Closed Double Circulation

Blood is enclosed within capillaries.
Blood travels through the heart twice in one complete circuit.

Double Circulation maintains a high blood pressure.

Types of Circulations

Pulmonary Circulation: Right ventricle pumps blood to the lungs.

Systemic Circulation: Left ventricle pumps blood to all body tissues.

Left Ventricle >> Right Ventricle

LV has a thicker wall than RV as LV pumps blood to all body tissues (systemic), so to generate more pressure to overcome high resistance.

Blood Capillaries

	Artery	Vein	Capillary
Tunica Intima	A very smooth **endothelium**, made of a single layer of **squamous epithelium cells**	A very smooth **endothelium**, made of a single layer of **squamous epithelium cells**	One cell thick wall, made of **endothelium**
Tunica Media	Made of: Elastic Fibres Smooth Muscle Collagen Fibres	Made of: Elastic Fibres *(very thin)* *some* Smooth Muscle ---	------
Tunica Externa	Made of: Collagen Fibres *some* Elastic Fibres	Made of: *mostly* Collagen Fibres ---	------

The capillaries

Capillaries have lumens with a diameter of 7 µm --> just big enough for a RBC to squeeze through.

Capillary wall is one cell thick --> Less diffusion distance

Capillaries have high surface area to volume ratio.

Capillaries are very narrow --> to bring the RBCs very close to the cells.

Capillaries have gaps in between the *endothelial cells* --> allow components of blood plasma to leak out, forming the tissue fluid.

The Arteries

Arteries *further away* from the heart have *fewer elastic fibers* in the tunica media, but they have *more muscle fibers*.

Arterioles have a *greater* proportion of *smooth muscle*.

The Veins

Wide lumen --> less resistance to blood flow.

Blood flows through veins by the contraction of skeletal muscles which squeeze inwards on the nearby veins, thus increasing the pressure inside them.

Valves

Valves prevent the backflow of blood.

Valves are held in place by **tendons** that are attached to **papillary muscles**.

Papillary muscles *contract* during ventricular systole *to hold the AV valves closed* and *prevent the AV valves from flipping inside out*.

EF, SM & CF

Elastic Fibers	Stretch during systole to expand/dilate the BV, to accommodate the high pressure. Recoil during diastole so the BV recoils back/constricts to its original size, pushing the blood forward.
Smooth Muscle	Relax to widen/dilate the BV, increasing the blood flow to tissues. Contract to narrow/constrict the BV, reducing the bl0od flow to tissues. They help to control the blood volume flowing into a tissue at different times.

EF, SM & CF (cont)

Collagen Fibers	Help in withstanding the high blood pressure.

BV = Blood Vessels --> Artery/Vein.

Cardiac Cycle

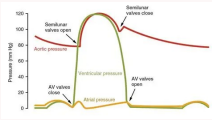
Definition	It is the sequence of events that make up one heartbeat.
1. Atrial Systole (0.1s)	The *atria contract*, generating a pressure that forces blood into the *relaxed ventricles* through the *open AV valves*, while *SL valves remain closed* (to prevent backflow of blood into veins).
2. Ventricular Systole (0.3s)	The *atria relax* and the *ventricles contract*, generating a larger pressure that forces the blood to *close the AV valves* (to prevent backflow of blood into atria) and to *open the SL valves* (to allow blood flow into the arteries).

Cardiac Cycle (cont)

3. Diastole (0.4s)	The *atria remain relaxed* and the *ventricles relax*, so pressure in ventricles decreases. When the ventricular pressure becomes lower than the **arterial** pressure and **atrial** pressure, *SL valves close* and *AV valves open*.

The heart beats around 75 times per minute.
Each cycle takes 0.8 seconds.

Cardiac Cycle Graph



Control of Heartbeat

1. SAN acts as a pacemaker, sending out waves of excitation, and causing the atria to contract.
2. Waves of excitation enters the AVN which delay the impulse for a fraction of a second (0.1s).
3. This delay ensures that the atria and ventricles do not contract at the same time, as the delay gives the atria enough time to fully empty their blood into the ventricles.
4. Waves of excitation pass down the Parkyne tissue down the septum, causing the ventricles to contract from bottom upwards.

The cardiac muscle is *myogenic* --> it spontaneously contracts on its own without the need for nerve impulses to initiate the contraction.