

NEET Revision Notes

Biology

Microbes in Human Welfare

Introduction

- Microbes are the most essential parts of biological systems on Earth.
- They can be found in soil, water, air, our bodies, and the bodies of other animals and plants. They can be found even in places where no other life could possibly exist.
- Protozoa, bacteria, fungi, etc are all examples of microbes. They also include microscopic plant viruses, viroids, and prions, which are proteinaceous infectious agents.
- Bacteria and many fungi can be developed on nutritive media to produce colonies visible with the naked eye. These cultures are beneficial in microorganism research.
- Microbes are responsible for a wide range of human diseases. Animal and plant diseases are also caused by them.
- However, this should not lead you to believe that all microbes are harmful, many microbes are beneficial too.

Microbes in Vaccination, Antibiotics and Industrial products

- Microbes synthesize various products that are beneficial to humans.
- Beverages and antibiotics are the most common products derived from microbes.
- Fermenters are special vessels used in industries for large-scale microbe cultivation and use.

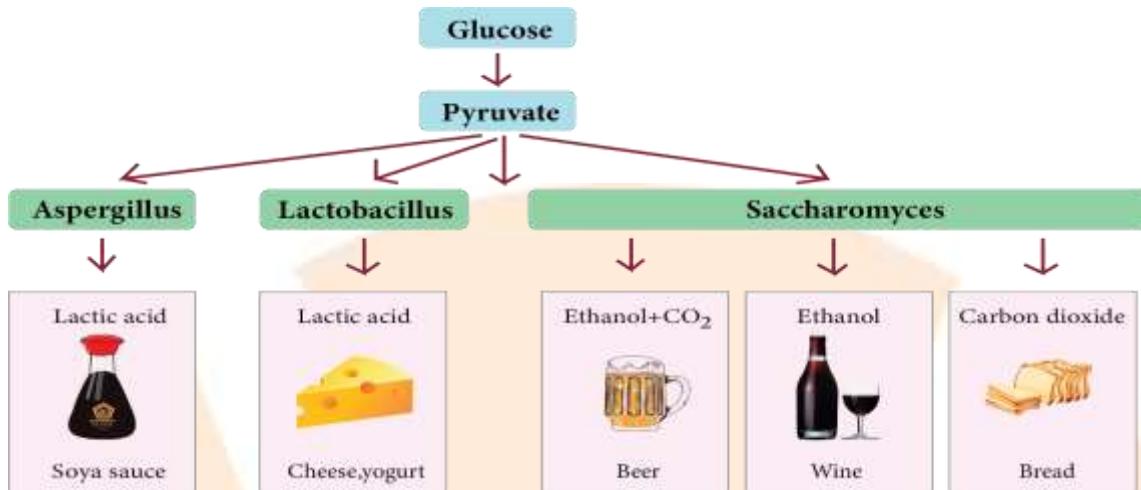


Image: Different types of food items which are prepared using microbes

Fermentation for Beverage Preparations:

- Fermented beverages including wine, whisky, and brandy, are as old as civilization.
- The most prevalent microbe to use for fermentation is *Saccharomyces cerevisiae*, also known as brewer's yeast. It has been used to manufacture ethanol by fermenting malt-based food products and fruit juices.
- Depending on the fermentation type and raw material used, various alcoholic beverages are produced.
- **Whisky, brandy, and rum** are manufactured by distillation of fermented broth, while both **wine and beer** are manufactured by fermentation of plant-based food products.

Antibiotics Production:

- Antibiotics are the organic chemical compounds produced by microbes that are effective against any disease-producing microbe.
- **Penicillin** was the first antibiotic discovered and is named after the mold *Penicillium notatum*.
- Antibiotics are required for the treatment of various diseases such as whooping cough, diphtheria, leprosy, plague, and others.

Production of other Industrial Products:

- Microbes are also used in the manufacturing of certain chemicals such as alcohols, organic acids, enzymes, and so on.
 - *Acetobacter aceti*, for example, is used to generate **acetic acid**.
 - *Aspergillus niger* yields **citric acid**.
 - *Lactobacillus* creates **lactic acid**.
- Microbes can also be used to produce lipase enzymes.
 - **Streptokinase**, which is formed by the bacterium *Streptococcus*, is very effective at eliminating clots from the patient's blood vessels who have had a myocardial infarction resulting in a heart attack, acting as a 'clot buster.'
 - **Cyclosporin A**, an immunosuppressive agent derived from the fungus *Trichoderma polysporum*, is used for organ transplantation.

Microbes in Household Products



Image: Household products

- *Lactobacillus* is a bacterium observed in **curd**. It is utilized to transform milk into curd. This bacterium produces **lactic acid** by partially digesting milk protein and coagulating it to form curd. A small curd inoculum is necessary for milk for the curd formation process. **Vitamin B12** is abundant in curd.
- **Fermentation** is a metabolic process by which alcohol is produced from sugar. There is no need for oxygen in this process. As a result, it is an anaerobic process. The fermentation process was discovered by **Louis Pasteur**. It is also used to create **bread**. The yeast *Saccharomyces cerevisiae*

is responsible for **dough fermentation**. Many **drinks** are needed by the same fermentation process.

- Bacterial action is also responsible for the formation of **dough** used in the production of food items such as **idli**, **dosa**, and so on. Bacteria are mainly accountable for the fermentation of the dough, which results in the final batter. The release of carbon dioxide causes the dough to puff up.
- *Propionibacterium sharmanii*, a fermenting bacteria, is responsible for the production of **cheese**. This bacterium is needed for the production of Swiss cheese.
- The '**Roquefort cheese**' is harvested by growing a specific fungus on it, which gives it a distinct flavor. Cheese is classified according to its texture, taste, and flavor.

Microbes in Sewage Treatment

- Human excreta is a significant constituent of wastewater. Thus, municipal wastewater is also referred to as sewage.
- It contains a large number of organic substances and microbes. Before releasing it into the environment, excreta should be treated to reduce pollution.
- Heterotrophic bacteria, which are generally present in wastewater, are required to treat the sewage.
- The sewage treatment procedure is divided into two stages: primary treatment and secondary treatment.

Primary Treatment-

- The procedure of primary treatment begins with the manual elimination of small and large particulate via filtration and sedimentation.
- To begin with, sequential filtration eliminates debris and then removes the soil and small pebbles.
- The remainder, known as effluent, is collected for secondary treatment.

Secondary Treatment-

- Effluent is moved through aeration tanks using continuous aeration.

- Aerobic microbes can grow rapidly thanks to aeration, which aids in the aerobic degradation of organic matter.
- Aerobic microbes combine to form flocs. Flocs are mesh-like structures formed by an association of fungal filaments from masses of bacteria.
- This lowers biological oxygen demand (BOD). The amount of oxygen ingested by bacteria as well as other microorganisms while decomposing organic matter under aerobic (oxygen present) environments at a specific temperature is referred to as biochemical oxygen demand (BOD). The levels of dissolved oxygen in rivers and other water bodies is directly affected by BOD. The higher the BOD, the faster oxygen is exhausted in the stream. This means that higher groups of aquatic life have less oxygen available to them.
- After the BOD of the sewage is lowered, it is carried into a settling tank to allow the bacterial flocs to settle. This sediment is referred to as activated sludge.
- A small portion of activated sludge is pumped back into the aeration tank to serve as inoculum.
- The remaining sludge is poured into large tanks known as anaerobic sludge digesters.

Various gases are produced during this process, including methane, carbon dioxide, and hydrogen sulfide.

- Furthermore, waste can be dumped into rivers, streams, and so on.
- The Ministry of Environment and Forests has adopted the **Ganga Action Plan** and the **Yamuna Action Plan** to protect our country's major rivers from pollution.
- One of the major policy ideas discussed in these plans is the construction of a significant number of sewage treatment plants to ensure that only treated sewage is discharged into rivers.

Microbes in production of Gobar gas

- Biogas is a gas mixture with the highest percentage of methane.
- Some bacteria that grow anaerobically on cellulose fibers produce a significant amount of methane in addition to CO₂ and H₂.

- These bacteria that generate methane as an outcome of anaerobic respiration are known as methanogens. *Methanobacterium* is an example of methanogenic bacteria.

Microbes as Biocontrol Agents

- The use of natural methods for controlling plant diseases and pests is known as **biocontrol**.
- Pesticides and insecticides have traditionally been used to control diseases and pests. As a result, these chemicals are enormously toxic and hazardous.

Biological Pest and Disease Control:

- ***Bacillus thuringiensis (Bt)*** is a bacterium that is employed as a biocontrol agent against insects and pests.
- Endotoxin is produced by this bacterium, which paralyzes the digestive tract of the insect/pest that utilizes it.
- **Bt cotton** is one such plant-produced product.
- ***Trichoderma*** is a fungus that is used to control plant pathogens.
- **Baculoviruses** are the microbes of insects and other arthropods. The majority of baculoviruses used as biocontrol agents are members of the genus *Nucleopolyhedrovirus*. These viruses are ideal for narrow-spectrum actions, such as species-specific insecticides. They have been shown to have no negative effects on other organisms such as plants, birds, mammals, and fish, as well as non-target insects.
- The Ladybird, a common beetle with red and black markings, and Dragonflies are useful in controlling aphids and mosquitoes, respectively.

Microbes in Biofertilizers:

- Microorganisms are also used as bio-fertilizers in some cases.
- *Rhizobium* is a nitrogen-fixing gram-negative bacterium observed as an endosymbiont in plants having root nodules called leguminous plants.
- Other free-living bacteria, such as *Azospirillum* and *Azotobacter*, can fix atmospheric nitrogen increasing the soil's nitrogen content.

- *Cyanobacteria* are photosynthesis microbes found in both aquatic and terrestrial environments, and many of them, such as *Anabaena*, *Nostoc*, and *Oscillatoria*, can fix atmospheric nitrogen. *Cyanobacteria* are an important biofertilizer in paddy fields. It also improve soil fertility by adding organic matter.

Microbes in the Human body

- Different microbes colonize various parts of the human body, like the gut, skin, reproductive tract, and so on.
- The gut is the most significant part where microbes are found in the human body are microflora.
- *Streptococcus*, *Staphylococcus*, and other bacteria are found in the stomach microflora. These microbes are always prepared to stay alive in the stomach's acidic environment.
- Enterobacteriaceae is a family of bacteria that make up the intestinal flora. This flora is required for digestion and absorption to function. As a result, the efficiency of digestion is increased, as it is the utility of the gut.
- The microbes are preventing another microbe from colonizing.
- They also naturally produce certain compounds that are necessary for food digestion.
- Viruses are also microbes that are used as a vector in recombinant DNA technology to transmit a required gene.

Microbes as Biofertilizers

- Farmers have been forced to shift to organic farming due to the excessive use of chemicals and their damaging effects.
- **Biofertilizers** are used in organic farming.
- Biofertilizers are living things that are necessary for soil nutrient enrichment.
- Bacteria, fungi, as well as *Cyanobacteria*, are all found in biofertilizers.
- *Rhizobium* bacteria are observed in leguminous plants such as peas and beans. This bacterium is needed by plants during the nitrogen absorption process.
- *Azospirillum* and *Azotobacter* are two other bacteria that fix nitrogen.

- When fungi form a mutual association with the roots of higher plants like gymnosperms, they are referred to as **mycorrhiza**.
- The fungus absorbs phosphorus from the soil and transports it to the plant.
- Autotrophic microbes are *Cyanobacteria*. They are found in both terrestrial and aquatic environments. For example, *Anabaena*, *Nostoc*, *Oscillatoria*, and others, can fix atmospheric nitrogen.
- As a result, an important biofertilizer, *Cyanobacteria*, is required, particularly in paddy fields.
- Blue-green algae add organic material to the soil for increasing its fertility.

Key points to remember:

- Microbes are an essential part of life on Earth.
- Formation of curd is done by bacteria *Lactobacillus*.
- The yeast *Saccharomyces cerevisiae* ferments the dough, which is used to make bread. Idli and dosa are two foods created from dough that has been fermented by bacteria.
- To give cheese a specific texture, taste, and flavour, bacteria and fungi are used.
- Lactic acid, acetic acid, and alcohol are examples of commercial products made by microbes that are employed in numerous industrial processes.
- For more than a hundred years, microbes are being used to treat sewage (waste water) by the process of activated sludge formation and this helps in recycling of water in nature.
- Methanogens produce methane (biogas) while degrading plant waste. Biogas produced by microbes is used as a source of energy in rural areas.
- Microbes can also be used to kill harmful pests, a process called as biocontrol. The biocontrol measures help us to avoid heavy use of toxic pesticides for controlling pests.
- There is a need these days to push for use of biofertilisers in place of chemical fertilisers.