XI

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EXCRETORY PRODUCTS AND THEIR ELIMINATION

SYLLABUS

Modes of excretion- Ammonotelism, ureotelism, uricotelism; Human excretory system-structure and fuction; Urine formation, Osmoregulation; Regulation of kidney function-Renin-angiotensin, Atrial Natriuretic Factor, ADH and Diabetes insipidus; Role of other organs in excretion; Disorders; Uremia, Renal failure, Renal calculi, Nephritis; Dialysis and artificial kidney.

KEY CONCEPTS

INTRODUCTION

* Osmoregulation and excretion help in maintaining chemical and fluid **homeostasis**(Maintenance of steady state,term given by walter cannon).
* **Osmoregulation :**It is process that regulates the body's salt and water content. It maintains the composition of the body fluids (extra-cellular and intracellular) at a steady state for efficient metabolism in the cells.
* **Excretion :** Metabolic reactions occurring in animal body produce certain nitrogen-containing materials that are of no use in the cells. These are called nitrogenous waste materials. They are formed from breakdown of proteins and nucleic acids. They become toxic if allowed to accumulate in the body. The elimination of nitrogenous waste products from the animal body to regulate the composition of the body, fluids and tissues is called excretion.
* **Osmoregulation** involves water (solvent) movement, which follows solutes by osmosis.
* **Osmosis:** It is a type of diffusion where the movement of water occurs from a dilute solution (hypotonic) to a strong solution (hypertonic) across a semipermeable membrane.
* **Osmolarity:** It is the total solute concentration expressed as moles of solute per litre of solution. The unit of measurement of osmolarity is millions mol per litre (mOsm L^{-1}). The osmolarity of fresh water is generally much less than 50 mOsm L^{-1}.
* **Osmoconformers :** These are the animals that do not actively control the osmotic condition of their body fluids. They show changes in the concentration of body fluids according to the concentration of surrounding medium. E.g. all marine invertebrates, some fresh water invertebrates and a single vertebrate i.e. hagfish (a marine cyclostome).
Osmoconformers can tolerate a wide range of cellular osmotic environments.
* **Osmoregulators :** These are the animals that maintain an internal osmolarity different from the surrounding medium in which they inhabit.
In hypotonic medium, these osmoregulators eliminate excess of water. Whereas, in hypertonic medium, these continuously intake water to compensate for water loss. In other words, osmoregulators maintain their osmolarity by taking water in or out of their bodies. E.g. most vertebrates (except elasmobranches and hagfish).

MODES OF EXCRETION

* 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.
* The process of excreting ammonia is **Ammonotelism**. Many bony fishes, aquatic amphibians and aquatic insects are ammonotelic in nature. 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.
* Mammals, many terrestrial amphibians and marine fishes mainly excrete urea and are called **ureotelic** animals. Ammonia produced by metabolism is converted into urea in the liver of these animals and released into the blood which is filtered and excreted out by the kidneys.
* Reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water and are called **uricotelic** animals.

EXCERATORY STRUCTURES

* **Protonephridia** or flame cells are the excretory structures in Platyhelminthes (Flatworms, e.g., Planaria), rotifers, some annelids and the cephalochordate - Amphioxus.
  Protonephridia are primarily concerned with ionic and fluid volume regulation, i.e., osmoregulation.
* **Nephridia** are the tubular excretory structures of earthworms and other annelids. Nephridia help to remove nitrogenous wastes and maintain a fluid and ionic balance.
* **Malpighian tubules** are the excretory structures of most of the insects including cockroaches. Malpighian tubules help in the removal of nitrogenous wastes and osmoregulation.
* **Antennal glands** or green glands perform the excretory function in crustaceans like prawns.

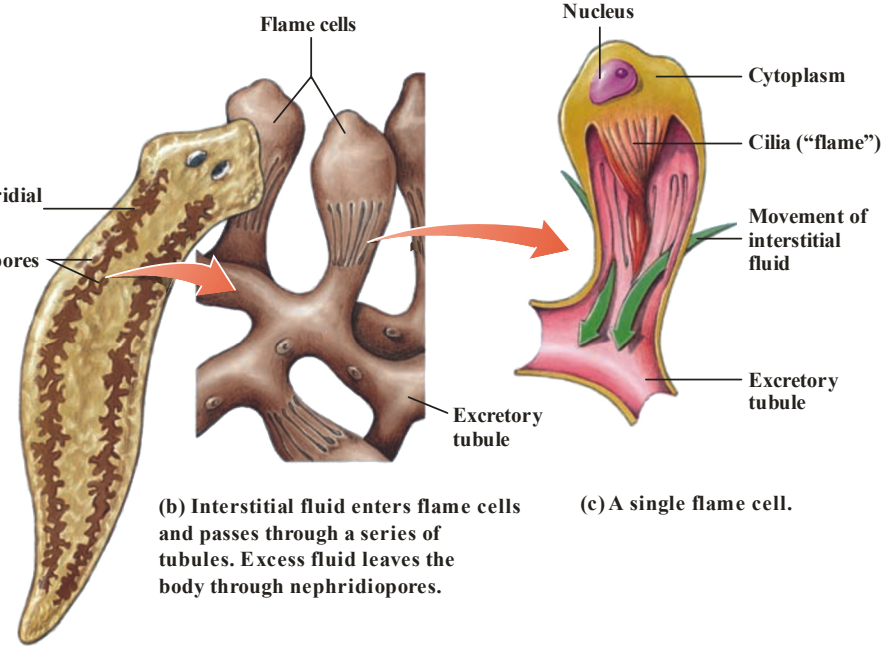


Figure : Protonephridia of a flatworm

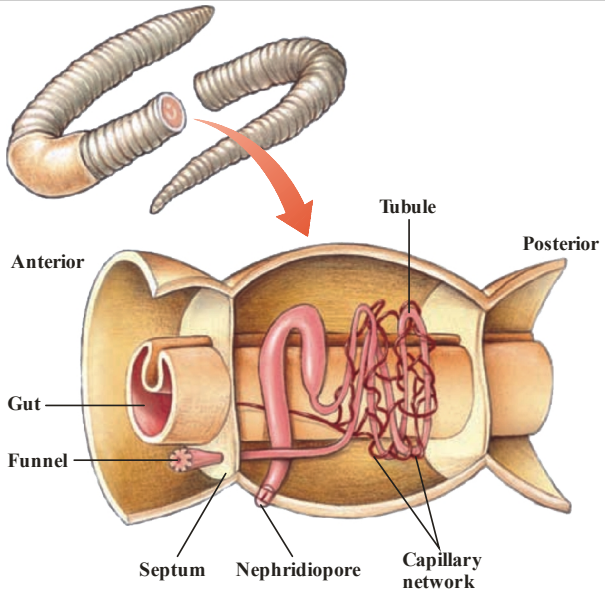


Figure : Metanephridium of an earthworm
Each metanephridium consists of a ciliated funnel opening into the coelom, a coiled tubule, and a nephridiopore opening to the outside. This 3-D internal view shows parts of three segments of the earthworm body.

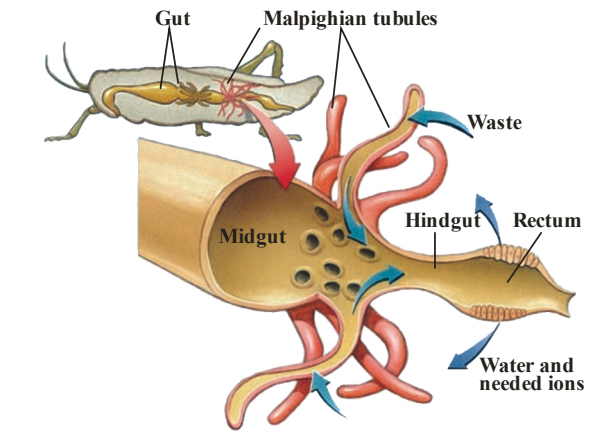


Figure : Malpighian tubules of an insect
The slender Malpighian tubules have blind ends that extend into the hemocoel. Their cells transfer uric acid and some ions from the hemolymph to the cavity of the tubule. Water follows by diffusion. The wastes are discharged into the gut. The epithelium that lines the rectum (part of the hindgut) actively reabsorbs most of the water and needed ions.

HUMAN EXCRETORY SYSTEM

* In humans, the excretory system consists of a pair of kidneys, one pair of ureters, a urinary bladder and a urethra .
* Kidneys are reddish brown, bean shaped structures situated between the levels of last thoracic and third lumbar vertebra close to the dorsal inner wall of the abdominal cavity.

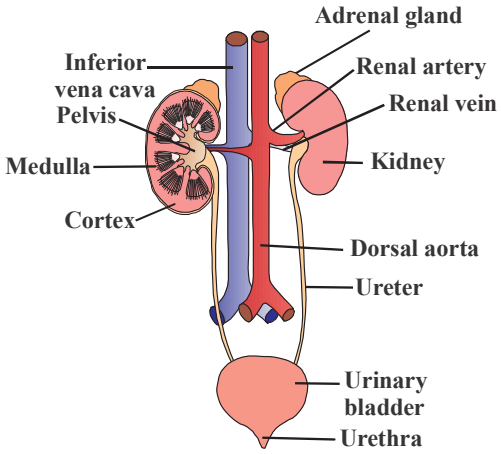


Figure : Human Urinary system

* 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 g.
* 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.**
* The outer layer of kidney is a tough capsule. Inside the kidney, there are two zones, an outer cortex and an inner medulla.
* The **medulla** is divided into a few conical masses (medullary pyramids) projecting into the calyces (sing.: calyx).

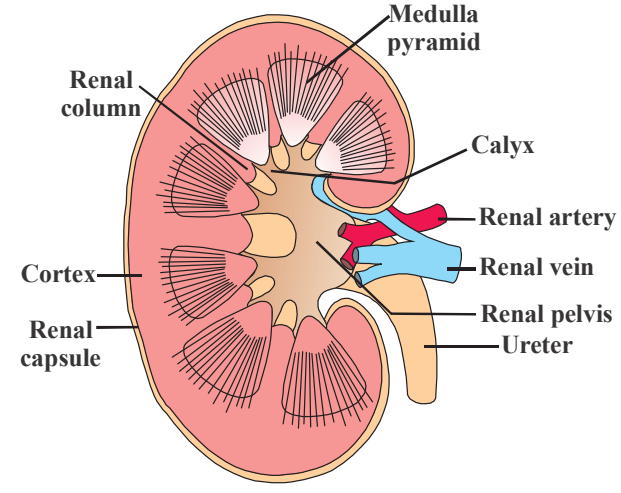


Figure : Longitudinal section (Diagrammatic) of Kidney

* The cortex extends in between the medullary pyramids as renal columns called **Columns of Bertini.**

* Each kidney has nearly one million complex tubular structures called **nephrons**, which are the functional units. Each nephron has two parts - the glomerulus and the renal tubule.
* **Glomerulus** 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.**
* The **renal tubule** begins with a double walled cup-like structure called **Bowman's capsule**, which encloses the glomerulus. Glomerulus alongwith Bowman's capsule, is called the **malpighian body** or renal corpuscle.

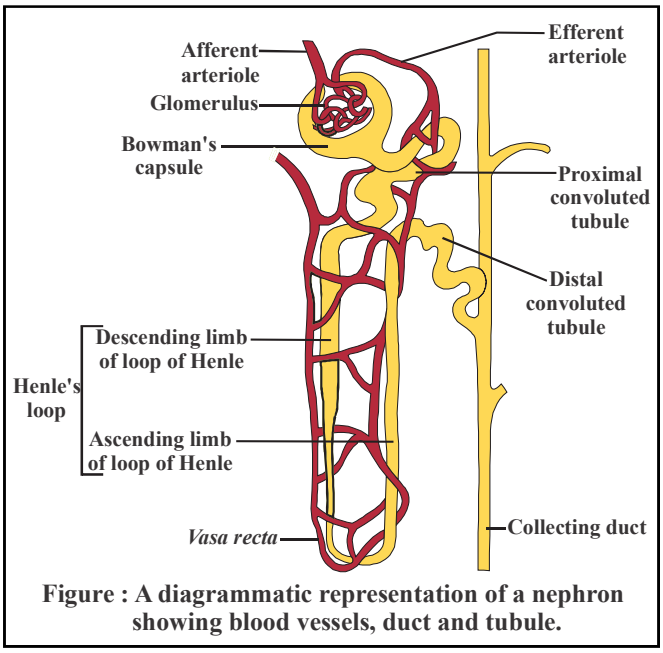


Figure : A diagrammatic representation of a nephron showing blood vessels, duct and tubule.

* The tubule continues further to form a highly coiled network - **proximal convoluted tubule (PCT).**
* A hairpin shaped **Henle's loop** is the next part of the tubule which has a descending and an ascending limb.
* The ascending limb continues as another highly coiled tubular region called **distal convoluted tubule (DCT).**
* The DCTs of many nephrons open into a straight tube called collecting duct, many of which converge and open into the renal pelvis through medullary pyramids in the calyces.

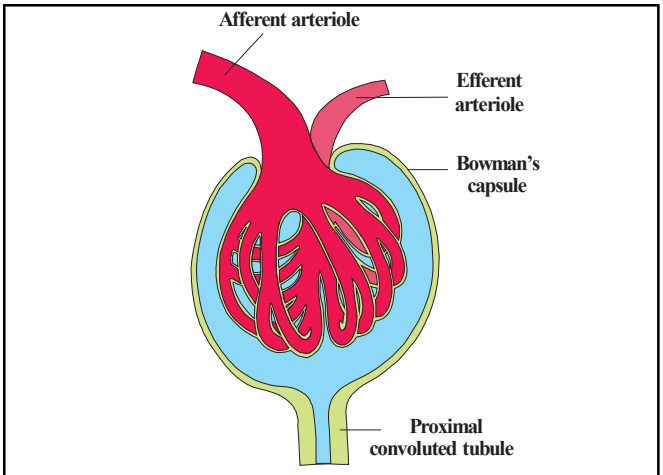


Figure : Malpighian body (renal corpuscle)

* 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. In majority of nephrons, the loop of Henle is too short and extends only very little into the medulla. Such nephrons are called **cortical nephrons.**
* In some of the nephrons, the loop of Henle is very long and runs deep into the medulla. These nephrons are called **juxta medullary nephrons.**
* The **efferent arteriole** emerging from the glomerulus forms a fine capillary network around the renal tubule called the **peritubular capillaries**. A minute vessel of this network runs parallel to the Henle's loop forming a 'U' shaped **vasa recta.** Vasa recta is absent or highly reduced in cortical nephrons.

URINARY BLADDER

* Urinary bladder has two parts. (i) Body (ii) Trigon
(i) **Body -** It is made of involuntary muscles which is called detrusor muscle.
(ii) **Trigon -** It is a triangular part. Two ureter open on its two corners.
* There are two sphinctors on the lower end of trigon.
(a) Internal sphinctor - Made of unstriated muscles.
(b) External sphinctor - Made of straited muscles.
* Urinary bladder has capacity of 700-800 ml.
* When it is filled upto 300-400 ml of urine then stretch receptors present on wall of urinary bladder, are stimulated and impulse is formed.

* This impulse is carried to S_{2-3-4} (Spinal segment) through pelvic nerve. Parasympathatic nerve fibers are exited and contraction detrusor muscle and relaxation in internal sphinctor occors.

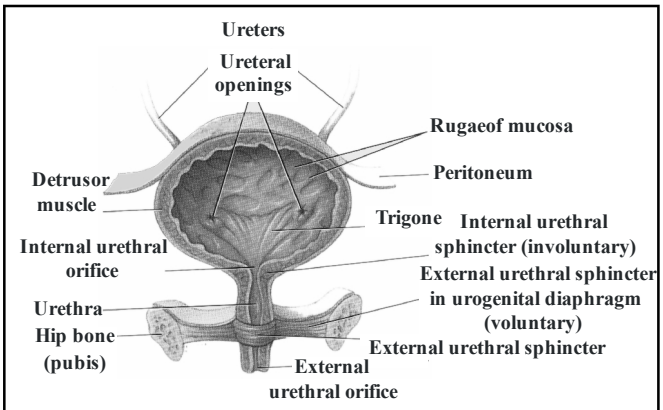


Figure : Parts of ureters, trigone of the bladder, sphincters and urethra

* This causes urine come out. This process is called micturation because external sphinctor is made of striped muscles.
* Micturation is unvoluntary in rabbit and children up to 2 years while it is voluntary in adult human.
* Abdominal muscles and diaphragm help in micturation.
* Lower part of urinary bladder is joint with urethra.
* **Urethra :** The urinary bladder leads into the urethra. In a female, it is quite short, only about 3 to 5 cm long, and carries only urine. It opens by urethral orifice, or urinary aperture in the vulva infront of the veginal or genital aperture. In a male urethra is much longer, about 20 cm and carries urine as well as spermatic fluid. It passes through the prostate gland and the penis. It opens out at the tip of the penis by urinogenital aperture. In males the epithelium of spongy urethra is stratified or pseudostratified columnar epithelia, except near external urethral orifice, which is non keratinized stratified squamous epithelia. The prostatic urethra lined by transitional epithelia, while membranous urethra lined by pseudostratified columnar.

UREA FORMATION

* Occur in liver through the Ornithin cycle or Kreb's Henseleit cycle.
* For the synthesis of one molecule of urea 3 ATP are consumed.
* One molecule of urea form by the 2 mole of ammonia and 1 mole CO_2, 1 mol of ammonia come from deamination of fat and other mol of ammonia comes from aspartic acid.
* Formation of citruline occurs in mitochondria.

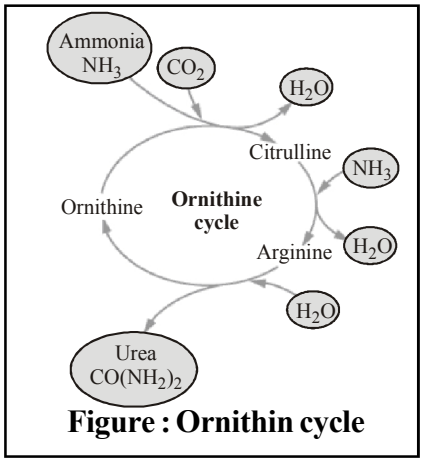


Figure : Ornithin cycle

URINE FORMATION

* Urine formation involves three main processes namely, glomerular filtration, reabsorption and secretion.
* The first step in urine formation is the filtration of blood, which is carried out by the glomerulus and is called **glomerular filtration.**

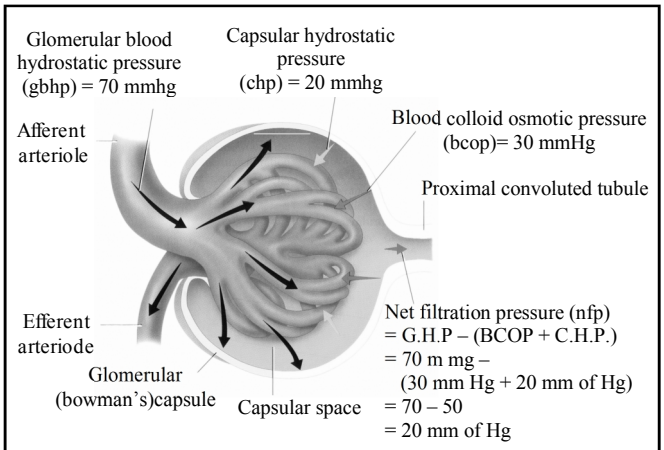
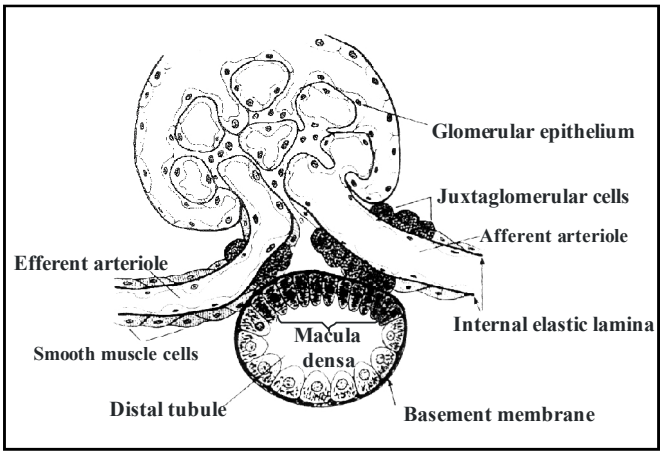


Figure : Ultra filtration

* 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.

* The glomerular capillary blood pressure causes filtration of blood through 3 layers, i.e., the endothelium of glomerular blood vessels, the epithelium of Bowman's capsule and 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 filtration slits or slit pores.
* 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 amount of the filtrate formed by the kidneys per minute is called **glomerular filtration rate** (GFR).GFR in a healthy individual is approximately 125ml/minute, i.e.,180 litres per day
* The kidneys have built-in mechanisms for the regulation of glomerular filtration rate. One such efficient mechanism is carried out by **juxta glomerular apparatus (JGA).**
* JGA is a special sensitive region formed by cellular modifications in the distal convoluted tubule and the afferent arteriole at the location of their contact.
* A 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.



* 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.** The tubular epithelial cells in different segments of nephron perform this either by active or passive mechanisms.
* Substances like glucose, amino acids, Na^+, etc., in the filtrate are **reabsorbed actively** whereas the nitrogenous wastes are absorbed by **passive transport**. Reabsorption of water also occurs passively in the initial segments of the nephron .
* During urine formation, the tubular cells secrete substances like H^+, K^+ and ammonia into the filtrate. 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.

FUNCTION OF THE TUBULES

* **Proximal Convoluted Tubule (PCT)**: PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment. PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate and by absorption of HCO_3^- from it.
* **Henle's Loop:** Reabsorption in this segment is minimum in its ascending limb. However, this region plays a significant role in the maintenance of high osmolarity of medullary interstitial fluid. The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes. This concentrates the filtrate as it moves down.
* **Distal Convoluted Tubule (DCT):** Conditional reabsorption of Na^+ and water takes place in this segment. 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.
* **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.

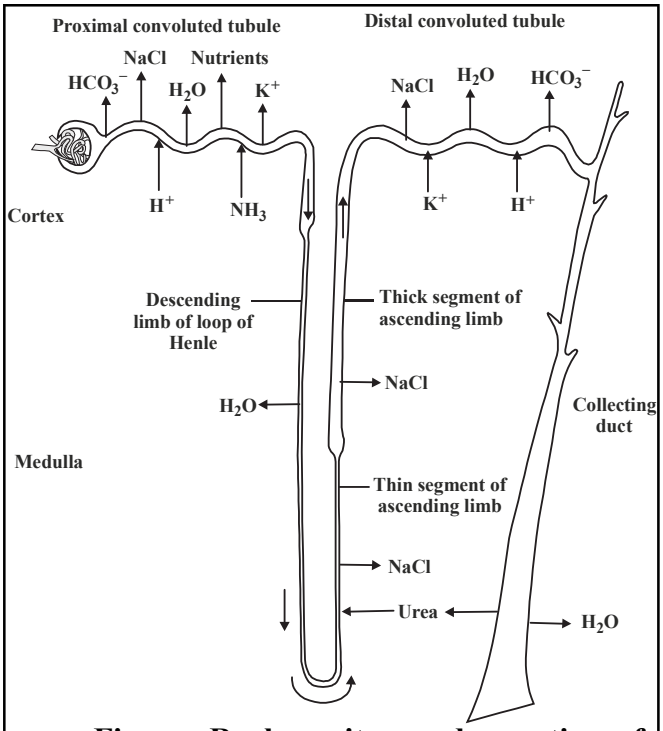


Figure: Reabsorpiton and secretion of major substances at different parts of the nephron (arrows indicate direction of movement of materials)

MECHANISM OF CONCENTRATION OF THE FILTRATE

* A counter current mechanism operates between the two limbs of the loop of Henle and those of vasa recta (capillary parallel to Henle's loop).
* The filtrate gets concentrated as it moves down the descending limb but is diluted by the ascending limb. Electrolytes and urea are retained in the interstitium by this arrangement.
* DCT and collecting duct concentrate the filtrate about four times, i.e., from 300 mOsmol L^{-1} to 1200 mOsmol L^{-1}, an excellent mechanism of conservation of water.
* 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. Similarly, 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.

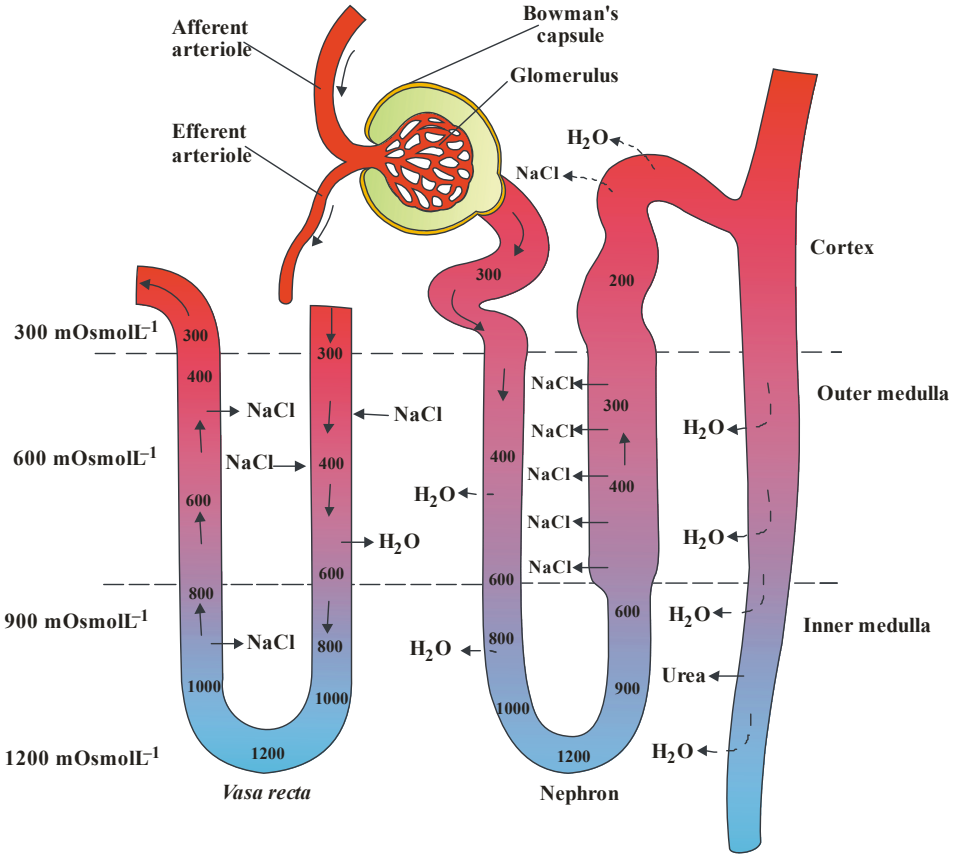


Figure : Diagrammatic representation of a nephron and vasa recta showing counter current mechanisms

REGULATION OF KIDNEY FUNCTION

* 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.
* 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.
* 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.**
* An increase in blood flow to the atria of the heart can cause the release of **Atrial Natriuretic Factor (ANF).**

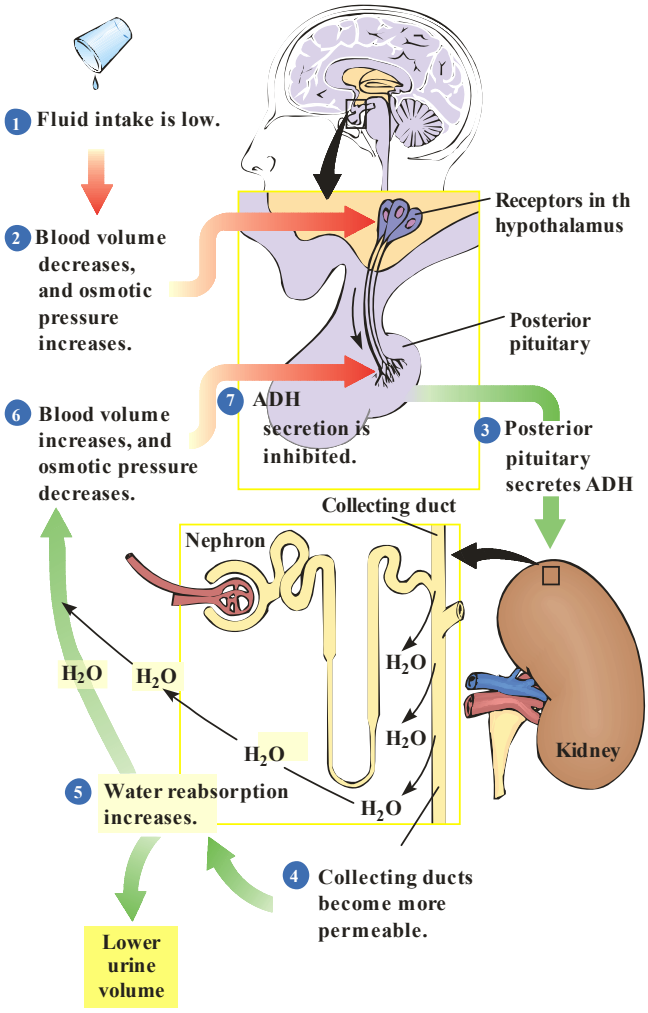


FIGURE : Regulation of urine volume by antidiuretic hormone (ADH). When the body is dehydrated, the hormone ADH increases the permeability of the collecting ducts to water. More water is reabsorbed, and only a small volume of concentrated urine is produced.

* 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.

Diabetes insipidus :

* Antidiuretic hormone (ADH) is one of the hormones that efficiently monitors and regulates the functioning of the kidneys.
* Antidiuretic hormone released-from the posterior pituitary, prevents wide swings in water balance, helping to avoid dehydration or water overload.

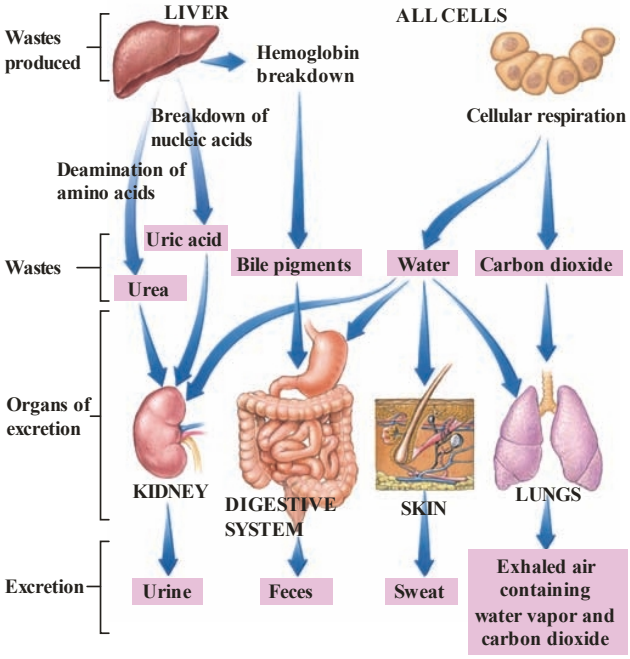
* ADH facilitates reabsorption of water by the distal parts of the kidney tubules and thereby prevents diuresis.
* Deficienc of ADH leads to diabetes insipidus; a condition marked by the output of huge amounts of urine and intense thirst.
* The name itself (*diabetes* = overflow; *insipidus* = tasteless) distinguishes it from diabetes mellitus (*mel* = honey), in which insulin deficiency causes large amounts of blood sugar to be lost in the urine.

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 characterestic 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. For example, presence of glucose (Glycosuria) and ketone bodies (Ketonuria) in urine are indicative of diabetes mellitus.

ROLE OF OTHER ORGANS IN EXCRETION

* Our lungs remove large amounts of CO_2 (approximately 200 ml/minute) and also significant quantities of water every day.
* Liver, the largest gland in our body, secretes bile-containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. Most of these substances ultimately pass out alongwith digestive wastes.
* 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.



Disposal of metabolic wastes in humans and other terrestrial mammals. To conserve water, mammals produce a small amount of hypertonic urine. Nitrogenous wastes are produced by the liver and transported to the kidneys. All cells produce carbon dioxide and some water during cellular respiration. These waste products are excreted by the lungs.

Figure : Excretory organs in terrestrial vertebrates

* Sebaceous glands eliminate certain substances like sterols, hydrocarbons and waxes through sebum.

This secretion provides a protective oily covering for the skin.

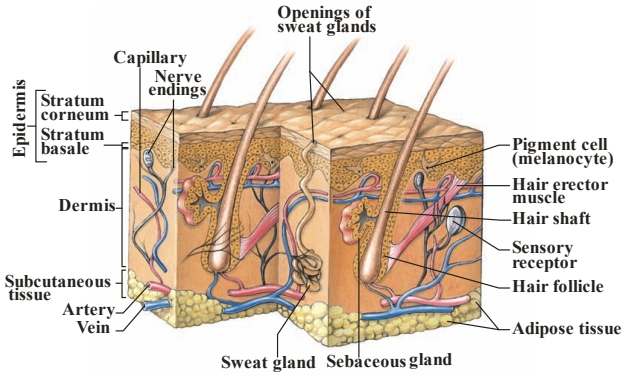


Figure : Human integumentary system
The integumentary system of humans and other mammals is a complex organ system consisting of skin and structures such as hair and nails that are derived from the skin. Stratum basale consists of a single layer of dividing epithelial cells

DISORDERS OF THE EXCRETORY SYSTEM

Pyelonephritis:

* It is an inflammation of renal pelvis, calyces and interstitial tissue.
* It is due to local bacterial infection. Bacteria reach here via urethra and ureter.
* Inflammation affects the countercurrent mechanism, and the victim fails to concentrate urine.
* Symptoms of the disease include pain the back, and frequent and painful urination.

Glomerulonephritis:

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

Cystitis:

* It is the inflammation of urinary bladder.
* It is caused by bacterial infection.
* Patient has frequent, painful urination, often with burning sensation.

Uremia:

* Malfunctioning of kidneys can lead to accumulation of urea in blood, a condition called uremia, which is highly harmful and may lead to kidney failure.
* In such patients, urea can be removed by a process called **hemodialysis.**
* During the process of haemodialysis the blood drained from a convenient artery is pumped into a dialysing unit called artificial kidney.

Kidney Stone (Renal Calculus):

* It is formed by precipitation of uric acid or oxalate. It blocks the kidney tubule.
* It causes severe pain (renal colic) in the back, spreading down to thighs.
* The stone may pass into the ureter or urinary bladder and may grow, and cause severe pain or blockade.
* When in bladder, the patient experiences frequent & painful urination & may pass blood in the urine.
* Surgery may be needed to remove stone and relieve pain.

Kidney (Renal) Failure (RF) :

* Partial or total inability of kidneys to carry on excretory and salt -water regulatory functions is called renal or kidney failure.
* **Result:** Kidney failure leads to (i) uremia, i.e., an excess of urea and other nitrogenous wastes in the blood (ii) salt-water imbalance; and (iii) stoppage of erythropoietin secretion.
* **Causes:** Many factors can cause kidney failure. Among these are tubular injury, infection, bacterial toxins, glomerulonephritis (inflammation of glomeruli), arterial or venous obstruction, fluid and electrolyte depletion, intrarenal precipitation of calcium and urates, drug reaction, haemorrhage, etc.
* **Prevention:** Renal failure can often be prevented by proper maintenance of normal fluid balance, blood volume and blood pressure.
  Dialysis: Dialysis should be started as soon as possible after the diagnosis is established.

Kidney (Renal) transplantation :

* Grafting a kidney from a compatible donor to restore kidney functions in a recipient suffering from kidney failure is called renal transplantation.
* **History:** First kidney transplant was performed between identical twins in 1954 by Dr. Charles Hufnagel, a Washington surgeon. India's first kidney transplant was done on December 1, 1971 at, Christian Medical College, Vellore, Tamil Nadu. The recipient was a 35 years old person Shaninughan.

* **Eligibility:** All patients with terminal renal failure are considered eligible for kidney transplantation, except those at risk from another life-threating disease.
* **Donors:** A living donor can be used in a kidney transplant. It may be an identical twin, a sibling, or a close relative. If the living donors are not available, a cadaver is donor may be used (cadaver is a dead body). Over half of the kidney transplants are from cadavers.
* **Success Rate:** A kidney transplant from an identical twin, called isogeneic graft or isograft, is always successful. A renal transplant from a sibling or a close relative or a cadaver, termed allogeneic graft or homograft, is usually successful with the use of an immunosuppressant that prevents graft rejection by body's immune response. Many renal transplant recipients are known to have retained functional grafts for over 20 years. Earlier, renal transplantation was limited to patients under 55 years. Now, however, with better techniques, kidney grafting has been done in selected patients in the 7^{th} decade of life.
* **Recipient-Donor Matching:** Recipient and donor are tested for 3 factors:

(i) **Blood Group :** Recipient's blood group should be compatible with donor's blood group.

(ii) **Human Leucocyte Antigen (HLA) :** It is a genetic marker located on the surface of leucocytes. A person inherits a set of 3 antigens from the mother and three from the father. A higher number of matching antigens increases the chances that the kidney graft will last for a long time.

(iii) **Antibodies :** Small samples of recipient's and donor's blood are mixed in a tube. If no reaction occurs, the patient will be able to accept the kidney.

CONCEPT REVIEW

* The principal waste products of animal metabolism are water; carbon dioxide; and **nitrogenous wastes**, including ammonia, urea, and **uric acid**. Ammonia is toxic and is excreted mainly by aquatic animals.
* Urea and uric acid are far less toxic than ammonia, but their synthesis requires energy. Urea excretion requires water. Uric acid can be excreted as a semisolid paste, a water-conserving adaptation.
* Most marine invertebrates are **osmoconformers** - the salt concentration of their body fluids varies with changes in the seawater. Some marine invertebrates, especially those inhabiting coastal habitats, are **osmoregulators** that maintain an optimal salt concentration despite changes in salinity of their surroundings.
* **Nephridial organs**, which include protonephridia and metanephridia, function in osmoregulation and waste disposal. **Protonephridia**, found in flatworms and nemerteans, are tubules with no internal openings. Interstitial fluid enters their blind ends, which consist of flame cells, cells with brushes of cilia. Beating of the cilia propels fluid through the tubules; excess fluid leaves through nephridiopores.
* Most annelids and mollusks have excretory tubules called **metanephridia**, which are open at both ends. As fluid from the coelom moves through the tubule, needed materials are reabsorbed by capillaries.
Urine, containing wastes, exits the body through nephridiopores.
* **Malpighian tubules**, extensions of the insect gut wall, have blind ends that lie in the hemocoel. Cells of the tubule actively transport uric acid and some other substances from the hemolymph into the tubule, and water follows by diffusion. The contents of the tubule pass into the gut, and water and some solutes are reabsorbed in the rectum. Malpighian tubules effectively conserve water and have contributed to the success of insects as terrestrial animals.
* The vertebrate kidney functions in excretion and osmoregulation and is vital in maintaining homeostasis. Its structure and function are adapted to the lifestyle of the animal.
* The kidney is the key organ of the **urinary system**, the principal excretory system in humans and other vertebrates. In mammals, the kidneys produce urine, which passes through the ureters to the urinary bladder for storage.

During urination, the urine is released from the body through the urethra.

* The outer portion of each kidney is the renal cortex; the inner portion is the **renal medulla**. The renal medulla contains 8 to 10 **renal pyramids**. The tip of each pyramid is a renal **papilla**. As urine is produced, it flows into collecting ducts, which empty through a renal papilla into a funnel-shaped chamber, the **renal pelvis**. Each kidney has more than a million functional units called nephrons.
* Each **nephron** consists of a cluster of capillaries, called a glomerulus, surrounded by a **Bowman's capsule** that opens into a long, coiled renal tubule. The renal tubule consists of a proximal convoluted tubule, loop of Henle, and distal convoluted tubule.
* **Cortical nephrons**, located almost entirely within the cortex or outer medulla, have small glomeruli. **Juxtamedullary** nephrons have large glomeruli and long loops of Henle that extend deep into the medulla. These nephrons are important in concentrating urine.
* Blood flows from small branches of the **renal artery** to **afferent arterioles** and then to glomerular capillaries. Blood then flows into an **efferent arteriole** that delivers blood into a second set of capillaries, the **peritubular capillaries** that surround the renal tubule. Blood leaves the kidney through the **renal vein.**
* Urine formation is accomplished by the **filtration** of plasma, **reabsorption** of needed materials, and secretion of a few substances such as potassium and hydrogen ions into the renal tubule.
* Plasma filters through the glomerular capillaries and into Bowman's capsule. The permeable walls of the capillaries and filtration slits between **podocytes**, specialized epithelial cells that make up the inner wall of Bowman's capsule, serve as a filtration membrane. Filtration is nonselective with regard to small molecules; glucose and other needed materials, as well as metabolic wastes, become part of the filtrate.
* About 99% of the filtrate is reabsorbed from the renal tubules into the blood. Reabsorption is a highly selective process that returns usable materials to the blood but leaves wastes and excesses of other substances to be excreted in the urine. The maximum rate at which a substance can be reabsorbed is its **tubular transport maximum (Tm).**
* In secretion, hydrogen ions, certain other ions, and some drugs are actively transported into the renal tubule to become part of the urine.
* Production of a concentrated urine depends on a high salt and urea concentration in the interstitial fluid of the kidney medulla. The interstitial fluid in the medulla has a concentration gradient in which the salt is most concentrated around the bottom of the loop of Henle. This gradient is maintained, in part, by salt reabsorption from various parts of the renal tubule. A counterflow of fluid through the two limbs of the loop of Henle concentrates filtrate as it moves down the descending loop and dilutes it as it moves up the ascending loop.
* Water is drawn by osmosis from the filtrate as it passes through the collecting ducts. This concentrates urine in the collecting ducts.
* Some of the water that diffuses from the filtrate into the interstitial fluid is removed by the **vasa recta**, a system of capillaries that extend from the efferent arterioles.
* Urine is a watery solution of nitrogenous wastes, excess salts, and other substances not needed by the body.
* Urine volume is regulated by **antidiuretic hormone (ADH),** which is released by the posterior lobe of the pituitary gland in response to an increase in osmotic concentration of the blood (caused by dehydration). ADH increases the permeability of the collecting ducts to water. As a result, more water is reabsorbed and only a small volume of urine is produced.
* Aldosterone and atrial natriuretic peptide work antagonistically. When blood pressure decreases, cells of the **juxtaglomerular** apparatus secrete the enzyme **renin**, which activates a pathway leading to production of **angiotensin II**. This hormone stimulates aldosterone release. Aldosterone increases sodium reabsorption, raising blood pressure.
* When blood pressure increases, **atrial natriuretic peptide** (ANP) increases sodium

excretion and inhibits aldosterone secretion. These actions increase urine output and lower blood pressure.

IMPORTANT POINTS

* The filtrate from the glomerulus contains urea, uric acid, glucose and water.
* The urine under normal conditions does not contain glucose because glucose in glomerular filtrate is reabsorbed in the uriniferous tubules.
* Loops of Henle occur in medulla.
* In a mammal excretion of water occurs in kidney.
* Cause of glomerular filtration is high pressure.
* Ammonia is excretory material in fresh water/ bony fishes.
* Reabsorption of useful substances from glomerular filtrate occurs in proximal convoluted tubule.
* Urea is formed in liver cells from ammonia and carbon dioxide.
* Function of loop of Henle is conservation of water.
* Glucose is absorbed actively by PCT.
* Excretion in cockroach occurs through malpighian tubules.
* Nephridia = Leech.
  Malphighian tubules = Cockroach
  Protonephridia = Roundworm.
  Kidneys = Shark
* Urine is isotonic in promimal convoluted tubule.
* Glucose is mainly absorbed in PCT.
* Juxtaglomerular cells of kidney produce a peptide hormone = Erythropoietin.
* Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed.
* Sebaceous glands eliminate certain substances like sterols, hydrocarbons and waxes through sebum. This secretion provides a protective oily covering for the skin.
* Gout : It is hereditary condition which is associated with high level of uric acid in blood.
* Ptosis : Displacement of kidney.
* $\text{Urea} \xrightarrow{\text{Urease}} NH_3 + CO_2$
* **Abnormal constituent of urine** - (i.e. Not present in normal condition)

1. **Protein -** If protein is present in urine it may be due to infection or injury in kidney. (Mainly albumin is filtered)
2. **Blood** - Due to infection and injury of kidney blood may appear in urine.
3. **Sugar** - In diabetes mellitus sugar appear in urine.
4. **Bile or bile pigment** - In jaundice bile pigment appear in urine.
5. **Ketone bodies** - In starvation and diabetes. Ketone bodies appear in urine.

* **Table : Hormonal Control of Kidney Function**

Hormone	Source	Target tissue	Actions	Factors that stimulate release
Antidiuretic hormone (ADH)	Produced in hypothalamus; released by posterior pituitary gland.	Collecting ducts	Increases permeability of collecting ducts to water, increasing reabsorption and decreasing water excretion.	Low fluid intake decreases blood volume and increases osmotic pressure of blood; receptors in hypothalamus stimulate posterior pituitary
Aldosterone	Adrenal glands (cortex)	Distal tubules and collecting ducts.	Increases sodium re-absorption.	Angiotensin II (when blood pressure decreases)
Angiotensin II	Produced from angiotensin I	Blood vessels and adrenal glands.	Constricts blood vessels, which raises blood pressure; stimulates aldosterone secretion.	Decrease in blood pressure causes renin secretion; renin catalyzes conversion of angiotensinogen to angiotensin I, which is then converted to angiotensin II by ACE.
Atrial natriuretic peptide (ANP)	Atrium of heart	Afferent arterioles; collecting ducts.	Dilates afferent arterioles; inhibits sodium reabsorption by collecting ducts; inhibits aldosterone secretion.	Stretching of atria due to increased blood volume.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.5

Match the column I with column II.

Q.1

	Column I	Column II
(a)	Ascending limb of loop of Henle	(i) Permeable to water
		(ii) Impermeable to water
(b)	Descending limb of loof of Henle	(iii) Permeable to electrolyte
		(iv) Impermeable to electrolytes

(A) a-ii, iv ; b-i, iii (B) a-ii, iii ; b-i, iv
(C) a-i, iv ; b-ii, iii (D) a-i, iii ; b-ii, iv

Q.2

	Column I		Column II (Physiological processes)
a.	Proximal convoluted tubule	i.	Formation of concenterated urine
b.	Distal convoluted tubule	ii.	Filtration of blood
c.	Henle's loop	iii.	Reabsorption of 70-80% of electrolytes
d.	Counter-current mechanism	iv.	Ionic balance
e.	Renal corpuscle	v.	maintenance of concentration gradient in medulla

(A) a-iii, b-v, c-iii, d-ii, e-i
(B) a-iii, b-iv, c-i, d-v, e-ii
(C) a-i, b-iii, c-ii, d-v, e-iv
(D) a-iii, b-i, c-iv, d-v, e-ii

Q.3

	Column I	Column II
(a)	Uremia	(i) Presenceof blood in urine
(b)	Dysuria	(ii) Painful urination
(c)	Pyuria	(iii) Presence of pus in urine
(d)	Hematuria	(iv) More urea in blood.

(A) a-i, b-iii, c-ii, d-iv (B) a-iii, b-ii, c-iv, d-i
(C) a-iv, b-ii, c-iii, d-i (D) a-ii, b-iv, c-iii, d-i

Q.4

	Column I		Column II
a.	Glycosurea	i.	Accumulation of uric acid in joints
b.	Renal calculi	ii.	Inflammation in glomeruli
c.	Glomerular nephritis	iii.	Mass of crystallised salts within the kidney
d.	Gout	iv.	presence of glucose in urine

(A) a-i, b-iii, c-ii, d-iv (B) a-iii, b-ii, c-iv, d-i
(C) a-iv, b-iii, c-ii, d-i (D) a-iv, b-ii, c-iii, d-i

Q.5

Column I	Column II
(a) Ammonotelism	(i) Birds
(b) Bowman's capsule	(ii) Water reabsorption
(c) Micturition	(iii) Bony fish
(d) Uricotelism	(iv) Urinary bladder
(e) ADH	(v) Renal tubule

(A) a-iii, b-v, c-iv, d-i, e-ii
(B) a-i, b-ii, c-iii, d-iv, e-v
(C) a-v, b-iv, c-iii, d-ii, e-i
(D) a-i, b-iii, c-ii, d-iv, e-v

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.6 to Q.22 :

Choose one word for the given statement from the list.

Adrenal cortex; Aldosterone, Afferent Atriole; Efferent atriole, Impermeable, Increasing, 300, 1200, Permeable,

Urinary bladder, CNS, Stretching, Vasopressin, Reabsorbed, Glomerulus; Filtration, 1100-1200, 1/5th, PCT, Concentrated, Urea, The nitrogeneous wastes, 25-30, Micturition

Q.6 Glomerulus is a tuft of capillaries formed by ____ (A fine branch of renal artery). Blood from the glomerulus is carried away by an ____.

Q.7 Large amount of water is _____ from collecting duct to produce _____ urine. This segment allows passage of small amounts of _____ into interstitium of medulla to keep up the osmolarity.

Q.8 Urine formed by nephornes is ultimately carried _____ where at stored fill a voluntary signal given by the _____ This signal is initiated by _____ of urinary bladder as it gets filled with urine.

Q.9 The first step in the urine formation is the filtration of the blood, which is carried by the ____ and is called ____. On an average ____ mL of blood is filtered by kidneys per minute, which constitutes ____ of the blood pumped out by each ventricle of the heart in a minute.

Q.10 Angiotensin-II activates the _____ and release _____.

Q.11 The proximity between Henle's loop and vasa-recta as well as the counter current in them help in maintaining an ____ in molarity towards inner interstitium medullary, region, i.e., from ____ mOs mol L^{-1} in the cortex to about ____ mOs mol L^{-1} in the inner medulla.

Q.12 Ascending limb of Henle's loop is ____to water whereas the descending limb is_____ to it.

Q.13 Reabsorption of water from distal parts of the tubules is facilitated by hormone_____.

Q.14 Dialysis fluid contains all the constituents as in plasma except ____.

Q.15 A healthy adult human excretes (on an average) ____ gm of urea/day.

Q.16 The process of release of urine is called ____.

Q.17 Reabsorption of glucose occurs in _____ of the nephron.

Q.18 Micturition is carried out by a reflex. **[True / False]**

Q.19 ADH helps in water elimination, making the urine hypotonic. **[True / False]**

Q.20 Protein-free fluid is filtered from blood plasma into the Bowman's capsule. **[True / False]**

Q.21 Henle's loop plays an important role in concentrating the urine. **[True / False]**

Q.22 Glucose is actively reabsorbed in the proximal convoluted tubule. **[True / False]**

SECTION - 3 (ENHANCE DIAGRAM SKILLS)

Q.23 Identify A to E in the given structure

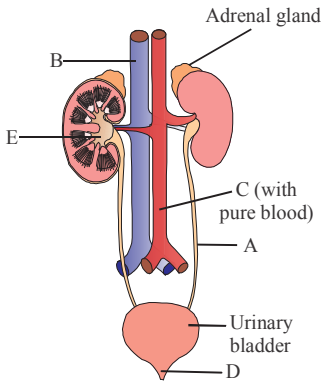
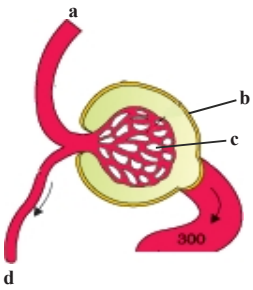


Figure : Human Urinary system

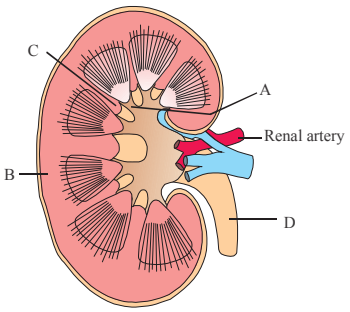
(A) A-Ureter, B-Inferior vana cava, C-Dorsal aorta, D-Urethra, E-Medulla
(B) A-Ureter, B-Inferior vana cava, C-Dorsal aorta, D-Pelvis, E-Urethra
(C) A-Ureter, B-Inferior vana cava, C-Dorsal aorta, D-Urethra, E-Pelvis
(D) A-Ureter, B-Inferior vana cava, C-Pelvis, D-Dersal aorta, E-Urethra

Q.24 Identify a to d in the given structure



(A) a-Afferent arteriole, b-Bowman's capsule, c-Glomerulus, d-Efferent arteriole
(B) a-Efferent arteriole, b-Bowman's capsule, c-Glomerulus, d-Afferent arteriole
(C) a-Afferent arteriole, b-Glomerulus, c-Bowman's capsule,d-Efferent arteriole
(D) a-Bowman's capsule, b-Afferent arteriole, c-Glomerulus, d-Efferent arteriole

Q.25 Identify A to D in the given structure



(A) A-Calyx, B-Cortex, C-Renal column, D-Ureter
(B) A-Calyx, B-Cortex, C-Renal column, D-Urethra
(C) A-Urethra, B-Cortex, C-Renal column, D-Calyx
(D) A-Urethra, B-Calyx, C-Renal column, D-Cortex

SECTION - 4 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : HUMAN EXCRETORY SYSTEM

Q.26 Structural and functional unit of the kidney is
(A) medulla (B) nephridia
(C) nephron (D) hilum

Q.27 In majority of nephrons, the loop of Henley's is found in the –
(A) cortical region of the kidney.
(B) medullary region of the kidney.
(C) Both (A) and (B).
(D) pelvis region of the kidney.

Q.28 In majority, juxta-medullary nephrons are found in the kidney of –
(A) kangaroo rat (B) camel
(C) Both (A) and (B) (D) fishes

Q.29 Which one of the following statements is incorrect?
(A) The medullary zone of kidney is divided into a few conical masses called medullary pyramids projecting into the calyces.
(B) Inside the kidney the cortical region extends in between the medullary pyramids as renal pelvis.
(C) Glomerulus alongwith Bowman's capsule is called the renal corpuscle.
(D) Renal corpuscle, proximal convoluted tabule (PCT) and distal convoluted tubule (DCT) of the nephron are situated in the cortical region of kidney.

Q.30 Each nephron has two parts, which are
(A) Bowman's capsule and PCT
(B) Glomerulus and renal tubule
(C) Glomerulus and Bowman's capsule
(D) Bowman's capsule and renal tubule

Q.31 In human, excretory system consists of
I. pair of kidneys II. one pair of ureters
III. urinary bladder IV. urethra
V. skin VI. lungs
VII. liver
(A) I, II, III and II
(B) I, II, III and V
(C) I, II, III and IV
(D) I, II, III, IV,V, IV and VII

Q.32 In juxta-medullary nephrons,
(A) vasa recta is prominent
(B) loop of Henle is long
(C) loop of Henle runs deep into the medulla
(D) All of the above

Q.33 The human kidney has about
(A) one million nephrons
(B) two million nephrons
(C) three million nephrons
(D) ten million nephrons

Q.34 The following substances are the excretory products in animals. Choose the least toxic form among them?
(A) Urea (B) Uric acid
(C) Ammonia (D) Carbon dioxide

Q.35 Which of the following structures are situated in the cortical region of the kidney?
I. Malpighian corpuscle
II. PCT (Proximal Convoluted Tubules)
III. DCT (Distal Convoluted Tubules)
IV. Loop of Henle
V. Collecting duct
(A) I, II and III (B) III, IV and V
(C) II, III and IV (D) IV, V and I

Q.36 Inner to the hilum of the kidney, there is a broad funnel-shaped space called
(A) renal pelvis (B) medulla
(C) cortex (D) adrenal gland

Q.37 Malpighian body or renal corpuscle is/are
(A) Bowman's capsule
(B) glomerulus
(C) Both (A) and (B)
(D) proximal convoluted tubule

Q.38 Part of the kidney through which the ureter, blood vessels and nerves enters into it is –
(A) renal cortex (B) renal medulla
(C) hilum (D) urethra

Q.39 In cortical nephrons–
(A) loop of Henle is short
(B) loop of Henle is long
(C) the PCT is very long
(D) the DCT is short

PART - 2 : URINE FORMATION

Q.40 Ultrafiltrate generated by the glomerulus is having all the constituent of the blood plasma except
(A) protein (B) RBC
(C) WBC (D) All of these

Q.41 Urea is produced in liver with the help of enzyme
(A) arginase (B) urease
(C) uricase (D) lipase

Q.42 A fall in the GFR rate activates the
(A) JG cells to release renin.
(B) JG cells to release aldosterone.
(C) JG cells to release epinephrine.
(D) JG cells to release nor-epinephrine.

Q.43 All Bowman's capsules of kidney are found in
(A) pelvis (B) medulla
(C) cortex (D) None of these

Q.44 Urine formation involves
I. glomerular filtration
II. tubular reabsorption
III. tubular secretion
(A) I and II (B) II and III
(C) I and III (D) I, II and III

Q.45 Reabsorption of the filtrate in the renal tubules takes place by
(A) active means (B) passively means
(C) Either (A) or (B) (D) osmosis means

Q.46 Choose the correct option containing compounds of ornithine cycle from the options given below.
(A) Ornithine, citrulline and fumaric acid
(B) Ornithine, citrulline and alanine
(C) Ornithine, citrulline and arginine
(D) Ornithine, citrulline and tyrosine

Q.47 JGA (Juxta Glomerular Apparatus), a sensitive region, which regulates the glomerular filtration rate is present near the
(A) DCT and PCT
(B) DCT and efferent arteriole
(C) DCT and afferent arteriole
(D) Loop of Henle's and DTC

Q.48 Select the right option.
(A) Nitrogenous excretory products are synthesised in kidney and eliminated in liver.
(B) Nitrogenous excretory products are synthesised in kidney, and eliminated also.
(C) Nitrogenous excretory products are synthesised in liver and eliminated via bile juice.
(D) Nitrogenous excretory products synthesised in liver eliminated by kidney.

Q.49 Podocytes are present on the
(A) endothelial cells of the glomerulus.
(B) endothelial cells of the Bowman's capsule.
(C) epithelium cells of the Bowman's capsule.
(D) epithelium cells of the glomerulus.

Q.50 GFR in a healthy individual is
(A) 125 mL/min (B) 150 L/day
(C) 125 mL/sec (D) 135 L/day

Q.51 Net pressure gradient that causes fluid to filter out of glomeruli in capsule is –
(A) 20 mm Hg (B) 75 mm Hg
(C) 30 mm Hg (D) 50 mm Hg

Q.52 Filtration in Malpighian body of the nephrons involves –
(A) one layer (B) two layer
(C) three layer (D) four layer

Q.53 I. Glucose II. Amino acid
III. Na^+ IV. Nitrogenous waste
Which of them reabsorbed actively in the nephron?
(A) I and II (B) I, II and III
(C) I and III (D) Only I

Q.54 How much percentage of the filtrate is reabsorbed in the renal tubules?
(A) 5% (B) 25%
(C) 90% (D) 99%

Q.55 Urea cycle is also called
(A) Krebs' cycle (B) Henselet cycle
(C) Kreb-Henselit cycle (D) Dark reaction

Q.56 GFR (Glomerular Filtration Rate) is the amount of filtrate formed by the kidney per
(A) hour (B) second
(C) minute (D) 10 seconds

PART - 3 : FUNCTION OF TUBULES

Q.57 An organism which don't have loop of Henle will excrete –
(A) no urine (B) dilute urine
(C) concentrated urine (D) no change in urine

Q.58 PCT helps in the maintenance of pH in the body fluid by
. . . . . $^+$ ions.
(B) selective secretion of ammonia.
(C) selective secretion of K^+ ions.
(D) All of the above

Q.59 PCT is lined by
(A) cuboidal epithelium (B) squamous epithelium
(C) columnar epithelium (D) stratified epithelium

Q.60 Choose the mismatched part of nephron with their function.
(A) Bowman's capsule-Glomerular filtration
(B) PCT-Reabsorption of Na^+ and K^+
(C) DCT-Reabsorption of glucose
(D) Loop of Henle-Urine concentration

Q.61 Transport of electrolytes through loop of Henle takes place by –
(A) actively (B) passively
(C) Both (A) and (B) (D) diffusion

Q.62 Collecting duct of nephron extends kidney from cortex to
(A) capsule region.
(B) inner part of medulla.
(C) outer part of medulla.
(D) middle part of medulla.

Q.63 Henle's loop of nephron plays a Significant role in maintaining a high osmolarity in
(A) intestitial fluid of hilum.
(B) medullary interstitial fluid.
(C) cortex interstitial fluid.
(D) All of the above

Q.64 Percentage of electrolytes and water reabsorbed by PCT is
(A) 60-70 (B) 70-80
(C) 80-90 (D) 90-95

Q.65 The ascending and descending limb of Henle's loop is respectively lined by –
(A) squamous epithelium, cuboidal epithelium.
(B) cuboidal epithelium, sequamous epithelium.
(C) ciliated epithelium. sequamous epithelium.
(D) cuboidal epithelium, ciliated epithelium.

Q.66 Main function of DCT of nephron is to maintain the –
(A) pH in blood
(B) Na-K balance of blood
(C) Both (A) and (B)
(D) temperature of blood

Q.67 Reabsorption is minimum, in which part of nephron
(A) PCT (B) DCT
(C) collecting duct (D) loop of Henle

PART - 4 : MECHANISM OF CONCENTRATION OF URINE

Q.68 Vasa recta is minute vessel of Peritubular capillaries network, which is
(A) also known as juxta-glomerular apparatus.
(B) running parallel to loop of Henle.
(C) running parallel to PCT.
(D) running parallel to DCT.

Q.69 Function of Henle's loop is –
(A) passage of urine
(B) formation of urine
(C) conservation of water
(D) filtration of H_2O

Q.70 We can produce a concentrated/ dilute urine. This is facilitated by a special mechanism. Identify the mechanism.
(A) Reabsorption from PCT
(B) Reabsorption from Collecting Duct
(C) Reabsorption/Secretion in DCT
(D) Counter current mechanism in Henle's loop/ Vasa recta

Q.71 NaCl is transported by ascending limb of Henle's loop, which is exchanged with
(A) DCT
(B) PCT
(C) ascending limb of vasa recta
(D) descending limb of vasa recta

Q.72 The renal fluid isotonic to the corticial fluid and blood is found in
(A) collecting duct and ascending duct.
(B) distal convoluted tubule and ascending limb.
(C) the proximal convoluted tubule and distal convoluted tubule.
(D) the ascending limbs and descending limb.

Q.73 Mammals have the ability to produce
(A) isotonic urine (B) hypertonic urine
(C) hypotonic urine (D) acidic urine

Q.74 Human kidneys can produce urine nearly
(A) three times concentrated than initial filtrate
(B) four times concentrated than initial filtrate.
(C) five times concentrated than initial filtrate.
(D) six times concentrated than initial filtrate.

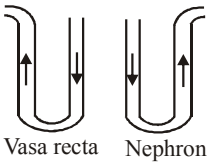
Q.75 The counter current mechanism operates in nephron
(A) in ascending and descending limb of vasa recta.
(B) in ascending limb of Henle's loop.
(C) in descending limb of Henle's loop.
(D) between the loop of Henle and vasa recta.

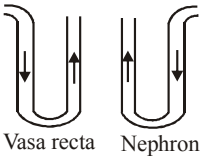
Q.76 The medullary gradient is mainly caused by –
(A) NaCl and urea (B) H^+ and K^+
(C) urea and K^+ (D) urea and H^+

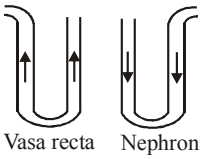
Q.77 Out of the four parts given below, which parts play significant role in forming concentrated urine in human?
I. Loop of Henle II. Glomerulus
III. Bowman's capsule IV. Vasa recta
(A) I and II (B) III and IV
(C) II and III (D) I and IV

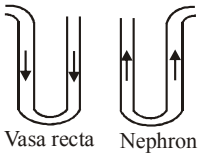
Q.78 What is the obligatory water reabsorption?
(A) Reabsorption of water from PCT.
(B) Reabsorption of water from loop of Henle.
(C) Both (A) and (B)
(D) Water secretion by Bowman's capsule.

Q.79 Which of the following diagrams correctly represents the counter current pattern ?

(A) 

(B) 

(C) 

(D) 

PART - 5 : REGULATION OF KIDNEY FUNCTION

Q.80 ADH is secreted by
(A) anterior lobe of pituitary.
(B) middle lobe of pituitary.
(C) posterior lobe of pituitary.
(D) All of the above

Q.81 ANF (Anti Natriuretic Factor) is released by
(A) lung (B) kidney
(C) heart (D) All of the above

Q.82 Renin is released by
(A) hypothalamus
(B) posterior lobe of pituitary
(C) anterior lobe of pituitary
(D) J G cells

Q.83 The functioning of the kidneys is efficiently monitored and regulated by the hormonal feedback mechanism involving –
(A) hypothalamus (B) JGA
(C) heart (D) All of the above

Q.84 Osmoregulation is the function of
(A) oxytocin (B) ADH
(C) prolactin (D) Both (A) and (B)

Q.85 ADH is also called –
(A) vasopressin (B) prolactin
(C) urease (D) oxytocin

Q.86 Aldosterone causes conditional reabsorption of ____ in the distal part of tubule.
(A) CO_2 (B) Ca^{2+}
(C) Na^{+} (D) Cl^{-}

Q.87 Autoregulation of GFR (Glomerulus Filtration Rate) takes place by
(A) renin angiotensis mechanism
(B) juxtaglomerulus apparatus
(C) vassopressin
(D) All of the above

Q.88 Facultative water reabsorption is
(A) reabsorption of water in PCT through ADH.
(B) reabsorption of water in loop of through ADH.
(C) reabsorption of water in DCT and CT through ADH.
(D) All of the above.

Q.89 ANF mechanism checks on
(A) oxytocin- renin mechanism
(B) counter- current mechanism
(C) renin- angiotensin mechanism
(D) oxytocin- angiotensin mechanism

Q.90 Osmoreceptores in the body is activated by the changes in
I. blood volume
II. body fluid volume
III. ionic concentration
(A) I and II (B) I and III
(C) III and II (D) All of these

Q.91 Reabsorption of water in DCT and CT part of nephron is function of
(A) prolactin (B) oxytocin
(C) vasopressin (D) luteinising hormone

Q.92 Factors, which regulates the osmoregulation of body fluids–
I. ADH II. Renin- angiotensin
III. ANF
IV. Counter- current mechanism
(A) I, II and III (B) II, III and IV
(C) I, II and IV (D) All of the above

PART - 6 : MICTURITION

Q.93 pH of urine (average pH) is
(A) 7.0 (B) 0.5
(C) 7.5 (D) 6.0

Q.94 Which of the following is the first formed nitrogenous waste of vertebrate?
(A) Uric acid (B) Urea
(C) NH_3 (D) NH_4

Q.95 Micturition reflex is a neural mechanism to
(A) release sweat
(B) formation of urine
(C) release urine
(D) release inorganic substance to the urine

Q.96 Composition of urine
I. Water : ___ %
II. Urea : ___ %
III. Uric acid : ___ %
IV. Salt : ___ %
(A) 90; 2.0; 1; 2
(B) 95; 2.6; 0.3; 1.5
(C) 80; 2.6; 0.3; 1.5
(D) 85; 2.6; 0.3; 1.5

Q.97 An adult human excretes on an average
(A) 2-3 litres of urine per day.
(B) 1-1.5 litres of urine per day.
(C) 2-5 litres of urine per day.
(D) 4-5 litres of urine per day.

Q.98 Indication of diabetes mellitus is/are
(A) presence of glucose in urine.
(B) presence of ketone bodies in urine.
(C) presence of amino acid in urine.
(D) Both (A) and (B)

Q.99 What happens in micturition?
(A) Contraction of smooth muscles of bladder.
(B) Relaxation of the urethral sphincter.
(C) Release of urine
(D) All of the above

Q.100 Which of the following is the osmoconformer vertebrate?
(A) Rabbit (B) Hag fish
(C) Bird (D) None of the above

Q.101 On an average the amount of urea in gram excreted out per day is
(A) 25-30 gm (B) 30-35 gm
(C) 20-25 gm (D) 35-40gm

Q.102 Urine is yellow in colour, due to
(A) prochrome (B) haemoglobin
(C) urochrome (D) creative

PART - 7 : OTHER ORGANS IN EXCRETION

Q.103 Chick excrete their secretion in the form of
(A) ammonia (B) urea
(C) uric acid (D) crystal of guanine

Q.104 Other than kidney which of the following organs help in elimination of excretory wastes?
I. Lungs II. Liver
III. Skin IV. Spleen
Choose the correct option containing all correct organs.
(A) I, II and III (B) II, III and IV
(C) I, III and IV (D) I, II and IV

Q.105 Choose the correct statements.
(A) Sebaceous gland eliminate sterols, hydrocarbons, waxes.
(B) Secretion of sebaceous gland provide oily protective covering of skin.
(C) Small amount of nitrogenous wastes eliminated through saliva.
(D) All of the above

Q.106 Largest gland of our body is
(A) spleen (B) lung
(C) liver (D) kidney

Q.107 Morphological and physiological units of mammalian kidney is –
(A) uriniferous tubules
(B) seminiferous tubules
(C) Henle's loop
(D) urethra

Q.108 A portion of uric acid is converted to urea and ammonia by intestinal.
(A) urogenolysis (B) ureolysis
(C) uricolysis (D) ureotolysis

Q.109 Sweat produced by sweat glands is a watery fluid which contain.
(A) NaCl (B) urea
(C) lactic acid (D) All of the above

Q.110 Our lungs release.
(A) 18 L of O_2 every day
(B) 18 L of CO_2 every day
(C) 10 L of CO_2 every day
(D) 10 L of O_2 every day

PART - 8 : DISORDERS OF EXCRETORY SYSTEM

Q.111 Polyuria is a condition in which
(A) amount of urine pass out is more.
(B) amount of urine pass out is less.
(C) no urine pass out.
(D) no urine formation.

Q.112 Melanuria is caused by abnormal catabolism of
(A) alanine (B) tyrosine
(C) proline (D) tryptophan

Q.113 Uremia is accumulation of urea in
(A) Liver (B) blood
(C) Kidney (D) bone joints

Q.114 Dialysing unit (artificial kidney) contains a fluid which is almost same as plasma except that it has
(A) High glucose (B) High urea
(C) No urea (D) High uric acid

Q.115 Renal calculi is
(A) soluble mass of crystallised salts in kidney.
(B) soluble mass of protein in kidney.
(C) insoluble mass of proteins in kidney.
(D) insoluble mass of crystallised salts in kidney.

Q.116 Nephritis is caused by
(A) fungi (B) bacteria
(C) virus (D) Protozoa

Q.117 Gout is a condition in which
(A) high level of urine in blood is found.
(B) high level of urea in blood is found.
(C) high level of uric acid in blood is found.
(D) All of the above

Q.118 In uremia condition the urea can be removed by a process called –
(A) haemolysis (B) haemodialysis
(C) dialysis (D) micturition

Q.119 Glomerulonephritis is –
(A) bleeding of glomeruli of kidney
(B) absence of glomeruli of kidney
(C) inflamation of glomeruli of kidney
(D) inflamation of PCTof kidney

Q.120 Anuria is failure of
(A) kidney to form urine.
(B) tubular secretion in kidney.
(C) tubular filtration in kidney.
(D) tubular reabsorption in kidney.

Q.121 Alkaptonuria is a condition in which
(A) accumulation of homogenestic acid in blood.
(B) excretion of homogenestic acid in sweat.
(C) excretion of homogenestic acid in urine.
(D) All of the above

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 The principal functional unit(s) in the vertebrate kidneys is/are –
(A) nephridia (B) nephrons
(C) Bowman's capsules (D) antennal glands

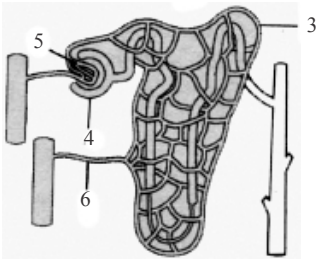
Q.2 Which of the following statements are true in relation to regulation of kidney function?
(A) A decrease in blood flow to the atria of the heart can cause release of ANF.
(B) ANF causes vasoconstriction, and hence an increase in blood pressure.
(C) RAAS opposes the regulation by ANF.
(D) ANF mechanism acts as a check on the renin-angiotensin mechanism.

Q.3 The process that maintains homeostasis of body fluids, keeping them from becoming too dilute or too concentrated is called –
(A) excretion (B) elimination
(C) osmoregulation (D) glomerular filtration

Q.4 Filtration of the blood takes place at
(A) PCT (B) DCT
(C) Collecting ducts (D) Malpighian body

Q.5 The main nitrogenous waste product of amphibians and mammals is
(A) urea (B) uric acid
(C) ammonia (D) carbon dioxide

Q.6 Which numbered part of the nephron and its associated blood vessels have the highest blood pressure?



(A) 3 (B) 4
(C) 5 (D) 6

Q.7 Which of the following most accurately describes changes in the concentration of filtrate in the two portions of the loop of Henle?
(A) decreases in both.
(B) increases in both.
(C) increases in descending/decreases in ascending.
(D) decreases in descending/increases in ascending.

Q.8 Arrange the following parts of the nephron in a sequential manner and select the correct option accordingly.
I. Glomerulus
II. Bowman's capsule
III. Henle's loop
IV. Proximal convoluted tubule
V. Collecting duct
VI. Distal convoluted tubule.
(A) I → II → III → IV → V → VI
(B) I → II → IV → III → VI → V
(C) I → II → IV → III → V → VI
(D) VI → III → II → I → VI → V

Q.9 Kidneys contribute to homeostasis and regulate the composition of blood and interstitial fluids. Which of the following is not the homeostatic function of the kidneys?
(A) Remove waste formed during cellular metabolism which may be toxic or non-toxic.
(B) Maintain appropriate concentrations of water and ions, especially sodium, potassium, chloride, calcium, magnesium, sulfate and phosphate ions.
(C) Regulate the appropriate balance of glucose in the blood.
(D) Control ion excretion, and thereby regulate the volume of blood and interstitial fluids.

Q.10 Highest and least concentration of urea will be observed respectively in
(A) hepatic vein and hepatic artery
(B) hepatic artery and renal vein
(C) hepatic vein and renal vein
(D) hepatic portal vein and hepatic vein.

Q.11 Which of the following is not a correct pair?
(A) protonephridia/flatworm
(B) metanephridia/annelid
(C) flame cell/flatworm
(D) Malpighian tubule/ mollusk

Q.12 Alcohol increases the frequency of urination because –
(A) It stimulates the hypothalamus to secrete more ADH.
(B) It stimulates the pituitary to secrete more ADH.
(C) It decreases the level of ADH, so there is more urination.
(D) It helps to eliminate the excess water, that is taken in along with alcohol.

Q.13 To compensate for fluid loss, many marine bony fishes
(A) accumulate urea
(B) have glands that excrete glucose
(C) eat a low-protein diet
(D) drink seawater

Q.14 About 180 litres of fluid is filtered by the kidney every day. Only 1.5 litres is excreted in urine. A failure of which organ would result in a higher volume of urine being formed?
(A) Pancreas (B) Pituitary gland
(C) Hypothalamus (D) Gall bladder

Q.15 The afferent arteriole delivers blood to the –
(A) renal artery
(B) efferent arteriole
(C) renal vein
(D) capillaries of the glomerulus

Q.16 A potato bug would excrete wastes by means of
(A) nephridia
(B) nephrons
(C) a pair of kidney-like structures
(D) Malpighian tubules

Q.17 Tubular transport maximum is –
(A) the maximum concentration of a substance in the plasma that can be reabsorbed by the kidney.
(B) the most rapid rate at which urine can be transported through the ureter.
(C) the maximum rate at which a substance can be reabsorbed from the filtrate in the renal tubules.
(D) the maximum rate at which a substance can pass through the loop of Henle.

Q.18 Which of the following does not contribute to the high salt concentration in the interstitial fluid in the medulla of the kidney?
(A) reabsorption of salt from various regions of Bowman's capsule.
(B) diffusion of salt from the ascending limb of the loop of Henle.
(C) active transport of sodium from the upper part of the ascending limb.
(D) counterflow of fluid through the two limbs of the loop of Henle.

Q.19 Identify the correct statement(s) regarding the human kidney.
(i) It is responsible for the storage of nutrients such as glycogen.
(ii) It concentrates the urine by actively transporting water from the filtrate.
(iii) It produces more dilute urine, when the collecting ducts become less permeable to water.
(iv) The kidney gets rid of urea from the body by secreting it into the descending arm of the loop of Henle.
(v) It responds to antidiuretic hormone by increasing urine output.
(vi) It responds to atrial natriuretic factor by decreasing urinary excretion.
(vii) Kidney functions are controlled by negative feedback circuits involving ADH, RAAS and ANF.
(A) (ii), (iv) and (v) (B) (v), (vi)
(C) (i), (iv), (vi) (D) (iii) and (vii)

Q.20 The different parts of the nephron and kidney, that are involved in urine flow have been given different numbers in the provided key. Using these numbers, identify the correct option representing the route of the urine flow after DCT.

1. Collecting duct 2. Connecting tubule
3. Major calyx 4. Minor calyx
5. Duct of Bellini 6. Renal pelvis
7. Renal papilla 8. Medullary pyramid
9. Column of Bertin

(A) 2, 1, 5, 8, 7, 4, 3, 6
(B) 1, 2, 3, 5, 4, 6, 8, 9
(C) 1, 2, 3, 4, 5, 6, 7, 8, 9
(D) 6, 7, 8, 9, 5, 4, 3, 2

Q.21 Given below are some of the features observed in the ship of the desert - camel to conserve water. Which of these is incorrect?
(A) Extra long loops of Henle
(B) Concentrated urine
(C) Nitrogenous waste as uric acid
(D) Utilization of metabolic water

Q.22 Which is not true of ADH?
(A) released by posterior lobe of the pituitary gland.
(B) increases water reabsorption
(C) secretion increases when osmotic pressure in body increases.
(D) increases urine volume.

Q.23 Aldosterone –
(A) is released by the posterior pituitary gland.
(B) decreases sodium reabsorption.
(C) secretion is stimulated by an increase in blood pressure.
(D) secretion increases in response to angiotensin II.

Q.24 Nephron is also known as –
(A) Juxto glomerular tubule
(B) Seminiferous tubule
(C) Uriniferous tubule
(D) All

Q.25 Which one of the following statements is incorrect?
(A) Birds and land snails are uricotelic animals.
(B) Mammals and frogs are ureotelic animals.
(C) Aquatic amphibians & aquatic insects are ammonotelic animals.
(D) Birds and reptiles are ureotelic.

Q.26 I. Na^+ II. H_2O
III. HCO_3^- IV. H^+
V. K^+ VI. NH_3
Which of the given ions are reabsorbed and secreted by DCT?

	Reabsorb	**Secreted**
(A)	I, II and III	IV, V and VI
(B)	IV, V and VI	I, II and III
(C)	I, II and V	III, IV and V
(D)	III, IV, and VI	I, II and V

Q.27 Which of the following pairs is wrong?
(A) Uricotelic ---------- Birds
(B) Ureotelic ---------- Insects
(C) Ammonotelic ---------- Tadpole
(D) Ureotelic ---------- Elephant

Q.28 Complete loop of Henle is found in –
(A) Amphibia (B) Reptilia
(C) Birds (D) Mammals

Q.29 Mammals are characterised by –
(A) Metanephric kidney with loop of Henle
(B) Mesonephric kidney with out Henle loop
(C) Metanephric kidney with out Henle loop
(D) Proanephric without Henle loop.

Q.30 Guano is –
(A) bird's nitrogenous excretion
(B) men's nitrogenous excretion
(C) fish's nitrogenous excretion
(D) amphibian's nitrogenous excretion

Q.31 GF. at the base of Henle's loop is
(A) Isotonic (B) Hypotonic
(C) Hypertonic (D) Insoluble

Q.32 Which vitamin is excreted out in high quantity through urine in man –
(A) Vit C (B) Vit D
(C) Vit E (D) Vit K

Q.33 Ornithine cycle discovered by
(A) Kreb and kornberg (B) Hans Kreb
(C) Kreb and Henseleit (D) Embden

Q.34 "Homeostasis" term proposed by –
(A) Clude Bemard (B) Water cannon
(C) Marcello Malpighi (D) Henle

Q.35 Which part of Nephron composed of ciliated epithelium
(A) P.C.T. (B) D.C.T.
(C) Neck (D) A & B both

Q.36 Ureotelic kidney is found in –
(A) Man (B) Frog
(C) Rabbit (D) All

Q.37 Contractile vacuole of Amoeba is equal to
(A) Kidney (B) Liver
(C) Intestine (D) Skin

Q.38 Urine contains How much water –
(A) 96% (B) 90%
(C) 70% (D) None

Q.39 Which secretes Renin –
(A) Stomach (B) Juxta glomerular body
(C) Juxta cortical cell (D) Juxta medullary cell

Q.40 Podocytes are present in –
(A) Afferent arteriole (B) Efferent arteriole
(C) Peritubular network (D) Bowman's cup

Q.41 Which excretory material is least toxic –
(A) Ammonia (B) Urea
(C) Uric acid (D) Trimethylamine oxide

Q.42 Which is absent in Gloomerular filtrate –
(A) Blood corpuscles (B) Fats
(C) Proteins (D) All

Q.43 Inner wall of Urinary bladder composed of –
(A) Unstriped muscles (B) Striped muscles
(C) Statified epithelium (D) Transitional epithelium

Q.44 Changeable threshold material in Renal tubules
(A) Water and Glucose
(B) Urea & Uric acid
(C) Glucose & Amino acids
(D) Water & salts

Q.45 Which material composed the "Gall stone" from layered
(A) $CaCO_3$ (B) Oxalates
(C) Cholesterol (D) $CaSO_4$

Q.46 Excretory material are formed in –
(A) Kidney (B) Rectum
(C) Liver (D) Everybody cell

Q.47 Sulphates phosphates and carbonates of calcium are excreted by –
(A) Kidney (B) Liver
(C) Spleen (D) Colon

Q.48 Which regulates reabsorption of salts from Glomerular filtrate –
(A) Oxytocin (B) Vassopressin
(C) Gluco orticoides (D) Mineral orticoids

Q.49 Patients of diabeties have glucose in urine because
(A) Glucose is not absorbed from G F.
(B) Glucose is absorbed from GF.
(C) Glandular cells secreted glucose in GF.
(D) Concentration of glucose is more in GF. as compared to its normal amount

Q.50 Healthy human does not excrete out in his urine
(A) Uric acid (B) Alanine
(C) Creatinine (D) B-complexvitamins

Q.51 Identify the correct statements.
I. The outer layer of the kidney is called capsule.
II. Cortex is divided into outer cortex and inner medulla.
III. Medulla is divided into medullary pyramids.
IV. The cortex extends in between the medullary pyramids which is called as columns of Bertini.
(A) I, III and IV (B) I and IV
(C) I, II and III (D) I, II, III and IV

Q.52 Which one of the following body functions is not performed by kidneys –
(A) Excretion
(B) Osmoregulation
(C) Regulation of blood volume
(D) Destruction of dead blood corpuscles

Q.53 If Henle's loop were absent from mammalian nephron, which of the is to be expected –
(A) The urine will be more dilute.
(B) There will be no urine formation.
(C) The urine will have more concentration.
(D) There will be hardly any change in the quality and quantity of urine formed.

Q.54 Kidney stones are –
(A) crystals of silica
(B) crystals of calcium oxalate
(C) crystals of potassium chloride
(D) crystals of sodium bicarbonate

Q.55 Dialysis is done in the condition when person is suffering from –
(A) diabetes (B) uremia
(C) polyuria (D) haemoptysis

Q.56 Layers between the glomerular and Bowman's capsule through which the filtration takes place are
I. endothelium of the glomerular blood vessel.
II. middle lamella,
III. basement membrane between the endothelium of glomerular blood vessels and epithelium of the Bowman's capsule.
IV. epithelium of the Bowman's capsule.
(A) I, II and III (B) II, III and IV
(C) I, III and IV (D) I, II and IV

Q.57 Which one of the following is also known as antidiuretic hormone?
(A) Oxytocin (B) Vasopressin
(C) Adrenaline (D) Calcitonin

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Arrange the following structures into an accurate sequence through which urine passes.
(a) urethra (b) urinary bladder
(c) kidney (d) ureter
(A) d, c, b, a (B) c, d, b, a
(C) a, b, c, d (D) d, b, a, c

Q.2 Arrange the following structures into an accurate sequence through which filtrate passes.
(a) proximal convoluted tubule
(b) loop of Henle
(c) collecting duct
(d) distal convoluted tubule
(e) Bowman's capsule
(A) e, d, c, b, a (B) c, d, b, e, a
(C) a, e, b, c, d (D) e, a, b, d, c

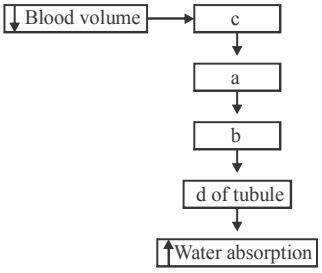
Q.3 Given below is a paragraph with blank spaces. Select the option that correctly fills up the blanks.
__(i)__ activates the adrenal cortex to release __(ii)__ which causes reabsorption of __(iii)__ and __(iv)__ from the distal parts of the tubule. This leads to an increase of __(v)__ and __(vi)__.
(A) (i) - Angiotensinogen; (ii) - Sodium; (iii) - H^+; (iv) - HCO_3^-; (v) - Blood volume; (vi) - pH.
(B) (i) - Angiotensin II; (ii) - Aldosterone; (iii) - Sodium; (iv) - Water; (v) - Blood pressure; (vi) - GFR.
(C) (i) - Angiotensin I, (ii) - Aldosterone; (iii) - Sodium; (iv) - Urea; (v) - Osmolarity; (vi) - Blood pressure.
(D) (i) - Renin; (ii) - Angiotensinogen; (iii) - Angiotensin I; (iv) - Angiotensin II; (v) - Sodium; (vi) - Water.

Q.4 Read the following statements and identify the correct sequence from the given codes:
T. Kidneys remove urea from blood and excrete it in urine.
P. Liver cells combine one molecule of CO_2 with two molecules of NH_3, using ATP, in the presence of carbamoyl phosphate synthetase enzyme.
R. Arginine is broken into urea and ornithine in the presence of arginase.
S. Carbamoyl phosphate reacts with ornithine to form citrulline.
Q. Citrulline combines with another molecule of ammonia to form arginine.
(A) P → Q → R → S → T
(B) P → S → Q → R → T
(C) P → R → S → Q → T
(D) T → P → R → S → Q

Q.5 If solubility of three nitrogenous wastes be arranged in the ascending order $S_1 < S_2 < S_3$, and their toxicity levels also arranged in ascending order $T_1 < T_2 < T_3$, identify the correct option:

	Ammonotelism	Ureotelism	Uricotelism
(A)	S_3T_1	S_2T_3	S_1T_2
(B)	S_2T_2	S_1T_1	S_3T_3
(C)	S_3T_3	S_2T_2	S_1T_1
(D)	S_1T_3	S_2T_2	S_3T_3

Q.6 Observethe flow chart and identify the correct answer from the given code:



(A) a - Neurohypophysis/posterior pituitary, b-ADH; c - Hypothalamus; d - DCT/Collecting duct
(B) a - Hypothalamus; b - ADH; c - Pituitary; d - PCT
(C) a - Renin; b - Angiotensin; c - JG cells; d - Loop of Henle
(D) a - Hypothalamus; b - Adenohypophysis; c - Aldosterone; d - Collecting Duct

Q.7 Which of the following statements is incorrect regarding the structure of kidney?
(i) Kidney is retroperitoneal in position, covered by a double fold of peritoneum, only on the dorsal side.
(ii) Right kidney is placed lower in the abdominal cavity, as the right liver lobe presses against it.
(iii) Each kidney contains 3 million nephrons, same as the number of alveoli in lungs.
(iv) A pair of adrenal or suprarenal glands lie on the inferior end of each kidney.
Identify the correct answer from the given codes:
(A) (ii) and (iv) (B) (i), (iii) and (iv)
(C) (ii) only (D) (i) and (ii)

Q.8 Glomerular filtrate contains –
(A) blood without blood cells and proteins.
(B) blood with proteins but without cells.
(C) plasma without sugar
(D) blood without urea

Q.9 Urea is directly produced in mammals from –
(A) ammonia released by oxidative deamination
(B) oxidative deamination of purines
(C) breakdown of omithine
(D) breakdown of arginine

Q.10 Glomerular hydrostatic pressure is present in –
(A) Tubule of kidney
(B) Bowman's capsule
(C) Malpighian tubule
(D) Glomerulus of uriniferous tubule

Q.11 **Statement 1 :** Urinary bladder and ureters are lined by transitional epithelium.
Statement 2 : Ureters carry the urine to urinary bladder where it is stored temporarily.
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1.
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement - 1 is True, Statement- 2 is False.
(D) Statement -1 is False, Statement -2 is False.

Q.12 Counter current mechanism helps to maintain a concentration gradient. This gradient help in
(A) easy passage of water from medulla to collecting tubule and thereby concentrating urine.
(B) easy passage of water from collecting tubule to interstitial fluid and thereby concentrating urine.
(C) easy passage of water from medullary interstitial fluid to collecting tubule and thereby diluting urine.
(D) inhibition of passage of water between the collecting tubule and medulla and so isotonic urine is formed.

Q.13 Which of the following are secreted by liver?
I. Bilirubin II. Biliverdin III. Cholesterol
IV. Degraded steroid hormone
V. Vitamin VI. Drug
Choose the correct option.
(A) I, II, III and IV
(B) II, III, IV and V
(C) III, IV, V and VI
(D) I, II, III, IV, V and VI

Q.14 Choose the correct statements.
I. Kidney transplantation is the ultimate method at the stage where drug or dialysis do not help.
II. Close relatives are often used as kidney donors to minimise risk of rejection.
III. Cylosporin-A is used as immuno-suppressive agent in kidney transplant patient.
IV. Heparin and antiheparin are used in hemodialysis.
Choose the correct option.
(A) I, II and III (B) IV, III and II
(C) I, III and IV (D) I, II, III and IV

Q.15 I. Excess loss of water from body
II. Hypothalamus
III. Osmoreceptors
IV. ADH
V. Neurohypophysis
VI. Water reabsorption DCT and CT
VII. Prevention of diuresis
Arrange the given processes in correct sequence for regulation in kidney.
(A) I → II → III → IV → V → VI → VII
(B) VII → VI → V → IV → III → II → I
(C) I → III → II → V → IV → VI → VII
(D) I → III → II → IV → V → VII → VI

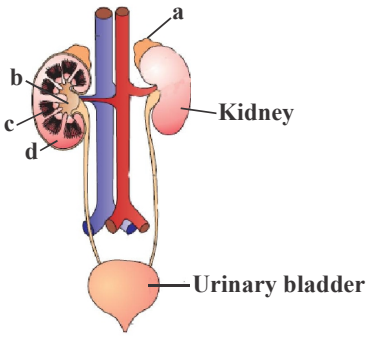
Q.16 Glucose, Na, and amino acid are actively transported substances, because –
(A) their movement occurs according to concentration gradient.
(B) their movement occurs against concentration gradient.
(C) ATP is not needed for transportation.
(D) they are transported by simple diffusion.

Q.17 During hemodialysis process
I. blood drained from a convenient artery and anticoagulant is added (heparin).
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 antiheparin 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

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 Figure shows human urinary system with structures labelled a to d. Select option which correctly identifies them and gives their characteristics and/or functions. **[NEET 2013]**



(A) d-Cortex - outer part of kidney and do not contain any part of nephrons.
(B) a-Adrenal gland - located at the anterior part of kidney. Secrete Catecholamines which stimulate glycogen breakdown.
(C) b-Pelvis - broad funnel shaped space inner to hilum, directly connected to loops of Henle.
(D) c-Medulla-inner zone of kidney and contains complete nephrons.

Q.2 Which of the following causes an increase in sodium reabsorption in the distal convoluted tubule? **[AIPMT 2014]**
(A) Increase in aldosterone levels.
(B) Increase in antidiuretic hormone levels.
(C) Decrease in aldosterone levels.
(D) Decrease in antidiuretic hormone levels.

Q.3 Which of the following does not favour the formation of large quantities of dilute urine ? **[AIPMT 2015]**
(A) Caffeine (B) Renin
(C) Atrial-natriuretic factor (D) Alcohol

Q.4 Removal of proximal convoluted tubule from the nephron will result in : **[AIPMT 2015]**
(A) More concentrated urine.
(B) No change in quality and quantity of urine.
(C) No urine formation.
(D) More diluted urine.

Q.5 Human urine is usually acidic because – **[RE-AIPMT 2015]**
(A) excreted plasma proteins are acidic
(B) potassium and sodium exchange generates acidity.
(C) hydrogen ions are actively secreted into the filtrate.
(D) the sodium transporter exchanges one hydrogen ion for each sodium ion, in peritubular capillaries.

Q.6 The part of nephron involved in active reabsorption of sodium is **[NEET 2016 PHASE 2]**
(A) Distal convoluted tubule
(B) Proximal convoluted tubule
(C) Bowman's capsule
(D) Descending limb of Henle's loop

Q.7 Which of the following statements is correct? **[NEET 2017]**
(A) The ascending limb of loop of Henle is impermeable to water.
(B) The descending limb of loop of Henle is impermeable to water.
(C) The ascending limb of loop of Henle is permeable to water.
(D) The descending limb of loop of Henle is permeable to electrolytes.

Q.8 Match the column **[NEET 2018]**

	Column I	**Column II**
a.	Glycosuria	i. Accumulation of uric acid in joints
b.	Gout	ii. Mass of crystallised salts within the kidney
c.	Renal calculi	iii. Inflammation in glomeruli
d.	Glomerular nephritis	iv. Presence of glucose in urine

(A) a-ii, b-iii, c-i, d-iv (B) a-i, b-ii, c-iii, d-iv
(C) a-iii, b-ii, c-iv, d-i (D) a-iv, b-i, c-ii, d-iii

Q.9 Match the column **[NEET 2018]**

Column I (Function)	**Column II (Part of Excretory system)**
a. Ultrafiltration	i. Henle's loop
b. Concentration of urine	ii. Ureter
c. Transport of urine	iii. Urinary bladder
d. Storage of urine	iv. Malpighian corpuscle
	v. Proximal convoluted tubule

(A) a-v, b-iv, c-i, d-ii
(B) a-iv, b-i, c-ii, d-iii
(C) a-iv, b-v, c-ii, d-iii
(D) a-v, b-iv, c-i, d-iii

Q.10 Which of the following factors is responsible for the formation of concentrated urine? **[NEET 2019]**

(A) Low levels of antidiuretic hormone
(B) Maintaining hyperosmolarity towards inner medullary interstitium in the kidneys.
(C) Secretion of erythropoietin by Juxtaglomerular complex
(D) Hydrostatic pressure during glomerular filtration

Q.11 Use of an artificial kidney during hemodialysis may result in : **[NEET 2019]**

(a) Nitrogenous waste build-up in the body
(b) Non-elimination of excess potassium ions
(c) Reduced absorption of calcium ions from gastro-intestinal tract
(d) Reduced RBC production

Which of the following options is the most appropriate?

(A) (a) and (b) are correct.
(B) (b) and (c) are correct.
(C) (c) and (d) are correct.
(D) (a) and (d) are correct.

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (B) **(2)** (B) **(3)** (C) **(4)** (C)
(5) (A)
(6) Afferent atriole; efferent atriole
(7) Reabsorbed, concentrated, urea
(8) Urinary bladder, CNS, stretching
(9) Glomerulus; filtration, 1100-1200, 1/5th
(10) Adrenal cortex; aldosterone
(11) Increasing, 300, 1200
(12) Impermeable, permeabl
(13) Vasopressin
(14) The nitrogeneous wastes **(15)** 25-30
(16) Micturition **(17)** PCT
(18) True **(19)** False **(20)** True
(21) True **(22)** True

EXERCISE - 1 [SECTION-3 & 4]																									
Q	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
A	C	A	A	C	A	C	B	B	C	D	A	B	A	A	C	C	A	D	A	A	C	D	C	C	C
Q	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**
A	D	C	A	A	C	B	D	C	C	B	D	A	C	C	B	B	B	B	C	D	B	C	D	D	C
Q	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**
A	B	B	D	A	D	C	A	C	C	D	D	B	A	C	D	C	C	D	C	D	D	C	C	B	B
Q	**98**	**99**	**100**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**	**121**	
A	D	D	B	A	C	C	A	D	C	A	C	D	B	A	B	B	C	D	B	C	B	C	A	C	

EXERCISE - 2																									
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
A	B	D	C	D	A	C	C	B	C	C	D	C	D	C	D	D	C	A	D	A	C	D	D	C	D
Q	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
A	A	B	D	A	A	C	A	C	B	C	D	A	A	D	D	C	D	D	D	C	D	D	D	D	B
Q	**51**	**52**	**53**	**54**	**55**	**56**	**57**																		
A	D	D	A	B	B	C	B																		

EXERCISE - 3																	
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
A	B	D	B	B	C	A	B	A	A	D	B	B	D	D	C	B	C

EXERCISE - 4											
Q	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
A	B	A	B	D	C	B	A	D	B	B	C

SOLUTIONS

EXERCISE-1

(1) (B) **(2)** (B) **(3)** (C) **(4)** (C)
(5) (A)
(6) Afferent atriole; efferent atriole
(7) Reabsorbed, concentrated, urea
(8) Urinary bladder, CNS, stretching
(9) Glomerulus; filtration, 1100-1200, 1/5th
(10) Adrenal cortex; aldosterone
(11) Increasing, 300, 1200
(12) Impermeable, permeabl
(13) Vasopressin
(14) The nitrogeneous wastes **(15)** 25-30
(16) Micturition **(17)** PCT
(18) True **(19)** False **(20)** True
(21) True **(22)** True **(23)** (C)
(24) (A) **(25)** (A)

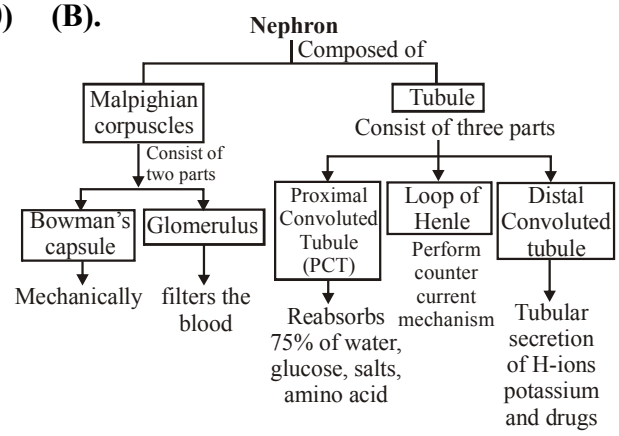
(26) **(C).** Each kidney has nearly one million complex tubular structures called nephrons, which are called functional unit of the kidney.

(27) **(A).** About 80% of the nephrons have, loop of Henle, which is too short, therefore it is present in the cortical region of the kidney. 20% nephron have long loop of Henle, which dips into the medulla of the kidney.

(28) **(C).** Juxta medullary nephrons are found in camel, kangaroo and rat.

(29) **(B).** Inside the kidney, the cortical region extends in between the medullary pyramids as renal columns called columns of Bertini.

(30) **(B).**



(31) **(C).** Human excretory system consists of (i) a pair of kidney (ii) a pair of ureter (iii) urinary bladder (iv) urethra

(32) **(D).** Juxta-medullary nephrones have following characteristics
(i) Vasa-recta is prominant.
(ii) Loop of Henle is long.
(iii) Loop of Henle runs deep into the medulla.
(iv) Found in xerophytic animals like camel, kangaroo and rat.

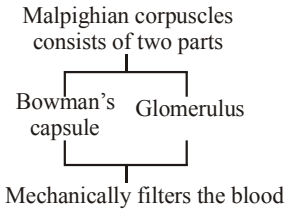
(33) **(A).**

(34) **(B).** Nitrogenous waste substances such as ammonia, urea or uric acid are produced during protein metabolism according to the species. Small amount of nitrogenous waste substances are also produced during the metabolism of nucleic acids. Ammonia is the most toxic, followed by urea and uric acid. The latter is the least toxic.

(35) **(A).** The Malpighian corpuscle, PCT and OCT of the nephrons are situated in the cortex or cortical part of the kidney whereas the loop of Henle dips into the medullary part of the kidney.

(36) **(A).**

(37) **(C).**



(38) **(C).** Towards the centre of the inner concave surface of the kidney, there is a notch called hilum through which ureter, blood vessels and nerves enter. Inner to the hilum is broad funnel-shaped space called the renal pelvis with the projections called calyces.

(39) **(A).** On the basis of the length of loop of Henle, the nephron is of two types.
(i) Cortical Nephron
* Found in the majority of animals except which is having special adaptation to xerophytic conditions.
* The loop of Henle is very short. e.g., fishes, rabbit, etc.
* Vasa-recta is absent or highly reduced.

(ii) Juxtamedullary Nephron

* Found in comparatively less animals, which have the special adaptability to conserve water.
* The loop of Henle is long. e.g., camel, kangaroo rat.
* Vasa recta is prominant.

(40) (D). Blood is filtered so finely through the membranes (three layers) that almost all the constituents of the plasma except the proteins, RBC and WBC pass into the lumen of the Bowman's capsule. Therefore, it is considered as the process of ultra filtration.

(41) (A). Urea cycle takes place in liver cells with the hydrolytic enzyme arginase. Arginase splits arginine into urea and ornithine with the elimination of water molecule.

(42) (A).

(43) (C). Cortex region of kidney is the outer region. The proximal end of each nephron forms a blind or closed enlarged and double walled cup, the Bowman's capsule in the cortex. Thus, all the Bowman's capsules of the kidney are found in cortex.

(44) (D). Urine formation involves three stages

(i) Ultrafiltration (step-I)

↓

(ii) Reabsorption (step-II)

↓

(iii) Tubular secretion (step-III)

(45) (C). The tubular epithelial cells in different segments of the nephrons perform reabsorption either by active or passive mechanisms. For example, substances like glucose, amino acids, Na^+ etc, in the filtrate reabsorbed actively whereas the nitrogenous wastes are absorbed by passive transport. Reabsorption of the water also occurs passively in the initial segments of the nephron.

(46) (C). Urea cycle : The reaction of urea cycle, which occur in the mitochondria are contained in the oval. CPS-I ⇒ Carbamyl phosphate synthetase-I, OTC is ornithine transcarbamylase.

* This is also called Kreb-Henseleit cycle (1932).
* Formation and transformation of three amino acids namely ornithine, citrulline and arginine one after the other constitute the major steps in this cycle.

(47) (C). The kidneys have built in mechanisms for the regulation of glomerular filtration rate. One such efficient mechanism is carried out by juxta glomerular apparatus (JGA). JGA is the special sensitive region formed by cellular modification in the distal convoluted tubule and the afferent arteriole at the location of their contact. A fall in GFR can activate the JG cells to release renin, which can stimulate the glomerular blood flow and there by GFR back to normal.

(48) (D). In humans, the principal nitrogenous excretory compound (urea) is synthesised in liver by ornithine cycle. Urea is eliminated mostly through kidney as excretory product.

(49) (C). **(50) (A).**

(51) (A). Kidneys help in formation of urine from the blood flowing through glomerular capillaries. About 20% of plasma fluid filters out into the Bowman's capsule through a thin glomerular capsular membrane due to net or effective filtration of about 10-15 mm Hg. So the nearest option is (A).

(52) (C). Glomerular capillary blood pressure causes the filtration of the blood through three layers. i.e.,

(i) The endothelium of the glomerular blood vessels.
(ii) Epithelium of Bowman's capsule.
(iii) Basement membrane between these two layers. The epithelium of the Bowman's capsule called podocytes are arranged in an intricate manner so as to leave some minute spaces called podocytes.

(53) (B).

(54) (D). A comparison of the volume of the filtrate formed per day (180 litre per day) with that of the urine released (1.5 litres), suggests that nearly 99% of this filtrate has to be reabsorbed by the renal tubules. This process is called reabsorption.

(55) **(C).**

(56) **(C).** GFR The amount of the filtrate formed by the kidneys per minute is called glomerular filtration rate. GFR in healthy individual is 125 mL/minute. i.e., 180 litres per day.

(57) **(B).** Henle's loop concentrate the urine. It is highly develop in the organism, which are found in xerophytic condition in order to conserve water. But organism, which produces the dilute urine have little or no Henle's loop like fishes.

(58) **(D).**

(59) **(A).** Cuboidal brush border epithelium, which increases the surface area for reabsorption, which secreted H^+, K^+ and ammonia into the filtrate and absorption of HCO_3^- from it.

(60) **(C).** **Distal Convoluted Tubule (DCT)**
Conditional reabsorption of Na^+ and water takes place in this segment. 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.

(61) **(C).**

(62) **(B).** **Collecting Duct**
(i) This is the long ducts extends from cortex of the kidney to the inner part of medulla.
(ii) Large amount of water reabsorbed from this region.
(iii) Concentrated urine production takes place.

(63) **(B).**

(64) **(B).** Nearly all of the essential nutrients and 70-80 per cent of electrolytes and water are reabsorbed by this segment. PCT also helps to maintain the pH and ionic balance of the body fluids by selective secretion of hydrogen ion and potassium ions into the filtrate and by absorption of HCO_3^- from it.

(65) **(B).** **Loop of Henle has two limbs.**
Descending : Thin walled, lined by squamous epithelium and permeable to water.
Ascending : Thick walled formed by cuboidal epithelium and impermeable to water.

(66) **(C).** Main function of DCT is to maintain. the pH and sodium-potassium balance in blood.

(67) **(D).** Reabsorption in the Henle's loop is minimum. However this region plays a significant role in maintenance of high osmolarity of medullary interstitial fluid.

(68) **(B).** Vasa recta are the blood vessels running parallel to loop of Henle forming a counter current system in juxta-medullary nephron. These are in the continuation of efferent arteriole. The slow blood flow of vasa-recta is responsible for maintaining the hyperosmolarity of interstitial fluid.

(69) **(C).** Loop of Henle, also called nephron loop is U-shaped tube that extends from proximal tubule. It plays a role in the transport of ions, water and the concentration of urine.

(70) **(D).** The counter current mechanism helps to concentrate the filtrate which occurs in loop of Henle and vasa recta in the medulla region of the kidney. This gradient is mainly caused by NaCl and urea. It helps in easy absorption of water from the filtrate present in the collecting duct so that the concentration of the filtrate (urine) is increased. Therefore, hypertonic urine is produced in human beings.

(71) **(D).** The gradient of medullary region is primarily due to NaCl and urea. NaCl is transported by ascending limb of Henle's loop which is exchanged with descending limb of vasa recta. Similarly small amount of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to interstitium by collecting tubule. The above described transport of substances facilitated by special arrangement of Henle's loop and vasa recta is called counter current mechanism.

(72) **(C).** The process of filtration through glomerular capillaries in Bowman's capsule is known as glomerular filtration and the filtrate is called renal fluid. Renal fluid is isotonic to cortical fluid and blood in PCT and DCT.

(73) **(B).** Mammals have the ability to produce a concentrated urine. Henle's loop and vasa recta plays a significant role in producing concentrated urine.

(74) **(B).** Presence of interstitial gradient helps in an easy passage of water from the collecting tubule there by concentrating the filtrate (urine). Human kidney can produce nearly four times concentrated urine than the initial filtrate formed.

(75) **(D).** The flow of blood through the two limbs of vasa recta is in counter current pattern (opposite). The proximity between the Henle's loop and vasa recta as well as the counter current in them helps in maintaining an increasing osmolarity toward the inner medullary interstitium. i.e., from 300 mOs mol^{-1} in cortex to about 1200 mOs mol^{-1} in the inner medulla. This is also called medullary gradient.

(76) **(A).**

(77) **(D).** The flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a counter current mechanism (The process due to which the urine is made hypertonic). Vasa-recta also plays a significant role in counter-current mechanism.

(78) **(C).** Large quantity of water is reabsorbed in PCT and loop of Henle. About 80% of water is reabsorbed in PCT and loop of Henle. This is called obligatory water reabsorption.

(79) (A) **(80)** (C)

(81) **(C).** ANF (Atrial Natriuretic Factor) mechanism
↓
Increase in blood flow to atria of heart
↓ Activate
Heart to secrete
↓
ANF causes
↓
Vasodilation (dilation of blood vessels)
↓ This cause
Decrease in blood pressure
↓
Hence the glomerulus filtration decrease
ANF-mechanism therefore, acts as a check on renin-angiotensin mechanism.

(82) **(D).**

(83) **(D).** Functioning of kidney is regulated by
(i) Hypothalamus by ADH or vasopressin hormone.
(ii) JGA by renin angiotensin mechanism.
(iii) Heart by ANF (Atrial Natriuretic Factor).

(84) **(B).** ADH hormone prevents the loss of water from our body by increasing the permeability of DCT. Hence, it regulates the osmoregulation of our body.

(85) (A) **(86)** (C) **(87)** (D)

(88) **(C).** Water reabsorption in DCT and CT by ADH is called the facultative water reabsorption. Vasopressin (ADH) hormone from posterior pituitary plays an important role in regulating the amount of urine passed out by effecting the permeability of DCT.

(89) (C) **(90)** (D) **(91)** (C)

(92) **(D).** ADH, Renin angiotensin, ANF, countercurrent mechanism all of them plays a significant role in osmoregulation of body fluids.

(93) **(D).** pH of urine ranges from the 5.0 to 7.8. Average pH = 6.0 (slightly acidic)

(94) **(C).** First formed vertebrate was fish, which excrete out ammonia. Ammonia is a water solubte compound so, it diffuse out from the body easily.

(95) **(C).**

(96) **(B).** Composition of urine
Water : 95 %, Urea : 2.6%,
Uric acid : 0.3%, Salt (NaCl) : 1.5 %

(97) **(B).** An adult human excretes, on an average, 1-1.5 L of urine per day. Volume of urine depends upon intake of fluids, external temperature and physical activities.

(98) **(D).** Analysis of urine helps in clinical diagnosis of many metabolic disorders as well as malfunctioning of the kidney. For example, presence of glucose (glycosuria) and ketone bodies (ketonuria) in urine are indicative of diabetes mellitus.

(99) **(D).**

(100) **(B).** Osmoconformers are those organisms whose body is osmotic, i.e., osmotic concentration of internal environment and surrounding seawater are approximately equal. There is no net tendency for water to move in or out of the body in osmocorformers. Among vertebrates hagfishes are osmoconformers.

(101) **(A).** On an average, 25-30 gm of urea is excreted per day. Various conditions can affect the characteristics of urine like type of food, weather condition, etc.

(102) **(C).** The yellow colour of urine is caused by the pigment urochrome, which is breakdown product of haemoglobin from worn out RBCs.

(103) **(C).** Terrestrial reptiles (lizard, snakes) bird and most insect excrete uric acid in order to con serve water in their body.

(104) **(A).** Our lungs removes CO_2 . Our liver secretes bile containing substances. The sweat and sebaceous gland in skin eliminate salts and other excretory product.

(105) **(D).** Sebaceous glands eliminate certain substances like sterols, hydrocarbons and waxes through sebum. This secretion provides a protective oily covering for the skin. Small amounts of nitrogenous wastes could be eliminated through saliva.

(106) **(C).** Liver, the largest gland in our body which secretes containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. Most of these substances ultimately pass out along with digestive wastes.

(107) **(A).** Uriniferous tubules are the vital morphological and physiological units of mammalian kidney.

(108) **(C).** Intestinal uricolysis converts uric acid into urea and ammonia.

(109) **(D).** Sweat produced by sweat gland 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.

(110) **(B).** Our lungs removes large amounts of CO_2 (18 L/day) and also significant quantities of water every day.

(111) **(A).**

(112) **(B).** Abnormal catabolism of tyrosine causes melanuria. The excretion of urine is dark colour resulting from presence of melanin or other pigment, etc.

(113) **(B).** Malfunctioning of kidneys can lead to the accumulation of urea in blood, this condition is called uremia which is very harmful and may lead to kidney failure. In such patient urea can be removed by process called haemodialysis.

(114) **(C).** Artificial kidney, called dialyzing unit, is a machine that is used to filter the blood of a person whose kidneys are damaged. The process is called haemodialysis. Dialyzing unit is a cellophane tube suspended in a salt-water solution of the same composition as the normal blood plasma, except that no urea is present. Blood of the patient is pumped from one of the arteries into the cellophane tube. Pores of the cellophane tube allow urea, uric acid, creatinine, excess salts and excess H^+ ions to diffuse from the blood into the surrounding solution. The blood thus purified is then pumped into a vein of the patient.

(115) **(D).** Renal calculi stones or insoluble mass of crystallised salts (oxalates, etc.) formed with in the kidneys.

(116) **(B).** **Nephritis :** The infection is caused by bacteria (streptococci) which results in inflammation of kidney that involve glomerulus.

(117) (C) **(118)** (B)

(119) (C) **(120)** (A)

(121) **(C).** **Alkaptonuria** is the genetic disease in which homogenestic acid is excreted out with urine.

EXERCISE-2

(1) **(B).** The nephron is the basic structural and functional unit of the kidney. Its chief function is to regulate the concentration of water and soluble substances like sodium salts by filtering the blood, reabsorbing what is needed and excreting the rest as urine.

(2) (D)

(3) **(C).** Osmoregulation: The maintenance of constant osmotic pressure in the fluids of an organism by the control of water and salt concentrations.

(4) **(D).** Each nephron has two parts- glomerulus and renal tubule. Glomerulus is a tuft of capillaries formed by afferent arteriole. The renal tubule begins with a double walled cup-like structure called Bowman's capsule,

which encloses glomerulus. Glomerulus along with Bowman's capsule, is called Malpighian body or renal corpuscle. The tube continues further to form PCT, loop of Henle and DCT. The first step in urine formation is the filtration of blood which is carried out by the Malpighian body.

(5) (A) **(6)** (C) **(7)** (C) **(8)** (B)
(9) (C) **(10)** (C) **(11)** (D) **(12)** (C)
(13) (D) **(14)** (C)

(15) **(D).** The afferent arterioles are a group of blood vessels that supply the nephrons in many excretory systems. They play an important role in the regulation of blood pressure as a part of the tubuloglomerular feedback mechanism. The afferent arterioles branch from the renal artery, which supplies blood to the kidneys.

A glomerulus is a network (as a tuft) of capillaries located at the beginning of a nephron in the kidney. It serves as the first stage in the filtering process of the blood carried out by the nephron in its formation of urine.

The glomerulus is surrounded by a cup-like sac known as Bowman's capsule. The blood plasma is filtered through the capillaries of the glomerulus into the capsule. The Bowman's capsule empties the filtrate into the proximal tubule that is also part of the duct system of the nephron.

A glomerulus receives its blood supply from an afferent arteriole of the renal circulation.

(16) (D) **(17)** (C) **(18)** (A) **(19)** (D)
(20) (A) **(21)** (C) **(22)** (D) **(23)** (D)
(24) (C)

(25) **(D).** Animals which excrete uric acid are called uricotelic Uric acid crystals are non-toxic and almost insoluble in water. Hence, these can be retained in the body for a considerable time. Uricotelic animals include most insects, some land crustaceans; land snails, land reptiles and birds. Animals which excrete ammonia are called as ammonotelic e.g., many aquatic animals like protozoans, tailed amphibians, tadpoles, aquatic insects, ete. Animals which excrete urea are called ureotelic e.g., man, frog, etc.

(26) **(A).** DCT (Distal Convoluted Tubule) Conditional reabsorption of Na^+ and water takes place in this segment. DCT is also capable of reabsorption of HCO_3^- and selective secretion of hydrogen and potassium ions and to maintain the pH and sodium-potassium balance in blood.

(27) **(B).** Insects are uricotelic i.e. they excrete uric acid.
(28) (D) **(29)** (A)

(30) **(A).** Uric acid is commercially extracted from the bird droppings. Bird droppings or excretion is also called guano.

(31) **(C).** The loop of Henle is a U-shaped tube that extends from the proximal tubule. It consists of a descending limb and an ascending limb. It begins in the cortex, receiving filtrate from the proximal convoluted tubule, extends into the medulla as the descending limb, and then returns to the cortex as the ascending limb to empty into the distal convoluted tubule. The primary role of the loop of Henle is to concentrate the salt in the interstitium, the tissue surrounding the loop.The descending limb is permeable to water and noticeably less impermeable to salt, and thus only indirectly contributes to the concentration of the interstitium. As the filtrate descends deeper into the hypertonic interstitium of the renal medulla, water flows freely out of the descending limb by osmosis until the tonicity of the filtrate and interstitium equilibrate. The hypertonicity of the medulla (and therefore concentration of urine) is determined in part by the size of the loop of Henle.

(32) (A) **(33)** (C) **(34)** (B) **(35)** (C)
(36) (D) **(37)** (A) **(38)** (A)

(39) **(D).** The juxtaglomerular apparatus is a microscopic structure in the kidney that regulates the function of each nephron, the functional units of the kidney. The juxtaglomerular apparatus is named because it is next to (juxta-) the glomerulus.

The juxtaglomerular cells are cells in the kidney that synthesize, store, and secrete the enzyme renin.

(40) **(D).** Podocytes are found lining the Bowman's capsules in the nephrons of the kidney.

(41) (C) **(42)** (D)

(43) **(D).** The innermost layer of the bladder is the mucosa layer that lines the hollow lumen. Unlike the mucosa of other hollow organs, the urinary bladder is lined with transitional epithelial tissue that is able to stretch significantly to accommodate large volumes of urine. The transitional epithelium also provides protection to the underlying tissues from acidic or alkaline urine.

(44) (D) **(45)** (C) **(46)** (D) **(47)** (D)

(48) **(D).** Mineral ocorticoid is a corticosteroid hormone, which is synthesized by the adrenal cortex. Aldosterone, the main mineralocorticoid, is necessary for regulation of salt and water in the body. It increases sodium re-absorption by an action on the distal tubules of the kidney.

(49) (D) **(50)** (B) **(51)** (D) **(52)** (D)

(53) (A) **(54)** (B) **(55)** (B) **(56)** (C)

(57) **(B).** Antidiuretic hormone (ADH) is also known as Vasopressin or Pitressin. It is secreted from posterior lobe of pituitary gland.

EXERCISE-3

(1) (B) **(2)** (D) **(3)** (B) **(4)** (B)

(5) (C) **(6)** (A) **(7)** (B) **(8)** (A)

(9) (A) **(10)** (D)

(11) **(B).** Urinary bladder and ureters of excretory system are lined by transitional epithelium because it is a stretchable epithelium, hence the urinary bladder and ureters may be considerably stretched without getting torn when they are filled with urine. Ureters are thin muscular tubes which emerge from the hilum of each kidney. Urine enters the ureters from the renal pelvis and is conducted along the ureters by peristaltic waves on their walls. Ureters from both the kidneys finally open in to urinary bladder which is a hollow muscular sac. In this way urine from both the kidneys is drained into the urinary bladder which stores it temporarily.

(12) **(B).** When blood from cortex goes through the descending loop, it loses water and gain salts and solutes. As blood ascends, the reverse occurs and it gains water and gradually loses salts and solutes.

(13) **(D).** Our liver secretes bilirubin, biliverdin, cholesterol, degraged steroid hormone, vitamin and drugs.

(14) **(D).** Kidney transplantation is the ultimate method in the correction of acute renal failure. A functioning kidney is used in transplantation from a donor, preferably a close relative, to minimise its chances of rejection by immune system of the host. Modern clinical procedures have increased the success rate of such complicated technique. Cyclosporin-A is used as immunosuppressive agent in the kidney transplant patient.

(15) **(C).** Osmoreceptors in the body are activated by changes in the 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 ADH (Antidiuretic Hormone) or vasopressin from neurohypophysis (posterior lobe of pituitary.) ADH facilitate the water reabsorption from latter parts of the tubule there by preventing derease or water loss.

(16) **(B).** Because these are ATP dependant substances whose movement occurs against concentration gradient. In active transport, ATP provided by mitochondria, provides energy needed to move these ions and molecules across the cell membrane.

(17) **(C).** **Haemodialysis :** During dialysis, the blood drained from a convenient artery is pumped into a dialysing unit after adding 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 dialysing fluid these substances freely move out, there by clearing the blood. The cleared blood is pumped back to the body through a vein after adding anti heparin to it. This method is a boon for thousands of uremia patient all over the world.

EXERCISE-4

(1) **(B).** In the given figure, a is adrenal gland which secretes two catecholamines; adrenaline (epinephrine) & noradrenaline (norepinephrine). Adrenaline increases the conversion of glycogen to glucose providing quick energy for "fight or flight" response. b is renal pelvis which is a sac like cavity of the kidney leading to ureters, is not directly connected to loop of Henle. c is medulla, the inner region of kidney containing loop of Henle, collecting ducts and ducts of Bellini. d is cortex which has proximal and distal convoluted tubules and contains Malpighian corpuscles.

(2) **(A).** When aldosterone is present in the blood, reabsorption of Na^+ in the filtrate is increased by the epithelial cells of the collecting duct. Retaining Na^+, raises the osmotic pressure of the blood and reduces water loss from the body.

(3) **(B).** Renin does not favour the formation of large quantities of dilute urine.

(4) **(D).** Removal of Proximal convoluted tubule from the nephron will result in more diluted Urine due to less Reabsorption of water. 70-80% of electrolytes and water are reabsorbed by this segment.

(5) **(C).** As various ions from the soil are actively transported into the vascular tissues of the roots, water follows and increases the pressure inside the xylem i.e., root pressure (positive pressure).

(6) **(B).** Proximal convoluted tubule is involved in active reabsorption of sodium.

(7) **(A).** Descending limb of loop of Henle is permeable to water but impermeable to electrolytes while ascending limb is impermeable to water but permeable to electrolytes.

(8) **(D).** Glycosuria denotes presence of glucose in the urine. This is observed when blood glucose level rises above 180 mg/100 ml of blood, this is called renal threshold value for glucose. Gout is due to deposition of uric acid crystals in the joint.
Renal calculi are precipitates of calcium phosphate produced in the pelvis of the kidney. Glomerular nephritis is the inflammatory condition of glomerulus characterised by proteinuria and haematuria.

(9) **(B).** Ultrafiltration refers to filtration of very fine particles having molecular weight less than 68,000 daltons through malpighian corpuscle. Concentration of urine refers to water absorption from glomerular filtrate as a result of hyperosmolarity in the medulla created by counter-current mechanism in Henle's loop. Urine is carried from kidney to bladder through ureter. Urinary bladder is concerned with storage of urine.

(10) **(B).** The proximity between loop of henle and vasa recta as well as counter current in them help in maintaining an increasing osmolalrity towards the inner medullary interstitium. This mechanism help to maintain a concentration gradient in medullary interstitium so human urine is nearly four times concentrated than initial filtrate formed.

(11) **(C).** a and b statements are incorrect because dialysis eliminates urea and potassium from the body whereas, c and d are correct. As phosphate ions are eliminated during dialysis, along with that calcium ions are also eliminated. So, there will be reduced absorption of calcium ions from gastrointestinal tract. RBC production will be reduced, due to reduced erythropoietin hormone.