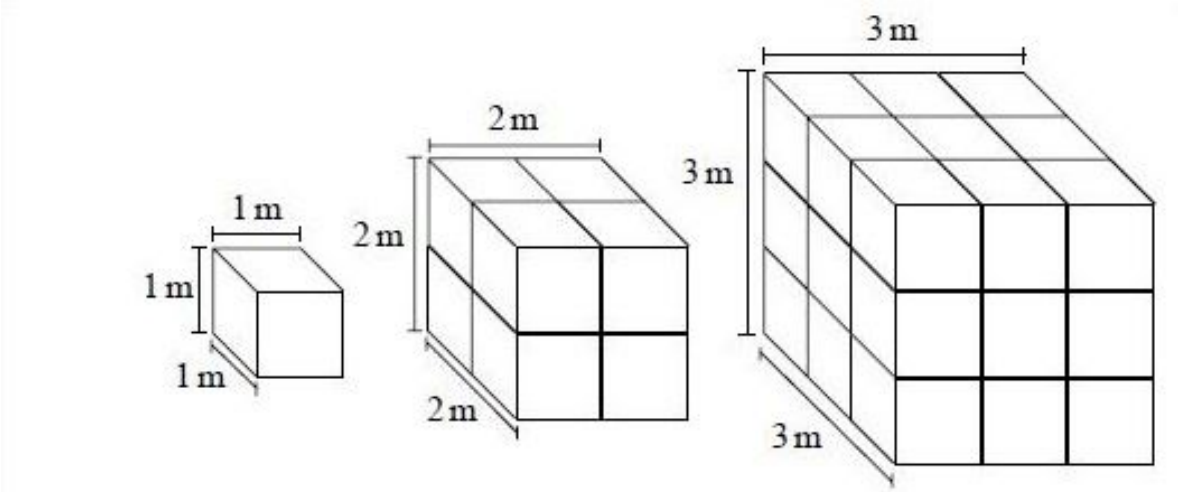
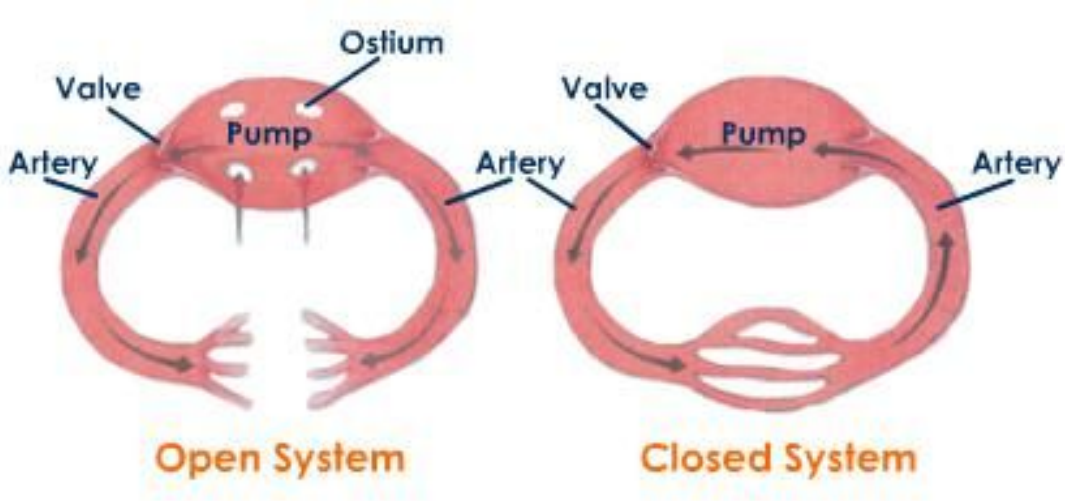
Circulatory System



surface area	$6m^2$	$24m^2$	$54m^2$
volume	$1m^3$	$8m^3$	$27m^3$
surface area: volume	6:1	3:1	2:1

As the surface area to volume ration decreases, it gets more difficult to supply the tissues with adequate oxygen and glucose using diffusion alone. Another mechanism - like a pump - is needed to ensure that all the cells are bathed in sufficient nutrients.

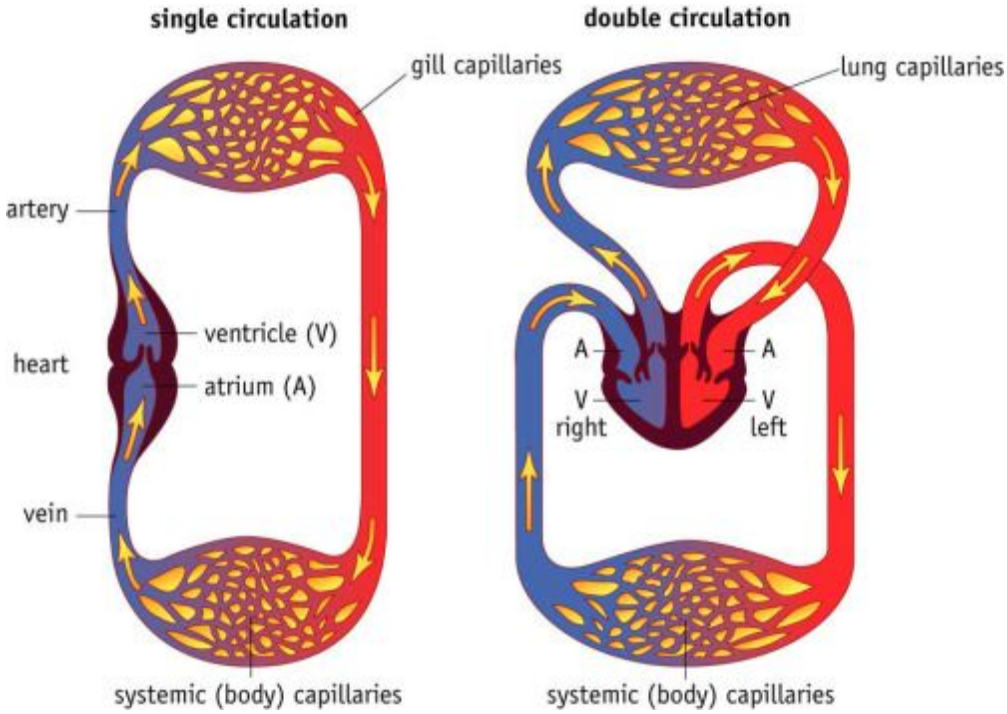
Open and Closed Circulatory Systems



Open system: Blood diffuses into an open cavity

Closed system: Blood enclosed in capillaries, RBCs are not in direct contact with tissues

Single and Double Circulatory Systems



Single: Blood from the tissues returns to the heart -> sent to the gas exchange surface -> oxygenated blood returns to tissues

Double: Blood from the tissues returns to the heart -> sent to the gas exchange surface -> oxygenated blood returns to heart -> pumped to tissues

The human heart

Atrium

Thin-walls, elastic and can stretch as it collects blood

Right Atrium

- Connected to the Vena Cava
- Receives deoxygenated blood from the body

Left Atrium

- Connected to the pulmonary vein
- Receives oxygenated blood from the lungs

Ventricle

Thicker muscular structure, that acts as a pump - capable of strong contractions

Right Ventricle

- Receives deoxygenated blood from right atrium
- Pumps it via the pulmonary artery, to the lungs

Left ventricle

- Receives oxygenated blood from the left atrium
- Pumps it via the aorta, to the body

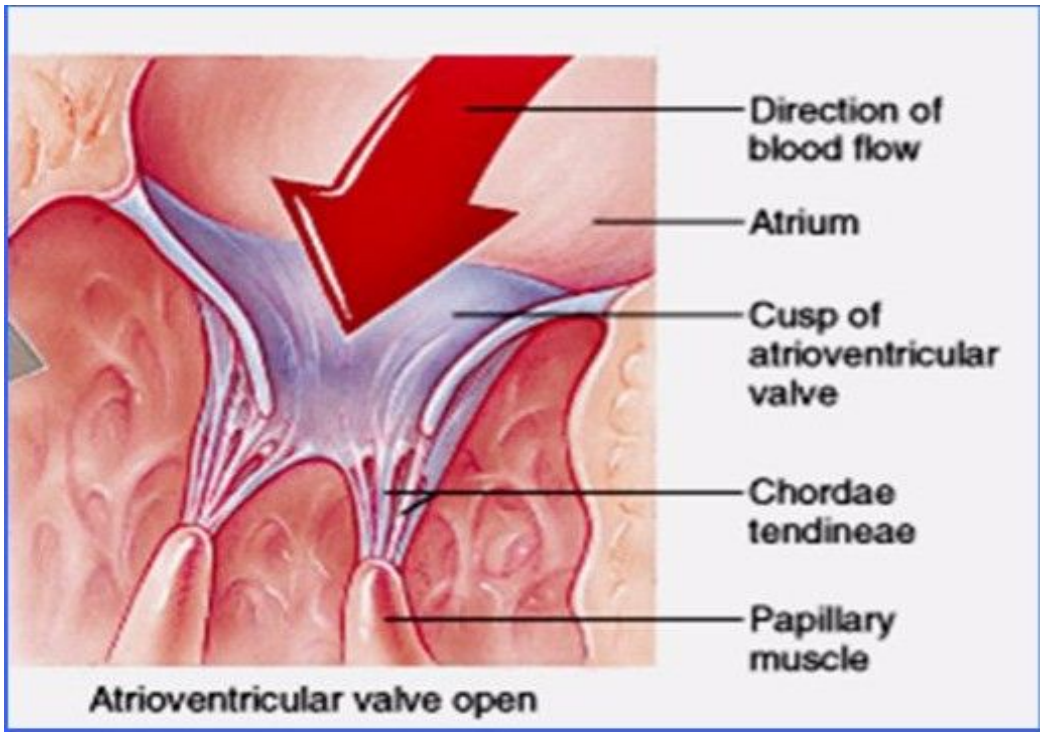
The left ventricle has a thicker muscle wall than the right ventricle, as it needs to generate enough pressure to pump blood to the rest of the body.

All four chamber of the heart can accommodate the same volume of blood.

A septum separates the right and left side of the heart.

Valves in the Heart

- Flow of blood between the atria and ventricles, and the ventricles and the body, is controlled by valves.
- Valves only allow one way flow
- Valves open and close in response to blood pressure
- High pressure on the inside forces the valve shut



Lub-dub sound of the heart is due to the valves snapping shut

AtrioVentricular Valves (AV)

- Control the flow of blood between atria and ventricles
- Right: tricuspid
- Left: biscuspid (mitral)

Semilunar valves

- Control the flow of blood between the ventricles and the body
- Right: pulmonary
- Left: aortic

Supplying the heart with oxygen

- Coronary artery

The cardiac cycle (pg 174)

1. Contraction of the atria (atrial systole)

- At the end of (the previous) cycle, the pressure is the atria is low
- This draws in blood from the vena cava (right atrium) and pulmonary artery (left atrium)
- As the atria fill up, both the pressure and the volume increase
- Pressure in the atria is now higher than ventricles
- The pressure causes some blood to trickle from the atria to the ventricles via the AV valves
- A electrical signal is generated by the pacemaker (SinoAtrial Node - SAN), which travels over both the atria at the same time
- This causes the atria to contract simultaneously -> the AV valves open (SL valves are closed)
- Blood is forced into the ventricles

The electrical signal from the SAN is delayed between the atria and ventricles, due to the presence of a thick band of connective tissue - this allows the atria to empty completely

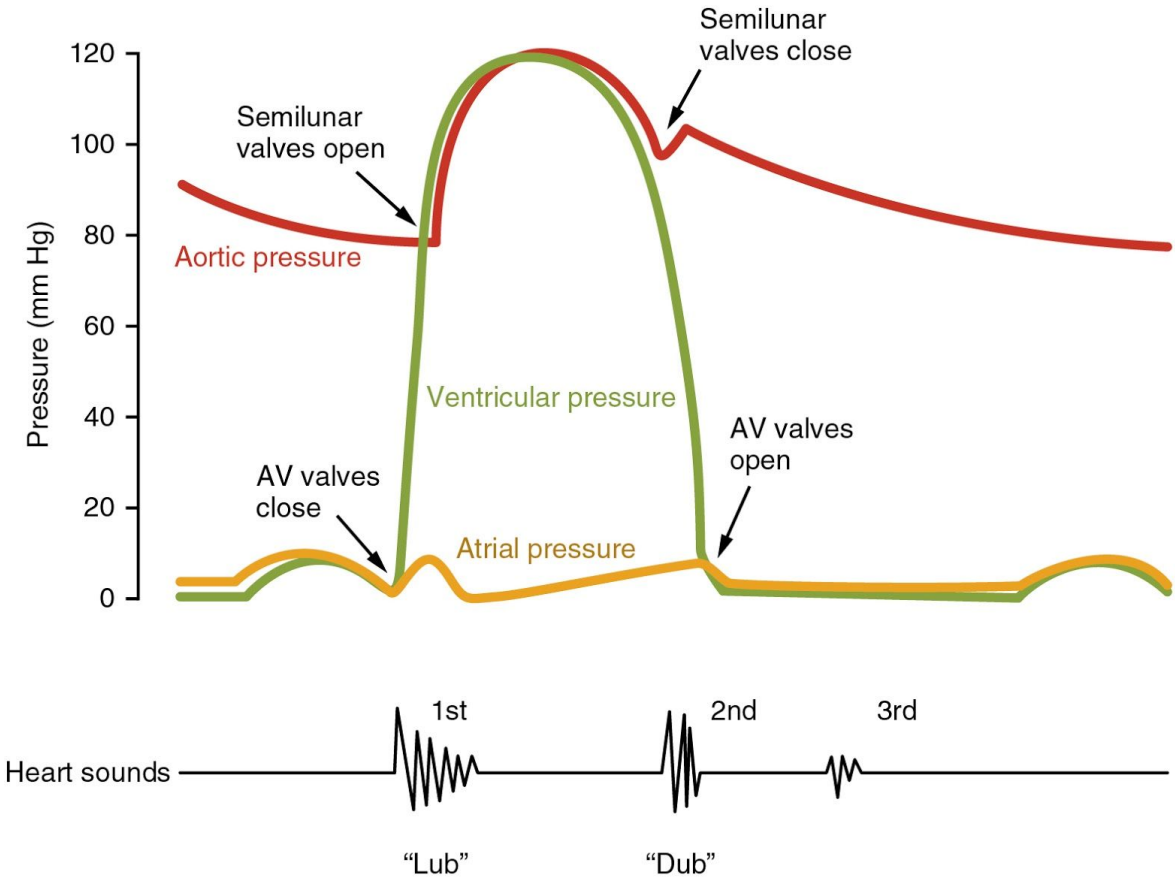
2. Contraction of the ventricles (ventricular systole)

- as the ventricles fill up with blood, both the pressure and the volume increase
- the AV valves close due to the high pressure in the ventricles (lub sound)
- the electrical signal travels to the base of the ventricle
- the ventricles start to contract from the base upwards
- this causes the Semi-Lunar valves to open
- blood is forced into the pulmonary artery (right ventricle) and aorta (left ventricle)
- as the ventricles empty, the pressure drops
- the SL valves snap shut (dub sound)

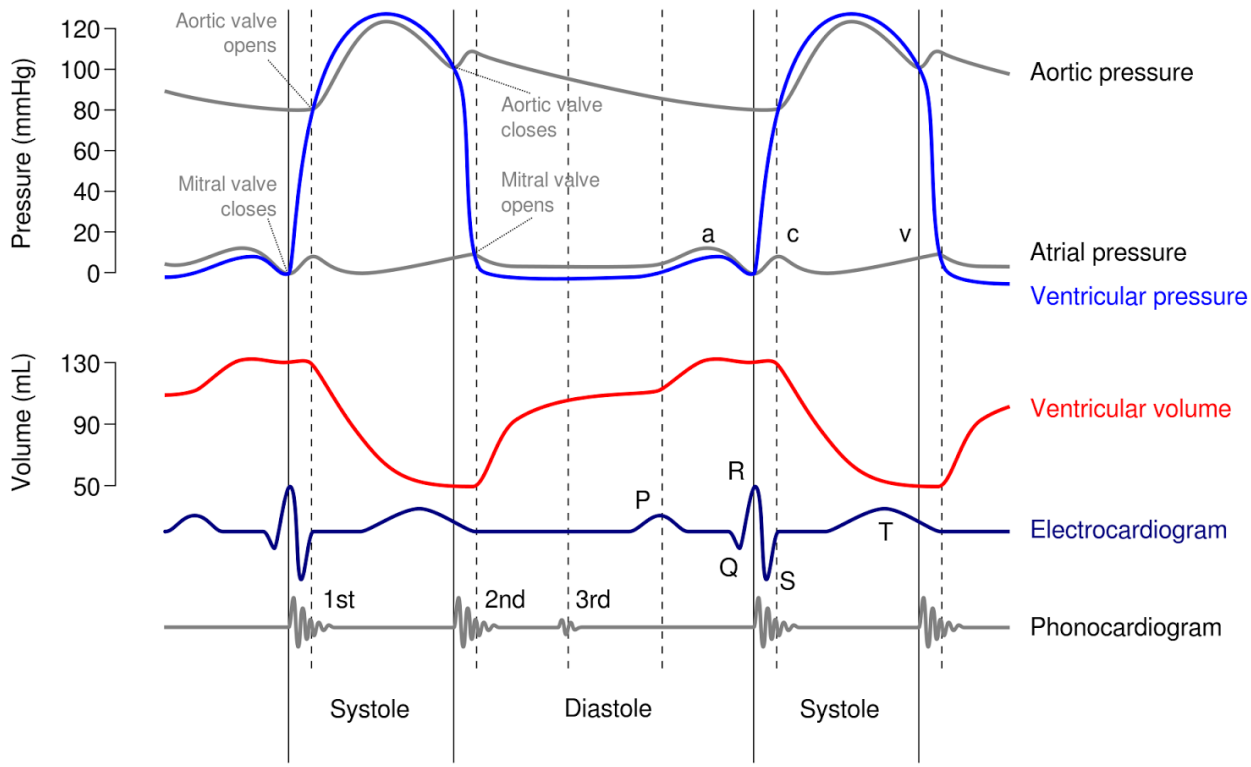
3. Diastole

- relaxation of the heart muscles
- both the atria and the ventricle muscles relax after contraction (recoil action)
- the diastole phase is slightly out of sync - when the atria relax, the ventricles begin to contact; when the ventricles relax, the atria start to fill with blood

Pressure Changes of the Heart (pg 176)

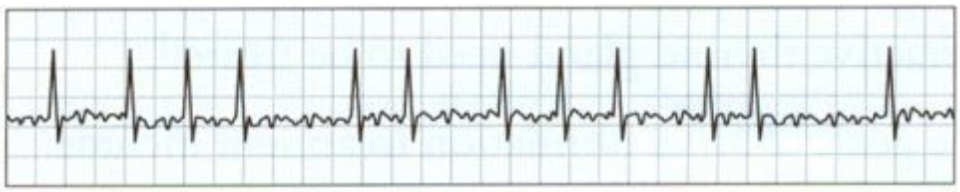


Volume changes (pg 176) and ECG (pg 177)



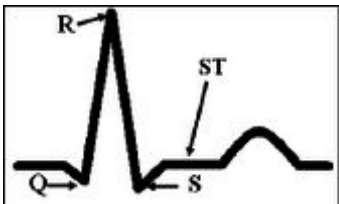
Atrial Fibrillation

ECG tracing of a normal heart rhythm.



In atrial fibrillation, the tracing shows tiny, irregular "fibrillation" waves between heartbeats. The rhythm is irregular and erratic.

Heart Attack

		
Cardiac cycle	**Minutes after heart arrack starts**	**Hours later**
Normal	**ST shifted**	**- ST shifted - R dropping - Q appears to be noticeable**