16. Excretion and Osmoregulation

16.0 : Introduction

Q.1. Define Excretion.

Ans: The process of separation, collection and elimination of nitrogenous waste products from the body is called excretion.

Q.2. Which excretory products are formed in the body ?

Ans: i) CO_2, H_2O, bile pigments and nitrogenous wastes are waste products formed in the body.

ii) Excess of inorganic salts, hormones and vitamins are also considered as wastes.

16.1 : Modes of Excretion

Q.3. Define deamination.

Ans: It is the process of removal of the excess of amino acids in the liver by converting it into ammonia.

Q.4. Name the three modes of excretion.

Ans: Three modes of excretion are : i) Ammonotelism. ii) Ureotelism. iii) Uricotelism.

Q.5. What is Excretion? Describe the various modes of excretion in animals. [Mar 09]

OR

Write a short note on i) Ammonotelism ii) Ureotelism iii) Uricotelism

Ans: Excretion : The process of separation, collection and elimination of nitrogenous waste products from the body is called excretion.

Modes of excretion in animals :

Based on the types of nitrogenous wastes there are four modes of excretion as given below :

i) Ammonotelism :

a) A process by which the nitrogenous waste is eliminated in the form of ammonia is called **Ammonotelism** and the animal is called **ammonotelic animal.**

b) Ammonia is highly soluble in water and highly toxic to the body.

c) It can be eliminated by simple diffusion.

d) Elimination of ammonia requires large quantity of water.

e) To eliminate one gm of ammonia, about 300 to 500 ml of water is required.

f) Ammonotelism is seen in aquatic invertebrates, bony fishes, tadpole larvae of frog etc.

g) In these animals, ammonotelism takes place through skin, gills and kidneys.

ii) Ureotelism :

a) The process by which the nitrogenous waste is eliminated in the form of urea is called ureotelism and the animal is called ureotelic animal.

b) In liver of these animals, ammonia combines with carbon dioxide to form urea which is less toxic.

c) Formation of urea requires expenditure of energy and takes place by ornithine cycle.

d) Urea can be stored for sometime in the body and can be excreted at lower rate.

e) Elimination of urea requires moderate amount of water i.e. 50 rnl of water for one gm of urea.

f) Ureotelism is seen in terrestrial animals like frog, turtles, toads, mammals, marine fishes etc.

iii) Uricotelism :

a) The process by which organisms eliminate nitrogenous waste in the form of uric acid is called **Uricotelism** and the animal is called **uricotelic animal.**

b) In liver of these animals, uric acid is formed from ammonia by ionosinic pathway.

c) Uric acid is insoluble in water and is least toxic.

d) It can be excreted out in the form of paste or solid pellets.

e) Its elimination requires negligible amount of water i.e. about 10 ml of water for one gm of uric acid.

f) Uricotelism is seen terrestrial animals like frog, turtles, toads, mammals, marine fishes etc.

Additional Information

Q.6. Write a short note on Guanotelism.

Ans:i) Excretion of guanine (a nitrogen base) is called guanotelism.
ii) Animals showing guanotelism are called guanotelic.
iii) Arachnids like spiders, scorpions and penguins are guanotelic.

Q.7. Which is the most toxic excretory product formed in animals ?

Ans: Ammonia is the most toxic excretory product formed in animals.

Q.8. Name the excretory product of marine fishes.

Ans: Urea is the excretory product of marine fishes.

Q.9. Human is ureotelic. Explain. OR
Terrestrial animals excrete urea as a nitrogenous waste. Explain.

Ans: i) Ammonia is more poisonous than urea.
ii) It cannot be excreted out immediately.
iii) Therefore it is converted into urea in the liver.
iv) Urea is soluble in water requires less water and can be excreted out through urine.
v) Urea is less toxic and can be stored for long time in the body.

Q.10. Tadpole larva is ammonotelic. Give reasons.

Ans:i) Tadpole larva is aquatic.
ii) In tadpole larva nitrogenous waste are eliminated in the form of ammonia.
iii) Ammonia is highly soluble in water so it is very toxic.
iv) For elimination of ammonia, large quantities of water is required.
v) Water loss occur during excretion can be made good through surrounding' water.

Q.11. Given reason: Aquatic animals excrete their nitrogenous waste products in the form of ammonia.

Ans:i) For aquatic animals considerable amount of water is available.
ii) Ammonia is highly soluble in water. It gets dissolved in water and is passed out continuously.
iii) Whatever water loss is there during excretion can be recovered from the surrounding water.

Q.12. Reptiles can survive in region with the scarcity of water. How ?

Ans:i) Reptiles are uricotelic animals eliminating nitrogenous wastes in the form of uric acid.
ii) Uric acid requires negligible amount of water for excretion.
iii) Thus reptiles can survive in region with scarcity of water.

Q.13. Why do birds excrete nitrogenous waste in the form of uric acid ?

Ans:i) Birds can synthesize uric acid from ammonia.
ii) Uric acid requires very less or no water for its elimination.
iii) This helps in the conservation of water as an adaption for flight.

Q.14. Distinguish between Ureotelism and Uricotelism. **[Mar 08]**

Ans:

No.	Ureotelism	Uricotelism
i.	It is the elimination of nitrogenous waste in the form of urea.	It is the elimination of nitrogenous waste in the form of uric acid.
ii.	Excretion of urea requires moderate amount of water.	Excretion of uric acid requires negligible amount of water.
iii.	Removal of 1 gm of urea requires 50 ml of water.	Removal of 1gm of uric acid requires 10ml of water.
iv.	It is excreted in the form of urine.	It is excreted in the form of solid pellets or thick paste.
v.	Urea is less toxic.	Uric acid is least toxic.
vi.	It can be retained in body for small duration.	It can be retained in body for longer duration.
vii.	It is seen in terrestrial animals like frog, mammals, marine fishes etc.	It is seen in terrestrial animals, reptiles and birds.

Q.15. Distinguish between Ammonotelism and Uricotelism.

Ans:

No.	Ammonotelism	Uricotelism
i.	It is the elimination of nitrogenous waste in the form of ammonia.	It is the elimination of nitrogenous waste in the form of uric acid.
ii.	Excretion of ammonia requires plenty of water.	Excretion of uric acid requires negligible amount of water.
iii.	Removal of 1gm of ammonia requires 300-500 ml of water.	Removal of 1gm of uric acid requires 10ml of water.
iv.	Ammonia is excreted in the form of liquid.	Uric acid is excreted in the form of paste or solid pellets.
v.	Ammonia is very toxic.	Uric acid is least toxic.
vi.	It is found in aquatic animals like aquatic invertebrates and bony fishes.	It is found in reptiles and birds.
vii.	Ammonia needs immediate removal.	Uric acid can remain in body for longer time.

Q.16. Terrestrial animals are generally either ureotelic or uricotelic, not ammonotelic. Why ?

Ans: i) Ammonia is highly toxic to animals and it requires large amount of water to dissolve and eliminate ammonia.

ii) Terrestrial animals cannot lose such a large amount of water.

iii) Ureotelism and uricotelism requires less amount of water.

iv) Hence to conserve water ureotelism and uricotelism is adapted.

Q.17.What is gout ?

Ans: Gout is the painful arthritis in whic..h excess uric acid gets deposited injoints of bone due to defective metabolism

16.2 : Human Excretory System

Q.18.Describe the human excretory system. Add a note on V.S of kidney. **[Mar 09]**

OR

Describe the V.S. of human kidney with a neat labelled diagram. **[Mar 10]**

OR

Sketch and label V.S. of human kidney. **[Oct 08]**

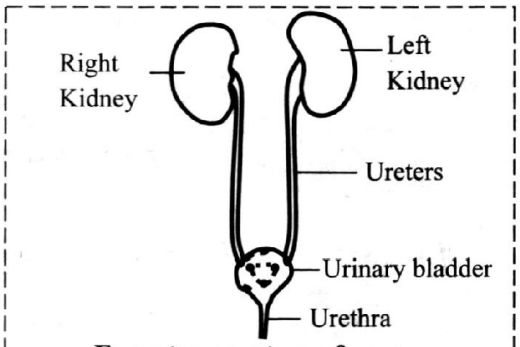
OR

With the help of a neat labelled diagram describe excretory system of man and add a note on V.S. of Kidney. **[Mar 2013 old course]**

OR

Ans:Excretory system of man consists of

A. Kidneys (a pair) **B. Ureters (a pair)** **C. Urinary Bladder** **D. Urethra**



Excretory system of man

A. Kidneys :

Kidneys are a pair of dark red, bean shaped organs about 10 em long, 5cm wide and 4 em thick.

They are attached to the dorsal body wall at the level of iz" thoracic to 3rd lumbar vertebra in the abdominal cavity.

They are retroperitoneal as they have 'peritoneal covering only on the anterior surface. They are situated on either side of the vertebral column. The right kidney is slightly lower than left kidney due to presence of

liver. Left kidney is slightly back than right kidney due to the position of stomach in front of it. On the concave surface there is a notch called hilus or hilum. Through the hilum, blood vessels, nerves, ureter, lymphatic vessels enter or exit. Renal arteries enter in both the kidneys while renal veins leave the kidneys. Each kidney is covered by three layers of tissues such as outer renal fascia, middle adipose tissue (perirenal fat) and inner renal capsule.

Functions:
i) Removal of nitrogenous waste
ii) Maintenance of water-salt balance [Homeostasis]
iii) Removal of excess of foreign substances like drugs and pigments.
iv) Osmoregulation.

B. Ureters :

From the hilum of each kidney, a thin, narrow and muscular duct emerges out which is called as ureter. It measures about 40cm in length. The ureters open into urinary bladder.

Functions: They carry urine from kidneys upto the urinary bladder by **peristalsis.**

C. Urinary bladder :

It is single, large and pear shaped structure.
It is located in pelvic cavity just behind the pubis bone.
It is thick walled and highly muscular.
It has a layer of detrusor muscles.
These muscles help in the expansion during the time of storage of urine.

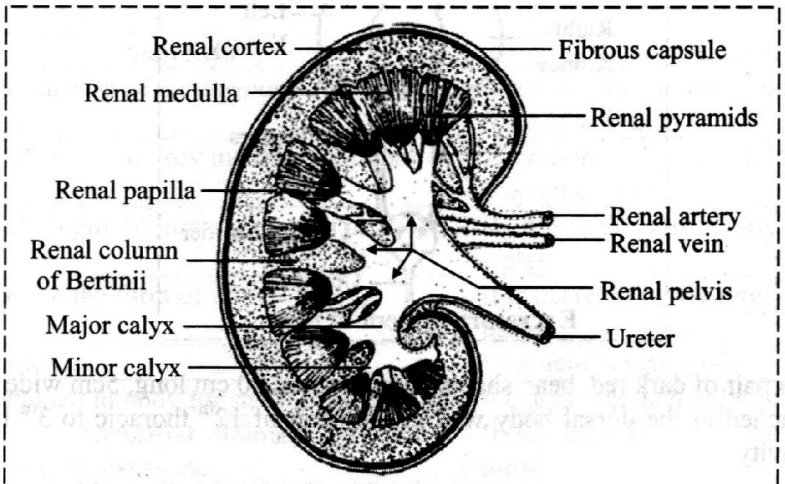
Functions : It stores urine temporarily (500 rnl to I litre of urine) and expels it at intervals through urethra.

D. Urethra :

It starts from the lower part of the urinary bladder and opens to the exterior.
Its opening is guarded by sphincter muscle called urethral sphincter.
Through urethral sphincter micturition (urination) takes place.
In males, urethra is long (20 cm) and has to pass through the penis.
In females, it is short (4 cm) and opens in vestibule.

L.S. of kidney :

Each kidney is covered by semi-liquid fatty tissue called adipose capsule. Outer covering of this capsule is made up of tough fibrous connective tissue called renal fascia. In L.S., kidney shows two regions within the capsule, renal cortex and renal medulla



V.S. of human kidney

i. Renal Cortex :

It is the outer peripheral region of kidney and is dark red in color.
The part of cortex continues inside the medulla between the pyramids.
These are called columns of Bertini.

ii. Renal Medulla :

It is present below the cortex and is light red in color.
It contains 6-20 conical projections called renal pyramids.
Renal pyramids are separated from each other by the projections of cortex called columns of Bertini.

Base of each renal pyramid is attached to the cortex while the narrow apex is directed towards an inner space called renal papillae.

The cup shaped structures at the apex of pyramid are called **minor calyx.**

2–3 calyces join to form **major calyx** while 2-3 major calyces open into a large space called **renal pelvis** i.e. **renal sinus.**

Renal pelvis is situated near hilus.

Urine is collected in the renal pelvis and passed down to ureter.

Q.19.Distinguish between the Ureter and Urethra.

Ans:

No.	Ureter	Urethra
i.	Ureters are two duct like structures arising from the pelvis of the kidney.	Urethra is a single tube-like structure arising from the urinary bladder.
ii.	Ureter carries urine from the kidney to the urinary bladder.	Urethra carries urine from the urinary bladder to the exterior of the body.
iii.	Ureters open into the urinary bladder by lateral openings.	Urethra opens to the outside by urethral sphincter.
iv.	Ureters are 40cm long.	Urethra in males is 20 cm long and in females it is about 4 cm long.
v.	Openings of ureters into urinary bladder are not under voluntary control. Urine keeps on trickling involuntarily into the urinary bladder.	Opening of urethra is under voluntary control. Urine is passed out of the body at one's own will.

Q.20.What are column of Bertini ?

Ans: Renal pyramids are separated from each other by the projections of cortex ,these projections are called column of Bertini.

Q.21. Explain the term Micturition.

Ans: i) The process of passing out urine is called micturition.

ii) When urine collects, the muscular wall of the bladder distend to accommodate it

iii) Distension of wall stimulates nerve ending in the bladder wall and set up reflexes,which cause an urge to pass urine.

iv) During discharge of urine, the urethral sphincter relax and smooth muscle of the bladder contract.This slowly drives urine from bladder.

Q.22.Explain blood circulation within the kidney.

i) Each kidney receives blood through renal artery; a branch of dorsal aorta.

ii) Each renal artery breaks into renal arterioles which further branch into afferent arteriole.

iii) Afferent arteriole branches into a number of capillaries to form glomerulus.

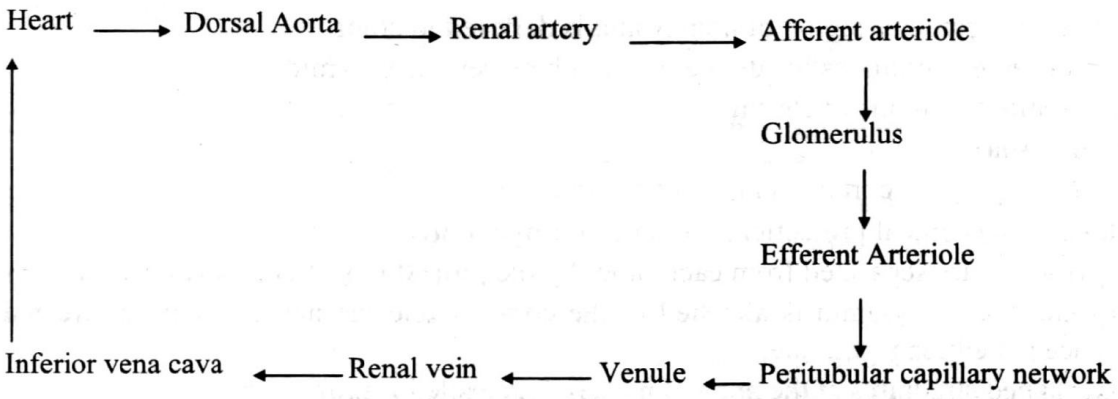
iv) Glomerular capillaries reunite to form efferent arteriole.

v) Afferent arteriole breaks up into capillaries which form a network around renal tubule called peritubular capillary network.

vi) These capillaries join to form venules which join to form renal vein.

vii) Renal vein drains blood into inferior vena cava which returns blood to heart.

It can be shown as given below :



Q.23. Write the main functions of kidney.

Ans: Functions of Kidneys :

i) **Excretion :** Removal of nitrogenous waste.
ii) Maintenance of water balance.
iii) Regulation of the pH of body fluid (Acid-Base balance).
iv) Regulation of salt content.
v) Regulation of blood pressure and blood volume.
vi) Elimination of excess soluble substances like vitamins, medicine, antibiotics, pigments etc.
vii) Thus kidney helps in homeostasis.

Q.24.With the help of a well labelled diagram describe the structure of nephron. [Mar 09]

OR

Describe the structure of Malpighian body. [Mar 08]

OR

Describe Malpighian body. Explain its role in urine formation.

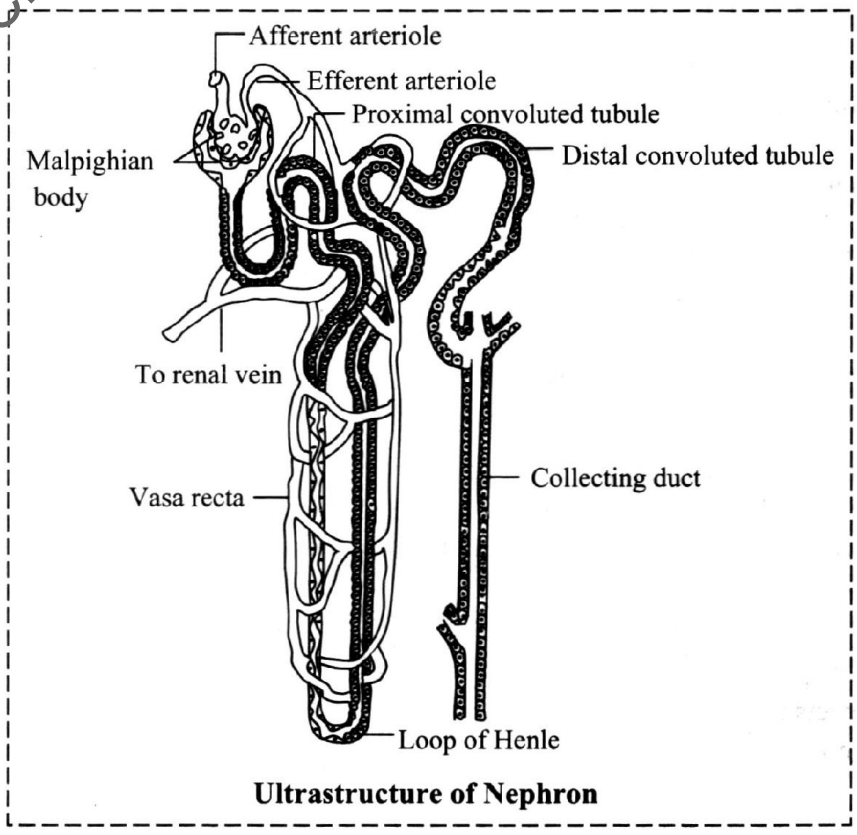
Ans: Nephron is functional unit of kidney. Each kidney contains about 1.2 millions ofnephrons.

Structure of nephron :

A nephron (uriniferous tubule) is a thin walled, coiled duct lined by a single layer of epithelial cells.

Each nephron is divided into two main parts.

i) Malpighian body / Malpighian corpuscle ii) Renal body



Ultrastructure of Nephron

i) Malpighian Body / Malpighian corpuscle/Pygmalion corpuscle :

It is cup-shaped part of nephron and is located in the cortex of kidney.

It consists of two parts namely :

a) Bowman's capsule :

It is the proximal blind end of the nephron and encloses the glomerulus. It is about 1.2 mm in diameter. It is double walled cup-shaped structure. Outer wall is known as parietal layer and inner wall is known as visceral layer. Outer wall is lined by flat squamous epithelium while inner wall is lined by modified epithelium cells called **podocytes.** Podocytes produce foot processes,

which form intimate contact with glomerulus. These cells leave microscopic pores and help in ultrafiltration. The space present between the two layers is called as **capsular space** or **urinary space.** The site at which urinary space continues into tubule is called as **urinary pole.**

b) Glomerulus :

It is present in the cavity of Bowman's capsule. It contains a tuft of 6 to 8 **renal blood capillaries** invaginated into the end of a tubule. It is a capillary network of **afferent** and **efferent renal arterioles.** Afferent arteriole supply blood to the glomerulus while the efferent arteriole carry the blood away from glomerulus. The diameter of afferent arteriole is larger than the efferent arteriole.

Functions:

Ultrafiltration of blood.

ii. Renal tubule :

It is long tubular and coiled part of nephron. It extends from cortex to medulla and then back into cortex of kidney. It consists of short, narrow neck and long renal tubule.

a) Neck :

It is indistinct, narrow and short part of nephron. It is internally lined by **ciliated epithelium.** It connects malpighian body to the renal tubule.

b) Renal tubule :

It is long tubular and coiled part of nephron. It consists of Proximal Convoluted Tubule (PCT), Loop of Henle's, Distal Convoluted Tubule (DCT) and Collecting Tubule (CT).

i) Proximal Convoluted Tubule (PCT) :

It is situated in the cortex of kidney. It is initially convoluted and distally straight. It is lined by cuboidal epithelium cells provided with **microvilli** to form **brush border** to increase the surface area for absorption. The cells contain many **mitochondria** to provide energy for **active absorption.**

Function: Reabsorption of useful substances from the filtrate.

ii) Loop of Henle :

It is located in the medullary region of kidney. It is straight tube and forms 'U' shaped structure. It consists of Descending Limb (DL), U shaped Hairpin turn and Ascending Limb (AL) . and connects to DCT.

Function of loop of Henle: Regulation of salt water balance.

iii) Distal convoluted tubule (DCT) :

It is present in the cortex of kidney. It is short, highly convoluted tubule. It is lined by cuboidal epithelium without microvilli. It is wider thin walled and connects to collecting tubule.

Functions:

a) Active reabsorption of Na^+ ions. Passive reabsorption of Cl^- ions.
b) Secretion of K^+, H^+ from blood into filtrate.
c) Maintain pH.

iv) Collecting tubule (CT) :

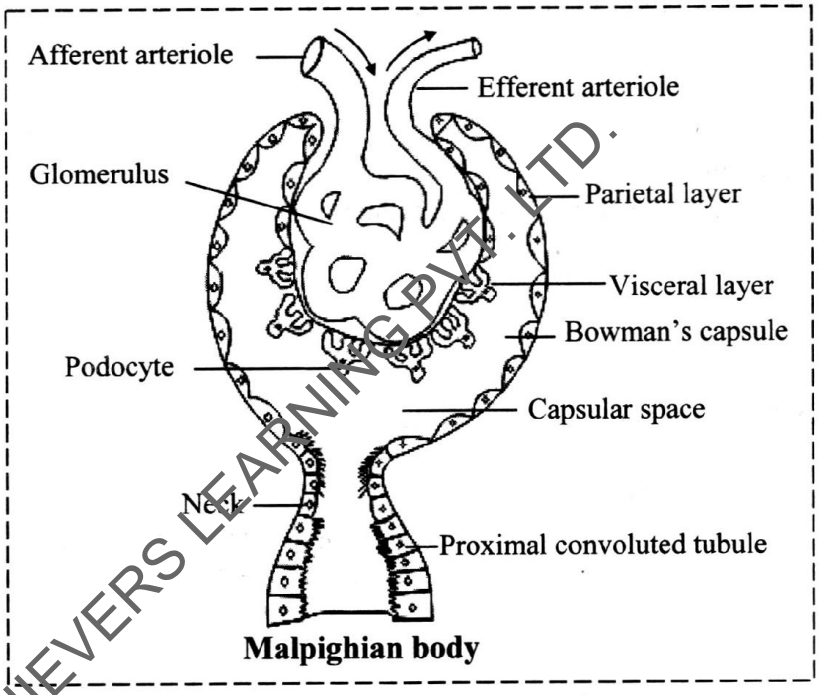
a) It is distal terminal part of nephron lined by **brush bordered cuboidal epithelium.**
b) It opens into the minor and major calyces and then into the renal pelvis which opens into the hilum, then to ureter.
c) The collecting tubules of many nephrons open into a large **collecting duct:**

Functions:

a) It helps in reabsorption of water from the filtrate under the influence of ADH.
b) Concentrate urine.

Q.25. Sketch and label Malpighian body.

Ans:



Malpighian body

Q.26. Which is structural and functional unit of kidney ?
Ans: Nephron is the structural and functional unit of kidney.

Q.27. Name two components of malpighian body.
Ans: Bowman's capsule and glomerulus are the two components of malpighian body.

Q.28. In which part of the nephron flltration takes place?
Ans: In glomerulus of the nephron filtration takes place.

Q.29. Where are nephrons found?
Ans: Nephrons or uriniferous tubules are found in the kidneys.

16.3 : Composition and Formation of Urine

Q.30.Name the pigment which gives colour to the urine.
Ans: Urochrome is the pigment which gives colour to the urine.

Q.31.Define excretion. Explain the mechanism of urine formation.

OR

Describe the process of ultraflltration.

OR

Describe the physiology of urine formation in human. [Mar 08]

Ans: Excretion :

The process of separation, collection and elimination of nitrogenous waste products from the body is called **excretion.**

The kidneys do the function of urine formation.

This complex process is completed in 3 steps namely.

i) Ultrafiltration
ii) Selective Reabsorption
iii) Tubular Secretion

i) Ultrafiltration :

Filtration of blood under pressure is called Ultraflltration.

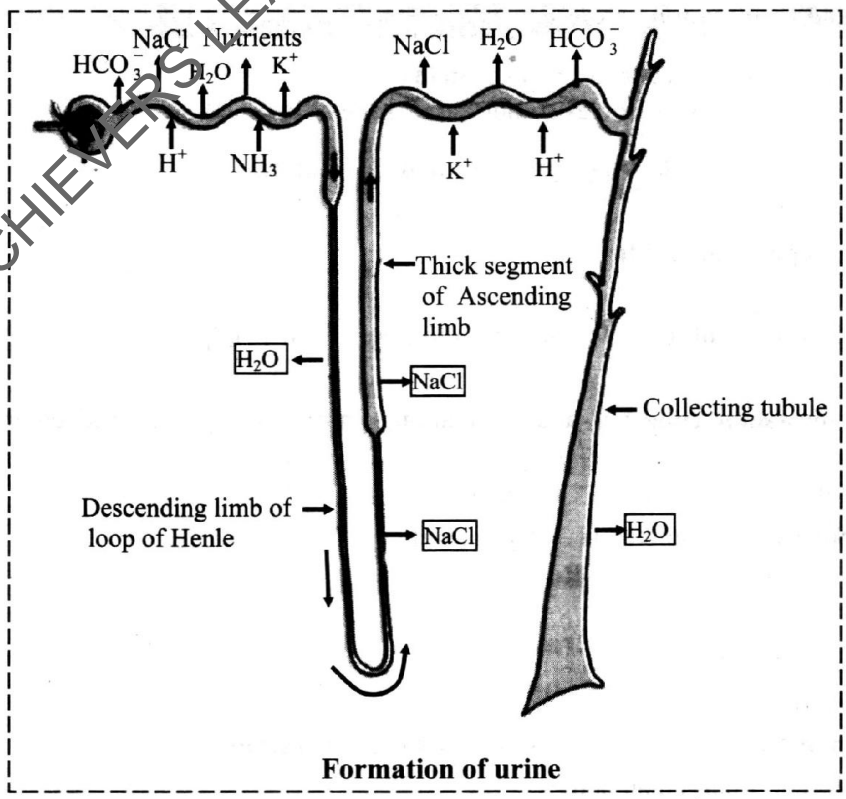
It takes place in Malpighian bodies.

It is physical process and occurs through the glomerulus under high osmotic pressure. Ultra pressure is developed in glomerulus due to difference in diameters of afferent and efferent renal arterioles. Blood enters the glomerulus at a fast rate through afferent arteriole with greater diameter and drains away by efferent arteriole with smaller diameter at slower rate. This creates hydrostatic pressure within glomerulus. This is called effective filtration pressure (EFP). The filtration takes place through

semipermeable membrane or filtration membrane under pressure. The ultrafiltrate enters the urinary space of Bowman's capsule. This filtrate is blood plasma without proteins (deproteinized plasma). About 125 ml of ultra filtrate is produced per minute.

ii) Selective reabsorption :

In this process 99% of the filtrate is reabsorbed. There are two processes involved in this step: Passive transport or osmosis and active transport. Active transport is transport against the concentration gradient by using ATP molecules. When the filtrate passes through the renal tubule there is exchange of substances between the blood in peritubular capillary network. High threshold substances e.g. glucose, amino acids, potassium and calcium ions etc. are completely reabsorbed. Urea and uric acid are low threshold substances. They are reabsorbed negligibly. Water is reabsorbed everywhere except in the ascending loop of Henle. This absorption occurs by osmosis and is known as obligatory absorption of water. Amino acids and ions are pumped out from peT. Glucose is maximally reabsorbed in healthy persons so that no glucose molecules remain in the urine. Urea is reabsorbed because urea molecule is very small and tubules are partially permeable to it



Formation of urine

iii) Tubular Secretion (Renal Secretion) :

It is also called active secretion or renal secretion. The separation and secretion of unwanted substances from peritubular capillary network into tubular fluid is called tubular secretion. During ultrafiltration some of the unwanted substances escape into the efferent arteriole. These substances are actively separated and secreted inside renal tubule such as K^+ion, H^+ion, creatinine, uric acid, penicillin, urea, ammonia etc. This process is important for homeostasis. Finally fluid become **hypertonic** which is excreted as urine. Absorption of water is controlled by ADH and absorption of salt is controlled by aldosterone.

Q.32.Describe the process of ultrafiltration.

Ans: *Refer Q. 31.*

Q.33. Where does the selective reabsorption of glomerular filtrate take place?

Ans: In the renal tubule selective reabsorption of glomerular filtrate takes place.

Q.34.Is the ultrafiltration in the glomerulus a passive or active process ?

Ans: It is a passive process.

Q.35. What are podocyte? In which part of the nephron are they present ?

Ans:i) An epithelium cells of the visceral layer of Bowman's capsule, having a foot like radiating processes

is called **podocyte.**

ii) They are present in Bowman's capsule of Nephron and attached to the outer surface of the glomerular capillary basement.

iii) Gaps between foot like processes are the filtration slits. They help in formation of ultra filtrate.

Q.36.Define glomerular filtration rate.

Ans: The amount of filtrate formed by kidneys per minute is known as the glomerular filtration rate. In a healthy individual, GFR is approximately 125ml per minute i.e. 180 litres per day.

Q.37.What is glomerular filtration pressure?

Ans: Glomerular filtration pressure (GFP) is the difference between the hydrostatic pressure(GHP) and the sum of blood colloidal osmotic pressure (BCOP)and capsular hydrostatic pressure(CHP) It can be represented as EFP = GHP – (BCOP + CHP)

Q.38. Define the following terms.

Ans:i) Glomerular hydrostatic pressure (GHP) :
Pressure developed in glomerulus due to difference in diameter of afferent and efferent arteriole is called Glomerular hydrostatic pressure.The GHP is normally 70mm Hg .

ii) Capsular hydrostatic pressure(CHP) :
The pressure developed in Bowman's capsule due to pre- existing fluid is called capsular hydrostatic pressure. CHP is 20mm Hg.

iii) Blood colloidal osmotic pressure :
Pressure developed in glomerulus due to plasma protein especially albumin is called blood colloidal osmotic pressure.BCOP is 32mm Hg.

Q.39. Write a short note on diabetes melitus.

Ans:i) Diabetes melitus is characterized by presence of glucose in urine i.e glucosuria.

ii) Reason for appearance of glucose in urine is all carrier sites are occupied and mechanism of active transport is overloaded.

Q.40.Define excretion. Describe the structure of nephron. Add a note on physiology of urine formation.

Ans: *Refer Q. 1,24 and 31.*

Q.41.Distinguish between selective reabsorption and tubular secretion.

Ans:

No.	Selective reabsorption	Tubular secretion
i.	Selective reabsorption is concerned with the selective absorption of useful substances from the glomerular filtrate.	Tubular secretion is concerned with the removal of unwanted substances from the peritubular blood capillaries
ii.	In this process, useful substances like glucose, amino acids and some salts are reabsorbed which are supplied back to the blood.	In this process, unwanted substances like ammonia, sodium and potassium salts, hydrogen ions and creatinine are removed from the blood and discharged along with the urine.
iii.	Selective reabsorption occurs in proximal convoluted tubule, Henle's loop, distal convoluted tubule and collecting duct.	Tubular secretion occurs in distal convoluted tubules only.

Q.42. Write the composition of urine.

Ans:i) Amount of urine produced depends upon the food and fluid consumed by the individual.

ii) About 1.2 to 1.5 litres of urine is produced per day.

iii) It is yellow in colour due to presence of pigment called urochrome.

iv) It shows presence of 95% water, organic substances like urea (2.5 %), uric acid creatinine which are formed in muscles.

Q.43. Explain the process of formation of urine with suitable diagram. Add a note on composition of urine. **[Oct 2013]**

Ans: *Refer Q. 31 & 42*

16.4 : Role of Kidney in Osmoregulation

Q.44. Define Osmoregulation.

Ans: Osmoregulation is the maintenance ofan optimal concentration of water and salts in the tissues and body fluids.

Q.45.Explain the term osmoregulation.

OR

What is meant by the term 'osmoregulation'?

Ans: i) Osmoregulation is the maintenance of an optimal concentration of water and salts in the tissues and body fluids.

ii) It is the maintenance of internal osmotic concentration (homeostasis) which is different from the surrounding medium.

iii) It is closely related to pH and temperature regulation.

iv) Kidney is the main organ concerned with osmoregulation.

Q.46.Explain role of kidney in osmoregulation.

OR

What is the effect of ADH on renal tubule ?

Ans: Role of kidney in osmoregulation :

i) Kidney tubules reabsorb water and prevent dehydration, thereby maintaining water balance.

ii) A pituitary hormone ADH (antidiuretic hormone) is released when water content of body fluids is low.

iii) ADH stimulates DCT and collecting duct to reabsorb more water and concentrated urine is produced.

iv) As against this if water content of body fluid is high, ADH secretion is suppressed and large amount of urine will be produced thus maintaining fluid balance.

Q.47. Which hormone deficiency causes diabetes insipidus? How ?

Ans: i) Diabetes insipidus is caused due to deficiency of ADH hormone.

ii) It is characterized by excessive thirst and excretion of large of amount of severely diluted urine.

iii) ADH hormone controls the permeability of distal convoluted tubule and collecting duct to water.

iv) If the volume of body fluid falls below nqrmal,ADH is released. It makes membrane of DCT and CT more permeable to water.

v) As a result water is passed from filtrate into interstitial fluid and maintain water balance.

vi) But in diabetes insipidus due to lack of ADH this mechanism fails resulting in excretion of large amount of urine.

16.5 : Kidney failure, Dialysis and Kidney stone, Transplantation

Q.48. Write a note on kidney failure.

Ans: i) Partial or complete or temporary loss of renal function is called kidney failure. Kidney failure is also called as Renal failure.

ii) Kidney failure is due to non-functioning of uriniferous tubules of the kidney.

iii. This means urea, excessive salts and other metabolic wastes are not filtered into the tubules from the blood, and consequently the toxic substances in the blood increases. Kidney failure or Renal failure can be divided into two types :

a) Acute Renal failure :

1) It is also called Acute kidney injury (AKI)
2) There is a sudden and severe reduction in the glomerular filtration rate.
3) Acute tubular necrosis (ATN) is the most common cause of acute renal failure.
4) It is characterised by oliguria (less than 400 ml of urine per day in adults) or anuria (absence of urine), and accumulation of urea and other metabolic waste products

b. Chronic Renal failure :

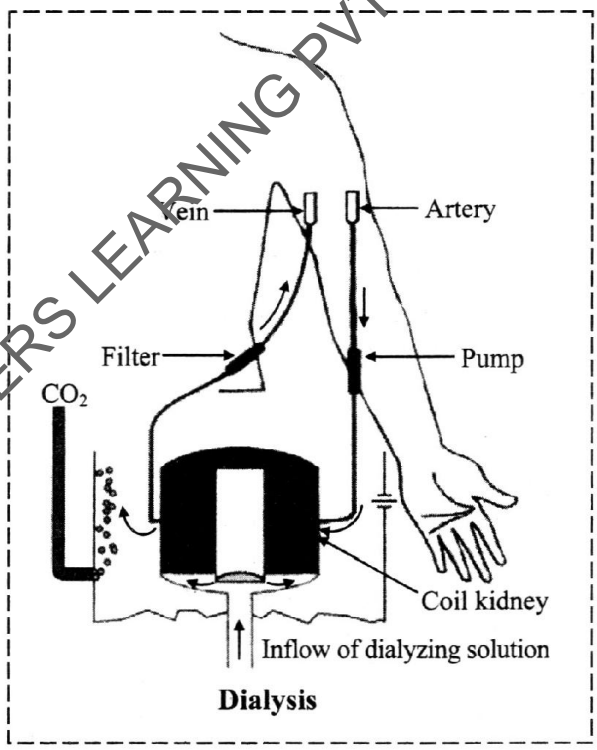
Chronic kidney disease may develop slowly. Initially shows few symptoms: CKD can be long term consequence of irreversible acute disease or part of disease progression.

Q.49. Explain the term dialysis. When it is used ?

Ans: i) Dialysis is technique which is employed to clear off urea and other waste products from the blood of patient, when both the kidneys fail to function due to renal failure.

ii) Dialysis is carried out for patients with an acute disturbance in kidney function such as acute kidney injury or for those with chronic kidney disease stage 5.

iii) When a kidney machine (or Hemodialysis machine) is used for dialysis, during renal failure, the treatment is called kidney replacement therapy.
iv) Dialysis may be used for those with an acute disturbance in kidney function.
v) Dialysis is temporary solution unless kidney transplant is done.
vi) Dialysis is an imperfect treatment to replace kidney function because it does not correct the endocrine functions of the kidney. Dialysis replace some of the functions of kidneys such as diffusion and ultrafiltration.



Dialysis

Q.50. Write a note on Kidney stone.

Ans: i) Kidney stone is also called as renal calculi. Kidney stones are formed in the kidneys and urinary bladder, when urinary constituents in solution are precipitated. The solutes involved are usually oxalates and phosphates, such as calcium oxalate, ammonium phosphate, magnesium, amino acid cysteine and uric acid.
ii) High levels of calcium in blood promote the formation of kidney stone. Kidney stones may be small or large.
iii) Small kidney stones may pass through or impacted in a ureter and damage the epithelium, leading to haematuria and after healing, fibrosis. Stones reaching the bladder may be passed in urine or increase in size and eventually obstruct urethra.
iv) Large calculi or stones may develop over many years filling the renal pelvis and the calyces, causing stagnation of urine, and occasionally kidney tumours. It may cause chronic renal failure.
v) Urolithiasis is the condition of having calculi in the urinary tract whereas ureterolithiasis is the condition of having calculus in the ureter.

Q.51. What is Uremia ?

Ans:i) Excess of urea (about 10 times) in blood is called uremia.
ii) It may lead to kidney failure.
iii) Normal value of urea in blood is 0.01 to 0.03%.
iv) When the level rise to above 0.05% then it is called uremia.

Q.52. What are renal calculi ?

Ans:i) Stone or insoluble mass of crystallised salts such as oxalates are called renal calculi.
ii) There are several types of crystals of which they consist.
iii) The majority of the renal stones are calcium oxalate stones followed by calcium phosphate stones.
iv) More rarely struvite stones are produced by urea splitting bacteria during urinary tract infection.
v) Certain metabolic abnormalities may produce uric acid stones or cystine stones.

Q.53. Write a short note on nephritis.

Ans:i) Nephritis is also called Bright's disease, characterized by inflammation of glomeruli of both kidneys.

ii) It may lead to kidney failure due to hypertension or retention of fluids.

iii) It primarily involve renal glomeruli like haematuria, proteinuria.

iv) Children of6 to 16 year commonly suffer from streptococcal glomerulonephritis.

v) It is caused due to infection of throat called streptococcal pharyngitis.

Symptoms :

a) Oliguria or Proteinuria.

b) Fever might be present.

c) Polyuria or haematuria.

d) Retention of fluid may cause slight puffiness of face or distend the whole body.

Q.54. What is kidney transplantation?

Ans:i) In kidney transplantation, the diseased kidneys of the patient are replaced by healthy kidneys of a donor which match the kidneys of the patient (or recipient)

ii) Transplantation is classified as deceased donor or living donor.

iii) Living donor transplant is further classified as genetically related or non related transplants depending on whether a biological relationship exist between donor and recepient.

Regulation of kidney function

Q.55.What is renin? Give its function.

Ans: Renin is an enzyme secreted by juxtaglomerular cells of afferent arteriole. Function : It activates angiotensinogen to angiotensin-I.

Q.56. What is the role of ADH in regulation of kidney function?

Ans:i) ADH plays important role in regulation of kidney function.

ii) High concentration of the body fluid activates osmoreceptors in hypothalamus from neurohypophysis.

iii) ADH increases the permeability of renal tubules for absorption of water and prevents excess of water from body.

iv) Increased volume of body fluid suppresses osmoreceptors and ultimately ADH secretion is also suppressed.

v) ADH constricts the blood vessels and increases blood pressure. Due to this glomerular filtration rate increases.

Q.57. Which organs regulates the functioning of kidney ?

Ans: Hypothalamus, juxta glomerular apparatus (JGA) and heart regulates the functioning of kidney.

Q.58. Explain the role of renin- angiotensin system in regulation of kidney function.

Ans:i) Decrease in blood pressure and sodium concentration triggers **juxtaglomerular cells of kidney** to manufacture a proteolytic enzyme **renin** and release into the blood via renal vein.

ii) Renin acts upon its specific plasma protein called angiotensinogen to a peptide, called angiotensin II.

iii) Angiotensin II has two functions :

a) Angiotensin II increases the force of heart beat and constricts the arterioles thus raising blood pressure.

b. It also bring about contraction of smooth muscles.

iv) Angiotensin II also increases blood volume in two ways:

a. Firstly by stimulating PCT to reabsorb more sodium and water.

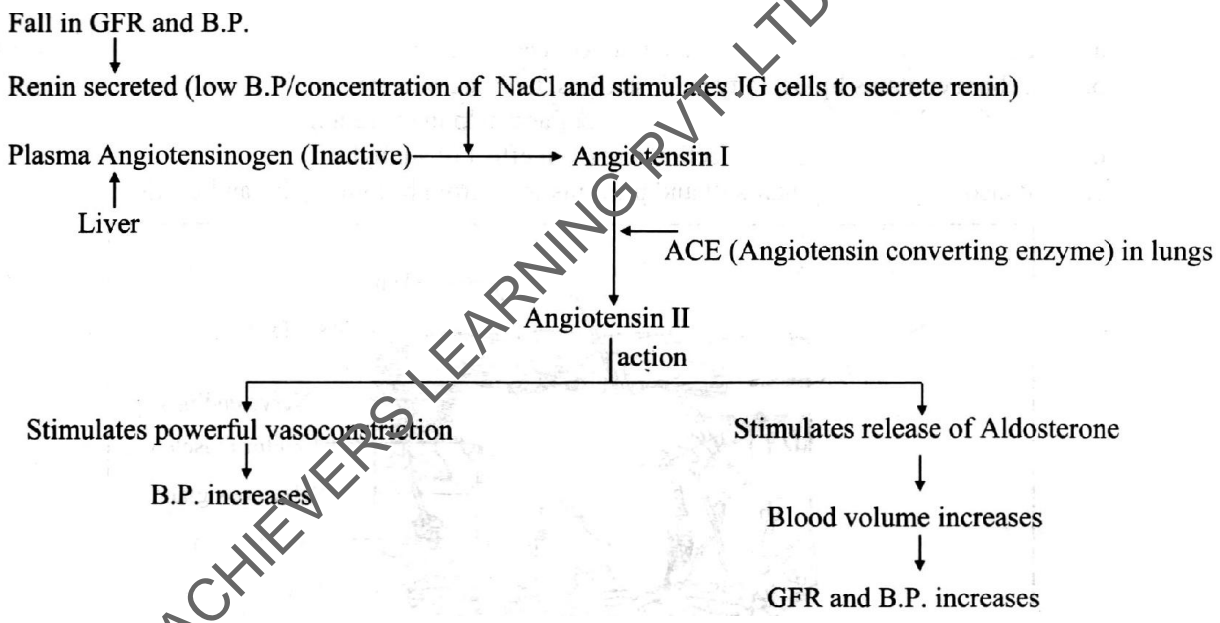
b. By stimulating adrenal cortex to release the electrolyte regulating hormone, aldosterone. Aldosterone stimulates DCT to reabsorb more sodium and water

v. This leads to increase in blood volume.

vi) It results in increase in blood pressure and renin production.

vii) Angiotensin II stimulates the adrenal cortex to release hormone, it is regarded as an intermediate or tropic hormone.

viii) Normal kidneys, plasma and other tissues (in small amount) contain a proteolytic enzyme called angiotensinase which is capable of destroying angiotensin.



ix) Renin -angiotensin activates the renal retention of fluid so that fall in blood volume get compensated.

x) Increased Na+ excretion results in decline in aldosterone.

Q.59. Explain the role of atrial natriuretic factor (ANF) in osmoregulation.

Ans: i) Atrial natriuretic factor (ANF) opposes the regulation by renin angiotensin aldosterone system.ANF is released from the walls of the atria of the heart in response to increase in blood volume and pressure.

ii) ANF inhibits the release of renin from the JGA, and as a result inhibits reabsorption of NaCl by collecting duct and reduces release of aldosterone from adrenal cortex.

iii) ANF is responsible for lowering blood volume and blood pressure by promoting salt and water excretion in the urine. ANF stimulates natriuresis and promotes Na^+ and water excretion in urine.

Q.60.Which hormones and factors are involved in regulation of kidney function ?

Ans: Antidiuretic hormone, renin,angiotensin and atrial natriuretic factor are involved in regulation of kidney function.

Q.61.How kidney functions are regulated? Add a note on kidney transplantation. [Mar 2013]

Ans: Antidiuretic hormone, rennin, angiotensin and atrial natriuretic factor plays important role in regulation of kidney function. For the functions of these hormones *refer Q.56,58* and 59 and for a note on kidney transplantation *refer Q. 54.*

16.6 : Accessory Excretory Organs

Q.62.Describe the role of skin of man in excretion.

Ans: In man, skin is thick, permeable and acts as accessory excretory organ.It shows presence of two types of glands: sweat gland and sebaceous glands.

i) Sweat gland :

a) These are distributed all over in the skin.

b) There are about 2 million sweat glands in human skin.

c) They are more in armpits, nostrils, palms, soles and forehead.

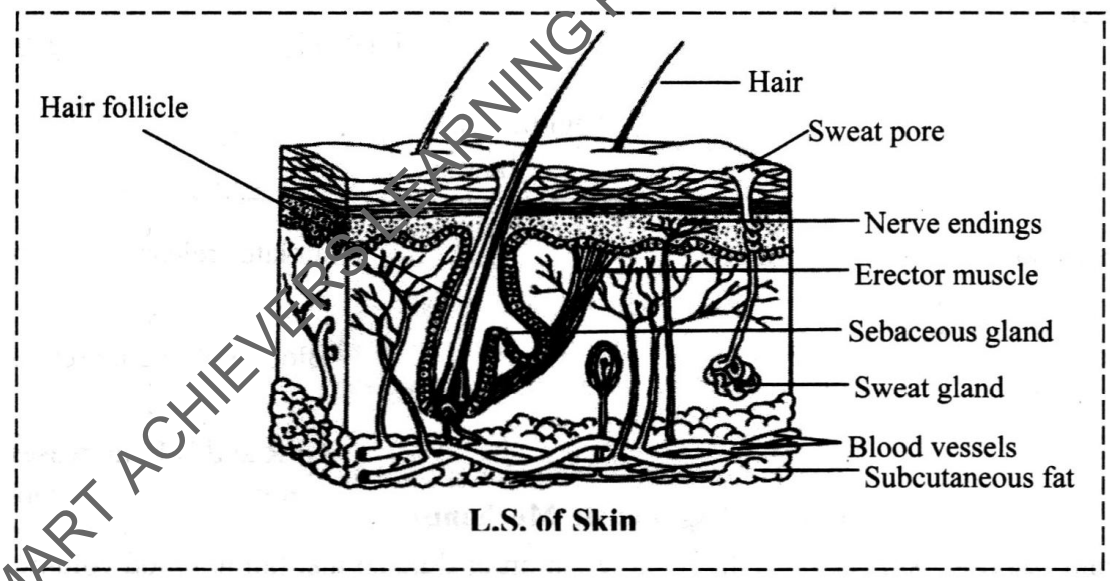
d) Each sweat gland opens outside on the surface of skin by sweat pore.

e) The secretion of sweat gland is called sweat.

f) Sweat is a watery fluid and is normally acidic.
g) It contains 90%water, inorganic salts(NaCl), lactic acid, some urea and CO_2.
h) Composition of sweat depends upon diet and heredity.

ii) Sebaceous glands :

a) Sebaceous glands secrete sebum, a waxy secretion.
b) Sebum contains lipids, fatty acid, steroids, hydrocarbon etc.
c) It keeps skin oily, pliable and water proof and help in excretion.
d) It protects the skin from infection and from effect of sunlight.
e) It also helps to keep hair soft and prevents them from becoming dry and brittle.



L.S. of Skin

Q.63. What are the components of sweat ?

Ans: Sodium chloride ,glucose,lactic acid, urea and water are the components of sweat.

Q.64.Explain the role of lungs in excretion.

Ans: Role of lungs in excretion :

i) Lungs are accessory excretory organs.
ii) The CO_2 and H_2O are produced as byproduct during cellular respiration.
iii) Blood transport CO_2 from tissue level to lungs in three different forms.
iv) These are bicarbonates of Na^+ and K^+,carbonic acid and carbaminohaemoglobin.
v) These compound dissociated at lung level and CO_2 is released. CO_2 is expelled by lungs during external respiration.
vi) Along with CO_2 the lungs also expel excess of H_2O in the form of vapours during expiration.

Q.65.Explain the role of kidney and lungs in excretion.

Ans: *Refer Q .46 and 64.*

Q.66.Name the accessory excretory organs in vertebrates.

Ans: Skin, lungs and liver.

Q.67.Enlist the human excretory organs and their excretory products.

Ans: Excretory Organs :

i) Lungs : Remove CO_2 and also water vapour to a considerable extent
ii) Kidneys : Remove nitrogenous waste products like ammonia, urea and uric acid, also remove excessive amount of water and salts.
iii) Skin : Remove some amount of nitrogenous waste products and salts by way of sweat.

Quick Review

Renal tubule consists of four parts

	Proximal convoluted tubule (PCT)	Loop of Henle (Nephron loop)		Distal convoluted tubule (DCT)	Collecting tubule (Terminal duct)
Position	In cortex, between malpighian body and loop of Henle	1st developed in mammals. Lies between PCT and DCT, extends in medulla, makes U shaped, hair pin bend and returns to cortex.		Between ascending limb and collecting tubule, lies in cortex, close to glomerulus	Present in medulla region of kidney. It is part after DCT
Structure	Bowman's capsule leads into a narrow, thick walled highly, convoluted (curved and twisted) tubule called PCT, through a narrow neck.	It consist of two straight parallel limbs as follows:		Wide lumen, Thin wall, tubule, which is short and convoluted.	It joins other collecting tubule to form collecting duct. It is distal, terminal part of nephron
		Descending Limb	**Ascending Limb**		
	Thick walled Lumen is small	It is continuation of PCT into the renal medulla. Thin walled, lumen wider	It re-enters the renal cortex and joins the DCT. As compared to descending limb, it is thicker, walled, lumen narrow	Thin walled	It is a straight tubule
Function	Main function is reabsorption of useful substances.	Permeable to water. Therefore reabsorbs H_2O. Not permeable to solute	Not permeable to water. Permeable to solute, therefore reabsorbs solute (i.e. NaCl)	Secretion of substances (Eg. NH_4^+, K^+, H^+)	Reabsorption of H_2O from filtrate and passage for urine

Multipal Choice Questions

1. Uricotelism is found in
a) birds, reptiles and insects
b) frogs and toads
c) mammals and birds
d) fishes and fresh-water protozoans

2. Mode of excretion in bony fishes is
a) Ammonotelism
b) Ureotelism
c) Uricotelism
d) Guanotelism

3. Nitrogenous waste which is less toxic, soluble in water and is formed during Ornithine cycle is
a) urea b) uric acid
c) ammonia d) amino acid

4. Conservation of water is possible in this mode of excretion
a) urea b) uric acid
c) ammonia d) guanine

5. Conversion of amino acids to ammonia is called
a) ammonification b) osmoregulation
c) deamination d) nitrification.

6. Which of the following in not a nitrogenous waste ?
a) Urea b) Uric acid
c) Guanine d) Carbon dioxide

7. Ammonotelic organism is
a) Hydra b) Camel
c) Frog d) Snail

8. Conversion of ammonia into uric acid occurs through **[Mar 2014]**
a) ornithine cycle b) guanine cycle
c) Ionosinic pathway d) Kreb's cycle

9. Which of the following is a guanotelic organism?
a) Spider b) Salamander
c) 'Bony fish d) Snail

10. Retroperitoneal kidney is
a) peritoneum on anterior side
b) peritoneum on posterior side
c) absence of peritoneum
d) peritoneum on both anterior and posterior side.

11. The part of the cortex continued inside the renal medulla between the pyramids is
a) columns of Bellini
b) 'columns of Bertini
c) columnae carnae
d) chordae tendinae

12. The structural and functional unit of kidney is
a) seminiferous tubules
b) uriniferous tubules
c) Malpighian tubule
d) Haversian canals

13. Cells named podocytes occur in
a) glomerulus of kidney
b) wall of capillaries
c) Bowman's capsule
d) neck of nephron

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b) wall of capillaries
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d) neck of nephron

14. Bowman's capsule occurs in
a) blood plasma b) kidneys
c) pituitary body d) adrenal gland

15. Blood vessel leading into a glomerulus is called
a) afferent arteriole b) efferent arteriole
c) renal artery d) renal vein

16. All the functions are performed by the kidney except
a) regulation of blood pressure
b) regulation of pH in the body fluid
c) secretion of antibodies.
d) removal of excretory product from the body

17. The urination becomes voluntary. when the urine comes in

18. The two kidneys of man lie
a) at the level of ovaries
b) at the same level
c) left kidney at a higher level than the right one
d) right kidney at a higher level than the left one

19. Kidneys arepresent.in _____cavity.
a) abdominal b) scrotal
c) pelvic' d) pectoral

20. Kidneys are located between
a) 12th thoracic vertebrae to 4th sacral vertebra
b) 8th cervical vertebrae to 3rd lumbar vertebrae
c) 12th thoracic vertebrae to 3rd lumbar vertebrae.
d) 5th lumbar vertebrae to coccyx.

21. Kidneys are covered by membrane.
a) peripheral b) peritoneal
c) visceral d) renal vein

22. The notch present on the inner surface of kidney is called
a) hilum b) calyx
c) medulla d) cortex

23. The part of the cortex continued inside the renal medulla between the pyramids is
a) Columns of Bertini b) uriniferous tubule
c) Columns carnae d) chordae tendinae

24. The funnel shaped space of kidney is called
a) convex b) medulla
c) pelvis d) renes

25. Ureters measure about_____ cm in length.
a) 5 b) 10
c) 40 d) 20

26. Urinary bladder is lined by
a) peritoneum b) squamous epithelium
c) transitional epithelium d) columnar epithelium

27. Urinary bladder wall muscles are called
a) dartos muscles b) detrusor muscles
c) datros muscles d) delivery muscles

28. Temporary storage of urine is done by
a) kidney b) urinary bladder
c) ureter d) urethra

29. The length of urethra in male is
a) 15 cm b) 20 cm
c) 5 cm d) 4 cm

30. The kidney is externally covered by fibrous connective tissue membrane called
a) pelvic capsule b) adipose capsule
c) hilum capsule d) cortex

31. The number of nephrons found in each kidney is about million.
a) 0.5 b) 1.2
c) 1.8 d) 2.2

32. Malpighian body IS located in the of kidney.
a) cortex b) medulla
c) pyramid d) calyx

33. Mark the wrong match from the following :
a) Bowman's capsule glomerular filtration
b) DCT - Absorption of glucose
c) Henle's loop - concentration of urine
d) PCT - Absorption of Na + and K + ions

34. Ultrafiltration takes place in
a) loop of Henle b) malpighian corpuscles
c) collecting duct d) minor calyx

35. Yellow colour of urine is due to
a) uric acid b) Urea
c) urochrome d) bilirubin

36. Filtration pressure in human kidneys is about
a) 10 mm of Hg b) 70 mm of Hg
c) 45 mm of Hg d) 55 mm of Hg

37. Which of the following is not a constituent of normal urine ?
a) Uric acid b) Urea
c) Lipoproteins d) Creatinine

38. Which one of the following is the normal constituent of urine ?
a) blood b) glucose
c) protein d) urea

39. Total filtrate formed in 24 hours in human kidney is
a) 1.8 litre b) 8.0 litre
c) 18 litre d) 180 litre

40. Ultrafiltration takes place in
a) loop of Henle
b) Malpighian corpuscles
c) collecting duct
d) minor calyx

41. In a normal healthy person, normal blood glucose level is
a) 45 to 95 mg per 100 ml of blood
b) 200 to 300 mg per 100 ml of blood
c) 5 to 10 mg per 100ml of blood
d) 500 to 600 mg per 100 ml of blood

42. Osmoregulation is carried out by
a) ureter b) nephron
c) ACTH d) ADH

43. ADH
a) synthesizes salts
b) increases water absorption
c) decreases water absorption
d) controls sugar- level

44. Juxtaglomerular cells under low glomerular blood flow release
a) angiotensin-I b) angiotensin-II
c) renin d) aldosterone

45. Blood dialysis is called artificial
a) lung b) kidney
c) heat d) liver

46. Kidney transplantation is classified as
a) deceased-donor b) living-donor
c) both a) and b) d) adolescent donor

47. Uremia is a disease related to the
a) failure of ADH secretion
b) excess of ADH secretion
c) failure of kidney
d) low blood pressure

48. Which oily secretion from the skin prevents evaporation of H_2O and helps in osmoregulation?
a) Sweat b) Oil
c) Sebum d) Wax

Answer Keys

1.	a)	**2.**	a)	**3.**	a)	**4.**	b)	**5.**	c)	**6.**	d)	**7.**	a)	**8.**	c)	**9.**	a)	**10.**	a)
11.	b)	**12.**	b)	**13.**	c)	**14.**	b)	**15.**	a)	**16.**	c)	**17.**	d)	**18.**	c)	**19.**	a)	**20.**	c)
21.	b)	**22.**	a)	**23.**	a)	**24.**	c)	**25.**	c)	**26.**	c)	**27.**	b)	**28.**	b)	**29.**	b)	**30.**	b)
31.	b)	**32.**	a)	**33.**	b)	**34.**	b)	**35.**	c)	**36.**	a)	**37.**	c)	**38.**	d)	**39.**	d)	**40.**	b)
41.	a)	**42.**	d)	**43.**	b)	**44.**	c)	**45.**	b)	**46.**	c)	**47.**	c)	**48.**	c)				