

Soil Microbiology

By

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Definition

- ▶ It is branch of science/microbiology which deals with study of soil microorganisms and their activities in the soil.

Components of Soil

- ▶ Soil is mixture of five major components viz. organic matter, mineral matter, soil-air, soil water and soil microorganisms/living organisms.
- ▶ Mineral / Inorganic Matter - Carbon, Calcium, Potassium, Manganese, Sodium, Sulphur, Phosphorus etc. are in trace amount.

Living organisms in Soil

▶ A. Soil Flora

- a) Microflora: 1. Bacteria 2. Fungi, Molds, Yeast, Mushroom 3. Actinomycetes, Streptomyces 4. Algae eg. BGA, Yellow Green Algae, Golden Brown Algae.
- ▶ 1. Bacteria is again classified in I) Heterotrophic eg. symbiotic & non - symbiotic N₂ fixers, Ammonifier, Cellulose Decomposers, Denitrifiers II) Autotrophic eg. Nitrosomonas, Nitrobacter, Sulphur oxidizers, etc.
- b) Macroflora: Roots of higher plants
- ▶ B. Soil Fauna
- ▶ a) Microfauna: Protozoa, Nematodes
- ▶ b) Macrofauna: Earthworms. moles, ants & others.

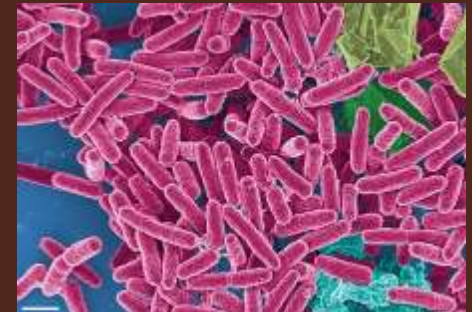
Living organisms in Soil

- ▶ Bacteria-aerobic (70%), anaerobic (13 %), Actinomycetes (13%), Fungi /molds (03 %) and others (Algae Protozoa viruses) 0.2-0.8 %.
- ▶ Soil organisms play key role in the nutrient transformations.

Bacteria

- ▶ Decomposers
- ▶ Bacteria play an important role in decomposition of organic materials, especially in the early stages of decomposition when moisture levels are high.
- ▶ Nitrogen fixers
- ▶ Rhizobium bacteria can be inoculated onto legume seeds to fix nitrogen in the soil.

Process/reaction	Bacterial genera
Cellulose decomposition (cellulolytic bacteria) most cellulose decomposers are mesophilic	a. Aerobic : <i>Angiococcus</i> , <i>Cytophaga</i> , <i>Polyangium</i> , <i>Sporocytophyga</i> , <i>Bacillus</i> , <i>Achromobacter</i> , <i>Cellulomonas</i> b. anaerobic: <i>Clostridium</i> <i>Methanosarcina</i> , <i>Methanococcus</i>
Ammonification (Ammonifiers)	<i>Bacillus</i> , <i>Pseudomonas</i>
Nitrification (Nitrifying bacteria)	<i>Nitrosomonas</i> , <i>Nitrobacter</i> <i>Nitrosococcus</i>
Denitrification (Denitrifies)	<i>Achromobacter</i> , <i>Pseudomonas</i> , <i>Bacillus</i> , <i>Micrococcus</i>
Nitrogen fixing bacteria	a Symbiotic- <i>Rhizobium</i> , <i>Bradyrhizobium</i> b Non-symbiotic: aerobic – <i>Azotobacter</i> <i>Beijerinckia</i> (acidic soils), anaerobic- <i>Clostridium</i>



Pseudomonas sp.



Rhizobium of
beans

Bacteria capable of degrading various plant residues in soil are :

<i>Cellulose</i>	<i>Hemicelluloses</i>	<i>Lignin</i>	<i>Pectin</i>	<i>Proteins</i>
Pseudomonas	Bacillus	Pseudomonas	Erwinia	Clostridium
Cytophaya	Vibrio	Micrococcus		Proteus
Spirillum	Pseudomonas	Flavobacteriumm		Pseudomonas
Actinomycetes	Erwinia	Xanthomonas		Bacillus
Cellulomonas		Streptomyces		

Actinomycetes

- ▶ They are unicellular like bacteria, but produce a mycelium.
- ▶ In the order of abundance in soils, the common genera of actinomycetes are Streptomyces (nearly 70%), Nocardia and Micromonospora although Actinomycetes, Actinoplanes, Micromonospora and Streptosporangium are also generally encountered.



Actinomycetes :Functions

- ▶ Degrade/decompose all sorts of organic substances like cellulose, polysaccharides, protein fats, organic-acids etc.
- ▶ They decompose / degrade the more resistant and indecomposable organic substance/matter and produce a number of dark black to brown pigments which contribute to the dark colour of soil humus.
- ▶ Many genera species and strains produce/synthesize number of antibiotics like Streptomycin, Terramycin, Aureomycin etc.
- ▶ One of the species of actinomycetes *Streptomyces scabies* causes disease "Potato scab" in potato.

Algae

- ▶ Algae are present in most of the soils where moisture and sunlight are available. Their number in soil usually ranges from 100 to 10,000 per gram of soil.
- ▶ Soil algae are divided into four main classes or phyla as follows:
 - ▶ 1. Cyanophyta (Blue-green algae)
 - ▶ 2. Chlorophyta (Grass-green algae)
 - ▶ 3. Xanthophyta (Yellow-green algae)
 - ▶ 4. Bacillariophyta (diatoms or golden-brown algae)
- ▶ The most common genera of green algae found in soil are: *Chlorella*, *Chlamydomonas*, *Chlorococcum*, *Protosiphon* etc. and that of diatoms are *Navicula*, *Pinnularia*, *Synedra*, *Frangilaria*.

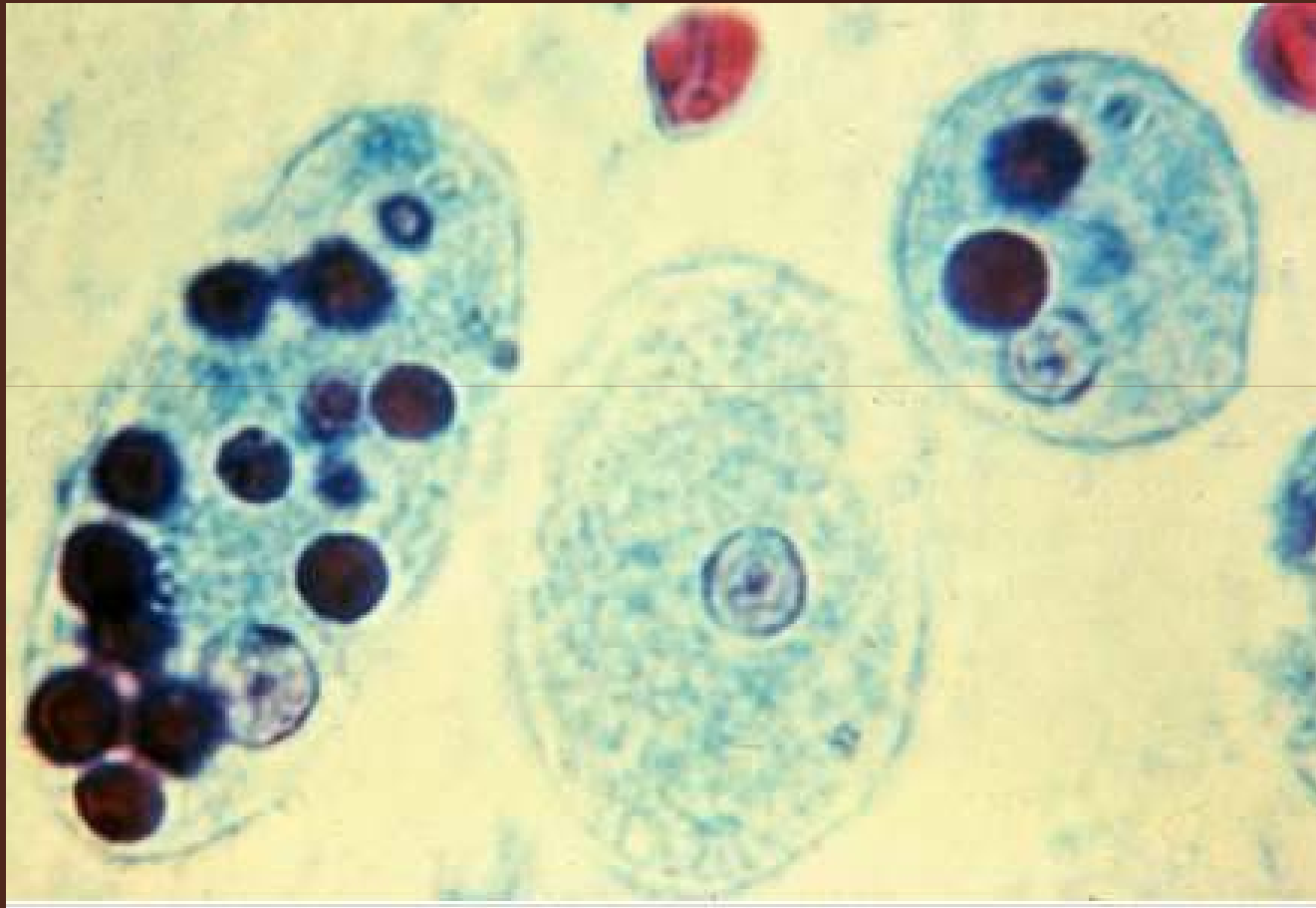


Functions

- ▶ Plays important role in the maintenance of soil fertility especially in tropical soils.
- ▶ Add organic matter to soil when die and thus increase the amount of organic carbon in soil.
- ▶ Most of soil algae (especially BGA) act as cementing agent in binding soil particles and thereby reduce/prevent soil erosion.
- ▶ Mucilage secreted by the BGA is hygroscopic in nature and thus helps in increasing water retention capacity of soil for longer time/period.
- ▶ *Anabaena-Azolla* association fix nitrogen symbiotically.

Protozoa

- ▶ These are unicellular, eukaryotic organism.
- ▶ Their population in soil ranges from 10,000 to 1,00,000 per gram of soil and are abundant in surface soil.
- ▶ Protozoa are abundant in the upper layer (15 cm) of soil. Soil moisture, aeration, temperature and PH are the important factors affecting soil protozoa.
- ▶ The important soil inhabitants of this class are *Colpidium*, *Colpoda*, *Balantiophorus*, *Gastrostyla*, *Halteria*, *Uroleptus*, *Vortiicella*, *Pleurotricha* etc.



Entamoeba histolytica in the trophozoite stage

Function :Protozoa

- ▶ Most of protozoans derive their nutrition by feeding or ingesting soil bacteria belonging to the genera *Enterobacter*, *Agrobacterium*, *Bacillus*, *Escherichia*, *Micrococcus*, and *Pseudomonas* and thus, they play important role in maintaining microbial / bacterial equilibrium in the soil.
- ▶ Several soil protozoa cause diseases in human beings which are carried through water and other vectors, eg. Amoebic dysentery caused by *Entomobea histolytica*.
- ▶ Some protozoa have been recently used as biological control agents against phytopathogens.

Fungi

- ▶ Soil fungi possess filamentous mycelium composed of individual hyphae. The fungal hyphae may be aseptate/coenocytic (Mastigomycotina and Zygomycotina) or septate (Ascomycotina, Basidiomycotina & Deuteromycotina).
- ▶ Most commonly encountered genera of fungi in soil are; *Alternaria*, *Aspergillus*, *Cladosporium*, *Cephalosporium*, *Botrytis*, *Chaetomium*, *Fusarium*, *Mucor*, *Penicillium*, *Verticillium*, *Trichoderma*, *Rhizopus*, *Gliocladium*, *Monilia*, *Pythium*, etc.

Penicillium chrysogenum



Front View of colony in PDA



Back View of colony in PDA



Microphotograph 10X 48x

Penicillium digitatum



Front View of colony in PDA



Back View of colony in PDA



Microphotograph 10X 48x

Aspergillus niger



Front View of colony in PDA



Back View of colony in PDA

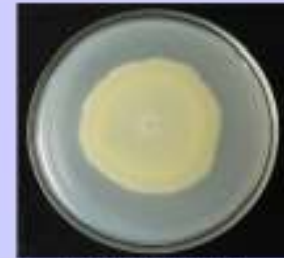


Microphotograph 10X 48x

Aspergillus niger var. *schroeterianus*



Front View of colony in PDA



Back View of colony in PDA



Microphotograph 10X 48x

Functions

- ▶ They play an important role in the degradation / decomposition of cellulose, hemicellulose, starch, pectin, lignin in the organic matter added to the soil.
- ▶ Lignin which is resistant to decomposition by bacteria is mainly decomposed by fungi.
- ▶ Some soil fungi are parasitic and cause a number of plant diseases such as wilts, root rots, damping-off and seedling blights eg. *Pythium*, *Phytophthora*, *Fusarium*, *Verticillium* etc.
- ▶ Some fungi produce amylase, cellulase, penicillin, citric acid, gluconic acid, alcohols etc.



Thankyou