

## 5.3 Cardiac and ventilation control

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 19 marks

**KEY WORDS** myogenic • sino-atrial node • Purkyne fibres  
• medulla oblongata • minute ventilation

### Objective

Practise statements 7.12-7.13 and 7.15 with Core Practical 17: the myogenic heart and its conducting system, cardiac output calculations, the medulla's control centres, and spirometer-trace analysis.

### 1 Key knowledge and worked examples

#### ■ The heart sets its own pace

Cardiac muscle is **myogenic** : contraction starts at the **sino-atrial node** without nerve input. The excitation spreads across the atria (atria contract), reaches the **atrio-ventricular node**, and runs along Purkyne fibres to the ventricle walls – delaying ventricular contraction until the atria have emptied.

#### ■ Control on demand

The cardiovascular control centre and ventilation centre sit in the **medulla oblongata** . They read chemoreceptors (CO<sub>2</sub>, pH) and baroreceptors, then adjust heart rate and depth and rate of breathing via the autonomic nervous system (sympathetic speeds, parasympathetic slows).

#### ■ Two formulas

$$\text{cardiac output} = \text{stroke volume} \times \text{heart rate}$$

$$\text{minute ventilation} = \text{tidal volume} \times \text{breathing rate}$$

#### ■ Worked example: reading a spirometer trace

At rest the trace oscillates 0.5 dm<sup>3</sup> about a baseline, 15 times a minute: tidal volume 0.5 dm<sup>3</sup>, minute ventilation 7.5 dm<sup>3</sup> min<sup>-1</sup>. During exercise the oscillations grow to 2.2 dm<sup>3</sup> and the frequency to 30 min<sup>-1</sup>: minute ventilation 66 dm<sup>3</sup> min<sup>-1</sup> – nearly tenfold. Oxygen consumption rises with it, measured as the slope of the falling trace volume.

## 2 Practice

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**2.1** State what is meant by a myogenic muscle. [1]

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**2.2** Name the structure where the heartbeat is initiated. [1]

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**2.3** Calculate cardiac output for stroke volume 95 cm<sup>3</sup> at 130 beats per minute, in dm<sup>3</sup> min<sup>-1</sup>. [2]

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## 3 Exam-style questions

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**3.1** Describe how the heartbeat is initiated and coordinated through the chambers of the heart, naming the structures in order. [5]

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**3.2** During exercise a runner's cardiac output rises from 5.6 to 17.5 dm<sup>3</sup> min<sup>-1</sup> while heart rate rises from 70 to 140 beats min<sup>-1</sup>. Calculate both stroke volumes and explain which factor - heart rate or stroke volume - has contributed more to the rise in cardiac output. [5]

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**3.3** Explain why the ventilation rate increases when blood carbon dioxide concentration rises, naming the receptors, the control centre and the effector. [5]

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