

## EXCRETION

The process by which metabolic wastes such as Carbon dioxide, Water and Nitrogenous wastes are removed from the body is called excretion. Animals have different types of excretory organs. Protozoans like Amoeba, Paramecium etc use contractile vacuoles for excretion as well as Osmoregulation. Nephridia of annelids, Malpighian tubules of Insects, Green glands of Crustaceans are excretory organs. Organ of Bojanus of Bivalve mollusks function as kidney. Vertebrates have well developed excretory system to remove wastes. The pattern of nitrogen excretion also vary. Ammonotelic animals ( Aquatic invertebrates, Frog's tadpole, Bony fishes ) excrete Ammonia in the form of Ammonium hydroxide. Ureotelic animals such as Cartilage fishes , Amphibians and Mammals convert ammonia to urea in the liver ( Ornithine cycle ) . Uricotelic animals ( Reptiles, Birds , Cockroach ) will have to conserve more water in the body and hence they convert urea to uric acid which can be excreted in the form of dry pellets. Spiders and Penguins excrete Xanthine and Guanine which are the metabolic wastes of Nucleotide metabolism. Trimethylamine oxide is formed in bony fishes from ammonia. Ornithuric acid ( birds ) Hippuric acid ( mammals ) are formed from Benzoic acid as waste materials. Creatinine is another excretory product formed from Creatine phosphate of muscle ( mammals )

Human excretory system consists of a pair of Kidney, Ureters, Urinary bladder and Urethra. Kidneys are bean shaped brownish organs located in the abdominal cavity on either side of the vertebral column. Human kidney is Metanephric . Each kidney has two regions - outer Cortex and inner Medulla. Cortex is covered by a tough connective tissue capsule. It contains Bowmans capsule, Proximal convoluted tubule and Collecting tubule of nephrons. Medulla is the inner region with many conical pyramids. The pointed side of pyramids is facing towards the Renal pelvis. Pelvis is a funnel shaped structure which continues as the Ureter. Columns of Bertini are invaginations of the cortex into the medullary region of kidney.

Each kidney contains about one million nephrons which are the functional units of the kidney. Nephron has a cup like Bowmans capsule to filter waste materials from the blood. Glomerulus is the capillary network present inside the Bowmans capsule. It consists of an Afferent artery and Efferent artery. The Bowmans capsule is continued as a tubule which is divisible into Proximal convoluted tubule ( PCT ), Henle's loop, Distal convoluted tubule ( DCT ) and Collecting tubule. The collecting tubules unite to form the Collecting duct. Many collecting ducts are joined together to form large ducts called Duct of Bellini.

Urine formation takes place in the nephrons and involves three steps namely Ultrafiltration, Tubular reabsorption and Tubular secretion. Ultrafiltration ( Pressure filtration ) occurs in the Bowmans capsule by the influence of Glomerular hydrostatic pressure ( GHP ), Blood colloid osmotic pressure ( BCOP ) and Capsular hydrostatic pressure ( CHP ). Due to these Effective filtration pressure ( EFP ), glomerular filtrate is formed in the bowmans capsule The normal glomerular filtration rate in adult man is 120 ml / minute. Glomerular filtration is a non selective process and hence both essential and non essential materials are filtered out. Tubular reabsorption is the absorption of materials like glucose, amino acids, vitamin C , Potassium, Sodium etc from the filtrate into the blood. These materials are absorbed by active

transport while water and chloride ions are absorbed passively. Loop of Henle maintains the sodium- potassium balance. Ascending limb of loop of Henle is impermeable to water and actively reabsorb Potassium ions. Descending limb of loop of Henle is not permeable to sodium but allow a small quantity of water to pass through. The urine becomes Hypertonic in the loop of Henle due to the exchange of sodium ions in the ascending and descending limbs. This is called “ Counter Current exchange “. Vasa recta is the system of blood vessels present parallel to the loop of Henle for the counter current exchange. Tubular secretion takes place in the DCT and it is the removal of unfiltered wastes from the blood to the filtrate. Potassium ions, Uric acid, Creatine, Antibiotics ( Penicillin ) etc are secreted into the tubules. Collecting tubule is the site of water reabsorption under the influence of ADH ( Vasopressin ) from the Posterior pituitary. Deficiency of ADH leads to the excretion of dilute urine ( Diabetes insipidus ).

Renin - Angiotensin system functions as an ‘ Autoregulation ’ of glomerular filtration rate by sensing the NaCl content in glomerular filtrate. Renin is secreted by the Juxtaglomerular apparatus when the blood pressure in the kidney falls. Renin then accelerates the reabsorption of sodium. Renin also stimulate the activation of Angiotensin into Angiotensin II . This causes secretion of Aldosterone from the adrenal cortex which enhances the reabsorption of sodium and excretion of potassium.

#### **Additional points**

1. Brights disease ( Nephritis ) is caused by Streptococcus bacteria. It leads to inflammation of kidney.
2. Haematuria is the presence of blood in the urine.
3. Ketosis is the appearance of Ketone bodies in the urine due to fat metabolism.
4. Gout is a hereditary disease characterized by excess uric acid in the blood.
5. Salt glands of marine birds excrete NaCl to maintain osmotic balance.
6. Urochrome ( Yellow pigment ) present in the urine is the breakdown product of Hb.
7. Mammals only excrete Hypertonic urine.
8. Kangaroo rat never drinks water and its loop of Henle is very long to conserve water.
9. Erythropoietin is produced from the kidney. It stimulate stem cells of bone marrow for Erythropoiesis.
10. Normal pH of urine is around 6 and is slightly acidic.