

7th Meeting

Activity of Soil Organisms

by

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“There can be no life without soil and no soil without life, they have evolved together”

- Charles E Kellogg

Activity of Soil Organisms



Breakdown
organic matter

Create soil
structure

Create
humus

Control pests
and diseases

Recycle
nutrients

Promote plant
growth

Fix
nitrogen

Soil Organisms and Soil Structure

- Soil structure dependent on stable aggregates of soil particles
- Soil organisms play important role in soil aggregation
- Constituents of soil are organic matter, polysaccharides, lignins and gum synthesized by soil microbes plays important role in cementing of soil particles
- Cells and mycelial strands of fungi and actinomycetes play important role in soil aggregation

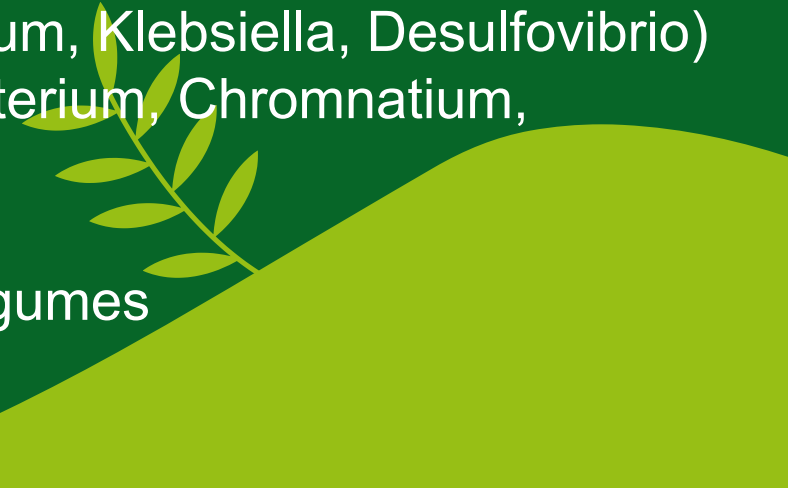


Soil Microbes and Plant Growth

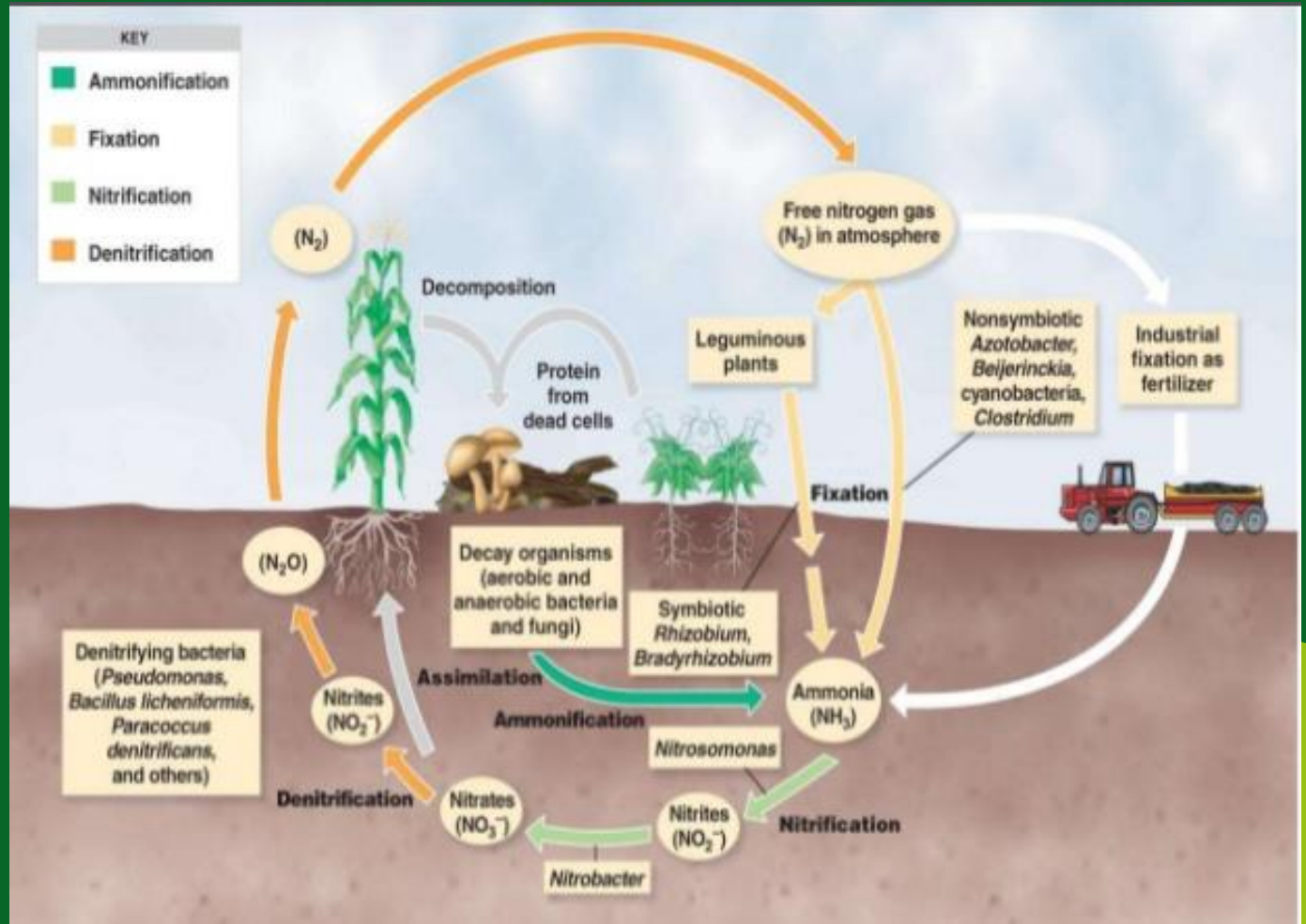
- Best medium for plant growth
- Convert complex organic nutrients into simpler inorganic forms which are readily absorbed by the plant for growth
- Produce variety of substances like IAA, gibberellins, antibiotics, etc. which directly or indirectly promote the plant growth



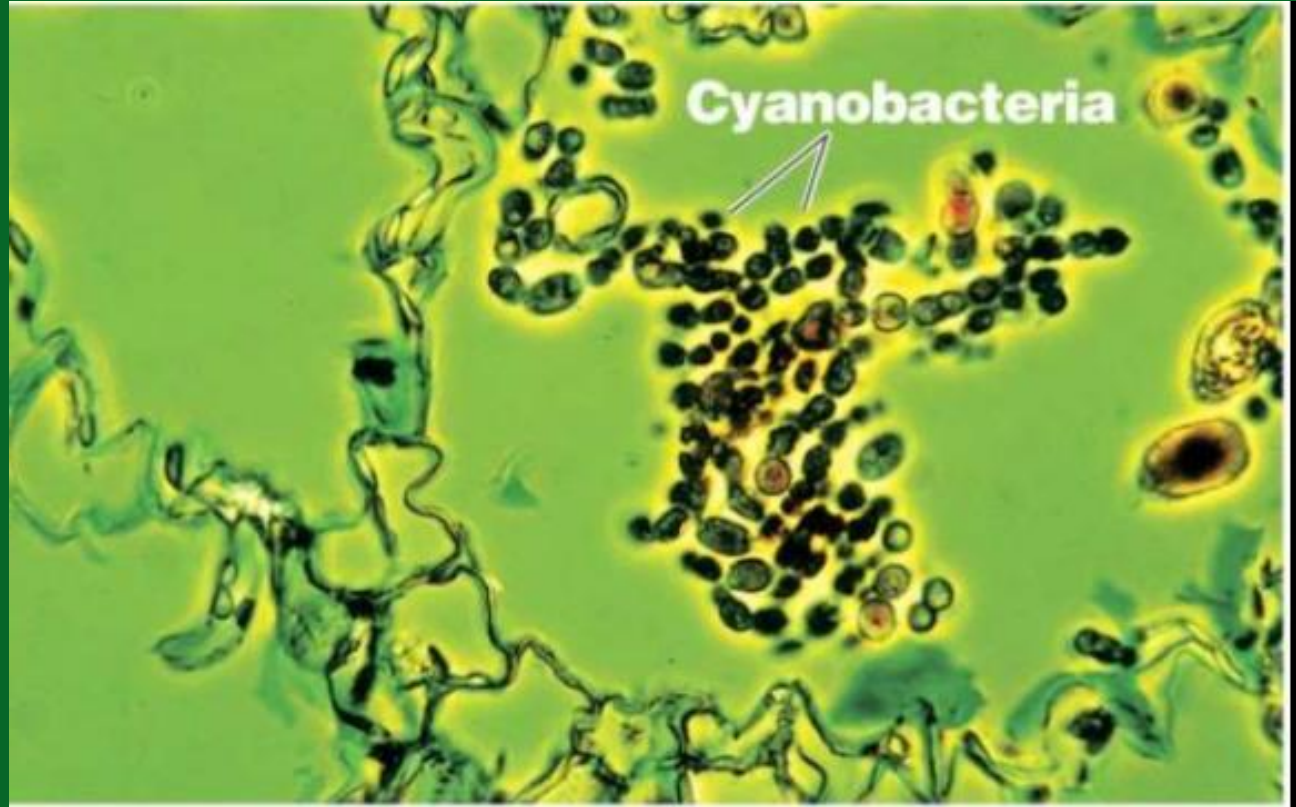
Biological Nitrogen Fixation

- Microorganisms fix 78% N_2 from the atmosphere
 - Two groups of microorganisms are involved in the process of BNF
 - Non-symbiotic (free living) :
 - Aerobic heterotrophs (Azotobacter, Pseudomonas, Achromobacter)
 - Aerobic autotrophs (Nostoc, Anabaena, Calothrix, BGA)
 - Anaerobic heterotrophs (Clostridium, Klebsiella, Desulfovibrio)
 - Anaerobic autotrophs (Chlorobacterium, Chromatium, Rhodospirillum, etc)
 - Symbiotic (Associative) :
 - Rhizobium, Bradyrhizobium in legumes
 - Both : Azospirillum
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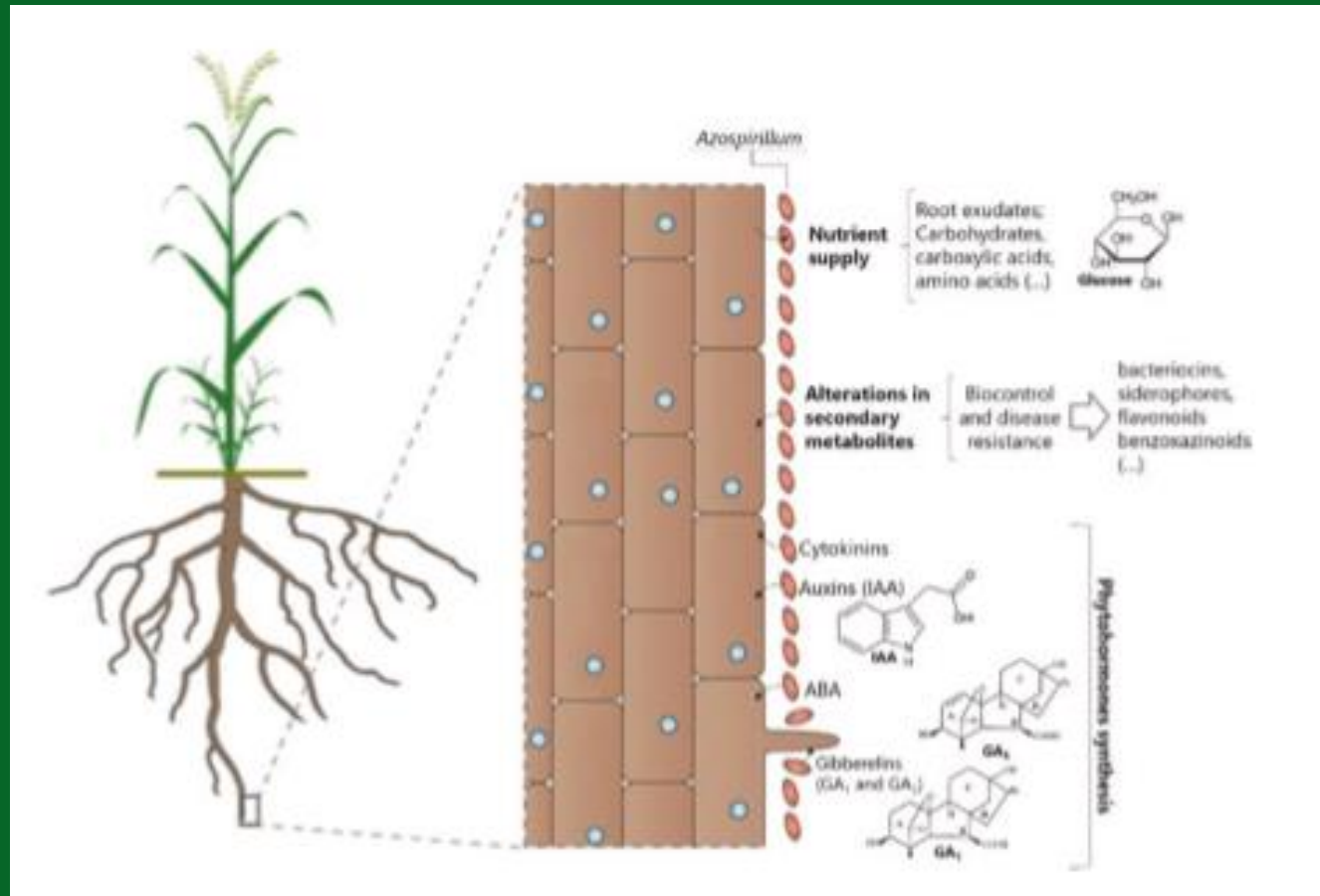
Nitrogen Cycle



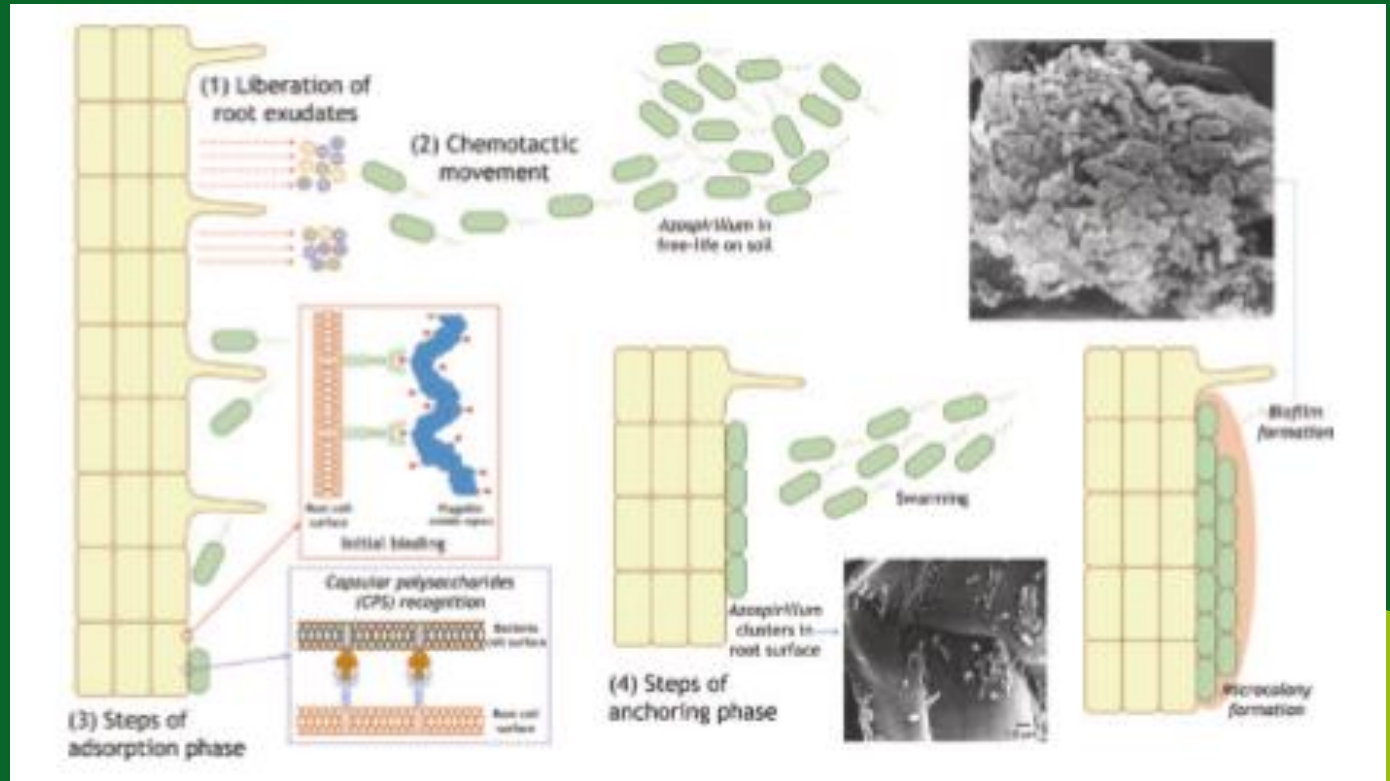
Nitrogen Fixation in Rhizosphere



Mechanism of Azospirillum



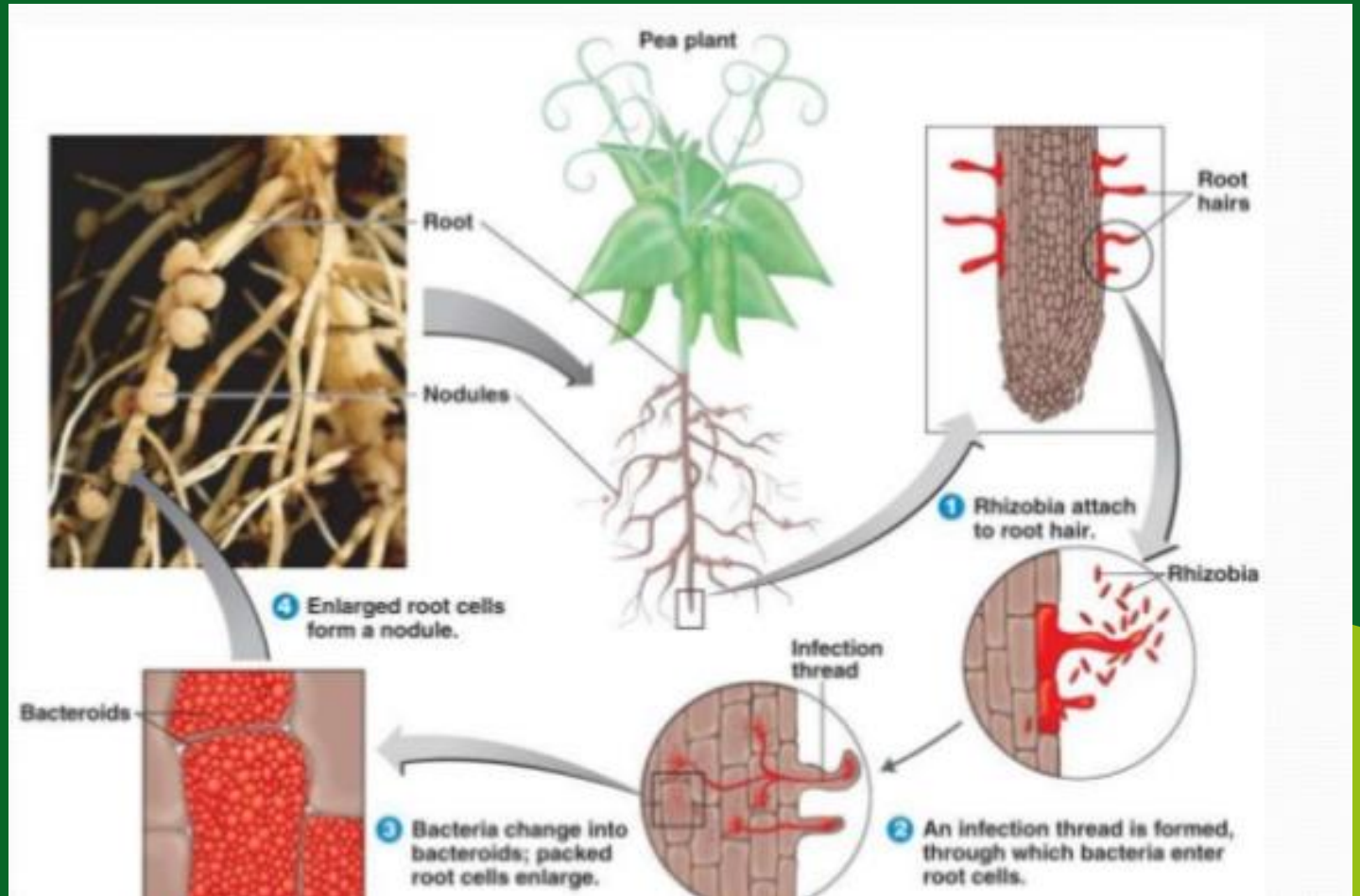
Mechanism of Azospirillum



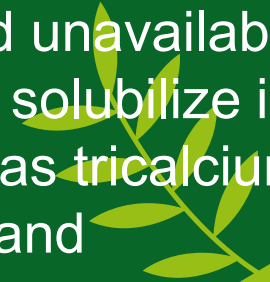
Nitrogen Fixation in Root Nodules



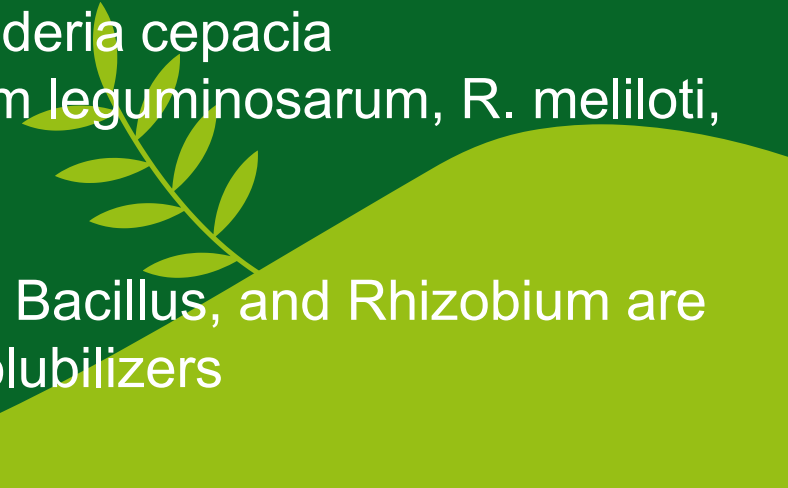
Formation of Root Nodules



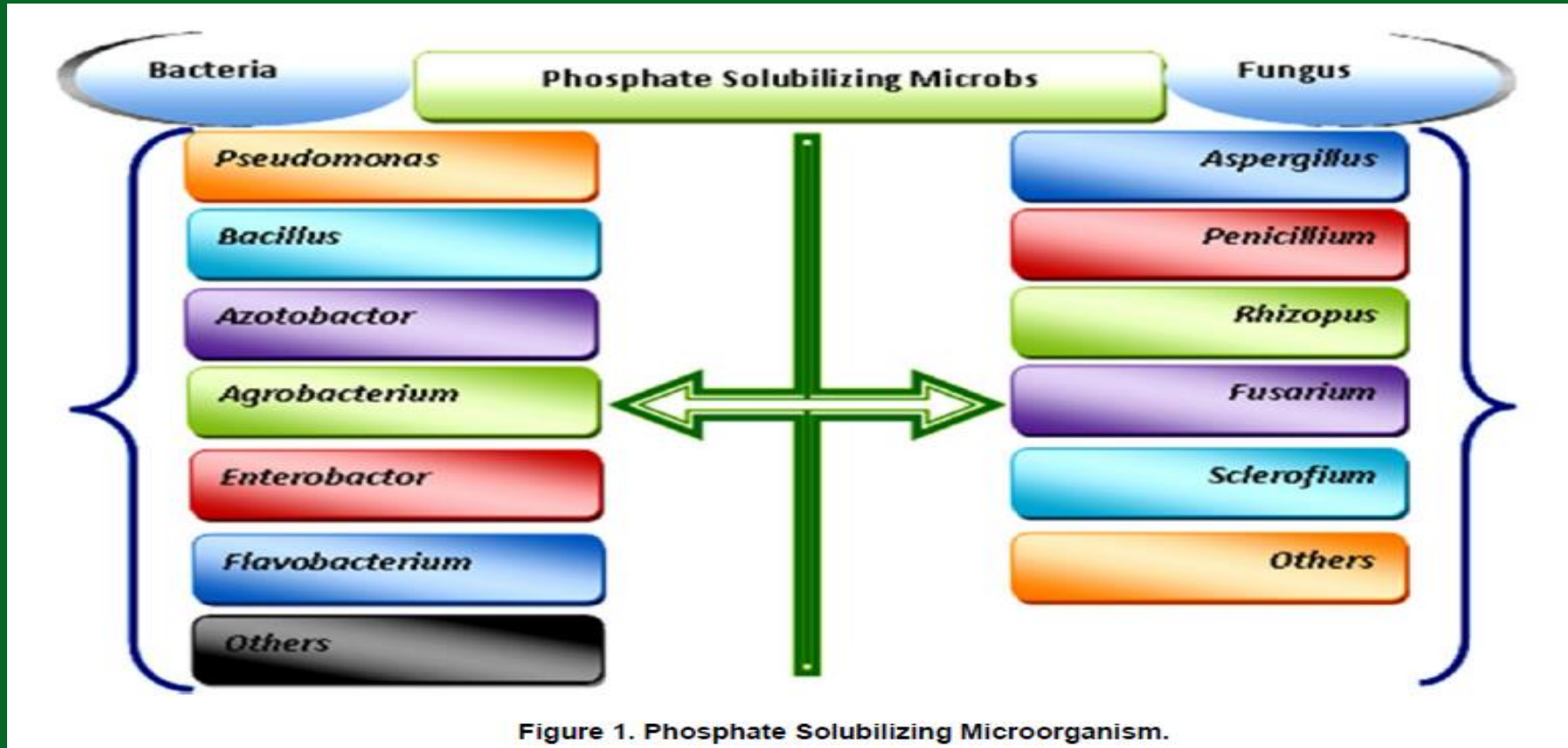
Phosphate Solubilizing Microorganisms

- Phosphorus is an essential element for plant development and growth making up about 0.2% of plant dry weight
 - Plants acquire P from soil solution as phosphate anions
 - However, phosphate anions are extremely reactive and may be immobilized through precipitation with cations such as Ca^{2+} , Mg^{2+} , Fe^{3+} , and Al^{3+} .
 - In these forms, P is highly insoluble and unavailable for plants
 - Different bacterial species has ability to solubilize in soluble inorganic phosphate compounds, such as tricalcium phosphate, dicalcium phosphate, hydroxyapatite, and rock phosphate
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Phosphate Solubilizing Microorganisms

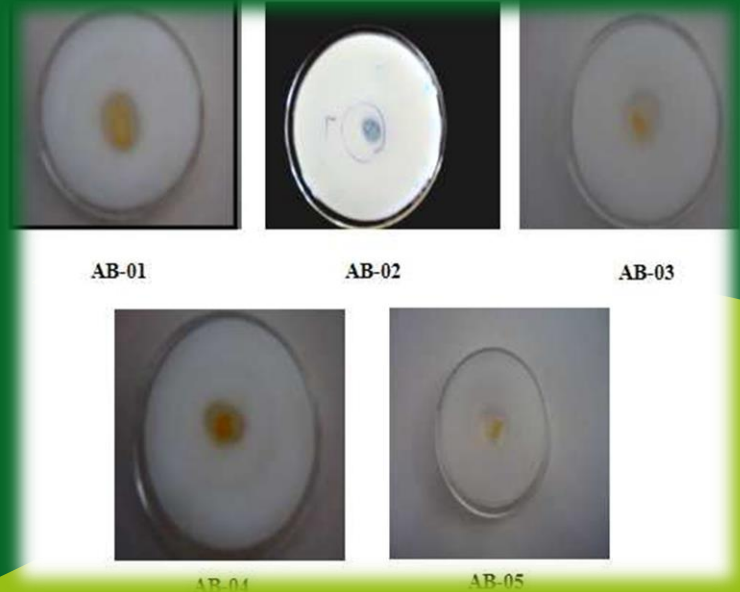
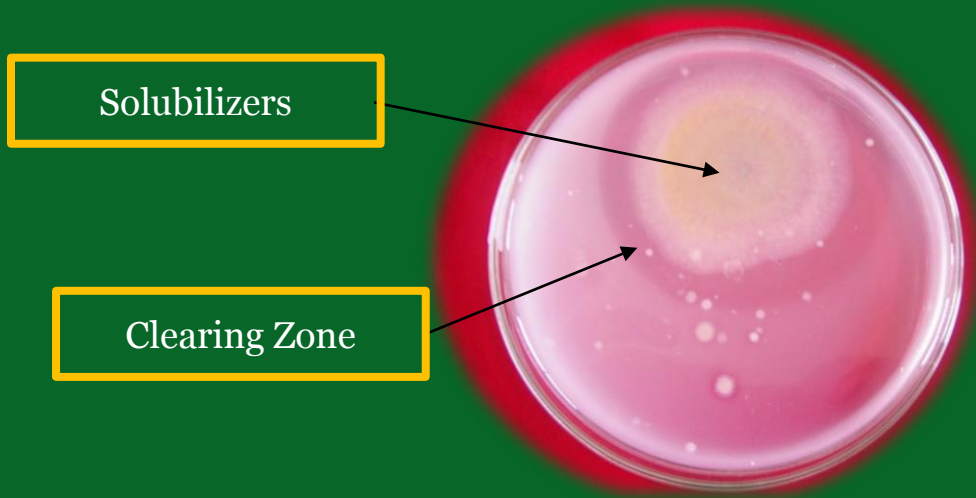
- The principal mechanisms for mineral phosphate solubilization is the production of organic acids.
 - Phosphate solubilization is the action of organic acids synthesized by soil organisms.
 - Ex Organic acid :
 - Gluconic acid : *Pseudomonas* sp, *Erwinia herbicola*, *Pseudomonas cepacia*, *Burkholderia cepacia*
 - 2-Ketogluconic acid : *Rhizobium leguminosarum*, *R. meliloti*, *Bacillus firmus*
 - Strains from the genera *Pseudomonas*, *Bacillus*, and *Rhizobium* are among the most powerful phosphate solubilizers
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Phosphate Solubilizing Microorganisms



Phosphate Solubilizing Bacteria

- Isolation of phosphate solubilizer possible using spread plate method in the Pikovskaya medium
- Phosphate solubilizers produce clearing zones around the microbial colonies in media



Soil Microorganisms as Biocontrol Agents

- Tricoderma sp and Gleocladium sp are used for biological control of seed and soil borne diseases
- Fungal genera Entomophthora, beauveria, Metarrhizium and protozoa Maltesia grandis, Malameba locustiae, etc are used in the management of insect pests
- Bacteria like Bacillus thuringiensis, Pseudomonas are used in cotton against Angular leaf spot and boll worms.



Soil Microorganisms as Biocontrol Agents

- *Azospirillum brasilense* can be used as a biocontrol agent to treat anthracnose disease in strawberry plants by inhibiting the use of Fe by pathogens by producing siderophores (Tortora et al (2011))

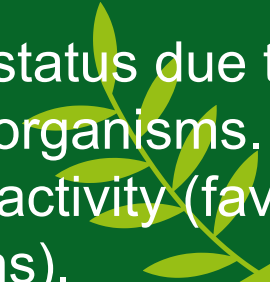


The Degradation/ Detoxification of Synthetic Chemicals

- Natural organic matter is easily degraded by microbes
- Degradation/ detoxification of toxic chemicals or pesticides: bacteria genera like *Pseudomonas*, *Clostridium*, *Bacillus*, *Thiobacillus*, *Achromobacter*, etc. and fungal genera like *Trichoderma*, *Penicillium*, *Aspergillus*, and *Rhizopus*
- Biodegradation of hydrocarbons : *Pseudomonas*, *Mycobacteria*, *Bacillus*, etc



Threats to Microbes in Soil

- Soil degradation (erosion, global warming, land use change, chemical pollution) which is accelerated by anthropogenic activities
 - Climate driven factors such as temperature, precipitation, wind or rain intensity can contribute in the distribution of soil organic matter
 - Soil compaction and reduction of soil porosity reduced of available habitats for soil organisms
 - Alteration of soil aeration and humidity status due to soil compaction can seriously impact the activity of soil organisms.
 - Oxygen limitation can modify microbial activity (favouring microbes that can withstand anaerobic conditions).
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The image is a composite illustration. The top half shows a vibrant rural scene with a cornfield on the left, a cow resting in a green field on the right, and a yellow field in the background. A dark green rectangular box is superimposed over the center. The bottom half of the image is a cross-section of brown soil, revealing various soil organisms such as earthworms, beetles, and larvae, along with plant roots and small circular diagrams showing biological processes.

THANK YOU

Stay Safe and Healthy everyone..!!