Elemental economy in the green lineage.

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Organisms use metals like copper, iron, manganese, molybdenum, vanadium, which have multiple stable oxidation states, for extracting energy from inorganic or organic chemicals to sustain life. At the same time, their reactivity can make these very elements harmful in the biological environment, especially in the presence of oxygen. Too little means that enzymes that use the trace metals as catalytic cofactors will not function, and too much means that the metals may react promiscuously. For this reason, there are homeostatic mechanisms to maintain elemental quotas in biology. One evolutionary adaptation to limitation in a particular element is the reduce, reuse, recycle paradigm. This paradigm operates, especially in microbes, on both macro- (S, N) and micro- (Cu, Fe) nutrient elements. These mechanisms have been discovered through classical genetics and biochemistry in multiple microbes, revealing metabolic signatures for elemental economy. Comparative genomics and metagenomics indicate widespread utilization of these economies in nature. I will present examples of these economic measures, followed by a focus on the spectrum of Cu nutrition states in Chlamydomonas, a single cell alga and a reference organism for dissecting metabolism in the green lineage.