

# The cardiac cycle and ECG

# Learning objectives

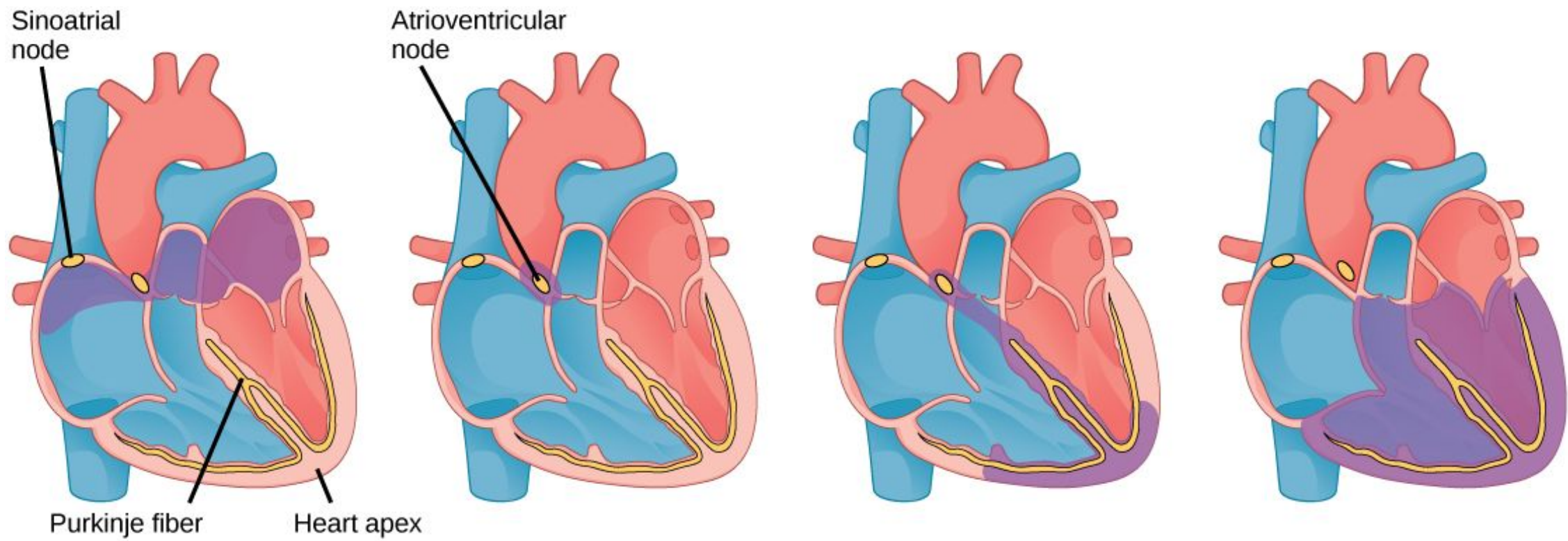
- 11.1.3.4 use an electrocardiogram to describe the cardiac cycle
- 11.1.3.5 explain oxygen dissociation curves for hemoglobin and myoglobin in adult and embryo

# Success creteria

1. Investigate the electrical process of in the heart .
2. Describe the structure of the heart and indicate the link between the structure of the heart muscles and its ability to automaticity.
3. Explain the mechanism of cardiac cycle.
4. Explain the essence of the Electrocardiography (ECG)

# Terminology

Atrium, ventricle, contract, systole, blood pressure, valves, aorta, pulmonary vein and arteria, relax, low and high pressure, diastole, vena cava, ECG – electrocardiogram, PQRST teeth, sinoatrial nodes and atrioventricular, atria, ventricles, Purkinje fibers, bundle branch block, septum, atrioventricular valves and semilunar valve, cardiac cycle, heart



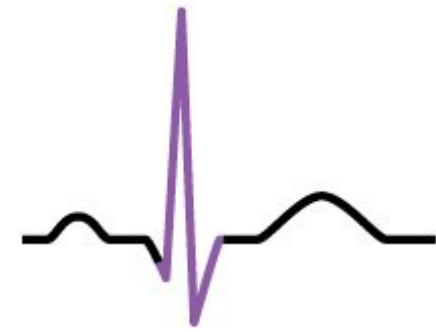
(a) An electrical impulse travels from the sinoatrial node to the walls of the atria, causing them to contract.



(b) The impulse reaches the atrioventricular node, which delays it by about 0.1 second.



(c) Bundle branches carry signals from the atrioventricular node to the heart apex.



(d) The signal spreads through the ventricle walls, causing them to contract.

# Cardiac cycle

Your heart beats around **70 times a minute**. The cardiac cycle is the sequence of events which makes up one heart beat.

**Three stages in this cycle.**

- **Atrial systole**
- **Ventricular systole**
- **Ventricular diastole**

# Atrial systole

The heart is filled with blood and the muscle in the **atrial walls contracts**. This stage is called **atrial systole**.

**The pressure developed by this contraction is not very great, because the muscular walls of the atria are only thin, but it is enough to force the blood in the atria down through the atrioventricular valves into the ventricles. The blood from the atria does not go back into the pulmonary veins or the venae cavae, because these have semilunar valves to prevent backflow.**



# Ventricular systole

About 0.1 seconds after the **atria contract**, the **ventricles contract**. This is called **ventricular systole**.

The thick, **muscular walls of the ventricles squeeze inwards on the blood, increasing its pressure and pushing it out of the heart**. As soon as the **pressure in the ventricles** becomes greater than the pressure in the atria, this pressure difference pushes the **atrioventricular valves shut**, preventing blood from going back into the atria.

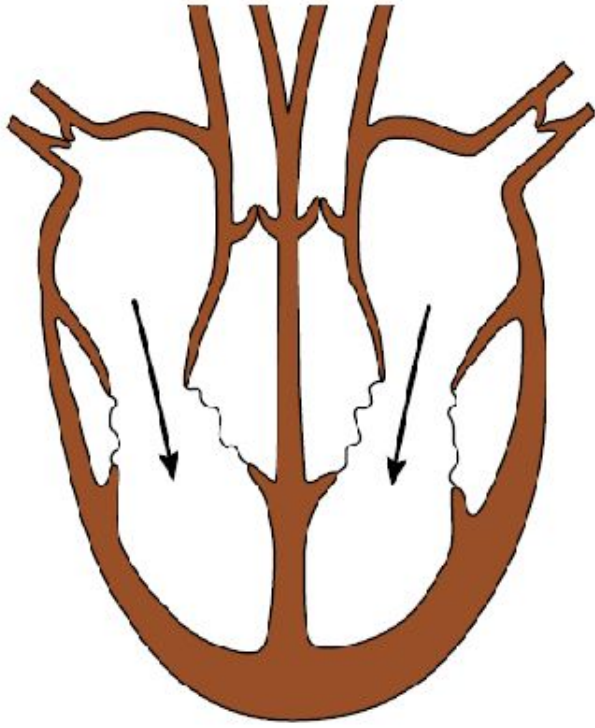
Instead, the **blood rushes upwards into the aorta** and the **pulmonary artery**, pushing open the semilunar valves in these vessels as it does so.

# Ventricular diastole

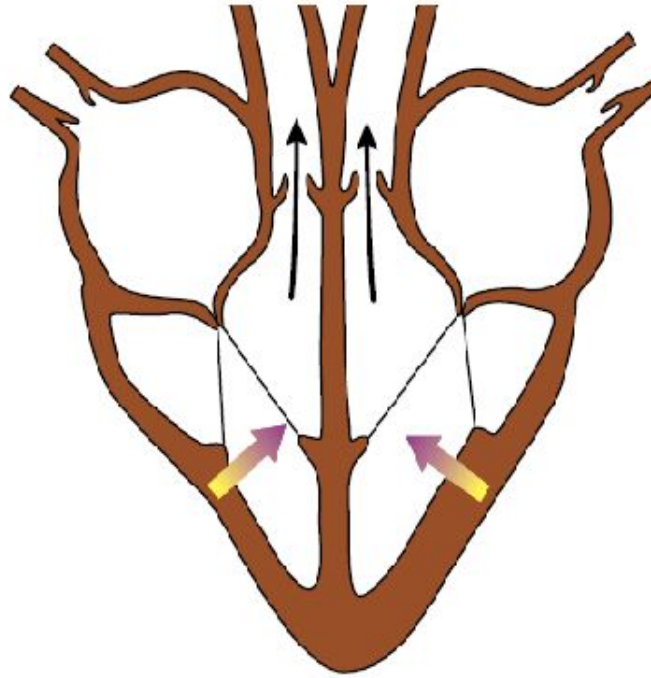
Ventricular systole lasts for about 0.3 seconds. The **muscle then relaxes**, and the stage called **ventricular diastole** begins.

As the **muscle relaxes**, the **pressure in the ventricles drops**. The high-pressure blood which has just been pushed into the arteries would flow back into the ventricles but for the presence of the semilunar valves, which snap shut as the blood fills their cusps.

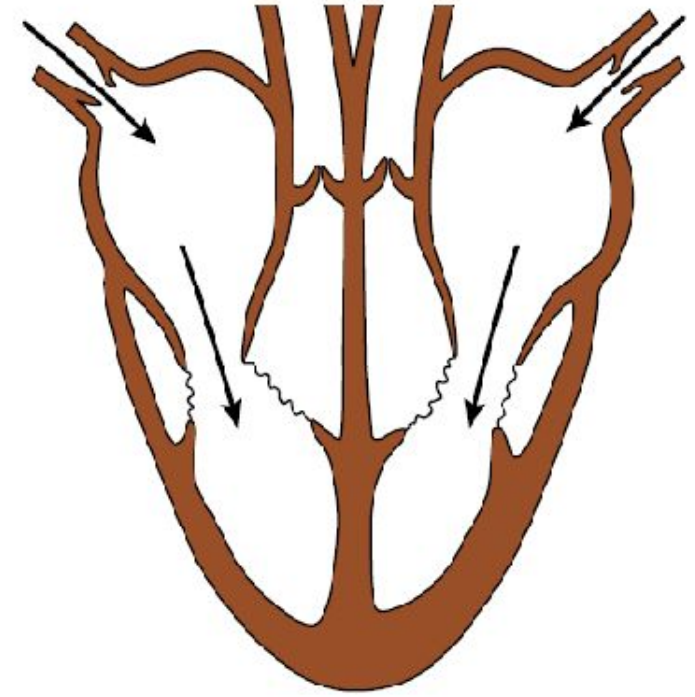
During diastole, as the whole of the **heart muscle relaxes**, **blood from the veins flows into the two atria**. The **blood** is at **a very low pressure**, but the thin walls of the atria are easily distended, providing very little resistance to the blood flow.




- 1 **Atrial systole.** Both atria contract. Blood flows from the atria into the ventricles. Backflow of blood into the veins is prevented by closure of the valves in the veins.




- 2 **Ventricular systole.** Both ventricles contract. The atrioventricular valves are pushed shut by the pressurised blood in the ventricles. The semilunar valves in the aorta and pulmonary artery are pushed open. Blood flows from the ventricles into the arteries.



- 3 **Ventricular diastole.** Atria and ventricles relax. The semilunar valves in the aorta and pulmonary artery are pushed shut. Blood flows from the veins through the atria and into the ventricles.

 pressure exerted by contraction of muscle

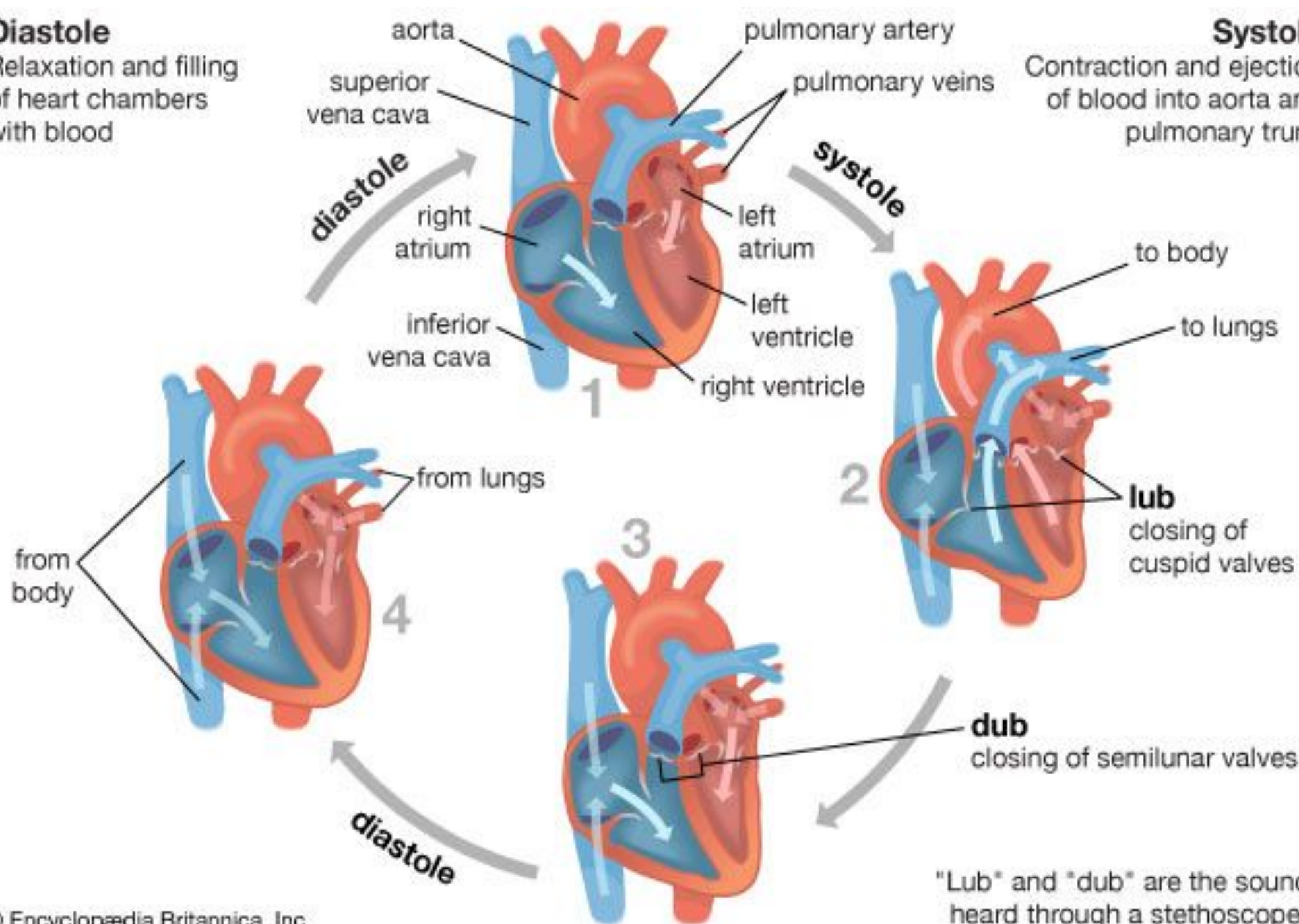
 movement of blood

## Diastole

Relaxation and filling of heart chambers with blood

## Systole

Contraction and ejection of blood into aorta and pulmonary trunk





## Blood flow steps

Oxygenated blood  
to all the cells in the  
body via aorta

Deoxygenated blood  
from body to RA  
through vena cava

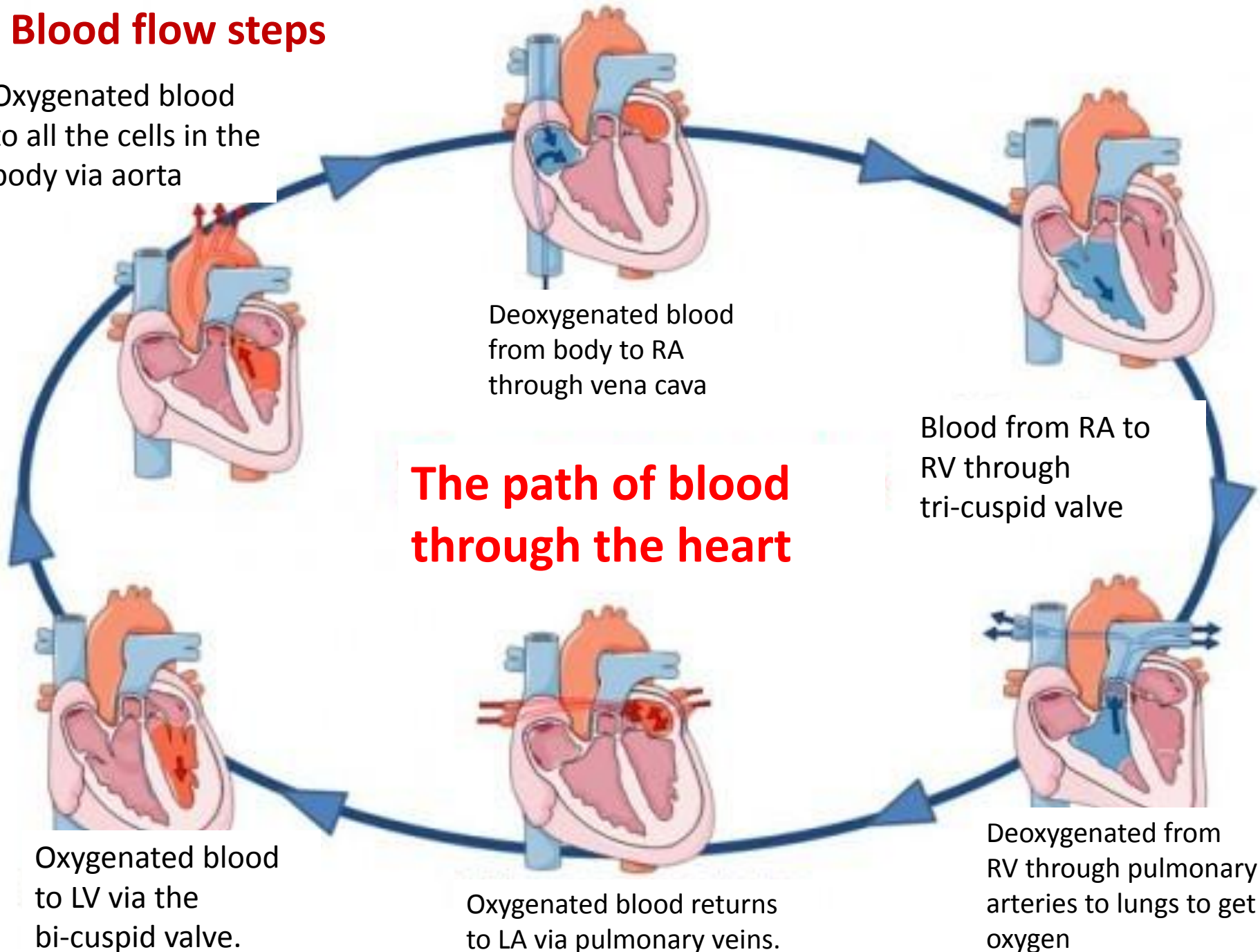
Blood from RA to  
RV through  
tri-cuspid valve

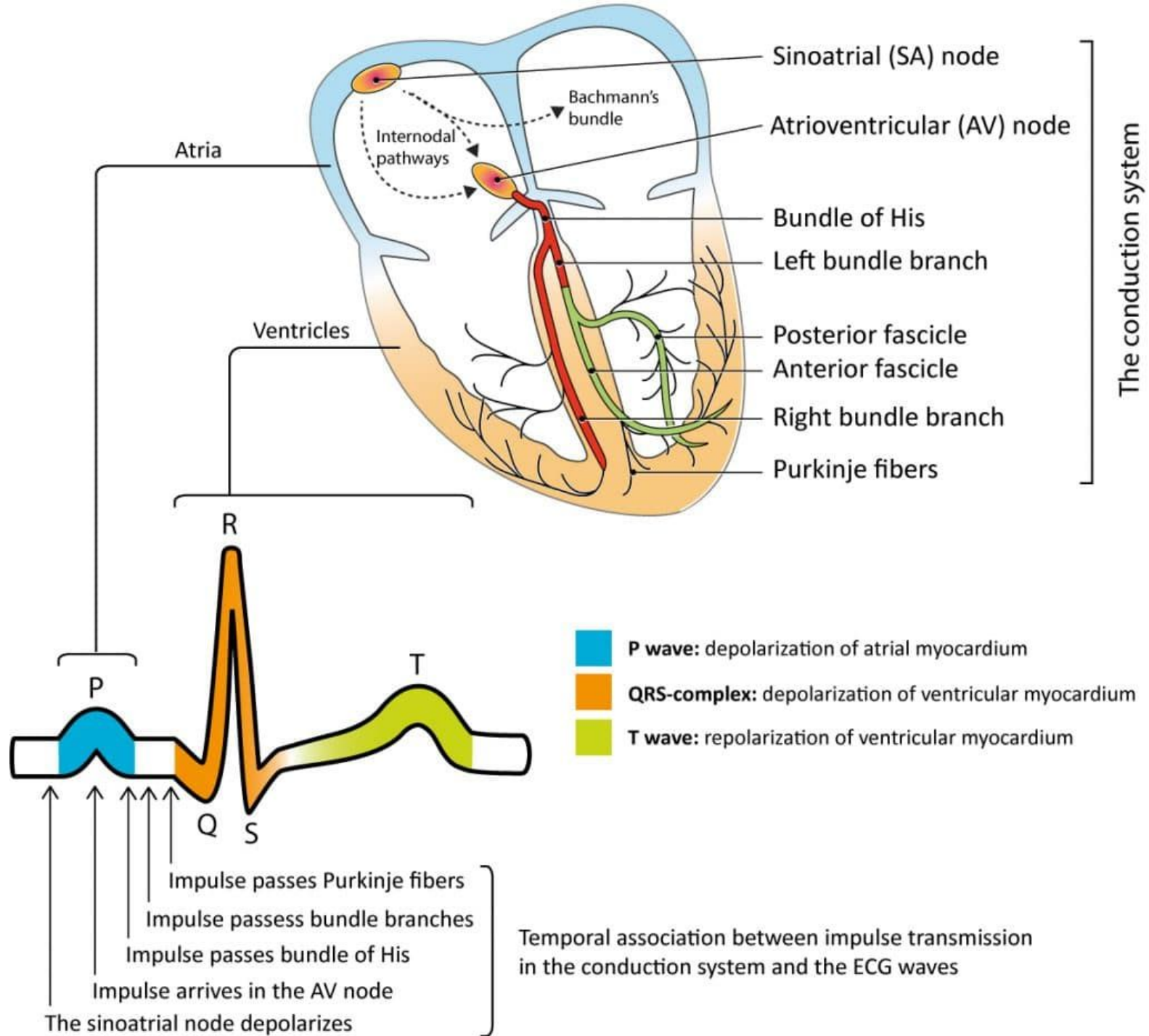
Deoxygenated from  
RV through pulmonary  
arteries to lungs to get  
oxygen

Oxygenated blood returns  
to LA via pulmonary veins.

Oxygenated blood  
to LV via the  
bi-cuspid valve.

**The path of blood  
through the heart**



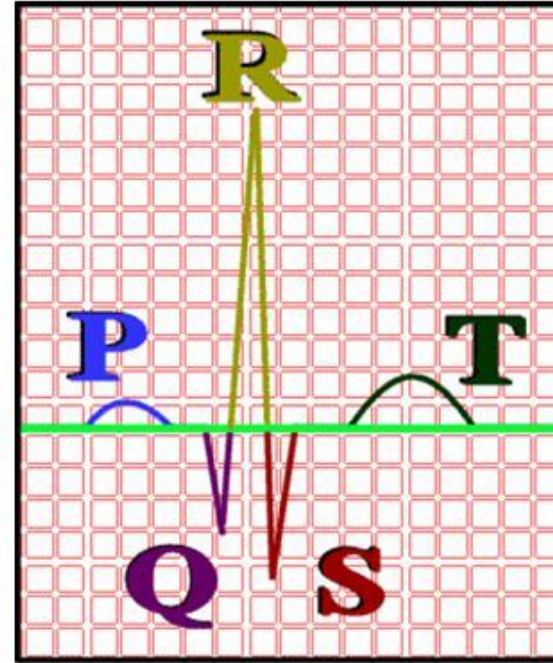


# Electrocardiograms (ECGs)

It is relatively easy to detect and record the waves of excitation flowing through heart muscle. Electrodes can be placed on the skin over opposite sides of the heart, and the electrical potentials generated recorded with time. The result, which is essentially a graph of voltage against time, is an electrocardiogram (ECG). The part labelled **P** represents the wave of excitation sweeping over the atrial walls. The parts labelled **Q, R and S** represent the wave of excitation in the ventricle walls. The **T** section indicates the recovery of the ventricle walls.

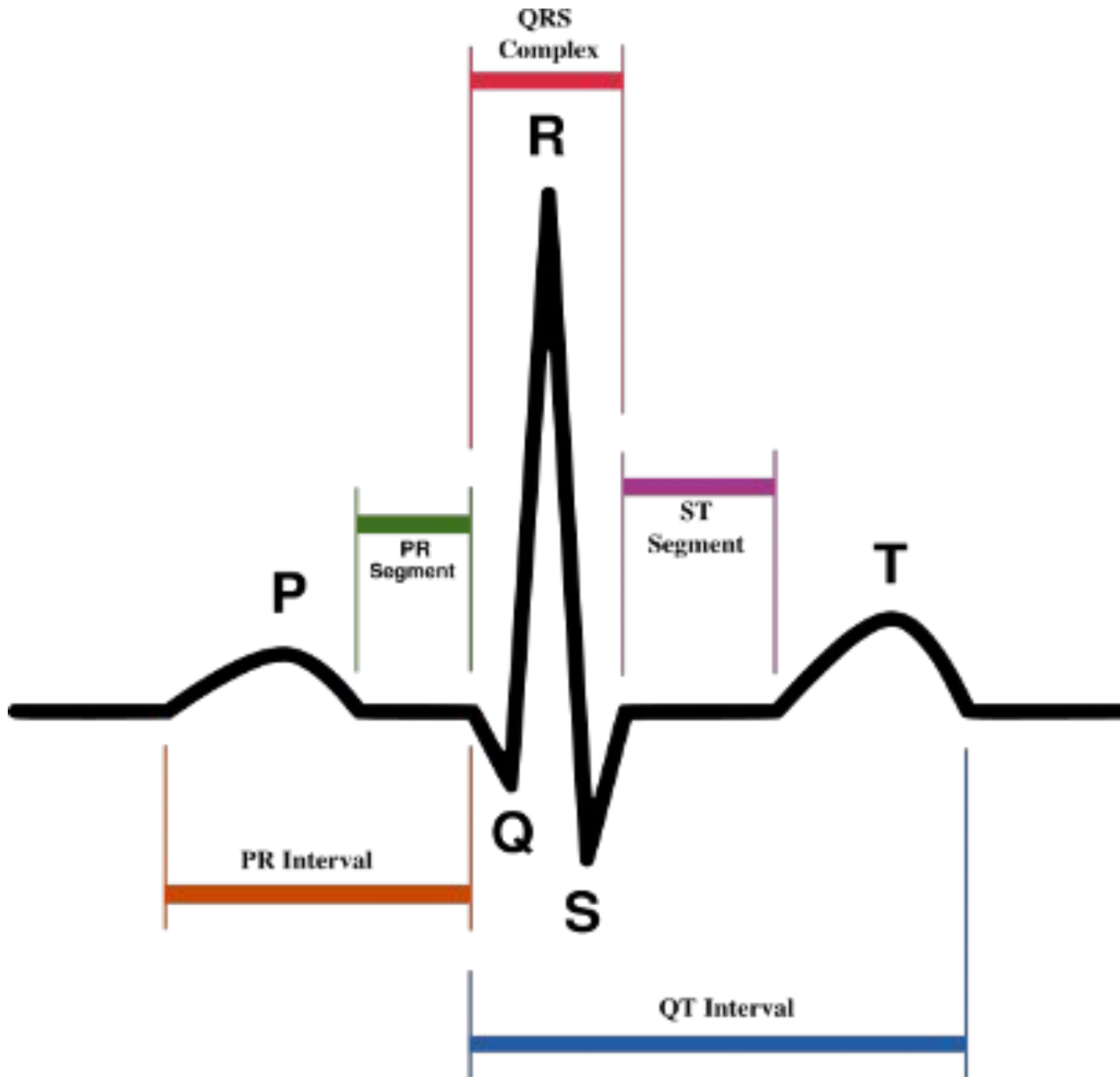
# ECG – electrocardiogram – a recording of the electrical events (changes) during a cardiac cycle

- P Wave – depolarization of the atria (atrial contraction – systole)
- QRS Complex – depolarization of the ventricles (ventricular contraction, systole)
- T Wave – Repolarization of the ventricles



Heart Sounds – opening and closing of the valves, flow of blood into and out of the chambers, vibrations in muscle



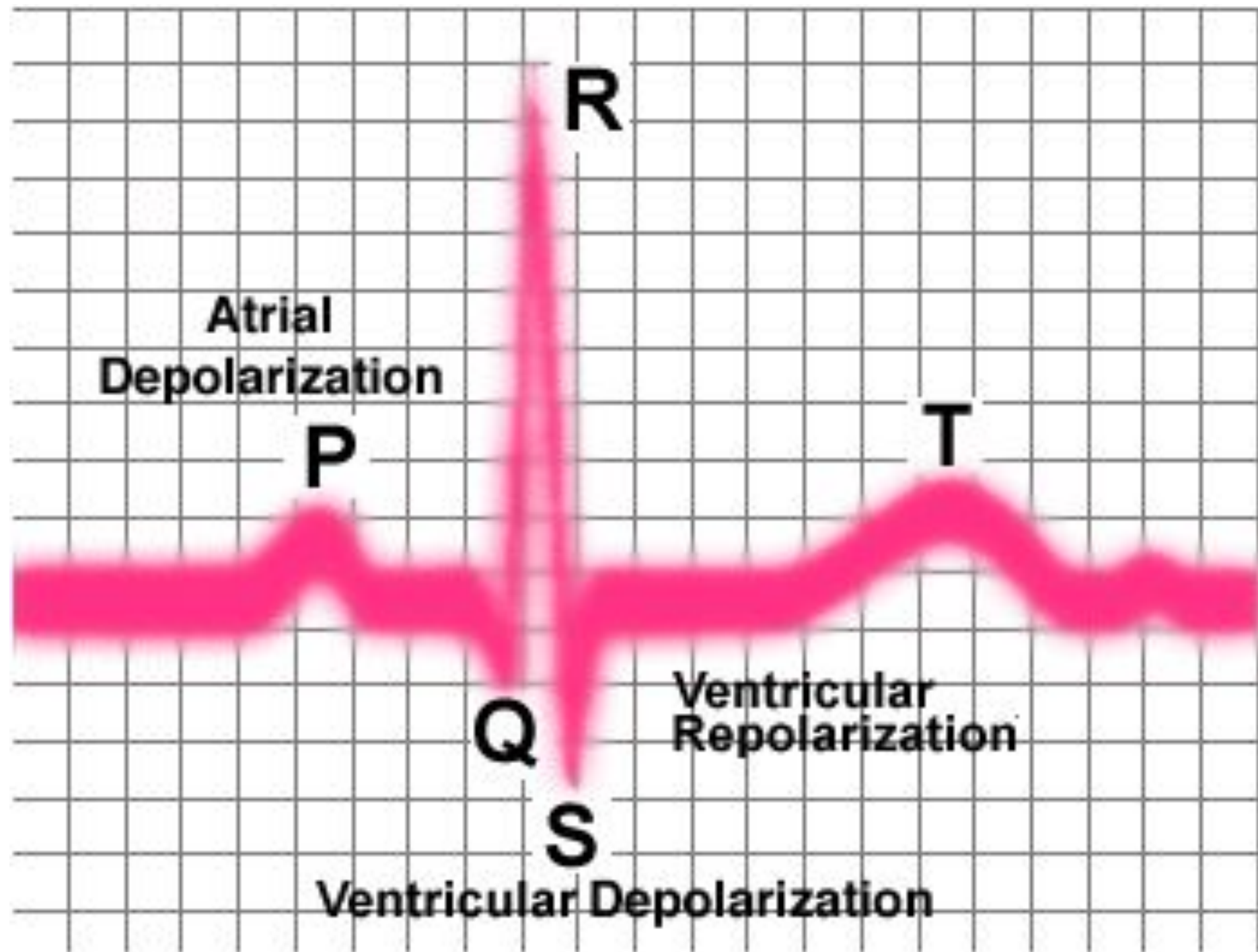


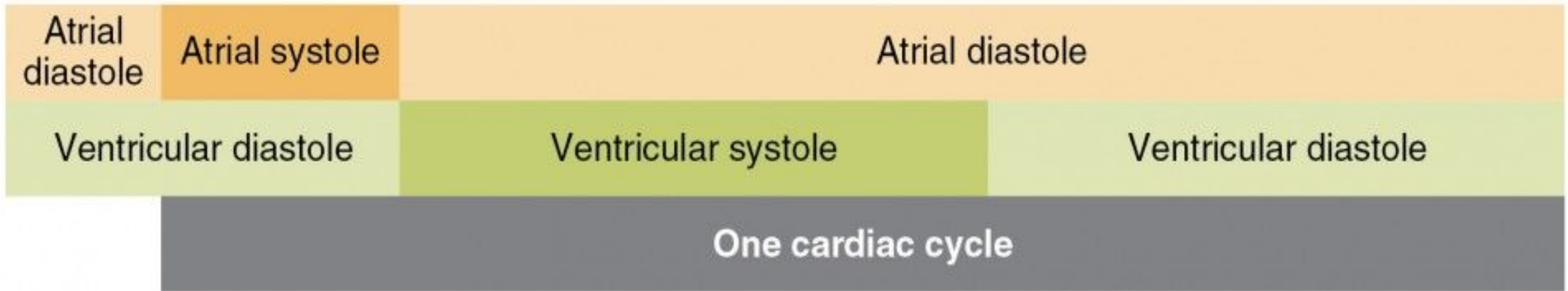
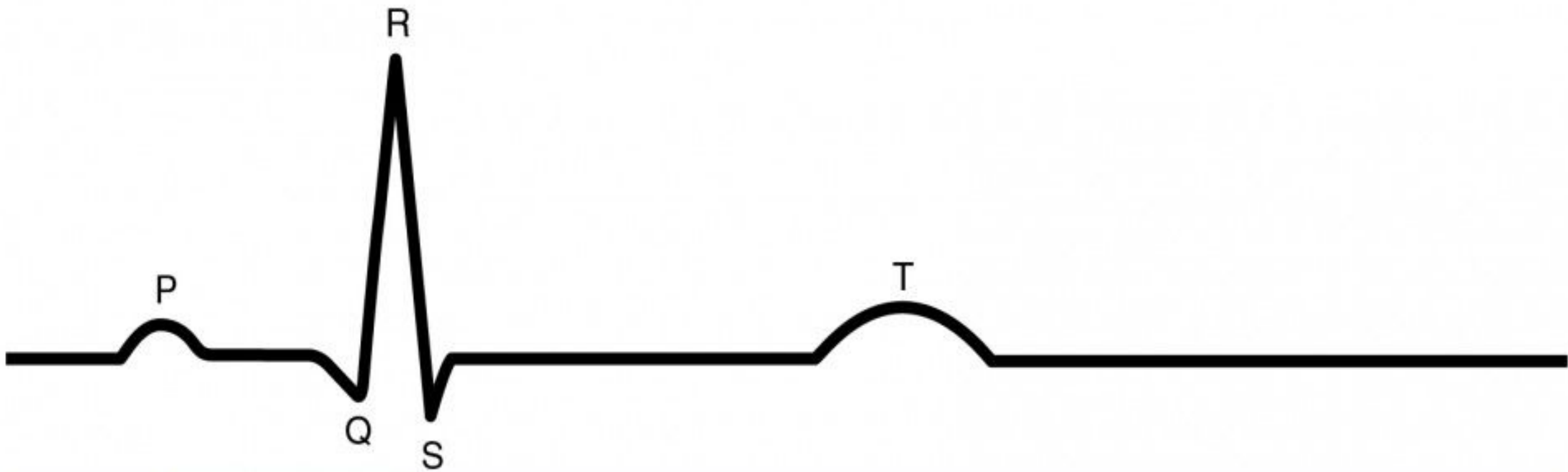
## ECG teeth

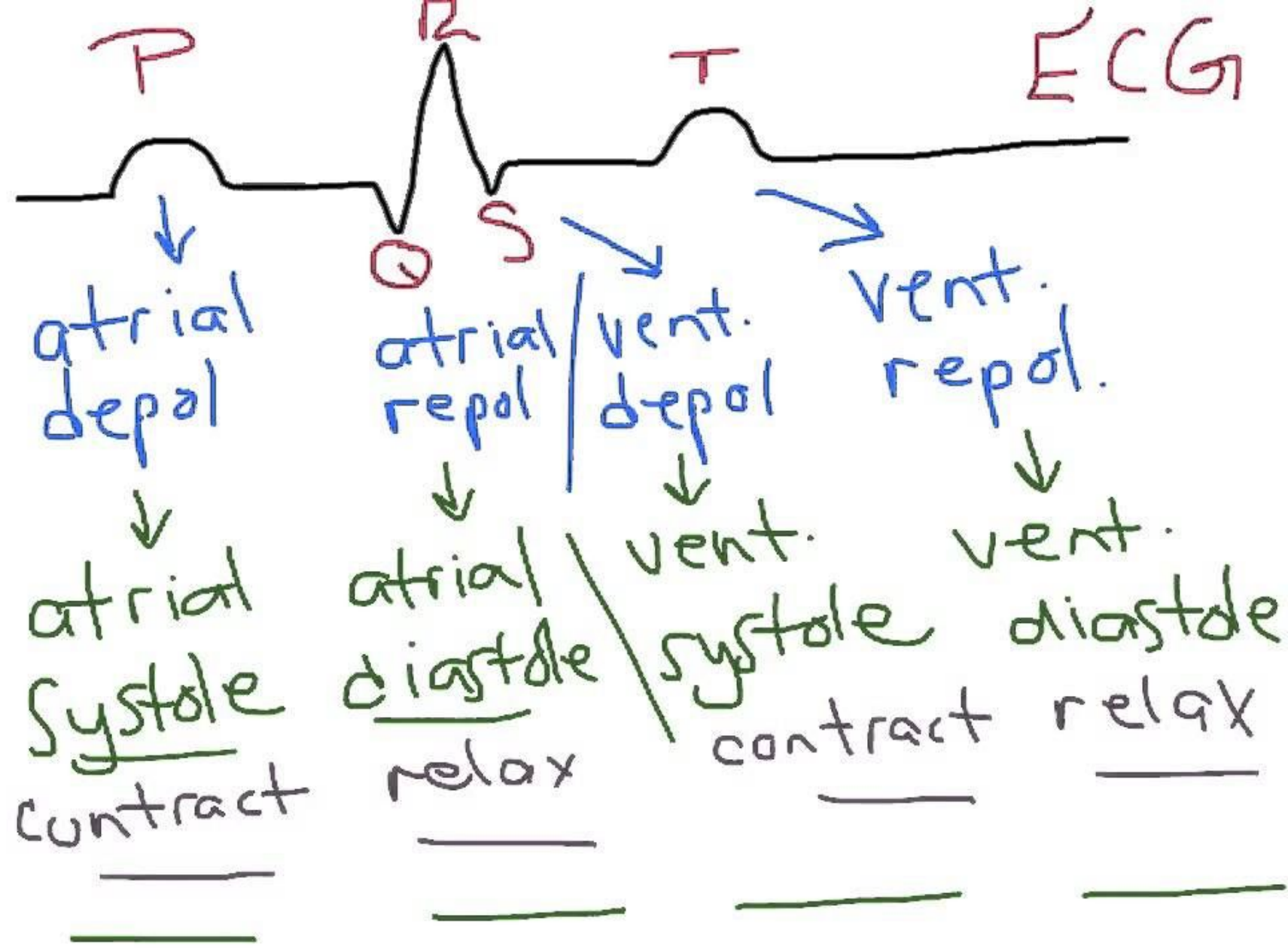
**P-** the sinoatrial node depolarization, impulse arrive in the AV node and impulse passes bundle of His

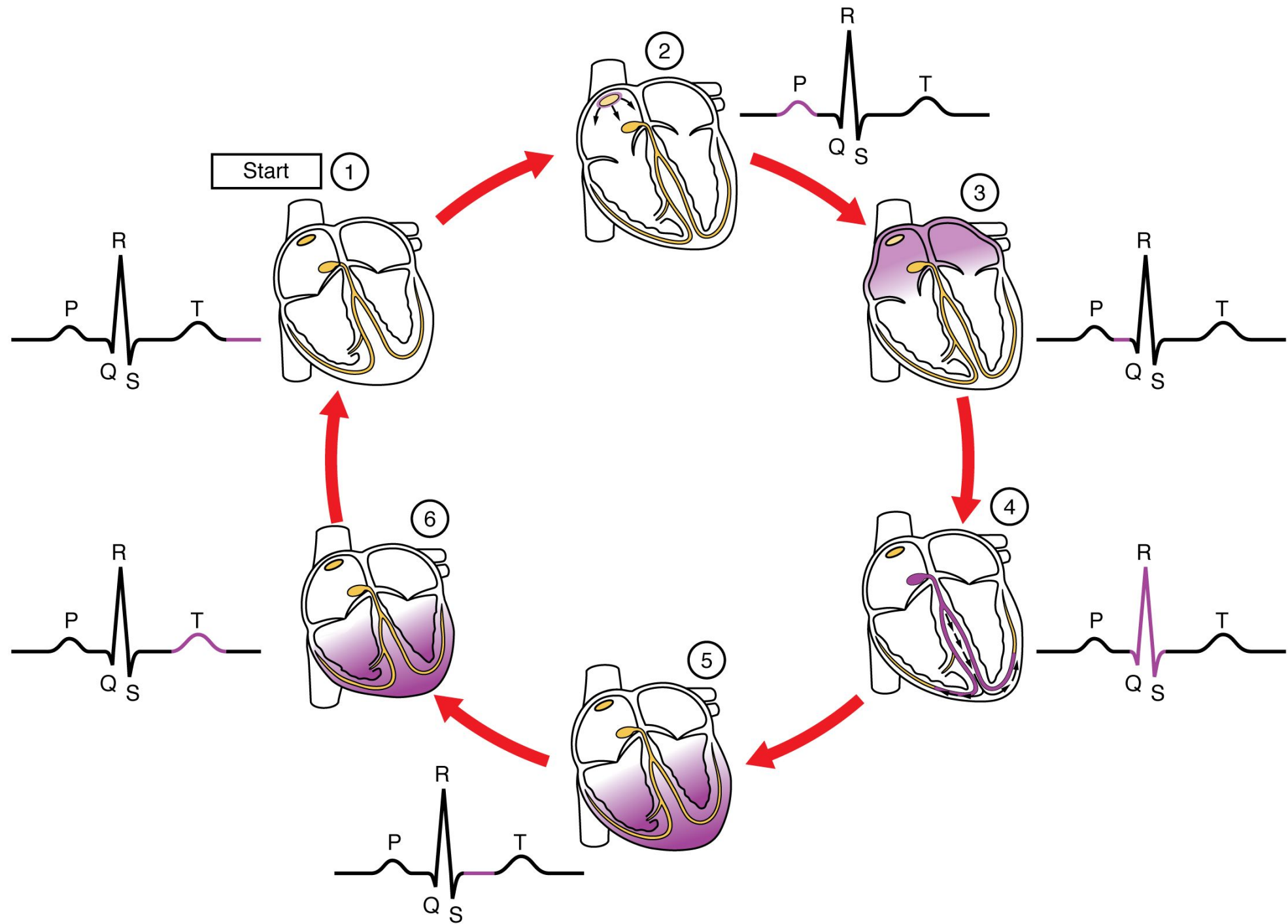
**QRS complex** - depolarization of ventricular myocardium

**T-** repolarization of ventricular myocardium

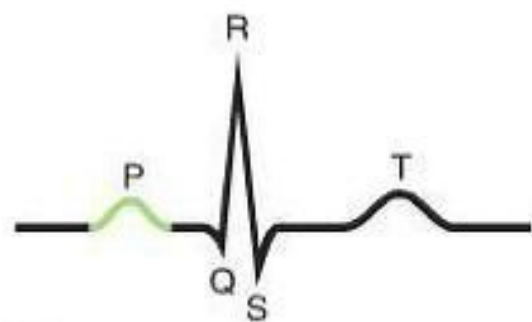
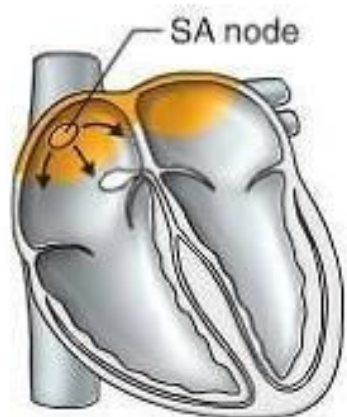




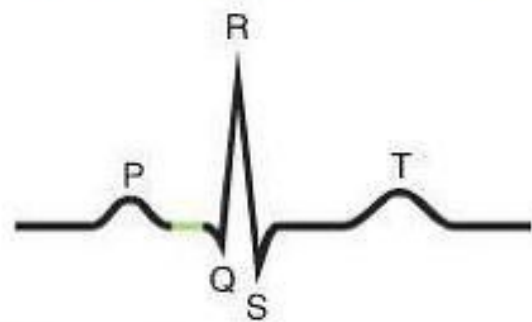
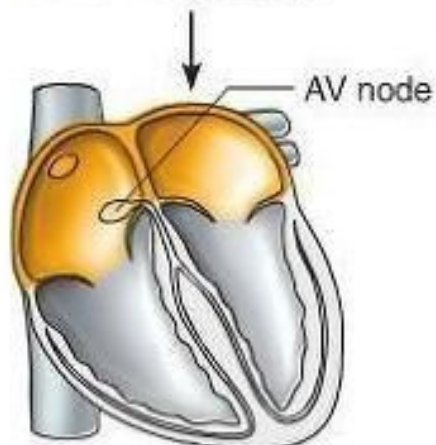




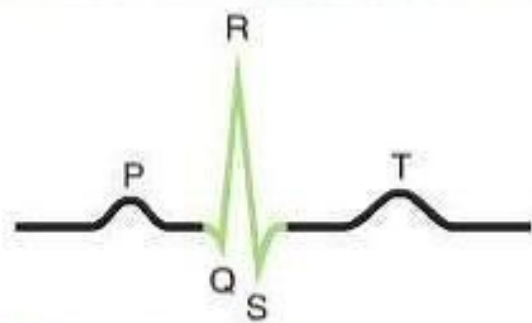
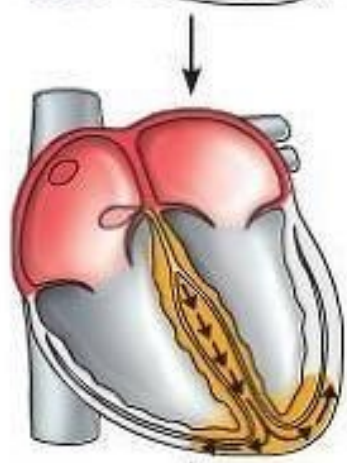




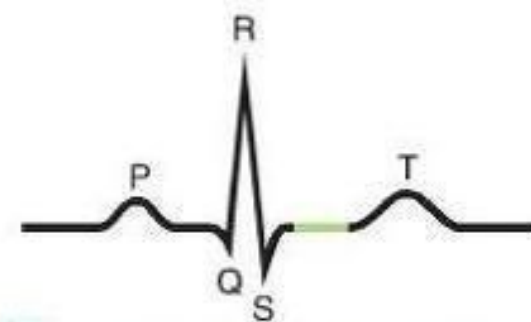
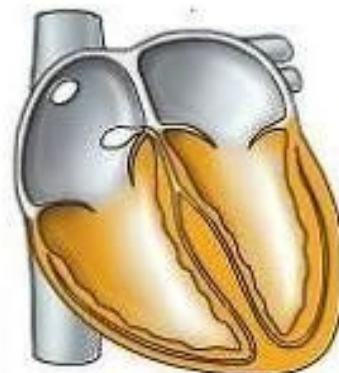
① Atrial depolarization, initiated by the SA node, causes the P wave.



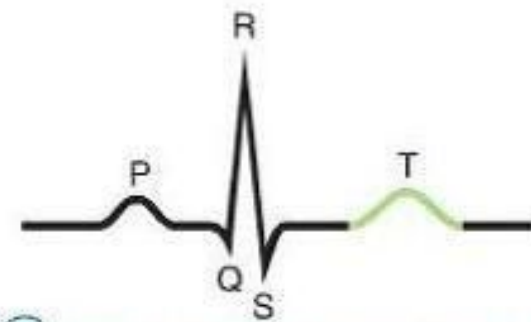
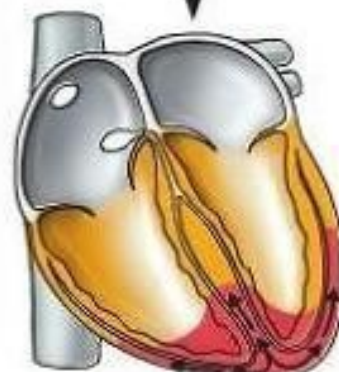
② With atrial depolarization complete, the impulse is delayed at the AV node.



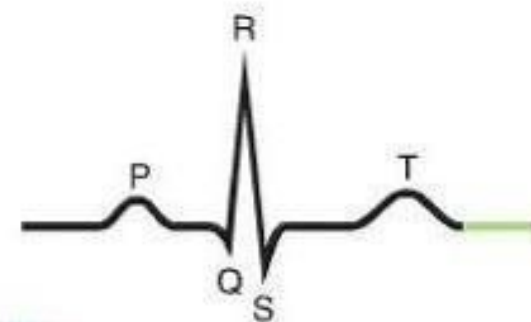
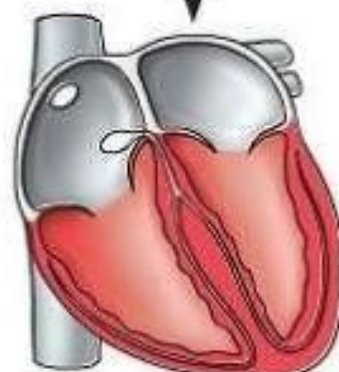
③ Ventricular depolarization begins at apex, causing the QRS complex. Atrial repolarization occurs.



④ Ventricular depolarization is complete.



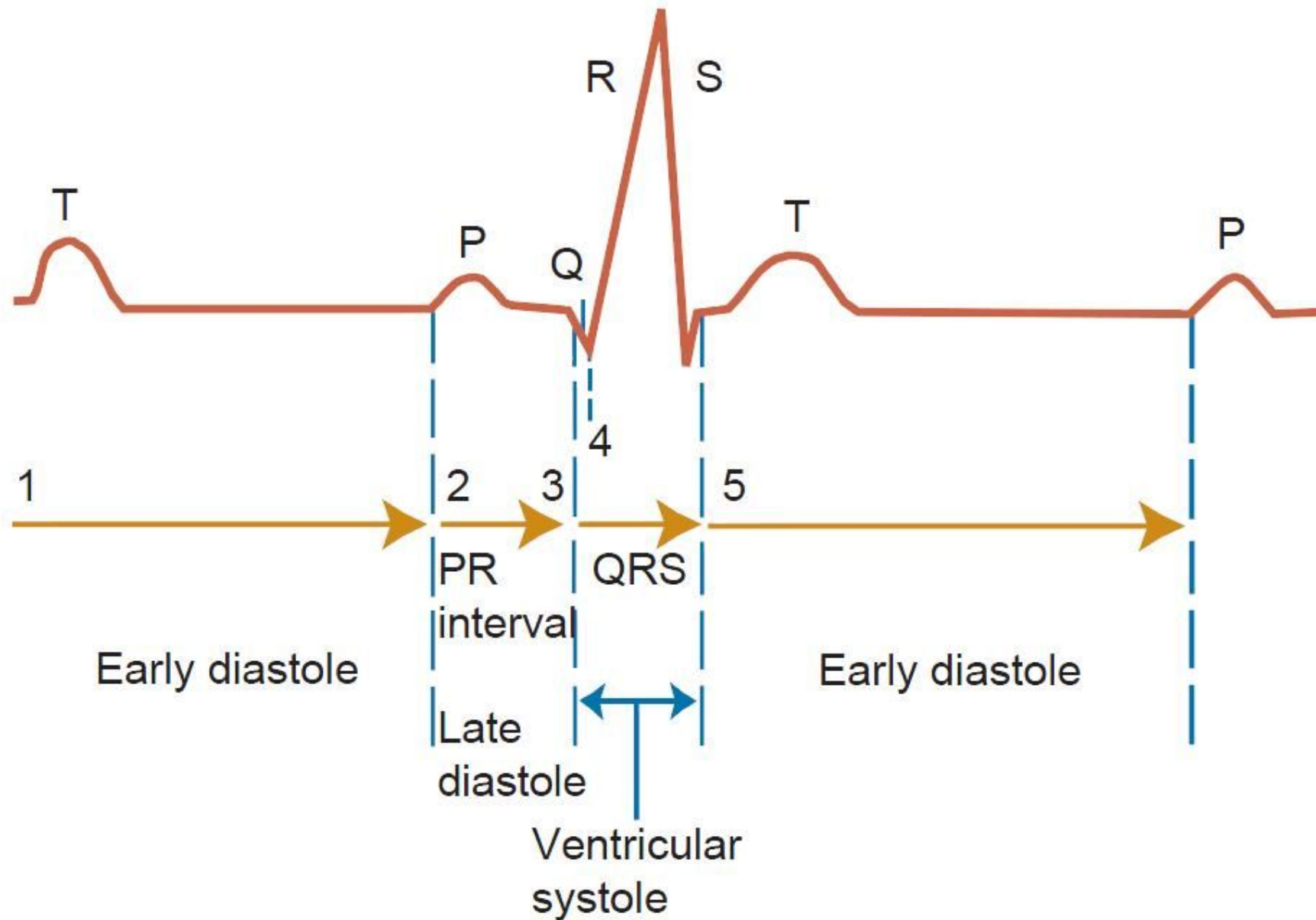
⑤ Ventricular repolarization begins at apex, causing the T wave.



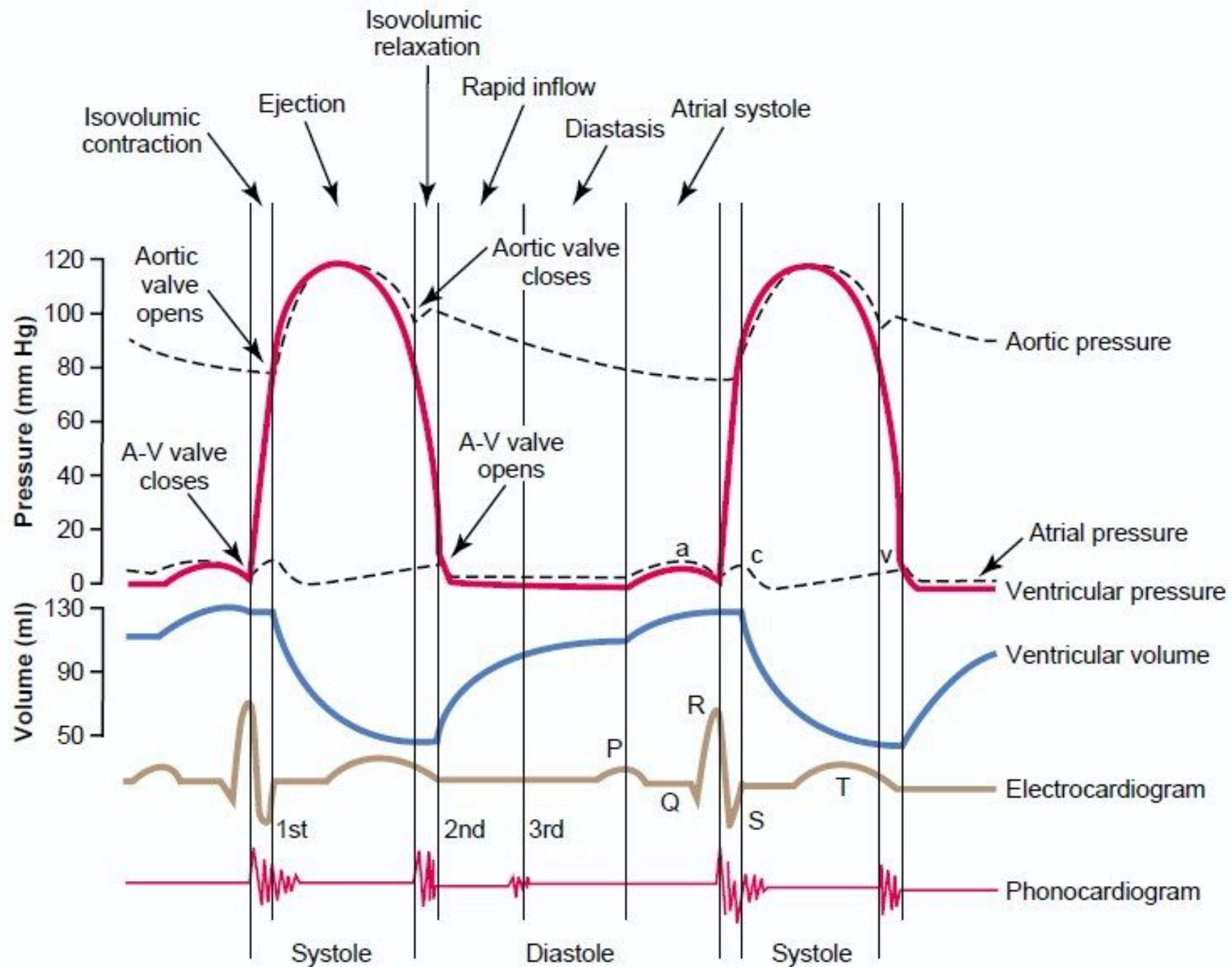
⑥ Ventricular repolarization is complete.

Depolarization

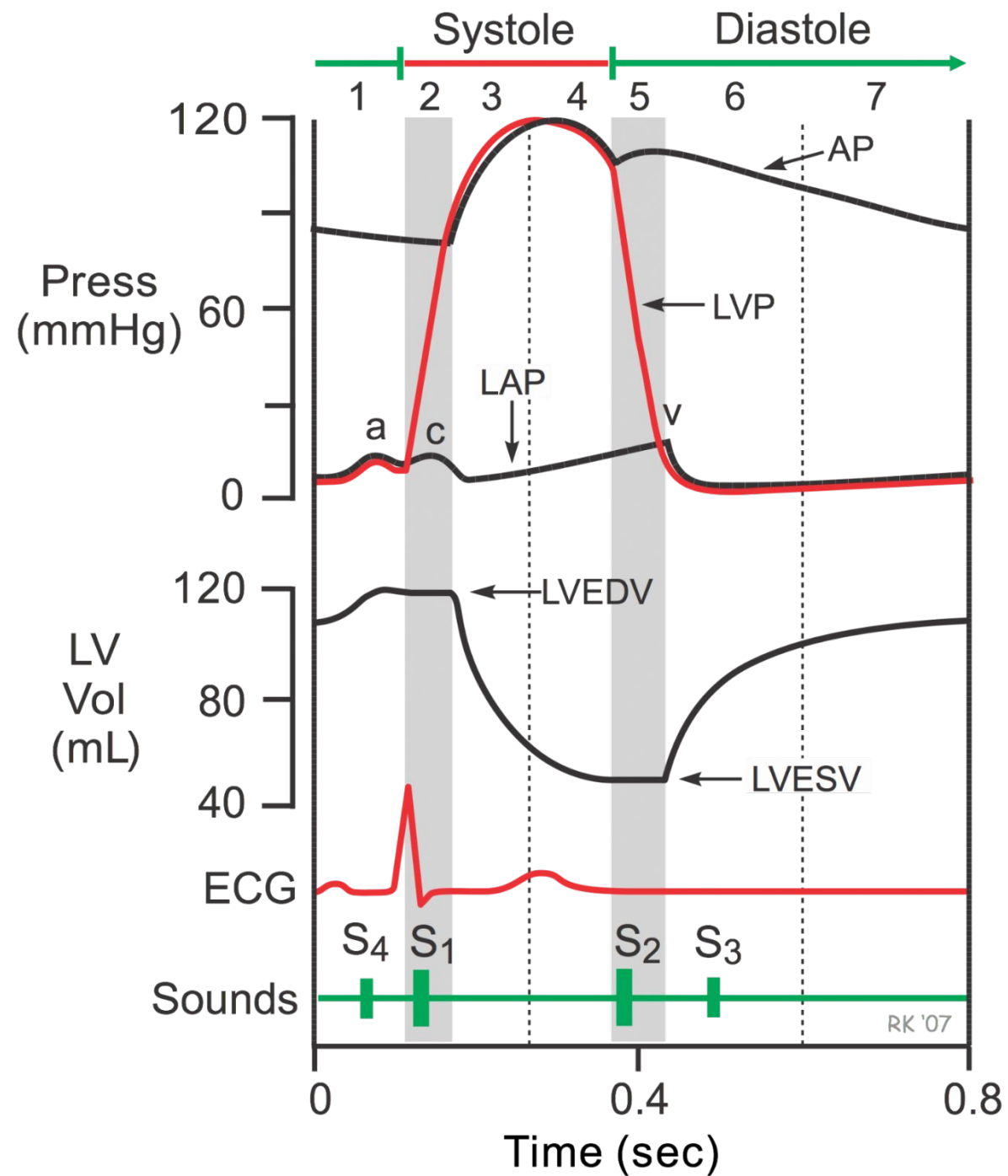
Repolarization

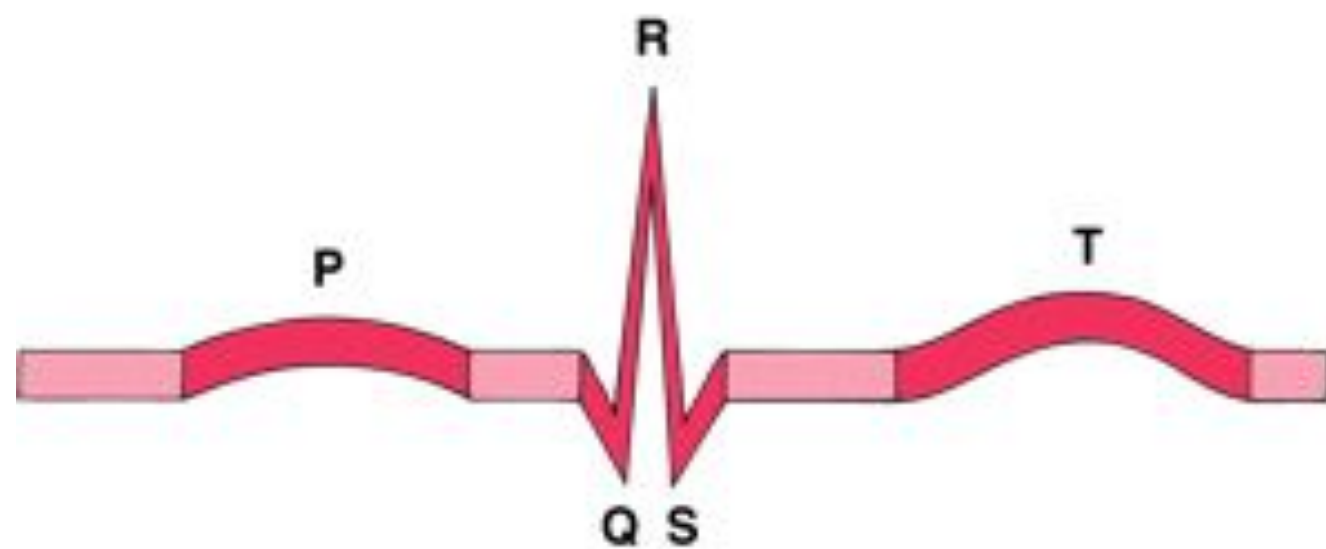


**FIGURE 16-8** ▲ Comparison of electrical and mechanical events during one cardiac cycle, using a normal electrocardiogram tracing.

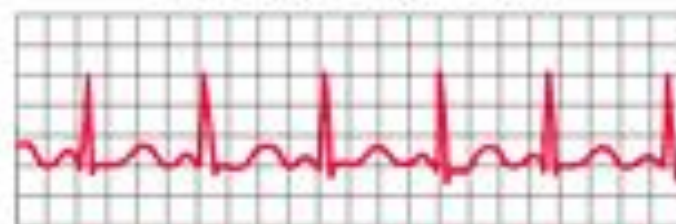




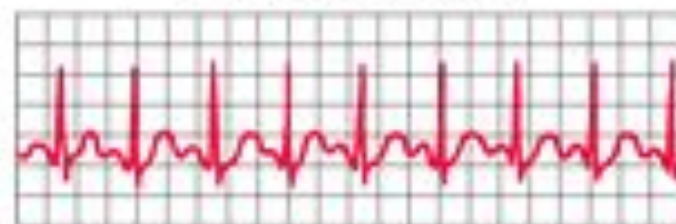




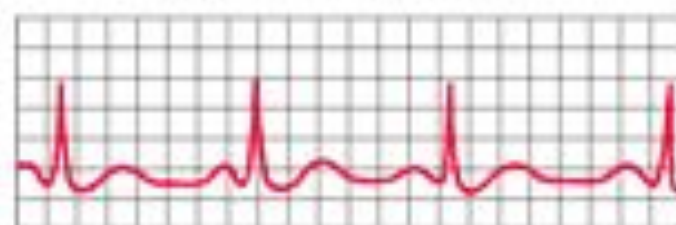
**Normal Heartbeat**



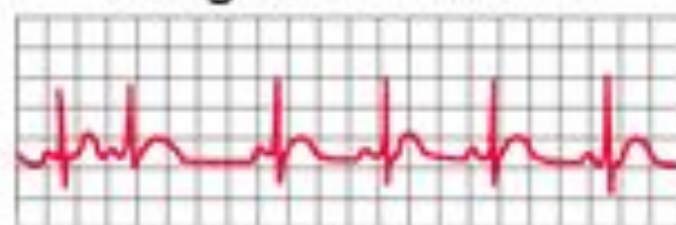
**Fast Heartbeat**



**Slow Heartbeat**



**Irregular Heartbeat**



**P Wave**



Activation of the  
atria

**QRS Complex**



Activation of the  
ventricles

**T Wave**



Recovery wave