

## 2

## Microorganisms : Friend and Foe



*"Algae by weight represent almost 60% of the biomass of all life on Earth. They produce more than half of all the oxygen we breathe."*

### Introduction

A microorganism is a living organism that is very minute. It can only be seen with the aid of a microscope. Consider that the largest human cells are about the diameter of human hair. Bacteria cells are one-hundredth the size of a human cell and viruses are much smaller again. A bacterium next to a human cell is like a tiny boat next to a big ship.

### Occurrence of microorganisms

- (i) Microorganisms are present everywhere in air, soil, water, foodstuffs, sewage waste as well as inside animal bodies.
- (ii) They can survive in all types of environments even in extremely harsh environmental conditions like hot springs, desert soil, saline water, ice-cold water and marshy lands.
- (iii) They are also present in dead and decaying organic matter.
- (iv) Some can live alone while others like bacteria and fungi may live in colonies.
- (v) Some microbes live as parasites either outside or inside the body of other organisms and cause diseases.



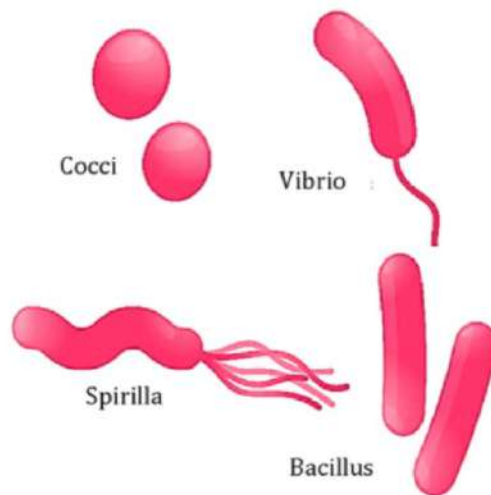
### Major groups of microorganisms

There are five major groups of microorganisms i.e. bacteria, virus, protozoan, algae and fungus.

1. **Bacteria :** These are single celled organisms, found in wide range of habitats ranging from glaciers to deserts and hot springs. e.g. *Lactobacillus* (curd bacteria). They are generally heterotroph, but some bacteria also show autotrophic nutrition.

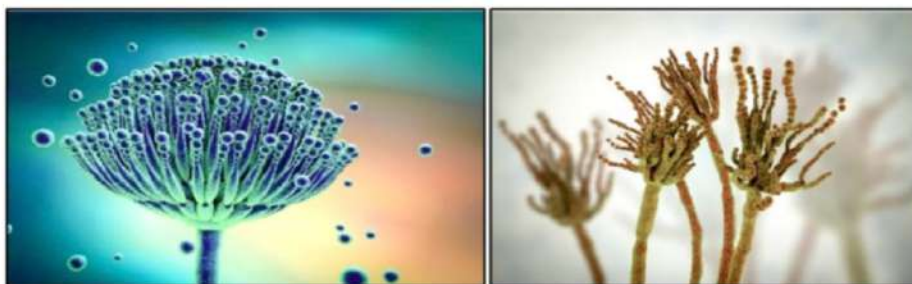


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**Various types of bacteria on the basis of shape**

2. **Fungi :** These are multicellular, heterotrophic organisms, lack chlorophyll and are generally found in colonies. Yeast is the only exception which is unicellular in nature. e.g. *Penicillium*, *Aspergillus*, *Breadmould*.

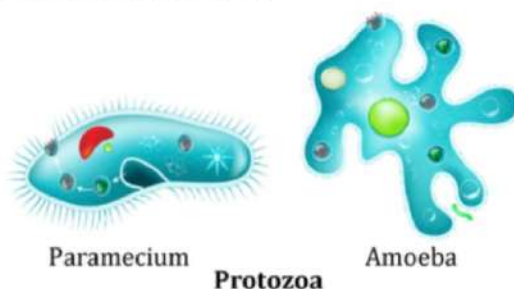


Aspergillus

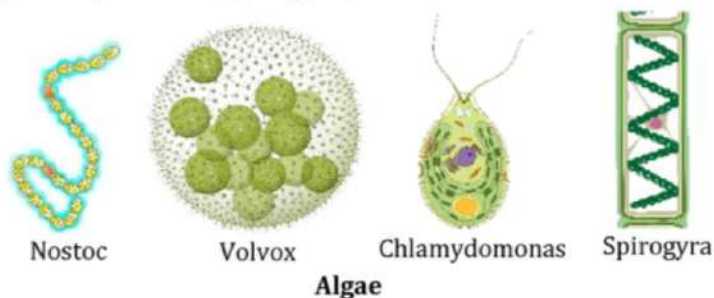
**Fungi**

Penicillium

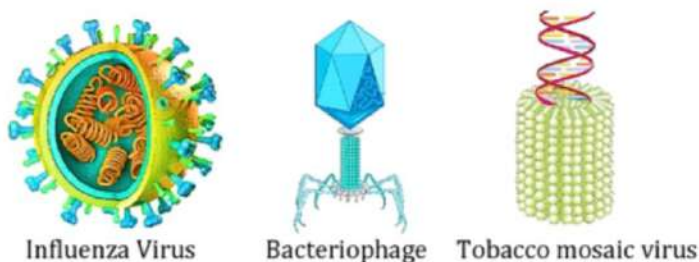
3. **Protozoa** : These are unicellular, heterotrophic microorganisms. Usually found in moist & aquatic habitats. e.g. *Amoeba*, *Paramecium*



4. **Algae** : These are unicellular or multicellular eukaryotic autotrophic organisms, contain chlorophyll pigment and carry out photosynthesis. Cell wall of algae is mainly made up of cellulose. e.g. *Chlamydomonas*, *Spirogyra*, *Chlorella*.



5. **Viruses** : Viruses are acellular structures because they are not built up of cells. They are much smaller than cells. These are ultramicroscopic organisms, which require cells of host organisms to reproduce. e.g. Influenza virus, polio virus, AIDS etc. Structure of virus consist of nucleic acid and a protein coat. Nucleic acid can either be DNA or RNA.



**Various types of Viruses**

Virus is considered as connecting link between living and non-living.

**SPOT LIGHT**

**Microbes-friend and foe** : It is almost impossible to think of any place without microorganisms. Most microorganisms are beneficial, for example, there are micro-organisms in our large intestine that synthesize vitamins. However, a tiny minority are pathogens (disease causing agents). These pathogens, often called germs, are a threat to all life forms.

**Microorganisms - as friends** : Microorganisms are used for a number of purposes such as:

- (1) Preparation of curd, bread, cake, idli, dosa and cheese.



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- (2) In industry – to produce alcohol, wine and acetic acid (vinegar).
  - (3) In agriculture – to increase soil fertility.
  - (4) In medicines – to produce antibiotics and vaccines.
  - (5) Cleaning the environment.

### 1. Preparation of curd, bread, cake, idli, dosa and cheese

- (i) **Formation of curd (dahi):** Making of curd is a process in which the lactose (milk sugar) of the milk is converted into lactic acid by the action of certain bacteria (mainly *Lactobacillus*).

This curd is further used in the preparation of idli-dosas and bhaturas.



**How does the addition of small amount of curd to milk converts the whole milk into curd?**

#### Explanation

Curd contains several microbes. Out of these, *Lactobacillus*, promotes the formation of curd. When the curd is added to lukewarm milk, the bacteria, multiply faster and results in conversion of whole milk into curd.



The process of conversion of sugar into alcohol is called fermentation. Louis Pasteur discovered fermentation in 1857.

**SPOT LIGHT**



#### Aim

To study *Lactobacillus* bacteria in curd.

#### Method

Take some curd in a test tube and add water to it. Shake it thoroughly. Place one drop of this solution on a clean glass slide and examine under a microscope.

#### Observation

You will see small rod-shaped bacteria floating in it.

This activity shows that curd contains *Lactobacillus* bacteria.

- (ii) **In bread making:** Yeast is added to the uncooked dough to make the dough "rise". The dough rises due to the production of carbon dioxide (because of respiration of yeast) in the dough. The bread is then baked. Heat of baking drives off the carbon dioxide, making the bread porous and light.



#### Aim

To show fermentation of dough.

### Method

Prepare some dough by mixing wheat flour, water, sugar and yeast. Keep it in a vessel and mark its upper level. Put a lid on the vessel and keep it in a warm place for 2 to 3 hours.

### Observation

You will find increase in volume of the dough. The increase in volume is because of release of carbon dioxide gas in the dough which helps it in its expansion.

**(iii) Add flavour:** Some fungi (*Aspergillus* and *Penicillium*) are added to cheese to give a special flavour.



**Do You  
Remember ?**

**Anaerobic respiration in yeast cell :** Yeast can survive in the absence of air. They are called anaerobes. They get energy through anaerobic respiration. The glucose breaks down into alcohol and carbon dioxide in the absence of oxygen. The reaction is called anaerobic respiration or fermentation.

## 2. Commercial use of microorganisms: In industry

The wine and beer (brewery) industries are important industries which make use of the fungus yeast. Yeast is grown on natural sugars present in crashed fruit juices and grains like barley, wheat and rice. Yeast brings about conversion of sugars into alcohol and carbon dioxide.

☐ Alcoholic beverages are major fermented foods in the diet of humans. The yeast also enriches the beverages with B-vitamins.

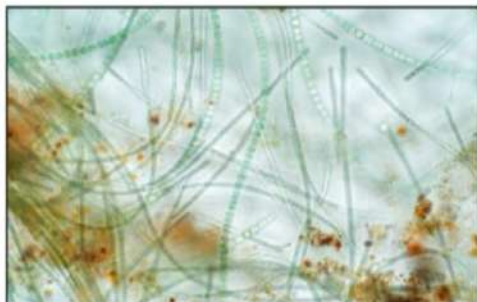
## 3. Agricultural use of microorganisms

All plants and animals need nitrogen, the gas that makes up 78% of the air. Some bacteria and Blue green algae are the only organisms that can take nitrogen directly from air. These microbes convert atmospheric nitrogen into compounds of nitrogen and so called as biological nitrogen fixers. Thus, they are very useful to agriculture, as they enrich the soil with nitrogen.



The microbes used to increase soil fertility are referred as bio-fertilizers. Soil microorganisms are one of the most important elements of a healthy soil.

**SPOT LIGHT**



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**Nitrogen Fixation:** Refers to the conversion of atmospheric nitrogen gas ( $N_2$ ) into a form usable by plants and other organisms.

It is conducted by a variety of bacteria, both as free-living organisms and in symbiotic association with plants. e.g. The roots of leguminous plants like beans and pea, bear certain swollen structures called root nodules. The bacterium *Rhizobium* lives in the root nodules. Bacteria fix nitrogen for the plants, while the plants give food and shelter to the bacteria. This type of relationship is called as symbiotic association.



**Symbiotic relationship:** Mutually beneficial association in which two organisms live together and share shelter and nutrients. This is called symbiotic relationship. For example, Mycorrhiza and Lichen.



### Aim

To demonstrate that *Rhizobium* bacteria are present in root nodules of pea plant.

### Method

Pull out a pea plant along with the roots from a field. Wash the roots with clean water and observe the roots. You will find many small outgrowths on the roots. These are called nodules. These nodules contain nitrogen fixing bacteria called *Rhizobium*. With the help of a blade, cut these nodules into very thin slices. Put one slice on a slide and observe under a microscope.

### Observation

You will see small bacteria. These are *Rhizobium* bacteria which fix nitrogen in the soil.



Root nodule



**Nitrogen cycle:** Nitrogen is an essential element for all living organisms because it is a principle component of proteins, chlorophyll, vitamin and nucleic acids. The circulation of nitrogen through the living and non-living components of the biosphere (air, soil, water, plants and animals) is called nitrogen cycle.

- ☐ Nitrogen cycle maintain the percentage of nitrogen in the atmosphere more or less at a constant.



The bacterium called *Rhizobium* can fix atmospheric nitrogen and convert it into a soluble form. But *Rhizobium* cannot make its own food. So, it lives in the roots of gram, peas, moong, beans and other legumes and provides them with nitrogen.

Pulses (dals) are obtained from leguminous plants. In return, the plants provide food and shelter to the bacteria. They have a symbiotic relationship. This association is of great significance for the farmers. They do not need to add nitrogen fertilizers to the soil in which leguminous plants are grown.

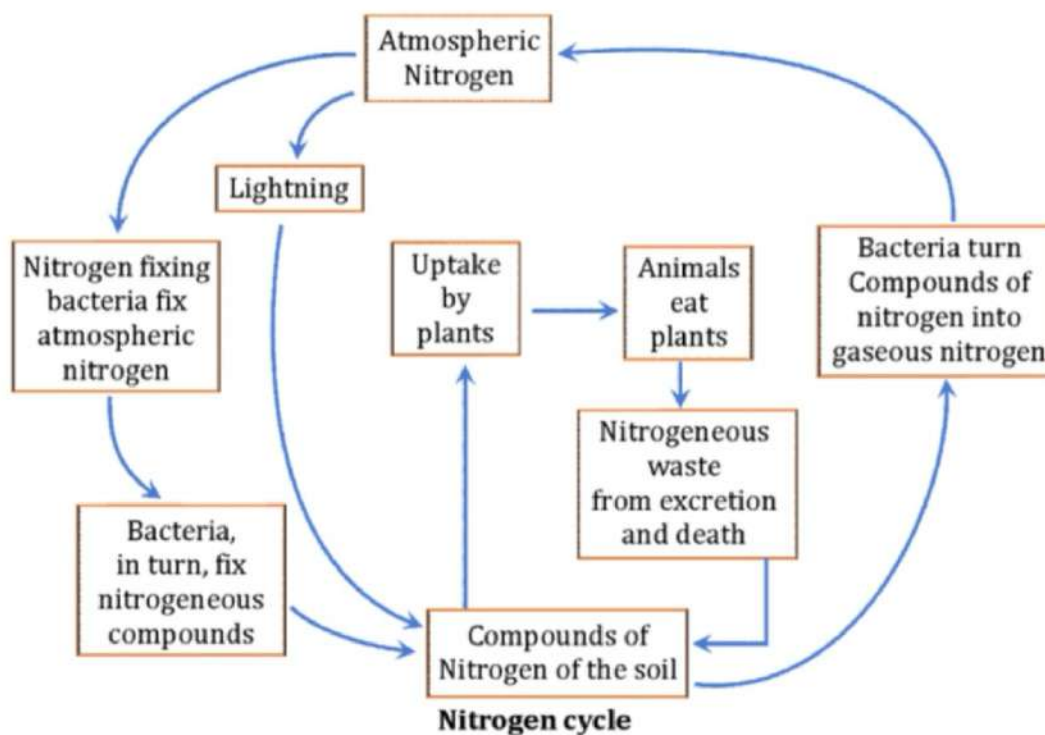
**Steps involved in nitrogen cycle:**

- (1) Atmospheric nitrogen is fixed into nitrogen compounds by *Rhizobium* bacteria, Blue green algae. This is called as nitrogen fixation.
- (2) The plants absorb nitrogen compounds from the soil and convert them into plant proteins.
- (3) The plants are eaten up by animals and thus plant proteins are used for making animal proteins.
- (4) When the plants and animals die, putrefying bacteria and fungi present in the soil decompose the proteins of dead plants and animals into ammonia. This process is called ammonification.
- (5) Ammonia thus formed is converted first into nitrites ( $\text{NO}_2^-$ ) and then to nitrates ( $\text{NO}_3^-$ ) by the action of *Nitrosomonas* and *Nitrobacter* bacteria respectively. The process is called nitrification. These nitrates are absorbed by plants.

- (6) The soil contains denitrifying bacteria called *Pseudomonas* which convert nitrate form of nitrogen into free nitrogen which goes back into the atmosphere. The process is called denitrification.



Schematic diagram of Nitrogen cycle





#### 4. Medicinal use of microorganisms

Microbes are being employed for the production of both antibiotics and vaccines.

**Antibiotics:** Antibiotics are produced by a number of microorganisms and inhibit the growth of other microorganisms even at very low concentrations. Fungi and bacteria are important microbes producing a variety of antibiotics.

**Antibiotics obtained from bacteria:** Streptomycin, aureomycin and chloromycetin, tetracycline, erythromycin.

**Antibiotics obtained from fungi:** Penicillin and Griseofulvin.

These antibiotics are used to cure a variety of diseases in humans, plants and animals.

In 1929, Alexander Fleming was working on a culture of disease-causing bacteria. Suddenly he found the spores of a little green mould in one of his culture plates. He observed that the presence of mould prevented the growth of bacteria. In fact, it also killed many of these bacteria. From this the mould penicillin was prepared.

☐ Antibiotics are not effective against cold and flu as these are caused by viruses.

##### Precautions to be taken while using antibiotics :

1. It should be taken only on the advice of a qualified doctor.
2. Patient must complete the entire course as prescribed by the doctor.
3. Excess dose must not be taken.
4. 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, antibiotic taken unnecessarily may kill the beneficial bacteria in the body.



The first antibiotic to be isolated was Penicillin from *Penicillium notatum* by Alexander Fleming in 1929.

SPOT LIGHT



- ★ Even if your symptoms go away, the bacteria may still be present in your body. If you stop treatment before the antibiotic cycle is over, the remaining bacteria can continue to multiply. If these bacteria become resistant to the antibiotics, they can potentially do even more harm.

**Vaccines:** A vaccine is a biological preparation that improves immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing microorganism and is often made from weakened or killed forms of the microbe or its toxins. When a disease-causing microbe enters our body, the body produces antibodies to fight the invader. The body



also remembers how to fight the microbe if it enters again. If dead or weakened microbes are introduced into a healthy body, the body fights and kills the invading bacteria by producing suitable antibodies. The antibodies remain in the body and we are protected from the disease-causing microbes for ever. This is how a vaccine works. At present, vaccines against several diseases have been produced such as diphtheria, measles, mumps, rubella and polio. Polio drops given to the children under pulse polio program is actually a vaccine. Edward Jenner discovered the first vaccine against smallpox (1798).



The conversion of dead organic matter into useful organic substance by the decomposing activity of microorganisms is known as composting.

**SPOT LIGHT**



### Why are children/infants given vaccination?

#### Explanation

Vaccination is given to children/infants to strengthen or activate the defence mechanism of the body against a disease and to protect the body from the disease-causing microbes, because the immunity of an infant is low and so is more susceptible to any infection.



1. Name the micro-organism that is useful in nitrogen fixation.
2. How are microbes useful in the field of medicine?
3. Name the process used to convert sugar into alcohol.
5. **Cleaning in the environment**
  - (i) Microbes, like bacteria and fungi, bring about the decay of dead plants and animals, both on land and in water.
  - (ii) They act on dead plants and animals and convert various complex organic compounds into simple inorganic substances. Thus, microbes also help in recycling of nutrients. Microorganisms present in soil can easily decompose plants waste but cannot decompose polythene bags.
  - (iii) They also help in sewage disposal by putrefaction (incomplete decomposition of dead organic matter).

## Microorganisms - as foe

Microorganisms can cause harm in many ways. Many microbes are the causative agents of various diseases that affect plants and animals. Such disease-causing microorganisms are called pathogens. They also cause damage of clothes, leather and spoilage of food.

### (1) Disease causing microorganisms

- (a) **In human:** Pathogens enter our body through various sources like air, water, food and infected person. The microbial diseases that can spread from an infected person to a healthy person through air, water, food, insects and physical contact are known as Communicable/Infectious diseases. e.g. Cholera, Common cold, Chicken pox, tuberculosis.



**Sneezing can cause infection to a healthy person. Explain?**

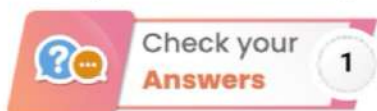
#### Explanation

When a person suffering from common cold sneezes, fine droplets of moisture carrying thousands of viruses are spread in the air. The virus may enter the body of healthy person while breathing.

**Vectors:** Those organisms which help the microbes in the transmission of disease, are known as vectors e.g. houseflies, mosquitoes, cockroaches, rats. Cholera and typhoid are spread through houseflies.

Another example of a vector is mosquito, Female *Anopheles* mosquito, which is the vector for the parasite (*Plasmodium*), that is the causative agent of malaria.

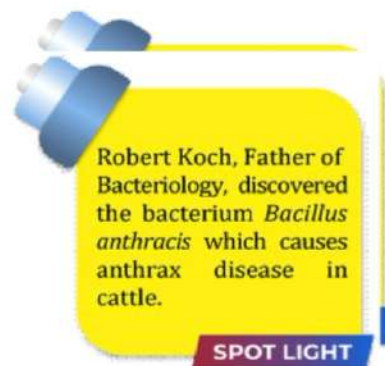
Similarly, Female *Aedes* mosquito is the vector of dengue virus which causes dengue fever.



1. Azotobacter or *Rhizobium*.
2. Microbes are used in the production of vaccines and antibiotics.
3. Fermentation.

#### Control measures of houseflies and mosquitoes

- (i) Food must be kept covered.
- (ii) Proper sanitation.
- (iii) Garbage should be disposed properly.





- (iv) Mosquitoes breed in water. So, water must not be allowed to collect anywhere.
- (v) Spraying of kerosene on the surface of water to form a thin film (this blocks oxygen and kills larvae of mosquitoes).

#### Some common human diseases caused by microbes:

Human disease	Causative micro-organism	Mode of transmission	Preventive measures (General)
Tuberculosis	Bacteria	Air	Keep the patient in complete isolation. Keep the personal belongings of the patient away from those of the others.
Measles	Virus	Air	
Chicken pox	Virus	Air/Contact	
Polio	Virus	Air/Water	Vaccination to be given at suitable age.
Cholera	Bacteria	Water/food	Maintain personal hygiene and good sanitary habits. Consume properly cooked food and boiled drinking water. Vaccination.
Typhoid	Bacteria	Water	
Hepatitis A	Virus	Water	Drink boiled 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.

- (b) **In animals:** Microbes not only cause disease in humans but also in other animals. The following table shows the list of microorganisms affecting various animals.

#### Common animal diseases

Microorganism	Name of animal diseases
Virus	Foot and mouth disease of cattle, Ranikhet of birds
Bacteria	Anthrax disease of cattle
Protozoa	Sleeping sickness (in cattle, pigs and horses)

- (c) **In plants:** There are several microbes causing diseases in plants. The list of microorganisms affecting plants is shown below in the table.

#### Common plant diseases

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

The diseases in plants result in decrease in crop yield. Therefore, the plants have to be treated by chemicals to protect them from disease causing microorganisms.



1. How are viruses different from other microbes?
2. Why do we use nitrogen fixing bacteria as a fertilizer?
3. Name any two diseases caused by bacteria in humans.

## (2) Microbes Causing food spoilage

The contamination of food by microorganisms results into food spoilage. The consumption of this spoiled food by humans or animals results into food poisoning.

Microorganisms like bacteria and fungi are responsible for food poisoning. These microbes when grow on food substances produce toxin. These make the food poisonous causing vomiting, serious illness and even death.

Therefore, there is a need to preserve food from being spoiled.

## Food Preservation

The food that we eat is either in raw or cooked form. All types of food can be targets of microbes which result into food spoilage.

## Methods of Food Preservation

The process of treating and handling food with an aim to stop or slow down its spoilage while maintaining its nutritional value, texture, and flavour.

- (i) **Heat and cold treatment:** Boiling of milk and liquid food products kills many microorganisms. Similarly, low temperature inhibits the growth of microbes.

**Pasteurisation:** This method was developed by scientist Louis Pasteur. It is used to store milk and liquid food products. In this the food is heated about 70°C for 15 to 30 seconds and then suddenly chilled and stored.



**Low temperature Storage:** Microorganisms present in food products cannot be destroyed by low temperature, but their metabolic activities can be arrested so that they

can't act on food products at  $-10^{\circ}\text{C}$  to  $-18^{\circ}\text{C}$  temperature. Fruits, eggs and meat can be stored for long time.

**Refrigeration :** Fresh fruits, vegetables, fish, meat, eggs, etc. can be stored by keeping the temperature below  $5^{\circ}\text{C}$ .



### Why does the milk that comes in packet does not require boiling?

#### Explanation

The milk that comes in packet is pasteurized milk, so it can be consumed without boiling as it is free from harmful microbes.

- (ii) **Chemical Method :** Chemicals which are used to check the growth of microbes are called preservatives. Salts and edible oils are commonly used for this. The commonly used preservatives are sodium benzoate, sodium metabisulphite and potassium metabisulphite. This method is employed in the preservation of fruit juices, jams, squashes, fruits, etc.
- (iii) **Preservation by common salt :** Common salt has been used to preserve meat and fish for ages. Concentrated solutions of common salt can kill microorganisms due to dehydration. Salting is also used to preserve amla (Indian gooseberry), tamarind and raw mangoes.
- (iv) **Preservation by sugar :** Sugar reduces the moisture content which inhibits the growth of bacteria. Jams, jellies and squashes are preserved by sugar.
- (v) **Preservation by oil and vinegar:** Use of oil and vinegar prevents spoilage of pickle because bacteria cannot live in this environment. Vegetables, fruits, fish and meat are often preserved by this method.
- (vi) **Preservation by radiation:** In this method air tight packed food substances, are passed through a radiation beam, microorganisms present in food substances get destroyed due to radiation. This method is new and cheaper.
- (vii) **Storage and Packing:** Dry fruits and vegetables are sold in sealed air tight packet to prevent the attack of microbes.



Mango gets spoiled at room temperature within few days, but the mango pickle remains as such for a long time.

Explain.

Explanation

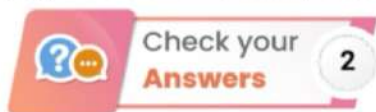




In pickles, we add some preservatives such as salt or acids that do not allow microbes to grow in such an environment. Therefore, mango pickles can remain fresh and preserved for a long time.

#### **Advantages of food preservation**

- (i) This prevents the food from being spoiled by the action of microorganisms.
- (ii) It increases the storage period of food materials.
- (iii) It helps in obtaining the off-season food materials.
- (iv) It makes the transportation of food materials easier.



1. Viruses are different as they do not have any cellular organization, so they cannot be classified as living. But when they enter into the body of a living organism, they become living and cause disease.
2. Nitrogen fixing bacteria helps in fixing atmospheric nitrogen into compounds of nitrogen, thereby enrich the soil with nitrogen. Therefore, they are used as fertilizers.
3. Typhoid and Tuberculosis.



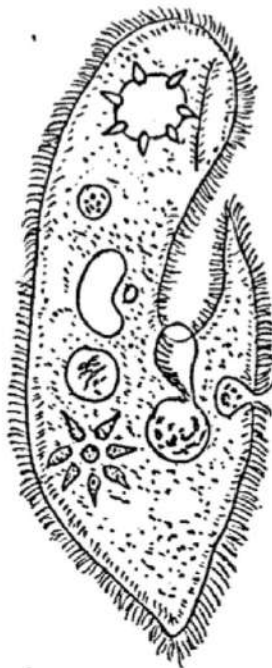
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## Biology Diagrams made Easy

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Amoeba



Paramecium

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## Chapter At a Glance

