

CONTENTS

List of contributors	xi
Preface	xvi
Acknowledgments	xviii
1 Transmembrane Receptors in Plants: Receptor Kinases and Their Ligands	1
<i>Keiko U. Torii</i>	
1.1 Introduction	1
1.2 Classifications of the RLK superfamily	2
1.3 Redundancy and antagonism among closely related RLKs	4
1.4 Ligands for RLKs	7
1.5 Small peptides	9
1.6 Cysteine-rich extracellular proteins	12
1.7 Other possible ligands and their-corresponding receptors	14
1.8 Ligand-receptor interactions	15
1.9 Early events in receptor kinase signaling: dynamics of receptor activation	17
1.10 Early events in receptor kinase signaling: emerging link to small GTP-binding proteins	20
1.11 Future perspectives	21
2 Heterotrimeric G-Protein-Coupled Signaling in Higher Plants	30
<i>Lei Ding, Jin-Gui Chen, Alan M. Jones, and Sarah M. Assmann</i>	
2.1 Introduction	31
2.2 Heterotrimeric G proteins in nonplant systems	31
2.3 Heterotrimeric G proteins in higher plants	34
2.4 Conclusions and future directions	54
3 ROP/RAC GTPases	64
<i>Ying Fu, Tsutomu Kawasaki, Ko Shimamoto, and Zhenbiao Yang</i>	
3.1 Introduction	64
3.2 Structural conservation and diversification	66
3.3 Physiological functions and downstream signaling	67
3.4 Mechanisms for the regulation of the ROP GTPase "ON/OFF" status	83
3.5 Potential upstream regulators of ROP signaling	88
3.6 Future perspectives	90

4	Mitogen-Activated Protein Kinase Cascades in Plant Intracellular Signaling	100
	<i>Shuqun Zhang</i>	
4.1	Mitogen-activated protein kinase cascades are evolutionarily conserved signaling modules in eukaryotic cells	100
4.2	History of plant MAPK research	101
4.3	Plant MAPK cascades	102
4.4	Negative regulation of plant MAPK cascades	104
4.5	Important tools/techniques in MAPK research	105
4.6	Biological functions of MAPK cascades in plants	108
4.7	Signaling specificity of plant MAPK cascades	124
4.8	Conclusion remarks	126
5	Calcium Signals and Their Regulation	137
	<i>Zhen-Ming Pei and Simon Gilroy</i>	
5.1	Introduction	137
5.2	Ca ²⁺ as a second messenger in plants: of signatures and switches	138
5.3	Ca ²⁺ channels and pumps	141
5.4	Decoding the Ca ²⁺ signal	143
5.5	Ca ²⁺ and Nod-factor signaling: a role for kinases in decoding the Ca ²⁺ signal?	144
5.6	Ca ²⁺ uptake and transport	149
5.7	Sensing extracellular Ca ²⁺	150
5.8	Ca ²⁺ , light, and circadian [Ca ²⁺] oscillations	151
5.9	Conclusions and perspectives	153
6	Paradigms and Networks for Intracellular Calcium Signaling in Plant Cells	163
	<i>Sheng Luan</i>	
6.1	Introduction	163
6.2	CDPKs, plant calcium "sensor responders"	165
6.3	CaM: small calcium sensors with a variety of target proteins	168
6.4	The CBL-CIPK network	174
6.5	Perspectives: complex networks for Ca ²⁺ decoding in plant cells	180
7	Reactive Oxygen Signaling in Plants	189
	<i>Gad Miller, Jesse Coutu, Vladimir Shulaev, and Ron Mittler</i>	
7.1	Introduction to reactive oxygen metabolism	189
7.2	ROS signaling and its modulation by the ROS gene network	190

7.3	Subcellular localization and coordination of the ROS network	194
7.4	Key components of the ROS gene network identified by reverse genetics	195
7.5	The ROS signal transduction pathway of plants	195
7.6	Summary	196
8	Lipid-Mediated Signaling	202
	<i>Wendy F. Boss, Daniel V. Lynch, and Xuemin Wang</i>	
8.1	Introduction	202
8.2	Plant-specific features of phosphoinositide signaling	203
8.3	Phospholipase D signaling	217
8.4	Sphingolipid signaling	224
8.5	Summary	232
9	The Cytoskeleton and Signal Transduction: Role and Regulation of Plant Actin- and Microtubule-Binding Proteins	244
	<i>Patrick J. Hussey and Takashi Hashimoto</i>	
9.1	Actin cytoskeleton	245
9.2	Actin nucleation	245
9.3	Actin-binding proteins that modulate monomer/polymer dynamics	249
9.4	Microtubule cytoskeleton	253
9.5	ROP	254
9.6	Protein phosphorylation	255
9.7	Calcium	261
9.8	Conclusion	262
10	The PCI Complexes and the Ubiquitin Proteasome System (UPS) in Plant Development	273
	<i>Yair Halimi and Daniel A. Chamovitz</i>	
10.1	General overview	273
10.2	The PCI complexes	274
10.3	PCI/MPN domain	278
10.4	Inter-PCI-complex relationships	279
10.5	Ubiquitin and ubiquitin-conjugating cascade	280
10.6	Other COP/DET proteins	286
10.7	The UPS and plant physiology	288
11	Signaling Between the Organelles and the Nucleus	307
	<i>Aurora Piñas Fernández and Åsa Strand</i>	
11.1	Introduction	307
11.2	Plastid-to-nucleus communication	308
11.3	Mitochondria-to-nucleus communication	318

11.4	Emission of organellar signals	321
11.5	Targets of retrograde communication	323
11.6	Organelle-to-organelle communication	325
11.7	Concluding remarks	327
12	Signaling by Protein Phosphorylation in Cell Division <i>Michiko Sasabe and Yasunori Machida</i>	336
12.1	Introduction	336
12.2	Progression of mitosis by cyclin-dependent kinases in plants	337
12.3	Aurora kinases in plants	339
12.4	Cytokinesis modulated by the MAP kinase cascade	345
12.5	Concluding remarks	351
13	Guard Cell Signaling <i>Yan Wu</i>	362
13.1	Introduction	362
13.2	ABA-mediated guard cell signaling	364
13.3	CO ₂ signaling in guard cells	373
13.4	Light signaling in guard cells	375
13.5	Innate immunity in guard cells	377
13.6	Extracellular Ca ²⁺ sensing in guard cells	378
13.7	Conclusions and prospects	379
14	The Molecular Networks of Abiotic Stress Signaling <i>Zhizhong Gong, Viswanathan Chinnusamy, and Jian-Kang Zhu</i>	388
14.1	Introduction	389
14.2	Abscisic acid	389
14.3	The molecular mechanisms of salt tolerance	395
14.4	The transcriptional regulation of cold- and drought-inducible genes	398
14.5	Oxidative stress management	402
14.6	Posttranscriptional regulation of gene expression	403
14.7	Future perspectives	406
	Index	417
	Color plate (between pages 174 and 175)	