



# Viruses and Bacteria



## Learning Objectives

Upon completion of topics, learners will:

- List the characteristics of viruses
- Classify viruses based on nucleic acid (DNA and RNA)
- Explain the life cycle of a virus
- List some viral diseases and organisms the attack, modes of transmission and methods of prevention
- Describe bacteria of various kinds
- Classify bacteria
- List and describe some common bacteria diseases, their symptoms and preventive measures
- Classify bacteria based on their autotrophic and heterotrophic nutrition; and aerobic, anaerobic and facultative respiration
- Explain the economic importance of bacteria
- List and describe some common bacterial diseases, their symptoms and preventive measures
- List sexually transmitted infections (STIs) that are caused by viruses and bacteria
- Describe symptoms and prevention of STIs
- Appreciate preventive measures to avoid risky sexual behaviour

## 1.1 VIRUS

**Virus** is a group of ultramicroscopic, non-cellular, highly infectious agents that multiply only intracellularly inside the living host cells without involving growth and division. Outside the host cell they are

inert particles. They are **nucleoproteins** having one or more nucleic acid molecule (either DNA or RNA) encased in a protective layer of protein.

### 1.1.1 Characteristics of Viruses

1. Viruses are ultramicroscopic, non-cellular, highly infectious particles.
2. They are **intracellular, obligate** parasites and attack specific hosts.
3. Viruses are active only when they are inside the host cells. Outside the host cells, they behave like chemical substances. Thus, they do not have their independent existence.
4. They are ultramicroscopic structures having following sizes:
  - Some animal virus of cattle is 10 nm causes foot and mouth diseases in cattle.
  - Smallest plant virus, Alfalfa virus is 17 nm.
  - Tobacco mosaic virus is  $300 \times 15$  nm.
  - Parrot fever virus is 400 nm.
  - Beet yellow virus is  $1250 \times 40$  nm.
5. Viruses can be of various shapes. In general, they are helical and cuboid shaped structures. Some specific shapes of viruses are as follow:
  - Spherical shaped (Alfalfa mosaic virus and foot and mouth virus)
  - Cubical shaped (Vaccinia)
  - Elongated rod-shaped (Tobacco mosaic virus)
  - Polyhedral shaped (Polio, Turnip yellow virus)
  - Tadpole like (Bacterial virus)
6. They possess genetic material (DNA or RNA), which determine their structure and development.
7. They are highly pathogenic and cause infectious diseases in animals and plants. They cause infection in host cells by means of nucleic acids.
8. They are easily transmitted from one organism to another by means of a vector.
9. They show irritability and respond to environmental conditions such as heat, ultraviolet rays, humidity, drought and alcohol.
10. They can be precipitated from suspensions like any other chemical substances.

11. They can be crystallized in the form of crystals for retaining their capacity of infection.
12. All viruses are nucleoproteins. The nucleic acid is protected by a protein coat against attack by nuclease enzyme.

### 1.1.2 Composition of Viral Structure

Viruses are made up of envelop, capsid, nucleoid and occasionally one or two enzymes.

**Envelop:** The viruses are covered by a thin and loose external covering called **envelop**. It is composed of proteins (from virus), lipids and carbohydrates (both from the host cell). Envelop is mainly found in animal viruses, such as Herpes virus, HIV and Influenza virus. Viruses, which do not possess envelop are called naked viruses.

**Capsid:** Capsid is a protein coat that surrounds the central portion of nucleoid and enzymes. The capsid together with the nucleic acid is called nucleocapsid. Each capsid is made of identical protein subunits called **capsomeres**.

**Nucleoid:** The nucleic acid present in the virus is called **nucleoid**. It is an infective part of virus which utilizes the metabolic machinery of the host cell for synthesis and assembly of viral components.

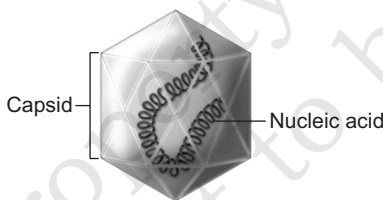


Fig. 1.1. Naked nucleocapsid virus

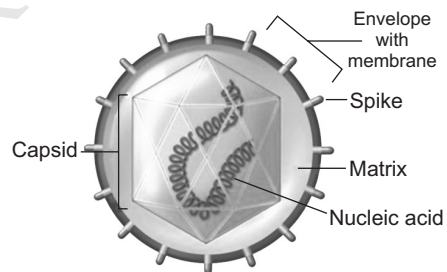


Fig. 1.2. Enveloped virus

**Enzymes:** Only few viruses contain certain enzymes. For example, Lysozyme in bacteriophages and Reverse transcriptase in Retroviruses

#### Antibiotics are Ineffective against Viral Diseases

Antibiotics are low molecular organic compounds produced by microorganisms that act against growth and development of other microorganisms. They are used as clinical drugs against bacterial pathogens, but are ineffective against viruses. Since, viruses are outside the host body behave like inert particles and do not possess cell wall and own protein synthesizing apparatus, they are not attacked by antibiotics. The viruses are killed or inactivate only by the antibodies of the attacked host.

## 1.2 CLASSIFICATION OF VIRUSES

There are four types of genetic materials present in the viruses. These are:

1. Double stranded DNA (ds DNA) found in Herpes virus, Pox virus, Cauliflower mosaic virus and Hepatitis-B virus
2. Single stranded DNA(ss DNA) present in Coliphage *fd* and Coliphage  $f \times 174$
3. Double stranded RNA (ds RNA) present in Reo virus and Wound tumour virus
4. Single stranded RNA(ss RNA) present in Tobacco mosaic virus, Influenza virus, Polio virus and HIV

Based on the type of nucleic acid present in them, viruses are classified as RNA and DNA viruses.

### 1.2.1 RNA Virus

The virus that possesses RNA as genetic material is called **RNA virus**. They can either be a single-stranded or a double-stranded RNA. Some of the diseases caused by the RNA virus to humans include common cold, hepatitis, polio, West Nile fever, influenza, SARS and measles. All plant viruses are examples of the RNA virus.

**Mutation** rates are higher for the RNA virus. Therefore, it may be considered as a one of the main reason for lacking back in preventing effective vaccines to treat and prevent certain viral diseases.

Double-stranded RNA virus comprises of distinct virus that differs widely based on host-virus such as fungi, bacteria, genome, virion, and organization.

A single-stranded RNA is categorized based on senses that are positive sense or negative sense.

- The Positive-sense RNA is similar to mRNA. They are usually translated into host cells.
- The Negative-sense RNA must be converted into positive sense RNA before translation using RNA polymerase.

### Structure of Tobacco Mosaic Virus (RNA virus)

The **tobacco mosaic virus** is a long, slender and rod-shaped measuring about 18 nm in diameter and 300 nm in length. It is a complex structure made up of nucleoprotein. In the tobacco mosaic virus, the single strand

of RNA formed its central core which is surrounded by the virus protein. The protein part makes the external sheath of rod called capsid. The capsid is made up of about 2,200 identical subunits called capsomeres which are closely-packed and arranged in a regular helix around a central lumen of 4 nm diameters surrounding a spirally coiled RNA lodged in their notches.

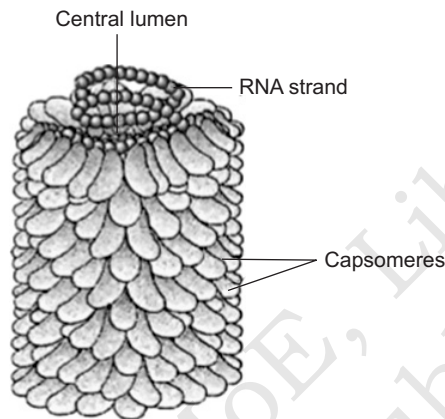


Fig. 1.3. Structure of tobacco mosaic virus (RNA virus)

### 1.2.2 DNA Virus

The virus that possesses DNA as a genetic material is called DNA virus. They are DNA dependent and they replicate using DNA polymerase. They are usually double stranded DNA but in some cases, they can either be single-stranded DNA. Bacteriophages, cyanophages and most of the animal virus are examples of DNA virus.

Based on the type of host and genetic material, there are three types of virus:

1. **Animal viruses:** The viruses which infect and live inside the animal cell including humans are called animal viruses. They contain DNA or RNA as genetic material. Some examples of animal viruses are rabies virus, influenza virus, poliovirus, mumps virus, etc.
2. **Plant viruses:** The viruses which infect plants are called as the plant viruses. They contain RNA as a genetic material, which remains enclosed in the protein coat. Some examples of plant viruses are potato virus, tobacco mosaic virus, beet yellow virus, turnip yellow virus etc.
3. **Bacteriophage:** The viruses which invade and infect bacterial cells are called as the bacteriophage. They contain DNA as genetic

material. There are varieties of bacteriophages. Usually, each kind of bacteriophage will attack only one species or only one strain of bacteria.

### 1.2.3 Structure of Bacteriophage (DNA virus)

The virus which attacks on the bacterial cell is called bacteriophage. It consists of a head and tail which are of approximately equal length. The head is a polyhedral structure which has an outer coat of protein enclosing a single molecule of DNA. The DNA is double helix, coiled and long molecule consisting of polynucleotide. The tail is much narrower in comparison to head. It is hexagonal in cross-section with a hollow central core. It is made up of four different kinds of proteinaceous components forming a spiral sheath. The protein of tail sheath is contractile and bears a disc-like hexagonal plate at its distal end. The tail bears 6 spikes to which are attached 66 tail fibres.

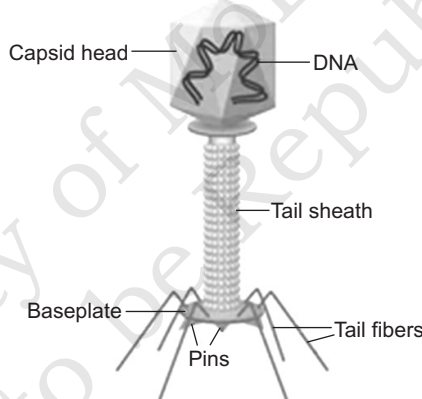


Fig. 1.4. Structure of Bacteriophage

## 1.3 LIFE CYCLE OF A VIRUS

The life cycle of a virus, *e.g.* Bacteriophage (Fig. 1.5) exhibits two major types of life cycles:

1. Lytic cycle or virulent cycle
2. Lysogenic cycle or temperate cycle

### 1.3.1 Lytic Cycle or Virulent Cycle

In the **lytic cycle**, a bacteriophage infects a bacterial cell and kills it to release progeny virus. This cycle takes place in the following steps:

- **Adsorption:** The bacteriophage attaches itself on the surface of bacteria. This process is known as adsorption. The tips of the tail fibres attach to specific receptors on the surface of the bacterial cell.
- **Penetration:** The tail sheath of the phage contracts after adsorption. The base plate and the tail fibres are attached firmly to the bacterial cell. The phage muramidase weakens a part of the cell wall and the hollow core is pushed downwards through it. The DNA is injected inside the bacterial cell.
- **Synthesis of phage components:** The components of new virus particles are produced after the nucleic acid is released into the cell. The sub-units of phage head, tail and late protein then appear. The synthesis is carried out by specific enzymes called early proteins. The nucleus and the cytoplasm also contain the components of a phage.
- **Maturation and assembly:** On maturation, the head and tail protein of phage DNA assemble and each component of phage DNA is surrounded by a protein coat. Ultimately, the tail structures are added forming a virion.
- **Release:** The infected bacterial cell is lysed releasing the progeny phages. The phage enzymes weaken the cell wall of bacteria during replication.

### 1.3.2 Lysogenic Cycle or Temperate Cycle

In **lysogenic cycle**, the phage becomes integrated with the chromosome of the host cell and is known as a prophage. This prophage is transmitted to progenies at the time of cell division during reproduction in bacteria. The bacteria carrying a prophage without being lysed is called lysogenic bacteria. When the lysogenic bacteria multiply, the prophage might be lost due to excision.

#### ACTIVITY ZONE (INDIVIDUAL PRESENTATION)

Diagramming the life cycle of bacteriophage on a chart paper and present it in your class.

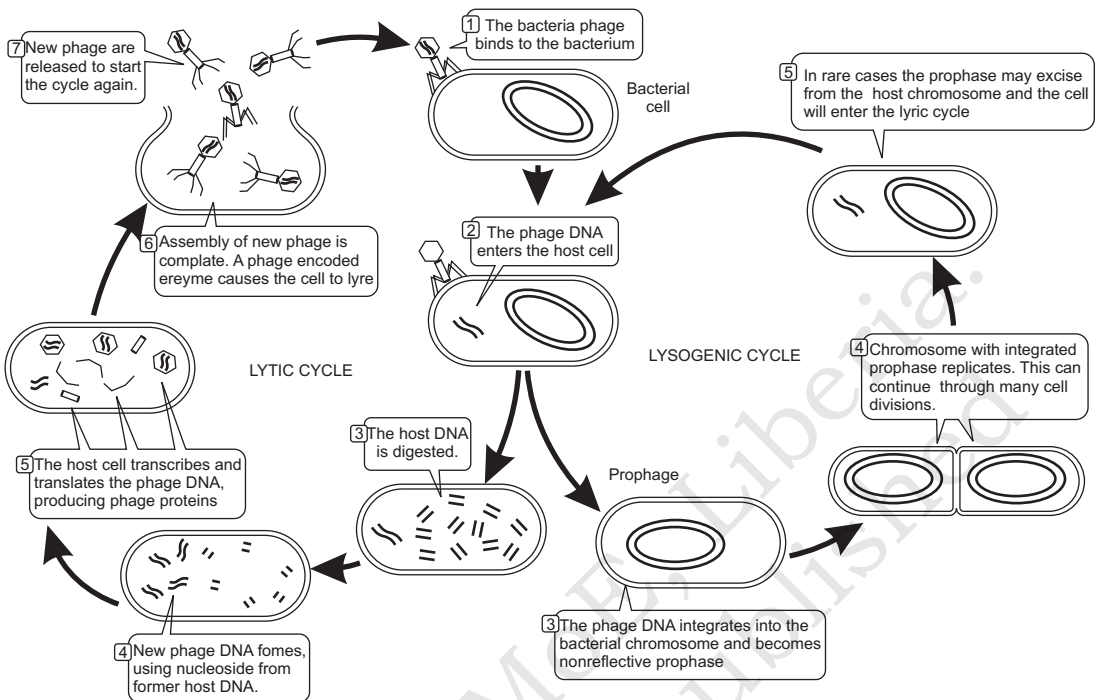


Fig. 1.5. Lytic and lysogenic cycles of bacteriophage

## 1.4 BACTERIA

Bacteria (singular: bacterium) are probably the first living organisms found on the earth. They are most primitive, unicellular, microscopic, simple and undifferentiated **prokaryotic** organisms which are usually identified by their specific functions and not by their general appearances. They are among the smallest and most widespread of all living things. They may live alone or in groups called colonies. Some bacteria are harmful, but most serve a useful purpose. They support many life forms, both plants and animals and they are used in industrial and medicinal processes.

**Definition:** Bacteria are unicellular organisms belonging to the prokaryotic group where the organisms lack a few organelles and a true nucleus.

### 1.4.1 General Characteristics of Bacteria

**Occurrence:** Bacteria are ubiquitous means they occur anywhere and everywhere, in air, in water, in soil and even in the body of all living organisms.



**Size:** Bacteria are the smallest living organisms on the earth. The average size of bacteria cell is  $1\ \mu\text{m}$  to  $10\ \mu\text{m}$  in length and from  $0.7\ \mu\text{m}$  to  $1.5\ \mu\text{m}$  width. The size of smallest bacterium (*e.g.* Cocci) is not more than  $0.1\ \mu\text{m}$  while the largest reaches up to  $500\ \mu\text{m}$ . The largest bacterium (*Beggiatoa mirabilis*) is  $16\text{--}45\ \mu\text{m}$  in diameter and several centimeters long.

**Shape:** Bacteria are able to change their shape and size with changes in environmental conditions. Based on their shapes, bacteria are classified as follows.

### 1.4.2 Classification and Shape

#### Classification of Bacteria on the Basis of their Shapes

1. **Coccus** (Gk. *Kokkos* meaning berry): The Coccus bacteria are spherical, ellipsoidal or ovoid in shape. They may occur singly (*Micrococcus*), or in pairs (*Diplococcus*). In chains (*Streptococcus*) or in sheets (*Staphylococcus*).
2. **Bacilli** (L. *bacillus* meaning small rod): They are straight, rod-shaped bacteria. Their end walls may be pointed, flat, concave or convex in shape. They may occur singly (*Bacillus*), in pairs (**Diplobacillus**) or in a chain (*Streptobacillus*).
3. **Spirillum** (L. *spira* meaning coil): The Spirillum bacteria are spiral or coiled-like or cork screw-shaped. These forms are usually rigid and bear two or more flagella at one or both the ends, *e.g.* *Spirillum*, *Spirochaete*, etc.
4. **Vibrio**: These are the rod-shaped bacteria with single curved, C-shaped or comma-shaped. They have one or more flagella at one pole, *e.g.* *Vibrio*.

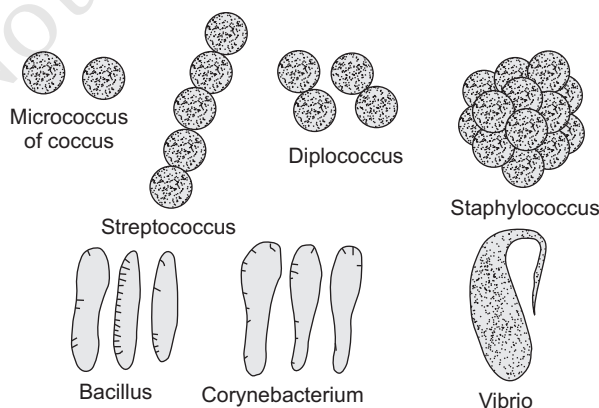
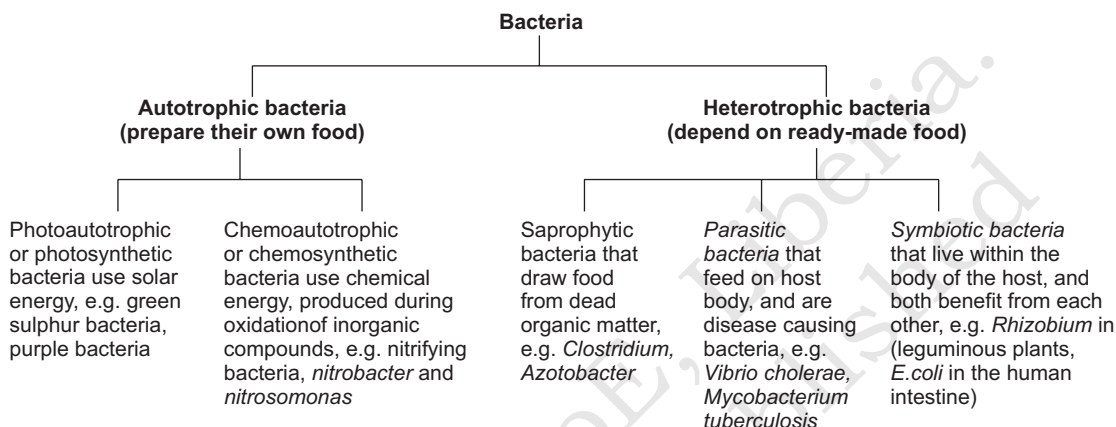


Fig. 1.6. Types of bacteria on the basis of their different shapes

## Classification of Bacteria on the Basis of their Modes of Nutrition

Nutrition is a process of acquiring energy and food. The need for energy is required for growth, reproduction, and maintenance. The main sources of nutrients in bacteria are carbon, nitrogen, water, phosphorous, iron, and some inorganic salts.



**Table 1.1.** Differences between the autotrophic and heterotrophic bacteria

<i>Autotrophic Bacteria</i>	<i>Heterotrophic Bacteria</i>
The bacteria synthesise their own food.	The bacteria obtain organic food or organic growth factors from outside sources.
They depend on an external sources of energy for synthesis of food.	An external source of energy is not required.
Autotrophic bacteria live on inorganic substrata.	Heterotrophic Bacteria live on organic living host.

## Classification of Bacteria on the Basis of their Modes of Respiration

According to the mode of respiration, bacteria can be of following three types:

1. **Aerobic Bacteria:** Some bacteria need free atmospheric oxygen for their respiration and are called **aerobic bacteria**. They oxidize food materials present in the cytoplasm to obtain energy. The free oxygen diffuses in through the bacteria cell wall and oxidizes the food materials present in the cytoplasm. Most of the aerobic bacteria used free oxygen of the atmosphere or the oxygen dissolved in the liquid environment. Example of aerobic bacteria includes Mycobacterium.

- Anaerobic Bacteria:** Some bacteria do not need oxygen for their respiration and are called **anaerobic bacteria**. They can live and multiply in the absence of free oxygen. The anaerobic bacteria obtain oxygen for their respiration from organic compounds such as sugar (glucose). During anaerobic respiration, bacteria decompose glucose and form alcohol and carbon dioxide. Actinomyces and Clostridium are the examples of anaerobic bacteria.
- Facultative Bacteria:** Facultative bacteria respire aerobically as well as anaerobically. Some aerobic bacteria can also survive in the absence of oxygen, e.g. Pseudomonas whereas some anaerobic bacteria, such as Chlorobium can also survive in the presence of oxygen.

### ACTIVITY ZONE (INDIVIDUAL ACTIVITY)

Prepare charts to show the classification of bacteria on the basis of the following topics and discuss about them in the class.

- Different shapes of bacteria
- Modes of nutrition in bacteria

### 1.4.3 Structure and Composition of a Bacteria Cell

A typical bacteria cell observed under a microscope shows the following structural features:

- Slime and Capsule:** Slime is a gelatinous substance secreted by the protoplast and deposited over the cell wall in the form of a loose gelatinous sheath called **slime layer**. It is usually composed of polysaccharides. In case of some virulent bacteria, the nitrogenous substances like amino acids are also present in addition to polysaccharides so that the slime layer becomes thick, called **capsule**.
- Cell Wall:** The bacteria cell wall is the outer, rigid covering of the cell which provides shape and protection to the protoplast and keeps the cell from bursting due to osmotic changes. Chemically, it consists of acetyl glycosamine, acetyl muramic acid a peptide chain of four or five amino acids. All these chemicals together form a polymer called **peptidoglycan**.
- Plasma Membrane:** Each bacteria cell has a thin, elastic and selective permeable plasma membrane which allows passage of dissolved substances in and out of the cell. The plasma membrane is composed of phospholipid, proteins and polysaccharides.

There are some structures associated with the plasma membrane. These are:

- **Mesosomes:** These are finger-like in foldings of plasma membrane which may help compartmentalize the bacteria cell.
- **Flagella:** These are long, thread-like structures concerned with the motility of some bacteria cell.
- **Pilli:** These are extremely, minute and straight hair-like appendages composed of protein subunits called pillin. The pilli help in the attachment of bacteria cells.

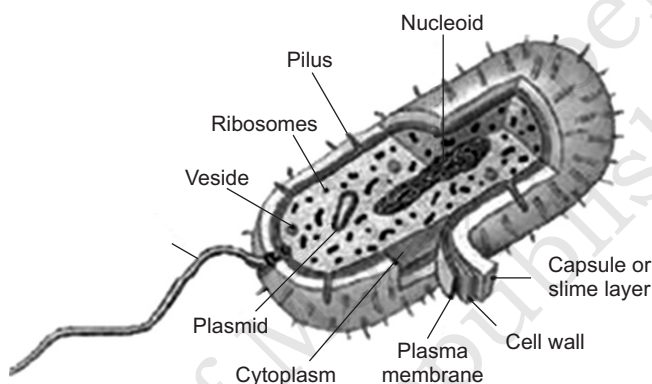


Fig. 1.7. The structure of a bacterial cell as seen under the microscope

4. **Cytoplasm:** The cytoplasm is a complex aqueous fluid consisting of carbohydrates, soluble proteins, enzymes, vitamins, lipids, mineral salts and nucleic acids. The cytoplasm is granular due to presence of a large number of ribosomes which occur singly or in groups called **polyribosomes**.
5. **Nucleoid:** In a bacteria cell, the nuclear material consisting of a naked DNA molecule called **nucleoid**. It is a circular, ring-like, double stranded DNA molecule with no free ends.
6. **Plasmids:** In addition to bacterial chromosomes, some bacteria have accessory rings of DNA, called **plasmids**. The plasmid DNA replicates independently and maintains independent identity of bacteria cell. The plasmids which temporarily associated with nucleoid DNA are known as **episomes**.

### ACTIVITY ZONE (LAB ACTIVITY)

Prepare a slide of bacteria with the help of your teacher in the lab. Using a microscope, observe its structure and try to draw on a sheet of paper. Also discuss why the genetic material of bacteria is called nucleoid instead of the nucleus.

### 1.4.4 Economic Importance of Bacteria

#### 1. Role of bacteria in agriculture

- **Decay of organic wastes:** Many saprophytic bacteria decompose the dead organic matter by putrefaction and decay. The simple compounds produced as a result of decomposition and decay are released back into the environment for recycling or absorbed by the plant as food.
- **Sewage disposal:** Some anaerobic bacteria are able to putrify sewage. They decompose the solid sewage into liquid sludge which is then passed to the coarse filters. After filtration, the effluent is finally purified and drained out into the river or used as fertilizers in the field.
- **Nitrogen fixation:** Nitrogen fixation is the process that biologically converts atmospheric nitrogen into its usable form. Certain leguminous plants, such as pea and bean plants have symbiotic bacteria (*Rhizobium*) in their root nodules. The bacteria take up free nitrogen from the atmosphere and convert the same into soluble nitrates such as potassium nitrate.
- **Role in improving soil fertility:** Some saprophytic bacteria such as, *Bacillus stearothermophilus* and *Clostridium thermocellum* present in the soil. They help in improving the fertility of soil by the formation of humus and manure.

#### 2. Role in industry: Bacteria are helpful in the production of some industrial products by the following ways:

- **Production of cheese and yogurt:** Some bacteria respire anaerobically when provided with a suitable source of sugar. One such bacterium is named *Lactobacillus*. *Lactobacillus* uses lactose sugar from milk as its energy source and converts it into lactic acid. In this process, it produces some amount of energy. Due to the presence of lactic acid the milk proteins coagulate and form clumps. The milk thus separates out into clumps, called curd, and a liquid, called whey.
- **Production of vinegar:** Vinegar is a fermentation product of cane juice. The vinegar juice is first converted to alcohol by alcoholic fermentation carried by yeast and then the alcohol is converted to acetic acid by the action of *Acetobacter* bacteria.
- **Curing of tobacco and tea:** The curing of tobacco and tea leaves is carried by fermenting action of certain bacteria to add their characteristic flavour and taste.

- **Leather tanning:** The process of tanning hides and skins, after drying, salting and cleaning involve the fermenting action of certain bacteria.

### 3. Medicinal uses of bacteria

- **Serum and vaccines:** Many bacteria are used in the preparation of serums and vaccines. These substances induce immunity against various infectious diseases in humans. Serums are effective against certain diseases like Diphtheria and Pneumonia whereas the vaccines are effective against Typhoid, Smallpox and Cholera.
- **Vitamins:** The riboflavin (vitamin B<sub>12</sub>) is produced by the action of a bacterium named *Clostridium butylicum*. The ascorbic acid (vitamin C) is produced from sorbitol by the action of *Acetobacter*.
- **Antibiotics:** The bulk of antibiotics are produced from the bacteria. Antibiotics are the chemical substances produced by the living microorganisms capable of destroying other disease-causing microbes. The very first antibiotic was **penicillin** and along with a family of related antibiotics, it is still widely used to treat many common infections. It is produced by *Penicillium notatum* bacteria and is given to a patient suffering from tetanus and diphtheria.

**Table 1.2.** Common antibiotics obtained from bacteria

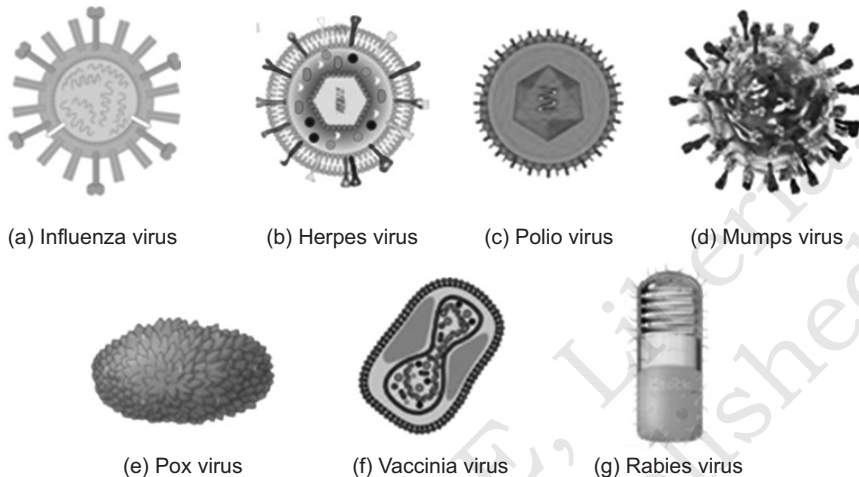
Antibiotic	Microbial source	Mode of action
Obtained from <i>Bacillus</i> sp. (True bacteria)		
1. Colistin	<i>Bacillus colistinus</i>	Deteriorates cell membrane
2. Bacitracin	<i>Bacillus subtilis</i>	Inhibits cell wall synthesis
3. Gramicidin	<i>Bacillus brevis</i>	Deteriorates cell membrane

## 1.5 SOME COMMON VIRAL AND BACTERIAL DISEASES

### 1.5.1 Common Viral Diseases

There are many viruses that can infect people and make them sick. One of the most common viral infectious diseases is influenza which is the main cause of flu. Other diseases caused by virus include the common cold, measles, mumps, yellow fever, hepatitis, AIDS, etc. Some virus called **oncovirus** also leads to a certain form of cancers. The most common among them is cervical cancer and liver cancer.

Some animal viruses can cause serious diseases in vertebrates like man, fowl, pigeon, dog, cow, etc. Fig. 1.8 represents morphological features of some disease-causing animal viruses.



**Fig. 1.8. Morphological features of some disease-causing animal virus**

Diseases caused by the viruses are as follows:

### AIDS

The disease AIDS or Acquired Immune Deficiency Syndrome is caused by Human Immunodeficiency Virus (HIV). The name refers to the fact that HIV infects and severely damages the patient's immune system. Cases of AIDS were first identified in 1981 in the United States. Millions of cases of AIDS have been diagnosed throughout the world so far. The AIDS virus is especially a fragile virus. One may become infected with HIV through direct contact of one's body fluids already having the virus. The virus can be transmitted through an infected mother, unprotected sexual intercourse, contaminated blood transfusion, contaminated and injection needles.

**Symptoms:** A HIV positive person may remain symptomless and healthy for several months as the disease may appear after 15 to 57 months of infection. The important symptoms of AIDS are:

- (i) Swollen lymph nodes.
- (ii) Regular fever, sweating at night and weightloss.
- (iii) Severe damage to brain, which may lead to loss of memory, ability to speak and clear thinking.
- (iv) Decreased count of blood platelets and hemorrhage.

**Prevention:** The disease can be prevented by educating people for the following:

- (i) Disposable needles and syringe should be used for injection.
- (ii) Before receiving blood for transfusion, one should ensure that it has been screened for HIV negative.
- (iii) Sexual contact with unknown people should be avoided.
- (iv) The common razor at the barber's shop should not be used.

### Chickenpox

Chickenpox is a common viral disease which mainly occurs in children, but sometimes it also affects the adults. It is caused by the Herpes virus, named *Varicella zoster*. The disease spreads quickly by close contact with an infected person.

**Symptoms:** In this disease, highly irritating rashes appear on the body starting from the chest and back which gradually spread to the arms, legs, face and eventually the whole body. The rashes first appear as pink spots and rapidly change to watery blisters. These blisters soon dry and form scabs. The scab formation is the highly infected stage of the disease.

**Prevention:** Vaccination of live attenuated vaccine containing *Varicella* is given to the children of the age of 12 to 18 months for active immunisation.

### Smallpox

Smallpox was the first disease to be eradicated from the world. Mass immunisation or vaccination has wiped it out. Smallpox is caused by the virus present in the droplets expelled from the patient's nose and mouth, during coughing. This virus spreads through the air.

**Symptom:** The symptoms appear after 10 to 12 days. The person develops aches and a high fever. Two to four days later, rashes appear on the face, spreading to other parts of the body. The rashes resemble thousands of small pimples, filled with pus. Scabs or crusts formed over the pimples fall off three or four weeks, later leaving scars.

In May 1980, WHO formally announced that the smallpox had been eliminated from the world.



## Mumps

Mumps is a contagious disease that causes painful swelling below and in front of the ears. It is caused by a virus present in the saliva of an infected person.

**Symptom:** The symptoms of the disease appear about 18 days after contact with the mumps virus. They include fever, headache and sometimes vomiting.

**Prevention:** There is no cure for mumps, but the vaccine of mumps provides immunity from the disease.

## Poliomyelitis

Poliomyelitis, commonly called polio, is a serious infection caused by the *Poliomyelitis virus*.

**Symptom:** The disease is sometimes called infantile paralysis because it may strike infants or children and lead to paralysis. If paralysis develops, the person may not be able to stand or walk.

**Prevention:** There are two polio vaccines Salk and Sabin that protect humans against the polio viruses. **The Salk** is injected into the skin whereas Sabin is administered orally. Polio vaccine is administered in four doses viz. at 2 months of age, 4 months of age, 18 months of age, and just before children enter school at 4 to 6 years of age.

## Rabies

Rabies, also known as hydrophobia, is caused by a virus called *Rhabdovirus*. This virus is found in most of the mammals and can be carried in the salivary glands for long periods of time. It spreads through the bite of certain rabid mammals, such as dogs, cats, horses and monkeys. If an animal, which carries the virus, bites another animal or a human being, infected saliva enters the open wound and the victim may get the rabies virus.

### Symptoms:

- (i) High fever, severe headache and painful contraction of muscles of throat and chest.
- (ii) The patient feels restless, has a choking feeling and finds difficulty in taking even liquid food.
- (iii) The patient develops fear of water.
- (iv) Severe damage is caused to central nervous system which results in paralysis and painful death.

**Prevention:**

- (i) Stray dogs and cats should be compulsorily immunised. Pet dogs should be vaccinated with anti-rabies vaccines.
- (ii) A rabid animal shows excessive salivation and tries to seek isolation after bite. Such animal should be killed.
- (iii) If a person is bitten by a dog, cat or jackal, wash the wound with carbolic soap and clean water immediately. Apply antiseptic medicine and consult a doctor for anti-rabies vaccine without further delay.
- (iv) The bitten person should be treated by Pasteur's treatment (discovery by Louis Pasteur) in which a course of 14 vaccines was given. At present five anti-rabies vaccines are prescribed at an interval of 0-3-7-14-30 days of dog bite.

**Influenza or Flu**

Influenza is a disease caused by the influenza virus. This disease is commonly called the flu. Influenza is mainly a respiratory disease. The virus is inhaled and comes in contact with the cells of the upper air passages. It penetrates the cells that line these passages.

**Symptoms:** The symptoms of influenza include chills, fever, headache, body aches and weakness which usually, disappear in about a week.

**Prevention:** Avoiding close contact, regularly washing of your hands, taking symptomatic medicines and rest are some preventive measures of influenza.

Table 1.3 summarizes common viral diseases of humans.

**Table 1.3.** Common viral diseases of humans

<i>Disease</i>	<i>Mode of transmission</i>	<i>Symptoms</i>	<i>Prevention</i>
1. AIDS	Through direct contact of body fluid of someone who already has the virus.	A continuous damage of the body immune system.	People should be educated about AIDS. Disposable syringes and needles should be used for injection. Avoid unprotected sex. Before blood transfusion, screening for HIV is a must.

2. Chickenpox	By close contact with an infected person.	Appearance of pink rashes starting from chest and abdomen and then the whole body. Rashes gradually change into the blisters.	Varicella vaccine is given to the children of age of 12 to 18 months for active immunisation.
3. Hepatitis	Through fecal-oral route of virus. Ingestion of contaminated water, food and milk,	High temperature, headache, fatigue, general weakness, nausea and vomiting.	Use chlorinated and boiled water, proper cleaning of hands, a vaccine should be taken to prevent the disease.
4. Common cold	Moisture duplets, contact with infected articles.	Profuse nasal discharge often accompanied by headache.	Infected person must cover mouth and nose while sneezing or coughing.
5. Smallpox	Droplet infection	Appearance of rash changing into pustules.	Smallpox vaccine
6. Polio myelitis	Direct and Oral	Stiffness of neck, convulsion and paralysis of legs.	Salk vaccine and oral polio vaccine Sabin.
7. Mumps	Contagious: droplet infection and direct contact	Painful enlargement of salivary glands; movements of jaw becomes difficult.	Mumps vaccine and isolation.
8. Rabies	Bite of rabid animals	Spasm of throat and chest, muscles, fears from water, and Paralysis.	Immunisation of dogs, rabies vaccine.
9. Ebola Virus Disease (EVD)	Direct contact with blood, bodily fluids, or skin of infected person or individuals who have died of the Ebola disease.	Sudden fever, intense weakness, muscle pain and a sore throat.	A regular washing of hands for 20 seconds with soap and running water or rubbing of hands with alcohol-based sanitiser. Avoid direct contact with an infected person's body fluids through clothes, medical equipment and needles.

## 1.5.2 Common Bacterial Diseases

Bacteria are the causative agents of a number of infectious diseases such as tuberculosis, tetanus, streptococcus infection and so on.

### Tuberculosis

Tuberculosis, commonly called TB, is a disease that mainly affects the lungs. Other body parts such as brain, kidney and bones are also affected by the tuberculosis. It is caused by a small, rod-shaped bacterium named *Mycobacterium tuberculosis*. The incubation period of tuberculosis is of 2–10 weeks. It is spread by the sputum of an infected person. When a person with tuberculosis coughs or sneezes, the bacteria spreads in the air and infects the other healthy persons. Actually, the germs of tuberculosis are widespread and almost everyone receives them. Most of the people overcome minor infection of disease but the people with low immunity may be affected severely with the tuberculosis.

**Symptoms:** Coughing and sputum production is the most common symptom of tuberculosis. If blood vessels in the lungs are damaged, there may be blood along with the sputum coming out. Other symptoms include chest pain, fever, sweating at night, fatigue, acute weight loss and loss of appetite.

**Prevention:** BCG vaccination is very effective to develop immunity against tuberculosis. An antibiotic called streptomycin stops the bacteria from multiplying and allow the body's natural defences to work.

### Tetanus

Tetanus, also known as lockjaw, is caused by the bacterium *Clostridium tetani*. These bacteria thrive in the dust and dirt and do not need air to live. They get into the body through cracks in the skin. Any dirt in a wound may contain these bacteria. The bacteria grow quickly if no air gets into the wound.

**Symptoms:** The symptoms of tetanus usually start within several days after infection. The victim feels depressed, has headache, fever, pain and soon has trouble in opening the mouth or swallowing caused due to paralysis of jaw muscles.

**Prevention:** Tetanus can be prevented. All wounds should be cleaned thoroughly. People may be against infection with injection of tetanus toxoid or antitoxin injection.

## Streptococcus Infection

*Streptococcus pneumoniae* is a bacterium that is commonly found in the nose and throat. It is spread from person to person by inhaling or direct exposure to the bacteria droplets through coughing or sneezing from an infected person. The bacteria can sometimes cause severe illness in children, the elderly and other people with weakened immune systems. It is the most common cause of middle ear infections, blood infection in children and pneumonia in immuno-compromised elders. Streptococcus can also cause meningitis (inflammation of the coverings of the brain and spinal cord) or sinus infections. It is considered invasive when it is found in the blood and spinal fluid.

**Symptoms:** Symptoms generally include an abrupt onset of fever and shaking or chills. Other symptoms may include headache, cough, chest pain, disorientation, shortness of breath, weakness, and occasionally a stiff neck.

**Prevention:** Invasive *Streptococcus pneumoniae* infections are treated with antibiotics. There is an increasing problem of *Streptococcus pneumoniae* bacteria developing drug resistance due to the overuse and misuse of antibiotics.

### ACTIVITY ZONE (GROUP DISCUSSION)

In a group, identify and list out common viral and bacterial diseases and discuss about their symptoms and prevention in the class.

## 1.6 SEXUALLY TRANSMITTED INFECTIONS (STIs)

Venereal infection sometimes referred to as sexually transmitted infections (STIs) that can be spread by non-protective sexual contact. It is also referred by the name reproductive tract infections (RTI). AIDS, Gonorrhoea, syphilis, genital herpes and warts, chlamydiosis and hepatitis-B are few commonly known STIs. Bacteria and viruses of different strains all contribute to STIs. The majority of these diseases develop without showing any symptoms which increase the risk factors, especially in women. Risk factors include infertility, pelvic inflammatory disease (PID), abortions, ectopic pregnancies, and in worse conditions, it may even lead to cancer of the reproductive tract. In general, the unusual discharges from genitals, genital ulcers, tumors, itching, etc. are few signs and symptoms of STDs.

Apart from sexual transmission, sexually transmitted infections are also transferred to other persons in various ways. These are—breastfeeding, sharing of infected needles, and so on. There are many diseases under the class of STI, and these can be cured by maintaining proper sexual health and hygiene.

### 1.6.1 STIs and their Symptoms and Preventions

#### AIDS/HIV

It is the most common and chronic STI caused by Human immunodeficiency virus (HIV). Direct sexual contact is the most probable way of transmission of HIV. An infected person of AIDS is susceptible to various other diseases. This is because the HIV destroys the immune system and makes the body very weak.

**Symptoms:** The initial symptoms of AIDS are headache, swollen lymph nodes, rashes, fever, chills and nausea.

**Prevention:** AIDS can be prevented by ensuring protective sexual contact. Once AIDS occurs, there is no cure for it. But effective treatment can increase the life time of the patient for a few years.

#### ACTIVITY ZONE (INDIVIDUAL ACTIVITY)

Knowledge of STIs and their complications is important for adequate prevention and treatment, as people who do not know the symptoms may fail to recognize their needs and so may not seek help. Make a presentation on modes of transmission and prevention of AIDS, and the importance of HIV testing and support.

#### Gonorrhoea

Gonorrhoea spreads by a bacterium named *Neisseria gonorrhoea*. These bacteria mostly affect the urinogenital pathway, including rectum, urethra and cervix (in females). Like any other STIs, gonorrhoea is majorly transmitted through direct sexual contact.

**Symptoms:** The symptoms of gonorrhoea include discharge of pus from the penis and burning sensation during urination in males. In females, the symptoms include discharge of pus from the vagina and pelvic or abdominal pain.

**Prevention:** Gonorrhoea can be prevented by protected sexual contact.

## Syphilis

The causative agent of syphilis is *Treponema pallidum*. The bacteria find their path in the body through wounds. It can also be transmitted from infected pregnant mothers to their children.

**Symptoms:** The early symptoms include a sore called Chancre. The other symptoms include headache, loss of weight, fatigue, loss of vision and, heart disease.

**Prevention:** Syphilis can be prevented by avoiding unprotected sexual contact.

## Herpes

Herpes simplex, commonly known as Herpes is caused by the herpes simplex virus (HSV). Based on the appearance on various parts of the body, it is of two types:

- **HSV-1:** It causes blisters primarily in mouth and face. Children are easily prone to this infection from general interaction with adults that are it may involve sharing same dining utensils, lip balms and toothbrush. HSV is difficult to get removed from our body by our immune system. Once a person gets affected by HSV, the virus remains in our body for the rest of life. Outbreaks of HSV-1 could occur during menstruation, due to steroids and fatigue.

**Note:** HSV-1 is not a STI.

- **HSV-2:** It is commonly known as genital herpes. It is a sexually transmitted infection (STI). It causes sores on the skin that comes in contact with the genitals of an infected person. Risk factors arise due to having multiple partners, immature immune system, having AIDS/HIV and female also are more prone to this disease. It might be inherited from a mother to child during the birth.

**Symptoms:** Specific symptoms of HIV-2 include pain in genital during urination, fever, Loss of appetite, swelling of lymph nodes and infection of skin affects genitalia.

**Prevention:** HSV-2 can be prevented by avoiding multiple sex partners and unprotected sexual contact.

### ACTIVITY ZONE (GROUP DISCUSSION)

Discuss in a group about STIs caused by viruses and bacteria. Also discuss about their causes, symptoms and preventive measures in controlling STIs.

### Strategies for Prevention

Despite advanced technologies, STIs are still a major threat to the nation. We come across a number of advertisements on the television about various programs promoting safe sexual habits, and awareness about various sexually transmitted diseases (STIs). All these efforts by the government and non-governmental organizations aimed at achieving a reproductively healthy society.

General awareness about STIs is necessary to control further waves. The introduction of sex education is one of the steps taken by the government which aims at creating awareness among adolescents about safe sexual practices. Apart from the awareness and education part, it is also essential to provide proper medical facilities to deal with problems related to STIs.

So let's conclude that 'Prevention is better than cure':

- Avoid unprotected sex
- Avoid sexual contacts with multiple partners
- Consult a qualified doctor for diagnosis and treatment



### KEY GLOSSARY

- **Aerobic bacteria:** Bacteria that need free atmospheric oxygen for their respiration.
- **Anaerobic bacteria:** Bacteria that do not need oxygen for their respiration.
- **Autotrophic:** Organisms which are capable of synthesizing their food.
- **Bacteria:** Unicellular organisms that belong to prokaryotic group.
- **Bacteriophage:** A virus which invades and infects the bacterial cell.
- **Capsid:** a protein coat that surrounds the central portion of nucleoid and enzymes in a virus.
- **Capsule:** An additional layer of bacteria cell around the slime layer to make it thick and strong.
- **DNA virus:** The virus that possesses DNA as its genetic material.
- **Heterotrophs:** Organisms that are not capable to synthesize food get their food from other organisms.
- **Lysogenic cycle:** A cycle by which a virus can replicate its DNA using a host cell.
- **Lytic cycle:** A cycle in which the phage replicates and lyses the host cell.



- **Mutation:** An alteration in the nucleic acid sequence of the genome of a virus.
- **Oncovirus:** A virus that cause certain form of cancer.
- **Parasitic bacteria:** Bacteria which derive their nutrition from a living organism (host).
- **Penicillin:** The first ever discovered antibiotic which is derived from the bacterium *Penicillium notatum*.
- **Plasmids:** Accessory rings of DNA in a bacterial chromosome.
- **Prokaryotic:** Organisms whose cells lack true nucleus and other membrane-bound organelles.
- **RNA virus:** The virus that possesses RNA as its genetic material.
- **Saprophytes:** Organisms which obtain their food from dead and decaying organic matter.
- **Symbiotic bacteria:** Bacteria that live in close association with other living organisms so that they both benefit from each other.
- **Unicellular:** Organisms that are made of single cell.

## SUMMARY

- Viruses are ultramicroscopic, non-cellular, highly infectious particles that multiply only intracellularly inside the living host cells without involving growth and division.
- Viruses can be of various shapes. In general, they are helical and cuboid shaped structures.
- Based on the type of nucleic acid present in them, viruses are classified as RNA and DNA viruses.

The life cycle of a virus exhibits two major types of life cycles—Lytic cycle or virulent cycle and lysogenic cycle or temperate cycle.

- Bacteria are most primitive, unicellular, microscopic, simple and undifferentiated prokaryotic organisms which are usually identified by their specific functions and not by their general appearances.
- They are of different sizes. Based on their shapes they are classified as Coccus, bacilli. Spirillum and Vibrio.
- Based on their modes of respiration bacteria are classified as aerobic, anaerobic and facultative bacteria.
- A typical bacteria cell shows following structural features—slime layer and capsule, cell wall plasma membrane, cytoplasm. Nucleoid and plasmids.

- There are some harmful effects of bacteria. In this reference, they cause food poisoning, spoilage of food and pollution of water.
- Both viruses and bacteria are highly infectious agents that can spread from an infected person to a healthy person and cause various infectious diseases.

## EXERCISES

### A. Multiple Choice Questions

1. Tuberculosis is an infectious disease caused by a  
(a) Virus (b) Bacterium  
(c) Worm (d) Fungus
2. Some of the diseases caused by bacteria are  
(a) Tuberculosis, gonorrhoea and syphilis  
(b) Tuberculosis, gonorrhoea and AIDS  
(c) Poliomyelitis, syphilis and gonorrhoea  
(d) AIDS, cholera and tuberculosis
3. Which of the following disease is caused by a bacterium?  
(a) Ringworm (b) Poliomyelitis  
(c) Syphilis (d) Malaria
4. The size of Tobacco mosaic virus is  
(a)  $1250 \times 40$  nm (b)  $300 \times 15$  nm  
(c) 400 nm (d) 17 nm
5. The viruses are covered by a thin and loose external covering called  
(a) Capsid (b) Envelop  
(c) Capsomere (d) Nucleoid
6. The bacteria lack  
(a) Cell wall (b) Cytoplasm  
(c) Endoplasmic reticulum (d) Ribosome
7. The cell wall of bacteria is made up of  
(a) Cellulose (b) Chitin  
(c) Peptidoglycan (d) Pectin
8. Food-poisoning is caused by the  
(a) *Lactobacillus* (b) *Micrococcus*  
(c) *Clostridium botulinum* (d) *Penicillium notatum*

9. Gonorrhoea is an example of STI and can be spread by a bacterium named  
(a) *Treponema pallidum*      (b) *Neissria gonorrhoeae*  
(c) *Clostridium tetani*      (d) *Vibrio cholerae*
10. Symptoms of streptococcus infection generally include  
(a) Abrupt onset of fever      (b) Headache  
(c) Disorientation      (d) All of them

**B. Fill in the blanks**

1. Viruses do not have an \_\_\_\_\_ metabolism.
2. Bacteria are \_\_\_\_\_ means they occur anywhere and everywhere
3. Bacteriophages are the viruses that attack \_\_\_\_\_.
4. Viruses are \_\_\_\_\_ outside the host cells.
5. Based on the type of \_\_\_\_\_ present in them, viruses are classified as RNA and DNA viruses.
6. Vibrio bacteria have one or more \_\_\_\_\_ at its one pole.
7. Bacteriophage is a \_\_\_\_\_ virus whereas tobacco mosaic is a \_\_\_\_\_ virus.
8. In general, viruses are \_\_\_\_\_ and \_\_\_\_\_ structures.
9. The green sunlight trapping pigment of photoautotrophic bacteria is called \_\_\_\_\_.
10. In anoxygenic photosynthesis, bacteria release \_\_\_\_\_ instead of oxygen.

**C. True and False**

1. Capsid is a thin and loose external covering of a virus.
2. Unlike the cold and flu virus, HIV never leaves the body of the host.
3. The chickenpox do not transmitted by the close contact with an infected person.
4. The bacteria carrying a prophage without being lysed is called lysogenic bacteria.
5. In lytic cycle, the bacteriophage attaches itself on the surface of bacteria and the process is known as adsorption.
6. The riboflavin (vitamin B<sub>12</sub>) is produced by the action of a bacterium named *Clostridium butylicum*.
7. In bacteriophage, the head and tail are of unequal in size.
8. In the tobacco mosaic virus, the protein part makes the external sheath of rod called capsid.
9. The plant viruses contain DNA or RNA as their genetic material.
10. The process of denitrification is same as the process of nitrification.

**D. Match the viruses with their correct names.**

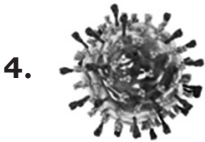
(a) Herpes



(b) Influenza



(c) Vaccinia



(d) Mumps

**E. Draw the diagrams of the following:**

1. Tobacco mosaic virus
2. Bacteriophage
3. A bacteria cell

**F. Answer the following questions.**

1. Define viruses.
2. What is the casual agent of AIDS?
3. Describe the composition of a virus.
4. What are the general characteristics of bacteria?
5. Why viruses are regarded as biological system as well as non-living particles? Give one reason each.
6. What are the photosynthetic bacteria? Classify them on the basis of their energy utilization.
7. Distinguish between a plant virus and an animal virus on the basis of their genetic materials.
8. What are the heterotrophic bacteria? Explain them by giving examples.
9. How bacteria are important in agriculture?
10. What are the sexually transmitted infections (STIs)?
11. Describe symptoms and prevention of following STIs along with their causative agents:
 

(a) Gonorrhoea	(b) Syphilis
(c) AIDS	