9.2B: General Morphology

Viruses have a variety of shapes and structures.

Learning Objectives

• Distinguish between the 5 main morphological virus types

Key Points

• Viruses are very small and to reliably visualize them, stains and electron microscopy are needed.
• Each virus is a nucleic acid (RNA or DNA) surrounded by a coating, referred to as an envelope or capsid.
• Viruses encode capsid proteins which encase the nucleic acid. Sometimes, viral proteins combine with host proteins to make the envelope.
• The shape of a viral coat has implications on how a virus infects a host.

Key Terms

• capsomere: Any of the individual protein subunits of a viral capsid
• capsid: The outer protein shell of a virus.
• icosahedral: of, relating to, or having the shape of an icosahedron

Viruses display a wide diversity of shapes and sizes, called morphologies. In general, there are five main morphological virus types:
1. Helical – These viruses are composed of a single type of capsomer stacked around a central axis to form a helical structure, which may have a central cavity, or hollow tube.

2. Icosahedral – Most animal viruses are icosahedral or near-spherical with icosahedral symmetry.

3. Prolate – This is an isosahedron elongated along one axis and is a common arrangement of the heads of bacteriophages.

4. Envelope – Some species of virus envelop themselves in a modified form of one of the cell membranes, either the outer membrane surrounding an infected host cell or internal membranes such as nuclear membrane or endoplasmic reticulum, thus gaining an outer lipid bilayer known as a viral envelope.

5. Complex – These viruses possess a capsid that is neither purely helical nor purely icosahedral, and that may possess extra structures such as protein tails or a complex outer wall.

A complete virus particle, known as a virion, consists of nucleic acid surrounded by a protective coat of protein called a capsid. These are formed from identical protein subunits called capsomeres. Viruses can have a lipid “envelope” derived from the host cell membrane. The capsid is made from proteins encoded by the viral genome and its shape serves as the basis for morphological distinction. Virally coded protein subunits will self-assemble to form a capsid, in general requiring the presence of the virus genome. Complex viruses code for proteins that assist in the construction of their capsid. Proteins associated with nucleic acid are known as nucleoproteins, and the association of viral capsid proteins with viral nucleic acid is called a nucleocapsid. The capsid and entire virus structure can be mechanically (physically) probed through atomic force microscopy.

Viruses are much smaller than bacteria. Most viruses that have been studied have a diameter between 20 and 300 nanometers. Some filoviruses have a total length of up to 1400 nm; their diameters are only about 80 nm. Most viruses, such as virions, cannot be seen with an optical microscope, so scanning and transmission electron microscopes are used to visualize them.

To increase the contrast between viruses and the background, electron-dense “stains” are used. These are solutions of salts of heavy metals, such as tungsten, that scatter the electrons from regions covered with the stain. When virions are coated with stain (positive staining), fine detail is obscured. Negative staining overcomes this problem by staining the background only.