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Editorial Perspective on Application of Physics in Molecular Biology

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Abstract

The Physics in molecular biology plays a pivotal role in the quantitative determination of many aspects. Of course, it is not directly appeared in living organisms but the development of physical statistical tools are increasing the importance of quantitative analysis of complex biomolecules during the process such as energy transduction of metabolic pathways, DNA & RNA division and replications, Protein folding and stabilization, Enzyme-Ligand interactions, Ionization of chemical substances, allosteric regulatory pathways, identification and quantitative measurement of molecules, etc. In this paper, brief applications are showed which were applied physically in the biomolecules.

Keywords: Physics; applications; Molecular biology;

Molecular biology studies the biological activity between biomolecules in the various systems of a cell in living organisms, including the interactions between DNA, RNA, proteins, lipids and carbohydrates and their biosynthesis, as well as the regulation of these interactions. Living organism must perform work to survive themselves as long as possible. The reactions that occur in the cell may require the energy to process such reactions. In the evolution, the cells develop the mechanisms for coupling of energy during the photosynthesis, molecular metabolism, enzyme kinetics and ecosystem balancing by prokaryotes, etc. These are the reactions which emphasize the energy transduction. For quantitative measurement of energy transduction in mechanisms, the developed physical statistical tools are helpful to increase the efficacy of measurements.

The reason behind that the living organism to carry the reactions is to exist the dynamic steady state level that is far from the equilibrium. A living organism is an open system and it exchange both energy and matter with its surroundings. For this determination, 3 laws of thermodynamics help to predict the energy transduction in the system. Chemical, electromagnetical, mechanical and osmotical energy transduction was predicted by first law with great efficacy. In second law of thermodynamics, mainly Gibb's free energy determines the enthalpy and entropy changes during the chemical reaction. It state's

$$G = H - TS$$

Whereas, G is the Gibb's free energy constant, H is the enthalpy, S is the entropy and T is the absolute temperature. The exergonic and endergonic reactions that occur in the reaction intermediates are absolutely central to the energy change in living system. When the system has reached equilibrium, standard free energy (ΔG^{o}) and equilibrium constant k_{eq} are the measures of the reaction to proceed spontaneously.

$$\Delta G^{0} = -RT\ In\ k_{eq}$$

For example, the hydrolysis of ADP from ATP may release the free energy and this can be calculated using the above equation by considering the standard free energy ($\Delta G'^{0}$).

$$\Delta G^{0} = \Delta G'^{0} - RT\ In\ \left[(ADP.Pi)/ATP\right]$$

For quantitative determination of energy release or consume during the reactions like metabolic pathways, chemical interactions, protein binding, membrane transport the free energy measurement (ΔG^{0}) may helpful.

A quantitative determination of protein- ligand interaction is the central part of many biomedical investigators.

$$Protein\ (P) + ligand\ (L) \rightleftharpoons Protein-ligand\ complex$$

The reversal binding of ligand and protein may characterized by equilibrium constant K_a.

$$K_a = \left[(PL)/\ (P)\ (L)\right]$$

Where, K_a is the association constant, P & L are the protein and ligand respectively.

In enzyme kinetics, the reaction between the substrate concentration and reaction rate in the enzyme and substrate reaction can be determined quantitatively. For this Michaelis-Menten proposed an equation and it is represented in Figure 1

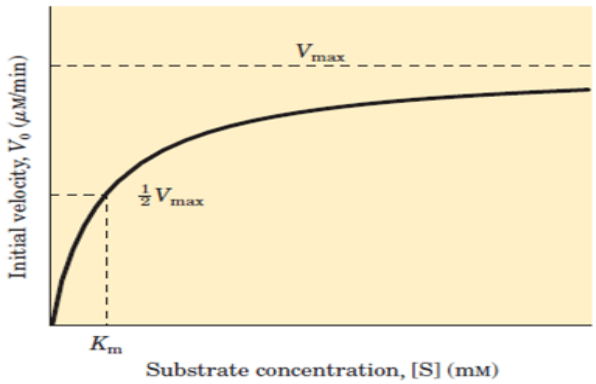

Figure 1: Effect of substrate concentration on the initial velocity of an enzyme-catalyzed reaction.

$$V_0 = V_{max}[S] / K_m + S$$

Where, V_0 is the initial velocity and V_{max} is the final velocity of reaction, K_m is the Michaelis-Menten constant and S is the substrate concentration.

A wide range of biomolecules in the living organism absorb at characteristic wavelength. The measuring of light absorption by Spectrophotometry is used to identify and detect the molecules and measure the concentration of biomolecules in solutions. Lambert-Beer Law is used for this measurement.

$$Log\ I_0 / I = \varepsilon cl$$

Where, I_0 and I are the intensity of incident light and transmitted light respectively, $\mathcal{E}$ is the molar extinction coefficient, c is the concentration of the sample and l is the path length. By using this phenomenon many of the spectrophotometers are invented and these are rapidly used in bioanalytical studies.

These are the some physical phenomenon's which are involved in the quantitative determination aspects of molecular biology were mentioned briefly. Based on the physical phenomenon's, no of the analytical instrumental techniques are also innovated and developed like Microscopy, Electrophoresis, HPLC, NMR, LC-MS/MS, FTIR, Blotting techniques, etc would help in the identification of known/unknown structures of the waste number of biomolecules.

References

1. Nelson David L and Michael M. Lehninger Principles of Biochemistry, 4th edition, W. H. Freeman & Company;2014.
2. Alberts Bruce, Johnson Alexander, Lewis Julian, Morgan David, Raff Martin, Roberts Keith and Walter, Peter. Molecular Biology of the Cell, 5th Edition, Garland Science. 2014;1–10.