Elements of Biophysics

Saul Pierotti

October 23, 2019

21/10/19

- The course is made of elements, it is not a complete course
- We want to understand biomolecules
- Structure-function relationship
- The scale of things
- I don't know something if I cannot describe it with a model
  - A model is an equation
- Laser time dependent X ray cristallography allows to see a molecule "breathing"
- The deeper you go in resolution, the more you have to increase the perturbation
  - Bragg diffraction theorem
- Life makes sense only in the light of thermodynamics
- A cell is held together by London forces
- Freeze fracturing
- Atomic force microscope
- rita.casadio@unibo.it
- Complexity means that there are emergent proprieties
  - We do not have models that can predict a cell from its components
- Mitosis, meiosis, apoptosis, developmental biology
- Protein synthesis
- In a cell there are at least 240k different proteins
  - Their relative concentration is of paramount importance
- We are able to label all the neurons in a mouse brain

22/10/19

- I came late
- Bonds can be polar
- Ionic bonds are 2.7/3Å long, and around -5 to -10 Kcal/mol
- Covalent bonds are around 100 Kcal/mol and they show an optimal nuclear distance, which is the bond lenght $(1 - 1.4Å)$
  - The typical C-C bond is 1.4Å
- Bond lenghts are calculated by X-ray diffraction studies, bond strenghts with calorimetry
- Disulphide bond are around -40 Kcal/mol, 2.07Å
  - This bond is stable in an oxydized ambient
- Redox ambient potential describes the tendency of molecules in an environment to lose or acquire electrons
- Steric hindrance
- Bond resonance
- Peptide bond is around 1.5Å (?) and is polar,
  - A long protein chain is highly polar end to end 2-4 Kcal/mol

- A Debye is the unit of measure of permanent dipoles
- A water molecule has a dipole
- The C-H bond is not polar (!)
- The OH_3 structure is called hydronium ion
  - One O atom generally interacts with 4 H, binding 2 at a time in a covalent way
- An H bond can be completely explained only with quantomechanics, it is 3-5 Kcal/mol and 1.5Å
- Cell membrames

23/10/19

- The dipolar interaction energy can be derived from the dipol moments
- The London force is the most dependent on distance
- The hydrophobic effect is the tendency of nonpolar molecules to aggregate in a polar solvent so to minimize the surface exposed to the solvent