side = systemic circuit
  - Vessels that carry the blood to and from all body tissues
PATHWAY OF BLOOD THROUGH THE HEART

right atrium (via vena cava) → tricuspid valve → right ventricle → pulmonary semilunar valve → pulmonary trunk → pulmonary arteries → lungs → pulmonary veins → left atrium → bicuspid valve → left ventricle → aortic semilunar valve → aorta → systemic circulation
1. Blood returning to the heart fills atria, putting pressure against atrioventricular valves; atrioventricular valves are forced open.

2. As ventricles fill, atrioventricular valve flaps hang limply into ventricles.

3. Atria contract, forcing additional blood into ventricles.

(a) AV valves open; atrial pressure greater than ventricular pressure

1. Ventricles contract, forcing blood against atrioventricular valve cusps.

2. Atrioventricular valves close.

3. Papillary muscles contract and chordae tendineae tighten, preventing valve flaps from everting into atria.

(b) AV valves closed; atrial pressure less than ventricular pressure
As ventricles contract and intraventricular pressure rises, blood is pushed up against semilunar valves, forcing them open.

(a) Semilunar valves open

As ventricles relax and intraventricular pressure falls, blood flows back from arteries, filling the cusps of semilunar valves and forcing them to close.

(b) Semilunar valves closed
HEART SOUNDS

- "lub-dup"

First heart sound, "lub", occurs when atrioventricular valves close.

Second heart sound, "dup", occurs when semilunar valves close.
Oxygen-rich, $CO_2$-poor blood

Oxygen-poor, $CO_2$-rich blood

Capillary beds of lungs where gas exchange occurs

Capillary beds of all body tissues where gas exchange occurs

Pulmonary arteries

Venae cavae

Right atrium

Right ventricle

Pulmonary veins

Aorta and branches

Left atrium

Left ventricle

Pulmonary Circuit

Systemic Circuit

Heart
The functional blood supply to the heart muscle

Arteries
- Right and left coronary arteries
- Branch off base of the aorta
- Extensive branching throughout epicardium → anastomoses
  - Collateral circulation

Cardiac veins feed into coronary sinus
(a) The major coronary arteries
Coronary sinus drains into right atrium

(b) The major cardiac veins

- Superior vena cava
- Anterior cardiac veins
- Great cardiac vein
- Coronary sinus
- Small cardiac vein
- Middle cardiac vein
Benefits of anastomoses
Heart attacks in young versus older patients
"Yes! That was very loud Sir, but I said I wanted to hear your HEART!"