

"KNOWN KNOWNS" AND "KNOWN UNKNOWNNS" ABOUT THE ORIGIN OF LIFE

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As Donald H. Rumsfeld, United States Secretary of Defense in the George W. Bush Administration is famous for stating (at a News Briefing in February 2002 dealing with US involvement in the Iraq conflict):

*"There are **known knowns** ... things we know that we know.
There are **known unknowns** ... things that we know we don't know. But there are also **unknown unknowns** ... things we don't know we do not know."*

This is true also about the origin of life. Among the **known knowns** are the following well-accepted organizing principles:

- (1) The primordial environment was essentially anoxic and characterized at Earth's surface by a high UV-flux.
- (2) Life's precursors were abiotically produced organic compounds.
- (3) The organisms from which all later life derived were microscopic single cells that exhibited anaerobic glycolysis-like metabolism and Darwinian evolution.

Among numerous **known unknowns** are such questions as:

- (4) When in the gap between Earth's formation (~4500 million years ago) and the beginning of the continuous fossil record (~3500 million years ago) did life begin?
- (5) In what environment(s) did life originate -- presumably marine but within the water column, at the surface of seafloor mud, associated with deep-sea fumaroles, or a diverse mix -- and where should evidence of the consommé-like "primordial soup" be sought?
- (6) What was the temperature of the life-generating environment(s) -- were the earliest forms of life mesophiles or thermophiles?

This talk will outline these and other "known knowns" and "known unknowns" and use that discussion to summarize briefly the presentations at this conference. This talk, however, will not address **unknown unknowns** -- aspects of the origin of life problem that have yet to be considered and for which relevant questions and answers are therefore not available.