

Lecture 22. Physiological bases of electrocardiography

ECG

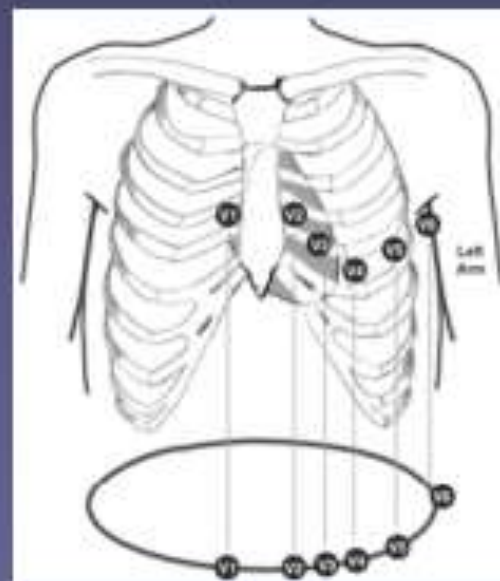
What is an ECG?

ECG = Electrocardiogram
 Tracing of heart's electrical activity

Electrode placement

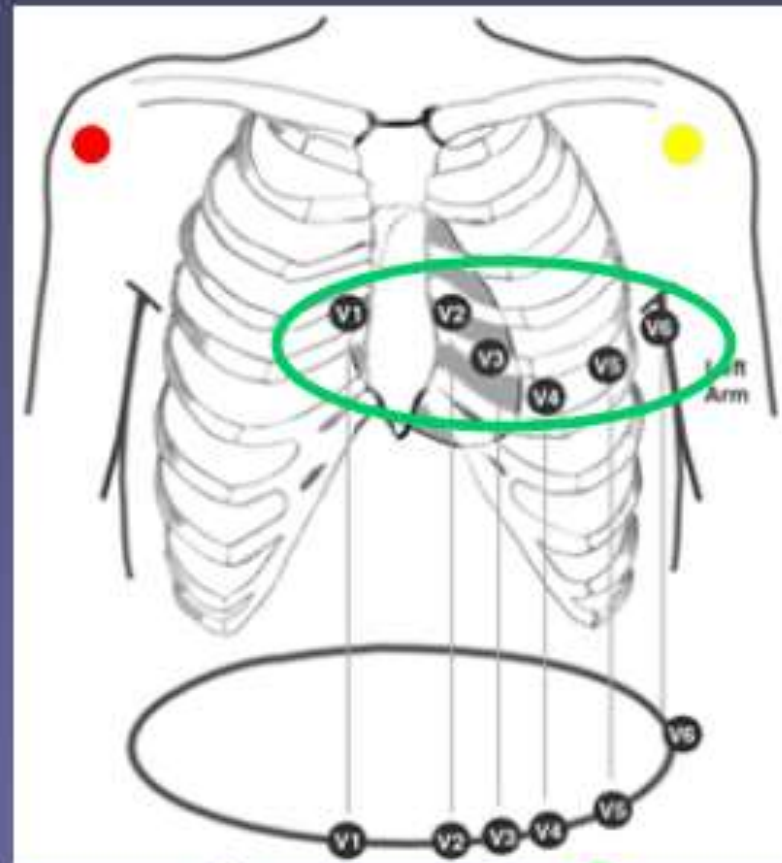
For the chest electrodes

- V1 4th intercostal space right sternal edge
- V2 4th intercostal space left sternal edge
 - (to find the 4th space, palpate the manubriosternal angle (of Louis))
 - Directly adjacent is the 2nd rib, with the 2nd intercostal space directly below. Palpate inferiorly to find the 3rd and then 4th space
- V4 over the apex (5th ICS mid-clavicular line)
- V3 halfway between V2 and V4
- V5 at the same level as V4 but on the anterior axillary line
- V6 at the same level as V4 and V5 but on the mid-axillary line



Electrode placement in 12 lead ECG

- 6 are chest electrodes
 - Called V1-6 or C1-6
- 4 are limb electrodes
 - **Right arm** **R**ide
 - **Left arm** **Y**our
 - **Left leg** **G**reen
 - **Right leg** **B**ike
- Remember
 - The right leg electrode is a neutral or "dummy"!



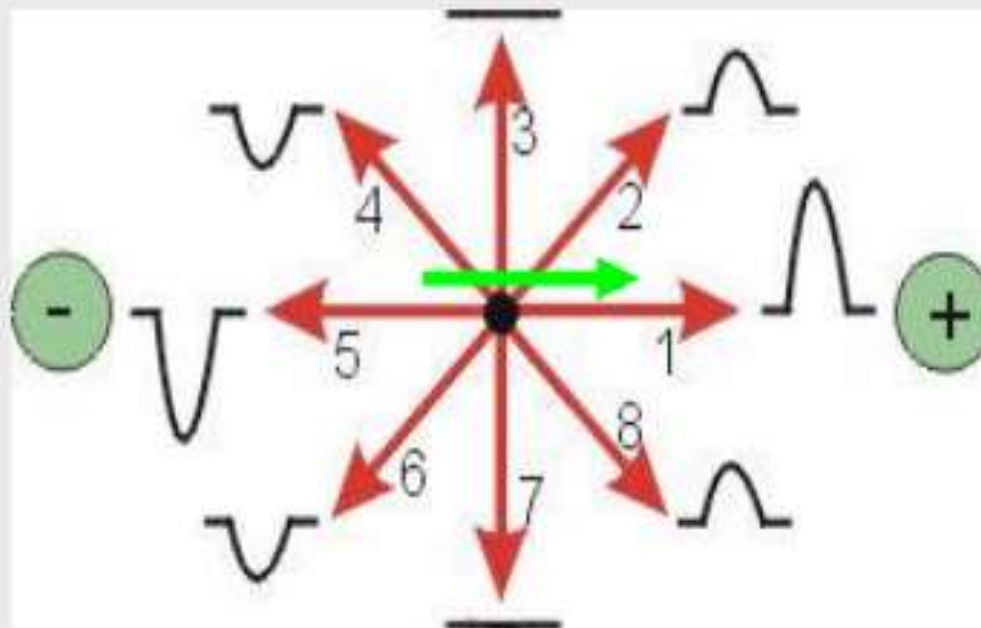
Electrophysiology

- Pacemaker = sinoatrial node
- Impulse travels across atria
- Reaches AV node
- Transmitted along interventricular septum in Bundle of His
- Bundle splits in two (right and left branches)
- Purkinje fibres

How does the ECG work?

- *Electrical impulse (wave of depolarisation) picked up by placing electrodes on patient*
- *The voltage change is sensed by measuring the current change across 2 electrodes – a positive electrode and a negative electrode*
- If the electrical impulse travels **towards** the positive electrode this results in a **positive** deflection
- If the impulse travels **away** from the positive electrode this results in a **negative** deflection

Away from
the
electrode
= negative
deflection



Towards
the
electrode
= positive
deflection

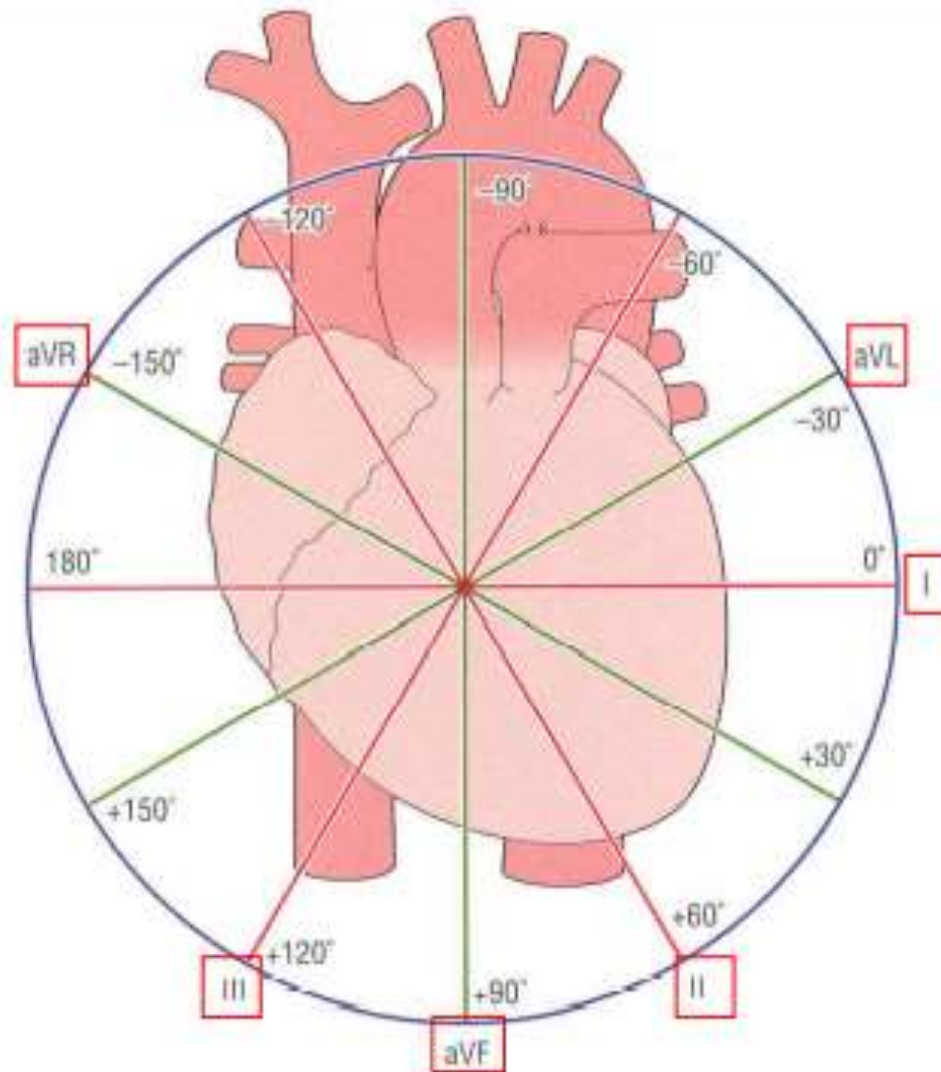
Direction of impulse (axis)

Types of Leads

- Coronal plane (Limb Leads)
 1. Bipolar leads — I, II, III
 2. Unipolar leads — aVL, aVR, aVF

- Transverse plane
V₁ — V₆ (Chest Leads)

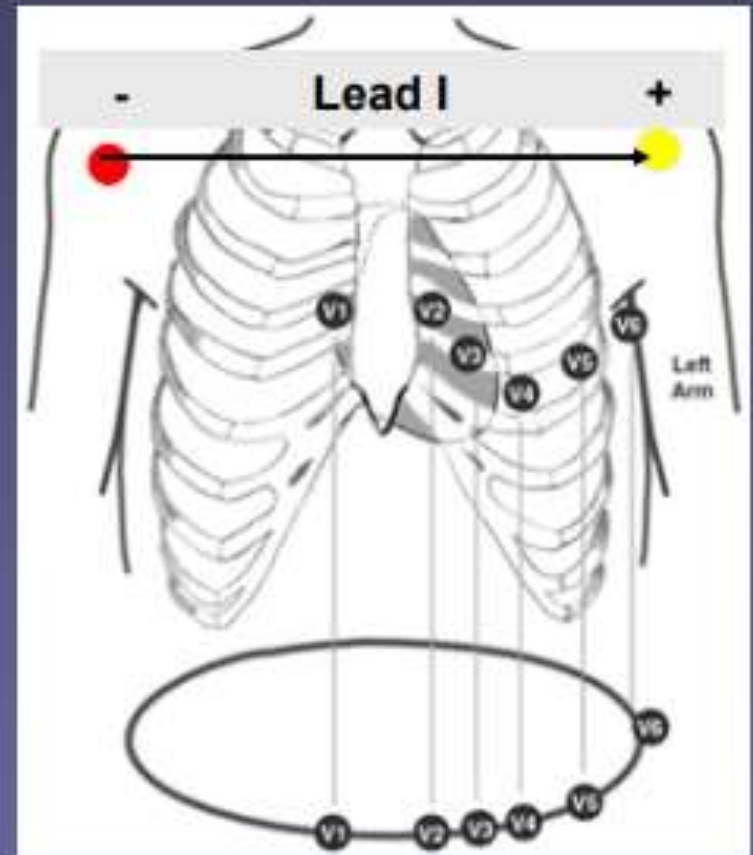
Electrodes around the heart



Leads

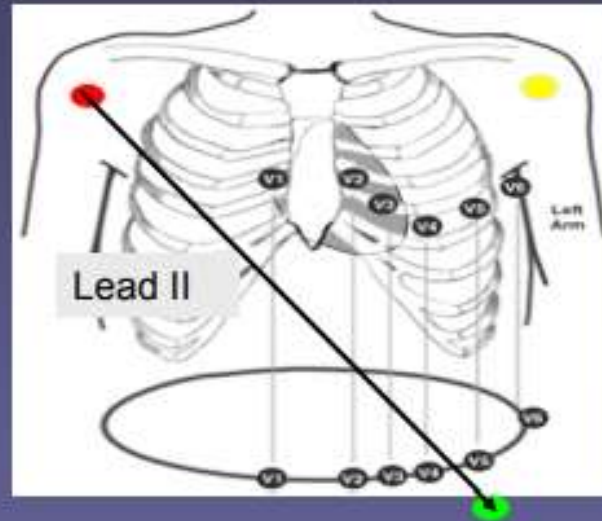
How are the 12 leads on the ECG (I, II, III, aVL, aVF, aVR, V1 – 6) formed using only 9 electrodes (and a neutral)?

- Lead I is formed using the **right arm electrode (red)** as the negative electrode and the **left arm (yellow)** electrode as the positive



Leads

- Lead II is formed using the **right arm electrode (red)** as the negative electrode and the **left leg electrode** as the positive



Leads

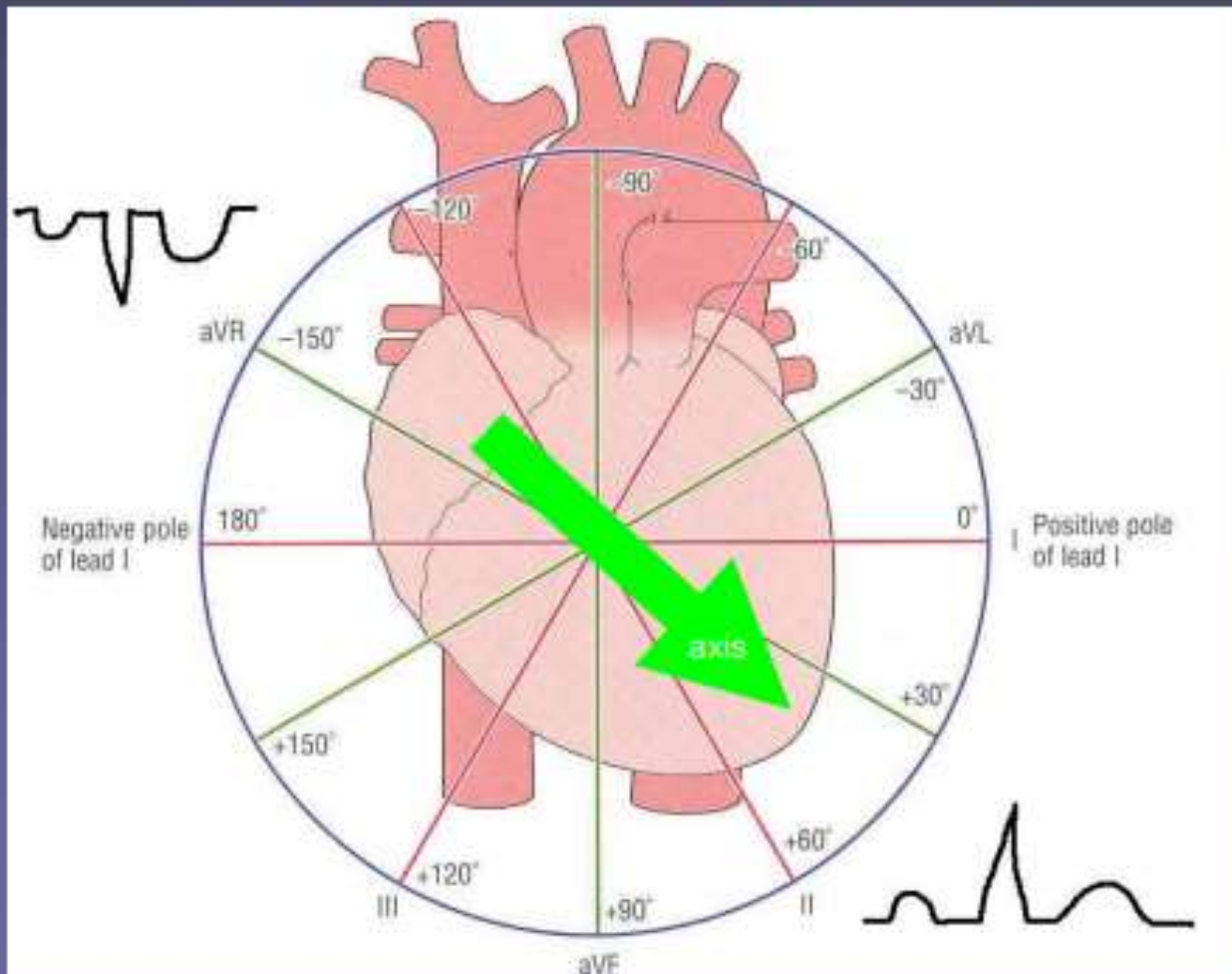
- Lead III is formed using the **left arm electrode** as the negative electrode and the **left leg electrode** as the positive
- aVL, aVF, and aVR are *composite leads*, computed using the information from the other leads

Limb leads

Limb leads look at the heart in the coronal plane

- aVL, I and II = lateral
- II, III and aVF = inferior
- aVR = right side of the heart

Leads look at the heart from different directions



Leads and what they tell you

Each lead can be thought of as 'looking at' an area of myocardium

Chest leads

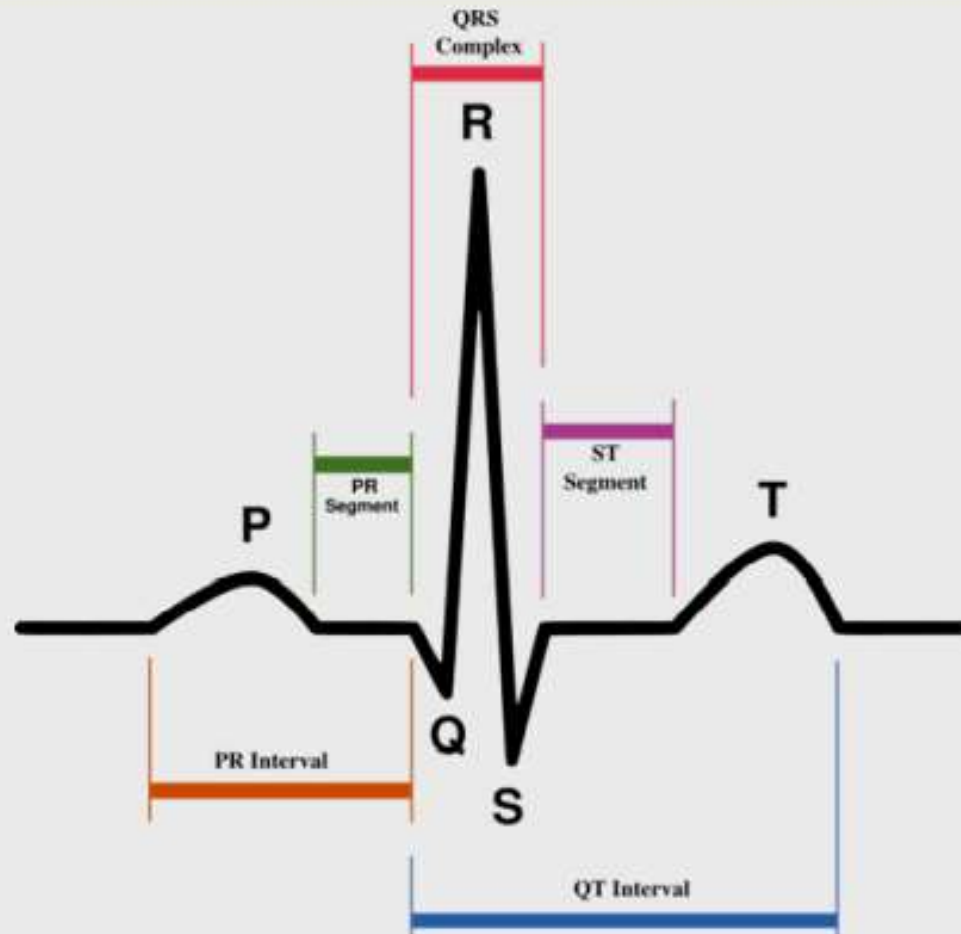
V₁ to V₆ 'look' at the heart on the transverse plain

- V₁ and V₂ look at the anterior of the heart and R ventricle
- V₃ and V₄ = anterior and septal
- V₅ and V₆ = lateral and left ventricle

Interpreting the ECG

- Check
 - Name
 - DoB
 - Time and date
 - Indication e.g. "chest pain" or "routine pre-op"
 - Any previous or subsequent ECGs
 - Is it part of a serial ECG sequence? In which case it may be numbered
- Calibration
- Rate
- Rhythm
- Axis
- Elements of the tracing in each lead

Elements of the trace



What do the components represent?

- P wave = atrial depolarisation
- QRS = ventricular depolarisation
- T = repolarisation of the ventricles

Axis

- The axis can be thought of as the overall direction of the cardiac impulse or wave of depolarisation of the heart
- An abnormal axis (axis deviation) can give a clue to possible pathology

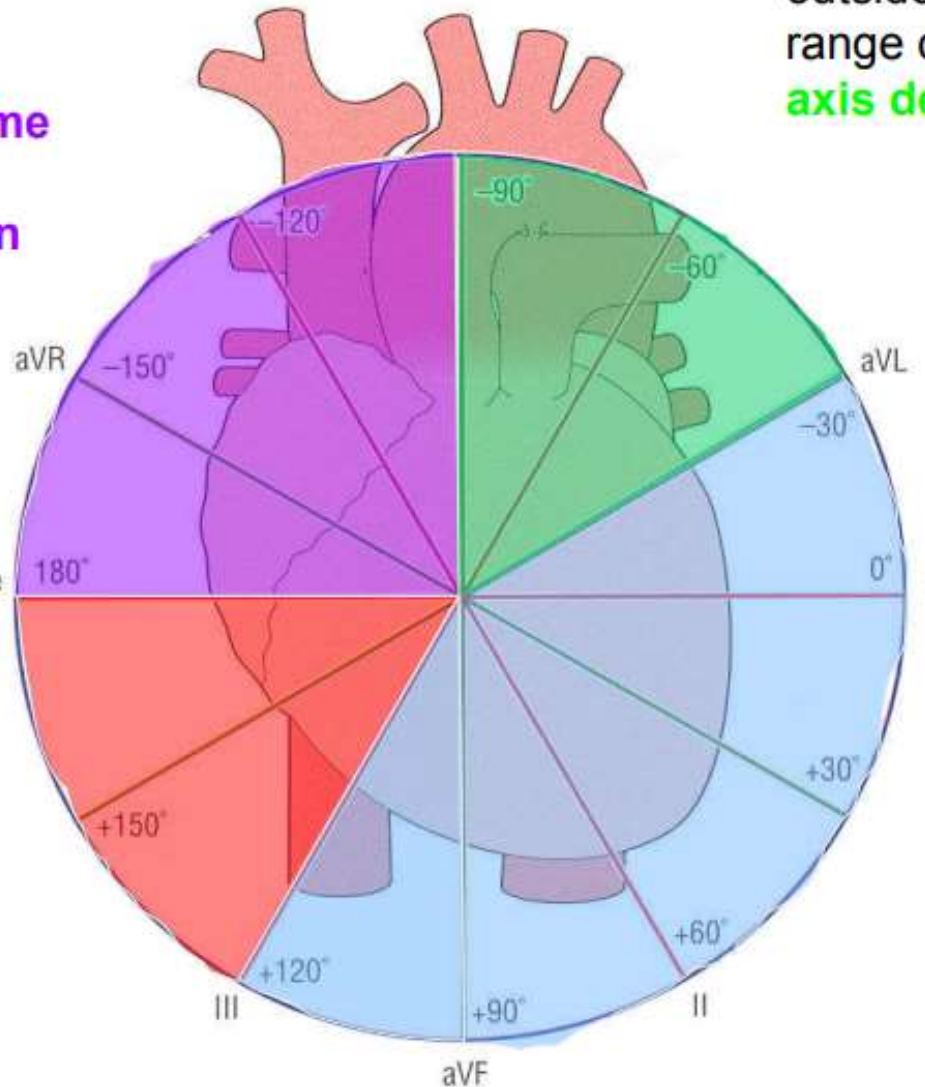
Axis

An axis falling outside the normal range can be **left axis deviation**

or **extreme axis deviation**

right axis deviation

Negative pole of lead I



A **normal axis** can lie anywhere between -30 and +90 degrees or +120 degrees according to some

Axis deviation - Causes

- Wolff-Parkinson-White syndrome can cause both Left and Right axis deviation

A useful mnemonic:

- “**RAD RALPH** the **LAD** from **VILLA**”

- **Right Axis Deviation**

- Right ventricular hypertrophy
- Anterolateral MI
- Left Posterior Hemiblock

- **Left Axis Deviation**

- Ventricular tachycardia
- Inferior MI
- Left ventricular hypertrophy
- Left Anterior hemiblock