Preface

Laser scanning microscopy (LSM) has become an established and broadly used method to obtain optical images with depth selectivity. LSM includes confocal laser scanning microscopy (cLSM) as its most common and commercially mature application, but also multiphoton microscopy gets increasingly used because it allows for obtaining images from living specimens with minimal phototoxicity and increased tissue penetration. The key features of both the techniques are that they permit optical sectioning, that data are obtained by scanning in a point-by-point fashion, and that images are then reconstructed by electronic means, which generates a digital data set that allows three-dimensional reconstructions and further analysis of complex objects.

Many novel advances in LSM are due to increased digital data processing power and mathematical analysis of the data sets, which allows users, for example, to perform 4D recordings, i.e., to follow 3D reconstructions over time in order to determine the dynamics of biological processes and scrutinize morphogenetic mechanisms. In addition, quantitative colocalization and connectivity analyses have become possible. Such applications are in particular useful for research in neuroscience, which deals with one of the most complex tissue, different cell types with extensive morphological differentiation and significant structural plasticity during nervous system development, maintenance, and aging.

The aim of this book is to introduce applications and quantitative image analysis using data sets obtained from confocal and multiphoton laser-scanning microscopy of neuronal tissue. The idea is to introduce key biological questions, to provide detailed information how to acquire data by laser-scanning microscopy, and to examine how to use the often huge digital data set in an efficient manner to extract maximum of information. Thus the book not only provides a compilation of diverse protocols but also aims to bring together biological bench work, laser scanning microscopy, *and* mathematical, computer-assisted data analysis to grasp novel insights of form, dynamics, and interactions of microscopy-sized biological objects. We are confident that the scope of this book goes much beyond current protocols compilations that introduce selected lab and microscopy techniques. We hope that the book will stimulate the reader to make efficient use of the application of laser scanning microscopy for his or her own research question. To achieve this goal, we have brought together contributions from research institutions all over the world covering pioneering applications in laser scanning microscopy and quantitative image analysis, and providing information about the power and limitations of this quickly developing field at the interface between biology, physics, informatics, and mathematics.

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