



# MICROBES IN HUMAN WELFARE

## INTRODUCTION

1

Microbes are the major components of biological systems on this earth. They are present everywhere—in soil, water, air, inside our bodies and that of other animals and plants.

2

They are present even at sites where no other life-form could possibly exist—like deep inside the geysers (thermal vents) where the temperature is 100° C, deep in the soil, under the layers of snow several metres thick and in highly acidic environments.

3

Microbes are diverse—protozoa, bacteria, fungi and microscopic animal & plant viruses, viroids and also prions.

4

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.

5

Microbes can be harmful and disease causing but many are useful to man in diverse ways.

## MICROBES IN HOUSEHOLD PRODUCTS

*Lactobacillus* & others (LAB) grow in milk & convert it to curd. LAB produce acids that coagulate & partially digest milk proteins, at suitable temperatures. It also improves its nutritional quality by increasing vit- B<sub>12</sub>. In our stomach too, LAB play beneficial role in checking pathogenic microbes.

Toddy is fermented sap from palms.

The dough used for dosa and idli is fermented by bacteria.

Microbes are used to ferment fish, soyabean & bamboo shoots to make foods.

Dough which is used for making bread, is fermented using baker's yeast (*Saccharomyces cerevisiae*).

The characteristic texture, flavour, taste and specificity of cheese is due to the microbes:  
a. **Swiss cheese** : Large holes are due to large amount of CO<sub>2</sub> produced by the bacterium. *Propionibacterium sharmanii*.  
b. **Roquefort cheese** : Ripened by a specific fungi, which gives the specific flavour.

## MICROBES IN INDUSTRIAL PRODUCTS

Requires growing microbes in fermentors

### Fermented Beverages

*Saccharomyces cerevisiae*, is used for beverages production and called brewer's yeast. It is also used for fermenting malted cereals & fruit juices to produce ethanol.

Wine & beer are produced without distillation, whereas whisky, brandy & rum are produced by distillation of fermented broth.

### Antibiotics (Anti = against, bio = life)

Penicillin—first antibiotic was a chance discovery by Alexander Fleming, while working on *Staphylococci* bacteria. When he observed that they didn't grow due to the growth of a mould *Penicillium notatum*. Its full potential was discovered by Chain & Florey. Fleming, Chain & Florey were awarded Nobel prize in 1945.





*Aspergillus niger* (a fungus) - Citric acid

*Saccharomyces cerevisiae* - Ethanol

*Acetobacter aceti* (a bacterium) - Acetic acid

## Chemicals, Enzymes & other Bioactive Molecules

Lipases - Used in detergent formulations.

*Clostridium butylicum* (a bacterium) - Butyric acid

Streptokinase produced by bacterium *Streptococcus* & modified by genetic engineering used as a 'clot buster' for removing clots from blood vessels in myocardial infarction patients.

*Lactobacillus* (a bacterium) - Lactic acid

Cyclosporin-A, used as immunosuppressive agent in organ-transplant patients, is produced from *Trichoderma polysporum* (a fungus).

Statins produced by yeast *Monascus purpureus* is a blood-cholesterol lowering agent.

## MICROBES IN SEWAGE TREATMENT

- 1 The municipal waste water is called sewage. A major component of this waste water is human excreta. It contains large amounts of organic matter & microbes.
- 2 Before disposal into natural water bodies like rivers and streams, it is treated in sewage treatment plants (STPs) to make it less polluting.
- 3 Treatment of waste water is done by the heterotrophic microbes naturally present in the sewage.

### Treatment is carried in two stages

#### Primary Treatment (Physical treatment)

- Involves physical removal of particles large & small from the sewage through filtration and sedimentation
- Floating debris is removed by sequential filtration
- Grit (soil & small pebbles) removed by sedimentation
- Solids that settle form the primary sludge & the supernatant forms the effluent.
- The effluent is taken for secondary treatment.

In anaerobic sludge digester anaerobic bacteria digest bacteria & fungi in the sludge. Produce a mixture of  $\text{CH}_4$ ,  $\text{H}_2\text{S}$ ,  $\text{CO}_2$  (Biogas)

A small part of the activated sludge is pumped back into aeration tank to serve as inoculum. Rest is pumped into anaerobic sludge digesters

Effluent passed into settling tank, where bacterial 'flocs' sediment, called activated sludge and then effluent from secondary treatment plant can be released into natural water bodies.

#### Secondary Treatment (Biological treatment)

Primary effluent is passed into large aeration tanks

Constantly agitated and air is pumped into it

Allows vigorous growth of useful aerobic microbes into flocs. (Bacteria + fungal filaments to form mesh like structures)

Microbes grow & consume the major part of organic matter, significantly reducing the BOD.

## MICROBES IN PRODUCTION OF BIOGAS

Biogas is a mixture of gases (predominantly methane) produced by microbial activity.

Methanogens, like *Methanobacterium*, grow anaerobically on cellulosic material to produce large amount of  $\text{CH}_4$  along with  $\text{CO}_2$  and  $\text{H}_2$ .

These bacteria are commonly found in anaerobic sludge during sewage treatment, rumen of cattle.

In rumen, these bacteria help in the breakdown of cellulose & play an important role in nutrition of cattle. The excreta of cattle (dung), commonly called Gobar is rich in these bacteria.

Dung can be used for generation of biogas, so commonly called Gobar gas.





## BIOGAS PLANT

01

Consist of a concrete tank (10-15 feet deep) in which biowastes are collected and a slurry of dung is fed.

02

A floating cover is placed over the slurry, which rises when gas is produced due to microbial activity.

03

It has outlet to transfer biogas.

04

Slurry is removed and may be used as fertiliser.

05

Biogas can be used for cooking and lighting.

06

The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) & Khadi & Village Industries Commission (KVIC).



## MICROBES AS BIOFERTILISERS

Organic farming uses biofertilizers.

Biofertilizers are organisms that enrich the nutrient quality of the soil.

Main sources of biofertilizer are bacteria, fungi & cyanobacteria.

Root nodules in leguminous plants is formed by symbiotic association of Rhizobium to fix atmospheric nitrogen into organic forms.

Free-living  $N_2$ -fixers like *Azospirillum* and *Azotobacter* enrich the soil.

Fungi-plant root, symbiotic association is called mycorrhiza. *Glomus* form mycorrhiza. Fungi- absorb phosphorus from soil & passes to the plant. Plants also show resistance to root-borne pathogens, tolerance to salinity and drought and overall increase in growth and development.

Cyanobacteria like *Anabaena*, *Nostoc*, *Oscillatoria* etc. fix atmospheric  $N_2$  in paddy fields.

BGA (blue green algae) also add organic matter to the soil and increase its fertility.

- The puffed-up appearance of dough is due to  $CO_2$  gas.
- Toddy is a traditional drink of some parts of Southern India.
- Antibiotics mean against life, in the context of disease causing organisms.
- Bottled juices are clarified by use of pectinases and proteases.
- Statins act by competitively inhibiting the enzyme responsible for synthesis of cholesterol.
- BOD (Biochemical Oxygen Demand) is the amount of oxygen consumed if all the organic matter in one liter of water were oxidised by bacteria.
- BOD test measures the rate of uptake of oxygen by microorganisms in a sample of water. BOD is a measure of the organic matter present in the water.
- In our country, a number of biofertilisers are available commercially in the market and farmers use these regularly to replenish soil nutrients and reduce dependence on chemical fertilizers.
- Microbes are a very important component of life on earth. Not all microbes are pathogenic and many are very useful.
- Microbes play a major role in treating millions of gallons of waste water everyday across the globe. Till date, no manmade technology has been able to rival the microbial treatment of sewage.
- The ministry of Environment and Forests has initiated Ganga Action Plan & Yamuna Action Plan to save these major rivers of our country from pollution.
- The biocontrol measures help us to avoid heavy usage of toxic pesticides for controlling pests.
- It is clear from the diverse usage that microbes are essential for our survival.