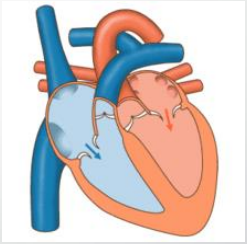
Cardiovascular Physiology

Cardiac Cycle- 2



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At end of this lecture you should be able to know:

- Electrical changes that occur in the cardiac cycle.
- Volume-Pressure relationship in the left ventricle.
- P-V Curve & P-V Loop.
- The systolic & diastolic periods.

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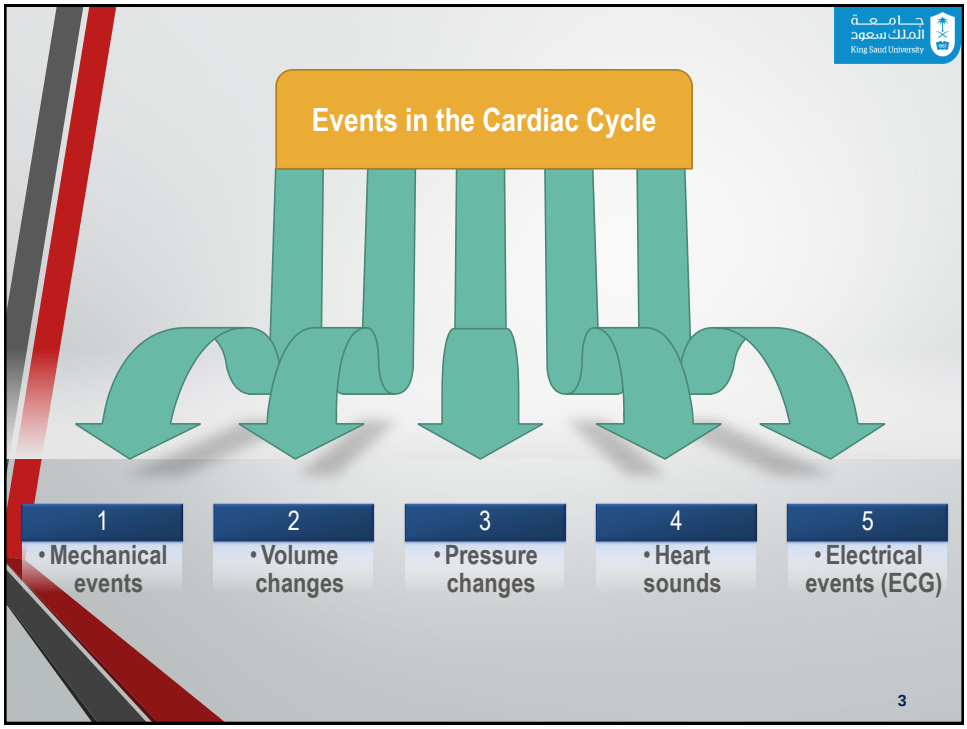
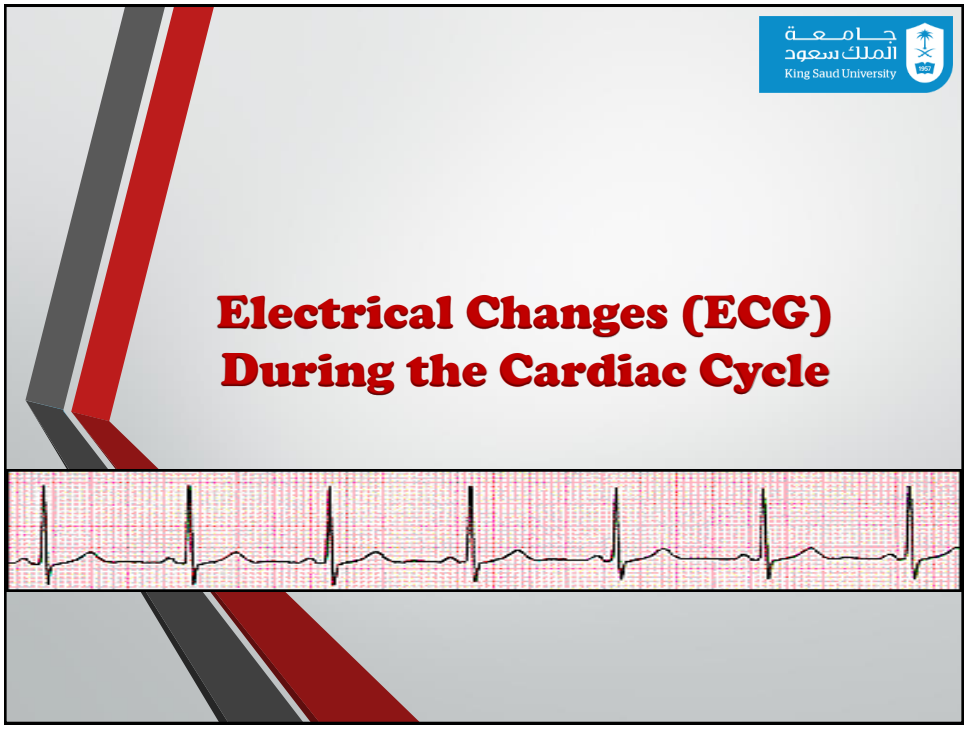
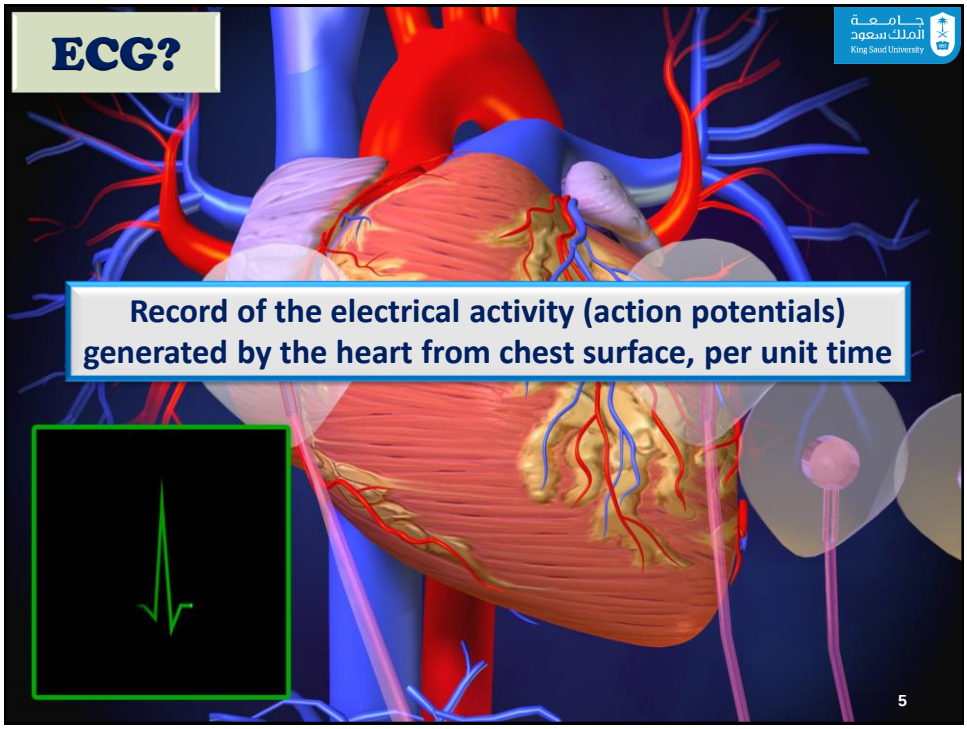

Events in the Cardiac Cycle
1
• Mechanical events
2
• Volume changes
3
• Pressure changes
4
• Heart sounds
5
• Electrical events (ECG)
3


Electrical Changes (ECG)
During the Cardiac Cycle


ECG?
Record of the electrical activity (action potentials) generated by the heart from chest surface, per unit time
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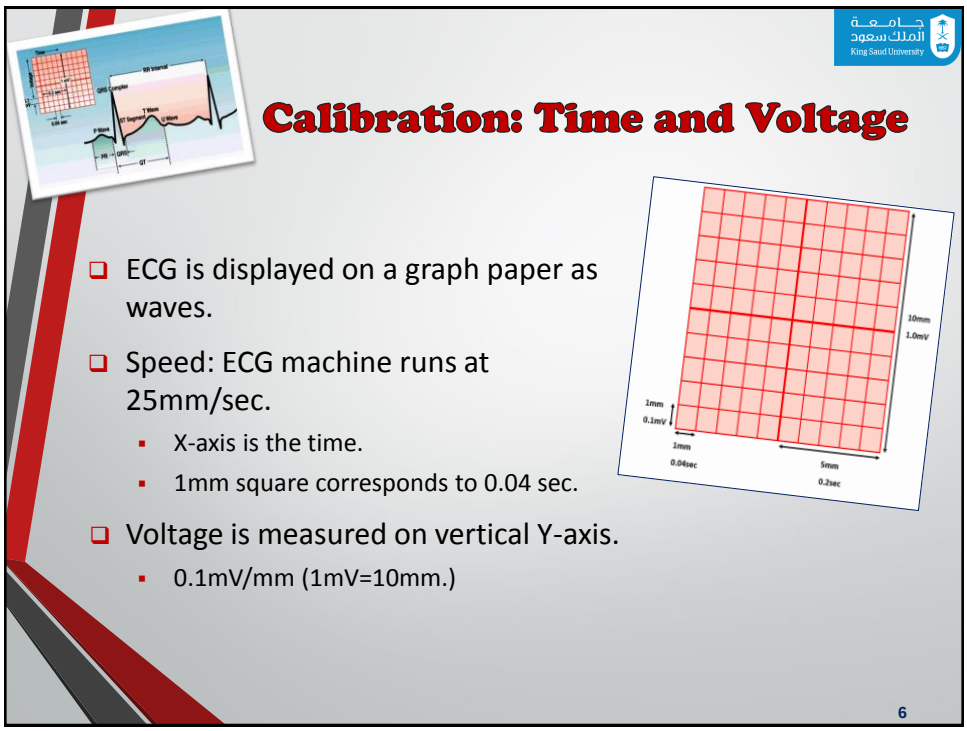
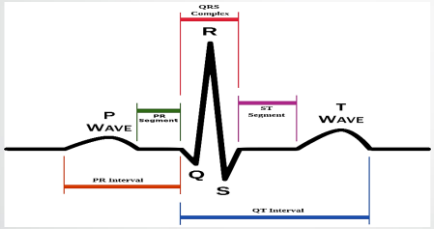

Calibration: Time and Voltage
ECG is displayed on a graph paper as waves.
Speed: ECG machine runs at 25mm/sec.
X-axis is the time.
1mm square corresponds to 0.04 sec.
Voltage is measured on vertical Y-axis.
0.1mV/mm (1mV=10mm.)
10mm
1.0mV
1mm
0.1mV
1mm
0.04sec
5mm
0.2sec
6

ECG waveforms

- **One heartbeat is normally recorded as:**



- **3 waves:** P- wave, QRS- complex & T- wave.
  - 3 positive waves (P, R & T.)
  - 2 negative waves (Q & S.)
- **2 intervals between waves:** PR & QT intervals.
- **2 segments:** PR & ST segments.

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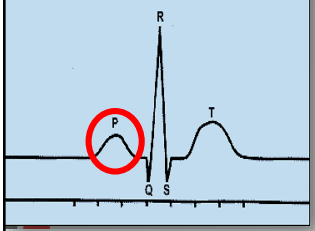
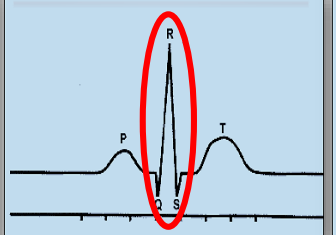
ECG waves

P- Wave



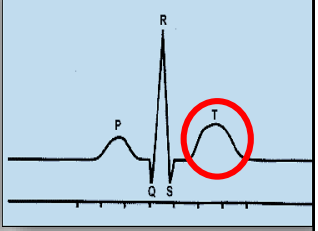
- Due to atrial depolarization.
- P- wave is recorded before the onset of the atrial systole.

QRS- Complex



- Due to ventricular depolarization.
- QRS complex is recorded before the onset of ventricular systole (isometric contraction phase.)

T- Wave



- Due to ventricular repolarization.
- T- wave is recorded before the onset of ventricular diastole.

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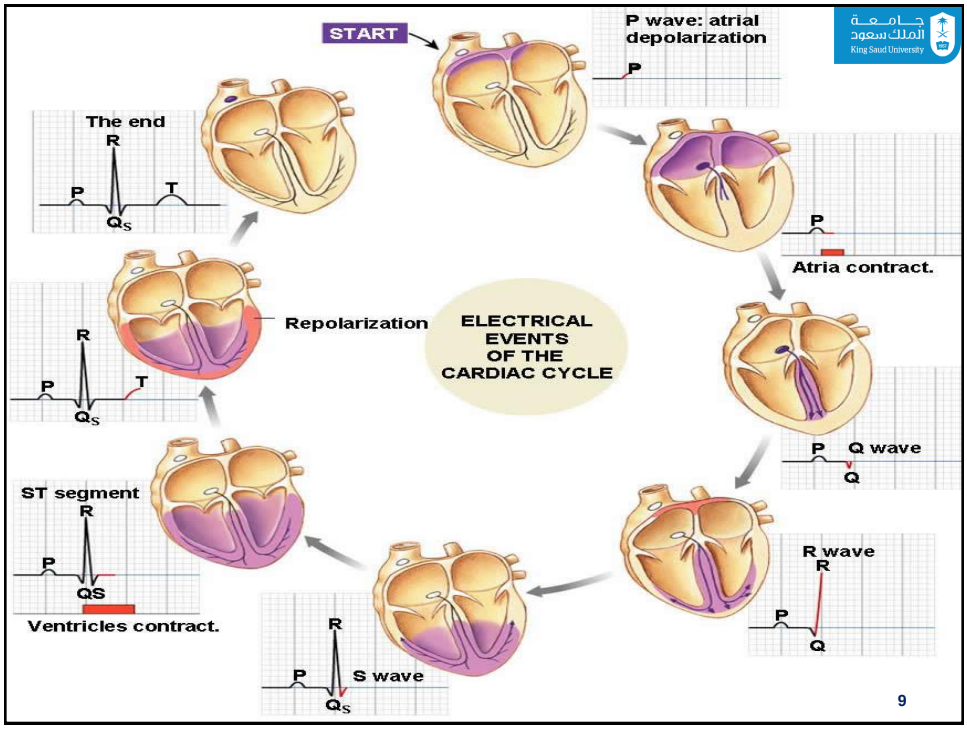
START
P wave: atrial depolarization
P
Atria contract.
P
Q wave
Q
R wave
R
P
Q
R
P
S wave
Q
ST segment
R
P
QS
Ventricles contract.
R
P
QS
T
Repolarization
The end
R
P
T
QS
ELECTRICAL EVENTS OF THE CARDIAC CYCLE
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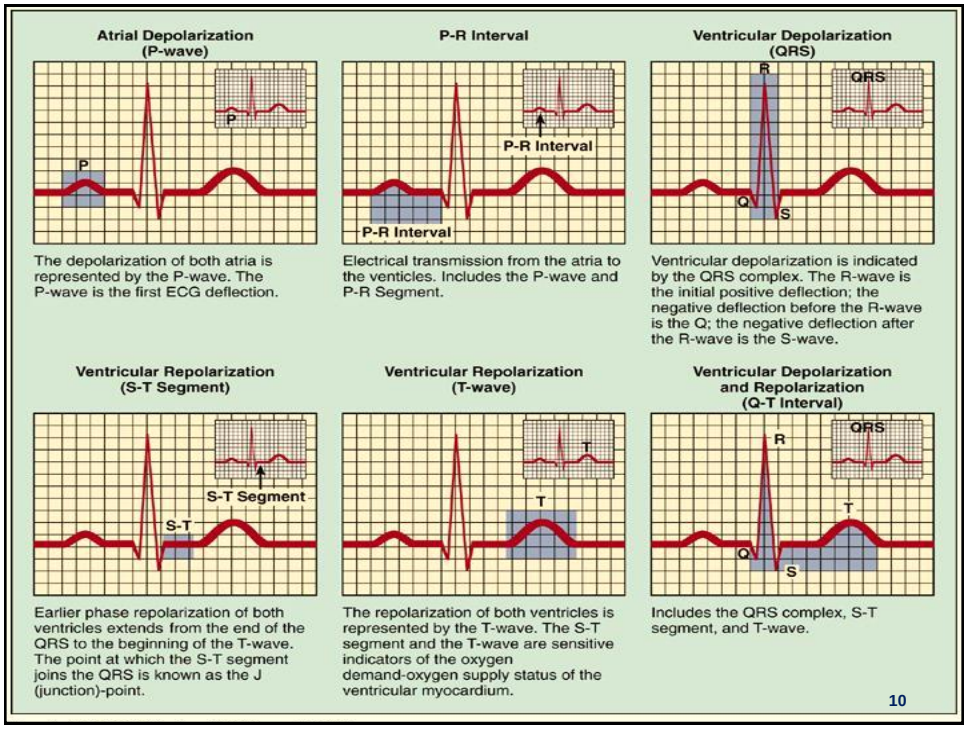
Atrial Depolarization (P-wave)
P
P
The depolarization of both atria is represented by the P-wave. The P-wave is the first ECG deflection.
P-R Interval
P-R Interval
P-R Interval
Electrical transmission from the atria to the venticles. Includes the P-wave and P-R Segment.
Ventricular Depolarization (QRS)
R
QRS
Q
S
Ventricular depolarization is indicated by the QRS complex. The R-wave is the initial positive deflection; the negative deflection before the R-wave is the Q; the negative deflection after the R-wave is the S-wave.
Ventricular Repolarization (S-T Segment)
S-T Segment
S-T
Earlier phase repolarization of both ventricles extends from the end of the QRS to the beginning of the T-wave. The point at which the S-T segment joins the QRS is known as the J (junction)-point.
Ventricular Repolarization (T-wave)
T
T
The repolarization of both ventricles is represented by the T-wave. The S-T segment and the T-wave are sensitive indicators of the oxygen demand-oxygen supply status of the ventricular myocardium.
Ventricular Depolarization and Repolarization (Q-T Interval)
R
QRS
T
Q
S
Includes the QRS complex, S-T segment, and T-wave.
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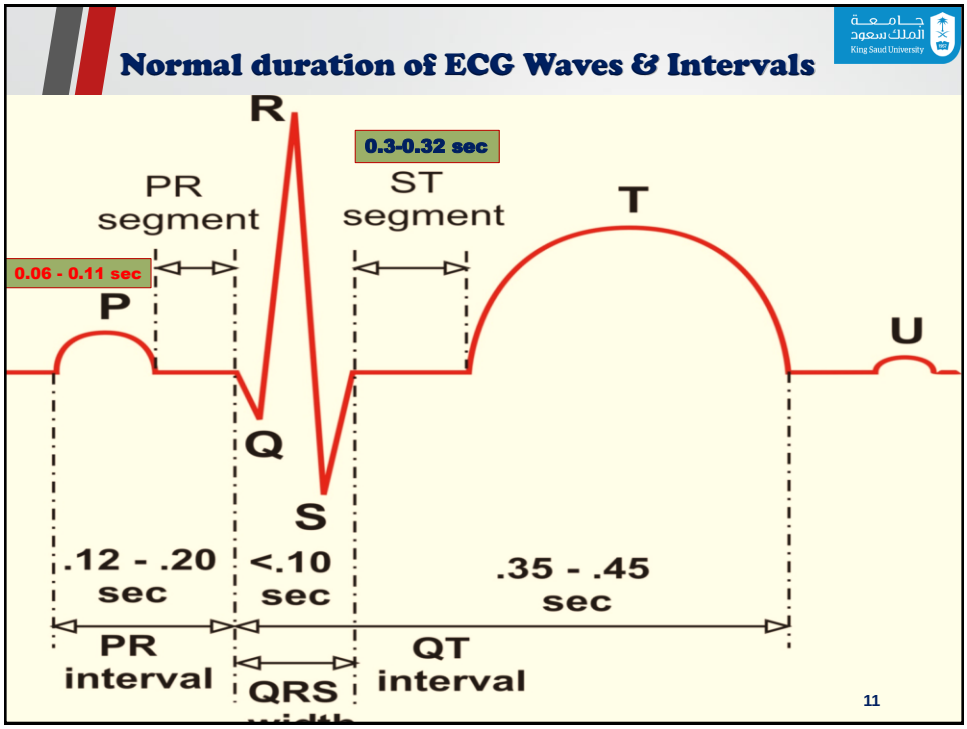
Normal duration of ECG Waves & Intervals
R
0.3-0.32 sec
PR segment
ST segment
T
0.06 - 0.11 sec
P
U
Q
S
.12 - .20 sec
<.10 sec
.35 - .45 sec
PR interval
QRS
QT interval
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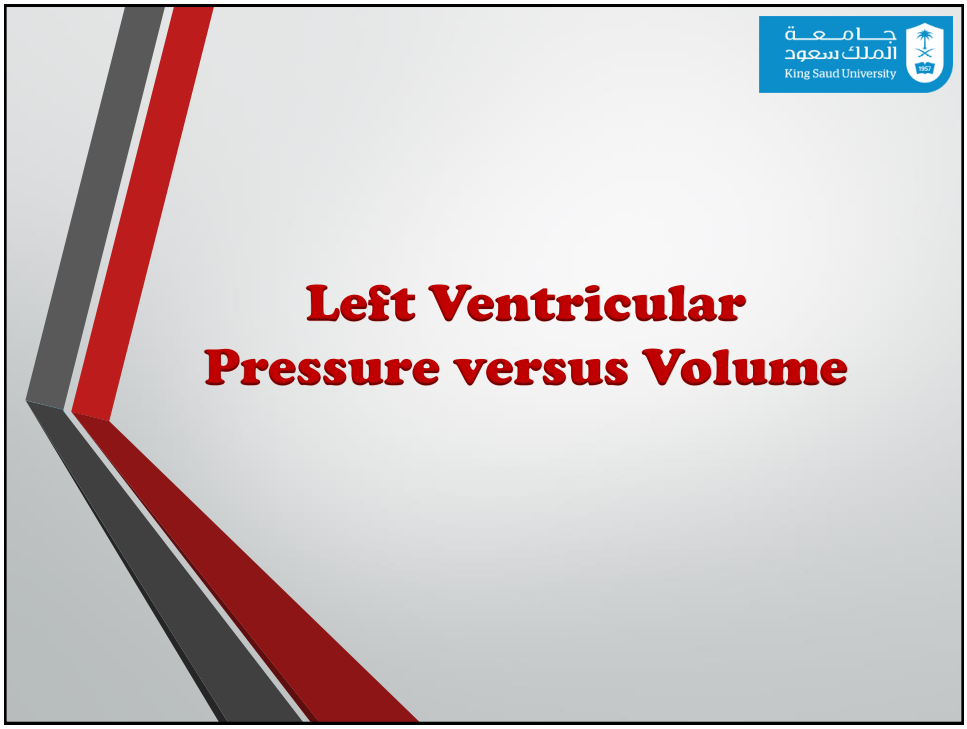
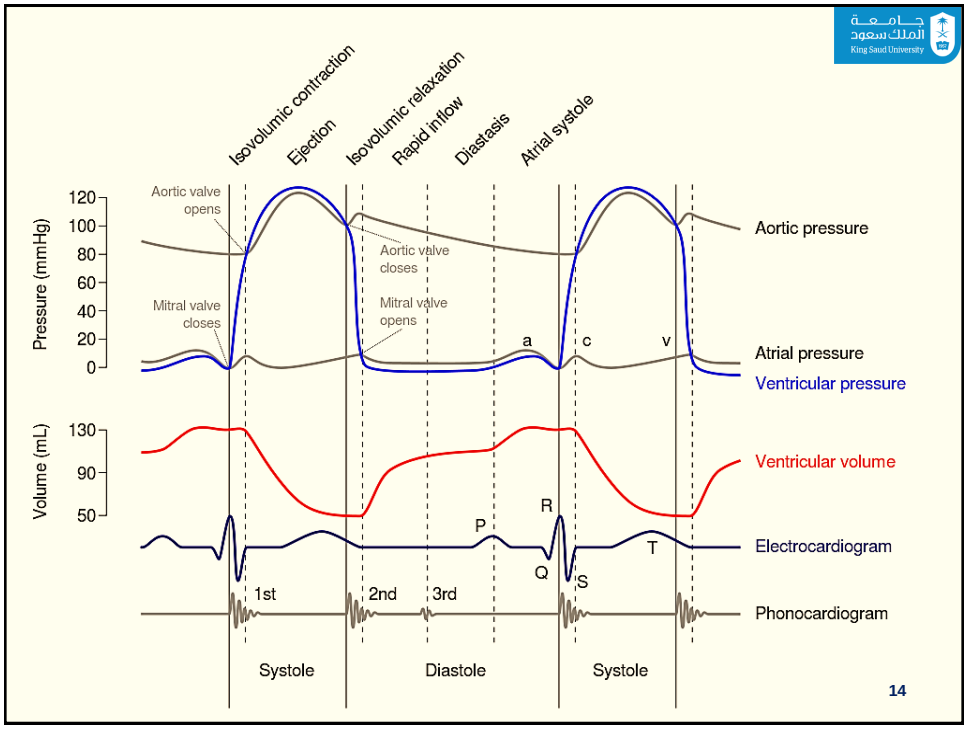

Left Ventricular
Pressure versus Volume

Left Ventricular Pressure – Volume Curve "The Complete Picture"



Left Ventricular Pressure - Volume Loop

Left Ventricular Pressure – Volume Loop

Correlation of intra-ventricular changes in volume & pressure that occur during one cardiac cycle

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Basic Myocardial Muscle Mechanics:

- Both ventricular systole & diastole can be divided into early & late phases.
- **Systole:**
  - Early systole = 'Isovolumetric Contraction.'
  - Late systole = Isotonic Contraction 'Ejection Phase.'
- **Diastole:**
  - Early diastole = 'Isovolumetric Relaxation.'
  - Late diastole = Isotonic Relaxation 'Filling Phase.'

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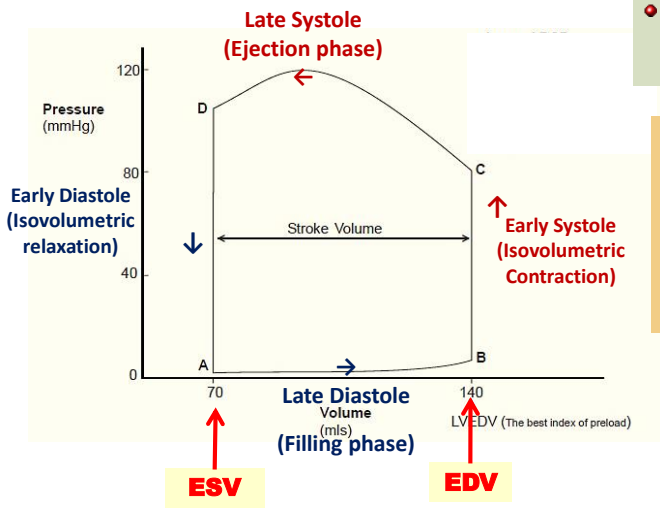
Ventricular Pressure - Volume Loop



- **Plots LV pressure against LV volume through one complete cardiac cycle**
- **Systole:** divided into,
  - Early systole
  - Late systole
- **Diastole:** divided into,
  - Early diastole
  - Late diastole

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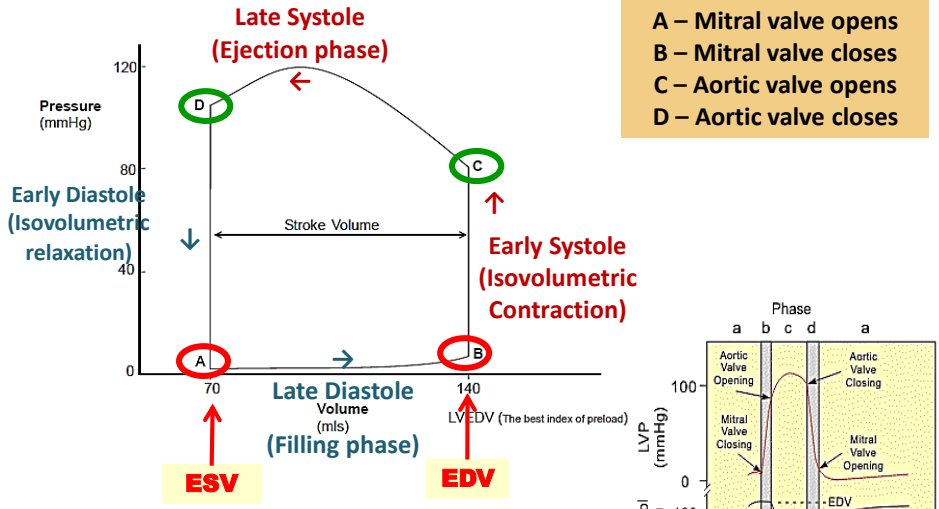
Ventricular Pressure - Volume Loop



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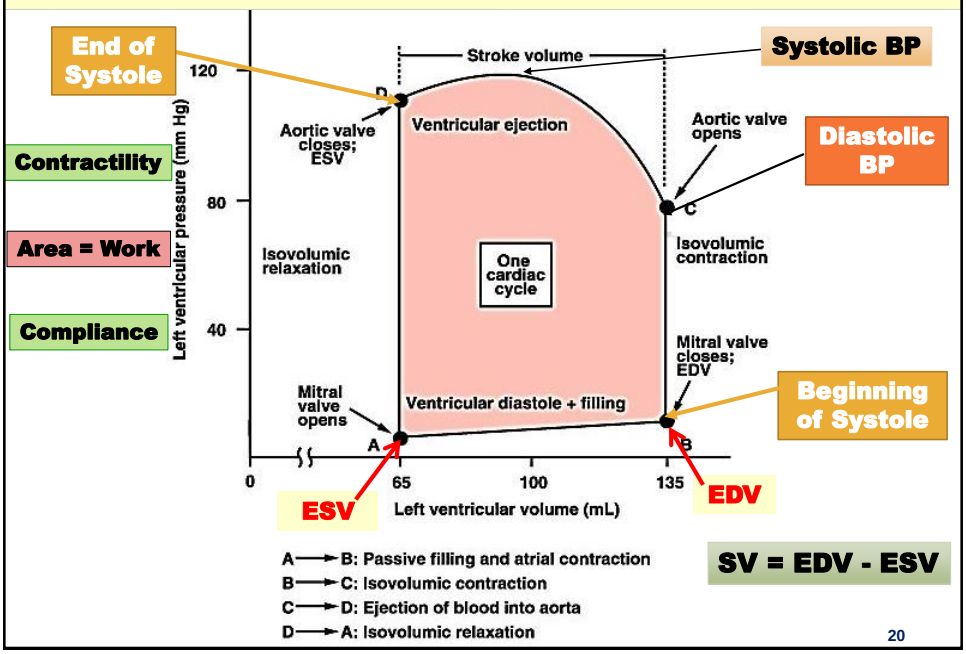
Ventricular Pressure - Volume Loop



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What you should remember about Pressure – Volume loop?

- Closer & opening of mitral & aortic- vs during each phase.
- Beginning of systole (B) & end (D.)
- Early & late systolic periods.
- Beginning of diastole (D) & end (B.)
- Early & late diastolic periods.
- Diastolic filling occurs between points A & B.
- Ejection occurs between points C & D.

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