Agricultural Microbiology: An Introduction

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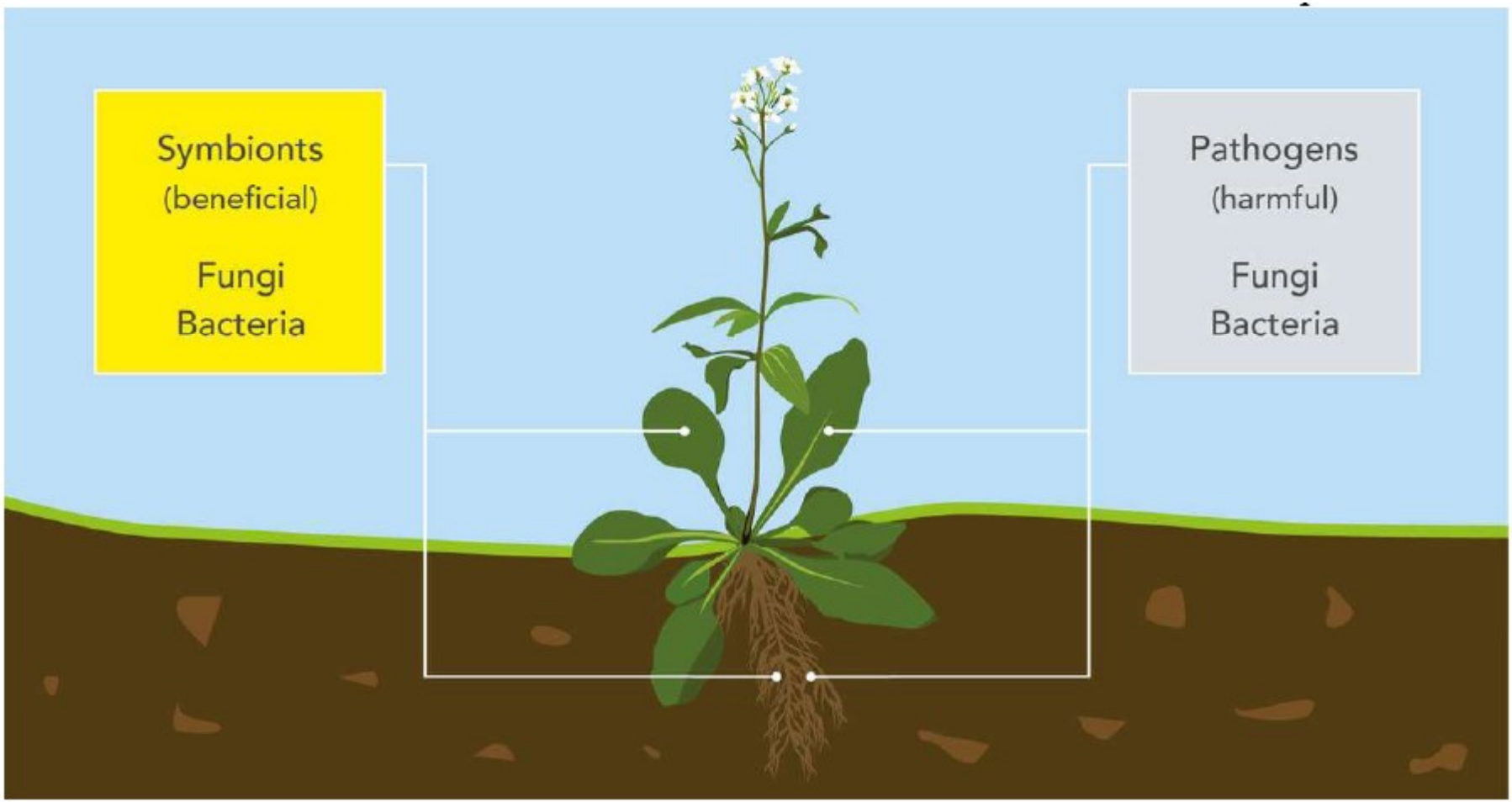
Introduction

- Agricultural microbiology is a field of study related to:
  - Plant-associated microbes .
  - Plant and animal diseases.
  - It also deals with the microbiology of soil fertility, such as microbial degradation of organic matter and soil nutrient transformations.

Plant Microbe Interactions



Plant Fungal Diseases

Fungal disease	Crops affected
White blister/White rust (*Albugo candida*)	Brassicas (including Asian leafy brassicas).
Clubroot (*Plasmodiophora brassicae*)	Brassicas (including Asian leafy brassicas).
Pythium species	Many vegetable crops in including cucurbits; brassicas; lettuce.
Sclerotinia rots (*S. sclerotiorum* and *S. minor*) – a range of common names are used	Most vegetable crops.

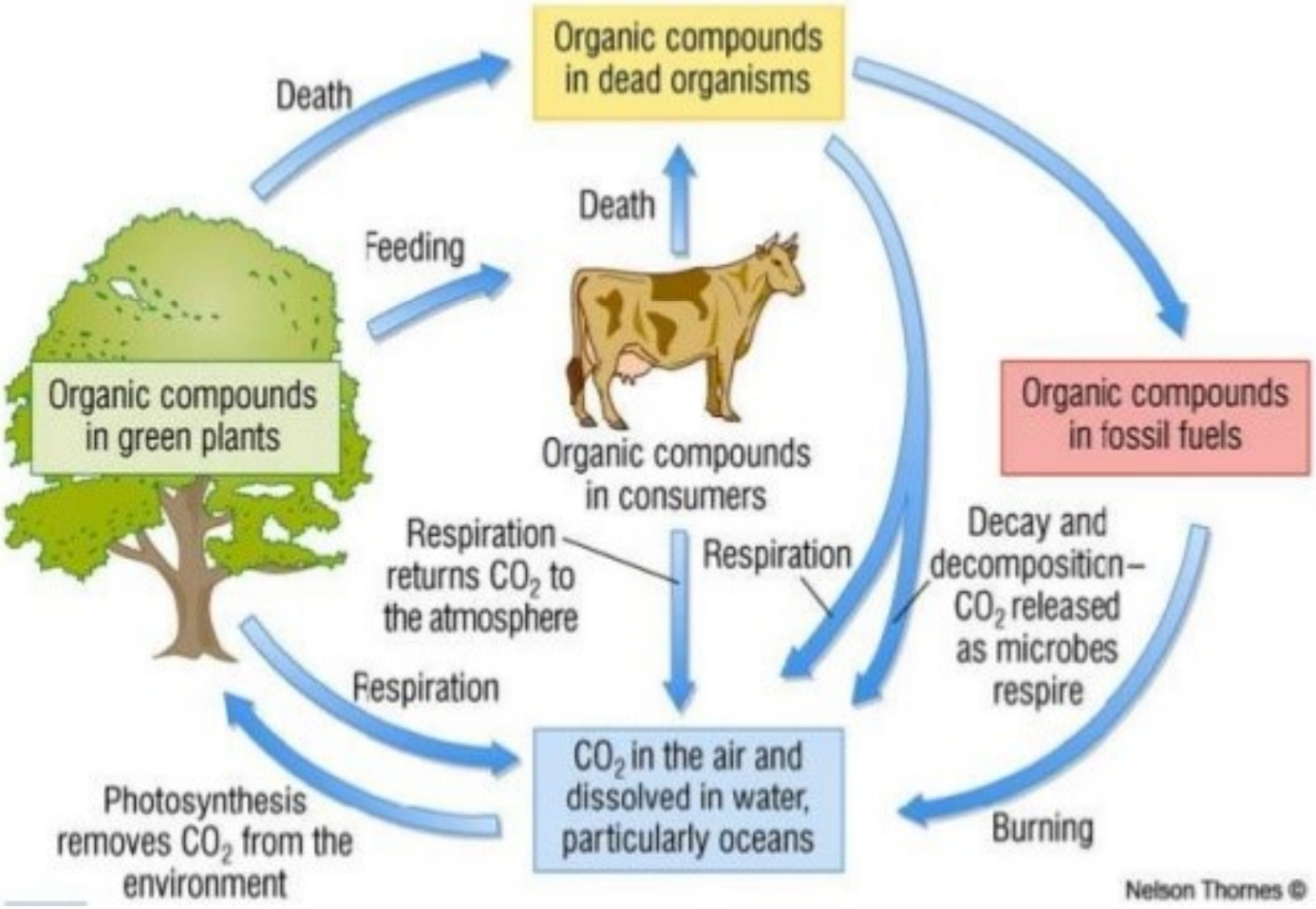
Plant Fungal Diseases

Fungal disease	Crops affected
Fusarium wilts and rots (Various Fusarium species including *F. solani* and *F. oxysporum*)	Wide host range including: brassicas; carrots; cucurbits;onions; spring onions; potato; tomato; herbs; peas; beans.
Botrytis rots – for example Grey mould (*Botrytis cinerea*)	Celery; lettuce; beans; brassicas; cucumber; capsicum; tomato.
Anthracnose (*Colletotrichum spp.* except for in lettuce – *Microdochium panattonianum*)	Wide range of crops including: lettuce; celery; beans; cucurbits; tomato, capsicum; potato; globe artichoke.
Rhizoctonia rots (*Rhizoctonia solani*) – range of common names, e.g. Bottom rot (lettuce) and Wire stem (Brassicas)	Wide host range including: lettuce; potato; brassicas;beans; peas; beets; carrots; capsicum; tomato; cucurbits.
Damping-off	

BIOGEOCHEMICAL CYCLES

- Microbes play an important role in Biogeochemical cycles
  - Mainly 3 types of biogeochemical cycles
  - Carbon cycle
  - Nitrogen cycle
  - Sulphur cycle

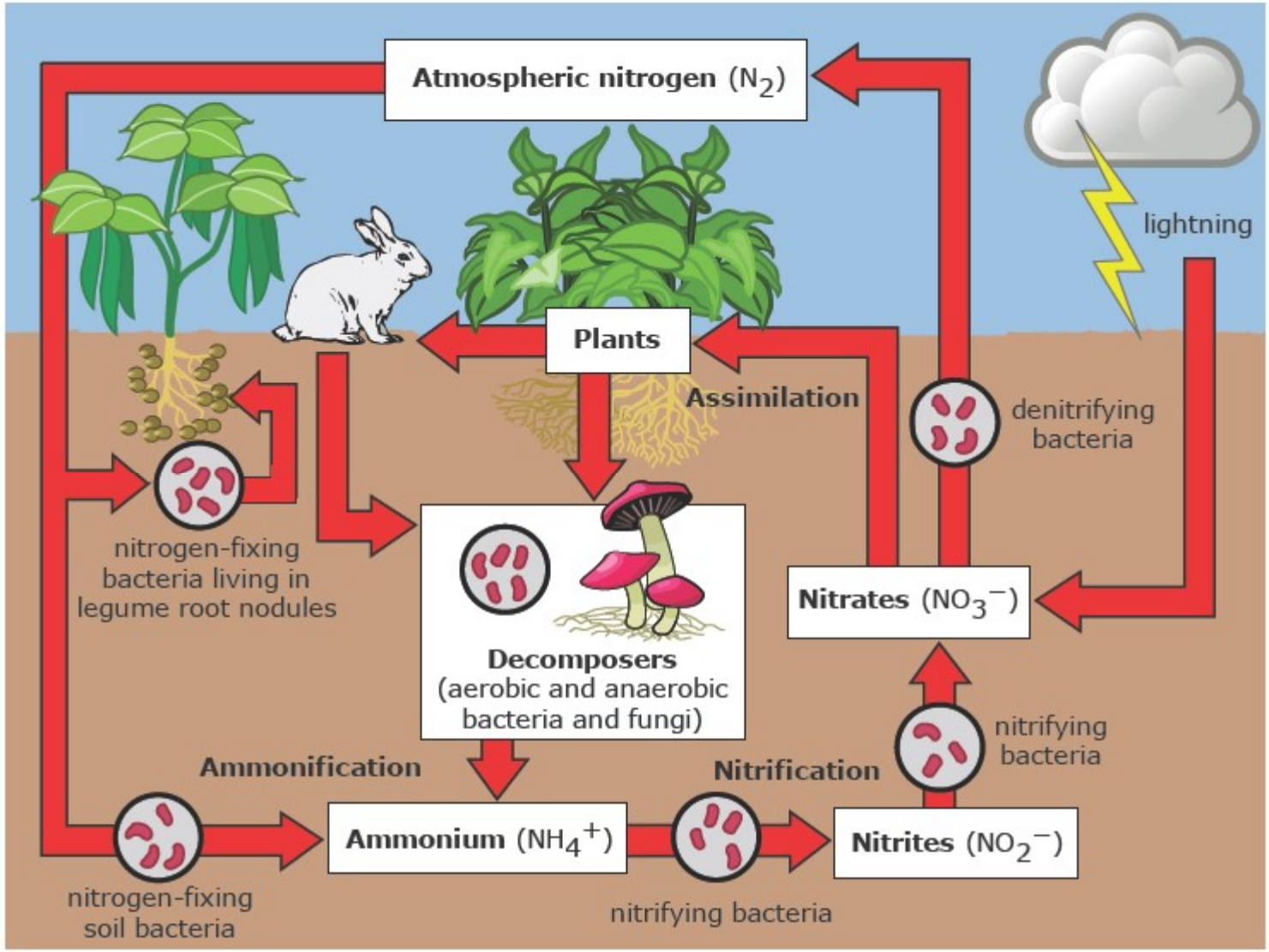
The Carbon Cycle



❖ Carbon cycle

- Decomposition of organic matter by microbes is very important
- Decomposition by fungi along with other microbes (mainly bacteria).
- Decomposition helps to release nutrients blocked in the dead organic matter of plants and animals.

Nitrogen Cycle



Nitrogen cycle

- It is a cyclic process by which nitrogen is converted between its various chemical forms

  1.Nitrogen fixation – atmospheric nitrogen is converted in to ammonia or organic compounds .

  2.Nitrification – In this step ammonium ion is initially oxidized to nitrite ions, subsequently into nitrate ions ,this process is carried out by nitrifying bacteria such as species of *Nitrospira, Nitrosococcus* and *Nitrosolobus.*

3.Assimilation

- Nitrogen compounds in various forms, such as nitrate, nitrite, ammonia, and ammonium are taken up from soil by plants which are then used in the formation of plant and animal proteins.

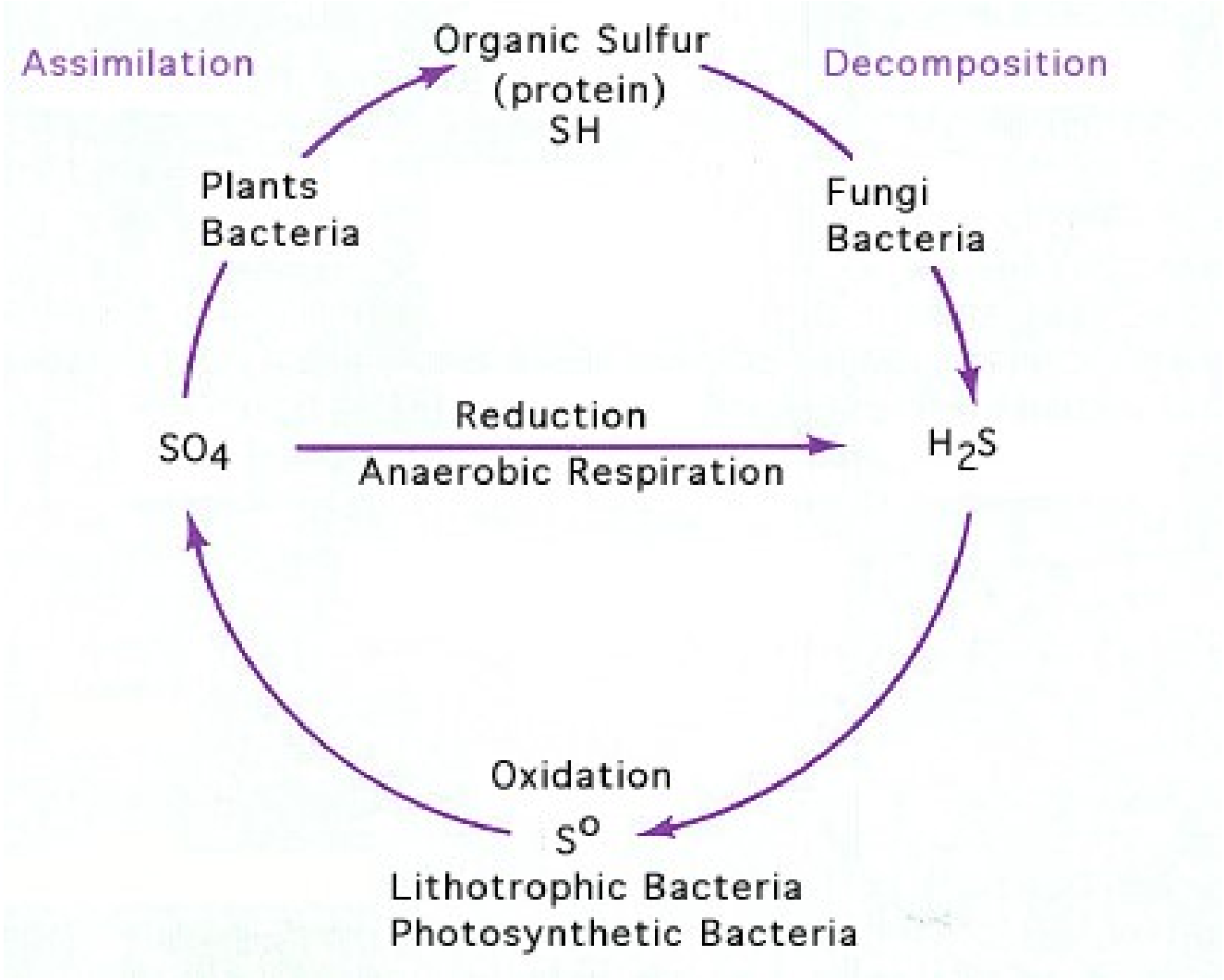
4.Ammonification

- When plants and animals die, it is broken down by other microorganisms, produces ammonia which is then available for other biological processes.

5.Denitrification

- Nitrogen makes its way back into the atmosphere through a process called denitrification, in which nitrate (NO^{3-}) is converted back to gaseous nitrogen (N_2).

Sulphur cycle

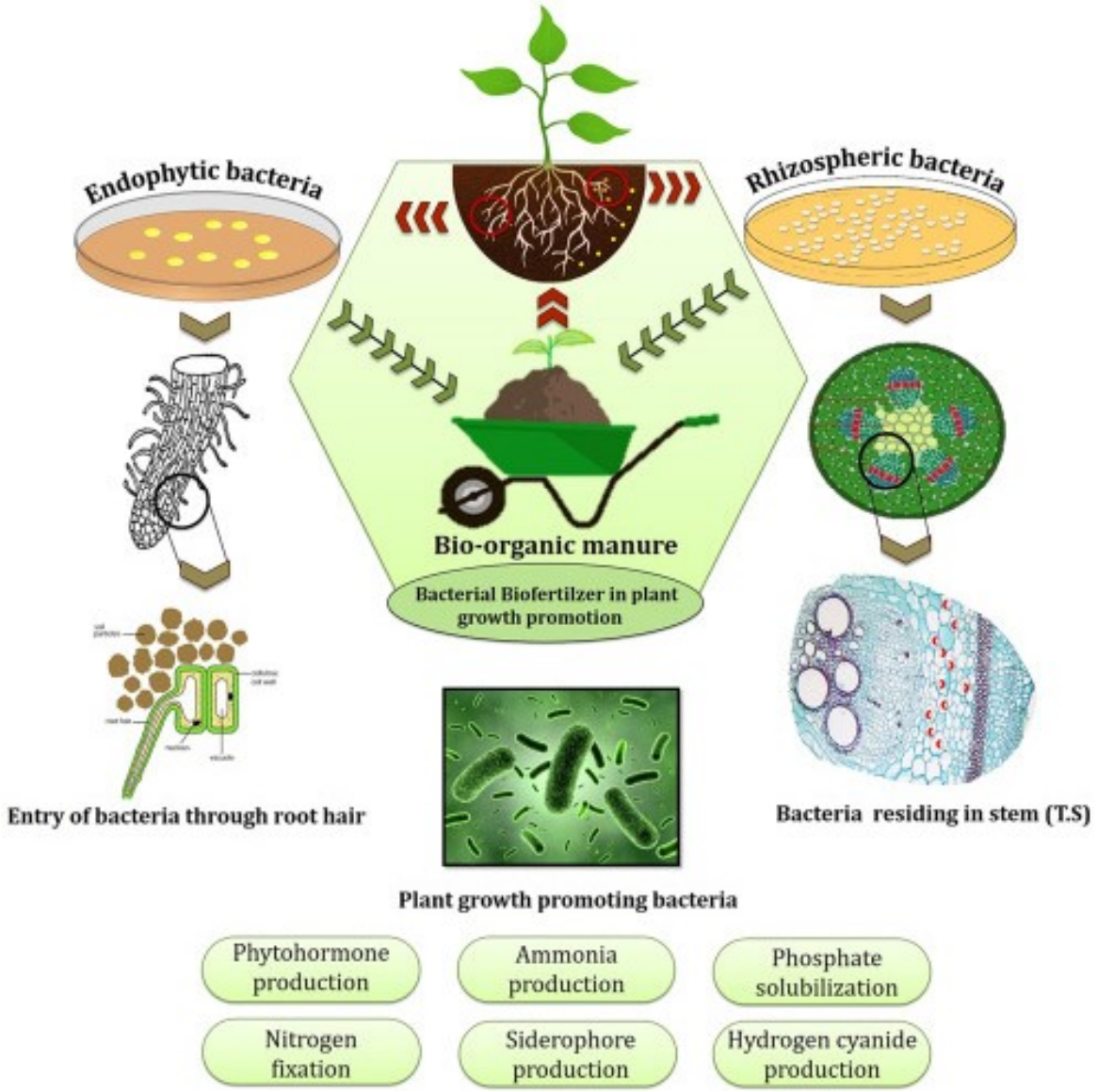


Sulphur Cycle

- Sulphur can exist in a variety of oxidation states (-2, 0, +2, +4 and +6), within organic and inorganic compounds .
- Each oxidation – reduction reaction is mediated by microbes .
- Under anaerobic condition H_2S is produced from mineralization of organic sulphur compounds and this H_2S is utilized by microbes.

Biofertilizers

- Low cost, renewable source of plant nutrients which supplement chemical fertilizers.
- Chemical fertilizers - health and pollution problem and expensive.



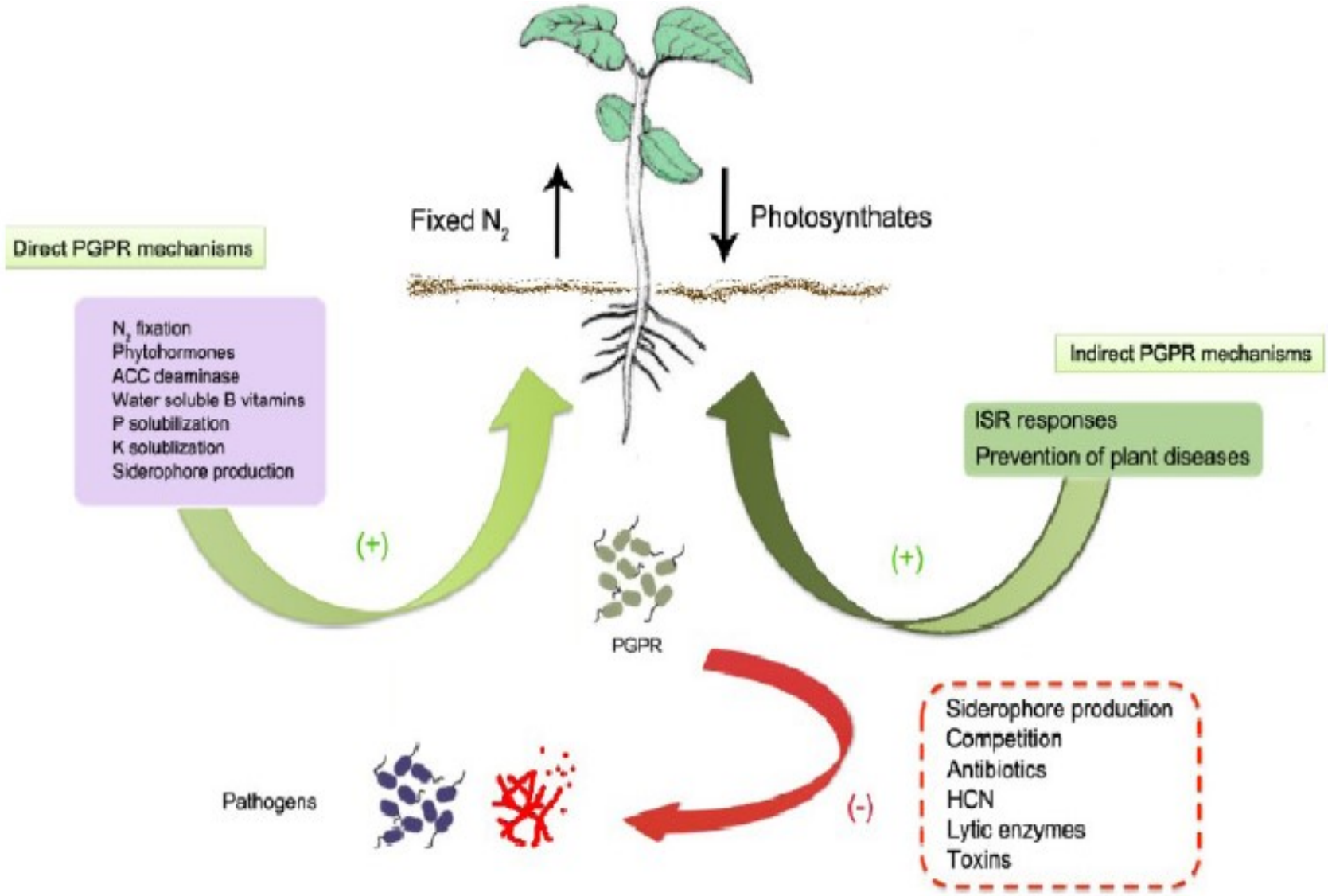
Types of Biofertilizers

- Bacterial
- Fungal
- Algal
- Aquatic Fern
- Earthworms

Bacterial biofertilizers

- Formulation of living bacteria which are able to fix atmospheric nitrogen in the available form for the plants.
- Green manuring.

Plant Growth Promoting Bacteria



ISR = Induced Systemic Resistance; ACC =1-aminocyclopropane-1-carboxylate (**ACC**) **deaminase**

Algal and other biofertilizers

- Biological nitrogen fertilizers play a vital role in solving the problem of soil fertility.
- *Anabaena azollae* – live in symbiotic association with Azolla .
- *Anabaena azollae* can grow photo autotrophically and fix atmospheric N_2 .

Azolla, a Biofertilizer

Phosphorous aiding Biofertilizers

- Some fungi such as, *Aspergillus awamori*, *Penicillium digitatum* etc .
- Bacteria like *Bacillus polymyxa, Pseudomonas striata etc* which can solubilize unavailable form of phosphorous into available forms.

Mycorrhizal Biofertilizers

- Vesicular arbuscular mycorrhizal (VAM) fungi colonize in the roots of several plants .
- They are Zygomycetes fungi belonging to the genera *Glomus, Acaulospora* .
- Obligate symbionts – cannot be cultured on synthetic media.
- Help plant growth through improved phosphorous nutrition and protects root against pathogen.

Microbial insecticides

Bacterial insecicides

- Several bacteria are used as insecticides .
- It include endospore forming *Bacillus* (*Bacillus thuringiensis*) and *Clostridium* species (*Clostridium bifermentans*).
- Non endospore forming –*Proteus*, *Pseudomonas, Enterobacter* etc...

Fungal Insecticides

- Most common and effective means of control of insect pests.
- Mainly entomogenous fungi are used .
- Different kinds of formulations have been developed and applied in different ways against insect pests .
- *Metarhizium, Verticillium, Hirsutella* and *Entomophthora*, etc.

Fungal Insecticides

It kill wide insects like

- Moths
- Beetle
- Mosquito
- Flies
- Aphids
- Ants
- Termite

Advantages

- Low cost.
- Environmentally safe.
- Absence of development of resistance.

Fungal Insecticides

Western tarnished plant bug (Lygus hesperus) killed by entomopathogenic fungus, *Beauveria bassiana*

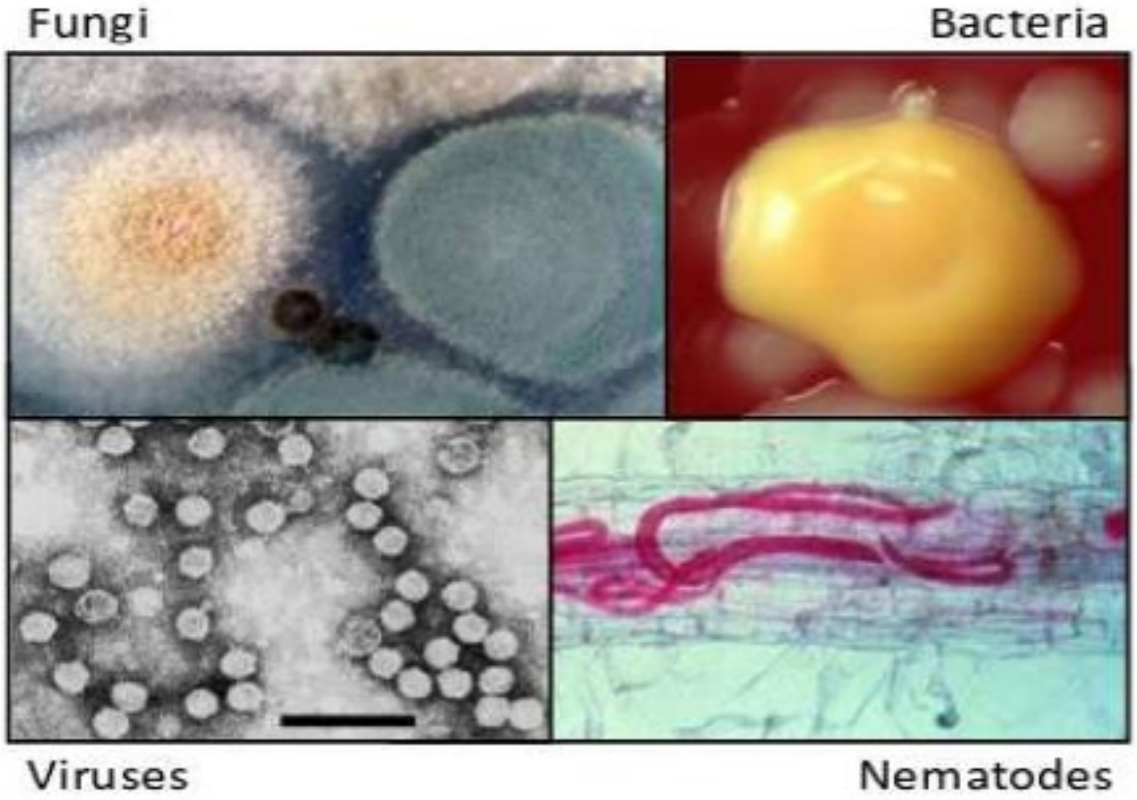
Metarhizium anisopliae on a rice shell pest

Plant pathogens

It is an organism that causes a disease on a plant ,they are

- Fungi
- Bacteria
- Viruses
- Viroids
- Virus-like organisms
- Phytoplasmas
- Protozoa, nematodes etc….

Types of pathogens



Thanks