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DNA Nanocaged Enzymes

Compartmentalization increases the overall activity and specificity of encapsulated enzymes by protecting the enzymes, maintaining a high concentration of enzymes and substrates, and promoting substrate channeling. While there have been artificial enzymatic particles that have been created using compartmentalization by virus-like proteins, liposomes, and chemical crosslinking, significant obstacles exist. The major obstacles include low encapsulation yield of large proteins, insufficient access to the enzyme, aggregation and limited control over spatial arrangement of proteins within the compartments.

Researchers at Arizona State University have developed a simple and robust strategy for DNA nanocage-templated encapsulation of metabolic enzymes with high assembly yield and controlled packaging stoichiometry. These DNA nanocaged enzymes demonstrate enhanced catalytic activity and stability. Nanocaged enzymes are created via self-assembling into DNA nanocages with well-controlled stoichiometry and architecture. Further, DNA nanocages protect the encapsulated enzymes against degradation, such as by proteases. Several different enzymes were encapsulated and shown to exhibit higher activity in the nanocages than the free enzyme, with enhancements ranging from 3- to 10-fold.

DNA nanocages serve as a highly useful molecular tool to accurately engineer the local environment of enzymes, demonstrating practical utility in functional biomaterials and biotechnology applications.

Potential Applications

- Biomaterials/smart materials
- Biotechnology
- Healthcare
  - Medical diagnostics, drug delivery, therapeutics, drug manufacturing, etc.
- Food industry
- Detergents
- Textile Industry

Benefits and Advantages

- Increased activities of DNA nanocage-encapsulated enzymes

o Several different DNA nanocage-encapsulated enzymes exhibited higher activity than the free enzyme, with enhancements ranging from 3-10-fold

- DNA nanocage-encapsulated enzymes are protected, providing stability against biological degradation (e.g. proteases)

- Self-assembled into well-controlled stoichiometry and architecture

- The porous DNA cages allow for controlled substrate transport

o The Km varies little between the encapsulated and free enzyme for most substrates

- The DNA cages retain their structural integrity during enzymatic reactions

- Enzymatic activity is significantly enhanced at low nanomolar concentrations

For more information about the inventor(s) and their research, please see Dr. Yan's laboratory webpageDr. Woodbury's directory webpage