Review of Cardiac Structure and Function
Four chambers (two pumps)

• Right heart acts as a volume pump – through low-resistance vessels of the pulmonary system

• Left heart acts as a pressure pump – through high-resistance vessels of the systemic circulation
Heart — Coronal Section (1)

- Superior vena cava
- Pulmonary valve
- Right pulmonary artery
- Branches of right pulmonary veins
- Right atrium
- Tricuspid valve
- Right ventricle
- Inferior vena cava
- Aorta
- Left pulmonary artery
- Pulmonary trunk
- Left pulmonary veins
- Left atrium
- Bicuspid valve
- Chordae tendineae
- Papillary muscle
- Left ventricle
- Interventricular septum
Path of Blood Flow

Vena cavae → RA → RV → Pulmonary trunk → Lungs → Pulmonary veins → LA → LV → Aorta → Systemic circulation → Vena cavae
Atrioventricular valves

- Lie between the atria and ventricles
- Tricuspid valve on the right
- Bicuspid or mitral valve on left
- Anchored against high pressure by the chordae tendineae and papillary muscles
Semilunar Valves

- Lie between ventricles and great vessels
- Pulmonary on right side
- Aortic on left side
Cardiac Cycle

- Sequence of events that compose the repeating pumping action of the heart
- Typically, **systole** refers to ventricular contraction and **diastole** refers to ventricular relaxation
- If referring to atria, specify atrial systole, etc.
• Remember, that unlike skeletal muscle, much of the Ca\(^{++}\) used in cardiac muscle contraction comes from the extracellular fluid.
Conduction System

- Conduction system cells are specialized myocardial fibers
- Heart has autorhythmicity—beats spontaneously at about 70 beats/min
- Impulse begins at sinoatrial (SA) node or pacemaker – sinus rhythm
- Spreads through atria via conducting myofibers to atrioventricular (AV) node in fibrous skeleton of heart
Regulation of Heart Rate

- Sympathetic N.S. increases heart rate and force of contraction – secretes norepinephrine – accelerator nerves
- Parasympathetic N.S. decrease heart rate and force of contraction through the vagus nerve. Sends continuous impulses. Secretes acetylcholine
Electrocardiogram ECG

- Measures electrical activity of the heart
- P wave – represents atrial depolarization
- QRS complex – represents ventricular depolarization
- T wave – represents ventricular relaxation (repolarization)
Normal ECG
Normal ECG
ECG: Waves, segments and intervals
Cardiac Output

• Cardiac Output:

• SV (ml/beat) X HR (beats/min) = CO(ml/min.)

• 70 ml X 80 = 5600 ml /min. or 5.6 liters L/min
Peripheral resistance

- Pressure = CO x Peripheral resistance
- Peripheral resistance mainly present in the arteriols and usually increases by atherosclerosis which cause hypertension
Factors affecting cardiac performance

- **Preload**: pressure generated at the end of diastole; depends on both heart and vascular system – the amount of filling of the ventricle during relaxation

- **Afterload**: Peripheral resistance to ejection during systole; depends on both heart and vascular system - the force that opposes ejection of blood from the heart; for the LV, this is the aortic systolic pressure
• **Heart rate**: a intrinsic characteristic of the heart tissue that is influenced by nervous and endocrine systems

• **Myocardial contractility**: the ability of the heart muscle to contract, the force of contraction - another cardiac tissue characteristic that is influenced by nervous and endocrine systems
(Frank-) Starling Law

- Within physiological limits, the greater the stretching of the muscle fibers (preload), the greater the force of contraction.
- The extra force of contraction is necessary to pump the increased volume of blood from the ventricle.
- Cardiac output increases
Neural reflexes

• Autonomic nervous system: Sympathetic increase heart rate and ventricular contraction. Parasympathetic decrease heart rate only.
• Bainbridge reflex – increased heart rate due to increased right atrial pressure
• Increased pressure in arteries stimulates a baroreceptor reflex that decreases heart rate.