

2. VIRUS REPLICATION

Viruses do not have biosynthetic enzymes for replication. Viruses depend on host cell for replication. Genetic information for viral replication is present in the viral nucleic acid. Viruses can undergo two main types of replication cycles: -LYTIC CYCLE and LYSOGENIC CYCLE.

Viral multiplication cycle can be divided into 6 phases:

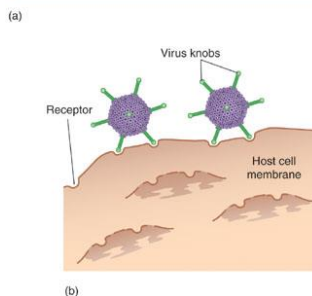
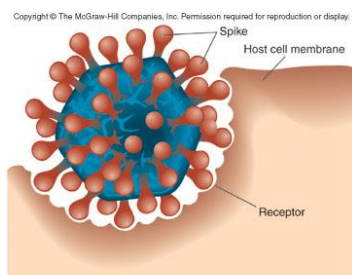
1. Adsorption – binding of virus to specific molecule on host cell
2. Penetration –virus enters host cell
3. Uncoating – release of viral genome
4. Replication – viral components produced
5. Assembly - viral components assembled
6. Maturation – completion of viral formation
7. Release – viruses leave cell to infect other cells

1. Adsorption:

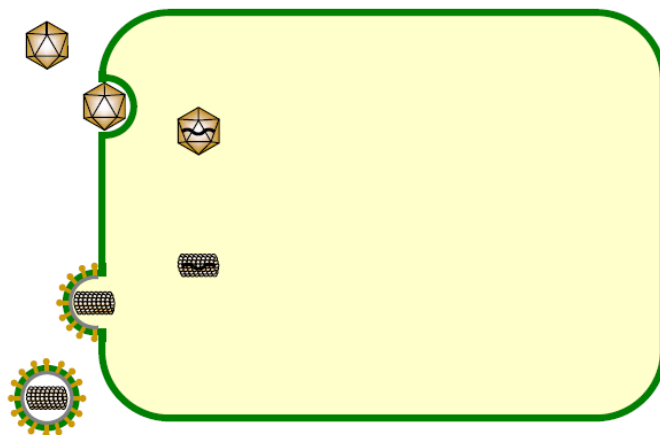
In Adsorption / Attachment, the virus must first attach itself to the host cell. This is usually accomplished through special glycoproteins receptors on the exterior of the capsid, envelope or tail.

e.g.-Influenza virus has hemagglutinin on the surface attaches to glycoprotein receptors on respiratory epithelium.

-HIV virus attaches to CD4 receptors on host cells & virus surface glycoprotein gp120.

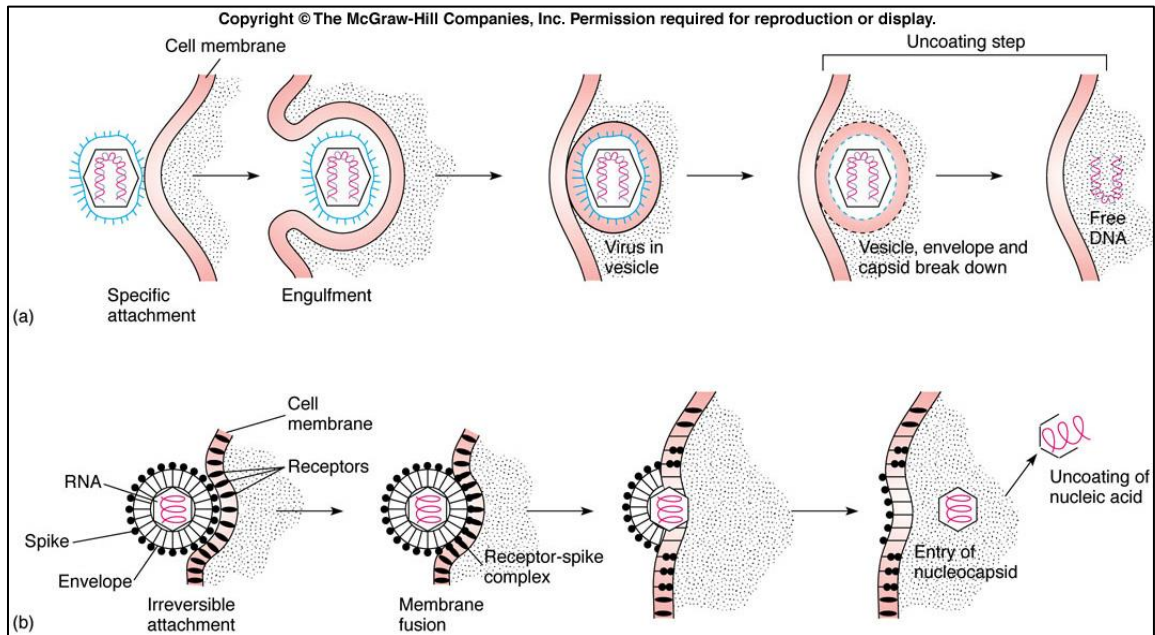


Virus replication: general



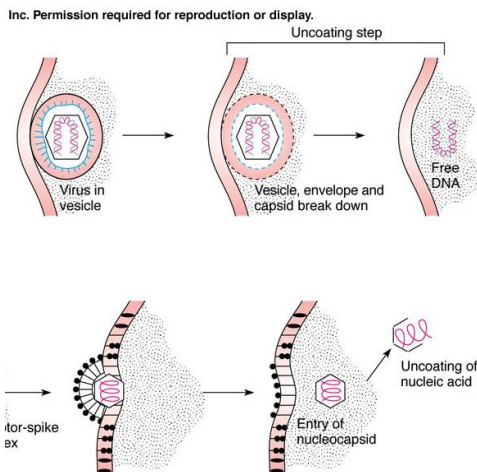
2. Penetration

Penetration occurs, either of the whole virus or just the contents of the capsid. If the entire capsid enters, the genetic material must be uncoated to make it available to the cell's replication machinery. In case of enveloped viruses, viral envelope may fuse with plasma membrane of host cell and release the nucleocapsid into the cytoplasm.



3. Uncoating

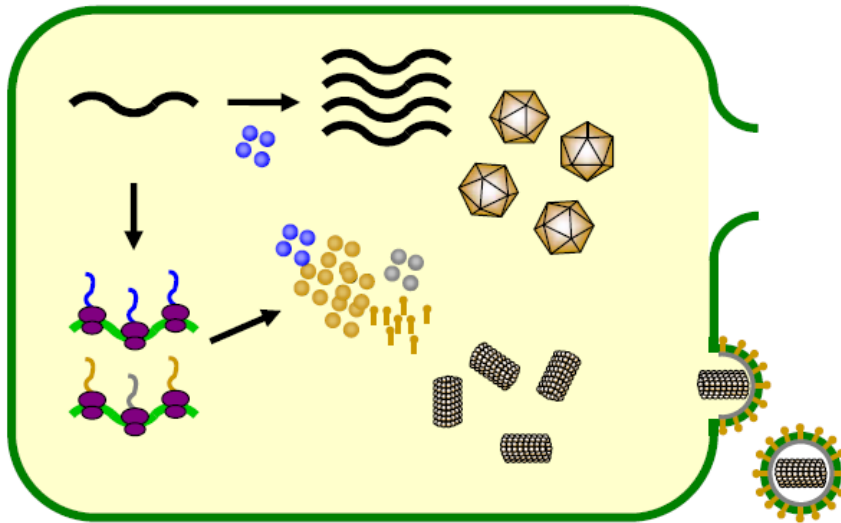
Uncoating of capsid and release of genetic material. Stripping of virus outer layer & capsid to release nucleic acid. Cell enzymes (lysosomal enzymes in phagocytic vacuoles) strip off virus proteins.



4. Replication

Synthesis of viral nucleic / capsid proteins / enzymes necessary for viral replication, assembly and release, regulatory proteins to shut down cell metabolism and the production of capsid and tail proteins.

Virus replication: general



REPLICATION/BIOSYNTHESIS/TRANSCRIPTION;

Biosynthesis consists of: Transcription of messenger RNA (mRNA) from viral nucleic acid, Translation of mRNA into early proteins, replication of viral nucleic acid and synthesis of late or structural proteins

On the basis of mRNA transcription, viruses have been categorized in 6 classes by BALTIMORE (1970)

CLASS 1: dsDNA virus (adeno – herpes – papovavirus)

CLASS 2: ssDNA virus (ss converted to ds)

CLASS 3: dsRNA transcribed to mRNA by viral polymerase

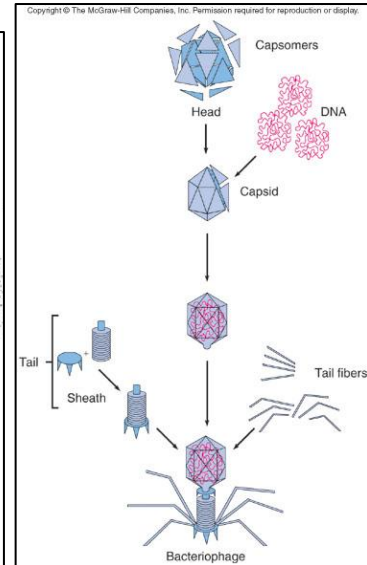
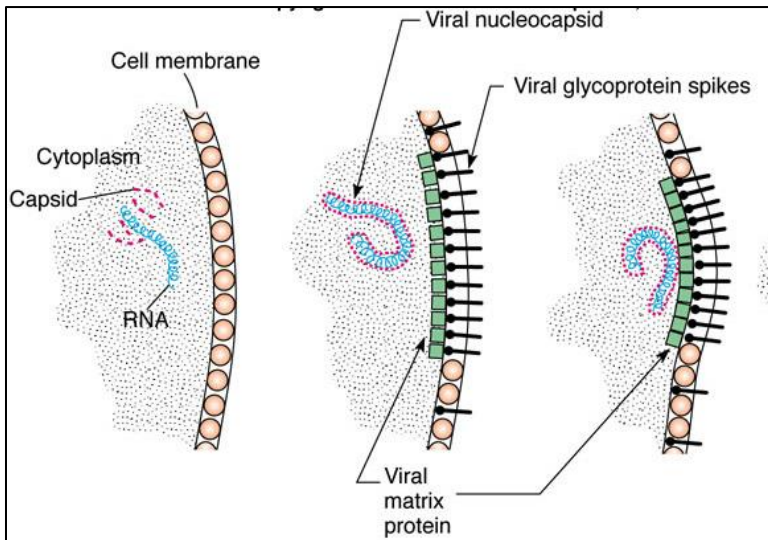
CLASS 4: ssRNA (+ strand) – viral RNA itself acts as mRNA

CLASS 5: ssRNA (-strand) – RNA is antisense (rhabdo – orthomyxo – paramyxoviridae)

CLASS 6: ssRNA (converted to RNA:DNA hybrid by reverse transcriptase. dsDNA is then synthesized and it forms PROVIRUS (integrates into host cell chromosome) Retroviridae

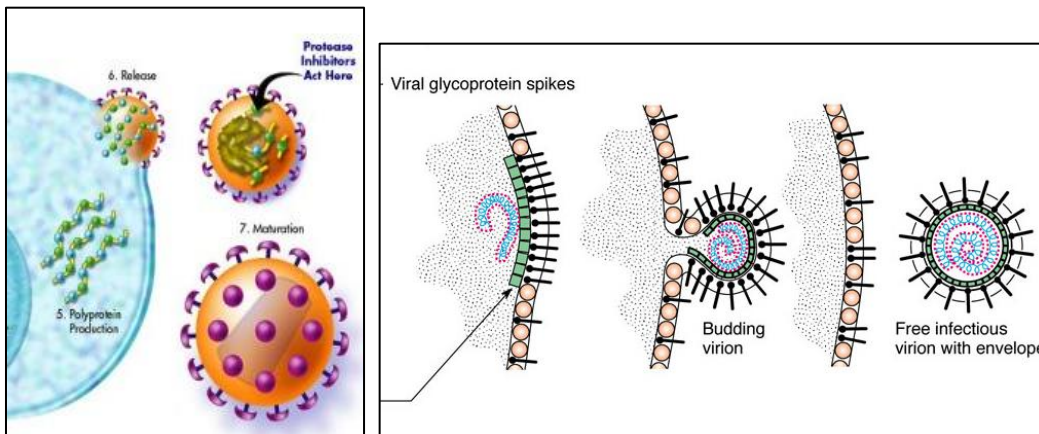
5. & 6 Assembly/Maturation:

Once all of the necessary parts have been replicated, individual virus particles are assembled (DAUGHTER VIRIONS). It takes place in host cell nucleus or cytoplasm. For enveloped viruses – envelope is derived from host cell membrane in the process of budding. Host cell membrane is modified by incorporation of virus specific proteins



7. Release

Release often takes place in a destructive manner, bursting and killing the host cell or by gradual extrusion (budding) of enveloped virus. Progeny virions are released into surrounding medium and may infect other cells. From stage of penetration till appearance of mature daughter virions, the virus cannot be seen inside the host cell. This period is called eclipse phase



ABNORMAL REPLICATION CYCLE:

-Due to defective assembly, some incomplete viruses are seen (influenza virus). High hemagglutinin titer but low infectivity is called von Magnus Phenomenon.

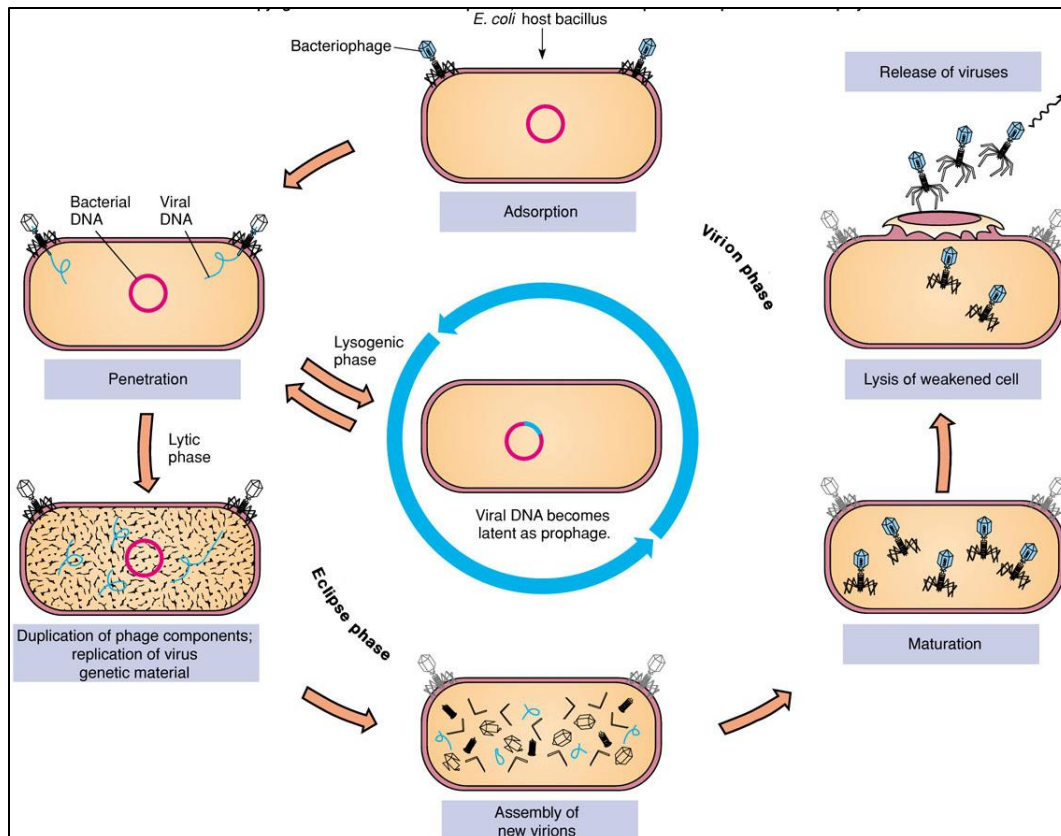
-Abortive infection: virus infection does not lead to production of complete infectious progeny virus (one part is missing). Viruses which are genetically deficient and incapable of producing infectious daughter virions are called defective virus.

Some viruses have a slightly more complicated replication cycle involving lytic and lysogenic phases (e.g. Bacteriophages).

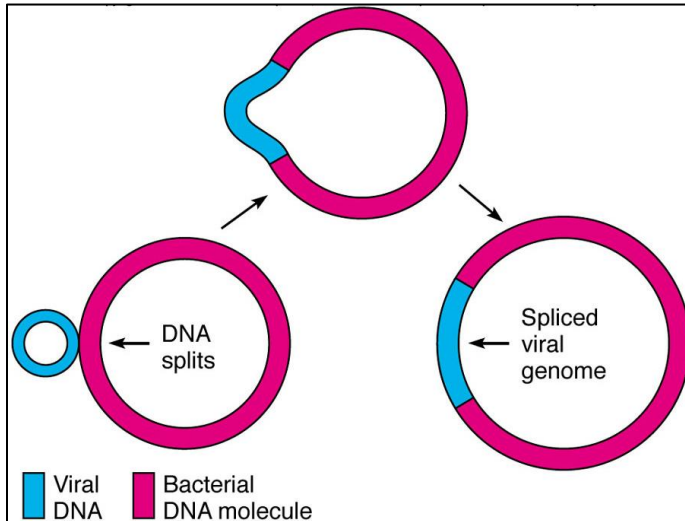
-The lytic phase is similar to that described above, with virus particles infecting and being replicated.

-In the lysogenic phase, however, viral genetic material that has entered the host cell becomes incorporated in the cell and lies dormant. It is passed on to the progeny of the infected cells.

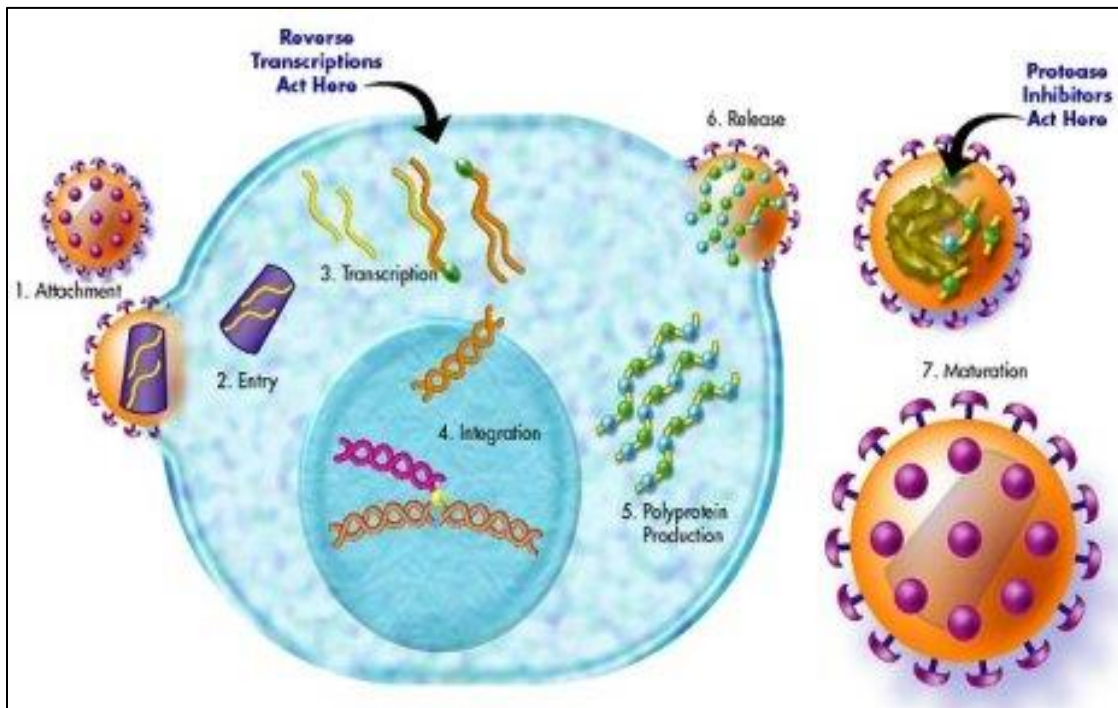
-Eventually, the lytic phase will start again, and cells that were never infected themselves, but carry the viral genetic material will begin to produce new virus particles.



Not all bacteriophages lyse cells. Temperate phages insert their viral DNA into the host chromosome & viral replication stops at there until some later time. Lysogeny is seen when bacterial chromosome carries phage DNA.

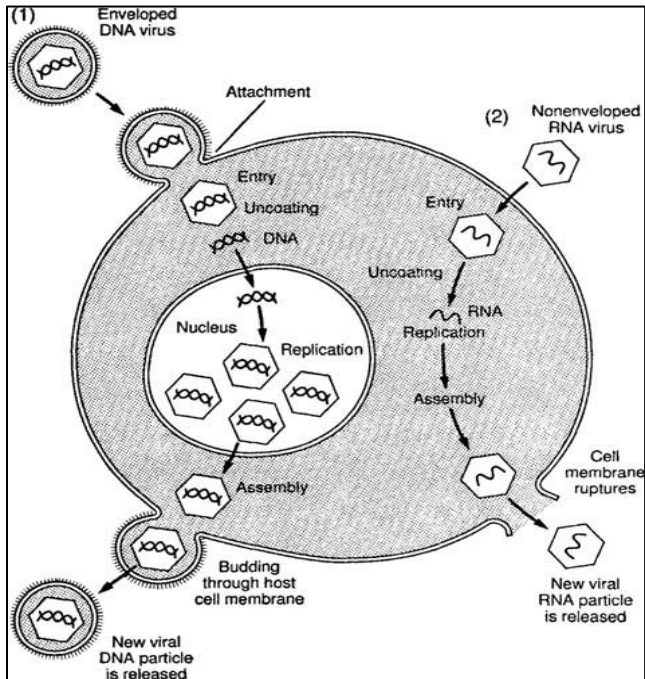


Life cycle of HIV



Life cycle of Viruses: A) Naked and enveloped Icosahedral viruses and B) Bacteriophage lytic life cycle.

A



B

