11.3 The Kidney & Osmoregulation

Question Paper

Course	DP IB Biology
Section	11. Animal Physiology (HL Only)
Topic	11.3 The Kidney & Osmoregulation
Difficulty	Medium

Time allowed: 60

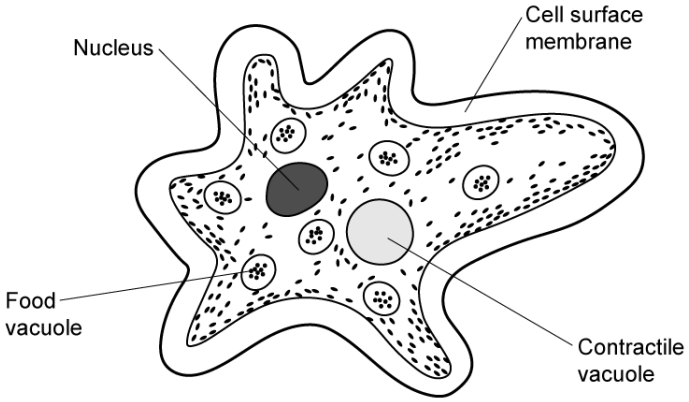
Score: /47

Percentage: /100

Question 1a

a)

Amoebas (singular amoeba) are free-living, single-celled eukaryotes that live in freshwater ponds and lakes. They carry out osmoregulation using an organelle called a contractile vacuole, shown in the image below.



Explain why amoebas need to carry out osmoregulation.

[3 marks]

Question 1b

b)

A contractile vacuole can expand to take on water, and is able to fuse with the cell-surface membrane.

Suggest how a contractile vacuole aids osmoregulation in amoebas.

[2 marks]

Question 1c

c)

Describe what would happen to an amoeba cell placed into saltwater.

[2 marks]

Question 1d

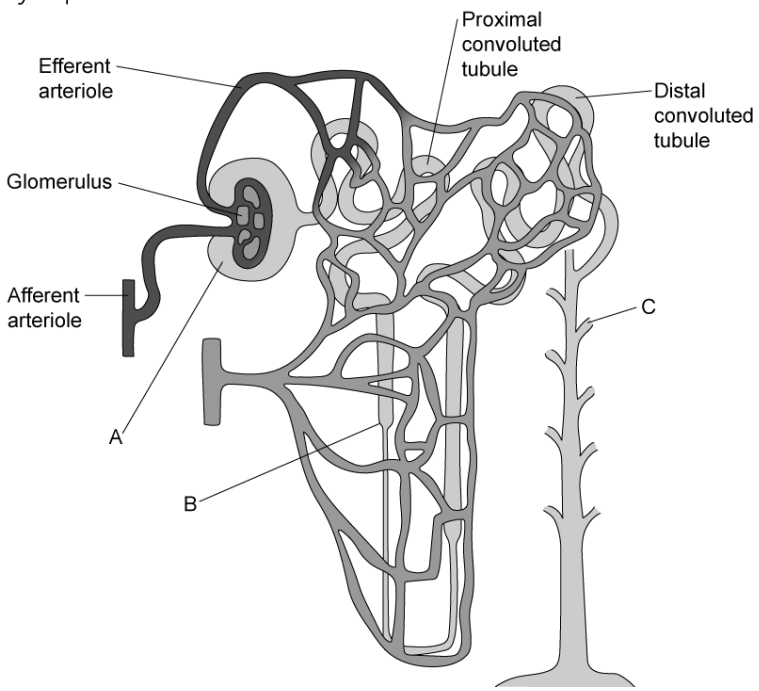
d)
Amoebas are an example of an osmoregulator. An alternative strategy for dealing with the problem of osmosis is to be an osmoconformer.

Outline what it means to be an osmoconformer.

[1 mark]

Question 2a

a)
The image below shows a kidney nephron.



Identify the structures labelled **A–C** in the image.

[3 marks]

Question 2b

b)
State, with a reason, **one** feature of structure **A** from the image in part a) which enables ultrafiltration to take place.

[2 marks]

Question 2c

c)
Selective reabsorption takes place after ultrafiltration.

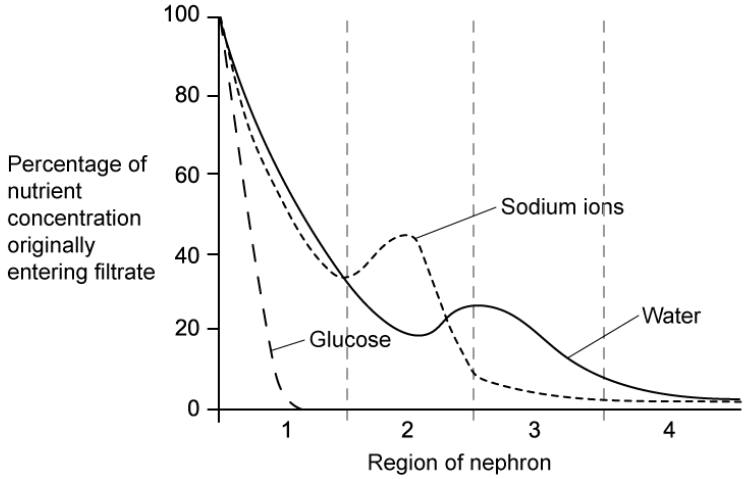
Describe the events of selective reabsorption.

[3 marks]

Question 3a

a)

The graph below shows what happens to various components of the glomerular filtrate as they move through the different regions of an individual's nephron.



Describe and explain the shape of the curve for glucose concentration.

[2 marks]

Question 3b

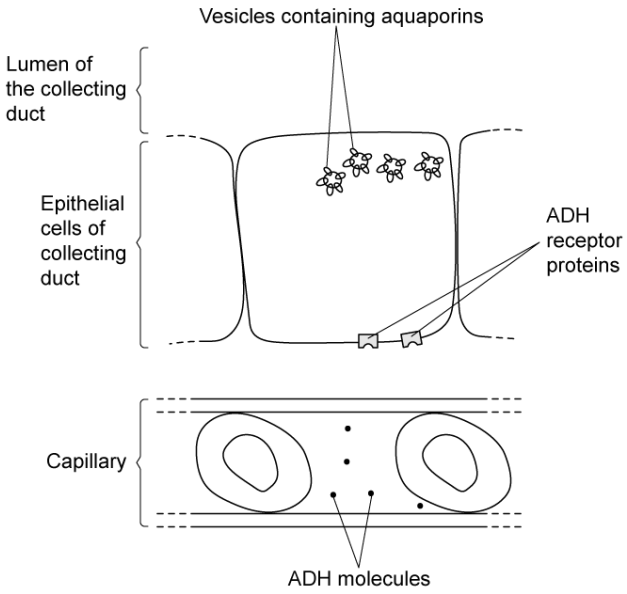
b)

Explain the shapes of the curves for sodium ions **and** water in the graph in part a) as they travel through the **first half of region 2** of the nephron. Note that region 2 in this graph is the loop of Henle.

[2 marks]

Question 3c

c)
The image below shows cells lining the collecting duct. ADH released from the pituitary gland binds to the receptor proteins on the collecting duct cell surface membranes. This triggers vesicles containing aquaporins to bind with the plasma membrane next to the lumen. Note that aquaporins are channel proteins that enable the movement of water molecules.



Explain how ADH increases the movement of water from the lumen of the collecting duct into the blood.

[3 marks]

Question 3d

d)
Suggest why ADH only affects the cells lining the kidney nephron.

[1 mark]

Question 4a

a)
Outline the link between excretion of nitrogenous waste and water loss in mammals.

[2 marks]

Question 4b

b)
The table below shows the maximum urine solute concentrations that can be achieved in different species of mammal. Seawater has been included for comparison.

	Solute concentration / mEq L^{-1}	**Urine:blood plasma osmolarity ratio**
Human urine	460	
Brown rat urine	600	8:1
Kangaroo rat urine	1200	14:1
Seawater	600	N/A

Humans have a blood plasma concentration of roughly 120 mEq L^{-1}.

Calculate the urine:blood plasma osmolarity ratio in humans.

[1 mark]

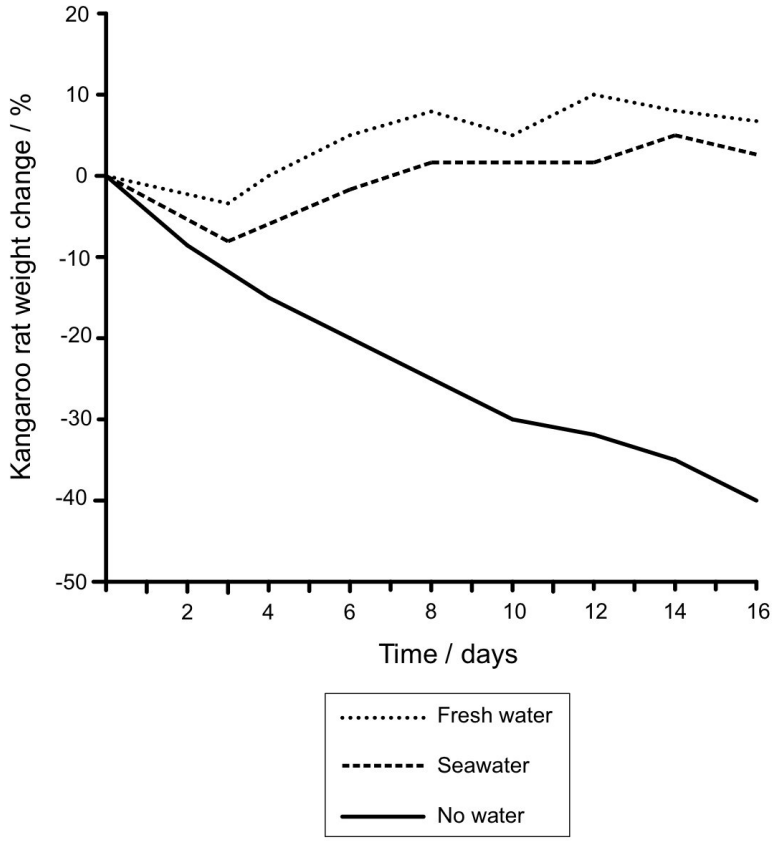
Question 4c

c)
Use information from part b) and your own knowledge to explain how kangaroo rats are adapted for survival in a **dry** environment.

[3 marks]

Question 4d

d)
A researcher wanted to investigate kangaroo rat kidneys. They fed the kangaroo rats on soybeans for several days to increase their thirst (kangaroo rats normally get all their water from their food), and then either gave the rats access to fresh water, seawater, or no water for the following 16 days, using weight over the experimental period as a measure of rat health. The results are shown in the graph below.



Suggest, with a reason, one possible conclusion about the capabilities of kangaroo rat kidneys that can be drawn from the graph above. Note that humans cannot drink seawater without becoming severely dehydrated.

[2 marks]

Question 5a

One mark is available for clarity of communication throughout this question.

a)
Draw a labelled diagram of the human kidney.

[3 marks]

Question 5b

b)
Outline the process of haemodialysis.

[4 marks]

Question 5c

c)
Describe how nitrogenous waste is excreted in land insects.

[8 marks]