Microscopy of the Heart

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Editors

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Preface

The heart is one of the most vital organs in the mammalian body—failure is immediately associated with the death of the entire organism. This is one of the reasons the heart is situated in the well-protected ribcage and is therefore hardly accessible by classical microscopic techniques. However, non-invasive imaging like sonography or magnet resonance tomography allows visualisation of the heart and its subunits in operation and is therefore referred to as functional imaging. Although these techniques are sometimes denoted as microscopic methods, within this book we regard microscopy to start at a resolution limit of one micrometre or below and therefore only such approaches are included. They allow subcellular investigations of the basic building blocks of the heart, the cardiomyocytes. Albeit a part of cardiac diseases can only be understood at the organ level, other pathologies have a clear cellular or molecular origin. These peculiarities require besides the investigations of molecular biology and genetics the microscopic characterisation of the cardiac myocytes, either in a histologic manner or with increasing importance as cellular functional readouts. Although this is more common in animal models, it is also possible with cells from patients' biopsies.

Most of the techniques presented in this book therefore require a particular sample preparation in the form of slices (electron microscopy) or cell isolations (optical microscopy, scanning ion conductance microscopy) or other modes of dissections like the preparation of the sinoatrial node (selective plane imaging) or the atrial auricles (second harmonic generation microscopy).

Since the first microscope was build, which is believed to have happened at the end of the sixteenth century, more than 400 years of research and development resulted in devices that not only are mechano-optical in nature as the first generations of microscopes but also to a large extent are based on electric and electronic components. There has been particular great progress in the development of microscopic methods within the last decades resulting in Nobel Prize for the development of both molecular sensors and imaging technologies. Within this book we provide an overview of state-of-the-art microscopic methods to investigate the ultrastructure of the cardiac cells (super-resolution microscopy, electron microscopy), their cellular und subcellular function (genetically encoded indicators, optical sectioning microscopy, uncaging techniques, scanning ion conductance microscopy) as well as extracellular components like the extracellular matrix (second harmonic generation

microscopy). It is a timely overview for both students and established scientists since many proof-of-principle techniques still await their final establishment and routine application in cellular cardiology, like the use of second harmonic generation microscopy (transmission mode) of myosin to quantify the contraction of stem cell-derived cardiomyocytes.

Homburg/Saar, Germany Lars Kaestner
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