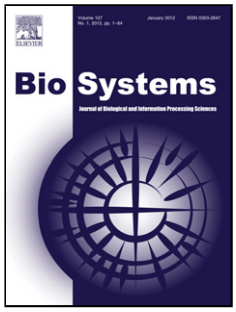

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The evolution of the genetic code: impasses and challenges

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Abstract

The origin of the genetic code and translation is a "notoriously difficult problem". In this survey we present a list of questions that a full theory of the genetic code needs to answer. We assess the leading hypotheses according to these criteria. The stereochemical, the coding coenzyme handle, the coevolution, the four-column theory, the error minimization and the frozen accident hypotheses are discussed. The integration of these hypotheses can account for the origin of the genetic code. But experiments are badly needed. Thus we suggest a host of experiments that could (in)validate some of the models. We focus especially on the coding coenzyme handle hypothesis (CCH). The CCH suggests that amino acids attached to RNA handles enhanced catalytic activities of ribozymes. Alternatively, amino acids without handles or with a handle consisting of a single adenine, like in contemporary coenzymes could have been employed. All three scenarios can be tested in *in vitro* compartmentalized systems.

Keywords

Origin of Life; genetic code; RNA world; ribozyme; coding coenzyme handle;

Introduction

Modern cells store information in DNA and have peptide enzymes to carry out the metabolism for the cell. The information stored in DNA sequences are translated to protein sequences via the process known as translation. During translation a messenger RNA (mRNA) is transcribed from the DNA. The mRNA attaches to the ribosome (rRNA), an RNA-peptide complex that catalyses the RNA dependent polymerization of amino acids. The amino acids are carried to the ribosome by transfer RNAs (tRNA). Thus between DNA and peptides we find a host of RNAs. This fact has already sparked the mind of Francis Crick to propose an RNA world (Crick, 1968), in which RNA acts both as information storing molecule and as enzymes. Naturally occurring RNA enzymes were found in the early '80s