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Biological Sciences review

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Activity

Water in biology

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The questions in this worksheet relate to Kevin Moffat's article 'Water: transport and regulation in the body'.

Students following the Pearson Edexcel Biology A (Salters-Nuffield) specification are not required to study the structure and action of the kidneys.

Questions

1 Which of the following statements best describes the direction of water movement by osmosis? [1 mark]

A	From a high water potential and high solute concentration to a low water potential and low solute concentration
B	From a high water potential and low solute concentration to a low water potential and high solute concentration
C	From a low water potential and high solute concentration to a high water potential and low solute concentration
D	From a low water potential and low solute concentration to a high water potential and high solute concentration

2 In which of the following structures is antidiuretic hormone (ADH) produced? [1 mark]

A	Anterior pituitary gland
B	Collecting duct
C	Hypothalamus
D	Posterior pituitary gland

3 Water is the most common compound in our bodies. About two-thirds of it is inside our cells. Give **two** properties of water that are important in human cells and explain their importance in these cells. [2 marks]

4 Give **one further** property of water that is important in the xylem tissue of plants and explain its importance in this tissue. [1 mark]

5 The median lethal dose (LD50) of water for humans is 6 dm^3. Explain the meaning of the term median lethal dose. [2 marks]

6 The water in our bodies is within three fluid compartments.

Vibrio cholerae is a bacterium that can infect cells lining the wall of the human small intestine. During infection, the bacteria produce an exotoxin that causes cells lining the intestinal wall to secrete Na^+, K^+ and HCO_3^- ions into the lumen of the small intestine.

a Define the term exotoxin. [1 mark]

b Explain how the exotoxin of *V. cholerae* causes a loss of water from the body's intravascular fluid compartment. [4 marks]

7 The table shows information about the urine of three mammals that live in different environments.

Mammal	**Environment**	**Concentration of urine/mmol dm^{-3}**	**Ratio of urine concentration to plasma concentration**
Beaver	Freshwater	540	1.7:1
Brown rat	Temperate	2900	9:1
Kangaroo rat	Desert	5500	16:1

a Use the data in the table to calculate the plasma concertation of each mammal. [1 mark]

b Comment on the biological significance of your answer to **a** above. [2 marks]

c Although a brown rat and a desert rat are about the same size, the loops of Henle of a desert rat are much longer than those of a brown rat. Explain how this relates to the urine concentrations of these two mammals. [4 marks]

8 The control of the water potential of the blood by antidiuretic hormone (ADH) is an example of negative feedback.

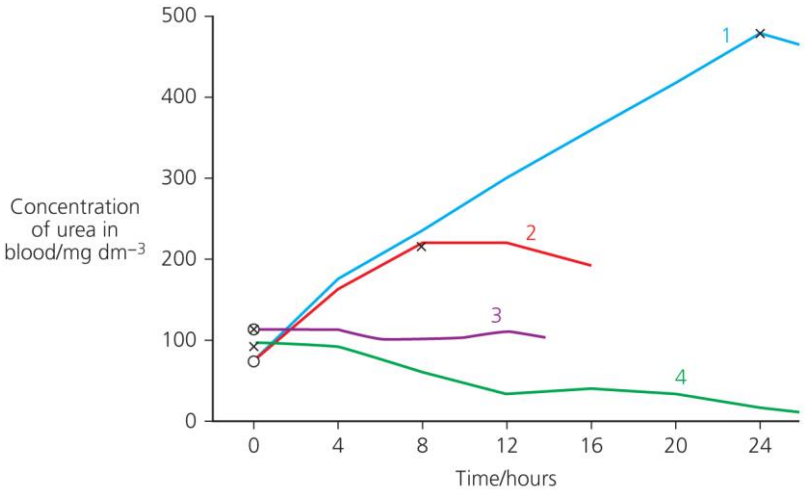
a Define the term negative feedback. [1 mark]

b Use information from Kevin Moffat's article and your own knowledge to describe what causes the release of ADH into the blood. [5 marks]

c Describe the effect that ADH has on the walls of the collecting ducts in the kidney. [2 marks]

d ADH is a peptide hormone that acts via a second messenger. Describe what is meant by the second messenger model of hormone action. [3 marks]

9 Urea is a nitrogen-containing metabolic product that is excreted in the urine. The graph shows the effects of kidney failure and liver failure on the concentration of urea in the blood plasma.



Key:

× represents time when liver function was lost

O represents time when kidney function was lost

a What can you conclude from curves 1 and 2 about the site of urea production? Explain your answer. [2 marks]

b Explain the shape of curve 3. [2 marks]

c Explain the shape of curve 4. [2 marks]

Answers

1 B

2 C

3 Universal solvent allowing metabolic reactions to occur *faster* (in solution).

Reactant in condensation/hydrolysis reactions.

4 Strong cohesion between water molecules ensures water column does not break.

5 Volume of water that will kill half of all the test subjects.

When drunk in a limited time interval/when drunk at once.

6 a Poison that is released into the environment by/secreted by living (bacterial) cells.

b Water moves by osmosis across partially permeable membranes from a higher to a lower/more negative water potential.

Ions lower water potential in lumen so water moves from cells lining intestine into lumen.

Water potential of cells falls so water moves from interstitial fluid compartment into cells.

Water potential of interstitial fluid falls so water moves from plasma into interstitial fluid.

7 a Beaver 318 mmol dm^{-3}, brown rat 322 mmol dm^{-3}, desert rat 344 mmol dm^{-3}.

b Concentration of body fluids affects metabolism/osmotic balance of cells.

Mammals have similar physiology/systems that relies on similar optimum concentration.

c Ascending limbs of loops of Henle actively secrete Na^+ and Cl^- ions into medulla.

The longer the loops of Henle, the *lower/more negative* the water potential of the medulla.

Causing *more* water to move by osmosis from collecting ducts into medulla.

So urine/ultrafiltrate becomes more concentrated.

8 a Deviation from 'ideal' value is sensed and stimulates mechanism to return it to 'ideal' value.

b Fall in water potential of blood causes shrinkage of neurones in brain.

(Shrinkage causes) movement of TRPV channels in neuronal membranes.

(Movement causes) change in flow of ions across neuronal membranes.

Resulting in action potentials to hypothalamus.

Which stimulates release of ADH from the posterior pituitary gland.

c Stimulates recruitment of aquaporins into surface membranes of cells lining ducts.

Which allows more water to leave the ducts and pass into the medulla.

d Hormone attaches to receptor on surface membrane of target cell.

Triggers release of a second messenger/of cAMP within the cell.

Which activates enzymes that catalyse specific reactions.

9 a [Produced in the liver (no mark).]

Kidneys not working so no removal of urea from blood.

But liver still working and concentration of urea rises.

b No urea being produced and none being excreted.

Residual amount of urea remains in blood.

c Liver not functioning so no urea being produced.

Kidneys continue to remove residual urea.