

Auxin and Its Role in Plant Development

Eva Zažímalová • Jan Petrášek • Eva Benková
Editors

Auxin and Its Role in Plant Development

 Springer

Editors

Eva Zažímalová
Jan Petrášek
Laboratory of Hormonal Regulations
in Plants
Institute of Experimental Botany AS CR
Prague 6
Czech Republic

Eva Benková
Hormonal Cross-talk Group
Institute of Science and Technology (IST),
Austria
Klosterneuburg
Austria

ISBN 978-3-7091-1525-1

ISBN 978-3-7091-1526-8 (eBook)

DOI 10.1007/978-3-7091-1526-8

Springer Wien Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014943106

© Springer-Verlag Wien 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

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

What Is Auxin? How It Operates?

Many articles dealing with plant growth and development start with the “auxin mantra”, such as: Auxin is involved in control of many developmental processes in plants.

When in 1881 Charles Darwin and his son Francis examined coleoptiles exposed to unidirectional light, and proposed the existence of a signalling molecule directing their bending, they might have not been fully aware of enormous significance of their discovery for understanding the key principles governing plant growth and development. Since then the mysterious signalling molecule was identified, named auxin, and an immense number of observations confirmed a crucial importance of this tiny compound throughout life of any plant. Besides its for a long time known function in regulation of organ bending in response to light and gravity, auxin was revealed to mediate growth reactions of plants to current environmental conditions in general, and on top of that to control also genetically pre-programmed physiological processes such as embryogenesis, and initiation and formation of diverse organs including flowers, leaves, shoots, roots, and ovules. However, in spite of tremendous progress in the auxin research in last decades, it is still not fully understood how auxin operates and how it can regulate so many and so different processes. So, in spite of years of intensive research bringing much essential information, auxin still remains rather enigmatic.

In this book, respected scientists—experts in different fields of “auxinology”—summarize recent progress in understanding of how auxin operates to control and coordinate plant development. In 18 chapters various aspects of auxin biology focusing on auxin metabolism, transport, signalling, and principles of auxin-regulated plant organogenesis, tropic responses, as well as other interactions with environment are reviewed and future perspectives are outlined.

We hope this compact contemporary overview on the enigma called auxin will inspire new fresh research ideas to address remaining auxin challenges.

Prague and Klosterneuburg
May 2014

Eva Zažímalová
Jan Petrášek
Eva Benková

Contents

Part I Auxin: Definition; Metabolism, Transport and Signalling

1 The Auxin Question: A Philosophical Overview	3
Tom Bennett and Ottoline Leyser	
2 Auxin Biosynthesis and Catabolism	21
Yangbin Gao and Yunde Zhao	
3 Identification and Profiling of Auxin and Auxin Metabolites	39
Ondřej Novák, Aleš Pěňčík, and Karin Ljung	
4 Intracellular Auxin Transport	61
David Scheuring and Jürgen Kleine-Vehn	
5 Intercellular Transport of Auxin	75
Jessica Reemmer and Angus Murphy	
6 Auxin Receptors and Perception	101
Richard M. Napier	

Part II Auxin and Plant Development

7 The Interplay Between Auxin and the Cell Cycle During Plant Development	119
Marlies J.F. Demeulenaere and Tom Beeckman	
8 Auxin on the Road Navigated by Cellular PIN Polarity	143
Pawel Baster and Jiří Friml	
9 Auxin Regulation of Embryo Development	171
Alejandra Freire Rios, Saiko Yoshida, and Dolf Weijers	
10 Auxin, Chief Architect of the Shoot Apex	191
Benoît Landrein and Teva Vernoux	

11 The Role of Auxin for Reproductive Organ Patterning and Development	213
Thomas Dresselhaus and Kay Schneitz	
12 Auxin and Its Henchmen: Hormonal Cross Talk in Root Growth and Development	245
Antia Rodriguez-Villalon and Christian S. Hardtke	
13 Evolutionary Aspects of Auxin Signalling	265
Priya Ramakrishna and Ive De Smet	
14 Auxin and Self-Organisation	291
Peter Nick	
15 Computational Models of Auxin-Driven Development	315
Adam Runions, Richard S. Smith, and Przemyslaw Prusinkiewicz	
 Part III Auxin versus Environment	
16 Auxin and Tropisms	361
Katarzyna Retzer, Barbara Korbei, and Christian Luschnig	
17 Auxin Coordinates Shoot and Root Development During Shade Avoidance Response	389
Valentino Ruzza, Giovanna Sessa, Massimiliano Sassi, Giorgio Morelli, and Ida Ruberti	
18 Auxin and the Interaction Between Plants and Microorganisms . . .	413
Jutta Ludwig-Müller	
Index	435