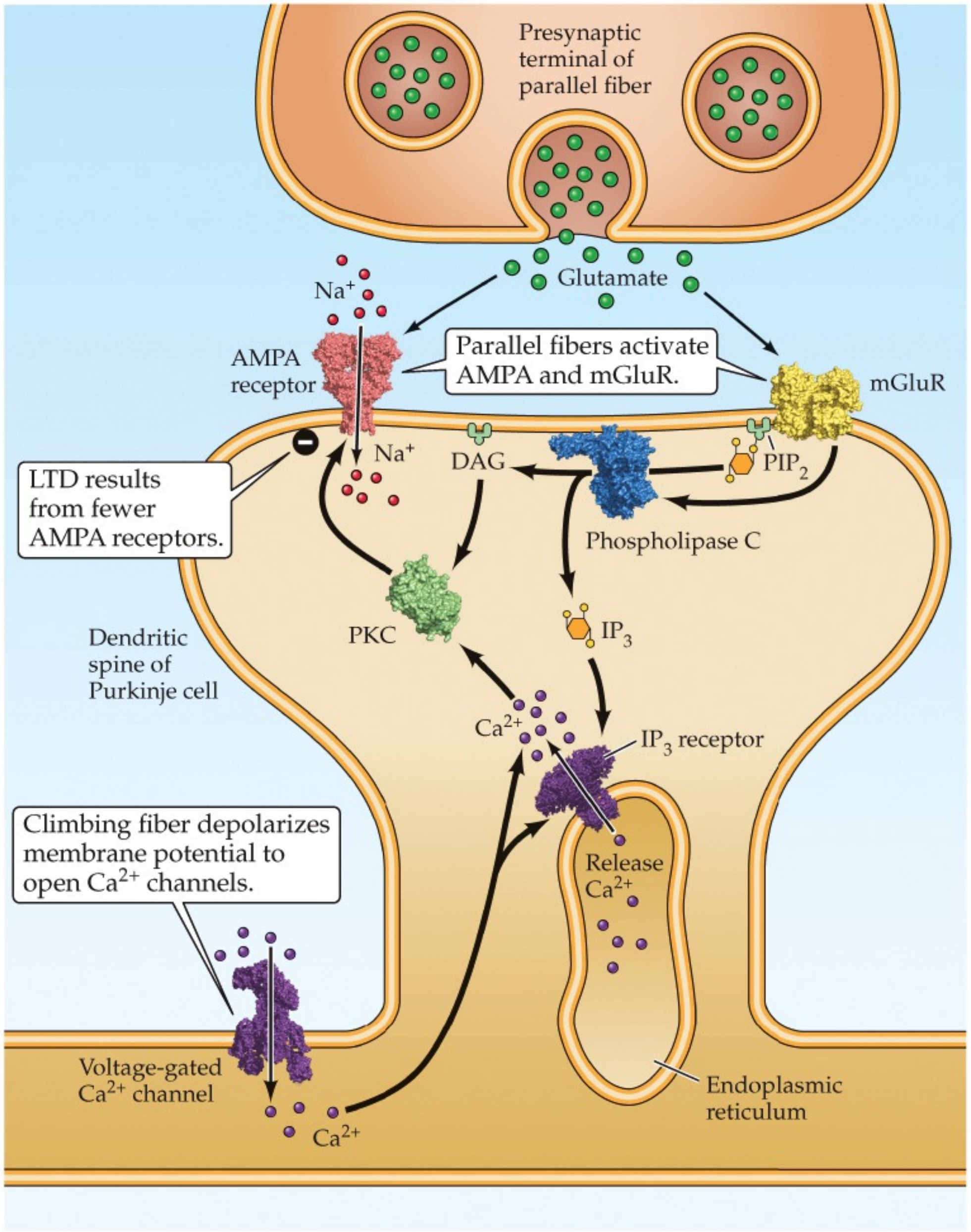
BMD ENG 301Quantitative Systems Physiology (Nervous System)

Lecture 13: Metabotropic receptors continued, + Synaptic Plasticity
2022_v1

Professor Malcolm MacIver

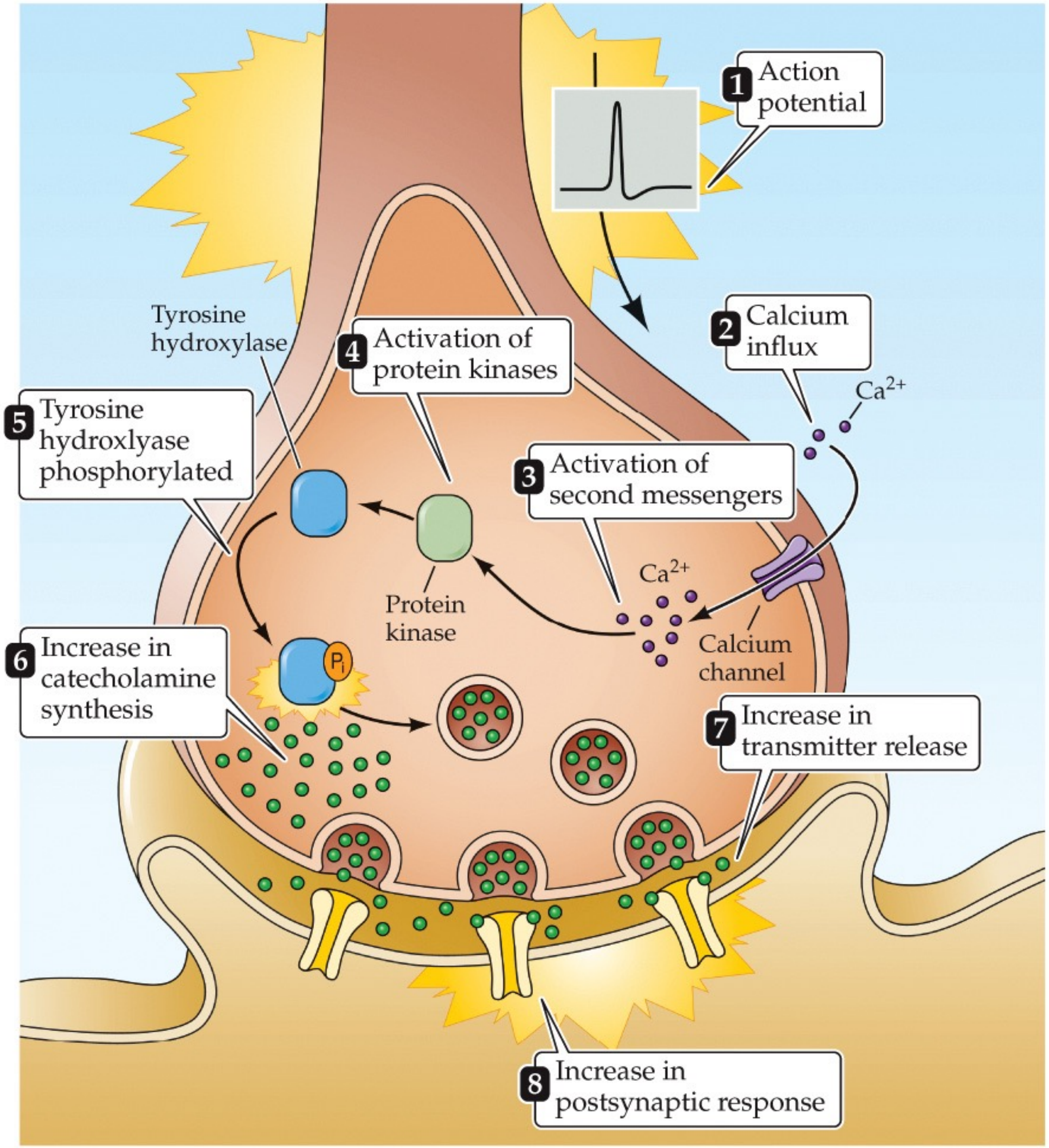
Signaling at cerebellar parallel fiber synapses during long-term synaptic depression



NEUROSCIENCE 6e, Figure 7.14

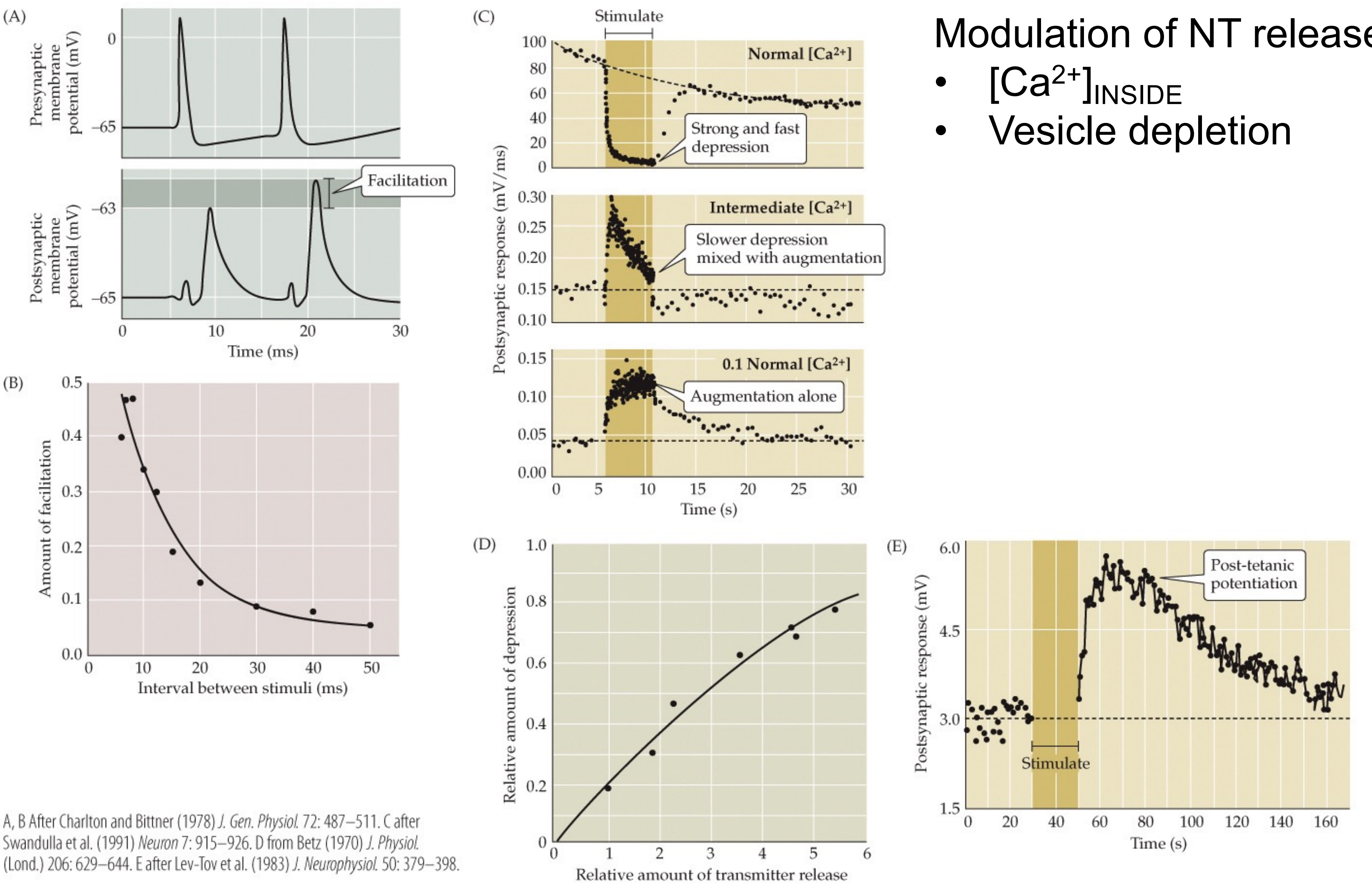
Regulation of tyrosine hydroxylase by protein phosphorylation

Tetanic stimulation resulting in persistent calcium increase and tyrosine hydroxylase increase



NEUROSCIENCE 6e, Figure 7.15

Forms of short-term synaptic plasticity



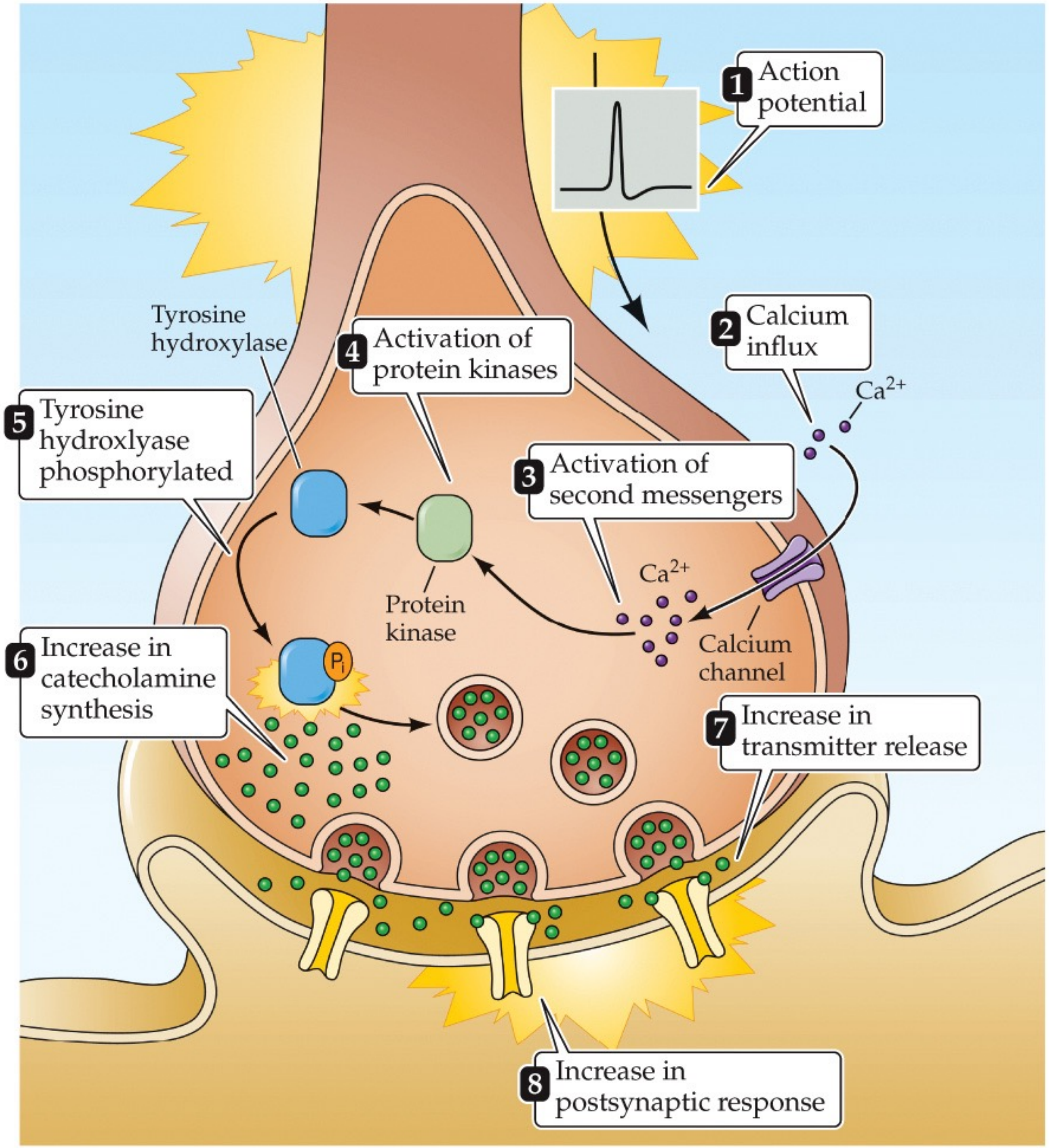
Modulation of NT release

- $[Ca^{2+}]_{INSIDE}$
- Vesicle depletion

A, B After Charlton and Bittner (1978) *J. Gen. Physiol.* 72: 487–511. C after Swandulla et al. (1991) *Neuron* 7: 915–926. D from Betz (1970) *J. Physiol.* (Lond.) 206: 629–644. E after Lev-Tov et al. (1983) *J. Neurophysiol.* 50: 379–398.

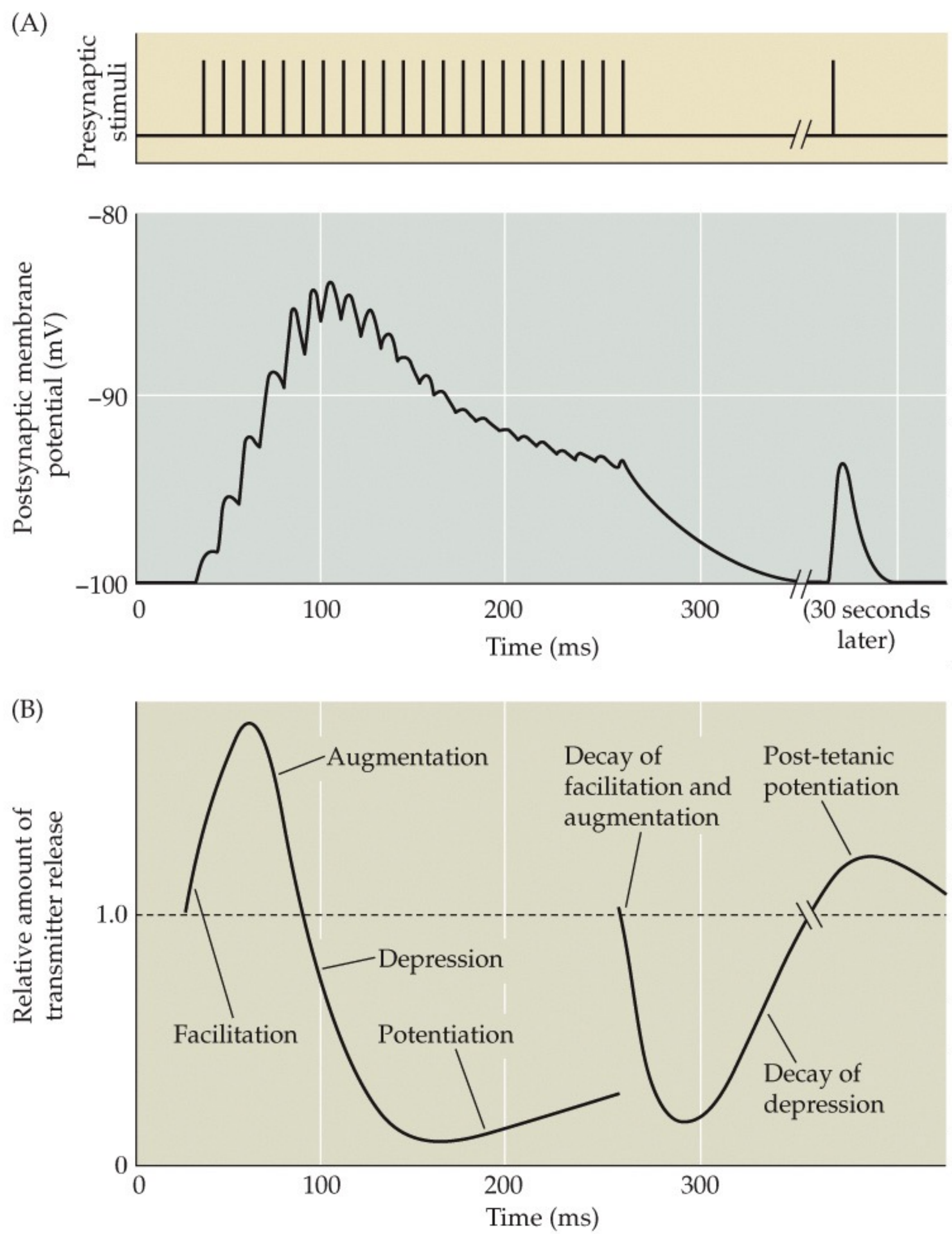
NEUROSCIENCE 6e, Figure 8.1

Regulation of tyrosine hydroxylase by protein phosphorylation



NEUROSCIENCE 6e, Figure 7.15

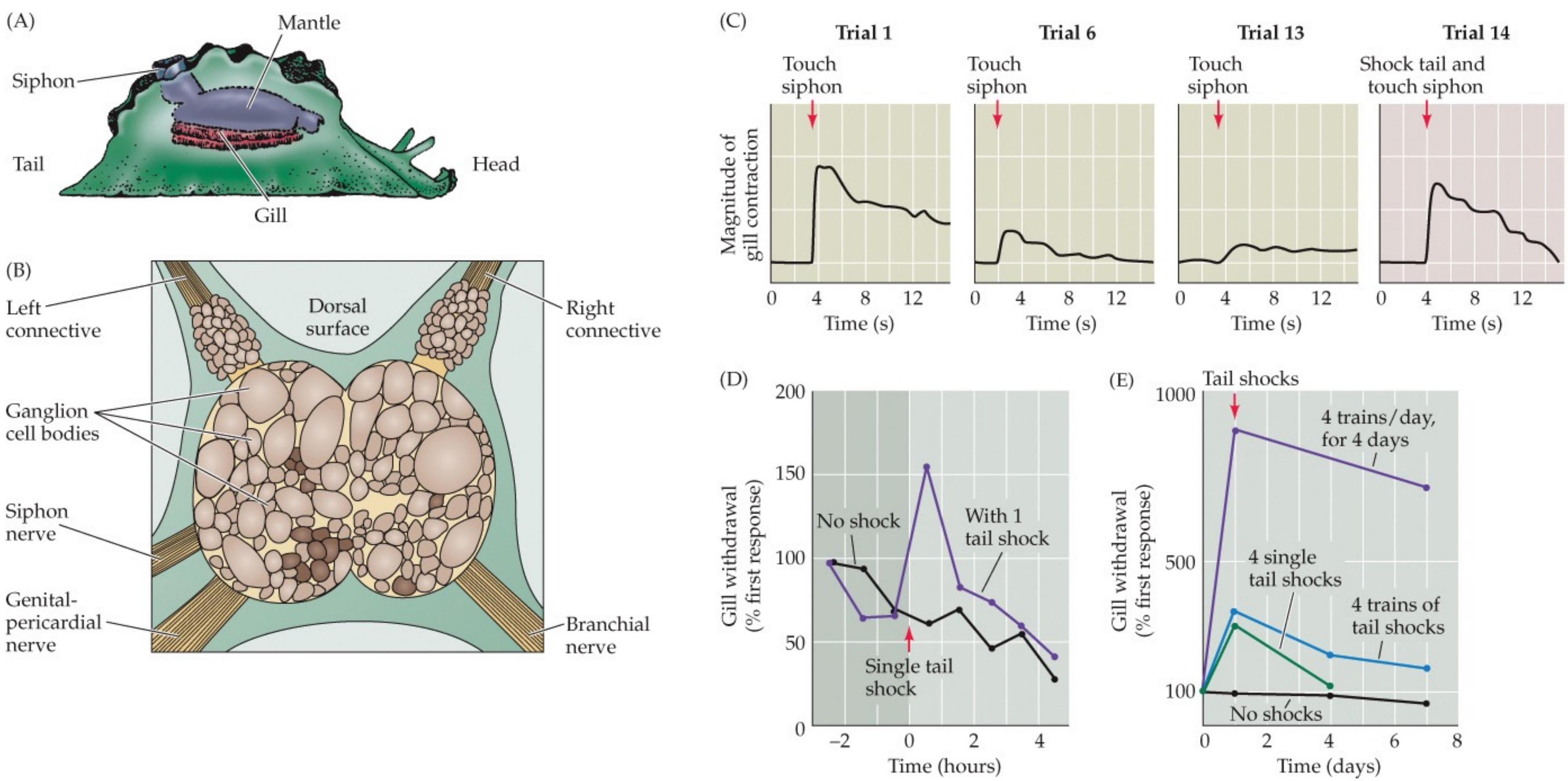
Short-term plasticity at the neuromuscular synapse



A after Katz (1966) *Nerve, Muscle, and Synapse*. New York: McGraw-Hill. B from Malenka and Siegelbaum (2001) Baltimore: Johns Hopkins University Press, 393–413.

NEUROSCIENCE 6e, **Figure 8.2**

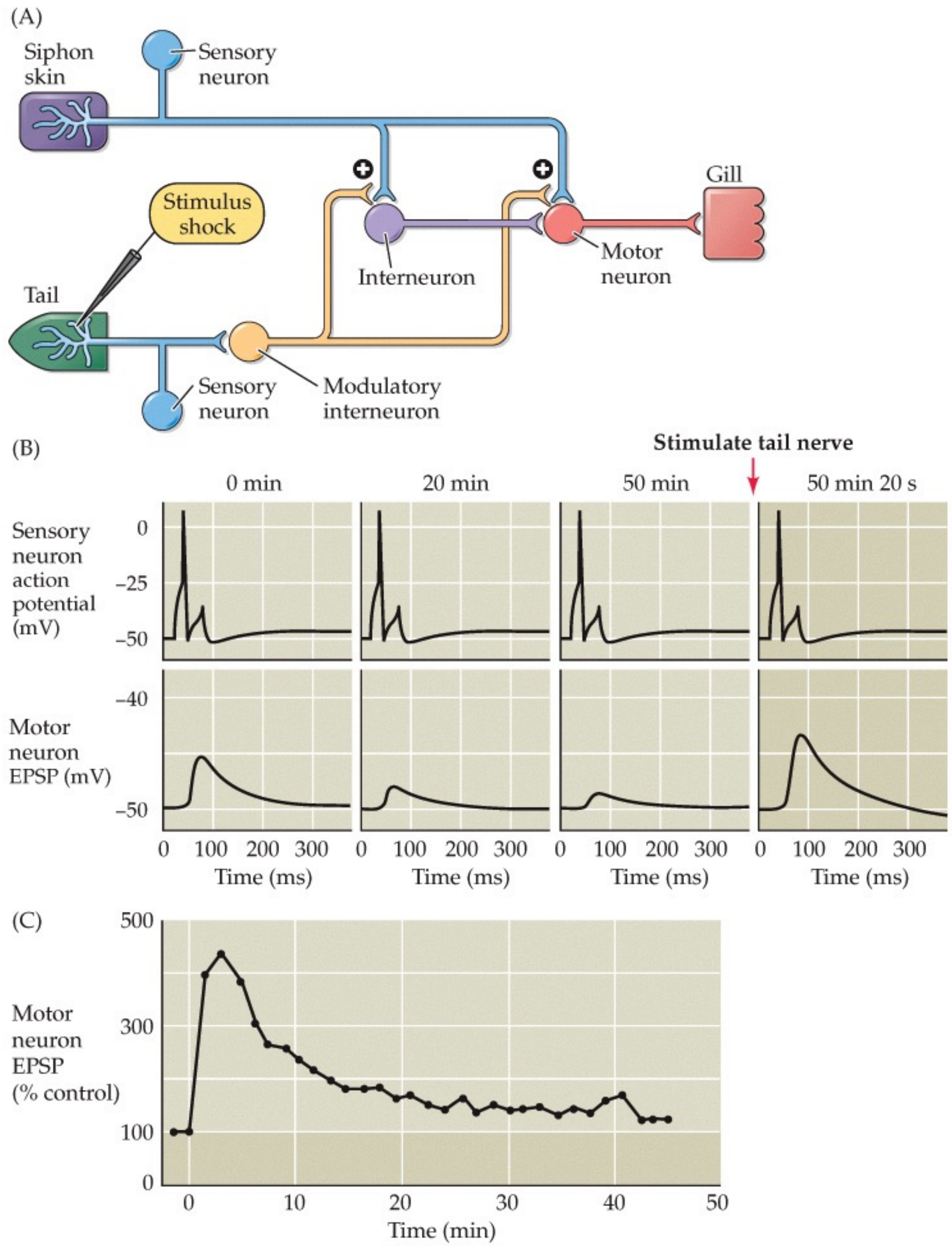
Short-term sensitization of the *Aplysia* gill withdrawal reflex



A after Squire and Kandel (1999) New York: Scientific American Library, 40. B, C after Squire and Kandel (1999) New York: Scientific American Library, 41. D, E after Squire and Kandel (1999) New York: Scientific American Library, 145.

NEUROSCIENCE 6e, Figure 8.3

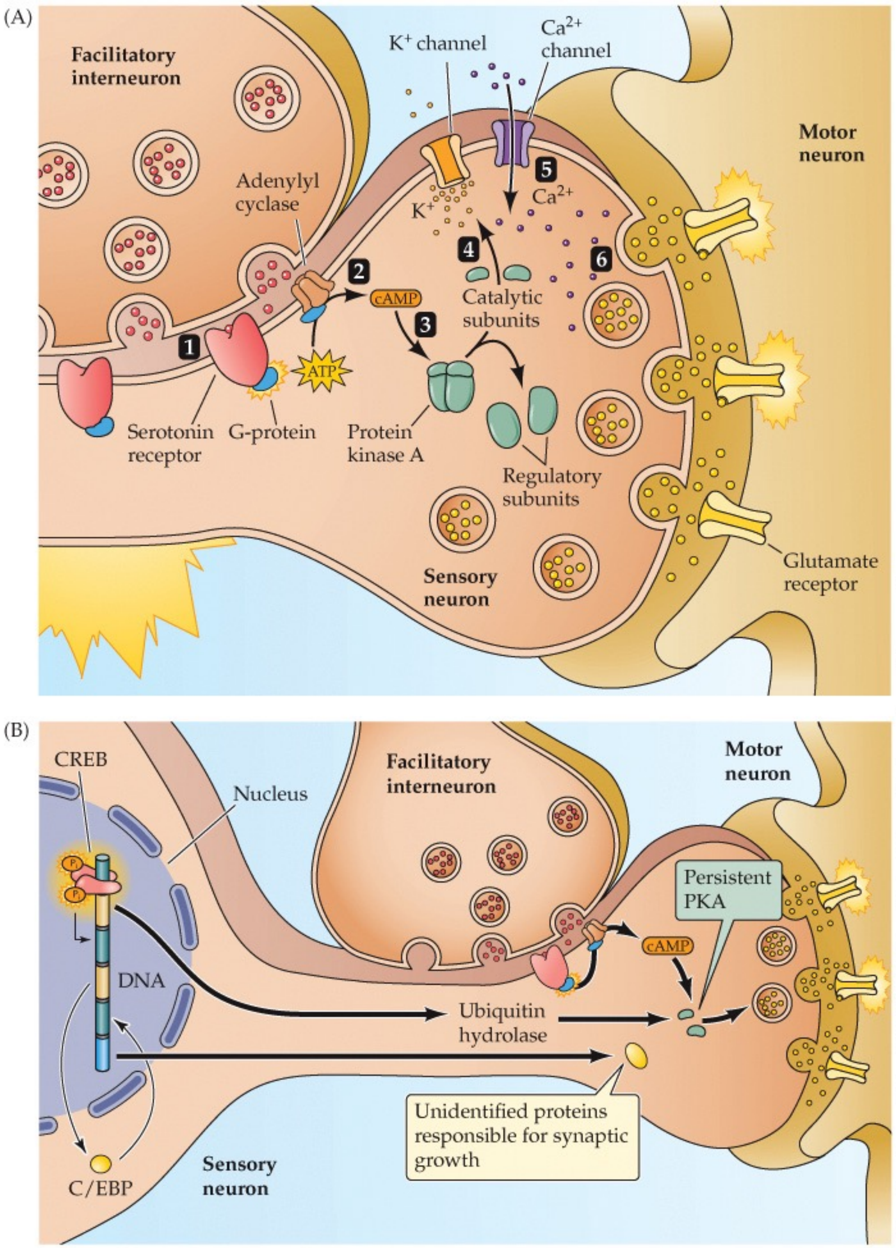
Synaptic mechanisms underlying short-term sensitization



A, B after Squire and Kandel (1999) New York: Scientific American Library, 54. C after Squire and Kandel (1999) New York: Scientific American Library, 57.

NEUROSCIENCE 6e, Figure 8.4

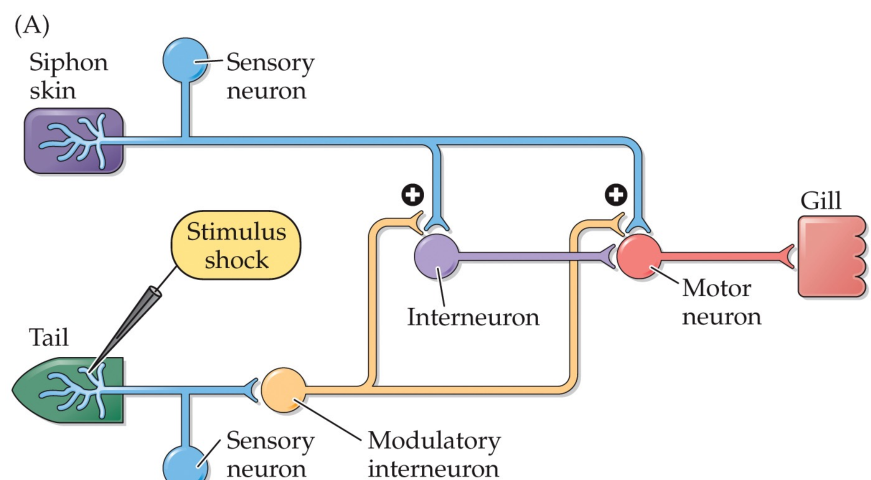
Mechanisms of presynaptic enhancement underlying behavioral sensitization



After Squire and Kandel (1999) New York: Scientific American Library, 60.

NEUROSCIENCE 6e, Figure 8.5

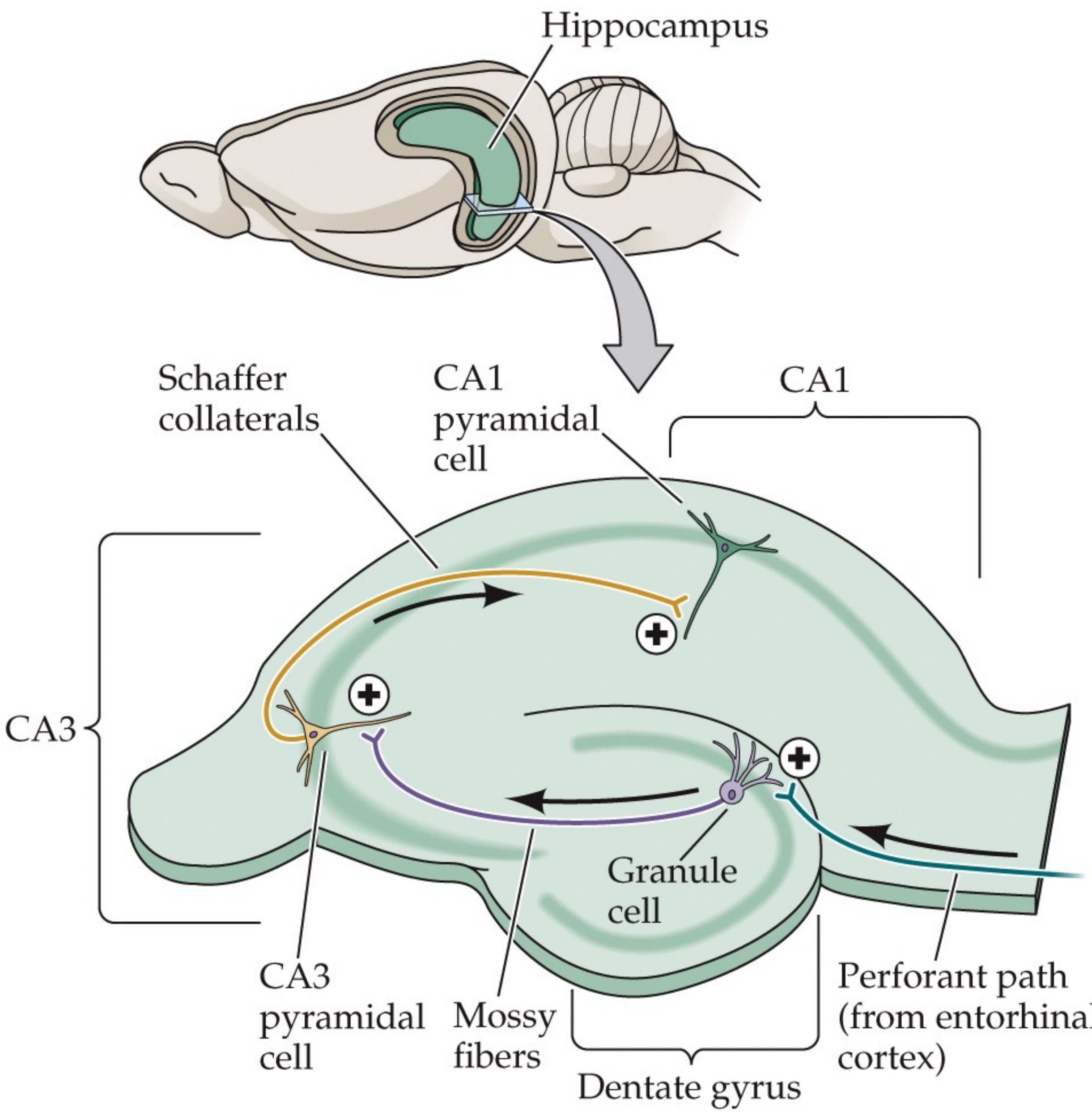
Short and long term effects



After Squire and Kandel (1999) New York: Scientific American Library, 54.

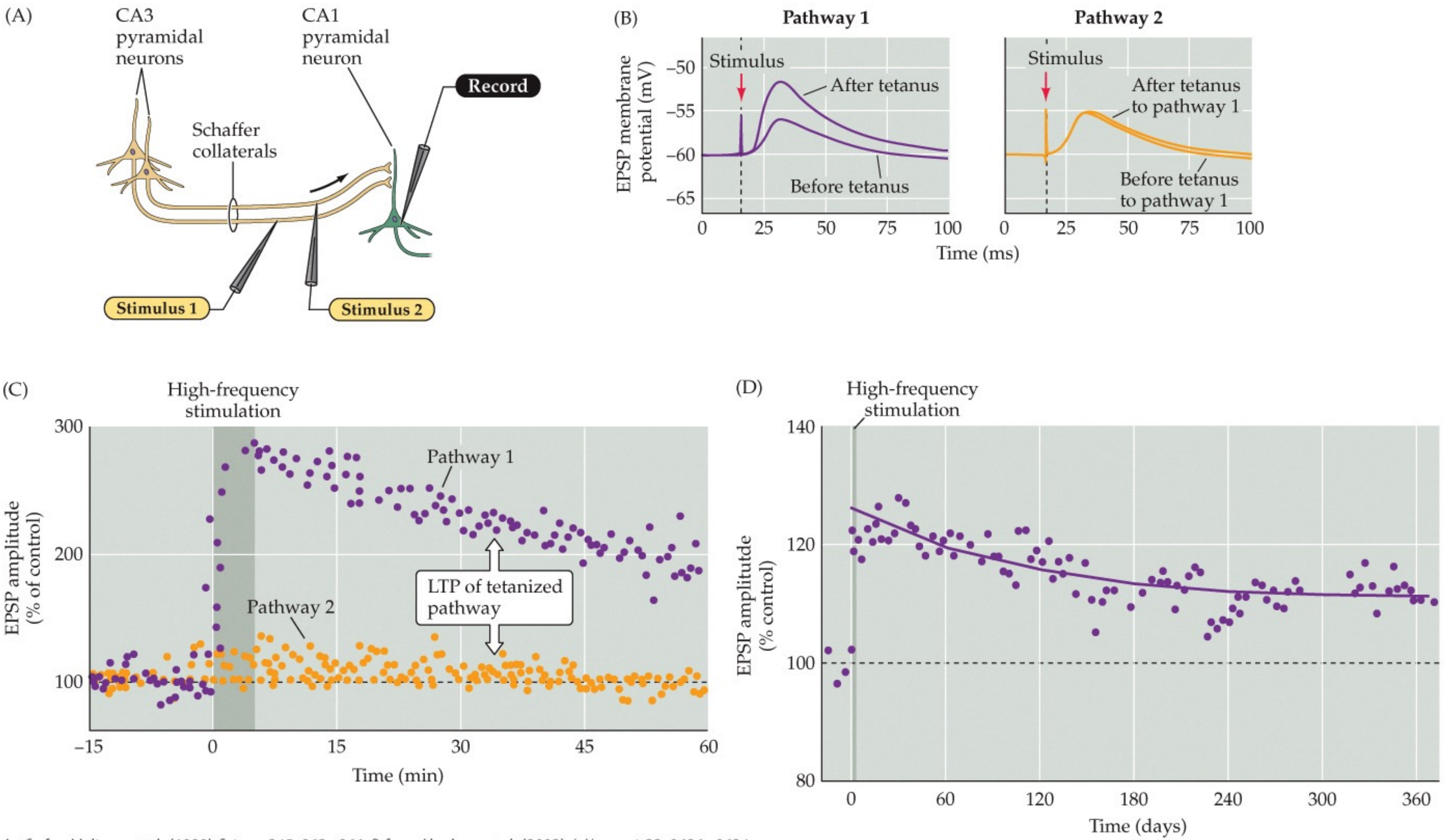
NEUROSCIENCE 6e, Figure 8.4 (Part 1)

The trisynaptic circuit of the hippocampus



NEUROSCIENCE 6e, Figure 8.6

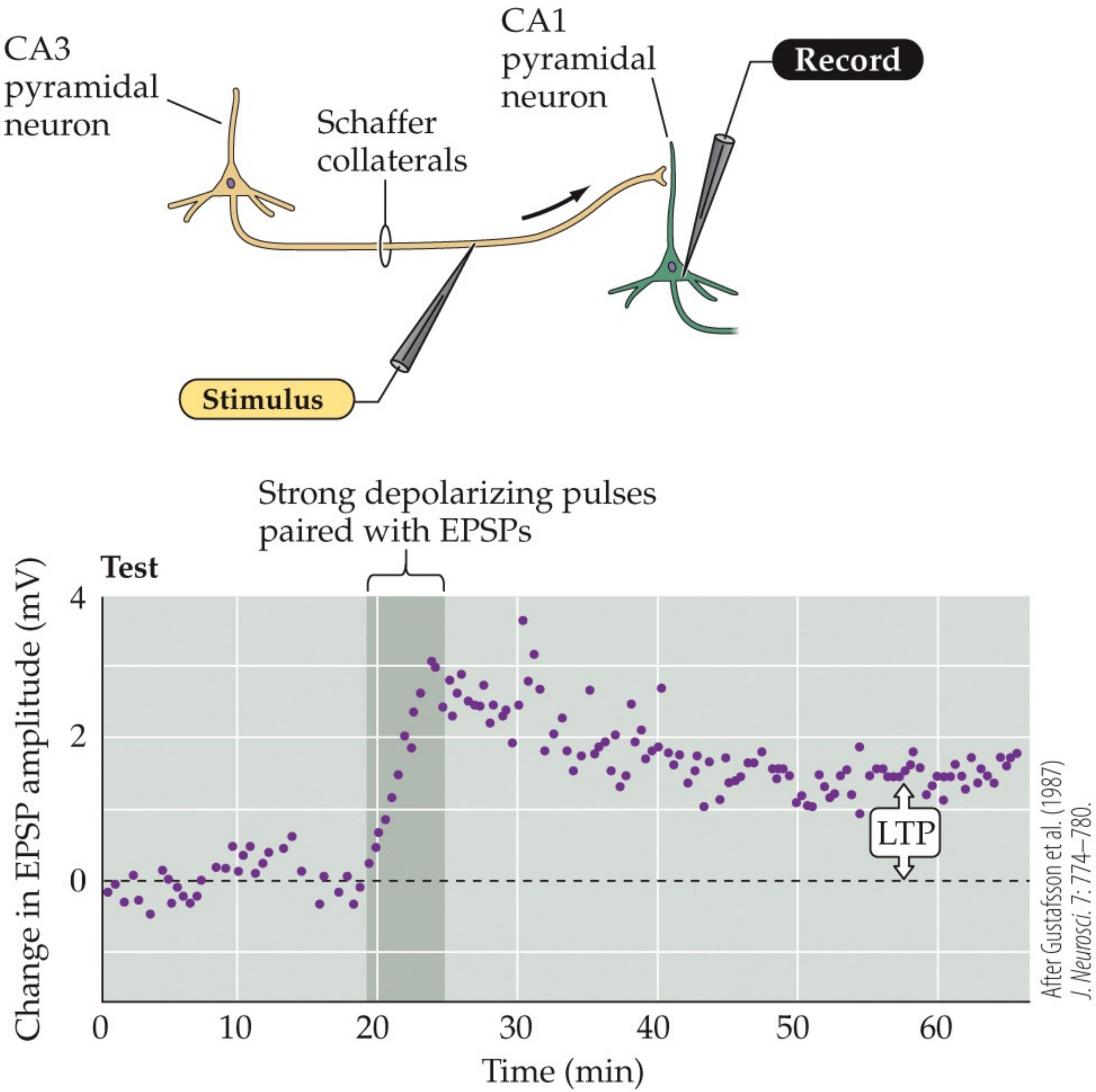
LTP of Schaffer collateral–CA1 synapses



A–C after Malinow et al. (1989) *Science* 245: 862–866. D from Abraham et al. (2002) *J. Neurosci.* 22: 9626–9634.

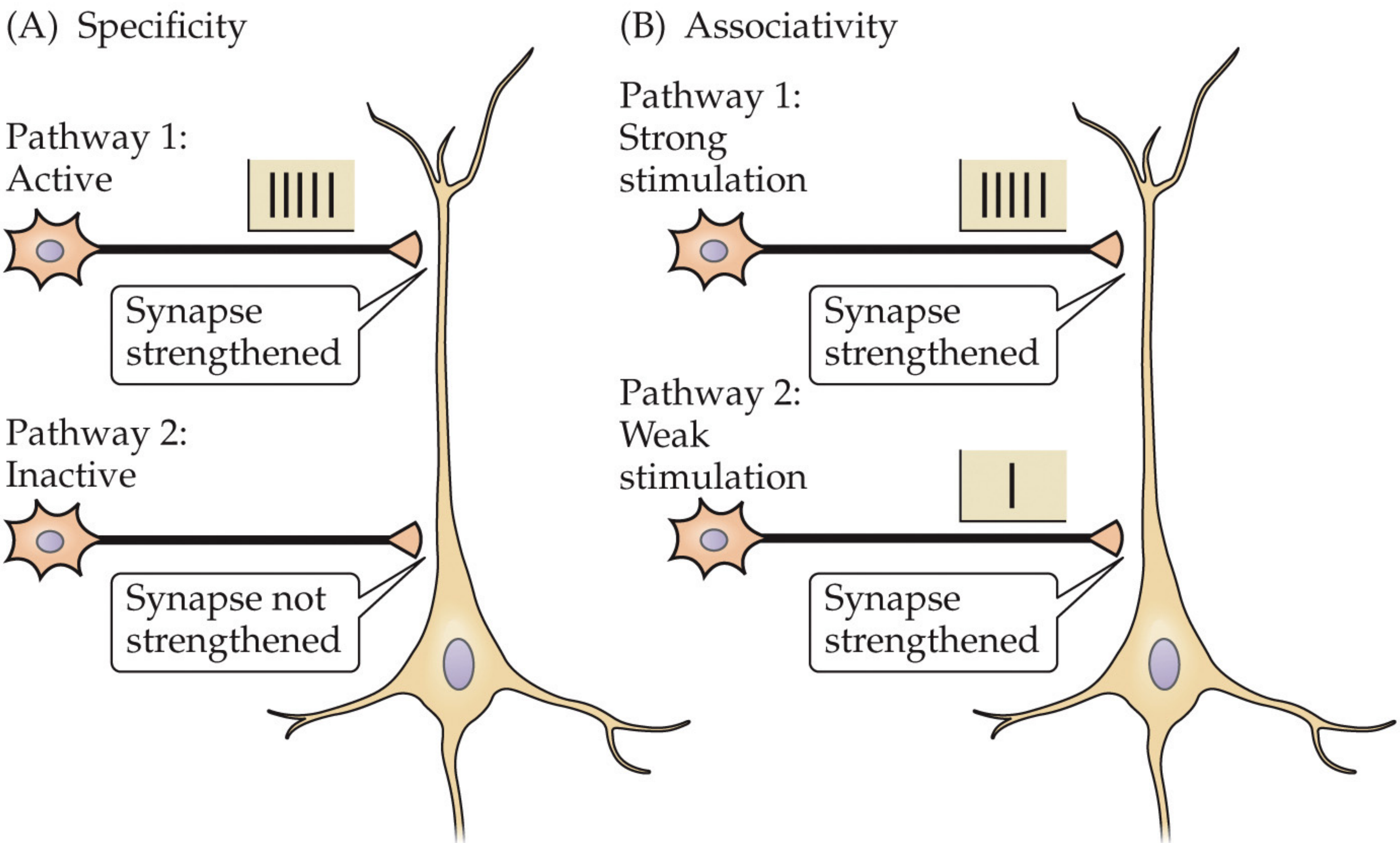
***NEUROSCIENCE 6e*, Figure 8.7**

Pairing presynaptic and postsynaptic activity causes LTP



NEUROSCIENCE 6e, Figure 8.8

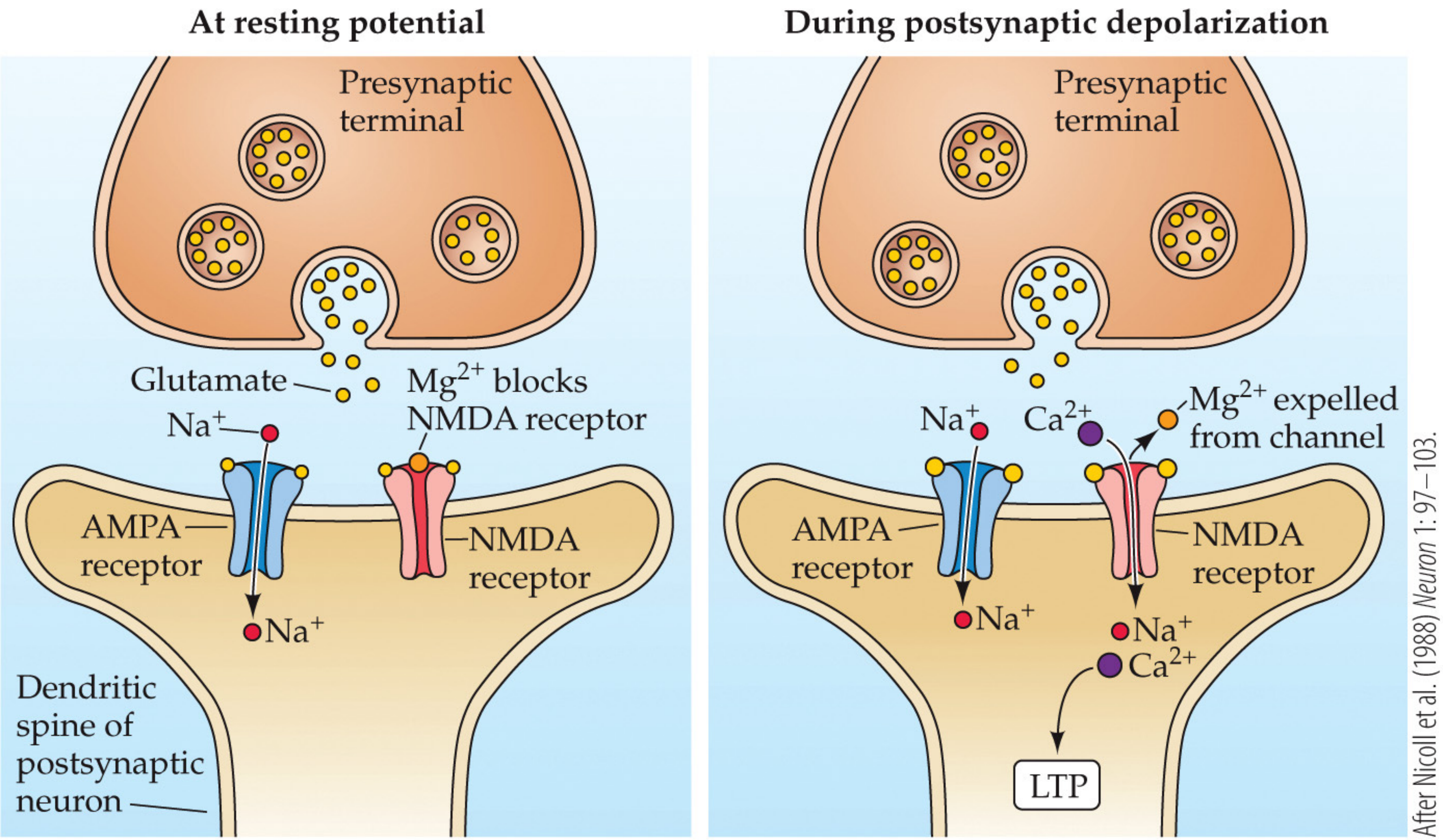
Properties of LTP at a CA1 pyramidal neuron receiving synaptic inputs from two independent sets of Schaffer collateral axons



NEUROSCIENCE 6e, Figure 8.9

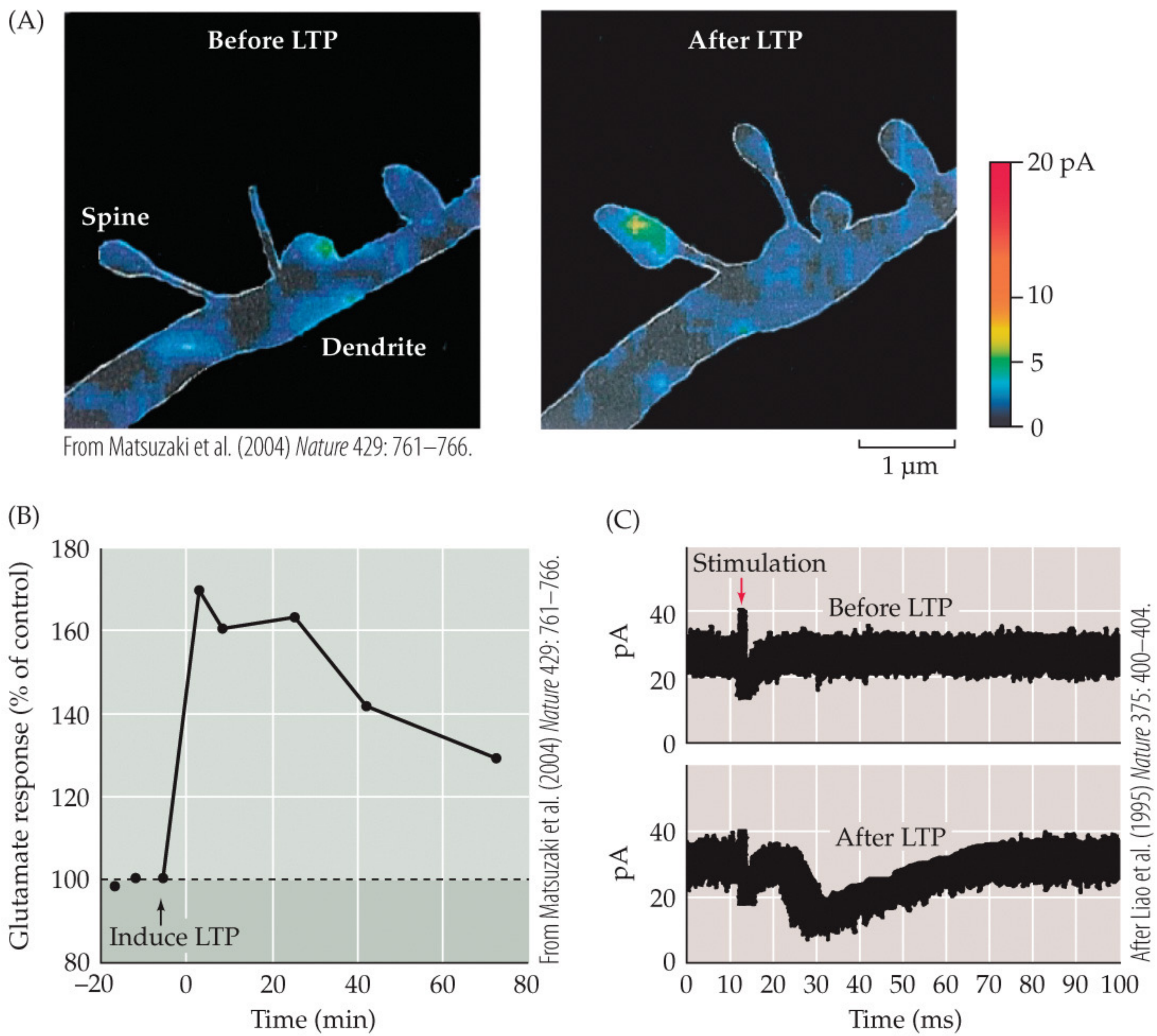
Neurons that fire together wire together

The NMDA receptor channel can open only during depolarization of the postsynaptic neuron from its normal resting potential



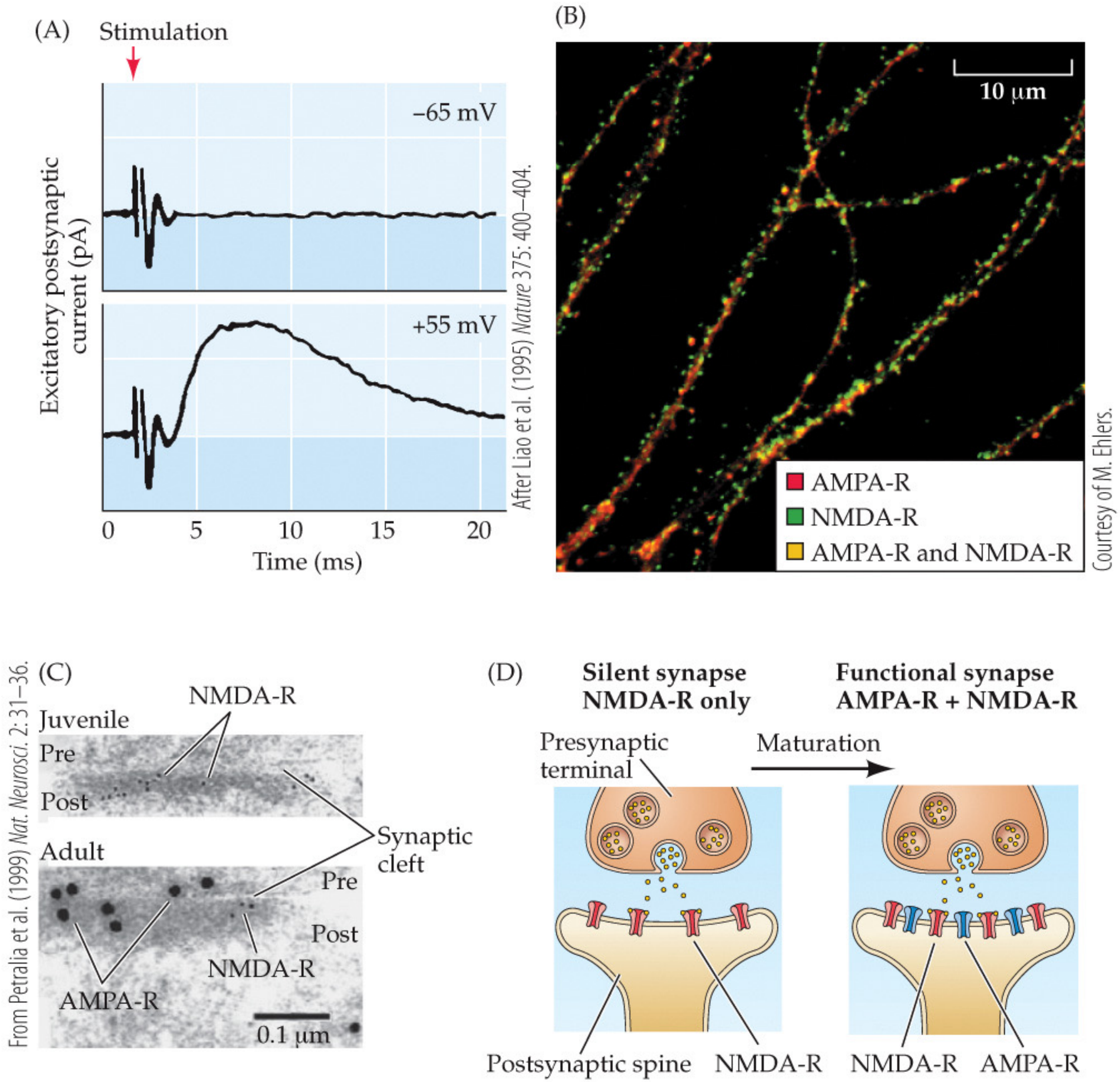
NEUROSCIENCE 6e, Figure 8.10

Addition of postsynaptic AMPA receptors during LTP



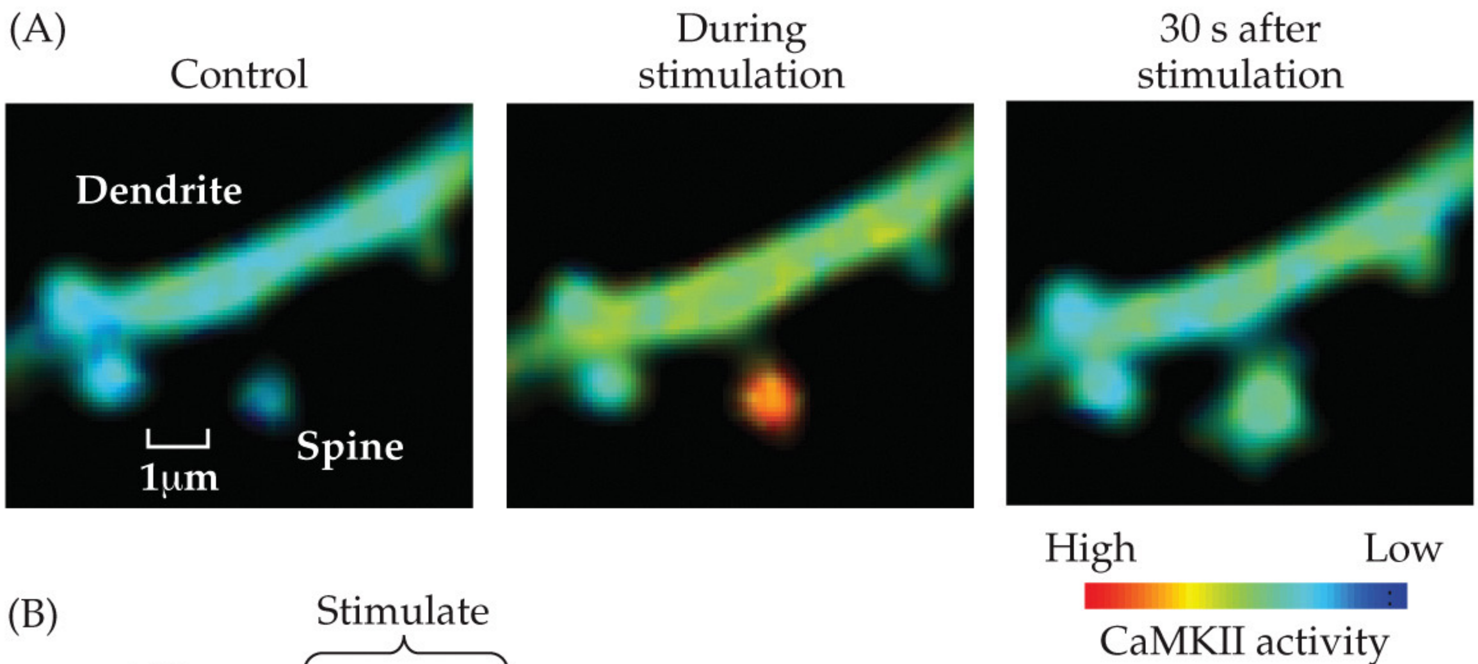
NEUROSCIENCE 6e, **Figure 8.11**

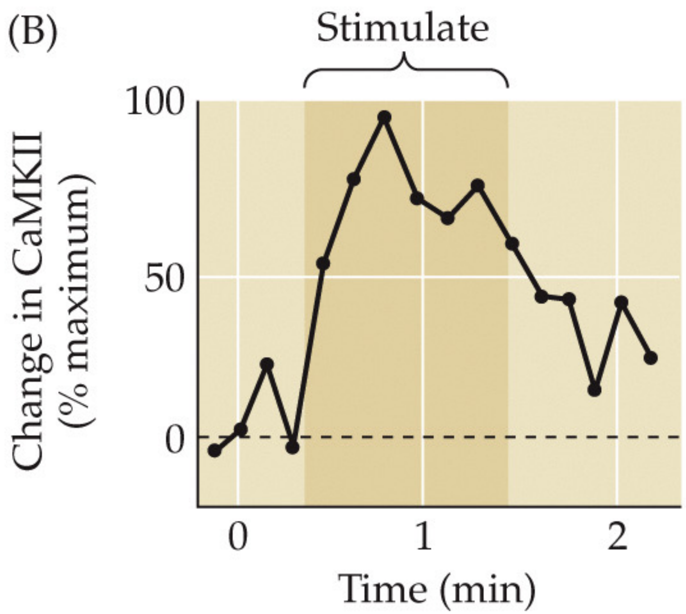
Silent Synapses



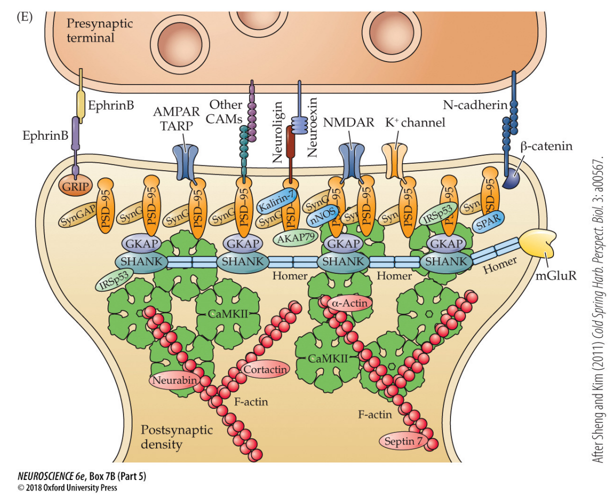
NEUROSCIENCE 6e, Box 8B

FIGURE 8.12 CaMKII activity in the dendrite of a CA1 pyramidal neuron during LTP



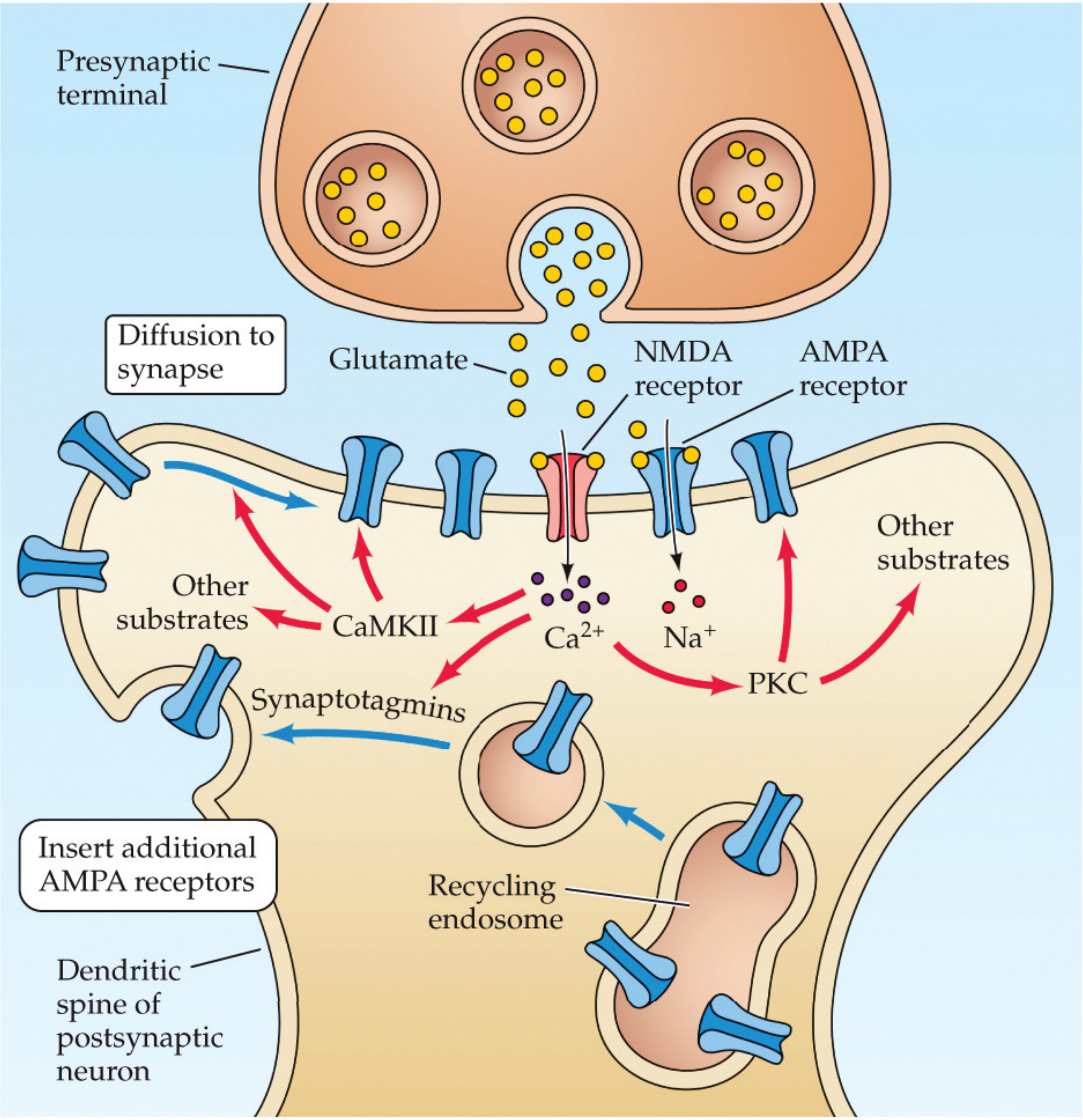


From Lee et al. (2009) *Nature* 458: 299–304.



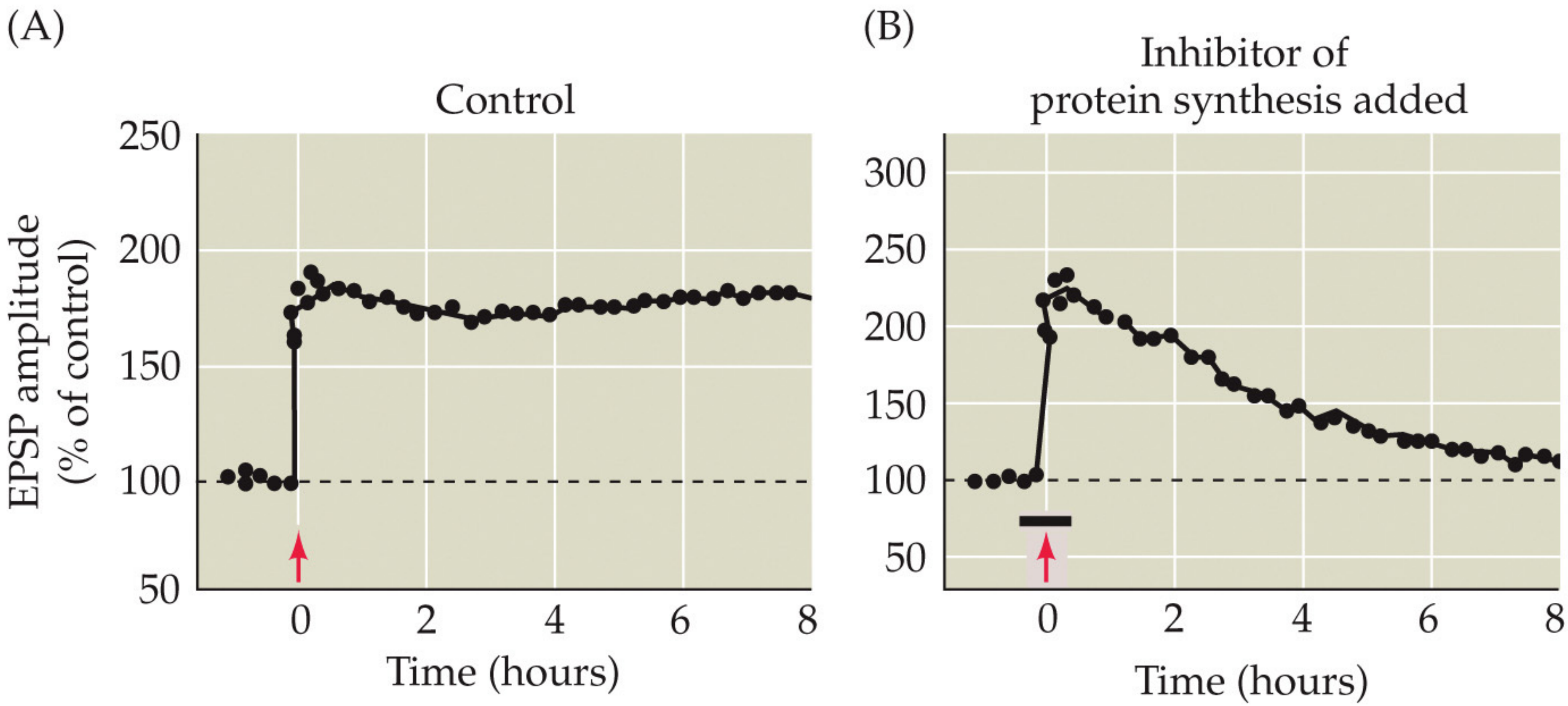
NEUROSCIENCE 6e, **Figure 8.12**

Signaling mechanisms underlying LTP



NEUROSCIENCE 6e, Figure 8.13

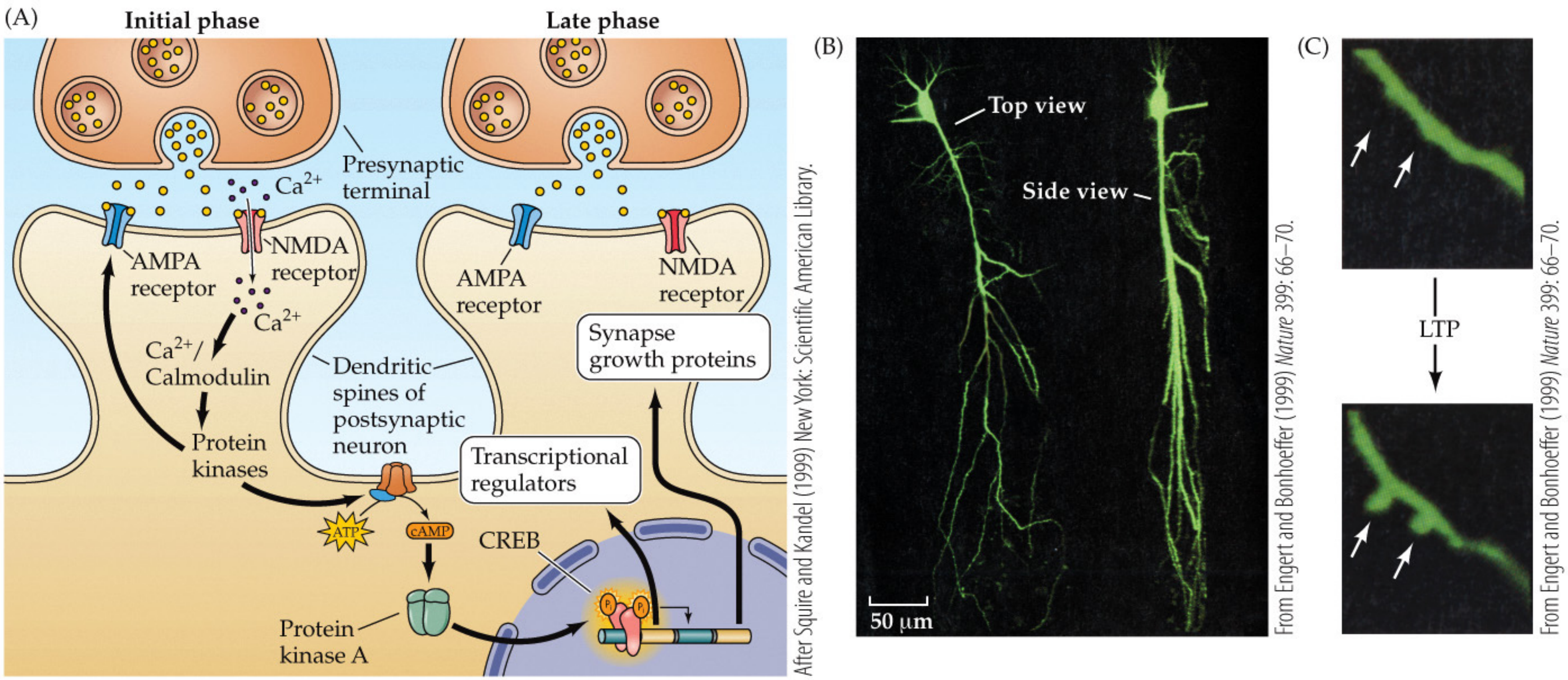
Role of protein synthesis in maintaining LTP



After Frey and Morris (1997) *Nature* 385: 533–536.

***NEUROSCIENCE 6e*, Figure 8.14**

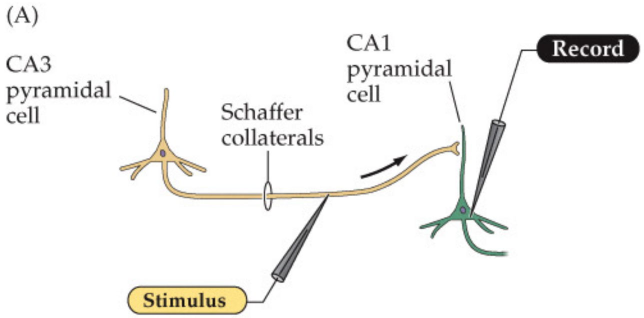
Mechanisms responsible for long-lasting changes in synaptic transmission during LTP

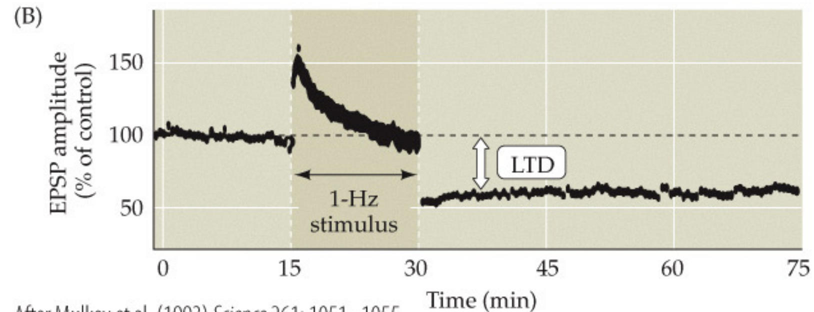


NEUROSCIENCE 6e, Figure 8.15

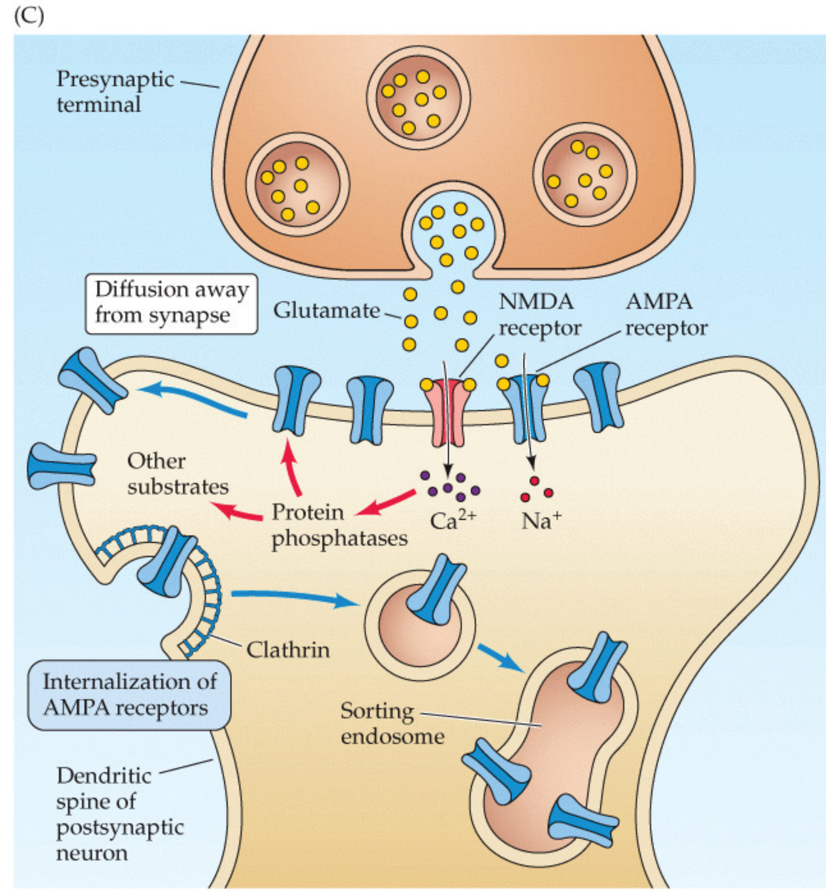
Growth of new dendritic spines

Long-term synaptic depression in the hippocampus





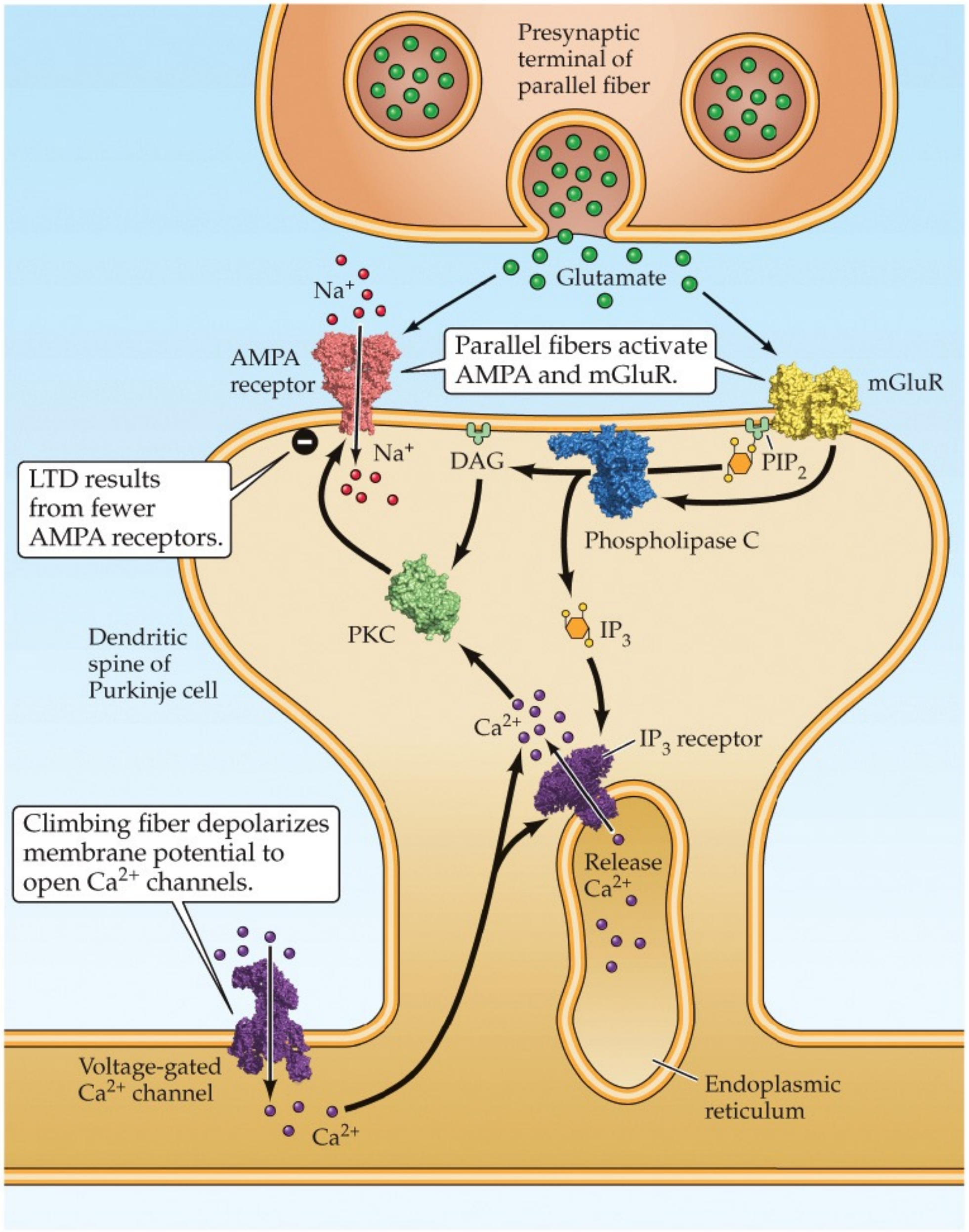
After Mulkey et al. (1993) *Science* 261: 1051–1055.



Eradication of memories

NEUROSCIENCE 6e, Figure 8.16

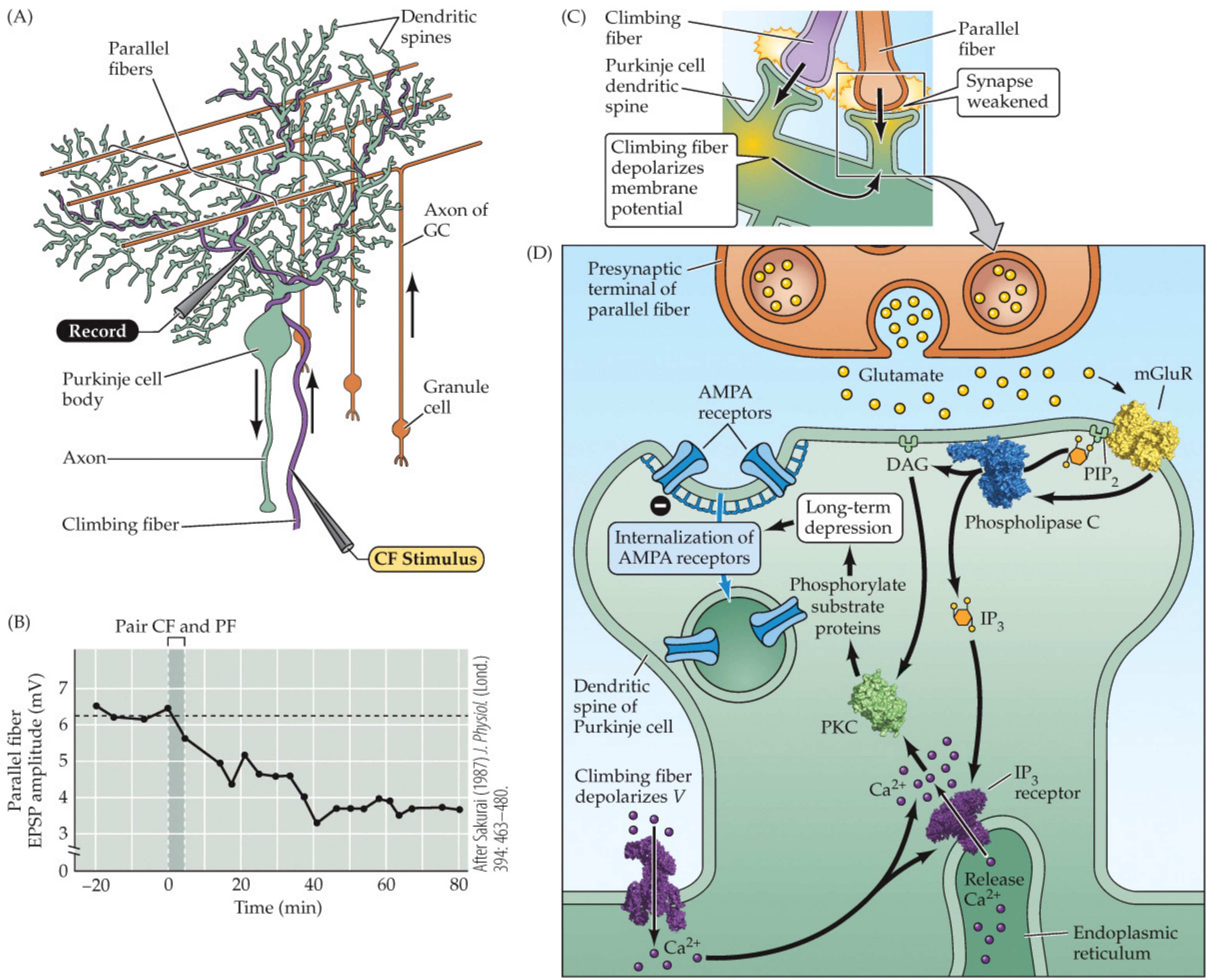
Signaling at cerebellar parallel fiber synapses during long-term synaptic depression



NEUROSCIENCE 6e, Figure 7.14

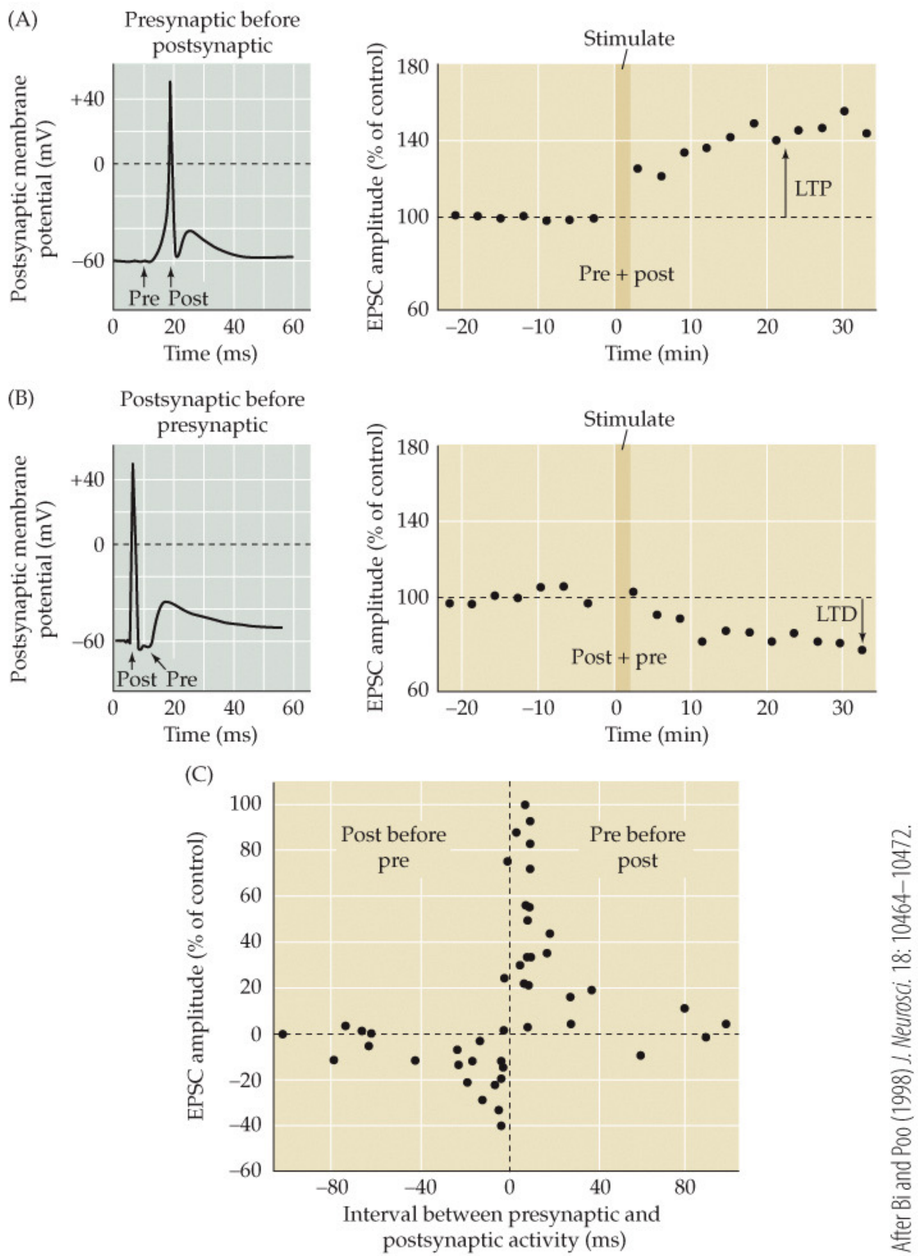
Cerebellar Purkinje cell is different

Long-term synaptic depression in the cerebellum



NEUROSCIENCE 6e, Figure 8.17

FIGURE 8.18 Spike timing-dependent synaptic plasticity in cultured hippocampal neurons



Coincidence leads to LTP
Separation gives LTD

NEUROSCIENCE 6e, Figure 8.18