PHOTOSYNTHESIS IN HIGHER PLANTS

Photosynthesis is an enzyme regulated anabolic process of manufacture of organic compounds inside the chrorophyll containing cells from carbon dioxide and water with the help of sunlight as source of energy.

+ 12H_2O ... + 6110 + 50,

ctikprophyli, light and CO2 is required for photosynthesis. It occurs only in green part of leayes in presence of light

Early Experiment

ir Joseph Priestley In 17705 concluded that foul air produced by animal Is converted into pure air by plants.

Priestley discovered Oxygen gas in 1774.

:0 Julius Van Sachs In 1854 shows that green plant in plants produces glucose which is stored as starch. Starch is the first visible product of photosynthesis_

- T.VV-Engelrnann {18 1/3-1913 9) diKOVUKI the effect of different wavelength of light an photopinthesi$Iiaction spectrum).

Cornelius Van Neil (1897-1935) on the basis of studies v.rith purple and green 5uJphur bacteria shows that photosynthesis Is a light dependent reaction in which hydrogen from an oxidisable compound reduces CO2 to form sugar_

11·1/2 A+CO_2 —4p--*2A CFI 0+

In green sulphur barteria, when 11,5„ instead of H_1O was used as hydrogen *icor, no O_3 was evolved. He Inferred that 02 eyoNeci try green plants comes from H2O but not from CO2. as thought earlier.

Where Does Photosynthesis Takes Place?

- Chioroplasts are green plastids which function as the site of photosynthesis in eukaryotic photpartotrophs
- Within the chloroplas't there Is a membranous system consisting of grarka, the strorna lamellae and the fluid Aroma_

I The reaction in which light energy is absorbed by grans to synthesis ATI> and hlADPH15 called light reaction- The later part of photosynthesis Inc which CO2 is reduced to sugar, in which light is not necessary is called dark reaction.

Pigments inkiotwed in Illibotosyntbesis – The plant pigments are found in chloroplasts on the thyla knids.

The 4 Plant Pigments are-

- Chlorophyll a: Light to medium green. Main photosynthetic pigment.
- Chlorophyll Blue-green, Accessory Pigment.
- Ca rotene7Yel low. Orange .. Accessory Pigment.
- xa nthophyll; Yellow. Accessory Pigment,

- Maximum absorption by chlorophyll a occurs in blue a nd red regions having higher rate of photosynthesis_ So, chlorophyll a Is the chief pigment.

Ught reaction

- Light reaction (photochemical phase} includes
  - a. Light absorption
  - b. Water splitting
  - c_ Oxygen release
  - d. Formation of high energy chemical intermediates (ATP and MACIPHI).

• The pigments are organized into two discrete LHC{ light harvesting complex) within photosystem I and photosystem
- LHC Ant made up of hundreds Of hundreds of pigmerrN molecules containing all pigments except single chlorophyll a molecules in each PS-
* The pigments in photosystern I and photosystem II absorbs the lights of different wavelength. Single. chlorophyll molecules make the reaction centre_ In PS I reaction centre has highest peak 7.00n m, hence called P700. And P5 II reaction centre has highest peak at 681:Inm, so ea illed1·'680.

The Electron Transport System

- Reaction centre of photosystern II absinths light of 680 nm in nEdl region and causing electron to becomes excited. These electrons are picked by electron an electron acceptor which passes to electron transport system consisting of cytochrome.
- Electrons passed through electron transport chain and passed on to the pigment of PSI. electron in the PSI also get excited due to light of wavelength 70Clnm and transferred to higher potential.
- + When electron pass in downhill direction, energy is released that reduce the ADP to ATP and NADP+ to NADI[5]H. The whole scheme of transfer of electron is called Z scheme due to Its shape.
- ● F'hototysis of water release electrons that provide electron to PS II. Oxygen is released during photosynthesis clue to in i5 also.

$214_2O \rightarrow 1"\text{-}r + O_2 + 4e^-$

Difference between Direlk and non-cyclic photophosphorylation

Cyclic ohotophosphorylation	Non-cyclk photophosphorylation
a.. It is performed by photosystem I independentliy.	a. It is performed by collaboration of both PS I and PS II.
0. An enemal source of electron is not required_	b. The process requires an external electron donor.
c. It synthesizes only ATP.	c. It synthesizes ATV and NADILI both.
ci, It occurs only in 5tro.rnal or intergra na l thylakoids_	d- It occ_vr5 in the granal thyla Wilt only.

Chemiosrnotic Hypothesis 431 ATP formation was proposed by Mitchell in 19E1.
The product of light reaction is used to drive the process leading to synthesis of sugar are called biosynthetic phase of photosynthesis_
Calvin Cycle/C1 cycle/Reductive Rentose Sugar Phosphate Pathway

Malvin Calvin, Benson and their colleagues used radioactive LAC and Chlorealla and Scenedesm us algae to discover that first CO2 fixation product is 3-carbon organic compound 13-phosphoglyceric acid] or RCA_ Later on a new compound was discovered which contain 4- carbon called Oxaloacatic Acid (AA0.1. On the basisof n umber of carbon atoms in first stable product they are named C, andl C, pathway.

■ Carboxylation is the fixation of CO2 into 3-phosphoglyceric acid (3-PGA). Carboxylation of RuBP occurs in presqlpe of enzyme RuBP carboxylase (RuSisCOl which results in the formation of two molecules of 3 -PGA.
■ Reduction is series of reaction that leads to formation of g.lurose. Two molecules of ATP and two molecules of NACIPH are required for reduction of one molecules of CO2. Sir: turn of this Cycle are required for removal of one molecu le of Glucose molecules from pathway.
* Regeneration is the generation of Ruff molecules for the continuation of cycle. This process require one rnOli2eu le5 of ATP,

Fig-Calvin Cycle/ IC/ Cycle

- For every molecules of 00.3 enterl ng the Calvin Cycle, 3 molecules of ATP and 2 molecules of NADPH are require

Ci pathway/Hatch Slack Pathway

- This pathway was work.ed out by Hatch and Slack 119E5. 19671, mainly operational in plants growing in dill tropical region like Maize. Sugarcane.. Sorghum etc,
- In this pathway first stable product is a 4-carbon compound Oxaloacetic acid AAA(1.11 so called as €, pathway_ C, plants have Kran2 Anatomy (vascular bundles are surrounded by bundle sheath cells. arranged In wreath like manner), characterized by large. no of chlaroplest. thick wall ifilpEPADLIS to gases and absence of intercellular spaces.
- The primer/ co; acceptor isa 3-carbon molecule Phosphoenol Pori...ate present irM onesophyll cells and enzyme inwolkred is PEP ca toxylase.
- OAA formed in mesophyll cell forms 4-carbon compound I lke mallc acid or aspartic acid which Is transported to bundle sheath cells.
- Irk bundle sheath cell,. *it* Is broken into CC1$_2$ and a 3- carbon molecule_ The 3-carbon molecule is returned back to rnesophyll cells to form PEP.
- The 1:02 molecules released in bundle sheath cells enters the Calvin cycle, when en2vrne RuBlsCO is present that farms Eitgar.

Phatorespiration

it i5 a light dependent process of oxygenation of FWEIP and release of carbon dioxide by photosynthetic organs of plants.

Ph respiration decrease the rate of photosynthesis when oxygen concentration is increased from 2-3%tqfq 21%.

Th ls pathway Invokes Chloroplast, Peroxlsorne and Mitochondria Photorespliatlon do not occurs I n C plants. ÇQ

; actors affecting photomenthe5is.

a. Light

b. Carbon dioxide corKenihration

c Temperature- Pt does not influence the rate of photosynthesis d Irec... ci)
is inhibited due to denaturation to affect the dark reaction.

d Water