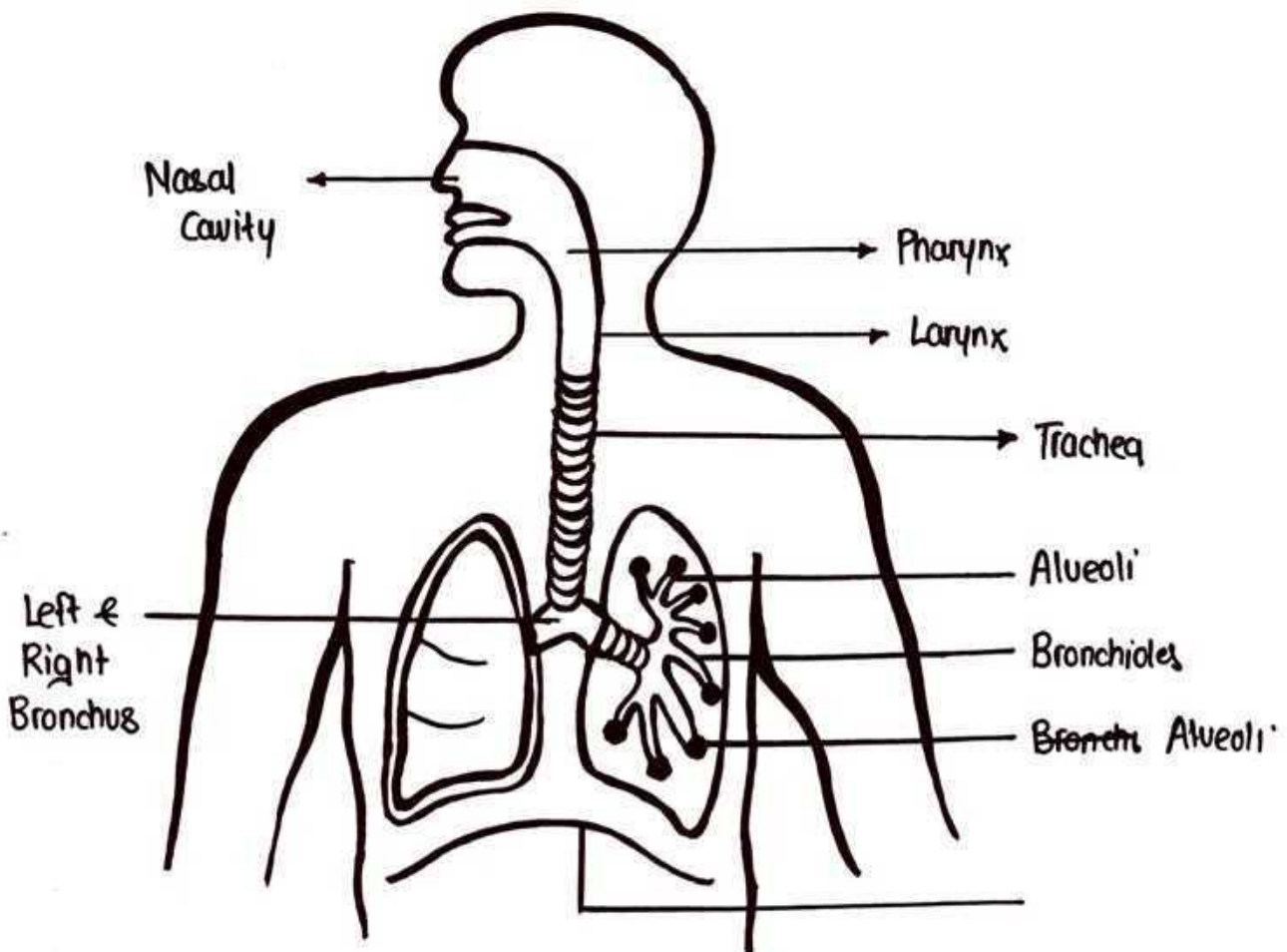


# **HUMAN ANATOMY & PHYSIOLOGY**

## **UNIT 3**

## RESPIRATORY SYSTEM

- Respiration is simply defined as process of exchange of gases b/w body tissues and external environment.
- Cells of our body continuously use oxygen for the metabolic reactions in which energy is released from nutrient molecules & ATP produces.
- Now during these metabolic reactions  $\text{CO}_2$  also released that must be excreted out from body.
- The supply of  $\text{O}_2$  & excretion of  $\text{CO}_2$  occurs only through Respiration & the system that performs respiration is called Respiratory System.



## Stages of Respiration

There are basically 3 stages of Respiration :

- ① Breathing / Ventilation
- ② Internal Respiration
- ③ Cellular Respiration

**BREATHING** : It is simply defined as the exchange of Gases b/w environment & lungs.

**INTERNAL RESPIRATION** : It is simply defined as exchange of gases between lungs & blood

**CELLULAR RESPIRATION** : It is simply defined as exchange of gases between blood & body tissues (cells)

## Types of Respiration

There can be two types of respiration :

- ① Aerobic Respiration
- ② Anaerobic Respiration

**AEROBIC RESPIRATION** :

- It occurs in the presence of oxygen.
- It always releases  $\text{CO}_2$  & water.
- This process produces much more energy.

**ANAEROBIC RESPIRATION** :

- It occurs in the absence of oxygen.
- May or may not produces  $\text{CO}_2$
- It produces less energy.

## Organs of Respiratory System

Respiratory System consist of following parts :

- Nose and Nasal Cavity
- Pharynx
- Larynx
- Trachea
- Bronchi
- Bronchioles
- Alveoli
- Lungs

### ① NOSE / NASAL CAVITY

- The respiratory pathway begins from nose
- Cavity of nose is known as Nasal Cavity.
- Nasal cavity is divided into right & left portions by the Nasal Septum.
- They contain small hairs that act as a filter for dust.
- The anterior portion of nasal chamber is known as Nasal Vestibule.

#### Functions :

- Allows air to enter into your body.
- Filters & cleans air.
- Provides a sense of smell
- It also acts as a air conditioner.

## ② PHARYNX

- It is the common pathway for Respiratory Tract & Gastrointestinal Tract.
- It is about 12 cm long.
- It is further divided into three parts:
  - ① Nasopharynx
  - ② Oropharynx
  - ③ Laryngopharynx

### Functions :

- It helps in movement of food to esophagus.
- Pharynx amplifies the sound produced by Larynx.
- Lymphoid tissues present in pharynx act as a first line defence against foreign pathogens.
- It is the pathway for air, food & liquid.

## ③ LARYNX

- It lies b/w pharynx & trachea.
- It is made up of following cartilages
  - (i) Thyroid Cartilage
  - (ii) Cricoid Cartilage
  - (iii) Artenoid Cartilage.
- It contains Epiglottis that makes sure that food must be enter into esophagus instead of Trachea.

## Functions of Larynx

- Larynx produces sound, hence also known as Sound Box.
- Larynx don't play any role in respiration but acts as a pathway for air.
- Epiglottis prevents food from entering into trachea.

## ④ **TRACHEA**

- It is a cylindrical tube like structure which is 12 cm long and 2.5 cm in diameter.
- It begins at lower end of pharynx.
- It is made up of 16-20 C shaped incomplete rings.
- It is made up of hyaline cartilage.

### Functions :

- It provides a clear pathway for air to enter & exit lungs.
- Small hairs are present in the inner walls of trachea that catches dust & other impurities from inhaled air.

## ⑤ **BRONCHI**

- The trachea ends up by dividing into two bronchi / bronchus named right & left bronchi.
- They further pass into the corresponding lungs.
- The right bronchus is shorter & wider than left.

### Functions :

- It connects windpipe with lungs.
- It allows air to pass into lungs.

## ⑥ BRONCHIOLES

- Bronchi of lungs further divided into smaller branches known as Bronchioles.
- Bronchioles don't have cartilage.
- They are lined by cuboidal epithelium. }

### Functions :

- Bronchioles end up to form alveoli & hence plays a major
- role in pathway of air from bronchi to alveoli

## ⑦ ALVEOLI

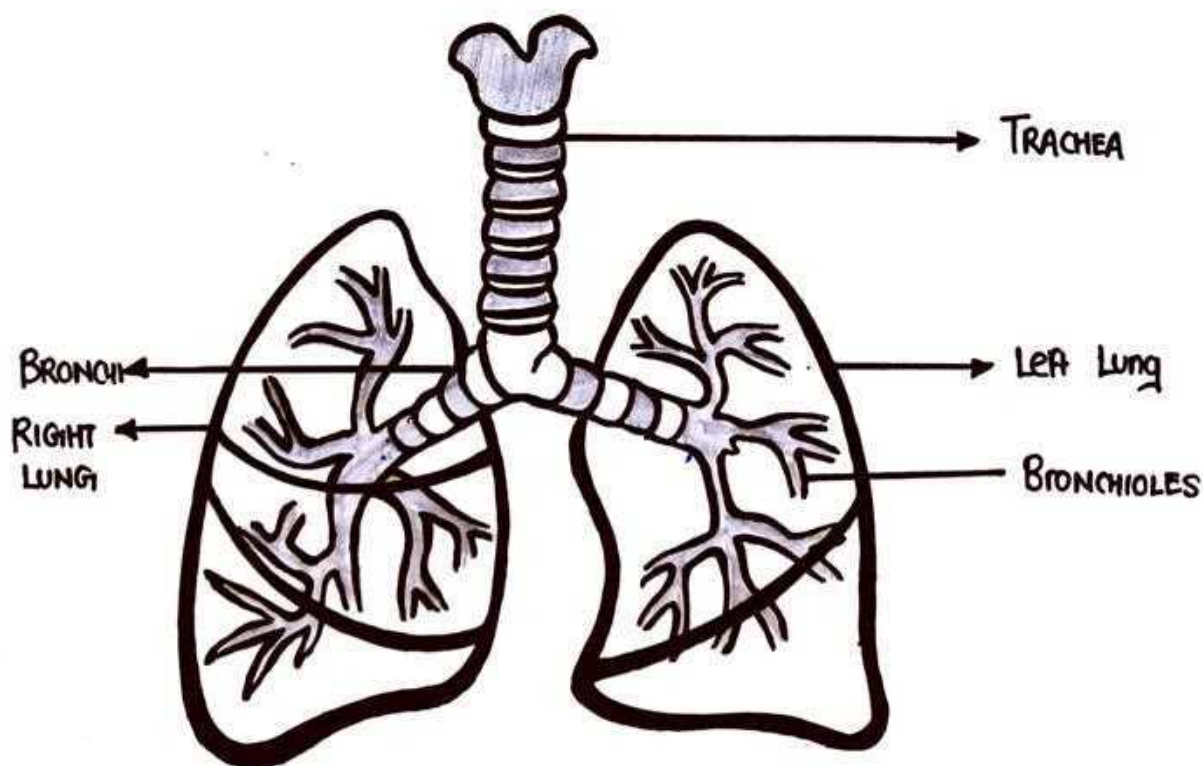
- Alveoli are known as functional unit of lungs & consist of small hollow area for gaseous exchange.
- They are lined by simple squamous epithelium that serves for gaseous exchange.
- There are approximately 300 million alveoli present in both lungs.
- They are rich in blood supply.
- They contain two types of cells :
  - ① Pneumocytes
  - ② Alveolar Macrophages

### Functions :

- Alveoli is site where exchange of oxygen & carbon di oxide occurs during the process of breathing.
- Once the blood receives oxygen it further transfer it to all the cells of our body.

# LUNGS

- Lungs are the principle organ of respiration.
- The lungs are pair of spongy air filled cone shaped organ located on either side of chest.
- They are present in pair i.e. left lung & right lung.
- Lungs are covered by a double membrane known as Pleural membranes.
- Outer Membrane : Parietal Pleura
- Inner Membrane : Visceral Pleura
- Between both the membranes a fluid is present known as Pleural fluid.
- The left lung is slightly smaller than right lung.
- Right lung has three lobes while left lung has only 2 lobes.





## Surfaces of Lungs

The lungs can be divided into 4 parts.

- Apex : Narrow Superior portion
- Base : Broad Inferior portion.
- Costal : Surface against ribs
- Surface : lateral boundary of Mediastinum.

## Lobes of Lungs

Lungs of each side contains different no. of lobes :

**RIGHT LUNG** : Right lung is subdivided into 3 lobes :

- Superior Lobe
- Middle Lobe
- Inferior Lobe

**LEFT LUNG** : Left Lung is subdivided into 2 lobes :

- Superior Lobe
- Inferior Lobe

## MECHANISM OF RESPIRATION

Mechanism of respiration involves two major steps :

- Breathing mechanism
- Exchange of Gases

### Mechanism of Breathing

- The process in which air moves in & out of the lungs is known as Breathing.
- The breathing mechanism involves two major process :
  - ① Inspiration
  - ② Expiration

### INSPIRATION

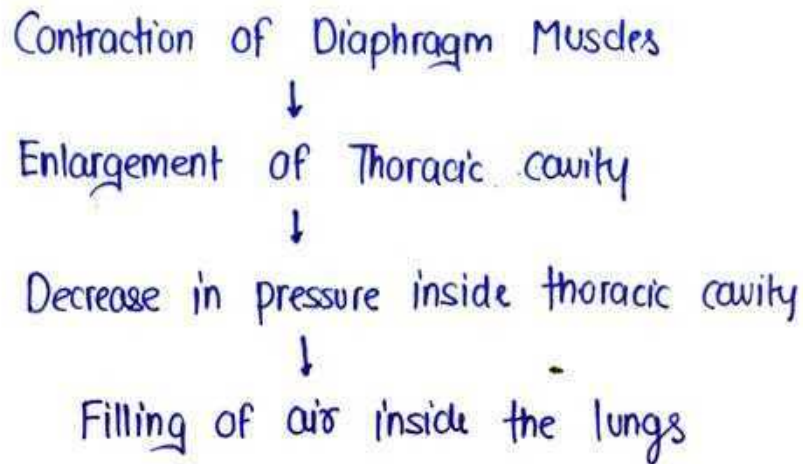
- The process of intake of atmospheric air is simply known as Inspiration.
- In this process air moves from atmosphere to lungs.
- The process is also known as Inhalation.
- It is an active process.

### Muscles involved in Inspiration

Two types of muscles mainly involved in Inspiration.

- Diaphragm
- External - Inter - costal muscles

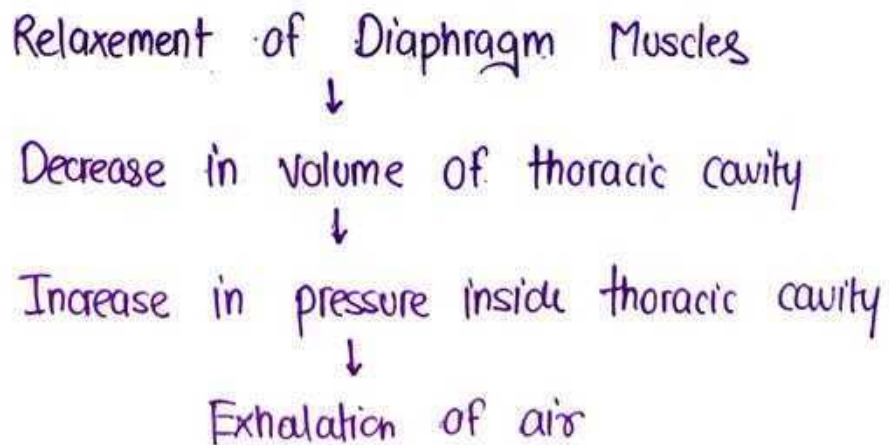
## Inspiration Mechanism



### **EXPIRATION**

- The process in which the air moves from lungs to the atmosphere is known as Expiration.
- It is also known as Exhalation.
- It is a passive process (doesn't require energy)

## Expiration Mechanism



## EXCHANGE OF GASES

- The gaseous exchange occurs in alveoli of lungs.
- It depends upon pressure difference b/w blood & tissues.
- Exchange of Gases takes place in following manner:
  - (i) Transport of Oxygen
  - (ii) Cellular Respiration
  - (iii) Transport of Carbon di Oxide

### Transport of $O_2$

When  $O_2$  is transferred from alveoli to blood then it is carried by Haemoglobin & then it is further transported to cells for cellular respiration.

### Cellular Respiration

The  $O_2$  received by the cell is further used for the process of cellular respiration in which cells use  $O_2$  to breakdown the glucose into  $CO_2$  & energy should be produced.

### Transport of $CO_2$

Now  $CO_2$  is a waste product hence it is further transferred from cells to blood & then blood to lungs & then finally exhaled out.

## LUNG VOLUMES

- Lung volumes are also known as respiratory volumes.
  - It refers to the volume of gas in the lungs at a given time.
  - There are various types of Lung volumes :
- ① Tidal Volume
  - ② Inspiratory Reserve Volume
  - ③ Expiratory Reserve Volume
  - ④ Residual Volume

### Tidal Volume

- It is simply defined as amount of air inhaled or exhaled during normal breath.
- Its value is about 500 ml

### Inspiratory Reserve Volume

- It is the maximum amount of air inhaled by a deep inspiration process.
- Its about 2500 - 3000 ml.

### Expiratory Reserve Volume

- It is simply defined as maximum amount of air exhaled by a deep expiration process.
- Its about 1000 - 1200 ml

### Residual Volume

- It is the amount of air that remains inside lungs forceful exhalation. 1200 - 1500 ml

## LUNG CAPACITY

- Lung capacities are derived from summation of different lung volumes :
  - They are also of different types :
- (i) Total lung capacity
  - (ii) Vital capacity
  - (iii) Expiratory capacity
  - (iv) Residual Capacity
  - (v) Inspiratory Capacity

Total Lung Capacity : • Total volume of air that person can hold in its lungs after a forced inhalation.  
• Sum of all volumes. M → 6000 ml F → 4500 ml

Vital Capacity : • It is amount of air that a person move in & out.  
• Sum of tidal volume & inspiratory reserve volume & expiratory reserve v.

Inspiratory Capacity : • Amount of air that can be inhaled after tidal volume, expiration.  
• Sum of tidal volume & inspiratory reserve volume.

Expiratory Capacity : • It is simply amount of air exhaled by a person.

Residual Capacity : • Amount of air remains after a normal tidal expiration.  
• Sum of expiratory reserve volume & residual volume.

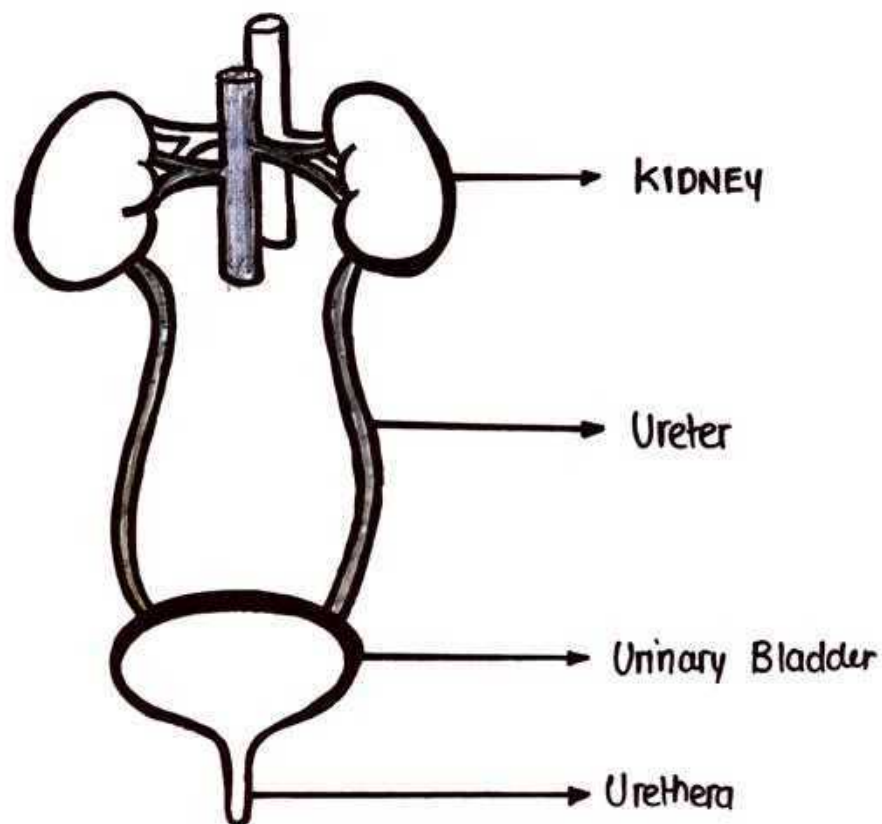
## URINARY SYSTEM

- Excretion is the process by which unwanted substances & metabolic wastes are eliminated from the body.
- Although there are various systems in our body that are involved in the excretion process, but Urinary System has major excretory capacity, hence it is known as major excretory system of human body.
- It is also known as Renal System.

### Parts Of Urinary System

Urinary System mainly consist of :

- A pair of kidneys
- Ureters
- Urinary Bladder
- Urethra



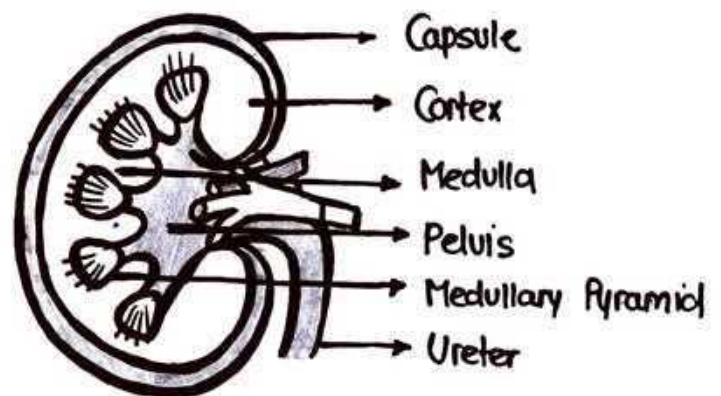
## KIDNEY

- They are present in a pair in our body.
- Kidneys are two bean shaped organ located on each side of vertebral column. (T-12 - L3).
- It is reddish-brown in colour.
- It is about 10-12 cm long & 5-7 cm wide.
- Its weight is about 120-170 gram.

### Layers of kidney

Kidney mainly contains 3 layers:

- ① Outer Cortex
- ② Inner Medulla
- ③ Renal Pelvis



### NEPHRONS

- Nephrons are the major functional unit of kidney.
  - Nephron is mainly consist of two parts:
- ① Renal Corpuscle
  - ② Renal Tubule

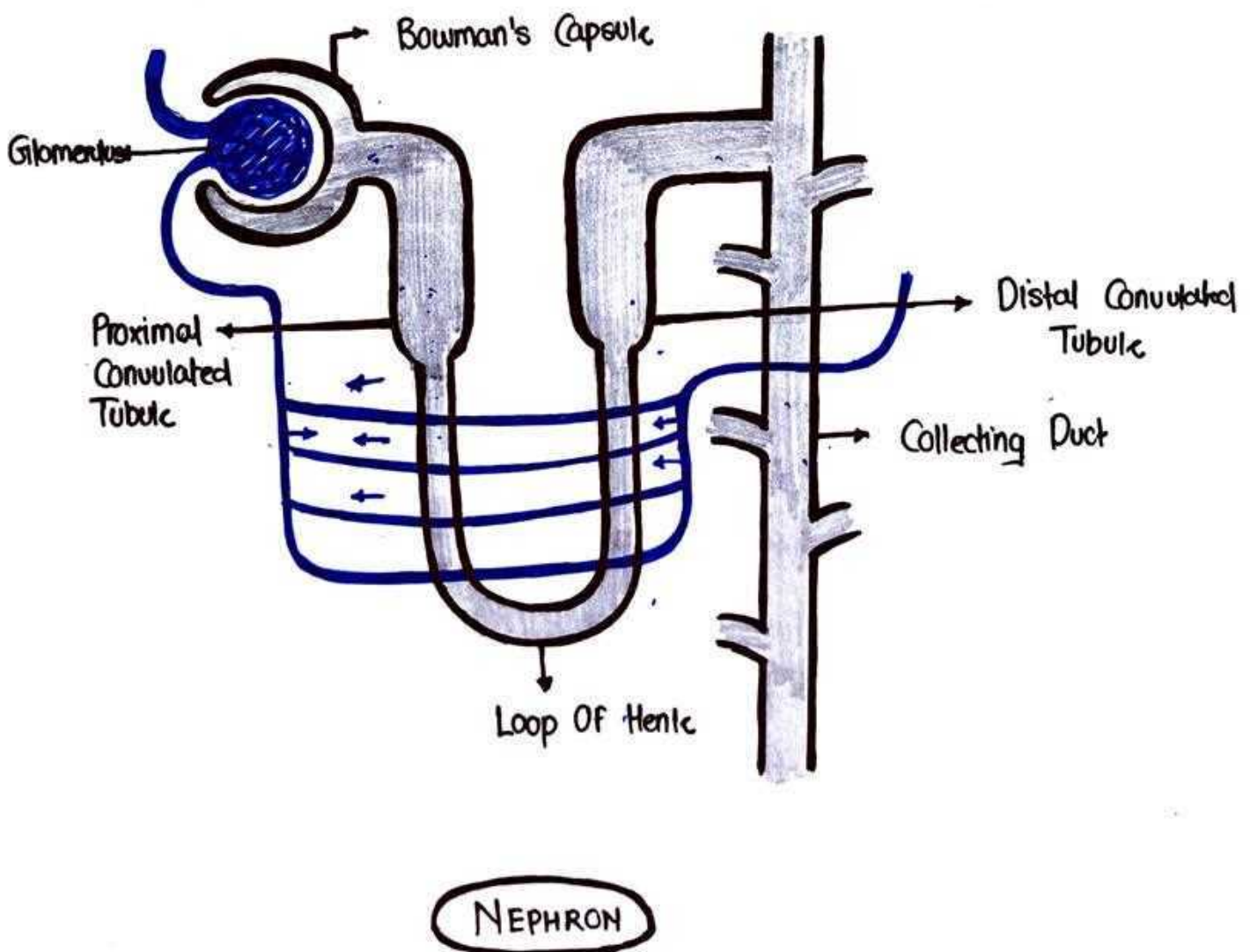
### RENAL CAPSULE CORPUSCLE

- It is present in the cortex of kidney.
  - The major function of renal corpuscle is filtration of blood.
  - It can be further subdivided into two portions
- ① Glomerulus : Bunch of capillaries.
  - ② Bowman's Capsule : Upper end of renal tubule.



## RENAL TUBULE

- It is a tube like structure and the continuation of Bowman's capsule.
- Proximal  $\subset$  Renal tubule mainly consist of 3 parts :
  - ① Proximal Convoluted Tubule : Present in Cortex
  - ② Loop of Henle : Present in Medulla
  - ③ Distal Convoluted Tubule : Present in Cortex
- Loop of Henle can be further subdivided into 2 parts :
  - (i) Descending Limb
  - (ii) Ascending Limb



## Types Of Nephrons

Nephrons are of basically two types :

- ① Cortical Nephrons : 85% , short Loop of Henle
- ② Juxta - Medullary Nephrons : 15% , Long Loop of Henle.

## PHYSIOLOGY OF URINE FORMATION

- Urine formation is a Blood Cleansing function.
- Normally about 1300 ml of blood enters into the kidney.
- Kidney excreted the unwanted substances from the blood as Urine .
- Normal Urine output is 1-1.5 Litre/ day.

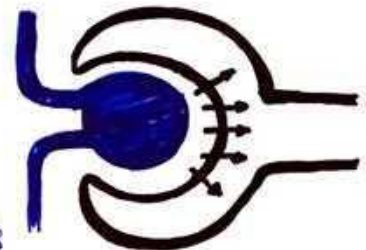
## Formation Of Urine

It mainly involves 3 steps :

- ① Glomerular Filtration
- ② Tubular Reabsorption
- ③ Tubular Secretion

### ① GLOMERULAR FILTRATION

- It is a process by which blood is filtered while passing through glomerular capillaries by filtration membrane.
- It is first step of Urine formation.
- When blood passes through glomerular capillaries the plasma is filtered in Bowman's capsule.



- All the substance of plasma filtered in glomerular filter except plasma protein & filtered fluid is known as Glomerular filtrate.

## Glomerular Filtration Rate

- Glomerular filtration rate (GFR) is defined as total quantity of filtrate formed in all the nephrons of both the kidney in the given unit of time.
- Normal GFR is 125 ml / minute or 180 L / day

## Factors Affecting GFR

- Renal blood flow
- Glomerular capillary Pressure
- Colloidal Osmotic Pressure
- Hydrostatic pressure in Bowman's capsule.

## ② TUBULAR REABSORPTION

- As we clearly saw that about 180 L filtrate formed per day but only 1.5 litre urine is excreted out from our body that means about 99% part of filtrate again reabsorbed in blood.
- It is the process by which water & other necessary substances are reabsorbed from Renal Tubule to Blood.
- The reabsorbed substances moves into the interstitial fluid of renal medulla & after that they moved into ~~cap~~ tubular capillaries.
- Tubular reabsorption is a selective reabsorption as the tubular cells reabsorbs only those substances that are necessary for our body.
- Essential substances get reabsorbed while unwanted substances excreted out from body.

## Site of Reabsorption

PROXIMAL CONVULATED TUBULE	LOOP OF HENLE	DISTAL CO. TUBULE
Glucose , Amino Acids Sodium , Potassium Calcium , Bicarbonates Chlorides , Phosphates Urea , Uric Acid Water	Sodium Chloride	Sodium Calcium Bicarbonates Water

### ③ TUBULAR SECRETION

- It is process in which substance are transported from blood to renal tubules.
- The unwanted substances that are not get filtered from blood to Bowman's capsule in first step are directly transported to renal tubules later in this process.

#### Substance secreted in different segment of renal capsule tubule

- Proximal Convulated Tubule : Potassium, Ammonia,  $H^+$  ions.
- Loop of Henle : Urea
- Distal Convulated Tubule : Potassium,  $H^+$  ions
- Collecting Ducts : Potassium.

## URETERS

- They are paired tube like structures.
  - They carry urine from kidney to urinary bladder.
  - The wall of ureter is made up of 3 layers.
- ① Inner Mucous Layer
  - ② Outer fibrous Layer
  - ③ Middle Muscular Layer

## URINARY BLADDER

- It is an inverted pear shaped structure that acts as a collector for urine.
  - It lies in the pelvic cavity.
  - The lower part of bladder is known as base while upper part is called Fundus.
  - It has three opening two for ureter & one for urethra.
  - It has 4 layers.
- ① Outer Serous Layer
  - ② Muscular Layer
  - ③ Sub-Mucous Layer
  - ④ Mucous Layer

## URETHRA

- It is a canal through which urine passes from bladder to outside.
- It is different in males & females.

## FUNCTIONS OF KIDNEY

- It helps in the excretion of waste products
- It maintains water- electrolyte balance.
- It maintains acid- base balance.
- It also helps in the process of erythropoiesis by secreting erythropoietin & also in thrombopoiesis by secreting thrombopoietin.
- It secretes renin, prostaglandin hormones.
- It also helps in regulation of blood pressure.
- It also regulates blood- calcium level.

## ROLE OF KIDNEY IN ACID BASE BALANCE

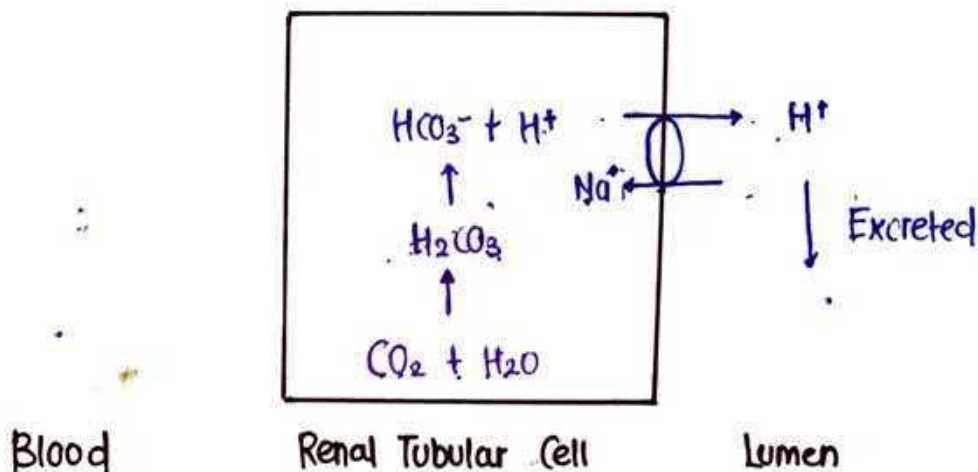
- Acid base balance is a part of homeostasis process that deals with maintenance of pH
- Most of the reactions in our body occurs at a specific pH & change in this pH can lead to major disturbances.
- The normal pH value of blood is approx 7.42 & survival range of pH in blood is between 6.8 - 8.0, now if the pH limit crosses this value then it may lead to death, so it becomes very important to maintain pH balance of our body.
- Now, there are various mechanism in our body to regulate this acid-base balance but the renal mechanism is the most effective & final process of acid-base balance in which kidneys play major role.

### Renal Mechanism of Acid base balance

It mainly works by 2 mechanism ∴

- Excretion of  $H^+$
- Reabsorption of bicarbonate ions

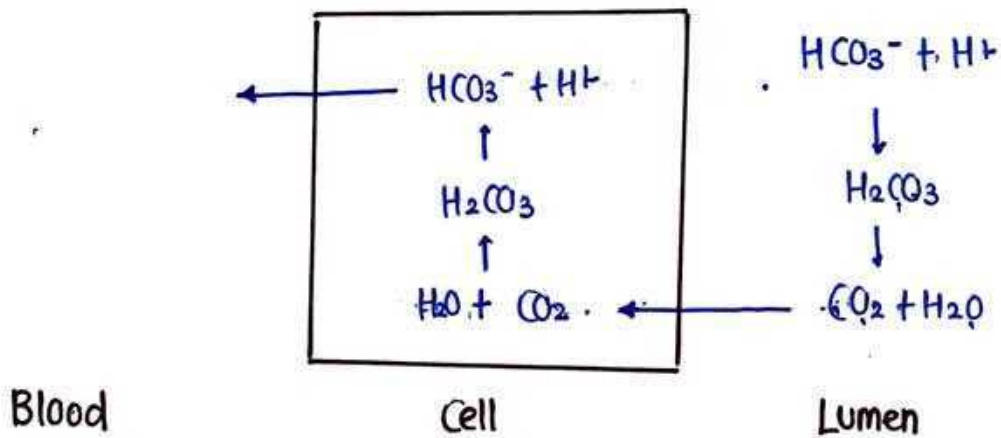
#### Excretion of $H^+$



## STEPS

- This step mainly occurs proximal tubule.
- $\text{CO}_2$  combines with  $\text{H}_2\text{O}$  to form  $\text{H}_2\text{CO}_3$
- Now  $\text{H}_2\text{CO}_3$  dissociates into  $\text{HCO}_3^- + \text{H}^+$
- $\text{H}^+$  is secreted in Lumen in exchange to  $\text{Na}^+$
- Now this  $\text{H}^+$  is excreted out from body through urine.

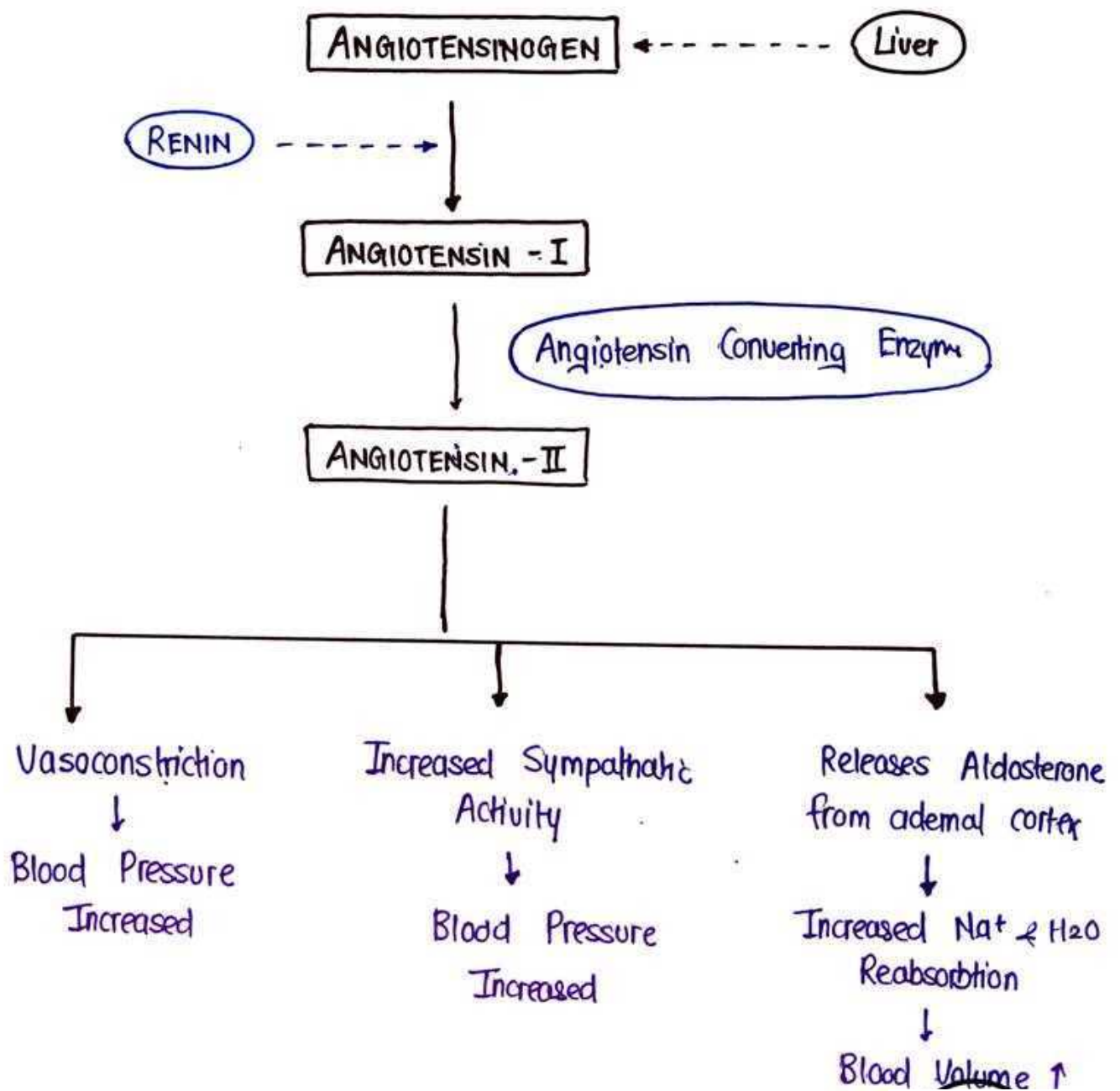
## ② REABSORPTION OF BICARBONATE IONS





## ROLE OF RAS In kidney

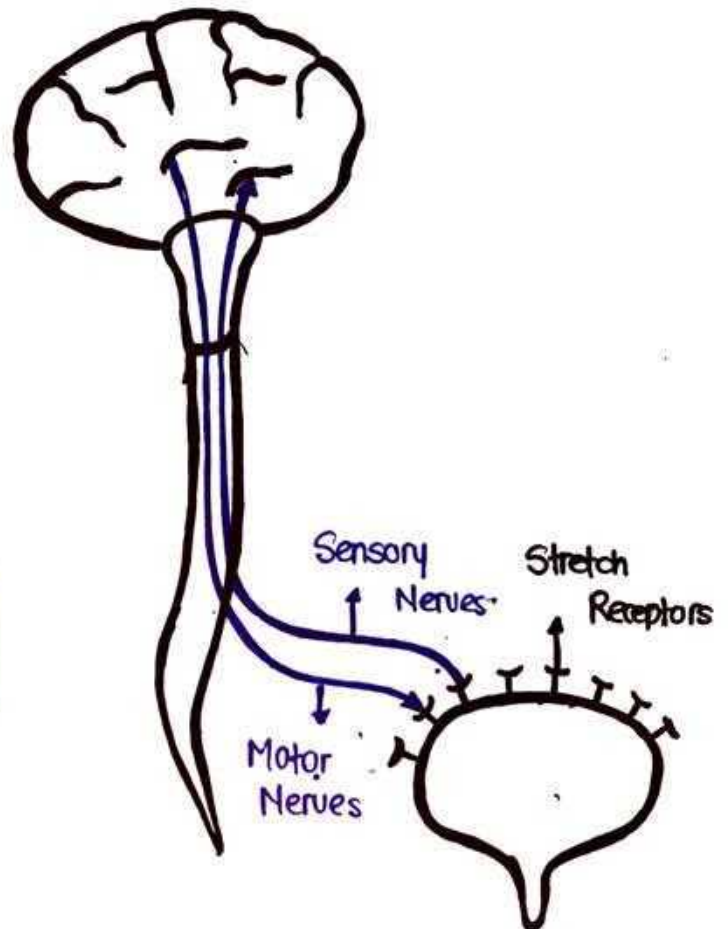
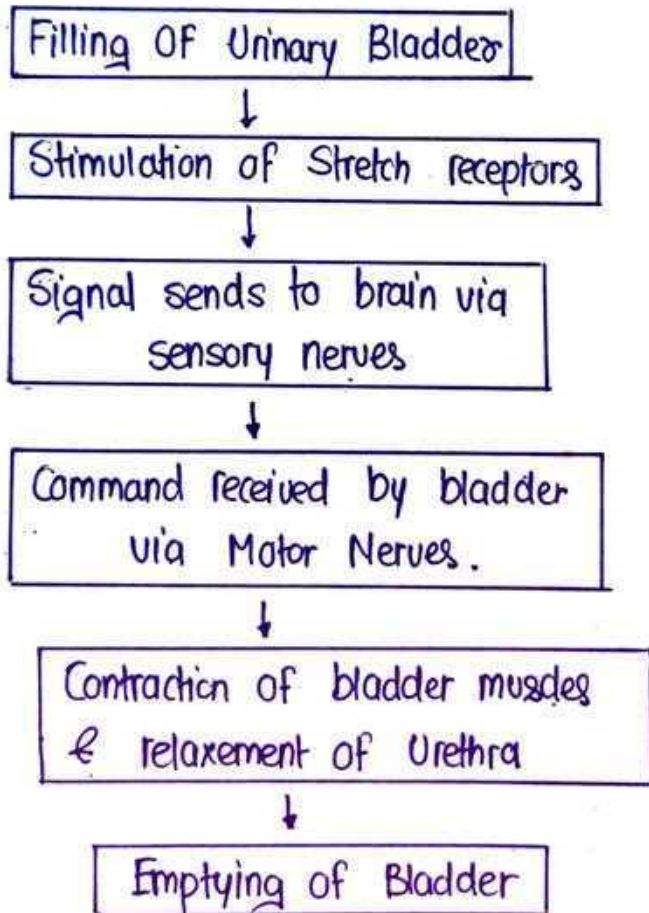
- RAS stands for Renin Angiotensin System.
- Renin Angiotensin system is a physiological hormone system involved in the regulation of arterial blood pressure & plasma sodium concentration
- Renin is a hormone secreted by Juxtaglomerular Apparatus.
- Angiotensinogen is a plasma protein released by liver



## MICTURITION

- Micturition is a process by which the urinary bladder empties when it becomes filled.
- This involves two main steps:
  - ① First the bladder fills progressively until the tension in its walls rises above a threshold level.
  - ② Now in the second step as bladder is filling continuously, A nervous reflex generates known as Micturitional Reflex that empties the bladder or atleast cause a desire of urination

## Micturitional Reflex



## DISORDERS OF URINARY SYSTEM

There can be various disorders related to Urinary System :

- Polycystic kidney Disease
- Urinary Tract Infection
- Nephrotic Syndrome
- Urinary Incontinence
- Kidney Stones

### Polycystic kidney Disease

- Enlargement of kidneys because of presence of many cyst within them.
- Polycystic kidney disease is an inherited disorder in which clusters of cyst develops over the kidney that cause enlargement of kidney & lose function over time

### Urinary Tract Infection

- Urinary Tract infections (UTI) are generally caused by harmful microorganism in Urinary Tract.
  - UTI are generally more common in females.
  - They usually occur in bladder or Urethra, but more serious infections involve the kidney
  - Bladder Infection leads to pain with urination, blood in the urine & increased urge to urinate.
  - A kidney infection may cause back pain, nausea, vomiting and fever :
  - Bacteria that lives in vaginal or anal area may enter the urethra & travel to bladder & can cause an infection.
  - It can be of two types :
- ① Upper UTI
  - ② Lower UTI

## Nephrotic Syndrome

- It is a type of renal failure occur due to increased glomerular permeability.
- Nephrotic syndrome is a kidney disorder that causes your body to pass too much protein in your urine.
- It generally occurs due to damage in blood vessels of kidney.

## Urinary Incontinence

- It is a common & embarrassing problem in which bladder control get lost.
- If this the urge of urination gets so strong that you can't control without discharge.

## Kidney Stones

- Kidney stones are hard deposits of mineral & salt that forms inside your kidney.
- They can be painful when passing through the urinary tract but usually don't cause permanent damage.
- It can be occur due to :
  - ① Drinking too little water
  - ② Obesity
  - ③ Weight loss surgery
  - ④ Eating food with too much salt or sugar