NSANGI SECONDARY SCHOOL

S.3 Biology Notes

HOMEOSTASIS

This is the maintenance of a constant internal environment of the body. The internal environment of the body is composed of tissue fluids, which surround cells. Homeostasis involves; excretion, control of blood sugar, control of carbondioxide concentration, control of PH of blood, control of salt/water balance, temperature regulation.

EXCRETION

Excretion is the removal of waste products of metabolism from the body. Most of the waste products are toxic when allowed to accumulate in the body.

Importance of excretion

- To remove toxic waste products whose accumulation in the body poisons/harms the organisms
- To remove excess materials in the body which when left to accumulate affects the body metabolism.

Excretory products are divided into two groups:

1. Nitrogenous excretory products.

These are excretory products, which contain the element nitrogen. They include ammonia, urea and uric acid.

Ammonia:

This is a highly toxic nitrogenous waste and it requires a lot of water for its elimination. It is very soluble in water and due to this it requires less energy to be excreted. Ammonia is excreted by organisms which live in fresh water and therefore have a lot of water in their bodies. Such organisms include bony fish, protozoans, and amphibians when in water,

Urea:
This is a less toxic nitrogenous waste. It requires less water for its excretion. It however requires a lot of energy for its excretion because of its low solubility in water compared to ammonia. Urea is excreted by terrestrial organisms, which have easy access to water, and marine organisms. Such organisms include terrestrial mammals, amphibians when on land, cartilaginous fish, etc.

Uric acid:
This is less toxic than urea and requires no water for its elimination from the body. It is insoluble in water. The demerit of excreting uric acid is that it requires a lot of energy for its excretion. Uric acid is excreted by birds, reptiles and insects and also common in desert animals.

2. Non nitrogenous excretory products.
These are excretory substances that do not contain the element nitrogen. Such products include Carbondioxide, excess salts and excess water.

A table showing examples of organisms, their excretory products, their excretory organs and their habitats

Example of organism	Excretory product	Excretory organ	Habitat
Bony fish	Ammonia	Kidney	Flesh water
Cartilaginous fish	Urea	Kidney	Marine water
Reptiles	Uric acid	Kidney	Terrestrial
Birds	Uric acid	Kidney	Terrestrial
Tadpoles	Ammonia	Gills	Flesh water
Adult amphibians	Ammonia	Kidney	Flesh water
	Urea		Terrestrial
Mammals	Urea	Kidney	Terrestrial
Insects	Uric acid	Malpighian tubules	Terrestrial

Animals producing nitrogenous compounds in form of urea are those living on land but have easy access to water. This is because though urea is less toxic than ammonia, it needs a relatively high amount of water to reduce its toxicity to the body during excretion. Urea is excreted in form of urine, which is a mixture of urea, salts and water. Urea is excreted by mammals, amphibians when on land and marine vertebrates.

Animals producing nitrogenous wastes in form of uric acid are those living on land with little access to water. Uric acid is the least toxic and needs the least amount of water for its excretion. Such animals conserve their water because it is not lost during excretion. These animals include, bird, reptiles and insects.

Excretory organs

These are organs that release excretory products. They include the following. **Table showing excretory organs and their corresponding excretory products**

Excretory organ	**Excretory product**
Lungs	Carbondioxide and water
Liver	Bile pigments
Kidney	Urea, excess salts and excess water
Malpighian tubules	Uric acid
Skin	Excess water, excess salts and some urea

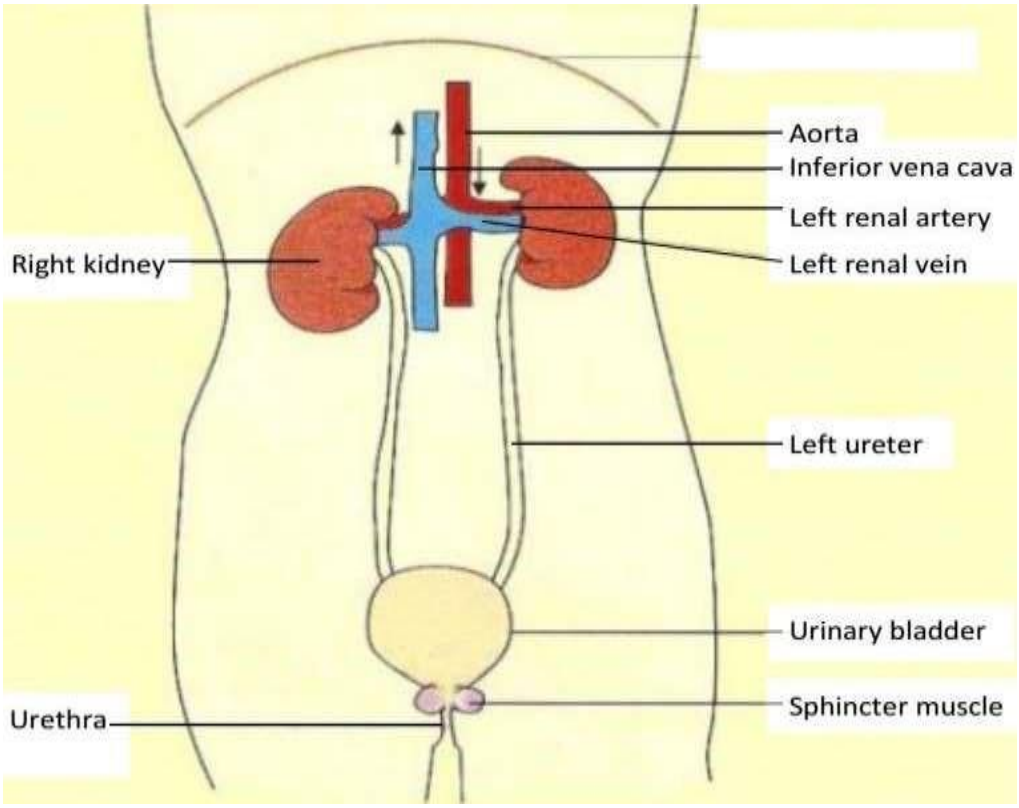
EXCRETION IN MAN

In man the excretory organs are the kidneys, skin and lungs. Their excretory waste products are as shown in the table below.

Excretory organ	**Excretory product**	**Excretory substance**
Skin	Sweat	Urea, excess salts and excess water
Lungs	Exhaled air	Carbondioxide and water
Kidney	Urine	Urea, excess salts and excess water.

THE KIDNEY AND THE EXCRETORY SYSTEM

Structure of urinary system



Parts and functions of the urinary system

1) Aorta

It carries oxygenated blood with all food nutrients to the kidney.

2) Renal artery:

This arises from dorsal aorta. It brings blood containing excretory products to the kidney.

3) Renal vein:

It carries filtered blood from the kidney to the posterior vena cava.

4) Ureter:

These are two narrow tubes arising from hilum of each kidney. They connect the kidneys to the urinary bladder. They transport urine to the urinary bladder.

5) Urinary bladder:

It is a thick walled elastic sac-like structure which stores urine.

6) Sphincter muscle:

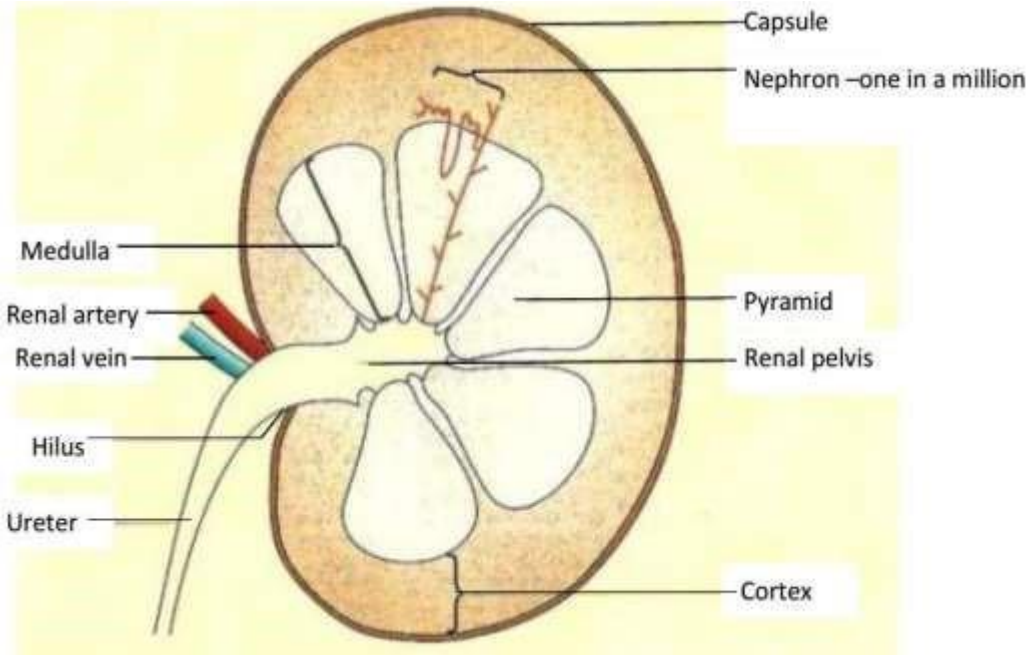
These muscles are elastic thus can contract and relax to control urine flow.

7) Urethra:

It is a passage for urine to the outside of the body.

THE KIDNEY

Structure of the kidney



The kidneys are solid bean-shaped structures and they occur in pairs in mammals. They are reddish-brown in colour enclosed in a transparent membrane and attached to the back of the abdominal cavity.

The kidney tissue consists of many capillaries and renal tubules connected together by connective tissue. The kidney has two major parts.

1. The **cortex** which is a dark outer part. It consists of the Bowman's capsule which is responsible for ultra-filtration of blood passing across it.
2. The **medulla**, which is a lighter inner, part. It is made up of many cone- shaped portions called pyramids.

The pelvis is the area where the ureter leaves the kidney.

The kidney performs three major functions in the body.

1. It carries out excretion.
2. It carries out the function of osmoregulation.
3. It contains endocrine glands, which secrete hormones.

The kidney is made up of several microscopic structures (functional units) called nephrons where the actual excretion and osmoregulation takes place.

THE NEPHRONE

This is the functional unit of the kidney. It carries out the function of excretion and osmoregulation in the kidney.

The nephron consists of a cup-shaped structure known as the ***bowmans' capsule***. Blood comes to the nephrone through the ***afferent vessel***, which is a branch of the renal artery, and it leaves through the ***efferent vessel***.

The efferent vessel joins many other efferent vessels from other nephrones to form the ***renal vein***.

In the bowmans' capsule the afferent vessel divides to form capillaries. The capillaries are highly coiled and they form a knot called ***glomerulus***.

Leading from the bowman's' capsule is a highly coiled tube known as ***proximal convoluted tubule***. This is continuous with a U shaped tubule called ***loop on Henle***.

The loop is divided into the descending loop and ascending loop.

From the loop of Henle the tube becomes highly coiled to form the ***distal convoluted tubule*** which leads to the ***collecting duct***.

Structure of the nephron

[leave 15 lines for the diagram]

Parts of nephron

1. Bowman's capsule:

It contains a dense-network of capillaries called **glomerulus.** The glomerulus is formed from the wider arteriole of renal artery called afferent arteriole. It is located in the cortex.

The Bowman's capsule serves the function of filtering small molecules in blood such as urea glucose, etc. through a process called ultra-filtration.

Adaptations of the glomerulus to ultra-filtration

i) Having high blood pressure that forces small molecules out of the glomerulus. This is due to the afferent arteriole being wider than the efferent. ii) Having many capillaries that give it a large surface area for ultra-filtration.

iii) Having a semi permeable membrane that can allow any small molecule to pass through.

Adaptations of the Bowman's capsule to collect the filtrate

i) Possession of cup-shaped structure which enables it to collect the filtrate.

ii) Having a porous upper membrane that easily allows filtration.

iii) Having a large volume that can accommodate more filtrate.

2. Proximal convoluted tubule:

This is a site where re-absorption of useful materials such as glucose and some small amino acids and water from glomerular filtrate back to blood takes place.

3. Loop of Henle: It's made up of a descending (going down) limb and an ascending (going up) limb. The ***main function of the loop of Henle is to make the tissue fluid in the medulla more concentrated than the glomerular filtrate in the nephron so that water needed in the body is reabsorbed***. *It's known to cause the retention of water*. ***This is one way of conserving water in camel because of its extremely long loop of Henle.***

4. Distal convoluted tubule:

It chiefly re-absorbs salts like chloride ions together with water, leaving a concentrated liquid now called urine which passes down to collecting ducts.

5. Collecting duct:

This duct carries urine from the distal tubule to the pelvis of kidney. It allows outward movement of water thus conserving it.

Adaptations of the nephron to re absorption

i) Having a thin membrane (one cell thick) for easy diffusion of materials.

ii) Having micro villi to increase the surface area for re absorption.

iii) Having numerous mitochondria to provide energy for active reabsorption.

URINE FORMATION

The process of urine formation takes place in the nephron. It occurs in two phases.

1. Ultra-filtration.
2. Selective re-absorption.

Ultra filtration

✓ Much blood comes from the **afferent vessel** into the glomerulus than that which leaves through **efferent** because the afferent vessel is larger than the efferent vessel.

✓ This generates pressure in the blood capillaries of the glomerulus forcing small molecules to filter out of the blood capillaries to form the glomerular filtrate.

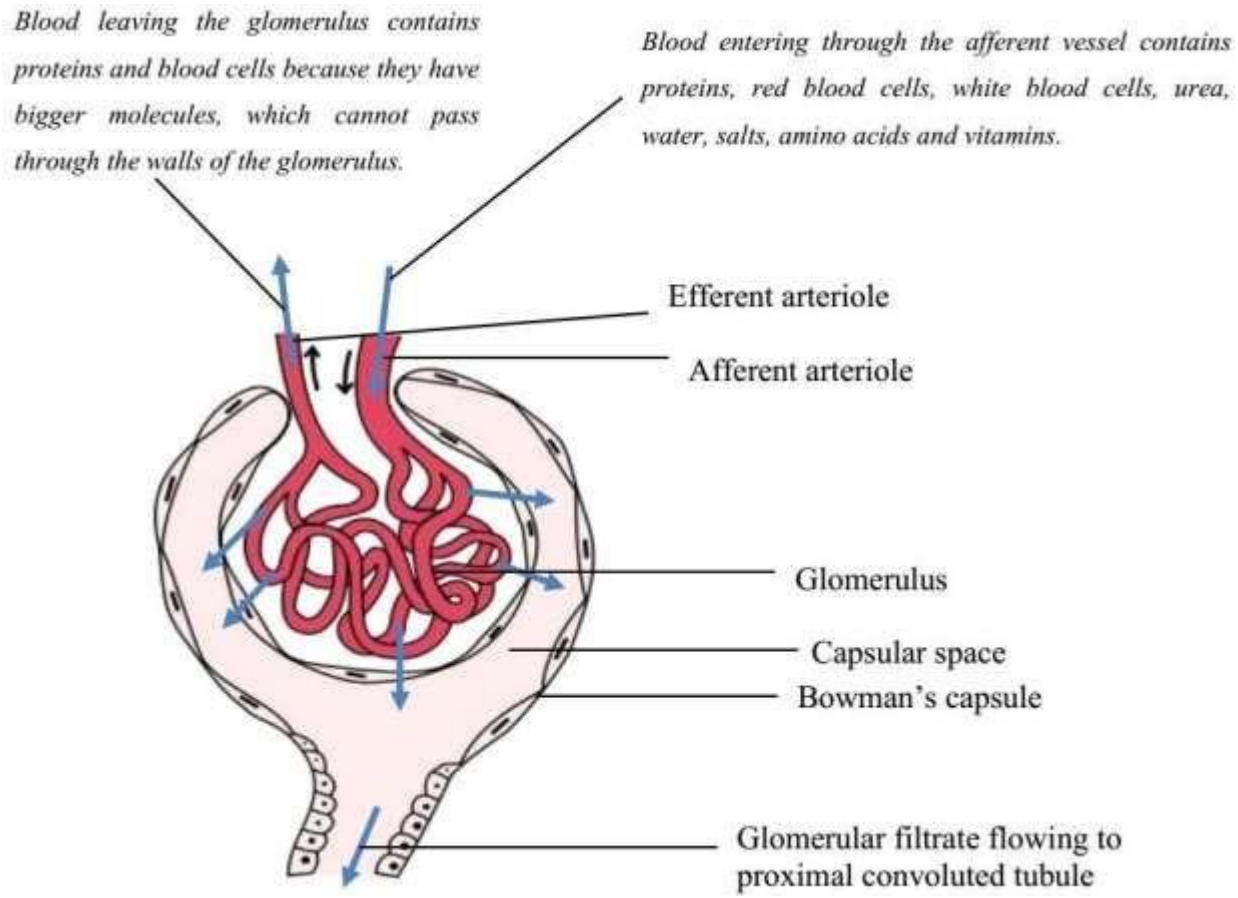
✓ Blood in the renal artery contains proteins, red blood cells, white blood cells, urea, water, salts, amino acids and vitamins.

✓ In the glomerulus, small molecules filter out by *ultra filtration* to form the glomerular filtrate. *This filtrate contains glucose, urea, water, salts and vitamins.*

✓ *Proteins and blood cells do not filter out* because they have bigger molecules, which cannot pass through the walls of the glomerulus.

✓ The filtrate formed moves from the Bowman's capsule through the capsular space to ***proximal convoluted tubule*** where selective reabsorption starts to occur.

Diagrammatic illustration of ultrafiltration



Selective reabsorption ***In the proximal convoluted tubule:***

✓ Most of the food materials are re absorbed into the blood capillaries by active transport e.g. all the glucose, vitamins, some salts like sodium chloride and even some water is re absorbed by diffusion.

In the loop of Henle:

✓ *As the filtrate flows down the descending limb, water is re absorbed* back into the capillaries *by osmosis* leading to increased concentration of the filtrate down the descending limb.

✓ *As the filtrate ascends, the thick ascending limb of loop of Henle, salts like Na and K are reabsorbed by active transport*. This leads to a decrease in concentration of the glomerular filtrate in the ascending limb.

In the distal convoluted tubule:

✓ Selective re absorption of salts by diffusion occurs.

In the collecting duct:

✓ Water is lost to the highly concentrated medulla tissues by osmosis from which later the remaining filtrate is ***urine*** which goes via the ureter and temporarily stored in the urinary bladder.

Summary of the steps involved in formation of urine in the kidneys

Name	Process	Examples of molecules
Ultra-filtration (pressure filtration)	High blood pressure forces small molecules from the glomerulus into bowman's capsule.	Water, glucose, amino acids, salts, urea, uric acid, creatinine.
Selective reabsorption	Diffusion and active transport return molecules to blood at the proximal convoluted tubule.	Glucose, water, salts and amino acids.
Tubular secretion	Active transport moves molecules from blood into the distal convoluted tubules.	Uric acid, creatinine, ammonia and hydrogen ions.
Reabsorption	Along the length of the nephron and notably at the loop of Henle and collecting duct, water returns by osmosis following active reabsorption of salts.	Water and salts.
Excretion	Urine formation rids body of metabolic wastes	Water, salts, urea, uric acid, ammonia.

Comparison of substances in blood and urine

Nitrogenous waste	In blood	In urine
Urea	0.03	2.0

Proteins	7-9	0
Glucose	0.1	0
Chloride ions	0.37	0.6
Sodium ions	0.32	0.35
Water	93	95

✓ There are proteins in blood and there is none in urine because proteins are not filtered out of the blood vessels into the glomerulus due to the large size of their molecules.

✓ Urea is more in urine than in blood because it is filtered out of blood and it is not reabsorbed back in the blood.

✓ Water is more in urine than in blood because it is used to dissolve urea.

✓ However the relative amounts of water in urine and in blood varies depending on the amount of water in the body, amount of solutes in the body, temperature and body activity.

✓ There is glucose in blood and no glucose in urine because glucose is reabsorbed from the glomerular filtrate back into the blood.

✓ Salts like chlorides and sodium ions are more in urine than in blood. This is because they are in excess and they are not reabsorbed back into the blood. Because of this they tend to concentrate in urine.

EXCRETION IN PLANTS

Plants excrete less poisonous waste products like CO_2 through the stomata and acids through dropping leaves and fruits. Plants do not require specialized excretory organs due to;

i) Plants can store excess proteins unlike in mammals.

ii) They accumulate less metabolic wastes due to their low metabolic rate.

iii) Plants synthesize their organic food substances according to their requirements. This ensures that no excess is made.

iv) Plants do not produce nitrogenous waste products. They produce non- nitrogenous wastes, which are less toxic to their bodies.

v) Some wastes accumulate in particular parts of the plant and they are eliminated when this part of the plant falls off.

vi) Some of the wastes are useful in other processes within the plants body. For example Carbon dioxide produced from respiration can be used in photosynthesis.

vii) They do not locomote and they are less metabolically active than animals.

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OSMOREGULATION IN MAN

It is the process by which the osmotic pressure of blood is kept/maintained constant.

The osmotic pressure of blood is kept neither high nor low but within a limit according to the demands of the body.

Osmotic pressure of blood means the water salt level in blood. When there is higher salt concentration in blood compared to the water, then the osmotic pressure of blood is said to be high.

A low Osmotic pressure of blood means low salt concentration but much water eg when a person drinks a lot of water, the osmotic pressure of blood becomes low [falls]. The body losses water through urine, sweat, exhaled air and egestion while water is gained by drinking, through food and from metabolic reactions such as respiration.

MECHANISM / PROCESS OF OSMOREGULATION

When the Osmotic pressure is higher e.g after taking a salty meal, this is detected by the cells of the **hypothalamus of the brain,** as blood passes through the brain and then the hypothalamus stimulates the posterior lobe of the pituitary gland to secrete a hormone called Antidiuretic hormone [ADH] into blood. The hormone is then transported by the blood to the kidney nephrone where it causes the distal convulated tubule and collecting ducts to become more permeable to water. This causes more water to be re-absorbed from the glomerular filtrate, into blood leading to production of small volume of concentrated urine.

When the Osmotic pressure of the blood falls far below the normal level e.g. after driving a lot of water this is detected by the cells of the hypothalamus in the brain. The hypothalamus is less stimulated and hence little or no antidiuretic hormone is secreted from the pituitary gland. The permeability of the distal convulated tubule and collecting duct in the nephrons lowers and hence little water is re-absorbed from the glomerular filtrate into blood. This leads to the passing out of large volume of dilute urine, due to much water lost and this increases the Osmotic pressure of blood to a normal level.

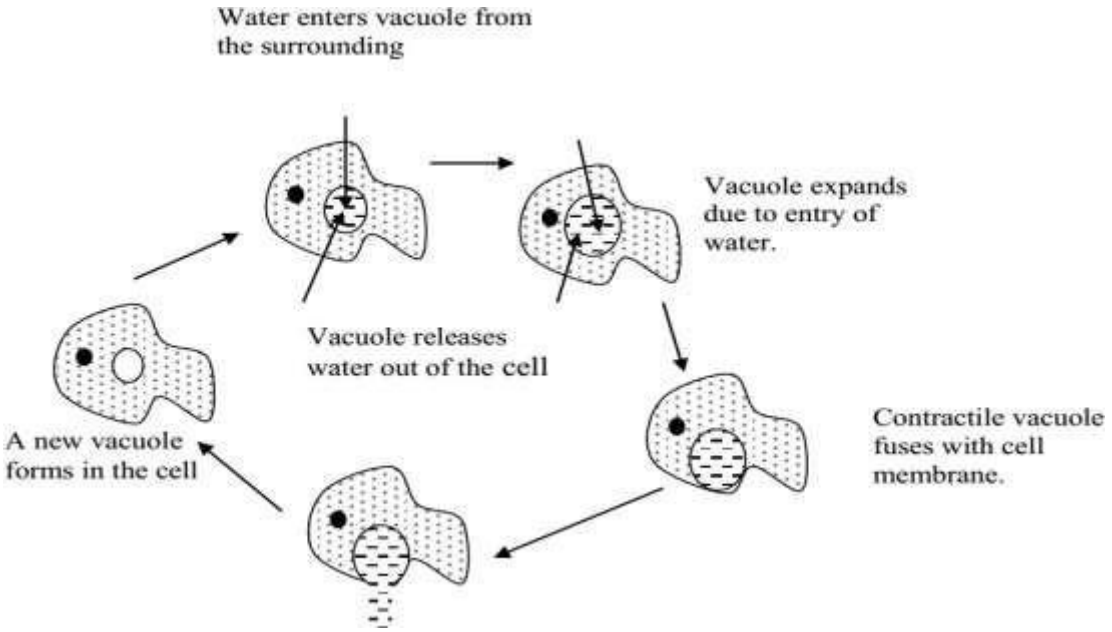
NB. A person who lacks sufficient amount of Antiduiretic hormone, losses a lot of water in urine and therefore, he urinates more frequently large volume of dilute

urine and complains of thirsty all the time, this condition is called **diabetes inspidus**

IN OTHER ANIMALS THE AMOEBA

Amoeba excretes excess water by use of a contractile vacuole. The contractile vacuole is a small sac-like structure lying inside the cytoplasm. The cell membrane surrounding amoeba is semi-permeable and since the concentration of the cytoplasm is higher than that in the environment surrounding amoeba, water molecules move by osmosis from out into the cytoplasm of amoeba. The organism uses some of the water and excess is secreted into the contractile vacuole, which is formed in the process. As the vacuole enlarges, it moves towards the cell membrane and finally fuses with it. It then bursts to release the excess water out. A new vacuole is formed when the organism is excreting more water.

Illustration



INSECTS

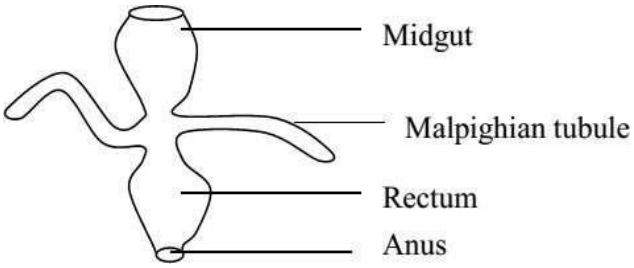
Excretion in insects is carried out by structures called Malpighian tubules, which are found between the mid gut and the rectum of the insect's alimentally canal.

Insect tissues produce nitrogenous wastes in form of potassium urate, which is liberated into the blood stream and taken to the malpighian

tubules. In the tubules, urate reacts with Carbondioxide and water to form uric acid, which is released out of the body along with feaces.

Diagram showing the position of the malpighian tubules

Malpighian tubules



HOMEOSTATIC CONTROL OF BLOOD SUGAR IN HUMANS

Blood sugar is called glucose. Its concentration is controlled by a section of the pancreas called islets of Langerhans. This gland regulates responding organs mainly the liver and muscles through its secretions.

Importance of blood sugar regulation

1. It prevents cells running short of glucose in case its level drops. Blood sugar (glucose) is the main source of energy.
2. Any slight increase in glucose level alters the concentration of blood's osmotic pressure, which results in alteration of the rate at which water moves in and out of the body cells by osmosis.

Blood glucose concentration is controlled by the pancreas. The pancreas has glucose receptor cells which monitor the concentration of glucose in the blood, and it also has ***endocrine cells*** (called *the* ***islets of Langerhans***), which secrete two hormones. The alpha cells (α cell) secrete a hormone called ***glucagon***, while the beta cells (β cells) secrete a hormone called ***insulin***. These two hormones are antagonistic, and have opposite effects on blood glucose.

PROCESS OF CONTROL OF BLOOD GLUCOSE /LEVEL OF GLUCOSE IN BLOOD

When the concentration of glucose increases above the normal [e.g after having a heavy meal], this is detected by special cells of the pancreas ,called beta cells

which then secretes a hormone called **Insulin** into the blood stream, and is then carried by blood to the liver ,where this hormone causes ;

- ✓ The liver cells to convert excess glucose into glycogen, which is then stored into the liver.
- ✓ Increase metabolic breakdown of glucose into carbon dioxide and water, in the liver cells through the process of respiration.
- ✓ Conversion of excess glucose into fats which are then stored under the skin and in the inner wall of blood vessels.
- ✓ Prevents formation of more glucose from the stored fats

The above processes lower glucose concentration to normal.

When the level of glucose in blood falls below the normal, the pancreas detects this and another hormone called **glucagon** is secreted from the alpha cells into the blood stream and transported to the liver, where it causes increase in the blood glucose to normal by; ✓ Converting stored glycogen to glucose.

- ✓ Converting fats into glucose.
- ✓ Lowering the rate of respiration [breakdown of glucose to water and carbondioxide] in the liver cells .

NB. A person with a faulty pancreas fails to secretes enough amount of insulin hormone, this low concentration of insulin in blood causing increased amount of glucose in blood and the excess glucose is passed out in urine ;a condition known as **diabetes mellitus**. This disease is detected by testing for presence of glucose /reducing sugar in the person's urine. This condition is treated by injecting insulin hormone directly into the blood of the patient.

THE LIVER

The liver is the largest organ in the body of a mammal. It performs several functions, which include the following.

1. Regulation of blood sugar level.

This is done with the help of a hormone called **insulin** from the □- cells of the islets of langerhans, in the pancreas. When the blood sugar level is high,

the pancreas produces insulin, which moves to the liver cells through blood. It then stimulates the liver cells to convert some of the glucose into glycogen for storage in the body. When the level of glucose drops in blood, it inhibits the secretion of insulin and stimulates the □- cell of the islets of langerhans in the pancreas to secrete a hormone called **glucagon**. Glucagon stimulates the liver to convert glycogen and fats to glucose. This raises the level of glucose in the blood.

2. Regulation of lipids.

The liver removes lipids from the blood stream by either breaking them down to release energy or storing them in fat deposits.

3. Regulation of amino acids and proteins

The body cannot store excess proteins and amino acids therefore excess is sent to the liver where the amino group (NH_2) is removed from them and converted into ammonia or urea to be excreted. This occurs in a process is called deamination. The remaining part is broken down to release energy or it is converted into fats for storage.

4. Detoxification.

This is the removal of toxic products from the body. All toxic products from any part of the body are taken to the liver where their toxicity is neutralized.

5. Production of heat

When the body temperature falls, metabolic processes take place in the liver to produce heat, which restores the temperature back to normal.

6. Production of bile.

Bile is manufactured in the liver and stored in the gall bladder.

7. Formation of cholesterol.

Cholesterol is a lipid part used in formation of cell membranes.

8. Elimination of sex hormones.

After their role is over, the sex hormones are modified and sent to the kidney or expelled into bile by the liver.

9. Storage of blood.

The liver has a good network of blood capillaries and most of the blood is stored in these capillaries. It holds more blood than any other body organ.

10. Storage of vitamins.

The liver stores most of the fat-soluble vitamins suck as vitamin E, vitamin D and vitamin K

11. Formation of red blood cells.

In adults the red blood cells are produced from the red bone marrows but in the foetus they are made in the liver.

12. Elimination of heamoglobin from red blood cells.

THE SKIN

This is the most extensively distributed tissue found all over the body of mammals. It is a continuous protective layer over the body.

Functions of the skin

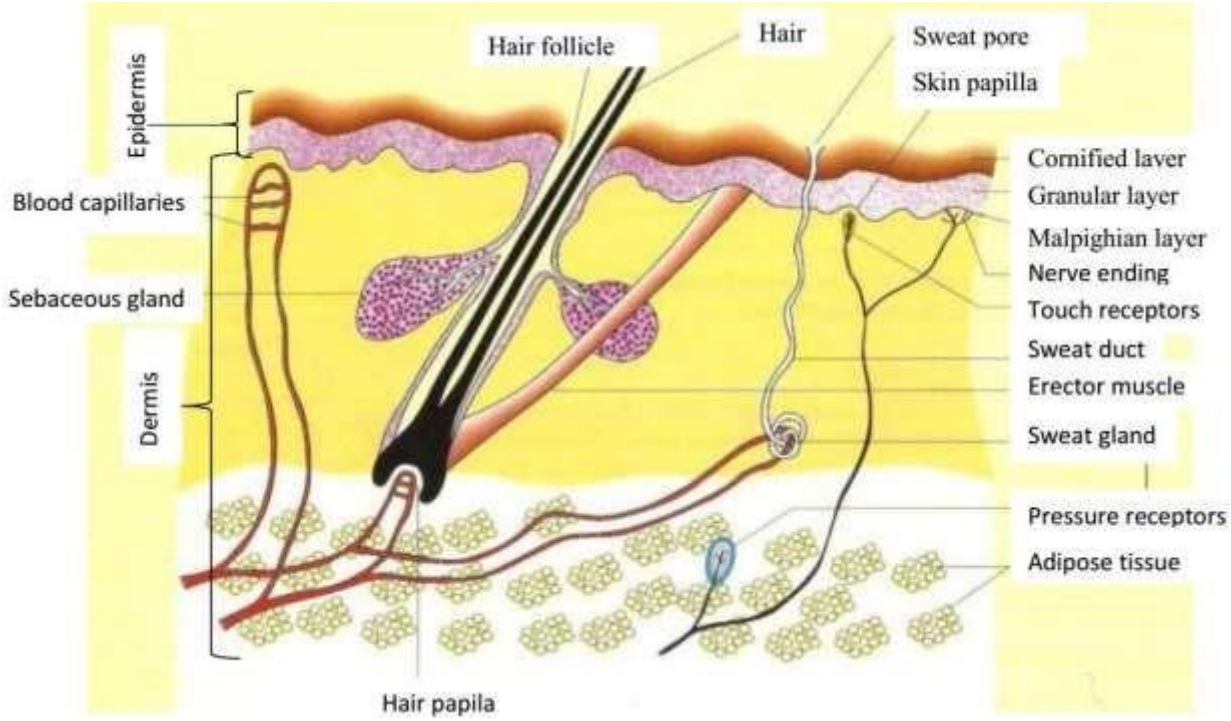
i) To protect the tissue below it from mechanical damage, bacterial and viral infections.

ii) It also prevents excess loss of water from the body. iii) It acts as a sense organ and it is sensitive to pain, touch and heat. This helps the organism to be aware of its environment.

iv) It helps to keep the body temperature of endothermic organisms constant. v) It synthesizes vitamin D in presence of sunlight.

vi) It acts as an excretory organ. It excretes sweat, which contains urea, water and excess salts.

The structure of the skin



The skin consists of two main layers.

1. The epidermis (outer layer)
2. The dermis (inner layer)

THE EPIDERMIS:

This is made up of three sub layers.

a) The Malpighian layer.
b) The granular layer.
c) The cornified layer.

1) The Malpighian layer

This is the inner most sub layer in the epidermis. It consists of dividing cells which give rise to cells of the granular layer. It secretes a pigment called melanin, which gives the skin its colour and protects the skin from ultraviolent rays. Albinos do not produce melanin in their skins.

2) The granular layer

This contains living cells arising from the malphigian layer. It is the biggest layer of the epidermis. It gives rise to cells of the cornified layer.

3) The cornified layer.

This is the outermost layer of the skin. It is made up of dead cells, which are keratinized. Cells of this layer continuously ware away and are replaced by cells from the granular layer. Its function is to protect the inner parts of the body from mechanical injury and entry of bacteria and other germs. It also offers water proofing to the skin.

THE DERMIS:

This is the inner layer of the skin. It is below the Malpighian layer. It is thicker than the epidermis. It contains the sweat glands, nerve fibers, fat cells and blood capillaries.

Other parts of the skin

1) Hairs.

The hairs extend from the dermis through the epidermis. They arise from hair follicles in the dermis. They protect the body and trap a layer of air on the skin, which insulates the body against heat loss.

2) Sebaceous gland

This secretes an oily substance called sebum. This oil softens the cornified layer and prevents it from cracking. The oil also provides water proofing to the skin.

3) Nerve endings.

These perceive external stimuli and transport impulses to the central nervous system.

4) Sweat glands.

These are coiled tubular glands located in the dermis. They excrete sweat, which is released out of the skin through the sweat duct.

CONTROL OF BODY TEMPERATURE (Temperature regulation).

This is the process of maintaining the temperature of the organism within narrow ranges, which favour body activity, and ensures optimum activity of body enzymes.

To maintain the body temperature constant, there must be a balance between heat loss and heat gain.

The body loses heat by;

a) **Radiation:** Heat diffuses from the warm body to the cold environment.

b) **Conduction:** The body loses heat to the cold object in contact with it.

c) **Convection:** Where cold air or wind carries heat from the warm body.

d) **Evaporation:** e.g. sweating leading to loss of heat

The body gains heat by;

a) Radiation: e.g. from the sun's heat and reflection from the ground.

b) Conduction: e.g. from the ground via the feet.

c) Convection: e.g. from the wind bringing hot air to the body.

d) Metabolism: e.g. since many of the body's chemical reactions release heat e.g. in respiration.

The rate of heat loss and gain depends on; a) Surface area to volume ratio i.e.

Small organisms having a large surface area to volume ration tend to lose more heat than the large ones with small surface area to volume ratio.

b) Temperature of surrounding environment:

Organisms tend to lose more heat in cold environment and gain more in hot environment.

c) Rate of respiration

The higher the rate of respiration, the more heat energy gained by the body.

d) Humidity of the environment

Heat loss increases in humid conditions because high humidity makes the environment colder.

Endothermic/Homoithermic animals:

Endothermic organisms are those that are able to maintain a constant body temperature irrespective of the surrounding environmental temperature. They depend mainly on heat generated within their bodies. They are also called warm blooded animals e.g. mammals.

Ectothermic/poiklothermic animals:

These are animals that cannot maintain a constant body temperature but their temperature changes with that of the environment. They are also called cold blooded animals e.g. reptiles and amphibians.

A graph showing how body temperature varies with External temperature in ectoderms and endotherms

[*LEAVE SPACE EQUIVALENT TO 20 LINES*]

The body temperature of endotherms remains constant despite the increase in surrounding temperature.

The body temperature of ectotherms varies with environmental temperature.

Control of body temperature in endotherms

When temperature is high, organisms respond in a way that lowers down the temperature and when the temperature is low, organisms respond in a way that raises their body temperature. These responses are categorized into two types.

1. **Physiological responses**. These are involuntary actions and they occur in body organs in response to temperature changes.
2. **Behavioral responses**. These are voluntary responses from the organism. The organism consciously decides what to do when external and internal temperatures change.

Response to cold weather in endothermic animals Physiological means.

1. The erector pill muscles of the hair contract to make the hairs stand upright to the skin. The hairs trap a layer of air, which insulates the skin.
2. The rate of sweating reduces in order to reduce on the amount of heat lost through it.
3. The metabolic activity of the liver increases to produce energy in form of heat.
4. Blood vessels near the skin constrict in the process called vasoconstriction to reduce on the blood reaching the skin. This reduces heat loss through radiation.
5. Small animals like the mouse undergo hibernation where they dig holes and live deep in them to reduce heat loss

6. Shivering. This is the rhythmic contractions of the skeletal muscles. It results into production of heat energy.

Behavioral means.

Endotherms may raise their body temperature behaviorally through;

1. Sitting near hot bodied to raise their body temperature by conduction or radiation.
2. Humans take hot drinks.
3. They do physical exercises to raise the metabolic activity of the body.
4. They can take a hot bath
5. They put on thick clothes, which insulate their bodies.

In hot weather

In hot environment, animals control the body temperature by increasing heat loss and lowering heat production through the following ways:

Physiological means.

1. The erecter pilli muscle of the skin relaxes making the hairs to fall on the skin. This allows heat loss by radiation.
2. The metabolic rate of the body reduces to reduce on the amount of heat produced.
3. Sweating increases. In this process excessive heat is lost as latent heat of vaporization to evaporate the sweat from the body hence losing heat.
4. Vasodilatation. Vessels dilate and allow more blood to reach the skin surface in order to lose heat to the surroundings by radiation.
5. Animals living in hot environments have a thin fat layer to reduce on the insulation.

Behavioral means.

1. Some rest on cold bodies like rocks to lose heat by conduction.
2. Humans sit near fans.
3. Some take cold drinks.
4. They put on light clothes

5. Panting. This involves hanging out of the tongue for example in dogs. This results into evaporation from the mouth, which eventually cools the animal.
6. Swimming.

Adaptations of mammals to cold conditions

1. They have a lot of hairs over their bodies to trap a layer of air 2. They have a thick fat layer to act as an insulator.
3. Some are very big and thus have a small surface area to volume ratio. This reduces the rate of heat loss.
4. They have few sweat glands to reduce of the heat lost during sweating
5. They have fewer blood vessels on the skin surface to avoid heat loss through radiation.

Behavioral:

1. Putting on thick clothes like in humans
2. Doing physical exercises
3. Hibernation. This is a state of long rest by burrowing into crevices and holes during extreme coldness.
4. Sun bathing

Adaptations to hot conditions

1. Having little hairs on the body to allow easy loss of heat.
2. Having less fat to reduce on the insulation effect of fats.
3. Having a large surface area to volume ratio. To allow a faster rate of heat loss.
4. Having a lot of sweat glands to increase heat loss.
5. Having many blood vessels near the skin for easy loss of heat by radiation.

Behavioral:

1. Resting under shade.
2. Bathing cold water.
3. Aestivation. This is a state of long rest by burrowing in crevices and holes during extreme hotness.
4. Putting on lighter clothes.
5. Sitting near cold things.

TEMPERATURE CONTROL IN ECTOTHERMIC ANIMALS

Ectothermic animals are animals whose body temperature changes with that of the environment. Examples of ectotherms are fish, reptiles and amphibians. Their body temperature is controlled by only behavioral means.

During hot conditions, they lose heat by.

1. They rest on cold rocks to lose heat by conduction.
2. They rest on cold stones and in shades to lose heat.
3. They burrow in cracks and lose heat by radiation.
4. Aestivation. This is a state of long rest by burrowing underground or under rocks during high temperatures.
5. Thermal gaping. This is the opening of the mouth to lose water by evaporation. This results into cooling. Thermal gaping occurs in crocodiles and a few other reptiles.

During cold conditions, they gain heat by;

1. Resting on hot rocks to gain heat by conduction.
2. They rest under the sun to gain heat by radiation.
3. They rest near hot bodies to gain heat by radiation.
4. They burrow in hot sand to gain heat by conduction.
5. Basking in the sun to gain heat.
6. Hibernation. This is a state of long rest by burrowing into crevices and holes during extreme coldness.

Merits of being endothermic

1. They are always active because their temperature is maintained at an optimum temperature for enzyme activity.
2. They can live in a wide range of environments i.e. both hot and cold.
3. Their metabolic rate is maintained at a high rate due to the ability to maintain a constant body temperature.

Disadvantages of being endothermic

1. Having a high rate of food consumption due to high rate of metabolism.
2. Maintaining the body temperature constant requires much energy.

Advantages of being ectothermic

1. Low food consumption due to low metabolic rate.
2. Easy to control body temperature by only behavioral means.

Disadvantages of being ectothermic

1. They have limited body activity in cold environments.
2. Show response to stimuli due to low metabolic rate.

END