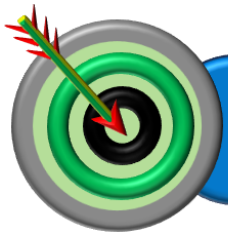
Chapter
16

Excretory Products and their Elimination



OBJECTIVES

- INTRODUCTION
- HUMAN EXCRETORY SYSTEM
- URINE FORMATION
- FUNCTION OF THE TUBULES
- MECHANISM OF CONCENTRATION OF THE FILTRATE
- REGULATION OF KIDNEY FUNCTION
- MICTURITION
- ROLE OF OTHER ORGANS IN EXCRETION
- DISORDERS OF THE EXCRETORY SYSTEM

Introduction

- Animals accumulate ammonia, urea, uric acid, carbon dioxide, water and ions like Na^+, K^+, Cl^-, phosphate, sulphate, etc., either by metabolic activities or by other means like excess ingestion. These substances have to be removed totally or partially.
- Ammonia, urea and uric acid are the major forms of nitrogenous wastes excreted by the animals.
- Ammonia is the most toxic form and requires large amount of water for its elimination, whereas uric acid, being the least toxic, can be removed with a minimum loss of water.

(i) Ammonia

- Ammonia is **highly toxic** and highly soluble in water. Its excretion requires a large amount of water.
- The process of excreting ammonia is **ammonotelism**.
- Animals excreting ammonia are known as **Ammonotelic**
- Ammonia, as it is readily soluble, is generally excreted by diffusion across body surfaces or through gill surfaces (in fish) as **ammonium ions**.
- Kidneys do not play any significant role in its removal.
- **Many bony fishes, aquatic amphibians and aquatic insects** etc.

(ii) Urea

- It is less toxic and requires less amount of water for excretion as compared to ammonia
- **Terrestrial adaptation** necessitated the production of lesser toxic nitrogenous wastes like urea and uric acid for conservation of water.
- Some amount of urea may be retained in the kidney matrix of some of these animals to **maintain a desired osmolarity.**
- The process of excreting urea is **ureotelism**.
- Animals excreting urea are known as **ureotelic**
  Examples: Mammals, many terrestrial amphibians and marine fishes.

(iii) Uric acid

- Least toxic
- Animals living in dry or arid conditions such as land gastropods **(snails)** , **most insects**, **land reptiles** (snakes and lizards), **birds** and **kangaroo rat (mammal)** etc., have to conserve water in their bodies.
- They excrete nitrogenous wastes as uric acid in the form of **pellet** or **paste** with a minimum loss of water.
- **Uric acid** is the main nitrogenous excretory product discharged in solid form.
- The process of excreting uric acid is **uricotelism**.

➢ **Excretory Organs in Animals**

Excretory organs	**Protonephridia (Flame cells)**	**Nephridia**	**Malpighian tubules**	**Green glands or Antennal glands**	**Kidneys**
Examples	- Platyhelminthes - Rotifers - Cephalochordate (Amphioxus) - Some annelids	Annelids (Earthworms)	Most of the insects (Cockroaches)	Crustaceans (Prawn)	All vertebrates

16.1 HUMAN EXCRETORY SYSTEM

Human excretory system consists of –

- A pair of kidneys,
- A pair of ureters,
- A urinary bladder
- A urethra.

➢ **Kidneys**

- **Colour** - reddish brown
- **Shape** - bean-shaped
- **Length**- 10-12 cm
- **Width** -5-7 cm
- **Thickness** - 2-3 cm
- **Weight** -120-170 g.
- **Location** - between the levels of last thoracic and third lumbar vertebra (T_{12}–L_3) close to the **dorsal** inner wall of the abdominal cavity.

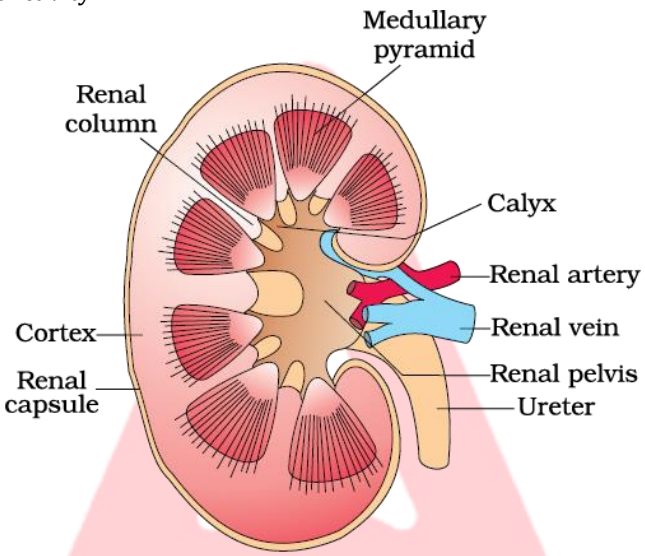


Fig.: Longitudinal section of Kidney

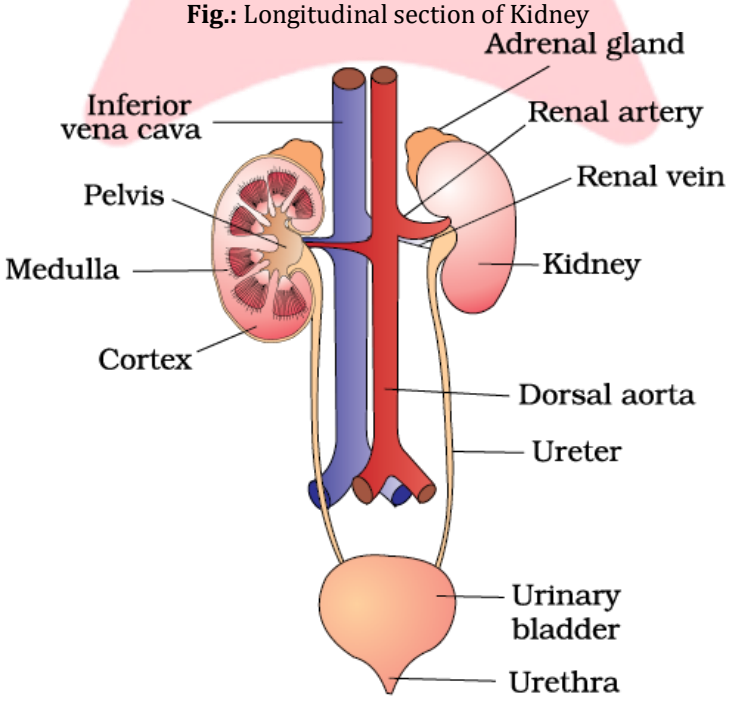


Fig.: Human Urinary system

- Left kidney is located slightly **upper** than the right kidney due to the larger size of the liver on the right side of the body.
- Towards the centre of the inner concave surface of the kidney is a notch called **hilum** through which ureter, blood vessels and nerves enter.
- Inner to the hilum is a broad funnel shaped space called the **renal pelvis** with projections called **calyces**.
- **Kidneys are metanephric in mammals.**
- The outer layer of kidney is a tough capsule
- Inside the kidney, there are **two zones**, an outer cortex and an inner medulla
- The renal medulla forms conical pyramid shaped masses which project into the renal pelvis. These are called as medullary pyramids or renal pyramids (8 to 12 in humans), projecting into the calyces, each having **broad base** towards the cortex and a narrow end called **renal papilla** towards the pelvis.
- Each renal papilla projects into the cavity of a **minor calyx**, minor calyx join to form **major calyx**.
- The major calyx open into a wide funnel like structure, the **pelvis**.
- The cortex extends in between the medullary pyramids as renal columns called **columns of Bertini.**

➢ **Ureters –**

- They are pair of muscular tubes of 25-30 cm in length, 3 mm in diameter.
- Ureter arise from hilum part of kidney, descend along abdominal wall, bend obliquely inward and upward to open into the urinary bladder.
- Ureter transports urine through the kidneys into the urinary bladder.
- Their wall consists of **transitional epithelium** surrounded by a layer of muscle fibres.
- Ureter always undergoing peristalsis which help in passing urine from kidney to the urinary bladder

➢ **Urinary bladder**

- Urinary bladder is **pear-shaped**, hollow muscular organ situated in pelvic cavity.
- Made up of smooth and involuntary muscles.
- The lower part or neck of the bladder leads into the **urethra.**
- Urinary bladder has **detrusor muscles.**
- It is lined by **transition epithelium** which has great power of stretching.
- Neck of bladder is guarded by two sphincters, **inner is involuntary** and **outer is voluntary.**

➢ **Urethra**

- It is found only in mammals.
- It starts from the neck of the urinary bladder and opens outside the body.
- In females, it is short (2-4 cm), concerned with the release of urine through a aperture called urethral orifice in the vulva.
- In males, it is long (20 cm), concerned with the release of urine as well as semen through a aperture called urinogenital aperture at the tip of the pennis.

➢ **Nephron**

- Each kidney has nearly one million complex tubular structures called nephrons
- Nephron is the structural and functional unit of kidney.
- Each nephron consist of two parts :- **glomerulus and renal tubule**

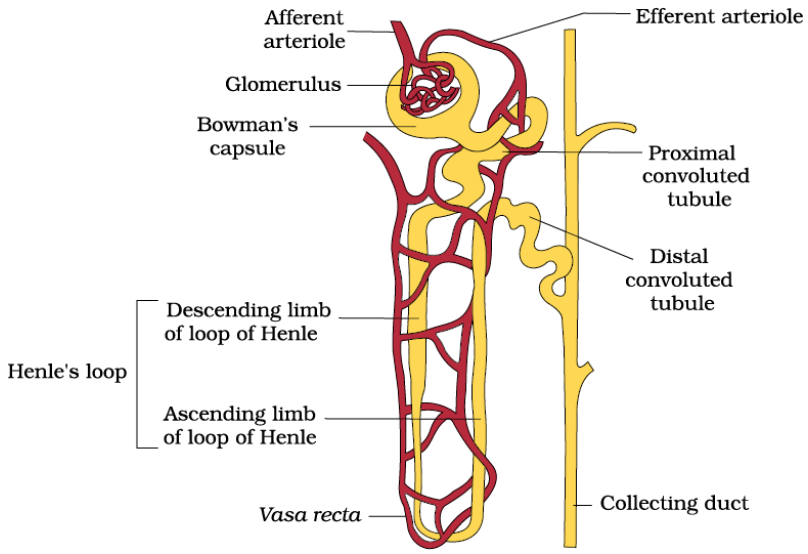


Fig.: A diagrammatic representation of a nephron showing blood vessels, duct and tubule

- **Glomerulus :-** It is a **tuft of capillaries** formed by the **afferent arteriole** – a fine branch of renal artery. Blood from the glomerulus is carried away by an efferent arteriole.
- **Renal tubule :-** It begins with Bowman`s capsule which encloses glomerulus and includes PCT, Loop Henle and DCT**.**

(A) Bowman's capsule :

- It is a double walled cup shaped structure
- The outer wall of Bowman's capsule is composed of flattened squamous cells.
- The inner wall is composed of a special type of cells called **Podocytes.** Which are arranged in an intricate manner so as to leave some minute spaces called **filtration slits** or **slit pores.**
- These cells are actually simple squamous cells and bear finger like projections which are coiled around the capillaries of glomerulus.
- The space between two layers of Bowman`s capsule is called as **capsular space**
- **Malpighian body :** Glomerulus and its surrounding Bowman's capsule together forms Malpighian body or Renal corpuscle. It is responsible for first step of urine formation (Filtration).

(B) Proximal convoluted tubule (PCT) :

- It is highly convoluted structure present after Bowman's capsule which collects filtrate from it.
- It is the major site of reabsorption and selective secretion.
- It is lined by simple cuboidal brush border epithelium.
- The membranes of these cells facing the tubule lumen has numerous microvilli (finger like projections or Brush Borders) which increase the surface area. Near its basolateral surface, the mitochondria are concentrated, to allow reabsorption of salts by active transport.

(C) Loop of Henle :

It starts after the proximal convoluted tubule, It ends before the distal convoluted tubule.
This hairpin like loop has a descending limb, followed by an ascending limb.

(i) Descending limb :

Its upper part - constitutes thick segment
- has the same diameter as PCT
- is also lined by simple cuboidal epithelium

Its lower part - constitutes thin segment
- is lined by flat squamous cells

(ii) Ascending limb :

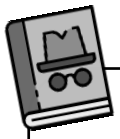
Its upper part - constitutes thick segment
- has the same diameter as DCT
- is also lined by simple cuboidal epithelium

Its lower part - constitutes thin segment
- is lined by flat squamous cells

(D) Distal convoluted tubule (DCT) :

The ascending limb of Henle's loop merges into **distal convoluted tubule**. This is lined by **cuboidal epithelial cells.**

The DCT of different nephrons open into a straight tube called **collecting duct**.



Clue Finder

Collecting ducts are long tubules which traverse through the medulla in the pyramids. In the papilla of the medullary pyramid, several adjacent collecting ducts converge to open into a common short and thick papillary duct, which open at the tip of the papillae into the pelvis.

Passage of urine

Nephron → Collecting duct →Papillary duct → Renal papilla → Renal pyramid → Minor calyx → Major calyx → Renal pelvis → Ureter → Urinary bladder → Urethra

- **Renal cortex :** The malpighian corpuscle, PCT & DCT of the nephrons are located here.
- **Renal medulla :** Loop of Henle, major part of collecting duct are found in this region.
  The efferent arteriole emerging from the glomerulus forms a fine capillary network around the renal tubule called peritubular capillaries. A minute vessel of this network runs parallel to the Henle's loop forming a "U" shaped **Vasa recta.**

Vasa recta is highly reduced or absent in cortical nephrons

Types of Nephrons	
Cortical nephrons	**Juxtamedullary nephrons**
Constitute about 85% of total.	About 15% of total.
Malpighian corpuscles are located in cortex close to the kidney surface.	Malpighian corpuscles are located at the junction of cortex and medulla.
Their loop of Henle are mostly confined to cortex and a very small part of it runs in the medulla.	The loop of Henle of these nephrons are long, dipping deep down into the medulla.
Peritubular capillary network is present	Peritubular capillary network is not well developed.
Vasa recta is absent or highly reduced	Vasa recta present.

➢ **Juxtaglomerular Apparatus (JGA)**

It consist of :- Juxtaglomerular cells + Macula densa + Lacis cell.

- JGA is a special sensitive region formed by cellular modifications in the DCT and the afferent arteriole at the location of their contact.
- It is built-in location for regulation of GFR.
- Fall in GFR can activate the JG cells to release renin which can stimulate the glomerular blood flow and thereby the GFR back to normal.

TOPIC CENTRIC EXERCISE 01

Q1. A notch present on the medial side of kidney is known as

(a) Ureter (b) Pelvis
(c) Hilum (d) Pyramid

Q2. Functional & structural unit of kidney is -

(a) Neuron (b) Seminiferous tubule
(c) JG Cells (d) Nephron

Q3. Loop of Henle has
(a) Three limbs (b) Two limbs
(c) Single limb (d) Four limbs

Q4. Nephrons are of ?
(a) Two types (b) Three types
(c) Single type (d) None of these

Q5. Malpighian body is formed by
(a) Bowman`s capsule (b) Glomerulus
(c) Both a and b (d) PCT and DCT

16.2 URINE FORMATION

- Urine formation involves **three steps** namely, glomerular filtration, reabsorption and tubular secretion.
- All these processes takes place in different parts of the nephron.

(1) Ultrafiltration or Glomerular Filtration

The first step in urine formation is the filtration of blood, which is carried out by the Malpighian corpuscle.

- This process occurs in the Malpighian corpuscle of the nephron.
- Filtration is a non-selective process performed by the glomerulus using the glomerular capillary blood pressure.
- On an average, 1100-1200 ml of blood is filtered by the kidneys per minute which constitute roughly 1/5th of the blood pumped out by each ventricle of the heart in a minute.

Critical Thinking

The glomerular capillary blood pressure causes filtration of blood through 3 layers
(a) The endothelium of glomerular blood vessels.
(b) The epithelium of Bowman's capsule.
(c) A basement membrane between these two layers.

- The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called as filtration slits or slit pores.
- The blood is filtered so finely through these membranes that almost all the constituents of the plasma except the proteins pass onto the lumen of the Bowman's capsule. Therefore it is considered as a process of **ultra filtration.**
- The plasma fluid that filters out from glomerular capillaries is called as glomerular filtrate. **It is protein less plasma.**
- About 20% of plasma fluid filters out into Bowman's capsule.
- The amount of the filtrate formed by the kidneys per minute is called **glomerular filtration rate (GFR)**. GFR in a healthy individual is approximately **125 ml/min i.e., 180 litres per day.**

Clue Finder

On an average 1100-1200 ml of blood is filtered by kidneys per minute (Renal blood flow) which constitute roughly 20-25% of the blood pumped by each ventricle of the heart in a minute (cardiac output) and of this blood about 650 ml is the blood plasma (55%). This 650 ml is called Renal plasma flow (RPF). About 20% of the blood plasma filtered by all nephrons of both kidney in a minute. It is 125 ml which called glomerular filtration rate (GFR).

Filtration fraction $= \frac{\text{GFR}}{\text{RPF}} = \frac{125 \text{ ml/min}}{650 \text{ ml/min}} = \frac{1}{5}$

The effective filtration pressure that causes ultrafiltration is determined by three pressures :
(1) Glomerular hydrostatic pressure,
(2) Colloid osmotic pressure of blood and
(3) Capsular hydrostatic pressure.

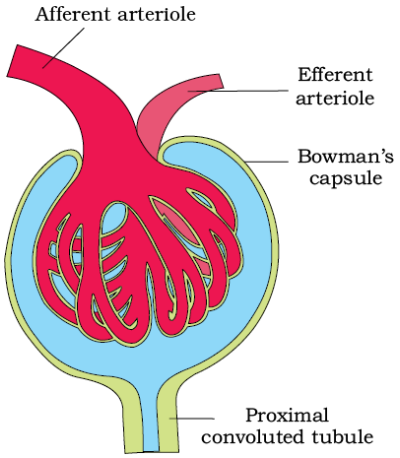


Fig.: Malpighian body (renal corpuscle)

Clue Finder

Glomerular hydrostatic pressure - due to the difference is diameter of afferent and efferent arteriole. (it is 60 to 65 mm Hg)
Colloid osmotic pressure - due to plasma proteins. It resists the filtration of fluid from the capillaries. (it is 30 to 32 mm Hg)
Capsular hydrostatic pressure – due to fluid (filtrate) that reaches into Bowman's capsule which resists filtration. (It is about 18 to 20 mm Hg)
Net filtration pressure
NFP = GHP – [BCOP + CHP]
= (60 or 65) – (32 + 18) mm of Hg
= 10 to 15 mm Hg.

- **Reabsorption**
  - During glomerular filtration, all substances except blood cells and proteins are pushed through the capillaries at high pressure.
  - A comparison of the volume of the filtrate formed per day (180 litres per day) with that of the urine released (1.5 litres), suggest that nearly 99 per cent of the filtrate has to be reabsorbed by the renal tubules. This process is called **reabsorption.**
  - Nearly **99 percent** of the filtrate has to be reabsorbed by the renal tubules. This process is called tubular reabsorption.
  - Absorption of some substances is passive, some substances are actively transported.

- The tubular epithelial cells in different segments of nephron perform this either by active or passive mechanisms.

Critical Thinking

- Substances like glucose, amino acids, Na^+, etc., in the filtrate are reabsorbed actively
- Nitrogenous wastes are absorbed by passive transport.
- Reabsorption of water also occurs passively in the initial segments of the nephron.

➢ **Tubular Secretion**

- During urine formation, the tubular cells secrete substances like H^+, K^+ and ammonia into the filtrate.
- It is an active process which occur in PCT, DCT & Collecting duct.
- Whenever excess K^+ is secreted into the filtrate, Na^+ ions are actively reabsorbed to maintain the Na-K balance.
- Tubular secretion is also an important step in urine formation as it helps in the maintenance of ionic and acid base balance of body fluids.
- Some **drugs** are not filtered in the glomerulus and so are **actively secreted** into the filtrate during the tubular secretion.

TOPIC CENTRIC EXERCISE 02

Q1. Which of the following is completely absorbed in P.C.T. ?

(a) Water (b) Na^+

(c) Glucose (d) Salt

Q2. GFR (Glomerular Filtration Rate) is the amount of filtrate formed by the kidney per

(a) 10 seconds (b) Second

(c) Minute (d) Hour

Q3. Urine formation mainly involves

(a) Single step (b) Two steps

(c) Three steps (d) Four steps

Q4. Ultrafiltration occurs in

(a) PCT (b) DCT

(c) Malpighian body (d) All parts of renal tubule

Q5. Which of the following substances are reabsorbed passively

(a) Water (b) Amino acid

(c) Glucose (d) All of these

16.3 FUNCTION OF THE TUBULES

FUNCTION OF THE TUBULES

(i) Proximal convoluted tubule (PCT)

- Lined by **simple cuboidal brush border epithelium** which increases the surface area for reabsorption.
- Nearly all of the essential nutrients and **70-80** percent of electrolytes and water are reabsorbed by this segment.
- Glucose, Amino acids, Fatty acids are completely reabsorbed by active transport in PCT.
- Water & Cl^- are reabsorbed passively. Reabsorption in this segment is maximum
- Most important buffer bicarbonate (HCO_3^-) is also reabsorbed from the filtrate.
- PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ions and ammonia into the filtrate and by absorption of HCO_3^- from it.

(ii) Henle's loop

- Reabsorption is **minimum** in its ascending limb.
- Plays a **significant role in the maintenance of high osmolarity of medullary interstitial fluid**.
- Descending limb of loop of Henle is **permeable to water** but almost **impermeable to electrolytes**. This concentrates the filtrate as it moves down.
- Ascending limb is **impermeable to water** but allows transport of electrolytes actively or passively.
- Therefore, as the concentrated filtrate pass **upward**, it gets **diluted** due to the passage of electrolytes to the medullary fluid.

(iii) Distal Convoluted Tubule (DCT)

- **Conditional reabsorption** of Na+ and water takes place in this segment. In the presence of aldosterone hormone salts (Na+) are reabsorbed actively and due to ADH water is reabsorbed passively
- DCT is also capable of reabsorption of HCO_3^- and selective secretion of hydrogen and potassium ions and NH_3 to maintain the **pH** and **sodium-potassium balance in blood**.

(iv) Collecting Duct

- This long duct extends from the **cortex of the kidney** to **the inner parts of the medulla**.
- **Large amounts of water** could be reabsorbed from this region to produce a **concentrated** urine.
- This segment allows passage of **small amounts of urea into the medullary interstitium** to keep up the osmolarity.
- It also plays a role in the **maintenance of pH and ionic balance** of blood by the selective secretion of H+ and K^+ ions.

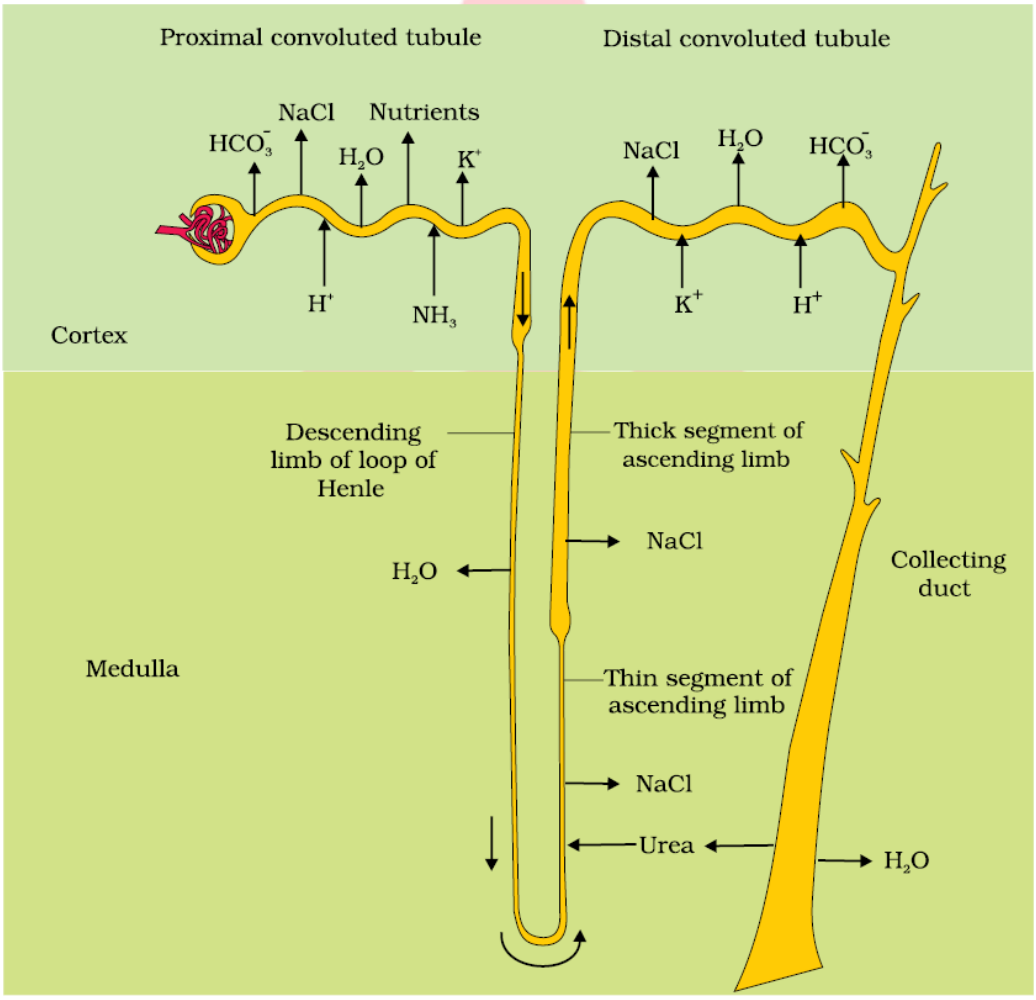


Fig.: Reabsorption and secretion of major substances at different parts of the nephron (Arrows indicate direction of movement of materials.)

Critical Thinking

- PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ions and ammonia into the filtrate and by absorption of HCO_3^- from it.
- DCT is also capable of reabsorption of HCO_3^- and selective secretion of hydrogen and potassium ions and NH_3 to maintain the pH and sodium-potassium balance in blood.
- It also plays a role in the maintenance of pH and ionic balance of blood by the selective secretion of H^+ and K^+ ions.

TOPIC CENTRIC EXERCISE 03

Q1. Reabsorption is minimum in
(a) PCT (b) DCT
(c) Ascending limb of Henle (d) Same in all parts

Q2. Collecting duct helps in selective secretion of
(a) H^+ (b) K^+
(c) Glucose (d) Both a and b

Q3. Descending limb of loop pf Henle is permeable to
(a) Electrolytes (b) Water
(c) Glucose (d) Amino acids

Q4. Conditional reabsorption occurs in
(a) PCT (b) Glomerulus
(c) DCT (d) Both a and c

Q5. K^+ is secreted by
(a) PCT (b) Bowman`s capsule
(c) All parts of nephron (d) DCT

16.4 MECHANISM OF CONCENTRATION OF THE FILTRATE

(Counter current mechanism)

- Mammals have the ability to produce a concentrated urine. The Henle's loop and vasa recta play a significant role in this.
- The flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a **counter current.** The flow of blood through the two limbs of vasa recta is also in a counter current pattern.
- The proximity between the Henle's loop and vasa recta, as well as the counter current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, i.e., from 300 mOsmolL–1 in the cortex to about 1200 mOsmolL–1 in the inner medulla.
- This gradient is mainly caused by **NaCl** and **urea**.
- Loop of Henle maintains the interstitial gradient of NaCl.
- **NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa recta. NaCl is returned to the interstitium by the ascending portion of vasa recta.**
- Small amounts of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.
- The second solute urea is added to the interstitial medullary fluid in small amount by diffusing out of the collecting duct. Urea remaining in the collecting duct is eventually excreted out. Urea re-enters in the ascending thin segment of the loop of Henle by diffusion.
- This special arrangement of Henle's loop and vasa recta is called the counter current mechanism. This mechanism helps to maintain a concentration gradient in the medullary interstitium.
- Presence of such interstitial gradient helps in an easy passage of water from collecting tubule. As the filtrate flow down in the collecting tubule more and more water moves out of the tubule by osmosis which makes

filtrate hypertonic to blood. Human kidney can produce **urine nearly four times concentrated** than the initial filtrate formed.

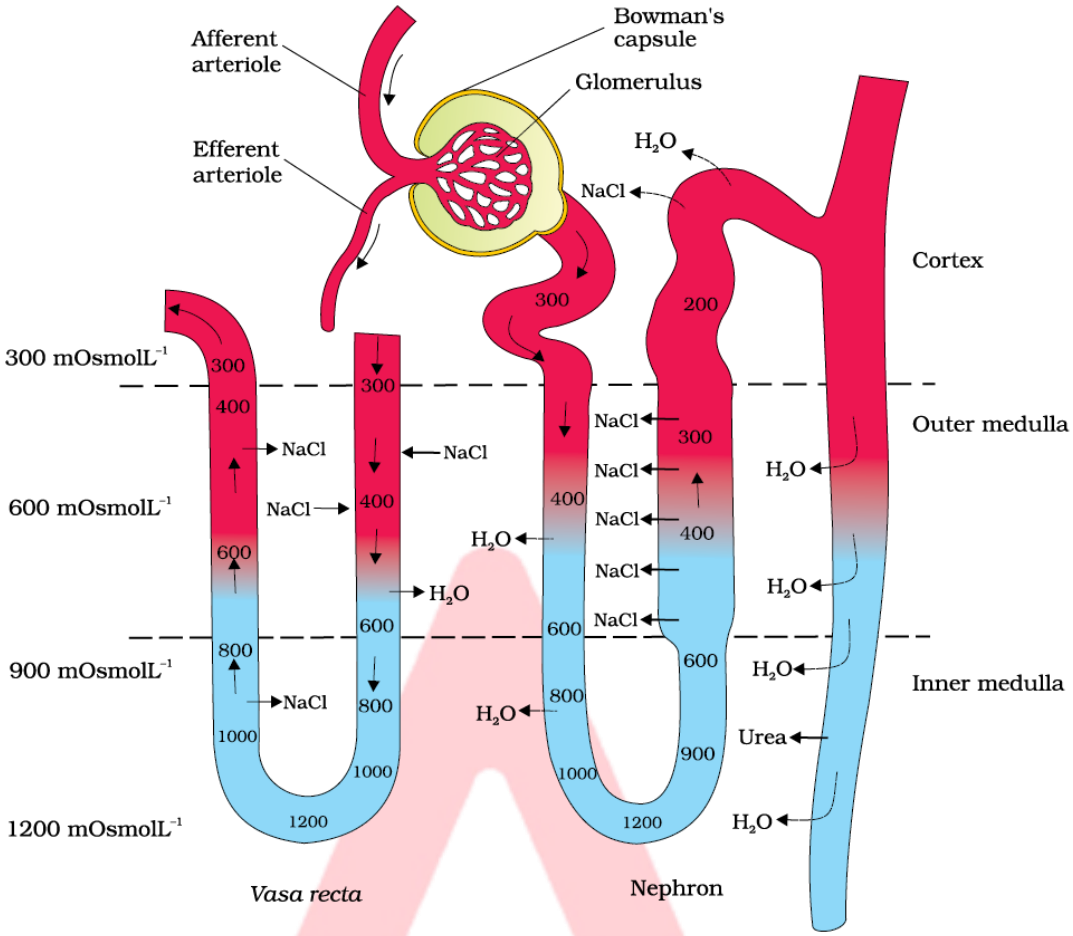


Fig.: Diagrammatic representation of a nephron and *vasa recta* showing counter current mechanisms

16.5 REGULATION OF KIDNEY FUNCTION

Hormonal Regulation

The functioning of the kidneys is efficiently monitored and regulated by hormonal feedback mechanisms involving the hypothalamus, JGA and to a certain extent, the heart.

(a) Regulation by ADH :

- Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration.
- An excessive loss of fluid from the body can activate these receptors which stimulate the hypothalamus to release **antidiuretic hormone (ADH) or vasopressin** from the **neurohypophysis**. **ADH facilitates water reabsorption from latter parts of the tubule, thereby preventing diuresis**.
- An increase in body fluid volume can switch off the osmoreceptors and suppress the ADH release to complete the feedback.
- ADH can also affect the kidney function by its constrictory effects on blood vessels. This causes an increase in blood pressure. **An increase in blood pressure can increase the glomerular blood flow and thereby the GFR.**

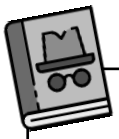
(b) RAAS Mechanism :

- The JGA plays a complex regulatory role. A fall in glomerular blood flow/glomerular blood pressure/GFR can activate the JG cells to release renin which converts angiotensinogen in blood to angiotensin I and further to angiotensin II.
- Angiotensin II, being a powerful vasoconstrictor, increases the glomerular blood pressure and thereby GFR.
- Angiotensin II also activates the adrenal cortex to release Aldosterone.

- Aldosterone causes reabsorption of Na^+ and water from the distal parts of the tubule, this also leads to an increase in blood pressure and GFR.
- This complex mechanism is generally known as the Renin-Angiotensin mechanism.

➢ **Atrial Natriuretic Factor :**

- An increase in blood flow to the atria of the heart can cause the release of Atrial Natriuretic Factor (ANF). ANF can cause vasodilation (dilation of blood vessels) and thereby decrease the blood pressure. ANF mechanism, therefore, acts as a check on the renin-angiotensin mechanism.



Clue Finder

Diuretic substances

There are some substances which increase the volume of urine to be excreted, these substances are called diuretic substances.

Example: Tea, coffee, alcohol etc.

Erythropoietin: It is secreted by juxtaglomerular apparatus Plays an important role in erythropoeisis (RBCs production).

TOPIC CENTRIC EXERCISE 04

Q1. ADH stands for

(a) Additional diuretic hormone (b) Antidiuretic hormone
(c) Anti drugs hormone (d) Alpha-diuretic hormone

Q2. ADH mainly acts on

(a) PCT (b) DCT
(c) Loop of Henle (d) Collecting duct

Q3. Osmoreceptors activates due to change in

(a) Blood volume (b) Ionic concentration
(c) Body fluid volume (d) All of these

Q4. Which of the following is not a part of RAAS mechanism

(a) Renin (b) Angiotensin
(c) Angiotensinogen (d) Rennin

Q5. Secretion of ANF result into

(a) Increase in blood pressure (b) Decrease in blood pressure
(c) Increase in blood volume (d) Increase in GFR

16.6 MICTURITION

- Urine formed by the nephrons is ultimately carried to the **urinary bladder** where it is stored till a **voluntary** signal is given by the **central nervous system (CNS)**.
- This signal is **initiated by the stretching** of the urinary bladder as it gets filled with urine.
- In response, the **stretch receptors** on the walls of the bladder send signals to the CNS.
- The CNS passes on motor messages to initiate the **contraction of smooth muscles** of the bladder and simultaneous **relaxation of the urethral sphincter** causing the release of urine.
- The process of release of urine is called **micturition** and the neural mechanisms causing it is called the **micturition reflex**.
- An adult human excretes, on an average, **1** to **1.5 litres** of urine per day.
- The urine formed is a light yellow coloured watery fluid which is slightly acidic **(pH-6.0)** and has a characteristic odour.
- On an average, **25-30 gm** of urea is excreted out per day.
- Various conditions can affect the characteristics of urine.

- Analysis of urine helps in clinical diagnosis of many metabolic discorders as well as malfunctioning of the kidney.

16.7 ROLE OF OTHER ORGANS IN EXCRETION

Other than the kidneys, **lungs, liver and skin** also help in the elimination of excretory wastes.

- **Skin**
  - **Many aquatic animals,** such as *Hydra* and starfish, excrete ammonia into the surrounding water by diffusion through the body wall.
  - The **sweat and sebaceous glands** in the skin can eliminate certain substances through their secretions.
  - **Sweat** produced by the sweat glands is a watery fluid containing NaCl, small amounts of urea, lactic acid etc.
  - **Though the primary function of sweat is to facilitate a cooling effect on the body surface**, it also helps in the removal of some of the wastes mentioned above
  - **Sebaceous glands** eliminate certain substances like **sterols, hydrocarbons and waxes through sebum**. This secretion provides a **protective oily covering** for the skin.
- **Lungs**
  - **Carbon dioxide** and **water** are the waste products formed in respiration.
  - Lungs remove **large amount of CO**2 (approximately 200 ml/minute) and also **significant quantities of water** every day.
- **Liver**
  - Liver is the **largest gland** in our body.
  - Liver is the main site for elimination of cholesterol, bile pigments (bilirubin & biliverdin), degraded steroid hormones, some vitamins and drugs.
  - Most of these substances ultimately pass out alongwith digestive wastes.
    - **Small amounts of nitrogenous wastes could be eliminated through saliva too**

TOPIC CENTRIC EXERCISE 05

Q1. Largest gland of the body is

(a) Skin (b) Pituitary
(c) Lungs (d) Liver

Q2. Lungs help in the elimination of

(a) CO_2 (b) Water
(c) Both CO_2 and water (d) Bilirubin

Q3. The process of release of urine is called

(a) Egestion (b) Micturition
(c) Excretion (d) Both b and c

Q4. Amount of urea excreted per day is

(a) 50 – 60 gm (b) 30 – 40 gm
(c) 25 – 30 gm (d) 05 – 10 gm

Q5. Voluntary signals for release of urine are sent by

(a) ANS (b) SNS
(c) PNS (d) CNS

16.8 DISORDERS OF THE EXCRETORY SYSTEM

(1) UREMIA

- Accumulation of an excessive amount of urea in the blood
- It results from the decreased excretion of urea in the kidney tubules due to bacterial infection
- (nephritis) or some mechanical obstruction.
- It is highly harmful and may lead to kidney failure.

- In such patients, urea can be removed by a process called haemodialysis.

❖ **Hemodialysis :**

- Following steps are involved in the process of Hemodialysis.
- During the process of haemodialysis, the blood drained from a convenient artery is pumped into a dialysing unit is called **artificial kidney .**
- Blood drained from a convenient artery is pumped into a dialysing unit after adding an anticoagulant like heparin.
- The unit contains a coiled cellophane tube surrounded by a fluid (dialysing fluid) having the **same composition as that of plasma except the nitrogenous wastes.**
- The porous cellophane membrane of the tube allows the passage of molecules based on concentration gradient.
- As nitrogenous wastes are absent in the dialysing fluid, these substances freely move out, thereby clearing the blood.
- The cleared blood is pumped back to the body through a vein after adding antiheparin to it.
- This method is a boon for thousands of uremic patients all over the world.

(2) RENAL FAILURE

- It is a syndrome characterised by renal dysfunction, sudden rise in metabolic waste products like urea & creatinine in blood (Uremia) .
- It is either of acute (sudden onset) or chronic (slow onset) nature.
- **Kidney transplantation** is the ultimate method in the correction of renal failures (kidney failure).
- A functioning kidney is used in transplantation from a donor, preferably a close relative, to minimise its chances of rejection by the immune system of the host.
- Modern clinical procedures have increased the success rate of such a complicated technique.

(3) GLOMERULONEPHRITIS

- It is the inflammation of glomeruli of kidney.
- It is caused by injury to the kidney, bacterial toxins, drug reaction etc
- Proteins and RBCs pass into the filtrate.

(4) RENAL CALCULI (Kidney stone)

- Formation of stone within kidney.
- These calculi are made of calcium phosphate, uric acid., cystine or **calcium oxalate**.

TOPIC CENTRIC EXERCISE 06

Q1. Uremia is a term used for condition such as

(a) Stone in kidney (b) Urea in blood
(c) Release of urine (d) Excessive urine

Q2. Accumulation of crystallised salts into the kidney is known as

(a) Renal failure (b) Kidney stone
(c) Glomerulonephritis (d) Haemodialysis

Q3. Glomerulonephritis is a condition of

(a) Inflammation of glomeruli (b) Removal of glomerulus
(c) Removal of stone from kidney (d) Urea in urine

Q4. Haemodialysis is used in case of

(a) Kidney stone (b) Renal failure
(c) Problem in egestion (d) Removal of RBCs from blood

Q5. Dialysing fluid have same composition as

(a) Blood except RBCs (b) Plasma
(c) Plasma except nitrogenous waste (d) Serum

Solved Examples

Ex: 1- Mammals generally produce _____ urine

(a) Hypotonic (b) Hypertonic
(c) Isotonic (d) Alkaline

Sol. **(b):** Urine produced by mammals has a higher concentration of solutes (such as salts, urea, and other waste products) compared to the blood plasma. This ability to produce concentrated urine is an adaptation that helps mammals conserve water

Ex: 2- NaCl is transported by the ascending limb of Henle's loop which is exchanged with
(a) DCT (b) PCT
(c) Descending limb of vasa recta (d) Ascending limb of vasa recta

Sol. **(c) :** NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of vasa recta. NaCl is returned to the interstitium by the ascending portion of vasa recta.

Ex: 3- Antidiuretic hormone secretion increases when the hypothalamus is stimulated by
(a) Glucose receptors (b) Osmoreceptors
(c) Renin receptors (d) Angiotensin receptors

Sol. **(b):** Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration. An excessive loss of fluid from the body can activate these receptors which stimulate the hypothalamus to release antidiuretic hormone (ADH) or vasopressin from the neurohypophysis.

Ex: 4- Which of the following is true about Atrial Natriuretic factor (ANF)?
(a) An increase in blood volume and B. P. stimulates cardiac atria to release ANF
(b) ANF promotes vasoconstriction and thereby decrease B.P.
(c) ANF acts as a check on RAAS
(d) a and c

Sol. **(d):** Atrial Natriuretic Factor (ANF) inhibits renin, aldosterone, and ADH release, reducing sodium and water reabsorption, lowering blood volume and pressure, and counteracting the effects of RAAS.

Ex: 5- The expulsion of urine from the urinary bladder is called
(a) Uremia (b) Anuria
(c) Micturition (d) Uricolysis

Sol. **(c):** Micturition is the process of expelling urine from the urinary bladder through the urethra

Ex: 6- Diabetes mellitus is characterised by
(a) Oligonuria (b) Ketonuria and glycosuria
(c) Anuria (d) Haematuria

Sol. **(b):** Diabetes mellitus is characterized by **ketonuria** and **glycosuria** due to the body's inability to properly regulate blood glucose levels.

Ex: 7- Least amount of water is required to eliminate
(a) Ammonia (b) Urea
(c) Uric acid (d) All need same amount of water

Sol. **(c):** Uric acid is the least toxic naming the nitrogenous wastes and requires least amount of water for its elimination .

Ex: 8- Which one of the following is not a part of a renal pyramid?
(a) Loops of Henle (b) Peritubular capillaries
(c) Convoluted tubules (d) Collecting ducts

Sol. **(c):** Bowaman`s capsule, PCT, and DCT are present in cortical region of kidney

Ex: 9- Which of the following animal can be regarded as uricotelic in nature
(a) Frog (b) Mammals
(c) Reptiles (d) Marine fishes

Sol. **(c):** Reptiles are **uricotelic animals**, meaning they excrete nitrogenous waste primarily in the form of **uric acid.**

Ex: 10- All of the following functions are carried out in the renal tubules, except
(a) Reabsorption (b) Ultrafiltration
(c) Secretion (d) All of these

Sol. **(b):** Renal tubule includes Bowman`s capsule, PCT, Loop of Henle and DCT, ultra filtration occurs in malpighian body (Glomerulus + Bowman`s capsule)

Exercise-01 Level -01

1. All are the part of nephron , except
(a) PCT (b) DCT
(c) Bowman's capsule (d) Vasa recta

2. Malpighian body or renal corpuscle is composed of glomerulus along with
(a) PCT (b) DCT
(c) Bowman's capsule (d) Loop of Henle

3. Which one of the following statement is **incorrect**?
(a) Birds and land snail excretes uric acid
(b) Mammals and frogs excrete urea
(c) Aquatic amphibians and aquatic insects excretes ammonia
(d) Birds and reptiles excretes urea

4. A notch through which arteries and veins enter or exit the kidney is called
(a) Renal papilla (b) Hilum
(c) Major calyces (d) Minor calyces

5. Excretory waste in most of the animals are excreted as urine (fluid) except
(a) Amphibians and reptiles
(b) Birds and Mammals
(c) Reptiles and Aves
(d) Reptiles and mammals

6. Nitrogenous waste excreted by mammals is
(a) Uric acid (b) Urea
(c) Ammonia (d) Paste

7. Which segment of nephron is responsible for concentration of urine
(a) PCT
(b) DCT
(c) Loop of Henle
(d) Collecting duct

8. Which of the following is also known as antidiuretic hormone?
(a) Oxytocin (b) Vasopressin
(c) Adrenaline (d) Aldosterone

9. Aldosterone stimulates the reabsorption of
(a) Na^+ ions (b) K^+ ions
(c) Glucose (d) Ca^{2+} ions

10. Protonephridia or flame cells or solenocytes are the excretory structures in
(a) Cephalochordates
(b) Rotifers and some annelids
(c) Platyhelminthes
(d) All of the above

11. Sweat contains
(a) NaCl
(b) Lactic acid
(c) Small amount of urea
(d) All of these

12. The kidneys are located near the dorsal inner wall of the abdominal cavity, between the
(a) C_2 and L_3 vertebra
(b) T1 and T_5
(c) T_3 and L_2
(d) T_{12} and L_3 vertebra

13. What is the amount of CO_2 removed by humans lungs per min?
(a) 2000 ml (b) 200 ml
(c) 10 ml (d) 120 ml

14. Compared to plasma, all of the following are constituents of dialysis fluid, except
(a) K^+ (b) Na^+
(c) Cl^- (d) Urea

15. Ammonia produced by metabolism is converted into the ...A... in the ...B... in ureotelic and released into the blood, which is filtered and excreted out by ...C...
(a) A-Uric acid, B-Spleen, C-Kidney
(b) A-Uric acid, B-Liver, C-Kidney
(c) A-Urea, B-Liver, C-Kidney
(d) A-Urea, B-Spleen, C-Kidney

16. Many collecting ducts converge through medullary pyramids in the calyces and open into the _____
(a) Renal pelvis (b) Ducts of Bellini
(c) Columns of Bertini (d) Vasa recta

17. Excretion in the from of uric acid in for paste in birds is helpful in
(a) Eliminating body water
(b) Conserving body water
(c) Eliminating excess water
(d) Conserving body heat

18. Which blood vessel takes blood away from kidney?
(a) Renal artery (b) Renal vein
(c) Afferent arteriole (d) Efferent arteriole

19. Average number of nephrons in a man is
(a) 0.07 million (b) 2.0 million
(c) 1.0 million (d) 1.6 million

20. Protonephridia or flame cells are the excretory structures present in
(a) Prawns, Ascaris
(b) Earthworm, Ascaris
(c) Rotifers, earthworm
(d) Planaria, Amphioxus

21. Antennal glands help in removal of nitrogenous wastes in
(a) Spider (b) Prawn
(c) Silverfish (d) Scorpion

22. In comparison to urea ammonia is
(a) Less toxic
(b) Require less water for elimination
(c) Highly toxic
(d) None of these

23. Renal tubule begins with the
(a) Afferent arteriole
(b) Efferent arteriole
(c) Bowman's capsule
(d) PCT

24. Shape of Henle's loop and vasa recta is
(a) 'C' shaped and 'U' shaped respectively
(b) 'U' shaped and 'C' shaped respectively
(c) Hairpin shaped and 'U' shaped respectively
(d) 'U' shaped and hairpin shaped respectively

25. In most nephrons, the loop of Henle is short and extends only slightly into the medulla. These nephrons are called
(a) Juxtaglomerular nephrons
(b) Medullary nephrons
(c) Juxtamedullary nephrons
(d) Cortical nephrons

26. JGA (Juxta Glomerular Apparatus), a sensitive region, which regulates the glomerular filtration rate is present near the
(a) DCT and efferent arteriole
(b) DCT and PCT
(c) Loop of henle's and DCT
(d) DCT and afferent arteriole

27. Which of the following is found in renal medulla
(a) Malpighian corpuscle
(b) Bowman`s capsule
(c) PCT
(d) Vasa recta

28. Diuresis is the condition in which
(a) The excretion of volume of urine increases
(b) The excretion of volume of urine decreases
(c) The kidney fails to excrete urine
(d) Both a and c

29. Kidneys have built in mechanisms for the regulation of GFR. One such efficient mechanism is carried out by
(a) JGA (b) Liver
(c) PNS (d) SNS

30. The filtration slits are formed by which of the following layers of filtration membrane?
(a) Layer of glomerulus
(b) Podocytes of Bowman's capsule
(c) Endothelium of vasa recta
(d) Basement membrane of PCT

31. Select the incorrect statement w.r.t. cortical nephrons.
(a) Loop of Henle is short and extends superficially in the medulla
(b) They are the most common type of nephrons in the kidneys.
(c) Peritubular capillary is absent
(d) Malpighian corpuscle, PCT and DCT of these nephrons are situated in outer cortex

32. Mark the incorrect statement w.r.t. counter current mechanism.
(a) The osmolarity of the filtrate increases as it moves down the descending limb of the loop of Henle.
(b) There will be no urine formation if loop of Henle is absent in mammalian nephrons
(c) NaCl and urea help maintain the osmolarity gradient in the medulla.
(d) Osmolarity of fluid moving out from the collecting duct is four times that of plasma

33. Which of the following step in urine formation helps in the maintenance of ionic and acid base balance of body fluids?
(a) Tubular secretion
(b) Ultrafiltration
(c) Reabsorption
(d) Both (a) and (b)

34. Angiotensin-II is responsible for all of the following except
(a) Vasoconstriction
(b) Increase in blood pressure
(c) Release of mineralocorticoids
(d) Decreased reabsorption of Na+ from renal tubules

35. The majority of useful substances are reabsorbed from the glomerular filtrate in
(a) Collecting tube
(b) Loop of Henle
(c) Proximal convoluted tubule
(d) Distal convoluted tubule

36. Which one of the following is totally reabsorbed in renal tubules?
(a) Na^+ ion (b) Urea
(c) H_2O (d) Glucose

37. Even with the influence of ADH, the site of maximum reabsorption of water is
(a) Collecting duct (b) DCT
(c) PCT (d) Loop of Henle

38. Which of the following defines the net filtration pressure (NFP)?
(a) BCOP – (GHP + CHP)
(b) GHP – (BCOP + CHP)
(c) (BCOP + GHP) – CHP
(d) (GHP – CHP) + BCOP

39. Which of the following statement is incorrect?
(a) ADH is a vasoconstrictor
(b) Aldosterone facilitates water reabsorption
(c) ANF enhances sodium reabsorption
(d) ANF causes vasodilation

40. Osmotic gradient between the cortex and medulla is created by
(a) Urea (b) Ammonia
(c) Sodium chloride (d) Both (a) and (c)

41. What is the osmolarity (in $mOsmolL^{-1}$) in the inner medulla and outer cortex region?
(a) 900 and 300 respectively
(b) 600 and 300 respectively
(c) 1200 and 300 respectively
(d) 300 and 1200 respectively

42. Which of the following pairs is wrong?
(a) Uricotelic - Birds
(b) Ureotelic - Insects
(c) Ammonotelic - Bony fishes
(d) Ureotelic - Elephant

43. Renin is released by
(a) Cortical nephron
(b) Collecting duct
(c) Juxtaglomerular apparatus
(d) Pelvis

44. ANF mechanism acts as a check on the
(a) Renin-angiotensin mechanism
(b) Counter-current mechanism
(c) Micturition reflex
(d) All of these

45. Urine formed by the nephrons is ultimately carried to the urinary bladder where it is stored till a voluntary signal is given by the
(a) CNS (b) PNS
(c) ANS (d) Endocrine system

46. In micturition
(a) Urinary bladder relax
(b) Urethral sphincter contracts
(c) Urethral sphincter relax
(d) Both urinary bladder and sphincter contract

47. If liver is removed, which component of blood will increase?
(a) Ammonia (b) Protein
(c) Uric acid (d) Urea

48. Occurrence of excess urea in blood due to kidney failure is
(a) Urochrome (b) Uremia
(c) Uricotelism (d) Ureotelism

49. Ultimate method in the correction of acute renal failure is
(a) Haemodialysis
(b) Kidney transplantation
(c) Both (a) and (b)
(d) None of the above

50. Ultra filtration in Malpighian body of the nephrons involves
(a) Four layer (b) One layer
(c) Three layer (d) Two layer

Exercise-02 Level -02

1. All the given statements are correct, except
(a) Uric acid is least toxic among nitrogenous wastes.
(b) Some amount of ammonia may be retained in the kidney matrix of ureotelic animals to maintain osmolarity
(c) Ammonia can be excreted through body surface by simple diffusion.
(d) In ureotelic organisms, ammonia is also a product of metabolism.

2. Juxtamedullary apparatus involves
(a) Loop of Henle and vasa recta
(b) PCT and afferent arteriole at the location of their contact
(c) PCT and DCT at the location of their contact
(d) DCT and afferent arteriole at the location of their contact

3. Which of the given statement can be regarded as correct with respect to haemodialysis
(a) Dialysing fluid has same composition as of blood
(b) Urea is removed from blood with the help of artificial kidney
(c) Ions are removed from blood

(d) Removal of sodium ions in the blood by artificial means

4. Which one of the four parts mentioned below does not constitute a part of a single uriniferous tubule?
(a) Bowman's capsule
(b) Distal convoluted tubule
(c) Loop of Henle
(d) Collecting duct

5. Which one of the following statement is correct?
(a) ADH prevents conversion of angiotensinogen in blood to angiotensin
(b) Renin stops RAAS mechanism
(c) ANF enhance squeezing of blood vessels
(d) Aldosterone facilitates water reabsorption

6. Which is correctly matched?
(a) Glomerular filtrate – Plasma with proteins
(b) Glucose reabsorption – Each segments of renal tubule
(c) Glomerular filtration rate - 180 L/day
(d) Reabsorption of water - Active absorption

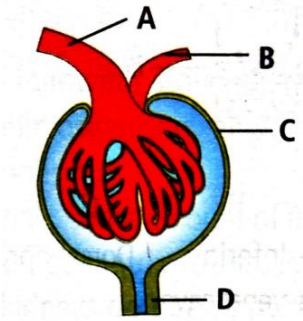
7. Filtrate with highest osmolarity is present in
(a) DCT (b) PCT
(c) Loop of Henle (d) Collecting duct

8. Which factor contributes to maintaining an increasing osmolarity in the inner medullary interstitium?
A. Proximity between the Henle's loop and vasa recta
B. Counter current pattern in Henle's loop
C. Counter current pattern in vasa recta
(a) A and B (b) A, B and C
(c) D only (d) A and C

9. Which one of the following statement is false?
(a) Presence of ketone bodies in urine is called as ketonuria
(b) Presence of glucose in urine is glycosuria
(c) Malfunctioning of kidneys can lead to accumulation of urea in blood, a condition called uremia
(d) All the given statements are correct

10. Reabsorption of filtrate occurs in all the segments of renal tubule, except
(A) Bowman's Capsule
(B) Distal Convoluted Tubule
(C) Proximal Convoluted Tubule
(D) Glomerulus
(E) Collecting Duct
Choose the correct answer from the options given below:
(a) (C), and (E) only
(b) (A), (D) and (E) only
(c) (A) and (D) only
(d) (C) and (D) only

11. The given figures represents the Malpighian body. Identify the labelled parts A to D and select the correct option.



(a) A- Efferent arteriole, B- Afferent arteriole, C- Bowman's capsule, D- Proximal convoluted tubules
(b) A- Afferent arteriole, B- Efferent arteriole, C- Renal corpuscle, D- Proximal convoluted tubule
(c) A- Afferent arteriole, B- Efferent arteriole, C- Bowman's capsule, D- Proximal convoluted tubules
(d) A- Afferent arteriole, B- Efferent arteriole, C- Bowman's capsule, D- Distal convoluted tubule

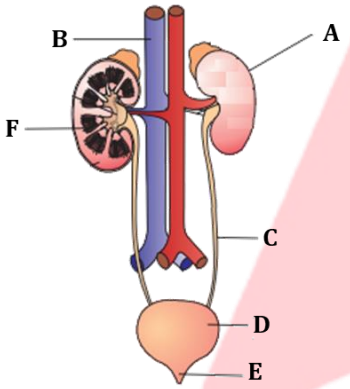
12. Which one of the following statement is **incorrect**?
(a) The renal corpuscle, Proximal Convoluted Tubule (PCT), and Distal Convoluted Tubule (DCT) of the nephron are located in the cortical region of the kidney.
(b) Inside the kidney, the cortical region extends in between the medullary pyramids as renal pelvis
(c) Glomerulus along with Bowman's capsule is called the renal corpuscle
(d) The medullary region of the kidney is divided into several cone-shaped masses known as medullary pyramids, which project into the calyces.

13. The amount of blood received by kidney is
(a) 50 percent of the cardiac output
(b) 10 percent of the cardiac output
(c) 20 percent of the cardiac output
(d) 40 percent of the cardiac output

14. How many statements are correct?
(a) Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed.
(B) Counter current mechanism helps to maintain a concentration gradient in the medullary interstitium.
(c) Nearly all of the essential nutrients and 70-80 per cent of electrolytes and water are reabsorbed by DCT.
(D) Tubular secretion helps in the maintenance of ionic and acid base balance of body fluids.
(a) One (b) Three
(c) Two (d) Four

15. Which of the following statement is correct for uremia
(a) It may lead to kidney failure
(b) Urea can be removed by haemodialysis
(c) It occurs when the level of urea in blood rises
(d) All of these

16. Identify the labelled part in the given human excretory system



(a) A-Kidney, B-Inferior vena cava, C-Ureter, D-Urinary bladder, E-Urethra, F-Renal pelvis
(b) A-Kidney, B-Abdominal aorta, C-Urethra, D-Urinary bladder, E-Ureters, F-Renal pelvis
(c) A-Kidney, B-Renal pelvis, C-Ureter, D-Urinary bladder, E-Ureter, F-Abdominal aorta
(d) A-Kidney, B-Abdominal aorta, C-Urethra, D-Urinary bladder, E-Renal pelvis, F-Ureter

17. Columns of Bertini in the kidney of mammals are formed as the extension of
(a) Medulla into cortex
(b) Cortex into medulla
(c) Pelvis into the kidney
(d) Pelvis into ureter

18. Identify the wrong statements about human excretory system and choose the correct option accordingly.
I. Each kidney of an adult human measures 10-12 cm in length, 5-7 cm in width, 2-3 cm in thickness with an average weight of 120-170 gram.
II. Kidneys are situated between the last thoracic and fifth lumbar vertebra.
III. Kidneys are reddish brown and bean-shaped structure.
(a) III (b) II
(c) III and I (d) None of these

19. Which of the following is not a affect of ADH
(a) Increase in blood volume
(b) Increase in urine volume
(c) Increase in blood pressure
(d) Increase in GFR

20. The counter current mechanism operates in nephron
(a) In ascending and descending limb of vasa recta only
(b) In ascending limb of Henle's loop only
(c) In descending limb of Henle's loop only
(d) Between the loop of Henle and vasa recta

21. In kidneys, urine is produced by_____ processes.
(a) Absorption, ultrafiltration and secretion
(b) Ultrafiltration, dialysis and secretion
(c) Ultrafiltration and secretion only
(d) Ultrafiltration, reabsorption and secretion

22. RAAS (Renin Angiotensin Aldosterone System)
(a) is triggered when juxtaglomerular cells of JGA releases renin in response to various stimuli
(b) is responsible for regulation of kidney function
(c) is switched-off by release of ANF from atria
(d) All of these

23. The Malpighian corpuscle, PCT and DCT of the nephron are situated in the ___A___ region of the kidney whereas the loop of Henle dips into the ___B___. In ___C___ of nephrons, the loop of Henle is too ___D___ and extends only very little into the medulla. Such nephrons are called cortical nephrons.
(a) A =Cortical, B = medulla, C = majority, D =long
(b) A =Cortical, B = medulla, C = majority, D =short
(c) A =medullary, B = cortex, C = majority, D =long

(d) A =Cortical, B = medulla, C = minority, D =long

24. Which one of the following is not correct with respect to human kidney?

(a) Peripheral region is cortex and central region is medulla

(b) Malpighian corpuscle are present in the cortex region

(c) Blood enters glomerulus through efferent arterioles

(d) Nerves enter through hilum

25. Mark the correct passage of urine.

(a) Collecting duct → Urinary bladder → Urethra → Renal papilla → Minor Calyx →Major calyx → Pelvis → Ureter

(b) Minor Calyx →Major calyx → Pelvis → Ureter → Urinary bladder→ Urethra →Collecting duct → Renal papilla

(c) Collecting duct → Renal papilla → Minor Calyx →Major calyx → Pelvis → Ureter → Urinary bladder → Urethra

(d) Collecting duct → Renal papilla → Minor Calyx →Major calyx → Pelvis → Ureter → Urethra → Urinary bladder

26. Consider the following statements (i) - (iii) and select the option that correctly identifies the true (T) and false (F) ones.

(i) ADH prevents diuresis by water reabsorption.

(ii) Protein-free fluid is filtered from blood plasma into the Bowman's capsule.

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

	(i)	(ii)	(iii)
(a)	T	T	T
(b)	T	F	F
(c)	F	F	T
(d)	T	F	T

27. The JGA plays a complex regulatory role. A ___A___ in glomerular blood flow/glomerular blood pressure/GFR can activate the JG cells to release ___B___ which converts ___C___ in blood to ___D___ and further to angiotensin II.

(a) A =fall, B = renin, C = angiotensin I, D = angiotensin II

(b) A =fall, B = aldosterone, C = angiotensin I, D = angiotensin II

(c) A =fall, B = renin, C = angiotensinogen, D = angiotensin I

(d) A =rise, B = renin, C = angiotensinogen, D = angiotensin I

28. Arrange the given processes in correct sequence for regulation in kidney.

I. Excess loss of water from body

II. Hypothalamus stimulation

III. Osmoreceptors activation

IV. ADH release

V. Stimulation of neurohypophysis

VI. Water reabsorption in DCT and collecting duct

VII. Prevention of diuresis

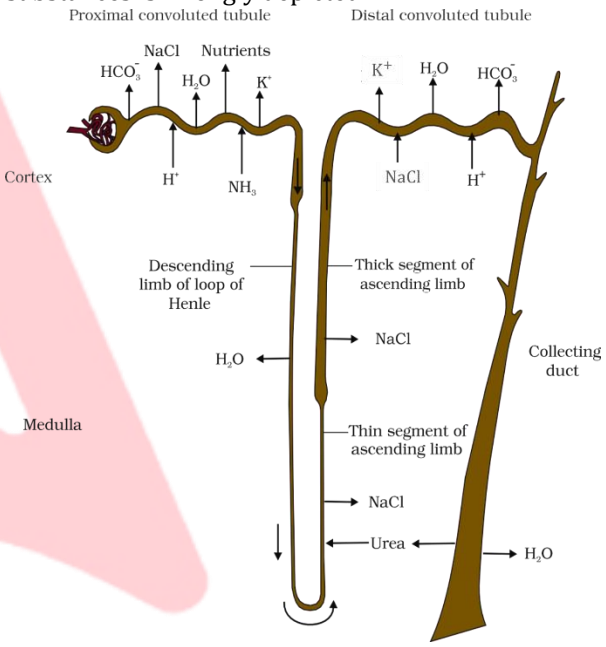
(a) II → III → IV → V → VI → VII→ I

(b) VII → VI → V → IV → III → II → I

(c) I → III → II → V → IV → VI → VII

(d) I → III → II → IV → V → VII → VI

29. The given figure shows reabsorption and secretion of major substances at different parts of the nephron. The movement of which of the following substances is wrongly depicted?



(a) NaCl and NH_3 at PCT

(b) NaCl and K^+ at DCT

(c) NaCl at ascending limb of loop of Henle

(d) H_2O at descending limb of loop of Henle

30. The outline of principle event of urination is given below in unorder manner :

(i) Stretch receptors on the wall of urinary bladder send signal to the CNS

(ii) The bladder fills with urine and becomes distended

(iii) Micturition

(iv) CNS passes on motor messages to initiate the contraction smooth muscles of bladder and simultaneous relaxation of urethral sphincter

The correct order of steps for urination is :
(a) i →ii→iii→iv (b) iv→iii→ii→i
(c) ii→i→iv→iii (d) iii→ii→i→iv

31. How many statements are correct ?
(A) The epithelial cells of Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called filtration slits or slit pores.
(B) The glomerular capillary blood pressure causes filtration of blood through 3 layers
(C) The first step in urine formation is the filtration of blood
(D) Some amount of urea may be retained in the kidney matrix of some animals to maintain a desired osmolarity.
(E) Generally human urine is hypertonic and acidic than blood plasma.
(a) Four (b) Five
(c) Three (d) Two

32. If Henle`s loop is removed from mammalian nephron, which 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) Urine will be more concentrated
(d) Urine will be more dilute

33. Which of the following statements are correct?
(i) Reabsorption of water occurs passively in the initial segment of nephron.
(ii) Substances like glucose, amino acids, Na^+, etc., in the filtrate are reabsorbed in PCT.
(iii) Conditional reabsorption of Na+ and water takes place in DCT.
(iv) DCT reabsorbs HCO_3^-.
(v) Filtrate in DCT is isotonic to blood plasma.
(a) (i) and (ii) only
(b) (ii), (iii) and (v) only
(c) (iv) and (v) only
(d) All of these

34. If the diameter of afferent arteriole and efferent arteriole become same then what will be happen?
(a) Urine formation will remain normal
(b) No ultrafiltration
(c) Ultrafiltration will be faster
(d) Tubular secretion will be start

35. Which of the following is most appropriate regarding kidney function regulation? Stimulation of
(a) Renin-angiotensin mechanism decreases the Glomerular Filtration Rate (GFR) while atrial natriuretic factor increases GFR.
(b) Both renin-angiotensin mechanism and atrial natriuretic factor increase the GFR
(c) Renin-angiotensin mechanism increases GFR while atrial natriuretic factor decreases GFR
(d) Both renin-angiotensin mechanism and atrial natriuretic factor decrease the GFR

36. Read the statements given below.
I. Highly coiled network.
II. Situated in the cortical region of kidney.
III. Reabsorption of 70-80% of electrolytes and water.
The above characteristics are associated with
(a) PCT
(b) Loop of Henle
(c) DCT
(d) Bowman's capsule

37. Why do we pass more urine in wet and cold season?
(a) Increase in water absorption by nephrons
(b) Kidney becomes more active
(c) Sweating is much decreased
(d) ADH secretion is increased

38. Which of the following does not favour the formation of large quantities of dilute urine?
(a) Caffeine (b) Renin
(c) Diuretic substances (d) Alcohol

39. Which of the following statements is not scientifically correct?
(a) Left kidney is slightly higher than the right one
(b) Columns of Bertin lie in between the pyramids
(c) Hilum is the gateway for the kidney
(d) Renal vein contains more amounts of excretory products than the renal artery

40. Identify which segment of nephron is not related with its most important function?
(a) PCT : Increases surface area for reabsorption
(b) LOH : Absorption of some water and salts
(c) DCT : Conditional reabsorption of sodium
(d) CD (Collecting ducts) : Dilution of urine

41. Diuresis is a specific pathological condition which leads to :
(a) Increased volume of urine excretion
(b) Decreased volume of urine excretion
(c) Decreases glucose excretion
(d) Decreased electrolyte concentration

42. Which one of the following is correct for a normal human being?

(a) pH of urine is around 8
(b) On an average, 25-30 mg of urea is excreted via urine
(c) Presence of ketone/glucose bodies in urine is an indicator of diabetes mellitus
(d) Relaxation of smooth muscles of bladder and simultaneous contraction of urethral sphincter causes release of urine

43. During hemodialysis process
I. Blood drained from a convenient artery and anticoagulant is added.
II. Removal of nitrogenous waste from blood.
III. Blood is passed through a coiled porous cellophane membrane of tube bathing in dialysis fluid.
IV. Blood is mixed with anti heparin and passed into vein.
Arrange the steps
(a) I → II → III → IV
(b) IV → III → II → I
(c) I → III → II → IV
(d) I → IV → II → III

44. Select the correct statement :
(a) Atrial Natriuretic Factor increases the blood pressure.
(b) Angiotensin II is a powerful vasodilator.
(c) Counter current pattern of blood flow is not observed in vasa recta.
(d) Reduction in Glomerular Filtration rate activates JG cells to release renin.

45. Urinary excretion of Na^+ is regulated by :
(a) Anterior pituitary
(b) Posterior pituitary
(c) Adrenal cortex
(d) Adrenal medulla

46. Following are the statements related to tubular secretion in kidney. Find the correct one.
1. H^+ and K^+ only are released from blood to filtrate passively.
2. It helps in maintenance of ionic and acid-base balance of body fluid.
3. H^+, K^+ and NH_4^+ are actively transported from blood to filtrate.
4. Tubular secretion chiefly occurs in descending and ascending limbs of Henle's loop.
(a) 1 and 2 are incorrect
(b) 1, 2 and 4 are correct
(c) 2 and 3 are correct
(d) 2, 3 and 4 are correct

47. Erythropoietin hormone which stimulates R.B.C. formation is produced by :
(a) Alpha cells of pancreas
(b) The cells of rostral adenohypophysis
(c) The cells of bone marrow
(d) Juxtaglomerular cells of the kidney

48. Due to insufficient filtration in the Bowman's capsule, all are likely to happen except :
(a) Accumulation of fluid in the body
(b) Increase in blood pressure
(c) Increase in blood urea level
(d) Loss of glucose through urine

49. Liquid which collects in the cavity of Bowman's Capsule is :-
(a) Blood plasma minus blood proteins
(b) Glycogen and water
(c) Urea, glycogen and water
(d) Urea

50. Net filtration pressure is:
(a) Calculated by subtracting the pressure that oppose filtration from the GHP.
(b) GHP promotes filtration.
(c) BCOP opposes filtration.
(d) All of these.

Exercise-03 Level -03

Assertion & Reason Based Questions

1. **Assertion (A):** Reabsorption of glucose from filtrate is termed as active process
Reason (R): The process of reabsorbing glucose from the filtrate requires the expenditure of energy.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

2. **Assertion (A):** Ammonia produced by metabolism is converted into urea in the liver of some animals and released into the blood which is filtered and excreted out by the kidneys
Reason (R): Some amount of urea may be retained in the kidney matrix of some of these animals to maintain a desired osmolarity.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

3. **Assertion (A):** In the descending limb of loop of Henle the urine is hypertonic, while in ascending limb of loop of Henle, the urine is hypotonic.
Reason (R): Descending limb is permeable to water while ascending limb is permeable to Na^+.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

4. **Assertion (A):** Loop Henle maintain the pH and ionic balance of blood.
Reason (R): Tubular secretion is maximum in this segment
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

5. **Assertion (A):** Each kidney has nearly one million complex tubular structures called nephrons.
Reason (R): Blood from the glomerulus is carried away by an efferent arteriole.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

6. **Assertion (A):** The Henle's loop and vasa recta play a significant role in producing a concentrated urine.
Reason (R): They helps to maintain a concentration gradient in the medullary interstitium.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

7. **Assertion (A):** Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration
Reason (R): An excessive loss of fluid from the body can activate these receptors
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

8. **Assertion (A):** ADH increases blood volume
Reason (R): ADH facilitates water reabsorption from latter parts of the tubule
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

9. **Assertion (A):** During micturition, urine is prevented from flowing back into the ureters.
Reason (R): Opening of ureters are oblique in urinary bladder due to which urine can not enter into ureter from bladder
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

10. **Assertion (A):** Angiotensin II increases the glomerular blood pressure thereby GFR.
Reason (R): JG cells secretes renin in case of fall in GFR
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.

(d) A and R are incorrect.

11. **Assertion (A):** ADH and RAAS work in response to low blood volume and blood pressure
Reason (R): ANF opposes the regulation by RAAS
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

12. **Assertion (A):** An increase in blood flow to the atria of the heart can cause the release of Atrial Natriuretic Factor (ANF)
Reason (R): As much as 99 percent of the material in the filtrate is excreted from the body.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

13. **Assertion (A):** Ammonia requires large amount of water
Reason (R): It is least toxic among the nitrogenous wastes
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

14. **Assertion (A):** Mammals and Marine fishes are said to be ureotelic animals.
Reason (R): It is because of the fact that their main nitrogenous waste product is urea.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

15. **Assertion (A):** Signal for micturition is initiated by the stretching of the urinary bladder as it gets filled with urine
Reason (R): The CNS passes on sensory messages to initiate the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

16. **Assertion (A):** Malfunctioning of kidneys can lead to accumulation of urea in blood
Reason (R): In such patients, urea can be removed by a process called hemodialysis
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

17. **Assertion (A):** ADH is also known as vasopressin
Reason (R): ADH has constrictory effect on blood vessels
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

18. **Assertion (A):** The sweat and sebaceous glands in the skin can eliminate certain substances through their secretion
Reason (R): Sweat produced by the sweat glands is a watery fluid containing NaCl, small amounts of urea, lactic acid, etc.
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

19. **Assertion (A):** An adult human excretes, on an average, 1 to 1.5 litres of urine per day
Reason (R): The urine formed is a light yellow coloured watery fluid which is slightly acidic
(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

20. **Assertion (A):** Ammonia, urea and uric acid are the major forms of nitrogenous wastes excreted by the animals

Reason (R): Ammonia is the most toxic form and requires large amount of water for its elimination

(a) Both A and R are correct, and R is the correct explanation of A.
(b) Both A and R are correct, but R is not the correct explanation of A.
(c) A is correct, but R is incorrect.
(d) A and R are incorrect.

Statement Based Questions

21. **Statement I:** – Sebaceous glands eliminate certain substances like sterols, hydrocarbons and waxes through sebum.
Statement II: This secretion provides a protective oily covering for the skin
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

22. **Statement I:** Vasa recta are present in cortical nephrons.
Statement II: Loop of Henle is too long in cortical nephrons.
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

23. **Statement I:** Kidney transplantation is the ultimate method in the correction of acute renal failures
Statement II: Each kidney of an adult human measures 5-7 cm in length, 10-12 cm in width, 2-3 cm in thickness.
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

24. **Statement I:** ANF can cause vasodilation (dilation of blood vessels) and thereby decrease the blood pressure
Statement II: ANF mechanism, acts as a check on the renin-angiotensin mechanism
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

25. **Statement I:** The renal tubule begins with a double walled cup-like structure called Bowman's capsule
Statement II: Glomerulus alongwith Bowman's capsule, is called the malpighian tubule
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

26. **Statement I:** Malpighian tubules have only one role to remove nitrogenous wastes
Statement II: In most of the invertebrates, excretory structures are simple tubular forms whereas vertebrates have complex tubular organs called kidneys.
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

27. **Statement I:** The primary function of sweat is to facilitate a cooling effect on the body surface
Statement II: Our lungs remove large amounts of CO_2
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

28. **Statement I:** Conditional reabsorption of Na+ and water takes place in DCT
Statement II: The DCTs of many nephrons open into a straight tube called *collecting duct*
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

29. **Statement I:** The Malpighian corpuscle, PCT and DCT of the nephron are situated in the cortical region of the kidney whereas the loop of Henle dips into the medulla.
Statement II: In some of the nephrons, the loop of Henle is very long and runs deep into the medulla. These nephrons are called cortical nephrons
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

30. **Statement I:** Removal of nitrogenous waste is known as excretion.
Statement II: Excretory structures also play significant role in osmoregulation.
(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

31. **Statement I:** Medulla has the higher osmolarity than cortex

Statement II: Urea and NaCl increases the osmolarity of medulla

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

32. **Statement I:** A fall in GFR can activate the atrial cells to release ANF

Statement II: Substances like glucose, amino acids, Na+, etc., in the filtrate are reabsorbed by diffusion

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

33. **Statement I:** The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes

Statement II: As the concentrated filtrate pass upward in loop of Henle, it gets diluted due to the passage of electrolytes to the medullary fluid.

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

34. **Statement I:** JGA is a special sensitive region formed by cellular modifications in the distal convoluted tubule and the efferent arteriole at the location of their contact

Statement II: The tubular epithelial cells in different segments of nephron perform reabsorption either by active or passive mechanisms.

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

35. **Statement I:** During urine formation in humans, Blood is filtered so finely through filtration membranes, that almost all the constituents of the plasma with the proteins pass onto the lumen of the Bowman's capsule

Statement II: The endothelium of glomerular blood vessels, the epithelium of Bowman's capsule and a basement membrane between these two layers forms filtration membrane.

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

36. **Statement I:** Ammonia, urea and uric acid are the major forms of nitrogenous wastes excreted by the animals.

Statement II: Many marine fishes, aquatic amphibians and aquatic insects are ammonotelic in nature.

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

37. **Statement I:** Various conditions can affect the characteristics of urine.

Statement II: Analysis of urine helps in clinical diagnosis of many metabolic discorders as well as malfunctioning of the kidney

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

38. **Statement I:** Inflammation of glomeruli of kidney is known as Glomerulonephritis

Statement II: Glomerulus is a part of renal tubule

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

39. **Statement I:** Skin, lungs and liver also assist in excretion

Statement I: Osmolarity of filtrate in less in PCT as compared to descending limb of loop of Henle.

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

40. **Statement I:** Vasa recta runs parallel to loop of Henle.

Statement II: High osmolarity of medulla facilitate concentration of urine in collecting duct

(a) Both statement I and II are true
(b) Statement I is true, but Statement II is false.
(c) Statement I is false, but Statement II is true.
(d) Both statement I and II are false.

Match up Based Questions

41. Match the columns and find out the correct combination:

Column I		Column II	
A	Prawn	(I)	Flame cells
B	Insects	(II)	Green glands
C	Annelids	(III)	Nephridia

D	Amphioxus	(IV)	Malpighian tubules

(a) A – (II), B –(I), C – (III), D-(IV)
(b) A – (III), B –(II), C – (IV), D-(I)
(c) A – (II), B –(III), C – (IV), D-(I)
(d) A – (II), B –(IV), C – (III), D-(I)

42. Match the column I with column II

Column I		Column II	
A	Cortical nephron	(I)	Less in number
B	Juxta medullary nephrons	(II)	More in number
		(III)	Vasa recta is highly reduced or absent
		(IV)	Loop of Henle runs deep into medulla

(a) A – (I), (III), B – (II), (IV)
(b) A – (I), (IV), B – (II), (III)
(c) A – (II), (III), B – (I), (IV)
(d) A – (I), (II), B – (III), (IV)

43. Match the columns and choose the correct option.

Column I		Column II	
A	Part of cortex between medullary pyramids	(I)	Less in number
B	Epithelial cells of Bowman's capsule	(II)	A fine vessel of peritubular capillaries running parallel to Henle's loop.
C	Nephrons with vasa recta	(III)	Columns of Bertini
D	Vasa recta	(IV)	Slit pores

(a) A – (II), B – (III), (C) – (IV), (D) – (I)
(b) A – (IV), B – (I), (C) – (II), (D) – (III)
(c) A – (III), B – (IV), (C)– (I), (D) – (II)
(d) A – (IV), B – (II), (C) – (I), (D) – (II)

44. Match the column I with column II

Column I		Column II	
A	Limb of Henle's loop near to DCT	(I)	Filtrate becomes hypotonic
B	Limb of Henle's loop near to PCT	(II)	Filtrate becomes hypertonic
C	PCT	(III)	Reabsorption of HCO_3^-
D	DCT	(IV)	More surface area due brush boarder Cuboidal epithelium

(a) (A) – (II), B – (I), C – (III) D – (IV)
(b) (A) – (I), B – (II), C – (IV) D – (III)
(c) (A) – (II), B – (I), C – (IV) D – (III)
(d) (A) – (IV), B – (III), C – (II) D – (I)

45. Match the columns and find out the correct combination:

Column I		Column II	
A	JGA apparatus	(I)	Glomerulus along with Bowman`s capsule
B	Hairpin shaped	(II)	Proximal convoluted tubule
C	Malpighian corpuscle	(III)	Concentration of urine
D	Simple cuboidal brush border epithelium	(IV)	DCT and afferent arteriole

(a) A – (II), B – (I), C – (IV), D – (III)
(b) A – (IV), B – (III), C – (I), D – (II)
(c) A – (I), B – (III), C – (II), D – (IV)
(d) A – (II), B – (IV), C – (III), D – (I)

46. Match the column I with column II

Column I		Column II	
A	GHP	(I)	30-32 mmHg
B	BCOP	(II)	60-65 mmHg
C	CHP	(III)	10-15 mmHg
D	NFP	(IV)	18-20 mmHg

(a) A – (III), B – (II), C – (IV), D – (I)
(b) A – (I), B – (II), C – (III), D – (IV)
(c) A – (II), B – (I), C – (IV), D – (III)
(d) A – (IV), B – (I), C – (II), D – (III)

47. Match column I with column II and select the correct option from the codes given below.

Column I		Column II	
A	Brush boarder cuboidal epithelium	(I)	Minimum reabsorption
B	Distal part of renal tubule	(II)	Concentration of urine
C	Ascending limb of Henle`s loop	(III)	Increases surface area for reabsorption

D	Counter current mechanism	(IV)	Conditional reabsorption

(a) A – (I), B – (IV), (C) – (III), (D) – (III)
(b) A – (II), B – (I), (C) – (III), (D) – (IV)
(c) A – (III), B – (IV), (C)– (I), (D) – (II)
(d) A – (II), B – (III), (C) – (I), (D) – (IV)

48. Match the column I with column II

Column I		Column II	
A	Endothelium	(I)	Between two layers
B	Podocytes	(II)	Bunch of capillary
C	Basement membrane	(III)	Bowman's capsule

(a) A – (II), B – (I), (C) – (III)
(b) A – (II), B – (III), (C) – (I)
(c) A – (III), B – (II), (C) – (I)
(d) A – (II), B – (I), (C) – (III)

49. Match the items given in column I with those in column II and select the correct option given below.

Column I		Column II	
A	Glycosuria	(I)	Artificial Kidney
B	Uremia	(II)	Mass of crystallised
C	Kidney stone	(III)	Inflammation in glomeruli
D	Glomerulo-nephritis	(IV)	Glucose in urine

(a) A – (IV), B – (II), C – (III), D – (I)
(b) A – (II), B – (I), C – (III), D – (IV)
(c) A – (II), B – (I), C – (III), D – (IV)
(d) A – (IV), B – (I), C – (II), D – (III)

50. Match the following columns and select the correct option.

Column I		Column II	
A	Less in diameter	(I)	Efferent arteriole
B	Isotonic filtrate	(II)	Descending limb of LOH
C	Collects filtrate from PCT	(III)	Afferent arteriole
D	More diameter	(IV)	Proximal convoluted tubules

(a) A – (III), B – (II), C – (IV), D – (I)
(b) A – (III), B – (IV), C – (I), D – (II)
(c) A – (III), B – (II), C – (I), D – (IV)
(d) A – (I), B – (IV), C – (II), D – (III)

Exercise-04 Previous Year Questions

1. Given below are two statements: **(2024)**
Statement I: In the nephron, the descending limb of loop of Henle is impermeable to water and permeable to electrolytes.
Statement II: The proximal convoluted tubule is lined by simple columnar brush border epithelium and increases the surface area for reabsorption.
In the light of the above statements, choose the correct answer from the options given below :
(a) Both Statement I and Statement II are false
(b) Statement is true but Statement II is false
(c) Statement l is false but Statement II is true
(d) Both Statement I and Statement II are true

2. Choose the correct statement given below regarding juxta medullary nephron. **(2024)**
(a) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.
(b) Loop of Henle of juxta medullary nephron runs deep into medulla.
(c) Juxta medullary nephrons outnumber the cortical nephrons.
(d) Juxta medullary nephrons are located in the columns of Bertini.

3. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R. **(2023)**
Assertion A: Nephrons are of two types:
Cortical and juxta medullary, based on their relative position in the cortex and medulla.
Reason R: Juxta medullary nephrons have a short loop of Henle whereas, cortical nephrons have a longer loop of Henle.
In the light of the above statements, choose the correct answer from the options given below:
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

4. Which of the following statements are correct? **(2023)**
A. An excessive loss of body fluid from the body switches off osmoreceptors.
B. ADH facilitates water reabsorption to prevent diuresis.
C. ANF causes vasodilation.
D. ADH causes an increase in blood pressure.
E. ADH is responsible for the decrease in GFR.
Choose the correct answer from the options given below:
(a) A and B only
(b) B, C and D only
(c) A, B and E only
(d) C, D and E only

5. Nitrogenous waste is excreted in the form of pellet or paste by: **(2022)**
(a) Salamandra
(b) Hippocampus
(c) Pavo
(d) Ornithorhynchus

6. Select the correct statement **(2020 Covid Re-NEET)**
(a) Angiotensin II is a powerful vasodilator
(b) Counter current pattern of blood flow is not observed in vasa recta
(c) Reduction in glomerular filtration rate activates JG cells to release renin
(d) Atrial Natriuretic Factor increases the blood pressure

7. The increase in osmolarity from outer to inner medullary interstitium is maintained due to **(2020 Covid Re-NEET)**
(i) Close proximity between Henle's loop and vasa recta
(ii) Counter current mechanism
(iii) Selective secretion of HCO_3^- and hydrogen ions in PCT
(iv) Higher blood pressure in glomerular capillaries
(a) (iii) and (iv)
(b) (i), (ii) and (iii)
(c) (i) and (ii)
(d) Only (ii)

Answer key

TOPIC CENTRIC EXERCISE 01 Answer Key

1. (c)	**2.** (d)	**3.** (b)	**4.** (a)	**5.** (c)

TOPIC CENTRIC EXERCISE 02 Answer Key

1. (c)	**2.** (c)	**3.** (c)	**4.** (c)	**5.** (a)

TOPIC CENTRIC EXERCISE 03 Answer Key

1. (c)	**2.** (d)	**3.** (b)	**4.** (c)	**5.** (d)

TOPIC CENTRIC EXERCISE 04 Answer Key

1. (b)	**2.** (b)	**3.** (d)	**4.** (d)	**5.** (b)

TOPIC CENTRIC EXERCISE 05 Answer Key

1. (d)	**2.** (c)	**3.** (b)	**4.** (c)	**5.** (d)

6.

TOPIC CENTRIC EXERCISE 06 Answer Key

1. (b)	**2.** (b)	**3.** (a)	**4.** (b)	**5.** (c)

Exercise-01 Level -01 Answer Key

1. (d)	**6.** (b)	**11.** (d)	**16.** (a)	**21.** (b)	**26.** (d)	**31.** (c)	**36.** (d)	**41.** (c)	**46.** (c)
2. (c)	**7.** (c)	**12.** (d)	**17.** (b)	**22.** (c)	**27.** (d)	**32.** (b)	**37.** (c)	**42.** (b)	**47.** (a)
3. (d)	**8.** (b)	**13.** (b)	**18.** (b)	**23.** (c)	**28.** (a)	**33.** (a)	**38.** (b)	**43.** (c)	**48.** (b)
4. (b)	**9.** (a)	**14.** (d)	**19.** (b)	**24.** (c)	**29.** (a)	**34.** (d)	**39.** (c)	**44.** (a)	**49.** (b)
5. (c)	**10.** (d)	**15.** (c)	**20.** (d)	**25.** (d)	**30.** (b)	**35.** (c)	**40.** (d)	**45.** (a)	**50.** (c)

Exercise-02 Level -02 Answer Key

1. (b)	**6.** (c)	**11.** (c)	**16.** (a)	**21.** (d)	**26.** (a)	**31.** (b)	**36.** (a)	**41.** (a)	**46.** (c)
2. (d)	**7.** (c)	**12.** (b)	**17.** (b)	**22.** (d)	**27.** (c)	**32.** (d)	**37.** (c)	**42.** (c)	**47.** (d)
3. (b)	**8.** (b)	**13.** (c)	**18.** (b)	**23.** (b)	**28.** (c)	**33.** (d)	**38.** (b)	**43.** (c)	**48.** (d)
4. (d)	**9.** (d)	**14.** (b)	**19.** (b)	**24.** (c)	**29.** (b)	**34.** (b)	**39.** (d)	**44.** (d)	**49.** (a)
5. (d)	**10.** (c)	**15.** (d)	**20.** (d)	**25.** (c)	**30.** (c)	**35.** (c)	**40.** (d)	**45.** (c)	**50.** (d)

Exercise-03 Level -03 Answer Key

1. (a)	**6.** (a)	**11.** (b)	**16.** (b)	**21.** (a)	**26.** (c)	**31.** (a)	**36.** (b)	**41.** (d)	**46.** (c)
2. (b)	**7.** (b)	**12.** (c)	**17.** (a)	**22.** (d)	**27.** (a)	**32.** (d)	**37.** (a)	**42.** (c)	**47.** (c)
3. (a)	**8.** (a)	**13.** (c)	**18.** (b)	**23.** (b)	**28.** (a)	**33.** (a)	**38.** (b)	**43.** (c)	**48.** (b)
4. (d)	**9.** (a)	**14.** (a)	**19.** (b)	**24.** (a)	**29.** (b)	**34.** (c)	**39.** (a)	**44.** (b)	**49.** (d)
5. (b)	**10.** (b)	**15.** (c)	**20.** (b)	**25.** (b)	**30.** (a)	**35.** (c)	**40.** (a)	**45.** (b)	**50.** (d)

Exercise-04 Previous Year Questions

1. (c)	**2.** (b)	**3.** (c)	**4.** (b)	**5.** (c)	**6.** (c)	**7.** (c)