MICROBES IN HUMAN WELFARE

Several microbes such as bacteria, viruses, fungi etc. are useful to man in many ways. Some of them are given below:

1. MICROBES IN HOUSEHOLD PRODUCTS

- **Lactobacillus or Lactic acid bacteria (LAB):**
  - It converts milk to curd by producing acids that coagulate and partially digest the milk proteins.
  - Fresh milk can be converted to curd by adding some curd containing LAB. It also increases vitamin B_{12} in curd.
  - In stomach, LAB helps to check pathogens.
- **Bacterial fermentation (anaerobic respiration)** in dough is used to make foods such as *dosa, idli* etc. The puffed-up appearance of dough is due to the production of CO_2.
- **Baker's Yeast (*Saccharomyces cerevisiae*):** It is used to make bread by fermenting dough.
- **Toddy** is made by fermenting sap from palms.
- Microbes are used to ferment fish, soya bean & bamboo-shoots and to produce cheeses.
- **Swiss cheese** has large holes due to production of CO_2 by ***Propionibacterium sharmanii*** (a bacterium).
  Roquefort cheese is ripened by growing a fungus (*Penicillium roqueforti*) on them.

2. MICROBES IN INDUSTRIAL PRODUCTS

Production of beverages, antibiotics etc. on an industrial scale, requires growing microbes in very large vessels **(fermentors).**

Fermented beverages

- ***Saccharomyces cerevisiae (Brewer's yeast)*** is used in the production of beverages by fermenting malted cereals and fruit juices to produce ethanol.
- Wine & Beer are produced without distillation.
- Whisky, Brandy, Rum, Gin, Arrack etc. are produced by distillation of fermented broth.

Antibiotics

- Chemical substances produced by some microbes and can kill or retard the growth of pathogens.
- They are used to treat plague, whooping cough, diphtheria, leprosy etc.
- **Penicillin:** First antibiotic discovered by **Alexander Fleming**. He observed that *Staphylococci* could not grow around a mould (*Penicillium notatum*) growing in unwashed culture plates. He extracted penicillin from it.
- **Earnest Chain** and **Howard Florey** established its full potential as an effective antibiotic.
- Fleming, Chain & Florey were awarded Nobel Prize (1945).

Chemicals, enzymes & other bioactive molecules

1. **Organic acids:** Acid producer microbes include

Aspergillus niger (a fungus)	:	Citric acid
Acetobacter aceti (a bacterium)	:	Acetic acid
Clostridium butylicum (a bacterium)	:	Butyric acid
Lactobacillus (a bacterium)	:	Lactic acid

2. **Alcohol:** Yeast (*S. cerevisiae*) is used to produce ethanol.
3. **Enzymes:**
   - **Lipases:** Used in detergent formulations. Help to remove oily stains from the laundry.
   - **Pectinases & Proteases:** To clarify bottled juices.
   - **Streptokinase:** Produced by ***Streptococcus.*** Used as a **'clot buster'** to remove clots from the blood vessels of patients who have **myocardial infarction.**
4. **Cyclosporine A:** Produced by ***Trichoderma polysporum*** (fungus). Used as an **immunosuppressive agent** in organ transplant patients.
5. **Statins:** Produced by ***Monascus purpureus*** (a yeast). Used as **blood-cholesterol lowering agents**. It inhibits the enzymes responsible for synthesis of cholesterol.

3. MICROBES IN SEWAGE TREATMENT

Sewage (municipal waste-water) contains large amount of organic matter and microbes.
Sewage is treated in **Sewage Treatment Plants (STPs)** to make it less polluting. It includes 2 stages.

1. Primary treatment

It is the physical removal of particles. It includes
a. Removal of floating debris by sequential **filtration.**
b. Removal of the grit (soil & pebbles) by **sedimentation.**
The settled solids form the **primary sludge** and the supernatant form the **primary effluent.**

2. Secondary treatment (Biological treatment)

Primary effluent is passed into large aeration tanks and constantly agitated. This allows vigorous growth of useful aerobic microbes into **flocs** (bacteria associated with fungal filaments to form mesh-like structures). These microbes consume the organic matter in the effluent. This reduces the **BOD (Biochemical Oxygen Demand)** of the effluent.

> **BOD:** Amount of O_2 consumed by bacteria to oxidize all organic matter in one litre of water. It is a measure of organic matter present in the water. The greater the BOD more is its polluting potential.

The effluent is then passed into a **settling tank** where the bacterial **'flocs'** are sediment. This 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 sludge is pumped into large tanks called **anaerobic sludge digesters.** Here, some anaerobic bacteria digest the bacteria and fungi in the sludge by producing gases like CH_4, H_2S and CO_2. These gases form the biogas.
The effluent is released into natural water bodies like rivers and streams.
The Ministry of Environment & Forests initiated **Ganga Action Plan & Yamuna Action Plan** to save from water pollution.

4. MICROBES IN THE PRODUCTION OF BIOGAS

- **Biogas** is a mixture of gases (mainly CH_4) produced by the microbial activity. It is used for cooking & lighting.
- **Methanogens** grow anaerobically on cellulosic material and produce CH_4. **E.g. *Methanobacterium.***
- ***Methanobacterium*** is found in the **anaerobic sludge** and **rumen of cattle** (for cellulose digestion).
- The cattle dung **(gobar)** is rich in these bacteria. Dung can be used for generation of biogas **(Gobar gas).**
- **The Biogas plant** consists of
  - A **concrete tank** (10-15 feet deep) to collect bio-wastes and slurry of dung. A floating cover is placed over the slurry, which keeps on rising as the biogas is produced.
  - An outlet which is connected to a pipe to supply biogas.
  - An outlet to remove spent slurry (used as fertilizer).

Indian Agricultural Research Institute (IARI) and **Khadi and Village Industries Commission (KVIC):** Developed technology of biogas production in India.

5. MICROBES AS BIOCONTROL AGENTS

- **Biocontrol** is the use of biological methods for controlling plant diseases and pests. E.g. **Lady bird (beetle)** controls aphids. **Dragon flies** control mosquitoes.
- **Chemical pesticides** and **insecticides** kill both useful and harmful organisms and cause pollution. Biocontrol method has no such problems.

Microbial biocontrol agents

- ***Bacillus thuringiensis (Bt):*** To control butterfly caterpillar. The dried spores of Bt (available in sachets) are mixed with water and sprayed on to vulnerable plants such as brassicas and fruit trees. These are eaten by the caterpillar. In their gut, the toxin is released and the larvae get killed.
  The scientists have introduced *B. thuringiensis* toxin genes into plants. E.g. Bt cotton.
- ***Trichoderma sp*** (fungus): These are free livings present in the root ecosystems. They control several plant pathogens.
- ***Baculoviruses*** (Especially genus ***Nucleopolyhedro-virus):*** Attacks insects and other arthropods.
  It is suitable for *species-specific*, narrow spectrum insecticidal applications and desirable in **IPM** (Integrated Pest Management) program to conserve beneficial insects.

6. MICROBES AS BIOFERTILISERS

- **Biofertilisers** are organisms that enrich nutrient quality of the soil. E.g. Bacteria, fungi, cyanobacteria etc.
- **Rhizobium** (symbiotic bacteria in root nodules of **leguminous plants)** fix atmospheric N_2.
- Free-living bacteria in the soil (E.g. *Azospirillum* and *Azotobacter)* enrich the nitrogen content of the soil.
- **Mycorrhiza:** Symbiotic association of fungi (E.g. genus of *Glomus*) with plants. The fungus gets food from plant.
  The fungal symbiont performs the following:
  - Absorb phosphorous from soil and passes it to the plant.
  - Give resistance to root-borne pathogens and tolerance to salinity and draught.
  - Give overall increase in plant growth and development.
- **Cyanobacteria (Blue green algae):** Autotrophic microbes. They fix atmospheric nitrogen. E.g. *Anabaena, Nostoc, Oscillatoria etc*. In paddy fields, Cyanobacteria serve as an important biofertilisers. It also adds organic matter to the soil and increases its fertility.