

# CHAPTER - 13

## URINARY SYSTEM

### Points to be covered in this topic

- ➔ 13.1 Introduction
- ➔ 13.2 Organ in the Urinary system
- ➔ 13.3 Physiology of Urine formulation
- ➔ 13.4 Renin-angiotensin system
- ➔ 13.5 Micturition
- ➔ 13.6 Composition of Urine
- ➔ 13.7 Disorder of Urinary system



# URINARY SYSTEM

## 13.1 INTRODUCTION

- The urinary system is one of the four excretory pathways of the body. The others are intestine, skin and lungs.
- It consists of two kidneys, which produce urine, two ureters which carry urine to the bladder, and the urethra which discharges urine from the bladder.
- Regulation of the concentration of substances excreted in the urine enables the body to control the concentration of substances in the blood, so as to maintain homeostasis of the body fluids.
- The branch of medicine that deals with male and female urinary systems called as urology. Urology is also called as renal system.

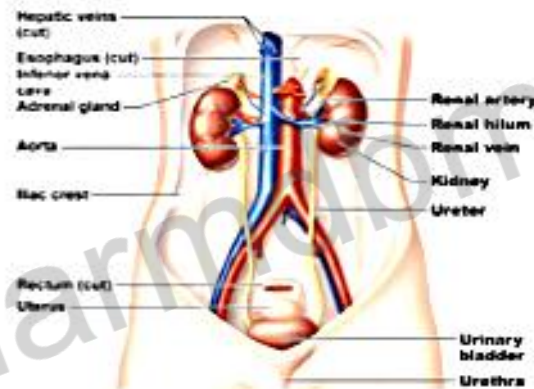


Fig.13.1: Structure of Urinary system

## 13.2. ORGAN IN THE URINARY SYSTEM

### ➤ KIDNEY

- Kidneys are two bean shaped excretory organs located on the posterior abdominal wall, one on each side of the lumbar part of the vertebral column.
- The left kidney is slightly at a higher level than the right kidney.

### ✓ Position of the kidneys

- The kidneys extend from the level of last thoracic vertebra to the third lumbar vertebra.

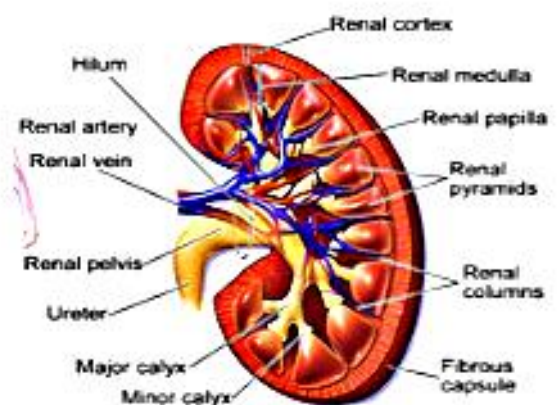


Fig.13.2: Anatomy of Kidney

Each kidney has two poles (upper and lower), two borders (medial and lateral) and two surfaces (anterior and posterior).

- Each kidney weighs about 130-150 gm.
- The lateral border of the kidney is convex. The medial border is concave.
- "Hilum" is situated on the medial border of the kidney.
- A suprarenal (adrenal) gland is situated at the apex of each kidney.

### ✓ Structure of kidney

- Kidney is surrounded by an outer fibrous capsule. Below this lies the substance of kidney which consists of:
  1. An outer "**Cortex**" which is reddish brown in colour.
  2. An inner "**Medulla**" which contains "**Renal pyramids**".
  3. An upper expanded end of ureter called "**Pelvis**".

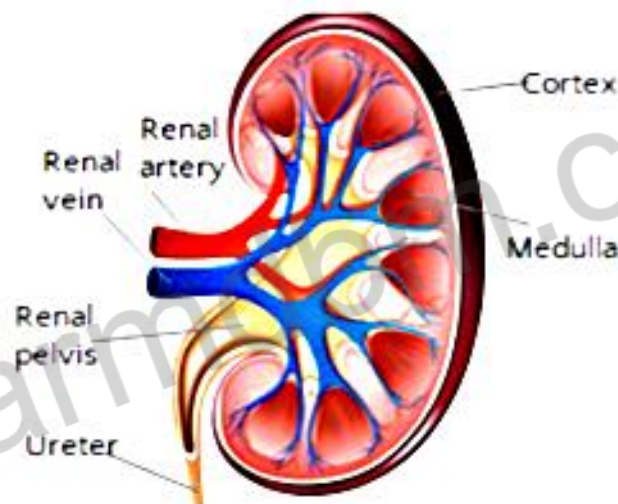


Fig .13.3: Structure of Kidney

### Nephron

- Nephron, functional unit of the kidney, the structure that actually produces urine in the process of removing waste and excess substances from the blood.
- There are about 1,000,000 nephrons in each human kidney. The most primitive nephrons are found in the kidneys (**Pronephros**) of primitive fish, amphibian larvae, and embryos of more advanced vertebrates.
- The nephrons found in the kidneys (**Mesonephros**) of amphibians and most fish, and in the late embryonic development of more advanced vertebrates, are only slightly more advanced in structure.
- The most advanced nephrons occur in the adult kidneys, or **Metanephros**, of land vertebrates, such as reptiles, birds, and mammals.

- Each nephron in the mammalian kidney is a long tubule, or extremely fine tube, about 30–55 mm (1.2–2.2 inches) long. At one end this tube is closed, expanded, and folded into a double-walled cuplike structure.
- This structure, called the renal corpuscular capsule, or Bowman's capsule, encloses a cluster of microscopic blood vessels—capillaries—called the glomerulus.
- The capsule and glomerulus together constitute the renal corpuscle.
- Blood flows into and away from the glomerulus through tiny arteries called arterioles, which reach and leave the glomerulus through the open end of the capsule. 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.
- As this filtrate passes through the tubule, its composition is altered by the secretion of certain substances into it and by the selective reabsorption of water and other constituents from it.
- The final product is urine, which is conveyed through the collecting tubules into the renal pelvis.

### ✓ Malpighian bodies

1. An expanded cup-shaped end called "Bowman's capsule".
2. A bunch of capillaries called "Glomerulus", which are present within the Bowman's capsule.

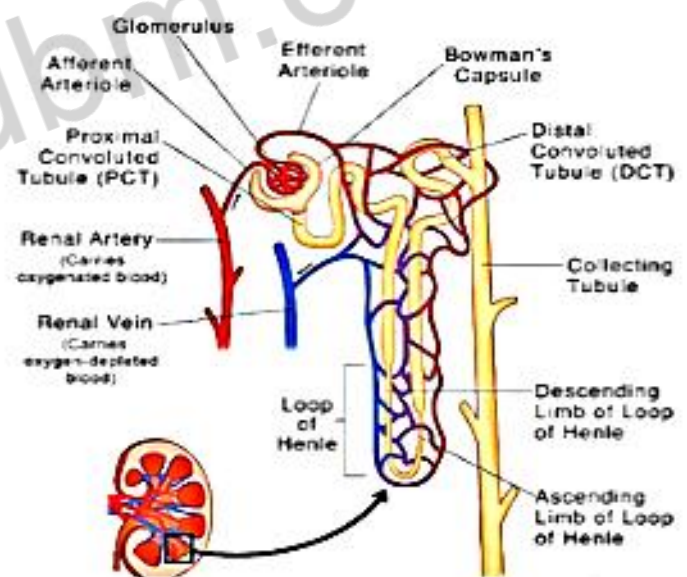


Fig .13.4: Structure of Nephron

### ✓ Renal tubules : They consist of 4 parts

<b>Proximal convoluted tubule</b>	Situated in the cortex
<b>Loop of Henle</b>	Present in the medulla
<b>Distal convoluted tubule</b>	Present in the cortex
<b>Collecting tubules</b>	Which pass through the medulla and open into the pelvis of the kidney.

### ✓ **Blood supply to kidney**

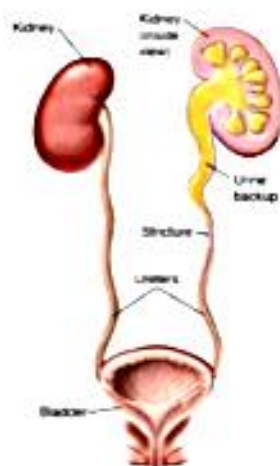
- Kidneys are supplied by renal arteries which are branches of abdominal aorta. Venous blood of kidney is drained by renal veins which open into inferior vena cava.

### ✓ **Functions of the kidney**

- The kidneys remove excess of water, excess salt, and waste materials of the body.
- They remove the waste products of protein metabolism like urea, phosphates, sulphates etc.
- They regulate osmotic pressure between the blood and tissues.
- They secrete hormones like renin and erythropoietin. Renin maintains blood pressure. Erythropoietin is necessary for RBC production.
- They regulate the pH of blood.
- They excrete harmful substances, drugs and toxins.

### ➤ **URETERS**

- They are two strong muscular ducts which carry urine from the kidney to the bladder.
- It is a tube-like structure measuring about 25 cm in length.
- It commences from the pelvis of the kidney. Later it passes down in the abdominal cavity and opens in the posterior aspect of the urinary bladder.
- Upper half of the ureters are present in the abdomen and the lower half is present in the pelvis



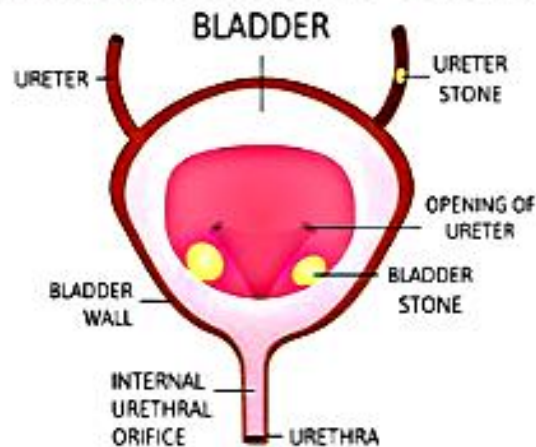
**Fig.13.5: Urinary bladder**

### ➤ **URINARY BLADDER**

- It is a pear shaped, hollow, muscular sac which acts as a reservoir for urine. It

lies in the pelvic cavity behind the "**Symphysis pubis**".

- The lowest part of the bladder is called as the "**Base**" and the upper part is called "**Fundus**".
- The normal capacity of the bladder at birth is **20-50 ml**; in **1-2 years**, it is about 200 ml and in adults it is about **500-600 ml**.



**Fig.13.6: Urinary bladder**

### ➤ **URETHRA**

- It is the urinary passage. The urine from the bladder enters the urethra and passes out. It differs in males and females.

#### ✓ **Male Urethra**

- It is about 20cm in length. It consists of three parts
  1. Pelvic part
  2. Perineal part
  3. Penile part

#### ✓ **Female urethra**

- It is short and measures about 4 cm in length. It starts from the base of bladder at the trigone. It opens externally in front of vaginal opening.

### **13.3 PHYSIOLOGY OF URINE FORMATION**

- The formation of urine by kidney involves three processes

#### **i. Glomerular filtration**

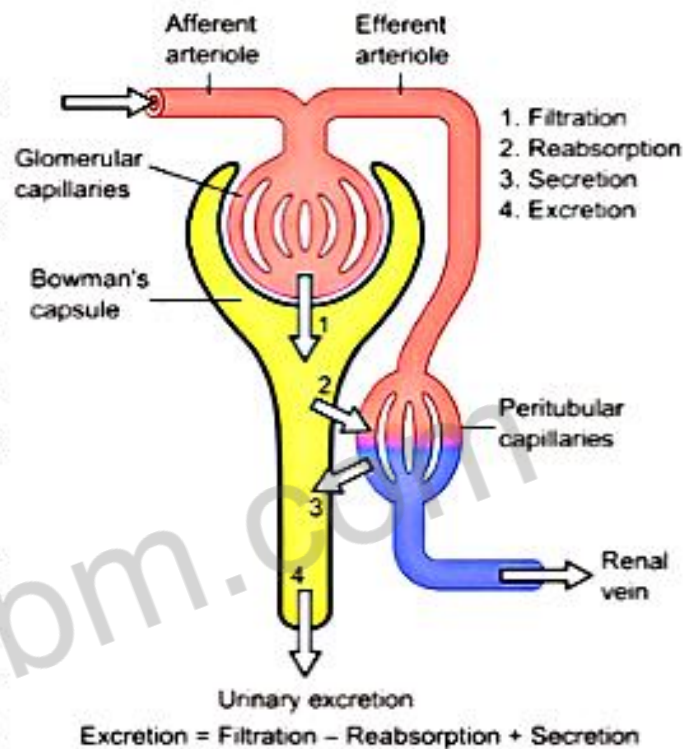
- Filtration of water, salts and other substances occur in the glomeruli.
- Glomerular filtrate is the fluid that is formed after filtration.
- About 100 ml of glomerular filtrate is formed per minute. This filtrate passes into the proximal convoluted tubule.

## ii. Tubular secretion

- It is an active process which occurs in the convoluted tubules.
- Abnormal substances or normal substances, present in excess in blood are eliminated by this process.
- Potassium, hydrogen ions, ammonium and drugs like penicillin's, sulphonamides and mercurial diuretics are excreted by tubular secretion.

## iii. Tubular reabsorption

- The rate of glomerular filtration is about 100 ml/minute. So about 6 litres of glomerular filtrate can be formed in one hour.
- But the volume of urine eliminated per day is only about 1.5 litres. It is so, because nearly 99% of the glomerular filtrate is reabsorbed.
- Reabsorption of water occurs in the convoluted tubules and collecting tubules. In addition to water, some salts are also reabsorbed in the renal tubules.
- Urine is the fluid that result from three processes, described above. It enters the collecting tubules and then enter into the minor calyces, major calyces and the pelvis of kidney.
- From there, it enters the urinary bladder through ureter. It finally passes out through the urethra.

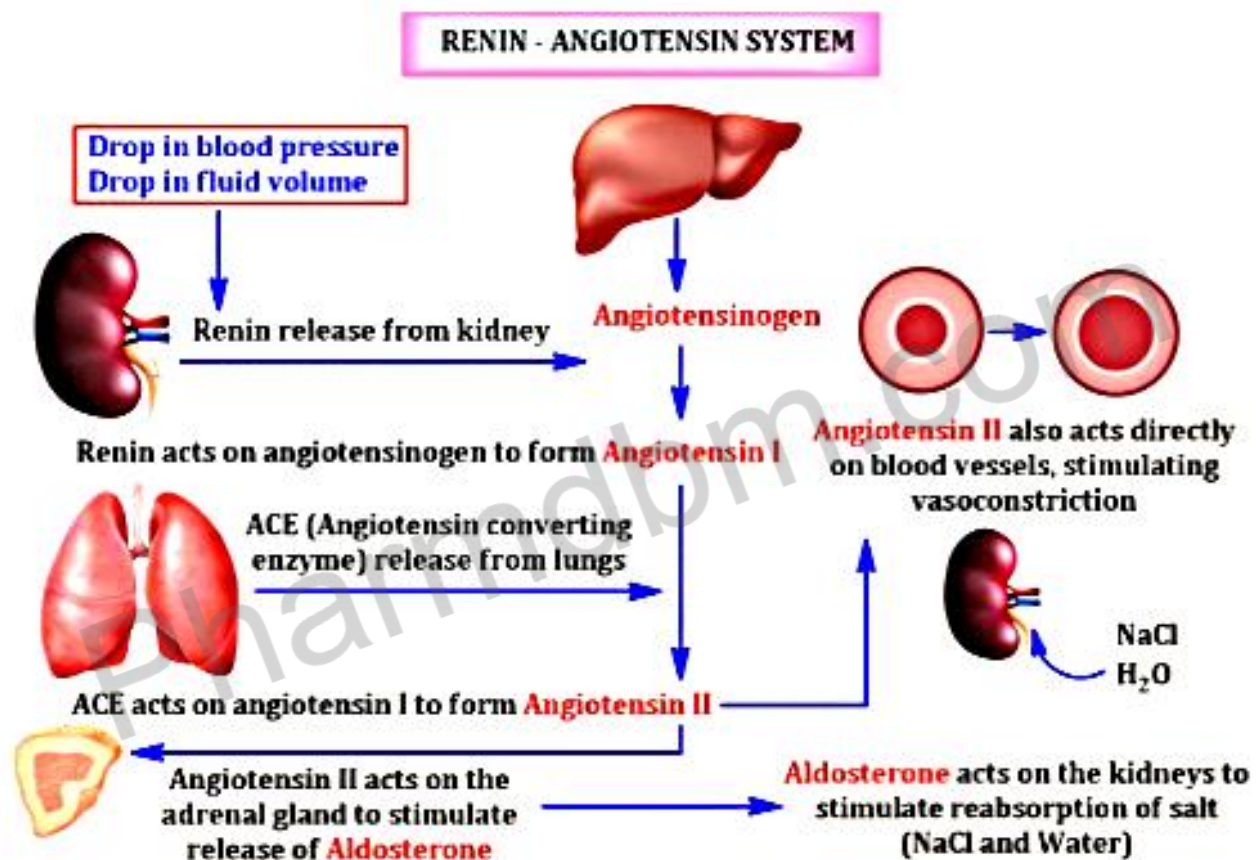


**Fig.13.7: Tubular reabsorption**

## 13.4 RENIN-ANGIOTENSIN SYSTEM

- Renin secretion occurs in response to decreased blood pressure, low extracellular fluid volume, low plasma sodium and sympathetic stimulation.

- Renin once present in blood acts on a specific plasma protein called angiotensinogen which is an alpha 2 globulin.
- Angiotensinogen converted to Angiotensin I, a decapeptide which further converted to Angiotensin II, an octapeptide by angiotensin converting enzyme (ACE) from lungs.
- Angiotensin II has actions of increased aldosterone secretion from adrenal cortex, vasoconstriction and increase in blood pressure, increased water intake and ADH secretion and regulation of glomerular filtration rate.



### 13.5 MICTURITION

- It is the act of passing urine. When urine accumulates in the bladder, it produces stretching of its walls.
- This raises the pressure within the bladder.
- This occurs when 170 to 230ml of urine has collected in the bladder.
- This in turn stimulates the afferent nerves of the bladder. The impulses are carried to higher centers which control micturition.
- Micturition occurs due to contraction of muscular coat of the bladder and relaxation of the sphincter.



### **13.6 COMPOSITION OF URINE**

- The volume of urine excreted in man varies from 1 to 2 liters daily. The colour of urine is pale amber, odour is aromatic and reaction is slightly acidic.
- Specific gravity varies from 1010 to 1025.
- Urine consists of **96% water, 2% urea and 2% uric acid and salts.**

### **13.7 DISEASES OF THE URINARY SYSTEM**

- ✓ **Glomerulo nephritis** :- An infection of kidney leading to inflammation of glomeruli
- ✓ **Pyelitis** :- An inflammation in pelvis of kidney due to infections
- ✓ **Polyurea** :- Secretion of large quantities of urine
- ✓ **Anuria** :- Cessation of urine secretion. Absence of formation of urine
- ✓ **Renal calculi** :- Deposition of insoluble substance in urinary tract
- ✓ **Cystitis** :- Inflammation of urinary bladder
- ✓ **Renal stones and hematuria** :- Stones form in the kidneys, ureter and urinary bladder when urinary constituents normally present as a solution are precipitated. The solutes involved are **oxalates, phosphates, urates and uric acid.**
- ✓ Renal stones produce severe pain. Renal stones may injure the kidney. As the result, blood may be passed along with urine. This is called **haematuria.**

#### ➤ **Hematuria may be due to**

- Renal stones**
- Injury of the kidneys**
- Inflammation of the bladder**