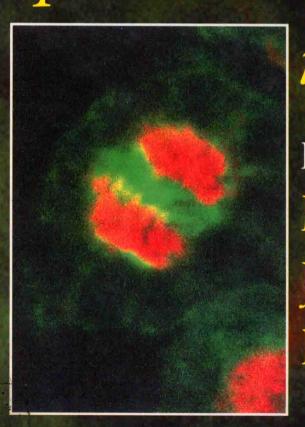
Chembranes: Specialized Functions



in Plants

Edited by

M. Smallwood,

J.P. Knox and

D.J. Bowles

Membranes: Specialized Functions in Plants

M. Smallwood

The Plant Laboratory, Department of Biology, University of York, PO Box 373, York YO1 5YW, UK

J.P. Knox

Centre for Plant Biochemisty and Biotechnology, University of Leeds, Leeds LS2 9JT, UK

D.J. Bowles

The Plant Laboratory, Department of Biology, University of York, PO Box 373, York YO1 5YW, UK



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Cover illustration: The inset on the front cover shows the cellular distribution of the endoplasmic reticulum (ER) in two daughter cells just after division of a tobacco cotyledon cell. The ER is visualized by the specific immunological detection of the ER resident protein calreticulin in combination with green fluorescent secondary antibodies. The DNA of the two daughter nuclei is visualized in orange by a subsequent propidium iodide staining. Note the accumulation of ER in the fragmoplast and the nuclear envelopes. The inset on the back cover shows a cell prior to cell division in the anaphase/metaphase, stained with the same procedure. The ER (green) is associated with the spindle figure on either side of the chromosomes (orange). The staining patterns suggest that, during cell division in plant cells, the ER moves along the microtubules in the opposite direction to the chromosomes and accumulates where the new cell plate is being formed. Original photographs courtesy of Dr Anna-Stina Höglund, Uppsala Genetic Center, Sweden.

Membranes: Specialized Functions in Plants

Contributors

- **Askerlund, P.** Department of Plant Biochemistry, Lund University, P.O. Box 117, S-221 00 Lund, Sweden
- Baker, A. Centre for Plant Biochemistry and Biotechnology, University of Leeds, Leeds LS2 9JT, UK
- **Blanton, R.L.** Department of Biological Sciences, Texas Tech University, Box 43131, Lubbock, TX 79409-3131, USA
- Block, M.A. Laboratoire de Physiologie Cellulaire Végétale, URA CNRS 567, Département de Biologie Moléculaire et Structurale, Centre d'Etudes Nucléaires de Grenoble et Université Joseph Fourier, F-38054 Grenoble Cedex 9, France
- **Boutry**, M. Unité de Biochimie Physiologique, Université Catholique de Louvain, Place Croix du Sud 2-20, B-1348 Louvain-la-Neuve, Belgium
- Brewin, N.J. Department of Genetics, John Innes Centre, Colney, Norwich NR4 7UH, UK
- Callow, J.A. School of Biological Sciences, The University of Birmingham, Birmingham B15 2TT, UK
- Cooke, T.J. Department of Plant Biology, University of Maryland, College Park, MD 20742, USA
- Crawford, J.W. Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, UK
- Denecke, J. Department of Biology, University of York, Heslington, York YO1 5DD, UK
- Ding, B. Section of Plant Biology, University of California, Davis, California CA 95616, USA.
 Present address: Department of Botany, Oklahoma State University, Stillwater, OK 74078, USA
- **Douce, R.** Laboratoire de Physiologie Cellulaire Végétale, URA CNRS 567, Département de Biologie Moléculaire et Structurale, Centre d'Etudes Nucléaires de Grenoble et Université Joseph Fourier, F-38054 Grenoble Cedex 9, France
- Dove, S.K. Department of Cell Biology, John Innes Centre, Colney, Norwich NR4 7UH, UK
- Drøbak, B.K. Department of Cell Biology, John Innes Centre, Colney, Norwich NR4 7UH, UK
- Faye, L. LTI-CNRS URA 203, Université de Rouen, 76821 Mont Saint Aignan, France
- Findlay, G.P. School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, South Australia, Australia 5001
- Frommer, W.B. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany

Garrill, A. School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, South Australia, Australia 5001. Present address: Molecular Genetics Group, Department of Zoology, University of Western Ontario, London, Ontario, Canada

- **Gray, J.** Department of Plant Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EA, UK
- **Green, J.R.** School of Biological Sciences, The University of Birmingham, Birmingham B15 2TT, UK
- **Grosbois, M.** Laboratoire de Physiologie Cellulaire et Moléculaire des Plantes, Université Pierre et Marie Curie, CNRS URA 1180 Tour 53 Case 154, 4 place Jussieu, F-75252 Paris Cedex 05 France
- Guerbette, F. Laboratoire de Physiologie Cellulaire et Moléculaire des Plantes, Université Pierre et Marie Curie, CNRS URA 1180 Tour 53 Case 154, 4 place Jussieu, F-75252 Paris Cedex 05 France
- **Hahn, M.G.** The University of Georgia, Complex Carbohydrate Research Center and Department of Botany, 220 Riverbend Road, Athens, GA 30602-4712, USA
- **Haigler, C.H.** Department of Biological Sciences, Texas Tech University, Box 43131, Lubbock, TX 79409-3131, USA
- **Harmon, A.C.** Department of Botany and the Graduate Program in Plant Molecular and Cellular Biology, University of Florida, P.O. Box 118526, Gainesville, FL 32611-8526, USA
- Harms, K. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany
- **Hawes, C.** School of Biological and Molecular Sciences, Oxford Brookes University, Gipsy Lane Campus, Oxford OX3 0BP, UK
- **Hepler, P.K.** Department of Biology, University of Massachusetts, Amherst, MA 01003-5180, USA
- Hirner, B. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany
- Jauh, G.Y. Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, USA
- Jolliot, A. Laboratoire de Physiologie Cellulaire et Moléculaire des Plantes, Université Pierre et Marie Curie, CNRS URA 1180, Tour 53 - Case 154, 4 place Jussieu, F-75252 Paris Cedex 05, France
- **Joyard**, **J.** Laboratoire de Physiologie Cellulaire Végétale, URA CNRS 567, Département de Biologie Moléculaire et Structurale, Centre d'Etudes Nucléaires de Grenoble et Université Joseph Fourier, F-38054 Grenoble Cedex 9, France
- **Kader, J.-C.** Laboratoire de Physiologie Cellulaire et Moléculaire des Plantes, Université Pierre et Marie Curie, CNRS URA 1180 Tour 53 Case 154, 4 place Jussieu, F-75252 Paris Cedex 05, France
- Kauss, H. FB Biologie der Universität, Postfach 3049, D-67653 Kaiserslautern, Germany
- **Knox, J.P.** Centre for Plant Biochemistry and Biotechnology, University of Leeds, Leeds LS2 9JT, UK

Contributors xxi

Kühn, C. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany

- Lee, J.-Y. Department of Botany and the Graduate Program in Plant Molecular and Cellular Biology, University of Florida, P.O. Box 118526, Gainesville, FL 32611-8526, USA
- Lichtscheidl, I.K. Institute of Plant Physiology, University of Vienna, Althanstrasse 14, A-1091 Vienna, Austria
- Lloyd, C.W. Department of Cell Biology, John Innes Centre, Colney, Norwich NR4 7UH, UK
- Loake, G.J. Institute of Cell and Molecuar Biology, Daniel Rutherford Building, King's Buildings', Mayfield Road, Edinburgh EH9 3JH, UK
- Lord, E.M. Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, USA
- Lucas, W.J. Section of Plant Biology, University of California, Davis, CA 95616, USA
- Marechal, E. Laboratoire de Physiologie Cellulaire Végétale, URA CNRS 567, Département de Biologie Moléculaire et Structurale, Centre d'Etudes Nucléaires de Grenoble et Université Joseph Fourier, F-38054 Grenoble Cedex 9, France
- Martin, T. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany
- Michelet, B. Unité de Biochimie Physiologique, Université Catholique de Louvain, Place Croix du Sud 2-20, B-1348 Louvain-la-Neuve, Belgium. Present address: Laboratory of Plant Molecular Biology, The Rockefeller University, 1230 York Avenue, New York, NY 10021-6399, USA
- Oparka, K.J. Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, UK
- Oursel, A. Laboratoire de Physiologie Cellulaire et Moléculaire des Plantes, Université Pierre et Marie Curie, CNRS URA 1180 Tour 53 Case 154, 4 place Jussieu, F-75252 Paris Cedex 05, France
- Palme, K. Max Plancke Institut für Züchtungsforschung, Carl-von-Linné-Weg 10, Koln, D-50829 Köln, Germany
- Prior, D.A.M. Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, UK
- Raikhel, N.V. Department of Energy-Plant Research Laboratory, Michigan State University, East Lansing, MI 48823, USA
- Reynolds, T.L. Monsanto Company Mail Zone AA3I, 700 Chesterfield Parkway North, St. Louis, MO 63198, USA
- Riesmeier, J.W. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany
- Robinson, C. Department of Biological Sciences, University of Warwick, Coventry CV4 7AL, UK
- Satiat-Jeunemaitre, B. CNRS, UPR 40, Institute des Sciences Végétales, 91198 Gif-sur-Yvette Cedex, France

- Schulz, B. Institut für Genbiologische Forschung, Ihnestrasse 63, Berlin, D-14195 Germany. Present address: Institut für Botanik, Universität zu Köln, Gyrhofstrasse 15, D-50931 Köln, Germany
- Shao, J. Department of Botany, University of Florida, P.O. Box 118526, Gainesville, FL 32611-8526, USA
- Smith, S.E. Department of Soil Science and The Cooperative Research Centre for Soil and Land Mangement, Waite Campus, The University of Adelaide, South Australia, Australia 5064
- Smith, F.A. Department of Botany, The University of Adelaide, South Australia, Australia 5005
- Sommarin, M. Department of Plant Biochemistry, Lund University, P.O. Box 117, S-221 00 Lund, Sweden
- **Staiger, C.J.** Department of Cell Biology, John Innes Centre, Colney, Norwich NR4 7UH, UK. Present address: Department of Biological Sciences, Purdue University, West Lafayette, IN 47907-1392, USA
- **Tester, M.** Department of Plant Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EA, UK
- Thain, J.F. School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ, UK
- Tilney, L.G. Department of Botany, University of Pennsylvania, Philadelphia, PA 19104, USA
- Tilney, M.S. Department of Botany, University of Pennsylvania, Philadelphia, PA 19104, USA
- **Tyerman, S.D.** School of Biological Sciences, Flinders University, GPO Box 2100, Adelaide, South Australia, Australia 5001
- Walling, L.L. Department of Botany and Plant Sciences, University of California, Riverside, CA 92521-0124, USA
- Wildon, D.C. School of Biological Sciences, University of East Anglia, Norwich NR4 7TJ, UK
- Willmitzer, L. Institut für Genbiologische Forschung, Ihnestrasse 63, D-14195 Berlin, Germany
- Yoo, B.-C. Department of Botany and the Graduate Program in Plant Molecular Cellular Biology, University of Florida, P.O. Box 118526, Gainesville, FL 32611-8526, USA

Abbreviations

ABA abscisic acid

ABP actin-binding protein

ACC aminocyclopropane-1-carboxylic acid

ACP acyl carrier protein

ADF actin depolymerizing protein
AGP arabinogalactan-protein
ALP alkaline phosphatase

AO active oxygen

ARF ADP-ribosylation factor

BFA brefeldin A
BiP binding protein
BL barley lectin

BrHMA bromohexamethylene amiloride

CaM calmodulin

CAM cell adhesion molecule
CaMV cauliflower mosaic virus
CCV clathrin-coated vesicle

CDPK calmodulin-like domain kinase/calcium-dependent protein kinase CHAPS 3-[(3-cholamidopropyl)dimethylammonio]-1-propanesulphonate

CHS chalcone synthase

CLSM confocal laser scanning microscopy

COP coat protein

CPMV cowpea mosaic virus CPY carboxypeptidase Y

CTPP carboxyl-terminal propeptide
DAPI 4,6-diamidino-2-phenylindole
DCB 2, 6-dichlorobenzonitrile
DCCD N, N'-dicyclohexylcarbodiimide

DCMU 3-(3,4-dichlorophenyl)-1,1-dimethylurea

DEAE diethylaminoethyl
DEPC diethylpyrocarbonate
DES diethylstilbesterol
DG diacylglycerol

DGDG digalactosyldiacylglycerol
DHFR dihydrofolate reductase
DMSO dimethylsulphoxide
DP degree of polymerization
DPAP dipeptidyl aminopeptidase

DTT dithiothreitol ECM extracellular matrix

EDTA ethylenediamine tetra-acetic acid

EF extracytoplasmic fracture EGF epidermal growth factor

EGTA ethylene glycol-bis(β -aminoethyl) ether N, N, N', N'-tetraacetic acid

EHM extrahaustorial membrane

ELISA enzyme-linked immunosorbent assay

EM electron microscopy
ER endoplasmic reticulum

ES extracytoplasmic surface **EST** expressed sequence tag filamentous actin F-actin

FBPase fructose-1, 6-bisphosphatase

FC fusicoccin

ferricyanide reductase **FCR** FITC fluorescein isothiocyanate

FN fibronectin

FNR ferredoxin:NADPH oxidoreductase fast protein liquid chromatography **FPLC**

BGlcY B-glucosyl Yariv reagent

G-actin globular actin

GTPase-activating protein GAP

GC generative cell

GC-MS gas chromatography-mass spectroscopy glyoxysomal malate dehydrogenase gMDH **GNRP** guanine nucleotide release protein GnT-I N-acetylglucosaminlytransferase

GO glycolate oxidase GS I β-glucan synthase I GS II B-glucan synthase II GT glucose transporter GUS B-glucuronidase HAO haemagglutinin

HATS high-affinity transport system

HC haustaurial complex

HPLC high-pressure liquid chromatography

HPR hydroxypyruvate reductase hypersensitive response HR

HRGP hydroxyproline-rich glycoprotein

Hsc heat shock cognate Hsp heat shock protein **HST** host-specific toxin hydroxyproline Hyp IAA indole-3-acetic acid IC intermediate compartment

ICL isocitrate lyase IF intermediate filament **IMP** intramembrane particle Ins(1,4,5)P₃ inositol(1, 4, 5)triphosphate

inositol phosphate **IPA** JA iasmonic acid

IIP jasmonate-induced protein LATS low-affinity transport system

LHCP light-harvesting chlorophyll-binding protein

LIMP lysosomal integral membrane protein

LOX lipoxygenase LPS lipopolysaccharide LRR leucine-rich repeat LTP lipid transfer protein LYCH Lucifer Yellow CH M₆P mannose 6-phosphate mAb monoclonal antibody

MAP microtubule-associated protein

Me-JA methyl jasmonate MF microfilament

MFS major facilitator superfamily

MGDG male germ unit

MI major intrinsic protein
MP movement protein
MS mechanosensitive
MT microtubule

NAA naphthyl-1-acetic acid

NBD-PC nitrobenzoxadiazol-phosphatidylcholine

NEM *N*-ethylmaleimide

NMR nuclear magnetic resonance NPTII neomycin phosphotransferase II

NSF N-ethylmaleimide-sensitive fusion protein

nsL-TP non-specific lipid transfer protein
NTPP amino-terminal propeptide
12-oxo-PDA 12-oxo-phytodienoic acid
P channel open probability
PAL phenylalanine ammonia-lyase

PAM periarbuscular membrane

PAT phosphoinothrian acetyl transferase

PBM peribacteroid membrane PC phosphatidylcholine

PC-TP proteins specifically transferring PC p-chloromercuribenzyl sulphonic acid

PCR partially coated reticulum p.d. potential difference

PDGF platelet-derived growth factor
PE phosphatidylethanolamine
PEP phosphoenolpyruvate

PEP phosphoenolpyruvate
PF protoplasmic fracture
PG phosphatidylglycerol
3-PGA 3-phosphoglycerate
PGA polygalacturonic acid
PGA/RG-I polygalacturonan/rham

PGA/RG-I polygalacturonan/rhamnogalacturonan I

PHA phytohaemagglutinin
PhyA active phytochrome
PI phosphatidylinositol

PI 3-kinase phosphatidylinositol 3-kinase PI-TP proteins specifically transferring PI phosphoinositidase C

PIC phosphoinositidase C
PKC protein kinase C
PLC phospholipase C
PLD phospholipase D
PM plasma membrane
PPB preprophase band
PP_i pyrophosphate
PP.ase pyrophosphatase

PPM peripheral plasma membrane

PrA proteinase A
PRK1 receptor-like kinase
PS protoplasmic surface
PtdIns phosphatidylinositol

PtdIns(4)P phosphatidylinositol(4)phosphate phosphatidylinositol(4,5)bisphosphate pTS phosphatidylinositol(4,5)bisphosphate class-1 peroxisomal targeting signal

PUFA polyunsaturated fatty acid rER rough endoplasmic reticulum

Rubisco ribulose 1,5-bisphosphate carboxylase/oxygenase

SA salicylic acid

SAM substrate adhesion molecule SAR systemic acquired resistance SBP sucrose binding protein

SDS-PAGE sodium dodecyl sulphate-polyacrylamide gel electrophoresis

SEL size exclusion limit

SGAT serine:glyoxylate amino transferase

SLG S-locus glycoprotein

SNAP soluble NSF attachment protein SPP stromal processing peptidase SQDG sulphoquinovosyldiacylglycerol

SRK S-locus receptor kinase SRP signal recognition particle SSU small subunit

SUT sucrose transporter

t-SNARE target membrane SNAP receptor

TC terminal complex

TEM transmission electron microscope

Tes N-[tris(hydroxymethyl)methyl]-2-aminomethanesulfonic acid

TGN trans-Golgi network
TIP tonoplast intrinsic protein
TLC thin-layer chromatography
TMV tobacco mosaic virus
TNF tumour necrosis factor

TPP thylakoidal processing peptidase triose-phosphate translocator

triose-P triose phosphate

UV ultraviolet

v-SNARE vesicle-specific SNAP receptor

VA vesicular-arbuscular

VAMP vesicle-associated membrane protein

VN vitronectin

VSP vegetative storage protein

XET xyloglucan endotransglycosylase

XG xyloglucan

Preface

When we were invited to design a book on 'membranes' we decided to highlight features of membrane biology that are specific to plants. We chose this strategy because we wanted to develop a reference book and survey of membrane biology *in relation* to plant biology. First and foremost we are plant biologists and the contents of this book reflect our enthusiasm and excitement about plants fuelled by the ever-increasing understanding of plant form and function at the molecular level. In a sense, we used the opportunity as editors to invite chapters on all of the areas of plant membranes that we find fascinating. This may have produced a rather personal viewpoint of the range of topics included, but we hope that there is also some intellectual foundation to our choice!

The Contents List begins with a section entitled "Membranes and the Cell Surface". The plasma membrane surrounds the protoplast and represent the junction and gateway linking it to the outer world of the symplast. It is increasingly recognized that the cell wall, plasma membrane and cytoskeleton interact to relay information across the hydrophobic barrier. The chapters in this section discuss the specialized functions of the plant plasma membrane within its cellular context: as a key site of synthesis of cell wall polysaccharides, as the major site of molecular recognition events, and as the location for the start of signalling cascades that link external stimuli to end-effect.

The second section, "Membrane Lipid Metabolism", addresses specialized lipids of plant cell membranes. It covers the structural role(s) of the galactolipids and sterols, the putative role of inositol-containing lipids in cell signalling, and the lipid-transfer proteins that are now known to exist in both the symplast and the apoplast and play important roles trafficking lipids around and between the two hydrophilic compartments.

In Section 3, "Regulation of Membrane Permeability", the authors address ion transport at the cell surface and vacuolar membranes. Movement of ions and the regulation of ion transport processes are fundamental to most, if not all, plant cell functions. We are now beginning to understand these events at the molecular level, with the aid of patch-clamp analyses, and this in turn is demonstrating the complexity of regulation both at the plasma membrane and, significantly for plants, at the tonoplast. Given the importance of turgor in the biology of plants, it is perhaps not surprising that the number of mechanosensitive channels identified is increasing. Ion fluxes have been linked causally as the stimulus—response coupling mechanism for some cellular responses. Interestingly, electrical activity is also now recognized as being of importance in long-distance systemic signalling although we are still some way from understanding the underlying molecular events leading to the variation potentials and action potentials that can be recorded.

The fourth section, "Membrane Compartments within the Cell", addresses the endomembranes, and again highlights specialized functions in plants. Authors discuss the problem of protein targeting to the vacuole, how plant peroxisomes are formed and the action of the endoplasmic reticulum, Golgi apparatus and secretory vesicles in assembling, sorting and transporting newly synthesized proteins, glycoproteins and polysaccharides. The cortical endoplasmic reticulum is also a feature of all plant cells, yet is rarely highlighted in the literature on membranes. In

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particular, the chloroplast is discussed with respect to events that control its division and thereby its biogenesis as well as events that lead to the import of nuclear-encoded gene products into the organelle.

Plasmodesmata, the topic of the fifth section, may seem an odd choice for a book on membranes, given that they are generally considered in texts discussing cell—cell junctions and cell signalling. Nevertheless, we chose to include plasmodesmata in this volume because of their significance to the understanding of the role of membranes in long-range communication throughout the plant. Given that membrane continuity through plasmodesmatal junctions is proven, fluidity of the lipid bilayer and mobility of protein and lipid components through plasmodesmata must be considered with the same emphasis as solute transport through the pore.

The book ends with a section on changes to membranes when plant cells are in intimate association with another organism; whether beneficial, in the context of symbiotic relationships, or detrimental, as when the cells of the plant are interacting with pathogens and pests. As yet, molecular information on these changes is limited. However, we wished to highlight this topic both for the light shed on fundamental processes in membrane biology and for the insights to be gained that may lead to novel crop protection applications.

We hope you as the reader will enjoy the selection of topics, and the very excellent reviews provided by the authors who have kindly contributed their time and enthusiasm to this book.

Margaret Smallwood Paul Knox Dianna Bowles

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