



# PHYSIOLOGY TEAM 432

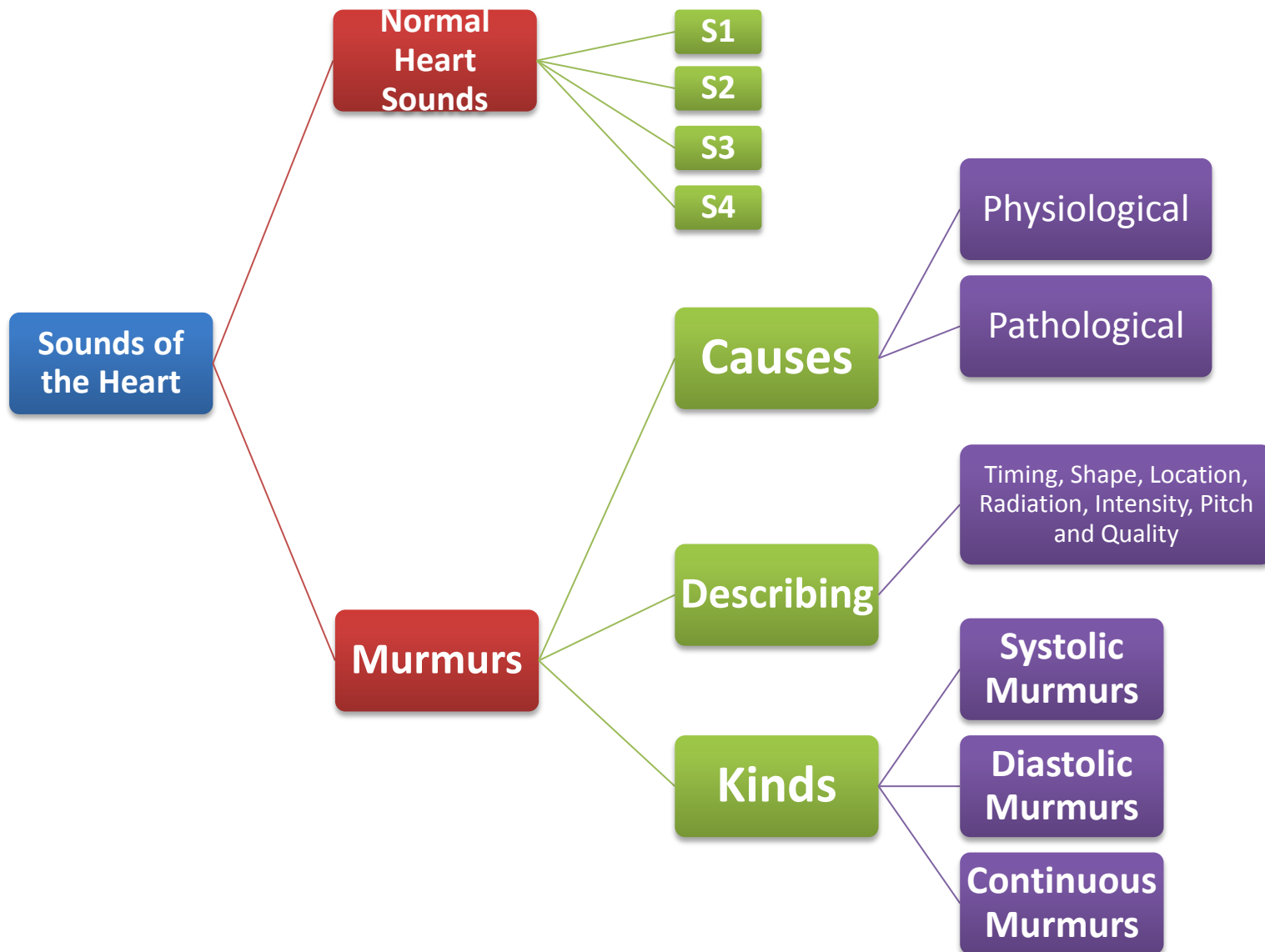
## *LECTURE: 7* Heart Sounds & Murmurs

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# OBJECTIVES

- List the major types of normal heart sounds.
- Understand the physiological basis for the production of normal heart sounds.
- Understand the patho-physiological basis for the production of heart murmurs .

# MIND MAP



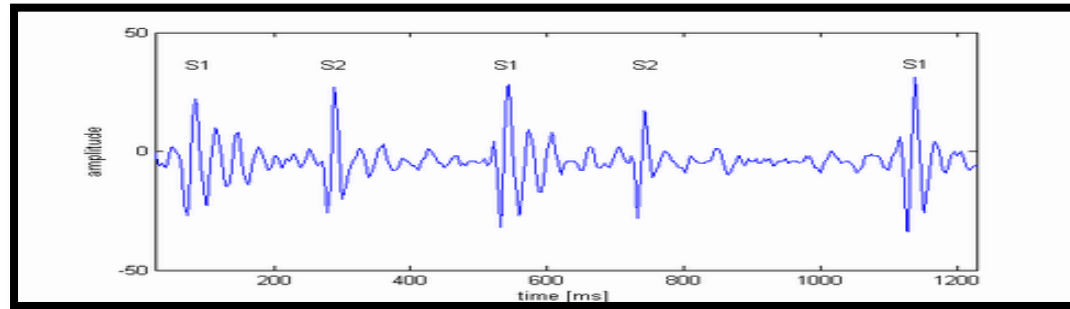
# Heart Sounds

Detected over anterior chest wall by:

- Auscultation: (Stethoscope) “hearing”



- Phonocardiography: (Sound recording device) “on piece of paper”



**‘4’ heart sounds can be detected:**

- 1st & 2nd ht sounds ... (**normally heard**)
- 3rd & 4th ht sounds ... (sometimes detected)

# Heart Sounds' Windows

نبضات القلب ممكن  
نسمعها في أي مكان  
بس هنا تكون أعلى  
وأوضح!

Best heard at 4 certain areas:

## Aortic area:

- 2nd Rt costal cartilage.

## Pulmonary area:

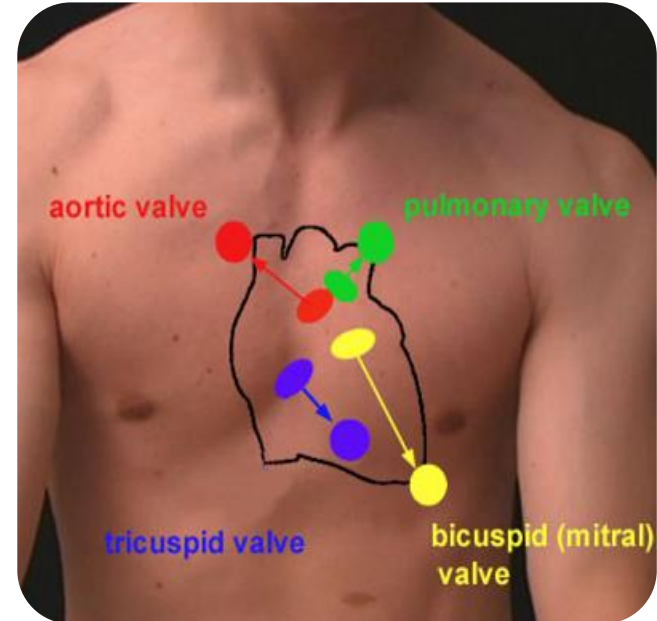
- 2nd Lt intercostal space.

## Tricuspid area:

- lower part of sternum towards Rt side.

## Mitral area:

- 5th Lt intercostal space crossing mid-clavicular line. or
- 9 cm (2.5-3 in) from sternum.



Easy way to memories them:

All People Take Medicine

	S1	S2	S3	S4
Cause	Sudden closure of AV-vs	Sudden closure of semilunar vs	Rush of blood during rapid vent filling → vibration of vent. muscles.	Vibration produced by cont. of atrial muscles (attributed to vent filling)
C-Cycle	Marks <u>beginning of vent systole</u> (Iso-volumetric contraction)	Marks <u>beginning of vent diastole</u> (Iso-volumetric relaxation)	Max vent filling phase of diastole	Atrial systole (just before 1st HS)
Duration	0.15 sec (Longer)	0.11-0.125 sec (Shorter)	0.05 sec	0.04 sec
Frequency	25-35 Hz	50 Hz	20-30 Htz	20 cycles / sec or less [Htz]
Character	Low pitch (LUB) (Louder)	High pitch (DUB) (Softer, Sharper) Split into 2 sounds during <b>inspiration only</b> = Physiological splitting (due to delay closure of pulmonary v). -ECG relationship: The second heart sound occur soon <b>after the T-wave of ECG.</b>	Usually not audible Heard in Children	Usually not audible (Rarely heard) Heard in Elderly
Best heard?	M & T لأقرب AV-vs	A & P لأقرب Semilunar vs	M	M

**The S<sub>2</sub> duration is 0.11 Sec and S<sub>1</sub> is about 0.14 second**

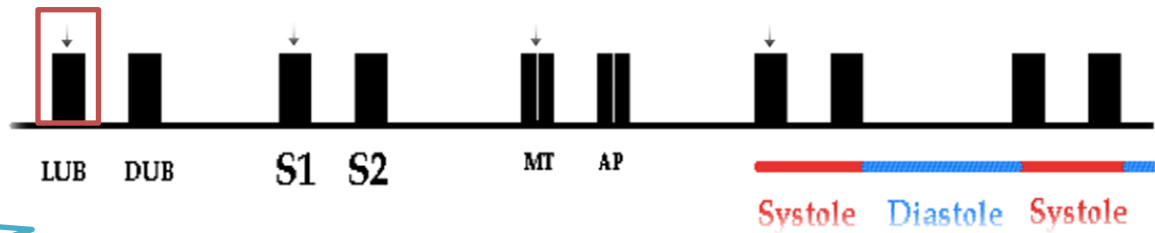
**The reason for the shorter S<sub>2</sub> is that semilunar valves are more tight than A-V valves, so they vibrate for a shorter time than A-V valve**

**The S<sub>2</sub> has higher frequency than the S<sub>1</sub> for two reasons:**

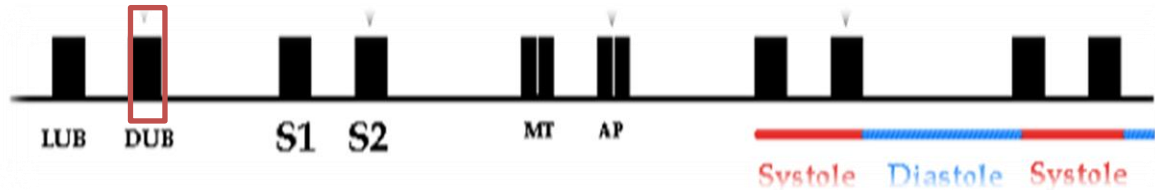
- 1. The tautness of the semilunar valves than A-V valves**
- 2. The greater elastic coefficient of the taut arterial walls that provide the principal vibrating chambers for the S<sub>2</sub>.**

# S1

The left valves always closes before the right valves. (M) then (T)



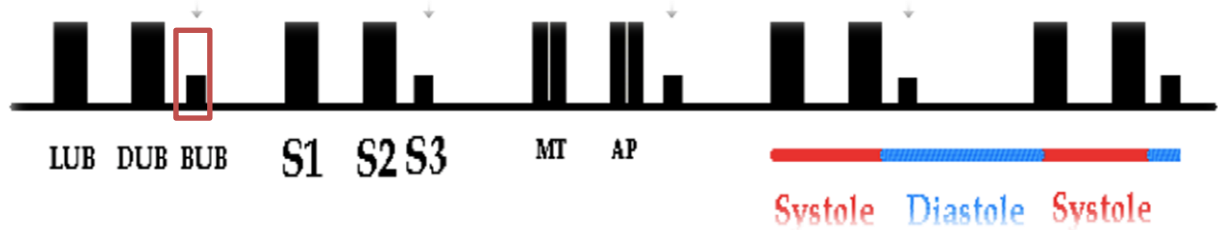
# S2



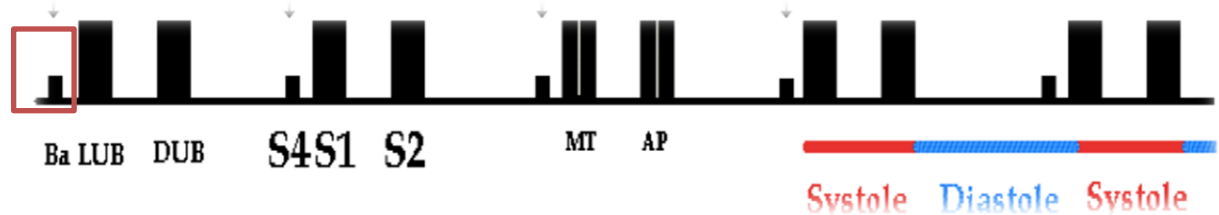
*Physiological splitting (during Deep inspiration) in S2 =>*



# S3



# S4





# What Makes Noises in the Heart?

**Valves closing: “Normal”**

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.

“هنا مو مرض بس  
الصوت الثالث  
والرابع صار عالي”

## Significance of heart sounds?

Important for diagnosis of abnormal heart sounds (murmurs)

# Murmurs

N.B. Murmurs are longer than heart sounds

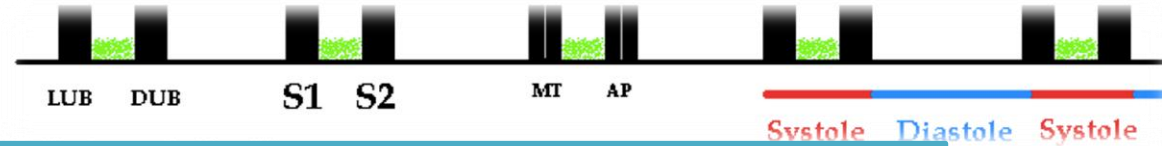
فترة الـ Murmurs أطول عشان كذا نقدر نسمعها

Causes	How to Describe?
<p><b>Physiological:</b></p> <ul style="list-style-type: none"><li>-Increase blood flow across <b>normal</b> valves:</li><li>- e.g.-Pregnancy-Hyperthyroidism-Anemia-Fever-children</li></ul>	<p><b>Timing (systolic or diastolic)</b></p> <p>لازم نعرف هو جا في فترة الانقباض أو الارتخاء</p> <p>إذا طلع الصوت بعد نبضة "انقباض" فهذا: systolic murmur.</p>
<p><b>Pathological:</b></p> <ul style="list-style-type: none"><li>- Congenital</li><li>- Turbulent flow through <b>abnormal</b> valves, or septal defect: e.g.</li><li>-Tight valve (stenosis <b>تضيّق</b>) thickness, stiffness, fibrosis</li><li>-Leaky valve (regurgitation or insufficiency) مو قادر يسكّر كويس</li></ul>	<p><b>Shape</b></p> <p><b>Location</b></p> <p><b>Radiation</b></p> <p>If it moves to another place.</p> <p><b>Intensity</b></p> <p><b>Pitch</b></p> <p><b>Quality</b></p>

# 1. Timing

- Systolic •
- Diastolic •
- Continuous •

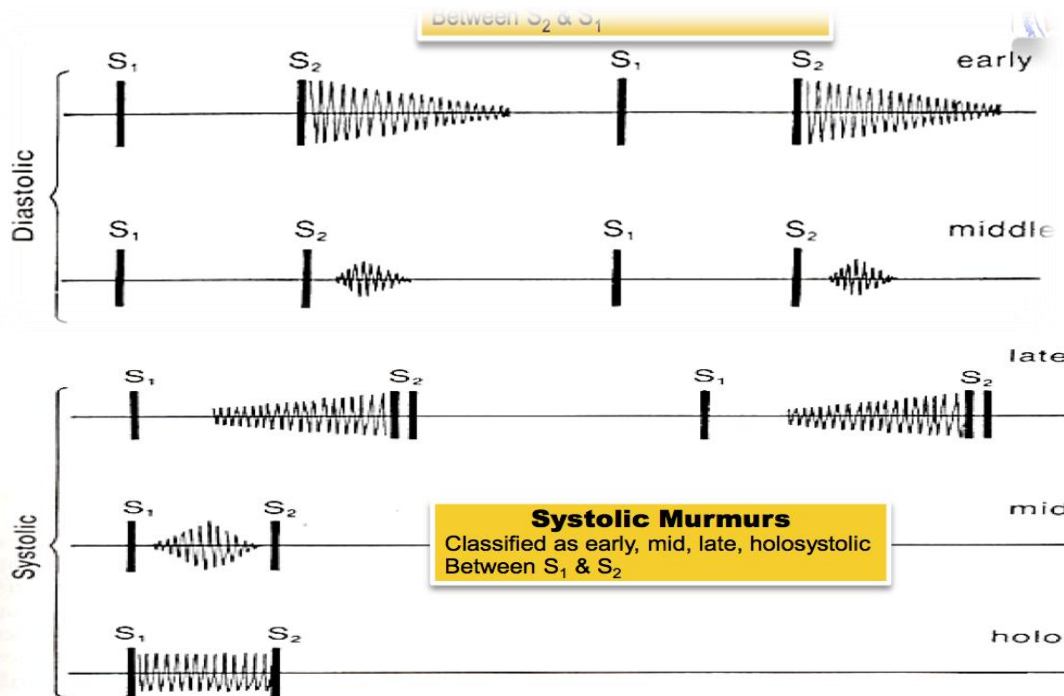
Holosystolic murmur "Pansystolic murmur":



Diastolic murmur:



Murmurs described according to position in the cardiac cycle



Diastolic Murmurs  
Classified as:  
early, mid, late  
Between S2 & S1

Systolic Murmurs  
Classified as:  
early, mid, late,  
holosystolic  
Between S1 & S2

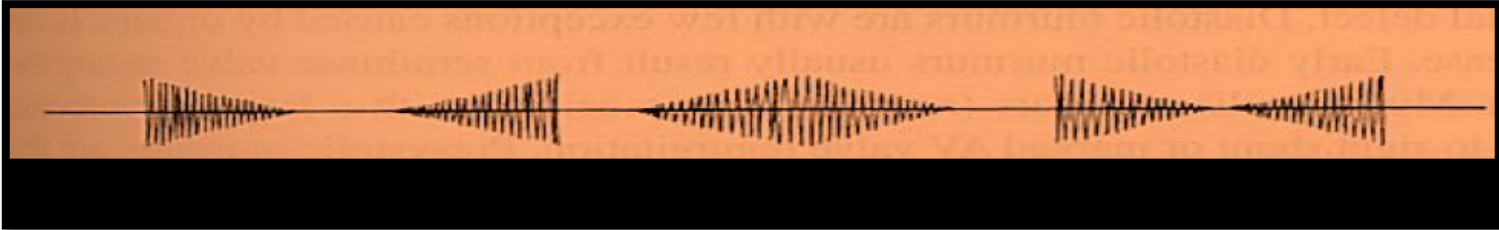
# Heart Murmurs

Valve	Abnormality	Timing of Murmur
Aortic or pulmonary	Stenosis	Systolic
	Insufficiency	Diastolic
Mitral or tricuspid	Stenosis	Diastolic
	Insufficiency	Systolic

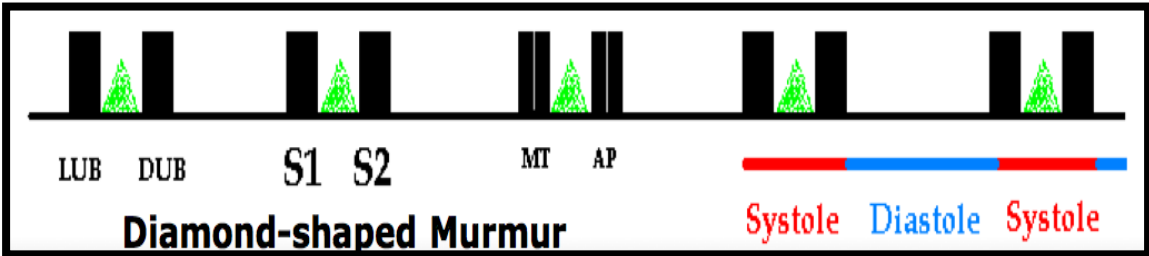
# 2. Shape

- Crescendo (grows louder) •
- Decrescendo •
- Crescendo-decrescendo (Diamond-shaped) •
- ”مستقيم“ Plateau •

Murmurs described according to the waxing & waning of the sound



Diamond shape  
ممکن یصیر من فوق بس.  
Crescendo-decrescendo is Diamond shaped but from both sides up and down.



### 3. Location of maximum intensity

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

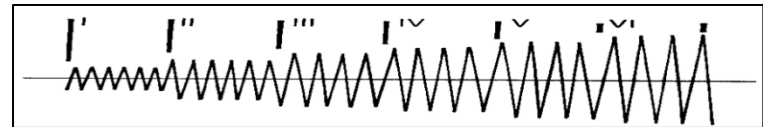
### 4. Radiation

Reflects intensity of the murmur & direction of blood flow.

For example: I heard it in the mitral area and it goes to the axilla, the voice is moving! I don't hear it on one place! If I move the stethoscope I still can hear it!

### 5. Intensity

Graded on a 6 point according to Levine scale:



<b>Grade1 (I)</b>	Lowest intensity - Very faint - need <u>quiet room</u> and <u>trained</u> ear to hear. (difficult to hear even by expert listeners) “real cardiologist can detect it”
<b>Grade2 (II)</b>	Low intensity - Quiet but heard immediately - audible to anyone who listens attentively (usually audible by all listeners)
<b>Grade3 (III)</b>	Medium intensity - Moderately loud - (easy to hear even by inexperienced listeners, but without a palpable thrill ‘I <u>can’t</u> feel it with my hand’)
<b>Grade4 (IV)</b>	Medium intensity - Loud - Thrills ‘I can feel it with my hand’- palpable: it produces a precordial thrill.
<b>Grade5 (V)</b>	Loud intensity - Heard with stethoscope partly off the chest - Thrills - audible with your stethoscope على الصدر عشان أسمعه، أقدر أسمعه من بعيد! placed perpendicular to chest wall. السماع تصير مائلة.
<b>Grade6 (VI)</b>	- Thrills!! بدون السماع Loudest intensity - audible without a stethoscope

# 6. Pitch

High, medium, low.

# 7. Quality

Blowing, harsh, rumbling & musical

# 8. Others:

Variation with respiration: •

Right sided murmurs change > left sided

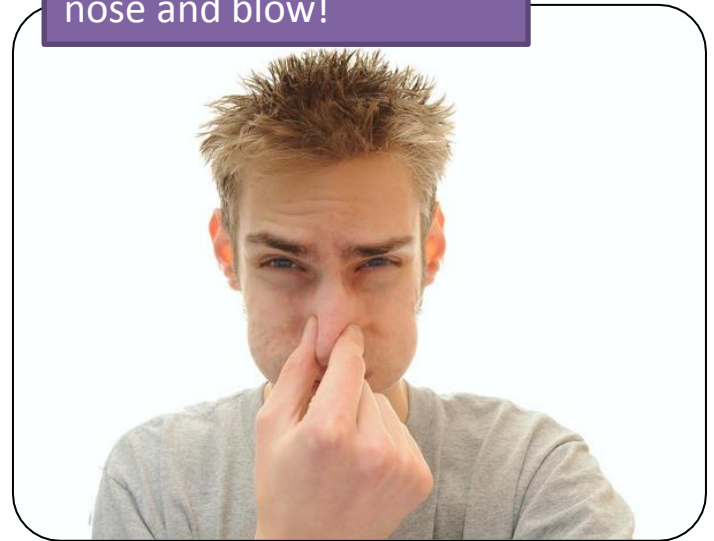
Variation with position of patient •

هل يختلف باختلاف وضعية المريض!

Variation with special maneuvers •

Valsalva >> Murmurs decrease in length & intensity

:\* Valsalva maneuver  
Close your mouth and  
nose and blow!



## Main principle for murmurs:

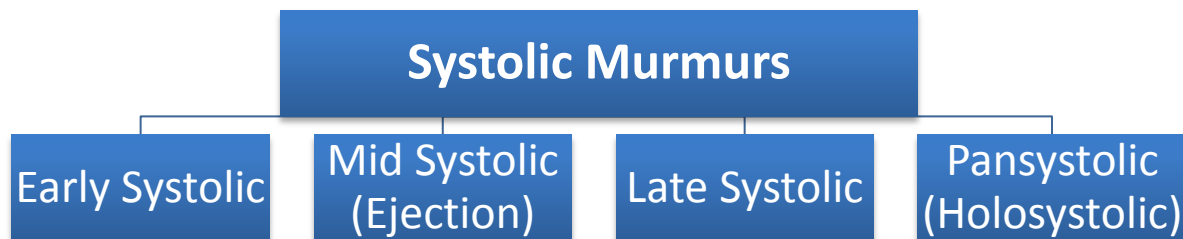
Semilunar Stenosis => Systolic murmur. AV Stenosis => Diastolic murmur.  
Insufficient Semilunar => Diastolic murmur. Insufficient AV => Systolic murmur.

# Systolic Murmurs

Derived from harsh & increase turbulence in flow.

Associated with:

1. ↑ flow across normal valve ↑ flow into a dilated great vessel.
2. ↑ flow across an abnormal valve, or narrowed ventricular outflow tract - e.g. *aortic /pulmonary stenosis*.
3. ↑ flow across an incompetent AV valve - e.g. *mitral/tricuspid regurgitation*.
4. ↑ flow across the inter-ventricular septum - e.g. VSD.





# Systolic Murmurs

Early Systolic

Mid Systolic  
(Ejection)

Late Systolic

Pansystolic  
(Holosystolic)

Most common kind of heart murmur - Usually crescendo-decrescendo.

They can 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.

## Aortic Stenosis:

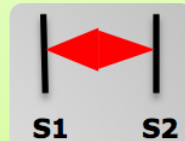
Narrowing of aortic outflow tract causing obstruction of flow from LV into ascending aorta.

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

## Mitral Prolapse:

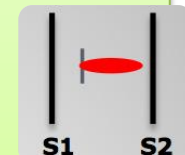
Bulging of one or both mitral valve leaflets into LA during LV systole.

T- mid- late systolic murmur

L- best heard @ apex

C- mid systolic *click*

A- ~5% normal population, asymptomatic, sudden death.



# Systolic Murmurs

Early Systolic

Mid Systolic  
(Ejection)

Late Systolic

Pansystolic  
(Holosystolic)

Pathological murmur.

Begins immediately with S1 & continues up to S2.

Heard with:

- Mitral/tricuspid regurgitation •
- Ventricular septal defect (VSD) •

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

## Mitral Regurgitation:

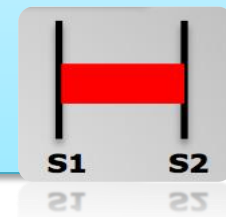
Retrograde flow from LV into LA through an incompetent mitral valve.

T- holo-systolic 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.



# Diastolic Murmurs

**Diastolic murmurs:** Very rare, low frequency, low intensity and best identified with **the bell of the stethoscope**

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

# Diastolic Murmurs

Early Diastolic

Mid Diastolic

Late Diastolic

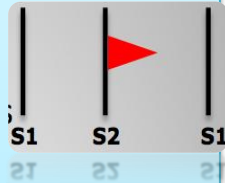
Note: T- Timing; L- Location; C- Character; A- Association

## 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)



## 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



Not splitting!!  
It's OPENING SNAP!

# 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) •

Murmur during systole and diastole.

في الـ Systole يكون (more tense) لان الضغط في الـ Aorta اعلى.

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

## Patent Ductus Arteriosus:

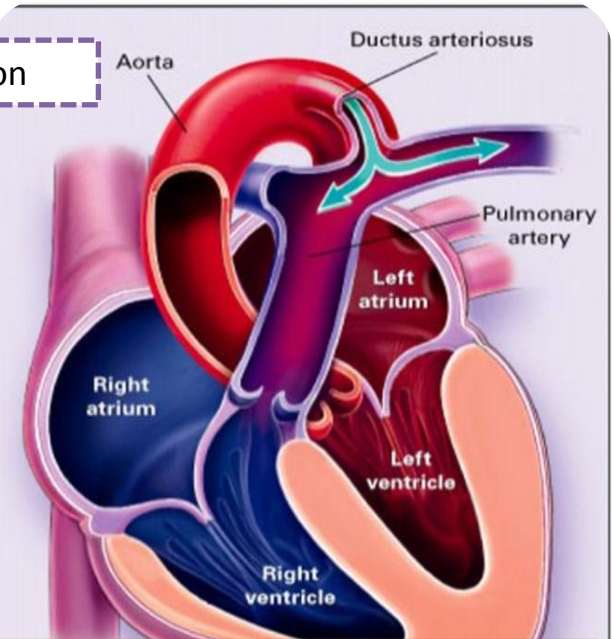
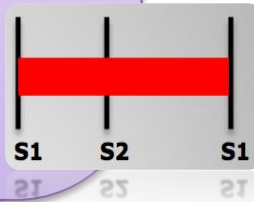
Failure of closure of the duct between pulmonary artery & aorta.

T- continuous murmur

L- best heard @ upper left sternal border

C- machine-like

A- left to right shunt, cyanosis



المفروض ان القناة تغلق عند ولادة الجنين !  
إذا لم تغلق يذهب بعض دم الـ Aorta  
إلى الـ Pulmonary

# SUMMARY

We can Detect heart sounds over anterior chest wall. •

There are 'windows' places to hear them clearer and louder. Aortic, •  
Pulmonary, Tricuspid and Mitral areas.

Normal heart sounds: S1, S2, S3 and S4. •

What make these noises are valves closing 'normal' and abnormal intra- •  
cardiac hemodynamics.

abnormal heart sounds => murmurs. •

We have to describe every murmur by the timing, shape, location, •  
radiation, intensity, pitch and quality.

The main principle for murmurs is: •

Semilunar Stenosis => Systolic murmur, AV Stenosis => Diastolic  
murmur.

Insufficient Semilunar => Diastolic murmur. Insufficient AV => Systolic  
murmur.

There are Systolic murmurs, Diastolic murmurs and continuous •  
murmurs.

# SUMMARY

Normal Heart Sound:

<http://youtu.be/X0p9GqvaKDw>

## Systolic Murmurs:

1. **Aortic stenosis** – ejection murmur <http://youtu.be/MJg257pyt4I>
2. **Pulmonary stenosis** – ejection murmur + *splitting S2*
3. **Mitral / Tricuspid regurgitation** – holosystolic [http://youtu.be/vL0s\\_nEkC8Q](http://youtu.be/vL0s_nEkC8Q)
4. **Mitral valve prolapse** – mid-late systole – mid systolic *click*
5. **Ventricular septal defect (VSD)** – holosystolic

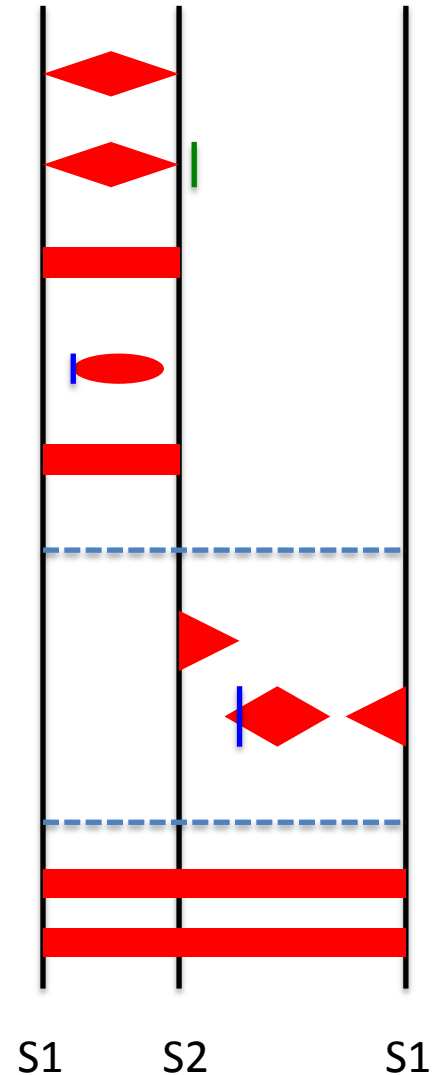
## Diastolic Murmurs:

*Softer, blowing, gurgle*

1. **Aortic regurgitation** - early diastole <http://youtu.be/HtDzHWNYKQM>
2. **Mitral stenosis** - mid to late (pre-systolic) diastole – *Open snap*  
<http://youtu.be/OQ9xrxDg3uc>

## Continuous Murmurs:

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



# QUESTIONS

1-the second heart sound occur soon.....

A-before the T-wave

B-after the T-wave

C-at QRS complex

2-tricuspid valve regurgitation occur in .....

A-systolic

B- diastolic

3- intensity graded on a 6 point according to .....

4-Mitral Stenosis best hear in.....

A- 2nd intercostal space

B-upper left sternal border

C-apex

1-b

2-a

3- Levine scale

4-c



***THE END***

**If there are any problems or suggestions  
Feel free to contact:**

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***THANK YOU***

**Actions speak louder than Words**