The Chemical Aspects of The Origin of Life

Life is the cumulative product of interactions among the many kinds of chemical substances that make up the cells of an organism.

- The first life on Earth originated from abiotic surroundings.

- Organic molecules have been successfully generated from abiotic elements.

- The abiotic chemical evolution of life follows 4 major steps:

    1. The abiotic synthesis and accumulation of small organic molecules, or monomers, such as amino acids and nucleotides.
    2. The joining of these monomers into polymers, including proteins and nucleic acids.
    3. The aggregation of abiotically produced molecules into droplets, e.g., protobionts, that had chemical characteristics different from their surroundings.
    4. The origin of heredity or information transference.

- To understand how this creation of life from abiotic material occured, we have to consider 2 critical concepts:

    1. The extension of the idea of natural selection to chemical level.

    2. The realization that the condition of the early Earth when life first arose must have been vastly different from present:

        a) non-oxidizing atmosphere: present level of oxygen, which began to accumulate around 2.1 billion years ago with the presence of cyanobacteria, would have been lethal to primitive organisms

        b) abundant resources produced non-biologically

        c) long time scale without competition

The Molecular Clues to the Origin of Life on Earth

- Molecules of living organisms are rich in **hydrogen-containing carbon** compounds. This suggests that there were little or no free molecular oxygen on primitive Earth.

- All **amino acids** exist in both the right-handed state and the left-handed state. However, only 20 amino acids of the left-handed variety are used by living organisms in proteins. Therefore, suggesting that there was one single origin of life.

- **DNA** and **RNA** are the universal informational basis of all life forms on Earth.

- **ATP** is the universal energy currency of all living organisms; suggesting a common origin of metabolism.

- In any cell, first steps of carbohydrate metabolism involve **fermentation**, with the last steps in aerobic organisms the usage of oxygen via **respiration** – suggesting that aerobic organisms evolved from anaerobic ones.