



Dipartimento di Scienze e Tecnologie

ACADEMIC YEAR 2017/2018

DEGREE in Biotechnology
COURSE of Physical Chemistry

TEACHER: Prof. Giuseppe Graziano

I and II laws of thermodynamics. Carnot cycle and Clausius entropy. Boltzmann's equation and statistical-molecular meaning of entropy. Equipartition theorem applied to an ideal biatomic gas. Degrees of freedom of a molecule. Heat capacity and quantization of energy levels. Boltzmann's distribution. Gibbs free energy and spontaneity of a process. Real gas: liquid-gas equilibrium. Van der Waals equation. Phase transitions. Equations of Clapeyron and Clausius-Clapeyron. Graphite-diamond transition. The denaturation of globular proteins as a phase transition: DSC measurements and stability curves.

Protein structure principles. Folding & unfolding of native structure. Marginal stability. Conformational entropy of the polypeptide chain. Hydrogen bonds and dispersion forces (Lennard-Jones). Hydrophobic effect. Hot denaturation and cold denaturation. Folding and mis-folding of polypeptide chains. Ribonuclease A and the domain-swapping phenomenon.

Molar partial quantities. Partial molar volume. Chemical potential. Thermodynamic description of chemical equilibrium. Homogeneous and heterogeneous equilibria. Dependence of the equilibrium constant upon temperature. Effect of pressure on chemical equilibrium.

Ideal solutions: Raoult law and its molecular meaning. Henry's law and gas solubility in water. Osmotic pressure. Non-ideal solutions. Demixing phenomena. Diffusion: I and II Fick's Law. Random walk.

Dialysis equilibrium and Scatchard's plot. Binding of oxygen on myoglobin and hemoglobin. Thermodynamic description and concept of cooperativity. Allosteric model of Monod-Wyman-Changeux. Sequential model of Koshland-Nemethy-Filmer. The concept of partition function to treat these models.

Electromagnetic waves: basic notions and overlapping principle. Molecular motions according to quantum mechanics. Electronic, vibrational and rotational levels. Treatment of the classic and quantum harmonic oscillator and normal modes of vibration. Boltzmann's distribution: the populations of various energy levels. Interaction between electromagnetic radiation and molecules. Infrared selection rules. Spontaneous emission, induced emission and absorption. What is a LASER?

Textbooks:

Physical Chemistry - Atkins and de Paula, Zanichelli.

Physical Chemistry: principles and applications in biological sciences di Tinoco, Sauer & Wang, 4th edition, Prentice Hall. Notes of the course.