SNS COLLEGE OF ALLIED HEALTH SCIENCE
Affiliated to The Tamil Nadu Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIAC TECHNOLOGY

COURSE NAME : Basic Electrocardiography

**UNIT :** Introduction to ECG and Cardiac Electrical Activity

TOPIC : Cardiac Depolarization & Repolarization

FACULTY NAME: Kavipriya S

EMPATHIZE – Understanding the Clinical and Learning Need

Objective:

❑ The heart functions as an **electrical pump**—its rhythm

   is controlled by electrical signals.

❑ We must understand **how**

 cardiac cells generate and transmit impulses to

interpret **ECG patterns** accurately.
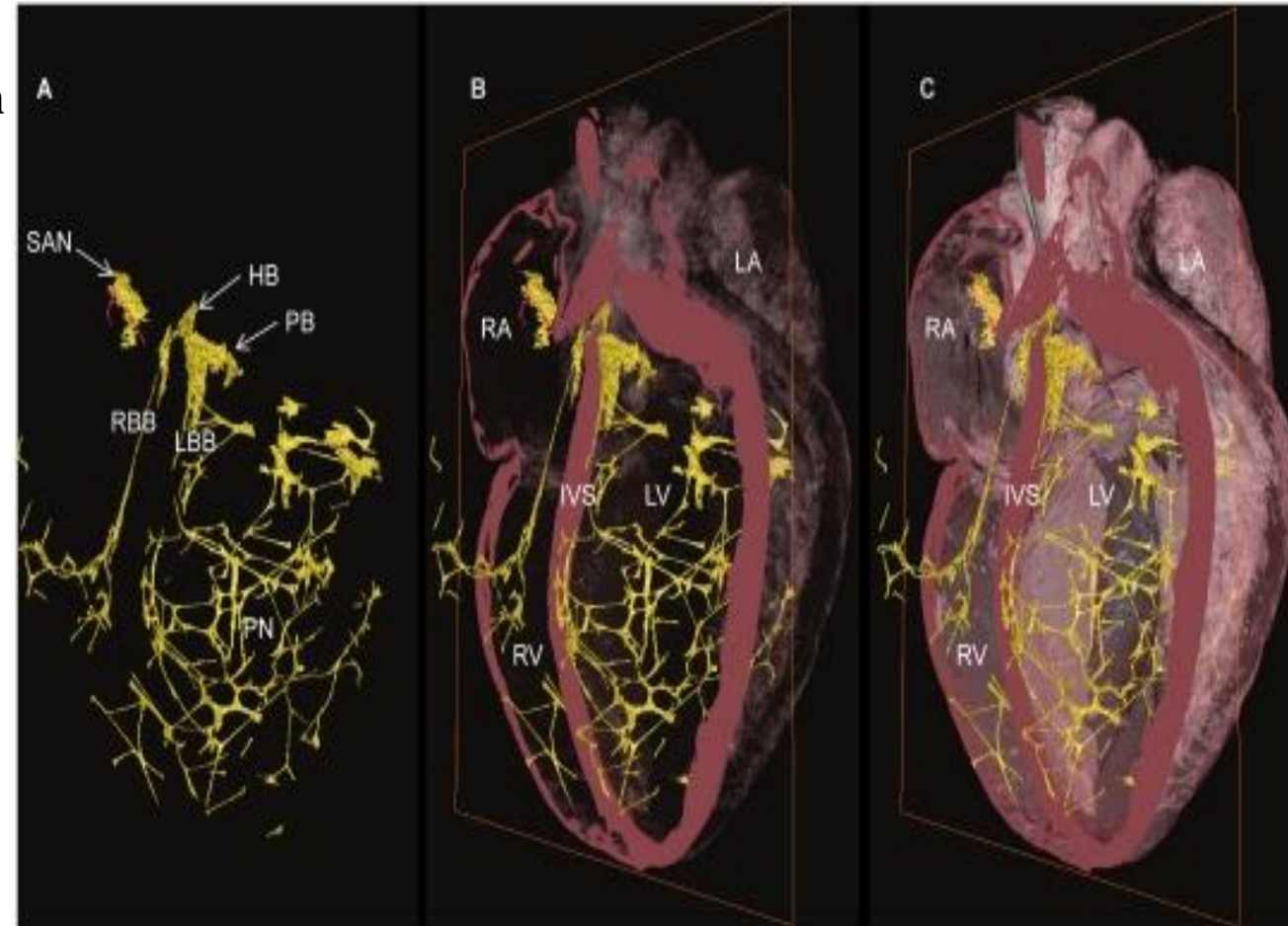
Clinical relevance

❑Abnormalities in depolarization and repolarization cause **arrhythmias, conduction blocks, and ischemic changes**.
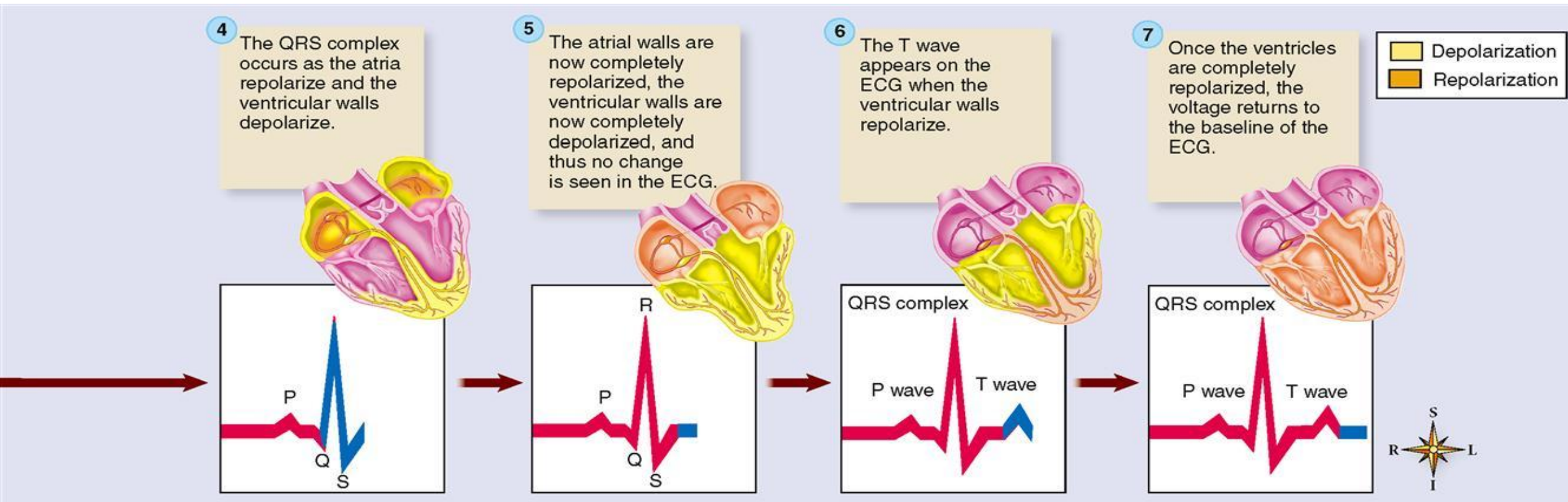
Key Clinical Scenarios:

❑ST-segment elevation → injury (abnormal repolarization)

❑Prolonged QT interval → delayed repolarization

❑Bundle branch block → altered depolarization pathway

# DEFINE – Identifying the Problem

Problem Statement:

👉 "How do cardiac muscle cells initiate, conduct, and recover from electrical impulses that produce each heartbeat?"

IDEATE - Concept Formation & Physiology

Ionic Basis:

- **Resting phase (Phase 4):**
  - Inside cell: negative (–90 mV)
  - Maintained by **Na^+/K^+ ATPase pump**.

- **Depolarization (Phase 0):**
  - **Fast Na^+ channels open**, Na^+ rushes in → membrane potential becomes positive.

- **Initial Repolarization (Phase 1):**
  - **K^+ channels open**, K^+ begins to leave the cell.

- **Plateau Phase (Phase 2):**
  - **Ca^{2+} enters** via slow channels → maintains contraction.

- **Final Repolarization (Phase 3):**
 - **K^+ efflux continues**, membrane returns to resting potential
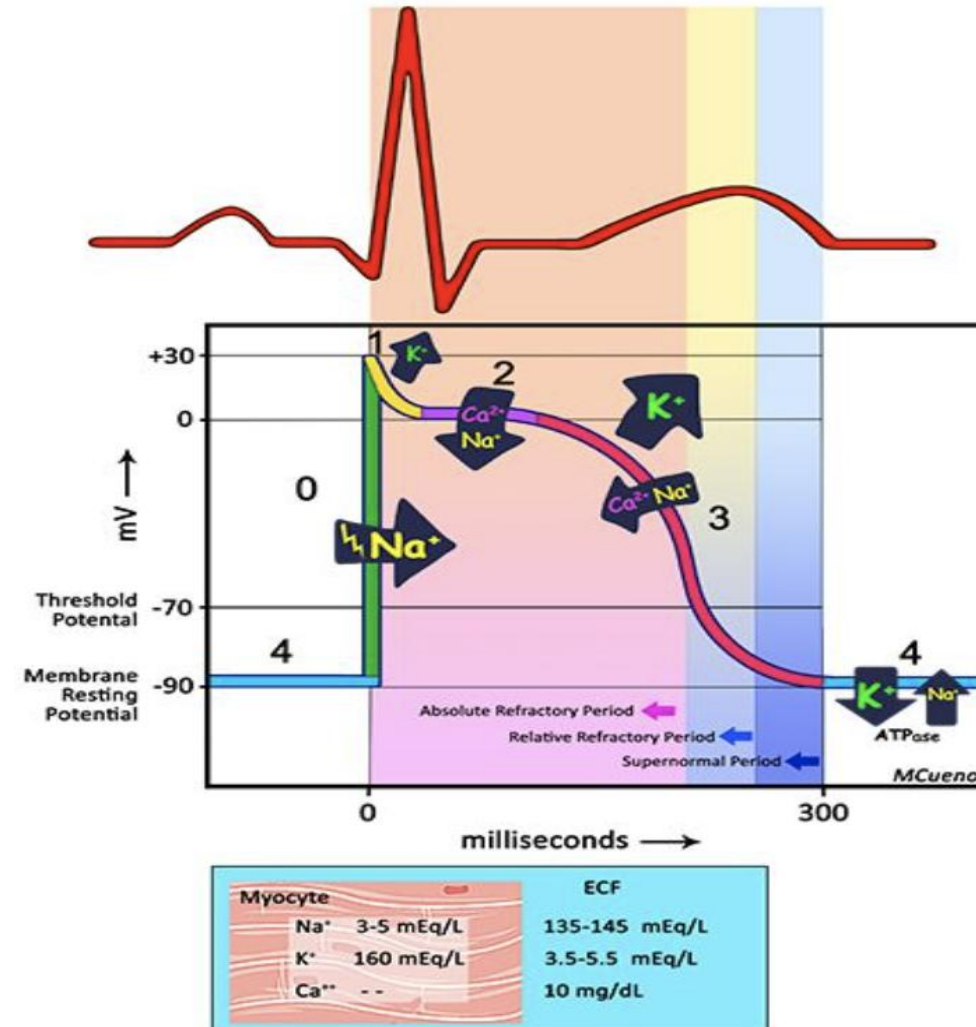
PROTOTYPE – Applying the Concept

Electrical Event	Mechanical Event	ECG Representation
Atrial depolarization	Atrial contraction	**P wave**
Ventricular depolarization	Ventricular contraction	**QRS complex**
Ventricular repolarization	Ventricular relaxation	**T wave**
Atrial repolarization	Hidden (in QRS)	Not visible

Sequence of Depolarization

❑ **SA node** → initiates impulse
❑ **Atrial muscle fibers** → spread depolarization
❑ **AV node** → slows conduction (delay for ventricular filling)
❑ **Bundle of His → Purkinje fibers** → rapid ventricular depolarization
❑ **Ventricles contract synchronously**

Atrial depolarization | Ventricular depolarization | Ventricular repolarization
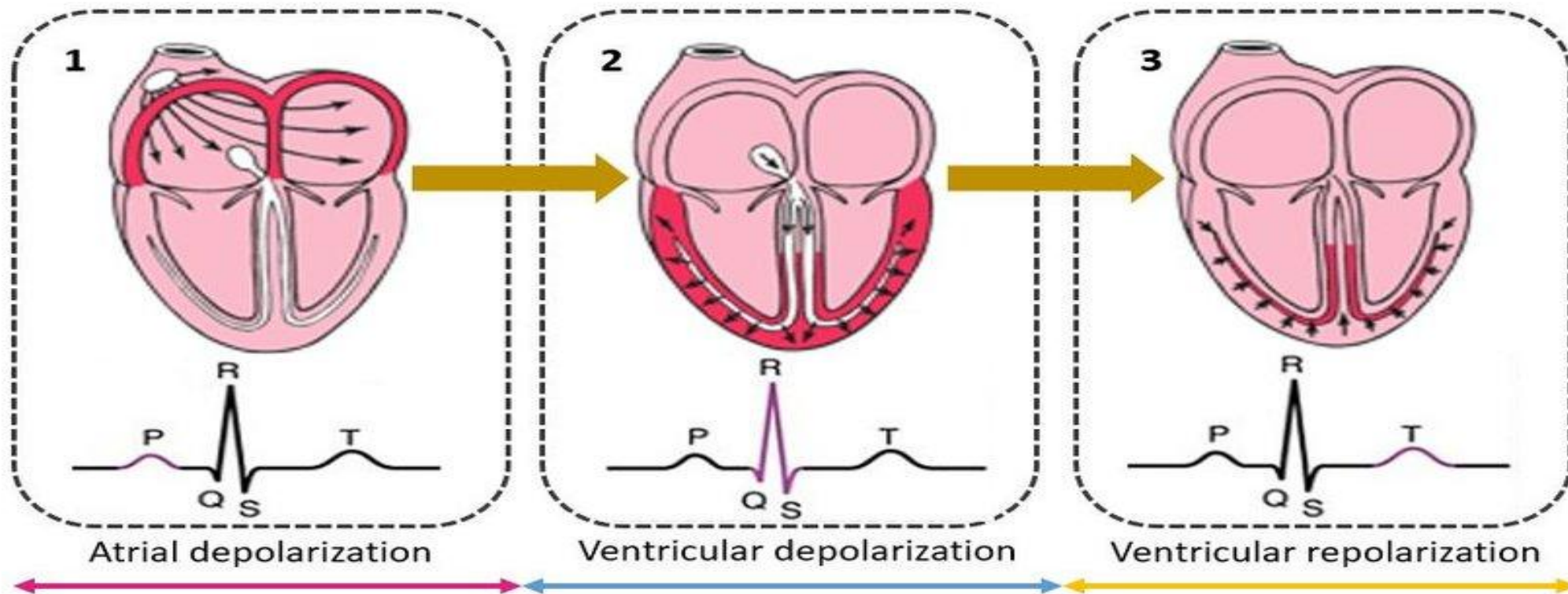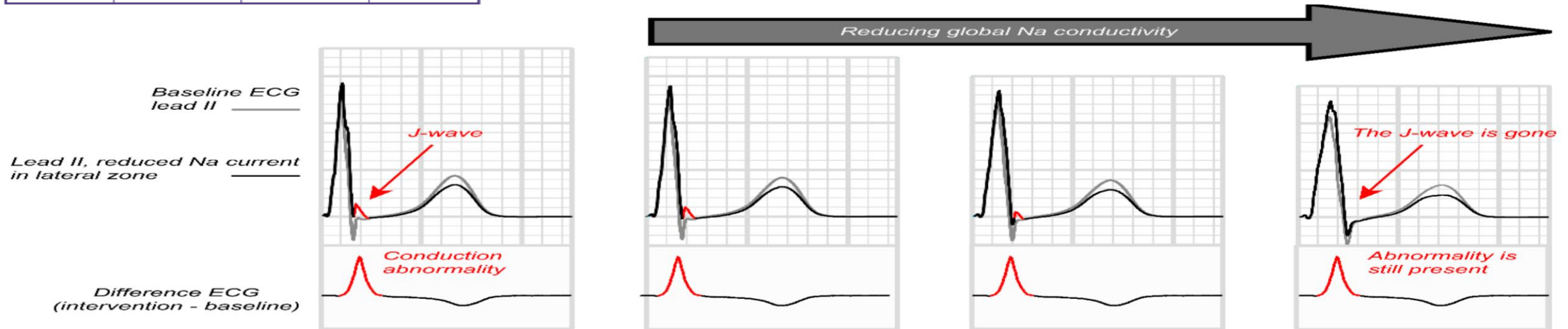
Test — Clinical and Diagnostic Application
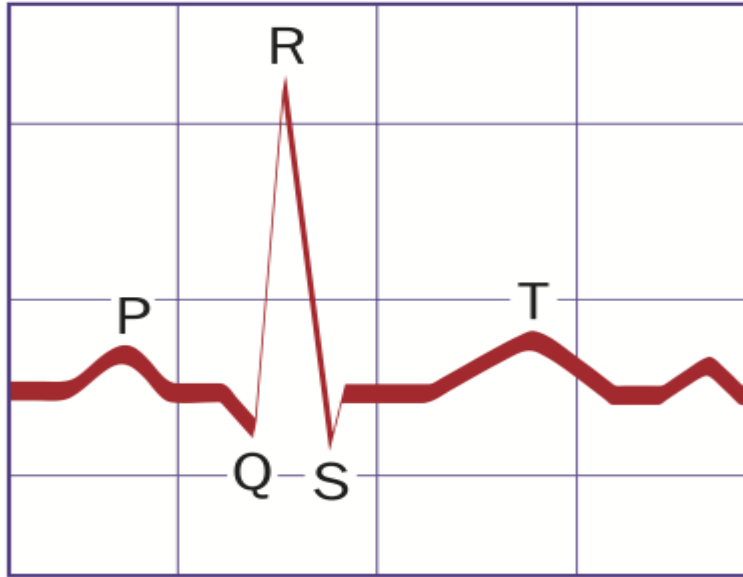
In ECG Interpretation:

- **Normal depolarization:** Narrow QRS, normal P wave.
- **Abnormal depolarization:**
  - Wide QRS → bundle branch block
  - Axis deviation → conduction imbalance
- **Abnormal repolarization:**
- Inverted T wave → ischemia
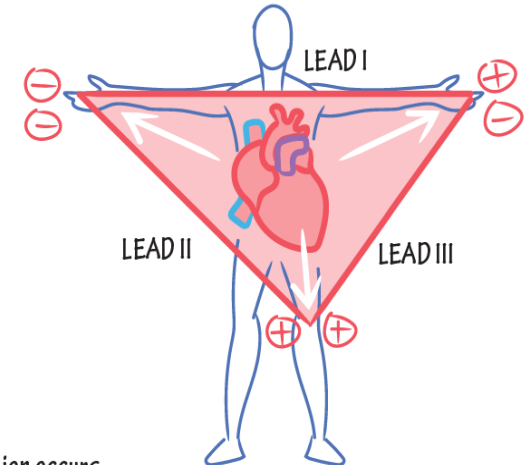- ST elevation/depression → myocardial injury or infarction
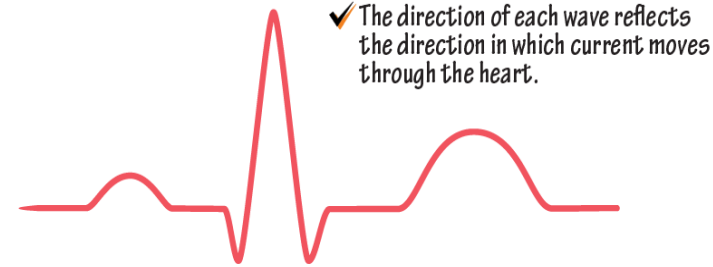

Reducing global Na conductivity

Baseline ECG lead II

Lead II, reduced Na current in lateral zone

Difference ECG (intervention - baseline)

J-wave

Conduction abnormality

The J-wave is gone

Abnormality is still present

Reflect — Learning Insights

- Depolarization and repolarization are **electrical reflections** of **mechanical heart activity**.

- ECG is the **surface representation** of these ionic changes.

- Integration of physiology + technology enables **accurate cardiac diagnosis**.


FUNDAMENTAL ELECTROCARDIOGRAM

- ECG: sum of heart's action potentials
- 12 electrodes: detect the heart's action potentials
- Lead: unseen axis, connects (+) electrode to (−) electrode
  - 3 standard limb leads
  - 3 augmented limb leads
  - 6 chest leads

Typical ECG

- The direction of each wave reflects the direction in which current moves through the heart.

- P wave is smaller than QRS complex because atria have smaller muscle mass than the ventricles

- End of ventricular ejection occurs at end of T wave, ventricles reach end systolic volume (ESV)

- Ventricular filling phase: cardiac muscles are completely repolarized

QRS complex

PR segment

ST segment

T wave

TP segment

P wave

R

Atrial depolarization

Q   S

Ventricular contraction
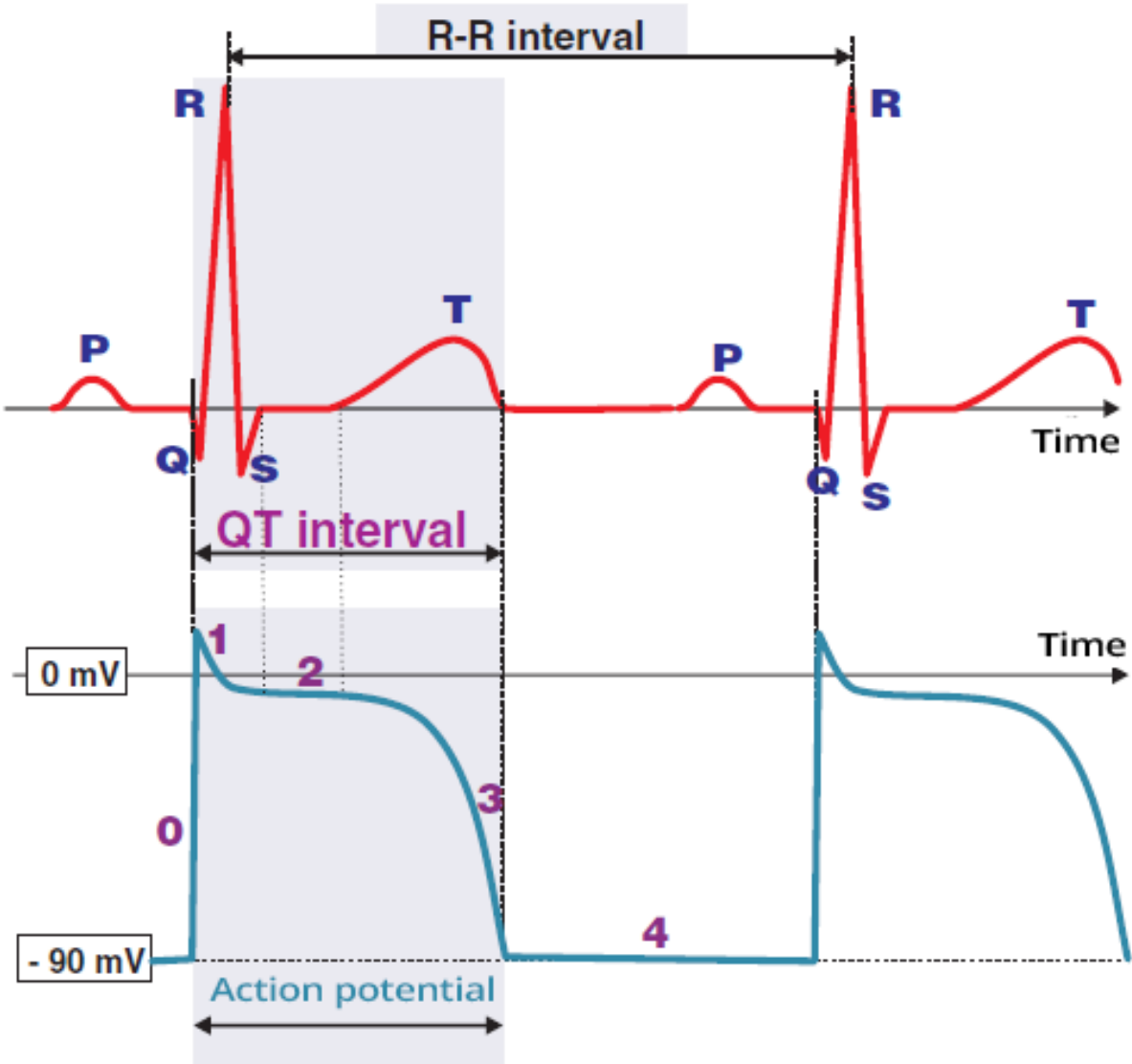
Ventricular repolarization

LEAD I

LEAD II   LEAD III

II = I + III

- 1 augmented lead lies on each arm and the left leg
- 6 chest leads are placed in 6 different locations around the heart
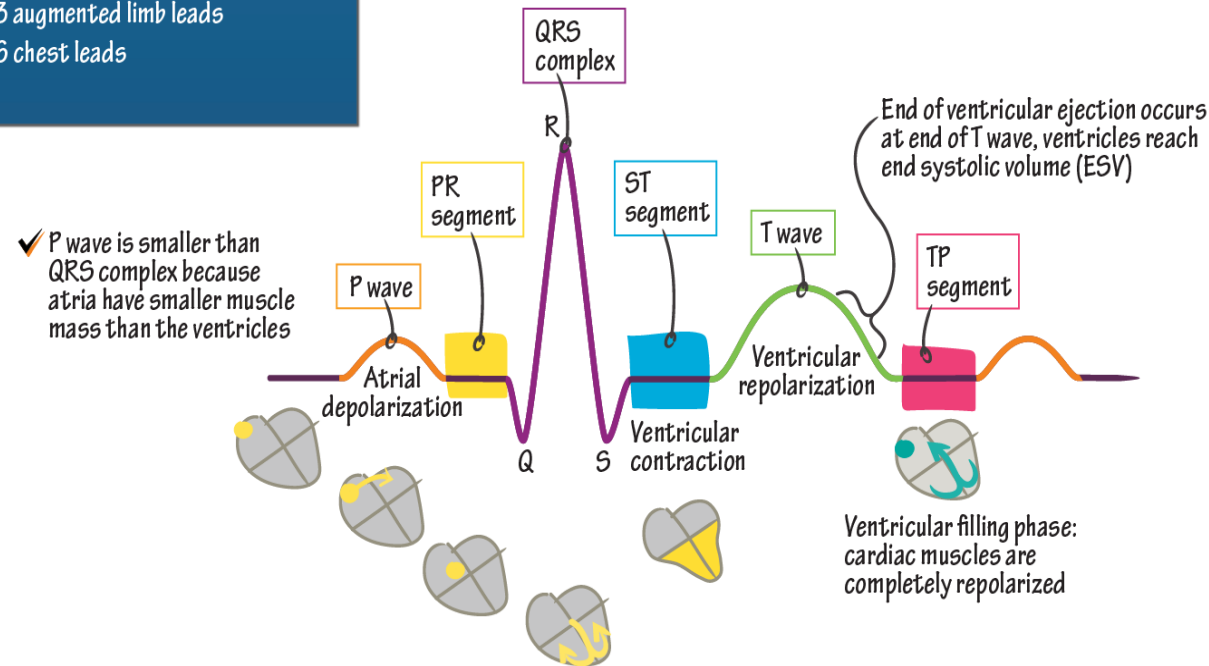
Summary

CARDIAC DEPOLARIZATION AND REPOLARIZATION / BASIC ECG / KAVIPRIYA
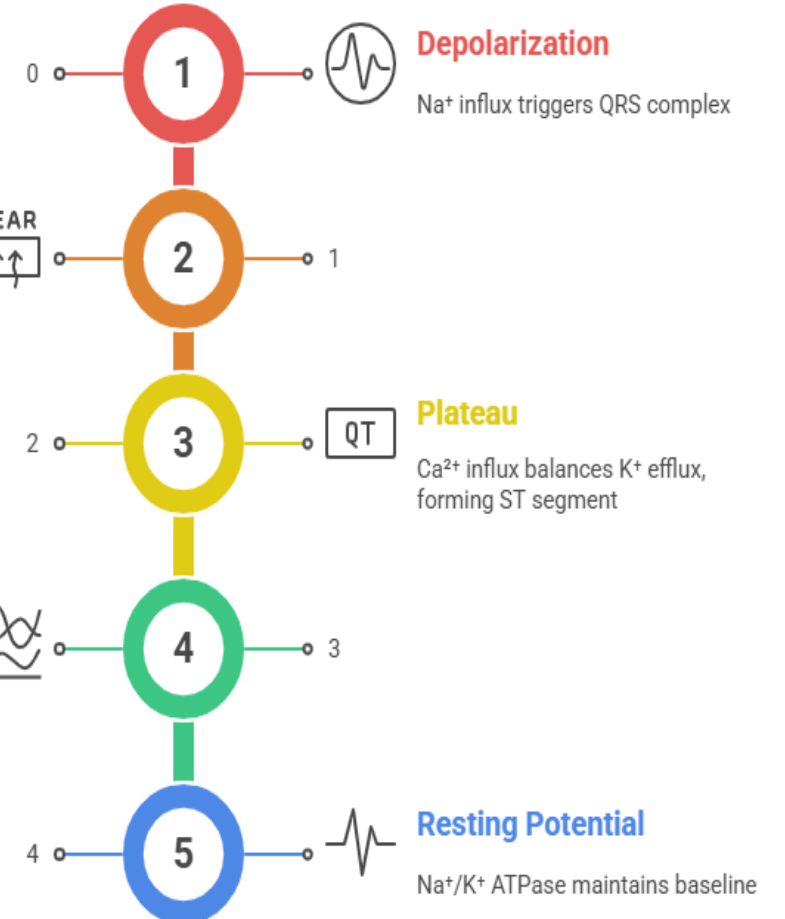
Reference Textbooks

❑ Guyton & Hall, *Textbook of Medical Physiology*, 14th Edition

❑ Arthur C. Guyton, *Cardiovascular Physiology Concepts* by Richard E. Klabunde

❑ Sembulingam & Sembulingam, *Essentials of Medical Physiology*

❑ John R. Hampton, *The ECG Made Easy*