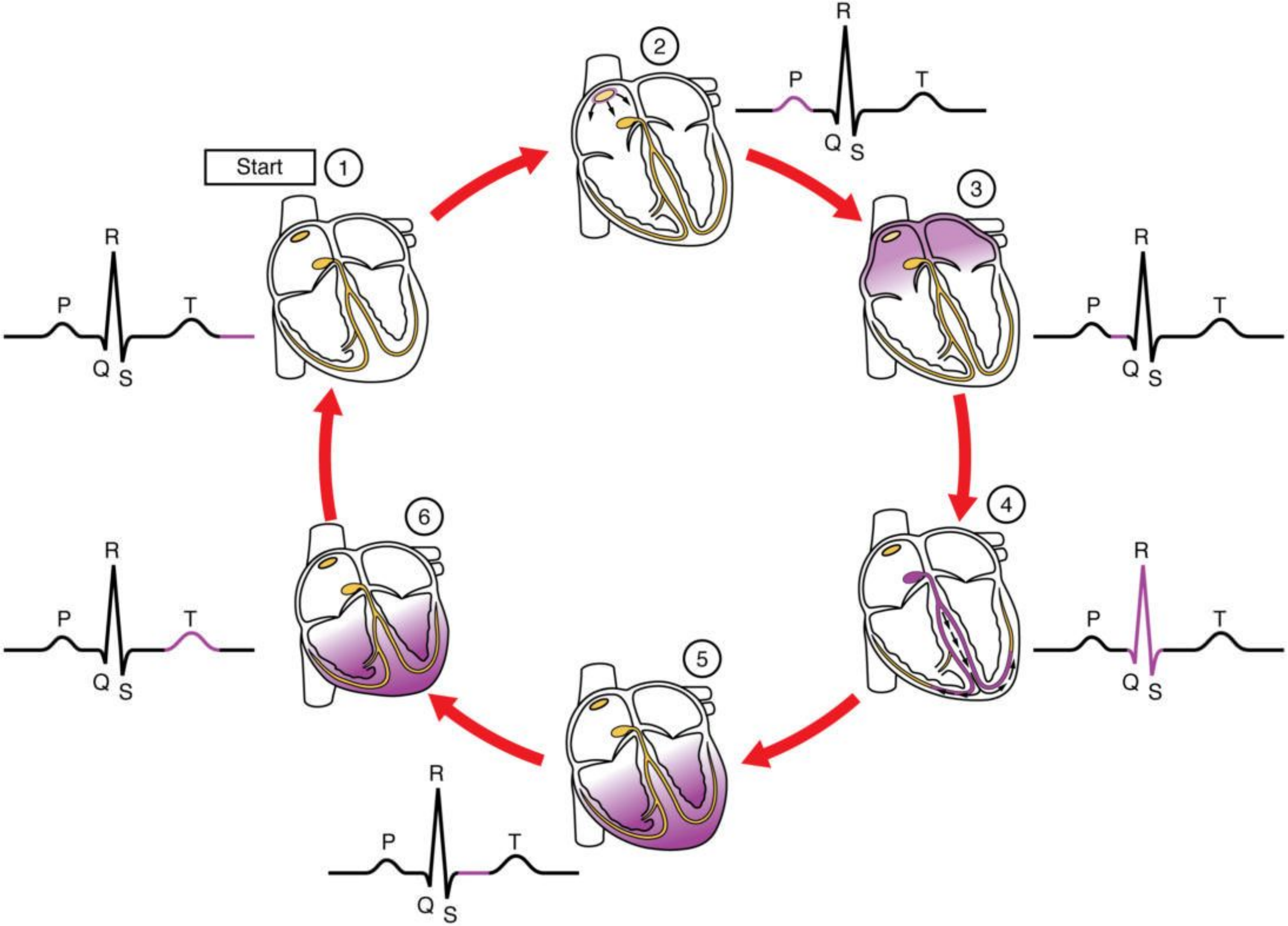

Start
1
2
3
4
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6
P
Q
R
S
T

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 .

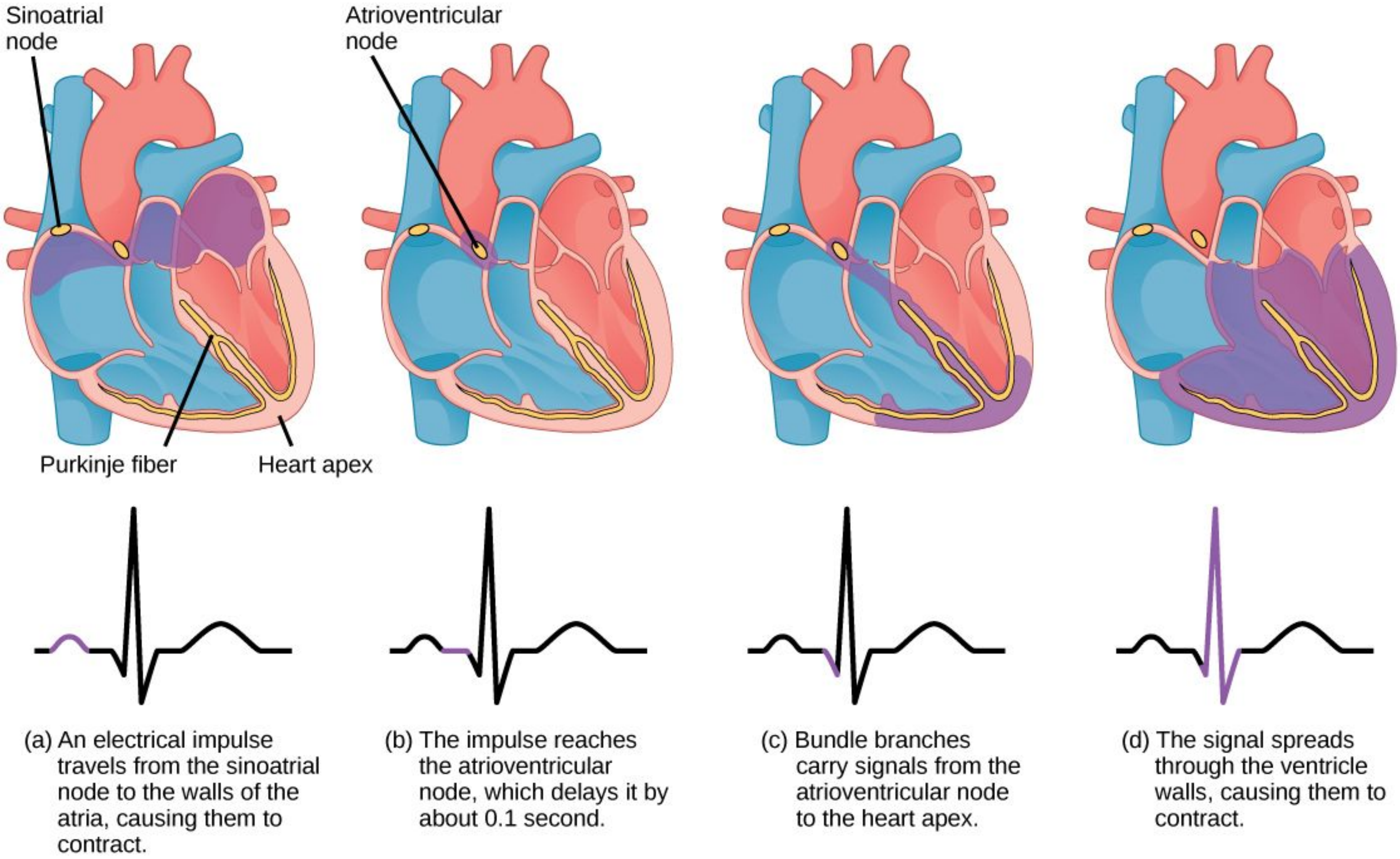
2.Describe the structure of the heart and indicate the link between the structure of the heart muscles and its ability to automaticity.

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


Sinoatrial node
Atrioventricular node
Purkinje fiber
Heart apex
(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.

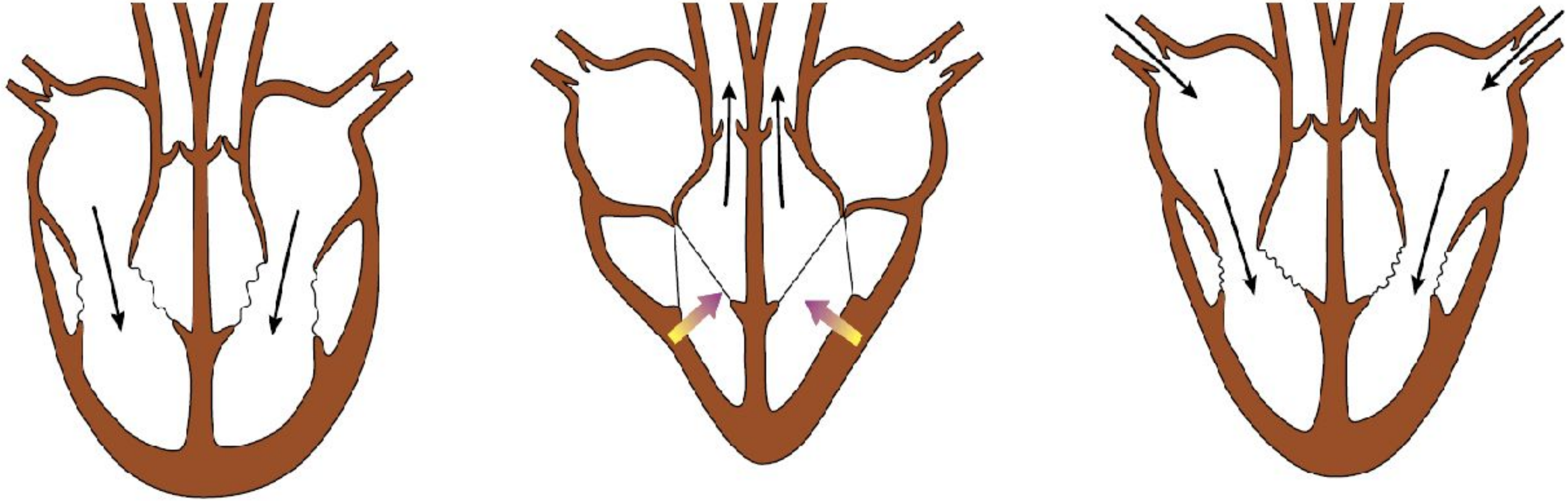
Instead, the **blood rushes upwards into the aorta** and the **pulmonary artery**, pushing open the semilunar valves in these vessels as it does so.

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.



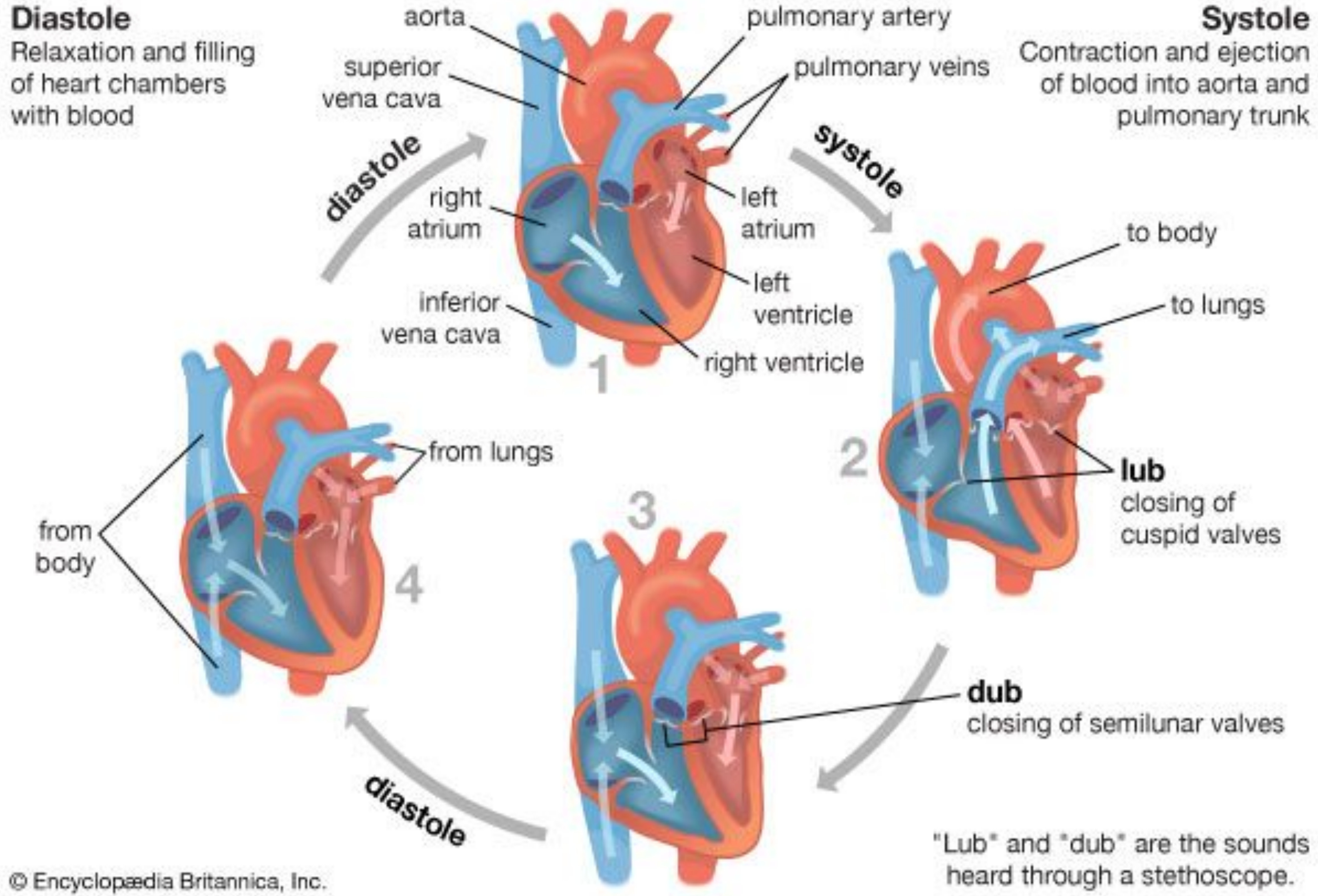
1 **Atrial systole.** Both atria contract. Blood flows from the atria into the ventricles. Backflow of blood into the veins is prevented by closure of the valves in the veins.

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
aorta
pulmonary artery
superior vena cava
pulmonary veins
diastole
systole
right atrium
left atrium
left ventricle
inferior vena cava
right ventricle
1
to body
to lungs
from lungs
from body
2
lub
closing of cuspid valves
3
4
dub
closing of semilunar valves
diastole
"Lub" and "dub" are the sounds heard through a stethoscope.
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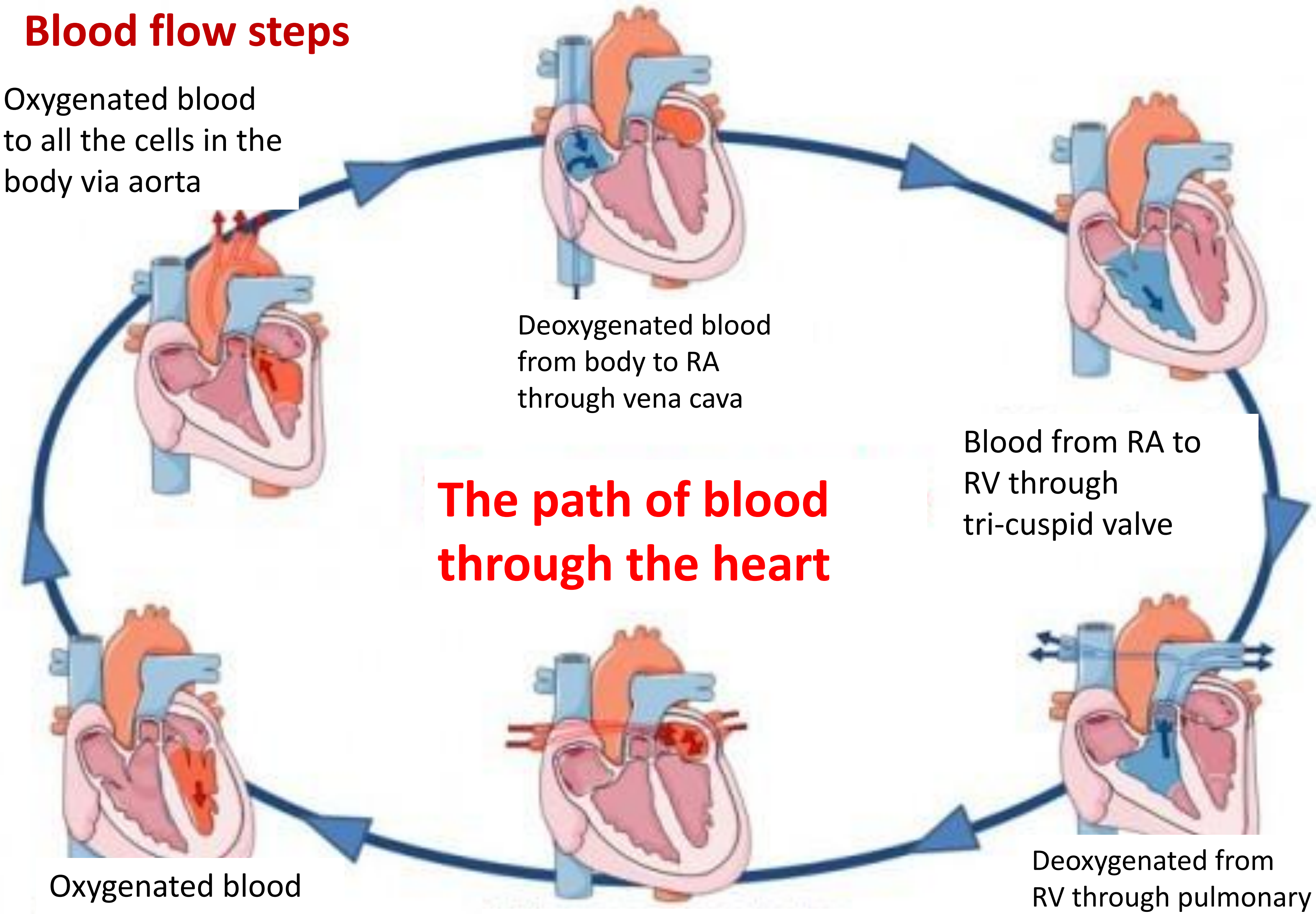
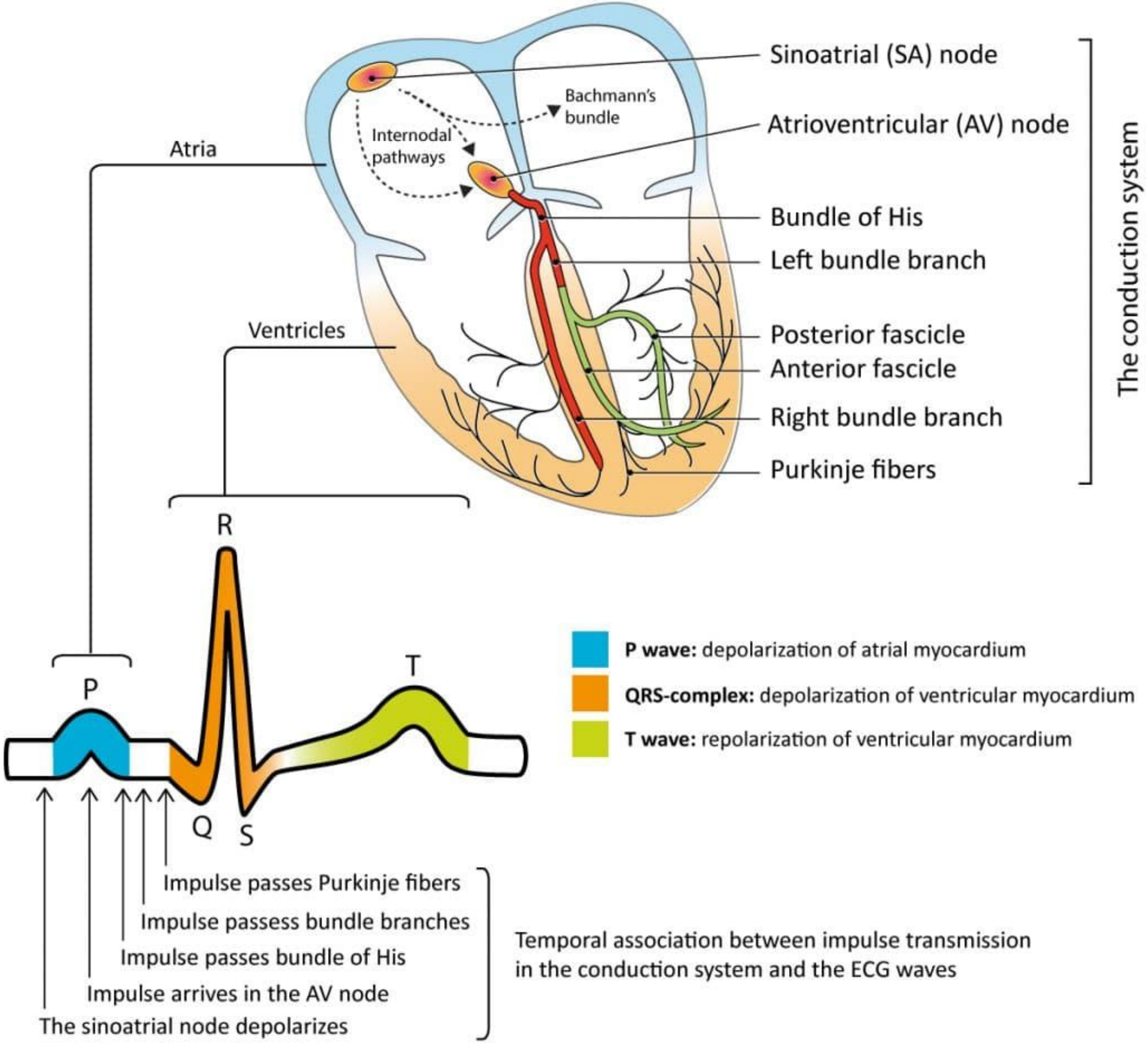
Blood flow steps

The path of blood through the heart



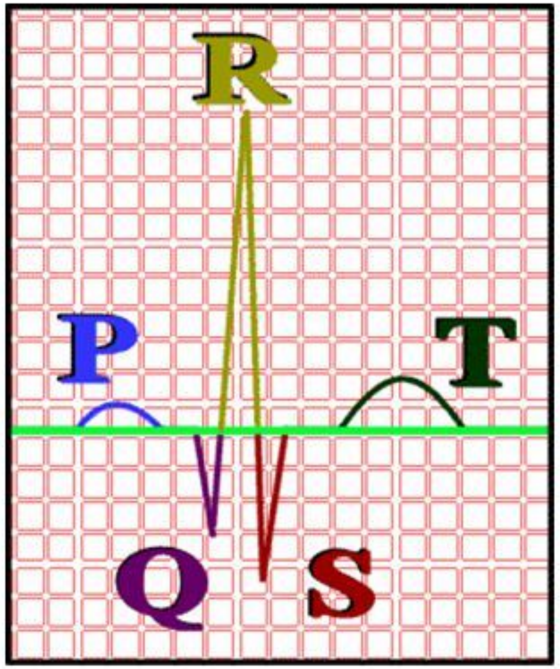

Sinoatrial (SA) node
Bachmann's bundle
Atrioventricular (AV) node
Internodal pathways
Atria
Bundle of His
Left bundle branch
Ventricles
Posterior fascicle
Anterior fascicle
Right bundle branch
Purkinje fibers
The conduction system
R
P
T
Q
S
P wave: depolarization of atrial myocardium
QRS-complex: depolarization of ventricular myocardium
T wave: repolarization of ventricular myocardium
Impulse passes Purkinje fibers
Impulse passess bundle branches
Impulse passes bundle of His
Impulse arrives in the AV node
The sinoatrial node depolarizes
Temporal association between impulse transmission in the conduction system and the ECG waves

Electrocardiograms (ECGs)

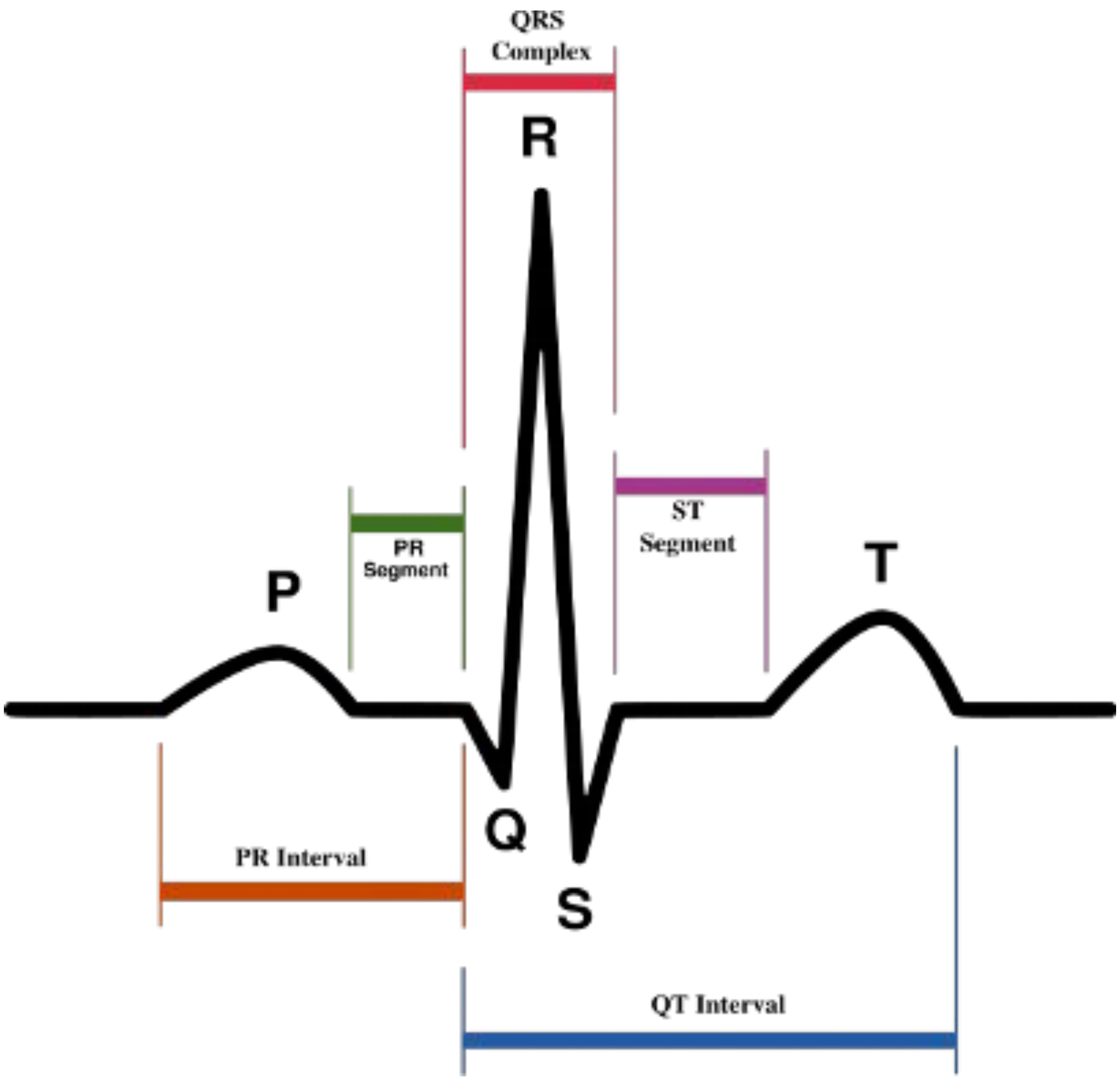
It is relatively easy to detect and record the waves of excitation flowing through heart muscle. Electrodes can be placed on the skin over opposite sides of the heart, and the **electrical potentials generated recorded with time.** The result, which is **essentially a graph of voltage against time, is an electrocardiogram (ECG)**. The part labelled **P** represents the wave of e**xcitation** 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.**

<u>ECG – electrocardiogram</u> – a recording of the electrical events (changes) during a cardiac cycle

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



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

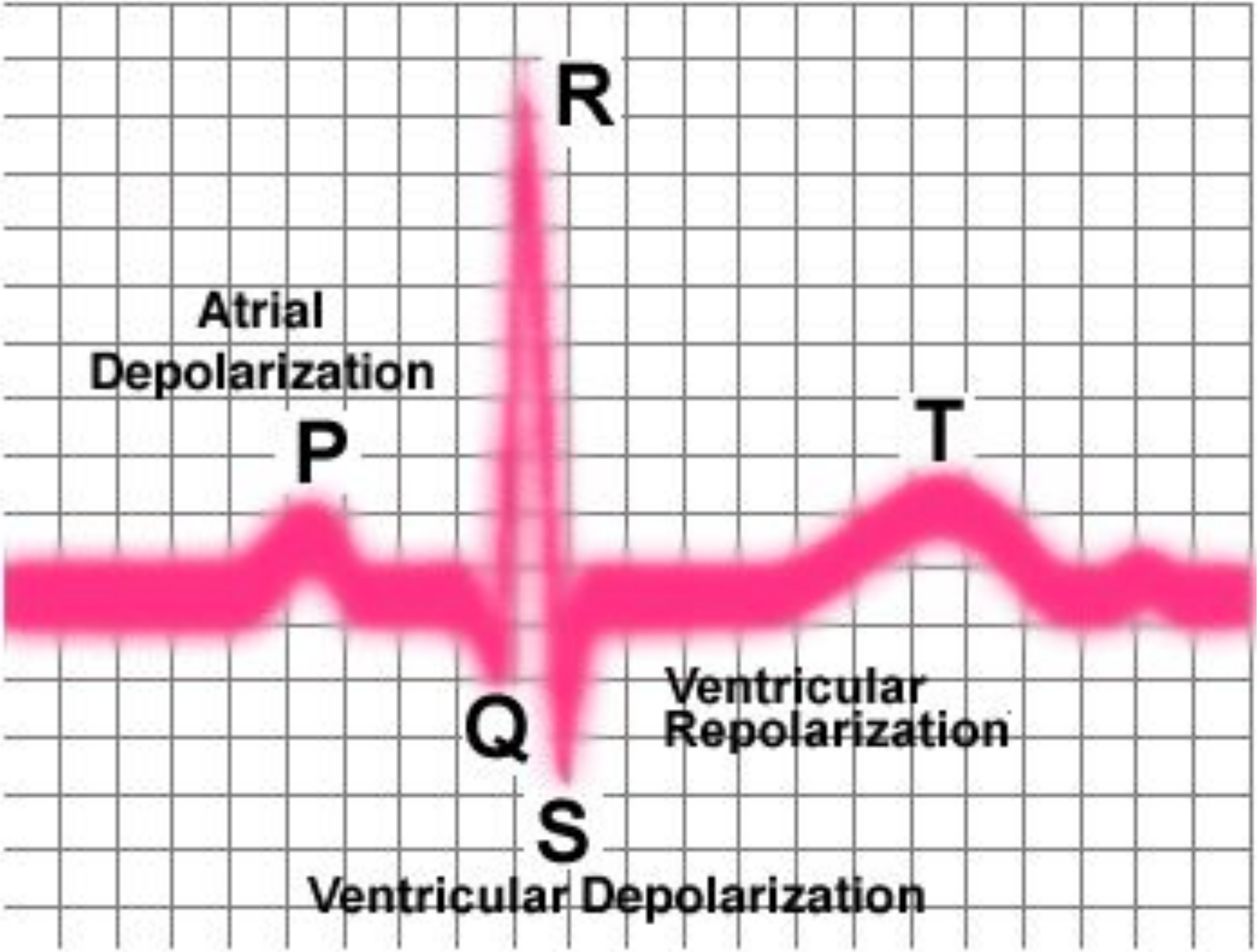


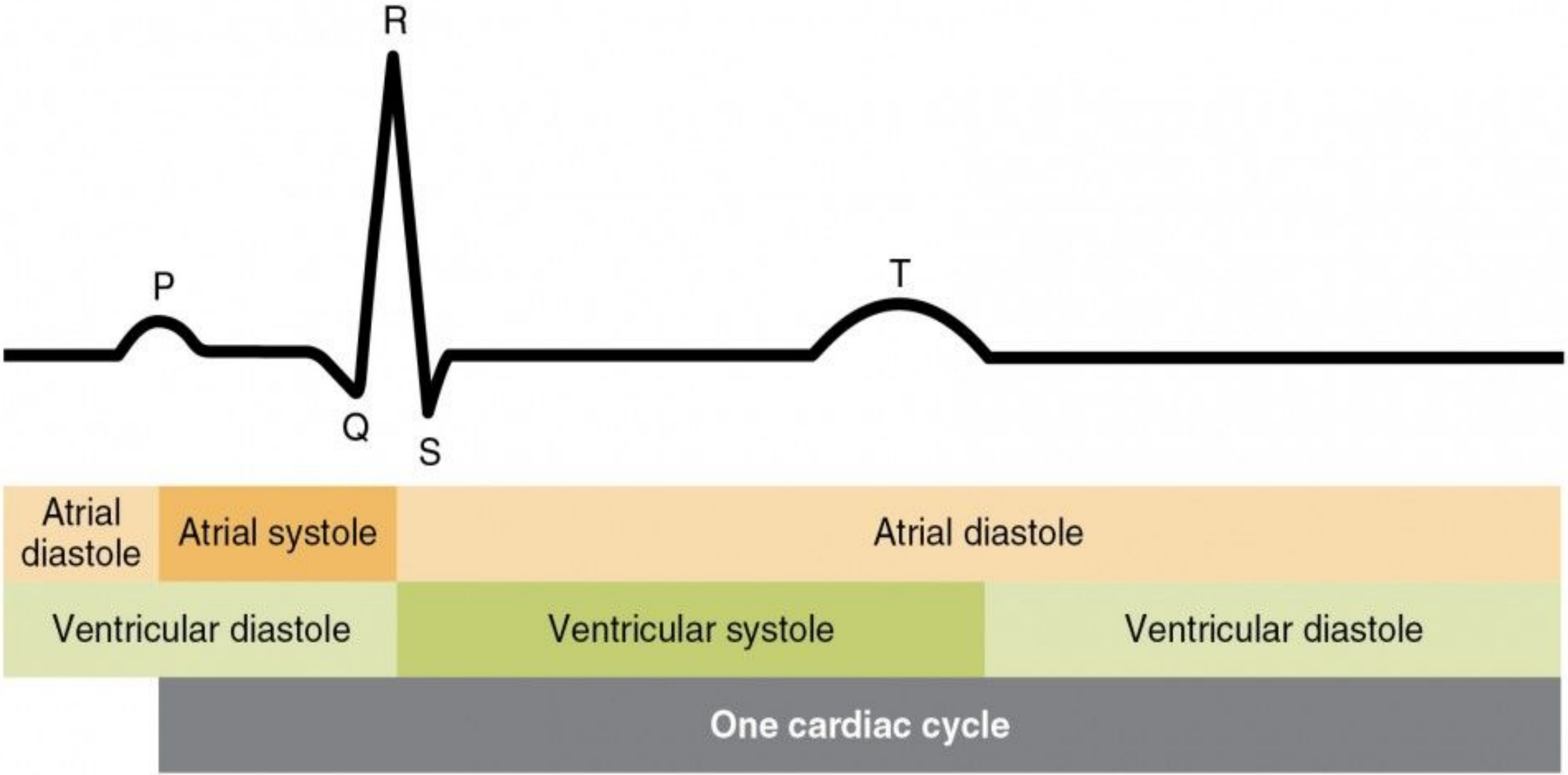
ECG teeth

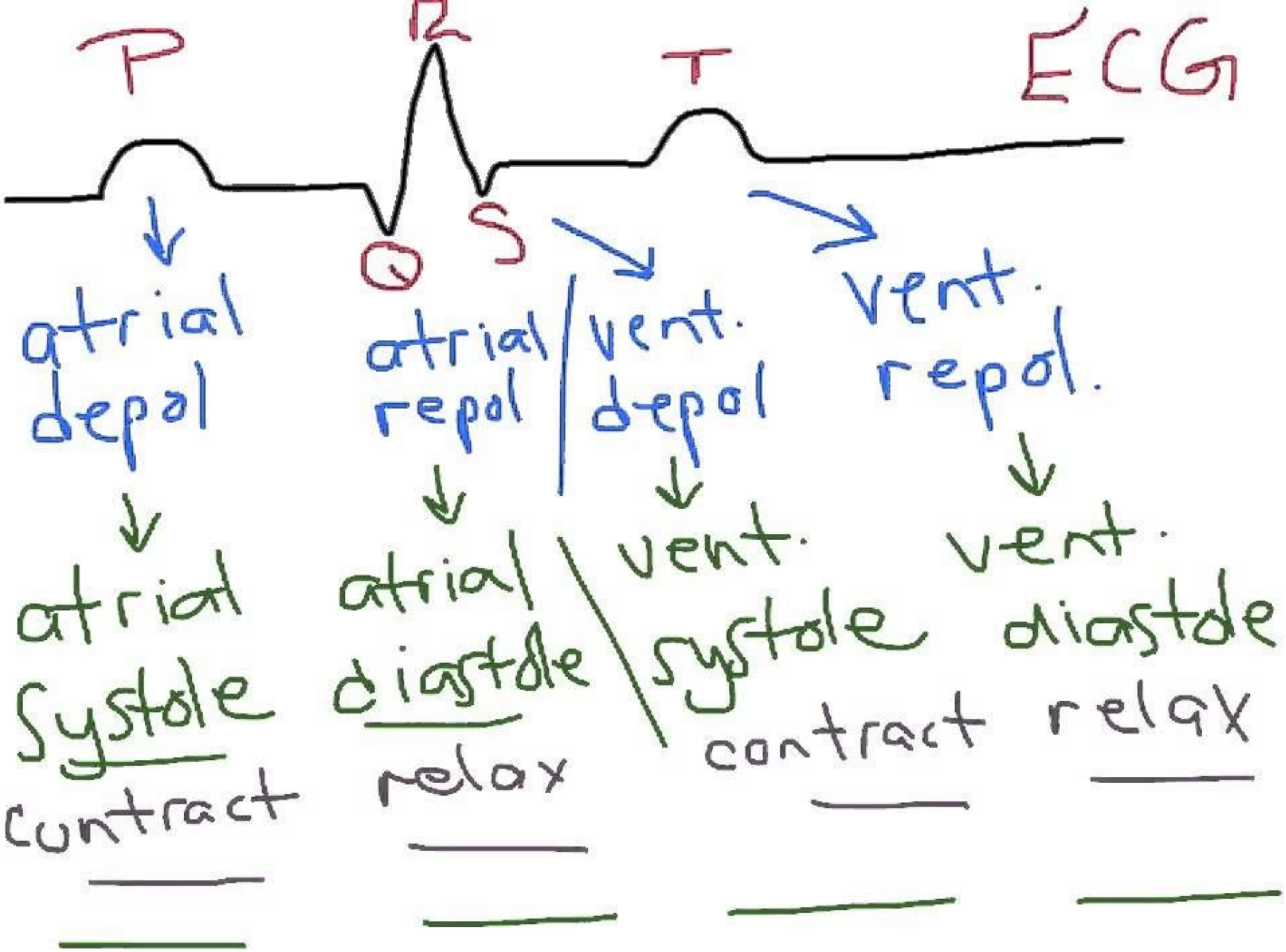
P- the sinoatrial node despoliation, impulse arrive in the AV node and impulse passes buddle of His

QRS complex - depolarization of ventricular myocardium

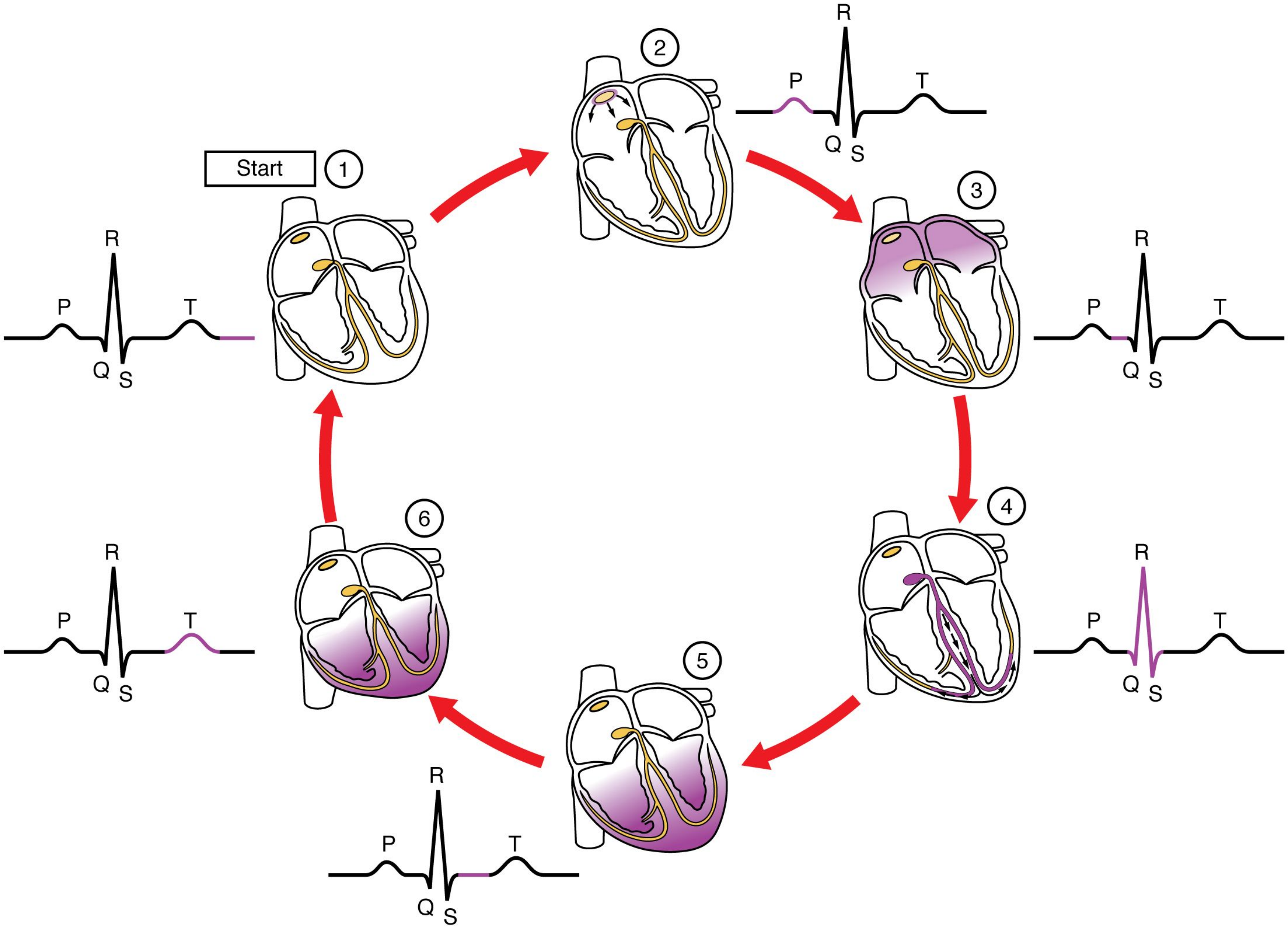
T- repolarization of ventricular myocardium


R
Atrial
Depolarization
P
T
Q
Ventricular
Repolarization
S
Ventricular Depolarization

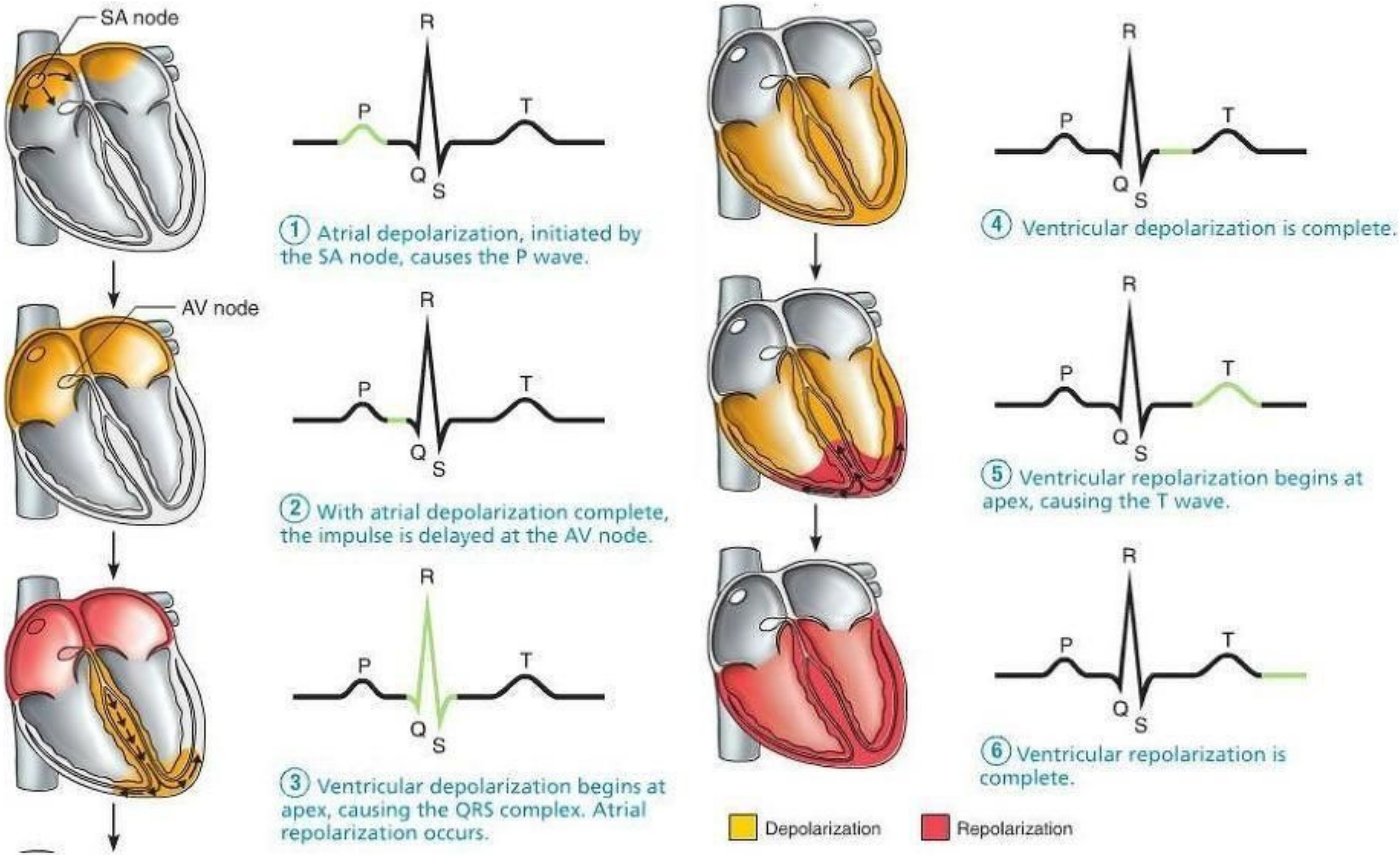

R
P
T
Q
S
Atrial diastole
Atrial systole
Atrial diastole
Ventricular diastole
Ventricular systole
Ventricular diastole
One cardiac cycle



ECG
P
R
T
Q
S
atrial depol
atrial repol
vent. depol
vent. repol.
atrial systole
atrial diastole
vent. systole
vent. diastole
contract
relax
contract
relax



Start
1
2
3
4
5
6
P
Q
R
S
T


SA node
AV node
P
Q
R
S
T
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

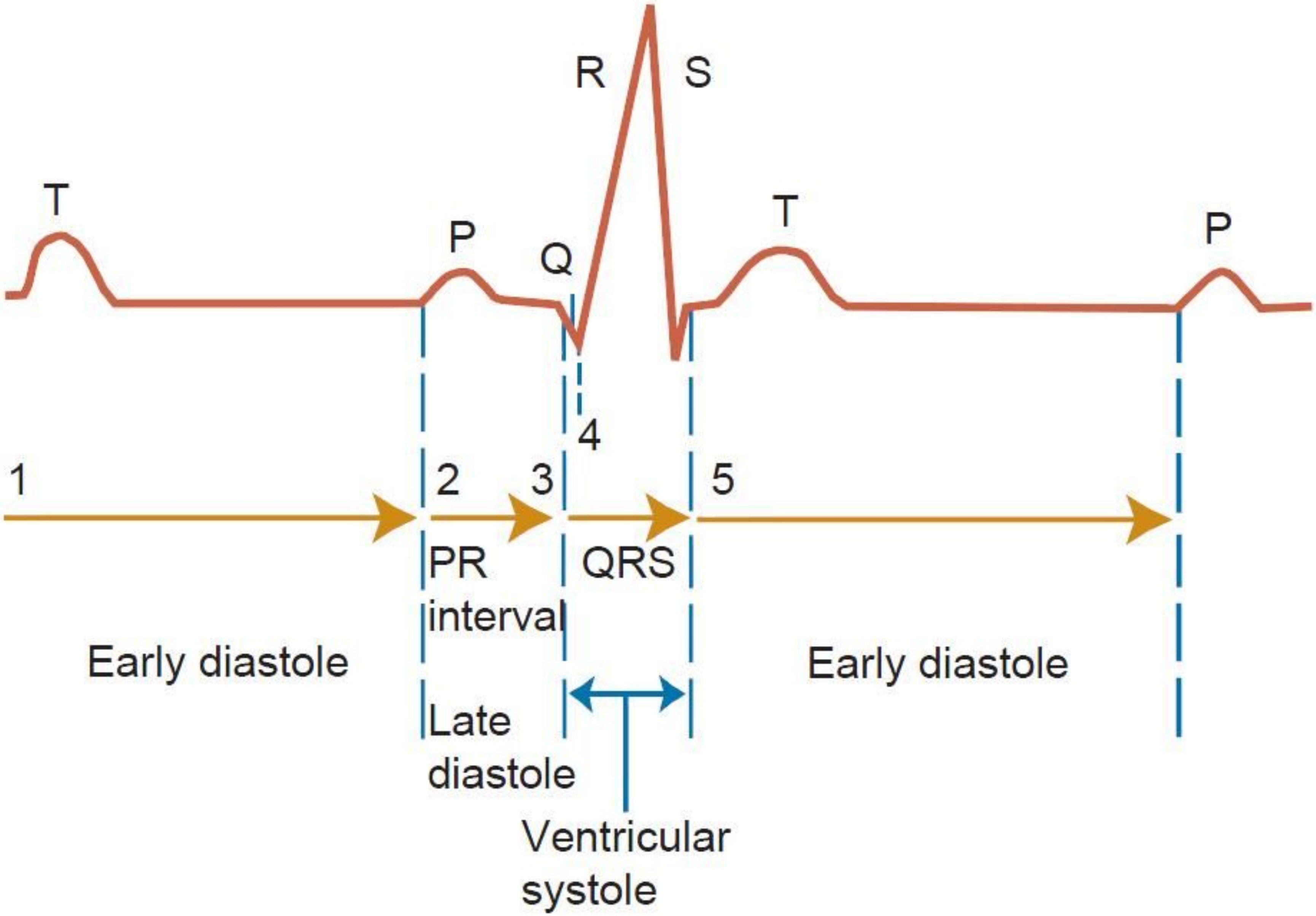
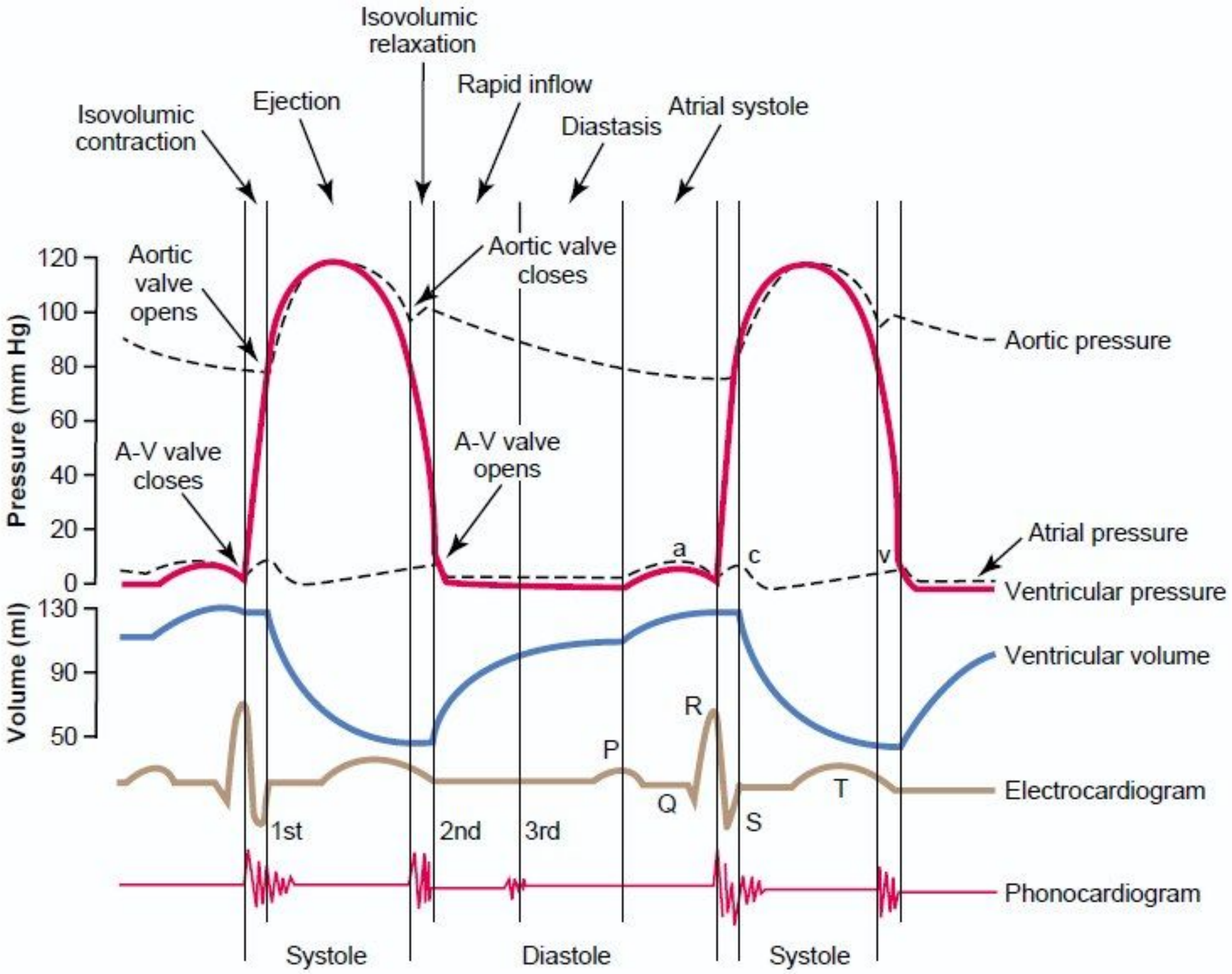
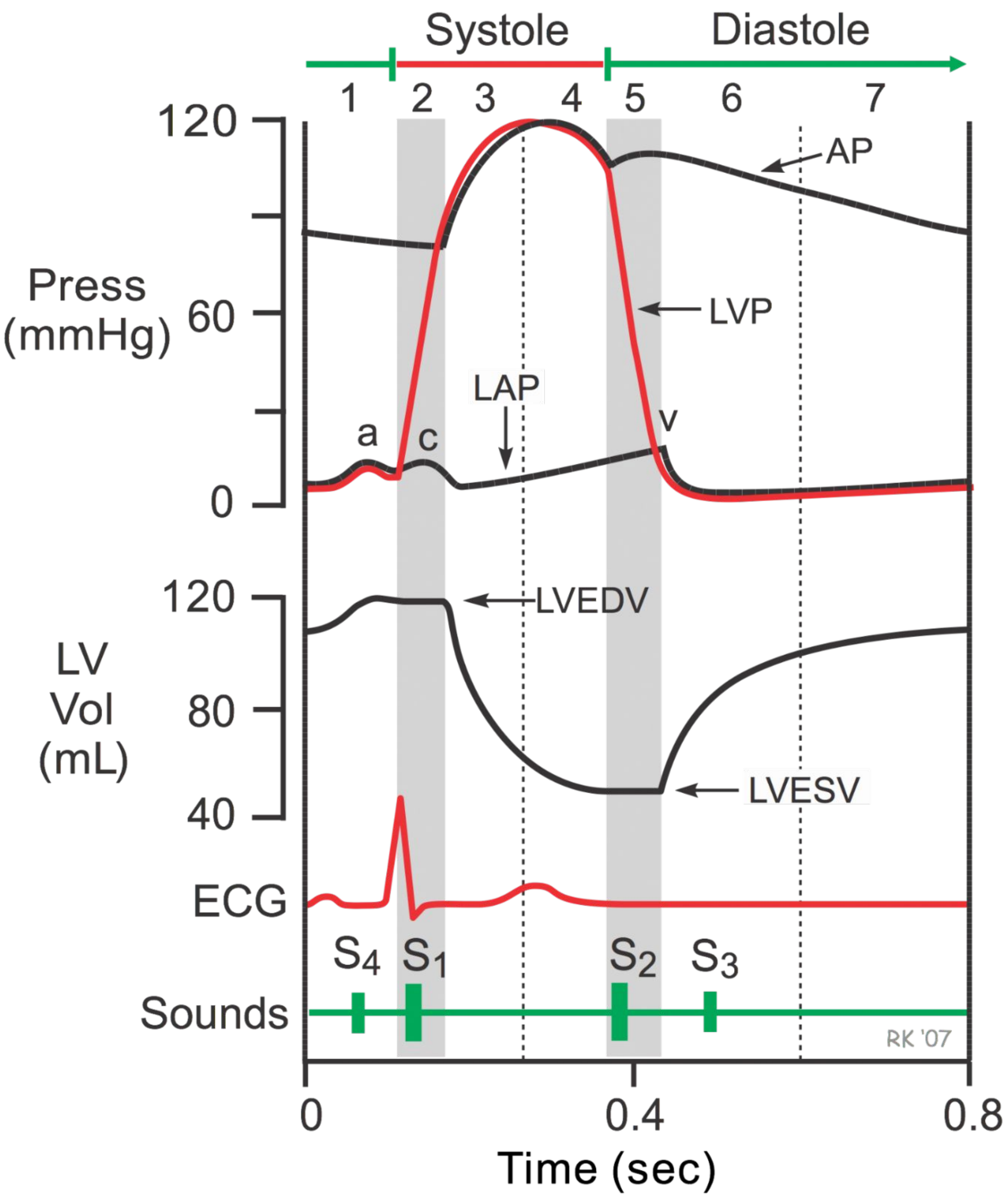
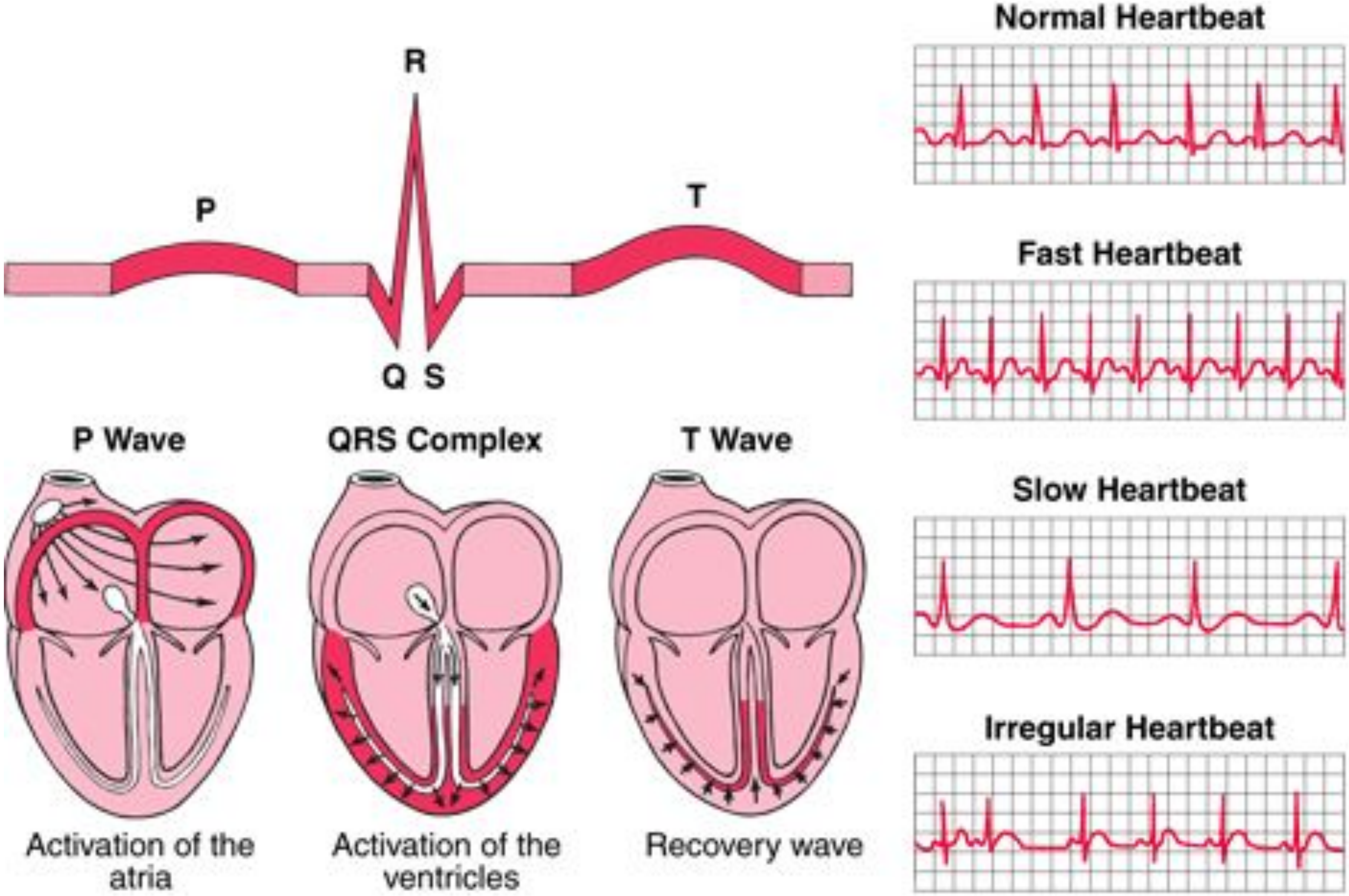


FIGURE 16-8 ▲ Comparison of electrical and mechanical events during one cardiac cycle, using a normal electrocardiogram tracing.


Isovolumic relaxation
Rapid inflow
Ejection
Atrial systole
Isovolumic contraction
Diastasis
Aortic valve closes
Aortic valve opens
Aortic pressure
A-V valve opens
A-V valve closes
Atrial pressure
a
c
v
Ventricular pressure
Ventricular volume
Electrocardiogram
Phonocardiogram
R
P
Q
S
T
1st
2nd
3rd
Pressure (mm Hg)
Volume (ml)
120
100
80
60
40
20
0
130
90
50
Systole
Diastole
Systole



Systole
Diastole
1 2 3 4 5 6 7
120
60
0
Press (mmHg)
AP
LVP
LAP
a
c
v
120
80
40
LV Vol (mL)
LVEDV
LVESV
ECG
S_4 S_1 S_2 S_3
Sounds
RK '07
0
0.4
0.8
Time (sec)


R
P
T
Q
S
P Wave
QRS Complex
T Wave
Activation of the atria
Activation of the ventricles
Recovery wave
Normal Heartbeat
Fast Heartbeat
Slow Heartbeat
Irregular Heartbeat