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UNIT

World of Microbes

Learning Objectives A Section Sect

After completing this lesson, students will be able to

- identify different groups of bacteria based on their shape and structure.
- categorize types of viruses.
- recognize the structural differences between unicellular and multicellular fungi.
- know the role of microbes in agriculture, food industries and medicine.
- gain knowledge on causative organism, modes of infection and disease transmission.
- describe the spectrum of diseases on the basis of the causative agents.
- understand microbe host interaction, symptoms of the diseases caused by the microbes.
- 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. We at one time or the other in our life, have suffered from bodyache, fever, cold, vomiting, diarrhoea and many other conditions which may give an individual discomfort or uneasiness. All these symptoms are associated with diseases which affect our health and make us feel uncomfortable. This topic will explore the beneficial and harmful effects of microbes in relation to welfare of human kind.

8.1 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.

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8.1.1 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 μ m in length and 0.2 to 1 µm micrometer in width. Bacteria may be motile or non-motile. For motility they have special structures called flagella which are found on the cell surfaces. Location of flagella varies with bacterial species.

Based on the arrangement of flagella, there are four types of bacteria:

- (i) Monotrichous: A single polar flagella. e.g. Pseudomonas aeruginosa.
- (ii) Lophotrichous: A cluster of polar flagella. e.g. Pseudomonas fluorescens.
- (iii) Amphitrichous: Either a single or cluster of flagella at both the cell poles. e.g. Aquaspirillum serpens.
- (iv) Peritrichous: Flagella arranged along the sides of the bacteria. e.g. Salmonella typhi.



(sphere) Figure 8.2 Shapes of bacteria

Spirillum

(spiral)

Based on the shapes, bacteria are grouped as:

1. Spherical shaped bacteria called as cocci

2. Rod shaped bacteria called as bacilli

3. Spiral shaped bacteria called as spirilla

(or coccus for a single cell).

(or bacillus for a single cell).

(or spirillum for single cell)

B. Structure of a bacterial cell

Bacillus

(rod)

A. Shapes of bacteria

Bacterial cell has cell membrane, covered by strong rigid cell wall made up of peptidoglycan. 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.



Figure 8.3 Structure of a bacterial cell

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C. Nutrition in bacteria

All living organisms require a source of energy. Bacteria have diversified energy requirements. Based on this they are categorized into autotrophic bacteria and heterotrophic bacteria.

a. Autotrophic bacteria (Autotrophs)

They synthesize their own food from inorganic sources (CO₂ and hydrogen donor). e.g. Nitrosomonas sp. Autotrophic bacteria are classified into two types based on their source of energy.

- **Phototrophs** that use light as source of energy.
- Chemotrophs that rely on chemical compounds for their energy.

b. Heterotrophic bacteria (Heterotrophs)

They are most abundant in nature. They do not synthesize their own food but depend on other organisms or dead organic matter for food. They may be classified as:

- Parasitic bacteria that live on live hosts like plants, animals and human. They can cause diseases to the living host.
- Saprophytic bacteria that live on dead organic matter.
- Symbiotic bacteria may live inside a live host, where they obtain nutrition and benefit the host in digestion and nitrogen fixing (Rhizobium).

Antonie Van Leeuwenhoek, the DO first microbiologist designed his (NOW?

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.

	Different shapes of Dacteria	
	Arrangement of Cocci	Examples
Diplococci	cocci are arranged in pairs	Streptococcus pneumoniae
Streptococci	cocci are arranged in chains	Streptococcus pyogenes
Tetracocci	cocci are arranged in packets of four cells	Aerococcus sp
Staphylococci	cocci are arranged in grape-like clusters	Staphylococcus aureus
	Arrangement of Bacilli	Examples
Diplobacilli	diplobacilli appear in pairs	Klebsiella sp
Streptobacilli	bacilli are arranged in chains	Streptobacillus sp
Coccobacilli	short and stumpy and appear ovoid	Haemophilus sp
	Arrangement of Spirilla	Examples
Vibrio	comma-shaped bacteria	Vibrio cholerae
Spirilla	rigid spiral structure	Helicobacter pylori
Spirochetes	helical shape and flexible bodies	Treponema pallidum

More to Know

Different shapes of Bacteria

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8.1.2 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 on plants, animals, human being and even bacteria. They can be easily transmitted from one host to another.

A. Living and Non-living characters

Viruses exhibit both living and non-living characters.

Living characters of viruses

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

Non-living characters of viruses

- (a) Viruses remain as inert material outside their hosts.
- (b) They are devoid of cell membrane and cell wall. Viruses are devoid of cellular organelles like ribosomes, mitochondria, etc.
- (c) 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.

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B. Types of Viruses

Viruses are categorised as:

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



Figure 8.4 Tobacco mosaic virus

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



Aenovirus





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



Figure 8.6 T4 bacteriophage

8.1.3 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**.

In general, fungi are larger than bacteria. Single celled yeast ranges from $1-5 \mu m$ 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 μ m wide. They are tube like structures filled with protoplasm and cellular organelles. Hyphae may or may not be intersected with plasmalemma (cell wall). Cell wall is made up of cellulose and hemicellulose.

Yeast cell

Penicillium

Figure 8.7 Structure of fungi

🚔 Activity 1

Observation of yeast cell

- Prepare a suspension of commercially available yeast powder with water.
- Take a drop of this suspension and a make a thin smear on a clean glass slide.
- Stain the smear using eosin or methylene blue.
- Observe the stained slide under compound microscope.
- Draw the structure of the cell you observe and label it.

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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 gamatengium are called antheridium and oogonium).

8.1.4 Prions

'Prion' means proteinaceous infective particle ('Protein gone bad'). 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 folded proteins. Misfolded proteins aggregate and accumulate as plaques. This results in the degeneration of nervous tissue.



Figure 8.8 Normal (A) and Abnormal (B) prion protein



Creutzfeldt-Jakob disease (CJD) is a **neurodegenerative disease**. As a result of this

disease cerebral cortex is affected and it is characterised by progressive dementia, memory loss, behavioral changes, poor coordination and visual disturbances.

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8.2 Applications of Microbes

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



8.2.1 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.

(i) 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.

(ii) 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



Figure 8.9 Rhizobium biofertilizer

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with the plants. e.g. *Nitrosomonas*, *Nostoc* (free living), symbiotic microbes like *Rhizobium*, *Frankia*, mycorrhizae.

Activity 2

Observation of symbiotic microbes

- Take the root nodules of any pulse or leguminous plant available in your locality.
- Wash it throughly 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.

8.2.2 Microbes in Industries

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

- (a) **Production of fermented beverages**: Beverages like wine are produced by fermentation of malted cereals and fruits by *Saccharomyces cerevisiae*.
- (b) **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.
- (c) **Production of curd**: *Lactobacillus sp.* converts milk to curd.
- (d) 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.

8.2.3 Microbes in Medicine

Antibiotics 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 pencillin. In human beings antibiotics are used to control infectious diseases like cholera, diptheria, pneumonia, typhoid, etc.

Table 8.1	Antibiotics produced by micro
	organisms

Class of Microorganisms	Type of Microorganism	Antibiotic produced
	Streptomyces griseus	Streptomycin
Bacteria	Streptomyces erythreus	Erythromycin
	Bacillus subtilis	Bacitracin
Funci	Penicillium notatum	Penicillin
rungi	Cephalosporium acremonium	Cephalosporin

Vaccines are prepared by killing or making the microbes inactive (attenuated). These inactive microbes are unable to cause the disease, but stimulate the body to produce antibodies against the antigen in the microbes.

Table 8.2Vaccines produced against
diseases

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

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8.3 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:

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

🏜 Activity 3

Can you frame the definition of health from the picture below?



8.3.1 Classification of disease based on occurence

Endemic: When the disease 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 : When the disease breaks out and affects large number of people in a particular geographical region and spreads at the same time. e.g. Influenza.

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Pandemic: When the disease is widely distributed on a global scale. e.g. Acquired Immunodeficiency Syndrome (AIDS).

Sporadic: When there is an occasional occurrence of a disease. e.g. Malaria and Cholera.

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World Health Day – 7th April
 World Malaria Day – 25th April
 World AIDS Day – 1st December

World Anti - Tuberculosis Day - 24th March

8.3.2 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 disease are noncommunicable 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. In other words, they are the breeding ground for pathogens. 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.



Figure 8.10 Chain of transmission of infection

Infection and Illness

Infection is the entry, development or multiplication of an infectious agent in the human body or animals. An illness is due to a specific infectious agent, capable of being directly or indirectly transmitted from person to person, animal to animal or from the environment (through air, water and food) and insects (vectors).

8.3.3 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.



RobertKoch(Father ofBacteriology)istheGermanphysiciantostudyhowpathogenscausecausediseases.

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. He found the rod shaped bacteria in the blood vessels of infected sheep and came to a conclusion that sheep and cattle came in contact with bacteria while grazing in the pastures.

Toxin Secretion: Many pathogens secrete poisonous substances called toxins which cause diseases. **Exotoxins** are directly secreted by the pathogens. **Endotoxins** are released by the disintegration of pathogens.

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

8.4 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 explained below.

8.4.1 Diseases caused by bacteria

Tuberculosis (TB)

It is one of the widely occurring communicable diseases. It is caused by the

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bacteria *Mycobacterium tuberculosis*. It mostly affects the lungs. Infected person has to be treated with anti-tuberculosis drugs for a period of 6 months to one year.



Figure 8.11 Tuberculosis

Diphtheria

It is caused by *Cornybacterium diphtheriae*. It generally affects the upper respiratory tract (nose and throat) and causes fever, sore throat and choking of air passage.

Whooping Cough

Whooping cough is caused by *Bordetalla pertussis*. It also affects the respiratory tract and causes mild fever, severe cough ending in whoop.

More information about airborne diseases caused by bacteria are given in Table 8.3.

More to Know

- Tuberculosis causing bacteria *Mycobacterium tuberculosis* was discovered by Robert Koch.
- Mantoux test: A highly specific tuberculin skin test for detection of tuberculosis.
- National Tuberculosis (TB) control programme was started in 1962.

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

Table 8.3 Airborne diseases caused by bacteria

8.4.2 Diseases caused by viruses

Common cold

Common cold is an infectious disease which affects the upper respiratory system and it is easily spread. Symptoms of common cold include cough, painful throat, running nose and sometimes fever. Though many viruses can cause this, it is generally caused by the **Rhinovirus**.

Influenza

Better known as flu, influenza commonly occurs during childhood. It is caused by **Myxovirus** resulting in inflammation of nasal mucosa and pharynx.

Measles

Measles is caused by **Rubeola virus** and it is easily transfered from infected people. Symptoms of measles include eruption of small rashes in skin, cough, sneezing, redness of eye, pneumonia and bronchitis. Affected individuals can recover from this by proper rest and diet.



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Mumps

It is caused by *Myxovirus parotidis* and affects the upper respiratory tract. Some of the more common symptoms of mumps include fever, headache, sore throat and swelling of parotid glands which makes the jaw movement difficult.



Figure 8.13 Mumps

Chickenpox

It is common among children and adults. It is a communicable disease caused by *Varicella virus*. It is characterized by eruptions of the skin in the form of blisters or spots in the body and face. The infected persons are isolated for a week until blisters are crusted.



Figure 8.14 Chicken pox

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Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms
Common Cold	Rhino virus	Droplet infection	Upper respiratory tract (Inflammation of nasal chamber)	Fever, cough, running nose, sneezing and headache
Influenza	Myxovirus	Droplet Infection	Respiratory tract, (Inflammation of nasal mucosa, pharynx)	Fever, body pain, cough, sore throat, nasal discharge, respiratory congestion
Measles	Rubeola Virus	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	Myxovirus parotidis	Droplet infection, droplet nuclei and direct contact with infected person	Upper respiratory tract	Enlargement of parotid gland, movement of jaw becomes difficult
Chicken Pox	Varicella Zoster virus	Droplet infection, droplet nuclei and direct contact with infected person	Respiratory tract	Eruptions of the skin, fever and uneasiness

Table 8.4 Airborne diseases caused by virus

8.5 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 are given below.

8.5.1 Diseases caused by bacteria

Cholera

Cholera is an epidemic disease and in the earlier days many people died due to this.



Figure 8.15 Vibrio cholerae

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It is caused by *Vibrio cholerae* mostly due to contaminated food and water. Acute diarrhoea with watery stool, vomiting, nausea and dehydration are the symptoms of this disease.

Typhoid

This disease is common in children of age group 1-15 years. Nearly 2.5 million people suffer from typhoid disease every year. This is caused by the bacteria *Salmonella typhi*. Food and water contaminated by the faeces of infected person causes this disease. Infected persons show symptoms of fever, weakness and vomiting.

Table 8.5 gives more information about water borne diseases caused by bacteria.



Figure 8.16 Salmonella typhi

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Disease	Causative Organism	Mode of Transmission	Tissue/ Organ Affected	Symptoms	Preventive and Control Measures
Cholera (Acute diarrhoeal disease)	Vibrio cholerae	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)	Salmonella typhi	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

Table 8.5 Waterborne diseases caused by bacteria

More to Know

- Cholera caused by *Vibrio cholerae* was first published by Robert Koch.
- Chloragen is a toxin produced by *Vibrio cholerae* causing harmful effects.

8.5.2 Diseases caused by virus

Poliomyelitis

It is caused by *polio virus* and spreads from person to person. This virus gets into the blood and enters into the brain or spinal cord and affects the central nervous system. Muscles get paralysed and result in difficulty in walking.





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More to Know

Polio virus is also called enterovirus. It is primarily an infection of the alimentary tract. The most vulnerable age is between 3-6 years of age. Pulse-polio programme was started in December 1995 in India. India has taken up a massive programme for the eradication of Polio under Pulse Polio Immunisation Programme in which young children are given polio vaccine drops orally.





No cases of polio reported in India since 13th January 2011. Without reporting any case of

polio for three years, WHO declared India as 'Polio-free country' on 13th January 2014.

🍰 Activity 4

Collect data on the success of pulse polio programme in your city/town/village.

Hepatitis A or Infectious Hepatitis

It is caused by Hepatitis A virus (HAV). It is transmitted through contaminated water and food and through oral route. It causes inflammation of liver resulting in jaundice (Yellow fever).



Figure 8.18 Hepatitis B virus

Acute Diarrhoea

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Acute diarrhoea is commonly caused by infection of intestine. It is caused by **Rotavirus** and results in sudden onset of frequent stools, three or more in a day. It is transmitted through



Figure 8.19 Rotavirus infection

contaminated water and food. Increased fluidity and the volume of bowel movements result in excessive loss of fluid and electrolytes from the intestine.

Symptoms of these diseases and preventive measure are given in Table 8.6.

Disease	Causative Organism	Mode of Transmission	Tissue/Organ Affected	Symptoms	Preventive and Control Measures
Poliomyelitis	Polio virus	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	Hepatitis A virus (HAV)	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	Rotavirus	Contaminated water, food and oral route	Intestine	Vomiting, fever, watery stools with mucus	Proper sanitation and hygiene

Table 8.6	Waterborne diseases	caused by	y virus
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8.6 Vector Borne Diseases

Vector is an agent that acts as an intermediate carrier of the pathogen. Many insects and animals acts 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, Filaria, Chikungunya, Dengue, and the diseases which are transmitted through animals are Bird flu and Swine flu.

8.6.1 Malaria

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Malaria continues to be one of the major health problems of developing countries. Malaria is caused by **protozoan** parasite *Plasmodium*. Four different species of *Plasmodium* namely, *Pvivax*, *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 may be fatal to human beings, but cure is available. 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, chillness and shivering, followed by rapid rise in temperature. The fever subsides with profuse sweating. Use of Quinine drugs kills the stages of malaria parasite.

Know your Scientist



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Sir Ronald Ross was an Indian born British doctor who 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.



8.6.2 Chikungunya

Chikungunya, which is caused by single stranded RNA virus, 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. Chillness, 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.



Figure 8.20 Chikungunya

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8.6.3 Dengue

Dengue is known as **break bone** fever. The name break bone fever was given because of the contortions caused due to the intense joint and muscle pain.



Dengue haemorrhagic fever is more severe form and can be life threatening or fatal.



Figure 8.21 Dengue

Activity 5

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?

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Dengue fever and Dengue haemorrhagic fever are caused by virus. It is transmitted by *Aedes aegypti* mosquito that has previously bitten an infected person. Incubation period of the virus is usually 5-6 days. Onset of high fever, severe headache, muscle and joint pain (break bone fever), rash and other haemorrhagic manifestation, 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.

Herbal Facts on Dengue Treatment (Source: AYUSH)

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.

8.6.4 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.

The parasite is deposited at the site of mosquito bite. It passes through the punctured skin and finally reaches the lymphatic system. They appear in large number in the blood stream during night displaying **nocturnal periodicity.**

8.6.5 Control and prevention of vector borne diseases transmitted through mosquitoes

- Prevention of mosquito bites by using mosquito nets, mosquito screens, mosquito repellents and ointments.
- Elimination of breeding places by providing adequate sanitation, underground wastewater 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.

8.7 Diseases Transmitted by Animals

8.7.1 Swine Flu

Swine Flu is so termed because the virus that first caused the disease had originated from pigs. People with weak immune system are at high risk of contracting swine flu. It is an acute respiratory virus which is contagious and spreads through air. Swine flu is caused by virus that affects pigs and has started infecting humans as well.





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Influeuza 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 fight infection.
- Always wash hands and practice good hygiene.

More to Know

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Swine flu first surfaced in April 2009. It affected millions of people and 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. There was a small outbreak in the Maldives in early 2017. Swine flu has spread to more than twenty countries across the world. World Health Organisation had then assigned pandemic alert level 5 to swine flu. This level indicates that human to human outbreak of swine flu is high.

8.7.2 Avian Influenza

Avian influenza is a contagious bird disease caused by a number of viruses. Birds that can carry and spread an avian influenza virus include poultry (like chickens, turkeys or ducks), wild birds and even pet birds. The virus has infected people during outbreaks in Asia, Africa, Middle East and parts of Europe. 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 8.23 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. The

A(H5N1) virus kills a high proportion of the poultry that it infects and is therefore known as a highly pathogenic avian influenza virus. H5N1 was first discovered in humans in 1997 by World Health Organisation. First outbreak was in December 2003.

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8.8 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 gonorrhea, genital warts, genital herpes, syphilis and AIDS

8.8.1 AIDS

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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 (T-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 8.24 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.

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Robert Gallo at National Institute of Health, USA and Luc Montagnier at Pasteur Institute, Paris in 1983 isolated Human Immunodeficiency Virus the (HIV), which causes AIDS.

More to Know

Acquired Immunodeficiency Syndrome caused by HIV (Human Immunodeficiency Virus), a retrovirus 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.

8.8.2 Hepatitis -B or Serum Hepatitis

It occurs due to infection of hepatitis-B virus (HBV) which is an enterovirus. The infecting virus damages the liver cells, causing acute inflammation 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.

Individual affected by this disease shows symptoms of fever, loss of appetite, nausea vomiting, yellowness of eyes and skin, light coloured stools, itching of skin, headache and joint pain. It also causes cirrhosis of liver.

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 8.7.



 Table 8.7
 Sexually transmitted diseases

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

8.9 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

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people in the community are benefited because the disease does not spread.

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

8.9.1 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.

Killed Vaccines

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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.

8.9.2 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. The immunization schedule indicates the age at which the vaccine should be administered to protect the children from infectious diseases. Table 8.8 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). It was developed for over a period of thirteen years. The bacilli are weakened and used for immunization against tuberculosis.

DPT (Triple Vaccine): It is a combined vaccine for protection against Dipetheria, 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 Diphtheria and Tetanus.

TT (Tetanus Toxoid): Toxin of Tetanus bacteria.

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

Age	Vaccine	Dosage
New born	BCG	1 st dose
15 days	Oral Polio	1 st dose
6th week	DPT and Polio	1 st dose
10th week	DPT and Polio	1 st dose
14th 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
10th year	TT and TAB	1 st dose
16th year	TT and TAB	2 nd booster

Table 8.8 Immunization Schedule for Children

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Know your Scientist



Louis Pasteur was an 18th century French chemist and microbiologist best known for vaccination and pasteurisation. He

coined the term vaccine. Pasteur developed vaccine against chicken pox, cholera, anthrax, etc. In 1885 Pasteur administered his first vaccine to a young boy named Joseph Meister who had been repeatedly bitten by rabid dog. The boy was inoculated with less virulent or weakened rabies virus preparations and was saved. He discovered the basis for attenuation, the process of weakening the virulence of pathogenic organisms without losing the capacity to induce immunity.

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*).
- Microbes play an important role in agriculture as biocontrol agent.
- Microorganisms which enrich the soil with nutrients are called as biofertilizers.
- Microbes play a vital role in the cycling of elements like carbon, nitrogen, oxygen, sulphur and phsopshorus.
- Microorganisms play an important role in the production of wide variety of valuable food products for the welfare of mankind.

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• According to WHO, immunisation currently prevents 2-3 million deaths every year.

- A new vaccine against dengue has been licensed in several countries. In 2018, first vaccine to protect children against malaria will be piloted in three African countries.
- Globally, mortality rate due to measles is reduced by 7 %.

Activity 6

Recently in 2018, Nipah virus was in the headlines of the daily newspaper. Collect the following information.

- (a) What is Nipah virus?
- (b) How it gets transmitted?
- (c) Mention the preventive measures taken by the government to check the disease.
- Certain bacteria and fungi are used to produce antibiotics.
- Vaccines are prepared from microbes that are dead or inactive.
- Microorganisms, insects and parasites (also called as pathogens) infect the human body and cause diseases.
- The time between infection and the first appearance of the diseases is called incubation period.
- Reservoir of infection refers to the specific environment in which the pathogens can thrive well and multiply without causing diseases.
- 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-ZGLOSSARY

Acute disease	It is a short duration disease which generally has a relatively severe effect.
Antibiotics	Substances that kill or prevent the growth of microorganisms.
Biofertilizer	Microorganisms which enrich the soil with nutrients are called as biofertilizers.
Biopesticides	The agents which control insect pests in natural way without causing harm to the environment. e.g. bioinsecticides.
Chronic disease	Disease which lasts for a long time, even throughout lifetime.
Flagella	It is a lash-like appendage protruding from the cell body of bacterial cell. It helps in locomotion.
Goitre	Swelling of the neck region due to the enlargement of thyroid gland.
Immunisation	It is the process by which the body produces antibodies against the specific vaccine when administered.
Killed vaccines	These vaccines are prepared by killing the pathogenic organisms by heat, UV rays, alcohol, formalin or phenol. (eg) Typhoid vaccine, Cholera vaccine.
Live vaccines	The pathogen is weakened to make it non-virulent (eg) Oral polio, BCG, MMR vaccine.
Microfilaria	Infective stage of filarial worm (Wuchereria bancrofti).
Pathogen	A pathogen is a biological agent that causes disease to its host. e.g. bacteria, virus etc.
Peptidoglycan	Peptidoglycan, is a combination of sugars and amino acids that forms the cell wall of most bacteria.
Prions	Viral particles which contain only protein. They do not contain nucleic acid.
Sporozoites	Infective stage of <i>Plasmodium</i> (Malarial parasite) which infect man and transmitted from salivary gland of mosquito.
Vaccination	It refers to the administration of vaccine.

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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.
Vector	Pathogens of certain diseases reach the human body through intermediate agents which act as carrier or vector. (eg) Housefly, Mosquito.
Virion	It is a complete viral particle (functional virus) comprising of nucleic acid (DNA or RNA) surrounded by a protective protein coat.
Viroids	Smaller than viruses with self replicating RNA and do not bear protein coat and infect plant cells



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TEXTBOOK EVALUATION

I. Choose the correct answer.

 Mycology is the branch of biology that deals with the study of

b)	virus
	b)

- (c) bacteria (d) fungi
- 2. The major constituent of vinegar is
 - (a) citric acid (b) acetic acid
 - (c) oxalic acid (d) hydrochloric acid
- 3. Bacteria involved in curd formation is
 - (a) Lactobacillus acidophilus
 - (b) Nitosomonas
 - (c) Bacillus ramous
 - (d) none of the above
- 4. Which of the following is transmitted through air?
 - a. Tuberculosis b. Meningitis
 - c. Typhoid d. Cholera
- 5. The most fatal form of Malaria is caused bya. *Plasmodium ovale*b. *Plasmodium falciparum*

- c. Plasmodium malariae d. Plasmodium vivax
- 6. One of the means of indirect transmission of a disease isa. sneezingb. coughing
 - c. vectors d. droplet infection
- 7. Syphilis is caused by a. *Treponema pallidum*
 - b. Leptospira
 - c. Pasteurella
 - d. Vibrio cholerae
- 8. Mosquito borne viral diseases are
 - a. malaria and yellow fever
 - b. dengue and chikungunya
 - c. filariasis and typhus
 - d. kala azar and diptheria
- 9. Diptheria affects the
 - a. Lungs b. Throat c. Blood d. Liver
- 10. Which one of the following is a pair of viral disease?a. Filariasis, AIDS
 - b. Common cold, AIDS

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- c. Dysentry, Common cold
- d. Typhoid, Tuberculosis
- 11. Which of the following disease is spread by animal bite?
 - a. Pneumoniab. Tuberculosisc. Cholerad. Rabies
- 12. The primary organ infected during tuberculosis isa. bone marrowb. intestine
 - c. spleen d. lungs
- 13. Microbes that generally enter the body through nose are likely to affect
 - a. gut b. lungs
 - c. liver d. lymph nodes
- 14. The organ affected by jaundice is

a. liver	b. lungs
c. kidney	d. brain

- 15. Severity of disease symptom depends upon a. number of microbes
 - b. target organ
 - c. both a and b
 - d. none of these.
- 16. Poliomyelitis virus which causes infantile paralysis enters the body througha. skinb. mouth and nosec. earsd. eye

II. Fill in the blanks.

- 1. _____ break down organic matter and animal waste into ammonia.
- 2. The hyphae with branches form a complex network called ______.
- 3. First antibiotic _____ was developed by _____.
- 4. Baker's yeast is _____.
- 5. The two non symbiotic nitrogen fixing bacteria are _____ and

- 6. Typhoid fever is caused by _____
- 7. H1N1 virus causes ______.
- 8. _____ is a vector of viral disease dengue.
- 9. _____ vaccine gives considerable protection against tuberculosis.
- 10. Cholera is caused by ______ and malaria is caused by ______.

III. Expand the following.

1. ORS	2. HIV	3. DPT
4. WHO	5. BCG	

- IV. Pick out the odd one from the following.
 - i) AIDS, Retrovirus, Lymphocytes, BCG,
 - ii) Bacterial disease, Rabies, Cholera, Common cold and Influenza
 - iii) Sporozoites, Merozoites, Trophozoites, Gametocytes (Infective stages of plasmodium in human)

V. State whether True or False. If false write the correct statement.

- 1. Glycogen and oil globules are stored form of food in fungi.
- One of the differences between virus and viroid is the presence of protein coat in viroid and its absence in virus.
- 3. *Rhizobium*, associated with root nodules of leguminous plants fixes atmospheric nitrogen.
- 4. Lophotrichous is a cluster of polar flagellae.
- Non- infectious diseases remain confined to the person who develops the disease and do not spread to others.
- 6. The process of vaccination was developed by Jenner in the year 1796.
- 7. Hepatitis B is more dangerous than Hepatitis A.

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VI. Match the following.					
Swine flu	Human Papilloma virus				
Genital warts	Human Immunodeficiency Virus				
AIDS	Mycobacterium				
Tuberculosis	Influeuza virus H1N1				

VII. Analyze the table and select the option given below that correctly fills the blank.

Disease	Causative organism	Symptoms
Hepatitis	-	Inflammation of the liver
Elephantiasis	Filarial worm	-
Malaria	Protozoan	-
Diarrhoea	-	Nausea, Vomitting, Dehydration

(Swelling of legs, Virus, Rota virus, Fever, Chills and Sweating)

VIII. Answer the following in a word or a sentence.

- 1. Name the chronic diseases associated with respiratory system.
- 2. Name the scientist who first discovered penicillin antibiotic. Can you name any other known antibiotic?
- 3. Name the organism causing diarrhoeal diseases and give one precaution against it.
- 4. Name two common mosquitoes and the diseases they transmit.
- 5. Name one disease that is transmitted by houseflies. Mention their causative pathogen.

IX. Define the following.

1. Pathogen4. Vaccines2. Bacteriophages5. Prions3. Plasmid

X. Answer the following in brief.

- 1. Distinguish between Virion and Viroid.
- 2. A baby is suffering from diarrhoea, while other babies in the same locality do not. Mention the possible causes that you think. What would be the possible solutions for this?
- 3. Name the vector of the malarial parasite. Mention the species of malarial parasite which cause malignant and fatal malaria.
- 4. What is triple antigen? Mention the disease which can be prevented by using the antigen.
- 5. Sanjay had an attack of chicken pox and has just recovered. The health officer of his locality says that the disease would not occur again for him. What would be the reason for this?

XI. Answer in detail.

- 1. Give an account of classification of bacteria based on the shape.
- 2. Describe the role of microbes in agriculture and industries.
- 3. Explain the various types of viruses with examples.
- 4. Suggest the immunization schedule for a new born baby till 12 months of age. Why it is necessary to follow the schedule?
- 5. Name the causative agent of typhoid in human. How does the pathogen gain entry into the human body? Write the diagnostic symptoms and mention the organ that is affected in severe cases.

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- Some human diseases are transmitted only when the blood of a patient comes in close contact with the blood of a healthy person. In one such disease, there is a progressive decrease in WBC of the patient.
 - a. Name the disease and its causative agent.
 - b. Name the type of WBC affected during infection.
 - c. How does the blood of a patient come in contact with blood of healthy patient?
 - d. Suggest three methods that help in preventing such infection.

XII. Questions based on thinking skills.

- 1. We are advised to take bland and nutritious food when we are sick. What is the reason?
- 2. Suggest precautionary measures you can take in your school to reduce the incidence of infectious disease.
- 3. Tejas suffered from typhoid while, Sachin suffered from tuberculosis. Which disease could have caused more damage and why?
- 4. How will you differentiate Hepatitis A from Hepatitis B?

XIII. Assertion and Reason.

Direction: In each of the following questions a statement of assertion (A) is given and a corresponding statement of reason (R) is given just below it. Mark the correct statement as.

- a) If both A and R are true and R is correct explanation of A
- b) If both A and R are true but R is not the correct explanation of A
- c) If A is true but R is false
- d) If both A and R are false.

1. Assertion : A patient with cholera is given oral rehydration therapy for rapid replacement of fluid and electrolytes.

Reason : Cholera can be diagnosed by the microscopic examination of the stool to identify the bacteria.

2. 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.

3. Assertion: Dengue can be treated by intake of antibiotics.

Reason: Antibiotics blocks the multiplication of viruses.

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INTERNET RESOURCES

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Concept Map

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