

Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Second Year)

Subject: Botany

Course Code: BOC 104

Course Title: Plant Physiology

Unit: Nitrogen metabolism

Module Name-Biological Nitrogen Fixation- Asymbiotic

Module No: 50

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Notes

Asymbiotic Biological Nitrogen Fixation

Nitrogen is the major part of proteins and nucleic acids which are the basis of all life forms. It is also present in chlorophylls, alkaloids and cytochromes. Nitrogen from the soil is continually depleted by soil erosion, chemical volatilisation, and denitrification etc.

Air contains approximately 79% nitrogen, but plants cannot use it.

In nature, nitrogen fixation takes place both by non-biological (physico-chemical) and biological means. The biological nitrogen fixation is more significant as compared to non-biological because more amount of nitrogen is fixed by biological means (140-700 mg/m²/year) than non-biological (about 35 mg/m²/year).

The conversion of N₂ into the compound which can be absorbed by the plants by biological means is termed as biological nitrogen fixation.

Nitrogen present in the atmosphere is in the dinitrogen (N=N) form, therefore, the microorganism which fixes nitrogen is called diazotrophs.

Asymbiotic Nitrogen fixation

The fixation of free nitrogen of the soil by all micro-organisms living freely or outside the plant cell is called asymbiotic biological nitrogen fixation. It is performed by living organisms like aerobic and anaerobic bacteria and blue green algae. Some of the bacteria and most of the cyanobacteria comprise this class of microorganisms. They are also called free-living diazotrophs. Both aerobic and anaerobic bacteria are free-living diazotrophs

Studies with radioactive isotopes of nitrogen (^{15}N) indicated that several other organisms also fix atmospheric nitrogen.

By Bacteria:

The soil contains a special type of bacteria called nitrogen fixing bacteria. They convert free nitrogen (N_2) of the soil into soluble compounds which are absorbed from the soil by plants. Aerobacter, Methanobacterium, colourless sulphur bacteria, , are all nitrogen fixing bacteria. They may be classified into the following four categories.

1. Free living aerobic nitrogen fixing bacteria:
Photosynthetic: Chlorobium, Chromatium
Non-photosynthetic : Azotobacter, Azomonas, Beijerinckia, Derxia
2. Free living anaerobic nitrogen fixing bacteria:
Photosynthetic: Rhodospirillum
Non- photosynthetic: Clostridium
3. Free living chemosynthetic bacteria:
Heterotrophic: Desulfovibrio

By Free living fungi:

The yeast present in the soil is called soil yeast. A few species of soil yeasts are involved in nitrogen fixation. *Pullularia* fungus is involved in nitrogen fixation.

By Cyanobacteria and blue green algae:

Among cyanobacteria unicellular, filamentous non-heterocystous and filamentous heterocystous fix nitrogen independently. Water, oxygen, nutrients are required in optimum amount, so that, the microorganism can grow. Cyanobacteria grow mainly in the crop fields. The site of nitrogen fixation in the cyanobacteria is the heterocyst because the enzyme nitrogenase) required for nitrogen fixation acts under anaerobic condition.

Unicellular and non-heterocystous cyanobacteria fix nitrogen by specializing some cells which have oxygen level reduced. Typically, they fix nitrogen in dark and photosynthesize in light.

About 40 species of blue green algae including Nostoc, Anabaena, Calothrix, Oscillatoria, Tolypothrix, Cylandrospermum and Scytonema are found freely in the soil where they fix free nitrogen into nitrogenous and ammonium compounds. Most of them bear thick-walled heterocysts which are the sites of nitrogen fixation.

The symbiotic free living nitrogen fixers are quite primitive. The fixation is a reduction process independent of respiration. These organisms fix nitrogen more actively under poor aeration, provided no hydrogen gas is being produced