PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

# BIOLOGY



## MARK SCHEME

TOPIC 9: CONTROL SYSTEMS

## OSMOREGULATION AND TEMPERATURE REGULATION

| SCORE | PERCENTAGE |
| --- | --- |
| /98 | % |

STEMUP

# These questions belong to Pearson Edexcel, not to us.

The examination questions and mark schemes in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

## What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question or mark scheme material in this pack. Pearson has not endorsed, approved or been involved in the production of it. Pearson, Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

## Where to find the originals

Pearson publishes its past papers and mark schemes free of charge. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

## Mark Scheme

Q1.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | The only correct answer is **B**<br>W and X<br><br>A is incorrect because glucose passes out of the glomerulus<br>C is incorrect because glucose is absorbed in the PCT<br>D is incorrect because glucose is absorbed in the PCT | | **1 comp** |

Q2.

| Question Number | Answer | Mark |
|---|---|---|
| **(i)** | (350 + 490 + 270 + 40 =) 1146 to 1150 | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to four of the following:<br>• {blood / plasma} concentration {low / decreased / dilute / high(er) water potential / hypotonic} (1)<br>• detected by {osmoreceptors / hypothalamus} (1)<br>• therefore {no/less} ADH released by pituitary (1)<br>• collecting duct is less permeable / impermeable (1)<br>• therefore less/no {reabsorption} of water (1) | **DO NOT ACCEPT** higher concentration of water<br>**ACCEPT** baroreceptors<br>**ACCEPT** fewer aquaporins | (4) |

Q3.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | • ultrafiltration | | (1) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to the following:<br>• proteins are too big to pass through (1)<br>• concentrations of the other molecules or ions are the same in both filtrate and plasma (1)<br>• because they are small enough to pass through (1) | | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (iii) | An answer that makes reference to the following:<br><br>• calculation of increase in concentration of urea (1)<br><br>• calculation of increase in concentration of chloride (1)<br><br>• calculation of how many more times concentrated urea is compared to chloride (1) | <u>Example of calculation</u><br><br>2.0 ÷ 0.03 = 66.7 / 66.67<br><br>0.6 ÷ 0.37 = 1.6 / 1.62<br><br>66.67 ÷ 1.62 = 41.2 / 41.15 times more<br><br>66.7 ÷ 1.6 = 41.7 / 41.69 times more<br><br>Correct answer with no working gains full marks<br><br>**ecf** allowed for Mp3 if number in Mp 1 or Mp2 inappropriate rounding | (3) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (iv) | An explanation that makes reference to two of the following:<br><br>• glucose has been (selectively) reabsorbed (1)<br><br>• by {active transport / against a concentration gradient} (1)<br><br>• in the proximal tubule (1) | **Do not accept** absorbed | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (v) | An explanation that makes reference to five of the following:<br><br>• {sodium / chloride} ions are moved out of the ascending limb by active transport (1)<br><br>• ascending limb is impermeable to water (1)<br><br>• this results in a {high(er) concentration / low(er) water potential} in medulla (1)<br><br>• (loop of Henlé) acts as a counter-current multiplier (1)<br><br>• the collecting ducts are permeable to water (1)<br><br>• therefore water moves out (of the collecting ducts) by osmosis (1) | | (5) |

Q4.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | • divide oxygen consumption by body mass (1)<br>• express answer in standard form (1) | Example of calculation<br>50 ÷ 4 000 = 0.0125<br>$1.25 \times 10^{-2}$<br>Correct answer gains full marks, with no working shown<br>**ACCEPT** one mark in working for 0.0125 | (2) |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to four of the following:<br>• {small(er) mammals / small(er) body mass} consume more oxygen (per kg) (1)<br>• mammals are endotherms / maintain body temperature / regulate body temperature (1)<br>• small mammals have larger surface area to volume ratio (1)<br>• therefore lose more heat (1)<br>• heat by respiration (1) | **ACCEPT** large(r) mammals consume more oxygen in $dm^3\ h^{-1}$<br>**ACCEPT** converse for Mps 1, 3 and 4 and 5 | (4) |

Q5.

| Question Number | Indicative content |
|---|---|
| * | Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme.<br><br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant.<br><br>Indicative content:<br><br>Proximal convoluted tubule: **(P)**<br><br>• glucose is all reabsorbed<br>• by active transport / use of energy / use of ATP<br>• urea concentration rises as water is reabsorbed<br>• sodium ions absorbed because concentration does not increase (despite less water)<br><br>Loop of Henle: **(L)**<br><br>• urea concentration rises<br>• sodium ion concentration rises in descending limb<br>• water reabsorbed from descending limb<br>• by osmosis<br>• sodium ion concentration falls in ascending limb<br>• sodium ions actively pumped out of ascending limb<br>• reference to countercurrent multiplier<br><br>Distal tubule and collecting duct: **(C)**<br><br>• urea and sodium ion concentration rise<br>• water is reabsorbed<br>• by osmosis<br>• ADH affects permeability |

| Level | Marks | |
|---|---|---|
| 0 | 0 | No awardable content |
| 1 | 1-2 | Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made.<br><br>The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.<br><br>**Any number of descriptions from graph = 1 point**<br>**Answer with description only and no explanation max 1**<br>**1 REGION and at least one explanation = 2** |
| 2 | 3-4 | Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented.<br><br>Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows some linkages and lines of reasoning with some structure.<br><br>**2 REGIONS and 3 to 4 points** |
| 3 | 5-6 | Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented.<br><br>Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures).<br><br>The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured.<br><br>**3 REGIONS and 5 plus points with no MAJOR errors e.g. urea moving into nephron, sodium ions moving into the nephron** |

Q6.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | A description that makes reference to two of the following:<br><br>• removal of amino group from amino acids / deamination (1)<br><br>• ammonia combines with carbon dioxide (1)<br><br>• the ornithine cycle produces urea (1) | | **(2)** |

Q7.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | B ☒ **B** 1 and 3<br><br>*A is incorrect because facilitated diffusion does not move substances against a gradient*<br>*C is incorrect because facilitated diffusion does not move substances between phospholipids*<br>*D is incorrect because facilitated diffusion does not move substances against a gradient* | | **1** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(ii)** | C increased permeability of the collecting duct to water, producing more concentrated urine<br><br>*A is incorrect because ADH increases the permeability of the collecting duct*<br>*B is incorrect because ADH increases the permeability of the collecting duct*<br>*D is incorrect because ADH results in more concentrated urine* | | **1** |

Q8.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to the following:<br>• large numbers of mitochondria (1)<br>• to provide ATP for active uptake of {glucose / salts / amino acids} (1)<br>• microvilli providing large surface area (1)<br>• for many carrier proteins for {glucose / salts / amino acids} (1) | **Accept** correct named minerals | **4** |

Q9.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to the following:<br>• overall net filtration pressure is 3.2 (1)<br>• so fluid will be forced from the glomerulus into the Bowman's capsule (1) | <u>Example of calculation</u><br>9.2 – 2.0 = 7.2<br>7.2 – 4.0 = 3.2<br>=3.2 | **(2)** |

Q10.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to four of the following:<br>• mice have large surface area to volume ratio (1)<br>• (therefore) {lose a lot of heat / lose heat quickly} (1)<br>• heat generated by {metabolism / respiration} (1)<br>• insufficient food to {maintain (high) metabolic rate / release enough energy} (1)<br>• no bedding {for insulation / to prevent heat loss} (1) | | **(4)** |

Q11.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | • glomerulus | **Do not accept** incorrect spelling | **(1)** |

Q12.

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(a)** | An answer that makes reference to the following:<br>• measure volume by use of {formula / three way tap and syringe} (1) | | **(1)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(b)** | An explanation that makes reference to the following:<br>• the indicator fluid movement would move to the left (1)<br>• because there is lower pressure (1)<br>• because there is respiration but no photosynthesis (1)<br>• therefore the pressure is reduced because the carbon dioxide produced is absorbed (1) | | **(4)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(c)(i)** | An explanation that makes reference to five of the following:<br><br>• use of a larger container because mice are bigger (1)<br>• need to use more carbon dioxide absorber to ensure all carbon dioxide is absorbed (1)<br>• convert readings into units per gram for each animal (1)<br>• attach a syringe to enable {repeat measurements / volume measurements}(1)<br>• abiotic variables such as light / temperature to be same as in the woodlouse experiment (1)<br>• barrier to protect mouse from carbon dioxide absorber / do not leave mouse in the container for a long time (1) | | **(5)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(c)(ii)** | An answer that makes reference to the following:<br><br>• mouse rate of respiration greater than woodlouse (1)<br>• because mice are endotherms / metabolic rate greater / need to maintain body temperature because of heat loss (1) | | **(2)** |

Q13.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| **(i)** | An explanation that makes reference to three from:<br><br>• capsaicin binds to (TPV) receptors in membrane of receptors cells (1)<br><br>• this causes neurotransmitter (from receptors) to bereleased onto sensory neurone {generating an epsp / opening sodium channels / causing sodium ions to flow in} (1)<br><br>• high concentrations of capsaicin generate an epsp that) overcomes threshold to form an {action potential} (1)<br><br>• action potential moves along the neurone by (opening sodium channels) (1) | **Allow** low concentrations does notovercome threshold<br>**Allow** high concentrations opens voltage gated sodium channels | **3** |

| Question Number | Indicative content | |
|---|---|---|
| (ii) | Answers will be credited according to candidate's deployment of knowledge and understanding ofmaterial in relation to the qualities and skills outlined in the generic mark scheme.<br><br>The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientificand relevant.<br><br>**Descriptions**<br>• 100 mg / 50 mg / higher doses / of capsaicin increase mass of sweat produced D<br>• sweat production from 100 mg decreases after 5 days D<br>• 10 mg has less effect D<br>• 10 mg / 50mg have same effect for all seven days D<br>• 100 mg effect decreases after 3/4/5 days D<br>• 100 mg generates less sweat than 50 mg after 5/6 days D<br><br>**Explanation / Optimal Dose**<br>• increased sweating and evaporation of water E<br>• evaporation of water requires heat energy E<br>• latent heat of vaporisation is high for water so sweating removes a lot of heat energy E<br>• 50 mg is optimal dose E<br>• because there 100 mg begins to lose effect after 3/4/5 days E<br>• and 100 mg produces more side effects / burning sensations / red rash E<br><br>**Validity of data**<br><br>• 50 mg dose has consistent sweat production as error bars all overlap V<br>• 100 mg and 50 mg are significantly higher than 10 mg as error bars do not overlap V<br>• 10 mg has a high variation between responses of volunteers V | **6** |

| | | | |
|---|---|---|---|
| | • no control experiment has been carried out V<br>• sample size is small V<br>• capsaicin may interfere with other medicines / may make illness worse / no tests done on illpeople V | | |
| **Level** | **Marks** | | |
| **Level 0** | Marks | No awardable content | |
| **Level 1** | 1-2 | Limited scientific judgement made with a focus on mainly just one method, with a fewstrengths/weaknesses identified.<br><br>A conclusion may be attempted, demonstrating isolated elements of biological knowledgeand understanding but with limited evidence to support the judgement being made.<br><br>**Basic description of the effects of each dose**<br>**one mark: any one from D, E, V**<br>**two marks: 3D, 2D + 1E, 2D + 1V** | |
| **Level 2** | 3-4 | A scientific judgement is made through the application of relevant evidence, with strengthsand weaknesses of each method identified.<br><br>A conclusion is made, demonstrating linkages to elements of biological knowledge andunderstanding, with occasional evidence to support the judgement being made.<br><br>**Detailed description and either E or V**<br>**three marks: at least four points from D + E or D + V**<br>**four marks: at least five points from D + E or D + V** | |
| **Level 3** | 5-6 | A scientific judgement is made which is supported throughout by sustained application ofrelevant evidence from the analysis and interpretation of the scientific information.<br><br>A conclusion is made, demonstrating sustained linkages to biological knowledge andunderstanding with evidence to support the judgement being made.<br><br>**Must have elements of D, E and V.**<br>**five marks: at least six points from D, E and V**<br>**six marks: at least seven points from D, E and V AND must refer to standard deviations** | |

Q14.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An explanation that makes reference to three of the following points:<br>• there is more protein in plasma than tissue fluid (1)<br>• because plasma proteins are too large to pass out of the capillary (1)<br>• and **oncotic** pressure generated by (plasma) proteins (1)<br>• (so fluid moves in) as {oncotic / osmotic} pressure is greater than hydrostatic pressure (1) | **Accept** converse<br>**Accept** converse | 3 exp |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An explanation that makes reference to four of the following points:<br>• sodium ions are not removed from the **ascending** limb (1)<br>• so the water potential of medullary fluid is higher (1)<br>• therefore less water is removed from the **descending** limb (1)<br>• and less water is removed from the {collecting duct / distal tubule} (1)<br>• (a higher volume of) {dilute / low concentration} urine is produced (1) | **Accept** less negative water potential **Accept** water potential gradient is lower **Accept** osmotic gradient is lower | 4 exp |

Q15.

| Question Number | Answer | Mark |
|---|---|---|
| | **The only correct answer is B**<br>***A*** *is not correct because X is the pelvis*<br>***C*** *is not correct because W is the cortex*<br>***D*** *is not correct because W is the cortex* | **(1)** |

Q16.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to the following:<br><br>• (substances) with higher (relative molecular) mass have a {lower ratio / ratio less than 1.00} (1)<br><br>• small(er) substances pass through / large substances do not pass through (1)<br><br>• because of the size of the pores in the {glomerulus / capillary / renal capsule / (basement) membrane} (1) | **ACCEPT** a ratio of 1.00 means substance passes through / a ratio less than 1.00 means not all substance passes through<br><br>**ACCEPT** substances with a mass lower than 180 pass through | **(3)** |

Q17.

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(a)** | An explanation that makes reference to the following:<br><br>• reference to electron transport chain (1)<br>• oxygen as final proton and electron acceptor (1) | | **(2)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(b)(i)** | • 25% of 8 g = 2 g and 10% of 8 g = 0.8 g (1)<br>• 2 g – 0.8 g = 1.2 g (1) | | **(2)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(b)(ii)** | An answer that makes reference to the following:<br><br>• *T. indica* because eats fewer plant roots (1)<br>• plant roots contain more water than insects (1) | | **(2)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(c)** | B | | **(1)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(d)** | C | | **(1)** |

| Question Number | Correct Answer | Additional guidance | Mark |
|---|---|---|---|
| **(e)** | An explanation that makes reference to the following:<br><br>• desert mammals have long loops of Henle (1)<br>• which allows for a greater counter current multiplier effect (1)<br>• therefore a higher concentration of solute / sodium chloride at base of the medulla (1)<br>• which causes greater amounts of water to be reabsorbed from collecting ducts (1) | | **(4)** |

Q18.

| Question Number | Acceptable Answer | Additional Guidance | Mark |
|---|---|---|---|
| | D (increased secretion of ADH and increased permeability of the collecting duct) | | **(1)** |

Q19.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| | line or bars at 100 $cm^3$ or below for total duration | | (1) |

Q20.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | An answer that makes reference to the following:<br>• hypothalamus | | (1) |
| (ii) | An explanation that makes reference to four of thefollowing:<br>• sweating occurs causing loss of water from the blood (1)<br>• therefore the water potential of the blood falls (1)<br>• osmoreceptors are stimulated (1)<br>• causing the pituitary gland to secrete {antidiuretic hormone /ADH} (into the blood) (1)<br>• causing the {collecting ducts / kidney tubules} in the kidneyto reabsorb more water (into the blood) (1) | | (4) |