Electrophysiology Review

I. Concepts
- A. Depolarization
  - -heart is stimulated from the electrical system to contract heart muscle
- B. Repolarization
  - -recharging the heart muscle
  - -resting period after contraction
- C. Resting State
  - 1. positive ions outside (sodium)
  - 2. negative ions inside (potassium)

II. Phases of Cardiac Action Potential
- A. Phase 0
  - -depolarization phase
  - -membrane reaches threshold potential
  - -sodium enters cell
  - -cell depolarizes and begins to contract
- B. Phase 1
  - -early repolarization phase
  - -sodium channels close
  - -loss of potassium from cell
  - -decrease in # of positive electrical charges in cell
- C. Phase 2
  - -plateau phase
  - -prolonged phase of repolarization
  - -finishes contracting and begins relaxing
  - -potassium continues to leave the cell and sodium slowly enters
- D. Phase 4
  - -period between action potentials
  - -membrane at resting potential
  - -inside of cell is negative again
  - -still an excess of sodium inside and potassium outside
  - -sodium-potassium pump activated

III. Refractory Periods
- A. Absolute
  - -phases 0, 1, 2, and part of 3
  - -cells have completely depolarized and are in the process of repolarization
  - -myocardial cell will not respond to stimulation no matter how strong the stimulus
- B. Relative
  - -corresponds to downslope of T wave
  - -some cardiac cells have repolarized to threshold potential
  - -can be stimulated to respond (depolarize) by a stronger than normal stimulus
- C. Supernormal Period
  - -after refractory
  - -weaker than normal stimulus can cause depolarization

IV. Ectopic Focus/Ectopic Beat
- -stimulation of cardiac contraction beginning somewhere other than the SA node
- -premature contractions, tachycardias, flutters, fibrillations
- -atrial, junctional, or ventricular in origin

A. Mechanisms Responsible

1. Enhanced Automaticity

-firing rate of pacemaker cells is increased beyond inherent rate
-cell membrane becomes abnormally permeable to sodium (phase 4)
-atrial, junctional, and ventricular ectopic beats
-Causes:
-increase catecholamines
-digitalis toxicity
-atropine
-hypoxia, hypercarbia, hypokalemia, hypocalcemia
-MI
-heating/cooling of heart

2. Reentry

-progression of an electrical impulse is delayed, blocked, or both in one area
-impulse is conducted normally through the rest of the conduction system
-delayed electrical impulse enters the cells that have just been depolarized
-delayed electrical impulse depolarizes cells prematurely
-PSVT, Vtach, premature complexes
-Causes:
MI, hyperkalemia
-if delay is constant, the abnormal beat will always follow the normal one at exactly the same interval of time (bigeminy, coupling)

3. Triggered Activity

-condition of nonpacemaker cells where cells may depolarize more than once after stimulation by a single impulse
-ectopic beats will be single, paired/couplets, or bursts of 3 or more
-Causes:
-catecholamines
-digitalis toxicity
-hypoxia
-MI
-cooling of heart

V. Autonomic Nervous System

A. Sympathetic

-norepinephrine is mediator
-adrenergic effects:
increased firing rate of SA node
increased conductivity of electrical impulses through atria/ventricles
increase in force of contractions

B. Parasympathetic

-acetylcholine is mediator
-cholinergic effects:
slowing of SA node firing rate
slowing of conduction