ABSTRACT
Virtually all non-equilibrium electron transfers on Earth are driven by a small set of biological machines comprised largely of multimeric protein complexes associated with a relatively small number of prosthetic groups. These machines evolved exclusively in microbes early in our planet’s history, yet despite their antiquity, are highly conserved from an evolutionary perspective; they are "frozen metabolic accidents." Hence, although there is enormous genetic diversity in nature, there remains a relatively stable set of core genes encoding for the major redox reactions essential for life and biogeochemical cycles. These genes, which both created and co-evolved with biogeochemical cycles, have been transferred through time from microbe to microbe, often by lateral gene transfer, with little change and are responsible for all the electron-transfer reactions involving H, C, O, N, and S. A major challenge in the coming decades is to understand how these machines evolved, how they work, and the processes that control their activity and interactions on both molecular and planetary scales.

BIOSKETCH
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