Introduction

The heart is a muscular organ that serves to collect deoxygenated blood from all parts of the body, carries it to the lungs to be oxygenated and release carbon dioxide. Then, it transports the oxygenated blood from the lungs and distributes it to all the body parts

- The heart pumps around 7,200 litres of blood in a day throughout the body.
- The heart is situated at the centre of the chest and points slightly towards the left.
- On average, the heart beats about 100,000 times a day, i.e., around 3 billion beats in a lifetime.
- An adult heart beats about 60 to 80 times per minute, and newborn babies heart beats faster than an adult which is about 70 to 190 beats per minute.

Anatomy

The heart is a conical hollow muscular organ situated in the middle mediastinum and is enclosed within the pericardium. It is positioned posteriorly to the body of the sternum with one-third situated on the right and two-thirds on the left of the midline. The heart measures 12 x 8.5 x 6 cm and weighs ~310 g (males) and ~255 g (females). It pumps blood to various parts of the body to meet their nutritive requirements. The Greek name for the heart is cardia from which we have the adjective cardia.

Relations

- Anteriorly: the body of the sternum, and adjoining costal cartilages; left lung, and pleura (apex)
- Posteriorly: oesophagus, descending thoracic aorta, azygos, hemiazygos veins, and thoracic duct
- Superficially : bifurcation of the main pulmonary trunk
- Inferiorly: diaphragm
- Laterally: lungs, pleura

Heart orientation

Apex

- **Location and Structure**: The apex is formed by the **left ventricle**, and it points downward, forward, and to the left.

- **Anatomical Position**: The apex is typically located at the level of the **5th left intercostal space**, about **9 cm (3.5 inches)** from the midline of the body. This position is just medial to the **midclavicular line**.
- **Clinical Relevance**: The apex of the heart is clinically significant because it can be palpated during a physical examination. This palpation is commonly referred to as the **point of maximal impulse (PMI)**, which can help assess the size and position of the heart, as well as its function.
- **Anatomical Composition**: The base of the heart is primarily formed by the **left atrium** (about two-thirds), while the **right atrium** contributes about one-third. This part of the heart is located opposite to the apex, facing posteriorly.
- **Orientation**: The base of the heart is directed backward and to the right, contrasting with the apex's downward, forward, and leftward direction.

Key Features of the Base:

1. **Opposite to the Apex**: As you mentioned, the base lies directly opposite to the apex, at the opposite end of the heart.The passage you provided describes the anatomical structure of the **base (or posterior surface) of the heart**. Here's a breakdown of the key details:
    - **Base of the Heart**: This refers to the portion of the heart that faces backwards (posterior) and is opposite the apex (the tip of the heart). The base is formed primarily by the atria (the upper chambers of the heart).
    - **Left Atrium**: The **left atrium** contributes the majority (about two-thirds) of the base of the heart. This chamber receives oxygenated blood from the lungs via the pulmonary veins.
    - **Right Atrium**: The **right atrium** contributes the remaining one-third of the base. This chamber receives deoxygenated blood from the body through the superior and inferior vena cavae.
    - **Orientation**: The base of the heart is directed **backwards and to the right**, meaning it faces away from the front of the body and towards the right side. This anatomical description is essential for understanding the positioning and relationship of the heart's chambers to other structures in the thoracic cavity.
2. **Relation to Vertebral Column**:
    - In a **recumbent (lying down) position**, the base of the heart is positioned in front of the middle thoracic vertebrae (T5–T8).

    - When in an **erect posture**, the base descends by one vertebra, typically positioned in front of T6–T9.

3. **Separation from Vertebral Column**: The base is separated from the vertebral column by several structures:
    - **Oblique pericardial sinus**: A recess in the pericardium that allows space for the heart's movement.
    - **Esophagus**: The muscular tube connecting the throat to the stomach, which lies behind the heart.
    - **Aorta**: The large artery that carries blood from the left ventricle to the rest of the body.

Clinical Relevance:

- **Great Blood Vessels**: The base of the heart is where the major blood vessels are attached, including the **superior vena cava**, **ascending aorta**, and **pulmonary trunk**. This makes the base significant in cardiovascular assessments.

1. **Sternocostal (Anterior) Surface**

- **Main contributors**: The **right atrium** and **right ventricle** primarily form this surface. These two chambers are separated by the **anterior atrioventricular groove**.
- **Additional contributors**: The **left auricle** and **left ventricle** also contribute to the sternocostal surface, but to a lesser extent.
- **Separation between ventricles**: The **right ventricle** is separated from the **left ventricle** by the **anterior interventricular groove**.
- **Important notes**:
    - The **left atrium** is not visible from the front because it is hidden by the **ascending aorta** and **pulmonary trunk**.
    - The **cardiac notch** of the **left lung** leaves an area of **superficial cardiac dullness** on the sternocostal surface.

2. **Diaphragmatic (Inferior) Surface**

- **Flat and rests on**: This surface is flat and lies on the **central tendon of the diaphragm**, providing support.
- **Main contributors**: It is formed by the **left and right ventricles**.

    - The **left ventricle** forms about **two-thirds** of the diaphragmatic surface.
    - The **right ventricle** forms the remaining **one-third**.
- **Separation between ventricles**: The **posterior interventricular groove** separates the left and right ventricles on the diaphragmatic surface.

3. **Left Surface**

- **Main contributor**: This surface is primarily formed by the **left ventricle**.
- **Additional contributors**: It is also partially formed by the **left atrium** and **left auricle**.
- **Direction**: The left surface is oriented **upwards**, **backwards**, and **to the left**, making it the most lateral surface of the heart.

1. **Right Border**

- **Formation**: The **right border** is primarily formed by the **right atrium**.
- **Extension**: It extends from the right side of the **opening of the superior vena cava (SVC)** to the right side of the **opening of the inferior vena cava (IVC)**.
- **Function**: This border separates the **base** of the heart from the **sternocostal surface**.

2. **Left Border**

- **Formation**: The **left border** is formed mainly by the **left ventricle** and partly by the **left auricle**.
- **Curvature**: It is **curved** and **oblique**, extending from the **left auricle** to the **apex** of the heart.
- **Function**: The left border separates the **sternocostal surface** from the **left surface** of the heart.

3. **Inferior Border**

- **Formation**: The **inferior border** is mainly formed by the **right ventricle**, with a small contribution from the **right atrium**.
- **Extension**: It extends from the **opening of the IVC** to the **apex** of the heart.
- **Function**: This border separates the **sternocostal surface** from the **diaphragmatic surface**.
- **Notch**: Near the apex, the inferior border features a notch called the **incisura apicis cordis**, which is a slight indentation.

4. **Upper Border**

- **Formation**: The **upper border** is formed by both the **right and left atria**, but it is mainly formed by the **left atrium**.
- **Obscured view**: This border is obscured from view on the **sternocostal surface** because it is covered by the **ascending aorta** and the **pulmonary trunk**.
- **Surface marking**: On the surface of the body, the upper border can be marked by a line:
    - From a point on the **lower border of the 2nd left costal cartilage** (1.5 inches from the median plane).
    - To a point on the **upper border of the 3rd right costal cartilage** (1 inch away from the median plane).

The heart wall consists of three layers enclosed in the pericardium:

1. Epicardium - the outer layer of the wall of the heart and is formed by the visceral layer of the serous pericardium.
2. Myocardium - the muscular middle layer of the wall of the heart and has excitable tissue and the conducting system.
3. Endocardium

- A middle concentric layer
- A subendocardial layer.

The rest of the heart is composed mainly of the subepicardial and subendocardial layers.

Structure and Function

The heart is subdivided by septa into right and left halves, and a constriction subdivides each half of the organ into two cavities, the upper cavity being called the atrium, the lower the ventricle. The heart, therefore, consists of four chambers:

- right atrium
- left atrium
- right ventricle
- left ventricle

It is best to remember the four chambers and four valves in order of the series that blood travels through the heart:

- Venous blood returning from the body drains into the right atrium via the SVC, IVC and coronary sinus
- The right atrium pumps blood through the tricuspid valve into the right ventricle
- The right ventricle pumps blood through the pulmonary semilunar valve into the pulmonary trunk to be oxygenated in the lungs
- Blood returning from the lungs drains into the left atrium via the four pulmonary veins
- The left atrium pumps blood through the bicuspid (mitral) valve into the left ventricle
- The left ventricle pumps blood through the aortic semilunar valve into the ascending aorta to supply the body.

Heart Valves

The valves of the heart maintain unidirectional flow of the blood and prevent its regurgitation in the opposite direction. There are two pairs of valves in the heart, a pair of atrioventricular valves and a pair of semilunar valves. Apart, it has four valves. All four valves of the heart have a singular purpose: allowing forward flow of blood but preventing backward flow. The outflow of each chamber is guarded by a heart valve:

Atrioventricular valves between the atria and ventricles

1. tricuspid valve (R side of the heart)
2. mitral valve/bicuspid valve (left side of the heart)

Semilunar valves which are located in the outflow tracts of the ventricles

1. aortic valve (L side heart)
2. pulmonary valve (R side heart)

See also Cardiac Valve Defects

Blood Supply

The heart is supplied by two coronary arteries:

1. Left main coronary artery carries 80% of the flow to the heart muscle. It is a short artery that divides into two branches

- Left anterior descending artery that supplies anterior two-thirds of the inter-ventricular septum and adjoining part of the left ventricular anterior wall
- Circumflex coronary artery that supplies blood to the lateral and posterior portions of the left ventricle.

2. Right coronary artery: branches supply the right ventricle, right atrium, and left ventricle's inferior wall.

Coronary arteries and veins course over the surface of the heart. Most coronary veins coalesce into the coronary sinus that runs in the left posterior atrioventricular groove and opens into the right atrium. Other small veins, called thebesian veins, open directly into all four chambers of the heart.

Image: Overview of the coronary arteries and cardiac veins - anterior and posterior views

See also Coronary Artery Disease

Venous drainage and Lymphatics

Venous drainage is via the variable coronary veins and the coronary sinus.

The lymphatic vessels drain mainly into:

1. Brachiocephalic nodes, in front of brachiocephalic veins
2. Tracheobronchial nodes**,** located at the distal end of the trachea.

Nerve Supply

The main control of the heart resides with the medulla oblongata. There is an area called the cardioacceleratory centre, or pressor centre, in the upper part of the medulla oblongata, and an area called the cardioinhibitory centre, or depressor centre, in the lower part. Together they are called the cardioregulatory centre, since they interact to control heart rate, etc.

The nervous supply to the heart is autonomic, consisting of both sympathetic and parasympathetic parts. The sympathetic fibres arise from the pressor centre, while the parasympathetic fibres arise in the depressor centre. See also Vagal Tone

- The sympathetic nervous system acts on the sinoatrial node, speeding up the depolarisation rate, and therefore increasing the heart rate.

- The parasympathetic system works in reverse in order to slow the heart rate down.
- The heart itself has a natural pacemaker, the sinoatrial node, which does not need a nervous supply to function. If you sever all the nerves to the heart, then it will continue to beat. In fact, it will beat faster than normal, since there is normally a parasympathetic supply slowing the heart down.

Heart Conduction System

An electrical conduction system regulates the pumping of the heart and timing of contraction of various chambers. Heart muscle contracts in response to the electrical stimulus received system generates electrical impulses and conducts them throughout the muscle of the heart, stimulating the heart to contract and pump blood. Among the major elements in the cardiac conduction system are the sinus node, atrioventricular node, and the autonomic nervous system.

1. The sinus node is the heart's natural pacemaker. The sinus node is a cluster of cells situated in the upper part of the wall of the right atrium. The electrical impulses are generated there. (The sinus node is also called the sinoatrial node.)
2. The electrical signal generated by the sinus node moves from cell to cell down through the heart until it reaches the atrioventricular node (the AV node), a cluster of cells situated in the center of the heart between the atria and ventricles.
3. The AV node serves as a gate that slows the electrical current before the signal is permitted to pass down through to the ventricles. This delay ensures that the atria have a chance to fully contract before the ventricles are stimulated. After passing the AV node, the electrical current travels to the ventricles along special fibers embedded in the walls of the lower part of the heart.
4. The autonomic nervous system (the same part of the nervous system as controls the blood pressure) controls the firing of the sinus node to trigger the start of the cardiac cycle. The autonomic nervous system can transmit a message quickly to the sinus node so it in turn can increase the heart rate to twice normal within only 3 to 5 seconds. This quick response is important during exercise when the heart has to increase its beating speed to keep up with the body's increased demand for oxygen.