

Exercise walk-through

# 13.1.1

## The urinary system, the kidney in section, and why urea cannot stay

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IGCSE Biology

## You must be able to

- state that carbon dioxide is excreted through the lungs
- state that the kidneys excrete **urea** 尿素 and excess water and ions
- identify in diagrams and images the **kidneys**, **ureters**, **bladder** and **urethra**
- identify in diagrams and images the structure of the kidney, limited to the **cortex** 皮质 and
- outline the structure and function of a **nephron** 肾单位 and its blood vessels: the role of
- describe the role of the **liver** in the **assimilation** 同化 of amino acids by converting
- state that urea is formed in the liver from excess amino acids

## You must be able to

- describe **deamination** 脱氨基作用 as the removal of the nitrogen-containing part of amino
- explain the importance of excretion, limited to the **toxicity** of urea

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The method

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## Method — The organs, and the order urine passes through them

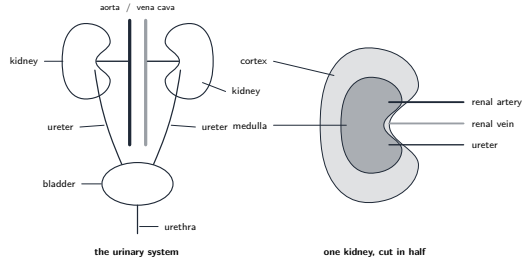
| structure                            | what it does                                       |
|--------------------------------------|----------------------------------------------------|
| <b>kidney</b> (one on each side)     | makes urine, by filtering the blood                |
| <b>ureter</b> (one from each kidney) | carries urine from the kidney down to the bladder  |
| <b>bladder</b>                       | stores urine                                       |
| <b>urethra</b>                       | carries urine from the bladder to outside the body |

## Method — The organs, and the order urine passes through them

△ **Ureter and urethra are different organs** and the examiner will not accept one for the other. There are **two ureters** – one per kidney – and **one urethra**. Cut a kidney in half and two regions are visible: the **cortex** on the outside and the **medulla** inside it. Three tubes meet at the notch: the **renal artery** brings blood in, the **renal vein** takes it away, and the **ureter** carries the urine out.

## Method — The organs, and the order urine passes through them

center  $\triangle$  Ureter and urethra are different organs and the examiner will not accept one for the other.



Learn the **order**, because that is what an "identify the labelled structure" question tests: blood in by the **renal artery**, filtered in the **cortex**, urine collected through the **medulla**, out by the **ureter** to the **bladder**, and finally through the **urethra**. Clean blood leaves by the **renal vein** – the only one of these that carries no urine.

*The urinary system labelled, and one kidney cut in half showing cortex and medulla*

## Method — Excretion is not just the kidneys

- The **lungs** excrete **carbon dioxide**, the waste product of respiration.
- The **kidneys** excrete **urea**, together with **excess water** and **excess ions**.

△ “Excess” is doing work in that sentence. Water and ions are not waste – the body needs both. Only the **surplus** is removed, which is why the amount in urine changes from day to day, while urea is removed whatever the amount.

## Method — Where urea comes from: the liver, not the kidney

The kidney **removes** urea; it does not make it. The chain is:

- 1 Protein in food is digested to **amino acids**, which are absorbed into the blood.
- 2 In the **liver**, the amino acids the body needs are built into the body's own proteins. That is **assimilation**.
- 3 The body **cannot store** the surplus amino acids, so in the liver they undergo **deamination** – the **removal of the nitrogen-containing part** of the amino acid. The rest of the molecule can be respired or stored.
- 4 That nitrogen-containing part forms **urea**, which travels in the blood to the kidneys.

**Why it must then be excreted: urea is toxic.** If it were allowed to build up in the blood it would poison the body's cells and damage tissues, so it must be removed continuously.

## Method — What the nephron does, in two steps

- **Filtration at the glomerulus.** Blood at high pressure in the glomerulus is filtered, and **water, glucose, urea and ions** pass out into the nephron. Blood cells and proteins are too large and stay in the blood.
- **Selective reabsorption along the rest of the nephron.** **All** of the glucose, **some** of the ions and **most** of the water are taken back into the blood.
- What is left – **urea, excess water and excess ions** – is the **urine**.

△ Learn the three quantity words exactly: *all* the glucose, *some* of the ions, *most* of the water. A healthy person has **no glucose** in their urine, which is precisely why glucose in urine is a sign of diabetes.

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Practice

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## Practice 2.1 ■ 2 marks

Name the structure that carries urine from a kidney to the bladder, and the structure that carries urine from the bladder to outside the body.

## Solution 2.1

Method: The organs, and the order urine passes through them — p.5

### Worked steps

- the **ureter** carries urine from the kidney to the bladder **B1**
- the **urethra** carries urine from the bladder to outside the body **B1**

## Practice 2.2 ■ 2 marks

Name the **two** regions that can be seen when a kidney is cut in half, and state which of them is on the outside.

## Solution 2.2

Method: The organs, and the order urine passes through them — p.5

### Worked steps

- the **cortex** and the **medulla** B1
- the **cortex** is on the outside B1

## Practice 2.3 ■ 2 marks

State the organ in which urea is made, and the substance it is made from.

## Solution 2.3

### Worked steps

- urea is made in the **liver** (B1)
- from **excess amino acids** (B1)

## Practice 2.4 ■ 2 marks

Describe what is meant by **deamination**.

## Solution 2.4

### Worked steps

- deamination is the **removal of the nitrogen-containing part** of an amino acid **B1**
- which forms **urea**; the rest of the molecule can be respired or stored **B1**

## Practice 2.5 ■ 2 marks

Explain why urea must be excreted from the body.

## Solution 2.5

Method: Where urea comes from: the liver, not the kidney — p.9

### Worked steps

- urea is **toxic** (B1)
- so if it built up in the blood it would poison and damage the body's cells; it must therefore be removed continuously (B1)

## Practice 2.6 ■ 2 marks

Describe the role of the liver in the **assimilation** of amino acids.

## Solution 2.6

Method: Where urea comes from: the liver, not the kidney — p.9

### Worked steps

- the liver takes the **amino acids** absorbed from digested protein **B1**
- and **converts them into the body's own proteins** – this is assimilation **B1**

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Exam-style

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## Exam-style 3.1 ■ 1 mark

Which substance is excreted through the lungs?

- A** urea
- B** excess water
- C** carbon dioxide
- D** excess ions

## Solution 3.1

- A urea
- B excess water
- C carbon dioxide 
- D excess ions

### Worked steps

C

- carbon dioxide, the waste product of respiration, is excreted through the lungs **B1**
- urea, excess water and excess ions (**A, B, D**) are all excreted by the **kidneys**

## Exam-style 3.2 ■ 7 marks

A student is shown a diagram of the human urinary system.

## Exam-style 3.2 (a) ■ 2 marks

Name, **in order**, the structures through which urine passes from the organ that makes it to outside the body.

## Solution 3.2 (a)

Method: The organs, and the order urine passes through them — p.5

### Worked steps

- **kidney** → **ureter** → **bladder** (B1)
- → **urethra** → out of the body (B1)
- $\triangle$  no mark if ureter and urethra are swapped

## Exam-style 3.2 (b) ■ 3 marks

The student is then shown a kidney cut in half. Name the two regions visible, and state which is nearer the outside of the organ.

## Solution 3.2 (b)

### Worked steps

- the **cortex** (B1)
- and the **medulla** (B1)
- the **cortex** is nearer the outside (B1)

## Exam-style 3.2 (c) ■ 2 marks

Name the blood vessel that carries blood **into** the kidney and the one that carries blood **away** from it, and state which of the two contains less urea.

## Solution 3.2 (c)

### Worked steps

- blood enters by the **renal artery** and leaves by the **renal vein** (B1)
- the **renal vein** contains less urea, because urea has been removed from the blood inside the kidney (B1)

## Exam-style 3.3 ■ 10 marks

A person eats a meal containing far more protein than their body needs.

## Exam-style 3.3 (a) ■ 3 marks

Describe what happens to the excess amino acids, naming the organ involved and the process.

## Solution 3.3 (a)

Method: Where urea comes from: the liver, not the kidney — p.9

### Worked steps

- the excess amino acids cannot be stored, so they are broken down in the **liver**  
B1
- by **deamination** – the nitrogen-containing part of each amino acid is removed  
B1
- forming **urea**, which is carried in the blood to the kidneys B1

## Exam-style 3.3 (b) ■ 2 marks

Explain why the product of that process must then be excreted.

## Solution 3.3 (b)

### Worked steps

- urea is **toxic** (B1)
- so allowing it to accumulate in the blood would damage or poison the body's cells (B1)

## Exam-style 3.3 (c) ■ 4 marks

Describe the roles of the **glomerulus** and of the rest of the **nephron** in producing urine.

## Solution 3.3 (c)

### Worked steps

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- at the **glomerulus**, blood is at high pressure and is **filtered** (B1)
- so water, glucose, urea and ions pass into the nephron, while blood cells and proteins are too large and remain in the blood (B1)
- along the rest of the nephron, **selective reabsorption** returns **all** the glucose, **some** of the ions and **most** of the water to the blood (B1)
- what remains – urea, excess water and excess ions – forms the **urine** (B1)

## Exam-style 3.3 (d) ■ 1 mark

Name **one** substance that is filtered out at the glomerulus but is then completely reabsorbed.

## Solution 3.3 (d)

### Worked steps

- **glucose** B1