Cardiac Cycle (CC4, unit4)

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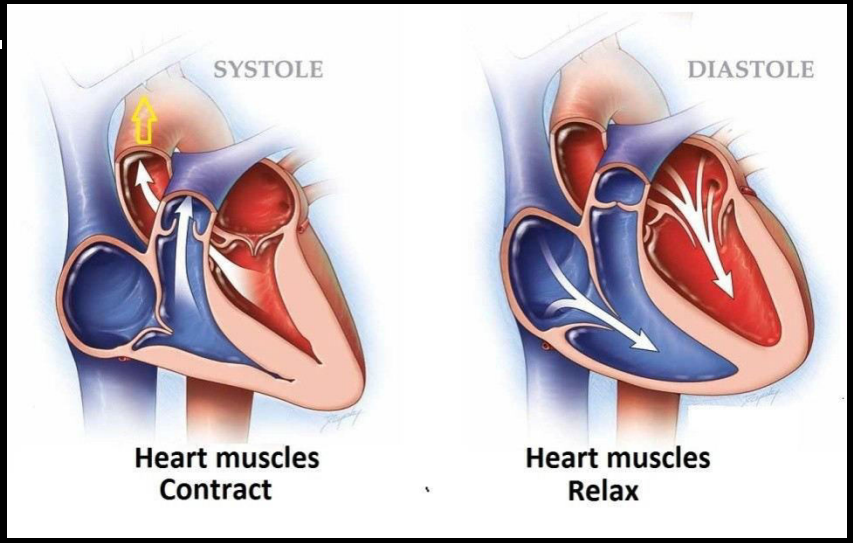
OBJECTIVES.

- Introduction
- Phases of cardiac cycle
- Events during cardiac cycle
- Duration of each phase
- Applied Physiology.

INTRODUCTION

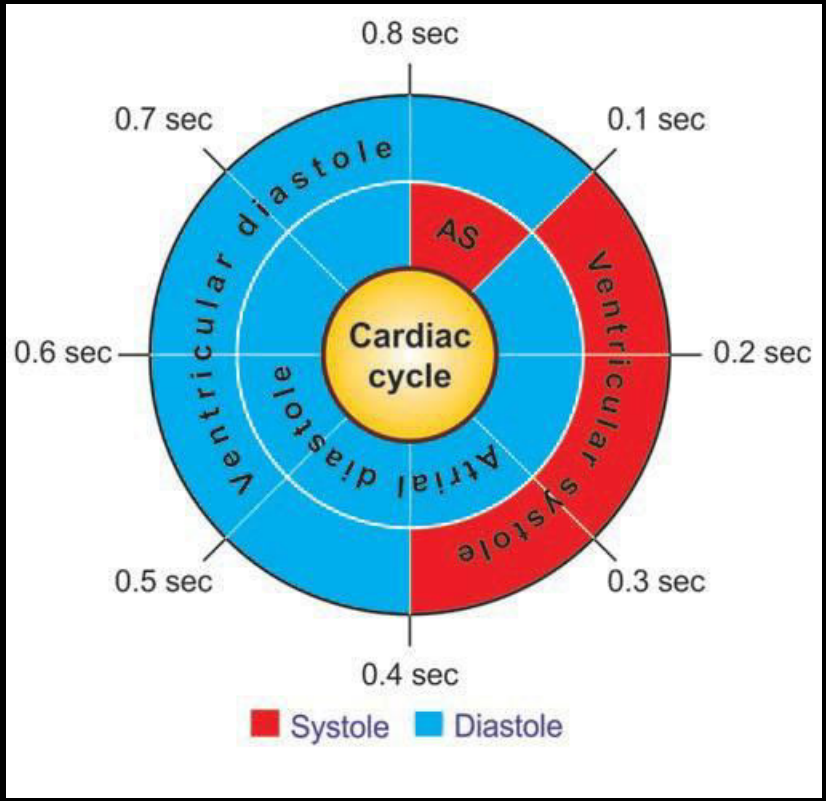
- The heart as a pump.
- 2 separate pump in series.
- **Systole** – contraction
- **Diastole** – relaxation.
- **Cardiac cycle** – both electrical & mechanical events from beginning of one heart beat to beginning of next.



DURATION OF CARDIAC CYCLE

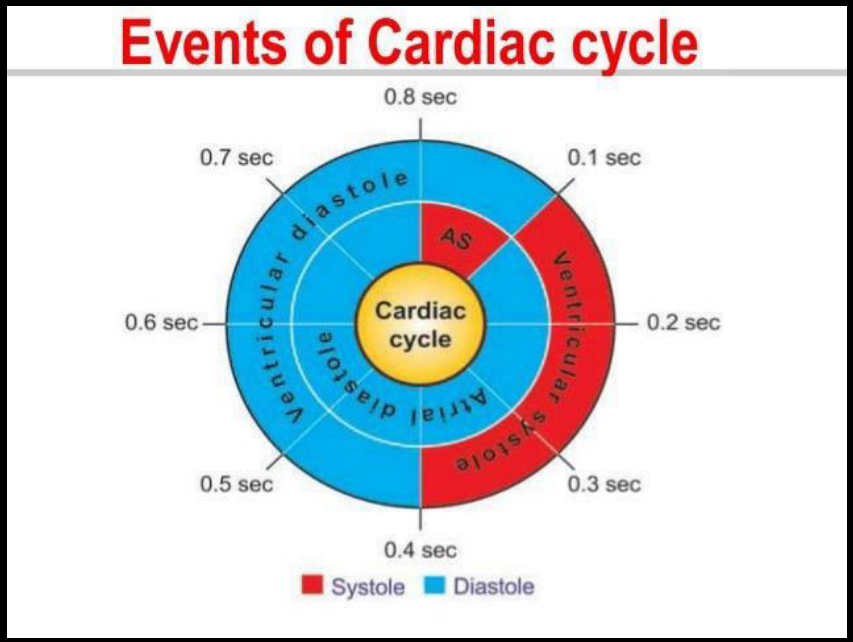
- IF Normal Heart rate is 75 beats /min
- Duration of one (1) beat = 60/75

  = 0.8 sec.



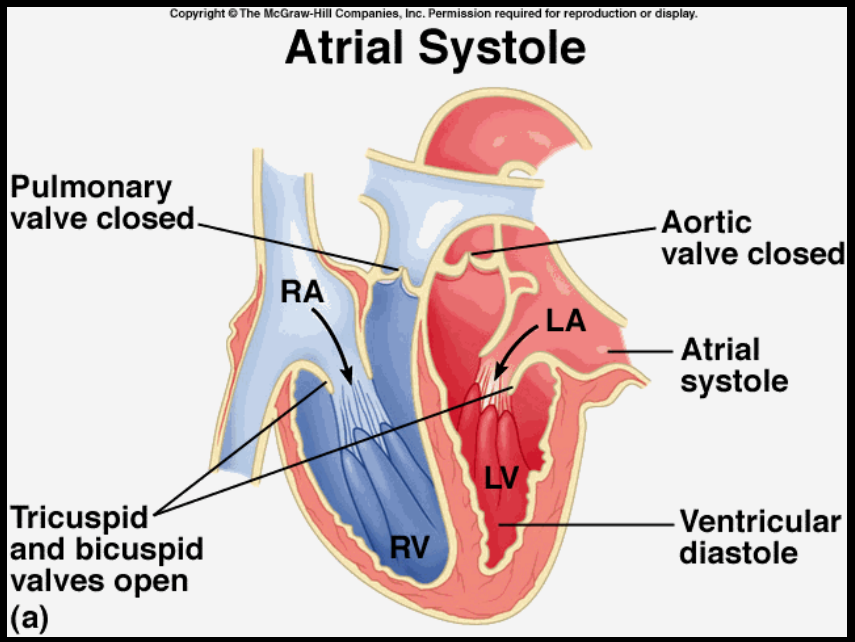
PHASES OF CARDIAC CYCLE

- **Atrial cycle (0.8)**
  - Atrial systole (0.1)
  - Atrial diastole (0.7)
- **Ventricular cycle (0.8)**
  - Ventricular systole (0.3)
  - Ventricular diastole. (0.5)



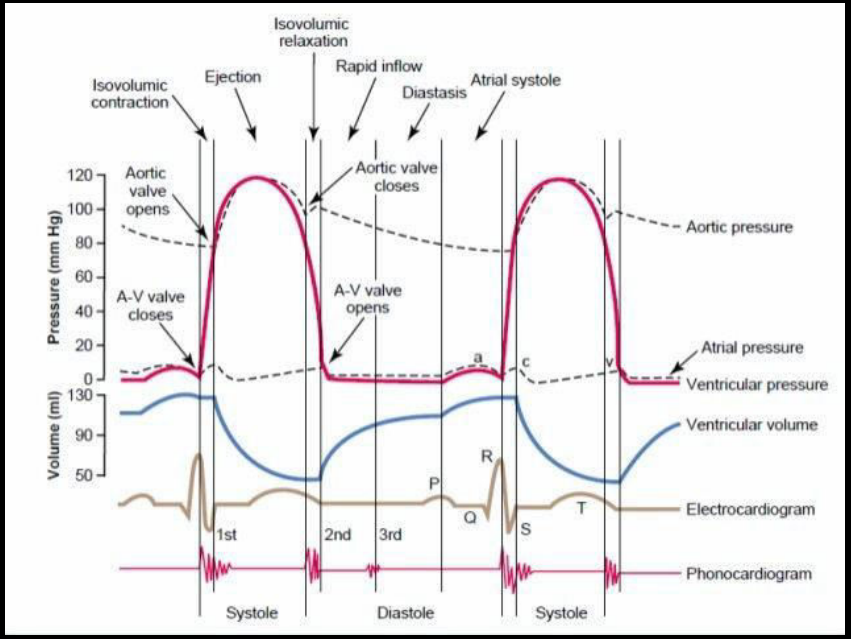
ATRIAL CYCLE

- **Atrial systole (0.1)**
- Coincide with last rapid filling phase of ventricles.
- Before this valves are open, ventricles relaxed with already 75% blood
- Contraction add only remaining 25% blood.



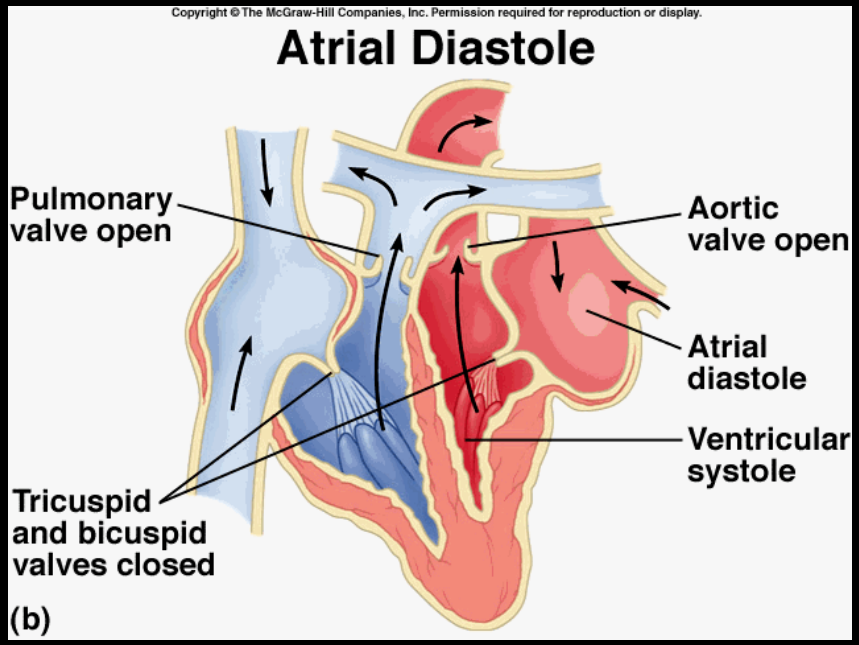
EFFECTS OF ATRIAL SYSTOLE.

- **Intraatrial pressure**
  - Right – 4-6mm Hg.
  - Left – 7-8 mm Hg.
- **Intraventricular pressure.**
- Narrowing of origin of great veins- Decreasing Venous Return.



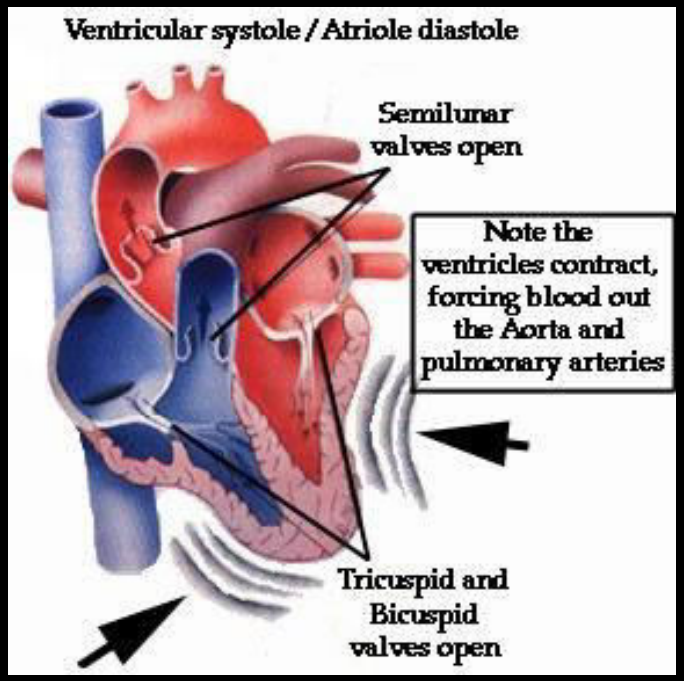
ATRIAL DIASTOLE (0.7)

- Coincide with Ventricular Systole & most of the ventricular diastole.
- **Atria Relax** – gradual filling of atria – pressure slowly increases.



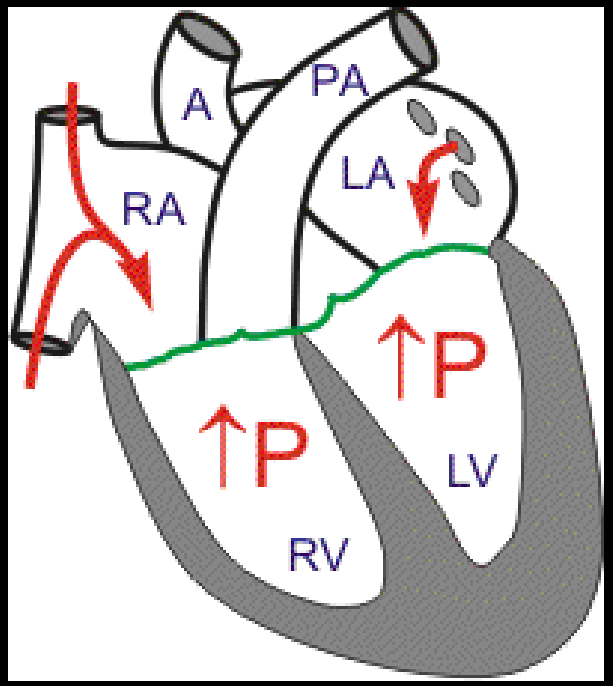
VENTRICULAR CYCLE

- **Ventricular systole (0.3) – phases**
  - Phase of Iso-Volumic (Iso-metric) Contraction
  - Phase of ventricular ejection.
    - Rapid phase
    - Slow phase.



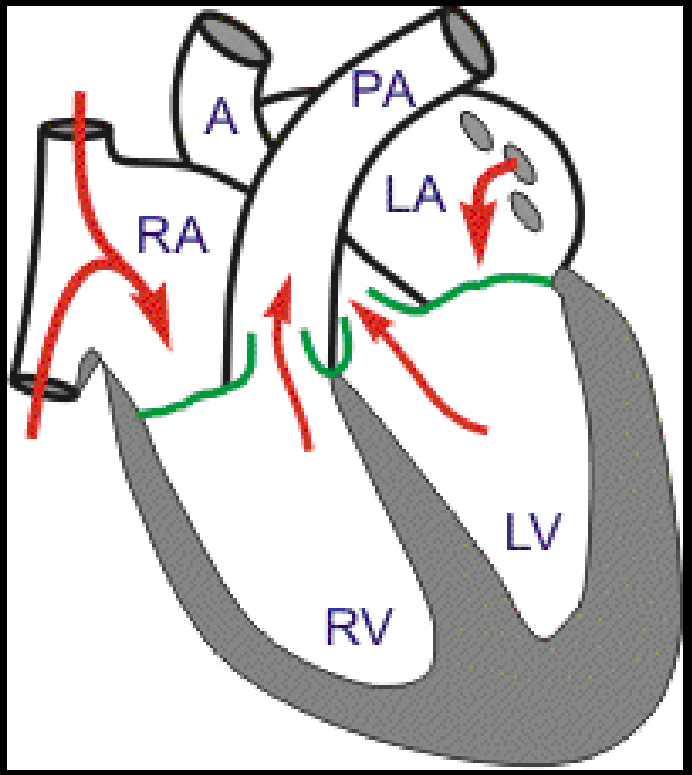
VENTRICULAR CYCLE (cont….)

- Phase of Iso-Volumic (Iso-metric) Contraction (0.05)
- When intra-ventricular pressure rises – closes AV valves – semilunar valves not yet open – so contracts as closed chamber.
- No change in volume so called – Iso-Volumic contraction.
- Sharp rise in Intraventricular pressure



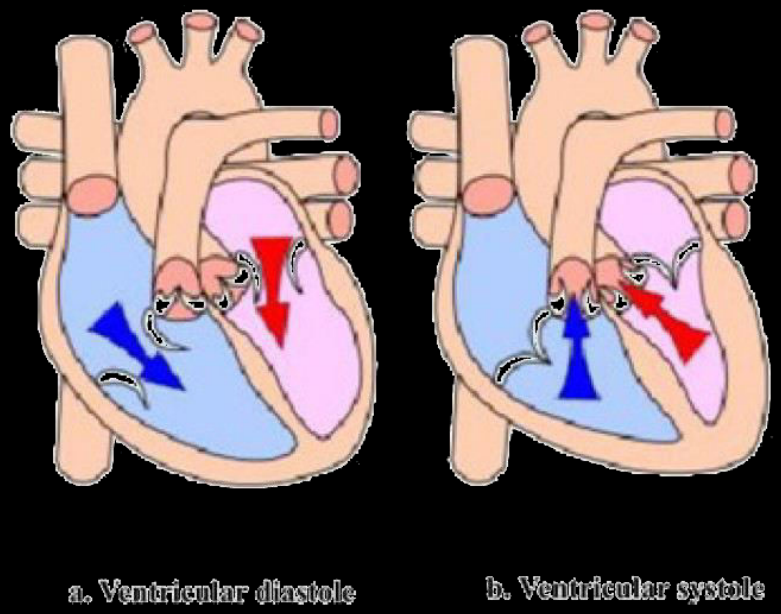
VENTRICULAR CYCLE (cont….)

- **Phase of ventricular ejection (0.25)** – begins with opening of semilunar valves.
- **Rapid phase (0.1)** – 2/3rd of stroke volume ejected.
  - Rt ventricles velocity is less than left but duration is more.
- **Slow phase.(0.15)** – 1/3rd of stroke volume ejected.



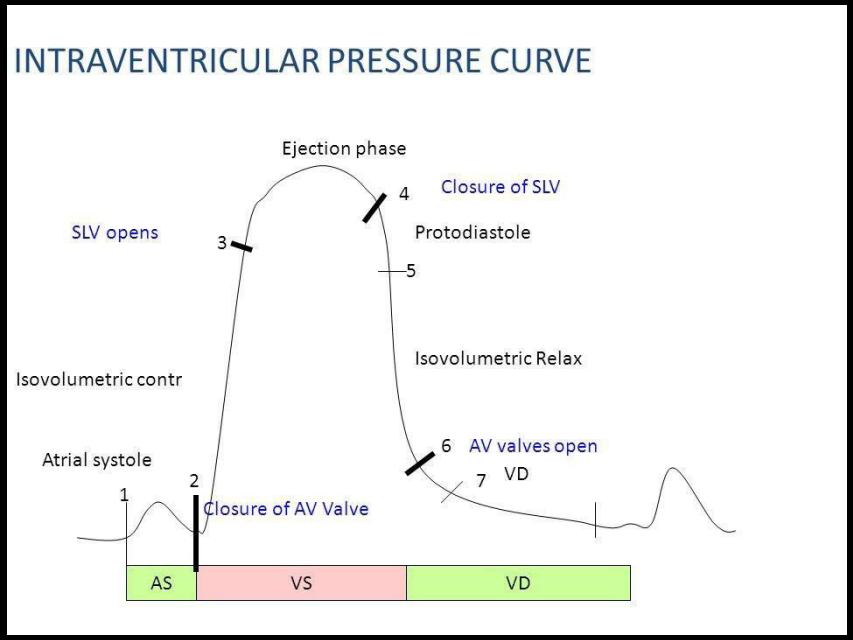
VENTRICULAR CYCLE

- **Venntricular Diastole (0.5) – phases**
  - Protodiastole
  - Isovolumic or Isometric Relaxation phase.
  - Rapid passive filling phase.
  - Reduced filling & Diastosis
  - Last rapid filling phase.



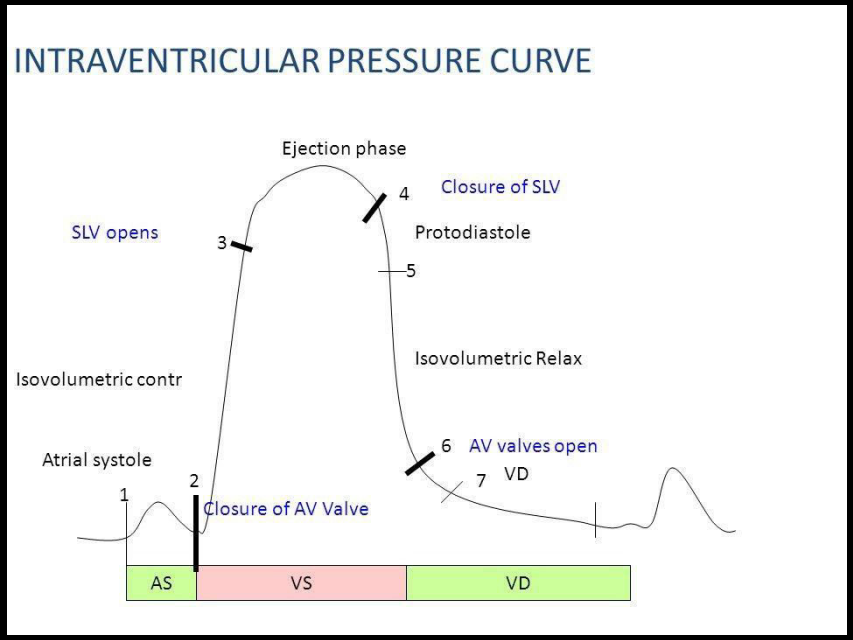
PROTODIASTOLE 0.04 sec.

- Ventricular systole ends – ventricles relax – Intraventricular pressure falls – blood comes back from vessels to ventricles – semilunar valves closes – **2nd heart sound**
- Causes **Diacrotic Notch** in pulse.



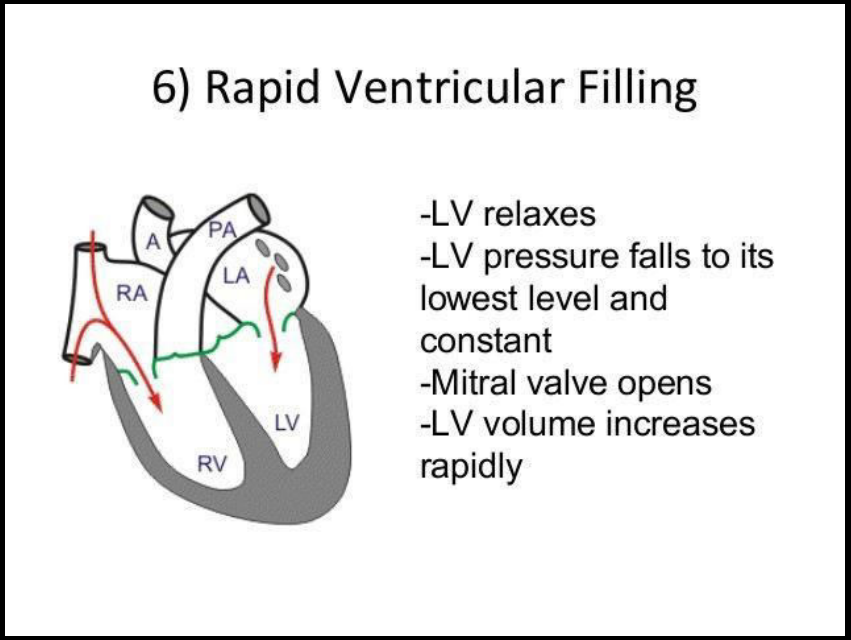
ISOVOLUMIC OR ISOMETRIC

- Lasts for 0.06 sec
- Begins with closure of semilunar valves.
- A-V valves not yet open – relax as closed chamber – as volume remains same – Iso-Volumic relaxation.
- Ends with opening of A-V valves



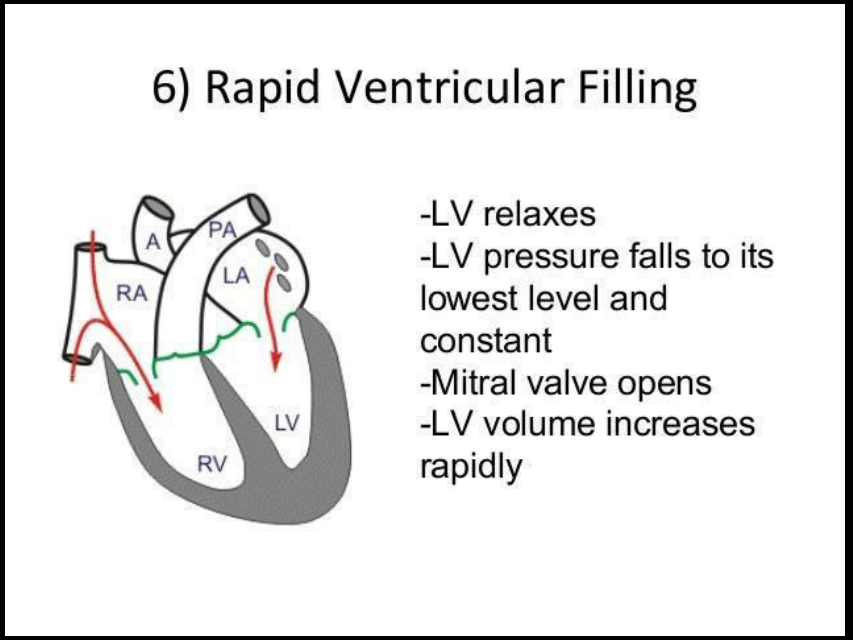
RAPID PASSIVE FILLING PHASE.

- As A-V valves open atria till now in diastole filled with venous return with increased pressure causes – rapid passive filling of ventricles (**3rd heart sound**)



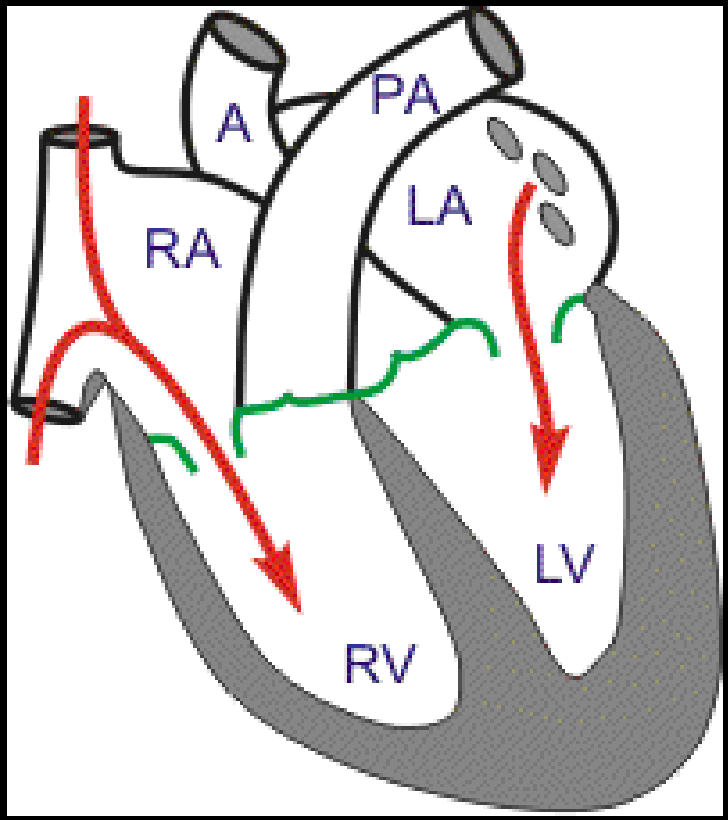
REDUCED FILLING & DIASTOSIS

- As ventricles filling continues pressure differences reduces – so filling rate decreases – **Diastasis**.
- Total blood transferred with rapid & slow filling is **75%** of total atrial blood.



LAST RAPID FILLING PHASE.

- As said earlier – it coincide with atrial systole – add remaining **25 %** of blood to ventricles.
- With this ventricular cycle completes.

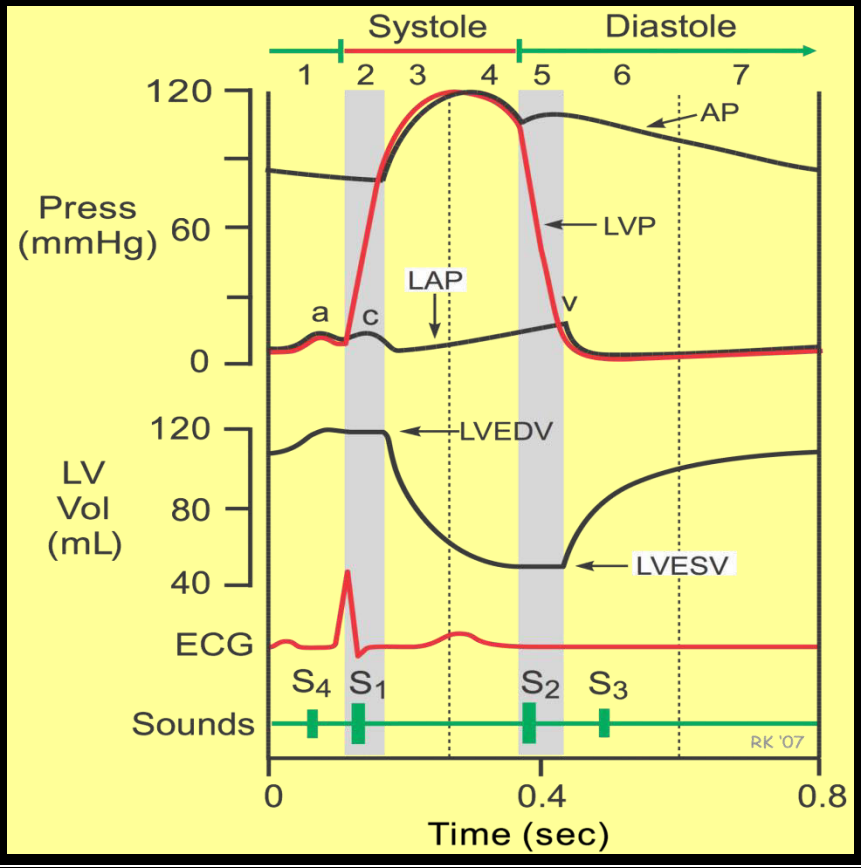


EVENTS DURING CARDIAC CYCLE

- **Pressure changes.**
  - In Ventricles
  - In Atria.
  - In Aorta
  - In Pulmonary Artery.
- **Volume changes.**
- In ventricles
  - During Atrial systole
  - During Ventricular systole.

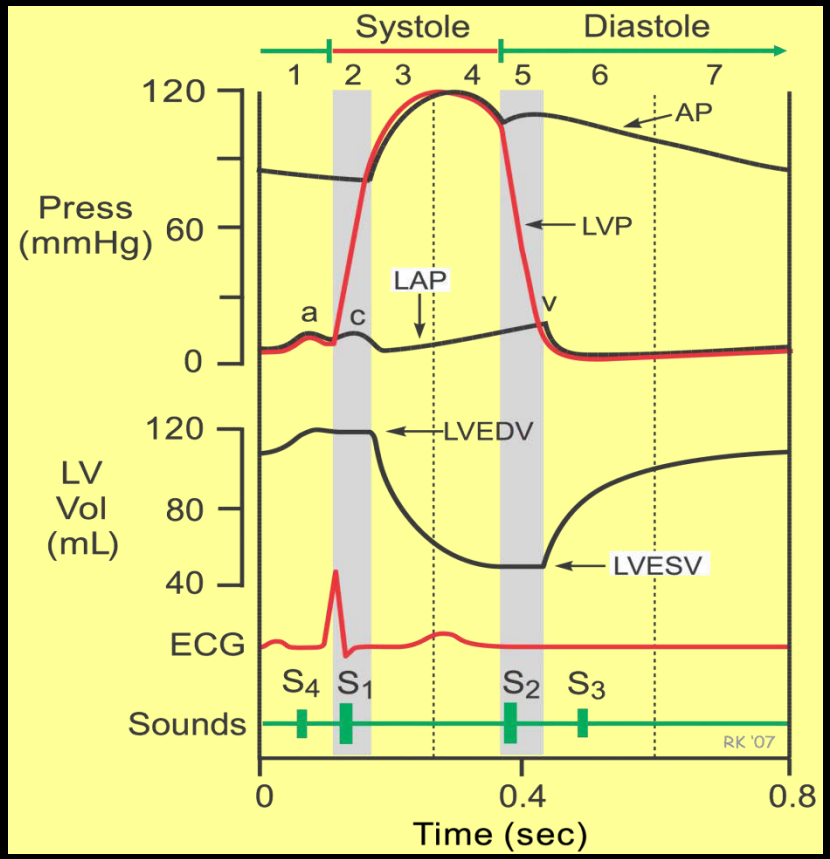
PRESSURE CHANGES. IN VENTRICLES

- During Atrial systole
- Ventricular systole
- Ventricular diastole.



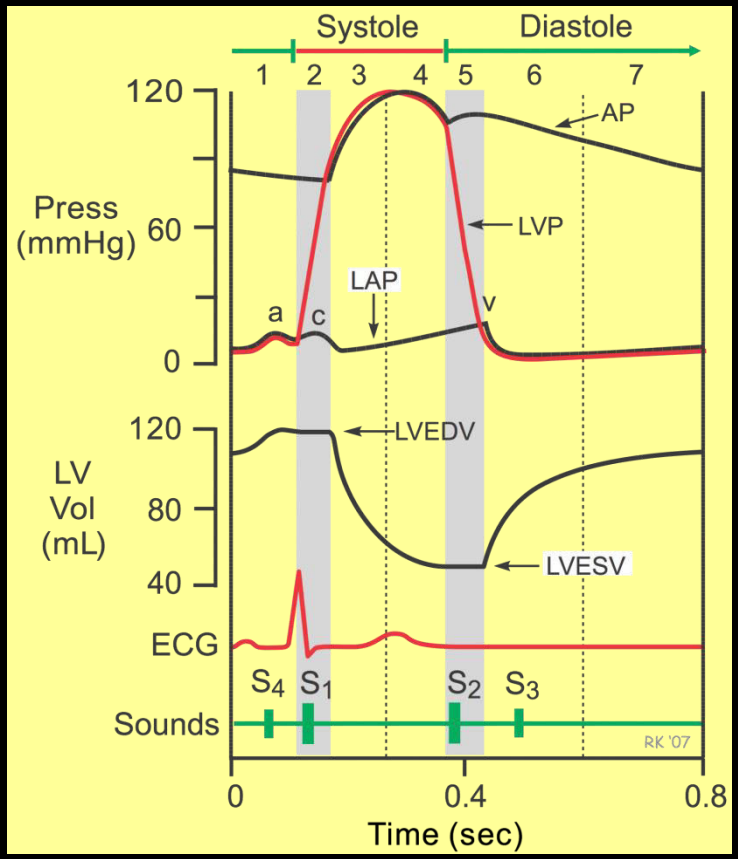
PRESSURE CHANGES. IN VENTRICLES DURING ATRIAL SYSTOLE

- Which coincide with last rapid filling phase of ventricles – pressure in ventricles is just above zero – with contraction pressure rises
- **Right – 6-7mm Hg.**
- **Left – 7-8 mmHg.**



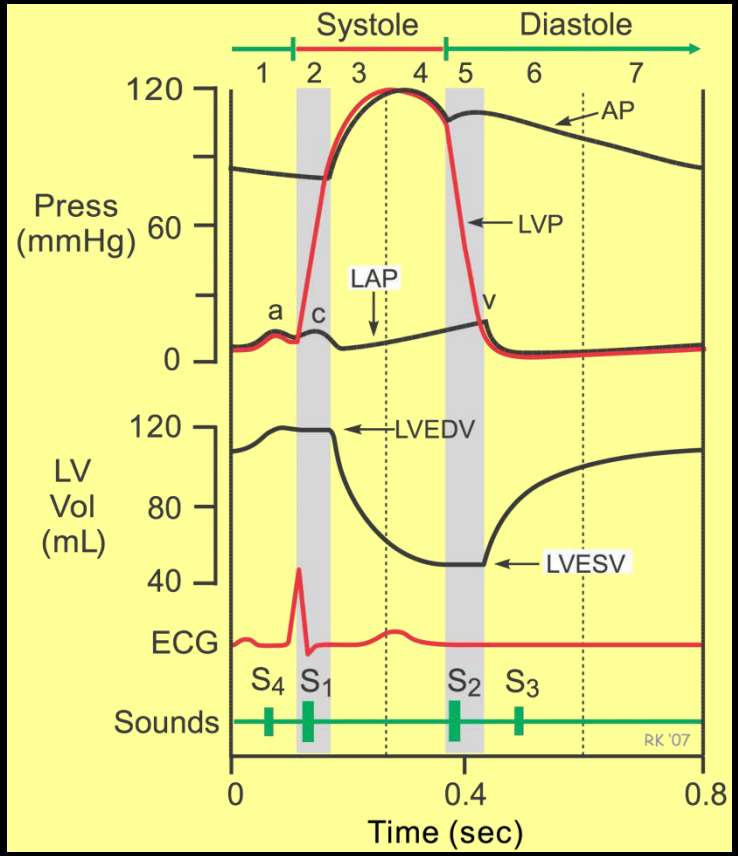
PRESSURE CHANGES. IN VENTRICLES DURING VENTRICULAR SYSTOLE

- **Iso-volumic contraction – 80mm Hg.**
- **Rapid ejection phase**
  - 120 mm Hg left side.
  - 80 mm Hg right side.
- **Slow ejection phase.**
  - Pressure starts declining.



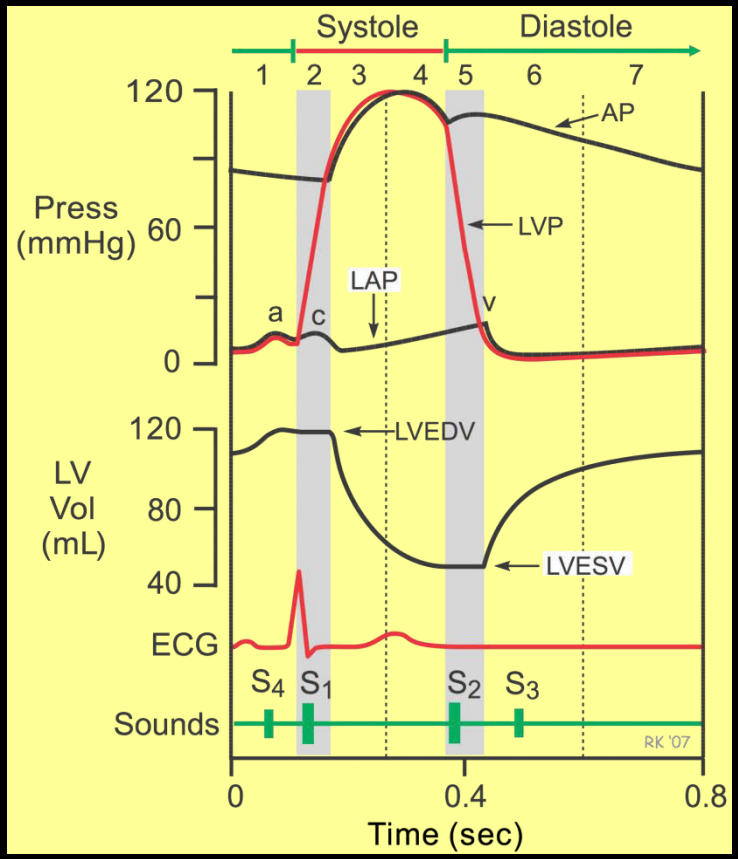
PRESSURE CHANGES. IN VENTRICLES VENTRICULAR DIASTOLE.

- **Protodiastole** – pressure drops rapidly – upto 80 mmHg.
- **Iso-volumic or Isometric Relaxation phase** – 2-3 mm Hg.
- Rapid passive filling phase – further falls (GH)
- Reduced filling & Diastosis – Pressure just above zero.
- Last rapid filling phase.



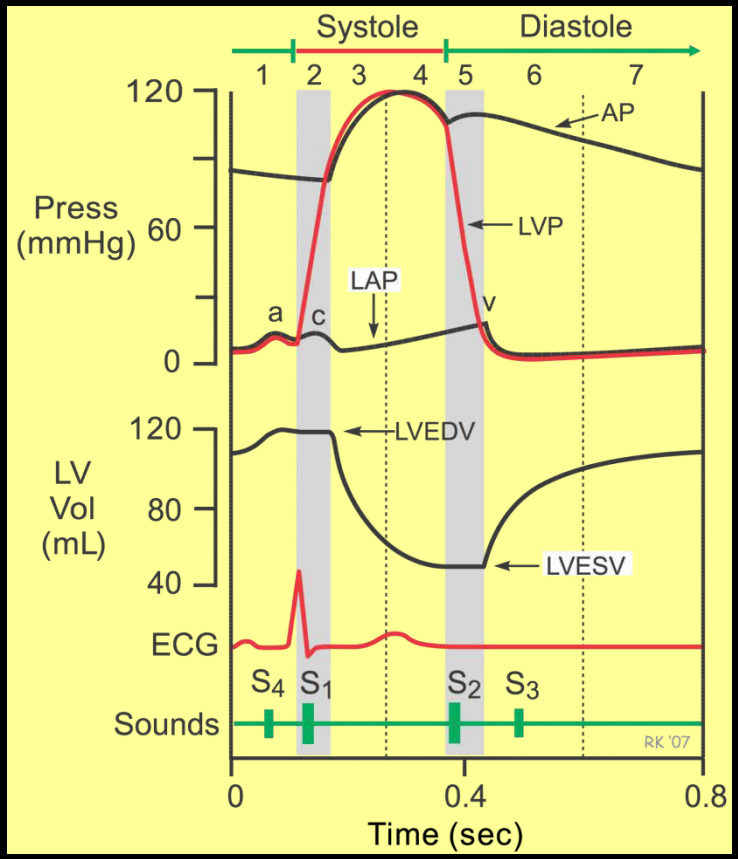
PRESSURE CHANGES IN ATRIA. DURING ATRIAL SYSTOLE

- Just before systole pressure is just above zero & slightly greater than ventricles
- During systole sharply increases left – 7-8 mm Hg & right 6-7 mmHg.
- Causes **'a' wave in JVP**.



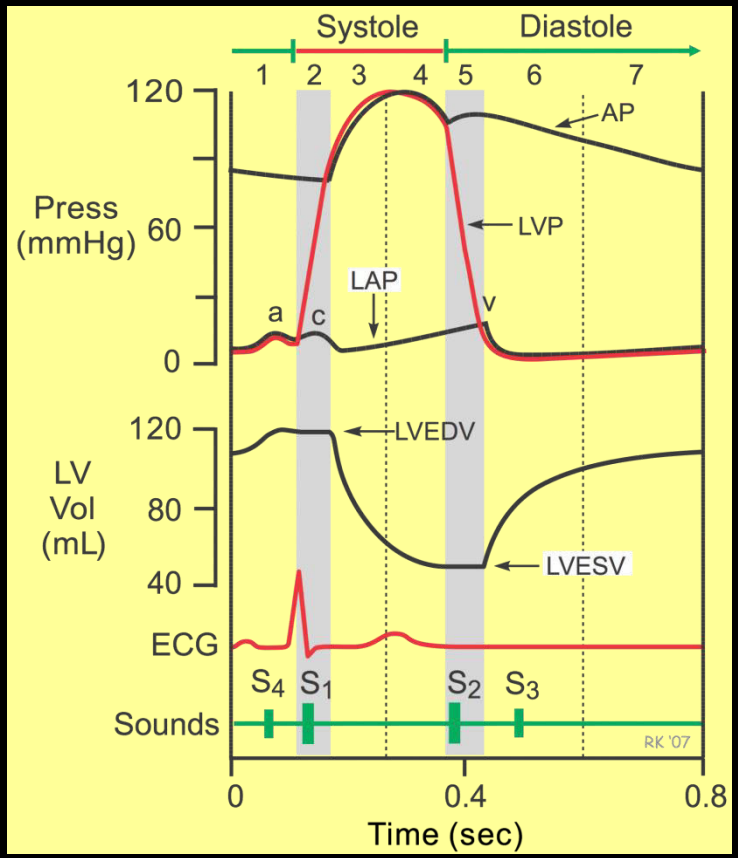
PRESSURE CHANGES IN ATRIA. DURING VENTRICULAR SYSTOLE.

- **Isometric contraction** – due to sharp rise in pressure- A-V valves bulges in atria – 'c' wave
- **Ejection phase**
  - Intra-atrial pressure drops sharply.
  - As papillary muscles pull A-V valves down – atrial volume rises & pressure decreases.



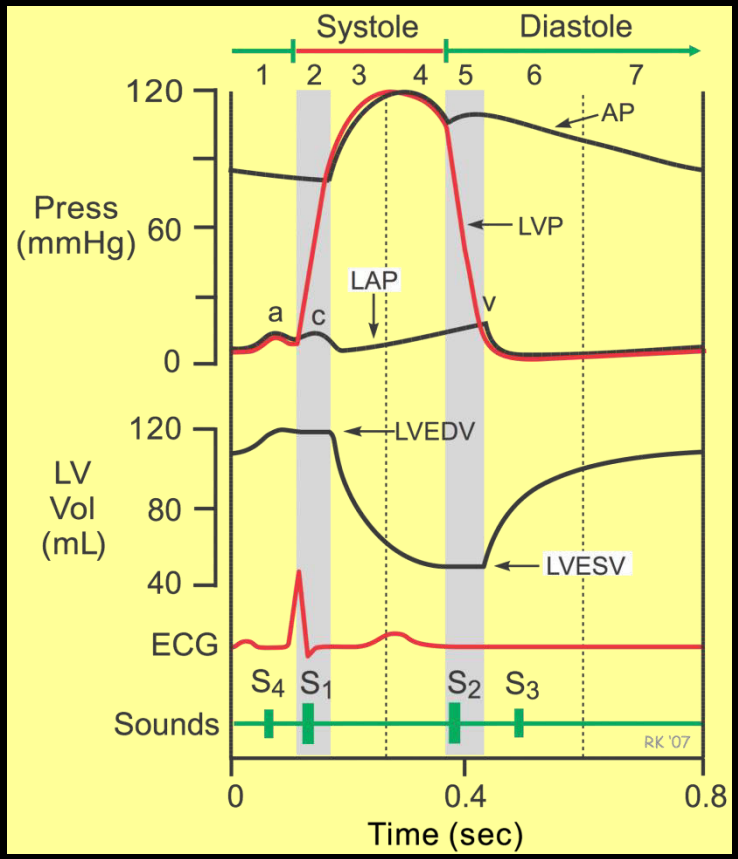
PRESSURE CHANGES IN ATRIA. DURING VENTRICULAR DIASTOLE.

- **Iso-volumic relaxation phase** – as A-V valve remains closed, due to venous filling – form 'v' wave in JVP
- **Rapid passive filling phase** – As A-V valves open passive filling – Atrial pressure drops down just above zero.



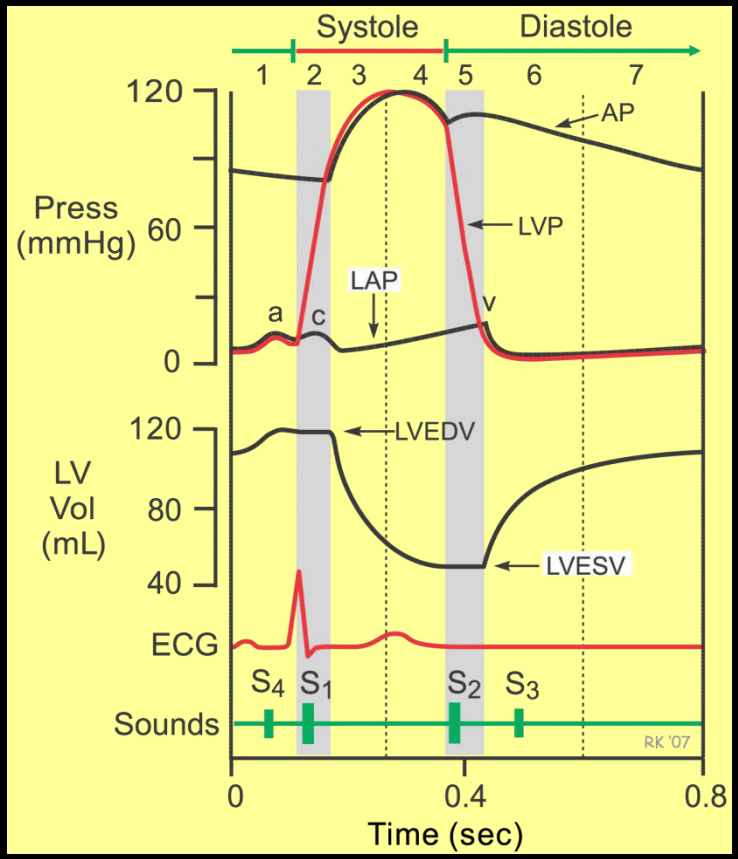
PRESSURE CHANGES IN AORTA DURING ATRIAL SYSTOLE

- Pressure in Aorta is **80 mm Hg.**



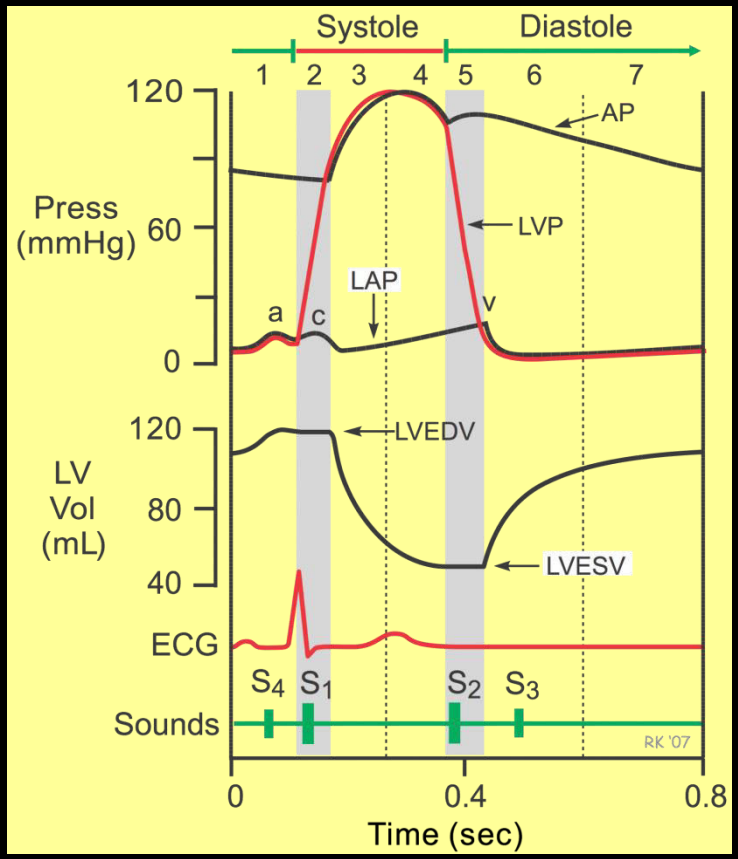
PRESSURE CHANGES IN AORTA DURING VENTRICULAR SYSTOLE

- **During ventricular systole** – aortic pressure is less than intraventricular pressure.
- As systole continues pressure reaches equal to ventricles (**120mm** Hg)



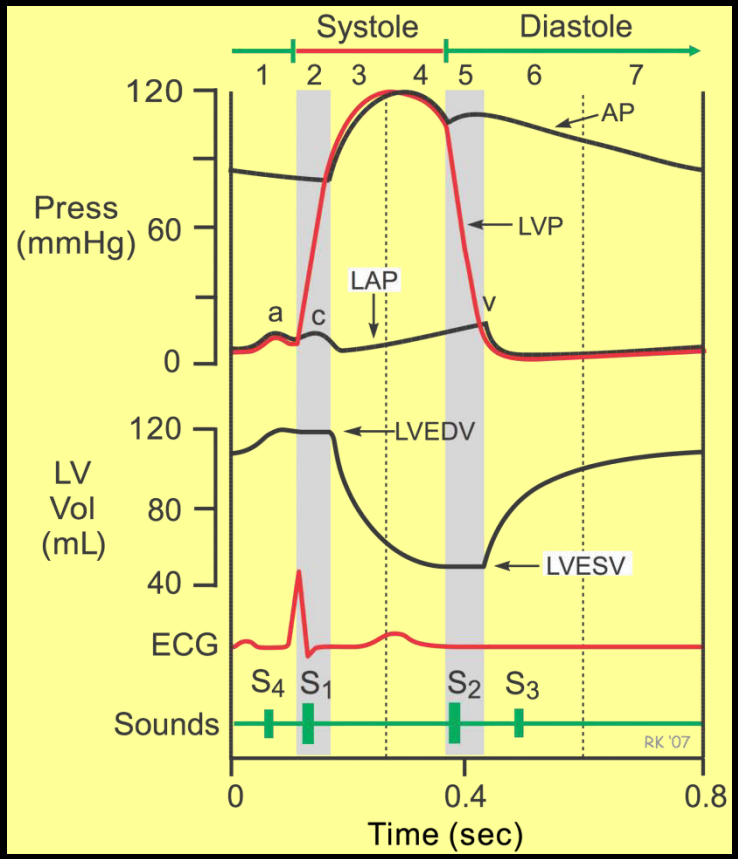
PRESSURE CHANGES IN AORTA DURING VENTRICULAR DIASTOLE

- **During Protodiastole** – Aortic pressure is higher than ventricles – back flow of blood – 2nd HS & Diacrotic notch.
- **Rest of diastole** – aortic pressure decline slowly up to 80 mm Hg.



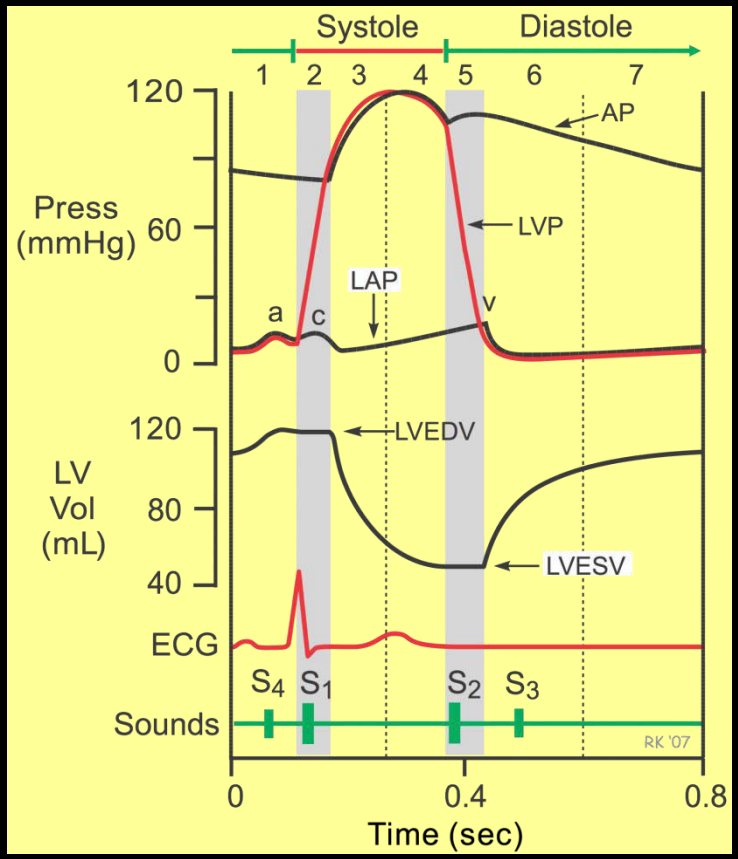
PRESSURE CHANGES IN PULMONARY ARTERY.

- Similar to Aorta but pressures are low.
- Systolic pressure goes up to **15-18 mm Hg**.
- Diastolic pressure up to **8-10 mm Hg.**



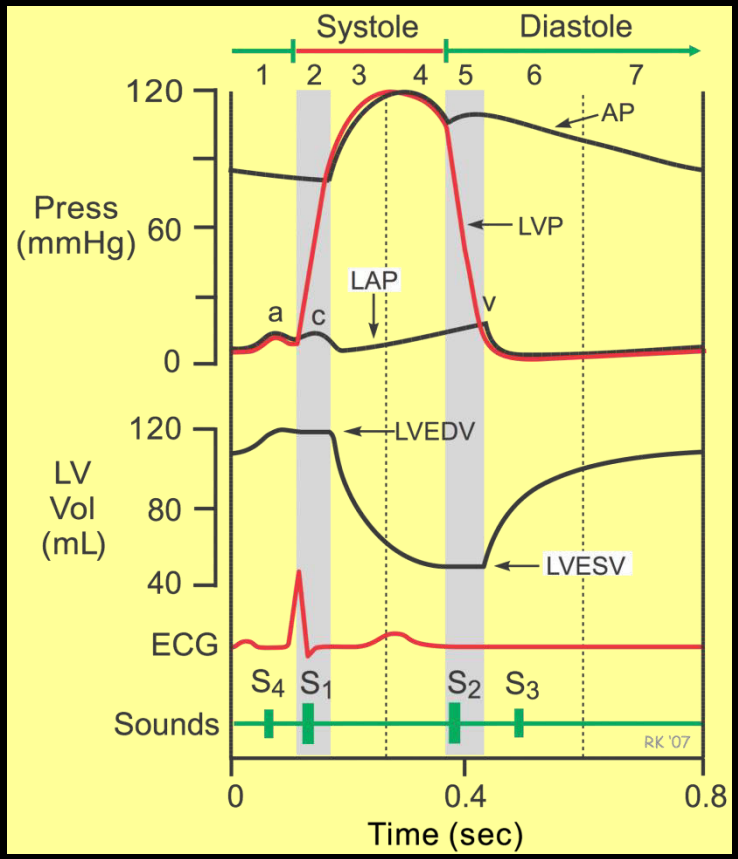
VOLUME CHANGES. IN VENTRICLES

- **During Atrial systole**
- Coincide with last rapid filling phase
- Out of total **130 ml (EDV)** in ventricles, **105 ml (75%)** blood already reaches ventricle before systole
- **25 ml (25%)** transferred due to atrial systole.



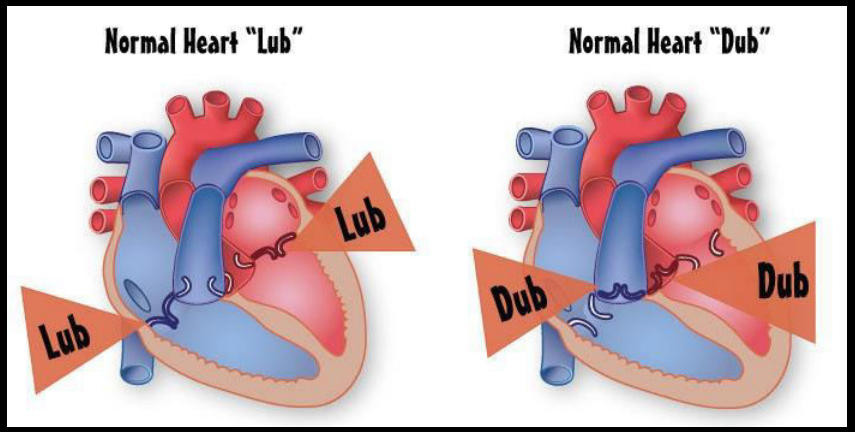
VOLUME CHANGES. IN VENTRICLES

- **During Ventricular systole.**
  - Iso-volumic contraction – no change
  - Ejection phase – 80 ml stroke volume,
  - Ejection fraction (80/130) = 65%
  - ESV = 50 ml.



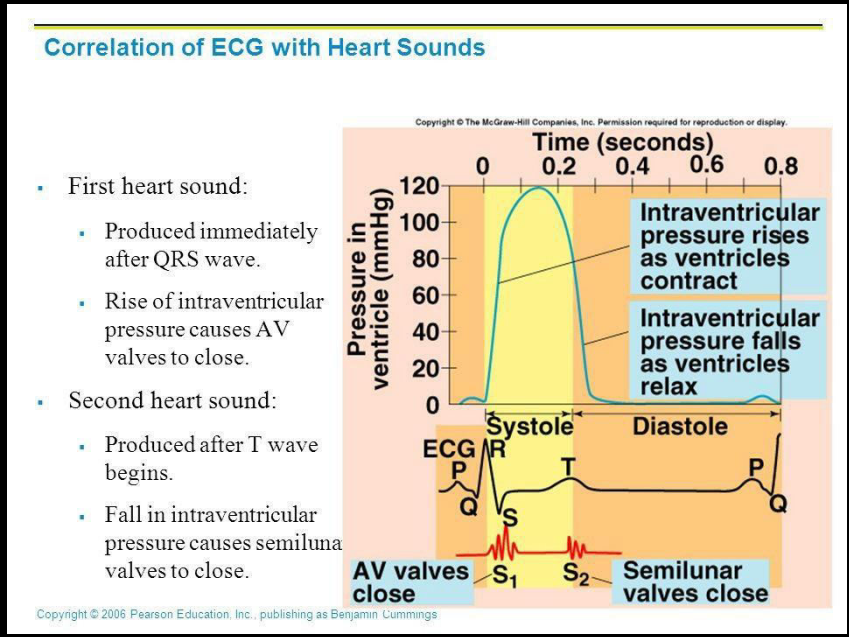
VALVULAR EVENTS (HEART SOUNDS)

- First heart sound
- Second heart sound
- Third heart sound
- Fourth heart sound



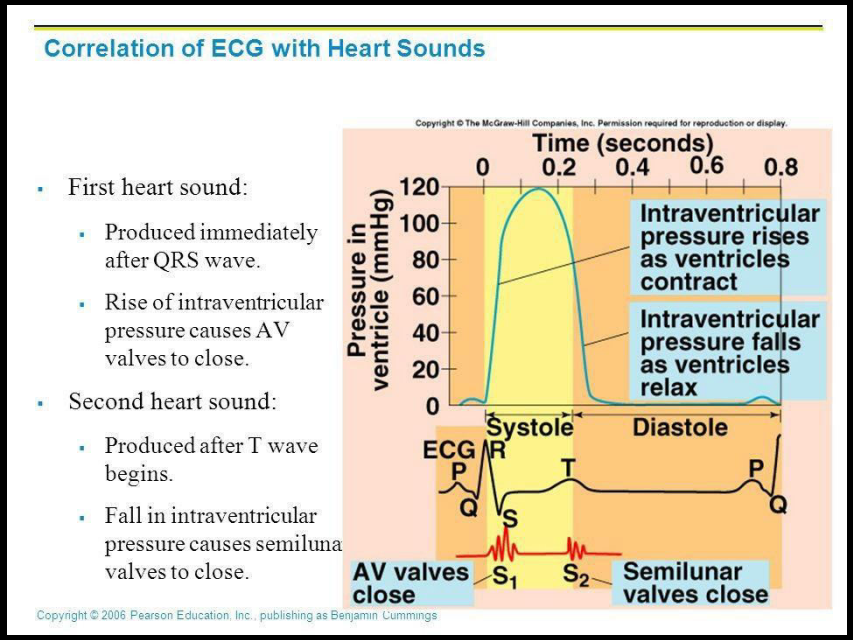
FIRST HEART SOUND

- **Cause** – closure of A-V valves.
- **Characteristics** – 'LUBB', duration -0.15 sec, freq – 25-45 Hz.
- **Site for auscultation** – Mitral & Tricuspid area.
- **Correlation with ECG** – coincide with peak of R wave.



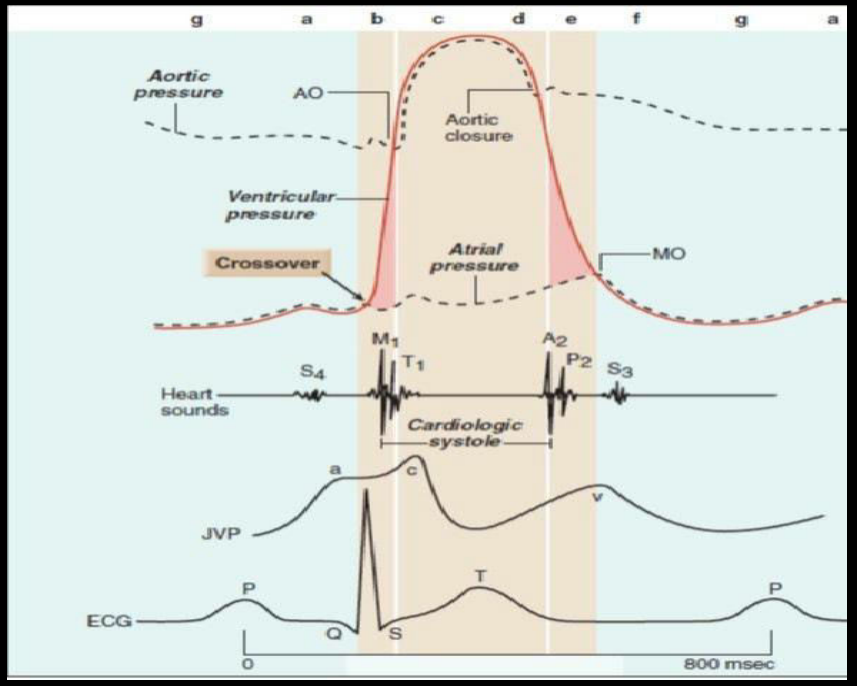
SECOND HEART SOUND

- **Cause** – closure of semilunar valves.
- **Characteristics** – 'DUBB', duration – 0.12 sec, freq – 50Hz.
- **Site for auscultation** – Aortic & Pulmonary area.
- **Correlation with ECG** – coincide with T wave.



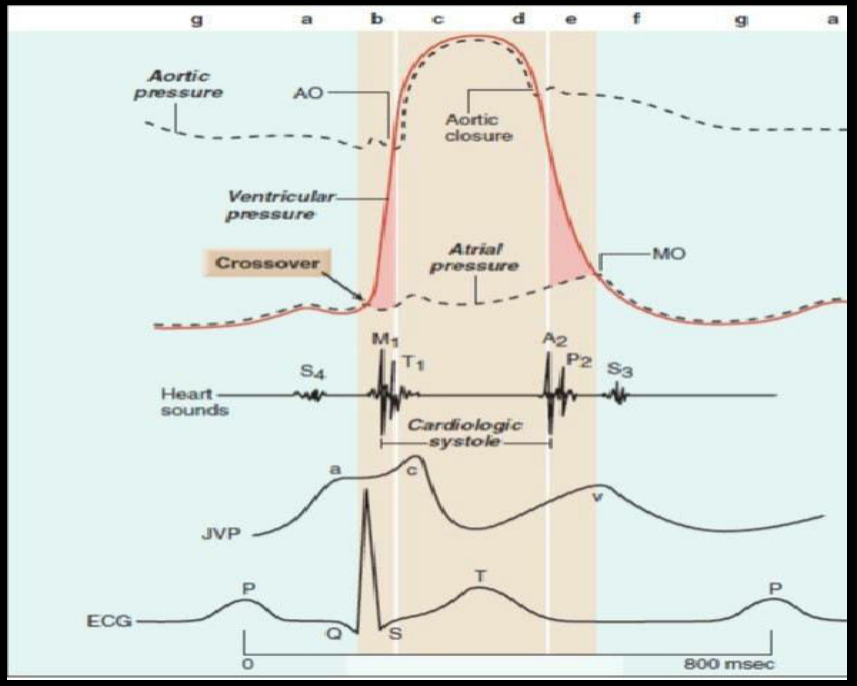
THIRD HEART SOUND

- **Cause** – Inrush of blood during rapid filling phase.
- **Characteristics** – Duration – 0.1 sec.
- **Correlation with ECG** – appears between T & P wave.



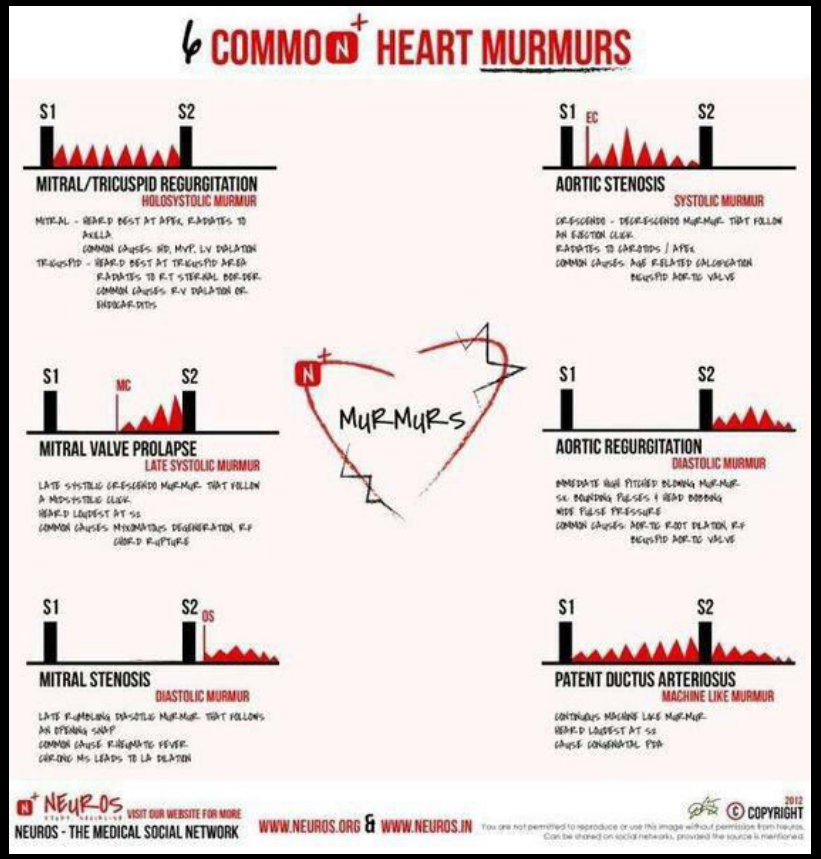
FOURTH HEART SOUND

- **Cause** – last rapid filling phase.
- **Characteristics** – Duration 0.03 sec, freq- 3 Hz.
- **Correlation with ECG** – appears between P wave 7 onset of Q wave.



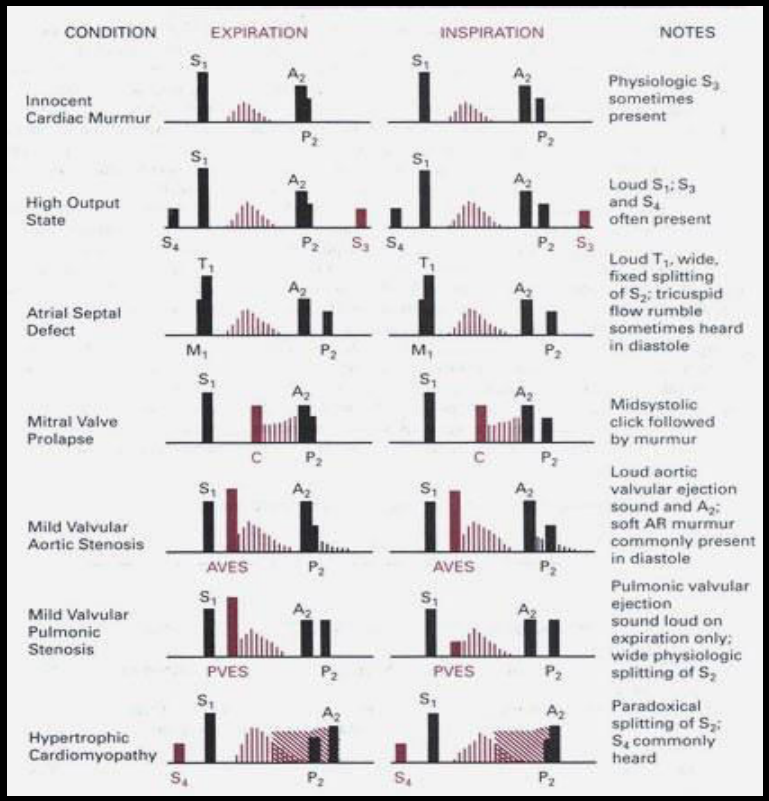
CARDIAC MURMURS

- **Abnormal** heart sounds during cardiac cycle.
- **Mechanism of production** – produced due to turbulent blood flow.



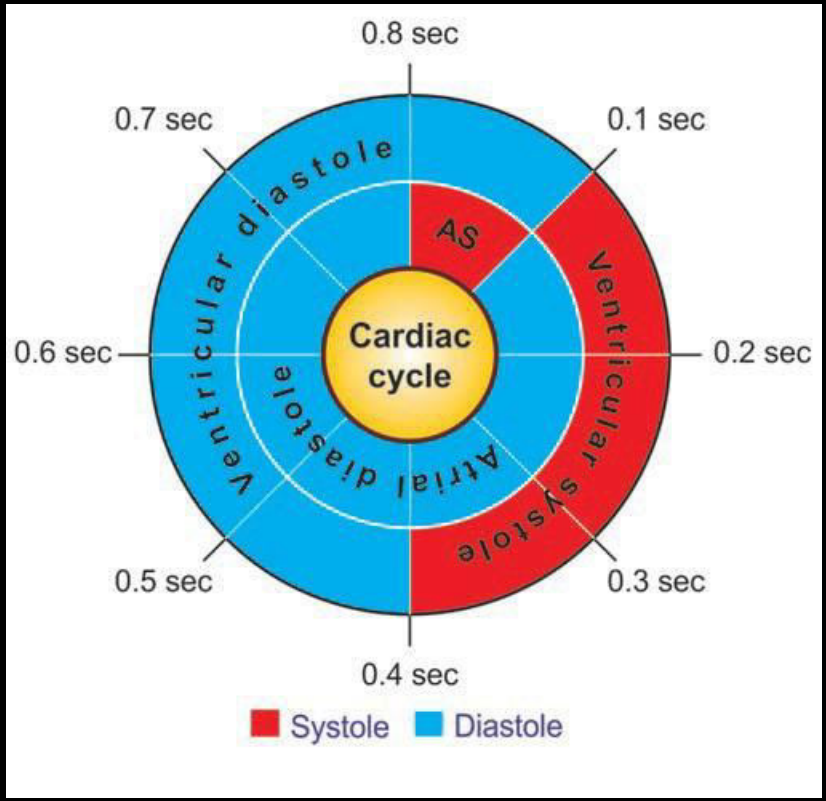
CARDIAC MURMURS

- **Causes** –
  - Valvular stenosis
  - Valvular insufficiency
  - Valvular septal defect.
  - Coarctation of aorta
- **Types**
  - Systolic
  - Diastolic
  - Continuous.



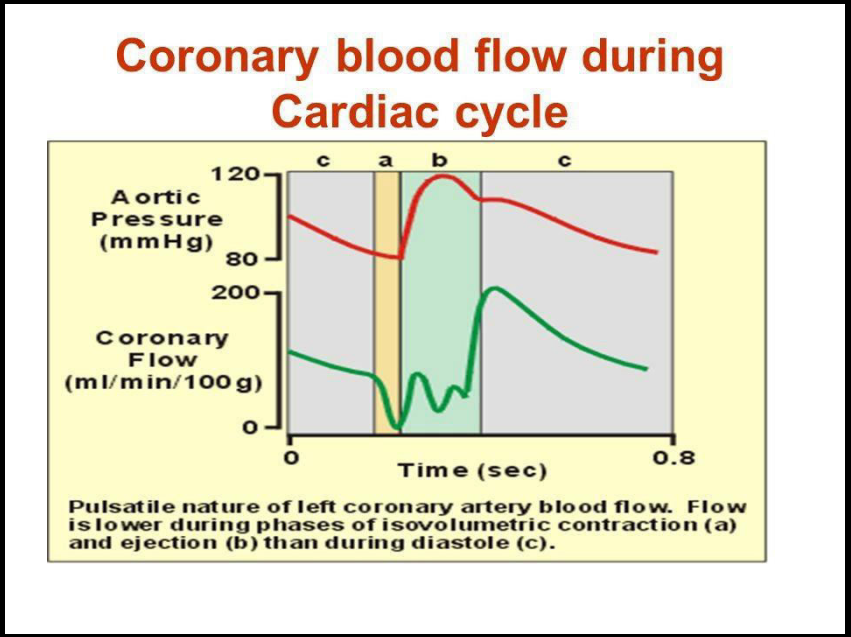
DURATION OF EACH PHASE

- **Effect of heart rate –**
- As HR ↑ – cardiac cycle duration ↓
- If HR 200, CC = 60/200 = 0.3 sec.
- Duration of each phases ↓
- But diastole ↓ > systole



APPLIED PHYSIOLOGY.

- **Coronary blood flow** to subendocardial area occurs during diastole – so diastole duration ↓ cardiac perfusion ↓
- Ventricular filling also occurs during diastole ↑ HR ↓ CO




"Life is like riding a bicycle, to stay balanced you must keep moving."

THANK YOU