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Stereospecificity in glucose consumption: A new approach to martian life detection

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In 1976, the Viking mission made a remarkable discovery: Martian soil was capable of decomposing an organic nutrient broth to carbon dioxide as if it contained live microorganisms. However, a biological interpretation of this finding is in apparent contradiction with the gas chromatograph-mass spectrometer aboard the Viking landers, which showed Martian soil to be devoid of indigenous organics. To reconcile these findings, it has been hypothesized that unknown abiotic oxidants, such as peroxide and superoxide, are present on Mars and that they were responsible for its soil reactivity. The objective of this research is to develop a life detection method that can distinguish biological reactivity from abiotic mimicry.

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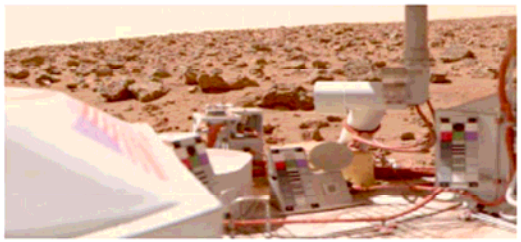


Is Mars a biological planet or a sterile (oxidized) world?

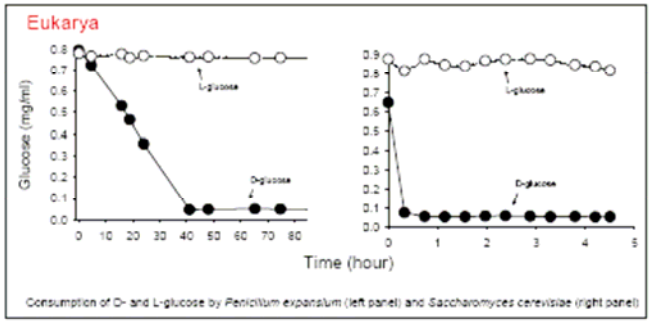
In 1976, the Viking mission made a remarkable discovery: Martian soil was capable of decomposing an organic nutrient broth to carbon dioxide as if it contained live microorganisms. However, a biological interpretation of this finding is in apparent contradiction with the gas chromatograph-mass spectrometer aboard the Viking landers, which showed Martian soil to be devoid of indigenous organics. To reconcile these findings, it has been hypothesized that unknown abiotic oxidants, such as peroxide and superoxide, are present on Mars and that they were responsible for its soil reactivity. The objective of this research is to develop a life detection method that can distinguish biological reactivity from abiotic mimicry.

Our approach to distinguishing between biological and chemical reactivity

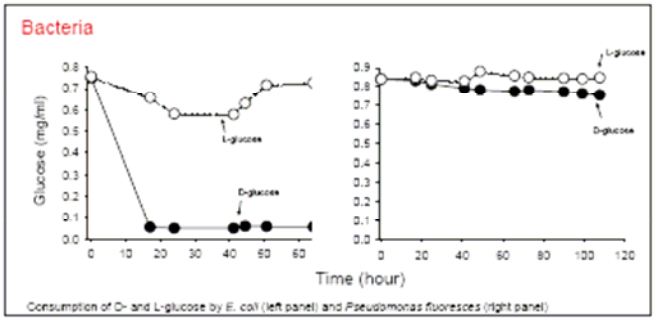
We hypothesize that organic consumption by living organisms is stereospecific, whereas abiotic destruction is not. In other words, if both D- and L-isomers of the same compound are fed to soil but only one is consumed, the soil is considered biologically reactive. On the other hand, if both isomers are destroyed, abiotic oxidants are assumed present.

Below, we provide experimental verification for this theory by demonstrating that: 1) only D-glucose, not L-glucose, is used by terrestrial organisms, and 2) non-life processes are not stereospecific and destroy both D- and L-glucose.

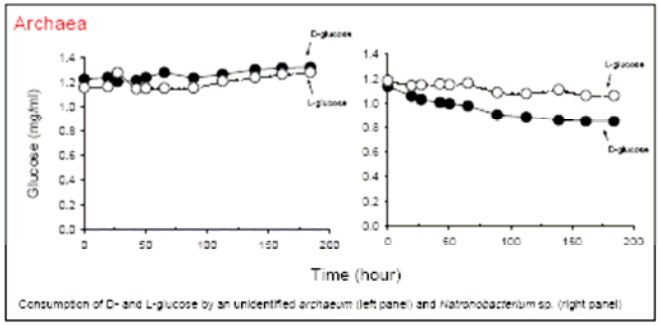
1. Glucose consumption by terrestrial life is stereospecific



Consumption of D- and L-glucose by *Penicillium expansum* (left panel) and *Saccharomyces cerevisiae* (right panel)

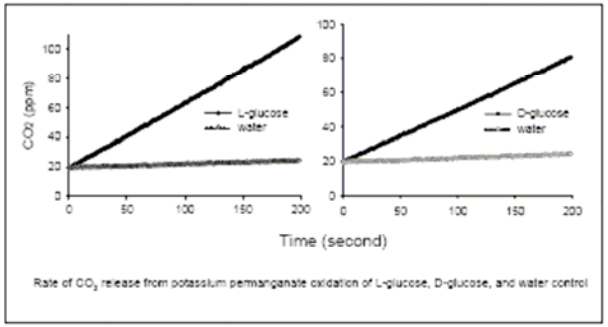


Consumption of D- and L-glucose by *E. coli* (left panel) and *Pseudomonas fluoresces* (right panel)



Consumption of D- and L-glucose by an unidentified archaeum (left panel) and *Natronobacterium* sp. (right panel)

2. Abiotic chemical oxidation is not stereospecific



Rate of CO_2 release from potassium permanganate oxidation of L-glucose, D-glucose, and water control

Discussion

Our data indicates that stereospecificity is a distinguishing character of life. With the exception of one of the archaea, which is apparently incapable of metabolizing glucose, all organisms studied consumed only D-glucose, not L-glucose. In contrast, chemical oxidation by potassium permanganate destroyed both D- and L-glucose. Further tests with more organisms will determine whether or not stereospecificity is a universal property of terrestrial life.

Future work will also consider lactic acid and amino acids. If these substrates are also utilized in a stereospecific manner like glucose, then they should also be used to maximize the probability of success of life detection. We envision that, once fully established, this new approach can be implemented on Mars to determine whether or not life exists on our neighboring planet.

Acknowledgements:

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