Medical physics

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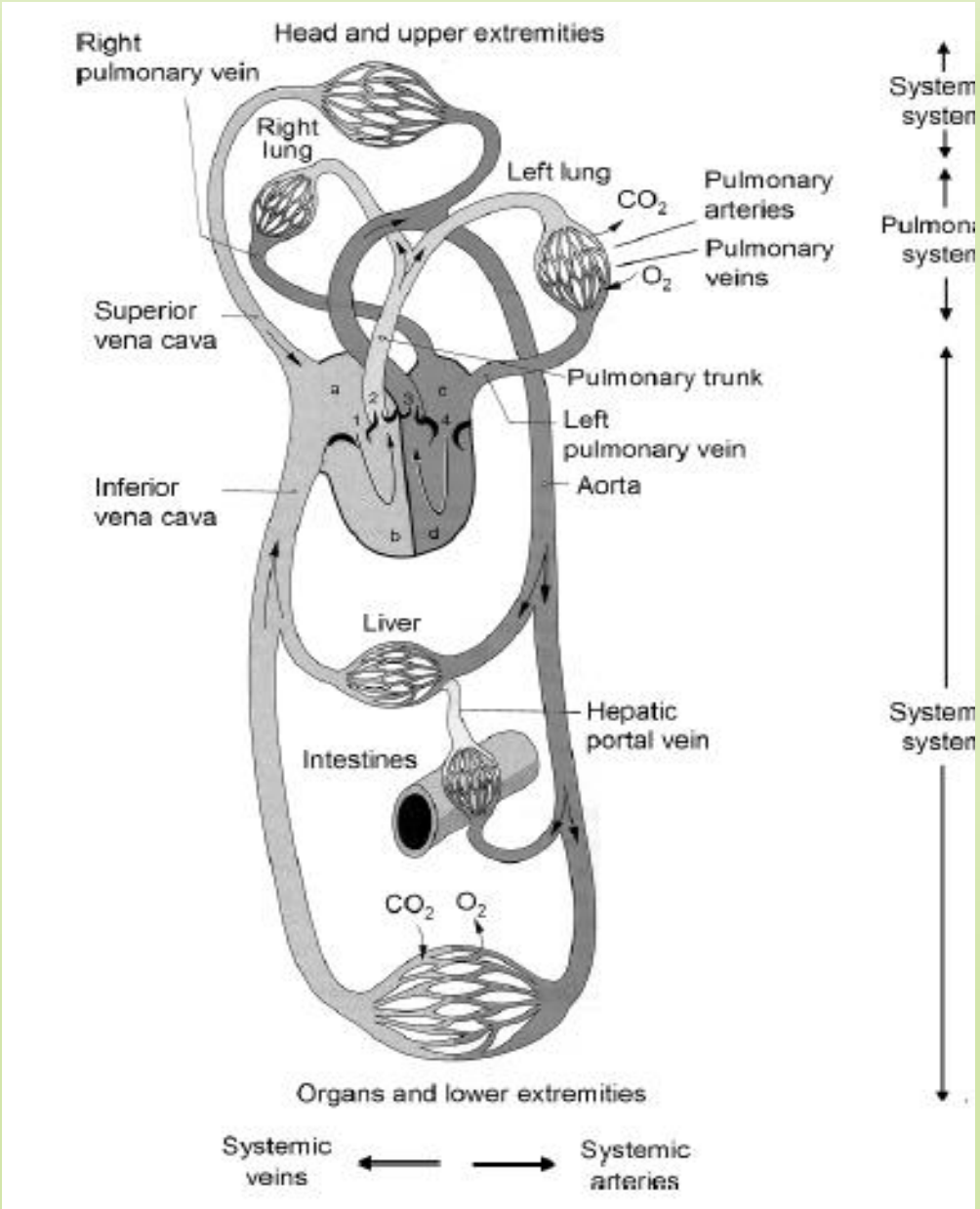
Cardiovascular System

There are three components of the cardiovascular system:

- ❖Blood.
- ❖Two major circulatory systems
  - ✓the pulmonary circulation
  - ✓systemic circulation
- ❖The heart is the four-chambered pump

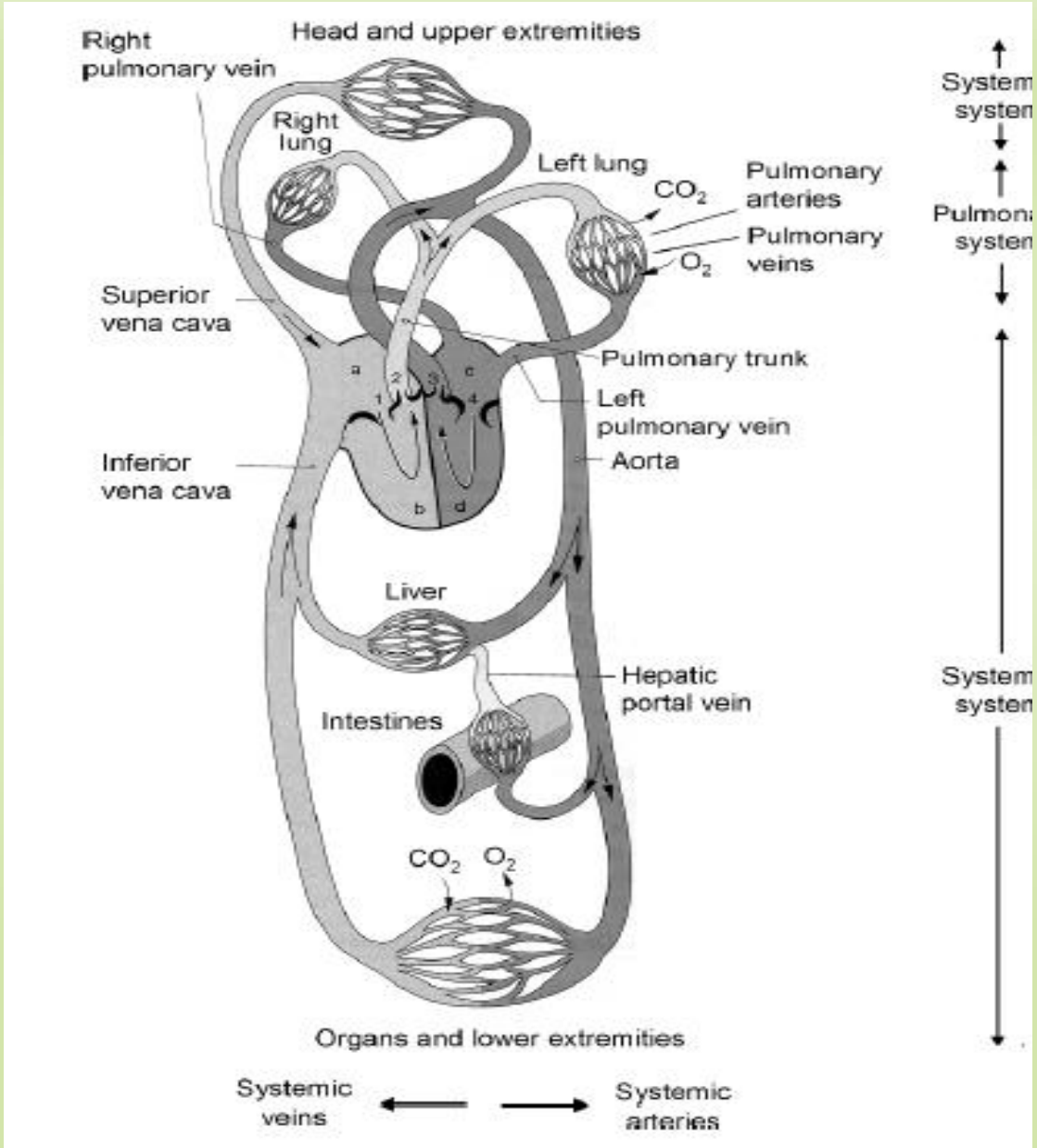
Circulation

- The heart consists of two independent pumps
- each made of two chambers called the *atrium* and the *ventricle*
- valves maintain the flow of blood in the proper direction



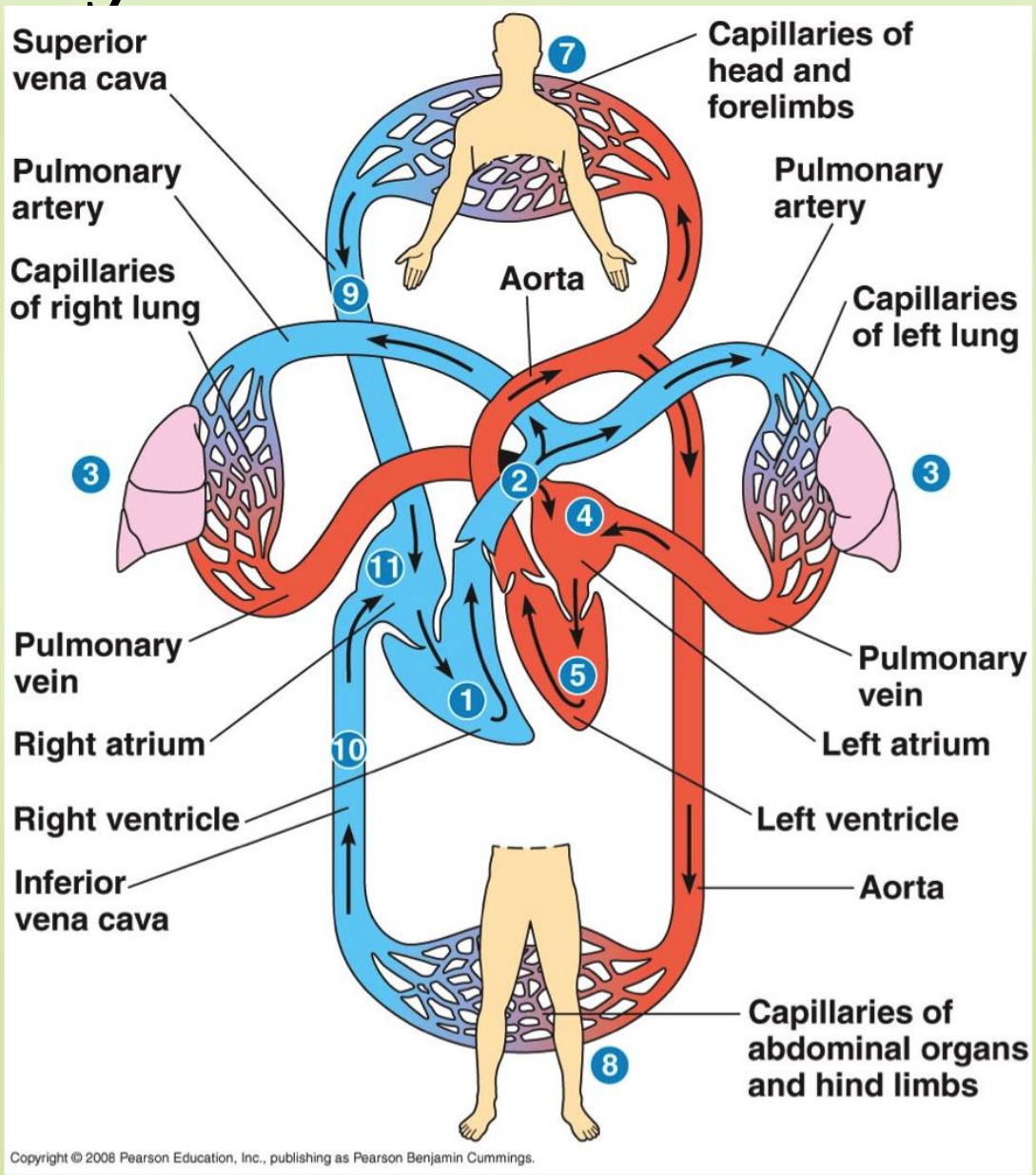
pulmonary circulation.

- Blood from all the body except the lungs enters the right atrium (RA) through the inferior and superior vena cava
- right atrioventricular valve to enter into the right ventricle (RV).
- Blood is pumped through the pulmonary semilunar valve to the pulmonary arteries
- which branch out into a series of more minor arteries and arterioles, and then into capillaries in The lungs



the systemic system

- blood enters the left atrium (LA) through the pulmonary veins
- The blood passes through the left atriovetricular valve to enter the left ventricle
- Blood is pumped through the aortic semilunar valve to the aorta
- The systemic and pulmonary systems have same volumetric flow rate Q
- septum



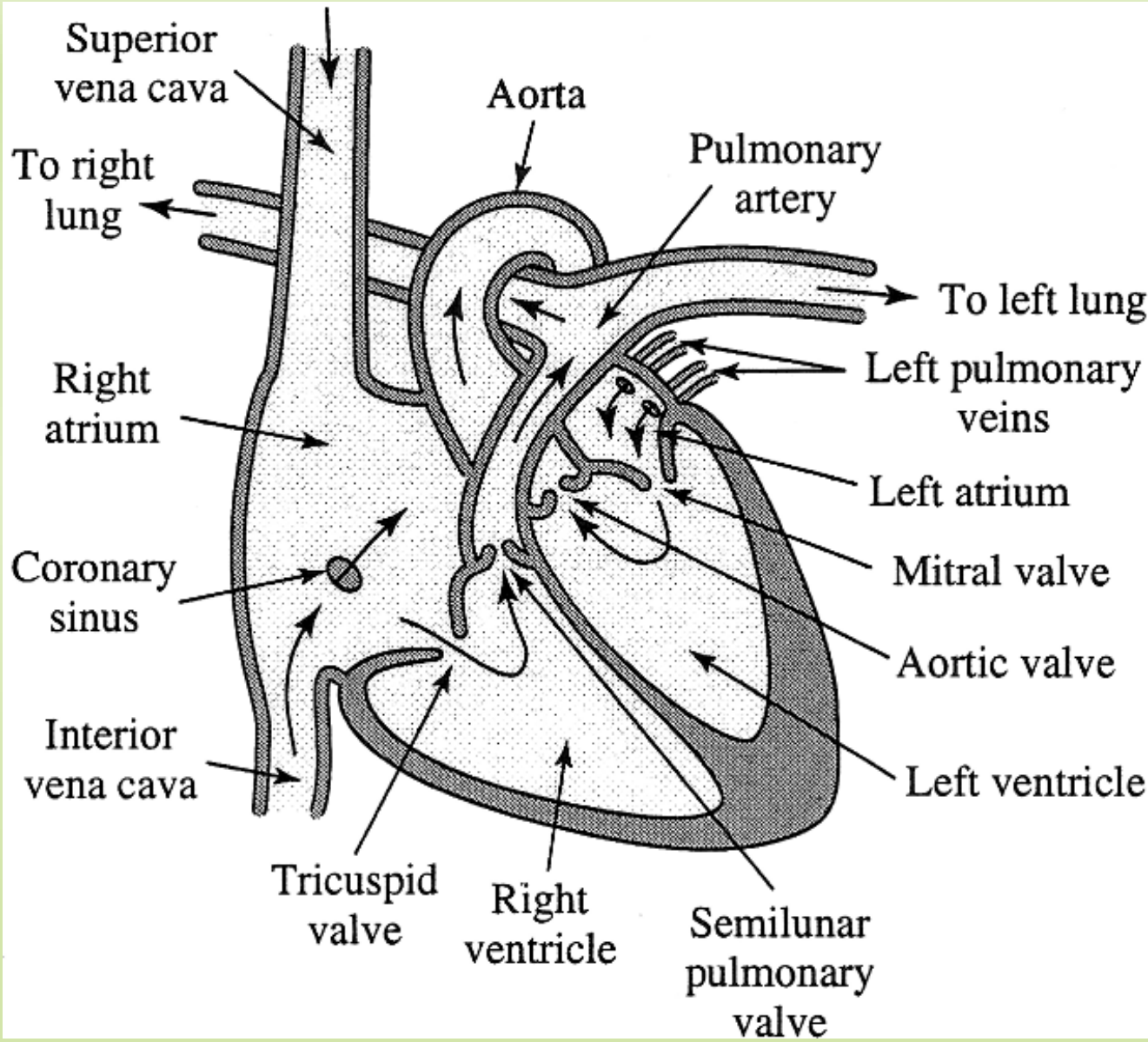
Cardiac Cycle

- <u>There is a highly controlled timing cycle in well-functioning hearts</u>

- In the first stage of diastole, the veins fill up both the right and left atria, while the right and left ventricles are relaxed

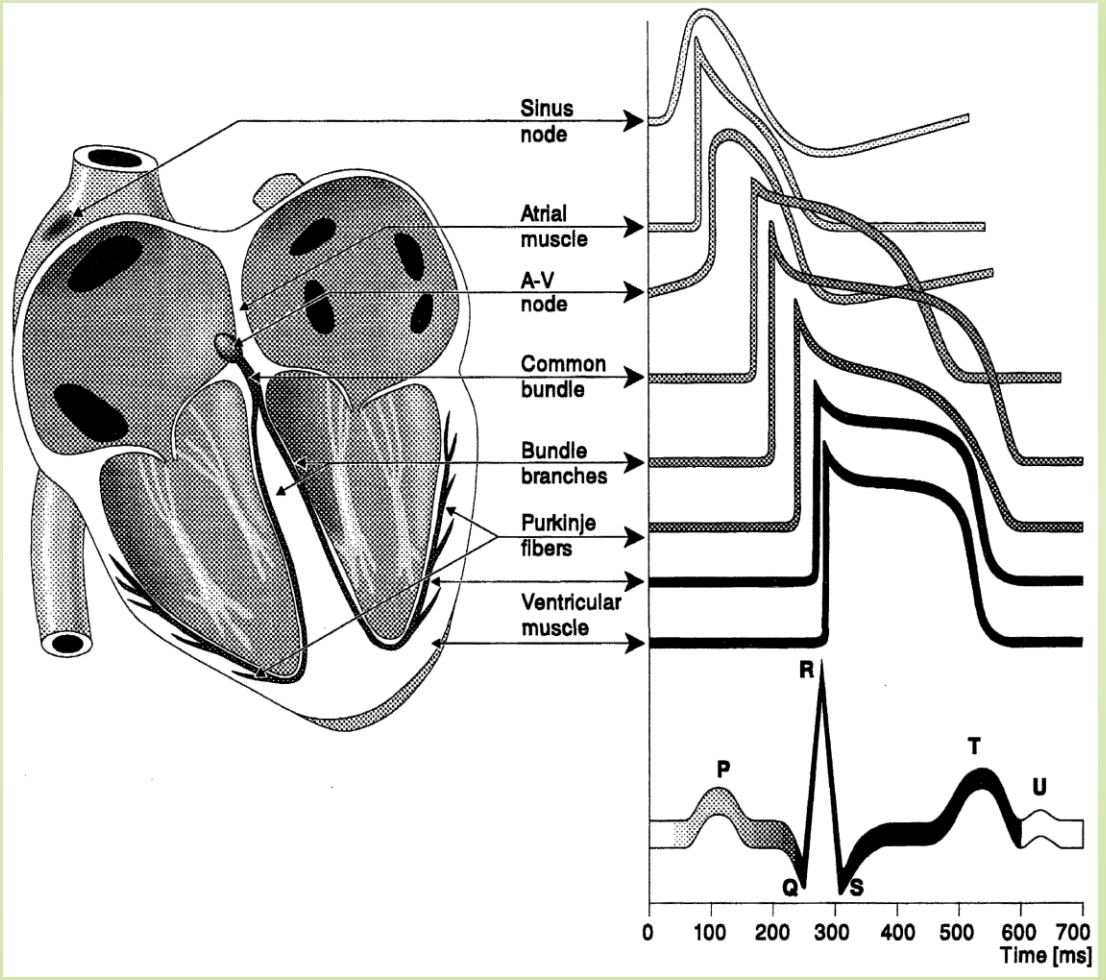
- In the second stage, the cardiac muscle (myocardium) of the right and left atria contract and pump blood through the (AV), into the right and left ventricles

- In the systole, both ventricles contract, and they eject blood through the semilunar valves: the right ventricle into the pulmonary arteries and the left ventricle into the aorta



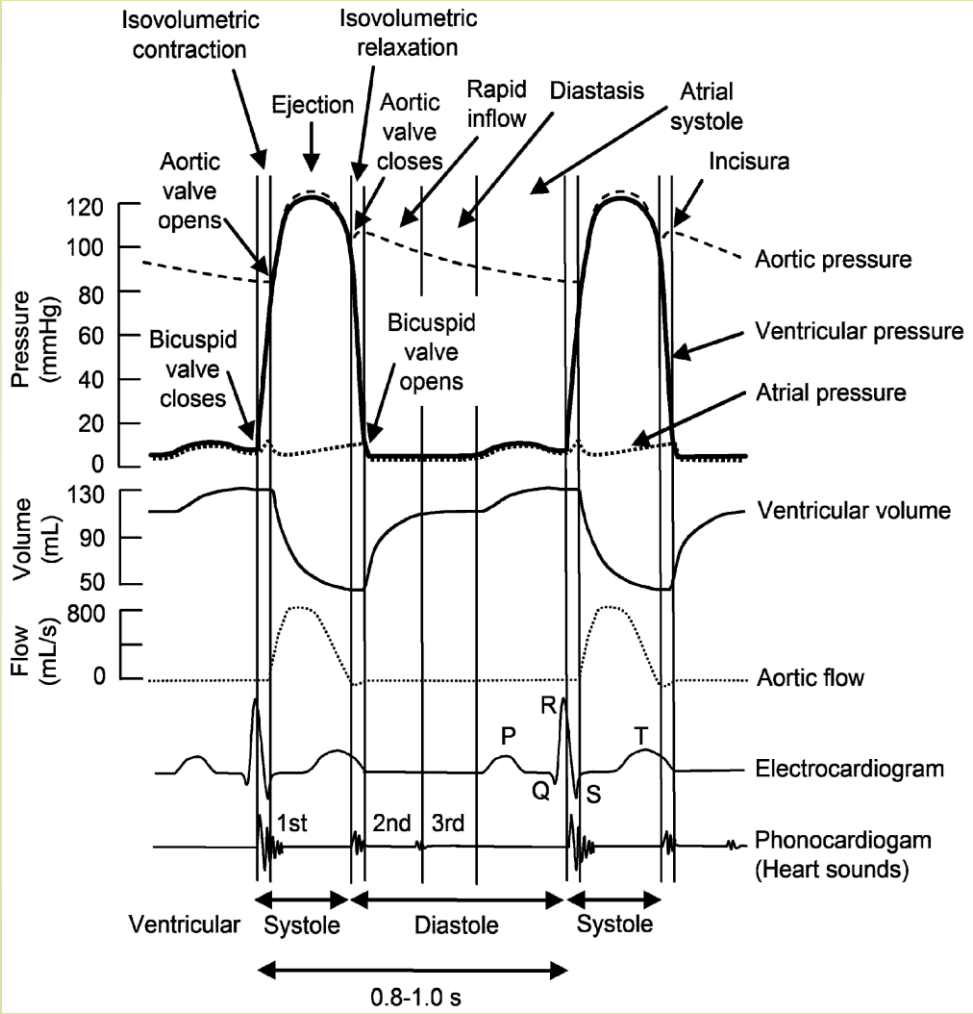
electrical signal of cardiac muscle

- There is a heart pacemaker or sinus node which sends an **electrical signal** to the atrial cardiac muscle of both atria for simultaneous atrial contraction.
- This electrical signal then travels to the atrioventricular or AV node, and then the node sends a signal to the ventricular cardiac muscle of both ventricles for simultaneous ventricular contraction



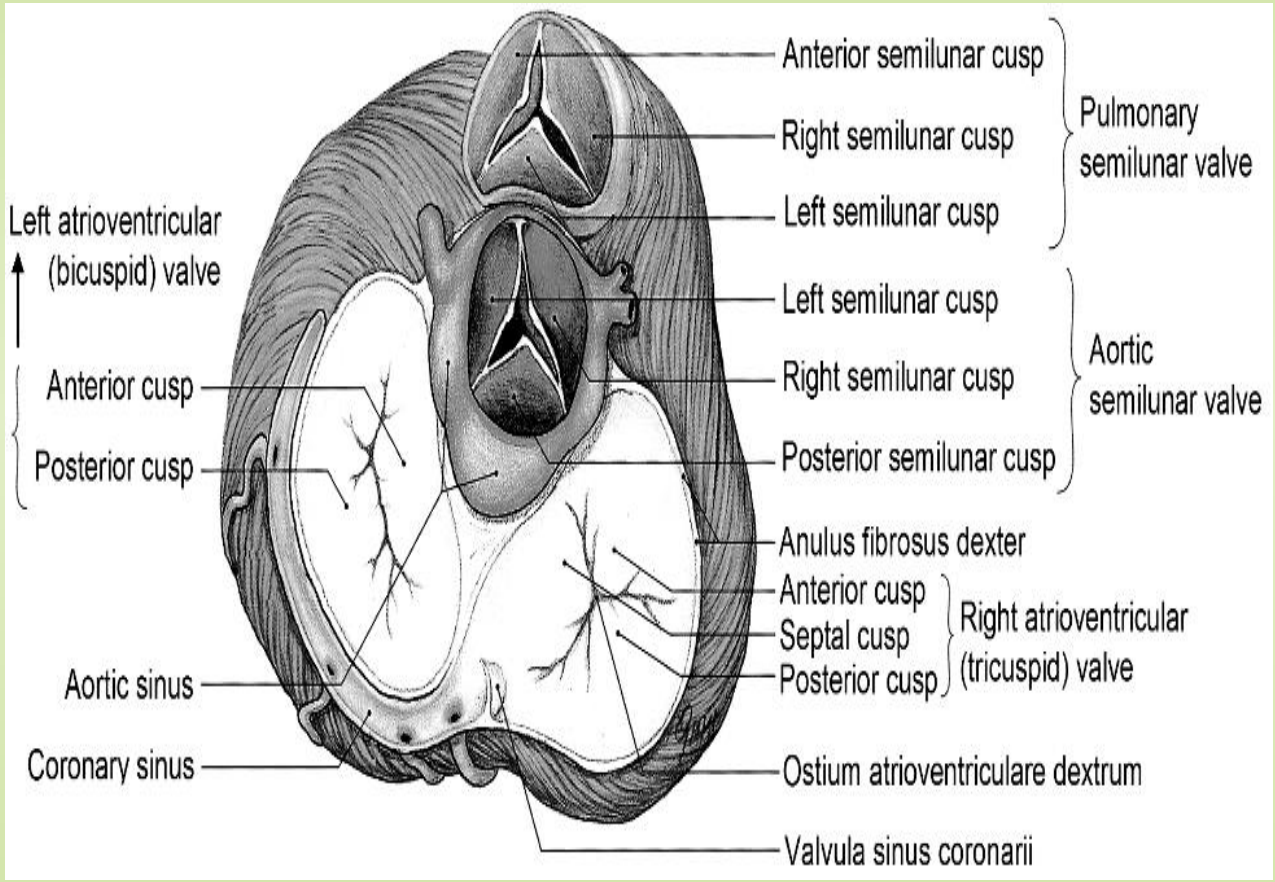
electrocardiogram

- The electrocardiogram (EKG or ECG) is a measurement of these electrical signals
- the EKG during one ~1 s long heartbeat.
- The P wave is due to atrial depolarization (which is atrial contraction)
- The QRS complex is due to ventricular depolarization (contraction)
- The T wave is due to ventricular repolarization (relaxation)
- Stethoscope!!

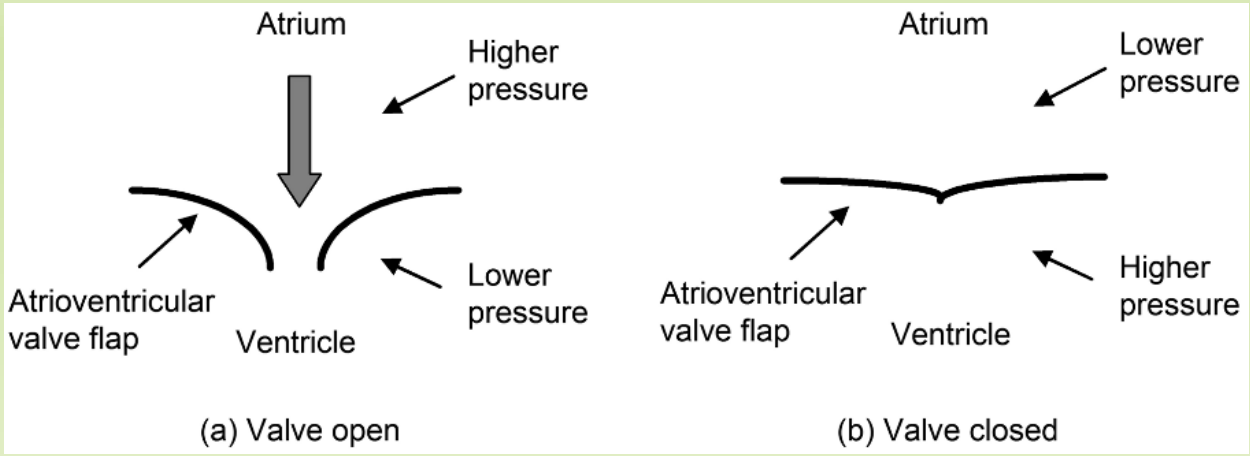


Valves

- The right atrioventricular valve controls flow between the right atrium and right ventricle. It has three flaps (or cusps).
- The pulmonary semilunar valve controls blood flow from the right ventricle to pulmonary arteries.
- The left atrioventricular valve controls flow from the left atrium to the left ventricle. It has two flaps. Another name for this valve is the mitral valve, because it looks like a miter.
- The aortic semilunar valve controls flow from the left ventricle to the aorta



Valves

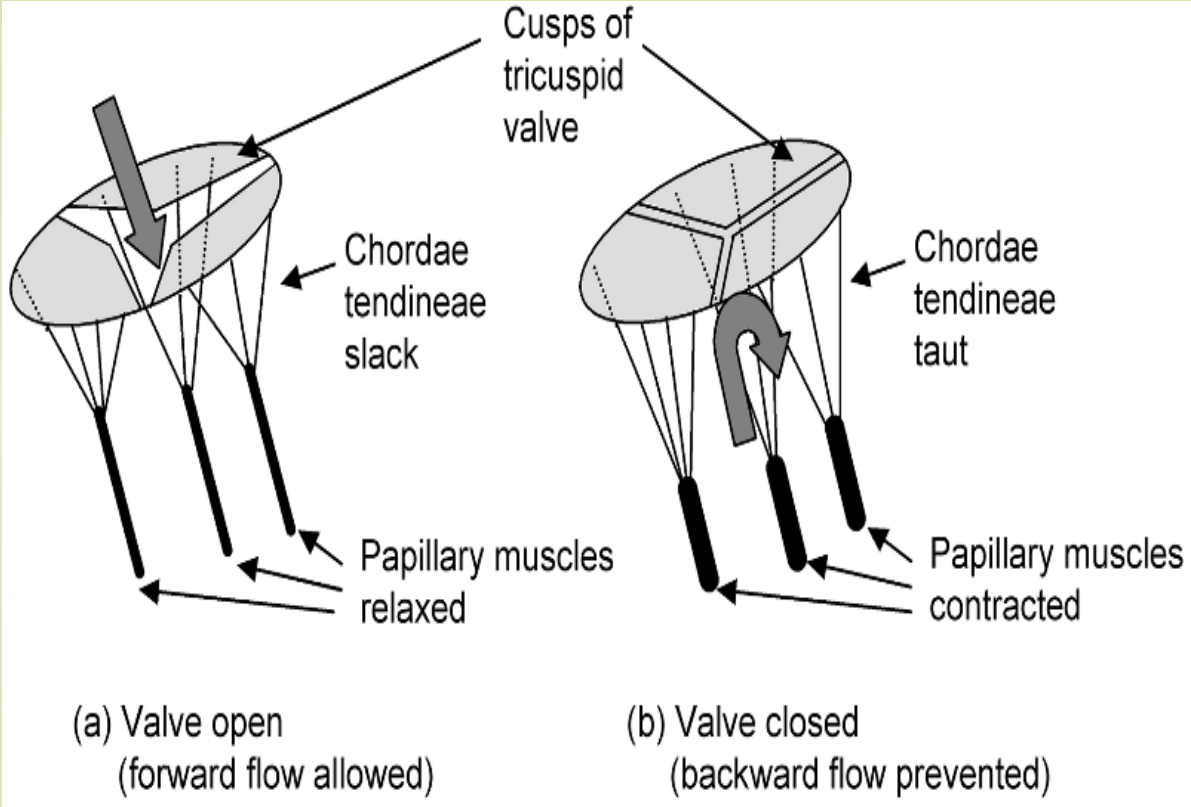


- They are one-way valves that allow blood flow
- this type of valve we can see how the flaps will open, when the pressure in front of the valve exceeds that on the other side.
- Backward opening of the atrioventricular valves is also prevented by the papillary muscles

Valves

- aortic semilunar valve

making the chordae tendineae that are attached to the flaps. This prevents the flaps from bending backward, so there is no backward flow of blood.

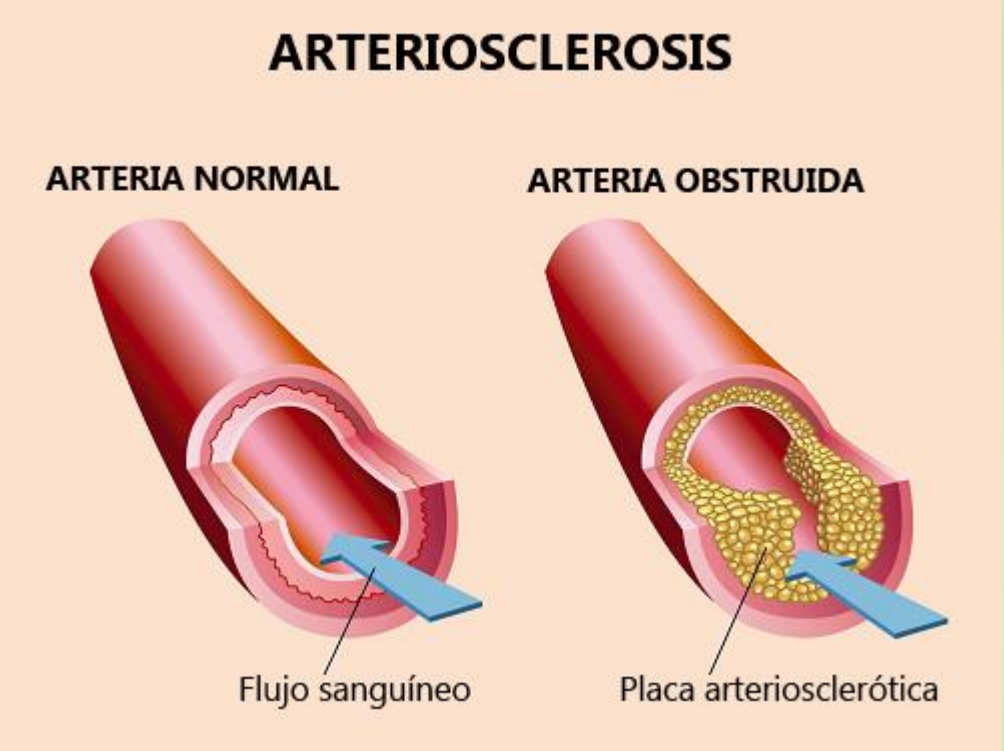


POWER PRODUCED BY THE HEART

- . The heart pumps about 80mL (= 80 cm^3) of blood per contraction;
- quantity is called the stroke volume V_{stroke}
- The power PH produced by the heart

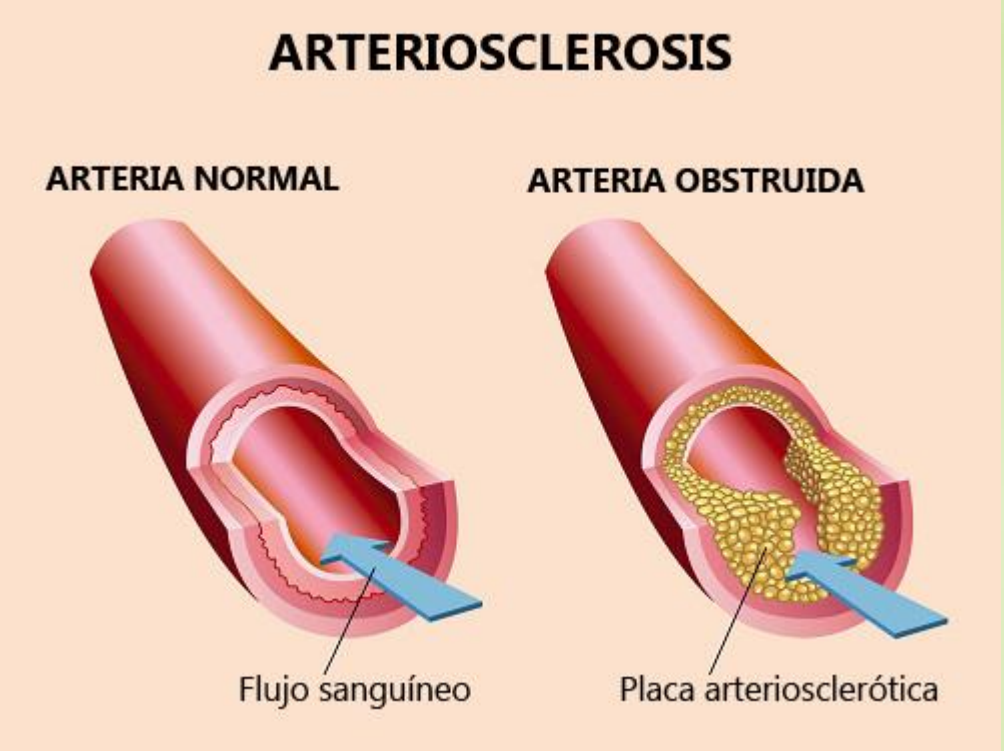
$$P_H = Q\left(\frac{cm^3}{sec}\right) \times E\left(\frac{erg}{cm^2}\right) = Q \times E \text{ erg/sec}$$

At rest, when the blood flow rate is 5 liter/min, or 83, 4 cm3/sec, the kinetic energy of the blood flowing through the aorta is 3. 33 × 10^3 erg/cm3. The energy corresponding to the systolic pressure of 120 torr is 160 × 10^3 erg/cm3



POWER PRODUCED BY THE HEART

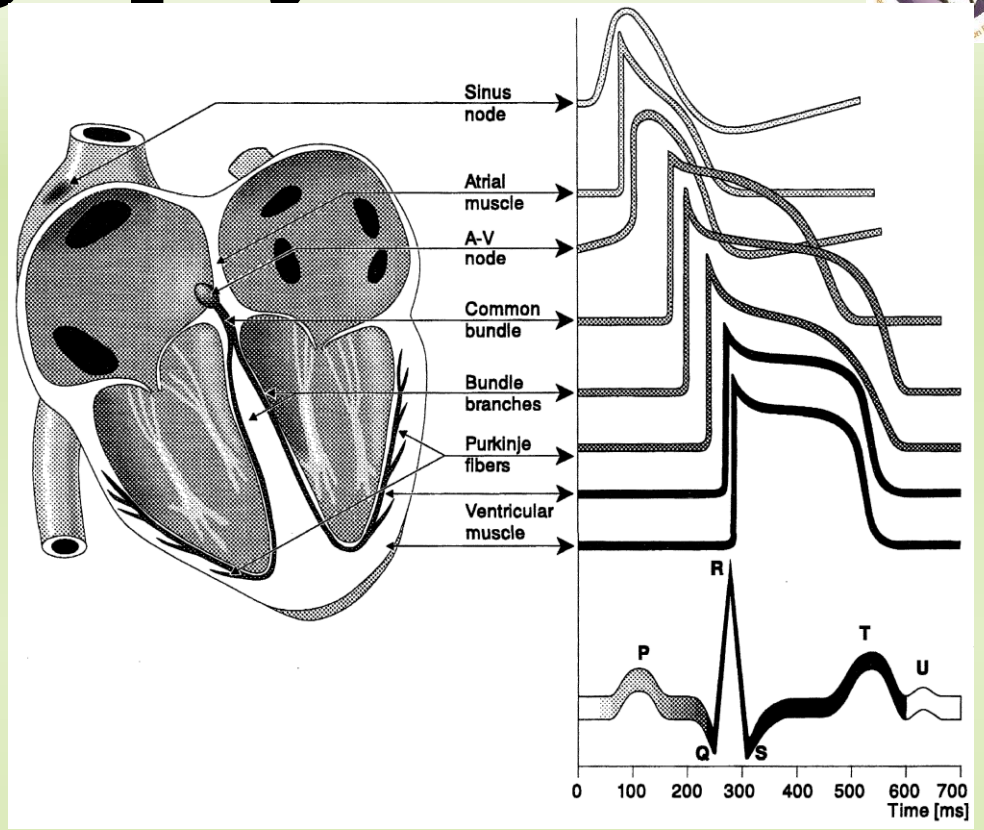
- . The flow rate through the right ventricle, which pumps the blood through the lungs, is the same as the flow through the left ventricle. Here, however, the blood pressure is only one sixth the pressures in the aorta. Therefore, the power output of the right ventricle is 0.25 W at rest and 4.5 W during intense physical activity. Thus, the total peak power output of the heart is between 1.9 and 14.6 W, depending on the intensity of the physical activity

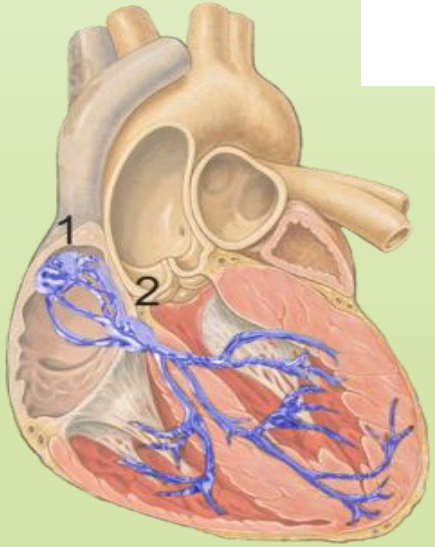


Electrocardiography (ECG)

- . is the process of recording the electrical activity of the heart over a period of time

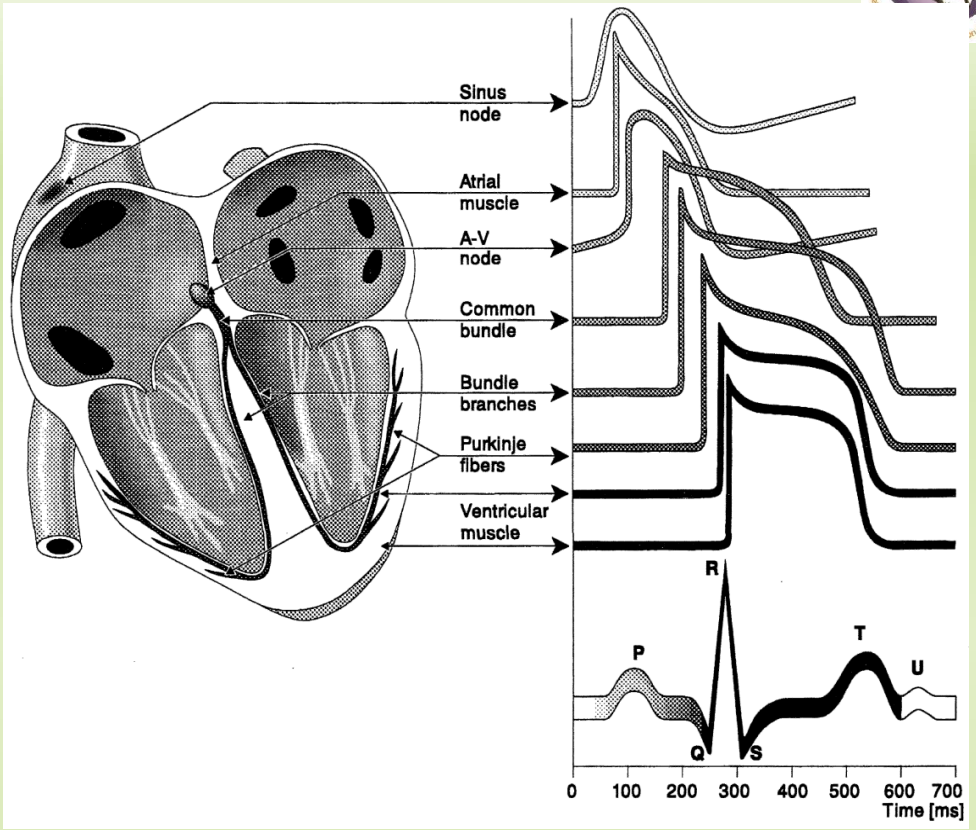
- using <u>electrodes</u> placed on the skin
- a healthy heart has an orderly progression of depolarization that starts with pacemaker cells in the sino aterial node





The theory of (ECG)

1-The P wave represents atrial depolarization.
2-The QRS complex represents ventricular depolarization.
3-The T wave represents ventricular repolarization.
4-The U wave represents papillary muscle repolarization.




Thank you