# Chapter- 2 Microorganisms: Friend and Foe





## Microorganisms

The invention of the microscope changed the way we see the world of microbes. In 1673, **Anton von Leeuwenhoek** put a couple of **lenses** together and was able to see a completely new world. He made the first microscope. It wasn't that impressive, but it started a whole history of exploration.

Microorganisms are very tiny one-celled organisms that are not visible by naked eye. Microorganisms can live in the air, on land and in fresh or salt water environments. Some of them may cause diseases while some may be beneficial for humans. The microbes cab be classified into



### Shapes of microbes

There are thousands of species of bacteria, but all of them are basically one of three different shapes.

Some are rod or stick-shaped and called bacilli. Examples of rod-shaped bacteria include *E.coli*, *Salmonella*, and *Bacillus anthracis* which is the bacterium that causes anthrax in cattle. Rodshaped bacteria include bent or curved rods; so Vibrio is a curved bacillus that causes cholera.

Others are shaped like little balls and called





cocci. Examples of bacteria with round cells include *Staphylococcus*, *Streptococcus*, and *Neisseria* (causes *gonorrhea*).

Some others are twisted, helical or spiral in shape and called spirilla. These twisted cells can be flexible (*Treponema* which causes syphilis) or rigid corkscrew shape like *Campylobacter* (bacterium that causes food-borne illness).

## Habitat of Microorganisms

- Microbes are found in boiling hot springs and on frozen snowfields.
- Some microbes can survive temperatures about the boiling point.
- Other microbes live on snow and ice and die at room temperature. Some microbes "breathe" substances other than oxygen such as nitric acid, sulfuric acid, iron, arsenic or uranium to produce energy.



Hot springs

- Some microbes live near roots of plants in symbiotic associations.
- Still other microbes flourish in chemical environments harmful to humans and remove toxins like oil and pesticides.
- Microbes live in overgrown slime, on pipes and in open oceans with few nutrients to support microbial life.
- In ponds there is a rich thriving ecosystem of microbial life including green and purple bacteria and algae, sulfate reducers, methane producers, and others.
- > Many microbes live in the bottom of lakes and rivers in sediments.
- Many animals have more microbe cells than they have animal cells living in or on them. Animals provide microbes with food and shelter.



## Importance of Micro-organisms in our Daily Life

Microorganisms are both beneficial as well as harmful to the living organisms i.e. they may cause diseases. Microbes are much more of our friends than our enemies. Although some microbes cause health problems such as chickenpox and the common cold, most microbes make our lives better such as:

*Bacillus thuringiensis* is a common soil bacterium that is a natural pest-killer in gardens and on crops.

*Pseudomonas putida* - one of many microbes clean wastes from sewage water at water treatment plants.

*Escherichia coli* are one of many kinds of microbes that live in your digestive system to help you digest your food every day.

#### Friendly Microorganisms

We've been using microbes for thousands of years to make products we need and enjoy.

All the organic matter like the vegetable peels, remains of animals, faeces, etc. are decomposed and broken down into simpler substances with the help of microbes that feed on them and return the nutrients back to the soil. In this manner the soil fertility is increased.

### Making of Curd and Bread

*Lactobacillus acidophilus* is a bacterium that turns milk into yogurt. It multiplies in milk and converts it into curd. Cheese and bread are two microbe-made foods.

Yeast reproduces rapidly and produces carbon dioxide during respiration. Bubbles of the gas fill the dough and increase its volume this is the basis of the use of yeast in the baking industry for making breads, pastries and cakes.









### **Commercial Use of Microorganisms**

Microbes are used on a large scale in industries for alcohol, wine and beer production. Yeasts are used for the production of alcohol. The process of conversion of sugars into alcohol is called as fermentation.



#### Medicinal Use of Microorganisms



Fungi and bacteria produce antibiotics such as penicillin and tetracycline. These are medicines we use to fight off harmful bacteria that cause sore throats, ear infections, diarrhea and other diseases. Antibiotics are even mixed with the feed of livestock and poultry to check microbial infection in animals. They are also used to control many plant diseases. They either kill bacteria or keep them from reproducing. Your body's natural defenses can usually take it from there.

#### **Antibiotics**

If you take antibiotics when not needed or in wrong doses, it may make the drug less effective when you might need it in future. Also antibiotics taken unnecessarily may kill the beneficial bacteria in the body. Antibiotics, however, are not effective against cold and flu as these are caused by viruses.

Although there are a number of different types of antibiotic they all work in one of two ways:

- A bactericidal antibiotic kills the bacteria. Penicillin is a bactericidal. A bactericidal usually either interferes with the formation of the bacterium's cell wall or its cell contents.
- A bacteriostatic antibiotic stops bacteria from multiplying.



### Vaccine

A vaccine is any preparation intended to produce immunity to a disease by stimulating the production of antibodies. Vaccines include, for example, suspensions of killed or attenuated microorganisms, or products or derivatives of microorganisms. The most common method of administering vaccines is by injection, but some are given by mouth or nasal spray.

When a person is inoculated with these preparations, the immune system confronts these harmless versions of the germs. The immune system quickly clears them from the body.

In turn the body remembers the germs so that later in life when it encounters the real live virulent germs it may be able to fight it off with the retained memory against the particular germ.



### Increasing Soil Fertility

Population of microorganisms living in the soil derives its energy by oxidizing organic residues left behind by the plants growing on the soil or by the animals feeding on these plants. In return, the plants growing on the soil subsist on the products of microbial activity, for the microorganisms are continually oxidizing the dead plant remains and leaving behind, in a form available to the plant, the nitrogenous and mineral compounds needed by the plants for their growth.

### Cleaning the Environment

The microbes are capable of degrading the organic waste and converting it into manure. Microbes are nature's ultimate garbage disposal, devouring the dead, decomposing and inert material that litters Earth's surface. The concept is called bioremediation, and it involves using organisms that naturally love to eat contaminants.



## Harmful Microorganisms

Microorganism are not always helpful, some have deleterious effect also. They can harm human, animals and even the plants.

Some microorganisms are capable of causing diseases. These disease causing microorganisms are called pathogens. Like the polio virus causes polio and *Mycobacterium tuberculosis* is responsible for Tuberculosis. Microorganisms can cause disease in humans through air, water, direct contact or through a carrier.



#### Mycobacterium tuberculosis

Microbial diseases are of two types:-

Communicable

#### Non-communicable

Diseases that can spread from an infected person to a healthy person through air, water or direct contact are called **communicable diseases** like the common cold, chicken pox and tuberculosis while the diseases that cannot be transmitted from an infected person to a healthy person are called non-communicable diseases. Examples are cancer and diabetes.

#### **Disease: Causing Microorganisms in Humans**

The microorganisms may get transmitted from an infected person to a healthy person through air while sneezing, by drinking infected water or by direct contact with the infected person.

#### Carriers

Another mode of transmission of diseases is through the **carriers** or vectors. They are nothing but certain animals and insects that transfer the pathogens to cause disease.

The pathogens stick to the bodies of houseflies and get transferred to uncovered food. This food is now said to be contaminated. Consuming this food may cause disease.





Another well known example is of female anopheles mosquito that transfers the *Plasmodium*, protozoa causing malaria. These mosquitoes bites the infected person and sucks the blood, the parasite also gets transferred with the mosquito. When this mosquito bites a healthy person the *Plasmodium* also enters his/her body. Dengue is also transmitted similarly by the *Aedes* mosquito.

Human Disease	Causative Microorganism	Mode of Transmission	Preventive measures (General)
Tuberculosis	Bacteria	Air	Keep the patient in complete
Measles	Virus	Air	Female anopheles mosquito
Chicken Pox	Virus	Air/Contact	perongings or the patient away
Polio	Virus	Air/Water	from those of the others.
			suitable age.
Cholera	Bacteria	Water/Food	Maintain personal hygiene and good sanitary habits. Consume
Typhoid	Bacteria	Water	properly cooked food and boiled drinking water. Vaccination.
Hepatitis B	Virus	Water	Drink boiled drinking water.
			Vaccination.
Malaria	Protozoa	Mosquito	Use mosquito net and repellents. Spray insecticides and control breeding of mosquitoes by not allowing water to collect in the surroundings.



### Disease: causing Microorganisms in Animals

The pathogens also cause diseases in the animals. The *Bacillus anthracis* bacterium is responsible for causing anthrax disease in cattle as well as humans. The foot and mouth disease in cattle is caused by a virus.



#### Disease: causing Microorganisms in Plants

Bacillus anthracis

The microbes also infect the plants. These cause diseases in them also and ultimately affect the crop yield. However they are be inhibited by the use of chemical that kill these microbes. The table shows the list of microbial diseases in plants.

Plant	Micro- organism	Mode	of
Diseases		Transmission	
Citrus canker	Bacteria	Air	
Rust of wheat	Fungi	Air, seeds	
Yellow vein mosaic of <i>bhindi</i> (Okra)	Virus	Insect	

## Food Poisoning

Food poisoning occurs when you swallow food or water that contains bacteria, parasites, viruses, or toxins secreted by these germs. Most cases of food poisoning are from common bacteria such as Staphylococcus or *E. coli*.

Symptoms of the most common types of food poisoning usually start within 2 - 6 hours of eating the food. That time may be longer or shorter, depending on the cause of the food poisoning.

Possible symptoms include:

- Abdominal cramps
- Diarrhea (may be bloody)
- Fever and chills
- Headache
- Nausea and vomiting
- Weakness (may be serious)



## **Food Preservation**

Food preservation is the process of treating and handling food to prevent growth of microorganism to slow down Food spoilage, loss of quality, edibility or nutritional value and thus allow for longer food storage.

The objectives of food preservation are to:

- Preserve quality
- Preserve shelf life
- Ensure safety

#### **Chemical Method**

Examples include some additives that inhibit growth of bacteria and molds, such as, sodium acetate and sodium benzoate. Sodium nitrite is used for cured meats, and specifically inhibits growth of *Clostridium* bacteria.

#### Preservation by Common Salt

Salting is the addition of salt (sodium chloride or NaCl) to food for the purpose of preservation. The growth of microorganisms is inhibited by the salt, which has the effect of drawing water out of the bacterial cells so they become dehydrated and die. In this manner, salt, in combination with other measures, acts as a preservative in many foods such as butter, cabbage, cheese, cucumber, meat and fish. It also gives a desired flavour to the food. Salting can be done by rubbing adequate quantities of dry salt into foods, or by immersion, where the food item is soaked in a concentrated salt solution (i.e. brine).



#### Salting

#### **Preservation by Sugar**



Sugaring refers to the action of sugar in food preservation. It is similar to the action of salt that depends on the removal of water. In concentrations of at least 65%, sugar solution is widely used as a sweetening and preserving agent. However, care is needed because at low concentrations, sugar solution can support the



growth of microorganisms. It has been found that microorganisms rarely survive in solutions above 20-25% sugar concentration.

## Preservation by Oil and Vinegar

Use of oil and vinegar prevents spoilage of pickles because bacteria cannot live in such an environment. Vegetables, fruits, fish and meat are often preserved by this method.

## Storage and Packing

## Canning and bottling

Canning involves the process of preserving foods in sealed containers by the application of heat. Primarily, it is based on the principle of sterilization. Firstly, all the micro-organisms present in the food are killed by the applications of heart at 275° to 350°F and then sealed in simultaneously sterilized air tight containers to prevent any further attack of micro organism.



Fruits, vegetables, fruit juices, pickles, cheese, butter, meat, fish etc. are generally canned or bottled.

### Heat and Cold Treatments

This system has become one of the most popular methods of preserving food-stuffs in rural and urban areas of today. Many seasonal fruits and vegetables are stored in cold storages and according to the demand of the market are carried to the place of requirement. This method is based on the principle of refrigeration. Mostly, vegetables, fruits, eggs, meat, fish are kept in cold storages.



### **Pasteurization**

This process is applicable to milk only. In this method milk is boiled at 160°F and then immediately cooled at 55°F. Normally, milk is pasteurized on a large scale to safeguard against any bacterial infection. The process aims at destroying the bacteria and inactivating the rest ones. The pasteurized milk is filled in sterilised bottles which are sealed. It could be preserved for five to six days and the colour and flavor of pasteurized



milk does not change in the process, as happens with the boiled milk.



## **Nitrogen Fixation**

The growth of all organisms depend on the availability of minerals nutrients, and none is more important than nitrogen, which is required in large amounts as an essential component of proteins, nucleic acids and other cellular constituents. There is an abundant supply of nitrogen in the earth's atmosphere- nearly 79% in the form of  $N_2$  gas. However for the nitrogen to be used for growth of plants it must be fixed (combined) in the form of ammonium and nitrate ions.

*Rhizobium* lives in the root nodules of leguminous plants, such as beans and peas, with which it has a symbiotic relationship. Sometimes nitrogen gets fixed through the action of lightning.



## Nitrogen cycle

In soil, bacteria or fungi converts nitrogen gas or ammonium compound into ammonium ions. This process is called **ammonification**.

Nitrogen from fertilizer like urea or ammonium compounds, urea from urine decomposes to ammonia or ammonium ions. Ammonia dissolves in cytoplast to form ammonium ions. Ammonium ion is converted into  $NO_2^-$  to  $NO_3^-$  with help of bacteria. This process is known as nitrification.

Nitrate ion  $(NO_3)$  easily absorbed into plants through the roots. The plants then use the nitrogen to convert compounds of nitrogen.

Some plants have special root nodules like soyabean, pea plants. Bacteria in root nodules fix nitrogen and convert into compound of nitrogen. Animals eat the plants to get nitrogen.

When plants and animals die, bacteria and fungi present in the soil convert the nitrogenous wastes into nitrogenous compounds to be used by plants again. Certain other bacteria convert nitrate ion into nitrogen. This process is known as **denitrification**. The gas goes back into the atmosphere. As result, the percentage of nitrogen in the atmosphere remains more or less constant.



