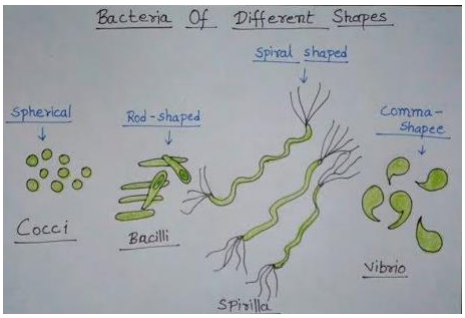
Microbes in Human Welfare

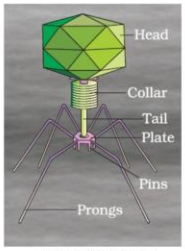
- Microbes are diverse-protozoa, bacteria, fungi and microscopic plants viruses, viroid (free double stranded RNA) and also prions proteinaceous infectious agents (causing Mad cow disease and Jacobs Disease).
- They are found everywhere soil, air, water, thermal vents (geyser), deep under snow, acidic environment etc.
- Bacteria and fungi can be grown on nutritive media to form colonies, which can be seen by naked eyes.
- Pathogen: Disease causing microbes.



Microbes in Household Products

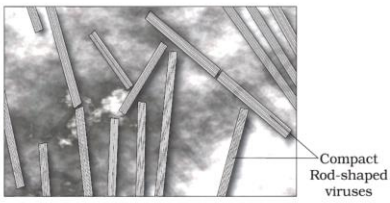
a. Lactobacillus/Lactic acid bacteria (LAB)

- Convert milk into curd by producing acid that coagulate and partially digest the milk proteins.
- *Inoculum*- small amount of curd added to milk as a starter (at suitable temp.) converts milk into curd.
- Improves nutritional quality by increasing vitamin B12.
- Checks disease-causing microbes in our stomach.



A bacteriophage


Adenovirus which causes respiratory infections



Rod-shaped Tobacco Mosaic Virus (TMV). Magnified about 1,00,000–1,50,000X

b. Yeast-*Saccharomyces cerevisiae*

Baker's yeast - Gives puffed-up appearance to dough (for dosa, idli, dosa etc) due to the production of CO_2 gas by fermentation.

c. Toddy – A traditional drink of some parts of southern India is made by fermenting sap from palms.

Microbes are use to ferment fish soya bean & bamboo-shoots and to produce cheese.

d) **Cheese**, is one of the oldest food items in which microbes were used.

Swiss cheese- Cheese with large holes produced due to production of a large amount of CO_2 by a bacterium named *Propionibacterium sharmanii*.

Roquefort cheese -ripened by growing a specific fungus on them for a particular flavour.

Microbes in Industrial Production

Fermentors: Very large vessels use to produce products like beverages and antibiotics etc with the help of microbes on large scale .

a. Fermented Beverages- *Saccharomyces cerevisiae* (brewer's yeast), is used for fermenting malted cereals and fruit juices, to produce beverages like wine, bear, whisky and rum etc

Non-Distillated Drinks: Naturally fermented drinks that have maximum alcohol content of about 13% only. Eg- Wine and bear

Distillated Drinks: Drinks produced by distillation of fermented broth that have higher alcohol content. Eg-whisky, brandy and rum etc

SN	Beverages	Concentration	Fermentation of Substrate
1	Beer	4-6%	Barley, wheat etc
2	Wine	10-13%	Fruits (grapes)
3	Champagne	12-13%	Grapes
4	Whisky	40-60%	**Distillate Drinks** from Wheat, Barley, fruits etc
5	Vodka	35-90%	
6	Rum	40-80%	
7	Brandy	40-80%	
8	Tequila	40-80%	

b. Antibiotics (against living)- Chemical substances produced by some microbes and can kill or retard the growth of other (disease causing)microbes.

Penicillin was first antibiotic to be discovered by Alexender Flemmings in 20th Century while working on Staphylococci bacteria. Mould growth in unwashed culture plates stopped the growth of Staphylococci. He found that chemical produced by mould & named "Penicillin" after the name of mould Penicillium notatum.

Its full potential was established much later by Ernest Chain and Howard Florey. This antibiotic was used to treat American soldiers wounded in World War II.

Fleming, Chain and Florey were awarded the Nobel Prize in 1945, for this discovery.

Antibiotics have great improved our capacity to treat deadly diseases such as plague, whooping cough, diphtheria and leprosy.

c. Chemical, Organic acids , Enzymes and other Bioactive Molecules are commercially produced by microbes.

Chemicals :	**Enzymes:**	**Bioactive molecules:**
• Aspergillus niger (fungus) – Citric acid • Acetobacter aceti (bacterium) – Acetic acid • Clostridium butylicum (bacterium) – Butyric acid • Lactobacillus (bacterium) – Lactic acid • Saccharomyces cerevisiae – Ethanol.	• Lipase – used in laundry detergents • Pectinase and protease – used in bottled juices • Streptokinase (Streptococcus bacterium) – used as clot buster (to remove clots) for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.	• 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

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** to make it less polluting by using heterotrophic microbes naturally present in sewage.

Primary Treatment

Physical removal of particles.

Filtration: Floating debris/material removed by bar screening.

Sedimentation: Grit (soil & small pebble) are removed by sedimentation in grit Tank.

Primary Sludge: All settled solid.

Effluent : Supernatant taken for secondary treatment.

Secondary or Biological Treatment

Aeration Tanks: Primary Effluent is constantly agitated. This allows vigorous growth of useful aerobic bacteria into flocs (bacteria associated with fungal filaments to form mesh like structure).

These microbes consume organic matter in the effluent. This reduces the BOD of the effluent.

Biochemical Oxygen Demand (BOD)- Amount of O2 consumed by bacteria to oxidise all the organic matter in one liter of water.

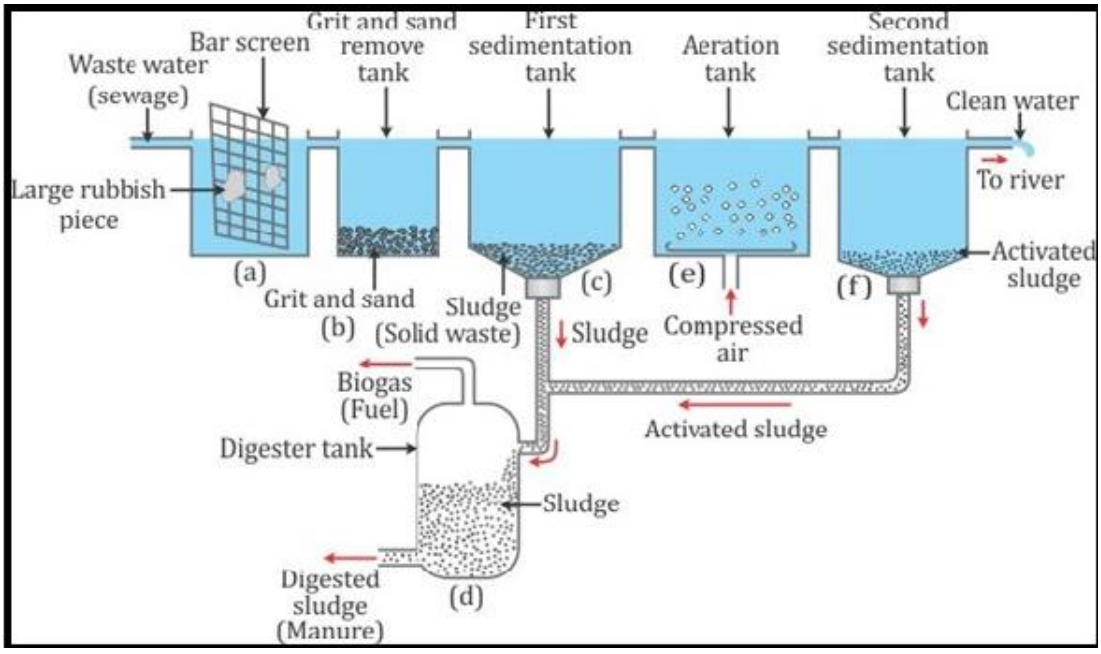
Higher the BOD-Higher is the Pollution

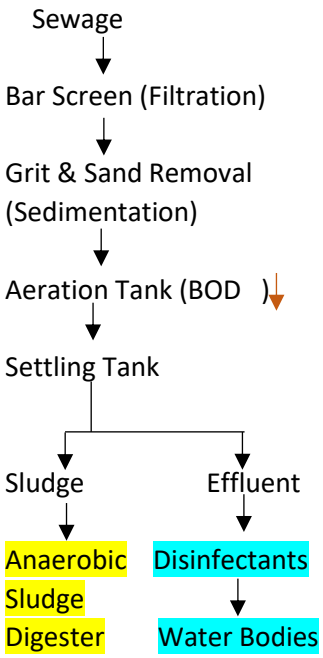
Settling tanks : The Secondary effluent from areation tanks is allowed to settle here, where the bacterial flocs sediment that is called activated sludge.

Inoculum- A part of the source material (activated sludge) that is pumped back (into aeration tank for re-growth of bacteria.

Anaerobic sludge Digester- Major part Sludge is passed into these tanks where anaerobic bacteria digest the bacteria and fungi in the sludge and produce mixture of gas called biogas (CH_4, H_2S and CO_2).

The effluents from the secondary treatment plant are released into water bodies. After treating with disinfectants like Chlorine.





- Ministry of Environment and Forests has initiated **Ganga Action Plan and Yamuna Action Plan** to save these major rivers from pollution & proposed to build a large number of sewage treatment plants.

Microbes in Production of Biogas

- Biogas is a mixture of gases produced by the microbial activity that can be used as fuel.
- **Methanobacterium** (found in rumen of cattle & anaerobic sludge) that grows anaerobically on cellulosic material produce large amount of methane (CH_4) along with CO2and H2.
- The excreta of cattle (gobar) is rich in **methanogens** bacteria and is used for generation of biogas (gobar gas)
- This technology developed in India mainly due *Indian Agricultural Research Institute (IARI)* and *Khadi and Village Industries Commission (KVIC).*
- More often build in rural areas as large amount of cattle dug is available easily.
- Biogas plant consists of:
  - A concrete tank (10-15 ft) in which bio-wastes are collected and slurry of dung is fed.
  - A floating cover is placed over digester that moves upward when gas is produced. Which is removed and supplied through an outlet pipe for consumption.
  - The spent slurry is removed through another outlet and used as fertilisers.

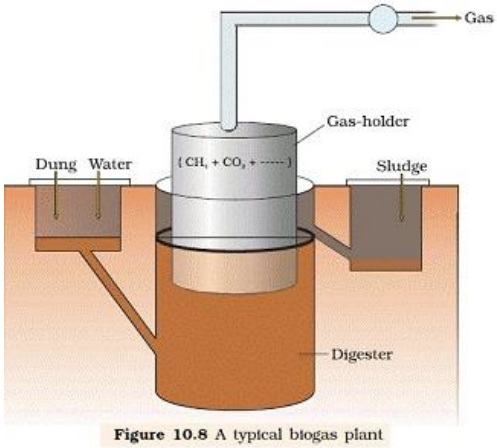


Figure 10.8 A typical biogas plant

Microbes as Biocontrol agent

- Biocontrol means use of biological method for controlling plant disease and pests.
  Eg: Lady bird (beetle with red and black markings) controls aphids, Dragon fly controls mosquitoes.
- Chemical pesticides and insecticides are harmful to humans, animals. pollute the environment & weedicide pollute soil.
- **Bacillus thuringiensis (BT)**: To control butterfly caterpillars- sachets of dried spores of **BT** mixed with water & sprayed onto vulnerable plants such as brassicas and fruit trees, when eaten by the insect larvae release toxin in their gut (activated at alkaline pH of gut hence do not harm plant, other animals or insect) that killed the larva .
- Trichoderma : Free-living fungi found in the root systems that control several plant pathogens.
- Baculoviruses: Pathogens that attack insects and other arthropods. Its genus Nucleopolyhedrovirus species specific narrow spectrum bioinsecticide with no side effects on plants, mammals, birds, fish and non-target insects.

Microbes as Bio fertilisers

Bio fertilisers are organisms that enrich the nutrient quality of the soil. The main sources include bacteria, fungi and cyanobacteria.

Rhizobium: Heterotrophic Bacteria found in root nodule of leguminous plants increase the nitrogen level of soil.

Azotobacter and Azospirillum are free living bacteria that live in soil and fix atmospheric nitrogen into organic forms.

Mycorrhiza: Symbiotic association of fungi with angiosperm plants that increase the fertility of soil. Ex: Glomus
Benefits: Absorbs phosphorus from soil and passes it to plant & increase overall growth & development.
Resistance to root-borne pathogens, tolerance to salinity and drought.

Cyanobacteria(Nostoc, Anabaena, Oscillatoria) : Autotrophic microbes found in aquatic and terrestrial environment fix atmospheric nitrogen. In paddy field Blue green algae also acts as important bio-fertiliser by adding organic matter to the soil.