

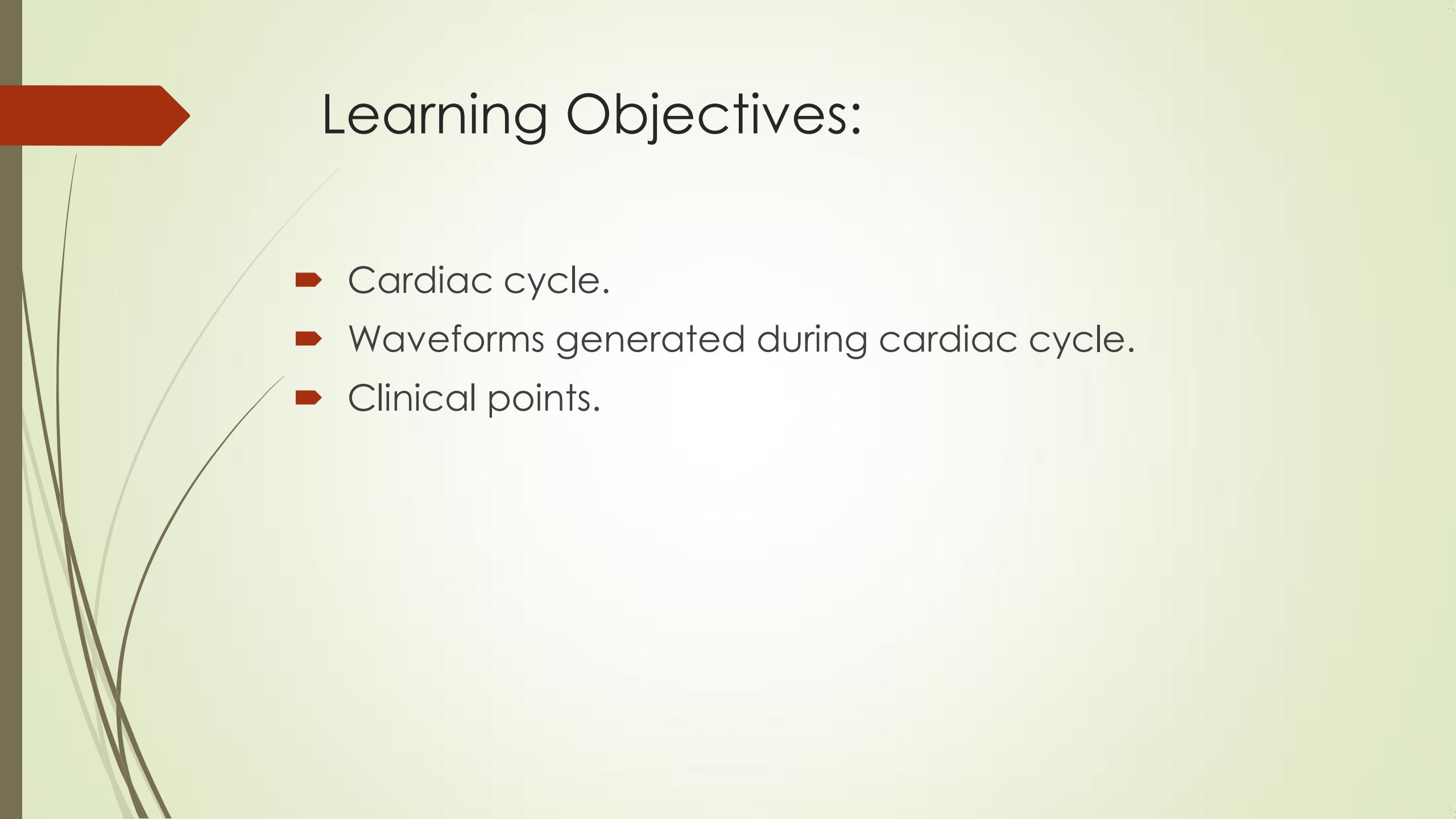


Department of Anesthesia Techniques

The lect. 3: Cardiovascular System

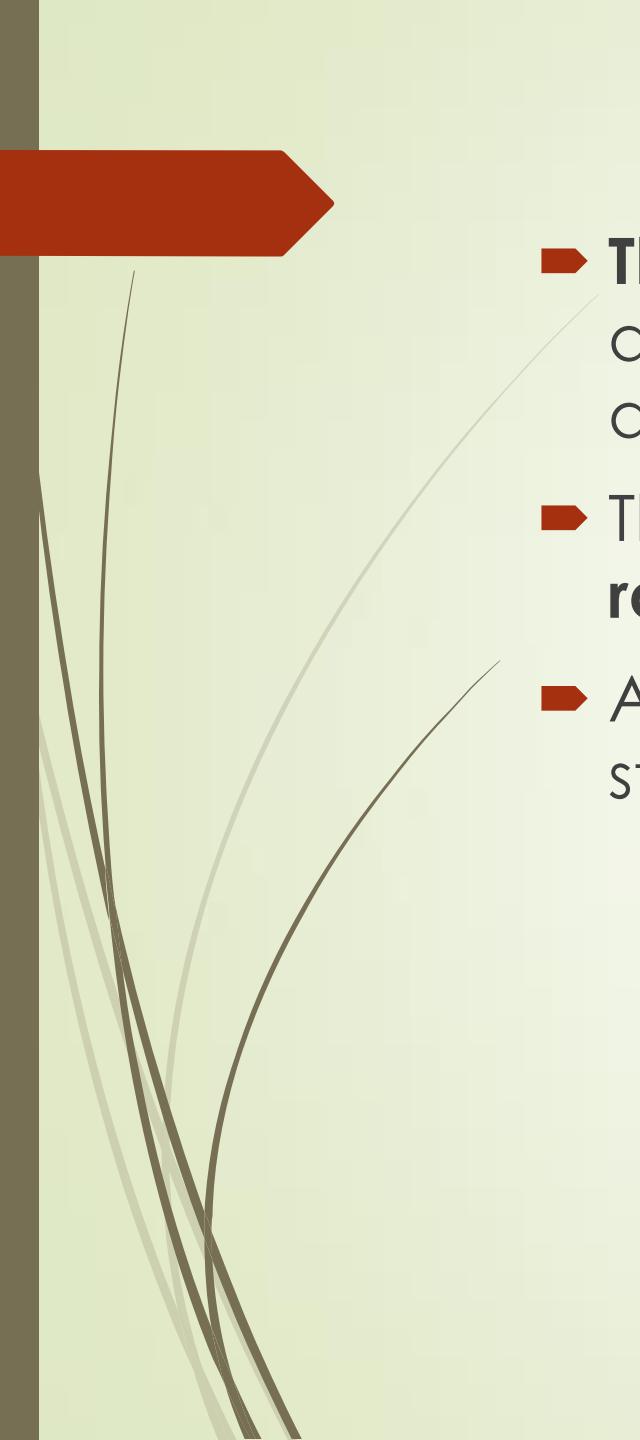
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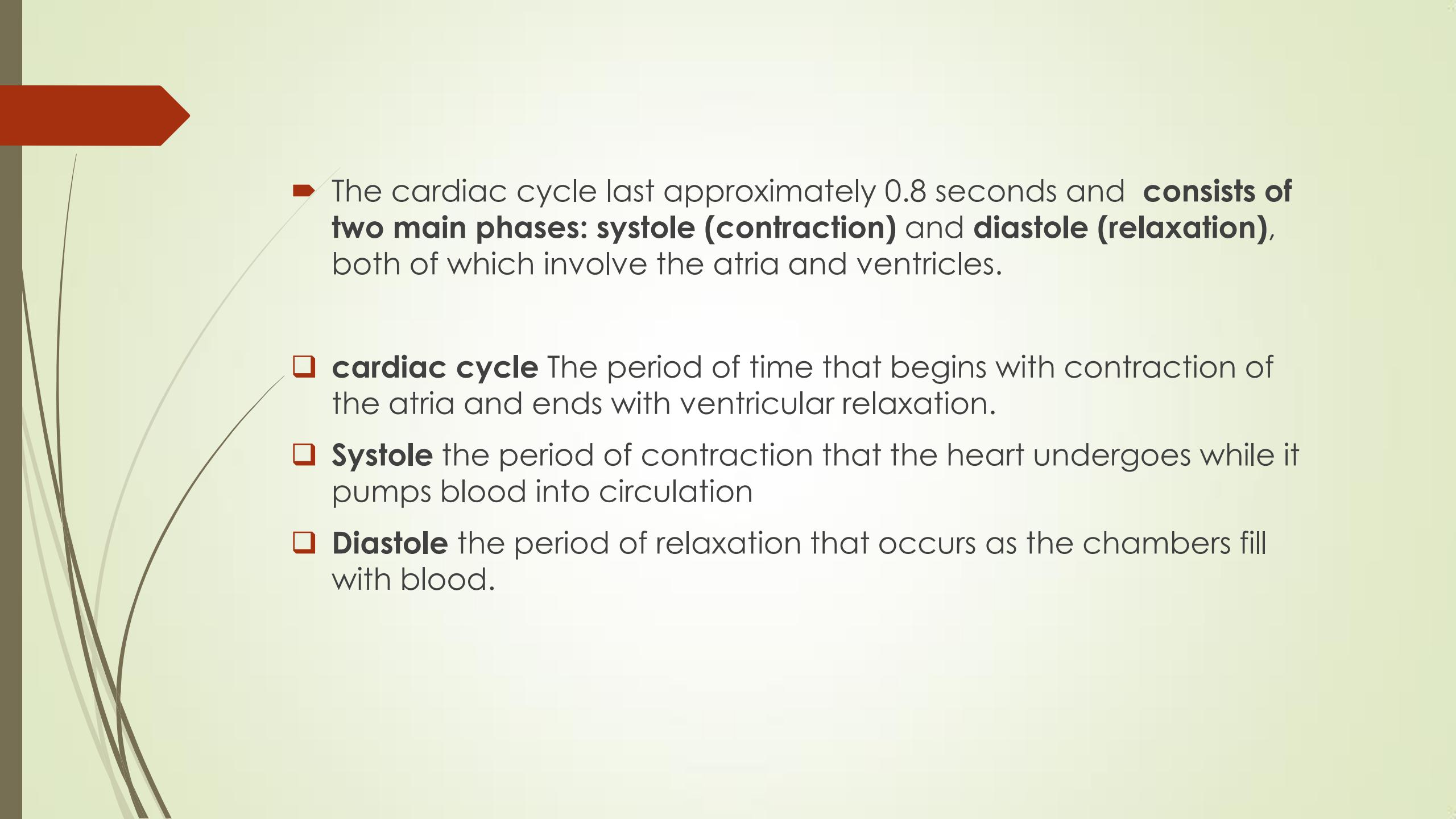


Learning Objectives:

- ▶ Cardiac cycle.
- ▶ Waveforms generated during cardiac cycle.
- ▶ Clinical points.



- **The cardiac cycle** refers to the sequence of mechanical and electrical events that occur with each heartbeat, allowing blood to circulate throughout the body.
- The occurrence of a cardiac cycle is illustrated by a **heart rate**, which is naturally indicated as beats per minute.
- A healthy human heart beats 72 times per minute which states that there are 72 cardiac cycles per minute.



► The cardiac cycle last approximately 0.8 seconds and **consists of two main phases: systole (contraction) and diastole (relaxation)**, both of which involve the atria and ventricles.

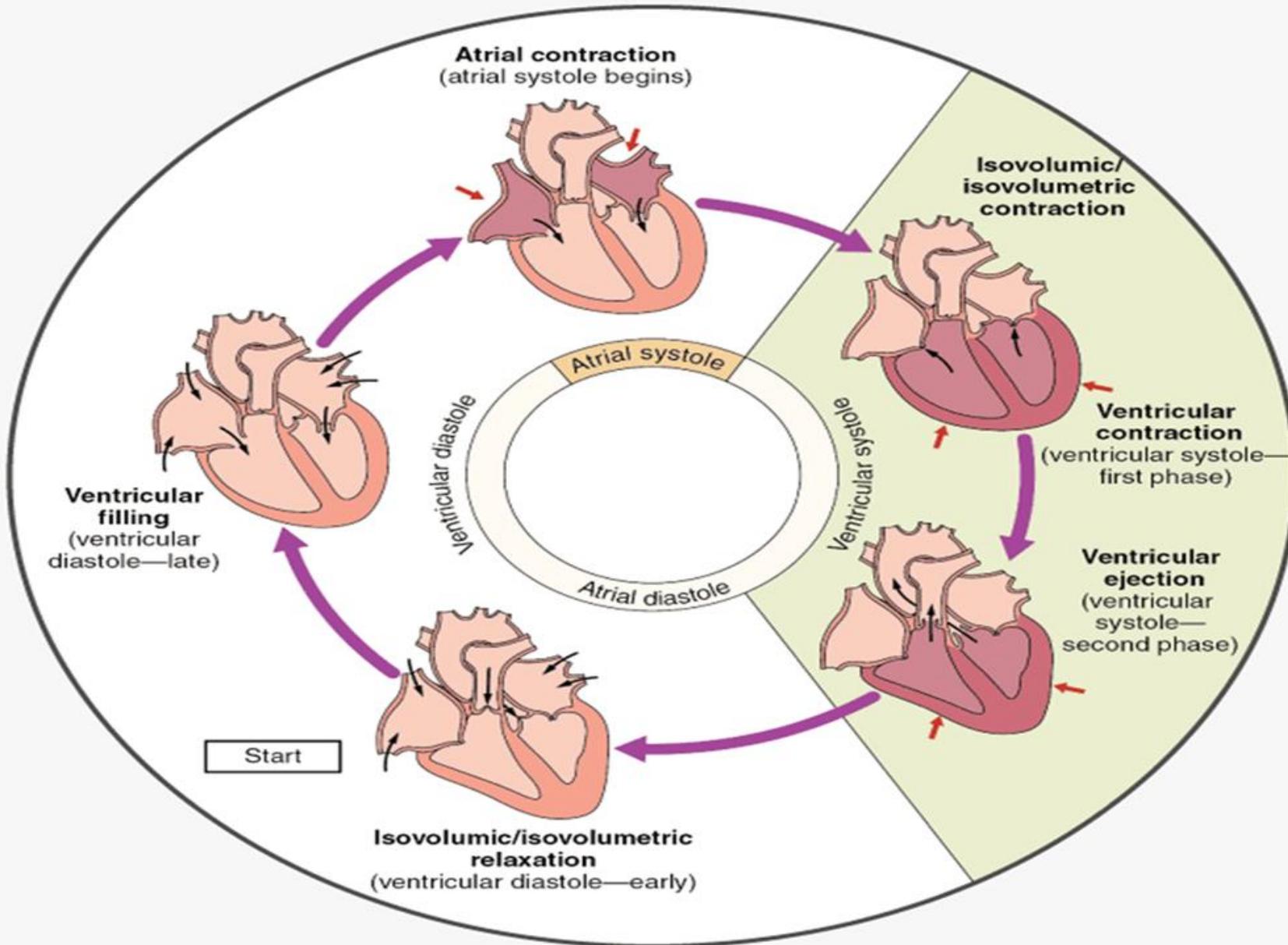
- **cardiac cycle** The period of time that begins with contraction of the atria and ends with ventricular relaxation.
- **Systole** the period of contraction that the heart undergoes while it pumps blood into circulation
- **Diastole** the period of relaxation that occurs as the chambers fill with blood.



► Cardiac Cycle Phases:

- The diagram below represents the different phases of the cardiac cycle. **The atrial systole, ventricular systole, atrial diastole, and ventricular diastole** are clearly mentioned in the cardiac cycle diagram given below.

CARDIAC CYCLE

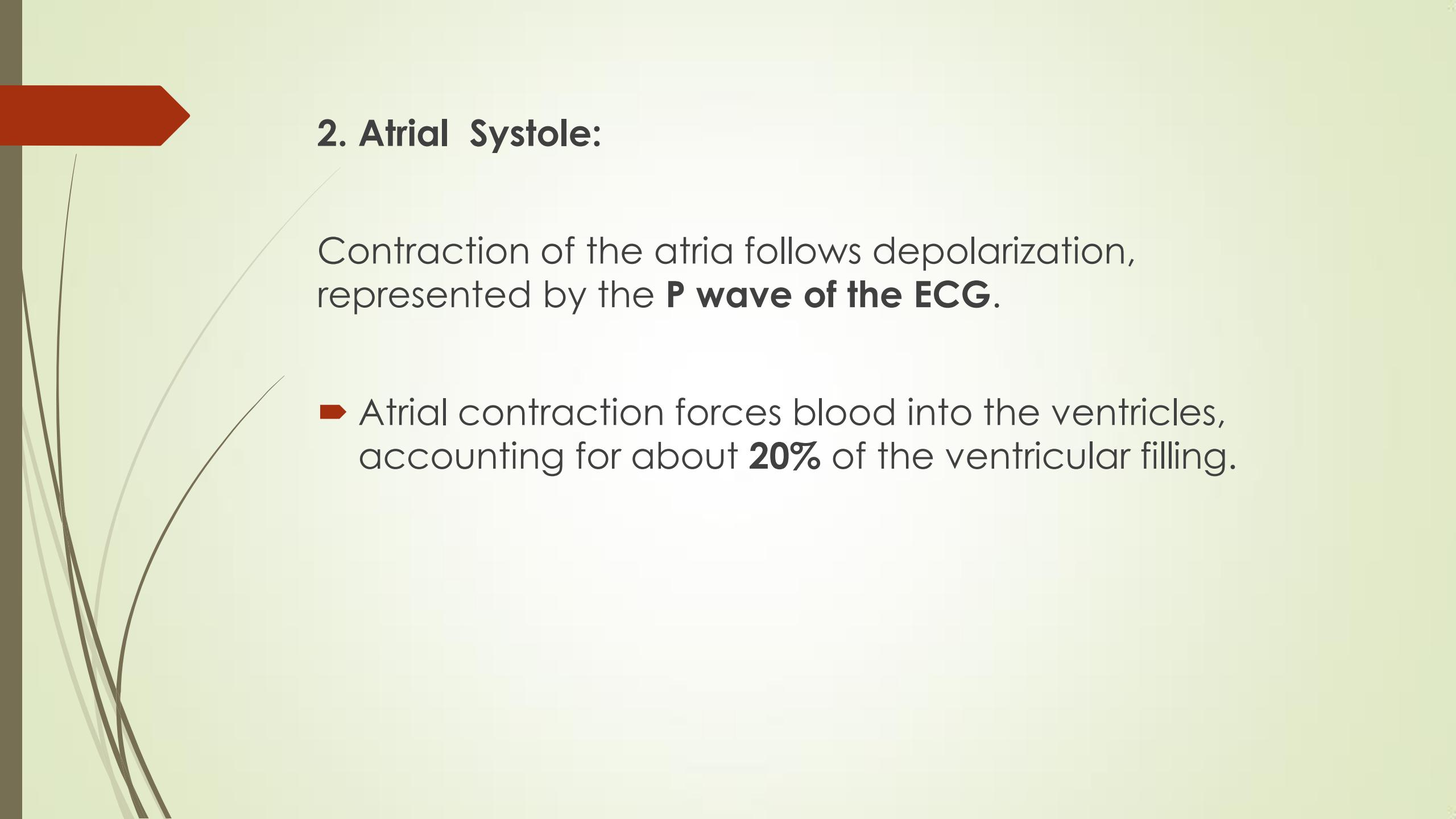




1. Atrial Diastole:

At the beginning of the cardiac cycle, both the atria and ventricles are **relaxed (diastole)**. Blood is flowing into the **right atrium** from **the superior and inferior venae cavae**. Blood flows into the **left atrium** from the **four pulmonary veins**.

- ⊕ The **two atrioventricular valves**, the tricuspid and mitral valves, are both **open**, so blood flows from the atria and into the ventricles. Approximately **80 percent** of ventricular filling occurs.
- ⊕ The **two semilunar valves**, the pulmonary and aortic valves, are **closed**



2. Atrial Systole:

Contraction of the atria follows depolarization, represented by the **P wave of the ECG**.

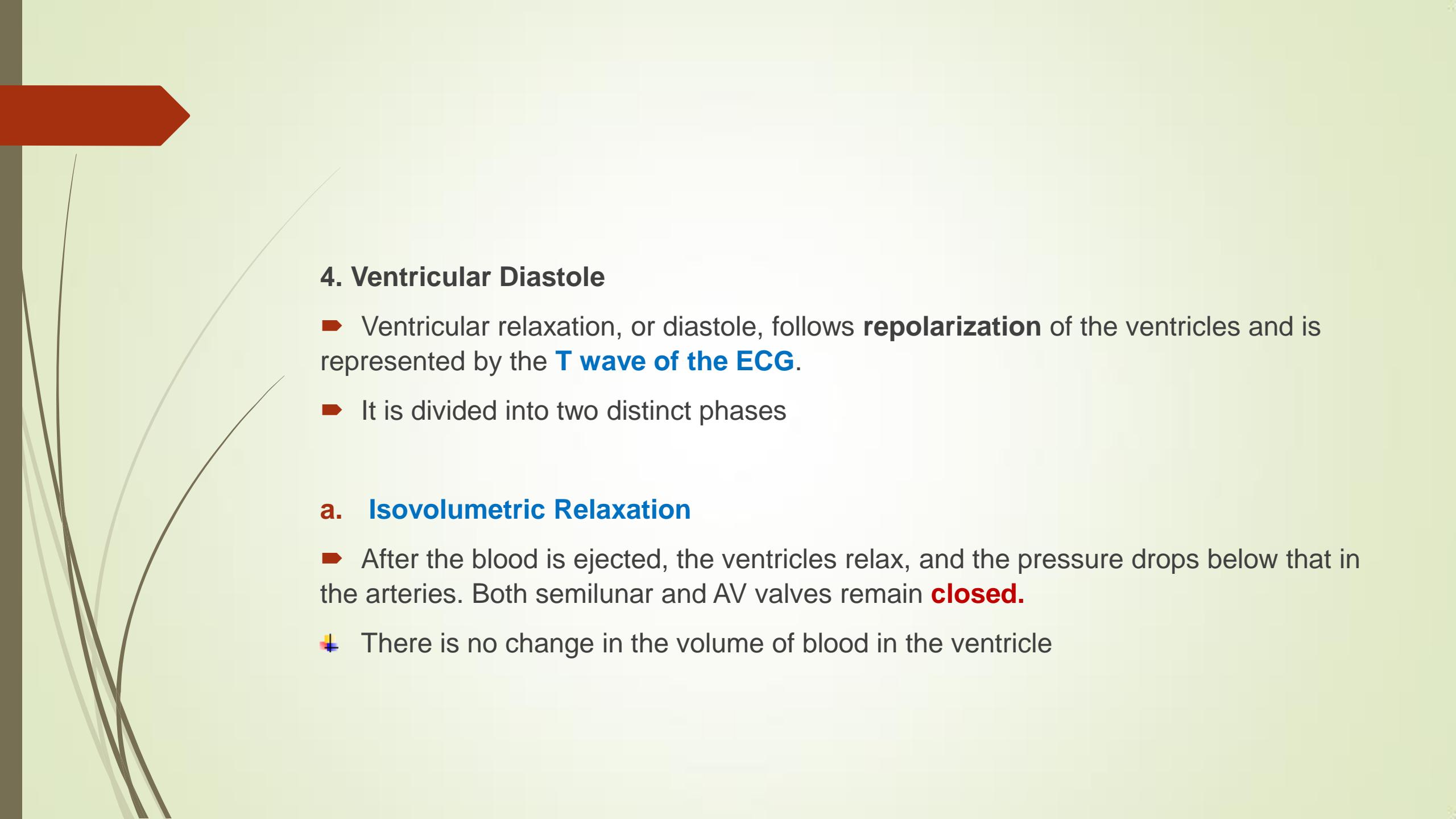
- ▶ Atrial contraction forces blood into the ventricles, accounting for about **20%** of the ventricular filling.

3. Ventricular Systole

- Ventricular systole follows the depolarization of the ventricles and is represented by the **QRS complex in the ECG**.
 - ✚ At the end of atrial systole and just prior to atrial contraction, the ventricles contain approximately 130 mL blood in a resting adult in a standing position. This volume is known as the **end diastolic volume (EDV)** or **preload**.
 - ✚ Ventricular systole divided into **two phases**:
 - Isovolumic Ventricular Contraction**
 - Ventricular Ejection**.

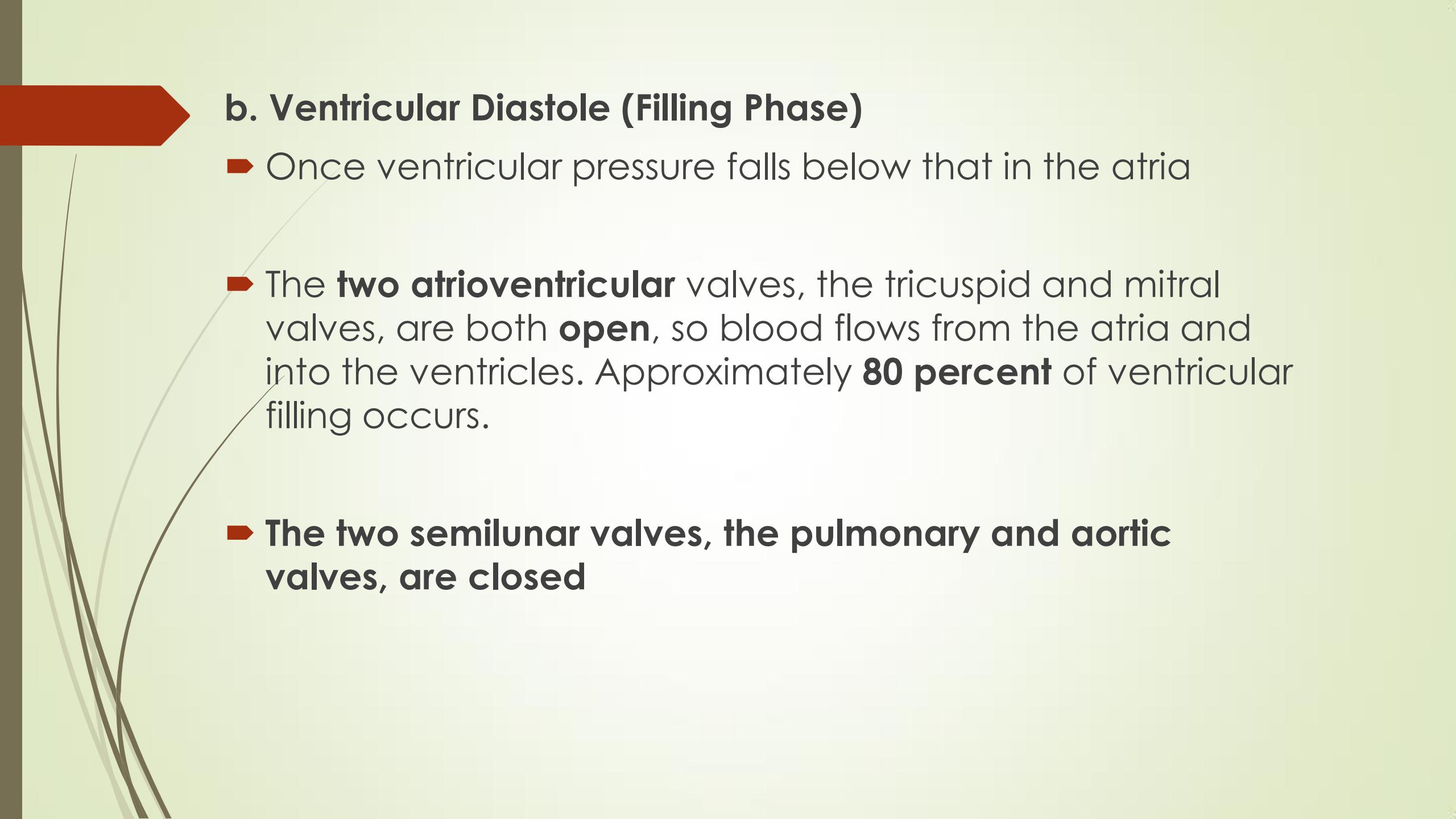
- a. **Isovolumic Ventricular Contraction** also called isovolumetric contraction
 - The ventricles begin to contract, but no blood is ejected because the atrioventricular (AV) and semilunar valves are still closed.

- a. **Ventricular Ejection**
 - Once the pressure in the ventricles exceeds that in the aorta and pulmonary artery, the semilunar valves open, and blood is ejected into the systemic and pulmonary circulations.
 - ⊕ Stroke volume depends on this phase which is the percentage of blood ejected from the ventricles.(60-80 ml)
 - ⊕ 50–60 mL of blood remaining in the ventricle following contraction. This volume of blood is known as the **end systolic volume (ESV)**.



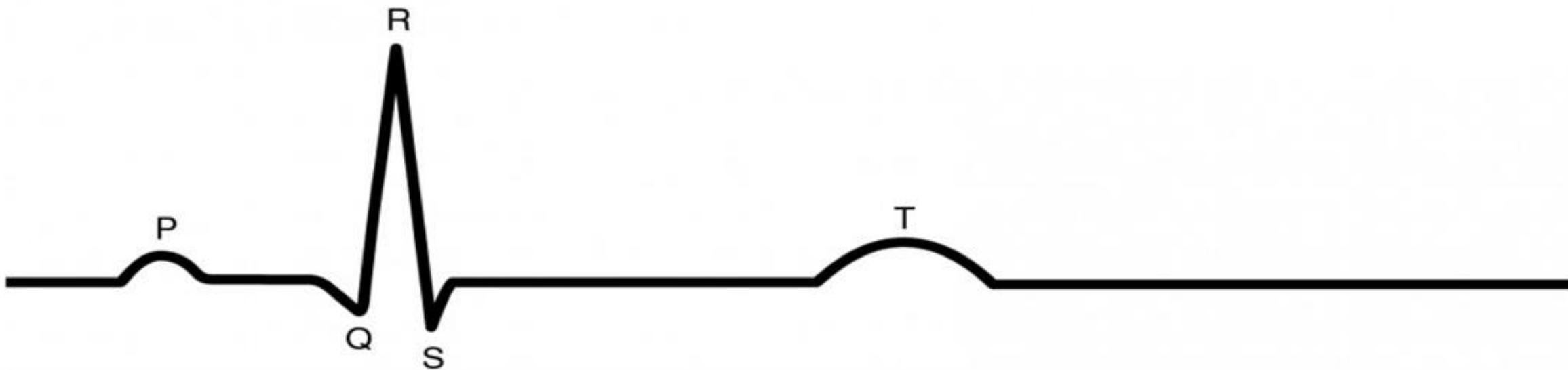
4. Ventricular Diastole

- ▶ Ventricular relaxation, or diastole, follows **repolarization** of the ventricles and is represented by the **T wave of the ECG**.
- ▶ It is divided into two distinct phases
 - a. **Isovolumetric Relaxation**
 - ▶ After the blood is ejected, the ventricles relax, and the pressure drops below that in the arteries. Both semilunar and AV valves remain **closed**.
 - ✚ There is no change in the volume of blood in the ventricle



b. Ventricular Diastole (Filling Phase)

- Once ventricular pressure falls below that in the atria
- The **two atrioventricular** valves, the tricuspid and mitral valves, are both **open**, so blood flows from the atria and into the ventricles. Approximately **80 percent** of ventricular filling occurs.
- The two semilunar valves, the pulmonary and aortic valves, are closed**



Atrial
diastole

Atrial systole

Ventricular diastole

Atrial diastole

Ventricular diastole

One cardiac cycle

Regulation and Control Mechanisms:

1. Autonomic Nervous System (ANS)

- **Sympathetic Stimulation:** Increases heart rate and contractility (positive inotropic and chronotropic effects), enhancing cardiac output.
- **Parasympathetic Stimulation (via the Vagus Nerve):** Slows heart rate and reduces contractility, conserving energy and maintaining baseline heart function.

2. Frank-Starling Law: Increased venous return stretches the ventricular walls, leading to stronger contractions and increased stroke volume

3. Vascular Resistance and Afterload: The pressure the ventricles must overcome to eject blood into the arteries. Increased afterload (e.g., from hypertension) can reduce stroke volume and strain the heart.

Clinical points:

the cardiac cycle is a tightly regulated process that ensures effective blood circulation in response to the body's metabolic demands

Cardiac abnormalities:

- **Heart Failure:** Results from inadequate ventricular contraction or filling, leading to decreased cardiac output.
- **Arrhythmias:** Disruptions in the electrical conduction can affect the timing of the cardiac cycle, leading to inefficient pumping.
- **Valvular Disease:** Conditions like stenosis or regurgitation alter the flow of blood through the heart, affecting cardiac efficiency.



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