CHEMICAL & Engineering News

Latest News

March 27, 2006
Volume 84, Number 13
p. 10

Biological Chemistry

Oxygen's Gift

Without O_2, life would be a lot simpler

Ivan Amato

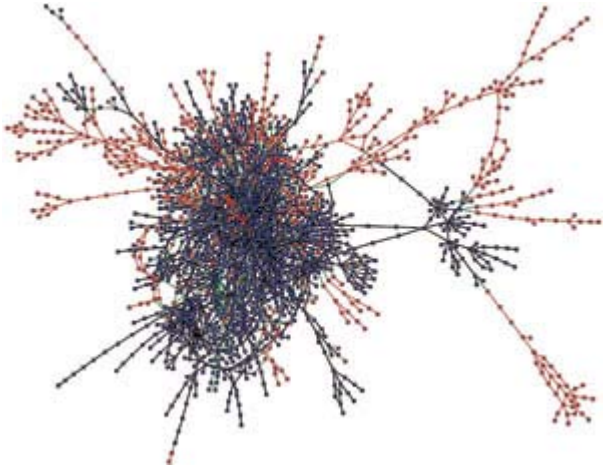
A grand plot point in the history of life was the center-stage entry of oxygen into the atmosphere roughly 2.2 billion years ago. At the time, oxygen was a waste gas that emanated from the bacterial innovators of photosynthesis and posed mortal hazards to the anaerobic life that had been evolving for more than a billion years. With oxygen's arrival, the choices for the planet's microbial masses were to die, hide from oxygen, or evolve ways to live with it.

Using a bioinformatics approach involving data from the genomes o 70 of today's aerobic and anaerobic microbes, as well as thousands of enzymatic reactions, Jason Raymond of Lawrence Livermore National Laboratory and Daniel Segré of both LLNL and Boston University have attempted to infer "how oxygen availability changed the architecture of metabolic networks" (*Science* **2006,** *311*, 1764). It's the type of insight that researchers can use to reconstruct how early microbial life evolved into complex life forms.

The researchers used a simulation technique called metabolic network expansion in which a set of seed compounds, such as ammonia, pyruvate, coenzyme A, carbon dioxide, and oxygen, is fed into an existing database of more than 6,800 enzymatic reactions that collectively occur in both aerobic and anaerobic

microbes. As these compounds react, their products join the seed set, and the procedure repeats until no new products can be formed. By comparing runs of seed sets that include oxygen with those that don't, oxygen's effect on the overall metabolic system becomes apparent.

"The arrival of oxygen had a massive effect on metabolic innovation," says molecular ecologist Paul Falkowski of Rutgers University, noting that the gas appears to facilitate more than 1,000 metabolic reactions unseen among anaerobes. Without an oxygen-instigated spate of biochemical evolution like this, Raymond suggests, life on Earth might still be single-celled.



Science © 2006

Oxygen Boost **This pruned version of a much larger network depicting 6,836 metabolic reactions indicates relationships and differences among oxygen-involved reactions and metabolites (red) and anoxic ones (blue), whose origins predate the arrival of oxygen into the atmosphere a few billion years ago.**

Chemical & Engineering News
ISSN 0009-2347