

The heart and blood vessels

4.2.2.2 · Biology · revision notes

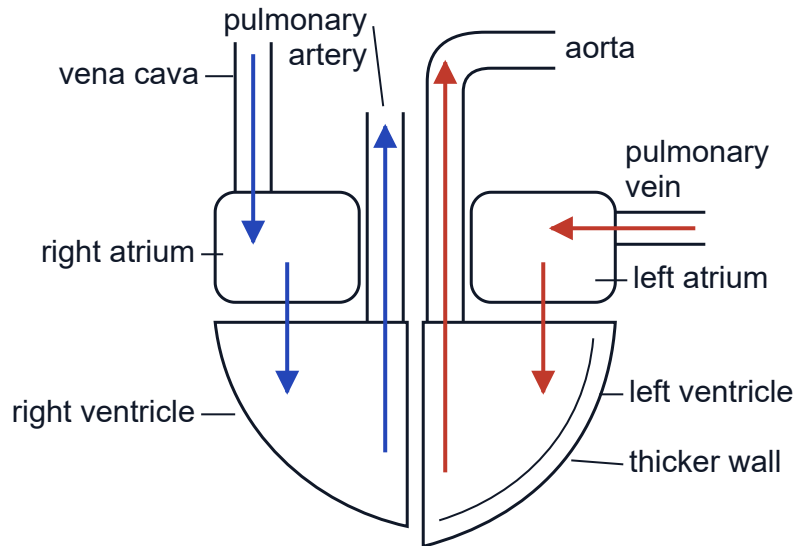
How the heart pumps blood around a double circulatory system, how the lungs are adapted for gas exchange, what the pacemaker does, and how arteries, veins and capillaries are adapted to their functions. Questions include labelling the heart, tracing the path of blood, explaining adaptations and calculating the rate of blood flow.

Key facts

- Right side of the heart → lungs; left side → rest of the body
- Arteries: away from the heart, high pressure, thick muscular and elastic walls
- Capillaries: walls one cell thick, short diffusion distance
- Pacemaker: a group of cells in the right atrium
- Rate of blood flow = volume of blood ÷ time
- Vena cava → RA → RV → pulmonary artery → lungs → pulmonary vein → LA → LV → aorta
- Veins: back to the heart, low pressure, thin walls, wide lumen, valves
- Coronary arteries: supply the heart muscle with oxygenated blood
- Lungs: trachea → bronchi → bronchioles → alveoli (surrounded by capillaries)

The heart and double circulation

- The heart is an organ, made mainly of muscle, that pumps blood. It has two **atria** at the top and two **ventricles** below.
- Blood flows: vena cava → right atrium → right ventricle → pulmonary artery → lungs → pulmonary vein → left atrium → left ventricle → aorta → body.



The heart from the front: its right side is on the left of the diagram.
Blue = deoxygenated blood, red = oxygenated blood.

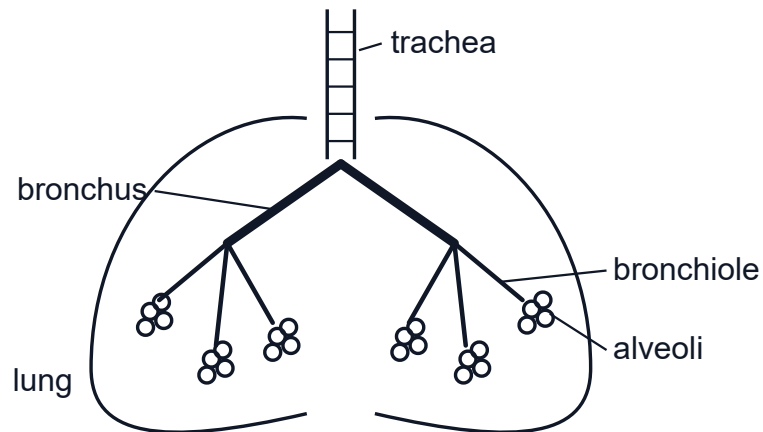
- This is a **double circulatory system**. The **right** ventricle pumps blood to the lungs, where gas exchange takes place. The **left** ventricle pumps blood around the rest of the body.
- Valves stop blood flowing backwards (you do not need their names).
- The **coronary arteries** branch off the aorta and supply the heart muscle itself with oxygenated blood.

Heart rate

- The natural resting heart rate is controlled by a group of cells in the **right atrium** that act as a **pacemaker**.
- An **artificial pacemaker** is an electrical device fitted to correct irregularities in the heart rate.

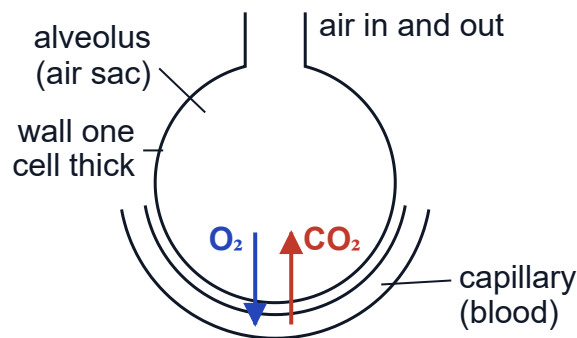
The lungs

- Air passes down the **trachea**, into the two **bronchi**, along the branching **bronchioles**, and on to millions of tiny air sacs called **alveoli**.



The lungs: trachea → bronchi → bronchioles → alveoli

- Each alveolus is surrounded by a network of **capillaries**. Oxygen diffuses from the air in the alveoli into the blood; carbon dioxide diffuses from the blood into the alveoli.



Gas exchange in an alveolus

- Adaptations: a very large surface area (many alveoli); thin walls, giving a short diffusion distance; a good blood supply and breathing, which keep a steep concentration gradient.

Blood vessels

- **Arteries** carry blood away from the heart at high pressure. They have thick walls containing muscle and elastic fibres, so they withstand the pressure and stretch and recoil with each heartbeat.
- **Veins** carry blood back to the heart at low pressure. They have thinner walls, a wide lumen and **valves** that stop blood flowing backwards.
- **Capillaries** are tiny vessels that run through tissues. Their walls are one cell thick, giving a short diffusion distance for substances to pass between the blood and the cells.



Blood vessels in cross-section (not to scale). Veins also have valves.

- Rate of blood flow = volume of blood ÷ time.

How to answer each type of question

Trace the path of blood or label the heart

1 to 4 marks

Grade 4

1. The heart is drawn as if you are facing the person, so the right side of the heart is on the left of the page.
2. Follow the order: vein → atrium → ventricle → artery.
3. Use the names in the specification: vena cava, pulmonary artery, pulmonary vein, aorta.

Example. Describe the path taken by blood from the vena cava until it leaves the heart on its way to the lungs.

Model answer. Vena cava → right atrium (1) → right ventricle (1) → pulmonary artery (1)

Don't lose marks

- ✗ Mixing up left and right on a diagram. The heart is drawn as if you are facing the person.
- ✗ Saying arteries always carry oxygenated blood and veins always carry deoxygenated blood. The pulmonary vessels do the opposite.
- ✗ Writing only 'thin walls' for capillaries when 'walls one cell thick' is the precise answer, or writing 'cell wall' (animal cells do not have cell walls).
- ✗ Saying the pacemaker is in the left atrium or in a ventricle. It is in the right atrium.
- ✗ Saying the heart muscle gets its oxygen from the blood inside its chambers. It is supplied by the coronary arteries.

✗ Forgetting to convert seconds to minutes in blood flow calculations.

More tips

Memory tricks

- Arteries carry blood **away** from the heart; veins carry it back in.
- 'Pulmonary' means 'to do with the lungs': the pulmonary artery goes to the lungs and the pulmonary vein comes back from them.
- Vessels are named by direction, not oxygen: the pulmonary artery carries deoxygenated blood and the pulmonary vein carries oxygenated blood.
- Blood always goes into an atrium first, then a ventricle: A before V, like the alphabet.
- The left side works harder (it pumps to the whole body), so the left side has the thicker wall.

Exam technique

- In adaptation questions, link each feature to its function: feature + 'so' + reason.
- Use the vessel names exactly: vena cava, pulmonary artery, pulmonary vein, aorta, coronary arteries.
- In calculations, check which unit the question asks for and show your working.
- For lung questions, use the terms surface area, diffusion distance and concentration gradient.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Name the three types of blood vessel

Arteries carry blood away from the heart, veins carry blood back to the heart, and capillaries link them inside tissues.

Grade 4

Label the heart's chambers and main vessels

Right and left atria and ventricles, the vena cava, pulmonary artery, pulmonary vein, aorta and coronary arteries.

Grade 5

Describe the double circulatory system

The right ventricle pumps blood to the lungs and the left ventricle pumps blood around the rest of the body.

Grade 5

Describe the role of the pacemaker

A group of cells in the right atrium controls the natural resting heart rate; an artificial pacemaker is an electrical device that corrects an irregular heart rate.

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