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ASAC 1101 : FUNDAMENTALS OF SOIL SCIENCE (2+1)

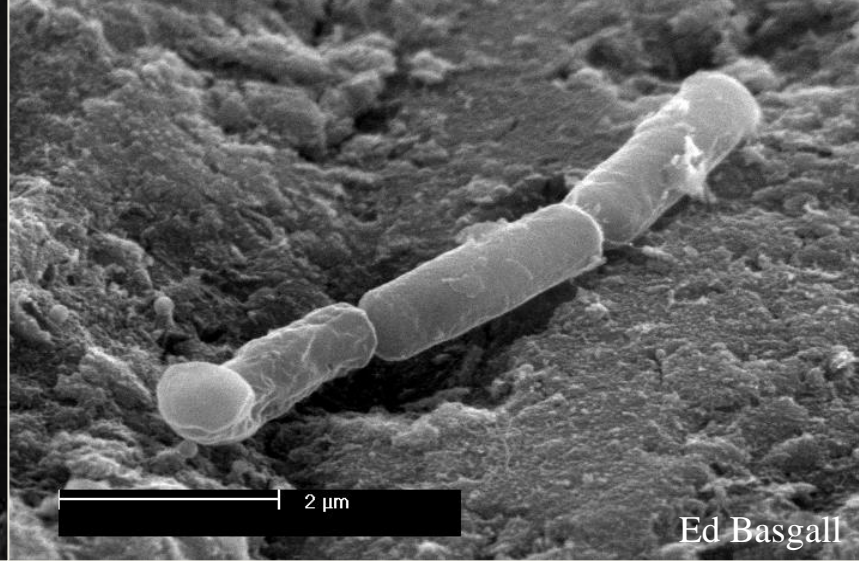
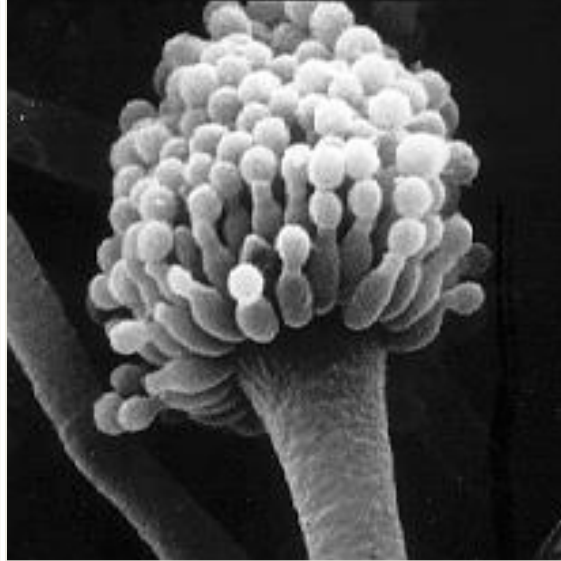
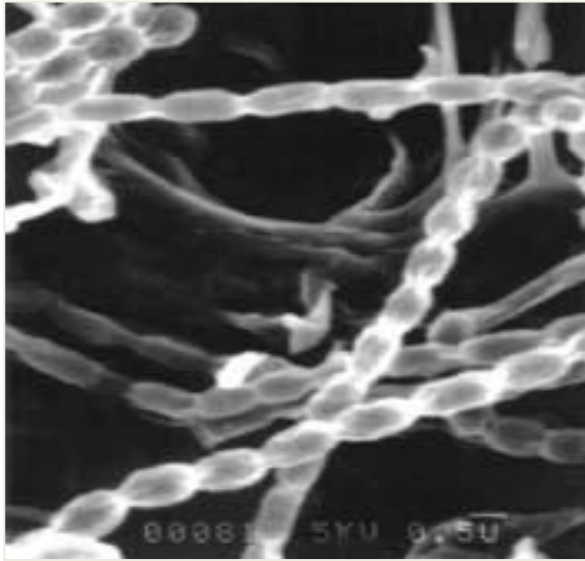
Level : B.Sc (Ag), I semester

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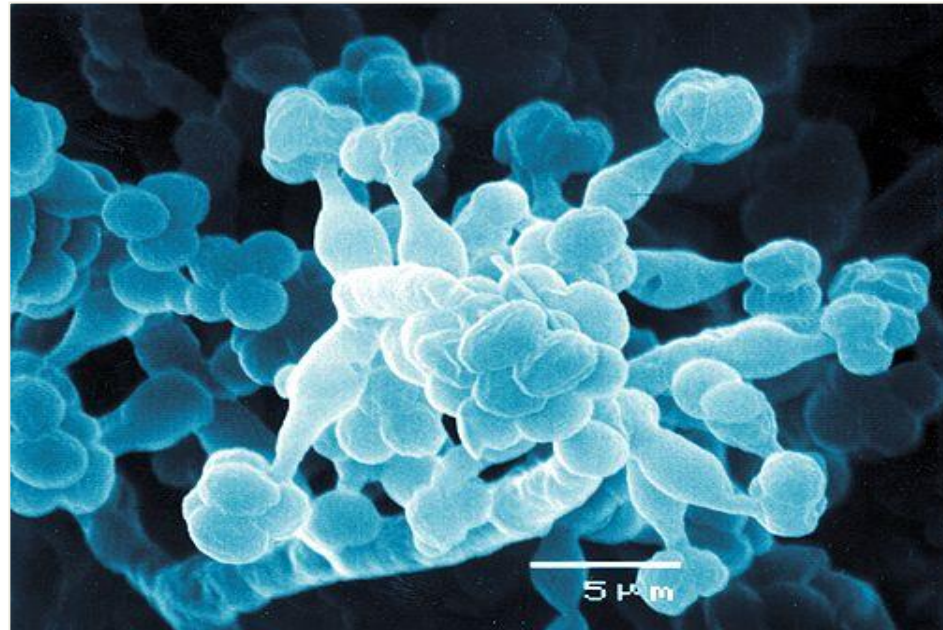
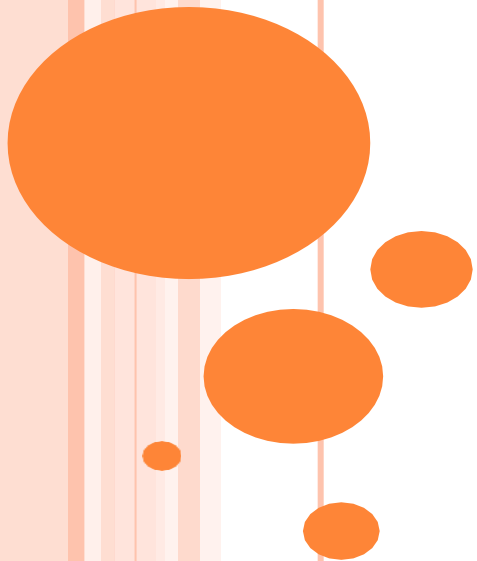
**SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
M.S.SWAMINATHAN SCHOOL OF AGRICULTURE,CUTM,
PARLAKHEMUNDI**

Topic

SOIL BIOLOGY



SOIL BIOLOGY




- **Soil biology** deals with soil organisms, their function and interaction within the soil.

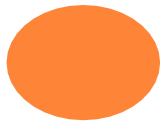
Biomass

- Biomass, as a renewable energy source, refers to living and recently dead biological material that can be used as fuel or for industrial production.
- It refers to plant matter grown to generate electricity.
- Biomass may also include biodegradable wastes that can be burnt as fuel.



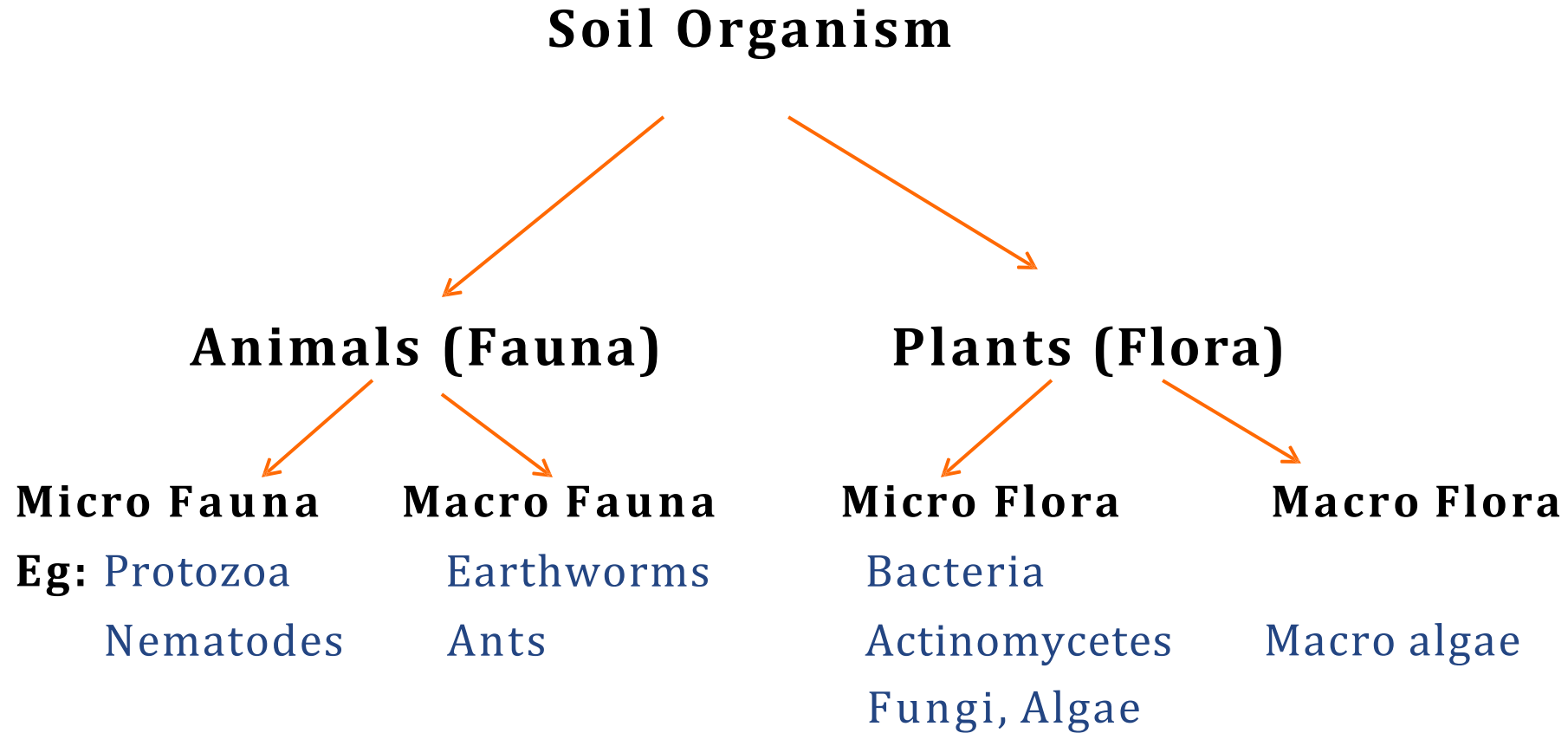
Roles of Microorganisms in soil fertility and crop production

- Decompose and turn crop residues into humus, carbon dioxide and water and release their nutrients slowly for efficient plant use.
 - Soil microorganisms play vital role in every chemical transformation taking place in soil.
 - Certain soil micro-organisms such as mycorrhizal fungi can also increase the availability of mineral nutrients (e.g. phosphorus) to plants.
 - For instance, nitrogen-fixing bacteria can transform nitrogen gas present in the atmosphere into soluble nitrogenous compounds that plant roots can utilize for growth.
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- Improve physical and chemical properties of soil.
 - Improve water absorption, retention, drainage and aeration of the soil and creates a better environment for root growth.
 - Increase the buffering capacity of the soil and reduce the toxicity of soil and fertilizer salts.
 - Help in breakdown and elimination of herbicide, pesticide and other chemical residues in the soil.
 - Produce plant hormones like IAA.
 - Produce antibiotic substances that inhibit potential disease producing organisms in the soil.
 - They are active participators in soil formation.
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Classification of organism in soil

- Organisms present in soil are mainly classified in to **Soil flora** and **Soil fauna**.



Classification based on requirement of molecular oxygen

Obligate aerobes

Facultative anaerobes

Obligate anaerobes

- **Obligate aerobes:** Organisms that **need O₂** for respiration and cannot survive without it. **E.g.: Nitrosomonas and Nitrobacter**
- **Facultative anaerobes:** Organisms which are aerobic but also adapted to grow under anaerobic conditions using oxidized substances like NO₂, SO₄, etc. **Eg: Denitrifying bacteria (Bacillus), Citrobacter**
- **Obligate anaerobes:** The organisms which grow in **the absence of O₂**.
Eg: Clostridium, Desulfovibrio, Methenobacteria etc.



Classification based on optimum temperature for growth

Psychrophiles	Optimum temperature for growth $< 20\text{ }^{\circ}\text{C}$	Eg: Arthrobacter
Mesophiles	20-35 °C	Pseudomonas, E. coli
Thermophiles	$>45\text{ }^{\circ}\text{C}$	<i>Thermus aquaticus</i>



Classification based on mode of nutrition

1. **Autotrophs:** Those organisms that are able to make energy containing organic molecule from inorganic material by using sunlight as energy source and CO_2 as C source.

A.Chemoautotrophs: Which get energy from the oxidation of simple inorganic compounds. (chemosynthesis)

Eg: **Thiobacillus**

B.Photoautotrophs: Organisms that can make their own energy using light and CO_2 via the process of photosynthesis.

Eg: **Algae**

2. **Heterotrophs:** A heterotroph is an organism that can't manufacture its own food and therefore drives its intake of nutrition from other sources of organic carbon mainly plant or animal matter.

○ Act as secondary and tertiary consumers. Eg:**Fungi**





BIOLOGICAL NITROGEN FIXATION

BNF: Fixation of elemental nitrogen in the atmosphere by the microorganism through a reductive process into ammonia is called as BNF.

- A variety of prokaryotic organism have the ability to reduce the atmosphere N_2 into ammonia with help of an enzyme called **nitrogenase**.
- Carried out by certain bacteria, actinomycetes, blue green algae, fungi and yeast.
- The most important of these are bacteria, which have ability to fix atmospheric nitrogen by symbiosis or free living.
- Rhizobium is the first group of organism realized for its potential of nitrogen fixation.



Free living	Azotobactor, Derixa, Beijerinckia, Cyanobacteria
Associative	Azospirillum, Acetobactor
Symbiotic	Rhizobia-Legume, Frankia-Non legume, Anabaena-Azolla




Cross inoculation groups of rhizobium (CIG)

- Not all rhizobia nodulate all legumes. Rather, particular rhizobia form a symbiosis with particular legumes or groups of legumes.
- The symbiosis between rhizobia and legumes appears to be precisely matched.
- It (CIG) refers the groups of leguminous plants that will develop effective nodules when inoculated with the rhizobia obtained from the nodules from any member of that legume group.



Rhizobium Spp.	Cross Inoculation Grouping	Legume Types
R. leguminosarum	Pea group	Pisum, Vicia, Lens
R. phaseoli	Bean group	Phaseolus
R. trifolii	Clover group	Trifolium
R. meliloti	Alfalfa group	Melilotus, Medicago, Trigonella
R. lupini	Lupini group	Lupinus, Orinthopus
R. japonicum	Soybean group	Glycine
		Vigna, Arachis

Process of symbiotic N₂ fixation

- Rhizobia have the ability to infect the plant roots and form nodules in them.
 - Energy required to break the triple bond between nitrogen atoms in the N₂ molecule is supplied by host plant from photosynthesis.
 - The ammonia further converted in to L-ketoglutamic acid and finally in to glutamic acid.
 - Genes directing specific steps in nodulation of a legume by a strain of Rhizobium are called **nod genes**.
 - Genes responsible for N₂ fixation are called **Nif genes**.
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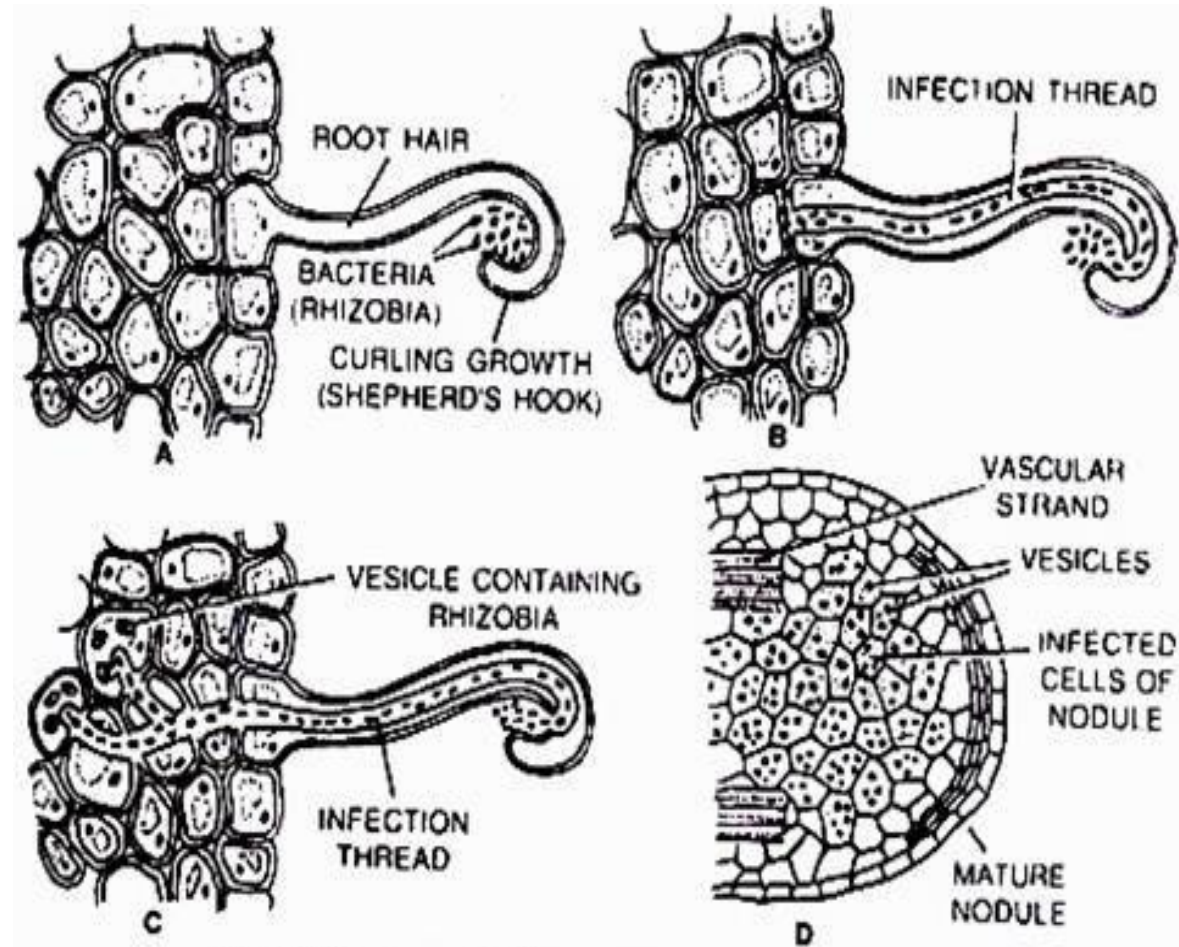


Fig. 5.1 Development of root nodule (nodulation) in legume.



Factors affecting BNF

- Type of legume
- Effectiveness of bacterial strain
- Inorganic N content
- Fertilizer N applied
- Adequate supply of P, K and secondary nutrients.
- Favorable environmental conditions (mainly temperature, moisture and pH)



- **Phosphate solubilizing microorganisms (PSMs)** are group of beneficial microorganisms capable of hydrolyzing organic and inorganic phosphorus compounds from insoluble compounds.
- **Phosphate solubilizing bacteria (PSB)** are beneficial bacteria capable of solubilizing inorganic phosphorus from insoluble compounds.

Eg : Bacillus and Pseudomonas



The mechanism of P solubilization that is employed mostly by soil microorganisms includes:

- (1) Release of complex compounds e.g. organic acid anions, siderophores, protons, hydroxyl ions, CO_2 ,
- (2) Liberation of enzymes
- (3) The release of P during the degradation of substrate.

Fungal genera (Penicillium and Aspergillus), actinomycetes, and arbuscular mycorrhizal (AM) are also help for P solubilization.

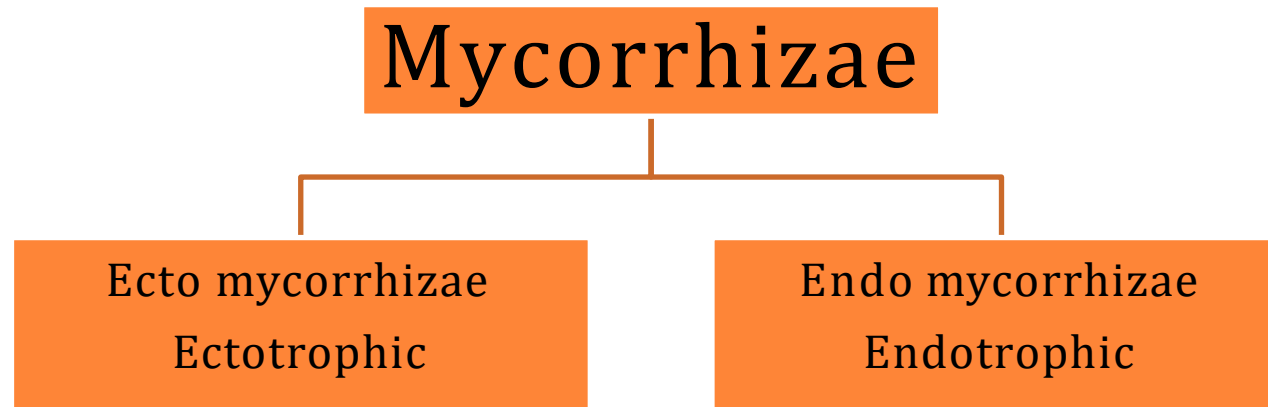


Mycorrhizae

- The symbiotic association between numerous fungi and the roots of higher plants is called mycorrhizae.
- This association increases the availability of several essential nutrients to plants especially from low fertile soils.
- This association provides sugars and other organic exudates from higher plants as food to the fungi.
- The fungi in turn provide an enhanced availability of several essential nutrients including P, Zn, Cu, Ca, Mg, Mn and Fe.



There are 2 types of mycorrhizal associations.



- **Ecto mycorrhizae** : The fungus forms a mantle or sheath over the surface of fine lateral roots of the host trees and sends some hyphae into the intercellular spaces of the outer cortex forming a so-called **Hartignet**. Eg: *Amanita spp.*, *Boletus spp.* etc.
- **Endo mycorrhizae**: Hyphae actually penetrate in to the cells of host plant. Eg: **Arbuscular mycorrhizal fungi**



Lichens

- It is a stable symbiotic association between a fungus (mycobiont) and algae (photobionts) and/or cyanobacteria.
- Where photosynthetic symbionts provide a source of carbon and surface protection from light and irradiation.
- The photosynthesizer benefits from the water and nutrients absorbed by the fungus.



Thank You