MCDB 4550/550
Homework 5
due 2/19/15

Please write out three well thought out questions about the literature paper to ask the presenters (and to hand in).

Please clearly explain any assumptions made and provide citations to any data used when performing estimates.

For the first two problems, you will consider assemblies made from 4096 monomers, where each monomer is a cubical bricks measuring 2 nm on a side. Assume assemblies of these monomers have a Young’s modulus of 2 GPa.

1. Spring constants of molecular assemblies. Determine the resistance to stretching along the largest linear dimension of a

   (a) cube
   (b) linear polymer (one monomer wide)
   (c) two-stranded polymer (two side-by-side protofilaments)
   (d) four-stranded polymer (four side-by-side protofilaments)

2. Bending of molecular assemblies. Determine the flexural rigidity for bending along the widest axis of a

   (a) linear polymer (one monomer wide)
   (b) two-stranded polymer (two side-by-side protofilaments)
   (c) four-stranded polymer (four side-by-side protofilaments)

How do the flexural rigidities you calculate compare to spring constants you found in problem 1 for the same structures?

3. Entropic elasticity. Consider a freely jointed chain with contour length 1 µm and segment length 10 nm at room temperature.

   (a) Determine the spring constant for small forces of this chain.
   (b) What happens to the spring constant if the temperature doubles? Explain qualitatively and quantitatively.
   (c) What happens to the spring constant if the segment length decreases to 1 nm? Explain qualitatively and quantitatively.

**Graduate student problem**

4. Buckling and drag of molecular assemblies. Using the same properties as in the first two problems, determine the critical buckling force and perpendicular drag coefficient of a

   (a) linear polymer (one monomer wide)
(b) two-stranded polymer (two side-by-side protofilaments)
(c) four-stranded polymer (three side-by-side protofilaments)

Compare the buckling forces you calculate to forces that can be generated by a single motor protein. Could a motor protein buckle these filaments?