

---

## Preface

What does “molecular imaging” mean? There are several definitions in the literature. The term “molecular imaging” was formed in the early twenty-first century as a discipline at the intersection of molecular biology and in vivo imaging. It is defined as the visualization, characterization, and quantification of biologic processes at the cellular and molecular levels in living organisms. With the help of molecular imaging procedures cellular and molecular pathways and mechanisms of disease can be studied in their own physiologically authentic environment in order to reveal their molecular abnormalities that form the basis of disease. This is a really innovative conception which is in deep contrast to the classical form of diagnostic imaging where documented findings show the end effects of molecular alterations which are typically verified by well-established methods of pathology.

Molecular imaging includes diagnostic methods of nuclear medicine along with various other different strategies to yield imaging signals. Nuclear medicine uses radiolabeled molecules (tracers) that produce signals by means of radioactive decay. Other methods of molecular imaging can lead to images via means of sound (ultrasound), magnetism (MR), or light (OI, optical techniques of bioluminescence and fluorescence) as well as other emerging techniques.

Nuclear medicine has been playing a crucial role in the development of molecular imaging over the past few decades, with other technologies (e.g., OI, MR) being adapted for molecular imaging by developing different types of molecular probes.

These molecular imaging procedures offer numerous potentialities in the field of diagnosis as well as therapeutic methods for diseases, such as cancer, and neurological and cardiovascular diseases. The description of the human genome may show a new direction via genomics and proteomics to the molecular and functional imaging methods.

Out of the increasing number of publications comprising all fields of molecular imaging this handbook focuses on the increasing impact of molecular imaging in the field of oncology. The development of molecular imaging in the twenty-first

century will and has to go ahead to multimodality imaging. Therefore, hybrid devices like SPECT/CT, PET/CT, and PET/MR which can cover the whole spectrum of preclinical and clinical imaging will become more and more relevant in the future. Prospects and challenges of these innovative techniques will be presented in detail in this handbook. In the field of clinical SPECT/CT applications we decided not to replicate the numerous literature and refer to the corresponding recent issues in *Seminars in Nuclear Medicine* (Delbeke et al. 2009; Even-Sapir et al. 2009). In addition, optical tomographic hybrid approaches such as fluorescence molecular tomography–X-ray computer tomography (FMT–XCT) systems or multi-spectral optoacoustic tomography (MSOT) systems offer unprecedented levels of performance (Condeelis and Weissleder 2010). These innovative multimodality imaging systems require the competency and accreditation of scientists from different disciplines. Therefore, molecular imaging in oncology in the twenty-first century is not possible without close interdisciplinary and interfaculty collaborations.

This handbook highlights the immense potential this reintegration of different disciplines will offer in the future. It provides updated information about molecular imaging in oncology for nuclear physicians as well as radiologists, oncologists, chemists, mathematicians, computer scientists, and physicists. A careful selection of experts in the different fields of molecular imaging was made to outline the major trends and challenges of molecular imaging in oncology bridging the gap between basic research and clinical applications in a unique way. With respect to the distinct profiles of expertise, each chapter is self-contained.

In view of this background the handbook was structured according to the single steps of molecular imaging, i.e. from probe design to clinical applications. Accordingly, the following chapters were defined:

- Technology and Probe Design
- Preclinical Studies
- Clinical Applications
- Future Challenges

We are very grateful that the handbook has assembled exceptionally comprehensive and stimulating contributions from outstanding stakeholders in molecular imaging in oncology from America and Europe.

## References

- Condeelis J, Weissleder R (2010) In vivo imaging in cancer. *Cold Spring Harb Perspect Biol* 2:a003848
- Delbeke D, Schöder H, Martin WH, Wahl RL (2009) Hybrid imaging (SPECT/CT and PET/CT): improving therapeutic decisions. *Sem Nucl Med* 39:308–340

Even-Sapir E, Keidar Z, Bar-Shalom R (2009) Hybrid imaging (SPECT/CT and PET/CT): improving the diagnostic accuracy of functional/metabolic and anatomic imaging. *Sem Nucl Med* 39:264–275

Münster, Germany

Otmar Schober  
Burkhard Riemann

Molecular Imaging in Oncology  
Schober, O.; Riemann, B. (Eds.)  
2013, XVI, 416 p., Hardcover  
ISBN: 978-3-642-10852-5