ENZYMES

Definition: These are organic biological molecules, protein in nature produced by living cells that speed up the rate of metabolic reactions but are not used up in the course of the reaction. The substance enzymes catalyse is called substrates. Examples of enzymes are: ptyalin or salivary amylase, pepsin, pancreatic lipase etc.

Properties of Enzymes

- They are protein in nature
- They are not destroyed by the reaction they catalyse
- They are rapid in action
- They are denatured by excessive or high temperature
- They are specific in action
- The reaction they catalyse are reversible example A+B↔C+D
- They are sensitive to specific pH.

- **Temperature**

Enzyme catalyse reaction within a temperature range of 35-40^{0}C. Out of this range, enzymes are inactivated or denatured. A fall in temperature below this range reduces the rate of reaction thus enzymes are inactivated and increase in temperature above this range equally causes a decrease in the rate of reaction thus enzymes are denatured. Temperature at which enzyme catalyse activity is greatest is called optimum temperature.

- **pH**

  This is the degree of acidity and alkalinity of a medium. Enzymes act within specific pH range. Some act best in extreme acidity while others in extreme alkalinity. Each enzyme has optimum pH at which it is most active. Example trypsin has an optimum pH of 8 and pepsin 2.

- **Enzyme**

The rate of enzyme catalyses reaction increases when enzyme concentration increase and vice versa. Substrate concentration has a similar effect.

- **Inhibitors**

These are substances that slow down the rate of enzyme catalyse reactions such as nicotine, cyanide and heavy metals. These substances slow down or stop enzyme control reactions.

Experiment to Test for Enzyme Activity.

- To Test for the effects of pH on Enzymes.

Requirement: Test tubes, starch solution, saliva, sodium carbonate solution, dilute hydrochloric acid, water bath.

Procedure
Four test tubes A, B, C and D are used. Test tube A contains 5% starch solution as control. Test tube B contains 5% starch solution plus ¼ teaspoon amylase solution or saliva.

Test tube C contains 5% starch solution plus ¼ teaspoon amylase and few drops of 1% $NaCO_3$ solution.

Test tube D contains starch plus ¼ teaspoon amylase, few millilitres of dilute HCl and test tube kept at 37^0C in a water bath. At intervals of 30 seconds a drop of each solution is placed on a white tile and a drop of iodine solution added.

Observation

Solution A produces a blue-black colour each that is no change in starch.

Solution B changes from blue-black to purple to brown showing that starch has disappeared.

Solution C showed similar results as B but changes occur faster.

Solution gives a blue-black colour all times

Conclusion. This shows that amylase convert starch to other forms. This conversion proceeds faster under favourable conditions such as alkaline medium and is hindered in acidic medium. Hence enzymes are specific to pH.

Dentition

This is the number, types an arrangement of teeth in the mouth of an animal. There are two types of dentition in animals namely homodont and heterodont dentition.

- Homodont dentition: teeth in the mouth are of the same size and shape as in fishes, amphibians and reptiles.
- Heterodont dentition: teeth in the mouth are of different shapes and sizes as in mammals (man, goat, cow, pig, rabbit etc.)

Types of Teeth in the Mouth of Mammals.

Mammals have two sets of teeth in their life time. The first set of teeth is called milk teeth while the second set are permanent teeth. There are four types of teeth in the mouth of mammals each with a specific function. The different types of teeth have the same basic structure. The four types of teeth include incisors, canines, premolars and molars. Molars are never found in milk teeth.

Below are the functions of the different tooth.

Incisors: Used in cutting and biting food, holding prey by some animals.

Canines: Used in tearing flesh from bones, seizing, piercing and killing prey.

Premolars and Molars: Used in crushing food and cracking bones.

Structure of the tooth (diagram)

Functions of Parts.

digestion is achieved by the teeth and muscles of the stomach while chemical digestion is achieve by enzymes.

- **Absorption:** This is the uptake of simple soluble product of digestion into the blood stream.
- **Assimilation:** This is the effective use of end products of digestion to provide energy, growth, repair and replacement of worn out tissues etc.
- **Egestion:** Elimination of undigested food to the outside through the anus.

Why digestion is necessary (importance).

- It increases surface area of food for easy break down by enzymes.
- It converts food into soluble and absorbable units for easy uptake by cells of the body.
- It helps to kills microbes in food.
- It enables valuable part of food to be selected and unwanted part eliminated.

Digestion in different parts of the gut or alimentary canal.

Digestion in the mouth

- When food is ingested into the mouth, it is chewed.
- Chewing break down food into smaller particles thus increase surface area for enzyme action.
- The chewed food is moistened with saliva to ease swallowing.
- Saliva also contain an enzyme called salivary amylase or ptyalin which begin chemical digestion of starch to maltose.
- Chewed food is roll by the tongue into a bolus
- The tongue is raised upward and backward to force the bolus to the back of the mouth for swallowing.
- During swallowing, breathing is temporally stopped as food presses on the epiglottis closing entrance into the wind pipe.
- Bolus move by peristalsis along the oesophagus into the stomach.

Digestion in the stomach

- It stores food temporarily after meals and release it slowly into the rest of the gut.
- presence of food in the stomach stimulates the stomach walls to secrete the hormone gastrin into the blood.
- gastrin stimulates the gastric gland in the stomach walls to secrete gastric juice.
- Gastric juice contains dilute solution of HCl and inactive enzymes pepsinogen and prorenin.

Ruminants	Non-ruminants
Have four chambered stomach	Absent
Chew their cud (rumination)	Does not chew their cud.
Upper jaw lack incisors	Upper jaw have incisors
Have cellulose digesting bacteria in their rumen	Bacteria in caecum
Examples as in goat, sheep, cow	Examples as in horse, rabbit.

Digestion in Ruminants (Goat).

- The goat uses it incisors to cut grass and this is aided by the long flexible tongue.
- Grass is chewed and swallowed. The diastema separates freshly cut grass from chewed grass.
- Chewed grass enter the first two compartment of the stomach (rumen and reticulum)
- In the rumen chewed grass undergo fermentation by symbiotic bacteria.
- Bacteria produce enzyme cellulase which digest cellulose to disaccharide.
- The end products of fermentation are carboxylic acids such as ethanoic acid carbon dioxide and methane.
- The acids are absorbed by the host which serves as a major source of energy in respiration.
- Bacteria obtain energy through chemical reaction of fermentation and have ideal temperature for survival.
- The partially digested food is passed to the second chamber the reticulum where it is moulded into cud or pellets.
- The cud is regurgitated (send back to the mouth) for thorough chewing. This process is rumination or chewing the cud.
- The food is re-swallowed and undergoes further fermentation.
- The partially digested food passes through the first three chambers of the gut to reach the abomasum which correspond to the stomach in man. From here, digestion continuous as in man.

Adaptations of Herbivores to Their Diet.

- Have sharp and chisel-like incisors for cutting grass.
- Have hard horny pad that help in cutting grass.
- Have the diastema that help to separate chewed grass from freshly cut grass.
- Premolars and molars have flat and broad surfaces for grinding grass.
- Have loose joint between the skull and lower jaw which permit to and fro, sideways movement of jaw for proper grinding of grass.

Respiration.

Definition. This is the chemical breakdown or oxidation of food in the presence or absence of oxygen to release energy. This energy is made available to cells in the form of ATP. When it occurs in the presence of oxygen it is called aerobic respiration while in the absence of oxygen it is called anaerobic respiration. The organic molecule most commonly used as substrates in this process is carbohydrates such as glucose or fats. They are broken down gradually in a series of enzyme controlled reactions with the release of small amount of energy some of which is stored in the form of ATP and the rest lost as heat.

Types of Respiration.

Aerobic Respiration. This is the chemical break down of food such as glucose or fat in the presence of oxygen to release energy. It can be summarised by the equation below

$$C_6H_{12}O_6 + O_2 \xrightarrow{\text{enzymes}} CO_2 + H_2O + 2827KJ\ Energy$$

It occurs in two stages that is partly in the cytoplasm in the absence of oxygen called glycolysis. During glycolysis glucose is broken down to pyruvate which enters the mitochondria for further break down. Second stage in the mitochondria where pyruvate is completely broken down into CO_2 and H_2O with the release of much energy in the form of ATP.

Anaerobic Respiration. This is the chemical break down of glucose or fat in the absence of oxygen to release energy. Little amount of energy is release and glucose or fat is partially broken down into CO_2 and ethanol as in equation below

$$C_6H_{12}O_6 \xrightarrow{\text{enzymes}} CO_2 + C_2H_5OH + 210KJ\ Energy\ (\text{in plants})$$

$$C_6H_{12}O_6 \xrightarrow{\text{enzymes}} \text{lactic acid} + 210\ KJ\ Energy\ (\text{in animals})$$

In animals such as man, it occurs in muscles during vigorous or stannous physical exercise. An oxygen debt is created due to insufficient supply oxygen thus the muscle resort to anaerobic respiration. This is a supplement to aerobic respiration to satisfy the energy need of the body during exercise. Accumulation of lactic acids in the muscle may cause muscle cramp during exercise. The lactic acid is slowly converted to pyruvate for further break down or pyruvate to glucose by reverse glycolysis.

Differences between Aerobic and Anaerobic Respiration.

Aerobic Respiration	**Anaerobic Respiration**
Require O_2	Does not require O_2
Food is completely oxidised	Food is partially oxidised
Occur in the mitochondria	Occur in the cytoplasm
Occur in higher organisms like man or animals	Occur in lower organisms like bacteria
Bi-products are not toxic CO_2 and H_2O	Bi-products are more toxic; ethanol and lactic acid
Involve breathing and tissue respiration	Involve only tissue respiration.
Produce much energy	Produce less energy.
Similar in plants and animals	Different in plants and animals

- At the distal convoluted tubule, more salt and water are reabsorbed.
- The fluid that move to the collecting duct is more concentrated than before.
- At the collecting duct more water is reabsorbed depending on the osmotic concentration of the body.
- The useful substances reabsorbed return to the body through the capillaries.
- Fluid that remain in the collecting duct is called urine which is made up of nitrogenous waste, some water and salt.
- Urine is carried through the ureter to the bladder for temporal storage and then release at intervals following relaxation of the sphincter muscle. (diagram)

Osmoregulation. This is the maintenance of a constant osmotic pressure of body fluid that is blood and tissue fluid by keeping the water and salt content constant. This is necessary to prevent water moving in and out of cells by osmosis.

How the kidney function in osmoregulation?

- When blood becomes more concentrated as a result of excessive sweating on a hot day, too little water drunk or much salt consume.
- The osmoreceptors in the hypothalamus are stimulated and impulses send to the pituitary gland.
- The pituitary gland release anti diuretic hormone (ADH) into the blood stream which is transported to the kidney tubules.
- ADH brings about permeability of the kidney tubules at the distal convoluted tubule and collecting duct to water.
- Thus water is reabsorbed from the glomerular filtrate to the blood stream. In this situation urine produce is usually less in quantity and coloured. This is common on a hot weather climate.
- When the body fluid is less concentrated due to much water drunk or less salt consume, the osmoreceptors are less stimulated and little or no ADH is secreted.
- This make the walls of distal convoluted tubule and collecting duct becomes less permeable to water. Thus less water is reabsorbed from the glomerular filtrate into the blood stream.
- This increases the osmotic pressure of blood and tissue fluid. In this situation very dilute and colourless urine is produced.

NB. Failure to produce enough ADH lead to a condition known as diabetes insipidus in which large quantity dilute urine is produced called (diuresis).

The skin.

This is the largest organ and forms the outer covering of the human body. The thickness varies with respect to part of the body and from person to person and has many different functions.

Vitamin synthesis. The skin synthesis vitamin D by converting steroids (oil) using UV light trapped from the sun. Deficiency of vitamin D in children causes rickets and osteomalacia (weak bones). The skin also synthesis sebum which is antiseptic and make the skin supple and water proof.

Reception of stimuli. The skin has sensory receptors sensitive to different stimuli such as the paccinian corpuscle, meisners corpuscle. The paccinian corpuscle is sensitive to pressure and touch while the meisners corpuscle is sensitive to pain. These receptors convert various stimuli into electrical impulses which travel to the brain and spinal cord.

Storage organ. The skin store excess fat in adipose tissues or subcutaneous fat.

Temperature control. The superficial blood vessels, hairs, sweat gland and subcutaneous fat help in the regulation of body temperature. If the temperature of the body is to remain constant over a given period of time, then heat gain by the body must be equals to heat loss by the body.

How the skin function in temperature regulation?

- **During overcooling**.
    - Decrease sweat production which reduces heat loss by evaporation.
    - Vasoconstriction. The arterioles which supply blood to the surface capillaries reduce in diameter or constrict. This lead to decrease in volume of blood flowing near the surface of the skin. Blood thus passes through shunt vessels deeper in the skin. This reduce heat loss by conduction, convection and radiation.
    - Hairs stand erect. The erector muscle of the hair contract and make the hair to stand erect. Erect hair trap an insulating layer of air above the skin. Since air is a poor conductor, it reduces heat loss from the body.
    - Shivering. This cause contraction of smooth muscles in the skin thus help to generate heat.
    - There is equally increase in metabolic activities which generate heat in the body.

During overheating.

- Sweating. There is more sweat production on the surface of the skin. Evaporation of sweat absorbs heat from the body thus reducing body temperature.
- Vasodilation. The arterioles under the skin open wider or dilate for more blood supply to the capillary network (superficial blood capillaries) under the skin. As such more blood flows to the surface of the skin and heat escapes to the surrounding by conduction, convection and radiation.
- Hairs lie flat. The erector muscle relaxes and hairs lie flat on the skin. In this position they offer least resistance to heat loss by radiation and convection.
- There is decrease in metabolic activities thus less heat is produce in the body.

Transport in Plants and Animals.

Illustration (blood-transport medium) tubes (vessels- arteries, veins and capillaries) pump (heart)

Differences between translocation and circulation.

Translocation	Circulation
Process is not continuous	Process is continuous
Heart is not involved	Heart is involved
Occurs in both plants and animals	Occurs only in animals
Materials move directly to site needing them	Materials move round the body supplying need of cells
Bidirectional movement of materials is possible	Different vessel transport to and from the heart

Composition of Blood.

Blood is a fluid body tissue that acts as a transport medium within an animal. It is contained within a blood vascular system and in vertebrates is circulated by means of contractions of the heart. Oxygen and food are carried to tissues, and carbon dioxide and chemical (nitrogenous) waste are transported from tissues to excretory organs for disposal (excretion). In addition, blood carries hormones and also acts as a defence system.

Blood is made up of a fluid called blood plasma in which are suspended cellular structures called blood cells. Blood cells include RBC, WBC and platelets. 45% of blood is made up of cells while the remaining 55% is plasma.

Blood plasma. The liquid part of the blood (i.e. excluding blood cells). It consists of water containing a large number of dissolved substances, including proteins, salts (especially sodium and potassium chlorides and bicarbonates), food materials (glucose, amino acids and fats), hormones, vitamins, and excretory materials.

Blood cells.

Blood cell (blood corpuscle). Any of the cells that are normally found in the blood plasma. These include red blood cells (erythrocyte), white blood cells (leucocyte) and platelets.

- Red blood cells (erythrocyte).

  They are the most numerous and contain the red pigment haemoglobin which is responsible for oxygen transport and give blood it red colour. They are produced in the red bone marrow of long bones such as the femur and humerus. Mammalian erythrocytes are disc-shaped and lack a nucleus while those of other vertebrates are oval and nucleated. In man the number of erythrocytes in the blood varies between 4.5 and 5.5 million per cubic millimetre. They are short-lived and can with a life span of about four months. Old unwanted RBC are then destroyed in the spleen and liver and stored as bile salt. Diagram

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