Microorganisms : Friend and Foe

Micro-organisms

You might have watched advertisements on television saying tap water is unsafe, or use aqua-guard, a water purifying system in order to get water safe for drinking. Then they show various germs that are magnified and labelled as culprits for our bad health. **Have you ever thought what these tiny monsters or germs are?**

Living organisms which are not visible to the naked eye are known as **micro-organisms**.

These germs are microorganisms or microbes. They are the tiniest possible living organisms that are too small to be seen through naked eyes. They are living organisms that can be seen only with a microscope or a magnifying glass.

Microorganisms were observed for the first time by Anton von Leeuwenhoek in 1674, using a microscope of his own.

Is the water that seems to be clean, clear, and transparent safe for drinking?

No! The water that seems to be clear and transparent is not always safe for drinking. It may contain some of the disease-causing microorganisms and other dissolved impurities that you cannot see with your naked eyes. However, if you view the water with the magnifying glass, you can see several microorganisms in it.

Therefore, it is advised to purify the water before drinking. The purification can be done by water purifying system or by boiling the water.

Microorganisms make up the largest number of living organisms on the planet. They are not just billions or trillions around the earth, but trillions of trillions and many more. There is a huge variety of microorganisms present on earth.

There are five major groups of microorganisms that include bacteria, protozoa, fungi, algae and viruses.

Can you tell what is the study of these microorganisms called?

The study of microorganisms is called **microbiology.**

Do you Know that these microorganisms can be cultivated in artificial media under certain conditions?

Microorganisms can be grown in laboratories in a special medium called culture media. This medium provides an appropriate environment for the gowth of microorganisms in the laboratories. Depending upon the special requirements of particular microorganisms, different kinds of culture media are formulated. Some are given below:

Microorganisms	Culture meida
Bacteria	Nutrient Agar(NA)
Fungi	Potato Dextrose Agar (PDA)
Protozoans	Nutrient Broth media
Algae	Beneck's Media
Virus	Animal cells

There are many scientists who have contributed in the field of microbiology. Let us discuss about the contribution of some scientists here.

Louis Pasteur (1822-1895)
The main contributions of Louis Pasteur are:

- He disapproved the theory of spontaneous generation of life. He proved this by his famous experiment known as **swan neck flask experiment**. Earlier it was thought that new life originates from non living things, but Pasteur disapproved this and established the theory of biogenesis.

- He developed the method of pasteurization to prevent spoilage of food by bacteria.

- He also contributed to the development of vaccines.

Robert Koch ((1843-1910)
The main contributions of Robert Koch in the field of microbiology include:

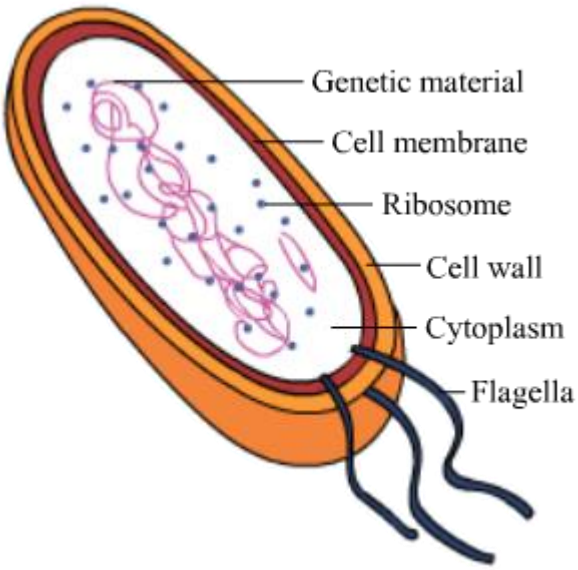
- Robert Koch developed the germ theory of disease that established the microbial cause of disease.
- He identified anthrax disease that infected cattle, sheep and even humans.
- He developed agar growth medium for the culture of microbes.

A General Study of Bacteria

Bacteria are the most primitive and diverse unicellular organisms found in living world. They are prokaryotic in nature as their genetic material, i.e. DNA, is not enclosed within a nuclear membrane. Because of their unique biochemical pathways and properties, they are of high economic importance to the human beings. Let us take a look at a general account of various features of bacteria.

Structure

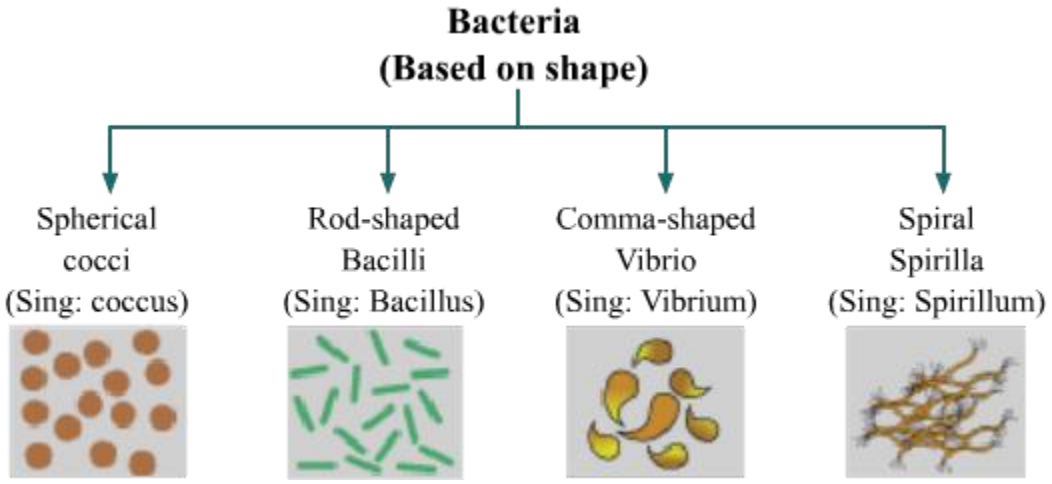
- Bacterium is unicellular in nature, consisting of a cell wall made up of peptidoglycan, cell membrane and protoplast.
- The cytoplasm lacks any cell organelle, except vacuoles and ribosomes.
- DNA lies freely in the central region of the cytoplasm.
- In some cases, the cell wall is further surrounded by a slimy protective layer, called capsule.
- Some bacteria also contain whip-like flagella that help them in their movement.



A Bacterial Cell

Shapes of bacteria:

Bacteria are of different shapes. They can be classified in four groups based on their shape.



(i) Rods: They are rod-shaped bacteria and are called bacilli. Examples are *E.coli*, *Salmonella*, and *Clostridium botulinum.*

(ii) Spheres: They are round in shape and are called cocci. An example of cocci is *Staphylococci.*

(iii) Spirals: They are spiral-shaped and are called spirilli. The comma-shaped bacteria, *Vibrio cholerae* is also an example of spiral bacteria. Another example is *Treponema pallidum*.

A General Study of Fungi

Fungi is a group of eukaryotic, unicellular as well as multicellular, non-photosynthetic organisms that includes mushrooms, moulds and yeasts. These organisms have a rigid cell wall made up of chitin and are found in diverse shapes and sizes.

Nutrition
Most of the fungal species are saprophytic in nature. Some of them are parasitic on various plants and animals as well.

Reproduction in Fungi

- Most fungi reproduce asexually, though sexual reproduction may also take place in few cases.
- Asexual reproduction may occur in the form of spore formation (as in *Rhizopus*) or as budding (as in yeast).

Classification of Microbes and their Habitats

Do you know which organisms are classified as microorganisms? Let us find out.

- Microorganisms can be classified into four major groups depending on their characteristics. Let us study the major groups of microorganisms.

There is a lot of variety of microorganisms in nature. The five major groups are as follows:

1. Bacteria

2. Fungi

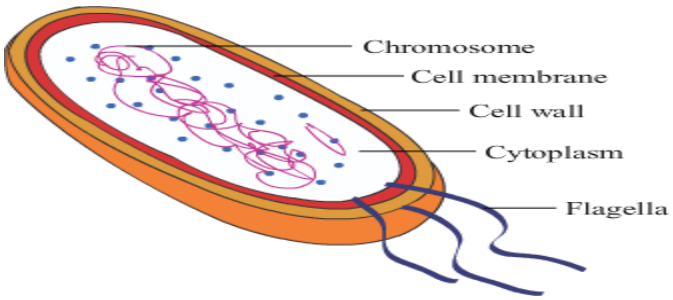
3. Protozoa

4. Algae

5. Viruses

Bacteria

Bacteria are the most abundant organisms on earth. They are found everywhere – on land, in water, and in the air. They are single-celled microorganisms that have a protective cell wall and lack nucleus. They reproduce by binary fission.



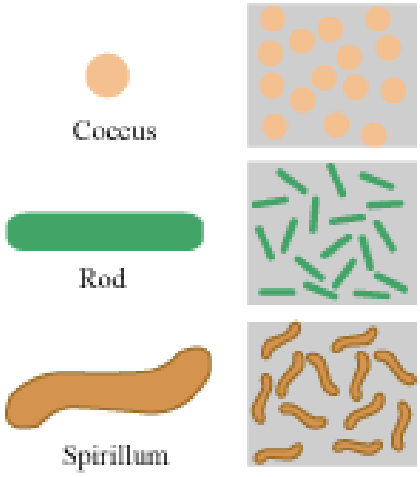
Structure of a Bacterium

Bacteria are classified into three types on the basis of their shape. They predominantly exist in three main shapes:

(i) Rods: They are rod-shaped bacteria and are called bacilli. Examples are *E.coli*, *Salmonella*, and *Clostridium botulinum.*

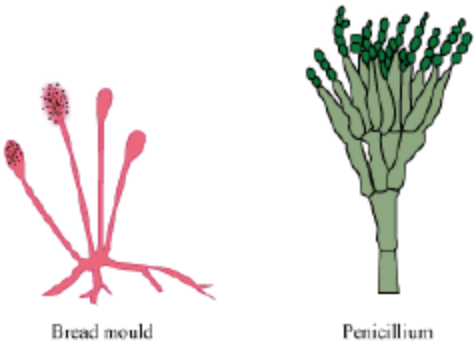
(ii) Spheres: They are round in shape and are called cocci. An example of cocci is *Staphylococci.*

(iii) Spirals: They are spiral-shaped and are called spirilli. Examples are *Vibrio cholerae* and *Treponema pallidum.*

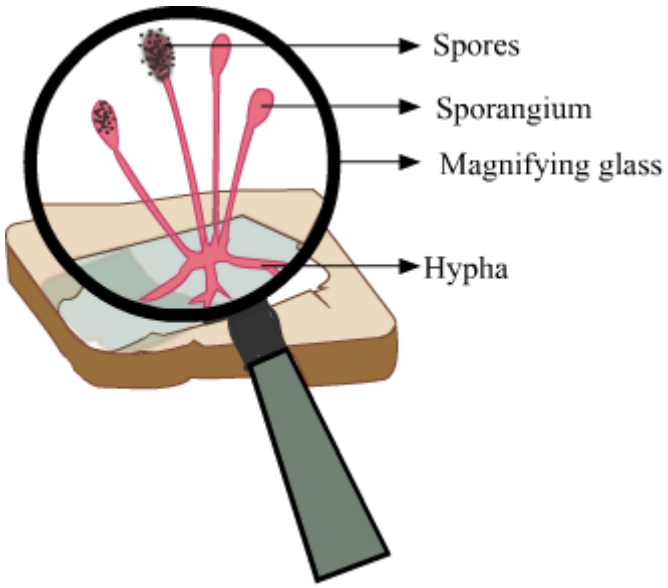


Fungi

Fungi are plant-like organisms that are multicellular. They are heterotrophic as they lack chlorophyll. Most of the fungi are invisible to the naked eyes. Yeast and moulds are the examples of fungi that cannot be seen through naked eyes.



We keep the food in the refrigerator for preserving the food for a longer time. **However, still have you ever noticed the presence of whitish and greyish patch on the slice of bread? Can you guess what these whitish and greyish patches are?**



The white greyish patches are the fungus, a multicellular organism that has developed on the slice of bread. If you observe it under a magnifying glass, then fungus appears as a thread-like structure. These thread-like filaments are called hyphae. They also produce tiny black, rounded structures that are called spores. The sexual and asexual reproduction of fungi takes place via these spores.

Fungi are of three types:

1. **Thread-like fungi –** They grow in the form of fine threads and form cottony masses on the surface of things such as bread and cheese. These threads are called hyphae. Some of the hyphae are root-like and grow downwards while some may grow upwards from the surface. The black dots seen on the contaminated bread are actually their spore sacs present at the tip of the hyphae.

2. **Club fungi**

A typical example of club fungi is mushroom. A mushroom consists of following parts:

Stalk –Stalk is the upright part of the mushroom.

Cap – It is the umbrella-shaped upper part of the mushroom.

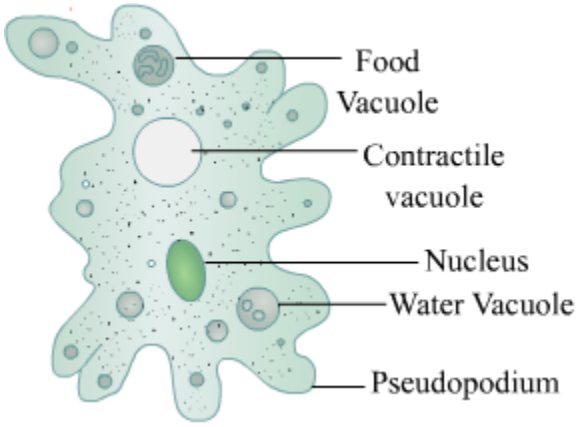
Both of them are made up of hyphae, which are the reproductive parts of the mushroom. Hyphae are tightly packed and are attached to the underground hyphae, which absorb food from the decaying matter. Remember that fungi are saprophytes.

On the underside of the mushroom caps, gills are present that carry spores.

3. **Sac fungi –** These fungi are of varying shapes and sizes ranging from unicellular yeast to large morels.

Protozoa

Protozoa are microscopic organisms that include *Amoeba, Paramecium, Euglena*, *Plasmodium*, etc. They can be unicellular or multicellular. They are simple primitive organisms that are usually found in water.



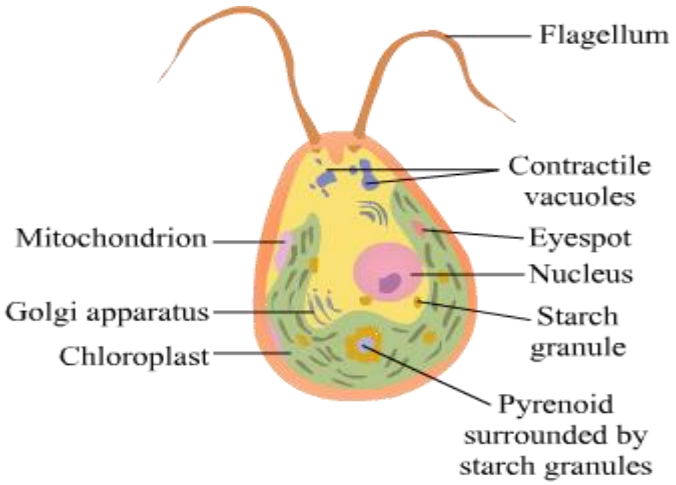
Algae

Algae are multicellular photosynthetic organisms. **Have you ever seen slimy green patches in ponds? What are those green patches called?**

The slimy green patches that are seen in ponds are called S*pirogyra. Spirogyra* is a green filamentous alga, which is commonly found in freshwater habitats. It appears as bright dark green filaments that gently move along with water currents.

Algae are of three types:

1. **Green algae –** They contain green pigment called chlorophyll and are capable of performing photosynthesis. They are a major source of food for aquatic organisms. They vary in their shapes and sizes. They can be single-celled such as *Chlamydomonas*, filamentous such as *Spirogyra*, or colonial such as *Volvox*.
The figure for *Chlamydomonas* is given below:

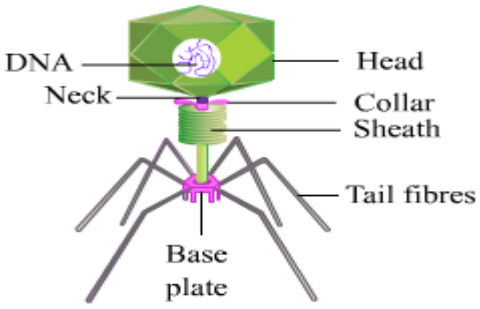


2. **Brown algae –** Most of them are aquatic and live in water as seaweeds. Examples include *Fucus* and *Laminaria* (kelps). Kelps are large and grow up to a length of 60 m. They are rich in minerals such as iodine and calcium and are used to fertilise soil and feed domestic animals. A gummy substance called algin is also obtained from kelps. Algin is used for making ice creams and toothpaste.

3. **Red algae -** They are also aquatic and are found in deep sea waters. Most common red alga is *Chondrus*, which is used for making a jelly-like substance that is used in salad dressing, toothpaste, etc. Agar is also obtained from red algae.

Viruses

Viruses are ultramicroscopic organisms that are visible only through an electron microscope. They are smaller than bacteria. They cannot reproduce on their own as they lack the required machinery for replication. Therefore, they need to infect a host cell. The virus gets inside the host cells and makes hundreds and thousands of copies of itself by using the host machinery. Rous sarcoma virus and HIV are the examples of viruses. Also there is a group of viruses that infect bacteria. These are known as bacteriophages.



Now that we have classified microorganisms, let us discuss few of the important features of microorganisms that make them unique and diverse in the environment.

Features of microorganisms

1. Microorganisms may be single-celled or multicellular. Bacteria, some algae, yeasts and protozoa are single-celled organisms whereas algae and fungi are multicellular.

2. They can be solitary or colonial. A protozoan such as *Amoeba* can spend its whole life alone, moving through the water. Others, such as fungi and bacteria, live and work together in colonies to help each other.

3. Microorganisms may be heterotrophic or autotrophic. Some bacteria, fungi, and viruses are heterotrophs. They obtain their food from other animals whereas algae are autotrophs. They prepare their own food using sunlight by the process of photosynthesis.

4. Microorganisms can reproduce sexually or asexually. Sexual reproduction involves the formation of a new individual by the fusion between their parent gametes while asexual reproduction involves the splitting of microbes into two identical pieces by itself. All the microbes either reproduce asexually, sexually or both. For example, a bacterium reproduces asexually by binary fission or sexually by conjugation.

Let us see some favourable conditions that help in the growth of microorganisms.

Sustainable conditions for growth of microorganisms

1. Temperature plays an important role in the growth of microorganisms. Some grow in warm, some in cold while some grow in moderate temperature.

2. Neutral pH is best suited for bacterial growth.

3. Microorganisms require water as they absorb all the essential nutrients from their surrounding water.

4. Gases like carbon dioxide, hydrogen and oxygen are also needed for their development.

Use of Microbes in Food Industry

Do you know that micro-organisms are used to prepare a number of food items we consume?

Let us explore the use of micro-organisms in the preparation of food.

i. Use of bacteria in preparing curd and yoghurt

You must have seen your mother preparing curd by adding a small amount of curd to warm milk and keeping it to set the whole night.

What do you think the small amount of curd contains, which helps in the preparation of curd from milk?

Curd contains several micro-organisms like the bacterium ***Lactobacillus*****,** which promotes the formation of curd. It multiplies in milk and converts it to curd.

Bacteria are also used in the preparation of cheese, pickles, and many other food items.

You must have heard about 'Yakult', seen its advertisement or tried it yourself. But why are we talking about 'Yakult' here?
It is because 'Yakult' is a probiotic drink. Now you may think what a probiotic is.

Probiotics are such edible preparations which contain useful active bacteria, like *Lactobacillus, Acidophilus, Lactobacillus casei, Bifidobacterium bifidum,* etc. These bacteria are beneficial for the intestine as they help in the process of metabolism. They are usually given when a person is suffering from diarrhoea or is under antibiotic treatment. Antibiotics kill both beneficial and harmful bacteria present in our body, thus affecting the metabolic process. These probiotics form the colonies of useful microbes in alimentary canal and thus aid in the digestion process.

ii. Use of yeast in preparing bread and cake

But how are micro-organisms useful in the preparation of bread?

Let us find out by performing this simple activity.

Take ½ kg of *maida* and add some sugar to it. Mix it with warm water and add a small amount of yeast powder to the mixture. Knead the *maida* to make soft dough. Keep the *maida* aside and record your observation after two hours. You will notice that *maida* has risen and has become fluffy. **Do you know the reason behind the fluffiness of *Maida*?**

This happens because yeast added to *maida* reproduces rapidly, and produces carbon dioxide gas while respiring. This gas fills the dough and increases its volume making it to rise.

Maida with Yeast Powder Raised maida

Based on this principle, yeast (which is a micro-organism) is used in the preparation of breads and cakes. It helps in making them spongy.

iii. Use of yeast in preparing alcohol and wine

Micro-organisms are used commercially to prepare alcohol, wine, and vinegar. Yeast is the most common micro-organism, which is used to prepare alcohol and wine. Let us find out how yeast takes part in the production of alcohol.

During the preparation of alcohol, yeast is grown on natural sugars present in grains like rice, wheat, barley, or crushed fruit juices. Yeast breakdowns the sugar present in these grains into alcohol, leading to the large-scale production of alcohol. This process of conversion of sugar into alcohol is known as **fermentation**.

iv. Use of bacteria in other food industries

- In the production of vinegar - Sugar solution is converted into acetic acid (vinegar) by the action of the bacteria called *Acetobacter*.
- In the curing of tea - Bacteria act upon the tea leaves and give tea its characteristic flavors.
- In the production of **cheese:** Cheese is a valuable food having high quantities of proteins, some fats, calcium, phosphorous, vitamin A and some quantities of vitamin B. It is prepared from milk with the help of *Lactobacillus* bacteria. Its preparation involves following steps:
- **Curdling of milk:** Done by adding *Lactobacillus*; curd thus produced is separated from whey.
- **Processing of curd:** Extra moisture is removed to form cottage cheese.
- **Salting:** To further remove moisture and prevent growth of undesirable microbes
- **Ripening:** To give cheese its characteristic flavour; done at suitable temperature and humidity

Did you Know?

- The bacterium *Propionibacterium sharmanii* is used in 'Swiss cheese' to give it its characteristic holes by producing large amount of carbon dioxide.

- 'Roquefort cheese' is ripened by growing certain fungi on them to give them their specific flavour.

v. Use of mushroom and *Penicillium* in food industries

- Some varieties of mushrooms such as *Agaricus* are edible and good sources of proteins and vitamins, but some wild mushrooms such as *Amanita* species are poisonous.
- *Penicillium spp.* is used in the flavouring of cheese.

Use of Microbes in Medicines

You know that micro-organisms cause diseases, but do you know that some micro-organisms are also used to prevent diseases? Let us explore.

You must have consumed antibiotics when you were ill. What do you think are antibiotics? Antibiotics are medicines which are obtained from certain micro-organisms. They kill or stop the growth of other disease-causing micro-organisms. Thus, they are useful for humans.

Sometimes, the symptoms of a disease are visible but the pathogens cannot be identified. In this case, broad-spectrum antibiotics are used that are active against a wide variety of bacteria. Example, phenicols, cephalosporins etc.
On the other hand, narrow-spectrum antibiotics are used when the pathogens are identified. Example, azithromycin, penicillin etc.

Fungi such as *Penicillium spp.* and *Aspergillus spp.* are used to produce antibiotics, which are used to cure deadly diseases such as pneumonia.

Bacteria are also used to produce antibiotics.

Subtilin, Bacitracin and Gramicidin are examples of antibiotics obtained from bacteria while penicillin, cyclosporin and cephalosporin are a few examples of the commonly used antibiotics obtained from fungi.

Apart from treating human diseases, antibiotics are also mixed with livestock and poultry food to check the spread of microbial infection among farm animals.

Some Interesting Facts:

- **Penicillin was the first antibiotic discovered. Scottish scientist, Alexander Fleming, discovered the drug in 1928.**

- **Do you know that proper use of antibiotics can stop the infection and save lives, while improper use of it can be more harmful than helpful? Therefore, knowing when to take antibiotics is very important.**

You must have been given injections to protect yourself against several diseases when you were young. These injections are called **vaccines. But what do you think these vaccines contain?** Vaccines are the dead or weakened micro-organisms, which help the body fight against diseases. Let us find out how.

Our body reacts to infection by micro-organisms by producing certain substances called **antibodies**. These antibodies kill the invading micro-organisms freeing the body from diseases. So, in order to protect the body from diseases caused by micro-organisms, some dead or weakened microbes are introduced into the body, which causes the production of antibodies. These antibodies then remain in the body for a long period of

time protecting the body from diseases. This whole process of introducing vaccines into the body is known as **vaccination.**

Vaccines are available for a large number of diseases like cholera, tuberculosis, smallpox, hepatitis, chicken pox, polio etc. Therefore, vaccines are another medium through which micro-organisms are used to prevent diseases in humans and other animals.

A number of bacteria have been used in the production of vaccines against some deadly diseases such as tuberculosis, whooping cough, diphtheria, etc.

Genetically engineered bacteria

Some genetically engineered bacteria are used in the production of insulin for the treatment of diabetes.

Some Interesting Facts:

- Polio vaccine is cultured on kidneys of monkeys and cells of aborted foetuses.

Rubella, chickenpox, and hepatitis A vaccines are cultured on cells of aborted foetuses.

Serums and Toxoids

When a pathogenic bacterium enters our body, it releases some harmful proteins during its growth or after death. These harmful proteins are known as **toxins**. The immune system defends our body from these harmful toxins by releasing **antitoxins**, which can react with and neutralise the toxins. These antitoxins are found in the **serum**.
Serum is a pale yellow coloured blood component which lacks any blood cell as well as clotting factors. It is basically the blood plasma from which all the clotting factors have been removed. Due to the presence of antitoxins/antibodies in serum, it can be used as a preventive measure against bacterial invasions. Let us see how this is done.

- A small dose of bacterial toxin or toxoid is introduced into the blood of a healthy animal. **(Toxoid: inactivated toxins of a particular bacterium)**
- The immune system of that animal will produce antitoxins against the injected toxin.
- After sometime, some amount of blood is taken out from the animal and allowed to clot.
- The serum thus obtained after clotting contains the antitoxins against that particular bacterial toxin or toxoid. It can now be used to provide protection against that bacterium.

Few serum compounds have been produced by genetically modified bacteria as well, for example, blood clotting factor VIII (for treatment of Haemophilia A), Factor IX (for treatment of Haemophilia B), etc.

Use of Microbes in Increasing Soil Fertility

Which element is the major element of the air? 'Nitrogen' is the most abundant element present in the air.

Information about nitrogen

Symbol	N
Atomic number	7
Atomic mass	14
Electronic configuration	$Is^2\ 2s^2\ 2p^3$
Valency	+3, +5
Physical state	Gaseous
Colour	Colorless

Nitrogen is the major element which is inevitable for the growth and sustenance of living organisms as it is the essential constituent of proteins.

So animals get nitrogen in the form of protein but what about plants? **From where plants get nitrogen?**

Do you know that some bacteria help in increasing soil fertility?

There are some bacteria which help in the conversion of ammonia into nitrites and nitrates by the process of nitrification. Plants take up these nitrites and nitrates from the soil.
E.g. *Nitrosomonas* and *Nitrobacter*. In this way, they help in increasing the fertility of soil.

Certain bacteria and blue-green algae fix the atmospheric nitrogen into soil and thereby, increase the fertility of soil. They are known as biological nitrogen fixers. This process of conversion of nitrogen into nitrogenous compounds is known as nitrogen fixation. These nitrogen-fixing bacteria can be both free-living (E.g. *Azotobacter*) and can have symbiotic relationships (E.g. *Rhizobium*) with the roots of leguminous plants like pulses. It lives in symbiotic association with plants and fixes the atmospheric nitrogen in leguminous plants.

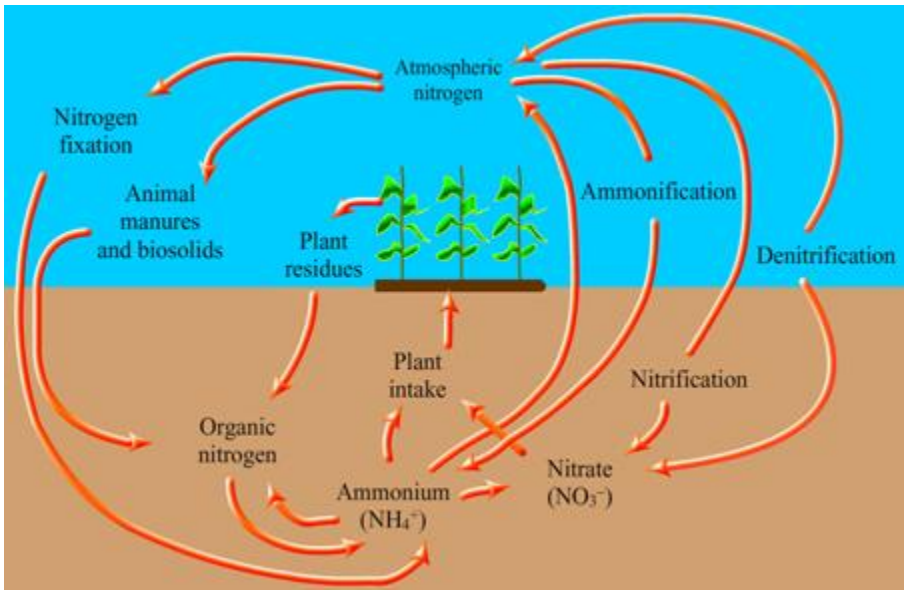
Micro-organisms not only increase soil fertility, but also help in recycling matter within the ecosystem, and thus help in cleaning the environment.

Let us understand how micro-organisms take part in recycling matter by taking a look at the nitrogen cycle.

Nitrogen cycle

You know that our atmosphere contains 78% of nitrogen. But all this nitrogen cannot be taken up directly by plants and animals. As studied earlier, certain bacteria and blue-green algae fix the atmospheric nitrogen into soil and convert it into compounds of nitrogen. *Rhizobium* is one such bacterium which does this. It converts the atmospheric nitrogen into usable form, which is then taken up by plants through their roots. This nitrogen is then utilized by plants to synthesize proteins and other such compounds. Nitrogen is then transferred to animals in the form of proteins when they feed on plants.

But how does this nitrogen reach back into the atmosphere? When plants and animals die, micro-organisms like bacteria and fungi present in soil convert nitrogen present in dead organisms into nitrogenous compounds by the process of **decomposition**, which can be used by plants again. Some micro-organisms convert these compounds into nitrogen gas, which goes back into the atmosphere. Therefore, micro-organisms help the nitrogen cycle to continue and maintain the percentage of nitrogen present in the atmosphere.



- Fungi are decomposers and reduce organic matter and release valuable nutrients into the soil and hence help in the recycling of nutrients.
- Some fungi form symbiotic associations with the roots of plants (Mycorrhiza), which help the roots to effectively absorb nutrients from the soil.

Microorganisms As Foe

You know that microorganisms are useful to us in a number of ways, but do you know that not all microorganisms are useful? There are some microorganisms, which are harmful to human beings and other organisms.

Microorganisms which cause diseases in plants, humans, and other animals are known as **pathogens**. Let us explore about them in detail.

The diseases which can spread from one person to another through air, water, or contact are known as **communicable diseases**. These diseases include cholera, common cold, tuberculosis, chicken pox, etc.

We had discussed earlier that carriers are insects and animals, which carry disease-causing microorganisms. **But how do they do this?** You must have noticed your mother covering food items to prevent flies from sitting on it. This is so because flies are carriers of a number of diseases. When they sit on garbage, many pathogens get stuck to their body. When they sit on uncovered food, these pathogens get transferred to the food item. Consuming this contaminated food can result in the occurrence of several diseases. Similarly, when a mosquito carrying the parasite of malaria bites a human, it transfers the parasite into the human body.

What measures can be undertaken to prevent the occurrence of communicable diseases and diseases caused by pathogens in humans? Preventive measures such as drinking boiled water, keeping food covered, isolating a diseased person from a healthy person, providing vaccination, etc. can be undertaken to prevent the occurrence of communicable diseases in humans.

Spread of malaria can be prevented by not allowing mosquitoes to breed in our surroundings. Since mosquitoes require a moist place to breed, one should not allow water to collect in places such as empty pots, coolers, tyres, etc. Therefore, it is essential to keep our surroundings clean.

Let us take a look at the given table to study about some common human diseases, their modes of transmission, pathogens involved, and the preventive measures to be taken to avoid the occurrence of these diseases.

Human disease	**Pathogen**	**Mode of transmission**	**Preventive measures (general)**
Tuberculosis Measles Chicken pox Polio	Bacteria Virus Virus Virus	Air Air Air/contact Air/water	Patient should be kept in isolation. Personal belongings of the patient should be kept away from others. Vaccination should be given at a proper age.

Cholera Typhoid	Bacteria Bacteria	Water/food Water	Water should be boiled and food should be properly cooked before consumption. One should maintain personal hygiene and good sanitary habits.
Hepatitis B	Virus	Water	Vaccination should be given. Water should be boiled before consumption.
Malaria	Protozoa	Mosquito	Mosquitoes should not be allowed to breed. This can be done by keeping surroundings clean and dry. Mosquito nets and repellents should be used to avoid contact with mosquitoes.

Pathogens causing diseases in other animals

Certain bacteria cause an acute disease in both humans and cattle known as **anthrax**. Foot-and-mouth disease is another disease, which occurs in cattle due to an infection from a type of virus.

Pathogens causing diseases in plants

Do you know that plants also suffer from diseases similar to humans and other organisms? A variety of plant pathogens cause a number of diseases in plants and can reduce the yield of a crop plant. Therefore, similar to human diseases, plant diseases also require to be prevented by using certain chemicals, which can kill the pathogens. Let us explore some of the plant diseases, their causative microorganisms, and their modes of transmission.

Plant disease	**Pathogen**	**Mode of transmission**	**Illustration representing the diseased plant**
Citrus canker	Bacteria	Air	
Rust of wheat	Fungi	Air, seeds	

Yellow vein mosaic of bhindi (okra)	Virus	Insects	

Food Preservation

Do you know that apart from causing diseases in plants and animals, micro-organisms are also responsible for spoilage of food?

You must have heard about people falling sick after eating some food items. This can happen when a person consumes a food item, which has been spoilt by the action of certain micro-organisms. This condition is known as **food poisoning**. It can become serious and can even lead to the death of a person.

What causes food spoilage?

Sometimes food spoilage is caused due to mishandling of food items and this deteriorates the food quality.

Few factors responsible for food spoilage are:

- overcooking
- improper transportation
- inappropriate storing (stored at damp places)

How can we prevent the chances of food poisoning?

Food poisoning can be prevented by carefully preserving food items. This process is known as **food preservation.** It works by preventing the growth of micro-organisms in food items.

How is food preservation done?

Let us study some common methods of food preservation used in daily use.

(i) Chemical methods of food preservation

You know that while cooking food, we add salt and oil to the vegetables. **They add taste to the food, but do you know that they also help in preventing the food from getting spoilt?**

The substances that prevent the attack of microbes on food are termed as **preservatives**. Let us find out what preservatives are used to preserve different food items:

- **Preservation by common salt**: Common salt is usually used to preserve meat and fish as it checks the growth of bacteria in these foods. It is also used to preserve *amla*, raw mangoes, and tamarind.

- **Preservation by sugar**: Sugar is usually used to preserve jam, jellies, and squashes. Sugar prevents spoiling of food by reducing the moisture content of food, which inhibits the growth of bacteria in it.

- **Preservation by oil and vinegar**: Oil and vinegar are used to preserve vegetables, fruits, fish, and meat. They prevent food from getting spoilt as micro-organisms cannot grow in such an environment.

- **Chemical preservatives:** Chemicals such as sodium metabisulphite, sodium benzoate and citric acid are also used as food preservatives.

(ii) Food preservation by heat and cold treatment

- **High temperature**

Food stuff can be heated at a temperature of 120° – 126°C at 15 lbs of pressure for 12 – 90 minutes. During this process, bacterial and fungal cells along with their spores are destroyed. This method is known as sterilisation and it is followed for canned food.

- **Pasteurisation**

Do you know why we keep food in the refrigerator?

This is because low temperature inhibits the growth of micro-organisms. Similarly, boiling also kills many micro-organisms.

You must have noticed that packed milk contains the label pasteurized. **What do you think it means?**

Pasteurization is a method of preserving milk, which involves both hot and cold treatment. This method was devised by Louis Pasteur in 1866. It is usually done for preventing milk from getting spoilt. There are two procedures involved.

- Milk is heated to 145° F (62.8°C) for 30 minutes; this process is called low temperature method.
- Milk is heated to 161°F (71.7°C) for 15 seconds; this process is called high temperature method.

The finished product is then cooled and stored at low temperature.

- **Low temperature storage**

  In this process, food stuff is stored at a low temperature of −10°C to −18°C where growth of microorganisms is completely inhibited.

  (iii) Storage and packing

  For a commercial purpose, vegetables and fruits are preserved by sealing them in air-tight packets, which prevent the attack of micro-organisms.

  (iv) Dehydration

  In this process, the food stuffs are preserved by reducing their overall water content.

  (v) Use of preservatives

  Jams, pickles, and jellies are preserved by adding salt, sugar, or chemical preservatives.