Identification of Candidate Extraterrestrial Organic Biomarkers

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One of the problems in the analysis of extraterrestrial samples for organic signatures of past or present life is the choice of target compounds. Judicious choice of target biomarkers is particularly important when sample size is minimal, since detection limits for various analytical techniques will dictate that assay priorities be established. Variations of specific biomarker compounds among species on Earth may be a consequence of historical evolutionary pathways, and extrapolation of these patterns to putative extraterrestrial biota may not be valid. Terrestrial biochemistry cannot be used as a detailed model for possible extraterrestrial life.

There are certain fundamental chemical functions, however, which must be carried out by any system that meets the general definition of a living organism. Some form of compartmentalization is necessary to maintain spatial proximity of components and to allow for generation of chemical potential gradients. Oxidation and reduction reactions must be carried out for energy production and carbon and nitrogen fixation. Osmotic balance between cell interiors and the external milieu must be maintained by osmolytes. Cell-cell recognition using quorum sensing compounds may be necessary to maintain optimal cell density.

Analyses for compounds such as fatty acids, quinones, amino acids, betaines, and lactones in various terrestrial environments are helping to focus the search for extraterrestrial organic biomarkers. This work is concentrating on extreme environments such as alkaline lakes, permafrost, and deserts, and is being carried out in conjunction with microbiology and molecular biology studies that are assessing the biodiversity of these environments.