5.4 Homeostasis, feedback and thermoregulation

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS homeostasis • negative feedback • positive feedback • hypothalamus • adrenaline

Objective

Practise statements 7.14 and 7.16-7.17: homeostasis, negative and positive feedback, adrenaline's fight-or-flight role, and thermoregulation by the hypothalamus.

1 Key knowledge and worked examples

Homeostasis

Maintaining the internal environment in a state of dynamic equilibrium: variables such as temperature, blood glucose, water potential and pH oscillate inside narrow limits, not held perfectly still.

Two loops

Negative feedback : a deviation triggers a response that returns the variable toward the set point – works in BOTH directions (too hot, too cold; too high, too low). **Positive feedback** : the response amplifies the deviation – rare, and usually a runaway (fever spiking, an action potential's depolarisation opening ever more sodium channels).

Thermoregulation by the hypothalamule

The **hypothalamus** as thermostat: heat gain centre (shivering, vasoconstriction, hair erection) and heat loss centre (vasodilation, sweating). Effectors are skin arterioles, sweat glands, skeletal muscles, hair erector muscles.

Adrenaline

Fight-or-flight: from the adrenal medulla; raises heart rate, dilates airways and muscle arterioles, and stimulates glycogenolysis – glucose for action.

Worked example: writing a feedback loop

"Blood glucose rises, beta cells detect it, insulin released, glucose uptake increases, glucose falls" – each step named in the direction that RESTORES the set point. The reverse loop for a fall (glucagon) completes negative feedback's two-sided character.

2 Practice

2.1 Define homeostasis. [2]

2.2 State one difference between negative and positive feedback. [2]

2.3 Name the structure that monitors blood temperature. [1]

3 Exam-style questions

3.1 Describe the body's responses to a fall in core temperature, naming the centre that coordinates them, two effectors, and how each response conserves or generates heat. [5]

3.2 Explain why negative feedback, but not positive feedback, can maintain a variable within narrow limits, using blood glucose as the example. [4]

3.3 Adrenaline is released before a race. Describe two effects of adrenaline on the cardiovascular and respiratory systems, and explain how each improves performance for a sprint. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Maintaining the internal environment in dynamic equilibrium within narrow limits, despite external change.

2.2 Negative feedback returns a variable toward its set point; positive feedback pushes it further away / amplifies the change.

2.3 The hypothalamus.

3.1 The hypothalamus's heat gain centre coordinates; skeletal muscles shiver, generating heat by respiration; skin arterioles constrict, reducing blood flow to the surface so less heat is lost; hair erects, trapping an insulating layer.

3.2 Negative feedback acts in both directions: above the set point one hormone lowers the variable, below it another raises it – insulin and glucagon hold glucose between narrow limits. Positive feedback amplifies one direction only, so the variable moves ever further from the set point until the process ends – it cannot stabilise anything.

3.3 Heart rate and stroke volume increase, raising cardiac output and oxygen delivery to muscle; airways dilate, reducing resistance and increasing ventilation; glycogenolysis raises blood glucose for rapid respiration.