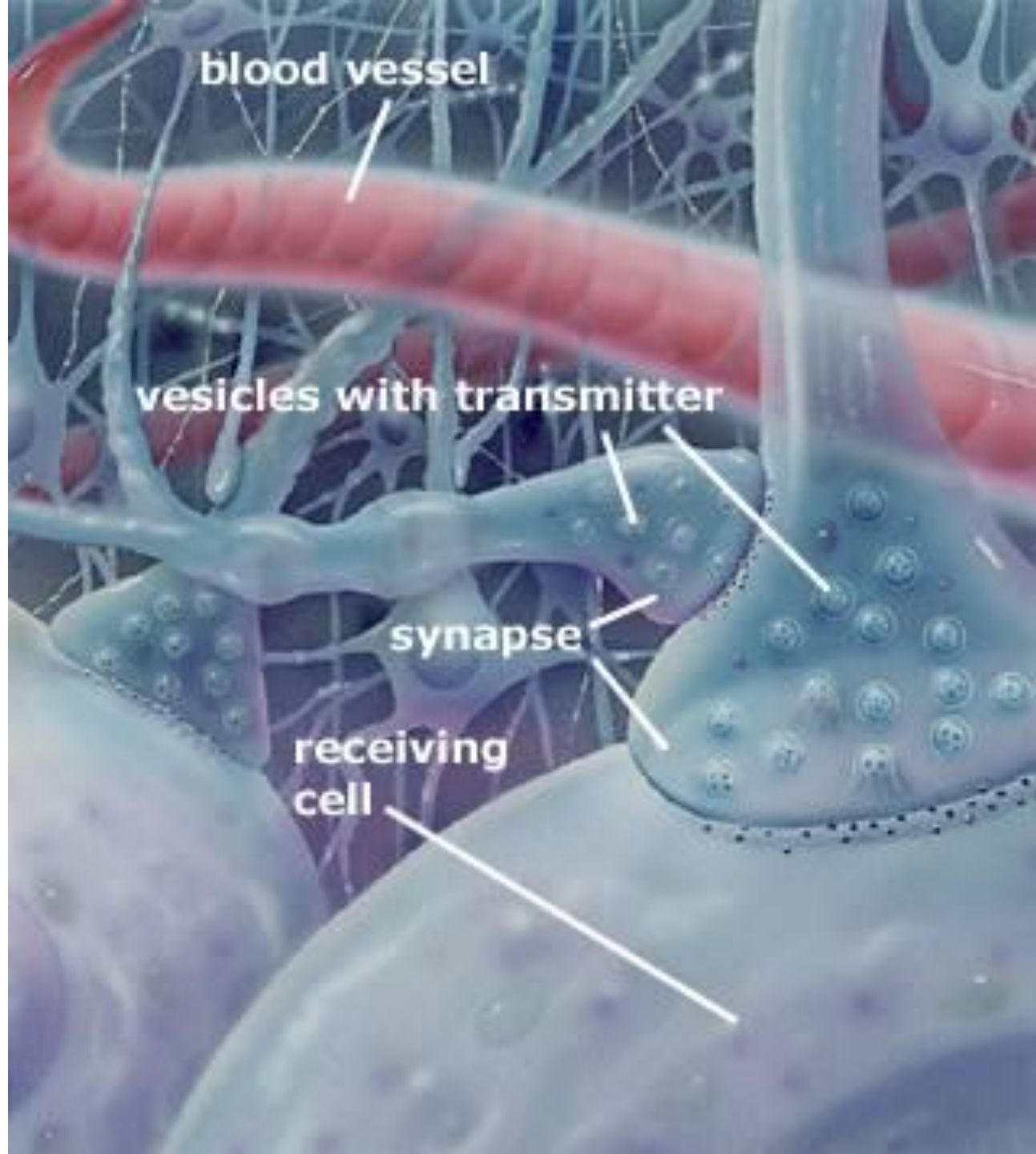


CSB 332

Neurobiology of the Synapse

Melanie A. Woodin
January 2012

Lecture 12
Synaptic Plasticity
Chpt 16

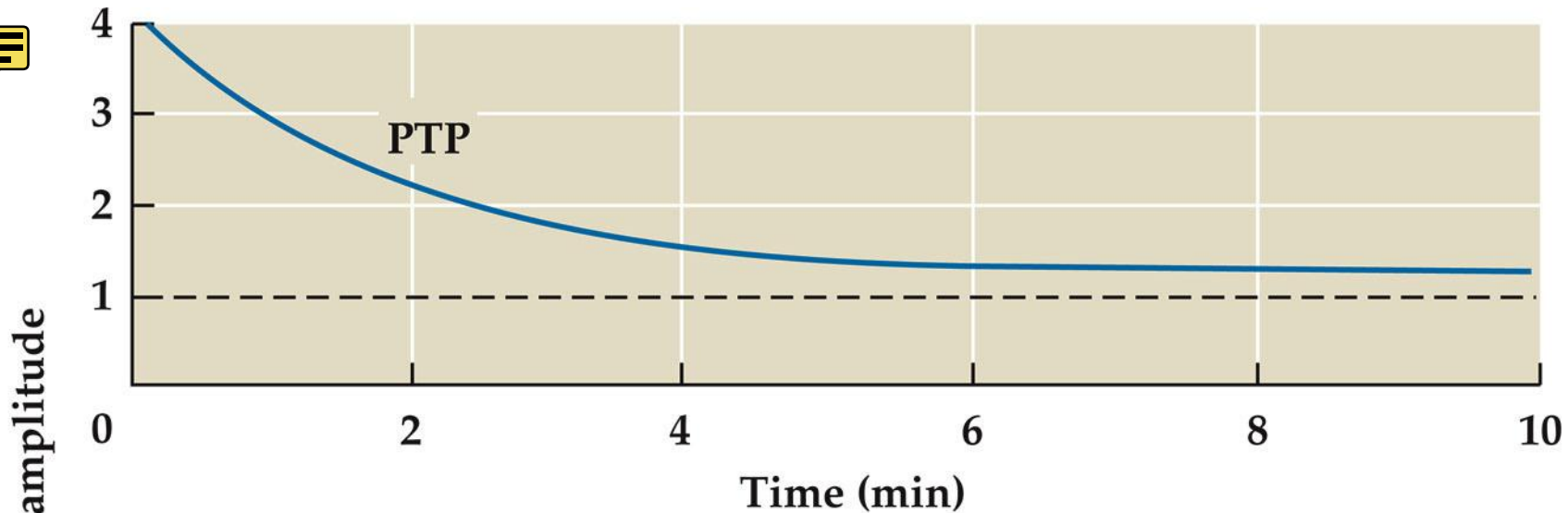


Look at HM's brain!

- <http://thebrainobservatory.ucsd.edu/hmblog/>

Figure 16.3 Time Courses of Activity-Induced Changes (Part 2)

(C) 



(D)

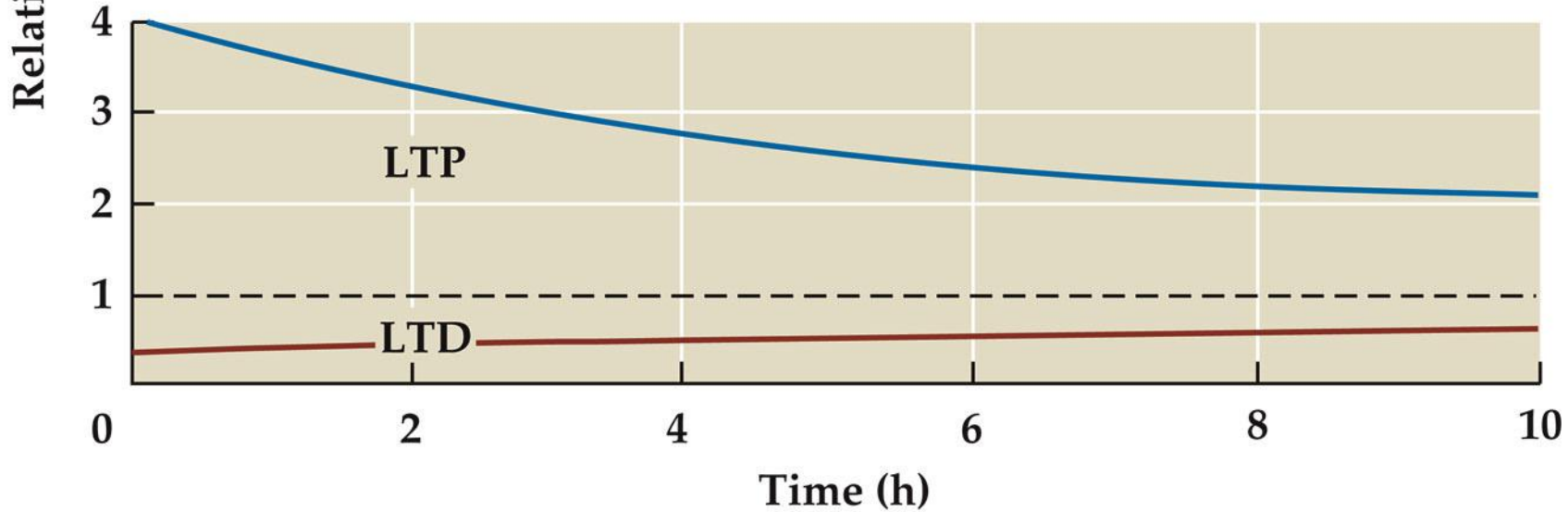


Figure 16.4 The Hippocampal Formation

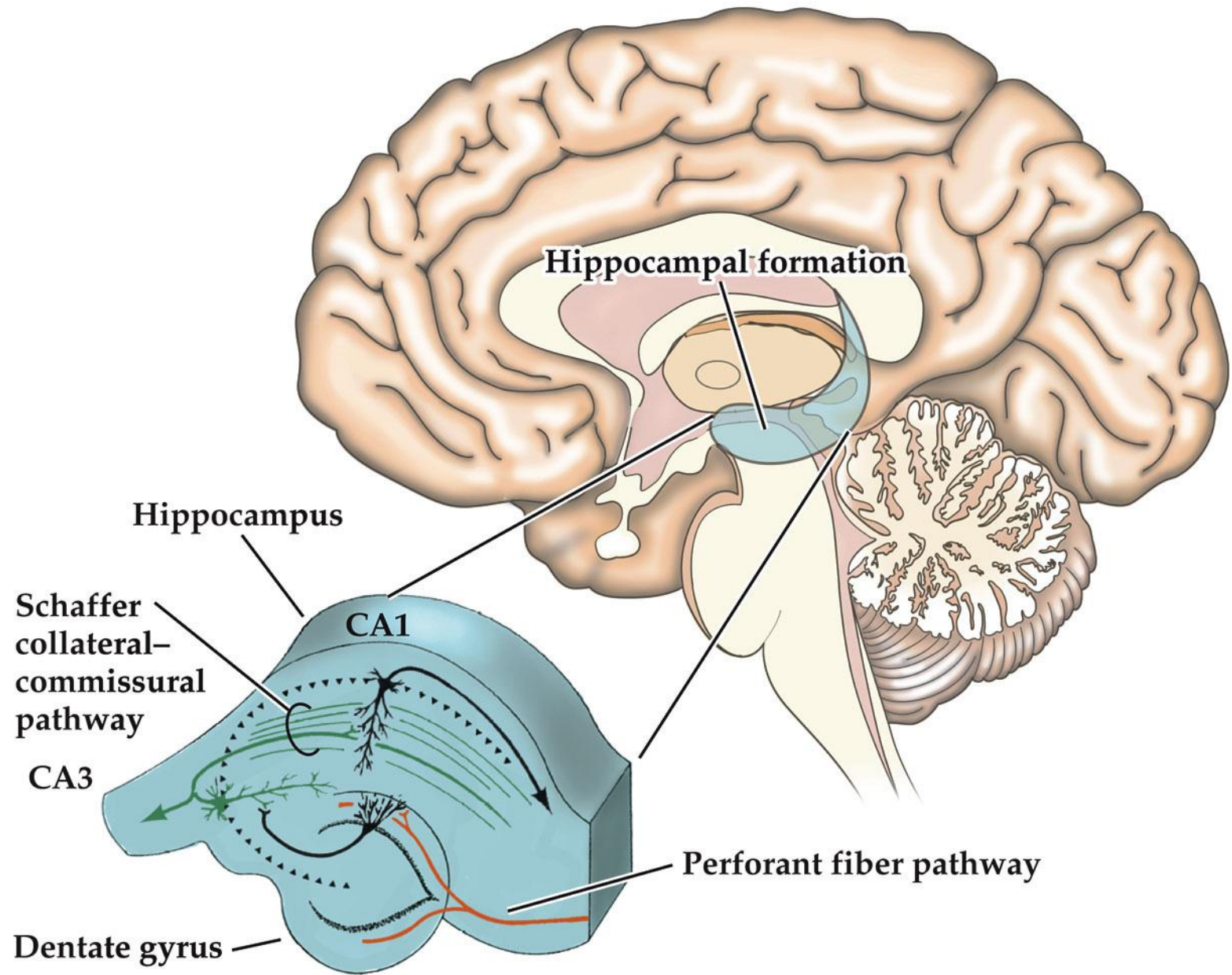


Figure 16.5 Long-Term Potentiation (LTP) (Part 1)

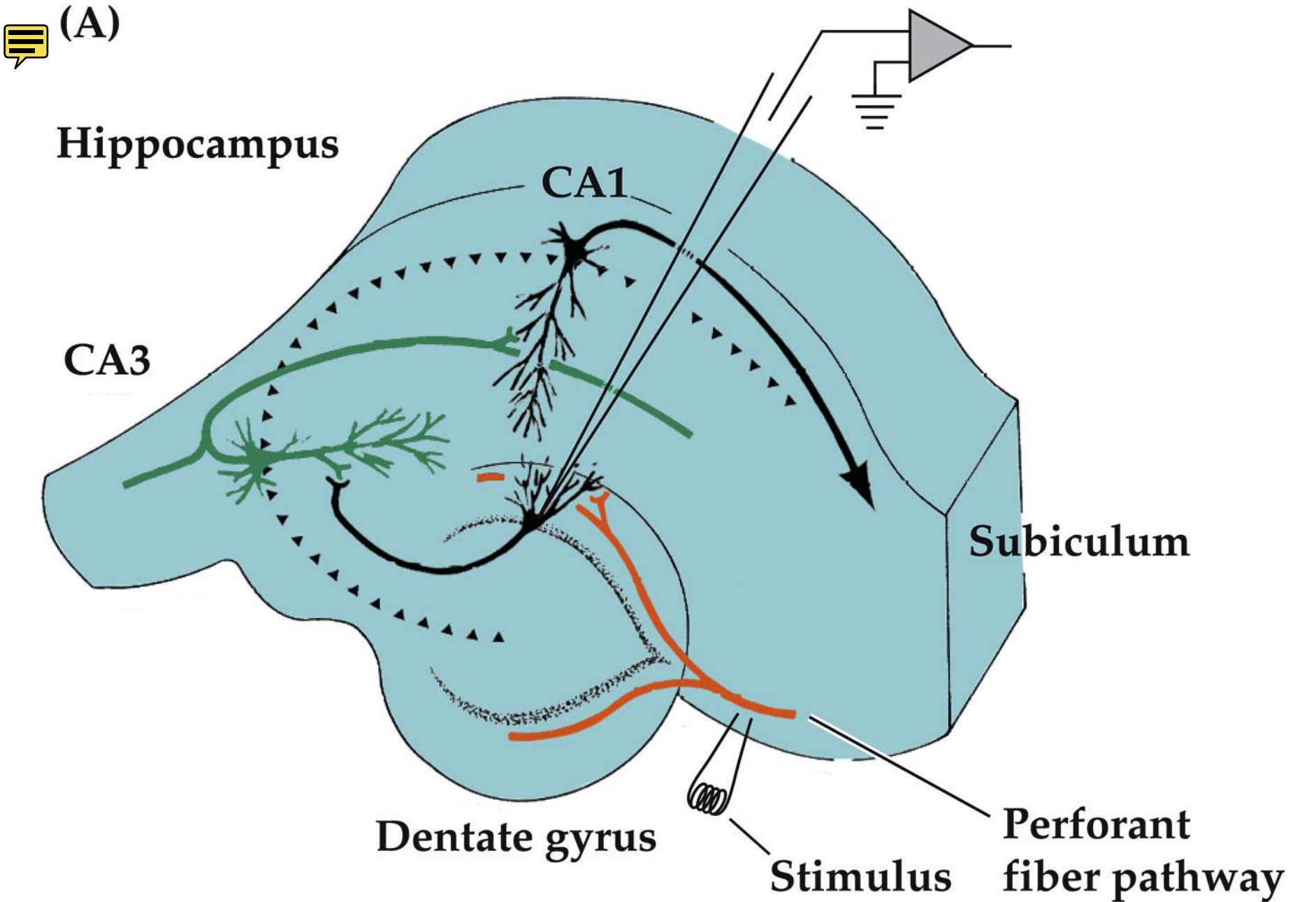
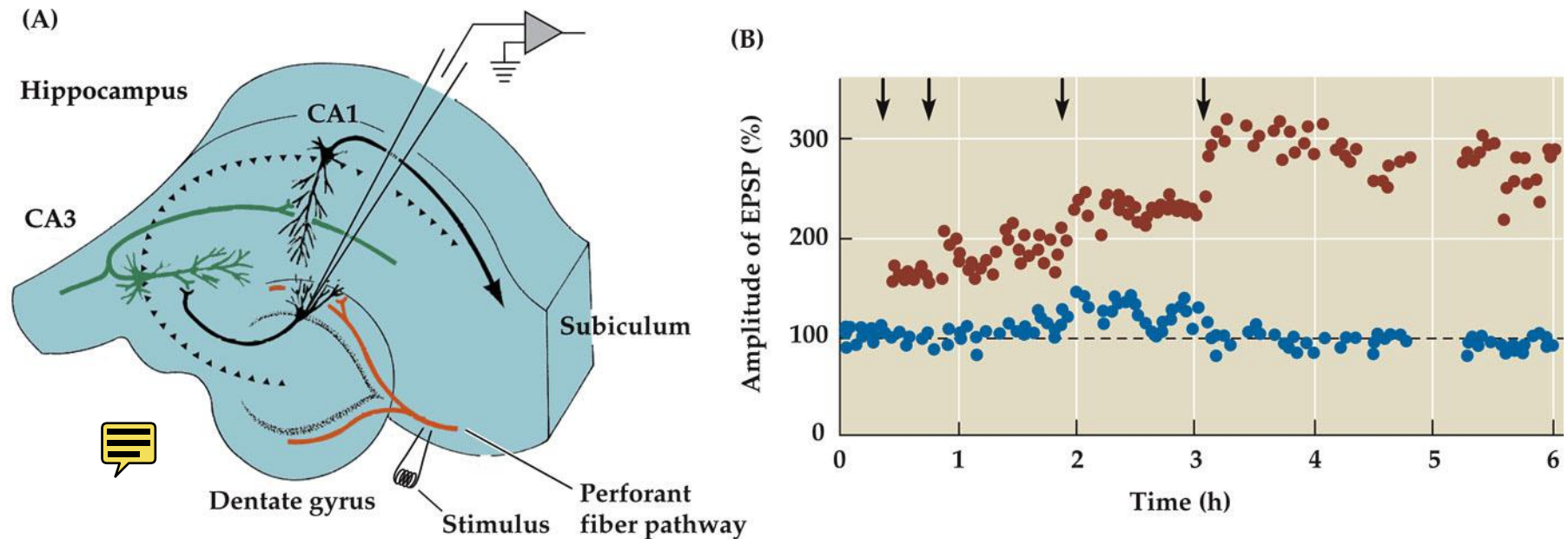


Figure 16.5 Long-Term Potentiation (LTP)

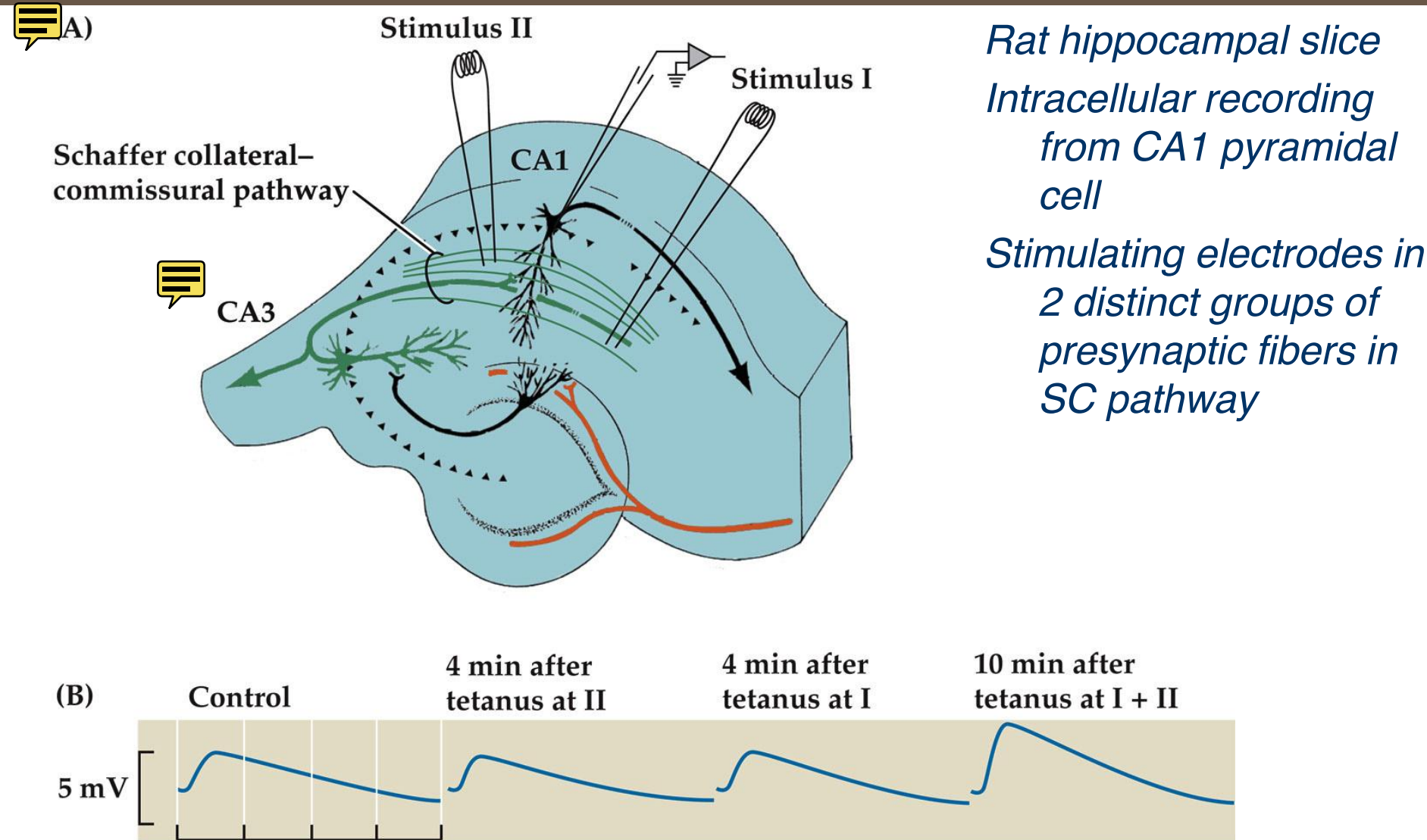


FROM NEURON TO BRAIN 5e, Figure 16.5

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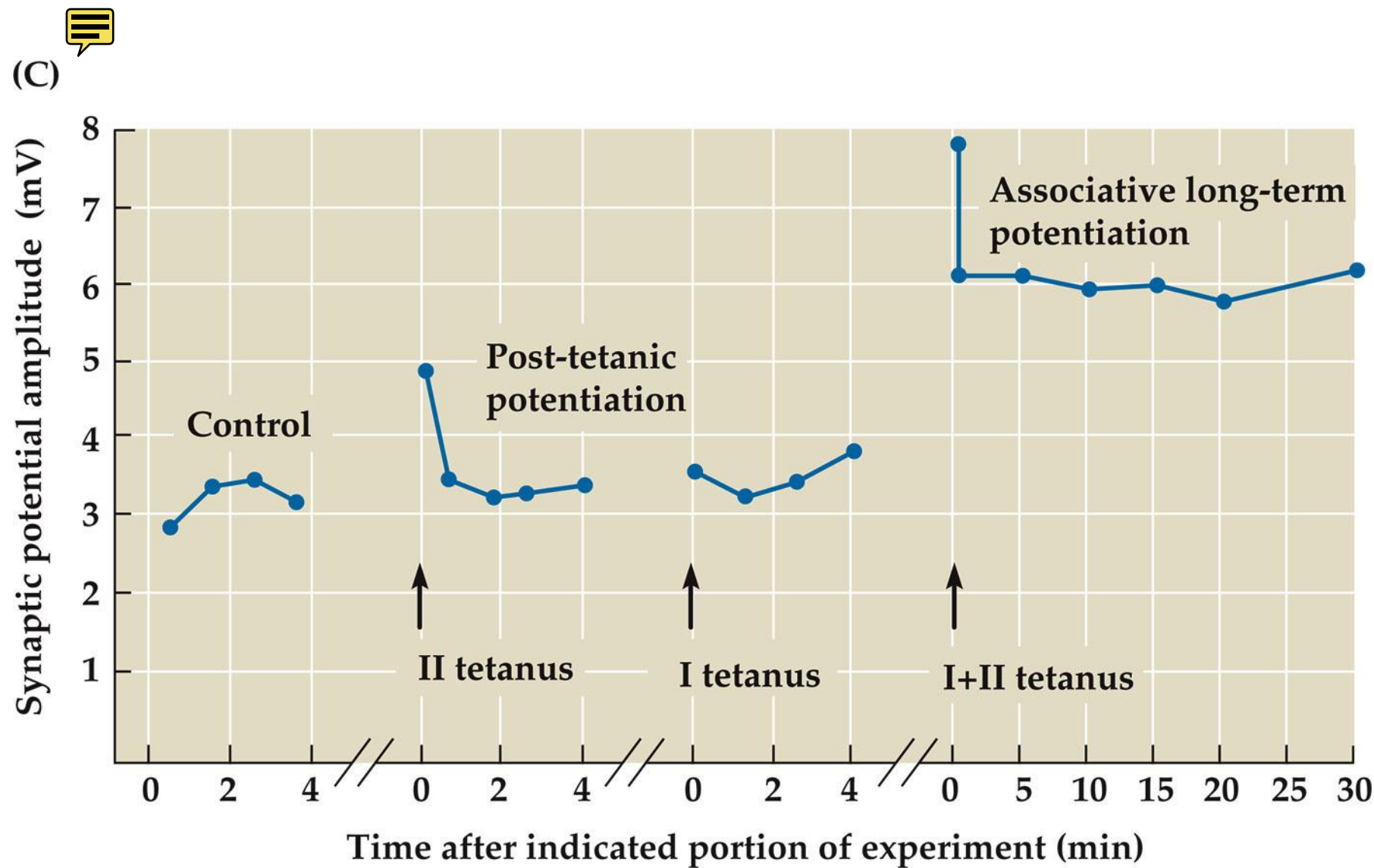
- LTP in hippocampus of anesthetized rabbit
- Tetanic stimuli (15/s for 10 sec) to PP; record from granule cells in DG
- Stimuli given at arrows
- Red dots are stimulated pathway
- Blue dots - control

Figure 16.6 Associative LTP in a Rat Hippocampal Slice (Part 1)



Associative LTP – repetitive activity to one synaptic input to a cell can influence whether another input to the same cell is also potentiated by repetitive activity

Figure 16.6 Associative LTP in a Rat Hippocampal Slice (Part 2)



FROM NEURON TO BRAIN 5e, Figure 16.6 (Part 2)

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NMDA and AMPA receptors


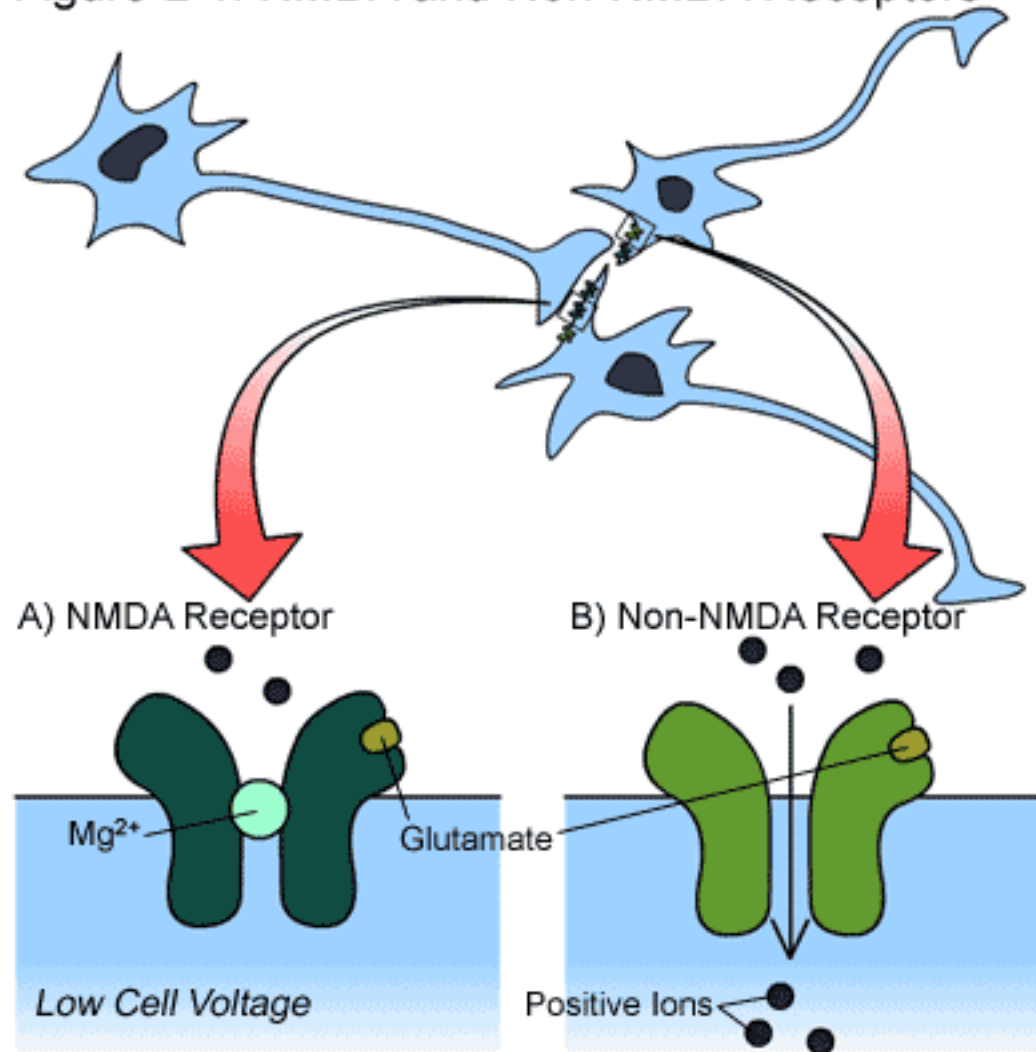
- Glutamate is the major excitatory neurotransmitter of the CNS
- Glutamate binds to NMDARs and AMPARs postsynaptically 
- NMDA and AMPA receptors are both cation channels

Figure L-1: NMDA and Non-NMDA Receptors



- A) The NMDA receptor is usually blocked by the Mg^{2+} ion. Positive ions are unable to rush in even if glutamate binds to NMDA unless the Mg^{2+} ion is removed by an increase in the cell voltage.
- B) The non-NMDA receptor opens as soon as glutamate binds to it. Opening of the non-NMDA receptor allows the entry of positive ions into the cell.

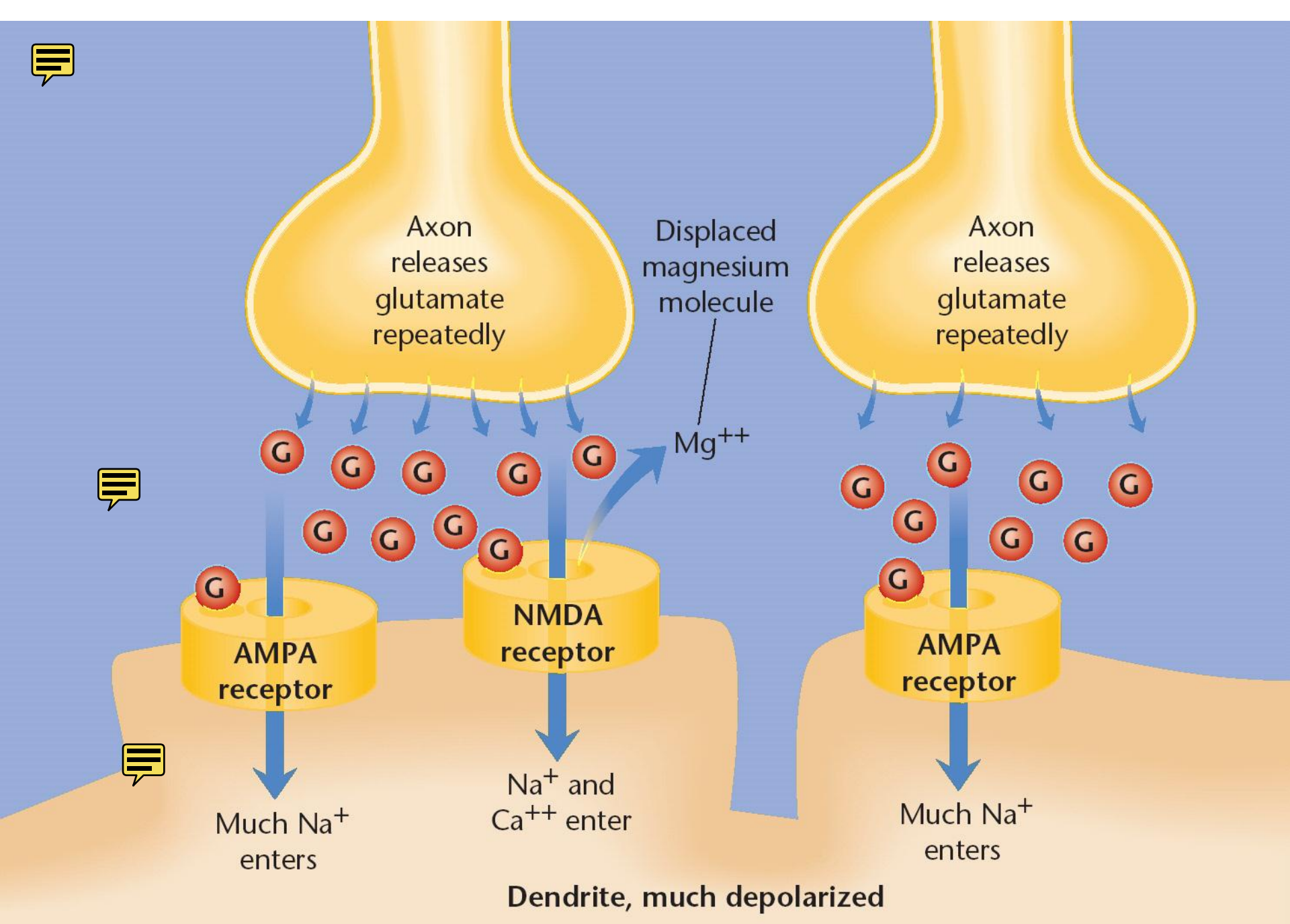
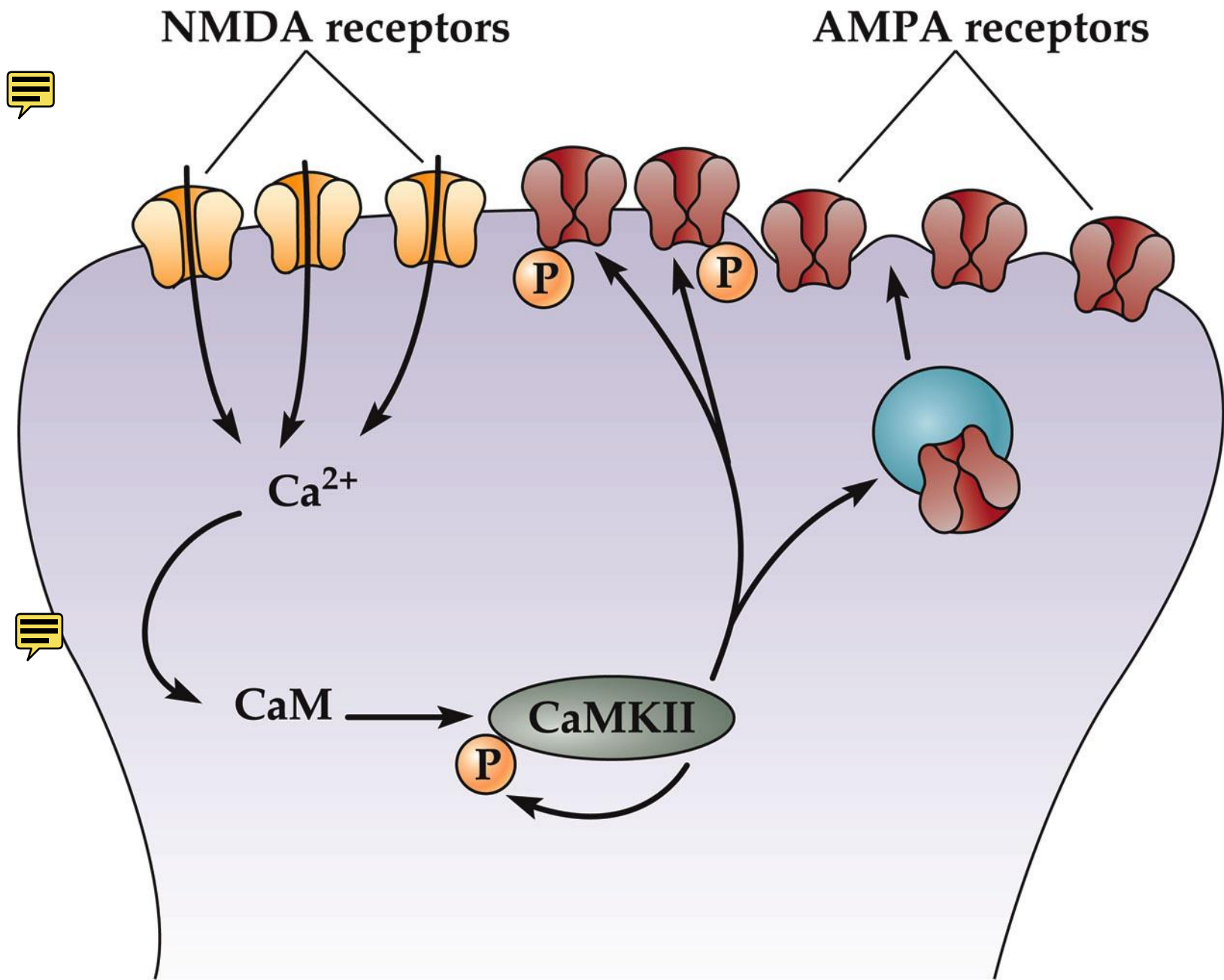
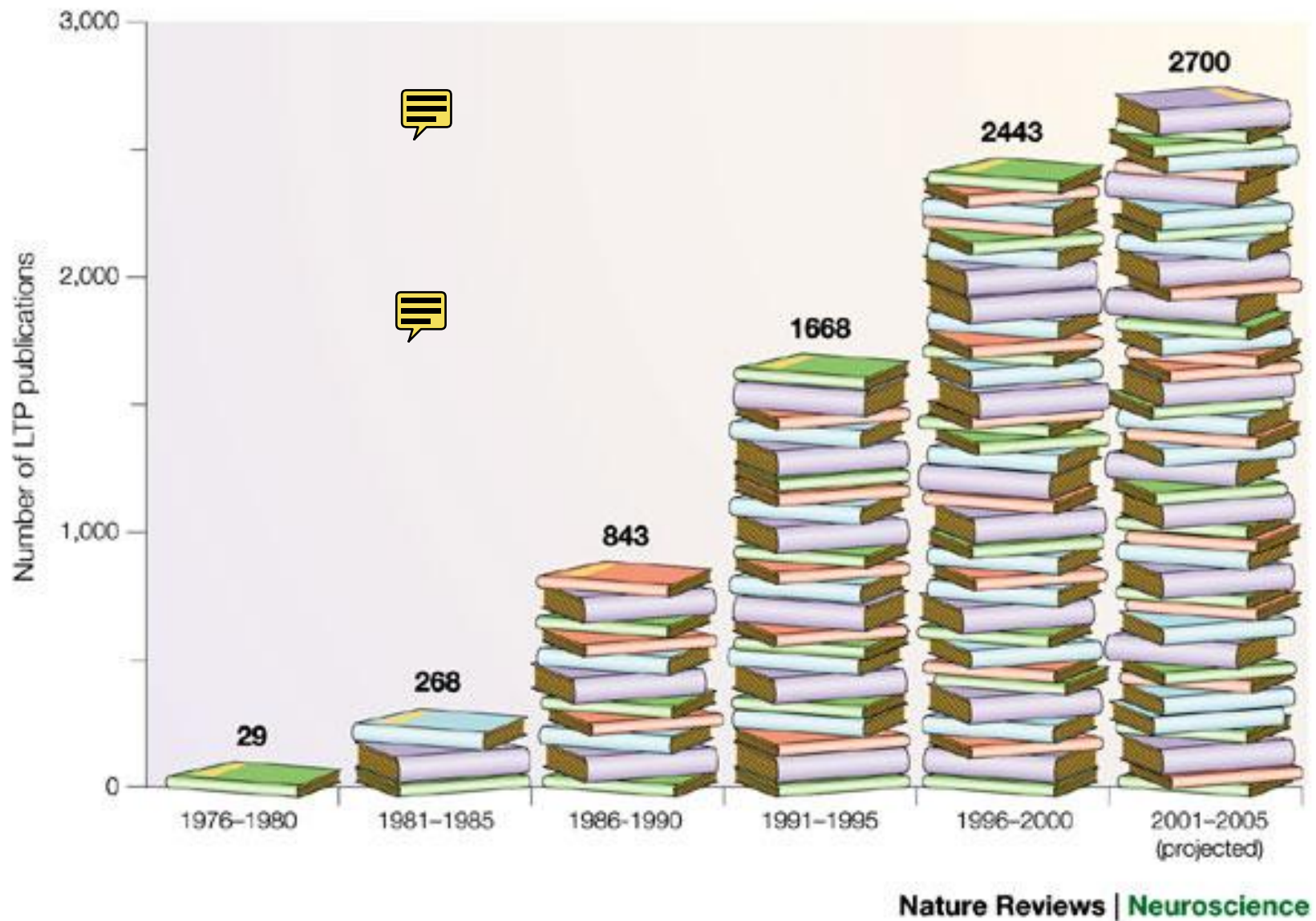


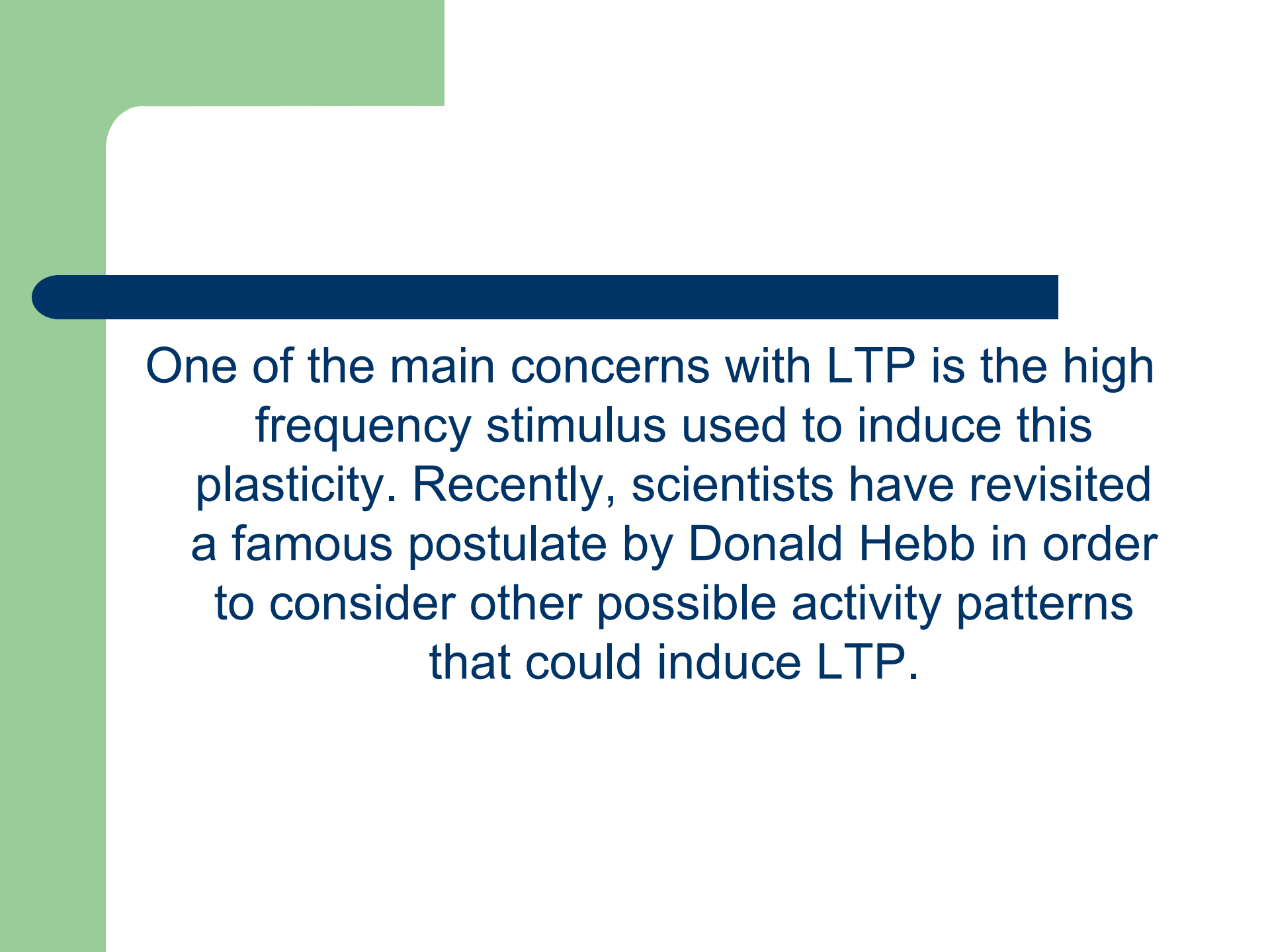
Figure 16.9 Proposed Mechanism for LTP



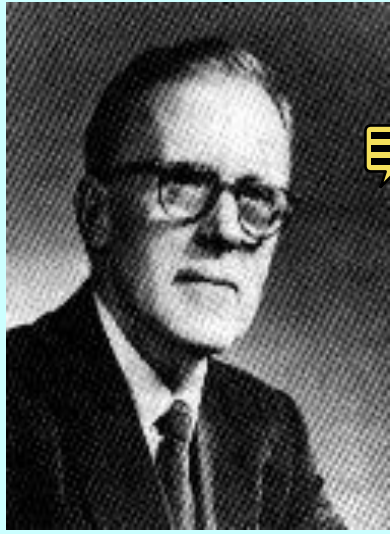


Nature Reviews Neuroscience 4; 923-926 (2003)

THE LONG-TERM POTENTIAL OF LTP



One of the main concerns with LTP is the high frequency stimulus used to induce this plasticity. Recently, scientists have revisited a famous postulate by Donald Hebb in order to consider other possible activity patterns that could induce LTP.



“When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A’s efficiency, as one of the cells firing B, is increased.”

— Donald O. Hebb

The Organization of Behavior, 1949

Hebb’s postulate is the most influential hypothesis in modern neuroscience; He postulated that learning and memory would involve synaptic strengthening elicited by coordinated firing of pre- and postsynaptic cells

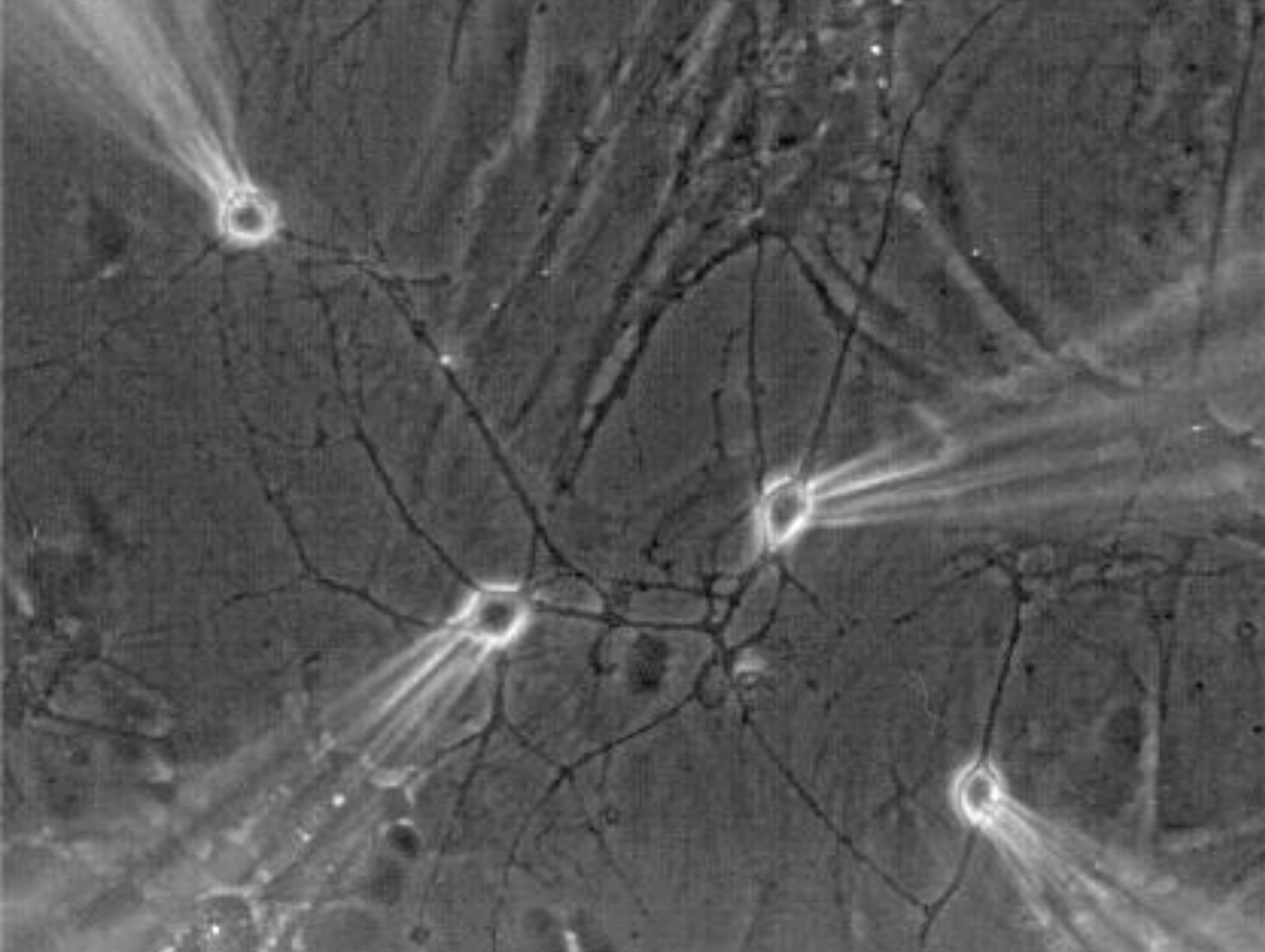


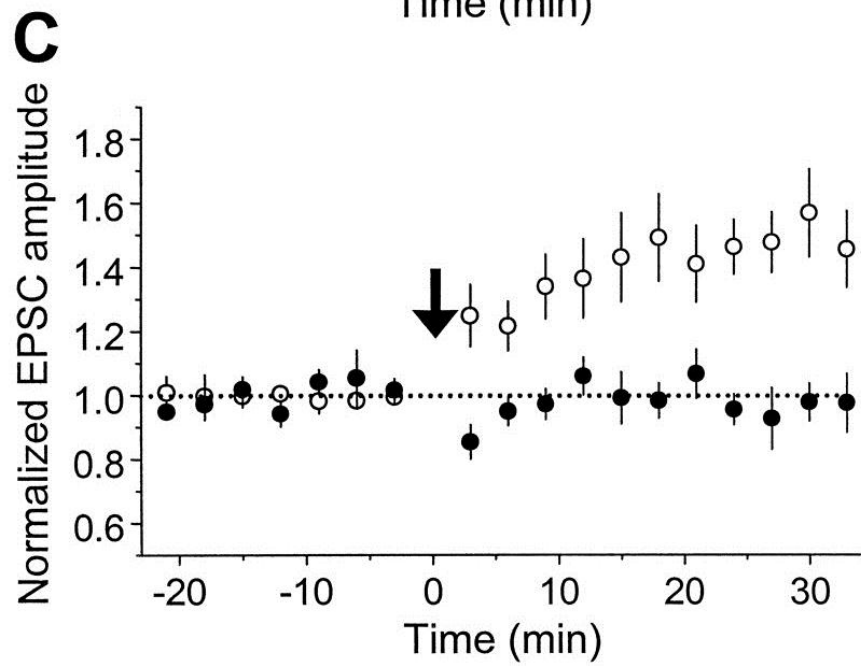
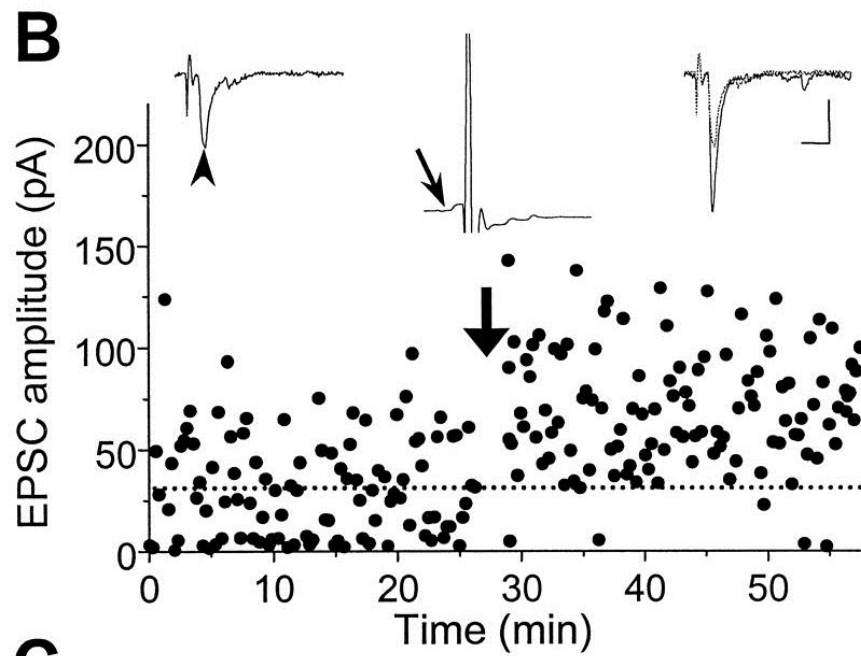
Synaptic Modifications in Cultured Hippocampal Neurons: Dependence on Spike Timing, Synaptic Strength, and Postsynaptic Cell Type

The Journal of Neuroscience,
December 15, 1998,
18(24):10464-10472

Guo-qiang Bi and Mu-ming Poo







Spike-Timing Dependent Synaptic Plasticity

- Instead of inducing LTP with high-frequency presynaptic stimulation, spike-timing protocols use lower-frequencies with paired pre- and postsynaptic activity
- Positive spike-timing interval: EPSP arrives before the postsynaptic AP is fired
- Negative spike-timing interval: EPSP arrives after the postsynaptic AP is fired

