1. Excretion and secretion are two processes that take place in the body of a mammal.

Complete the table below to compare the processes of excretion and secretion.

	excretion	secretion
one difference		
one example of a product		
one similarity		

[Total 3 marks]

2. Blood enters the kidneys through the renal arteries and the human kidneys process 1200 cm^3 of blood every minute. This 1200 cm^3 of blood contains 700 cm^3 of plasma. As this blood passes through a glomerulus, 125 cm^3 of fluid passes into the renal tubule.

(i) Name the process by which the fluid passes from the glomerulus into the renal tubule.

.....

[1]

(ii) Calculate the percentage of plasma that passes into the renal tubule.

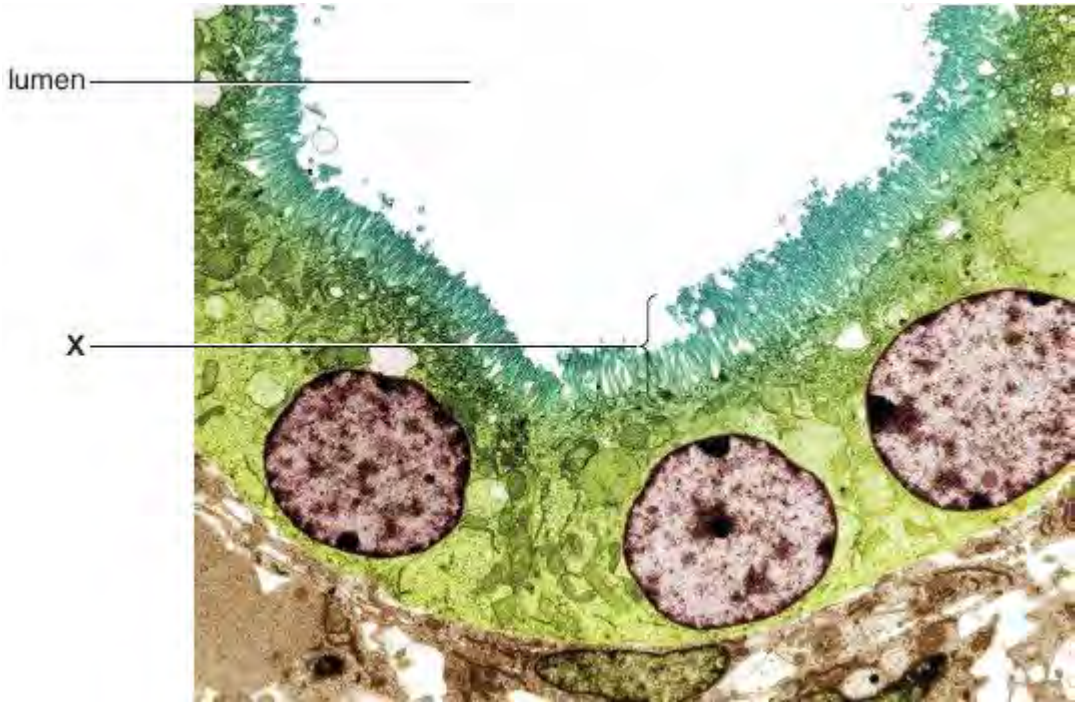
Show your working and **give your answer to one decimal place**.

Answer = ... %

[2]

[Total 3 marks]

3. The figure below is an electronmicrograph of a transverse section of part of a proximal convoluted tubule.



(i) Name the tissue that lines the proximal convoluted tubule.

.....

[1]

(ii) Name the structures indicated by **X**.

.....

[1]

(iii) The table below shows the approximate concentration of some of the substances in the blood plasma, the glomerular filtrate and the urine leaving the collecting duct.

substance	concentration in blood plasma ($g\ dm^{-3}$)	concentration in glomerular filtrate ($g\ dm^{-3}$)	concentration in urine leaving collecting duct ($g\ dm^{-3}$)
amino acids	0.50	0.50	0.00
glucose	1.00	1.00	0.00
inorganic ions	7.30	7.30	15.60
nitrogenous waste (not including urea)	0.03	0.03	0.28
protein	80.00	0.00	0.00
urea	0.30	0.30	21.00

Some of the changes observed between the glomerular filtrate and the urine are as a result of activity in the proximal convoluted tubule.

With reference to the table above, explain how these observed changes in concentration are brought about by the **proximal convoluted tubule**.

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

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[4]

[Total 6 marks]

4. When the kidneys cease functioning or fail to work effectively, renal dialysis may be necessary.

Fig. 1 outlines the procedure of haemodialysis, a type of renal dialysis.

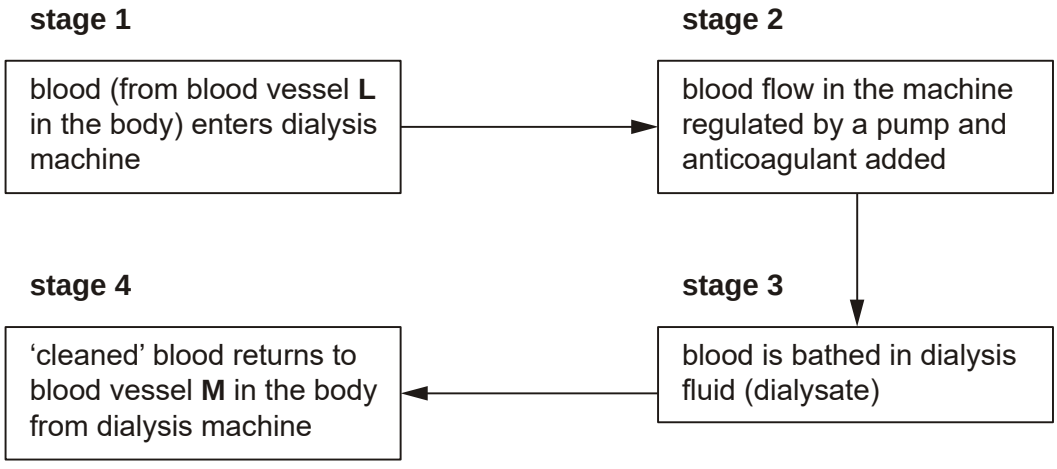

Fig. 1

Fig. 2 shows further detail of how **stage 3** is achieved.

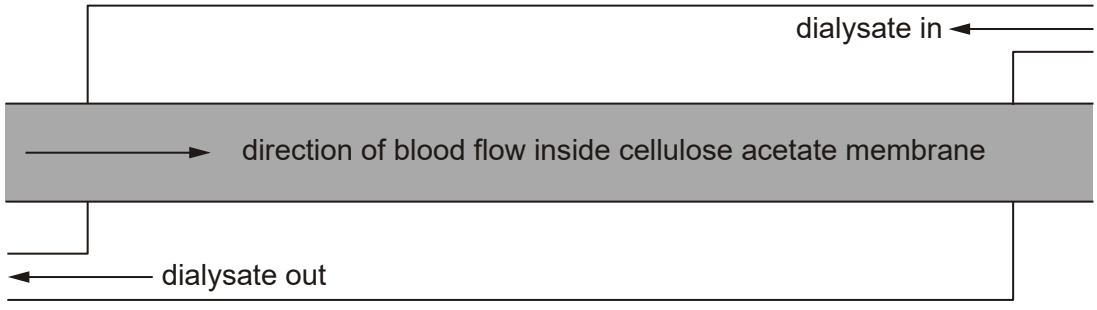

Fig. 2

(i) State the **types** of blood vessel represented by **L** and **M** in Fig. 1.

L .....

M .....

[1]

(ii) Suggest why it is necessary to add an anticoagulant to the blood in **stage 2**.

.....

.....

[1]

(iii) Suggest why **no** anticoagulant is added to the blood towards the end of a dialysis session.

.....

.....

[1]

(iv) State the process by which molecules and ions, **other than water**, will move from the blood into the dialysate.

.....

[1]

(v) Suggest why the direction of flow of the blood and the dialysate is as shown in Fig. 2.

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[1]

[Total 5 marks]

5. Define the term *excretion*.

.....

.....

[Total 2 marks]

6. The table below shows the mass of different substances excreted by a volunteer during two 24 hour periods. During the first 24 hour period, the volunteer was fed a protein-deficient diet; during the second 24 hour period, the volunteer was fed a protein-rich diet. All other variables were kept constant.

	mass of substance excreted / g	
substance excreted	protein-deficient diet	protein-rich diet
urea	2.20	14.70
uric acid	0.09	0.18
ammonium ions	0.04	0.49
creatinine	0.60	0.58

(i) Calculate the percentage increase in urea excreted when the volunteer switched from a protein-deficient to a protein-rich diet. Show your working.

Answer = ...%

[2]

(ii) Describe how excess protein is converted into urea.

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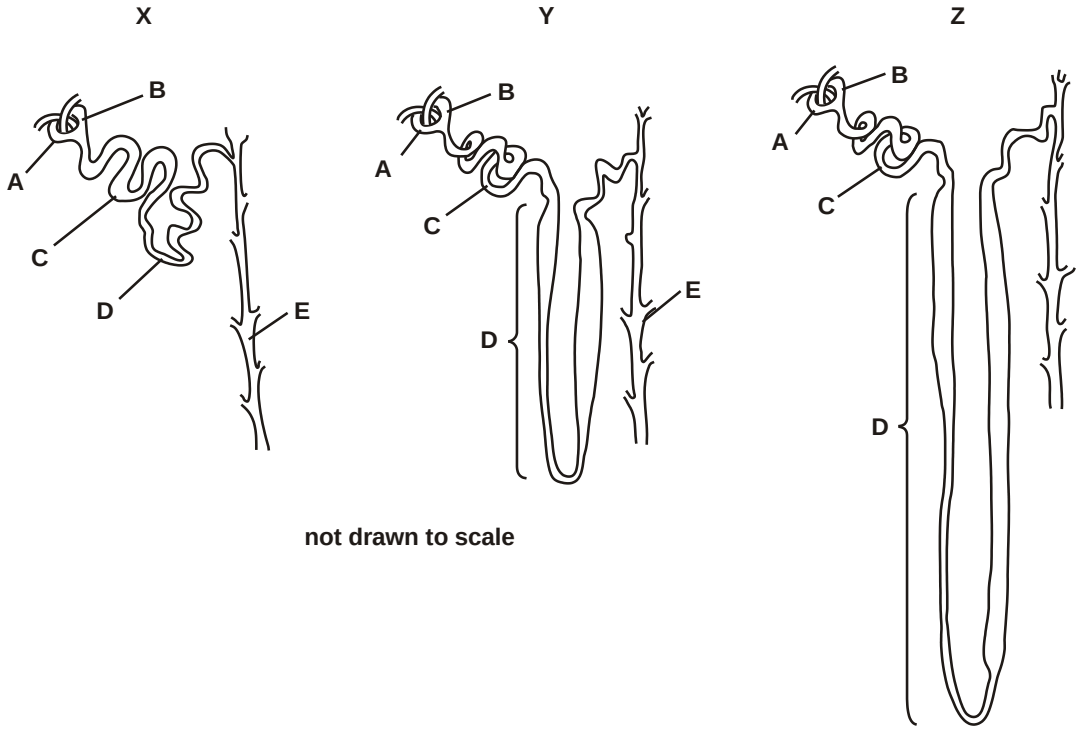
[3]

[Total 5 marks]

7. The figure below shows diagrams of nephrons from the kidneys of three different mammals, **X**, **Y** and **Z**.



	X	Y	Z
name of mammal	beaver	house mouse	desert living gerbil
water potential of urine	high	low	very low

Explain the relationship between the length of the section D in the nephrons and the water potential of the urine each mammal produces.

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[Total 3 marks]

8. The hypothalamus produces anti-diuretic hormone (ADH) that is released by the posterior pituitary gland into the blood.

Brain damage can occur due to trauma to the head. Traumatic brain injury (TBI) can cause many and varied malfunctions of parts of the brain. One condition that can arise from TBI is a lack of ADH in the blood.

Suggest the symptoms you would expect in a person with a lack of ADH.

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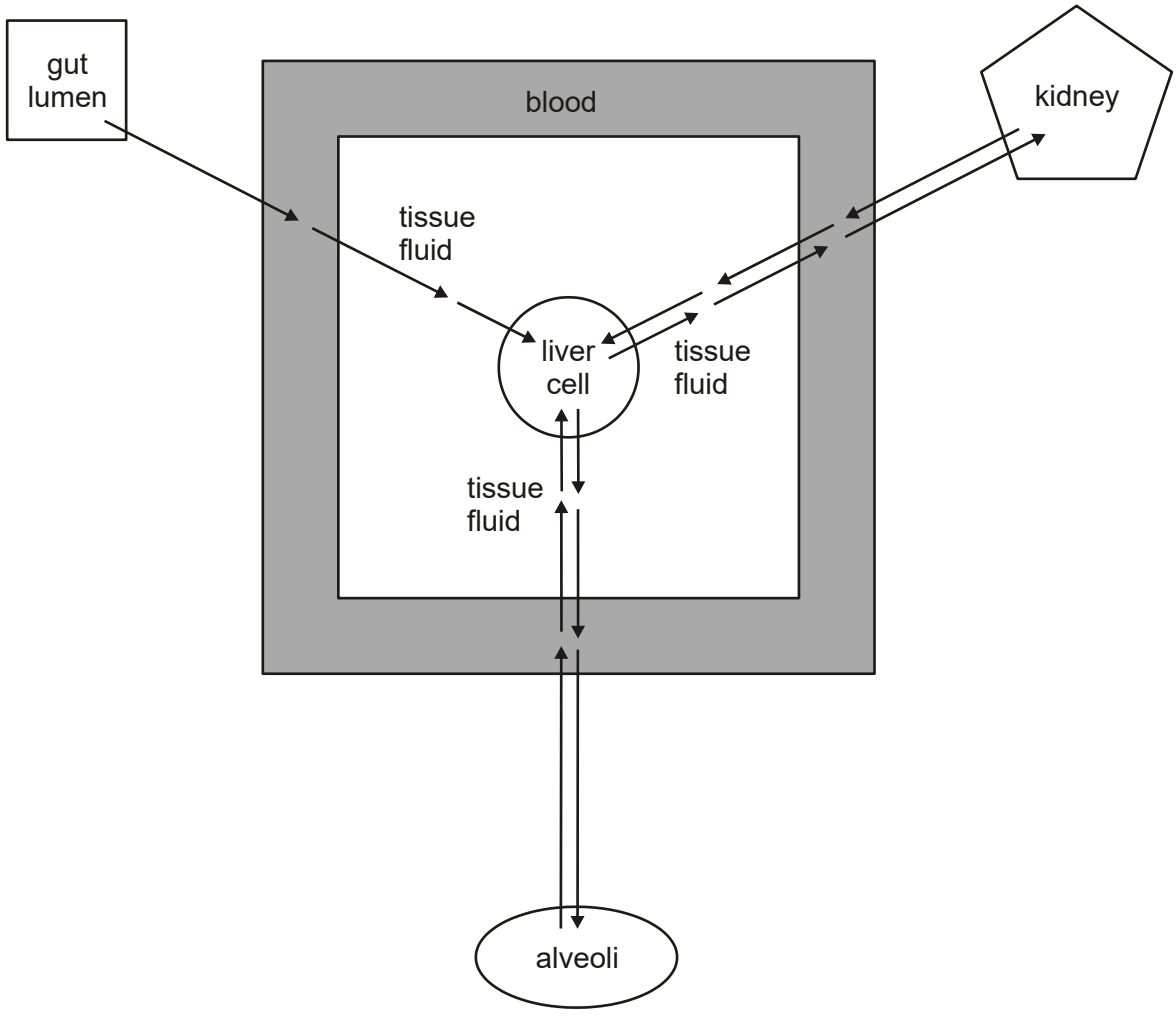
[Total: 3 marks]

9. In this question, one mark is available for the quality of spelling, punctuation and grammar.

Some of the key physiological areas of a mammal are the:

- blood
- alveoli
- gut
- kidney.

The figure below shows some of the pathways where biochemicals are exchanged between these areas, the tissue fluid (extracellular fluid) and a liver cell.



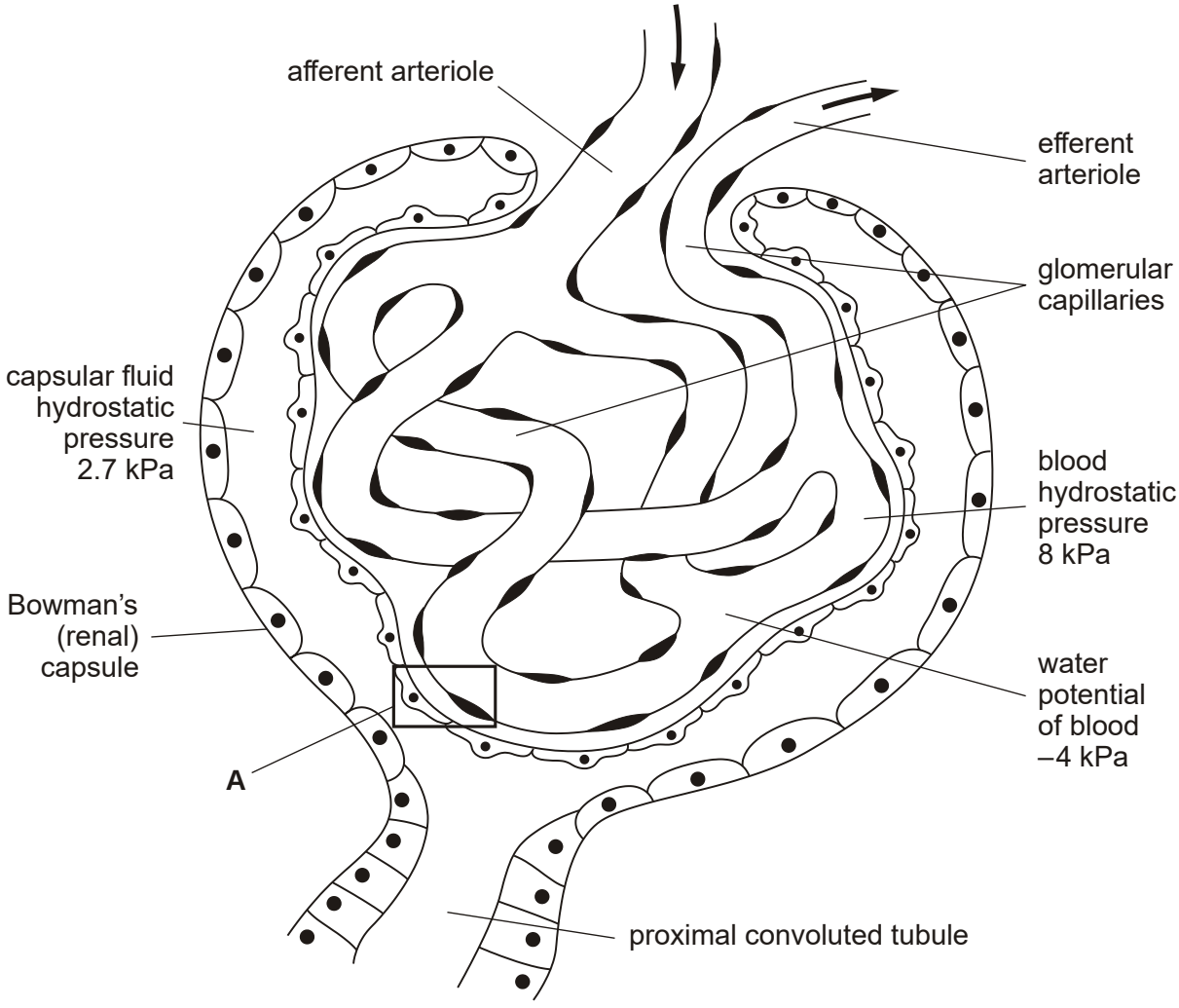
Use the diagram to describe how these exchange pathways function to maintain relatively constant concentrations of biochemicals **in the liver cell**.

[7]

Quality of Written Communication [1]

[Total 8 marks]

10. The first stage in the formation of urine is glomerular filtration. This results in the production of glomerular filtrate in the Bowman's (renal) capsules. Below is a diagram that shows the structures and forces involved in the filtration process.



(a) The normal blood hydrostatic pressure in other capillaries is 3.3 kPa.

(i) Using the diagram, explain why the blood pressure in the glomerular capillaries is considerably higher than in other capillaries.

.....

.....

.....

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.....

[2]

(ii) Using the data given in the diagram, calculate the effective filtration pressure.

Answer = ...kPa

[2]

(b) The presence of protein molecules in the urine of an individual is a sign of kidney disease or kidney damage.

(i) Explain why it is unusual for protein molecules to appear in the urine.

.....

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.....

.....

[2]

(ii) Explain why protein in the urine is often a symptom of chronic high blood pressure.

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[2]

(c) A complex barrier exists between the blood plasma in the glomerular capillaries and the fluid in the renal capsule.

Describe in detail the structure of the region labelled **A** on the diagram above.

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[4]

(d) Coffee contains the drug caffeine, which inhibits the release of ADH.

Describe **and** explain the effect of drinking coffee on the volume **and** concentration of urine produced.

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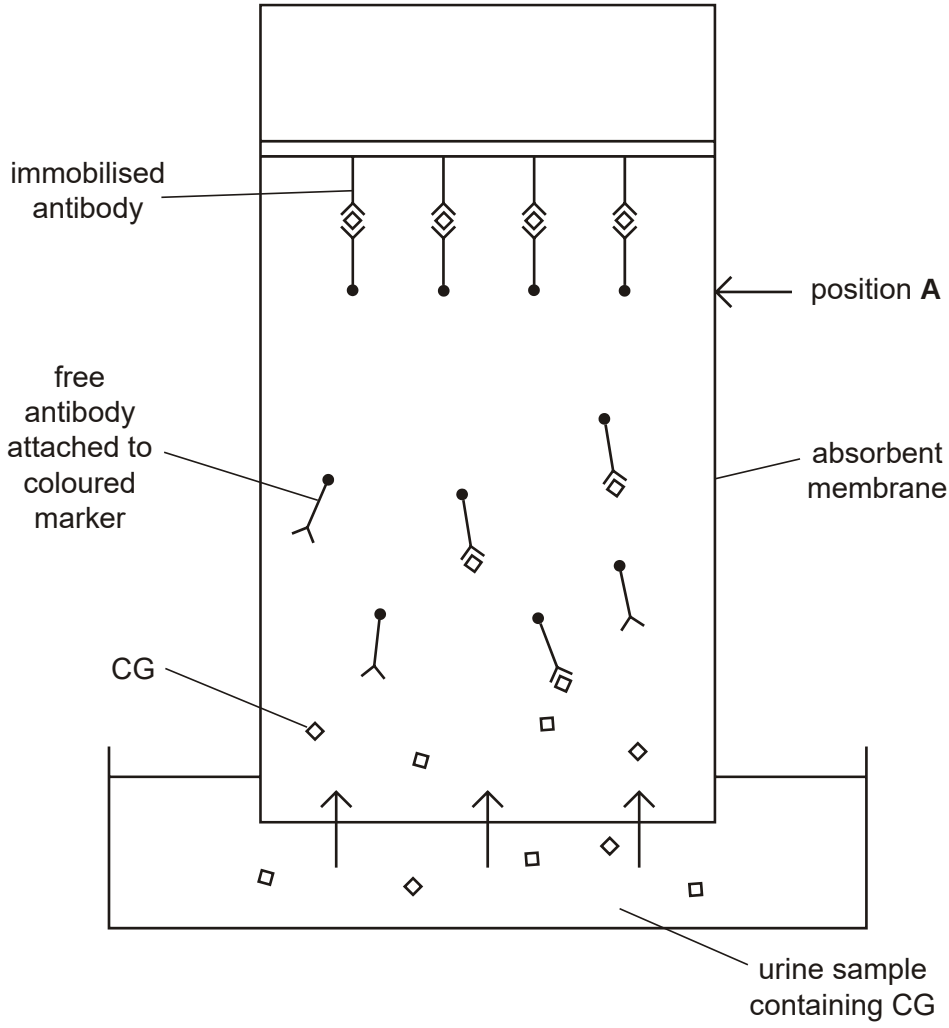
[4]

[Total: 16 marks]

11. The presence of CG in the urine can be used in pregnancy testing. Information about a pregnancy testing kit is given below and in the figure.

- An absorbent membrane is dipped into urine.
- The membrane contains free antibodies that are specific to CG.
- The free antibodies are attached to coloured markers.
- There is a line of immobilised antibodies above position **A**.
- A positive result is shown by a coloured line at position **A**.



Using information from the figure, explain how the presence of CG in the urine results in a coloured line at position **A**.

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[Total 4 marks]

12. The liver is responsible for many aspects of protein metabolism, such as transamination and deamination.

What is transamination **and** why is it necessary?

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[Total 2 marks]

13. Define the term *excretion.*

.....

.....

[Total 2 marks]

14. Name **two** groups of macromolecules that are broken down to form nitrogenous excretory products in mammals.

1 .....

2 .....

[Total 2 marks]

15. The table below shows the amount of different substances excreted by a volunteer during two 24 hour periods. During the first 24 hour period the volunteer was fed a protein-deficient diet; during the second 24 hour period the volunteer was fed a protein-rich diet. All other variables were kept constant.

substance excreted	protein-deficient diet	protein-rich diet
urea / g	2.20	14.70
uric acid / g	0.09	0.18
ammonium ions / g	0.04	0.49
creatinine / g	0.60	0.58

(i) Calculate the percentage increase in urea excreted when the volunteer switched from a protein-deficient to a protein-rich diet. Show your working.

Answer = ……..%

[2]

(ii) Explain why more urea is produced when eating a protein-rich diet.

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.....

.....

[2]

[Total 4 marks]

16. Explain why the main nitrogenous excretory product of humans is urea rather than ammonia.

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.....

[Total 2 marks]

17. The following table shows the concentrations of glucose and urea in the renal artery and renal vein.

	concentration / mg 100 cm^{-3} plasma	
	renal artery	renal vein
glucose	90	80
urea	30	16

Both substances are present in lower concentration in the renal vein than in the renal artery. However, urea appears in the urine of a healthy individual but glucose does not.

Explain why this is so.

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[Total 5 marks]

18. In both plants and animals, chemical messengers help to transfer information from one part of the organism to another to achieve coordination.

The table below lists some of these chemicals together with their functions.

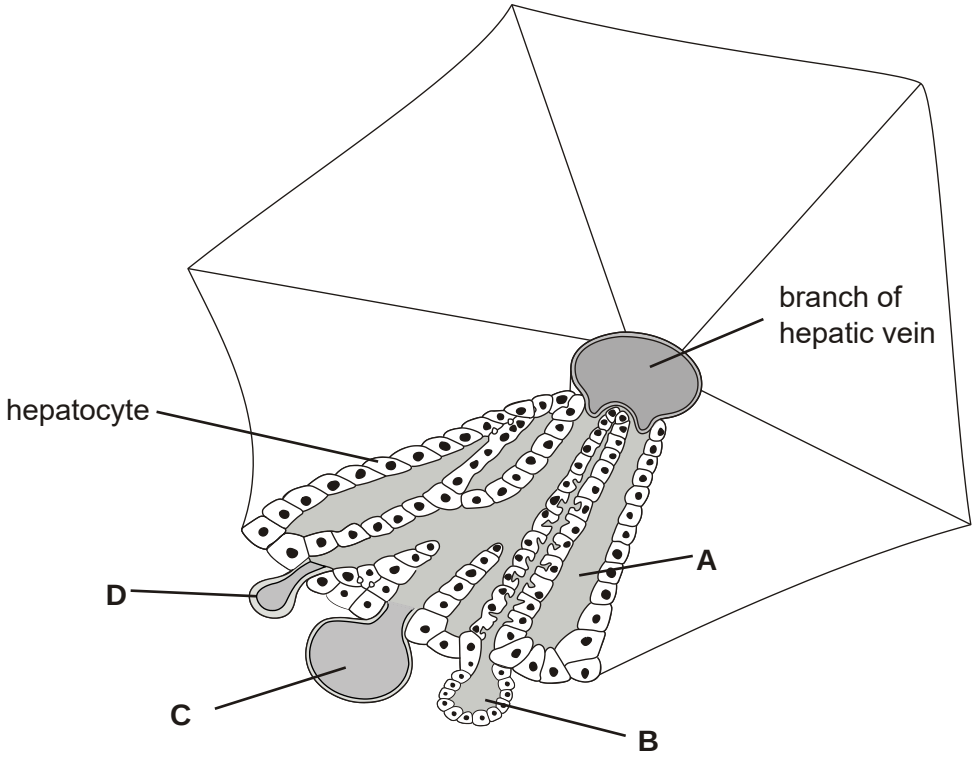
Complete the table.

name of chemical messenger	function
.....	controls water permeability of collecting ducts in kidney
insulin	....
glucagon	....
.....	stimulates stomatal closure during water stress
.....	controls apical dominance

[Total 5 marks]

19. The mammalian liver is made up of lobules that consist of liver cells (hepatocytes) arranged in plates.

The figure below shows a section of a liver lobule and its associated blood vessels.



Name structures **A** to **D**.

A .....

B .....

C .....

D .....

[Total 4 marks]

20. Sometimes the liver does not function normally. This may result in a condition known as jaundice. The symptoms of jaundice include yellowing of the sclera at the front of the eyes, yellow skin, orange coloured urine and white faeces.

Suggest what abnormal events are happening in the liver to produce these symptoms.

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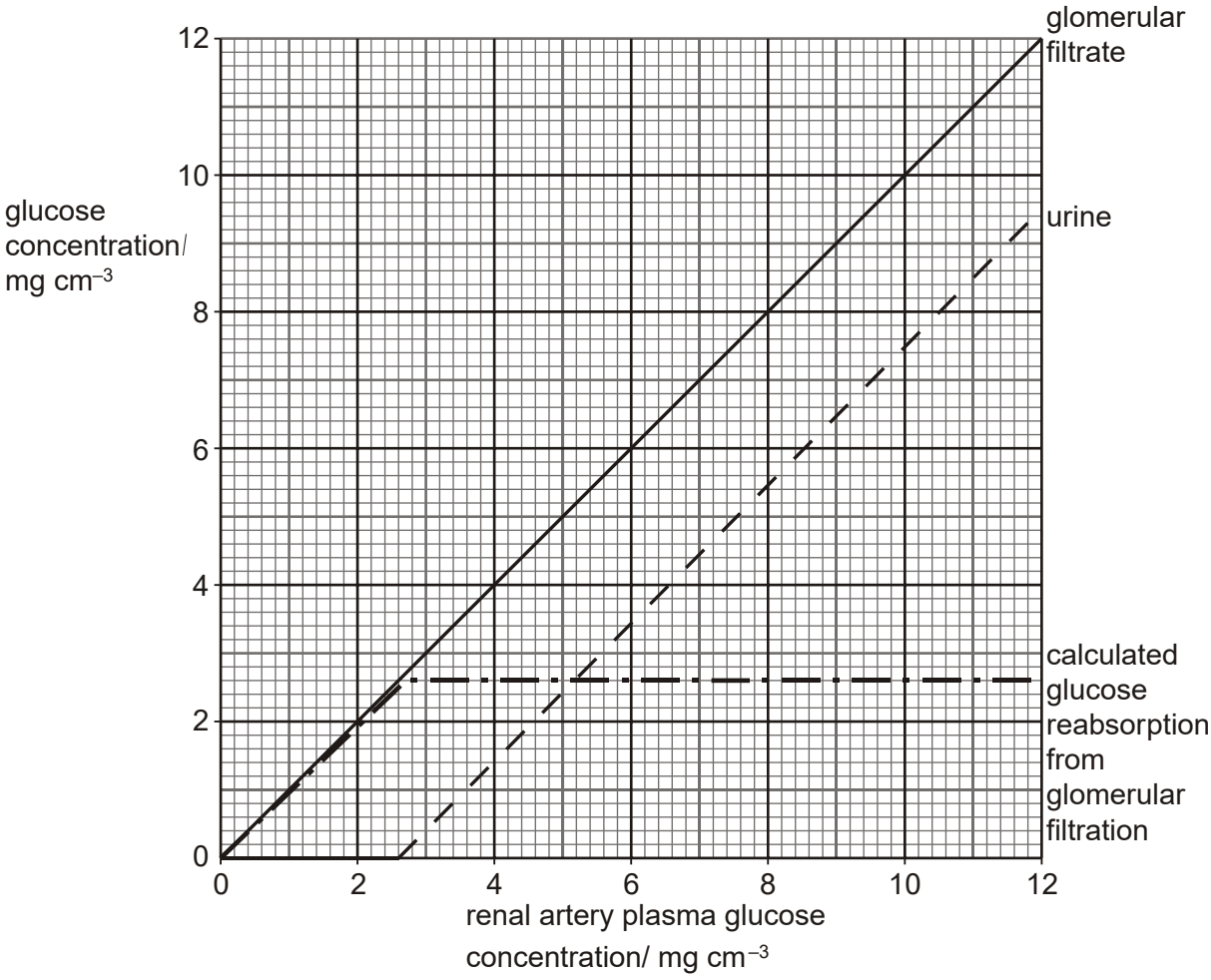
[Total 2 marks]

21. An investigation was conducted into the filtration and reabsorption of glucose in the kidney of a mammal.

The glucose concentration in the plasma of the renal artery was increased. The glucose concentrations were measured in the following fluids:

- glomerular filtrate
- urine.

From the measurements obtained, the concentration of glucose in the fluid reabsorbed from the glomerular filtrate was calculated. The results of this investigation are shown below.



Use the data in the figure above to answer the following questions.

(i) Describe the relationship between plasma glucose concentration in the renal artery and the concentration of glucose in the glomerular filtrate.

.....

.....

[1]

(ii) State the plasma glucose concentration in the renal artery above which the kidney is unable to reabsorb all the glucose from the glomerular filtrate.

Answer = ... mg cm^{-3}

[1]

(iii) Explain why plasma glucose concentrations in the renal artery greater than the figure you have given in **(ii)** would result in the presence of glucose in the urine.

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[3]

[Total 5 marks]

22. The kangaroo rat, *Dipodomys spectabilis*, is common in the deserts of North America. It does not need to drink water and feeds mostly on seeds and other dry plant material. It produces very little urine.

(i) Suggest how the kidney of this mammal is adapted to reduce the volume of urine produced.

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[3]

(ii) Suggest how desert mammals, such as the kangaroo rat, are able to obtain water from dry seeds.

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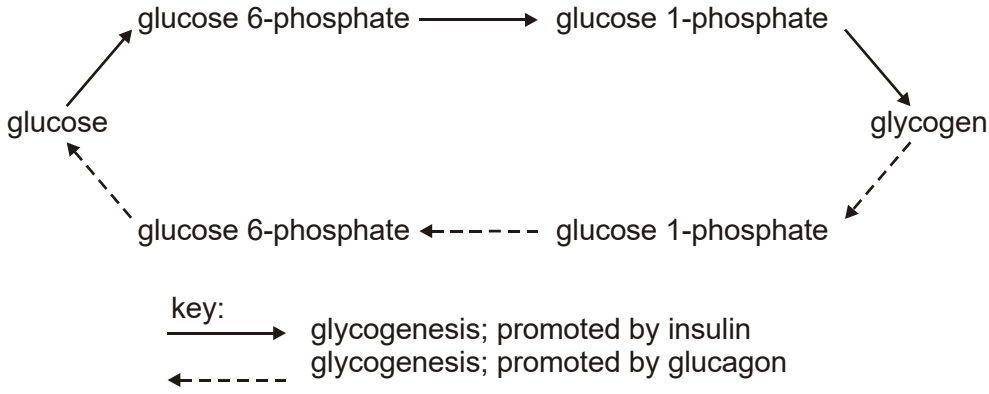
[3]

[Total 6 marks]

23. The liver plays an important role in carbohydrate metabolism. The balance between the processes of glycogenesis and glycogenolysis helps to regulate the concentration of glucose in blood plasma. The figure below shows some of the stages of these processes.



(a) (i) Name **one** other hormone that promotes **glycogenolysis**.

.....

[1]

(ii) Explain why glycogen is suitable for energy storage in cells.

.....

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[3]

The last step in **glycogenesis** is catalysed by the enzyme glycogen synthetase. The first step in **glycogenolysis** is catalysed by the enzyme glycogen phosphorylase.

Glucose molecules have direct effects on glycogen synthetase and on glycogen phosphorylase. These effects do **not** require the presence of insulin and glucagon.

The table below shows the rate of activity of glycogen synthetase and glycogen phosphorylase inside liver cells, during exposure of the cells to a concentrated solution of glucose.

time after addition of glucose solution / s	rate of activity of glycogen synthetase / arbitrary units	rate of activity of glycogen phosphorylase / arbitrary units
0	28	410
30	28	280
60	32	140
90	49	65
120	94	42
150	136	40
180	189	40
210	272	40

(b) Explain how a high concentration of glucose causes the storage of glycogen in liver cells. You will gain credit if you use the data in the table in your answer.

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[5]

(c) After a prolonged period of fasting, glycogen levels in the liver are depleted. However, the liver can still produce glucose by the process of **gluconeogenesis**.

Describe **one** way in which this is done.

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[3]

[Total 12 marks]