Most people have heard about viruses because they are famous for all the wrong reasons. Namely, viruses have a long history of tormenting living systems. Certainly less well-known is their architectural beauty. Indeed, many single-stranded (ss) RNA-genome viruses have just two structural components: the RNA, encoding the genetic information, and the capsid protein (CP), many copies of which form an icosahedrally symmetric container – capsid – to protect the genome.

Recent in vitro studies on the self-assembly of ssRNA with the CP of Cowpea Chlorotic Mottle Virus (CCMV) into virus-like particles have shown that CCMV CP can package ssRNAs ranging in length from a few hundred to 12,000 nucleotides. Furthermore, the relative packaging efficiencies of these RNAs have been measured in in vitro “competition” experiments. Under typical in vitro self-assembly conditions and in particular for the case of many ssRNA viruses whose CP have cationic N- termini, the adsorption of CP onto the (anionic) RNA is non-specific because the CP concentration exceeds the largest dissociation constant for CP-RNA binding.

We have developed a coarse-grained model of RNA bound by CP in an effort to formulate a theoretical – statistical thermodynamic – underpinning for these in vitro studies, in particular those quantifying the competition of different RNAs for the same CPs. In these experiments equal masses of different RNAs compete for a limited amount of CP. The exchange of CP between the RNAs is found to be reversible at neutral pH, but one of the RNAs binds more than its share of CP, according to its relative length or compactness. Our Monte Carlo simulations demonstrate that, for a given RNA mass, the sequence with the highest affinity for protein is the one with the most compact secondary structure arising from self-complementarity; similarly, a long RNA steals protein from an equal mass of shorter ones because of the energetic preference of forming one large cluster of CPs over forming two smaller clusters. These results provide important insights into the in vivo packaging selectivity of viral RNA by its capsid protein, amidst a background of host cellular RNA.

Presented by

Surendra W. Singaram
Prof. William Gelbart's & Prof. Charles Knobler’s group
Department of Chemistry & Biochemistry
University of California, Los Angeles

Thursday, June 2, 2016
12:00 P.M.
2033 Young Hall