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Section

Regenerative Engineering

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Section Information

Regenerative Engineering is a multidisciplinary platform aiming to facilitate the development of novel technologies towards tissue regeneration as well as de novo biofabrication of living tissues and organs. Stemming from a classical tissue engineering concept (cells, scaffolds, signaling molecules and the microenvironment), regenerative engineering advances into the areas of biomaterials including nanomaterials, drug carriers, bioinks, 3D printing, organoids, microfluidics, microfabrication, bioprocessing, sensors, and personalized medicine. Of particular interest is the application of advanced experimental tools based on machine learning and AI-based methods for disease diagnostics, including cancer, and the computational modeling of the systems' in vitro and in vivo performance.

Section Regenerative Engineering

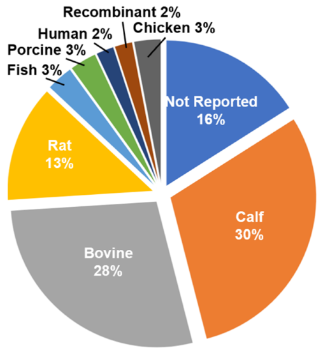
Featured Papers

DOI:10.3390/bioengineering8030039

Collagen-Based Electrospun Materials for Tissue Engineering: A Systematic Review

Authors: Britani N. Blackstone, Summer C. Gallentine and Heather M. Powell

Abstract: Collagen is a key component of the extracellular matrix (ECM) in organs and tissues throughout the body and is used for many tissue engineering applications. Electrospinning of collagen can produce scaffolds in a wide variety of shapes, fiber diameters and porosities to match that of the native ECM. This systematic review aims to pool data from available manuscripts on electrospun collagen and tissue engineering to provide insight into the connection between source material, solvent, crosslinking method and functional outcomes. D-banding was most often observed in electrospun collagen formed using collagen type I isolated from calfskin, often isolated within the laboratory, with short solution solubilization times. All physical and chemical methods of crosslinking utilized imparted resistance to degradation and increased strength. Cytotoxicity was observed at high concentrations of crosslinking agents and when abbreviated rinsing protocols were utilized. Collagen and collagen-based scaffolds were capable of forming engineered tissues in vitro and in vivo with high similarity to the native structures.

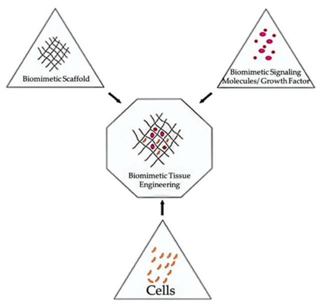


DOI:10.3390/bioengineering8020027

Natural Biomaterials and Their Use as Bioinks for Printing Tissues

Authors: Claire Benwood, Josie Chrenek, Rebecca L. Kirsch, Nadia Z. Masri, Hannah Richards, Kyra Teetzen and Stephanie M. Willerth

Abstract: The most prevalent form of bioprinting—extrusion bioprinting—can generate structures from a diverse range of materials and viscosities. It can create personalized tissues that aid in drug testing and cancer research when used in combination with natural bioinks. This paper reviews natural bioinks and their properties and functions in hard and soft tissue engineering applications. It discusses agarose, alginate, cellulose, chitosan, collagen, decellularized extracellular matrix, dextran, fibrin, gelatin, gellan gum, hyaluronic acid, Matrigel, and silk. Multi-component bioinks are considered as a way to address the shortfalls of individual biomaterials. The mechanical, rheological, and cross-linking properties along with the cytocompatibility, cell viability, and printability of the bioinks are detailed as well. Future avenues for research into natural bioinks are then presented.

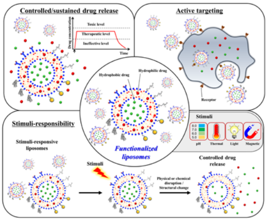


DOI:10.3390/bioengineering8100137

Bioactive Scaffolds Integrated with Liposomal or Extracellular Vesicles for Bone Regeneration

Authors: Minjee Kang, Chung-Sung Lee and Min Lee

Abstract: With population aging and increased life expectancy, an increasing number of people are facing musculoskeletal health problems that necessitate therapeutic intervention at defect sites. Bone tissue engineering (BTE) has become a promising approach for bone graft substitutes as traditional treatments using autografts or allografts involve clinical complications. Significant advancements have been made in developing ideal BTE scaffolds that can integrate bioactive molecules promoting robust bone repair. Herein, we review bioactive scaffolds tuned for local bone regenerative therapy, particularly through integrating synthetic liposomal vesicles or extracellular vesicles to the scaffolds. Liposomes offer an excellent drug delivery system providing sustained release of the loaded bioactive molecules. Extracellular vesicles, with their inherent capacity to carry bioactive molecules, are emerging as an advanced substitute of synthetic nanoparticles and a novel cell-free therapy for bone regeneration. We discuss the recent advance in the use of synthetic liposomes and extracellular vesicles as bioactive materials combined with scaffolds, highlighting major challenges and opportunities for their applications in bone regeneration. We put a particular focus on strategies to integrate vesicles to various biomaterial scaffolds and introduce the latest advances in achieving sustained release of bioactive molecules from the vesicle-loaded scaffolds at the bone defect site.

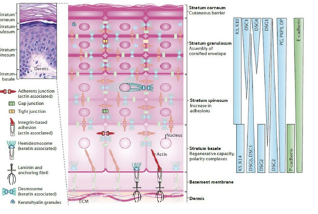


DOI:10.3390/bioengineering8110148

The Importance of Mimicking Dermal-Epidermal Junction for Skin Tissue Engineering: A Review

Authors: Mina Aleemardani, Michael Zivojin Trikić, Nicola Helen Green and Frederik Claeyssens

Abstract: There is a distinct boundary between the dermis and epidermis in the human skin called the basement membrane, a dense collagen network that creates undulations of the dermal–epidermal junction (DEJ). The DEJ plays multiple roles in skin homeostasis and function, namely, enhancing the adhesion and physical interlock of the layers, creating niches for epidermal stem cells, regulating the cellular microenvironment, and providing a physical boundary layer between fibroblasts and keratinocytes. However, the primary role of the DEJ has been determined as skin integrity; there are still aspects of it that are poorly investigated. Tissue engineering (TE) has evolved promising skin regeneration strategies and already developed TE scaffolds for clinical use. However, the currently available skin TE equivalents neglect to replicate the DEJ anatomical structures. The emergent ability to produce increasingly complex scaffolds for skin TE will enable the development of closer physical and physiological mimics to natural skin; it also allows researchers to study the DEJ effect on cell function. Few studies have created patterned substrates that could mimic the human DEJ to explore their significance. Here, we first review the DEJ roles and then critically discuss the TE strategies to create the DEJ undulating structure and their effects. New approaches in this field could be instrumental for improving bioengineered skin substitutes, creating 3D engineered skin, identifying pathological mechanisms, and producing and screening drugs.



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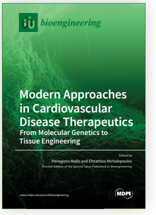
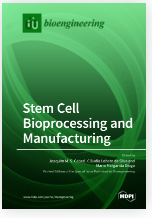
Modern Approaches in Cardiovascular Disease Therapeutics: From Molecular Genetics to Tissue Engineering



Stem Cell Bioprocessing and Manufacturing



Stem Cell and Biologic Scaffold Engineering

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