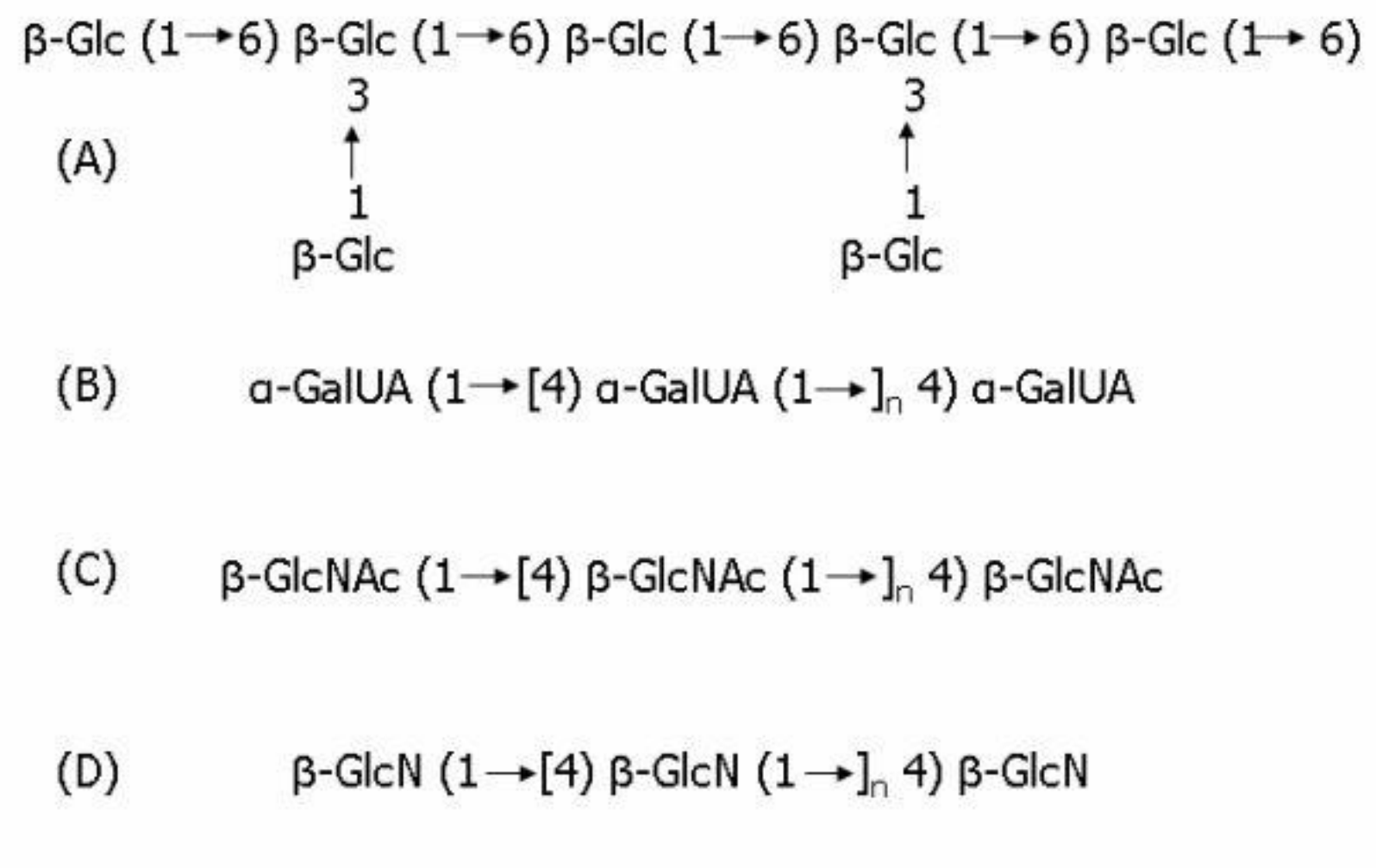
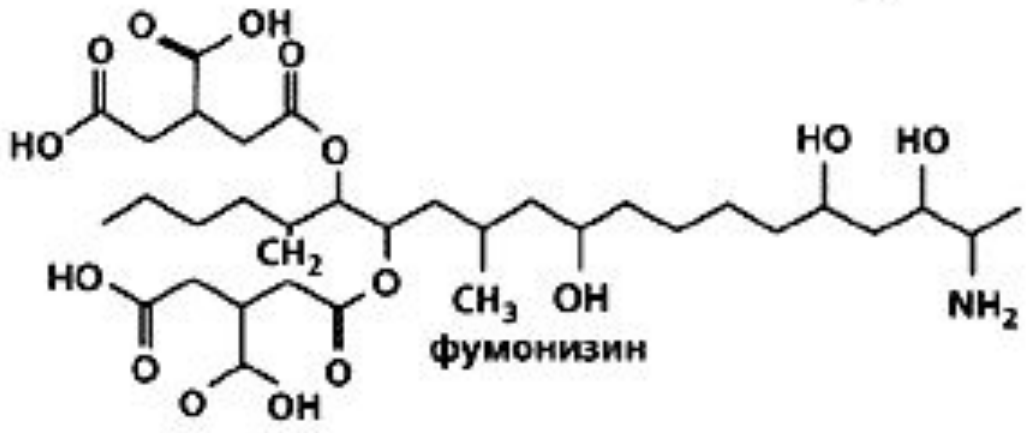
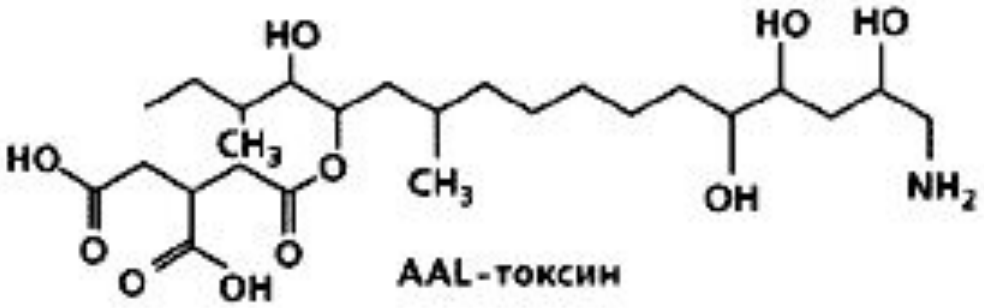
Major oligosaccharides recognized by plants:
(A) oligoglucans, (B) oligogalacturonide, (C) chitin-oligomer (D) chitosan-oligomer. Glc, glucose; GalUA, galacturonic acid; GlcNAc, N-acetyl glucosamine; GlcN, N-glucosamine.







Синтез церамида (регулятора клеточного цикла и апоптоза) из сфинганина и структура грибных антиметаболитов фумонизина и AAL-токсина.

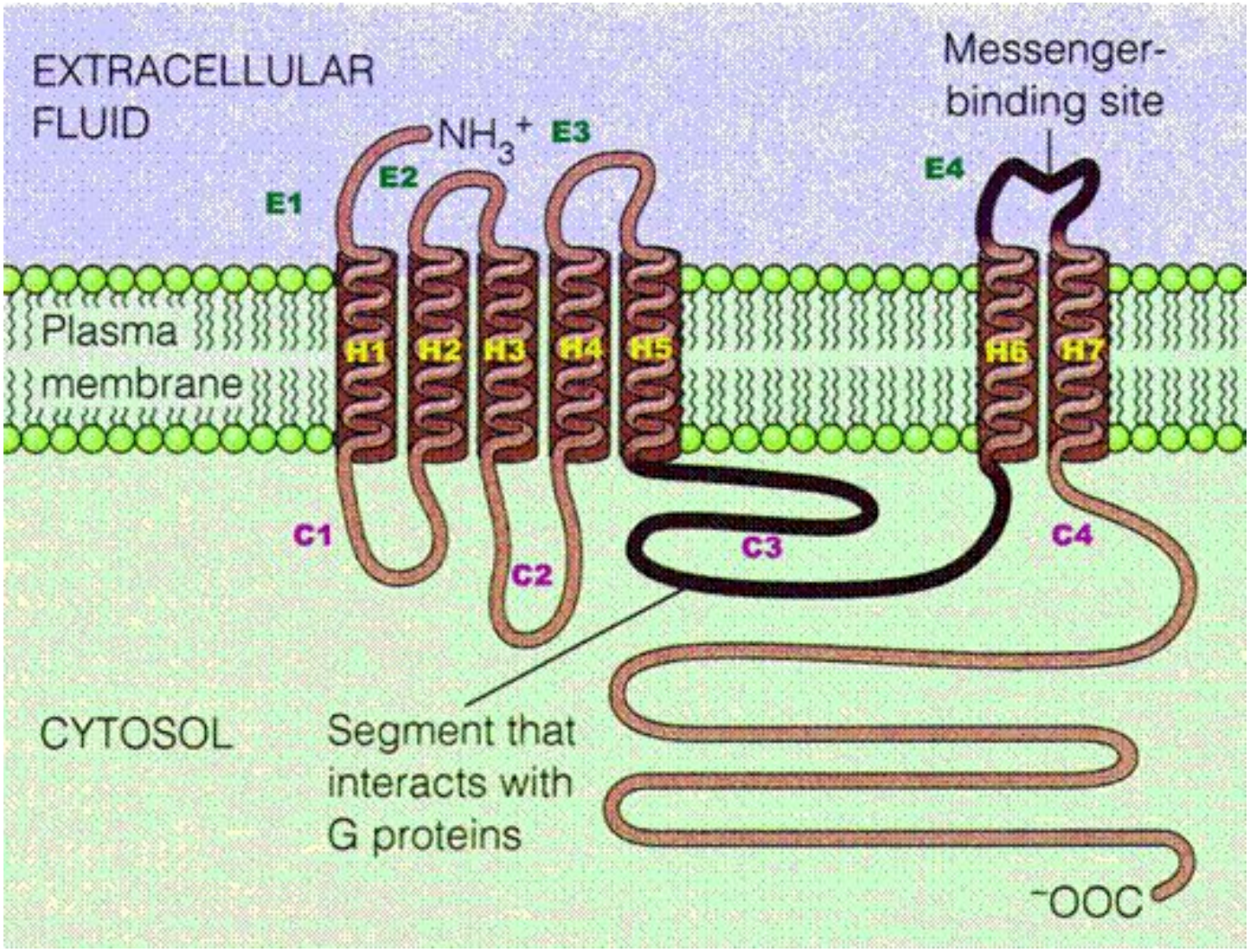
У растений эти токсины подавляют защитные реакции и транспорт сахаров, приводят к неопластическому росту и некрозам.

У человека и сельскохозяйственных животных фумонизин вызывает гепатотоксикозы, разные формы неоплазмозов и гибель клеток.

Сигнальные системы передачи сигнала для возбуждения экспрессии защитных генов:

1. циклоаденилатная,
2. MAP-киназная (mitogen-activated protein-kinase),
3. фосфатидокислотная,
4. кальциевая,
5. липоксигеназная,
6. НАДФ-Н-оксидазная (супероксидсинтазная),
7. NO-синтазная.

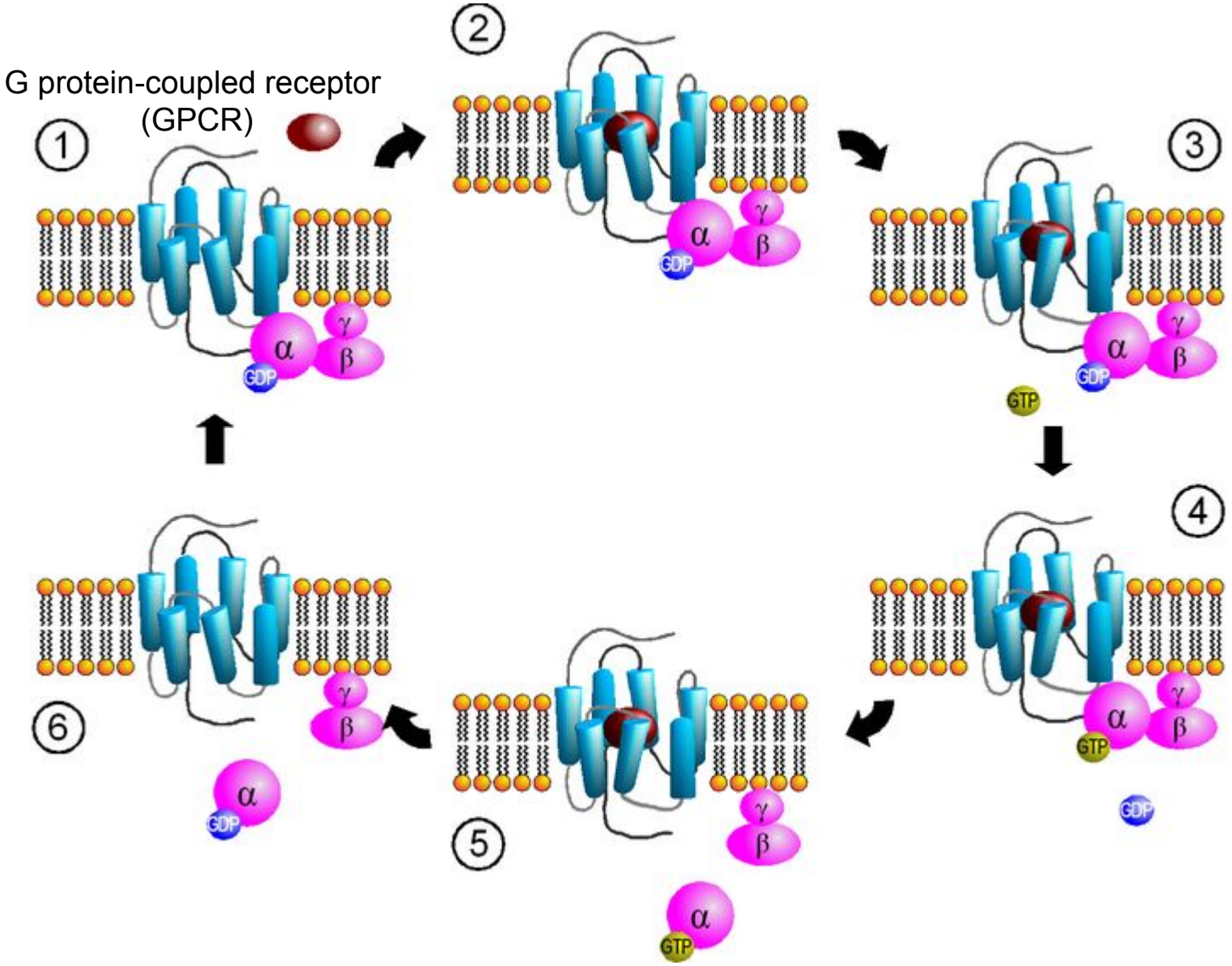
Structure of GPCRs



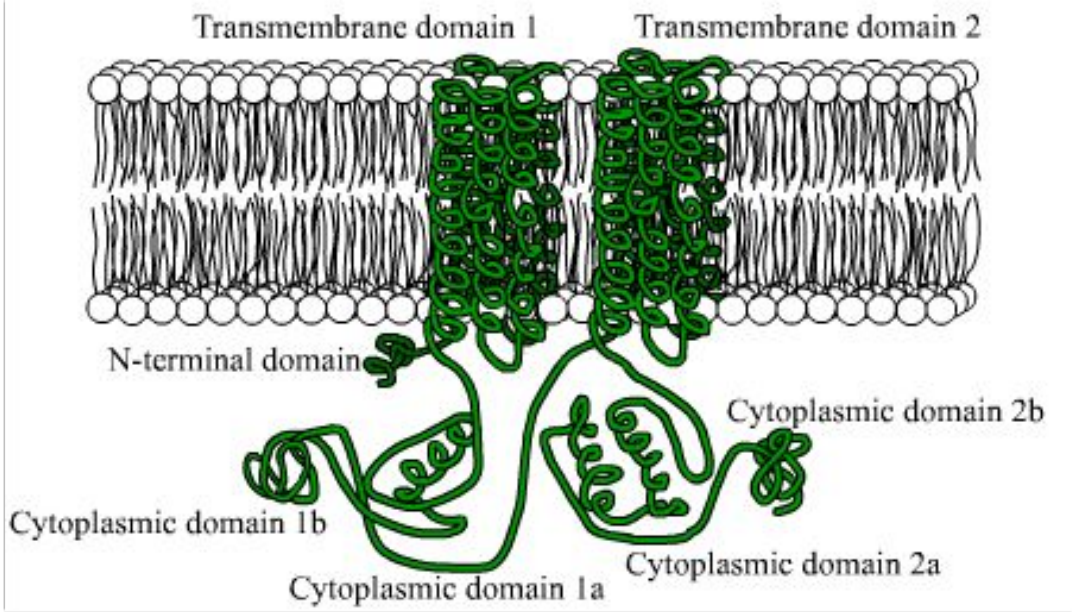
Classification of GPCRs:

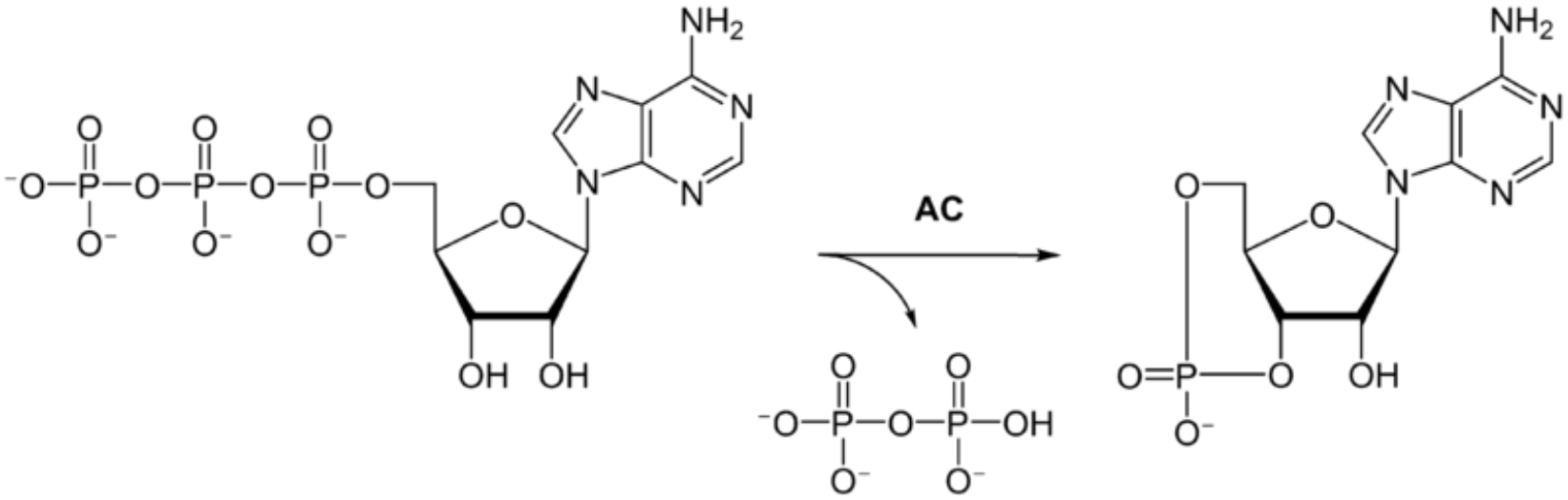
Class A (1) (Rhodopsin-like)
Class B (2) (Secretin receptor family)
Class C (3) (Metabotropic glutamate/pheromone)
Class D (4) (Fungal mating pheromone receptors)
Class E (5) (Cyclic AMP receptors)
Class F (6) (Frizzled/Smoothened)

G-proteins

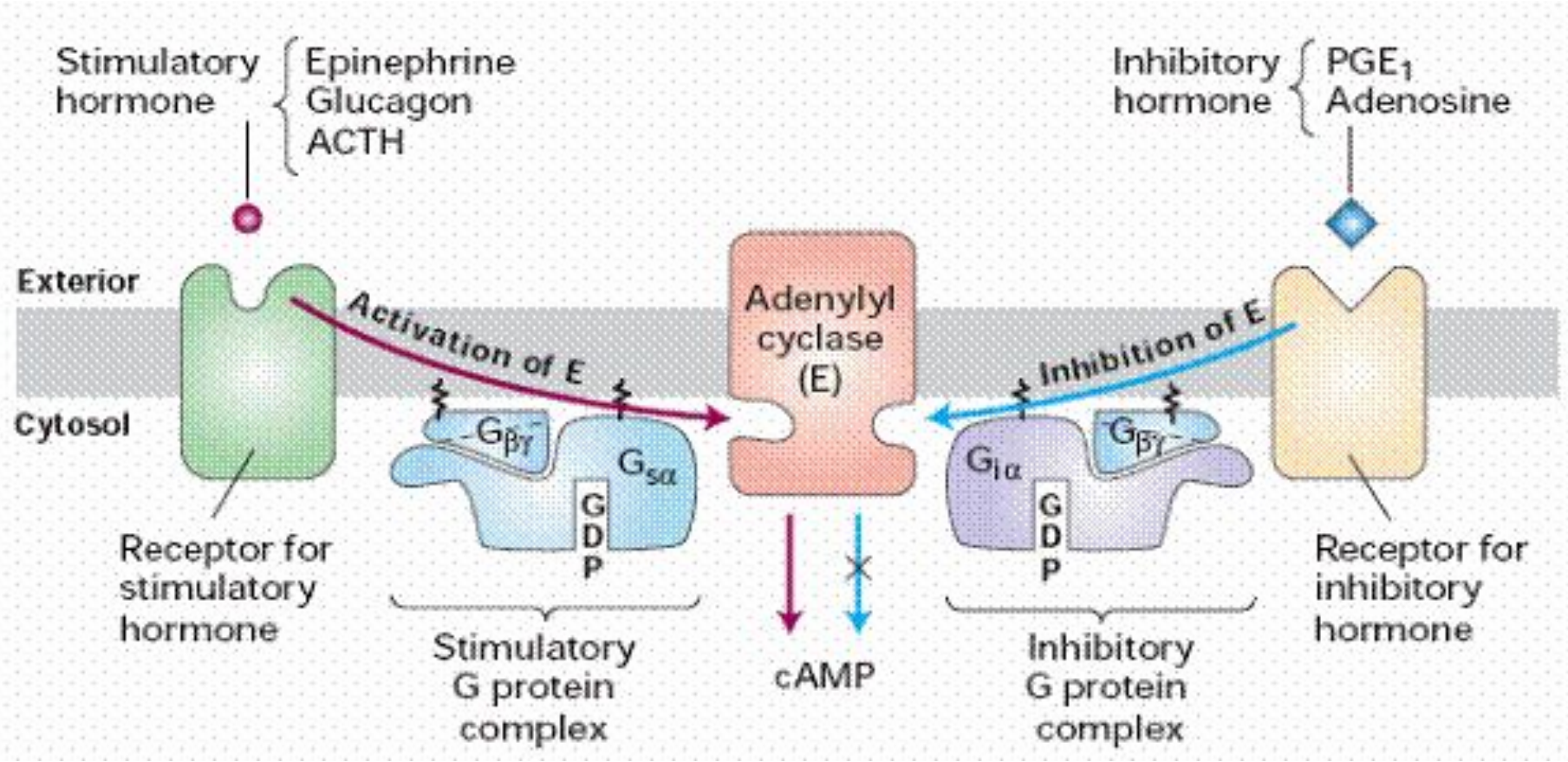


Adenylate Cyclase catalyzes the conversion of ATP to 3',5'-cyclic AMP

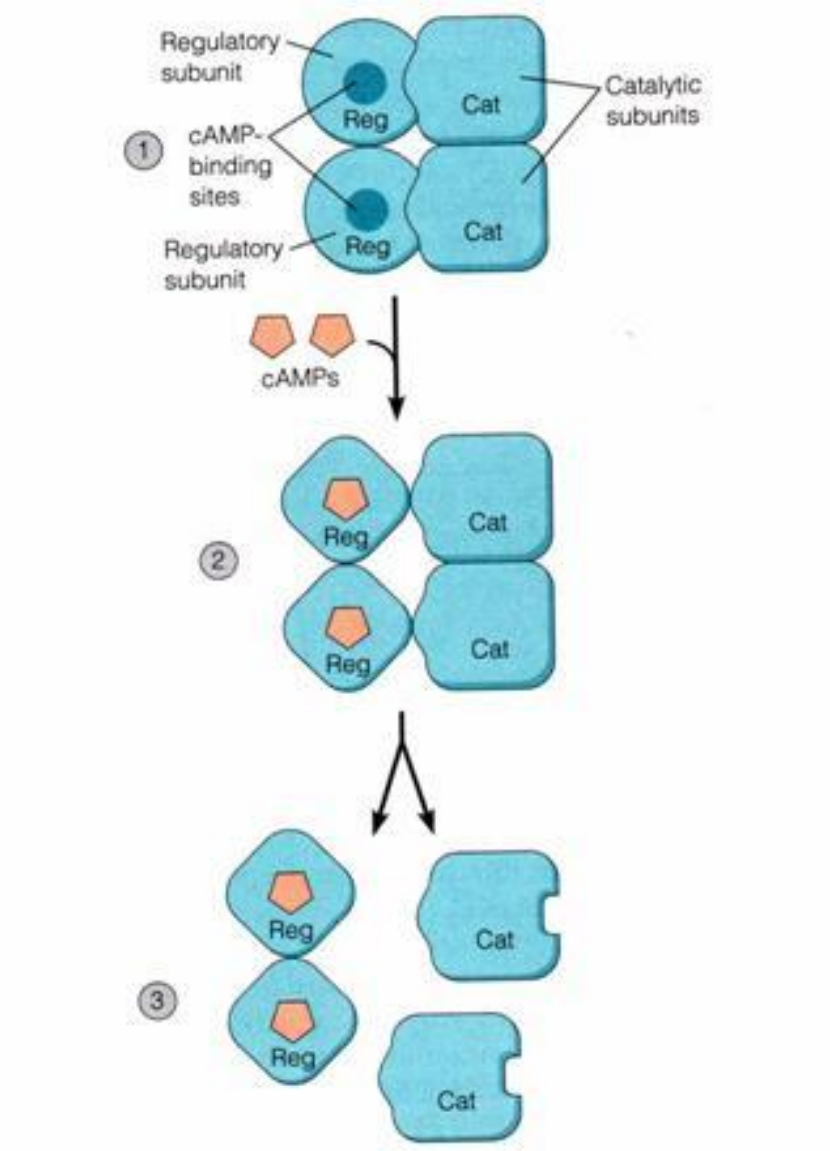


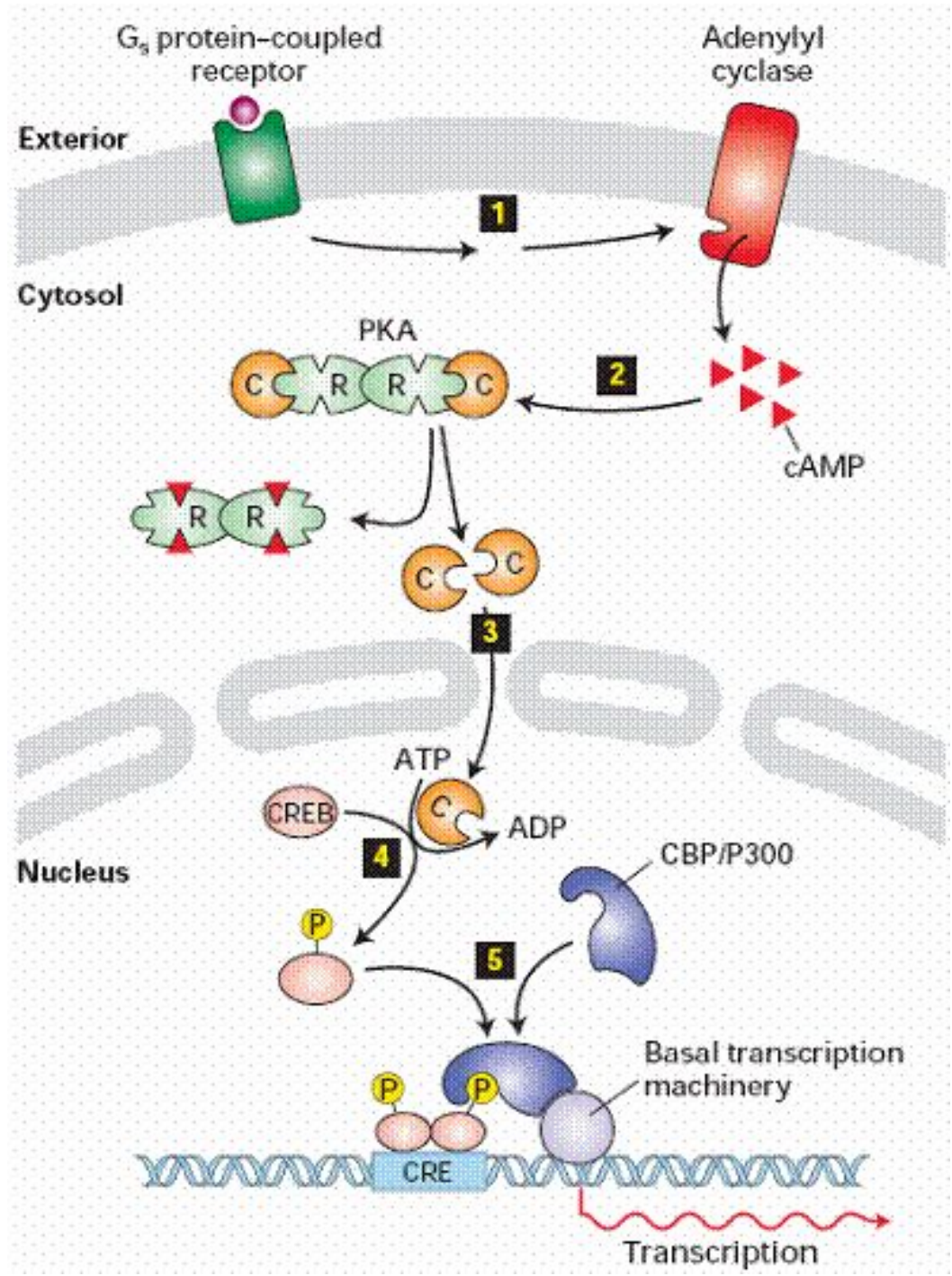


Regulation of Adenylate cyclase



Activation of PK-A

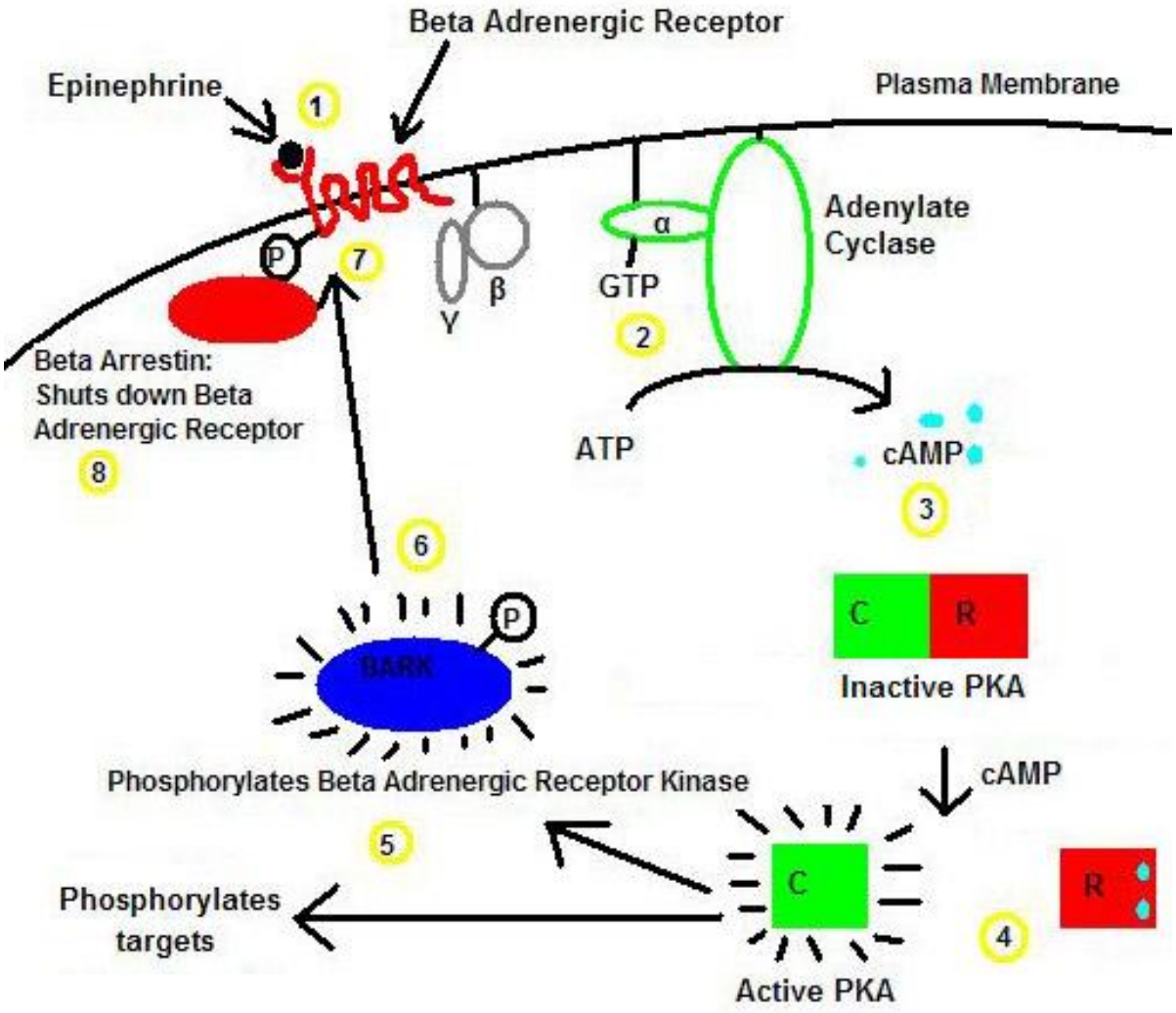




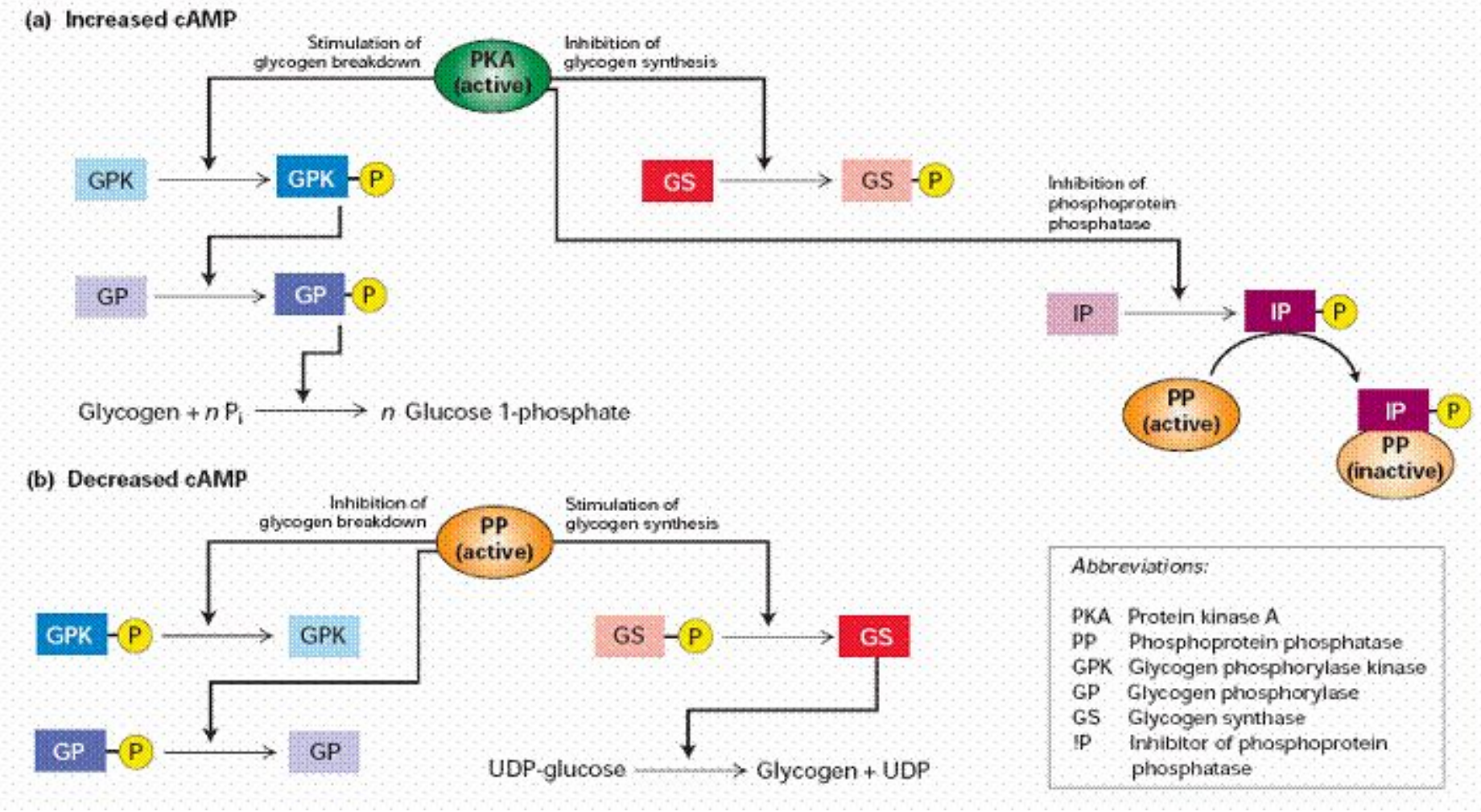
CREB (cAMP response element binding)

Phoshorylated CREB then binds with CBP/P300 (co-activator) and forms activator for cyclic AMP response element (CRE). This activator then binds with CRE and express various genes and proteins.

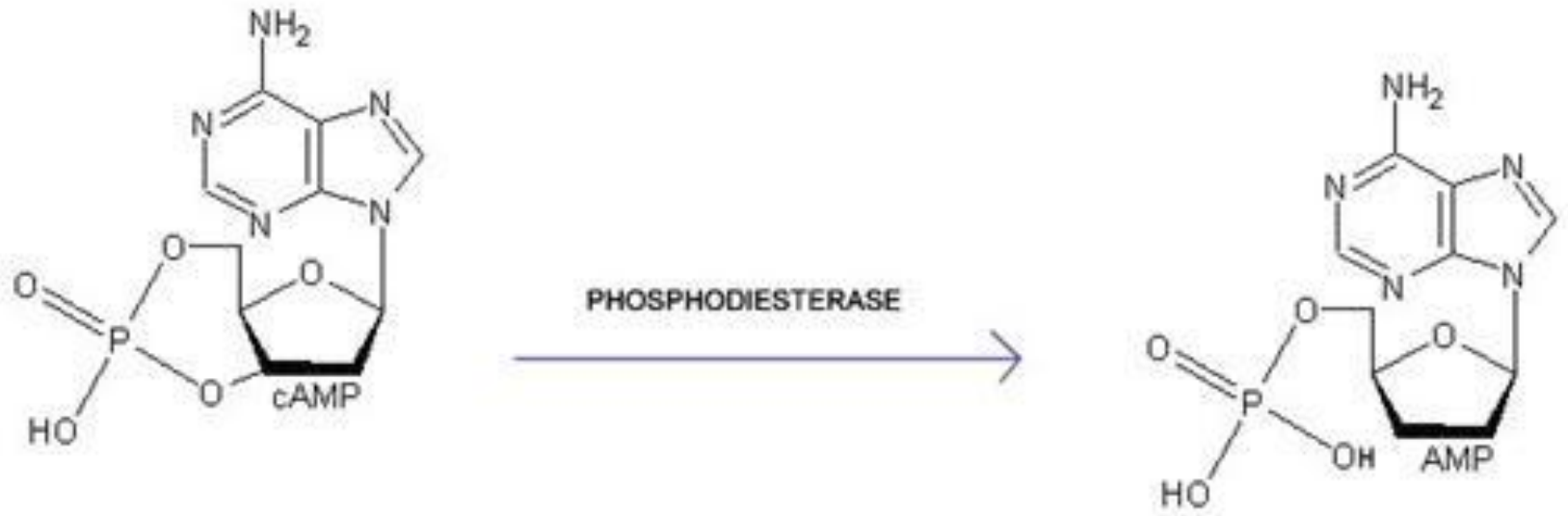
Beta adrenergic receptor kinase pathway

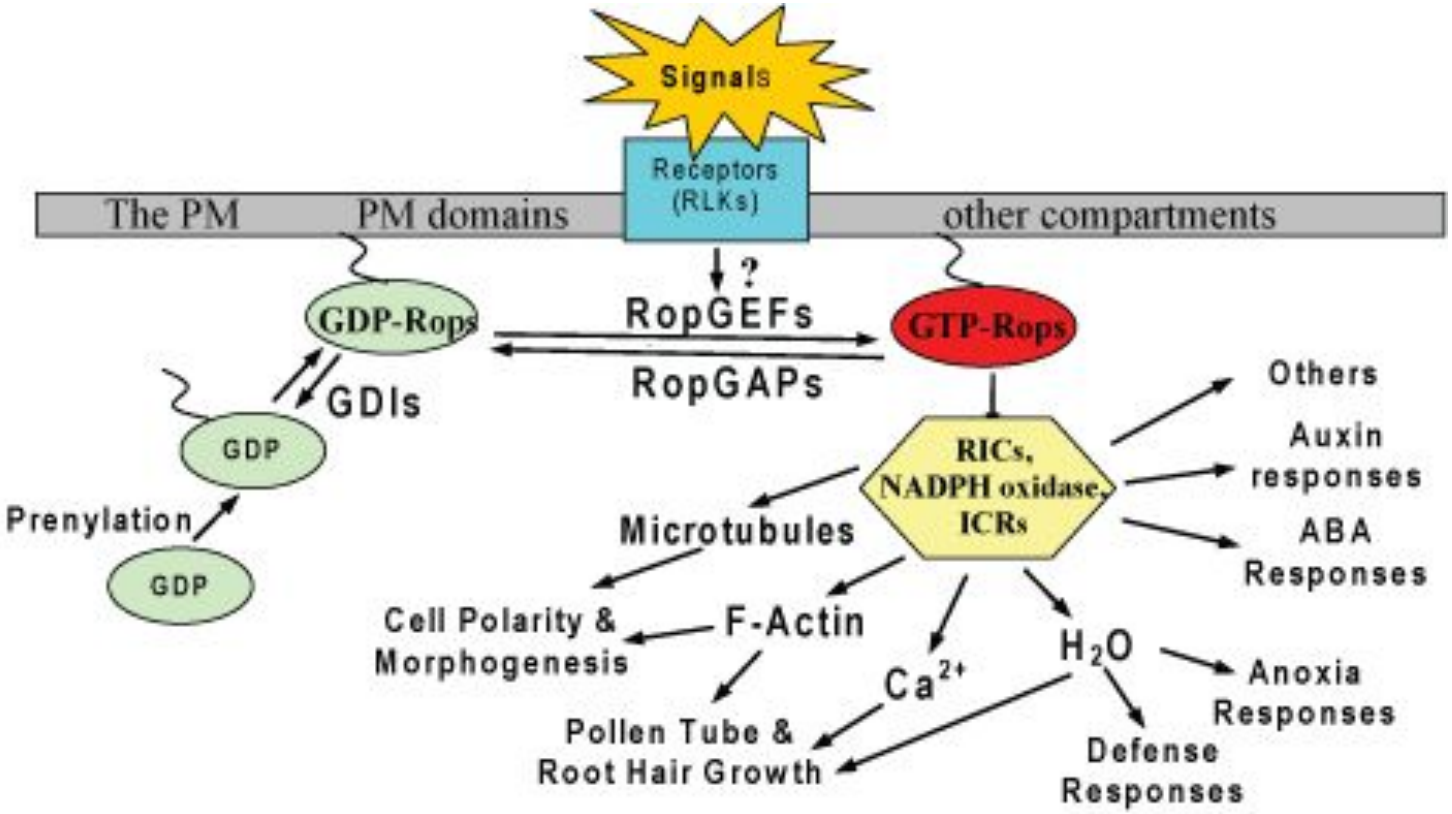


Regulation of glycogen metabolism by cAMP



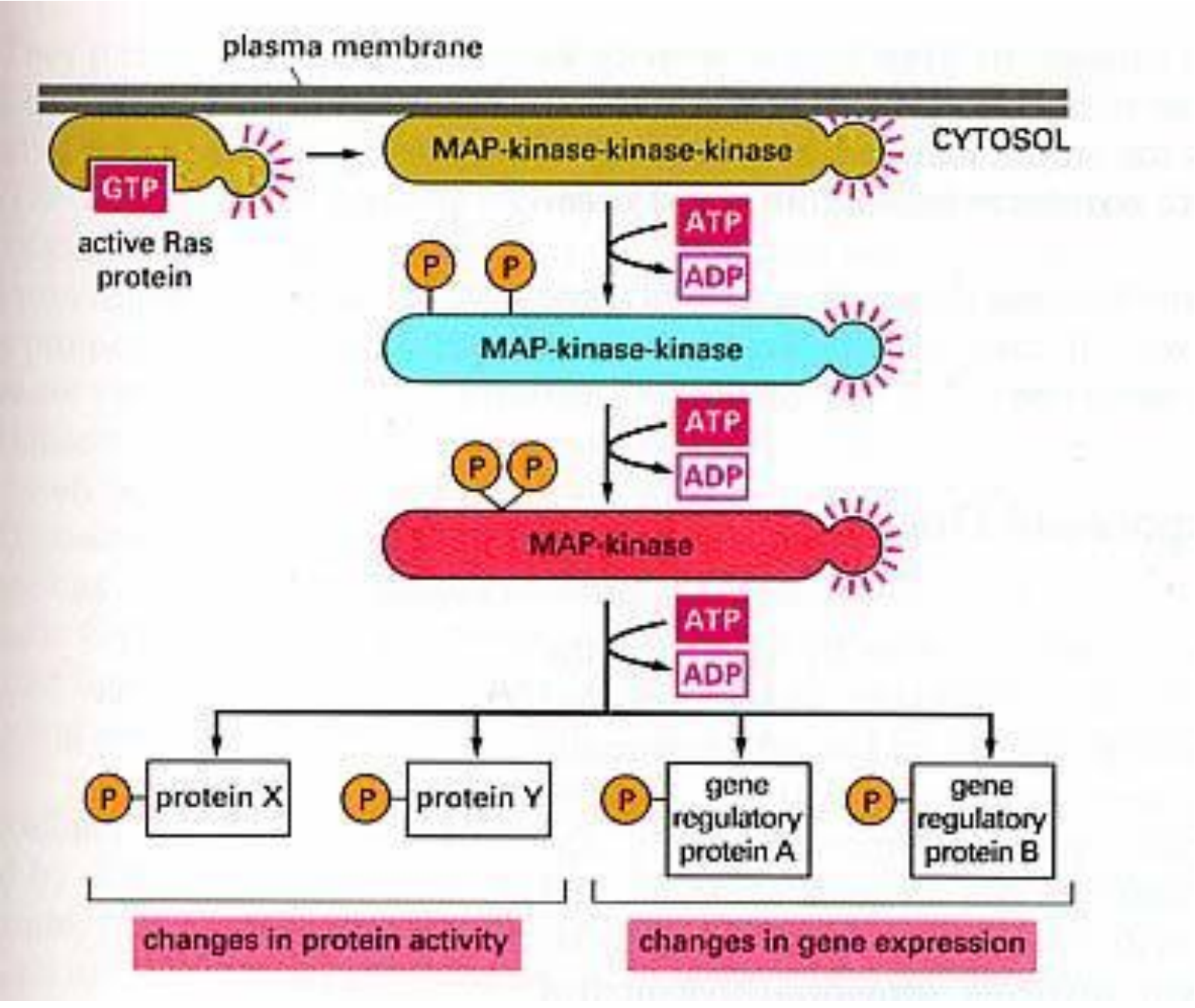
Degradation of cAMP



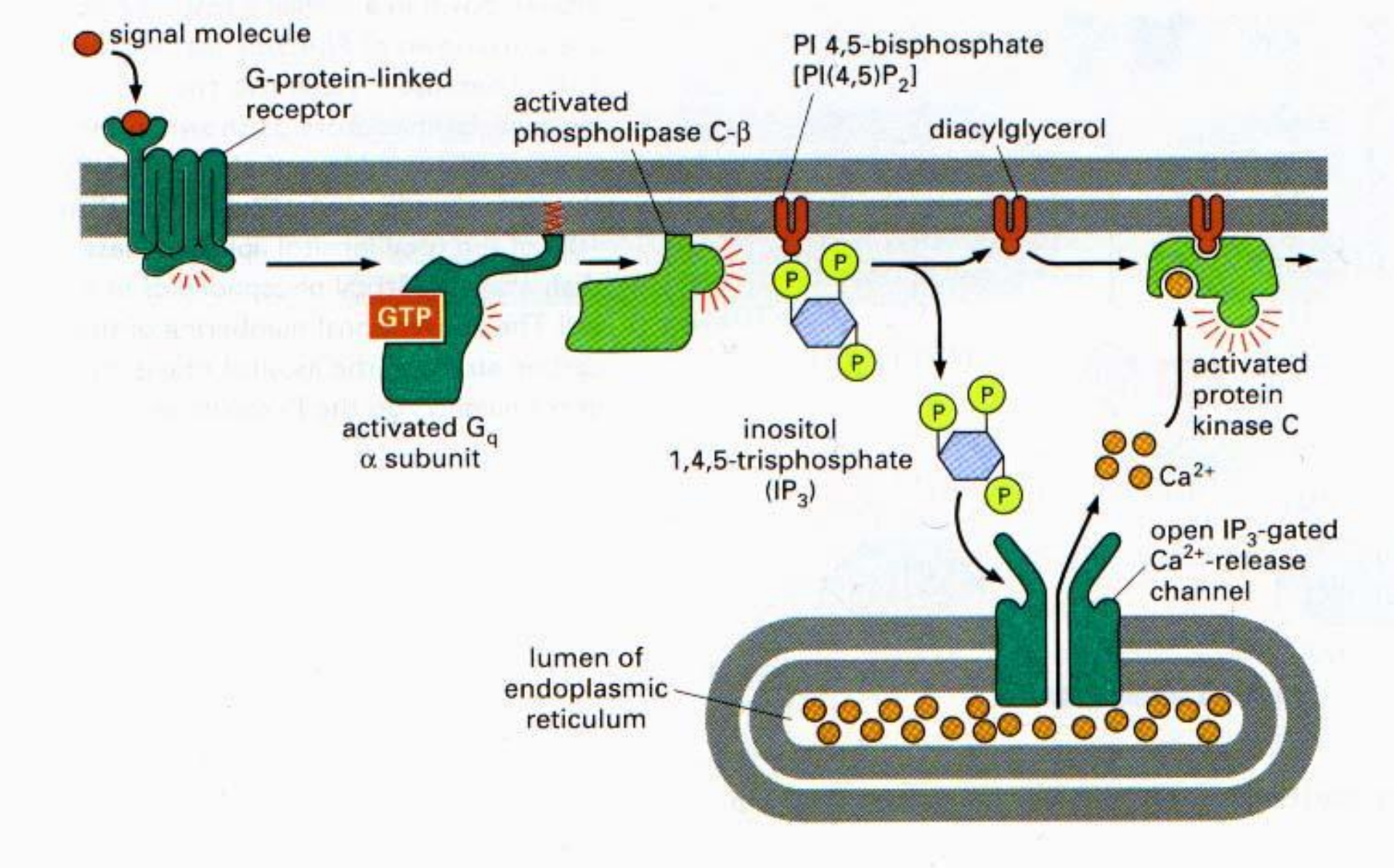


A generalized scheme illustrating the role of Rop GTPase as a signaling switch and a "hub" for controlling signaling networks.
RLK, receptor-like ser/thr kinases; GEF, guanine nucleotide exchange factor; GDI, guanine nucleotide dissociation inhibitor; RopGAP, Rop GTPase activating protein. RIC, Rop-interacting CRIB-containing proteins. ICR, interactor of constitutively active ROPs.

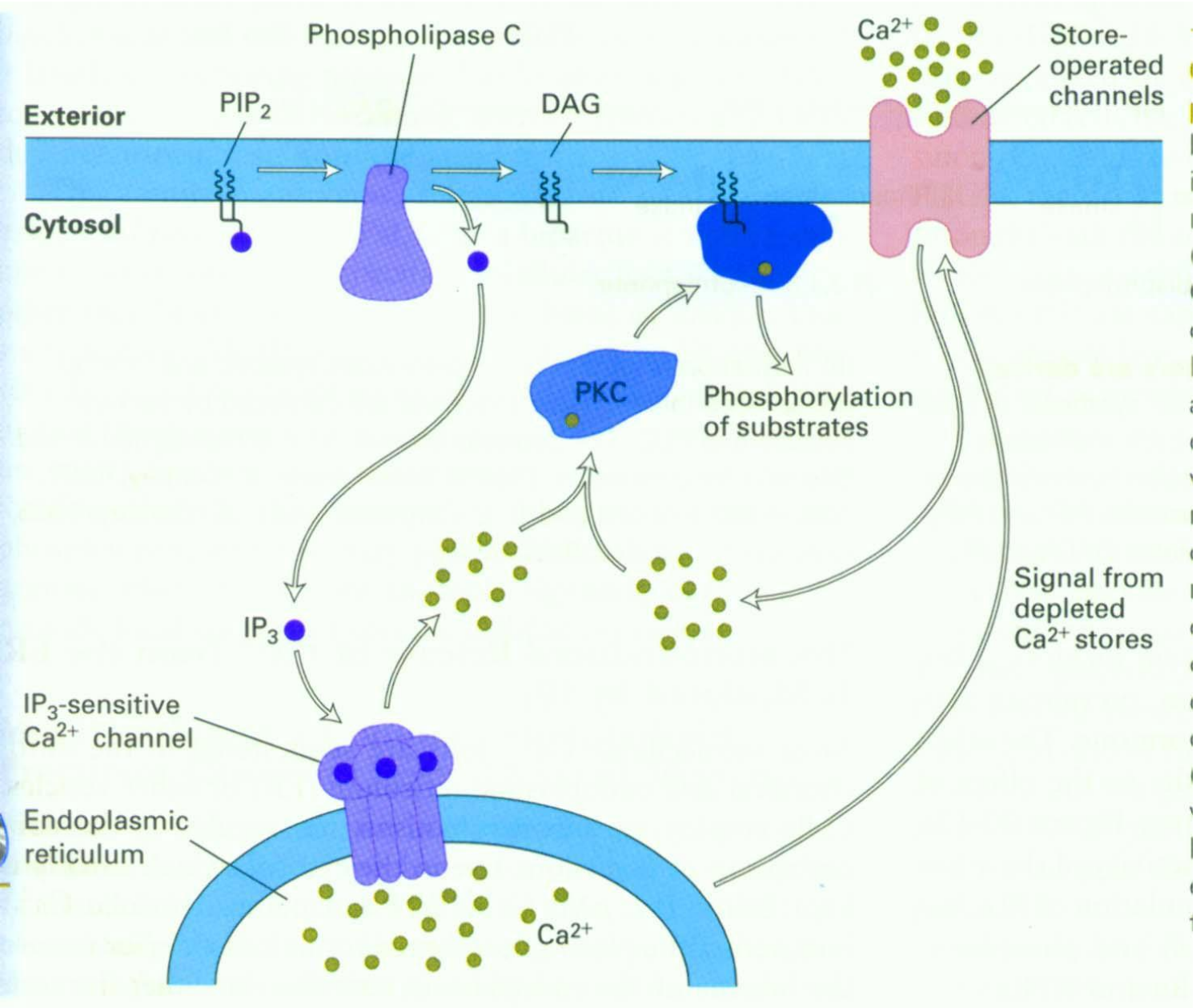
MAP-kinase serine/threonine phosphorylation pathway activated by Ras



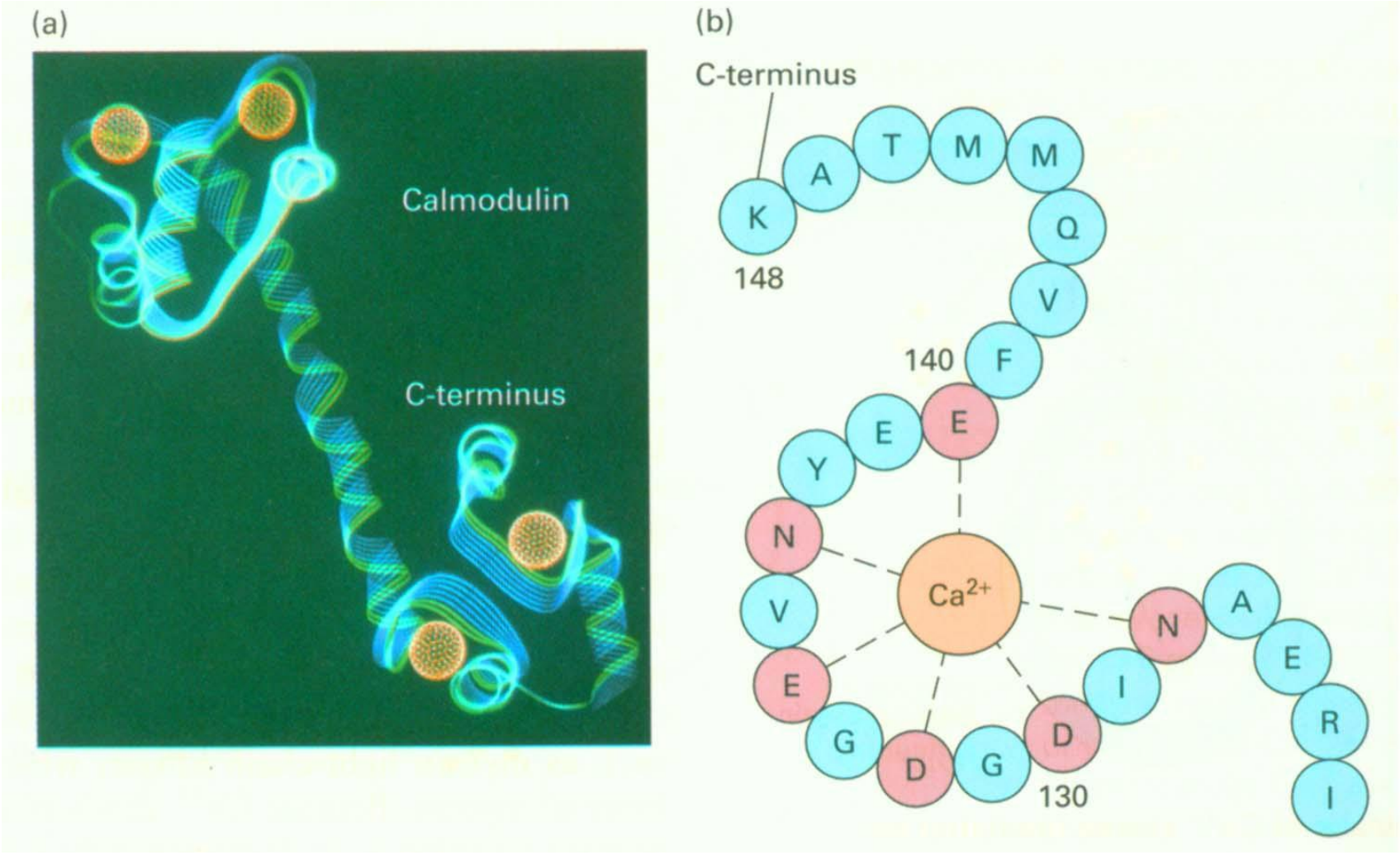
The pathway through phospholipase C results in a rise in intracellular Ca+



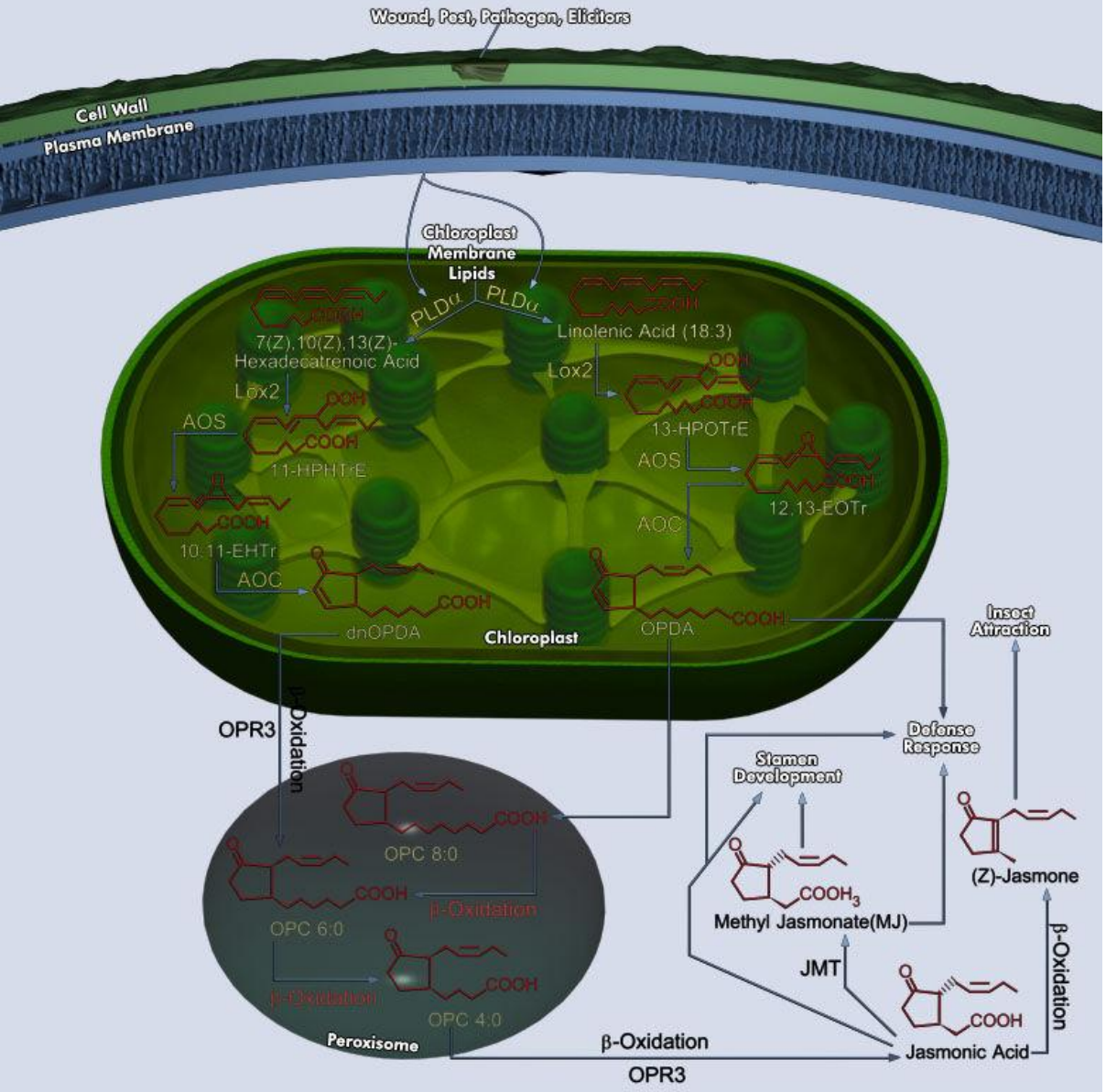
Elevation of cytosolic Ca2+ via the IP signaling pathway

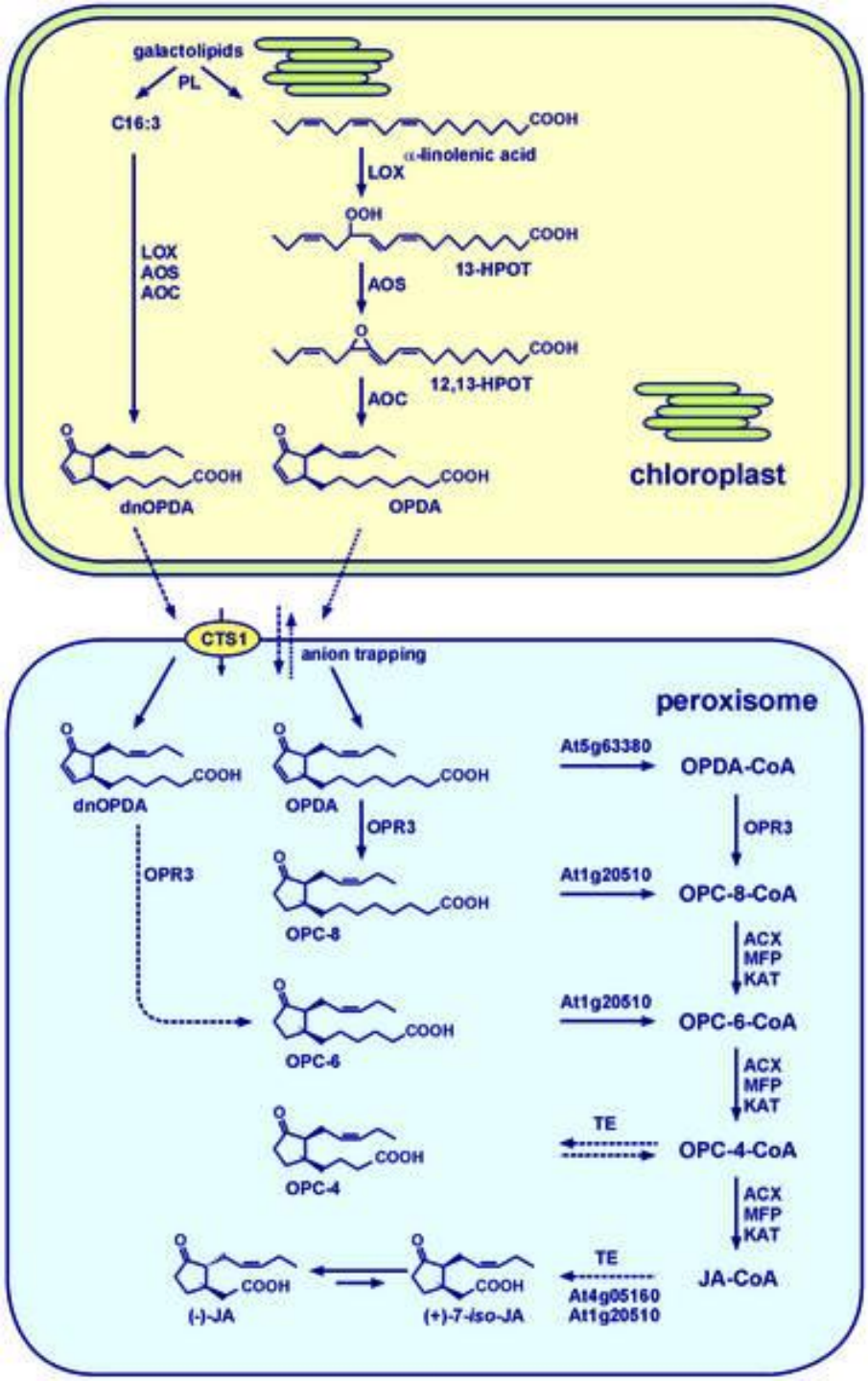


Calmodulin, a cytosolic protein of 148 amino acids that bind Ca2+ ions

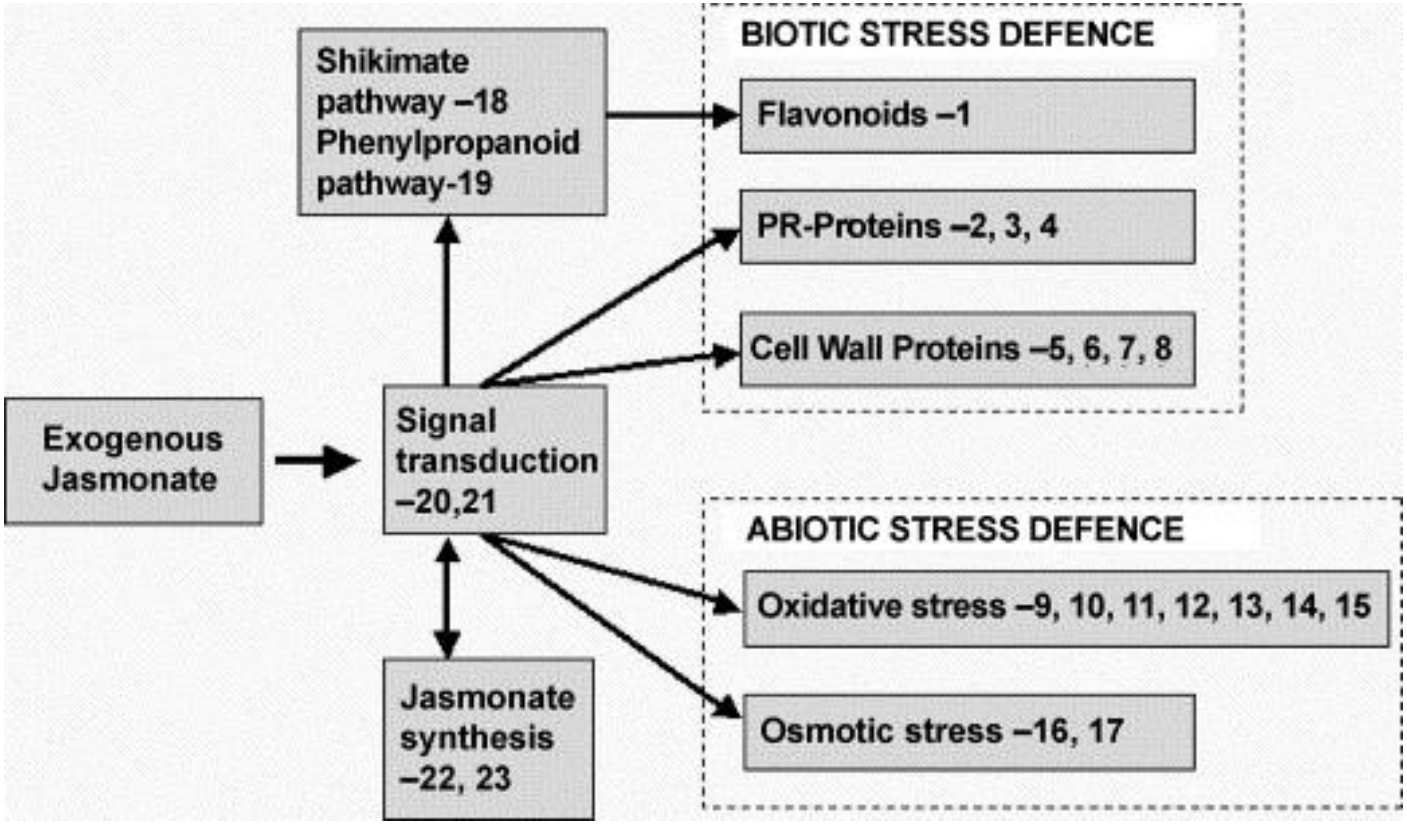


Jasmonate Biosynthesis in *Arabidopsis*



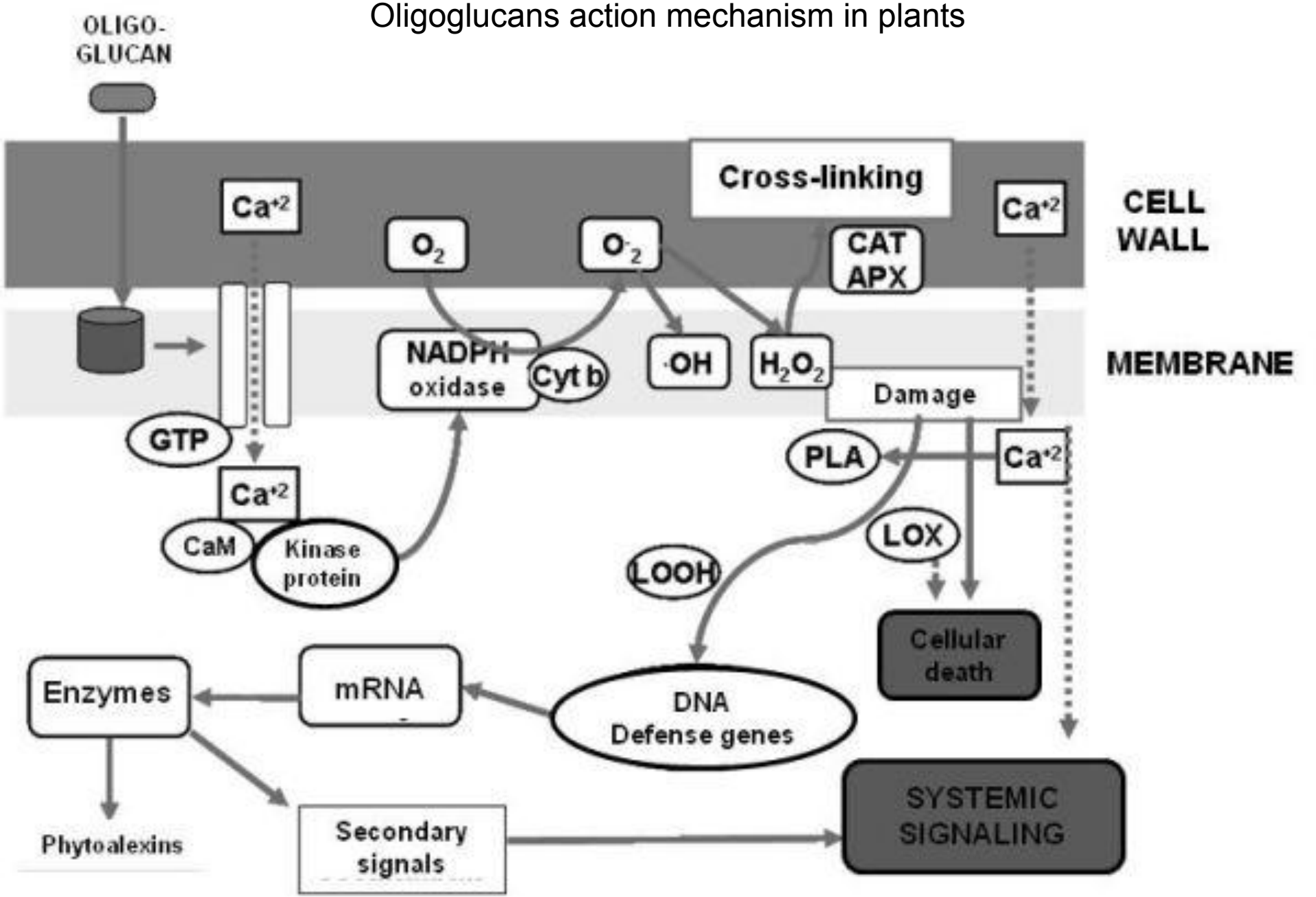

galactolipids
PL
C16:3
COOH
α-linolenic acid
LOX
OOH
COOH
13-HPOT
AOS
O
COOH
12,13-HPOT
AOC
LOX
AOS
AOC
O
COOH
dnOPDA
O
COOH
OPDA
chloroplast
CTS1
anion trapping
peroxisome
O
COOH
dnOPDA
O
COOH
OPDA
OPR3
OPR3
O
COOH
OPC-8
O
COOH
OPC-6
O
COOH
OPC-4
O
COOH
(-)-JA
O
COOH
(+)-7-iso-JA
At5g63380
OPDA-CoA
OPR3
At1g20510
OPC-8-CoA
ACX
MFP
KAT
At1g20510
OPC-6-CoA
ACX
MFP
KAT
TE
OPC-4-CoA
ACX
MFP
KAT
TE
At4g05160
At1g20510
JA-CoA

Possible gene network that is activated following application of exogenous methyl jasmonate



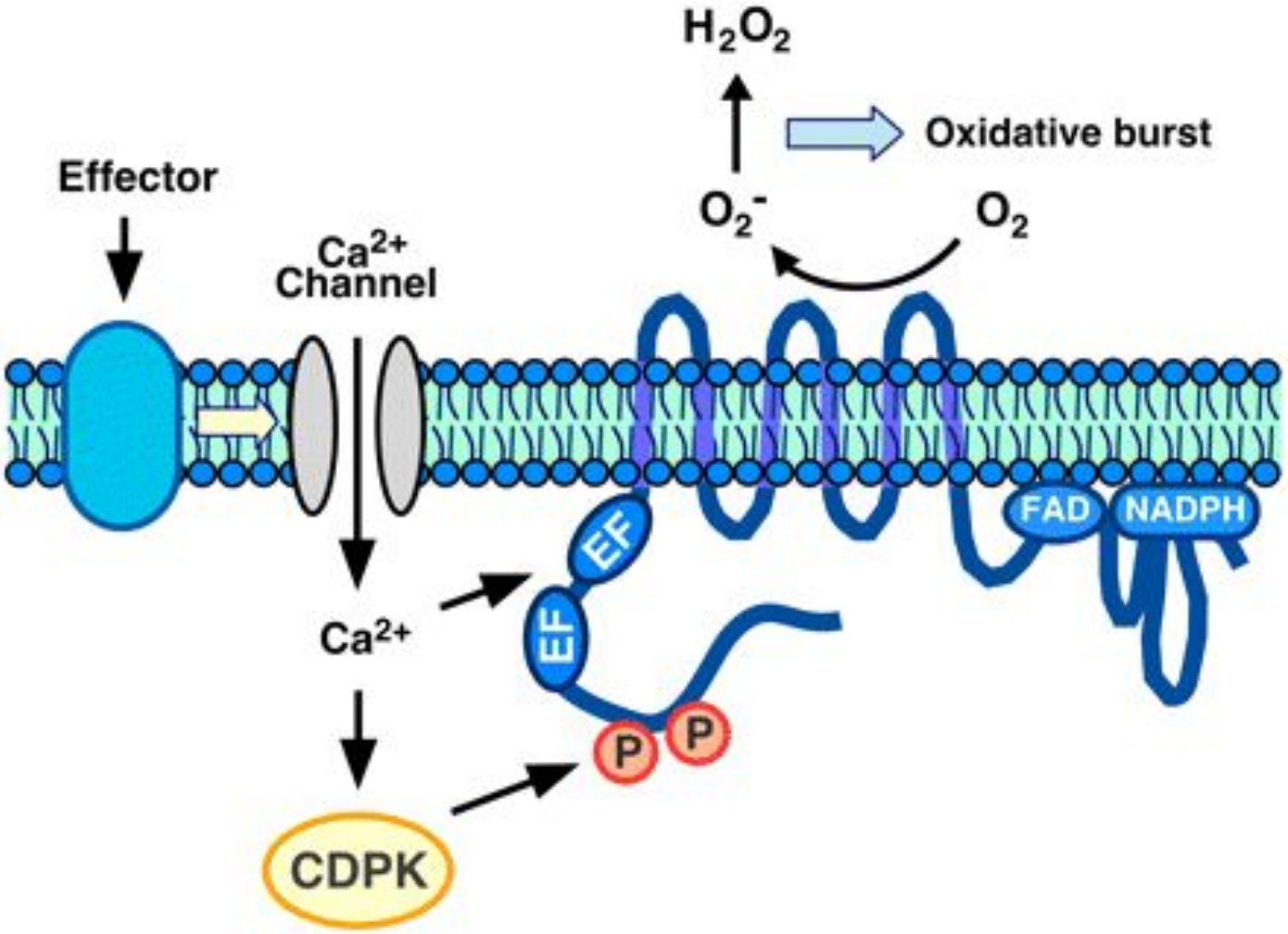
(1) Chalcone synthase; (2) pathogenesis-related (PR) protein 5; (3) PR-protein 10; (4) benzothiadiazole-induced protein; (5) dirigent; (6) glycine-rich protein; (7) proline-rich protein; (8) actin; (9) glutathione-*S*-transferase; (10) ferredoxin; (11) haemoglobin; (12) DNA repair protein; (13) aldose reductase; (14) dTDP-glucose 4,6-dehydratase; (15) methionine synthase; (16) phosphoethanolamine *N*-methyltransferase; (17) trehalose-6-phosphate synthase; (18) DAHP synthase; (19) phenylalanine ammonia lyase; (20) Myb transcription factor; (21) receptor-like protein; (22) patatin lipase-like protein; (23) lipoxygenase.

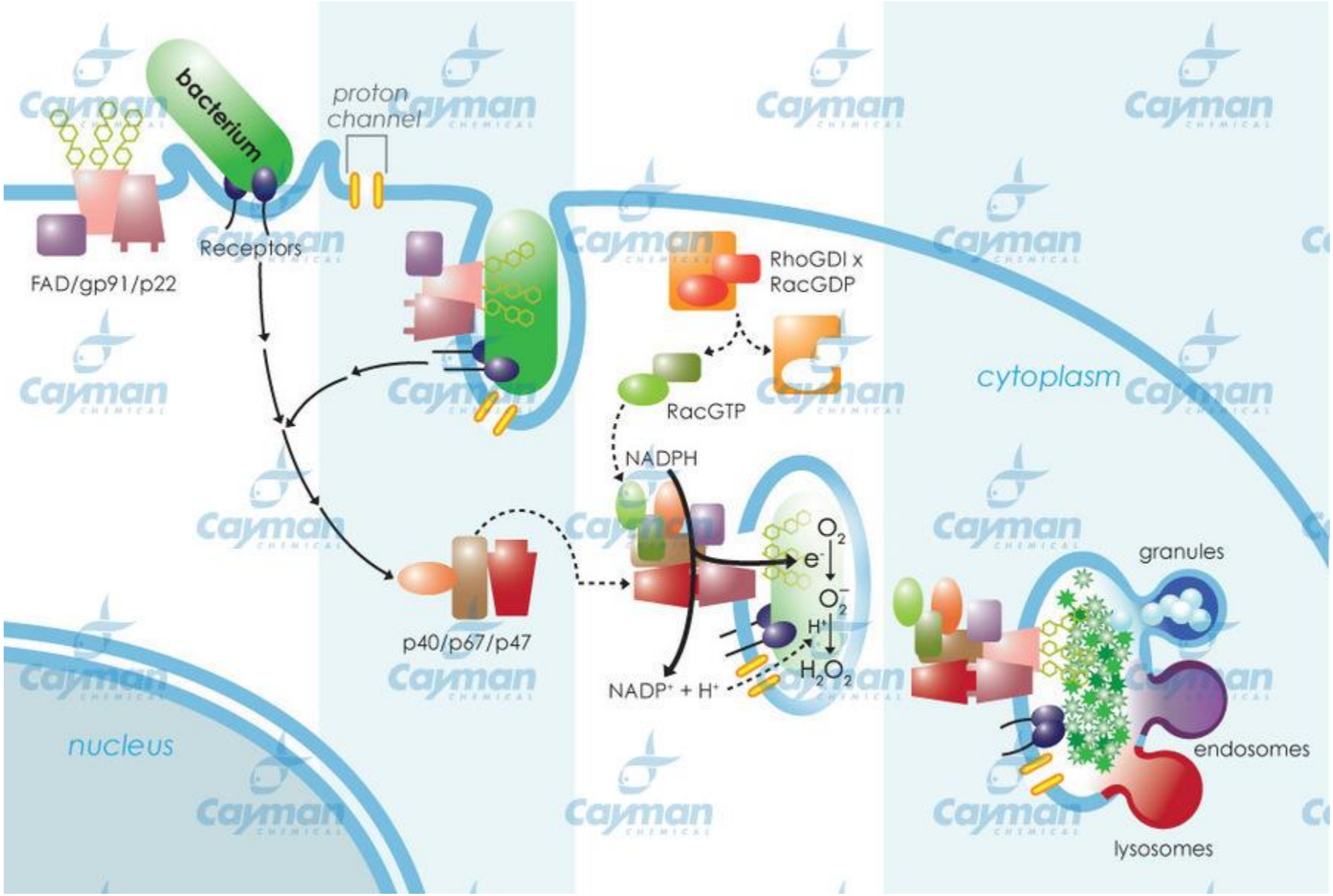
Oligoglucans action mechanism in plants



Model for St RBOHB Regulation by CDPK.

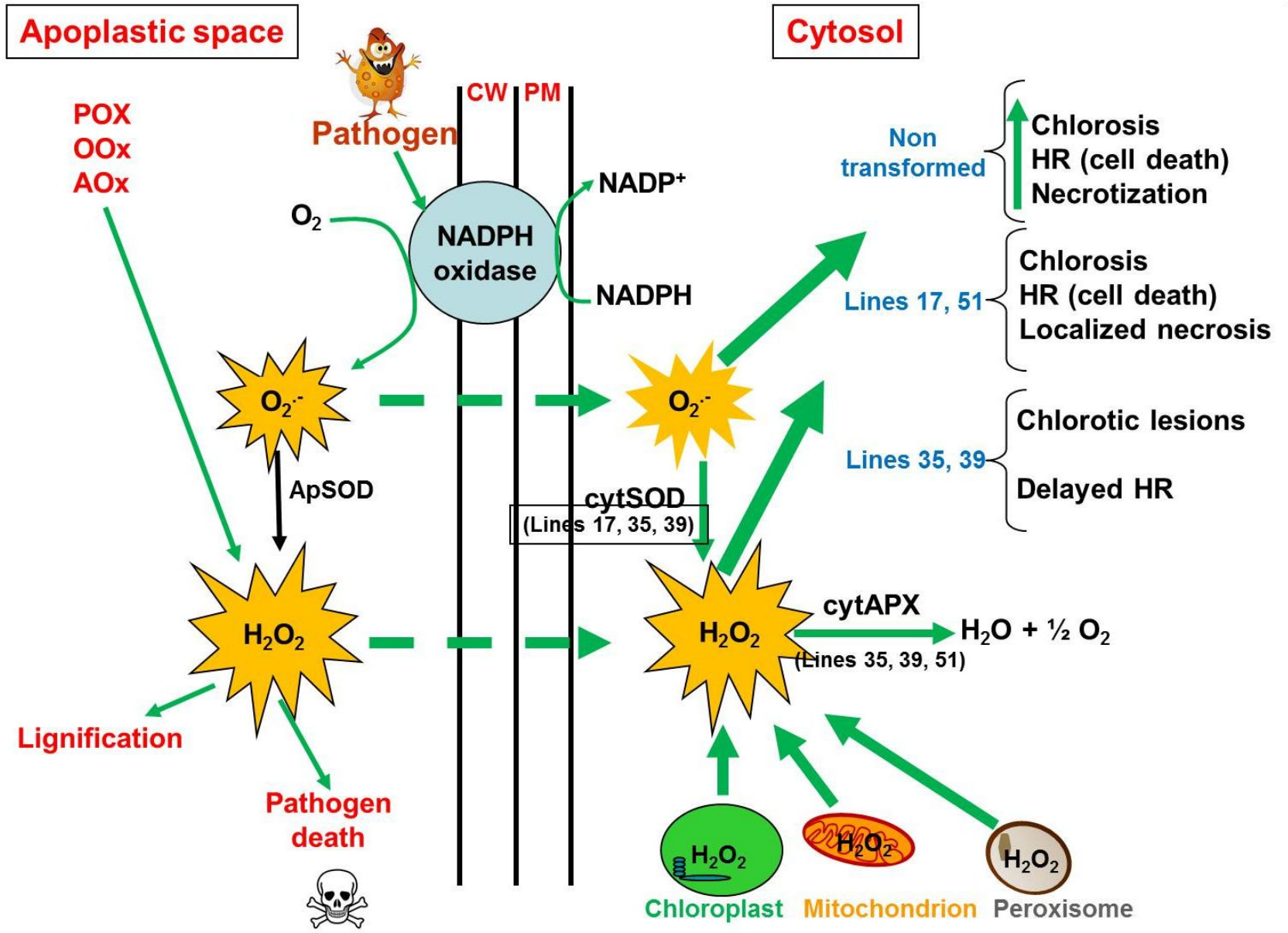
The elicitor induces Ca2+ influx. Increase of intracellular Ca2+ concentration provokes Ca2+ binding to EF-hand motifs of **CDPK** (calcium-dependent protein kinases) and the **RBOH** (Respiratory Burst Oxidase Homolog) N-terminal region. Phosphorylation of St RBOHB by CDPK results in ROS production.



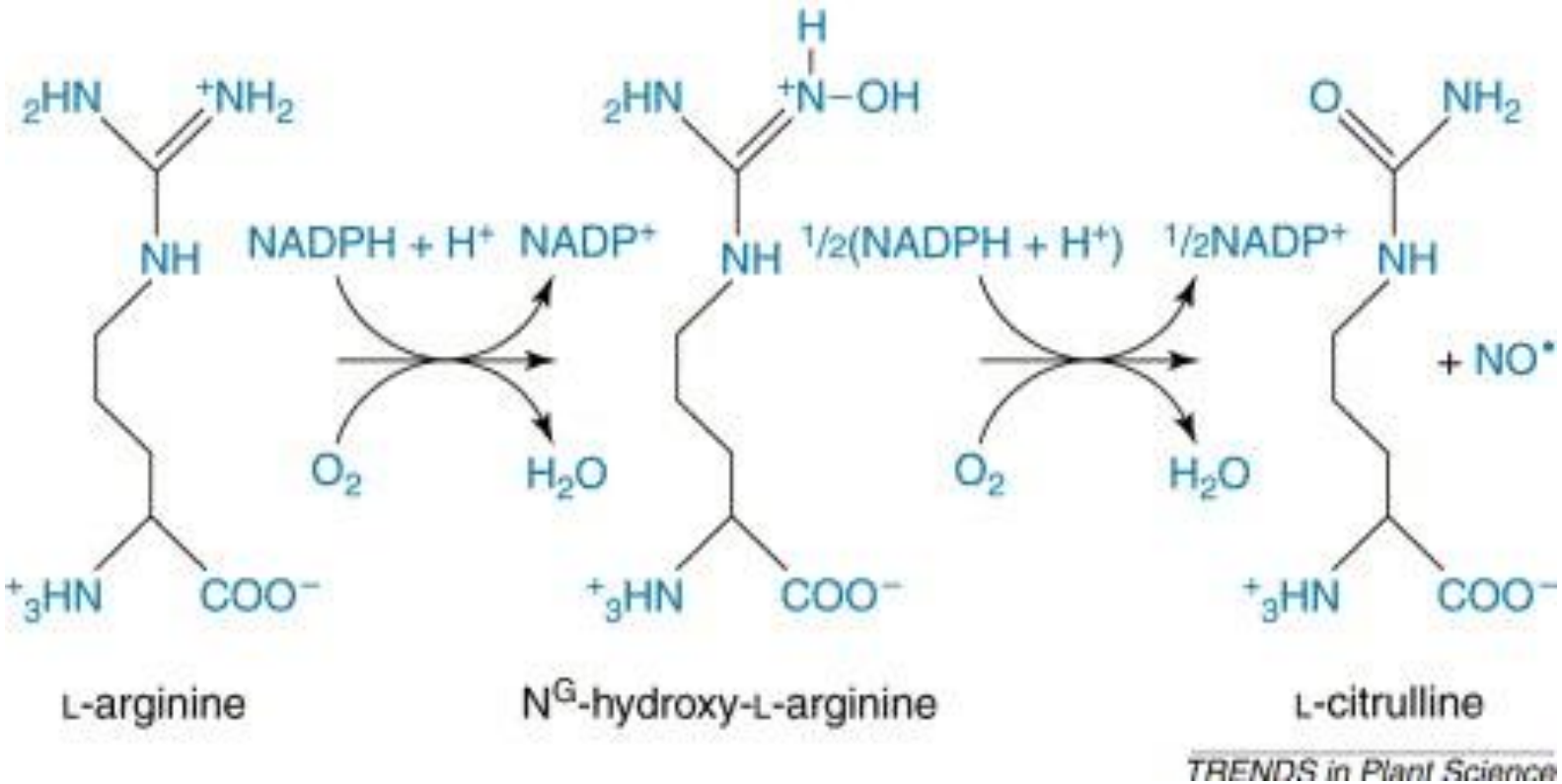

bacterium
proton channel
Receptors
FAD/gp91/p22
RhoGDI x RacGDP
RacGTP
cytoplasm
NADPH
p40/p67/p47
O_2
e^-
O_2^-
H^+
H_2O_2
$NADP^+ + H^+$
granules
endosomes
lysosomes
nucleus

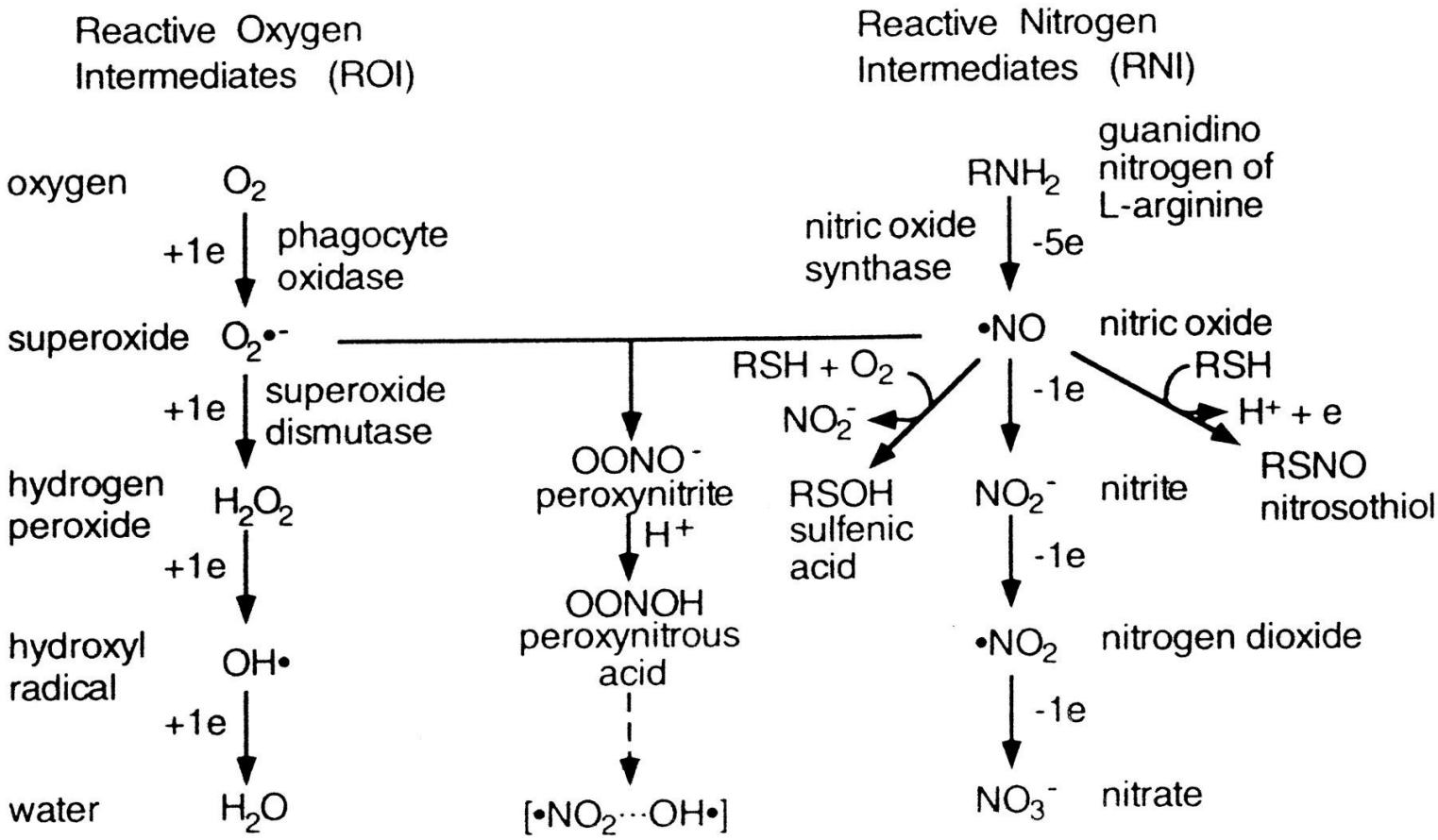
Pathogen-induced ROS generation in the apoplastic space (Lamb & Dixon 1997)

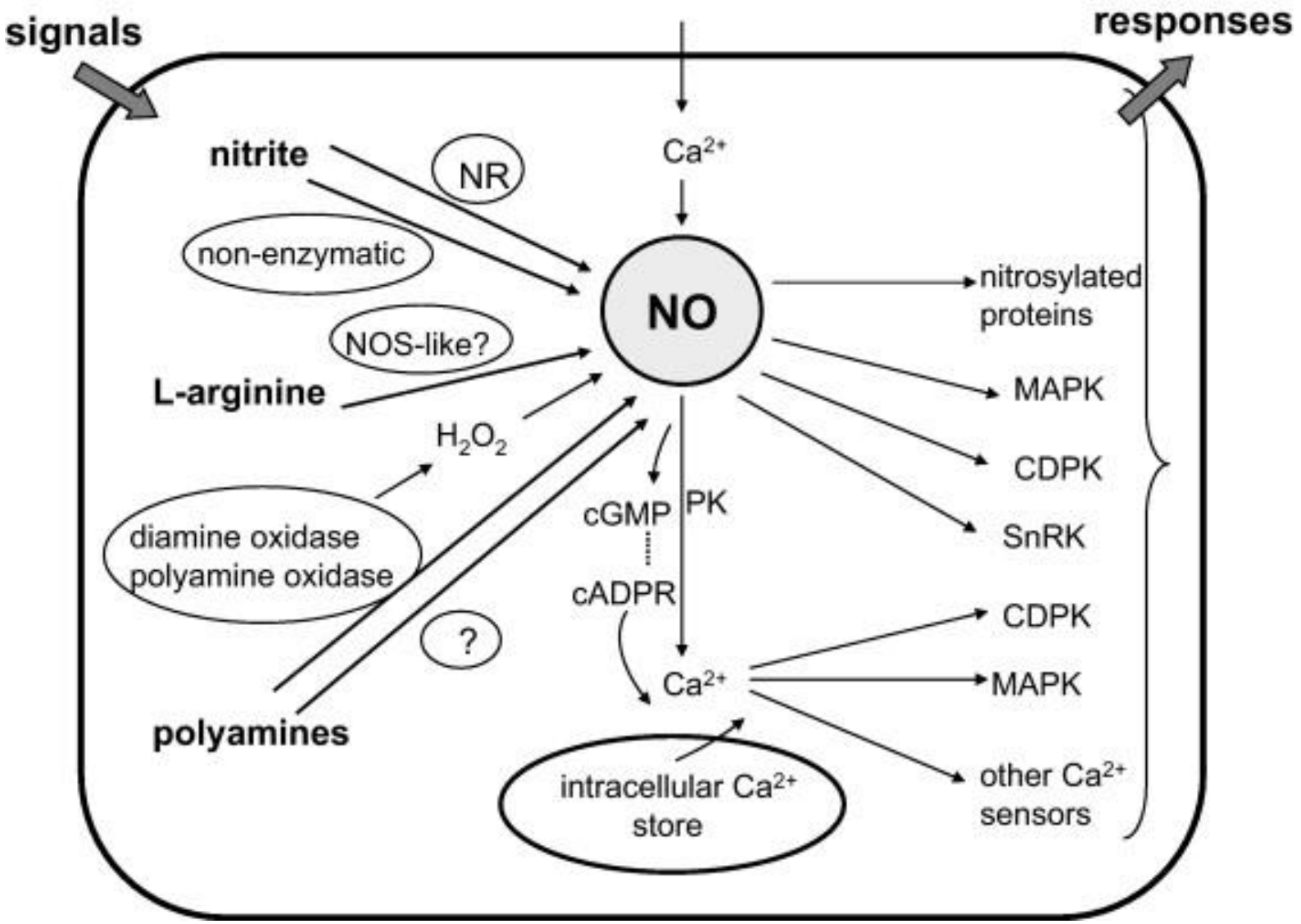
HR-hypersensitive reaction, cytSOD - cytosolic Cu,Zn - superoxide dismutase, cytapx - ascorbate peroxidase



The reaction catalyzed by mammalian nitric oxide synthases (NOSs)

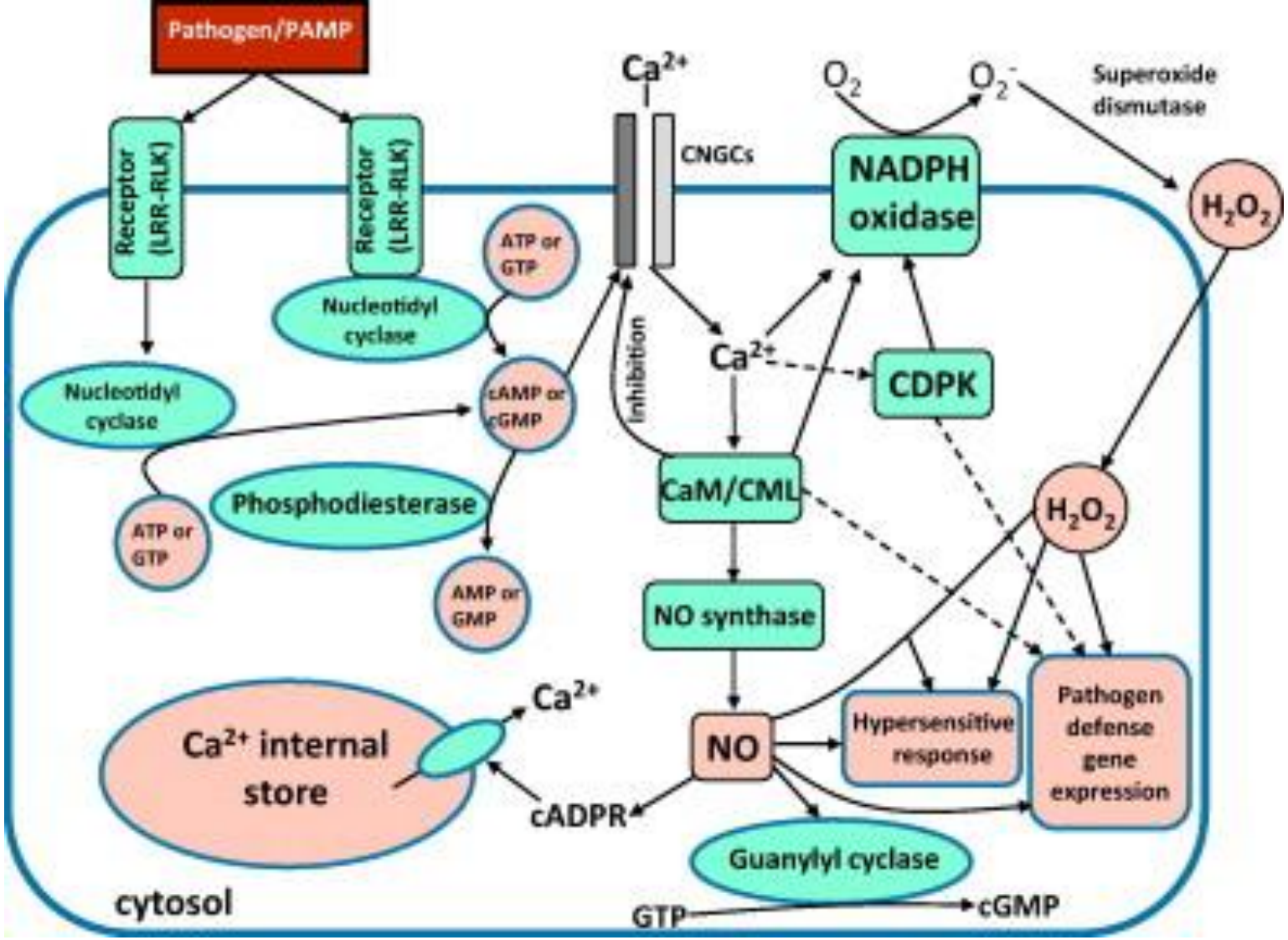



Reactive Oxygen Intermediates (ROI)
Reactive Nitrogen Intermediates (RNI)
oxygen
O_2
+1e
phagocyte oxidase
superoxide
$O_2^{\bullet -}$
+1e
superoxide dismutase
hydrogen peroxide
H_2O_2
+1e
hydroxyl radical
OH•
+1e
water
H_2O
$OONO^-$
peroxynitrite
H^+
OONOH
peroxynitrous acid
$[\bullet NO_2 \cdots OH\bullet]$
RNH_2
guanidino nitrogen of L-arginine
nitric oxide synthase
-5e
•NO
nitric oxide
RSH + O_2
NO_2^-
RSOH
sulfenic acid
-1e
NO_2^-
nitrite
RSH
H^+ + e
RSNO
nitrosothiol
-1e
$\bullet NO_2$
nitrogen dioxide
-1e
NO_3^-
nitrate



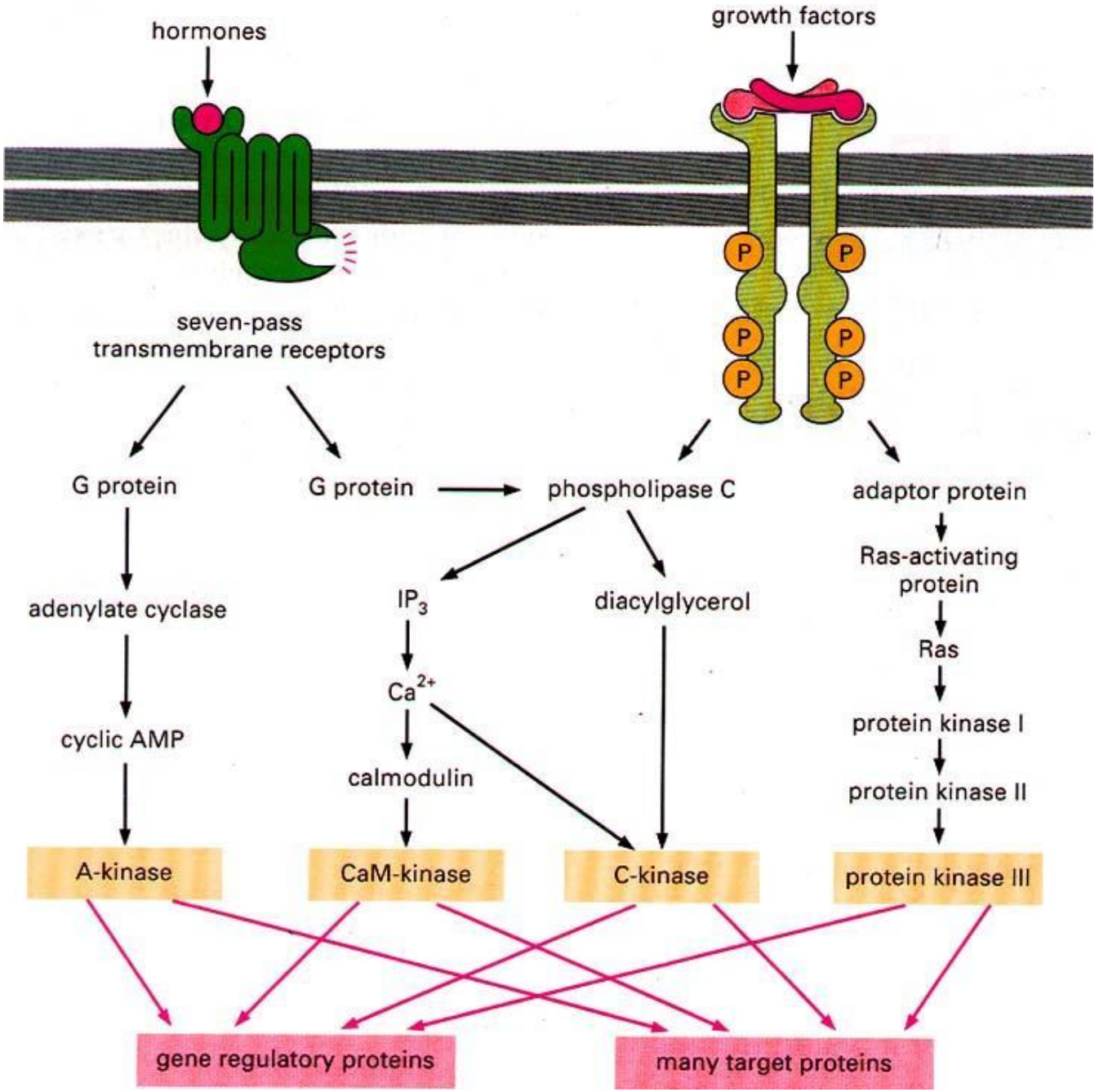
Schematic representation of NO signalling in plant cells.

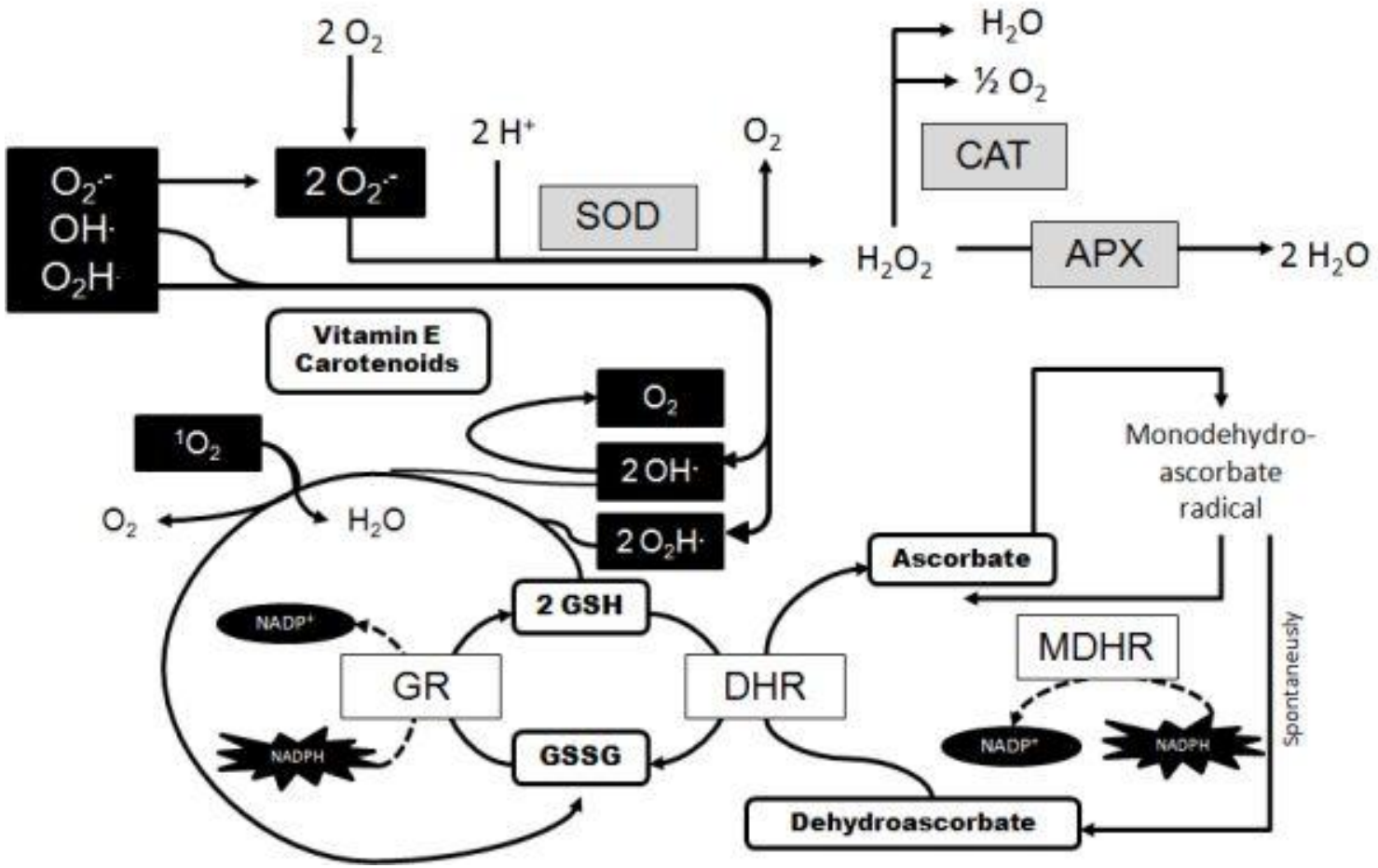
Nitrate reductase (NR), nitric oxide synthase-like enzyme (NOS-like), polyamines (PAs) DAO and PAOoxidise Pas, cyclic ADP ribose (cADPR), cyclic GMP (cGMP), protein kinases (PK), Ca2+ dependent protein kinases (CDPKs), mitogen activated protein kinases (MAPKs)



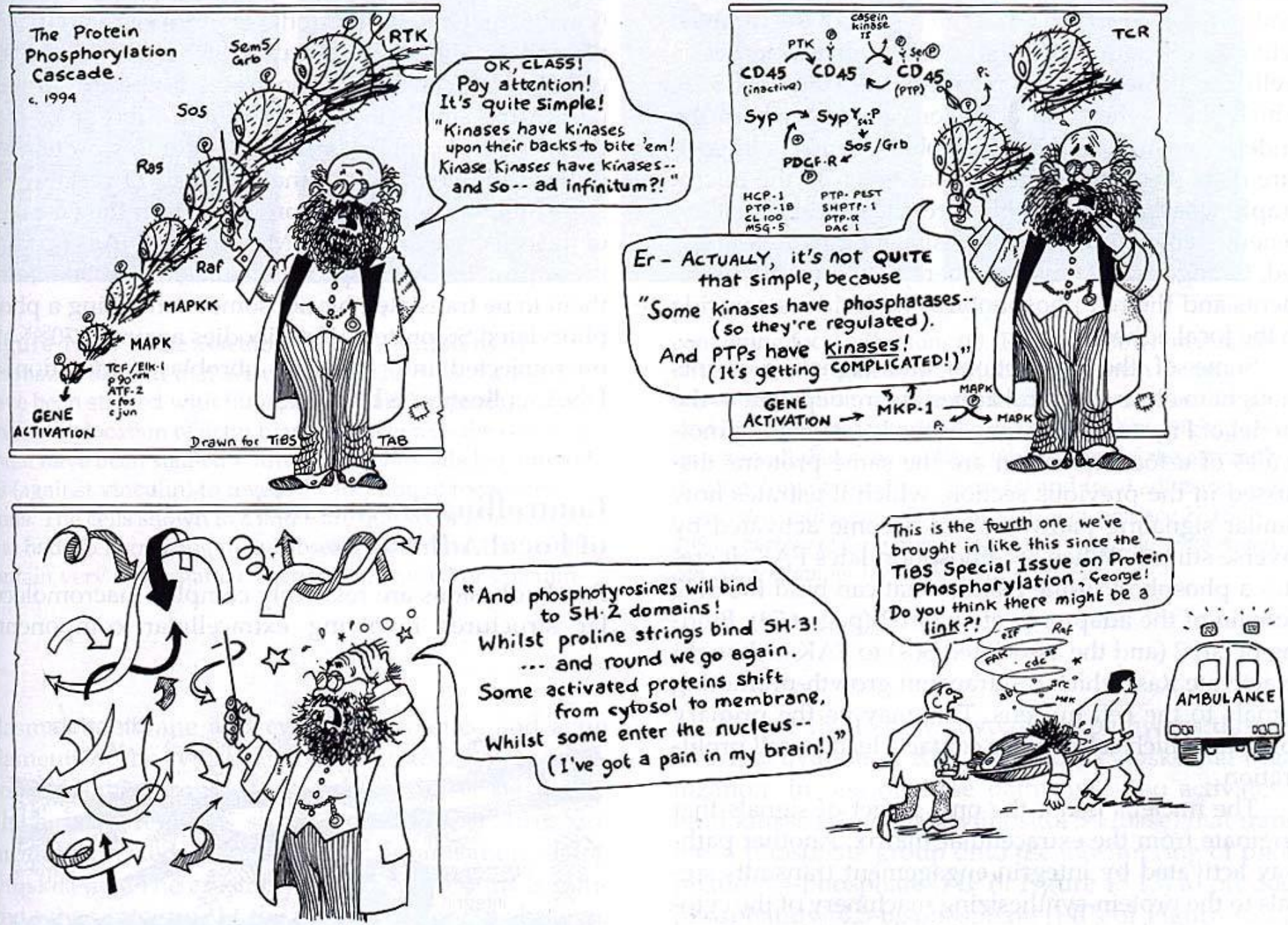
Model of possible early events in the plant immune response signaling cascade.

Pathogen/PAMP is recognized by a receptor which leads to an increase of cyclic nucleotide in cytosol. The rise of cyclic nucleotide leads to the activation possibly heteromeric cyclic nucleotide gated ion channels (CNGCs), resulting in Ca2+ influx. Cytosolic Ca2+ elevation results in increased amount of Ca2+ complexed with calmodulin (CaM) (or CaM-like protein (CML)), which leads to nitric oxide (NO) and H2O2 synthesis. NO and H2O2 are vital for hypersenstive response (HR) development. Cytosolic Ca2+/CaM increase competes with cyclic nucleotide and inhibits the further Ca2+ influx through CNGC. Arrows imply activation in all cases unless the notation ‘inhibition’ is shown. Some arrows are shown in broken lines for clarity.


hormones
growth factors
P
seven-pass
transmembrane receptors
G protein
G protein
phospholipase C
adaptor protein
adenylate cyclase
IP3
diacylglycerol
Ras-activating
protein
Ras
Ca2+
cyclic AMP
protein kinase I
calmodulin
protein kinase II
A-kinase
CaM-kinase
C-kinase
protein kinase III
gene regulatory proteins
many target proteins



Enzymatic and non-enzymatic antioxidant system in plants.
Superoxide dismutase (SOD), catalase (CAT) and ascorbate peroxidase (APX) are the proteins responsible for eliminating ROS. While the elimination of ROS by non-enzymatic processes is carried out by vitamin E, carotenoids, ascorbate, oxidized glutathione (GSH) and reduced (GSSG). Enzymes that promote the elimination of ROS via the ascorbate-glutathione cycle are monodehydroascorbate reductase (MDHR), dehydroascorbate reductase (DHR) and glutathione reductase (GR) (Modified from Halliwell, 2006).


The Protein Phosphorylation Cascade.
c. 1994
RTK
Sem5/ Grb
Sos
Ras
Raf
MAPKK
MAPK
TCF/Elk-1
p90rsk
ATF-2
c fos
c jun
GENE ACTIVATION
Drawn for TiBS
TAB
OK, CLASS! Pay attention! It's quite simple!
"Kinases have kinases upon their backs to bite 'em! Kinase Kinases have kinases-- and so-- ad infinitum?!"
TCR
PTK
CD45 (inactive)
CD45
casein kinase II
CD45 (PTP)
Syp
Syp Y546:P
Sos/Grb
PDGF-R
HCP-1
PTP-1B
CL 100
MSG-5
PTP-PEST
SHPTP-1
PTP-α
DAC 1
Er - ACTUALLY, it's not QUITE that simple, because
"Some kinases have phosphatases-- (so they're regulated).
And PTPs have Kinases! (It's getting COMPLICATED!)"
GENE ACTIVATION
MKP-1
MAPK
"And phosphotyrosines will bind to SH-2 domains!
Whilst proline strings bind SH-3!
... and round we go again.
Some activated proteins shift from cytosol to membrane,
Whilst some enter the nucleus--
(I've got a pain in my brain!)"
This is the fourth one we've brought in like this since the TiBS Special Issue on Protein Phosphorylation, George! Do you think there might be a link?!
eIF
Raf
FAK
cdc
src
MEK
AMBULANCE