HL Paper 3

Explain ADH secretion and how it is controlled.

Markscheme

control of ADH secretion by negative feedback;

ADH controls water reabsorption in kidney;

osmoreceptors in hypothalamus monitor water content (in blood);

ADH produced by neurosecretory cells in the hypothalamus;

transported (down axons of these cells) to the posterior pituitary;

low water content/high solute concentration in blood ((usually) causes action potential to be sent to posterior pituitary);

posterior pituitary releases ADH which travels to collecting ducts of kidney;

more water reabsorbed (by collecting ducts) making water content (of blood) higher/solute concentration lower;

less ADH released;

Examiners report

This was probably the best answered question in the paper. Many candidates gained all marks for ADH; there were nevertheless some answers lacking the details required by some marking points and a number of confused and incomplete answers.

Explain the control of ADH secretion.

Markscheme

ADH secreted by hypothalamus;

by neurosecretory cells;

transport of ADH to posterior pituitary for storage;

through axon;

osmoreceptor cells monitor concentration of blood plasma;

if blood plasma too concentrated, ADH released;

kidney produces a small volume of hypertonic urine / reabsorption of water in collecting ducts;

if plasma too dilute, ADH level of blood drops;

kidney produces a large volume of hypotonic urine / little water reabsorbed from collecting ducts;

controlled by negative feedback;

Examiners report

There were variable responses from very poor to very good with many responses being awarded full marks.

Describe the control of ADH secretion.

Markscheme

receptors in hypothalamus detect decrease in blood solute potential/increase in blood concentration;

occurs when excessive sweating/too little water intake/excessive salt intake;

nerve impulses pass to posterior pituitary gland where ADH is released;

ADH secreted by neurosecretory cells;

ADH makes epithelium of convoluted tubule /collecting duct more permeable to water;

water reabsorption results in more concentrated urine;

when high intake of water/solute potential of blood increases/blood more dilute ADH release is inhibited;

walls of convoluted tubule and collecting duct become less permeable to water;

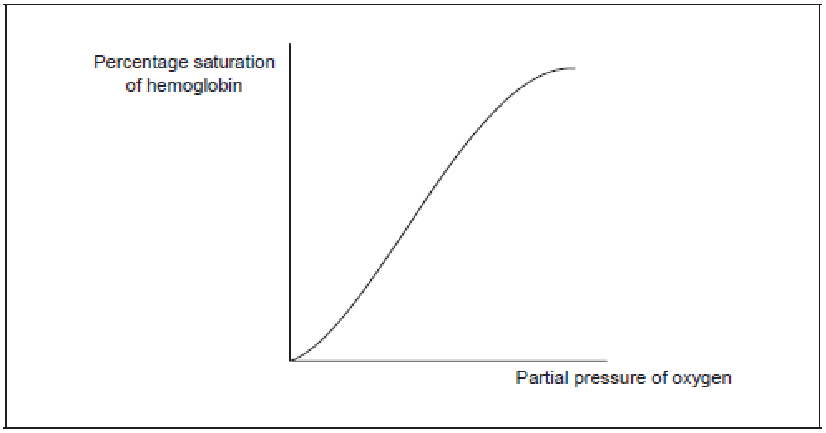
less water is reabsorbed creating dilute urine;

is example of negative feedback;

Examiners report

Many quality answers with marks being lost due to insufficient or erroneous details or incomplete accounts, lacking details of the type of urine produced.

The graph shows the oxygen dissociation curve for adult haemoglobin.



a. State the pathway by which hormones travel from the hypothalamus to the anterior pituitary gland. [1]

b. State the condition of the blood that would stimulate the release of ADH (vasopressin). [1]

d(i). Using the graph, draw a line to show how the oxygen dissociation curve changes with the Bohr shift. [1]

d(ii). Explain the role of the Bohr shift during vigorous exercise. [2]

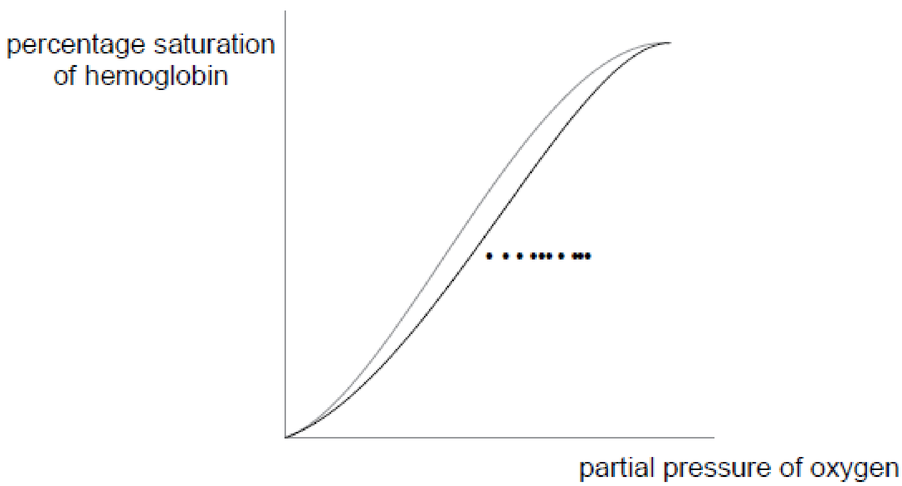
Markscheme

a. (pituitary) portal vein

Do not accept if portal vein is qualified as "hepatic".

b. low water content / high blood solute concentration

d(i).



similar shaped curve; *(drawn to the right of the curve, starting at 0, on the question paper)*

d(ii). a. more CO_2 is produced which lowers the pH of the blood;

b. hemoglobin releases more oxygen (at lower pH) for same partial pressure of oxygen;

c. more oxygen is available to respiring tissues;

Examiners report

a. Many candidates could not name the portal vein, but confused this with other neurosecretory paths. They provided good answers about the release of ADH. The answers about gastrin were often incomplete, with most recognizing gastrin as controlling the release of gastric juices, although some thought it was an enzyme; fewer candidates mentioned the need of the presence of food in the stomach for its release, some confusing it with the stimulus of the smell or sight of food and involving some control from the hypothalamus or medulla. Too many candidates do not understand the Bohr shift, incorrectly drawing it on the graph and/or being unable to explain it; many did not seem to understand the lowering of affinity of hemoglobin for oxygen is at the same partial pressure.

b. Many candidates could not name the portal vein, but confused this with other neurosecretory paths. They provided good answers about the release of ADH. The answers about gastrin were often incomplete, with most recognizing gastrin as controlling the release of gastric juices, although some thought it was an enzyme; fewer candidates mentioned the need of the presence of food in the stomach for its release, some confusing it with the stimulus of the smell or sight of food and involving some control from the hypothalamus or medulla. Too many candidates do not understand the Bohr shift, incorrectly drawing it on the graph and/or being unable to explain it; many did not seem to understand the lowering of affinity of hemoglobin for oxygen is at the same partial pressure.

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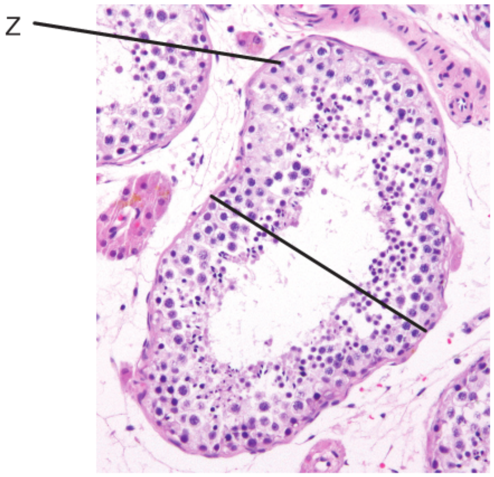
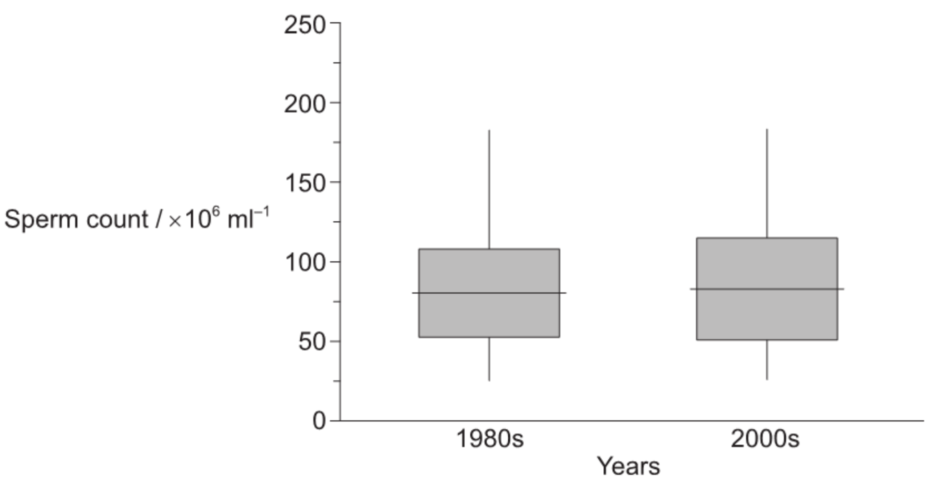
The light micrograph shows a cross section of seminiferous tubules.



[Source: Micrograph of a seminiferous tubule with sperm by Nephron (https://commons.wikimedia.org/wiki/File:Seminiferous_tubule_and_sperm_low_mag.jpg)]

a. Concerns have been raised about the effect of rising pollution levels on sperm production in men. To investigate the possible effects of pollution on spermatogenesis, sperm samples from men of similar ages were collected in Kolkata in the 1980s and 2000s. The box plot represents the mean and range of sperm counts in the 1980s and 2000s. [3]



[Source: Republished with permission of Elsevier Science and Technology Journals, from ‘Semen quality and age-specific changes: A study between two decades on 3729 male partners of couples with normal sperm count and attending an andrology laboratory for infertility-related problems in an Indian city’, Dyutiman Mukhopadhyay, Alex C. Varghese, Manisha Pal, Sudip K. Banerjee, Asok K. Bhattacharyya, Rakesh K. Sharma, and Ashok Agarwal, Fertility and Sterility, 93 (7), 2009; permission conveyed through Copyright Clearance Center, Inc]

A hypothesis has been suggested that pollution may have a negative effect on spermatogenesis. Evaluate whether the data support this hypothesis.

b.i. Calculate the actual size of the seminiferous tubule in the area indicated by the line across it, giving the units. [1]

b.ii. Identify the type of cell labelled Z. [1]

Markscheme

a. a. hypothesis not supported as there is a «slight» increase/not much difference in sperm count between the 1980s and the 2000s

OR

hypothesis not supported as similar means/values for both groups

b. no information on sample size

c. no information/data provided on pollution levels/types of pollution

d. other factors affecting sperm count not considered

OR

other elements than sperm count could be affected

e. data limited to Kolkata/one country/one city

OR

pollution may affect spermatogenesis elsewhere

[Max 3 Marks]

b.i. 62 mm Y400 = 0.155 mm/155 μm/micrometers/10^{-6} m

OR

61 mm Y400 = 0.153 mm/153 μm/micrometers/10^{-6} m

Calculation and units required. Accept correct answers expressed in cm

b.ii. spermatogonium

OR

primary spermatocyte

Examiners report

a. [N/A]

b.i. [N/A]

b.ii. [N/A]