

WJEC (Wales) Biology GCSE

Topic 2.6: Role of Kidney in Homeostasis

Notes

(‘Higher Tier only’ in **bold**)



The kidney

The **kidney** has a range of functions:

- Removes **toxic waste substances** from the body.
- **Osmoregulation**.
- Controls the **volume** and **concentration** of **urine**.

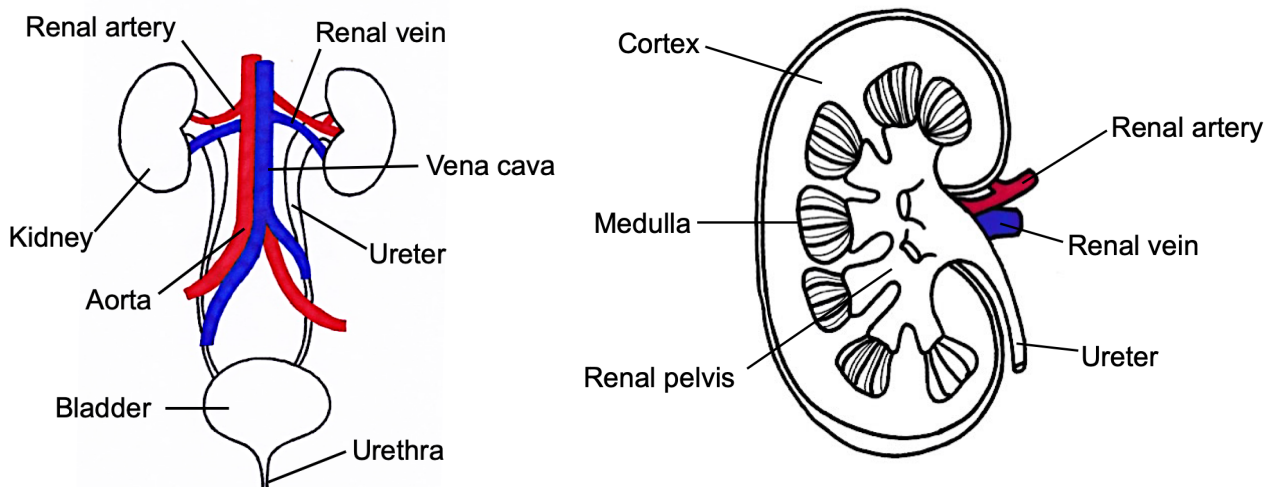
Osmoregulation

Osmoregulation is the maintenance of constant water levels in the body fluids of an organism.

This is important because...

- Prevents **cells bursting** or **shrinking** when water enters or leaves by osmosis.
- **Cellular reactions** occur in **aqueous solution** ∴ water levels affect concentrations and the rate of reactions in cells.

Structure of the human excretory system

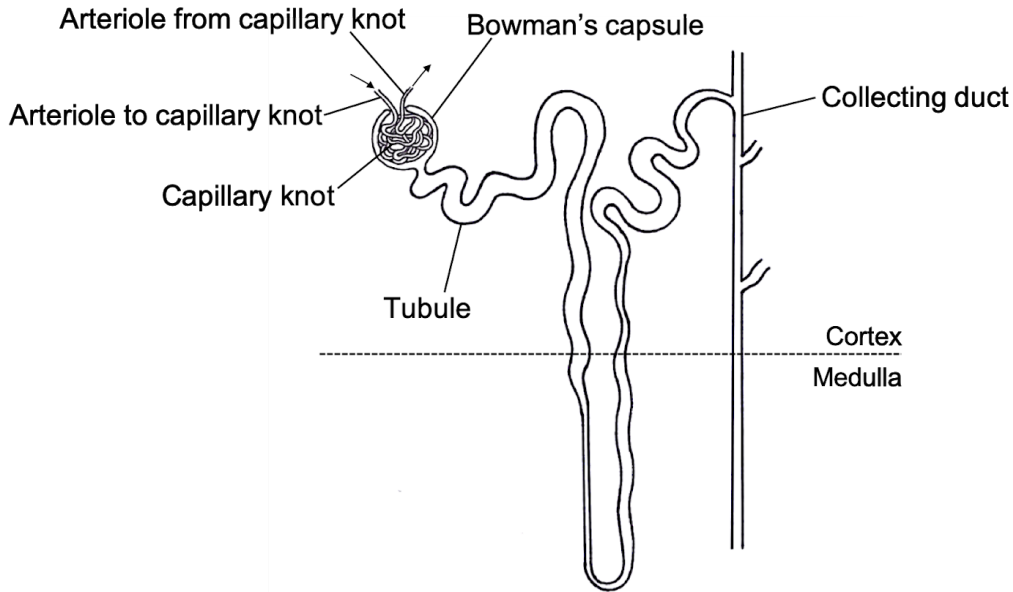


(a) structure of the human excretory system (b) structure of a section through the kidney

Structure	Function
Renal artery	Supplies blood to the kidneys
Renal vein	Drains blood from the kidneys
Ureter	Takes urine to the bladder from the kidneys
Urethra	Releases urine from the bladder, out of the body



Nephrons are the functional units of the kidney where filtration and selective reabsorption take place to produce urine (a waste product of the kidney containing urea, excess water and excess ions).



The process of excretion

There are **three stages** involved in the formation of urine:

- **Filtration**
- **Selective reabsorption**
- **Osmoregulation**

Filtration

- Blood flows through the **capillary knot** under high pressure.
- The arteriole leading into the capillary knot is **wider** than the arteriole taking blood from the capillary knot. This creates a **build up of pressure**.
- Small molecules (e.g. urea, glucose), water and salts are **filtered** out of the blood and into the **Bowman's capsule**.
- Large molecules (e.g. RBCs, proteins) **remain** in the blood as they are **too large** to fit through the **pores** in the capillary walls.



Selective reabsorption

Glucose, some water and some salts are reabsorbed into the bloodstream.

The molecules not selectively reabsorbed travel down the kidney tubule as **urine** and are transported to the **bladder** via the ureter. Here they are stored and eventually **excreted**.

Osmoregulation

The water content of the blood is adjusted:

- If blood water levels are **high**, **more dilute** urine is produced.
- If blood water levels are **low**, **more concentrated** urine is produced.

The volume of water reabsorbed is controlled by **anti-diuretic hormone, ADH**, which is secreted by the **pituitary gland**. ADH causes the kidneys to reabsorb **more water** into the blood producing **more concentrated** urine.

Composition of blood, filtrate and urine

Component	Blood	Filtrate	Urine
Water	✓	✓	✓
Salts	✓	✓	✓
Urea	✓	✓	✓
Glucose	✓	✓	x
Proteins	✓	x	x
Cells	✓	x	x

The presence of **glucose** in the **urine** may indicate **diabetes**.

The presence of **blood** or **cells** in the **urine** may indicate **kidney disease**.

Treating kidney disease

There are two methods of treating kidney disease:

- Kidney **dialysis**
- Kidney **transplant**



Method	Description	Advantages	Disadvantages
Kidney dialysis	<p>A machine artificially filters a patient's blood:</p> <ul style="list-style-type: none"> • Selectively permeable barrier separates patient's blood from dialysis fluid. • Materials exchanged across the barrier e.g. urea, excess ions and water move out of the blood and into the dialysis fluid. • Large cells and proteins remain in the blood. 	<p>Does not involve surgery.</p> <p>Patient can undergo kidney dialysis while waiting for a donor kidney.</p>	<p>Connected to a dialysis machine for many hours a week.</p> <p>May have to travel to hospital.</p> <p>Must control diet (e.g. fluid and salt intake).</p> <p>Not a permanent solution.</p>
Kidney transplant	<p>Taking a kidney from a living donor or someone recently deceased and implanting it into the patient.</p> <p>To minimise the risk of kidney rejection:</p> <ul style="list-style-type: none"> • Tissue typing ensures that the transplanted organ is 'compatible' with the recipient. • Immunosuppressant drugs help prevent the immune system from rejecting the organ. 	<p>More permanent solution.</p> <p>Improves patient's quality of life.</p>	<p>Difficult to find a suitable donor.</p> <p>Involves major surgery.</p> <p>Transplanted kidney has a limited life-span.</p> <p>Risk of organ rejection.</p> <p>May have to take immunosuppressant drugs for life.</p> <p>Immunosuppressants increase the risk of other infections.</p>

