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Opinion Article

Balanced Metabolic Engineering in Living Cells

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DESCRIPTION

Recent advances in Systems and Synthetic Biology have greatly aided the use of industrial enzymes in the production of valuable chemical compounds.

In vivo and *in vitro* systems for converting simple to complex compounds have been established. Balanced metabolic engineering in living cells is achieved by controlling gene expression levels, translation, scaffolding, compartmentation, and flux control. Proteins are post-translationally modified and arranged in artificial metabolic channels to improve stability and catalytic activity. While synthetic biology provides the components and information about various biological phenomena, metabolic engineering attempts to apply all of this information towards the optimization of a desired compound's biological synthesis trajectory.

Examples of synthetic biology are also examples of genetic engineering. Despite this, these two areas are dependent on advances in DNA modification methods, techniques, and tools.

Metabolic engineering seeks to develop microbes as biocatalysts for the increased and cost-effective production of numerous secondary metabolites. Secondary metabolites can be used to make industrial chemicals, pharmaceuticals, and fuels. Plants are also important targets for metabolic engineers in order to produce secondary metabolites.

Metabolic engineering of both microorganisms and plants aids in drug discovery. Metabolic engineers must be well-versed in cell physiology and metabolism in order to effectively implement advanced metabolic engineering techniques.

Genome-scale mathematical models of integrated metabolic, signal transduction, gene regulatory, and protein-protein interaction networks, as well as experimental validation, can provide such knowledge. Such models can be developed with the help of inverse metabolic engineering and metabolic control analysis (MCA).

Artificial intelligence methodology can also be used to improve the efficiency and accuracy of metabolic engineering. Metabolic engineering and its application on microorganisms and plants, which leads to drug discovery.

Finally, inverse metabolic engineering related to modern metabolic engineering. Using recombinant DNA technology, traditional metabolic engineering alters cell metabolism by changing its pathway enzyme(s) or regulatory protein(s), thereby increasing the productivity and yield of an industrial fermentation product or producing novel biochemical compounds.

However, because traditional metabolic engineering rarely takes gene regulation into account, it is difficult to guide the selection of target genes for modification. Inverse metabolic engineering makes use of information gained from mutants or existing strains with improved performance.

High-throughput functional genomics methods enable more effective metabolic engineering design and analysis, but they are not without drawbacks. Future metabolic engineering should take into account every biochemical network in the cell and account for cellular responses to genetic changes and environmental cues through its own regulation hierarchy. The bioprocesses will continue to be aided by evolutionary engineering and conventional process engineering techniques up until we have a thorough understanding of the cell and its intricate metabolic and regulatory networks.

CONCLUSION

Metabolic engineering seeks to develop microbes as biocatalysts for the increased and cost-effective production of numerous secondary metabolites. In living cells, metabolic engineering is achieved by controlling gene expression levels, translation, scaffolding, compartmentation, and flux control. Metabolic engineering of both microorganisms and plants aids in drug discovery.

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