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**

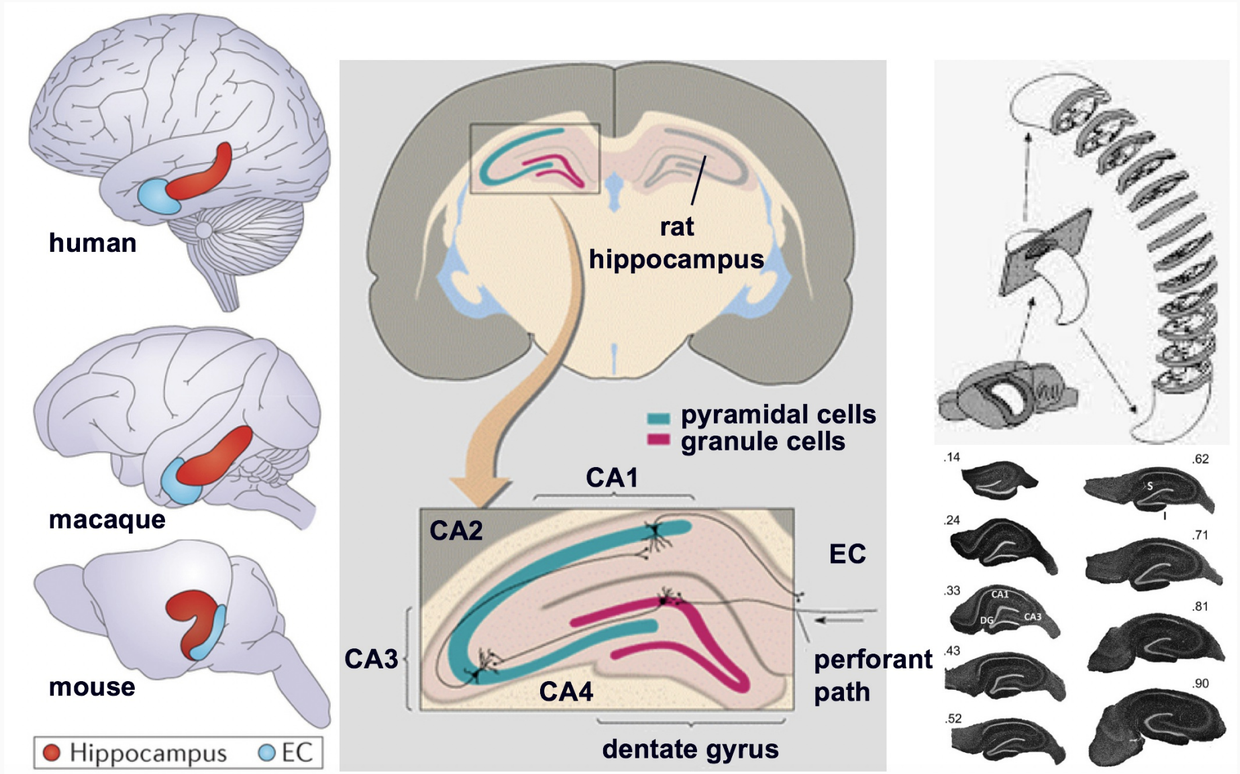
Neurobiological Mechanisms

Disorders

Synaptic Plasticity

The Hippocampus.

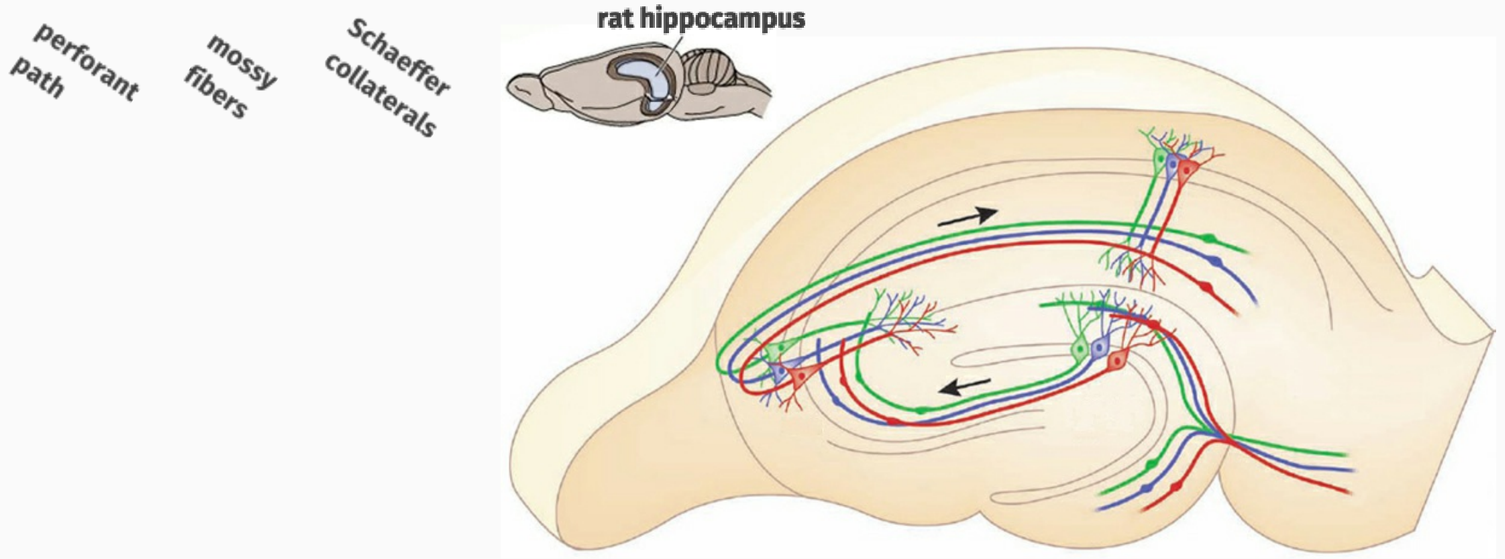
- important role in consolidation of declarative memories



Synaptic Plasticity

The Hippocampus.

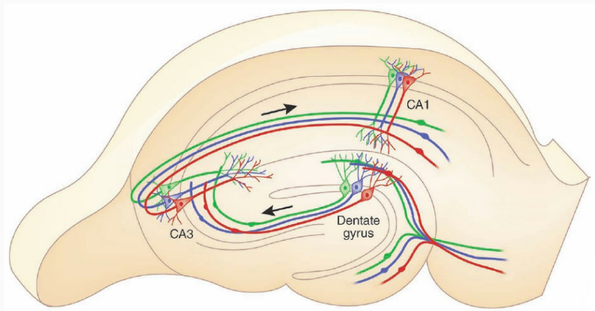
- important role in consolidation of declarative memories
- EC → DG → CA3 → CA1

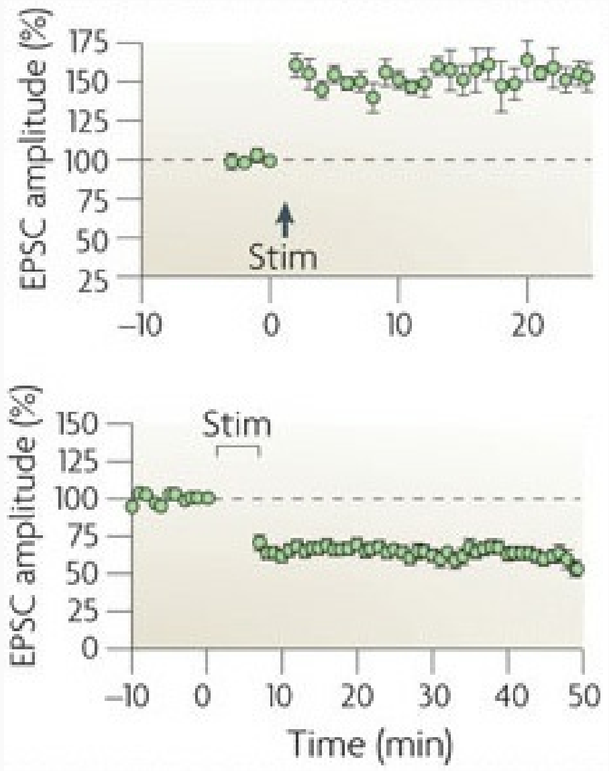


Synaptic Plasticity

Long-Term Potentiation and Long-Term Depression.

- originally and extensively studied in hippocampus
- LTP: brief, high frequency, strong stimulation (100 Hz) of inputs produces long-lasting enhancement of stimulated extracellular field potentials

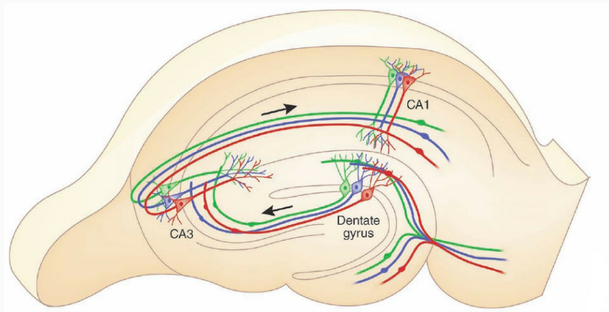


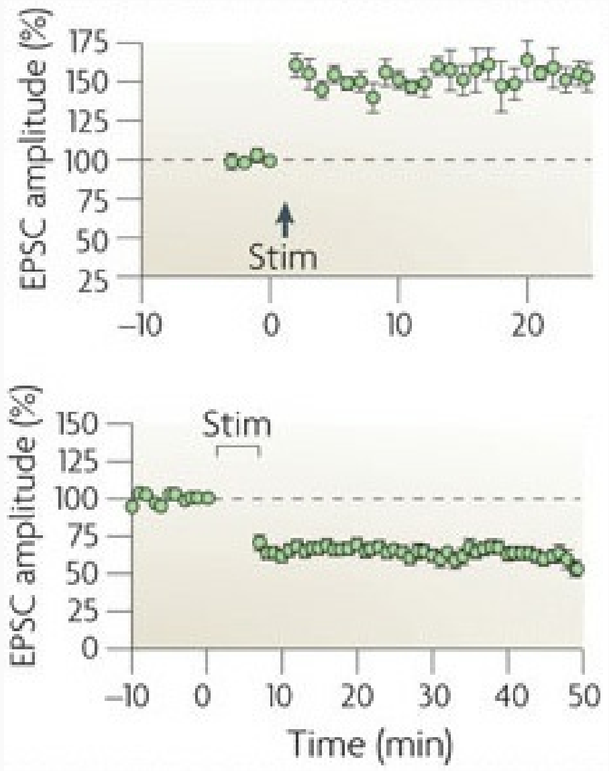


Synaptic Plasticity

Long-Term Potentiation and Long-Term Depression.

- originally and extensively studied in hippocampus
- LTD: prolonged, low frequency, weak stimulation (5-15 min at 1-3 Hz) produces long-lasting depression of stimulated extracellular field potentials

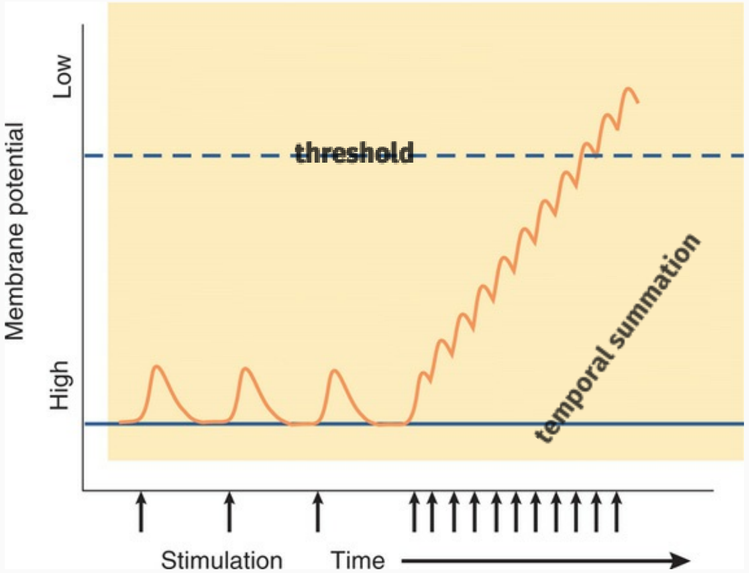




Synaptic Plasticity

Long-Term Potentiation.

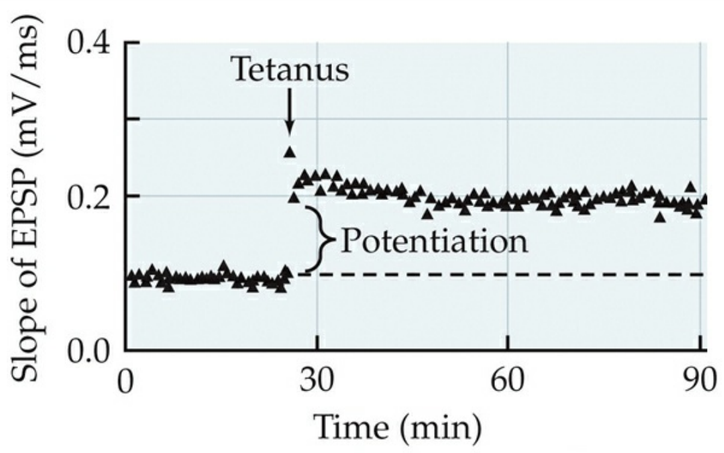
- strong high frequency stimulation (HFS) temporally summates to reach threshold for LTP
- strong low frequency stimulation or weak stimulation does not summate to reach threshold

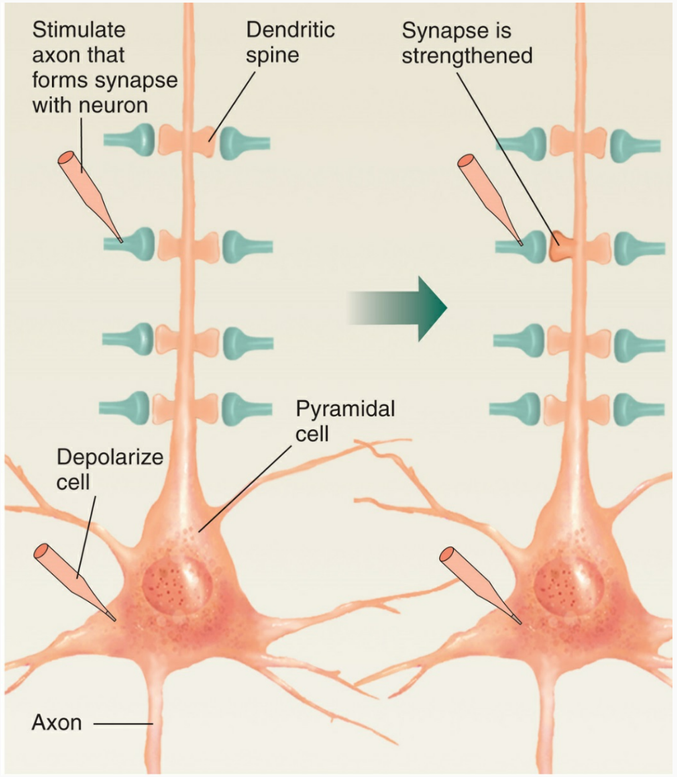


Synaptic Plasticity

Long-Term Potentiation.

- 2 events required:
  - synaptic activity
  - postsynaptic depolarization

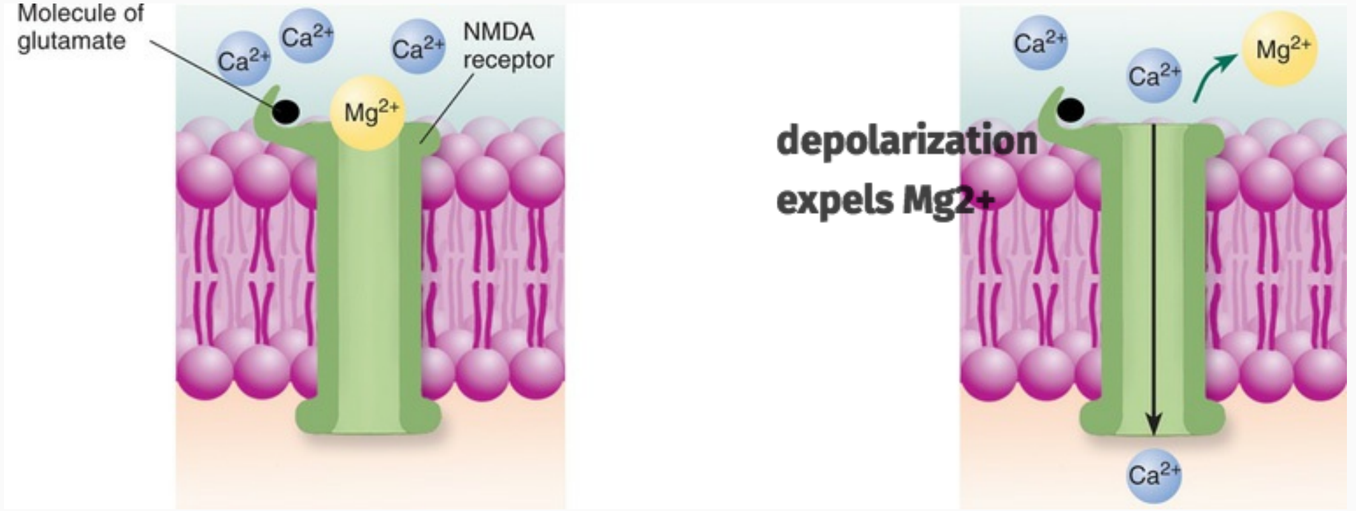




Synaptic Plasticity

Long-Term Potentiation.

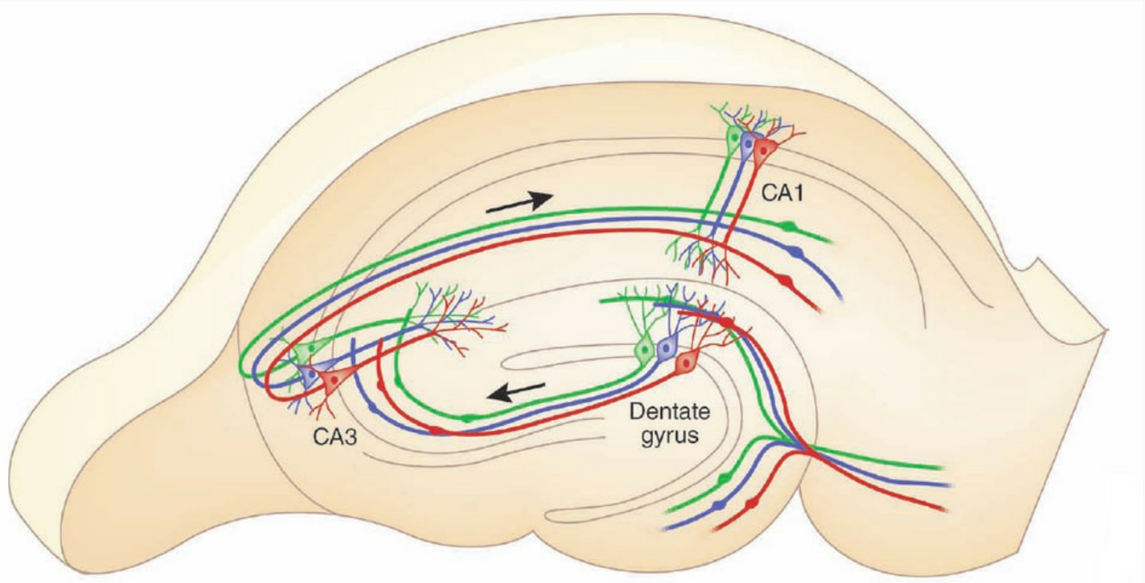
- NMDA receptor recognizes contiguous presynaptic activity (glutamate release) and postsynaptic depolarization
- back-propagating action potentials



Synaptic Plasticity

Associative Long-Term Potentiation.

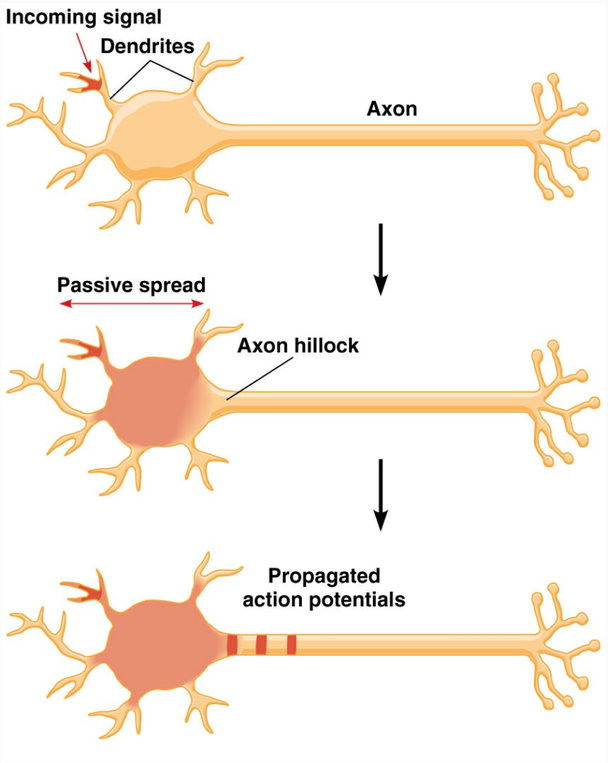
- Hebb's Rule: "neurons that fire together, wire together"
- weak stimulus alone does not expel Mg2+
- well-timed weak stimulus benefits from depolarization induced by strong stimulus



Synaptic Plasticity

Associative Long-Term Potentiation.

- back-propagating action potentials



Synaptic Plasticity

Associative Long-Term Potentiation.

- back-propagating action potential from strong input removes Mg2+ block from synapse where weak input occurs, and weak input activates Ca2+ influx

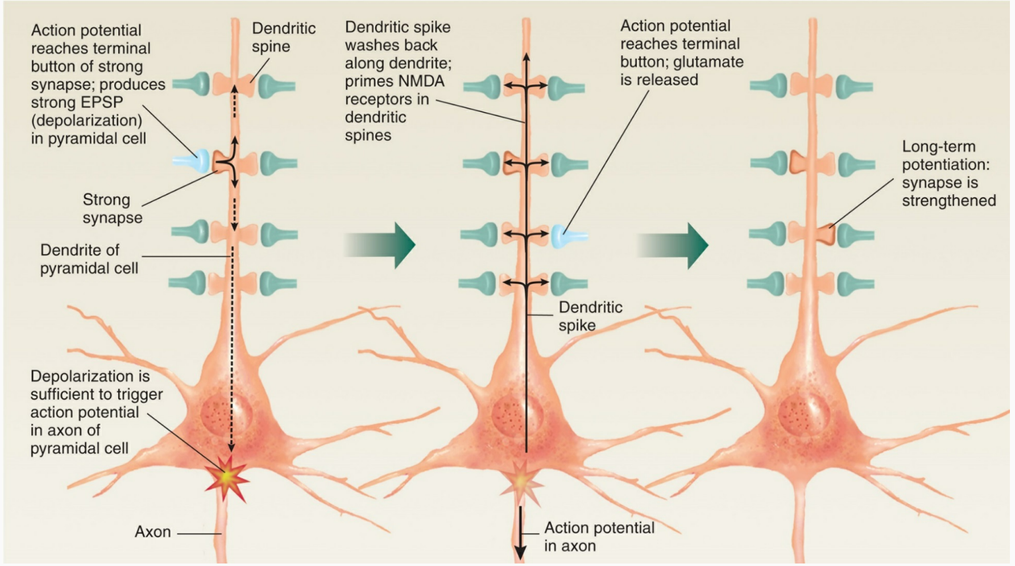


Image Credits

- slide 2: Pinel, J.P.J. (1997). Biopsychology, 4th ed. Allyn and Bacon http://becuo.com/lower-brain-hippocampus http://farm5.static.flickr.com/4067/4533138943_5979daa80f_b.jpg http://www.nature.com/nrn/journal/v15/n10/images/nrn3785-f1.jpg
- slide 3: http://i2.wp.com/neurosciencenews.com/neuroscience_images/rat-hippocampus-public.jpg http://www.nature.com/neuro/journal/v14/n4/images/nn.2783-F1.jpg
- slide 4-5: http://www.nature.com/neuro/journal/v14/n4/images/nn.2783-F1.jpg http://www.nature.com/nrn/journal/v11/n7/images/nrn2867-f3.jpg
- slide 6: Carlson, N.R. (2012). Physiology of Behavior, 11th ed. Pearson Publishing
- slide 7: Carlson, N.R. (2012). Physiology of Behavior, 11th ed. Pearson Publishing Breedlove, S.M., Watson, N.V. (2013). Biological Psychology: An Introduction to Behavioral, Cognitive, and Clinical Neuroscience, 7th ed. Sinauer Associates, Inc.
- slide 8: http://www.nature.com/neuro/journal/v14/n4/images/nn.2783-F1.jpg
- slide 10: http://www.mun.ca/biology/desmid/brian/BIOL2060/BIOL2060-13/13_11.jpg
- slide 11: Carlson, N.R. (2012). Physiology of Behavior, 11th ed. Pearson Publishing