

Article 6 - Replication of synthetic recognition-encoded oligomers by ligation of trimer building blocks

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(No figures mentioned)

Synopsis

In the article "Replication of Synthetic Recognition-Encoded Oligomers by Ligation of Trimer Building Blocks," published in *Organic Chemistry Frontiers*, researchers explore a method for replicating synthetic molecules that encode information through specific recognition patterns. This approach is significant for advancing the field of synthetic biology, where creating molecules that can replicate and transmit information is a fundamental goal.

The study focuses on triazole oligomers, which are synthetic molecules designed to mimic the structure and function of natural DNA. These oligomers are composed of sequences that encode information, similar to how genetic information is stored in biological systems. The researchers aimed to develop a method to replicate these synthetic molecules, thereby enabling the transfer of encoded information.

To achieve this, the team employed a template-directed replication strategy. This method involves using an existing molecule (the template) to guide the formation of a new molecule with the same sequence. In their approach, a primer molecule was covalently attached to the template through a specific chemical bond. This primer then facilitated the non-covalent binding of complementary building blocks, which were designed to align with the template's sequence. The interaction between the primer and the building blocks promoted a chemical reaction that extended the primer, effectively replicating the sequence encoded in the template.

A key aspect of this replication process was the use of trimer building blocks—molecules consisting of three connected units. These trimers were engineered to form multiple hydrogen bonds with the template, enhancing the specificity and efficiency of the replication process. The researchers found that increasing the number of hydrogen bonds between the building blocks and the template significantly accelerated the replication reaction.

The study also examined the competition between the templated replication process and intermolecular reactions. For shorter building blocks, unintended reactions between molecules could interfere with the desired replication. However, by using trimer building blocks capable of forming three hydrogen bonds with the template, the researchers achieved quantitative replication, meaning that the replication process was highly efficient and produced the desired product in large quantities.

Through nuclear magnetic resonance (NMR) spectroscopy and molecular modeling, the researchers confirmed that the template could adopt a specific folded structure. When the trimer building blocks were added, they formed a complex with the template, aligning the reactive groups in a favorable geometry for the chemical reaction. This alignment was crucial for the successful replication of the encoded information.

The resulting product duplex exhibited the expected hydrogen-bonded base pairs, demonstrating that the covalent and non-covalent interactions were geometrically compatible. This finding is significant because it shows that synthetic molecules can be designed to replicate information through a combination of covalent and non-covalent interactions, mimicking the complexity of natural biological systems.

This research represents a significant advancement in the field of synthetic biology, as it provides a method for replicating synthetic molecules that encode information. Such replication is essential for developing systems that can store and transmit information, a characteristic fundamental to life. The ability to replicate synthetic recognition-encoded oligomers opens avenues for creating more complex synthetic systems capable of performing tasks similar to those of natural biological systems.

In summary, the article presents a novel approach to replicating synthetic molecules that encode information through specific recognition patterns. By employing a template-directed strategy and utilizing trimer building blocks capable of forming multiple hydrogen bonds with the template, the researchers achieved efficient and specific replication. This work contributes to the broader goal of developing synthetic systems that can mimic the information storage and transmission capabilities of natural biological systems.