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Teun Munnik
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# Lipid Signaling in Plants

Springer

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ISSN 1861-1370 e-ISSN 1861-1362
ISBN 978-3-642-03872-3 e-ISBN 978-3-642-03873-0
DOI 10.1007/978-3-642-03873-0
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2009933122



*Cover design:* WMXDesign GmbH, Heidelberg, Germany

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

*To my friend and mentor, Alan Musgrave*

# About the Editor

**Teun Munnik** is an associate professor plant cell biology at the Swammerdam Instituut for Life Sciences of the University of Amsterdam, The Netherlands. He obtained his B.Sc. degree in Botany from the University of Applied Sciences and his Ph.D. in Biology from the University of Amsterdam. His research pioneered phospholipid-based signaling mechanisms in plants, involving labs of Alan Musgrave (University of Amsterdam, NL), Robin F. Irvine (Cambridge University, UK), Heribert Hirt (Vienna Biocenter, AT) and George M. Carman (Rutgers University, NJ, US). Dr. Munnik serves on the editorial board of several international journals and has published over 70 original research papers and 7 book chapters. His current research is focused on studying phospholipid signaling in plant stress and development, using the model plant, *Arabidopsis thaliana*.

# Preface

Phospholipids have long been known for their key role in maintaining the bilayer structure of membranes and in physically separating the cytosol from organelles and the extracellular space. In the past decade, a completely novel and unexpected function emerged, fullfilling a crucial role in cell signaling. It was the discovery in animal cells, that agonist-activated cell surface receptors led to the activation of a phospholipase C (PLC), to hydrolyze the minor lipid, phosphatidylinositol 4,5-bisphosphate into two second messengers, inositol 1,4,5-trisphosphate ($InsP_3$) and diacylglycerol (DAG). While $InsP_3$ diffuses into the cytosol, where it releases $Ca^{2+}$ from an intracellular store by activating a ligand-gated $Ca^{2+}$-channel, DAG remains in the membrane to recruit and activate members of the protein kinase C family.

Over the years, a variety of other lipid based-signaling cascades were discovered. These include, phospholipase A, generating lyso-phospholipids and free fatty acids (to be converted into prostaglandins and leukotrienes), phospholipase D, to generate the lipid second messenger, phosphatidic acid (PA), and phosphoinositide 3-kinase (PI3K), generating a distinct set of polyphosphoinositides (PPI) phosphorylated at the D3-position of the inositol ring, all with separate signaling functions. Sphingolipids, representing another important group of signaling lipids, also came across.

The majority of these lipid-based signaling pathways have been discovered in plant cells too. Moreover, they have been found to be activated in response to a wide variety of biotic and abiotic stress signals, but also to be basically involved in plant growth and development. While many of the enzymes, lipids, and their targets involved are well conserved, major differences with the mammalian paradigms have also emerged.

This book highlights the current status of plant lipid signaling. All chapters have been written by experts in the field and cover information for both beginners and advanced lipidologists. Part I includes phospholipases (Chaps. 1–3), part II, lipid kinases (Chaps. 4–7), part III, lipid phosphatases (Chaps. 8–9), part IV, inositolphosphates and PPI metabolism (Chaps. 10–13), part V, PA signaling (Chaps. 14–17), and part VI, additional lipid signals, e.g. oxylipins, NAPE and sphingolipids (Chaps 18–20). It has been a great pleasure to be the editor of this book and to be a witness of this lipid-signaling adventure.

Amsterdam, June 2009 Teun Munnik

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