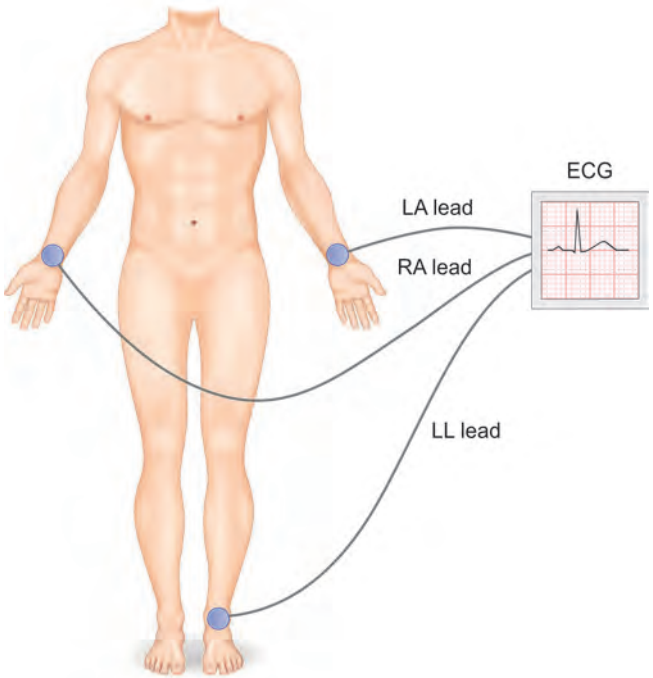
# Contents

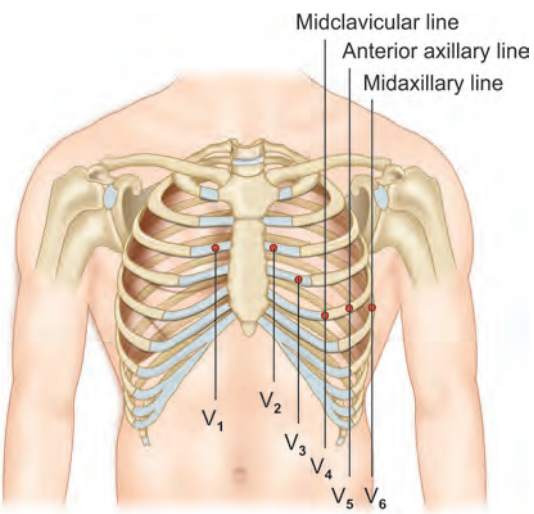
# CHAPTER 1

# Basic Concepts of ECG

"Workout the best method for examination and practice it until it is a second nature to you"




**Standard leads**




**Chest leads**

## SPECIALIZED CONDUCTIVE SYSTEM OF THE HEART

There are five specialized tissues which are called conductive system of the heart. These are:

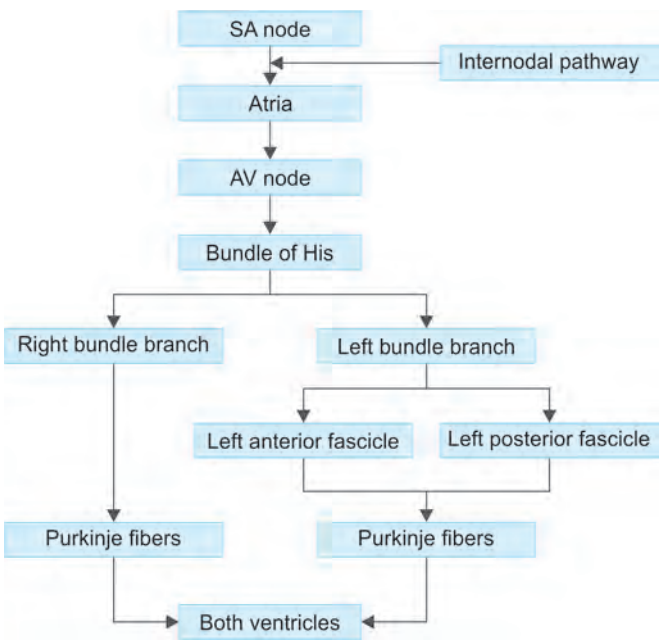
- Sinoatrial (SA) node
- Atrioventricular (AV) node
- Bundle of His
- Right bundle branch (RBB) and left bundle branch (LBB)
- Purkinje fibers

These specialized conductive pathways allow the heart to be electrically activated in a predictable manner (see the sequence below).

The electrical activity or the impulse of the heart starts in the SA node (which is called primary pacemaker), then spreads across the atria (by three internodal pathways and Bachmann's bundle), causing depolarization of both atria. From the atria, the impulse reaches the AV node, where there is some delay, which allows atria to contract and pump blood into the ventricles. The impulse then spreads along the bundle of His, then along the LBB and RBB, finally into the ventricular muscles through Purkinje fibers, causing ventricular depolarization.

Initially, the ventricular septum is depolarized and moves from left to right, then depolarization is of body of the left ventricle, and finally the right ventricle.

**Sequence of impulse formation and conduction**




(SA: sinoatrial; AV: atrioventricular)

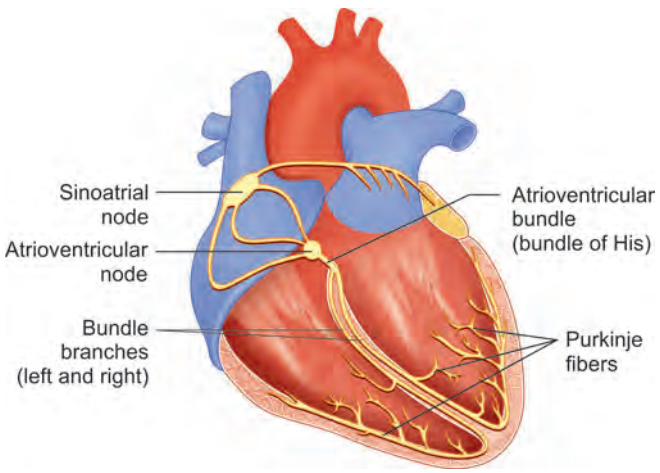
This is the normal sequence of stimulation of the specialized tissue. Normal rhythm is called sinus rhythm. The way electrical impulse flows through the heart is called conduction. If abnormalities of electrical activity of the heart or if any disturbance of this sequence occur, there is rhythm disturbance, which is called arrhythmia, or if there is any abnormality of conduction, it is called heart block. Any changes of normal flow of electricity through the heart can be detected by electrocardiogram (ECG) tracing and may indicate damaged cardiac muscle or any abnormality.

Sinoatrial node is the dominant pacemaker. Other pacemaker sites in the heart are atria, AV node, and ventricles. All these are dormant, but can initiate impulse at a slow rate when SA node fails.

## ANATOMY OF CONDUCTIVE TISSUE

1. *SA node*: It is located in the superior and right side of right atrium, near the root of superior vena cava. Normally, the impulse arises in the SA node, called sinus rhythm. From the SA node, the impulse spreads along three internodal pathways (anterior, middle, and posterior) into both right and left atria. Finally, these three internodal pathways enter into the AV node. There is an additional internodal pathway, called Bachmann's bundle, which transmits impulse to the left atrium.
   Normal rate in SA node is 60–100/min.
2. *AV node*: The AV node is smaller than the SA node. It is located in the subendocardial surface of right side of right atrium, at the posterior part of interatrial septum, near the opening of coronary sinus, just above the tricuspid valve. If the SA node is blocked or fails, the AV node can initiate cardiac impulse and perform as a pacemaker. Normal rate of the AV node is 40–60/min. According to the electrical response, the AV node is divided into three parts:
   - High nodal (AN region)
   - Mid nodal (N region)
   - Low nodal (NH region)

   In ECG, these three regions can be detected by looking at the configuration of "P" wave (see details on page no. 17).
3. *Bundle of His*: It is the extension of the tail of the AV node that extends downward and to the left, then enter into the interventricular septum, near the junction of muscles and fibrous part of ventricular septum. Then, it is divided into two branches: Right and left bundle branches.
   When there is AV block, bundle of His can initiate cardiac impulse and perform as a pacemaker. Normal rate of bundle of His is 20–40/min.
4. *Right bundle branch*: It extends on the right side of interventricular septum and spreads into the right ventricle through Purkinje fibers.
5. *Left bundle branch:* It divides into anterior and posterior fascicles. Anterior fascicle spreads into the anterosuperior part of the left ventricle. Posterior fascicle spreads into the posteroinferior part of the left ventricle, through Purkinje fibers.
6. *Purkinje fibers*: These are the terminal network of fibers, diffusely spread into the ventricular muscles in subendocardial and subepicardial myocardium. Normal intrinsic rate of Purkinje fibers is 15–40/min.



**Conduction system**

**NB:** Most specialized cardiac fibers contain large number of automatic cells. But atrial and ventricular muscles fibers, under normal condition, have no automatic activity.

# CORONARY CIRCULATION

There are two major coronary arteries: (1) Right and (2) left.

## 1. Right Coronary Artery

It arises from the right coronary sinus of Valsalva, runs along the right AV groove, and gives marginal branch that supplies right atrium and right ventricle. It continues as posterior descending artery, which runs in the posterior interventricular groove and spreads into the posterior part of interventricular septum and inferoposterior aspect of the left ventricular wall.

Right coronary artery supplies the following parts:

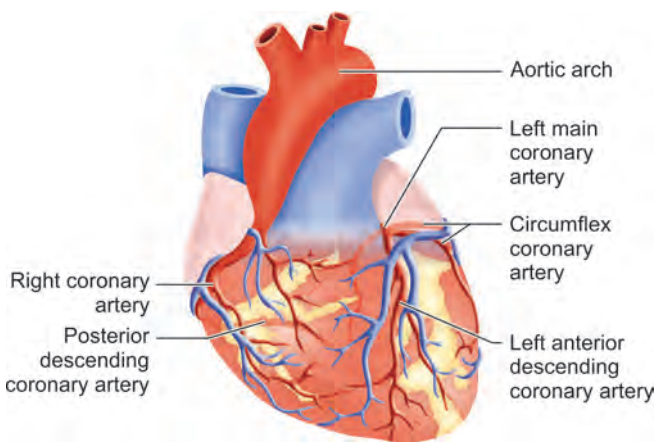
- *SA node*: 60% cases
- *AV node*: 90% cases
- Right atrium and right ventricle
- Inferoposterior aspect of left ventricle

So, the occlusion of right coronary artery results in sinus bradycardia, AV block, infarction of inferior part of left ventricle, and occasionally of right ventricle.

## 2. Left Coronary Artery

It arises from the left coronary sinus of valsalva. Within 2.5 cm of its origin, left main coronary artery divides into two branches: (1) Left anterior descending artery and (2) Circumflex artery.

- *Left anterior descending artery*: It runs in the anterior interventricular groove and gives branches to supply the anterior part of interventricular septum, anterior wall, and apex of the left ventricle.
- *Circumflex artery*: It runs posteriorly in the left AV groove and supplies the marginal branch to the left atrium, also lateral and posteroinferior part of the left ventricle.




**Coronary circulation**

Left coronary artery also supplies:

- SA node in 40% cases
- AV node in 10% cases
- Bundle of His
- Right and left bundle branches

Occlusion of the left anterior descending artery and the circumflex artery causes infarction of the corresponding territories of left ventricle. Occlusion of the left main coronary artery causes extensive damage and is usually fatal.

Venous system mainly follows coronary arteries, but drains to the coronary sinus in the AV groove, then to the right atrium.

Coronary vessels receive sympathetic and parasympathetic innervations. Stimulation of α-receptor causes vasoconstriction and $\beta_2$ causes vasodilatation. Sympathetic stimulation of coronary artery causes dilatation and parasympathetic stimulation also causes mild dilatation of normal coronary artery. Healthy coronary endothelium releases nitric oxide, which promotes vasodilatation. Systemic hormones, neuropeptides, and endothelin also influence arterial tone and coronary flow.