Biosensors, Medical Imaging, and Biology for Engineers

Edited by Paul King

3-D Cell-Based Biosensors in Drug Discovery Programs: Microtissue Engineering for High Throughput Screening

William S. Kisaalita, CRC Press, 2010, ISBN: 978-1-4200-7349-2 404 pages, US$130.

The author, William S. Kisaalita, is a bioengineer in the field of cellular engineering. The main focus of his research is cell–surface interactions with applications in cell-based biosensing for drug discovery. This book is written to help bioengineers and bioscientists understand cell-based biosensor systems and apply them for their research in the areas of pharmaceutical and biopharmaceutical industries. The content is designed to provide the latest—from theory to practice— information on the challenges and opportunities for incorporating three-dimensional (3-D) cell-based biosensors or assays in drug discovery programs. This book is primarily written as a textbook focusing on 3-D cell-based sensor systems for not only biomedical engineers and scientists in the biopharmaceutical industry but also bioengineering graduate students in the academic field. The books also provides a wider spectrum of introduction for bioengineering trainees to the integrative basics of cell biology, drug discovery, and engineering using current case study examples. This four-part text is easy to read and is packed with relevant examples from biosensor and drug discovery fields of bioengineering with figures to aid comprehension, useful beginning-of-chapter introductions and end-of chapter conclusions, and primary research articles as references. The four parts are organized to provide evidence in support of embracing 3-D cell-based systems. Each chapter begins with a concise introduction to specific engineering/biology concepts, then applies these concepts to biosensor systems, and finally provides a conclusion section that helps audiences understand the key points of the given chapter.

The focus of Part I is to provide an introduction of bioassays and biosensors (Chapter 1) and case studies of drug discovery (Chapter 2). Specifically, the overall objective of Chapter 2 is to demonstrate how theory and practical development can be coupled and how design and science are linked in drug discovery. Part II (Chapters 3–4) concentrates on transcriptional profiling, proteomics, structure and function in comparison between 3-D and two-dimensional (2-D) cultures. Part III (Chapters 5–10) deals with bioengineering principles related to particular types of designing systems. Part IV (Chapters 11–13) discusses the challenging and cases for 2-D cultures in drug discovery. The last section also includes ideal case study design.

Overall, this appears to be a good textbook for bioengineers and biomedical scientists at the training level. The strengths of this book is that this is suitable for a wide audience, including a comprehensive coverage of fundamental bioengineering principles and their drug discovery applications, well illustrated with pictures, and illustrations that substantially facilitate understanding concepts. The text would serve as a good reference source to bioengineering trainees, practitioners interested in understanding the operation of specific biosensor technologies, and students wanting to relate engineering principles to drug discovery applications.

It should be acknowledged that the authors did a nice job to explain in-depth basic microenviromental factors (e.g., Chapters 5–7); however, such information may be overwhelming for students who are not familiar with ECM biology and falls a little short of cohesiveness, since the parts compile biological and biomechanical text knowledge. The book deals with the too wide a range of topics for the expertise of a single professor to cover. This book could be a good supplement to individual classes, such as tissue engineering, bioinstrumentation, and nanobiotechnology.

In closure, despite the above observations, this textbook certainly provides a very comprehensive overview of the issues that bioengineers and scientists deal with, such as biosensors, drug discovery, and nanotechnology.

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Digital Object Identifier 10.1109/MPUL.2011.941526
Date of publication: 2 June 2011

Medical Imaging: Principles, Detectors, and Electronics

Krzysztof Iniewski, Editor. Wiley-Interscience, 2009. ISBN: 978-0-470-39164-8. Hardcover, xvii + 305 pages, US$110.

The development of medical imaging over the past decades has been truly radical. What is perhaps most remarkable about these revolutionary advances is the fact that the challenges have required significant innovation in hardware design, emerging new detector technologies, circuit design techniques, new materials, and innovative system approaches.

This book addresses the state-of-the-art integrated circuit design in the context of medical imaging of the human body, reviewing new opportunities

Digital Object Identifier 10.1109/MPUL.2011.941527
Date of publication: 2 June 2011

in ultrasound, computer tomography, magnetic resonance imaging, and nuclear medicine. In fact, this book could also be titled *Electronics for Medical Imaging* as it not only discusses the technologies themselves, but also provides electronics or biomedical engineers, researchers in medical research, medical physicists, and professional engineers with information on how to design electronics for each technology.

There are four major imaging modalities described in this book, and they correspond to each one of the four parts in which this book has been divided: "X-Ray Imaging and Computed Tomography" (four chapters), "Nuclear Medicine (SPECT and PET)" (two chapters), "Ultrasound Imaging" (one chapter), and "Magnetic Resonance Imaging" (two chapters). This one-editor book has been written by 13 authors, providing a deep understanding in the technology behind each one of the medical imaging modalities covered by this book. The following is a brief overview of the contents of each chapter.

Part I: X-Ray Imaging and Computed Tomography

- Chapter 1, "X-Ray and Computed Tomography Imaging Principles," introduces the physical principles of X-ray imaging from its generation to its detection as well as the CT imaging principles.
- Chapter 2, "Active Matrix Flat Panel Imagers (AMFPI) for Diagnostic Medical Imaging Applications," deals with circuit, process, and development for large-area, digital imaging applications using amorphous silicon (a-Si) technology for diagnostic medical imaging.
- Chapter 3, "Circuits for Digital X-Ray Imaging: Counting and Integration," discusses the results of a project focusing on the exploration and realization of a new signal processing concept for medical X-ray imaging with direct-conversion semiconductor sensors.
- Chapter 4, "Noise Coupling in Digital X-Ray Imaging," handles the problems associated with noise coupling in digital X-ray systems, where the focus lies in the prediction of noise coupling in a design chain.

Part II: Nuclear Medicine (SPECT and PET)

- In Chapter 5, "Nuclear Medicine: SPECT and PET Imaging Principles," the author reviews the physical principles and tomographic reconstruction methods in nuclear medicine as well as its main clinical applications.
- Chapter 6, "Low-Noise Electronics for Radiation Sensors," introduces the reader to some of the state-of-the-art practices in formulating low-noise electronics for radiation sensors, with some examples of design concepts and circuit solutions adopted in several high-resolution and high-counting-rate radiation-detection systems.

Part III: Ultrasound Imaging

- Chapter 7, "Electronics for Diagnostic Ultrasound," begins with the general principles involved in forming ultrasonic images. It also discusses ultrasound systems and probes, giving the reader a background for appreciating the role of large-scale integration in this context. It continues covering the state of the art of the electronics in ultrasound (transmit, receive, and beam-forming electronics), and the last section is dedicated to describe the current approaches to miniaturization in widespread use throughout the industry.

Part IV: Magnetic Resonance Imaging

- Chapter 8, "Magnetic Resonance Imaging," describes the physical basis of nuclear magnetic resonance and magnetic resonance imaging (MRI) and provides a brief account of the most important MRI techniques used in both clinical and research applications of this technology.

Current trends in MRI using large receiver coil arrays require new approaches to constructing and receiving data from such arrays. The main issues (RF interactions and quantity of data) are successfully addressed in Chapter 9, "MRI Technology: Circuits and Challenges for Receiver Coil Hardware," by the use of wireless/fiberoptic communications and dedicated preprocessing hardware, respectively. It presents new advances in this context in semiconductor technology, including photonics, wireless high-speed communications, large-scale integration, and microelectromechanical systems.

This is a book primarily used by physicists and electrical engineers who focus on electronics present in the health-care field as well as interested computer scientists and medical technicians. This book must be read by anyone working in electronics in the health-care sector.

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Biology for Engineers

Arthur T. Johnson, CRC Press, 2011. ISBN: 978-1-4200-7763-6, 758+ xvii pages, US$99.95.

The textbook *Biology for Engineers* by Dr. Johnson is the product of about nine years of student testing, experiences in classroom teaching, reflections on the literature, an interesting sense of self and humor, and personal experiences. It is a unique textbook in my estimation as will be seen from the discussions given below of the various chapters.

The text consists of eight chapters in six sections. Each chapter contains well-referenced text, useful and relevant quotations, great examples, useful summaries, thought questions (referenced to the relevant section of the text), and a good sense of humor.

- Chapter 1 (and Section 1) is largely an introduction of the general topic of biology and engineering in the form of biological engineering. It covers topics such as inductive and deductive reasoning, hypothesis testing, and theoretical and empirical modeling. It also includes a brief discussion of biological engineering.
- Section 2 is titled "Principles from the Sciences" and consists of four chapters. Chapter 2, the first unit, is titled "Principles of Physics" and covers the expected gamut of physics terms that are relevant to the study of biology. We are given a neatly condensed version of first-year physics as applied to biology. Chapter 3, titled "Principles of Chemistry," is a

Digital Object Identifier 10.1109/MPUL.2011.941528
Date of publication: 2 June 2011