

# Index

## A

AAL toxin, 315  
ABI1, 206  
  PA, 49  
  PLD, 49  
Abscisic acid (ABA), 300  
  DGPP, 268–270  
  NAE metabolism, 300  
  NO, 224  
  PA, 224  
  PAP, 140  
  PLC, 28  
  PLD, 47, 49  
  PPI metabolism, 152  
Accelerated-cell-death11, 316  
ADI3, 251  
Adventitious root (AR) formation, 226, 227  
AGC kinase, 244, 245  
Alkamides, 293  
Allene oxide synthase, 279  
Amidase, 303  
Anionic lipid, 207, 213–214, 216  
AOS. *See* Allene oxide synthase  
Arabidopsides, 279  
Arachidonic acid, 4  
AtSAC1, 178. *See* Fragile Fiber 7 (FRA7)  
AtSAC7. *See* Root hair defective4 (RHD4)  
Auxin, 8, 12  
  InsP<sub>6</sub>, 285  
  IP metabolism, 167  
  PA, 232  
  PDK1, 253  
  phospholipid signaling, 233

  PLA<sub>2</sub>, 3, 8, 11  
  PLD, 50, 233  
  pPLA<sub>2</sub>, 9  
Auxin-receptor, TIR1, 285

## B

Basic residues, 210  
Biosensors, 191  
  new tools, 194  
BODIPY, 11  
1-Butanol, 51

## C

Ca<sup>2+</sup>-dependent protein kinase (CDPK), 29  
Ca<sup>2+</sup>/InsP<sub>3</sub>, 30, 145  
C6 aldehydes, 280  
Ca<sup>2+</sup> signaling and oxylipins, 284  
catalytic, 235  
C1 domain, 112  
C2 domain, 214–215  
CDPK, 233  
Ceramide-1-phosphate (Cer-1-P), 204, 213  
*coil*. *See* CORONATINE INSENSITIVE 1  
Confocal microscopy, 188  
Constitutive Triple Response 1 (CTR1),  
  51, 206  
CORONATINE INSENSITIVE 1 (*coil*),  
  280  
cPTIO, 227  
CVP2, 124  
Cytoskeletal organization, PPIs, 179  
Cytoskeletal protein, 256

## D

DAD1, 14  
 DAF-2DA, 227  
 DAG. *See* Diacylglycerol  
 Dehydratase, 312  
 Dehydroxy-lysophosphatidic acid, structure, 204  
 DES. *See* Divinyl ether synthase  
 DGDG. *See* Digalactosyldiacylglycerol  
 DGPP. *See* Diacylglycerol pyrophosphate  
 Diacylglycerol (DAG), 131  
   biosensor, 192  
   PA interconversion, 33, 107, 203, 223, 263  
   structure, 24  
   tip growth, 32  
   YFP-C1a<sub>PKC $\gamma$</sub> , 191  
 Diacylglycerol kinase (DGK), 52, 205, 207  
   abiotic stress, 110  
   activity, 109  
   biotic stress, 111  
   classification, 107  
   differential labeling, 110  
   gene expression, 109  
   protein structure, 108  
   regulatory domains, 107  
   signaling, 109  
 Diacylglycerol pyrophosphate (DGPP), 136, 187, 205, 263  
   ABA, 271  
   drought, 266  
   identification, 264–266  
   metabolism, 267–270  
   stress induced, 266  
   structure, 264  
 Digalactosyldiacylglycerol, 279  
 Dihydrosphingosine, 309  
 Dihydroxyacetone phosphate (DHAP), 205  
 Dinor-OPDA, 279  
 Dissociation constant, 209, 212  
 Divinyl ether synthase, 279  
 dn-OPDA. *See* Dinor-OPDA  
 Docking of the membrane interacting protein on a di-anionic PA molecule, 212  
 Docking site, 214, 216  
 Domains  
   C1, 112, 192  
   C2, 5, 27, 31, 41, 43

EF-loop, 27  
 FKBP12, 195  
 FRB, 195, 206  
 FYVE, 191, 192  
 LKU, 67  
 MORN repeats, 83  
 NH, 67  
 PA, 206  
 PH, 67, 191–193, 248  
 PH (FAPP1), 72, 191  
 PIP kinase, 80  
   plant-lipid binding, 192  
 PLD, catalytic, 43, 235  
 pleckstrin homology (PH), 191, 192  
 PPC, 68  
 PtdInsP<sub>2</sub>, 32  
 PX, 41, 192  
 SAC, 70, 178  
 UBL, 68  
   X, Y (PLC-catalytic), 27  
 DONGLE (DGL), 14

## E

Eicosanoids, 279  
 Electrophilic ketodienes, 280  
 Electrostatic/hydrogen-bond model, 204  
 Electrostatic/hydrogen bond switch model, 207, 211–216  
 Electrostatic interaction, 207, 211  
 Endocannabinoid, 293  
 Enoyl-reductase, 312  
 Epoxy alcohol synthase (EAS), 279

## F

FAB1, 84  
 Fatty acid amide hydrolase (FAAH), 294  
 Fatty acids, 15  
 Fig4, 70  
 FM4-64, 97  
 Fragile Fiber 3 (FRA3), 123, 179  
 Fragile Fiber 7 (FRA7), 127, 179  
 Free fatty acid, PLA<sub>2</sub>, 11  
 Freezing tolerance, PLD/PA, 52–53  
 Frequenin, 67  
 FRY1, 153  
 FYVE, 97

## G

- Galactolipids, 3, 14
  - digalactosyldiacylglycerol, 279
  - monogalactosyldiacylglycerol, 137, 279
- Glucosylceramides, 310
- Glycerol-3-phosphate (G3P), 131
- G-protein, 28, 29, 31
- Green leaf volatiles, 281
- Guard cells, 235
  - DGPP, 271
  - LPP, 136
  - PIPK, 85
  - PPI turnover, 152
  - PLC, 28
  - PLD, 49

## H

- HeLa cells, 188
- Herbivory, phosphoinositides, 284
- HKD motifs. *See* Phospholipase D (PLD)
- HPL. *See* Hydroperoxide lyases
- Hydrogen bond, 203, 207, 211–214
- Hydroperoxide lyases, 279
- Hydrophobic interaction, 213
- Hydrophobic protein domains, 213
- Hydroxyl group, 209, 213
- Hypersensitive-response (HR), oxylipins, 280

## I

- INO1. *See* Inositol monophosphatase
- Inositol hexakisphosphate (InsP<sub>6</sub>), 28, 148, 161, 186, 285
  - mRNA export, 169
  - synthesis, 164
- Inositol lipids, 186
- Inositol monophosphatase, 163
- Inositol (1,3,4)P<sub>3</sub> 5/6-Kinases/Inositol trisphosphate kinases (IP56K/ITPK), 167–168
- Inositol polyphosphate kinase 1 (Ipk1), 169–170
- Inositol polyphosphate kinase 2 (Ipk2), 148, 165–167
- Inositol polyphosphate 5-phosphatase (InsP 5-ptase), 153, 179

- Inositol polyphosphates, 161
  - kinases, 168
  - substrates, 168
  - synthesis, 162–165

Inositol 1,4,5-trisphosphate (InsP<sub>3</sub>), 24

- ABA, 152
- analysis, 148
- Arabidopsis mutants, 152
- calcium release, 29, 145
- degradation, 147
- gravistimulation, 153
- InsP<sub>6</sub>, 152
- metabolism, 147
- receptor, 29, 30, 151
- signaling, 145
- structure, 24
- synthesis, 147
- wounding, 284

## Inositol trisphosphate kinases (ITPK), 164

InsP<sub>3</sub>. *See* Inositol 1,4,5-trisphosphateInsP<sub>6</sub>. *See* Inositolhexakisphosphate

## Inter-organismic signaling, 281–282

## Invasion plasmid D gene (IpgD), 121

## Ionization properties, 203, 207, 208, 211, 213

## J

- JA-resistant 1 (*jar1*), 280
- Jasmonic acid (JA), 5, 8, 13, 277
  - biosynthesis, 277
  - JA-Ile, 279
  - MeJA, 279
  - SA cross-talk, 283

## K

- Kennedy pathway, 131
- Ketoreductase, 312
- K<sup>+</sup><sub>in</sub> channels, 231

## L

- LCB. *See* Long chain base
- Leaf discs, 188
- Linolenic acid, 13, 278
- Lipid-activated protein kinase, 15
- Lipid binding domain, *See* Domains
- Lipid biosensors, 72, 86, 181, 188–191

- Lipid phosphate phosphatase (LPP), 137, 269
- Lipid-rafts, 88
- Lipid-second messengers, 186
- Lipid, visualization, 187–191
- Lipin, 139
- Lipoxygenases (LOXs), 278
- Long chain base, 309
- LOXs. *See* Lipoxygenases
- LPC. *See* Lysophosphatidylcholine
- LPP. *See* Lipid phosphate phosphatases
- Lysophospholipids, 9, 15
- Lysophosphatidic acid, structure, 204
- Lysophosphatidylcholine, 11, 15
- M**
- Magic angle spinning (MAS), 209
- Mammalian target of rapamycin (mTOR), 206, 247
- MAPK, 233
- MeJA, 279
- Membrane curvature, 206
- Membrane-interacting peptides, 214
- Membrane-occupation-and-recognition-nexus (MORN) repeats, 83
- Membrane structure, 207
- Membrane trafficking, 70, 186, 206  
PA, 206
- MGDG. *See* Monogalactosyldiacylglycerol
- MIPS. *See* Myo-inositol phosphate synthase
- Monogalactosyl diacylglycerol (MGDG), 137, 279
- MRH3, 125
- Mss4p, 88
- Myo-inositol, 162
- Myo-inositol phosphate synthase, 163
- Myotubularin (MTM), 119–121
- Myristoylated alanine-rich C-kinase substrate (MARCKS), 207
- N**
- N*-acylethanolamine hydrolase, 295
- N*-acylethanolamines (NAE), 293  
acid amidase, 302  
amidase, 302, 303  
hydrolase, 294, 301
- N*-acyl taurines, 302
- NADPH oxidase, 98, 229, 250
- NAE. *See* *N*-acylethanolamine
- Nitric oxide (NO), 223  
localization, 224  
PLD/PA, 55, 223  
production, 224
- Nitrosylation, 224, 234  
motifs, 234
- Non-specific phospholipase (NPC), 26, 132
- O**
- Octadecanoids, 279
- Oleic acid, 15, 43, 278
- OPDA. *See* 12-oxo phytodienoic acid
- Osmotic stress  
DGPP, 266–267  
PLD, 54–55
- Oxidative burst, 52, 225, 228
- OXIDATIVE SIGNAL-INDUCIBLE1 (OXI1), 101, 250
- 12-oxo phytodienoic acid (OPDA), 279
- Oxylipins, 277–285  
developmental signaling, 282–283  
hypersensitive response, 280  
physiological roles. *See* phytohormones, 83–285  
plant defence, 279–281  
signaling, 277–285
- P**
- PA-binding domain, 206, 214
- PA-binding proteins, 212
- PA kinase (PAK), 187, 264, 268
- PAP. *See* phosphatidic acid phosphatase
- PA signaling, 206  
guard cells, 231
- PA - attenuation, 107, 131, 263
- PA - NO signaling, 223
- PA - targets, 107, 203, 223, 243
- Patatin, 6
- Patatin-related phospholipases A<sub>2</sub> (pPLA<sub>2</sub>), 7, 14–15  
Arabidopsis genes, 7  
structure and properties, 6–8
- Pathogen attack (See also Plant defence)  
arabidopsides, 280  
oxylipins, 279

- PLA<sub>2</sub>, 11–13
- PDK1, See Phosphoinositide-dependent protein kinase 1
- Peripheral membrane protein, 207, 214
- Peroxygenases (POX)
- PH domain, 67, 72, 191–193, 248, 249  
lipid binding, 67
- Phosphatase and tensin homologue (PTEN), 119
- Phosphatases  
Fig4, 70  
phosphoinositides, 117  
Sac, 70
- Phosphatidate phosphohydrolase (PAH), 139
- Phosphatidic acid (PA), 28, 187, 203, 223  
ABA, 47  
ABI1, 48  
adventitious root formation, 232  
binding, 203  
biosynthesis, 204–205  
cone-shaped lipid, 214  
cytoskeletal reorganization, 39  
DAG, interconversion, 33, 107, 131, 205  
DGK/PLC, 29, 107, 205  
electrostatic hydrogen-bond switch  
model, 210–212  
lipid degradation, 39  
membrane remodeling, 39  
membrane trafficking, 206  
metabolism, 131, 204–205  
NO, 55, 223  
osmotic stress, 54  
phosphatases, 131  
physiological functions, 206–207  
protein interactions, 208  
salt stress, 54  
structure, 24, 204  
Targets 55, 57, 107, 203, 223  
vesicular trafficking, 39
- Phosphatidic acid phosphatase  
biochemical features, 132  
glycolipid metabolism, 139  
LPP, 134, 135  
phospholipid metabolism, 139, 205  
prokaryotic, 137  
TAG biosynthesis, 139
- Phosphatidylcholine-cleaving PLC (PC-PLC), 24, 26, 34
- Phosphatidylethanolamine, structure, 24
- Phosphatidylinositol (PtdIns), 186
- Phosphatidylinositol 4,5-bisphosphate [PtdIns(4,5)P<sub>2</sub>], 79, 188  
biosensor, 191–193  
levels, 188  
<sup>32</sup>P-labeling, 185  
PtdInsP 5-kinase (or PIP5K), 79–89
- Phosphatidylinositol 3-kinase (PI3K), 95  
auxin, 97  
endocytosis, 97  
in growth and development, 100  
inhibitors, 96  
molecular classification, 96  
ROS, 98, 101  
salt stress, 97
- Phosphatidylinositol 5-monophosphate (PtdIns5P), 118, 186
- Phosphatidylinositol 4-OH kinase (PI4K), 65, 118, 185  
*Arabidopsis* (12), 69  
family members, 66  
LSP6, 69  
PIK1, 69  
Rab, 69  
STT4, 69
- Phosphatidylinositol 3-phosphatase  
MTM, 120–121  
PTEN, 61, 101
- Phosphatidylinositol 3-phosphate (PtdIns3P), 95, 118, 186  
biosensor, 97–99, 191–193  
ROS, 98  
YFP-2xFYVE, 97–99, 191
- Phosphatidylinositol 4-phosphate (PtdIns4P), 65, 178, 186  
biosensor, 192–194  
imaging, 72, 185, 191  
metabolism, 66, 185  
phosphatase mutant, 194  
phosphatases, 70, 121, 194  
root hairs, 192  
YFP-PH<sub>FAPP1</sub>, 97–99, 191
- Phosphatidylinositol synthase, 163
- Phosphatidylserine, structure, 24

- Phosphoinositide-dependent protein kinase-1 (PKD1), 101, 206, 244
- PA target, 107, 203, 223, 243
- PH domain, 248  
structural features, 245–249
- Phosphoinositides  
biosensors, 185  
cell wall synthesis, 175  
cytoskeleton, 175  
ion channel regulation, 86  
kinases, 65, 79, 95, 118  
membrane trafficking, 175, 186  
metabolism, 118, 179, 187  
pathways, 118, 187  
Rab, 69  
<sup>32</sup>P-labeling, 185  
phosphatases, 118, 175  
secondary wall synthesis, 179–181  
vesicle transport, 175  
wounding, 284
- Phosphoinositide-specific PLC (PI-PLC),  
*See* Phospholipase C (PLC)
- Phospholipase A<sub>1</sub> (PLA<sub>1</sub>), 4  
DAD1, 14  
SRG2, 14
- Phospholipase A<sub>2</sub> (PLA<sub>2</sub>)  
auxin, 8  
cPLA<sub>2</sub>, 5  
G-protein regulation, 12  
inhibitors, 9  
iPLA<sub>2</sub>, 5  
JA, 8  
KO, 8, 13  
lysolipids, 9  
nomenclature, 6  
patatin, 6  
plant defence, 12  
pPLA<sub>2</sub>, 6  
sequences, 7  
sPLA<sub>2</sub>, 4
- Phospholipase C (PLC), 24, 34, 152, 163, 187, 205, 207, 225  
animal cells, 27  
biochemical characterization, 27  
C2 domain, 31  
DAG, 28, 107, 185, 203, 223  
domains, 27  
EF loop, 31  
genes, 27  
G-proteins, 27  
InsP<sub>3</sub>, 28, 118, 187, 229–233  
InsP<sub>6</sub>, 28, 187  
isoforms, 27  
membrane targeting, 32  
PA, 28, 110, 187, 231  
pollen tube growth, 31  
role in plants, 28, 32  
substrates, 24, 27  
tip growth, 32
- Phospholipase D (PLD), 205, 207, 212, 225, 231  
ABA, 44, 47, 49, 227–231  
activity, 42  
Arabidopsis genes, 40, 235  
auxin, 50  
biochemical properties, 42  
biotechnology, 55  
C2, 41  
Ca<sup>2+</sup> regulation, 42  
catalytic domain, 41  
C2-binding, 43  
cellular and physiological functions, 47  
cytokinin, 51  
cytoskeletal reorganization, 39  
*vs.* DGK-generated PA, 109  
domain structure, 40, 41  
DRY motif, 41, 48  
ethylene, 51  
freezing tolerance, 52, 53  
galactolipid synthesis, 54  
gene architecture, 40  
gene expression, 46  
G-protein regulation, 44, 49  
HKD motifs, 41  
lipid degradation, 39  
membrane binding, 43  
membrane remodeling, 39  
NO, 55, 223  
PA, 40, 107, 203, 223  
P<sub>i</sub> starvation, 54  
plant defence, 51  
protein interaction, 44  
PX/PH, 41  
regulation, 44  
rice genes, 41

- root development, 54
    - salt stress, 54
    - seed aging, 56
    - seed germination, 47
    - subcellular distribution and expression
      - pattern, 45
    - vesicular trafficking, 39
  - Phospholipids
    - headgroups, 24
    - imaging, 187
    - <sup>32</sup>P-labeling, 187
    - quantification, 187
    - turnover, 187
    - visualization, 187
  - Phosphomonoester, 203, 207, 208, 211, 212, 215
  - Phosphorylceramide, 309
  - Phototropin, 254
  - Phox homology (PX), 98
  - pH titration curves, 210
  - Phytate, phytic acid. *See* InsP<sub>6</sub>
  - PIK1, 178
  - PINOID, 253
  - PI pathway, 146
  - PIP5-kinase, 79–89
    - enzymes, 80
    - gene expression, 85
    - gene family Arabidopsis, 82
    - guard cell function, 85
    - interactors, 88
    - lipid interactions, 87
    - physiological functions, 85
  - <sup>32</sup>P<sub>i</sub>-radiolabeling, 187–188
  - Plant defence
    - NO, 223, 227–229
    - PA, 51, 107, 223–229, 279
    - PDK1, 250–252
    - PLA<sub>2</sub>, 12
  - Plant-pathogen interactions
    - DGK, 51
    - NO, 223, 227–229
    - PA, 51, 107, 223–229, 279
    - PLD, 51, 223–229
  - PLA<sub>2</sub>. *See* Phospholipase A<sub>2</sub>
  - PLCδ. *See* Phospholipase C (PLC)
  - Pleckstrin homology (PH) domain, 248
  - <sup>31</sup>P-NMR, 208
  - Pollen tube growth, PLC, 29
  - Polyphosphoinositides (PPIs), 186
    - isomers, 65, 79, 95, 117, 186
    - kinases, 65, 79, 95, 185
    - membrane trafficking, 65, 186
    - phosphatases, 117
    - 3-phosphatases, 101, 119
    - 4-phosphatases, 70, 121, 178, 194
    - 5-phosphatases, 123
    - Rab, 69
    - turnover, 187
  - Polyunsaturated fatty acids (PUFAs), 277
  - POX. *See* Peroxygenases
  - PPIs. *See* Polyphosphoinositides
  - <sup>32</sup>P-radiolabeling, 188
  - Protein kinase, 244
  - Protein kinase C (PKC), 23, 29, 186
  - PtdIns(3,4)P<sub>2</sub>, 186
  - PtdIns(3,4,5)P<sub>3</sub>, 119, 186
  - PtdIns(3,5)P<sub>2</sub>, 125, 178, 186
  - PtdIns(4,5)P<sub>2</sub>, 24, 33, 79, 178, 186, 188
    - biosensor, 192, 193
    - <sup>32</sup>P-labeling, 185
    - tip growth, 32
    - YFP-PH<sub>PLCδ1</sub>, 191
  - PUFAs. *See* Polyunsaturated fatty acids
- R
- R59022, 227
  - Raf-1 kinase, 214
  - Reactive oxygen species (ROS), 225, 229
    - PA, 111, 223
    - PDK1, 249
    - PI3K, 98
    - PtdIns3P, 95
    - sphingolipids, 316
  - Root hair defective-4 (RHD4), 73, 122, 178, 181, 194
  - Root hair elongation, 224
- S
- SAC. *See* Suppressor of actin
  - Salt stress
    - DGPP, 266
    - PLD, 54
    - <sup>32</sup>P-lipid responses, 188
    - PtdIns3P, 98
    - PtdIns(4,5)P<sub>2</sub>, 188

- Seed germination, PLD, 47  
 Serine palmitoyl transferase (SPT), 311  
 SGR2, 14  
 S6 kinase, 101, 249  
 Small GTPases, 256  
 SNAP, 227  
 Sphingolipids, 307–317  
   function, 312–317  
   signaling, 314–317  
   structure, 309–312  
 Sphingomyelin, 309  
 Sphingosine-1-phosphate (S1P), 212, 270, 310, 314  
   phosphatase, 138  
 Stomatal closure, 223, 227, 229–231  
   DGPP, 271  
   LPP, 136  
   NO 223, 227, 229–231  
   PA, 47, 224  
   PIPK, 85  
   PLD, 47, 224  
 Structure  
   C1P, 203  
   DAG, 25, 81, 177  
   DGPP, 264  
   glucosylceramide, 309, 310  
   L-PA, 203  
   N-acylethanolamines, 311  
   PPI, 81, 177  
   PA, 204, 211  
   sphingolipids, 308–310  
   sphingomyelin, 309, 310  
   sphingosine, 309, 310  
   transmembrane proteins, 207, 213, 216  
 Suppressor of actin (SAC)  
   *Arabidopsis* genes, 71, 127  
   *Arabidopsis* mutants, 72, 122
- T  
 TGD, 139  
 Thin layer chromatography, 188
- Tip growth, 65, 86, 194  
   PA, 33  
   PI4K, 69  
   PIP5K, 86  
   PLC, 29, 32  
   PPIs, 181  
   PtdInsP<sub>2</sub>, 33, 75, 86, 181  
 TIR1. *See* Auxin-receptor  
 TOR kinase, 247  
 Transport-inhibitor-resistant1 (TIR1), 10, 171  
 Triacylglycerol, 131
- U  
 U-73122, 28, 227
- V  
 Vesicle trafficking, PPIs, 179  
 Volatiles, 281  
 Vps34, 96
- W  
 WD40, 123  
 Wounding  
   arabidopsides, 280  
   oxylipins, 279  
   polyphosphoinositides, 284
- X  
 Xylanase, 228
- Y  
 YFP-C1a<sub>PKC $\gamma$</sub> , 192  
 YFP fluorescence, 192, 194  
 YFP-PH<sub>FAPP1</sub>, 191  
 YFP-PH<sub>PLC $\delta$ 1</sub>, 191–193  
 YFP-2xFYVE, 191–193