Chapter 9: Biochemical Mechanisms for Information Storage at the Cellular Level

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Chapter 9: Dendritic Spine

Summary: Three Primary Issues Related to Mechanisms for E-LTP

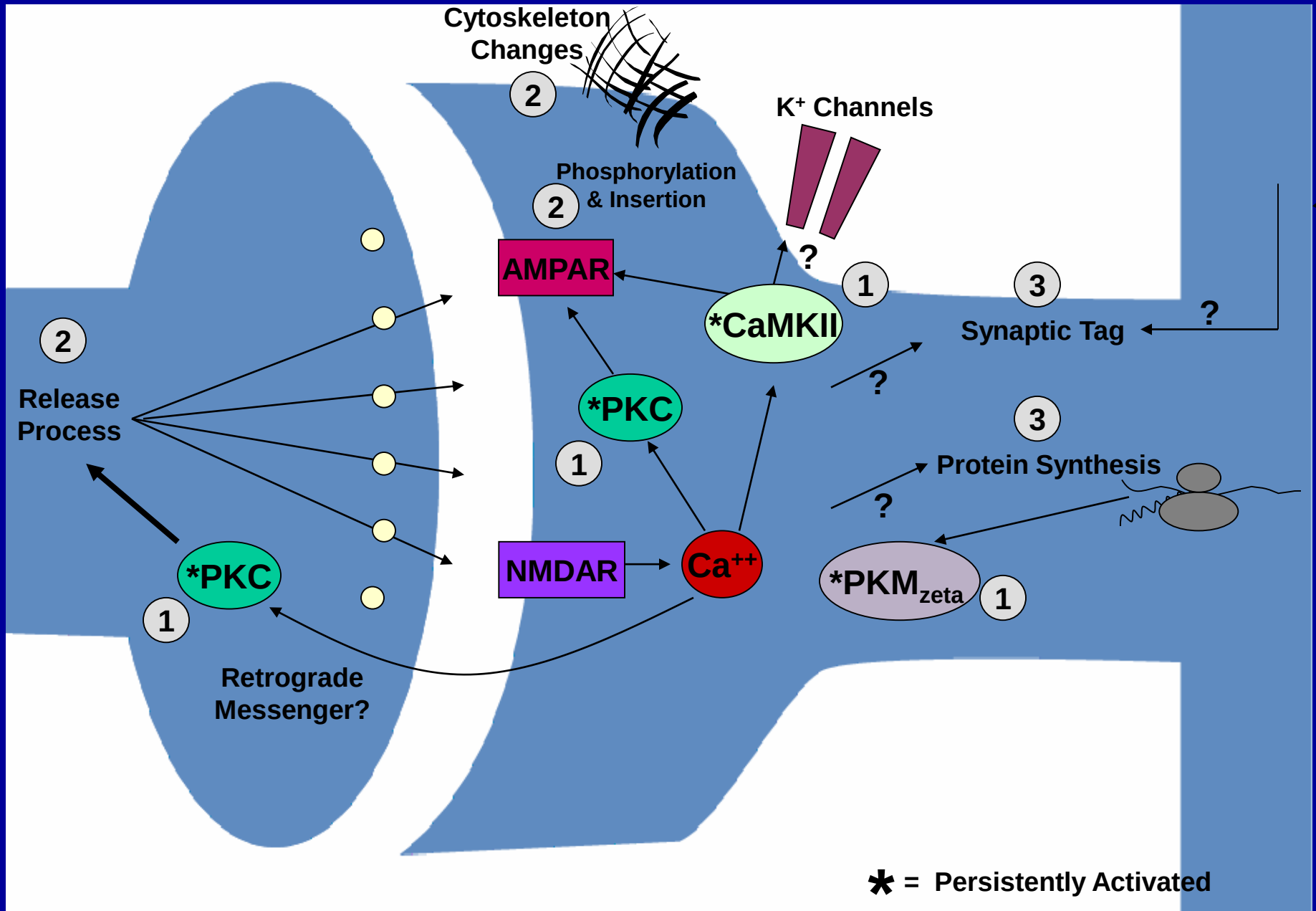


Figure 1

Structures of Calcium-Binding Proteins

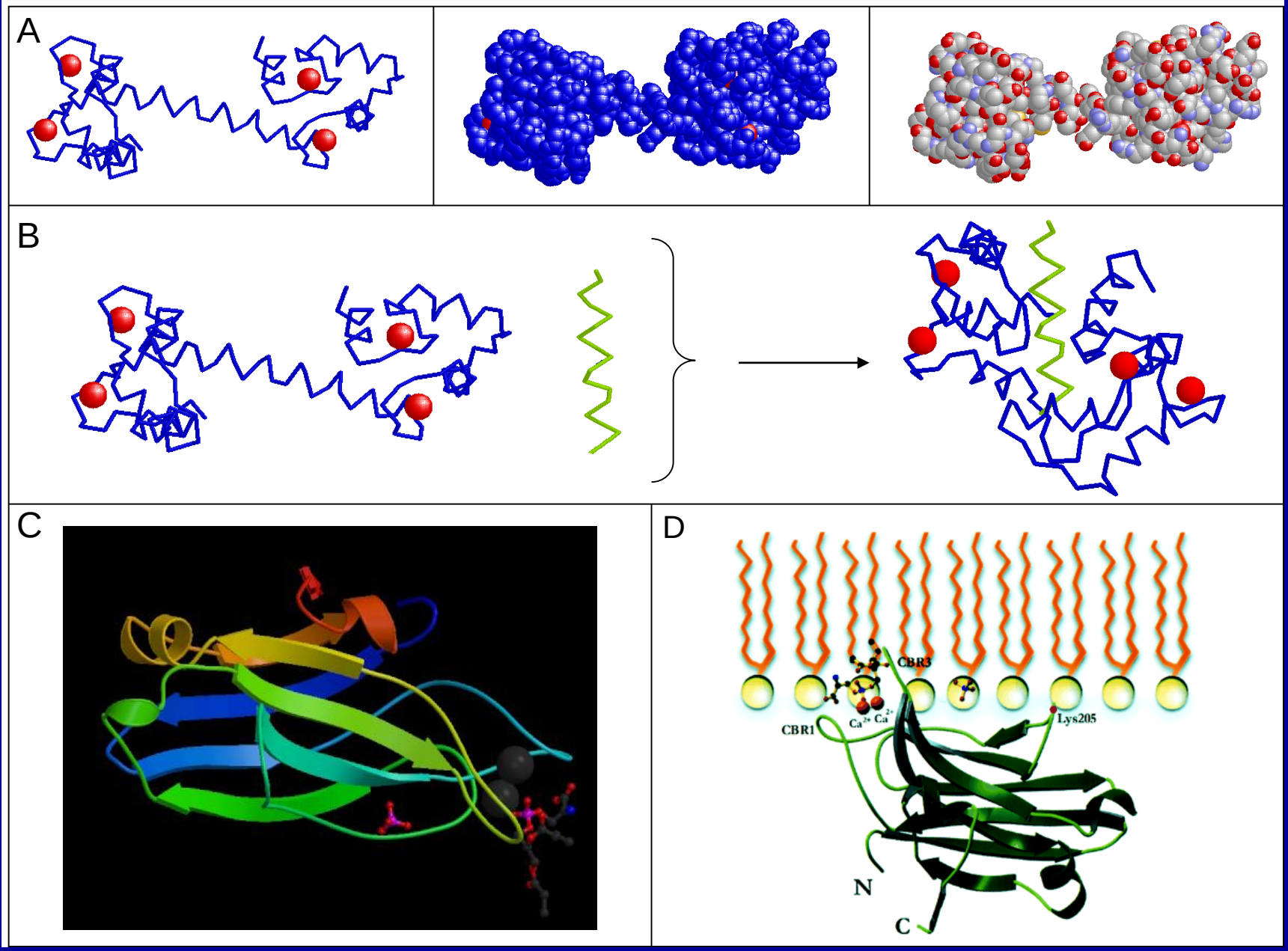


Figure 2

Structure of CAMKII

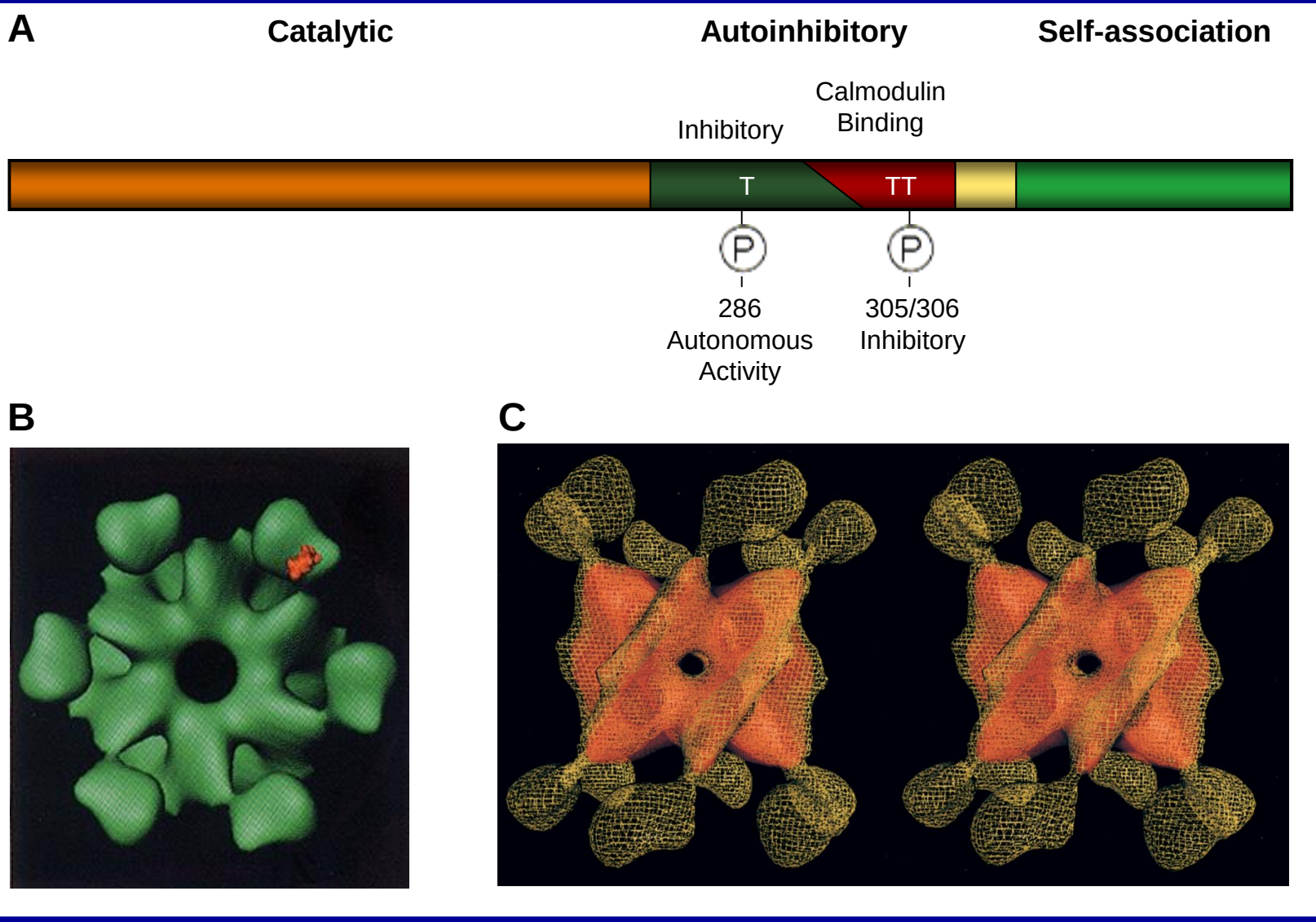


Figure 3

Three Different Effects of Ca/CaM on CaMKII

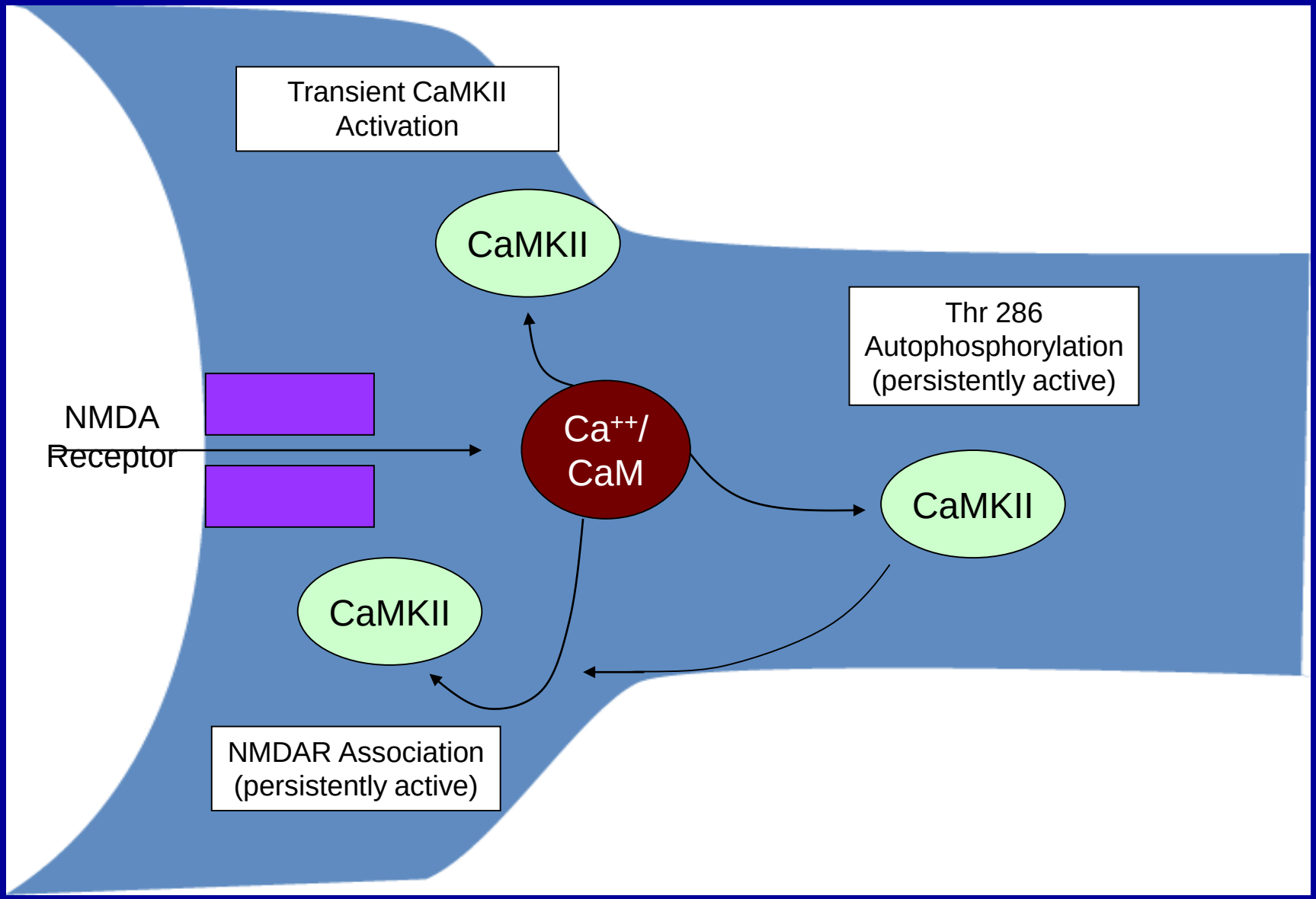


Figure 4

Catalysis of cAMP by Adenylyl Cyclases

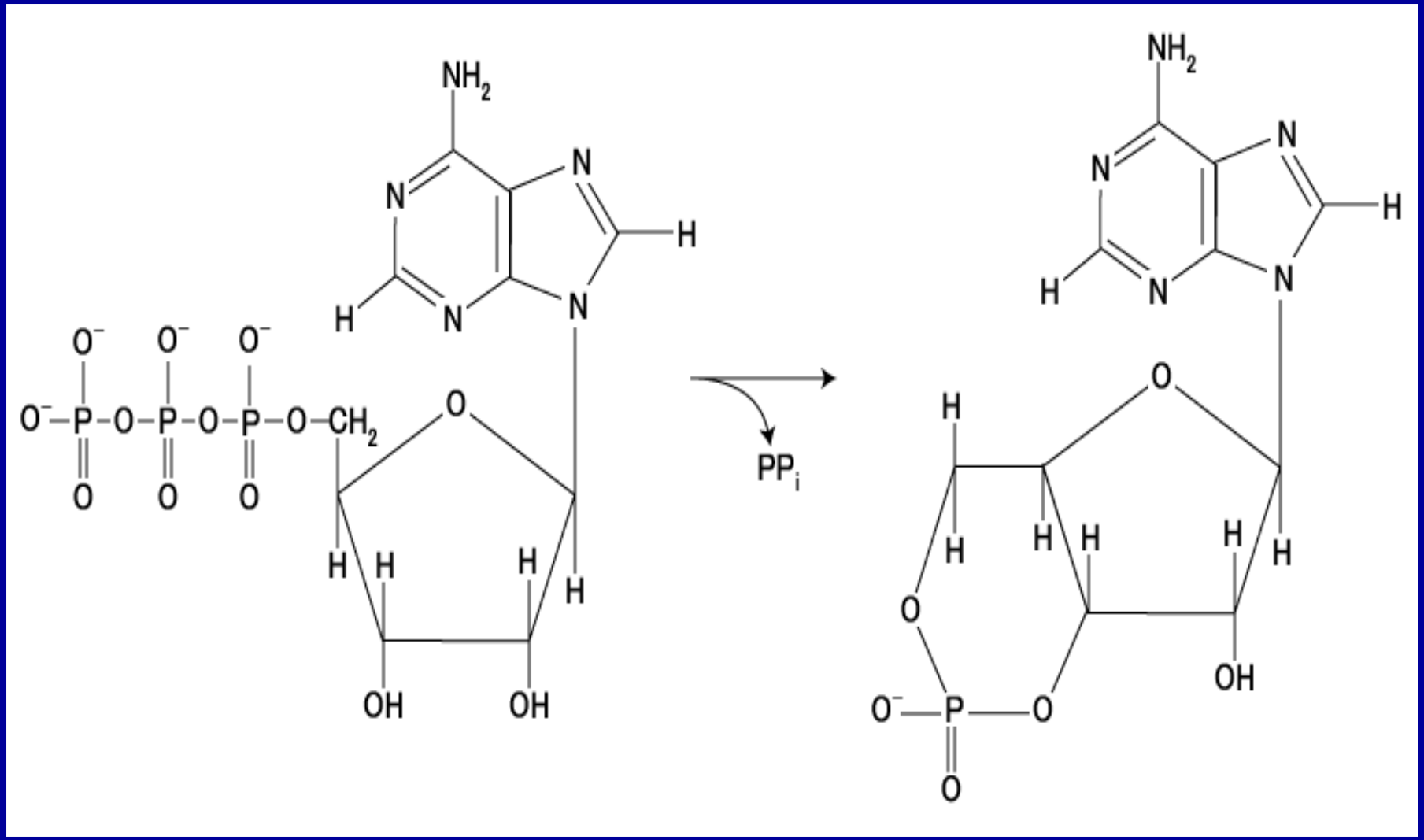


Figure 5

LTP in Adenylyl Cyclase-Deficient Mice

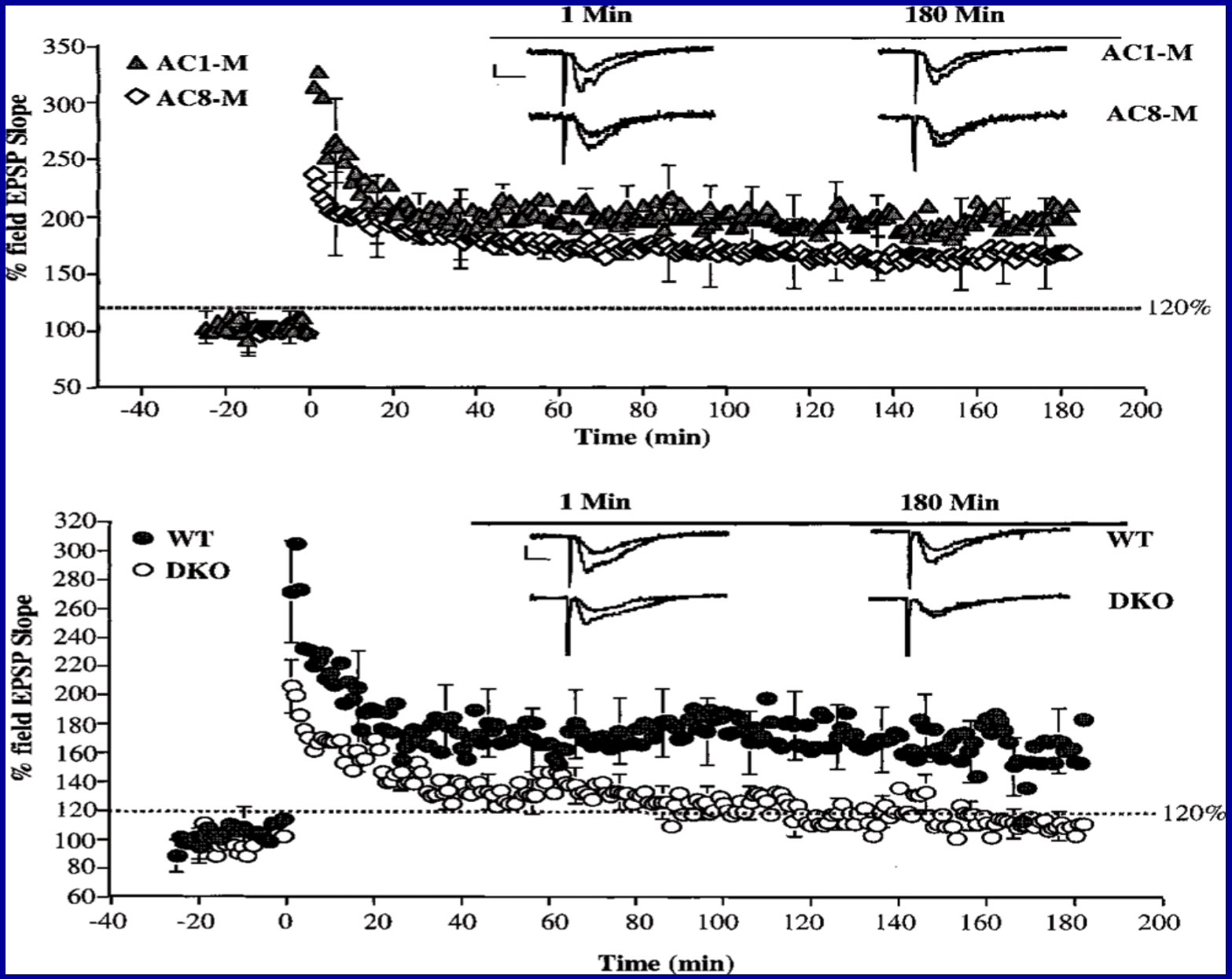


Figure 6

Domain Structures of Isoforms of PKC

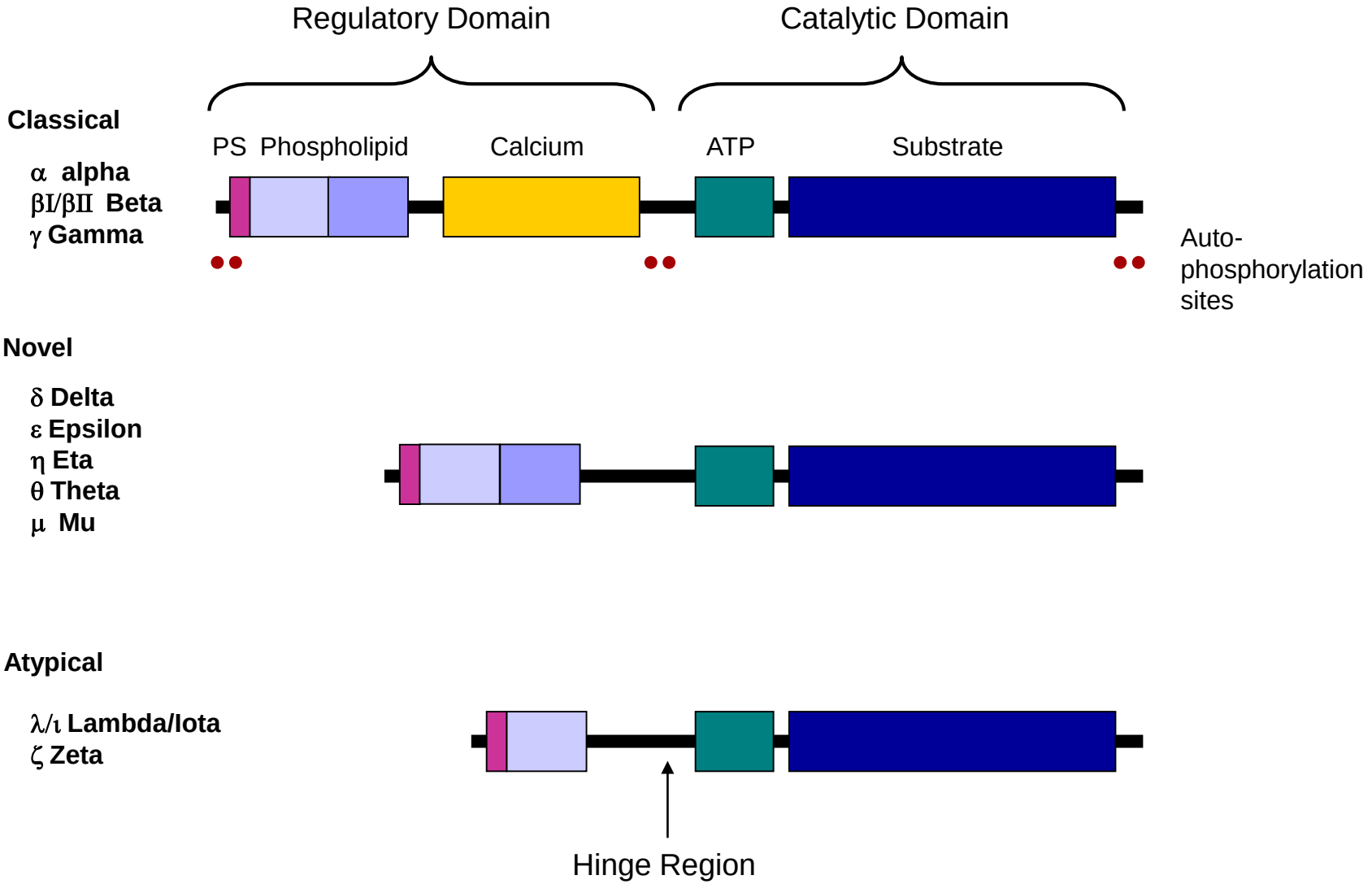


Figure 7

Hippocampal LTP in PKC Isoform-Specific Knockout Mice

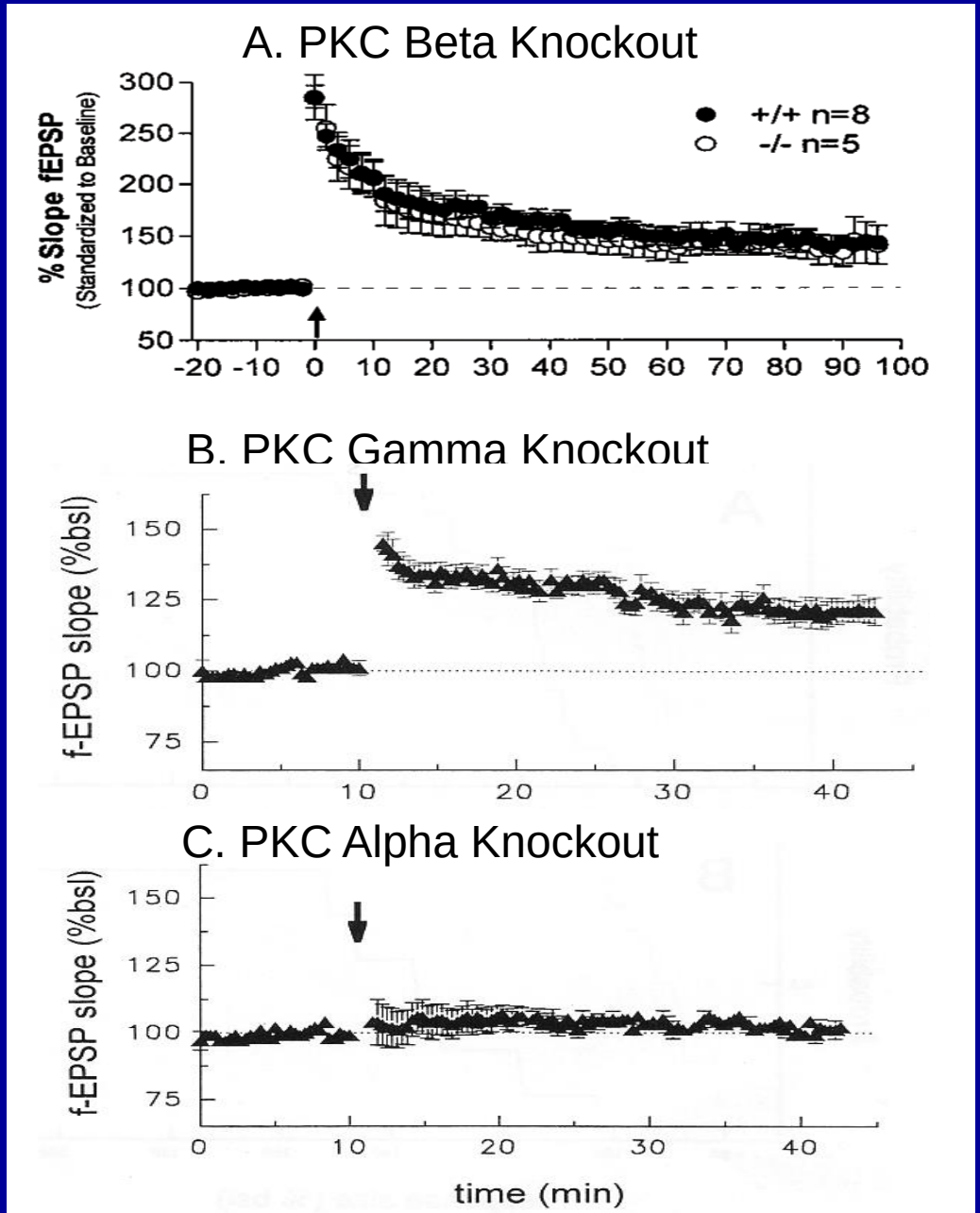


Figure 8

PKMζ mRNA Formation from Internal Promoter within PKCζ Gene

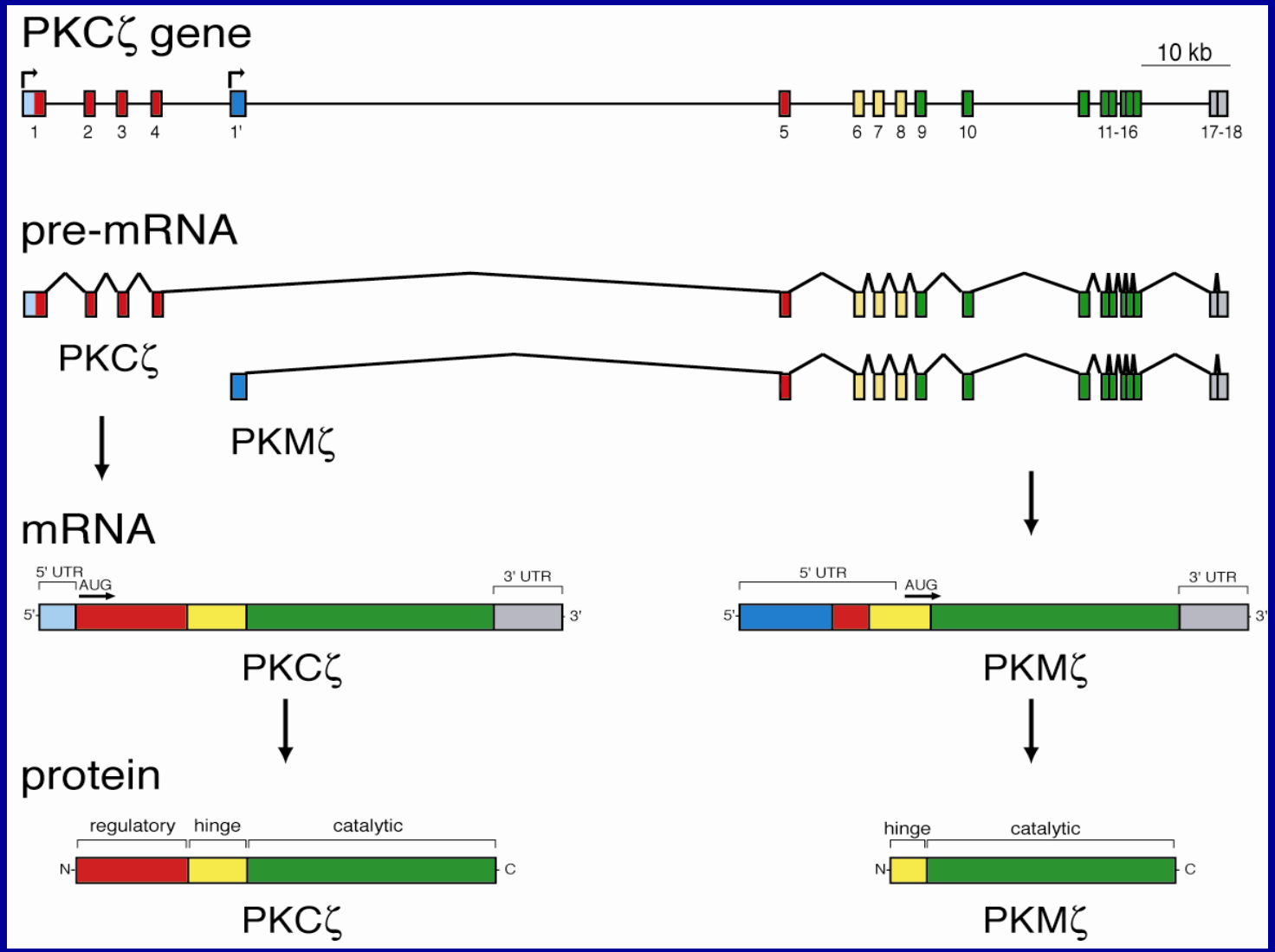


Figure 9

PKMζ and LTP Maintenance

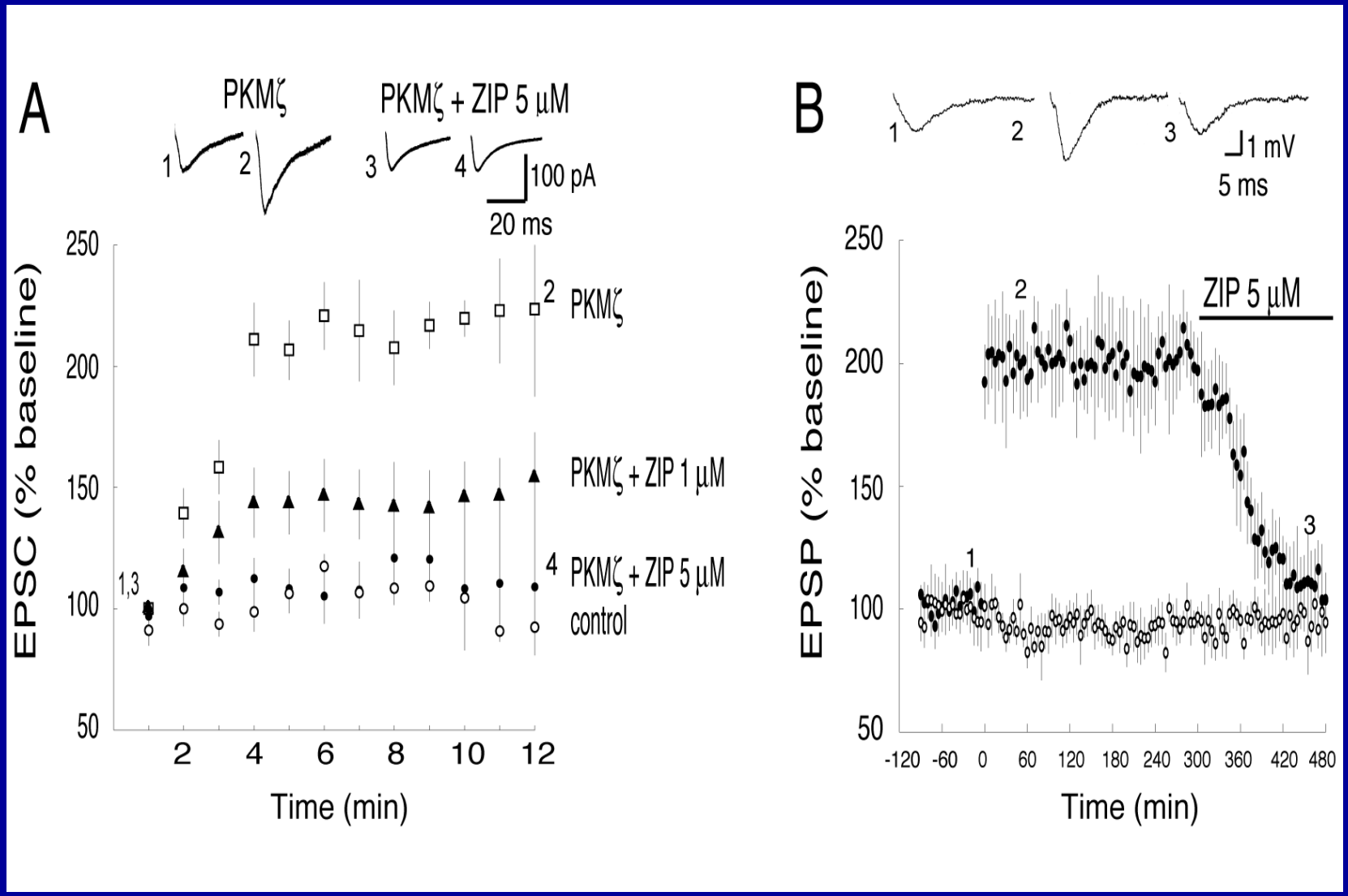


Figure 10

TABLE I: PROPOSED MECHANISMS FOR GENERATING PERSISTING SIGNALS IN E-LTP

MOLECULE	MECHANISM	ROLE
CaMKII	Self-perpetuating autophosphorylation coupled with low phosphatase activity	Effector phosphorylation, Structural changes
Various PKCs	Direct, irreversible covalent modification by reactive oxygen species	Effector phosphorylation
PKMζ	De novo synthesis of a constitutively active kinase	Effector phosphorylation

TABLE II: PROPOSED MECHANISMS FOR AUGMENTING AMPA RECEPTOR FUNCTION IN E-LTP

Mechanism	Likely molecular basis
Increased single-channel conductance	Direct phosphorylation of AMPA receptor alpha subunits by CaMKII or PKC
Increased steady-state levels of AMPAR	CaMKII (+ PKC?) phosphorylation of AMPAR-associated trafficking and scaffolding proteins
Insertion of AMPAR into silent synapses	CaMKII phosphorylation of GluR1-associated trafficking proteins

AMPA Receptor Regulation During LTP

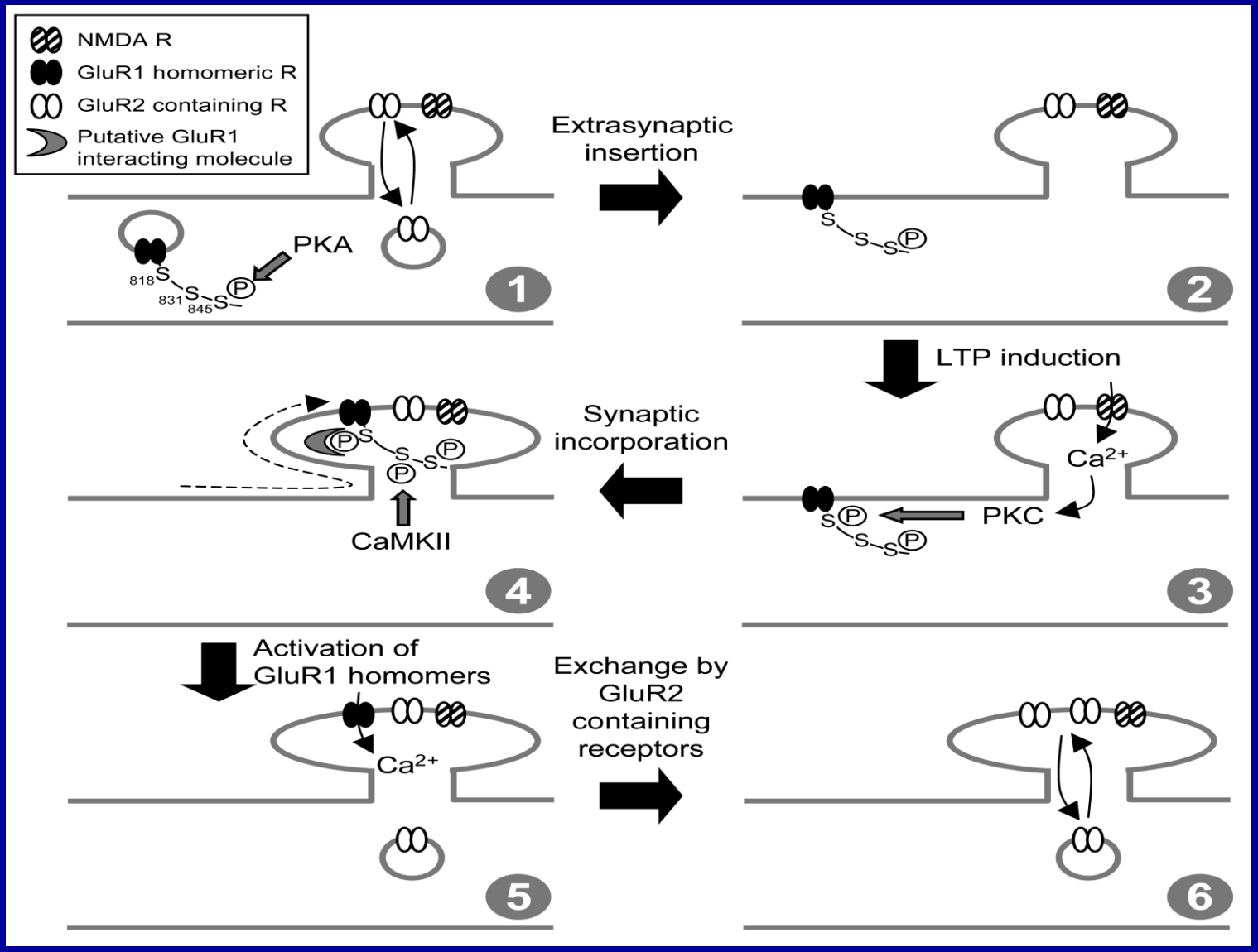


Figure 11

Glutamate Receptor Insertion and Stabilization in E-LTP

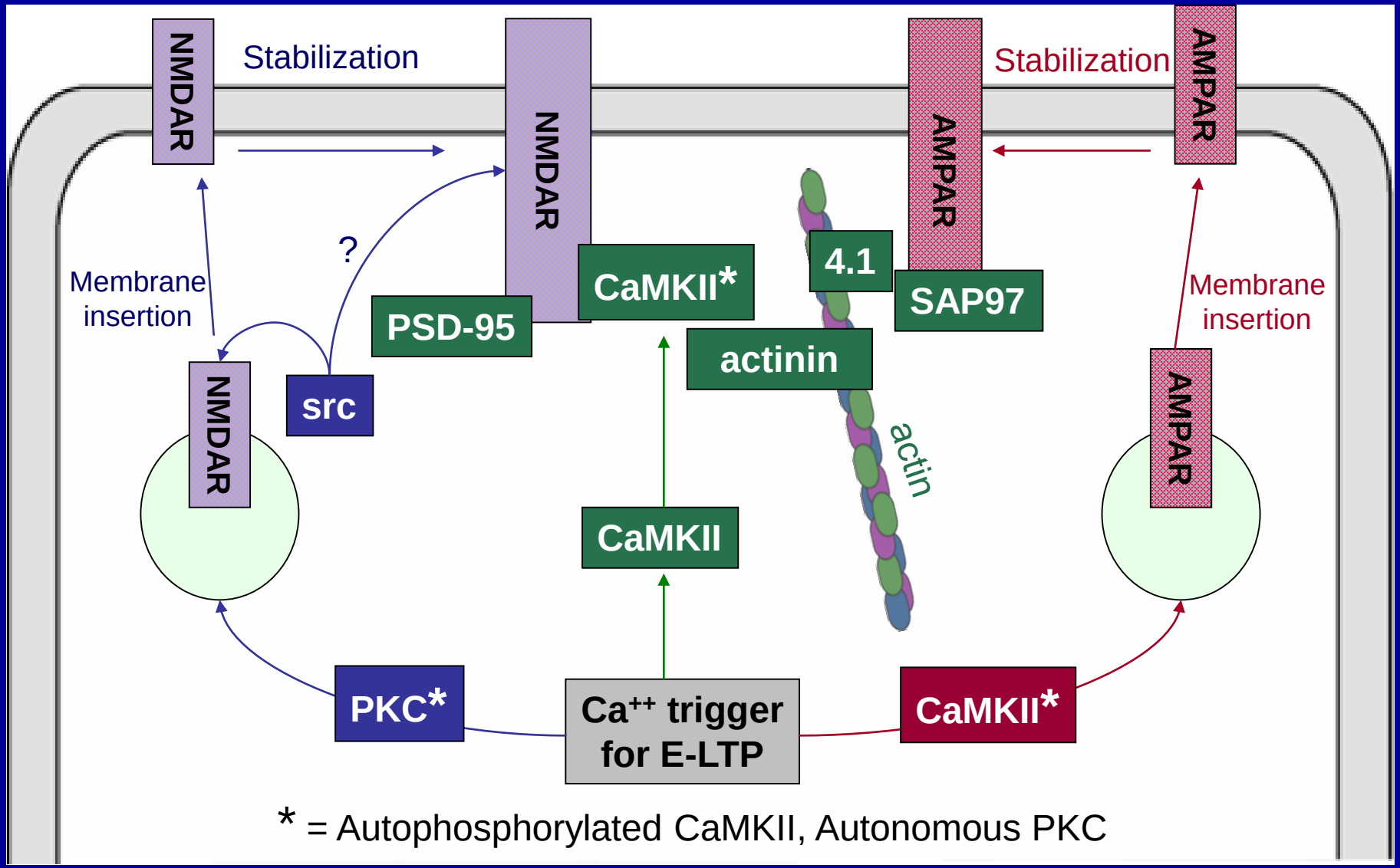


Figure 12

Retrograde Signaling in E-LTP

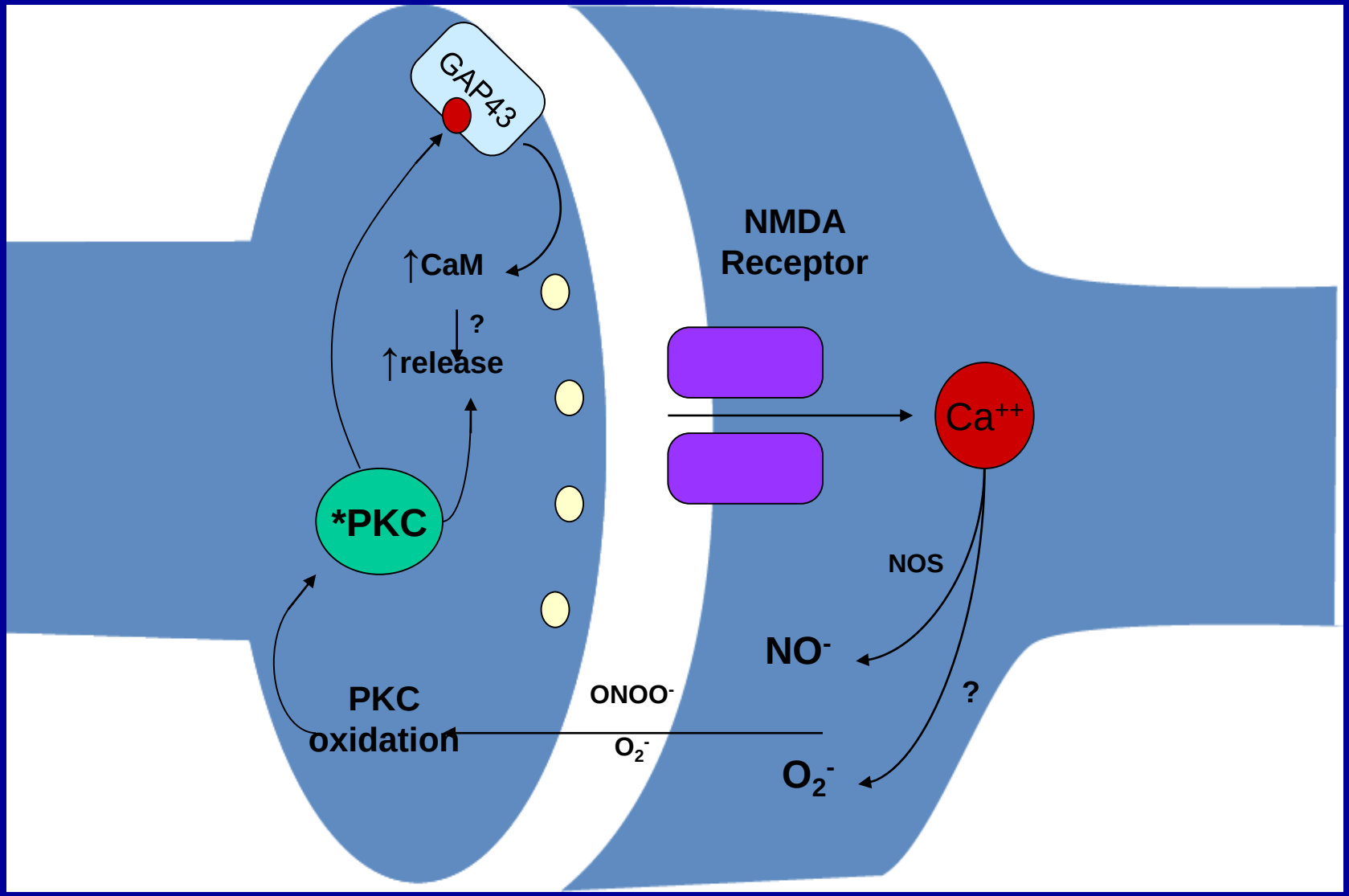


Figure 13

Activity-Dependent Regulation of Local Protein Synthesis and Spine Morphological Changes in LTP

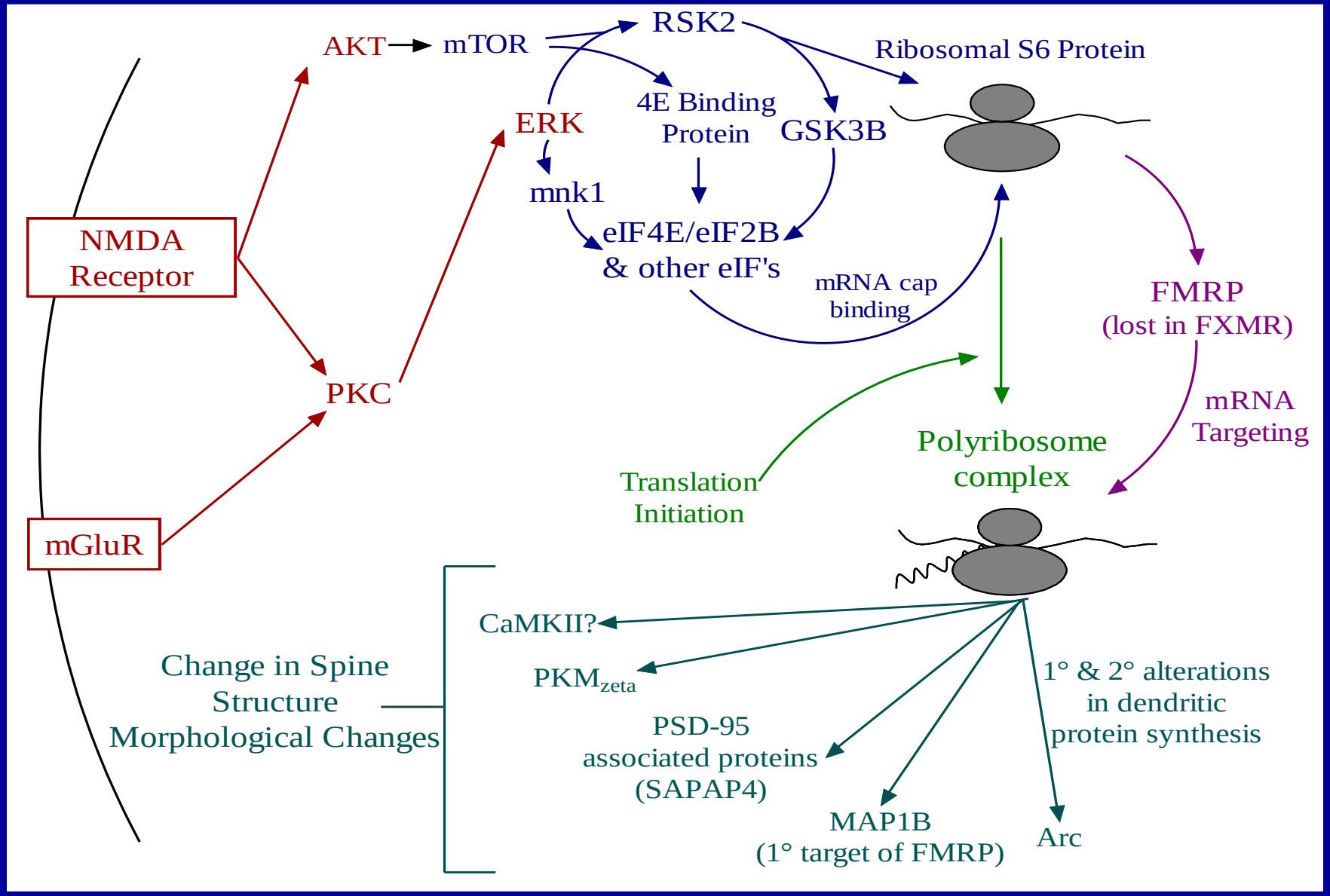
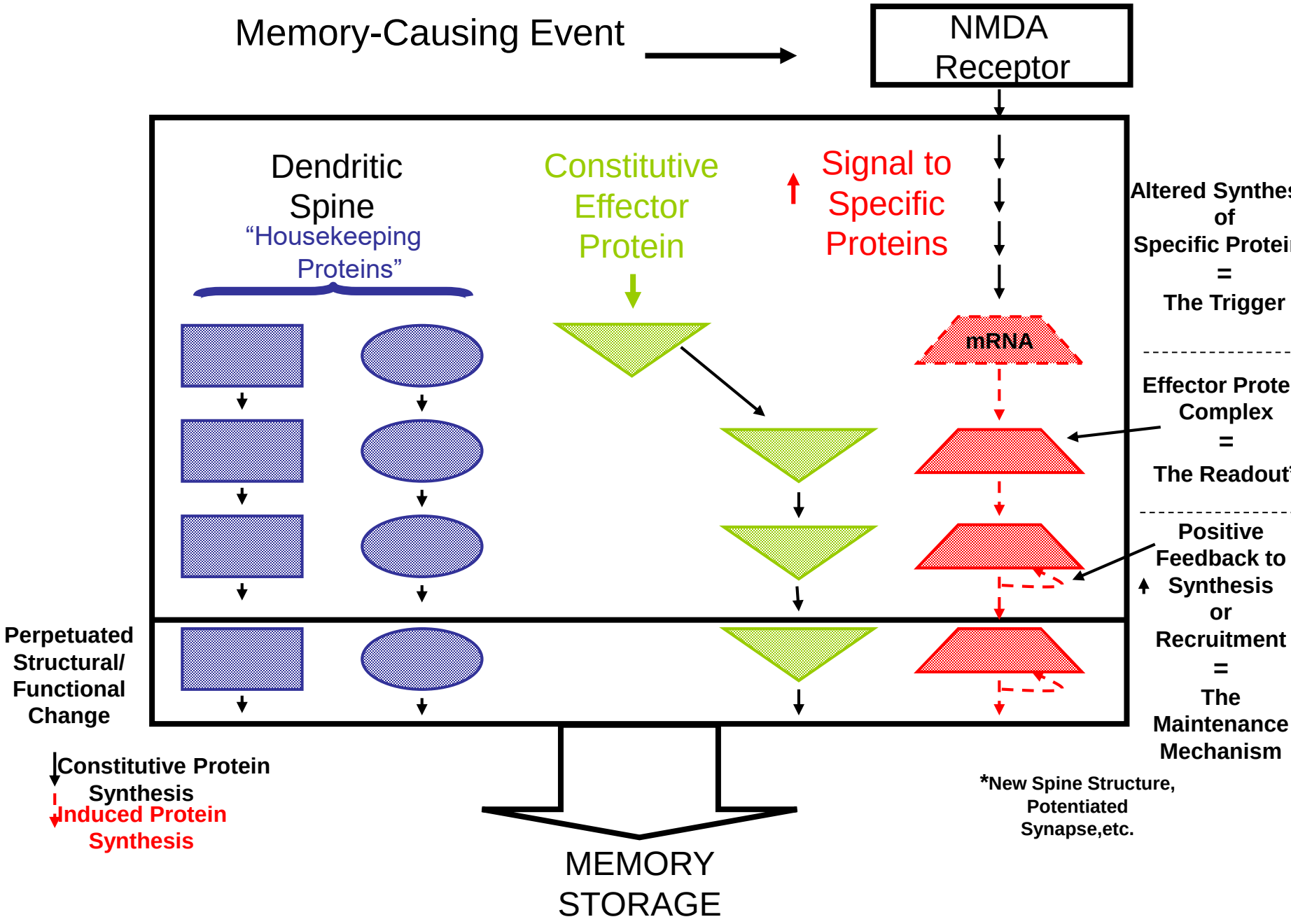
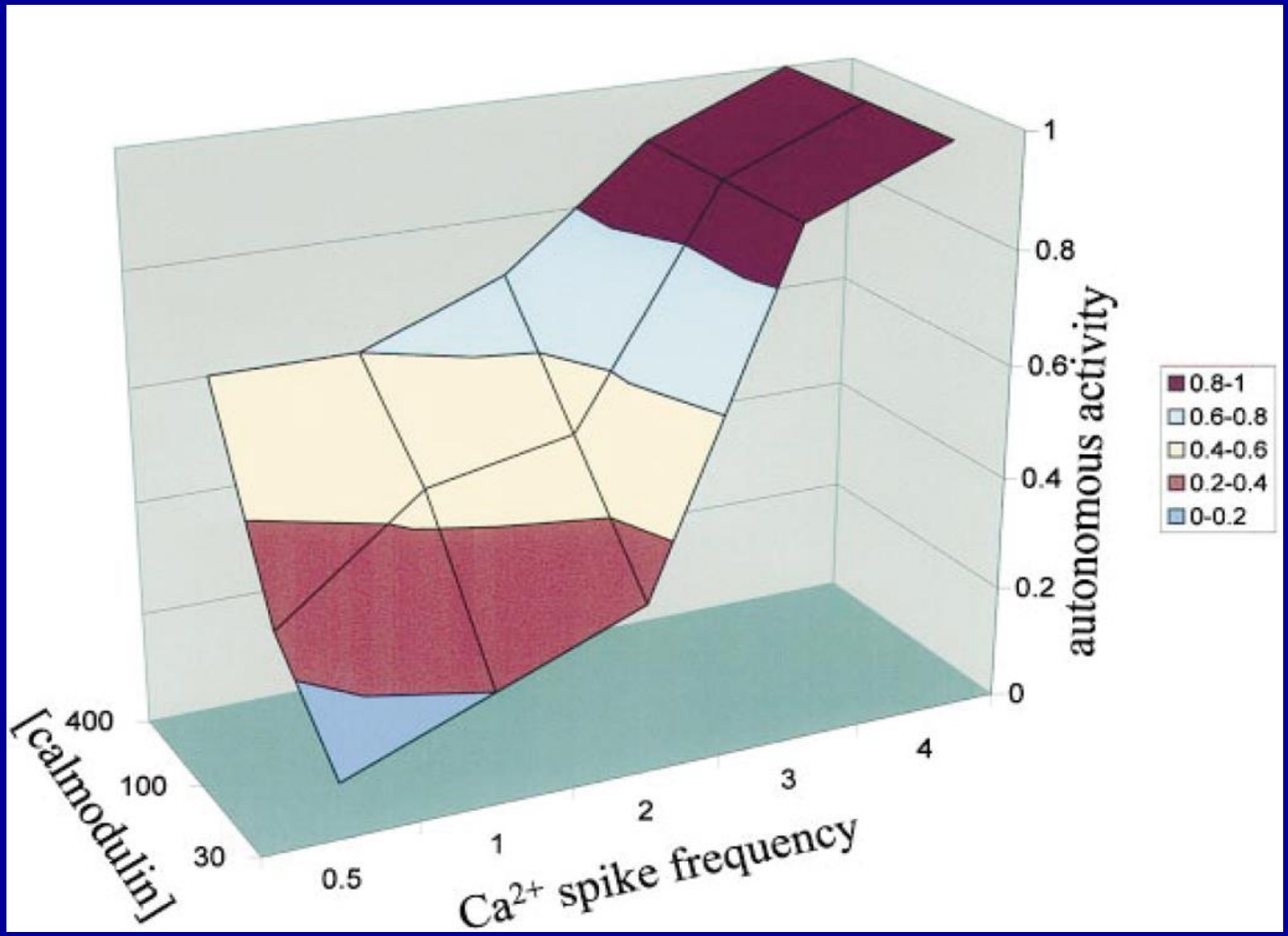


Figure 14

Altered Protein Synthesis as Trigger for Memory

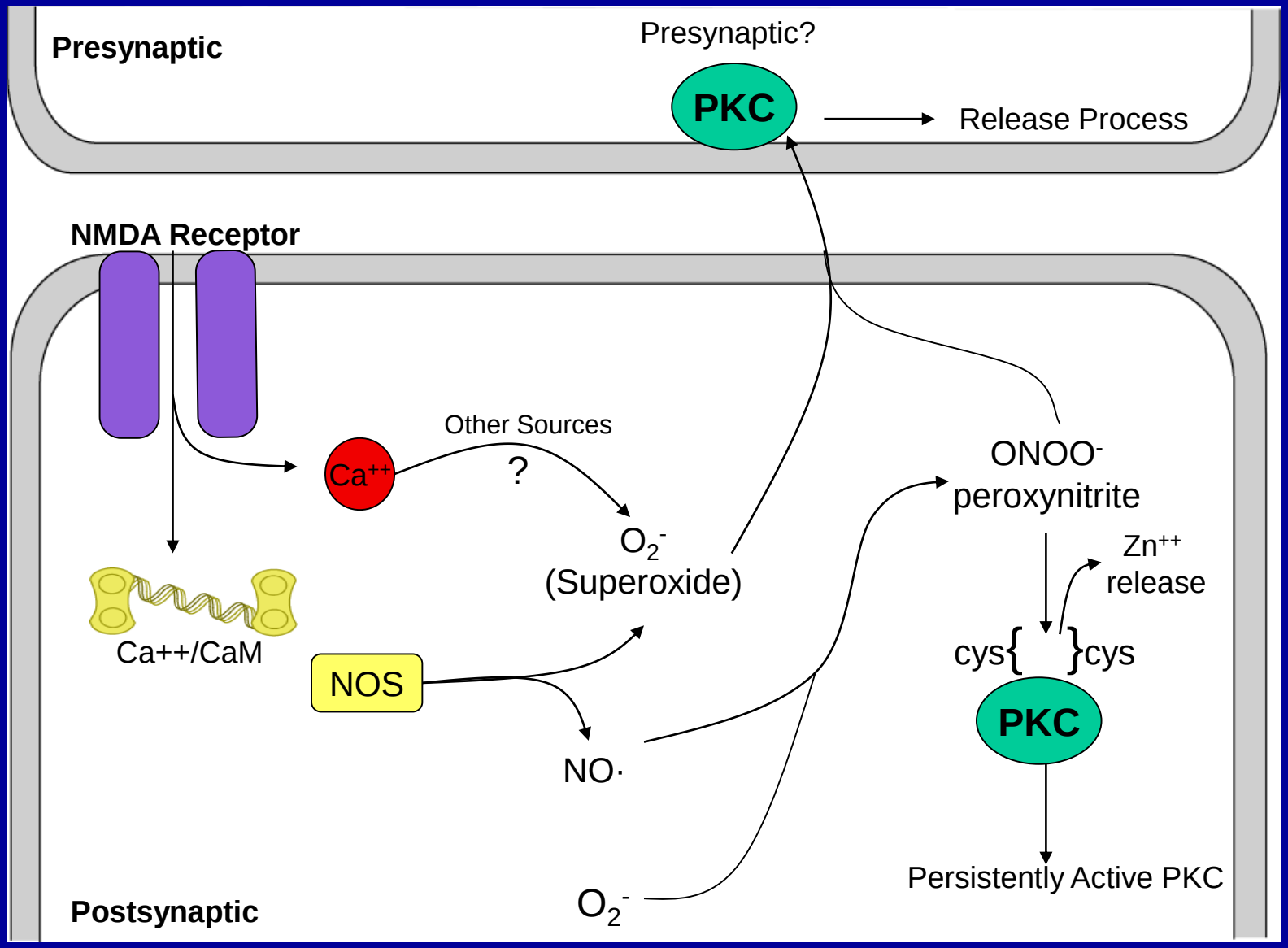


CAMKII as a Temporal Integrator

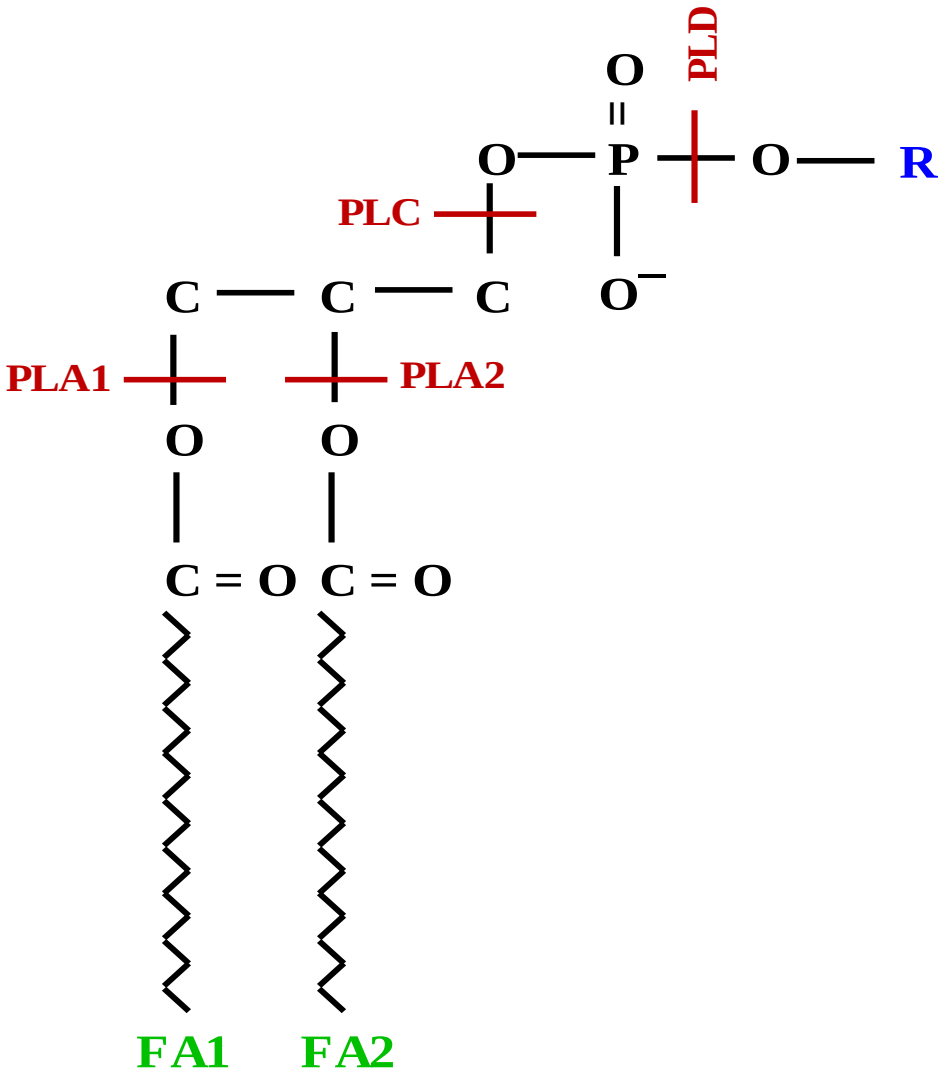


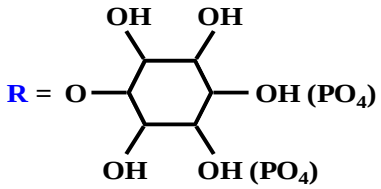
Blue Box 1

Oxidative Activation of PKC in LTP

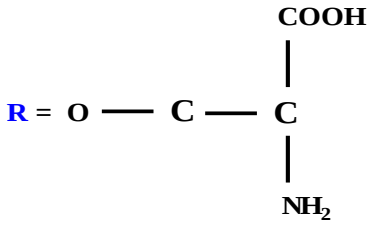


Sites of Cleavage of Phospholipids by Phospholipases

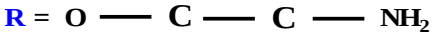




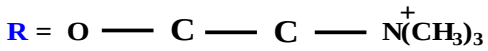
Inositol
(Inositol Phosphates)



Serine



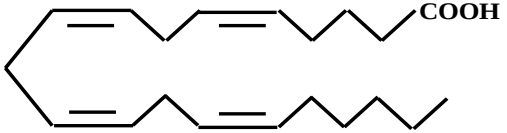
Ethanolamine



Choline

FA_1 = Any of a number of 16-20 carbon fatty acids

FA_2 = Typically Arachidonic Acid in plasma membrane



Arachidonic Acid

Synaptic Tagging and the E-LTP/ L-LTP Transition