MINISTRY OF EDUCATION

SECONDARY ENGAGEMENT PROGRAMME

GRADE 11

BIOLOGY

WEEK 1 **LESSON 2**

Topic: Excretion

Sub-topic: The Human excretory system

OBJECTIVES

- After viewing a labeled diagram, students will identify at least four structures of the kidney.
- By looking at a video, students will correctly explain the functions of each part of the kidney.
- After reading the handout, students will correctly explain how the kidneys remove metabolic waste from the body.
- By looking at a video, students will correctly explain the role of kidneys in osmoregulation.

CONTENT

- Metabolic activities that take place in the body produces waste substances that have to be removed from the body by excretion. Water and salts, produced in excess of what the body's needs, also have to be excreted. In humans and other mammals, the kidney is the main excretory organ. The kidney also plays a role in osmoregulation because it regulates the amount of water and the concentration of salts and other useful substances in the blood.

DID YOU KNOW?

The length of an adult human kidney is about 12 cm long, about the size of a computer mouse. The human kidneys make 170 litres of filtrate every day and produce 1 to 2 litres of urine. The rest of the filtrate is reabsorbed,

The structure of the kidneys

Figure 1 shows where the kidneys are located in the human body. Each kidney receives blood from a renal artery. Blood is returned to the circulatory system through the renal vein. In the kidneys, ions and small molecules, such as water and glucose, are removed from the blood. Most of these are returned to the blood before it leaves the kidneys. However, those that are not needed or are in surplus to the body's needs become part of the urine. The urine passes from the kidneys to the bladder, where it is stored. When the bladder is full, the urine is passed out of the body during urination.

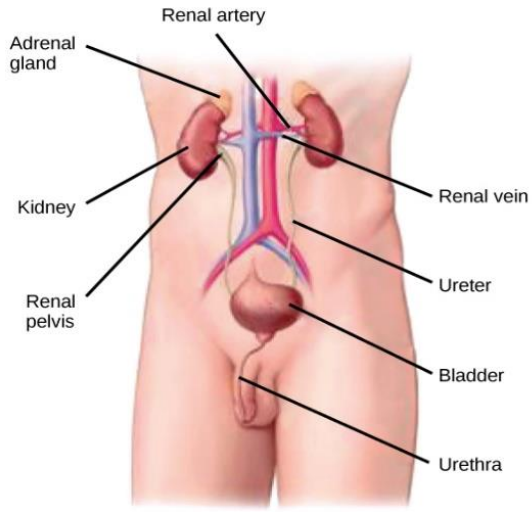


Figure 1 showing the position of kidneys in the Human body

(Retrieved from Lumen, 2020)

Figure 2 shows a view of the vertical section through a kidney. The outer region is the cortex where small molecules are filtered from the blood and where most are returned to the blood before it leaves the kidney. The inner medulla helps in the control of the water content of the blood. Urine flows down small tubes in the pyramids into a region at the top of the ureter called the pelvis.

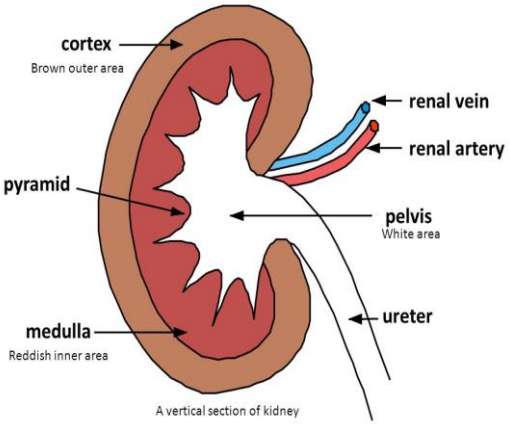


Figure 2: Vertical section through a kidney

(Image taken from Nickels, 2020)

Functions of the kidneys

The kidneys have four main functions. The table below summarises the functions of the kidneys. Note that the kidneys have functions other than excretion.

Table 1 Showing summary of kidney function

Function	**How achieved**
Excretion	Urea and certain other waste substances including those made in the body when alcohol, drugs and other toxins are metabolized, these excretory wastes are removed from the blood and passed out in the urine.
Osmoregulation	Surplus water is removed from the blood and incorporated into the urine.
Controls the pH of blood	Surplus hydrogen ions are neutralized or removed from the blood and incorporated into the urine.
Endocrine organ	Releases a hormone that increases the production of red blood cells in the bone marrow.

The nephron and its role in kidney function

Each kidney contains about one million microscopic tubules called nephrons. It is in these nephrons that blood is filtered and urine is formed. **Figure 3** below shows the structure of the nephron. One end of the nephron has a cup-like shape, the Bowman's capsule, enclosing a knot of blood capillaries called the glomerulus. The blood that enters the bowman's capsule via the afferent blood vessel contains a mixture of several substances such as water, glucose, ions (sodium, chloride and potassium), amino acids and urea. Red blood cells and large molecules, such as proteins, remain in the blood because they are too large to pass through the pores and the fibrous membranes. The other substances are filtered through the glomerulus and enter the proximal convoluted tubule where selective reabsorption takes place. In this tubule, 70% water, all of the glucose, some salts and some amino acids are reabsorbed. The solution then moves to the loop of Henle where some more water is reabsorbed. It then moves to the distal convoluted tubule where some water and some salts are reabsorbed.

The fluid is further sent to the collecting duct where more water is reabsorbed. The remaining fluid (known as urine) which comprises a mixture of urea, water, and salts moves down the pelvis to the ureter and into the bladder, where it is released via the urethra.

(follow link for more details) https://www.youtube.com/watch?v=2Htzn2FSOl0

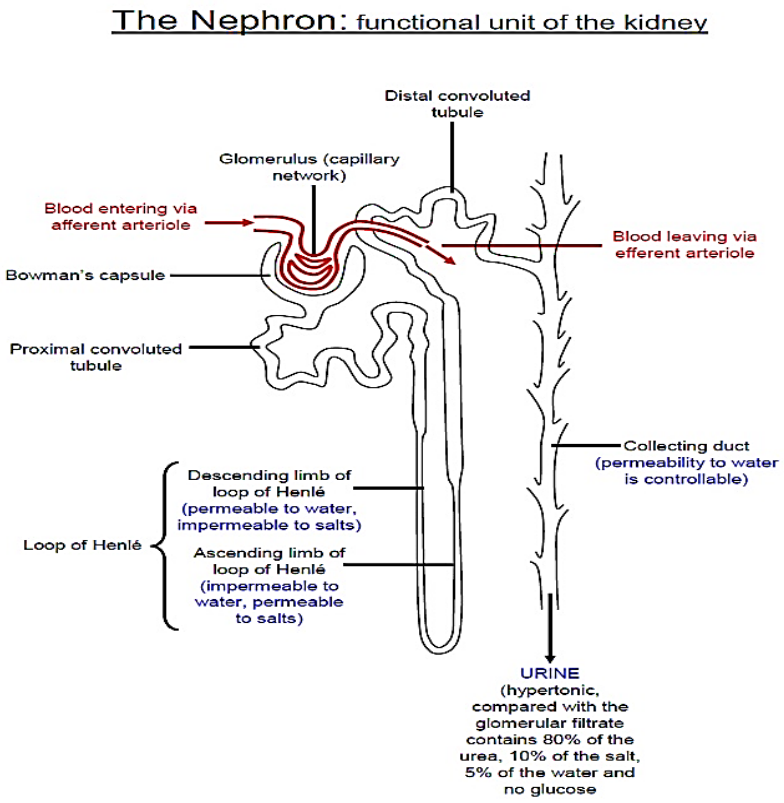


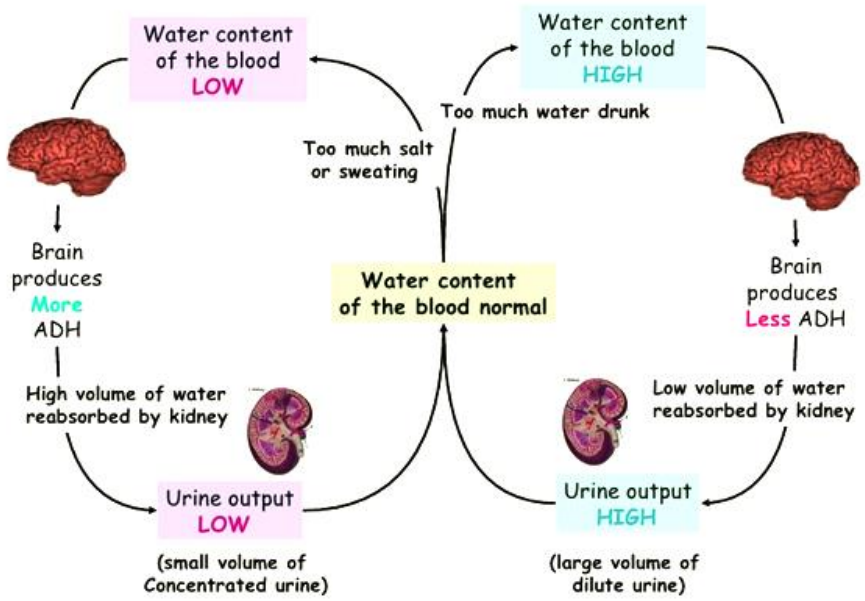
Figure 3 Showing the structure of the Nephron

The kidneys and osmoregulation

Osmoregulation is the process of maintaining the balance between water and salts in body fluids. To aid in this process, there are special receptors in the hypothalamus at the base of the brain that detect changes in the concentration of the blood. If a person carries out strenuous activities on a hot day, their body temperature rises to cause an increased rate of sweating so water is lost from the blood. When the blood becomes concentrated, the hypothalamus sends a message to the pituitary gland which secretes a hormone known as Antidiuretic hormone (ADH) into the blood. The secretion of this hormone stimulates the collecting duct to reabsorb more water from the urine and release into the blood thereby returning the blood plasma to normal. As a result, less urine travels to the bladder and it is more concentrated and darker in colour.

On a cold, staying indoors day and if a person consumes a lot of water, the opposite happens. Low rate of sweating so water is not lost from blood. The concentration of blood decreases and is detected by the hypothalamus which sends a message to the pituitary gland to stop secreting ADH. Water is therefore not reabsorbed by the collecting duct and as a result, more urine is sent to the bladder that is more dilute and lighter in colour. (click link for additional information: https://www.youtube.com/watch?v=qfWx8msgHqM)

The flow chart below summarises the process of osmoregulation:



(Flowchart retrieved from: byjus.com)

DID YOU KNOW?

The yellow colour of urine is due to urochrome, which is formed from bile pigments. Usually the urine passed first thing in the morning is dark yellow because over night the kidneys have been reabsorbing lots of water to prevent dehydration.

Homework

Kidneys are important for the removal of toxins from the body. Briefly explain two complications one might experience with their kidneys and state the effects and treatment for the complication.

References

Byju's. (2020). *Osmoregulation definition*. Retrieved from what is osmoregulation: https://byjus.com/biology/osmoregulation/

Delochan, A., Fosbery, R., Givens, P., Hunte, P., & Morris, M. (2010). *Human and Social Biology for CSEC* (2nd edition ed.). Glasgow, UK: Oxford University Press.

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