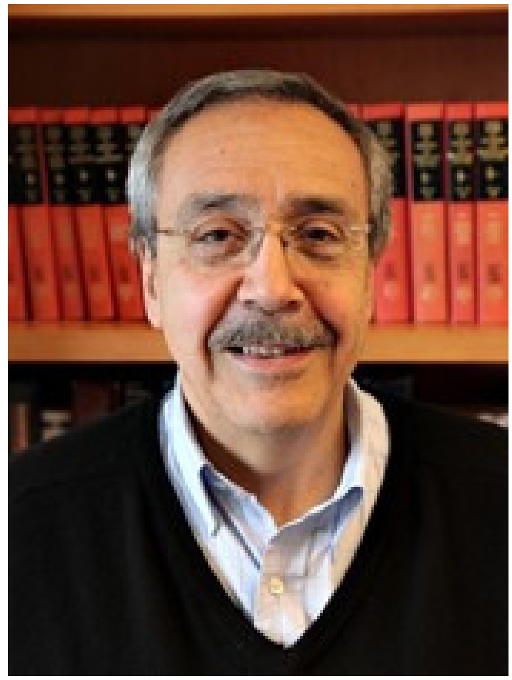
Department of Chemistry and Biochemistry

IMPACT Lecture Series

Thursday, September 15
4:00 pm
127 Nieuwland Science Hall



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Division of Labor Among the Subunits of a Highly Coordinated Ring ATPase

As part of their infection cycle, many viruses must package their newly replicated genomes inside a protein capsid. Bacteriophage phi29 packages its 6.6 mm long double-stranded DNA using a pentameric ring nano motor that belongs to the ASCE (Additional Strand, Conserved E) superfamily of ATPases. A number of fundamental questions remain as to the coordination of the various subunits in these multimeric rings. The portal motor in bacteriophage phi29 is ideal to investigate these questions and is a remarkable machine that must overcome entropic, electrostatic, and DNA bending energies to package its genome to near-crystalline density inside the capsid. Using optical tweezers, we find that this motor can work against loads of up to ~55 picoNewtons on average, making it one of the strongest molecular motors ever reported. We establish the force-velocity relationship of the motor. Interestingly, the packaging rate decreases as the prohead fills, indicating that an internal pressure builds up due to DNA compression attaining the value of ~6 MegaPascals at the end of the packaging. This pressure, we show, is used as part of the mechanism of DNA injection in the next infection cycle. We have used high-resolution optical tweezers to characterize the steps and intersubunit coordination of the pentameric ring ATPase responsible for DNA packaging in bacteriophage Phi29. By using non-hydrolyzable ATP analogs and stabilizers of the ADP bound to the motor, we establish where DNA binding, hydrolysis, and phosphate and ADP release occur relative to translocation. We show that while only 4 of the subunits translocate DNA, all 5 bind and hydrolyze ATP, suggesting that the fifth subunit fulfills a regulatory function. Finally, we show that the motor not only can generate force but also torque. We characterize the role played by the special subunit in this process and identify this the symmetry-breaking mechanism. These results represent the most complete studies done to date on these widely distribute class of ring nano motors.

Join us for a CGSO sponsored reception immediately following. Refreshments provided.

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