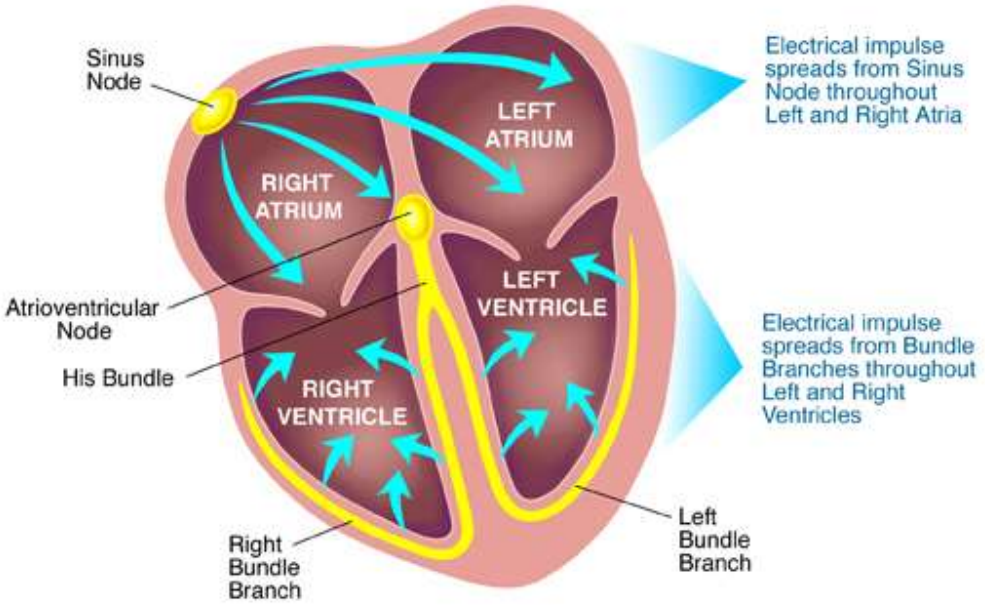
their own contraction without the help of external nerves. The conducting system initiates the heartbeat and helps spread the impulse rapidly throughout the heart.

Components of Conductive System:

1. sinoatrial (SA) is located in the upper wall of the right atrium
2. atrioventricular (AV) node situated in the lower right atrium
3. Bundle of His
4. Right and left bundle branches
5. Purkinje fibers.

The sinoatrial node, often known as the cardiac pacemaker, is responsible for the wave of electrical stimulation that initiates atrial contraction by creating an action potential. Once the wave reaches the AV node, it is delayed there before being conducted through the bundles of His and back up the Purkinje fibers, leading to a contraction of the ventricles. The delay at the AV node to allow the left and right atria to finish contracting and allows enough time for all of the blood in the atria to fill their respective ventricles.



Action potential in cardiomyocytes

Action potential: electrical stimulation created by a sequence of ion fluxes through specialized channels in the membrane (*sarcolemma*) of cardiomyocytes that leads to cardiac contraction. The Sinus Node Controls the Rate of Beat of the

Entire Heart. The membrane potential of a sinus node fiber is 55 - 60 millivolts compared with 85- 90 millivolts in a ventricular muscle fiber.

The action potential in typical cardiomyocytes is composed of 5 phases (0-4), beginning and ending with phase 4.

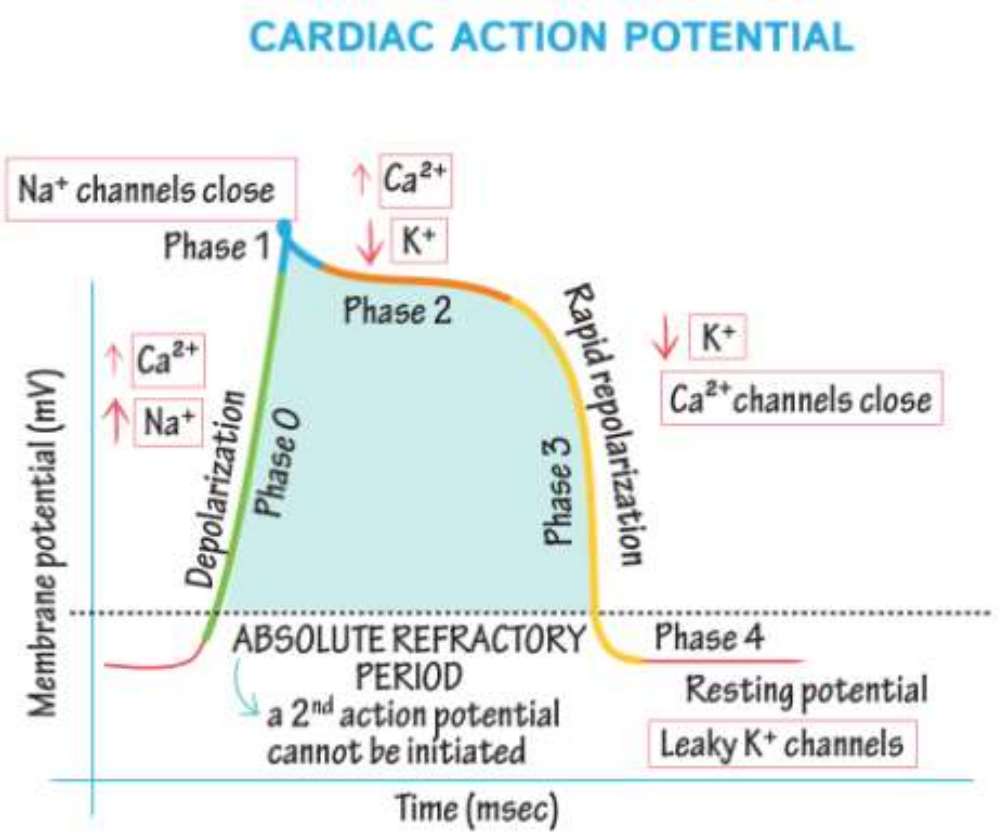
Phase 4: The resting phase.

Phase 0: Depolarization.

Phase 1: Early repolarization.

Phase 2: The plateau phase.

Phase 3: Repolarization.



Electrocardiogram (ECG; EKG)

ECG is a record of the electrical activity of the conducting system and shows the electrical events associated with the heartbeat.

Parts of the ECG explained

P-waves: It represent atrial depolarization (arterial contraction).

PR interval: It represents the time taken for electrical activity to move between the atria and ventricles.

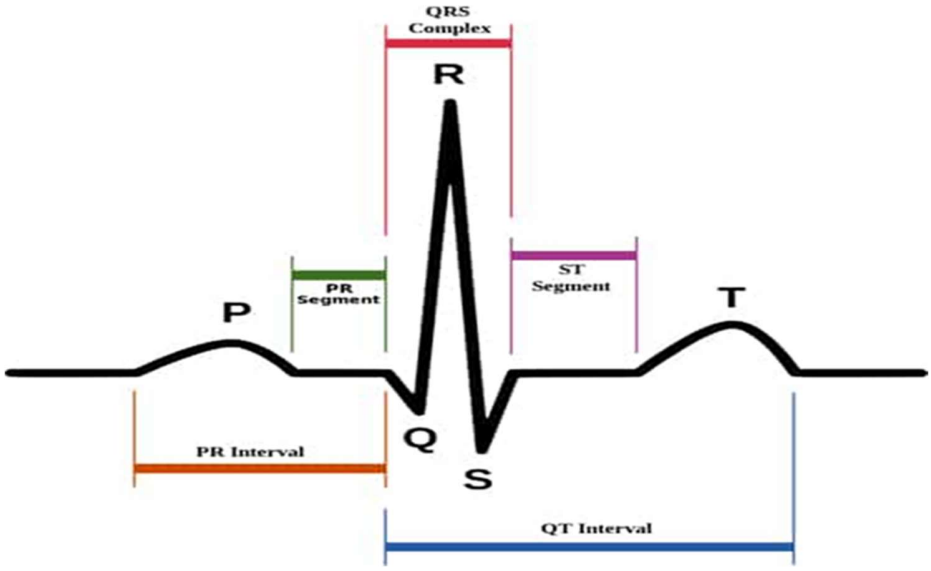
QRS complex: It represents depolarization of the ventricles(contraction).

ST segment: The ST segment is an isoelectric line that represents the time between depolarization and repolarization of the ventricles (i.e. contraction).

T-wave: The T-wave represents ventricular repolarization(relaxation).

RR-interval: It represents the time between two QRS complexes.

QT-interval: It represents the time taken for the ventricles to depolarize and then repolarize.



Heart sounds

Heart sounds are the sounds produced by mechanical activities of heart during each cardiac cycle.

Heart sounds are produced by:

1. Flow of blood through cardiac chambers

2. Contraction of cardiac muscle

3. Closure of valves of the heart.

Heart sounds are heard by placing the ear over the chest or by using a stethoscope or microphone. The Study of heart sounds has important diagnostic value in

clinical practice because alteration in the heart sounds indicates cardiac diseases involving valves of the heart. contraction and relaxation of ventricles produces characteristic heart sounds: **lub-dub**

lub = systolic sound due to contraction of ventricles and closing of AV valves

dub = diastolic sound is shorter, sharper sound due to ventricles relax and Semilunar valves close.

abnormal sounds: **"murmurs"** occur due to defective valves, congenital and septal defects.

Cardiac Output (CO)

The amount of blood that the heart pumps/min

Stroke Volume = The amount of blood pumped out of the ventricles per beat / contraction (approx. 70mls in a healthy adult male)

Heart Rate = number of heart beats per one minute

CO = Heart Rate X Stroke volume

= 75b/m X 70ml/b

= 5.250 ml/min (=5.25 l/min)~ normal blood volume

during strenuous exercise heart may increase output 4 or 5 times this amount

Heart Rate

- **Normal heart rate** is 72/minute. It ranges between 60 and 80 per minute.
- **Tachycardia** is the increase in heart rate above 100/minute.

Physiological Conditions when tachycardia Occurs:

1. Childhood 2. Exercise 3. Pregnancy 4. Emotional conditions such as anxiety.

Pathological Conditions when tachycardia occurs:

1. Fever 2. Anemia 3. Hypoxia 4. Diseases of heart valves

- **Bradycardia** is the decrease in heart rate below 60/minute.

Physiological Conditions when bradycardia occurs:

1. Sleep 2. Athletes.

Pathological Conditions when bradycardia occurs:

1. Hypothermia 2. Congenital heart disease 3. Heart attack

Circulation (Blood Flow)

Refers to the study of movement of blood through circulatory system. blood flows from a high pressure area to a region with lower pressure. Blood flows in the same direction as the decreasing pressure gradient: arteries to capillaries to veins.

Types of blood flow

Blood flow through a blood vessel is of two types:
1. Streamline or laminar flow
2. Turbulent flow.

1. Streamline Flow

Streamline flow is a **silent flow.** Within the blood vessel, a very thin layer of blood is in contact with the vessel wall. It does not move or moves very slowly.

2. Turbulent Flow

Turbulent flow is the **noisy flow.** When the velocity of blood flow increases above critical level, the flow becomes turbulent. Turbulent flow creates sounds.

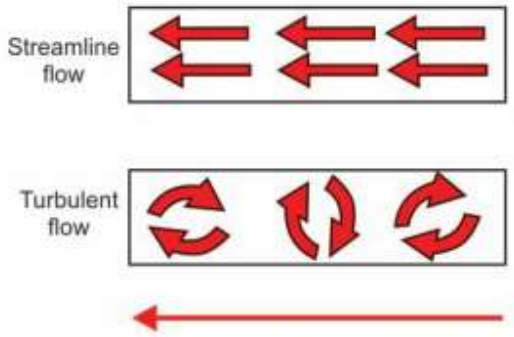


FIGURE 102.1: Streamline flow and turbulent flow