

Excretory Products And Their Elimination

Question and Answer:

Question 1.

Define Glomerular Filtration Rate (GFR)

Answer:

Glomerular Filtration Rate (GFR) refers to the quantity of filtrate formed by the kidneys per minute.

In a healthy adult, it is approximately **125 mL per minute**, which is roughly **180 litres per day**.

Question 2.

Explain the autoregulatory mechanism of GFR.

Answer:

The kidneys have built-in mechanisms to regulate the **glomerular filtration rate (GFR)**. This regulation is primarily carried out by the **juxtaglomerular apparatus (JGA)**, a specialized region formed by cellular modifications at the contact point of the distal convoluted tubule (DCT) and the afferent arteriole.

- When there is a fall in GFR, the juxtaglomerular (JG) cells release renin.
- Renin helps restore GFR by stimulating glomerular blood flow through the renin-angiotensin mechanism, ensuring that the filtration rate remains close to normal.

Question 3.

Indicate whether the following statements are true or false :

- (a) Micturition is carried out by a reflex.
- (b) ADH helps in water elimination, making the urine hypotonic.
- (c) Protein-free fluid is filtered from blood plasma into the Bowman's capsule.

(d) Henle's loop plays an important role in concentrating the urine.

(e) Glucose is actively reabsorbed in the proximal convoluted tubule.

Answer:

(a) **True** – Micturition is carried out by a reflex called the micturition reflex.

(b) **False** – ADH helps in water reabsorption, making the urine concentrated (hypertonic), not hypotonic.

(c) **True** – A protein-free fluid is filtered from blood plasma into the Bowman's capsule during glomerular filtration.

(d) **True** – Henle's loop plays an important role in establishing a medullary osmotic gradient, which helps in concentrating urine.

(e) **True** – Glucose is actively reabsorbed in the proximal convoluted tubule (PCT).

Question 4.

Give a brief account of the counter current mechanism.

Answer:

Mammals can produce concentrated urine, and the loop of Henle along with the vasa recta play a key role in this process. The flow of filtrate in the two limbs of Henle's loop is in opposite directions, forming a countercurrent. Similarly, blood in the vasa recta flows in a countercurrent pattern.

- This arrangement, along with their proximity, helps maintain an increasing osmolarity from the cortex (≈ 300 mOsm/L) to the inner medulla (≈ 1200 mOsm/L).
- The osmotic gradient is mainly created by NaCl and urea. NaCl is transported out by the ascending limb of Henle's loop and exchanged with the descending limb of the vasa recta. Small amounts of urea also move into the interstitium via the collecting tubule.
- This countercurrent mechanism maintains the medullary osmotic gradient, allowing water to be

reabsorbed easily from the collecting tubule, thereby concentrating the urine. Human kidneys can produce urine nearly four times more concentrated than the initial filtrate.

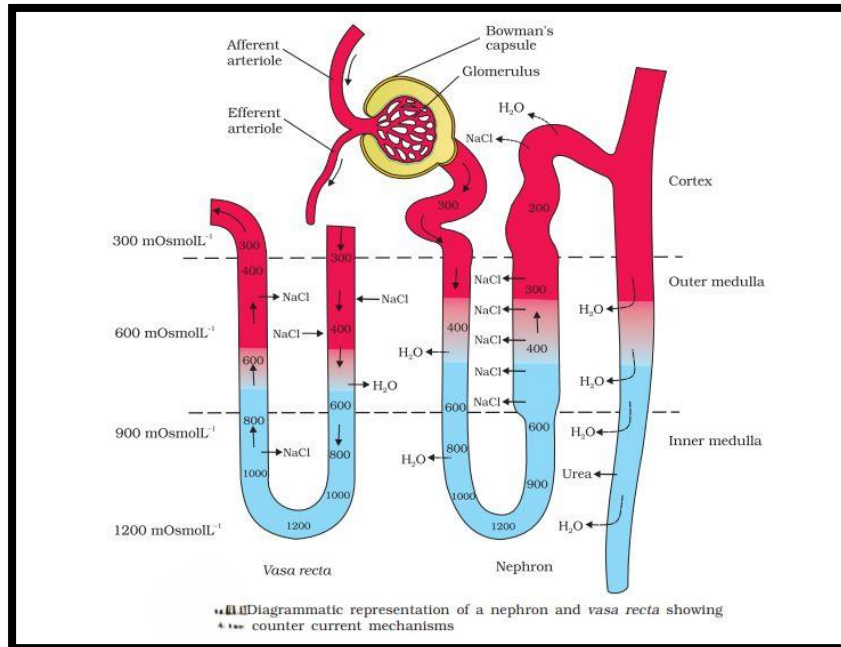


Diagram: Diagrammatic representation of a nephron and vasa recta showing the counter current mechanism.

Question 5.

Describe the role of liver, lungs and skin in excretion.

Answer:

- **Lungs:** Eliminate large amounts of **carbon dioxide** (**≈18 litres/day**) and **water vapor**, helping maintain acid-base and water balance.
- **Liver:** Secretes **bile**, which contains **degraded steroid hormones, drugs, certain vitamins**, and other waste products.
- **Skin:**
 - **Sweat glands** excrete water, salts, and small amounts of urea, while also producing a **cooling effect**.

- **Sebaceous glands** eliminate certain wastes through **sebum**, providing a protective oily covering for the skin.

Question 6.

Explain micturition.

Answer:

Micturition or urination is the process of expelling urine from the urinary bladder through the urethra.

- It occurs by the simultaneous contraction of the smooth muscles of the bladder wall and relaxation of the skeletal muscles of the urethral sphincter.
- Micturition is primarily a reflex process, but in grown-up children and adults, it can be voluntarily controlled to some extent.

Question 7.

Match the items of column I with those of column II:

Column I

- (a) Ammonotelism
- (b) Bowman's capsule
- (c) Micturition
- (d) Uricotelism
- (d) ADH

Column II

- (i) Birds
- (ii) Water reabsorption
- (iii) Bony fish
- (iv) Urinary bladder
- (v) Renal tubule

Column I	Column II
(a) Ammonotelism	Bony fish
(b) Bowman's capsule	Renal tubule
(c) Micturition	Urinary bladder
(d) Uricotelism	Birds

(e) ADH	Water reabsorption
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Question 8.

What is meant by the term osmoregulation?

Answer:

Osmoregulation is the maintenance of a constant osmotic concentration in the body cells and extracellular fluids by regulating the amount of water and salts in the body.

Question 9.

Terrestrial animals are generally either ureotelic or uricotelic, not ammonotelic, why?

Answer:

Terrestrial adaptation requires **conservation of water**, so animals produce **less toxic nitrogenous wastes**.

- **Ureotelic animals** (e.g., mammals, many terrestrial amphibians) convert ammonia into **urea** in the liver. Urea is less toxic and excreted via the kidneys, sometimes retained in the kidney matrix to maintain osmolarity.
- **Uricotelic animals** (e.g., reptiles, birds, land snails, insects) excrete **uric acid** as a **paste or pellet**, minimizing water loss.

In contrast, ammonotelic animals (e.g., bony fishes, aquatic amphibians, aquatic insects) excrete ammonia directly through diffusion or gills, which requires large amounts of water and is unsuitable for terrestrial life.

Question 10.

What is the significance of juxta glomerular apparatus (JGA) in kidney function?

Answer:

The juxtaglomerular apparatus (JGA) plays a crucial role in regulating kidney function:

- A fall in glomerular blood flow, blood pressure, or GFR activates the juxtaglomerular (JG) cells to release renin.
- Renin converts angiotensinogen in the blood into angiotensin I, which is further converted to angiotensin II, a powerful vasoconstrictor that increases glomerular pressure and restores GFR.
- Angiotensin II also stimulates the adrenal cortex to release aldosterone, promoting reabsorption of Na^+ and water from distal tubules.
- This Renin-Angiotensin mechanism helps maintain blood pressure, GFR, and fluid-electrolyte balance in the body.

Question 11:

Name the following:

- a) A chordate animal having flame cells as excretory structures
- b) Cortical portions projecting between the medullary pyramids in the human kidney
- c) A loop of capillary running parallel to Henle's loop

Answer:

- Cephalochordate (Amphioxus)
- Columns of Bertini
- Vasa recta

12. Fill in the gaps:

- (a) Ascending limb of Henle's loop is limb is to it. to water whereas the descending
- (b) Reabsorption of water from distal parts of the tubules is facilitated by hormone
- (c) Dialysis fluid contain all the constituents as in plasma except
- (d) A healthy adult human excretes (on an average) gm of urea/day.

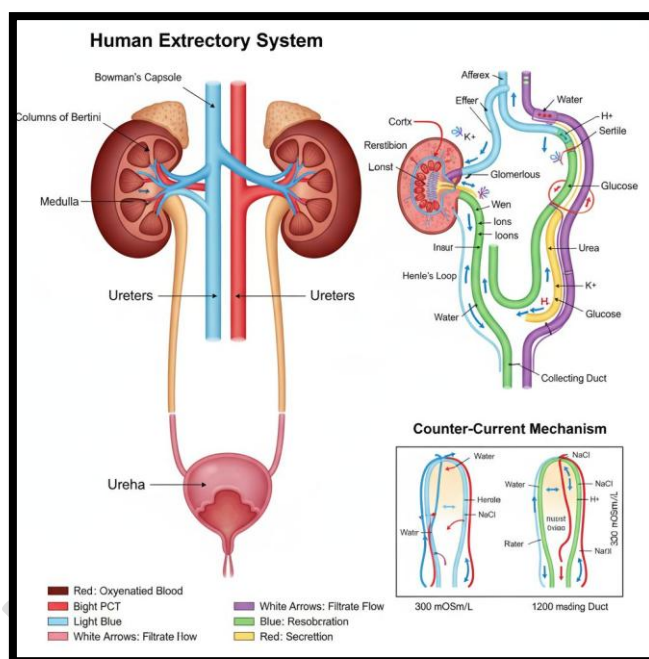
Answer:

(a) Ascending limb of Henle's loop is **impermeable** to water whereas the descending limb is **permeable** to water.

(b) Reabsorption of water from distal parts of the tubules is facilitated by **antidiuretic hormone (ADH)**.

(c) Dialysis fluid contains all the constituents as in plasma except **nitrogenous wastes**.

(d) A healthy adult human excretes (on average) **25–30 g** of urea per day.



Additional Questions and Answers

Question 1:

Differentiate between cortical nephrons and juxtamedullary nephrons.

Answer:

Feature	Cortical Nephron	Juxtamedullary Nephron
Location of loop of Henle	Short, barely enters medulla	Long, extends deep into medulla

Function	Mainly filtration and reabsorption	Concentration of urine and osmotic gradient formation
Presence of vasa recta	Absent or highly reduced	Well-developed

Question 2:

What are the main nitrogenous wastes excreted by animals?

Answer:

The main nitrogenous wastes are:

1. **Ammonia** – highly toxic, excreted by ammonotelic animals (e.g., bony fishes, aquatic amphibians).
2. **Urea** – less toxic, excreted by ureotelic animals (e.g., mammals, many terrestrial amphibians).
3. **Uric acid** – least toxic, excreted by uricotelic animals (e.g., reptiles, birds, insects) to conserve water.

Question 3:

Name the excretory structures in the following animals:

- (a) Flatworms
- (b) Earthworms
- (c) Insects
- (d) Crustaceans

Answer:

- (a) **Protonephridia (flame cells)** – Flatworms
- (b) **Nephridia** – Earthworms
- (c) **Malpighian tubules** – Insects
- (d) **Antennal glands (green glands)** – Crustaceans

Question 4:

What is the role of the proximal convoluted tubule (PCT) in urine formation?

Answer:

- Lined with **brush border epithelium** to increase surface area for reabsorption.
- Reabsorbs **nearly all essential nutrients, 70–80% of electrolytes and water**.
- Helps in **pH and ionic balance** by secreting H^+ , NH_4^+ , and K^+ into the filtrate and reabsorbing HCO_3^- .

Question 5:

How does hemodialysis help in kidney failure?

Answer:

- Blood is withdrawn from an artery and passed through a dialyzing unit (artificial kidney).
- The dialysis fluid has the same composition as plasma except nitrogenous wastes.
- Nitrogenous wastes like urea diffuse out of blood into the dialysis fluid, clearing the blood.
- Cleaned blood is returned to the body after adding anti-heparin.