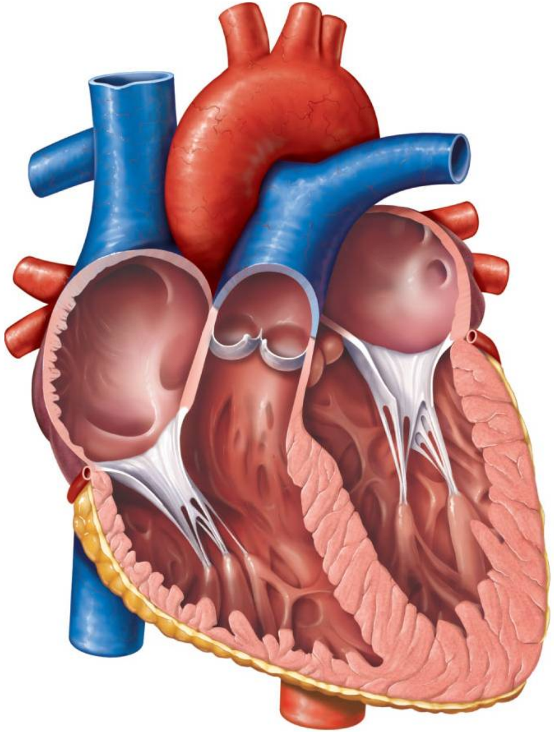
Label the chambers of the heart

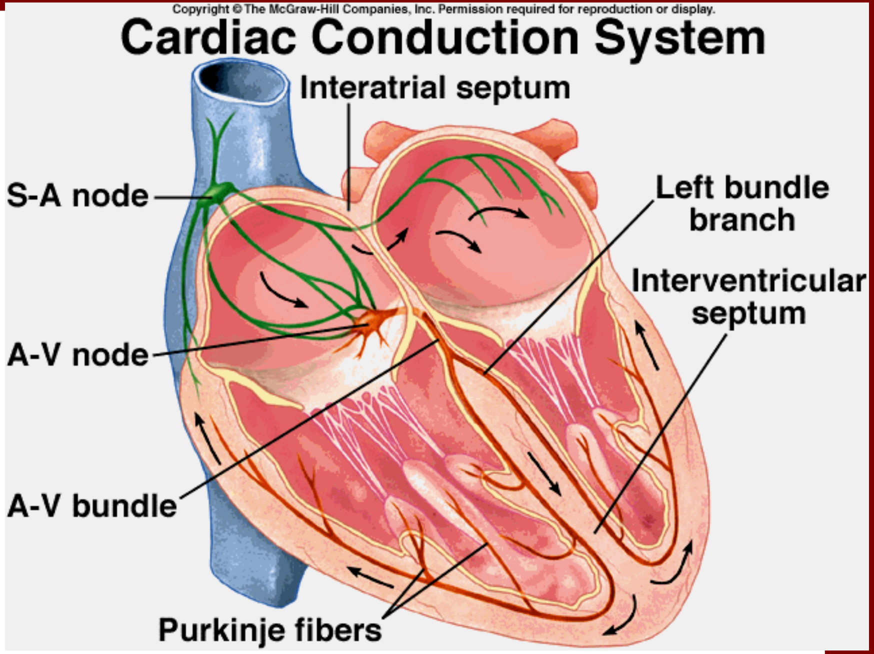


Heart Contraction

Cardiovascular System - Part II

Contraction Components

- Conducting Cells
- Contractile Cells
- Sinoatrial (SA) Node
- Atrioventricular (AV) Node
- AV Bundle (interventricular bundle)
- Purkinje Fibers



Cardiac Cycle

- A normal heart beats 80-100 beats per minute
- A normal heartbeat lasts about 370 ms
- Contraction starts at the SA Node
- Action potential stimulates contraction
- Atria contract, then ventricles
- Automaticity
  - the ability of cardiac muscle to contract on its own

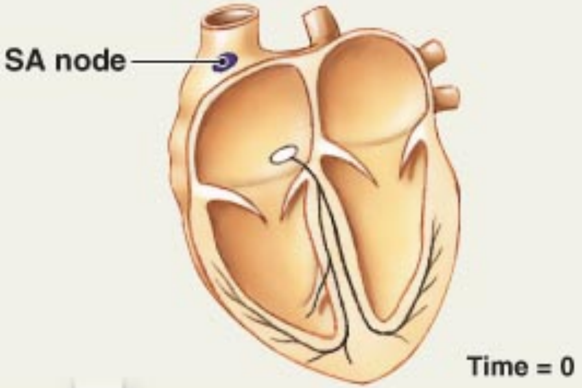
The Conducting System

- Starts at the SA Node in the right atrium
  - Pacemaker Cells
- Action potential is transmitted to the AV Node (50 ms)
  - Conducting cells follow internodal pathways in both atris, passing along the action potential to the contractile cells in the atria
  - 100 ms delay

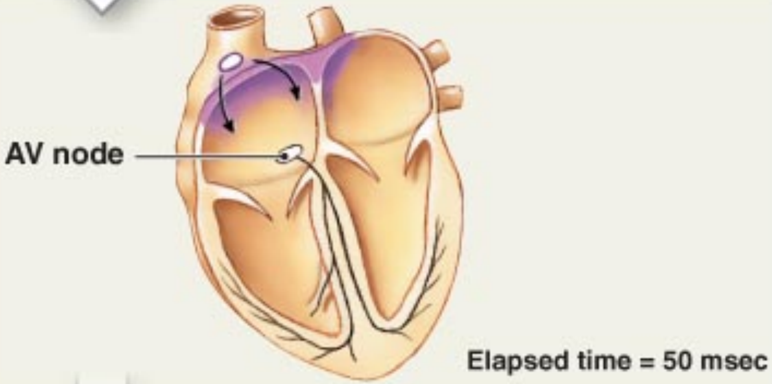
The Conducting System cont...

- Action potential is transmitted to the AV bundle and the bundle branches
  - Bundle branches run throughout the ventricular myocardium near the septum
  - Papillary muscles contract
- Lastly, action potential ends at the Purkinje Fibers
  - Ventricles contract
  - When the action potential reaches the myocardium, contractile cells are stimulated for contraction

1 An action potential is generated at the SA node, and atrial activation begins.

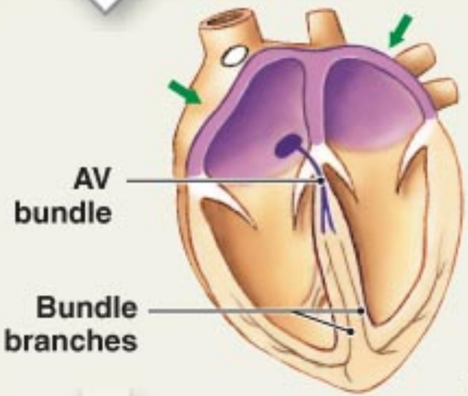


2 The stimulus spreads across the atrial surfaces by cell-to-cell contact within the internodal pathways and soon reaches the AV node.



3

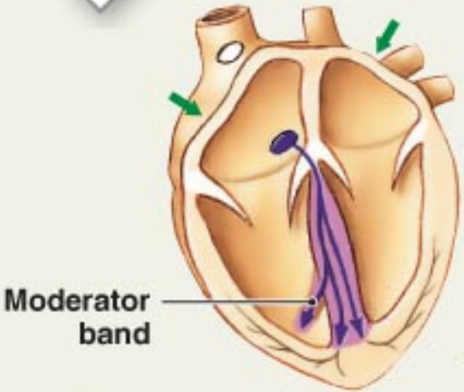
A 100-msec delay occurs at the AV node. During this delay, atrial contraction occurs.



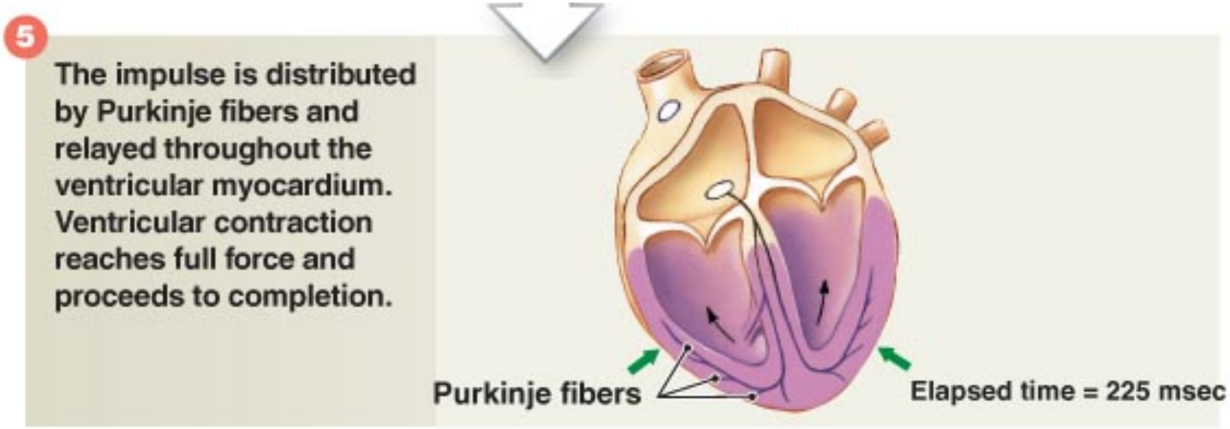
Elapsed time = 150 msec

4

As atrial contraction is completed, the impulse travels along the interventricular septum within the AV bundle and the bundle branches to the Purkinje fibers and, via the moderator band, to the papillary muscles of the right ventricle. Ventricular contraction begins.



Elapsed time = 175 msec

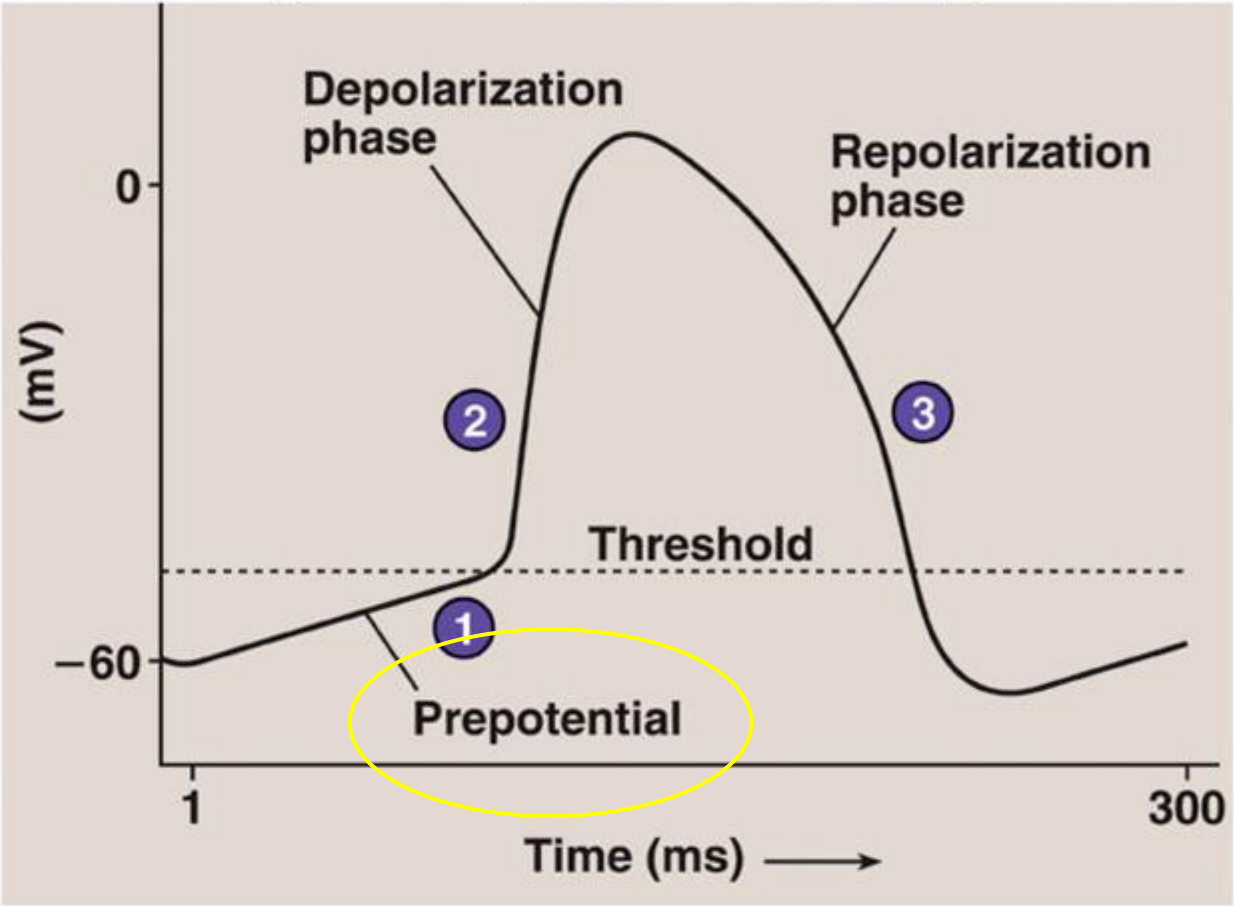

5
The impulse is distributed by Purkinje fibers and relayed throughout the ventricular myocardium. Ventricular contraction reaches full force and proceeds to completion.
Purkinje fibers
Elapsed time = 225 msec

Conducting Cells

- Most conducting cells are smaller than contractile cells
    - Also have fewer myofibrils
- Purkinje Cells are bigger
    - responsible for contracting ventricle walls
    - produce a stronger contraction to force the blood out of the heart

Prepotential

- Gradual depolarization in the conducting cells of the nodes
  - The nodes do not maintain a resting potential
    - SA Node generates 80-100 action potentials per minute
      - reaches the threshold first
    - AV Node generates 40-60 action potentials per minute

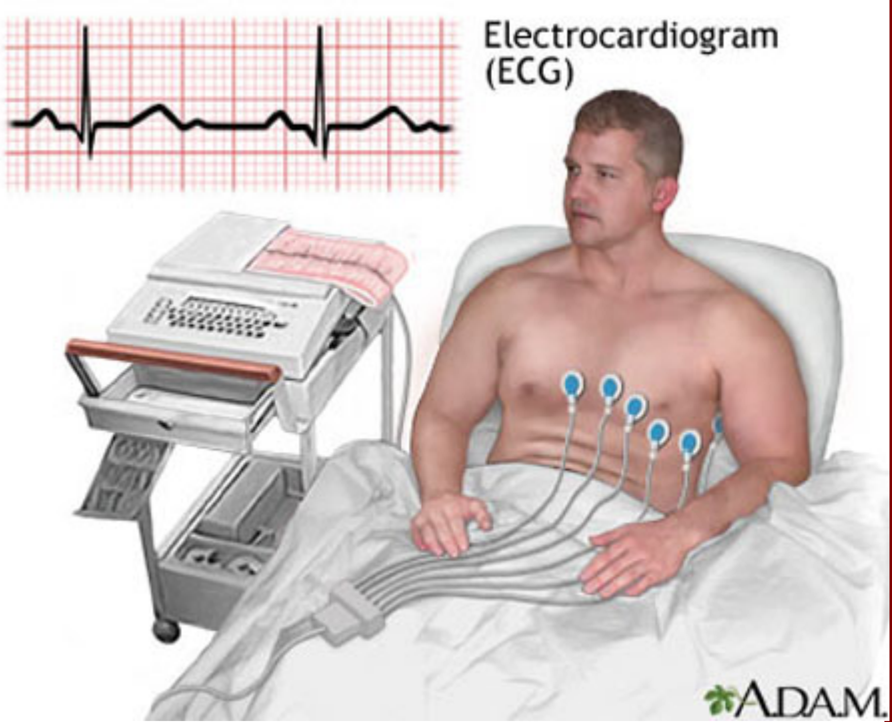

Depolarization phase
Repolarization phase
0
(mV)
2
3
Threshold
1
−60
Prepotential
1
300
Time (ms)

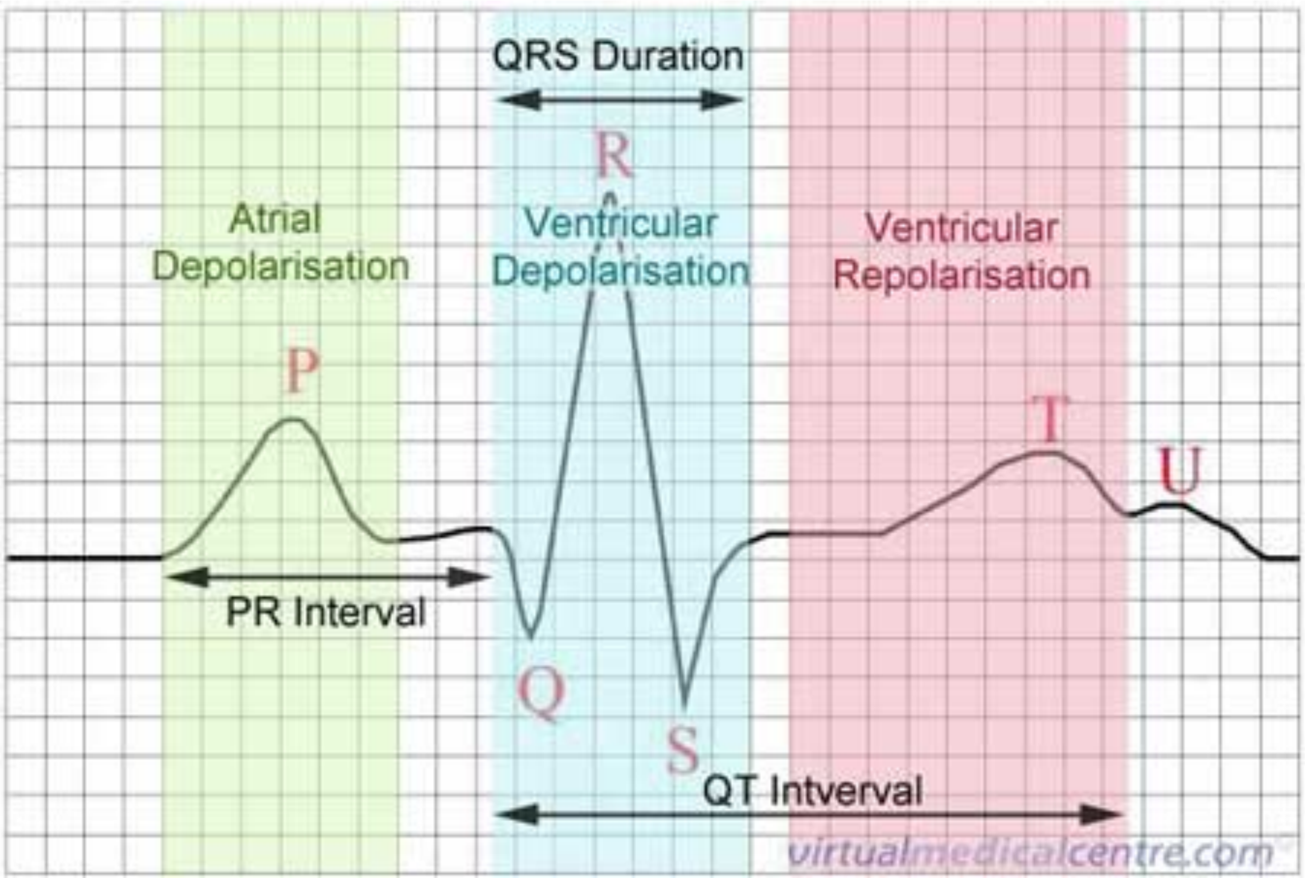
Abnormal Heart Contraction

- Bradycardia
  - heart beats slower than normal
- Tachycardia
  - heart beats faster than normal
- Ectopic Pacemaker
  - overrides the conducting system due to damaged conducting pathways

Electrocardiogram

- Recording of the heart's electrical events
- Cardiac Arrhythimas
  - irregular cardiac electrical activity

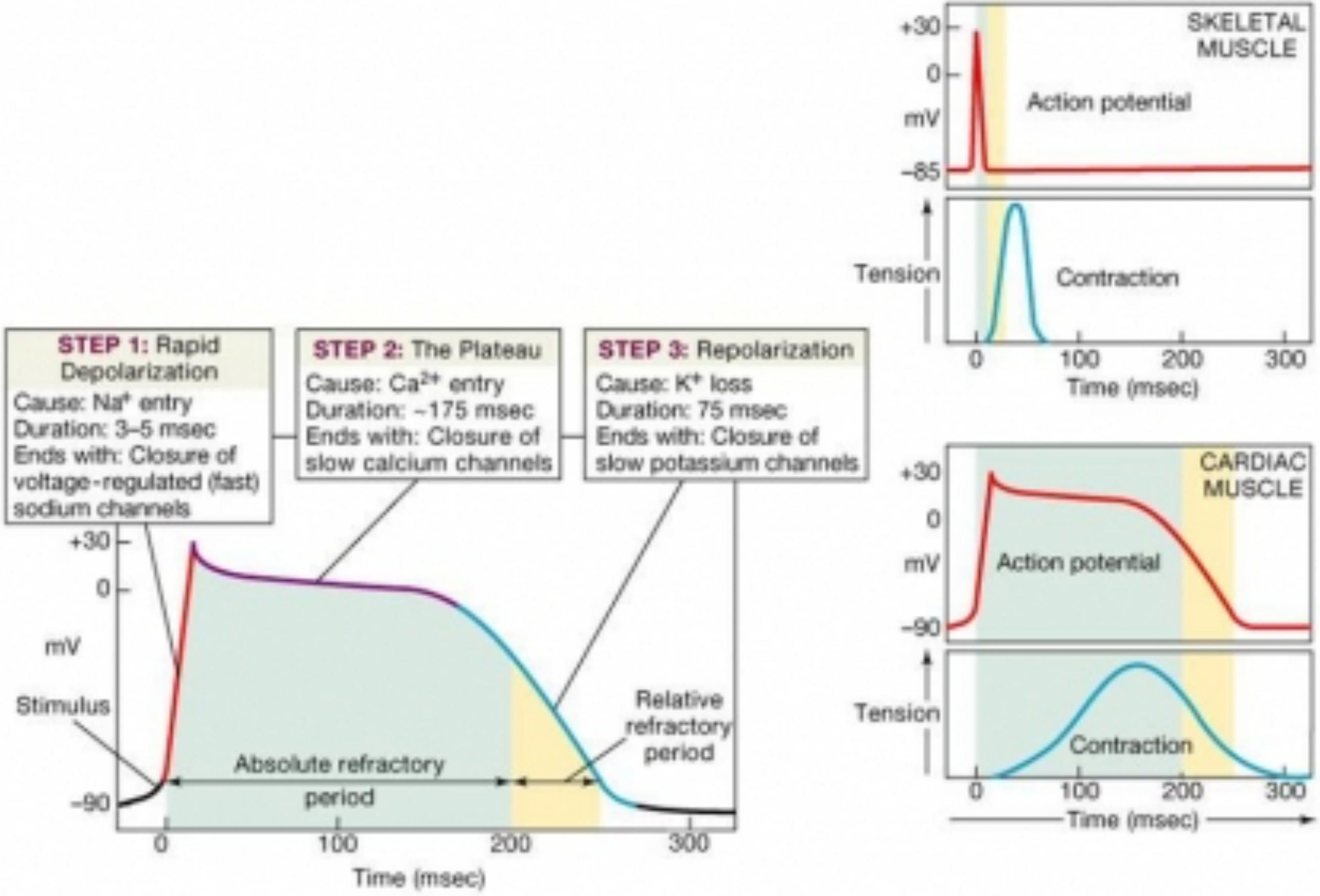




P Wave: atrial depolarization

QRS Complex: ventricle depolarization

T Wave: ventricle repolarization



(a) Cardiac muscle

(b)

Cardiac Cycle Within a Chamber

- Two Phases:
  - Systole
    - contraction
    - pushes blood into the next chamber
  - Diastole
    - relaxation
    - chamber fills with blood again

Ventricular Volume

- End-Diastolic Volume (EDV)
  - maximum amount of blood from the atria that the ventricles can hold
- Stroke Volume
  - the amount of blood that will leave the heart during contraction
  - ~60% of the EDV
- End-Systolic Volume
  - the amount of blood remaining in the ventricles after contraction

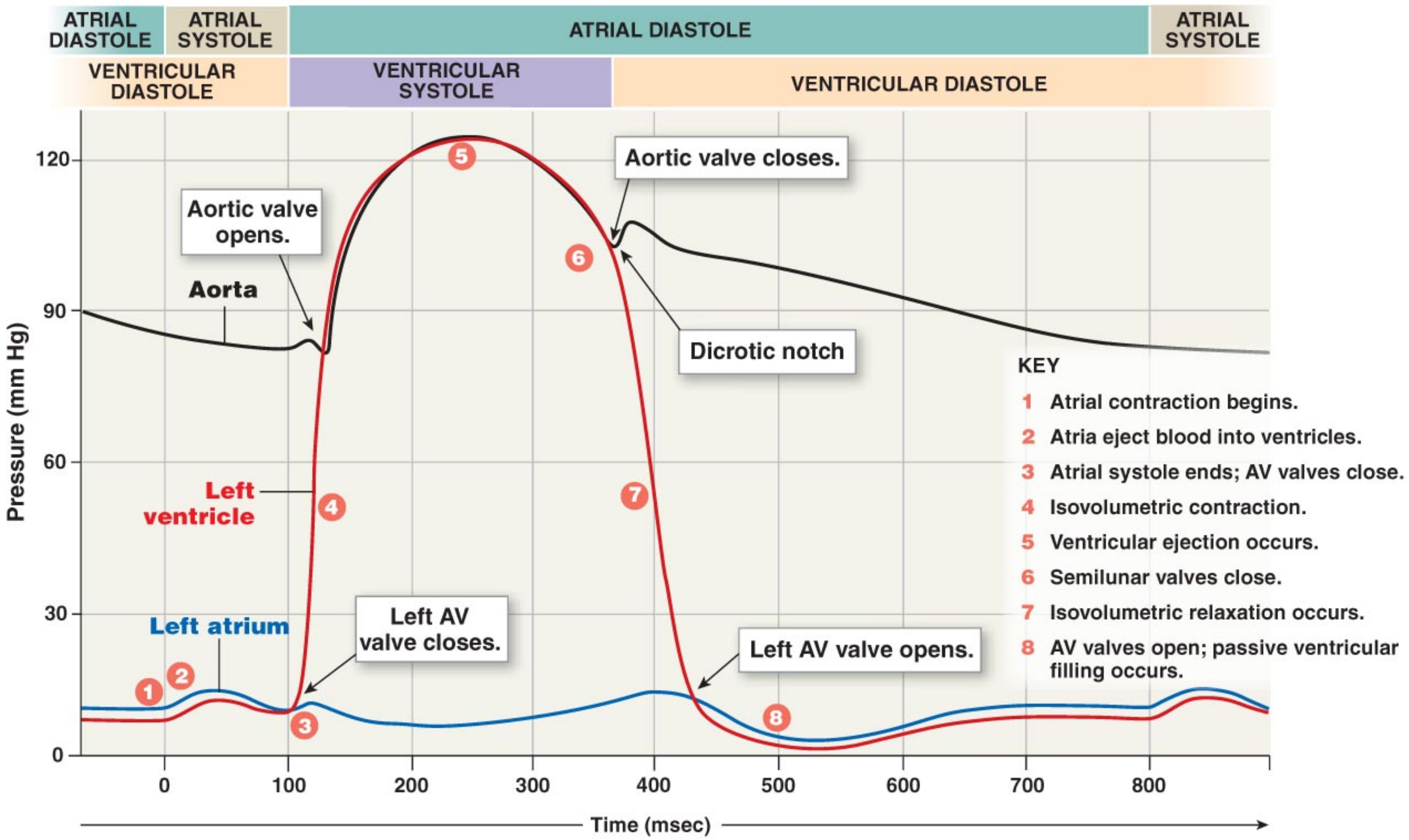
Cardiac Output

- The amount of blood pumped from the left ventricle in one minute
- Indicates if blood flow is adequate

Cardiac Output = Heart Rate x Stroke Volume

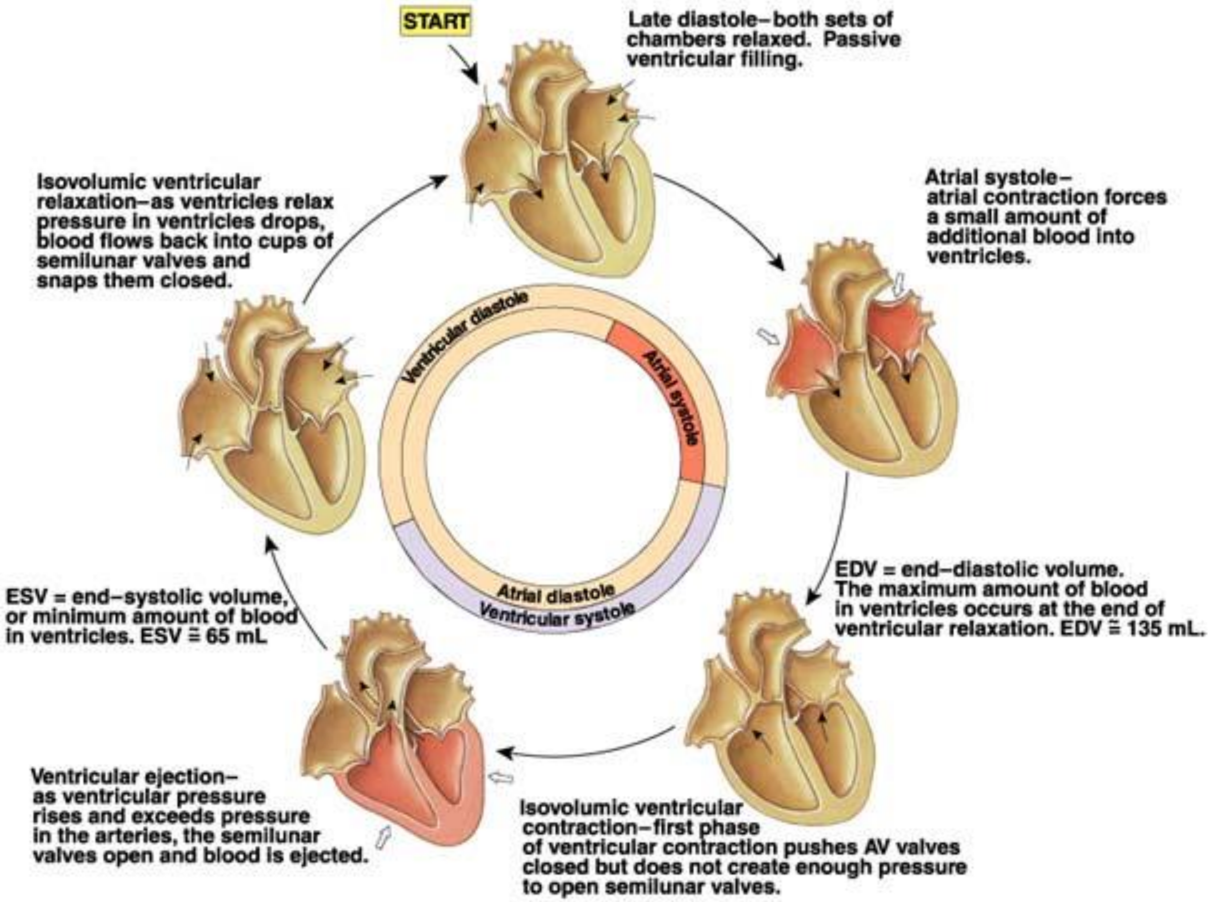
(mL/min) (beats/min) (mL/beat)

The pressure changes within the aorta, left atrium, and left ventricle during the cardiac cycle



Heart Sounds

- Stethoscope - instrument used to listen to heart sounds
- Four Heart Sounds:
    - S1 “lubb”
        - ventricles contract
        - atrioventricular valves close
    - S2 “dubb”
        - semilunar valves close
        - ventricles start to fill with blood
    - S3
        - blood flowing into ventricles
    - S4
        - atrial contraction


START
Late diastole–both sets of chambers relaxed. Passive ventricular filling.
Atrial systole– atrial contraction forces a small amount of additional blood into ventricles.
EDV = end–diastolic volume. The maximum amount of blood in ventricles occurs at the end of ventricular relaxation. EDV ≅ 135 mL.
Isovolumic ventricular contraction–first phase of ventricular contraction pushes AV valves closed but does not create enough pressure to open semilunar valves.
Ventricular ejection– as ventricular pressure rises and exceeds pressure in the arteries, the semilunar valves open and blood is ejected.
ESV = end–systolic volume, or minimum amount of blood in ventricles. ESV ≅ 65 mL
Isovolumic ventricular relaxation–as ventricles relax pressure in ventricles drops, blood flows back into cups of semilunar valves and snaps them closed.
Ventricular diastole
Atrial systole
Atrial diastole
Ventricular systole