i. 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 enrgy (ATP).

ii. This is the principal method of salt absorption. The idea that the cell membrane is impermeable to exchange of free ions has lead 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.

SOME CYCLES OF RAW MATERIALS IN NATURE

Chemicals substances are utilized by plants; animal utilize plants and some of the raw chemical, both excrete unwanted materials, both die and their remains are subjected to the decaying action of micro-organism, thus, the raw materials are put back into circulation again. There is thus, for all these raw materials, a broad cycle of absorption utilization, and ultimate return to the raw material status again.

Diagram

CHEMOSYNTHESIS:

Chemosynthesis involve the transformation of one kind of chemical energy (and not light energy) to another.

Colourless autotrophic bacteria are able to synthesize carbohydrate without chlorophyll and therefore, without light as a source of energy. Their bacteria are aerobic, and the energy required for the metabolic process is derived from the oxidation of certain inorganic compounds present in their environment. The energy released by this oxidation process is used to convert CO_2 through several intermediate reactions to carbohydrate and other organic compounds, such as proteins, fats, etc.

Chemosynthetic bacteria do not use water (H_2O) either as the 'donor' of hydrogen to reduce CO_2, as in normal photosynthesis and therefore, no liberation of oxygen take place in the process. Common chemosynthesis bacteria are sulphur bacteria, iron bacteria and nitrifying bacteria. Sulphur bacteria synthesise organic compounds from CO_2, using energy derived from oxidation of hydrogen sulphide (H_2S). Sulphur is deposited in the bacterial cells. Iron bacteria obtain the energy needed for chemosynthesis by the oxidation of ferrous hydroxide to ferric hydroxide. The two groups of Nitrifying bacteria transform ammonia (NH_3) during the process of protein decay in soil, first into Nitrites by nitrisomonas.

$2NH_3 + 3O_3 \qquad 2HNO_2 + 2H_2O + Cal$

and then into nitrates by Nitrobacter $2\ HNO_2 + O_2 \qquad 2HNO_3 + 21.6\ Cal$. The energy thus liberated by the oxidation of ammonia is used to make their own metabolic products.

PHOTOSYNTHESIS

Photosynthesis consist of the manufacture of simple carbohydrates such as sugars in the green leaves by the chlorophyll (in the chloroplasts) in the presence of sunlight (as a source of energy) from carbondioxide and water absorbed from the air and the soil. The process is accompanied by liberation of oxygen. By this process considerable amount of radiant energy is transformed by green cells into chemical energy and stored in the organic substances formed. Since glucose or fructose appears to be the first carbohydrates formed in photosynthesis he overall equation may be represented as

$6CO_2 + 12H_2O \qquad C_6H_{12}O_6 + 6H_2O + 6O_2$

The mechanism of photosynthesis is completed in two stages or phases i.e. the light and dark phases. The light (Hill reaction) phase involves a series of chemical reaction of which light is indispensable and therefore called light reaction. This involves absorption of light energy by chlorophyll, splitting of water molecules with the production of reducing agent (NADP) and some cellular energy. The dark phase which does not need light, is a series of chemical reaction of CO_2 (fixation of carbondioxide) by the reducing agent (got from light phase) to organic compounds.

Diagram (Carbon cycle)

ESSENTIAL OF LIGHT REACTION

- Chlorophyll pigment (in the grana of chloroplast) absorbed light energy (quanta) from sunlight and becomes activated or excited.
- The extra energy stored in the chlorophyll now goes to break up water molecules (proteolysis of water) to give energized electrons and oxygen.
- There are two light trapping sites or photosystems each with its own electron acceptors in the chloroplast.
- High energy or excited electrons are passed from photosynthesis II through its electron acceptor to the cytochrome or photosynthetic electron-transport chain.
- Energy of the electron is used to synthesize a molecule of ATP or cellular energy at a site on the cytochrome chain. This is known as Photophosphorylation.
- Electrons passed down the cytochrome chain are re-energised by more radiant energy absorbed in photosystem I.
- The excited or energized electrons are accepted by the electron acceptor of photosystem I and are eventually used to reduce NADP to NADPH a reducing factor or agent needed in the next phase of photosynthesis.
- However at times one more ATP molecules when re-energised electron are passed from the electron acceptor of photosystem I back to the cytochrome chain. The synthesis of ATP as a result of this cyclic transport of electron is called cyclic photophosphorylation.
- The product of the light phase include ATP (cellular energy) and NADPH a reducing factor. These are needed in the next phase of photosynthesis (i.e. Dark phase).

Diagram

Chlorophyll

Molecules

nH_2O $nH^+ + n(OH)^-$

$n(OH)^- + n(OH)$ $nH_2O + nO_2$

2H 2e- + 2H+

Diagram

ESSENTIALS OF DARK REACTION

i. All reduction steps from CO_2 to sugar are dark reactions.

ii. A 5c compound, ribulose-P is activated by ATP forming Ribulose-di-P also a 5c compound.

iii. The (5C) RUDP combines with CO_2 to form an unstable 6C complex.

iv. The complex split into two parts one of which is a stable 3-carbon compound called phosphoglyceric acid.

v. Many of the remaining portion of the splitting complex is used to reform ribulose phosphate which fed into the chain of reactions to maintain the continuity of the process.

vi. There is further activation of phosphoglyceric acid to diphosphoglyceric acid using ATP.

vii. Phosphoglyceric acid is reduced to phospholyceraldehyde using the reducing factor NADPH.

viii. The 6-carbon hexose sugars e.g. glucose or fructose are formed from many molecules of 3-C phosphoglyceraldehyde.

ix. The various step in the dark phase or calvin cycle is catalysed by many enzymes.

DARK PHASE OF PHOTOSYNTHESIS (diagram)

OTHER ORGANIC SUBSTANCES SYNTHESIZED

The other organic compounds synthesized are amino acids, proteins, fats and oils etc. about 20 amino acids are known to be constituents of especially plants proteins. Amino acid are synthesized in the green leaves and in roots. There is experimental proof that the reduction of nitrate to ammonia and synthesis of amino acids usually takes place in the green leaf in the presence of light. The synthesis of amino acids is correlated with photosynthesis which supplies necessary carbon, hydrogen and oxygen. Most amino acids are formed through trans amination which involves transfer of amino group (NH_2) from some organic compounds e.g. glutamic acid to the carboxyl group (-COOH) of any of the keto-acids. The group of enzymes catalyzing this reaction is called trans aminases. Some amino acids include Alanine, Glycine Leucine, aspartic acid, glutamic acid, cystine, tyrosine, etc. amino acids are the precursors of proteins. The proteins synthesis depends on the codes from the sequence of basis in DNA in the nucleus transferred to the structure of the RNAs.

Fats and oils are lipids (fatty) substances formed in the living cells of both plants and animals. They are composed of carbon hydrogen and oxygen. Oxygen occurs in low percentage. Fats and oils are made from glycerol and fatty acids by condensation. Fats and oils have been known to be formed from carbohydrates.

Respiration (Diagram)

Respiration is essentially a process of oxidation of organic compounds especially simple carbohydrate 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 store 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 O_2, water and energy. This is shown by the equation

$C_6H_{12}O_6 + 6O_2 \qquad 6CO_2 + 6H_2O + 38$ 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

(a) $C_6H_{12}O_6 \qquad 2C_2H_5OH + 2CO_2 + 2$ ATP

Fermentation

(b) $C_6H_{12}O_6 \qquad 2CH_2CHOHCOOH + 2H_2O + 2$ ATP

There are three phases or stages to the complete oxidation of a molecule of glucose to carbondioxide water and 38 ATP molecules. The first phase is glycolytic and it takes place in he 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 electron transport chains in which the high energy electrons of the hydrogen removed are fed to produce cellular energy or ATP at different points.

Phase 1 (Anaerobic or Glycolytic phase)

Glucose is first phosphorylated by ATP. The phosphorylated glucose molecule is stepwisely broken to two molecules of phosphoglyceric acid a 3-carbon compound and finally 2 molecules of pyruvic acid a key 3-carbon compound. Other common reserve materials used starch, glycogen, sucrose, maltose. Each is however first hydrolysed to glucose.

It is to be noted that the fate of pyruvic acid depends on the type of cell. In yeast it is converted to ethanol and CO_2 while in some bacteria or tired muscle cells it is converted to lactic acid and H_2O.

Phase II (Aerobic phase, Kreb's cycle)

With the presence of oxygen the pyruvic acid ($C_3H_4O_3$) undergoes oxidative decarboxylation to form Acetyl-Co enzyme A in a series of steps catalysed by some enzymes. The Acetyl-Cp A (C_2H_3O CoA) is a connecting link between the Anaerobic phase and the anaerobic phase or kreb's cycle of respiration. Kreb's cycle consist of series of enzyme catalysed chemical reactions under aerobic conditions proceeding in a cycling manner. The cycle is also called citric acid or tricarboxylic acid cycle. This is because most of the organic acids in the circle (the Chief of which is citric acid) have three carboxyl groups COOH within their structures.

Acetyl Co A enters the cycle by reacting with oxaloacetic acid (with co-enzyme A part been released) to form citric acid etc. Apart from the release of CO2, there is also stepwise removal of a total of 12 hydrogen atoms passed on to 12 hydrogen, acceptors or NAD to form 12 NADH now a reducing agent.

Phase III (Electron transport of cytochrome chain)

All the powerful electrons removed (usually accompanied by removal of hydrogen to give 12 NADH) are fed into an oxidation reduction system in the mitochondrion. This is where the energy still stored in electrons energy. Therefore the metabolic pathway through which the electrons pass from one compound to another is called electron transport or cytochrome system. In respiration, it consists of commonly of NAD (Nicotinamide Adenine di nucleotide), FAD (Flavin Adenine di nucleotide), Co-enzyme and the cytochromes b, c, a (cytochromes and pigmented bodies with ion in their structure). The ATP molecules are produced at three points along this chain for every 2e or NADH, molecule passed alogn it. At each of these point ATP is usually formed from addition of an inorganic phosphate to ADP i.e. ADP + P ATP.

It is to be noted that phosphorylation of ADP in the mitochondrion at the expense of chemical energy oxidation reduction reactions of the electron transport system is called oxidative phosphorylation. With the reduction of the cytochromes, the electrons pass down to oxygen and the 'activated' oxygen freely combines with hydrogen (now released to the cytoplasm from the mitochondrion) to form water (H_2O).

ELIMINATION OF WASTE MATERIALS OR PRODUCTS AND METHODS IN PLANT 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 materials which have never been part of the cellular constituents of the body. Faeces are eliminated or ejected from the gut through peristaltic movement of the muscles of the elementary 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 CO_2 into the surrounding water or atmosphere. Parts of plants such as leaves branches, seeds and fruits may be shed and carry with them accumulations of unnecessary substances. However such elimination is purely secondary to the true purpose 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 plant species in which they are found. Such alkaloids are deposited in plant parts such as Bark leaves, flowers, fruits, seeds. The alkaloids include: nitocine from tobacco leaves, quinine from the bark of cinchona tree, morphine from the fruits of poppy plant, strychnine and brucine from strychnos plant, Atrophine from the deadly night shade (Atropa) and colchicine from the meadow safon. The listed alkaloids are useful in medicine.

Simplified Scheme representing Aerobic and Anaerobic respiration (Diagram)

Excretory Methods and Products in Animals

Excess protein and other nitrogen containing compounds such as the purine and pyrimidine bases of nucleic acids are potential sources of danger. The processes involved in making part of these molecules useful e.g. conversion to carbohydrate results information of toxic nitrogenous compounds which must be eliminated of such compounds is Ammonia (NH_3). In unicellular organisms e.g. the protozoans especially those bathed in fluid medium continuously, NH_3 being soluble may diffuse into the surrounding fluid medium in an unchanged state. The animals (invertebrate) which do this are described as AMMONOTELIC where the organism is large and free diffusion from its surface is impossible the NH3 is converted to non-harmful substances as urea, uric acid etc. Hence some animals are described as either URECTELIC or URICOTELIC. Ureotelic animals are able to form urea from ammonia while the uricotelic ones form uric acid from ammonia. Urecotelic animals include birds, terrestrial reptiles and some insects.

An examination of excreted matter shows the presence of other nitrogenous compounds in many instances. These include hippuric acid and ornithuric acid which are formed from benzoic acid in the diet. A creatinine and creatinine are also found in muscle. Excreted nitrogenous pigments resulting from the breakdown of haemoglobin are the orange-red bilirubin and the green product derived from uric acid. Allanto acid is derived from oxidation of allantoin.

Excretory methods in animals

	Method/Structure	Animals
1.	By diffusing from cell surfaces	protozoa, sponges, coelenterates
2.	Through contractile vacuole	protozoa
3.	By flame – cell system	flatworms
4.	By solenocyte cells	amphioxus
5.	By nephridium system	Coelomate

		Animals such as earthworms, round worms, mollusks, crustaceans
6.	By green gland (modified Nepridum)	Astacus (cray fish)
7.	By Malphigian tubules	Insects, spiders
8.	By Kidney	Vertebrates e.g. fishes, reptiles, birds, mammals

primarily, all the systems of animals concerned with excretion of nitrogenous substances employ the same principle. They involve surface through which