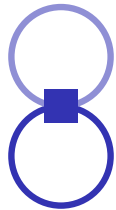
Transport in Mammals

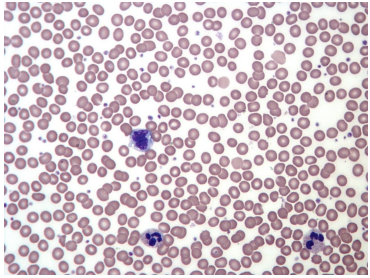
A-Level Biology ▪ Topic 8

A-Level Biology



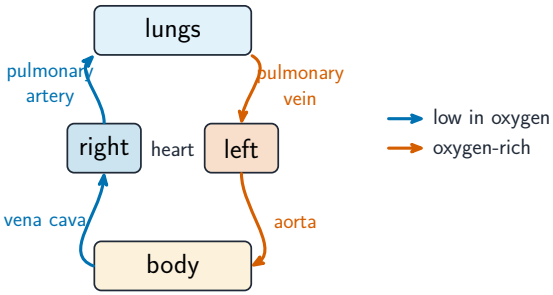
What we will cover

1. Double circulation
2. Blood vessels & tissue fluid
3. Oxygen transport
4. Carbon dioxide transport
5. The heart
6. Controlling the heartbeat



red & white blood cells

Double circulation

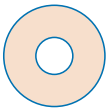


A **closed double circulation** 封闭双循环: blood passes through the heart twice per trip.

- **pulmonary** 肺循环 loop – to the lungs
- **systemic** 体循环 loop – to the body

Order: **arteries** 动脉 → **capillaries** 毛细血管 → **veins** 静脉.

Blood vessels



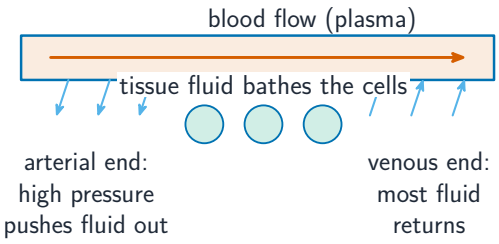
artery
thick muscular, elastic wall; narrow lumen (high pressure)

vein
thin wall; wide lumen; valves (low pressure)

capillary
wall one cell thick; very narrow (exchange)

- **artery** 动脉 – thick muscular & elastic wall; high pressure
- **capillary** 毛细血管 – one cell thick; fast exchange
- **vein** 静脉 – thin wall, **valves** 瓣膜 stop backflow

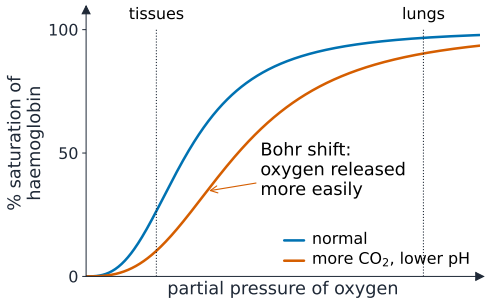
Tissue fluid



At the arterial end, high pressure pushes liquid (not cells/proteins) out of the **plasma** 血浆.

This **tissue fluid** 组织液 bathes the cells with oxygen & glucose; most returns at the lower-pressure venous end.

Oxygen transport and the Bohr shift



Haemoglobin 血红蛋白 loads oxygen in the lungs (high **partial pressure** 分压) and unloads it in the tissues.

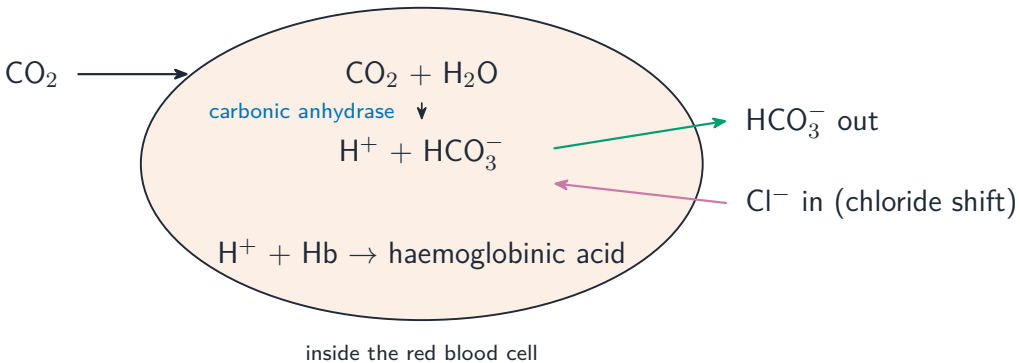
> The **Bohr shift** 波尔位移: more CO_2 (lower pH) moves the curve right, so oxygen is released where it is most needed.

Carbon dioxide transport

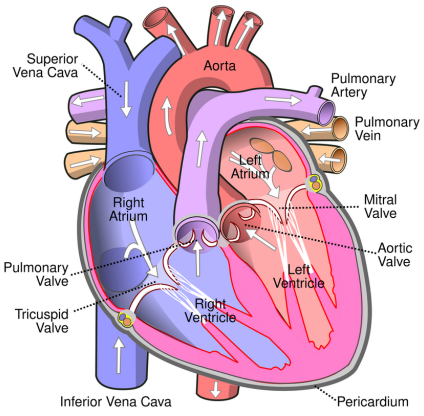
Most CO_2 travels as **hydrogencarbonate ions** 碳酸氢根离子:

- **carbonic anhydrase** 碳酸酐酶 speeds CO_2+ water
- the **chloride shift** 氯转移 keeps charge balanced
- haemoglobin mops up the H^+

Carbon dioxide transport



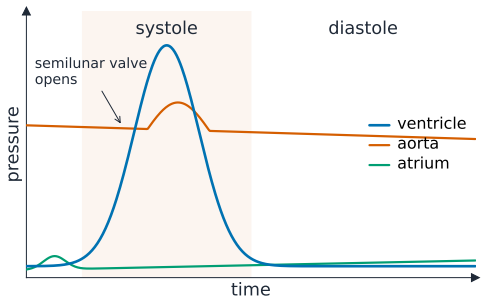
The heart



Four chambers: thin-walled **atria** 心房 above, thick **ventricles** 心室 below.

> The left ventricle wall is thickest – it pumps blood all the way round the body; the right side only reaches the lungs.

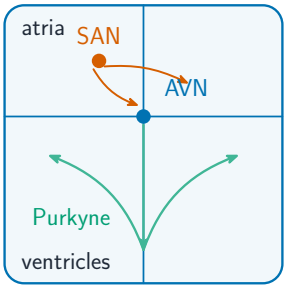
The cardiac cycle



One heartbeat: **systole** 收缩期 (contract) then **diastole** 舒张期 (relax & fill).

> A pressure change opens or closes a **valve** 瓣膜 wherever two pressure curves cross – so blood flows one way only.

Controlling the heartbeat



SAN fires → atria contract → AVN delays → Purkyne → ventricles contract from the bottom up

The heart sets its own rhythm:

- the **SAN** 窦房结 (pacemaker) fires; the atria contract
- the **AVN** 房室结 delays, then passes it on
- **Purkyne tissue** 浦肯野组织 makes ventricles contract bottom-up

Worked example – the Bohr shift

Explain why the oxygen dissociation curve shifts right in an exercising muscle.

- An exercising muscle respires hard, so it releases more CO_2.
- CO_2 forms carbonic acid in the blood $\Rightarrow$ pH falls.
- Lower pH slightly changes haemoglobin's shape, lowering its affinity for oxygen.
- At the same pO_2 it is now less saturated $\Rightarrow$ more oxygen unloaded exactly where it is needed.

Right shift = unloads more readily. The S-shape itself comes from cooperative binding: the first O_2 makes the next one easier to bind.

Topic 8 – key takeaways

1 Circulation

closed, double; arteries to capillaries to veins

2 Oxygen

dissociation curve; Bohr shift releases O_2

3 Carbon dioxide

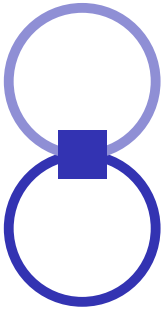
carried as hydrogencarbonate; chloride shift

4 Heart

SAN sets rhythm; left ventricle wall thickest

Check yourself

1. Which vessel has valves to stop back-flow?
2. Which way does the Bohr shift move the curve?
3. In which form is most CO_2 carried?
4. Which node is the heart's pacemaker?



Answers **1.** veins **2.** to the right **3.** hydrogencarbonate ions **4.** the sinoatrial node (SAN)