IGCSE BIOLOGY • EXERCISE SHEET

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

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

KEY WORDS urea 尿素 • ions 离子 • amino acids 氨基酸 • glucose 葡萄糖 • nephron 肾单位

Objective

Sheet 13.1 covers the nephron and then moves on to homeostasis. This sheet takes the two statements it leaves out, and they are the ones a paper actually opens with: **identifying the organs of the urinary system and the regions of the kidney in a diagram**, and **explaining why excretion matters at all** – which comes down to where urea is made and how poisonous it is. This sheet covers syllabus 13.1.

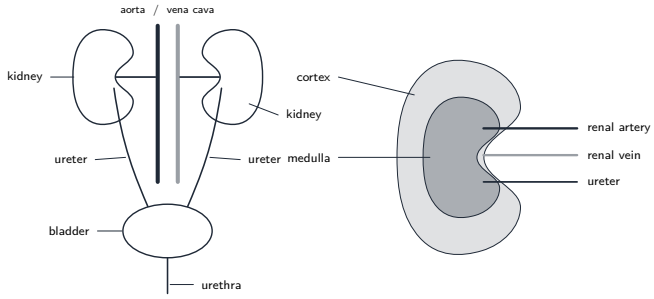
You must be able to:

- 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 **medulla** 髓质
- outline the structure and function of a **nephron** 肾单位 and its blood vessels: the role of the **glomerulus** 肾小球 in filtration, the reabsorption of all the glucose, some ions and most of the water, and the formation of urine
- describe the role of the **liver** in the **assimilation** 同化 of amino acids by converting them to proteins
- state that urea is formed in the liver from excess amino acids
- describe **deamination** 脱氨基作用 as the removal of the nitrogen-containing part of amino acids to form urea
- explain the importance of excretion, limited to the **toxicity** of urea

1 Worked examples

Study these first. Each one shows a **method** that a question later on this sheet needs.

■ The organs, and the order urine passes through them



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.

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

△ **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.

■ 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.

■ 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.

■ **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.

2 Practice

Now use the methods above.

2.1 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. [2]

2.2 Name the **two** regions that can be seen when a kidney is cut in half, and state which of them is on the outside. [2]

2.3 State the organ in which urea is made, and the substance it is made from. [2]

2.4 Describe what is meant by **deamination**. [2]

2.5 Explain why urea must be excreted from the body. [2]

2.6 Describe the role of the liver in the **assimilation** of amino acids. [2]

3 Exam-style questions

3.1 Which substance is excreted through the lungs? [1]

A	B
C	D

A urea
B excess water
C carbon dioxide
D excess ions

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

(a) Name, **in order**, the structures through which urine passes from the organ that makes it to outside the body. [2]

(b) 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. [3]

(c) 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. [2]

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

(a) Describe what happens to the excess amino acids, naming the organ involved and the process. [3]

(b) Explain why the product of that process must then be excreted. [2]

(c) Describe the roles of the **glomerulus** and of the rest of the **nephron** in producing urine. [4]

(d) Name **one** substance that is filtered out at the glomerulus but is then completely reabsorbed. [1]

Solutions

Each answer shows the steps, then the **result**.

2.1

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

2.2

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

2.3

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

2.4

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

2.5

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

2.6

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

3.1 C

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

3.2

(a)

- **kidney** → **ureter** → **bladder**
- → **urethra** → out of the body
- △ no mark if ureter and urethra are swapped

(b)

- the **cortex**
- and the **medulla**
- the **cortex** is nearer the outside

(c)

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

3.3

(a)

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

(b)

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

(c)

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

(d)

- **glucose**