

Kinetic consequences of replacing the internucleotide phosphorus atoms in DNA with arsenic

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Abstract

It was claimed in a recent publication that a strain of Halomonadacea bacteria (GFAJ-1) isolated from the arsenic-rich waters of Mono Lake, California is able to substitute arsenic for phosphorus in its macromolecules and small molecule metabolites. In this short Perspective, we consider chemical and biochemical issues surrounding the central claim that Halomonadacea GFAJ-1 is able to survive while incorporating kinetically labile arsenodiester linkages into the backbone of its DNA. Chemical precedents suggest that arsenodiester linkages in the putative arsenic-containing DNA of GFAJ-1 would undergo very rapid hydrolytic cleavage in water at 25 °C with an estimated half-life of 0.06 s. In contrast, the phosphodiester linkages of native DNA undergo spontaneous hydrolysis with a half-life of approximately 30,000,000 y at 25 °C. Overcoming such dramatic kinetic instability in its genetic material would present serious challenges to Halomonadacea GFAJ-1.

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