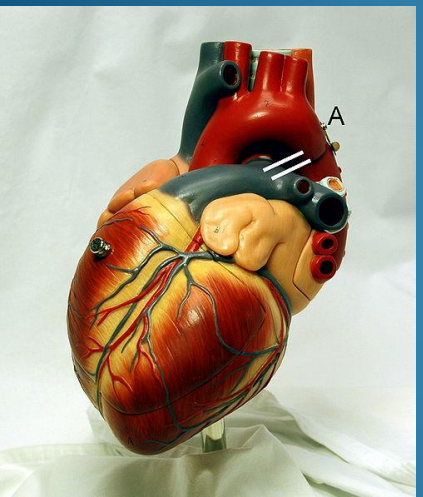
# Cardiovascular System Block
# Cardiac Arrhythmias
# (Physiology)

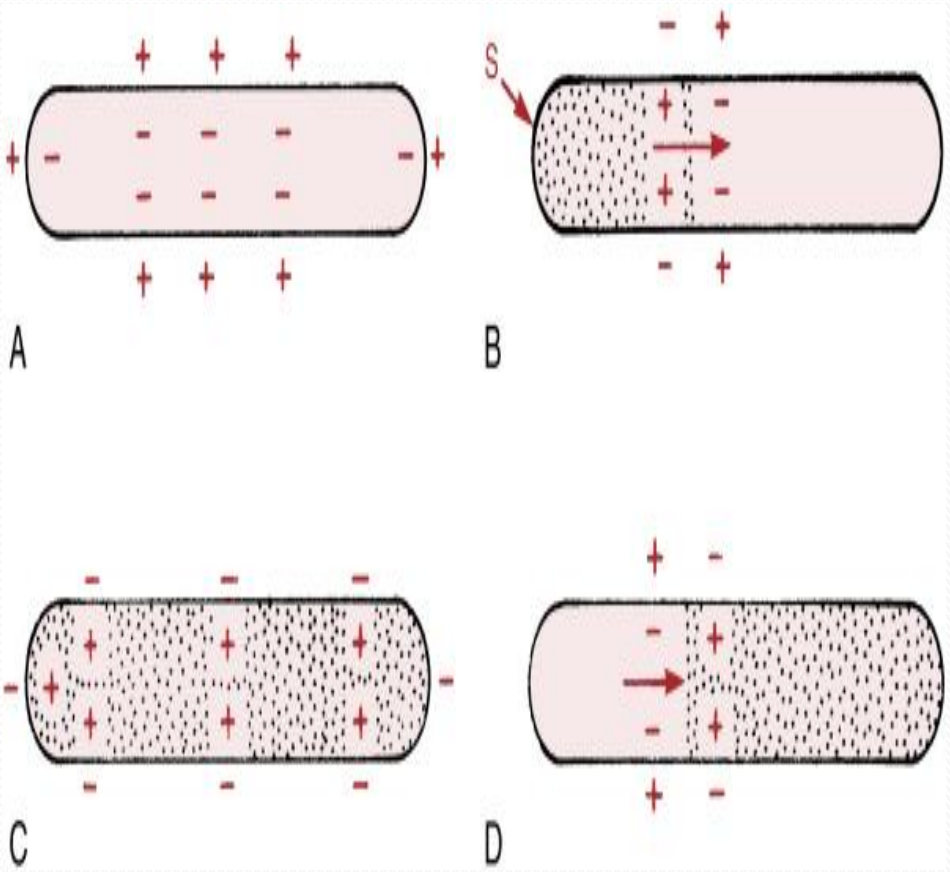
**Ahmad Hersi**

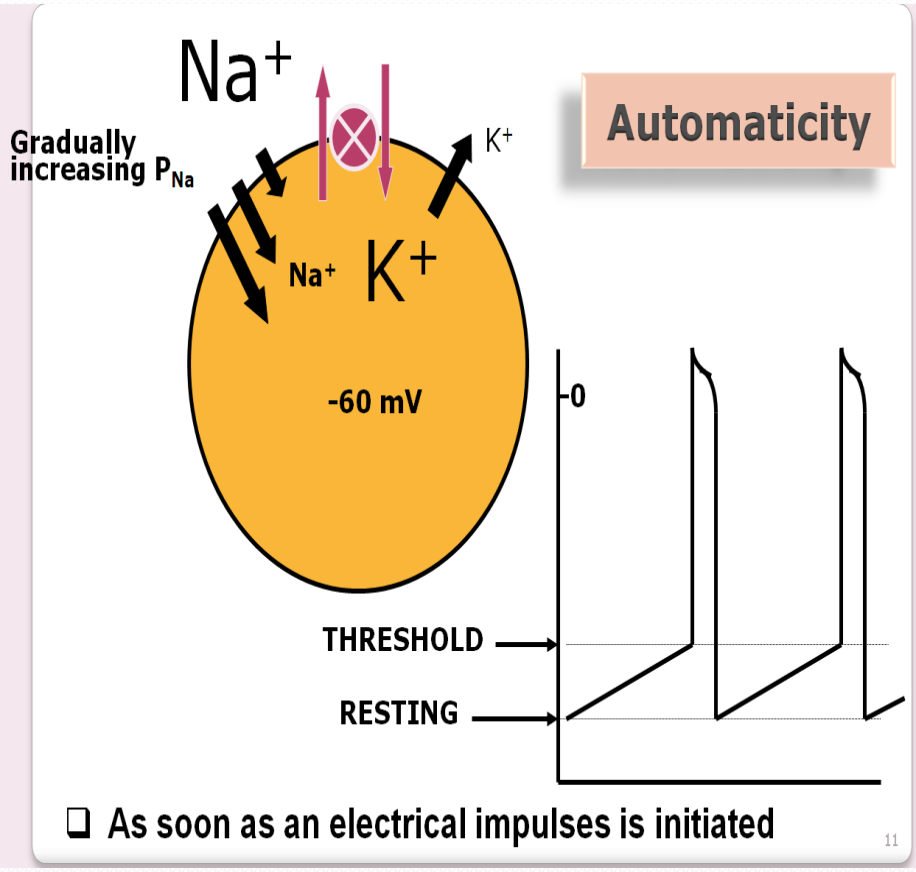


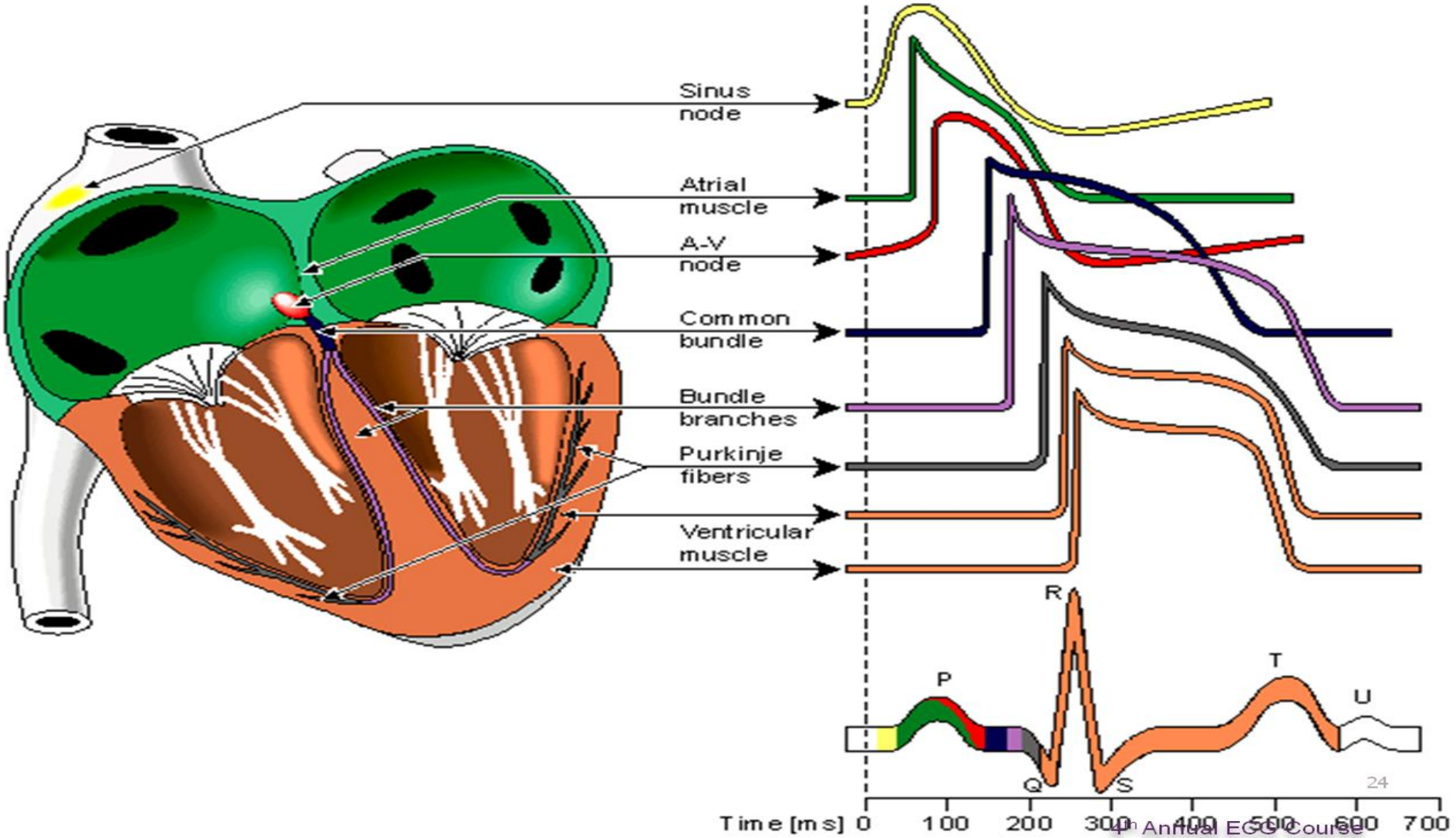
# Lecture Objectives

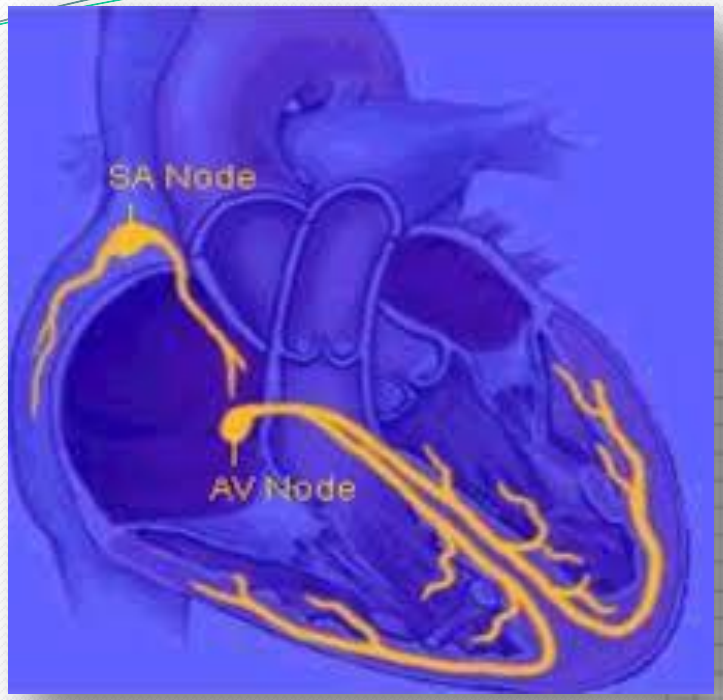
- Describe sinus arrhythmias
- Describe the main pathophysiological causes of cardiac arrhythmias
- Explain the mechanism of cardiac block
- Explain the origin of an ectopic foci
- Enumerate the common arrhythmias and describe the basic ECG changes

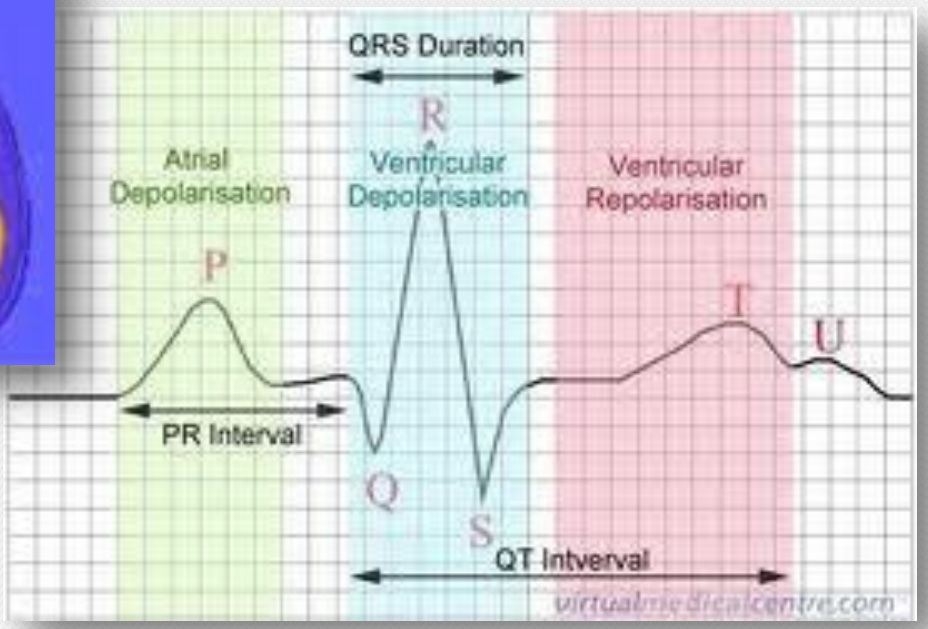
# Depolarization and Repolarization




Sinus node
Atrial muscle
A-V node
Common bundle
Bundle branches
Purkinje fibers
Ventricular muscle
R
P
T
U
Q
S
Time [ms] 0 100 200 300 400 500 600 700



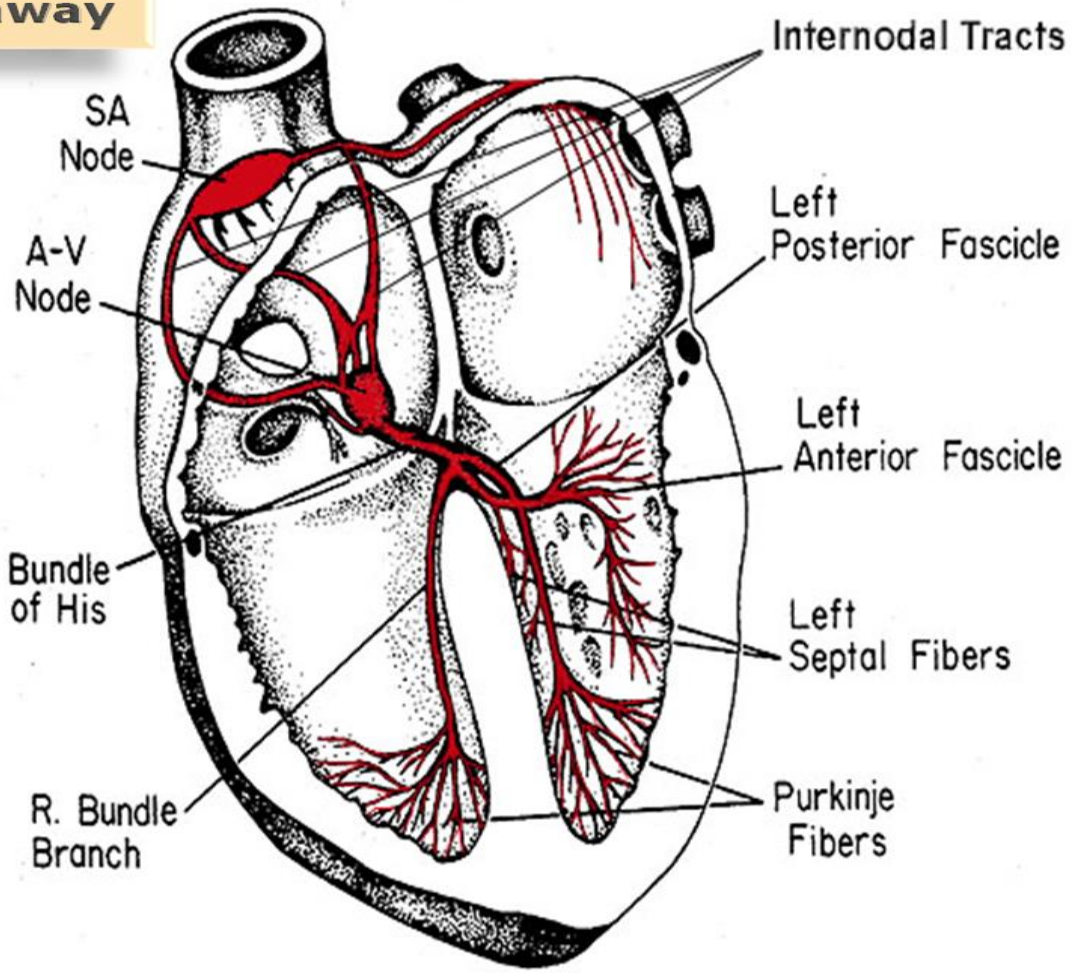




# Electrical Conduction

# The conduction system

## Electrical Conduction Pathway

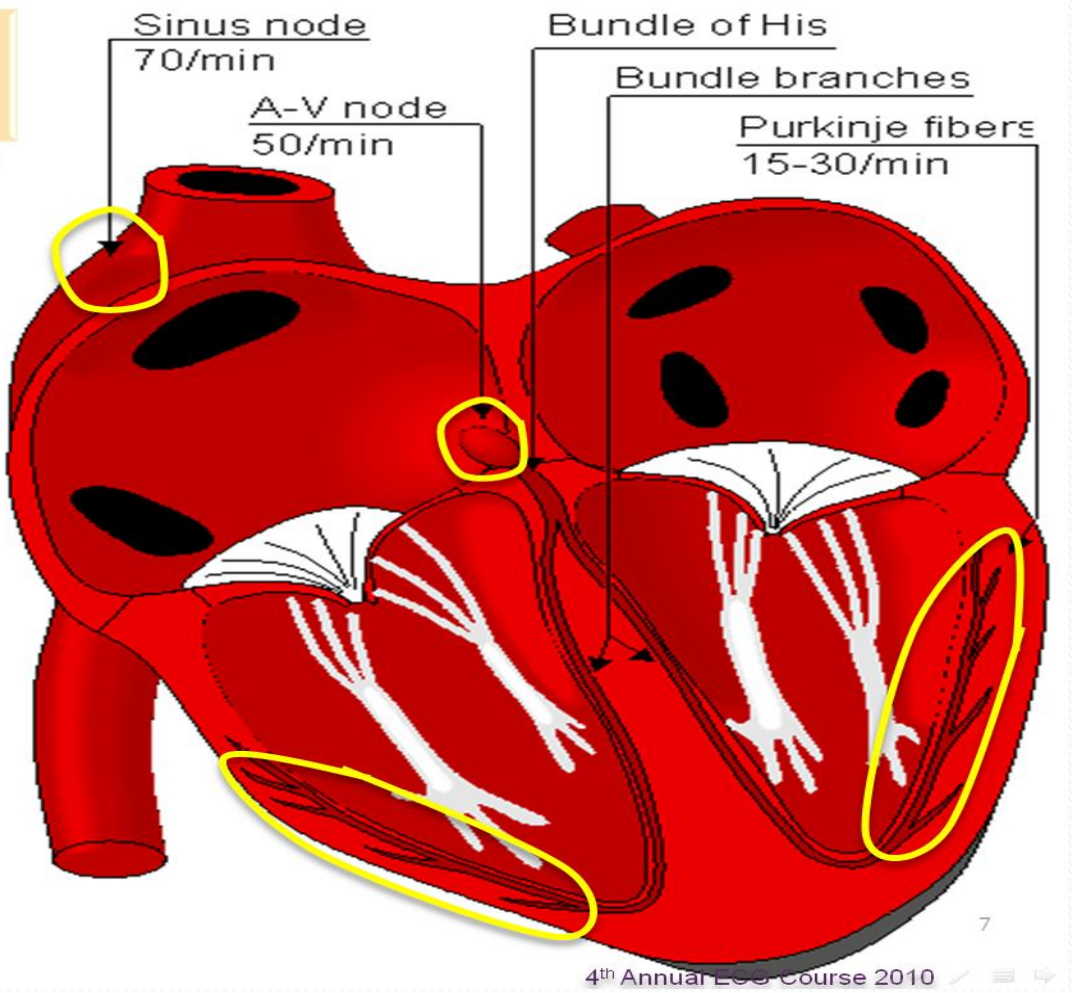
- **Sinoatrial (SA) node**
- **Internodal & Interatrial pathways**
  - Anterior internodal tract
  - Middle internodal tract (Wenckebach's tract)
  - Posterior internodal tract (Thorel's tract)
- **Atrioventricular (AV) node**
- **AV bundle (bundle of His)**
- **Rt & Lt bundle branches**
- **Purkinje fibers**



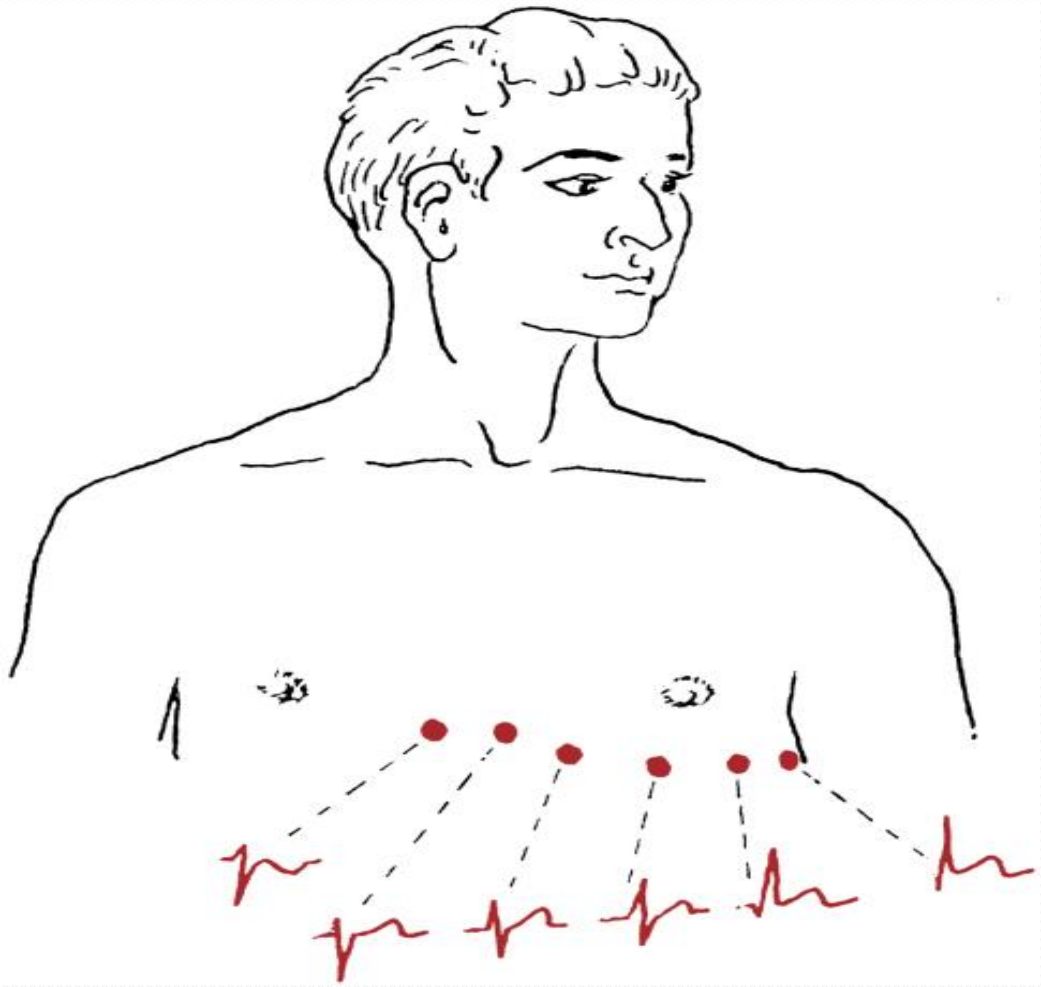
# Intrinsic Firing Rates

**Three potential areas capable of beginning cardiac conduction**

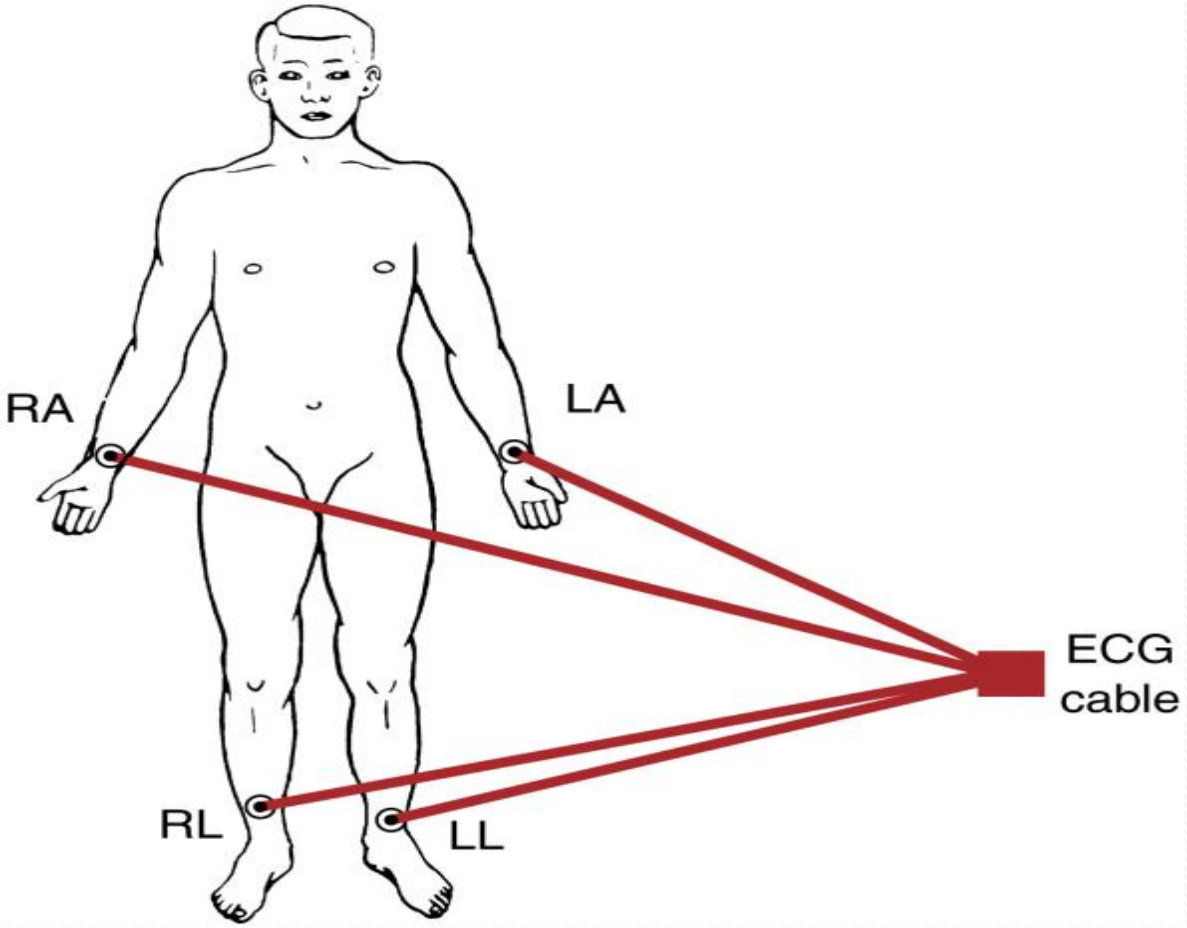
- **SA node:**
  - Cardiac pacemaker
  - Paces at a rate of 60–100 bpm
  - Average of 70 bpm
- **AV node:**
  - 45-60 bpm
- **Purkinje:**
  - 15-45 bpm

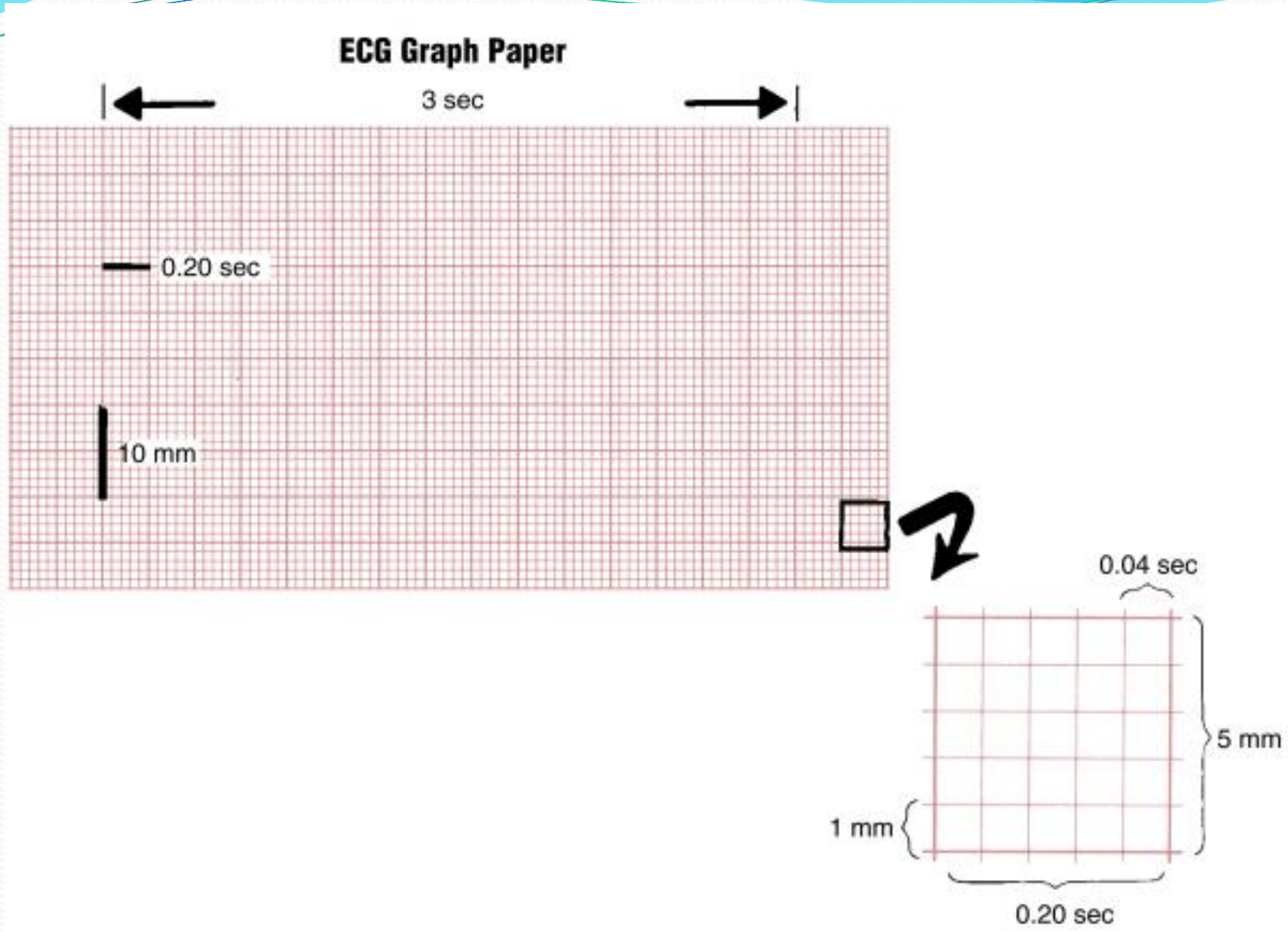


# Chest leads

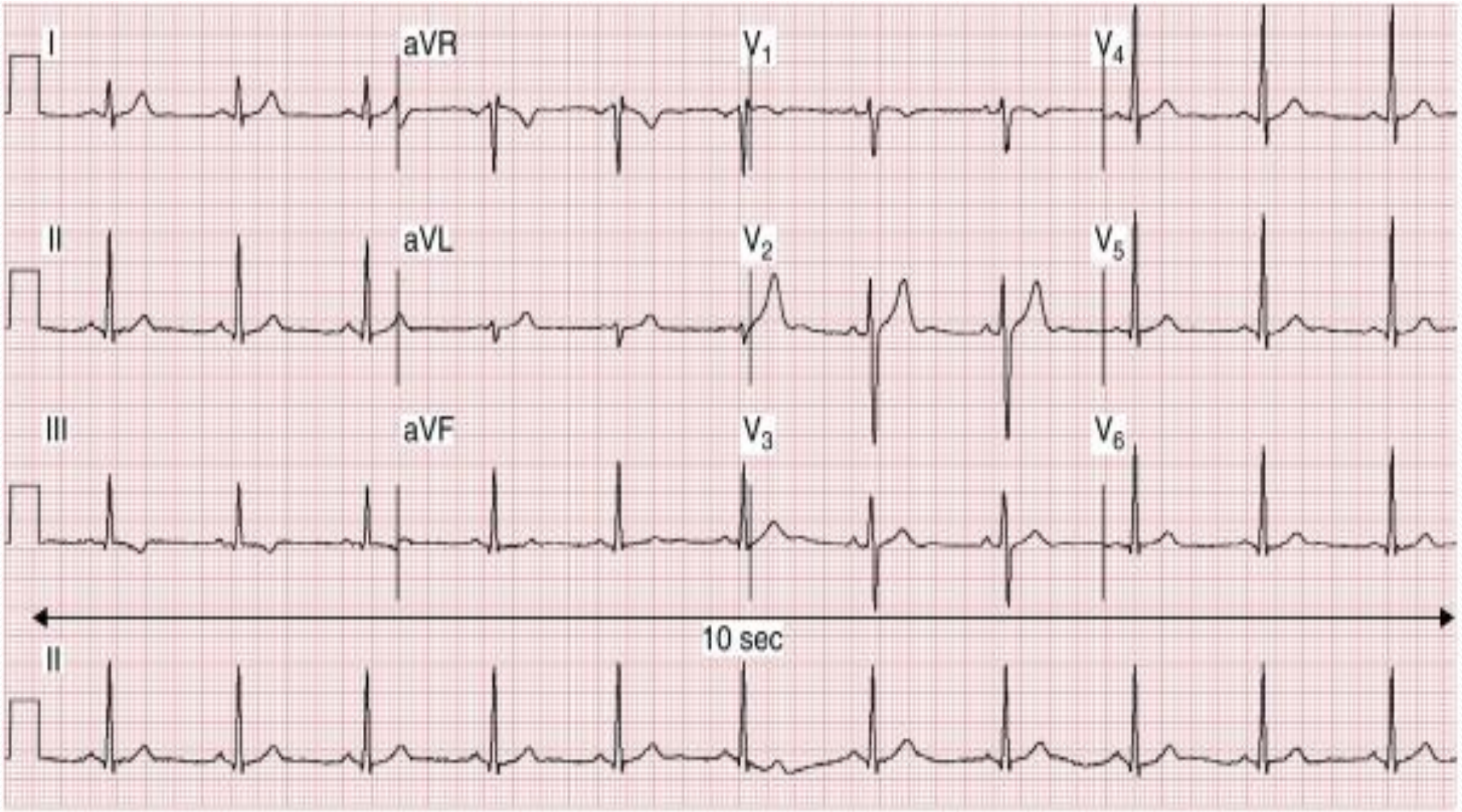


# Limb leads




ECG Graph Paper
3 sec
0.20 sec
10 mm
0.04 sec
5 mm
1 mm
0.20 sec

# 12 Leads EKG



# Normal Sinus Rhythm

- Regular
- Single p-wave precedes every QRS complex
- P-R interval is constant and within normal range
- P-P interval is constant

# Rate

- **Normal sinus rate:** (60-100).
- **Tachycardia:** >100.
- **Bradycardia:** <60.

# Causes/Mechanisms of Cardiac Arrhythmias

1. Abnormal rhythmicity of the pacemaker
2. Shift of the pacemaker from the sinus node to another place in the heart
3. Blocks at different points in the spread of impulse through the heart
4. Triger
5. Reentry

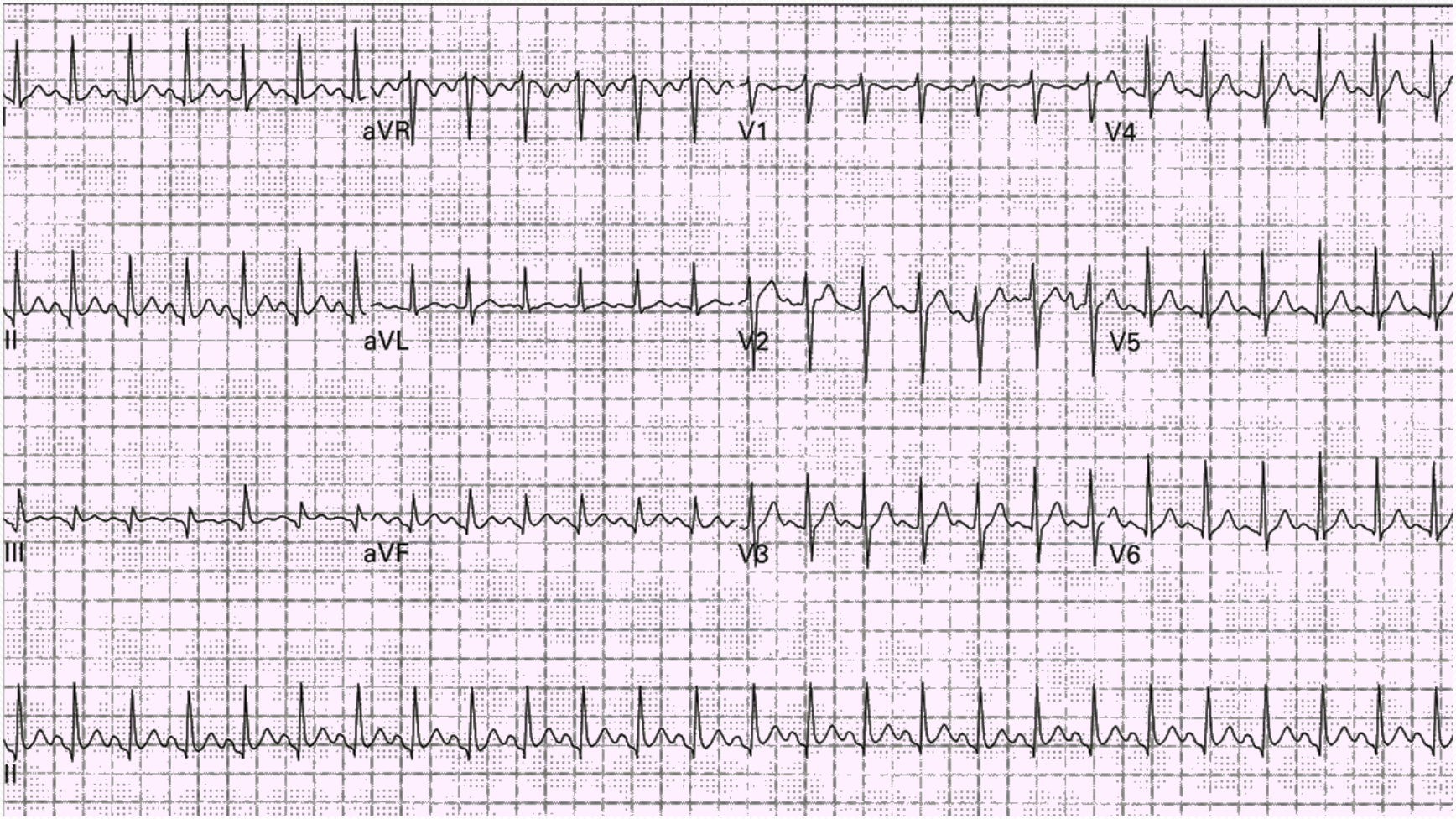
# Classification of Cardiac Arrhythmias

- Rate above or below normal (tachy vs. Brady)
- Regular or irregular rhythm
- Narrow or broad QRS complex
- Relation to P waves
- Supraventricular Vs. ventricular

# Abnormal Sinus Rhythm

- Tachycardia: an increase in the heart rate
  - Heart rate > 100 beats per minute
  - Causes:
    - Increased body temperature
    - Sympathetic stimulation
    - Drugs

# 24 year-old pregnant woman with three days of frequent vomiting



# Abnormal Sinus Rhythm

- Bradycardia:
  - Slow heart rate < 60 beats per minute
  - Causes:
    - Parasympathetic stimulation

# Sinus Arhythmia

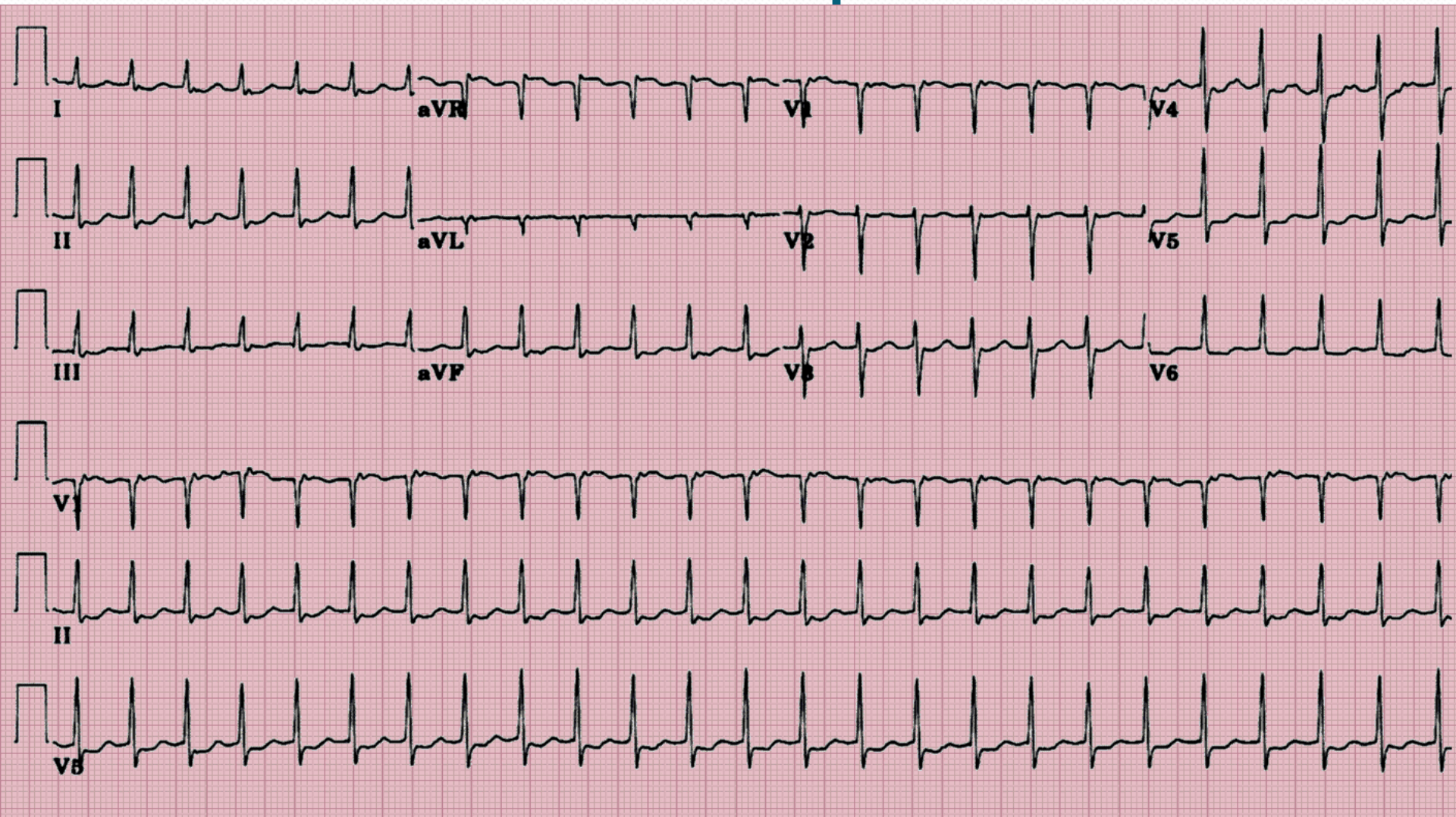
- Result from spillover of signals from the medullary respiratory center into the adjacent vasomotor center during inspiration and expiratory cycles of respiration
- The spillover signals cause alternate increase and decrease in the number of impulses transmitted through the sympathetic and vagus nerves to the heart

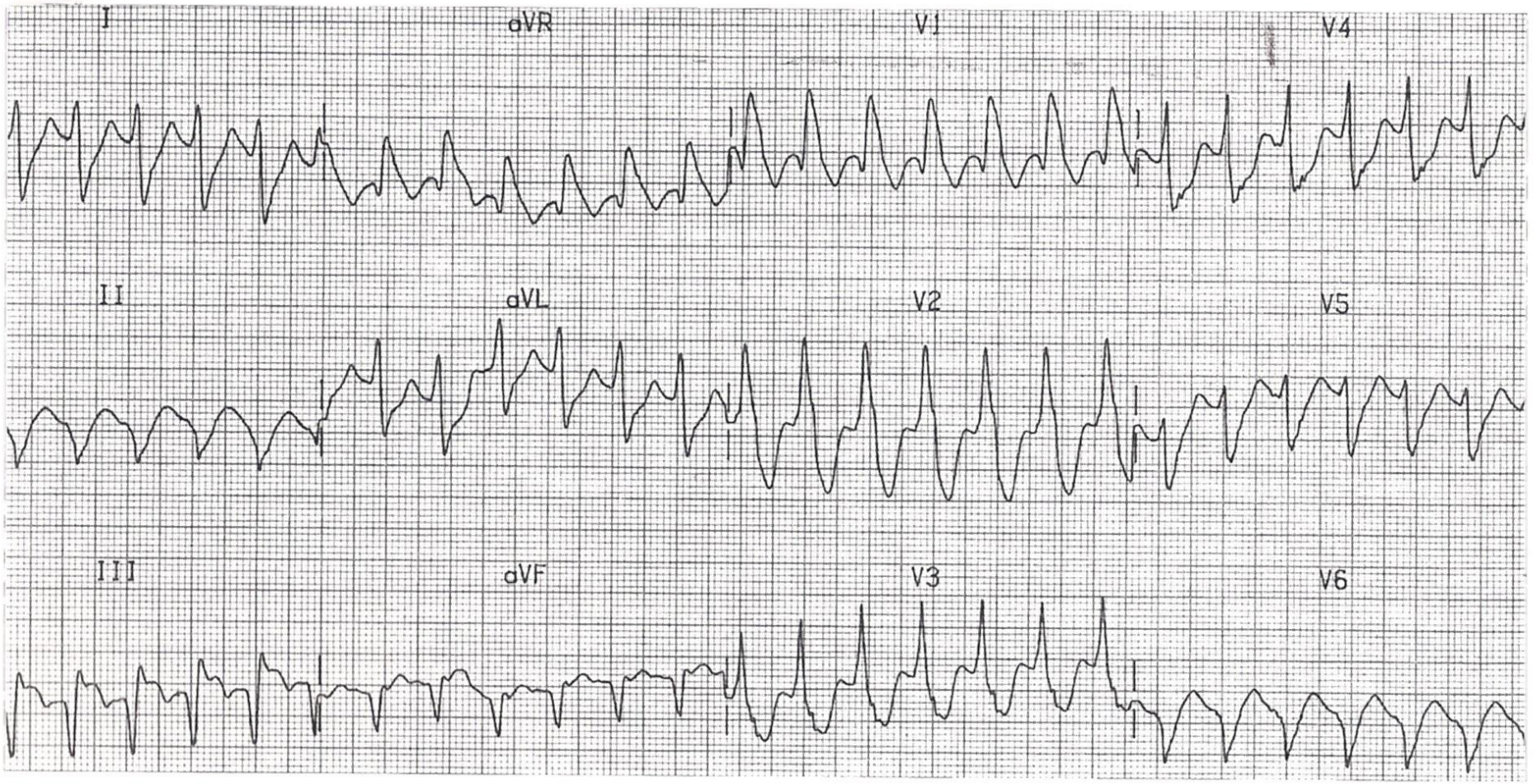
# Abnormal Cardiac Rhythms that Result from Impulse Conduction Block

- **Sinoatrial Block**
  - The impulse from the S-A node is blocked before it enters the atrial muscle
  - Cessation of P waves


Hall: Guyton and Hall Textbook of Medical Physiology, 12th Edition

# AVRT-Narrow complex




I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

# Abnormal Cardiac Rhythms that Result from Impulse Conduction Block

- **A-V Block**
  - When impulse from the S-A node is blocked
  - Causes:
    - Ischemia of the A-V node
    - Compression of the A-V node by scar formation
    - Inflammation of the A-V node
    - Strong vagal stimulation

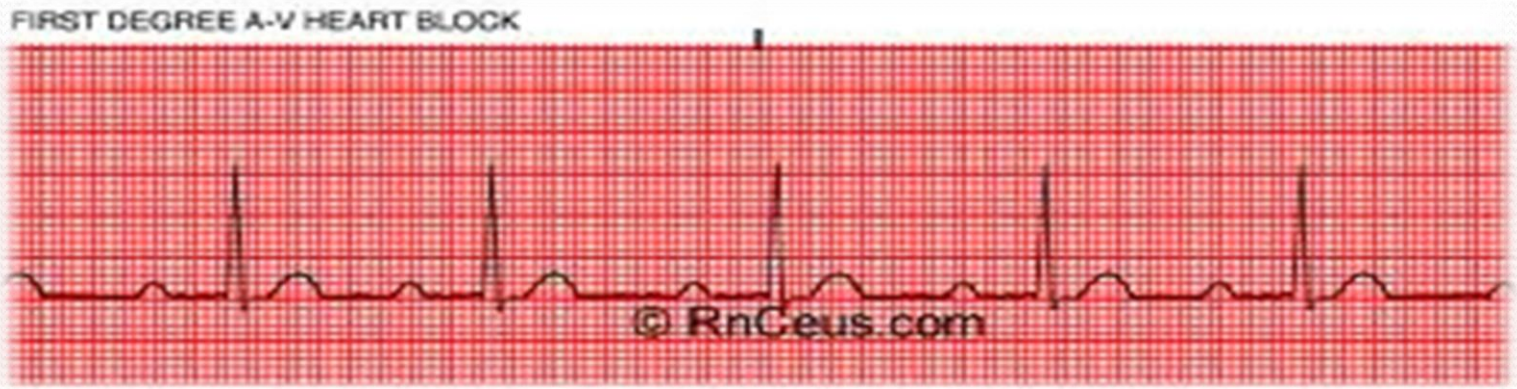
# Types of the A-V Block

- First degree block
- Second degree block
- Third degree block

# Heart Block

| | |
|---|---|
| 1st○ | • Constant PR prolongation without drop beat. |
| 2nd○ | • **Mobitz1:** Progressive PR prolongation + drop beat.<br>• **Mobits2:** Constant PR prolongation + drop beat. |
| 3rd ○ | • Complete dissociation between P and QRS. |

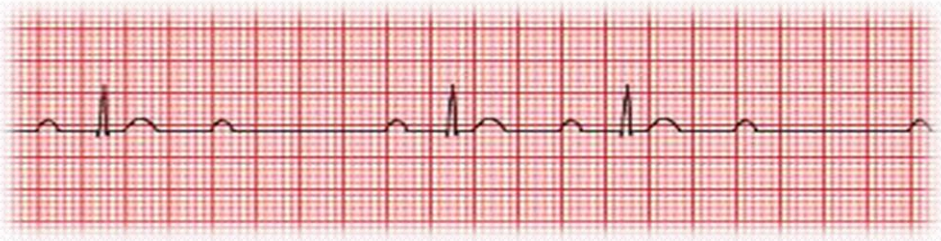
# First Degree Heart Block



# Second Degree Heart Block

- **Mobitz (I):**

- **Mobitz (II):**



# Third Degree Heart Block

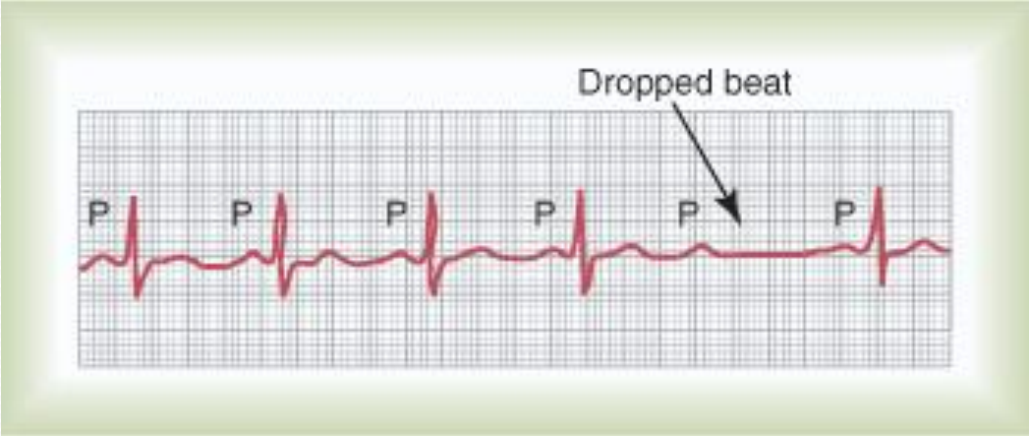
# Types of the A-V block

## Second Degree Block

- P-R interval > 0.25 second
- Only few impulses pass to the ventricles

  → atria beat faster than ventricles

  →"dropped beat" of the ventricles



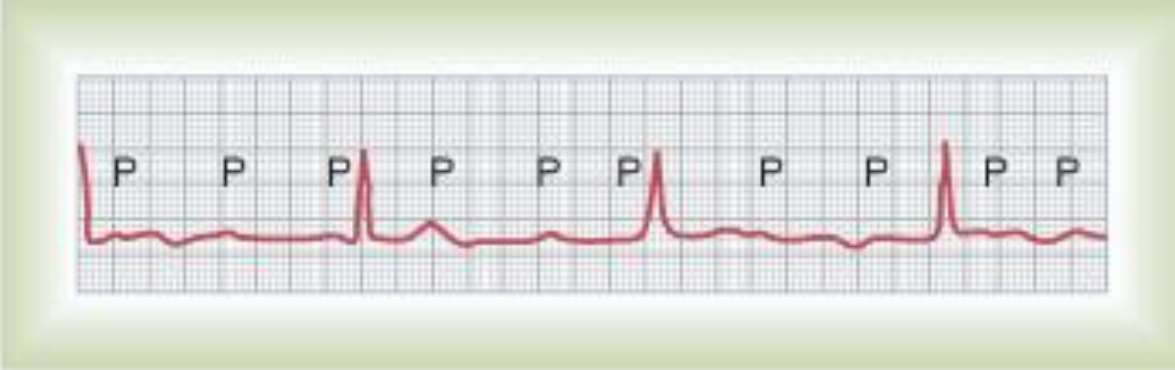
# Types of the A-V block

## Third degree block (complete)

- Complete dissociation of P wave and QRS waves

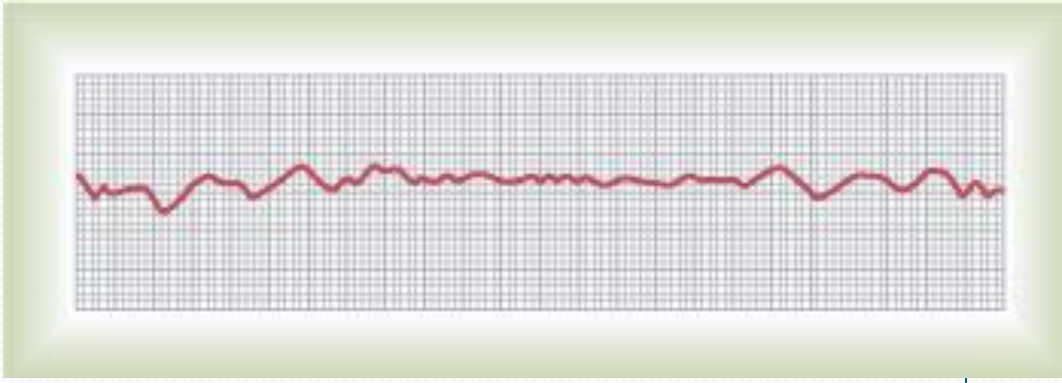
→The ventricle escape from the influence of S-A node

- *Stokes-Adams Syndrome*: AV block comes and goes



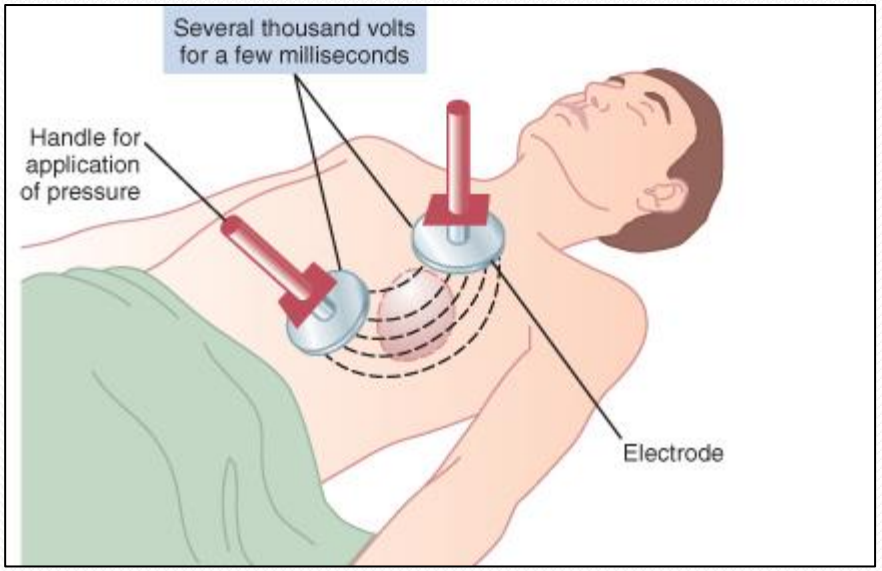
# Ventricular Fibrillation

- The most serious of all arhythmias
- Cause: impulses stimulate one part of the ventricles, then another, then itself. Many part contracts at the same time while other parts relax *(Circus movement)*
  - Tachycardia
  - Irregular rhythm
  - Broad QRS complex
  - No P wave
- *Treatment : DC shock*



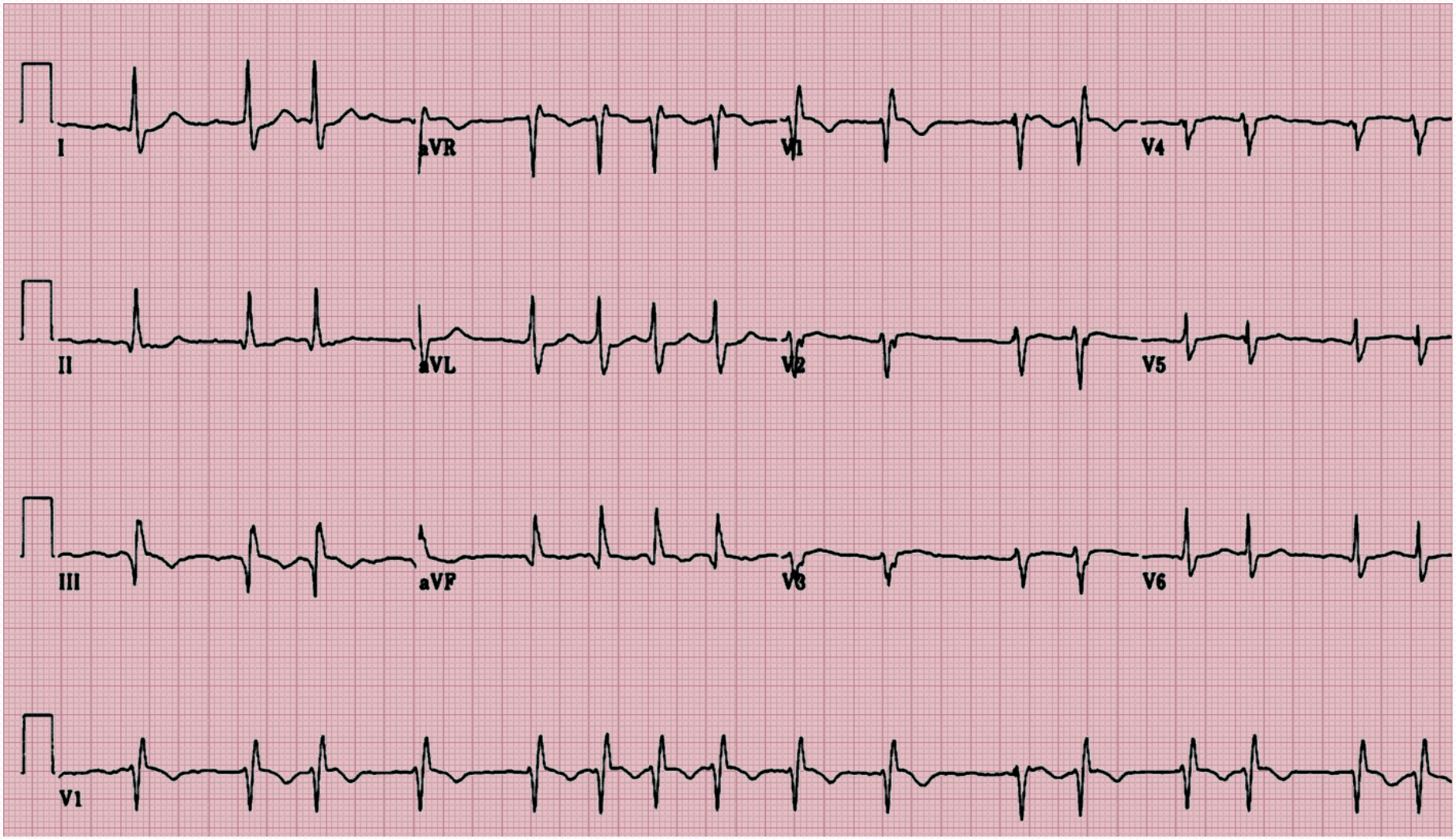
# Ventricular Fibrillation

- *Treatment : DC shock*



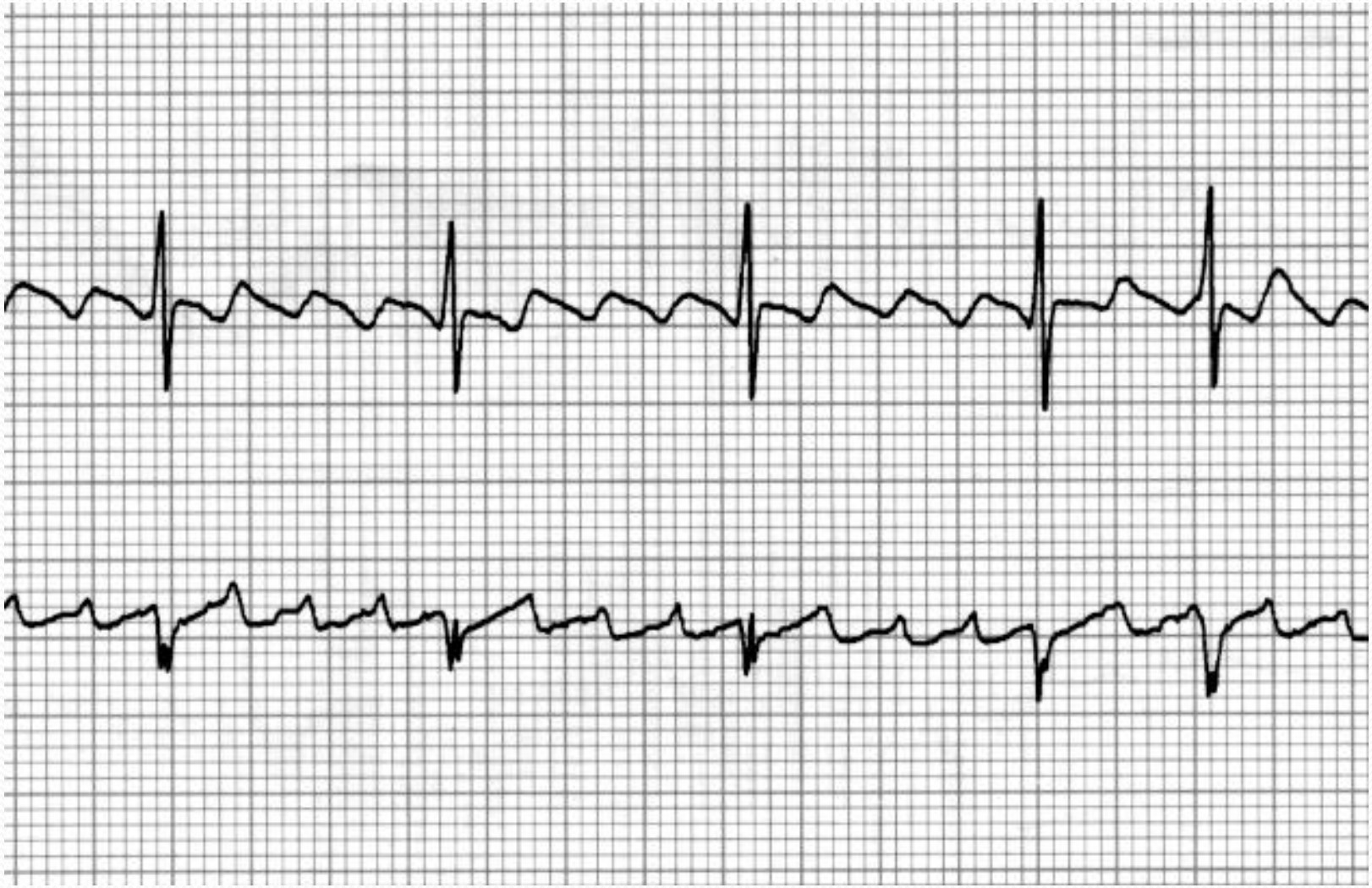
# Atrial Fibrillation

- Cause: as ventricular fibrillation
- It occurs more frequently in patients with *enlarged heart*
- The atria do not pump if they are fibrillating
- The efficiency of ventricular pumping is decreased 20 to 30%
- A person can live for years with atrial fibrillation


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1

# Atrial Flutter

- A single large wave travels around and around in the atria
- The atria contracts at high rate (250 time per minute)

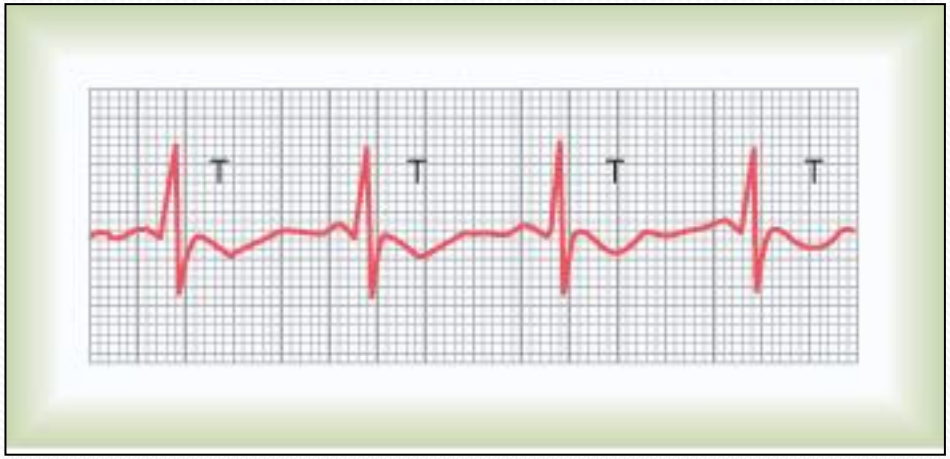


# Ischemia and the ECG

- One of the common uses of the ECG is in acute assessment of chest pain
- Cause: restriction of blood flow to the myocardium, either:
  - Reversible: angina pectoris
  - Irreversible: myocardial infarction
- ***Ischemia → injury → infarction***

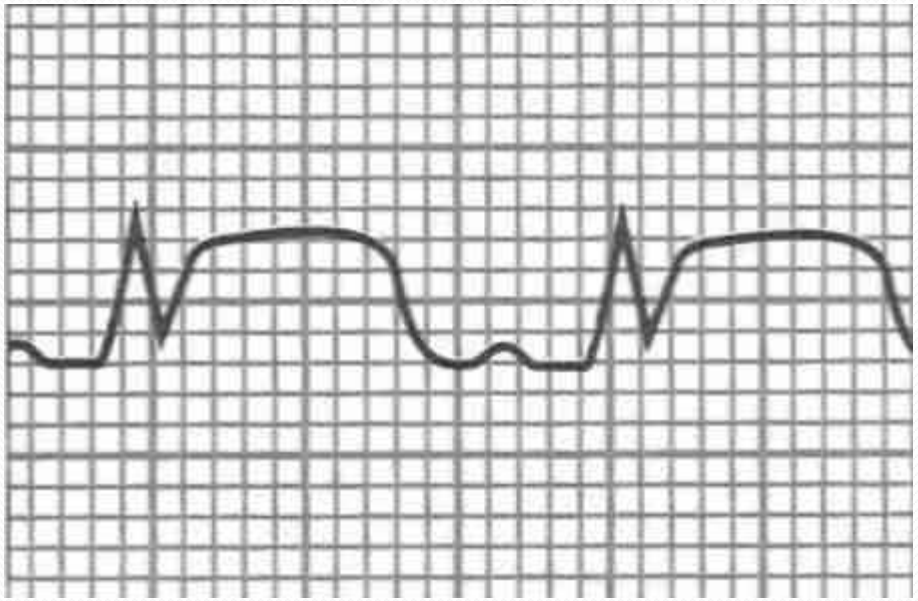
# Reversible ischemia

- *Inverted T wave*
- *ST segment depression*

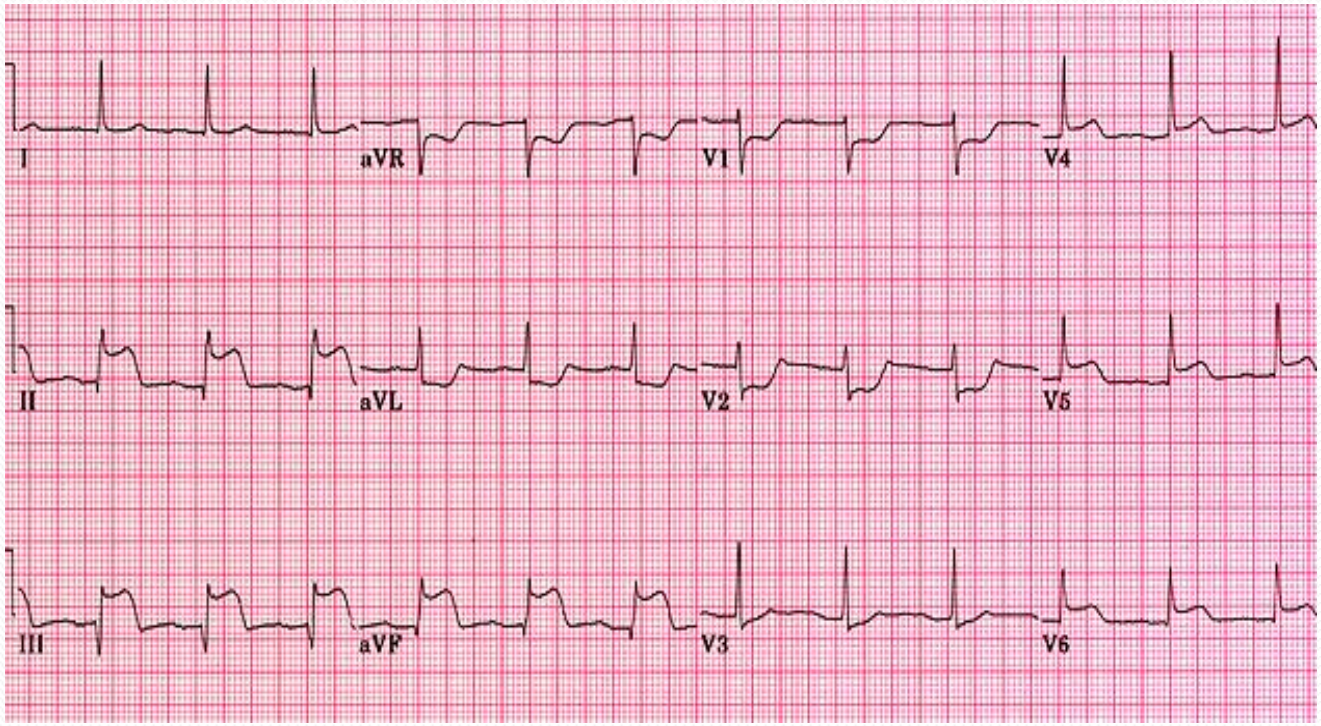


# Myocardial Infarction

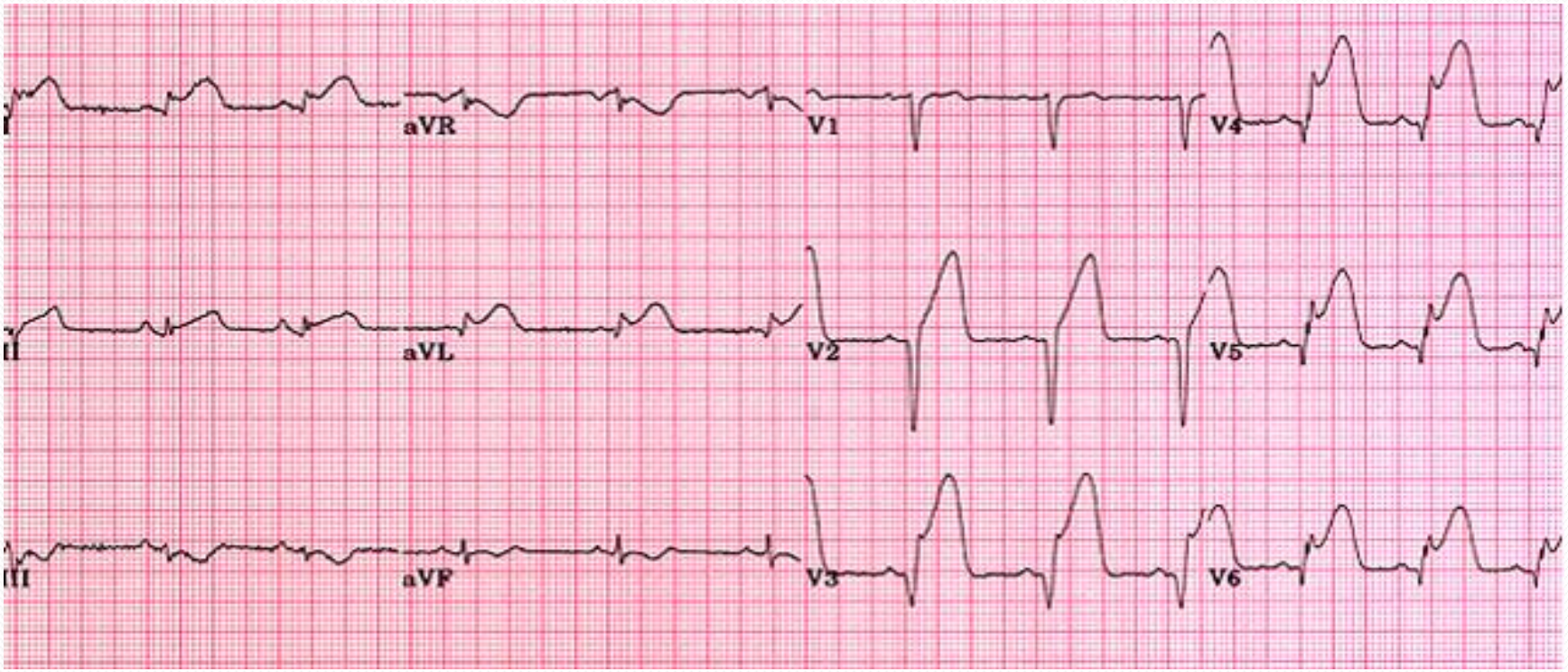
- Complete loss of blood supply to the myocardium resulting in necrosis or death of tissue
  - *ST segment elevation*
  - *Deep Q wave*



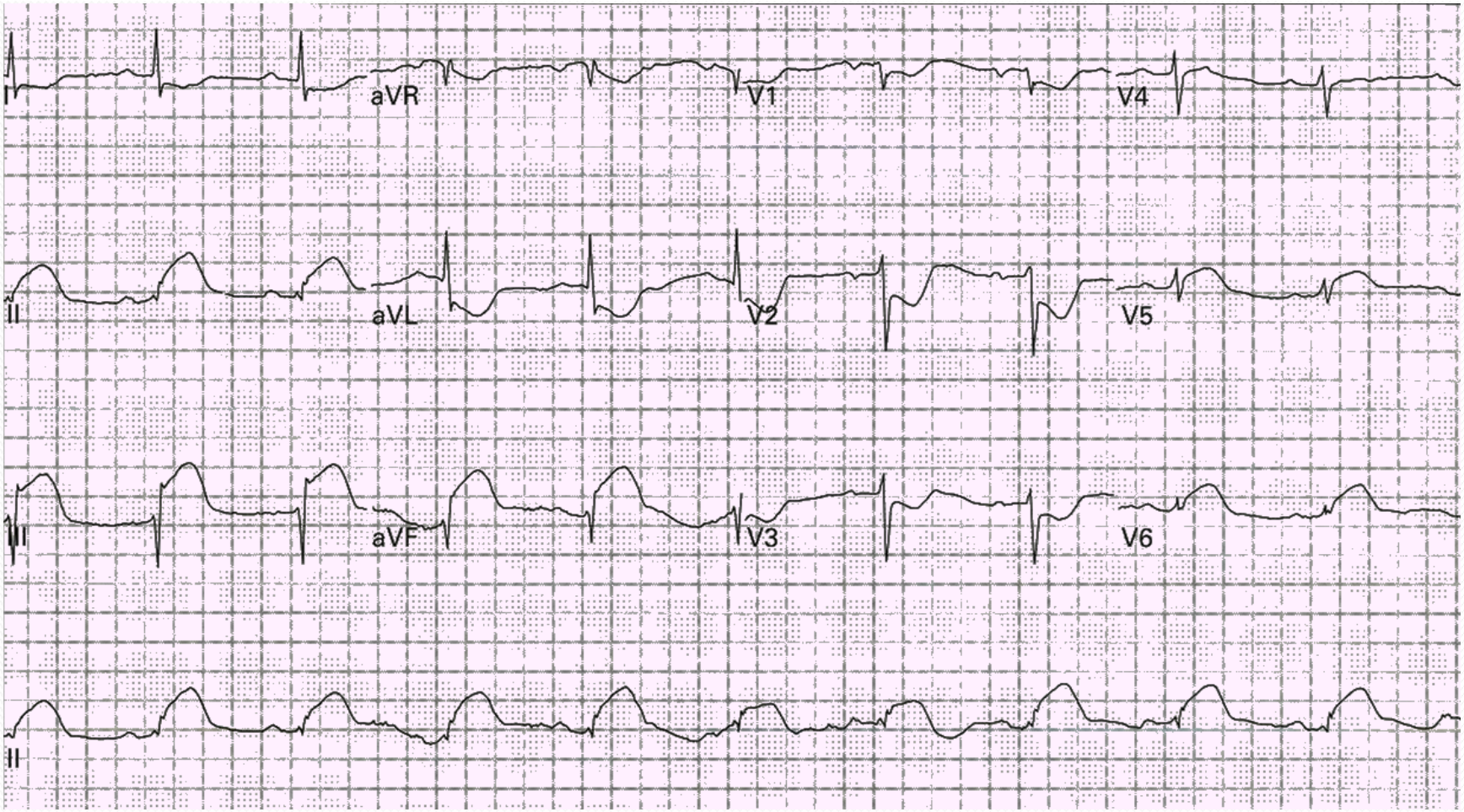
# Infero-Posterior MI



# Antero-Lateral MI

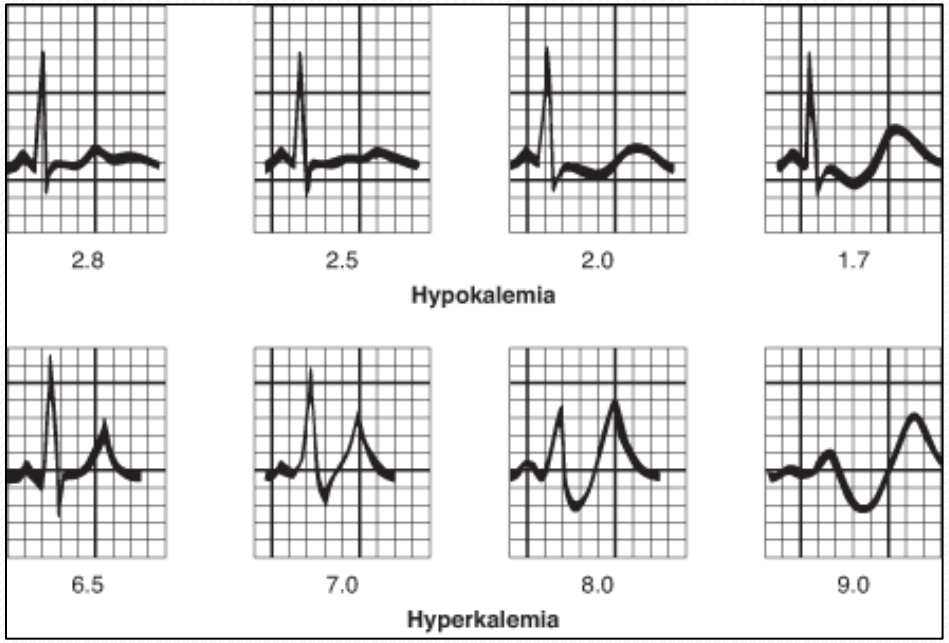


# 57 year-old man with chest pressure and diaphoresis



# Potassium and the ECG

- Hypokalemia:
  - flat T wave
- Hyperkalemia:
  - Tall peaked T wave



## For further readings and diagrams:

**Textbook of Medical Physiology by Guyton & Hall**

Chapter 10 (Cardiac Arrhythmias and their Electrocardiographic Interpretation)