

8.3 The heart

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS ventricle 心室 • cardiac cycle 心动周期 • systole 收缩期
• atrioventricular node 房室结 • atria 心房

Objective

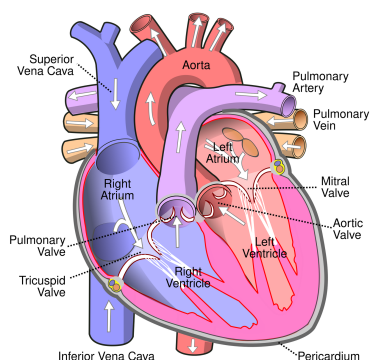
Build the skills to answer exam questions on **the heart** — its structure, the **cardiac cycle** 心动周期, and the control of the heartbeat by the **sinoatrial node** 窦房结.

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

1 Worked examples

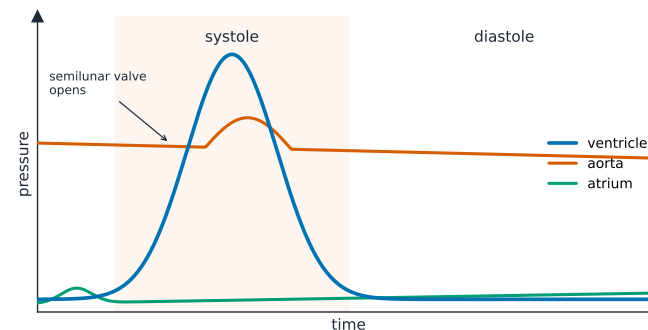
■ Heart structure



Four chambers, valves and main vessels; the left ventricle wall is the thickest

- **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.

■ The cardiac cycle

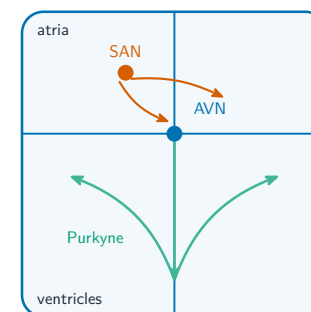


systole = contraction (high P) • diastole = relaxation/fill • valves open on P gradients

The ventricle pressure spikes in systole; a valve opens or closes whenever two pressure curves cross

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.

■ Controlling the heartbeat



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

The SAN sets the rhythm; the AVN delays the wave; the Purkyne tissue makes the ventricles contract bottom-up

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.

2 Practice

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

2.2 State what happens to a heart valve when the pressure in front of it (downstream) becomes higher than the pressure behind it. [1]

3 Exam-style questions

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

3.2 During ventricular systole, the semilunar (aortic) valve opens when: [1]

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

3.3 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. [2]

(b) During exercise the heart rate rises to 150 beats per minute and stroke volume to 90 cm^3 . Calculate the new cardiac output. [1]

3.4 Describe the sequence of events from the firing of the SAN to the contraction of the ventricles. [4]

Solutions

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

2.2 the valve closes.

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

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

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

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

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