Exploiting and Manipulating Nanozyme Target Recognition for Highly Selective Analytical Sensors

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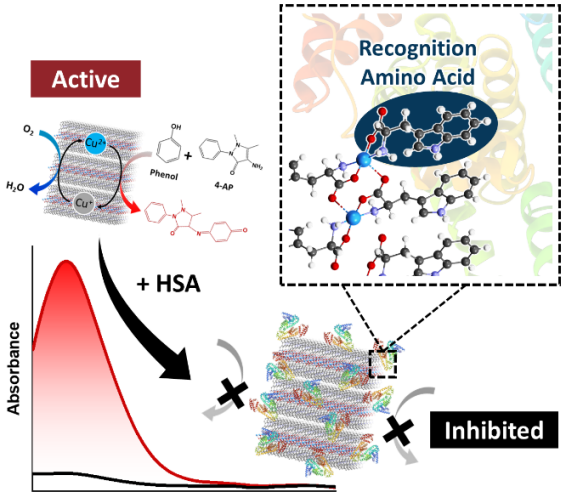
Nanozymes are emerging nanomaterials owing to their superior stability and enzyme-mimicking catalytic functions. However, unlike natural enzymes with inherent amino acid-based recognition motifs for target interactions, manipulating nanozyme selectivity toward specific targets remains a major challenge. In this talk, we introduce the de novo strategy using the supramolecular assembly of L-tryptophan (L-Trp) as the recognition amino acid with copper (Cu) ions for creating human serum albumin (HSA)-responsive bionanozyme.[1] This amino acid-engineered bionanozyme enables selective colorimetric detection of HSA, a critical urinary biomarker for kidney diseases, overcoming the challenge that HSA is neither a typical substrate nor an inhibitor for most nanozymes. Kinetic studies and competitive tests reveal that HSA subdomain IIIA binding to L-Trp sites limits electron transfer-induced structural changes of L-Trp-Cu chelate rings, resulting in noncompetitive inhibition. This inhibition effect is significantly stronger than that observed for canonical amino acids, common proteins, and urinary interference species. Colorimetric monitoring of bionanozyme activity enables sensitive HSA detection with a detection limit of 1.3 nM and a quantification range of 2 nM to 10 μM. This approach is exceptionally more sensitive and offers a broader detection range compared to conventional colorimetric and fluorescent methods, suitable for diagnostics across various clinical stages of disease. This innovative rational strategy to designing and manipulating selective nanozyme-target interactions not only addresses the limitations of nanozymes but also expands their precise applications in complex biological systems.



References:

[1] Siang-Yun Chiang, J.-W. L., Chun-Hsiang Peng, Jia-Wei Kuo, Yang-Wei Lin, Chia-Her Lin, Chong-You Chen. “Amino Acid-Engineered Bionanozyme Selectivity for Colorimetric Detection of Human Serum Albumin.” *submitted*