Department of Anesthesia Techniques

Title of the lecture: ECG II

Dr. Mohammed Sami

Mohammed.sami.hasan@uomus.edu.iq

Cardiac Cycle

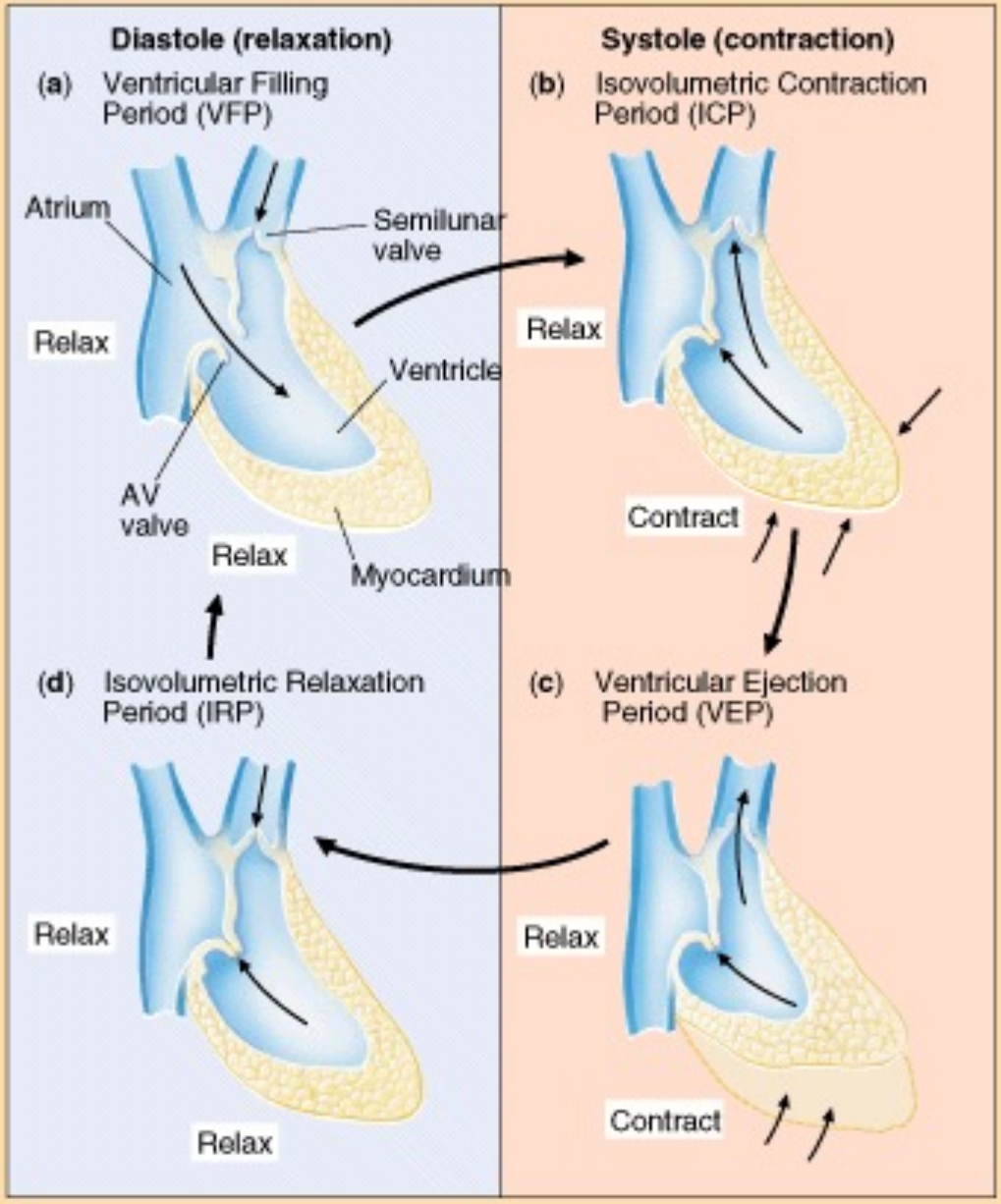
Cardiac Cycle: the electrical, pressure and volume changes that occur in a functional heart between successive heart beats.

- ***Diastole:*** Phase of the cardiac cycle when myocardium is **relaxed**
- ***Systole:*** Phase of the cardiac cycle when the myocardium **contracts**
- ***Atrial systole***: when atria contract.
- ***Ventricular systole***: when ventricles contract.

Mechanical Events of the Cardiac Cycle

1. **Ventricular Filling** [ventricular diastole, atrial systole]
2. **Isovolumetric Contraction** Period [ventricular systole]
3. **Ventricular Ejection Period** [ventricular systole]
4. **Isovolumetric Relaxation** Period [ventricular diastole, atrial diastole]

► Periods of the Cardiac Cycle



Cardiac Cycle

- Electrical changes in heart tissue cause mechanical changes, i.e. muscle contraction.
- changes in electrical membrane potential of specific parts of the heart tissue represent mechanical events in specific areas of the heart tissue.

Electrocardiography

- Two common abbreviations for electrocardiogram: **EKG and ECG**.
- EKG comes from German language where cardiogram is written as kardiogram.
- The ECG records the electrical activity of the heart.
- Mechanical activity of the heart is sensed by **Echocardiography**.

Electrocardiography

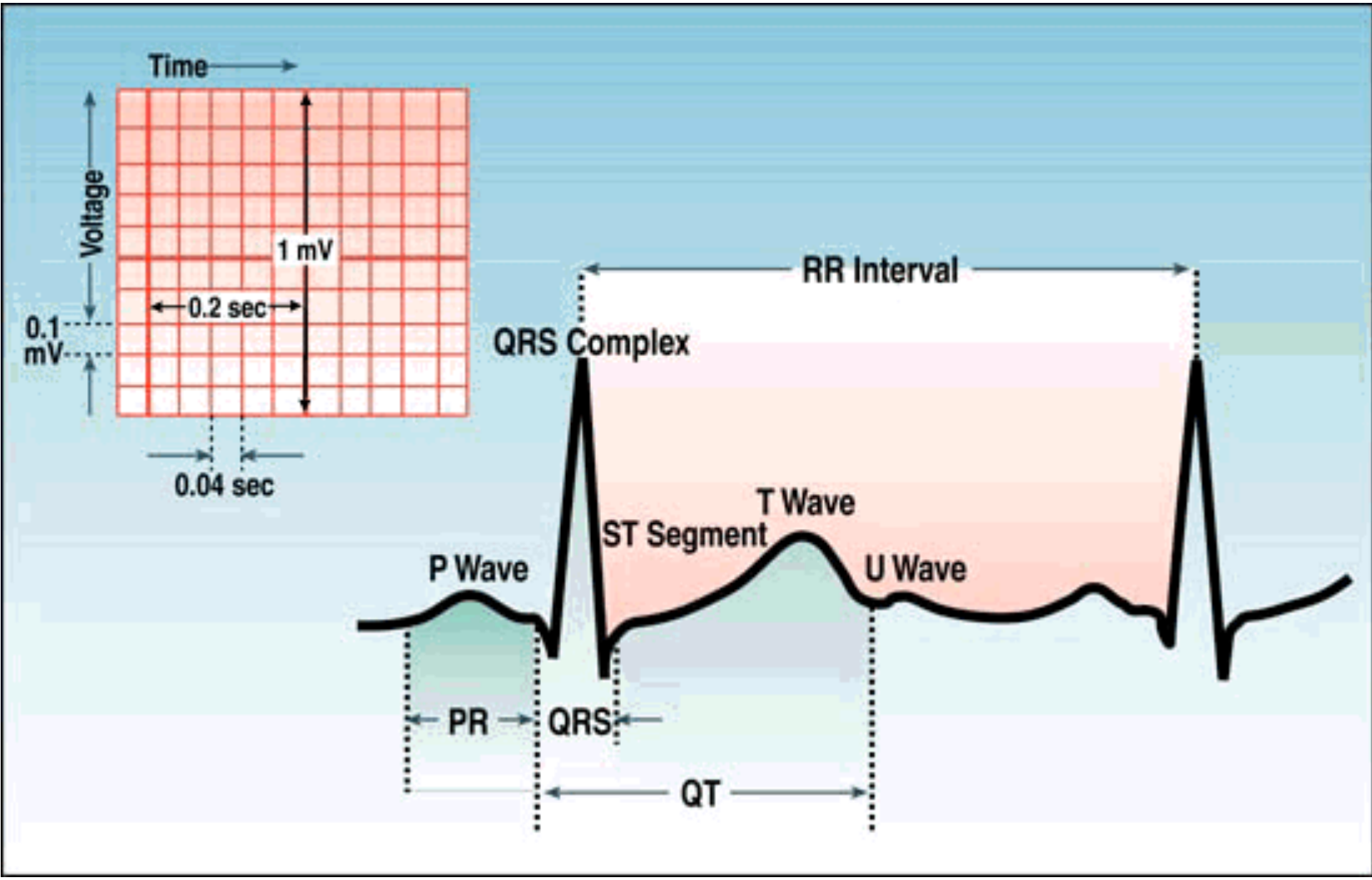
ECG - electrocardiogram

- graphic recording of electrical events

- When myocardial muscle is completely polarized or depolarized, the ECG will not record any electrical potential but rather a flat line, ***isoelectric line***.
- After depolarization, myocardial cells undergo repolarization to return to electrical state at rest.

ECG Time & Voltage

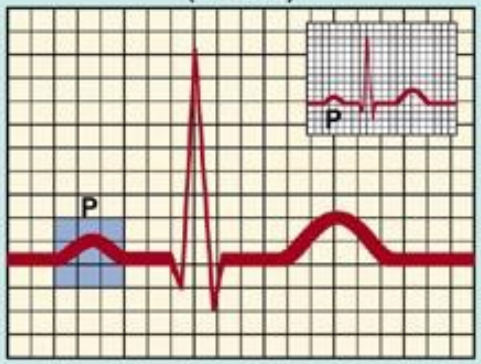
- ECG machines can run at **50 or 25 mm/sec.**
- **Major grid lines are 5 mm** apart; at standard 25 mm/s, 5 mm corresponds to 0.2 seconds.
- **Minor lines** are 1 mm apart; at standard 25 mm/s, 1 mm corresponds to 0.04 seconds.
- Voltage is measured on vertical axis.
- Standard calibration is 0.1 mV per mm of deflection.


Time
Voltage
1 mV
0.2 sec
0.1 mV
0.04 sec
RR Interval
QRS Complex
T Wave
ST Segment
P Wave
U Wave
PR
QRS
QT

Electrocardiogram

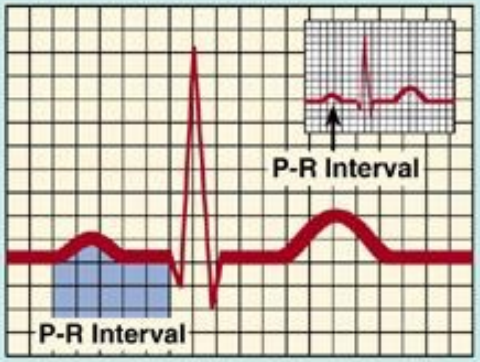
- Normal **P** wave has amplitude of ≤ 0.25 mV
- **Q** wave is first downward deflection after P wave= ***start of ventricular depolarization***
- **R** wave is positive deflection after Q wave
- **S** wave is negative deflection preceded by Q or R waves
- **T** wave follows QRS

Atrial Depolarization (P-wave)



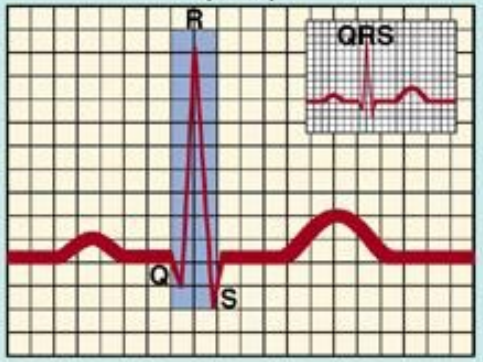
The depolarization of both atria is represented by the P-wave. The P-wave is the first ECG deflection.

P-R Interval



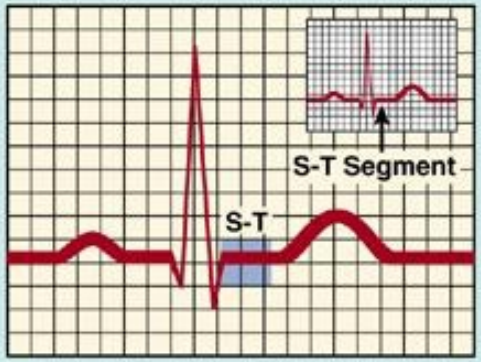
Electrical transmission from the atria to the venticles. Includes the P-wave and P-R Segment.

Ventricular Depolarization (QRS)



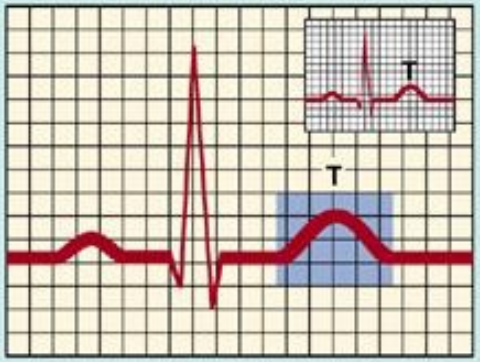
Ventricular depolarization is indicated by the QRS complex. The R-wave is the initial positive deflection; the negative deflection before the R-wave is the Q; the negative deflection after the R-wave is the S-wave.

Ventricular Repolarization (S-T Segment)



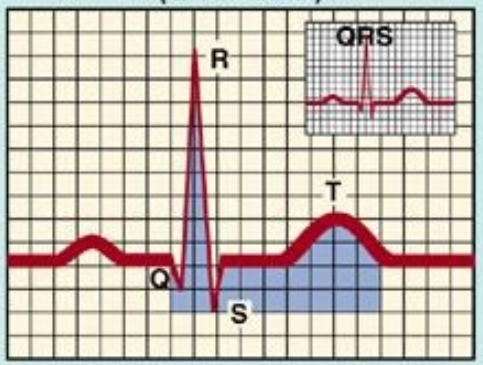
Earlier phase repolarization of both ventricles extends from the end of the QRS to the beginning of the T-wave. The point at which the S-T segment joins the QRS is known as the J (junction)-point.

Ventricular Repolarization (T-wave)

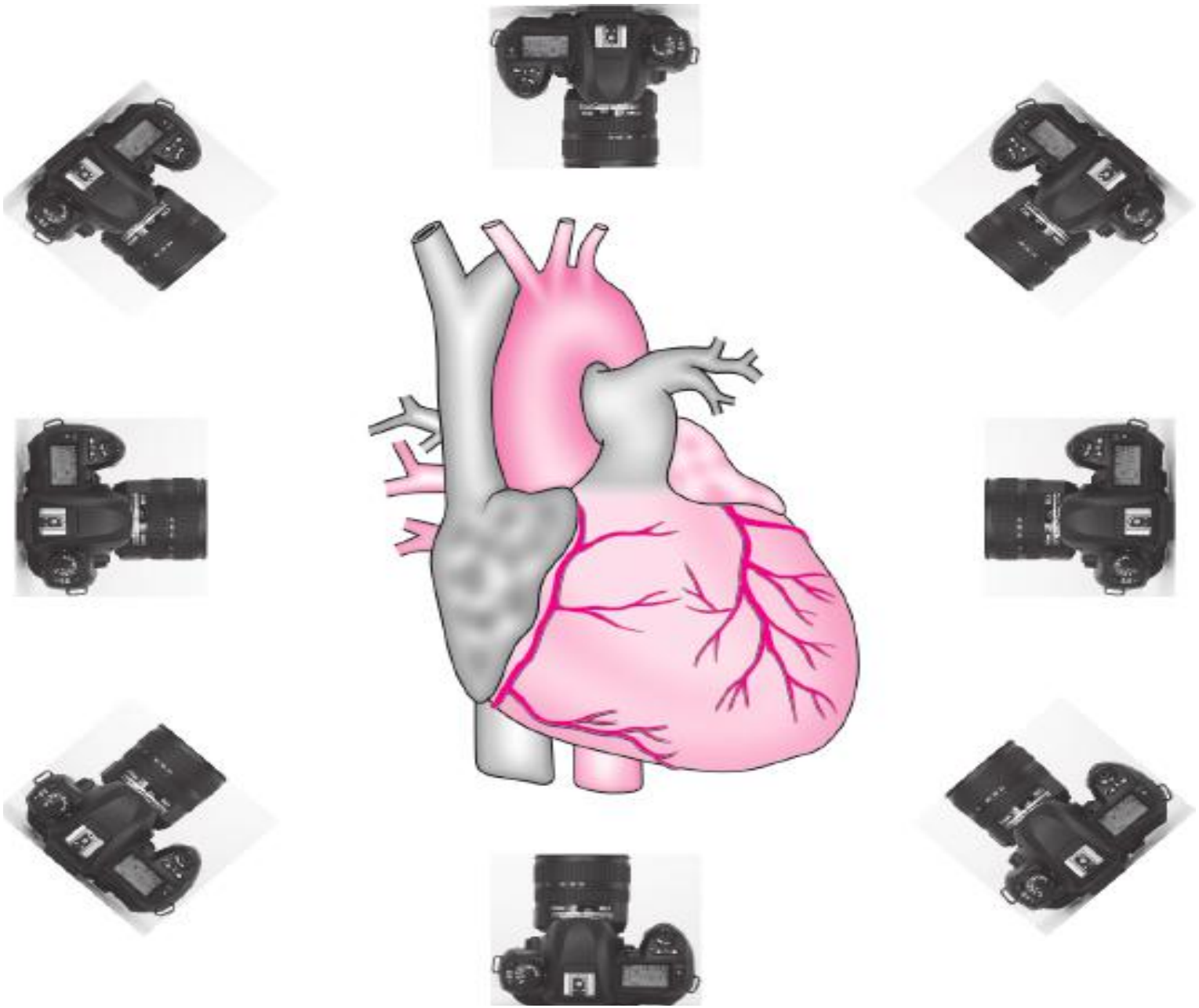


The repolarization of both ventricles is represented by the T-wave. The S-T segment and the T-wave are sensitive indicators of the oxygen demand-oxygen supply status of the ventricular myocardium.

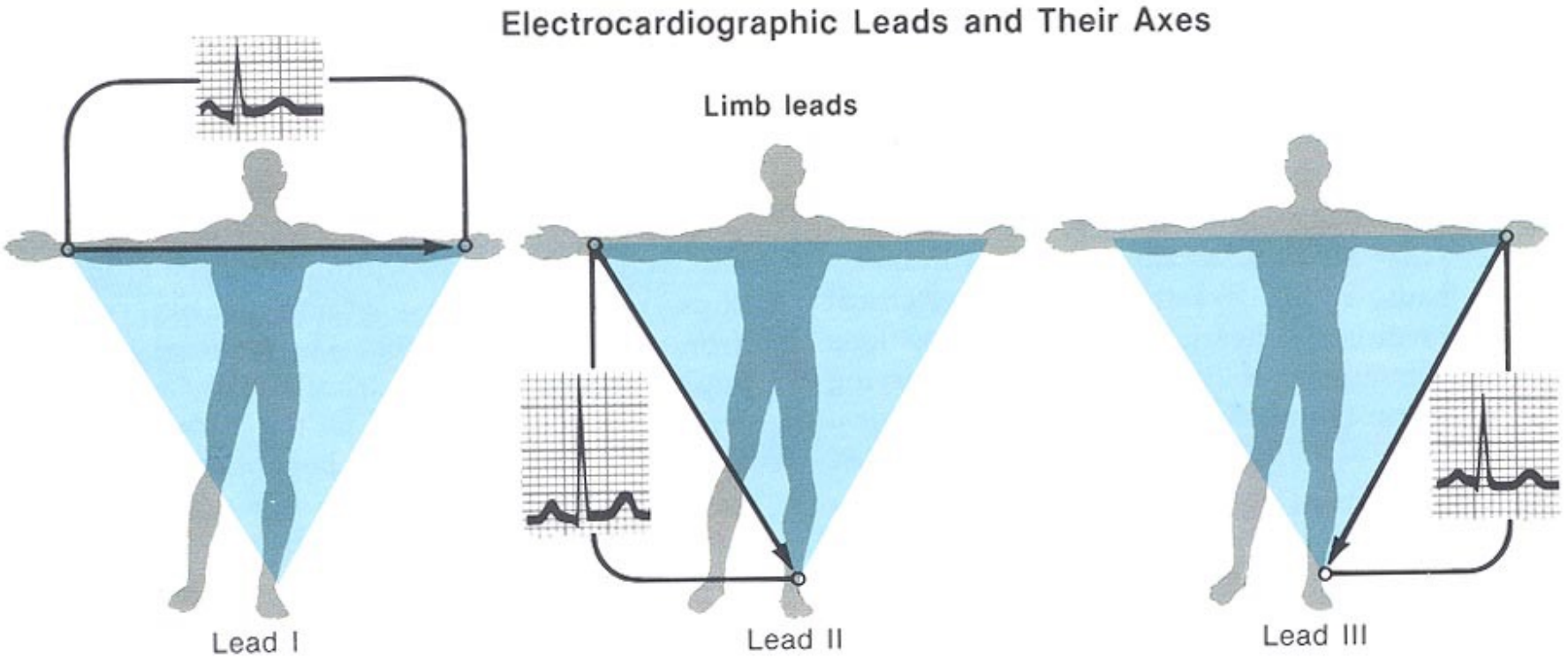
Ventricular Depolarization and Repolarization (Q-T Interval)



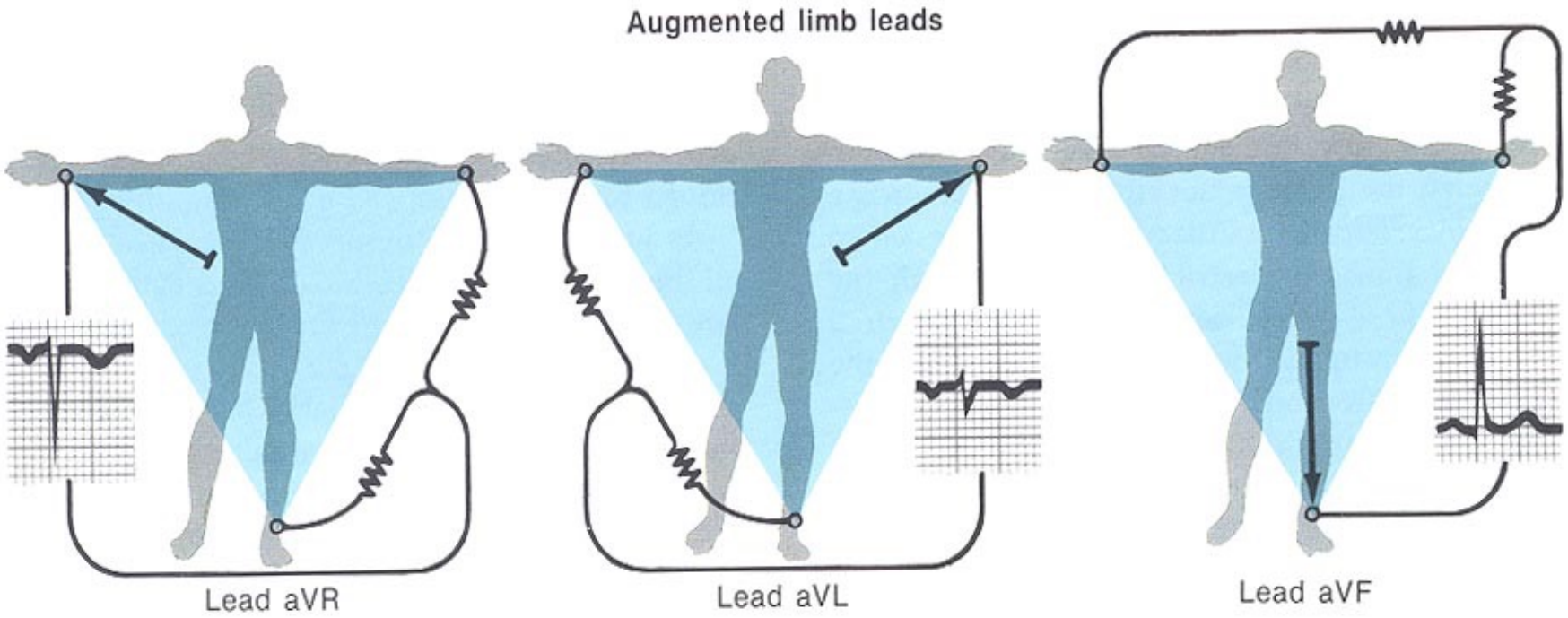
Includes the QRS complex, S-T segment, and T-wave.



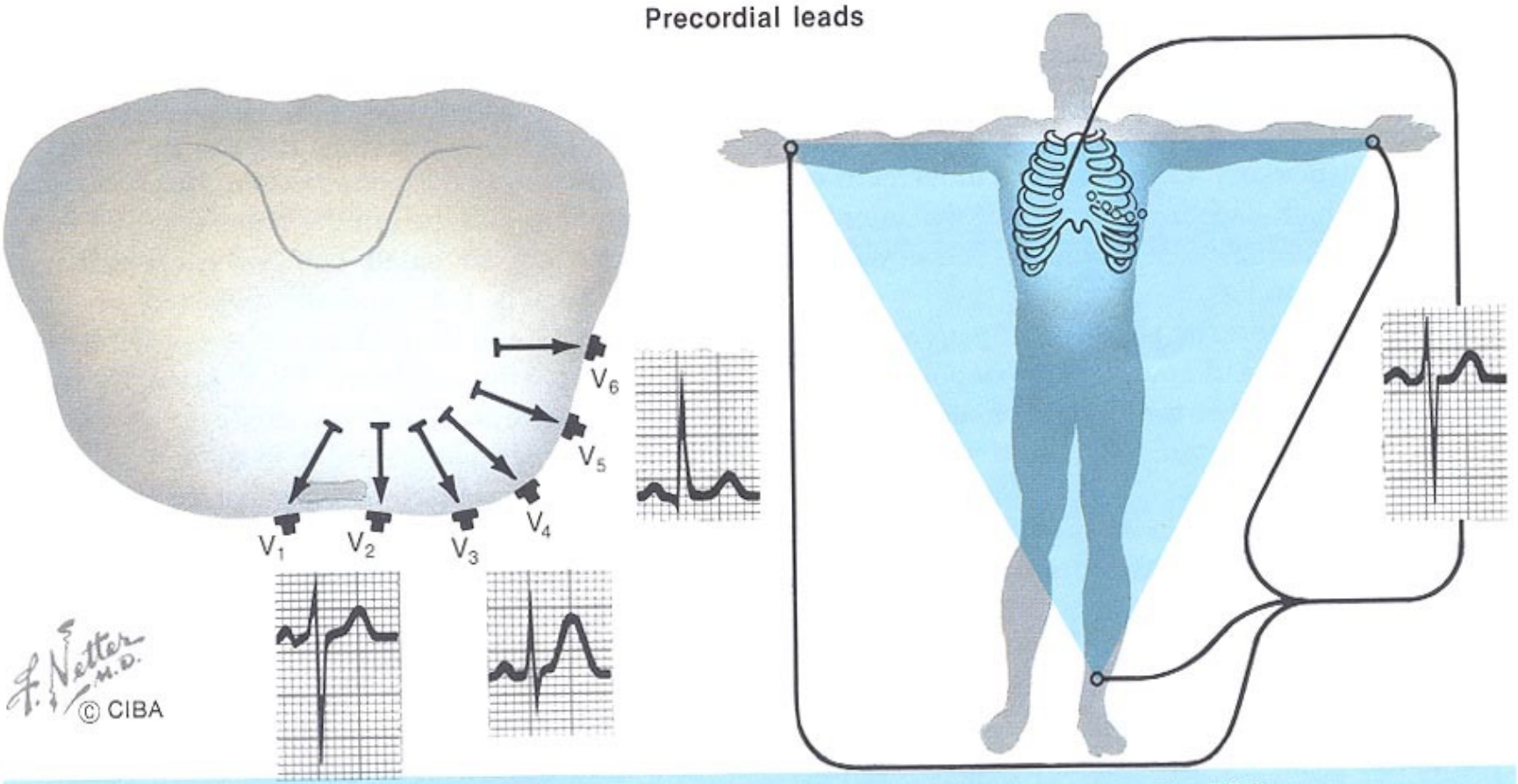
ECG Limb Leads



ECG Augmented Limb Leads



ECG Precordial Leads

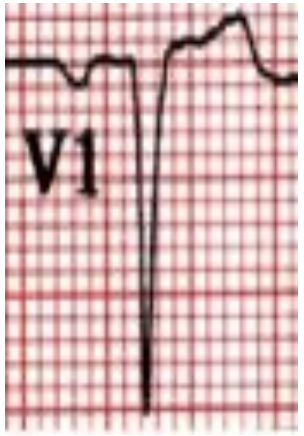


When current flows toward arrowheads (axes), upward deflection occurs in ECG
When current flows away from arrowheads (axes), downward deflection occurs in ECG
When current flows perpendicular to arrows (axes), no deflection occurs

12-Lead ECG

- Limb lead II shows large R because left ventricle current vector lies parallel with electrode placement.

- Chest lead V_1 has large S wave because left ventricle current vector is directed away from electrode.



Interpretation of ECG:
Rate

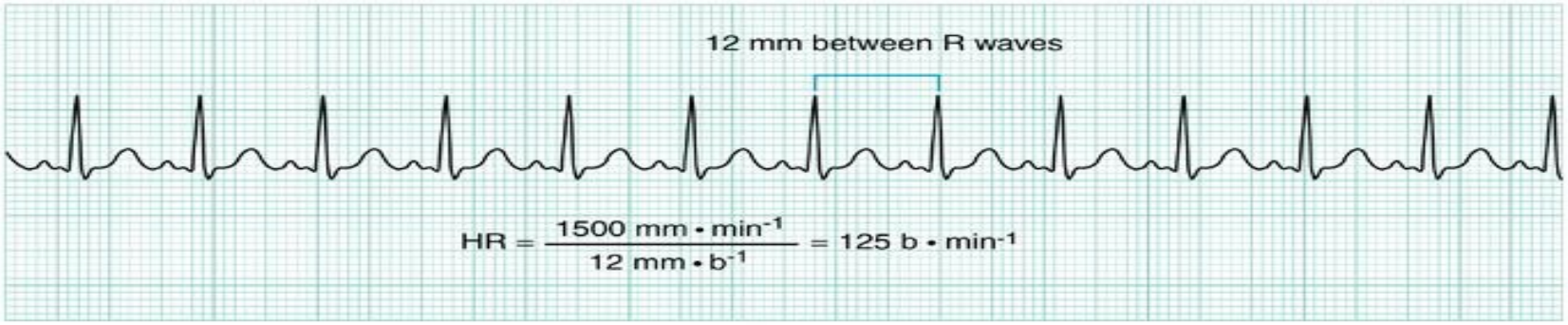
First measurement to calculate is heart rate. PQRST waves represent one complete cardiac cycle.

1. At standard paper speed, divide 1500 by distance between R to R waves.
2. Find R wave Count for each following line. Where next R lands is quick estimate.
3. Multiply number of cycles in 6 second marks by 10.

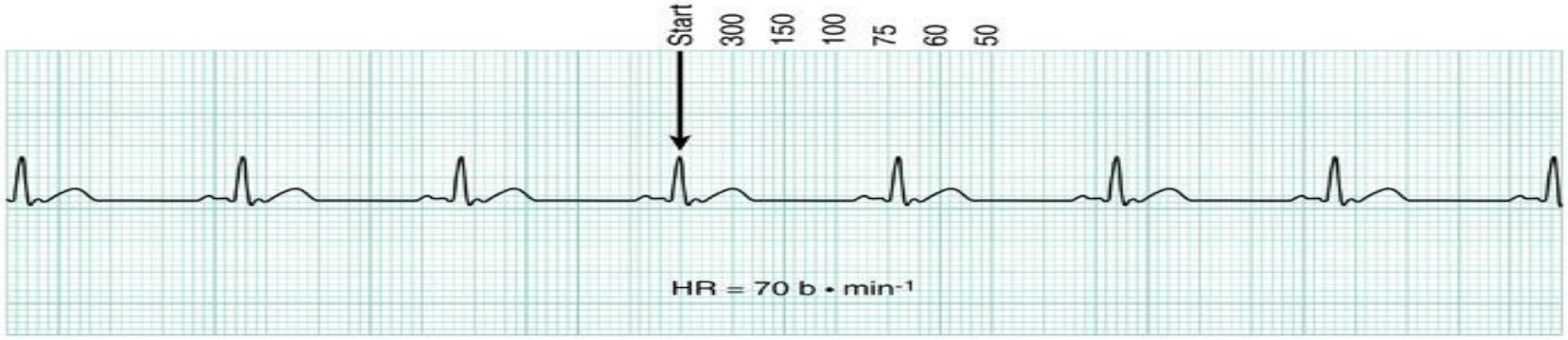
Interpretation of ECG:

Rate

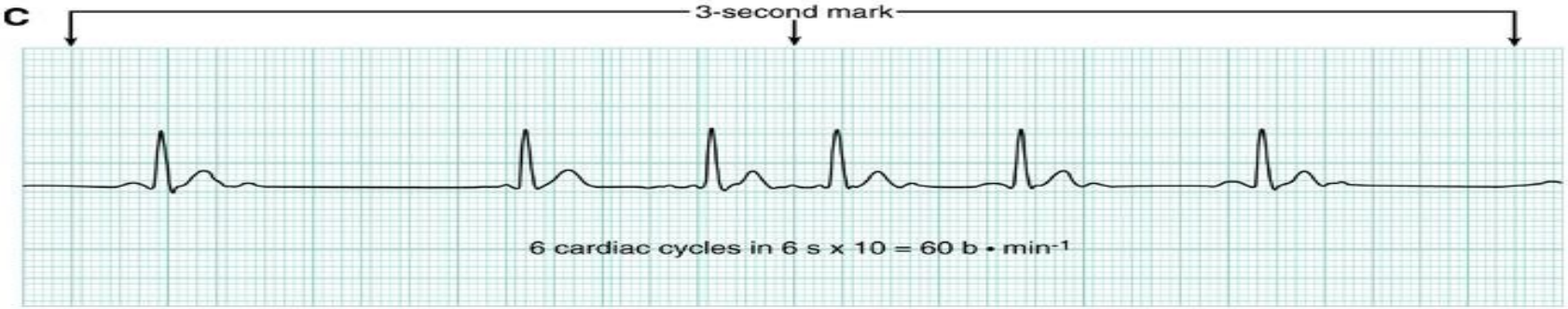
A



B

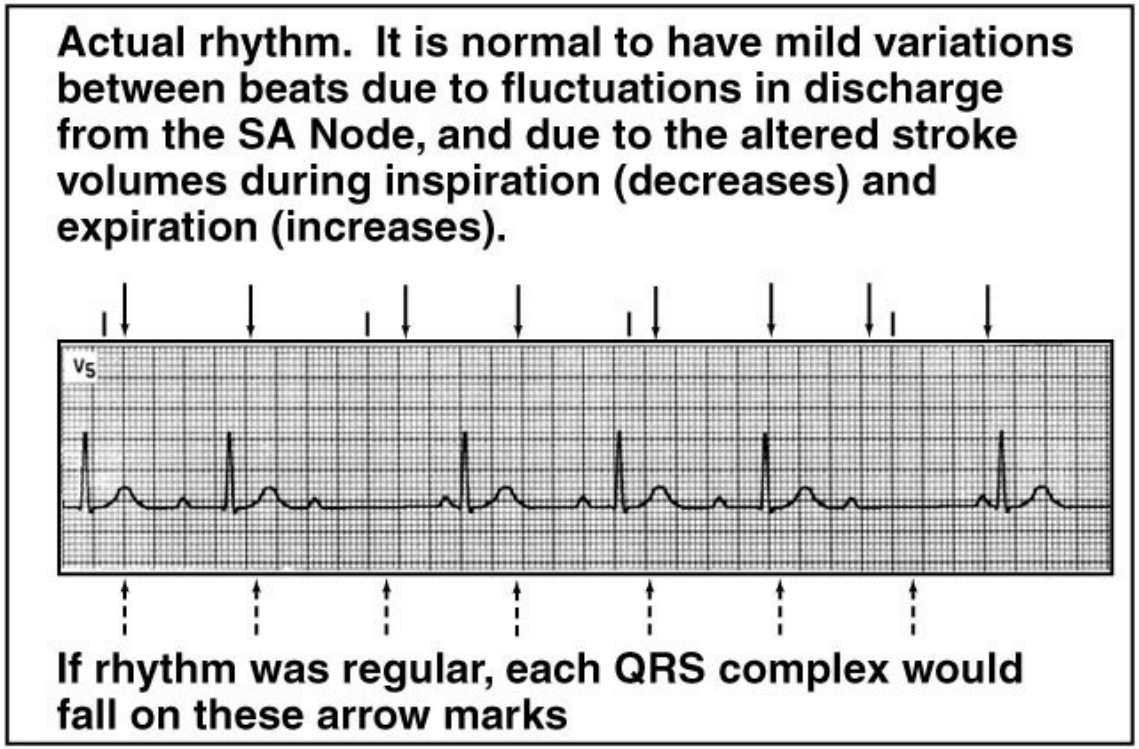


C



Interpretation of ECG:
Rhythm

- Normal heart rhythm has consistent R-R interval.
- Mild variations due to breathing also normal.



Interpretation of ECG: Rhythm

Normal Sinus Rhythm

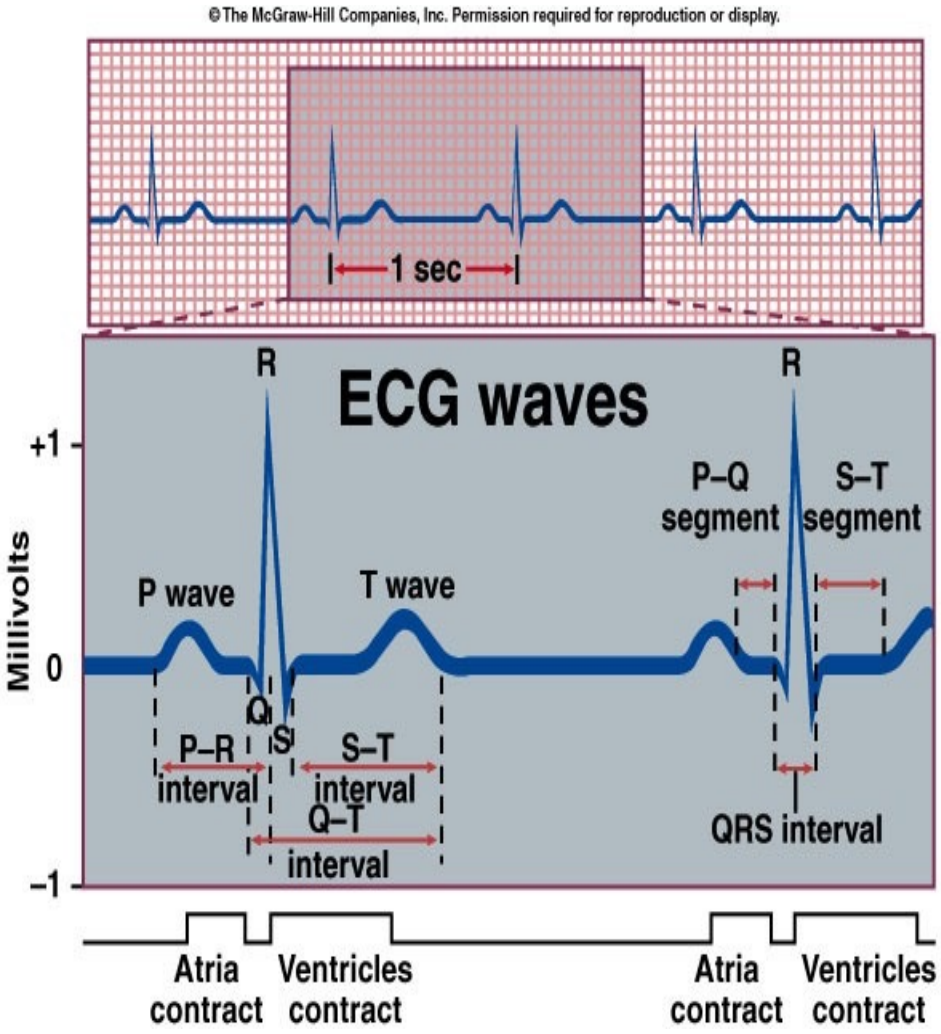
- Rate: 60-100 b/min
- Rhythm: regular
- P waves: upright in leads I, II, aV_F
- PR interval: < .20 s
- QRS: < .10 s

Sinus Bradycardia

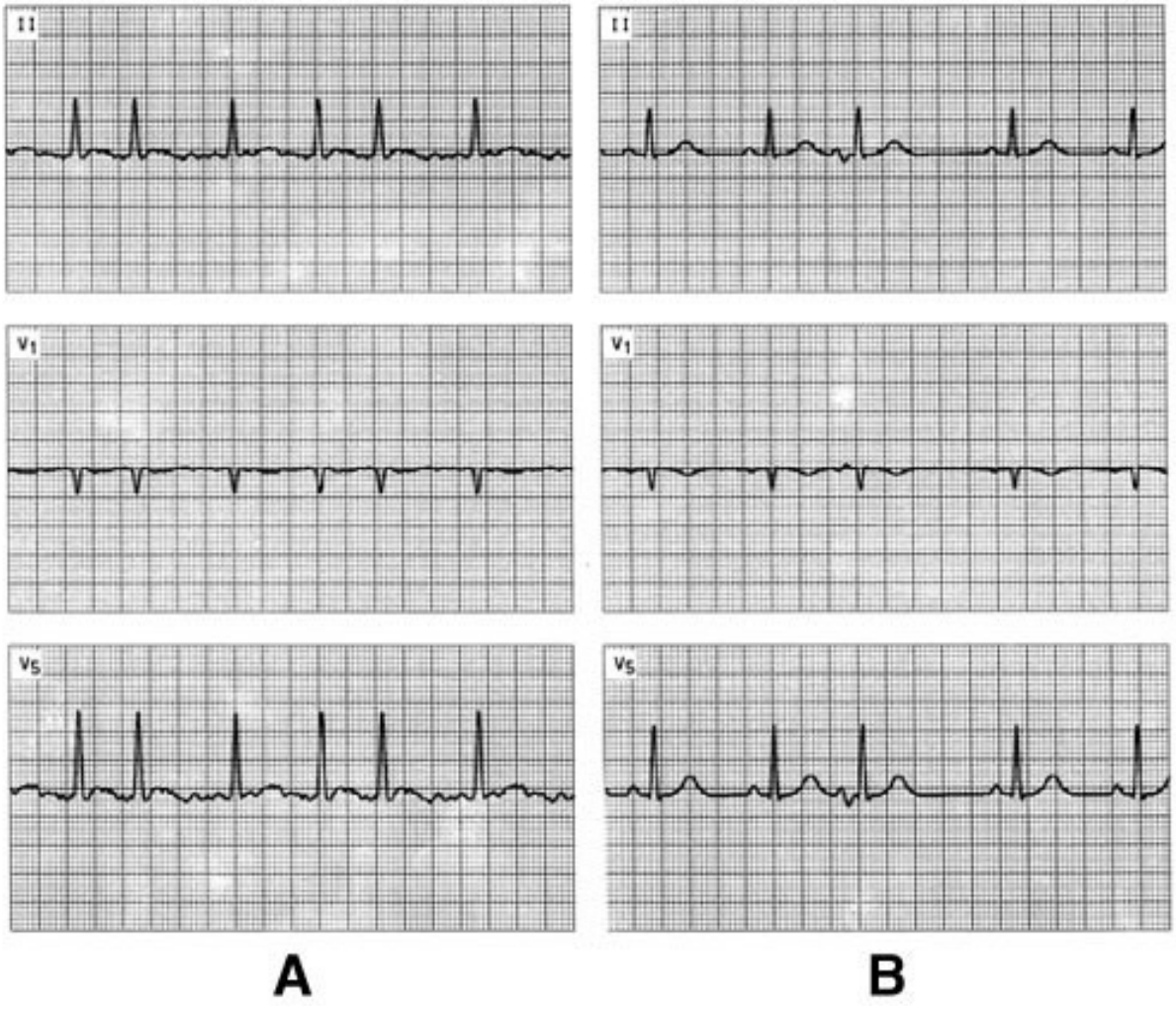
- Rate: < 60 bpm
- Rhythm: regular

Sinus Tachycardia

- Rate: > 100 bpm

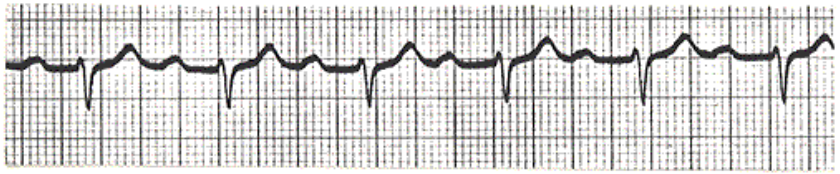


Irregular ECGs

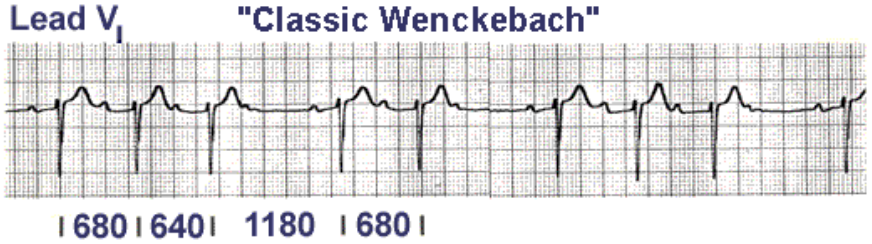


AV Conduction Disturbances

- Atrioventricular conduction disturbances refer to blockage of electrical impulse at AV node.
  - 1st degree P waves result in delayed QRS.
  - 2nd degree some but not all P waves have QRS.



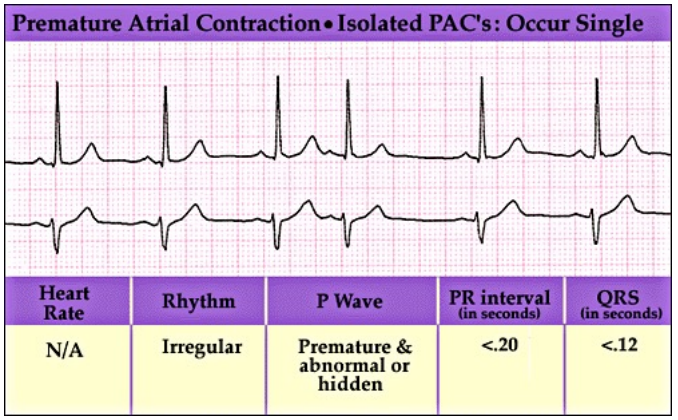
1st degree AV block (PR = 280 ms)

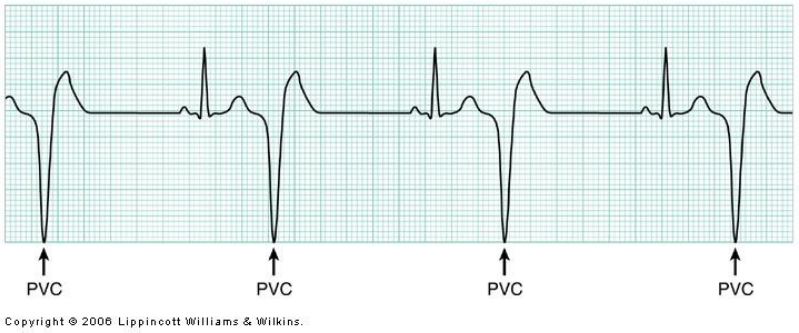


Arrhythmias

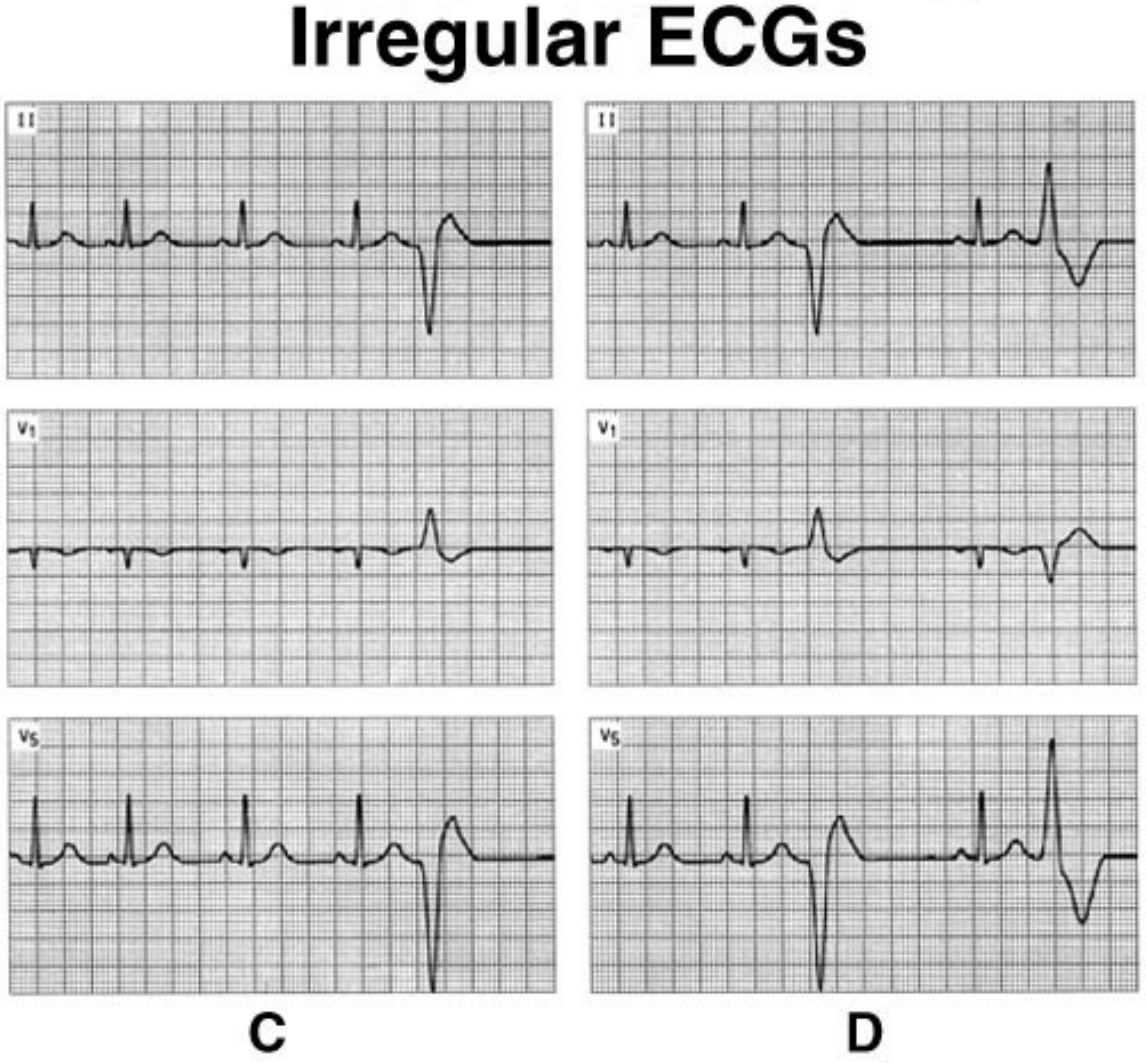
Arrhythmia: an irregular heartbeat.

- Sinus arrhythmia- P wave precedes QRS but RR interval varies.
- Premature Atrial Contraction (PAC)
- Premature Ventricular Contraction (PVC)

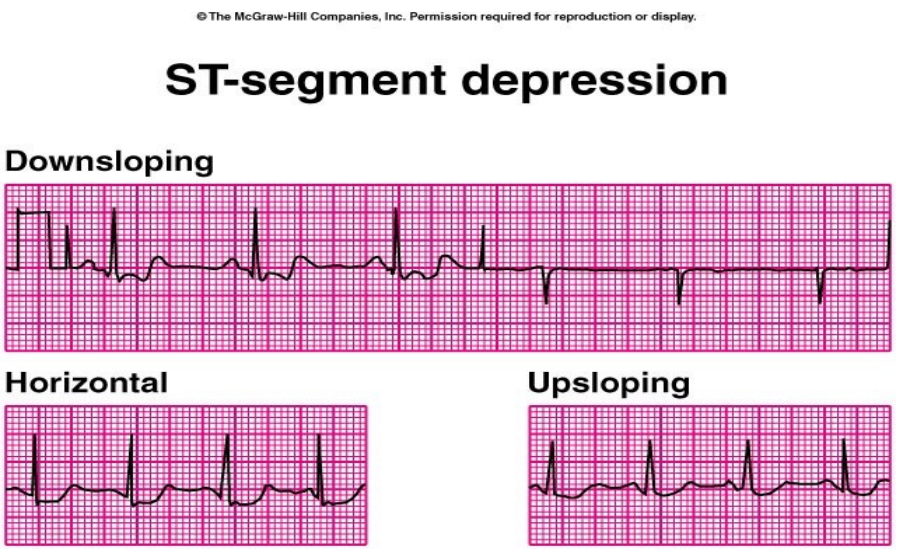


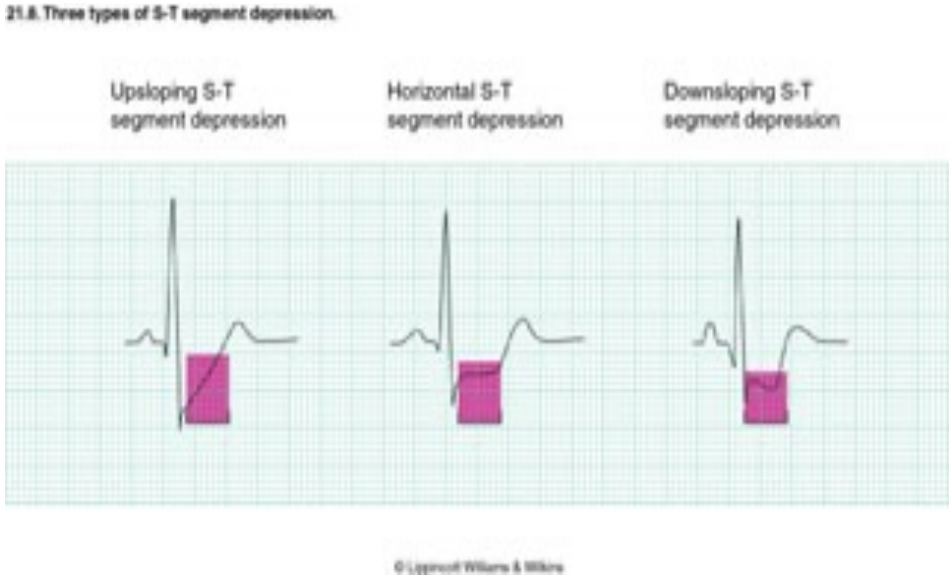


Arrhythmias



Myocardial Ischemia





ST segment depression.

- Hallmark of myocardial ischemia.
- Reduction of oxygen-rich blood supply alters normal cellular action causing ST segment displacement ≥ 1 mm below line.
- Upsloping, horizontal, downsloping

SYSTEMATIC INTERPRETATION GUIDELINES FOR ELECTROCARDIOGRAM

1. Look for standardization and lead aVR
2. Rate
3. Rhythm
    I. Regular
    II. Irregular
4. Axis
    I. Normal
    II. Right axis deviation
    III. Left axis deviation
5. P wave morphology
    I. P-Mitrale
    II. P-Pulmonary
6. P-R interval
    I. First degree heart block
    II. Second degree heart block
    III. Third degree heart block
7. ST segment and T wave abnormality
    I. S-T segment elevation
    II. S-T segment depression
    III. T wave inversion
8. Hypertrophy
    I. Left ventricular hypertrophy
    II. Right ventricular hypertrophy
9. Bundle branch block
    I. Right bundle branch block
    II. Left bundle branch block.