UNIT 16

MICROORGANISMS

Learning Objectives

After the completion of this lesson, students will be able to:

- understand different types of microorganisms.
- differentiate various microorganisms based on their shape and occurrence.
- know the role of microbes in various fields such as medicine, agriculture, industry and daily life.
- know the effects of harmful microorganisms.
- understand the relationship between man and microbes.
- know the effects of prions and virions on human health.

Introduction

Microorganisms are very small in size that they cannot be seen through naked eye. These organisms can be seen only with the help of a microscope. Therefore, they are also known as microbes. The science that deals with the study of microorganisms is known as **microbiology**. Microorganisms are found everywhere. They are found in air, water (ponds, lakes, rivers and oceans), soil and even inside our bodies. They remain inactive under unfavourable conditions and become active during favourable conditions. Microorganisms can be studied under five categories. They are: virus, bacteria, fungi, algae and protozoa. Let us study about them in detail.

16.1 Virus

A virus is a tiny particle made up of genetic material and protein. They are intermediate between living and non living things. Virus means 'poison' in Latin. Viruses are intracellular obligatory parasites. The study of virus is called **virology**. Viruses are 10,000 times smaller than bacteria. Viruses have different shapes. They can be rod shaped, spherical or of other shapes.

16.1.1 Structure of Virus

A virus contains a core DNA or RNA. Surrounding that core is a protein coat. In some viruses, the protein coat is covered by an envelope made of proteins, lipids, and carbohydrates. These envelopes have spikes that help the virus particles attach to the host cells. Viruses cause many diseases to plants, animals and human beings.

16.1.2 Characteristics of Virus

Viruses show both living and non living characters.

Living characters

- They respond to heat, chemicals and radiations.
- They reproduce inside the host cells and produce copies of themselves.

Non-living characters

- They are inactive when present freely in the environment.
- They can be crystallized and stored for a very long time, like other non-living things.

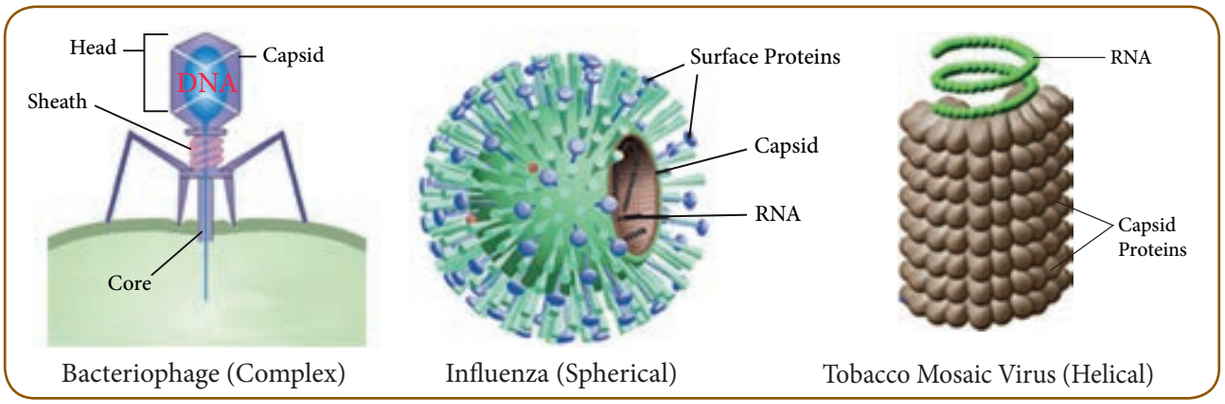

Figure 16.1 Shapes of Virus

16.2 Bacteria

Bacteria are single-celled prokaryotes (cells without nuclei). They are considered to be the first living organisms on earth. Bacteria are grouped under the kingdom Monera. The study of bacteria is called bacteriology. The size of bacteria ranges from 1µm to 5µm (micrometer). Bacteria are of two types based on respiration. They are:

- Aerobic bacteria (requires oxygen).
- Anaerobic bacteria (does not require oxygen).

16.2.1 Cell structure of Bacteria

A bacterium has an outer covering known as the cell wall. Nuclear material is represented by a nucleoid without nuclear membrane. An extra chromosomal DNA called plasmid is present in the cytoplasm. Protein synthesis is carried out by 70S ribosomes. Other cell organelles (mitochondria, golgi body, endoplasmic reticulum etc.,) are absent. Flagella aids in locomotion.

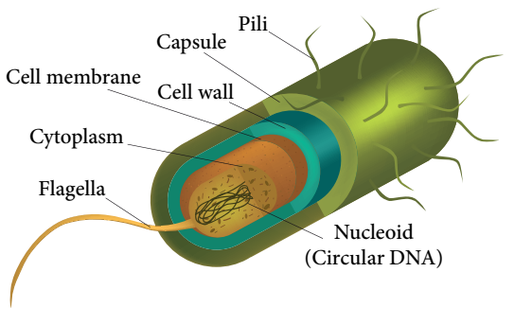

Figure 16.2 Cell structure of Bacteria

Bacteria are classified according to the shape of their cells. They are:

- Bacilli: Rod shaped bacteria.
  Eg. *Bacillus anthracis*
- Spirilla: Spiral shaped bacteria.
  Eg. *Helicobacter pylori*
- Cocci: Spherical or ball shaped bacteria. They can stick together in pairs (diplococcus) or form a chain (streptococcus) or occur in bunches (staphylococcus).
- Vibrio - Comma shaped bacteria.
  Eg. *Vibrio cholera*.

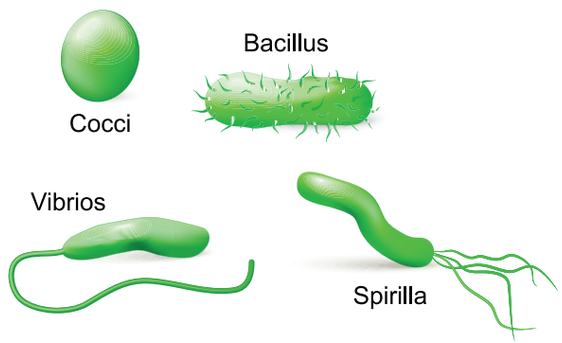

Figure 16.3 Shapes of Bacteria

Bacteria are also classified according to the number and arrangement of flagella. They are as follows.

- Monotrichous: Single flagella at one end.
  Eg. *Vibrio cholera*
- Lophotrichous: Tuft of flagella at one end.
  Eg. *Pseudomonas*.
- Amphitrichous: Tuft of flagella at both ends.
  Eg. *Rhodospirillum rubrum*.

- Peritrichous: Flagella all around. Eg. *E.coli.*
- Atrichous: Without any flagella.
  Eg. *Corynebacterium diptherae.*

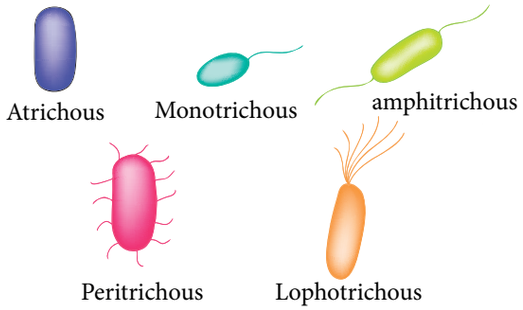

Figure 16.4 Flagellation types in Bacteria

Bacteria get their food in many ways. Photosynthetic bacteria make their own food (Eg. Cyanobacteria). Bacteria that live in harsh environment use chemicals (Ammonia, Hydrogen sulphide) to produce their food instead of utilizing energy from the sun. This process is called chemosynthesis. Some bacteria exhibit symbiotic relationship (Eg. E.coli lives in the intestine of man). Bacteria reproduces by fission (Binary and multiple fission).

Activity 1

Take one or two drops of butter milk on a slide and spread it. Heat the slide slightly on a lamp (3 – 4 seconds). Add a few drops of crystal violet and leave it for 30 to 60 seconds. Then wash the slide gently with water. Observe the slide under the compound microscope.

16.3 Fungi

Fungi are a group of eukaryotic organisms that lack chlorophyll. They grow in dark environments. They may be either unicellular (Eg. Yeast) or multicellular (Eg. Penicillium). They are found in all kinds of habitats. They are included under kingdom Fungi. The study of fungi is called **mycology**. Some fungi are macroscopic (Eg. Mushroom). There are around 70,000 species of fungi, living in the world.

Here, we will study about yeast which is a unicellular fungi. You will study about multicellular fungi elaborately in Chapter 17.

16.3.1 Cell structure of Yeast

Yeasts are found freely in the atmosphere. Yeast grows in all kinds of media containing sugar. The cell is ovoid in shape, containing cell wall and a nucleus. The cytoplasm is granular, and has vacuoles, organelles and glycogen an oil globules. Yeast aids in fermentation with the help of the enzyme zymase. It respires anaerobically and reproduces by budding.

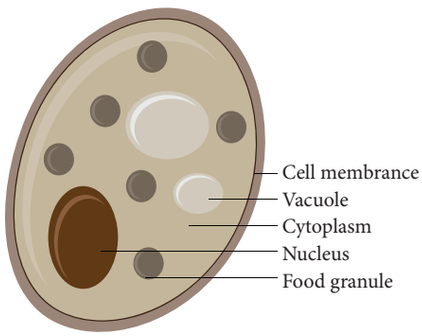

Figure 16.5 Structure of Yeast

16.4 Algae

Algae are very simple plant like eukaryotic organisms. They are found in moist habitats. They are rich in chlorophyll and can be seen as thin film on the surface of lakes and ponds. Therefore they are known as 'grass of water'. They are autotrophic and they produce their own food with the help of chloroplast. Chloroplast contain chlorophyll (green pigments) for photosynthesis. The study of algae is called **algology (phycology)**.

Figure 16.6 Different types of Algae

Their size varies from 1 micron to 50 meter. Algae may be unicellular and microscopic (Eg. *Chlamydomonas*) or multicellular and macroscopic (Eg. *Sargassum*). Unicellular algae exhibits variety of shapes (i.e., spherical, rod, spindle), where as multicellular algae are in the form of filaments and branches. In this section we will study about unicellular algae (Chlamydomonas) alone. Multicellular algae are explained in detail in the next chapter.

16.4.1 Cell structure of Chlamydomonas

Chlamydomonas is a simple, unicellular, motile fresh water algae. They are oval, spherical or pyriform in shape. The pyriform (pear shape) is a common one found in ponds, ditches and water tanks. They have a narrow anterior end and a broad posterior end.

The cell is surrounded by a thin and firm cell wall made of cellulose. The cytoplasm is seen in between the cell membrane and the chloroplast. The cell contains large dark nucleus lying inside the cavity of the cup shaped chloroplast. The anterior part of the cell bears two flagella which helps in locomotion. Two contractile vacuoles are seen at the base of each flagellum. The anterior side of the chloroplast contains a tiny red coloured eyespot. *Chlamydomonas* exhibits sexual and asexual modes of reproduction.

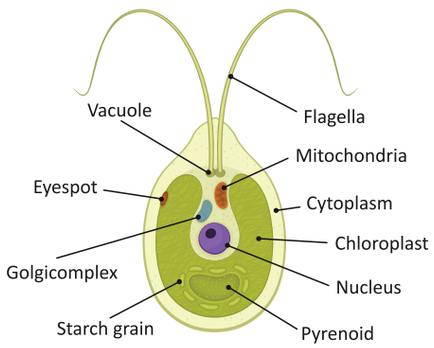

Figure 16.7 Structure of Chlamydomonas

16.5 Protozoa

A protozoan (In Greek, 'protos' means first and 'zoan' means animal) is a single-celled eukaryote. They are included under the kingdom **Protista**. The study of protozoa is called **Protozoology**. They are found in ponds, ocean, in moist soil, and in the cells and tissues of plants and animals causing diseases. They range from 2 to 200 microns. Protozoans have specialized organelles. These organelles are used for movement, feeding, and other functions. The types of protozoans are as follows:

Ciliates: Presence of cilia for locomotion.

Eg. *Paramecium*

Flagellates: Presence of flagella for locomotion.
Eg. *Euglena*

Pseudopods: Presence of pseudopodia for locomotion. Eg. *Amoeba*

Sporozoans: Parasites.
Eg. *Plasmodium*

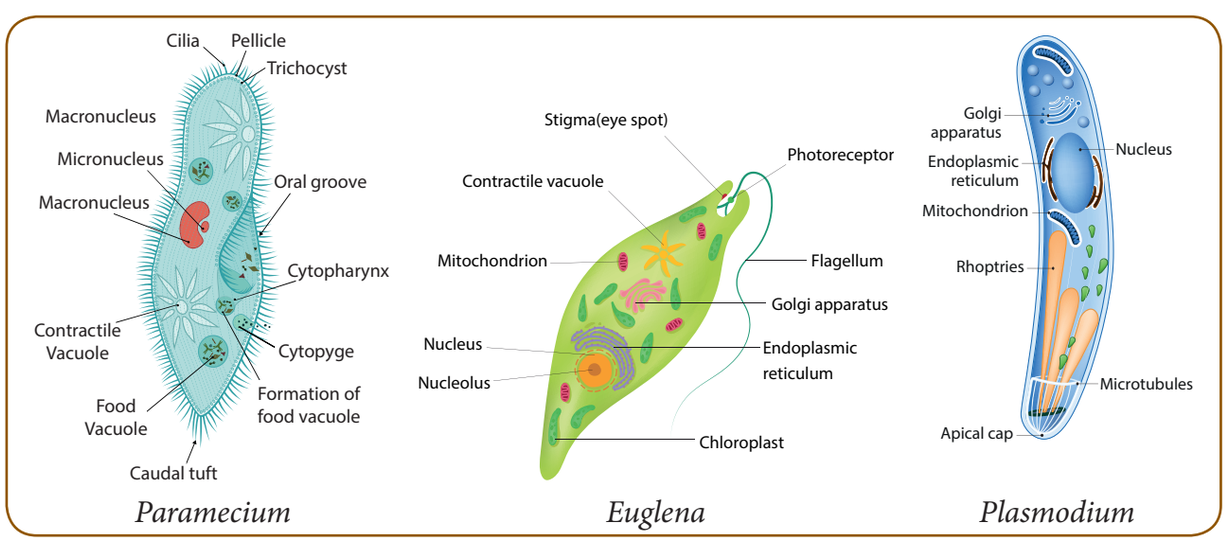

Figure 16.8 Common Protozoans

Activity 2

Take one or two drops of hay (In tamil, vaikol) decoction on a slide and observe it under the microscope.

16.5.1 Cell structure of Protozoa

Amoeba is a unicellular microscopic organism. It is found in ponds. *Amoeba* is irregular in shape. It has cell membrane, cytoplasm and nucleus. It is a protozoan that moves by means of pseudopodia (In Latin, 'false feet'). Pseudopodia are the extended part of cell membrane. It helps to catch its prey (Algae). The body flows around the food particle and engulfs it forming food vacuoles. Contractile vacuoles are seen in the cytoplasm that help in excretion. *Amoeba* reproduces by means of fission and sporulation.

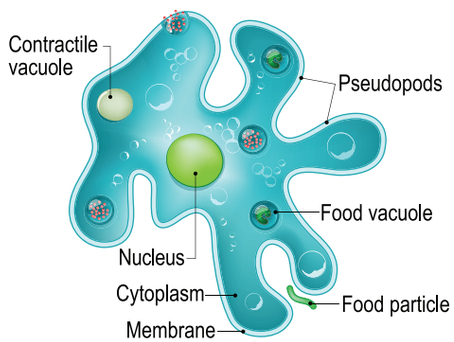

Figure 16.9 Amoeba

16.6 Prions

The word prion is derived from 'protinaceous infectious particle'. Prions have neither DNA nor RNA to transmit infection. A prion is a mutted form of a usually harmless protein. Prions cause diseases by affecting brain or neural tissue. Eg. Creutzfeldt-Jackob disease. Another example is Kuru- associated with cannibalism.

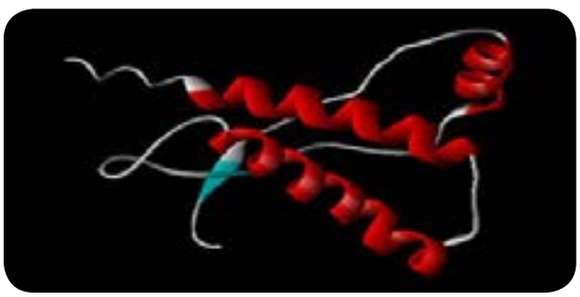

Figure 16.10 Structure of Prion

16.7 Virions

Virion is an entire virus particle consisting of an outer protein shell called a capsid and an inner core of nucleic acid (RNA or DNA). If the virus is found outside the cell (extracellular) it is known as virion. Virion has the capacity to infect the living tissue.

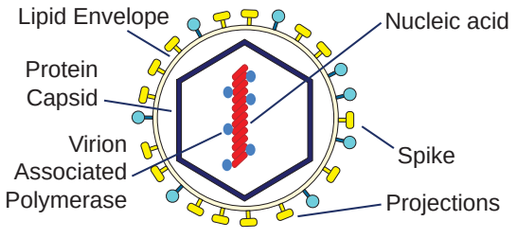

Figure 16.11 Structure of Virion

16.8 Uses of Microorganisms

Microorganisms are useful in different fields such as medicine, agriculture and industry. Some of them are given below.

16.8.1 Medicine

We obtain antibiotics and vaccines from microbes.

Antibiotics

The word 'anti' means 'against'. Antibiotic is a substance produced by living organisms which is toxic for other organisms.

Figure 16.12 Penicillium chrysogenum

Sir Alexander Fleming was the first person to discover the antibiotic penicillin in the year 1928. The antibiotic penicillin was obtained from the fungi *Penicillium chrysogenum*. It is used to treat diseases such as tetanus and diphtheria. The antibiotic, streptomycin is obtained from *Streptomyces* bacteria to cure various bacterial infections. Eg. Plague.

Vaccines

Vaccines are prepared from dead or weakened microbes. Edward Jenner was the first person to discover small pox vaccine. He coined the term vaccination. When the vaccine is injected to the body of a patient, the body produces antibodies to fight against the germs. These antibodies remain inside the body and protect from future invasion of the germs. Therefore, vaccination is otherwise called as immunization. Eg: MMR vaccine is given for preventing Measles, Mumps and Rubella. BCG (Bacille Calmette Guerin) vaccine is given for preventing Tuberculosis.

16.8.2 Agriculture

Natural fertilizer

Microorganisms are called as decomposers because they act upon degradable wastes. During the process, nitrates and other inorganic nutrients are released into the soil, making the soil fertile. This compost is called as natural fertilizer.

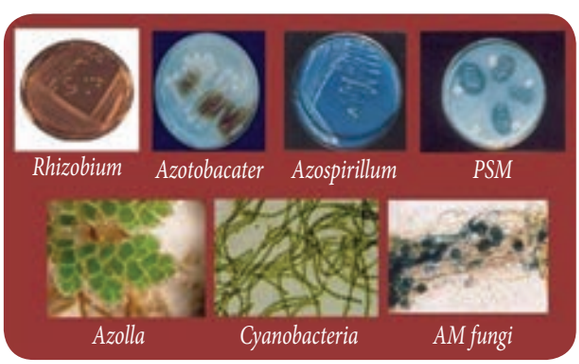

Figure 16.13 Types of Biofertilizers

Nitrogen fixation

Rhizobium bacteria living in the root nodules of leguminous plants enrich the soil by fixing the atmospheric nitrogen as nitrates which are essential for the growth of plants. Some free living bacteria in soil, like Cyanobacteria Nostoc can also fix nitrogen biologically.

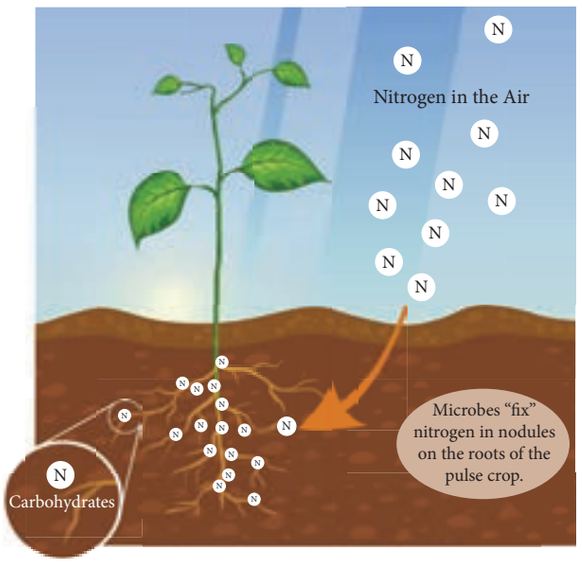

Figure 16.14 Nitrogen fixation in plants

Bio-control agents

Microbes are used to protect the crops from pests. Some of them are given below.

- *Bacillus thuringiensis* (Bt cotton) helps to control insects.
- *Trichoderma* (Fungi) helps to protect roots and controls plant pathogens.
- *Baculoviruses* (Virus) attack insects and other arthropods.

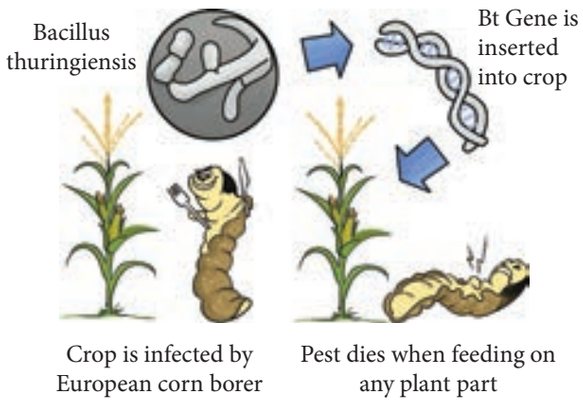

Figure 16.15 Biocontrol agents

16.8.3 Industry

Sewage treatment

Aerobic microbes are allowed to grow in the primary effluent during the secondary stage of waste water treatment. These microbes consume the major part of the organic matter in the effluent. Eg. Nitrobacter sps. In the anaerobic treatment of sewage Methanobacterium is used.

Production of biogas

Human and animal faecal matter and plant wastes are broken down by anaerobic bacteria to produce methane (biogas) along with carbon dioxide and hydrogen. These bacteria are called as methanogens.

Production of alcohol and wine

Alcoholic drinks are prepared by fermentation process using yeast. Sugars present in grapes are fermented by using yeast. Beer is produced by the fermentation of sugars in rice and barley.

Microbes in retting and tanning

Flax plants are tied in bundles and kept in water. Bacteria loosen the supporting fibres of the stem by acting on the stem tissues. This process is known as retting. Linen thread is made from these fibres. Eg. *Pseudomonas aeruginosa*.

In tanning industry bacteria act upon the skin of animals and makes it soft and therefore it becomes pliable.

16.8.4 In daily life

Making bread

Yeast is used in bakeries to make bread and cakes. They are added to the dough to produce carbon dioxide which makes the dough rise. Bread and cakes are soft due to carbon dioxide gas. *Chlorella* (green algae) which is rich in proteins and vitamins is added to the dough to enrich the bread with nutrients.

Preparation of curd and cottage cheese

Lactose in the milk gets turned into Lactic acid by the action of *Lactobacillus* (bacteria). Therefore, milk becomes thick (curd). It gives the sour taste. When curd is processed cottage cheese (panneer) is obtained.

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In Human Intestine

- *Lactobacillus acidophilus* that lives in the human intestine helps in digestion of food and fights against harmful disease causing organisms.
- *E.coli* bacteria living in human intestine help in synthesizing vitamin K and vitamin B complex.

16.8.5 Microbes in Food Process

Microorganisms commonly used for food processing are yeast, bacteria, and moulds. Fermentation process which is carried out by microorganisms results in the production of organic acids, alcohol and esters. They help to preserve food and generate distinctive new food products.

a. Food preservation

Two techniques are followed in food preservation. They are:

- Traditional techniques
- Modern techniques

1. Traditional techniques

Fermentation, pickling, boiling and sugaring are the traditional techniques followed in food preservation.

Fermentation

Fermentation is the microbial conversion of starch and sugars into alcohol. It makes foods more nutritious and palatable.

Pickling

Pickling is a method of preserving food in an edible antimicrobial liquid. It is of two types: chemical pickling and fermentation pickling.

In chemical pickling, food is placed in an edible liquid that kills bacteria and other microorganisms. Eg. Vinegar, alcohol, vegetable oil (pickling agents). In fermentation pickling, bacteria in the liquid produce organic acid as preservation agent that produces lactic acid due to the presence of *Lactobacillus*.

Boiling

Boiling liquid food items kill all the microbes. Eg. Milk and Water.

Sugaring

Sugar is used to preserve fruits in an antimicrobial syrup with fruits such as apples, pears, peaches, plums or in a crystallized form, so that the product is stored in dry condition.

2. Modern techniques

Pasteurization

It is a process for preservation of liquid food. This method was invented by Louis Pasteur in 1862. Milk is preserved by this method. It is heated up to 70 °C to kill the bacteria and it is cooled to 10 °C to prevent the growth of remaining bacteria. Then milk is stored in sterilized bottles in cold places.

b. Food production

Probiotics

Probiotics are live food supplements used in yoghurt and other fermented milk products. Eg. *Lactobacillus acidophilus* and *Bifidobacterium bifidum*. These bacteria improve the microbial spectrum in the gut and thus contribute to the following effects.

- Decrease the risk of colon cancer
- Decrease cholesterol absorption
- Prevent diarrheal diseases by increasing immunity.

16.9 Harmful Microorganisms

A few microorganisms are harmful to plants, animals and humans. They cause diseases and hence they are called as pathogens. Pathogens enter into the body through cuts and wounds in the skin, mouth or nose and cause diseases. Viruses causing 'flu' are spread through air. When the patient sneezes droplets containing viruses spread in air and it gets entered to another person when he breathes. Some of the diseases caused by the microorganisms in plants, animals and humans are given in the tables below.

Citrus canker Potato blight disease

Figure 16.16 Disease in plants

Table 16.1 Diseases caused by microorganisms in plants

Plant diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/ Treatment
Citrus canker	*Xanthomonas axonopodis* (Bacteria)	Air, water	Lesions on leaves, stems and fruit	Copper based bactericides can be used
Potato blight disease	*Phytophthora infestans* (Fungi)	Air	Brown lesions on the surface of tubers	Fungicides are used

Table 16.2 Diseases caused by microorganisms in animals

Animal diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/Treatment
Anthrax (also affects humans)	*Bacillus anthracis* (Bacteria)	Through contaminated soil and food	Difficulty in breathing, unconsciousness, loss of appetite	Anthrax vaccine
Foot and mouth disease	*Aphthovirus* (Virus)	Through air and animal vectors	Fever, blisters in mouth, weight loss, decreased milk production	FMD vaccine

Table 16.3 Diseases caused by microorganisms in humans

Human diseases	Causative microorganisms	Mode of transmission	Symptoms	Preventive measures/ Treatment
Tuberculosis	*Mycobacterium tuberculosis* (Bacteria)	Through air and sputum of infected person	Persistent cough, blood mucus, loss of weight, breathlessness	BCG Vaccine
Cholera	*Vibrio cholera* (Bacteria)	By flies and contaminated food and water	Watery diarrhoea, vomiting, rapid dehydration.	Anticholera vaccine, maintaining personal hygiene.
Common cold	*Influenza* (virus)	Through air	Running nose, sneezing	Isolation of patient
Rabies	*Rhabdo viridae* (Virus)	Animal bite	Fever, hallucination, paralysis, inability to swallow	Anti-rabies vaccine
Amoebic dysentery	*Entamoeba histolytica* (Protozoa)	Food water and flies	Severe diarrhea and blood in stool	Proper sanitation to be followed and metronidazole antibiotic to be administered
Malaria	*Plasmodium* (Protozoa)	Female anopheles mosquito	Nausea, vomiting, high fever	Antimalarial drugs like quinine and chloroquine to be taken and usage of mosquito repellents and nets.

16.10 Relationship Between Man and Microbes- Balances, Imbalances and Uses

Thousands of bacteria, fungi and other microbes that live in our gut are essential contributors to a good health. They break down toxins, manufacture some vitamins and essential amino acids and form a barrier against invaders. Gut microbes are the bacteria in human gut. They are one of the most important allies in our overall health and well being. Gut ensures that the body is absorbing all the important nutrients, to function at its highest level. Many different aspects of health are attached to it.

Points to Remember

- The organisms which can be seen only with the help of microscope are called microorganisms.

- Virus show both living and non living characteristics.
- Bacteria is a prokaryotic, single celled organism.
- Fungi is a eukaryotic, non-photosynthetic, spore-forming organism. They range from single celled organisms to very complex multicellular organisms.
- Algae is a single-celled or multicellular eukaryotic, photosynthetic organism.
- Protozoa is a eukaryotic, single celled organism that usually lacks chlorophyll.

A-Z GLOSSARY

Antibiotic	A chemical that kills or inhibits the growth of micro organism and is used to treat infections.
Bacteria	A prokaryotic, single celled organism.
Capsid	The protein coat surrounding a virus.
Fermentation	Conversion of organic compounds such as carbohydrate into simpler substances by microbes, usually under anaerobic conditions (with no oxygen present).
Hyphae	A very fine thread that is the basic structure of fungi.
Microorganism	A small living thing which includes bacteria, protozoa, algae, fungi and viruses.
Pathogen	An organism that causes disease.
Vaccine	A special type of medicine that is given to both people and animals to artificially increase immunity to a particular disease and to prevent an infectious disease from developing.

TEXTBOOK EXERCISES

1TSVQ

I. Choose the best answer.

1. Microorganisms are measured in _____.
   a) cm b) mm c) micron d) meter.
2. _____ shows both living and nonliving characteristics.
   a) Protozoa b) Virus c) Bacteria d) Fungi
3. _____ is a prokaryotic microorganisms.
   a) Virus b) Algae c) Fungi d) Bacteria
4. Based on shape, the bacteria are classified into _____ types.
   a) two b) three c) four d) five
5. Common cold in human is caused by _____.
   a) plasmodium b) influenza
   c) vibrio cholera d) aphthovirus

II. Fill in the blanks.

1. _____ is prepared from a mould called penicillium.
2. _____ are the infectious protein particles.
3. The infecting virus particle found outside the host cell is _____.
4. Microorganism can be seen with the help of a _____.
5. Bacteria, which has a flagellum at one end is classified as _____.

III. State true or false. If false, correct the statement.

1. Disease causing microorganisms are called pathogens.

2. Female anopheles mosquito is a carrier of dengue virus.
3. Chicken pox is a communicable disease.
4. Citrus canker is transmitted by insects.
5. Yeast is used in the large scale production of alcohol.

IV. Match the following.

Nitrogen fixing bacteria	Vaccine
Tuberculosis	Prion
Kuru	Lactobacillus acidophilus
Probiotics	Bacteria
Edward Jenner	Rhizobium

V. Answer the following questions.

Mark the correct one as:

a. If both assertion and reason are true and reason is the correct explanation of assertion.

b. If both assertion and reason are true and reason is not the correct explanation of assertion.

c. If assertion is true but reason is false.

d. If both assertion and reason are false.

1. Assertion: Malaria is caused by Protozoa. Reason: The disease is transmitted by mosquito.
2. Assertion: Algae are heterotrophic. Reason: They do not have chlorophyll.

VI. Answer very briefly.

1. Write the name of any nitrogen fixing bacteria.
2. Name the bacteria used in the production of vinegar.
3. Write the names of any three protozoans.
4. Who discovered penicillin?
5. Which diseases can be prevented by vaccination?

VII. Answer briefly.

1. Write the four types of bacteria, based on their shape.
2. What are antibiotics?
3. What are pathogens?
4. How disease causing microorganisms enter into human beings?
5. Why microorganisms are essential for agriculture?

VIII. Answer in detail.

1. Write a short note on bacteria and its structure.
2. How microorganisms are useful in the field of medicine?
3. Write a short note on common human diseases caused by microorganisms.
4. How can we improve the beneficial bacterial count in human beings?
5. Write a short note on probiotics.

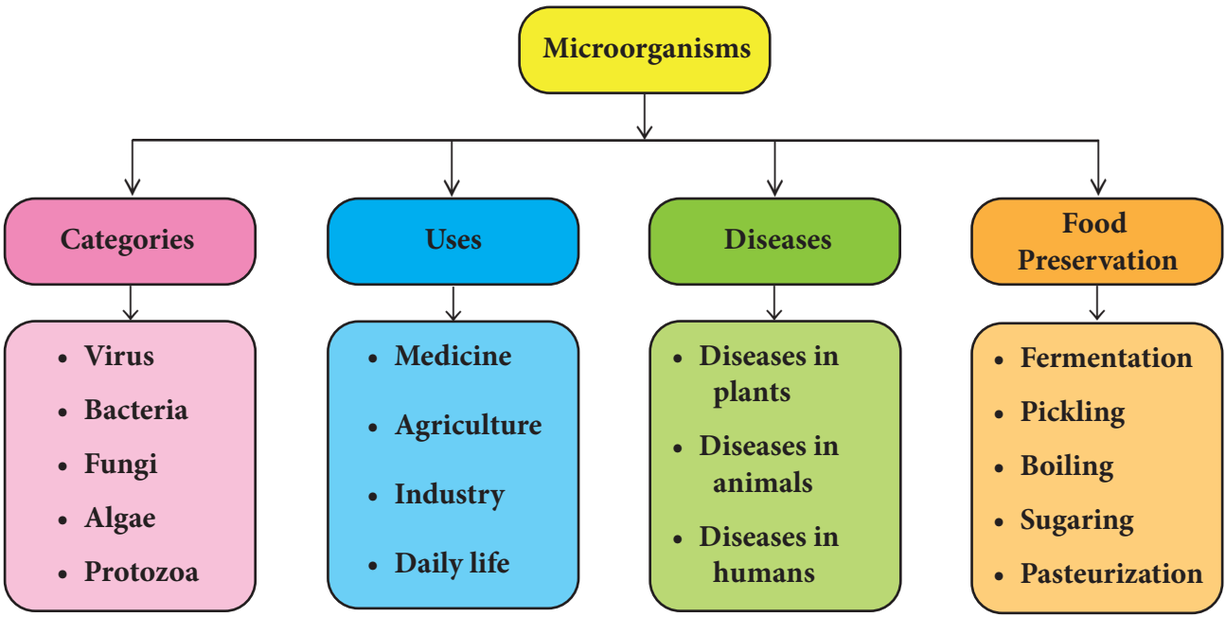
REFERENCE BOOKS

1. Ananthnarayan and Panicker's-Textbook of Medical Microbiology. Edited by C.K.J.Panicker.
2. Essential Microbiology - Stuart Hogg.
3. Textbook of Microbiology - Surinder Kumar.

INTERNET RESOURCES

1. https://en.wikipedia.org/wiki/Microorganism
2. https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/microorganisms

Concept Map



ICT CORNER

MICROORGANISMS

This activity enables the students to know about the Classification of Micro organisms

Steps

- Open the Browser and type the given URL (or) Scan the QR Code.
- Options will be given. Select the "Classification of Microorganisms"
- Click and touch the button slides one by one
- To know about the "Classification of Microorganisms"


Step1


Step2


Step3


Step4

Web link: https://www.slideshare.net/mgcnkedahsc/11-classsification-of-microorganisms

(or) scan the QR Code