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Volume 12

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Anne Mie C. Emons • Tijs Ketelaar  
Editors

# Root Hairs

 Springer

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# Editors



Anne Mie C. Emons studied Biology (M.Sc. 1969, cum laude) at the Radboud University of Nijmegen, The Netherlands, and after a family break, did her Ph.D. at the same university in 1986 and postdoctorate at Wageningen University in 1987, and John Innes Centre, Norwich, UK, on EMBO grant in 1988 under Dr. Keith Roberts. From 1988, she was an Assistant, Associate and Full Professor at Wageningen University, laboratory of Plant Cell Biology and since 2002 Advisor Bio-organization FOM Institute AMOLF, Theory Biomolecular Matter group.

Her major research interests are plant cell biology, cell polymers: actin filaments, microtubules and cellulose microfibrils, plant cell cyto-architecture, tip growth, and legume root hair Rhizobium interaction



Tijds Ketelaar studied Plant Breeding (M.Sc. 1996) at Wageningen University, the Netherlands, which was followed by a Ph.D. at the laboratory of Plant Cell Biology of Wageningen University in 2002. From 2001 to 2004, he was a postdoctorate in the laboratory of Professor Patrick Hussey at the University of Durham, UK, after which he received a VENI fellowship from the Dutch Science Foundation (NWO) at the laboratory of Plant Cell Biology of Wageningen University (2004–2007). From 2007 he has been an Assistant Professor in the same laboratory.

His research interests are actin cytoskeleton, plant cell cyto-architecture, polar cell expansion, and root hairs.

# Preface

Root hairs stand out from the root body, extending the surface area of the root to facilitate anchoring in the soil and absorption of ions and water. They grow at their tips, and are the first target cells in the symbiotic relations of seed plants with micro-organisms. These properties make them an excellent model system for plant cell elongation studies and many aspects of plant cell signaling to an increasingly large number of plant biologists. In addition, root hairs are easy to observe *in vivo* because the growth process takes place on the surface of the plant. Root hair mutants are simple to distinguish and generally fertile, and drugs and signal molecules can be easily applied, making them close to ideal cells for experimental manipulation.

Due to the polarized nature of tip-growing root hairs, a polarized cyto-architecture is required to supply the material for cell growth and cell wall production to the cell tip. This cyto-architecture is characterized by a number of general features. The central vacuole is absent from the apical region and the nucleus is at a constant distance from the tip. The actin cytoskeleton is organized such that exocytotic vesicles reach the plasma membrane specifically at the site of cell expansion, whereas the microtubule cytoskeleton determines and maintains growth direction. The vesicle membranes fuse with the plasma membrane through exocytosis and deliver their contents and membrane-embedded enzymes for cell wall production. The robust intracellular organization employed in the growth process requires feedback regulation with, amongst others, calcium ions, ROP proteins, and plant growth regulators (auxin). Signal molecules from symbiotic microbes tap into these signaling cascades, and redirect them to orchestrate plant cell processes for their own benefit.

Almost all life on earth needs nitrogen compounds to produce nucleic acids and proteins, and most organisms, including plants, cannot use atmospheric nitrogen for this purpose. Many plant species have set up symbioses of various sorts with nitrogen fixing fungi and bacteria, which supply the useful nitrogen compounds and receive energy compounds in return. The last chapters of this book cover recent advances in research on these symbioses of plants with rhizobia and mycorrhizal fungi. The well-studied interaction between legume plants and *Rhizobium* bacteria, particularly, has provided insight into the early signaling events taking place in root hairs.

This book not only reviews recent advances in the molecular cell biology of root hair research, but most chapters also contain detailed explanations of techniques

that were successfully used to study several aspects of root hairs, making the book useful in daily laboratory practice. Some chapters deal with these techniques in the form of detailed comparative “Methods” sections, while other chapters give straightforward protocols.

We enjoyed working on this book in collaboration with the contributing authors. It was especially gratifying to see the clear progress that has been made since the molecular cell biology book on root hairs, edited by Ridge and Emons, (Springer, 2000) appeared.

Wageningen, March 2008

Anne Mie C. Emons  
Tijs Ketelaar

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