

Heart sound	Cause	Timing	Location	Pitch	abnormalities
S1	Closure of mitral and tricuspid valves	at the onset of ventricular systole	apex		Table 4.18
S2	Closure of aortic and pulmonic valve	at the end of ventricular systole	Left sternal angle		Table 4.19
S3	Rapid ventricular filling immediately after opening of AV valve.	Early diastole	Apex (bell)	Low pitched	-Left ventricular failure. -Mitral regurgitation. -Physiological in children, febrile, pregnancy (high CO).
S4	Forceful atrial contraction against a non-compliant or stiff ventricle	Late diastole	Apex (bell)	Soft low pitched	Left ventricular hypertrophy (due to HTN, aortic stenosis, HOCM). *always pathological*

Added sounds	Cause	Timing	Location	Pitch	abnormalities
Opening snap	Sudden opening of a stenosed valve during diastole	early in diastole just after S2	Apex	High pitched	-Mitral stenosis -Rarely tricuspid stenosis
Ejection click	Sudden opening of a stenosed valve during systole	early in systole just after S1	Right and left sternal angle	High pitched	Congenital pulmonary or aortic stenosis. (if calcific valve → absent sound)
Mid-systolic click	Sudden tensing of prolapsed leaflet during systole		Apex	High pitched	Mitral valve prolapse

Pericardial rub (friction rub)			All over the pericardium but usually localized	Coarse scratching sound	-Acute pericarditis. -few days after MI.
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- Mechanical mitral valve replacement → Metallic S1 + opening snap
- Mechanical aortic valve replacement → Metallic S2 + ejection click

Systolic murmurs	Location	radiation	Character and pitch	Intensity	duration
Aortic stenosis	Right 2 nd ICS	Upper right sternal edge, suprasternal notch, carotid arteries	Harsh, musical in children (still's murmur), high pitched (audible all over the pericardium)	may be associated with thrill	Reach max intensity in mid-systole then fades, stopping before S2 (crescendo-decrescendo murmur)
Pulmonary stenosis	Left 2 nd ICS				
Mitral regurgitation	apex	Left Axilla	Blowing in character, high pitched	may be associated with thrill	Pansystolic
Mitral valve prolapse					Late systolic
Tricuspid regurgitation	Lower left sternal edge				
Ventricular septal defect	Left sternal border	Right sternal edge		Associated with thrill	Pansystolic

Diastolic murmurs	Location	Character and pitch	duration
Aortic regurgitation	Rt 2 nd ICS, Lt 3 rd ICS (Erb's area)- leaning forward with held expiration	Low pitch	Early
Pulmonary regurgitation	Left 2 nd ICS		Early
Austin flint murmur			Mid diastolic
Mitral stenosis	Apex -(patient positioned on left side)	Low pitched, rumbling sound, blowing in character	Late diastolic
Tricuspid stenosis	Lower left sternal edge		

⇒ **Pulmonary** regurgitation is called Graham Steell murmur if it's caused by pulmonary artery dilatation in pulmonary HTN.

⇒ Aortic regurgitation is accompanied by:

1) Austin flint murmur (caused by regurgitant jet striking the anterior leaflet of the mitral valve, restricting the inflow to the left ventricle).

2) flow systolic murmur (ejection murmur).

Continuous murmurs	Location	radiation	Character and pitch
Patent ductus arteriosus	Left infraclavicular	Left scapula	Machinery like character, high pitch, louder in systolic

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