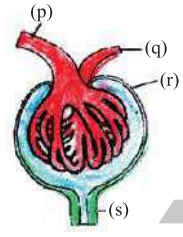

Chapter - 19

Excretory products and Their Elimination

Points To Remember

Excretory Products : Ammonia (most harmful) it needs large amount of water for excretion. Urea (less harmful) and Uric acid (least harmful) needs least amount of water for excretion.

MODE OF EXCRETION

(*On the basis of type of excretory end products*)

Ammonotelism
- Excretion of ammonia
- Bony Fishes, Aquatic Amphibians & Aquatic Insects.

Ureotelism
- Excretion of urea
- Mammals, Many Terrestrial Amphibians & Marine Fishes

Uricotelism
- Excretion of Uric acid
- Snails, Reptiles, Birds & Insects.

Human Excretory System:

Pair of kidney, pair of Ureter, Urinary bladder and Urethra.

Nephron And Its Structure:

The structural and functional unit of kidney is nephron. Each kidney contains about one million of nephrons. A nephron consist of glomerulus (tuft of capillaries-JGA juxtra glomerulus apparatus), and renal tubule. Renal tubule consist of bowman's capsule, proximal convulated tubule (PCT), loop of henle, distal convulated tubule (DCT) and collecting Duct.

Structure of Kidney :

Size 10-12 cm in length, 5-7 cm in width, 2-3 cm thick, average weight about 120-170 g.

- The blood vessels, ureters and nerves enter the kidney through hilum (a notch).
- The outer layer of kidney is a tough capsule.
- The outer zone of kidney is cortex and the inner is medulla.
- The medulla is divided into few conical masses (medullary pyramids) projecting into calyces.

- The cortex extends between medullary pyramids called columns of Bertini.

Glomerular Filtration :

The filtration of blood in glomerulus, about 1100-1200 ml of blood is filtered by the kidney per minute.

Glomerular Filtration Rate (GFR) :

The amount of filtrate formed by the kidney per minute is called GFR. In a healthy individual it is about, 125 ml/minute, i.e. 180 litres per day.

Types of Nephrons :

(i) Juxtamedullary Nephron—About 15% of total nephrons, Glomeruli are found in inner region of cortex, large in size, long loop of Henle and found deep in medulla, associated with vasa recta control plasma volume when water supply is short.

(ii) Cortical Nephron—About 85% of total nephron mainly lie in renal cortex, glomeruli found in outer cortex, short loop of Henle, extends very little in medulla. They do not have vasa recta or vasa recta is highly reduced.

Functions of Tubules :

(i) PCT—absorption of all essential nutrients and 70-80% of electrolytes and water, helps to maintain the pH and ionic balance of body fluids by selective secretion of H^+, ammonia and K^+ into filtrate.

(ii) Henele's Loop—reabsorption in this segment is minimum, it plays a significant role in maintenance of higher molarity of medullary interstitial fluid.

(iii) DCT—conditional reabsorption of Na^+ and water takes place here, reabsorption of HCO_3^- and selective secretion of H^+ and K^+ and ammonia to maintain the pH and sodium-potassium balance in blood.

(iv) Collecting duct—Large amount of water is absorbed from this region to produce concentrated urine, it plays a role in maintenance of pH and ionic balance of blood by selective secretion of H^+ and K^+ ions.

Steps of Urine Formation

1. **Glomerular Filtration**—Blood is filtered by glomerulus through three membranes i.e., endothelium of blood vessel, filtration slits of Bowman's capsule and basement membrane between these two layers. This filtration is called ultrafiltration as all constituents of plasma comes into filterate except proteins.

2. **Reabsorption**—99% of filtrate is reabsorbed by the renal tubules by active or passive mechanism.

   It is evident by the fact that out of 180L of filtrate formed per day only 1.5 L of urine released.

3. **Secretion**—Tubular cells secrete H^+, K^+, ammonia into the urine. It maintains acid-base balance of body fluids.

Mechanism of concentration of the Filtrate (Countercurrent Mechanism) :

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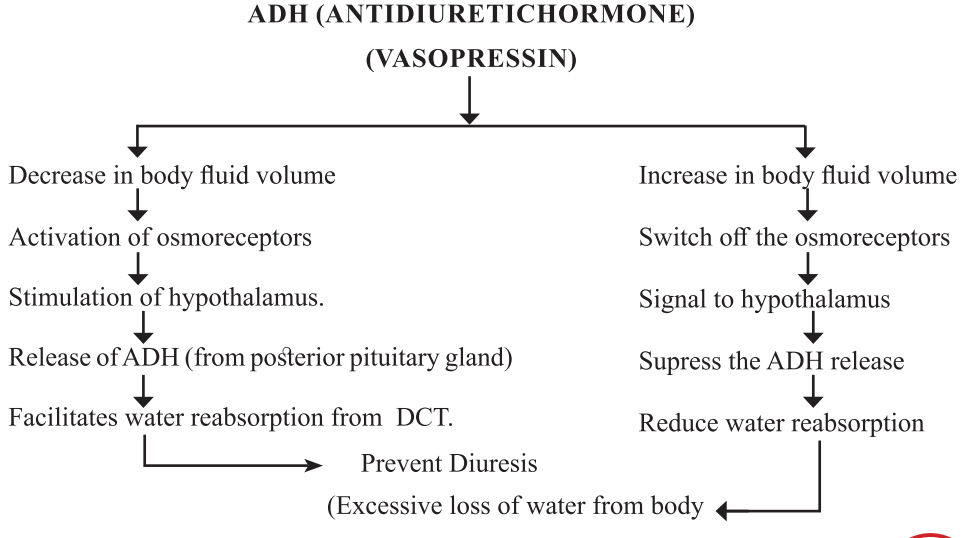
- This mechanism is said to be countercurrent mechanism because the out flow (in the ascending limb) runs parallel to and in the opposite direction of the inflow (in the descending limb).
- NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa-recta. (Capillaries running parallel to loop of Henle)
- NaCl is returned to the interstitium by the ascending portion of **vasa recta.**
- Henle's loop and vasa recta as well as the counter current in them help to maintain an increasing osmolarity towards the inner medullary interstitium i.e., from 300 mosmol/L in cortex to about 1200 mosmol/L in inner medulla.
- Small amount of urea enter, the thin segment of ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.
- This mechanism helps to maintain a concentration gradient in the medullary tubule interstitium.



- It helps in an easy passage of water from the collecting tubule to concentrate the filtrate i.e. urine.

Renin Angiotensin System

Fall in GFR

↓ Renin from JG cells

Angiotensinogen → Angiotensin I → Angiotensin II

↓ Acts on

Adrenal Cortex

↓ Secretes aldosterone

Reabsorption of Na+ and water from DCT

↓

Increase in GFR

Atrial natriuretic factor (ANF)

- Increase in blood flow to Atria of heart release of ANF.
- Causes vasodilation and thus decrease blood pressure.
- ANF acts as a check on renin-angiotensin mechanism.

Micturition :

The expulsion of urine from the urinary bladder is called micturition. It is a reflex process but can be controlled voluntarily up to some extent in grown up children and adults.

- The CNS (Central Nervous System) sends the signal which cause the stretching of the urinary bladder when it gets filled with urine.
- In response, the stretch receptors on the walls of the bladder sends signals to the CNS.
- The CNS passes on motor message to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.

  Urine is slightly acidic in pH 6.0 and yellow in colour due to urochrome pigment derived from breakdown of haemoglobin from worm out RBCs.
- An adult human excretes on an average 1 to 1.5 Litres of urine per day.
- On an average 25-30 gram of urea is excreted out per day.

Role of other organs in excretion :

- **Lungs**—removes CO_2 (18L/day) and water.
- **Liver**—secretes bilirubin, biliverdin etc. helps to eliminate these substances along. with cholesterol, vitamins, drugs and degraded steroid hormones through digesive wastes.
- **Sweat and sebaceous glands**—These glands of skin help to eliminate small amount of urea, NaCl and lactic acid etc. through sweat while sebaceous glands help to eliminate some substances like steroids, hydrocarbons and waxes through sebum.
- **Saliva**—It can help to eliminate small amount of nitrogenous wastes.

Disorders of Excretory system :

- **Uremia**—The accumulation of urea in blood due to malfunctioning of kidney.

  Hemodialysis—The process of removal of urea from the blood artificially. In this process the blood from an artery is passed into dialysing unit after adding an anticoagulant like heparin. The blood passes through coiled cellophane tube, surrounded by dialysing fluid. The nitrogenous wastes form the concentration gradient and the blood becomes clear. This blood is pumped back to the body through vein after adding anti-heparin to it.
- **Renal calculi**—The formation of insoluble mass of crystallised salts (oxalates or phosphates of calcium).
- **Glomerulonephritis**—Inflammation of glomeruli of kidney.

Kidney Transplantation

- Kidney transplantation is done in a patient in which both the kidneys fail to work i.e. at total failure of kidney. Kidney transplantation is the ultimate method for treatment of renal failure. In case of kidney transplantation both the damaged kidneys of patient are removed by surgery. And a functional kidney from a healthy donar preferably from close relative is taken and transplanted in the body of patient. After successful transplantation the patient and donar can survive on one kidney.

Precautions taken for successful transplantation of Kidney :

1. Kidney should be taken from a healthy donor preferably from close relative.
2. Matching of blood group and other factor and compatibility should be done carefully before transplantation.

3. The patient (recipient) has to take some prescribed medicines immunosuppressants through out the life to suppress the immune system.

Questions

(SRT) Select Response Type Question (1 mark each)

1. Which gland secrete sebum?
   (a) lacrymal (b) Adrenal
   (c) sebaceous gland (d) Thymus
2. A part of Henle's Loop is impermeable to water that is
   (a) decending limb (b) ascending limb
3. State true or false:
   Sodium chloride, lactic acid, glucose are the constituent of the human sweat beside water.

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answer Questions (1 marks each)

1. Explain the function of vasa recta.
2. Name two types of nephrons found in human kidney.
3. Define GFR (Glomerular Filtration Rate).
4. The mechanism of concentration of filtrate is also known as counter current mechanism. Justify the statement.
5. What is micturition ?
6. Write the function of hormone 'renin' produced by kidney.
7. Name the excretory product of (i) reptiles (ii) Prawns (iii) Tapeworm (iv) Marine fish (v) Insects (vi) Birds.
8. What is vasa recta ?

Short Answer Questions-I (2 marks each)

12. Mark the odd ones in each of the following—
    (a) Renal pelvis, medullary pyramid, renal cortex, ureter.
    (b) Afferent arteriole, Henle's loop, vasa recta, efferent arteriole.
    (c) Glomerular filtration, antidiuretic hormone, hypertonic urine, collecting duct.
    (d) Proximal convoluted tubule, distal convoluted tubule, Henle's loop renal corpuscle.

13. In the following diagram of longitudinal section of kidney (Fig.–i) identify and label a, b, c and d respectively.

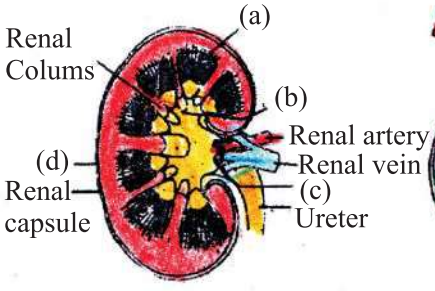


fig. (i)

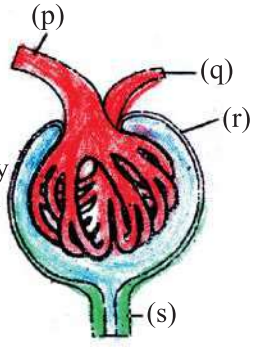
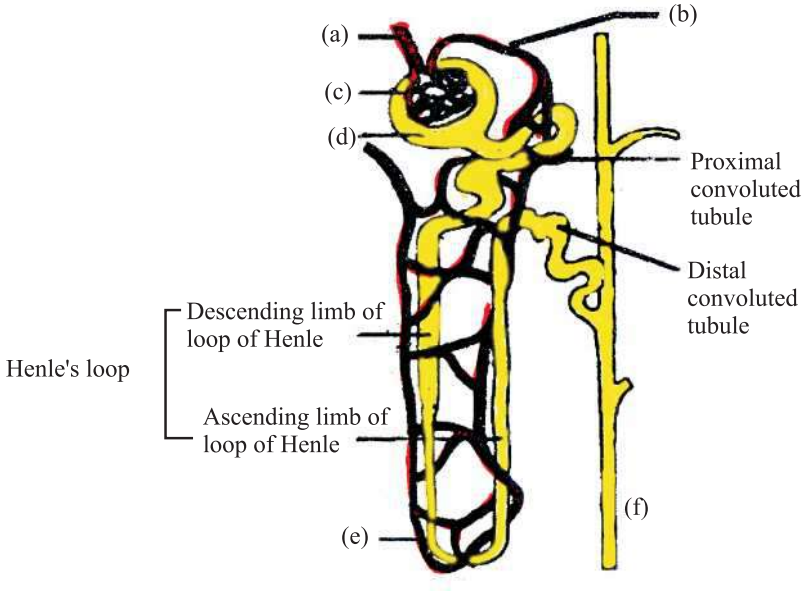


fig. (ii)

14. In the diagram (Fig.-ii) showing malpighian body (renal corpuscle) identify and label p, q, r, s.
15. Name two metabolic disorder which can be diagnosed by analysis of urine.

Short Answer Questions-II (3 marks each)

16. In the following diagram (Fig.-3) showing structure of a nephron label a, b, c, d, e and f.



17. Describe the hormonal feed back circuit in controlling the renal functions.
18. Give three points of difference between Rennin and Renin.

19. What are ammonotelic, ureotelic and uricotelic animals ? Give an example of each type of these.
20. Why is urine formation less during summers ?

Long Answer Questions (5 marks each)

21. Draw a labelled diagram of human urinary system and write one function each of adrenal gland, ureter, urinary bladder, kidney and urethra.
22. Describe how urine is formed in the nephron through filtration reabsorption and secretion.

OR

Explain the steps involved in the process of urine formation.

23. Distinguish between (i) Uricotelism and Ureotelism (ii) Sebum and sweat (iii) Proximal and distal convoluted tubules (iv) Ascending and descending limbs of Henle's loop (v) Cortical and Medullary nephrons.
24. Explain the process of reabsorption and secretion of major substances at different parts of nephron with the help of schematic diagram.

Case Based/Competency Based Question (4 marks)

25. For the regulation of glomerular filtration rate (GFR) the kidneys have a built-in mechanism. One such efficient mechanism is known as renin-angiotensinogen system and is carried out by the distal convoluted tubule and the afferent arteriole at the location of their contacts. Fall in GFR can stimulate the JG cells to release renin which can stimulate the glomerular blood flow and thereby bring the GFR back to normal. An increase in blood flow in the atria of the heart can cause the release of the Atrial natriuretic factor (ANF). This causes vasodilation of blood vessels and thereby decreases the blood pressure. ANF mechanism, therefor, acts as a check on renin-angiotensin mechanism.

1. Why is GFR called ultrafiltration?

   (a) As it is very efficient

   (b) As it is using ultraviolet rays of filtration

   (c) As all constituent of plasma come into filtrate except proteins

   (d) All of the above

2. Where is JGA located?

   (a) Below renal corpuscle

   (b) At Henle's loop

   (c) At the contact region between distal convoluted tubule and afferent arteriole.

   (d) Below glomerulus

3. Give the causes of the release of ANF.

   (a) Decrease in blood flow to the atria of the heart

   (b) Increase in blood flow to the atria of the heart

   (c) Decrease in blood flow to the ventricle of the heart

   (d) Increase in blood flow to the ventricle of the heart

4. Which mechanism can act as a check on renin-angiotensin mechanism?

   (a) Self-check and control

   (b) Atrial natriuretic factor

   (c) Parasympathetic system

   (d) Vasopressin factor

5. What do JG cells release to control GFR?

   (a) Renin

   (b) Rennin

   (c) Angiotensin

   (d) Antidiuretic hormone

(SRT) Assertion reasoning type questions-II **(1 marks each)**

DIRECTIONS : In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

(a) If both (A) and (R) are correct and (R) is the correct explanation of (A)

(b) If both (A) and (R) true, but (R) is not the correct explanation of (A)

(c) If (A) is true but (R) is false

(d) If both (A) and (R) are false

26. **Assertion :** In cortical nephrons vasa recta is absent or highly reduced.

Reason : Cortical nephrons are mainly concerned with the concentration of urine.

27. **Assertion :** Compared to uric acid, urea is a more toxic excretory substance.

Reason : Birds and insects are uricotelic animals.

28. **Assertion :** Vasopressin increases the water permeability of the distal convoluted tubule.

Reason : In absence of ADH, water reabsorption is considerably reduced.

Answers

(SRT) Select Response Type Question (1 mark each)

1. (c) Sebaceous glands (wax-glands)
2. (b) Ascending limb
3. True

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answer (1 mark each)

4. It helps to retain reabsorbed ions and urea in the interstitial fluid of the medulla, to maintain its high osmotic pressure.
5. (i) Juxta medullary nephron (ii) Cortical nephron
6. The amount of filtrate formed by the kidney per minute.
7. In the ascending limb, the outflow runs parallel to and in the opposite direction of the inflow in the descending limb.
8. The act of passing out urine from urinary bladder.
9. Renin is used to convert angiotensinogen to angiotensin.

10. (i) Uric acid (ii) Ammonia (iii) Ammonia (iv) Urea (v) Uric Acid (vi) Uric acid.

11. Capillary network running parallel to loop of Henle is known as Vasa recta.

Short Answer-I (2 marks each)

12. (a) Ureter (b) Henle's loop (c) Glomerular filtration (d) Renal Corpuscle.

13. Refer fig. 19.2, page 292 (NCERT Class XI-Biology)

14. Refer fig. 19.4 page 293 (NCERT class XI-Biology)

15. Glycosuria, Ketonuria

Short Answer-II (3 marks each)

16. Refer fig. 19.3, page 292, (NCERT class XI-Biology)

17. Refer content 19.5, page 297 (NCERT class XI-Biology).

18.

Rennin	Renin
(i) It is a proteolytic enzyme.	(i) It is a hormone that acts as an enzyme.
(ii) It helps in the digestion of milk protein.	(ii) It converts the protein angiotensinogen into angiotensin
(iii) It is secreted as an inactive form Prorennin which is activiated to rennin by HC1.	(iii) It is secreted as renin.
(iv) Its secretion is stimulated by food.	(iv) It secretion is stimulated by a reduction of Na^+ level in tissue fluid.

19. Refer content given in the beginning of the chapters of NCERT Text Book page 290 class XI-Biology or Points to remember of this support material.

20. Due to sweating in summers blood volume is decreased. ADH is secreted from hypothalamus which increase reabsorption from D.C. tubules thus amount of urine is decreased.

Long Answer (5 mark each)

21. Support Material Points to Remember.

22. Refer content points to remember of this support material.

23. Refer the content given in Points to remember of this chapter of support material.

24. Refer Support material points of remember.

25. 1. (c) 2. (c)

    3. (b) 4. (b)

    5. (a)

SRT Questions II Answers.

26. (c)

27. (b)

28. (b)