F Structure of birnavirus-like particles determined by combined electron cryomicroscopy and X-ray crystallography

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First Published Online: 01 August 2005, Journal of General Virology 86: 2339-2346, doi: (Digital Object Identifier) 10.1099/vir.0.80942-0 (https://dx.doi.org/10.1099/vir.0.80942-0)

Subject: Animal - RNA viruses

Received: 02/02/2005 | Accepted: 21/04/2005 | Cover date: 01/08/2005

Birnaviruses possess a capsid with a single protein layer in contrast to most double-stranded RNA viruses infecting multicellular eukaryotes. Using freeze-drying and heavy metal shadowing, the capsids of two birnaviruses, infectious bursal disease virus (IBDV) and infectious pancreatic necrosis virus, as well as of an IBDV virus-like particle (VLP) are shown to follow the same T=13 laevo icosahedral geometry. The structure of the VLP was determined at a resolution of approximately 15 Å (1·5 nm) by a combination of electron cryomicroscopy and a recently developed three-dimensional reconstruction method, where the scattering density is expressed in terms of symmetry-adapted functions. This reconstruction methodology is well adapted to the icosahedral symmetry of viruses and only requires a small number of images to analyse. The atomic model of the external capsid protein, VP2, recently determined by X-ray crystallography, fits well into the VLP reconstruction and occupies all the electron densities present in the map. Thus, similarly to the IBDV virion, only

VP2 forms the icosahedral layer of the VLP. The other components of both VLP and IBDV particles that play a crucial role in the capsid assembly, VP1, VP3 and the peptides arising from the processing of pVP2, do not follow the icosahedral symmetry, allowing them to be involved in other processes such as RNA packaging.

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eISSN 1465-2099 ISSN 0022-1317