

Maintaining water and nitrogen balance

4.5.3.3 · Homeostasis and response · revision notes

How the body loses water, how the kidneys make urine, and how kidney failure is treated. Expect data questions comparing blood, filtrate and urine, and questions on dialysis and transplants. This subtopic is in GCSE Biology only.

Key facts

- Water lost: lungs (breathing out), skin (sweat), kidneys (urine); only kidney losses are controlled
- Reabsorbed: all the glucose, some ions, some water
- Dialysis fluid: normal glucose and ion concentrations, no urea
- Kidney: filtration, then selective reabsorption
- Urine: urea, excess ions, excess water (no glucose or protein when healthy)
- Transplant: shortage of donors; drugs needed to prevent rejection

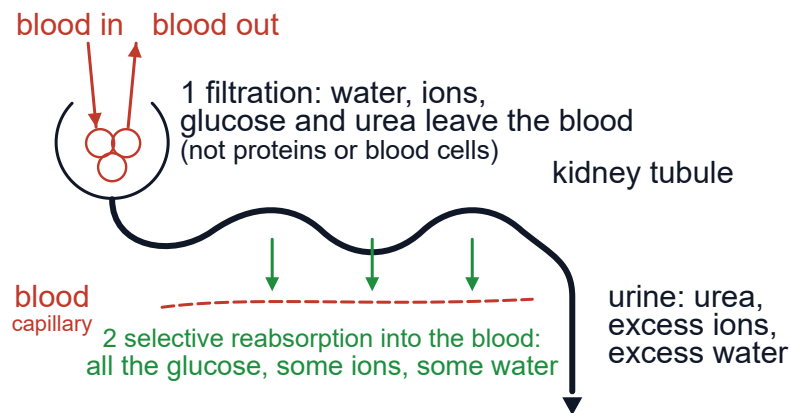
Notes

Water and ion balance

- Water leaves the body from the **lungs** when you breathe out. Water, ions and urea are lost from the **skin** in sweat.
- There is **no control** over these losses. Excess water, ions and urea are removed by the **kidneys** in **urine**.
- If body cells lose or gain too much water by **osmosis**, they do not function efficiently.

How the kidneys work

- **Filtration:** small molecules (water, ions, glucose, urea) are filtered out of the blood into the kidney tubules. Proteins and blood cells are too large and stay in the blood.
- **Selective reabsorption:** useful substances (all the glucose, some ions and some water) are reabsorbed into the blood.

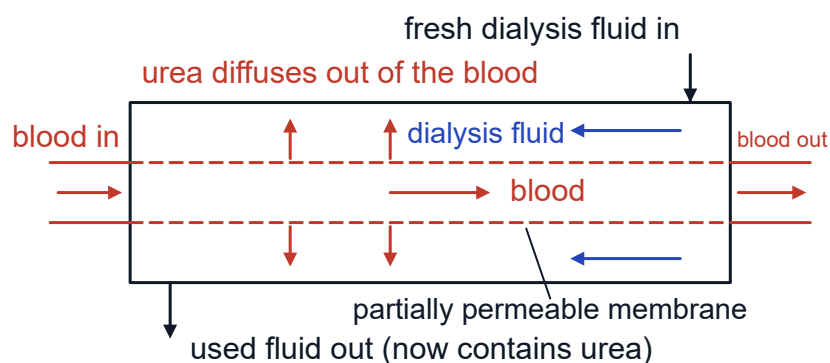


How the kidney makes urine: filtration, then selective reabsorption.

- Urine contains urea, excess ions and excess water. A healthy person's urine contains **no glucose** and no protein.

Treating kidney failure

- **Dialysis:** the patient's blood flows through a machine, separated from **dialysis fluid** by a **partially permeable membrane**.
- The fluid contains the **same concentration** of glucose and useful ions as normal blood, so these do not diffuse out. It contains **no urea**, so urea diffuses from the blood into the fluid. Excess ions and water are also removed.



Dialysis: urea diffuses from the blood into the fluid; glucose and useful ions stay in the blood.

- **Transplant:** a healthy kidney from a donor. There is a shortage of donors, and the patient must take drugs for life to reduce the risk of **rejection**.

How to answer each type of question

Interpret data on filtrate and urine

3 to 5 marks

Grade 5

1. Compare the values in the filtrate and the urine.
2. Missing from the filtrate: too big to be filtered. Missing from the urine: reabsorbed.
3. More concentrated in the urine: water has been reabsorbed.

Example. The table shows the concentrations of some substances in the fluid filtered into a kidney tubule and in the urine of a healthy person.

Substance	Filtered fluid (g/dm ³)	Urine (g/dm ³)
Protein	0	0
Glucose	1.0	0
Urea	0.3	20

- (a) Explain why there is no protein in the filtered fluid.
- (b) Explain why there is no glucose in the urine.
- (c) Suggest why urea is more concentrated in the urine than in the filtered fluid.

Model answer. (a) Protein molecules are too large to be filtered out of the blood (1)
(b) All the glucose is reabsorbed into the blood (1) because it is useful / needed for respiration (1)
(c) Water is reabsorbed into the blood (1), so the urea left in the tubule becomes more concentrated (1)

Don't lose marks

- ✗ Saying glucose is not filtered. It is filtered, but all of it is then reabsorbed.
- ✗ Saying dialysis fluid has no glucose so that glucose is not lost. It has glucose at the normal level so that none diffuses out.
- ✗ Using 'osmosis' for urea. Osmosis is only for water; urea moves by diffusion.

More tips

Memory tricks

- The kidney in two words: filter, then take back (reabsorb) what is useful.
- Dialysis fluid copies clean blood: normal glucose and ions, zero urea.

Exam technique

- In data questions, follow each substance from blood to filtrate to urine and explain each change as filtration or reabsorption.
- In 'evaluate' questions, cover both treatments and end with a justified conclusion.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

List ways water leaves the body

From the lungs when you breathe out, from the skin in sweat, and from the kidneys in urine.

Grade 4

Describe how the kidneys produce urine

Filtration of the blood, then selective reabsorption of useful substances such as glucose, some ions and water.

Grade 5

Explain why cell water content must be controlled

If cells gain or lose too much water by osmosis, they do not function efficiently.

Grade 5

Describe the basic principles of dialysis

Blood flows past a partially permeable membrane; urea and excess ions diffuse into the dialysis fluid.

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