HEART

The heart is comprised of two strong **muscular pumps**, which are connected by two complementary sets of arteries: one for the systemic and one for pulmonary circulation. They are essential in the delivery of oxygen to the millions of cells of the body and in the removal of their waste products.

The heart pushes **deoxygenated blood** to the lungs and **oxygenated blood** around the entire body. It must continually beat to sustain life and so its muscular walls (**cardiac muscle** and **myocardium**) are made of specialized cardiac muscle cells that carry their own intrinsic contractile rhythm.

POSITION OF THE HEART

The heart is positioned above and upon the superior surface of the respiratory **diaphragm**, posterior to the **sternum**. It lies in a space covered with connective tissue, behind the sternal body, called the **middle mediastinum**, which divides the thoracic cavity into two pleural cavities.

It is roughly cone-shaped and is orientated with its broad **base** superior, and its blunt **apex** inferior. It lies obliquely, with the apex pointing anterior and to the left, close to the 5th intercostal space, and the base pointing posterior and to the right.

Between the base and the apex the heart measures approximately 12 cm; it is approximately 9 cm across its widest diameter and 6 cm from front to back. The heart weighs approximately 300 g in the male and 250 g in the female.

The heart is anchored to the diaphragm, to the back of the sternum and to the **great vessels** (aorta, pulmonary arteries and veins, and the venae cavae) by the pericardium.

**NB:** The heart in this 3D model is larger than the average, as this individual suffered from heart disease.

PERICARDIUM

The pericardium is made up of two serous membrane layers, each composed of an epithelial lining with an underlying connective tissue. The pericardium keeps the heart in place, limits its motion, prevents it from over expanding, whilst the pericardial fluid reduces the **friction** between it and its surrounding structures.

Did you know?

The heart is on the right side of the thorax in a very small percentage of people. These people have a condition called dextrocardia which is a developmental anomaly. When the position of the organs of the abdomen is also affected, the condition is known as **situs inversus**.
**Serosal pericardium**

The serosal pericardium forms a closed sac composed of two thin membranous layers:

- The **visceral layer** lies directly on the outer surface of the heart wall.
- The **parietal layer** lies directly on the deep surface of the fibrous pericardium.

Between the visceral and parietal layers is the **pericardial cavity**, a narrow cavity filled with a thin serous fluid, called **pericardial fluid**.

Imagine a softly blown up balloon with some water inside of it. Now imagine pushing your fist into the side of that balloon. You would now have three layers surrounding your fist; the first layer would be the balloon immediately touching your fist (visceral layer), the second layer would be the water inside the balloon (pericardial fluid), and the third layer would be the other side of the balloon (parietal layer).

**Function**
The fluid in the pericardial cavity reduces friction as the heart beats, allowing the visceral and parietal layers to slide over each other.

**Fibrous pericardium**

Fibrous pericardium is the superficial layer of the pericardium which is composed of dense irregular connective tissue. It attaches to the parietal layer of the serous pericardium, and encloses the heart. The fibrous pericardium is attached below to the diaphragm and above to the great vessels of the heart, which helps to anchor the heart within the chest cavity.

**Function**
It limits the motion of the heart. Due to its tough, fibrous nature, the fibrous pericardium is able to resist stretch, which prevents the heart from over expanding.

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**LAYERS OF THE HEART WALL**

The **heart wall** is made up of three layers, the **endocardium**, **myocardium**, and **epicardium**:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endocardium</strong></td>
<td>A smooth, thin membrane that lines the inner surface of the heart chambers, the endocardium is composed of a thin layer of endothelial cells, which lies over a thin layer of connective tissue. This innermost layer also covers the valves of the heart, and helps to prevent resistance as blood passes through the vessels and chambers of the heart.</td>
</tr>
<tr>
<td><strong>Myocardium</strong></td>
<td>The myocardium - the <strong>heart muscle</strong> itself, varies in thickness depending on its location, being thin in the atria and thick in the ventricles. It is composed of cardiac muscle fibers, which exhibit striations diagonally across the heart.</td>
</tr>
<tr>
<td><strong>Epicardium</strong></td>
<td>The epicardium is the thin, outer <strong>serous membrane</strong> of the heart wall, which is also described as the inner-most layer of the serous pericardium, known as the <strong>visceral pericardium</strong>. It is composed mainly of connective tissue mesothelial cells, which gives a smooth texture on the outer surface of the heart.</td>
</tr>
</tbody>
</table>

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**CHAMBERS OF THE HEART**

The heart is a **myocardial** muscular pump consisting of four chambers, two auricles, four valves, and a muscular septum.

The **atria** are the two upper chambers of the heart and are positioned near its base. They possess small semi-elastic pouches called **auricles**, that expand when filled with blood. The auricles ensure that there is sufficient blood volume to permit maximal contraction of the ventricles.

The atrial walls are thin as they only have to squeeze blood past the **atrioventricular valves** into their corresponding left or right ventricles.
Right atrium

- A small, thin walled chamber, the right atrium receives deoxygenated blood from the entire body via the superior and inferior vena cava. It also receives blood from the myocardium itself through the coronary sinus.

**Function**

It pumps deoxygenated blood from the atrioventricular (tricuspid) valve into the right ventricle.

Left atrium

- A small, thin walled chamber that forms much of the base of the heart, the left atrium receives oxygenated blood from the lungs via the four pulmonary veins.

**Function**

It pumps oxygen-rich blood from the atrioventricular (bicuspid) valve into the left ventricle.

The ventricles are the two lower chambers of the heart positioned near its apex. The ventricle walls are thicker than those of the atria and the wall of the left ventricle is especially thick, as it must push the blood at high pressure around the entire body: the left ventricular wall is three times thicker than the thickness of the right ventricle. This is because it pumps blood at a higher pressure into the systemic circulation through the aorta. The left ventricle is also longer and more conical in shape than the right and forms the apex of the heart.

Right ventricle

- The right ventricle is a thick walled chamber that forms most of the anterior surface of the heart. It receives deoxygenated blood through the tricuspid valve from the right atrium.

**Function**

It pumps deoxygenated blood into the lungs from the pulmonary valve and trunk.

Left ventricle

- The left ventricle is the thickest walled chamber (three times as thick as the right ventricle. It is cone-shaped and forms most of the back and lower surface of the heart. It receives oxygenated blood through the bicuspid valve into the left atrium.

**Function**

It pumps oxygenated blood to the entire body through the aortic valve via the aorta.

The muscular septum is divided into two different areas: the interatrial septum separates the left and right atria, and the interventricular septum divides the left and right ventricles. A small depression is present on the interatrial septum, called the fossa ovalis, which is the embryonic remnant of the foramen ovale, an opening in the fetal heart which closes shortly after birth.

The atria are separated from the ventricles by shallow grooves on the external surface of the heart called sulci. These are known as the coronary sulcus, the anterior interventricular sulcus, and the posterior interventricular sulcus.

Coronary sulcus

- The coronary sulcus is a groove on the external surface of the heart, which marks the division between the superior atria and the inferior ventricles. It contains the trunks of the coronary vessels and the coronary sinus.

Anterior interventricular sulcus

- The anterior interventricular sulcus is a shallow groove on the sternocostal, anterior surface of the heart, which marks the division between the right and left ventricles. It contains the branch of the left coronary artery.

Posterior interventricular sulcus

- The posterior interventricular sulcus is a shallow groove on the diaphragmatic, posterior surface of the heart, which marks the division between the right and left ventricles. It contains the posterior interventricular artery and the middle cardiac vein.

In addition to cardiac muscle, the heart wall also contains a layer of dense connective tissue, called the cardiac skeleton, which connects the atria and ventricles. This fibrous skeleton serves as an insertion point for cardiac muscle fibers, and provides electrical insulation through the atrioventricular node from the right atria to the right ventricle.
In addition, the cardiac skeleton provides structural stability in the form of rings of connective tissue that surround the valves of the heart.

**DISSECTION IMAGES**

To see a human dissection of the heart click on the thumbnail below:

![Dissection Image](image)

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**VALVES OF THE HEART**

There are four valves in the heart: the pulmonary valve, aortic valve, right atrioventricular valve, and left atrioventricular valve. They open and close in response to pressure created by the volume of blood as it is pumped into each chamber as the heart contracts.

These four valves prevent the blood from flowing back into the chambers and assure that the direction of blood flow into and out of the heart remains constant.

The **atrioventricular valves** (AV) are located between the atria and the ventricles and prevent the blood in the ventricles from flowing back into the atria. When the atrioventricular valves close, they create the first heart sound: **lub**.

**Right atrioventricular valve (tricuspid)**

- The right atrioventricular valve lies in between the right atrium and right ventricle. It is also known as the **tricuspid valve** because it has three **cusps (leaflets)**, *tri-* meaning three.

  - Attached to the inferior portion of the cusps are thin, string-like **chordae tendineae**, which are attached at the opposite end to the ventricular wall or **papillary muscles**. They prevent the valve **prolapsing** into the right atrium.

**Function**

- It prevents the back flow of blood from the right ventricle into the right atrium during ventricular systole.

**Left atrioventricular valve (bicuspid)**

- The left atrioventricular valve lies in between the left atrium and left ventricle. It is also known as the **mitral valve or bicuspid valve**, because it has two **cusps (leaflets)**, *bi-* meaning two.

  - Attached to the inferior portion of the cusps are thin, string-like **chordae tendineae**, which are attached at the opposite end to the ventricular wall or **papillary muscles**. They prevent the valve **prolapsing** into the left atrium.

**Function**

- It prevents the back flow of blood from the left ventricle back into the left atrium during ventricular systole.

The **semilunar valves** prevent the back flow of blood from the pulmonary trunk and the aorta to the right ventricle and left ventricle, respectively. Each valve has three crescent-shaped cusps.

When the ventricles are contracting, the cusps of the valves are pushed flat against the walls of the vessels, therefore keeping the valves open. When the ventricles stop contracting, the blood immediately tries to flow back in the opposite direction (back into the ventricles). This returning blood flows into the cusps of the valves, opening them out, and thereby blocking the flow of blood back into the ventricles. When the pulmonary and aortic valves close, they create the second heart sound: **dup**.
### Pulmonary valve

The pulmonary valve lies in between the right ventricle and the pulmonary trunk.

It is a **semilunar valve** (SL) with three crescent-shaped cusps. The cusps are attached partly to the wall of the **right ventricle** and partly to the walls of the **pulmonary trunk**.

**Function**

After the ventricle has contracted, pressure from blood trying to rush back into the ventricle from the pulmonary trunk fills the cusps and closes the valve.

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### Aortic valve

The aortic valve lies in between the left ventricle and the aorta.

It is a **semilunar valve** (SL) with three crescent-shaped cusps. The cusps are attached partly to the wall of the **left ventricle** and partly to the walls of the **aorta**.

**Function**

After the ventricle has contracted, pressure from blood trying to rush back into the ventricle from the aorta fills the cusps and closes the valve. Just above the cusps are the openings to the **coronary arteries**. The back flowing blood supplies the **myocardium** (heart muscle).

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**Did you know?**

The heart valves are aligned more or less in a vertical line behind the sternum. The order from the top down is: the aortic valve, pulmonary valve, bicuspid valve, and tricuspid valve.

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**DISSECTION IMAGES**

To see a human dissection of the heart valves click on the thumbnail below: