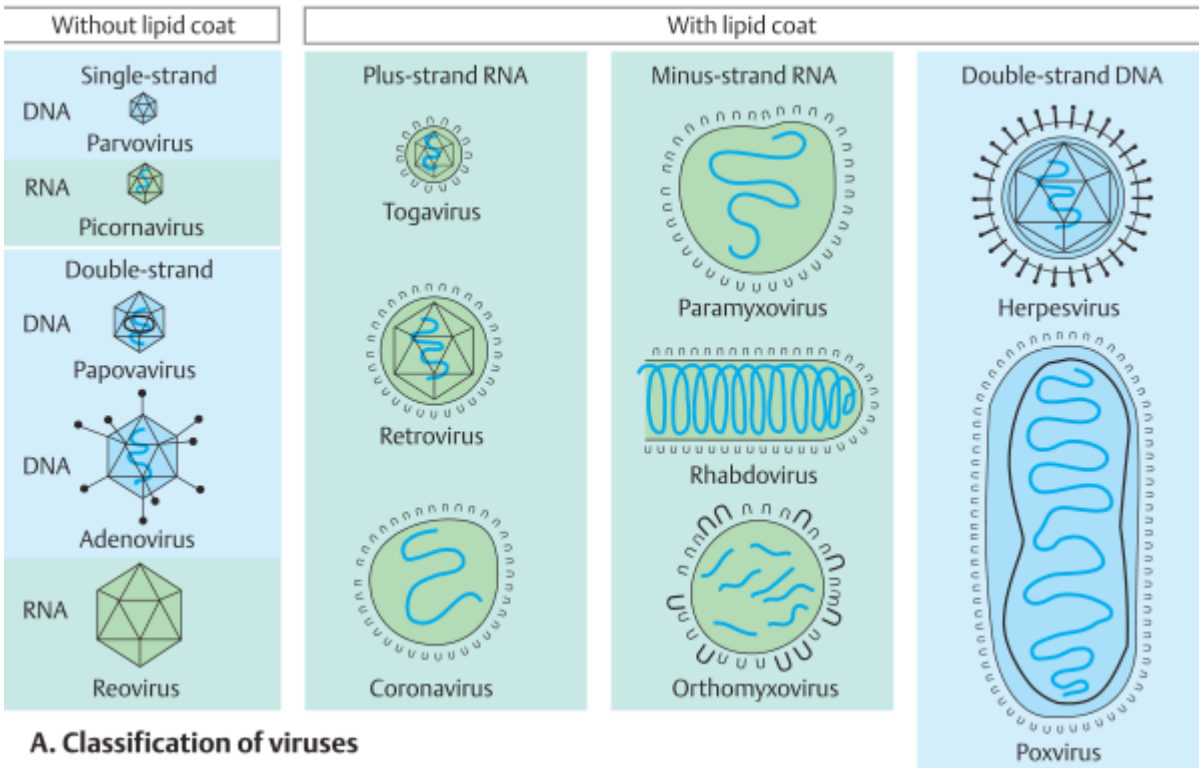
Viruses

Viruses are important pathogens in plants and animals, including man. The complete infectious viral particle is called a virion. Its genome carries a limited amount of genetic information, and it can replicate only in host cells. From analysis of the structure and expression of viral genes, fundamental biological processes such as DNA replication, transcription regulation, mRNA modification (RNA splicing, RNA capping, RNA polyadenylation), reverse transcription of RNA to DNA, viral genome integration into eukaryotic DNA, tumor induction by viruses, and cell surface proteins have been recognized and elucidated. The extracellular form of a virus particle includes a protein coat (capsid), which encloses the genome of DNA or RNA. The capsids contain multiple units of one or a few different protein molecules coded for by the virus genome. Capsids usually have an almost spherical, icosahedral (20 plane surfaces), or occasionally a helical structure. Some viral capsids are surrounded by a lipid membrane envelope.

Classification of viruses

Viruses can be classified on the basis of the structure of their viral coat, their type of genome, and their organ or tissue specificity. The genome of a virus may be enclosed simply in a virus-coded protein coat (capsid) or in the capsid plus an additional phospholipid membrane,which is of cellular origin. The genome of a virus may consist of single-stranded DNA(e.g., parvovirus), double-stranded DNA (e.g., papovavirus, adenovirus, herpesvirus, and poxvirus), single-stranded RNA (e.g., picornavirus, togavirus, myxovirus, rhabdovirus), or double stranded RNA (e.g., reovirus). Viruses with genomes of single-stranded RNA are classified according to whether their genome is a positive (plusRNA) or negative (minusRNA) RNAstrand. Only an RNA plus strand can serve as a template for

translation (5′ to 3′ orientation).

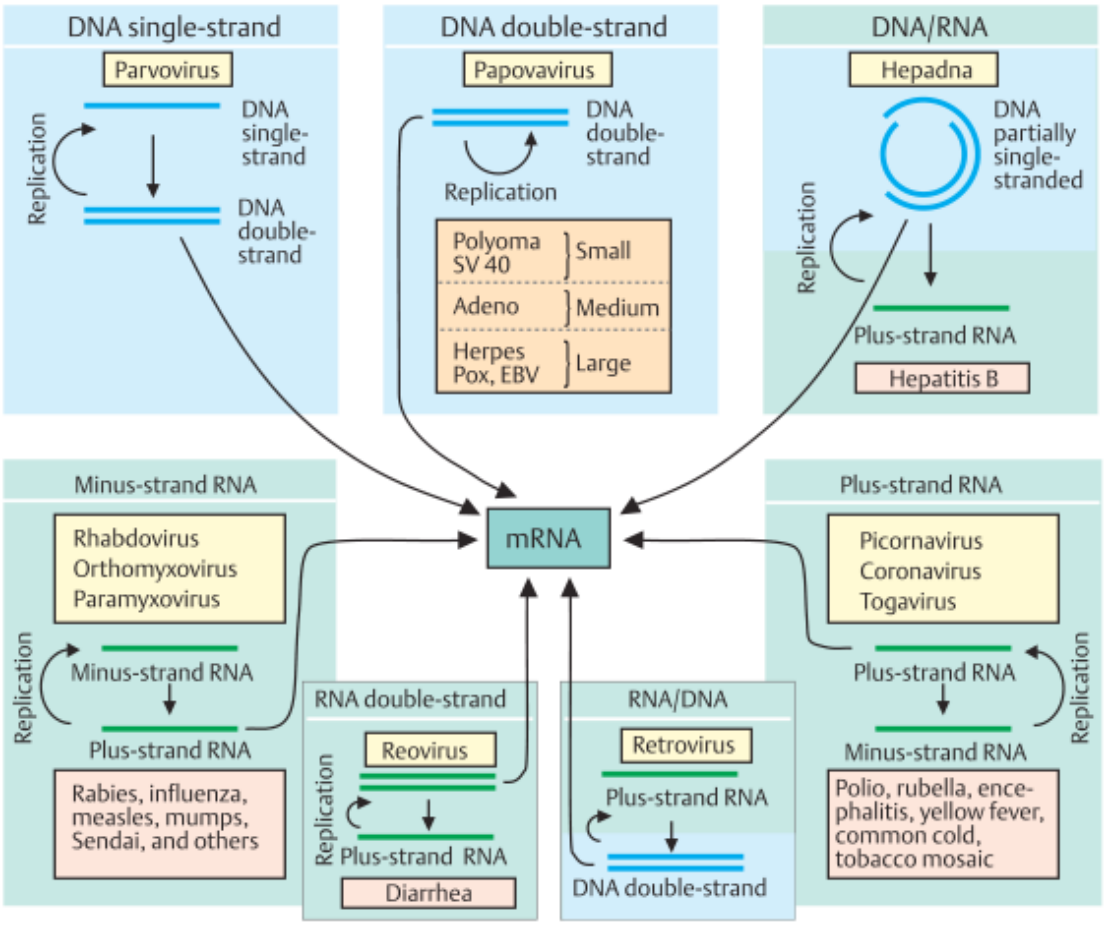


A. Classification of viruses

Replication and transcription of viruses

Since viral genomes differ, the mechanisms for replicating their genetic material also differ. Viruses must pack all their genetic information into a small genome; thus, one transcription unit (gene) of a viral genome is often used to produce several mRNAs by alternative splicing, and each mRNA codes for a different protein. In some RNA viruses, initially large precursor proteins are formed from the mRNA and subsequently split into several smaller functional proteins. An RNA plus strand can be used directly for protein synthesis. An RNA minus strand cannot be used directly; an RNA plus strand must be formed from the RNA minus strand by a transcriptase before translation is possible. RNA viruses contain a transcriptase to replicate their RNA genomes. RNA viruses in which DNA is formed as an intermediate step (retroviruses) contain a reverse transcriptase. This can form DNA from RNA. The DNA intermediate step in the replication of

retroviruses becomes integrated into the host cell. Several RNA viruses have segmented genomes. They consist of individual pieces of RNA genome, each of which codes for one or more proteins (e.g., influenza virus). The exchange of individual pieces of RNA genome of different viral serotypes plays an important role in the formation of new viral strains (e.g., influenza strains). (Figure after Watson et al., 1987).



Replication and transcription of viruses