



Universiteit
Leiden
The Netherlands

Calcium- and BTB domain protein-modulated PINOID protein kinase directs polar auxin transport

Robert-Boisivon, H.S.

Citation

Robert-Boisivon, H. S. (2008, May 21). *Calcium- and BTB domain protein-modulated PINOID protein kinase directs polar auxin transport*. Retrieved from <https://hdl.handle.net/1887/12863>

Version: Not Applicable (or Unknown)

License: [Leiden University Non-exclusive license](#)

Downloaded from: <https://hdl.handle.net/1887/12863>

Note: To cite this publication please use the final published version (if applicable).

**Calcium- and BTB domain protein-modulated
PINOID kinase directs polar auxin transport**

Hélène Robert-Boisivon

Cover	Inflorescence of <i>pinoid-14 pinoid binding protein1-1</i> (front cover) GFP:FABD localization in Arabidopsis root hairs at the hypocotyl-root junction (back cover) GFP:FABD line was kindly provided by Tijs Ketelaar, Plant Cell Biology Lab., Wageningen University. Designed by Martin Brittijn
Invitation	Pin-like structure of <i>pinoid-14</i>
Printed by:	Ponsen & Looijen bv, The Netherlands
ISBN:	978-90-6464-250-0

Calcium- and BTB domain protein-modulated PINOID kinase directs polar auxin transport

Proefschrift

Ter verkrijging van
de graad van Doctor aan de Universiteit Leiden,
op gezag van Rector Magnificus Prof. Mr. P.F. van der Heijden,
volgens besluit van het College voor Promoties
te verdedigen op woensdag 21 mei 2008
klokke 13:45 uur

door

Hélène Stéphanie Robert-Boisivon

geboren te Mont Saint Aignan (France) in 1977

Promotor: Prof. Dr. P.J.J. Hooykaas

Co-promotor: Dr. R. Offringa

Referent: Dr. P. Genschik (IBMP, Strasbourg, France)

Overige leden: Prof. Dr. J. Memelink
Prof. Dr. P.M. Brakefield
Prof. Dr. B. van Duijn

“Calcium- and BTB domain protein-modulated PINOID kinase directs polar auxin transport”
by Hélène Robert-Boisivon

A ma p'tite KRob,
du plaisir que j'ai à la retrouver tous les soirs ;
A mon Grand Homme à la Maison,
pour son soutien durant ces années de labeur.

Contents

	Page
Abbreviations	9
Chapter 1	Calcium and BTB proteins: generic signaling components with specific roles in auxin transport 13
	Thesis outline 26
Chapter 2	TOUCHing PINOID: regulation of kinase activity by calcium-dependent sequestration 35
Chapter 3	Cell-type and tissue-specific regulation of PID signaling by small calcium-binding proteins 63
Chapter 4	BT scaffold proteins: a crucial function in plant development 87
Chapter 5	A BTB domain protein interacts with the protein kinase PINOID to fine tune its activity 115
Summary	143
Samenvatting	153
<i>Curriculum vitae</i>	161
Color supplements	163

List of abbreviations

ATP	Adenosine tri-phosphate
ATTERT	<i>Arabidopsis thaliana</i> telomerase reverse transcriptase
BB	Binding buffer
BELL	BEL1-like homeobox protein
BET/GTE	Bromodomain and extraterminal domain protein/Global transcriptional factor group E
BP	BREVIPEDICELLUS
BSA	Bovine serum albumin
BTB	Broad-Complex, Tramtrack, Bric-a-brac domain
BT	BTB and TAZ domain protein
Ca ²⁺	Calcium
CaD	Catalytic domain
Cam	Chloramphenicol
CaM/CaML	Calmodulin/calmodulin-like
CaMBD	Calmodulin binding domain
Cb	Carbenicillin
CBP	p1300/CREB binding protein
cDNA	Complementary DNA
CDPK	Calcium-dependent protein kinase
CFP	Cyan Fluorescent protein
CHZ	Chalazal pole
Col	Columbia
cort	Cortex cells
CSy	Collapsed synergid cell
CT	C-terminal
CUL3	Cullin 3
dag	Days after germination
DIC	Differential interference contrast
DMSO	Dimethyl sulfoxide
DNA	Deoxyribonucleic acid
Ds element	Dissociation element
EB	Extraction buffer
EC	Egg cell
EDTA	Ethylene diamine tetra-acetic acid
ENP	Enhancer of PINOID
EOL	ETO1-like
ep	Epidermis cells
EtBr	Ethidium bromide
ETO1	Ethylene overproducer1
FG	Female gametophyte development stage
FMN	Flavin mononucleotide
FRET	Förster (fluorescence) resonance energy transfer
gDNA	genomic DNA
<i>gfa</i>	GAMETOPHYTIC FACTOR
GFP	Green fluorescent protein

GST	Glutathione S-transferase
GT	Gene trap
GUS	(beta-) glucuronidase
h	hour
HEPES	4-(2-Hydroxyethyl)piperazine-1-ethanesulfonic acid
His	Histidine
Hm	Hygromycin
hpPBP1H	hairpin RNA spanning the complete PBP1H coding region
HRP	Horse radish peroxidase
IAA	3-Indoleacetic acid, natural auxin
IPTG	Isopropyl β -D-1-thiogalactopyranoside
JLO	JAGGED LATERAL ORGANS
KCBP	Kinesin-like calmodulin-binding protein
KIC	KCBP-interacting calcium-binding protein
KIPK	KCBP-interacting protein kinase
Km	Kanamycin
KNOX	KNOTTED-1 like homeobox proteins
KRP	KIC-related protein
La	Lanthanum
LB	Lysis buffer
LC	Luria–Bertani medium containing 10 mM MgSO ₄ and 5 mM CaCl ₂
<i>Ler</i>	<i>Landsberg erecta</i>
LOB domain	Lateral organ boundaries domain
LOV domain	light, oxygen, or voltage domain
MAB4	MACCHI-BOU4
MADS box	MCM1, AGAMOUS, DEFICIENS and SRF box
MATH domain	Meprin and TRAF-C homology domain
MBP	Myelin basic protein
MC	Micropyle pole
min	minute
ml	milliliter
mM	millimolar
MT	microtubules
MYB domain	Myeloblastosis domain
NAA	1-naphthaleneacetic acid, synthetic auxin
NASC	Nottingham Arabidopsis Stock Centre
NES	Nuclear export signal
NLS	Nuclear localization signal
nm	nanometer
NPA	1-naphthylphthalamic acid
NPH3	NON-PHOTOTROPIC HYPOCOTYL3
NPY1	NAKED PINS IN YUC MUTANTS1
NT	N-terminal
(Ni-)NTA	Nickel nitrilotriacetic resin
PAT	Polar auxin transport
PBP1/PBP1H	PINOID BINDING PROTEIN1/PINOID BINDING PROTEIN1 HOMOLOGUE

PBP2	PINOID BINDING PROTEIN2
PBS	Phosphate buffer saline
PCR	Polymerase chain reaction
PDK1	3-phosphoinositide-dependent protein kinase1
PDVF	Polyvinylidene Difluoride
PHOT	Phototropin
PID	PINOID
PIF	PDK-interacting fragment
PIN	PIN-FORMED
PKA	Protein kinase A
PKC	Protein kinase C
PKG	Protein kinase G
PMSF	Phenylmethanesulfonyl Fluoride
PN	Polar nuclei
PNF	POUND-FOOLISH
PNY	PENNYWISE
PP2A	Protein phosphatase 2A
<i>pro</i>	promoter
Rif	Rifampicin
(m)RNA	(Messenger) riboxynucleic acid
RNAi	RNA interference
ROC	ROTAMASE CYLOPHILIN protein
ROI	Region of interest
RPS5A	RIBOSOMAL. PROTEIN S5A
RPT2	ROOT PHOTOTROPISM2
RT-PCR	Reverse transcriptase-PCR
SAM	Shoot apical meristem
SDS	Sodium Dodecyl Sulfate
SDS-PAGE	SDS-poly acrylamide gel electrophoresis
Spc	Spectinomycin
STM	SHOOTMERISTEMLESS
Sy	Synergids
TAC1	TELOMERASE ACTIVATOR1
TAZ/POZ	Transcriptional adaptor zinc finger/Pox virus zinc finger
Tc	Tetracain
TCH3	TOUCH3
T-DNA	Transfer-DNA
TIR	TRANSPORT INHIBITOR RESPONSE1
UPN	Unfused polar nuclei
YFP	Yellow fluorescent protein
ZZ	Zinc
α TUB	alfa Tubulin
μ g	microgram
μ l	microliter
μ m	micrometer
μ M	micromolar

