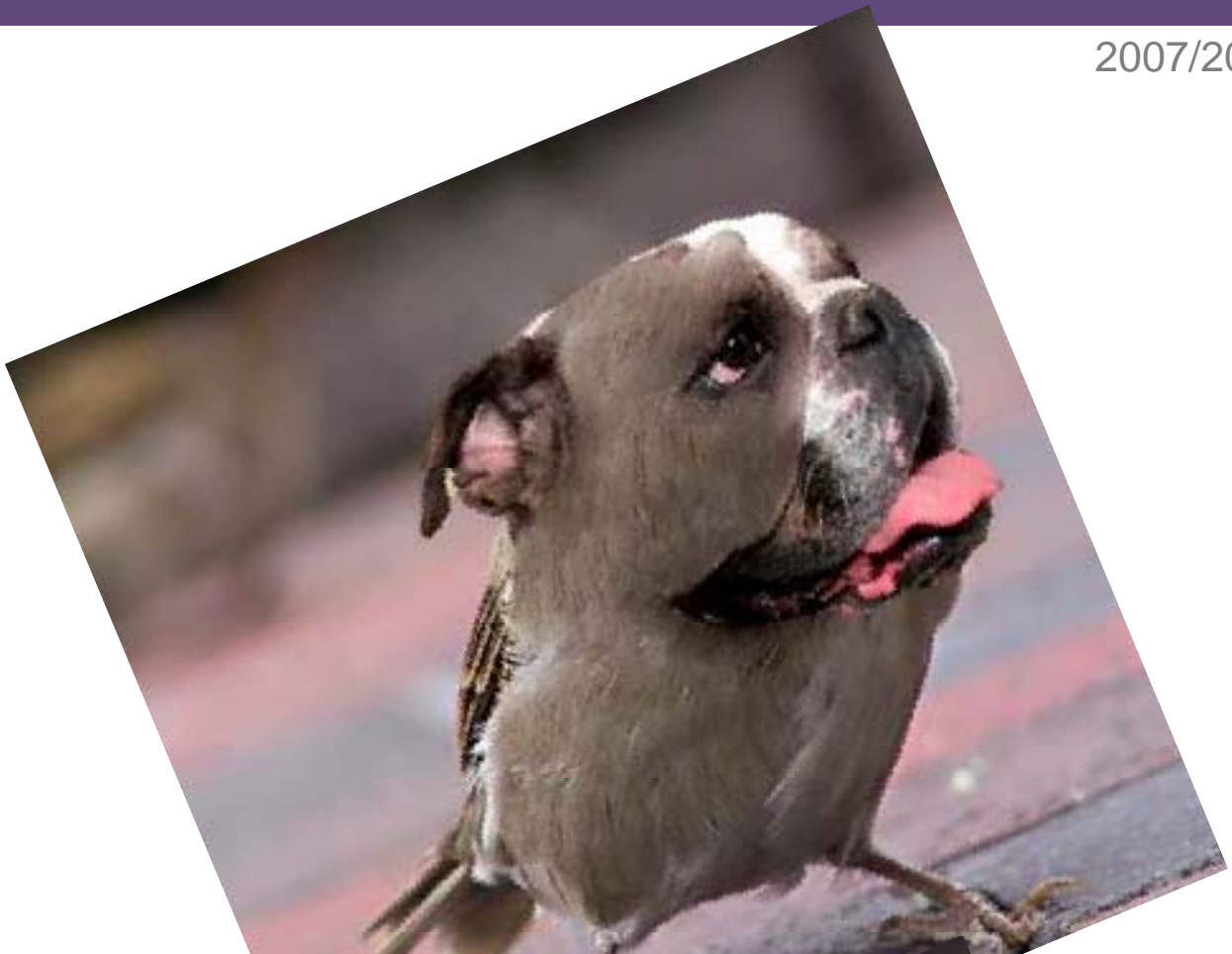


2007/2008



BIOLOGY  
GENERAL  
SECONDARY

# NUTRITION



Chapter 1 | Mr. Ayman Elsangary

## Nutrition

Nutrition is a concept given to the scientific study of food and various modes of nutrition of living organisms.

### Autotrophic Nutrition:

Autotrophs are those organisms which can make their own food by themselves like green plants, They can convert low energy raw materials like Carbon dioxide, Water and mineral salts into high energy types of food such as Sugar, Starch, fats and proteins

### Heterotrophic nutrition:

Heterotrophs obtain their food as high energy food from the bodies of plants or animals that had been feeding on plants and they can be classified into the following:

#### 1)Holozoic nutrition:

##### A) Carnivores:

Which feed on the flesh of animals - e.g. Cats, Dogs, and eagles.

##### B)Herbivores:

Which feed on plants e.g. Rabbits, Cattle, and horses.

##### C)Omnivores:

Which feed on plants and animals e.g. Man

#### 2)Parasites:

Which can live as ecto parasites or endo parasites in or on the host's body, They obtain their food either ready-made or partially prepared from their host , Of course they are harmful to the host e.g. Bilharzia worms(endo parasites) and flies ( ecto parasites).

#### 3)saprophytes:

Which obtain their liquid food from the decayed remains of dead organisms .e.g. fungi .

## Autotrophic Nutrition

### As autotrophic organisms plants need to do:

- 1- Absorption of water and salts
- 2- Photosynthesis

### Absorption of salts through root hair:

#### Structure of the root hair:

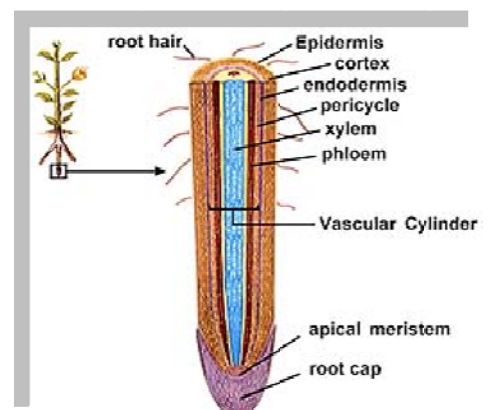
It is an elongated extension from a plant cell that is covered by a thin layer of cytoplasm that contains a nucleus or more and a large vacuole length = 4mm life span between days to weeks (short life)

**G.R** Root hairs have short life span?

Because cells of the cortex are damaged due to the friction between the root and the soil

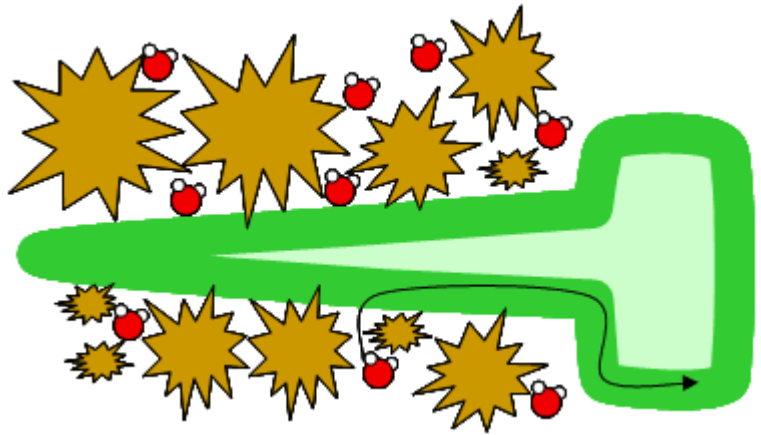
**G.R** In spite of the damage of the root hairs plants compensate them

Because the root has an area called elongation zone that always give rise to new cells that will replace the damaged cells



### Adaptation of the root hair

- 1- Very thin wall **GR** to allow the passage of water and salts
- 2- So many in number **GR** to increase surface area and absorb more water and mineral salts
- 3- Concentration of the sap is greater than concentration of the soil **GR** to facilitate the passage of water from the soil to the plant
- 4- Secrete viscous substance **GR** to facilitate penetration of the plant to the soil and fix the plant to the soil



### Mechanisms of water absorption:

#### 1- Diffusion:

Movement of ions or molecules from high concentration area to a lower concentration one E.G drop of ink in water cup

#### 2- Permeability

As the wall of the cells determine its permeability we have 3 kinds of walls:

- 1- Fully permeable (cellulose) allows water and mineral salts to pass
- 2- Impermeable (Surin, Cutin and lignin ) they do not allow water or salts to pass
- 3- Semi permeable or selective permeable (Plasma membranes)

#### Plasma membranes

Very thin perforated membrane the pores of it can :

- 1- Allow some materials to pass freely
- 2- Allow some materials to pass slowly
- 3- Prevent some materials

### Selective permeability

The property that allow water to pass, prevent sugar and amino acids, determine the flow of many salts

#### 3- Osmosis:

Water transfers from high concentration of water (low concentration of salts) to a lower concentration of water (higher concentration of salts), The force that causes it is called osmotic pressure.

#### 4- Imbibitions:

Colloidal particles of the plant absorb water and increase in size then it ripen and the walls of the plant cells absorb water to perform its vital activities

**Important things to be noticed**

Terrestrial desert plants and the plants of salty soil have a very high atmospheric pressure (**GR**)

Ordinary plants have O.P =5 to 20 A.P

Salt land and desert plants have O.P = 50 to 200 A.P

**Paths of water through the root reaching to the stem:**

- 1- Through sap vacuoles (by osmosis)
- 2- Through cytoplasm (by threads Known as plasmodisma)
- 3- Cell walls and intercellular spaces (by imbibitions)
- 4- Endodermis cells organize the path of water and salts as follows:
  - a. Endodermis facing phloem are completely thickened by suprin to prevent water from passing through it
  - b. Endodermis facing Xylem suprin is found on the Casper strip only
  - c. This is why water passes through the endodermis against the xylem by osmosis and under th control of protoplasm (these cells are called the passage cells)

**Mechanism of salts absorption:**

- 1- particles of solutes are either cations  $K^+$ ,  $Na^+$  or anions  $Cl^-$ ,  $NO_3^-$  and  $SO_4^-$
- 2- those ions are selected by semi permeable plasma membranes to pass to the plant according to its needs
- 3- cation exchange may happen (Like when Na gets out and K gets in )
- 4- Ions may move against concentration gradient which is known as active transport
- 5- Experiments performed on nettela algae proved that ions pas against concentration gradient and according to the needs of the plant

**Active transport**

It is the movement of any substance inside the cell membrane as long as it needs energy

Energy needed for active transport came from aerobic respiration (This is why sugar and oxygen are needed to absorb salts)

An experiment was performed on oat tip and it was found that decreasing Oxygen leads to decreasing respiration rate which will lead to decrease on the energy needed for active transport to transport  $SO_4$  to the plant

**Photosynthesis****Importance of photosynthesis:**

- 1- Base of life on earth as it provides food and Oxygen
- 2- Also it cleans the atmosphere from  $CO_2$
- 3- Source of fibres for textile and paper industry
- 4- Fossil fuels were originated from photosynthesis in older geological eras

**Explanation of water absorption by the root**

- 1- Root hairs secret its viscous substance (colloidal substance) so it will imbibe water
- 2- Sugar dissolved in the cell sap increases the concentration of sugar than that of the soil solution causing the water to pass inside the cell (Osmosis)
- 3- Water then pass to the plant epidermis then cortex and so on reaching to the xylem vessels in the centre of the root

**Required for photosynthesis:**

- 1- Water = source of hydrogen needed to reduce CO<sub>2</sub> into starch
- 2- Carbon dioxide = source of Carbon
- 3- NO<sub>3</sub> , SO<sub>4</sub> and PO<sub>4</sub> are needed to convert carbohydrates into proteins or fats
- 4- Phosphorus to fix energy
- 5- Magnesium important in the structure of chlorophyll
- 6- Iron Important for some enzymes that involve in photosynthesis

**Coming out of photosynthesis:**

**Starch :**

- 1- coming from the primary product of photosynthesis (monosaccharide)
- 2- To prove the presence of starch we use iodine after leaving it in dark 12 hours then in light for a proper time to perform photosynthesis then boil it to kill it and make it stop photosynthesis then in hot alcohol of 90% concentration to get rid of the green colour of chlorophyll then test it with iodine if it turns blue then it contains starch
- 3- Using this method we can measure the quantity of carbohydrate and use it to estimate the rate of photosynthesis
- 4- Photosynthesis rate is quantity of starch produced in a unit time so the rate of photosynthesis is 1 gm starch\m<sup>2</sup> of the leaf's surface in good light illumination

**Oxygen:**

We can prove the evolution of Oxygen by putting an upside down funnel over an elodea plant in a cup filled with water contains potassium bicarbonate as a source of carbon dioxide, then invert a test tube over the funnel and a gas will evolve if you test it with a glowing splint you'll find that it is Oxygen  
 You can measure the rate of photosynthesis by measuring the amount of Oxygen

**The place of photosynthesis:**

- 1- Green plastids in the leaves
- 2- Herbal stems that have chlorenchyma tissue

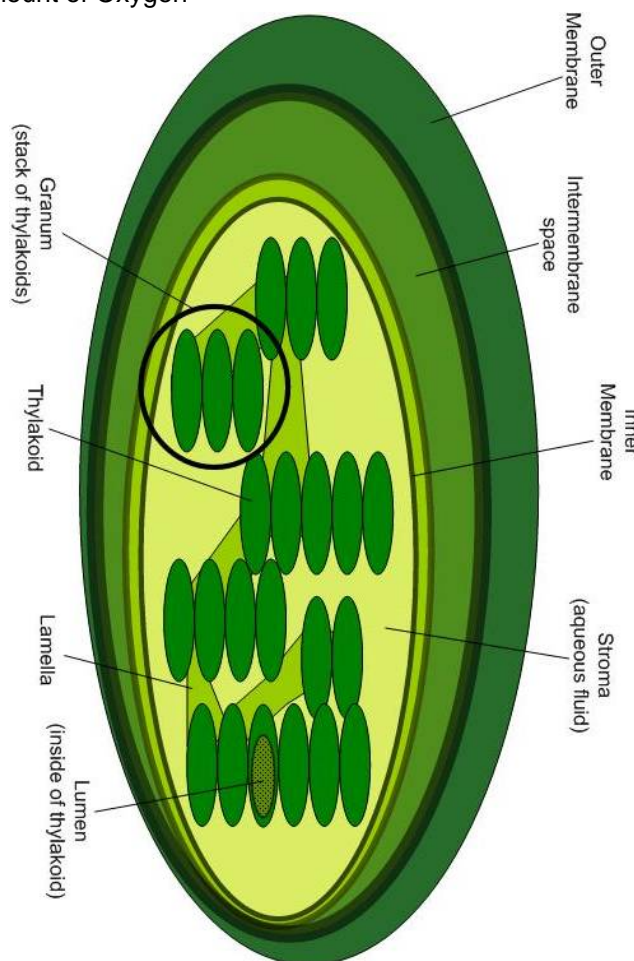
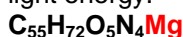
**Structure of plastid**

- 1- Double thin membrane contains transparent protein known as stroma
- 2- Embedded inside the stroma there is grana which are a pile of disks of a diameter 0.5 and thickness of 0,7 micron
- 3- There are grana lamella between grana that increase the surface area exposed to cell
- 4- Grana are hollow and they carry the pigments as follows:

**Pigments in green plastids**

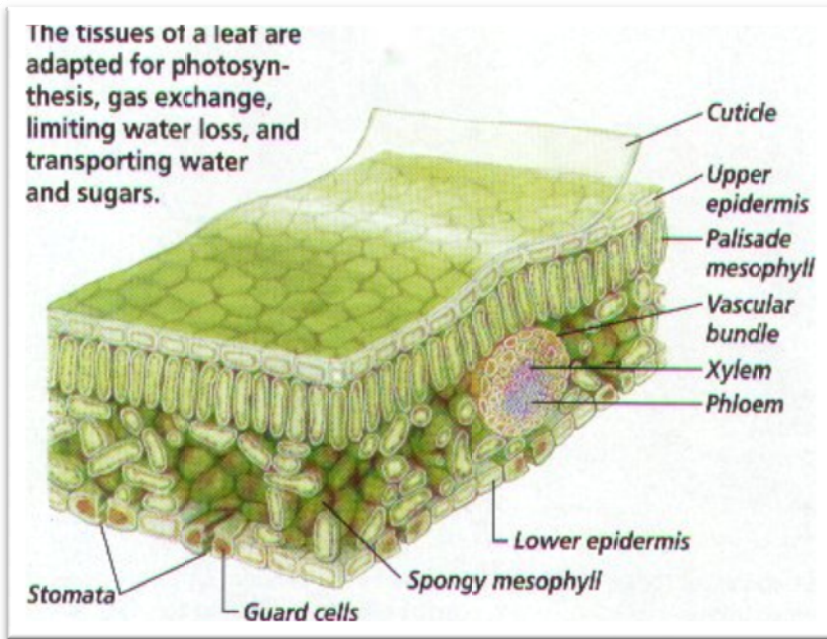
Pigment name	Pigment colour	Percentage
Chlorophyll a	Bluish green	70%
Chlorophyll b	Yellowish green	
Xanthophyll	Lemon yellow	25%
Carotene	Orange yellow	5%

Chlorophyll absorbs light energy because it contains **Mg** atom which has been proved to have an important role in polarizing light energy.





Structure of the leaf and its adaptation in the photosynthesis



Adaptation of the leaf:

- 1- Arranged in a way that facilitates their exposure to sunlight.
- 2- The leaf blade is thin and flattened to absorb as much light as possible
- 3- Supported by a midrib branched into smaller veins and smaller veinules to facilitate transport of water, salt and absorbed food.
- 4- The upper and lower surface of the leaf are covered with cutin to prevent water loss
- 5- Mainly in the lower and some on the upper surface are tiny pores called stomata for gaseous exchange,

1- Upper and lower epidermis:

- a. One row of adjacent, barrel shaped parenchyma cells with no chlorophyll.
- b. Stomata are spread on it (specially the lower epidermis)
- c. Coated with cutin

2- The mesophyll:

- a. Lies between upper and lower epidermis
- b. Transverse by veins
- c. Consists of 2 layers:

1- Palisade layer:

- 1- One row of cylindrical, elongated and parenchymatous cells
- 2- Arranged as columns perpendicular to the leaf surface
- 3- Possess many chloroplast which tend to be in the highest light

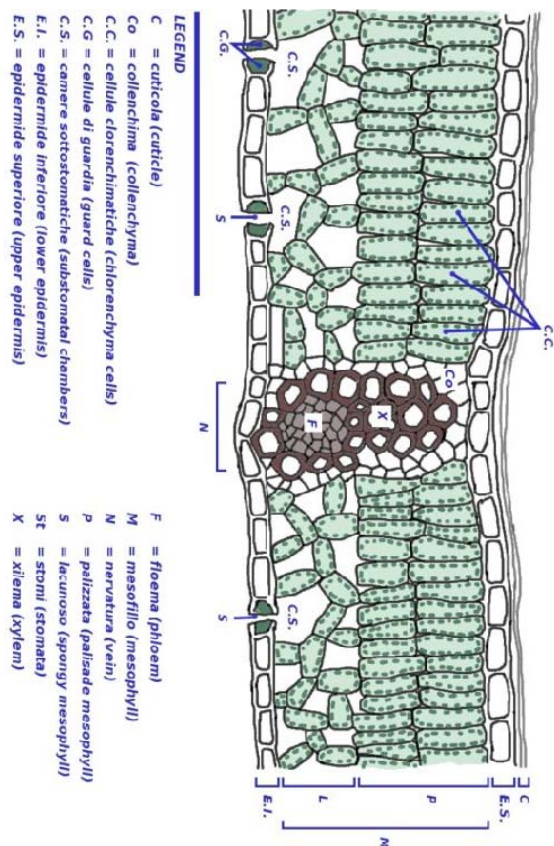
2- Spongy layer:

- 1- Irregular shaped, loosely arranged parenchyma cells
- 2- Lies below the palisade
- 3- They have wide intercellular spaces
- 4- Have less chloroplasts than palisade

3- Vascular tissue:

- 1- Consists of numerous vascular bundles through veins and veinules
- 2- The midrib has the main vascular bundle
- 3- Every bundle consists of:
  - a. Vertical rows of xylem vessels
  - b. Thin walled xylem parenchyma separates xylem from each other
  - c. Phloem directed to the lower epidermis

Mesophyll makes food and phloem transports it to all plant parts.



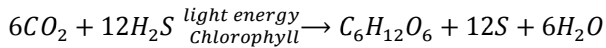
The source of Oxygen evolved during photosynthesis:

American Van Neil suggested that light decomposes hydrogen sulphide into hydrogen and sulphur in the presence of bacteriochlorophyll.

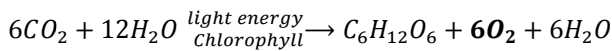
He was conducting his experiments on both green and purple bacteria (Bacterial chlorophyll is simpler than ordinary chlorophyll).

H<sub>2</sub>S is like H<sub>2</sub>O in the case of swamp bacteria and hydrogen coming from them is used to reduce CO<sub>2</sub> into carbohydrates.

**For swamp bacteria**



**For ordinary plants**



Using radioactive isotopes (which can be followed by Geiger counter ) and having 2 kinds of Oxygen (O<sub>16</sub> and O<sub>18</sub>) They found that O evolved is coming from H<sub>2</sub>O not CO<sub>2</sub> in all cases.

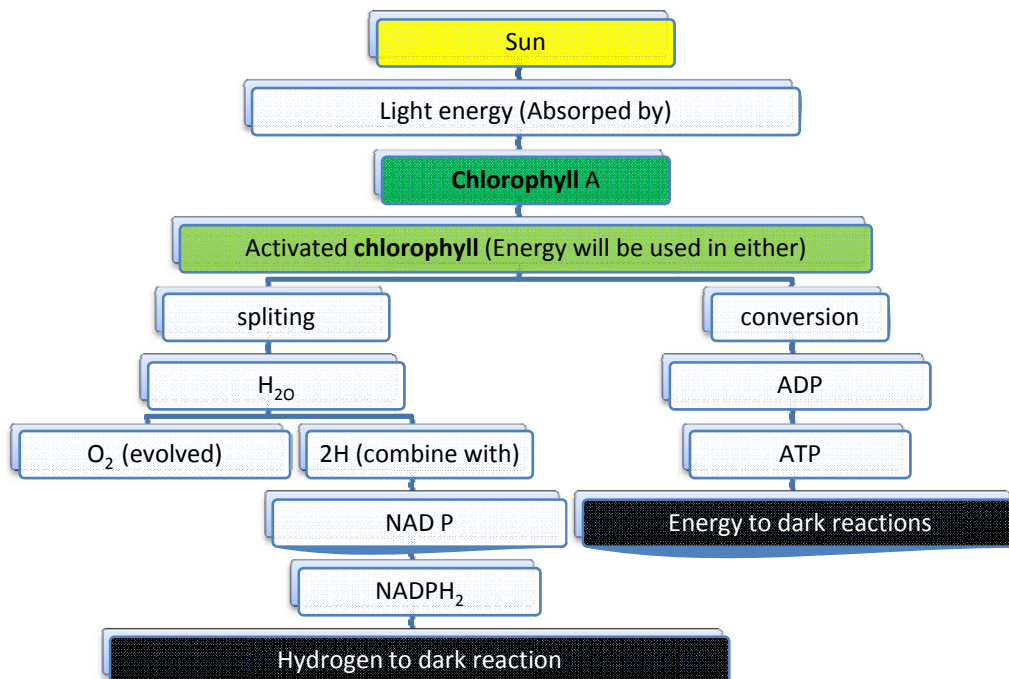
**Light and dark reactions:**

Light reactions are those reactions which are limited by light.

Dark reactions or enzymatic reactions are those reactions which are limited by temperature.

**a- Light reactions:**

- 1- Light falls on the grana inside the chloroplast
- 2- Some electrons in the atoms of chlorophyll will gain energy trying to shift themselves up to a higher level of energy (kinetic light energy will be converted to potential chemical energy chlorophyll will be activated or excited)
- 3- When stored energy is released excited chlorophyll will come back to stable state (electrons fall back to the original energy level and chlorophyll is ready to absorb light energy again)
- 4- Part of the energy will be used to split water to hydrogen and Oxygen



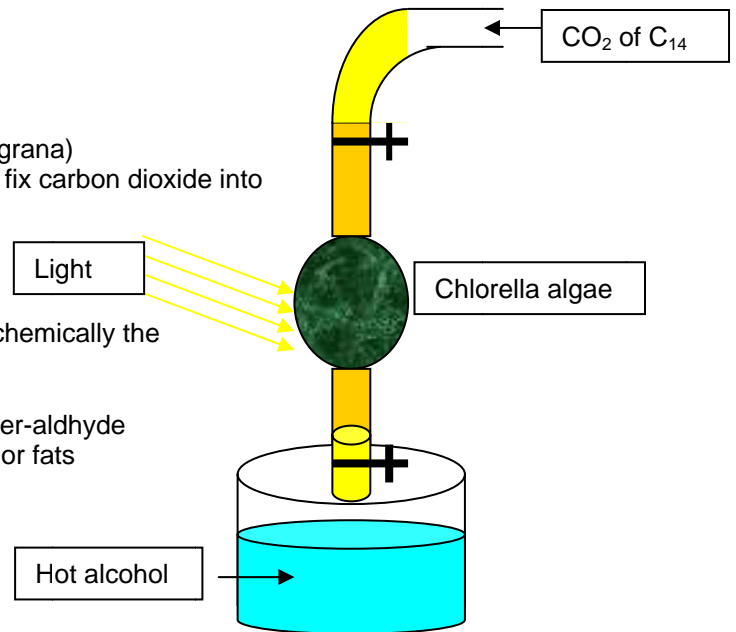
- 5- Another part will transfer ADP to ATP by forming a new high energy bond with P (usually marked ~ squiggle )

- 6- Hydrogen will combine with NADP forming NADPH<sub>2</sub> which will carry Hydrogen to dark reactions
- 7- Oxygen will be released to the surrounding atmosphere

- 1- ADP stands for adenosine di-phosphate.an ATP stands for Adenosine tri-phosphate
- 2- Adenosine means adenine and a sugar called ribose
- 3- NADP is a hydrogen carrier called nicotine-amide di-nucleotide

**b- Dark reactions**

- 1- Take place in the stroma of chloroplast (outside the grana)
- 2- In these reactions Hydrogen carried by NADPH<sub>2</sub> will fix carbon dioxide into carbohydrates with the help of energy stored in ATP
- 3- Melvin Calvin revealed the nature of dark reactions using C<sub>14</sub>
- 4- They used CO<sub>2</sub> containing C<sub>14</sub> and flash light then they used hot alcohol to kill the algae and then find chemically the 1<sup>st</sup> stable compound that was formed
- 5- They find that PGAL was the 1<sup>st</sup> stable compound
- 6- PGAL is a 3 carbon compound called phosphor-glycer-aldehyde
- 7- PGAL can be converted to glucose, starch, proteins or fats
- 8- PGAL can also be used in respiration
- 9- Calvin pointed that synthesis of hexose sugar is not completed in one step but through several intermediate reactions catalysed by certain specific enzymes.



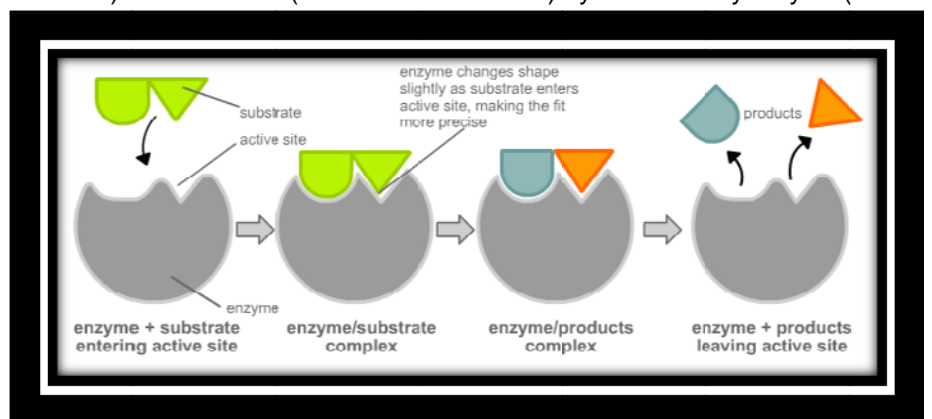
**Heterotrophic nutrition:**

**Digestion:**

The conversion of polymers(Large food molecules ) to monomers (small food molecules) by means of hydrolysis (This process is catalyzed by enzymatic action.

**Enzyme**

It is a protein substance which has the properties of a catalyst (It has the ability to activate certain chemical reaction) when the reaction is completed the enzyme will be free again and ready to perform another reaction.



**Some properties of the enzyme:**

- 1- Some enzymes have reversible effect
- 2- Enzymes accelerate the reaction till it reaches the equilibrium
- 3- Some enzymes are secreted in an inactive form so they need another substance to activate it such as pepsinogen which needs HCl and a certain temperature and PH to be active pepsin and digest proteins

