Microbes in Human Welfare

Microbes: Microbes are the major components of biological systems on this earth.

- Microbes are present everywhere that is in soil, water, air, inside the body of plants and animals, inside thermal vents, deep in the soil, under the layers of snow several meters thick and in highly acidic environments.
- Microbes are diverse such that they are protozoa, bacteria, fungi and microscopic plants viruses, viroids and prions that are proteinacious infectious agents.
- Microbes like bacteria and many fungi can be grown on nutritive media to form colonies which can be seen with naked eyes.

Microbes in household products

➢ **Production of curd:** Milk is converted to curd by microorganisms such as Lactobacillus and others commonly called lactic acid bacteria (LAB) which grow in milk and convert it to curd.

- During growth of bacteria, the LAB produces acids that coagulate and partially digest the milk proteins.
- A small amount of curd is added to the fresh milk as inoculum or starter which at suitable temperatures multiply, thus converting milk to curd, which also improves its nutritional quality by increasing vitamin B12.
- In our stomach, the LAB plays a very beneficial role in checking disease causing microbes.

➢ **Fermentation:** The dough, which is used for making foods such as dosa and idli is also fermented by bacteria.

- The puffed–up appearance of dough is due to the production of CO_2
- The dough, which is used for making bread, is fermented using baker' s yeast (Saccharomyces cerevisiae).
- A number of traditional drinks and foods are also made by fermentation by the microbes.
- Toddy, a traditional drink of some parts of southern India is made by fermenting sap from palms.
- Microbes are also used to ferment fish, soya bean and bamboo shoots to make foods.

➢ **Production of cheese:** Different varieties of cheese are known by their characteristic texture, flavor and taste, the specificity coming from the microbes used.

- The large holes in ' Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named Propionibacterium sharmanii.
- The ' Roquefort cheese' are ripened by growing a specific fungi on them, which gives them a particular flavor.

Microbes in industrial products: Production on an industrial scale, requires growing microbes in very large vessels called fermenters.

- Beverages, antibiotics, enzymes are some of the industrial products produced by microbes.

➢ **Fermented beverages:** Microbes are used for the production of beverages like wine, beer, whiskey, brandy or rum.

• Saccharomyces cerevisiae, is used for the production of fermented beverages.

• Malted cereals and fruit juices are fermented by S.cerevisiae to produce ethanol.

• Wine and beer are produced without distillation.

• Whisky, brandy and rum are produced by distillation of the fermented broth.

➢ **Antibiotics:** Antibiotics are the chemical substances which are produced by some microbes and can kill or stop the growth of other microbes.

• Alexander Flemming discovered penicillin obtained from Penicillium notatum which was the first antibiotic to be discovered.

• Antibiotics are used against deadly diseases like plague, whooping cough, leprosy, malaria etc.

➢ **Chemicals, enzymes and other bioactive molecules:** Microbes are used for the production of organic acids, alcohols and enzymes.

Examples: Aspergillus niger (a fungus) produces citric acid, Acetobacter aceti (a bacterium) produces acetic acid, Clostridium butylicum (a bacterium) produces butyric acid and Lactobacillus (a bacterium).

• Yeast (Saccharomyces cerevisiae) is used for commercial production of ethanol.

• Lactobacillus (a bacterium) is the producer of lactic acid.

Enzymes produced by the microbes are–

a) Lipases– used in detergent formulations.

b) Pectinases and proteases– used in making bottled fruit juices clearer.

• Streptokinase produced by the bacterium Streptococcus is used as a ' clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.

Bioactive molecules produced by microbes are–

a) Cyclosporin A– used as an immunosuppressive agent in organ– transplant patients, is produced by the fungus Trichoderma polysporum.

b) Statins – produced by the yeast Monascus purpureus are used as blood– cholesterol lowering agents which act by competitively inhibiting the enzyme responsible for synthesis of cholesterol.

Microbes in sewage treatment: Municipal waste– water which contains large amounts of organic matter is called sewage. Sewage treatment is carried out in two stages.

1) Primary treatment: These treatment steps basically involve physical removal of large and small particles.

• Initially, floating debris is removed by sequential filtration and then the grit are removed by sedimentation.

• All solids that settle form the primary sludge, and the supernatant forms the effluent.

• The effluent from the primary settling tank is taken for secondary treatment.

2) Secondary or biological treatment: The primary effluent is passed into large aeration tanks where it is constantly agitated which allows vigorous growth of useful aerobic microbes into flocs.

- Flocs are the masses of bacteria associated with fungal filaments to form mesh like structures.
- While growing, the microbes significantly reduce the BOD (biochemical oxygen demand) which is the amount of oxygen required to oxidize total organic matter in the effluent.
- The BOD test measures the rate of uptake of oxygen by microorganisms, the greater the BOD of waste water, more is its polluting potential.
- The effluent is passed into a settling tank where the bacterial ' flocs' are allowed to sediment and the sediment is called activated sludge.
- A small part of the activated sludge is pumped back into the aeration tank to serve as the inoculum.
- The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters where other kinds of bacteria grow anaerobically which digest the bacteria and the fungi in the sludge.
- During digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide which form biogas .
- The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.

Microbes in the production of biogas: Biogas is a mixture of gases (containing predominantly methane) produced by the microbial activity.

- Certain bacteria grow anaerobically on cellulosic material and produce large amounts of methane along with CO_2 and H_2 which are collectively called as methanogens.
- One common methanogen is Methanobacterium
- These bacteria are commonly found in the anaerobic sludge during sewage treatment and in the rumen of cattle to digest cellulose in the food of the cattle , thus the excreta of cattle, commonly called gobar can be used for generation of biogas, commonly called gobar gas.

- **Biogas plant:** The biogas plant consists of a concrete tank (10–15 feet deep) in which bio–wastes are collected and a slurry of dung is fed.
- A floating cover is placed over the slurry, which keeps on rising as the gas is produced in the tank due to the microbial activity.
- The biogas plant has an outlet, which is connected to a pipe to supply biogas to nearby houses.
- The spent slurry is removed through another outlet and may be used as fertilizer.
- The biogas thus produced can be used for cooking and lighting.

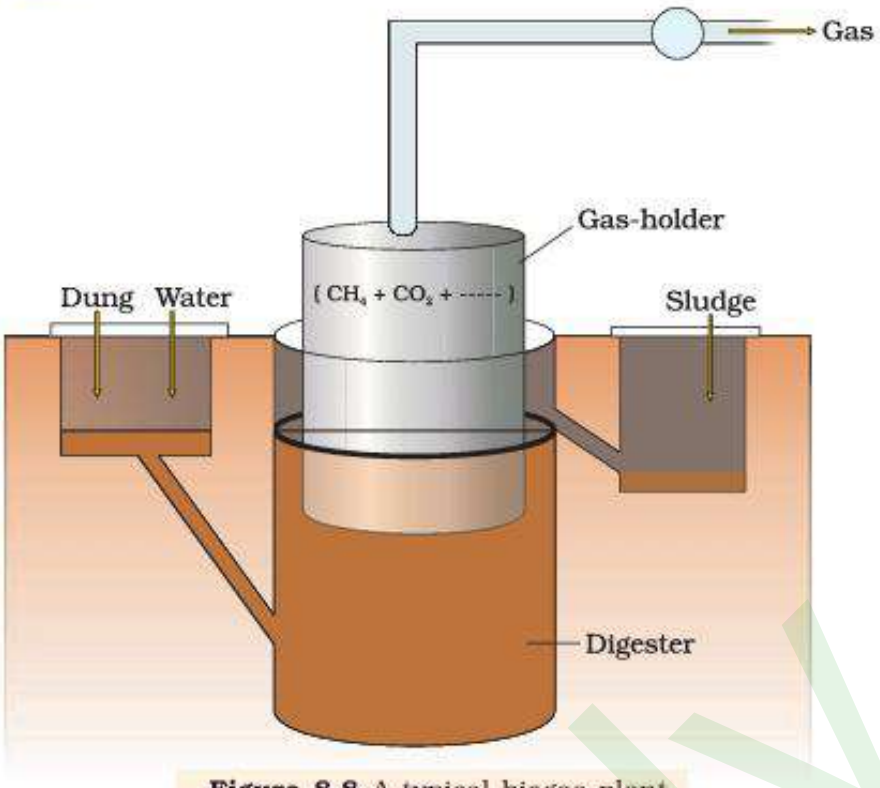

Figure 8.8 A typical biogas plant

Microbes as biocontrol agents: Biocontrol refers to the use of biological methods for controlling plant diseases and pests.

• Chemicals, insecticides and pesticides are extremely harmful to human beings and also these pollute our environment.

• The use of biocontrol measures will greatly reduce our dependence on toxic chemicals and pesticides.

• Biocontrol agents are which are useful in controlling plant diseases and pests are–

- The ladybird, a beetle with red and black markings and dragonflies are useful to get rid of aphids and mosquitoes respectively.
- Bacteria Bacillus thuringiensis (Bt) is used to get rid of butterfly caterpillars.
- Trichoderma species are free–living fungi found in the root ecosystem; these are effective as biocontrol agents of several plant pathogens.

- Baculoviruses are pathogens that attack insects and other arthropods and the majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus.

Microbes as biofertilizers: Biofertilizers are organisms that enrich the nutrient quality of the soil.

- The main sources of biofertilizers are bacteria, fungi and cyanobacteria.
- Some microbes used as biofertlizers are–
  - Rhizobium from root nodules in leguminous plants and fix atmospheric nitrogen into organic forms, which is used by the plant as a nutrient.
  - Free living bacteria like Azospirilium and Azotobacter fix atmospheric nitrogen, hence increasing nitrogen content of the soil.
  - Many members of the genus Glomus form Mycorrhiza, which is the symbiotic association of fungi with roots of the plants.
- The fungal symbiont in these associations absorbs phosphorus from soil and passes to the plants.
- Plants having symbiotic association show resistance to root-borne pathogens, tolerance to salinity and drought, and an overall increase in plant growth and development.
- Cyanobacteria are autotrophic microbes which can fix atmospheric nitrogen. Example – Anabaena, Nostoc, Oscillatoria
- Blue green algae also add organic matter to the soil and increase its fertility