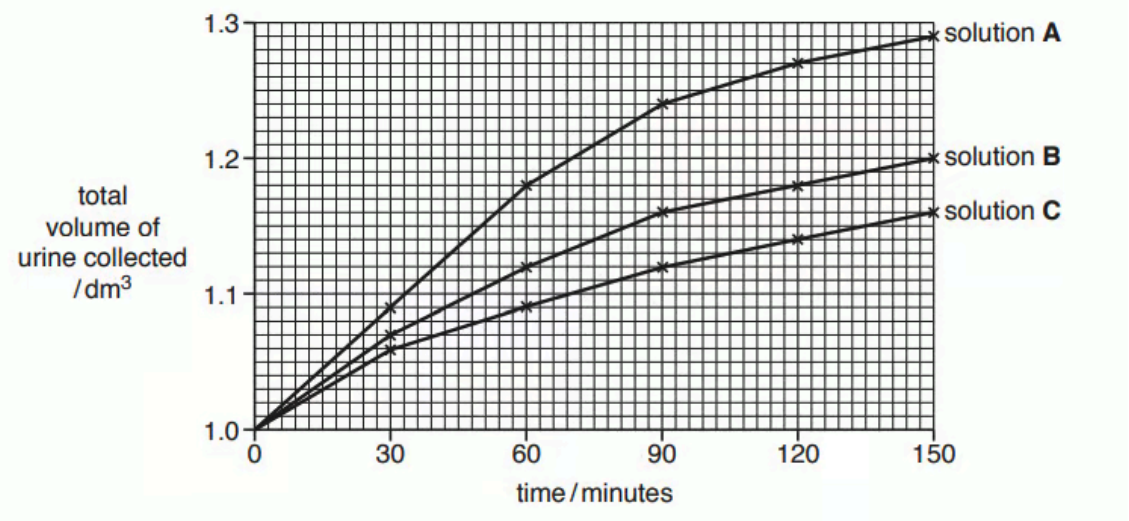
1.

A scientist investigated the effect of drinking sugar solutions, of different concentrations, on the volume of urine produced.

- 1.5 dm^3 of sugar solution **A** was consumed by a healthy adult.
- Urine was collected at thirty minute intervals for 150 minutes.
- The volume of urine produced every thirty minutes was added to the previous total volume.
- This procedure was repeated with sugar solutions **B** and **C**.

The results are shown in Fig. 1.



Suggest which of the 3 solutions contained most sugar

- Solution C
- The reason is it has the lowest volume of urine that was produced

2. Factors affecting volume and concentration of urine produced

- Water intake
- Temperature of body/surrounding
- Exercise/physical activity/ sweat produced

3. Ways in which the body loses water

- In urine
- In sweat
- In expired air / expired water vapour / exhalation / from breathing
- In faeces / diarrhoea
- In vomit / tears / mucus

4. How excess amino acids are broken down

- Deamination / removal of nitrogen containing part of amino acids

- Part of the amino acid is converted to ammonia
- Ammonia is converted to urea

5.

The volume and concentration of urine varies with changing conditions.

Table 1 shows three changing conditions.

Write **increase** or **decrease** in each of the boxes in Table 1 to show how each change affects the volume and the concentration of urine.

Table 1

changing condition	volume of urine	concentration of urine
increase in water intake		
increase in temperature		
increase in exercise		

changing condition	volume of urine	concentration of urine
increase in water intake	**increase**	**decrease**
increase in temperature	**decrease**	**increase**
increase in exercise	**decrease**	**increase**

NOTE: People sweat and lose water whilst exercising. This is what causes the volume of urine to decrease in this scenario.

6. Describe & explain how structure of glomerulus & Bowman's capsule help to remove urea from the bloodstream

- The glomerulus consists of a knot/network of capillaries
- The glomerulus sits inside the cup-shaped Bowman's capsule
- The capillaries (of the glomerulus) are narrow which increase the pressure of the blood (moving through them)
- The Bowman's capsule and glomerulus let small molecules (such as urea) pass into the tubules (of the nephron)
- During the process of ultrafiltration

7. Why increase in protein consumption causes more urine to be produced

More urea/waste products are produced, which requires more water to dissolve it in

8. Why there should be no glucose present in urine, under normal circumstances

- Glucose is a useful substance needed by the cells (for aerobic respiration)

- It is therefore completely reabsorbed back into the blood as it moves through the proximal convoluted tubule

9.

Glomerulonephritis is a set of kidney diseases that affect the glomeruli in the kidneys. One of the effects of glomerulonephritis is a thickening of the capillary walls of the glomerulus due to the presence of extra endothelial cells.
Suggest an explanation for the effect that this may have on the process of ultrafiltration.

- (The walls may become) less permeable to substances (due to the thickening / presence of extra endothelial cells)
- Leading to a decrease in the rate of ultrafiltration
- (This means that) less waste products / urea is removed/excreted/filtered from the blood OR more waste products / urea remains in the blood (of the glomerulus)

10.

If left untreated, glomerulonephritis may lead to kidney failure. One of the symptoms of kidney failure is swelling of the legs, ankles and feet.
Explain this symptom.

- The kidneys are unable to excrete excess water (from the body) OR the kidneys are not able to regulate the amount of water excreted
- (This leads to) excess water remaining in the blood / an increase in blood volume
- Which accumulates in the legs, ankles and feet due to (the force of) gravity

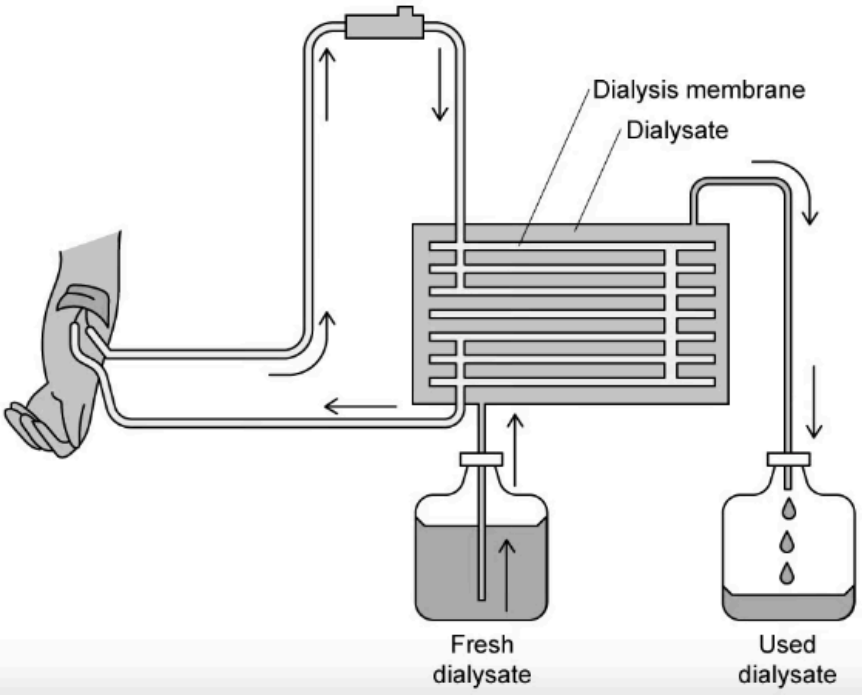
11.

Patients suffering from kidney failure will have to undergo kidney dialysis on a regular basis while waiting for a kidney transplant.

During the process of dialysis, blood from the patient flows through a dialysis machine which contains a series of convoluted tubes. These tubes are made from a selectively permeable substance called a dialysis membrane.

The tubes are surrounded by a solution called dialysate, which ensures that the dialysis machine performs the same function as normal kidneys. Once the blood has flowed through the entire dialysis machine, it returns back to the body.

Fig. 1 shows the process of kidney dialysis.



Describe & explain the possible composition of the dialysate

- It would contain no urea / waste products to ensure that these substances are removed from the blood
- Useful substances/glucose/salts/ions would be present in the same concentration as the blood (plasma) to ensure none is lost/removed from the blood
- The dialysate should have the same water content as the blood to avoid changes in blood volume/pressure

12.

In order for kidney dialysis to be effective, the dialysate must be constantly replaced with a fresh solution.

Suggest a reason for this.

- It maintains the concentration gradient of substances/urea/salts/glucose/water between the blood and the dialysate
- To ensure that diffusion of substances / osmosis of water molecules occurs (between the blood and dialysate)

13. Why it is important to excrete carbon dioxide

- It dissolves easily in water / it is very soluble
- To form a acidic solution (in the body)
- This lowers the pH of the cells
- Which may reduce the activity of enzymes OR may denature the enzymes (controlling metabolic reactions)

14. Substances that form the filtrate (after ultrafiltration)

- Water
- Salts
- Glucose
- Urea

15. How loop of Henle allows water to be reabsorbed into the blood

- Salts are reabsorbed back into the blood by diffusion / salts move down their concentration gradient into the blood
- (As the salts are reabsorbed into the blood,) water follows by osmosis

16. Describe the fate of urea once it is produced by the liver

- It dissolves in the blood and is transported to the kidneys
- Urea is removed from the blood during ultrafiltration
- Before it is excreted in the urine
- Some urea is also (transported to the skin and) excreted in sweat

17. Consequences of high levels of urea in the body

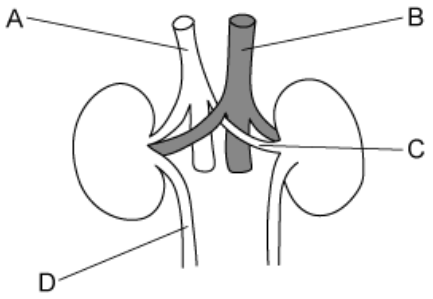
- (It may lead to) cell death
- There could be reduced response to insulin / may lead to the development of diabetes
- (Excess urea may) form deposits inside blood vessels

18.

The table below shows the composition of a solution found in the human body.

component	concentration / arbitrary units
glucose	0.00
urea	4.00
protein	0.00
salts	3.00
amino acids	0.00

In a healthy person, which of the following structures would contain this solution?



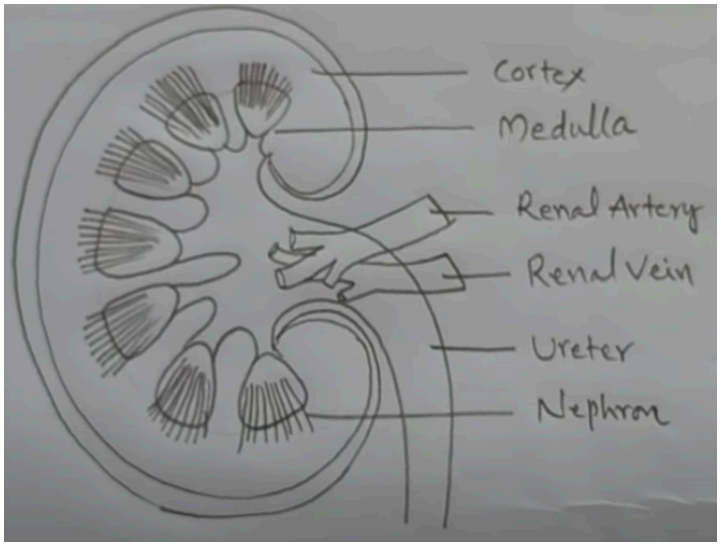
Answer: D

NOTE: Function of kidneys is to remove excess urea from the blood

19. Deamination

- removal of nitrogen containing part of amino acids
- to form urea

20. Cross section of kidney



21. Structure of glomerulus

- Network of capillaries / tangled / knotted
- Round / ball-shaped
- Capillaries are one cell thick
- Has fenestrations / pores

22. Role of glomerulus

- provides blood at high pressure
- provides a large surface area
- ultrafiltration
- small or soluble molecules / water / glucose / urea / salts are filtered out
- large or insoluble molecules / blood cells stay in the glomerulus

23. How salts are reabsorbed against a concentration gradient

- Active transport
- From region of lower concentration to region of higher concentration
- Through cell membrane
- Uses energy
- From respiration
- Requires carrier proteins

24. Explain why urine tests are a good indicator of how much salt has been consumed

- excess salt is excreted / removed from body in urine
- some salt is reabsorbed in the kidney / tubules / into the blood
- people are not reliable in recording / remembering / measuring how much salt they eat

25.

Table 2.1 shows the concentrations of some substances in blood plasma and in the regions labelled 1 and 3 on the tubule shown in Fig. 2.1.

Table 2.1

substance	concentration / mg per cm^3		
	blood plasma	region 1	region 3
protein	8000	0	0
glucose	100	100	0
salts	320	320	300
urea	30	30	2000

Outline how the kidney tubules function to produce urine from the substances in blood plasma.

Use the information in Fig. 2.1, Fig. 2.2 and Table 2.1 to support your answer.

- no protein in, region 1 / (Bowman's / renal) capsule / protein only in P / blood / plasma
- all glucose / salts / urea, is filtered out, of P / blood plasma / into region 1 / (Bowman's / renal) capsule
- (re)absorption of all glucose, by region 3 / loop of Henle / in tubule / in region 2 / after region 1
- (re)absorption of, some salts, by / at, region 3 / by loop of Henle / in tubule / in region 2 / after region 1
- urea concentration is, increased / higher in, region 3 / loop of Henle
- idea that size of the substance determines what is filtered
- glucose / salts / urea, filtered out of blood / plasma OR proteins, stay in blood / plasma / not filtered out, of blood / plasma
- active transport, of glucose / salts (from tubule / back into blood / back into plasma) ;
- movement of, glucose / salts, against a concentration gradient / through proteins (in membranes)
- (active transport) uses energy from, respiration / mitochondria
- (most) water (re)absorbed by osmosis (in region 3 / loop of Henle)
- urea concentration increases as a result of reabsorption of water
- urea / excess salt, is, an excretory substance / waste product (of metabolism) / toxic
- urine contains salts and urea

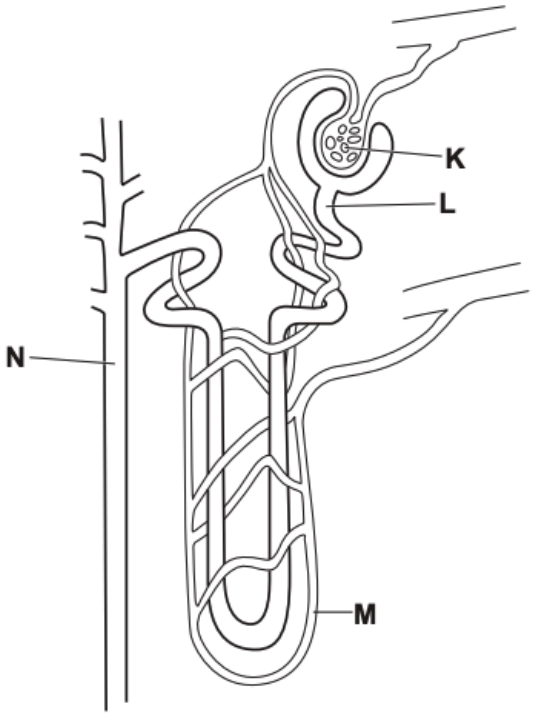
26. Describe how urea is formed.

- deamination
- in the liver

- the removal of the nitrogen-containing part
- of excess amino acids

27.

Fig. 4.1 shows a drawing of a nephron in the human kidney and associated blood vessels.



Describe how the structures labelled in Fig. 4.1 produce urine.

- the glomerulus / K, is where the blood is filtered ;
- water / glucose / urea / ions, move into, nephron / L ;
- the nephron / L, reabsorbs all glucose ;
- the nephron / L, reabsorbs some of the, water / ions ;
- into, the blood / M / capillary ;
- urine flows through N ;
- urine contains urea and excess water and excess ions ;

28.

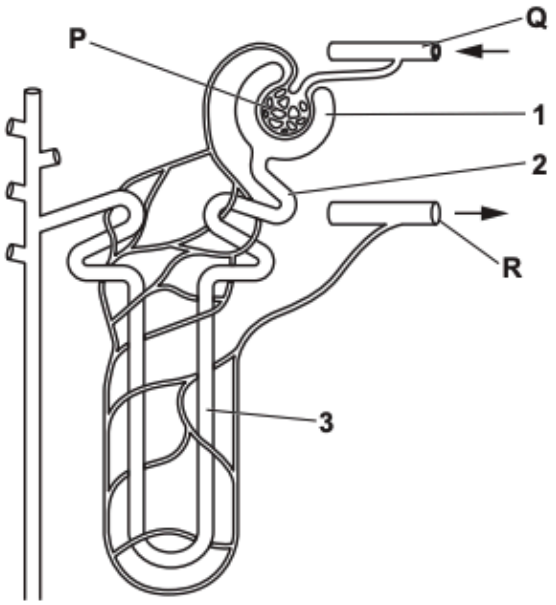


Fig. 2.1

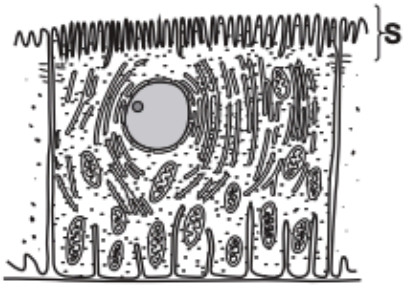


Fig. 2.2

2.1: kidney tubule and associated blood vessels; arrows show direction of blood flow.
2.2: vertical section through a cell from the lining of region 2 of the tubule.

Suggest why blood vessel Q has the highest blood pressure.

- (vessel Q) is a (renal) artery / blood has not passed through any capillaries
- blood (in Q) comes (straight) from the heart / an artery / aorta
- (vessel Q) is narrower than R
- (vessel Q) has thick / elastic walls
- for ultrafiltration

Explain the importance of microvilli on the surface of cells lining region 2

- increase surface area
- for faster / more reabsorption of glucose / amino acids / minerals / ions / salts / water / vitamins / nutrients / other relevant substances