CHAPTER – 9

THE EXCRETORY SYSTEM

Excretion

- Process of elimination by an organism of the waste products that arise as a result of metabolic activities
- Excretory wastes - nitrogen compounds, water, CO 2, phosphates, sulphates, etc.
- Excretory organs - The important human excretory organs are- kidneys, ureter, urethra, urinary bladder, skin, liver, intestine and lungs.

Why is excretion very important ?

- Toxic waste must be disposed of properly or there can be serious consequences.
- Major ways the body maintains homeostasis
- the balance between inorganic ions and water and maintain acid-base balance through this process.

Different organs and excretory products

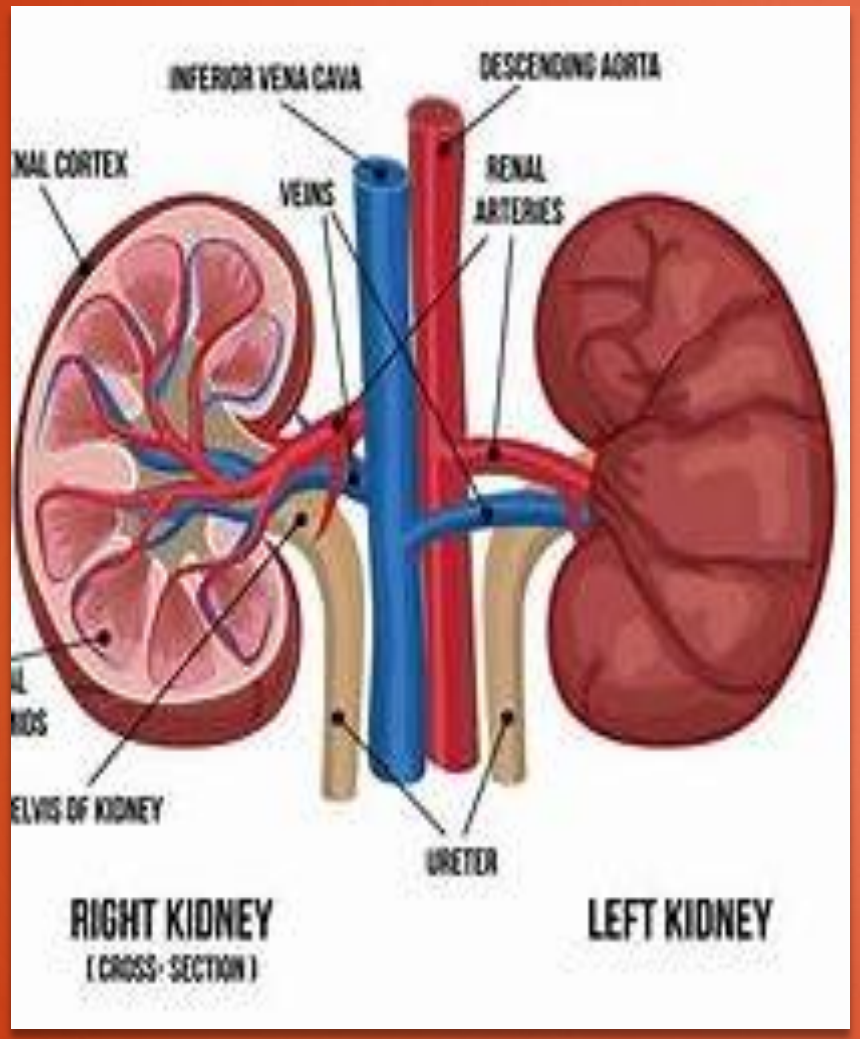
The large intestine eliminates solid wastes that remain after the digestion of food.

The liver breaks down excess amino acids and toxins in the blood.

The skin eliminates excess water and salts in sweat.

The lungs exhale water vapor and carbon dioxide.

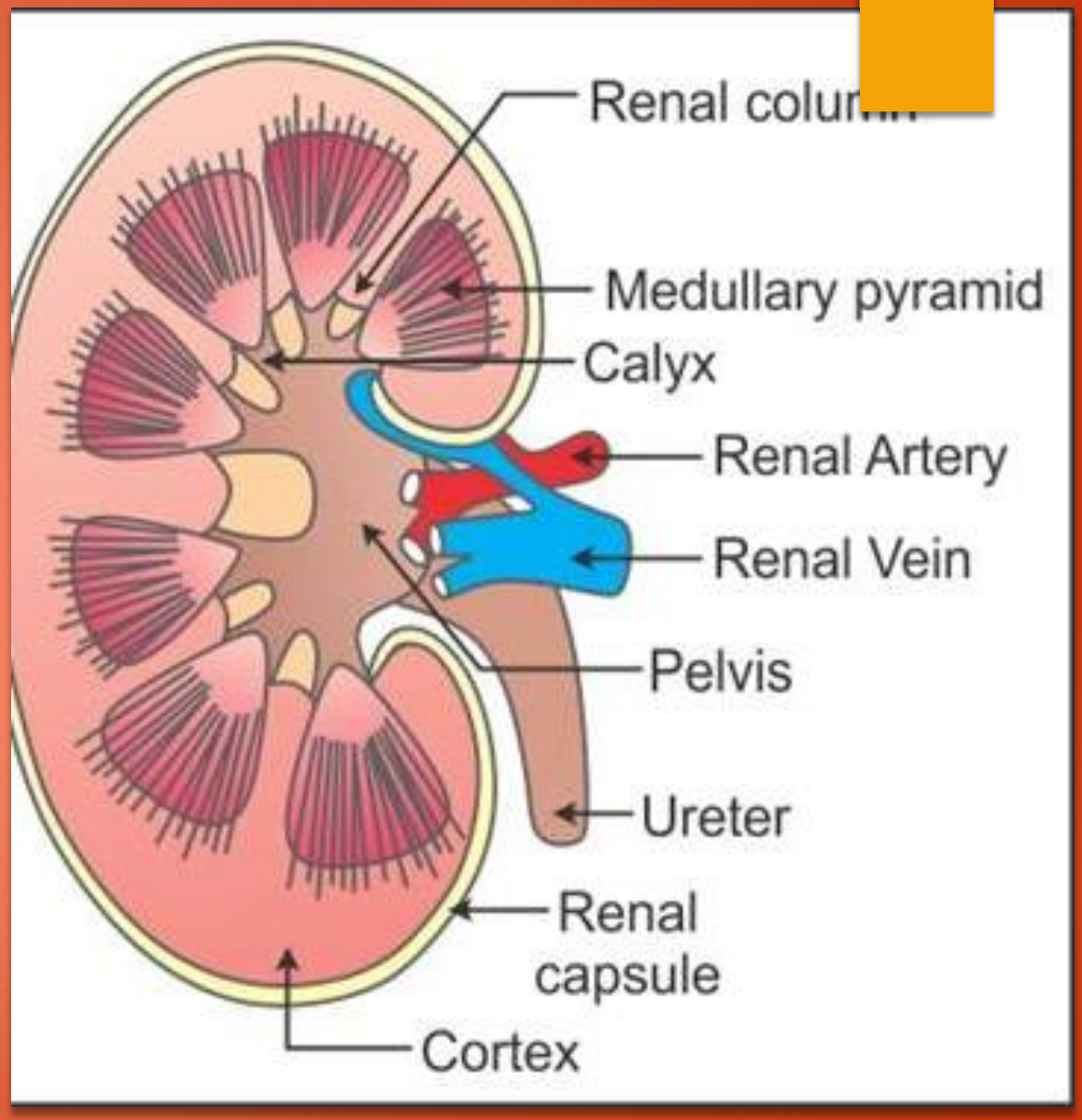
Kidney



- Human excretory system includes organs that facilitate the removal of nitrogenous wastes from the body. The main excretory organs include kidney, ureter, urinary bladder and urethra. Kidneys filter the blood and urine is the filtrate obtained. Urine passes to the urinary bladder via ureter and is expelled out of the body.

Structure of kidney

- Each kidney has over a million tubular structures called nephrons. The kidneys are small bean-shaped organs approximately 6 cm wide and 12 cm long and consist of two main layers an inner layer called the medulla and an outer layer called the cortex.
- Your kidneys are an essential part of filtering your blood. Heres how the urinary system works: Your blood enters each kidney through lots of little arteries.



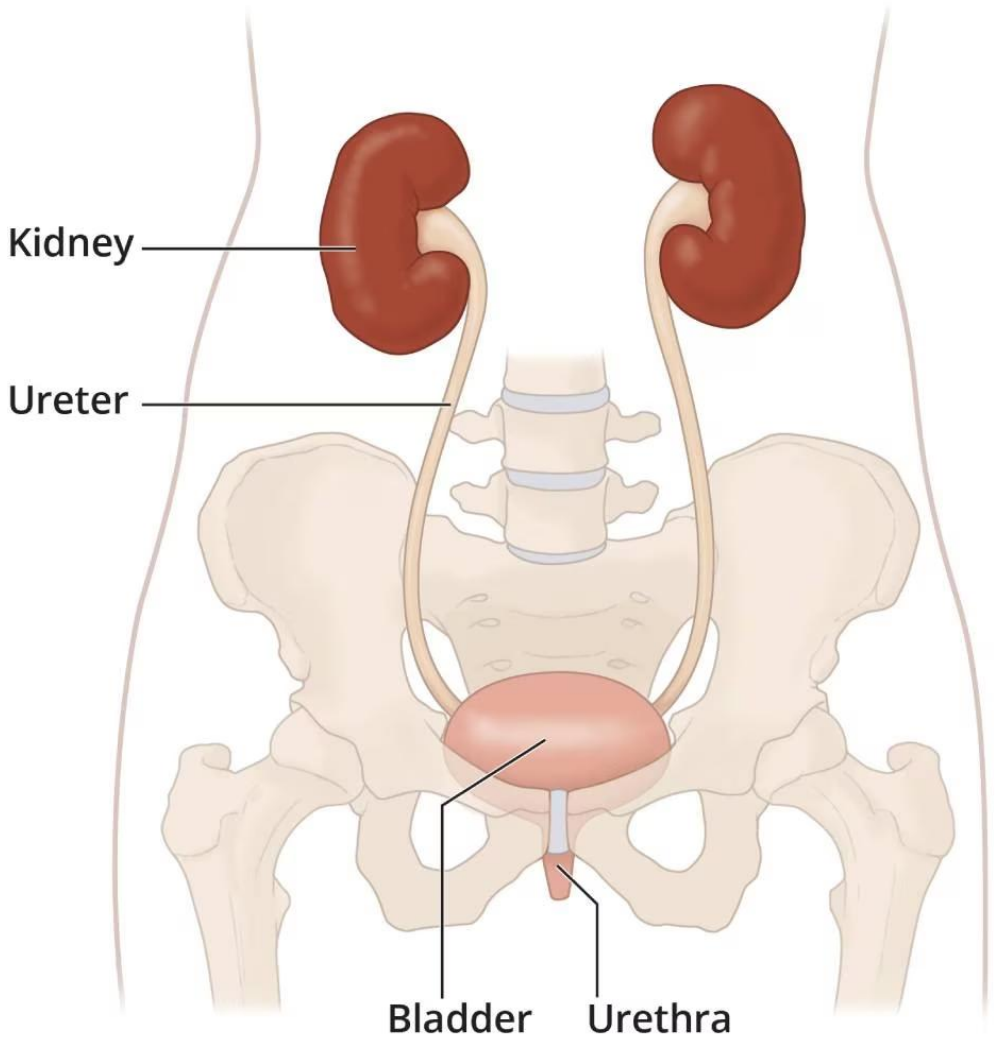
Nephrons

- The **nephron** is the minute or microscopic structural and functional unit of the kidney.
- It is composed of a renal corpuscle and a renal tubule.
- The renal corpuscle consists of a tuft of capillaries called a glomerulus and a cup-shaped structure called Bowman's capsule.
- The renal tubule extends from the capsule.
- The capsule and tubule are connected and are composed of epithelial cells with a lumen.
- A healthy adult has 1 to 1.5 million nephrons in each kidney.

Your Kidneys & How They Work

- The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of your spine.
- Healthy kidneys filter about a half cup of blood every minute, removing wastes and extra water to make urine.
- The urine flows from the kidneys to the bladder through two thin tubes of muscle called ureters, one on each side of your bladder.
- Your bladder stores urine. Your kidneys, ureters, and bladder are part of your urinary tract.

Urinary Tract



Why are the kidneys important?

Your kidneys remove wastes and extra fluid from your body.

Your kidneys also remove acid that is produced by the cells of your body and maintain a healthy balance of water, salts, and minerals—such as sodium, calcium, phosphorus, and potassium—in your blood.

Without this balance, nerves, muscles, and other tissues in your body may not work normally.

Your kidneys also make hormones that help:

control your blood pressure

make red blood cells

keep your bones strong and healthy

How do my kidneys work?

- Each of your kidneys is made up of about a million filtering units called nephrons. Each nephron includes a filter, called the glomerulus, and a tubule.
- The nephrons work through a two-step process:

✓ the glomerulus filters your blood, and

✓ the tubule returns needed substances to your blood and removes wastes.

The glomerulus filters your blood

As blood flows into each nephron, it enters a cluster of tiny blood vessels—the glomerulus.

The thin walls of the glomerulus allow smaller molecules, wastes, and fluid—mostly water—to pass into the tubule.

Larger molecules, such as proteins and blood cells, stay in the blood vessel.

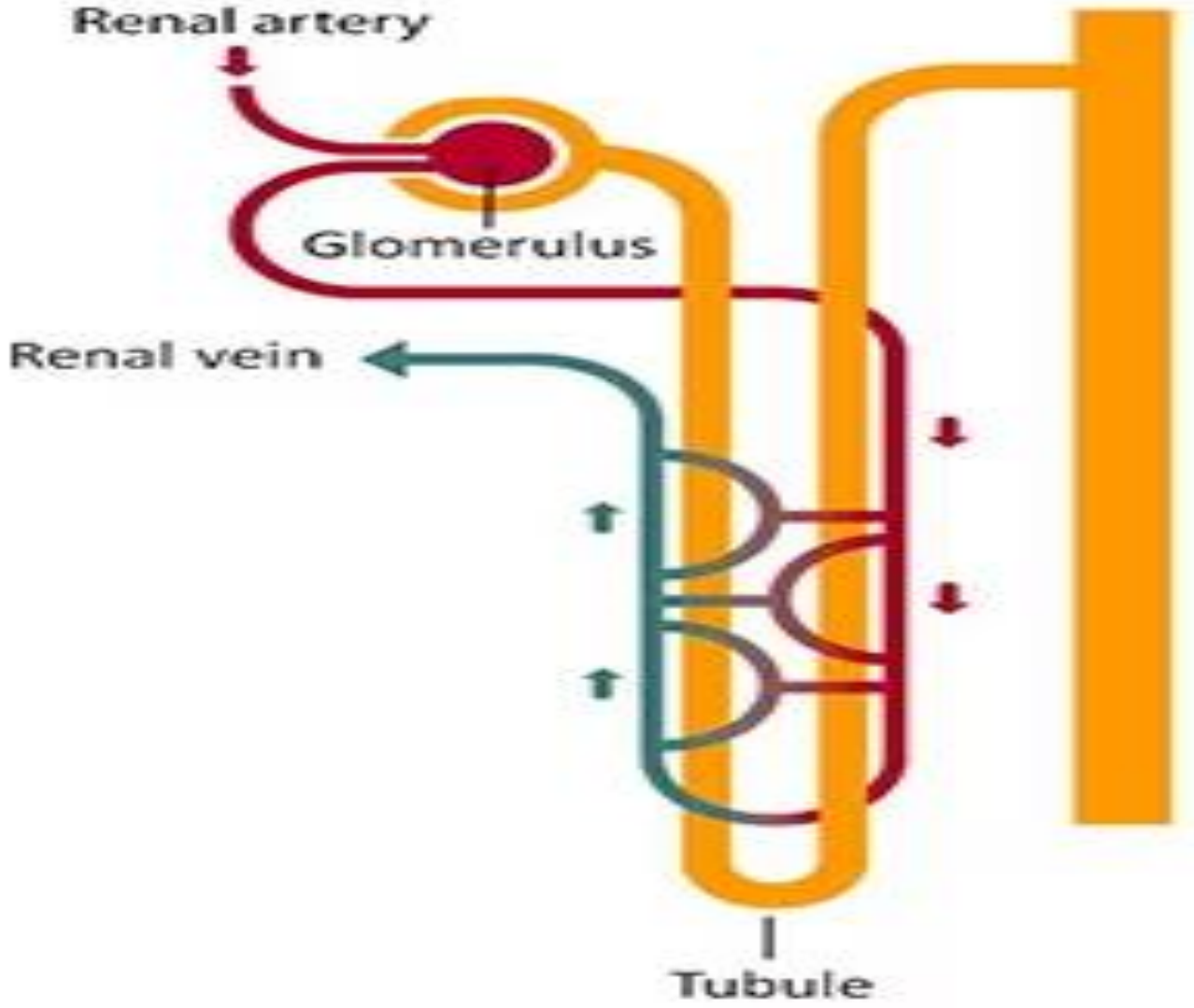
The tubule returns needed substances to your blood and removes wastes

A blood vessel runs alongside the tubule.

As the filtered fluid moves along the tubule, the blood vessel reabsorbs almost all of the water, along with minerals and nutrients your body needs.

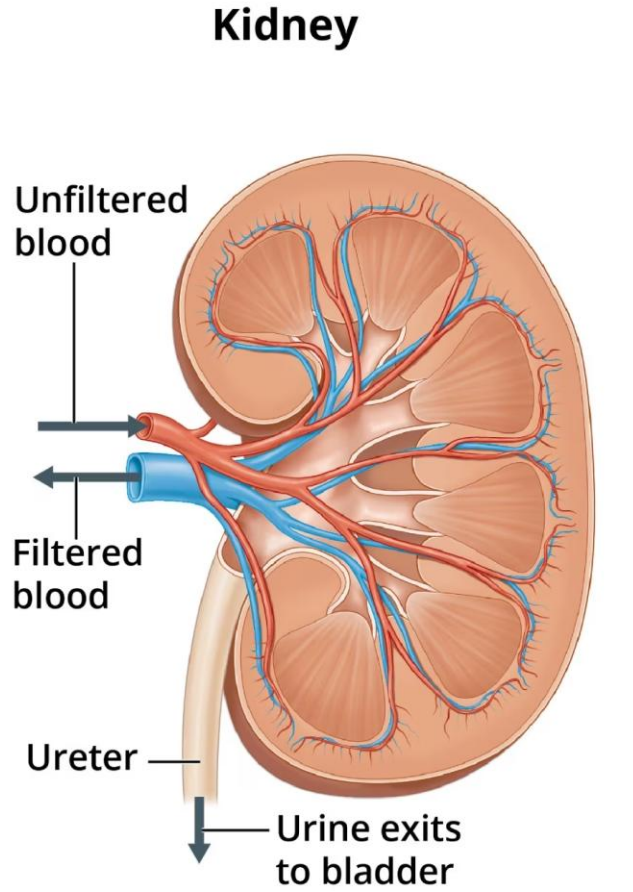
The tubule helps remove excess acid from the blood. The remaining fluid and wastes in the tubule become urine.

The Nephron



How does blood flow through my kidneys?

- Blood flows into your kidney through the renal artery.
- This large blood vessel branches into smaller and smaller blood vessels until the blood reaches the nephrons.
- In the nephron, your blood is filtered by the tiny blood vessels of the glomeruli and then flows out of your kidney through the renal vein.

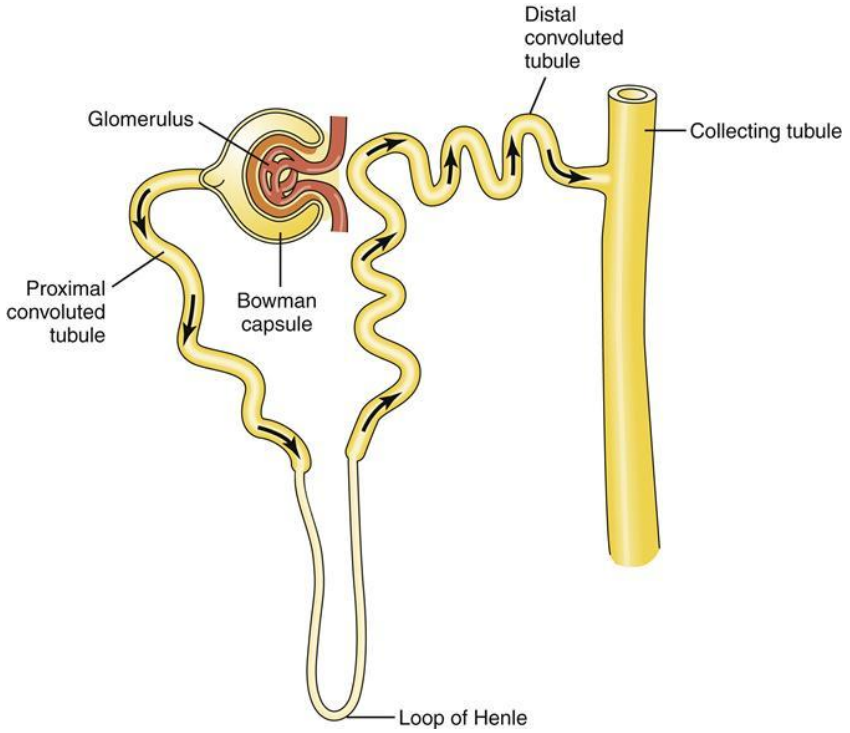


Bowman's capsule

- **Bowman's capsule**, also called **Bowman capsule, glomerular capsule, renal corpuscular capsule,** or **capsular glomeruli**.
- Double-walled cuplike structure that makes up part of the nephron.
- The filtration structure in the mammalian kidney that generates urine in the process of removing waste and excess substances from the blood.
- Bowman's capsule and the glomerulus together constitute the renal corpuscle. Blood flows into and away from the glomerulus through tiny arteries called arterioles
- In the renal corpuscle, fluid filters out of the blood in the glomerulus through the inner wall of the capsule and into the nephron tubule.

What is the difference between distal and proximal?

- Proximal means near or close to and distal means away or farther from the point of reference.



LOOP OF HENLE

- Henle loop, nephron loop or its Latin counterpart ansa nephroni) is the portion of a nephron that leads from the proximal convoluted tubule to the distal convoluted tubule.

PRODUCTION OF URINE

- ULTRAFILTRATION - Glomerular filtration is a process in which water and some other substances in the blood plasma pass from the capillaries of the glomerulus into the Bowman's capsule. Very small molecules can pass through the filtration membrane into the Bowman's capsule. This includes water, electrolytes, glucose, fatty acids, amino acids, nitrogenous wastes, and vitamins

- TUBULAR SECRETION AND REABSORPTION - This involves removal and addition of chemicals, after glomerular filtrate leaves the Bowman's capsule and enters the renal tubule. **Tubular reabsorption** is the process of reclaiming water and other substances from the tubular fluid (glomerular filtrate which passes from the Bowman's capsule to the renal tubule) and returning them to the blood.

Part of renal tubule	Activity
1. GLOMERULUS	• Ultrafiltration
2. BOWMAN'S CAPSULE	• Receives glomerular filtrate
3. PROXIMAL CONVOLUTED TUBULE	• Reabsorbs most water (about two-thirds), and much of glucose and sodium and chloride ions
4. LOOP OF HENLE	• Some absorption of water and sodium ions
5. DISTAL CONVOLUTED TUBULE	• Reabsorption of remaining chlorides and some water. • Walls secrete potassium and foreign chemicals such as penicillin and other drugs into the forming urine

CONSTITUENTS OF URINE

Organic in (g/L)		Inorganic in (g/L)	
Urea	2·3	Sodium chloride	9·0
Creatinine	1·5	Potassium chloride	2·5
Uric acid	0·7	Ammonia	0·6
Others	2·6	Others	2·5

ABNORMAL CONSTITUENTS IN URINE

- **BLOOD CELLS – PRESENCE OF BLOOD IN URINE – HAEMATURIA**
- **GLUCOSE – EXCESS GLUCOSE IN URINE – GLYCOSURIA – DIABETES MELLITUS**
- **ALBUMIN – EXCESS ALBUMIN DUE HIGH BLOOD PRESSURE – ALBUMINURIA**
- **BILE PIGMENT – DUE TO HEPATITIS [JAUNDICE]**

OSMOREGULATION

- The maintenance of constant osmotic pressure in the fluids of an organism by the control of water and salt concentrations.

- The kidney is the main organ responsible for osmoregulation in humans. Water, amino acids and glucose are reabsorbed by the kidneys. When the water level in the body is high, it releases a large amount of hypotonic urine. When the water level is low, it retains water and produces a low amount of hypertonic urine.

ARTIFICIAL KIDNEY

- Artificial kidney is often a synonym for hemodialysis, but may also refer to the other renal replacement therapies

- Hemodialysis is a method for removing waste products such as creatinine and urea, as well as free water from the blood when the kidneys are in kidney failure. The mechanical device used to clean the patient's blood is called a dialyser, also known as an artificial kidney.

Excretory substances	Excretory organs	Remarks
Carbon dioxide	Lungs	As a gas in expired air
Minerals salts, Nitrogenous waste products : 1. Mainly urea 2. Creatinine 3. Uric acid	Kidneys	As constituents of urine
	Skin	As constituents of sweat, though sweat contains only small quantities of nitrogenous products
Water	Kidneys	Excess water excreted out as the main constituent of urine
	Skin	Water lost as the main constituent of sweat
	Lungs	Water lost as water vapour in expired air.
Bile pigments (from haemoglobin breakdown)	Liver	Through the intestines (via bile juice poured into duodenum).