

EXCRETION AND HOMEOSTASIS

(a) Excretion;

ü is the removal of toxic/poisonous metabolic waste products from the body of an organism. Example of metabolic waste products

(i) metabolic waste in Animals:

Sub divided into;

ü **Nitrogenous waste products** (Ammonias, Urea, Uric acid, Cretinine, Trimethyl Amine oxide) ü **Non-Nitrogenous waste products** (Excess water, Excess salts, Carbon dioxide).

(ii) Waste products in plants: (Oxygen, Carbon dioxide, Excess water, Organic waste products, Resins, Tannin, Latex)

Why Excretion is Necessary in Animals/significance of excretion

- ✓ Metabolic waste if left to accumulate in the body would become toxic to the body cells; i.e. it enables removal of toxic wastes.
- ✓ Prevents the body from disease infections.

(b) Homeostasis;

- ✓ is the process where the body self adjust/maintains a relatively constant internal environment /surroundings of living cells in the body. **OR**
- ✓ maintenance of fairly constant internal environment of the organism"s body.
 - Ø Internal environment includes all conditions in fluids surrounding the living cells, i.e., **Temperature, pH of blood, osmotic pressure of blood and tissue fluid(salt ,sugar and water concentration),sugar/glucose level, Amino Acid concentration , blood pressure etc**

Significance of Homeostasis

- Enable the body of organism to maintain optimum conditions for efficient functioning of enzymes
- Prevents the body from disease infections

Concept of Osmo- regulation

Osmo- regulation is the process by which the osmotic pressure of blood and tissue fluid is kept fairly constant.

Involves controlling the water content and the salt concentration in the body fluid of an organism.

Excretion and osmo- regulation in protozoa e.g amoeba

Protozoa e.g. amoeba have large surface area to volume ratio; their waste products (carbon dioxide, excess mineral salts and ammonia) diffuse out of all the cell across their cell membrane into surrounding water.

-In protozoa /Amoeba, osmo -regulation of water is by a **contractile vacuole** .

During osmo- regulation;

- contractile vacuole forms,
- water enters amoeba via its cell membranes by osmosis,
- excess water collects in the contractile vacuole making it to swell;
- contractile vacuole with water moves towards cell surface, fusing with it and bursts open releasing its content into the surrounding water.

Describe how excretion and Osmo regulation takes place in a named protozoa.

EXCRETION IN PLANTS

Plants have simple excretory systems as compared to animals; ie depend on simple diffusion via lenticels, stomata and store wastes as less toxic products.

QN Explain why plants do not have an elaborate excretory system?

- Are less active /do not locomote, low metabolic rate, hence very little accumulation of toxic waste in their bodies.
- Some plant waste products (gaseous products) are utilized by plant e.g. carbon dioxide for photosynthesis and oxygen for aerobic respiration.
- Excess/extra gaseous waste is removed from plants by simple diffusion via stomata and lenticels.
- Most waste substances formed are stored in the tissue in less harmful forms; e.g Resins.
- Excess water and dissolved gases are removed through transpiration process via stomata and lenticels.
- some plants remove waste products by exudation e.g. Gums, Resins, Latex and Rubber

- Excess salts in some plants ooze out via Hydathodes through Guttation. Example in maize seedlings.
- Plant convert toxic substances into harmless substances and store them in petals, Leaves, fruits and seeds that mature and fall off.
- Synthesise all their organic requirements according to demand hence no excess is always produced.

Some plant excretory products, plants source and effects/Economic importance to humans.

Excretory products	Plant source	Effects/Economics importance
Caffeine	Coffee and tea plant	-Mild stimulant, increases mental activity and reduces fatigue. -increase activity of Adrenaline. -Addiction may cause heart and kidney damage.
Quinine	Cinchona tree	For treatment of ailment like malaria
Cocaine	Coca plant	-used as a local anaesthetic drugs -cause addiction -Leads to extreme agitation ,anxiety, hallucinations and even death
Rubber	Rubber plant	-Raw materials in leather shoes and tyre industry. -Manufacture of chewing gum
Cannabis	Cannabis sativa	-stimulant that leads to less concentration, intellectual and less manual abilities. -used to make drugs.
Tannins	Barks of trees	-Turn hides of cow into leather used in making shoes, bags belts etc -used in printing fabrics ,dyeing clothes and making mats
Latex	Barks of trees	-used in shoe industry, manufacture of tyres and making rubber
Nicotine	Tobacco plant	-Making insecticide ,cigarettes. -cause lung cancer, respiratory disease, low birth weight in babies.

Papain	Pawpaw plant	Has papaw enzyme used in meat industry as tenderizer(softening tough meat)
Khat	Miraa plant (catha edulis)	-mild stimulant -used as medicine -used in Genetic research
Opiates	Opium poppy plant	-manufacture of pain killer drugs e.g morphine -cause addiction -over dose can lead to coma and death
Gum Arabic	Arabic tree	-Food processing -printing industry -making perfumes and medicine.

Excretory methods of waste products in plants

- Water vapour and carbon dioxide diffuse out of the plant cells ; released via stomata & lenticels.
- Oxygen produced as byproduct of photosynthesis, some are used up during respiration at night , excreted during day via the stomata .
- Carbon dioxide is used up during photosynthesis at day time. Excess Carbon dioxide produced during day and night is eliminated by diffusion via stomata and lenticels
- Toxic substances are converted into harmless substances and stored in petals ,leaves, fruits ,Roots and seeds which then shed off.
- Some wastes are stored in vacuole of plant cells and in dead permanent tissues e.g perennial trees; □ Aquatic plants release most of their waste products directly in the water.

Questions

- Explain the role of stomata in getting rid of water vapour carbon dioxide
- Explain how plants get rid of metabolic waste products
- Explain how some waste products of plants are useful to humans.

EXCRETION IN ANIMALS

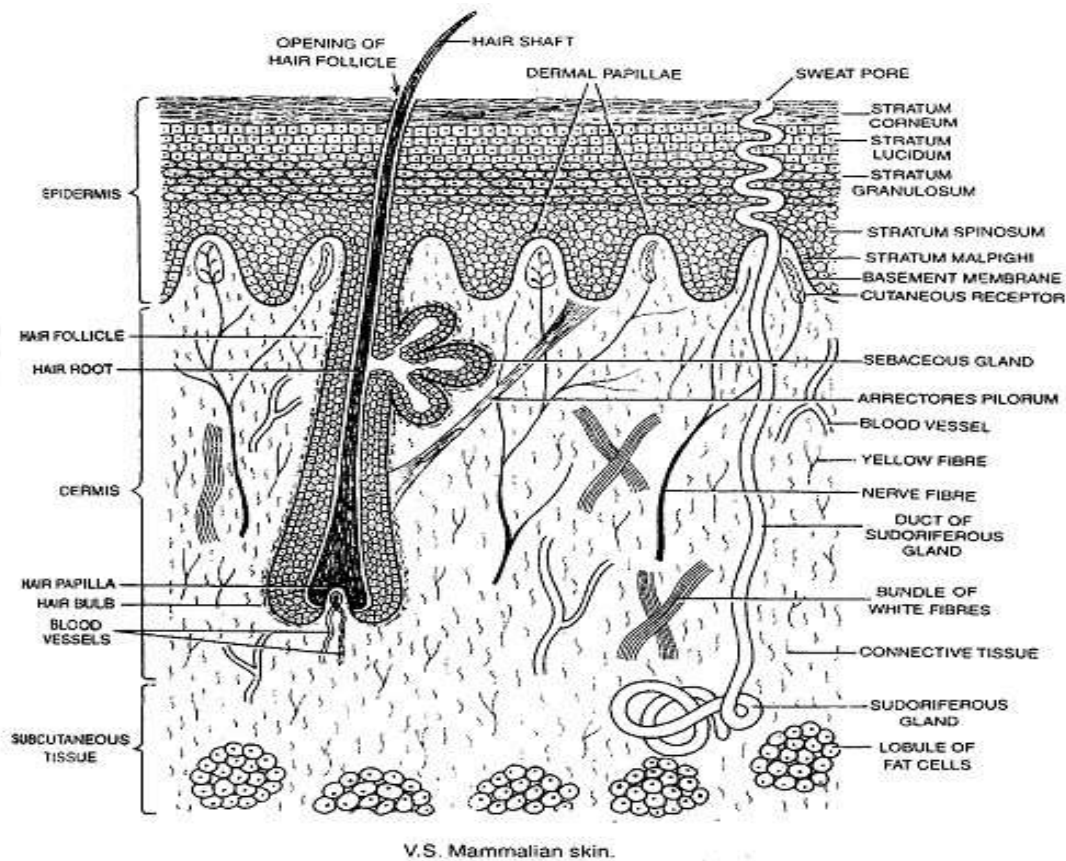
Waste products are separated and eliminated from animal bodies via special organs, **excretory organs**

Examples of excretory and homeostatic organs in various animals are as summarized in the table below;

Animals	Excretory /homeostatic structures
Platyhelminthes, Annelids e.g., earthworms Insects Arachnids Fish Amphibians (i) Adults (ii) Tadpoles Reptiles Birds Mammals Antennal gland	-flame cells -Nephridia -malpighian tubules -book lungs -Gills and kidney -Lungs,kidney,skin,liver -External gills,liver,kidney -Lungs,liver,and kidney -Lungs ,kidney and liver -Liver,lungs,kidney and skin -crabs

STRUCTURE AND FUNCTION OF MAMMALIAN SKIN

Structure of the mammalian skin;



Mammalian skin consists of two main layers, the ;

- ✓ Outer layer (epidermis) consisting of cornified layer, granular and malpighian layer
- ✓ Inner layer (Dermis) blood vessels, nerve endings, sweat glands, hair follicles and subcutaneous fat layer.

Detailed structure of mammalian skin.

Part	Structural features	Functions
(a) Epidermis		
(i) cornified Layer	-Outer most layer, made up of dead cells; forming a tough protective outer layer. -thickness varies from one part of the body to another e.g., thicker in soles of feet. -wears away and is continuously replaced by new cells produced by malpighian layer - cells here are filled with keratin protein.	-protects against entry of micro organisms (pathogen) into the body. - reduces water loss and protect inner layers from mechanical damage. - keratin strengthens the skin and makes it water proof.
(ii) granular layer	- middle layer of Epidermis.	-consists of living cells, which form cornified layer

(iii) malpighian layer.	-inner most layer - consists of actively dividing cells that renew epidermis. -has melanin(black pigment)	melanin contributes to skin color& protects skin against ultra violet rays which would damage the skin cells beneath.
(b)Dermis	- thicker than epidermal layer	
(i)sweat glands		- secrete and release sweat via pores on the surface of skin, & on evaporation , provides a cooling effect. NB; sweat contains ; -excess water, excess mineral salts e.g sodium chloride ,traces of urea and lactic acid
(ii) Blood capillaries		-serve the skin with oxygen ,nutrients and - carry away carbon dioxide and other wastes.
(iii) Hair follicles	- tiny pits in which hair grows after an addition of cells. - Hair is a composition of dead skin and keratin protein.	
(iv) sebaceous glands	- open into hair follicles	- produce an oily substance (sebum) which softens skin and kills bacteria on the skin surface.
(v) Erector pilli muscle	- attached at bottom part of hair follicle and epidermis.	- regulates the position of hair on skin surface; i.e., during cold weather, it contracts ,making hair erects/stand and goose pimples appears ,thereby increasing insulation & during warm/hot weather, relaxes ,making hair lie flat to reduce insulation and encourage heat loss;
(vi) Subcutaneous fat layer		-insulates against heat loss

QUESTION;

- o With the aid of a well labeled diagram ,describe the structure of a mammalian skin
- o Describe the structure of a mammalian skin and state the function of some parts.

General functions of the mammalian skin

- ✓ protect underlying tissue from mechanical injury, loss of water and entry of disease causing germs(pathogens) and ultra- violet rays.
- ✓ temperature regulation

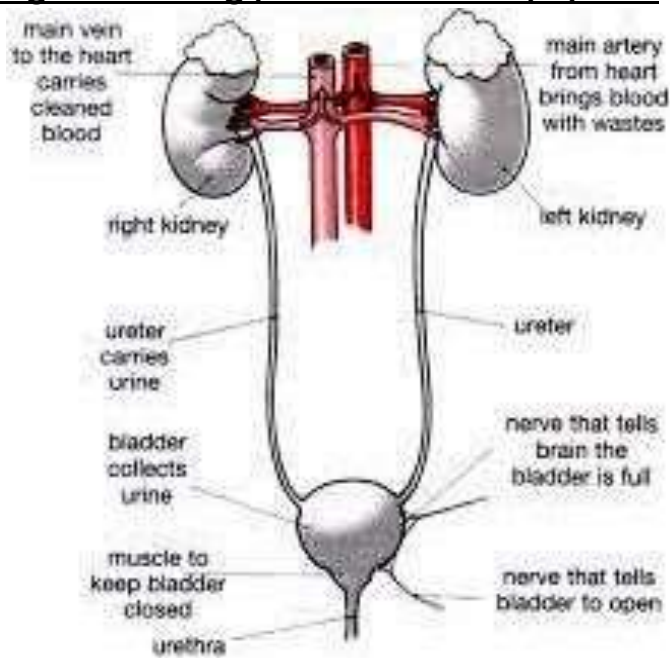
- ✓ lipid storage (fat storage in fat cells)
 - ✓ excretion of excess salts, excess water, traces of urea and lactic acid via sweat.
 - ✓ synthesis of vitamin D
- Receives stimuli inform of heat, cold, pain, touch and pressure since it has numerous sensory nerves.

QUESTION.

Describe the functions of the mammalian skin.

THE URINARY SYSTEM

Diagram showing parts of the urinary system



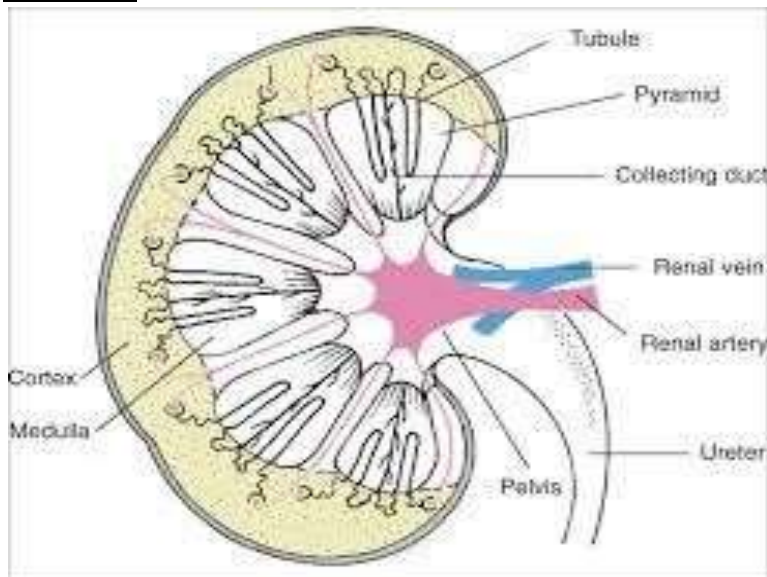
Gross structure of the kidney

- Are paired bean shaped, red brown organs located below the middle of the back on each side of the spine; with left slightly above the right kidney.
- Each is supplied by blood from the aorta through the renal artery containing oxygen and nutrients; drained by renal vein; taking blood to the heart via vena cava.
- Urine leaves the kidney through a pair of ureters; which pour into the urinary bladder; for temporary storage; where it leaves through the urethra; controlled by sphincter muscle.

Transverse section of kidney

- Consists of 2 distinct region; **cortex** and **medulla**.
- Cortex is covered by fibrous capsule & consists of glomerulus, renal capsule, parts of nephron.
- Medulla contains renal tubules; collecting duct; and blood vessel, which together form renal pyramid.
- Apices of renal pyramids; project into pelvis.

Diagram of the mammalian kidney through a vertical section showing its structure



Qn(a) Describe the structure of a mammalian Kidney

(b) With the aid of a well labeled diagram , describe the structure of a mammalian kidney.

Functions of a kidney

- ✚ Removal of metabolic wastes
- ✚ Regulation of water content of blood
- ✚ Ionic balance of blood
- ✚ Regulate the blood pH

Role of the Nephron in Excretion

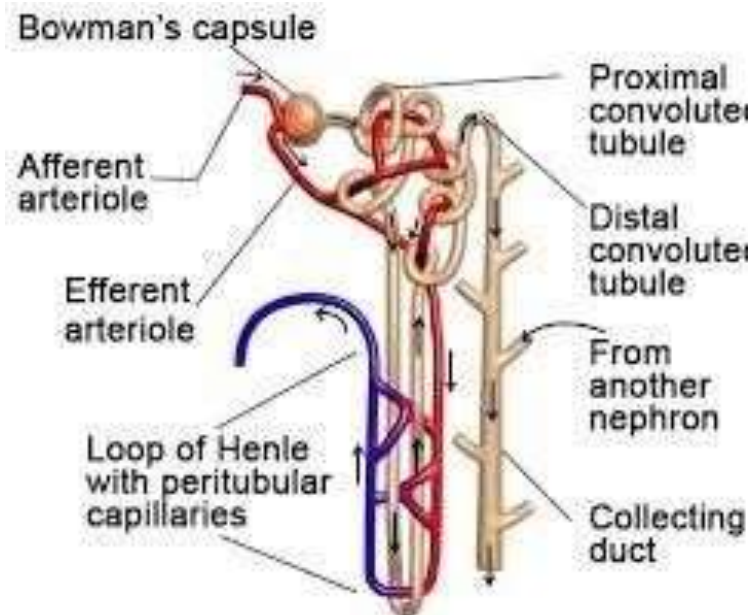
Structure of a nephron

ü Nephron is a basic structural and functional unit of a kidney, are numerous in each kidney .Each kidney has about one million nephrons .

Each nephron is composed of;

- Glomerulus , supplied by afferent arteriole and drained by efferent arteriole,
- Bowman capsule, proximal convoluted tubule , loop of henle ,Distal convoluted tubule ,collecting tubule, linking the nephron to the collecting ducts that later empties urine into ureter.

Diagram showing the structure of a Nephron



QUESTION

□ Describe the structure of the kidney(Nephron) responsible for urine formation.

Excretion by the Nephron./ urine formation

Excretion of the nephron is **ultra –filtration** and **selective re**

absorption (i) Ultra filtration;

-occurs in renal capsule/ bowman"s capsule and endothelium of glomeruli.

During ultra-filtration;

- ✓ High blood pressure at the glomerulus, caused by arteriole (afferent arteriole) entering the bowmans capsule being wider than the efferent arteriole forces liquid part of blood with dissolved substances urea, glucose, salts ,Amino acids and water out through the pores in the glomerulus into the cavity of Bowmans capsule ; forming **glomerular filtrate**.
- ✓ Blood proteins and cells (RBC and WBC, platelets) are retained because of their large molecular size.

(ii) selective reabsorption;

-Is a process in which many solute materials (amino acids, vitamins, hormones, glucose, antibodies, Na⁺ etc) still of importance to the body are taken back to the blood stream; from the glomerular filtrate.

-Occurs in the proximal and distal convoluted tubules.

During selective re-absorption ;

- ✓ glomerular filtrate flows down into proximal convoluted tubule and other tubule as useful substances are re-absorbed, into blood capillaries ,i.e., amino acids and glucose , water, some vitamins and some minerals which are actively re-absorbed in the Proximal convoluted tubule.
- ✓ Sodium ions & water are re-absorbed at loop of henle under influence of Aldosterone Hormone.
- ✓ Water is re-absorbed at both Proximal convoluted tubule and Distal convoluted tubule ,but highest percentage at collecting ducts by osmosis influenced by Antidiuretic hormone (ADH)/ vasso pressin .
- ✓ From the DCT , glomenular filtrate then flows into collecting duct where its now urine ; ÷ Urine drains into pelvis, ureter and finally urinary bladder.

- QUESTION;**
1. Explain how kidney function to get rid of waste product
 2. Describe the process of urine formation in the kidney.

Percentage concentration of components in blood , Plasma,Renal fluid and urine

components	% in bloodplasma	% in Renal fluid	% in Urine
Water	70-93	90-92	95
Protein	70	0.0	0.0
Glucose	1.1	0.1	0.0
Sodium ions	0.3	0.3	0.35
Chloride ions	0.4	0.4	0.6
Urea	0.033	0.33	2.0

Interpretation

- composition of urine is water ,urea and salts(chorides & sodium ions)
- Glucose and proteins are absent in urine because all the glucose is completely re-absorbed in the proximal convoluted tubule; as proteins are retained in the glomerulus ,proteins (plasma proteins) are too large to filter through capillary walls .
- Amino acids are also completely re-absorbed and are absent in Urine.

Role of the kidney in Osmo regulation

Kidney regulates concentration of water in blood by checking on its absorption and salts by tubules.

A fall in water content in blood;

- ✓ is detected by osmoreceptors in hypothalamus in the brain ,
- ✓ responds by sending impulses to the pituitary glands, stimulating it to secrete Antidiuretic hormone(ADH) into blood : carried to kidney tubules making their walls more permeable hence allowing more water re-absorption from filtrate into blood and water content is restored to normal, less volume of concentrated urine is produced.

Arise in water content in blood above normal;

- ✓ Is detected by the osmoreceptors in hypothalamus in the brain
- ✓ Responds by sending impulses to pituitary glands, stimulating it to secrete less or no ADH making kidney tubule walls less permeable ; decreasing its re-absorption back into blood stream → Excess water in blood is lost as dilute urine and a large volume of urine is produced.

NB: Failure of ADH secretion by the body (pituitary glands) due to surgical removal of pituitary glands/ malfunction glands, causes kidney condition described as **Diabetes insipidus/diuresis..**

Its characterized by excessive loss of water /large volumes of dilute urine frequently and hence frequent thirsty and dehydration.

QUESTION ;

1. (a) Explain the role of kidney in osmo- regulation in man (**see notes**)
2. In an investigation , the approximate composition of plasma, glomerular filtrate and urine in a mammal was determined .The results are shown below in a table

Components	Plasma g/100cm ²	Glomerular filtrate g/100cm ²	Urine g/100cm ²
Urea	0.04	0.04	2.10
Uric Acid	0.005	0.005	0.07
Glucose	0.20	0.20	0.00
Amino acids	0.07	0.07	0.00
Plasma Proteins	9.00	0.00	0.00
Sodium ions(Na ⁺)	0.0032	0.0032	0.0035
Chloride ions(Cl)	0.0037	0.0037	0.006

- (a) Explain the absence of the following
 - (i) Plasma protein in glomerular filtrate
 - (ii) Glucose and amino acids in urine
- (b) (i) From the above results, identify the two types of wastes eliminated from mammalian blood.
 - (iii) Other than excretion, Give other functions of the mammalian kidney.
- (c) (i) State the principle requirement of filtration that forms glomerular filtrate.

- (d) Explain why urea concentration is greater in the urine than in plasma and glomerular filtrate.

Solution

- a) (i). Plasma protein are retained in the glomerulus; because they are large sized to filter through capillary walls;
(ii). Glucose and Amino acid are completely re-absorbed along the kidney tubules/proximal and distal convoluted tubules.
- b) (i) Nitrogenous wastes, mineral salts /excess mineral salts, excess water
(ii). Osmo- regulation , conservation of glucose and amino acids
- c. (i).high pressure caused by large Lumen of afferent renal arteriole being wider than efferent arteriole, .pumping action of the heart; narrow capillaries of glomerular
- d) Concentration increases due to re-absorption of water in the tubules and No urea is reabsorbed.

3. The table below shows how the quantities of sweat and urine vary with external temperature;

External temperature in °C	Urine cm ³ /hour	Sweat cm ³ /hour
0	100	5
5	90	6
10	80	10
15	70	20
20	60	30
25	50	60
30	40	120
35	30	200

- a) Plot the quantities of urine produced and sweat produced against the external temperature on the same graph.
- b) At what temperature are the amounts of sweat and urine produced equal
- c) What happens to the amount of sweat produced as temperature rises .Explain the observation.
- d) Explain the observation made on the amount of urine produced as the temperature increases

e) How is the skin adapted for temperature regulation.

Solution

(a) graph

b) see from plotted graph

c) Sweat production increases with increase in temperature blood;
because high temperature increase the evaporation rate ; more sweat is converted to vapour ,using up latent heat of vapourization from the body and cause cooling.

d) An increase in the temperature decreases the amount of urine produced .This is due to increased sweating which raises the osmotic pressure of blood .A lot of water is re-absorbed into the blood at the kidney tubules, resulting in the production of less and concentrated urine .

Lungs and their role in the temperature regulation

The body loses heat through breathing out .The air breathed in is cold , but gets warm as its carried along respiratory tubes .Cold air gains heat through conduction as it provides cooling effect.

Lungs and their Roles in excretion

- Lungs remove carbon dioxide ,water in form of vapour and heat from the body.
- Carbon dioxide and water are end products of Aerobic cellular respiration that diffuse out of the blood plasma into alveoli of lungs while in the lungs (water,carbondioxide) are eliminated through exhalation.

MAMMALIAN LIVER

- Largest gland in the body ,found beneath the diaphragm;
- Its connected to blood vessels that include hepatic artery ,the hepatic portal vein and the hepatic veins.

Functions of the Liver

(i) Regulation of amino acids

- ❖ Excess amino acids are destroyed/ hydrolysed in the liver during deamination.
- ❖ Involves removal of Amino group from each amino acid which is later converted into ammonia, meanwhile the remaining amino acids residue is converted to carbohydrate compound, pyruvic acid, oxidized during respiration.
- ❖ ammonia formed is quickly combined with carbon dioxide because it's more toxic, thereby forming less toxic Nitrogenous wastes- urea,
- ❖ Urea is released into the blood stream and carried to the kidney where it's excreted.

GUIDING QUESTIONS;

1. Describe how the liver gets rid of excess amino acids /proteins in the body
2. Describe the formation of urea in the mammalian body and state where it's excreted.

(ii) Detoxification

- Is the process of converting toxic substances (drugs, alcohol, & hydrogen peroxide) to harmless ones
e.g Hydrogen peroxide produced by respiring cells is broken down by enzyme catalase to form water and oxygen which are harmless.

(iii) Regulation of blood sugar level

- Blood sugars are vital for cellular respiration/production of energy
 - The normal blood glucose level required in the body is regulated by the liver within 90-100 mg/100cm³ of blood.
 - After the digestion of a carbohydrate rich meal, glucose is formed that is absorbed at ileum, through Hepatic portal veins into the liver.
- Its absorption raises blood glucose level above normal,
- ❖ Deviation is detected by hypothalamus ; sends impulses to the pancreas; stimulating the beta cells of islet of Langerhans to secrete insulin hormone into bloodstream ;

- ❖ On reaching the liver, insulin stimulates the liver to convert excess glucose into glycogen for storage in the liver and muscle cells ,
- ❖ Insulin hormone also increases respiration (cellular respiration) causing more breakdown of excess glucose into carbon dioxide and water,
- ❖ Increase conversion of excess glucose into fats for storage, all causing blood glucose level to decrease to normal.

When the level of blood glucose decreases below normal due to starvation/during exercise,

- ❖ Deviation is detected by hypothalamus; which send impulses to the pancreas, stimulating the Alpha cells of islets of langerhans to secrete Glucagon hormone into blood stream.
- ❖ On reaching the liver ; stimulates it to convert stored glycogen to glucose and reduce cellular respiration(metabolism of glucose), restoring blood glucose level to normal.

Other functions of the Liver

- ✓ Manufacture of Red blood cells during foetal stages
- ✓ Formation and elimination of excess cholesterol
- ✓ Storage of vitamins A,B,C,D,E and storage ions such as copper,Zinc and iron
- ✓ Storage of blood since its highly vasculonised and holds a large volume of blood
- ✓ Formation of bile
- ✓ Destruction of old and worn out Red blood cells
- ✓ Breakdown of hormones especially during sex hormones
- ✓ Temperature regulations. The liver is very active with many metabolic activities that lead to production of heat.
- ✓ Synthesis and regulation of plasma proteins.

ACTIVITY

In an investigation, two persons A and B drunk the same amount of glucose solution. Their blood sugar levels where determined immediately and thereafter at intervals of one hour for the next six hours. The results where as shown in the table.

Time(hours)	Blood glucose levels	
	Person A	Person B

0	90	120
1	220	360
2	160	370
3	100	380
4	90	240
5	90	200
6	90	160

- Draw a graph of blood sugar levels of persons A and B against time on the same axes
- Explain each of the following observations
 - blood sugar level increased in person A between 0 and 1 hour
 - The blood sugar levels dropped between 1 and 4 hours
- From the graph, what is the normal blood sugar level for human beings
- Suggest a reason for high sugar level in person B
- How can the high blood sugar level in person B controlled
- What is the biological significance of maintaining a relatively constant sugar level in a human body?
- Account for the decrease in the blood sugar level of person B after 4 hours

Temperature Regulation in Animals

Animals have the ability to regulate body temperature within an optimum range to **enhance proper functioning of enzymes within their optimum range i.e., low temperature below optimum inactivates and high temperature above optimum denature enzymes** Categories of organism according to temperature regulation

a) Endotherms/Homoiotherms (b) Ectotherms/poikilotherms

(a) Endotherms/Homoiotherms

- ✓ Animals which are able to regulate/ maintain constant body temperature irrespective of the changes in environmental temperature;

- ✓ E.g Mammals and Birds

Advantages of Endothermy

- ✓ allows organisms to live in a wide range of environment conditions since they are able to regulate their body temperature.
- ✓ allows enzyme controlled reactions to go on without interference since temperatures do not reach extreme.
- ✓ Permits organism to be active always ie maintain high metabolism rate throughout the day. ü Quick response to stimulus

Disadvantages of Endothermy

- ✓ require more food to provide heat energy
- ✓ Require efficient methods to raise/lower body temperature in very hot and cold seasons ü Require advanced structures for excretion due to high metabolism rate.

(b) Ectotherms /poikilotherms

- ❖ are animals whose body temperatures depend entirely on those of the environment; thus unable to maintain a fairly constant temperature.
- ❖ Their body temperature fluctuate periodically with those of the environment v e.g Amphibians, Reptiles and Fish, insects.

Advantages

- ✓ require less food /food consumption is low because of low metabolism
- ✓ Require simple activities to regulate their body temperature e.g basking in the sun

Disadvantages

- ✓ low metabolic rates and therefore respond slowly to stimulus. ü less active at low environmental temperatures
- ✓ unable to survive in some habitats with extreme temperature

Temperature regulation in Endotherms

a) In cold conditions,

- ✓ Increase the rate of metabolism to ensure production of more heat

- ✓ Arterioles constrict (Vaso constriction) so that less blood enters the capillary network towards the skin surface, less heat is lost through radiation and convection.
- ✓ Sweat glands become inactive and hence reduced sweat production, so no heat is lost
- ✓ In dogs, Jaws are closed so that breathing is slow and it occurs only via the Nostril
- ✓ For Aquatic endotherms, they come out of water at night when air in the environment is cooler.
- ✓ The hair is raised making a thicker coat for trapping a layer of warm air /more air as an insulating layer against heat loss.
- ✓ By shivering /contraction and relaxation of the skeletal muscles to generate heat ü Have a thick subcutaneous fat layer which insulates the body against heat loss.
- ✓ Behaviorally through taking hot /warm drinks e.g man/human beings, Wearing heavy clothes, Engaged in vigorous exercise ,sleeping under heavy blankets, sit near heat source, some animals come close together (rooting) to gain heat from one another.

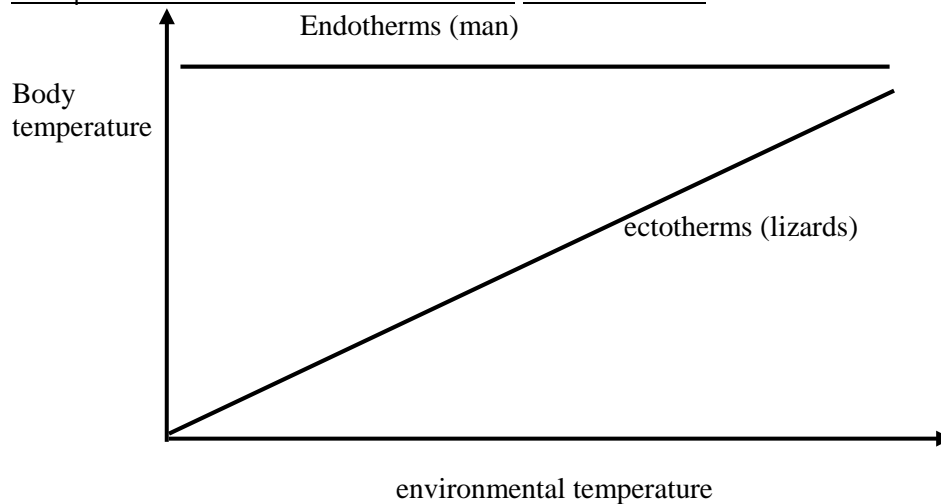
b) In hot conditions,

- ✓ Sweat glands in the skin are activated and hence increased sweat production to ensure heat loss through evaporation of sweat.
- ✓ Hair Erector pilli muscles relax making hair to lie flat on the body .This encourages heat loss through radiation and convection.
- ✓ Rate of metabolism decrease so that less heat is generated
- ✓ Arterioles relax and more blood enters the capillaries network near skin surface to encourage more heat loss via Radiation and convection.
- ✓ In dogs panting occurs so that water in saliva evaporates as the animal exhales
- ✓ Animals in warm areas have a thin fatty layer to increase heat loss
- ✓ Behaviorally through ;
 - i. Moving away from direct heat source
 - ii. Moving under shade/go to the shade
 - iii. Putting on light clothes
 - iv. Deep sleep when hot(aestivation)
 - v. Taking cold drink to allow cooling effect
 - vi. Regular bathing/swimming as in some animals
 - vii. Turn on fan and air conditioners e.g. human beings

Temperature regulation in Ecotherms

- ✓ Basking in the sun to gain heat
- ✓ Moving to the shade to cool their body temperature
- ✓ Burrowing into cracks in walls on cold days
- ✓ Deep sleep when temperatures are low/Hibernation
- ✓ Thermal gapping, opening their mouth widely so as to lose heat through evaporation.
- ✓ Deep sleep when the temperatures are high in the cold season(Aestivation) ü Swimming on hot days.

Graphical relationship between environmental temperature and body temperatures of Ectotherms and Endotherms



Interpretation

- Body temperature of Endotherms remains constant with increasing environmental temperature because their body is able to maintain a constant internal temperature.
- Body /internal temperature ectotherms increases with the increasing external/environmental temperatures because they lack means for maintaining a constant internal body temperature.