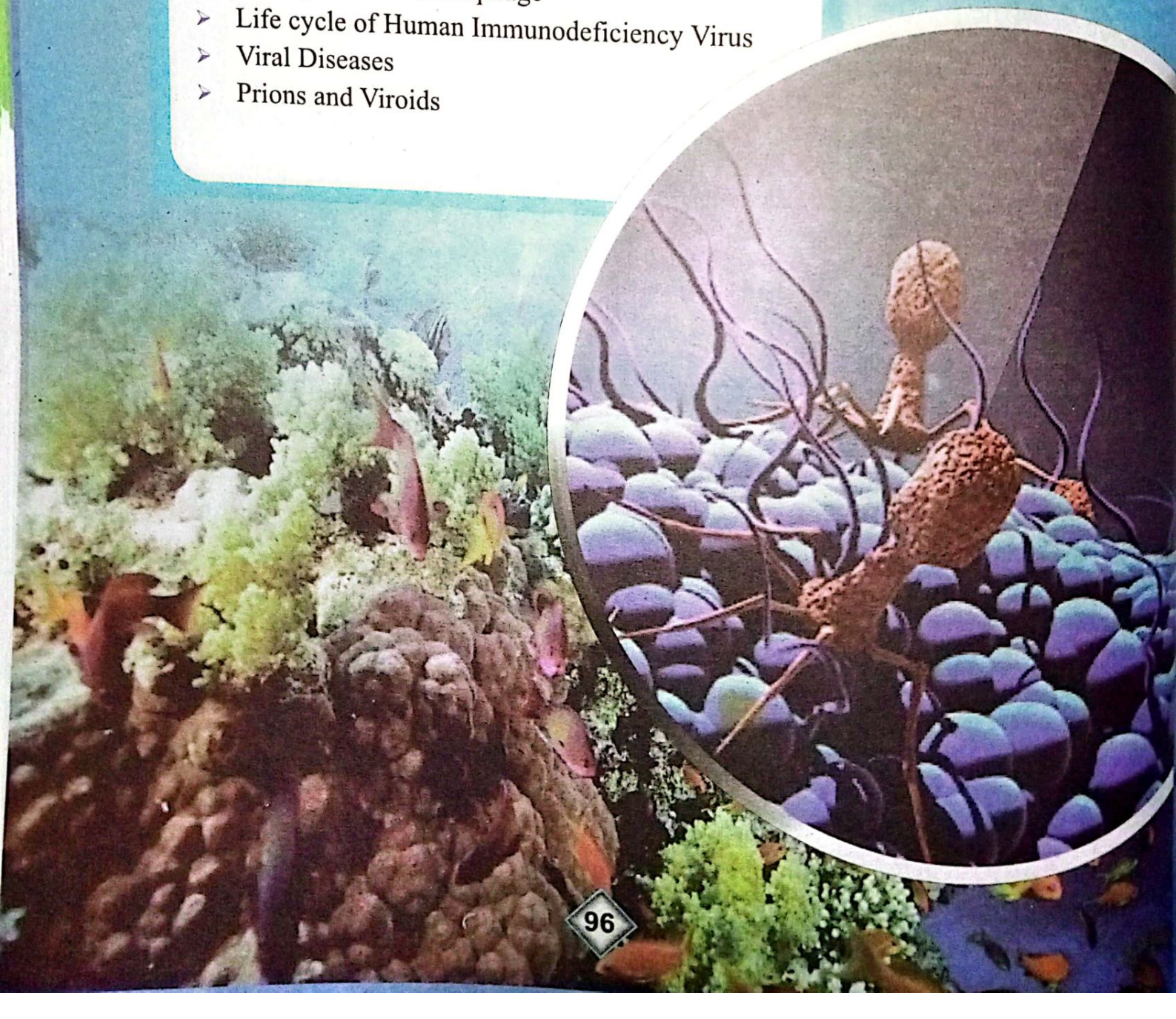
ACELLULAR LIFE

Chapter 5

Major Concept

In this Unit you will learn:

- Viruses - Discovery and Structure
- Parasitic Nature of Viruses
- Life cycle of Bacteriophage
- Life cycle of Human Immunodeficiency Virus
- Viral Diseases
- Prions and Viroids



Introduction

Evolution reveals that life originated on earth at the level of variety of molecules like DNA and protein which later on evolved into cellular life. In the beginning some structures emerged which lack intact cells or a living entity without cells called noncellular living things, such as viruses, prions and viroids. Living things are categorized into two groups, firstly, living entities or molecules and secondly the complete cell-based organisms.

Viruses are a major threat to the human health and countries economy. Viruses like small pox and influenza caused millions of deaths in different era. Recently due to **Corona** world has suffered millions of deaths and massive decrease in industrial productions of different goods by the year 2022. Many viruses also damage crops and livestock of economic importance.

5.1. VIRUS EITHER LIVING OR NON-LIVING

Viruses characters of both living and non-living things. A comparison of these characters is given below for clear understanding.

Living characters of a virus

Viruses replicate like living organisms by using host cellular contents. They have their own nucleic acid either DNA or RNA as genome and undergo mutation. Viral genome determines its functionality and formation of important biomolecules of its own structural importance. Viruses also contain some proteins which work as enzyme in host cell. Viruses interact genetically and physiologically with the host organisms they infect. Viruses are intracellular obligate parasites. Ultraviolet rays can harm viruses like other living cells.

Non-living characters of a virus

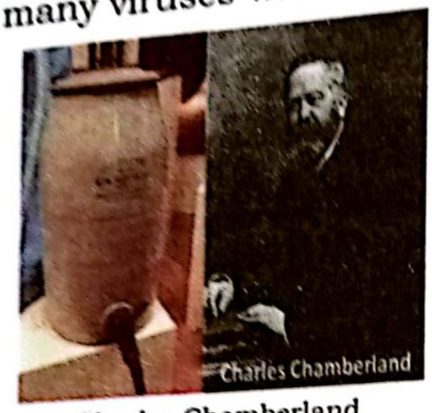
Viruses may become inactive for indefinite period of time without replication. They lack cellular organelles. They can't perform metabolism and generate energy molecules either. They can crystalize and store. They do not express vital activities like respiration, excretion, movement etc. They act as non-living, non-reactive particle outside the cell.

5.1.1. Viruses- discovery and structure

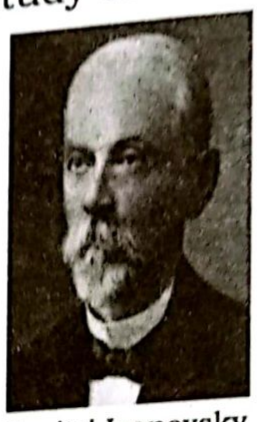
The name virus was derived from the Latin word meaning slimy liquid or poison. In 1984 an assistant of louis pasture named Charles Chamberland invented a porcelain water filter (Chamberland-Pasteur filter) to isolate the microorganisms from some infectious samples. Porcelain Chamberland filters have a pore size of 0.1 μm, which is small enough to remove all bacteria ≥ 0.2 μm from any liquids passed through the device. Later on, **Chamberland filter** was first used by Dmitri Ivanovsky in 1892 to examine the infectious tobacco plant leaf extract. During his research he found that the contagious filtrate of infected tobacco leaf, after removal of

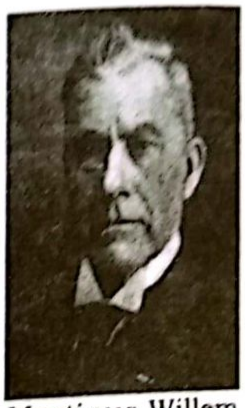
bacteria still caused the disease in plant, he concluded that the filtrate contains infectious component smaller than a bacterium that causes tobacco mosaic disease (TMD). After few years in 1899 another scientist Martinus Beijerinck, proceeded the investigation about the cause of TMD and reported that the pathogenic agent responsible was a "contagious living fluid,". These pathogenic fluids were known as filterable agents and was later named as virus. In 1935 W.M. Stanley crystalized the infectious particle, now known as tobacco mosaic virus (TMV). The invention of electron microscope revealed the discoveries of many viruses which being study under the virology.


Adolf Mayer



Charles Chamberland


Dmitri Ivanovsky


Martinus Willem Beijerinck

Viruses have variety of shape and structure they are filamentous, enveloped with nucleic acid inside or nonenveloped, icosahedral and some have head and tail. Enveloped viruses have outer lipid covering e.g., COVID-19, Influenza, Hepatitis B and C, Ebola virus etc., while non-enveloped viruses do not have a lipid covering and more resistant to environmental stresses like drying out and heat these include common colds (Rhinovirus) and Polio viruses. Filamentous viruses appear as elongated and cause diseases in many plants for example **Tobacco mosaic virus**. The head and tail group of viruses are pathogenic for bacteria example bacteriophage virus.

General structure of viruses

The structure of viruses are very simple, usually it consists of two parts:

i) The outer coat ii) The inner core

i) The coat:

outer covering of virus which is also called capsid. In some viruses envelope is also present with capsid to form its coat. The capsid is made of identical units of protein called capsomeres. The arrangement and number of capsomeres are specefic in particular kind of viruses. The capsid may be icosahedral or helical. In icosahedral the capsomers are arrange in 20 triangle to form either polyhedron or spherical structure where as in helical structure capsomeres are arranged in a hollow coil, gives rod shape to virus.

In some viruses another outer layer of lipoprotein is also present which covers the capsid this lipoprotein layer is called envelope which is also

provided by glyco protein spikes which help to recognise the host cell. The lipoprotein layer of envelop is derived from the cell surfsce membrane of host cell. It also contain virally encoded proteins.

ii) The inner core

The inner side of capsid contain another part which is called genome. Genome is generally called total genetic material of a living thing. tn the case of viruses this genome may be DNA or RNA. Which may be single stranded (Ss) or double (Ds) stranded. Sometime proteins are also present with it which work as enzyme and facilitate viruses during its action in host cell.

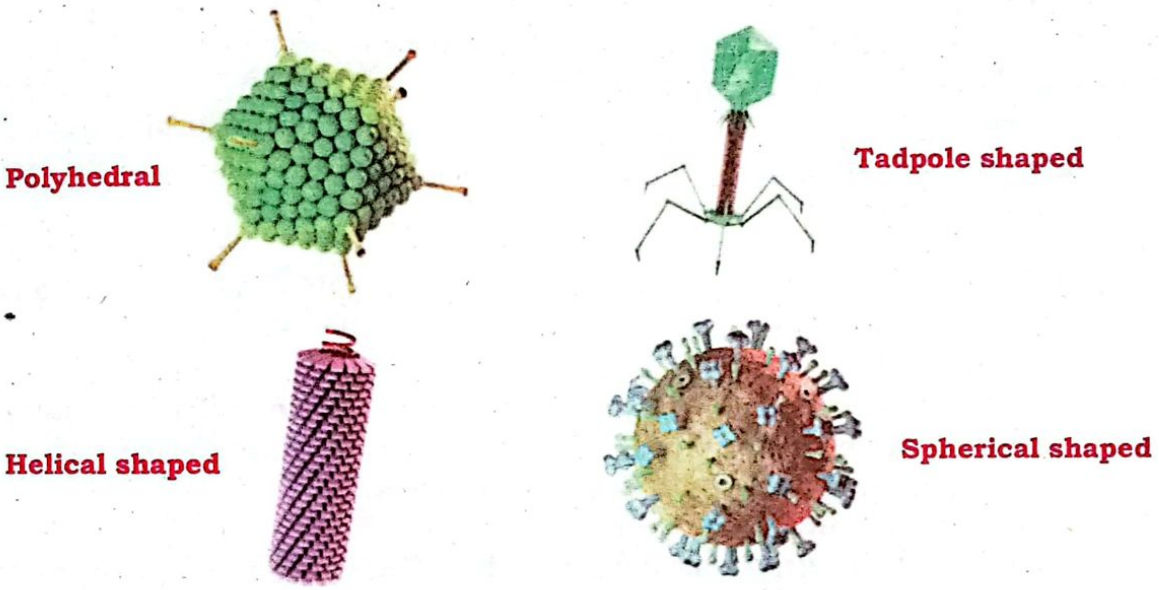


Fig. 5.1 Different shapes of viruses

5.1.2 Classification of Viruses

Viruses are obligate parasite so it can be classified on the basis of host or shape or genome

Classification on the basis of host		
Phytophage (Plant viruses)	**Zoophage** (Animal viruses)	**Bacteriophage** (Bacterial viruses)
➢ More than 2000 types RNA genome	➢ DNA or RNA genome both	➢ ds DNA as genome
➢ Rod shaped capsid usually	➢ Spherical in shape usually	➢ Have head and tail
➢ E.g. T.M.W, CaMV, (Cauliflower mosaic viruses) etc.	➢ E.g. Rhino viruses, Covid-19 etc.	➢ E.g. T phages, X phages

Classification on the basis of capsid	
Shape of capsid	**Viruses**
➢ Helical shape	➢ TMV
➢ Polyhedron	➢ Adenoviruses
➢ Tadpole shaped	➢ Bacteriophage
➢ Enveloped shape	➢ Flu viruses
➢ Spherical shaped	➢ CaMV
➢ Circular	➢ HIV

Virus Classification on the basis of genome

Viruses are diversified in their structure. David Baltimore 1971, a Nobel Prize-winning virologist classified viruses in seven different groups on the basis of their genomic constitution. Recently in 2018-2019 The Baltimore classification was slightly modified in view of some evolutionary aspects that some groups of viruses arise from common ancestors. The modified classification of viruses is given below.

DNA viruses

These viruses have deoxyribonucleic acid (DNA) as their genome and further classified into two groups which are as follows.

i. Double-stranded DNA viruses

Their DNA is double-stranded which synthesize mRNA by using host cell enzymes in the host cell nucleus. Some of them may cause cancer but no one known to infect a plant. Example Herpes.

ii. Single-stranded DNA viruses

They have a single-stranded DNA. They also prepare mRNA by transcription but first they become double stranded in host cell and then synthesize mRNA after that new progeny again have single stranded DNA. Example Parvoviruses.

RNA viruses

These viruses possess RNA as their genomes and are categorized into following groups.

iii. Double-stranded RNA viruses

Their RNA is double stranded and present as genome. When they enter the host cell, they prepare single stranded mRNA by using cell enzymes. The newly formed mRNA is used either for translation or replication of double stranded RNA's which act as genome for new progeny. Example Reoviruses.

iv. Positive sense single-stranded RNA viruses

They have a single stranded RNA. Positive sense means that their RNA function as mRNA and directly translated by host cell without involving transcription. Example Corona virus, Dengue virus, Hepatitis C virus.

v. Negative sense single-stranded RNA viruses

These have single stranded RNA. When they enter the host cell, they prepare mRNA from their RNA in the host cell for any translation. Rhabdo virus, Paramyxovirus

Reverse transcribing viruses

The process of making DNA form RNA is called reverse transcription. This group of viruses are further classified which are as follows.

vi. Single-stranded RNA viruses with a DNA intermediate

They have single stranded positive sense RNA, but it needs to replicate via DNA intermediate. At first their RNA forms a DNA by using an enzyme reverse transcriptase inside the host, later on that DNA is integrated into the host genome for transcription and translation by using enzyme integrase. This includes retroviruses such as *HIV* (Have two single strand RNA).

vii. Double-stranded DNA viruses with an RNA intermediate

Their genome is DNA which forms RNA during its replication cycle. That RNA is then used for reverse transcription to replicate their genome inside the capsid. Example Hepatitis B.

Besides the genome-based classification mentioned above, viruses may also be grouped on the basis of their host parasite relationship e.g., bacteriophages that infect bacteria, phytophages which infect plants e.g., TMV and the zoophages infect animals and humans e.g., HIV, COVID-19.

5.2 PARASITIC NATURE OF VIRUSES

Virus needs a host cell to complete its life cycle

Viruses are noncellular living entity so they are nonfunctional without any host cell. Since they do not possess any kind of organelle and metabolic machinery to generate energy of their own or to prepare protein or any other macromolecule essentially require to develop its own structure therefore it must need a living cell that provide facilities to accomplish its requirement. A cell that represents all the vital activities of life and has all the necessities to regulate these activities. It can also provide assistance to an invader like virus upon demand. Viruses have nucleic acid that contain such powerful genes which can overtake and forcefully derive all the cellular metabolic machinery including enzymes, organelles to work according to the directions of viral genome.

5.2.1. How virus survive inside a host cell?

Viruses have variety of host cells that includes prokaryotes and eukaryotes both. viruses resist from host cell immune system by different means which are as follows

1. Degrading host cell genome

When a phage virus attacks bacterium, its DNA synthesizes endonuclease enzymes to degrade bacterial DNA and control the process of replication,

transcription, and translation to prepare viral proteins required for making new phage viruses.

2. Deactivating the complement system

Complement system is a part of innate immunity. It comprises of plasma protein that are activated upon the detection of pathogen. Viruses when enters the host cell they prepare proteins that mimics the complement proteins activators and blocks the complement protein.

3. Viruses block the interferon response

Interferons are the proteins released from virally infected cells that provide signals for immune system to respond. In contrast viruses blocks the specific genes and interrupt the metabolic activities to produce proteins.

4. Inactivation of major histocompatibility complex (MHC)

Viruses suppress the helper T cells to display viral components presented by MHC which delays the detection of virus invasion.

5. Viruses suppress B cell activation

Some viruses develop a system to reduce the functions B cell to anticipate viral activities and inhibit B cells proliferation and differentiation.

6. Viruses can alter their genome

Viruses can mutate and frequently change their genomic constitution so that drugs and vaccines become less effective and they survive in host cell.

5.2.2. Virus survival in environment

Viruses growth and survival can be influence by different environmental limiting factors like temperature and moisture, some organic compounds like mucous, radiations like UV etc. Here we are going to discuss about the effect of some factors.

1. Virus survival and temperature

Temperature affects viral survival through protein denaturation, damage to nucleic acid, or capsid dissociation. Usually, it is observed that DNA viruses have more endurance than RNA viruses but extreme temperature makes no difference in damaging both. Generally, temperature 60^{0}C and above is enough to inactivate most of the viruses but in this condition a virus take shelter from the surrounding organic material like blood, feces, saliva etc. contagious airborne viruses like influenza and Corona use saliva and mucous as cover and barrier for external unfavorable environment during coughing and sneezing when expelled out form the opening like mouth and nose.

2. Airborne virus survival and relative humidity

Virus survival in external environment without host depends upon levels of relative humidity. The difference in the percentage of water vapor presents in between normal condition at specific temperature and time. Lipid enveloped viruses are more vulnerable than non-lipid enveloped viruses.

Enveloped viruses including influenza, coronaviruses, tend to survive at the range of 20-30%, while viruses without enveloped like adenoviruses and rhinoviruses can tolerate and survive longer at higher level of humidity i.e., 70–90%.

3. Virus survival and light

Viruses living in aquatic environment influenced by light particularly phytoplankton viruses in both negative and positive way. It is required not only for plankton growth but also for the viral replication cycle which is very energy demanding and the requirement is fulfilled by light energy. It limits the viral attachment to the host cell. Light can also have the negative effects on viral replication like UV radiation is the major cause of viral decay moreover it also effects the photosynthetic viral hosts.

4. pH factor affecting viral survival

Viral activation requires appropriate pH environment. Studies reveal that favorable pH for viral survival is around 6.5 high while value around 7.2-8 and 5.0 to 5.5 damage its structure. Lipids are vulnerable and hydrolyze in very high basic pH value. Many viruses contain lipoprotein envelop that protect from environmental affects but on the other hand it is more interactive with the organic solvents, detergents and sanitizers of alkaline nature that degenerate its structure destroy virus. Nonenveloped viruses may not be destroyed but their replication abilities are affected therefore

Structure of viruses

Bacteriophage

A virus Bacteriophage means 'bacteria eater'. Bacteriophage is a group of viruses that kills bacteria. These viruses are grouped on the basis of different shapes like T-phages which contain developed tail fibers and λ (lambda) without or less developed tail fibers phages, enveloped and nonenveloped bacteriophage. Here we are going to discuss the structure of tailed bacteriophage virus. Tailed bacteriophage T4 virus has three major structures:

1. Head with DNA inside
2. A tail, that act as a channel that allow transport of DNA into host cell
3. A base plate at the bottom of the tail which is adhesive and helps to identify the host cell for attachment.

1. Head

The head is three dimensional called polyhedral and consist of small protein units called capsomeres. These capsomeres are connected with each other in geometrical manner called icosahedral. The DNA of bacteriophage is present in their head region and contain different genes.

2. Phage tail

Bacteriophage tail is formed by different proteins. The upper most part of the tail which connects it with the head is called collar. Tail is a tube like structure and has two regions, an outer region is a contractile sheath and other inside region is a non-contractile tube. The contraction of the outer sheath drives the inner tail tube creating a channel for DNA delivery into the host cell.

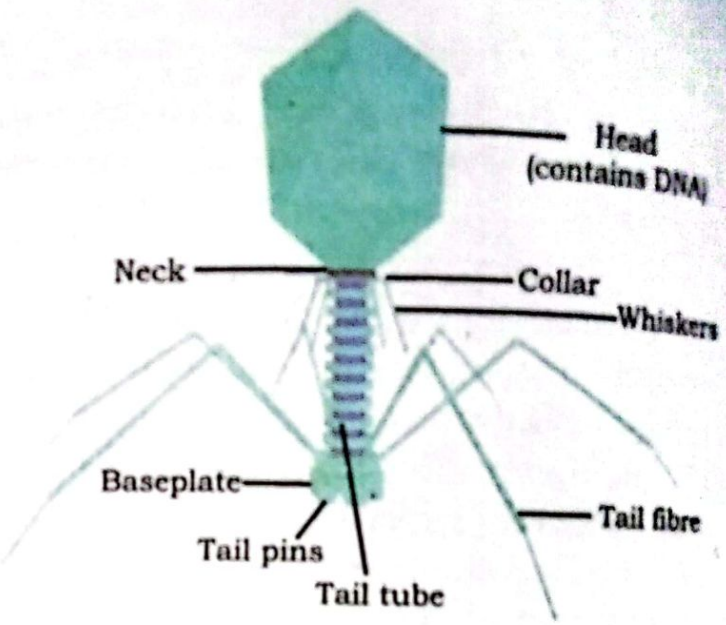


Fig. 5.2 Bacteriophage

3. Base plate

At the end of phage tail, a discoidal base plate is located. It has tail fibres usually 6 in numbers. These fibres provide strong attachment with host cell Its adsorption apparatus located on the distal end and recognizes host cell receptors and ensures DNA transfer to the cell cytoplasm. Base plate is surrounded by proteinaceous retractile "pins" at the base. These pins penetrate the bacterial coverings with the help of an enzyme lysozyme present at the base plate and helps to injects phage genome inside the bacterial cell.

1. Tobacco mosaic virus (TMV)

TMV is the virus of tobacco plant and cause Tobacco mosaic disease. It is made up of centrally located single stranded RNA as genetic material surrounded by protein coat called capsid. Most of its structure formed by protein coat with estimated 2,130 subunits named capsomeres arranged in a helical manner. Each capsomere contains about 158 amino acids and arranged in about 130 turns per rod.

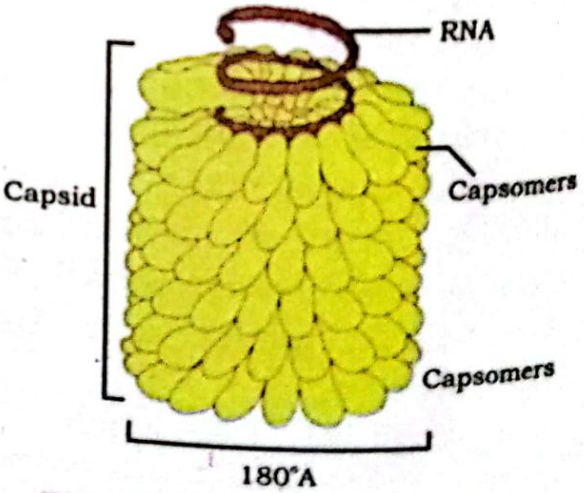


Fig. 5.3 Tobacco mosaic virus

5.3 LIFE CYCLE OF BACTERIOPHAGE

There are two types of life cycles are found in bacteriophage, the lytic cycle and lysogenic cycle.

Lytic Cycle

During a virus attack on a bacterium, it replicates inside the host cell kill the cell by plasmolysis and releases the new virus progeny, so they can infect more bacterial cells. This type of life cycle called lytic life cycle.

Step 1: Phage attachment

Bacteriophage virus starts lytic phase of life cycle by attach itself to the bacterium. At this stage virus interacts with specific bacterial surface receptors. This attachment is reversible and specific to the host bacterium.

Step 2: Genome penetration

Bacteriophage strikes by its contractile tail sheath on the surface wall of bacterium and break it down. Virus injects its DNA in to the bacterium through a hollow tube and phage head and remaining components remain outside the bacteria and called the "ghost".

Step 3: Biosynthesis or Replication of Phage DNA

The cell's metabolic machinery, directed by phage DNA, produces phage proteins, and nucleotides from the cell's degraded DNA, are used to make copies of the phage genome. The phage parts come together. Three separate sets of proteins assemble to form phage heads, tails, and tail fibers forming daughter phages.

Step 4: Maturation

When all the component of phage structure synthesized including proteins and nucleic acid then assembling of these components begins to form new phages. During this phase new phage DNA are created called virions.

Step 5: Lysis and release of phage viruses

The newly formed bacteriophages releases and enzyme lysozyme to break bacterial wall and cause lysis, releasing 100-200 phage progeny into the surrounding and infect new bacterium.

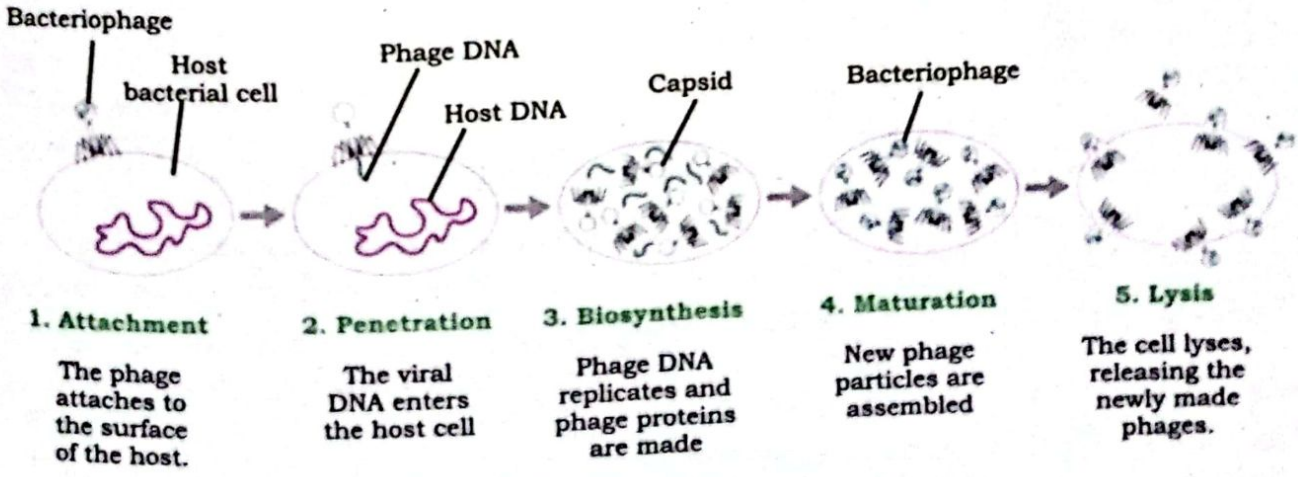


Fig. 5.4. The lytic life cycle stages of bacteriophage virus

Lysogenic life cycle

In lysogenic cycle bacteriophage virus does not involve the killing of bacteria infect viral genome joins with the host bacterial nucleic acid and creating a **prophage**. The bacterium survives and multiply normally while during reproduction the conjugated genetic material (prophage) is transferred in to the next progeny of bacteria without any interference. Lysogenic life cycle can be explained by following steps

Step 1: In the first step phage virus injects its DNA into the bacterial cell. The attachment of virus with bacteria follows the same process as it occurs in lytic phase.

Step 2: Phage genome is incorporated with host DNA and called prophage.

Step 3: The viral DNA replicates along with the bacterial DNA during bacterial division and remain calm without affecting the host cell.

Step 4: The prophage may active under the unfavorable conditions and switch to the lytic cycle.

The phage genes remain inactive during lysogenic phase if any environmental trigger like radiations and chemicals stimulates, then they start the synthesis of specific enzymes to cut down the integrated viral DNA from the bacterial DNA and thus now act las a virus of lytic stage. Now the specific proteins which are required to develop their structures are produced and new phages are produced.

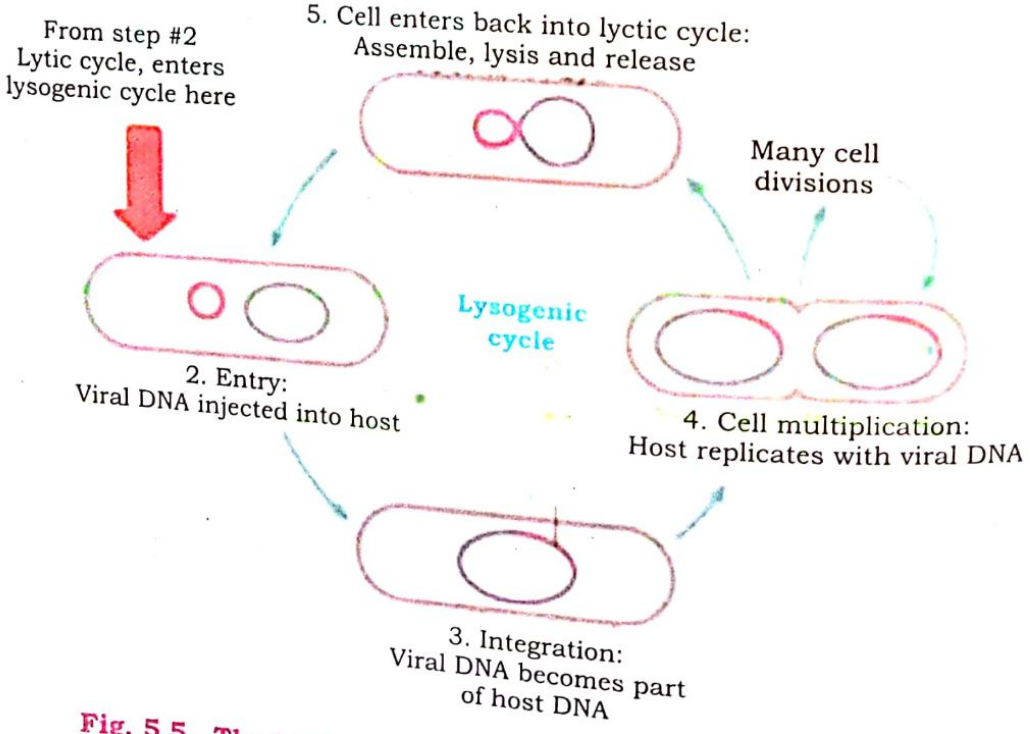


Fig. 5.5. The lysogenic life cycle stages of bacteriophage virus

5.3.1. Bacteriophage and genetic engineering

Bacteriophages are abundantly present on earth. They are used in genetic engineering for the transfer of required gene form one cell to another which benefit the organism or produce valuable products. Recently these phages are used to treat bacterial infections. The genetically modified phages when inducted in the body they attack the pathogenic bacteria inside the body and destroy them by using their genome as a weapon. Keeping In view that they are host specific and do not harm the other microbes and cells of the body. Phages are also used to present antigens which provide identification for the immune system to activate and destroy the pathogens that invades on our body.

5.4 HUMAN IMMUNODEFICIENY VIRUS (HIV)

AIDS (Acquired immune Deficiency Syndrome) caused by a virus called HIV. It was first reported in 1981 in California. AIDS spread more in poor developed countries. According to UNAIDS in 2019 above 35 million people around the world caught by AIDS in which 5% are children aged under 15 years.

Structure of human immunodeficiency virus (HIV)

HIV belongs to the group retroviruses which are known to use their genetic material for reverse transcription. HIV size is about 60 times lesser than an RBC. It is spherical in shape and contains two RNA molecules in somewhat coiled and folded form with 9 genes enveloped in protein coat called capsid. These genes serve to prepare structural protein that form virus structure and develop ability to infect the host cell. HIV is an enveloped virus which is made of two layers of lipids with spikes made of glycoprotein, which helps virus to get stuck on the surface of target cell receptors and enters the cell.

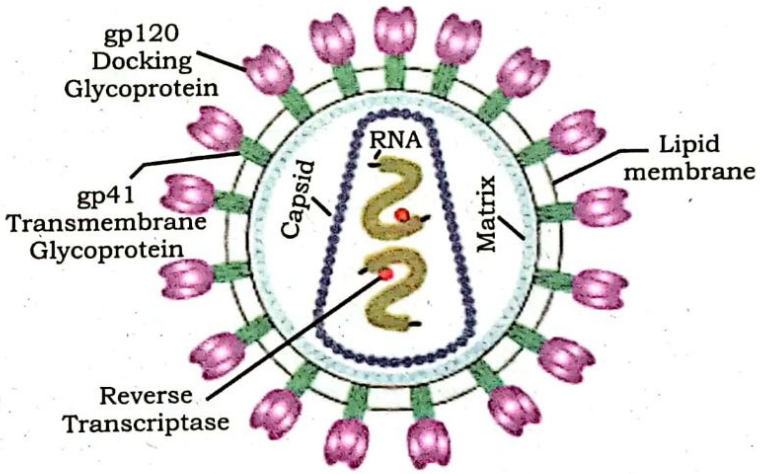


Fig. 5.6
Human immuno-deficiency virus

This virus has unique capability of reverse transcription means making DNA from its own RNA by using own enzymes namely the reverse transcriptase and integrase. The former is used to make DNA from RNA while later enzyme helps the viral genome remain intact inside the host cell.

HIV life cycle

Life cycle of HIV consists of series of steps to multiply in the body which are: 1) binding; 2) fusion; 3) reverse transcription; 4) integration; 5) replication; 6) assembly; and 7) budding.

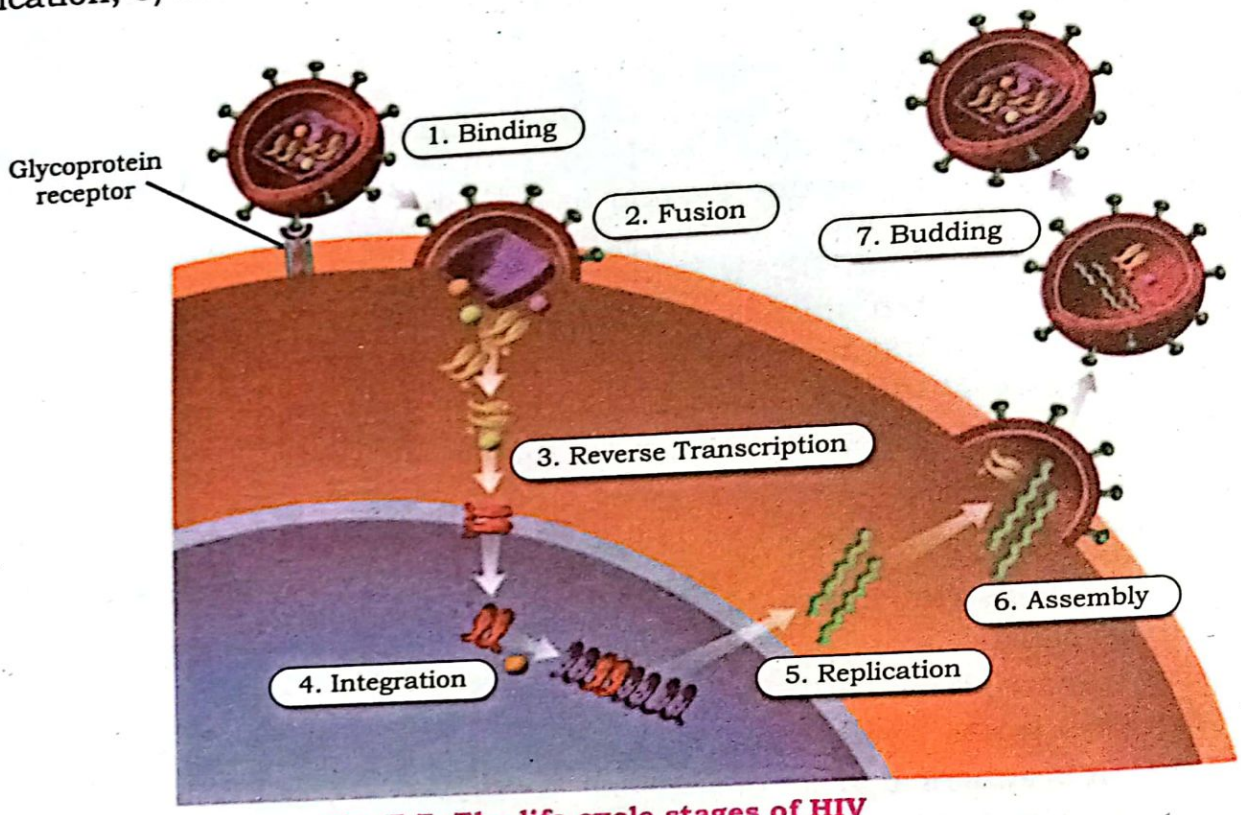


Fig. 5.7. The life cycle stages of HIV

1. **Attachment:** At first the virus attaches with a lymphocyte cell surface glycoprotein receptor that allow HIV to enter the cell.
2. **Fusion:** While remain attached the virus injects its RNA into the host cell.
3. **Reverse Transcription:** The viral RNA makes a new DNA this process is called reverse transcription. In this process virus uses its own enzyme called reverse transcriptase.
4. **Integration:** The viral DNA enters the host cell's nucleus, where it integrates with host DNA by an enzyme integrase. This DNA is called provirus, which may remain inactive for several years, producing few or no new copies of HIV.
5. **Transcription:** Now integrated host DNA develops mRNA for the process of protein synthesis to make viral protein and also by using host cell enzyme called RNA polymerase it creates the copies of HIV genomic material as mRNA which is used to direct the making of long chains of HIV proteins.

6. **Assembly:** When proteins are formed HIV use its another enzyme called protease to cut down protein in to small fragments that later join together with the HIV genome and develop new progeny.
7. **Budding:** New progeny of virus when matures it connects with the cell membrane and forms a small projection as bud from infected cell. The bud acquired some of the glycoprotein part of the cell membrane for its own covering. They released out of the cell and move on to infect other cells.

5.4.2. HIV specificity for the host cell

The virus HIV termed as human immunodeficiency virus because it destroys the most precious and valuable asset of our body immune system component the T lymphocyte cells and particularly Helper T lymphocyte cells. These cells are the part of adaptive immunity and not only help to activate their own fellow cytotoxic lymphocyte but also B cells to secrete antibodies and macrophages to ingest and destroy foreign invaders. Therefore, these cells act as activators for our immune response.

Now the question arises why T lymphocyte cells why not other cells as target for HIV? It is just because the T cells has specific protein receptors which are recognized and identified by HIV glycoprotein surface spikes that binds with these receptors as lock and key manner and initiate cell mediated endocytosis which brings the viral content into the cell. HIV controls cellular activities particularly protein synthesis and parasitize host cell.

5.4.3. Symptoms of AIDS

In the beginning of HIV infection symptoms appear for short duration like fever, flu, headache appears within the duration of six weeks repeatedly and that person can infect others. In the next stage the virus may last for an average of ten years without any symptoms but person may have lymph glands swollen in neck region. While immune system weakens other infections like tuberculosis (TB), pneumonia and cancers (Kaposi's Sarcoma) may occur. Some other viral infections may occur like Herpes and Influenza (flu). Finally, the immune system weakens due to destruction of T lymphocyte cells weight loss, night sweats, diarrhea, septicemia, dementia like infections causes death of a person.

5.4.4. Treatment of AIDS

At first a test for HIV is needed to detect the presence of virus that can be done by sample of blood or saliva. Other ways to check virus are antibody tests and nucleic acid tests (NATs). Different medicines are used in combinations to treat HIV this method is called Antiretroviral therapy (ART). The drugs used in AIDS therapy belong to the group of different enzyme inhibitor that inhibits the viral enzymes activity. The drugs **Rukobia**, **Descovy** and **Truvada** are found remarkable against HIV.

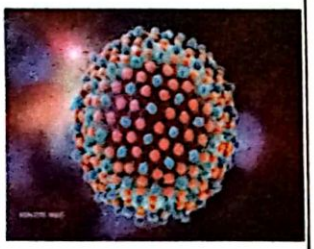
5.4.5. Transmission and control of HIV

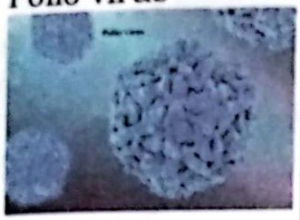
HIV spreads through contaminated blood transfusion or one to another by exposed wounds and from placenta of mother to child. It can also transmit by sexual contact in which urinogenital tract and its fluids facilitates viral transmission. Those who share or vaccinated through unsterilized syringes becomes cause of viral transmission.

The spread of HIV one should take precautionary measure before having sexual interaction, remain intact with religious Islamic preaching. Get vaccinated to prevent from opportunistic infections during AIDS although there is no vaccine to prevent or treat HIV. Sharing needles should be avoided. There is no cure for this disease.

5.5 VIRAL DISEASES

Table 5.1 viral diseases

Viral disease	Causative agent	Symptoms	Transmission	Treatment and prevention
Hepatitis	Hepatitis virus 	Fever, pain in Belly. dark yellow urine, Fatigue, Jaundice, pain in joint, loss of appetite.	Through Fecal oral, Needle, blood, Sexual activities	Proper hand wash before and after meal, avoid to meet infected person with close contact use clean food and sanitize yourself by soap.
Herpes	*Herpes simplex* virus 	fever blisters around the mouth and sexual organs. A person may experience painful sores in genital region and anus, burning sensation in urination, flu and fever.	virus can enter the body through a break in skin, through mouth, reproductive organs and anus. Insanitary may lead to the spread of this disease	Use antiviral drugs on doctor's advice, avoid insanitary conditions

Poliomy elitis	Polio virus 	The major symptom is paralysis of lower limbs while along with fever, sore throat, headache, body pain and tetany appears.	It is usually transmitted through contaminated water and food and by secretions from the nose, mouth or faeces of an infected person from fecal oral route in areas with poor sanitation then absorbed in blood and lymphatic system spread throughout the body and stays about 7 to 14 days.	disease it can only be handled prophylactically by vaccination and proper sanitary conditions. This virus may lead to death if not treated properly
Cotton Leaf Curl disease	*Begomovirus*  	Most common symptom is leaf curling upward or downward, veins thickening appears in leaves and quality of fibre are variably affected by leaf curl disease	This virus is transmitted through white fly pest	Use spray at every seven days and practice crop rotation. Or just cut and burn the infected plants.

Economic losses due to viral diseases

Viral diseases always remain a significant threat to the world economy. These are responsible to the sizable losses of agricultural products as well as livestock commodities. For example, Pakistan ranks fourth in area and production of cotton in the world. It has 9.36% of total world cotton area,

10.18% of production, 8.06% of consumption and 4.55% of total world export of raw cotton. The impact of cotton leaf curl virus on the Pakistan national economy cannot be forgotten as the country has lost Rs. 50 to 55 billion since 1992 and it is essential to maintain vigilance over the disease. Similarly, bird flu viral disease caused around 700 to 800 million Rupees. Huge loss at one time during its peak time.

5.6 PRIONS AND VIROIDS

Viroids and Prions

Some entities are more simplified and smaller than viruses. These entities are called subviral particles. These include viroids and prions.

Prions

An American biologist named Stanley B. Prusiner discover prions and received noble prize in 1997. These are infectious just protein molecule comprises of 29 amino acids with single disulfide bond. And without any nucleic acid. Prions are found in body tissues and in brain. Prions may cause Trisomy 21, Alzheimer's disease, sleeplessness (insomnia) in humans and mad cow disease in cattle.

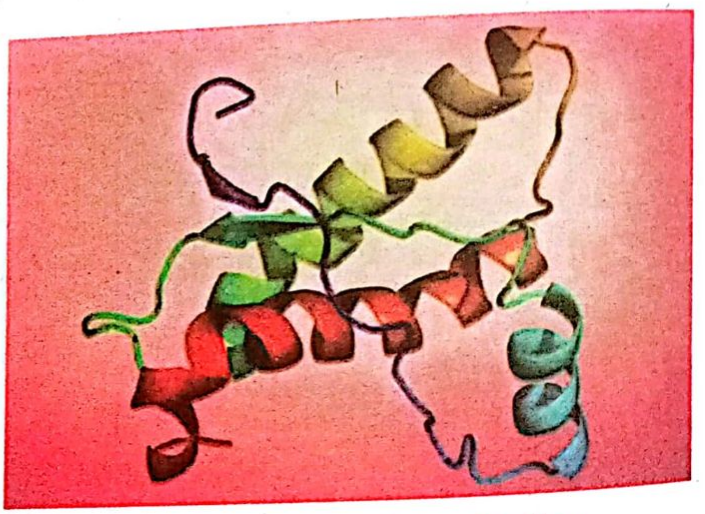


Fig. 5.8. Structure of prion

Viroids

Viroids were discovered by an American plant pathologist, Theodor O. Diener, in 1971. They are simple nonenveloped single stranded RNA infectious molecules with some double stranded regions. They can be transmitted by pollen or seeds. The smallest viroid discovered so far is 220 nucleotides long while the smallest known virus causing infection are around 2000 bases in size. Viroids synthesize new RNA from its genome as template by using host cell enzyme RNA polymerase. The *Potato spindle tuber viroid* identified as first viroid and now the known species of viroids are about 33 in number. Viroids don't interrupt protein synthesis but they only replicate and produce specific RNA molecule. Viroids mainly cause plant diseases and infected plants show distorted growth. There is no evidence of human disease caused by viroids.

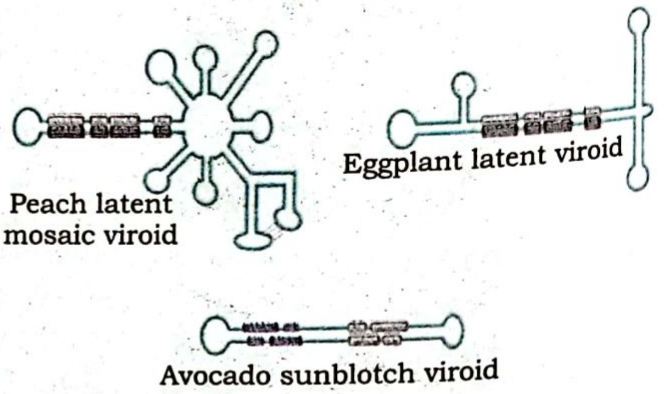


Fig. 5.9. Different shapes of viroids

Table 5.2 Animal viruses their transmission and symptoms

Name of virus	Vector /Host	Type of nucleic Acid	Transmission	Symptoms
Chikungunya virus	*Aedes* Mosquito and nonhuman primates	RNA virus with a positive-sense single-stranded genome	Blood	Headache, body muscles and joints pain, Nausea, Vomiting, swollen glands, and painful eyes.
Dengue virus	*Aedes* mosquito human	positive-sense, single stranded RNA	Blood	vomiting. Rashes with pain Nausea, pain typically behind the eyes, and in the body
Ebola virus	Canid animals Bats, dogs etc.	Negative sense stranded RNA virus.	Body fluid	Hemorrhagic fever
Hepatitis C virus	Human infected blood	positive sense single-stranded RNA	transmission of Hepatitis C virus occurred mainly during blood transfusions	Fever, yellow skin, Fatigue. Muscle and joint pain. Nausea and loss of appetite. Stomach pain.
Measles virus	air borne droplets from nose and throat mucus in human	negative-sense RNA gen ome	Sneezing and coughing of infected person	fever, cough, and a runny nose, followed by a body rash
Corona virus	Bats	RNA viruses	Air born droplets	Laboured breathing Pressure inside the chest with pain, weakness, difficulty in speech. Low oxygen level.

SUMMARY

- Viruses are a major threat to human health and countries economy. Millions of people died during 1918-1919 and now a days Corona becomes havoc to human beings. Due to Corona industrial production fell by 20 per cent on average in 93 per cent of countries during 2019 to 2020.
- Viruses have their own nucleic acid with genome that determine their functionality and shows complicated assemblies of molecules, including proteins, nucleic acids, lipids, and carbohydrates as present other living cells. There is an undeniable genetic and physiological connection between viruses and the organisms they infect.
- Viruses were first discovered after the development of a porcelain filter by Charles Chamberland (1884) in Paris, called the Chamberland-Pasteur filter.
- A virus Bacteriophage means 'bacteria eater'. Bacteriophage is a group of viruses that kills bacteria.
- Viruses have nucleic acid that contain such powerful genes which can overtake and forcefully derive all the cellular metabolic machinery including enzymes, organelles to work according to the directions of viral nucleic acid.
- A virus integrates its genome with the host cell nucleic acid and control the metabolic activities it also interrupts transcription and making protein of its own kind in the host cell. Viruses also misguide the immune response and establish a chronic infection.
- Many environmental factors may affect virus survival including temperature, humidity.
- Bacteriophages have genetic material compatible to incorporate any foreign eukaryotic gene for the betterment of living standards related with health and protection not only from diseases but to enhance the potential benefit of any organism of utmost importance for humans.
- HIV destroys our body T lymphocyte cells and particularly Helper T lymphocyte cells.
- Hepatitis is a viral disease that causes inflammation and damage to the liver. There are about five different types of hepatitis viruses like A, B, C, D and E.
- Some structures are more simplified and smaller than viruses. These structures are called subviral particles. These include viroids and prions

EXERCISE

1. Encircle the correct choice.

(i) Viruses evolve by using the
(a) Cellular organelles (b) Cellular enzymes
(c) Cellular energy (d) All of them

(ii) The pathogenicity of a virus depends upon
(a) the immunity of the host body
(b) the effective penetration of its genome
(c) the overall environment inside the body
(d) the overall environment outside the body

(iii) Bacteriophages escape from host cell by the activity of
(a) Lysozyme (b) Ribozyme
(c) Peroxisomes (d) Glyoxisomes

(iv) The smaller proteins are cut down and forms a new virus structure by the process called
(a) Integration (b) Transcription
(c) Budding (d) Assembly

(v) Virus that severely damage motor neurons and causes paralysis called
(a) HIV (b) Dengue
(c) Polio (d) Herpes

(vi) Proteins that cause pathogenicity in humans and animals called
(a) Prions (b) Viroids
(c) Antigen (d) Antibodies

(vii) Smaller than viruses having single stranded RNA with some double stranded regions are called
(a) Prions (b) Viroids
(c) Minus strand viruses (d) Double stranded DNA viruses

(viii) Dengue fever, encephalitis and yellow fever are caused by which group of viruses?
(a) Arbo-viruses (b) Retro-viruses
(c) Rhabdo-viruses (d) Rhino-viruses

(ix) Aedes mosquito is the vector of
(a) Dengue virus (b) Ebola virus
(c) Hepatitis virus (d) Measles virus

2. Write short answers of the following questions:

1. Discuss the living and nonliving status of virus
2. What do we mean by positive and negative sense virus?
3. Name the groups of viruses from Baltimore classification
4. How does bacteriophage virus infect bacteria?
5. Differentiate lytic and lysogenic life cycle of bacteriophage.
6. What is reverse transcription? How it performs by HIV in human?
7. List down any five animal and plant viruses with their vector transmission and symptom
8. List down the sequences involved in the lytic and lysogenic life cycle of bacteriophage?
9. How a virus survives without host discuss.
10. What are the symptoms of AIDS?
11. What is the prevention and control of AIDS?
12. Differentiate Prions and Viroids.

3. Write detailed answers of the following questions:

1. Explain the lytic life cycle of Bacteriophage with labelled diagram.
2. Explain the life cycle of HIV with labelled diagram.
3. Explain the pathogenicity and economic losses caused by viruses to the humans.