بسم الله الرحمن الرحیم

سازمان تحقیقات آموزش و ترویج کشاورزی
پژوهشگاه بیوتکنولوژی کشاورزی

نقش میکروارگانیسم ها در پژوهش های کشاورزی و محیطی

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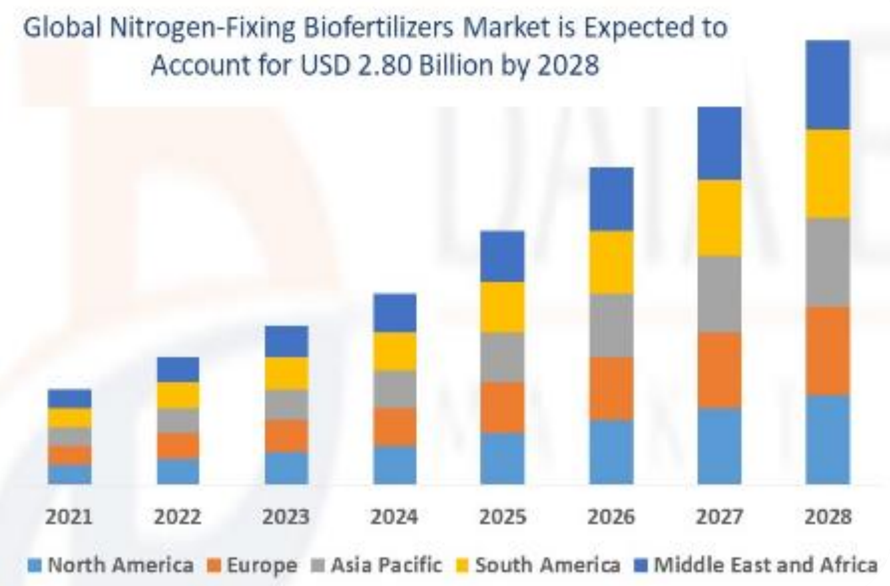
Historical perspective

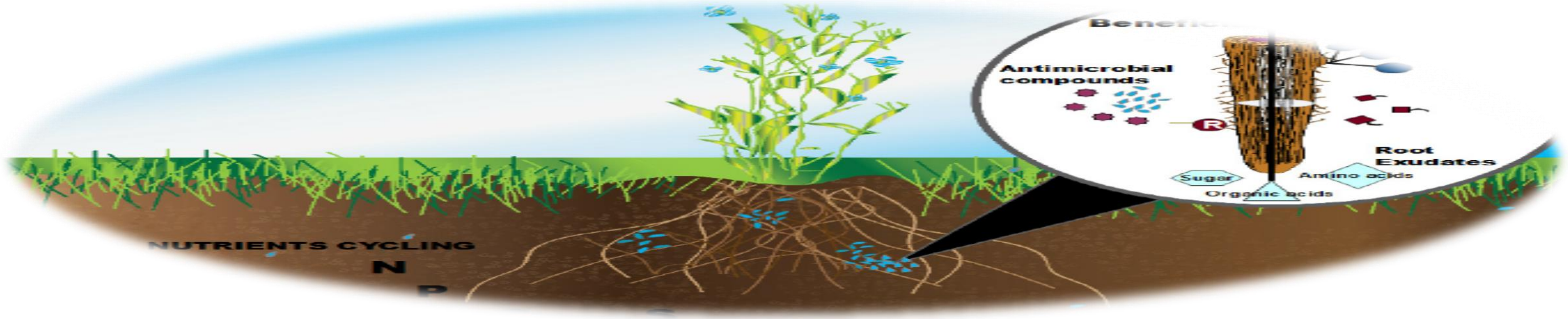
- ✓ The root nodule bacteria (**RNB**) for legumes were almost certainly the first group of agricultural microbes to be studied at the microscopic level (in **1883**).



The first inoculant industries for RNB developed in the 1920s.Global inoculation of legumes with RNB is valued at in excess of US$ 10 billion annually

Historical perspective

- The fungus-root interaction with mycorrhizae was described in 1885, and it is now realized that they interact with about 95 percent of all vascular plants.



- The concept of the 'rhizosphere' and its role in plant growth was described in the 1950s, and Rumen microbiology had become a discrete science by the 1970s.
- Molecular communication between microbes and plant roots (or animal cells), leading to regulation of gene cascades, was revealed in the 1980s.

What are the main microbial resources for food and agriculture?

1. Plant micro-symbionts

- The root nodule bacteria (RNB) nodulate the Leguminosae, which is one of the largest families of flowering plants.

- The RNB plays a significant role in world agricultural productivity by annually converting approximately 100 million tonnes of atmospheric nitrogen into ammonia and saving $US 10 billion in fertilizer N.

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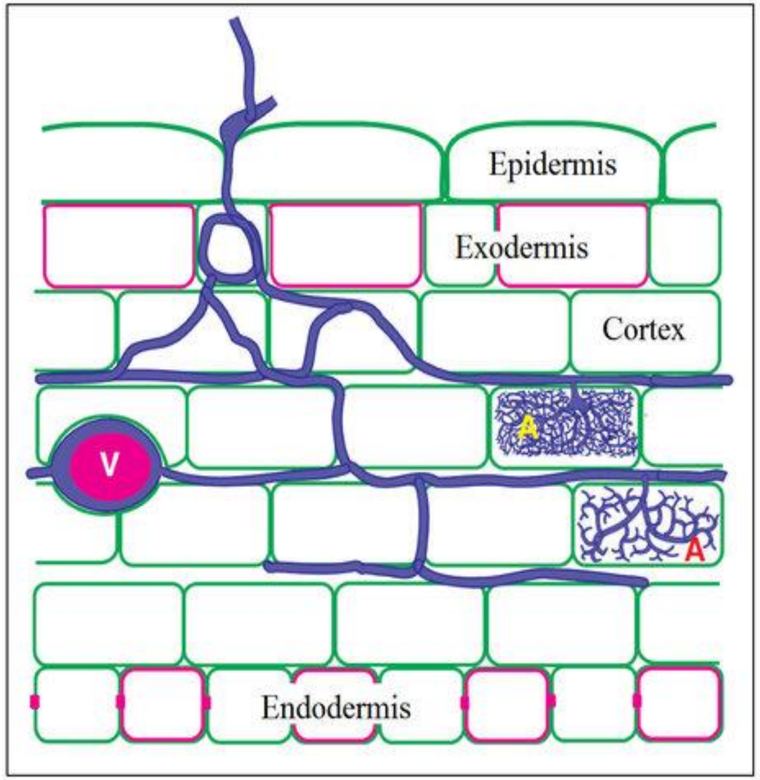
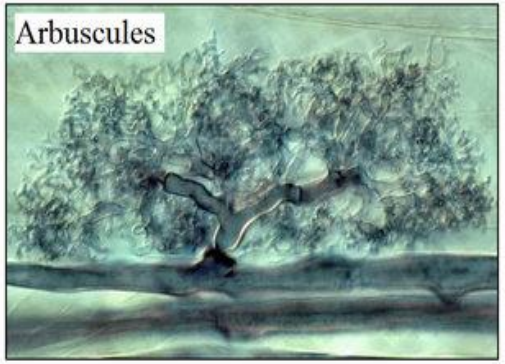
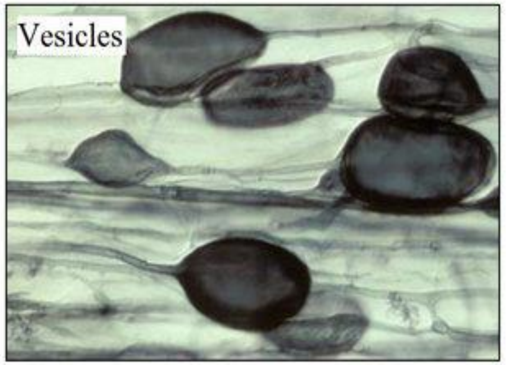
2.Mycorrhizae & Ectomycorrhizae

- Approximately 90 percent of all flowering plant species belong to families that form mycorrhizal associations that can be either endophytic or ectophytic.

- Capture and uptake of nutrients
- Protection against pathogens
- Maintenance of soil structure
- Buffering against moisture stress

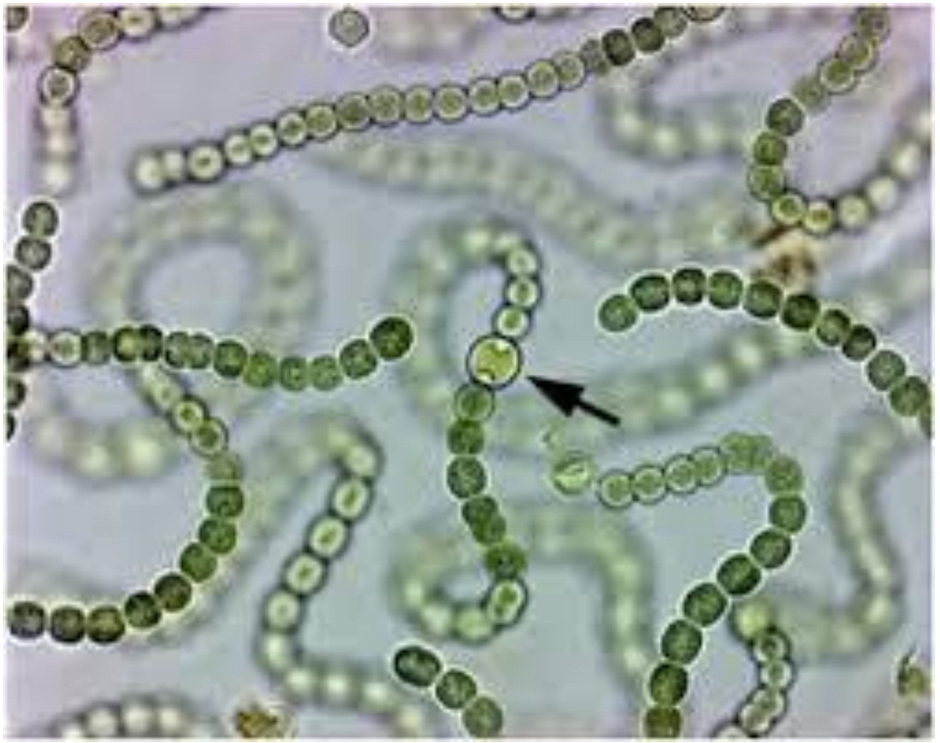






3.Microalgae, including Cyanobacteria

- **Cyanobacteria** (formerly termed blue-green algae) are photosynthetic prokaryotes, usually unicellular, some of which have the capacity to fix atmospheric nitrogen.



Nostoc **spp.**

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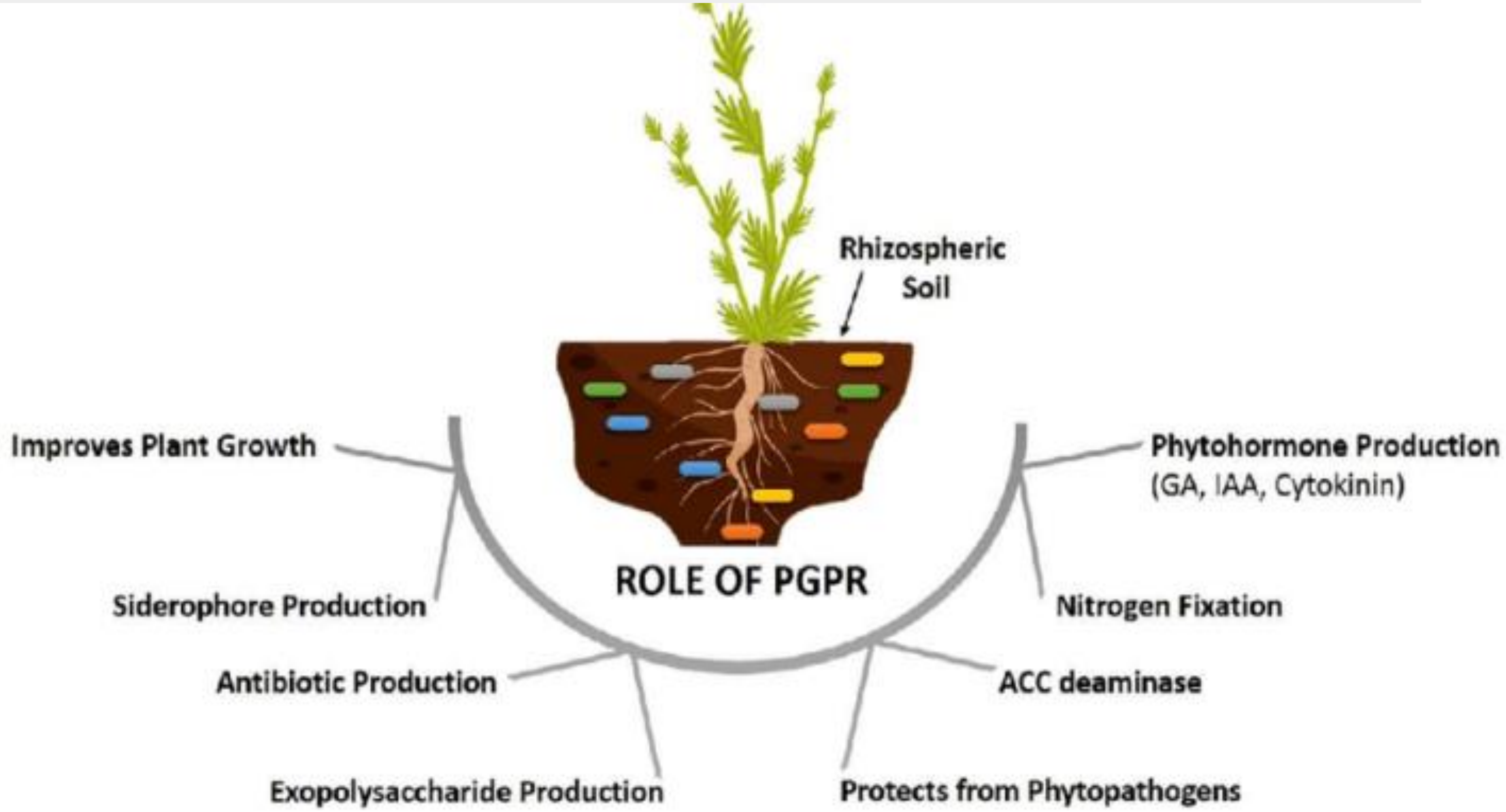
4.Plant Growth Promoting Rhizosphere organisms

- The rhizosphere is the site of a range of complex interactions between the living and dead soil components as follow:

- **Produce of enzymes**
- **Produce of phytohormones**
- **Plant gene expression control**
- **Nutrient solubilization**
- **Disease protection**



5. Rumen organisms

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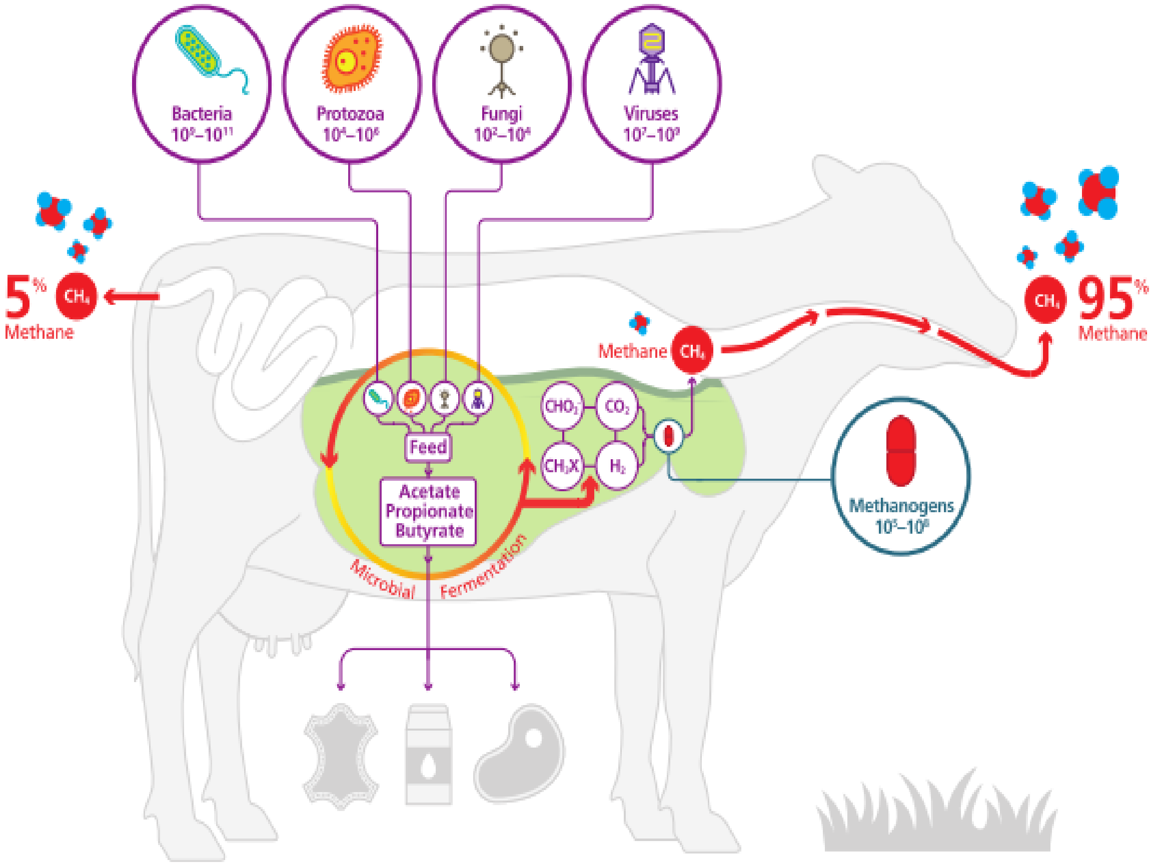
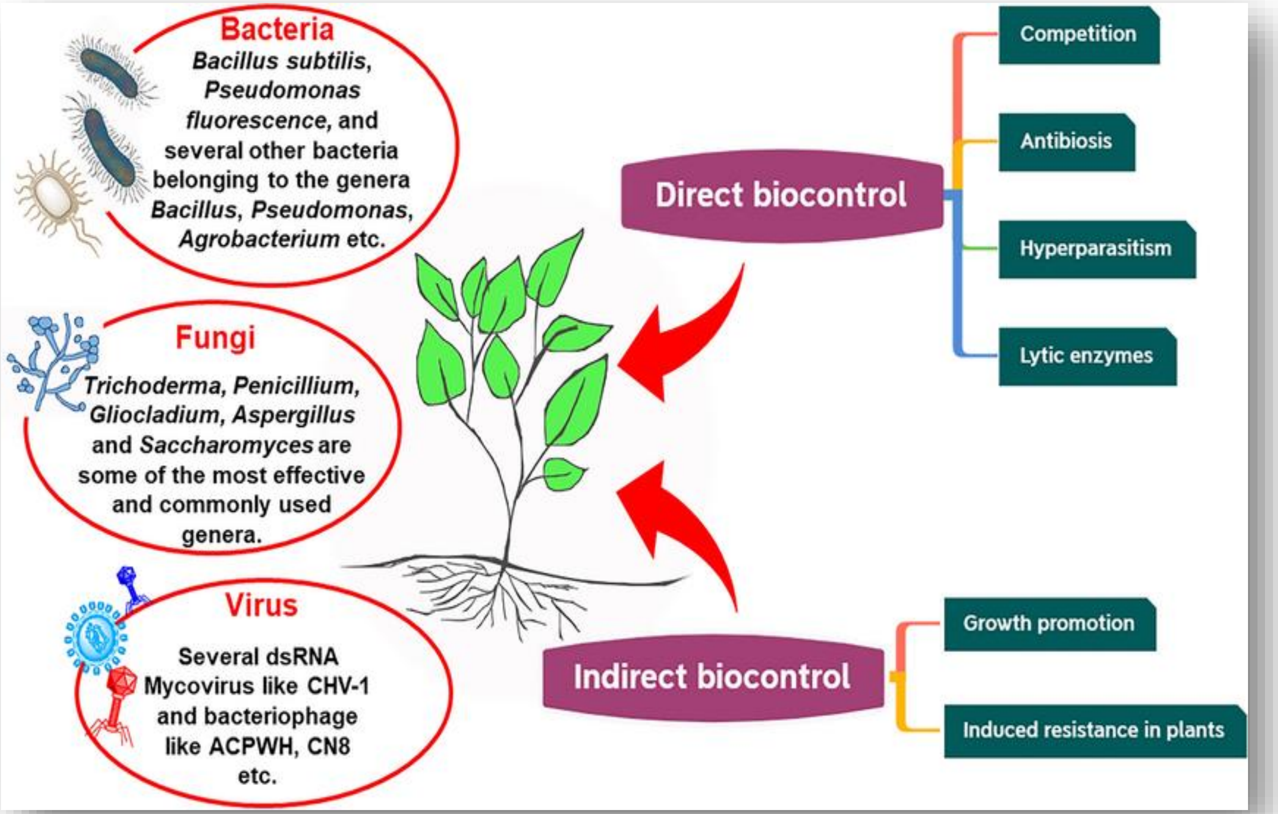
- Some animals have a second stomach called the rumen, in which a suite of microbes assist in the breakdown of otherwise indigestible forages.

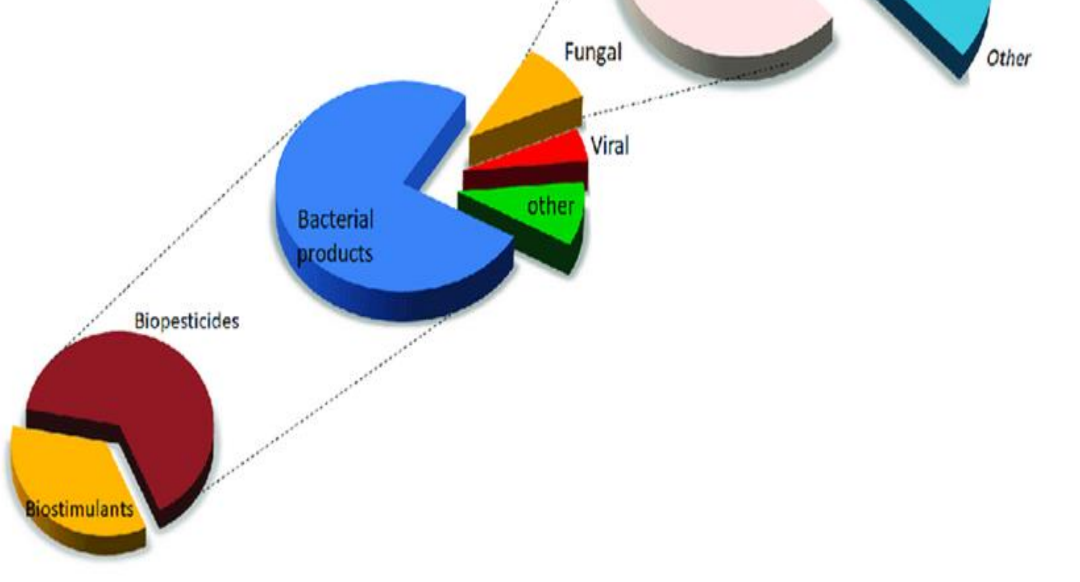
- **Digestion of forage containing high tannin levels**
- **Enhance fiber and cellulose digestion**
- **Minimizing methane production**
- **Mitigate anti-nutritional factors**
- **Metabolize toxic compounds**



6. Biocontrol agents

- Biological control is the practice or process by which an undesirable organism is controlled by means of another (beneficial) organism.

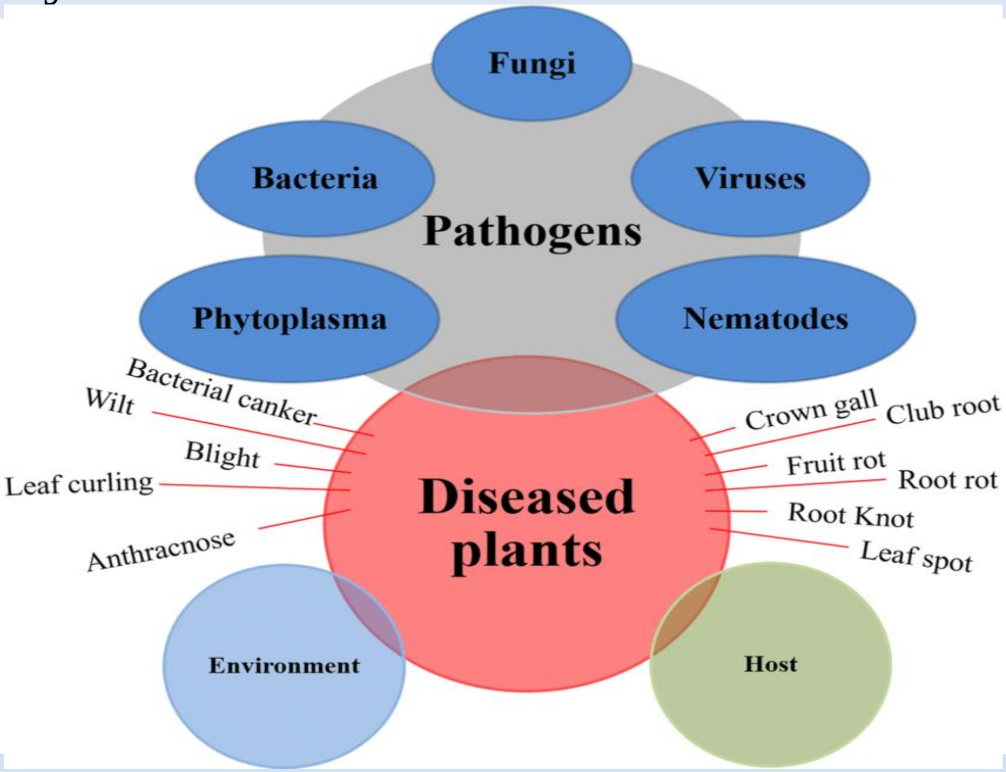




7. Pathogens of plants or animals

- Animal and plant diseases pose a serious and continuing threat to food security, food safety, national economies, biodiversity and the rural environment.

- *Listeria*
- *Yersinia*
- *Shigella*
- *E. coli*
- *Campylobacter*
- *Salmonella*
- *Norovirus*



- Plant and animal pathogens need to be considered as AMiGRs because they are held in germplasm collections to facilitate breeding or selection programmes to find resistance to them.

8.Microbial agents for food production

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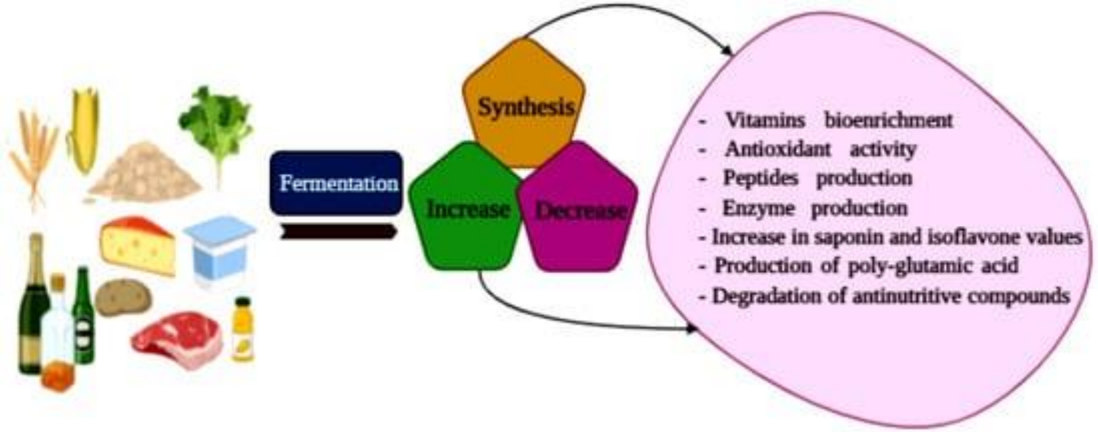
- Post-harvest control

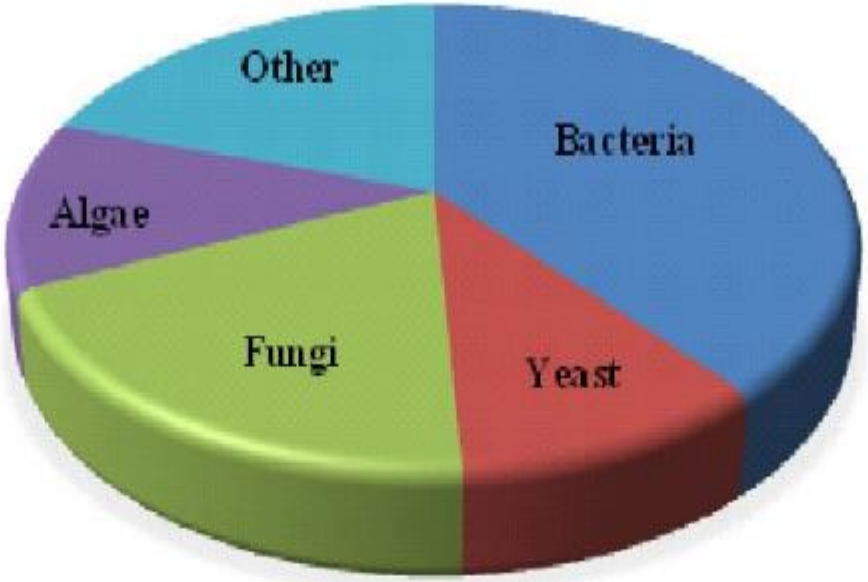
- Edible fungi

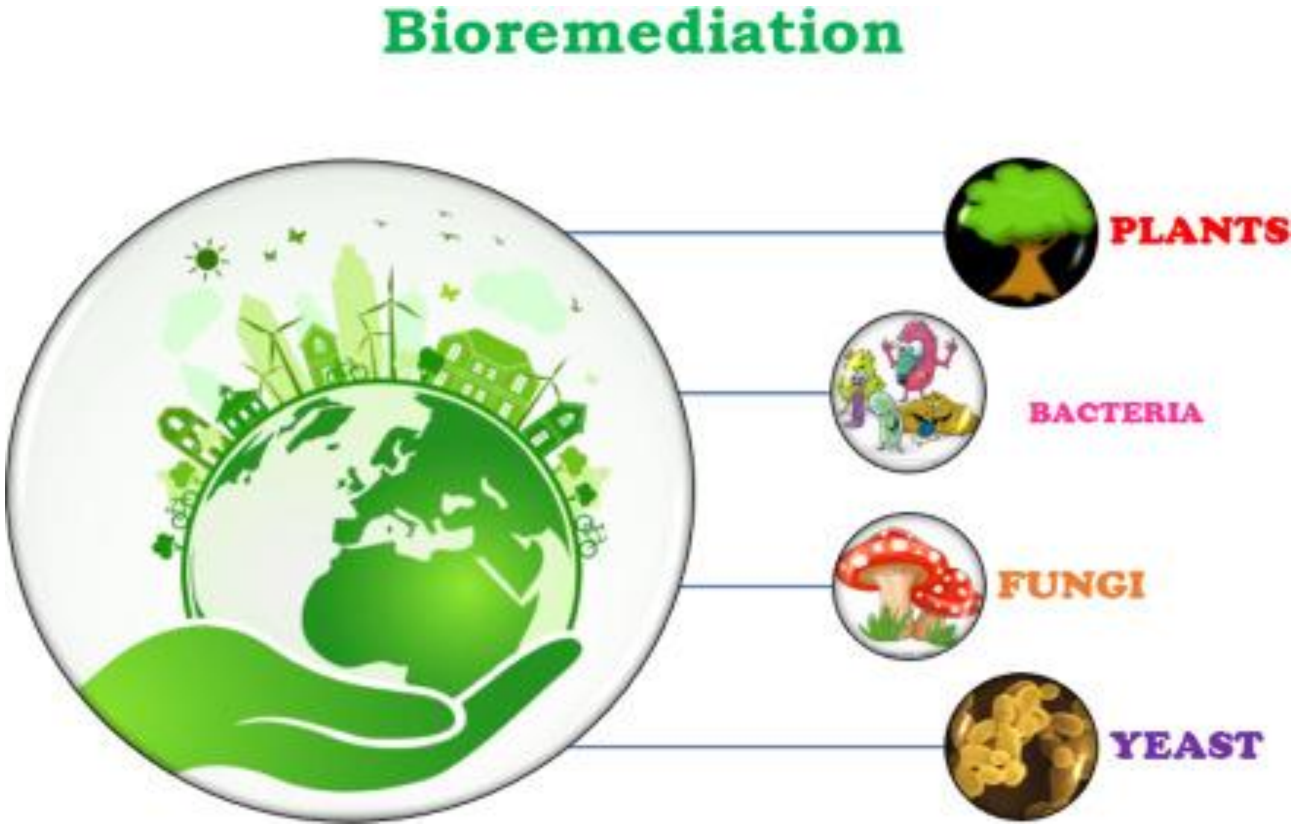
- Fermenting microorganisms



9. Bioremediation agents

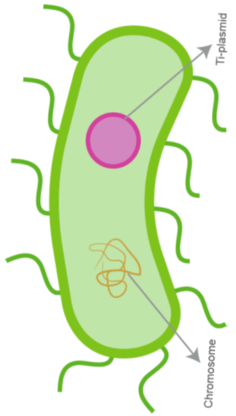
- Targets for this group include the toxic chemicals in which chemical reactions mediated by microbial organisms degrade or transform contaminants to less or non toxic form.

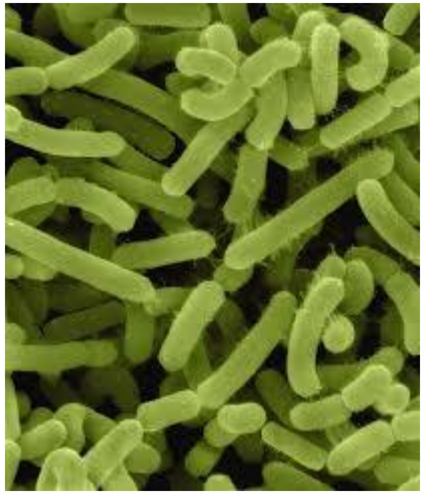


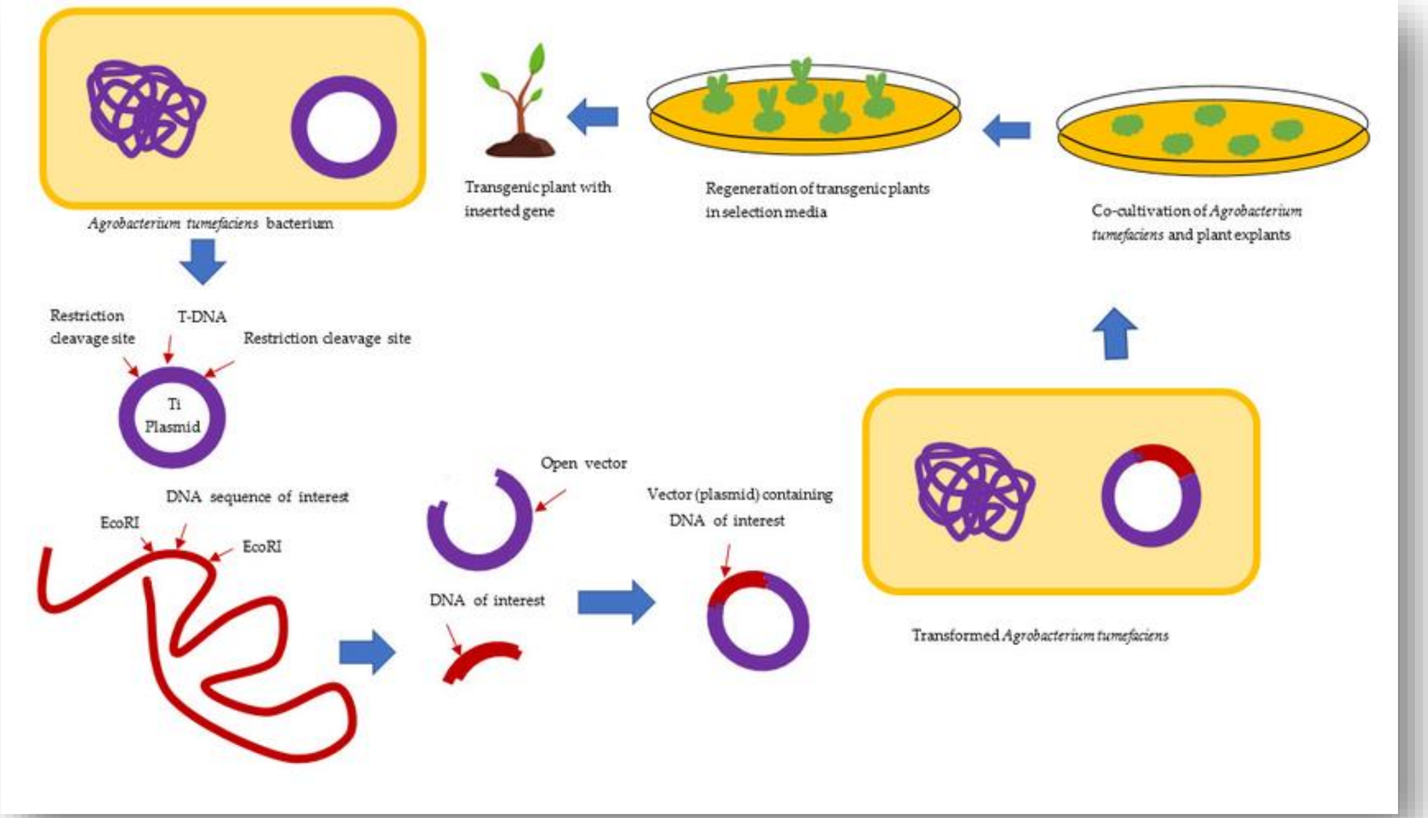


10. Microbial agents for DNA transfering

- The most common vectors in agricultural research are *Agrobacterium* spp. for plant-to-plant transfer and *Escherichia coli* for inter-bacterial transfer.



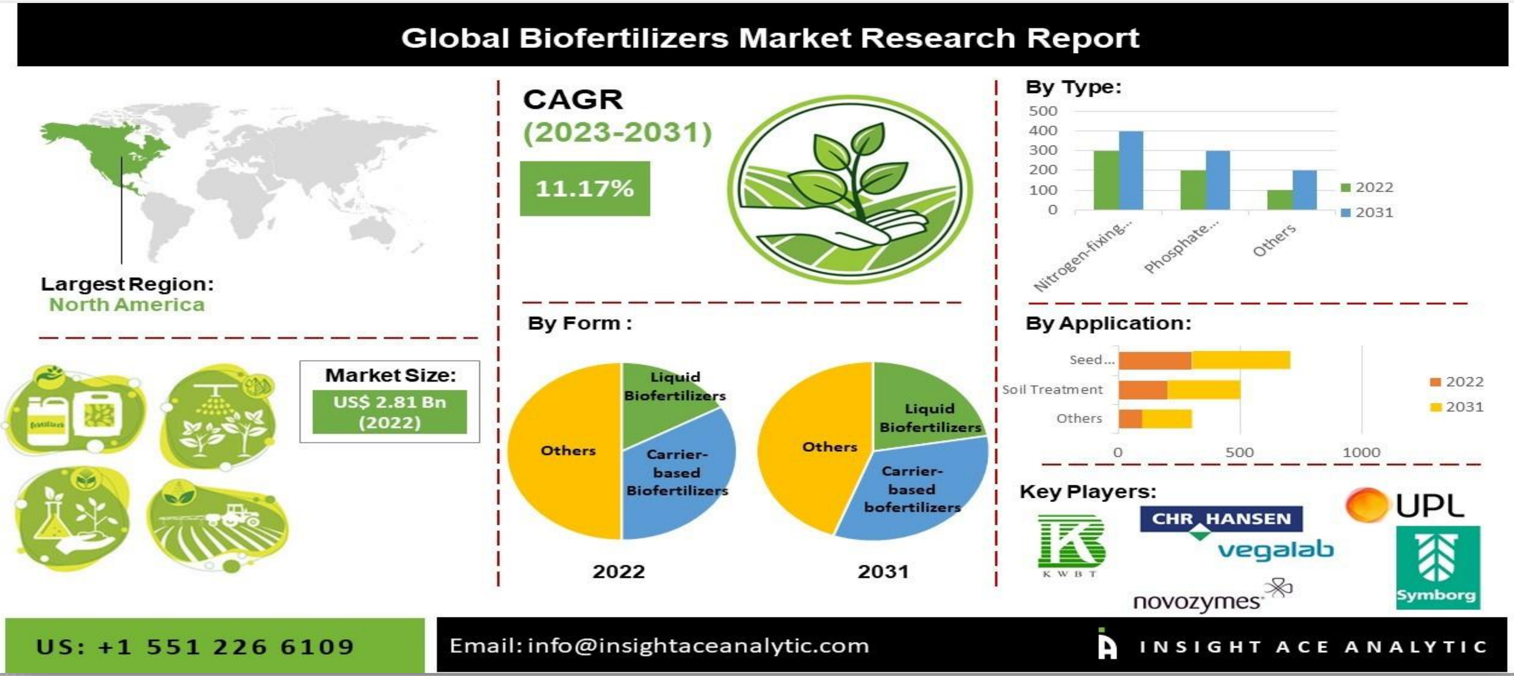




Micro-organisms in agro-industrial processes

Biofertilizers

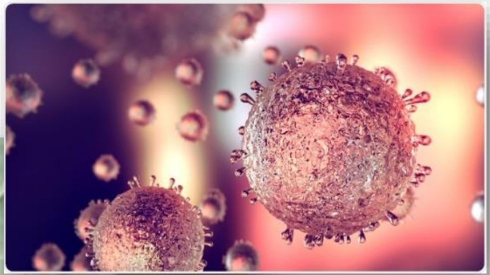
- A **biofertilizer** is a substance that contains living unicellular micro-organisms that, when applied to seeds, plant surfaces or soil, colonize the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host



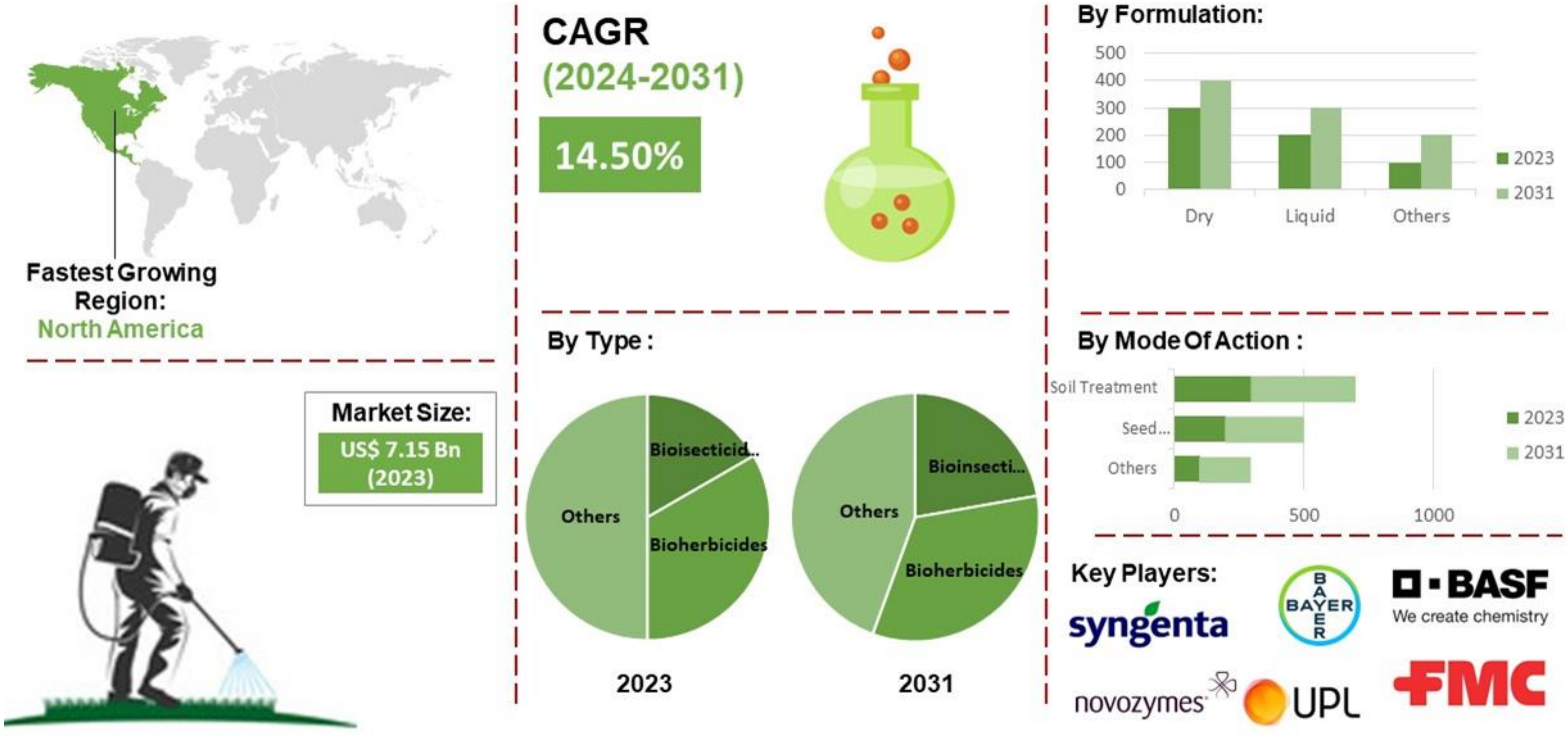
Biopesticides

- Microbial biopesticides are used to control a variety of pests and diseases in food and agricultural Systems.

- *Bacillus thuringiensis* (Bt)
- *Baculoviruses*
- *Metarhizium anisopliae*
- *Bacillus subtilis*

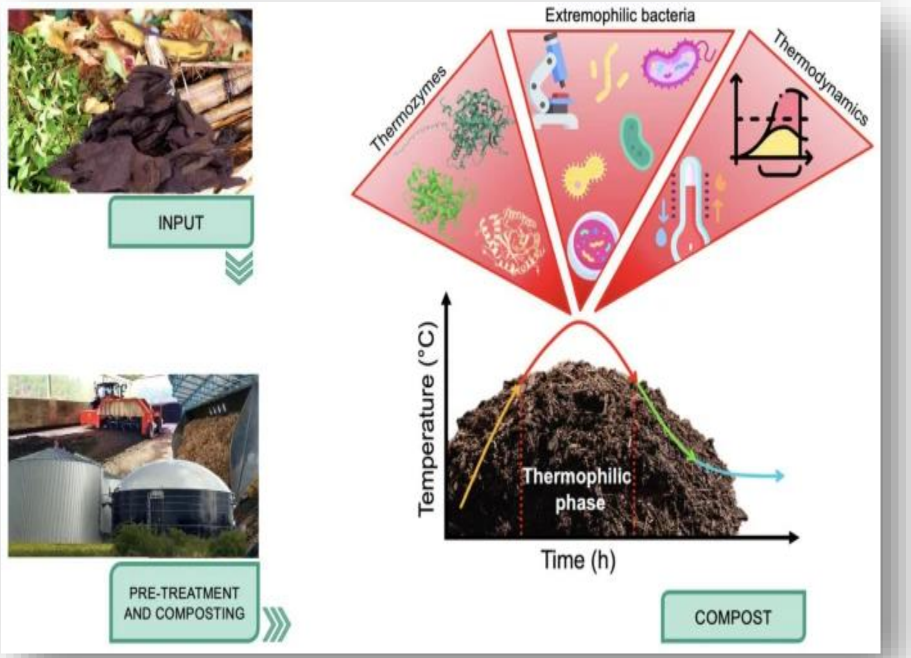


Global Biopesticides Market Research Report



Composting of agro-industrial by-products

- Large quantities of agro-industrial by-products are generated worldwide. Much of this material is made up of cellulose, hemicellulose and lignin. Several groups of fungi / bacteria are able to decompose these substances and convert them into compost.



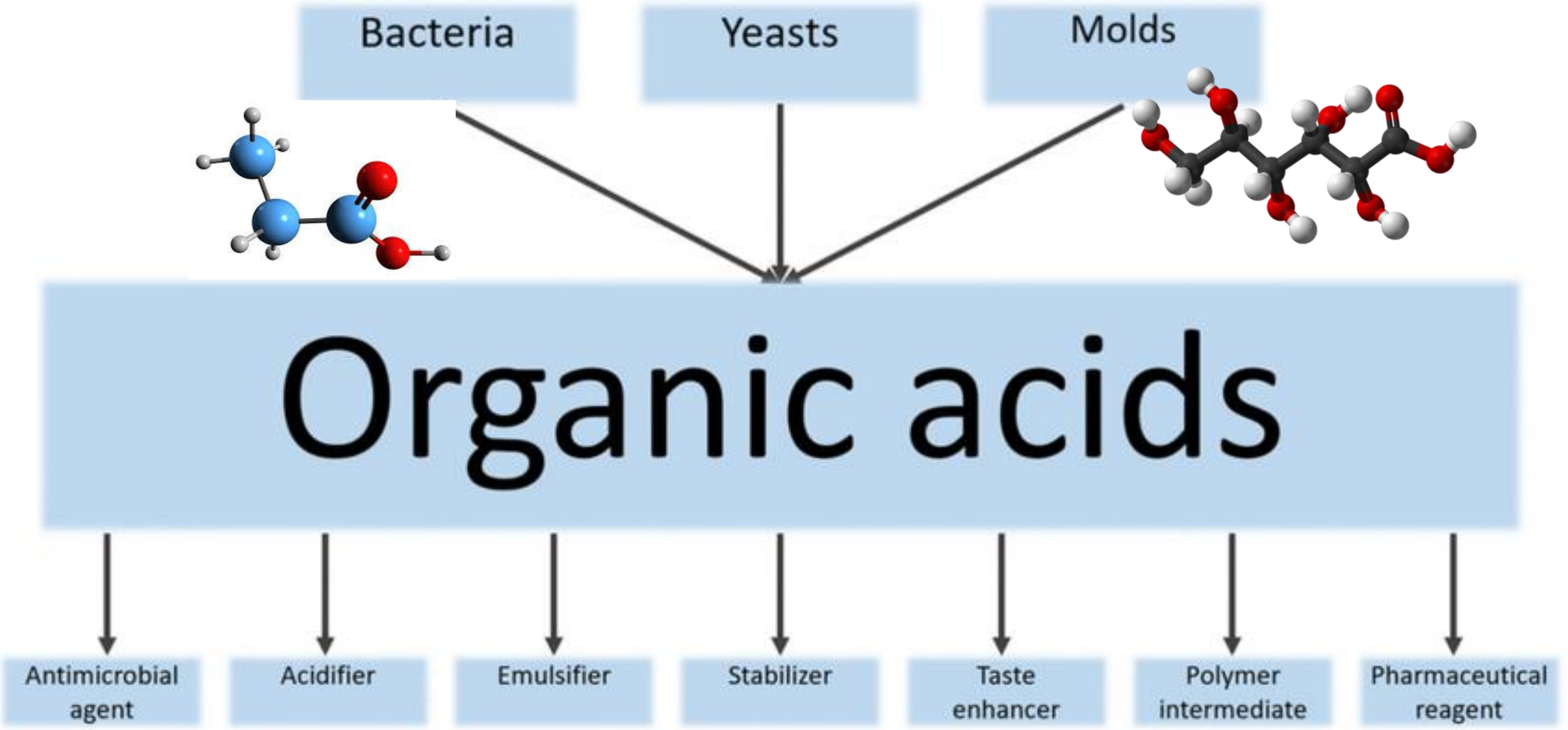
Thermophilic bacteria	Emphasized characteristics	Compost type
Bacillus stearothermophilus; B. subtilis; genus *Thermus*	Metabolic activity above 70 °C	n.d.
Bacillus licheniformis; B. subtilis; B. coagulans type B; *B. stearothermophilus; B. sphaericus*	*Bacillus* spp. found during the thermophilic phase	Table scraps and shredded newspaper
Hydrogenobacter spp.	Sulfur- and hydrogen-oxidizing, autotrophic thermophilic bacteria	Green waste, wood chips, and kitchen waste, or sewage sludge
Bacillus stearothermophilus; Thermus thermophilus HB8	Growth between 65–69 °C; growth between 65–82 °C	Kitchen waste and shredded garden waste or methanized sewage sludge, and wood chips
Thermus thermophilus; Bacillus spp.		
Bacillus pallidus; B. stearothermophillus; B. thermodenitrificans		
Bacillus thermodenitrificans; B. sporothermoduran thermosphaericus		
Aneurinibacillus sp.; *Brevibacillus* sp.		
Geobacillus toebii		
Geobacillus toebii subsp. *decanicus* subsp. nov		
Geobacillus galactosidasius		
Bacillus composti; B. thermophilus		
Aeribacillus composti		

Enzyme	Thermophilic phase	Prominent bacteria	Compost type	Refs.
Cellulase	4th–12th week/24	*Bacillus nealsonii* 104C	Agricultural residue/sawdust 97:3 and 15:85	[54]
	Not specified	*Bacillus subtilis* A-, M- and N-SRETCR	Coffee residues/cow manure 3:1 (v/v)	[61]
	9th–28th week/44	*Devosia, Flavobacterium, Pseudoxanthomonas, Pseudomonas,* and *Achromobacter*	Textile waste	[20]
	4 days/24	Firmicutes	Sewage sludge/saw dust 4:1 (w/w)	[65]
	4th–7th day/11	Mostly *Bacillus* sp.	Sludge/corn straw 3:1 (w/w)	[57]
	3rd–16th day/25	Mostly *Bacillus* sp.	Chicken manure/rice husk (17.3 C/N)	[58]
	5th–22nd day/39	*Nonomuraea* sp., *Virgibacillus* sp.	Cow manure, mushroom residue, sawdust	[59]
	From 6 to 26 days/31	Firmicutes, Proteobacteria	Food waste	[15]
	2nd–7th day/11	*Bacillus* sp.	Sewage sludge/sawdust/ biochar	[68]
β-glucosidase	2nd–4th week/24	*Bacillus nealsonii* 104C	Agricultural residue/sawdust 97:3 and 15:85	[54]
	4th–16th day/25	*Stenotrophomonas, Bacillus*	Mulberry branches/cow dung 3:7 (w/w)	[23]
	2nd–7th day/11	*Bacillus* sp.		
Xylanase	4th–12th week/24	*Paenibacillus validus* 1VC		
	4th–16th day/25	*Stenotrophomonas, Bacil*		
	3rd–16th day/25	*Bacillus* sp.		
	9th–28th week/44	*Devosia, Flavobacterium,* and *Achromobacter*		
	11 days/180	Firmicutes		
Ligninase	2nd–4th week/24	*Paenibacillus koreensis* 1		
Peroxidase	4th–7th day/11	*Bacillus* sp.		
	2nd–7th day/11	*Bacillus* sp.		

Enzyme	Thermophilic phase	Prominent bacteria	Compost type
Protease	4th–8th week/24	*Paenibacillus validus* 1VC	Agricultural residue/sawdust 97:3 and 15:85
	4th–16th day/25	*Stenotrophomonas, Sinibacillus*	Mulberry branches/silkworm excrement 1:9 (w/w)
	4th–7th day/11	*Ureibacillus, Bacillus, Pseudomonas, Flavobacterium, Sporosarcina*	Sludge/corn straw 3:1 (w/w)
	3rd–16th day/25	*Bacillus* sp.	Chicken manure/rice husk (17.3 C/N)
	5th–22nd day/39	*Nonomuraea* sp., *Virgibacillus* sp.	Cow manure, mushroom residue, sawdust
	2nd–7th day/11	*Bacillus* sp.	Sewage sludge/sawdust/ biochar
Urease	From 6 to 26 days/31	Firmicutes, Proteobacteria	Food waste
	4th–8th week/24	*Paenibacillus validus* 1VC	Agricultural residue/sawdust 97:3 and 15:85
	4th–16th day/25	*Stenotrophomonas, Sinibacillus; Stenotrophomonas, Bacillus*	Mulberry branches/silkworm excrement 1:9 (w/w); mulberry branches/cow dung 3:7 (w/w)
	4th–7th day/11	*Ureibacillus, Bacillus, Pseudomonas, Flavobacterium, Sporosarcina*	Sludge/corn straw 3:1 (w/w)
	3rd–16th day/25	*Bacillus* sp.	Chicken manure/rice husk (17.3 C/N)
	2nd–7th day/11	*Bacillus* sp., *Candidatus microthrix*	Sewage sludge/sawdust/ biochar

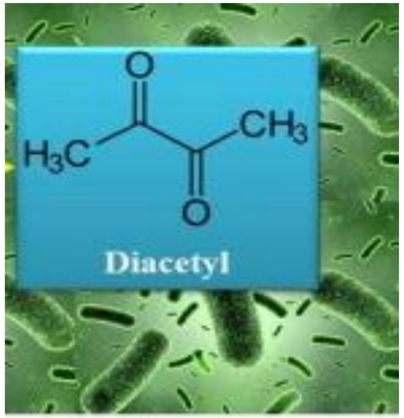
Organic acids

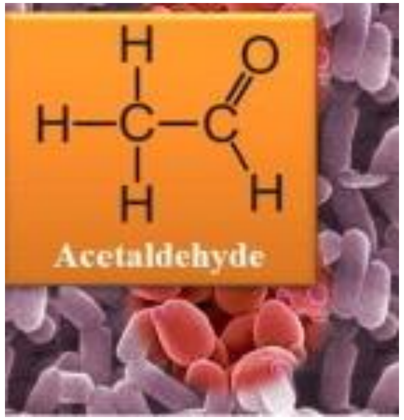
- ❑ Citric acid
- ❑ Succinic acid
- ❑ Lactic acid
- ❑ Itaconic acid
- ❑ Lactobionic acid
- ❑ Gluconic acid
- ❑ Fumaric acid
- ❑ Propionic acid
- ❑ Acetic acid

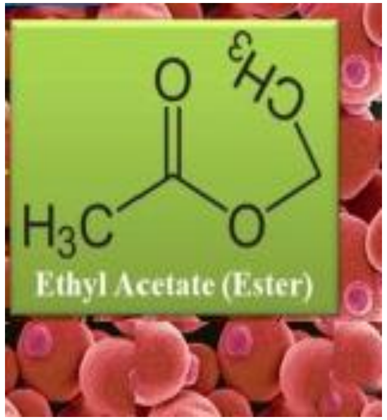


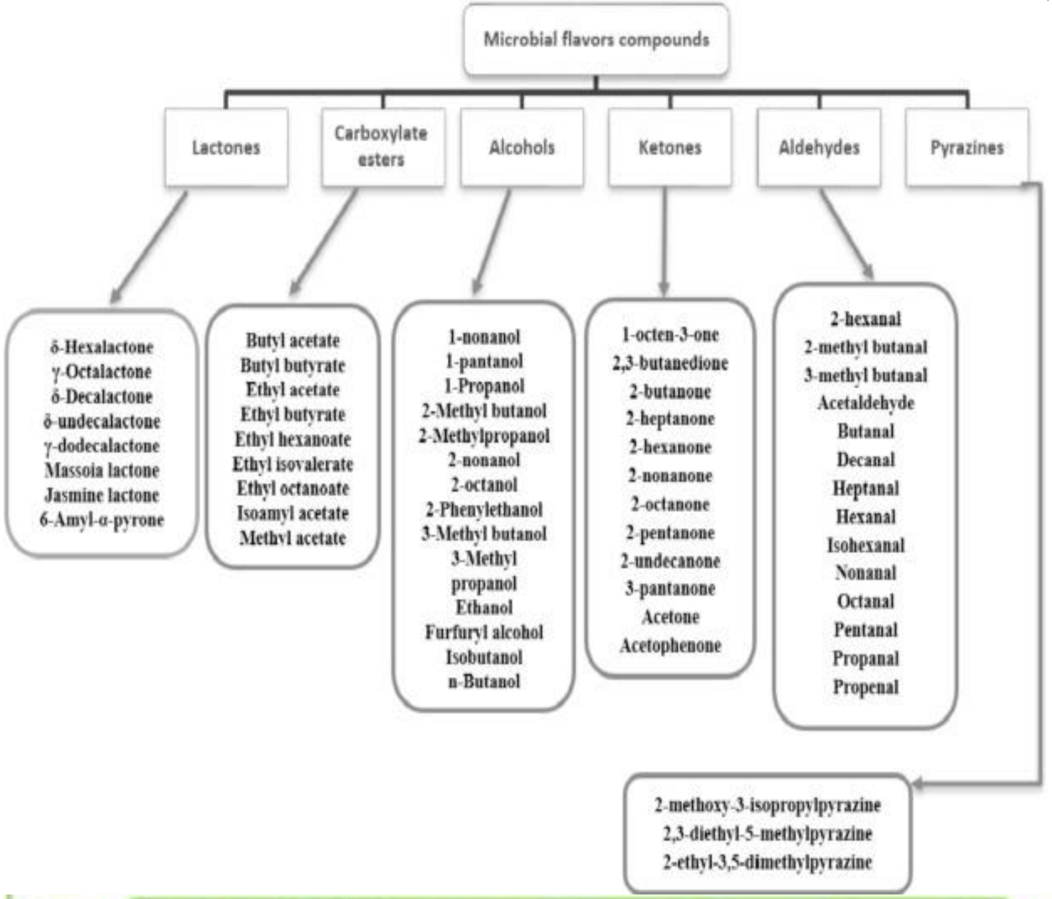
Aroma and flavor compounds

- Microbial flavor compounds are emerging as promising substitutes for synthetic methods of producing aroma compounds for use in the production of food, drinks, perfumes and essential oils. Both fungi and bacteria can be used to produce aroma compounds.









Enzymes

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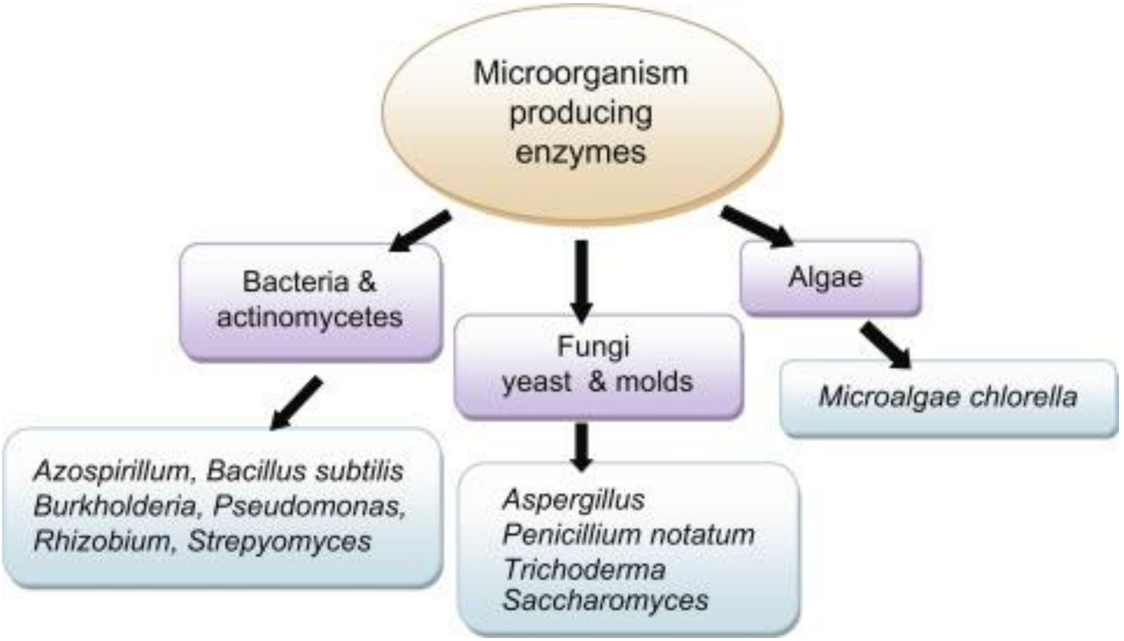
- Fungi and bacteria grown on agro-industrial by-products in large-scale fermenters are an important source of enzymes used in a variety of industries, including the food-biotechnology, animal-feed, pharmaceutical, textile and paper industries.



Microbial pigments

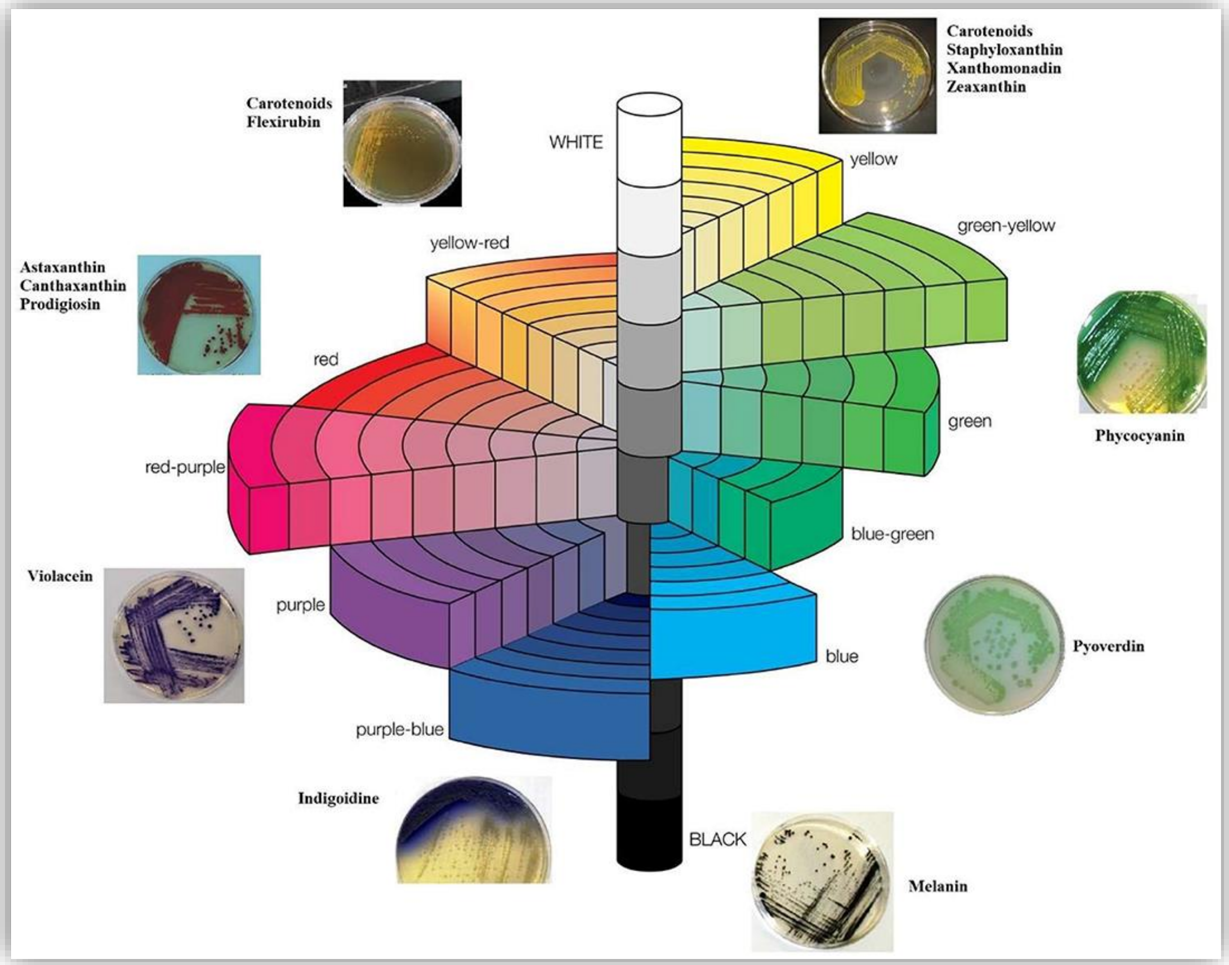
- There is growing interest in microbial derived substitutes for synthetic food coloring agents, some of which have been banned on account of their potential carcinogenicity and teratogenicity.

Yellow pigment

- *Ashbya gossypi*

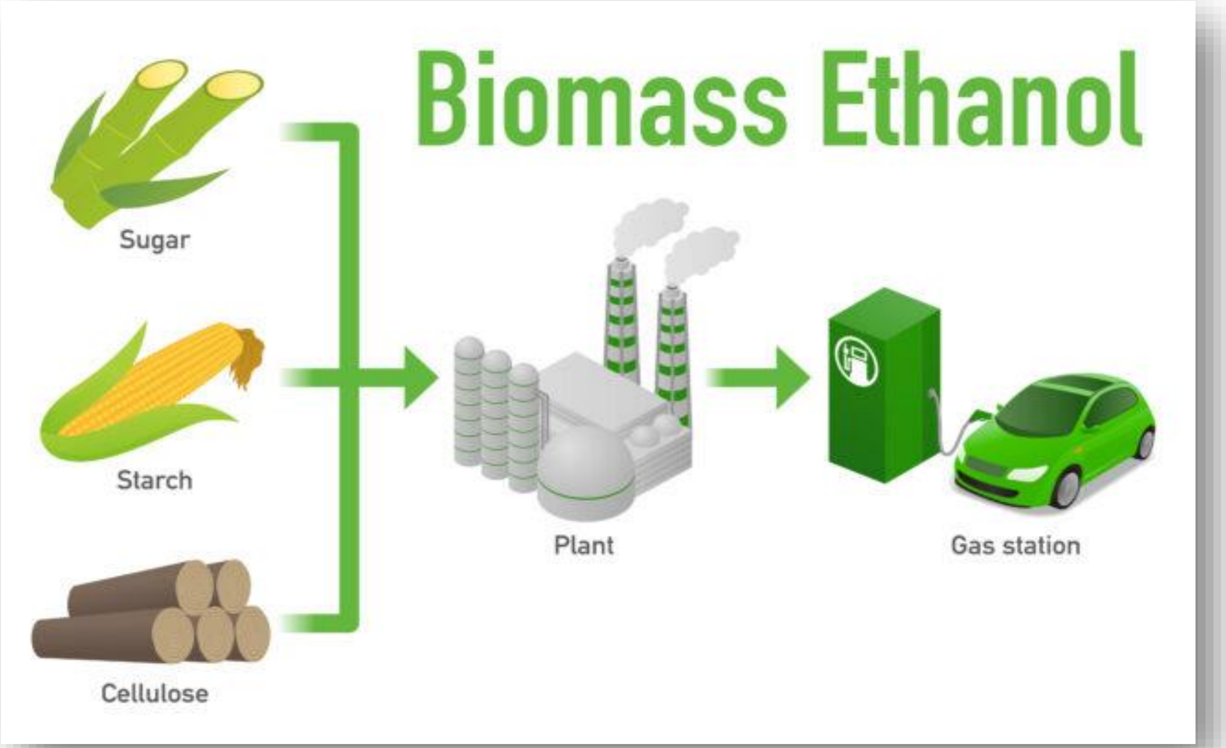
Red pigment

- *Monascus purpureus*



Biofuel production

- Biofuels, such as ethanol, have been considered an expedient alternative to fossil fuels since the petroleum fuel crisis of the 1970s. Essentially, carbohydrates derived from sugar-rich plants are fermented to ethanol by yeast/bacteria/fungi/microalgae in anaerobic respiration.



Climate change ;

Effects on functional groups of Agri- microorganisms

Climate change ;
Effects on Soil, plant and rhizosphere inhabitants

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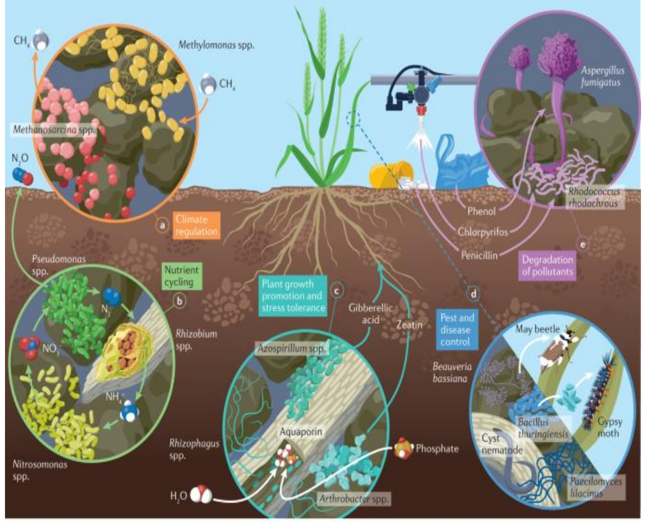
- raising the C:N ratio

- increased root growth and root exudation

- an increase in the level of atmospheric CO 2

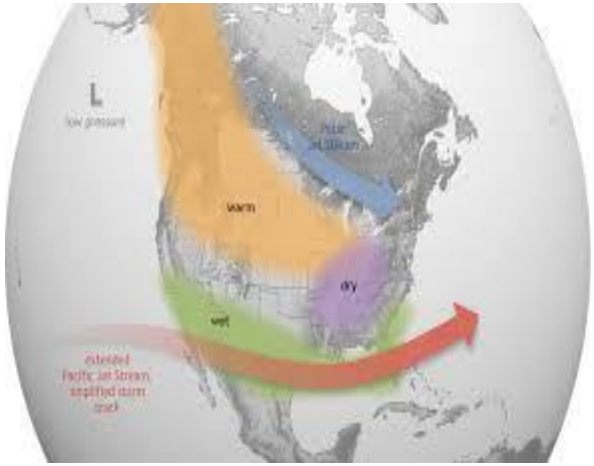
- increase tannins and total phenolic compounds



- Change the soil micro-organism community

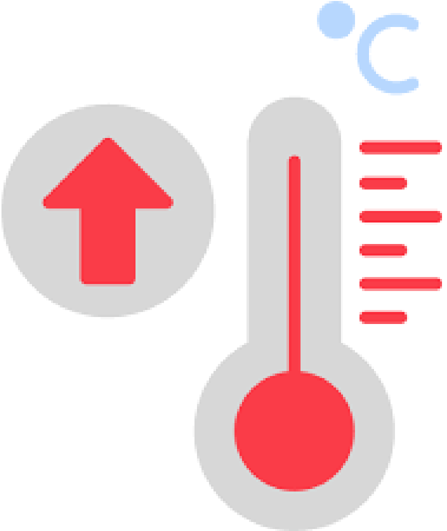
Climate change ;
Effects on plant pathogens

- Severe **rust** and **head blight** epidemics and El Niño
- **potato late blight** epidemics and spring rainfall, summer temperature and SO_2
- **needle blight** in pine trees and increased summer rainfall



Climate change ;
Effects on biological control

- ❑ *Streptomyces scabies*



- ❑ increase in temperature

- ❑ *Streptomyces* spp.
- ❑ *Bacillus* spp.
- ❑ *Pseudomonas* spp.

Microorganism resources role in climate change; buffering, adaptation and mitigation

Micro-organism biodiversity ; Resilience and sustainability of the ecosystem

- Agricultural soils in intensive farming systems where a limited range of crops are grown may be less resilient and more vulnerable to such changes than soils in natural ecosystems where the diversity of the soil micro-organism community may allow more rapid adaptation.

- Crop rotation
- Green fertilizer
- Organic manure
- Biological control

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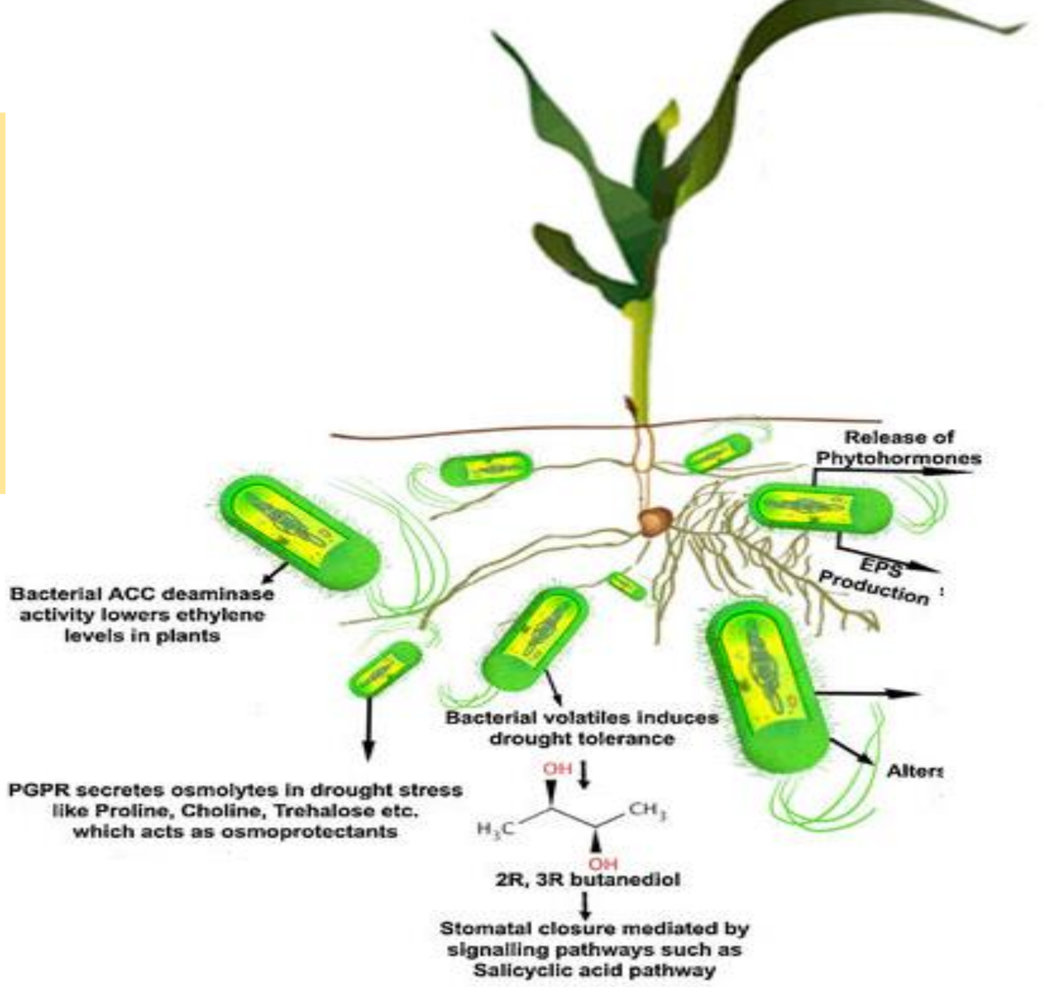
Role of micro-organism in adapting to the effects of climate change

- Micro-organisms can play a key role in assisting humankind to adapt to the effects of climate change (drought tolerance)



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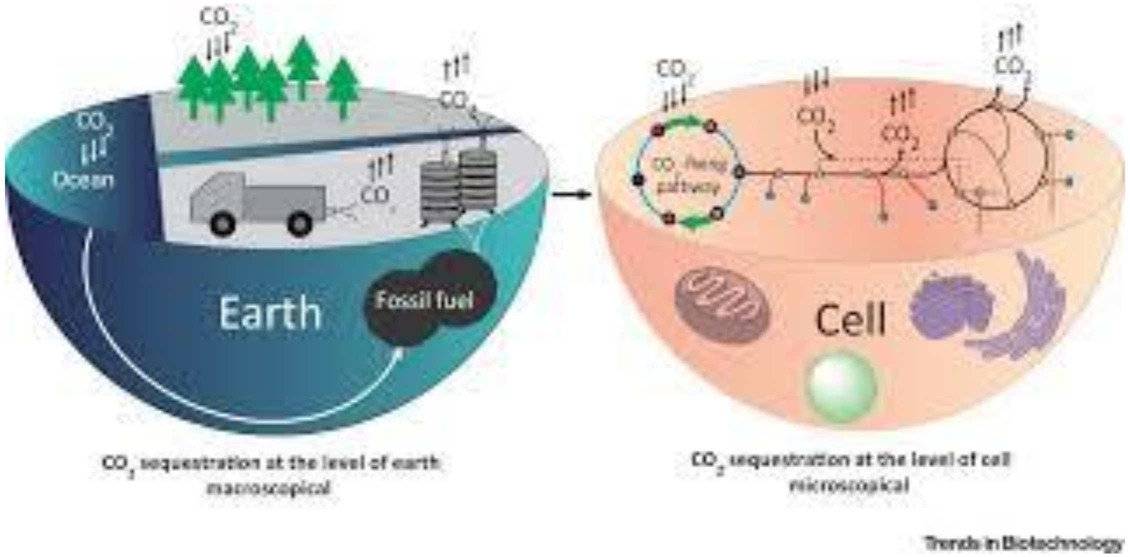
Role of micro-organism resources in mitigating climate change

- Given the enormous amount of carbon stored in the world's soils and reduction in pesticides and fertilizers usage, micro-organisms are extremely significant to efforts to mitigate climate change.



Micro-organism genetic resources for sustainable agriculture

تقدیر و تشکر