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Genome Organisation and Assembly of RNA Viruses: Where Geometry Meets Function

Cryo-electron microscopy and X-ray crystallography have revealed ordered features in the genome organisation of a number of ssRNA viruses. These include a dodecahedral RNA cage in Pariacoto virus and a double-shell organisation in bacteriophage MS2. We show here that these ordered features are due to symmetry constraints on the overall organisation of these particles.

We moreover show that these mathematical results can be used to better understand the mechanisms underlying the formation (assembly) of viruses. In particular, we demonstrate that the geometric constraints on genome organisation result in a strong reduction of the combinatorially possible pathways of assembly and hence contribute to the remarkable assembly efficiency of these viruses. Since assembly efficiency is important for viruses in order to outcompete their hosts immune system, these results provide important insights into the strategies and mechanisms underlying the viral infection process.

References

[1] T. Keef, J. Wardman, N. A. Ranson, P.G. Stockley & R. Twarock (2010) Viruses measure up to mathematical prediction 3D Geometry imposes fundamental constraints on the structures of simple viruses, submitted to Current Biology

[2] Twarock R, Keef T (2010) Viruses and geometry where symmetry meets function, Micobiology Today 37: 24-27.

[3] Dykeman EC, Stockley PG, Twarock R (2010) Dynamic allostery controls coat protein conformer switching during MS2 phage assembly, J Mol. Biol. 395: 916-23

[4] Dykeman EC, Twarock R (2010) All-atom normal-mode analysis reveals a dynamic RNA-induced allostery in a bacteriophage coat protein, Physical Review E. 81, 031908.

[5] ElSawy KM, Caves L, Twarock R (2010) The impact of viral RNA on the association rates of capsid protein assembly: bacteriophage MS2 as a case study, J. Mol. Biol. 400(4):935-47.

[6] Victoria L. Morton, Eric C. Dykeman, Nicola J. Stonehouse, Alison E. Ashcroft, Reidun Twarock and Peter G. Stockley (2010) The Impact of Viral RNA on Assembly Pathway Selection, J. Mol. Biol. 401(2):298-308.

[7] E.C. Dykeman, N. Grayson, N. A. Ranson, P.G.Stockley & R. Twarock, Simple rules for efficient assembly predict the layout of a packaged viral RNA (2011), to appear in J. Mol. Biol. (selected as research highlight)