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Understanding Proteins: The Wonder Molecule

Ranjeet Kumar

Molecular and Structural Biology Division
Central Drug Research Institute, Lucknow - 226001, India

Biological systems are quite intriguing and the enigma called life has puzzled the human rationale since antiquity. The self sustaining biological process called life has been greatly debated and understanding the fine fabric that lies as a common theme to all living forms is still a holy grail yet to be comprehended in great details. In biophysical terminology according to physicists such as John Bernal, Erwin Schrödinger, Eugene Wigner, and John Avery, life is a member of the class of phenomena which are open or continuous systems able to decrease their internal entropy at the expense of substances or free energy taken in from the environment and subsequently rejected in a degraded form[1,2].The basic organizational unit of all living organisms is cell that finally forms the interwoven communicating assembly providing the platform for genesis of life. The functional pleotropy of the cells arise from the formation of specific consortium formed by the proteins, sugars, lipids and nucleic acids. The cells in addition contain myriad sea of chemical constituents with water forming the base of life's cocktail and constituents such as small inorganic and organic molecules: K^+, Na^+, Ca^{++}, Mg^{++},Cl^-, $P0_4^{--}$, organic bases, all vital amines (vitamins) and cofactors floating freely regulating and maintaining the integrity and dynamics of life. If life be considered gods intelligently designed complex engine then these small molecules can be analogical to tiny tools, nuts, bolts and spare parts which facilitates efficient running. The blueprint of the very core of this engine even its design and prototype lies in the well written seminal script of DNA and RNA, but of all the molecules that represents life in all its vitality and vigor protein occupies the centre stage. Proteins are biomolecules that provide the diverse plethora of ingredients for god's finest recipe called life. They form the most abundant molecule in biology other than water [3]. Our body is made up of more than 1,00,000 different protein that virtually govern all the crucial life processes [4]. Thus the present scientific marathon passes the baton on to the firm hands of contemporary researchers to delineate these molecules holistically taking up the systems biology approach.

Proteins drive the nature dynamic machine called life. It has been a challenging bio-molecule to investigate and delineate. The wizardry and diversity they exhibit are enormous. Central dogma ends on this molecule and what begins there on that very point is puzzle called life. Demystifying the architecture of these wonder molecules and appreciating them in the light of laws of chemistry and physics yield information seminal to their structure-function aspects. Their very nature, the diversity, their ability to interact and act in cascade, drive important metabolic pathway act as defense molecule and intricate involvement in almost every function that a cell carries to sustain thrive exist proliferate and die. Disease and ailments are also by virtue of short-circuiting of these molecules caused by mutation or hostile condition. DNA undergoes transcription to yield RNA the process mediated by RNA polymerases which is further translated to yield the building blocks of life proteins. A fine orchestra of RNA and protein assembly is involved to produce life's key molecular machine ribosomes the site for protein synthesis which is nature's marvelous ergonomic design. The blue print for each amino acid is laid down by sets of three letters known as codons the ribosomes serves as the site where codons are recognized and each amino acid is added to yield the linear primary sequence of the protein which is governed by biological necessity as posed by the cell. The linear sequence is transformed in to functional protein by virtue of its indigenously motivated assembly in to a folded entity by the process of protein folding which finally gives it a three dimensional shape.

The discipline of protein folding "Foldiomics" is an endeavor to understand the diverse biological molecule called proteins. Studying folding in light of sequence to delineate sequence structure relationship reaching a universal folding code, stability flexibility, diversity the involved energetics and smooth transitioning from disordered to well ordered forms is a great scientific pursuit and scintillating academic challenge. The range of human diseases associated with protein misfolding and aggregation which results in cellular malfunctioning [5-7] are focus of contemporary quest. Defects in protein folding have been linked to a number of pathologies where aggregates (amyloids) are observed, including neurodegenerative conditions such as Parkinson's, Alzheimer's and Huntington's diseases[8]

The dynamic personalities of protein have always been an exciting area of research. A nascent polypeptide may reach to its native form traversing many folding intermediates. Its fate may further be governed by its propensity to undergo aggregation and degradation. Another intriguing feature that these aggregate can adopt is to form structured fibrilar topology leading to amyloid fibers. The populations and interconversions of the various states are determined by their relative thermodynamic and kinetic stabilities under any given conditions. In living systems, however, transitions between the different states are highly regulated by control of the environment, and by the presence of molecular chaperones, proteolytic enzymes, and other factors. Failure of such regulatory mechanisms is likely to be a major factor in the onset of misfolding diseases[9].

In nutshell studying these wonder molecules can lead us in better understanding of ourselves. It will also open new vistas to our knowledge of pathophysiology of existing and emerging diseases thereby better therapeutics and ultimately help in improving the quality of life on the planet.

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Corresponding Author:
Phone No. Phone: +91-522-4048067
Email: drkumar.ranjeet@gmail.com