Heart Physiology
Cardiac Cycle

• Systole = Contraction
• Diastole = Relaxation
• Ave Rate = ~75 BPM
  – Cardiac cycle = 0.8sec
• Complete Heartbeat
  – Atrial systole (0.1sec)
  – Ventricular systole (0.3sec)
  – Quiescent period (0.4sec)
• Valves prevent backflow
Events of the Cardiac Cycle

- Aortic valve opens
- Aortic valve closes
- A-V valve opens
- A-V valve closes
- Atrial pressure
- Ventricular pressure
- Ventricular volume
- Electrocardiogram
- Heart sounds
- Ventricular systole
- Ventricular diastole
Atrial Diastole

- Pulmonary semilunar valve open
- Aortic semilunar valve open
- Atrial diastole
- Ventricular systole
- Tricuspid and bicuspid valves closed
Sites of Heart Valve Sounds

- Aortic area
- Pulmonary area
- Tricuspid area
- Bicuspid area
Cardiac Conduction System

- S-A node
- A-V node
- A-V bundle
- Interatrial septum
- Left bundle branch
- Purkinje fibers
- Interventricular septum
Ventricular Wall Muscle Fibers

Myocardial muscle fibers
Heart Rate Control

Cerebrum (coronal section)
Hypothalamus
Medulla (transverse section)
Cardiac center
Parasympathetic vagus nerve
Spinal cord (transverse section)
Sympathetic trunk

Carotid baroreceptors
Carotid sinus
Sensory fibers
Common carotid artery
Aorta
Aortic baroreceptors
S-A node
A-V node

Sympathetic nerve
Ion Influence on Heart Rate

- Potassium (K\(^+\))
  - Hyperkalemia
  - Hypokalemia
- Calcium (Ca\(^+\))
  - Hypercalcemia
  - Hypocalcemia
- Sodium (Na\(^+\))
  - Hypernatremia
Normal ECG and Its Pattern
Electrocardiogram (ECG)

P: Peak
R: Rise
Q: Dip
S: Spike
T: Top

PR interval

Milliseconds

Millivolts
Cardiac Impulse Conduction

- SA node generates impulse, atrial excitation begins
- Impulse delayed at AV node
- Impulse passes to heart apex; ventricular excitation begins
- Ventricular excitation complete

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Cardiac Volumes & Output

- **Stroke Volume** = ml blood pumped per beat
  = End diastolic vol. – End systolic vol.
  - Healthy heart, SV = ~60% of chamber vol.

- **Cardiac Output** = ml blood pumped per min.
  = (Heart Rate) x (Stroke Vol.)
  - Normal adult CO = ~5L

- **Cardiac Reserve** = Resting CO – Max CO
Factors Affecting Stroke Volume (1)

- Preload
  - Amount of muscle fiber stretch
  - Frank-Starling law
Factors Affecting Stroke Volume (2)

- **Afterload**
  - Back pressure of arterial blood
  - ~80 mmHg
  - Relatively constant
Factors Affecting Stroke Volume (3)

• Contractility
  – Increased sympathetic stimulation
Tachycardia
Bradycardia
Congenital Cardiovascular Defects

(a) Ventricular septal defect. The superior part of the interventricular septum fails to form; thus, blood mixes between the two ventricles. Occurs in about 1 in every 500 births.

(b) Coarctation of the aorta. A part of the aorta is narrowed, increasing the work load on the left ventricle. Occurs in about 1 in every 1500 births.

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Age Related Changes In The Heart

• Sclerosis & Thickening of Valves
• Drop in Cardiac Reserve
• Fibrosis of Cardiac Muscle
• Atherosclerosis
• Enlargement of the Left Ventricle