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 (CO2, 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 dm3 about a baseline, 15 times a minute: tidal volume 0.5 dm3, minute ventilation 7.5 dm3 min-1. During exercise the oscillations grow to 2.2 dm3 and the frequency to 30 min-1: minute ventilation 66 dm3 min-1 – nearly tenfold. Oxygen consumption rises with it, measured as the slope of the falling trace volume.

2 Practice

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

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

2.3 Calculate cardiac output for stroke volume 95 cm3 at 130 beats per minute, in dm3 min-1. [2]

3 Exam-style questions

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

3.2 During exercise a runner's cardiac output rises from 5.6 to 17.5 dm3 min-1 while heart rate rises from 70 to 140 beats min-1. Calculate both stroke volumes and explain which factor - heart rate or stroke volume - has contributed more to the rise in cardiac output. [5]

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