THE PULMONARY AND SYSTEMIC CIRCUITS

• Two pumps side by side

• “Right Heart”

• “Left Heart”

• Pulmonary Circuit

• Systemic Circuit

• 2 receiving chambers (atria)

• 2 pumping chambers (ventricles)
HEART ANATOMY

• Goals

• Describe the size, shape, location, and orientation of the heart in the thorax.

• Name the coverings of the heart.

• Describe the structure and function of each of the three layers of the heart wall.
HEART SIZE, LOCATION, AND ORIENTATION

- Roughly the size of your fist (weighs less than 1 pound)
- Found within the mediastinum
- Rests on the diaphragm
COVERINGS OF THE HEART

- Enclosed in double-walled sac called the pericardium
  - fibrous pericardium
  - Pericardial cavity
  - serous pericardium
    - parietal layer
    - visceral layer (epicardium)
LAYERS OF THE HEART WALL

- Epicardium
- Myocardium
  - contractile layer
  - cardiac skeleton
- Endocardium
  - endothelial sheet
CHECK YOUR UNDERSTANDING

• From inside to outside, list the layers of the heart wall and heart coverings

• What is the purpose of the serous fluid inside the pericardial cavity?
CHAMBERS AND ASSOCIATED GREAT VESSELS

- 4 Chambers
- 2 Atria
- 2 Ventricles
HEART VALVES

- Atrioventricular valves (fig 18.7)
  - Right AV, Left AV
- Semilunar Valves (fig 18.8)
  - Aortic, Semilunar
PATHWAY OF BLOOD THROUGH THE HEART

• Page 669 (Important)
CHECK YOUR UNDERSTANDING

• # 5 and 6 page 671
• Describe the Structural and Functional properties of cardiac muscle. Compare and Contrast these properties with skeletal muscle.

• Briefly describe the events of cardiac muscle cell contraction
MICROSCOPIC ANATOMY

- Cardiac Muscle
  - Short fat interconnected
  - connected to fibrous cardiac skeleton via connective tissue
  - interconnected by intercalated discs
  - 25-35% mitochondria by volume

- Skeletal Muscle
  - Long, cylindrical
  - connected to skeleton via connective tissue
  - functionally and electrically independent
  - 2% mitochondria by volume
MICROSCOPIC ANATOMY
# MECHANISMS AND EVENTS OF CONTRACTION

<table>
<thead>
<tr>
<th>3 Fundamental Differences</th>
<th>Cardiac Muscle</th>
<th>Skeletal Muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Means of Stimulation</strong></td>
<td>Self-Excitable</td>
<td>Each skeletal fiber innervated by a nerve ending</td>
</tr>
<tr>
<td><strong>Organ Versus Motor Unit Contraction</strong></td>
<td>All or none muscle contraction</td>
<td>Impulses do not spread from cell to cell (utilize motor unit contraction)</td>
</tr>
<tr>
<td><strong>Length of Absolute Refractory Period</strong></td>
<td>&gt;200 ms</td>
<td>1-2 ms</td>
</tr>
</tbody>
</table>
CARDIAC ACTION POTENTIAL

- 1% of cardiac fibers are auto rhythmic and display pacemaker potentials.
- The rest of the heart displays an action potential like that to the right.

![Action Potential of Contractile Cardiac Muscle Cells](image_url)
CHECK YOUR UNDERSTANDING

• Page 674
HEART PHYSIOLOGY

• Goals

  • Name the components of the conduction system of the heart, and trace the conduction pathway

  • Name the normal waves and intervals of an ecg tracing
The independent activity of the heart is a product of:

1. Presence of Gap Junctions

2. Activity of internal, non-contractile conduction system
**ACTION POTENTIAL INITIATION BY PACEMAKER CELLS**

- Cardiac Pacemaker cells are autorhythmic.
- Unlike neurons, pacemaker cells have an unstable resting potential.
- These spontaneous potentials are called = Pacemaker Potentials.
1. The sinoatrial (SA) node (pacemaker) generates impulses.

2. The impulses pause (0.1 sec) at the atrioventricular (AV) node.

3. The atrioventricular (AV) bundle connects the atria to the ventricles.

4. The bundle branches conduct the impulses through the interventricular septum.

5. The Purkinje fibers stimulate the contractile cells of both ventricles.
EXTRINSIC INNERVATION OF THE HEART

• Cardioacceleratory center
• Cardioinhibitory center
ELECTROCARDIOGRAPHY

1. Atrial depolarization, initiated by the SA node, causes the P wave.

2. With atrial depolarization complete, the impulse is delayed at the AV node.

3. Ventricular depolarization begins at apex, causing the QRS complex. Atrial repolarization occurs.

4. Ventricular depolarization is complete.

5. Ventricular repolarization begins at apex, causing the T wave.

6. Ventricular repolarization is complete.

Depolarization: Yellow
Repolarization: Red
HEART SOUNDS

• Lub-Dub

• S1 = AV valves close

• S2 = SL valves close
CARDIAC CYCLE

- Figure 18.21
- Cardiac Cycle
  - 1. Ventricular Filling
  - 2. Ventricular Systole
  - 3. Early Diastole
CARDIAC OUTPUT

• Goals

• Name and Explain the effects of various factors regulating stroke volume and HR

• Explain the role of the Autonomic Nervous System in regulating CO
CARDIAC OUTPUT

• Volume of blood pumped out by each ventricle in 1 minute

• $CO = HR \times SV$
REGULATION OF SV

- EDV - ESV = SV. Ex: 120ml - 50ml = 70 ml

- 3 most important regulatory factors
  - preload, contractility, and afterload
**PRELOAD**

- Preload = the degree to which cardiac muscle cells are stretched just before they contract
- Increased preload = Increased SV
- Frank-Starling Law of the Heart
- Length-Tension Relationship (Skeletal vs. Cardiac)
- Influenced by venous return
CONTRACTILITY

- The contractile force achieved at a given muscle length
- Increases when more calcium enters the cytoplasm from the extracellular fluid and SR
- Sympathetic stimulation increases contractility
- Positive inotropic agents = epinephrine, digitalis, glucagon
- Negative inotropic agents = Acidosis, calcium channel blockers
AFTERLOAD

- The pressure that ventricles must overcome to eject blood
- Only a major player in people with HTN
AUTONOMIC NERVOUS SYSTEM REGULATION OF HR

- Most important extrinsic HR control mechanism
- Sympathetic nervous system brings pacemaker cells to threshold more quickly, and increases contractility
- The Heart demonstrates Vagal tone
STUDY GUIDE

• www.aandponline.com

• Physiology Tab

• The Heart

• Study Guides