Position of the Heart and Associated Structures

- Coronary trivia
  Pumps blood through 60,000 miles of blood vessels
- Pumps about 3,600 gal per day
- 2.6 million gal per year
Approximate location of the heart projected to the surface

Landmarks

- Superior R point: Is at the superior border of the R 3rd costal cartilage
- Superior L point: Is located at the inferior border of the L 2nd costal cartilage
- Inferior L point: (the apex) is located at of the heart in the L 5th intercostal space
- Inferior R point: Is located at the superior border of the 6th R costal cartilage

Layers of the heart wall and its associated membranes
External Anatomy of the Heart

(c) Posterior view showing surface features

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Internal Anatomy of the Heart

Position and Function of the Cardiac Valves
Circulation Patterns of the Heart

Veins carry blood **TO** the heart.
Arteries carry blood **AWAY** from the heart.

Coronary Vessels and Circulation
Histology of Cardiac Muscle
Cardiac Conduction Systems: The Heart Pacemaker

1. Action potential initiated by the SA node
2. Action potential conducted to the Purkinje fibers
3. Depolarization of sarcolemma opens voltage-gated fast Na+ channels causing rapid depolarization
4. Prolonged depolarization called the “plateau” involves opening of voltage-gated slow Ca2+ channels

Physiology of Cardiac Muscle Contraction
Physiology of Cardiac Muscle Contraction

5. Repolarization is caused by opening of voltage-gated K+ channels
6. The prolonged depolarization causes an absolute refractory period where the cardiac muscle cannot respond to additional stimulus.

The parts of an Electrocardiogram during a cardiac cycle

- **P wave** = atrial rapid depolarization (Large P = atrial enlargement)
- **QRS complex** = ventricular rapid depolarization (Large Q = myocardial infarction)
- **T Wave** = ventricular repolarization (Flat T = coronary artery disease)
- **P-Q interval** = Time required for conduction from SA node to Purkinje fibers
The parts of an Electrocardiogram during a cardiac cycle

- **S-T segment** = Time when ventricular myocardia is undergoing slow depolarized (elevated S-T indicates acute myocardial infarction)
- **Q-T interval** = Time from start of ventricular depolarization to ventricular repolarization. (Lengthened by myocardial damage)

The Cardiac Cycle: Putting it all together

- **Atrial Systole**
- **Atrial Diastole**
- **Ventricular Filling**
- **Ventricular Ejection**
- **Ventricular Systole**
- **Ventricular Diastole**
- **Isovolumetric Contraction**
- **Isovolumetric Relaxation**
Cardiac Cycle Events

Atrial systole = 0.1 second
Ventricular systole = 0.3 second
Relaxation period of ALL four chambers = 0.4 second

TOTAL CYCLE = 0.8 second

Average Heart Rate = 75 beats per minute
60 seconds divided by 75 beats = 0.8 second EACH cardiac cycle

The Cardiac Cycle:

End-diastolic volume: amount of blood a ventricle contains at the end of diastole, just before ventricular contraction occurs

End-systolic volume: the amount of blood that remains in the ventricle at the end of ventricular systole
Cardiac Output (CO)

- CO = volume of blood ejected from the left ventricle into the aorta each minute.
- CO = SV x HR
- SV = stroke volume, volume of blood ejected from ventricle (70 ml)
- HR = Heart rate, heartbeats per minute

Heart Rate

Pulse = expansion and recoil of artery wall with each ventricular ejection used to determine HR.

Normal resting pulse = 70 to 80 beats per minute
age: baby's heart rate is greater than 120 beats per minute.
sex: female heart rate is slightly higher than male.
physical fitness: regular exercise lowers the resting heart rate.
body temperature:
  - fever = increased heart rate
  - hypothermia = lowered heart rate

For Adults:
Tachycardia = >100 beats per minute
Bradycardia = <60 beats per minute
Cardiac Output (CO)

- **Factors that affect SV**
  1. **Preload**: degree of stretch of the myocardium before contraction
  2. **Contractility**: force of contraction of the ventricular myocardium
  3. **Afterload**: Force or pressure that the ventricular myocardium must exceed to open the semilunar valves.
Points of Auscultation

Nervous Control of Cardiac Activity