Mini Review
Volume 14:10, 2022

Journal of Bioanalysis & Biomedicine

ISSN: 1948-593X

Open Access

Simulated Biology for Bio-Derived Operational Resources

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Abstract

There are numerous applications for materials derived from biological sources outside of the biomedical sector. However, due to the difficulty of elucidating, imitating, or adjusting the natural biosynthetic mechanisms, it is difficult to alter the properties of these materials. As a result, numerous bio-derived materials are produced by isolating substitutes from natural tissues or by producing them recombinantly and then changing them. The developing field of synthetic biology, which is developing a "toolbox" of innovative techniques to tune biomolecules and biosynthetic mechanisms is driving a significant paradigm shift. In terms of materials, this has made it possible to design novel materials by combining desired domainsand has resulted in higher production titers due to reprogrammed natural biosynthesis. Bio-derived ribosomal and nonribosomal polymer materials for biomedical applications are the focus of recent synthetic biology applications. We then depict cutting edge strategies that will affect bio-determined material creation and designing sooner rather than later. A new era of biomaterial design and synthesis is expected to begin as a result of ongoing innovation at the convergence of synthetic biology and materials science.

Keywords: Biological sources • Natural biosynthesis • Biomedical applications

Introduction

The field of biomedical engineering known as tissue engineering relies heavily on bio-derived structural materials like polyesters, polysaccharides, and proteins. The processes of gene expression, metabolism, cell signaling, and extracellular assembly are all part of the biosynthesis of these materials. Even after the development of recombinant DNA technology, it has been difficult to control material properties due to the complexity of these processes. The range, variety, and function of bio-derived functional materials are constrained as a result. Tools that can engineer biological processes are required to overcome this limitation. Tools that are able to design, predict, and control complex biological processes have been created as a result of innovations in the new engineering field known as synthetic biology. This has eliminated the traditional obstacles to designing materials. As a result, the application of the "tool box" of synthetic biology to bio-derived materials heralds a new era in which engineered biosynthesis is used to replicate, imitate, and modify bio-derived materials. Recent studies on structural biomolecules using synthetic biology are discussed in this summary. The current state of synthetic biology and its implications for material synthesis are then discussed. We reason that synthetic biology is essential for the scalable production of structural bio-derived materials with desired properties in light of this potential.

Discussion

Synthetic biology can be used to improve or modify structural polymers that are relevant to medicine that are produced by microbes. Non-ribosomally synthesized polymers and ribosomally synthesized proteins are the two main categories of these biomaterials. The majority of structural biomaterials based on ribosomal proteins are polypeptides that either represent or mimic the extracellular matrix (ECM). ECM proteins like collagen, laminin, fibronectin, and elastin, which are currently obtained from tissue or through low-yield recombinant fermentations, are included in this category. For instance, collagen has a long history of low yield and has only recently been produced in sufficient quantities by tobacco plants to make medical devices based on collagen. Additionally, heterotrimeric laminin can be customized at laboratory scale and is available commercially. Due to the limited availability of ECM proteins, ECM protein mimics have been sourced from non-mammals. Resilin, an insect elastomer, silk from arthropods, and recombinant bacterial collagen-like proteins are examples of ECM analogs that can be produced using recombinant DNA in microbial fermentation systems. Silk fibroin, in particular, is a protein with remarkable mechanical properties that have led to its widespread application as a structural biomaterial [1-3].

The natural production of non-ribosomally synthesized structural polymers in a number of microorganisms has piqued interest for biomedical applications, as well as for biofuels and bioplastics in general. Polyesters, exopolysaccharides, and other heteropolymers are examples of these. Structural biopolymers made from sugars that are either made outside of the cell or secreted by microorganisms are called exopolysaccharides. High-molecular-weight polysaccharides with a variety of properties, such as branched or linear structures and homomeric or heteromeric composition, are made possible by the assembly mechanisms. Several of these exopolysaccharides have been identified as potential molecules for the production of "green" materials and have been discussed elsewhere [4,5].

Conclusion

Although numerous polysaccharides are utilized as structural materials, bacterial cellulose and hyaluronic acid have recently received attention. Due to its regular nanostructure and high purity, bacterial cellulose has numerous applications in electronics, acoustics, and medical applications. In addition to exopolysaccharides, polyhydroxyalkanoate (PHA) polyesters, which are produced in microbes as carbon and energy storage materials and have attracted interest as candidate biomedical scaffolds, are also a sustainable alternative to petroleum-derived polyesters. Hyaluronic acid (HA) is natively synthesized and secreted from Streptococcus as part of the immune-evading capsule. The heteropolymer poly-glutamic acid (PGA), which is linked by amide bonds between an -amino group and a -carboxylic acid group through microbes' non-ribosomal synthesis, is another interesting polymer.

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Received: 02 October 2022, Manuscript No. jbabm-22-83307; **Editor assigned:** 04 October 2022, PreQC No. P-83307; **Reviewed:** 16 October 2022, QC No. Q-83307; **Revised:** 21 October 2022, Manuscript No. R-83307; **Published:** 28 October 2022, DOI: 10.37421/1948-593X.2022.14.351

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Janbozorgi, Mohammad. "Simulated Biology for Bio-Derived Operational Resources." J Bioanal Biomed 14 (2022): 351.