

## Lec 5

## Human Urinary System

The Urinary System is a group of organs in the body concerned with filtering out excess fluid and other substances from the bloodstream. The substances are filtered out from the body in the form of urine. Urine is a liquid produced by the kidneys, collected in the bladder and excreted through the urethra. Urine is used to extract excess minerals or vitamins as well as blood corpuscles from the body.

The Urinary organs include the kidneys, ureters, bladder, and urethra. The Urinary system works with the other systems of the body to help maintain homeostasis. The kidneys are the main organs of homeostasis because they maintain the acid base balance and the water salt balance of the blood.

About 1-2 litres of urine are produced every day in a healthy human, although this amount may vary according to circumstances such as fluid intake.

### **There are several functions of the Urinary System :**

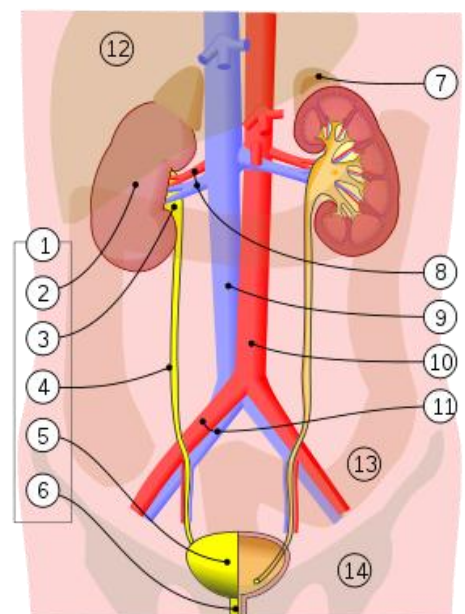
- Controlling blood volume and maintaining blood pressure
- Removal of waste product from the body (mainly urea and uric acid)
- Regulation of electrolyte balance (e.g. sodium, potassium and calcium)
- Regulation acid-base homeostasis

### **Human urinary system:**

2. Kidney, 3. Renal pelvis, 4. Ureter, 5. Urinary bladder, 6. Urethra. 7. Adrenal gland Vessels, 8. Renal artery and vein, 9. Inferior vena cava, 10. Abdominal aorta, 11. Common iliac artery and vein With transparency: 12. Liver, 13. Large intestine, 14. Pelvis

The order of impurities being excreted from the kidneys:

**Kidneys → Ureters → Urinary Bladder → Urethra**



- **KIDNEYS**

We have two bean shaped kidneys, one on each side of the spinal cord near the lower back, one behind the Stomach the other behind the Liver. Together they regulate the chemical composition of blood.

The Kidneys excrete the Nitrogenous Wastes, the excretion of Water is necessary to dissolve wastes and is closely regulated by the Kidneys, the Main Organ of the Urinary system. The kidneys are the main organs of the excretory system.

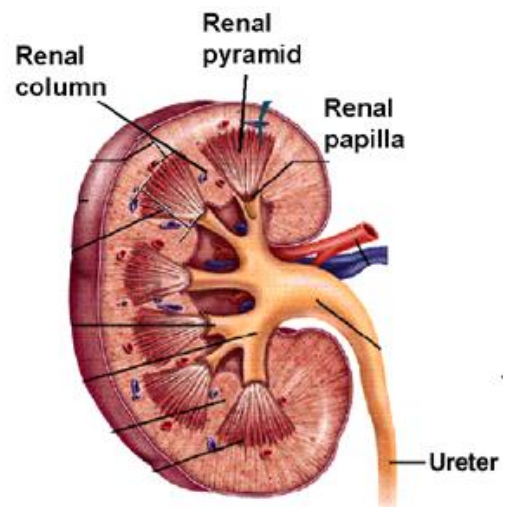
There are three major regions of the kidney, renal cortex, renal medulla and the renal pelvis. The outer, granulated layer is the renal cortex. The cortex stretches down in between a radially striated inner layer. The inner radially striated layer is the renal medulla. This contains pyramid shaped tissue called the renal pyramids, separated by renal columns. The ureters are continuous with the renal pelvis and is the very center of the kidney.

Two blood vessels enter and leave each kidney. The renal artery enters each kidney and the renal vein exits each kidney.

A third vessel, the ureter, leaves each Kidney carrying fluid to the urinary bladder.

Waste-filled blood enters the kidney through the renal artery. Excess water, Urea, and other waste products are removed from the blood and are collected in the ureter.

The most common metabolic waste is urea.  
The filtered blood exits through the renal vein.



- **KIDNEY STRUCTURE**

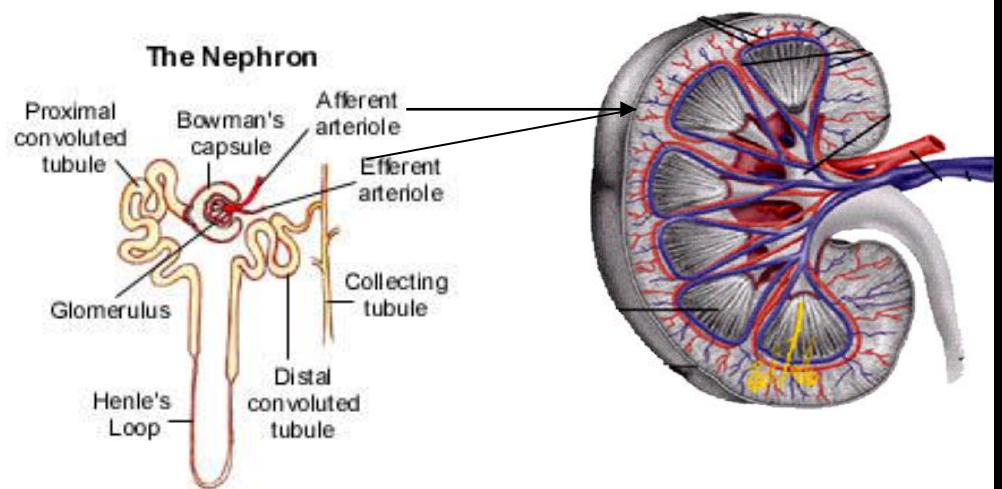
Each Kidney is a Bean-Shaped organ, about the size of a Fist.

The Kidney has THREE Regions; the Inner part called the renal medulla; the Outer part called the renal cortex and the renal pelvis, a Funnel Shaped Structure in the Center of the Kidney. The renal cortex contains the Nephrons.

- **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.

nephron eliminates wastes from the body, regulates blood volume and blood pressure, controls levels of electrolytes and metabolites, and regulates blood pH. Its functions are vital to life and are regulated by the endocrine system by hormones such as antidiuretic hormone, aldosterone, and parathyroid hormone. In humans, a normal kidney contains 800,000 to 1.5 million nephrons



In the first part of the nephron, the renal corpuscle blood is being filtrated from the circulatory system into the nephron. A pressure difference between forces the filtrate from the blood across the filtration membrane.

The filtrate includes water, small molecules and ions that easily pass through the filtration membrane. However larger molecules such as proteins and blood cells is prevented from passing through the filtration membrane.

The amount of filtrate produced every minute is called the glomerular filtration rate or GFR and amounts to a staggering 180 litres per day. About 99% of this filtrate is then reabsorbed as it passes through the nephron and the remaining 1% becomes urine.

Measuring the **glomerular filtration rate (GFR)** is a diagnostic test of kidney function. A decreased GFR may be a sign of renal failure. Conditions that can affect GFR include: arterial pressure, afferent arteriole constriction, efferent arteriole constriction, plasma protein concentration and colloid osmotic pressure.

As blood enters a Nephron through an Arteriole, impurities are filtered out and emptied into the collecting tubule. Purified blood leaves the nephron through a venule.

The process of Blood Purification involves Two Separate Processes:- **FILTRATION AND REABSORPTION.**

When blood enters a Nephron, it flows into a network of 50 Capillaries known as a GLOMERULUS

- **GLOMERULUS**

The Glomerulus is encased in the upper end of the nephron by a cup-shaped structure called BOWMAN'S CAPSULE.

Bowmans Capsule is a blind sac at the beginning of a the tubular component of a nephron in the mammalian kidney. A glomerulus is enclosed in the sac. Fluids from blood in the glomerulus are collected in the Bowman's capsule and further processed along the nephron to form urine.

The blood is under pressure and the walls of the capillaries and Bowman's Capsule are permeable, much of the fluid from the blood filters into Bowman's Capsule and the material filtered from the blood flows through the renal tubule, a long tube with permeable walls.

Materials from the blood are forced out of the glomerulus and into the bowmen's capsule during a process called **FILTRATION**. The materials that are filtered from the blood are known as FILTRATES



**Bowmans Capsule**

The filtrate contains water, urea, glucose, salts, amino acids, and vitamins. plasma proteins, cells and platelets are too large to pass through the membrane; they remain in the blood.

## **REABSORPTION**

Approx. 180 liters of filtrate pass from the blood into the collecting tubules each day. Not all of this is excreted. Most of the materials removed from the blood at Bowman's Capsule makes its way back into the blood by a process known as **REABSORPTION**. Approximately 99 percent of the water that is filtered into the Bowman's capsule is reabsorbed into the blood. Glucose and minerals are returned to the blood by active transport .

some substances pass from the blood into the filtrate through a process called secretion. These substances include wastes and toxic materials .

Urine from the collecting ducts flows through the renal pelvis and into the ureter.

A Ureter leads from each kidney to the URINARY BLADDER. Urine is collected in the Urinary Bladder and stored until it can be released through the URETHRA . Purified blood is returned to the Circulatory system through the renal vein.

- **CONTROL OF KIDNEY FUNCTION**

The main proposes of our Kidneys is to maintain the chemical composition of our blood. The kidneys are the master chemist of our blood supply.

Two Important Things Controlled by the Kidneys are; **CONCENTRATION OF WATER IN BLOOD; AND THE LEVEL OF SALT IN OUR BLOOD.**

- filter blood plasma, separate wastes, return useful materials to the blood, and eliminate the wastes
- regulate blood volume and osmolarity
- regulate acid-base balance of the body fluids.
- detoxify superoxides, free radicals, and drugs.

Drink too much liquid, and the Kidneys will decrease the rate of reabsorption, excess water is sent to the urinary bladder to be excreted. Eat salty foods and the kidneys will respond by returning less salt to the blood by reabsorption. The excess is excreted in our urine. The kidneys ensure that the composition of our blood remains constant.

- **Ureters**

The ureters are a pair of tubes that carry urine from the kidneys to the urinary bladder. The ureters are about 10 to 12 inches long and run on the left and right sides of the body parallel to the vertebral column. Gravity and peristalsis of smooth muscle tissue in the walls of the ureters move urine toward the urinary bladder. The ends of the ureters extend slightly into the urinary bladder and are sealed at the point of entry to the bladder by the ureterovesical valves. These valves prevent urine from flowing back towards the kidneys.

- **Urinary Bladder**

The urinary bladder is a sac-like hollow organ used for the storage of urine. The urinary bladder is located along the body's midline at the inferior end of the pelvis. Urine entering the urinary bladder from the ureters slowly fills the hollow space of the bladder and stretches its elastic walls. The walls of the bladder allow it to stretch to hold anywhere from 600 to 800 milliliters of urine.



- **Urethra**

The urethra is the tube through which urine passes from the bladder to the exterior of the body. The female urethra is around 2 inches long and ends inferior to the clitoris and superior to the vaginal opening. In males, the urethra is around 8 to 10 inches long and ends at the tip of the penis. The urethra is also an organ of the male reproductive system as it carries sperm out of the body through the penis.

- **Urea**

**Urea** is a nitrogenous product made by the liver. Nitrogenous wastes are initially brought to the Liver as Ammonia, a chemical compound of nitrogen so toxic that it could not remain in the body without harming cells.

The liver removes Ammonia from the blood and converts it to the less harmful substance urea. The urea enters the bloodstream and is then removed by the kidneys

### **Urine formation**

Average urine production in adult humans is about 1 – 2 L per day, depending on state of hydration, activity level, environmental factors, weight, and the individual's health. Producing too much or too little urine needs medical attention. Polyuria is a condition of excessive production of urine ( $> 2.5$  L/day),

The first step in urine formation is the filtration of blood in the kidneys. In a healthy human the kidney receives between 12 and 30% of cardiac output, but it averages about 20% or about 1.25 L/min.

### **Urine movement**

Urine moves from the nephrons collecting duct system to the minor calyx and then the major calyx before entering the renal pelvis, a funnel-like dilated proximal part of the ureter within the kidney.

The major function of the renal pelvis is to act as a funnel for urine flowing to the ureter. From here the urine flows through the ureters to the bladder, where it is stored until urination takes place out of Urethra.