

**Introduction:**

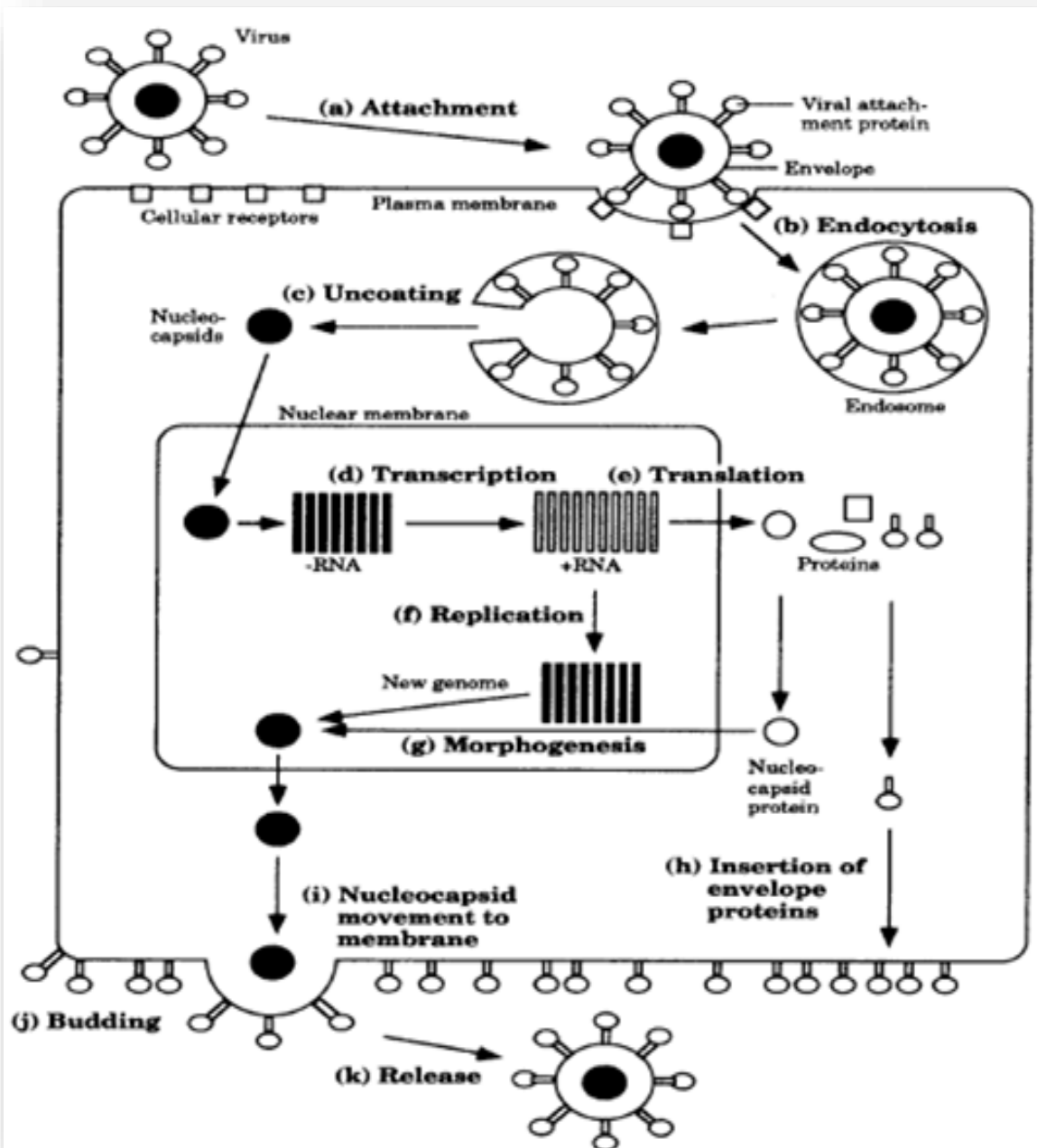
Viruses are the simplest form of life and they exist on the borderline between the living and the inanimate, non-biological world. They are mostly DNA/RNA that happen to be wrapped in a coating (termed a *capsid*). The capsid affords protection for the viral genes and allows viral genes to gain entrance to appropriate host cells. They are obligate parasites in the sense that they can only replicate after they have invaded and parasitized a host cell. However, the distinction of viruses from living organisms is drawn on basis of following observable facts about viruses:

- Virus particles are produced from the assembly of preformed components, whereas other agents grow from an increase in the integrated sum of their components and reproduce by division.
- Virus particles themselves do not grow or undergo division.
- Viruses lack the genetic information that encodes apparatus necessary for the generation of metabolic energy or for protein synthesis.

**Life cycle of viruses:**

The following steps represent the generalized productive life cycle for animal viruses:

- A) The virus attaches to host receptor on the plasma membrane through its many attachment proteins.
- B) The host plasma membrane surrounds the virus and draws it into the cell, a process called endocytosis.
- C) Viral envelope fuse with endosomal membrane releasing nucleocapsids
- D) Nucleic Acid (NA) of virus covered by capsid proteins
- E) Viral NA enters cytoplasm
- F) Viral NA serves as a template for new viral NA
- G) Nucleocapsid enters the nucleus and begins the process of morphogenesis
- H) Envelope proteins pass through the ER and golgi body
- I) Nucleocapsid movement to membrane
- J) Budding process
- K) Viral particle release



### Classification of eukaryotic Virus:

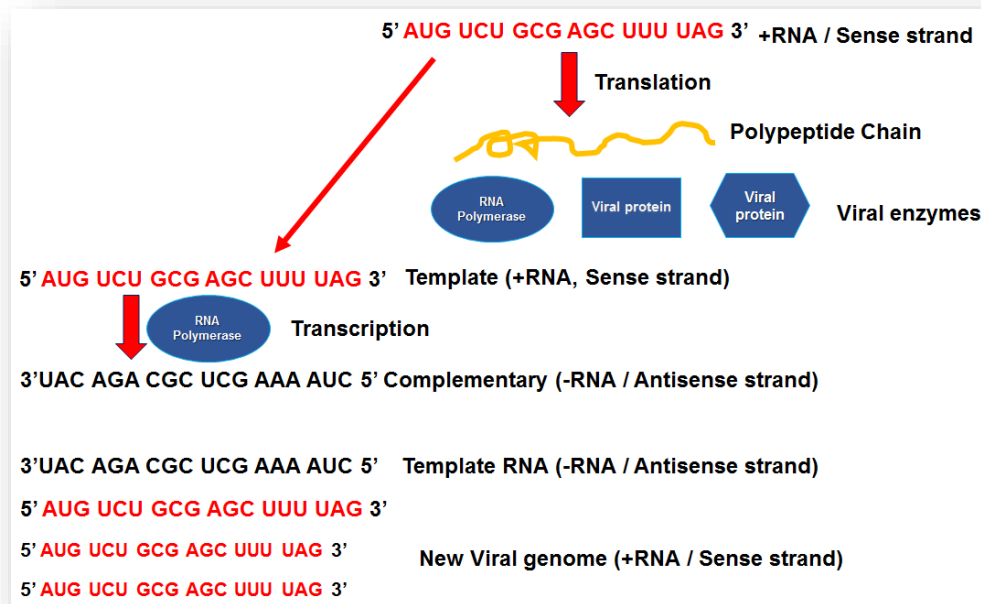
The primary characteristics used to differentiate eukaryotic viruses are associated with their nucleic acid. First, viruses may be separated based on whether they are DNA viruses or RNA viruses. The nucleic acid may be single-stranded (ss) or double-stranded (ds), depending on the species. If the ssRNA is able to function as mRNA it is referred to as plus strand RNA (+RNA); if it is the equivalent to antisense RNA it is known as minus strand RNA (-RNA). Virion shape is also used to differentiate among the viruses since they have a number of distinctive forms: cylindrical or helical, spherical, icosahedral, bulletshaped, or even more complex shapes.

### Replication strategies:

This genetic material is the source for coding all the proteins needed for the virus to survive and propagate in a host cell. After the process of replication or protein synthesis stages are completed, new virus particles are produced by the association of the newly synthesized protein coats and the newly synthesized virus genetic material. The replication of the nucleic acid is extremely diverse, however, some general features can be outlined.

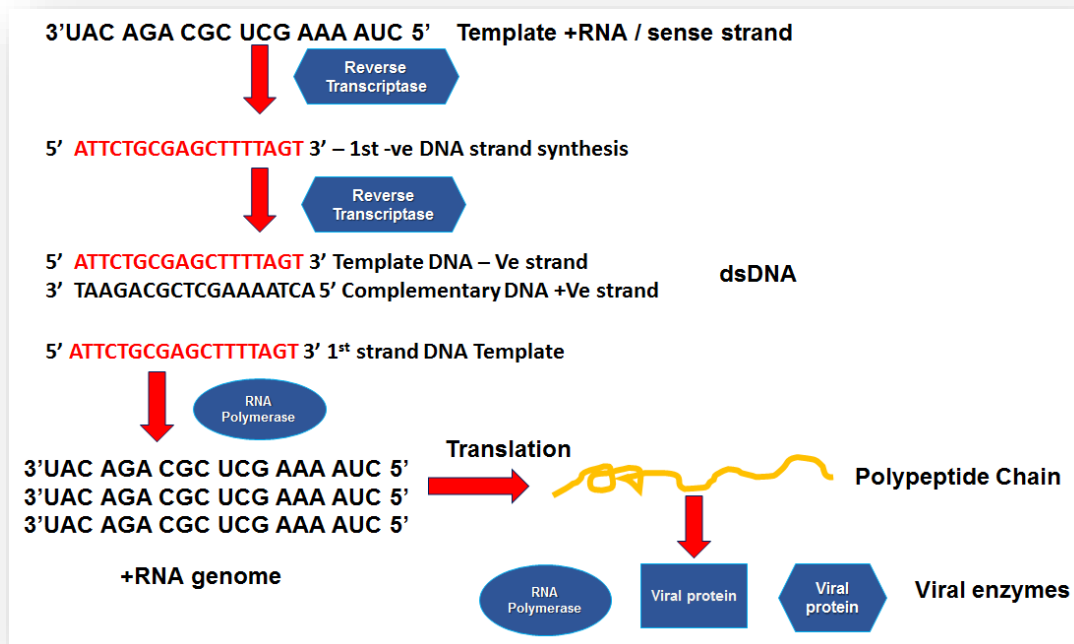
#### + ssRNA Virus genome replication

Single-stranded +RNA viruses, such as picornaviruses and togaviruses, may be directly translated. A viral encoded RNA-dependent RNA polymerase is produced early on and catalyzes the transcription of intermediate complementary -RNA strands. The minus strands then serve as templates for the synthesis of genomic +RNAs.



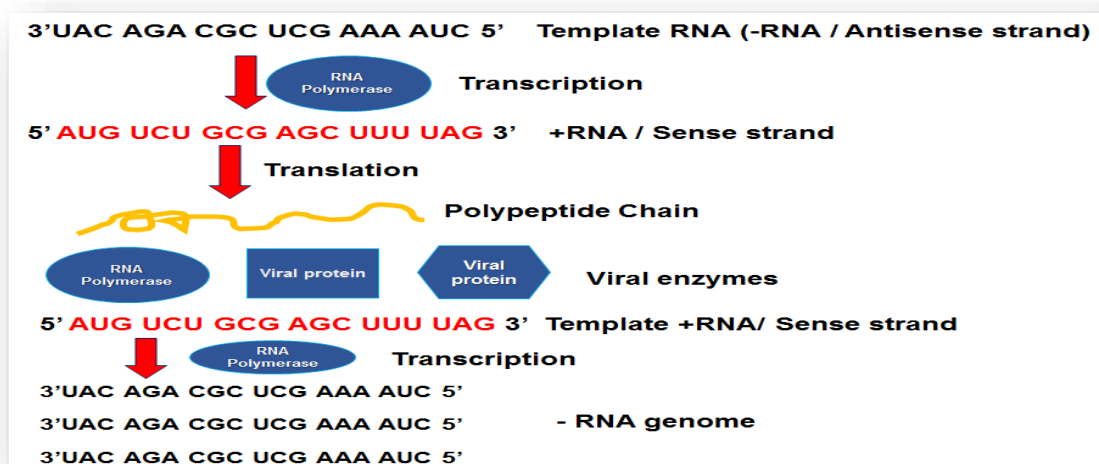
#### RT directed +ssRNA virus genome replication

Retroviruses are an unusual group of +RNA viruses in that they synthesize new +RNA using a DNA template. The plus genome is converted in a step-wise manner to a dsDNA molecule by reverse transcriptase, which is carried by the virus. Reverse transcriptase subsequently synthesizes a DNA strand complementary to the first and the resulting dsDNA integrates into the host genome. Finally +ssRNA are created using the dsDNA as template



### - ssRNA virus genome replication

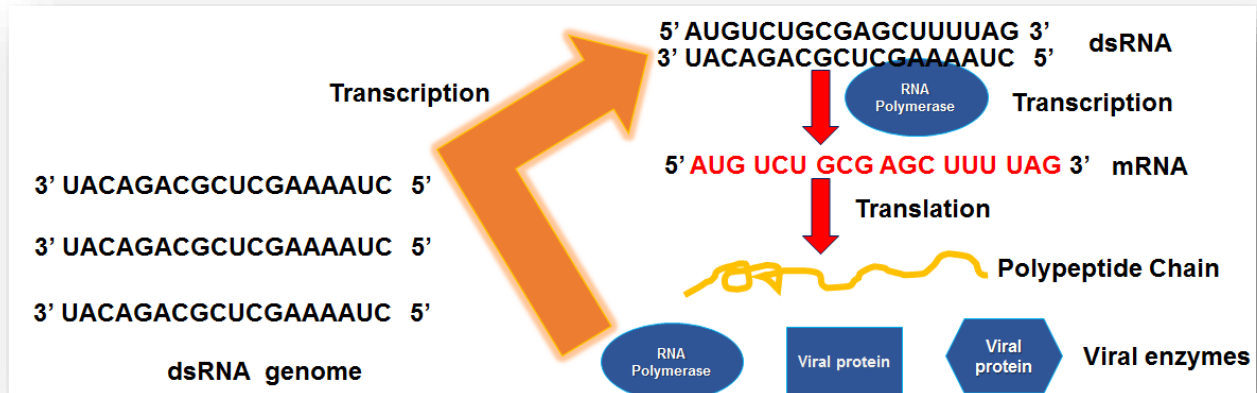
Single-stranded –RNA viruses are those with nucleic acids (genomes) that cannot be translated. The –RNA strand serves as a template for the synthesis of +RNA that functions as mRNA. Viral proteins translated from the mRNA promote the synthesis of full-length +RNA strands that function as templates for the synthesis of full-length –RNA genome strands. Usually the virus brings into the cell an RNA-dependent RNA polymerase for making viral mRNA.



### ds RNA virus

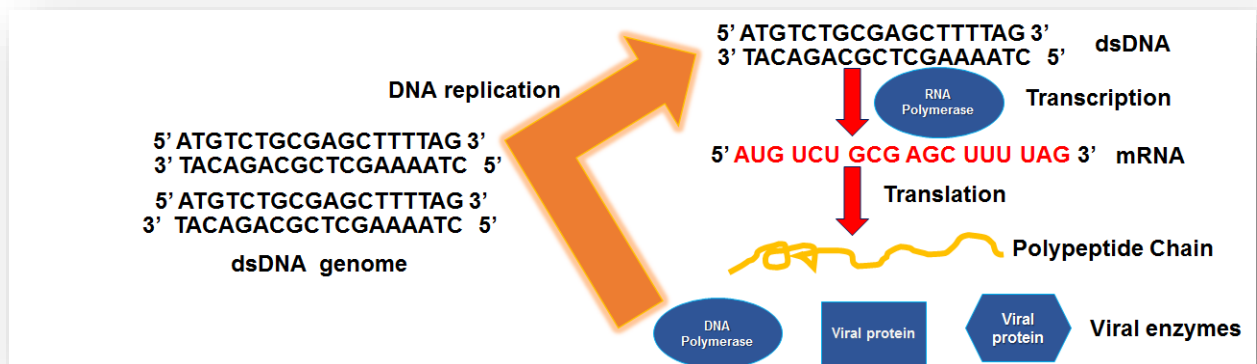
Double-stranded RNA viruses, such as reoviruses, are segmented and carry a dsRNA-dependent RNA polymerase which they use to transcribe their genomes. The RNA segments and the mRNA molecules specified by them only encode for one protein each. These viruses replicate their dsRNA

genomes by producing many copies of plus strand RNA that are not translated, but serve as templates for the synthesis of complementary minus strands.



### ds DNA virus genome replication

The simplest viruses to understand are those with genomes of double-stranded DNA (dsDNA). Once the nucleocapsid of this type of virus enters the cell, it proceeds to the nucleus where it mimics the genome of the host cell. The viral genome is replicated using the host cell DNA polymerase, and the viral genome is transcribed by the host cell RNA polymerase. The resulting transcripts carrying information encoding viral proteins is then transported to the cytoplasm and viral proteins are produced with the host ribosomes. These newly synthesized viral proteins are used as the protein capsid around newly replicated viral DNA molecules. These new virions are released from the cell and trigger new rounds of replication. But some viruses produce their own DNA polymerase and use them for the next round of replications.



**Making the most of a limited genome:** In a continuous arrangement of one nucleotide after the other, it is possible that a second reading frame could be formed in which nucleotide number 2 to 4 forms the first codon, nucleotide number 5 to 7 forms second codon and so on. It is easy to imagine that on similar lines, a third reading frame is also possible. So we can imagine that depending on whichever reading frame is used during translation, the same gene may produce two or three entirely different polypeptide or proteins from the same gene.

5' ATTCTGCGAGCTTTTAGT 3' - Coding DNA  
3' TAAGACGCTCGAAAATCA 5' - Template DNA

5' AUU CUG CGA GCU UUU AGU 3' - mRNA

Ile-Iue-Arg-Arg-Phe-Ser - one reading frame AA chain

5' A UUC UGC GAG CUU UUA GU 3' - mRNA

Phe-Cys-Glu-Leu-Leu - Second reading frame AA chain

5' AU UCU GCG AGC UUU UAG U 3'

Ser-Ala-Ser-Phe-Stop - Third reading frame AA chain

The above information showing how the same nucleotide sequence of an mRNA be read as three different proteins due to alterations of the reading frame. While in the first reading frame, the mRNA sequence shall be translated as “Ile-leu-Arg-Phe-Ser” amino acid residues; in the second the same mRNA will be translated into “Phe-Cys-Glu-Leu-Leu”. In the third reading frame, the translation will be termed prematurely as a stop codon gets created.

### **Overlap of genes within a genome**

Though in most organisms, a gene normally encodes only one polypeptide or protein as translation always begins on the same reading frame, in several viruses, the same DNA base sequence codes for two different proteins by employing two different reading frames giving raise to overlapping genes. For example, virus or bacteriophage has two overlapping genes in its genome. Overlapping genes are also observed in the genomes of virus or phage. It has been suggested that because of the fixed, small size of viral capsid, viruses require economical use of a limited amount of DNA to code for the variety of proteins needed to infect a host cell and replicate within it. Overlapping genes provide an opportunity to achieve this. Normally, overlap of genes is considered as a primitive characteristics of a genome.