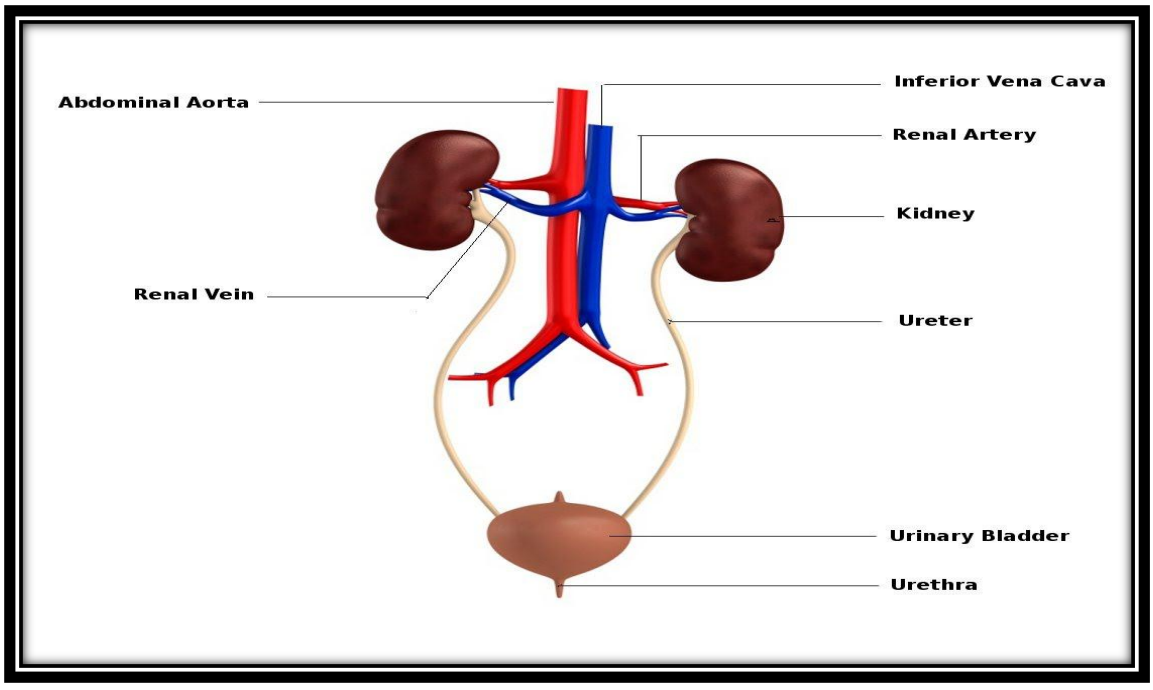
Urinary System

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:

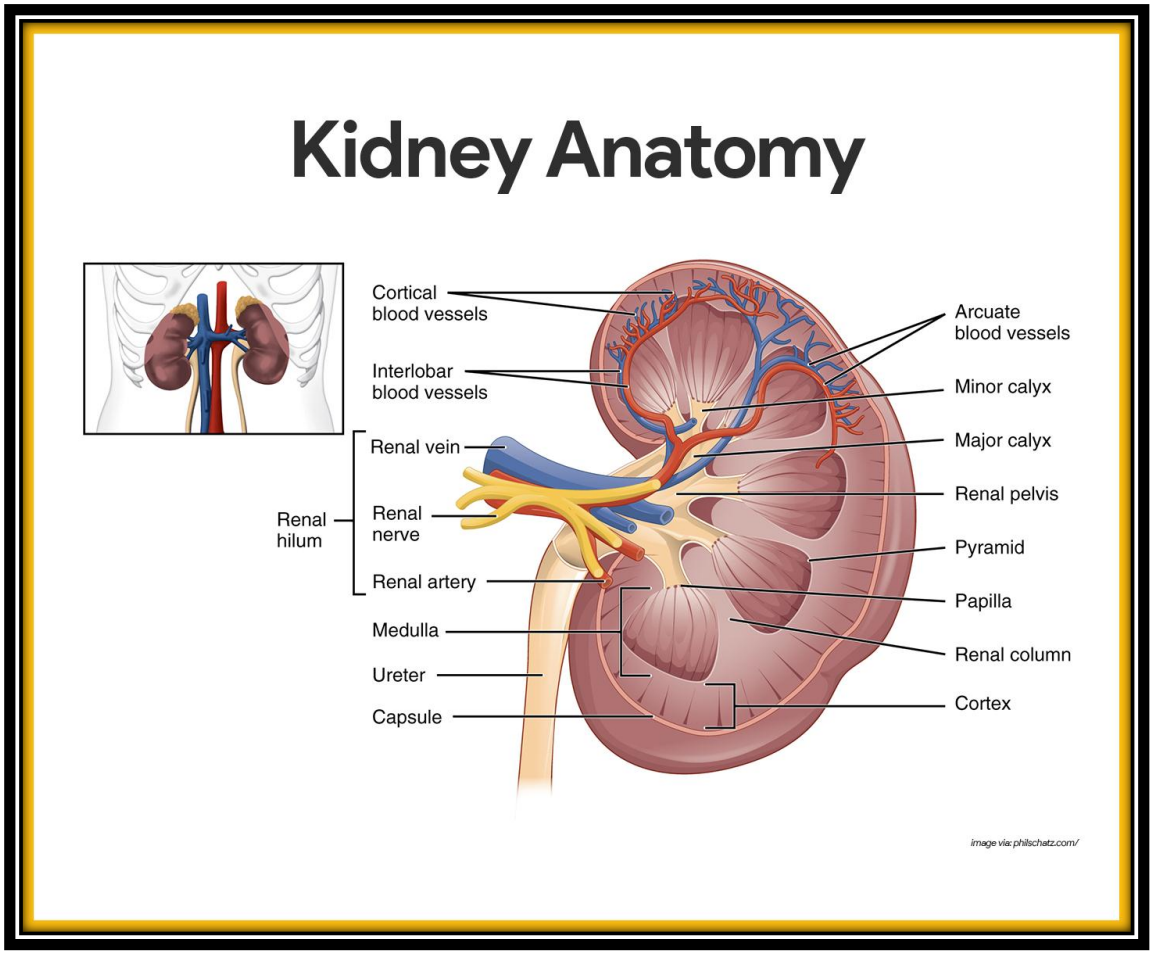
1. Kidneys.
2. Ureters.
3. Bladder.
4. Urethra.

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.



The Kidney

Kidney is a compound tubular gland covered by a connective tissue capsule. There is a depression on the medial border of kidney called hilum, through which renal artery, renal veins, nerves and ureter pass.



Kidneys perform several vital functions besides formation of urine. By excreting urine, kidneys play the principal role in homeostasis. Thus, the functions of kidneys are:

1. Role of homeostasis

The primary function of kidneys is homeostasis. It is accomplished by the formation of urine. During the formation of urine, kidneys regulate various activities in the body, which are concerned with homeostasis such as:

i. Excretion of Waste Products.

Kidneys activities: excrete the unwanted waste products which are formed during metabolic

a. Urea -end product of amino acid metabolism.

b. Uric acid- end product of nucleic acid metabolism.

c. Creatinine- end product of metabolism in muscles.

d. Bilirubin- end product of hemoglobin degradation.

e. Products of metabolism of other substances

f. Harmful foreign chemical substances like toxins, drugs, heavy metals, etc.

ii. Maintenance of Water Balance

Kidneys maintain the water balance in the body by conserving water when it is decreased and excreting water when it is excess in the body

iii. Maintenance of Electrolyte Balance

Maintenance of electrolyte balance, especially sodium is in relation to water balance. Kidneys retain sodium if the osmolarity of body water decreases and eliminate sodium when osmolarity increases

iv. Maintenance of Acid-Base Balance

The kidneys contribute to acid-base regulation, along with the lungs and body fluid buffers, by excreting acids and by regulating the body fluid buffer stores. The kidneys are the only means of eliminating from the body certain types of acids, such as sulfuric acid and phosphoric acid, generated by the metabolism of proteins.

2. Hemopoietic function:

Kidneys stimulate the production of erythrocytes by secreting erythropoietin, which stimulates the production of red blood cells by hematopoietic stem cells in the bone marrow. Erythropoietin is the important stimulating factor for erythropoiesis. Kidney also secretes another factor called thrombopoietin, which stimulates the production of thrombocytes.

3. Endocrine function:

Kidneys secrete many hormonal substances in addition to erythropoietin and thrombopoietin. The hormones secreted by kidneys are:

a. Erythropoietin
b. Thrombopoietin
c. Renin
d. 1, 25-dihydroxycholecalciferol (calcitriol)
e. Prostaglandins

4. Regulation of blood pressure

Kidneys play an important role in long-term regulation of arterial blood pressure by excreting variable amounts of sodium and water. The kidneys also contribute to short- term arterial pressure regulation by secreting hormones and vasoactive factors.

5. Regulation of blood calcium level

Kidneys play a role in the regulation of blood calcium level by producing the active form of vitamin D,1,25-dihydroxyvitamin D3 (calcitriol), by hydroxylating this vitamin. Calcitriol is essential for normal calcium deposition in bone and for calcium reabsorption by the gastrointestinal tract.

6. Glucose Synthesis (gluconeogenesis)

The kidneys synthesize glucose from amino acids and other precursors during prolonged fasting, a process referred to as gluconeogenesis. The kidneys' capacity to add glucose to the blood during prolonged periods of fasting rivals that of the liver.

The components of kidney are arranged in three layers:

1. Outer cortex

2. Inner medulla

3. Renal sinus.

1. Outer Cortex

Cortex is dark and granular in appearance. It contains renal corpuscles and convoluted tubules. At intervals, cortical tissue penetrates medulla in the form of columns, which are called renal columns or columns of Bertini

2. Inner Medulla

Medulla contains tubular and vascular structures arranged in parallel radial lines. It is divided into 8 to 18 medullary or Malpighian pyramids

3. Renal Sinus

Renal sinus consists of the following structures

a. Renal pelvis: Upper expanded part of ureter.
b. Subdivisions of pelvis-major calyces and minor calyces
c. Branches of nerves, arteries and veins.
d. Loose connective tissues and fat.

Parenchyma of kidney

It is made up of tubular structures called *uriniferous tubules*, which are of two types

1. Terminal or secretary tubules called nephrons,

Which are concerned with formation of urine

2. Collecting ducts or tubules

Which are concerned with transport of urine from nephrons to pelvis of ureter. The collecting ducts unite to form ducts of Belini, which open into minor calyces through papilla.

Nephron and Juxtaglomerular Apparatus

Nephron is defined as the structural and functional unit of kidney. Each kidney consists of 1 to 1.3 million of nephrons. The kidney cannot regenerate new nephrons. Therefore, with renal injury, disease, or normal aging, the number of

nephrons gradually decreases. After age 40 years, the number of functioning nephrons usually decreases about 10 percent every 10 years

Each nephron is formed by two parts:

1. A blind end called renal corpuscle or Malpighian corpuscle

2. A tubular portion called renal tubule.

Renal corpuscle

The renal corpuscle is also known as Malpighian corpuscle. It is a spheroidal and slightly flattened structure with a diameter of about 200 . The function of the renal corpuscle is the filtration of blood which the first phase of urine formation. Renal corpuscle is situated in the cortex of the kidney either near the periphery or near the medulla. Based on the situation of renal corpuscle, the nephrons are classified into two types:

1. Cortical nephrons or superficial nephrons

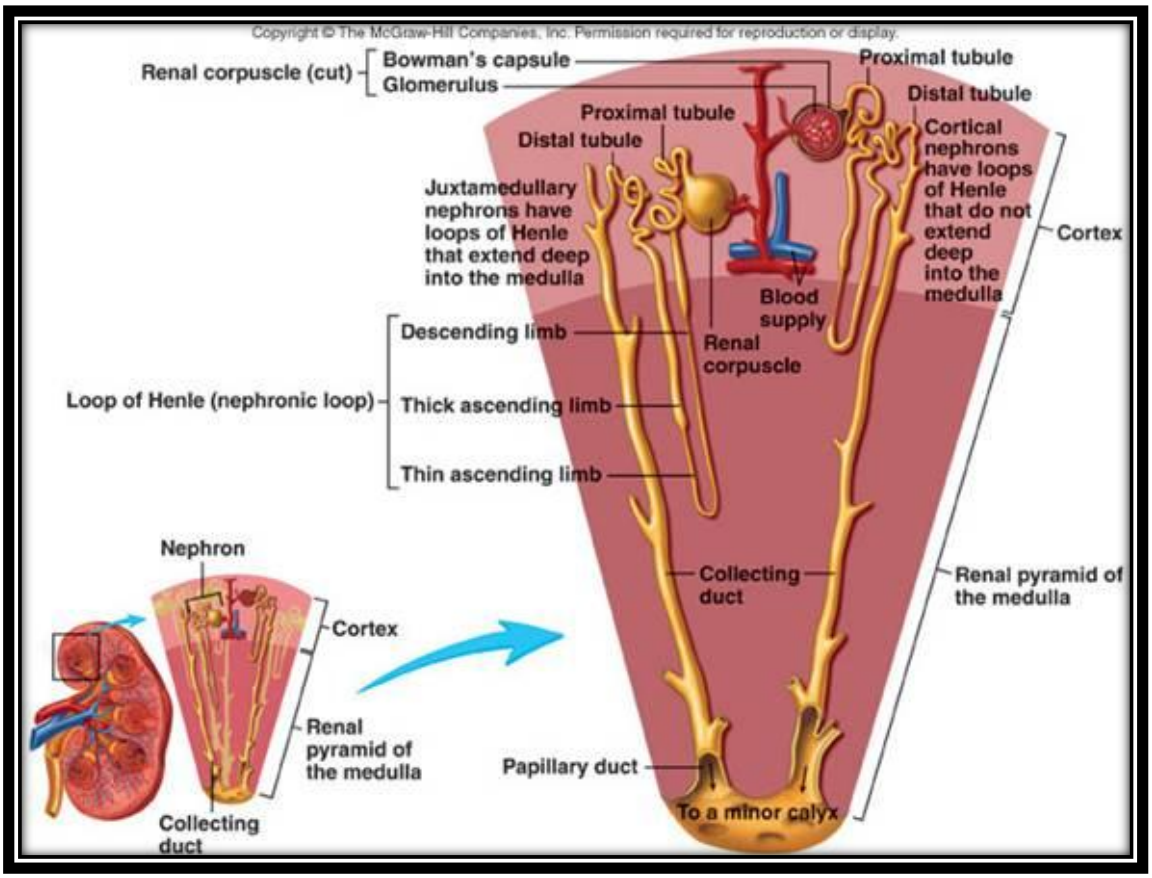
2. Juxtamedullary nephrons.

1. Cortical Nephrons

Cortical nephrons are the nephrons, which have their corpuscles in the outer cortex of the kidney near the periphery. In human kidneys 85 % nephrons are cortical nephrons.

2. Juxtamedullary Nephrons

Juxtamedullary nephrons are the nephrons which have their corpuscles in the inner cortex near medulla or corticomedullary junction.



Features of two types of nephron Features

Features	Cortical nephron	Juxtamedullary nephrons
Situation of renal corpuscle	Outer cortex near the periphery	Inner cortex near medulla
Loop of Henle	Short	Long
Function	Formation of urine	Mainly the concentration of urine and formation of urine