BIOCHEMICAL NETWORK REWIRING DURING THE TRANSITION TO AEROBIOSIS OR HOW TO BUILD AN AEROBE IN JUST A FEW HUNDRED MILLION YEARS. W. D. Swingley[1] and J. Raymond[1],
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Introduction: The invention of oxygenic photosynthesis stands as one of the major catastrophes in the history of life on Earth and had a profound effect on the evolution of the biosphere. Though geological evidence has allowed reconstruction of some of the widespread changes in Earth's atmosphere and oceans, very little is known about the molecular details of oxygen's influence on early life [1].

We have integrated methods from evolutionary biology and systems biology to reconstruct the stepwise development of biochemical networks in ancient organisms, focusing on the changes promulgated by the transition from anaerobiosis to aerobiosis. This analyses makes use of all publicly available genomes, as well as inferred enzymatic reactions and metabolic networks for each. We have found that a broad range of enzymes, above and beyond those required for aerobic respiration, are tightly associated with the aerobic transition. Surprisingly, most of the biochemical network 'rewiring' centered on the loss--and presumed replacement--of anaerobic enzymes, whereas oxygen detoxification and coupling oxygen reduction to energy generation required the invention and/or modification of only a few enzymes.

Many of the enzymes lost after aerobic transition are metalloproteins that exhibit strong oxygen sensitivity and are associated with key biosynthetic and redox pathways. While the invention of analogous oxygen-tolerant enzymes has substituted many of these anaerobic enzymes, some, such as those involved in methanogenesis and nitrogen-fixation, remain strictly anaerobic processes. Here we discuss the role these enzymatic innovations had in expanding the biochemical repertoire of early organisms as well as laying the foundations for the subsequent evolution of complex life.

References: [1] Raymond, J. and Segre, D. (2006) *Science, 311*, 1764–7.