Chapter 15: Excretion and Osmoregulation

EXERCISE [PAGES 1 - 192]

Exercise | Q 1. (A) | Page 190
Choose the correct option.

Which one of the following organisms would spend maximum energy in the production of nitrogenous waste?

1. Polar bear
2. **Flamingo**
3. Frog
4. Shark

SOLUTION

Flamingo

Exercise | Q 1. (B) | Page 190
Choose the correct option.

In human beings, uric acid is formed due to metabolism of _____.

1. amino acids
2. fatty acids
3. creatinine
4. **nucleic acids**

SOLUTION

In human beings, uric acid is formed due to the metabolism of **nucleic acids.**

Exercise | Q 1. (C) | Page 190
Choose the correct option.

Visceral layer : Podocytes :: PCT : _____.

1. Cilliated cells
2. Squamous cells
3. Columnar cells
4. **Cells with brush border**

SOLUTION

Visceral layer : Podocytes :: PCT : **Cells with brush border.**

Exercise | Q 1. (D) | Page 190
Choose the correct option.

Deproteinised plasma is found in _____.

a. Bowman's capsule
b. Descending limb
c. Glomerular capillaries
d. Ascending limb

SOLUTION

Deproteinised plasma is found in **Bowman's capsule, Descending limb, Ascending limb.**

Exercise | Q 1. (E) | Page 190
Choose the correct option.
Specific gravity of urine would _____ if level of ADH increases.

1. remain unaffected
2. **increases**
3. decreases
4. stabilise

SOLUTION

Specific gravity of urine would **increases** if level of ADH increases.

Exercise | Q 1. (F) | Page 190
Choose the correct option.
What is micturition?

1. **Urination**
2. Urine formation
3. Uremia
4. Urolithiasis

SOLUTION

Urination.

Exercise | Q 1. (G) | Page 190
Choose the correct option.
Which one of the following organisms excrete waste through nephridia?

1. Cockroach
2. **Earthworm**
3. Crab
4. Liver Fluke

SOLUTION

Earthworm

Exercise | Q 1. (H) | Page 190
Choose the correct option.
Person suffering from kidney stone is advised not to have tomatoes as it has _____.

1. seeds
2. lycopene
3. **oxalic acid**
4. sour taste

SOLUTION

Person suffering from kidney stone is advised not to have tomatoes as it has **oxalic acid**.

Exercise | Q 1. (I) | Page 190
Choose the correct option.
Tubular secretion does not take place in _____.

1. DCT
2. **PCT**
3. collecting duct
4. Henle's loop

SOLUTION

Tubular secretion does not take place in **PCT.**

Exercise | Q 1. (J) | Page 190
Choose the correct option.
The minor calyx _____.

1. **collects urine**
2. connects pelvis to ureter
3. is present in the cortex
4. receives column of Bertini

SOLUTION

The minor calyx **collects urine**.

Exercise | Q 1. (K) | Page 190
Choose the correct option.
Which one of the following is not a part of human kidney?

1. Malpighian body
2. **Malpighian tubule**
3. Glomerulus
4. Loop of Henle

SOLUTION

Malpighian tubule

Exercise | Q 1. (L) | Page 190
Choose the correct option.

The yellow colour of the urine is due to presence of _____.

1. uric acid
2. cholesterol
3. **urochrome**
4. urea

SOLUTION

The yellow colour of the urine is due to presence of **urochrome.**

Exercise | Q 1. (M) | Page 190
Choose the correct option.
Hypotonic filtrate is formed in _____.

1. PCT
2. DCT
3. **LoH**
4. CT

SOLUTION

Hypotonic filtrate is formed in **LoH.**

Exercise | Q 1. (N) | Page 190
Choose the correct option.
In reptiles, uric acid is stored in _____.

1. **cloaca**
2. fat bodies
3. liver
4. anus

SOLUTION

In reptiles, uric acid is stored in **cloaca.**

Exercise | Q 1. (O) | Page 190
Choose the correct option.
The part of nephron which absorbs glucose and amino acid is _____.

1. collecting tubule
2. **proximal tubule**
3. Henle's loop
4. DCT

SOLUTION

The part of nephron which absorbs glucose and amino acid is **proximal tubule.**

Exercise | Q 1. (P) | Page 190
Choose the correct option.

Bowman’s capsule is located in kidney in the _____.

1. **cortex**
2. medulla
3. pelvis
4. pyramids

SOLUTION

Bowman's capsule is located in kidney in the **cortex**.

Exercise | Q 1. (Q) | Page 190
Choose the correct option.
The snakes living in desert are mainly _____.

1. aminotelic
2. ureotelic
3. ammonotelic
4. **uricotelic**

SOLUTION

The snakes living in desert are mainly **uricotelic.**

Exercise | Q 1. (R) | Page 190
Choose the correct option.
Urea is a product of breakdown of _____.

1. fatty acids
2. **amino acids**
3. glucose
4. fats

SOLUTION

Urea is a product of breakdown of **amino acids.**

Exercise | Q 1. (S) | Page 190
Choose the correct option.
Volume of the urine is regulated by _____.

1. aldosterone
2. ADH
3. **both aldosterone and ADH**
4. none

SOLUTION

both aldosterone and ADH

Exercise | Q 2. (A) | Page 191
Answer the following question.
Doctors say Mr. Shaikh is suffering from urolithiasis. How it could be explained in simple words?

SOLUTION

Urolithiasis is the condition of having calculi in the urinary tract (which also includes the kidneys), which may pass into urinary bladder.

Exercise | Q 2. (B) | Page 191

Answer the following question.

Anitaji needs to micturate several times and feels very thirsty. This is an indication of change in permeability of certain part of nephron. Which is this part?

SOLUTION

1. Need to micturate several times (polyuria) and feeling very thirsty (polydipsia) is a symptom of diabetes insipidus (imbalance of fluids in the body).
2. ADH prevents diuresis and due to absence of ADH, large amount of dilute urine is excreted.
3. ADH stimulates reabsorption of water from last part of DCT and entire collecting duct by increasing the permeability of cells.
4. If the permeability of these cells changes, it will result in increase in urine volume (frequent micturition) and increase in the osmolarity of blood. An imbalance in volume and osmolarity of body fluids increases thirst.

Exercise | Q 2. (C) | Page 191

Answer the following question.

Effective filtration pressure was calculated to be 20 mmHg; where glomerular hydrostatic pressure was 70 mm of Hg. Which other pressure is affecting the filtration process? How much is it?

SOLUTION

The other pressure affecting the filtration process is osmotic pressure of blood and filtrate hydrostatic pressure.
Commonly effective filtration pressure (EFP) is represented as;
EFP = Glomerular Hydrostatic pressure in glomerulus – (Osmotic pressure of blood + Filtrate Hydrostatic pressure)
If EFP = 20 mmHg and Glomerular Hydrostatic pressure = 70 mmHg
20 = 70 – (Osmotic pressure of blood + Filtrate hydrostatic pressure)
∴ (Osmotic pressure of blood + Filtrate hydrostatic pressure) = 70 – 20
Then (Osmotic pressure of blood + Filtrate Hydrostatic pressure) = 50 mmHg

Exercise | Q 2. (D) | Page 191

Answer the following question.

Name any one guanotelic organism.

SOLUTION

Spiders, scorpions and penguins are guanotelic organisms as they excrete guanine.

Exercise | Q 2. (E) | Page 191

Answer the following question.

Why are kidneys called 'retroperitoneal'?

SOLUTION

Kidneys are located in abdomen. Kidneys are not surrounded by peritoneum instead they are located posterior to it. Thus, kidneys are called retroperitoneal.

Exercise | Q 2. (F) | Page 191

Answer the following question.
State the role of liver in urea production.

SOLUTION

1. Ammonia formed during the breakdown of amino acids is converted into urea in the liver of ureotelic animals.
2. This conversion takes place by the help of the ornithine/urea cycle.
3. 3 ATP molecules are used to produce one molecule of urea using the ornithine/urea cycle.

   Since, the liver contains carrier molecules and enzymes necessary for urea cycle, it plays a major role in urea production.

Exercise | Q 2. (G) | Page 191

Answer the following question.
Why do we get bad breath after eating garlic or raw onion?

SOLUTION

1. Raw onion and garlic contain volatile sulphur-containing compounds.
2. Sulphur-containing compounds have a distinctive odour which remain in the mouth after consumption of onion and garlic.
3. Also, volatile compounds (like certain sulphur containing compounds) in foodstuffs are generally excreted through the lungs and may result in bad breath.

Exercise | Q 3. (A) | Page 191

Answer the following question.
John has two options as a treatment for his renal problem: Dialysis or kidney transplants. Which option should he choose? Why?

SOLUTION

1. If John has two options of dialysis and kidney transplant, readily available he must opt for kidney transplant.
2. A kidney transplant, if successful, can improve the quality of life of a patient and reduce the risk of death.

3. The patient would not have to endure frequent dialysis procedures. Repeated visits for dialysis takes time and may not allow the patient to perform normal activities or go to office regularly.
4. Dialysis is regarded as a holding measure until kidney transplant can be performed or a supportive measure in those for whom a transplant would be inappropriate. However, dialysis cannot replace all the functions of a normal kidney such as production of hormones like erythropoietin, calcitriol and renin. Hence, if John has an option of kidney transplant, he must opt for it.

Exercise | Q 3. (B) | Page 191

Answer the following question.
Amphibian tadpole can afford to be ammonotelic. Justify.

SOLUTION

1. Tadpole (larval stage of life cycle of amphibian) is aquatic. They are ammonotelic as they excrete nitrogenous waste in the form of ammonia.
2. Ammonia is very toxic and requires large amount of water for its elimination.
3. It is readily soluble in water and diffuses across the body surface and into the surrounding water.
4. Also, the water lost during excretion can be made up through the surrounding water in ammonotelic organisms.
   Hence, amphibian tadpole can afford to be ammonotelic.

Exercise | Q 3. (C) | Page 191

Answer the following question.
Birds are uricotelic in nature. Give reason.

SOLUTION

1. Birds are capable of converting ammonia into uric acid by ‘inosinic acid pathway’ in their liver.
2. Uric acid is least toxic and hence, it can be retained in the body for some time.
3. It is least soluble water hence, negligible amount of water is required for its elimination.
4. This mode of excretion can also help reduce body weight (an adaptation for flight) and those animals which need to conserve more water follow uricotelism.
   Hence, in order to conserve water as an adaptation for flight, birds are uricotelic in nature.

Exercise | Q 4. (A) | Page 191

Write the explanation in your words.
Nitya has been admitted to hospital after heavy blood loss. Till proper treatment could be given; how did Nitya's body must have tackled the situation?

SOLUTION

1. Heavy blood loss is called haemorrhage. In case of haemorrhage or severe dehydration, the osmoreceptors stimulate Antidiuretic hormone (ADH) secretion.

2. ADH is important in regulating water balance through the kidneys.

   Regulating water reabsorption through ADH:

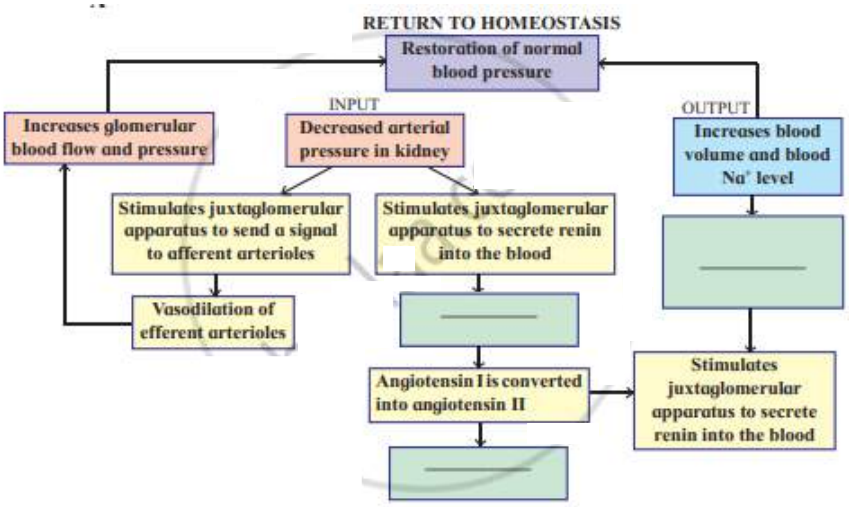
   Hypothalamus in the midbrain has special receptors called osmoreceptors which can detect change in osmolarity (measure of total number of dissolved particles per liter of solution) of blood. If osmolarity of blood increases due to water loss from the body (after eating namkeen or due to sweating), osmoreceptors trigger release of Antidiuretic hormone (ADH) from neurohypophysis (posterior pituitary). ADH stimulates reabsorption of water from last part of DCT and entire collecting duct by increasing the permeability of cells. This leads to reduction in urine volume and decrease in osmolarity of blood. Once the osmolarity of blood comes to normal, activity of osmoreceptor cells decreases leading to decrease in ADH secretion. This is called negative feedback. In case of hemorrhage or severe dehydration too, osmoreceptors stimulate ADH secretion. ADH is important in regulating water balance through kidneys. In absence of ADH, diuresis (dilution of urine) takes place and person tends to excrete large amount of dilute urine. This condition called as diabetes insipidus.

3. Another regulatory mechanism that must have been activated is RAAS.

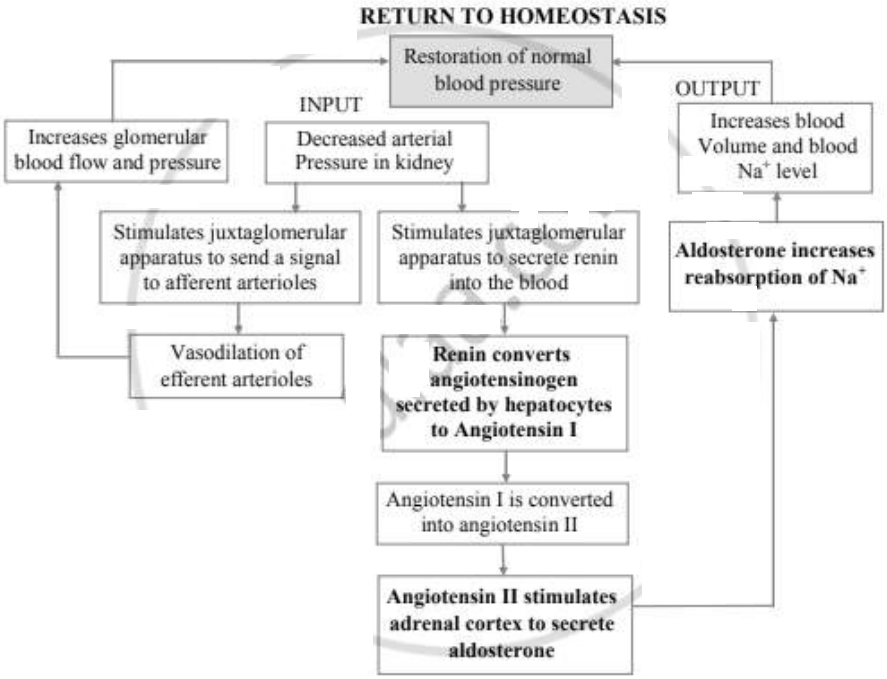
   Electrolyte reabsorption through RAAS: Another regulatory mechanism is RAAS (Renin Angiotensin Aldosterone System) by Juxta Glomerular Apparatus (JGA). Whenever blood supply (due to change in blood pressure or blood volume) to afferent arteriole decreases (e.g. low BP/dehydration), JGA cells release Renin. Renin converts angiotensinogen secreted by hepatocytes in liver to Angiotensin I. 'Angiotensin converting enzyme' further modifies Angiotensin I to Angiotensin II, the active form of hormone. It stimulates adrenal cortex to release another hormone called aldosterone that stimulates DCT and collecting ducts to reabsorb more Na + and water, thereby increasing blood volume and pressure.

Exercise | Q 5. (A) | Page 191

Complete the diagram/chart with correct labels/ information. Write the conceptual details regarding it.

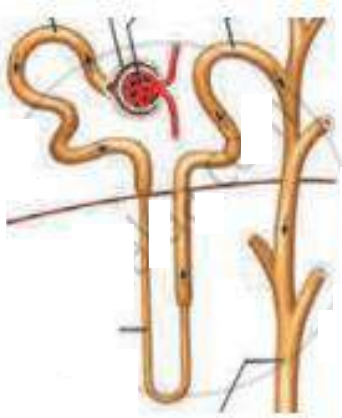


SOLUTION

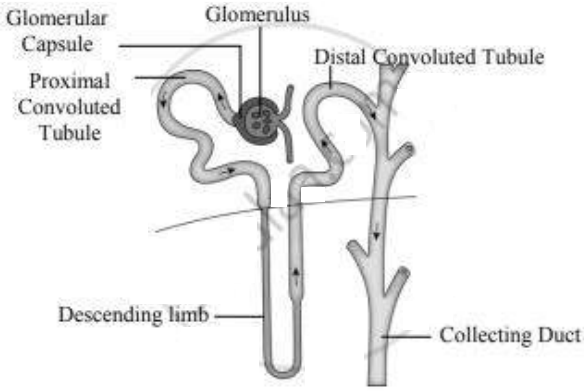


Exercise | Q 5. (B) | Page 191

Complete the diagram/chart with correct labels/ information. Write the conceptual details regarding it.



SOLUTION



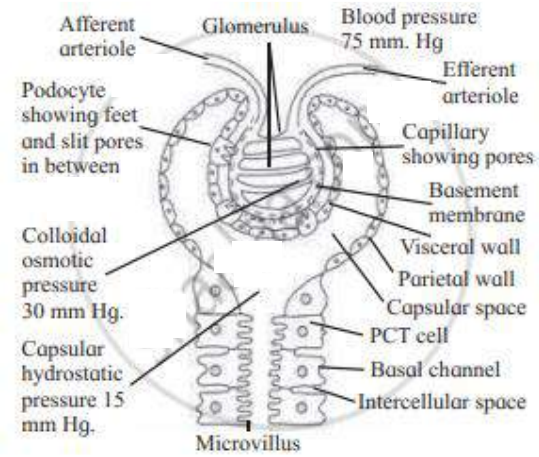
1. Nephrons are structural and functional units of kidney.
2. Each nephron consists of a 4 – 6 cm long, thin-walled tube called the renal tubule and a bunch of capillaries known as the glomerulus.
3. The wall of the renal tubule is made up of a single layer of epithelial cells.
4. Its proximal end is wide, blind, cup-like and is called as Bowman's capsule, whereas the distal end is open.
5. The nephron is divisible into Bowman's capsule, neck, proximal convoluted tubule (PCT), Loop of Henle (LoH), distal convoluted tubule (DCT) and collecting tubule (CT).
6. The glomerulus is present in the cup-like cavity of Bowman's capsule and both are collectively known as renal corpuscle or Malpighian body.

Exercise | Q 5. (C) | Page 1

Complete the diagram/chart with correct labels/ information. Write the conceptual details regarding it.

SOLUTION

Malpighian body-



Nephron is the structural and functional unit of kidney.

Malpighian body: Each Malpighian body is about 200µm in diameter and consists of a Bowman's capsule and glomerulus.

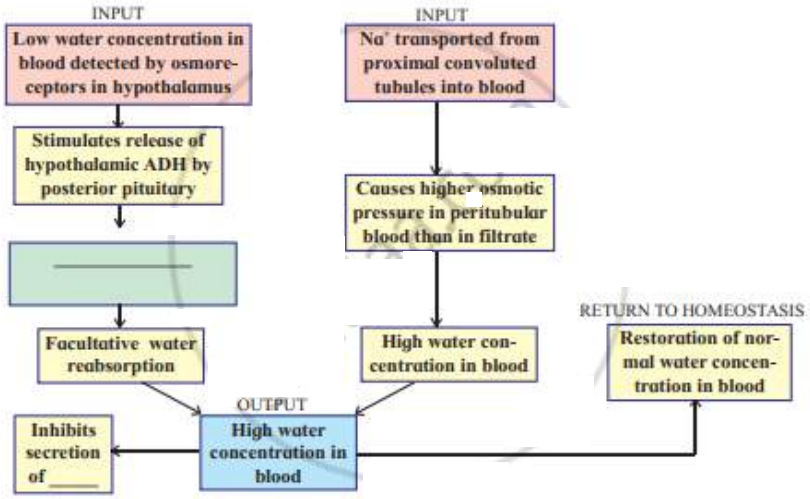
1. **Glomerulus:**
   Glomerulus is a bunch of fine blood capillaries located in the cavity of Bowman's capsule. A small terminal branch of the renal artery, called as afferent arteriole enters the cup cavity (Bowman capsule) and undergoes extensive fine branching to form network of several capillaries. This bunch is called as glomerulus. The capillary wall is fenestrated (perforated). All capillaries reunite and form an efferent arteriole that leaves the cup cavity. The diameter of the afferent arteriole is greater than the efferent arteriole. This creates a high hydrostatic pressure essential for ultrafiltration, in the glomerulus.

2. **Bowman's capsule:**
   It is a cup-like structure having double walls composed of squamous epithelium. The outer wall is called as parietal wall and the inner wall is called as visceral wall. The parietal wall is thin consisting of simple squamous epithelium. There is

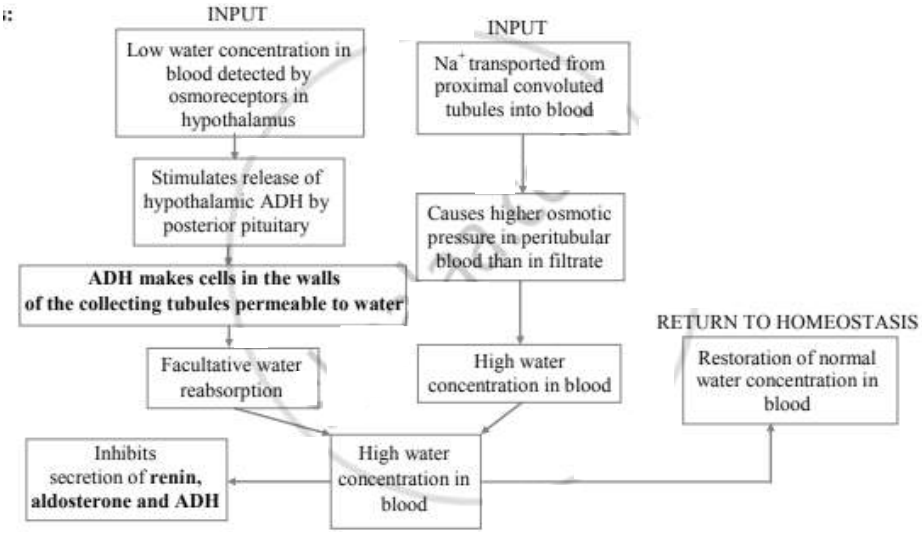
a space called as capsular space / urinary space in between two walls. Visceral wall consists of special type of squamous cells called podocytes having a foot-like pedicel. These podocytes are in close contact with the walls of capillaries of glomerulus. There are small slits called as filtration slits in between adjacent podocytes.

Exercise | Q 5. (D) | Page 192

Complete the diagram/chart with correct labels/ information. Write the conceptual details regarding it.



SOLUTION



The composition of urine depends upon food and fluid consumed by an individual. There are two ways in which it the composition is regulated. They are as follows:

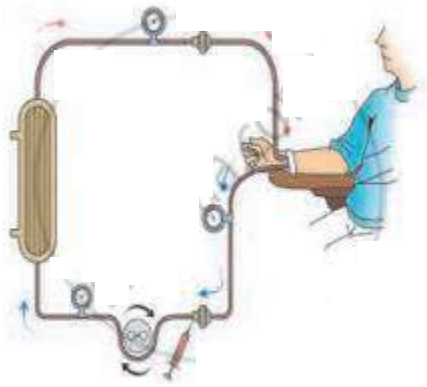
1. **Regulating water reabsorption through ADH:**
   Hypothalamus in the midbrain has special receptors called osmoreceptors which can detect a change in osmolarity (measure of a total number of dissolved particles per liter of solution) of blood. If osmolarity of blood increases due to water loss from the body (after eating namkeen or due to sweating), osmoreceptors trigger the release of Antidiuretic hormone (ADH) from neurohypophysis (posterior pituitary). ADH stimulates reabsorption of water from the last part of DCT and the entire collecting duct by increasing the permeability of cells. This leads to a reduction in urine volume and a decrease in osmolarity of blood. Once the osmolarity of blood comes to normal, the activity of osmoreceptor cells decreases leading to a decrease in ADH secretion. This is called negative feedback. In case of hemorrhage or severe dehydration too, osmoreceptors stimulate ADH secretion. ADH is important in regulating water balance through the kidneys. In absence of ADH, diuresis (dilution of urine) takes place and person tends to excrete large amounts of dilute urine. This condition called diabetes insipidus.

2. **Electrolyte reabsorption through RAAS:**
   Another regulatory mechanism is RAAS (Renin Angiotensin Aldosterone System) by Juxta Glomerular Apparatus (JGA). Whenever blood supply (due to change in blood pressure or blood volume) to afferent arteriole decreases (e.g. low BP/dehydration), JGA cells release Renin. Renin converts angiotensinogen secreted by hepatocytes in the liver to Angiotensin I. 'Angiotensin-converting enzyme' further modifies Angiotensin I to Angiotensin II, the active form of the hormone. It stimulates the adrenal cortex to release another hormone called aldosterone that stimulates DCT and collecting ducts to reabsorb more Na^+ and water, thereby increasing blood volume and pressure.

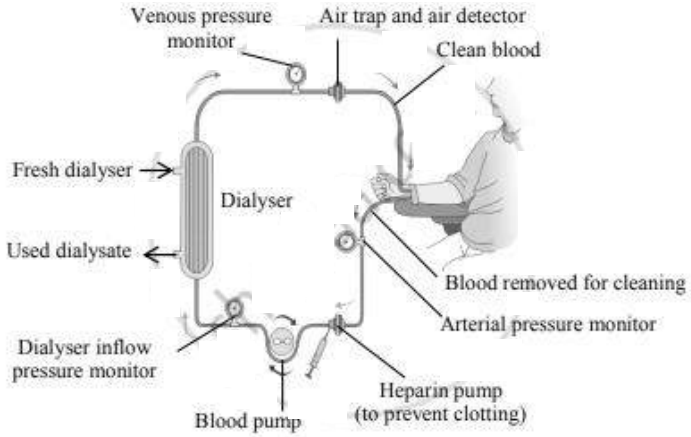
3. **Atrial natriuretic peptide (ANP):**
   A large increase in blood volume and pressure stimulates the atrial wall to produce atrial natriuretic peptide (ANP). ANP inhibits Na^+ and Cl^- reabsorption from collecting ducts inhibits the release of renin, reduces aldosterone and ADH release too. This leads to a condition called Natriuresis (increased excretion of Na^+ in urine) and diuresis.

Exercise | Q 5. (E)

Complete the diagram/chart with correct labels/ information. Write the conceptual details regarding it.



SOLUTION



1. When the renal function of a person falls below 5 – 7 %, the accumulation of harmful substances in the blood begins. In such a condition, the person has to go for artificial means of filtration of blood i.e. hemodialysis.

2. In haemodialysis, a dialysis machine is used to filter blood. The blood is filtered outside the body using a dialysis unit.

3. In this procedure, the patients' blood is removed; generally from the radial artery and passed through a cellophane tube that acts as a semipermeable membrane.

4. The tube is immersed in a fluid called dialysate which is isosmotic to normal blood plasma. Hence, only excess salts if present in plasma pass through the cellophane tube into the dialysate.

5. Waste substances being absent in the dialysate, move from the blood into the dialyzing fluid.

6. The filtered blood is returned to vein.

7. In this process it is essential that anticoagulant like heparin is added to the blood while it passing through the tube and before resending it into the circulation, an

adequate amount of anti-heparin is mixed.

8. Also, the blood has to move slowly through the tube and hence the process is slow.

Exercise | Q 6 | Page 192

Prove that mammalian urine contains urea.

SOLUTION

1. Urea is a nitrogenous waste formed by breakdown of protein (deamination of amino acids).

2. During this process, amino groups are removed from the amino acids present in the proteins and converted to highly toxic ammonia. The ammonia is finally converted to area through ornithine cycle. Thus, the urea formed is passed to kidneys and excreted out of the body through urine.

3. Reabsorption of urea (proximal tubule, collecting ducts) and active secretion of urea (Henle loop) leads to a urea circulation (urea recycling) between the lumen of the nephron and renal medulla, which is an important element of the renal urine concentration.

4. About 54 g of urea is filtered per day in the glomerular capsule, of which approximately 30 g is excreted in the urine and 24 g is reabsorbed into blood (assuming GFR is 180 litres/day).

5. Urinalysis can help detect the amount of urea in urine (Urine urea nitrogen test, urease test, etc.).