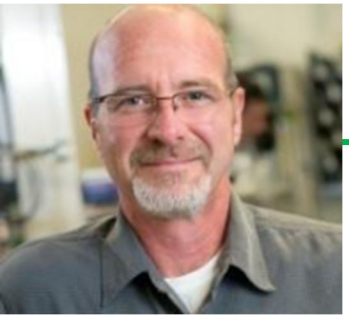
BioFrontiers - Biology & BioDiscovery Institute Seminar



September 12, 2025; 3:00 PM

Eagle Student Service Center (ESSC) -255

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The parameters that define flavin-based electron bifurcation

The term “Electron Bifurcation” (EB) has its origins as a component of the “Chemiosmotic Hypothesis” in the explanation of the functioning of what is coined the “Q cycle”. The basics of the “Chemiosmotic Hypothesis” are that the electron transport chain (ETC) couples the negative change in free energy from exergonic electron transfer reactions, from both mobile and fixed electron carriers, to drive the formation of a proton/ion gradient. The potential energy of the proton/ion gradient is then harnessed to drive the formation of chemical energy in the form of ATP, which is the unifying form of energy for life processes. The elegant interconversion between potential energy species provides the basis for defining biological energy conservation, fundamental to life. Phenomena satisfying this criterion were not recognized again for nearly forty years, when about a decade ago, EB re-emerged in the context of anaerobic metabolism. Several examples of flavin-based electron bifurcating enzymes have been described that involve the coupling of the oxidation of a two-electron donor such as the organic cofactor NAD(P)H coupled intimately to one electron reductions of a high potential acceptor and the low potential electron carrier ferredoxin (right). In anaerobic metabolism, where free energy cannot be squandered without dire consequences to cell viability, EB provides a high-fidelity mechanism to promote efficient energy conservation. Recent work from our research laboratories and others has provided the basis for defining the basic tenets that define flavin-based bifurcation. We suggest these tenants include 1) a bifurcating center capable of brokering both single and pairwise electron transfer reactions, 2) an energetic intermediate is required capable of driving a reduction reaction more negative than the average reduction potential of the two redox transitions of the bifurcating center, 3) a fixed and defined stoichiometry of 1:1 electrons transferred along different energetic paths, and 4) an energy landscape or specific mechanism that circumvents energy-wasting short-circuiting reactions. The talk will discuss the elegant enzyme architectures and the interesting physical properties and mechanistic features they have evolved to satisfy these criteria.