Exercise 05

The transcriptional machinery in eukaryotes

In the thermodynamic models of gene regulation discussed in class the RNA polymerase is treated as a single molecular species. While this might be a reasonable assumption for transcription in prokaryotes, in eukaryotes tens of different molecules need to come together in order to form the transcriptional machinery. The objective of this problem is to develop intuition about the requirements for our simple model to apply in such a complex case by assuming that the transcriptional machinery is made out of two different subunits, X and Y, that come together at the promoter.

(a) Calculate the probability of finding the complex X + Y bound to the promoter in the case where unit X binds to DNA and unit Y binds to X. Can you reduce this to an effective one molecule problem such as in the bacterial case?

(b) Using transcriptional machinery such as that proposed in part (a)calculate the fold change in gene expression for simple repression (consider the model when repressor binds to a site overlapping the X binding site). Explore the weak promoter assumption in order to reduce the expression to that corresponding to the bacterial case. Repeat this for the case where an activator can contact Y.

(c) Repeat parts (a) and (b) for a case when Y binds to a site on the DNA which is near the X binding site, and there is an interaction energy between X and Y.