Elements of the conduction system of heart and heartbeat:

The conduction system of the heart is a group of specialized cells that generates and coordinates the electrical signals that regulate the heartbeat. These cells are located in several areas of the heart, including the sinoatrial (SA) node, atrioventricular (AV) node, bundle of His, and Purkinje fibers.

Sinoatrial (SA) node: The SA node is a group of cells located in the right atrium that acts as the heart's natural pacemaker. It initiates the electrical impulses that cause the heart to contract and generates an electrical signal that spreads through the atria, causing them to contract.

Atrioventricular (AV) node: The AV node is located between the atria and ventricles, and it acts as a gatekeeper, slowing down the electrical signal before it reaches the ventricles. This delay allows the atria to fully contract before the ventricles receive the signal to contract.

Bundle of His: The bundle of His is a group of specialized muscle fibers that conduct the electrical signal from the AV node to the ventricles.

Purkinje fibers: The Purkinje fibers are specialized muscle fibers that distribute the electrical signal throughout the ventricles, causing them to contract in a synchronized and coordinated manner.

The heartbeat is the result of the electrical signals generated by the conduction system of the heart, which causes the heart to contract and pump blood throughout the body. The heartbeat is controlled by the SA node, which initiates an electrical signal that spreads through the atria, causing them to contract. The electrical signal then passes through the AV node, where it is delayed, allowing the ventricles to fill with blood. The signal then travels down the bundle of His and the Purkinje fibers, causing the ventricles to contract and pump blood out of the heart.

In summary, the conduction system of the heart and the coordinated electrical signals it generates are critical to the normal function of the heart and the circulation of blood throughout the body.

Conduction system of heart regulation by the autonomic nervous system:

- The autonomic nervous system (ANS) plays an important role in regulating the conduction system of the heart. The ANS is a division of the nervous system that controls many of the body's automatic functions, including heart rate and rhythm. The ANS has two main branches: the sympathetic nervous system and the parasympathetic nervous system, which have opposite effects on the heart's conduction system.
- **Sympathetic nervous system:** The sympathetic nervous system is activated during times of stress or physical activity, and it increases heart rate and the strength of heart contractions. It does this by releasing the hormone adrenaline (also known as epinephrine) and activating the SA node and other parts of the conduction system. This leads to a faster heart rate and more forceful contractions, allowing the heart to pump more blood to meet the body's increased demand.
- **Parasympathetic nervous system:** The parasympathetic nervous system is activated during times of relaxation or rest, and it has the opposite effect on the heart than the sympathetic nervous system. It slows down heart rate and decreases the strength of

heart contractions by releasing the neurotransmitter acetylcholine, which acts on the SA node and other parts of the conduction system. This leads to a slower heart rate and weaker contractions, conserving energy and allowing the body to rest.

- The balance between the sympathetic and parasympathetic nervous systems is important for maintaining a normal heart rate and rhythm. When this balance is disrupted, it can lead to abnormal heart rhythms and other cardiac problems. For example, an overactive sympathetic nervous system can cause a rapid heart rate, while an overactive parasympathetic nervous system can cause a slow heart rate.
- In summary, the autonomic nervous system plays a crucial role in regulating the conduction system of the heart. The sympathetic and parasympathetic branches of the ANS have opposite effects on the heart's conduction system, and their balance is important for maintaining a normal heart rate and rhythm.

Cardiac output:

- Cardiac output is a measure of the amount of blood that the heart pumps per unit of time, usually measured in liters per minute. The human heart typically pumps about 5 liters of blood per minute at rest, but this can increase during physical activity or other times of increased demand.
- Cardiac output is determined by two factors: heart rate and stroke volume. Heart rate is the number of times the heart beats per minute, while stroke volume is the amount of blood that the heart pumps with each beat. The formula for calculating cardiac output is:
- Cardiac Output = Heart Rate x Stroke Volume
- For example, if a person has a heart rate of 70 beats per minute and a stroke volume of 70 milliliters per beat, their cardiac output would be:
- Cardiac Output = 70 beats/minute x 70 mL/beat = 4.9 L/minute
- The heart can increase its cardiac output in response to increased demand, such as during exercise or in response to stress. This is achieved by increasing both heart rate and stroke volume. During exercise, the sympathetic nervous system is activated, leading to an increase in heart rate and the release of hormones that increase stroke volume by increasing the force of heart contractions. This allows the heart to pump more blood to meet the body's increased demand for oxygen and nutrients.
- In summary, cardiac output is the amount of blood that the heart pumps per unit of time, and it is determined by heart rate and stroke volume. The human heart typically pumps about 5 liters of blood per minute at rest, but this can increase during physical activity or other times of increased demand.

Cardiac cycle:

- The cardiac cycle is the sequence of events that occurs in one complete beat of the heart. The pumping phase of the cycle, also known as systole, occurs when heart muscle contracts. The filling phase, which is known as diastole, occurs when heart muscle relaxes. At the beginning of the cardiac cycle, both atria and ventricles are in diastole.
- During this time, all the chambers of the heart are relaxed and receive blood. The atrioventricular valves are open. Atrial systole follows this phase. During atrial systole,

the left and right atria contract at the same time and push blood into the left and right ventricles, respectively. The next phase is ventricular systole.

- During ventricular systole, the left and right ventricles contract at the same time and pump blood into the aorta and pulmonary trunk, respectively. In ventricular systole, the atria are relaxed and receive blood.
- The atrioventricular valves close immediately after ventricular systole begins to stop blood going back into the atria. However, the semilunar valves are open during this phase to allow the blood to flow into the aorta and pulmonary trunk. Following this phase,Â the ventricles relax that is ventricular diastole occurs.
- The semilunar valves close to stop the blood from flowing back into the ventricles from the aorta and pulmonary trunk. The atria and ventricles once again are in diastole together and the cycle begins again.
- The adult heart beats around 70 to 80 times a minute at rest. When you listen to your heart with a stethoscope you can hear your heart beat. The sound is usually described as “lubb-dupp”. The “lubb” also known as the first heart sound, is caused by the closure of the atrioventricular valves. The “dupp” sound is due to the closure of the semilunar valves when the ventricles relax (at the beginning of ventricular diastole). Abnormal heart sounds are known as murmurs. Murmurs may indicate a problem with the heart valves, but many types of murmur are no cause for concern.