

UNIVERSITY OF AGRICULTURE, ABEOKUTA

DEPARTMENT OF BIOLOGICAL SCIENCES.

BIO 103 INTRODUCTORY PHYSIOLOGY

Nature of Living Organism

Living organisms are characterized by the performance of certain life processes or functions which distinguish them from non-living things. Non-living things may perform one or more of these processes, for example a crystal can grow and machine can move. It is only a living organism that can perform all of the following processes at some time in its life.

- (1) Movement is of the whole body in locomotion or part of the body internally or externally in plants and animals. Transport is a process of moving materials over short or long distances within the organism.
- (2) Irritability, also called sensitivity and responsiveness is the process of responding to changes in the surroundings or environment.
- (3) Feeding or nutrition is the intake of energy and simple raw materials by plants and their synthesis into food. Food is used by plants and animals to construct and maintain life.
- (4) Respiration is the process of releasing energy from food, for the performance of life processes.

Oxidation of food

- (5) Excretion is the removal of waste products from chemical reactions which have occurred in the organism.

- (6) Growth is generally an increase in size of an organism arising from the synthesis of new structural material using the energy provided by respiration and raw materials from outside the organism.
- (7) Reproduction occurs at some time in an organism's life and is a process of continuing life of the species by offspring.

Homeostasis

All the life processes occurring in the living organism must be performed in spite of changes in the surrounding environment and of different demands on the organism. Homeostasis is a self-regulating control which keeps the living organism functioning correctly.

Homeostasis can be defined as the maintenance of steady state in the animal body. Plants may also be considered to show homeostatic adjustment to such stimuli as light, but owing to their sessile nature, their systems of physiological co-ordination are mainly much less elaborate than those of animals. Homeostasis can also be defined as a means whereby physiological systems operate both separately and together to buffer against fluctuations from the optimum conditions.

PLANT NUTRITION

MATERIAL REQUIREMENTS SOURCES

The raw materials required by green plants are H_2O , CO_2 and a variety of inorganic ions. The so-called essential elements or macro nutrients are ten: Nitrogen, Phosphorous, sulphur, potassium, calcium and iron (N, P, S, K, Mg, Ca, Fe). Many plants require certain other elements in such small quantities that they are known as trace elements or micro nutrients. They include boron, manganese, zinc, copper, molybdenum (B, Mn, Zn, Cu, Mo). The sources of these substances vary

with the environment of the plant concerned. Terrestrial plants must be supplied from either the soil or atmosphere.

SOURCES OF METABOLITES

The organic substances used by plants and animals in their metabolic activities were fundamentally the same. They both require carbohydrate, protein, fats, and many other organic compounds. Most of these compounds are manufactured by plants while majority of them have to be presented to animals in many forms. The metabolites are manufactured by the plants from inorganic materials.

METABOLITES: Are therefore materials involved in metabolic activities of the living cell and these include:

1. Various carbohydrates
2. Nitrogen containing compounds
3. Fats and oils, waxes etc. These are stored in plants in the endosperm, cotyledons, roots, leaves, stem etc.

UPTAKE OF NUTRIENTS (ABSORPTION AND CONDUCTION)

Green plants absorb water and inorganic salts passively from the soil by the unicellular root-hairs. Absorption is also actively carried out by the roots. Small quantities of various soluble inorganic salts such as nitrates, chlorides, sulphates, phosphates etc. dissolved in soil water are independent of each other and they are not. The mineral salts absorbed undergo extensive ionization.

The ionized particles of such salts are taken up by the cells where they accumulate sometimes in heavy concentration. The ions may travel and as such they combine into suitable compounds.

Although some compounds are passed through the plasma membrane by diffusion. The fact that the

ions of some salt are higher in concentration in the cell sap and yet more ions are still added shows that some active transport against the concentration gradient is going on.

Therefore ions of mineral salts are either absorb ACTIVELY OR PASSIVELY.

I Passive absorption is physical and non-metabolic i.e. it doesn't need the expenditure of ATP or cellular energy. Ions may move upwards through the transpiration current along with the mass flow of water. Transpiration may help in the absorption of ions through the transpiration pull.

Active absorption; This is dependent on cellular energy (ATP).

II This is the principal method of salt absorption. The idea that the cell membrane is impermeable to exchange of free ions has led to the conception of a specific Carrier Mechanism to explain this active transport. It is assumed that a Carrier Molecule (probably a phospholipid called lecithin) picks up ions from the outer part of the membrane, into the inner part. The carrier moves in one direction and hence ions carried in cannot be leached and washed out and therefore cannot be exchanged for those in the external solution. The carrier method has been found to be dependent on ATP especially from oxidation of glucose molecules. Absorption of salts depends on a number of conditions including aerobic root respiration, light intensity, rate of transpiration, permeability of cell membrane, temperature, PH.

ELIMINATION OF WASTE MATERIALS OR PRODUCTS AND METHODS IN PLANTS AND ANIMALS.

The term excretion can be applied only to a process which eliminates substances which have been taken up by cells or have been formed as a result of their activities. Excretory products are of

numerous different kinds and they vary from species to species, and even from time to time in the same organism according to the food supply and the condition. They may be taken in as foods, or with foods but not required as such. They may be products of cellular decomposition, or substances formed as a result of normal metabolic processes, or the result of some disease condition. Animal faeces are largely compound of material which have never been part of the cellular constituents of the body. Faeces are eliminated or ejected from the gut through the peristaltic movement of the muscles of the alimentary canal. In most animals there exist special body system for elimination of waste materials. However in plants, there are none.

Excretory methods and products in plants

There are no specialized excretory organs or systems in plants. Unwanted metabolites may be secreted into intra or intercellular spaces. The aerating system of the plant makes possible the ready diffusion of respiratory CO₂ into the surrounding water or atmosphere. Parts of plants such as leaves, branches, seeds and fruits may be shed and carry with them accumulation of unnecessary substances. However such elimination is purely secondary to the true purposes of leaf fall and seed and fruit dispersal.

Excretory products in plants may include Calcium salts of organic acids oxalic acid, calcium oxalate crystals, some metallic ions. Leaf abscission can regularly aid removal of metallic ions such as excess calcium, iron, manganese and silica, from plants, Brazil nuts sometimes contain large quantities of barium, and the walls of some fungi show the presence of barium sulphate . Aluminium oxide may make up as 30-80% of Australian oak. Many alkaloids are physiologically an important by products of nitrogen metabolism of the plants species in which they are found. Such alkaloids include; nicotine from tobacco leaves, quinine from the bark of cinchona tree,

morphine from the fruits of poppy plant, strychnine and brucine from strychnosplant, Atropine from the deadly night shade(Atropa) and colchicine from the meadow safon. The listed alkaloids are useful in medicine.

GROWTH AND DEVELOPMENT

Growth is the increase in size of an organism arising from the synthesis of new structural material using the energy provided by respiration and raw materials from outside the organism.

During growth, the amount of cytoplasm generally increases, causing an increasing length, volume, area or weight of the organism.

Closely linked with growth is the process of development of an organism when cells differentiated into tissues and organs. Plants in their development may form seeds which germinate and show primary growth into roots, stems, leaves and flowers. Some plants may show secondary growth in trees. Animal development may show profound changes called metamorphosis seen in insects and amphibians. The overall growth of multicellular organisms is achieved by increase in the number of body cells as a result of cell division, this is accompanied by increase in size of individual cells by cell growth. When the rate of anabolism is greater than the rate of catabolism, the organism will show growth. When catabolism exceeds anabolism, the organism will show a decrease in size and ultimately dies.

Enzymes Properties, Composition, Types, mechanism of action

Classification

Enzymes are biological catalyst which accelerate or decelerate chemical reactions in living cells.

They differ from inorganic catalysts because of their specificity and they are not able to withstand high temperature (50°C).

Enzymes are proteinous in nature and sometimes the proteins have non-protein parts attached to them. If the attachment between protein and non-protein parts of an enzyme is tightly bonded by covalent bond; the non-protein part is called a prosthetic group, examples being metals, like Cu, Mg, Fe.

If the attachment between the protein and non-protein part of an enzyme is loosely bonded by hydrogen bond, the non-protein part is called a co-enzyme or co-factor, examples being vitamins. The co-enzymes and prosthetic groups may become attached to several different proteins, thereby forming different enzymes. Enzymes were first discovered in the 19th century by Edward Buchner when he found yeast turning sugar into alcohol.

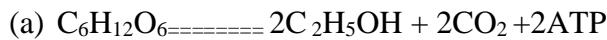
Respiration

Respiration is essentially a process of oxidation of organic compounds especially simple carbohydrates such as glucose in the living cell with the release of energy in form of ATP. The important feature of the oxidative process is that the potential energy stored in organic compounds in the living cell is released stepwisely in the form of kinetic energy under the influence of a series of enzymes.

The energy produced is made available to the living cell for its metabolic activities other stored food materials such as fats, proteins and other carbohydrates can be used in the absence of glucose. These are first hydrolyzed and then oxidized.

The oxidation of glucose may be (i) complete as in Aerobes (i.e. living organisms that take in oxygen) with the formation of CO_2 , water and energy. This is shown by the equation

$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + 38\text{ATP}$. The oxidation may also be incomplete as in some anaerobes (living organism) that does not utilize oxygen e.g. bacteria, yeast etc. with the formation of ethyl alcohol or some organic acids (e.g. lactic acid) and CO_2 as shown by the equations



Fermentation



There are three phases or stages to complete oxidation of a molecule of glucose to carbon dioxide, water and 38ATP molecules. The **first phase** is glycolytic and it takes place in the absence of oxygen.

The **second phase** which is the complete oxidation of pyruvic acid formed (from the first phase) to CO_2 and H_2O is called the kreb's cycle.

The third phase is the electron transport chains in which the high energy electrons of the hydrogen removed are fed to produce cellular energy or ATP at different points.