

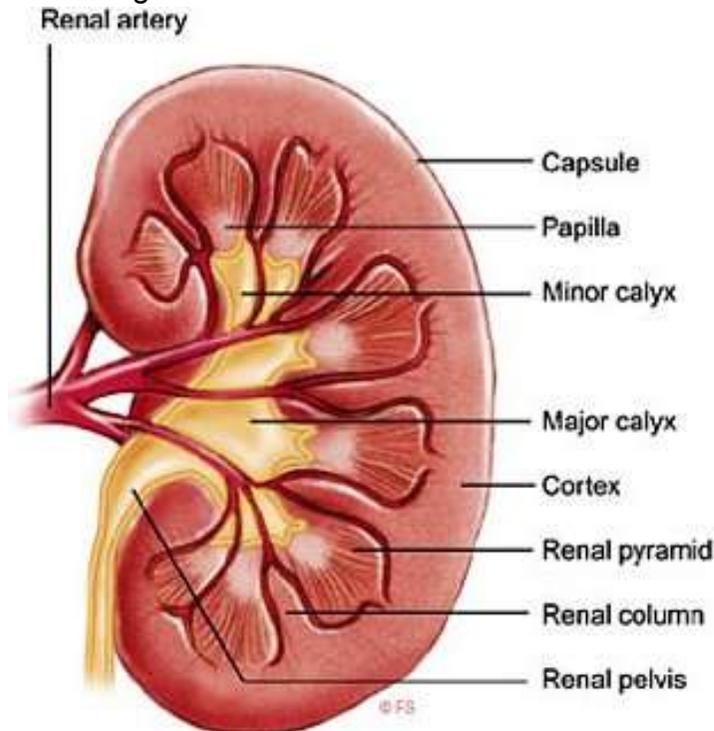
The Urinary System

The Urinary System consists of:

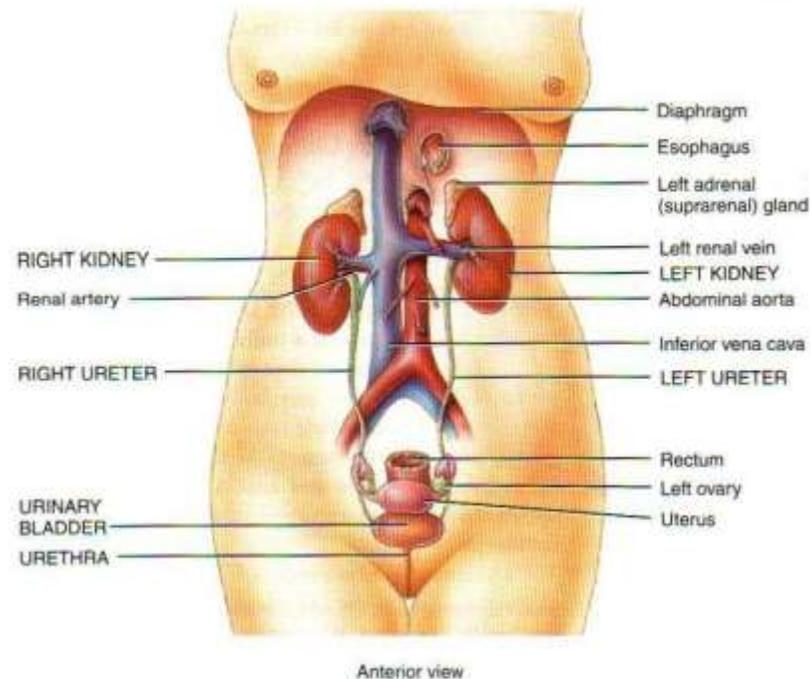
- 2 kidneys
- 2 ureters
- 1 bladder
- 1 urethra

Figure 1 - Anatomy of Urinary System

The primary function of the urinary system is to help maintain homeostasis by controlling the volume and composition of the blood. The kidney is essentially a high-pressure filtration system, reabsorbing what the body needs to keep, and eliminating the rest. The eliminated materials are



Organs of the female urinary system in relation to the surrounding structures



Functions of the Urinary System

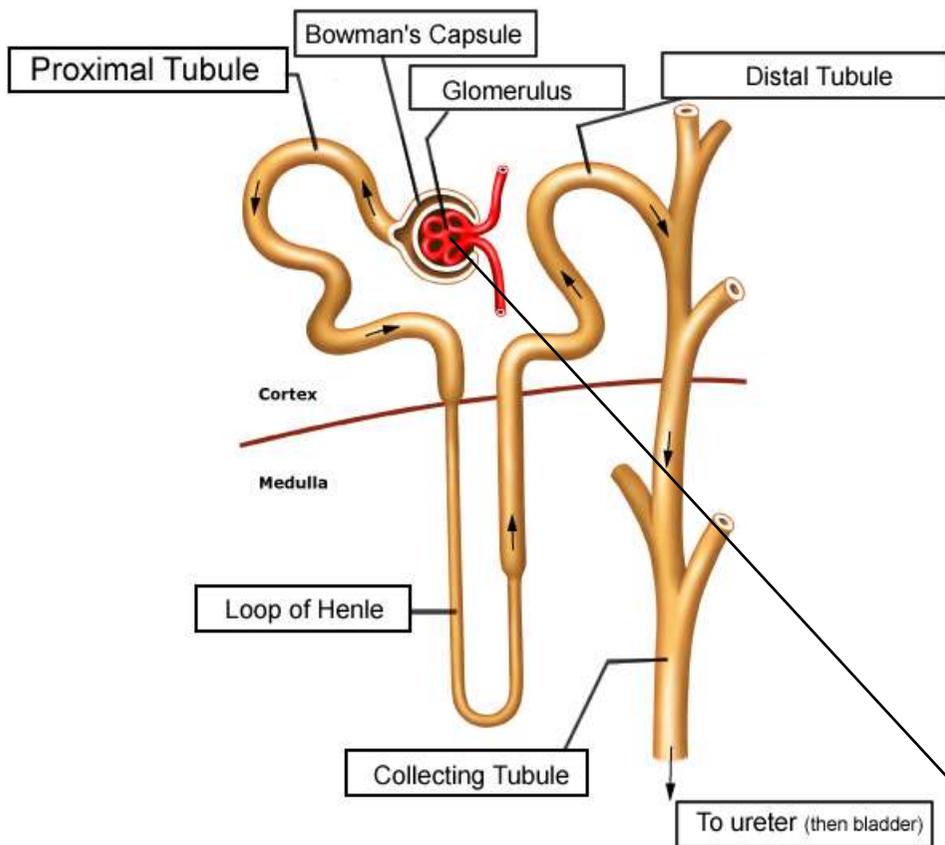
1. The kidneys regulate blood volume and composition, help regulate blood pressure and pH, produce two hormones, and excrete wastes.
2. The ureters transport urine from the kidneys to the urinary bladder.
3. The urinary bladder stores urine and expels it into the urethra.
4. The urethra discharges urine from the body.

collectively called urine –urine consists of water, solutes, toxic wastes (ammonia, urea etc.)

Figure 2 - Kidney Structure

The kidneys are located behind the abdominal peritoneum (retroperitoneal), extending from the 12th thoracic vertebra to the 3rd lumbar vertebra. The right kidney is a little lower than the left, owing to the position (and size) of the liver above it. They are bean shaped glands with the concave border towards the vertebrae. Near the centre of the concave portion are ducts, one from each kidney, called ureters.

The ureters connect the kidneys with the bladder. They are between 10 –12 inches long and carry the urine from the kidneys to the bladder for storage for excretion. The bladder is situated in the pelvic cavity, behind the pubic bones. It is a hollow muscular organ, which serves as a reservoir for urine.



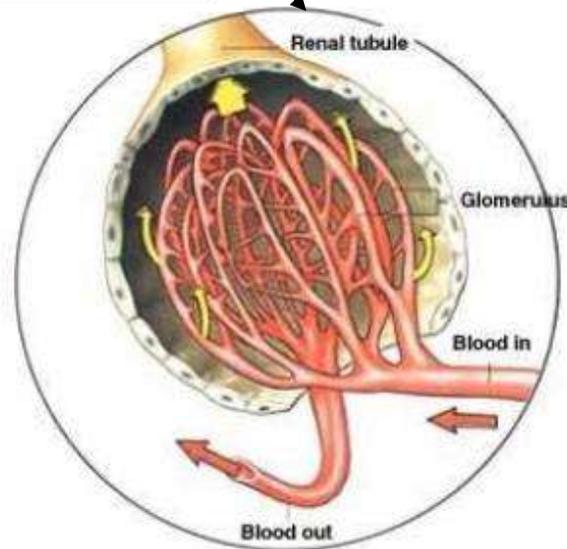
The functional unit of the kidney is the **nephron** (Fig. 230), and each kidney has between 1.0 – 1.5 million nephrons. Each nephron consists of:

- **Glomerulus**
- **Bowman's capsule**
- **Reabsorption tubule** (with a proximal convoluted tubule, a loop of Henle, a distal convoluted tubule)
- **Collecting duct**

Figure 3 - The Nephron

The glomerulus, at the beginning of the nephron, is a knot of capillaries with an afferent arteriole and an efferent arteriole. The pressure in the afferent arteriole is higher than that in the efferent arteriole; hence it is a high-pressure filtration system as fluid is forced out. The glomerulus is surrounded by the Bowman's capsule and substances such as water, salts, glucose urea etc., are pushed through the semi-permeable walls of the capillaries into the Bowman's capsule; from here it passes into the reabsorption tubule. Blood cells and proteins are too large to pass through.

Figure 4 - The Glomerulus



Reabsorption in the tubules is an active process, with the tubules being lined by cuboidal epithelium,. Substances absorbed in the tubule are:

- sodium chloride
- bicarbonate
- glucose
- potassium
- amino acids

The rate of absorption has a capacity -(a maximum it can reabsorb in any unit time); this capacity is the renal threshold. An example of this is glucose. All the glucose is normally reabsorbed, but if there is an excess of glucose in the blood, as in diabetes mellitus, the reabsorption process can work at capacity but still not be able to reabsorb all the glucose.

This results in the presence of glucose in the urine.

Water reabsorption by the tubule is partly controlled by the **antidiuretic hormone (ADH)**, which works on the collecting duct. If the osmotic pressure (i.e. its concentration) of the blood rises, as in dehydration, ADH is released and more water is reabsorbed by the tubule. If the osmotic pressure falls (i.e. it is more dilute), the amount of ADH released into the blood is reduced and more dilute urine is produced.

The end product, urine, passes into the collecting duct and onto the renal pelvis. From here it drains into the ureter and is carried by gravity and peristalsis to the bladder. The bladder is elastic, muscular sac, which dilates as it fills with urine.

The volume of urine produced daily is between 1-2 litres, but depends on:

- Blood pressure – the filtration rate in the glomerulus depends on the blood pressure.
- Blood concentration – i.e. from fluid intake; drugs (alcohol)
- Temperature – high temperatures cause the body to sweat more, so there is less bodily fluid and the kidneys will reabsorb more and there will be less urine produced.
- Mental state – stress can increase blood pressure and therefore the filtration rate.

Disorders of the Urinary System

Nephritis – Inflammation of the kidney. There are various types:

- **Pyelonephritis** – this is an inflammation of the whole kidney
- **Pyelitis** – inflammation of the renal pelvis and calyces (the area collecting the urine before it passes into the ureter); if this is chronic it can cause scarring and impede flow
- **Glomerulonephritis** – this is inflammation of the glomeruli. It can be caused by an allergic reaction to toxins of a Streptococcal infection of elsewhere (e.g. the throat). The glomeruli become so inflamed, swollen and engorged with blood it upsets the membranes and allows blood cells and proteins to enter the filtrate, causing haematuria and proteinuria. The glomeruli can also become damaged, leading to renal failure.

Cystitis – Inflammation of the urinary bladder. Bacterial infection, chemicals or mechanical injury can cause it. It causes burning or painful micturition, with urgency, frequency and low back pain. It is more frequent in females because of the shorter, wider, urethra.

Urinary Tract Infection – Infection of part of the urinary system. Bacteria are found in urine (normally sterile) and can cause urethritis, cystitis or pyelonephritis. It manifests as painful micturition, urgency, frequency and low back pain. More frequent in males.



Pyuria (pus in urine from infection)



Renal Failure – Essentially, when the kidney stops working and is defined as no urine production for 24 hours

- Acute – results from low blood volume, decreased cardiac output or damage.
- Chronic – progressive decrease in function; usually irreversible and caused by inflammation or trauma.

Kidney Stones (renal calculi)

Insoluble stones forming from solidification of crystals of urine salts (uric acid, calcium oxalate and calcium carbonate). They can cause severe pain, especially when one is passing down the ureter.

