Chapter 18: The Heart

I. ANATOMY

(A) General: Less than one pound, fist-sized.

Within mediastinum, lies oblique, 2/3 of it on left. Attached at base, apex tilts inferior, left (site of apical pulse).

(B) Coverings: Pericardium- fibrous and serous with parietal and visceral layers (=epicardium), fluid between. Pericarditis causes friction rub. When severe, fluid accumulates, leads to cardiac tamponade.

(C) Wall Layers: epicardium; myocardium- reinforced with fibrous skeleton; endocardium- endothelium & thin CT, continuous with blood vessel lining.

(D) Chambers & Great Vessels:

Two atria, two ventricles, septa (walls), sulci for blood vessels and fat. Auricles continuous with atria, lined with pectinate muscles. Ventricles lined with trabeculae carnae. Papillary muscles attached to AV valves via chordae tendinae. Great vessels = vena cavae, pulmonary trunk and veins, aorta.


(F) Coronary Circulation: nourishes myocardium Includes coronary arteries, cardiac veins, coronary sinus → Right Atrium. Angina Pectoris = transient ischemia Myocardial Infarction (MI) = “heart attack”.

(G) Valves: prevent backflow. Atrioventricular (AV) – right = tricuspid; left = bicuspid or mitral. Cusps attached to chordae tendinae.
Semilunar: **Aortic** and **Pulmonary**. Regulate blood flow from ventricles.

Valvular Malfunctions: **Incompetant** (leaky); **stenosis** (narrowed); may be replaced.

II. CARDIAC MUSCLE

**(A) Anatomy:** Fibers short, wide, branched, striated and interconnected by intercalated discs (contain desmosomes and gap junctions).

Myocardium a functional syncytium.

Large mitochondria.

**(B) Contraction:** Some fibers with autorhythmicity.

Long absolute refractory period prevents tetany.

Like skeletal muscle, depolarization opens voltage gated Na+ channels, leads to action potential.

Calcium activates cross bridges, promotes sliding.

Ca++ from outside cell and from inner sarcoplasmic reticulum.

K+ movement reestablishes resting potential.

**(C) Energy Requirements:** More dependent upon O2.

III. HEART PHYSIOLOGY

**(A) Electrical Events**

Intrinsic conduction system- non contractile cardiac muscle fibers with autorhythmicity, extra leaky channels. **Pacemaker potentials.**

SA node → AV node → AV Bundle (of HIS) → right and left Bundle Branches → Purkinje Fibers.

Intrinsic rhythms modified by the ANS.

Arrhythmias- **fibrillation** (asynchronous excitation); **ectopic** (wrong place) focus; **heart block**.....
Medulla with **cardioacceloratory** and **inhibitory centers**. 
ECG = **electrocardiogram**, produces tracing of electrical events.

**P Wave** represents atrial depolarization, 
**QRS** ventricular depolarization 
**T Wave**, ventricular repolarization.

(B) **Heart Sounds**: distinguished by **auscultation** (listening).

Associated with valve closures.
**Murmurs** when sound abnormal.

(C) **Mechanical Events**: described in Cardiac Cycle.

Average adult BPM = 75.

Alternation between systole (contraction) and diastole (relaxation).

Ventricular filling followed by ventricular systole:  
**Isovolumetric contraction**, when artery P > ventricular P  
Then ventricular ejection, when ventricular P higher.

Isovolumetric relaxation is early diastole.

Backflow from aorta causes dicrotic notch.

(D) **Cardiac Output**:

Volume of blood pumped per minute/ ventricle.
Stroke Volume (SV) is the volume per contraction.

**CO = SV x HR**

Cardiac Reserve is the maximum CO minus the resting CO.

-1- **Regulation of Stroke Volume**: EDV – ESV

EDV = end diastolic volume; ESV = end systolic volume
Based on,
a. **Preload** = degree of stretch.  
Described by **Frank-Starling Law**.  
Increasing venous return increases preload.

b. **Contractility**, independent of stretch.  
Positive **ionotropic agents** enhance contractility,  
vs. negative ionotropic agents.

c. **Afterload** = back pressure exerted by arterial blood.  
Increased with hypertension.  
Reduces stroke volume.

-2- **Regulation of HR** – done with positive and negative **chronotropic factors**.  
A function of the ANS.  
Usually influenced by vagal tone.  
Sensory input from baroreceptors and chemoreceptors.  
Chemical regulation involves hormones (epinephrine, thyroxine, e.g.)  
ions (Ca++, K+, e.g.)  
Normal range 60-100 BPM.

<60 – **bradycardia**  
>100 – **tachycardia**

(E) **Homeostatic Imbalances** result in **congestive heart failure**.

Include **coronary atherosclerosis**,  
**Chronic Hypertension**,  
Multiple MIs  
Dilated **Cardiomyopathy**,  
**Peripheral** vs. **Pulmonary Congestion**.