Chapter 18 - Heart

I. Heart Anatomy: size of your fist; located in mediastinum (medial cavity)

A. Coverings: heart enclosed in double walled sac called the pericardium
   1. Fibrous pericardium: dense connective tissue
   2. Serous pericardium: serous membrane composed of 2 layers
      a. Parietal: lines the overlying fibrous pericardium
      b. Visceral: also called epicardium - covers and is part of heart wall

B. Heart wall: consists of 3 layers

   1. Epicardium: outermost layer
   2. Myocardium: fibrous connective tissue “skeleton” plus cardiac muscle
   3. Endocardium: lines chambers and covers valves
C. Chambers and great vessels: 4 chambers and 4 types of vessels

1. Chambers: 2 upper and 2 lower

   a. Atria: possess thin walls
      1) Parts
         a) Auricles: ear-like flaps
         b) Pectinate muscle: muscle has a bundle-like appearance
         c) Fossa ovalis: oval depression in the interatrial septum

      2) Right atrium: receives used blood from the entire body
         a) Superior vena cava
         b) Inferior vena cava
         c) Coronary sinus

      3) Left atrium: pulmonary veins enter

   b. Ventricles: relatively thick walls
      1) Parts
         a) Interventricular septum: the wall between ventricles
         b) Trabeculae carneae: ridges of muscle in the ventricular wall
         c) Papillary muscles: small stalks of muscle extending from the wall

      2) Right ventricle: relatively thin wall

      3) Left ventricle: relatively thick walls
**D. Heart Valves:** *keep blood flowing in one direction*

1. **Atrioventricular valves:** *located between atria and ventricles*
   a. Anchored by chordae tendineae into ventricular wall
   b. Papillary muscles contract to limit movement

![Heart Valves Diagram](image)

   c. **Tricuspid:** *between R.A. and R.V. - 3 cusps*
   d. **Bicuspid:** *(mitral) - between L.A. and L.V. – 2 cusps*

2. **Semilunar valves:** *at entrance of aorta and pulmonary trunk*

![Semilunar Valves Diagram](image)

   a. **Aortic semilunar:** *at the base of the aorta*

   b. **Pulmonary semilunar:** *at the base of the pulmonary trunk*

**E. Coronary circulation:** *blood flow to heart tissue itself*

1. **Coronary arteries:** *exit aorta via coronary ostia*

2. **Coronary veins:** *collect used blood*

**II. Pathway of blood through the heart:** *2 main circuits*

A. **Pulmonary:** *used blood from the body to lungs and back to the heart again*
III. Cardiac physiology

A. Microscopic anatomy: *short rectangular cells with a single nucleus*
1. **Intercalated disc**: thickened membrane at the ends of the muscle cell
   
   a. **Desmosomes**: “spot weld” the cells together
   
   b. **Gap junctions**: allow ions to flow from cell-to-cell

2. Many mitochondria

3. Differences between skeletal and cardiac contraction
   
   a. **All-or-none**: the heart contracts as a unit
   
   b. **Automaticity**: some cardiac muscle cells can initiate their own depolarization
   
   c. **Refractory period**: long refractory period (250 msec vs 1-2 msec)

**B. Mechanism of contraction**

1. Action potential hits muscle cells:
   
   a. **Na⁺ gates open**
   
   b. **Ca²⁺ gates open**
   
   c. **Na⁺ gates close, Ca²⁺ lags behind**
   
   d. **Ca²⁺ gates close**
   
   e. **K⁺ gates open**
   
   f. Diagram of a single action potential:

**C. Excitation and electrical events**

1. **Intrinsic conduction system**: the nodal system
a. Action potentials generated by cardiac cells
   1) Unstable resting potentials
      a) Increased Na\(^+\) leakage
      b) Decreased K\(^+\) leakage
   c) Threshold is reached: action potential occurs
   d) K\(^+\) gates open: to repolarize the cell
   e) Diagram of pacing mechanism:

2. Conduction system parts

   a. Sinoatrial node: SA node - in the R.A. wall just below SVC opening

   b. Atrioventricular node: AV node - just above the tricuspid valve in the interatrial septum
c. **AV bundle**: just below the AV node, in the lower part of the interatrial septum
d. **Bundle branches**
e. **Purkinje fibers**

**D. Extrinsic innervation of the heart**
1. **Cardioaccelerator center**: in medulla oblongata of brain stem
2. **Cardioinhibitory center**: also in the medulla oblongata

**E. ECG (EKG)**: electrocardiogram – a graphical recording of electrical activity of heart

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1. **P wave**: atrial depolarization
2. **QRS complex**: ventricular depolarization
3. T wave: *ventricular repolarization*

F. **Cardiac cycle:** *all the events of one heartbeat*
   1. **Terminology**
      a. Diastole: *relaxation*
      b. Systole: *contraction*

   2. **Ventricular filling:** *starting mid to late diastole*
      a. Blood flows passively into ventricles (70% of SV)
      b. At the end of ventricular filling, atria contract forcing another 30% of SV into ventricles

3. **Ventricular systole**
   a. Begins as atria go into diastole
   b. Intraventricular pressure rises rapidly
   c. **Isovolumetric contraction:** *intraventricular pressure rises*
   d. **Ventricular ejection:** *blood moves from ventricles into arteries*

4. **Ventricular diastole:** *intraventricular pressure drops*
   a. **Isovolumetric relaxation:** *intraventricular pressure continues to drop*

   1) **Dicrotic notch:** *brief pressure disturbance as aortic valve snaps shut*

5. **Quiescent period:** *quiet time between cycles*

G. **Heart sounds:** *2 sounds can be auscultated in normal individuals*
   1. 1\textsuperscript{st} heart sound: *due to closure of the AV valves*
   2. 2\textsuperscript{nd} heart sound: *due to closure of the semilunar valves*
H. **Cardiac output**: the amount of blood pumped by a ventricle in 1 minute

1. **Stroke volume**: the amount of blood pumped by one ventricle in one beat

2. Cardiac output = (stroke volume) x (heart rate)

I. **Regulation of heart rate**

1. Autonomic NS regulation
   a. Sympathetic
   b. Parasympathetic
   c. Vagal tone: *constant partial stimulation*
   d. Receptors: *baroreceptors (or pressoreceptors)*

   1) **Carotid sinus**: receptors located in the neck

   2) **Aortic bodies**: similar to carotid bodies

   3) **Atrial reflex**: *(Bainbridge reflex)*

2. Chemical control
   a. Hormones: *epi/norepi - increases H.R. and force*
   b. Ions