Chapter 13: Learning and Memory

The Nature of Learning

Four Principal Types of Learning

Two Principal Types of Memory

Memory Consolidation

Synaptic Plasticity

- Electrophysiological mechanisms
- Biochemical mechanisms

Neurobiological Mechanisms

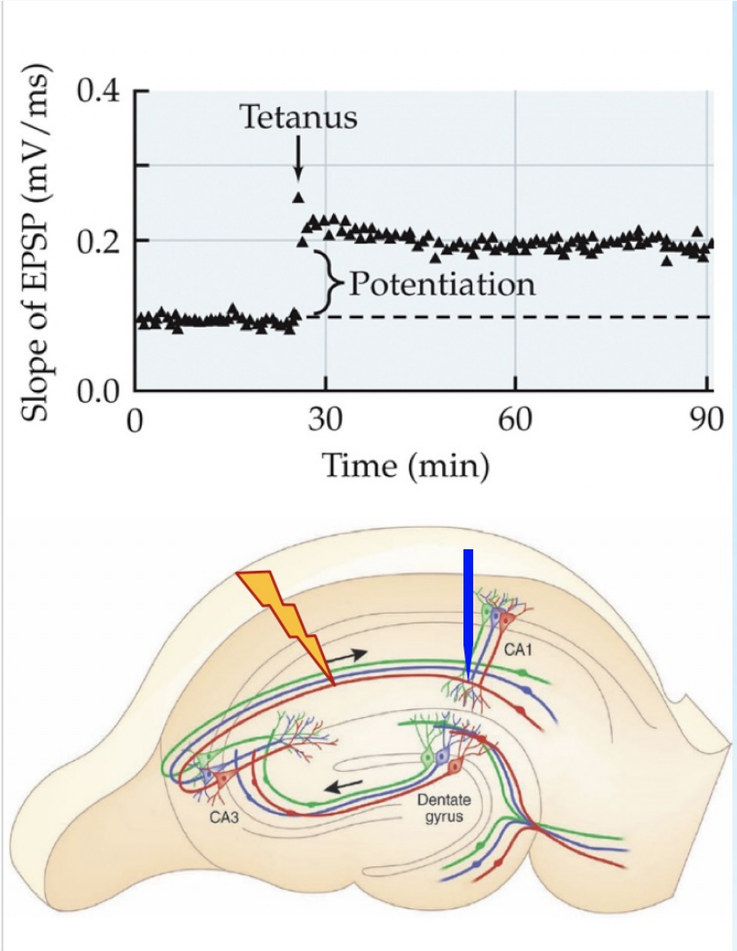
Disorders

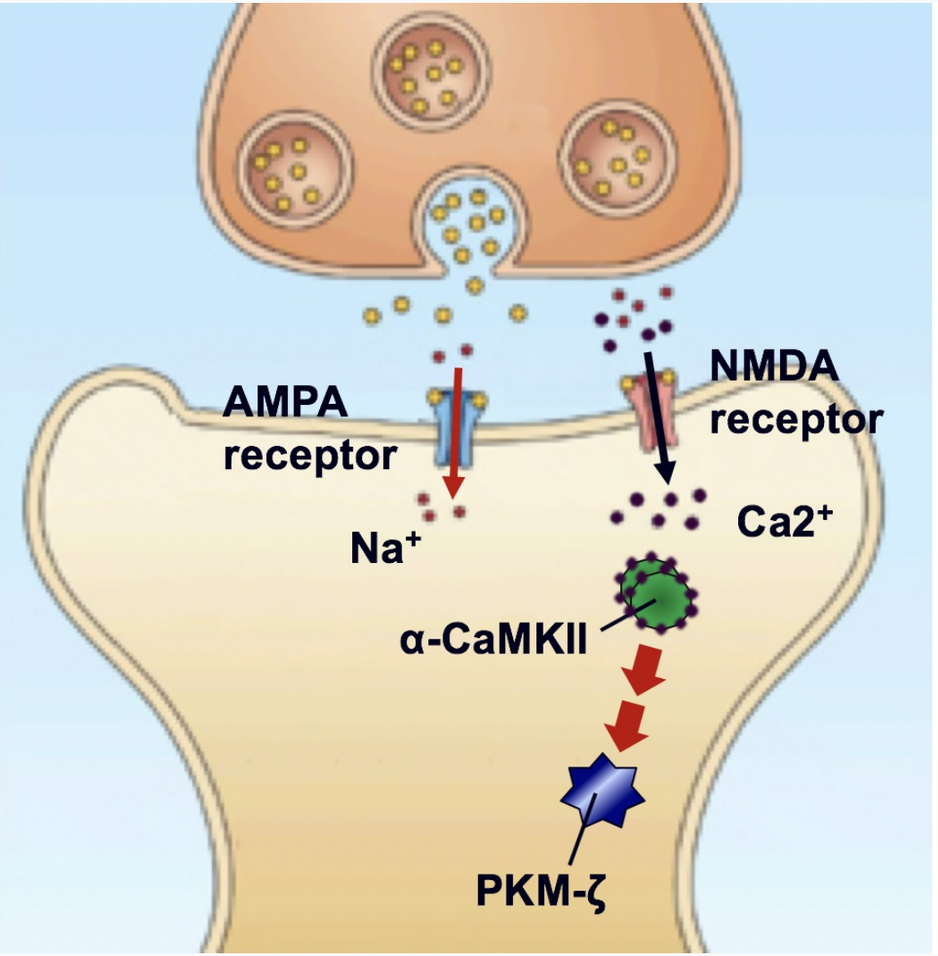
Neurobiological Mechanisms

Long-Term Potentiation - NMDA and AMPA Receptors.

Step 1:

- activate Ca2+-dependent enzymes including protein kinase f -CAMKII (Ca2+/calmodulin-dependent kinase)
- recruitment of additional enzymes like PKM-zeta



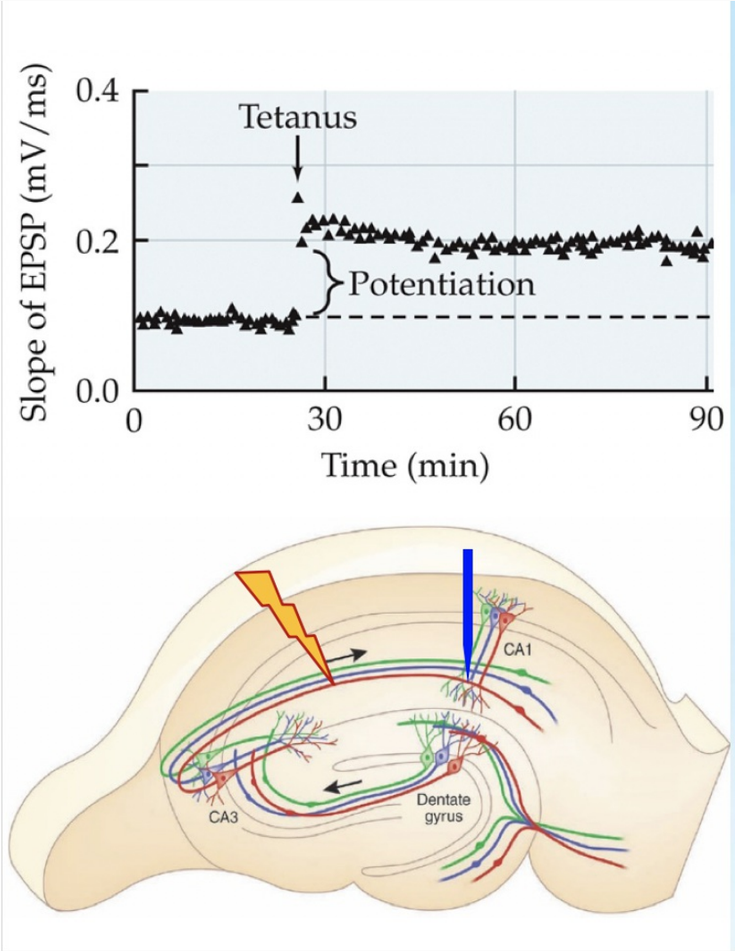


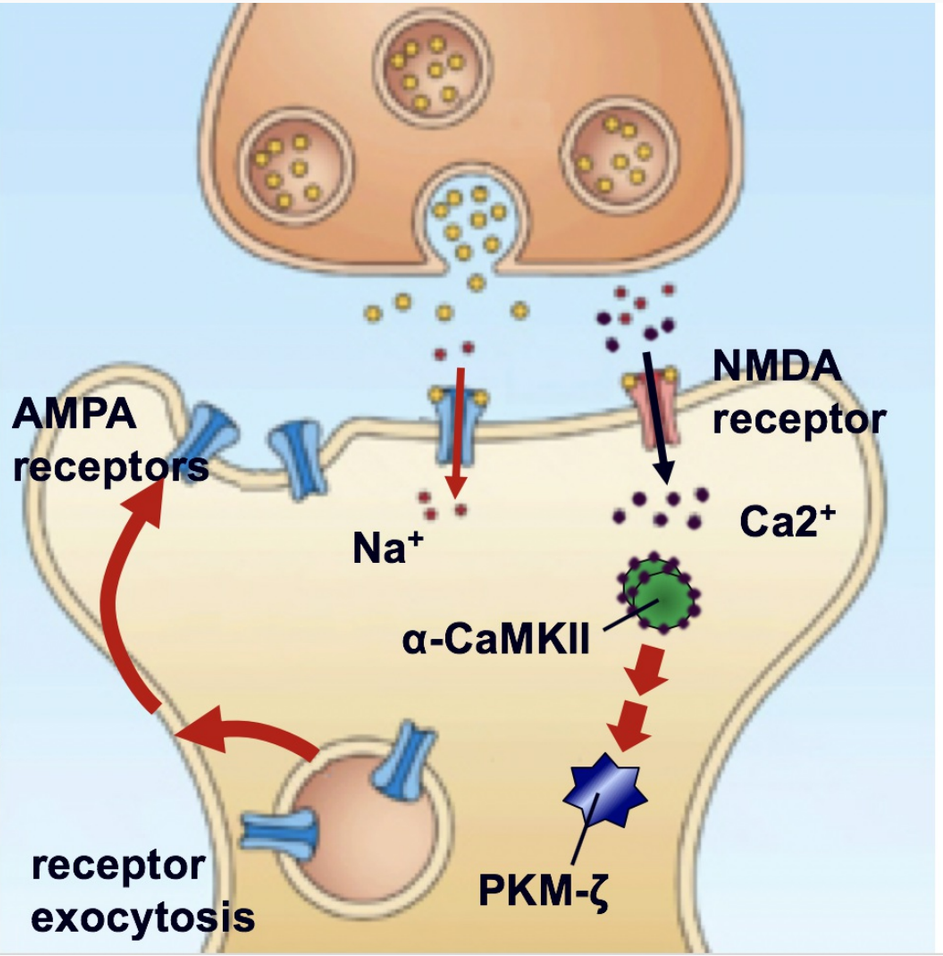
Neurobiological Mechanisms

Long-Term Potentiation - NMDA and AMPA Receptors.

Step 2:

- activated enzymes induce functional changes in postsynaptic structures of the stimulated synapse
- increased postsynaptic AMPA receptor insertion



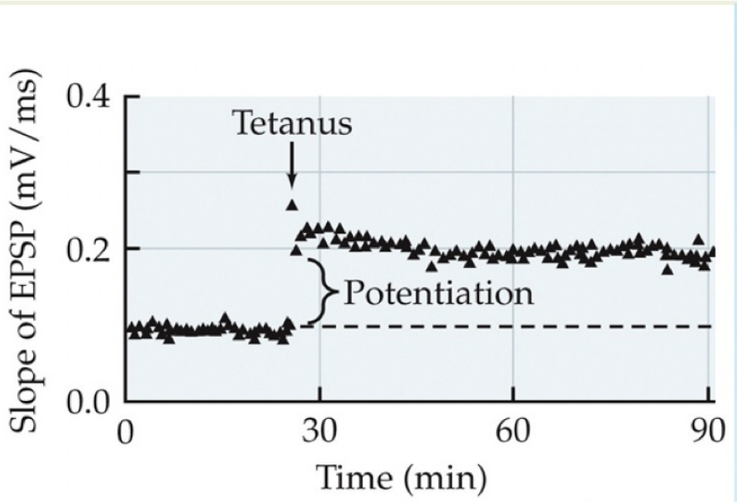


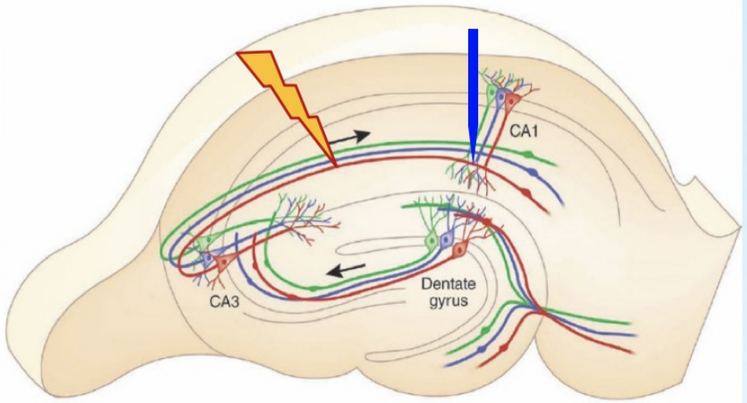
Neurobiological Mechanisms

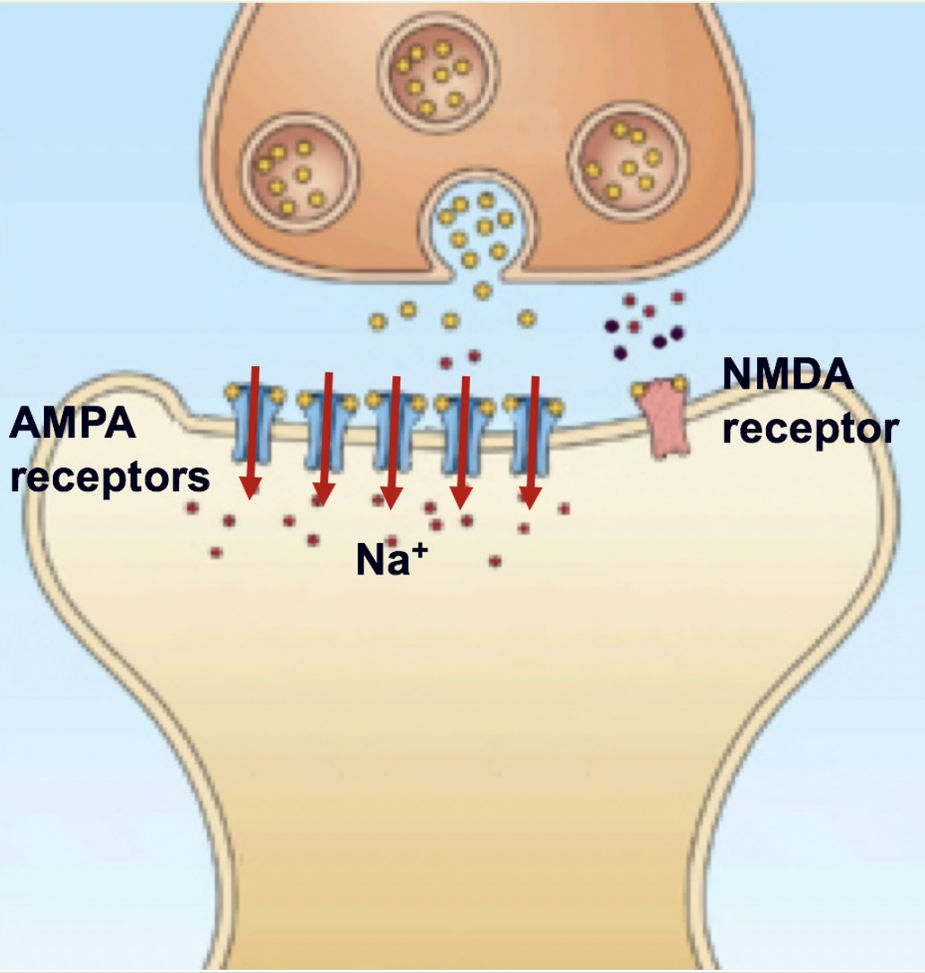
Long-Term Potentiation - NMDA and AMPA Receptors.

Step 2 (continued):

- increased AMPA receptor expression enhances response to glutamate inputs without need for postsynaptic depolarization





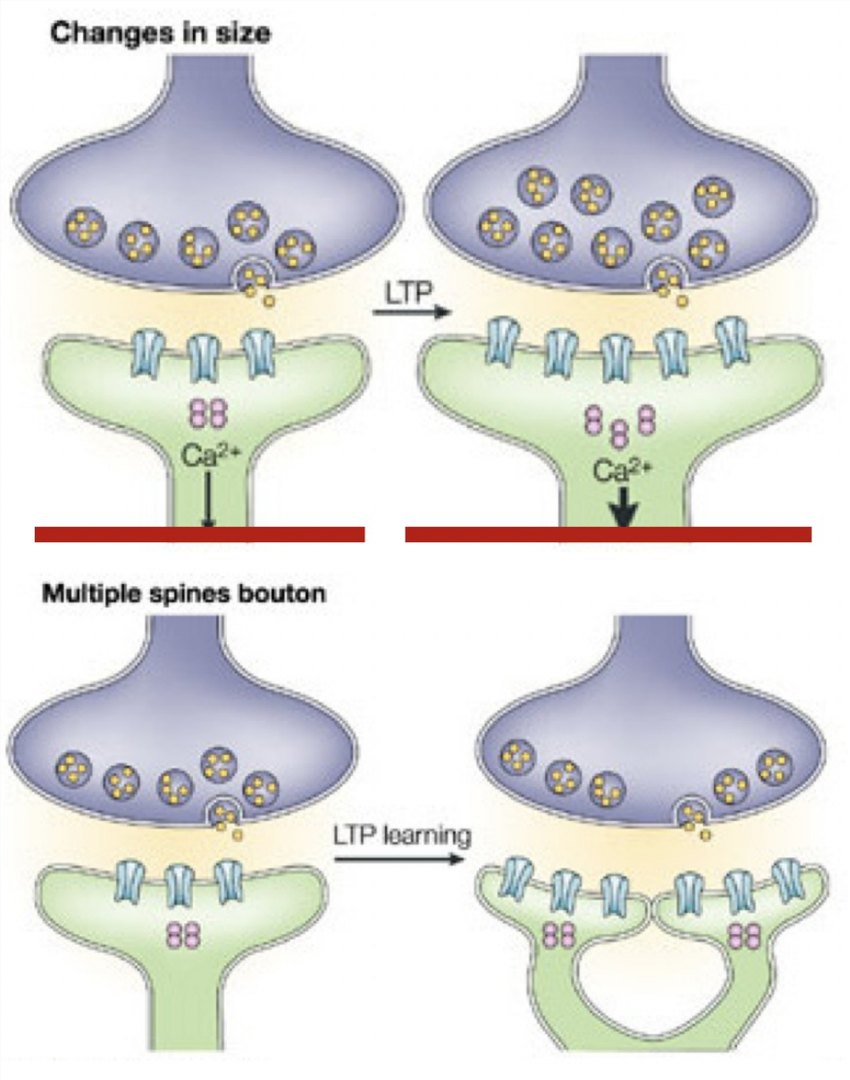


Neurobiological Mechanisms

Long-Term Potentiation - Postsynaptic Structural Changes.

Step 3

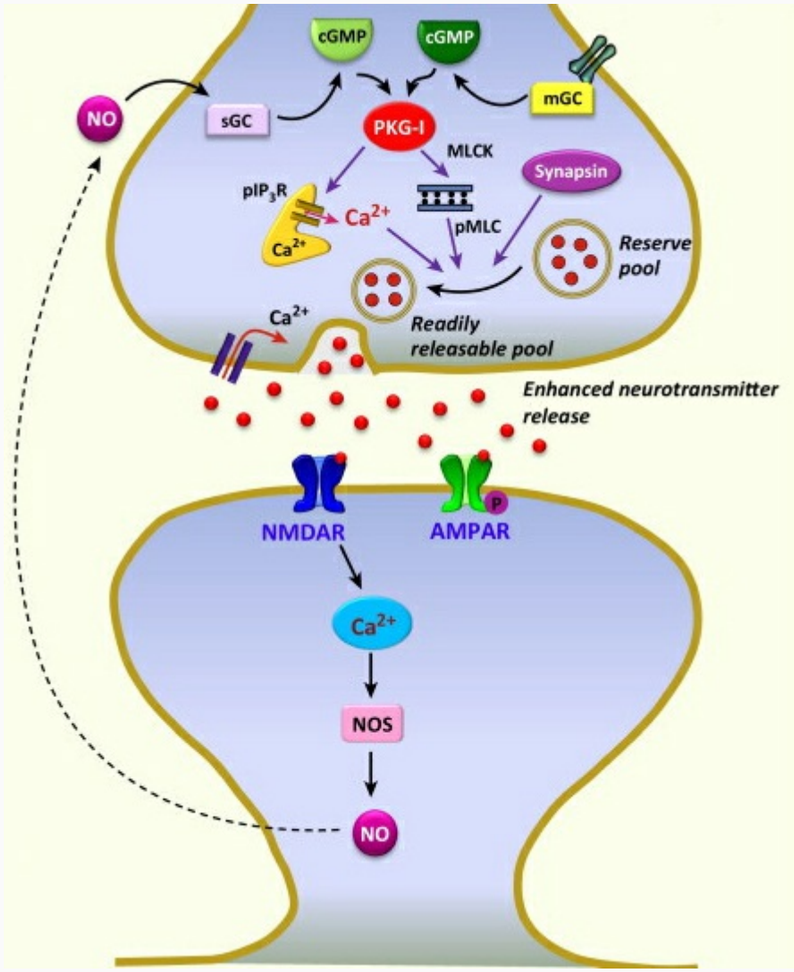
- activated enzymes induce structural changes
- remodel spines
- new functional spines
- requires protein synthesis



Neurobiological Mechanisms

Long-Term Potentiation - Presynaptic Structural Changes.

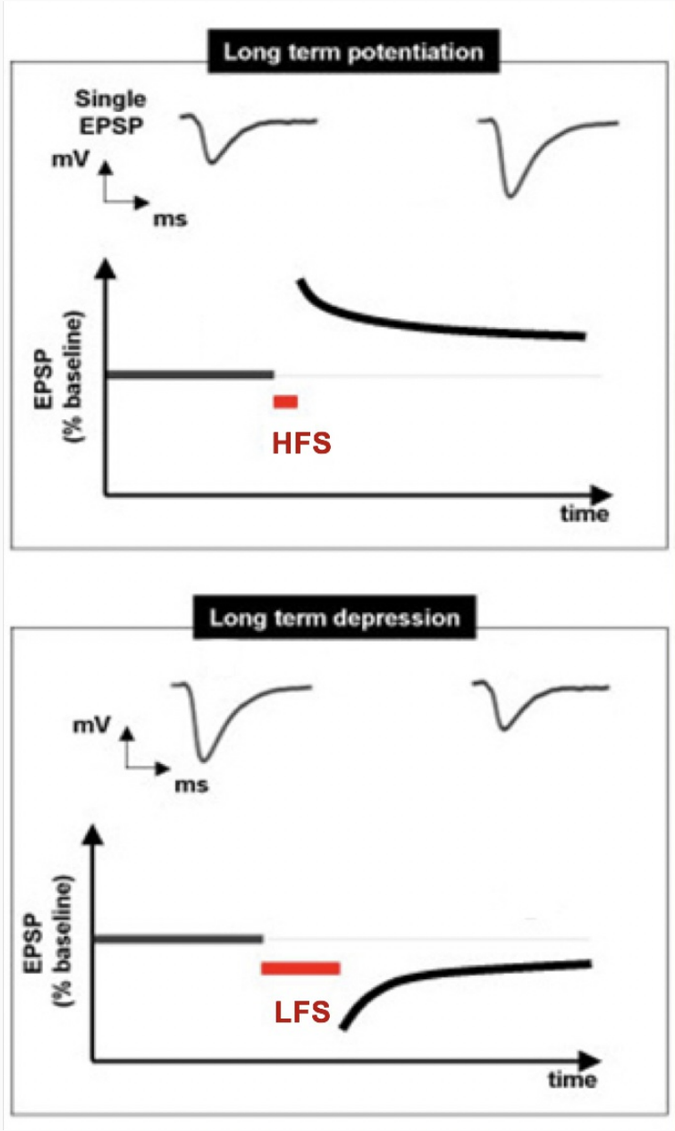
- increase in size of active zone
- increased release of neurotransmitter
- NO signaling

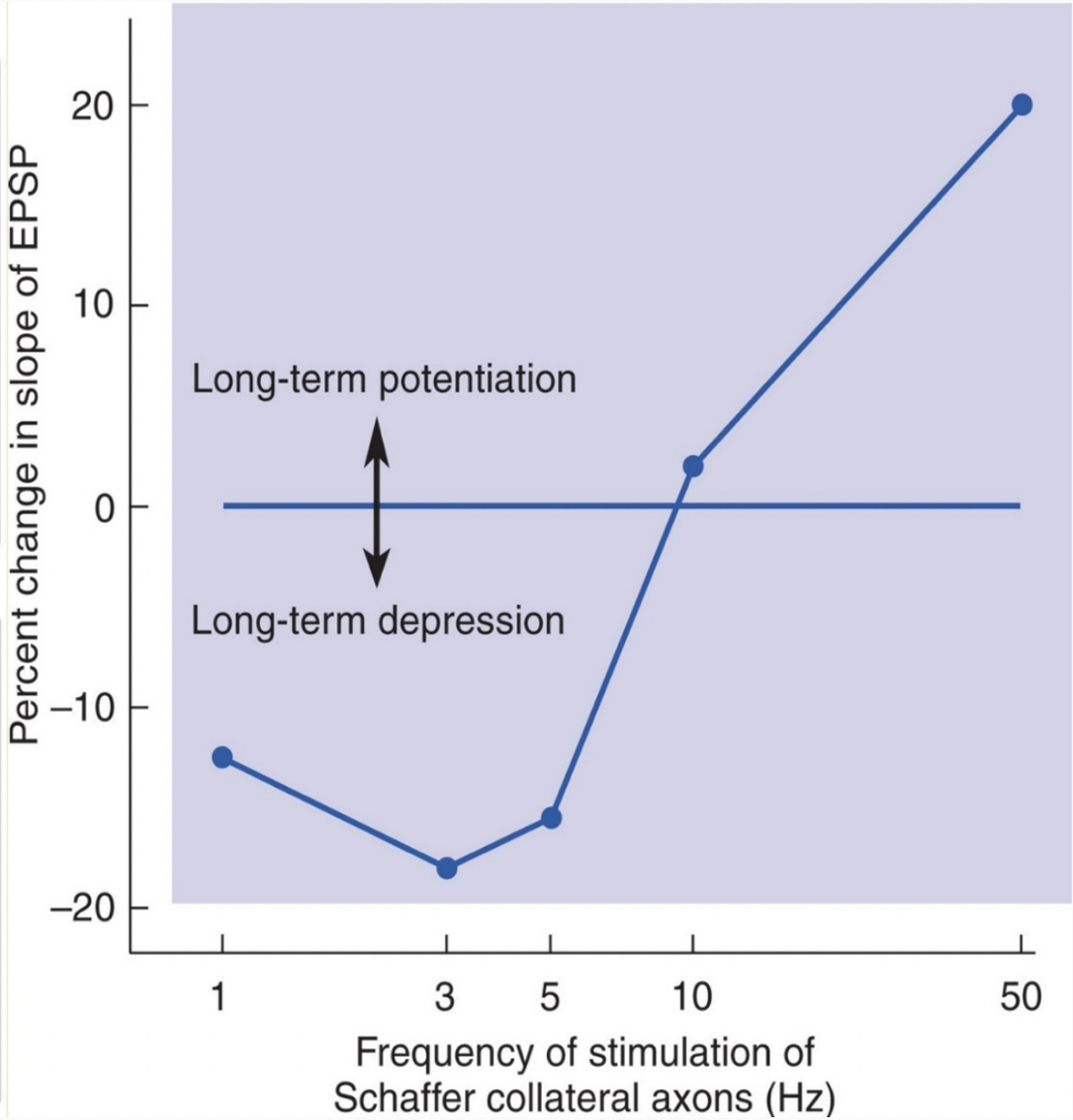


Neurobiological Mechanisms

Long-Term Depression.

- LFS-induced depression, usually dependent on NMDAR





Neurobiological Mechanisms

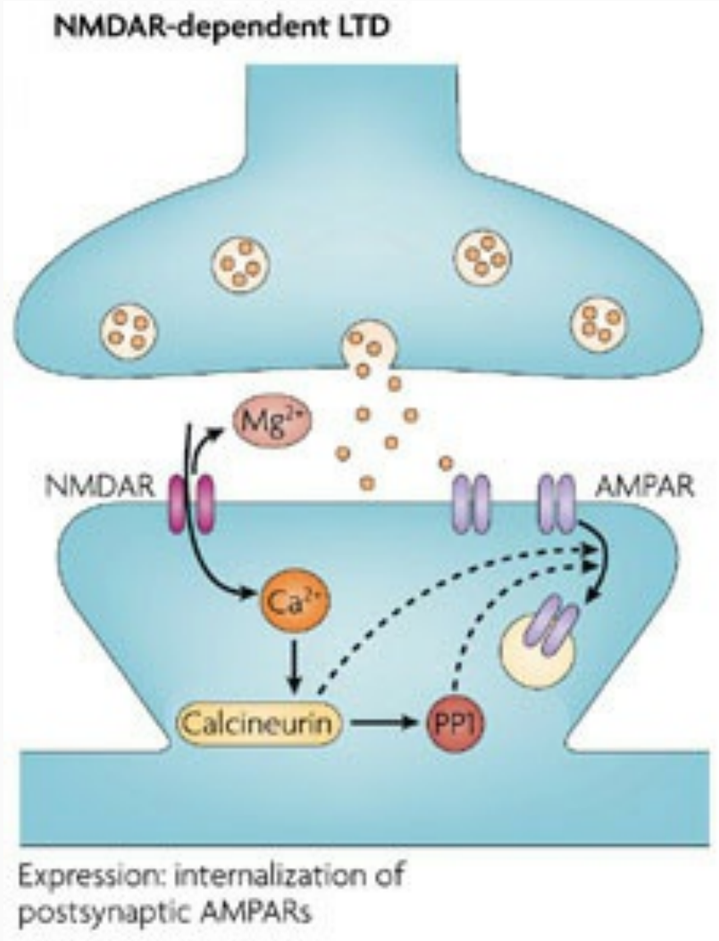
Long-Term Depression - NMDA and AMPA Receptors.

- **Step 1**:
  - contiguous presynaptic glutamate release and very small amounts of postsynaptic depolarization
  - very small amounts of Ca2+ influx through NMDAR
  - activation of Ca2+-dependent enzymes including calcineurin, a protein phosphatase

Neurobiological Mechanisms

Long-Term Depression - NMDA and AMPA Receptors.

- **Step 2**:
  - activated enzymes induce functional changes in postsynaptic structures of depressed synapse
  - dephosphorylation of proteins causes internalization of AMPA receptors from postsynaptic density
- **Step 3**:
  - decreased expression of AMPA receptors decreases overall response to glutamate



Neurobiological Mechanisms

Long-Term Depression - Presynaptic Structural Changes.

- decreased release of neurotransmitter
- eCB signaling

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