CHAPTER 2

Microorganisms: Friends or Foes?

More than three hundred years ago, Anton van Leeuwenhoek, a Dutchman was looking at a drop of pond water under a crude microscope he had made. To his surprise, he found tiny living things moving about in the water. He called them 'animalcules' which meant tiny animals. These organisms, which are too small to be seen with the naked eye, are now called **microorganisms.** They can only be seen when magnified by a **microscope.** All viruses, bacteria, unicellular organisms and some multicellular fungi and algae are termed as microorganisms.

Activity 1

With the help of your teacher, look at a drop of pond water under a microscope. You may be able to see some of the microorganisms that you are going to learn about in this chapter.

These days the terms 'viral infection' and 'viral fever' are widely used. Almost every person has suffered from viral fever. If you have ever had mumps, chicken pox or measles, then you have had a disease caused by a **virus.** Other diseases caused by viruses are rabies, influenza (or flu), dengue, hepatitis and AIDS. Viruses are very small indeed! They are fifty times smaller than a bacterium. All viruses are parasites and cause diseases in human beings, animals and plants.

Viruses are on the borderline between living and non-living things. They are made of some compounds found in living things. They can carry out all their life processes and reproduce when they are inside a living organism. However, they behave like non-living things when outside living cells.

Did you know?

Anton van Leeuwenhoek, born in Delft, Holland, in 1632, was an unlikely scientist. He came from a family of tradesmen, had no higher education or university degrees and knew no languages other than his native Dutch. Yet with skill, diligence, endless curiosity and an open mind free of the scientific dogma of his day, Leeuwenhoek succeeded in making some of the most important discoveries in the history of biology. It was he who discovered bacteria, free-living and parasitic microscopic protists, sperm cells, blood cells, microscopic nematodes and much more.

His researches, which were widely circulated, opened up an entire world of microscopic life for scientists to explore.

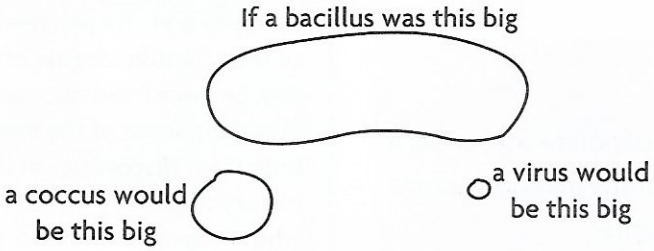
▲ Anton van Leeuwenhoek

Look up the meanings of these words in a dictionary: protists; nematodes.

Bacteria

Bacteria (singular: **bacterium**) are found anywhere and everywhere. They are found inside and outside your body, in the air, in soil and in water. They can survive harsh conditions like drought and heat. Some bacteria, which can respire without oxygen, are called **anaerobic** bacteria. Others, called **aerobic** bacteria, need oxygen for respiration.

Bacteria are made up of one cell and are only visible under a compound microscope. They are of different shapes and sizes. The rod-shaped bacteria are called **bacilli** (singular: **bacillus**). Some bacteria are spherical and are called **cocci** (singular: **coccus**). The spiral-shaped ones are called **spirilla** (singular: **spirillum**) and still others are comma-shaped. Their size may vary from 0.2 to 100 micron (1 micron = one-millionth of a metre).



▲ The figure here compares the sizes of a rod-shaped bacterium, a coccus and a virus.

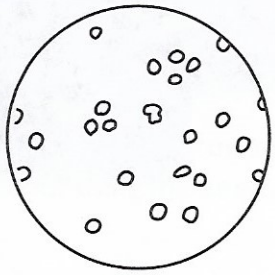
Most bacteria lack chlorophyll. Therefore, they either live as saprophytes or parasites. Some bacteria live in a symbiotic relationship with the other organisms. For example, a bacterium called *Escherichia coli* lives in the intestine of man and can synthesise vitamins B and K which are useful to man.

Exercise 1

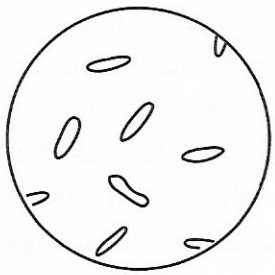
Do you remember the difference between saprophytes and parasites?

Exercise 2

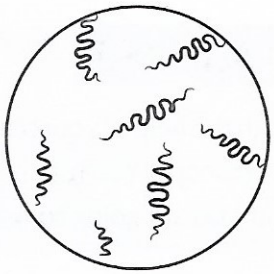
In the last chapter you had learnt about one kind of symbiotic bacteria. Can you name it and describe what it does?



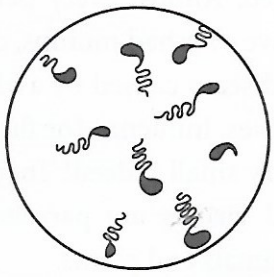
▲ cocci



▲ bacilli



▲ spirilla



▲ comma-shaped bacteria

▲ different shapes of bacteria

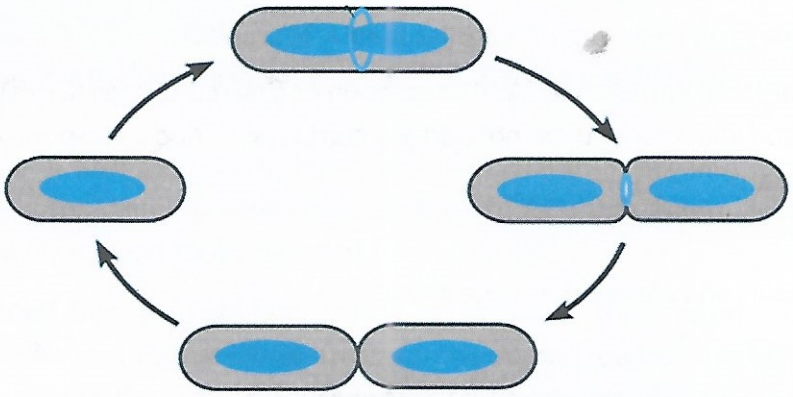
Blue-green bacteria were earlier called blue-green algae by scientists. They are able to make their own food because they have chlorophyll in them. The cells of blue-green bacteria may occur as single cells or in a cluster called a **colony**. In a colony, similar cells are attached to each other. You may have seen these colonies of blue-green bacteria, as a large mass of bluish-green scum floating on the surface of a pond. Another example of blue-green bacteria, called *Nostoc*, can be found in flooded rice fields.

Exercise 3

i. What role do blue-green bacteria play in the rice field?

ii. Are they heterotrophic or autotrophic?

Under favourable conditions—suitable temperature, moisture and enough food—bacteria divide rapidly. They multiply by **fission**. A bacterium simply divides into two organisms. Bacteria may divide as often as once in every 20 to 40 minutes.



▲ binary fission in bacteria

Exercise 4

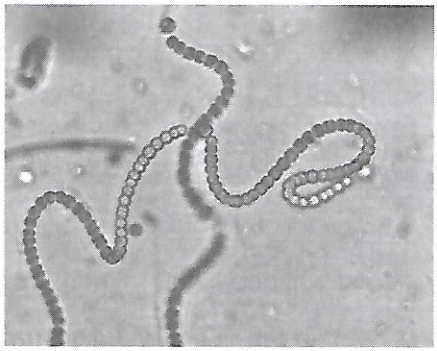
Suppose a bacterium divides once every one minute. It can divide and fill half a tea cup in one hour. How much time will it take to fill the whole tea cup?

Bacteria as Friends and Foes

Parasitic bacteria can cause diseases in human beings, animals and plants. Tuberculosis, typhoid, cholera, pneumonia, sepsis of wounds and sore throat are human diseases caused by bacteria.

Did you know?

If you magnify the width of your hair 100,000 times, it will appear six meters thick! You would have to magnify a virus 100,000 times to see it. Viruses can only be seen under an **electron microscope** which can achieve this magnification. For this reason viruses were first seen only when the electron microscope was developed in the 1930s.



▲ *Nostoc* (highly magnified)

Did you know?

Earlier blue-green bacteria were classified as algae, the simplest of plants. This was because they showed the most important characteristics of plants, namely the presence of chlorophyll and a cell wall. Later, they were found to show more similarity in structure to bacteria than to algae. Scientists now classify them with bacteria, in a group or kingdom called Monera.

Bacteria also spoil food when it is not stored properly. However, there are instances where bacteria are helpful to us.

Bacteria and fungi act as **decomposers.** They break down dead plant and animal matter and help return the minerals to the soil. Farmers make use of bacteria to make compost by decomposing biodegradable household waste. Bacteria also help farmers in making **biogas** and ***gobar* gas** from human and animal wastes. These gases are used for cooking purposes or for making electricity. The solid material, left after the gas is formed, is used as manure. You have read last year how bacteria help in the treatment of sewage.

Blue-green bacteria and some symbiotic bacteria help in the fixation of atmospheric nitrogen.

Ruminants, such as cows, buffaloes, sheep, goats, have bacteria in their digestive system which help in the digestion of cellulose, that is, the fibrous part of food.

Some bacteria help in the making of vinegar, the tanning of leather and the curing of tea.

Spirulina, a blue-green bacterium, is used in making a protein-rich food supplement.

Activity 2 What makes curd set?

You can carry out this experiment in school or at home.

You will need: 400 ml milk, curd, four small clean jars with lids labelled A, B, C and D

Pour about 100 ml of lukewarm boiled milk into each jar. Add a teaspoon of fresh curd in jar A. Heat a small quantity of the curd strongly and add it to jar B. Do not add any curd in jar C. Add a teaspoon of curd to jar D and place it in a refrigerator.

Place jars A, B and C in a warm place.

Observe the jars after four to five hours and answer these questions.

i. What do you see in jars A, B and C?

ii. Why did the milk in jars B and C not set into curd?

iii. What happened in D? Can you say why?

Exercise 5

Why is left-over food usually stored in a refrigerator?

Exercise 6

Which one gets spoilt faster: dry flour or kneaded dough made out of it?

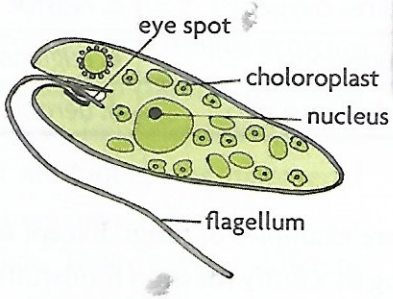
Exercise 7

What do you think are the conditions required for the growth of bacteria?

Protists

Some unicellular organisms form a group called **protists** (*protos*: first). They are single-celled microorganisms that live in water or in moist places. There are **plant-like protists** such as **diatoms** and ***Euglena***, which make their own food. *Euglena*, however, shows the characteristics of both plants and animals. Like plants, *Euglena* has chlorophyll. But when there is not enough sunlight, it can obtain its food from the surrounding water, like animals. It also lacks a cell wall and moves like an animal with the help of a whip-like **flagellum**.

▲ *Euglena* (highly magnified)



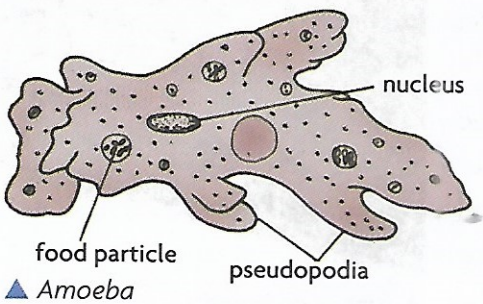
▲ Practise this drawing.

Diatoms have a two part, glassy, shell-like cell wall. When they die, they form 'diatomaceous earth'. Because of its rough nature, it is used for making toothpaste and for polishing.

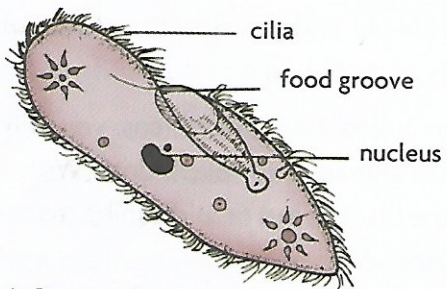
Animal-like protists are called **protozoans** (first animals). ***Amoeba*** and ***Paramecium*** are examples of protozoans. *Amoeba* moves with the help of **pseudopodia** (singular: **pseudopodium**) and **cilia** help in the movement of *Paramecium*.

Just like bacteria, most protists reproduce asexually by fission.

▲ *Paramecium (highly magnified)*



▲ *Amoeba*



▲ *Paramecium*

(Practise these drawings.)

Did you know?

Bacteria play an important role in the field of genetic engineering. Diabetes is a disease in which the pancreas of the patient produces little or no insulin. Earlier, insulin was extracted from cows and pigs. This had unwanted side effects. Nowadays, insulin is made with the help of bacteria. It is used to treat diabetic patients. The insulin produced by these bacteria is similar to human insulin. Many GM (genetically modified) foods are also made using bacteria.

Most protists are harmless. However, one species of *Amoeba* lives in the intestines of human beings and causes a disease called **amoebic dysentery**. This leads to frequent loose motions and stomach upsets. Another common protozoan is the **malarial parasite** (*Plasmodium*) which causes malaria. The female *Anopheles* mosquito carries this protist from malaria patients to other healthy persons.

Exercise 8

Match the terms in column A and column B.

Column A	Column B
i. cilia	**a.** *Amoeba*
ii. autotrophic bacteria	**b.** *fission*
iii. flagellum	**c.** *Paramecium*
iv. requires oxygen	**d.** *Nostoc*
v. pseudopodia	**e.** *Euglena*
vi. dividing into two	**f.** *aerobic*

Fungi

Yeasts, moulds and mushrooms are examples of fungi. Except for mushrooms, fungi are microscopic. You may have seen mould growing as a fluffy mass on foodstuffs, shoes, dead plant and animal matter. Fungi were once classified as non-green plants. Fungi have characteristics different from both plants and animals.

Fungi lack chlorophyll. Their cell walls are made up of a material different from plant cell walls. They get their food from other living things like animals; but fungi are not animals. Animals digest their food inside their body; fungi digest it outside their body by releasing enzymes on the food. Once the food is digested, it is absorbed by the fungus. All saprophytic fungi obtain their food like this. When they live

Activity 3 Growing Bread Mould

Take a fresh slice of bread or a *chapatti*. Place it inside a plastic bag and close it. Put it in a warm place and observe it after three to four days. You will probably find that the bread has white, black and greenish patches of mould on it.

Observe the mould on the bread with a hand lens; you will see a fluffy mass of cotton-like threads with black dots. With your teacher's help, a slide of the black bread mould can be made and observed under the microscope.

▲ fungus on bread

Activity 4 Teacher Demonstration

You will need: test tubes, yeast, sugar, water and small balloons

Take two clean test tubes labelled A and B. Put a pinch of dry yeast and a pinch of sugar in each test tube. Now add one teaspoon of water to test tube B. Fix a small balloon on the mouth of each test tube. Make sure that the balloons are fixed tightly so that the test tubes are air tight. Place the test tubes in a warm place for 24 hours.

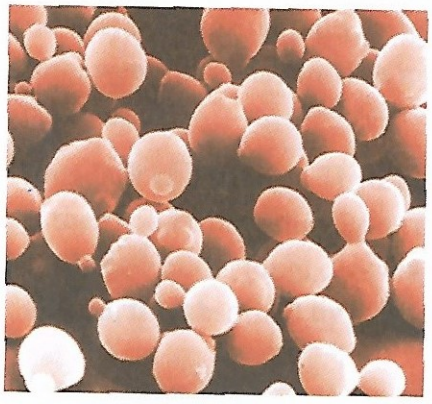
i. What do the contents in the two test tubes look like after 24 hours?

ii. What happens to the balloon in each of the test tubes?

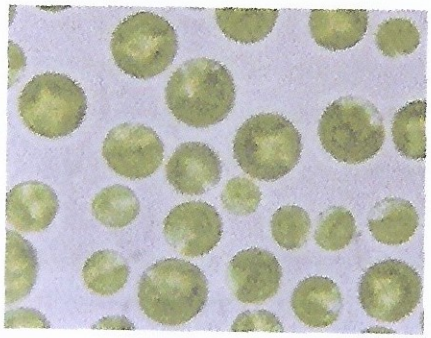
iii. Why is there a change in one test tube but none in the other?

iv. Take some lime water in a test tube and pass the gas collected in the balloon of test tube B into the lime water. What do you see?

v. With your teacher's help, make slides from samples taken from both the test tubes and observe them under a microscope. What do you see?



▲ budding in yeast (highly magnified)



▲ *Chlorella* (highly magnified)

Exercise 9

Have you seen *dosa* and *idli* dough rise after it is kept overnight? What happens in the dough?

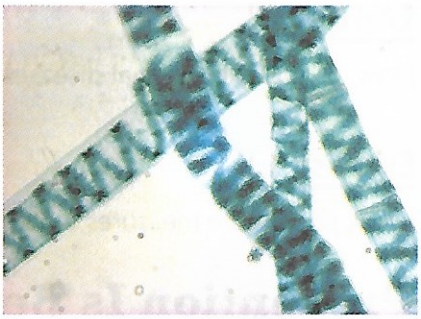
Algae

Algae belong to the plant kingdom. They are the simplest plants. All algae are autotrophic, as they posses chlorophyll. Most algae live in water. Some algae are microscopic, and some others, like sea weeds, are big enough to be seen with the naked eye. Some algae, like *Chlorella*, are unicellular. Others, like *Spirogyra*, are multicellular. *Spirogyra*, has similar cells joined end to end in long chains called **filaments**. It is therefore called a **filamentous alga**.

Algae play a major role in the production of oxygen on the earth. Microscopic algae are part of the **phytoplanktons** that inhabit the sunlit layers of seas. Phytoplanktons form food for many small aquatic animals. Some whales also eat phytoplanktons. Marine phytoplanktons provide 90% of the earth's oxygen!

Exercise 10

Arrange the following organisms in order starting with the smallest.
coccus, mould, virus, bacillus, yeast, *Spirogyra*



▲ *Spirogyra* (highly magnified)

Communicable Diseases

All infections and **communicable diseases** are spread through microorganisms or **microbes**. Disease-causing microbes are called **pathogens**. How do these pathogens spread? Microbes are present all around us. They enter our body through cuts or wounds. They may also enter the body through the air we breathe, the water we drink and the food we eat. When you sneeze or cough, you should cover your mouth with a handkerchief. The act of sneezing or coughing gives out a fine spray of droplets in the air. The disease-causing germs are carried through these droplets to a healthy person and spread the infection. Chicken pox, measles, diphtheria, whooping cough, influenza and tuberculosis of the lungs are spread through **droplet infections**.

▲ *Aedes* mosquito

Last year you learnt how water is made safe for drinking. If drinking water is polluted, it can lead to both, **communicable** and **non-communicable diseases**. Cholera, polio, hepatitis and gastroenteritis spread through water. You may have read the warnings in newspapers, specially during an epidemic. The simplest way to remove germs from water is to boil it for at least ten minutes.

Exercise 11

The swimming pools were closed when a few cases of hepatitis were reported in the city. Can you say why?

Some insects act as **carriers** or **vectors** of diseases. Malaria is spread by the female *Anopheles* mosquito which carries the malarial parasite (*Plasmodium*). The mosquito, *Aedes aegypti*, acts as a carrier for the **dengue virus**. Houseflies carry germs from dirty places like garbage and animal wastes. When the flies sit on exposed food, the food gets contaminated. A healthy person falls sick if he eats this food.

▲ *Anopheles* mosquito

Several diseases are spread by direct contact with a sick person—by sharing towels, clothes and crockery used by the sick person. Fungal diseases in human beings are spread by direct contact. Conjunctivitis, a severe eye infection, spreads in a similar manner. AIDS and hepatitis B can spread through blood transfusion.

Exercise 12

How do you think fungal diseases, like rust, spread in plants?

Exercise 13

What preventive measures would you take against the spread of malaria and dengue?

Prevention Is Better than Cure

What steps should be taken to prevent the spread of the communicable diseases? Patients suffering from highly communicable diseases like chicken pox, measles, mumps and TB, should be kept apart from healthy persons. They should not share their clothes and towels with anyone. All items of personal use should be periodically disinfected to kill disease-causing microorganisms.

Your body has a defense mechanism to fight infections. The body reacts to infections by producing **antibodies** against the disease. These destroy the foreign bodies and germs that enter the body. These antibodies remain in the blood for some time and provide **immunity** or protection against such infections. Sometimes, immunity is provided artificially in the form of **vaccines**. These vaccines are made commercially on a large scale for diseases like measles, mumps, diphtheria, chicken pox, polio, tuberculosis, hepatitis B, cholera, typhoid and rabies. Smallpox has been eradicated completely due to successful immunisation drives across the world. The inoculations (vaccines) given to a person contain antibodies for a particular disease. The inoculations may also contain dead or weakened microbes. The weakened or dead microbes do not produce the disease, but stimulate the body to produce protective antibodies.

Exercise 14

Ayesha caught measles when she was five years old. A year later, she went and visited her friend Radha who was suffering from measles, but she did not catch the disease. However, soon after, Ayesha did get an attack of chicken pox. Explain.

Animals are also protected against diseases like anthrax, foot and mouth disease and rabies by **inoculations**.

With the world becoming a global village and travel becoming frequent, infected persons may carry diseases from one country to another. Hence, international tourists are required to have inoculations against certain diseases. For instance, passengers travelling through Africa and landing in India must have yellow fever inoculation.

Exercise 15

Find out what inoculations you received in your childhood.

Food Preservation

Microorganisms spoil cooked and processed foods. Today we use a lot of packaged foods. You might have read the terms 'best before' followed by a date on packaged food items. It gives the date upto which the food can be safely consumed. The package may also carry a label which says 'permitted preservatives used'. **Preservatives** are chemicals that are added to increase the shelf life of food items. Chemical preservatives can be harmful if they are not of the correct kind or are used in excess. The FPO or Food Preservation Order lists those chemicals which can be safely used to preserve foodstuffs.

Various other methods of preserving food have been used since ancient times. In very cold places like Ladakh, Kashmir and areas of North India, it is not possible to grow fresh food in the winter. All vegetables used to be **sun dried** in summers and preserved. Now with better transport, fresh products are available throughout the year. However, in most countries, seasonal fruits are still made into jams and jellies. Seasonal vegetables may be pickled or sun dried. Sun drying reduces the moisture content in food materials and prevents the growth of microorganisms. This method is also known as **dehydration**. Vegetables like cauliflower or fenugreek leaves (*methi*) are preserved this way. Salt, oil, sugar and spices are used as preservatives in pickling and making jams. Meat can be salted or smoked and dried out.

Refrigeration of fresh fruit, vegetables and meat, preserves them for a short period only. The temperature in a refrigerator is about 5°C. When **frozen and stored at –18°C**, (18°C below the freezing point of water) food can stay fresh for months. Food taken out of a refrigerator should be heated well before eating. Refrigeration does not kill the microorganisms, it only makes them inactive. Microorganisms start multiplying, once they find suitable temperatures.

Pasteurisation is used mainly to preserve milk. The milk is first heated to 72°C for 15 seconds. It is then cooled quickly. The heating kills most bacteria. The milk is chilled to prevent the growth of any bacteria that may have remained.

Did you know?

Dr Edward Jenner was the first person to discover the small pox vaccine in 1798. He found that milkmaids who had had cowpox, did not get small pox. So, he took some fluid from a cowpox sore and put it on a scratched surface of a healthy boy's arm. The boy developed cowpox. He was then exposed to smallpox. The boy did not develop smallpox. He had acquired immunity to smallpox!