



B5bD Hormonal Coordination and Homeostasis: Exam Drill

AQA 8464 · Calculator allowed · about 95 minutes

Total Marks

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Name: _____ Date: ____ / ____ / ____

Answer ALL questions. Show all your working.

- 1** Blood glucose concentration is controlled by hormones released from the pancreas, as part of a negative feedback system.
- (a) Name the hormone that lowers blood glucose concentration, and the hormone that raises it. (2)
- (b) State what is meant by 'negative feedback'. (1)

(Total for Question 1 is 3 marks)

- 2** A nurse measured the blood glucose concentration of two patients every 30 minutes after they had eaten the same meal. Patient 1 does not have diabetes. Patient 2 has type 2 diabetes.

Time after meal (minutes) -- Patient 1 (mmol/L) -- Patient 2 (mmol/L)

0 -- 5.2 -- 6.8

30 -- 8.6 -- 11.4

60 -- 6.9 -- 12.6

90 -- 5.4 -- 10.8

120 -- 5.1 -- 9.7

- (a)** Calculate the increase in blood glucose concentration between 0 and 30 minutes for Patient 2. **(1)**

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- (b)** Describe one difference between the two patients' blood glucose concentration curves, using the data in the table. **(1)**

- (c)** Explain, in terms of insulin, why Patient 2's blood glucose concentration takes much longer to return to a normal level than Patient 1's. **(2)**

(Total for Question 2 is 4 marks)

3 Tomasz has type 1 diabetes. He uses an insulin-to-carbohydrate ratio of 1 unit of insulin for every 8 g of carbohydrate he eats. His correction factor is that 1 unit of insulin lowers his blood glucose concentration by 2.5 mmol/L. His target blood glucose concentration before a meal is 7 mmol/L.

(a) Tomasz is about to eat a meal containing 56 g of carbohydrate. Calculate the units of insulin he needs for the carbohydrate in this meal. (2)

(b) Before this meal, Tomasz's blood glucose concentration is 14.5 mmol/L. Calculate the extra correction dose of insulin he needs to bring it down to his target of 7 mmol/L. (2)

(c) Calculate the total dose of insulin Tomasz should inject before this meal. (1)

(Total for Question 3 is 5 marks)

4 A health survey recorded the percentage of adults with type 2 diabetes in a UK city, grouped by body mass index (BMI) category.

BMI category -- Percentage with type 2 diabetes

Healthy weight -- 3%

Overweight -- 9%

Obese -- 18%

(a) Calculate how many times greater the percentage of adults with type 2 diabetes is in the 'obese' category than in the 'healthy weight' category. (2)

(b) A newspaper reported the headline: 'Being overweight causes type 2 diabetes, data proves'. Evaluate whether this data alone proves that being overweight causes type 2 diabetes. (2)

(Total for Question 4 is 4 marks)

- 5** A student investigated the effect of gravity on the growth of newly germinated cress seedlings. She placed one group of seedlings on their sides in a lined Petri dish, so their roots and shoots were growing horizontally, and kept them in constant darkness so that light could not affect their growth. She set up a second, control group of seedlings on a slowly rotating clinostat, also lying on their sides in the dark, so that the effect of gravity was evenly distributed on all sides.
- (a)** Explain why the student kept the seedlings in constant darkness during this investigation. **(1)**
- (b)** Explain the purpose of using a rotating clinostat for the control group. **(1)**
- (c)** Predict and describe the direction of growth of the root and the shoot of a seedling placed on its side (not on the clinostat) after several days. **(2)**
- (d)** Explain, in terms of the distribution and effect of auxin, why the root and shoot grow in these different directions. **(3)**
- (e)** The student measured the angle of curvature of each root using a protractor, to the nearest degree. Suggest one way she could improve the precision of this measurement. **(1)**

(Total for Question 5 is 8 marks)

6 Elena took part in a school play and measured her heart rate immediately before walking on stage, and again while she was speaking her opening lines, using a heart-rate monitor. Before: 72 beats per minute. During: 117 beats per minute.

(a) Calculate the percentage increase in Elena's heart rate. (2)

(b) Name the hormone responsible for this rapid increase in heart rate, and the gland that releases it. (2)

(c) Explain why an increased heart rate is a useful response for the body to have in this situation. (1)

(Total for Question 6 is 5 marks)

7 Higher tier only. Femi has an underactive thyroid gland (hypothyroidism) and takes a daily dose of thyroxine medication. Her doctor measured the concentration of TSH (thyroid-stimulating hormone) in her blood before she started treatment, and again three months after starting treatment.

Before treatment: TSH concentration high, thyroxine concentration low.

After three months of treatment: TSH concentration close to normal, thyroxine concentration close to normal.

(a) Name the gland that releases TSH. (1)

(b) Explain why Femi's TSH concentration was high before she started taking thyroxine medication. (1)

(c) Explain, using ideas about negative feedback, why Femi's TSH concentration fell back towards normal after three months of taking thyroxine medication. (3)

(Total for Question 7 is 5 marks)

- 8** Higher tier only. Kofi runs a marathon on a hot day. He sweats heavily throughout the race but only drinks small amounts of water at drink stations.
- (a) Name the hormone that controls how much water is reabsorbed by the kidneys, and the gland that releases it. (2)
- (b) Explain what will happen to the concentration of ADH released into Kofi's blood during the marathon, and why. (2)
- (c) Explain the effect of this change in ADH concentration on Kofi's kidneys, and on the volume and concentration of urine he produces during the race. (3)

(Total for Question 8 is 7 marks)

- 9** A fertility clinic published data on the success rate of one cycle of IVF treatment, grouped by the age of the woman being treated.

Age group -- Number of IVF cycles -- Number resulting in a live birth

Under 35 -- 400 -- 132

35 to 39 -- 300 -- 63

40 and over -- 200 -- 14

- (a) Calculate the percentage of IVF cycles that resulted in a live birth for women aged under 35. (2)

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- (b) Calculate the percentage of IVF cycles that resulted in a live birth for women aged 40 and over. (2)

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- (c) Suggest a biological reason why the success rate of IVF treatment decreases as the age of the woman being treated increases. (1)

(Total for Question 9 is 5 marks)

10 A clinic gives patients the following information to help them choose a method of contraception.

Contraceptive implant: a small rod inserted under the skin of the arm, releasing progesterone; lasts up to three years without further action needed; over 99% effective; does not protect against sexually transmitted infections (STIs); some users report irregular bleeding as a side effect; fertility usually returns quickly after removal.

Male condom: used during intercourse; about 98% effective with perfect use, about 82% effective with typical use; the only common method that also protects against most STIs; no hormonal side effects; must be used correctly every time, and a new one is needed for each act of intercourse.

Compare the contraceptive implant with the male condom as methods of contraception, and evaluate which might be more suitable for a couple who want a long-term method that they do not need to think about often, and who are not concerned about the risk of STIs.

(Total for Question 10 is 6 marks)

Mark scheme · B5bD Hormonal Coordination and Homeostasis: Exam Drill

Question 1

- (a) **B1** insulin lowers it
- (a) **B1** glucagon raises it
- (a) **Answer: Insulin lowers blood glucose concentration; glucagon raises it.**
- (b) **B1** a control system that detects when a level in the body moves away from its normal range, and triggers a response that brings it back towards normal, oe
- (b) **Answer: A control system that detects when a level in the body moves away from normal, and triggers a response that brings it back towards normal.**

Question 2

- (a) **B1** 4.6 mmol/L (11.4 - 6.8), cao
- (a) **Answer: 4.6 mmol/L**
- (b) **B1** e.g. Patient 2's blood glucose concentration rises to a higher peak (12.6 mmol/L, compared with 8.6 mmol/L for Patient 1) and takes much longer to fall back down (still 9.7 mmol/L at 120 minutes, compared with 5.1 mmol/L for Patient 1), oe
- (b) **Answer: Patient 2's blood glucose concentration rises to a much higher peak (12.6 mmol/L compared with 8.6 mmol/L) and stays high for much longer, still at 9.7 mmol/L after 120 minutes, whereas Patient 1's has returned to close to its starting value.**
- (c) **B1** in type 2 diabetes, the body's cells no longer respond properly to insulin (insulin resistance), and/or the pancreas may not produce enough insulin, oe
- (c) **B1** so glucose is taken up from the blood by cells, and converted into glycogen by the liver, much more slowly than normal, keeping blood glucose concentration higher for longer, oe
- (c) **Answer: In type 2 diabetes, the body's cells no longer respond properly to insulin, and/or the pancreas does not produce enough insulin, so glucose is removed from the blood much more slowly than normal, keeping blood glucose concentration raised for longer.**

Question 3

- (a) **M1** 56 / 8
- (a) **A1** 7 units cao
- (a) **Answer: 7 units**
- (b) **M1** (14.5 - 7) / 2.5
- (b) **A1** 3 units cao
- (b) **Answer: 3 units**
- (c) **B1** 10 units (their (a) + their (b), ft), cao
- (c) **Answer: 10 units**

Question 4

- (a) **M1** 18 / 3
- (a) **A1** 6 times (6x) cao
- (a) **Answer: 6 times**
- (b) **B1** the data shows a correlation (association) between higher BMI category and a higher percentage of type 2 diabetes, but this alone does not prove that one causes the other, oe
- (b) **B1** other factors could also be involved, e.g. diet, exercise levels, age or genetic factors could affect both body weight and diabetes risk, so a controlled study would be needed to establish cause, oe
- (b) **Answer: The data shows a correlation between BMI category and type 2 diabetes rates, but correlation alone does not prove causation; other factors, such as diet, exercise, age or genetics, could affect both body weight and diabetes risk, so this data alone does not prove the headline's claim.**

Question 5

- (a) **B1** so that the seedlings' growth response is caused only by gravity, and not also by light (an uncontrolled variable would make the test unfair), oe
- **(a) Answer: So that any growth response seen is caused only by gravity, and not also by light, which would make the investigation an unfair test.**
- (b) **B1** rotating the seedlings evenly distributes the effect of gravity on all sides of the root and shoot, so they experience no net directional response to gravity, allowing a comparison with the seedlings that experienced gravity from one direction only, oe
- **(b) Answer: Rotating the seedlings evenly distributes the effect of gravity around the root and shoot, so they experience no net directional response, giving a fair comparison for the seedlings that were not rotated.**
- (c) **B1** the root bends and grows downwards, towards the direction of gravity, oe
- (c) **B1** the shoot bends and grows upwards, away from the direction of gravity, oe
- **(c) Answer: The root bends and grows downwards, towards the direction of gravity. The shoot bends and grows upwards, away from the direction of gravity.**
- (d) **B1** when a seedling is placed on its side, auxin accumulates on the lower side of both the root and the shoot, oe
- (d) **B1** in the shoot, the higher concentration of auxin on the lower side causes greater cell elongation there, so the shoot bends upwards, oe
- (d) **B1** in the root, the higher concentration of auxin on the lower side inhibits cell elongation there, so the upper side elongates more and the root bends downwards, oe
- **(d) Answer: Auxin accumulates on the lower side of both the root and the shoot. In the shoot, this higher auxin concentration increases cell elongation on the lower side, so the shoot bends upwards. In the root, the higher auxin concentration on the lower side inhibits cell elongation there instead, so the upper side elongates more and the root bends downwards.**
- (e) **B1** e.g. use a protractor with smaller, finer divisions, photograph the seedlings and measure the angle from an enlarged image, or use digital image analysis software, oe
- **(e) Answer: For example, photograph the seedlings and measure the angle from an enlarged image, or use a protractor with finer divisions.**

Question 6

- (a) **M1** $(117 - 72) / 72 \times 100$
- (a) **A1** 62.5% cao
- **(a) Answer: 62.5%**
- (b) **B1** adrenaline
- (b) **B1** adrenal glands
- **(b) Answer: Adrenaline, released by the adrenal glands.**
- (c) **B1** an increased heart rate delivers blood (carrying oxygen and glucose) to the muscles more quickly, supplying them with what they need for increased respiration, preparing the body for action ('fight or flight'), oe
- **(c) Answer: An increased heart rate delivers oxygen and glucose to the muscles more quickly, supplying what they need for increased respiration and preparing the body for rapid action.**

Question 7

- (a) **B1** pituitary gland
- **(a) Answer: The pituitary gland.**
- (b) **B1** her thyroxine concentration was low, so the pituitary gland released more TSH to try to stimulate the thyroid gland to produce more thyroxine (negative feedback response to low thyroxine), oe
- **(b) Answer: Her thyroxine concentration was low, so the pituitary gland released more TSH to try to stimulate her thyroid gland to produce more thyroxine, as part of the negative feedback response.**
- (c) **B1** the thyroxine medication raised the concentration of thyroxine in her blood, oe
- (c) **B1** the pituitary gland detected this rise in thyroxine concentration and responded by releasing less TSH, oe
- (c) **B1** reducing TSH means the (remaining activity of the) thyroid gland is stimulated less, helping to keep her thyroxine concentration close to its normal level, oe
- **(c) Answer: The thyroxine medication raised her blood thyroxine concentration. The pituitary gland detected this rise and responded by releasing less TSH. reducing stimulation of her thyroid gland and helping to keep her thyroxine**

Question 8

- (a) **B1** ADH (antidiuretic hormone)
- (a) **B1** pituitary gland
- **(a) Answer: ADH (antidiuretic hormone), released by the pituitary gland.**
- (b) **B1** the concentration of ADH released will increase, oe
- (b) **B1** because sweating heavily while drinking only small amounts of water reduces the water content of his blood, and this is detected as needing correction, oe
- **(b) Answer: The concentration of ADH released will increase, because sweating heavily while drinking only small amounts of water reduces the water content of his blood, which needs to be corrected.**
- (c) **B1** the increased ADH concentration makes the kidney tubules more permeable to water, oe
- (c) **B1** so more water is reabsorbed back into the blood from the kidney tubules, oe
- (c) **B1** producing a smaller volume of more concentrated urine, oe
- **(c) Answer: The increased ADH concentration makes the kidney tubules more permeable to water, so more water is reabsorbed back into the blood. This means a smaller volume of more concentrated urine is produced.**

Question 9

- (a) **M1** $132 / 400 \times 100$
- (a) **A1** 33% cao
- **(a) Answer: 33%**
- (b) **M1** $14 / 200 \times 100$
- (b) **A1** 7% cao
- **(b) Answer: 7%**
- (c) **B1** as a woman gets older, both the number and the quality of the eggs remaining in her ovaries decreases, reducing the chance of a viable embryo forming and developing successfully, oe
- **(c) Answer: As a woman gets older, both the number and the quality of the eggs remaining in her ovaries decreases, reducing the chance of a viable embryo forming and developing successfully.**

Question 10

- **Level 3** (5-6): A clear, logically structured comparison of both methods, covering effectiveness, duration of action/convenience and STI protection, leading to a well-reasoned evaluation that directly addresses the couple's stated priorities, using the data given.
- **Level 2** (3-4): Some accurate comparison of the two methods, covering at least two of effectiveness, convenience and STI protection, but the evaluation is incomplete, one-sided, or not always clearly linked to the couple's situation.
- **Level 1** (1-2): Basic, isolated statement(s) about one method or one piece of data, with little or no comparison or evaluation. The answer may be a simple list.
- **Indicative content:**
 - The implant is more effective at preventing pregnancy than the male condom, both compared with perfect use (over 99% vs about 98%) and, more noticeably, compared with typical/everyday use (over 99% vs about 82%).
 - The implant lasts up to three years without the user needing to remember to do anything, whereas the condom must be used correctly every single time, which is why its typical-use effectiveness is much lower than its perfect-use effectiveness.
 - The implant provides no protection against STIs, whereas the male condom is the only one of the two methods that also protects against most STIs.
 - The implant can cause side effects such as irregular bleeding, which the condom does not.
 - Because this couple specifically want a long-term method they do not need to think about often, and are not concerned about STI risk, the implant would be more suitable for them, as it removes the need to remember to use contraception at the time of intercourse.
 - A balanced answer might note that fertility returns quickly after either method is stopped (the implant is removed, or condom use ends), so neither has a long-term effect on future fertility.