CHAPTER 10
MICROBES IN HUMAN WELFARE

Microbes are the major components of the biological systems on the earth except macroscopic plant and animals. Microbes are present everywhere either in soil, water, air inside our bodies and that of other animals and plants. They are present event at sites where no life –form could possibly exist sites as deep inside the thermal vents where the temperature may be as high as 100^{o}C, deep in the soil, under the layers of snow several metres thick and in highly acidic environments,. Microbes are diverse (different forms). They are protozoa, bacteria, fungi, microscopic animals and plant viruses. Viroid's and prions are proteinaceous infections agents. Microbes like bacteria and many fungi can be grown on nutritive media to form colonies that can be seen with naked eyes. Such Cultures are useful in studies on micro-organisms.
Microbes cause a large number of diseases in human, animals and plants. But several microbes are useful to man in diverse ways.

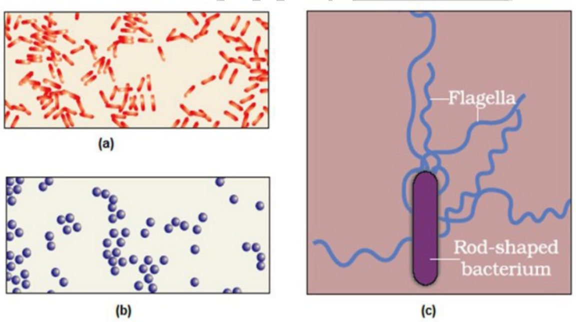

Fig: **Bacteria:** (a) Rod shaped (magnified 1500x); (b) Spherical shaped (magnified 1500x); (c) A rod shaped bacterium showing flagella (magnified 50000x)

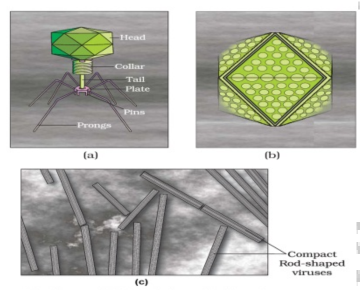

Fig: Viruses: (a) A bacteriophage; (b) Adenovirus (c) Rod- Shaped Tobacco Mosaic Virus (TMV).

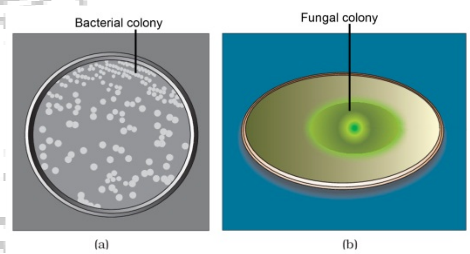

Fig: (a) Colonies of bacteria growing in a petri dish; (b) Fungal colony growing in a petri dish

MICROBES IN HOUSE HOLD PRODUCTS: - Every day we use microbes or its products. Lactobacillus and others commonly called lactic acid bacteria (LAB) grow in milk and convert it to curd. The curd also improves the nutritional quality of food by increasing vitamin B_{12}. In our stomach, the LAB play very important role in checking disease causing microbes.

The dough, which is used for making food items such as Dosa and Idli is also fermented by bacteria. The puffed –up appearance of dough is due to the production of carbon dioxide gas. The dough is used for making bread by the fermentation using baker's yeast (i.e. saccharomyces cerevisiae). Toddy is made by fermenting sap from palms. Microbes are also used to ferment fish, soyabean and bamboo shoots to make foods; cheese is one of the oldest food

items in which microbes were used. Different varieties of cheese are classified on basis of texture, flavour and taste.

Eg: 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 is ripened by growing specific fungi on them, which gives them a particulars flavour.

MICROBES IN INDUSTRIAL PRODUCTS: Microbes are used to synthesise a no. of products importance to human beings. Production on an industrial scale requires growing microbes in very large vessels called Fermentors.


Fig: Fermentors

Fermented Beverages: - Microbes especially yeasts have been used for the production of beverages like wine, whisky, beer, brandy or rum. For this purpose, the same yeast saccharomyces cerevisiae used for breed making. Saccharomyces is used for fermenting cereals and fruits juices to produce ethanol. Different types of alcoholic drinks are produced depending on the type of the raw materials used for fermentation and type of processing (with or without distillation). Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

Antibiotics: - Antibiotics are chemical substances which are produced by some microbes and that can kill or retard the growth of other disease causing microbes (pathogen). Penicillin was the first antibiotic produced by Alexander Fleming from penicillium notatum. Alexander Fleming while working on stalophylococci bacteria. Once observed a mould growing in one of his unwashed culture plates around which staphylococci could not


Fig: Fermentation plant

grow. He found that it was due to a chemical produced by the mould and he named it penicillin after the mould penicillium notatum. However, its full potential as an effective antibiotic was established much later by Earnest chain and Howar Florey. Alexander Fleming, Ernest chain and Howard Florey were awarded the Nobel Prize in 1945, for this discovery.

After penicillin, other antibiotics were purified from other microbes. Antibiotics are used to treat diseases like plague, diphtheria, whooping cough and leprosy.

CHEMICALS, ENZYMES, AND OTHER BIOACTIVE MOLECULES: Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes. Aspergillus Niger produced citric acid and Acetobacter aceti produced acetic acid. Clostridium butylicum produced butyric acid. Lactobacillus produced Lactic acid.

Microbes are also used for production of enzyme Lipases are used in detergent to remove oily strains from the laundry. Pectinases and proteases are used to clarify bottled juices. Streptokinase produced by the bacterium Streptococcus is used as a clot buster for removing clots from the blood vessels of patients with myocardial infarction. Another bioactive molecule, cyclosporin A is used as an immune suppressive agent in organ transplant patients, is produced by the fungus Trichoderma polysporum. Statin produced by the yeast Monascus purpureus is used as blood cholesterol lowering agents.

MICROBES IN SEWAGE TREATMENT: Sewage contains large amount of organic matter and microbes. Many of which are pathogenic. Sewage is treated in sewage treatment plant (STPs) to make it less polluting .Treatment of waste water is done by heterotrophic microbes naturally present in sewage. It is carried out in the following stages:

Fig: Secondary treatment

Fig: An aerial View of a Sewage plant

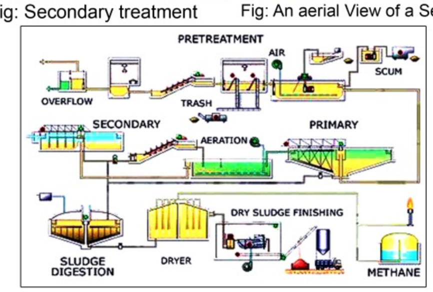

Fig: A sewage treatment plant

PRIMARY TREATMENT: It removes floating and suspended solids from the sewage through filtration and sedimentation. Initially floating debris is removed by sequential filtration. Then, the small grit (soil and small pebbles) are removed by sedimentation. All solids that settle form primary sludge and the supernatant forms the effluent. The effluent from the primary settling is taken for secondary treatment.

SECONDARY TREATMENT OR BIOLOGICAL TREATMENT: The primary effluent is passed into large aeration tanks and air is pumped into it. This allows the vigorous growth of useful aerobic microbes into flocs (masses of bacteria associated with fungal filaments to form mesh like structures). While growing, these microbes consume the major part of the organic matter in the effluent. This significally reduces the biological Oxygen demand (BOD) of the effluent. The sewage water is treated till the BOD is reduced.

Once BOD of sewage or waste water is reduced significally, the effluent is then passed into a settling tank where the bacterial flocs are allowed to sediment. This sediment is called activated sludge. A small part of the activated sludge is pumped back into the aeration tank to serve as inoculum. The remaining major part of the sludge is pumped into large tank called anaerobic sludge digesters. During this digestion, bacteria produce biogas. Biogas can be used as source of energy.

The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams. So, the untreated sewage is often

discharged directly into rivers or streams leading to their pollution and increase in water borne diseases.

The Ministry of Environment and Forests, Government of India, has initiated Ganga Action plan and Yamuna Action Plan to save these major rivers of our country from pollution. It proposed to build a large number of sewage treatment plants so that only treated sewage may be discharged into the rivers.

MICROBES IN PRODUCTION OF BIOGAS: - Biogas is a mixture of gases containing predominantly methane produced by the microbial activity and it may be used as fuel. Certain bacteria which grow an aerobically on cellulosic material produce large amount of methane along with CO_2 and H_2. These bacteria are called methanogens and one such common bacterium is Methanobacterium. Methanogens are commonly found in the anaerobic sludge during sewage treatment. In rumen, methanogenic bacteria help in the breakdown of cellulose and play an important role in the nutrition of cattle. The excreta (dung) of cattle, commonly called gobar, are rich in these bacteria. The excreta (dung) of cattle can be used for generation of biogas.

The Biogas is commercially produced inside the biogas plant. The biogas plant consists of a concrete tank (10-15 feet deep) in which bio- wastes are collected and slurry of dung is fed. A floating cover is placed over the slurry which keeps on rising as the gas produced in the tank due to microbial activity. The biogas plant has an outlet, which is connected to a pipe to supply biogas to nearby houses. The spent slowly is removed through another outlet and may be used as fertilizer. The biogas is used for cooking and lighting. The biogas plant is more often built in rural areas because cow dung is available in large quantities in rural areas where cattle are used for a variety of purpose. The technology of biogas

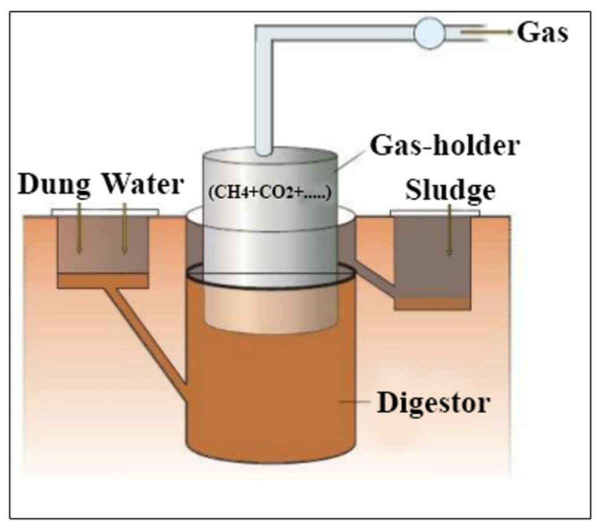

Fig: A typical biogas plant

production was developed in India mainly by India Agricultural Research Institute (IARI) and khadi and village Industries commission (KVIC).

Microbes as bio control Agents: Bio control refers to the use of biological methods for controlling plant diseases and pest. The use of bio control measures will greatly reduce our dependence on toxic chemicals and pesticides.

Lady bird (beetle with red and black marking) which feeds on aphids is used in agriculture for aphid control. The dragonflies prey upon mosquitoes. Free living fungal Trichoderma species found in the root system act as biocontrol agent over several plant pathogens.

Baculoviruses mostly of genus nucleopolyhedrovirus are useful in controlling many insects and other arthropods. They have no negative impacts on plants, mammals, birds, and fish or even on non-target insects.

In integrated pest management programme (IPM), use of different pest control methods are ecologically sound. Eg: Better agricultural practices like crop rotation, sanitation etc. An example of microbial control agent is the soil bacteria, Bacillus thuringiensis that can be control butterfly caterpillars. These are available in sachets as dried spores which are mixed with water and sprayed onto vulnerable plants such as brassicas and fruit trees where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released and the larvae get killed.

Bioherbicides are used for inhibiting the growth of unwanted plants. Weeds control can be done by the introduction of specific organisms like insects etc. which feed on the weeds. Eg: Cochineal insects feed upon opuntia and check its growth. In general, application of herbicide will kill only weeds and not the crop plants.

The biological agents are used to control harmful insects. They are predators, parasite and pathogens etc.

MICROBES AS BIOFERTILISERS: Biofertilisers are organisms which enrich the nutrient quality of the soil by enhancing the availability of nutrients like nitrogen, phosphorous to crops. The main sources of biofertilisers are bacteria, fungi and cyanobacteria. The nodules on the roots of leguminous plants are

formed by the symbiotic association of Rhizobium Species. Rhizobium can fix atmospheric nitrogen into organic forms which is used by plant as nutrient. Free living N_2 fixing bacteria live freely in the soil and perform atmospheric nitrogen fixation. Eg: Azospirillum and Azotobacter.

Fungi are also known to form symbiotic associations with the roots of higher plants (mycorrhiza). Many members of the genus Glomus form mycorrhiza. The fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Plants having such associations show other benefits such as resistance to root borne pathogens, tolerance to salinity and drought, and overall increase in plant growth and development.

Cyanobacteria are autotrophic microbes widely found in aquatic and terrestrial environments many of which can fix atmospheric nitrogen. Eg: Anabaena, Nostoc, Azolla and Oscillatoria etc. In paddy fields, cyanobacteria (blue green algae) serve as an important biofertilisers. Blue green algae also add organic matter to the soil and increase its fertility.

Biofertilisers are eco-friendly. It can replenish soil nutrients and to reduce dependence on chemical fertilizers.