

Edexcel (B) Biology A-level

9.9 - Osmoregulation and temperature regulation

Flashcards

This work by [PMT Education](https://www.pmt.education) is licensed under [CC BY-NC-ND 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)



Describe the gross structure of the mammalian urinary system.



Describe the gross structure of the mammalian urinary system.

A: kidney

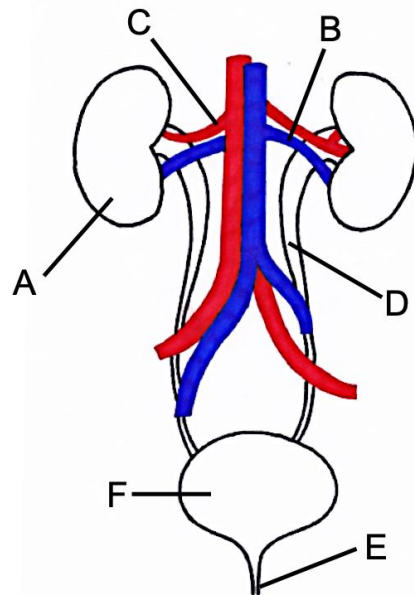
D: ureter

B: renal vein

E: urethra

C: renal artery

F: bladder



Describe the gross structure of a mammalian kidney.



Describe the gross structure of a mammalian kidney.

Fibrous capsule: protects kidney.

Cortex: outer region consists of Bowman's capsules, convoluted tubules, blood vessels.

Medulla: inner region consists of collecting ducts, loops of Henle, blood vessels.



Describe the structure of a nephron.



Describe the structure of a nephron.

A: glomerulus

B: Bowman's capsule

C: proximal convoluted tubule

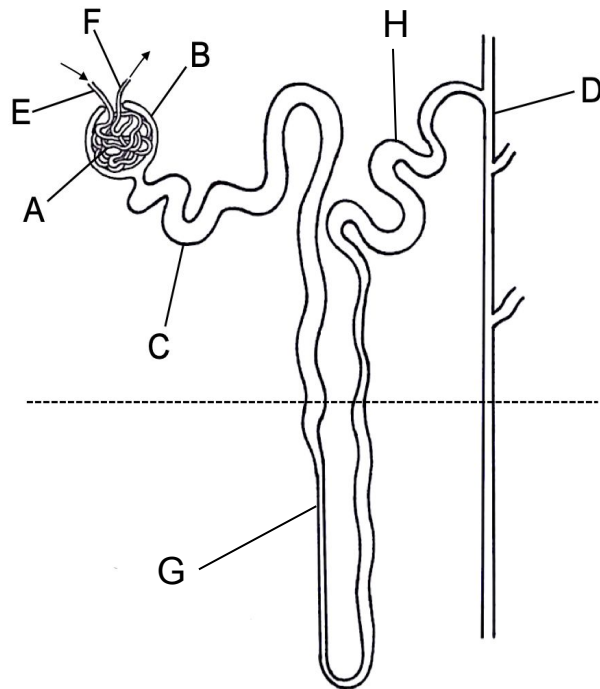
D: collecting duct

E: afferent arteriole

F: efferent arteriole

G: loop of Henle

H: distal convoluted tubule



Describe the blood vessels associated with a nephron.



Describe the blood vessels associated with a nephron.

Wide afferent arteriole from **renal artery** enters renal capsule & forms **glomerulus**: branched knot of capillaries which combine to form **narrow efferent arteriole**.

Efferent arteriole branches to form **capillary network** that surrounds tubules.



Describe the sections of a nephron.



Describe the sections of a nephron.

Bowman's capsule at start of nephron: cup-shaped, surrounds glomerulus, inner layer of podocytes.

Proximal convoluted tubule (PCT): series of loops surrounded by capillaries, walls made of epithelial cells with microvilli.

Loop of Henle: hairpin loop extends from cortex into medulla.

distal convoluted tubule : similar to PCT but fewer capillaries.

collecting duct: DCT from several nephrons empty into collecting duct, which leads into pelvis of kidney.



How is urea produced?



How is urea produced?

1. Hepatocytes deaminate excess amino acids to form ammonia.
2. Ornithine cycle in liver cells converts ammonia to urea, which is less toxic.



How is urea removed from the bloodstream?



How is urea removed from the bloodstream?

Ultrafiltration in Bowman's capsule.

High **hydrostatic pressure in glomerulus** forces small molecules (urea, water, glucose, mineral ions) out of capillary fenestrations **AGAINST** osmotic gradient.

Basement membrane acts as filter. Blood cells & large molecules e.g. proteins remain in capillary.



How are cells of the Bowman's capsule adapted for ultrafiltration?



How are cells of the Bowman's capsule adapted for ultrafiltration?

- Fenestrations between epithelial cells of capillaries.
- Fluid can pass between & under folded membrane of podocytes.



State what happens during selective reabsorption and where it occurs.



State what happens during selective reabsorption and where it occurs.

Useful molecules from glomerular filtrate e.g. glucose are reabsorbed into the blood.

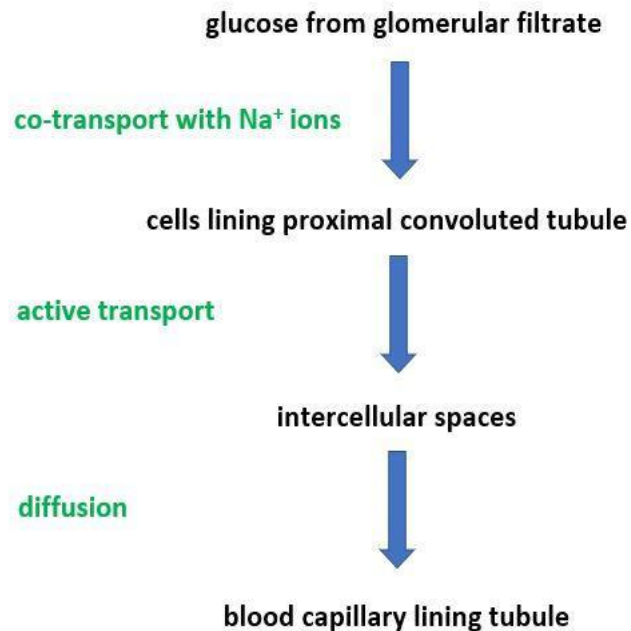
Occurs in proximal convoluted tubule.



Outline the transport processes involved
in selective reabsorption.



Outline the transport processes involved in selective reabsorption.



How are cells in the proximal convoluted tubule adapted for selective reabsorption?



How are cells in the proximal convoluted tubule adapted for selective reabsorption?

- **Microvilli:** large surface area for co-transporter proteins.
- Many **mitochondria:** ATP for active transport of glucose into intercellular spaces.
- **Folded basal membrane:** large surface area.



What happens in the loop of Henle?



What happens in the loop of Henle?

1. Active transport of Na^+ & Cl^- out of **ascending limb**.
2. Water potential of **interstitial fluid** decreases.
3. Osmosis of water out of **descending limb**.
(ascending limb is impermeable to water)
4. Water potential of **filtrate** decreases going down descending limb: lowest in **medullary region**, highest at top of ascending limb.



Explain the role of the distal convoluted tubule.



Explain the role of the distal convoluted tubule.

Reabsorption:

- a) of water via osmosis
- b) of ions via active transport

Permeability of walls is determined by action of hormones.



Explain the role of the collecting duct.



Explain the role of the collecting duct.

Reabsorption of water from filtrate into interstitial fluid via osmosis through aquaporins.



Explain how the loop of Henle acts as a countercurrent multiplier.



Explain how the loop of Henle acts as a countercurrent multiplier.

Ensures filtrate in collecting ducts is always beside an area of interstitial fluid that has a lower water potential.

Maintains water potential gradient for maximum reabsorption of water.



Define osmoregulation.



Define osmoregulation.

Control of plasma water potential via negative feedback homeostatic mechanisms.



What might cause blood water potential to change?



What might cause blood water potential to change?

- level of water intake
- level of ion intake in diet
- level of ions used in metabolic processes or excreted
- sweating



Explain the role of the hypothalamus in osmoregulation.



Explain the role of the hypothalamus in osmoregulation.

1. Osmosis of water out of **osmoreceptors** in hypothalamus causes them to shrink.
2. This triggers hypothalamus to produce more **antidiuretic hormone (ADH)**.



Explain the role of the posterior pituitary gland in osmoregulation.



Explain the role of the posterior pituitary gland in osmoregulation.

Stores and secretes the ADH produced by the hypothalamus.



Explain the role of ADH in osmoregulation.



Explain the role of ADH in osmoregulation.

Forms hormone-receptor complex on surface membrane of cells in collecting duct. Triggers activation of cAMP as secondary messenger.

Triggers cellular processes that increase reabsorption of water. Urine becomes more concentrated.



How does ADH increase reabsorption of water?



How does ADH increase reabsorption of water?

1. Makes cells lining collecting duct more permeable to water:

Binds to receptor → activates phosphorylase → vesicles with aquaporins on membrane fuse with cell-surface membrane.

2. Makes cells lining collecting duct more permeable to urea: water potential in interstitial fluid decreases.



How is the kidney of a kangaroo rat
(*Dipodomys* sp.) adapted for life in a dry
environment?



How is the kidney of a kangaroo rat (*Dipodomys* sp.) adapted for life in a dry environment?

Long loop of Henle = more concentrated medullary region = greater effect as countercurrent multiplier.

More water reabsorbed.



What is an ectotherm?



What is an ectotherm?

Organism that cannot increase its respiration rate to increase the internal production of heat. Relies on external sources to regulate its body temperature. e.g. may orient body to minimise/ maximise sun exposure.



What is an endotherm?



What is an endotherm?

Organism that can regulate its body temperature independently of external sources. Thermoreceptors send signals to the hypothalamus, which triggers a physiological or behavioural response.



Outline behavioural methods
endotherms use to regulate their body
temperature.



Outline behavioural methods endotherms use to regulate their body temperature.

- basking in the sun
- pressing against warm surfaces
- digging burrows
- hibernation/ aestivation
- panting (heat lost as water evaporates from mouth)



How does the autonomic nervous system enable endotherms to thermoregulate?



How does the autonomic nervous system enable endotherms to thermoregulate?

Via negative feedback. Thermoreceptors in the hypothalamus detect changes in blood temperature.

Hypothalamus sends impulses to effectors. May result in: vasodilation/ constriction, sweating, piloerection, shivering, an increase in metabolic rate.



Explain the role of the skin in thermoregulation.



Explain the role of the skin in thermoregulation.

Vasodilation/ constriction of arterioles supplying skin capillaries controls heat loss to skin surface.

Hair erector muscles contract & follicles protrude to trap air for insulation.

Evaporation of sweat cools skin surface.

