# ECONOMIC IMPORTANCE OF ALGAE

- **Role of Algae in Soil fertility**
- **Biofertilizer**
- **Nitrogen Fixation**
- **Symbiosis**

Dr. Sugandha Tiwari
sugandhatiwari7@gmail.com

- Role of Algae in Soil fertility
- Nitrogen Fixation
- Symbiosis

# Role of Algae in Soil fertility

# Seaweed Manure

Seaweeds, being rich in potassium, phosphorus, trace elements and growth substances, are extensively utilized as manure.

The seaweed manure, however, is poorer in nitrogen and phosphorus than the farmyard manure.

# Extracellular algal products

Many algae produce considerable amounts of extracellular substances such as

- organic acids,
- amino acids and
- polypeptides

# Extracellular algal products

These extracellular substances chelate organic and inorganic ions and maintain them in a state readily available to plants.

The extracellular products also serve as sources of carbon and nitrogen for other microorganisms that regulate the overall balance of soil nitrogen, sulphur, phosphorus and carbon.

# Blue-Green Algal Fertilizers

Members of cyanophyceae (Blue-Green Algae) can fix atmospheric nitrogen.

Examples of nitrogen fixing BGA are *Anabaena, Nostoc, Tolypothrix, Aulosira, Nostoc* etc.

*Azolla* pteridophyte has symbiotic BGA *Anabaena azollae* that can fix atmospheric nitrogen.

*Azolla* is used as a **biofertilizer** in rice fields.

# Blue-Green Algal Fertilizers

The yield of paddy is substantially increased following the inoculation of fields with blue - green algae (*Aulosira fertilissima, Tolypothrix tenuis*)

Algologists at the Central Rice Research Institute, Cuttack (India) inoculated rice fields with four species of nitrogen-fixing blue-green algae; the grain yield increased by nearly 30 per cent.

# Role of BGA in soil reclamation

Blue-green algae can be used to help reclaim saline and alkaline wastelands in various parts of India.

BGA decrease pH and increase nitrogen, phosphorus and organic matter content of the field thus converting it into a fertile cultivable land.

# Nitrogen fixation

# Nitrogen fixation

All known nitrogen-fixing organisms are prokaryotes.

In nitrogen fixation, N2 from the atmosphere is fixed by the enzyme **nitrogenase** into ammonium using ATP as a source of energy.

The process is one of the most metabolically expensive processes in biology, requiring 16 ATP for each molecule of N2 fixed.

$$N_2 + 8\,H^+ + 8e^- + 16\,ATP \rightarrow 2\,NH_3 + H_2 + 16\,ADP + 16\,Pi$$

# Nitrogen fixation

Nitrogenase is composed of two components, dinitrogenase reductase (iron protein) and dinitrogenase (molybdenum–iron protein) encoded by the nif HDK operon.

Nitrogenase, the nitrogen-fixing enzyme, is very sensitive to inactivation by oxygen.

# Nitrogen fixation

Cyanobacteria have evolved three different mechanisms designed to exclude oxygen from the area of the cells containing nitrogenase.

1. Heterocystous cyanobacteria
2. Cyanobacteria fixing nitrogen in dark
3. Nitrogen fixing cells- diazocytes

# Heterocystous cyanobacteria

(1) **Heterocystous cyanobacteria**

- Heterocysts are surrounded by a glycolipid layer which is impermeable to $O_2$.
- Heterocysts lack photosystem II and, therefore, the ability to evolve $O_2$.
- Heterocysts do have cyclic photophosphorylation and can produce ATP necessary for nitrogen fixation.
- Heterocysts also have cyanoglobin that scavenges oxygen, preventing inhibition of nitrogenase .

# Cyanobacteria that Fix nitrogen in dark

(2) **Non-filamentous cyanobacteria** that **fix nitrogen in the dark** but not in the light.

These cyanobacteria fix nitrogen in the dark when photosynthesis is not producing nitrogenase- inhibiting oxygen.

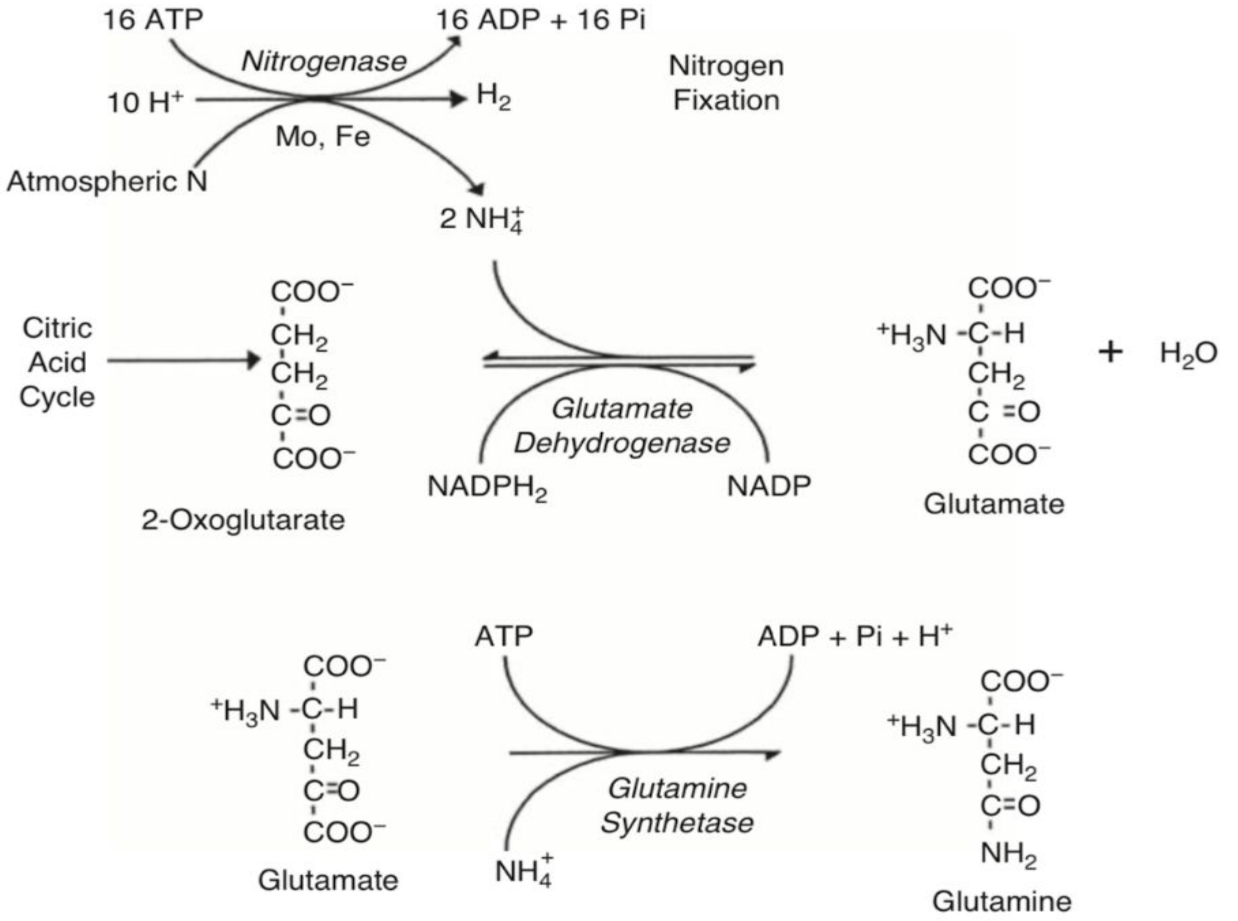
Eg. *Synechococcus*

# Nitrogen fixing cells: diazocytes

(3) *Trichodesmium* and *Katagnymene* (cyanobacteria) are responsible for fixing one-quarter of the total nitrogen in the oceans of the world .

These filamentous cyanobacteria have cells called diazocytes that have nitrogenase enzyme to fix nitrogen.

Diazocytes have a denser thylakoid network with fewer gas vacuoles and cyanophycin granules .




**The chemistry of Nitrogen fixation**

# Hydrogen gas as a byproduct of nitrogen fixation

Hydrogen gas is also produced in nitrogen fixation and has drawn interest as a renewable energy source as hydrogen fuel-cell technology for motor vehicles.

# Symbiosis

# SYMBIOSIS

Symbiosis can be defined as two or more organisms of different species that live in close physical contact. Mutualism is a type of symbiotic association in which all organisms involved benefit in some way.

Algae present in mutualistic relationships often provide essential fixed carbon and oxygen to one or more heterotrophs. Cyanobacteria provide fixed nitrogen.

# Bacterial-Algal Associations

**Algae** serve as sources of fixed carbon and nitrogen for adherent bacteria.

**Bacteria** may, in turn, provide growth factors, vitamins, chelators, or remineralized inorganic nutrients (Fe, $C0_2$, $NH^{4+}$, $N0_3$, or $PO_4^{3-}$).

Heterotrophic nitrogen-fixing bacteria may excrete needed fixed nitrogen to eukaryotic algae growing in N-limited environments.

**Aerobic heterotrophic bacteria** may also help to lower $O_2$ concentrations, facilitating $0_2$-sensitive reactions such as nitrogen fixation.

# Lichens: Algae-Fungi symbiosis

Lichens are associations between fungi (known as mycobionts) and algae (green algae and/or cyanobacteria known as phycobionts ).

Some 85% of lichens contain unicellular or **filamentous green algae**,

10% contain **cyanobacterial** partners, and

4% or more contain both green and cyanobacterial algae.

# Lichens: Algae-Fungi symbiosis

The unicellular green algae *Trebouxia* and *Asterochloris* are by far the most common phycobionts.

In 98% of lichen species the fungal partner is an ascomycete and (in few others basidiomycetes or deuteromycetes).

# Lichens: Algae-Fungi symbiosis

**Mycobionts** frequently reproduce sexually whereas the phycobionts usually do not, the **lichens are classified with the fungi**.

In the symbiotic association, the **phycobiont** fixes carbon in photosynthesis and liberates it as glucose, which the mycobiont converts into mannitol and assimilates .

**Benefits to the alga** are probably limited to some protection against desiccation.

Lichens are regarded as important contributors to soil integrity and fertility .

# Algal Symbiosis

A number of **liverwort, hornwort, moss, fern, cycad, and angiosperm** species are closely associated with nitrogen-fixing cyanobacteria-typically species of Nostoc.

Photosynthesis is primarily the job of the plant partner.

The cyanobacteria mainly function in providing fixed nitrogen in exchange for a supply of fixed carbon from the plant.

# Algal Symbiosis: Azolla

The **aquatic fern Azolla** is commonly used as a biofertilizer in paddy (rice) fields. Azolla has cavities in the dorsal lobe of the leaf that are occupied by Anabaena azollae .

Cyanobacterium fixes nitrogen , some of which is excreted into the cavity and taken up by the cells of the Azolla.

Azolla been used as a green manure in rice fields, where about 3 kg of atmospheric nitrogen per hectare per day is fixed by Azolla symbionts

# Algal Symbiosis

**Cycads** typically produce above ground roots (known as coralloid roots) that contain *Nostoc* colonies .

These cyanobacteria are able to fix nitrogen and contribute a portion of the fixed nitrogen to the cycad cells.

The tropical flowering plant **Gunnera** harbors Nostoc colonies in special mucilage-filled glands at the bases of petioles .