Short Review

SELF ASSEMBLY AND MAGNETISM OF LIVING BIOLOGICAL MOLECULES

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ABSTRACT

Biological molecules are essentially nano size structure. All of them are complex structure with specific function dedicated to perform normal ordered organizational system. The forces for their work are non-covalent interactions; include spontaneous folding of proteins, DNA, RNA and other bio-macromolecules, ligand-receptors interactions, assembly-disassembly of macromolecule, and transportation or movement of many other nano size sub cellular components. The non-covalent interactions are weak bonds system that is low energetic chemical and physical forces. The energetic forces are mainly atomic forces such as electromagnetic force emergence from electron spinning and transitions at every atom of the complex macromolecular structure. The energy will work along with different level of energy, and atomic positioning within macromolecules. This paper review and discuss the role of magnetism on molecular working process as part of thermodynamically open systems to develop order, which is constantly receiving, transforming and dissipating energy, can and do continually exhibit self assembly and organization, along with the self repairing, and perpetuation.

Keywords: *self assembly, magnetism, biological molecules*

INTRODUCTION

Statistical mechanics shows that large scale phenomena can be viewed as large system of small interacting components consistent to mechanical law of thermodynamics. The large scale is usually measurable quantities on our scale, like the dimension, temperature, pressure, and concentrations. These are of interest because are easily seen and practicable even though aware to much greater simplicity and formalism. Glansdorff *et al*. (1974) proposed a deeper view at nano scale level where the principles of thermodynamics are explicitly seen as irreversibility along with the concept of dissipation and temporal orientation in regard to thermodynamically open systems. Overcoming the situation found in the polimerization process of isolated tublin molecules Itoh and Sato (1984) measured the hydrophobicity role in the polymerization process where the principles of thermodynamics is in accordance to the concepts of Glansdorff *et al*.

Biological molecules and organelles are essentially nano size structure. All of them are complex structure with specific function dedicated to perform normal ordered organizational system. The forces for their work are non-covalent interactions; include spontaneous folding of proteins, DNA, RNA and other bio-macromolecules, ligand-receptors interactions, assembly-disassembly of macromolecule, and transportation or movement of many other nano size sub cellular components.

The non-covalent interactions are weak bonds system that is low energetic chemical and physical forces. The energetic forces are mainly atomic forces such as electromagnetic force emergence from electron spinning and transitions at every atom of the complex macromolecular structure. The energy will work along with different level of energy, and atomic positioning within macromolecules. The molecular working process it self is considered part of thermodynamically open systems to develop order, which is constantly receiving, transforming and dissipating energy, can and do continually exhibit self assembly and organization, self repairing, and perpetuation.

Since living system is ceaseless flow of energy and materials obey the thermodynamic laws, and there is electrical current namely series of electron transition process among macromolecules of different level of energy, the magnetism can be thought as the basic principle of energy generation in living phenomena. In the nano scale perspective of the normal equilibrium states, it can be assumed that the energy generation is characterized by electromagnetic energy absorption, the upper state has a higher electric potential to generate more emission leading to gain electromagnetic wave at the transition frequency. This physical phenomenon is discussed and proposed

to be the basic mechanism of energy generation of live macromolecules in living system. In this paper we are discussing about the force generation of those biological compounds like DNA and proteins to conduct activities like moving, folding, or assembling are tightly related with this magnetism.

LIVING ORGANISMS AND MAGNETISM

A live animal which contains more than 80% water levitates inside a vertical bore in a magnetic field. The animal levitates like a superconductor, acts as an essentially perfect diamagnetic material when placed in a magnetic field and it excludes the field, and the flux lines avoid the region. Diamagnetism is the property of an object or material which causes it to create a magnetic field in opposition to an externally applied magnetic field. Diamagnetism is believed to be due to quantum mechanics, and occurs because the external field alters the orbital velocity of electrons around their nuclei, thus changing the magnetic dipole moments. According to Lenz's law, the field of these electrons will oppose the magnetic field changes provided by the applied field. Compounds are diamagnetic when they contain no unpaired electron. Molecular compounds such as protein, DNA, and hemoglobin that contain one or more unpaired electron are paramagnetic, ferromagnetism, and ferrimagnetisms, a manifestation of ordered magnetism, and the anti-ferromagnetic order may exist at sufficiently low temperatures (Sumitro, 2011). The instrumentation used to observe their magnetic characters are instrumentations such as Magnetic Circular Dichroism Spectroscopy and Electron Spin Resonance Spectroscopy.

In electrodynamics, linear polarization of light can be changed into circular polarization in which the electric field of the passing wave does not change strength but only changes direction in a rotary type manner. In the case of those circularly polarized wave, if the wave is frozen in time, the electric field vector of the wave describes a helix along the direction of propagation. The Left Circularly Polarized (LCP) light and the Right Circularly Polarized (RCP) light is caused by the asymmetry of the molecule.
Magnetic Circular Dichroism (MCD) is the differential absorption of left and right circularly polarized (LCP and RCP) light, induced in a sample by a strong magnetic field oriented parallel to the direction of light propagation. MCD measurements can detect transitions which are too weak to be seen in conventional optical absorption spectra; they can also probe paramagnetic properties and the symmetry of the electronic levels of the studied systems, such as metal ion sites. MCD can be used as an optical technique for the detection of electronic structure of both the ground states and excited states of molecules.

In the past 40 years, a lot of studies used Circular Dichroism to test the theoretical concept of any magnetism phenomena of organic compounds is done (Pettegrew, *et al*., 1977, Stone, *et al*., 1982). The study of magnetism continues with more complex biological components such as nucleotide, enzymes and mitochondrial electron transportation component (Spector, *et al*., 1996, Debrunner, *et al*., 1966). All of these studies indicate the important role of magnetism in providing most considerable potential force related to intelligentsia of biological compounds in developing organization order such as communication, reparation, reproduction, self assembly, as well as their contribution in life perpetuation.

Electrodynamics Studies in Understanding Self Assembly of Biological Molecules

Self assembly in Diological system is defined as the spontaneous and reversible organization of molecular units into ordered structures by non-covalent interactions. Implicitly it says that the self assembled structure must have a higher order that the isolated components (Itoh and Sato, 1984). This is not in accordance with the general understanding of chemical reactions, where an ordered state may proceed toward disordered state depending on thermodynamic parameters. The other aspect of self assembly is related with the key role of weak interactions such as Van der Walls, Hydrogen bonds, and magnetism. Although typically less energetic, these weak interactions play important role in larger material assembly. These weak interactions system determine the physical properties of the organization molecules (protein, nucleonic acid, lipid, carbohydrates). The building blocks feature of self assembly span a wide range of nano- and micrometer structures with different of chemical components, shape and functionalities. Examples of self-assembly in material science include the formations of molecular crystals, colloids, lipid bilayers, and DNA, chromosome and other sub cellular organelles. Experiment of microtubule assembly indicates temperature dependent hydrophobic interaction during polymerization of tubulins to form microtubule. The self assembled structure (microtubule) is thermodynamically more stable than the single unassembled components (tubulins, both in form either monomer or dimer) (Oosawa and Asakura 1975; Sumitro *et al.*, 1989). This should because of Chirality of monomeric α-tubulin and β-tubulin assembled into dimeric and protofilament to form microtubules. The role of chirality on molecular self assembly are firstly shown

by Spector *et al*. (1996). They used circular dichroism to test the theoretical concept that the formation of tubules is driven by chiral molecular packing. The difference in the absorption of right and left circularly polarized light, arises from the chirality of a molecular architecture. The vast majority of biological molecules are chiral. This chirality can arise from either the structure of individual molecules or from the chiral packing of molecules into larger aggregates. Observation of tubular crystal rose from complex mixture of acetosal and urea collected after rubbed respectively onto the human skin (the *Balur*) indicated similar result that is showing the assembled components into polymerized form (Sumitro, 2011). Further observation showed that these tubular crystals emitted fluorescence when irradiated with UV light showing dissipative energy content during polymerized state (recognized by their autofluorence under UV irradiation).

Since the acetosal and urea do not perform any fluorescence emission under UV irradiation, indicates that they may gains energy to perform polymerization from the nano materials drawn from the skins. The result of SDS PAGE analyses of the Balur waste (figure 1B) confirmed

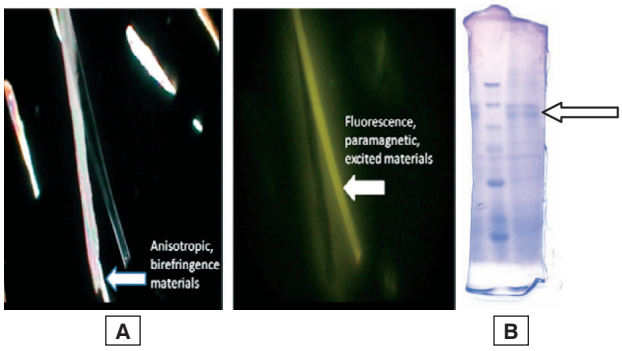

Figure 1. A: The same object of Balur' waste showing a Polarized (left) and fluoresence (right) microscopical images. This figure indicating that the growing crystals only show fluorence image when they anable to make perfect tubular structure. The other crystals which not showing fluorency are showing unisotropical character seen under polarized microscope. B. SDS PAGE of proteins found in Balur' waste.

that some proteins exist, which may contributes to the raised level of energy along with tubular crystal formation. Further data from ESR studies also indicate the triplet state of energy level of the waste (data not shown). We are now investigating the chirality of monomeric proteins in the waste which may constibute to the tubular self assembly.

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