

Q1.

Alport syndrome (AS) is an inherited disorder that affects kidney glomeruli of both men and women. Affected individuals have proteinuria (high quantities of protein in their urine).

- (a) Suggest how AS could cause proteinuria.

(2)

- (b) AS results from a sex-linked mutation.

In a male with AS, where would the sex-linked mutation be located?

Tick (✓) **one** box.

The homologous section of a Y chromosome

The homologous section of an X chromosome

The non-homologous section of a Y chromosome

The non-homologous section of an X chromosome

(1)**Q2.**

- (a) Describe how ultrafiltration occurs in a glomerulus.

(3)

- (b) Glucose and water are reabsorbed by the proximal convoluted tubule of a nephron.

Put a tick (✓) in the box next to the correct ways in which glucose and water are reabsorbed.

Glucose by active transport and water against a water potential gradient

Glucose by diffusion and water down a water potential gradient

Glucose by facilitated diffusion and active transport and water against a water potential gradient

Glucose by facilitated diffusion and active transport and water down a water potential gradient

(1)

- (c) The equation shows the relationship between urine concentration in arbitrary units (y) and mean length of the loop of Henle in mm (x).

$$y = 0.72x + 4$$

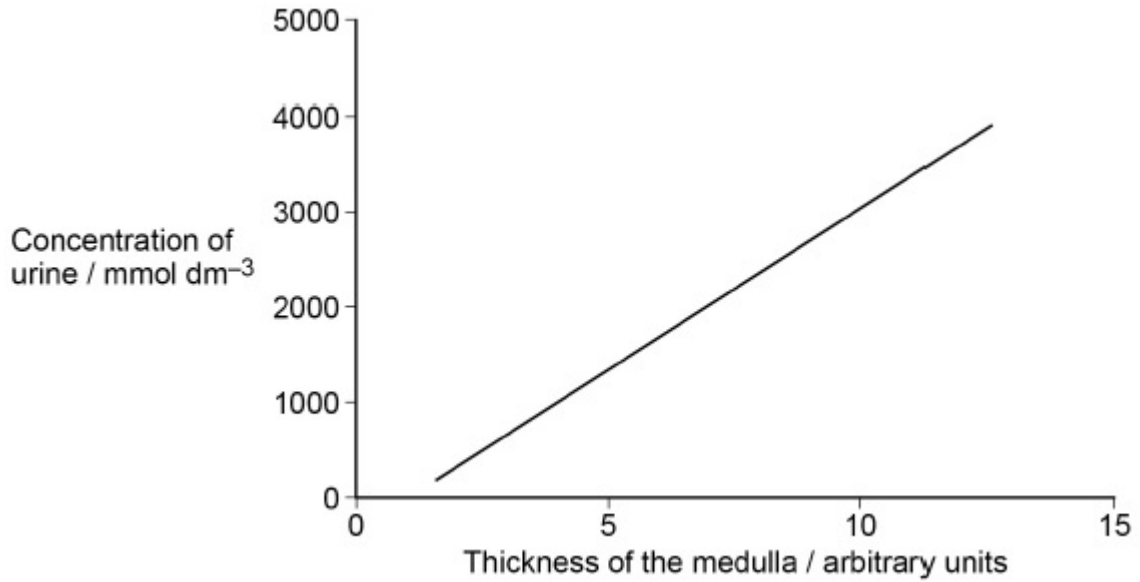
Calculate the mean length of the loop of Henle in an organism that produces urine with a concentration of 16.56 arbitrary units.

Answer = _____ mm

(1)

- (d) Scientists investigated the relationship between the thickness of the kidney medulla of different species of mammals and the concentration of their urine.

The graph shows their results.



Explain the pattern shown by the results in the graph above.

(3)
(Total 8 marks)

Q3.

Furosemide and CVT are drugs used to remove excess fluid from the body. Scientists investigated the effect of these drugs on the volume of urine produced by human volunteers. The scientists used the following method.

- They divided volunteers into three groups, **A**, **B** and **C** at random.
- They gave all the volunteers the same food for 3 days.
- After 3 days, they gave the volunteers in group **A** a tablet containing furosemide, the volunteers in group **B** a tablet containing CVT and the volunteers in group **C** a placebo (a tablet that did **not** contain either drug).
- They then found the mean volume of urine produced by each group in the 4 hours after taking the tablets.

Some of the results the scientists obtained are shown in **Table 1**.
A value of ± 2 standard deviations from the mean includes over 95% of the data.

Table 1

Group	Mean volume of urine produced in 4 hours / cm^3 (± 2 standard deviations)
A (furosemide)	1980 (± 152)
B (CVT)	1201 (± 119)
C (placebo)	312 (± 57)

- (a) All the volunteers were given the same food for 3 days.

Suggest and explain **one** reason why they were given the same food.

(2)

- (b) Using **Table 1**, what can you conclude about the effectiveness of furosemide and CVT in the removal of excess fluid from the body?

(2)

- (c) Furosemide is sometimes used to treat high blood pressure.
Suggest how furosemide would cause a decrease in blood pressure.

(1)

- (d) Furosemide inhibits the absorption of sodium and chloride ions from the filtrate produced in the nephrons.

Explain how furosemide causes an increase in the volume of urine produced.

(3)

The scientists also measured the mean rate of flow of blood plasma into the kidneys.

The results the scientists obtained are shown in **Table 2**.

Table 2

Group	Mean rate of flow of blood plasma into the kidneys / cm³ min⁻¹
A (furosemide)	380
B (CVT)	342
C (placebo)	295

- (e) The mean rate of flow of blood plasma is 60% of the mean rate of blood flow into the kidneys.

How much greater is the flow of blood into the kidneys with furosemide than with group **C** (placebo) over the 4 hours of the investigation? Give your answer in cm³.

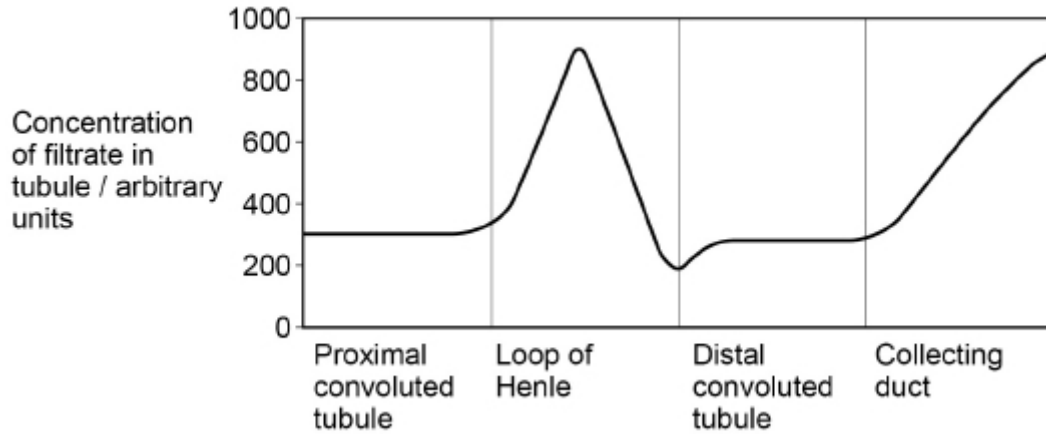
Answer = _____ cm³

(1)

(Total 9 marks)

Q4.

The graph below shows the concentration of the filtrate in different parts of one kidney tubule.



- (a) More than 99% of biological molecules are reabsorbed from the filtrate in the proximal convoluted tubule.

Despite this, the concentration of fluid in this tubule remains constant.

Explain why.

(1)

- (b) Explain the shape of the curve in the loop of Henle in the graph.

(3)

Q6.

Osmoreceptors are specialised cells that respond to changes in the water potential of the blood.

- (a) Give the location of osmoreceptors in the body of a mammal.

(1)

- (b) When a person is dehydrated, the cell volume of an osmoreceptor decreases.
Explain why.

(2)

- (c) Stimulation of osmoreceptors can lead to secretion of the hormone ADH. Describe and explain how the secretion of ADH affects urine produced by the kidneys.

(4)

The efficiency with which the kidneys filter the blood can be measured by the rate at which they remove a substance called creatinine from the blood. The rate at which they filter the blood is called the glomerular filtration rate (GFR).

In 24 hours, a person excreted 1660 mg of creatinine in his urine. The concentration of creatinine in the blood entering his kidneys was constant at 0.01 mg cm^{-3} .

- (d) Calculate the GFR in $\text{cm}^3 \text{ minute}^{-1}$.

Answer = _____ (1)

- (e) Creatinine is a breakdown product of creatine found in muscle tissues. Apart from age and gender, give **two** factors that could affect the concentration of creatinine in the blood.

1. _____

2. _____

(1)

(Total 9 marks)