Cardiovascular System Block
Heart Sounds & Murmurs
(Physiology)

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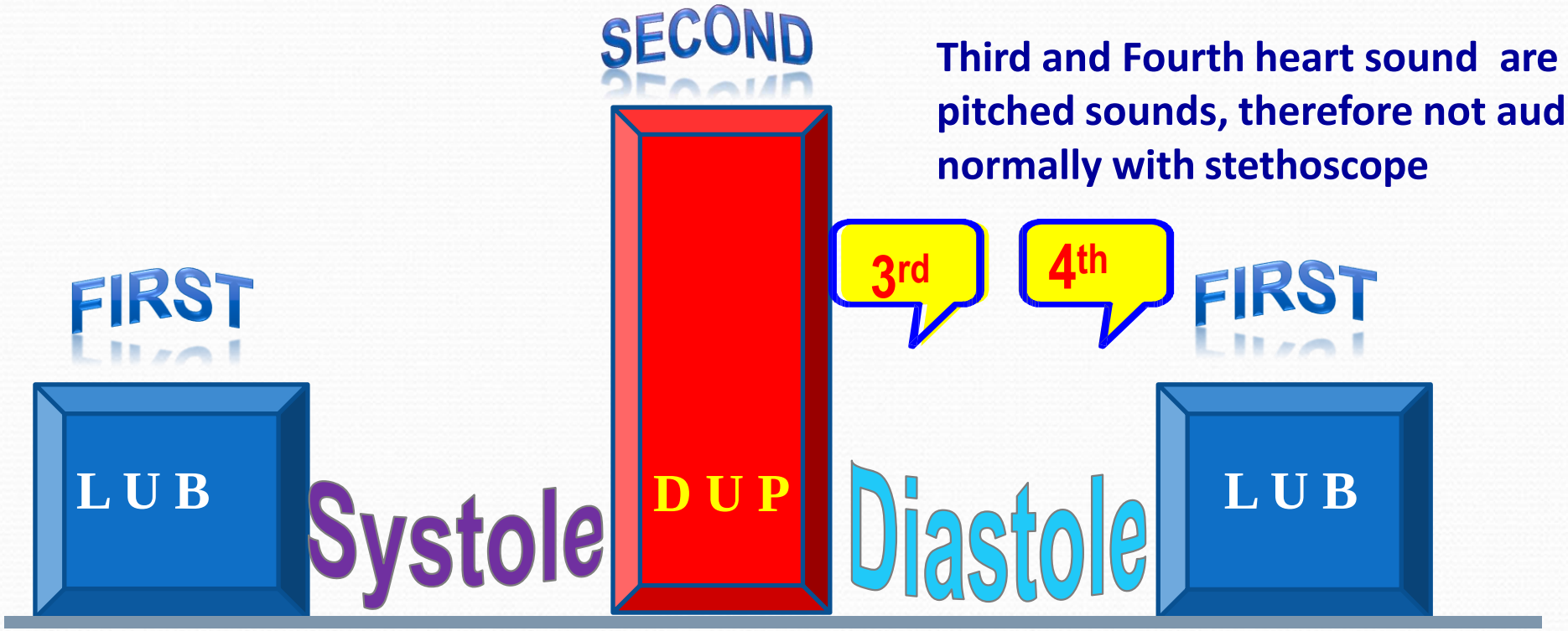
Learning Objectives

1. Normal heart sounds, causes & characteristic features
2. Causes of abnormal heart sounds
3. Describe heart murmurs
4. Different examples of heart murmurs

Heart Sounds



Third and Fourth heart sound are low pitched sounds, therefore not audible normally with stethoscope

Detected by

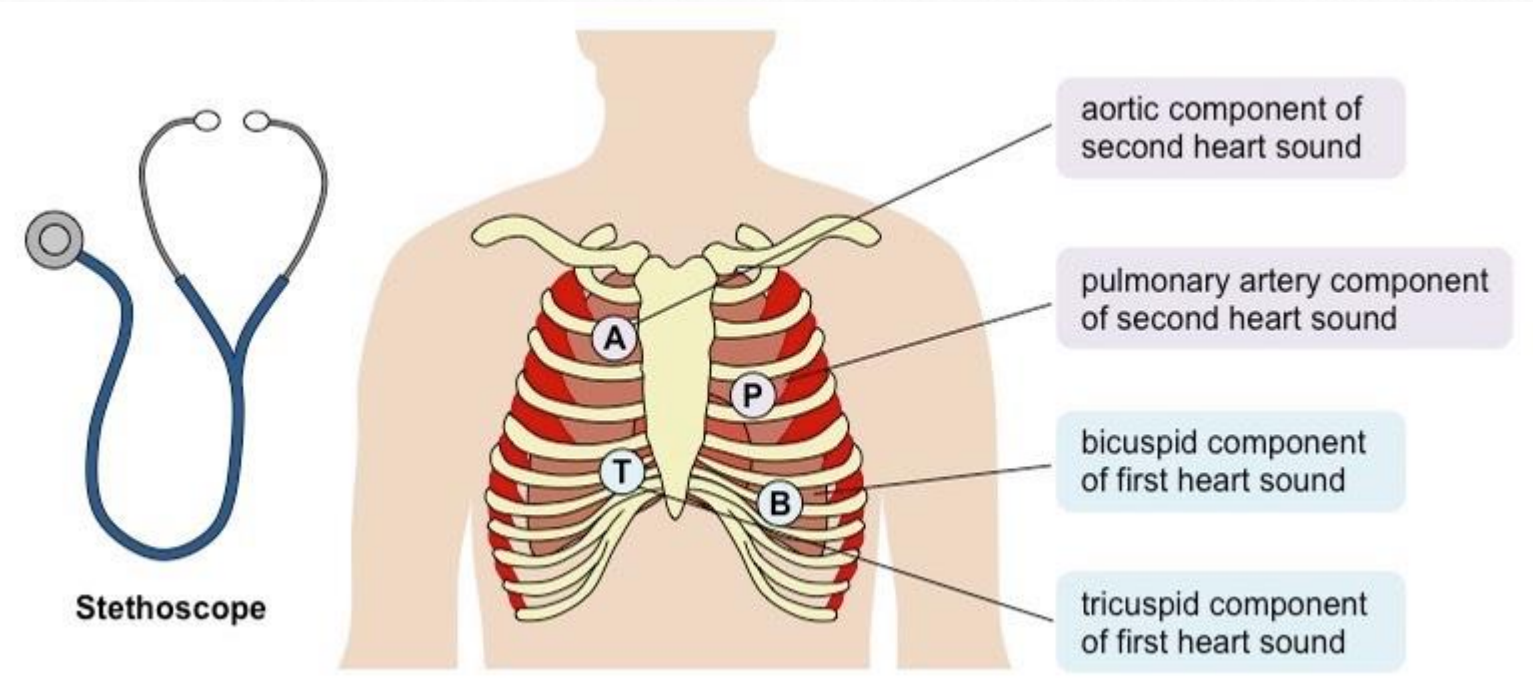
- Auscultation…..(Stethoscope)
- Phonocardiography…..(sound recording device)

The heart sound you hear when you first feel the pulse is S1, and when the pulse disappears is S2

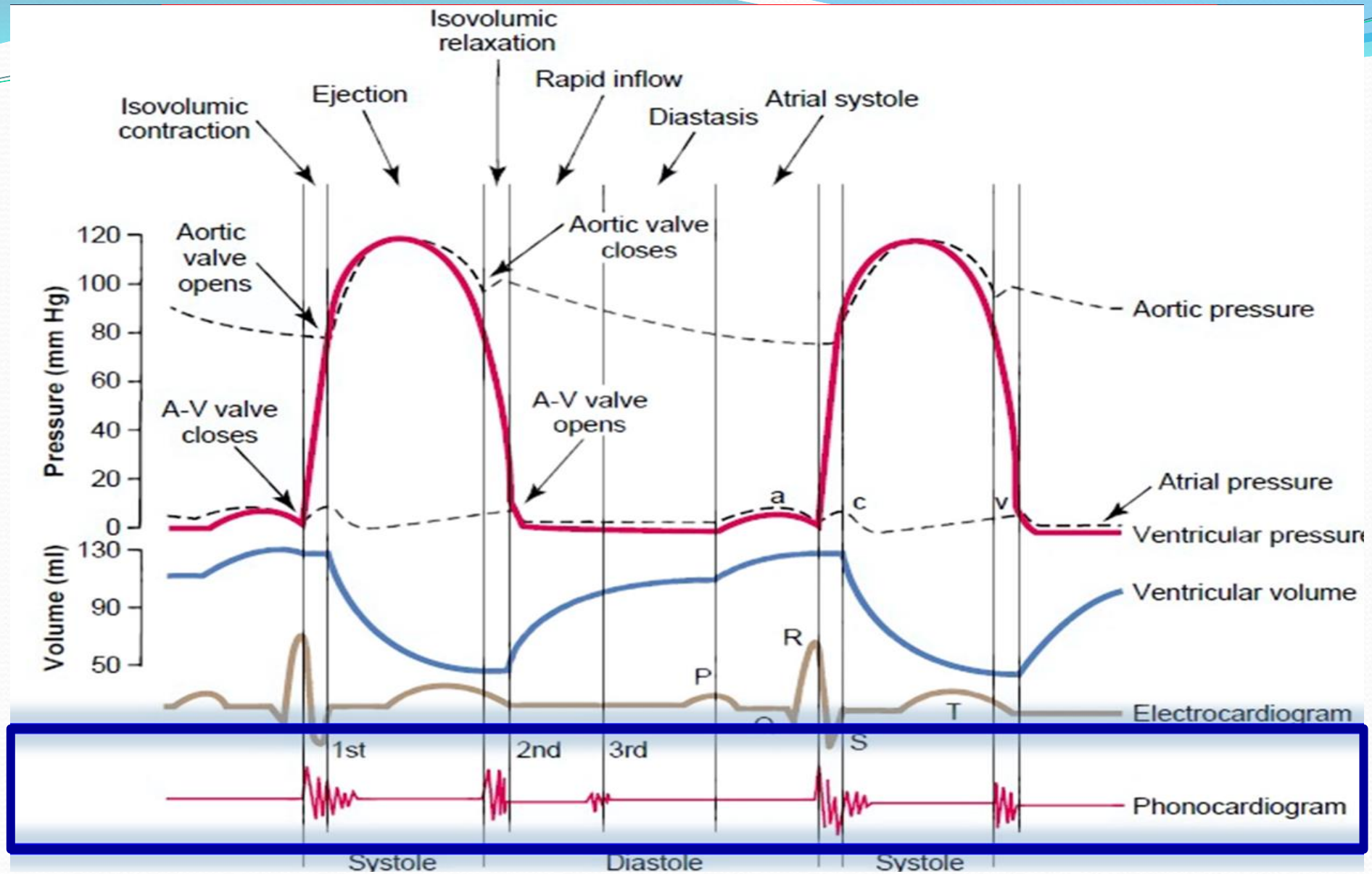
Heart Sounds

- There are four heart sounds SI, S2, S3 & S4.
- Two heart sound are audible with stethoscope S1 & S2 (Lub -Dub).
- S3 & S4 are not audible with stethoscope under normal conditions because they are low frequency sounds.
- Ventricular systole is between First and Second heart sound.
- Ventricular diastole is between Second and First heart sounds.

Areas Of Auscultation

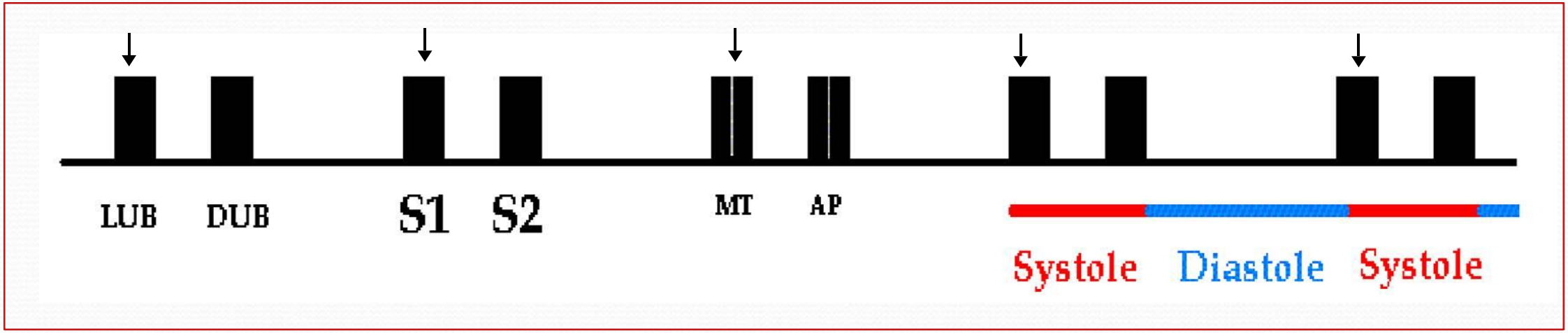


- **Aortic area:**
  2nd Rt costal cartilage.
- **Pulmonary area:**
  2nd Lt intercostal space.
- **Mitral (bicuspid) area:**
  5th Lt intercostal space crossing mid-clavicular line, or 9 cm (2.5-3 inches) from sternum.
- **Tricuspid area:**
  lower part of sternum towards Rt side.



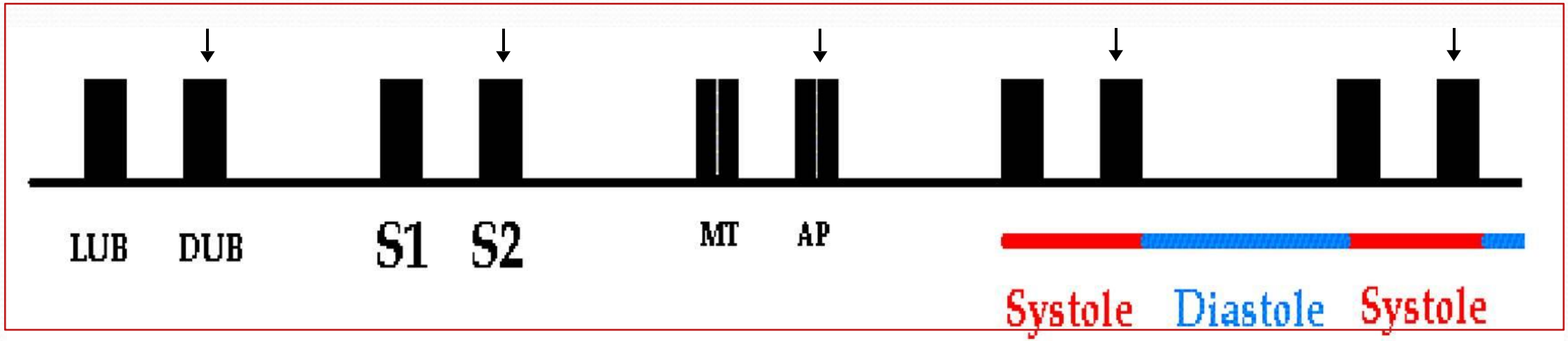
Heart Sounds During the Cardiac Cycle

1st Heart Sound =S1



- Produced due to closure of the A-V valves.
- Recorded at the beginning of the 'isovolumetric contraction phase.'
- It marks beginning of ventricular systole.
- Sounds like LUB (low pitch). Loud, heavier when compared to the 2nd heart sound
- Best heard at **Mitral** & **Tricuspid** areas.
- Frequency: 25-35 Hz
- Time: 0.15 sec.

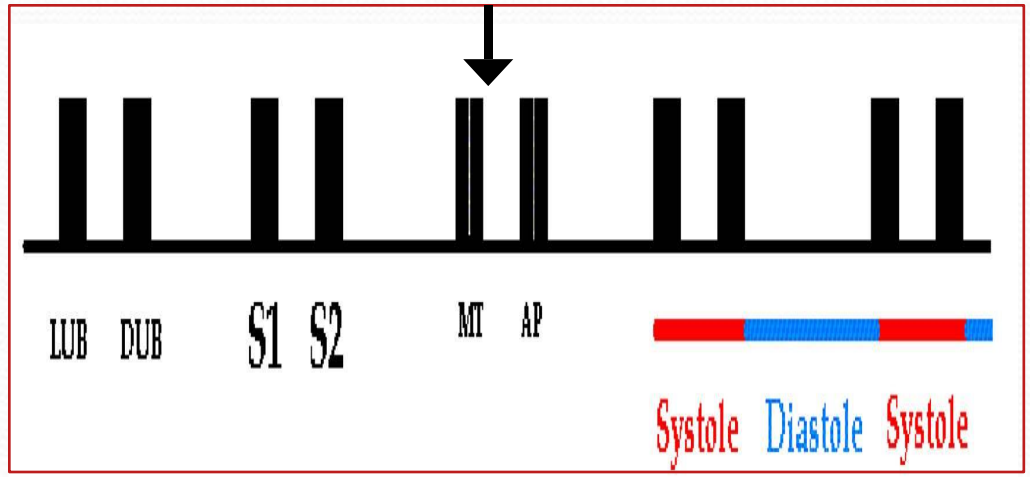
2nd Heart Sound =S2

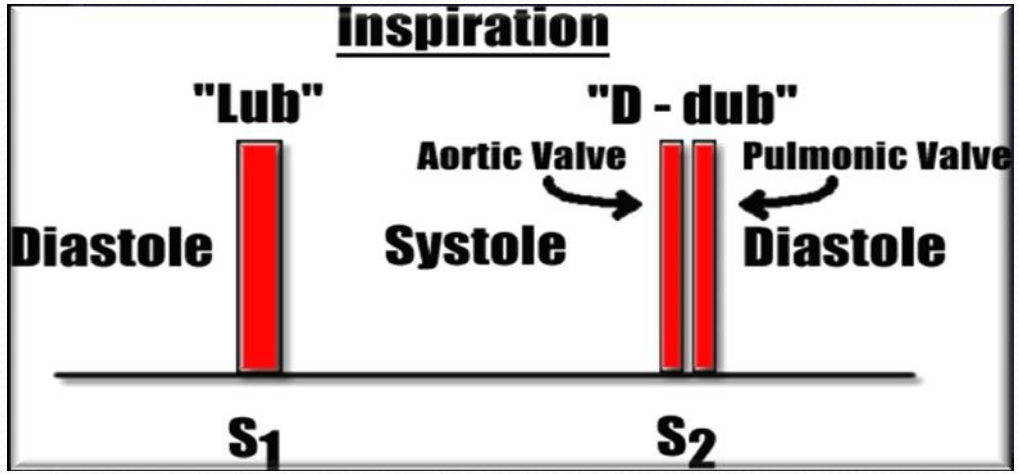


- Produced due to closure of semilunar valves.
- Recorded at the beginning of the 'isovolumetric relaxation phase'.
- Marks the beginning of ventricular diastole.
- It is shorter (duration=0.12 sec).
- Of high pitch sounds like (DUB) .
- Soft, louder and sharp compared to the 1st heart sound.
- Frequency: 50 Hz.
- Best heard at **Aortic** & **Pulmonary** areas.

Physiological Splitting of the 2nd Heart Sound

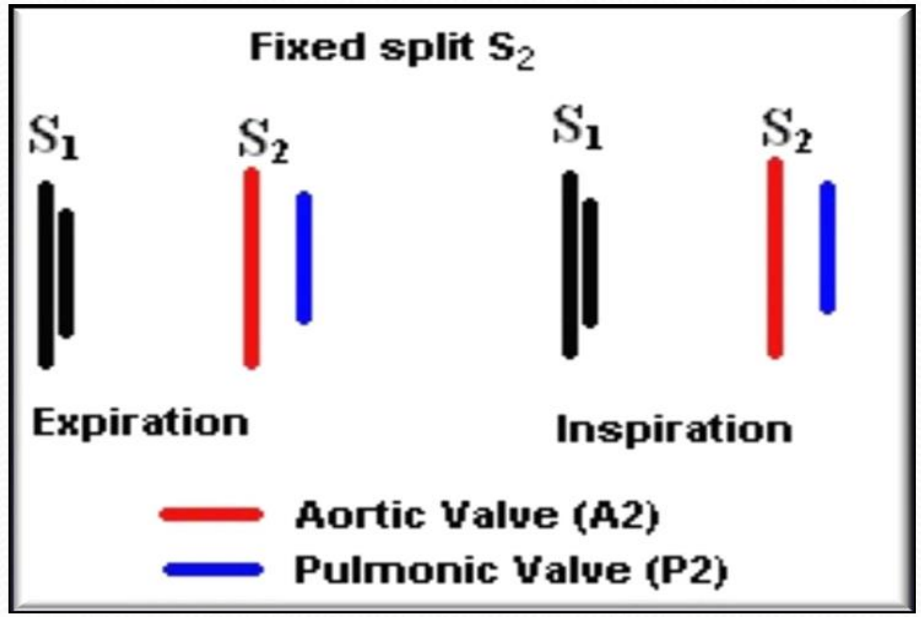
- During inspiration, the aortic valve closes before pulmonary valve → reduplication (splitting of S2).
- The increased venous return to the right side of the heart delays closure of the pulmonary valve.
- The right ventricle has more blood than usual to eject and it thus takes more time.
- No splitting of the second heart sound is normally seen during expiration.





Fixed Splitting of S2

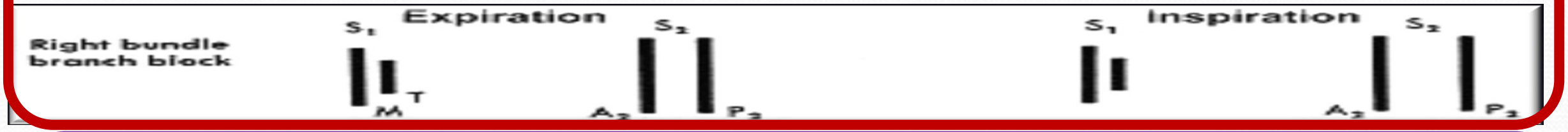
- Splitting of S2 is heard both during inspiration and expiration, with the aortic valve closing before the pulmonary valve.
- This is heard in cases of ***Atrial Septal Defect.***



Wide Splitting of S2

- A split in the second heart sound during inspiration may become wider and the split may also be seen during expiration if:

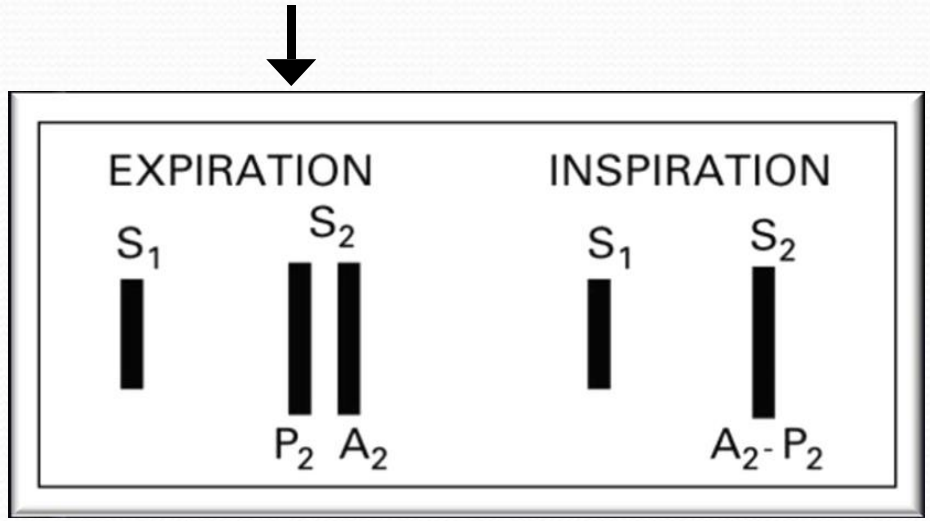
- There is a delay in the closing of the pulmonic valve (as would be seen in right bundle branch block due to delay in right ventricular depolarization & contraction).

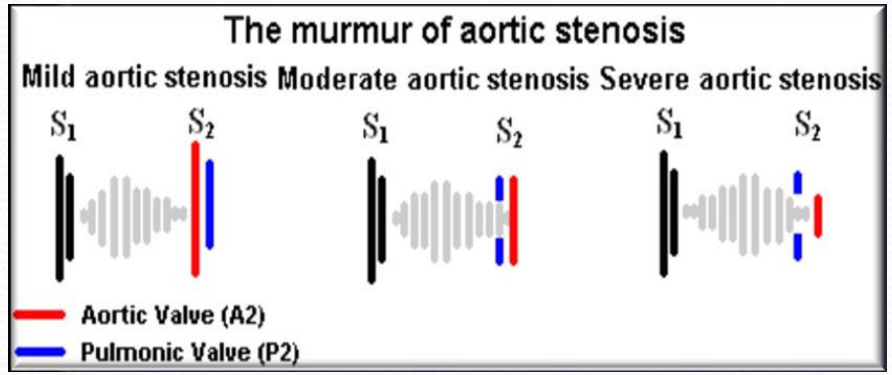


- The aortic valve closes earlier than normal (this is seen with either mitral regurgitation or ventricular septal defect).

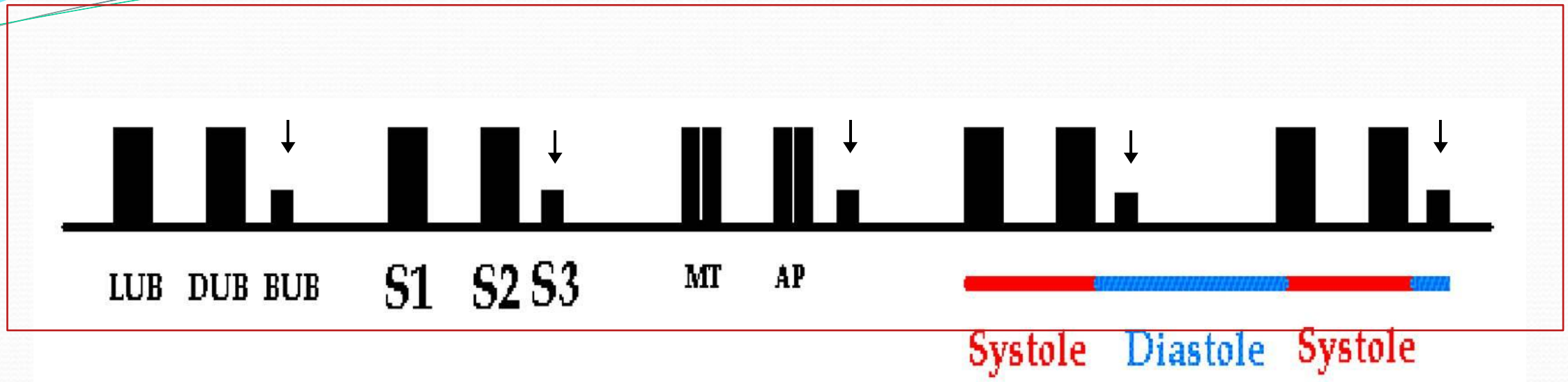
Paradoxical (Reversed) Splitting of S2

- Reversed (paradoxical) splitting of the S2 is typically heard during expiration, with the pulmonary valve closing before the aortic valve.
- No splitting is apparent during inspiration, since the pulmonary valve is closing earlier (relative to the aortic valve) than normal.
- This may be caused by the following:
  - Delayed onset of left ventricular systole (example: left bundle branch block).
  - Prolonged left ventricular systole (examples: aortic stenosis, severe hypertension, left-sided congestive heart failure).
  - Early onset of right ventricular systole (example: Wolff-Parkinson White syndrome).



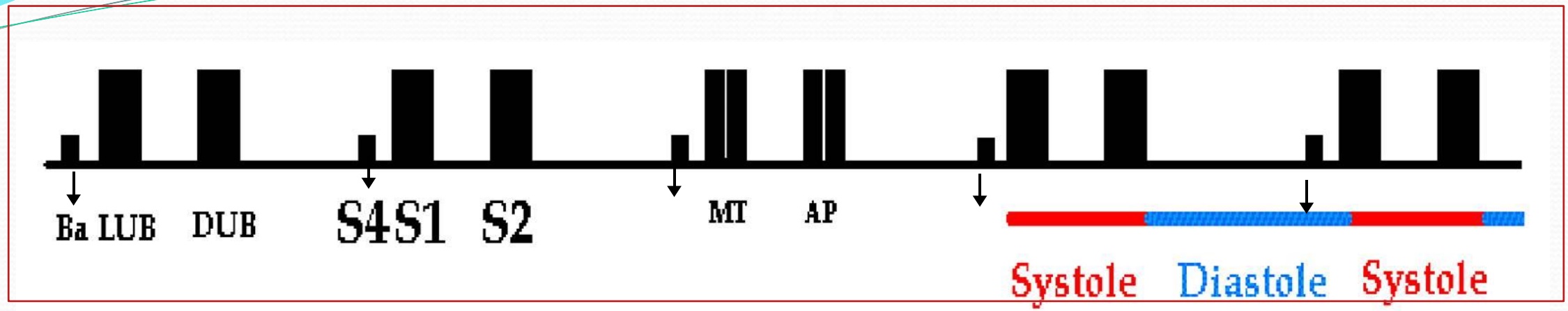


3rd Heart Sound =S3



- It is recorded during the 'rapid filling phase' at the beginning of middle third of diastole due to rush of blood from the atria into the ventricle.
- S3 is usually not audible (very low pitch.)
- Frequency:20-30 Htz
- Time: 0.05 sec.
- ? Heard in children (pathological in old age).
- Best heard at **Mitral** area.

4th Heart Sound =S4



- Recorded during 'atrial systole, at the last one third of diastole.
- Cause: Due to atrial systole which causes rapid flow of blood to ventricle and vibration in the blood causing oscillations of the ventricles during atrial contraction.
- S4 is usually not audible (very low pitch).
- S4 may be heard in elderly but is usually pathologic in the young.
- Frequency: < 20 Htz (low pitch)
- Time: 0.04 sec
- Best heard at **Mitral** area.

Significance of Heart Sound

Important for diagnosis of heart murmurs.

- **Abnormal extra heart sounds heard during the heart beat cycle.**
- **Produced by turbulence (abnormal patterns) of blood flow through the heart & its valves.**
- **Murmurs are longer than heart sounds.**

What Make Noise In The Heart
Causes & Significance Of Heart Sounds

- ***Closure of valves of the heart***
  - Atrio-ventricular (Mitral & Tricuspid) valves= (S1)
  - Semilunar (Aortic & Pulmonary) valves= (S2)
- ***Increased intra-cardiac hemodynamics***
  - Blood striking the left ventricle = (S3, S4)
  - Increased flow across normal valves.
  - Turbulent flow through an abnormal valve.
  - Turbulent flow through septal defect.

} (Murmurs)

Physiological VS Pathological Murmurs

1- Physiological Murmurs:

- **↑ blood flow across normal valves:**

  e.g.:-

  - Pregnancy
  - Hyperthyroidism
  - Anemia
  - Fever
  - Children

2- Pathological Murmurs:

- **Turbulent flow** through abnormal valves, or septal defect…..Congenital?

  e.g:-

  - Tight valve, narrowing (stenosis): the valve does not open properly.
  - Leaky, (regurgitation or incompetency), the valve fails to close completely, and hence causing backflow or leaks of the blood across the insufficient valve.
  - A combination of Stenosis and Insufficiency.

Heart Murmurs

- **Murmurs are abnormal, pathologic added heart sounds produced due to abnormal flow of blood (Turbulance) and/or valvular abnormalities.**

Valve	Abnormalities	Timing of Murmurs
Aortic or pulmonary	Stenosis Insufficiency	Systolic Diastolic
Mitral or tricuspid	Stenosis Insufficiency	Diastolic Systolic

How to Describe Heart Murmurs

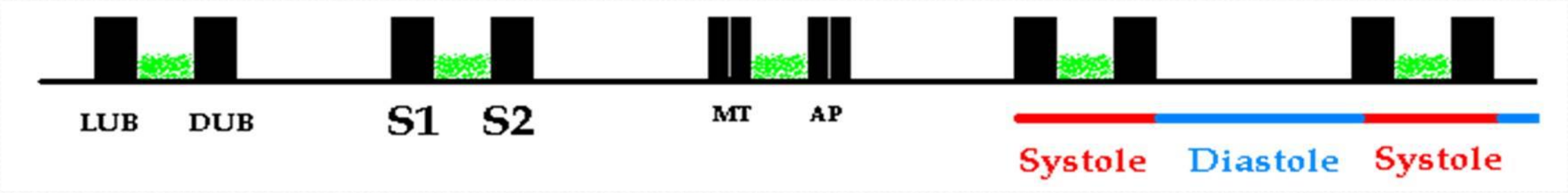
- Timing (systolic or diastolic)
- Shape
- Location
- Radiation
- Intensity
- Pitch
- Quality

Gallop:
Three or four sounds are spaced to audibly resemble the pace of a horse, the extra sounds occurs after S2.

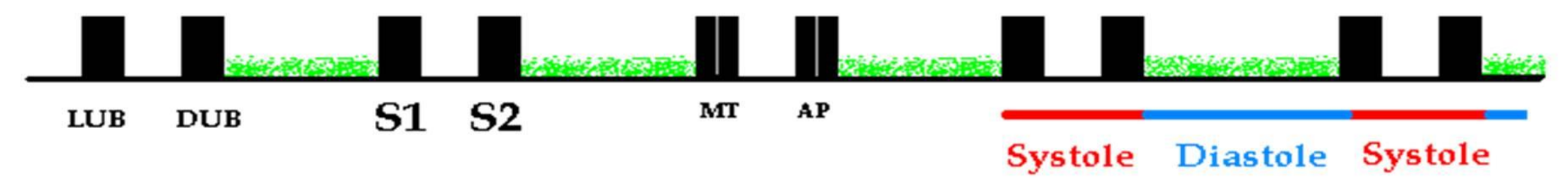
1- Timing

Murmurs are described according to their position in the cardiac cycle:

- Systolic.
- Diastolic.
- Continuous.



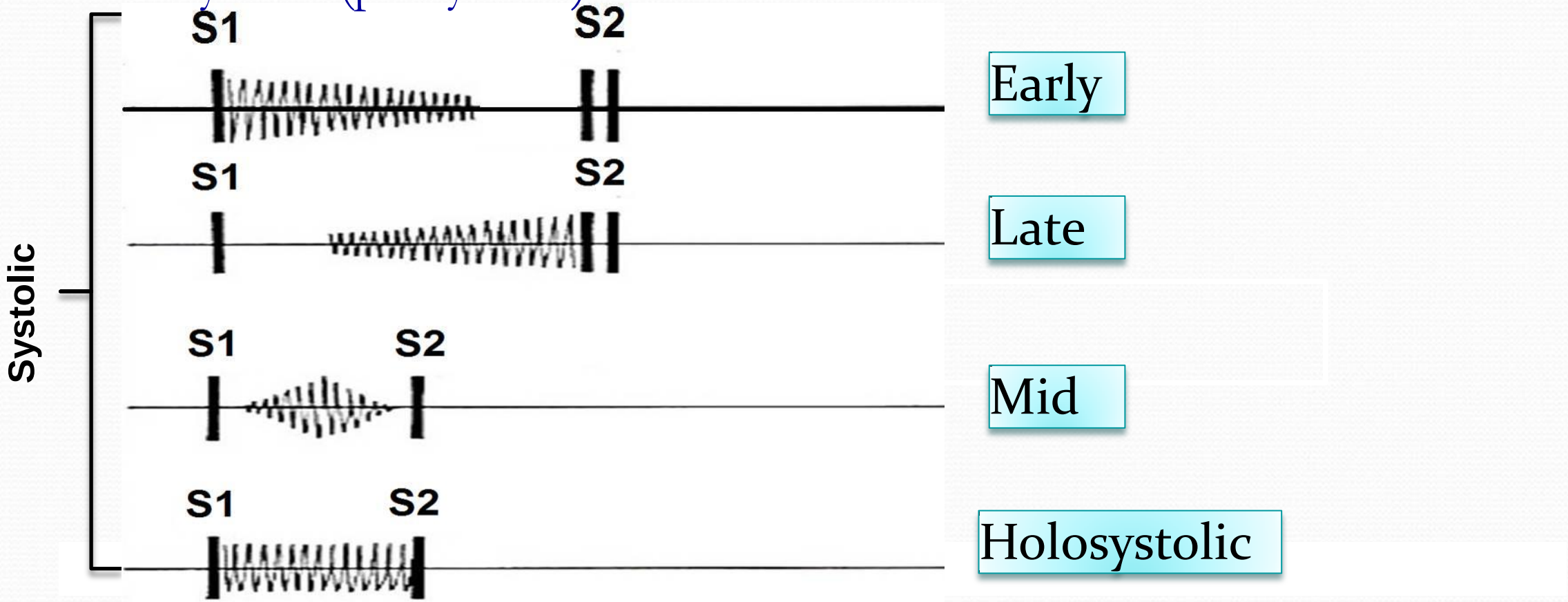
Holosystolic Murmur



Diastolic Murmur

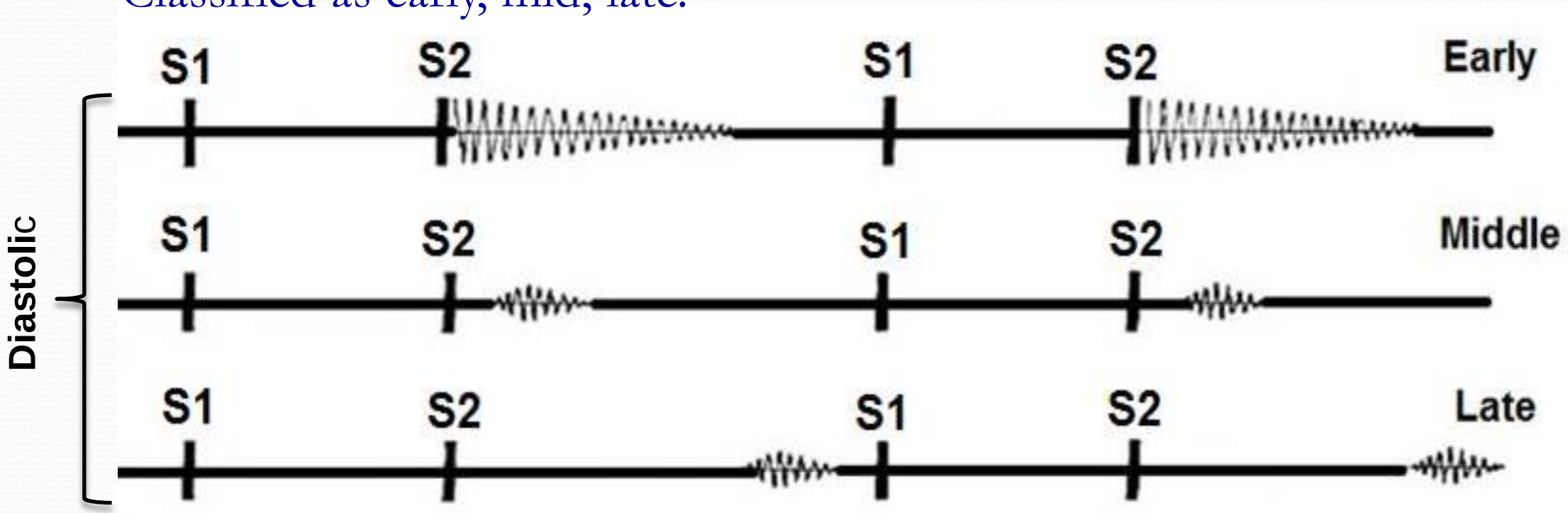
Systolic Murmurs

- Between S1 & S2
- Classified as early, mid (ejection systolic murmur ESM), late and holosystolic (pansystolic)



Diastolic Murmurs

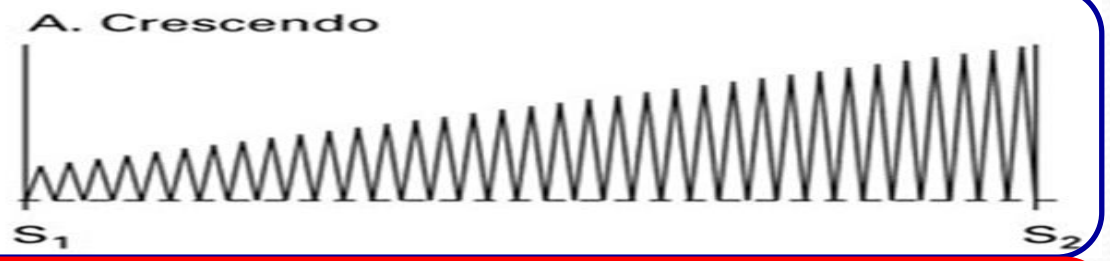
- Between S2 & S1
- Classified as early, mid, late.



2- Shape

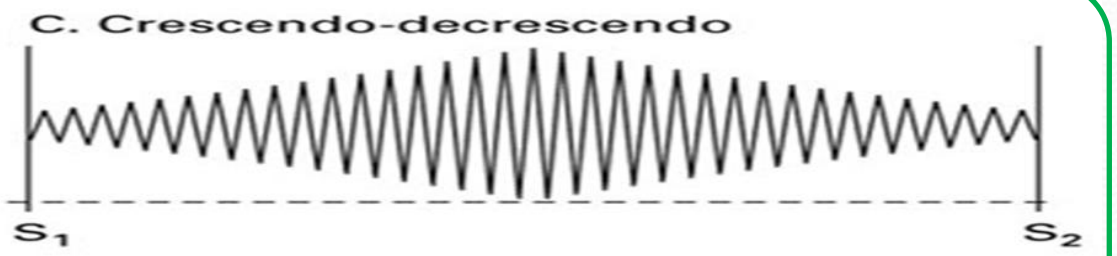
Murmurs are described according to the waxing & waning of the sound

- Crescendo (increasing intensity).

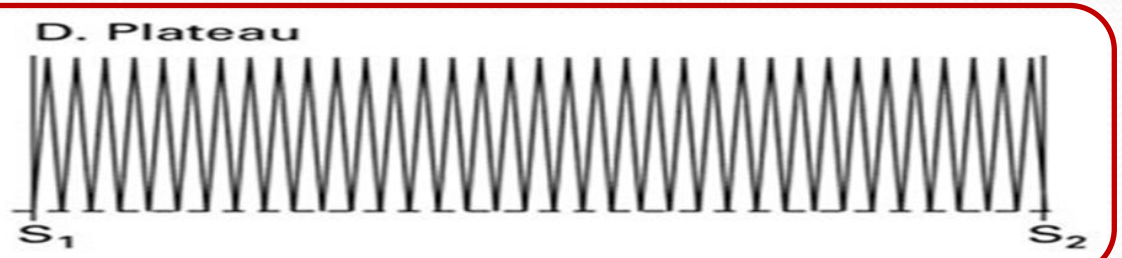


- Decrescendo (decreasing intensity).

- Crescendo-decrescendo (Diamond-shaped); (increasing then immediate decreasing intensity).



- Plateau (uniform); the intensity of the murmur remains uniform throughout.



Describing a Heart Murmurs…..Cont

3- Location of maximum intensity

Determined by the site where the murmur originates;

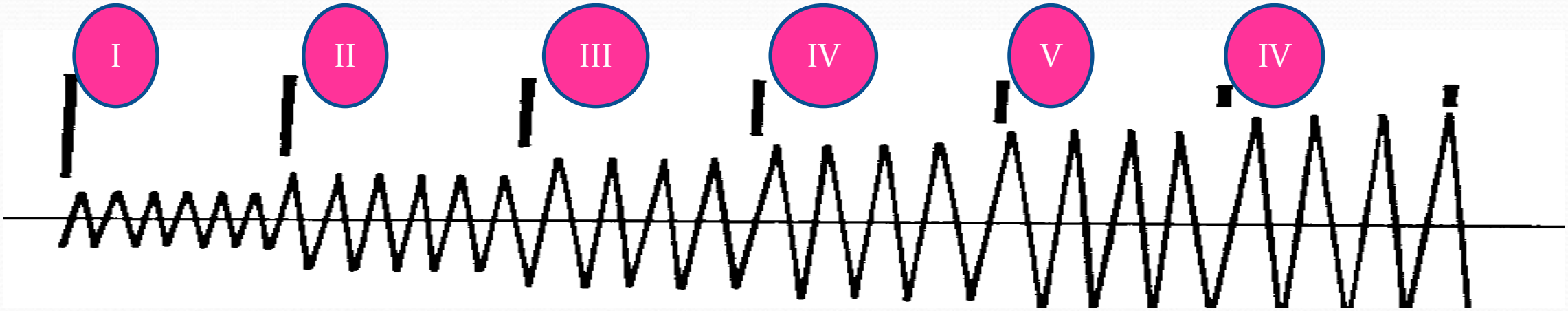
e.g. Aortic, Pulmonary, Tricuspid, & Mitral listening areas.

4- Radiation

Reflects intensity of the murmur & direction of blood flow.

5- Intensity

- Graded on a (6) point according to Levine scale:



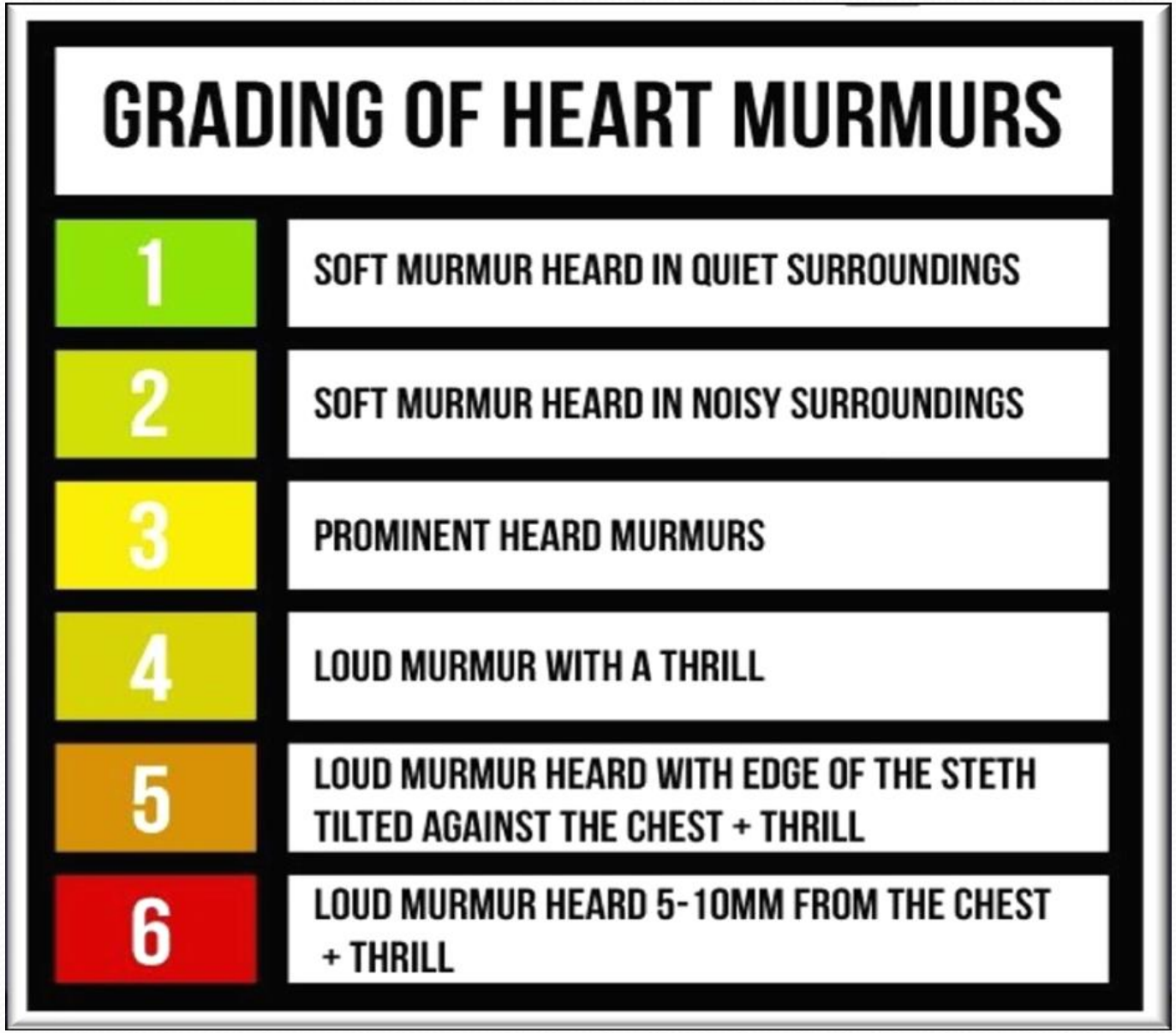
Classification of murmurs by loudness

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6
• Lowest intensity • Very faint	• Low intensity • Quiet but heard immediately	• Medium intensity • Moderately loud	• Medium intensity • Loud • Thrill	• Loud intensity • Heard with stethoscope partly off the chest • Thrills	• Loudest intensity • No stethoscope needed • Thrills

5- Intensity

- Graded on a (6) points according to Levine scale:

A thrill is a slight palpable vibration felt by the hand over the chest wall



Describing a Heart Murmurs…..Cont

6. **Pitch**

   High, medium, low.

7. **Quality**

   Blowing, harsh (hard) ,resonant (rumbling) & musical.

8. **Others:**

   i. **Variation with respiration:**

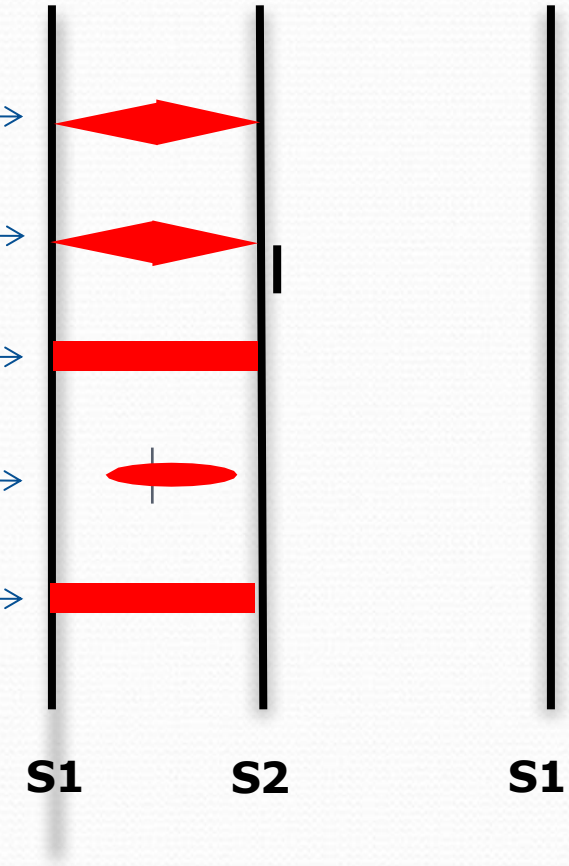
   ii. **Variation with position of patient.**

   iii. **Variation with special maneuvers:**

   Valsalva (forced expiration) ⇒ decreases the intensity and duration of most murmurs.

Common Systolic Murmurs and Timing

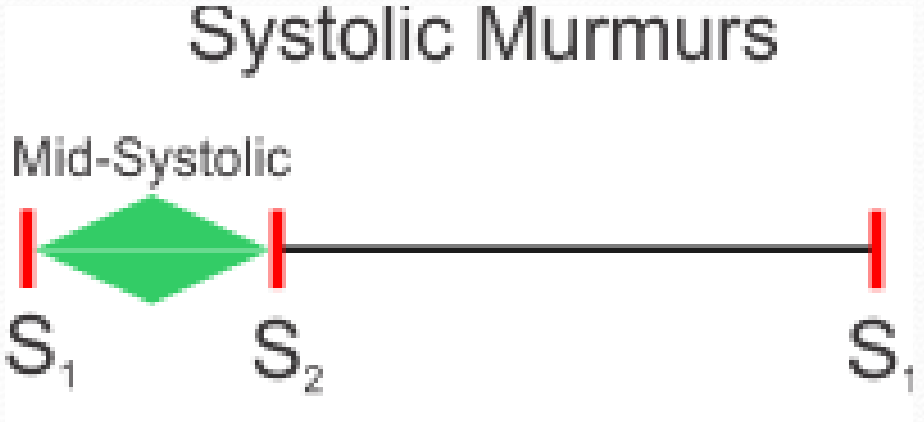
1. **Aortic stenosis –** ejection murmur.
2. **Pulmonary stenosis –** ejection murmur
3. **Mitral/Tricuspid regurgitation –** holosystolic.
4. **Mitral valve prolapse –** mid-late systolic.
5. **Ventricular septal defect (VSD) –** holosystolic.



Ejection (Mid- Systolic) Murmurs

Most common kind of heart murmur.

Usually crescendo-decrescendo.



They may be:

1. **Innocent**
   Common in children & young adults.

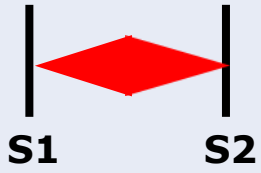
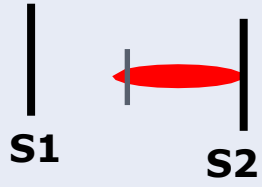
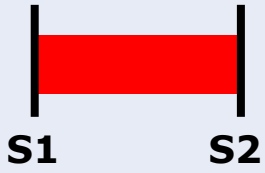
2. **Physiological**
   Can be detected in hyper-dynamic states,
   e.g. anemia, pregnancy, fever & hyperthyroidism.

3. **Pathological**
   Secondary to structural CV abnormalities,
   e.g. Aortic/pulmonary stenosis, Hypertrophic cardiomyopathy & mitral prolapse.

Pan- Systolic (Holosystolic) Murmurs

- Pathological murmur.
- Begins immediately with S1 & continues up to S.2
- Heard with:
  - Mitral/tricuspid regurgitation.
  - Ventricular septal defect (VSD).

Systolic Murmurs

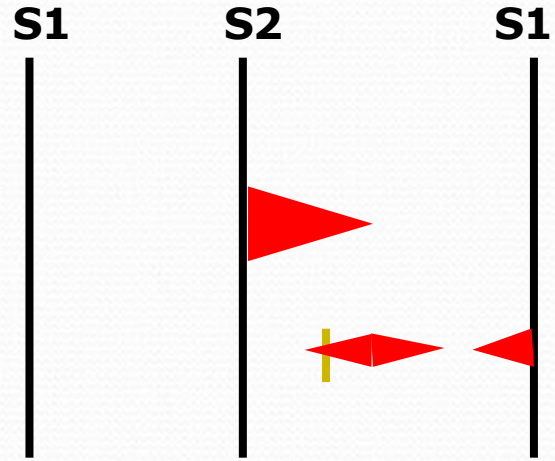
	Aortic Stenosis	Mitral Prolapse	Mitral Regurgitation
Cause	Obstruction of flow from LV into ascending aorta	Bulging of 1 or 2 mitral valve leaflets into LA during LV systole	Retrograde flow from LV into LA through an incompetent mitral valve
Timing	mid-systolic murmur	Mid- late systolic murmur.	Holosystolic murmur.
Location	Best heard on aortic area, radiates along carotid arteries.	Best heard at the apex.	Best heard at apex, radiates to left axilla.
Character	Harsh, loud, may have associated with thrill, "ejection click."	Mid-late systolic click.	Soft, high-pitched, blowing
Association	Old age, bicuspid aortic valve, rheumatic fever.	~5% normal population, asymptomatic, ? Sudden death.	MV prolapse, or myxomatous degeneration, rheumatic heart disease, endocarditis
			

Diastolic Murmurs

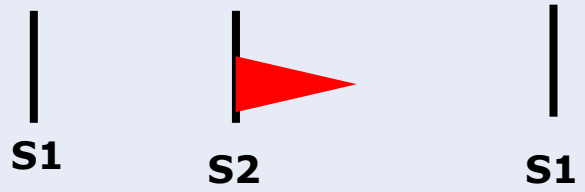
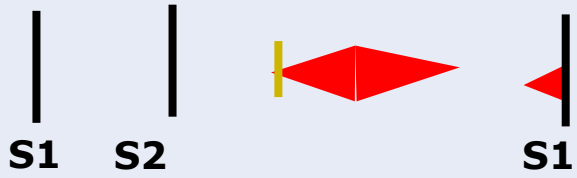
- Almost always indicate heart disease.
- Two basic types:

1. **Early decrescendo diastolic murmurs:**
   Signify regurgitant flow through an incompetent semilunar valve,
   e.g. aortic/pulmonary regurgitation.

2. **Rumbling diastolic murmurs in mid- or late diastole or** (pre-systolic)
   Suggest stenosis of an AV valve,
   e.g. mitral/tricuspid stenosis.

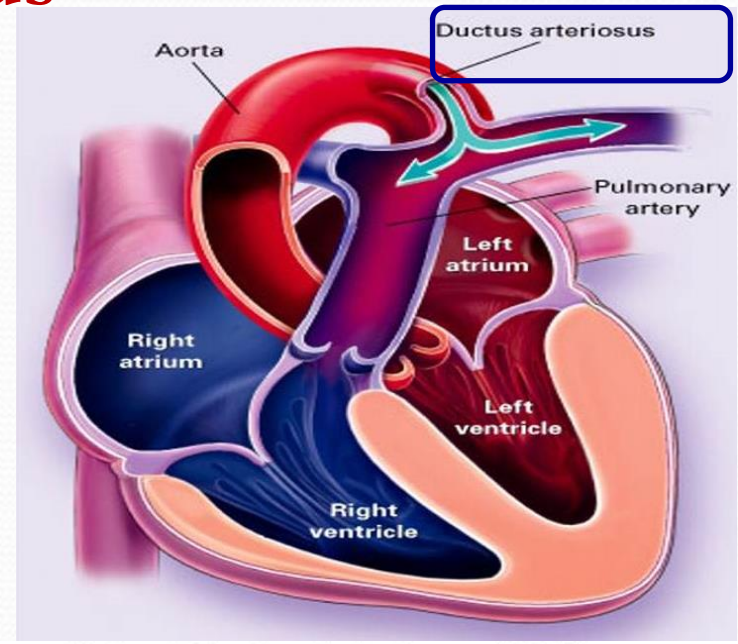


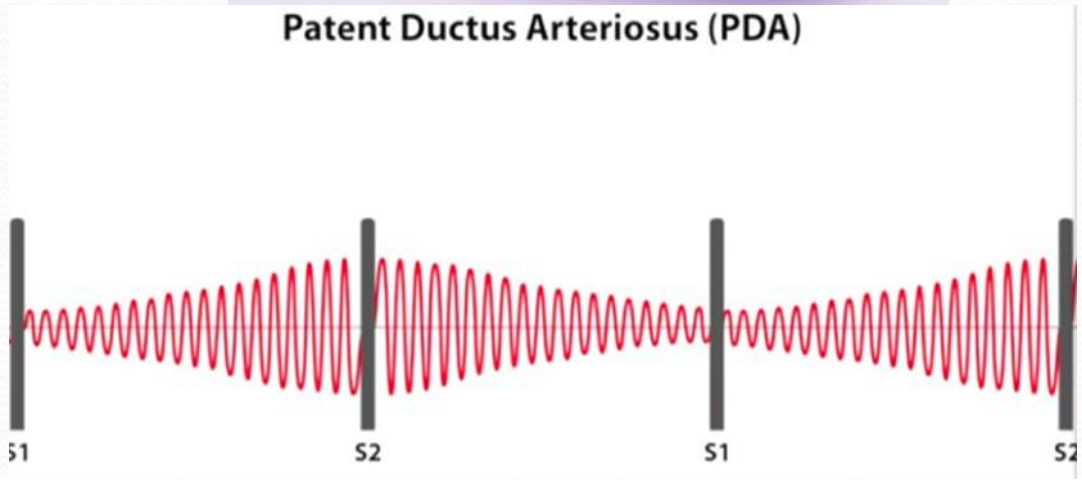
Diastolic Murmurs

	Aortic Regurgitation	Mitral Stenosis
Cause	Retrograde flow from aorta into LV through incompetent aortic cusps	Obstruction of flow from LA to LV (Valve becomes narrowed, thickened & calcified)
Timing	Diastolic (early) murmur.	Diastolic (mid-diastolic, or pre-systolic) murmur
Location	Best heard at 2nd-4th left intercostal spaces.	Best heard at apex.
Character	High-pitched, blowing, decrescendo	Low pitched (heard with bell)
Association	Aortic root degeneration, rheumatic heart disease, VSD with aortic valve prolapse (kids).	Rheumatic fever.
		

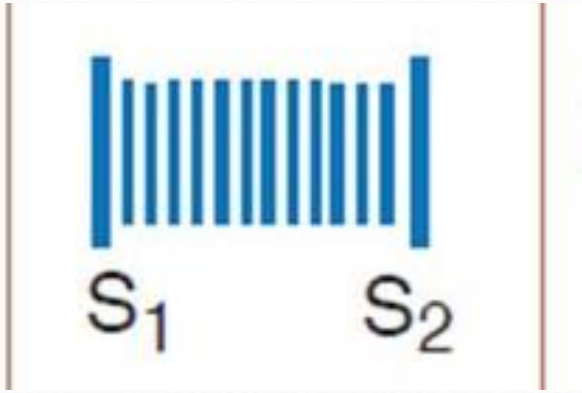
Continuous Murmurs:
Patent Ductus Arteriosus

- Failure of closure of the ductus arteriosus between pulmonary artery & aorta results in a continuous murmur.
- Best heard at upper left sternal border.
- Machine-like.
- May be associated with left to right shunt, cyanosis.

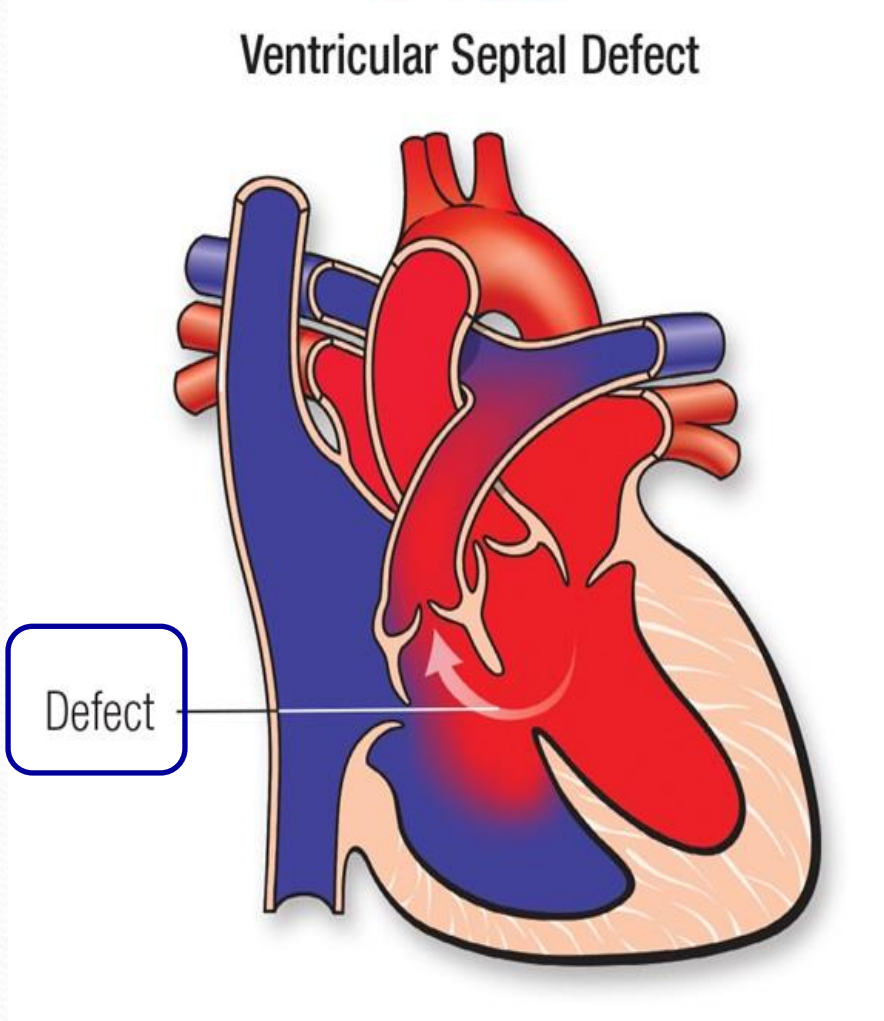




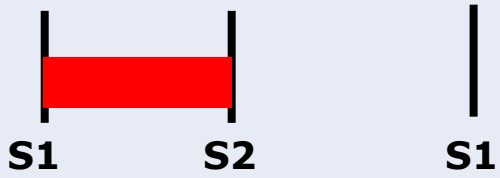
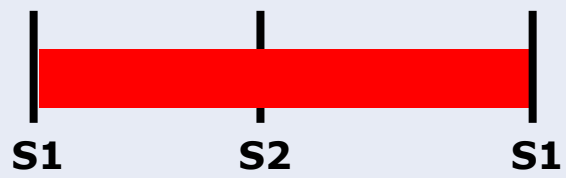
Continuous Murmurs:
Ventricular Septal Defect

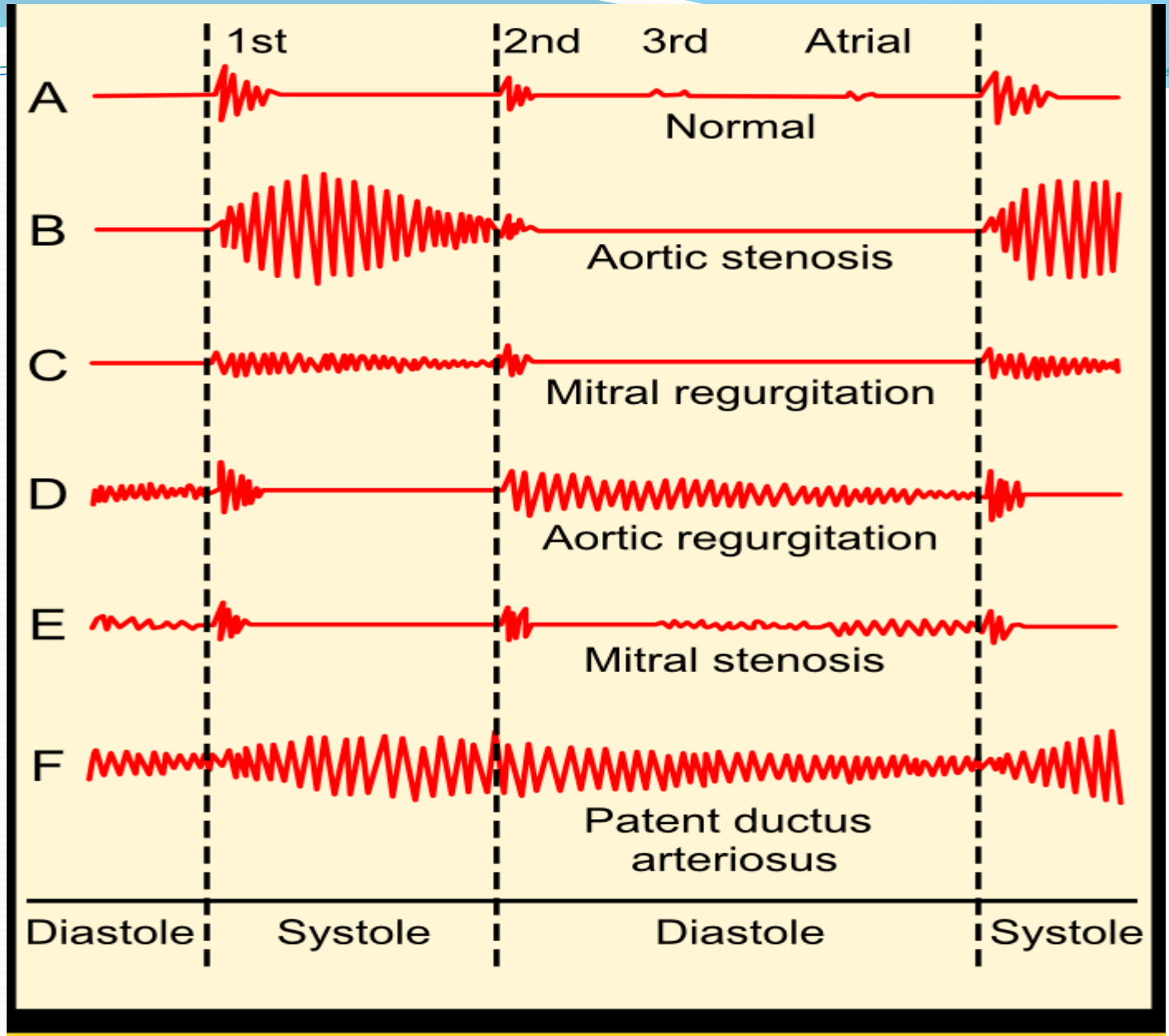


Pansystolic (Holosystolic) Murmur



Murmurs of Ventricular Septal Defect vs Patent Ductus Arteriosus

	Ventricular septal defect	Patent ductus arteriosus
Cause	A congenital condition associated with abnormal blood flow between the left ventricle and the right ventricle	Failure of closure of the duct between pulmonary artery & aorta
Timing	Holosystolic murmur, may be diastolic murmur due to turbulent flow through mitral valve	Continuous murmur.
Location	Best heard at tricuspid area.	Best heard at upper left sternal border.
Character	A medium pitched murmur fills all of systole	Machine-like.
Association	Volume overload of right ventricle	Left to right shunt, cyanosis.
		



Phonocardiograms from normal and abnormal heart sounds

سبحانك اللهم وبحمدك أشهد أن لا إله إلا أنت
استغفرك وأتوب إليك