

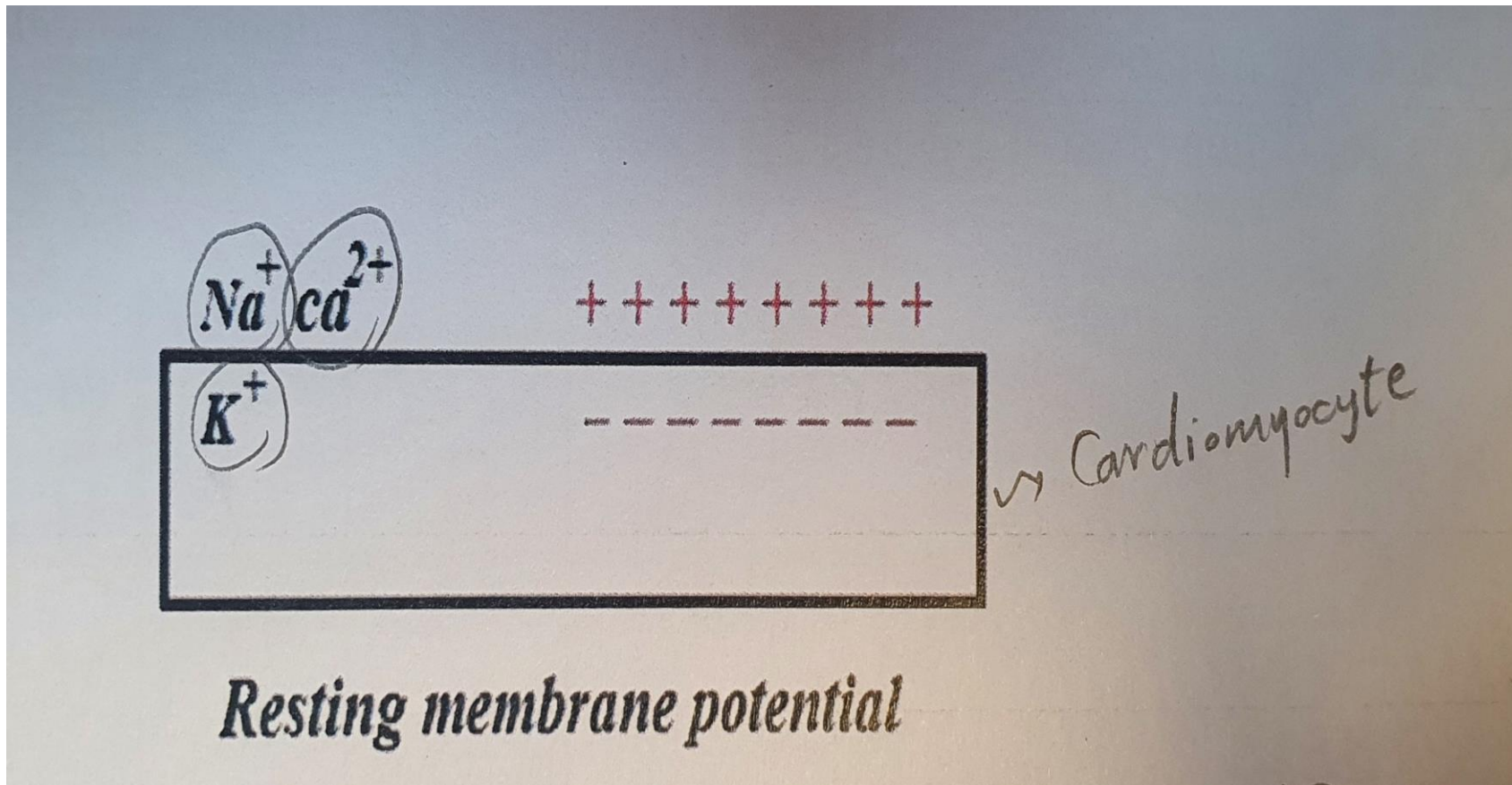


ECG/Action Potential
Nima Gholizade.MD
28.7.00

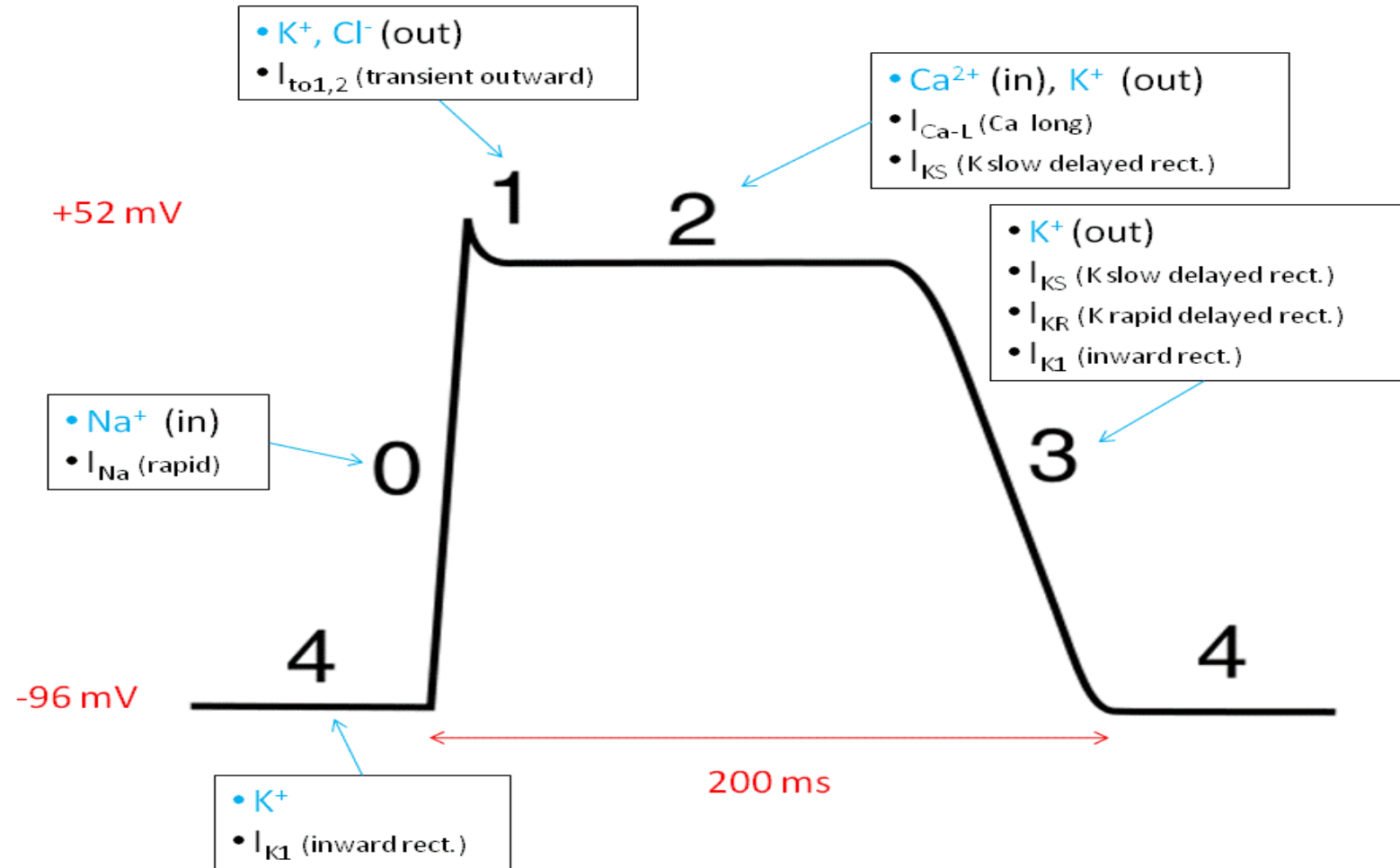
Cardiac Action Potential

- ▶ **Ion Channels:** membrane_bound proteins which control the flow across the cell membrane.
- ▶ The most important **ion currents** involving in membrane potential are:
 - I_{k1}
 - Na⁺/K⁺ ATPase
 - Na⁺/Ca²⁺ exchanger
 - I_{ca, L}
 - I_{kr}
 - I_{ks}

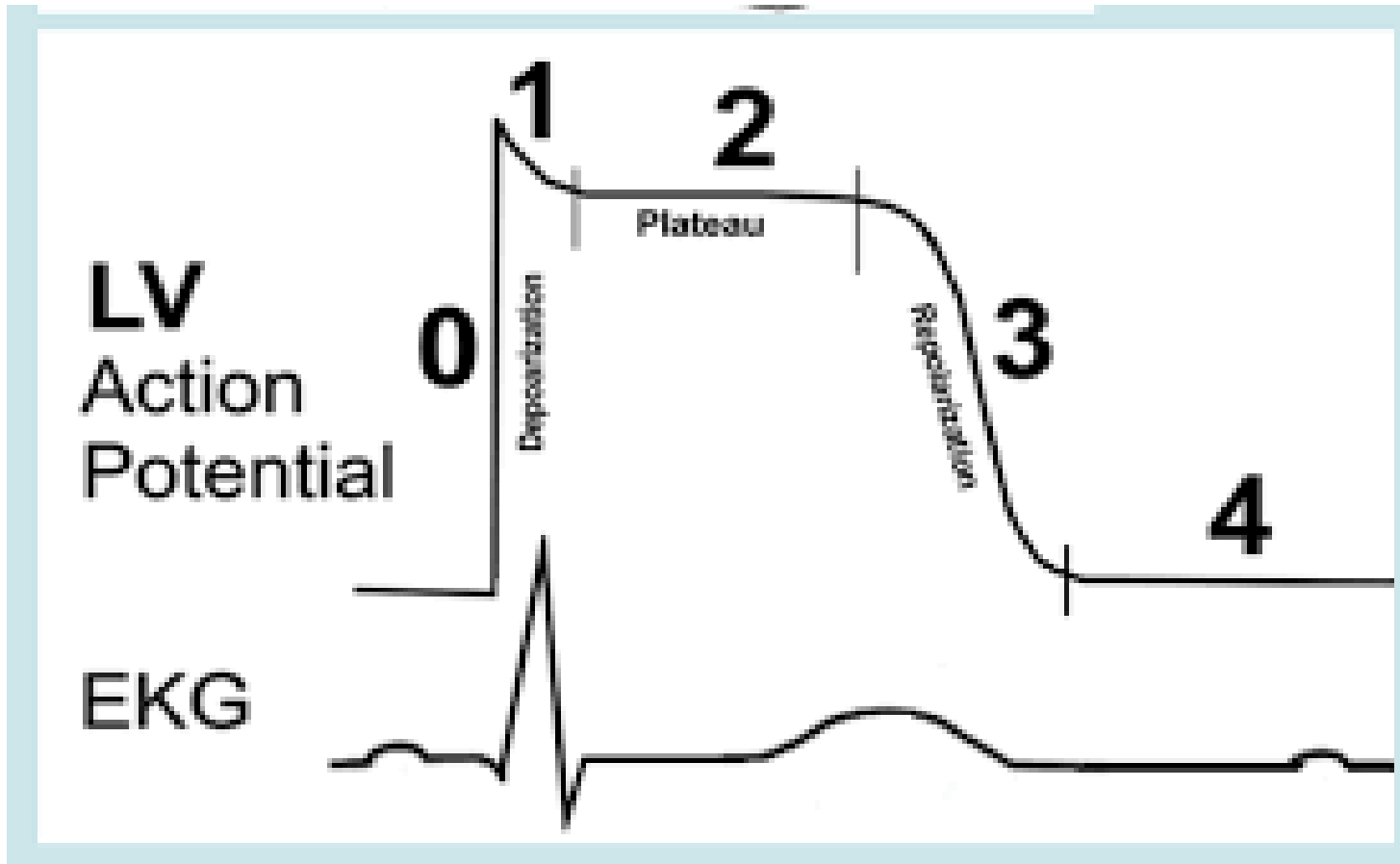
Resting Membrane Potential



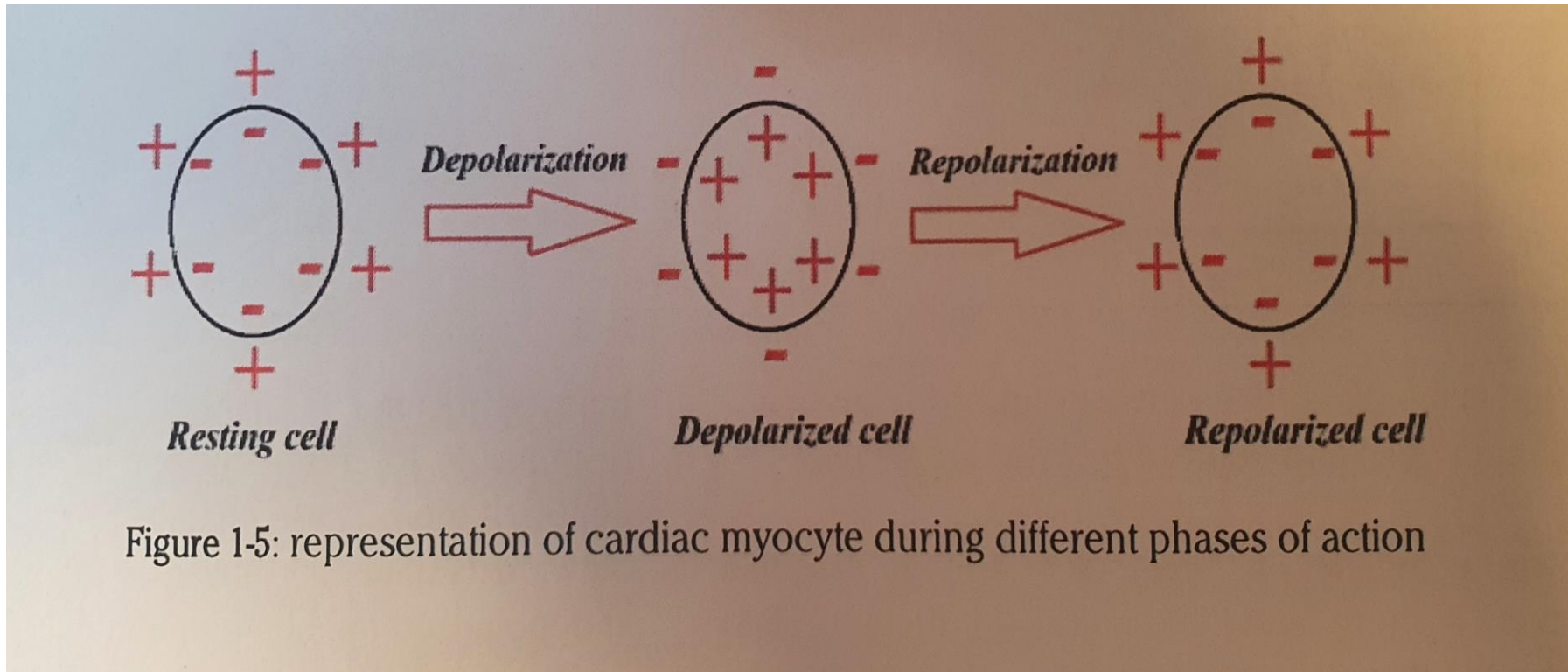
Action Potential



Comparison of AP phases with ECG



Recording of depolarization and repolarization



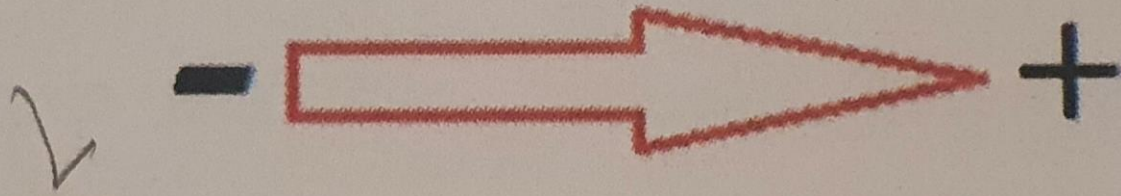


Figure 1-6: Cardiac dipole potential.

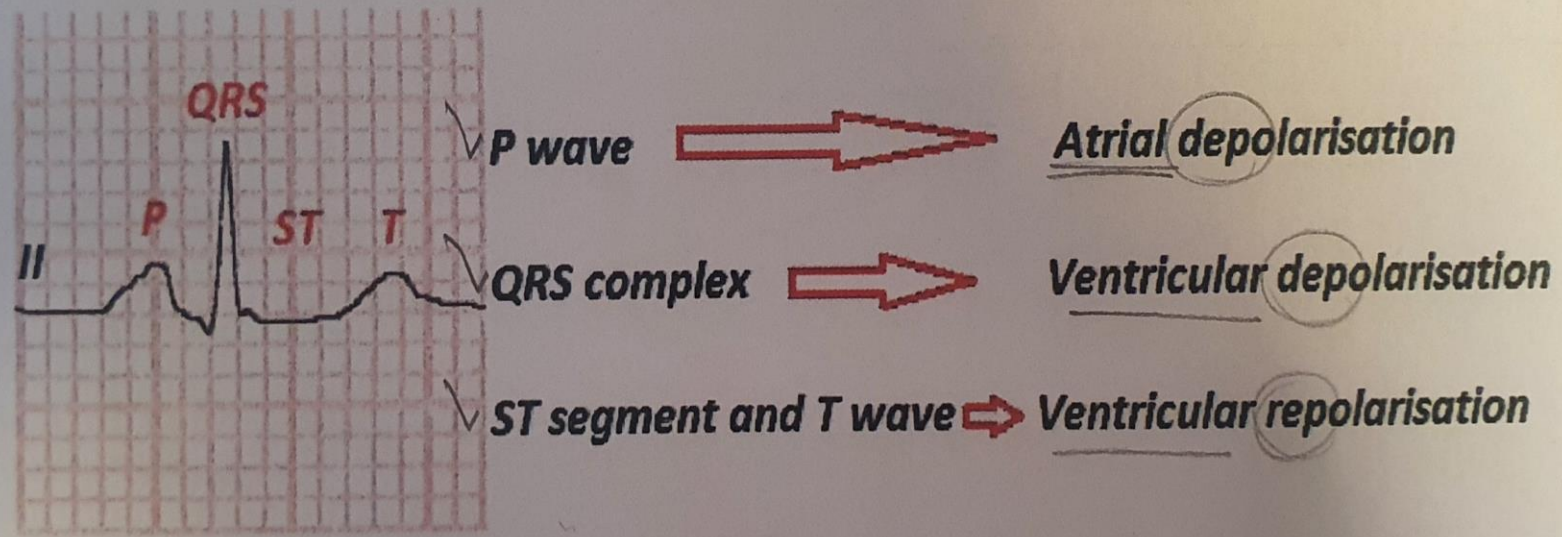
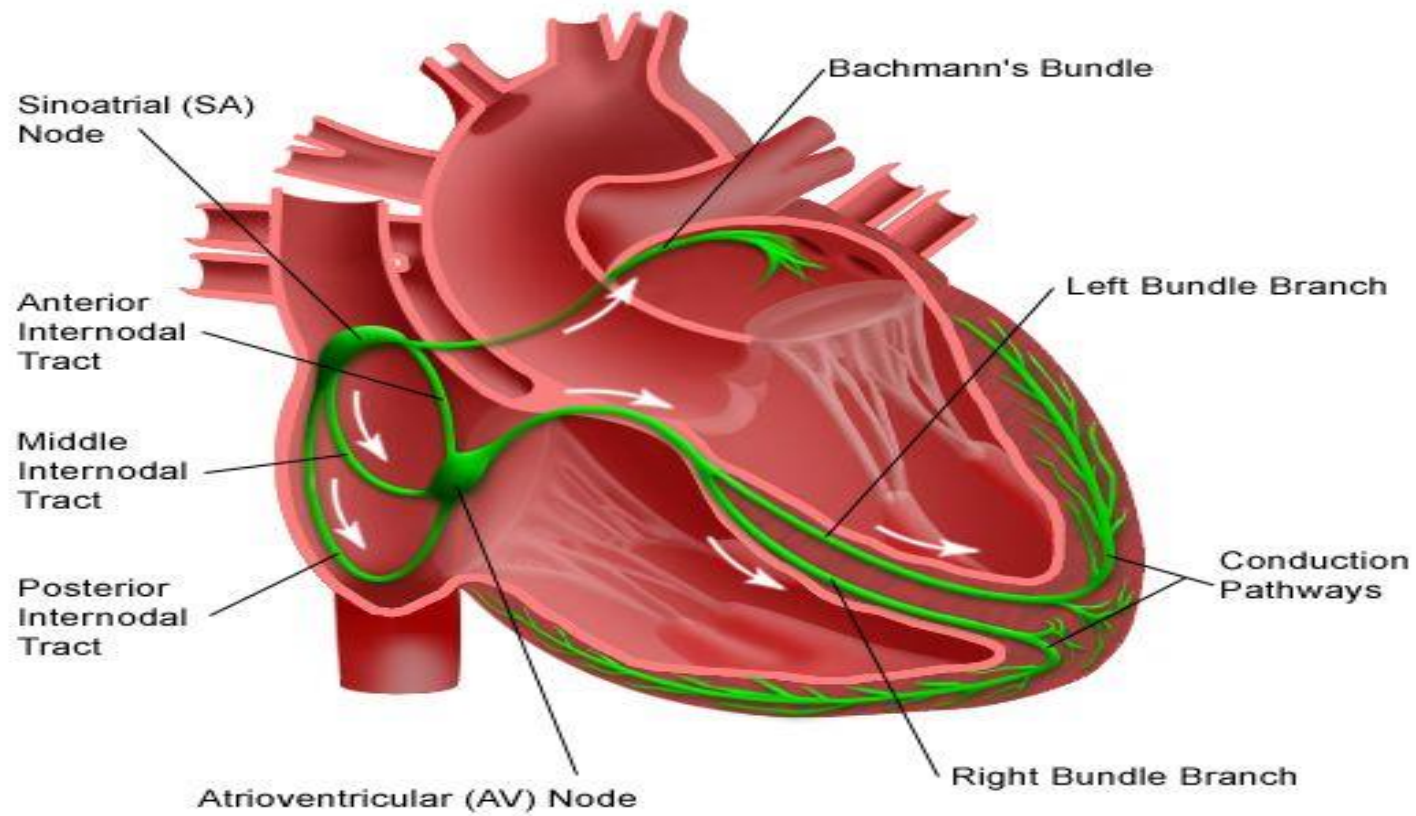


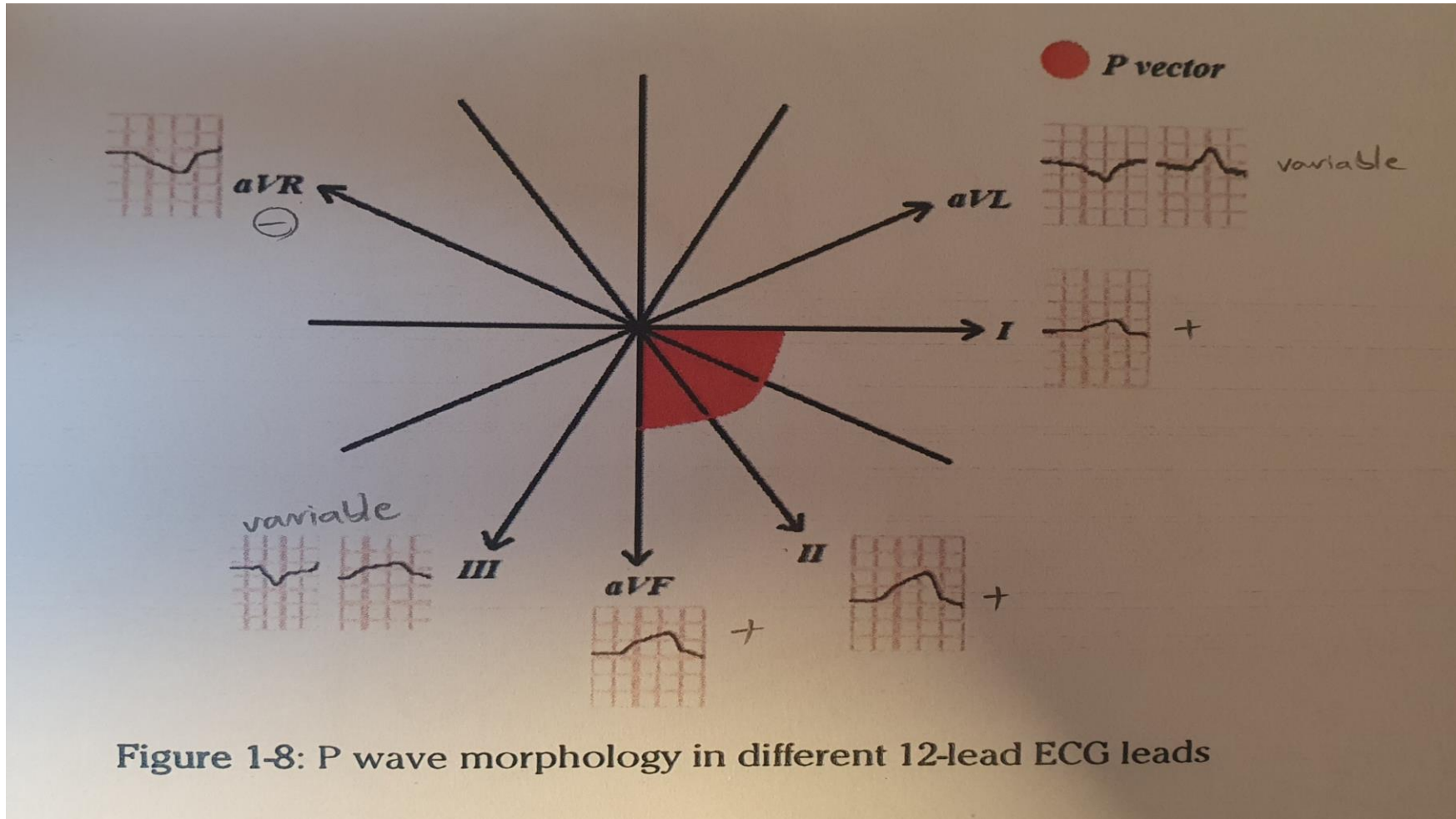
Figure 1-7: Different Cardiac waves in 12-lead ECG

Atrial Depolarization

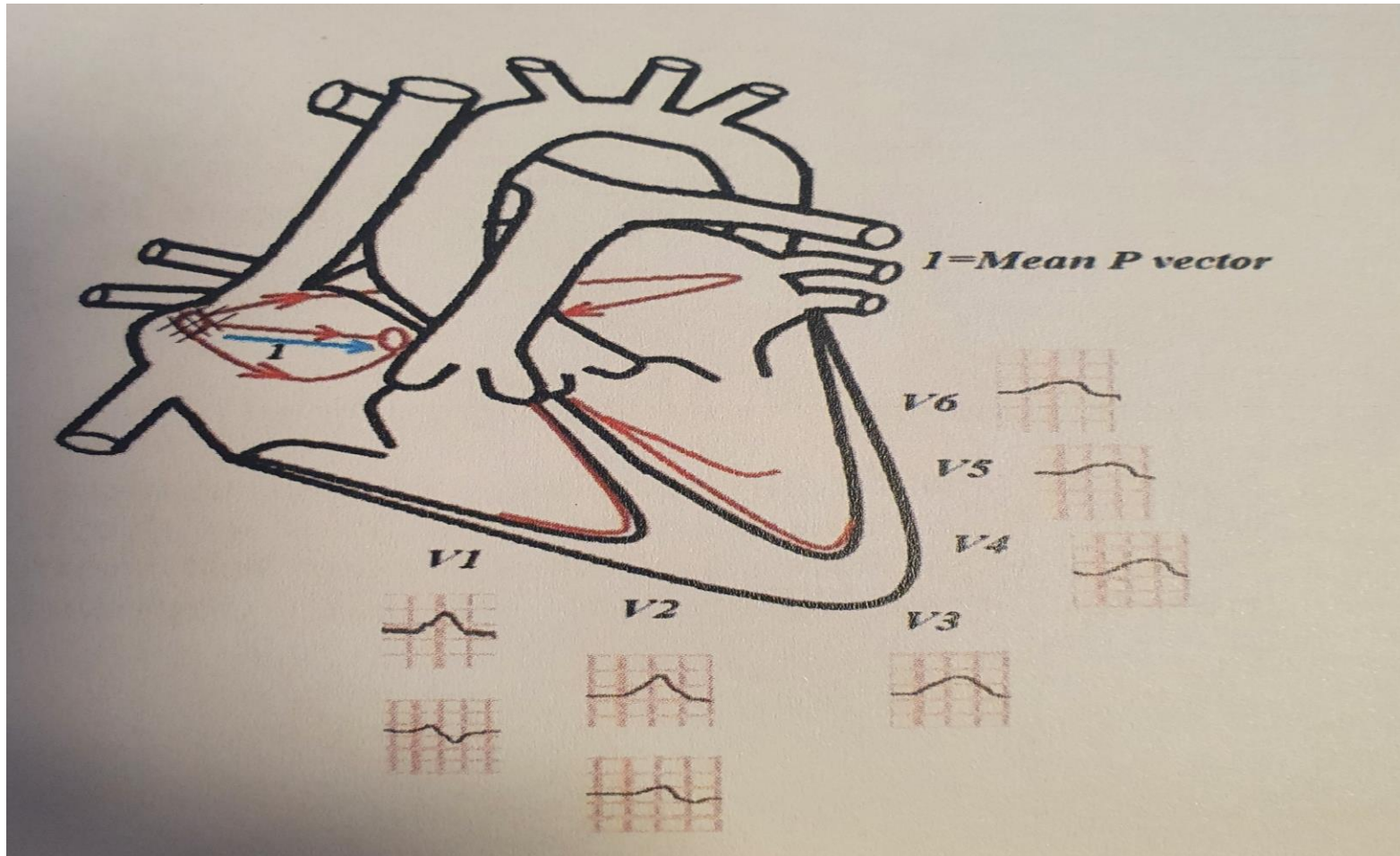
Electrical System of the Heart



P wave morphology in Frontal plane



P wave morphology in horizontal plane



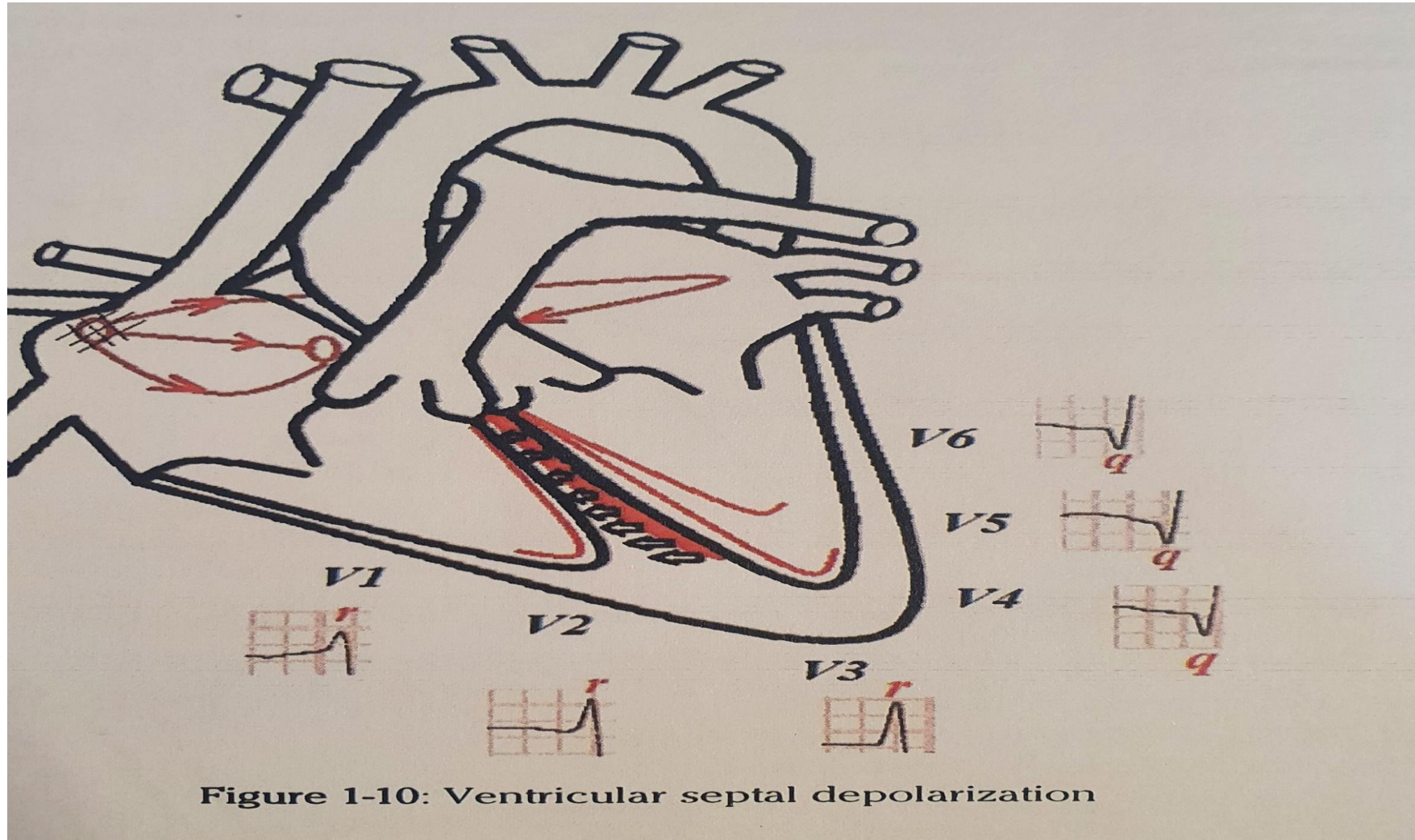
Ventricular Depolarization

▶ Endocardial layer  Epicardium (+vector)

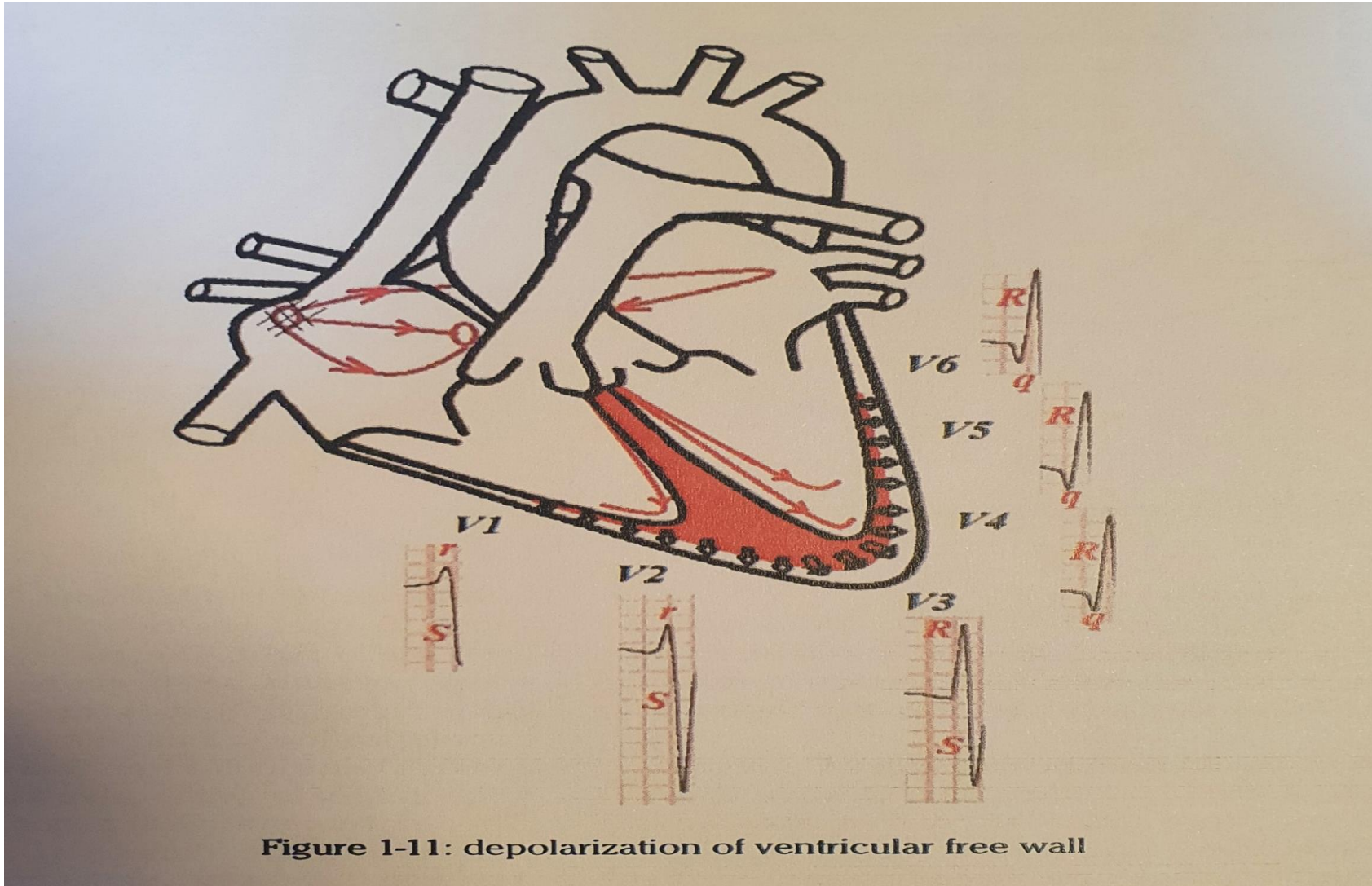
▶ Sequence:

1. IVS(septum)
2. Free wall
3. Post.Basal LV and RVOT

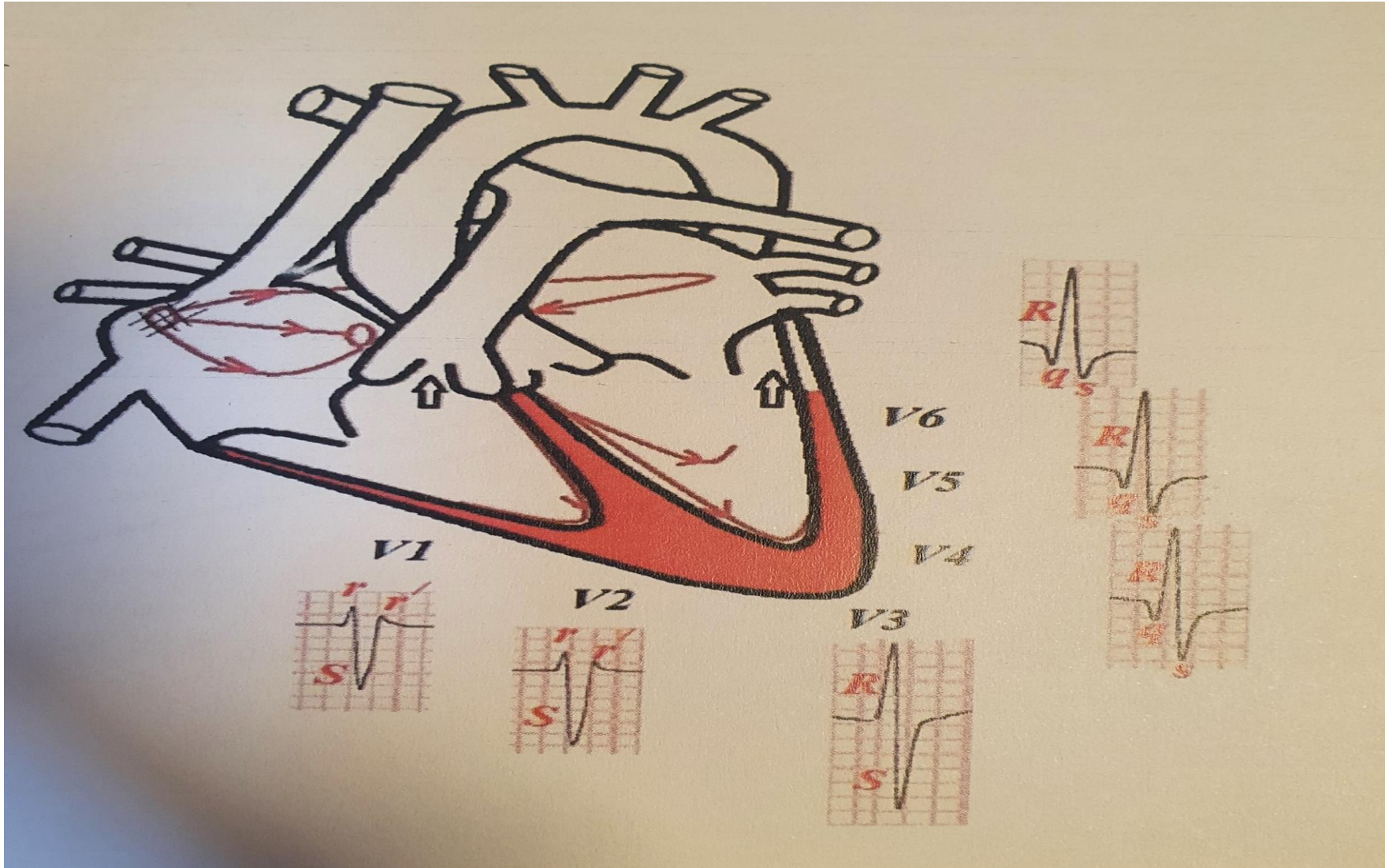
1. Septal Depolarization



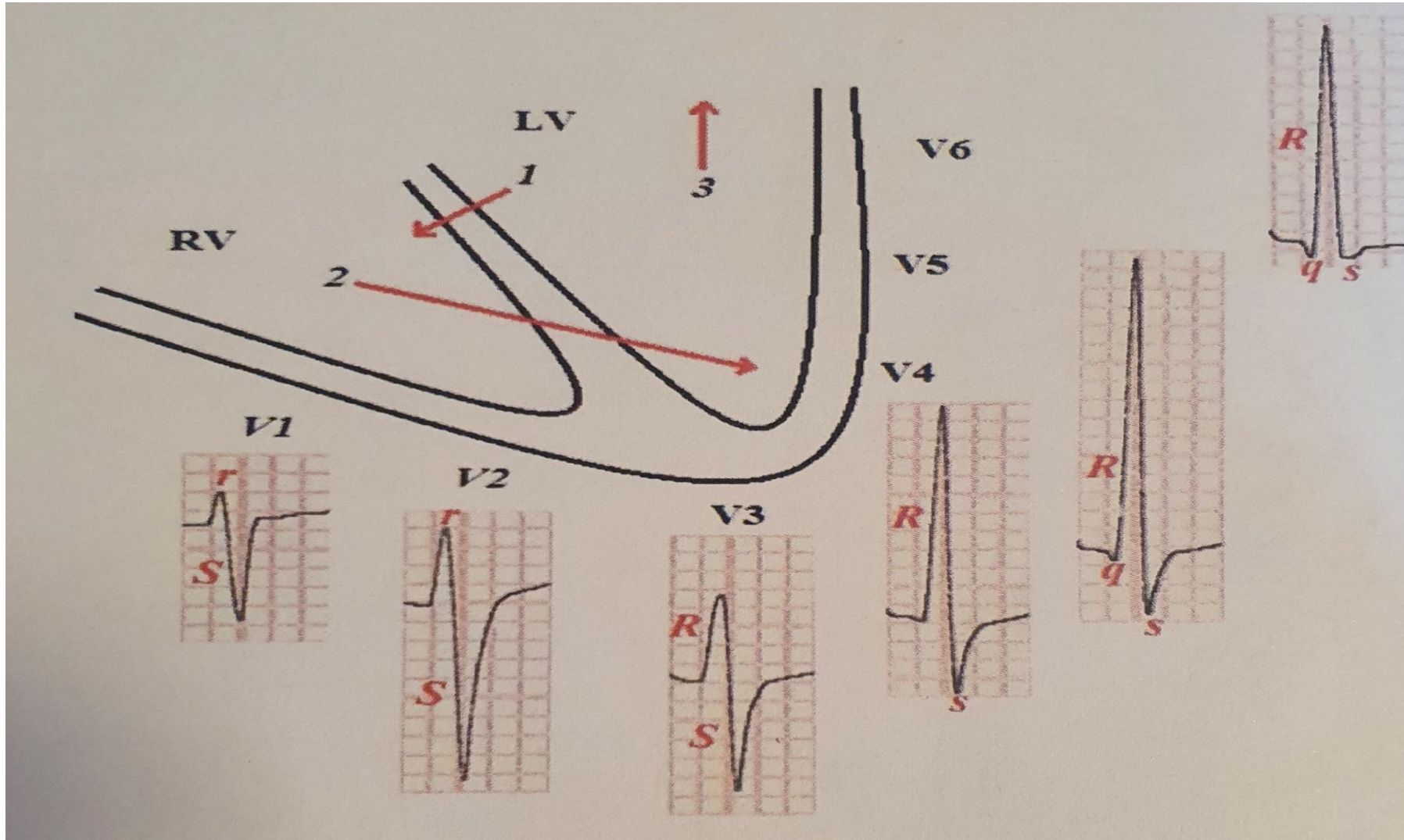
2.Activation of ventricular free wall



3.Activation of Post.Basal LV and RVOT



Precordial R wave progression



Cardiac Axis

- ▶ QRS vector in frontal plane (in limb leads) is variable and depends on cardiac position and the presence of conduction system disease.
- ▶ QRS vector in frontal plane is known as *cardiac axis*.

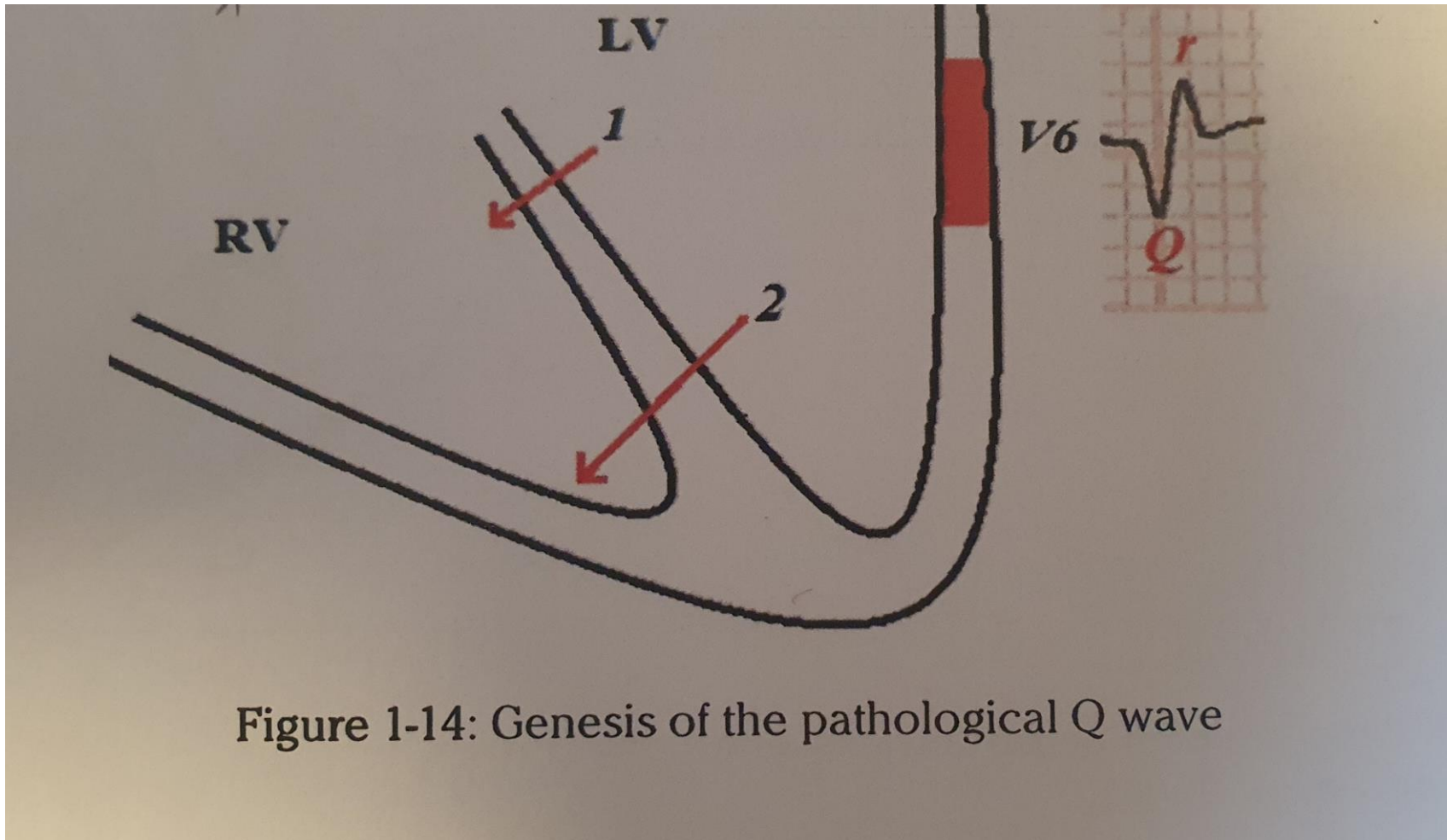
Mechanism of the pathological Q wave genesis

- ▶ *Pathological Q wave:*

width ≥ 40 ms **or** amplitude $> 1/4$ R wave amplitude

- ▶ **Myocardial necrosis** due to myocardial infarction and other causes.

Mechanism



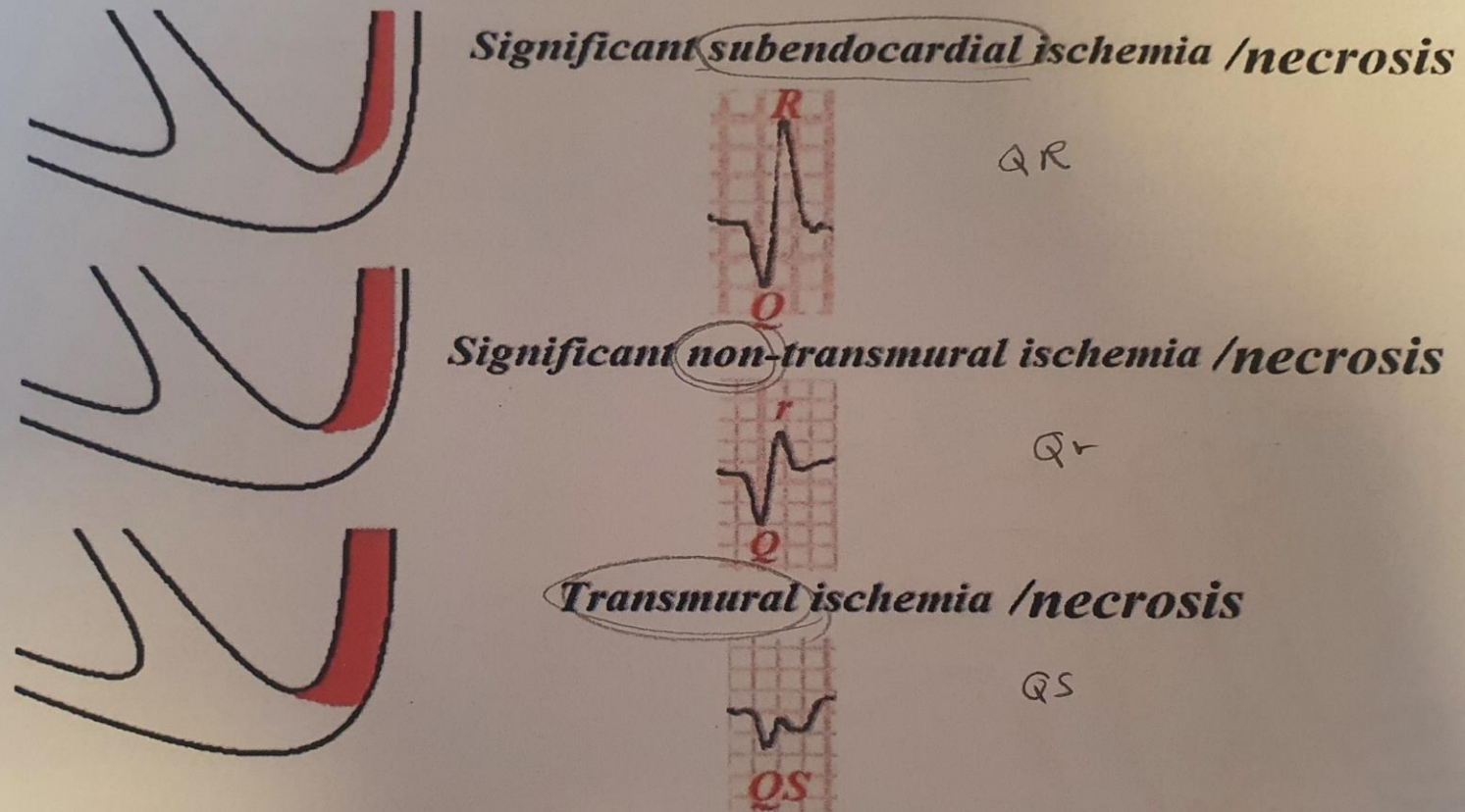
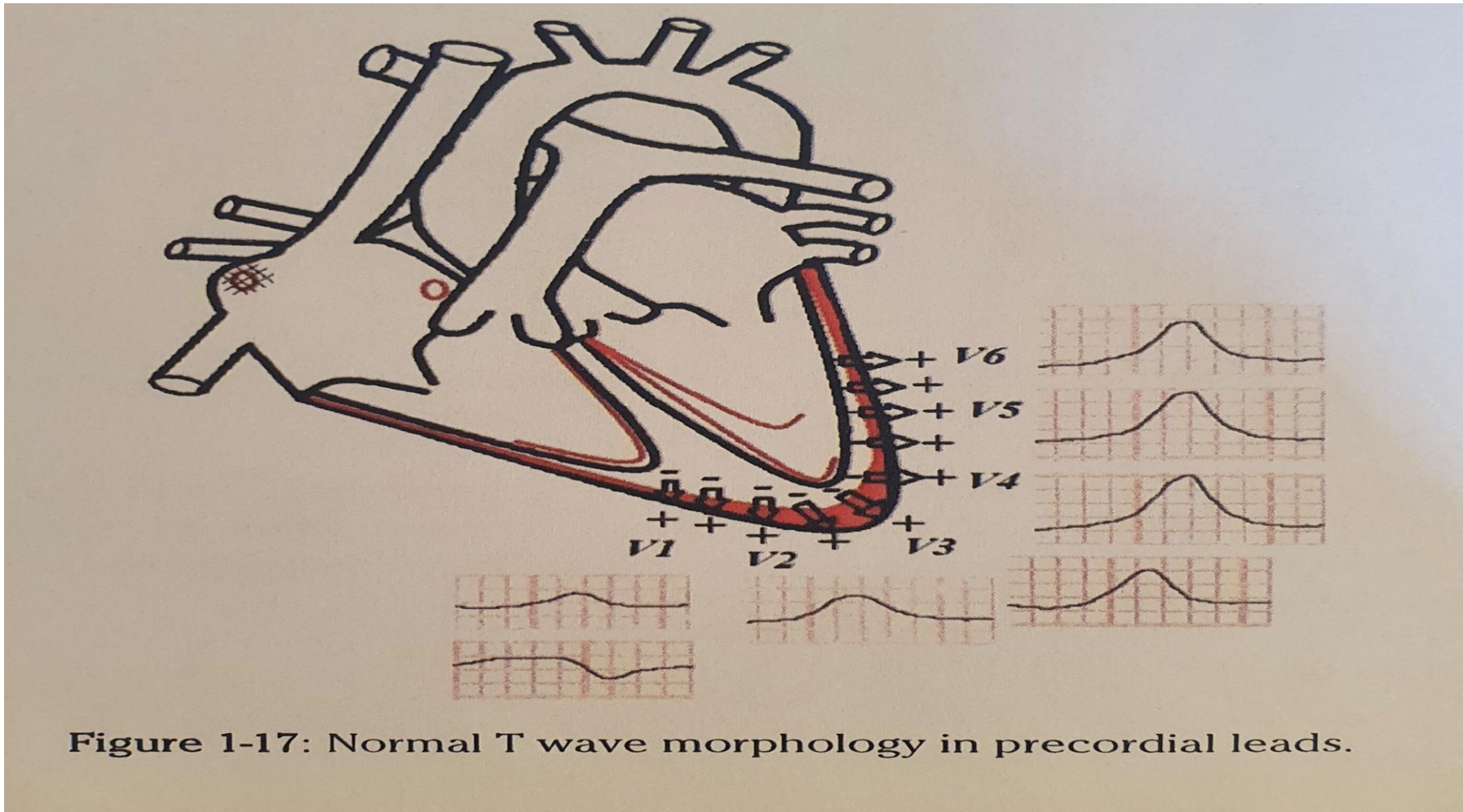


Figure 1-16: Genesis of the pathological Q wave, Qr wave, and QS waves due to different degrees of myocardial necrosis.


Ventricular Repolarization

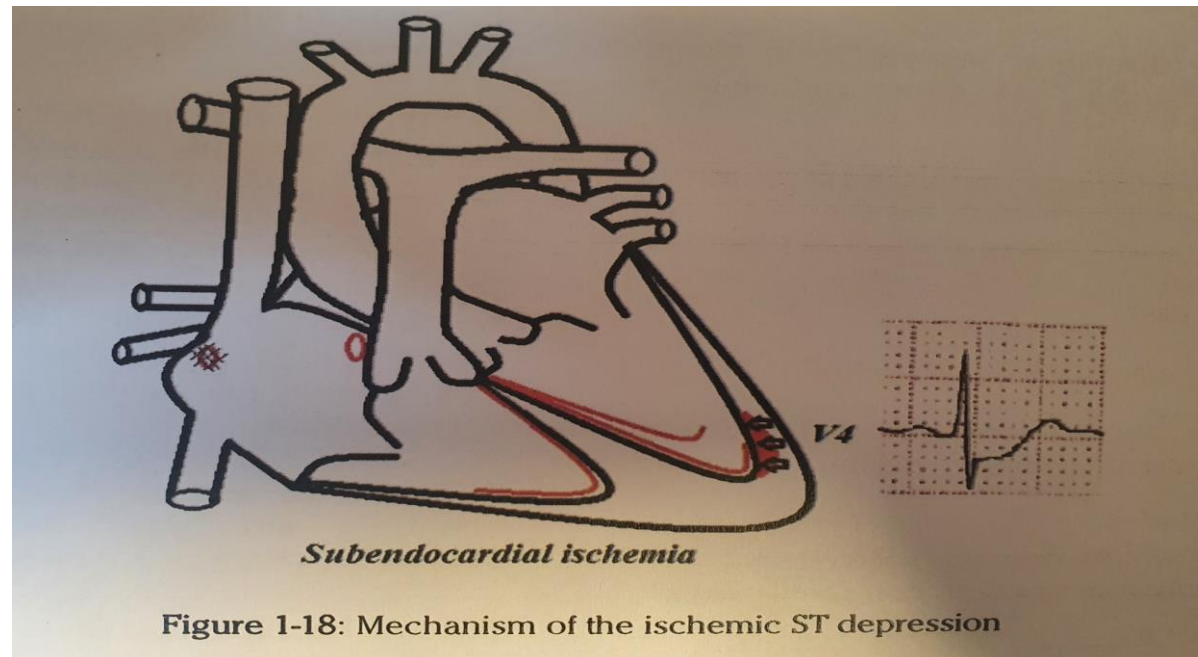
- ▶ Surface ECG → ST segment and T wave.
- ▶ Normal repolarization of the ventricles:
epicardial surface → endocardium
- ▶ Repolarization **Vector** is in the **same direction** as the depolarization vector.
endocardium → epicardium

T wave vector



Repolarization Abnormality

- ▶ ST segment deviation (elevation/depression) from the baseline (**TP segment**) is the most important abnormality of the ECG in myocardial ischemia/infarction.
- ▶ In subendocardial ischemia, the ST segment vector is toward the ischemic region  ST depression in adjacent leads.



- ▶ In transmural ischemia, the ST segment vector is toward epicardial surface
→ ST elevation in adjacent leads and ST depression in opposite leads(**reciprocal changes**)

