WHY IS CATALASE SO FAST? A Novel Hypothesis to Explain the Incredibly Fast Enzyme-catalysed Decomposition of Hydrogen Peroxide.

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Conventional (reductionist) biochemistry may be likened to a theatrical performance: our attention is captivated by the main 'actors' - nucleic acids, proteins, lipids, etc. But what about their 'theatre of operations', the cell's inner aqueous/semi-aqueous environment, which nurtures and ultimately enables all their intricate coordinated reactions? In this talk, I will show how by making these aqueous-mediated relationships more explicit, a more holistic understanding of catalase enzyme action is possible (and therefore by association perhaps other enzymes), which does not contradict known text-book enzyme kinetics.[1]

As vital parts of our immune systems, catalases are some of the most efficient enzymes known, breaking down potentially dangerous hydrogen peroxide (H_2O_2) at around tens of millions of molecules *per second*. Conventional biochemistry suggests this reaction rate depends on a random, diffusion-limited mechanism, in which H_2O_2 molecules meander through the cellular aqueous medium, down long channels from the enzyme surface, into its reactive sites. Though at the extreme end of fast diffusion limited reaction rates, it is difficult squaring this mechanism with the rapidity of catalase kinetics.

Alternative (albeit, still conventional chemical) pathways are proposed in which catalases act as epicentres for an extended network of hydrogen-bonded coherent domain water clusters and H_2O_2 molecules, stretching out far beyond the enzymes' active sites, into the cell's internal aqueous medium.[2] As catalases function, they may be thought to provide coherent oxidative 'pulses', which rapidly spread throughout the H-bonded network of water coherent domains, effectively 'unzipping' H_2O_2 molecules (via Grotthuss-like mechanisms), potentially as far as they extend from the enzyme.

These pathways predict catalase H_2O_2 disproportionation should occur outside the enzyme. A potential experimental protocol is proposed to test this prediction. If successful, it a) should suggest holistic re-appraisal of the conventional mechanistic framework of enzyme kinetics is required, and b) help encourage more research into understanding the biochemical effects of CAM therapies.

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[1] Milgrom LR (2016). Why is catalase so fast? A preliminary network hypothesis for the rapid enzyme-catalysed decomposition of hydrogen peroxide. WATER **7**:129-146.
[2] Milgrom LR (2018). Why is catalase so fast? Part 2: schemes for rapid, exo-enzymatic disproportionation of hydrogen peroxide. WATER (accepted for publication).

Dr Lionel Milgrom – Biog

Lionel has been/is a research chemist/academician (porphyrin chemistry); co-founder and first CEO of a university spin-out company; science writer/journalist; lecturer and teacher; homeopath and independent homeopathic researcher.
His current research interests concentrate on attempting to apply holistic principles to reductionist biochemistry; investigating the nature of the therapeutic process in broadly quantum theoretical terms, and developing a model of the (much maligned) Vital Force based on a quantised gyroscope or spinning top.