CHAPTER-8 EXCRETION

Evaluation

1.Arrange the following structures in the order that a drop of water entering the nephron would encounter them.

(a) Afferent arteriole

(b) Bowman's capsule

(c) Collecting duct

(d) Distal tubule

(e) Glomerulus

(f) Loop of Henle

(g) Proximal tubule

(h) Renal pelvis

Answer:

(a) Afferent arteriole
(e) Glomerulus
(b) Bowman's capsule
(g) Proximal tubule
(f) Loop of Henle
(d) Distal tubule
(c) Collecting duct
(h) Renal pelvis

2.Name the three filtration barriers that solutes must come across as they move from plasma to the lumen of Bowman's capsule. What components of the blood are usually excluded by these layers?

a. Glomerular capillary endothelium – Prevents blood cells and negatively charged plasma proteins.
b. Basal lamina – ECM of glycoproteins, plasma proteins.
c. Epithelium of bowman's capsule,

3.What forces promote glomerular filtration? What forces opposes them? What is meant by net filtration pressure?

1. Glomerular pressure is the chief force that promotes glomerular filtration.
2. The two opposing forces are the plasma proteins in the capillaries contributed by the colloidal osmotic pressure and the capsular hydrostatic pressure due to the fluids in the glomerular capsule.

Net filtration pressure

= Glomerular hydrostatic pressure – (Colloidal osmotic pressure + capsular hydrostatic pressure)

= 55 m Hg – (30mm Hg + 15mm Hg)

= 10 mm Hg

The net filtration pressure of 10mm Hg is responsible for renal filtration.

4.Identify the following structures and explain their significance in renal physiology?

a. Juxtaglomerular apparatus
b. Podocytes
c. Sphincters in the bladder

d. Renal cortex

a. Juxtaglomerular apparatus :

1. Juxta glomerular apparatus (JGA) is a specialized tissue in the afferent arteriole of the nephron that consists of macula densa and granular cells.
2. The macula densa cells sense distal tubular flow and affect afferent arteriole diameter, whereas the granular cells secrete an enzyme called renin.
3. A fall in glomerular blood flow, glomerular blood pressure and glomerular filtration rate, can activate JG cells to release renin which converts a plasma protein, angiotensinogen (synthesized in the liver) to angiotensin I.
4. This starts off a series of events known as Renin – Angiotensin – Aldosterone system which finally increases the glomerular blood pressure and glomerular filtration rate.

b. Podocytes:

1. In a nephron, the external parietal layer of the glomerulus is made up of simple squamous epithelium and the visceral layer is made of epithelial cells calledpodocytes.
2. The podocytes end in foot processes which cling to the basement membrane of the glomerulus. The openings between the foot processes are called filtration slits. This acts as a filter to retain blood cells and large protein in plasma while permitting the passage of fluids.

c. Sphincters in the bladder:

1. The external and internal sphincters are muscles guarding the opening of the urinary bladder at the urethra.
2. When the urinary bladder gets filled with urine, the urinary bladder stimulates the central nervous system via sensory neurons and brings about contraction of the bladder. Simultaneously somatic motor neurons induce the sphincters to close.
3. Smooth muscles contract resulting in the opening of the internal sphincter passively and relaxing the external sphincter. When the stimulatory and inhibitory controls exceed the threshold, the sphincter opens and urine is expelled out. Thus the sphincter muscles keep the urethral closed except during expulsion of urine.
4. Thus the sphincter muscles keep the urethra closed except during expulsion of urine.

d. Renal cortex:

1. The outer layer of the kidney is called Renal cortex.
2. In the renal tubules, proximal convoluted tubule and distal convoluted tubule of the Nephron are situated in the cortical region of the kidney.
3. The part of cortex that extends between the medullary pyramids is the renal columns of bertini.

5.In which segment of the nephron most of the re-absorption of substances takes place?

About 70% of the reabsorption takes place in the proximal convoluted tubules of the nephron.

6.When a molecule or ion is reabsorbed from the lumen of the nephron, where does it go? If a solute is filtered and not reabsorbed from the tubule, where does it go?

a. When a molecular or ion is reabsorbed from the lumen of the nephron it goes out of the lumen through the blood in the efferent arteriole.
It is reabsorbed into the efferent arteriole which leaves the Nephron, and enters the peritubular capillaries.

b. If a solute is filtered and not reabsorbed from the tubule it will finally reach the distal convoluted tubule of the nephron and enter the collecting duct to be sent out as waste in the form of urine.

7.Match each of the following substances with its mode of transportation in proximal tubular reabsorption.

(a) Na^+	-	Simple diffusion
(b) Glucose	-	Primary active transport
(c) Urea	-	Indirect active transport
(d) Plasma	-	Paracellular movement
(e) Proteins	-	Facilitated diffusion
(f) Water	-	Endocytosis

Answer:

(a) Na^+	-	Primary active transport
(b) Glucose	-	Indirect active transport
(c) Urea	-	Simple diffusion
(d) Plasma	-	Facilitated diffusion
(e) Proteins	-	Endocytosis
(f) Water	-	Paracellular movement

8.Which segment is the site of secretion and regulated reabsorption of ions and pH homeostasis?

The distal convoluted tubule of the nephron is the site of secretion and regulated reabsorption of ions and pH homeostasis.

9.What solute is normally present in the body to estimate GFR in humans?

Creatinine. Some of it is secreted but the quantity present is very low and its clearance is a measure of estimating glomerular filtration rate (efficiency of the kidney).

10.Which part of the autonomic nervous system is involved in micturation process?

When the urinary bladder gets filled with urine, the stretch receptors in the urinary bladder are stimulated.

Stretching of the urinary bladder stimulates the central nervous system via the sensory neurons of the parasympathetic nervous system and brings about contraction of the bladder.

Simultaneously somatic motor neurons induce the sphincters to close. Smooth muscles contract and opening of the internal sphincters occurs passively and external sphincter relaxes.

When the stimulatory and inhibitory controls exceed the threshold, the sphincter opens and urine is expelled out.

11.Match the following terms.

(a) α-receptor	-	Afferent arteriole
(b) Autoregulation	-	Basal lamina
(c) Bowman's capsule	-	Capillary blood pressure
(d) Capsule fluid pressure	-	Colloid osmotic Pressure
(e) Glomerulus	-	GFR
(f) Podocyte	-	JG cells
(g) Vasoconstriction	-	Plasma proteins Norepinepherine

Answer:

(a) α-receptor	-	Capillary blood pressure
(b) Autoregulation	-	GFR
(c) Bowman's capsule	-	Afferent arteriole
(d) Capsule fluid pressure	-	Plasma proteins
(e) Glomerulus	-	Colloid osmotic pressure
(f) Podocyte	-	Basal lamina
(g)Vasoconstriction	-	JG cells

12.If the afferent arteriole of the nephron constricts, what happens to the GFR in that nephron? If the efferent arteriole constricts what happens to the GFR in that nephron? Assume that no auto regulation takes place.

Constriction of the afferent arteriole of the nephron causes decrease in Glomerular filtration rate (GFR). since the quantity of blood flow through the arteriole decreases.

Constriction of the efferent arteriole of the nephron causes increase in Glomerular Filtration rate.

13.How is the process of micturition altered by toilet training?

1. The process of release of urine from the urinary bladder is called micturition. It is more than a simple reflex. The control of micturition is learnt is infancy. It induces other sensory fibres in the bladder which conveys the information on fullness of bladder.
2. This information reaches the centres in thalamus and cerebral cortex of the brain via the spine.
3. The brain can sense the need to pass urine and urgency of the situation.
4. The brain centres can control the micturition reflex by inhibiting the parasympathetic motor fibres.

5. When convenient, the brain centre removes this control and permits micturition under conscious control.
6. Further the link between spine and cerebral cortex is developed only nearing 2 years of age. Hence toilet training is not possible in infants.
7. Therefore by training children at a young age the micturition reflex can be brought under control.

14.Concentration of urine depends upon which part of the nephron

(a) Bowman's capsule **(b) Length of Henle's loop**

(c) P.C.T. (d) Network of capillaries arising from glomerulus

15.If Henle's loop were absent from mammalian nephron, which one of the following is to be expected?

(a) There will be no urine formation

(b) There will be hardly any change in the quality and quantity of urine formed

(c) The urine will be more concentrated

(d) The urine will be more dilute

16.A person who is on a long hunger strike and is surviving only on water, will have

(a) Less amino acids in his urine

(b) Macula densa cells

(c) Less urea in his urine

(d) More sodium in his urine

17.What will happen if the stretch receptors of the urinary bladder wall are totally removed?

(a) Micturition will continue

(b) Urine will be continue to collect normally in the bladder

(c) There will be micturition

(d) Urine will not collect in the bladder

18.The end product of Ornithine cycle is

(a) carbon dioxide (b) uric acid **(c) urea** (d) ammonia

19.Identify the wrong match

(a) Bowman's capsule - Glomerular filteration

(b) DCT - Absorption of glucose

(c) Henle's loop - Concentration of urine

(d) PCT - Absorption of Na^+ and K^+ions

20.Podocytes are the cells present on the

(a) Outer wall of Bowman's capsule

(b) Inner wall of Bowman's capsule

(c) Neck of nephron

(d) Wall glomerular capillaries

21.Glomerular filtrate contains

(a) Blood without blood cells and proteins (b) Plasma without sugar

(c) Blood with proteins but without cells (d) Blood without urea

22.Kidney stones are produced due to deposition of uric acid and

(a) Silicates (b) Minerals (c) Calcium carbonate **(d) Calcium oxalate**

23.Animal requiring minimum amount of water to produce urine are

(a) ureotelic (b) ammonotelic **(c) uricotelic** (d) chemotelic

24.Aldosterone acts at the distal convoluted tubule and collecting duct resulting in the absorption of water through

(a) Aquaporins (b) Spectrins (c) GLUT (d) Chloride channels

25.The hormone which helps in the reabsorption of water in kidney tubules is

(a) cholecystokinin (b) angiotensin II

(c) antidiuretic hormone (d) pancreozymin

26.Malpighian tubules remove excretory products from

(a) mouth (b) oesophagus **(c) haemolymph** (d) alimentary canal.

27.Identify the biological term.

Homeostasis, excretion, glomerulus,urea, glomerular filtration, ureters, urine, Bowman's capsule, urinary system, reabsorption, micturition, osmosis, glomerular capillaries via efferent arteriole, proteins.

a. A liquid which gathers in the bladder.
b. Produced when blood is filtered in a Bowman's capsule.
c. Temporary storage of urine.
d. A ball of inter twined capillaries.
e. A process that changes glomerular filtrate into urine.
f. Removal of unwanted substances from the body.
g. Each contains a glomerulus.
h. Carry urine from the kidneys to the bladder.
i. Contains urea and many useful substances.
j. Blood is filtered through its walls into the Bowman's capsule.
k. Scientific term for urination.
l. Regulation of water and dissolved substances in blood and tissue fluid.
m. Carry urine from the kidneys to the bladder.
n. Consists of the kidneys, ureters and bladder.
o. Removal of useful substances from glomerular filtrate.
p. The process by which water is transported in the proximal convoluted tubule.
q. Where has the blood in the capillaries surrounding the proximal convoluted tubule come from?
r. What solute the blood contains that are not present in the glomerular filtrate?

Answer:

1. Urine
2. No suitable option (correct Ans. : Glomerular filtrate)
3. No proper option
   (Correct answer : Urinary bladder)
4. Glomerulus
5. Reabsorption
6. Excretion
7. Bowman's capsule

8. Ureters
9. No suitable option
   (Correct Answer : Glomerular filtrate)
10. Glomerular capillaries
11. Micturition
12. Homeostasis
13. Ureters (Question 'h' repeated)
14. Urinary system
15. Reabsorption
16. Osmosis
17. Glomerular Capillaries via efferent arteriole
18. Proteins.

28.With regards to toxicity and the need for dilution in water, how different are ureotelic and uricotelic excretions? Give examples of animals that use these types of excretion.

Ureotelism :

1. The process of excreting urea is calledureotelism.
2. Animals which are found in places where water availability is not abundant have this mode of excretion.
3. They convert Ammonia produced in the body into urea in the liver and release it to the blood. This is filtered and excreted by the kidneys, Eg: Mammals, many terrestrial amphibians and marine fishes.
4. In terms of toxicity urea is more toxic than uric acid but it is soluble in water and is thus excreted as urine.

Uricotelism :

The process of excreting uric acid is called **uricotelism**.

1. Uric acid can be removed from the body with a minimal loss of water and the excreta is in the form of pellet or paste (semisolid).
2. Eg. : Many desert animals, Reptiles, Birds, Insects.
3. In terms of toxicity, uric acid is the least toxic nitrogenous waste. It is also insoluble in water.

29.Differentiate protonephridia from metanephridia.

S. No.	Protonephridia	Metanephridia
1.	It consists of tubular excretory structures which end in specialised cells such as flame cells inside the body and open out by means of excretory pores.	They are excretory glands with a ciliated funnel like opening into the body cavity and connected to a duct which opens outside the body.
2.	It mainly helps in osmoregulation.	It helps in excretion and osmoregulation
3.	It is found in acoelomates and coelomates. Eg: Flat worms	It is found in coelomates only Eg: Annelids, Arthropods.
4.	They are primitive in nature.	They are advanced than protonephridia.

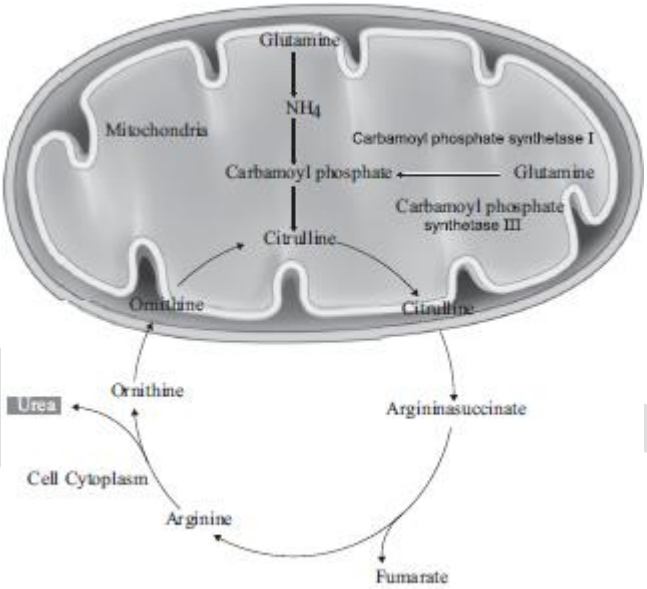
30.What is the nitrogenous waste produced by amphibian larvae and by the adult animal?

Nitrogenous waste produced by amphibian larvae is Ammonia. Since they are aquatic, ammonia diffuses into the water.

Nitrogenous waste produced by adult amphibian is urea since they are terrestrial. Further production of urea as excretory waste requires less water.

31.How is urea formed in the human body?

The nitrogenous waste formed as a result of breakdown of amino acids is converted to urea in the liver by the Ornithine cycle or urea cycle.



Ornithine cycle

32.Differentiate cortical from medullary nephrons.

Cortical Nephrons :

In majority of the nephrons, the loop of Henle is too short and extends very little into the medulla i.e, they lie in the renal cortex. These are called **corticalnephrons** and form about 80% of total nephrons in the kidney.

Medullary Nephrons :

In some nephrons, the loop of Henle is very long and run deep into the medulla. They are called**Medullary nephrons**.

33.What vessels carry blood to the kidneys? Is this blood arterial or venous?

Renal artery branches out from the dorsal aorta and supplies the kidney with arterial blood.

It breaks into small arterioles and an afferent arteriole enters into each nephron.

34.Which vessels drain filtered blood from the kidneys?

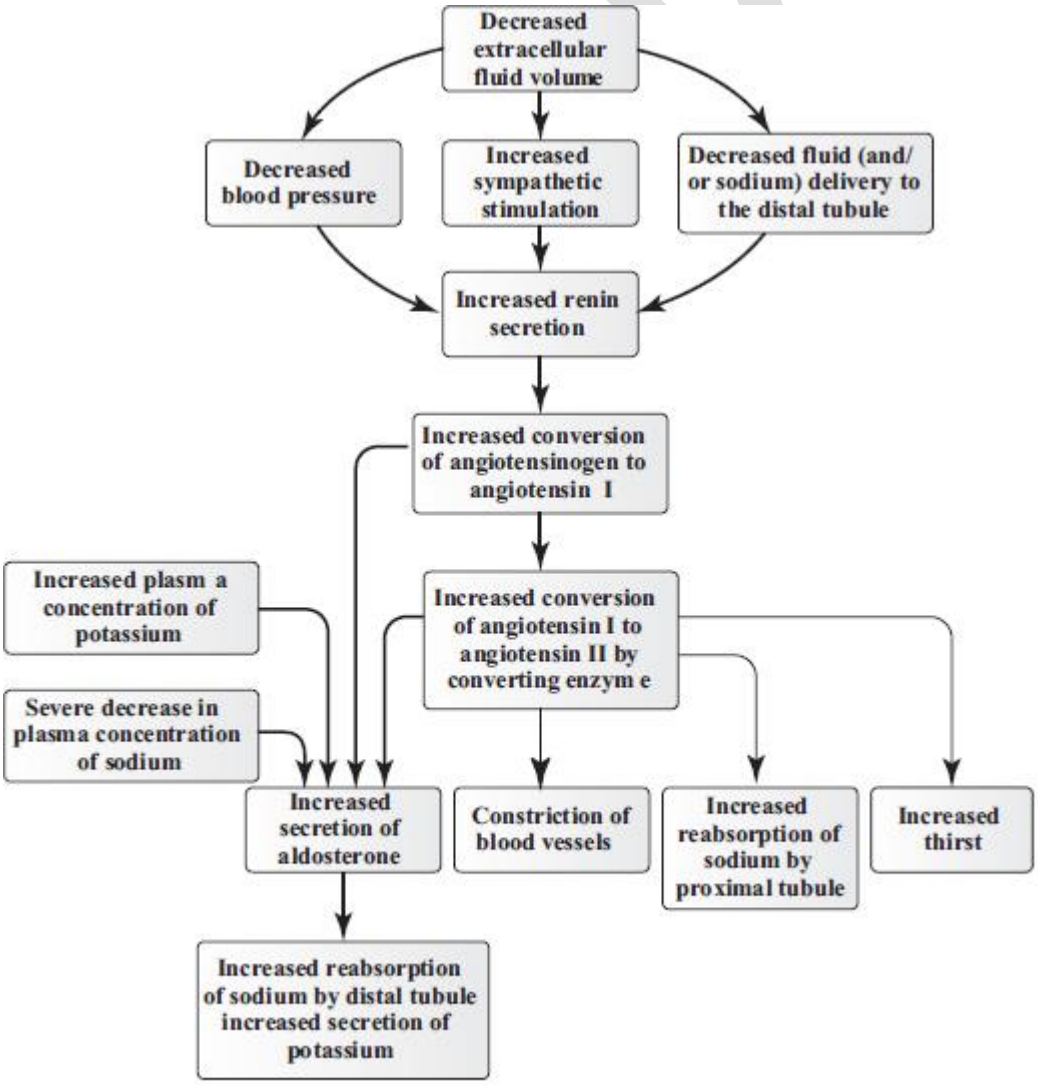
The efferent arteriole drains the filtered blood from the nephron. All the efferent arterioles from the nephrons join to form the renal vein. This carries venous blood and leaves the kidney to join the inferior vena cava.

35.What is tubular secretion? Name the substances secreted through the renal tubules.

1. Tubular secretion is the passage of waste material from the blood to the filtrate in the Nephron. It is the last stage of Excretory process taking place in the Nephron.
2. Substances such as H^+, K^+, NH_4^+, creatinine and organic acids move into the filtrate from the peritubular capillaries into the tubular fluid.
3. Most of the water is absorbed in the proximal convoluted tubule and Na^+ is exchanged for water in the loop of Henle. Hypotonic fluid enters the distal convoluted tubule and substances such as urea and salts pass from peritubular blood into the cells of DCT.
4. The urine excreted contains both filtered and secreted substances. Once it enters the collecting duct, water is absorbed and concentrated hypertonic urine is formed.
5. For every H^+ secreted into the tubular filtrate, a Na^+ is absorbed by the tubular cell. The H^+ secreted combines with HCO_3^-, HPO_3^- and NH_3^- and gets fixed as $H_2CO_4^+$, $H_2PO_4^+$ and NH_4^+respectively. Since H^+ gets fixed in the fluid, reabsorption of H^+ is prevented.

36.How are the kidneys involved in controlling blood volume? How is the volume of blood in the body related to arterial pressure?

Answer:



Schematic representations of the various hormones in the regulation of body fluid concentration

1. Juxta glomerular apparatus (JGA) is a specialized tissue in the afferent arteriole of the nephron that consists of macula densa and granular cells.
2. The macula densa cells sense distal tubular flow and affect afferent arteriole diameter, whereas the granular cells secrete an enzyme called **renin**.
3. A fall in glomerular blood flow, glomerular blood pressure and glomerular filtration rate, can activate JG cells to release renin which converts a plasma protein, angiotensinogen (synthesized in the liver) to angiotensin I.
4. Angiotensin converting enzyme (ACH) converts angiotensin I to angiotensin II. Angiotensin II stimulates Na^+reabsorption in the proximal convoluted tubule by vasoconstriction of the blood vessels and increases the glomerular blood pressure.
5. Angiotensin II acts at different sites such as heart, kidney, brain, adrenal cortex and blood vessels.
6. It stimulates adrenal cortex to secrete aldosterone that causes reabsorption of Na^+, K^+ excretion and absorption of water from the distal convoluted tubule and collecting duct.
7. This increases the glomerular blood pressure and glomerular filtration rate. This complex mechanism is generally known as Renin-Angiotensin-Aldosterone System (RAAS).

37.Name the three main hormones that are involved in the regulation of the renal function?

Hormones involved in regulation of renal function are :

1. Vasopressin (Anti diuretic Hormone)
2. Aldosterone
3. Atrial natriuretic peptide hormone

38.What is the function of antidiuretic hormone? Where is it produced and what stimuli increases or decreases its secretion?

1. When there is excessive loss of fluid from the body or when there is an increase in the blood pressure, the osmoreceptors of the hypothalamus respond by stimulating the neurohypophysis to secrete theantidiuretic hormone (ADH) orvasopressin (a positive feedback).
2. ADH facilitates reabsorption of water by increasing the number of aquaporins on the cell surface membrane of the distal convoluted tubule and collecting duct. This increase in aquaporins causes the movement of water from the lumen into the interstitial cells, thereby preventing excess loss of water by diuresis.
3. When you drink excess amounts of your favourite juice, osmoreceptors of the hypothalamus is no longer stimulated and the release of ADH is suppressed from the neurohypophysis (negative feedback) and the aquaporins of the collecting ducts move into the cytoplasm.
4. This makes the collecting ducts impermeable to water and the excess fluid flows down the collecting duct without any water loss. Hence dilute urine is produced to maintain the blood volume. Vasopressin secretion is controlled by positive and negative feedback mechanism.
5. Defects in ADH receptors or inability to secrete ADH leads to a condition called diabetes insipidus, characterized by excessive thirst and excretion of large quantities of dilute urine resulting in dehydration and fall in blood pressure.

39.What is the effect of aldosterone on kidneys and where is it produced?

1. Excessive stretch of cardiac atrial cells cause an increase in blood flow to the atria of the heart and release Atrial Natriuretic Peptide or factor (ANF) travels to the kidney where it increases Na^+ excretion and increases the blood flow to the glomerulus, acting on the afferent glomerular arterioles as a vasodilator or on efferent arterioles as a vasoconstrictor.
2. It decreases aldosterone release from the adrenal cortex and also decreases release of renin, thereby decreasing angiotensin II.
3. ANF acts antagonistically to the renin-angiotensin system, aldosterone and vasopressin.

40.What evolutionary hypothesis could explain the heart's role in secreting a hormone that regulates renal function? What hormone is this?