Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 11, Issue, 10, pp.7769-7770, October, 2019

DOI: https://doi.org/10.24941/ijcr.37010.10.2019

ISSN: 0975-833X

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

REVIEW ARTICLE

QUANTUM PHENOMENA IN BIOLOGICAL CELLS: DO RECENT EXPERIMENTS INDICATE SOMETHING?"

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ARTICLE INFO

Article History:
Received 24th July, 2019
Received in revised form
19th August, 2019
Accepted 25th September, 2019
Published online 30th October, 2019

Key Words:
Quantum, Biology,
Superposition, Qubits.

ABSTRACT

Closer investigation of the spaces within the cell indicates that signal transduction through conformational change may not be a plausible mechanism of information communication. As an alternative to this we have earlier proposed that non-local communication may exist between molecules in the biological cell. Recent experiments indicate that even complex molecules may exhibit quantum properties such as non-local communication thus indicating that non-local communication may not be impossible between complex biomolecules in the cell.

***Citation: Monendra Grover, Dwijesh Chandra Mishra and Ranjeet R. Kumar.* 2019.** "Quantum Phenomena in Biological Cells: Do recent experiments indicate something?"", *International Journal of Current Research*, 11, (10), 7769-7770.

INTRODUCTION

Albert Szent Gyorgyi said that living processes are too rapid and subtle to be explained by random bumping about of molecules. He spent considerable time searching for systems in living organisms which could account for life's speed and subtlety. He concluded that electrons, protons, resonance and electromagnetic coupling between molecules could fit the picture. Conventional biology tells us that in living organisms a variety of messenger molecules such as hormones and growth factors bind to cell surface and trigger a cascade of events mediated by second messengers. Primary messengers such as growth factors are thought as being transported throughout the body via the circulatory system, and then through extracellular fluids by diffusion. In a similar fashion, the second messengers are thought to diffuse through the cell interior, which is viewed as a dilute solution. Diffusion of regulatory molecules is a relatively slow and random process as molecules move randomly in all directions. However in a concentration gradient molecules diffuse from higher concentration gradient to the lower concentration gradient. The speed of diffusion is proportional to the difference in concentration and inversely proportion to size of molecules.

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Albrecht-Buehler (1990) in his work "In Defense of Nonmolecular Cell Biology" pointed out that cells in the body do not float about in a large volume of fluid. On the contrary cells are tightly packed within the tissues. Considering the average fluid volume around an individual cell, a hormone with a concentration of 6 $X10^{11}$ molecules/l has a concentration of about 8 molecules in the space surrounding an individual cell. Therefore, in the region around the receptor, the hormone concentration is practically nil (Oschman, 2016). Besides this, the cell is not a bag filled with dilute solution of dissolved molecules.

Cells are packed with filaments, fibres, tubules and other organelles and components that may present barrier to molecular diffusion. Thus the scenario of molecules diffusing about randomly until they have chance collision with other molecules resulting in chemical reactions may not be a realistic one. In addition to this there is little water in the cells that can act as solvent for the "dissolved" molecules. Luby-Phleps (2000) concluded that in a more realistic scenario, the interior of the cell is crowded not dilute. Diffusion is further restricted by binding and compartmentation. She also hypothesized that enzymes are not dissolved and most of proteins inside the cell are solid rather than dissolved. In context of above several alternative mechanisms have been proposed for intermolecular communication such as electromagnetic energy and vibrational energy (Oschman, 2016).

We have earlier proposed in our papers that non-local communication may exist between molecules in a living cell (Grover and Kumar, 2014). However an objection to above proposal is that the quantum effects exist at the level of elementary particles or simple molecules and they may not exist at the level of complex molecules. A recent study has shown that it is possible to bring hot, complex molecules composed of about 2000 atoms into quantum superposition and to make them interfere (Fein et al. 2019). Thus the non-local communication between biomolecules in a living cell may not be entirely impossible. Researchers from the University of Vienna in collaboration with the University of Basel have tested quantum superposition on a massive scale. Superposition is the central tenet of quantum physics and it describes particles using wave functions.

The quantum waves can also be associated with single particles. The molecules in the experiments mentioned above have masses greater than 25 KDa, several times larger than the previous record. The molecule sent through the interferometer, C707H260 F90 8N16S53Zn4, is composed of more than 40,000 protons, neutrons, and electrons. The quantum superposition of these massive particles was demonstrated by measuring interference fringes in a new 2-m-long Talbot–Lau interferometer The molecules in this study have de Broglie wavelengths of 53 fm, five orders of magnitude smaller than the diameter of the molecules themselves. The interference fringes have more than 90% of the expected visibility and the macroscopicity value of 14.1 is an order of magnitude higher than previous experiments.

The above mentioned report points out that quantum phenomena in biological cells such as non-local communication may not be impossible in the biological cell, howsoever far-fetched it may seem at present.

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