1.12 Biology: Homeostasis and Response: 30-minute Pack

AQA 7402 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The hypothalamus contains thermoreceptors that monitor the temperature of blood flowing through the brain and coordinates responses that keep core body temperature close to 37°C.

(a) Explain the role of the hypothalamus as a coordination centre in thermoregulation. **(3)**

(b) Explain how vasodilation of arterioles supplying skin capillaries, and increased sweat gland activity, help to lower core body temperature when it rises above normal. **(4)**

(c) Explain how shivering and vasoconstriction help to raise core body temperature when it falls below normal. **(2)**

(d) Explain why thermoregulation is described as operating by negative feedback. **(2)**

(e) A student used a hand-held infrared thermometer to measure forehead skin temperature in ten volunteers, and concluded that forehead skin temperature is a reliable way to estimate core body temperature. Evaluate this conclusion. **(2)**

(Total for Question 1 is 13 marks)

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2 During childbirth, the hormone oxytocin is involved in a positive feedback mechanism that increases the strength and frequency of uterine contractions.

(a) Using the example of childbirth, explain how positive feedback operates, referring to the hormone oxytocin. **(3)**

(b) Suggest why positive feedback mechanisms, such as this one, are relatively rare in the control of body systems, whereas negative feedback mechanisms are common. **(3)**

(Total for Question 2 is 6 marks)

3 Compare the underlying causes of type 1 and type 2 diabetes mellitus, and discuss how the treatments used for each type relate to these causes.

(Total for Question 3 is 6 marks)

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Mark scheme · 1.12 Biology: Homeostasis and Response: 30-minute Pack

Question 1

(a) thermoreceptors in the hypothalamus (and in the skin) detect changes in blood/core temperature (and skin temperature) **B1**

(a) the hypothalamus compares this information with a genetically determined normal/set core temperature (about 37°C) **B1**

(a) the hypothalamus (acting as the coordination centre) sends nerve impulses, via the autonomic nervous system, to effectors to bring about an appropriate corrective response **B1**

(a) Answer: Thermoreceptors in the hypothalamus detect deviations from the normal core temperature; the hypothalamus compares this to the set point and sends impulses via the autonomic nervous system to effectors.

(b) arterioles supplying skin capillaries dilate (vasodilation), increasing the flow of warm blood close to the skin surface **B1**

(b) this increases the rate of heat loss (by radiation, convection and conduction) from the blood to the surrounding environment **B1**

(b) sweat glands increase the secretion of sweat onto the skin surface **B1**

(b) heat energy from the body is used to evaporate water in the sweat (latent heat of vaporisation), transferring heat away from the skin/body, producing a cooling effect **B1**

(b) Answer: Vasodilation increases blood flow near the skin surface, increasing heat loss by radiation/convection/conduction; increased sweating uses body heat to evaporate water from the skin, cooling the body.

(c) skeletal muscles contract rapidly and repeatedly (shivering); this increased muscle contraction requires increased respiration, which releases heat as a by-product, warming the blood **M1**

(c) arterioles supplying skin capillaries constrict (vasoconstriction), reducing blood flow near the skin surface (diverting blood through shunt vessels), reducing heat loss from the skin and helping retain heat in the body core **A1**

(c) Answer: Shivering increases muscle contraction and respiration, releasing heat as a by-product; vasoconstriction reduces blood flow to the skin surface, reducing heat loss and conserving core heat.

(d) a deviation from the normal core temperature (37°C) in either direction (a rise or a fall) triggers effector responses that counteract/reverse the change **M1**

(d) this returns core temperature back towards the normal set point, which removes the original stimulus and switches off the corrective response (oe) **A1**

(d) Answer: A deviation from 37°C in either direction triggers responses that reverse the change, returning temperature to the set point and removing the original stimulus.

(e) skin temperature is strongly influenced by ambient/environmental temperature and by blood flow to the skin (vasodilation/vasoconstriction), so it may not accurately reflect core (deep body) temperature, particularly during a thermoregulatory response **M1**

(e) the conclusion is not fully supported without comparing forehead readings to a direct measure of core temperature (e.g. tympanic, oral or rectal) as a reference method, so further evidence would be needed to justify it (oe) **A1**

(e) Answer: The conclusion is not well supported: skin temperature is affected by ambient conditions and blood flow, so it may not reliably reflect core temperature without comparison to a validated core-temperature method.

Question 2

(a) stretching of the cervix (by the baby's head) stimulates the release of oxytocin from the posterior pituitary gland **B1**

(a) oxytocin causes the muscle of the uterus wall to contract more strongly and more frequently, pushing the baby further against the cervix **B1**

(a) this increases cervical stretching further, stimulating (even) more oxytocin release, so contractions become progressively stronger, until the process ends with the birth of the baby (removing the original stimulus) **B1**

(a) Answer: Cervical stretching stimulates oxytocin release, which strengthens uterine contractions and increases cervical stretching further, so more oxytocin is released; this cycle intensifies until birth occurs and the stimulus is removed.

(b) positive feedback amplifies a change away from the normal state rather than correcting it, so it could not be used to maintain a stable internal environment in the way homeostasis requires **M1**

(b) if positive feedback operated continuously (without a natural endpoint), it could rapidly drive a variable to a harmful or fatal extreme, so it is generally only suited to rapid, self-limiting processes with a definite endpoint (such as childbirth), rather than long-term regulation (oe) **A1**

(b) a further valid supporting example, e.g. the blood clotting cascade is also positive feedback with a natural endpoint (it switches off once a fibrin mesh has sealed the wound), illustrating why such mechanisms are reserved for rapid, self-limiting events rather than continuous regulation (oe) **B1**

(b) Answer: Positive feedback amplifies change rather than restoring stability, so if left unchecked it could drive a variable to a dangerous extreme; it is therefore only suited to rapid processes with a natural endpoint, unlike the continuous stability negative feedback provides.

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Question 3

Level 3 A clear, logically structured comparison of the causes of type 1 and type 2 diabetes, with treatment for each type explicitly and accurately linked back to its underlying cause. Appropriate scientific terminology used accurately throughout.	**5-6**
Level 2 Some accurate description of the causes of type 1 and/or type 2 diabetes, with some links made between treatment and cause, but the comparison is incomplete or lacks clarity in places.	**3-4**
Level 1 Basic or limited statements about type 1 and/or type 2 diabetes causes or treatments, with little or no linkage made between cause and treatment.	**1-2**
Level 0 No relevant content.	**0**

Indicative content:

- Type 1 diabetes is an autoimmune condition in which the immune system destroys the insulin-secreting beta cells of the islets of Langerhans, so little or no insulin is produced.
- Type 1 diabetes usually develops in childhood or early adulthood and is not linked to lifestyle or obesity.
- Type 1 diabetes is treated with regular insulin injections, because the body cannot produce its own insulin.
- Insulin cannot be taken as a tablet/orally because it would be digested/broken down by protease enzymes in the gut before it could act, so it must be injected.
- Type 2 diabetes develops when body cells (liver, muscle, fat) become less responsive to insulin (insulin resistance), and/or the pancreas cannot produce enough insulin to compensate for this.
- Type 2 diabetes is strongly associated with lifestyle factors such as obesity, poor diet and lack of exercise, and usually develops later in life.
- Type 2 diabetes is initially managed with lifestyle changes (diet, exercise, weight loss) and/or oral medication that improves insulin sensitivity or secretion, rather than insulin injections, because the patient's own insulin production and response may still be partly functional.
- In more advanced or severe type 2 diabetes, insulin injections may eventually become necessary.
- Both types result in chronically raised blood glucose concentration if poorly controlled, which can damage blood vessels and organs over time.

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