Excretion

Model Answers 3

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Communication, homeostasis and energy
Topic	Excretion
Booklet	Model Answers 3

Time allowed: **51 minutes**

Score: **/38**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

The kidneys of a healthy individual filter 178 dm^3 day^{-1} of fluid from the glomeruli into the renal capsules. However, only 1.5 dm^3 day^{-1} of urine is produced.

What percentage of the filtrate is reabsorbed back into the blood?

A 176.5

B 0.8

C 11.8

D 99.2

[1]

176.5 of the 178 litres is reabsorbed which is 99.2. You almost don't need a calculator for this one.

Question 2

Fig. 5.1 is a photomicrograph of a horizontal section through the cortex of a mammalian kidney.

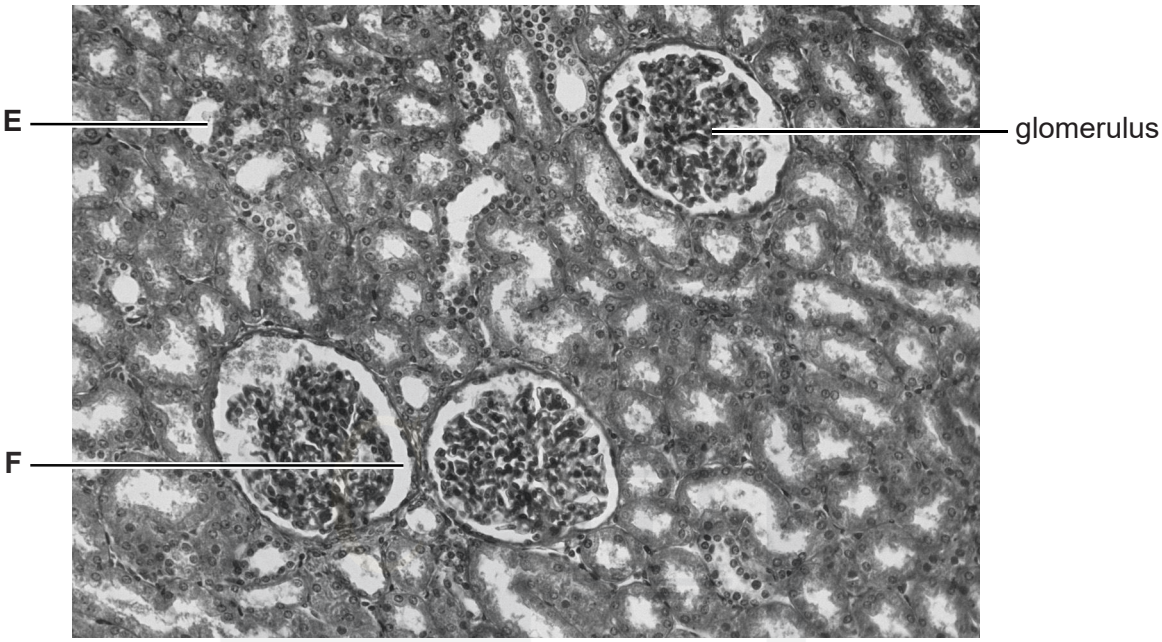
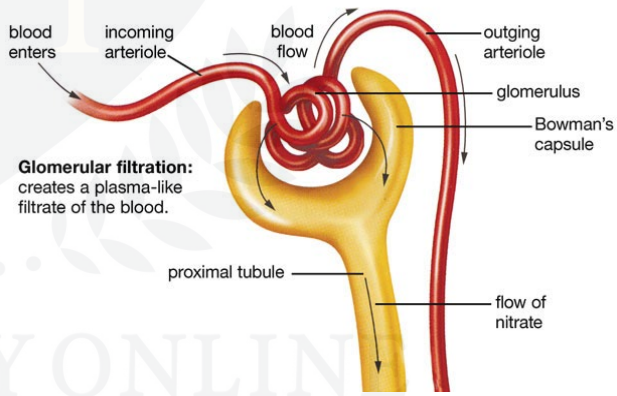


Fig. 5.1

(a) Identify the structures labelled **E** and **F** in Fig. 5.1. **[2]**

E proximal convoluted tubule

F Bowman's capsule



(b) (i) Explain how the glomerulus is able to perform its function.

In your answer, you should use appropriate technical terms, spelt correctly.

[3]

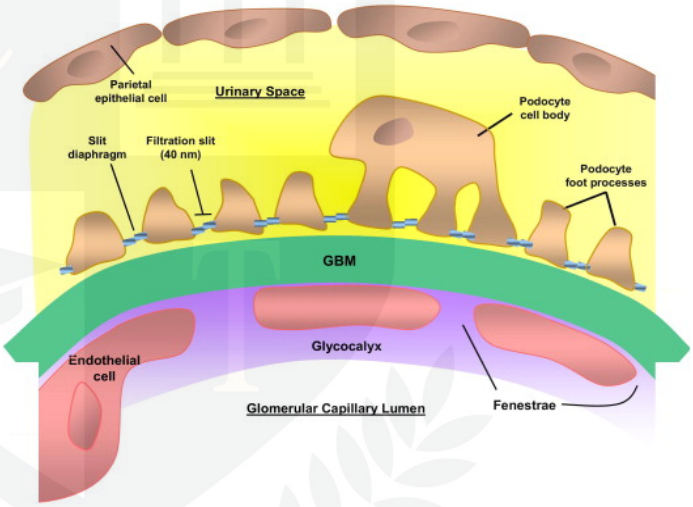
- The lumen of the afferent arteriole is greater than the lumen of the afferent arteriole
- This causes a build-up of hydrostatic pressure in the blood
- The endothelium of the capillaries has small pores or fenestrations
- These pores allow ultrafiltration

The wall of the capillary is made up of endothelium, which is surrounded by a basement membrane consisting of a mesh of collagen. It is the basement membrane that filters the blood and determines which substances remain in the blood stream and which substances leave, such as glucose, water, salt and urea

(ii) **Name** the specialised cells present in structure **F** that assist in the function you described in **(b)(i)**.

[1]

Podocytes



Podocytes make up the lining of Bowman's capsule. They are a specialised type of epithelium designed to allow the filtrate, forced out of the glomerulus, to enter the proximal convoluted tubule without any type of obstruction. The processes that project from the podocytes prevent them from fitting tightly together which creates gaps between them. The gaps allow easy passage of the filtrate

(c) Kidney failure has serious consequences for the individual.

(i) Suggest the effects of complete kidney failure on the **composition of the blood**. **[2]**

- Kidney failure would result in an increase in urea
- The concentration of salt would also increase
- The amount of water in the bloodstream would also increase

This question is basically asking you to describe the functions of the kidney in controlling osmoregulation and the excretion of urea and water

(ii) One way of treating a person with kidney failure is by giving them a kidney transplant. Explain the need for close matching of the donated kidney to the recipient. **[3]**

- Unless the donated kidney is a close match it will be recognised as foreign or non-self
- The antigens on the surface of the cells will be different in the donated kidney
- This will cause rejection of the donated kidney
- Rejection will be caused by the killer T cells of the immune system
- Immuno-suppressant drugs will need to be taken for the rest of their lives

[Total: 11]

Question 3

(a) Fig. 5.1 is a drawing representing a vertical section through a mammalian kidney.

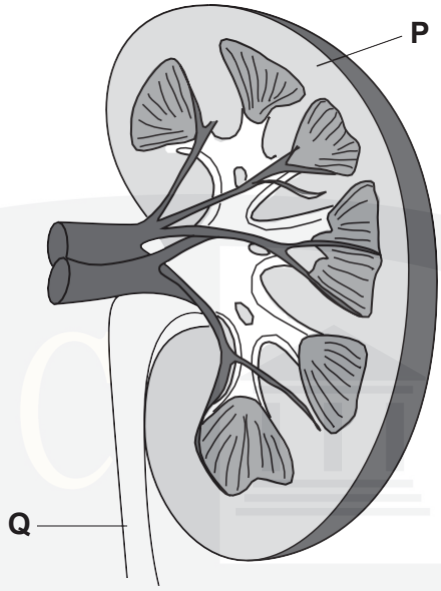
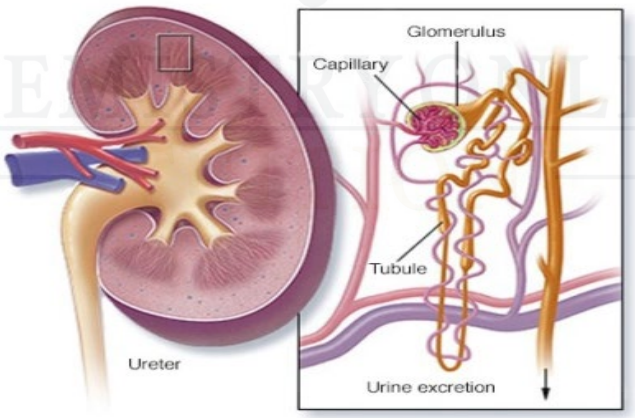


Fig. 5.1

Name the region **P** and the structure **Q**.

P .....cortex.....

Q .....ureter..... **[2]**



(b) (i) Each kidney contains approximately one million nephrons. Each section of a kidney nephron is adapted to perform its function effectively.

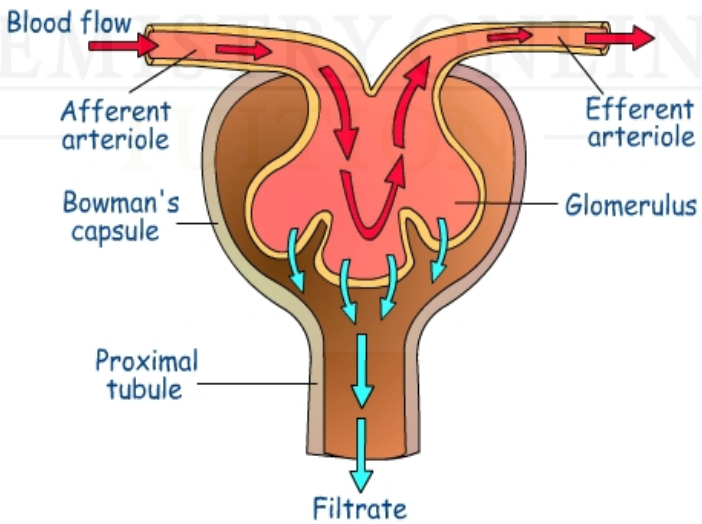
Describe the features of the **glomerulus** and **Bowman's capsule** that allow them to perform their function effectively.

In your answer, you should use appropriate technical terms, spelt correctly.

[4]

- The glomerulus and Bowman's capsule together carry out ultrafiltration
- The lumen of the afferent arteriole is wider than that of the efferent arteriole
- This builds up a hydrostatic pressure
- The endothelium has gaps / fenestrations to allow substances to pass through
- The basement membrane prevents molecules with a high molecular mass from leaving the bloodstream

Normally when the filtrate is forced out of the bloodstream, it is reabsorbed by the opposing pressure created by plasma proteins which remain in the blood. To overcome this, the glomerulus is designed to increase the hydrostatic pressure even further to make sure that the net pressure is enough to prevent this happening.



(ii) Nephritis is a condition in which the tissue of the glomerulus and proximal convoluted tubule becomes inflamed and damaged.

Suggest **two** differences in the composition of the urine of a person with nephritis when compared to the urine of a person with healthy kidneys. **[2]**

- More proteins will be present
- Blood cells will be present
- Glucose will be in the urine
- Urine will be more dilute
- More salts / ions will be present

If the kidneys are inflamed they will allow larger structures than normal to leave the capillaries, they will also find it difficult to reabsorb to the same level so some substances will be found in the urine that shouldn't.

(c) Caffeine is a mild diuretic. Caffeine prevents the introduction of additional aquaporins into the wall of the collecting duct of the nephron and therefore additional water is not removed from the urine.

Aquaporins are channels in the cell surface membrane that allow water molecules to pass through.

Fig. 5.2 represents an aquaporin.

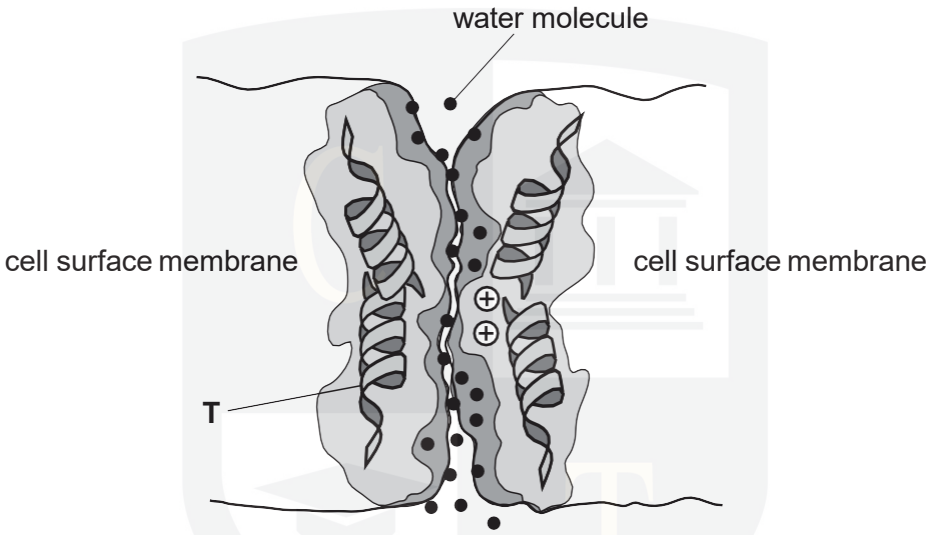


Fig. 5.2

(i) Identify the type of molecule labelled **T**. **[1]**

- Aquaporins are channels which are created by proteins. They allow facilitated diffusion.

(ii) The aquaporin allows water to travel from the collecting duct into the surrounding tissues but prevents the passage of ions such as sodium ions and potassium ions.

With reference to Fig.5.2, suggest **two** ways in which the structure of this aquaporin prevents the passage of ions. **[2]**

- The channel is too narrow for ions to pass through
- The positive charges shown will repel any positive charges from passing through.

All the information for this question can be gathered from the diagram, don't let its complexity put you off!

[Total: 11]

Question 4

Osmoregulation is a key feature of homeostasis and maintains the water potential of the blood within certain limits. This is achieved by the action of anti-diuretic hormone (ADH).

(a) Explain the likely effect on the blood cells if the water potential of the plasma was allowed to increase significantly.

[2]

- If the water potential of the plasma increased, it would be higher than that of the blood cells
- Water would enter the cells by osmosis
- The blood cells may burst or undergo lysis, for example red blood cells are haemolysed

Fig. 4.1 is a simplified diagram of the structure of ADH.

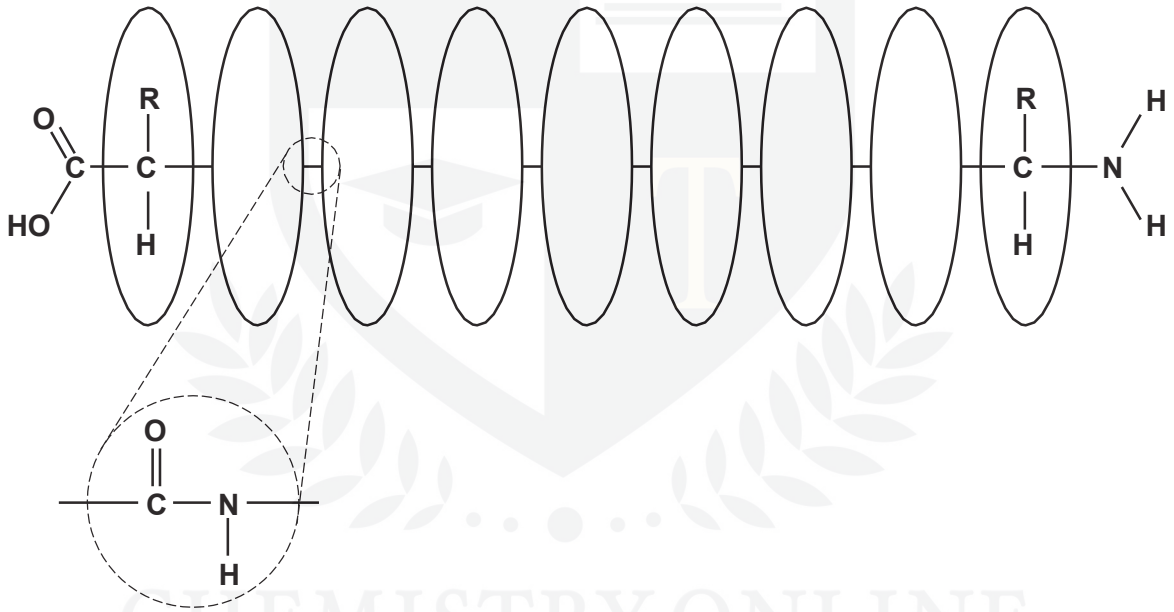


Fig. 4.1

(b) Name the type of monomer that makes up a molecule of ADH and the bond that joins the monomers together.

[2]

type of monomer amino acid

name of bond peptide bond

The clue to this question is in the diagram, the amino and carboxyl groups represent amino acids

(c) Complete the following passage, using the **most suitable** term in each case: **[8]**

ADH is a hormone that is produced by specialised nerve cells known as .....osmoreceptor..... cells. These cells detect changes in the water potential of the blood flowing through the .....hypothalamus..... . If the water potential of the blood is too low then ADH is released.

ADH is not secreted immediately into the blood but passes along the .....axon..... of the specialised nerve cells to the .....posterior pituitary..... gland, from where it is released into the blood.

ADH acts on the cells of the .....collecting duct..... .

The ADH molecule attaches to receptors on the .....cell membrane..... of these cells and causes protein channels known as .....aquaporins..... to insert themselves into the membrane. Water passes through these channels by .....osmosis..... and a smaller volume of more concentrated urine is produced.

(d) ADH does not stay in the blood indefinitely.

Suggest where ADH is removed from the blood **and** describe what then happens to the ADH molecule.

[3]

- ADH is removed by the liver and the hepatocytes
- The protein is hydrolysed to amino acids
- The amino acids are deaminated by the removal of ammonia
- Ammonia is converted to urea by the ornithine cycle
- The remaining keto acid can be used in respiration, for example a 2 carbon keto acid could enter at Krebs Cycle
- As a small molecule it can also be filtered by the kidney

This question becomes more straightforward if you change 'Suggest where **ADH** is removed from the blood' to 'Suggest where **proteins** are removed from the blood'. And think about the context of the question, which begins with proteins. You may also be thinking 'We never covered removal of ADH from the blood!' Correct. But you did study removal of excess protein.

[Total: 15]