# BB 101 Tutorial – 3

**Assignment question.**
**Please write the answer on an A4 sheet and submit it at the beginning of the tutorial class. Ensure your Roll number and name are on the A4 sheet.**

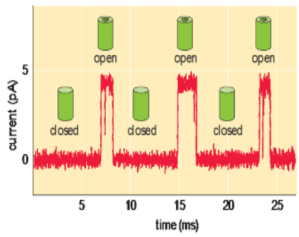
1. Consider a protein folding in a free energy landscape (recall the folding funnel discussed in the class). Plot the free energy diagram (2D) for
   (a)Protein having one unique native structure.
   (b)Protein having two native structures (states) with one is slightly more probable than the other.
   Plot the graphs separately.

**(1+1 Marks)**

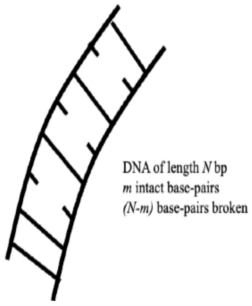
(Please turn over to see tutorial questions)

**Tutorial questions**

1. The figure below represents the current through an ion-channel. Answer the following question:
   Assume that the system can be found only in two discrete states: open state and closed state. Based on the figure, let us conclude that the probability of finding the ion channel in the closed state is 0.75. Assuming that the system obeys Boltzmann probability, calculate the energy of the closed state, if the energy of the open state is 0 kBT

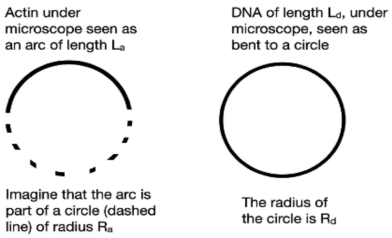



2. Consider a double stranded DNA of N basepairs (bp) at temperature T. Assume that each base pairing gains energy E. The thermal fluctuations will break some of the base-pairing interactions to "melt" the double-stranded DNA into single stranded DNAs. Consider a situation where m base-pairs are intact and (N-m) base-pairs are broken (due to thermal fluctuations). Assuming E = 1kBT, compute:




   (A) Entropy of the system, S(c), where c=m/N is the fraction of the intact base-pairs.
   (B) Energy of the system, E(c)
   (C) The Free energy of the system

3. Many of the biopolymers, like actin and DNA, will appear like a bendable wire (cable) under a microscope. Assume that the picture below represents actin and DNA bent into an arc or circle, due to thermal fluctuations, at room temperature T=300K. The energy to bend such filaments of length L to an arc of a circle of radius R is E = BL /R2 where B is the bending stiffness of the filament (it is the elastic constant of the filament related to the Young's modulus).




(A) An actin filament of length La = 10 micrometer is bent to arc which is a part of a circle or radius Ra = 10 micrometer (see the left side picture). Calculate the approximate value of the bending stiffness. Use SI units. Assume actin is stable and not polymerising or depolymerising.
(B) A DNA of length Ld = 2 micrometer is bent to a full circle or radius Rd. Calculate the approximate value of the bending stiffness. Use SI units.