Bags, not boxes: integrative modelling of enveloped viruses

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1. Abstract

Viruses are infectious because they direct cells to package their genomes into virus particles, self-assembling nanocontainers that carry the infection to new hosts. The physicochemical properties of these virus particles are the ultimate determinants of how viruses are transmitted and which hosts they can infect. While some viruses create extremely regular, 'box-like' icosahedral virus particles, others, including many of the most serious human pathogens, are transmitted by irregular 'bag-like' particles bounded by an envelope of membrane. For many enveloped virus particles their microscopic size and irregular shape means that no single method can completely describe their structure. Here, we take two intensively-studied enveloped viruses, the influenza viruses and SARS-CoV-2, and show how an integrative modelling approach can be used to build detailed pseudo-atomic models of their structures. By bringing together information from multiple sources including mass spectrometry and cryo-electron microscopy, we can construct models with varying degrees of constraint, generating the hypotheses needed for experimental studies of their assembly and function.