

Exercise walk-through

The heart ■ 8.3

eXercise

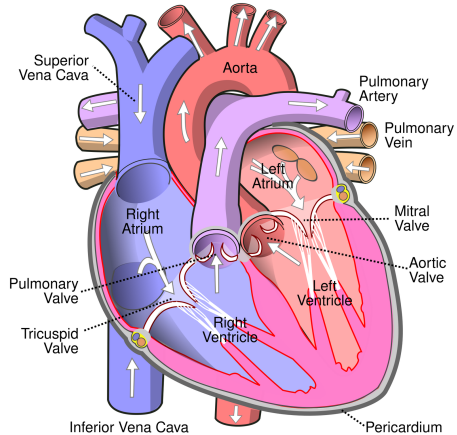
You must be able to

- describe the structure of the heart and explain the differences in wall thickness
- describe the cardiac cycle and how pressure changes open and close the valves
- explain the roles of the SAN, AVN and Purkyne tissue

Method — Heart structure

- **atria** 心房 — thin walls (only push blood into the ventricles).
- **ventricles** 心室 — thick muscular walls (pump blood out).
- the **left ventricle** wall is thickest, to pump blood all round the body; the right only pumps to the nearby lungs.

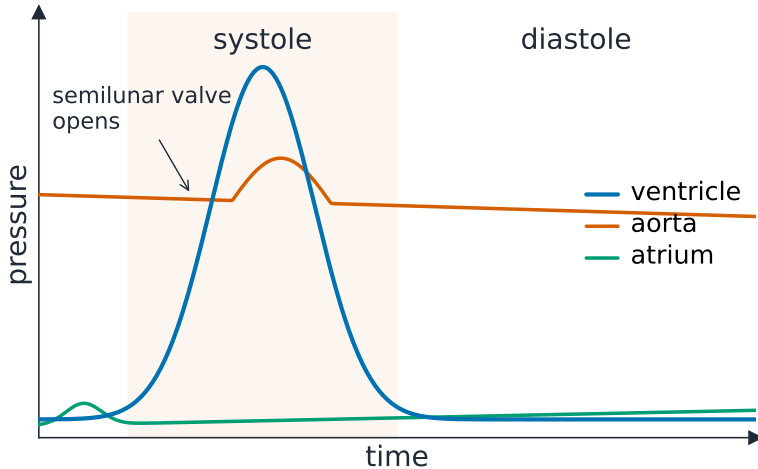
Method — Heart structure



Method — The cardiac cycle

Systole 收缩期 = contraction (pressure rises); **diastole** 舒张期 = relaxation/filling. A valve opens when the pressure behind it is higher, and closes when the pressure in front is higher — so blood flows one way only.

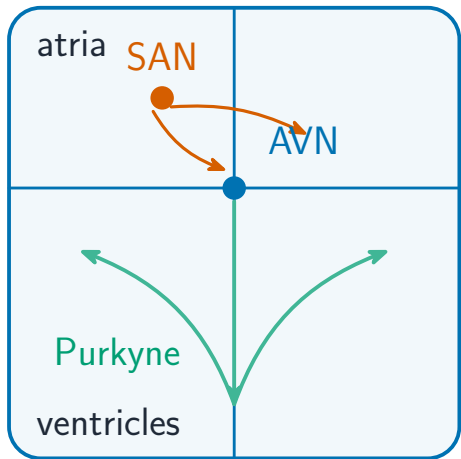
Method — The cardiac cycle



Method — Controlling the heartbeat

The **SAN** (pacemaker) fires a wave that contracts the atria; the **AVN** delays it (so atria empty first); the **Purkyne tissue** 浦肯野组织 carries it through the ventricle walls so they contract from the bottom up.

Method — Controlling the heartbeat



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

Practice 2.1 ■ 2 marks

Explain why the wall of the left ventricle is thicker than the wall of the right ventricle.

Solution 2.1

Method: Heart structure

Worked steps

the left ventricle pumps blood all the way round the body (the systemic circulation) **M1**, which needs a higher pressure, so it needs more muscle than the right, which only pumps to the lungs **A1**.

Practice 2.2 ■ 1 mark

State what happens to a heart valve when the pressure in front of it (downstream) becomes higher than the pressure behind it.

Solution 2.2

Method: The cardiac cycle

Worked steps

the valve closes **B1**.

Exam-style 3.1 ■ 1 mark

What is the role of the atrioventricular node (AVN)?

- A** to set the basic heart rhythm
- B** to delay the wave of excitation so the atria empty first
- C** to pump blood into the aorta
- D** to close the semilunar valves

Solution 3.1

- A to set the basic heart rhythm
- B to delay the wave of excitation so the atria empty first** 
- C to pump blood into the aorta
- D to close the semilunar valves

Worked steps

- B.** The AVN delays the wave so the atria finish emptying before the ventricles contract.

Exam-style 3.2 ■ 1 mark

During ventricular systole, the semilunar (aortic) valve opens when:

- A** atrial pressure exceeds ventricular pressure
- B** ventricular pressure exceeds aortic pressure
- C** the ventricle relaxes
- D** the atria contract

Solution 3.2

Method: The cardiac cycle

- A atrial pressure exceeds ventricular pressure
- B ventricular pressure exceeds aortic pressure**
- C the ventricle relaxes
- D the atria contract



Worked steps

- B. The semilunar valve opens when ventricular pressure rises above aortic pressure.**

Exam-style 3.3 ■ 2 marks

A person has a stroke volume (volume pumped per beat) of 70 cm^3 and a heart rate of 75 beats per minute.

- (a) Calculate the cardiac output (volume pumped per minute), in cm^3 per minute.
- (b) During exercise the heart rate rises to 150 beats per minute and stroke volume to 90 cm^3 . Calculate the new cardiac output.

Solution 3.3

Method: The cardiac cycle

Worked steps

(a) cardiac output = $70 \times 75 = 5250 \text{ cm}^3 \text{ min}^{-1}$ **M1** **A1**.

(b) $90 \times 150 = 13\,500 \text{ cm}^3 \text{ min}^{-1}$ **A1**.

Exam-style 3.4 ■ 4 marks

Describe the sequence of events from the firing of the SAN to the contraction of the ventricles.

Solution 3.4

Worked steps

the SAN fires and the wave spreads across the atria, making them contract **B1**; the AVN picks it up and delays it **B1**; the wave passes down the Purkyne tissue **B1** and up the ventricle walls, so the ventricles contract from the base upwards **B1**.