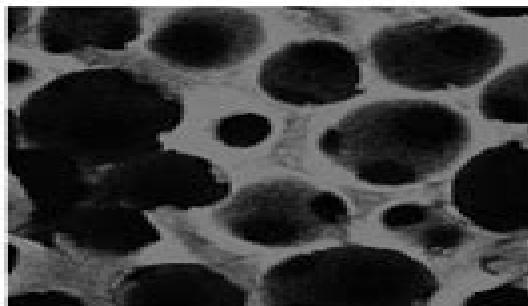


Functionalized Synthetic Biodegradable Polymer Scaffolds for Tissue Engineering

Xiaohua Liu, Jeremy M. Holzwarth, Peter X. Ma*

Scaffolds (artificial ECMs) play a pivotal role in the process of regenerating tissues in 3D. Biodegradable synthetic polymers are the most widely used scaffolding materials. However, synthetic polymers usually lack the biological cues found in the natural extracellular matrix. Significant efforts have been made to synthesize biodegradable polymers with functional groups that are used to couple bioactive agents. Presenting bioactive agents on scaffolding surfaces is the most efficient way to elicit desired cell/material interactions. This paper reviews recent advancements in the development of functionalized biodegradable polymer scaffolds for tissue engineering, emphasizing the syntheses of functional biodegradable polymers, and surface modification of polymeric scaffolds.



1. Introduction

As a multi-disciplinary field, tissue engineering integrates materials science with regenerative medicine by applying the principles of engineering and biology to clinical issues.^[1,2] A typical tissue engineering strategy can be separated into three components: a scaffold [an artificial extracellular matrix (ECM)], cells, and biological factors. The

scaffold serves as a template for tissue regeneration and plays a pivotal role in cell adhesion, proliferation, differentiation, and new tissue formation in three dimensions (3D). Ideally, a scaffold should be designed to possess the following characteristics: (i) a biocompatible and biodegradable substrate with controllable degradation rates; (ii) a 3D and highly porous architecture to accommodate cell attachment, penetration, proliferation, and ECM deposition; (iii) an interconnected pore network to facilitate nutrient and waste exchange; (iv) a suitable mechanical strength to support regeneration; and (v) a proper surface chemistry and surface topography to promote cellular interactions and tissue development.^[3-6] With the advancement of developmental biology and nanotechnology, recent research on scaffolding has more focused on the design and synthesis of functionalized scaffolds that can elicit desirable cell/material interactions to guide cell behavior and enhance new tissue formation.^[7-14]

Scaffolds can be produced from a variety of materials, including metals, ceramics, and polymers. Metallic alloys are popular for both dental and bone implants^[15] while ceramics with good osteoconductivity have been used for

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Synthetic Biodegradable Polymer Scaffolds Tissue Engineering

Victor S. Lin

Synthetic Biodegradable Polymer Scaffolds Tissue Engineering:

Synthetic Biodegradable Polymer Scaffolds Anthony Atala,David J. Mooney,2013-11-11 This body of work represents the first volume of a book series covering the field of tissue engineering Tissue engineering which refers to a category of therapeutic or diagnostic products and processes which are based upon a combination of living cells and biomaterials was defined as a field only a few years ago 1988 Tissue engineering is an inherently interdisciplinary field combining bioengineering life sciences and clinical sciences The definition of this area of work as the field of tissue engineering brought together scientists from multiple backgrounds who already were working toward the achievement of similar goals Why a book series exclusively devoted to tissue engineering The field of tissue engineering is heterogeneous The cells involved in tissue engineering can be autologous allogeneic or xenogeneic The biomaterials utilized can be either naturally occurring synthetic or a combination of both The application of the technology can be either for acute or permanent purposes An attempt to cover the field of tissue engineering in a single volume with the degree of detail necessary for individuals with different scientific backgrounds and disciplines would be a difficult task to accomplish particularly when this field is just emerging and changing rapidly Therefore addressing different technologies within the field of tissue engineering in a comprehensive manner is the main mission of this series of volumes A stellar group of scientists has been brought together to form the editorial board of the series *Synthetic Biodegradable Polymer Scaffolds* Anthony Atala,David J. Mooney,1997 Brings together articles from leading researchers in the field of the synthesis and properties of biodegradable polymers utilized in tissue engineering It should provide guidance on potential new materials or applications in the tissue engineering field *Biodegradable Polymer-Based Scaffolds for Bone Tissue Engineering* naznin sultana,2012-12-15 This book addresses the principles methods and applications of biodegradable polymer based scaffolds for bone tissue engineering The general principle of bone tissue engineering is reviewed and the traditional and novel scaffolding materials their properties and scaffold fabrication techniques are explored By acting as temporary synthetic extracellular matrices for cell accommodation proliferation and differentiation scaffolds play a pivotal role in tissue engineering This book does not only provide the comprehensive summary of the current trends in scaffolding design but also presents the new trends and directions for scaffold development for the ever expanding tissue engineering applications *Scaffolding In Tissue Engineering* Peter X. Ma,Jennifer Elisseeff,2005-08-19 The growing interest in scaffolding design and increasing research programs dedicated to regenerative medicine corroborate the need for Scaffolding in Tissue Engineering While certain books and journal articles address various aspects in the field this is the first current comprehensive text focusing on scaffolding for tissue engineering

Advanced Polymers in Medicine Francesco Puoci,2014-12-02 The book provides an up to date overview of the diverse medical applications of advanced polymers The book opens by presenting important background information on polymer chemistry and physicochemical characterization of polymers This serves as essential scientific support for the subsequent

chapters each of which is devoted to the applications of polymers in a particular medical specialty The coverage is broad encompassing orthopedics ophthalmology tissue engineering surgery dentistry oncology drug delivery nephrology wound dressing and healing and cardiology The development of polymers that enhance the biocompatibility of blood contacting medical devices and the incorporation of polymers within biosensors are also addressed This book is an excellent guide to the recent advances in polymeric biomaterials and bridges the gap between the research literature and standard textbooks on the applications of polymers in medicine

Natural-Based Polymers for Biomedical Applications Rui L. Reis, Nuno M.

Neves, Joao F. Mano, Manuela E. Gomes, Alexandra P. Marques, Helena S. Azevedo, 2008-08-15 Polymers from natural sources are particularly useful as biomaterials and in regenerative medicine given their similarity to the extracellular matrix and other polymers in the human body This important book reviews the wealth of research on both tried and promising new natural based biomedical polymers together with their applications as implantable biomaterials controlled release carriers or scaffolds for tissue engineering The first part of the book reviews the sources processing and properties of natural based polymers for biomedical applications Part two describes how the surfaces of polymer based biomaterials can be modified to improve their functionality The third part of the book discusses the use of natural based polymers for biodegradable scaffolds and hydrogels in tissue engineering Building on this foundation Part four looks at the particular use of natural gelling polymers for encapsulation tissue engineering and regenerative medicine The penultimate group of chapters reviews the use of natural based polymers as delivery systems for drugs hormones enzymes and growth factors The final part of the book summarises research on the key issue of biocompatibility Natural based polymers for biomedical applications is a standard reference for biomedical engineers those studying and researching in this important area and the medical community Examines the sources processing and properties of natural based polymers for biomedical applications Explains how the surfaces of polymer based biomaterials can be modified to improve their functionality Discusses the use of natural based polymers for hydrogels in tissue engineering and in particular natural gelling polymers for encapsulation and regenerative medicine

Ligament Tissue Engineering Using Synthetic Biodegradable Polymer Fiber Scaffolds Victor S. Lin, 1998

Concise Encyclopedia of Composite Materials Andreas Mortensen, 2006-12-08 Concise Encyclopedia of Composite Materials draws its material from the award winning Encyclopedia of Materials Science and Technology and includes updates and revisions not available in the original set This customized collection of articles provides a handy reference for materials scientists and engineers with an interest in composite materials made from polymers metals ceramics carbon biocomposites nanocomposites wood cement fibers etc Brings together articles from the Encyclopedia of Materials Science extensive bibliographies cross referencing and indexes guide the user to the most relevant reading in the primary literature Covers areas of active research such as biomaterials and porous materials

Advanced Biomaterials VI Xingdong Zhang, Junzo

Tanaka, Yao Ting Yu, Yasuhiko Tabata, 2005-06-15 ASBM6 Proceedings of the 6th Asian Symposium on Biomedical Materials

Emei Chengdu China July 19 22 2004 *Principles of Regenerative Medicine* Anthony Atala, Robert Nerem, James A. Thomson, 2011-04-28 Virtually any disease that results from malfunctioning damaged or failing tissues may be potentially cured through regenerative medicine therapies by either regenerating the damaged tissues *in vivo* or by growing the tissues and organs *in vitro* and implanting them into the patient. *Principles of Regenerative Medicine* discusses the latest advances in technology and medicine for replacing tissues and organs damaged by disease and of developing therapies for previously untreatable conditions such as diabetes, heart disease, liver disease and renal failure. Key for all researchers and institutions in Stem Cell Biology, Bioengineering and Developmental Biology. The first of its kind to offer an advanced understanding of the latest technologies in regenerative medicine. New discoveries from leading researchers on restoration of diseased tissues and organs.

Tissue Engineering in Musculoskeletal Clinical Practice Linda Jo Sandell, Alan J. Grodzinsky, 2004 When will tissue engineered materials be ready for the OR? How will they be introduced into clinics? What's available in the field now? *Tissue Engineering* answers these questions and brings insight into the potential for tissue engineering as a biological solution to the critical need for human tissues in orthopaedic surgery. This book is a compilation of the proceedings of the *Tissue Engineering in Musculoskeletal Clinical Practice* workshop held in Santa Fe, NM in January 2003. It is written by orthopaedic surgeons for practical application. *Tissue Engineering* addresses the present and future direction of the clinical, scientific and business aspects of the development and application of tissue engineered materials in orthopaedic surgery. Sections address clinical and marketing challenges, methodologies used in the construction of tissue engineered materials as well as tissue engineering of bone, cartilage, ligament, tendon, meniscus, intervertebral disk and muscle.

Handbook of Stem Cells Robert Paul Lanza, 2004 Accompanying CD ROM in v 2 has image collections which can be saved in PowerPoint or HTML. *Porous Materials for Tissue Engineering* Dean Mo Liu, Vivek Dixit, 1997-09-11. *Tissue Engineering* is an interdisciplinary field that involves the development of bio artificial organs and implants. The main purpose of such prostheses is the repair, regeneration and reconstruction of lost, damaged or degenerated tissues and organs.

Handbook of Biodegradable Polymeric Materials and Their Applications Surya Mallapragada, Balaji Narasimhan, 2006 *Highly Porous and Interconnected Polymer Matrices* Adam Jon Kramschuster, 2008 **Bioceramics 25** Vasile Iulian Antoniac, Simona Cavalu, Teodor Traistaru, 2013-11-15 Selected peer reviewed papers from the 25th Symposium and Annual Meeting of the International Society for Ceramics in Medicine BIOCERAMICS 25 November 7-10 2013 Bucharest Romania.

Composite Synthetic Scaffolds for Tissue Engineering and Regenerative Medicine Naznin Sultana, Mohd Izzat Hassan, Mim Mim Lim, 2014-10-16 This book addresses important biomaterials which are commonly used to fabricate scaffolds and it describes two major protocols employed in scaffold fabrication. Tissue engineering or regenerative medicine aims at restoring *ex novo* tissues and organs whose functionality has been compromised as a consequence of diseases or traumatic events. The innovative concept underlying tissue engineering is the

use of autologous cells obtained from a biopsy of the patient Cells are seeded on a porous scaffold which has the role of supporting and guiding cells towards the development of tissue like structures as well as providing a platform for the delivery under controlled condition of growth factor release etc The successful manufacture of scaffolds for tissue engineering applications is crucial In this book these biomaterials are discussed The book also covers illustrated examples structure and properties of scaffolds cellular interactions and drug delivery

Fabrication of Hydroxyapatite-biodegradable Polymer

Scaffolds by Electrospinning for Potential Bone Tissue Application Satomi Suzuki,2006 The purpose of this study is to determine the potential of combining hydroxyapatite HA and polymers to form synthetic composite materials used for bone tissue engineering applications In this study ceramic biodegradable polymer composites are fabricated by electrospinning method The biodegradable polymers used are poly L lactic acid PLLA and poly lactide co glycolide PLGA Two types of HA polymer solutions are first prepared to achieve HA weight percentage of 0 10 and 25%of the total combined weight of HA and PLLA and HA and PLGA The solutions are electrospun to form nanofibrous mats incorporated with HA powder A biomimetic process was also conducted as a secondary approach The nanofibrous mats obtained follow characterization using scanning electron microscope SEM Energy Dispersive X ray Analysis EDXA Thermogravimetric Analysis TGA and X ray Diffraction XRD In this study hydroxyapatite HA particles were successfully incorporated into the three dimensional porous biodegradable PLLA and PLGA polymer fiber mats by electrospinning

Combined Polymeric Scaffold Delivery of Condensed DNA, Protein, and Stems Cells for Bone Tissue Engineering Yen-Chen Huang,2004 Development of Non-viral Gene Transfer and Growth Factor Delivery to Direct Bone Regeneration Kathryn Warnock Riddle,2005

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