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A Portal Vertex Channel Mediated Communication System in a Viral Genome Packaging Machine

Weichun Tang[1]*, Masashi Waga[1]*, Mounir Fizari[2], Brandon Rawson[2], Andrei Fokine[3], Taekjip Ha[4], Yann Chemla[5], Douglas E. Smith[2] and Venigalla B. Rao[1]
[1]Bacteriophage Medical Research Center, Department of Biology, The Catholic University of America,
Washington, DC, USA
[2]Department of Physics, University of California, San Diego, La Jolla, CA, USA
[3]Department of Biological Sciences, Purdue University, West Lafayette, IN, USA
[4]Boston Children's Hospital, Harvard University, Boston, MA, USA
[5]Department of Physics, Center of the Physics of Living Cells, University of Illinois at Urbana-Champaign, Urbana, IL, USA

*These authors contributed equally

Large icosahedral viruses and tailed bacteriophages encode a portal protein that assembles into a dodecameric ring and occupies one of the twelve five-fold-symmetric vertices of a viral capsid. This unique symmetry-mismatched and structurally conserved portal vertex is essential for head assembly, genome packaging, neck/tail attachment, and genome ejection, but the underlying mechanisms remain poorly understood. Here, we present evidence that the phage T4 portal functions as a global assembly communicator and signal transducer, with its basket-shaped channel containing twenty-four anti-parallel helices at its core. Disruption of a single inter-helical salt-bridge that connects helices in a circular brace impairs channel movements that might be essential for a DNA grip-release mechanism during genome translocation. Second and third site suppressors that compensate for this defect fall in distant portal and packaging motor domains that together form a sophisticated communication network. Such networks might underlie the structural frameworks of macromolecular assemblies in biological systems.