2.6 Excretion and coordination

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

Objective

Build the skills to answer exam questions on **excretion and coordination** : the kidney and the nephron, water balance and ADH, homeostasis and temperature control, the nervous system and reflexes, the eye, and plant tropisms.

You must be able to:

- describe how the nephron filters blood and makes urine
- explain how water balance and body temperature are controlled
- describe the path of a reflex arc
- use data on water balance in a calculation

1 Key knowledge and worked examples

Excretion and control

idea	rule
excretion	lungs remove carbon dioxide; kidneys remove urea and excess water; skin loses some water and salts in sweat
kidney	about a million nephrons filter the blood and make urine from urea, excess water and salts
homeostasis	keeping internal conditions (temperature, water, glucose) nearly constant
negative feedback	a change is detected and a response reverses it
nerves and hormones	nerves: electrical impulses, fast, short-lived; hormones: chemicals in the blood, slower, longer-lasting
percentage change	(new − old) ÷ old ×100

Worked example 1: percentage change. Heart rate rises from 60 to 90 beats per minute. Find the percentage change.

1. Known: old 60; new 90.
2. Rule: change ÷ old ×100.
3. Numbers: $30 \div 60 \times 100$.
4. Result: +50%.

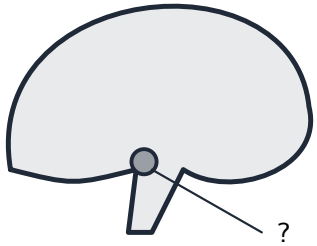
Worked example 2: water balance. A person takes in 2.5 dm^3 of water a day and loses 1.4 dm^3 in urine, 0.5 in sweat and 0.4 in breath. Find the balance.

1. Known: in 2.5; out $1.4 + 0.5 + 0.4$.
2. Rule: balance = in − out.
3. Numbers: $2.5 - 2.3$.
4. Result: +0.2 **dm^3** (a gain).

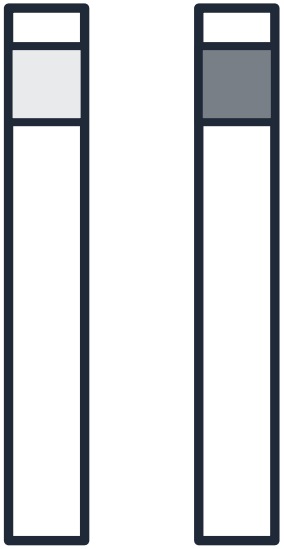
Answer shapes: for control, give the receptor, the coordinator and the effector, then how the response reverses the change.

2 Practice

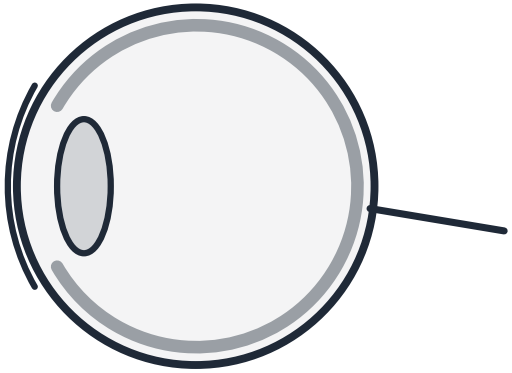
2.1 Name the hormone that controls the water content of the blood, and the gland that releases it. [2]



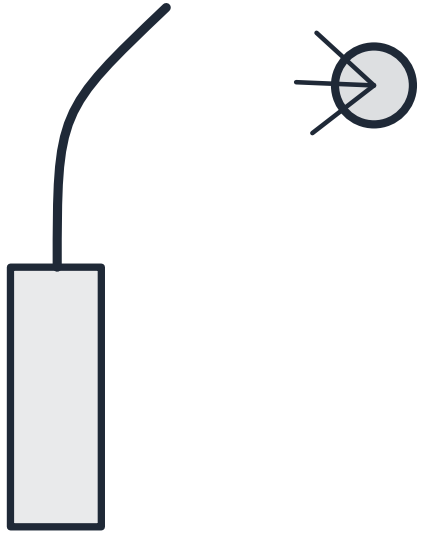
2.2 Explain why glucose is found in the urine of a person with untreated diabetes, but not in a healthy person. [2]



2.3 State the function of the iris and of the retina. [2]

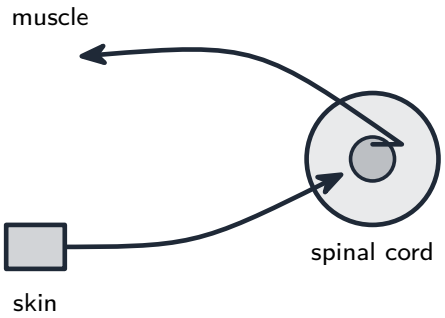


2.4 Explain why a plant shoot grows towards light. [2]

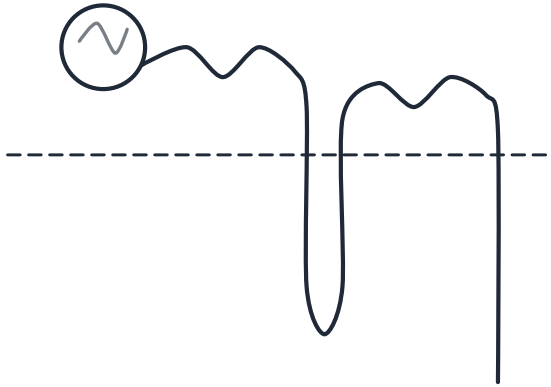


3 Exam-style questions

3.1 A hand touches a hot plate and pulls away. Describe the path of the nerve impulse in this reflex arc. [3]



3.2 Describe how the nephron filters the blood and makes urine. [3]



3.3 An athlete records her water intake and loss on a normal day and on the day of a long race in hot weather. The results are shown.



water / dm^3 per day	normal day	race day
drunk and in food	2.0	3.0
urine	1.5	0.6
sweat	0.5	2.3
breath	0.3	0.4

(a) Calculate the percentage decrease in urine volume on race day. [3]

(b) Explain how ADH causes less urine to be made on race day. [4]

(c) Calculate the athlete's water balance on race day, and explain what this means for her body. [3]

(d) Explain how her body stops her temperature rising too far during the race. [6]

Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

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

2.1

- ADH (antidiuretic hormone)
- the pituitary gland

2.2

- in a healthy person all the filtered glucose is reabsorbed in the first coiled tubule
- in diabetes the blood glucose is so high that not all of it can be reabsorbed

2.3

- iris: controls how much light enters the eye (the size of the pupil)
- retina: contains receptor cells (rods and cones) that detect light

2.4

- auxin collects on the shaded side of the shoot
- cells on the shaded side elongate more, so the shoot bends towards the light (positive phototropism)

3.1

- a receptor in the skin detects heat and starts an impulse in a sensory neurone
- the impulse passes to a relay neurone in the spinal cord
- then along a motor neurone to the effector, a muscle that contracts

3.2

- high pressure in the glomerulus forces small molecules (water, glucose, urea, salts) into the Bowman's capsule: ultrafiltration
- all the glucose is reabsorbed into the blood in the first coiled tubule: selective reabsorption
- water is reabsorbed in the loop and collecting duct; what is left (urea, excess water and salts) is urine

3.3

(a) decrease $1.5 - 0.6 = 0.9$ dm^3; $0.9 \div 1.5 \times 100 = \mathbf{60}\%$

(b) sweating lowers the water content of the blood; the hypothalamus detects this, and the pituitary releases more ADH; ADH makes the collecting ducts more permeable to water; more water is reabsorbed into the blood, so a small volume of concentrated urine is made

(c) out: $0.6 + 2.3 + 0.4 = 3.3$ dm^3; balance $3.0 - 3.3 = \mathbf{-0.3}$ dm^3; she is losing more water than she takes in, so she becomes dehydrated unless she drinks more

(d) points to include:

- the hypothalamus detects the rise in blood temperature (K)
- sweat glands release more sweat; water evaporates from the skin, taking heat energy away (K)
- arterioles near the skin surface widen (vasodilation) (K)
- more blood flows near the surface, so more heat is lost by radiation (An)
- hairs lie flat, so less air is trapped as insulation (K)
- this is negative feedback: the response brings the temperature back towards 37 °C (An)

Levels: **5–6** a full, logical answer with correct biology and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.