CHAPTER 12

Electrophysiology of the Heart
Action Potentials

- Polarized or resting state
- Resting membrane potential (RMP)
Fig. 12-1. The polarized state. For each Na$^+$ ion that diffuses into the cell, about 75 K$^+$ ions diffuse out of the cell. The result is a deficiency of positive cations inside the cell; this is a cell with a negative charge.
THE FIVE PHASES
OF THE ACTION
POTENTIAL
• Phase 0: Rapid depolarization
  – Early phase
Fig. 12-2. The action potential and the Na⁺, K⁺, and Ca²⁺ changes during phases 0, 1, 2, 3, and 4.
Repolarization:

- Process of heart cells returning to their resting state
  - Phase 1: Initial repolarization
  - Phase 2: Plateau state
  - Phase 3: Final rapid repolarization
  - Phase 4: Resting or polarized state
Properties of the Cardiac Muscle Composed of Two Cardiac Cells

- Contractile muscle fibers
- Autorhythmic cells
Four Specific Properties

- Automaticity
- Excitability
- Conductivity
- Contractility
Four Specific Properties

• Automaticity
  – Unique ability of the cells in the SA node (pacemaker cells) to generate an action potential without being stimulated.
Action Potential of Pacemaker and Nonpacemaker Myocardial Cells

Fig. 12-3. Schematic representation comparing action potential of pacemaker and nonpacemaker (working) myocardial cells.
Four Specific Properties

• Excitability (irritability)
  – Ability of a cell to reach its threshold potential and respond to a stimulus or irritation
Four Specific Properties

• Conductivity
  – Ability of the heart cells to transmit electrical current from cell to cell throughout the entire conductive system.
• Contractility
  – Ability of cardiac muscle fibers to shorten and contract in response to an electrical stimulus
Refractory Periods

- Absolute refractory period
- Relative refractory period
- Nonrefractory period
Absolute Refractory Period

• Time in which the cells cannot respond to a stimulus
• Phases 0, 1, 2, and about half of 3 represent the absolute refractory period
Relative Refractory Period

- Time in which repolarization is almost complete
- Strong stimulus may cause depolarization of some of the cells
- Second half of phase 3 represents the relative refractory period
Nonrefractory Period

- Occurs when all the cells are in their resting or polarized state
- Phase 4 represents the nonrefractory period
Conductive System of the Heart

Fig. 12-4. Conductive system of the heart.
Cardiac Response to Autonomic Nervous System Changes

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<th>Sympathetic Stimulation</th>
<th>Sympathetic Block</th>
<th>Parasympathetic Stimulation</th>
<th>Parasympathetic Block</th>
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<td>↑ Heart Rate</td>
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Table 12-1