CHAPTER 10 XII BIOLOGY
MICROBES IN HUMAN WELFARE

Microbes - Household and Industrial applications

Household Applications

- **Lactic acid bacteria (LAB)**
  - Milk $\xrightarrow{LAB}$ Curd
  - LAB produces acids that coagulate and partially digest milk proteins.
  - Small amount of curd that is added to the milk for curdling acts as an inoculum containing thousands of LABS, which further multiply.
  - LAB enhances the nutritional value of milk by increasing Vitamin B_{12}.
  - LAB present in stomach prevents infections.
- **Fermentation**
  - Dosaand idli dough is fermented by bacteria, which produces CO_2gas and gives it a puffed-up appearance.
  - Dough used for making breads is fermented by baker's yeast (*Saccharomyces cerevisiae*).
- 'Toddy' (a traditional drink from South India made by fermenting sap from palm trees)
- **Cheese making**
  - The bacterium *Propionibacterium sharmanii* is used in 'Swiss cheese' to give it its characteristic holes by producing large amount of carbon dioxide.
  - 'Roquefort cheese' is ripened by growing certain fungi on them to give them their specific flavour.

Industrial applications

- For industrial purposes, microbes are grown in large vessels called fermentors.
- On industrial scale, fermented beverages, antibiotics, enzymes, and other bioactive molecules are prepared using microbes.
- **Fermented beverages**

  Saccharomyces cerevisiae, also called brewer's yeast, is used to prepare wine, beer, whisky, brandy, rum, etc. depending upon the type of raw material and processing.
- If fermented broth is distilled, then brandy and rum are produced while wine and beer are produced without distillation.
- **Antibiotics**

- Certain microorganisms inhibit the growth of other microorganisms wherever they grow.
- Antibiotics are chemical substances produced by certain microbes that kill or retard the growth of other microbes (disease-causing microbes).
- Penicillin discovered by Alexander Fleming was the first antibiotic to be discovered.
- Fleming discovered it by chance when he was working on the bacterium *Staphylococcus*. He discovered that growth of *Staphylococcus* ceases in the culture plates where *Penicillium notatum* was grown.
- Later on, its use as an effective antibiotic was established by Chain and Florey.

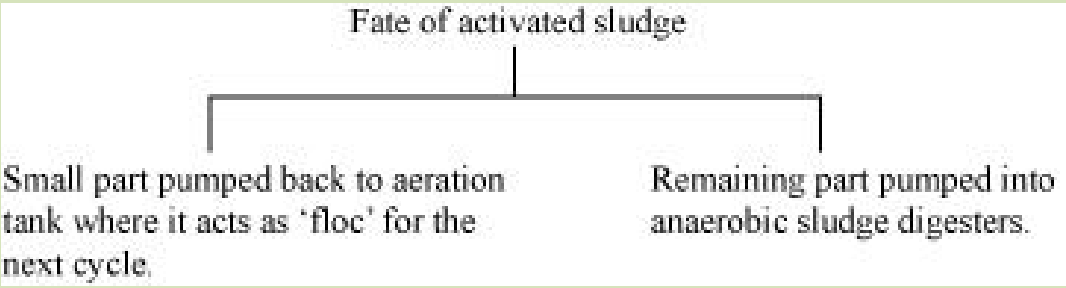
- **Chemicals, enzymes, and bioactive agents**

Microorganism	Substance produced
Fungus *Aspergillus*	Citric acid
Bacterium *Acetobacter aceti*	Acetic acid
Bacterium *Clostridium butylicum*	Butyric acid
Bacterium *Lactobacillus*	Lactic acid
Yeast *S.cerevisiae*	Ethanol
Bacterium *Streptococcus*	Streptokinase (used as a clot buster for removing clots from blood vessels of patients with myocardial infarction)
Fungus *Trichoderma polysporum*	Cyclosporin A (used as immune-suppressive agent in organ transplantation)
Yeast *Monascus purpureus*	Statins (lower blood cholesterol levels)

1. Microbes: Applications in Sewage Treatment and Biogas Production

Microbes in Sewage Treatment

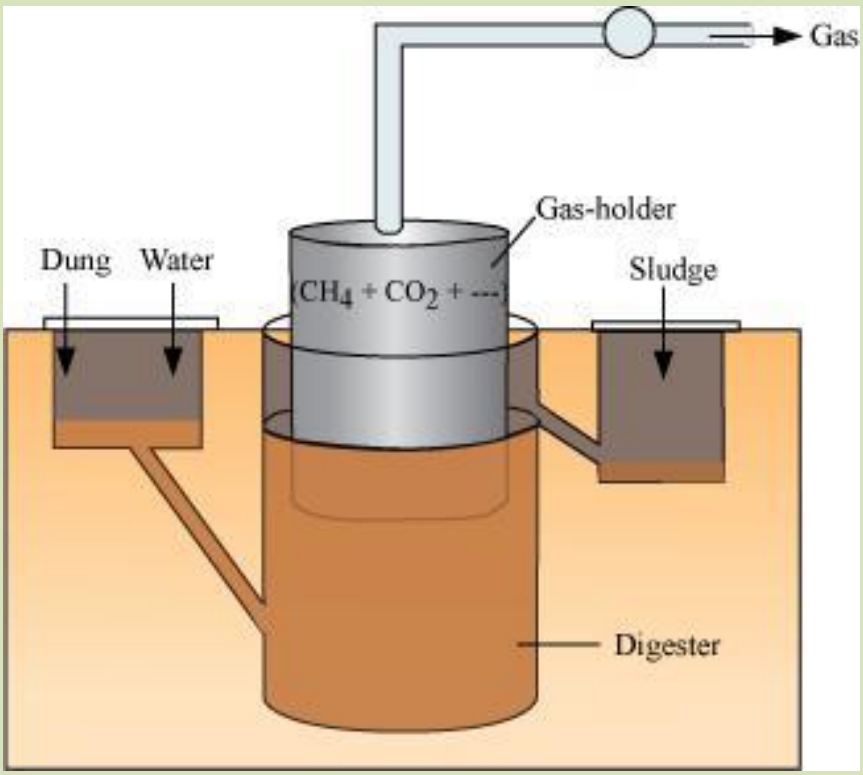
- Sewage basically consists of human excreta. It may contain many microbes, which may be pathogenic also.
    - Sewage disposal is a huge problem. It cannot be directly disposed into rivers and streams. Hence, it has to be treated first in sewage treatment plants (STPs).
- The heterotrophic microbes present in the sewage itself aid in its treatment.
- Treatment of sewage includes two stages – primary treatment and secondary treatment.
- **Primary Treatment** – Involves physical removal of particles by filtration and sedimentation
    - Initially, **sequential filtration** is used to remove floating debris.
    - Then, grit (soil + small pebbles) are removed by **sedimentation**. Solids that settle down form the sludge while the supernatant forms the effluent.
    - Effluent is taken for secondary treatment.
- **Secondary Treatment**
    - Effluent is passed to aeration tank → Constant agitation → Air pumped → Vigorous growth of bacteria → Floc formation → Consumption of organic matter by bacteria → Decrease in BOD
    - BOD is the amount of oxygen required by bacteria to oxidise all the organic matter present in the effluent.
    - Naturally, if organic matter decreases → BOD decreases → Pollution decreases
- **What is a floc?**
    - Floc = Bacteria + Fungal filaments (in a mesh-like structure)
    - When BOD and hence pollution is reduced, effluent is passed into a settling tank. Here, flocs settle down and it is known as **Activated Sludge**.
- In anaerobic sludge digesters, anaerobic bacteria act on the activated sludge to produce biogas (CH_4, CO_2, H_2S).



- The effluent from secondary treatment plant is released into water bodies.
- Microbial technology for sewage treatment is so effective that no
  - human technology has been able to beat it till date.

2. Microbes in Production of Biogas

- Microbes produce many gases during their metabolism.
- The type of gas produced depends upon the substrate they grow on and the type of microbe.
- Anaerobic bacteria usually produce methane along with CO_2 and H_2. Such bacteria are called methanogens. Example - *Methanobacterium*
- Methanogens are commonly found in anaerobic sludge (as in sewage treatment) and in the rumen of cattle. In the rumen of cattle, these bacteria help in cellulose digestion.
- Hence, excreta of cattle (*gobar*) are rich in methanogens. Biogas is also called *gobar gas*.
- **Biogas Plant** – Components of biogas plant:



- Concrete tank– Here, slurry of dung is fed. It is a 10 – 15 feet deep tank.
- Floating cover– Placed on slurry; rises as the gas is produced
- outlet – It is connected to the pipe.
- Pipe – It supplies the biogas to nearby houses.
- Outlet for spent slurry – Spent slurry can be used as a fertiliser.

- Biogas plant is usually set up in rural areas since cow dung is available in abundance there.
- Biogas is used for cooking and lighting.
- Biogas technology in India is due to the efforts of:
  - IARI (Indian Agricultural Research Institute)
  - KVCI (Khadi and Village Industries Commission)

Microbes: Bio control Agents and Biofertilizers

Microbes as Bio control Agents

- Chemical insecticides and pesticides are harmful as:
  - They kill the useful and harmful life forms indiscriminately.
  - They are toxic to human beings as well as in the long run.
  - If all insects of a particular species are killed, then the natural predator-prey relationship and food chains will get distorted.
- Hence, biological means to eradicate pests can be used. This requires knowledge of the life forms (predator + prey) that inhabit a particular area, their life cycle and patterns of feeding and preferred habitats.
- Example – Ladybirds and dragonflies are used to get rid of aphids and mosquitoes.
- Microbes can also act in the same manner. *Bacillus thuringiensis* (*Bt*) is used to control butterfly caterpillars.
- This bacterium is available in sachets as dried spores, which are sprayed on the crops. The spores get into the gut of the larvae and kill it while the other insects remain unperturbed.
- By methods of genetic engineering, the genes of *B. thuringiensis* responsible for killing the larvae have been incorporated into the plants.
- Cotton plant with *Bt* gene incorporated is called *Bt*-cotton.
- The fungus *Trichoderma* living in roots of plants acts as a bio control agent against several plant pathogens.

- Baculoviruses, particularly genus *Nucleopolyhedrovirus,*are also used as narrow spectrum insecticidal agents.
- Bio control agents are particularly useful when useful insects are required to
    - be conserved under IPM (integrated pest management programmes).

Microbes as bio-fertilizers

- Chemical fertilizers contribute to the pollution.
- Bio-fertilizers are organisms that enrich the nutrient quality of the soil.
- Many bacteria, fungi, and cyanobacteria act as biofertilizers.
- They act as bio-fertilizers by living in symbiotic association with root nodules of leguminous plants such as *Rhizobuim*.
- These bacteria fix atmospheric nitrogen and enrich the nitrogen content of soil.
- Fungi also form symbiotic associations with plants (Mycorrhiza) such as *Glomus*. They absorb phosphorus and pass it to plants.

- Cyanobacteria such as *Nostoc, Anabaena*, etc. also fix atmospheric nitrogen and act as bio-fertilizers especially in paddy fields.

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