Extensive Questions

19.Trace the history of viruses since their discovery.

Ans:Viruses-Discovery and Structure:

Influenza , bird flu,polio ,swine flu, dengue fever etc. all these and many other diseases are caused by the infectious agants called viruses. The viruses are pathogens , which cause diseases in animals and plants. Viruses are not cells, they are not capable of independent replication , can synthesize neither their own energy are nor their own proteins and are too small to be seen in the light microscope.

History and Discovery of Virus:

The word virus is derived from a latin word "venom" meaning 'poison'. In past, the term virus was associated with infectious diseases which have unknown cause. The first evidence about the existence of virus came when in 1884 **Charles Chamberland** , who worked with **Louis Pateur**, found that the causative agents of rabies could pass through the procelain filter (which has pore sizes 0.1-1micron i.e , 100 -1000 nm). However such filters could be used to completely remove all bacteria or other cells known at the time from a liquid suspension.

Tobacco Mosaic Disease:

Tobacco Mosaic Disease was thought to be caused by bacteria. In 1892 **Iwanowsky** extracted the juice from the leaves of tobacco mosaic disease. In order to remove bacteria the juice on the leaves of healthy plants,expecting no disease to develop, but the healthy leaves soon showed the symptoms of the disease.

By 1900, similar disease producing substance had been discovered in both plants and animals. The name filterable viruses were given to these

substances. In 1935 **W.M.Stanley** crystallized the infectious particle , now known as tobacco mosaic virus (TMV). Subsequently, many other viruses actually have been seen with the help of the electron microscope. The study of virus is called **virology.**

20.Give the classification of viruses based upon capsid and genomes.

Ans: Classification of viruses:

Virus classification is either based upon host orgasisms or no other structural characters such as morphology, genome type and mode of action in the host.

The internationally agreed system of virus classification is based on the structure and composition of the virus particle (virion). In some cases the mode of replication is also important in classification.

Classification of viruses based upon of structure:

(i) On the bases of capsid:

Although diverse in size and shape viruses have common features, most of which appear in the following four types:

(a) Viruses having helical capsid with over all shape of a rigid rod e.g , tobacco mosaic virus.

(b) Viruses having a polyhedral capsid with a glycoprotein spike at each vertex e.g , adenoviruses.

(c) Viruses having an outer envelope studded with glycoprotein spikes e.g , Influenza viruses.

(d) Viruses having a complex capsid consisting of a polyhedral head and a tail apparatus e.g , Bacteriophage.

(ii) On the bases of genomes:

The genomes of viruses may consists of :

(a) Double-stranded DNA (dsDNA) e.g , Proxivirus (smallpox virus, cowpox virus).

(b) Single-stranded DNA(ssDNA) e.g, Parovirus (mild rash).

(c) Double-stranded (dsDNA) e.g , Reovirus (diarrhea).

(d) Single-stranded RNA (ssRNA) serves a mRNA e.g , Togavirus (Rubella virus).

(e) ssRNA: template for mRNA synthesis e.g , Orthomyxovirus (Influenza virus).

(f) ssRNA : template for DNA synthesis , Retrovirus(HIV).

21.Describe the general structure of a virus.

Ans: General Structure of a Virus:

Virion:

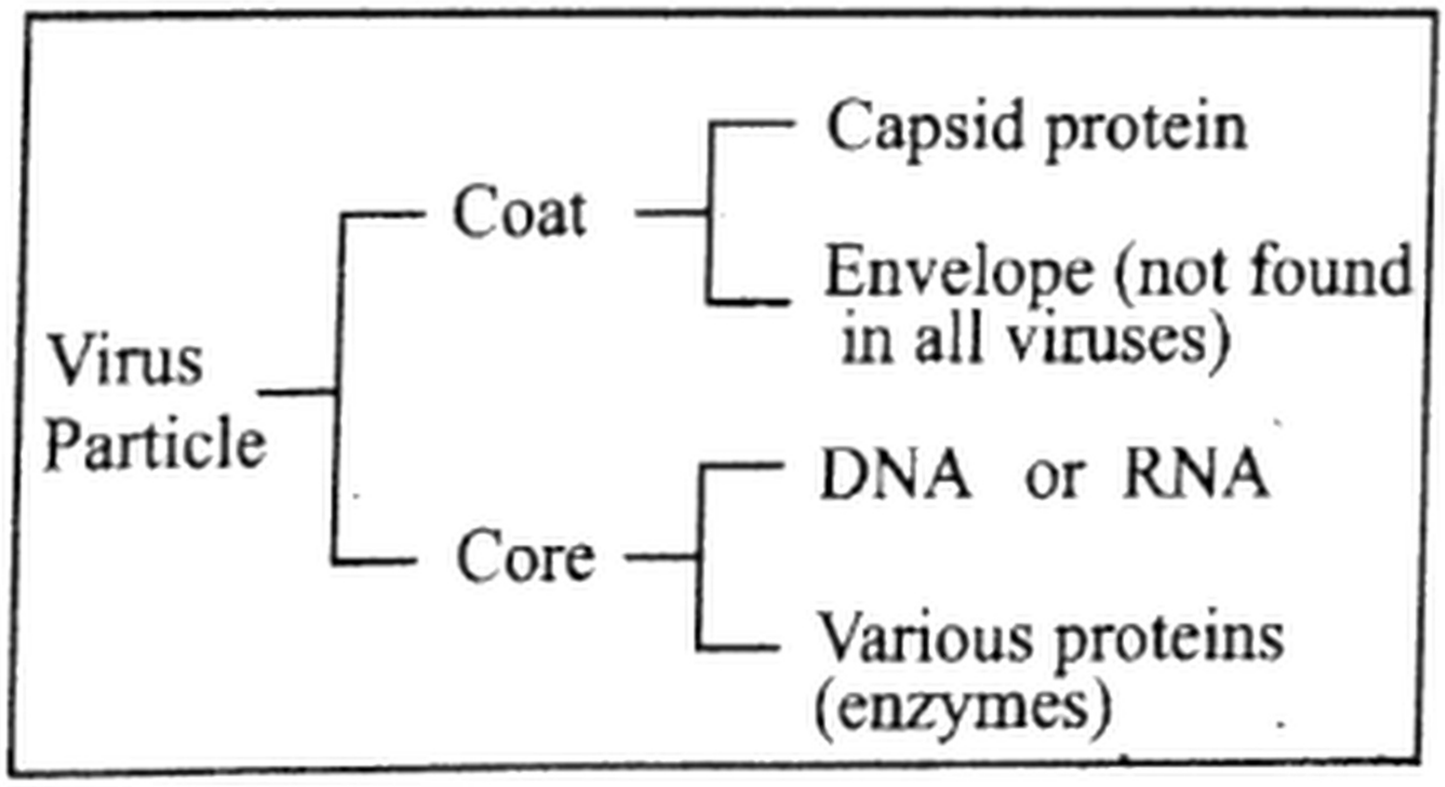
A complete viral particle is called virion. Primarily , it can be divided into two parts i.e , **core** and **coat.**

Core:

The core is inner part of vriion which consists of viral genome and various proteins (enzymes).

Genome:

Genome is the genetic material, which is either DNA or RNA , which may be single stranded or double stranded. **Core protein** include one or more enzymes that facilitate the virus inits mode of action within host body. For example, all single stranded RNA viruses have the enzyme transcriptase (RNA dependent RNA polymerase) to convert single stranded RNA genome into double stranded RNA genome. Retroviruses and hepatitis B virus contain the enzyme reverse transcriptase to convert single stranded RNA genome into double stranded DNA genome.



Coat:

The coat is the outer covering of viral particle which particle which consists of capsid and envelope.

Capsid:

The **capsid** is the protective coat of protein surrounding the core. Capsid is composed of identicle repeating subunits called **capsomers**. The number of capsomers is specific to a particle kind of virus. For example: herpes virus has 162 capsomers in its capsid while adenovirus that causes common cold contains 252 capsomers in its capsid. There are two forms of symmetry in virus capsid . when the capsomers are arranged in 20 triangles, it is called icosahedral (polyhydral or pherical). When the capsomers are arranged in a holo coil that appiers rod shaped, it is **helical.**

Envelope:

A few viruses have an additional lipoprotein envelope arround the capsid which is derived from the cell surface membrane of the host. And also contain virally encoded proteins. The viral envelope often covered with **glycoprotein spikes** that help them to recognse the host cell.

22. Describe the structure of bacteriophage with diagram.

Ans: Structure of Model Viruses:

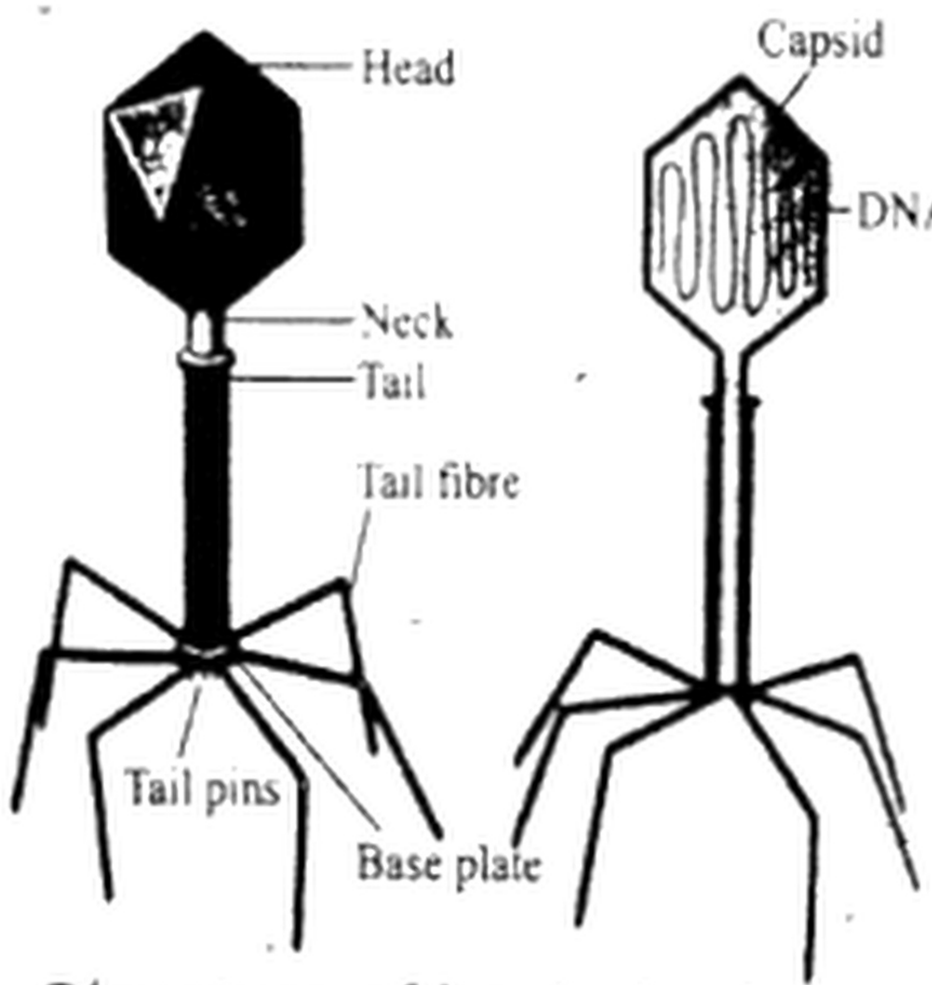
The structure of bacteriophage , flu virus and HIV has been described here to explain the structure of model viruses.

Structure of Bacteriophage:

The bacteriophage or simply phage is the virus that attacks upon bacteria. It is generally a tapole shaped virus. It consists of head,neck and tail.

Head:

The head is icosahedral in shape. The inner core of head consists of a single stranded DNA genome.



Structure of bacteriophage

Narrow Neck or Collar:

Below the head is narrow neck or collar which separate head and tail.

Tail:

The tail is a hollow tube made up of proteins through which the nucleic acid passes during infection. The tail is surrounded by a contractile sheath, which contracts during infection of the bacterium.

Basal Plate:

At the end of the tail a basal plate is present which possesses about six tail fibres around it and several tail pins or spikes at its lower surface. The tail fibres and tail pins are involved in the binding of the phage to the bacterial cell.

At the bottomm o core tube of tail , an enzyme , the lysozyme is present which is released upon contraction of tail. It digests the portion of the host cell wall so that core tibe can be penetrated into the host cell during infection.

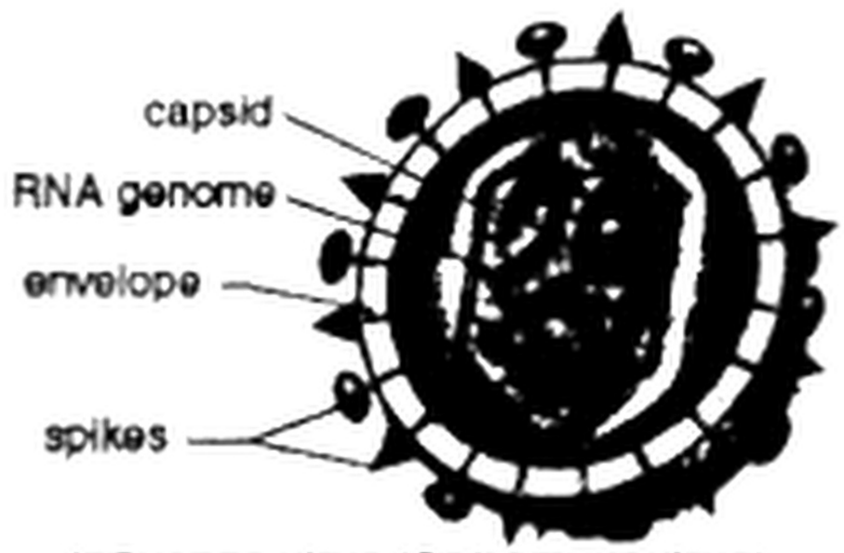
23.Describe the Structure of Influenza or Flu virus with diagram.

Ans: Structure of Influenza or Flu virus:

Influenza virus exists in three forms called A,B,C.

Composition of influenza virus

Influenza virus is composed of a segmented single-stranded RNA. A membranous envelope surrounds the capsid having spikes.



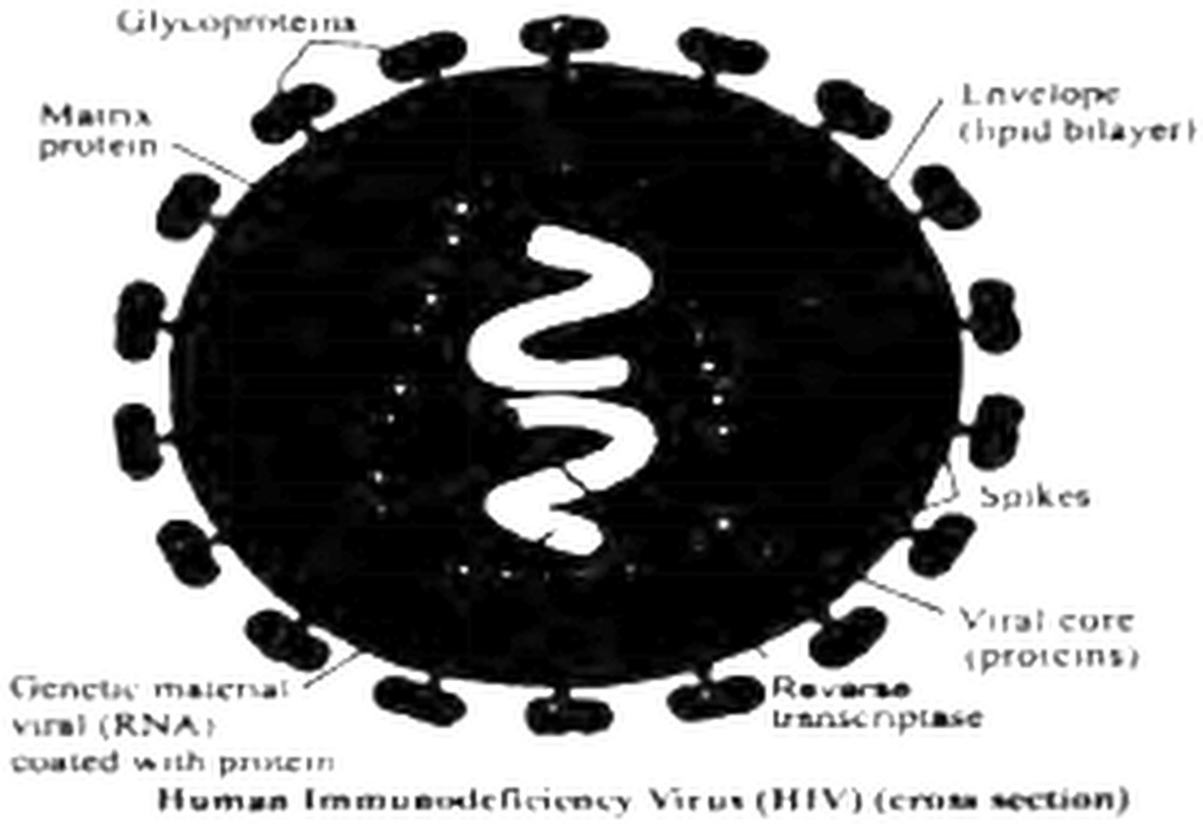
Influenza virus (Orthomyxovirus)

24.Describe the structure of human immunodeficiency virus with diagram.

Ans: Structure of Human Immunodeficiency Virus:

Human immunodeficiency virus (HIV) is a **retrovirus.** It is spherical in shape.

The outer covering is a lipoprotein envelope whoch consists of two layers of lipids:different proteins are embedded in the viral envelope, forming **"spikes"** consisting of the outer **glycoprotein (gp 120)** and the **transmembrane gp 41**. The lipid membran eis borrowed from the host cell during the budding process (formation of new particles), gp 120 is needed to attach to the host cell and gp 41 is critical for the cell fusion process . beneath envelope another protein shell is present which is made up of **matrix protein**. It lies between the envelope and capsid. The HIV capsid is somewhat conical shaped which is composed of capsomers. The viral core contains two single-strands of **HIV RNA** and the enzymes needed fro HIV replication, some as reverse transcriptase, integrase and protiase. The **reverse transcriptase** enzyme is use to convert viral RNA genome into viral DNA genome,integrase enzyme is use to incorporate viral DNA into host DNA while the protease enzyme is use to break large structural proteins into smaller units. These structural proteins are encoded by three out of the nine virus genes.



Human Immunodeficiency Virus (HIV) (cross section)

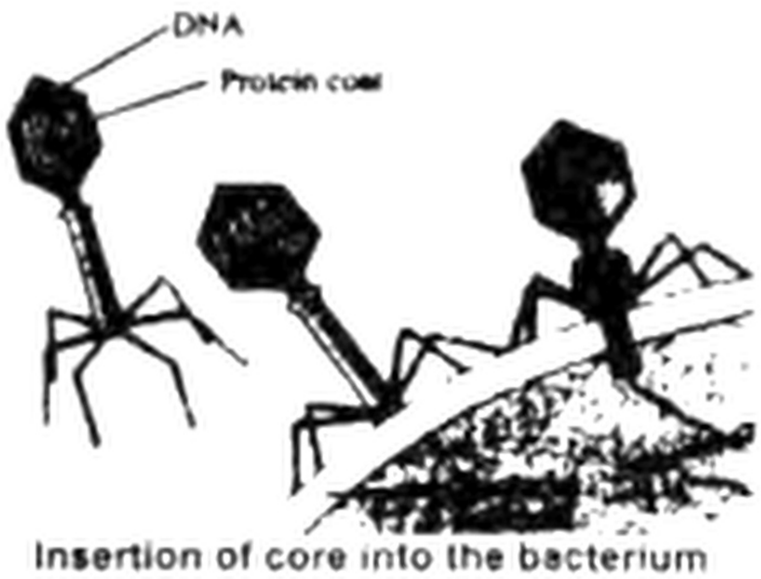
25. Describe the Lytic and Lysogenic life cycles of a virus.

Ans: Life Cycle of a Bacteriophage:

Bacteriophage or phages show two types life cycles i.e. **Lytic cycles and Lysogenic cycle.**

Steps of Life Cycle of Bacteriophage:

The life cycle of bacteriophage comprises two main steps i.e. infection process and replication within the host cells.



Insertion of core into the bacterium

The initial steps in the infection process such as adsorption, penetration and genome injection are quite similar in both cycles but mode of replication is much different in lytic cycle or lysogenic cycle.

Infection Process:

The common steps of infection process of bacteriophages to their host are as under:

Adsorption:

The first step in the infection process is the adsorption of the phage to the bacterial cell. This step is mediated by the tail fibres and tail pins/spikes. Phages attach to specific receptors on the bacterial cell.

Penetration:

The binding of the phage to the bacterium results in the contraction of the sheath and release of lysozyme that digest the portion of bacterial envelope; as a result, the hollow core tube is pushed through the bacterial envelope. This insertion of core tube is called **penetration.**

Genome injection:

The penetration of core results into the injection of viral DNA in the bacterial cytoplasm whereas, the remainder of the phage remains on the outside of the bacterium.

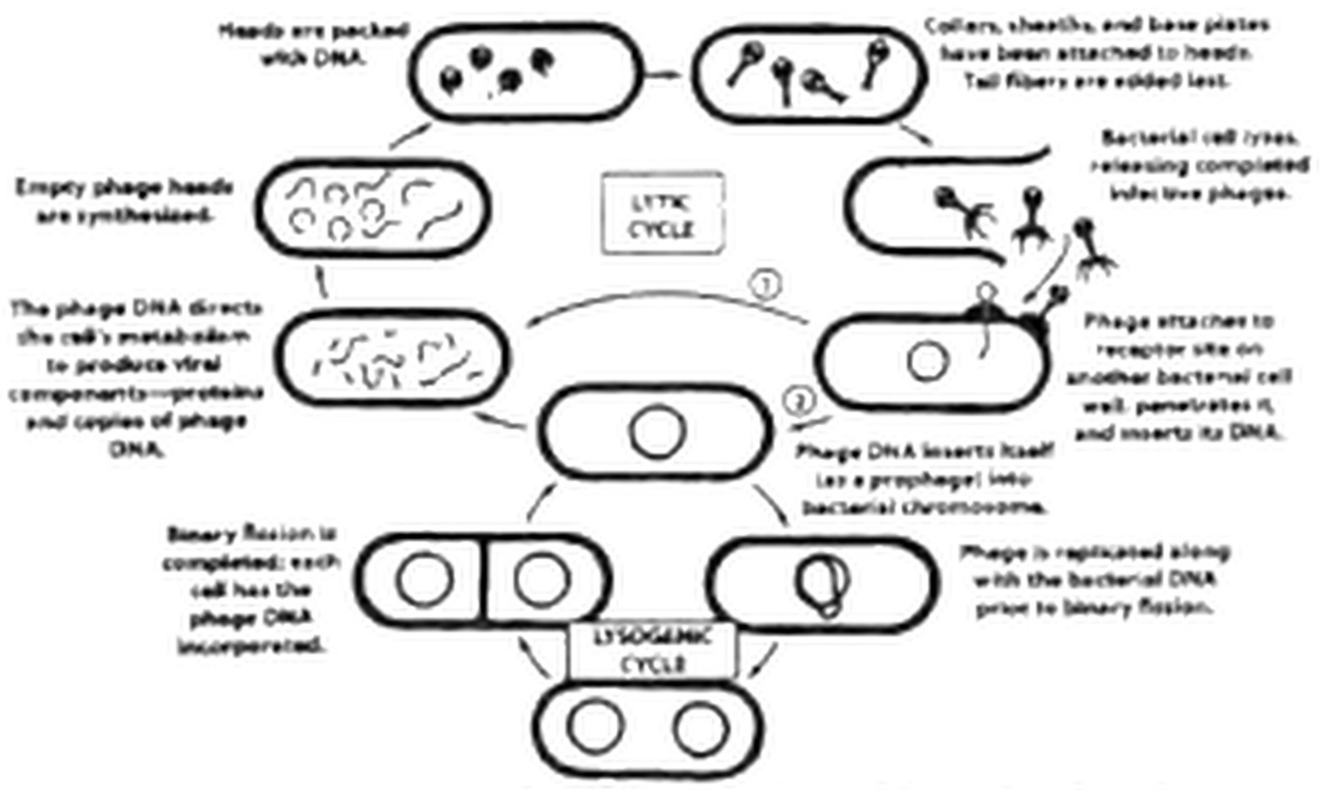
Replication of Bacteriophage in Lytic Cycle:

Lytic or Virulent Phage:

The bacteriophage that performs lytic cycle is called **lytic** or **virulent phage** because it immediately causes lysis (breakdown) of its host cell after its own multiplication. It develops **Master-Slave relationship** with the host cell because host genomic DNA is immediately disintegrated by the virally encoded DNA digesting enzyme (DNAase). Since viral DNA is already undergone certain chemical modification therefore, such enzymes do not affect it. The disintegration of host DNA enables the viral DNA to takes over the control of the whole metabolic machinery of its host. In lytic cycle the subsequent steps are **synthesis of phage components,**

Assembly, maturation, lysis and **release.**

Soon after the disintegration of host DNA phage specified mRNAs and proteins are began to produce. Structural proteins (head, tail) that compromise the phage as well as the proteins needed for lysis of the bacterial cell are separately synthesized Nucleic acid is then packaged inside the head and then tail is added to the head. The assembly of phage components into mature infective phage particle is known as maturation. Within 20 to 25 minutes approximately 200 phage particles are produced. In lysis and release phase the bacteria begin to lyse due to the accumulation of the phage lysis protein i.e. lysozyme and intracellular phage particles are released into the medium.



Lytic and lysogenic life cycle of bacteriophage

Replication of Bacteriophage in Lysogenic Cycle:

Lysogenic or Temperate Phages:

The bacteriophage that perform lysogenic cycle are called **lysogenic** or **temperate phages.** These phages can either multiply via the lytic cycle or enter a dormant state in the cell. Such phages develop **Host-Guest relationship** because in this case the phage DNA actually integrates into the host chromosome and is replicated along with the host chromosome and passed on to the daughter cells. This integrated state of phage DNA is termed as

prophage. This process is known as **lysogeny** and the bacteria harboring prophage are called **lysogenic bacteria.**

Induction:

The lysogenic state of a bacterium can get terminated anytime when it exposed to adverse conditions. This process is called **induction.**

Conditions that favor the termination of the lysogenic state include:

Desiccation exposure to UV or ionizing radiation, exposure to mutagenic chemicals etc. the separated phage DNA then initiates lytic cycle resulting in cell lysis and releases of phages.

Such phages are then capable of infecting new susceptible cells and render them lysogenic.

26. Describe the usage of bacteriophage in genetic engineering.

Ans: Usage of Bacteriophages in Genetic Engineering:

Genetic engineering is the field of bacteriophage in which alteration in genetic material of an organism is carried out such as transfer of gene from one organism to another. Several biological tools have been used in genetic engineering to accomplish the required task.

The bacteriophage has also been used in number of ways in different approaches of genetic engineering. Some of them are outlined below:

a) Beside bacterial plasmids the phage DNA has also been used as vector in genetic engineering techniques such as development of genomic library (a collection of bacteria or bacteriophage clones which contains multiples copies of all the genes of an individual's genome)

b) Phage therapy is the application of genetically engineered phages that can kill pathogenic bacteria. Phage therapy has advantages over

conventional antibiotic therapy. As phages are fairly narrow in their spectrum of activity, meaning that with phage treatment it is possible to kill bacterial pathogens while avoiding harming of normal bacterial flora, that is, our good bacteria.

c) Bacteriophages have been discovered in which bacteriophages can be formulated as targeted drug-delivery vehicles.

27. Explain the life cycle of HIV.

Ans: Life Cycle of Human Immunodeficiency:

Human immunodeficiency virus (HIV) is the causative agent of acquired immune deficiency syndrome or AIDS. It was identified in 1984 by research team from Pasture Institute in France and National Institute of Health in USA. In 1986 the virus was named HIV.

Life Cycle of HIV:

The primary hosts of HIV are helper T lymphocytes (CD4 or T4 cells). In addition, macrophages and certain brain cells may also be affected.

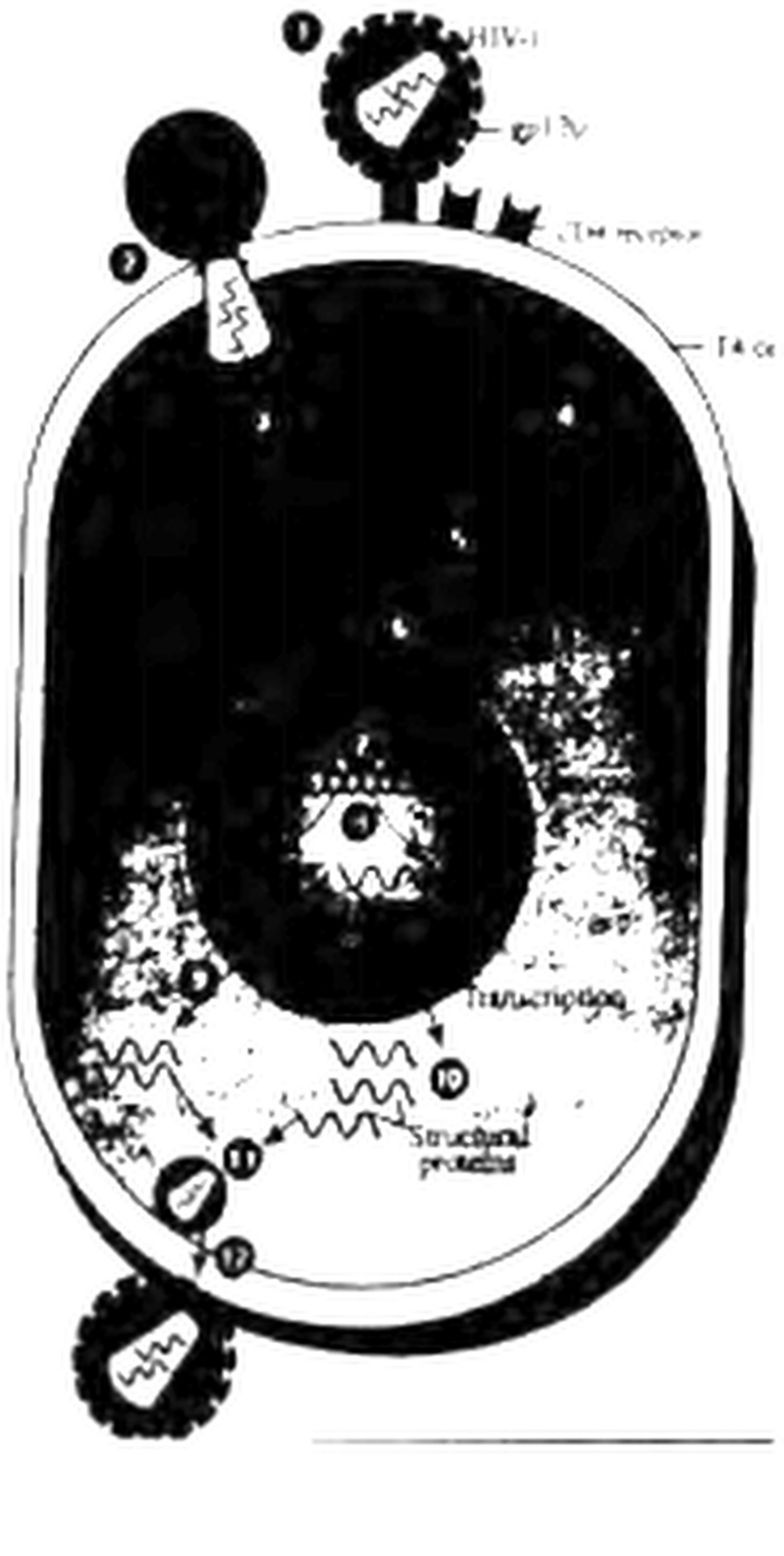
Following steps are involved in the life cycle of HIV.

1) The initial step in the life cycle of HIV is adsorption/attachment which is characterized by the binding of the virion glycoprotein 120 envelope proteins to the CD4 proteins (a receptor) on the surface of T4 cells.

2) Next the fusion of the envelope with the cell membrane takes place and the virion enters the cell by endocytosis. Once inside the host cell, the HIV particle sheds its protective coat i.e. uncoating occurs. This leaves the single stranded viral RNA in the cytoplasm along with viral enzymes.

3) The enzyme called reverse transcriptase synthesizes a single stranded DNA complementary to virus RNA therefore called complementary DNA (cDNA).

4) After reverse transcription the viral genomic RNA is disintegrated by the ribonuclease (RNAase) enzyme.
5) The single stranded cDNA is replicated to form double stranded cDNA.
6) The double stranded cDNA then integrates into the host cell DNA. Integration is mediated by a virus encoded enzyme integrase.
7) The integrated DNA is now called provirus.
8) Viral mRNA is transcribed from the proviral DNA by the host cell RNA polymerase. Suring transcription not only viral mRNAs for different protein are formed but viral genomic RNA is also produced.
9) The viral mRNAs are translated by host ribosomes into several large proteins, which are then cleaved by the virus-encoded protease to form the virion structural proteins.
10) The viral components are assembled and nature virions are produced.
11) Finally, the mature virions are gradually released by budding off from the host cell and enclosing a portion of host cell membrane around them. In this way host cell size is decreased enough that it becomes non-functional.



Life Cycle of HIV (Retrovirus):

1. **Attachment: Spike combines with receptor.**
2. **Penetration: virus enters cell and uncoating occurs.**
3. **Reverse transcription: produces cDNA strand.**
4. **Break down: Viral DNA breaks down.**
5. **Replication: Produces double-stranded cDNA.**
6. **Integration: Viral DNA passes on when cell reproduce.**
7. **Provirus: The integrated DNA is known as provirus.**
8. **Transcription: Produces many strands of mRNA.**
9. **Biosynthesis: Genomic RNA is formed.**
10. **Formation of protein: Structural proteins are formed.**
11. **Maturation: Assembly of viral components.**
12. **Release: Budding gives virus an envelope.**

Since, helper T cells regulate immunity by enhancing the response of other immune cells so, the decrease in the number of helper T cells causes deficiency of the human immune system. The virus affects the human immune system; therefore the virus has been named Human Immunodeficiency Virus (HIV).

28. Describe the treatments available for AIDS.

Ans: Treatment of AIDS:

The aim of HIV treatment is to reduce the viral load (it is the quantity of virus at which it is detected in an organism) to an undetectable level as long as possible and to reduce transmission by using antiviral drugs. The decision to start therapy is a major one. It is dependent upon the symptom status of the patient, the CD4 count the viral load and wishes of the patient.

Antiretroviral Therapy (ART):

HIV is treated using a combination of medicines to fight HIV infection. This is called **antiretroviral therapy** (ART). ART is not a cure but it can control the virus so that HIV positive person can live a longer, healthier life and reduce the risk of transmitting HIV to others. ART is a highly effective treatment for HIV infection, preventing progression of the disease in the vast majority of recipients. When ART is accessible and started early in the course of infection, the lifespan of HIV-positive people is typically very close to that of comparable HIV-negative people. But ART can have toxicities, is often costly, and requires strict daily pill taking that can lessen quality of life. Because of the limitations of ART, a cure for HIV infection remains a vital goal for research.

29. Describe the causative agent, symptoms, transmission, treatment and prevention of the following diseases:

(a) Hepatitis **(b) Herpes**

(c) Polio **(d) Cotton leaf curl disease**

Ans: (a) Hepatitis:

Hepatitis is generally characterized as inflammation of liver including other symptoms.

Cause:

It is generally caused by viral infection or rarely due to toxicity of drugs and certain other causes. It may present in acute (recent infection, relatively rapid onset) or chronic (slowly progressing) forms.

The most common causes of viral hepatitis are the five unrelated hepatotropic (that replicate in liver cells) viruses i.e. Hepatitis A, Hepatitis B, Hepatitis C, Hepatitis D, and Hepatitis E.

i. **Hepatitis "A":**

Causes:

Hepatitis A (also called infectious hepatitis) is caused by HAV (Picornavirus).

Transmission:

HAV is transmitted by the fecal-oral route.

Symptoms:

The typical symptoms are fever, anorexia, nausea, vomiting and jaundice. Dark urine, pale faces are also seen. Treatment No antiviral therapy is available.

Prevention:

Active immunization with a vaccine containing inactivated HAV is available.

ii. **Hepatitis "B":**

Causes:

Hepatitis B (also called serum hepatitis) is caused by HBV (Hepadnavirus).

Symptoms:

It is similar lot hepatitis A.

Transmission:

The three main modes of transmission are via Mood, sexual contact and prenatally from mother to newborn.

Treatment:

Alpha interferon is effective against HBV.

Prevention:

Vaccine is highly effective in preventing.

iii. **Hepatitis "C":**

Causes:

Hepatitis C is caused by Hepatitis C virus (Flavivirus).

Transmission:

It is only transmitted by blood.

Symptoms:

Symptoms are just like hepatitis B.

Treatment:

A combination of alpha interferon and ribavirin is the treatment choice for chronic hepatitis C.

Prevention:

No. vaccine is available. Blood transfusion should be screened as preventive measure.

iv. **Hepatitis "D":**

Causes:

The only human disease known to be caused by a viroid is hepatitis D.

Transmission:

The hepatitis d viroid can only enter a human liver cell if it is enclosed in a capsid that contains a binding protein. It obtains this from the hepatitis B virus. The viroid then enters the blood stream and can be transmitted via blood or serum transfusions.

Symptoms:

As in hepatitis B but more severe.

Treatment and Prevention:

Same as HBV.

v. **Hepatitis "E":**

Causes:

It is caused by HEV.

Transmission:

Like HAV, it is also transmitted by the fecal-oral route.

Treatment and Prevention:

There is no antiviral treatment and vaccine.

Observation of proper hygiene.

(b) **Herpes:**

Herpes Simplex:

Herpes simplex is a superficial viral infection characterized by one or more painful, fluid-filled sores or blisters (an elevation of the skin) appear on the skin or epithelium of outer openings of the body.

Tingling, itching or burning may be felt on the skin before the blisters appear. Blisters break open and often ooze fluid and form a crust, before

healing. The sores can last from 7 to 10 days. Where the sores appear often varies with types.

Types of Herpes:

There are two primary types of herpes i.e. oral herpes and genitial herpes.

I. **Oral Herpes:**

Causes:

It is caused by herpes simplex virus type-1.

Transmission:

HSV Type-1 is transmitted primarily through oral secretions (saliva) or physical contact with sores on the skin. It can also be spread by sharing objects such as toothbrushes or eating utensils.

Symptoms:

Most blisters appear on the lips or around the mouth. Sometimes blisters form on the face on the tongue.

Treatment:

Antiviral drugs are used to treat herpes.

Prevention:

Avoid contact with affected area of the patient.

II. **Genitial Herpes:**

Causes:

It is caused by herpes simplex virus type-2.

Transmission:

In general, a person can only get HSV type-2 infection during sexual contact with someone who has a genitial HSV-2 infection.

Symptoms:

In genitial herpes the sores typically occur on the penis, vagina, buttocks, or anus.

Treatment:

Antiviral drugs are used to treat Herpes.

Prevention:

Avoid contact with affected area of the patient.

(c) Polio:

Poliomyelitis:

Causes:

It is caused by polio virus which is also an enterovirus.

Transmission:

Polio virus is transmitted by the fecal oral route.

Symptoms:

It replicates in the oropharynx and intestinal tract and spread to blood and central nervous system where virus replicates in the motor. Death of these cells results in paralysis of the muscles innervated by neuron located in the spinal cord. The motor nerve damage is permanent.

Treatment:

There is no antiviral therapy Physiotherapy for the affected muscles is important.

Prevention:

Polio can be prevented by the killed (salk vaccine, inactivated vaccine) and the live, attenuated (weakened) vaccine (sabin vaccine, oral vaccine).

(d) Cotton Leaf Curl Disease:

Cotton leaf curl disease (CLCuD) is a serious disease of cotton.

Causes:

The viruses associated with CLCuD complex on the Indian subcontinent, five of which have been identified as begomoviruses.

Transmission:

This disease is transmitted by the whitefly Bemisia tabaci.

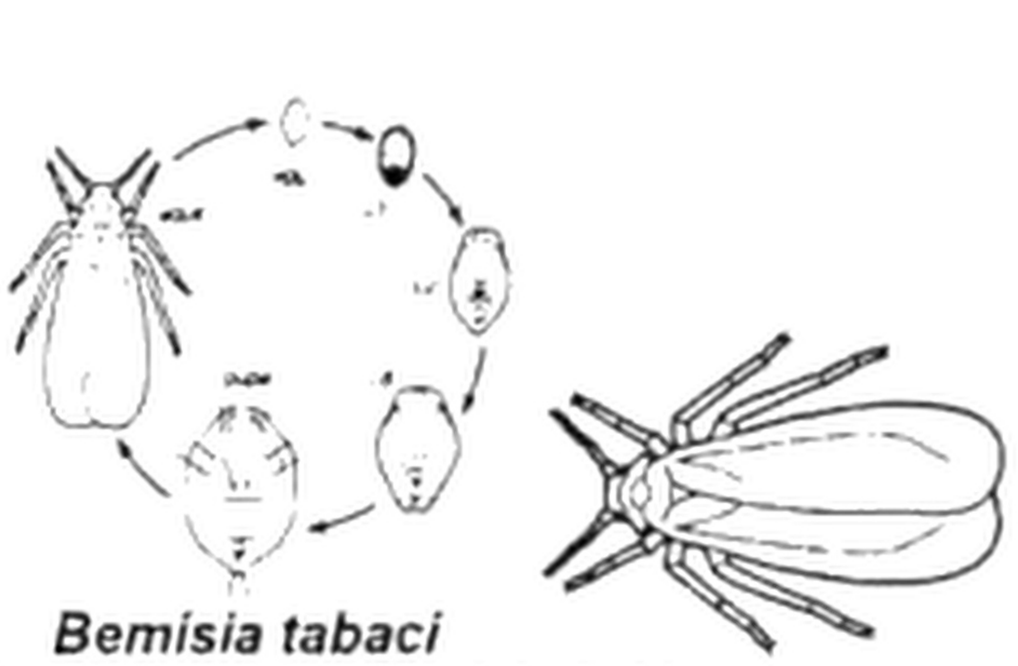
Symptoms:

The symptoms are initially characterized by a deep downward cupping of the youngest leaves. This is followed by development of cup-shaped, leaf-like structures.

Treatment and Prevention:

Control of CLCuD is mainly based on insecticide treatments against the insect vector (Bemisia tabaci).

Cotton leaf curl disease



Bemisia tabaci

Table: Losses due to cotton leaf curl disease, in Punjab, Pakistan

Year	Affected Area (000 ha)			Loss in	Loss in Pak
	Partial	Complete	Total	Production	Rupees

				(000 balse)	(million)
2006-07	1686.4	25.21	1711.63	1231.7	14063
2007-08	1432.8	2.5	1435.29	953.5	13778
2008-09	1440.1	40.25	1480.35	1115.7	16079
2009-10	1693.5	43.39	1956.62	1840.1	44160
2010-11	1341.8	28.33	1370.12	1164.90	48457
2011-12	569.6	0.00	569.60	482.20	11815

Production loss in balse calculated on the survey reports conducted by PWQ, Punjab. Economics loss estimated on the basis if annual average lint prices at Multan Market Committee Courtesy: Mr. Tariq Mehmood, Director, CCRI, Multan.