

BOOK SERIES - 50th Year of Hacettepe University
Series Editor: Adil Denizli

BIOMATERIALS AND STEM CELLS: FROM BASICS TO APPLICATIONS

***Bora Garipcan
Editor***



**HACETTEPE
UNIVERSITY
2018**

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Adil Denizli *Series, Editor*

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Kitapta yer alan yazı, resim ve şekil 5846 sayılı yasanın hükümlerine göre kısmen ya da tamamen basılamaz, dolaylı dahi olsa kullanılamaz, teksir, fotokopi ya da başka bir teknikle çoğaltılamaz. Her hakkı saklıdır, HACETTEPE ÜNİVERSİTESİ'ne aittir.

PREFACE

We have proudly celebrated the 50th anniversary of the foundation of Hacettepe University. We take pride in being one of the most successful universities in Turkey and being ranked among the leading universities in the World. Since the year 1967, when Hacettepe earned the status of ‘*University*’, it has never given up on its principle of continuously going ahead and reaching for the very best. Hacettepe, always preserving its values and basic principles, has become a pioneer university that has been intertwined with the society and pursued innovations, achieving many “firsts” ahead of others.

From medicine to biology, philosophy, statistics, physics and chemistry; from history of arts to the English, German and French languages; from sociology to engineering, fine arts and conservatory, Hacettepe University started almost 50 years ago developing interdisciplinary collaborations across a wide range of scientific fields, a research trend which has achieved a status of global recognition in the 21st century.

Hacettepe University, which was recognized as “*Research University*” by the decision of Council of Higher Education, dated September 26, 2017, has built a strong “brand” image over these 50 years with its qualified and unique contributions to science in Turkey and has been the country’s gateway to global scientific advances. It has graduated tens of thousands of students, each of whom has been our source of pride with their contributions to science, society and humanity as well as with their worldwide achievements. So have its graduates always been proud of Hacettepe.

Hacettepe University owes its success to its people who have always aimed to move forward by promoting interdisciplinarity and without giving up on the understanding “*To the leading edge... Toward being the best...*”

The Turkish and English series of books you are presented have been prepared in memory of the 50th anniversary of Hacettepe University by Prof. Dr. Adil Denizli, a distinguished researcher and faculty member who has heartily devoted himself to his university and science. Among the editors and authors of the book series are respected scientists from Hacettepe University, Turkey and abroad. The series covers the studies from the multi-/interdisciplinary research areas of sciences, mainly from Medicine, Science and Engineering Sciences, which particularly stand out among the World’s and Hacettepe’s research interests.

Readers benefiting from these books will certainly appreciate the value of the profound contributions Hacettepe University made to science both in the country and in the World

each time they see the name of “*Hacettepe University*” in the context of the authors, editors, footnotes, citations and bibliographies. This work is an expression of respect for Hacettepe University and for those who have meticulously served in this university for 50 years with an interdisciplinary understanding.

Thank you Adil Denizli... I would like to express my sincere gratitude and thanks to all those who have contributed to this precious work.

I wish many 50 more years to go forward in line with our motto “*To the leading edge... Toward being the best...*”

Prof. Dr. A. Haluk ÖZEN
Rector

PREFACE

In 1954 “Hacettepe” was founded in two chambers of an old Ankara house as a Chair of Child Health, then in 1967 officially earned “university” status. Hacettepe University celebrated its 50th anniversary in 2017 by proud of rich heritage and the positive, life-changing impact globally through the strength of our research, teaching, innovation and enterprise. In just 50 years Hacettepe University has managed to forge a powerful global reputation as a strong research-led university. To celebrate 50th anniversary numerous standout events were planned and performed by proud of past and dreaming of the future.

The Hacettepe Book Series are published to honor the five decades of work not only for the field but also for society at large and to leave the scientific mark of Hacettepe University to the history.

Prof. Dr. Adil Denizli
Series Editor

PREFACE

Stem cells are undifferentiated cells that are capable of proliferating and differentiating into specific cell types through asymmetric cell divisions. Stem cells possess unique roles in regenerative medicine and tissue engineering which will influence human lifetime and standards and future plans such as space missions. Biomaterials will be a part of these influences for sure. This book covers the importance of biomaterials in stem cell research from fundamentals to applications.

The book titled as “Biomaterials and Stem Cells: From Basics to Applications” outlines, first a valuable introductory chapter by Prof. Dr. Antonios G. Mikos from Department of Bioengineering, Rice University, USA. In Chapter 2, the stem cells, biomaterials and their applications in regenerative medicine and tissue engineering were briefly summarized. Recent Advances in Cardiac Tissue Engineering were reviewed in Chapter 3. In Chapter 4, “Stem Cells And Neural Tissue Engineering: All The Appropriate Signals Are Necessary” and in Chapter 5 “Combinatorial Approaches Using Biomaterials and Stem Cells for The Treatment of Central Nervous System Disorders”, focuses on the essence of orchestrated integration of different signals for neural tissue regeneration and combination of biomaterials and stem cell transplantation in the central nervous system (CNS) were discussed in tissue-engineered-based approach, respectively. In chapter 6, “Scaffold and Stem Cell-Guided Musculoskeletal Tissue Engineering” and in Chapter 7 “Stem Cell Differentiation For Skeletal Muscle Engineering”, use of stem cells and biomaterials in musculoskeletal tissue engineering were reviewed. Recent advances in the 3D printing technology that has translated into clinic were summarized in Chapter 8 as “Clinical Applications of 3D Printing”. “The Recent Developments and Future Perspectives on Biomaterials for Corneal Tissue Engineering” was indicated at Chapter 9 from a physician’s perspective. In Chapter 10, “Decellularized Matrices in Stem Cell Research” the role of decellularized scaffolds and in Chapter 11 “Polyurethanes, Stem Cell Interactions And Tissue Engineering Applications” as one of the most widely used synthetic polymers in biomedical science, were given in details, respectively. Chapter 12, “Scaffold-supported Perfusion Bioreactor Design for Bone Regeneration of Human Mesenchymal Stem Cells” as a model study about using scaffolds for bone regeneration in a bioreactor system will be

very useful for the audience. Chapter 13 is an engaging chapter “Stem Cells Biomaterials and Space” which will inform the readers about biomaterials used in space studies.

I would like to thank the authors who contributed to the book including all scientists and researchers who devoted their life into the biomaterials and stem cell research fields. I would like to thank specially to Prof Adil Denizli as being my M.Sc advisor, as one of my model scientist and for letting me be a part of this book as an editor, Prof. Dr. Erhan Piskin as being my PhD advisor and his pioneer research at Hacettepe University and Turkey about biomaterials, and to Prof. Dr. Antony Mikos, for his enormous contribution to the tissue engineering and regenerative medicine areas as well as to the book. I also would like to thank my students for their endless encourage. I do believe and hope this book will be very helpful for the biomaterials, tissue engineering, regenerative medicine, and stem cell research as well as material science and technology community. Last but not least, it is a great honor for me to edit this book for the 50th anniversary of Hacettepe University, Ankara, Turkey.

Bora Garipcan, Ph.D
Editor

Biomaterials and Stem Cells: From Basics to Applications

Edited by Bora Garipcan

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Dr. Bora Garipcan received his BSc degree (1999) from Hacettepe University, Department of Chemistry, and his PhD degree (2008) in Bioengineering from Hacettepe University, Ankara Turkey. His main research areas are; Biomimetic, Bioinspired materials and Biosensors. He is a member of Boğaziçi University, Institute of Biomedical Engineering since July 2011. Garipcan`s research focuses on surface engineering of several biomedical surfaces (such as titanium, silisium, gold, biodegradable polymers, and elastomers) by changing their surface properties (stiffness, topography, chemistry and biochemistry) for controlled and directed cellular behavior (adhesion, proliferation, and differentiation).

