MCB 100A

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1 Chapter 6 review

If we have two charges of opposite sign, there will be an attractive force between two charges. We are intersted how these charges behave in water for a biochemistry class—which you can do, if you consider every single charge in the system.

In general all proteins present a charged surface because acid groups can take up or release a proton.

Water's dielectric constant is 80ϵ.

When you apply electric field, the dielectric property of water **alone** reduces the distance between charges by a factor of 80. This isn't even the most significant thing water does. Water also acts as a conductor. The water itself is going to give you its own ions. If there's an interaction, the colombs potential alone will tell you they attract.

Check out coulomb's potential in chapter 6

The tendency of moelcules to mix through entropic forces **plus** the electric forces causes these ions to interact at a surface (assuming some are bound), generates negative exponential-like behavior as a function of distance. Therefore there's a limiting length scale at physiological ionic strength (150 mM; it also depends on the temp of the solution, etc) is $\sigma = \frac{10}{\sqrt{ionicstrength(mM)}}$

electrostatics are real, expect they act at very short ranges. These forces become so small over a small distance that it's negligible.

2 Entropy

Entropy is a concept we **completely** understand. The principle of it is very clear, and even more clear when we consider it in the face of probability.

3 A brief digression into basic probability

$\mathrm{P}_h = \frac{n_h}{N_T}$

AND rule: $\mathrm{P}_{xandy} = P_x P_y$

OR rule: $\mathrm{P}_{xory} = P_x + (1 - P_x)P_y$

it may be worthwhile going over the

$$1 - P_x$$

factor in this equation

What's the probability of getting two heads or two tails (we don't care about order):

$$W(M, N) = \frac{M!}{N!(M - N)!}$$

note: this has a correction factor for overcounting

$$p(M, N) = W(M, N)p^N(1 - p)^{M-N}$$

this describes the binomial distribution.

There are a number of things we can do now. Working with factorials can be challening for large values, so we'll use **sterling's approximation**. By using sterling's approximation we turn the binomial distrubtion into a continous distribution.

$$ln(N!) = NlnN - N$$

In turning the bionomial into a continous distribution we can now use the gaussian

$$p(x) = \frac{1}{\sqrt{2p_i\sigma}}e^{-\frac{x-\mu^2}{2\sigma^2}}$$

we can now calculate the entropy of a system based on the number of microscopic states the system has.

$$S = K_B lnW$$

Another mathematical trick is to realize that this definaiton of entropy can be described as a probabilty.

$$S = -NK_B \sum p_i ln(p_i)$$

concentration is like a probability. The probability that the random molecule you picked is your solute rather than your solvent.

If it's a continous curve

$$S = -NK_B \sum p_i ln(p_i)$$

S turns into an integral.

Therefore entropy can be intuitively described as the most likely thing to happen is the most likely thing. it's an entirely circular law and its purely mathematical.