Unit 20 · Excretory System

ANSWER KEY · FOR TEACHERS

Full marks 32

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. uricotelic
2. retroperitoneal
3. hilum
4. podocytes
5. glomerular filtration rate
6. obligatory
7. trigone
8. detrusor

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. Malpighian body
2. proximal convoluted tubule
3. descending limb
4. loop of Henle
5. ascending limb
6. distal convoluted tubule

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **b.** it lies behind the peritoneum, against the back wall of the abdomen — K · 1

Retro- means behind: the kidneys sit **behind** the peritoneal cavity, with the peritoneum covering only their front.

ii. **a.** collecting duct → duct of Bellini → calyx → renal pelvis → ureter — K · 1

Collecting ducts join into the wider **ducts of Bellini**, which open at the papilla of a pyramid into a **calyx**; the calyces drain into the **renal pelvis**, which leads into the **ureter**.

iii. **b.** the adult spends time on land, where water can't be spared to wash ammonia away — U · 1

In water the tadpole loses ammonia freely across its gills and skin. The adult lives partly on land, where it must save water, so its liver turns ammonia into the less toxic urea, which can be held in the body and passed out in less water.

iv. **c.** antidiuretic hormone (ADH) — A · 1

Short of water, the pituitary releases **ADH**, which makes the late DCT and the collecting ducts let water out into the salty medulla. More water returns to the blood, and the little urine left is concentrated, so its pigment looks darker.

v. **b.** many juxtamedullary nephrons, with long loops reaching deep into a thick medulla — A · 1

Concentrated urine is made by the **long loops** of **juxtamedullary** nephrons, which build up a very salty medulla that draws water out of the collecting ducts. The longer the loops, the saltier the medulla can get, and desert mammals have very long ones.

4 Short answers

a. MARKING SCHEME — K · 2

✓ Renal capsule innermost, then the adipose capsule.

✓ Renal fascia outermost.

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b. MARKING SCHEME U · 2

✓ More blood enters than can easily leave, so the glomerular pressure stays high.
✓ The high pressure drives ultrafiltration.

c. MARKING SCHEME A · 2

✓ In health all filtered glucose is reabsorbed in the PCT.
✓ Glucose in urine: blood glucose too high to reabsorb, a sign of diabetes mellitus.

d. ANSWER U · 3

Any three:

Cortical nephron	Juxtamedullary nephron
Malpighian body in the outer cortex	Malpighian body in the cortex next to the medulla
about 80–85% of nephrons	about 15–20%
short loop of Henle, barely in the medulla	long loop reaching deep into the medulla
no vasa recta	vasa recta present
adjusts plasma volume with normal water intake	makes concentrated urine when water is short

MARKING SCHEME

✓ A first correct difference.
✓ A second correct difference.
✓ A third correct difference.

5 Numerical problem

ANSWER A · 4

- Net filtration pressure = 60 − (32 + 18) = **10 mmHg**.
- Filtrate a day = 125 ml × 60 × 24 = 180 000 ml = **180 L**.
- Reabsorbed = 180 − 1.8 = **178.2 L**.
- 178.2 ÷ 180 × 100 = **99%**.

MARKING SCHEME

✓ NFP = 60 − (32 + 18) = 10 mmHg.
✓ 180 L of filtrate a day.
✓ 178.2 L reabsorbed.
✓ 99% reabsorbed.

6 Long answer

ANSWER U · 4

- **PCT:** about 65–70% of the filtrate is taken back: all the **glucose and amino acids**, vitamins and HCO_3^- and about 65% of the Na^+ **actively**; water by osmosis (**obligatory**); K^+, Cl^- and about half the urea by diffusion. The filtrate stays isotonic.
- **Loop of Henle:** water leaves the **descending limb** into the salty medulla (filtrate becomes hypertonic); Na^+, K^+ and Cl^- leave the waterproof **ascending limb**, actively in its thick part (filtrate hypotonic, medulla salty: counter-current multiplier).
- **DCT:** Na^+ under **aldosterone**, Ca^{2+} under **parathormone**, water under **ADH** (facultative).
- **Collecting duct:** more water under **ADH** into the salty medulla, making concentrated urine; Na^+ under aldosterone; some urea.

MARKING SCHEME

✓ PCT: glucose, amino acids, Na^+ actively, obligatory water, about two-thirds of the filtrate.
✓ Loop of Henle: water out of the descending limb, salts out of the waterproof ascending limb.
✓ DCT: Na^+ with aldosterone, Ca^{2+} with parathormone, water with ADH.
✓ Collecting duct: water with ADH (concentrated urine), Na^+ with aldosterone.

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7 Think

ANSWER HA · 3

Losing so much fluid lowers the blood volume, so the **glomerular blood pressure falls**.
The lost water also leaves the plasma proteins more concentrated, so the **colloid osmotic pressure rises**; the capsular pressure stays about the same.
The net filtration pressure, glomerular pressure − (osmotic + capsular), drops to about **zero or below**, so **filtration nearly stops** and little urine forms.

MARKING SCHEME

- ✓ The glomerular blood pressure falls with the lost fluid.
- ✓ The plasma proteins' osmotic pressure rises as the blood concentrates.
- ✓ The net filtration pressure falls to about zero, so filtration and urine nearly stop.

8 Activity: The color of your urine

(not marked)

WHAT STUDENTS SHOULD FIND

Darker and less in the morning and on a hot afternoon; pale and plentiful after drinking a lot. The pigment **urochrome** is the same, but it is diluted in more water. When the body is short of water the pituitary releases **ADH**, which makes the **late DCT and collecting ducts** let water back into the blood; after a lot of water, little ADH is released and dilute urine is passed.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	10	8	3	**32**

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