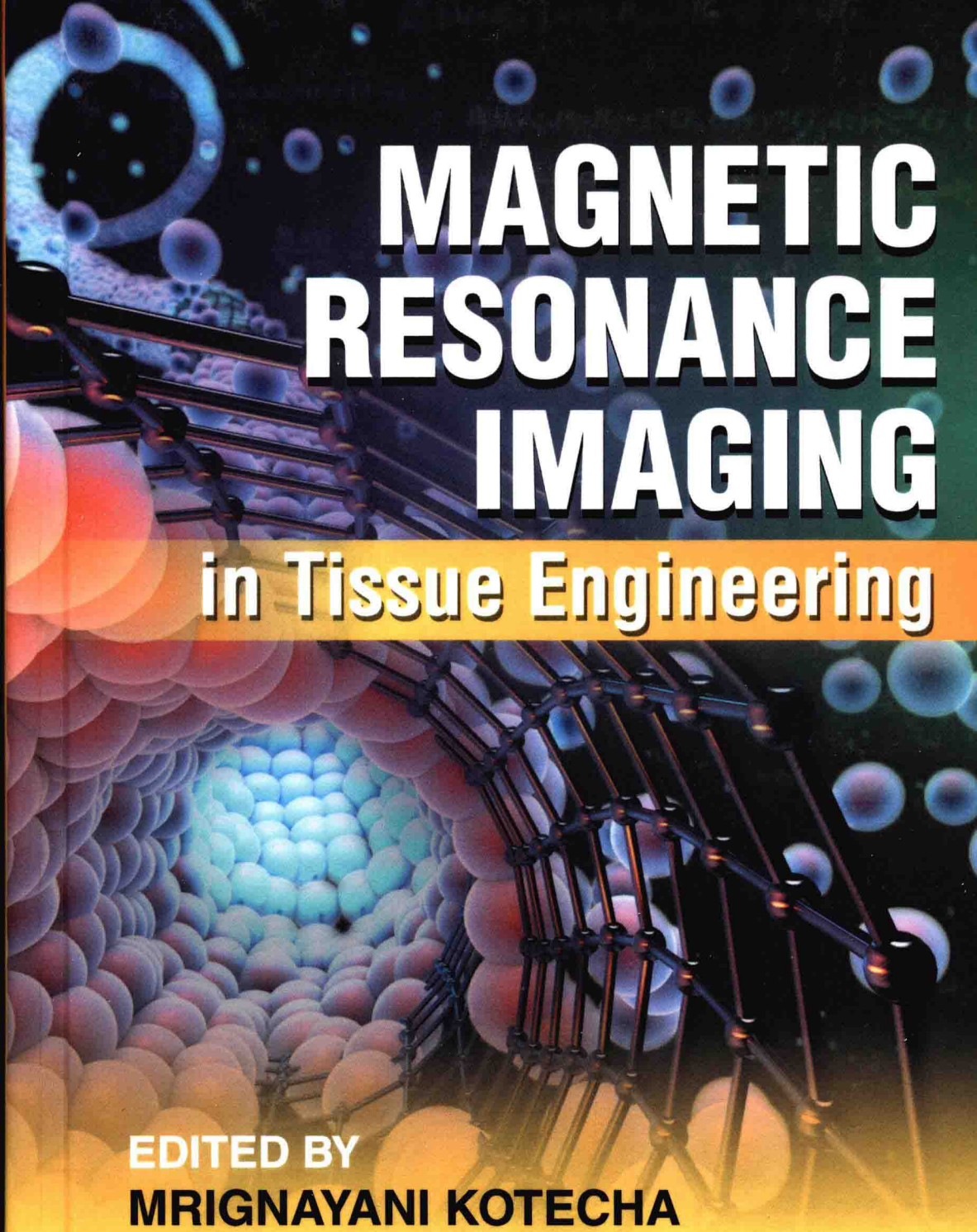

MAGNETIC RESONANCE IMAGING

in Tissue Engineering

EDITED BY
MRIGNAYANI KOTECHA
RICHARD L. MAGIN
JEREMY J. MAO

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Magnetic Resonance Imaging in Tissue Engineering

Edited by Mrignayani Kotecha, Richard L. Magin, and Jeremy J. Mao

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Magnetic Resonance Imaging in Tissue Engineering

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Figure 1.3 Cell migration into a synthetic three-dimensional (3D) scaffold. A composite 3D scaffold composed of poly(methacrylic acid) (PMMA) and poly(hydroxyethyl methacrylate) (PHEMA) was developed for cornea tissue engineering. Confocal microscopy was used to monitor migration of corneal fibroblasts into the acellular scaffold. Using a viability assay, the live or dead cells fluoresce different in different wavelengths. Because the confocal images were collected at different focal depths, reconstructed 3D images can be produced with detailed information in the direction of cell migration into the scaffold. * indicates $p < 0.05$. *11*

Figure 1.4 Four-color imaging of osteogenesis. Human MSCs were induced to differentiate to osteoblasts. At day 14, the cells were labeled and visualized to quantify the extent of osteogenesis. Using a multiphotom microscope (Bio-Rad, Radiance 2000), a set of four fluorophores was selected to label and image simultaneously the nuclei (blue), osteocalcin expression (green), microtubule (yellow), and microfilament (red) organization. These four fluorophores were carefully chosen to minimize potential spectroscopic overlaps. *13*

Figure 2.7 The calculated T_1 and T_2 as functions of the water molecule tumbling rate and magnetic field strength (100–700 MHz) calculated using the BPP theory of relaxation [50]. As the tissue matures, both T_1 and T_2 decrease, as shown by the red arrow. Most human tissues fall within the range shown by the blue ellipse. T_2 is commonly used in the assessment of cartilage regeneration, as can be seen in a recent clinical trial [2, 6]. The figure shows that relaxation times are field dependent for soft tissues. The inset shows an example of how T_2/T_1 can be used as a unit-free biomarker for the assessment. As shown in the inset, the control gel has the highest T_2/T_1, but the ratio is lowest for osteogenic constructs with chondrogenic constructs falling between the two. Data in the inset are adapted from [25, 51]. *35*

Figure 3.6 (a) Schematic of a sample preparation for MRI measurement (the black arrow indicates the sample inside a 5 mm tube). (b) A representative T_2-weighted

About the Editors

Mrignayani Kotecha

Dr. Mrignayani Kotecha received her M.Sc. and Ph.D. in physics from Jabalpur University, India, in 1990 and 2001, respectively. She is research professor of Bioengineering at University of Illinois at Chicago, Chicago, IL, USA. Prior to this, she was assistant professor of physics at Government Autonomous Science College, Jabalpur, India (1993–2001), visiting scientist in chemical physics at Weizmann Institute of Science, Rehovot, Israel (2001–2003), and staff scientist in chemistry at the University of Duisburg-Essen, Essen, Germany (2003–2006). She has received University Grants Commission (UGC) teacher fellowship in 1999, Science and Engineering Research Council (SERC), visiting scientist fellowship from the department of science and technology (DST), Government of India in 2000, and Feinberg visiting scientist fellowship from Weizmann Institute of Science, Israel, in 2001. Her research is focused on applications of magnetic resonance spectroscopy and imaging to biomaterials. She is also involved in developing standards for noninvasive MRI assessment of engineered tissue with the American Society for Testing and Materials (ASTM) and the International Organization for Standardization (ISO) as an expert in the field.

Richard L. Magin

Richard L. Magin (M'69–SM'81–F'96) received the B.S. and M.S. degrees in physics from the Georgia Institute of Technology, Atlanta, GA, USA, in 1969 and 1972, respectively. He received the Ph.D. degree in biophysics from the University of Rochester, Rochester, NY, USA, in 1976. Currently, he is Distinguished Professor of Bioengineering at the University of Illinois at Chicago, Chicago, IL, USA. His research interests focus on the application of magnetic resonance imaging in science and engineering. He served as Editor for the Critical Reviews in Biomedical Engineering (2005–2010). He is a member of the Biomedical Engineering Society and of the International Society of Magnetic Resonance in Medicine. He is a Fellow of the American Institute for Medical and Biological Engineering. In 2005, he received a Fulbright award for research and teaching in Kosice, Slovakia.

Jeremy J. Mao

Jeremy J. Mao is currently professor at Columbia University and Edwin Robinson Endowed Chair. His research has been at the interface between stem cell biology and biomaterials. His research group has made several important discoveries in endogenous stem cells that are recruited into three-dimensional (3D)-printed biomaterials for the healing of tissue and organ defects, including a cover article in the *Lancet*. In addition, his work has been published in *Nature Medicine*, *Lancet*, *Science Translational Medicine*, *Cell Stem Cell*, etc. He has published over 260 scientific papers and proceedings and written two books. His research has led to over 70 patents and establishment of two biotechnology companies. He has received a number of prestigious awards including Yasuda Award, IADR Distinguished Scientist Award, and Spenadel Award. He is consultant to funding agencies in the United States (NIH, NSF, DARPA) and over 18 other countries.

List of Contributors

Abeid Anslip
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Hanying Bai
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Alison M. Biercevicz
Department of Orthopedics
Warren Alpert Medical School
Brown University/Rhode Island Hospital
and
School of Engineering
Brown University
Providence, RI, USA

Shan-Ho Chan
Department of Medical Imaging and Radiology
Shu-Zen Junior College of Medicine and Management
Kaohsiung, Taiwan, R.O.C.

Bo Chen
Department of Bioengineering
University of Texas
Arlington, TX, USA

Mo Chen
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Hai-Ling Margaret Cheng*
Institute of Biomaterials and Biomedical Engineering
The Edward S. Rogers Sr. Department of Electrical and Computer Engineering
University of Toronto
and
Ted Rogers Centre for Heart Research
Translational Biology and Engineering Program
Toronto, Ontario, Canada

Michael Cho*
Department of Bioengineering
University of Texas
Arlington, TX, USA

* indicates corresponding authors.

Thomas DeBerardino
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Boris Epel*
Department of Radiation and Cellular Oncology, Center for EPR In Vivo Physiology
The University of Chicago
Chicago, IL, USA

Braden C. Fleming
Department of Orthopaedics, Warren Alpert Medical School
Brown University/Rhode Island Hospital
and
School of Engineering
Brown University
Providence, RI, USA

Anne George*
Brodie Tooth Development Genetics and Regenerative Medicine Research Laboratory, Department of Oral Biology, Collage of Dentistry
University of Illinois at Chicago
Chicago, IL, USA

Qimei Gong
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University
Medical Center
New York, NY, USA

Howard J. Halpern
Department of Radiation and Cellular Oncology, Center for EPR In Vivo Physiology
The University of Chicago
Chicago, IL, USA

Ling He
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Shan-hui Hsu*
Institute of Polymer Science and Engineering
National Taiwan University
Taipei, Taiwan, R.O.C.

Elnaz Pour Issa
Department of Biomedical Engineering
Florida International University
Miami, FL, USA

Laurence H. Jackson*
Center for Advanced Biomedical Imaging
University College London
London, UK

Rex M. Jeffries
Department of Biomedical Engineering
University of North Carolina at Chapel Hill
Chapel Hill, NC, USA

Mrignayani Kotecha*
Department of Bioengineering
University of Illinois at Chicago
Chicago, IL, USA

Haakil Lee*
Department of Chemical Engineering
Keimyung University
Dalseo-Gu, Daegu, South Korea

Ling Lei
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Weiguo Li
Department of Bioengineering
University of Illinois at Chicago
Chicago, IL, USA

Caleb Liebman
Department of Bioengineering
University of Texas
Arlington, TX, USA

Yifei Liu*
Department of Mechanical and Industrial Engineering
University of Illinois at Chicago
Chicago, IL, USA

Yongxing Liu
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Mark F. Lythgoe
Center for Advanced Biomedical Imaging
University College London
London, UK

Jeffrey M. Macdonald*
Department of Biomedical Engineering
University of North Carolina at Chapel Hill
Chapel Hill, NC, USA

Richard L. Magin
Department of Bioengineering
University of Illinois at Chicago
Chicago, IL, USA

Jeremy J. Mao*
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Martha M. Murray
Department of Orthopedic Surgery
Children's Hospital Boston
Boston, MA, USA

Xuguang Nie
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Syam Nukavarapu*
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Emmanuel Nwachuku
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Shadi F. Othman*
School of Engineering and Computer Science
University of the Pacific
Stockton, CA, USA

Parisa Rabbani
Department of Bioengineering
University of Texas
Arlington, TX, USA

Sharan Ramaswamy*
Department of Biomedical Engineering
Florida International University
Miami, FL, USA

Sriram Ravindran
Department of Oral Biology
Collage of Dentistry
University of Illinois at Chicago
Chicago, IL, USA

Thomas J. Royston*
Departments of Bioengineering, Mechanical, and Industrial Engineering
University of Illinois at Chicago
Chicago, IL, USA

Nilse Dos Santos
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Tyler Stahl
Orthopedic Surgery, Materials Science and Engineering, and Biomedical Engineering
University of Connecticut
Farmington, CT, USA

Daniel J. Stuckey
Center for Advanced Biomedical Imaging
University College London
London, UK

Andrey P. Tikunov
Department of Biomedical Engineering
University of North Carolina at Chapel Hill
Chapel Hill, NC, USA

Vincent M. Wang*
Department of Biomedical Engineering and Mechanics
Virginia Tech
Blacksburg, VA, USA

Guodong Yang
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Yixiong Zhang
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Jinxuan Zheng
Center of Craniofacial Surgery,
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA

Juan Zhong
Center of Craniofacial Surgery
College of Dental Medicine
Columbia University Medical Center
New York, NY, USA