A Step Forward in Synthetic Biology

Xeno-Genetics, an advanced molecular device to create desired and targeted DNA molecules

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IN all organisms, genetic material is inherited from parental stocks, and the order of behaviour of the offspring is controlled and decided by the inherited DNA molecules. The rule of the order of DNA molecules may be advantageous or disadvantageous depending on the information encoded in the inherited DNA molecules from the parents. In the recent past, several advanced molecular devices have been invented to intervene or alter the DNA structure to bring desired or targeted functional properties in the organisms so that disorders that affect the life process can be controlled and eliminated to a larger extent. To alter the genes or DNA structure, several genetic technologies like androgenesis, gynogenesis, diploids, triploids, forced mutations, recombinants, transgenesis, and the latest gene editing techniques have been used with partial or increasing gradation of success depending on standard operational procedures and the conditions prevailing at that time. These technologies are being used in all fields of science, including agriculture, animals, and fisheries. In humans, because of the completion of whole genome mapping work, efforts are being made on gene modulations to develop gene therapy technologies for treating severe, incurable disorders, including cancer.

Now the world is looking for a new concept of synthetic biology and its applications to make the impossible possible. Synthetic biologists try to engineer useful biological systems that do not exist in nature. According to Markus Schmidt, they design new (orthogonal) chromosomes termed XNA (Xeno Nucleic Acids), which are different from natural DNA and RNA that exist in the organisms. XNA exhibits a variety of structural chemical changes relative to its natural counterparts, and these changes make this novel information-storing biopolymer "invisible" to natural biological systems. Xeno Nucleic Acids are artificial nucleic acids, in which the chemical composition of the sugar moiety is changed. It is currently used for incorporating natural DNA to encode nonstandard amino acids in polypeptides to increase their efficiency and potency. XNA has been used to produce XNA zymes that are similar to ribozymes. XNA has the potential to be used as a drug for controlling a disease. Nowadays, XNA is a growing area and has the potential to discover not only the stored genetic information but also serve as enzymes that increase the possibility of life elsewhere, beginning with nucleic acids other than DNA or RNA. Here, we focus on XNA and its derivative-bearing chemical and structural diversity, and its applications. These modifications impart distinct physical and chemical properties to XNAs, which lead to changes in their biological, chemical, and physical stability. Additionally, these alterations influence the binding dynamics of XNAs to their target molecules. Consequently, XNAs find expanded applications as functional materials in diverse fields.

Therefore, Xeno-genetics technology is considered an advanced molecular device that creates desired and targeted DNA molecules for the functions designed by the cell in the body. However, XNA in the biological system cannot transfer hereditary characteristics as done by the natural DNA and RNA molecules. It has been mentioned that XNA zyme, a polymerase enzyme, is capable of copying XNA from DNA templates and also copying XNA back into DNA. In recent years, success has been achieved in creating XNA zymes, the XNA equivalent of a ribozyme enzyme made of RNA. This perhaps indicates that XNAs not only store hereditary information but can also serve as enzymes.

After the discovery of DNA molecules and realising their vital role in life processes, scientists all over the world started playing with DNA molecules and tried to modify the existing DNA to achieve new and desired strains with targeted functional properties. In synthetic biology, efforts are being made one step further to create an entirely new sequence of DNA molecules and a new biological system with pre-determined functions.

Structure of Xeno nucleic acid

XNA exhibits a variety of structural chemical changes relative to its natural counterparts. Most work has focused on different chemical structures in place of the ribose, including

- 1,5-Anhydrohexitol Nucleic Acid (HNA)
- Cyclohexene Nucleic Acid (CeNA)
- Threose Nucleic Acid (TNA)
- Glycol Nucleic Acid (GNA)
- Locked Nucleic Acid (LNA)
- Peptide Nucleic Acid (PNA)
- Fluoroarabino Nucleic Acid (FANA)

How Xeno Nucleic Acids are Modified and Work

In Xeno-genetics technology, new nucleic acids are synthesised, and with the assembly of these nucleic acids, new DNA sequences are made that code for new specific traits with predetermined functions and behaviour. In designing such new DNA molecules, multidisciplinary knowledge is required, and several experts are involved with different specialisations. By designing the new sequence of DNA molecules, one can create genetic circuits that command and decide how the cell behaves. Such DNA molecules can be