Preface

Positron Emission Tomography (PET) has been allowing for the assessment of biochemical and physiological processes in the living human brain for more than 30 years. With the introduction of Single Photon Emission Computed Tomography (SPECT) a few years later, nuclear imaging techniques became available for a wider range of users, because SPECT is less demanding with regard to logistics and the devices needed. For both methods, a pharmaceutical (radiopharmaceutical, tracer, radiotracer) is labeled with a radioactive isotope in order to noninvasively quantify biomolecules (e.g., receptors, transporters) or their activity (e.g., enzymes) in living organisms. The essential advantage of these nuclear imaging methods over all other modern functional imaging techniques is their enormous sensitivity. PET and SPECT allow for quantification of concentrations of material as low as 10^{-9} M to 10^{-12} M. This sensitivity makes them several magnitudes more sensitive than any magnetic resonance technique. For example, gadolinium can be quantified with magnetic resonance imaging (MRI) only in concentrations of up to 10^{-4} M. Magnetic resonance spectroscopy (MRS) allows for assessment of γ-amino butyric acid (GABA) or even glutamine only in concentrations of up to 10^{-3} M. Thus, although molecular imaging with MR-based technology has made considerable progress in recent years and will continue to do so (see Chap. 14, this volume), nuclear imaging methods will remain the most important tools for the study of neurochemistry and pharmacology in humans in vivo in the foreseeable future. In addition, the rapidly evolving opportunities for visualization and quantification of signal transduction and gene expression provide novel applications of these methods (see Chap. 17, this volume).

While researchers with PET and SPECT essentially addressed questions from the whole spectrum of cardiology, oncology, and the neurosciences, it was most notably the latter that provided completely new insights into physiological and disturbed human brain function. Along with molecular genetics and molecular biology, functional imaging techniques including PET and SPECT generated the largest gain in knowledge in the clinical neurosciences, particularly in psychiatry. From the very beginning of the use of molecular imaging technology in neuroscience research, it has also provided tremendous insights into the pharmacokinetics and pharmacodynamics of psychotropic drugs, which in many respects led to improvements in everyday patient care.

This book will provide the reader with up-to-date information on the basic principles of molecular imaging and its major applications in the clinical neurosciences. The authors are, without exception, world experts in their respective fields. The first part of the book offers a comprehensive review of the methodological foundations from physics, chemistry, and mathematics including mathematical modeling, the latter being essential for meaningful data analysis. The second part covers the major biological principles and neurochemical targets relevant in current neuroimaging research. This book section also includes a chapter on small animal imaging, which plays a crucial role in translational research in the imaging sciences. The major clinical applications from the fields of psychiatry (dementia, substance abuse and dependence, affective disorders, schizophrenia) and neurology (cerebrovascular diseases, brain tumors, Parkinson's disease, epilepsy) are discussed in the third part of this volume. Thus, this book claims to be a helpful source of knowledge for both basic and clinical scientists from psychology, psychiatry, neurology, nuclear medicine, nuclear

chemistry, and all the associated disciplines, all of which make molecular imaging such a rewarding, interdisciplinary field of work.

Finally, I have to thank the series editor, Wolfgang Walz, for initiating this venture and Patrick J. Marton and David Casey, Humana Press, for their constant support. Last but not least, I have to express my gratefulness to all the authors for their engagement in and dedication to this important project.

Aachen, Germany ***Gerhard Gründer***

http://www.springer.com/978-1-61779-988-4

Molecular Imaging in the Clinical Neurosciences
Gründer, G. (Ed.)
2012, XII, 400 p. 119 illus., 48 illus. in color., Hardcover
ISBN: 978-1-61779-988-4
A product of Humana Press