I. Cardiovascular Physiology

A. Cardiac Cycle

1. Systole – Contraction of Chambers
2. Diastole – Relaxation of Chambers
3. Cardiac Cycle for Resting Heart Rate (HR) 75 beats/min (0.8 sec)
4. Phases of the Cardiac Cycle (Figure 37.1)
   a. Atrial Systole begins
      1) Contributes final 30% of Ventricular Filling
      2) Lasts 0.1 sec
   b. Atrial Systole ends & Atrial Diastole begins
   c. First Phase of Ventricular Systole
      1) Ventricular Contraction pushes blood against AV Valves and closes them
      2) Isovolumetric Contraction – ALL 4 Valves are closed – 50 msec
   d. Second Phase of Ventricular Systole
      1) When Left Ventricular Pressure rises above Aortic Pressure – 80 mm Hg & when right Ventricular Pressure rises above Pulmonary Trunk Pressure – 15-20 mm Hg
         a) Semilunar Valves open
         b) Ventricular Ejection – 250 msec
      2) Ventricular Systole lasts 0.3 sec
e. Early Ventricular Diastole
   1) Dicrotic Notch (Wave) results from Blood trapped in Cusps of Semilunar Valves (Figure 37.2b)
      a) Valves close so blood rebounds
      b) Results from elastic recoil of aorta
   2) Isovolumetric Relaxation – ALL 4 Valves are closed
   3) Blood flows into the relaxed Atria
f. Late Ventricular Diastole
   1) When Ventricular Pressure drops below Atrial Pressure – AV Valves open
   2) Rapid Ventricular Filling – Beginning of filling
   3) Diastasis – Middle of filling time
   4) 70% of Blood Fills Ventricles during Diastole
      a) Due to Gravity and Fluid Pressure
   5) Ventricular Diastole or the Relaxation (Quiescent) Period lasts 0.4 sec (faster heartbeat shortens this period the most)
B. Heart Sounds

1. Auscultation using Stethoscope
   a. Lubb ($S_1$) – AV Valves closing
   b. Dubb ($S_2$) – Semilunar Valves closing
   c. $S_3$ – Blood flowing into Ventricles
   d. $S_4$ – Contraction of the Atria

2. Proper Placement of Stethoscope Bell with Diaphragm
   a. Tricuspid Valve – Fifth intercostal space usually just to the left of the sternum
   b. Bicuspid Valve – Fifth intercostal space left at apex of heart (inferior to left breast)
   c. Aortic Semilunar Valve – Second intercostal space just right of the sternum
   d. Pulmonary Semilunar Valve – Second intercostal space just left of the sternum

3. Clinical Application: Heart Murmurs
   a. Regurgitation (Incompetence)
      1) Swishing sound due to backflow
   b. Stenosis (Incompetence)
      1) Screeching sound due to scarring
   c. Functional (Innocent or Physiologic) Murmur
      - Not diagnostically significant

4. Aortic Semilunar Valve closes before Pulmonary Semilunar Valve – especially with long slow breaths
C. Blood Pressure (Auscultation Method)

1. Sphygmomanometer measures pressure within large arteries
   a. Cuff
   b. Pressure Gauge
   c. Rubber Bulb
   d. Valve
   e. Orientation Arrows
2. Korotkoff’s Sounds – due to turbulent blood flow
3. Systolic Blood Pressure
4. Diastolic Blood Pressure
5. Pulse Pressure = Systolic minus Diastolic
6. Mean Arteriole Pressure (MAP) = Diastolic + 1/3 Pulse Pressure
7. 3:2:1
8. Effect of Posture on Blood Pressure
9. Effect of Exercise on Blood Pressure
10. Clinical Applications
    a. Hypertension
        1) Dietary Salt Intake
    b. Hypotension
D. Pulse – Wave of pressure in arteries
1. Feel Pulse at Pressure Points
   a. Radial
   b. Common Carotid
   c. Brachial
   d. Femoral
   e. Popliteal
   f. Posterior Tibial
   g. Dorsal Pedal (Dorsalis pedis)
   h. Facial
   i. Temporal
2. Pulse Deficit = Apical Pulse (Heart Beats) – Radial Pulse
3. Plethysmogram – Recording of Volume of Blood
E. Electrocardiography - Electrocardiogram (EKG or ECG)

1. Components of the ECG
   a. Standard grid
      1) x axis measures time in seconds (s)
      2) y axis measures amplitude in millivolts (mV)
   b. Isoelectric line – baseline
   c. Deflection waves – record voltage and time of electrical events of large amounts of muscle tissue
      1) P wave – Atrial Depolarization
      2) QRS complex – Ventricular Depolarization and undetected Atrial Repolarization
      3) T wave – Ventricular Repolarization
   d. Intervals – analyze time
      1) P-R interval
         a) Time from SA node to ventricles
      2) Q-T interval
         a) Time for ventricular depolarization and repolarization
   e. Segments – analyze deflection from isoelectric line
      1) P-R segment
         a) End of P until beginning of QRS
      2) S-T segment
         a) End of S until beginning of T
http://www.learntheheart.com/
3. Standard (Indirect) Leads – Vertices of Einthoven’s Triangle
   a. Lead I (RA – LA) – measured using ADI
   b. Lead II (RA – LL)
   c. Lead III (LA – LL)
   d. Einthoven’s Law: The sum of the voltages of Leads I and III equals that in Lead II.
   e. Electrodes
   f. Ground or Earth (RL)

4. Clinical Applications
   a. Tachycardia - > 100 beats/minute
   b. Bradycardia - < 60 beats/minute
   c. Arrhythmia
      1) Fibrillation
      2) Heart Block
      a) Partial AV Heart Block – longer than normal PR interval
      b) Complete (Third-Degree or Total) Heart Block – No impulses go through AV node – Treated with Pacemaker
      c) Right or Left Bundle Branch Block – longer than normal QRS interval