

World of Microbes

Learning Objectives

After completing this lesson, students will be able to

- identify different groups of bacteria based on their shape and structure.
- categorize types of viruses.
- know the role of microbes in agriculture, food industries and medicine.
- gain knowledge on modes of infection and disease transmission.
- describe the spectrum of diseases on the basis of the causative agents.
- know disease control and preventive measures.



Introduction

Microbiology (greek words: mikros -small, bios- life bearing, logy- study), is a branch of biology that deals with living organisms of microscopic size, which include bacteria, fungi, algae, protozoa and viruses. Microbes are found in habitats like terrestrial, aquatic, atmospheric or in living hosts. Some of them survive in extreme environments like hot springs, ice sheets, water bodies with high salt content and low oxygen, and in arid places with limited water availability.

Some of the microorganisms are beneficial to us and they are used in the preparation of curd, bread, cheese, alcohol, vaccines and vitamins, while some others are harmful causing diseases to plants and animals including human being. This lesson will explore the beneficial and harmful effects of microbes in relation to welfare of human kind.

22.1 Microbes and their Types

Microorganisms differ from each other in size, morphology, habitat, metabolism

and several other features. Microbes may be unicellular (Bacteria), multicellular (Fungi), acellular (not composed of cells-Virus). Types of microbes include bacteria, viruses, fungi, microscopic algae and protists.

22.1.1 Bacteria

Bacteria are microscopic, single celled prokaryotic organisms without nucleus and other cell organelles. Although majority of bacterial species exist as single celled forms, some appear to be filaments of loosely joined cells. The size varies from less than 1 to 10 μm in length and 0.2 to 1 μm micrometer in width. Bacteria may be motile or non-motile. Special structures called flagella are found on the cell surfaces for motility

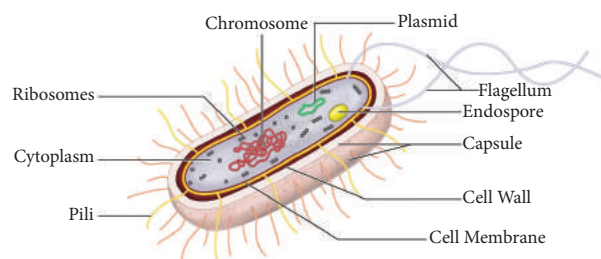


Figure 22.1 Structure of a bacterial cell



a. Shapes of bacteria

Based on the shapes, bacteria are grouped as:

1. Spherical shaped bacteria called as cocci (or coccus for a single cell).
2. Rod shaped bacteria called as bacilli (or bacillus for a single cell).
3. Spiral shaped bacteria called as spirilla (or spirillum for single cell).

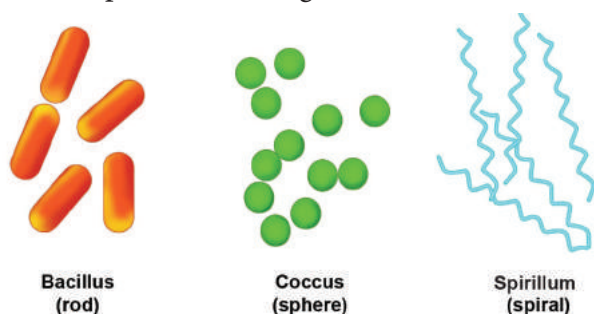


Figure 22.2 Shapes of bacteria



Antonie Van Leeuwenhoek, the first microbiologist designed his own microscope. In 1674, he took plaque from his own teeth and observed it under the microscope. He was astonished to see many tiny organisms moving around, which was otherwise invisible to naked eyes.

b. Structure of a bacterial cell

Bacterial cell has cell membrane, covered by strong rigid cell wall. In some bacteria, outside the cell wall there is an additional slimy protective layer called **capsule** made up of **polysaccharides**. The plasma membrane encloses the cytoplasm, **incipient nucleus** (nucleoid), ribosomes and DNA which serve as genetic material. Ribosomes are the site of protein synthesis. They lack membrane bound organelles. In addition to this, a small extra chromosomal circular DNA called plasmid is found in the cytoplasm.

22.1.2 Viruses

The term 'virus' in Latin means 'venom' or 'poisonous fluid'. Viruses are non-cellular, **self-replicating parasites**. They are made up of a **protein** that covers a central **nucleic acid** molecule, either RNA or DNA. The amount of protein varies

from 60% to 95% and the rest is nucleic acid. Nucleic acid is either DNA (T4 bacteriophage) or RNA (Tobacco mosaic virus, TMV).

A simple virus particle is often called a **virion**. They grow and multiply only in living cells. They are the smallest among the infective agents varying over a wide range from 18-400 nm (nanometre). They can live in plants, animals, human being and even bacteria. They can be easily transmitted from one host to another.

a. Characters of Viruses

Viruses exhibit both living and non-living characters.

Living characters of viruses

1. They have the nucleic acid (DNA or RNA) i.e., the genetic material that can replicate.
2. They can multiply in the living cells of the host.
3. They can attack specific hosts.

Non-living characters of viruses

1. Viruses remain as inert material outside their hosts.
2. They are devoid of cell membrane and cell wall. Viruses are devoid of cellular organelles like ribosomes, mitochondria, etc.
3. They can be crystallised.

More to Know

The protein free pathogenic RNA of virus is Viroids. They are found in plant cells and cause disease in plants.

b. Types of Viruses

Viruses are categorised as given below:

Plant virus: Virus that infect plants. e.g. Tobacco mosaic virus, Cauliflower mosaic virus, Potato virus.

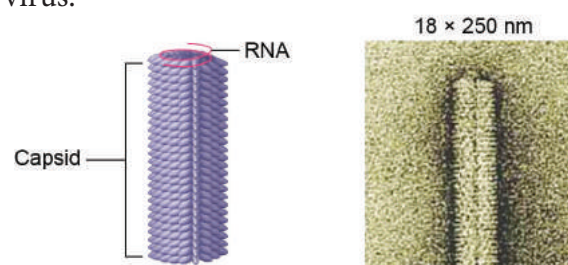


Figure 22.3 Tobacco mosaic virus



Animal virus: Virus that infect animals. e.g. Adenovirus, Retrovirus(HIV), Influenza virus, Polio virus.

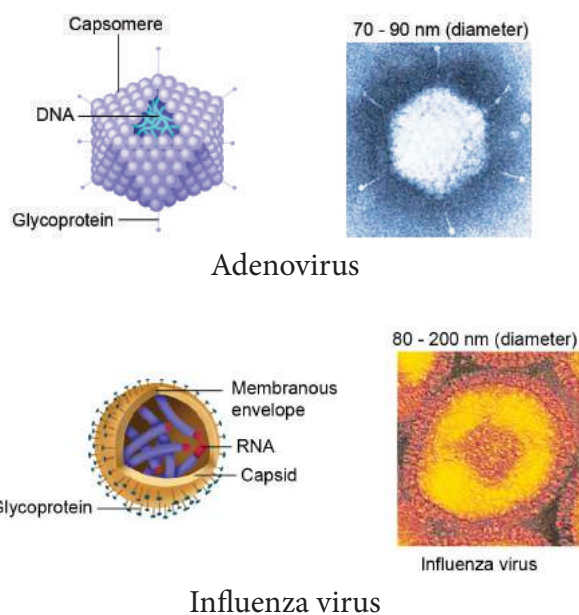


Figure 22.4 Animal virus

Bacteriophages: Virus that infect bacterial cells. e.g. T4 bacteriophage.

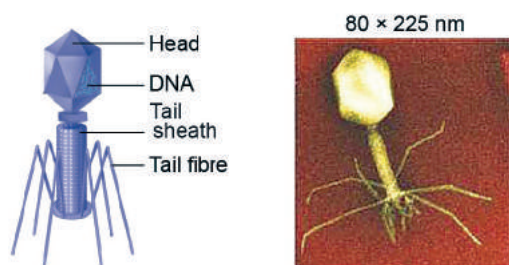


Figure 22.5 T4 bacteriophage

22.1.3 Fungi

They lack chlorophyll, hence depend on living or dead host for their nutritional needs. Fungi living on living hosts are called parasites, and those living on dead organic matter are called saprophytes. The body of the fungus is called **thallus**.

Single celled yeast ranges from 1 to 5 μm in width. They are spherical in shape. Flagella are absent and hence they are non-motile. In the case of multicellular forms, thallus is called mycelium. **Mycelium** is a complex of several thin filaments called **hyphae** (singular: Hypha).

Each hypha is 5 to 10 μm wide. They are tube like structures filled with protoplasm and cellular organelles. Cell wall is made up of cellulose or chitin. Cytoplasm contains small vacuoles filled with cell sap, nucleus, mitochondria, golgi body, ribosomes, and endoplasmic reticulum. Food material is stored in the form of glycogen or oil globules.

They reproduce vegetatively (binary fission, budding and fragmentation), asexually (spore formation-conidia) and sexually (male and female gametangium are called antheridium and oogonium).



Figure 22.6 Structure of fungi

22.1.4 Prions

The term 'prion' was coined by Stanley B. Prusiner in 1982. Prions are **viral particles** which contain only proteins. They do not contain nucleic acid. They are infectious and smaller than viruses. Prions are found in neurons and are rod shaped. Prions induce changes in normal proteins. This results in the degeneration of nervous tissue.

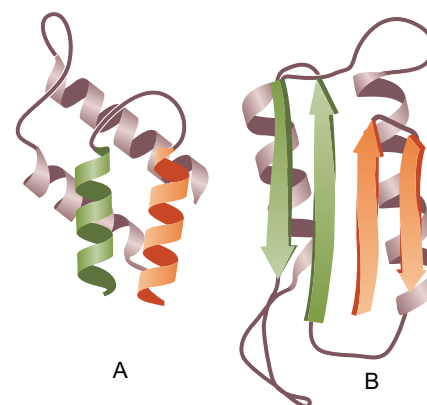


Figure 22.7 Normal (A) and Abnormal (B) prion protein

22.2 Applications of Microbes

Microorganisms contribute to human welfare in many ways. In this section we will study about the diversified usefulness of microbes.



22.2.1 Microbes in Agriculture

Microbes play an important role in agriculture as biocontrol agents and biofertilizers. Microbes play a vital role in the cycling of elements like carbon, nitrogen, oxygen, sulphur and phosphorus.

Microbes as biofertilizers: Microorganisms which enrich the soil with nutrients are called as biofertilizers. Bacteria, cyanobacteria and fungi are the main sources of biofertilizers. Nitrogen is one of the main source of plant nutrients. Atmospheric nitrogen has to be converted to available form of nitrogen. This is done by microbes either in free living conditions or by having symbiotic relationship with the plants. e.g. *Azotobacter*, *Nostoc* (free living), symbiotic microbes like *Rhizobium*, *Frankia*.

Activity 1

Take the root nodules of any pulse or leguminous plant available in your locality. Wash it thoroughly with water. Crush the nodules on a clean glass slide. Add a drop of distilled water to the crushed material on the glass slide. Observe the preparation under compound microscope.

Microbes as biocontrol agents: Microorganisms used for controlling harmful or pathogenic organisms and pests of plants are called as biocontrol agents (Biopesticides). *Bacillus thuringiensis* (Bt) is a species of bacteria that produces a protein called as 'cry' protein. This protein is toxic to the insect larva and kills them. Spores of *B.thuringiensis* are available in sachets, which are dissolved in water and sprayed on plants infected with insect larva.

22.2.2 Microbes in Industries

Microorganisms play an important role in the production of wide variety of valuable products for the welfare of human beings.

Production of fermented beverages: Beverages like wine are produced by fermentation of grape fruits by *Saccharomyces cerevisiae*.

Curing of coffee beans, tea leaves and tobacco leaves: Beans of coffee and cocoa, leaves of tea and tobacco are fermented by the bacteria *Bacillus megaterium*. This gives the special aroma.

Production of curd: *Lactobacillus sp.* converts milk to curd.

Production of organic acids, enzymes and vitamins: Oxalic acid, acetic acid and citric acid are produced by fungus *Aspergillus niger*. Enzymes like lipases, invertase, proteases, and glucose oxidase are derived from microbes. Yeasts are rich source of vitamin-B complex.

22.2.3 Microbes in Medicine

Antibiotics: These are metabolic products of microorganisms, which in very low concentration are inhibitory or detrimental to other microbes. In 1929, Alexander Fleming produced the first antibiotic penicillin. In human beings antibiotics are used to control infectious diseases like cholera, diphtheria, pneumonia, typhoid, etc.

Table 22.1 Antibiotics produced by micro organisms

Class of Microorganisms	Type of Microorganism	Antibiotic produced
Bacteria	<i>Streptomyces griseus</i>	Streptomycin
	<i>Streptomyces erythreus</i>	Erythromycin
	<i>Bacillus subtilis</i>	Bacitracin
Fungi	<i>Penicillium notatum</i>	Penicillin
	<i>Cephalosporium acremonium</i>	Cephalosporin

Vaccines: These are prepared by killing or making the microbes inactive (attenuated). These inactive microbes are unable to cause

disease, but stimulate the body to produce antibodies against the antigen in the microbes.

Table 22.2 Vaccines produced against diseases

Type of Vaccine	Name of the vaccine	Disease
Live attenuated	MMR	Measles, Mumps and Rubella
	BCG (Bacillus Calmette Guerin)	Tuberculosis
Inactivated (Killed antigen)	Inactivated polio virus (IPV)	Polio
Subunit vaccines (Purified antigens)	Hepatitis B vaccine	Hepatitis B
Toxoid (Inactivated antigen)	Tetanus toxoid (TT)	Tetanus
	Diphtheria toxoid	Diphtheria

22.3 Microbes and Diseases

Disease (dis = against; ease = comfort) can be defined as an impairment or malfunctioning of the normal state of the living organism that disturbs or modifies the performance of vital functions of the body. Disease can be categorized based on:

- The extent of occurrence (endemic, epidemic, pandemic or sporadic).
- Whether infectious or non-infectious.
- Types of pathogen – whether caused by bacterial, viral, fungal or protozoan infections.
- Transmitting agent – whether air borne, water borne or vector borne.



World Health Day – 7th April
 World Malaria Day – 25th April
 World AIDS Day – 1st December
 World Anti-Tuberculosis Day – 24th March

22.3.1 Classification of Disease based on Occurrence

Endemic: Disease which is found in a certain geographical area affecting a fewer number

of people (low incidence). e.g. Occurrence of goitre in Sub-Himalayan regions.

Epidemic: Disease which breaks out and affects large number of people in a particular geographical region and spreads at the same time. e.g. Influenza.

Pandemic: Disease which is widely distributed on a global scale. e.g. Acquired Immuno deficiency Syndrome (AIDS).

Sporadic: Disease which occur occasionally. e.g. Malaria and Cholera.

22.3.2 Manifestation of Disease

Communicability of diseases

Infectious diseases are communicable diseases. They are caused by external factors like pathogenic organisms (bacteria, virus, vectors, parasites) invading the body and causing diseases. e.g. Influenza, Tuberculosis, Chickenpox, Cholera, Pneumonia, Malaria, etc

Non-infectious diseases are non-communicable diseases. They are caused by internal factors like malfunctioning of organs, genetic causes, hormonal imbalance and immune system defect. e.g. Diabetes, Coronary heart diseases, Obesity, Cancer, Goitre, etc

Point of entry and place of infection

The disease causing microbes enter the body through different means. An infection develops when these pathogens enter the human body through contaminated air, water, food, soil, physical contact, sexual contact and through infected animals. They may be organ specific or tissue specific within our body where microbes reside.

Reservoir of infection

Reservoir of infection refers to the specific environment in which the pathogens can thrive well and multiply without causing diseases. eg. Water, soil and animal population.

Incubation period

The interval between infection and first appearance of the diseases is called incubation period. It may vary from few hours to several days.

Infection

Infection is the entry, development or multiplication of an infectious agent in the human body or animals.

22.3.3 Harmful Effects of Microbes

Pathogens cause disease in two ways. They are tissue damage and toxin secretion.

Tissue Damage: Many pathogens destroy the tissues or organs of the body causing morphological and functional damage. For example, bacterium of pulmonary tuberculosis damages the cells of the lungs, and virus causing hepatitis destroys liver tissue.

Toxin Secretion: Many pathogens secrete poisonous substances called toxins which cause tissue damage leading to diseases.

Let us now study about the causative organism, mode of infection, occurrence, symptoms and preventive measures of a few airborne, waterborne, vectorborne and sexually transmitted diseases.



Robert Koch (Father of Bacteriology) is the first German physician to study how pathogens cause diseases. In 1876, he showed that the disease called anthrax of sheep was due to *Bacillus anthracis* which exist in pastures in the form of protective spores.

22.4 Airborne Diseases

Human beings inhale atmospheric air. Due to continuous inhalation of contaminated air the chances for airborne microorganisms to find a host and cause infection are higher.

Most of the respiratory tract infections are acquired by inhaling air containing the pathogen that are transmitted through droplets caused by cough or sneeze, dust and spores.

Airborne diseases are caused by bacteria and viruses. A few air borne diseases and their modes of transmission are given in the table below.

Table 22.3 Airborne diseases caused by virus

Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
Common Cold	<i>Rhino virus</i>	Droplet infection	Upper respiratory tract (Inflammation of nasal chamber)	Fever, cough, running nose, sneezing and headache
Influenza	<i>Myxovirus</i>	Droplet Infection	Respiratory tract, (Inflammation of nasal mucosa, pharynx)	Fever, body pain, cough, sore throat, nasal discharge, respiratory congestion
Measles	<i>Rubeola virus</i>	Droplet infection, droplet nuclei and direct contact with infected person	Respiratory tract	Eruption of small red spots or rashes in skin, cough, sneezing, redness of eye (conjunctiva), pneumonia, bronchitis
Mumps	<i>Myxovirus parotidis</i>	Droplet infection, droplet nuclei and direct contact with infected person	Upper respiratory tract	Enlargement of parotid gland, movement of jaw becomes difficult
Chicken Pox	<i>Varicella zoster virus</i>	Droplet infection, droplet nuclei and direct contact with infected person	Respiratory tract	Eruptions of the skin, fever and uneasiness



Table 22.4 Airborne diseases caused by bacteria

Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
Tuberculosis	<i>Mycobacterium tuberculosis</i>	Droplet infection from sputum of infected persons	Lungs	Persistent cough, chest pain, loss of weight and appetite
Diphtheria	<i>Corynebacterium diphtheriae</i>	Droplet infection, droplet nuclei	Upper Respiratory tract (nose, throat)	Fever, sore throat, choking of air passage
Whooping Cough	<i>Bordetella pertussis</i>	Droplet infection, direct contact with infected person	Respiratory tract	Mild fever, severe cough ending in whoop (loud crowing inspiration)

22.5 Waterborne Diseases

Microbes present in the contaminated water cause various infectious diseases. Some of the water borne diseases are cholera, typhoid,

infectious hepatitis, poliomyelitis, diarrhoea, etc. The most common waterborne diseases and their causative microbial agents, symptoms of these diseases and preventive measure are given in the tables below .

Table 22.5 Waterborne diseases caused by virus

Disease	Causative Organism	Mode of Transmission	Tissue/Organ Affected	Symptoms	Preventive and Control Measures
Poliomyelitis	<i>Polio virus</i>	Droplet infection, sputum discharge, secretion from nose, throat, contaminated water, food and milk	Central nervous system	Paralysis of limbs	Salk's vaccine or Oral Polio Vaccine (OPV) is administered
Hepatitis A or Infectious Hepatitis	<i>Hepatitis A virus (HAV)</i>	Contaminated water, food and oral route	Inflammation of liver	Nausea, anorexia, acute fever and jaundice	Prevention of food contamination, drinking chlorinated boiled water, personal hygiene
Acute Diarrhoea	<i>Rotavirus</i>	Contaminated water, food and oral route	Intestine	Vomiting, fever, watery stools with mucus	Proper sanitation and hygiene

Table 22.6 Waterborne diseases caused by bacteria

Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms	Preventive and Control Measures
Cholera (Acute diarrhoeal disease)	<i>Vibrio cholerae</i>	Contaminated food, water, oral route and through houseflies	Intestinal tract	Acute diarrhoea with rice watery stools, vomiting, muscular cramps, nausea and dehydration	Hygienic sanitary condition, intake of Oral Rehydration Solution (ORS)
Typhoid (Enteric fever)	<i>Salmonella typhi</i>	Food and water contaminated with faeces of infected person and through houseflies	Small intestine	High fever, weakness, abdominal pain, headache, loss of appetite, rashes on chest and upper abdomen	Preventing contamination of food by flies and dust, improvement of basic sanitation, treatment with antibiotic drugs



22.6 Vector Borne Diseases

Vector is an agent that acts as an **intermediate carrier** of the pathogen. Many insects and animals act as vectors. Diseases transmitted by vectors are called vector borne diseases. These vectors can transfer infecting agents from an infected person to another healthy person. Some of the insect vector borne diseases are Malaria, Filariasis, Chikungunya, Dengue, and the diseases which are transmitted through animals are Bird flu and Swine flu.

22.6.1 Malaria

Malaria continues to be one of the major health problems of developing countries. Malaria is caused by **protozoan** parasite *Plasmodium*. Four species of *Plasmodium* namely, *P.vivax*, *P.malariae*, *P.falciparum* and *P.ovale* cause malaria. Malaria caused by *Plasmodium falciparum* is malignant and fatal. Approximately 300 million people around the world get infected with Malaria every year.

It spreads through the bite of an insect vector, the female *Anopheles* mosquito which feeds on human blood and usually lasts less than 10 days. A person affected by malaria will show symptoms of headache, nausea, muscular pain, chilliness and shivering, followed by rapid rise in temperature. Fever subsides with profuse sweating. Use of Quinine drugs kills the stages of malaria parasite.

Know your Scientist



Sir Ronald Ross, an Indian born British doctor, is famous for his work concerning malaria. He worked in the Indian Medical Service for 25 years. He identified the developing stages of malarial parasite in the gastrointestinal tract of mosquito and proved that malaria was transmitted by mosquito. In 1902, he received the Nobel Prize for Physiology or Medicine for his work on the transmission of malaria.

22.6.2 Chikungunya

Chikungunya is caused by virus. It is transmitted in humans by the bite of infected *Aedes aegypti* mosquito during the day time. It causes severe and persistent joint pain, body rashes, headache and fever. Joint pains can last for a very long time.

Incubation period of the virus is usually 2-12 days. Chilliness, high fever, vomiting, nausea, headache, persistent joint pain and difficulty in walking are the common symptoms associated with this disease. The joints get inflamed and the person finds it difficult to walk. Paracetamol is given to relieve pain and reduce fever.

22.6.3 Dengue

Dengue is known as **break bone** fever. The name break bone fever was given due to the cause of intense joint and muscle pain. Dengue fever is caused by virus. It is transmitted by *Aedes aegypti* mosquito.

Incubation period of the virus is usually 5-6 days. Onset of high fever, severe headache, muscle and joint pain, rashes, haemorrhage, fall in blood platelet count are the symptoms associated with this disease. Vomiting and abdominal pain, difficulty in breathing, minute spots on the skin signifying bleeding within the skin are also associated with dengue fever. Paracetamol is given to reduce fever and body ache. Complete rest and increased intake of fluid is essential.

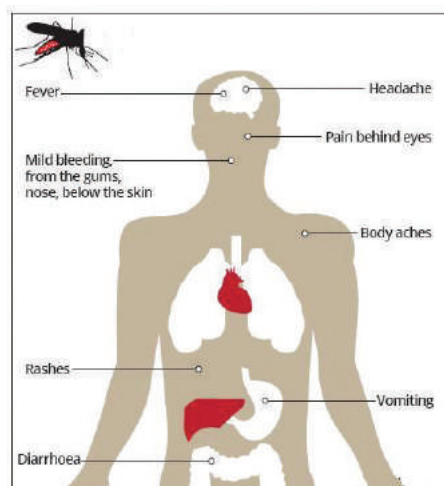


Figure 22.8 Dengue



**DO
YOU
KNOW?**

An extraction of tender leaves of papaya and herbal drink Nilavembu Kudineer is given to dengue patients. It is known to increase the blood platelet count. (Source: AYUSH)

Activity 2

Observe the mosquitoes that are active during the day time. Catch them using an insect net and observe their body and legs. What do you observe?. Why are cases of Dengue reported in large numbers during post-monsoon season?

22.6.4 Filaria

Filariasis is a major health problem in India. This disease is caused by **nematode** worm *Wuchereria bancrofti*. The adult worms are usually found in the lymphatic system of man. It is transmitted by the bite of infected *Culex* mosquito.

Incubation period of filarial worm is 8-16 months and the symptoms include acute infection, fever and inflammation in lymph glands. In chronic infection the main feature is **elephantiasis** which affects the legs, scrotum and the arms.

22.6.5 Mosquitoes - Prevention and Control

- Prevention of mosquito bites by using mosquito nets, mosquito screens, mosquito repellents and ointments.
- Elimination of breeding places by providing adequate sanitation, underground waste water disposable system and drainage of stagnant water.
- Collection of water in any uncovered container such as water tank, pots, flower pots, discarded tyres should be avoided.
- Control of mosquito larvae by spraying oil on stagnated water bodies.
- Adult mosquitoes can be killed by spraying insecticides.
- Application of citronella oil or eucalyptus oil on the exposed skin.

22.7 Diseases Transmitted by Animals

22.7.1 Swine Flu

Swine Flu first originated from pigs. It is caused by virus that affects pigs and has started infecting humans. The virus spreads through air. It affects the respiratory system.

Influeza virus H1N1 has been identified as the cause of this disease. It is transmitted from person to person by inhalation or ingestion of droplets containing virus from people sneezing or coughing. Fever, cough, nasal secretion, fatigue, headache, sore throat, rashes in the body, body ache or pain, chills, nausea, vomiting and diarrhoea, and shortness of breath are the symptoms associated with the disease.

Prevention and Control

- Administration of nasal spray vaccine.
- Avoiding close contact with a person suffering from flu.
- Intake of water and fruit juices will help prevent dehydration.
- Plenty of rest will help the body to fight infection.
- Always wash hands and practice good hygiene.

More to Know

Swine flu first surfaced in April 2009 and affected millions of people. Then in June 2009 it was declared a pandemic by the World Health Organization (WHO). In 2015, India reportedly had over 31,000 people infected and 1,900 resulting deaths.

22.7.2 Avian Influenza

Avian influenza is a contagious bird disease caused by viruses. Birds that can carry and spread avian influenza virus include poultry (chickens, turkeys or ducks), wild birds and pet birds.

It is caused by **Influenza Virus H5N1**. The incubation period of the virus is 2-7 days. People who have close contact with infected birds or

surfaces that have been contaminated by the bird's secretion from mouth, eyes, mucus, nasal secretion or droppings (bird faeces) transmit this disease.

Fever, cough, sore throat, running nose, muscle and body aches, fatigue, headache, redness of eyes (conjunctivitis) and difficulty in breathing are the symptoms of this disease.

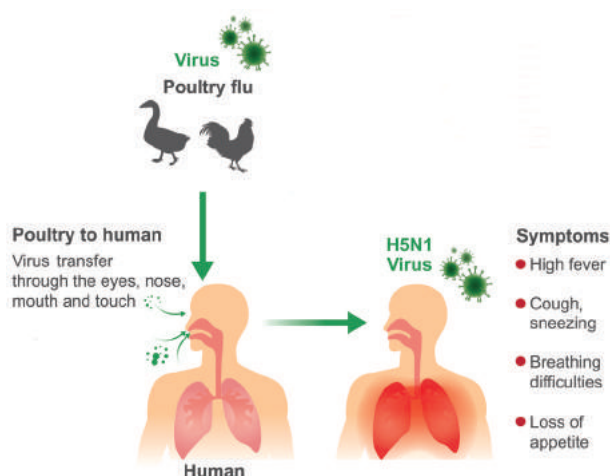


Figure 22.9 Transmission of Avian influenza virus

Prevention and Control

- Avoiding open air markets where infected birds are sold.
- Avoiding contact with infected birds or consumption of infected poultry.
- Proper cleaning and cooking of poultry.



The avian influenza virus A (H5N1) emerged in 1996. It was first identified in Southern China and Hong Kong. H5N1 was first discovered in humans in 1997 by World Health Organisation. First outbreak was in December 2003.

22.8 Sexually Transmitted Diseases

Some pathogens are transmitted by sexual contact from one partner to another and not by casual physical contact. A few sexually transmitted diseases are AIDS, Gonorrhea, Genital warts, Genital herpes and Syphilis.

22.8.1 AIDS

Acquired Immunodeficiency Syndrome (AIDS) is caused by **retrovirus** (RNA virus) known as **Human Immunodeficiency Virus** (HIV). The virus attacks the white blood cells or **lymphocytes** and weakens the body's immunity or self defence mechanism.

It is transmitted through sexual contact (from infected person to a healthy person), blood contact (transfusion of unscreened blood), by surgical equipments (infected needles and syringes), maternal – foetal transmission (from infected mother to the foetus).

Weight loss, prolonged fever, sweating at night, chronic diarrhoea are some of the important symptoms.

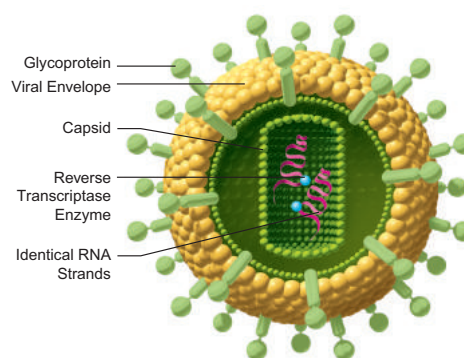


Figure 22.10 Structure of HIV

Prevention and Control

- Disposable syringes and needles should be used.
- Protected and safe sexual contact.
- Screening of blood before blood transfusion.
- Avoid sharing shaving blades/razors.
- People should be educated about AIDS transmission.



HIV was first recognised in Hatai (USA) in 1981. In India the first confirmed evidence of AIDS infection was reported in April 1986 from Tamil Nadu. The AIDS vaccine RV 144 trial was conducted in Thailand in 2003 and reports were presented in 2011.

22.8.2 Hepatitis -B or Serum Hepatitis

It occurs due to infection of **hepatitis-B virus** (HBV). The virus damages the liver cells causing **acute inflammation** and **cirrhosis** of liver.

It is transferred from infected mother to their babies or by sexual contact. It is also transmitted by contact with infected person's secretions such as saliva, sweat, tears, breast milk and blood.

Symptoms observed are fever, loss of appetite, nausea vomiting, yellowness of eyes and skin, light coloured stools, itching of skin, headache and joint pain.

Prevention and Control

- Screening of blood donors before blood donation can prevent the transmission.
- Injection of drugs to be prevented.
- Having safe and protected sex.
- Sharing of razors should be avoided.
- The hepatitis B vaccine offers excellent protection against HBV. The vaccine is safe and highly effective.

Some of the other sexually transmitted diseases caused by bacteria and virus are discussed in Table 22.7.

22.9 Immunization

Immunization is a process of developing resistance to infections by administration of antigens or antibodies. Inoculation of vaccines into the body to prevent diseases is called as vaccination.

One effective way of controlling the spread of infection is to strengthen the host defenses. This is accomplished by immunization, which is one of the cost effective weapon of modern medicine.

When a large proportion of a community is immunized against a disease, the rest of the people in the community are benefited because the disease does not spread.

22.9.1 Vaccines and its Types

Vaccines are preparation of living or killed microorganisms or their products used for prevention or treatment of diseases. Vaccines are of two types: Live vaccines and Killed vaccines

Live Vaccines: They are prepared from living organisms. The pathogen is weakened and administered. e.g. BCG vaccine, oral polio vaccine.

Table 22.7 Sexually transmitted diseases

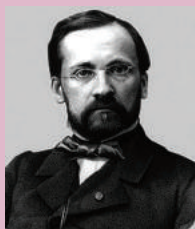
Infectious agent	Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
Bacteria	Gonorrhoea	<i>Neisseria gonorrhoea</i>	Sexual contact	Urethra is affected	Discharge from genital openings, pain during urination
	Syphilis	<i>Treponema pallidum</i>	Sexual contact	Minute abrasion on the skin or mucosa, of genital area	Ulceration on genitals, skin eruption
Virus	Genital Herpes	<i>Herpes Simplex Virus</i>	Sexual contact, entry through mucous membrane of genital region	Genital organs of male and female individuals	Painful blisters in mouth, lips, face and genital region
	Genital Warts	<i>Human Papilloma virus</i>	Sexual contact (skin to skin)	Genital areas of male and female individuals	Vaginal discharge, itching, bleeding and burning



The process of vaccination was introduced by Edward Jenner. According to the World Health Organisation (WHO), Jennerian vaccination has eliminated small pox totally from the human population.

Killed Vaccines: Micro organisms (bacteria or virus) killed by heat or chemicals are called killed or inactivated vaccines. They require a primary dose followed by a subsequent booster dose. e.g. Typhoid vaccine, cholera vaccine, pertussis vaccine.

Know your Scientist



Louis Pasteur is an 18th century French chemist and microbiologist. He coined the term vaccine. Pasteur developed vaccine against chicken pox, cholera, anthrax, etc.

22.9.2 Immunization Schedule

The World Health Organization in the year 1970 has given a schedule of immunization for children. This schedule is carried out in almost all countries. Table 22.8 gives the schedule of vaccination procedures followed in India.

BCG (Bacillus Calmette Guerin): This was prepared by two French workers Calmette and Guerin (1908-1921). The bacilli are weakened and used for immunization against tuberculosis.

DPT (Triple Vaccine): It is a combined vaccine for protection against Diptheria, Pertussis (whooping cough) and Tetanus.

MMR: Mumps, Measles, Rubella vaccine gives protection against viral infections.

DT: It is a dual antigen or combined antigen. It gives protection from Diptheria and Tetanus.

TT (Tetanus Toxoid): Toxin of Tetanus bacteria.

TAB: Combined vaccine for typhoid, paratyphi A and paratyphi B.

Table 22.8 Immunization Schedule

Age	Vaccine	Dosage
New born	BCG	1 st dose
15 days	Oral Polio	1 st dose
6 th week	DPT and Polio	1 st dose
10 th week	DPT and Polio	1 st dose
14 th week	DPT and Polio	1 st dose
9 – 12 months	Measles	1 st dose
18 – 24 months	DPT and Polio	1 st dose
15 months – 2 years	MMR	1 st dose
2 – 3 years	TAB	2 doses at 1 month gap
4 – 6 years	DT and Polio	2 nd booster
10 th year	TT and TAB	1 st dose
16 th year	TT and TAB	2 nd booster

Activity 3

Recently in 2018, Nipah virus was in the headlines of the daily newspaper. Collect the following information. What is Nipah virus? How it gets transmitted? Mention the preventive measures taken by the Government to check the disease.

Points to Remember

- ❖ Bacteria are single celled prokaryotic organisms, without a well defined nucleus (nucleoid) and other cell organelles. The genetic material is DNA.
- ❖ Viruses are small microscopic infectious agents that can multiply only inside the living cells.
- ❖ Fungi are group of eukaryotic heterotrophs which are either single celled (Yeast) or multicellular (*Penicillium*, *Agaricus*).
- ❖ Microorganisms which enrich the soil with nutrients are called as biofertilizers.



- ❖ Most of the respiratory tract infections are acquired by inhaling air containing the pathogen that are transmitted through droplets caused by cough or sneeze, dust and spores.
- ❖ Some of the air borne diseases are tuberculosis, whooping cough, diphtheria, chicken pox, mumps, measles and influenza.
- ❖ Infectious diseases that can spread through water are diarrhoea, dysentery, cholera, typhoid, hepatitis and poliomyelitis.
- ❖ Diseases transmitted by vectors are called vector borne diseases. Some of them are malaria, filaria, chikungunya and dengue.
- ❖ Diseases transmitted by animal to man are swine flu and bird flu.
- ❖ Sexually transmitted diseases such as gonorrhea, genital warts, genital herpes, syphilis, AIDS are transmitted from one person to another by close physical contact.

A-Z GLOSSARY

Antibiotics	Substances that kill or prevent the growth of microorganisms.
Biofertilizer	Microorganisms which enrich the soil with nutrients.
Biopesticides	Agents which control insect pests in natural way without causing harm to the environment.
Flagella	Lash-like appendage protruding from the cell body of bacterial cell.
Immunisation	Process by which the body produces antibodies against the specific vaccine when administered.
Pathogen	A biological agent that causes disease to its host. e.g. bacteria, virus etc.
Prions	Viral particles which contain only protein. They do not contain nucleic acid.
Vaccines	Preparation of antigenic proteins of pathogens (weakened or killed) which on inoculation into a healthy person provides temporary / permanent immunity against a particular disease.



TEXTBOOK EXERCISES



I. Choose the correct answer.

1. Which of the following is transmitted through air?
a. Tuberculosis b. Meningitis
c. Typhoid d. Cholera
2. One of the means of indirect transmission of a disease is
a. sneezing b. coughing
c. vectors d. droplet infection
3. Diphtheria affects the
a. lungs b. throat
c. blood d. liver
4. The primary organ infected during tuberculosis is
a. bone marrow b. intestine
c. spleen d. lungs
5. Microbes that generally enter the body through nose are likely to affect
a. gut b. lungs
c. liver d. lymph nodes
6. The organ affected by jaundice is
a. liver b. lungs c. kidney d. brain
7. Poliomyelitis virus enters the body through
a. skin b. mouth and nose
c. ears d. eye



II. Fill in the blanks.

- _____ break down organic matter and animal waste into ammonia.
- Typhoid fever is caused by _____.
- H1N1 virus causes _____.
- _____ is a vector of viral disease dengue.
- _____ vaccine gives considerable protection against tuberculosis.
- Cholera is caused by _____ and malaria is caused by _____.

III. Expand the following.

- ORS
- HIV
- DPT
- WHO
- BCG

IV. Pick out the odd one.

- AIDS, Retrovirus, Lymphocytes, BCG,
- Bacterial disease, Rabies, Cholera, Common cold and Influenza.

V. State whether true or false. If false, correct the statement.

- Rhizobium*, associated with root nodules of leguminous plants fixes atmospheric nitrogen.
- Non-infectious diseases remain confined to the person who develops the disease and do not spread to others.
- The process of vaccination was developed by Jenner.
- Hepatitis B is more dangerous than Hepatitis A.

VI. Match the following.

Swine flu	Human Papilloma virus
Genital warts	Human Immunodeficiency Virus
AIDS	<i>Mycobacterium</i>
Tuberculosis	Influenza virus H1N1

IX. Define the following.

- Pathogen
- Bacteriophages
- Vaccines
- Prions

X. Answer very briefly.

- Distinguish between Virion and Viroid.
- Name the vector of the malarial parasite. Mention the species of malarial parasite which cause malignant and fatal malaria.
- What is triple antigen? Mention the disease which can be prevented by using the antigen.
- Name the chronic diseases associated with respiratory system.
- Name the organism causing diarrhoeal disease and give one precaution against it.
- Name two common mosquitoes and the diseases they transmit.

XI. Answer briefly.

- Give an account of classification of bacteria based on the shape.
- Describe the role of microbes in agriculture and industries.
- Explain the various types of viruses with examples.
- Suggest the immunization schedule for a newborn baby till 12 months of age. Why it is necessary to follow the schedule?

XII. Assertion and Reason.

Mark the correct statement as.

- If both A and R are true and R is correct explanation of A.
- If both A and R are true but R is not the correct explanation of A.
- If A is true but R is false.
- If both A and R are false.

- Assertion:** Chicken pox is a disease indicated by scars and marks in the body.

Reason: Chicken pox causes rashes on face and further spreads throughout the body.

- Assertion:** Dengue can be treated by intake of antibiotics.

Reason: Antibiotics blocks the multiplication of viruses.

XII. Higher Order Thinking Skills.

1. Suggest precautionary measures you can take in your school to reduce the incidence of infectious disease.
2. Tejas suffered from typhoid while, Sachin suffered from tuberculosis. Which disease could have caused more damage and why?

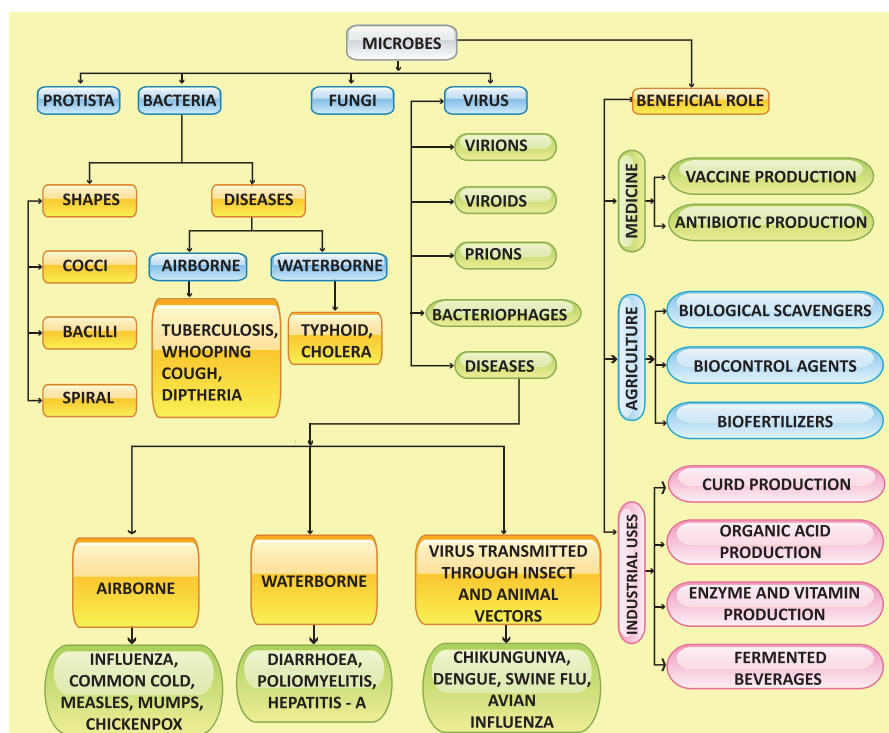


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2. Willey, Sherwood and Wollverton, Prescott's Microbiology, 8th edition, McGrawHill Education Pvt Ltd.
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Concept Map



ICT CORNER

Microbes

Steps

- Type the following URL to reach “Cells Alive” home page and select “Start the Animation”.
- Place the pointer on the “Bacteria Cell Model” to view the parts of the cell, or click the parts given below the animation to highlight it on the diagram.
- Click the highlighted parts to get a brief description about it.
- Click the “Speaker Icon” on the bottom of the animation to read the description for you.



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