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Commentary

Applications of Biosensors, Cell Transformation, and Designed Proteins in Synthetic Biology

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DESCRIPTION

In the field of science known as synthetic biology, organisms are given new abilities in order to be reconfigured for use in real-world applications. Synthetic biology researchers and entrepreneurs are utilizing the power of nature to address problems in agriculture, industry, and medicine. Drug development and screening can benefit from synthetic biology that can also be utilized to identify novel drug targeting sites. With the quick advancement of synthetic biology, new bioinformatics techniques are now available for the analysis of potential therapeutic targets.

Applications

Designed proteins: Natural proteins can be modified, for instance by directed evolution, to create novel protein structures that are functionally equivalent to or superior to those of the current proteins. One team created a helix bundle with features similar to those of hemoglobin and the ability to bind oxygen but not carbon monoxide. While one protein formed a structurally and sequentially new ATPase, another was created to support a range of oxidoreductase activities. Another team created a family of G-protein coupled receptors known as DREADDs that were insensitive to the native ligand acetylcholine but could be triggered by the inactive small chemical clozapine N-oxide.

Utilizing computational methods, novel capabilities or protein specificity can also be generated. In one work, two distinct computational techniques were employed to mine sequence databases using bioinformatics and molecular modeling and to reprogram enzyme specificity using computational enzyme design. Both approaches produced designed enzymes that were more than 100 times more selective for the synthesis of longer chain alcohols from sugar.

Biosensors: The toolkit of the synthetic biologist is incomplete without biosensors. These molecular protein scaffolds convert input signals into manageable outputs using biologically inspired rational design and evolutionary techniques. A biosensor is an artificially created organism, typically a bacterium that can detect environmental phenomena like the presence of heavy metals or poisons. The Aliivibrio fisheries Lux operon is one such system. It can be inserted after a responder promoter to express the luminescence genes in response to a certain environmental stimuli. The Lux operon codes for the enzyme that causes bacterial bioluminescence.

One such sensor was made by covering a photosensitive computer chip with a bioluminescent bacterial layer to identify specific petroleum contaminants. The microorganisms glow when they detect the contaminant. The detection of landmines using a modified *E. coli* reporter strain that can detect TNT and its principal breakdown product TNT and afterwards produce a green fluorescent protein is another example of a similar method.

Cell transformation: Gene circuits—interacting genes and proteins—are used by cells to carry out a variety of functions, including communication, decision-making, and responding to environmental cues. There are three essential elements: Gene circuits that can regulate gene expression at the transcriptional, post-transcriptional, and translational levels were created by scientists working with DNA, RNA, and synthetic biology. The additions of foreign gene combinations and optimization by directed evolution have strengthened conventional metabolic engineering. Although living cells can be altered with fresh DNA, entire organisms have not yet been generated from start.

However, after the appropriate genetic code is generated, it is merged into a living cell that is anticipated to exhibit the desired new capabilities or phenotypes while growing and thriving. Several methods allow for the construction of synthetic DNA components and even full synthetic genomes. The process of cell transformation produces biological circuits that can be controlled to produce specific results.

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