CLASS XII BIOLOGY

: CHAPTER 10 :

MICROBES IN HUMAN WELFARE

Microbes

- Microbes are present everywhere – in soil, water, air, inside our bodies and that of other animals and plants. They are present even at sites where no other life-form could possibly exist–sites such as deep inside the geysers (thermal vents) where the temperature may be as high as 1000C, deep in the soil, under the layers of snow several metres thick, and in highly acidic environments. Microbes are diverse–protozoa, bacteria, fungi and microscopic plant viruses, viroids and also prions that are proteinacious infectious agents.

Microbes

- Microbes like bacteria and many fungi can be grown on nutritive media to form colonies (Figure 10.3), that can be seen with the naked eyes. Such cultures are useful in studies on micro-organisms.
- Microbes cause a large number of diseases in human beings. They also cause diseases in animals and plants. But this should not make you think that all microbes are harmful; several microbes are useful to man in diverse ways. Some of the most important contributions of microbes to human welfare are discussed in this chapter.

MICROBES IN HOUSEHOLD PRODUCTS

- We use microbes or products derived from them everyday. A common example is the production of curd from milk. Micro-organisms such as Lactobacillus and others commonly called **lactic acid bacteria** (LAB) grow in milk and convert it to curd. During growth, the LAB produce acids that coagulate and partially digest the milk proteins. A small amount of curd added to the fresh milk as inoculum or starter contain millions of LAB, which at suitable temperatures multiply, thus converting milk to curd, which also improves its nutritional quality by increasing vitamin B12. In our stomach too, the LAB play very beneficial role in checking diseasecausing microbes.

MICROBES IN HOUSEHOLD PRODUCTS

- 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 known by their characteristic texture, flavour and taste, the specificity coming from the microbes used. For example, 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' are ripened by growing a specific fungi on them, which gives them a particular flavour.

MICROBES IN INDUSTRIAL PRODUCTS

- Even in industry, microbes are used to synthesise a number of products valuable to human beings. Beverages and antibiotics are some examples. Production on an industrial scale, requires growing microbes in very large vessels called fermentors

Fermented Beverages

- Microbes especially yeasts have been used from time immemorial for the production of beverages like wine, beer, whisky, brandy or rum. For this purpose the same yeast *Saccharomyces cerevisiae* used for bread-making and commonly called brewer's yeast, is used for fermenting malted cereals and fruit juices, to produce ethanol.
- Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

Antibiotics

- Antibiotics produced by microbes are regarded as one of the most significant discoveries of the twentieth century and have greatly contributed towards the welfare of the human society. Anti is a Greek word that means 'against', and bio means 'life', together they mean 'against life'
- whereas with reference to human beings, they are 'pro life' and not against. Antibiotics are chemical substances, which are produced by some microbes and can kill or retard the growth of other (disease-causing) microbes.

Antibiotics

- Alexander Fleming while working on Staphylococci bacteria, once observed a 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. However, its full potential as an effective antibiotic was established much later by Ernest Chain and Howard Florey. This antibiotic was extensively used to treat American soldiers wounded in World War II. Fleming, Chain and Florey were awarded the Nobel Prize in 1945, for this discovery.
- After Penicillin, other antibiotics were also purified from other microbes Antibiotics have greatly improved our capacity to treat deadly diseases such as plague, whooping cough (kali khansi), diphtheria (gal ghotu) and leprosy (kusht rog), which used to kill millions all over the globe. Today, we cannot imagine a world without antibiotics.

Chemicals, Enzymes and other Bioactive Molecules

- Microbes are also used for commercial and industrial production of certain chemicals like organic acids, alcohols and enzymes.
- Examples of acid producers are *Aspergillus niger* (a fungus) of citric acid, *Acetobacter aceti* (a bacterium) of acetic acid; *Clostridium butylicum* (a bacterium) of butyric acid and *Lactobacillus* (a bacterium) of lactic acid. Yeast (*Saccharomyces cerevisiae*) is used for commercial production of ethanol. Microbes are also used for production of enzymes. Lipases are used in detergent formulations and are helpful in removing oily stains from the laundry.

Chemicals, Enzymes and other Bioactive Molecules

- Streptokinase produced by the bacterium Streptococcus and modified by genetic engineering is used as a 'clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infaction leading to heart attack. Another bioactive molecule, cyclosporin A, that is used as an immunosuppressive agent in organ-transplant patients, is produced by the fungus Trichoderma polysporum. Statins produced by the yeast Monascus purpureus have been commercialised as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol.

MICROBES IN SEWAGE TREATMENT

- We know that large quantities of waste water are generated everyday in cities and towns. A major component of this waste water is human excreta. This municipal waste-water is also called sewage. It contains large amounts of organic matter and microbes. Many of which are pathogenic. Before disposal, sewage is treated in sewage treatment plants (STPs) to make it less polluting. Treatment of waste water is done by the heterotrophic microbes naturally present in the sewage. This treatment is carried out in two stages:
- Primary treatment
- Secondary treatment or Biological treatment

Primary treatment

- These treatment steps basically involve physical removal of particles – large and small – from the sewage through filtration and sedimentation. These are removed in stages; initially, floating debris is removed by sequential filtration. Then the grit (soil and small pebbles) are removed by sedimentation. All solids that settle form the primary sludge, and the supernatant forms the effluent. The effluent from the primary settling tank is taken for secondary treatment.

Secondary treatment or Biological treatment

- The primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it. This allows 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 significantly reduces the BOD (biochemical oxygen demand) of the effluent.

BOD (biochemical oxygen demand)

- BOD refers to the amount of the oxygen that would be consumed if all the organic matter in one liter of water were oxidised by bacteria. The sewage water is treated till the BOD is reduced. The BOD test measures the rate of uptake of oxygen by micro-organisms in a sample of water and thus, indirectly, BOD is a measure of the organic matter present in the water. The greater the BOD of waste water, more is its polluting potential.

Secondary treatment or Biological treatment

- Once the BOD of sewage or waste water is reduced significantly, 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 the inoculum. The remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters. Here, other kinds of bacteria, which grow anaerobically, digest the bacteria and the fungi in the sludge. During this digestion, bacteria produce a mixture of gases such as methane, hydrogen sulphide and carbon dioxide. These gases form biogas and can be used as source of energy as it is inflammable. The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.

- Due to increasing urbanisation, sewage is being produced in much larger quantities than ever before. However the number of sewage treatment plants has not increased enough to treat such large quantities. So the untreated sewage is often discharged directly into rivers leading to their pollution and increase in water-borne diseases.

Action Plan

- 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 in the rivers. A visit to a sewage treatment plant situated in any place near you would be a very interesting and educating experience.