The circulatory system, The system that contains the heart and the blood vessels and moves blood throughout the body. This system helps tissues get enough oxygen and nutrients, and it helps them get clear of waste products.

The **circulatory system** has three components:

1. The **heart** is the pump that imparts pressure to the blood to establish the pressure gradient needed for blood to flow to the tissues. Like all liquids, blood flows down a pressure gradient from an area of higher pressure to an area of lower pressure.
2. The **blood vessel**s are the passageways through which blood is directed and distributed from the heart to all parts of the body and subsequently returned to the heart.
3. **Blood** is the transport medium within which materials being transported long distances in the body, such as O2, CO2, nutrients, wastes, electrolytes, and hormones, are dissolved or suspended.

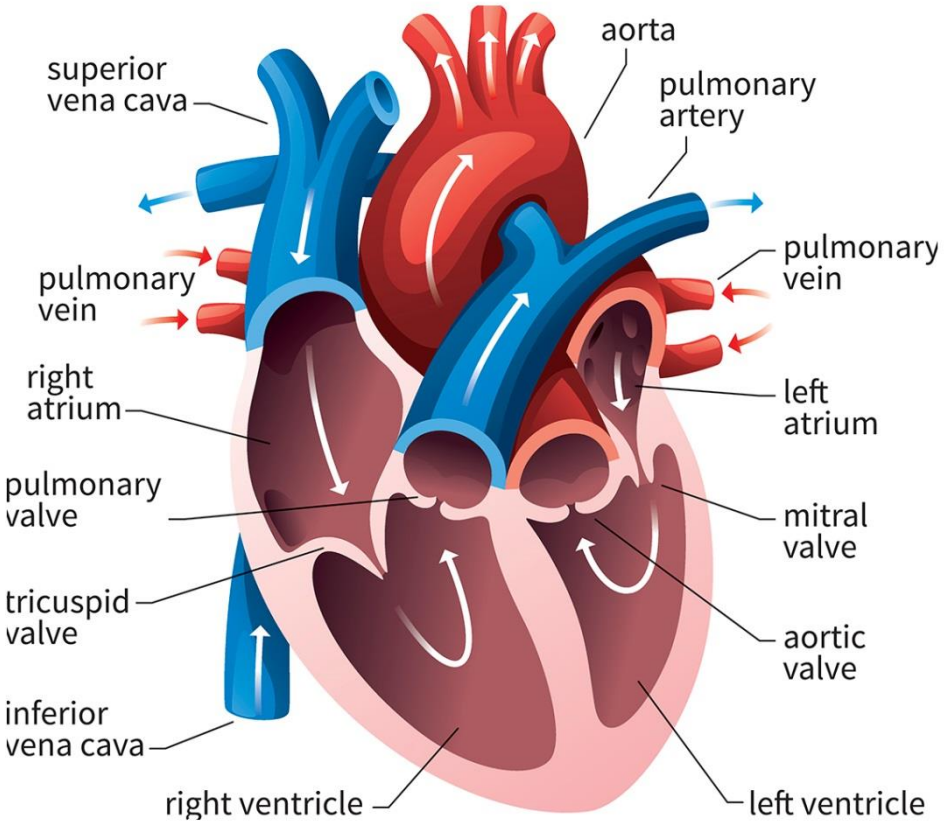


Figure : the human heart

The heart is positioned in the middle of the thoracic cavity

The heart is a hollow, muscular organ about the size of a clenched fist. It lies in the **thoracic** (chest) **cavity** about midline between the **sternum** anteriorly and the **vertebrae** posteriorly. The heart is actually in the middle. The heart has a broad **base** at the top and tapers to a pointed tip, the **apex**, at the bottom. It is situated at an angle under the sternum so that its base lies predominantly to the right and the apex lies to the left of the sternum.

Pulmonary and systemic circulations

Blood travels through the circulatory system to and from the heart through two separate vascular (blood vessel) loops, both originating and terminating at the heart. The **pulmonary circulation** consists of a closed loop of vessels carrying blood between the heart and the lungs. The **systemic circulation** is a circuit of vessels carrying blood between the heart and all body systems (except for lung)

The heart is a dual pump

The heart is divided into right and left halves and has four chambers, an upper and a lower chamber within each half . The upper chambers, the atria (singular, **atrium**), receive blood returning to the heart and transfer it to the lower chambers, the **ventricles** which pump blood from the heart. The vessels that return blood from the tissues to the atria are **veins**, and those that carry blood away from the ventricles to the tissues are **arteries**. The two halves of the heart are separated by the **septum**, a muscular partition that prevents blood mixing from the two sides of the heart.

The Complete Circuit of Blood Flow

1- Blood returning from the systemic circulation enters the right atrium via two large veins, the **venae cavae**, one returning blood from above and the other returning blood from below heart level.

2- This blood flows from the right atrium into the right ventricle, which pumps it out through the **pulmonary artery**.

3- This artery immediately forms two branches, one going to each of the two lungs.

4- Within the lungs, blood loses CO2 and picks up O2 by gas exchange with the air sacs before being returned to the left atrium via the **pulmonary veins.**

5- This O2-rich blood returning to the left atrium subsequently flows into the left ventricle, the pumping chamber that pushes the blood to the body systems.

6- The single large artery carrying blood away from the left ventricle is the **aorta**. Major arteries branch from the aorta to bring blood to the various organs.

7- Tissue cells within the organ take O2 from the blood and use it to oxidize nutrients for energy production; in the process, the tissue cells form CO2 as a waste product that is added to the blood . The drop of blood, returns to the right side of the heart.

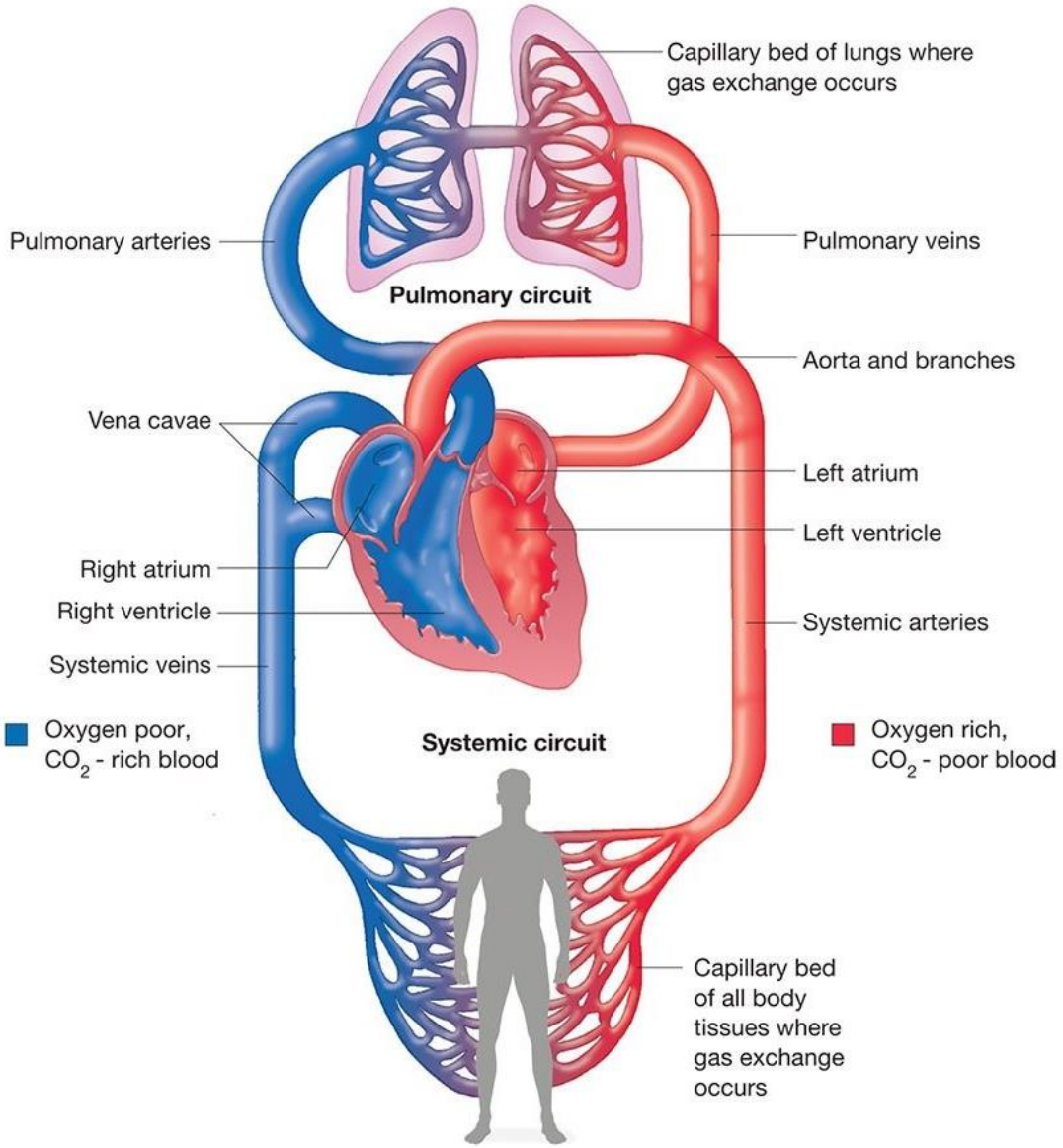


Figure : Pulmonary and systemic circulations

Atrioventricular Valves Between the Atria and Ventricles

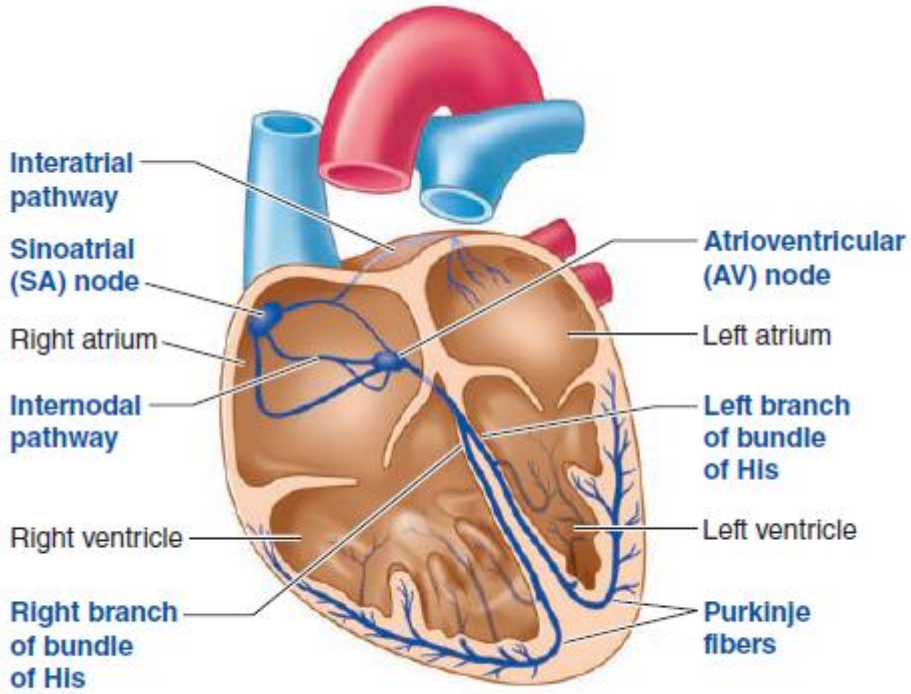
Two of the heart valves, the **right** and **left atrioventricular (AV) valves**, are positioned between the atrium and the ventricle on the right and the left sides, respectively.

These valves let blood flow from the atria into the ventricles during ventricular filling but prevent the backflow of blood from the ventricles into the atria The right AV valve is also called the **tricuspid valve** because it consists of three cusps. Likewise, the left AV valve, which has two cusps, is often called the **bicuspid valve** or the **mitral valve.**

The sinoatrial node is the normal pacemaker of the heart.

The specialized cardiac cells capable of autorhythmicitylie in the following sites:

1. The **sinoatrial node (SA node)**, a small, specialized region in the right atrial wall near the opening of the superior (upper) vena cava.
2. The **atrioventricular node (AV node)**, a small bundle of specialized cardiac muscle cells located at the base of the right atrium near the septum.
3. The **bundle of His** , a tract of specialized cells that originates at the AV node and enters the septum between the ventricles. Here, it divides to form the right and left bundle branches that travel down the septum, curve around the tip of the ventricular chambers, and travel back toward the atria along the outer walls.
4. **Purkinje fibers**, small terminal fibers that extend from the bundle of His and spread throughout the ventricular myocardium, much like small twigs of a tree branch.



(a) Specialized conduction system of the heart

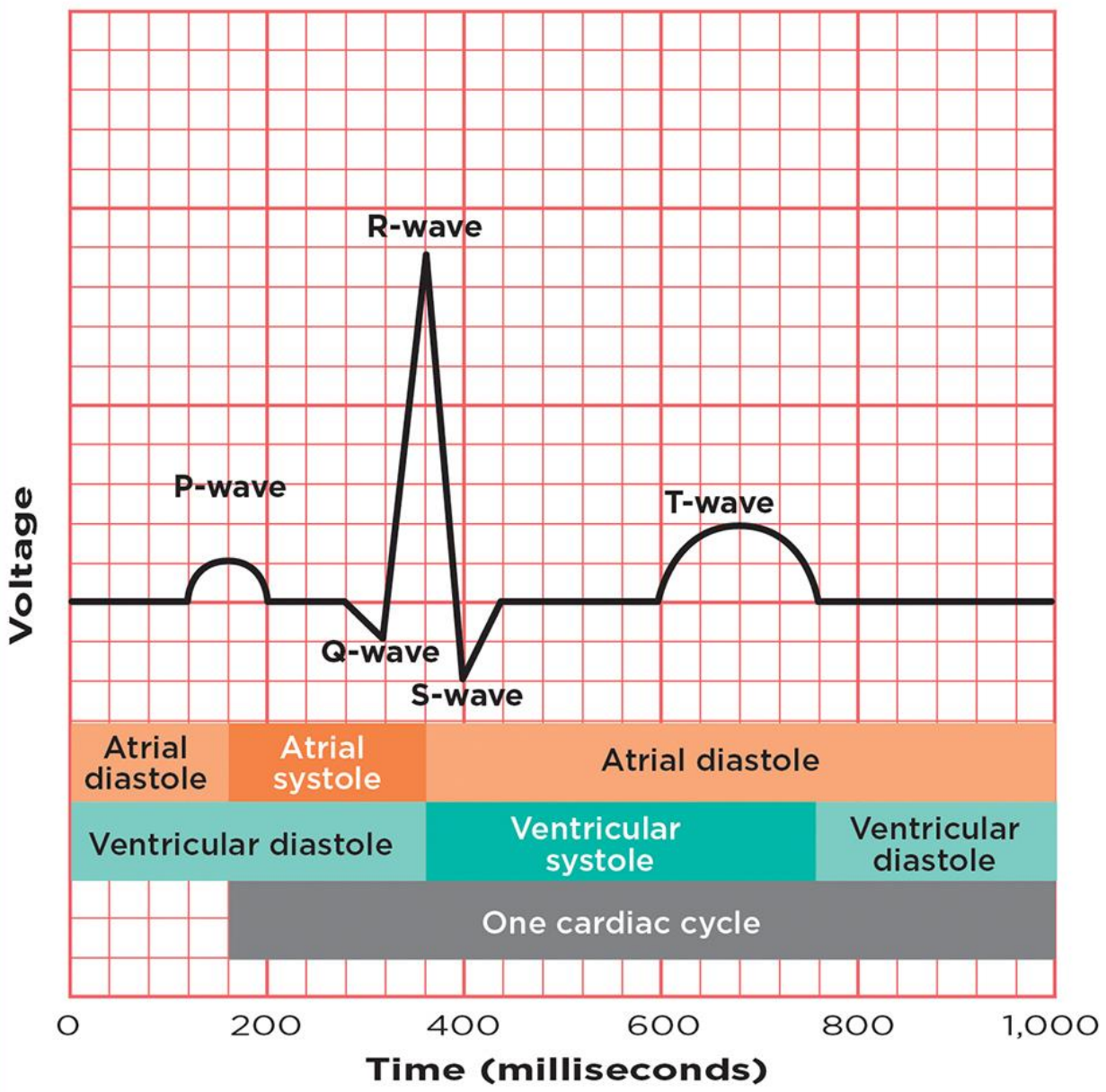
The ECG is a record of the overall spread of electrical activity through the heart.

The electrical currents generated by cardiac muscle during depolarization and repolarization spread into the tissues around the heart and are conducted through the body fluids. A small part of this electrical activity reaches the body surface, where it can be detected using recording electrodes. The record produced is an **electrocardiogram,** or **ECG**.

The heart alternately contracts to empty and relaxes to fill.

The **cardiac cycle** consists of alternate periods of **systole** (contraction and emptying) and **diastole** (relaxation and filling).

Fig 2. **Relationship between ECG and cardiac cycle stages**



ECG = electrocardiogram.

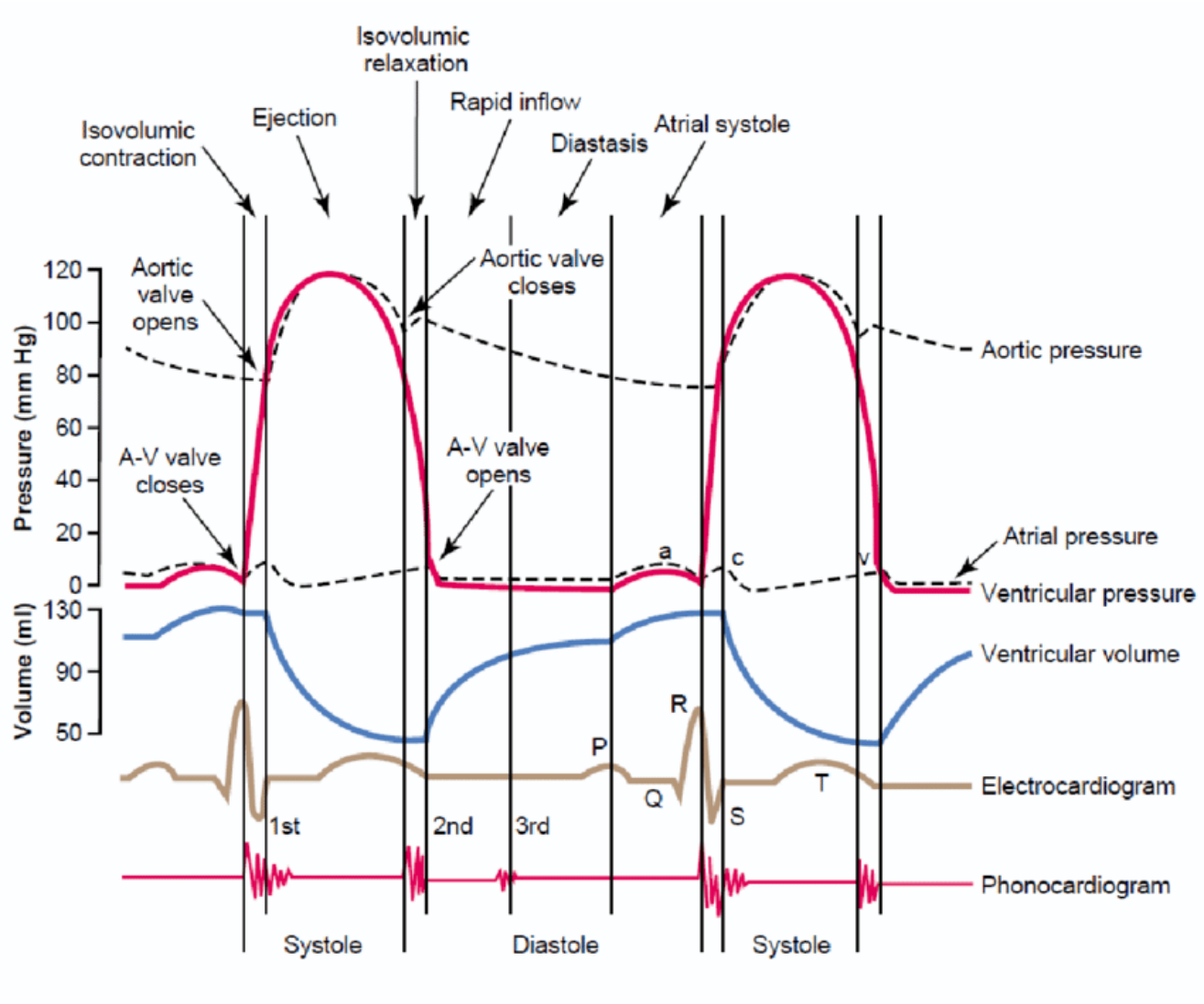


FIGURE 91.5: Comprehensive diagram showing ECG, phonocardiogram, pressure changes and volume changes during cardiac cycle