Tissue Engineering By Palsson

Links basic science and engineering principles to show how engineers create new methods of diagnosis and therapy for human disease.

The opportunity that tissue engineering provides for medicine is extraordinary. In the United States alone, over half-a-trillion dollars are spent each year to care for patients who suffer from tissue loss or dysfunction. Although numerous books and reviews have been written on tissue engineering, none has been as comprehensive in its defining of the field. Principles of Tissue Engineering combines in one volume the prerequisites for a general understanding of tissue growth and development, the tools and theoretical information needed to design tissues and organs, as well as a presentation of applications of tissue engineering to diseases affecting specific organ systems. The first edition of the book, published in 1997, is the definite reference in the field. Since that time, however, the discipline has grown tremendously, and few experts would have been able to predict the explosion in our knowledge of gene expression, cell growth and differentiation, the variety of stem cells, new polymers and materials that are now available, or even the successful introduction of the first tissue-engineered products into the marketplace. There was a need for a new edition, and this need has been met with a product that defines and captures the sense of excitement, understanding and anticipation that has followed from the evolution of this fascinating and important field. Key Features * Provides vast, detailed analysis of research on all of the major systems of the human body, e.g., skin, muscle, cardiovascular, hematopoietic, and nerves * Essential to anyone working in the field * Educates and directs both the novice and advanced researcher * Provides vast, detailed analysis of research with all of the major systems of the human body, e.g. skin, muscle, cardiovascular, hematopoietic, and nerves * Has new chapters written by leaders in the latest areas of research, such as fetal tissue engineering and the universal cell * Considered the definitive reference in the field * List of contributors reads like a "who's who" of tissue engineering, and includes Robert Langer, Joseph Vacanti, Charles Vacanti, Robert Nerem, A. Hari Reddi, Gail Naughton, George Whitesides, Doug Lauffenburger, and Eugene Bell, among others

Tissue engineering is the use of a combination of cells, engineering and materials methods, and suitable biochemical and physio-chemical factors to improve or replace biological functions. While most definitions of tissue engineering cover a broad range of applications, in practice the term is closely associated with applications that repair or replace portions of or whole tissues (i.e., bone, cartilage, blood vessels, bladder, etc.). Often, the tissues involved require certain mechanical and structural properties for proper function.

The term has also been applied to efforts to perform specific biochemical functions using cells within an artificially-created support system (e.g. an artificial pancreas, or a bioartificial liver). The term regenerative medicine is often used synonymously with tissue engineering, although those involved in regenerative medicine place more emphasis on the use of stem cells to produce tissues. This book presents recent and important research in the field.

It is our pleasure to present this special volume on tissue engineering in the series Advances in Biochemical Engineering and Biotechnology. Thisvolume re?ects the emergence of tissue engineering as a core discipline of modern biomedical engineering, and recognizes the growing synergies between the technological developments in biotechnology and biomedicine. Along this vein, the focusof thisvolume istoprovide abiotechnology driven perspective on cell engineering fundamentals while highlighting their signi?cance in p- ducing functional tissues. Our aim is to present an overview of the state of the art of a selection of these technologies, punctuated with current applications in the research and development of cell-based therapies for human disease. To prepare this volume, we have solicited contributions from leaders and experts in their respective ?elds, ranging from biomaterials and bioreactors to gene delivery and metabolic engineering. Particular emphasis was placed on including reviews that discuss various aspects of the biochemical p- cesses underlying cell function, such as signaling, growth, differentiation, and communication. The reviews of research topics cover two main areas: cel- lar and non-cellular components and assembly; evaluation and optimization of tissue function; and integrated reactor or implant system development for research and clinical applications. Many of the reviews illustrate how bioche- cal engineering methods are used to produce and characterize novel materials (e. g. genetically engineered natural polymers, synthetic scaffolds with ce- type speci?c attachment sites or inductive factors), whose unique properties enable increased levels of control over tissue development and architecture.

Cells and Biomaterials in Regenerative Medicine
From Cells to Organisms
Biomaterials for Musculoskeletal Regeneration
Advanced Techniques in Bone Regeneration
Introductory Biomechanics

Thoroughly revised and updated for the second edition, this comprehensive textbook integrates basic and advanced concepts of mechanics with numerical methods and biomedical applications. Coverage is expanded to include a complete introduction to vector and tensor calculus, and new or fully updated chapters on biological materials and continuum mechanics, motion, deformation and rotation, and constitutive modelling of solids and fluids. Topics such as kinematics, equilibrium, and stresses and strains are also included, as well as the mechanical behaviour of fibres and the analysis of one-dimensional continuous elastic media. Numerical solution procedures based on the Finite Element Method are presented, with accompanying MATLAB-based software and dozens of new biomedical engineering examples and exercises allowing readers to practise and improve their skills. Solutions for instructors are also available online. This is the definitive guide for both undergraduate and graduate students taking courses in biomechanics.

Drawing a distinguished editors and international team of contributors, this book reviews the latest research and advances and how they can be used to develop treatments for disease states. An innovative and up-to-date reference, it begins with a discussion of general issues and then moves on to review characterization. Building on this foundation, later chapters analyze bone regeneration and specific types of tissue engineering and repair such as cardiac, intervertebral disc, skin, kidney and bladder tissue. The book concludes with coverage of themes such as nerve bioengineering and the micromechanics of hydroxyapatite-based biomaterials and tissue scaffolds.

Under the direction of John Enderle, Susan Blanchard and Joe Bronzino, leaders in the field have contributed chapters on the most relevant subjects for biomedical engineering students. These chapters coincide with courses offered in all biomedical engineering programs so that it can be used at different levels for a variety of courses of this evolving field. Introduction to Biomedical Engineering, Second Edition provides a historical perspective of the major developments in the biomedical field. Also contained within are the fundamental principles underlying biomedical engineering design, analysis, and modeling procedures. The numerous examples, drill problems and exercises are used to reinforce concepts and develop problem-solving skills making this book an invaluable tool for all biomedical students and engineers. New to this edition: Computational Biology, Medical Imaging, Genomics and Bioinformatics. * 60% update from first edition to reflect the developing field of biomedical engineering * New chapters on Computational Biology, Medical Imaging, Genomics, and Bioinformatics * Companion site: http://intro-bme-book.bme.uconn.edu/ * MATLAB and SIMULINK software used throughout to model and simulate dynamic systems * Numerous self-study homework problems and thorough cross-referencing for easy use

This book covers the basics of the biomaterials science its applications to bone tissue engineering. The introductory section describes the most necessary concepts and techniques related to the cell and molecular biology with a particular focus on evaluating the biocompatibility property. The layout of this book facilitates easier understanding of the area of bone tissue engineering. The book integrates the Materials Science and Biological Science. It covers processing and basic material properties of various biocompatible metals and ceramics-based materials, in vitro and in vivo biocompatibility and toxicity assessment in the context of bone tissue engineering, and processing and properties of metal-, ceramic- and polymer-based biocomposites, including the fabrication of porous scaffold materials. The book can be used as a textbook for senior undergraduate and graduate coursework. It will also be a useful reference for researchers and professionals working in the area.

Tissue Engineering
Principles, Design and Operation
Scaffolding In Tissue Engineering
I & II
Anthropological Perspectives

Biophysical models have been used in biology for decades, but they have been limited in scope and size. In this book, Bernhard Ø. Palsson shows how network reconstructions that are based on genomic and bibliomic data, and take the form of established stoichiometric matrices, can be converted into dynamic models using metabolomic and fluxomic data. The Mass Action Stoichiometric Simulation (MASS) procedure can be used for any cellular process for which data is available and allows a scalable step-by-step approach to the practical construction of network models. Specifically, it can treat integrated processes that need explicit accounting of small molecules and protein, which allows simulation at the molecular level. The material has been class-tested by the author at both the undergraduate and graduate level. All computations in the text are available online in MATLAB and MATHEMATICA® workbooks, allowing hands-on practice with the material.

Organised around problem solving, this book introduces the reader to computational simulation, bridging fundamental theory with real-world applications.

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. Scaffolding in Tissue Engineering reviews the general principles of tissue engineering and concentrates on the principles, methods, and applications for a broad range of tissue engineering scaffolds. The first section presents an in-depth exploration of traditional and novel materials, including alginates, polysaccharides, and fibrillar fibrin gels. The following section covers fabrication technologies, discussing three-dimensional scaffold design, laboratory-scale manufacture of a cell carrier, phase separation, self-assembly, gas foaming, solid freeform fabrication, injectable systems, and immunoisolation techniques. Subsequent chapters examine structural and functional scaffold modification, composite scaffolds, bioactive hydrogels, gene delivery, growth factors, and degradation of biodegradable polymers. The final section explores various tissue engineering applications, comprising chapters on blood cell substitutes, and tissue engineering of nerves, the tendons, ligaments, cornea, cartilage and myocardium, meniscal tissue. While providing a comprehensive summary of current knowledge and technologies, Scaffolding in Tissue Engineering gives readers insight into new trends and directions for scaffold development and for an ever-expanding range of tissue engineering applications.

Describing the role of engineering in medicine today, this comprehensive volume covers a wide range of the most important topics in this burgeoning field. Supported with over 145 illustrations, the book discusses bioelectrical systems, mechanical analysis of biological tissues and organs, biomaterial selection, compartmental modeling, and biomedical instrumentation. Moreover, you find a thorough treatment of the concept of using living cells in various therapeutics and diagnostics. Structured as a complete text for students with some engineering background, the book also makes a valuable reference for professionals new to the bioengineering field. This authoritative textbook features numerous exercises and problems in each chapter to help ensure a solid understanding of the material.

Biomedical Engineering Handbook 2
Principles and Practices
Principles of Biomedical Engineering
Special Issue
An Introduction to Modeling of Transport Processes

Many potential applications of synthetic and systems biology are relevant to the challenges associated with the detection, surveillance, and responses to emerging and re-emerging infectious diseases. On March 14 and 15, 2011, the Institute of Medicine's (IOM's) Forum on Microbial Threats convened a public workshop in Washington, DC, to explore the current state of the science of synthetic biology, including its dependency on systems biology; discussed the different approaches that scientists are taking to engineer, or reengineer, biological systems; and discussed how the tools and approaches of synthetic and systems biology were being applied to mitigate the risks associated with emerging infectious diseases. The Science and Applications of Synthetic and Systems Biology is organized into sections as a topic-by-topic distillation of the presentations and discussions that took place at the workshop. Its purpose is to present information from relevant experience, to delineate a range of pivotal issues and their respective challenges, and to offer differing perspectives on the topic as discussed and described by the workshop participants. This report also includes a collection of individually authored papers and commentary.

Chemical cross-linking reagents have attained great practical use in industry as well as in basic research, and an understanding of their fundamental principles of reaction is paramount to their applications. With broad coverage of the development and application of these reagents, Chemistry of Protein Conjugation and Cross-Linking discusses the mechanism of reaction and allows you to put the theory into practice. The book offers an explanation of the underlying mechanism of chemical modification, surveys all the bifunctional reagents used in bioconjugation and cross-linking, and provides a review of practical applications of these reagents in various areas of biochemistry, molecular biology, biotechnology, nucleic acid chemistry, immunochemistry, and diagnostic and biomedical disciplines. It contains numerous examples and illustrations, plus step-by-step explanations to reaction procedures. It is an excellent introduction and a comprehensive reference about chemical modification.

The first comprehensive single-authored textbook on genome-scale models and the bottom-up approach to systems biology.

A volume in the new Principles and Applications in Engineering series, Tissue Engineering provides an overview of the major physiologic systems of current interest to biomedical engineers: cardiovascular, endocrine, nervous, visual, auditory, gastrointestinal, and respiratory. It contains useful definitions, tables of basic physiologic data, and an introduction to the literature. Then, the book reviews the status of tissue engineering of specific organs, including bone marrow, skeletal muscle, and cartilage. Readers will acquire a good understanding of the engineering and cell biological fundamentals of tissue engineering and will develop ideas for further development of this emerging and important field.

Tissue Engineering II
Basics of Tissue Engineering and Tissue Applications
Nucleotides and Regulation of Bone Cell Function
Tissue Engineering Methods and Protocols
Applications to Biomedical Systems

Frontiers in Tissue Engineering is a carefully edited compilation of state-of-the-art contributions from an international authorship of experts in the diverse subjects that make up tissue engineering. A broad representation of the medical, scientific, industrial and regulatory community is detailed in the book. The work is an authoritative and comprehensive reference source for scientists and clinicians working in this emerging field. The book is divided into three parts: fundamentals and methods of tissue engineering, tissue engineering applied to specialised tissues, and tissue engineering applied to organs. The text offers many novel approaches, including a detailed coverage of cell-tissue interactions at cellular and molecular levels; cell-tissue surface, biochemical, and mechanical environments; biomaterials; engineering design; tissue-organ function; new approaches to tissue-organ regeneration and replacement of function; ethical considerations of tissue engineering; and government regulation of tissue-engineered products.

Tissue EngineeringCRC Press

The contributors to this book focus on the relationship between nature and society from a variety of theoretical and ethnographic perspectives. Their work draws upon recent developments in social theory, biology, ethnobiology, epistemology, sociology of science, and a wide array of ethnographic case studies -- from Amazonia, the Solomon Islands, Malaysia, the Mollucan Islands, rural comunities from Japan and north-west Europe, urban Greece, and laboratories of molecular biology and high-energy physics. The discussion is divided into three parts, emphasising the problems posed by the nature-culture dualism, some misguided attempts to respond to these problems, and potential avenues out of the current dilemmas of ecological discourse.

Introductory Biomechanics is a new, integrated text written specifically for engineering students. It provides a broad overview of this important branch of the rapidly growing field of bioengineering. A wide selection of topics is presented, ranging from the mechanics of single cells to the dynamics of human movement. No prior biological knowledge is assumed and in each chapter, the relevant anatomy and physiology are first described. The biological system is then analyzed from a mechanical viewpoint by reducing it to its essential elements, using the laws of mechanics and then tying mechanical insights back to biological function. This integrated approach provides students with a deeper understanding of both the mechanics and the biology than from qualitative study alone. The text is supported by a wealth of illustrations, tables and examples, a large selection of suitable problems and hundreds of current references, making it an essential textbook for any biomechanics course.

Systems Biology: Simulation of Dynamic Network States
Concepts and Computation

Roles, Materials, and Applications
Bridging Medicine and Technology

ATP's powerful impact on the heart and blood vessels was first described in 1929, but it was not until the 1970s that ATP was proposed as the 'purinergic' neurotransmitter in autonomic nerves. The door to this area of research was thrown open when receptors for ATP and its ectoenzymatic breakdown product adenosine were first cloned in the early 1990s. Now, rapidly accelerating research has taken scientists beyond the nervous system, to isolate receptors for purines and pyrimidines in many biological systems. Increasing evidence suggests that research into this area may lead to breakthrough applications in treating many of the most pressing health issues of today, including rheumatoid arthritis, osteoporosis, inflammation, and cancer. Nucleotides and Regulation of Bone Cell Function brings together the most important findings in the field, written by the very pioneers who have energized the research. Covering many aspects of purinergic signaling with regard to osteoblasts, osteoclasts, and chondrocytes, this volume provides an up-to-date exploration of the actions of nucleotides on skeletal cells. Supported by recent studies, this volume describes the distribution of receptors for purines and pyrimidines in skeletal tissue cells. It considers purinergic and P2 nucleotide receptor signaling in osteoclasts and osteoblasts, examines the role of purinergic signaling in regulating cartilage metabolism and chondrocyte function, and details ATP release mechanisms. It also delves into inflammation and immunomodulation, considers the pathophysiologic implications of the findings, and discusses future directions of research, including purine-related therapeutic interventions in a variety of diseases. In providing a compilation of major breakthroughs, Nucleotides and Regulation of Bone Cell Function offers the most definitive account currently available of the role played by purinergic extracellular signaling in both normative and pathologic conditions.

Maintaining quality of life in an ageing population is one of the great challenges of the 21st Century. This book summarises how this challenge is being met by multi-disciplinary developments of specialty biomaterials, devices, artificial organs and in-vitro growth of human cells as tissue engineered constructs. Biomaterials, Artificial Organs and Tissue Engineering is intended for use as a textbook in a one semester course for upper level BS, MS and Meng students. The 25 chapters are organized in five parts: Part one provides an introduction to living and man-made materials for the non-specialist; Part two is an overview of clinical applications of various biomaterials and devices; Part three summarises the bioengineering principles, materials and designs used in artificial organs; Part four presents the concepts, cell techniques, scaffold materials and applications of tissue engineering; Part five provides an overview of the complex socio-economic factors involved in technology based healthcare, including regulatory controls, technology transfer processes and ethical issues. Comprehensive introduction to living and man-made materials Looks at clinical applications of various biomaterials and devices Bioengineering principles, materials and designs used in artificial organs are summarised

Tissue engineering is a multidisciplinary field incorporating the principles of biology, chemistry, engineering, and medicine to create biological substitutes of native tissues for scientific research or clinical use. Specific applications of this technology include studies of tissue development and function, investigating drug response, and tissue repair and replacement. This area is rapidly becoming one of the most promising treatment options for patients suffering from tissue failure. This abundantly illustrated and well-structured guide serves as a reference for all clinicians and researchers dealing with tissue engineering issues in their daily practice.

Tissue engineering research continues to captivate the interest of researchers and the general public alike. Popular media outlets like The New York Times, Time, and Wired continue to engage a wide audience and foster excitement for the field as regenerative medicine inches toward becoming a clinical reality. Putting the numerous advances in the field into a broad context, Tissue Engineering: Principles and Practices explores current thoughts on the development of engineered tissues. With contributions from experts and pioneers, this book begins with coverage of the fundamentals, details the supporting technology, and then elucidates their applications in tissue engineering. It explores strategic directions, nanobiomaterials, biomimetics, gene therapy, cell engineering, and more. The chapters then explore the applications of these technologies in areas such as bone engineering, cartilage tissue, dental tissue, vascular engineering, and neural engineering. A comprehensive overview of major research topics in tissue engineering, the book: Examines the properties of stem cells, primary cells, growth factors, and extracellular matrix as well as their impact on the development of tissue-engineered devices Focuses upon those strategies typically incorporated into tissue-engineered devices or utilized in their development, including scaffolds, nanocomposites, bioreactors, drug delivery systems, and gene therapy techniques Presents synthetic tissues and organs that are currently under development for regenerative medicine applications The contributing authors are a diverse group with backgrounds in academia, clinical medicine, and industry. Furthermore, this book includes contributions from Europe, Asia, and North America, helping to broaden the views on the development and application of tissue-engineered devices. The book provides a useful reference for courses devoted to tissue engineering fundamentals and those laboratories developing tissue-engineered devices for regenerative medicine therapy.

Introduction to Bioengineering
Nature and Society
Tissue Engineering & Cell Therapies
Tissue Engineering Using Ceramics and Polymers
I

A volume in the new Principles and Applications in Engineering series, Tissue Engineering provides an overview of the major physiologic systems of current interest to biomedical engineers: cardiovascular, endocrine, nervous, visual, auditory, gastrointestinal, and respiratory. It contains useful definitions, tables of basic physiologic data, and an

Since the publication of Carr and Brown's biomedical equipment text more than ten years ago, it has become the industry standard. Now, this completely revised second edition promises to set the pace for modern biomedical equipment technology.

Advanced Techniques in Bone Regeneration is a book that brings together over 15 chapters, written by leading practitioners and researchers, of the latest advances in the area, including surgical techniques, new discoveries, and promising methods involving biomaterials and tissue engineering. This book is intended for all who work in the treatment of disorders involving problems with the regeneration of bone tissue, are doctors or dentists, as well as are researchers and teachers involved in this exciting field of scientific knowledge.

The editors of this special volume would first like to thank all authors for their excellent contributions. We would also like to thank Prof. Dr. Thomas Scheper, Dr. Marion Hertel and Ulrike Kreusel for providing the opportunity to compose this volume and Springer for organizational and technical support. Tissue engineering represents one of the major emerging fields in modern b- technology; it combines different subjects ranging from biological and material sciences to engineering and clinical disciplines. The aim of tissue engineering is the development of therapeutic approaches to substitute diseased organs or tissues or improve their function. Therefore, three dimensional biocompatible materials are seeded with cells and cultivated in suitable systems to generate functional tissues. Many different aspects play a role in the formation of 3D tissue structures. In the first place the source of the used cells is of the utmost importance. To prevent tissue rejection or immune response, preferentially autologous cells are now used. In particular, stem cells from different sources are gaining exceptional importance as they can be differentiated into different tissues by using special media and supplements. In the field of biomaterials, numerous scaffold materials already exist but new composites are also being developed based on polymeric, natural or xenogenic sources. Moreover, a very important issue in tissue en- neering is the formation of tissues under well defined, controlled and reprod- ible conditions. Therefore, a substantial number of new bioreactors have been developed.

Basic Transport Phenomena in Biomedical Engineering
Chemistry of Protein Conjugation and Cross-Linking
Biomedical Engineering
The Science and Applications of Synthetic and Systems Biology
Systems Biology

The response of cells to biomaterials is critical in medical devices. Traditionally inert biomaterials were used to minimise the reaction in cells in contact with the material. However, it has been realised that specific cell responses may be beneficial in such areas as encouraging adhesion, healing or cell multiplication. Cellular response to biomaterials discusses the response of cells to a wide range of biomaterials targeted at specific medical applications. Part one discusses cell responses to a variety of polymers and ceramics with chapters on such topics as degradable polymers and biocompatibility. Part two covers cell responses and regenerative medicine with coverage of themes such as vascular grafts, nerve repair and Bioglass®. Part three examines the effect of surfaces and proteins on cell response. Specific chapters review nano-engineered surfaces, the influence of plasma proteins on bone cell adhesion and surface modification of titanium implants. With its distinguished editor and team of international contributors, Cellular response to biomaterials is an essential read for those researching or studying medical devices in industry and academia. Examines the response of cells to a wide range of biomaterials targeted at specific medical applications Discusses cell responses and regenerative medicine with specific chapters on vascular grafts and nerve repair Assesses the effect of surfaces and proteins on cell response including the influence of plasma proteins on cell adhesion and surface modification of titanium implants

This will be a substantial revision of a good selling text for upper division/first graduate courses in biomedical transport phenomena, offered in many departments of biomedical and chemical engineering. Each chapter will be updated accordingly, with new problems and examples incorporated where appropriate. A particular emphasis will be on new information related to tissue engineering and organ regeneration. A key new feature will be the inclusion of complete solutions within the body of the text, rather than in a separate solutions manual. Also, Matlab will be incorporated for the first time with this Fourth Edition.

Bioengineering is attracting many high quality students. This invaluable book has been written for beginning students of bioengineering, and is aimed at instilling a sense of engineering in them.Engineering is invention and designing things that do not exist in nature for the benefit of humanity. Invention can be taught by making inventive thinking a conscious part of our daily life. This is the approach taken by the authors of this book. Each author discusses an ongoing project, and gives a sample of a professional publication. Students are asked to work through a sequence of assignments and write a report. Almost everybody soon realizes that more scientific knowledge is needed, and a strong motivation for the study of science is generated. The teaching of inventive thinking is a new trend in engineering education. Bioengineering is a good field with which to begin this revolution in engineering education, because it is a youthful, developing interdisciplinary field.

This book serves as a good starting point for anyone interested in the application of tissue engineering. It offers a colorful mix of topics, which explain the obstacles and possible solutions for TE applications. The first part covers the use of adult stem cells and their applications. The following chapters offer an insight into the development of a tailored biomaterial for organ replacement and highlight the importance of cell-biomaterial interaction. In summary, this book offers insights into a wide variety of cells, biomaterials, interfaces and applications of the next generation biotechnology, which is tissue engineering.

A Primer with Laboratory Demonstrations
From Lab to Clinic
Biomechanics
Introduction to Biomedical Equipment Technology
Workshop Summary

For the first time in a single volume, the design, characterisation and operation of the bioreactor system in which the tissue is grown is detailed. Bioreactors for Tissue Engineering presents an overall picture of the current state of knowledge in the engineering of bioreactors for several tissue types (bone, cartilage, vascular), addresses the issue of mechanical conditioning of the tissue, and describes the use of techniques such as MRI for monitoring tissue growth. This unique volume is dedicated to the fundamentals and application of bioreactor technology to tissue engineering products. Not only will it appeal to graduate students and experienced researchers in tissue engineering and regenerative medicine, but also to tissue engineers and culture technologists, academic and industrial chemical engineers, biochemical engineers and cell biologists who wish to understand the criteria used to design and develop novel systems for tissue growth in vitro.

In recent years, the field of tissue engineering has begun, in part, to c- lesce around the important clinical goal of developing substitutes or repla- ments for defective tissues or organs. These efforts are focused on many tissues including skin, cartilage, liver, pancreas, bone, blood, muscle, the vascu- ture, and nerves. There is a staggering medical need for new and effective treatments for acquired as well as inherited defects of organs/tissues. Tissue engineering is at the interface of the life sciences, engineering, and clinical medicine and so draws upon advances in cell and molecular biology, mate- als sciences, and surgery, as well as chemical and mechanical engineering. Such an interdisciplinary field requires a broad knowledge base as well as the use of a wide assortment of methods and approaches. It is hoped that by bringing together these protocols, this book will help to form connections - tween the different disciplines and further stimulate the synergism underlying the foundation of the tissue engineering field.

Bioreactors for Tissue Engineering
Frontiers in Tissue Engineering
Cellular Response to Biomaterials
Concepts
Bioreactor Systems for Tissue Engineering