

from 20 triangular faces or (2) a *helical* symmetry. However, viruses occasionally have more complex structures (e.g., the poxviruses) (Fig. 190-1).

Enveloped viruses (e.g., measles virus) are efficient in infecting cells because the viral lipid membrane fuses easily with the plasma membrane of the host cell or with internal membranes to deliver the nucleocapsid to the cytoplasm of the host cell. Thus, these viruses are highly transmissible. The lipid envelope is susceptible to disruption by detergents or organic solvents; thus, enveloped viruses such as measles virus and influenza virus can be inactivated by soap and water or alcohol-based hand sanitizers. In contrast, unenveloped viruses (e.g., norovirus or poliovirus) have a tough protein shell whose resistance to small-intestine bile salts—a surfactant that emulsifies lipids—allows them to infect the intestine. Unenveloped viruses, especially those that infect the gastrointestinal tract, are not inactivated by detergents or organic solvents and must be inactivated by peroxide or hypochlorite or removed by washing with soap and water.

CLASSIFICATION OF VIRUSES

Viruses have been classified as a free-standing group because they are not formally related to organisms within any of the major kingdoms. The highest level of viral classification was originally the family, but some families have been grouped into orders as more has been learned about them. The major viruses of clinical interest can be conveniently classified into a number of families (Table 190-1), each of which has characteristic virion and genome structures (Fig. 190-2). Classification of viruses into families, genera, and species is based on multiple criteria, including type of genomic nucleic acid (i.e., RNA or DNA; ss positive or negative strand or double strand), capsid symmetry (helical, icosahedral, or complex), presence or absence of an envelope, mode of replication, and tropism (preferred cell type for replication) or type of disease it causes. Recent sequence analysis of viral genomes has refined and revised some of the original virus classifications. The International Committee on Taxonomy of Viruses specifies both formal and