**Topic 11.3 – The kidney**

***11.3.1 Define excretion.***

Excretion is the removal from the body of the waste products of metabolic pathways.

***11.3.2 Draw and label a diagram of the kidney.***

Include the cortex, medulla, pelvis, ureter and renal blood vessels.

***11.3.3 Annotate a diagram of a glomerulus and associated nephron to show the function of each part.***

The microscopic nephron is the functional unit of the kidney. Ultrafiltration in the Bowman’s capsule; selective reabsorption in the proximal tubule; maintenance of a hypertonic medulla region by the loop of Henle; and the final production of hypertonic urine in the collecting duct are the four essential annotations.

***11.3.4 Explain the process of ultrafiltration, including blood pressure, fenestrated blood capillaries and basement membrane.***

The renal artery branches extensively inside the kidney. The tiny branch leading to each nephron is called the afferent renal arteriole. The afferent arteriole sub-divides into a dense network of capillaries called glomerulus inside each Bowman's capsule. The capillaries merge again into a single blood vessel that leaves the Bowman’s capsule called the efferent renal artery. The afferent arteriole is slightly more muscular and has a larger lumen than the efferent arteriole. This means that blood inside the glomerulus is under high pressure. The pressure forces plasma through the fenestrated walls of the capillary into the capsule. Podocytes are epithelial cells of the inner lining of the capsule which have tentacle-like processes that cling to the capillary cell basement membrane. They provide an intimate interface and a massive filtration surface. Blood cells and large molecules like blood proteins and are held back. However, the process is a crude one. Glucose, amino acids and other valuable end-products of digestion end up in the glomerular filtrate.

***11.3.5 Define osmoregulation.***

Osmoregulation is the control of the water balance of the blood, tissue or cytoplasm of a living organism.

***11.3.6 Explain the reabsorption of glucose, water and salts in the proximal convoluted tubule, including the roles of microvilli, osmosis and active transport.***

After ultrafiltration the reabsorption of valuable nutrients and homeostatic restoration of osmotic balance is necessary. The inside of the proximal tubule is lined with microscopic microvilli that provide a large surface area for selective reabsorption. Amino acids and glucose are regained by active transport. The reabsorption of salt molecules pulls back H2O by passive osmosis.

***11.3.7 Explain the roles of the loop of Henle, medulla, collecting duct and ADH (vasopressin) in maintaining the water balance of the blood.***

The descending loop of Henle reabsorbs water by osmosis. The hair-pin bend of the loop enters the medulla section. The medulla is hypertonic compared to the cortex. This concentration gradient is maintained by the loop of Henle which acts as a counter-current multiplier. This is contrived by pumping Na+ ions by active transport across from the ascending limb to the descending limb. This results in accumulation of Na+ in the bend of the loop. As fast as they might be carried away by the ascending limb they are pumped back over to the descending limb where they travel back down. The collecting duct runs towards the medulla parallel to the loop of Henle. H2O is removed from the urine in the collecting duct by passive osmosis as it travels through the hypertonic medulla region. Fine tuning of H2O balance is controlled by hormone ADH (vasopressin). Secretion of ADH increases the permeability of the collecting duct wall concentrating the urine. As the name suggests ADH has an anti-diuretic effect.

***11.3.8 Explain the differences in the concentration of proteins, glucose and urea between blood plasma, glomerular filtrate and urine.***

The renal artery enters the kidney with unfiltered blood containing urea and other unwanted materials. It also carries much needed oxygen to the highly metabolically active kidney. The renal vein leaves the kidney with blood that contains adjusted levels of salt, and water and dissolved CO2 in the form of HCO3-. No urea remains since it is eliminated in the filtrate.

***11.3.9 Explain the presence of glucose in the urine of untreated diabetic patients.***

In primitive conditions a doctor might diagnose diabetes by tasting the urine of a patient! If urine is present above a certain threshold selective reabsorption is insufficient and some excess sugar appears in the urine. This is by no means sufficient to prevent dangerous symptoms.