

Cluster 5 (Biophysics) Goals (2018)

What are the goals of the biophysics half of this cluster?

In your high school courses you may have been introduced to the idea of chemical reactions how molecules A and B, combine to form products X and Y. You may even have learned rules for how the rate at which reactions occur depends on the concentration of the initial ingredients, roughly speaking the more of A and B that are present, the faster X and Y get produced.

The specific objective of Cluster 5 is to examine this process in more detail and in particular to try to understand how biological molecules locate each other in a cell. Will they find each other rapidly enough if they simply randomly bump around inside the cell until they happen upon each other? Or do molecules need to be guided in some way to their destinations?

We will develop some answers to this question by writing computer programs which simulate the random walks that molecules take inside cells. After putting together initial programs we will be able to do numerical experiments to generate data telling us, for example, whether molecules find each other more rapidly in long narrow cells or in more roundish environments. Alternately we can see how the size and shape of a molecule itself affect things.

This ultimate objective involves learning different things along the way:

- The linux operating system
- Programming in C and python
- Basics of cells/biological molecules
- Introduction to probability theory
- Random walks
- Molecular motors

Some of these intermediates involve generally useful skills. Physics majors at UC Davis are required to complete a computational course using C and scientific python with Linux. Others involve concepts which appear in contexts other than biophysics. For instance, the diffusion and merger of defects which ultimately cause materials to break, the motion of electrons in solids which determine whether they are metals, insulators, or semiconductors, and many other situations, involve ideas of probability and random walks. Additionally, in

learning python, we will write some warm-up programs which illustrate interesting biology and genetics concepts. Examples include predicting the populations of predators and prey in an ecosystem and simulating how the body translates the genetic code(DNA) into specific proteins. Many of the programming skills learned in the biophysics section will be carried over into the robotics section, and vice-versa.