The Cardiovascular System

Part 1

Cardiovascular System

- Blood
- Heart
- Blood vessels

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
  - Also other mammals, birds
- Double pump \(\rightarrow\) two closed circuits
- 5 L/minute

The Heart

- Symmetrical in design, but not in position
  - 2/3 of mass to the left of midline
  - 1/3 to right
Located within mediastinum

- Midsternal line
- 2nd rib
- Diaphragm
- Point of maximal intensity (PMI)

(a)

Pericardium

- Membrane surrounding and protecting the heart
  - Confines while still allowing free movement

Pericardium

- Double walled organ
  - Fibrous pericardium
  - Serous pericardium

Pericardium

- Double walled organ
  - Fibrous pericardium
  - Serous pericardium
  - Serous epithelium
  - Double layer
    - Parietal layer
      - Epithelial cells
      - Secrete serous fluid (thin mucus)
      - Fused to fibrous pericardium
    - Visceral layer (epicardium)
      - Thin connective tissue
      - Forms surface of heart

(c)
Pericardium

- Pericardial cavity
  - Between visceral and parietal serous pericardium
  - Scant amount of serous fluid – accumulation may cause...
- Pericarditis
  - Inflammation of pericardium
  - Sharp, stabbing chest pain
  - May be caused by viral infection, heart attack
  - Begins suddenly but resolves quickly

Muscular Wall of the Heart

- Three layers
  - Epicardium
    - Also called the...
  - Myocardium
  - Endocardium

Muscular wall of the heart

- Epicardium
  - Serous membrane
  - Typically infiltrated with fat in the elderly
Muscular wall of the heart

- **Myocardium**
  - Primarily cardiac muscle
  - Bulk of heart
  - Variable thickness
  - Ventricles thicker than atria
  - Left ventricle thicker than right
  - Inner surface raised into finger-like projections
  - Papillary muscles

Muscular wall of the heart

- **Myocardium**
  - Branching cardiac muscle cells
  - Connected to one another by crisscrossing connective tissue fibers
  - Non-excitile – limits the spread of action potentials to specific pathways in the heart
  - Arranged in spiral or circular bundles
  - Bundles interlace and effectively link all parts of the heart together

Myocardium

- **Cardiac muscle bundles**

Muscular wall of the heart

- **Endocardium**
  - Squamous epithelium
  - Smooth, white
  - Continuous with endothelial linings of large blood vessels entering/exiting the heart

Muscular wall of the heart

- **Endocardium**
  - Endocarditis – inflammation of the endocardium
  - Common in IV drug users
  - Leads to valve damage, emboli

Anatomy of the Heart

- **Chambers**
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
  - Blood vessels that supply the myocardium rest inside
  - Auricles
    - Atrial appendages
    - Increase atrial volume

- Right and left ventricles
  - Separated by interventricular septum

Interventricular septum

Right ventricle

Left ventricle

Major Vessels of the Heart

- Numerous blood vessels are associated with the heart...
Atria
The Receiving Chambers

- Vessels entering right atrium
  - Superior vena cava
  - Inferior vena cava
  - Coronary sinus
- Vessels entering left atrium
  - Right and left pulmonary veins
Ventrils
The Discharging Chambers

- Vessel leaving the right ventricle
  - Pulmonary trunk → right and left pulmonary arteries
- Vessel leaving the left ventricle
  - Aorta

**Figure 18.4b**
(b) Anterior view

**Major Vessels of the Heart – Exiting Right Ventricle**

Brachiocephalic trunk
Superior vena cava
Right pulmonary artery
Ascending aorta
Pulmonary trunk
Right atrium
Right coronary artery
Arteries of left atrium
Great cardiac vein
Great cardiac vein
Interventricular septum
Apex

**Major Vessels of the Heart – Exiting Left Ventricle**

Brachiocephalic trunk
Superior vena cava
Right pulmonary artery
Ascending aorta
Pulmonary trunk
Right atrium
Right coronary artery
Arteries of left atrium
Great cardiac vein
Great cardiac vein
Interventricular septum
Apex
Coronary Arteries

- Supply blood to the heart wall itself

Heart Valves

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

*Unidirectional blood flow through the heart*
Cardiac Circulation

- The heart is two side-by-side pumps
  - Right side = pulmonary circuit
  - Left side = systemic circuit
  - Vessels that carry the blood to and from all body tissues

Pathway of Blood Through the Heart

1. Blood returning to the heart fills atria, putting pressure against atrioventricular valves, which are forced open.
2. As ventricles contract, blood flows against atrioventricular valve cusps.
3. As ventricles relax and intraventricular pressure falls, blood flows back from arteries, filling the cusps of semilunar valves and forcing them to close.

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

- Right atrium (via vena cava)
- Tricuspid valve
- Pulmonary veins
- Pulmonary veins
- Aorta and branches
- Left atrium
- Right ventricle
- Pulmonary semilunar valve
- Pulmonary trunk
- Pulmonary arteries
- Lungs
  - Pulmonary veins
  - Aorta
  - Pulmonary trunk
  - Left atrium
  - Right ventricle
  - Bicupid valve
  - Systemic circulation
Heart Sounds

• “lub-dup”

  First heart sound, “lub”, occurs when atrioventricular valves close

  Second heart sound, “dup”, occurs when semilunar valves close

Coronary (Cardiac) Circulation

• Blood from the chambers cannot serve as a functional blood supply to the heart

• Heart muscle has its own blood supply
  – Coronary circulation

Coronary (Cardiac) Circulation

• Arteries
  – Right and left coronary arteries
  – Branch off base of the aorta
  – Extensive branching throughout epicardium
  – Common for branches from right and left coronary arteries to unite
    – Anastomoses

• Cardiac veins feed into coronary sinus directly into right atrium
Collateral Circulation

- Benefits of anastomoses
- Provides additional route of blood flow
- Older heart attack patients are more likely to survive than younger ones
  - Sudden clot formation vs gradual