**13. The Urinary system**

The urinary system filters blood and produces urine. It consists of the kidneys, ureters, bladder and urethra.

The urinary system is one of the human body's waste disposal units and its filtration unit. Composed of the kidneys, ureters (tubes connecting kidneys to the bladder), bladder and urethra, this system helps to empty the body of potentially harmful waste substances, like urea and alcohol. It does so through filtration and excretion.

**TOPIC 1: STRUCTURE**

**WHAT IS A KIDNEY?**

A kidney is a bean-shaped organ, about 11cm long. Humans have two of them, positioned on the posterior wall of the abdomen, either side of the spine, in the upper lumbar part of the back. On its way through the body about a quarter of the total blood in circulation passes through the kidneys in order to be filtered of toxic substances before re-circulating.

**Structure**: a kidney's structure has two distinct parts - the cortex on the outside and the medulla on the inside. The medulla leads into an area called the pelvis (sometimes called the renal pelvis). The concave centre of the kidney is known as the hilum and it is at this point that blood vessels, lymphatic vessels, nerves and the ureter enter the organ. Kidney tissue is made up of over a million twisted tubes called nephrons, which do the kidneys' work of filtration and excretion.

**Functions:** to filter the blood, reabsorb useful materials needed by the body and form urine.

**WHAT IS THE RENAL PELVIS?**

**Structure:** the renal pelvis is a funnel-shaped cavity which connects the medulla to the ureter.

**Function:** it collects urine from the tubules in the medulla and passes it into the ureter.

**WHAT ARE URETERS?**

The tubes which connect the kidneys to the bladder.

**Function:** to take urine from the kidneys to the bladder. The presence of urine inside them stimulates a mechanical contraction which propels the fluid forwards.

**WHAT IS THE BLADDER?**

**Structure:** sometimes called the urinary bladder this is a sac-like organ in the pelvic cavity.

**Function:** a reservoir for urine. When about 200ml of urine has been collected the presence of the liquid stimulates the autonomic nerve endings in the bladder wall and the walls contract. The bladder has an internal sphincter which relaxes when the walls contract, thus opening and emptying the urine into the urethra.

**WHAT IS THE URETHRA?**

**Structure:** a narrow tube passing from the bladder to the outside of the body.

It has an external sphincter which is voluntarily controlled by the central nervous system. It is shorter in women, thus making them more susceptible to infection.

**Function:** to take urine from inside the body (the bladder) to outside. In men, the urethra is also the passage for semen.

**TOPIC 2: FUNCTIONS**

The three stages of filtration and urine production

**1. Filtration in the Bowman's capsule**

Blood enters the kidneys via the afferent arterioles. These tiny blood vessels become the glomerulus, a tangle of capillaries surrounded by the glomerular capsule, also known as the Bowman's capsule. The blood in the capillaries is under pressure and since the capillary walls are permeable to water and other substances these pass through into the capsule, whilst blood cells and protein remain in the blood vessel. The Bowman's capsule thus serves as the collection point for the waste products carried in the blood. However, at this point the capsule has also collected other substances which are not waste and these will be reabsorbed as they pass through the nephron.

**2. Re-absorption in the convoluted tubules**

Once the filtered substances have been collected by the capsule they are passed into a system of twisted tubes, known as convoluted tubules. The tubes of the nephron which lead away from the Bowman's capsule are known as the proximal convoluted tubules. These straighten out into a long loop, called the Loop of Henle, which passes into the medulla and back to the cortex. Finally, there is another series of twists called the distal convoluted tubules. Reabsorption takes place in the tubules. Cells in the lining of the tubules are able to absorb any water, glucose, salts and ions which the body needs that must not be disposed of as waste. Only 1% of the liquid filtered into the Bowman's capsule is actually excreted as urine. The rest is re-absorbed.

**3. Collection in the pelvic calyces**

The nephron straightens out into a collecting tube in the medulla. These collecting tubes form masses called pyramids of the medulla, the tops of which stick up into the renal pelvis. The branches of the pelvis, or calyces, connect with the tops of these pyramids and collect the waste liquid, funneling it back into the pelvis, from where it will empty into the ureter.

**WHAT IS EXCRETED: COMPOSITION OF URINE**

The liquid that results from the processes of filtration and reabsorption is known as urine. This amber-coloured liquid is composed of 96% water, 2% urea, and 2% other substances, such as ammonia, sodium, potassium, phosphates, chlorides, sulphates and excess vitamins. The salts must be excreted in order to maintain the correct balance of fluids and electrolytes in the body. The colour of urine comes from bilirubin, a bile pigment. Normal urine is acidic, but this varies depending on diet and other factors.

**URINE PRODUCTION**

About 1.5 litres of urine is produced every 24 hours, which is only a small percentage compared to the amount of liquid filtered from the blood in the glomerulus. Urine production is increased by liquid intake and cold weather and decreased by drinking less and any activity or state that increases sweating (hot weather, exercise). Humans need a minimum of 0.5 litres of water per day for waste removal.

**TOPIC 3: DISEASES AND DISORDERS**

**CYSTITIS**

Inflammation of the bladder, causing pain when urinating. Sometimes caused by infections. Very common in women due in part to the shorter length of the female urethra.

**KIDNEY STONES**

Deposits of substances found in urine which form solid stones within the renal pelvis, bladder or ureters. Extremely painful and often removed by surgery.

**NEPHRITIS OR BRIGHT'S DISEASE**

Inflammation of the kidney, resulting from causes other than infection. Often used to refer to a wide range of different inflammatory disorders.

**DIABETES INSIPIDUS**

Impaired ADH production by the pituitary gland, or response to it by the kidneys. Causes excessive urine production so toxins in the body become too concentrated.

**GLOMERULONEPHRITIS**

A type of glomerular kidney disease in which the kidneys' filters become inflamed and scarred, and slowly lose their ability to remove wastes and excess fluid from the blood to make urine.

**PYELONEPHRITIS**

Inflammation of the kidney and its pelvis caused by bacterial infection.

**URINARY TRACT INFECTIONS**

Is a bacterial infection that affects any part of the urinary tract.

**URETHRITIS**

Inflammation of the urethra; results in painful urination.

**DYSURIA**

Painful or difficult urination, most frequently caused by infection or inflammation.

**ENURESIS**

An inability to control the flow of urine and involuntary urination. This can also be known as bed wetting.

**INCONTINENCE**

An involuntary urination or defecation.

**NEPHROBLASTOMA**

A tumour of the kidneys that typically occurs in children.

**RENAL FAILURE**

An inability of the kidneys to excrete waste resulting in a situation in which the kidneys fail to function adequately.

**RENAL COLIC**

Is a type of pain commonly caused by the obstruction to the flow of urine, often caused by kidney stones.

**URAEMIA**

An accumulation in the blood of nitrogenous waste products (urea) that are usually excreted in the urine.

**INTERRELATIONSHIPS**

Urinary system links to:

**Circulatory:** the kidneys purify all the blood in the body. Endocrine: the kidneys produce the enzyme renin which helps to regulate, blood pressure as part of a system involving hormones.

**Skeletal:** the kidneys help to stimulate the production of bone marrow in the long bones.

**Skin:** the urinary system removes waste by excretion and therefore links to the other excretory system - the skin.

**Summary**

The urinary system

* Filters blood of potentially harmful substances
* Produces urine through the processes of filtration and re-absorption
* Excretes waste (urine).