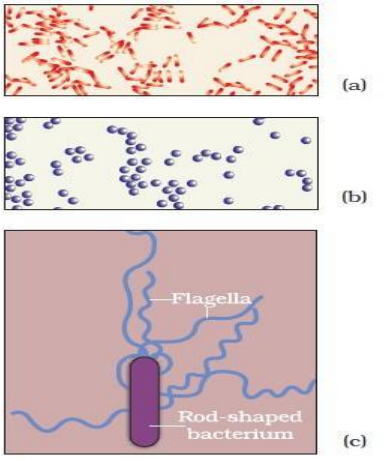
CHAPTER 10

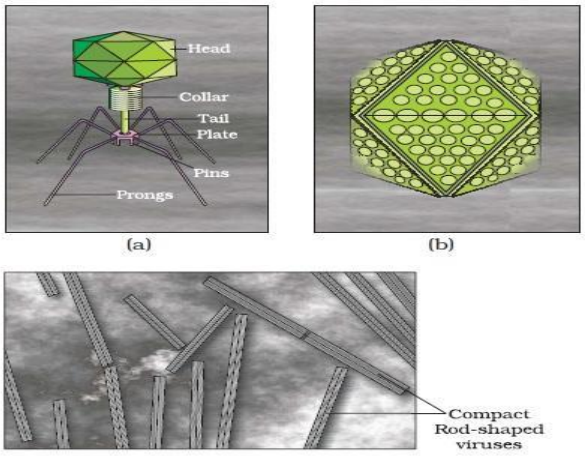
MICROBES IN HUMAN WELFARE

INTRODUCTION **Microorganisms** are those which are microscopic, i.e, can be seen only under a microscope. Microbes are diverse-protozoa, bacteria, fungi and microscopic plants viruses, viroid and also prions that are proteinaceous infectious agents. They are found everywhere on earth ranging from soil, air water and some inhabitable places.

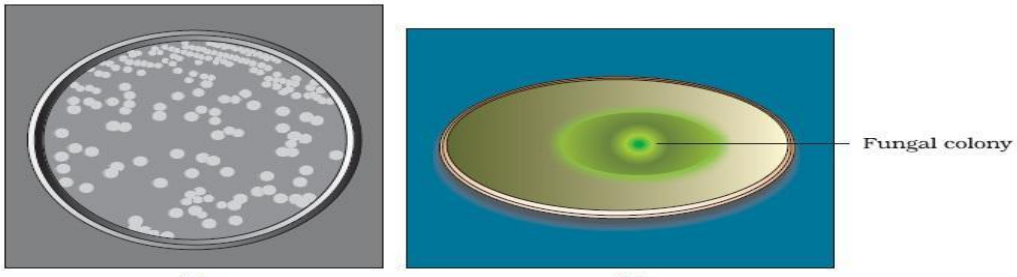
Bacteria and fungi can be grown on nutritive media to form colonies, which can be seen by necked eyes and very useful in study of microorganisms.Microbes cause many diseases in human beings, plants and animals. Several microorganisms are useful to man in diverse ways



. Bacteria: (a) Rod-shaped, magnified 1500X; (b) Spherical shaped, magnified1500X; (c) A rod-shaped bacterium showing flagella, magnified 50,000X



Viruses: (a) A bacteriophage; (b) Adenovirus which causes respiratory infections; (c) Rod-shaped Tobacco Mosaic Virus (TMV). Magnified about 1,00,000–1,50,000X



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

MICROBES IN HOUSEHOLD PRODUCTS

a. CURD:

Microorganisms like *Lactobacillus* and other commonly called lactic acid bacteria (LAB) grow in milk and convert it to curd. The LAB produces acids that coagulate and partially digest the milk proteins.

It also improves its nutritional quality by increasing vitamin B12.

In our stomach too, the LAB play very beneficial role in checking disease-causing microbes.

b. DOUGH:

The dough is used for making foods such as dosa and idli is fermented by bacteria. The puffed-up appearance of dough is due to the production of CO2 gas. The dough used for making bread is fermented using baker's yeast (*Saccharomyces cervisiae*).

c. CHEESE:

Cheese, is one of the oldest food items in which microbes were used. The large holes in 'Swiss cheese' are due to production of a large amount of CO2 by a bacterium named *Propionibacterium sharmanii*. The 'Roquefort cheese' is ripened by growing a specific fungus on them for a particular flavour.

d. TODDY:

It is traditional drink of Southern India. It is made by fermentation of sap from palm trees by bacteria.

MICROBES IN INDUSTRIAL PRODUCTION

A number of products like beverages and antibiotics involve uses of microbes. Production on large scale requires growing microbes in very large vessels called fermentors.

a. FERMENTED BEVERAGES:

Saccharomyces cerevisiae used for bread-making and commonly called brewer's yeast, is used for fermenting malted cereals and fruit juices, to produce beverages like wine, bear, whisky and

rum.. Wine and bear are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

Fermentors

Fermentation Plant

b. ANTIBIOTICS: **Anti** is a Greek word that means 'against' and bio means 'life', together they mean 'against life'. They are chemical substances produced by some microbes and can kill or

retard the growth of other microbes. **Penicillin** was first antibiotic to be discovered. Alexander Fleming while working on *Staphylococci* bacteria, once observed mould growing in one of his unwashed culture plates around which *Staphylococci* could not grow. He found out that it was due to a chemical produced by the mould and he named it Penicillin after the mould *Penicillium notatum*. Further its full potential was established by Ernest Chain and Howard Florey. The antibiotic was extensively used to treat American soldiers wounded in World War II. Fleming, Chain and Florey were awarded the noble prize in 1945, for this discovery.

Antibiotics have great improved our capacity to treat deadly diseases such as plague, whooping cough (kali khansi), diphtheria (gal ghotu) and leprosy (kusht rog).

c. CHEMICAL, ORGANIC ACIDS:

Enzymes and other Bioactive Molecules are commercially produced by microbes.

Chemicals :

Aspergillus niger (fungus) – Citric acid

Acetobacter aceti (bacterium) – Acetic acid

Clostridium butylicum (bacterium) – Butyric acid

Lactobacillus (bacterium) – Lactic acid

Saccharomyces cerevisiae – Ethanol

Enzymes:

Lipase –	used in laundry detergents. -helps in removing oily stains from laundry.
Pectinase and protease –	used in bottled juices
Streptokinase (Streptococcus bacterium) –	used as clot buster (to remove clots)

Bioactive molecules:

Cyclosporin A (*Trichoderma polysporum* fungi) – used as immunosuppressive agent (for organ transplant patients).

Statins (*Monascus purpureus* yeast) – used as blood cholesterol lowering agents.

MICROBES IN SEWAGE TREATMENT

A major component of waste water is human excreta. Municipal waste water (sewage) contains large amount of organic matter and microbes which are pathogenic and cannot be discharged into natural water bodies like rivers and streams.

Sewage is treated in sewage treatment plant (STP) to make it less polluting by using heterotrophic microbes naturally present in sewage. Sewage treatment is done in two stages-

Primary treatment:

This step involves physical removal of particles from sewage through filtration and sedimentation. Floating debris is removed by sequential filtration. Grit is removed by sedimentation. All solids that settle form the **primary sludge**. The supernatant forms the **effluent.** The effluent is sent for secondary treatment.

Secondary treatment or biological treatment:

It involves passing of primary effluents in large aeration tank to help the growth of aerobic microbes into **flocs** (masses of bacteria associated with fungal filaments to form mesh like structures). These microbes increase the consumption of organic wastes and decrease the BOD (biological oxygen demand)of the effluents.

SECONDARY TREATMENT

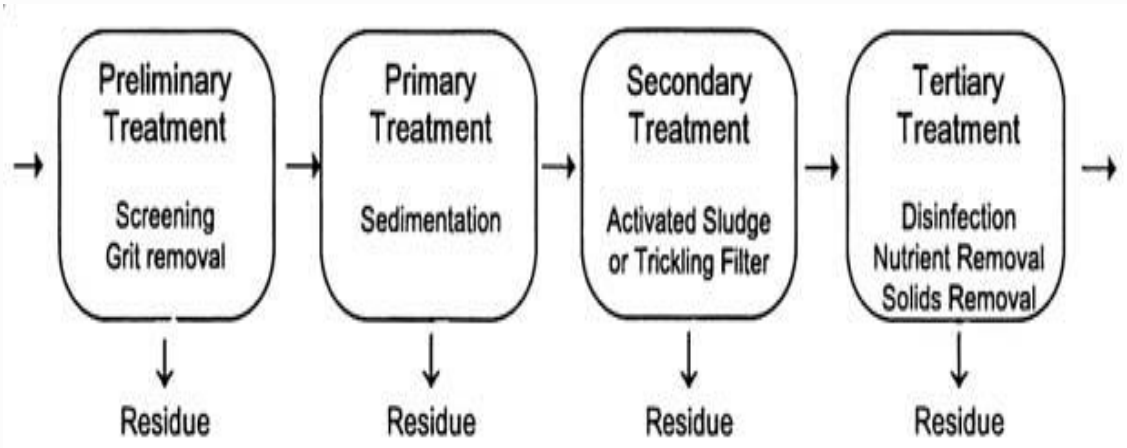
BOD is the amount of oxygen that would be consumed if all the organic matter in one litre of water were oxidised by bacteria. It measures the amount of organic matter present in the water. Greater the BOD of water more it is polluted.

Once the BOD of sewage or waste water is reduced, 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 aeration tank to serve as inoculums. Sludge is passed into large tanks called **anaerobic sludge digesters** in which anaerobic bacteria digest the bacteria and fungi in the sludge and produce mixture of gas called biogas, which is a mixture of methane, hydrogen sulphide and carbon dioxide.

The effluents from the secondary treatment plant are released into water bodies.

An aerial view of sewage plant



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

MICROBES IN PRODUCTION OF BIOGAS

Biogas is a mixture of gases produced by the microbial activity that can be used as fuel.

Different types of gaseous end products are produced by microbes during their growth and metabolism. Some microbes produce carbon dioxide, while some others produce methane (along with carbon dioxide and hydrogen). Bacteria which produce methane are called methanogens. These bacteria grow anaerobically on cellulosic material, e.g. methanobacterium.

.The type of gas produced depends upon the microbes and the organic substrates they utilize.

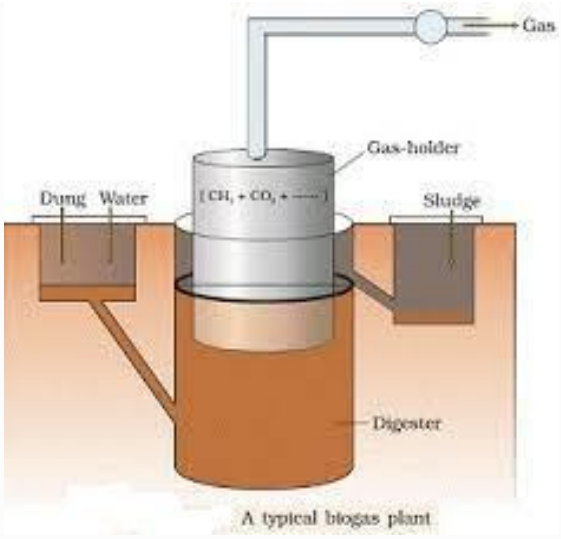
Biogas Plant:

The excreta of cattle (gobar) are rich in methanogens bacteria and is used for generation of biogas also called as gobar gas.

It consists of a concrete tank about 10 to 15 feet deep. Bio-wastes and slurry of dung is fed in this tank. A floating cover is placed over the slurry. A floating cover is placed over digester that moves upward when gas is produced. The gas produced is removed and supplied through an outlet pipe for consumption.

The cover keeps on rising with incremental production of gas. An outlet takes the biogas to the house where the gas can be utilized for various energy needs. The spent slurry is removed through another outlet and can be used as fertilizer.

Cattle dung is available in large quantities in rural areas where cattle are used for a variety of purposes. So these plants are more often in rural areas. The biogas thus produced is used for cooking and lighting. The technology of biogas production was developed in India by Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC).



A typical biogas plant

MICROBES AS BIOCONTROL AGENT

Biocontrol means use of biochemical method for controlling plant disease and pests. The chemical used as pesticides and insecticides are harmful to human beings and animals. These chemicals are toxic and extremely harmful, to human beings and animals alike, and have been polluting our environment (soil, ground water), fruits, vegetables and crop plants. Our soil is also polluted through our use of weedicides to remove weeds.

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

Biological control of pests and disease is a method of controlling pest on natural prediction rather than chemicals. The organic farmer creates a system where the pests are not eradicated but kept at manageable level by complex system of check and balance within the living and vibrant ecosystem.

For example, the **Ladybird** and Dragonflies are used to get rid of **aphids** and **mosquitoes** respectively.

On **brassicas** and **fruit** tree, to control butterfly caterpillars bacteria *Bacillus thuringiensis* is used. These are available in sachets as dried spores which are mixed with water and sprayed onto vulnerable plants, where they are eaten by insects larvae. In the gut of the larvae, the toxin is released and the larvae get killed. The bacterial disease will kill the caterpillar, but leave other insects unharmed.

Biological control developed for use in the treatment of plant disease is the fungus *Trichoderma*. Trichoderma are free-living fungi that are very common in the root systems that control several plant pathogens.

Baculoviruses are pathogens that attack insects and other arthropods. The majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus. These viruses are excellent candidates for species-specific, narrow spectrum insecticidal applications. They have been shown to have negative impacts on plants, mammals, birds, fish or even on non

target insects. This is especially desirable when beneficial insects are being conserved to aid in an overall integrated pest management (**IPM**), or when ecologically sensitive area is being treated.

MICROBES AS BIO FERTILISERS

The way to overcome the problems associated with use of chemical fertilizers has put large pressure on organic farming. Bio fertilisers are organisms that enrich the nutrient quality of the soil. The main source includes bacteria, fungi and cyanobacteria.

The root nodule formed by Rhizobium bacteria on root of leguminous plants increase the nitrogen level of soil, necessary for various metabolic processes. Azotobacter and Azospirillum are free living bacteria that live in soil and fix atmospheric nitrogen into organic forms.

Symbiotic associations of fungi with angiosperm plants (mycorrhiza) also increase the fertility of soil. **Glomus** form mycorrhiza that absorbs phosphorus from the soil and passes it to the plant. These microbes also provide benefits like resistance to root-borne pathogens, tolerance to salinity and drought.

Cyanobacteria (Nostoc, Anabaena), an autotrophic microbes found in aquatic and terrestrial environment fix atmospheric nitrogen. In paddy field this acts as important bio-fertiliser. **Blue green algae** also add organic matter to the soil and increase its fertility.

IMPORTANT TERMS-chp-10-MICROBES IN HUMAN WELFARE

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FERMENTERS: Production on large scale requires growing microbes in very large vessels called fermentors.

ANTIBIOTICS: **Anti** is a Greek word that means 'against' and bio means 'life', together they mean 'against life'. They are chemical substances produced by some microbes and can kill or retard the growth of other microbes.

BOD : is the amount of oxygen that would be consumed if all the organic matter in one litre of water were oxidised by bacteria. It measures the amount of organic matter present in the water. Greater the BOD of water more it is polluted.

BIOGAS: Biogas is a mixture of gases produced by the microbial activity that can be used as fuel.

YAP: **Yamuna action plan.**

EFFLUENTS: **The product of primary treatment.**

KVIC: **Khadi and village industries commission.**

LAB: Lactic acid bacteria.

FLOCS: Mass of mesh like structure formed by bacteria and fungi.

METHANOGENS: Bacteria producing methane.

STPs: Sewage treatment plans.

IARI: Indian agricultural research institute.

IPM: Integrated pest management.