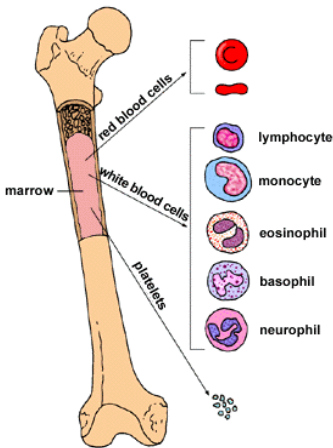


Circulation System

Blood



55% plasma: carries CO₂; glucose, urea, amino-acids, hormones, heat, cells!
45% cells: all made in bone marrow; short life; destroyed in liver; only WBC's have nucleus, reproduce
RBC's carry O₂; no nucleus; biconcave (↑ SA); contain haemoglobin; small (8µm so ↑SA)
WBC's: 3 sorts: **Lymphocytes** (antibodies); **Monocytes** ('eat' bacteria); **Granulocytes** (many jobs)
Platelets: bits of cells **vital for blood clotting** (and tissue repair)

Blood Vessels

Blood pressure falls around system; highest, and varies most, **in ventricles**;
Falls most in arterioles; travels slowest (most resistance) in capillaries; **only veins have valves**.

Heart ventricles → arteries → arterioles → capillaries → venules → veins → heart atria

Arteries: aorta (body); carotid (neck); renal (kidney); pulmonary (lungs, - O₂); hepatic (liver)

Veins: vena cava (body); jugular (neck); renal (kidney); pulmonary (lungs, + O₂); hepatic portal (gut → liver); hepatic (liver).

Arteries: thick, muscular walls, help to pump blood along (elastic recoil); narrow lumen (= high pressure); smooth lining (lowers resistance)

Arterioles: muscular walls so blood flow follows demand (gut after meal, muscles for exercise, skin for cooling).

Supply to brain is constant.

Capillaries: site of exchange with cells; walls 1 cell thick (thus leak); high resistance, slow flow;

Veins: thin walls, large lumen (thus very low pressure); run between muscle blocks (contraction squeezes blood along);

pocket valves ensure blood flows one way (→ heart)

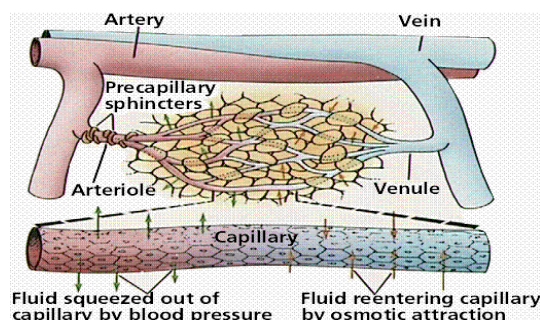
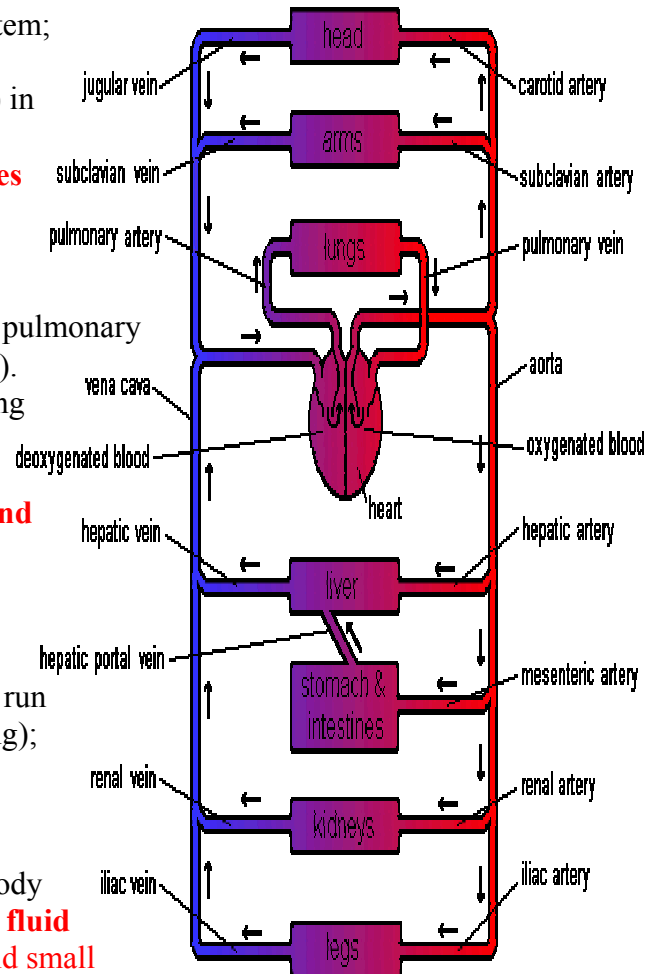
Tissue fluid

Fluid surrounding body cells; isotonic with all cells in body

Formation: High blood pressure at artery end forces fluid out; low pressure at venous end not a problem; water and small molecules forced out (10%); proteins and cells remain behind (too big); thus water potential lowers

Lower water potential at venous end so water re-enters by osmosis, down water potential gradient. Remaining fluid; drains into lymphatic system.

Lymphatic system: Drains tissue fluid – no 'pump'; many valves; relies on muscle contraction to force fluid along; collects at 'lymph nodes' = site of lymphocyte production (tonsils); also drain fats from guts in lacteals. Lymph returns to blood just outside the heart (right atrium).



The Heart

Dual pump; all 4 chambers have same volume; myogenic (does not need nerves to stimulate)

Diastole = filling chamber (**low pressure**); **Systole** = contracting chamber (**high pressure**)

Right side – **deoxygenated**, blood **from** vena cava **to** lungs; **lower pressure** (short artery, no gravity)

Left side: oxygenated, blood **from** lungs **to** body;

highest pressure (long trip, problem of gravity)

Blood flows: right atrium → right ventricle → lungs

→ left atrium → left ventricle → body (aorta)

Valves: semi-lunar valves between ventricles and main arteries; **open at start of ventricular systole**; close at **end of ventricular systole** (**pressure in ventricle < artery**)

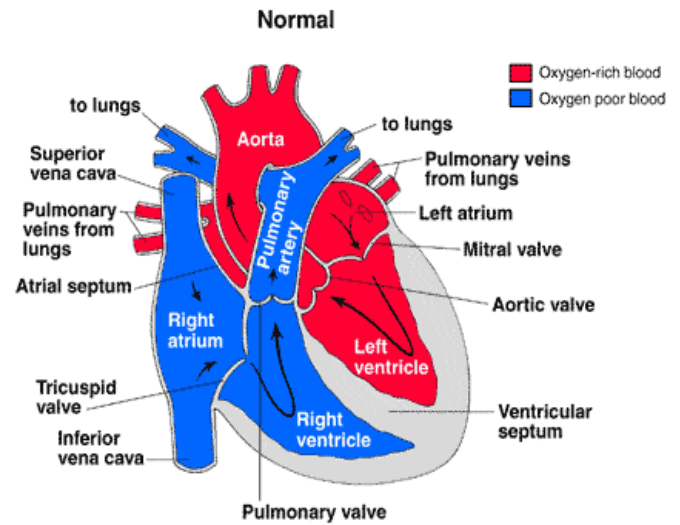
Atrio-ventricular (a-v) valves are between atria and ventricles (**L = bicuspid, R = tricuspid**)

A-V valves open when atria contract (systole);

(**pressure > than ventricles**);

A-V valves close when ventricular systole begins

(**pressure > that in atria**)



<p>Diastole Blood returning from the body flows into the right atrium, and oxygen-rich blood flowing from the lungs flows into the left atrium.</p>	<p>Atrial systole The right and left atria contract to push blood into the ventricles. The semi-lunar valves close to stop the blood flowing back into the heart.</p>	<p>Ventricular systole The ventricles contract to push blood out of the heart through semi-lunar valves. Both sets of AV valves close to prevent backflow.</p>
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Control: regulated by **autonomic nerves** (vagus↓, cardiac↑) and by **hormones** (adrenalin, insulin)
Nerve impulse arrives at **sino-atrial node (SAN)**; impulse travels over atria, causing contraction; to **Atrio-ventricular node (AVN)**; **DELAY** (allows time for ventricles to fill);

impulse → down **Bundle of His**; causes ventricles to contract **from bottom** (thus fully emptying)

Cardiac Output = **stroke volume** x **heart rate** (= pulse rate)

Heart rate affected by: stress; exercise; drugs (caffeine); hormones; volume of blood returning

