



# Root Genomics and Soil Interactions

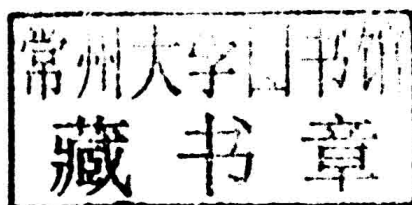
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# Root Genomics and Soil Interactions

*Edited by*  
MARTIN CRESPI



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# **Root Genomics and Soil Interactions**



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## Preface

### Roots and Their Soil Interactions: What We Can Learn from Genomics

Developmental plasticity allows higher organisms to adapt to their environment. In contrast to animals, plants exhibit a remarkable flexibility in their architecture and growth pattern in response to external conditions, due to the continuously active shoot and root meristems and their capability to generate new organs after embryogenesis. External cues influence plant growth by modulating hormone levels and signaling. The root architecture of the plant constitutes an important model to study how developmental plasticity is translated into growth responses under different soil conditions and plays an important role in water and nutrient acquisition. Indeed, primary root development and the formation of *de novo* meristems to generate lateral roots are conditioned by the soil environment. Lateral root growth and development is the main determinant of the shape of the root system, a trait controlled by internal cues and external factors. In addition to Arabidopsis, there are other relevant models where genomic information is becoming available, notably cereals and legumes. Both plants are able to develop symbiotic interactions with soil organisms, namely, mycorrhizal fungi and, for legumes, soil rhizobia. These interactions lead to further adaptation of root growth, the so-called mycorrhizal roots, and even to the formation of new organs, distinct from lateral roots, the nitrogen-fixing root nodules.

The diversity of root responses to biotic and abiotic stresses as well as symbiotic interaction can be analyzed at a genome-wide scale using transcriptomic and proteomic approaches. The advent of genomic technologies will open new perspectives for the analysis of how roots adapt to the soil environment. This work, mainly done in model systems such as Arabidopsis, uncover diverse regulatory genes (e.g., environmental sensors, protein kinases, transcription factors, and more recently, small regulatory RNAs) that participate in genetic programs, regulating root growth and architecture. Integration of these data with genomic approaches on different genetic backgrounds has already revealed, and will continue to reveal, critical regulatory networks and molecular hubs, whose orthologs could then be analyzed in crop plants to establish the generality of these mechanisms and impact agricultural practices.

This book contains 13 chapters from recognized experts in the field, which provide a comprehensive and integrated view of how root genomics can open new perspectives for root physiology and agriculture. The first six chapters deal with various novel areas where genomics, in combination with modeling, physiology, in-depth analysis of the transcriptome, and epigenetics, have revealed several regulatory networks controlling diverse aspects of root growth and development. Then, the remaining chapters describe genomic approaches being applied for the analysis of root responses to the soil environment, such as abiotic stresses, symbiotic interactions, or pathogenic nematode infections. The final chapter focuses on translational genomics and how genomics can guide crop

improvement. I hope that this book will serve many, from plant researchers to plant and crop physiologists, breeders, graduate students, and their professors who want to have an overview of the highlights in root genomics and how this information could be screened and integrated without having considerable expertise in bio-statistics. While reading this book, the reader will realize how fascinating the actual global view of the genome is and how many complex mechanisms remain to be discovered to understand root growth and development. There are exciting agricultural challenges, such as the modulation of root architecture or drought adaptation, which may derive from the application of this new fundamental understanding of life principles to the control of major root traits.

*Martin Crespi*

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Contents

Contributors		ix
Preface		xv
Chapter 1	<b>Genomics of Root Development</b>	<b>3</b>
	Boris Parizot and Tom Beeckman	
	Introduction	3
	Genomics of LRI	7
	Rise of New Technologies to Understand Lateral Root Development	19
	ComparativOmics, the Future	20
	Acknowledgments	21
	References	21
Chapter 2	<b>The Complex Eukaryotic Transcriptome: Nonprotein-Coding RNAs and Root Development</b>	<b>29</b>
	F. Ariel, A.B. Moreno, F. Bardou, and M. Crespi	
	Genomic Approaches Reveal Novel Aspects of the Eukaryotic Transcriptome	29
	The Role of RNA-Binding Proteins in npcRNA Metabolism and Activity	34
	Nonprotein-Coding RNAs in Root Development	38
	Future Perspectives	42
	Acknowledgments	42
	References	42
Chapter 3	<b>Genomics of Auxin Action in Roots</b>	<b>49</b>
	Elisabeth L. Williams and Ive De Smet	
	Introduction	49
	The Basis of Auxin Biology	49
	Auxin Genomics in Root Development	55
	Auxin and Root Hair Development	56
	Auxin in Gravitropism	57
	Auxin in LR Initiation	57
	Conclusion	58
	Acknowledgments	58
	References	58

<b>Chapter 4</b>	<b>Cell-Type Resolution Analysis of Root Development and Environmental Responses</b>	<b>63</b>
	José R. Dinneny	
	Introduction	63
	Tools for Cell-Type Resolution Analysis	64
	Analysis of Spatiotemporal Expression Patterns in the Arabidopsis Root	69
	Analysis of Cell-Type-Specific Expression Patterns in the Rice Root	70
	Cell-Type-Specific Analysis of Auxin	71
	Cell-Type-Specific Analyses of Chromatin	71
	Cell-Type-Specific Analyses of Responses to Environmental Change	72
	Future Prospects	76
	Acknowledgments	76
	References	77
<b>Chapter 5</b>	<b>Toward a Virtual Root: Interaction of Genomics and Modeling to Develop Predictive Biology Approaches</b>	<b>79</b>
	Julien Lavenus, Leah Band, Alistair Middleton, Michael Wilson, Mikael Lucas, Laurent Laplaze, and Malcolm Bennett	
	Assembling Root Gene Regulatory Pathways Using Genomics	79
	Modeling Well-Characterized Small Root Gene Regulatory Networks	81
	Building New Large-Scale Root Gene Regulatory Network	84
	Multi-Scale Modeling Approaches to Study Root Growth and Development	88
	Conclusions and Future Challenges	89
	References	91
<b>Chapter 6</b>	<b>Genomics of Root Hairs</b>	<b>93</b>
	Hyung-Taeg Cho	
	Genomics with Single Cells	93
	Root Hair Development	94
	High-Throughput Approaches for the Characterization of Root Hairs	95
	Functions of Root Hair-Specific Genes	103
	The Regulatory Pathway for Root Hair-Specific Genes	110
	Perspective	111
	Acknowledgments	111
	References	112
<b>Chapter 7</b>	<b>The Effects of Moisture Extremes on Plant Roots and Their Connections with Other Abiotic Stresses</b>	<b>117</b>
	Laura M. Vaughn and Henry T. Nguyen	
	Introduction	117
	Low Water Availability—Drought	118
	Excess Water—Soil Waterlogging, Flooding, and Submergence	128
	Common Plant Root Responses to Abiotic Stressors	135

	Continuing Challenges in Breeding for Plant Root Systems Tolerant to Abiotic Stress	137
	Acknowledgments	138
	References	138
<b>Chapter 8</b>	<b>Legume Roots and Nitrogen-Fixing Symbiotic Interactions</b>	<b>145</b>
	Philippe Laporte, Andreas Niebel, and Florian Frugier	
	Genetic Dissection of the Legume Root System	145
	Functional Genomic Analyses of Legume Nodules and Roots	155
	Concluding Remarks	161
	Acknowledgments	162
	References	162
<b>Chapter 9</b>	<b>What the Genomics of Arbuscular Mycorrhizal Symbiosis Teaches Us about Root Development</b>	<b>171</b>
	Damien Formey, Cyril Jourda, Christophe Roux, and Pierre-Marc Delaux	
	Forward and Reverse Genetics for Identifying Myc Mutants	172
	Comparative Transcriptomics of AM Symbiosis: Toward Identification of Genes Involved in Root Development	175
	Small RNAs in AM Symbiosis	181
	Acknowledgments	183
	References	183
<b>Chapter 10</b>	<b>How Pathogens Affect Root Structure</b>	<b>189</b>
	Michaël Quentin, Tarek Hewezi, Isabelle Damiani, Pierre Abad, Thomas Baum, and Bruno Favery	
	Introduction	189
	Root Infection and Feeding Cell Ontogenesis	190
	Genome-Wide Analysis of the Plant Response to Infection	192
	The Plant Cytoskeleton Is Targeted by Root Pathogens	193
	Root Pathogens Hijack Cell Cycle Regulators	194
	Severe Cell Wall Remodeling Is Associated with Feeding Site Formation	195
	Phytohormones Regulating Development and Defense May Control Feeding Site Formation	196
	Role of miRNAs in Feeding Site Formation and Function	198
	Nematode Effectors That Alter Root Cell Development during Parasitism	200
	Conclusion	203
	Acknowledgments	204
	References	204
<b>Chapter 11</b>	<b>Genomics of the Root—Actinorhizal Symbiosis</b>	<b>211</b>
	Valérie Hocher, Nicole Alloisio, Laurent Laplaze, Didier Bogusz, and Philippe Normand	
	Introduction	211
	Actinorhizal Symbiosis	212

Development of Actinorhizal Nodules	214
Genomic Resources for Studying Actinorhizal Symbiosis	217
What Did We Learn from Actinorhizal Genomics?	220
Conclusion and Future Directions	222
Acknowledgments	222
References	223

## **Chapter 12 Plant Growth Promoting Rhizobacteria and Root Architecture** **227**

Thais L.G. Carvalho, Paulo C.G. Ferreira, and Adriana S. Hemerly

Introduction	227
Different Root Niches for PGPR Colonization	228
PGPR Recognition by Plants	229
Modulation of Root Growth and Architecture by PGPRs	232
Mechanisms of Plant Growth Promotion by PGPRs	234
Plant Genetic Programs Controlling Modulation of Root Growth and Architecture by PGPRs	240
Conclusions	241
Acknowledgments	242
References	242

## **Chapter 13 Translational Root Genomics for Crop Improvement** **249**

Reyazul Rouf Mir, Mahendar Thudi, Siva K. Chamarthi, L. Krishnamurthy, Pooran M. Gaur, and Rajeev K. Varshney

Introduction	249
Molecular Dissection of Root Trait	258
Molecular Breeding for Root Traits	259
Summary and Outlook	260
Acknowledgments	260
References	260

## **Index** **265**

*Color plate located between pages 144 and 145*



## **Root Genomics and Soil Interactions**