1. Ribonucleic Amino Acid - Science & Technology

A new study shows how RNA and amino acids could have linked on early Earth without enzymes, using thioesters as an intermediate step. This discovery helps bridge the gap between the "RNA World" and "Metabolism-First" hypotheses on the origin of life.

Context of the Study

A recent study has shed light on how RNA (ribonucleic acid) and amino acids, two fundamental components of life, might have joined together under conditions similar to those on early Earth, approximately four billion years ago. This discovery is significant as it enhances our understanding of the potential origins of the interaction between genes and proteins.

Ribonucleic acid (RNA)

Definition - RNA is a crucial biomolecule that is essential for all known forms of life.
Key Functions - It plays multiple roles, including carrying genetic information, facilitating the synthesis of proteins, and acting as a catalyst and regulator in cellular processes.
Structure - RNA is a polymer made of repeating units called nucleotides. Each nucleotide consists of a phosphate group, a ribose sugar, and one of four nitrogenous bases. Unlike DNA, which typically forms a double helix, RNA is usually single-stranded. However, it has the ability to fold upon itself to create complex three-dimensional shapes, including loops and helices.
Nitrogenous Bases - The four bases that make up RNA are Adenine (A), Guanine (G), Cytosine (C), and Uracil (U).
Base Pairing Rule - In RNA, Uracil pairs with Adenine (U-A), and Guanine pairs with Cytosine (G-C).

Amino Acid

Definition - An amino acid is an organic compound that serves as the fundamental building block of proteins.
Types - There are 20 standard amino acids that combine in various sequences to create all the proteins found in the human body.
Secondary Function - They can also be utilized by the body as an energy source when other sources like carbohydrates and fats are scarce.

Key Findings of the Study

Enzyme-Free Bonding - Researchers discovered that amino acids can attach directly to RNA without the need for enzymes. This process occurs through simple prebiotic chemistry in water at a neutral pH.
The Chemical Pathway - The amino acids first react with a thiol compound called pantetheine. This reaction creates a thioester, which is a high-energy intermediate compound. The thioester then facilitates the transfer of the amino acid onto the end of an RNA strand.
Primitive Peptide Formation - Once an amino acid is attached to RNA (forming what is called aminoacyl-RNA), further reactions can occur within the same system. These reactions lead to the formation of short peptides, which are chains of two or more amino acids, all without the presence of any pre-existing proteins or enzymes. This finding demonstrates a plausible primitive pathway for the creation of proteins from simpler molecules.
Significance for Origin-of-Life Theories - The study's findings provide a crucial link, effectively bridging two major hypotheses about the origin of life -

1. **RNA World Hypothesis** - This theory proposes that self-replicating RNA molecules were the earliest forms of life. They were capable of both storing genetic information (like DNA) and catalyzing chemical reactions (like proteins).
2. **Thioester World (Metabolism-First) Hypothesis** - This theory suggests that energy-rich thioester compounds were the driving force behind early metabolic reactions, which occurred *before* the evolution of complex genetic systems like RNA or DNA.

Source - https - //www.thehindu.com/sci-tech/science/uncovered-how-rna-amino-acids-may-have-linked-on-early-earth/article69998866.ece