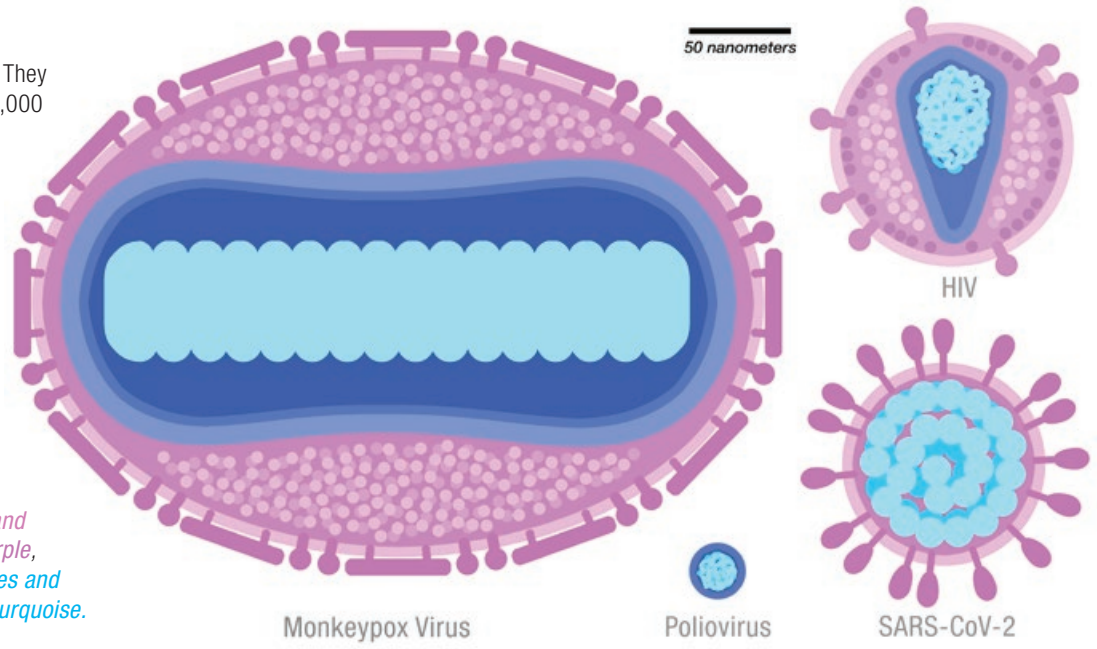
# POXVIRUSES

***Structures of poxvirus proteins are helping researchers find new ways to combat mpox.***

For most of human history, smallpox was a serious threat to human life. With discovery of vaccines based on the similar, less dangerous vaccinia virus, this changed, and a global public health effort has eradicated smallpox from the face of the Earth. Other poxviruses, such as mpox and cowpox, are still causing rare, localized infections. These are often the result of transfer of the virus from animals to humans.

## Giant Viruses

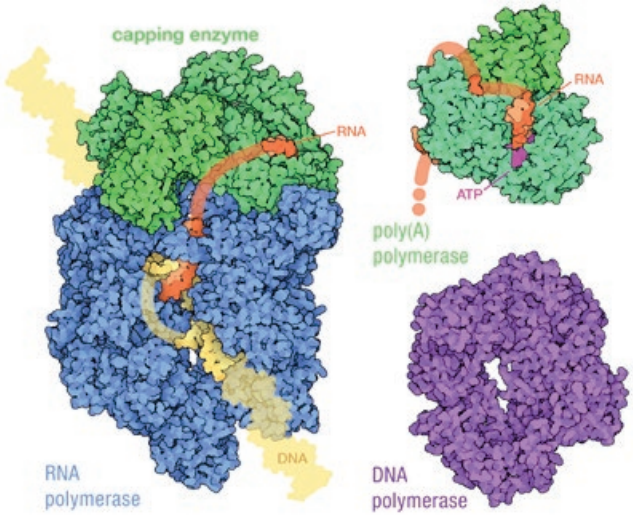
Poxviruses are large, complex viruses. They carry a DNA genome with roughly 190,000 base pairs that encodes about 200 proteins. Remarkably, this is about one quarter the size of the genomes of the smallest bacterial cells. The viral genome includes structural proteins to build the infectious form of the virion, proteins for hijacking cells and evading cellular defenses, and a complete set of molecular machines for replicating and transcribing the DNA genome.




*Schematic illustration of several viruses, drawn to scale. Membranes and membrane-bound proteins are in purple, capsids are in dark blue, and genomes and nucleoid-associated proteins are in turquoise.*

## Replication Machinery

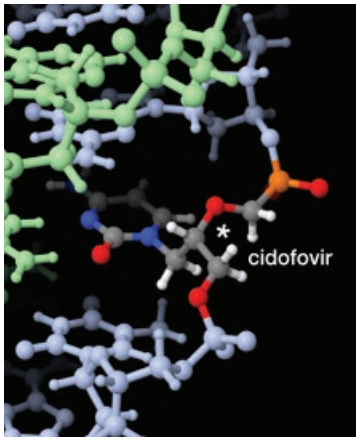
Poxviruses spend their entire life cycle in the cytoplasm of the cells they infect, which is unusual for viruses with DNA genomes. This lifestyle choice requires that they build all their own DNA-related machinery, since the cell's own machinery is sequestered in the nucleus. Three-dimensional (3D) structures have been determined for several of these enzymes, including a DNA polymerase that replicates the viral genome, an RNA polymerase that transcribes messenger RNA from the DNA, and enzymes that add 7-methyl-G caps and poly(A) tails to the messenger RNA, making them ready for translation into viral proteins by cellular ribosomes.




*Several enzymes encoded in the vaccinia virus genome that are involved in DNA replication and transcription. The structures were determined with small fragments of RNA and DNA bound, so the missing pieces are shown schematically. PDB ID 6rie, 3erc, 5n2g.*

## Combatting Mpox

Recently, mpox infections have been detected in individuals living outside the African regions where the virus normally occurs in wild animals. Understanding of these viruses is allowing researchers and clinicians to devise effective ways to stop its spread. For example, knowledge of how the virus is transmitted, primarily through contact and also through respiratory droplets, helps determine guidelines for isolation and masking. Research has also shown that mpox is similar to smallpox, so some smallpox vaccines provide protection against mpox (e.g., MVA-BN or Jynneos is 85% effective against mpox). Research into the structural biology of the virus will provide ways to optimize vaccines and design therapeutics against this virus. Already, there are several drugs to treat poxvirus infections, such as cidofovir that targets the viral DNA polymerase. For more information on mpox virus treatments, see the pages at the Centers for Disease Control and Prevention.




*PDB ID 2l8p includes the structure of a DNA double helix with the antiviral drug cidofovir incorporated into one strand. This drug is similar to a normal cytosine nucleotide, but doesn't include the sugar in the backbone (notice that there is no 5-membered ring in the location noted with the asterisk). This different shape causes problems during replication in DNA viruses such as smallpox and mpox.*

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