

# About the urinary system and kidneys

This infoKID topic is for parents and carers about children's kidney conditions. Visit [www.infoKID.org.uk](http://www.infoKID.org.uk) to find more topics about conditions, tests & diagnosis, treatments and supporting information.

Each topic starts with an overview followed by several sections with more information.

[Links to sections](#) in topic | [Other topics](#) available on website

If your child has a health condition that affects his or her kidney or another part of the urinary system, you may wish to find out more about these parts of the body.

The urinary system has a very important job to get rid of waste from the body so that we can grow and stay healthy. It has two kidneys, two ureters, a bladder and an urethra.

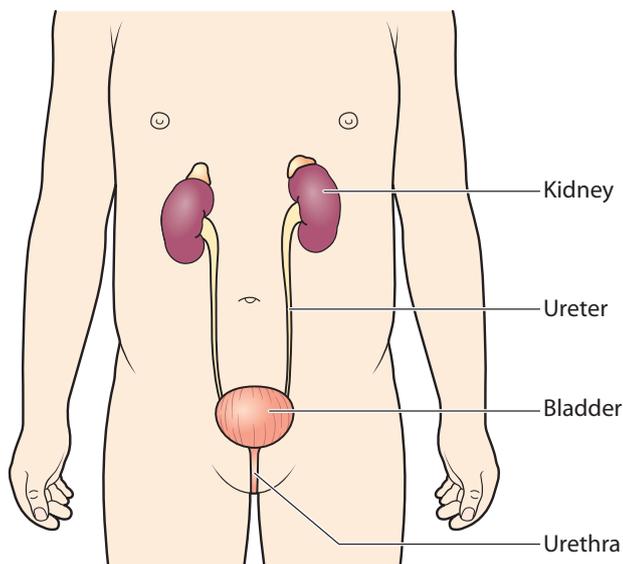


## Overview

### Kidneys

The two kidneys remove substances our bodies no longer need. They filter blood and make urine (wee). Most of us have two kidneys. The kidneys are on either side of our spine (backbone), near the bottom edge of our ribs.

» [More about the kidneys](#)



### Other parts of the urinary system

#### Ureters

The two **ureters** are long tubes. They carry urine from the kidneys to the bladder.

#### Bladder

The **bladder** is a round, muscular bag that sits low down in the pelvis. The bladder fills up with urine like a balloon. When full, it sends signals to the brain which 'tell' the bladder muscles to push urine out through the urethra. This is how we pass urine.

#### Urethra

The **urethra** is a tube that carries urine from the bladder to the outside of the body. We urinate through the opening.

In boys and men, the urethra passes through the penis. It is much longer than in girls and women.

## What the kidneys do

The kidneys remove waste from the body – things that we no longer need or that are harmful. They also control the amount of water in the blood, and make sure it has the right balance of chemicals, including salt and acid.

They also:

- control blood pressure
- help keep bones and teeth strong and healthy
- control the production of **red blood cells**, the living parts of the blood that carry oxygen round the body

» [More about what the kidney does](#)

## Medical terms

You may hear or read lots of words related to the kidneys and other parts of the urinary system.

### Renal

- **Renal** means anything related to the kidney.
- A **paediatric renal unit** of a hospital is where children with kidney problems are treated.

## Nephrology

- **Nephrology** is the medical specialty of kidney diseases.
- **Nephrologists** are specialist doctors who treat people with kidney problems.
- If they work especially with babies, children and young people, they are called **paediatric nephrologists**.

## Urology

- **Urology** is the surgical specialty of the urinary system.
- **Urologists** are specialist surgeons who treat people with problems in their urinary system.
- If they work especially with babies, children and young people, they are called **paediatric urologists**.

Urologists and nephrologists often work together.

## Other doctors

- Other doctors, including **general practitioners** (GPs – family doctors), and **general paediatricians** (children's doctors), will be able to treat some kidney conditions in children.

## Your notes

# About the kidney

This section includes information about:

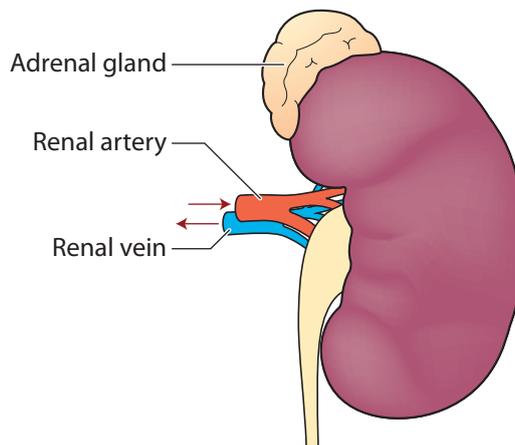
- the adrenal gland, which sits on top of the kidney
- blood vessels going in, around and out of the kidney
- areas of the kidney
- the nephron, which filters blood and makes urine – made up of the glomerulus and renal tubule

## What the kidney looks like

A kidney is reddish and shaped like a kidney bean. One side bulges out (called the **convex** side). The other side curves in, or is indented (called the **concave** side).

Our kidneys grow as we get older. Each kidney is about the size of our fist.

Most newborn babies have kidneys that are about 4 centimetres long. When they reach eight years old, their kidney will have grown to about 8 centimetres. Adults' kidneys are about 13 centimetres long.



## Adrenal glands

We have two **adrenal glands**, one on top of each kidney. (“Ad” means on top of” and “renal” means to do with the kidney.) They are shaped like pyramids.

The adrenal glands help to control how the kidneys work. They make and release chemicals called **hormones**, which are carried in the blood to send messages to other parts of the body. These hormones are very important with many of the body functions, especially at times of stress such as when we are ill or have an operation.

## Blood vessels

Like other parts of the body, the kidney needs blood for everything it does. Blood is pumped around the body by the heart, through tubes called **blood vessels**.

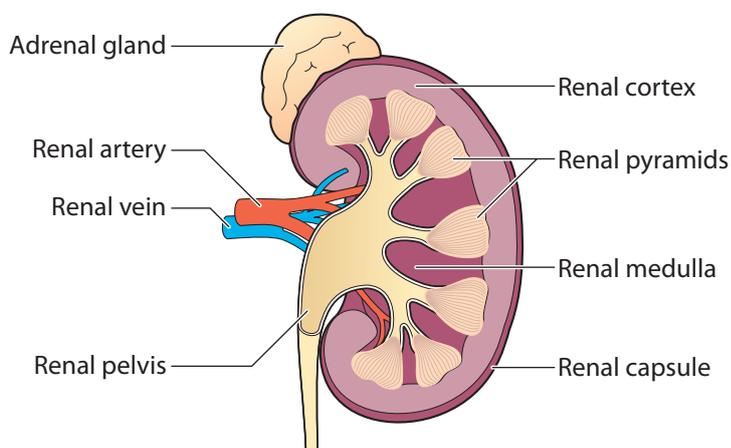
- The **renal artery** carries blood into the kidney.
- The **renal vein** carries blood out of the kidney. These large blood vessels go into the kidney at a dip on its side.

Other smaller blood vessels carry blood around the kidney. These have different names, depending on their size. The smallest of these blood vessels are **capillaries**.

## Areas of the kidney

The kidney has a few different areas. Starting from the outside of the kidney, these are:

- **renal capsule** – a membrane (like a skin) that covers and protects the kidney
- **renal cortex** – the outer area
- **renal medulla** – the inner area, which has about eight sections shaped like triangles called **renal pyramids**
- **renal calyces** – these are small areas that collect urine made by the kidney
- **renal pelvis** – urine flows from the calyces to this larger area before moving down into the **ureter**, the tube that leads to the bladder

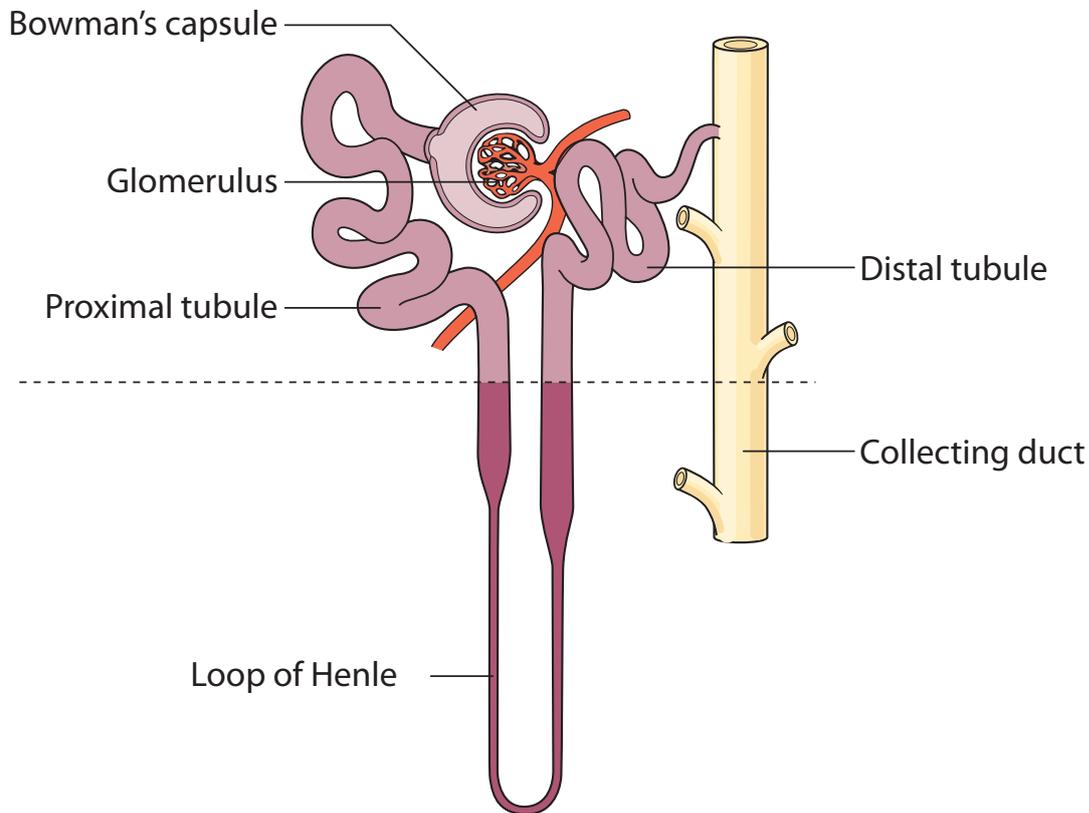


# Nephron

Inside each kidney there are about one million **nephrons**. Nephrons are tiny but very important units that filter blood and make urine.

Each nephron has two main parts:

- **glomerulus**
- **renal tubule**



**A nephron**

## The glomerulus

Blood that comes into the kidney flows into each **glomerulus**, a tight bunch of capillaries (tiny blood vessels). When we talk about more than one glomerulus, we say **glomeruli**.

The glomerulus acts like a sieve – waste, water and salt from the blood pass through the glomerulus.

The space that surrounds the blood vessels of the glomerulus is called the **Bowman's capsule**, or **glomerular capsule**.

This part of the nephron is in the **renal cortex**, the outer part of the kidney (above the dotted line in the image).

## The renal tubule

The **renal tubule** is a long, narrow tube, starting from the Bowman's capsule. Everything that is filtered through the glomerulus goes into the renal tubule. This liquid eventually becomes urine.

Part of the renal tubule is in the renal cortex, and part of it is in the renal medulla.

The tubule has four sections: proximal tubule, loop of Henle, distal tubule and collecting duct.

## Blood vessels

There are tiny blood vessels that go into and out of the nephron, and that surround it.

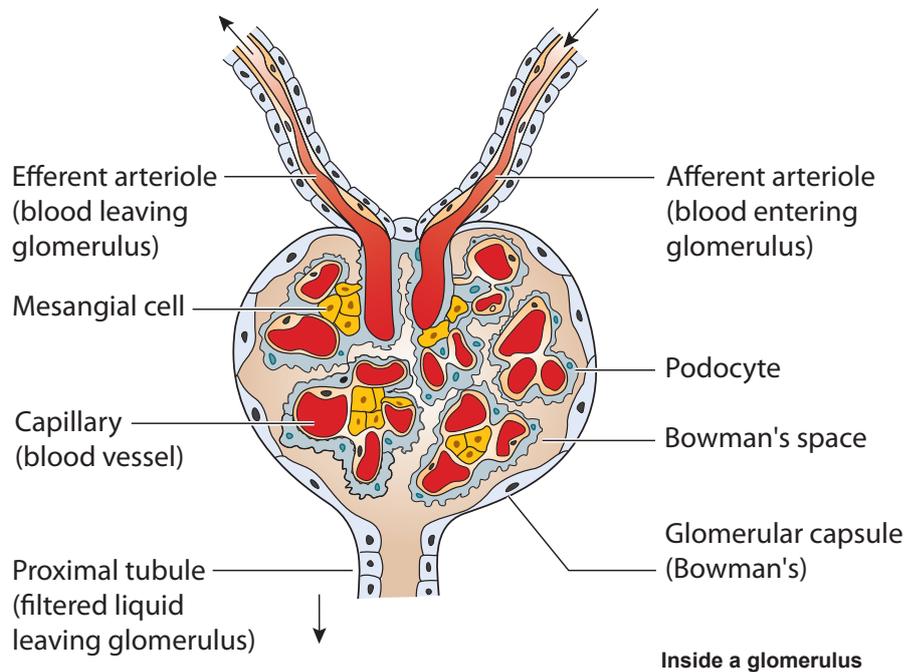
## Glomerulus

The wall of the glomerulus works as a filter, letting some substances out and keeping some in. This wall is called the glomerular filtration membrane.

It is quite leaky, and so water and other substances in the blood filter out of the glomerulus. However, blood cells and some proteins are too large to pass through the membrane and so stay in the capillaries.

The glomerular filtration membrane is like a sandwich with a few layers.

- **Endothelial cells** – these cells are on the inside surface, and have tiny openings called pores.
- **Glomerular basement membrane (GBM)** – a layer of material around the glomerular endothelium.
- **Podocytes** – cells that wrap around the glomerulus. They have long projections that look like feet. Liquid can filter through the slits between these “feet”.
- **Mesangial cells** sit around the glomerulus and support it. They can contract, or tighten, to control how much is filtered through the glomerulus.



## Renal tubule

The liquid that is filtered through the glomerulus flows along the tubule in the order shown below.

- **Proximal tubule** – this is a coiled-up section next to the glomerulus and Bowman's capsule. “Proximal” means next to.
- **Loop of Henle** – this is the next part of the renal tubule. It is a U-shaped section that dips down into the renal medulla. Some nephrons have longer loops of Henle.
- **Distal tubule** – this is a coiled-up section that connects the loop of Henle to the collecting duct. “Distal” means distant - it is further away from the glomerulus and Bowman's capsule.
- **Collecting duct** – this is the final section of the renal tubule. It is where urine collects before it flows to the renal pelvis before leaving the kidney.

The renal tubule is lined with living cells called **tubule cells**. These cells help carry substances between the renal tubule and the bloodstream.

## Blood vessels around the nephron

There are tiny blood vessels around the nephron.

- Blood goes into the glomerulus through the **afferent arteriole** (“afferent” means carried in).
- Blood that is not filtered through the glomerulus leaves through the **efferent arteriole** (“efferent” means carried out).
- This blood is then passed into the **peritubular capillaries**, which surround the nephron.

# What the kidney does

The kidneys filter blood and make urine (wee). This means that they can:

- remove waste from the body – things that we no longer need or that are harmful
- control the amount of water in the blood, and make sure it has the right balance of chemicals, including salt and acid.

The kidneys also:

- control blood pressure
- help keep bones and teeth strong and healthy
- control the production of red blood cells.

## How kidneys filter blood and make urine

The kidneys filter blood and make urine in the nephron – there are about one million of these tiny filtering units inside each kidney. There are a few stages.

### The glomerulus

The first stage – **filtering** – happens in the glomerulus, the tight bunch of small blood vessels (**capillaries**).

- Blood flows into the kidneys through blood vessels and into each glomerulus.
- The glomerulus is quite leaky, and so most of the water and some substances filter out of the blood into the **Bowman's capsule**, which surrounds the glomerulus.
- The blood cells and most proteins are too large to filter through the glomerulus, and so stay in the blood.

### The renal tubule

The next two stages happen along the renal tubule. They help make sure the body keeps what it needs and removes what it no longer needs into urine.

Whatever has been filtered flows into the renal tubule. The rest of it is flows through the tiny blood vessels that surround the nephron (**peritubular capillaries**)

- The body needs to take back some of the water and substances that were filtered and are in the renal tubule. These are reabsorbed (taken back) into the blood vessels.
- The body also needs to get rid of some substances that were not filtered and are still in the blood vessels. These are secreted (released) into the renal tubule.

### Urine

The liquid in the renal tubule is now urine. It is mostly water, but also has some substances that the body no longer needs, such as salt and wastes.

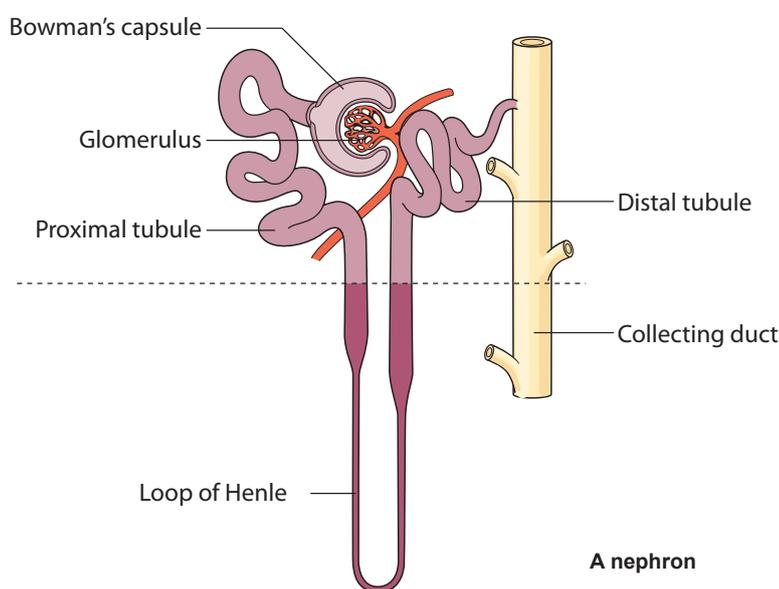
The urine flows to the **renal pelvis** and then leaves the kidney. It flows through the ureters to the bladder. When we are ready to go to the toilet, the bladder pushes urine out through the **urethra**.

If there is a problem in the glomerulus or renal tubule, this may affect how the kidneys remove waste and extra water.

## Removing waste from the body

Our bodies are constantly making waste – for example, when we use our muscles and when we eat food, which the body breaks down for energy. This waste needs to be removed so it does not build up and cause any damage in the body. The kidneys do this job.

» [Read more on the next page](#)



### Blood flow into the kidney

- Blood is pumped around the body by the heart through blood vessels.
- Blood flows into the kidney through the blood vessel called the **renal artery**.
- It then flows through a network of blood vessels inside the kidney into the **afferent arteriole**, the tiny blood vessel that leads to the glomerulus.

### Filtration in the glomerulus

The first stage is **filtration**, which happens in the glomerulus, the tight bunch of capillaries.

- The glomerulus filters blood. This has several layers, including the **glomerular basement membrane (GBM)** and some cells. Because of the high pressure in the afferent arteriole and because the glomerulus has tiny pores (holes), most of the water and substances in the blood, such as chemicals from food (**nutrients**) and waste products are forced through the glomerulus and into the Bowman's capsule.
- This liquid is called the **ultrafiltrate**. The amount of ultrafiltrate made per minute by both kidneys is called the **glomerular filtration rate (GFR)**. **Measuring or estimating the GFR** is one important way that doctors can find out how well the kidneys are working.
- The blood cells and most proteins stay in the bloodstream. This is mostly because they are too large to filter through the glomerulus.

The ultrafiltrate flows out of the Bowman's capsule into the renal tubule. The rest of it flows through the **peritubular capillaries**, the small blood vessels that surround the nephron.

### Reabsorption in the renal tubule

The body needs to keep some of the water and substances in the ultrafiltrate, which is flowing through the renal tubule.

- The **tubule cells**, which line the renal tubule, have special **transport pumps**, which allow them to

move substances in and out of the cells. These cells help move substances out of the renal tubule into the kidney tissue.

- The substances then pass into the peritubular capillaries.

This process is called **reabsorption**. This is because the substances that were filtered out of the blood are taken back, or reabsorbed, into the blood.

### Secretion in the renal tubule

The body needs to get rid of some substances, including waste products, which is flowing through the peritubular capillaries.

- The substances pass out of the peritubular capillaries into the kidney tissue.
- The tubule cells help move substances into the renal tubule.

This process is called **secretion**. This is because the tubule cells secrete, or release, substances into the renal tubule.

### Production of urine

The liquid flows through the different sections of the renal tubule until it reaches the final part – the **collecting duct**. This is now **urine**. It is mostly water, but also has some substances that the body no longer needs, such as salt and wastes.

The urine flows to the **renal pelvis** and then leaves the kidney. It flows through the ureters to the bladder. When we are ready to go to the toilet, the bladder pushes urine out through the urethra.

Waste is made during metabolism, a set of chemical reactions that are necessary for us to live. In metabolism, a chemical is converted (changed) into another chemical within the body's cells. Often a waste product is made.

For example:

- when we eat, the body converts the food into fuel so we have energy. The liver breaks down protein, which makes the waste product urea

- when we use our muscles, the body breaks down a chemical. This makes the waste product creatinine.

These waste products move round the body in the bloodstream. When blood enters the kidney, it goes into the glomerulus, where it is filtered. The waste is safely removed in urine.

## Controlling the amount of water and minerals in the blood

The kidneys also control the amount of water and some important chemicals in our body. They do this by controlling what gets kept in the body and what is removed into urine.

### Water

It is very important to have the right amount of water in the body. We get water from drinking and eating. We lose water in lots of ways, including going to the toilet and sweating.

- If we do not have enough water in our body, the kidneys take back (**reabsorb**) more water from the renal tubule into the bloodstream. This means that less water is removed in urine.
- If we have too much water in our body, the kidneys move more water from the bloodstream into the renal tubule. More water is removed in urine.

### Electrolytes

**Electrolytes are chemicals in the body that help make sure that the muscles, including the heart muscle, bones, teeth and blood, are healthy.**

The kidneys control the amounts of some important electrolytes. If we have too much or too little, this can cause problems, and may mean there is a problem with the kidneys or another part of the body.

Some important electrolytes include:

- sodium (salt)
- potassium
- bicarbonate (which controls the amount of acid)
- phosphate
- calcium

## Controlling blood pressure

Blood pressure is the force, or pressure, caused mainly by the heart pumping. This pressure helps the blood flow round the body (**circulate**).

Kidneys control blood pressure to help make sure it is at a healthy level. If kidneys are not working properly, they may not be able to control blood pressure well.

If blood pressure is too high, this is called **hypertension**. If blood pressure is not controlled, this can cause problems in the body.

» [Read more about blood pressure on www.infoKID.org.uk](http://www.infoKID.org.uk)

### Read more about electrolytes

- **Sodium** helps balance the amount of water in the body. **Hypernatraemia** is too much sodium (“hyper” means too much).
- **Potassium** is needed for muscles, including the heart muscle, to work properly. **Hyperkalaemia** is too much potassium and **hypokalaemia** is too little potassium (“hypo means too little”) – either of these may mean there is a problem with the kidneys.
- **Bicarbonate** balances the amount of acid in our body, or the **pH balance** (also called **acid–base balance**). If there is not enough bicarbonate then the blood is acidic. This is called acidosis.
- **Phosphate** is important for bones, teeth and muscles. **Hyperphosphataemia** is too much phosphate.
- **Calcium** is important for bones and teeth, helps blood to clot, and also helps the muscles, including the heart muscle, to work.

## Keeping bones and teeth strong and healthy

We need vitamin D to help keep our bones and teeth strong and healthy. It is important that everyone – including children – gets vitamin D from sunlight on the skin and from some foods (such as oily fish, eggs and breakfast cereal with added vitamin D). Kidneys help our bodies to use the vitamin D we get from food or sunlight.

Kidneys also help to control what happens to the **nutrients** from the food we eat, including vitamin D and other minerals such as calcium and phosphorus. Because of this, they play a part in helping children grow.

## Controlling the production of red blood cells

**Red blood cells (RBCs)** are in the blood and carry oxygen round the body. They are made in the bone marrow, which is found in the long bones such as the leg bones. Kidneys help control this process by producing a hormone.

**Hormones** are chemicals in the blood that send messages to other parts of the body. When the body does not have enough red blood cells, the kidney releases a hormone called **erythropoietin**.

Erythropoietin is carried into the bone and causes it to produce more red blood cells.

## Other hormones

Other hormones affect how the kidneys work. These hormones control how much water and salt is removed in urine: **antidiuretic hormone (ADH)** and **aldosterone**.

### Read more about ADH and aldosterone

**Antidiuretic hormone (ADH)** controls how much urine the body makes. (A **diuretic** is a substance that makes our kidneys make more urine; an **antidiuretic** is one that makes the kidneys produce less.)

ADH is carried in the blood to the cells in the kidneys. When a lot of ADH is released, the kidneys reabsorb more water. This means there is less water in the urine, and so it is more concentrated.

The amount of ADH varies, depending on blood pressure and the blood volume (amount of blood in the

body). For example, if there is a lot of bleeding, the body makes more ADH so that the kidneys keep more water in the blood. This allows the blood volume to increase.

**Aldosterone** is made in the adrenal gland, which sits on top of the kidney. When aldosterone is released into the blood, it is carried to the kidneys. The kidneys reabsorb more salt and water. They also secrete more of the electrolyte, potassium.

# Your notes and contact information

[www.infoKID.org.uk](http://www.infoKID.org.uk)



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