2.5 Transport in plants and humans

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **transport in plants and humans** : xylem and phloem, transpiration, blood and its cells, the heart, blood vessels and the effect of exercise on heart rate.

You must be able to:

- describe the roles of xylem, phloem and the parts of blood
- link the structure of the heart and blood vessels to their function
- explain how conditions change the rate of transpiration
- calculate rates of water uptake from potometer results

1 Key knowledge and worked examples

Transport

idea	rule
double circulation	the right side of the heart pumps blood to the lungs; the left side pumps it to the rest of the body
arteries	carry blood away from the heart at high pressure
veins	carry blood back to the heart at low pressure; have valves
capillaries	walls one cell thick; substances are exchanged with the tissues
transpiration	evaporation of water from leaves, mostly through the stomata; faster when warm, dry, windy and bright
rates	heart rate = beats ÷ minutes; water uptake = distance the bubble moves ÷ time

Worked example 1: heart rate. 18 beats are counted in 15 s. Find the heart rate.

1. Known: 18 beats; 15 s = 0.25 min.
2. Rule: beats ÷ minutes.
3. Numbers: 18 ÷ 0.25.
4. Result: 72 **beats per minute**.

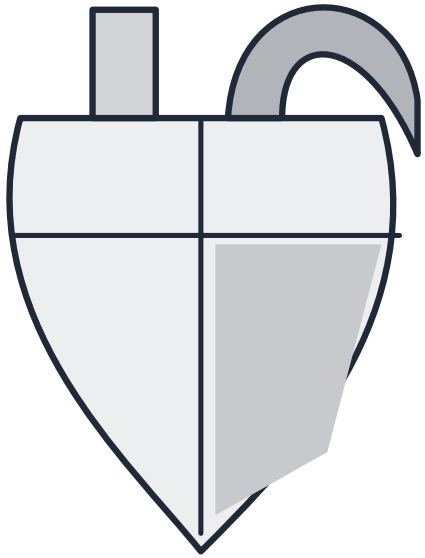
Worked example 2: water uptake. The bubble in a potometer moves 24 mm in 6 minutes. Find the rate.

1. Known: 24 mm; 6 min.
2. Rule: distance ÷ time.
3. Numbers: 24 ÷ 6.
4. Result: 4.0 **mm per minute**.

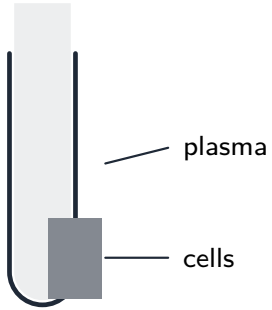
Answer shapes: for transpiration, link the condition to the concentration gradient of water vapour between the leaf and the air.

2 Practice

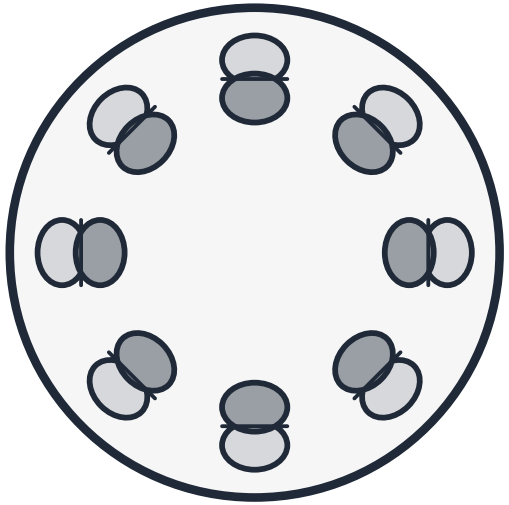
2.1 Explain why the wall of the left ventricle is thicker than the wall of the right ventricle. [2]



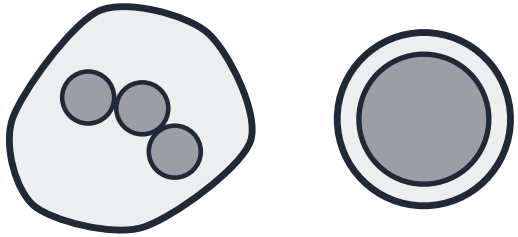
2.2 Give **two** substances carried by the blood plasma. [2]



2.3 Name the tissue that carries water in a plant, and the tissue that carries sucrose. [2]

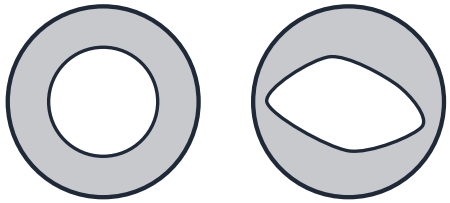


2.4 Describe how phagocytes and lymphocytes protect the body from pathogens. [2]

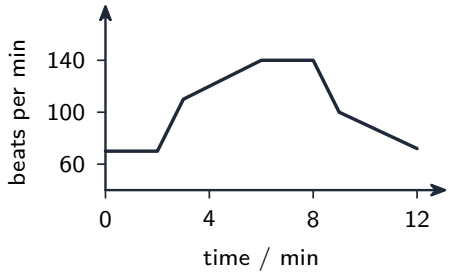


3 Exam-style questions

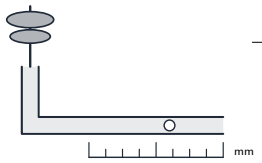
3.1 Compare the structure of an artery and a vein, and link each difference to its function. [3]



3.2 Explain why the heart rate rises during exercise. [3]



3.3 A student uses a potometer to measure water uptake by a leafy shoot. The air bubble moves along the capillary tube as the shoot takes up water. Results for 5 minutes in each condition are shown.



condition	bubble moves in 5 min / mm
still air	15
fan	40
plastic bag	6
dark	4

(a) Calculate the rate of water uptake in still air and with the fan, in mm per minute. [3]

(b) Explain the effect of the fan and of the plastic bag on the rate of water uptake. [4]

(c) The capillary tube has a radius of 0.5 mm. Calculate the volume of water taken up in still air in 5 minutes. Use volume $= \pi r^2 \times$ distance. [3]

(d) Explain why the rate is lowest in the dark, and describe how water moves from the roots to the leaves. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- the left ventricle pumps blood all round the body; the right pumps only to the lungs
- it needs more muscle to make a higher pressure

2.2

Any two (1 mark each): carbon dioxide, glucose, amino acids, urea, hormones, heat

2.3

- water: xylem
- sucrose: phloem

2.4

- phagocytes engulf and digest pathogens (phagocytosis)
- lymphocytes make antibodies

3.1

- arteries have thick, muscular, elastic walls, to withstand high pressure
- veins have thin walls and a wide lumen, as the pressure is low
- veins have valves to stop blood flowing backwards

3.2

- the muscles respire faster, so they need more oxygen and glucose
- more carbon dioxide must be removed
- the heart beats faster to pump more blood to the muscles (adrenaline also raises the rate)

3.3

(a) still air: $15 \div 5 = \mathbf{3.0}$ mm/min; fan: $40 \div 5 = \mathbf{8.0}$ mm/min

(b) the fan blows away water vapour near the leaf, so the concentration gradient between the leaf and the air is steeper and water vapour diffuses out of the stomata faster; the bag traps water vapour, so the air becomes humid and the gradient is shallower, so transpiration slows

(c) $\pi \times 0.5^2 \times 15 = \pi \times 0.25 \times 15 = \mathbf{11.8}$ mm^3

(d) points to include:

- in the dark most stomata close, so less water vapour escapes (K)
- water evaporates from the cells inside the leaf and diffuses out through the stomata (K)
- this pulls water up the xylem in a continuous column (the transpiration stream) (An)
- water enters root hair cells from the soil by osmosis (K)
- it moves across the root to the xylem, which carries it up the stem (K)
- the potometer measures uptake, which is close to the rate of transpiration (An)

Levels: **5–6** a full, logical answer with correct biology and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.