

Oxygenic and anoxygenic microorganism

M.Sc 2nd Semester
Microbial Physiology and Metabolism
paper-203

Oxygenic and anoxygenic photosynthesis

- All the living organism require energy to carry out their different activities of life for this energy is needed which comes by the oxidation of carbohydrates, proteins, fat similar to green plant ,these have certain chlorophyll containing compound which synthesis food from simple carbon dioxide, water.
- Photosynthesis in bacteria defined as the synthesis of the carbohydrate by the chlorophyll in the presence of similar compound such as carbon dioxide and reductant taken from the air and oxygen does not evolve as a product
- $2H_2A + CO_2 \xrightarrow{\hspace{10em}} (CH_2O)_x + 2A + 2H_2O$

- All the photosynthetic bacteria are classified into the 35 groups. The group 10 contain anoxygenic phototrophic bacteria while 11 belongs to oxygenic phototropic bacteria .
- The anoxygenic group has purple and green sulphur bacteria while oxygenic contain the cyanobacteria .
- Another type of oxygenic bacteria under **prochlorphyta** .Its acts as a bridge between cyanophyta and chlorophyta

Chlorophyll

- Chlorophyll is a complex molecule. Several modifications of chlorophyll occur among plants and other photosynthetic organisms. All photosynthetic organisms have chlorophyll a and accessory pigments.
- Accessory pigments contain chlorophyll b, c, d, and e, xanthophyll, and carotenoids. They absorb energy from different wavelengths such as violet-blue, reddish, orange-red, etc.
- All chlorophyll molecules contain a lipid-soluble hydrocarbon tail ($C_{20}H_{39}$) and a flat hydrophilic head with a magnesium ion at its center.

Stage of photosynthesis

- When chlorophyll absorb light energy ,an electron gain energy and excited .The excited electron is transferred to another molecule (called primary electron acceptor)
- The chlorophyll molecule is oxidized (loss of electron) and has a positive charge .Photoactivation of chlorophyll results a splitting of the water molecule and transfer of energy to ATP and NADP+
- The chemical reaction include condensation reaction responsible for water molecule splitting out including phosphorylation**, oxidation ,reduction involving electron transfer chain
- **Phosphorylation –The addition of phosphate group to an organic compound

Types of photosynthesis

- There are two types of photosynthesis

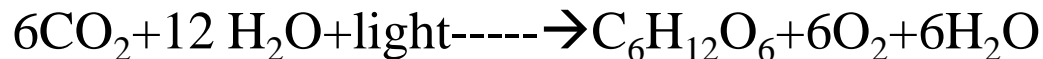
1. Anoxygenic Photosynthesis -phototrophic bacteria H₂O is not oxidized and O₂ is not produced, and thus the process is called **anoxygenic photosynthesis**.



Example-Purple bacteria

H₂A=H₂O, H₂S, H₂ etc.

2. Oxygenic Photosynthesis-The oxidation of H₂O produces molecular oxygen (O₂) as a by-product. Because O₂ is produced, photosynthesis in these organisms is called **oxygenic photosynthesis**.



Example-Eukaryotes and cyanobacteria

Anoxygenic photosynthesis

- It is type of photosynthesis process which frequently occurs in the microorganism which are mostly found in aquatic habitat . This reaction does not involve production of oxygen.
- Sulfur is used as a reducing agent during the process in green sulfur bacteria and purple bacteria

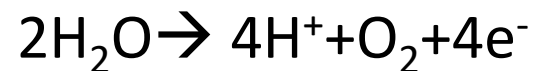
Anoxygenic photosynthetic bacteria

- Some photosynthetic bacteria can use light energy to extract electrons from molecules other than water.
- These organisms are of ancient origin, presumed to have evolved before oxygenic photosynthetic organisms.
- Anoxygenic photosynthetic organisms occur in the domain Bacteria and have representatives in four phyla – Purple-Sulphur Bacteria, Purple non- Sulphur Bacteria, Green-Sulfur Bacteria, Green non-Sulfur Bacteria.
- Anoxygenic photosynthesis depends on electron donors such as reduced sulphur compounds, molecular hydrogen or organic compounds.
- They are found in fresh water, brackish water, marine and hypersaline water.
- Anoxygenic photosynthetic bacteria have been divided into three groups on the basis of pigmentation: purple bacteria, green bacteria and heliobacteria.

Oxygenic photosynthesis

- During this process ,light energy transfer electron from water to carbon dioxide to produce carbohydrate .In this reaction the carbon dioxide is reduced or receive the electron and water become oxidised or losses electron .Ultimately oxygen is produced along with carbohydrate.
- $6\text{CO}_2+12 \text{H}_2\text{O}+\text{light} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6+6\text{O}_2+6\text{H}_2\text{O}$
- This is a two stage process
 1. Light dependent reaction
 2. Light independent reaction

- 1-Light dependent reaction-This is a series of reaction which occurs in the grana of chloroplast and require direct energy from the sunlight .Light energy is trapped for the ATP synthesis at some time water is photolysed in to Oxygen and Hydrogen ion and free electron carrier.



- 2-Light Independent reaction – A light independent reaction is a series of reaction in the stroma of chloroplast .It help to make the carbohydrate from carbon dioxide molecule by reduction process .

- In contrast to electron flow in anoxygenic phototrophs, electron flow in oxygenic phototrophs proceeds through two distinct but interconnected series of light reactions.
- The two light systems are called photosystem I and photosystem II, each photosystem having a spectrally distinct form of reaction center chlorophyll a.
- Photosystem I (PSI) chlorophyll, called P700, absorbs light at long wavelengths (far red light), whereas PSII chlorophyll, called P680, absorbs light at shorter wavelengths (near red light).
- Oxygenic phototrophs use light to generate both ATP and NADPH, the electrons for the latter arising from the splitting of water into oxygen and electrons.

Oxygenic Photosynthetic Bacteria

- The Oxygenic Photosynthetic Bacteria are unicellular or multicellular and possess bacteriochlorophyll a and carry out oxygenic photosynthesis.
- They are mostly represented by gram-negative cyanobacteria.
- Carboxysomes and gas vesicles are present and also show gliding movement.
- Photosynthesis is oxygenic and autotrophic.
- Photosynthates get accumulated in the form of glycogen.