**Applications of Microorganisms in the environment**

1. **Chemicals, Enzymes And Other Bioactive Molecules**

The microbial activity also helps to produce chemicals like organic acids and alcohols. Examples of organisms used are Aspergillus niger (citric acid), Clostridium butylicum (butyric acid), Acetobacter aceti (acetic acid).

The detergents used to remove oily stains contain enzymes such as lipases derived from microbes. Another microbe Streptococcus produces Streptokinase that helps to remove blood clots in patients suffering a heart attack.

Microbes (Trichoderma polysporum) also produce bioactive molecules like cyclosporin A. They are used to suppress the immune system during organ transplant procedures. Microbes such as Monascus purpureus produce statins which help to lower blood cholesterol levels.

1. **In Sewage Treatment**

The wastewater humans generate every day, is treated in Sewage Treatment Plants (STPs) to make it less harmful before releasing into natural water bodies. The microbes present in the sewage itself help in the treatment. It involves the following two stages:

* Primary Treatment

This step involves the removal of large and small particles from sewage. First, a process called ‘sequential filtration’ removes the floating debris. Then the process of ‘sedimentation’ removes soil and small pebbles. The solid material that settles is ‘primary sludge’ while the supernatant forms the ‘effluent’. The effluent is then passed through secondary treatment.

* Secondary Treatment

It involves the following steps:

-Mechanical agitation of the effluent in large aeration tanks. This allows growth of useful aerobic microbes into flocs. These microbes reduce BOD (Biological oxygen demand) of the effluent by consuming the organic matter. BOD is the amount of oxygen consumed if all the organic matter in a litre of sewage is oxidised by bacteria.

 -Treatment of the sewage water till the BOD is low. (Greater BOD means more polluting power).

 - Passage of the effluent through the settling tank. Here, ‘flocs’ sediment and generate ‘activated sludge‘.

 -Addition of a small part of the activated sludge to the aeration tank (as inoculum) and the remaining part to ‘anaerobic sludge digesters‘. Here, anaerobic bacteria digest other bacteria and fungi and produce gases (methane, CO2). This is used as biogas and the effluent is released into rivers and streams.

1. **In Biogas Production**

Microbial activity produces a mixture of gases (mostly methane). This is biogas and is used as fuel. Different microbes give rise to different gases based on the substrates they use. Anaerobic bacteria feed on cellulose and generate large amounts of methane along with CO2 and H2.  These bacteria are ‘methanogens’. Methanobacterium, found in the anaerobic sludge (mentioned above) is a common example. Cattle dung is also rich in these bacteria because they help break down cellulose in the rumen of cattle. Therefore, cattle dung is commonly used to generate biogas. Biogas plants are more common in rural areas because cattle dung is available in large quantities in villages. The Indian Agricultural Research Institute (IARI) and the Khadi and Village Industries Commission (KVIC) developed the technology of biogas production in India. A typical biogas plant has the following parts:

 -Concrete tank in which a slurry of dung is fed and bio-wastes are added.

 -Floating cover on the slurry, which rises as microbes produce gas in the concrete tank.

 -An outlet connected to a pipe to supply biogas to nearby households.

 -Another outlet to remove the spent slurry and use it as fertiliser.

1. **As Biocontrol Agents**

Using pesticides and insecticides not only kills harmful pests but also gets rid of beneficial life forms. Therefore, farmers are now turning to the use of biological methods to control pests and plant diseases. This use of biological methods is ‘Biocontrol’. An example of a microbial biocontrol agent is the bacteria Bacillus thuringiensis that is toxic to butterfly caterpillars but does not harm other insects.

Lately, through genetic engineering scientists have introduced toxin genes from this bacteria into plants, making them resistant to attack by pests. Example: Bt-cotton. Another biocontrol agent developed to treat plant diseases is the fungus Trichoderma. Baculoviruses are also excellent biocontrol agents because they attack harmful pests without negatively impacting plants and beneficial insects.