



Cardiovascular Physiology


Heart Sounds & Murmurs

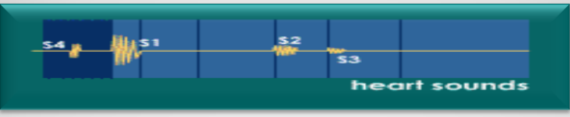


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HEART SOUNDS

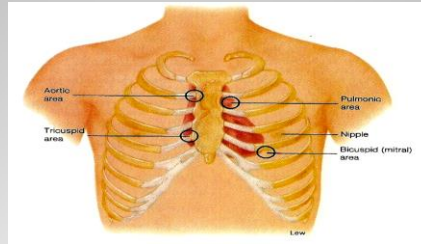
- Detected over anterior chest wall by:
 - Auscultation: ... (Stethoscope) 
 - Phonocardiography: (sound recording device)



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HEART SOUNDS' WINDOWS

- Best heard at 4 certain areas:



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

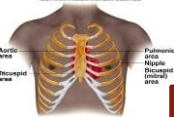

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Heart Sounds:

- '4' heart sounds can be detected:
 - 1st & 2nd ht sounds ... (usually audible)
 - 3rd & 4th ht sounds ... (sometimes detected)



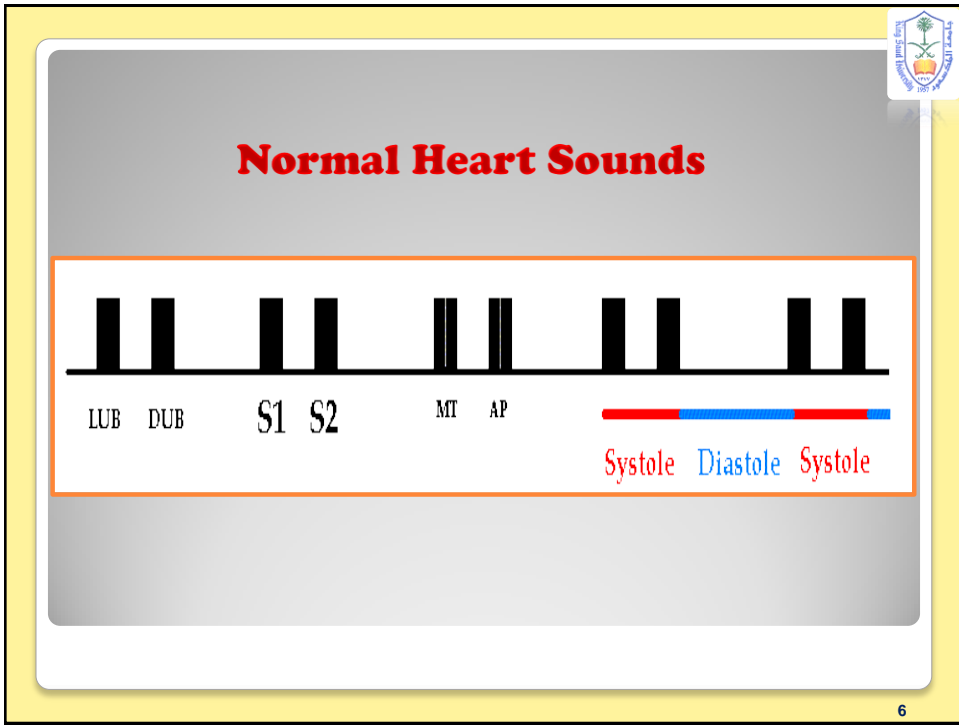
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Different Heart Sounds

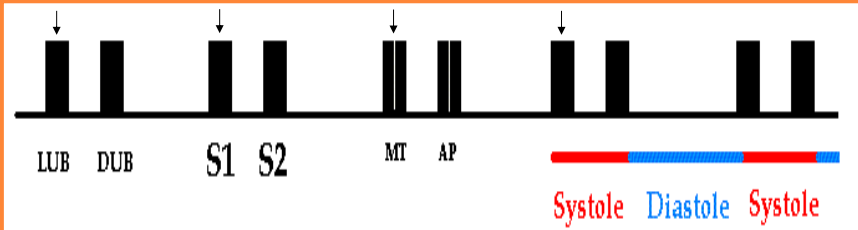
	S1	S2	S3	S4
Cause	Sudden closure of AV-vs	Sudden closure of semilunar vs	Rush of bl during rapid vent filling → vibration of vent ms.	Vibration produced by cont of atrial ms (attributed to vent filling)
C-cycle	Marks beginning of vent systole (Isovolumetric contraction)	Marks beginning of vent diastole (Isovolumetric relaxation)	Max vent filling phase of diastole	Atrial systole (just before 1 st HS)
Duration	0.15 sec (Longer)	0.11-0.125 sec (Shorter)	0.05 sec	0.04 sec
Frequency	25-35 Hz	50 Hz		
Character	Low pitch (LUB) (Louder)	High pitch (DUB) (Softer, sharper) Split into 2 sounds during inspiration = Physiological splitting (due to delay closure of pulm v).	Usually not audible	Usually not audible (Rarely heard)
Best heard	M & T	A & P	M	M

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(S1)

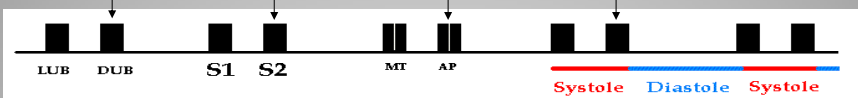


- Due to closure of the AV- vs
- Recorded at the beginning of the the 'isovolumetric contraction phase'
- Marks beginning of ventricular systole

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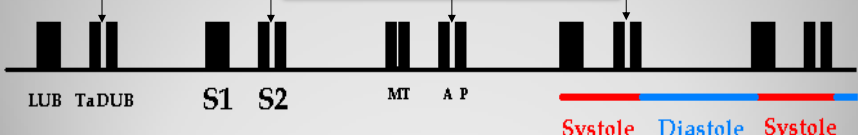


(S2)




- Due to closure of semilunar- vs
- Recorded at the beginning of the 'isovolumetric relaxation phase'
- Marks the beginning of ventricular diastole

Physiological splitting during INSPIRATION



- S2 splits physiologically during inspiration:
 - aortic v closes slightly earlier than pulmonary v



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(S3)

LUB DUB BUB S1 S2 S3 MT AP Systole Diastole Systole

- Recorded during the 'rapid filling phase'
- S3 is usually not audible
- ? heard in children


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(S4)

Ba LUB DUB S4 S1 S2 MT AP Systole Diastole Systole

- Recorded during 'atrial systole'
- S4 is usually not audible
- ? heard in elderly


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What Makes Noises in the Heart?

- ❑ **Valves closing:**
 - Atrio-ventricular = (S1)
 - Semilunar = (S2)
- ❑ **Abnormal intra-cardiac hemodynamics:** e.g.
 - ❑ **Blood striking the left ventricle:** = S3 & S4
 - ❑ **Increased flow across normal valves:**
 - ❑ **Turbulent flow through an abnormal valve**
 - ❑ **Turbulent flow through septal defect**


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Significance of heart sounds?

Important for diagnosis of abnormal heart sounds (murmurs)

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Causes of Heart Murmurs

1. Physiological Murmurs:


- ↑ blood flow across normal valves:
- e.g.
- Pregnancy
- Hyperthyroidism
- Anemia
- Fever
- children

2. Pathological Murmurs:

- ? Congenital
- Turbulent flow through abnormal valves, or septal defect:
- e.g.
- Tight valve (stenosis)
- Leaky valve (regurgitation or insufficiency)

▪ N.B. Murmurs are longer than heart sounds

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How to Describe Heart Murmurs?

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

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1. Timing:

- Systolic
- Diastolic
- Continuous

The diagram illustrates the timing of two types of murmurs relative to heart sounds and the cardiac cycle. The cardiac cycle is represented by a horizontal line with a red segment for Systole and a blue segment for Diastole. Heart sounds are marked as LUB (lub), DUB (dub), S1, S2, MT (mitral closure), and AP (aortic closure).

Holosystolic Murmur: The murmur (green shaded area) starts at S1 and continues through the entire systole, ending at S2. It is present during the entire red (Systole) segment of the cycle.

Diastolic Murmur: The murmur (green shaded area) starts at S2 and continues through the entire diastole, ending at the next S1. It is present during the entire blue (Diastole) segment of the cycle.

Diastolic Murmurs

Classified as early, mid, late
Between S₂ & S₁

This diagram shows the timing of diastolic and systolic murmurs. Diastolic murmurs are shown between S₂ and S₁ and are classified as early, middle, or late. Systolic murmurs are shown between S₁ and S₂ and are classified as mid or holo (holosystolic).

Diastolic Murmurs:

- early:** Murmur starts early in diastole, after S₂.
- middle:** Murmur starts in the middle of diastole.
- late:** Murmur starts late in diastole, just before S₁.

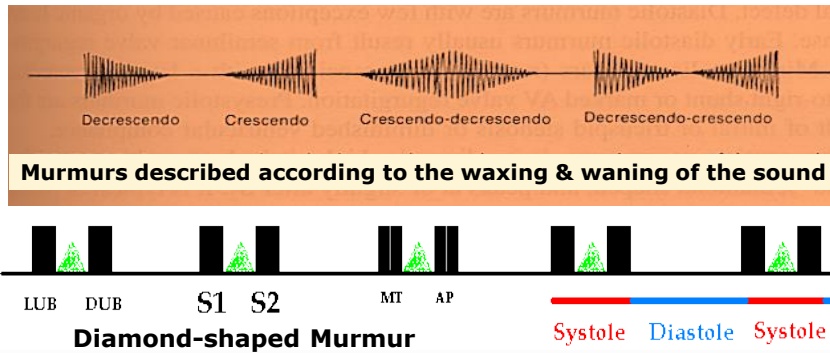
Systolic Murmurs:

- mid:** Murmur starts after S₁ and ends before S₂.
- holo:** Murmur starts at S₁ and continues through S₂.

Murmurs described according to position in the cardiac cycle

2. Shape:

- Crescendo (grows louder)
- Decrescendo
- Crescendo-decrescendo (Diamond-shaped)
- Plateau



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Describing a heart murmur ... (Cont.)

3. Location of maximum intensity

Determined by the site where the murmur originates
e.g. A, P, T, M listening areas

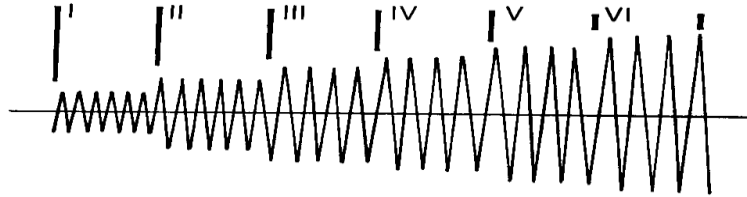
4. Radiation

Reflects intensity of the murmur & direction of blood flow

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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
<ul style="list-style-type: none"> Lowest intensity Very faint 	<ul style="list-style-type: none"> Low intensity Quiet but heard immediately 	<ul style="list-style-type: none"> Medium intensity Moderately loud 	<ul style="list-style-type: none"> Medium intensity Loud Thrills 	<ul style="list-style-type: none"> Loud intensity Heard with stethoscope partly off the chest Thrills 	<ul style="list-style-type: none"> Loudest intensity No stethoscope needed Thrills

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Heart murmurs Intensity

I / VI	need quiet room and trained ear to hear. (difficult to hear even by expert listeners)
II / VI	audible to anyone who listens attentively (usually audible by all listeners)
III / VI	loud, but not palpable (easy to hear even by inexperienced listeners, but without a palpable thrill)
IV / VI	loud and palpable: it produces a precordial thrill
V / VI	audible with your stethoscope placed perpendicular to chest wall
VI / VI	audible without a stethoscope

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Describing a heart murmur ... (Cont.)

6. Pitch

High, medium, low

7. Quality

Blowing, harsh, rumbling & musical

8. Others:

i. Variation with respiration

Right sided murmurs change > left sided

ii. Variation with position of patient

iii. Variation with special maneuvers

Valsalva \Rightarrow Murmurs \downarrow in length & intensity

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Systolic Murmurs

Early systolic

Mid Systolic (ejection)

Late systolic

Pansystolic (holosystolic)



SYSTOLIC MURMURS

- ❑ Derived from harsh & ↑ turbulence in flow
- ❑ Associated with:
 1. ↑ flow across normal valve
 2. ↑ flow into a dilated great vessel
 3. ↑ flow across an abnormal valve, or narrowed ventricular outflow tract - e.g. aortic /pulmonary stenosis
 4. ↑ flow across an incompetent AV valve - e.g. mitral/tricuspid regurgitation
 5. ↑ flow across the inter-ventricular septum - e.g. VSD


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MID-SYSTOLIC (EJECTION) MURMURS

- ❑ Most common kind of heart murmur
- ❑ Usually crescendo-decrescendo
- ❑ They ? 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


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Aortic Stenosis


Narrowing of aortic outflow tract causing obstruction of flow from LV into ascending aorta

- **T**- mid-systolic (ejection) murmur
- **L**- best heard @ aortic area, radiates along carotid arteries
- **C**- harsh, loud, may have associated thrill, "ejection click"
- **A**- older age, bicuspid aortic valve, rheumatic fever



Note: T- Timing; L- Location; C- Character; A- Association

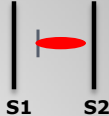
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Mitral Prolapse

Bulging of one or both mitral valve leaflets into LA during LV systole

- **T**- mid- late systolic murmur
- **L**- best heard @ apex
- **C**- mid systolic click
- **A**- ~5% normal population, asymptomatic, ? sudden death



Note: T- Timing; L- Location; C- Character; A- Association

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PAN-SYSTOLIC (HOLOSYSTOLIC) MURMURS

- ❑ Pathological murmur
- ❑ Begins immediately with S1 & continues up to S2
- ❑ Heard with:
 - Mitral/tricuspid regurgitation
 - Ventricular septal defect (VSD)

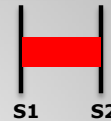
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Mitral Regurgitation

Retrograde flow from LV into LA
through an incompetent mitral valve

- T- holosystolic murmur
- L- best heard @ apex, radiates to left axilla
- C- soft, high-pitched, blowing
- A- MV prolapse, MV myxomatous degeneration, MI, rheumatic heart disease, cardiomyopathy, endocarditis

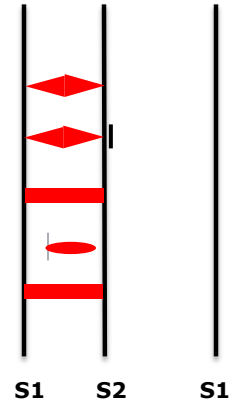


Note: T- Timing; L- Location; C- Character; A- Association

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IN SUMMARY: COMMON SYSTOLIC MURMURS AND TIMING

1. **Aortic stenosis** – ejection murmur
2. **Pulmonary stenosis** – ejection murmur + spilling S2
3. **Mitral / Tricuspid regurgitation** – holosystolic
4. **Mitral valve prolapse** – mid-late systole
5. **Ventricular septal defect (VSD)** – holosystolic



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Diastolic Murmurs

Early diastolic

Mid diastolic

Late diastolic

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**
Suggest stenosis of an AV valve
e.g. mitral/tricuspid stenosis

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Aortic Regurgitation


Retrograde flow from aorta into LV
through incompetent aortic cusps

- T- diastolic (early) murmur
- L- best heard @2nd-4th left intercostal spaces
- C- high-pitched, blowing, decrescendo
- A- aortic root degeneration, rheumatic heart disease, VSD
w/aortic valve prolapse (kids)



Note: T- Timing; L- Location; C- Character; A- Association

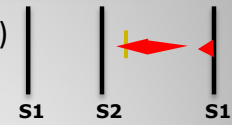
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Mitral Stenosis


**Obstruction of flow from LA to LV because of a narrowed mitral orifice
(Valve becomes thickened & calcified)**

- **T-** diastolic (mid-diastolic, or pre-systolic) murmur with 'opening snap' after closure of aortic valve
- **L-** best heard @ apex
- **C-** low pitched (heard with bell)
- **A-** rheumatic fever

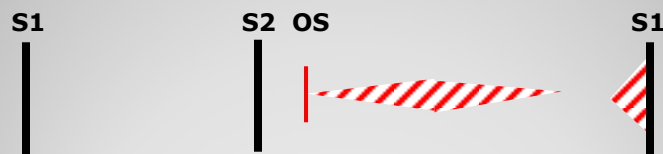


Note: T- Timing; L- Location; C- Character; A- Association

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Mitral Stenosis ... (Cont.)

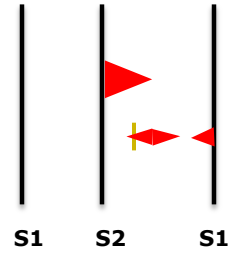


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IN SUMMARY: COMMON DIASTOLIC MURMURS AND TIMING

Softer, blowing, gurgle

1. Aortic regurgitation - early diastole
2. Mitral stenosis - mid to late (pre-systolic) diastole



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Continuous Murmurs

Continuous Murmurs

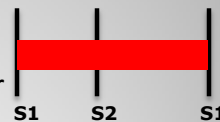
- ❑ Begin in systole, ? peak near S2 & continue into all or part of diastole
- ❑ Heard with:
 - Patent ductus arteriosus (PDA)
 - Ventricular septal defect (VSD)

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Patent Ductus Arteriosus

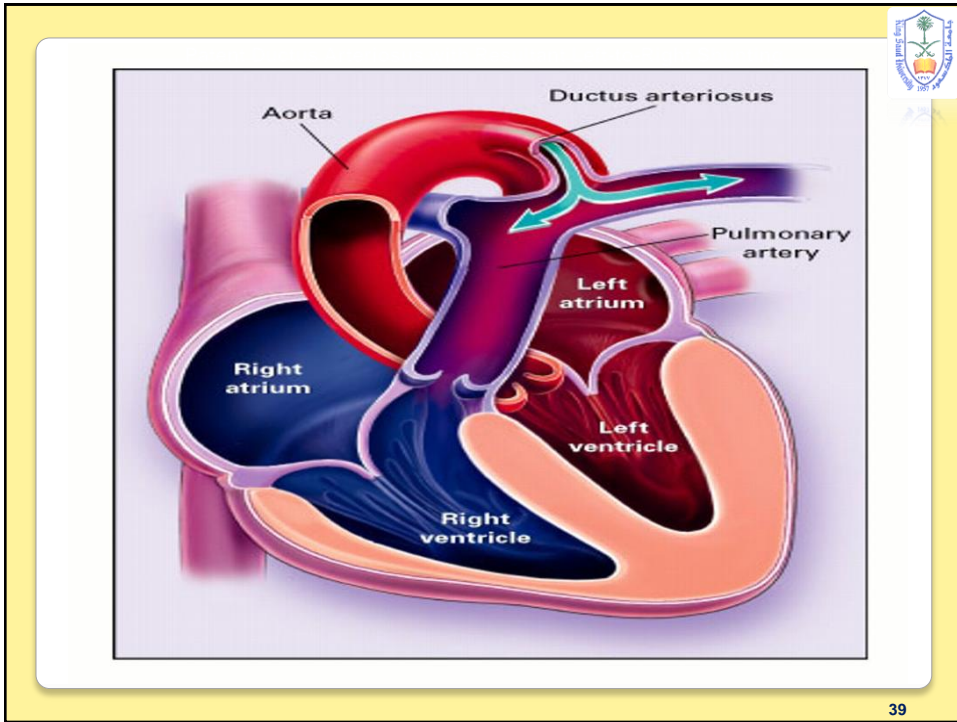
Failure of closure of the duct
between pulmonary artery & aorta

- **T**- continuous murmur
- **L**- best heard @ upper left sternal border
- **C**- machine-like
- **A**- left to right shunt, cyanosis



Note: T- Timing; L- Location; C- Character; A- Association

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IN SUMMARY: COMMON CONTINUOUS MURMURS AND TIMING

1. Patent ductus arteriosus (PDA)
2. ? Ventricular septal defect (VSD)

S1 S2 S1

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