



# Cambridge (CIE) IGCSE Biology



Your notes

## Excretion in Humans

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# Excretion of carbon dioxide & urea

## What is the excretory system?

- The human excretory system is a group of organs which are specialised for the removal of certain excretory products
  - They include the **lungs and kidneys**
  - The **liver** also has a vital role in excretion

Organ	Mainly Excretes	Explanation
Lungs	Carbon dioxide	The lungs excrete carbon dioxide (the waste product of aerobic respiration) during exhalation
Kidneys	Excess water, salts and urea	The kidneys excrete excess water, salts and urea (produced in the liver from excess amino acids) through the formation of urine

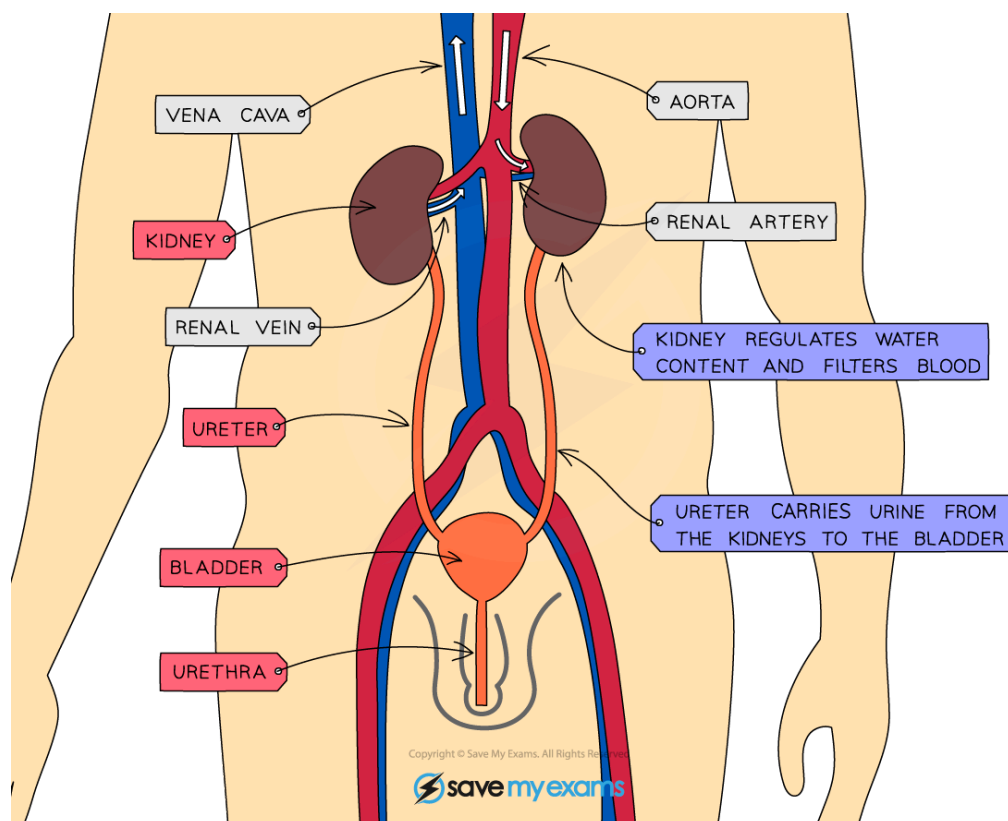
## What is excretion?

- Excretion is the **removal of the waste substances of metabolic reactions (the chemical reactions that take place inside cells), toxic materials and substances in excess of requirements**
- **Carbon dioxide** must be excreted as it dissolves in water easily to form an acidic solution which can **lower the pH of cells**
  - This can **reduce the activity of enzymes** in the body which are essential for controlling the rate of metabolic reactions
  - For this reason, too much carbon dioxide in the body is **toxic**
- **Urea** is also toxic to the body in higher concentrations and so must be excreted

## The excretory system diagram



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### The excretory system in humans

## The main components of the excretory system:

Structure	Explanation
Kidney	Two bean-shaped organs that filter the blood
Ureter	Tube connecting the kidney to the bladder
Bladder	Organ that stores urine (excess water, salts and urea) as it is produced by the kidney
Urethra	Tube that connects the bladder to the exterior; where urine is released



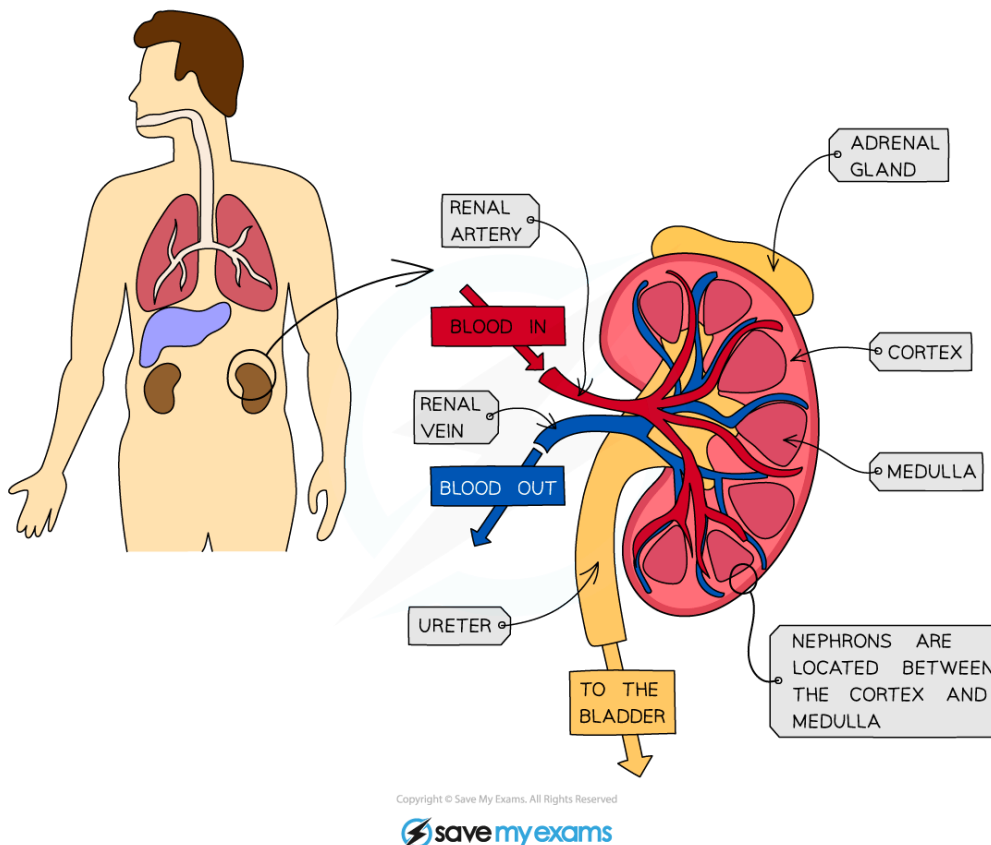
### Examiner Tips and Tricks

Note the difference between the 'ureter' and the 'urethra'. These two names are commonly confused by students so take care to learn them and know which tube is which – they are NOT interchangeable!



# The Kidney & the Nephron: Extended

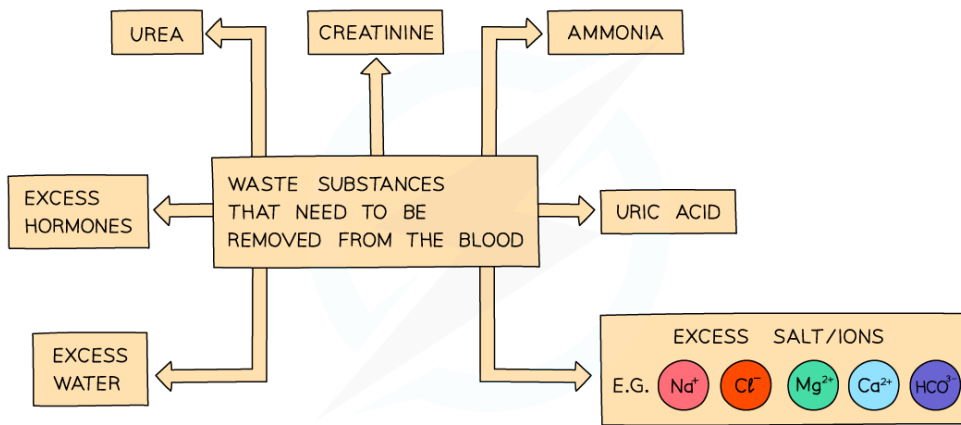
- The kidneys are located in the back of the abdomen and have two important functions in the body:
  - **They regulate the water content of the blood** (vital for maintaining blood pressure)
  - **They excrete the toxic waste products of metabolism** (such as urea) and substances in excess of requirements (such as salts)



*The structure of a human kidney*



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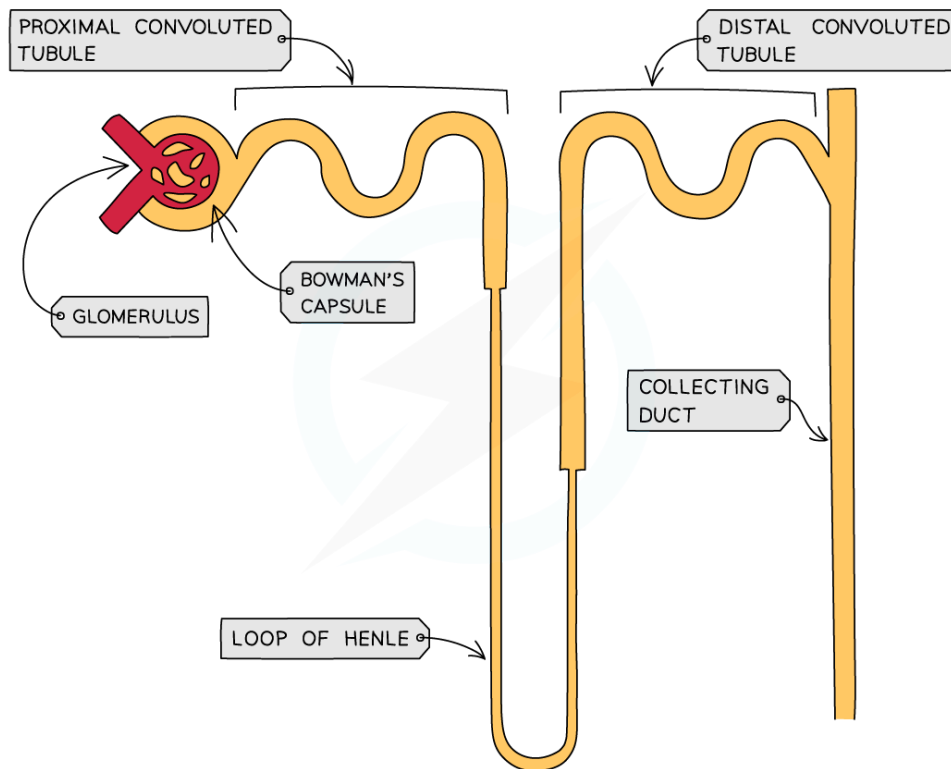
### Waste substances

## The Nephron

- Each kidney contains around a million tiny structures called **nephrons**, also known as **kidney tubules** or **renal tubules**
- The nephrons start in the **cortex** of the kidney, loop down into the **medulla** and back up to the cortex
- The contents of the nephrons drain into the innermost part of the kidney and the **urine collects** there before it flows into the **ureter** to be carried to the **bladder** for storage



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### Structure of a nephron

#### 1) Ultrafiltration



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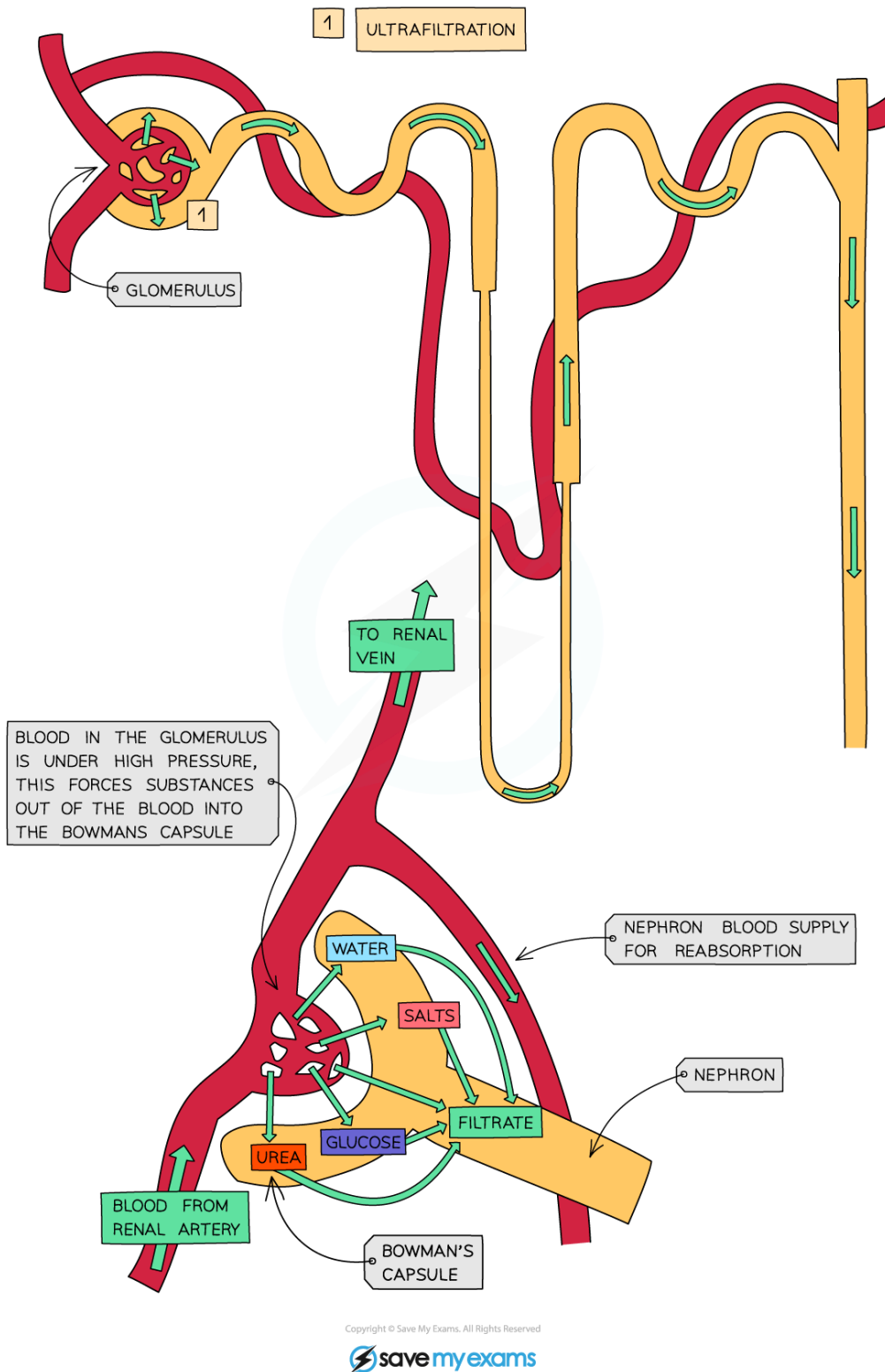


Diagram showing the process of ultrafiltration

- Arterioles branch off the **renal artery** and lead to each nephron, where they form a knot of capillaries (the **glomerulus**) sitting inside the cup-shaped **Bowman's capsule**



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- The capillaries get **narrower** as they get further into the glomerulus which **increases the pressure** on the blood moving through them (which is already at high pressure because it is coming directly from the renal artery which is connected to the **aorta**)
- This eventually causes the smaller molecules being carried in the blood to be **forced out of the capillaries and into the Bowman's capsule**, where they form what is known as the filtrate
- This process is known as **ultrafiltration**
- The substances forced out of the capillaries are: **glucose, water, urea, salts**
- Some of these are useful and will be **reabsorbed back into the blood** further down the nephron

Components of filtrate:

COMPONENT	REABSORBED AT
WATER	LOOP OF HENLE AND COLLECTING DUCT
SALTS	LOOP OF HENLE
GLUCOSE	PROXIMAL (FIRST) CONVOLUTED
UREA	NOT REABSORBED

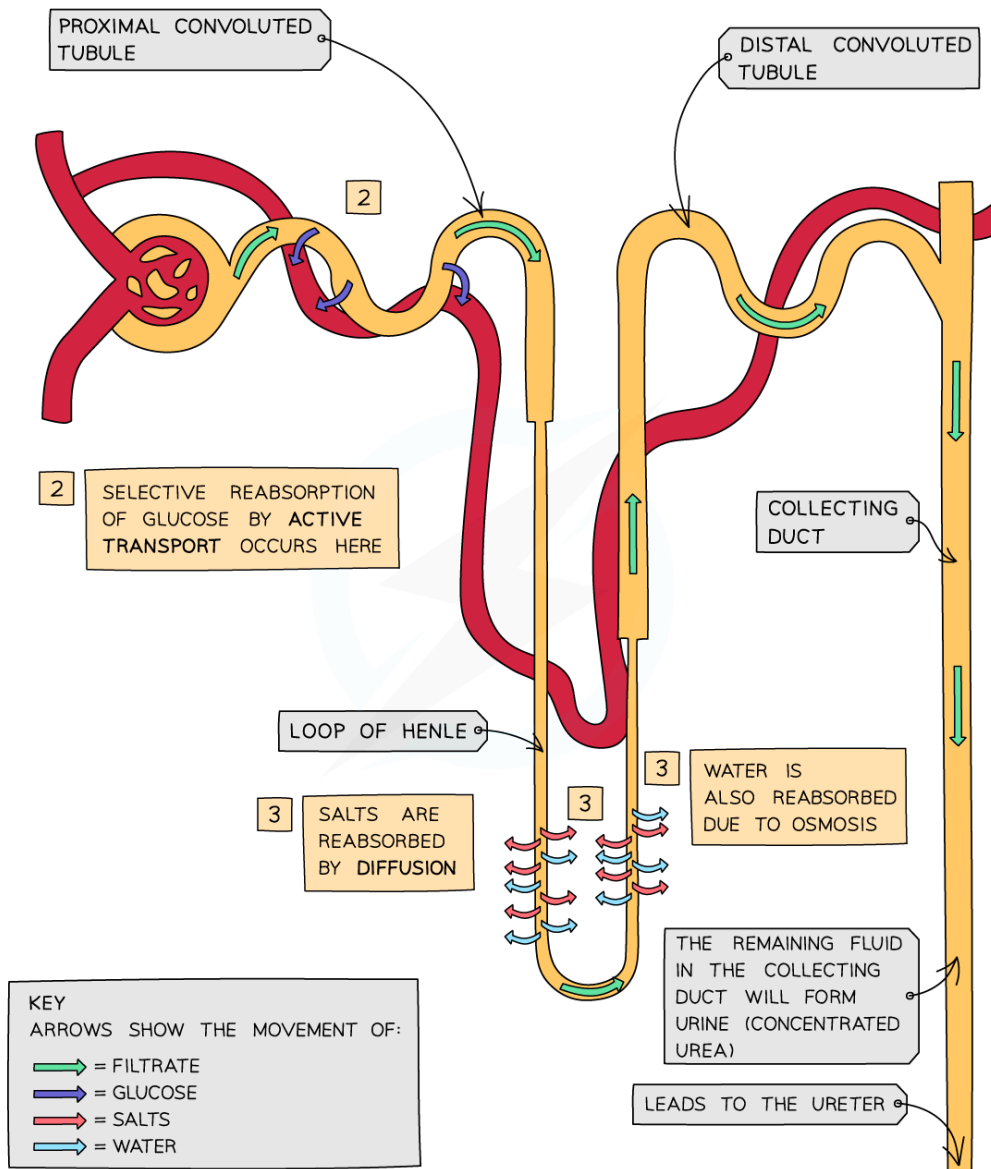
## 2) Selective Reabsorption

### Reabsorption of Glucose





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**Diagram showing the reabsorption of glucose**

- After the glomerular filtrate enters the Bowman's Capsule, **glucose** is the first substance to be reabsorbed at the **proximal (first) convoluted tubule**
- This takes place by **active transport**
- The nephron is adapted for this by having **many mitochondria** to provide energy for the active transport of glucose molecules
- Reabsorption of glucose **cannot take place anywhere else in the nephron** as the gates that facilitate the active transport of glucose are only found in the proximal convoluted tubule



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- In a person with a normal blood glucose level, there are enough gates present to remove all of the glucose from the filtrate back into the blood
- People with **diabetes** cannot control their blood glucose levels and they are often very high, meaning that not all of the glucose filtered out can be reabsorbed into the blood in the proximal convoluted tubule
- As there is nowhere else for the glucose to be reabsorbed, it continues in the filtrate and **ends up in the urine**
- This is why one of the first tests a doctor may do to check if someone is diabetic is to test their urine for the presence of glucose

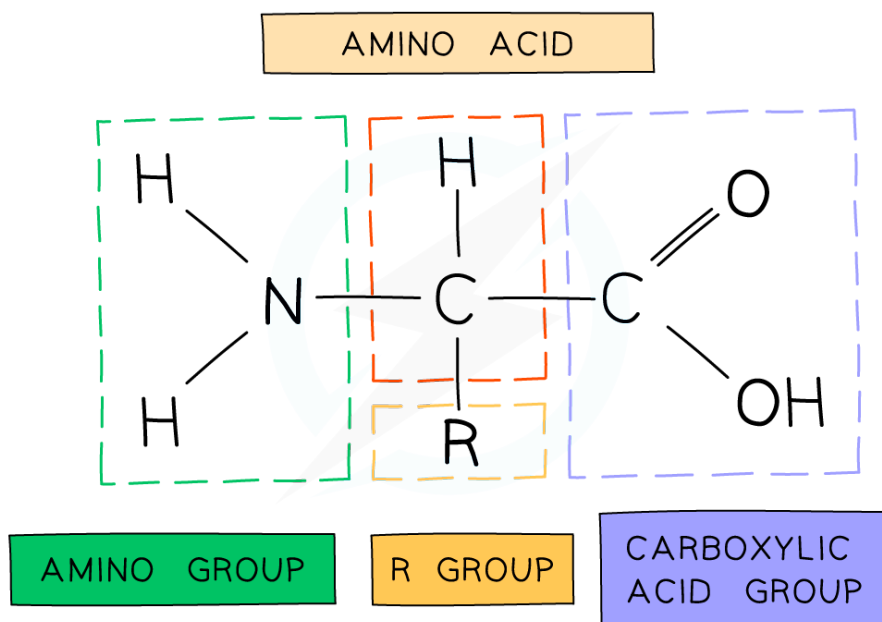
#### Reabsorption of Water & Salts

- As the filtrate drips through the **Loop of Henle** necessary salts are reabsorbed back into the blood by **diffusion** and **active transport**
- As salts are reabsorbed back into the blood, **water** follows by **osmosis**
- Water is also reabsorbed from the collecting duct in different amounts depending on how much water the body needs at that time



# Excretion by Deamination of Amino Acids: Extended

- Many digested food molecules absorbed into the blood in the small intestine are carried to the liver for **assimilation** (when food molecules are converted to other molecules that the body needs)
- These include amino acids, which are used to build proteins such as **fibrinogen**, a protein found in blood plasma that is important in blood clotting
- Excess amino acids** absorbed in the blood that are not needed to make proteins **cannot be stored**, so they are broken down in a process called **deamination**
  - The amino group of all amino acids -  $\text{NH}_2$  (which contains the nitrogen atoms) is removed, hence the term de-**amin(o)**-ation
- Enzymes in the liver split up the amino acid molecules
- The part of the molecule which contains **carbon** is turned into **glycogen** and stored
- The other part, which contains **nitrogen**, is turned into **ammonia**, which is highly toxic, and so is immediately converted into **urea**, which is less toxic
- The urea dissolves in the blood and is taken to the **kidney** to be excreted
- A small amount is also excreted in **sweat**



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### Amino acid groups

- In deamination, the nitrogen-containing amino group is removed and converted into ammonia and then urea to be excreted
- The toxic consequences of high urea levels, if it is not excreted effectively, are very serious:
  - Cell death
  - Reduced response to insulin, leading to diabetes
  - Deposits inside blood vessels



### Examiner Tips and Tricks

Excretion and egestion are two terms that often get confused:

Excretion is the **removal from the body of waste products** of metabolic reactions, toxic substances and substances in excess of requirements.

Egestion is the **expulsion of undigested food waste** from the anus.



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