The Kidneys

A Level

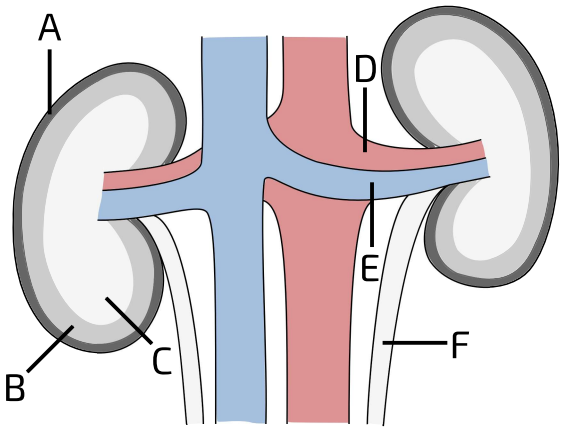

Figure 1: Diagram of the mammalian kidneys (and associated blood vessels). Blood vessels are colour-coded by oxygen concentration (blue = low, red = high).

Part A Label the kidneys

Match the letter in **Figure 1** to the structure in the table below.

Letter	Structure
A	
B	
C	
D	
E	
F	

Items:

pulmonary vein | renal medulla | urethra | renal vein | renal capsule | renal cortex | pulmonary artery | ureter | renal artery

Part B Nephrons

Match the letter in **Figure 1** to the nephron regions that are primarily located there.

Letter	Nephron region
	Glomerulus
	Bowman's capsule
	Collecting duct

Items:

A B C D E F

Part C Name the organ

Name the organ to which structure **F** in **Figure 1** transports urine.

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Nephrons

A Level

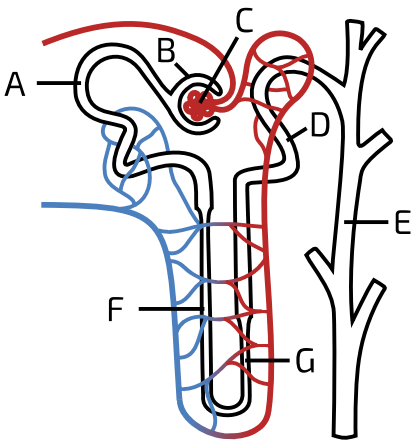

Figure 1: Diagram of an individual nephron (and associated blood vessels). Arterioles are shown in red and venules are shown in blue.

Part A Label the nephron

Match the letter in **Figure 1** to the structure in the table below.

Letter	Structure
A	
B	
C	
D	
E	
F	
G	

Items:

collecting duct | proximal convoluted tubule | distal convoluted tubule | glomerulus | loop of Henle: descending limb | Bowman's capsule | loop of Henle: ascending limb

Part B Glucose reabsorption

Identify the region(s) in **Figure 1** where glucose is selectively reabsorbed into the blood capillaries.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G

Part C Cortex regions

Identify the region(s) in **Figure 1** present in the renal cortex.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G

Part D Podocytes

Identify the region(s) in **Figure 1** where podocytes are located.

- [ ] A
- [ ] B
- [ ] C
- [ ] D
- [ ] E
- [ ] F
- [ ] G

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STEM SMART Biology Week 41

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Antidiuretic Hormone (ADH)

A Level

Antidiuretic hormone (ADH), also called vasopressin or arginine vasopressin (AVP), is a small peptide hormone composed of just nine amino acids. It plays an important role in osmoregulation.

Part A ADH release

From where is ADH released into the bloodstream?

Part B Osmoregulation

Drag the steps below into the correct order on the right to show the response of an organism to a **decrease** in blood water potential (i.e. an increase in osmolarity).

Note that not all of the items below are part of the correct sequence of events, and so you should not use all of the items below.

Available items

- osmoreceptors in the hypothalamus detect a decrease in blood water potential
- ADH is released into the bloodstream
- a large volume of dilute urine is produced
- ADH binds to membrane receptors of cells lining the collecting ducts
- less water is reabsorbed from the collecting ducts into the bloodstream
- more water is reabsorbed from the collecting ducts into the bloodstream
- a small volume of concentrated urine is produced
- vesicles (which contain aquaporins) inside the cells lining the collecting ducts fuse with the cell membranes, increasing the number of aquaporins in these cell membranes
- ADH passes through the membranes of cells lining the collecting ducts and binds to receptors inside the cells

Part C Back to normal

Once water potential reaches normal levels again, osmoreceptors detect this and stop the release of ADH into the bloodstream.

What is the name given to this kind of mechanism?

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Human Water Loss

A Level

The table shows the sources of water lost in one particular day from a healthy human.

Percentage of the water that is lost	Source
16	exhaled air
4	faeces
20	sweat
60	urine

On another day, the percentage of water lost in urine decreased by a sixth.

The percentage of water lost in exhaled air and in faeces remained the same.

The total volume of water lost was $2500\,\mathrm{cm}^3$ on both days.

Part A Increase in sweat

Calculate the percentage increase in the volume of sweat produced.

Part B Decrease in urine

What is the reason for the decrease in the volume of urine?

- An increase in ADH
- A decrease in ADH
- An increase in insulin
- A decrease in insulin

Adapted with permission from NSAA 2020 Section 2 Q47

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Urine Changes

A Level

On a cool spring day (day 1), a healthy human produces $1500\,\mathrm{cm}^3$ of urine. The concentration of urea in the urine was measured as $2.00\,\mathrm{g}$ per $100\,\mathrm{cm}^3$.

On a similar day (day 2), the same person plays a game of hockey and produces 20% less urine. However, the mass of urea excreted in the urine remains the same.

The volume of urine produced is affected by the movement of water in the nephron.

Part A Urea concentration

Calculate the urea concentration in the urine, in $\mathrm{g\,dm}^{-3}$, on day 1.

Calculate the urea concentration in the urine, in $\mathrm{g\,dm}^{-3}$, on day 2.

Part B Change in urine volume

The volume of urine produced in day 2 was less than day 1 because of [ ] in production of the hormone [ ], which caused [ ] in the reabsorption of water in the [ ] of the kidneys.

Items:

insulin **nephrons** **a decrease** **glomeruli** **an increase** **ADH**

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Sodium Ion Reabsorption

A Level

Samples of solution removed from different positions inside a nephron are analysed.

The rate of flow of the solution through the nephron is measured at each position where the samples are taken.

The rate of flow is the volume of solution passing a particular point per unit time.

In the Bowman's capsule, the concentration of sodium ions is the same as in the blood. The rate of flow is 100 arbitrary units.

At the collecting duct, the concentration of sodium ions is twice that in the blood. The rate of flow is 1 arbitrary unit.

Calculate the percentage of sodium ions reabsorbed in the nephron.

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