Examination of thorax II

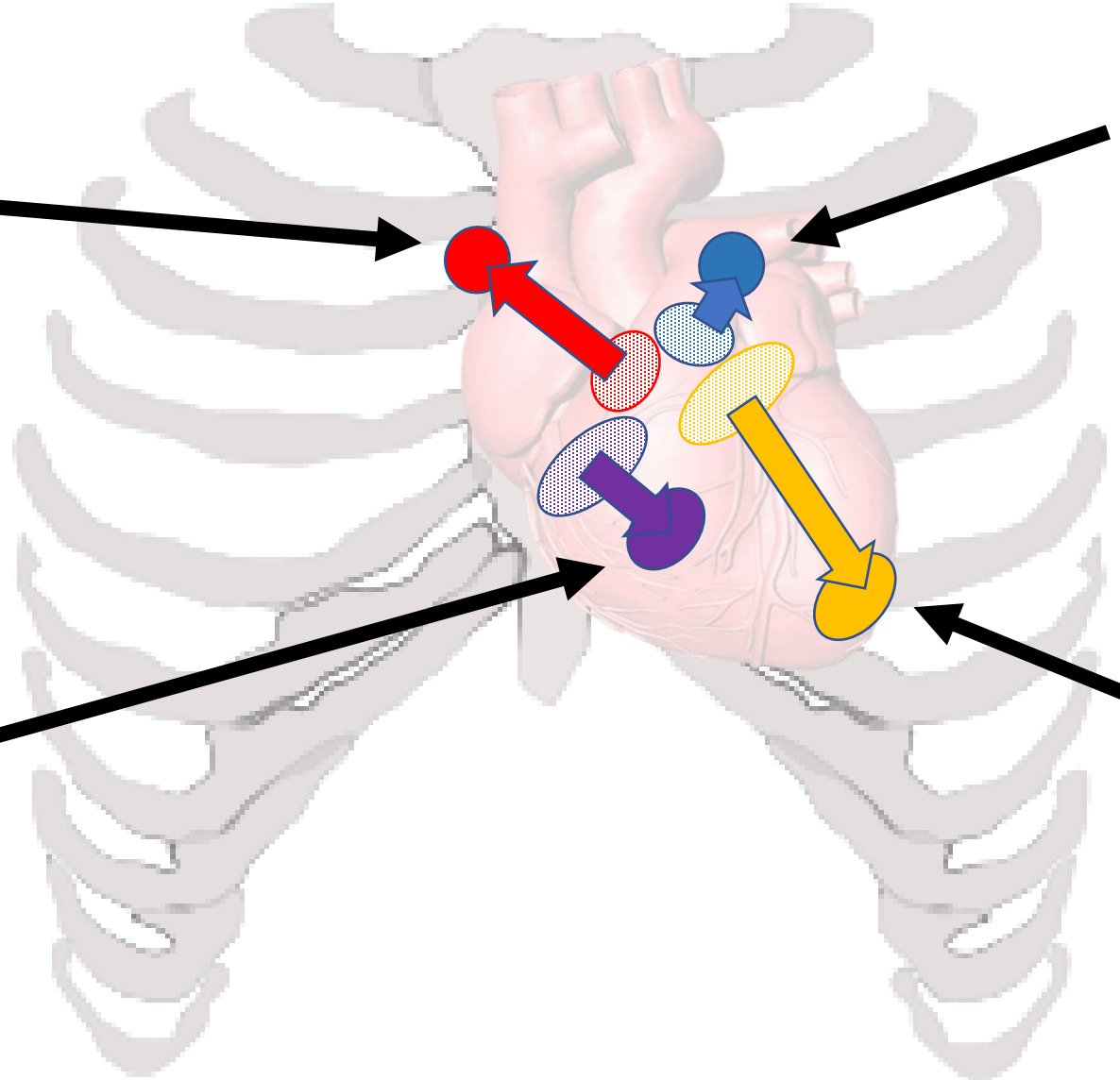
- auscultation

+ physiology and pathophysiology comments

Josef Korinek

2nd department of internal medicine
- Cardiology and Vascular medicine
General University Hospital
1. Faculty of Medicine
Charles University in Prague
Czech Republic

Auscultation points - *basic 4 points*



Aortic valve:
- 2. right intercostal space

Pulmonary valve:
- 2. left intercostal space

Trikuspid valve:
- 4. left intercostal space

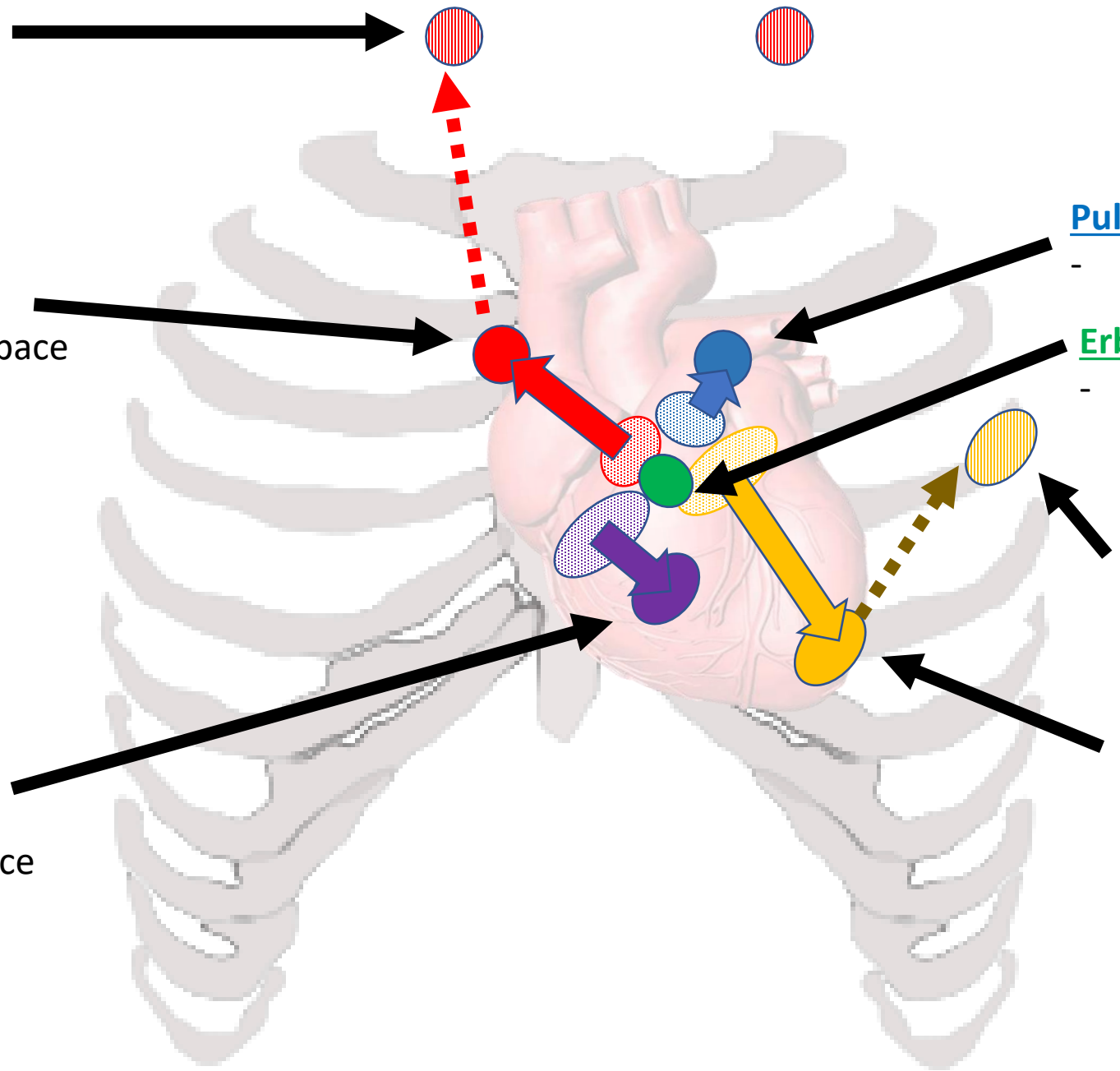
Mitral valve:
- 4.-5 intercostal space in medioclavicular line

Auscultation points- radiation points

Radiation – carotid a.:
- neck

Aortic valve:
- 2. right intercostal space

Trikuspid valve:
- 4. left intercostal space



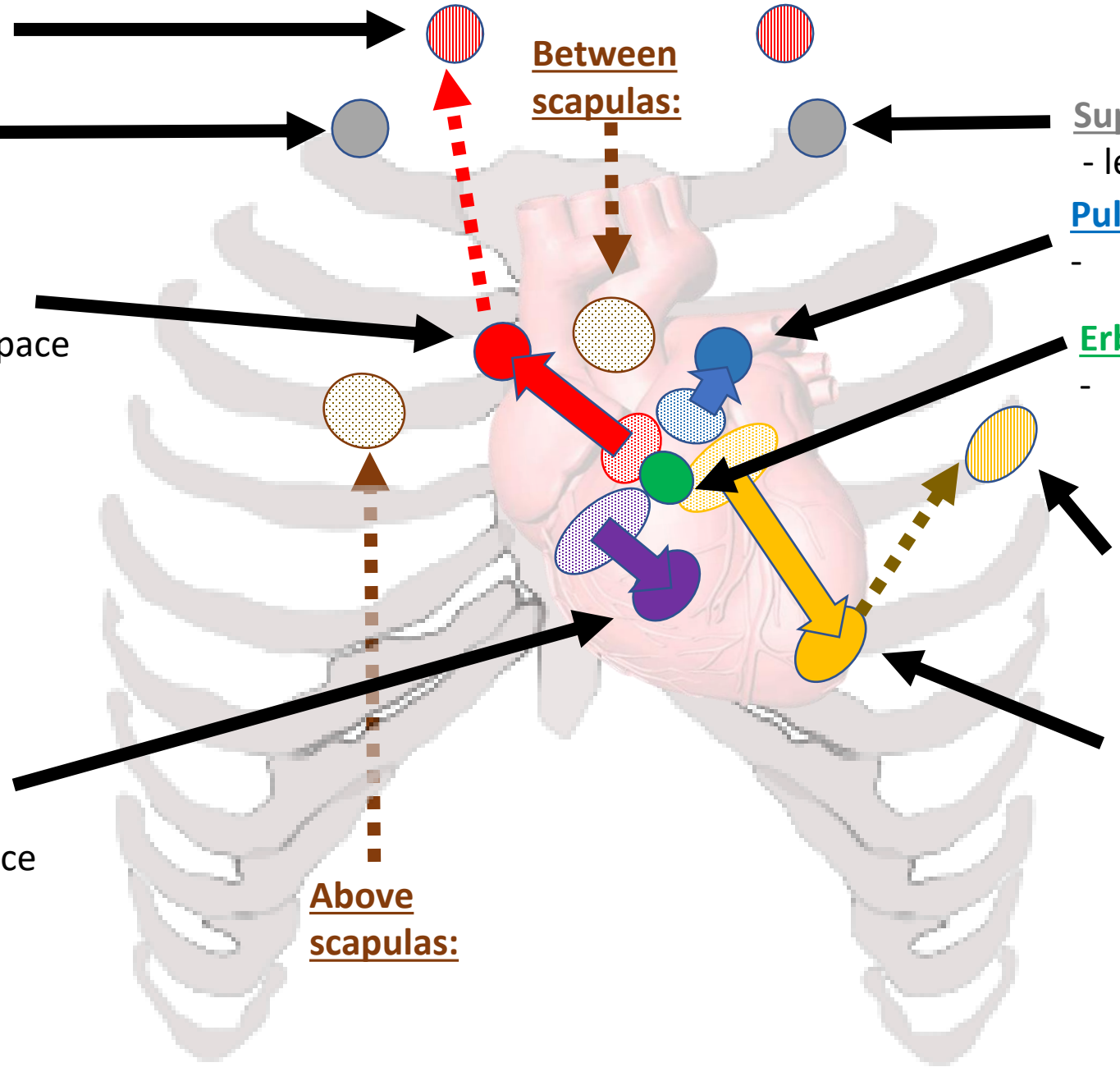
Pulmonary valve:
- 2. left intercostal space

Erb´s point:
- 3. (-4.) left intercostal space

Radiace – left atrium:
- axilla

Mitral valve:
- 4.-5 intercostal space in medioclavicular line

Auscultation points – other points



Radiation – carotid a.:
- neck

Supraclavicular
- right

Between scapulas:

Supraclavicular region
- left

Pulmonary valve:
- 2. left intercostal space

Aortic valve:
- 2. right intercostal space

Erb´s point:
- 3. (-4.) left intercostal space

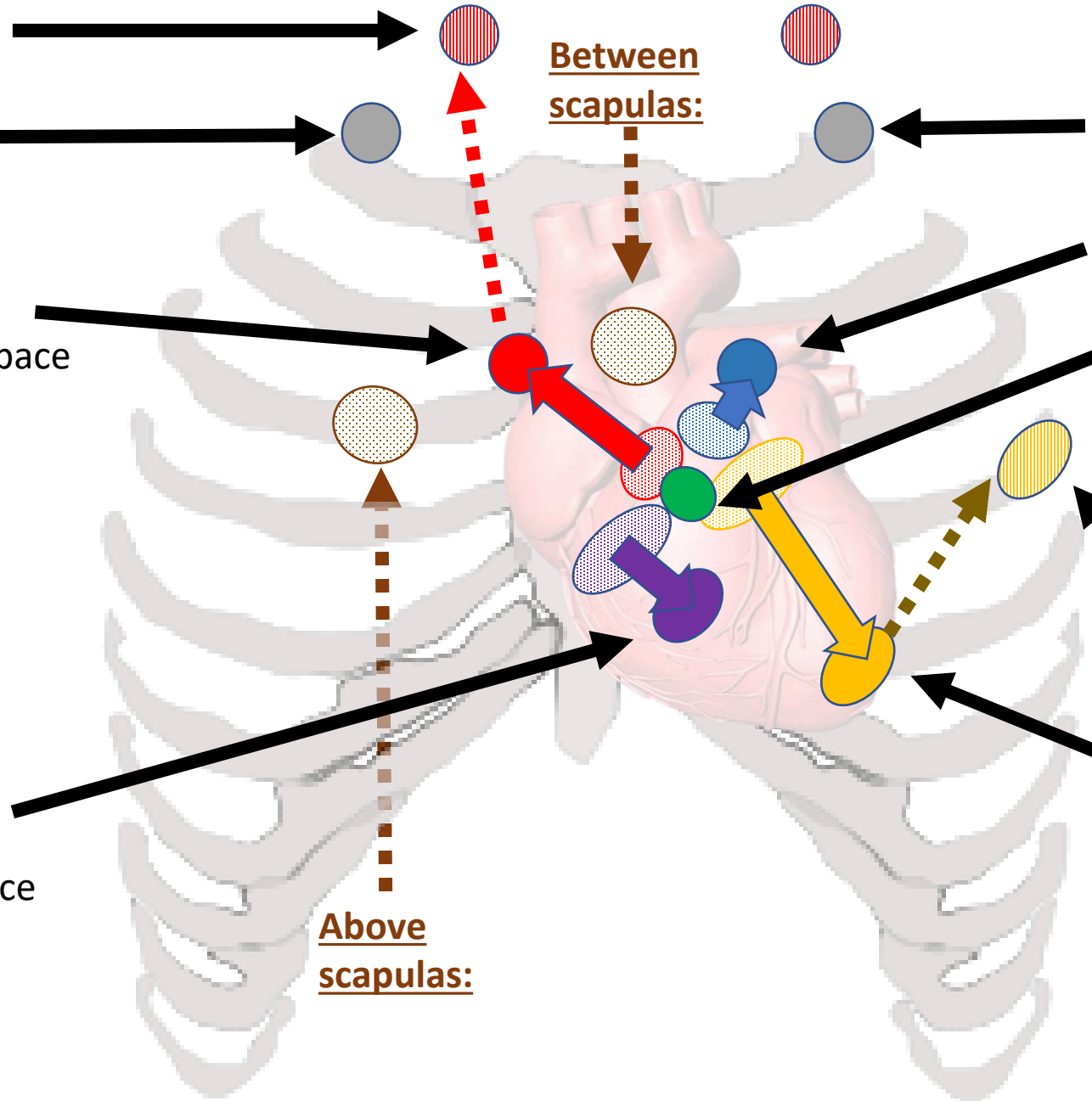
Radiace – left atrium:
- axilla

Trikuspid valve:
- 4. left intercostal space

Above scapulas:

Mitral valve:
- 4.-5 intercostal space in medioclavicular line

Auscultation points



Radiation – carotid a.:
- neck

Supraclavicular
- right

Between scapulas:

Supraclavicular region
- left

Pulmonary valve:
- 2. left intercostal space

Aortic valve:
- 2. right intercostal space

Erb´s point:
- 3. (-4.) left intercostal space

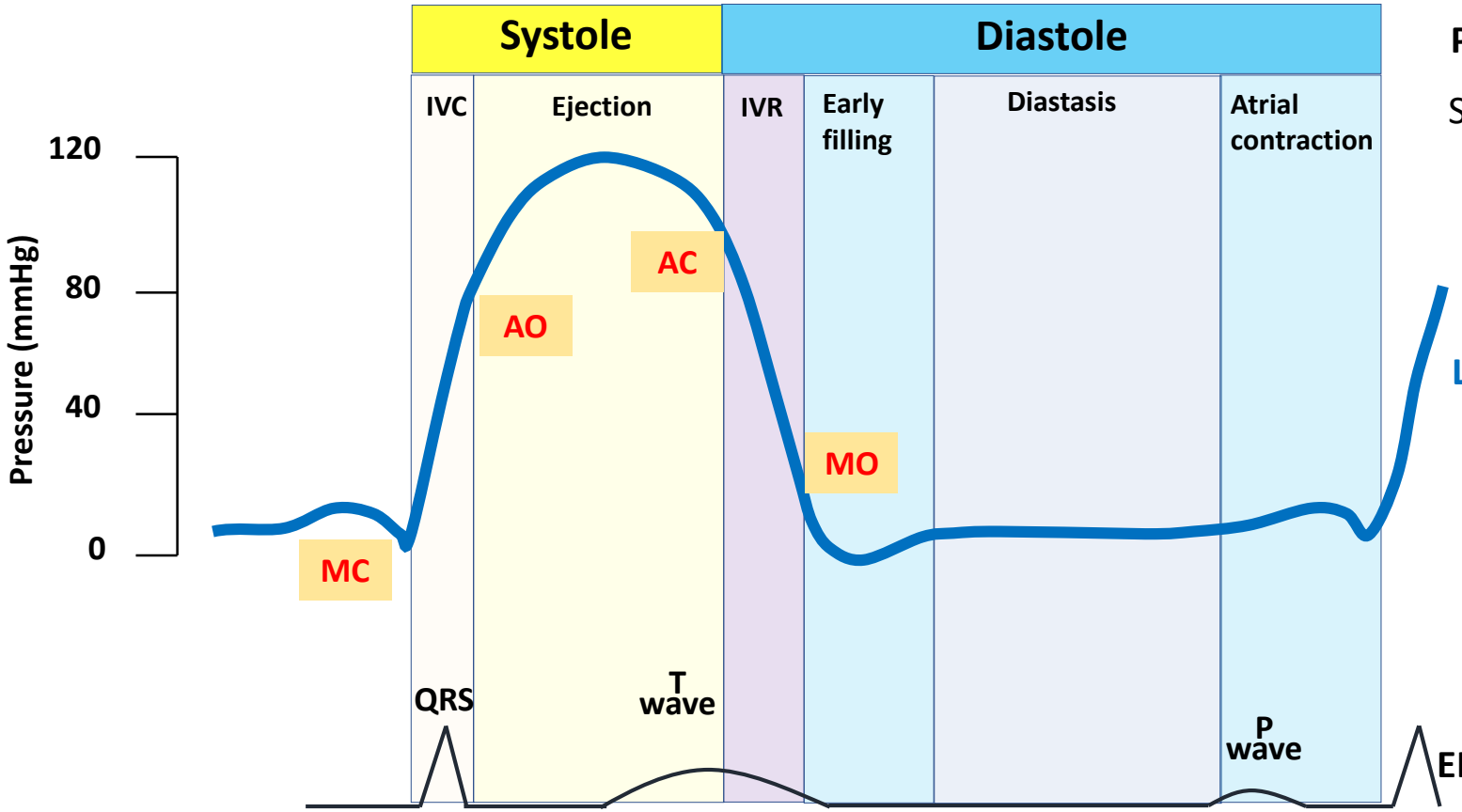
Radiace – left atrium:
- axilla

Trikuspid valve:
- 4. left intercostal space

Above scapulas:

Mitral valve:
- 4.-5 intercostal space in medioclavicular line

Cardiac cycle – PRESSURE CURVES and ECG



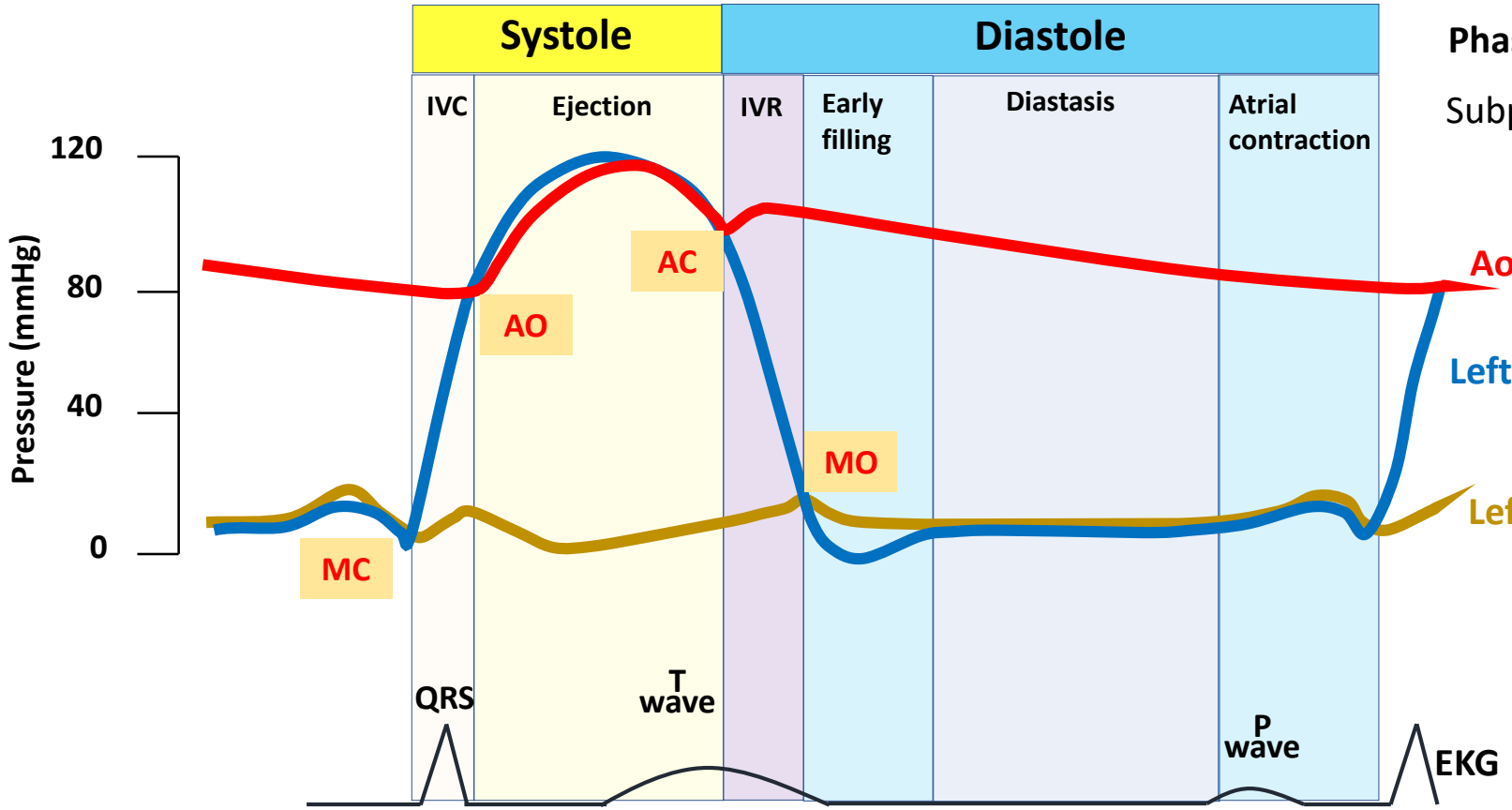
Phases of cardiac cycle

Subphases of cardiac cycle

Left ventricular pressure curve

IVC – isovolumic contraction
IVR - isovolumic relaxation
MO – mitral opening
MC – mitral closure
AO – aortic opening
AC - aortic closure

Cardiac cycle – PRESSURE CURVES and ECG



Phases of cardiac cycle

Subphases of cardiac cycle

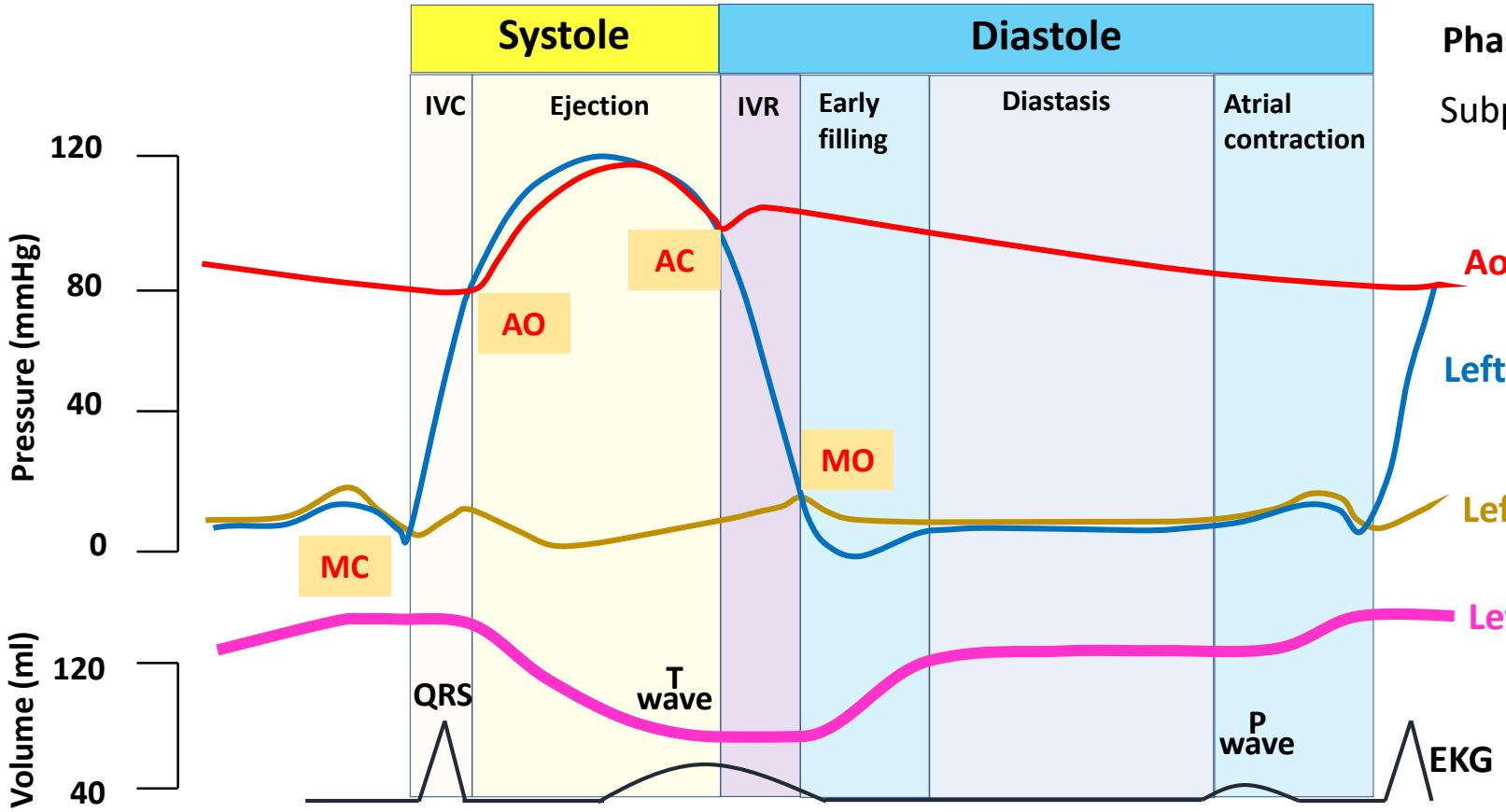
Aortic pressure curve

Left ventricular pressure curve

Left atrial pressure curve

IVC – isovolumic contraction
IVR - isovolumic relaxation
MO – mitral opening
MC – mitral closure
AO – aortic opening
AC - aortic closure

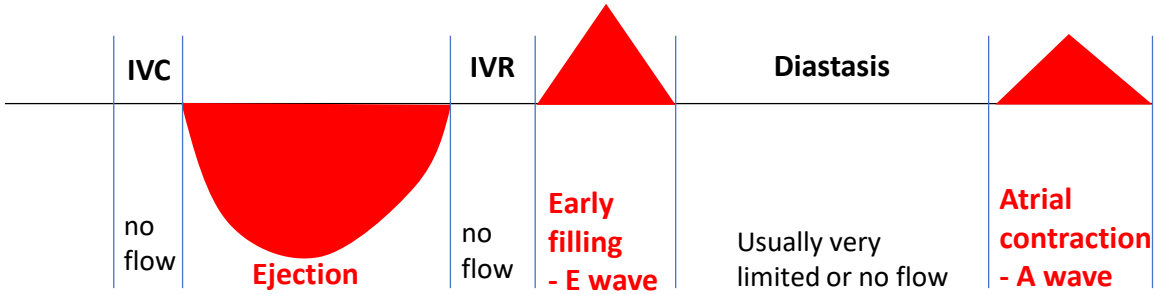
Cardiac cycle – VOLUME + BLOOD FLOWS



Phases of cardiac cycle

Subphases of cardiac cycle

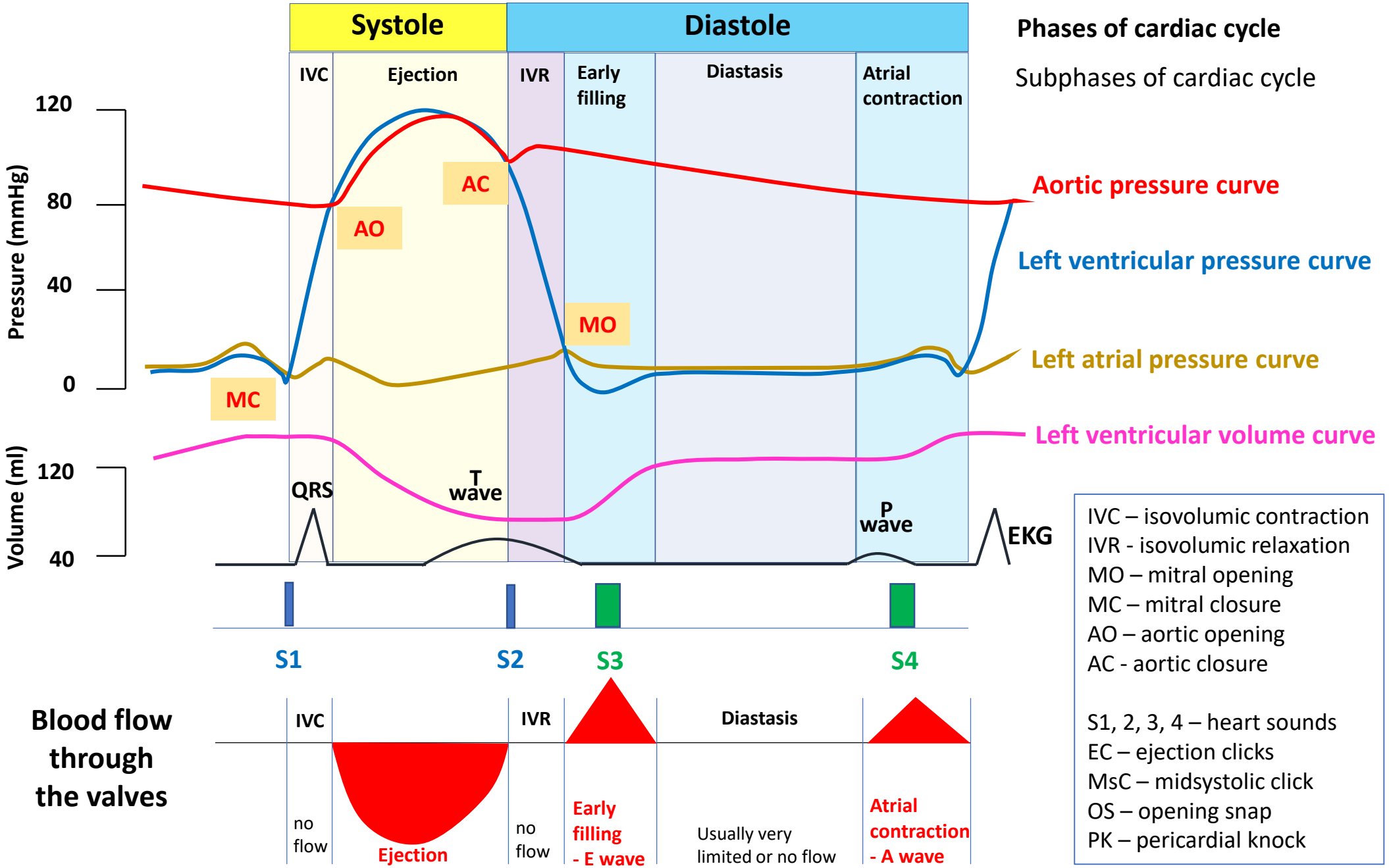
Blood flow through the valves



IVC – isovolumic contraction
IVR - isovolumic relaxation
MO – mitral opening
MC – mitral closure
AO – aortic opening
AC - aortic closure

S1, 2, 3, 4 – heart sounds
EC – ejection clicks
MsC – midsystolic click
OS – opening snap
PK – pericardial knock

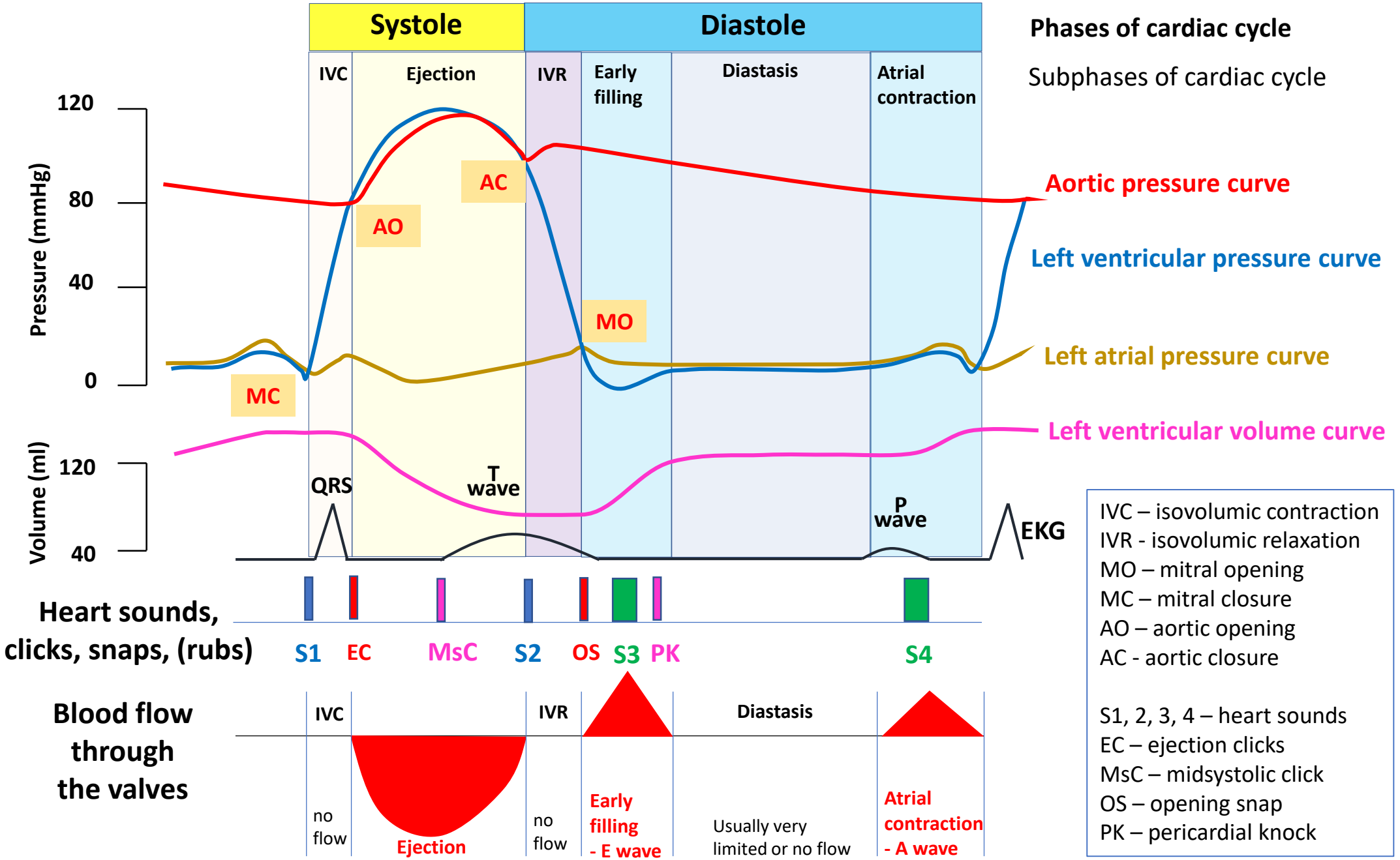
Cardiac cycle – HEART SOUNDS



IVC – isovolumic contraction
IVR - isovolumic relaxation
MO – mitral opening
MC – mitral closure
AO – aortic opening
AC - aortic closure

S1, 2, 3, 4 – heart sounds
EC – ejection clicks
MsC – midsystolic click
OS – opening snap
PK – pericardial knock

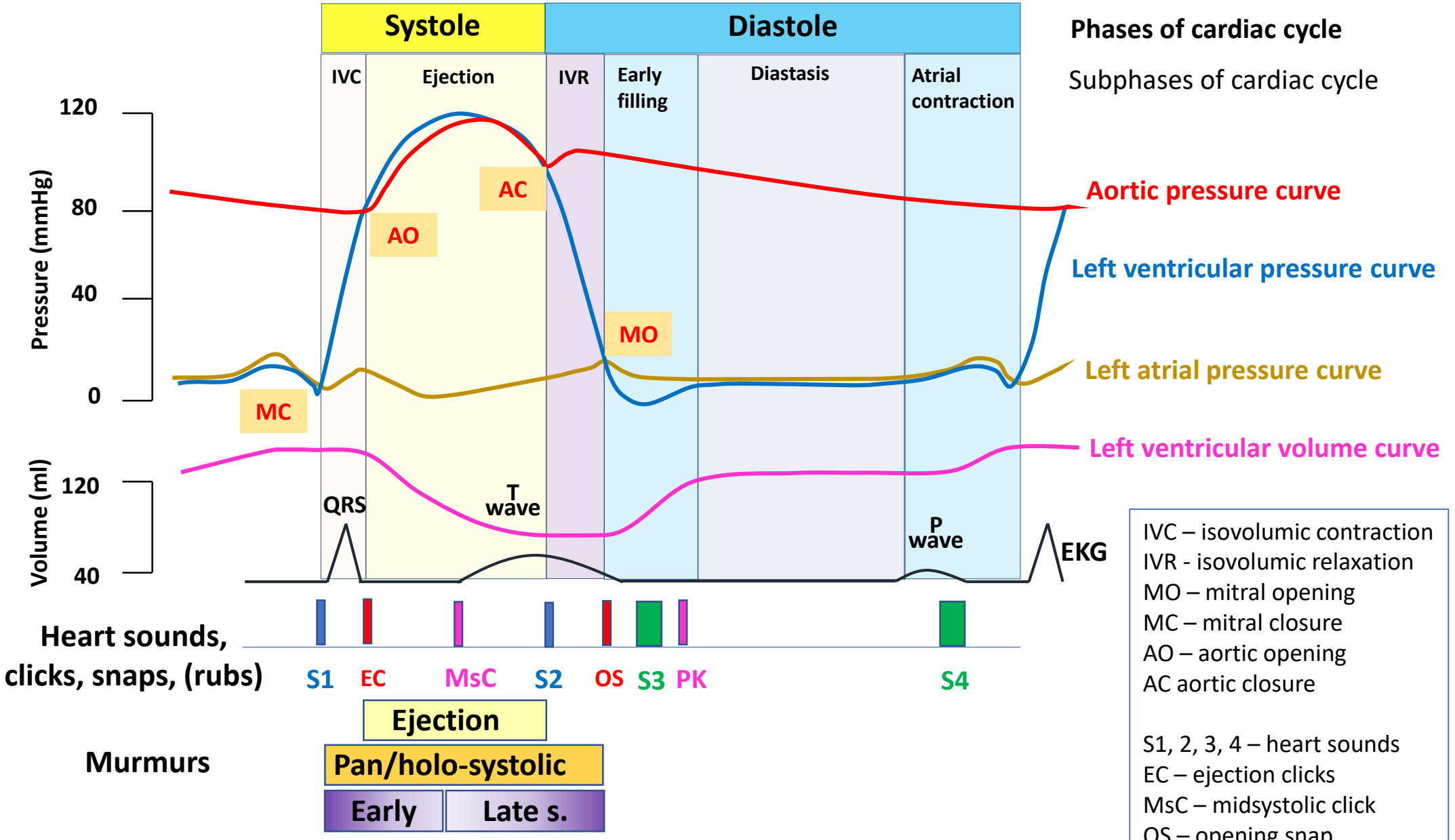
Cardiac cycle – HEART SOUNDS + CLICKS, SNAPS, (RUBS)



IVC – isovolumic contraction
IVR - isovolumic relaxation
MO – mitral opening
MC – mitral closure
AO – aortic opening
AC - aortic closure

S1, 2, 3, 4 – heart sounds
EC – ejection clicks
MsC – midsystolic click
OS – opening snap
PK – pericardial knock

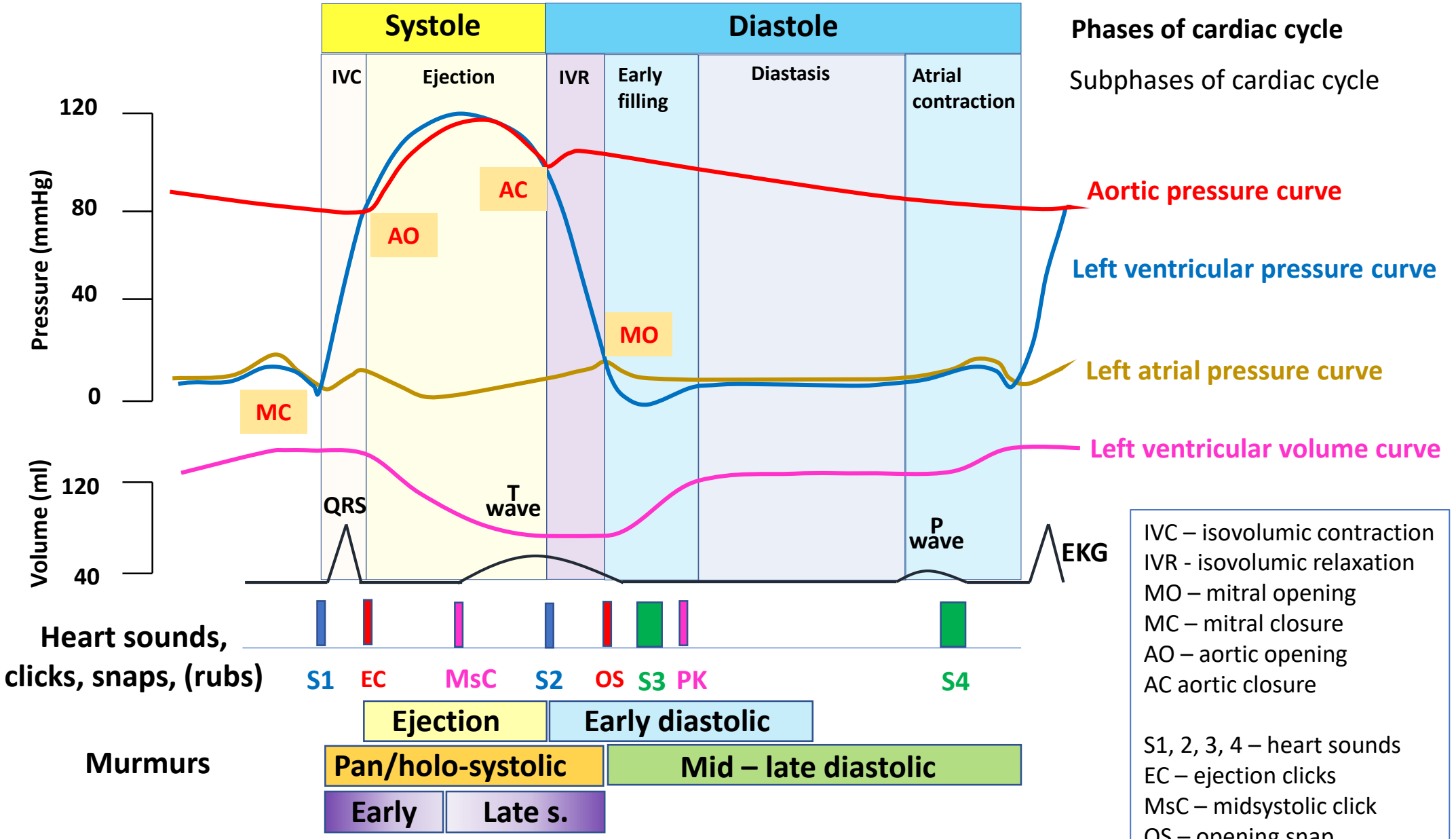
Cardiac cycle – MURMURS - systolic



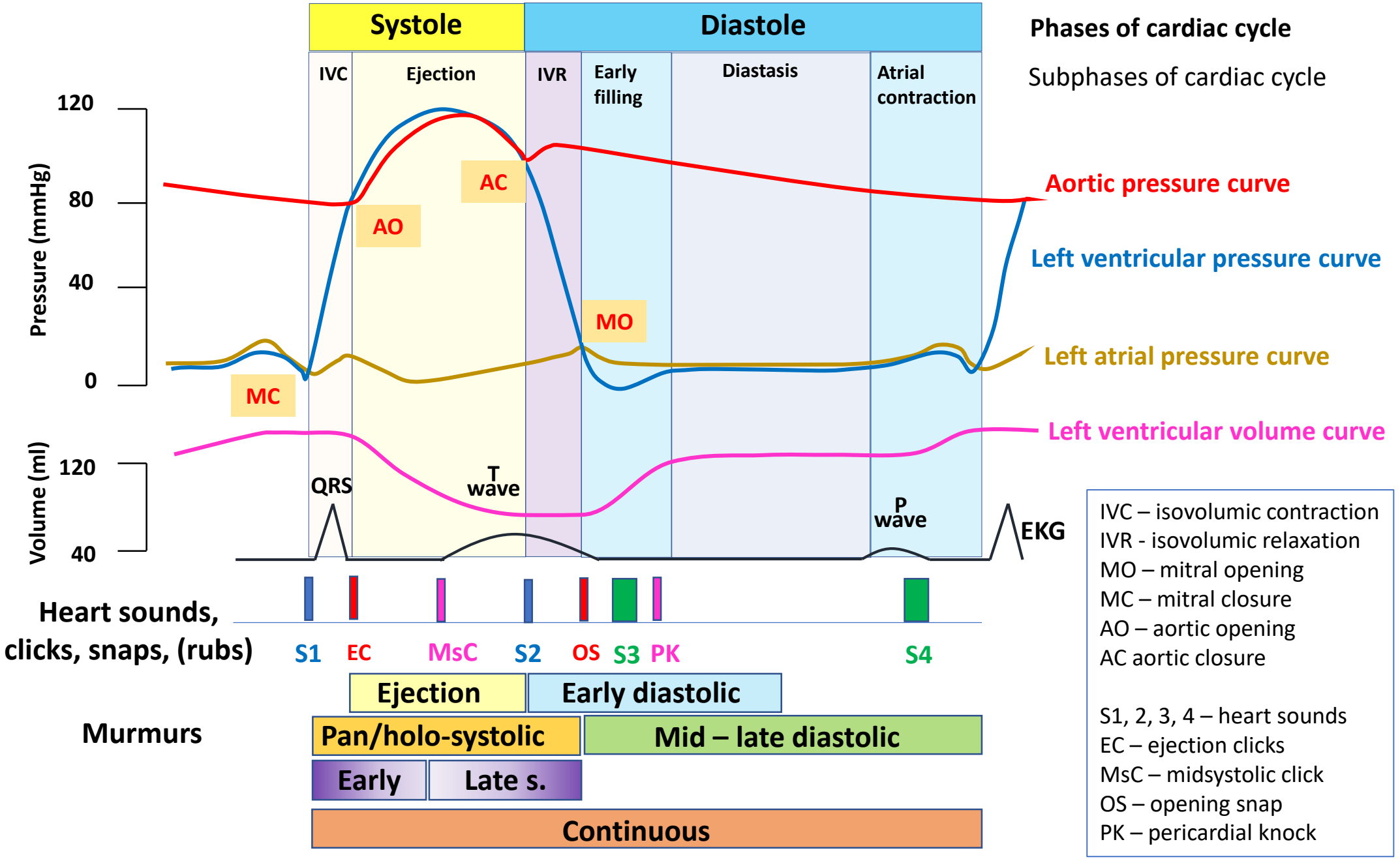
IVC – isovolumic contraction
IVR - isovolumic relaxation
MO – mitral opening
MC – mitral closure
AO – aortic opening
AC aortic closure

S1, 2, 3, 4 – heart sounds
EC – ejection clicks
MsC – midsystolic click
OS – opening snap
PK – pericardial knock

Cardiac cycle – MURMURS – diastolic



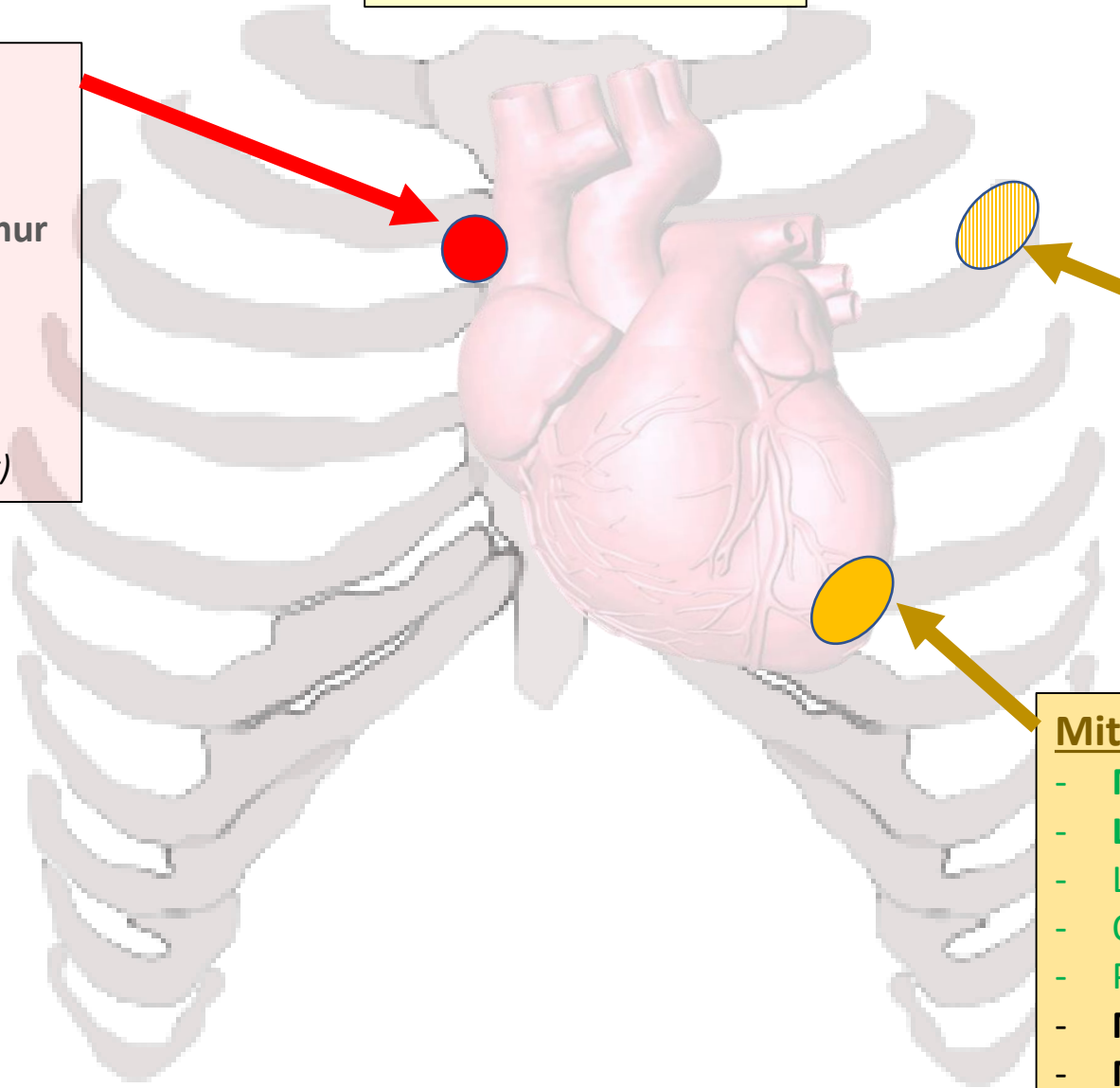
Cardiac cycle – MURMURS - continuous



Sounds, clicks, murmurs - locations

Radiation – carotid
- **Aortic stenosis**
- *(aortic regurgitation)*

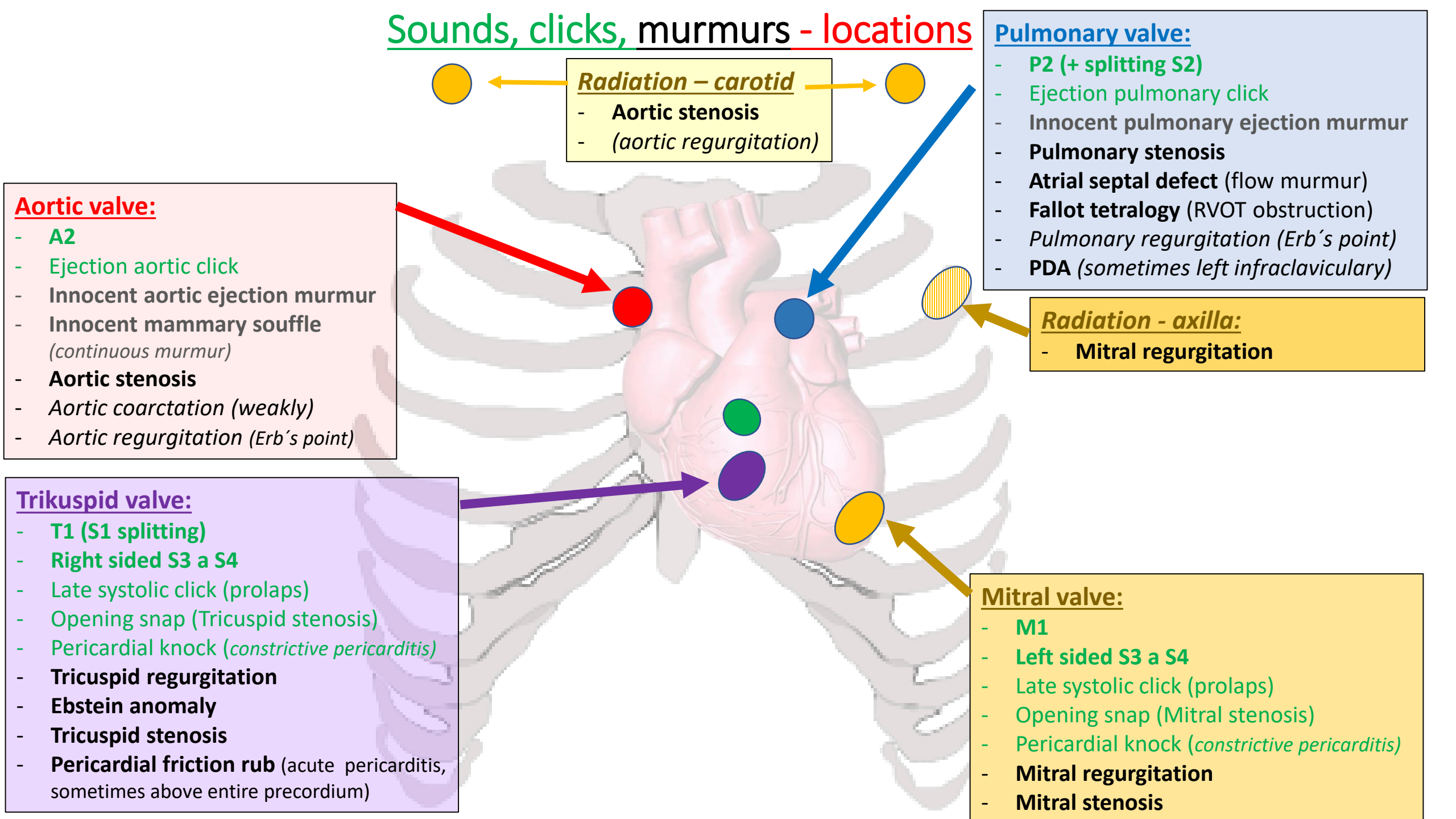
Aortic valve:
- **A2**
- Ejection aortic click
- **Innocent aortic ejection murmur**
- **Innocent mammary souffle**
  (continuous murmur)
- **Aortic stenosis**
- *Aortic coarctation (weakly)*
- *Aortic regurgitation (Erb´s point)*



Radiation - axilla:
- **Mitral regurgitation**

Mitral valve:
- **M1**
- **Left sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Mitral stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Mitral regurgitation**
- **Mitral stenosis**

Sounds, clicks, murmurs - locations



Radiation – carotid
- **Aortic stenosis**
- *(aortic regurgitation)*

Pulmonary valve:
- **P2 (+ splitting S2)**
- Ejection pulmonary click
- **Innocent pulmonary ejection murmur**
- **Pulmonary stenosis**
- **Atrial septal defect** (flow murmur)
- **Fallot tetralogy** (RVOT obstruction)
- *Pulmonary regurgitation (Erb´s point)*
- **PDA** *(sometimes left infraclaviculary)*

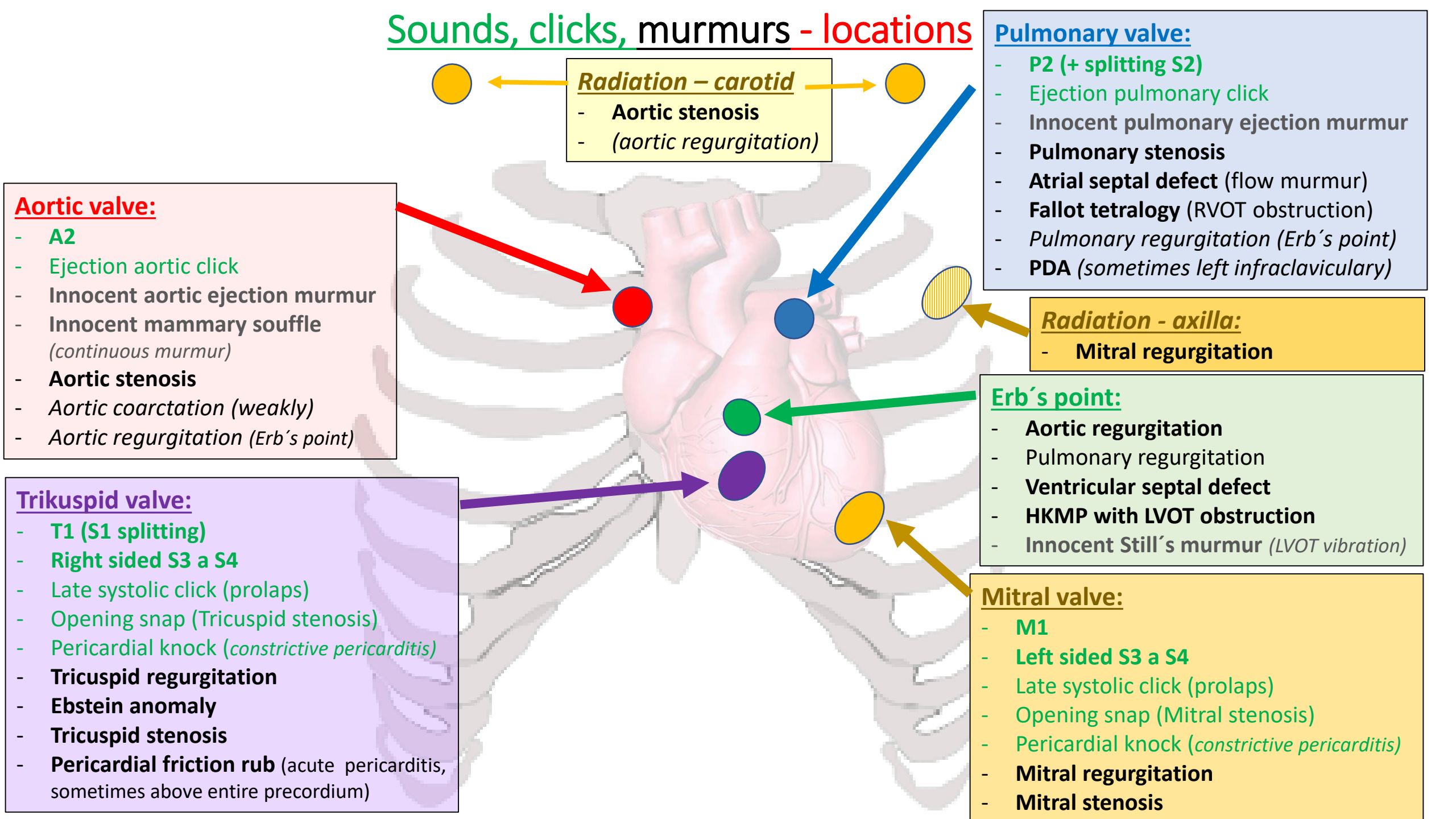
Aortic valve:
- **A2**
- Ejection aortic click
- **Innocent aortic ejection murmur**
- **Innocent mammary souffle** *(continuous murmur)*
- **Aortic stenosis**
- *Aortic coarctation (weakly)*
- *Aortic regurgitation (Erb´s point)*

Radiation - axilla:
- **Mitral regurgitation**

Trikuspid valve:
- **T1 (S1 splitting)**
- **Right sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Tricuspid stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Tricuspid regurgitation**
- **Ebstein anomaly**
- **Tricuspid stenosis**
- **Pericardial friction rub** (acute pericarditis, sometimes above entire precordium)

Mitral valve:
- **M1**
- **Left sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Mitral stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Mitral regurgitation**
- **Mitral stenosis**

Sounds, clicks, murmurs - locations



Radiation – carotid
- **Aortic stenosis**
- *(aortic regurgitation)*

Pulmonary valve:
- **P2 (+ splitting S2)**
- Ejection pulmonary click
- **Innocent pulmonary ejection murmur**
- **Pulmonary stenosis**
- **Atrial septal defect** (flow murmur)
- **Fallot tetralogy** (RVOT obstruction)
- *Pulmonary regurgitation (Erb´s point)*
- **PDA** *(sometimes left infraclaviculary)*

Aortic valve:
- **A2**
- Ejection aortic click
- **Innocent aortic ejection murmur**
- **Innocent mammary souffle** *(continuous murmur)*
- **Aortic stenosis**
- *Aortic coarctation (weakly)*
- *Aortic regurgitation (Erb´s point)*

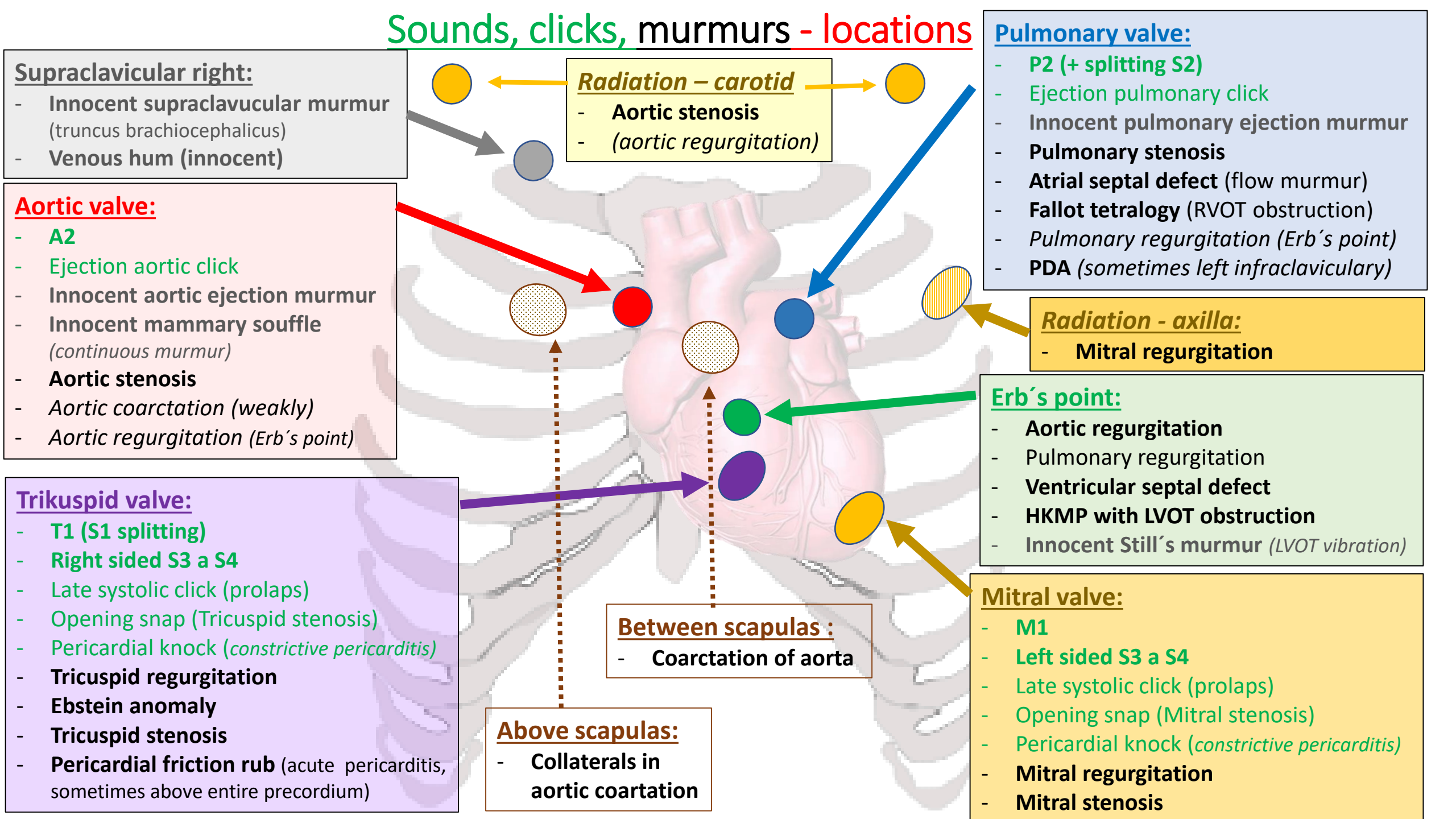
Radiation - axilla:
- **Mitral regurgitation**

Erb´s point:
- **Aortic regurgitation**
- Pulmonary regurgitation
- **Ventricular septal defect**
- **HKMP with LVOT obstruction**
- **Innocent Still´s murmur** *(LVOT vibration)*

Trikuspid valve:
- **T1 (S1 splitting)**
- **Right sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Tricuspid stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Tricuspid regurgitation**
- **Ebstein anomaly**
- **Tricuspid stenosis**
- **Pericardial friction rub** (acute pericarditis, sometimes above entire precordium)

Mitral valve:
- **M1**
- **Left sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Mitral stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Mitral regurgitation**
- **Mitral stenosis**

Sounds, clicks, murmurs - locations



Supraclavicular right:
- **Innocent supraclavucular murmur** (truncus brachiocephalicus)
- **Venous hum (innocent)**

Radiation – carotid
- **Aortic stenosis**
- *(aortic regurgitation)*

Pulmonary valve:
- **P2 (+ splitting S2)**
- Ejection pulmonary click
- **Innocent pulmonary ejection murmur**
- **Pulmonary stenosis**
- **Atrial septal defect** (flow murmur)
- **Fallot tetralogy** (RVOT obstruction)
- *Pulmonary regurgitation (Erb´s point)*
- **PDA** *(sometimes left infraclaviculary)*

Aortic valve:
- **A2**
- Ejection aortic click
- **Innocent aortic ejection murmur**
- **Innocent mammary souffle** *(continuous murmur)*
- **Aortic stenosis**
- *Aortic coarctation (weakly)*
- *Aortic regurgitation (Erb´s point)*

Radiation - axilla:
- **Mitral regurgitation**

Erb´s point:
- **Aortic regurgitation**
- Pulmonary regurgitation
- **Ventricular septal defect**
- **HKMP with LVOT obstruction**
- **Innocent Still´s murmur** *(LVOT vibration)*

Trikuspid valve:
- **T1 (S1 splitting)**
- **Right sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Tricuspid stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Tricuspid regurgitation**
- **Ebstein anomaly**
- **Tricuspid stenosis**
- **Pericardial friction rub** (acute pericarditis, sometimes above entire precordium)

Between scapulas :
- **Coarctation of aorta**

Above scapulas:
- **Collaterals in aortic coartation**

Mitral valve:
- **M1**
- **Left sided S3 a S4**
- Late systolic click (prolaps)
- Opening snap (Mitral stenosis)
- Pericardial knock (*constrictive pericarditis)*
- **Mitral regurgitation**
- **Mitral stenosis**

S1 - first heart sound

1. **Intensity** *(loudness, amplitude) – 2 audible components: M1 and T1*
2. **Degree of splitting** *(lower left sternal border – better heard T1)*

↑ *intensity (loud)*

- ***Stenosis (rheumatic)*** *→ stiff leaflets (MS,TS)*
- ***↑ stroke volume/contractility***
  (exercise, pregnancy, fever…)

↓ *intensity (soft)*

- ***Preclosure AV valves -*** *1st degree AV block*
  → rapid ↑ LV diastolic pressure: ***Acute AR***
- ***Murmur*** *(murmur blunting S1)*
  → ***M1 - MR, VSD***
- ***Systolic dysfunction → LV dysfunction***
- ***Immobile calcified valve → stenosis*** *(MS)*
- ***Incompetent valve → regurgitation*** *(MR)*

S1 - first heart sound

1. **Intensity** *(loudness, amplitude) – 2 audible components: M1 and T1*
2. **Degree of splitting** *(lower left sternal border – better heard T1)*

↑ *intensity (loud)*

- ***Stenosis (rheumatic)*** *→ stiff leaflets (MS,TS)*
- ***↑ stroke volume/contractility***
  (exercise, pregnancy, fever…)

↓ *intensity (soft)*

- ***Preclosure AV valves -*** *1st degree AV block*
  → rapid ↑ LV diastolic pressure: ***Acute AR***
- ***Murmur*** *(murmur blunting S1)*
  → ***M1 - MR, VSD***
- ***Systolic dysfunction → LV dysfunction***
- ***Immobile calcified valve → stenosis*** *(MS)*
- ***Incompetent valve → regurgitation*** *(MR)*

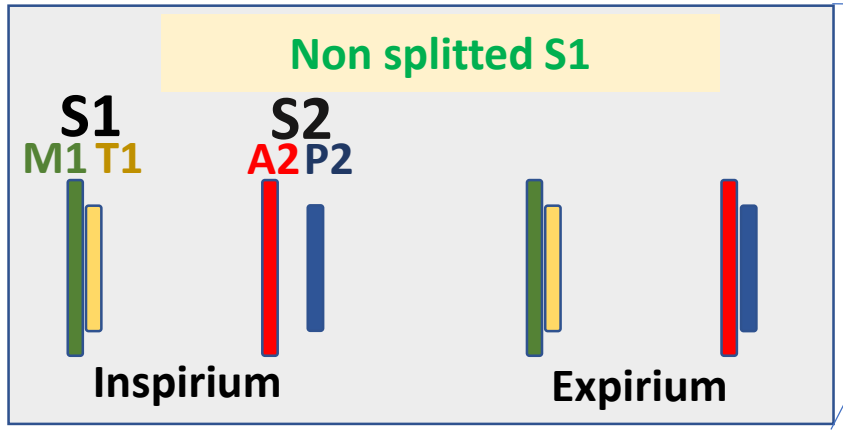
Wide split S1

- ***Delayed RV filling***
  → ***delayed T1*** *→ TS, Ebstein, ASD*
- ***Delayed RV activation*** *(earlier LV activation)*
  → ***delayed T1*** *→ RBBB, LV pacing*

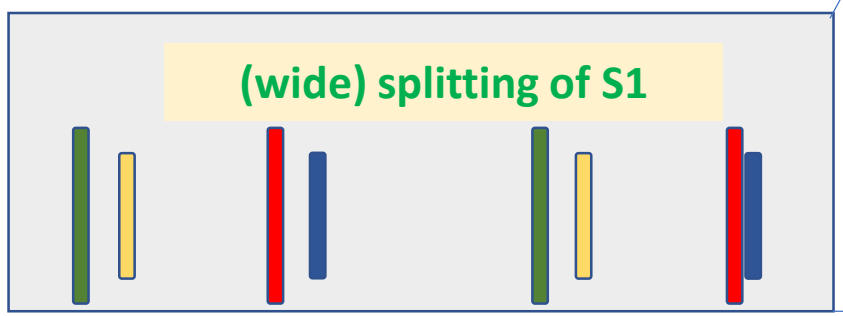
Paradoxical (reverse) split S1

- ***LV systolic dysfunction***
  → ***delayed M1*** *→ LV systolic dysfunction*
- ***Prolonged LV filling***
  → ***delayed M1*** *→ MS, myxome (LA)*
- ***Delayed LV activation*** *(earlier RV activation)*
  → ***delayed M1*** *→ LBBB RV pacing*

S1 – first heart sound

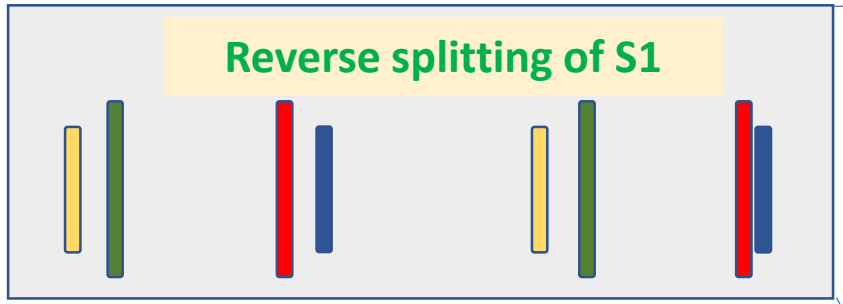


Physiologic S1
- Forms „lub“ of „lub-dub“
- M1 precedes T1 slightly
- Low frequency (low-pitched)



Delayed T1
- **Trikuspid stenosis**
- **Ebstein anomaly**
- **Atrial septal defect**

Late right ventricular activation
- **RBBB**
- **Pacing of LV**



Delayed M1
- **Systolic LV dysfunction**
- **Mitral stenosis**
- **(Myxoma)**

Later left ventricular activation
- **LBBB**
- **Pacing of RV**

Loud S1 (M1)
- **Mitral stenosis** *(rheumatic)*
- **Increased stroke volume** *(exercise, pregnancy, fever, thyreotoxikosis, anemia)*

Decreased intensity of S1 (M1)
- **Systolic LV dysfunction**
- **Aortic stenosis**
- **Aortic regurgitation**
- **Mitral stenosis** (calcified)
- **Mitral regurgitation**
- **Ventricular septal defect**

Loud T1
- **Tricuspid stenosis**
- **Ebstein anomaly**
- **Atrial septal defect**

Variable intensity S1
- **Arrhythmias** (AV block 2. a 3. d., atrial flutter and fibrillation)
- **Tamponade** („auskultatory alternans“)

S2 - second heart sound

1. **Intensity** *(loudness, amplitude) – 2 audible components: A2 and P2*
2. **Degree of splitting** *(2nd left intercostal – better heard P2)*

   \+ **variation with respiration,**

↑ *intensity*

- ***Great vessel dilatation*** *(aorta, P. artery)*
- ***Hypertension*** *(systemic, pulmonary)*

↓ *intensity*

- ***Murmur*** *(during IVR, murmur blunting S2)*
  → ***A2 - MR, VSD***
  → ***P2 - TR***
- ***Systolic dysfunction → LV dysfunction***
- ***Immobile calcified valve → stenosis*** *(AS)*
- ***Incompetent valve → regurgitation***

S2 - second heart sound

1. **Intensity** *(loudness, amplitude) – 2 audible components: A2 and P2*
2. **Degree of splitting** *(2nd left intercostal – better heard P2)*

\+ **variation with respiration,**

↑ *intensity*

- ***Great vessel dilatation*** *(aorta, P. artery)*
- ***Hypertension*** *(systemic, pulmonary)*

↓ *intensity*

- ***Murmur*** *(during IVR, murmur blunting S2)*
  → ***A2 - MR, VSD***
  → ***P2 - TR***
- ***Systolic dysfunction → LV dysfunction***
- ***Immobile calcified valve → stenosis*** *(AS)*
- ***Incompetent valve → regurgitation***

Wide split S2

- ***RV pressure overload*** *(prolonged RV systole)*
  → ***delayed P2*** → *PS, PH*
- ***Acceleration „LV emptying“*** *(shorter LV systole)*
  → **early A2** → *MR, VSD*

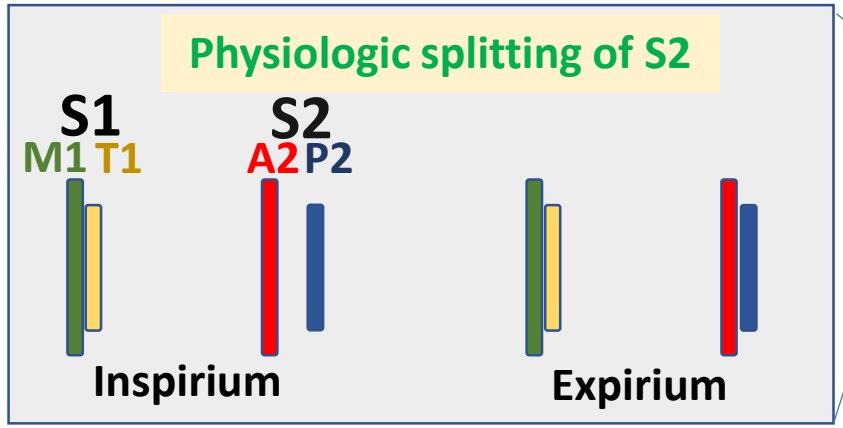
Paradoxical (reverse) split S2

- ***LV pressure overload*** *(prolonged LV systole)*
  → ***delayed A2*** → *AS, AH*
- ***Acceleration „LV emptying“*** *(shorter LV systole)*
  → **early A2** → *MR, VSD*

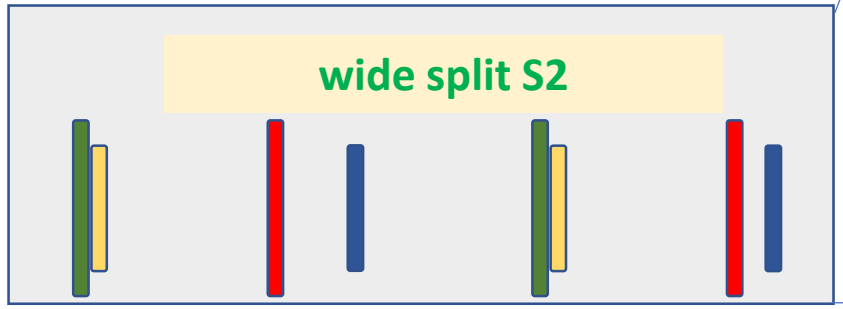
Wide fixed plit S2

- ***RV volume overload*** *(prolonged RV systole)*
  → ***delayed P2*** → *ASD (large)*

S2 – second heart sound

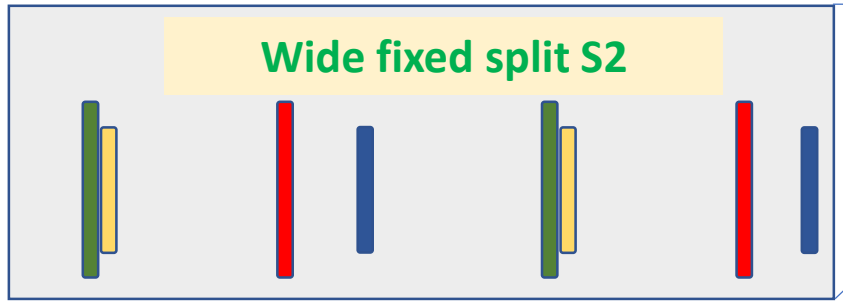


Physiologic S2

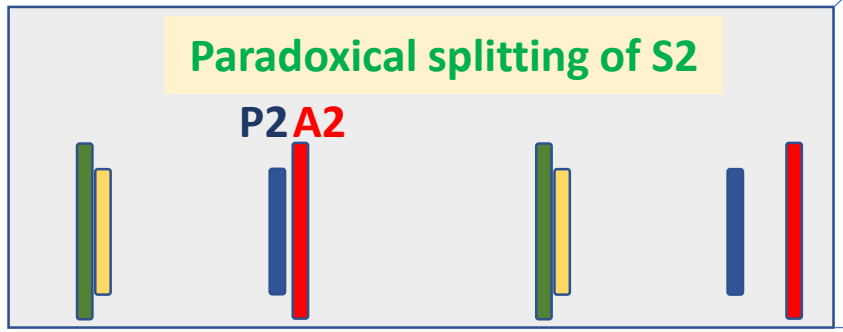


Delayed P2
- **Pulmonary stenosis**
- **Pulmonary hypertension**
- Masive pulmonary embolism

Early A2
- **Mitral regurgitation**
- **Ventricular septal defect**
- *Constrictive pericarditis*



- **Atrial septal defect**
- *Pulmonary hypertension with RF failure*



Delayed A2
- **Aortic stenosis**
- **HCMP**
- **Coarctation of aorta**

Early P2
- **Tricuspid regurgitation**

Deacreased intensity of A2
- **Aortic stenosis** (calcified)
- **Aortic reurgitation**
- **Mitral regurgitation**
- **Ventricular septal defect**
- **Systolic LV dysfunction**

Loud A2
- **Systemic arterial hypertension**
- **Aortic root dilatation**
- *Aortic stenosis* (rheumatic)

Decreased intensity P2
- **Pulmonary stenosis** *(heavily altered not mobile valve)*
- **Pulmonary regurgitation**
- ***HCMP*** *(delayed A2 + murmur → not audible P2)*

Loud P2
- **Pulmonary hypertension**
- **Dilatation of pulmonary artery**
- *Pectus excavatum*

S3 – „ventricular gallop“

- ↑ **velocity of early filling** *(„S1=Ken; S2=tuck; S3=y“)*
- **can be a sign of congestive heart failure (systolic)**

S3

↑ pressure gradient in early diastole
→ *higher degree of* **diastolic dysfunction**
(pseudonormalisation, restrictive filling)
→ **HF (systolic= ↓ EF, …not exclusively)**

↑Volume overload – („chronic“)
→ **chronic regurgitation** (MR, AR, PR, TR)
→ **renal failure**
→ jatrogenic (**i.v. fluids, transfusions**)
→ **L-R shunts (ASD, VSD, PDA)**

↑ cardiac output states (+ tachycardia)
→ anemia, thyreotoxicosis, AV fistulas

S3 – „ventricular gallop“

- ↑ **velocity of early filling** *(„S1=Ken; S2=tuck; S3=y“)*
- **can be a sign of congestive heart failure (systolic)**

S4 – „atrial gallop“

- ↑ **velocity of late filling** (atrial contraction); *"Tennessee" (S4= Ten)*
- **can be a sign of congestive heart failure (diastolic)**

S3

↑ ***pressure gradient in early diastole***
→ *higher degree of* **diastolic dysfunction**
(pseudonormalisation, restrictive filling)
→ **HF (systolic= ↓ EF, …not exclusively)**

↑***Volume overload – („chronic“)***
→ **chronic regurgitation** (MR, AR, PR, TR)
→ **renal failure**
→ jatrogenic (**i.v. fluids, transfusions**)
→ **L-R shunts (ASD, VSD, PDA)**

↑ ***cardiac output states (+ tachycardia)***
→ anemia, thyreotoxicosis, AV fistulas

S4

↑ ***pressure gradient in late diastole***
→ *mild degree of* **diastolic dysfunction**
(impaired relaxation)
→ **HF („diastolic -preserved EF; not only)**

↑***Volume overload - acute***
→ **acute regurgitation** (MR, AR)

↑ ***pressure afterload*** (↑ LV stiffness)
→ ***stenosis*** (AS, PS, .. coarctation, HCMP)
→ **hypertension** (AH, PH)

↑ ***cardiac output states (+ tachycardia)***
→ anemia, thyreotoxicosis, AV fistulas

S3 and S4 (gallops)

Left-sided S3

Left-sided heart failure
- **Preserve or reduced EF**

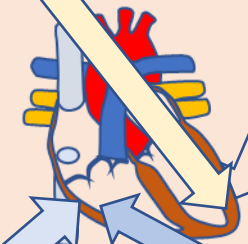
High output states
- **Anemia**
- **Thyreotoxicosis**
- **AV fistula**

Shunts
- **Left-rught shunts (VSD, PDA)**

Fluid retention and ↑ administr.
- **Renal failure**
- **↑ i.v. fluids, transfusions**

Chronic LV volume overload
- **Aortic regurgitation** (chronic)
- **Mitral regurgitation** (chronic)

S3 – physiologically
– children, young adults



S4 „physiological“
– Older adults

Left-sided S4

↑ LV afterload (↑ LV stiffness)
- **Aortic stenosis**
- **Coarctation of aorty**
- **HCMP with LVOT obstruction**
- *Systemic arterial hypertension* (někdy)

Ishemic heart dis. (akute, chronic)

High output states
- **Anemia**
- **Thyreotoxicosis**
- **AV fistula**

Acute LV volume overload
- **Aortic regurgitation** (acute)
- **Mitral regurgitation** (acute)

Right-sided S3

Right-sided heart failure
- **Various causes**

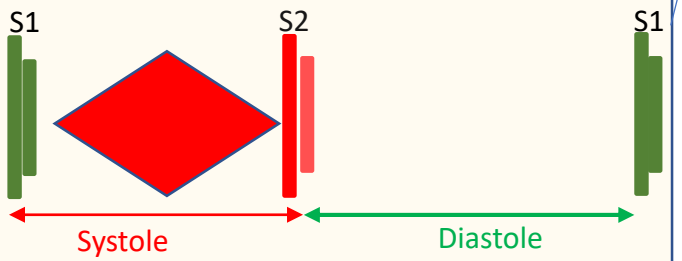
RV volume afterload
- **Pulmonary regurgitation**
- **Tricuspid regurgitation**
- **Shunts - ASD**

Right-sided S4

↑ RV afterload
- **Pulmonary hypertension**
- **Pulmonary stenosis**
- **RVOT obstruction**

Murmurs – schematic diagrams - systolic

Ejection (midsystolic)

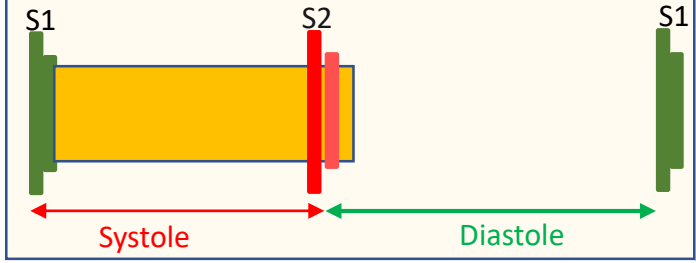


Stenotic
- **Aortic and pulmonary stenosis**
- **HKMP with LVOT obstruction**
- **Aortic coarctation**

Non obstructive
- Dilatation of aortic root
- Dilatation pulmonary artery
- Aortic sclerosis/calcification
- Bikuspid aortortic vlave

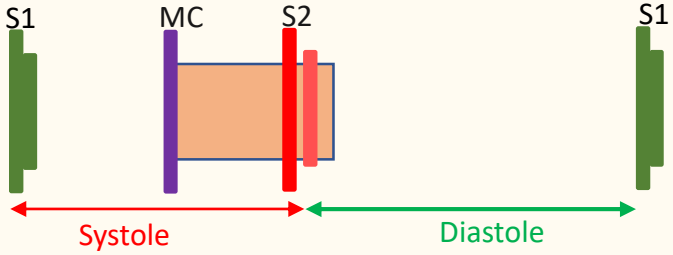
Flow
- Aortic regurgitation (aorta)
- Atrial septal defect (pulm.a.)
- *Innocent aortic ejection m.*
- *Innocent pulmonary ejection m.*

Holosystolic (pansystolic)



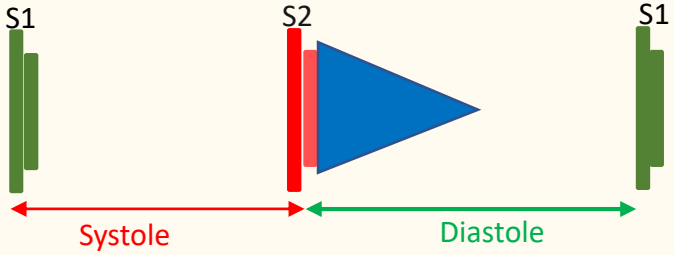
Regurgitation
- **Mitral regurgitation**
- **Tricuspid regurgitation**
- **VSD** (small to mid size)

Late systolic



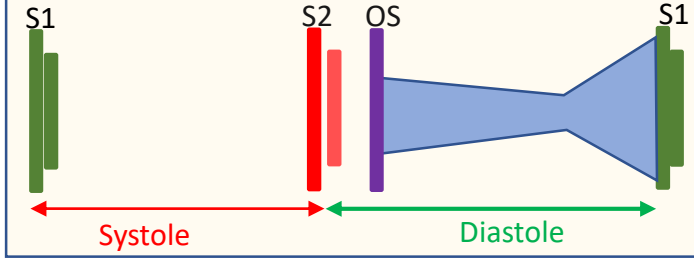
Regurgitation - prolapses
- **Mitral valve prolaps**
- **Trikuspid valve prolaps**
- **Papillary muscle ischemia**

Early diastolic



Regurgitation
- **Aortic regurgitation**
- **Pulmonary regurgitation**

Mid (to late) diastolic



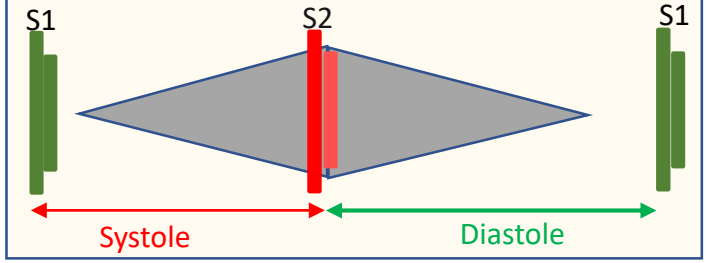
Stenotic
- **Mitral stenosis**
- ***(Carey-Coombs murmur)***
- ***(Austin-Flint murmur – AR)***
- **Trikuspid stenosis**

Flow

Mitral valve:
- High cardiac output
- shunts: VSD, PDA
- Mitral regurgitation

Tricuspid valve
- Tricuspid regurgitation
- Shunts: ASD

Continuous



Aorto-pulmonary
- **PDA**

Venous *(louder in diastole)*
- *Innocent supraclavicular*

Arterial *(louder in systole)*
- **Coarctation of aorta** (severe)
- *Innocent mammary souffle*