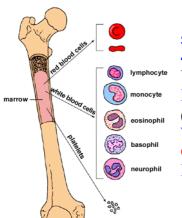
Circulation System



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 O_2 ; no nucleus; biconcave (\uparrow SA); contain haemoglobin; small ($8\mu m$ so \uparrow 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

jugular vein-

subclavian vein-

pulmonary artery

yena caya-

hepatic vein

hepatic portal vein -

renal vein

iliac vein <

~carotid artery

-subclavian artery

pulmonary vein

oxygenated blood

hepatic artery

mesenteric artery

renal artery

iliac artery

ntestines

aorta

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 \rightarrow 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** (\rightarrow heart)

Tissue fluid

Fluid surrounding body cells; isotonic with all cells in body

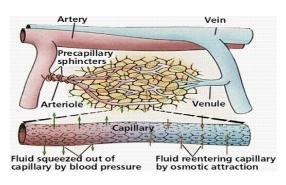
Formation: High blood pressure at artery end forces fluid
out; low pressure at veinous end not a problem; water and small

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 Hea

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)

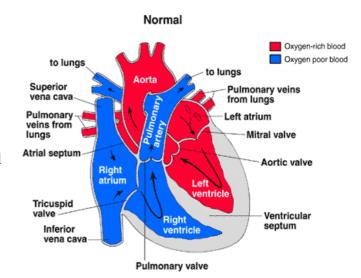
Left side: oxygenated, blood from lungs to body; highest pressure (long trip, problem of gravity) Blood flows: right atrium \rightarrow right ventricle \rightarrow lungs \rightarrow left atrium \rightarrow left ventricle \rightarrow body (aorta)

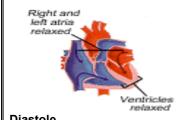
Valves: semi-lunar valves between ventricles and main arteries; open at start of ventricular systole; close at **end** of ventricular systole (pressure in ventricle < artery)

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);

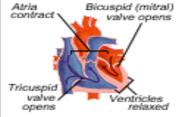
A-V valves close when ventricular systole begins (pressure > that in atria)





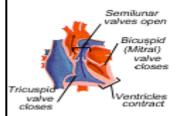
Diastole

Blood returning from the body flows into the right atrium, and oxygenrich blood flowing from the lungs flows into the left atrium.



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.



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.

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 \rightarrow 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

