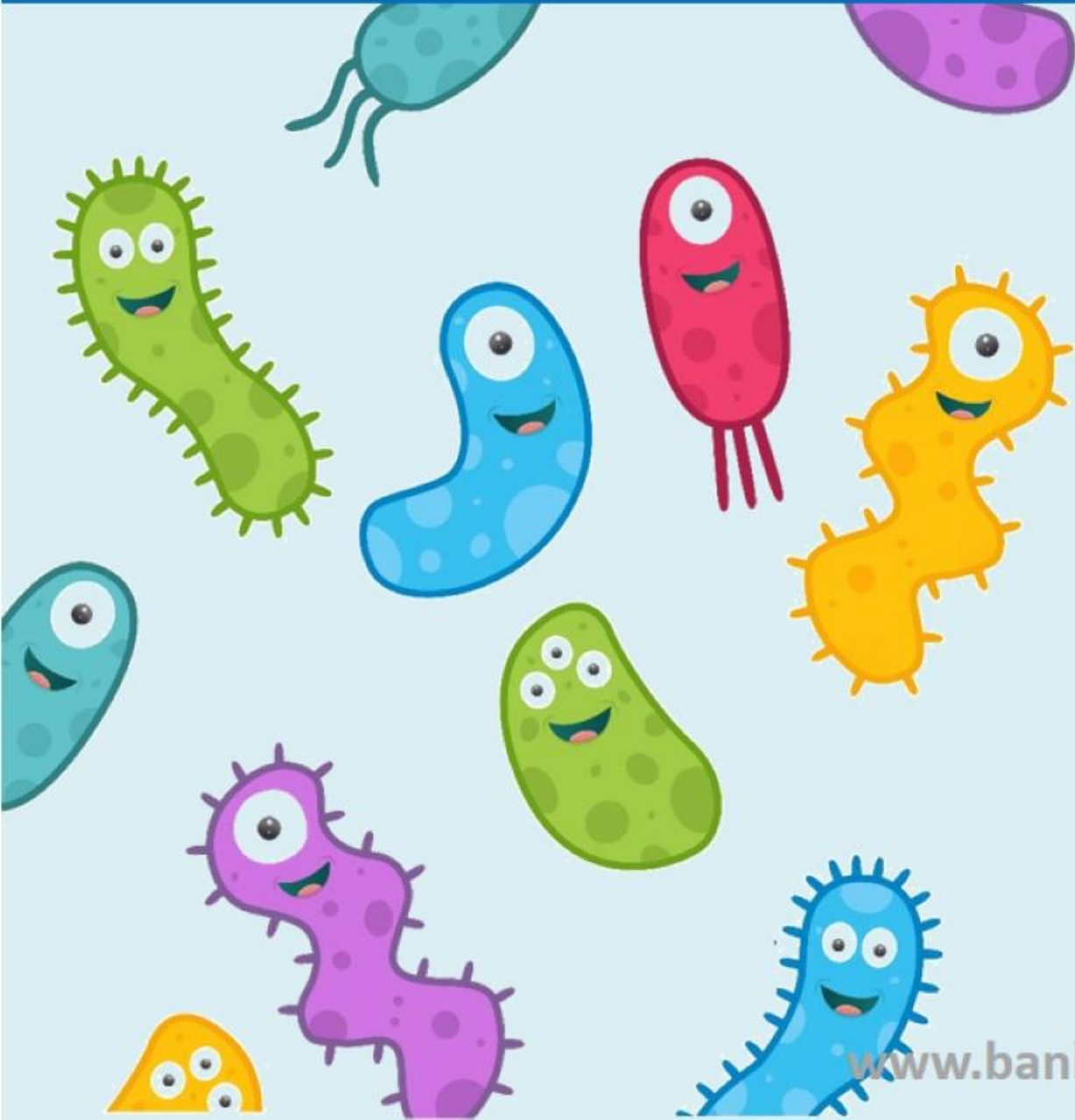




MICROBES IN HUMAN WELFARE

Topics to be discussed

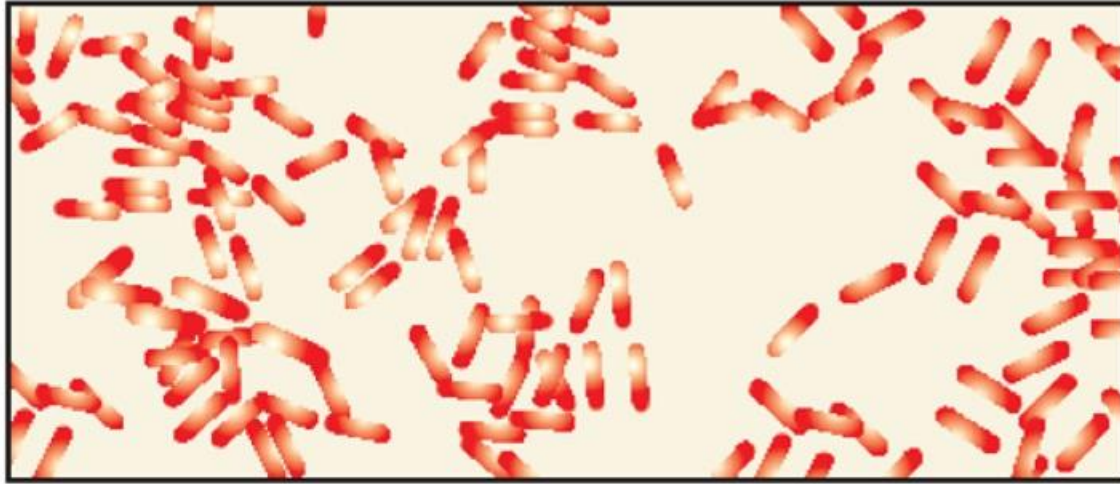


1. **MICROBES IN HOUSEHOLD PRODUCTS**
2. **MICROBES IN INDUSTRIAL PRODUCTS**
3. **MICROBES IN SEWAGE TREATMENT**
4. **MICROBES IN BIOGAS PRODUCTION**
5. **MICROBES AS BIOCONTROL AGENTS**
6. **MICROBES AS BIOFERTILISERS**

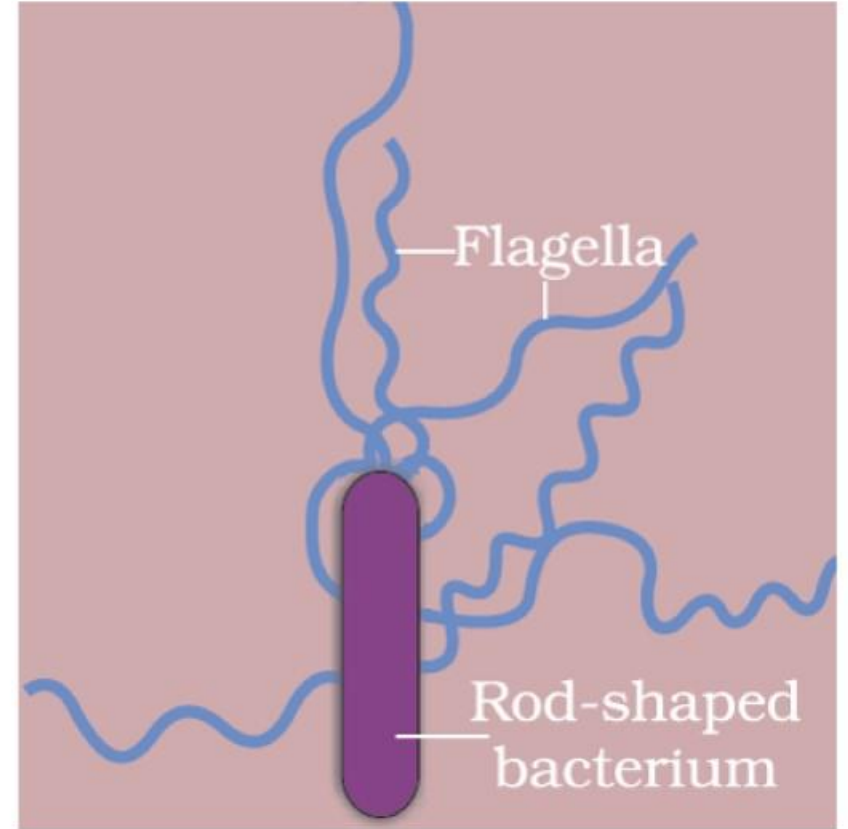
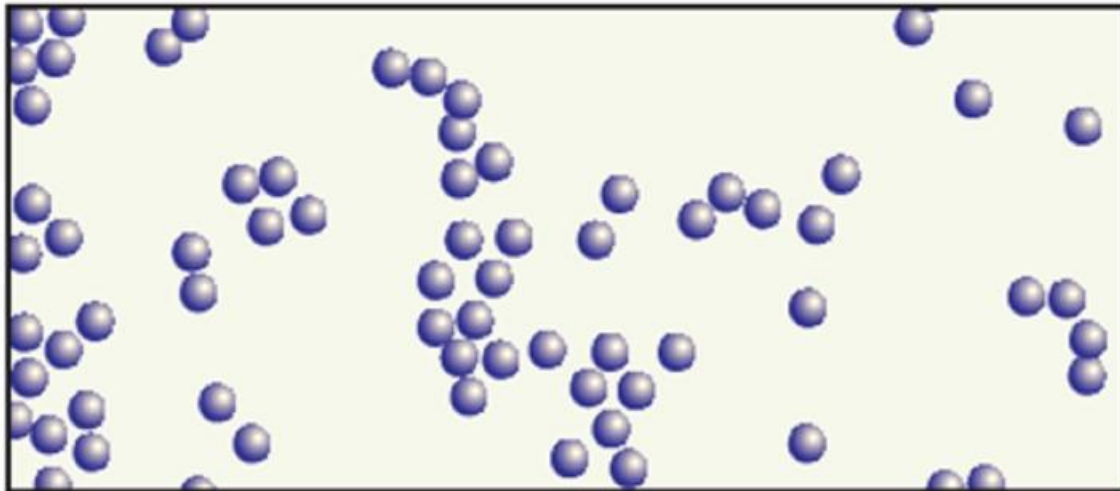
Various Microbes

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**Bacteria:
Rod-shaped,
magnified
1500X**

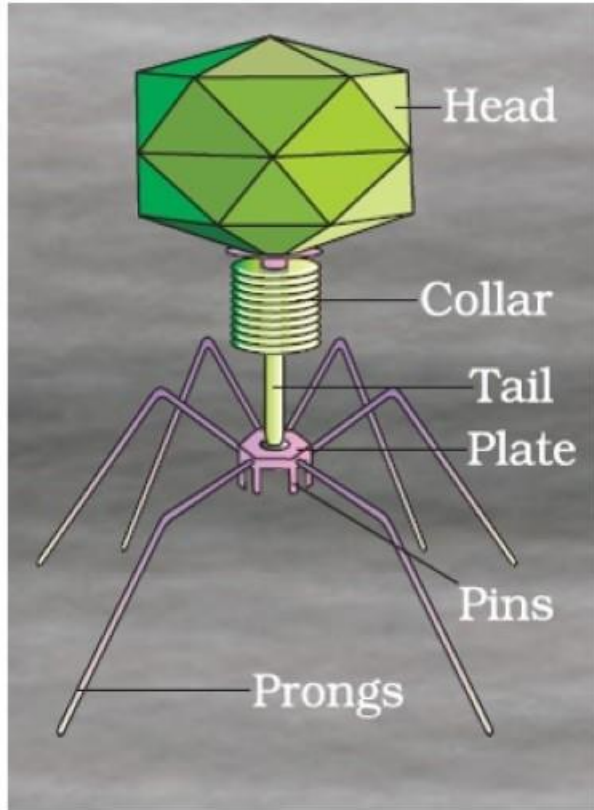


**Bacteria:
Spherical
shaped,
magnified
1500X**

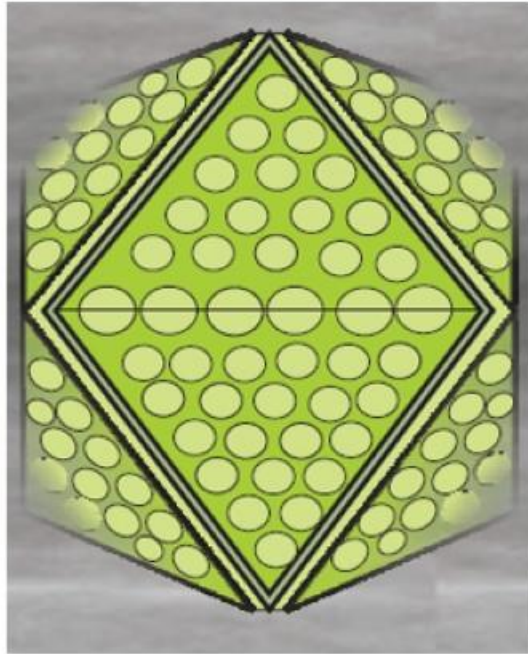


**A rod-shaped
bacterium showing flagella,
magnified 50,000X**

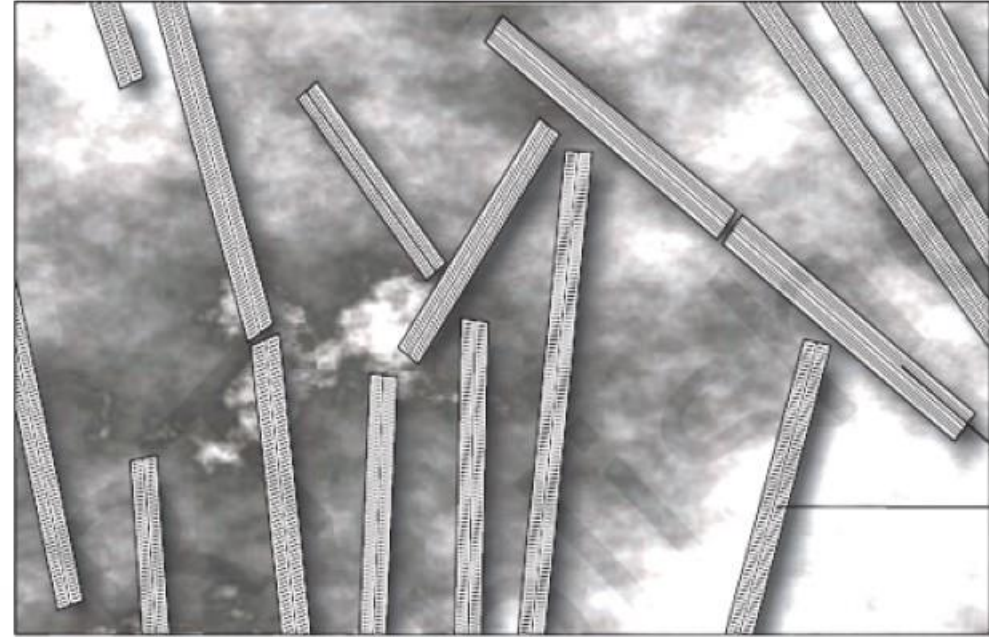
Various Microbes



A bacteriophage



Adenovirus which causes respiratory infections



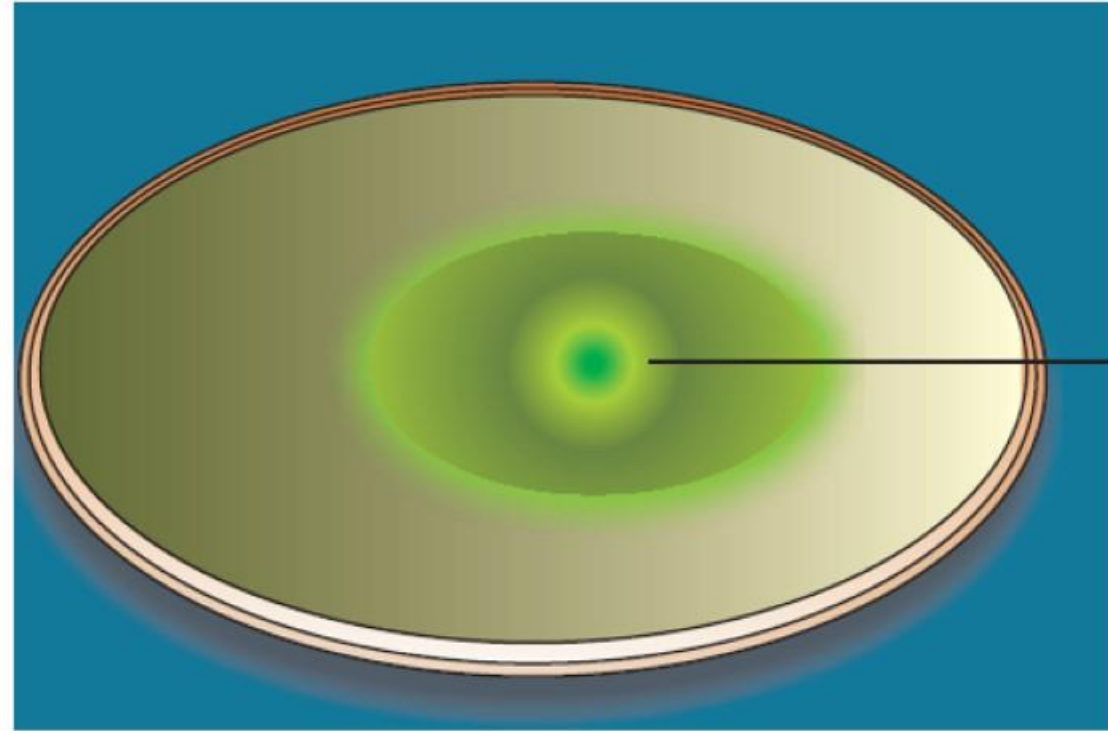
Compact Rod-shaped viruses

Rod-shaped Tobacco Mosaic Virus (TMV). Magnified about 1,00,000–1,50,000X

Various Microbes

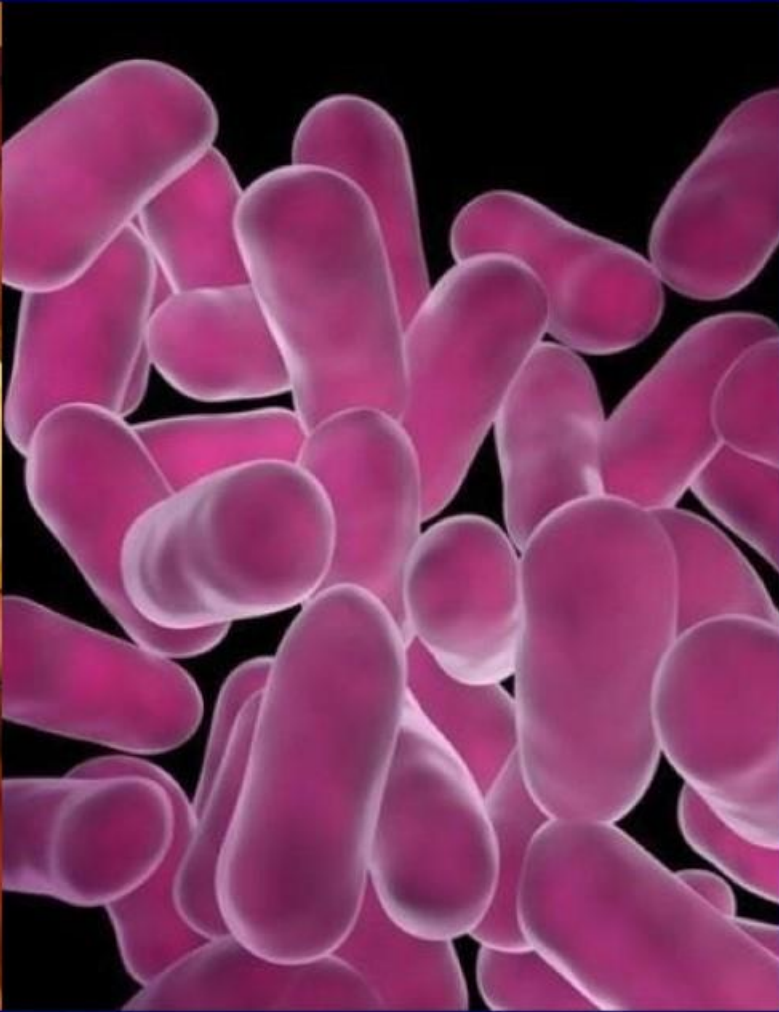


Colonies of bacteria growing in a petri dish



Fungal colony

Fungal colony growing in a petri dish

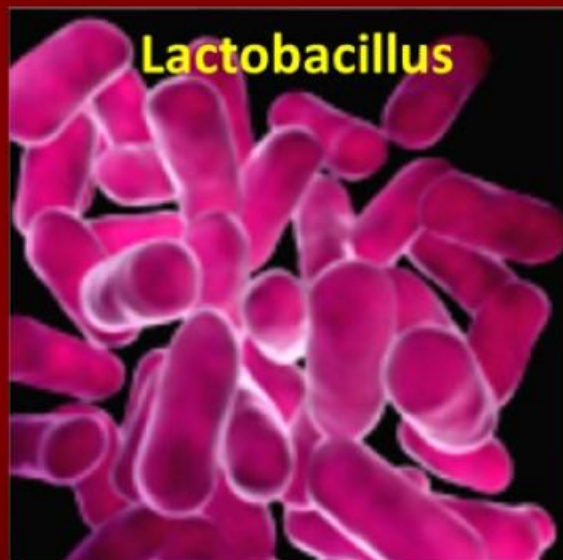


MICROBES IN HOUSEHOLD PRODUCTS

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MICROBES IN HOUSEHOLD PRODUCTS

Lactobacillus or Lactic acid bacteria (LAB)



- It converts **milk to curd** by producing acids that coagulate and partially digest the milk proteins.
- Fresh milk can be converted to curd by adding some curd containing LAB. It also increases **vitamin B₁₂**.
- In stomach, LAB helps to check pathogens.

MICROBES IN HOUSEHOLD PRODUCTS

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- **Bacterial Fermentation (Anaerobic respiration)** in dough is used to make foods such as *dosa*, *idli* etc.
- Puffed up appearance of dough is due to the production of CO_2 gas.



MICROBES IN HOUSEHOLD PRODUCTS



- **Baker's Yeast (*Saccharomyces cerevisiae*):** It is used to make bread by fermenting dough.

MICROBES IN HOUSEHOLD PRODUCTS



Toddy



Fermented fish



Fermented bamboo shoot



Fermented soya bean

- **Toddy** is made by fermenting sap from palms.
- Microbes are used to ferment fish, soya bean & bamboo-shoots and to produce cheeses.

MICROBES IN HOUSEHOLD PRODUCTS



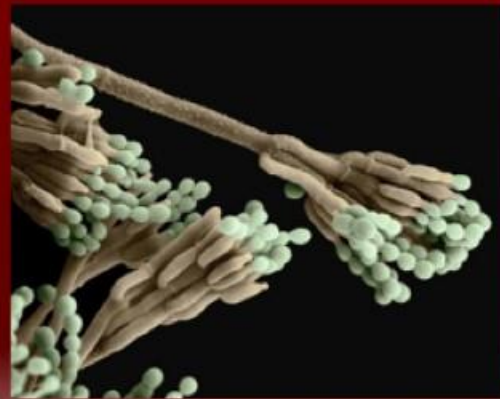
Swiss cheese



Roquefort cheese



Propionibacterium



Penicillium roqueforti

- **Swiss cheese** has large holes due to production of CO_2 by *Propionibacterium sharmanii* (a bacterium).
- **'Roquefort cheese'** is ripened by growing a fungus (*Penicillium roqueforti*) on them.



MICROBES IN INDUSTRIAL PRODUCTS

MICROBES IN INDUSTRIAL PRODUCTS



Production of beverages, antibiotics etc. on an industrial scale, requires growing microbes in very large vessels (**fermentors**).

MICROBES IN INDUSTRIAL PRODUCTS

Fermented beverages



- ***Saccharomyces cerevisiae* (Brewer's yeast)** is used in the production of beverages by fermenting **malted cereals** and **fruit juices** to produce **ethanol**.
- **Wine & beer** are produced without distillation.
- **Whisky, Brandy, Rum, Gin, Arrack etc.** are produced by distillation of fermented broth.

MICROBES IN INDUSTRIAL PRODUCTS

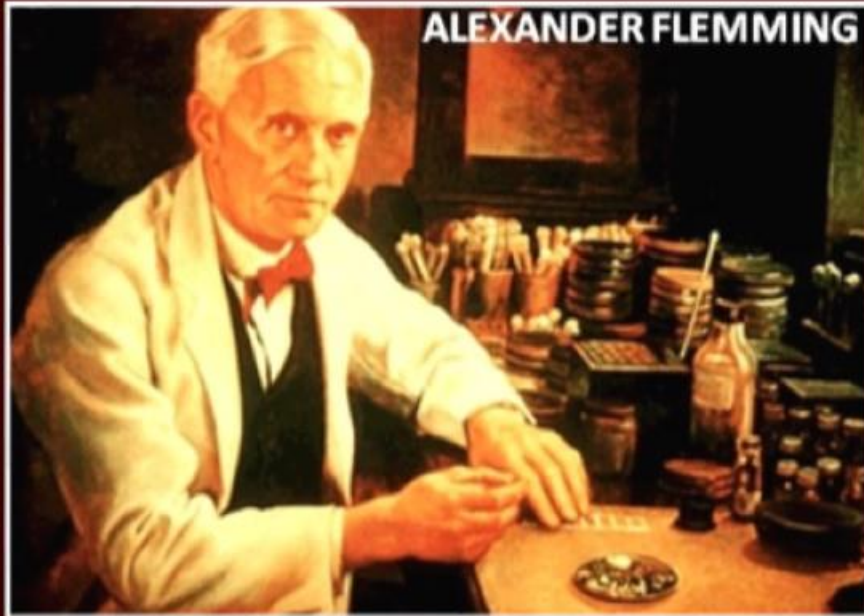
Antibiotics



- Antibiotics are chemical substances produced by some microbes and can kill or retard the growth of pathogens.
- Used to treat **plague, whooping cough, diphtheria, leprosy etc.**

MICROBES IN INDUSTRIAL PRODUCTS

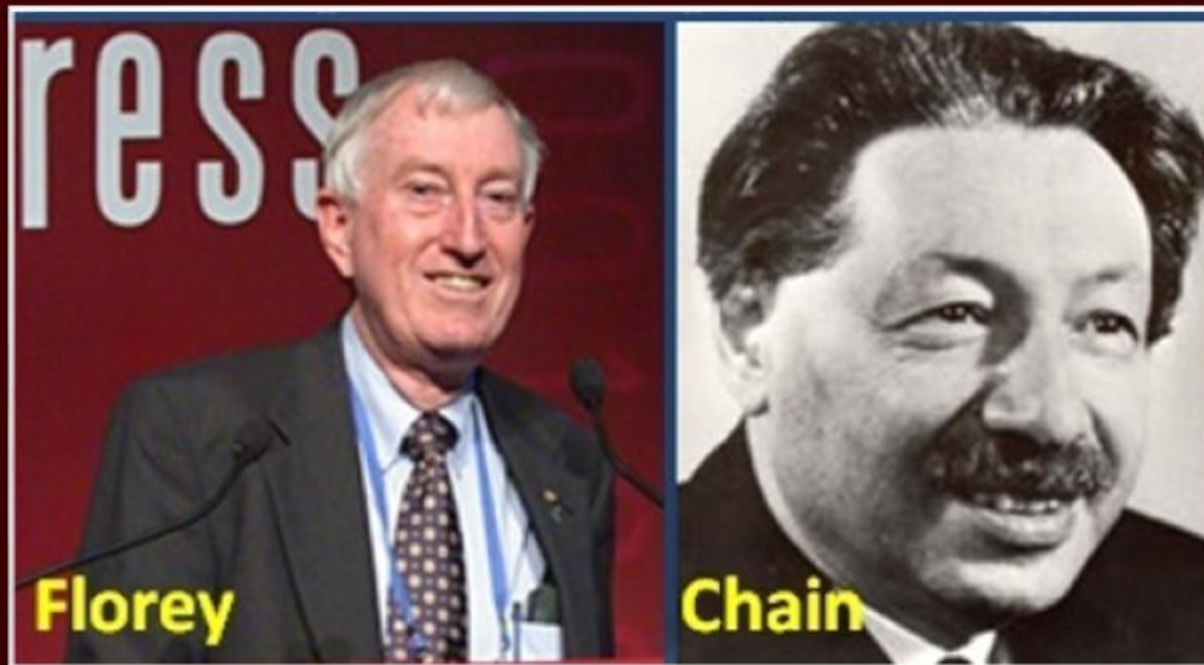
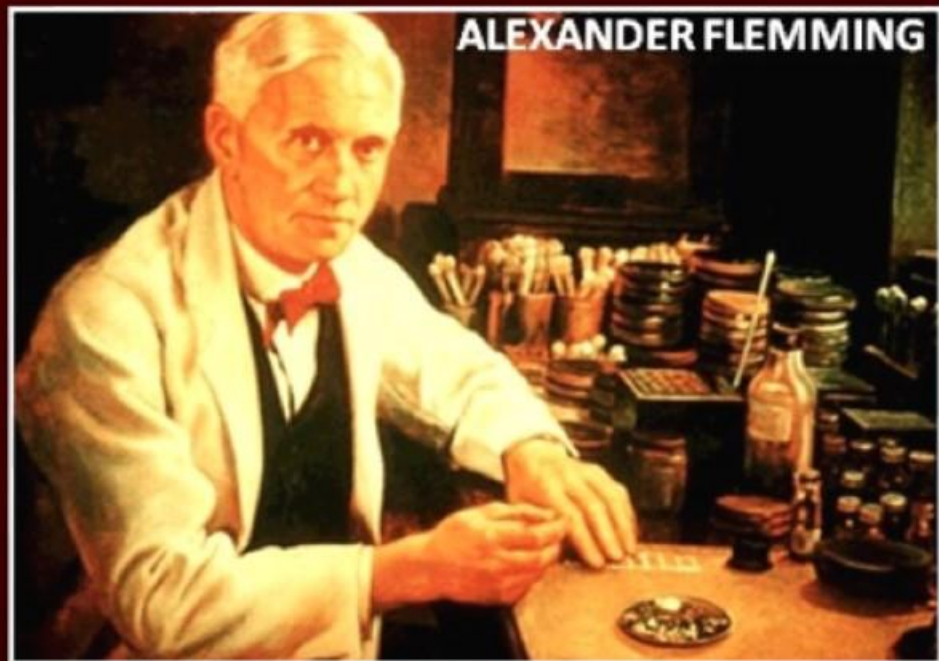
Antibiotics



- **Penicillin:** First antibiotic discovered by **Alexander Fleming**.
- He observed that **Staphylococci** could not grow around a mould (**Penicillium notatum**) growing in unwashed culture plates. He extracted penicillin from it.

MICROBES IN INDUSTRIAL PRODUCTS

Antibiotics



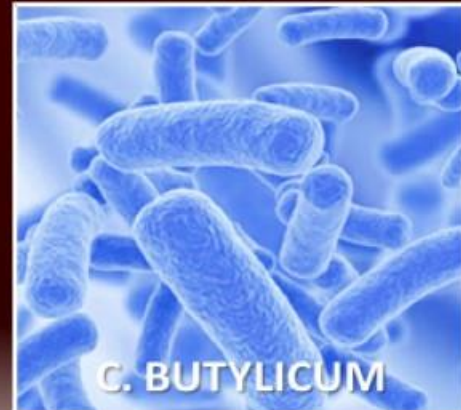
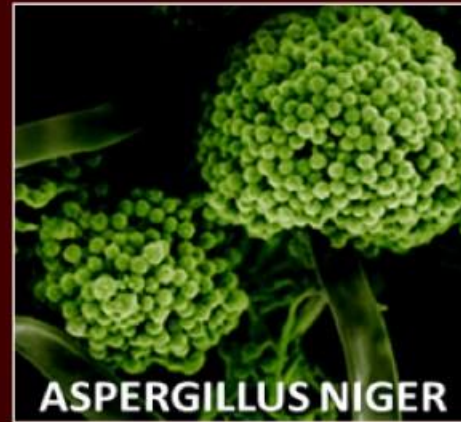
- **Ernest chain & Howard Florey** established its full potential as an effective antibiotic.
- **Fleming, Chain & Florey** were awarded Nobel Prize (1945).

MICROBES IN INDUSTRIAL PRODUCTS

Chemicals, Enzymes and other Bioactive molecules

1. Organic acids: Acid producer microbes include

Microbe	Organic acid
1. <i>Aspergillus niger</i> (a fungus)	Citric acid
2. <i>Acetobacter aceti</i> (a bacterium)	Acetic acid
3. <i>Clostridium butylicum</i> (a bacterium)	Butyric acid
4. <i>Lactobacillus</i> (a bacterium)	Lactic acid



MICROBES IN INDUSTRIAL PRODUCTS

Chemicals, Enzymes and other Bioactive molecules

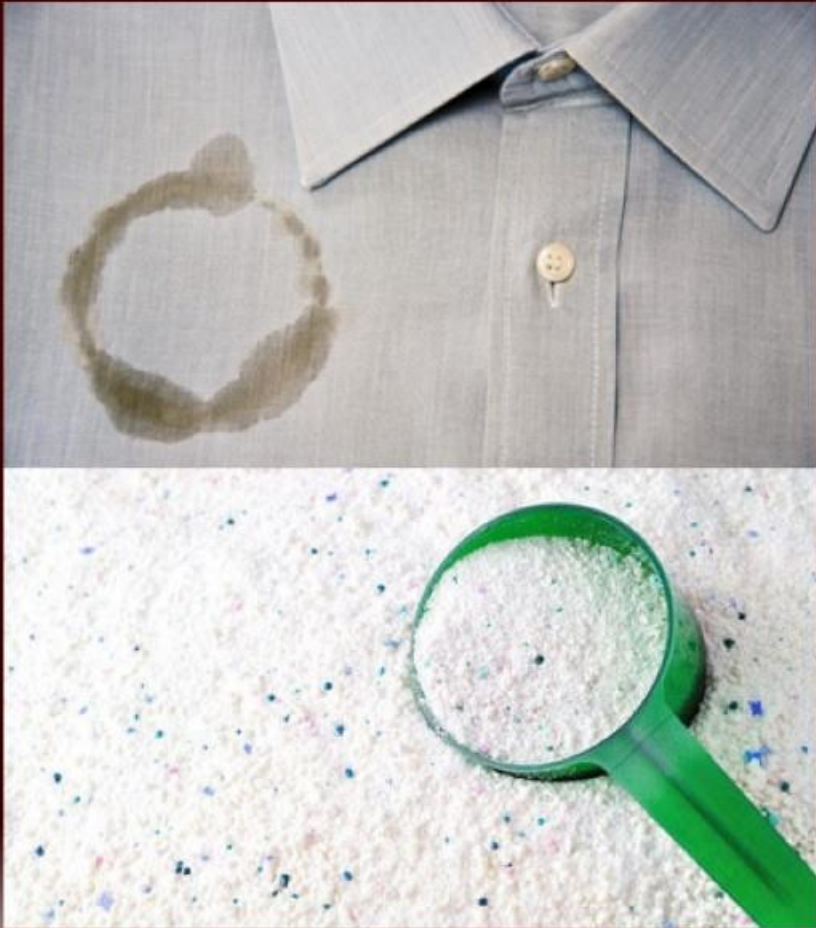


2. **Alcohol:** Yeast (*S. cerevisiae*) is used to produce ethanol.

MICROBES IN INDUSTRIAL PRODUCTS

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Chemicals, Enzymes and other Bioactive molecules



2. **Alcohol:** Yeast (*S. cerevisiae*) is used to produce ethanol.

3. **Enzymes:**

- **Lipases:** Used in detergent formulation. Help to remove oily stains from laundry.

MICROBES IN INDUSTRIAL PRODUCTS

Chemicals, Enzymes and other Bioactive molecules



2. **Alcohol:** Yeast (*S. cerevisiae*) is used to produce ethanol.

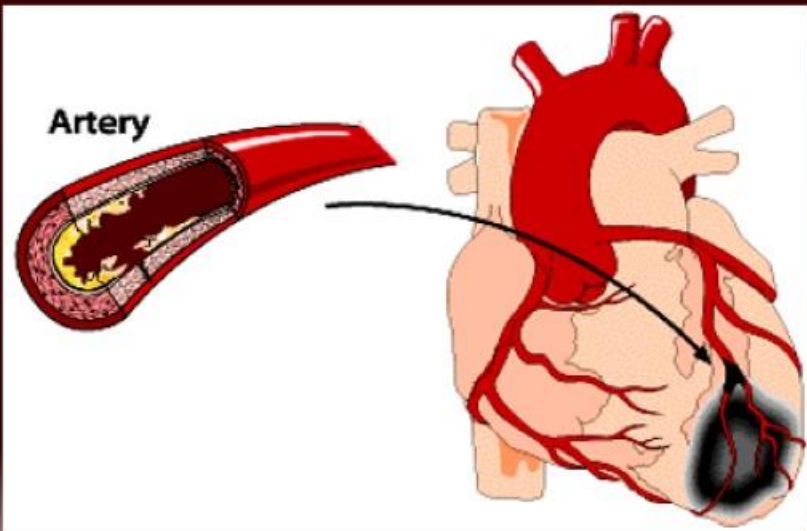
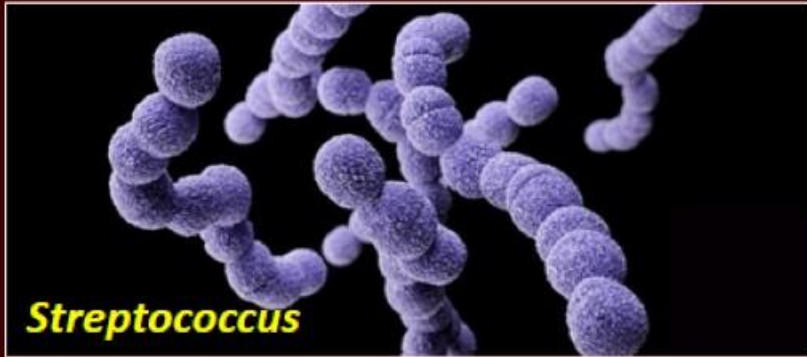
3. **Enzymes:**

- **Lipases:** Used in detergent formulation. Help to remove oily stains from laundry.
- **Pectinases and Proteases:** To clarify bottled juices.



MICROBES IN INDUSTRIAL PRODUCTS

Chemicals, Enzymes and other Bioactive molecules



2. **Alcohol:** Yeast (*S. cerevisiae*) is used to produce ethanol.

3. **Enzymes:**

- **Lipases:** Used in detergent formulation. Help to remove oily stains from laundry.
- **Pectinases and Proteases:** To clarify bottled juices.
- **Streptokinase:** Produced by *Streptococcus*. Used as a 'clot buster' to remove clots from the blood vessels of patients who have myocardial infarction.

MICROBES IN INDUSTRIAL PRODUCTS

Chemicals, Enzymes and other Bioactive molecules



Monascus purpureus
growing on white rice



4. Cyclosporine A:

- Produced by *Trichoderma polysporum* (fungus).
- Used as an immunosuppressive agent in organ transplant patients.

5. Statins:

- Produced by *Monascus purpureus* (a yeast).
- Used as blood-cholesterol lowering agents. It inhibits the enzymes responsible for synthesis of cholesterol.



MICROBES IN SEWAGE TREATMENT

MICROBES IN SEWAGE TREATMENT



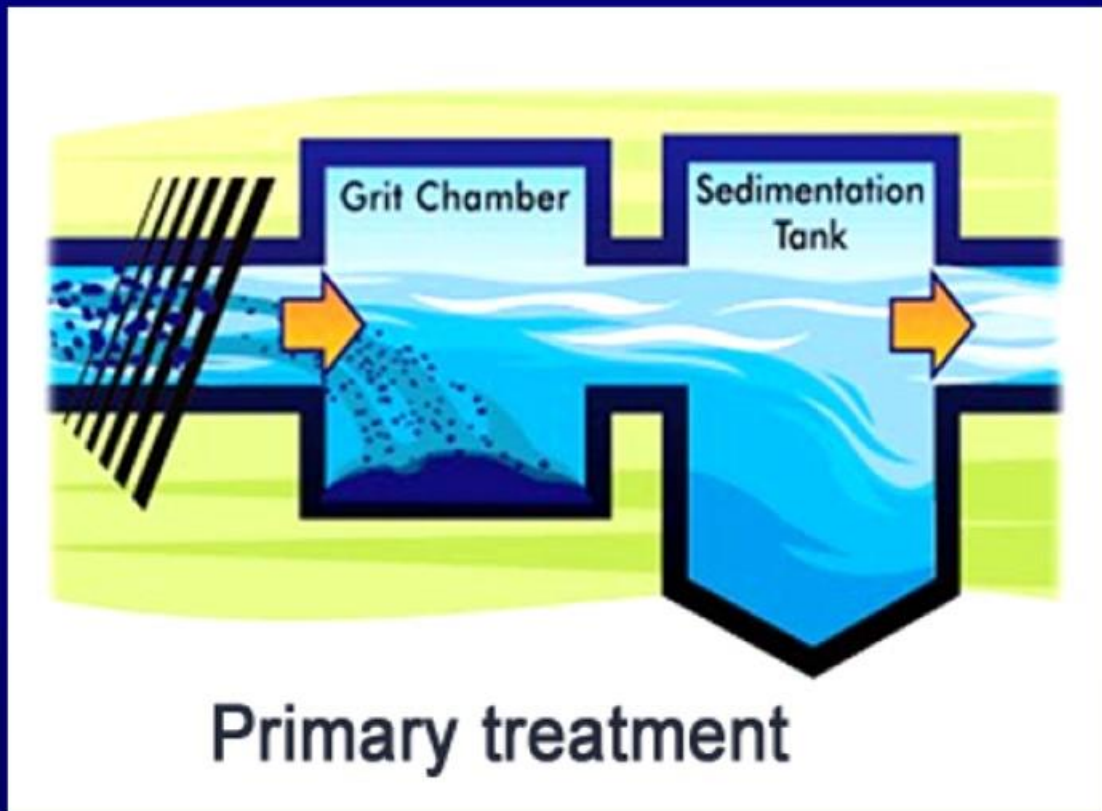
- **Sewage (municipal waste-water)** contains large amount of organic matter & microbes.
- Sewage is treated in **Sewage Treatment Plants (STPs)** to make it less polluting.
- It includes 2 stages:



1. Primary treatment
2. Secondary treatment
(Biological treatment)

MICROBES IN SEWAGE TREATMENT

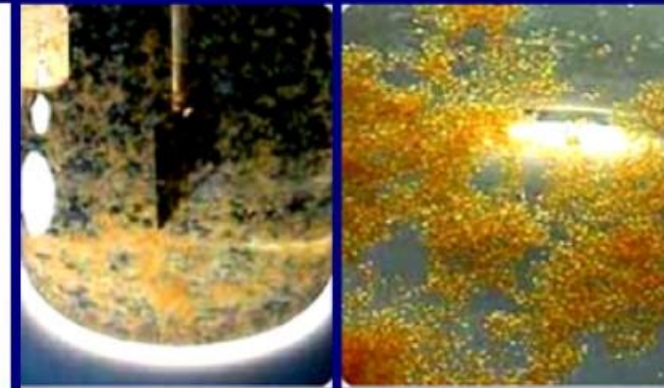
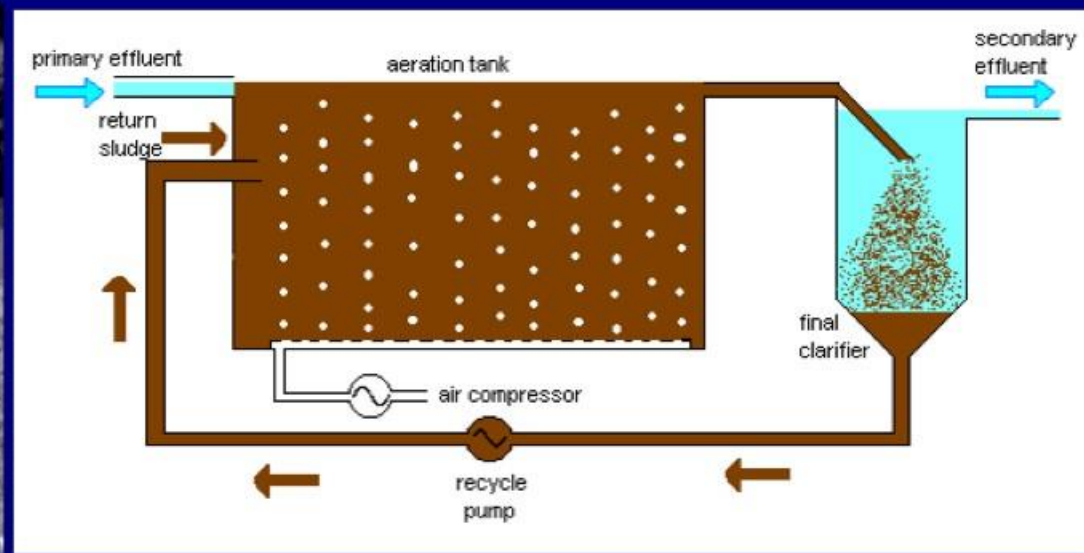
1. PRIMARY TREATMENT



- It is the physical removal of particles.
- It includes
 - ✓ Removal of floating debris by **sequential filtration**.
 - ✓ Removal of the grit (soil & small pebbles) by **sedimentation**.

The settled solids form **primary sludge** and the supernatant forms the **primary effluent**.

2. SECONDARY (BIOLOGICAL) TREATMENT

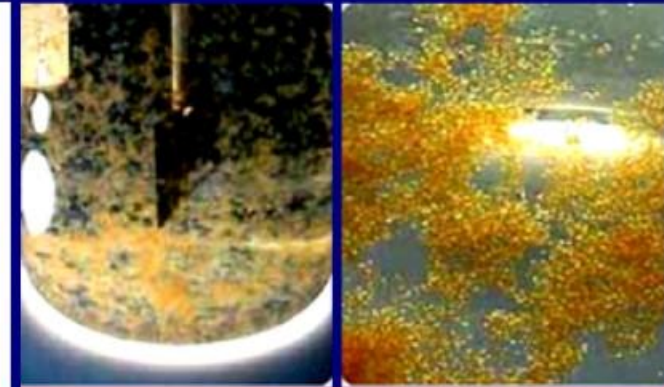
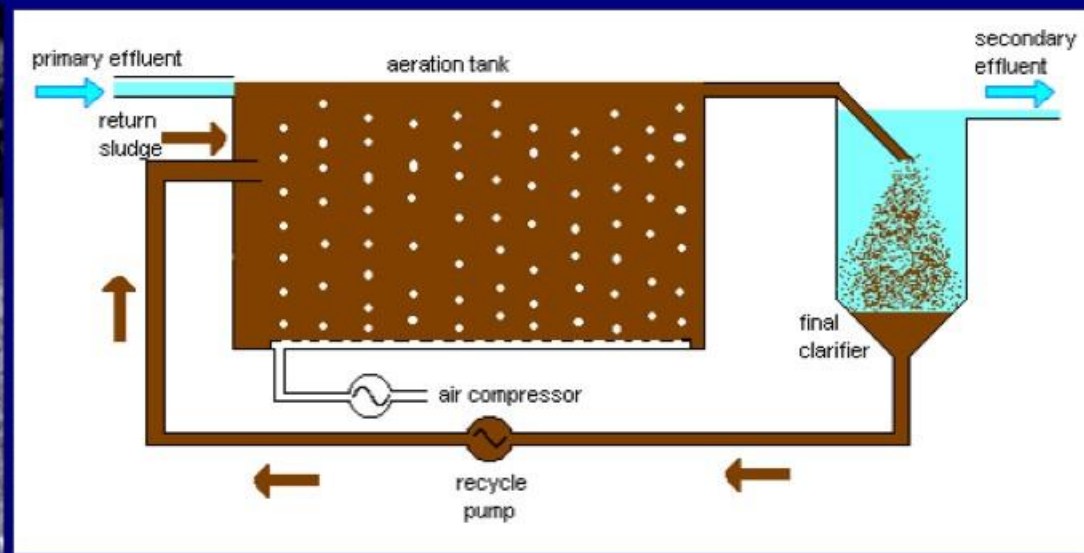


Flocs (mesh-like masses of bacteria & fungal filaments)

- **Primary effluent** is passed into large **aeration tanks** and constantly agitated.
- This allows vigorous growth of useful **aerobic microbes** into **flocs** (bacteria associated with fungal filaments to form mesh-like structures).
- These microbes consume the organic matter in the effluent. This reduces the **BOD (Biochemical Oxygen Demand)** of the effluent.

MICROBES IN SEWAGE TREATMENT

2. SECONDARY (BIOLOGICAL) TREATMENT

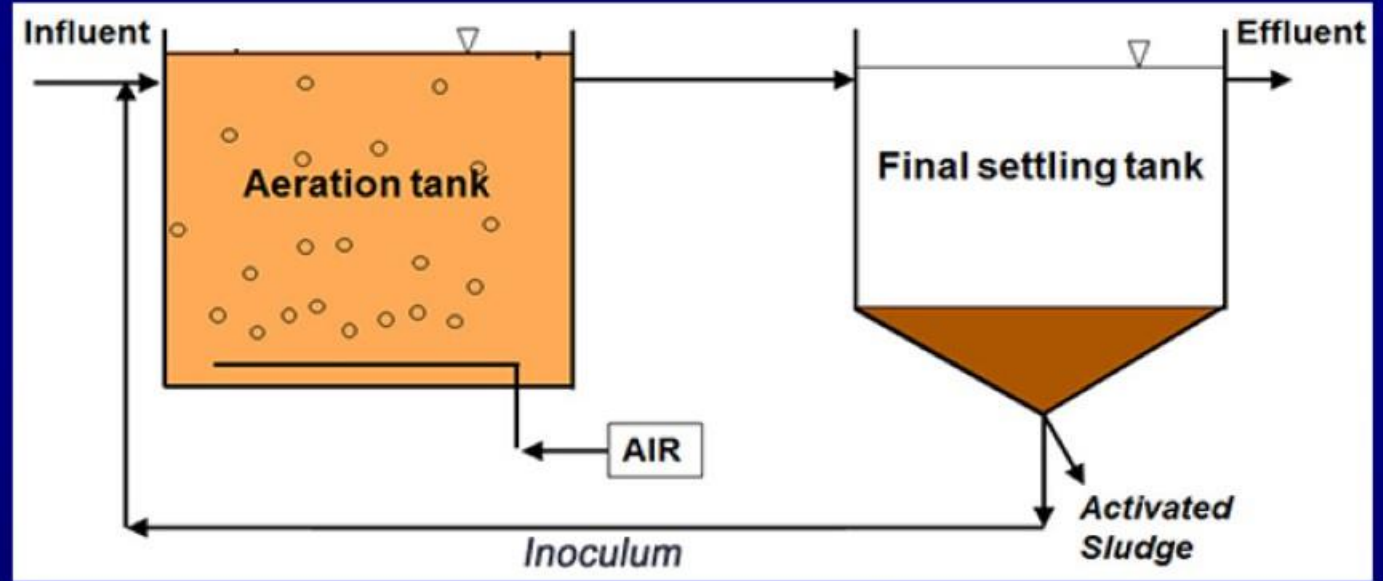


Flocs (mesh-like masses of bacteria & fungal filaments)

- **BOD (Biochemical Oxygen Demand):** Amount of O_2 consumed by bacteria to oxidize all the organic matter in one litre water.
- It is a measure of organic matter present in water.
- The greater the BOD more is its polluting potential.

MICROBES IN SEWAGE TREATMENT

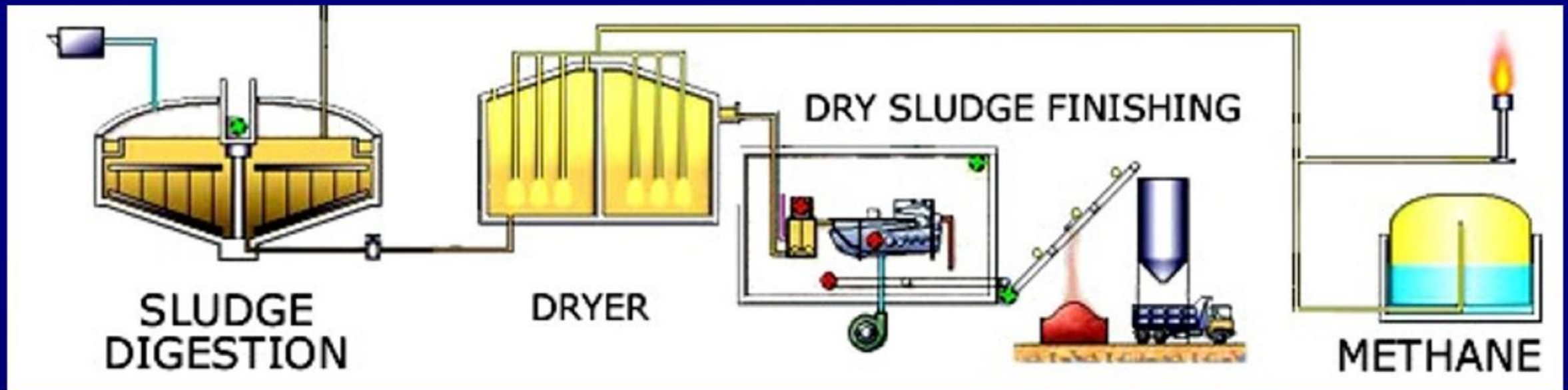
2. SECONDARY (BIOLOGICAL) TREATMENT



- The effluent is then passed into a **settling tank** where the bacterial 'flocs' are sediment. This sediment is called '**activated sludge**'.
- A small part of the activated sludge is pumped back into the aeration tank to serve as the **inoculum**.

MICROBES IN SEWAGE TREATMENT

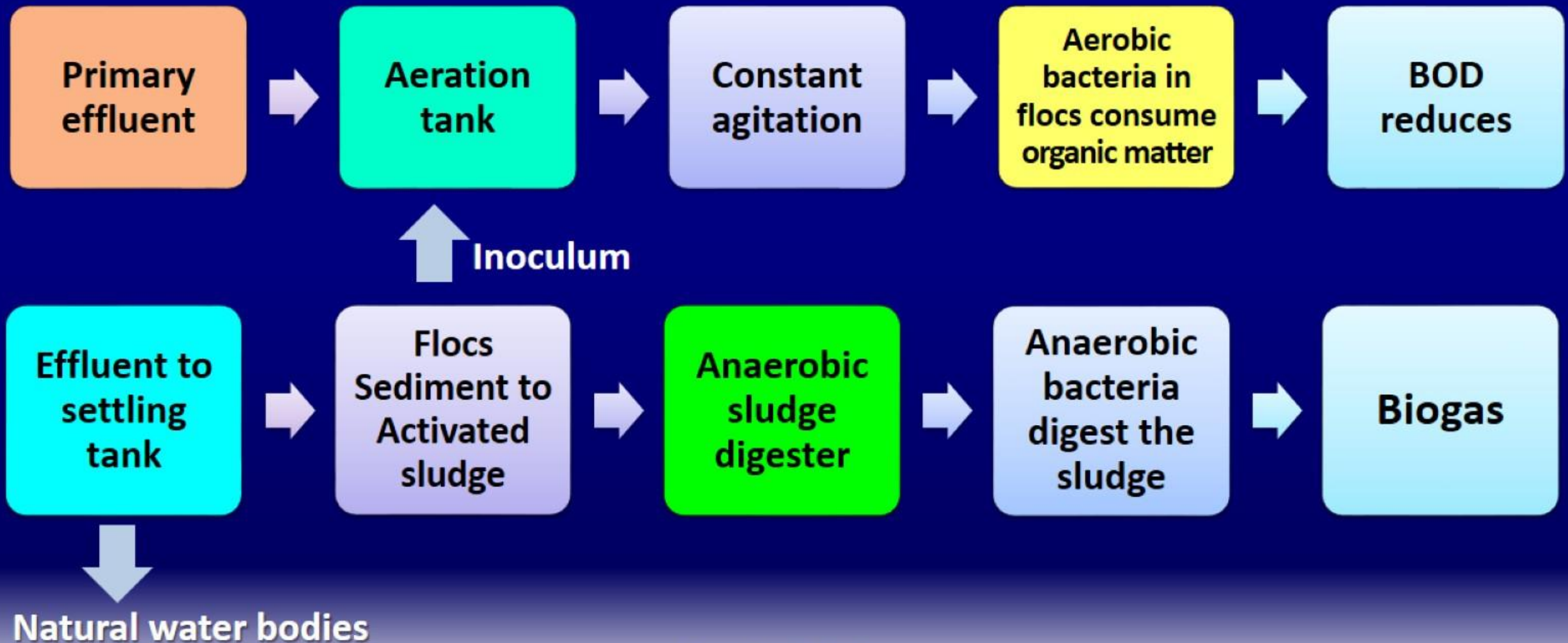
2. SECONDARY (BIOLOGICAL) TREATMENT



- The remaining sludge is pumped into large tanks called **anaerobic sludge digesters**. Here, some **anaerobic bacteria** digest the bacteria and fungi in the sludge by producing gases like CH_4 , H_2S and CO_2 . These gases form the **biogas**.
- The effluent is released into natural water bodies like rivers and streams.

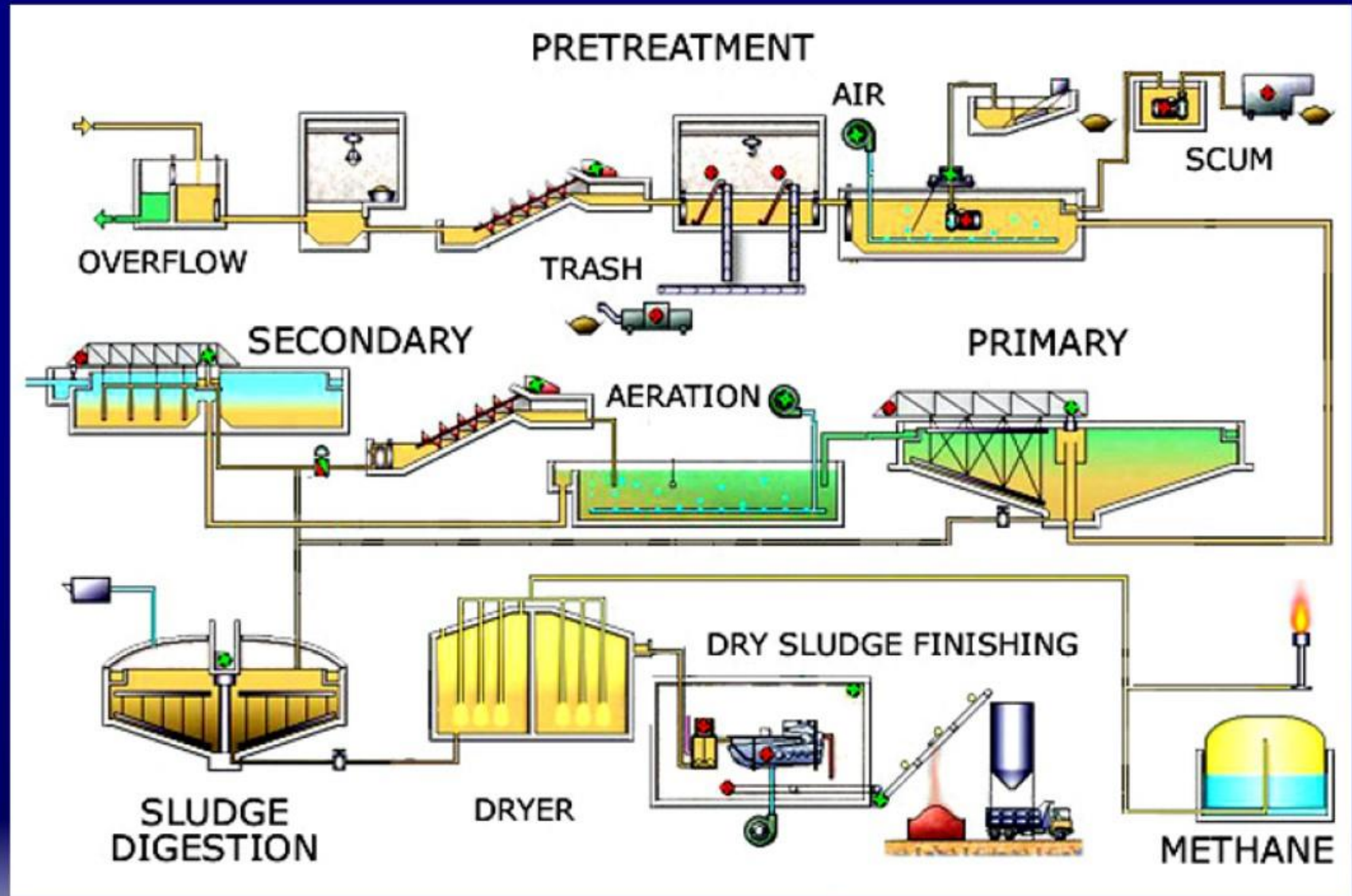
MICROBES IN SEWAGE TREATMENT

SECONDARY (BIOLOGICAL) TREATMENT – OVER ALL STEPS



MICROBES IN SEWAGE TREATMENT

SEWAGE TREATMENT: AT A GLANCE



MICROBES IN SEWAGE TREATMENT



The Ministry of Environment & Forests has initiated Ganga Action Plan & Yamuna Action Plan to save from water pollution.



MICROBES IN THE PRODUCTION OF BIOGAS

MICROBES IN BIOGAS PRODUCTION



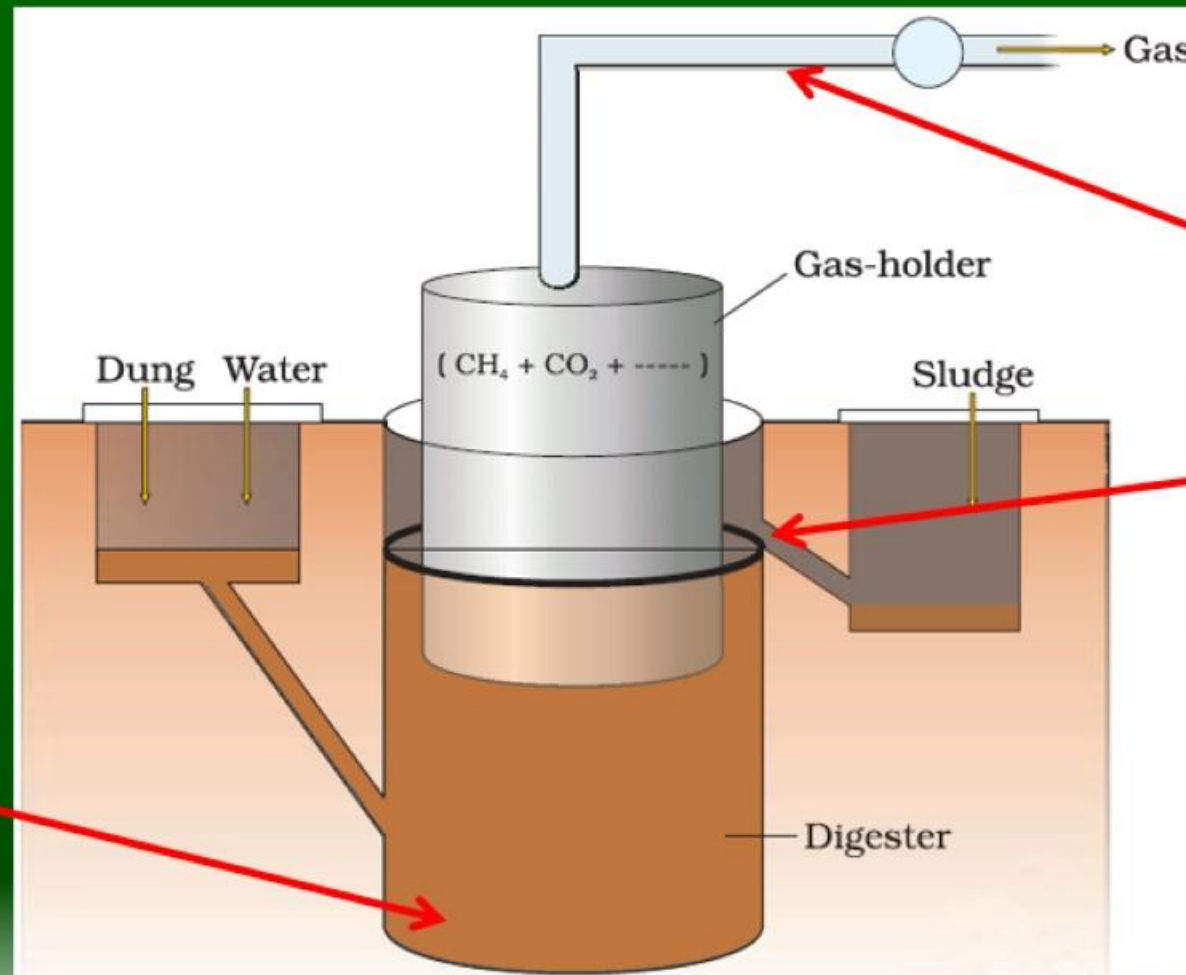
- Biogas is a mixture of gases (mainly CH_4) produced by the microbes such as **Methanogens**.
- Methanogens grow anaerobically on cellulosic material and produce CH_4 along with CO_2 & H_2 . E.g. *Methanobacterium*.
- *Methanobacterium* is found in the anaerobic sludge and rumen of cattle (for cellulose digestion).
- Biogas is used for **cooking and lighting**.
- Cattle dung (gobar) contains these bacteria. So dung is used to produce biogas (**Gobar gas**).

MICROBES IN BIOGAS PRODUCTION

PARTS OF A BIOGAS PLANT

1. A concrete tank (10-15 feet deep) to collect bio-wastes and slurry of dung.

A floating cover is placed over the slurry, which keeps on rising as the biogas is produced.



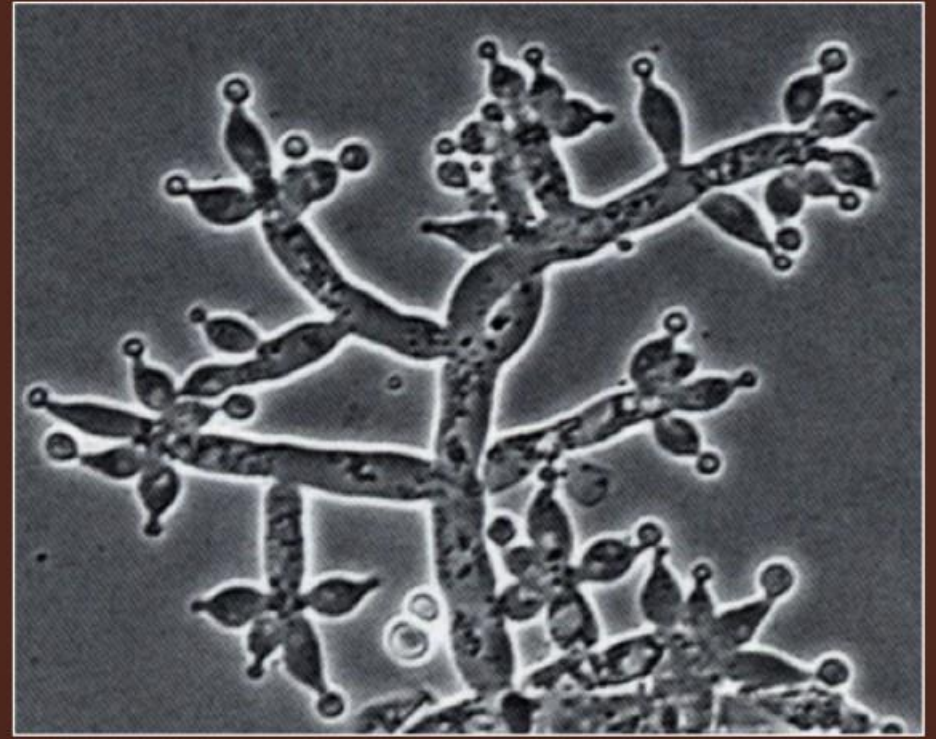
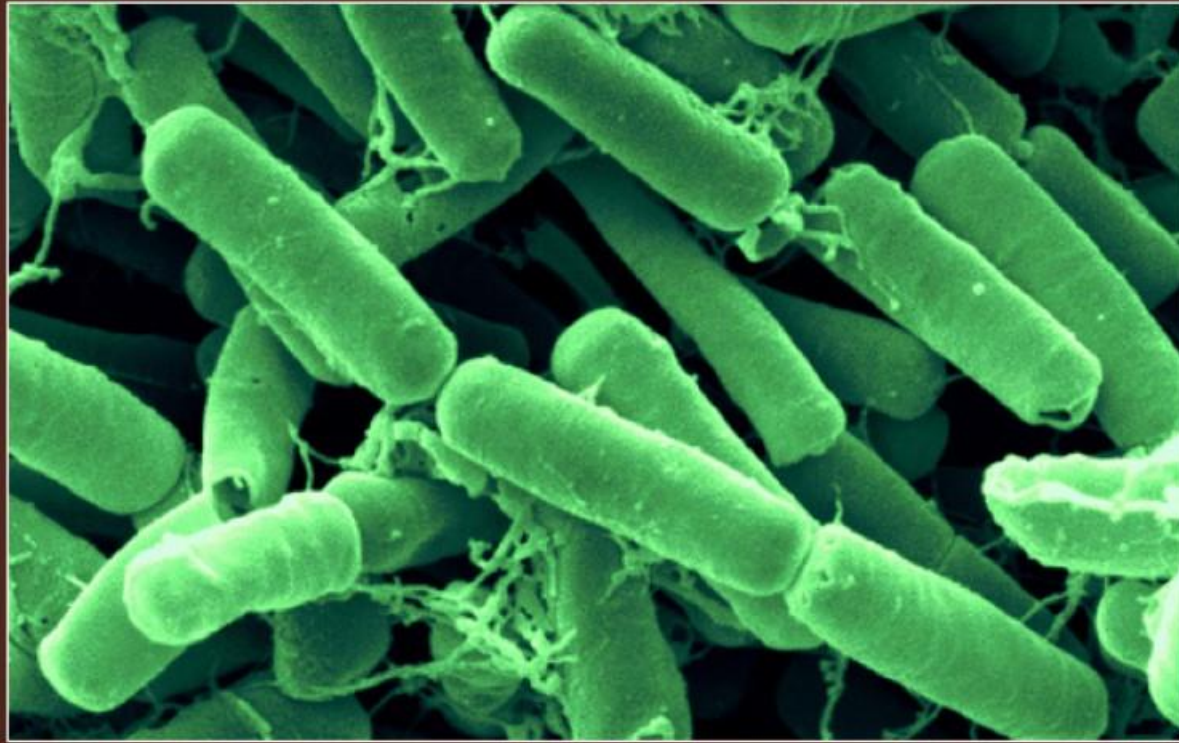
2. Outlet to supply biogas.

3. Outlet to remove spent slurry (used as fertilizer).

MICROBES IN BIOGAS PRODUCTION



- **Indian Agricultural Research Institute (IARI) and Khadi & Village Industries Commission (KVIC) developed technology of biogas production in India.**



MICROBES AS BIOCONTROL AGENTS

MICROBES AS BIOCONTROL AGENTS bankofbiology.com



- Biocontrol is the **use of biological methods for controlling plant diseases and pests.**
- E.g. Lady bird (beetle) controls aphids. Dragon flies control mosquitoes.



- Chemical pesticides and insecticides kill both useful and harmful organisms and cause pollution. Biocontrol method has no such problems.

MICROBES AS BIOCONTROL AGENTS

MICROBIAL BIOCONTROL AGENTS

1. *Bacillus thuringiensis* (Bt)

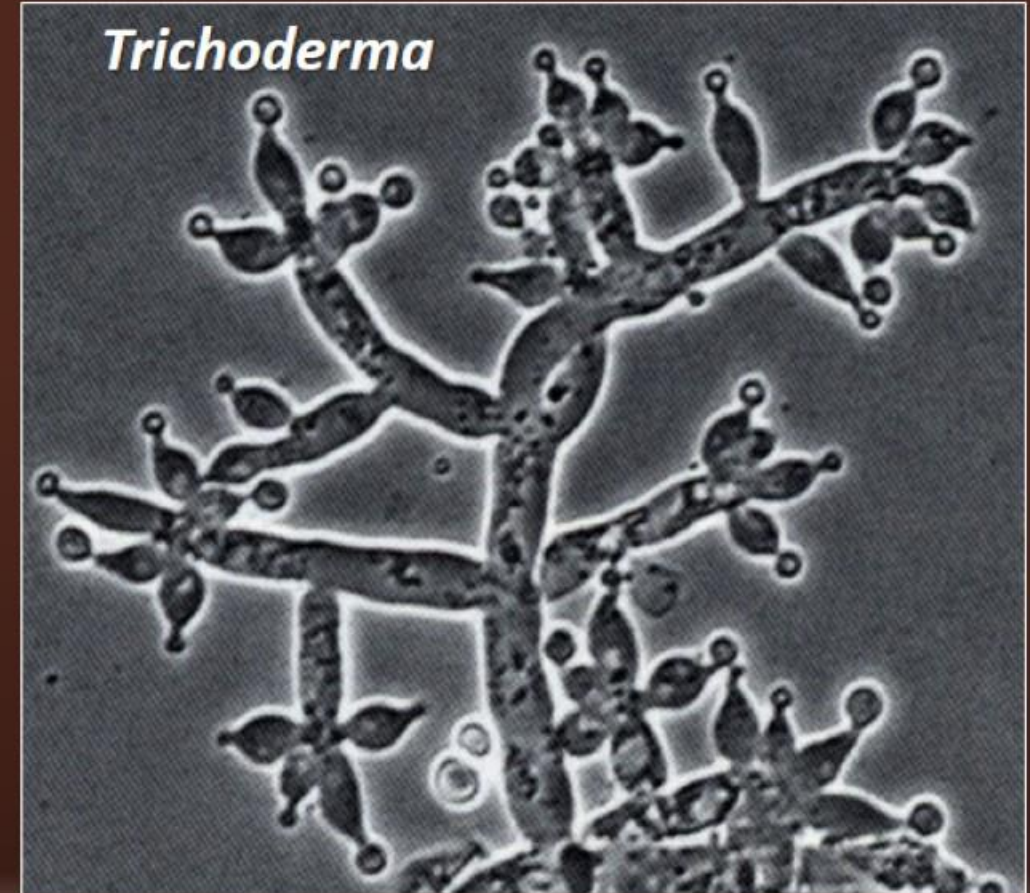
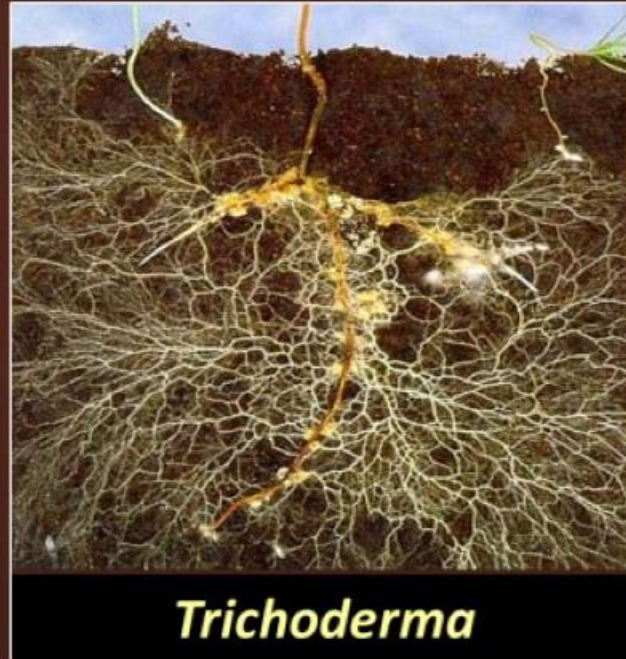


- To control **butterfly caterpillar**.
- The dried spores of Bt (available in sachets) are mixed with water and sprayed on to vulnerable plants such as brassicas and fruit trees. These are eaten by the caterpillar. In their gut, the toxin is released and the larvae get killed.
- Scientists have introduced *B. thuringiensis* toxin genes into plants. E.g. **Bt cotton**.

MICROBES AS BIOCONTROL AGENTS

MICROBIAL BIOCONTROL AGENTS

2. *Trichoderma* *sp (fungus)*

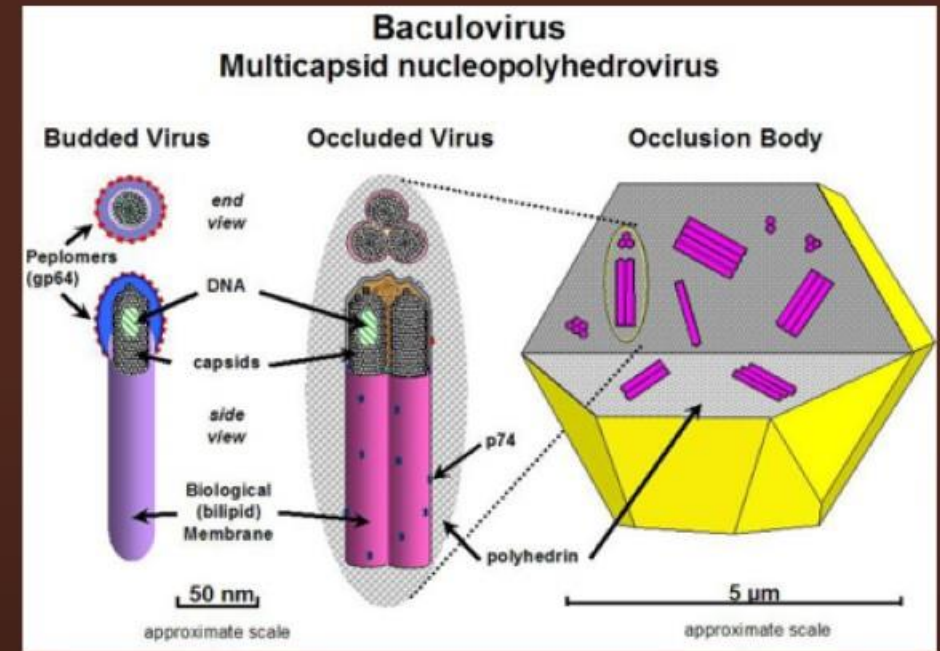
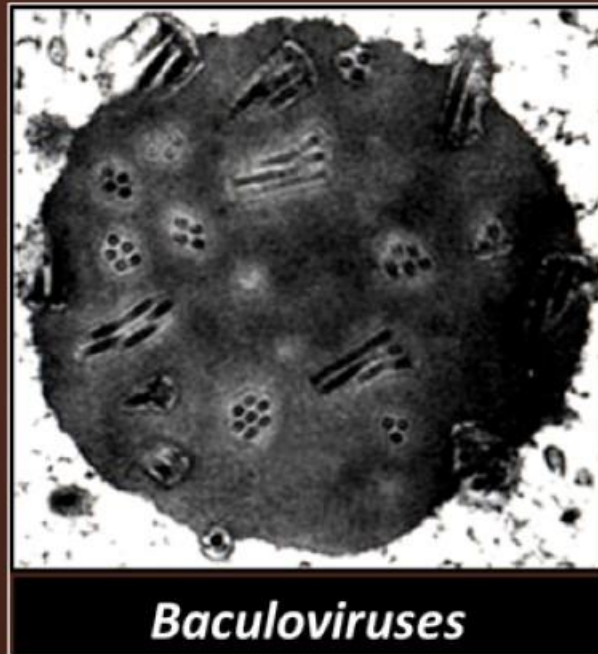


- They are seen in the root ecosystems.
- They control several plant pathogens.

MICROBES AS BIOCONTROL AGENTS

MICROBIAL BIOCONTROL AGENTS

3. *Baculoviruses* (Especially genus *Nucleopolyhedro* *virus*)

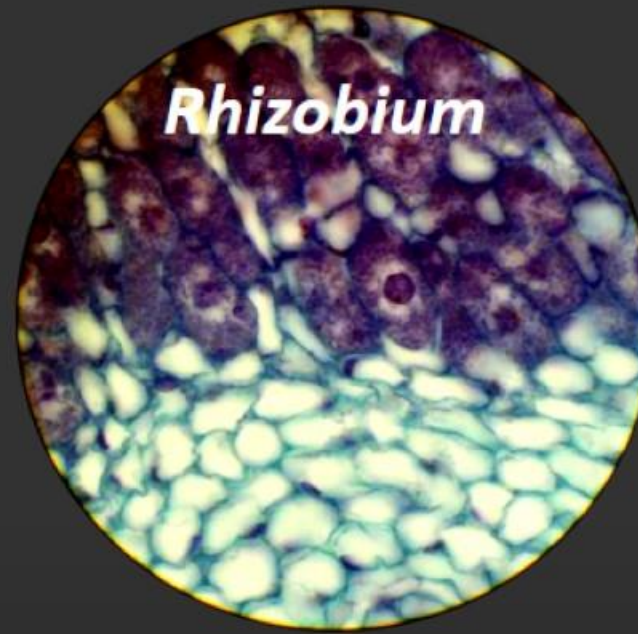
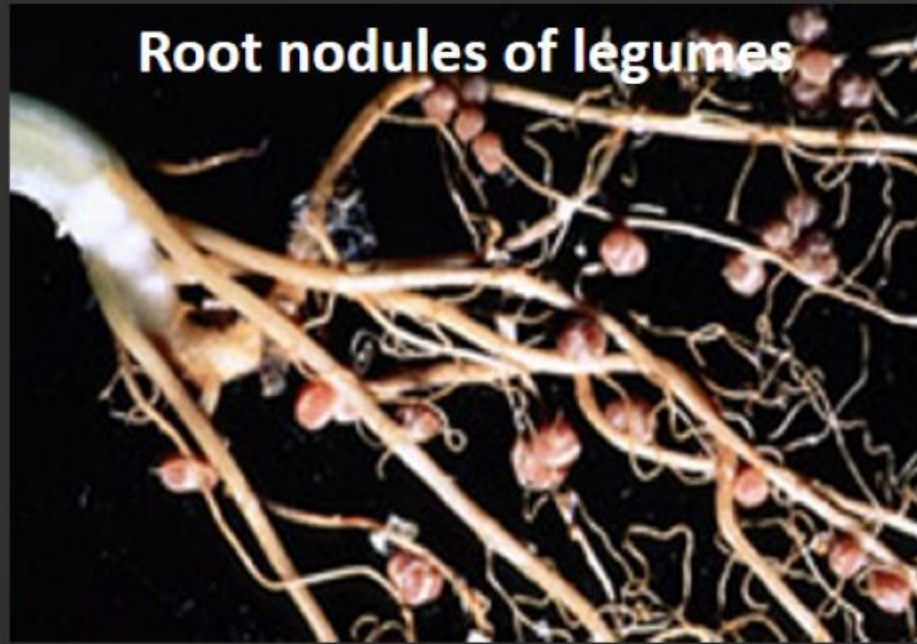


- Attacks insects and other arthropods.
- It is suitable for **species-specific**, narrow spectrum insecticidal applications and desirable in **IPM (Integrated Pest Management)** program to conserve beneficial insects.



**MICROBES AS
BIOFERTILISERS**

MICROBES AS BIOFERTILISERS



- **Biofertilisers** are organisms that enrich the nutrient quality of the soil.
- E.g. Bacteria, fungi, cyanobacteria etc.
- **Rhizobium** (symbiotic bacteria in root nodules of leguminous plants) fix atmospheric N_2 .
- Free-living bacteria in the soil (E.g. **Azospirillum** and **Azotobacter**) enrich the nitrogen content of the soil.

MICROBES AS BIOFERTILISERS

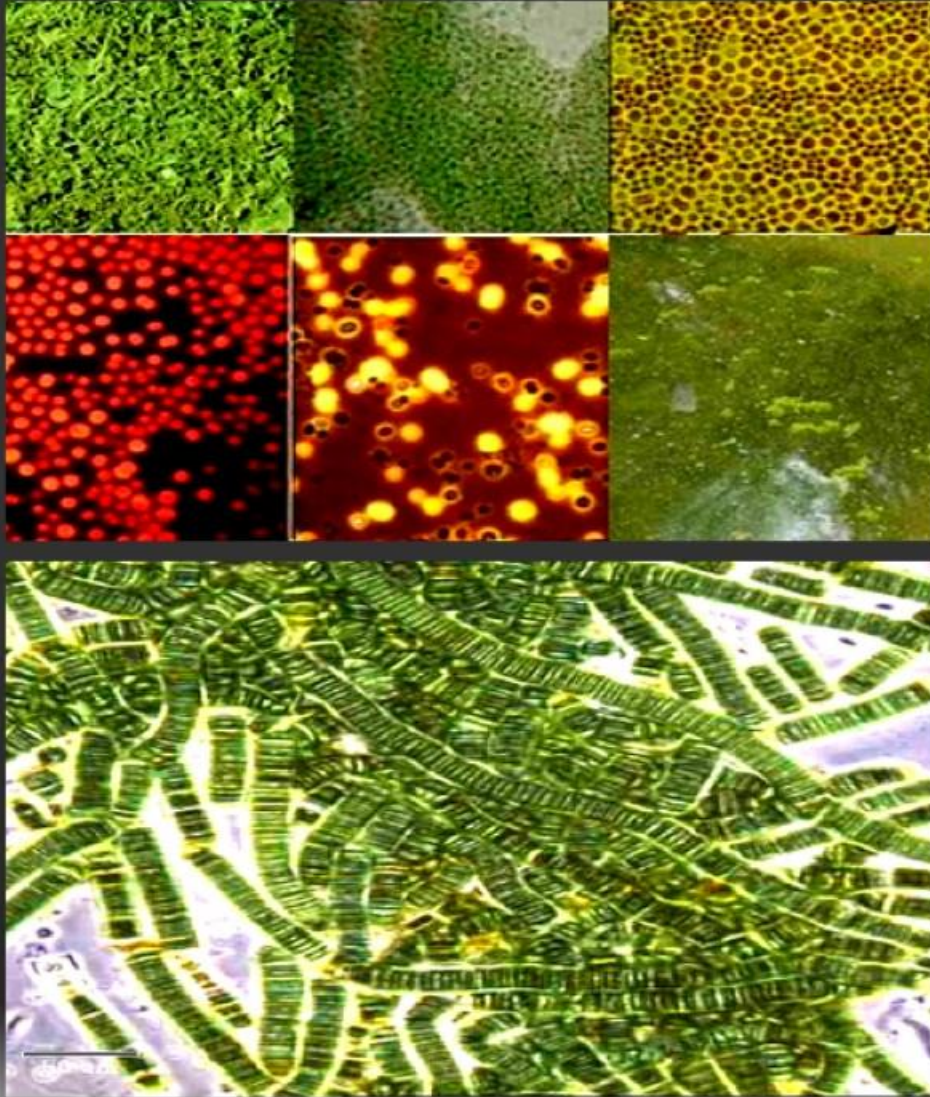


Mycorrhiza

Mycorrhiza

- Symbiotic association of fungi (E.g. *Glomus*) with plants. The fungus gets food from the plant.
- The fungal Symbiont performs the following:
 - ✓ Absorb phosphorous from soil and passes it to the plant.
 - ✓ Give resistance to root-borne pathogens and tolerance to salinity and draught.
 - ✓ Give overall increase in plant growth and development.

MICROBES AS BIOFERTILISERS



Cyanobacteria (Blue green algae)

- Autotrophic microbes.
- They fix atmospheric nitrogen.
- E.g. *Anabaena*, *Nostoc*, *Oscillatoria* etc.
- In paddy fields, *Cyanobacteria* serve as biofertilisers. It also adds organic matter to the soil and increases its fertility.