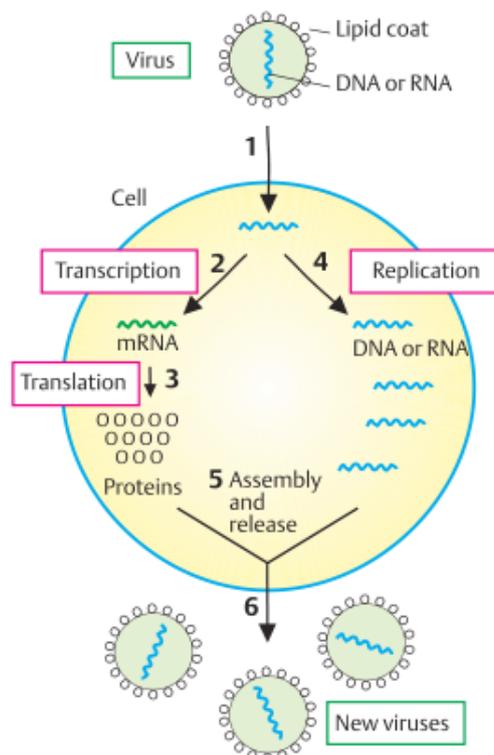


Replication Cycle of Viruses

With all their different genomic structures, forms, and sizes, viruses basically have a relatively simple replication cycle. While only the genome of a bacteriophage enters a bacterium, the complete virus (genome and capsid) enters a eukaryotic cell.

General sequence of the replication cycle of a virus in a cell

The replication cycle of a virus consists of five principal consecutive steps: (1) entrance into the cell and release of the genome (uncoating), (2) transcription of the viral genes and (3) translation of the mRNAs to form viral proteins, (4) replication of the viral genome, (5) assembly of new viral particles in the cell and release of the complete virions from the host cell (6).

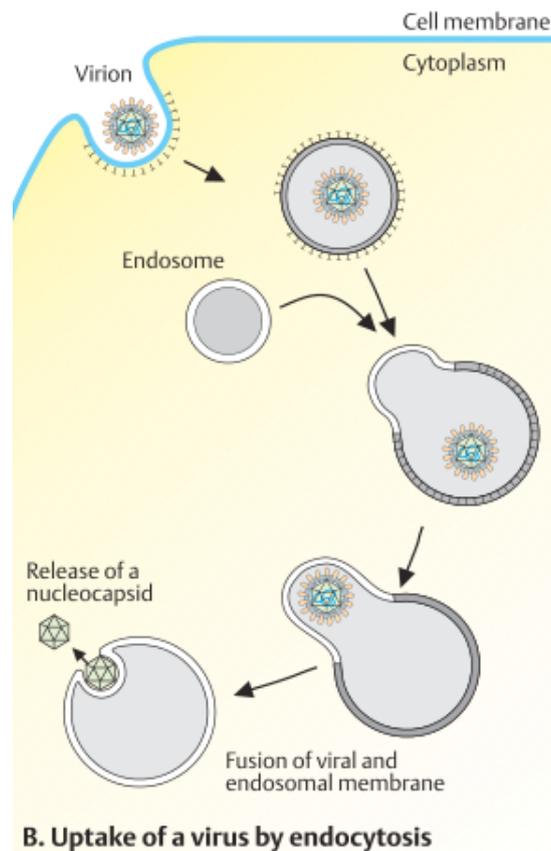


A. General sequence of the multiplication cycle of a virus in a cell

General sequence of the
replication cycle of a
virus in a cell

Uptake of a virus by endocytosis

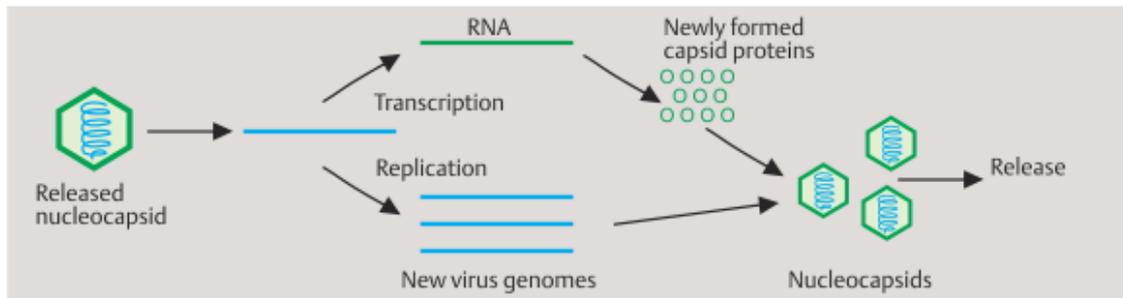
Besides fusion of the lipid membrane of membrane-enclosed viruses with the cell membrane of the host cell, the most frequent mechanism for a virion to enter a cell is by a special form of endocytosis. The virus attaches to the cell membrane by using cell surface structures (receptors), which serve other important functions for the cell, e.g., for the uptake of macromolecules. Like these, the virus is taken into the cytoplasm by a special mechanism, receptor-mediated endocytosis (coated pits, coated vesicles). Within the cell, the virus-containing vesicle fuses with other cellular vesicles (e.g., primary lysosomes). The viral coat is extensively degraded in the endocytotic vesicle, and the viral core (genome, associated with virus-coded proteins) is released into the cytoplasm or nucleus, depending on the viral type. Replication and expression of the viral genome follow. Whether a cell can be infected by a virion depends on a specific interaction between the virus and a cellular receptor. Some viruses, such as the paramyxoviruses (e.g., mumps and Sendai virus), enter the cell by direct fusion of the viral and cellular membranes, mediated by a viral coat glycoprotein (F or fusion protein).



Uptake of a virus by endocytosis

Transcription and replication of a virus

The first viral genes to be expressed after the virus has entered the cell are the early genes of the viral genome. Gene products of these early viral genes regulate transcription of the remaining viral genes and are involved in replicating the viral genome. Synthesis of the capsid proteins begins later (late genes), at the same time as genome replication, when new virions are formed from the genome and capsids (assembly). The virions (nucleocapsids = genome plus capsid) are then released from the cell by one of several mechanisms, depending on the type of virus.

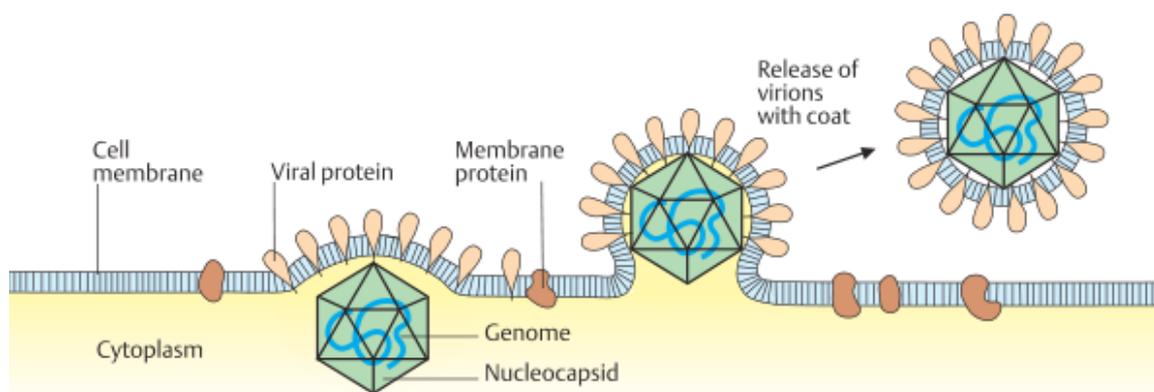


C. Transcription and replication of a virus

Transcription and replication of a virus

Release of a virus by budding

The release of a virus coated by a lipid membrane occurs by budding. First, molecules of a viral-coded glycoprotein are built into the cell membrane, to which the virus capsid or virus core (containing the viral genome) attaches. Attachment of the genome leads to increased budding of that region of the cell membrane. Eventually, the entire virion is surrounded by a lipid membrane envelope of cellular origin containing viral proteins and is released. Virions can be expelled from the cell continuously and in great numbers without the death of the virus-producing cell. (Figures from J. D. Watson et al., 1987).



D. Release of a virus by budding

Release of a virus by budding