CHAPTER OVERVIEW

9: Macromolecular Mechanics

An alternative approach to describing macromolecular conformation that applied both to equilibrium and non-equilibrium phenomena uses a mechanical description of the forces acting on the chain. Of course, forces are present everywhere in biology. Near equilibrium these exist as local fluctuating forces that induce thermally driven excursions from the free-energy minimum, and biological systems use non-equilibrium force generating processes derived from external energy sources (such as ATP) in numerous processes such as those in transport and signaling. For instance, the directed motion of molecular motors along actin and microtubules, or the allosteric transmembrane communication of a ligand binding event in GPCRs.

Our focus in this section is on how externally applied forces influence macromolecular conformation, and the experiments that allow careful application and measurement of forces on single macromolecules. These are being performed to understand mechanical properties and stress/strain relationships. The can also be unique reporters of biological function involving the strained molecules.

Single Molecule Force Application Experiments

	Force Range (pN)	Displacement (nm)	Loading Rate (pN/sec)	
Optical Tweezers:	0.1-100 pN	0.1-10^5	5-10	Near Equilibruim
AFM:	10-10^4	0.5-10^4	100-1000	Non-equilibrium!
Stretching under flow:	0.1-1000 pN	10-10^5	1-100	Steady state force
MD simulations:	Arb.	<10 nm	10^5-10^7!	

Remember k_BT: 4.1 pN nm