Opinion

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Development of Sustainable Technologies and Outer-Layer Deals with Integration

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Description

The discussions the corresponding author has had with the co-authors, who are from academia and industry in Europe, over the scope and significance of chemical and biochemical engineering as a field have resulted in the article's contents. The end product is a multilayered view of chemical and biochemical engineering in which the fundamental principles and their application are the focus of the inner layer; The consolidation and expansion of the principles through a combination of science and engineering in the middle layer leads to the creation of environmentally friendly technologies; In order to create a society that is more sustainable, the outer layer deals with the integration of knowledge and collaboration with other fields. This multi-layered perspective highlights a number of significant issues in education, research, and practice, as well as challenges and opportunities for the present and future.

Digitalization of Biochemical Systems in Biochemical Engineering

The field of biochemical engineering has strong connections to a number of global research themes as well as strategic national priorities like energy, sustainability, and healthcare. It encompasses all aspects of the development of biological processes, from the preparation of raw materials to the synthesis of bio products and the valorization of biowaste, with numerous applications primarily relevant to industrial, environmental, and medical and healthcare biotechnology. Natural science subjects like chemistry and biology are seamlessly combined with engineering subfields like chemical engineering and process systems engineering in biochemical engineering. The scientific community has subdivided biochemical engineering into a number of distinct subfields due to the scope of this research area. Some examples of these subfields include bio catalysis, biomaterials, systems and synthetic biology, bioreactor engineering, tissue and protein engineering, metabolic engineering, and environmental biotechnology. In particular, the term "engineering" suggests that research in biochemical engineering focuses not only on the discovery of natural science but also on the engineering aspect, which aims to translate scientific knowledge into practical industrial applications. Biochemical engineering has experienced unprecedented growth and has had a significant impact on modern industry and society. It originated in the field of chemical engineering, which were one of the earliest engineering fields and a product of the first industrial revolution. The UK's bio economy is currently worth £220 billion and is anticipated to double by 2030. The biochemical engineering sector supports over 5 million jobs in the UK. Starting around 2011, it has been generally acknowledged that ongoing industry is changing into the fourth Modern Upheaval .The German government first proposed this industry conceptual framework, which aims to computerize and automate manufacturing procedures. As a result, the development of mathematical modeling tools with a focus on industry and the digitalization of biochemical systems are now driving forces in biochemical engineering innovation and research. However, completing this task has been hampered by a number of significant obstacles. First-principle knowledge is traditionally used to build mathematical models.To simulate the kinetics of microbial biomass growth and product synthesis, numerous mechanistic and physics-based empirical models have been developed; to estimate metabolic flux within the cell to ascertain liquid elements and thermodynamics for bioreactor increase and bio separation unit plan and to develop novel enzymes and proteins. Because of the need for in-depth human comprehension of the underlying system, the ongoing development of these mechanistic models justified by these successes will continue for many decades to come. In a similar vein, the pharmaceutical and fermentation industries continue to employ the traditional "scale-up" method, which necessitates a significant investment of time and labor in order to transfer a technology from the laboratory into commercial operations. However, it is understood that in order to save time and resources for technology development during the fourth industrial revolution, more time-efficient methods such as the "scale-down" simulation approach must be used, and experiments conducted at laboratory or bench scale must be well designed to accurately predict industrial-scale performance.

Mechanical and Biological Stability of Reconstituted Collagen Assemblies

Over the past three decades, tissue engineering has relied on collagen as a native structural protein to engineer membranes and scaffolds. The biocompatibility, available compound functionalization, and in vivo turnover of collagen are certain resources for collagen frameworks and films to be created for clinical applications. Engineered collagen scaffolds, on the other hand, have a number of major drawbacks, the most significant of which are their lack of mechanical property, poor structural stability, and rapid degradation. The properties of collagen scaffolds in vitro have not yet been fine-tuned to the same level as those of tissues in vivo. The mechanical and biological stability of reconstituted collagen assemblies has been controlled through the use of chemical and physical crosslinking techniques. Glutaraldehyde, hexamethylene diisocyanate (HMDI) and 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC) are the chemical crosslinking reagents that are utilized the most frequently. Plant extracts like genipin and photo reactive agents like riboflavin have also been used. The cytotoxicity, calcification, and foreign body response that are associated with these chemical exogenous collagen crosslinking methods usually outweigh their crosslinking potential. To avoid the cytotoxicity of chemical cross linkers, physical methods like dehydrothermal and UV irradiation have also been looked at. Physical crosslinking techniques like heating, drying, and irradiation, on the other hand, do not produce sufficient degrees of crosslinking. As a result, crosslinking agents that are optimally low-toxicity and capable of providing mechanical advantages without affecting long-term tissue homeostasis are required. A possible solution would be to selectively re-engineer collagen native crosslinks in new scaffolds in order to mimic the properties of collagen found in tissues and preserve as much of the ECM's composition and structure as possible. Procollagen-chains undergo a series of post-translational modifications following in vivo synthesis, resulting in the assembly of procollagen molecules. N- and O-linked glycosylation, trimerization, disulphide bonding, prolyl cis-trans isomerization, folding of the triple helix, and modifications of proline residues to hydroxyproline are among these. As a feature of this cycle, the tropocollagen particles' principal adjustment is accomplished by the protein disulphide isomerase (PDI) whose primary capability is to catalyze the development and modification of the disulphide bonds otherwise called intermolecular crosslinks. Collagen molecules are once more exposed to further stabilization within the fibril after fibrillogenesis. Covalent crosslinks are created in this final step of collagen biosynthesis to stabilize the supramolecular assembly of collagen molecules into fibrils. Through the enzymatic lysyl oxidase (LOX), lysyl oxidase-like (LOXL), LOXL, LOXL3, LOXL4, and transglutaminase pathways, as well as no enzymatic glycation, collagen fibrils undergo natural intermolecular crosslinking in physiological conditions. However, the number of glycation-mediated crosslinks increases with age while the number of enzymatic crosslinks does not change. As the ratio of glycation-mediated crosslinks to enzymatic-mediated crosslinks rises, this results in an overall imbalance in crosslinking formation in favor of the glycation products.