Learning & Memory

Memory has 3 phases:
- Encoding
  - acquisition
  - consolidation
- Storage
- Retrieval

Experimentally, memory can be subdivided into three types
- Sensory memory
  - very short lasting (milliseconds to seconds)
  - many items can be held
- Short term (working) memory
  - lasts seconds to minutes
  - can hold about 7 items
  - requires rehearsal (disrupted by distractor tasks)
  - accounts for recency effect
  - affected by damage to the left angular gyrus
- Long term memory
  - rehearsal facilitates storage into long-term memory (accounts for primacy effect)
  - memories last up to a lifetime
  - unlimited number of items can be stored
  - many types of LTM mediated by different brain regions

Long term memory can be divided into many subtypes
- Nondeclarative memory (implicit memory)
  - procedural memory (skills)
    - affected by damage to the striatum and cerebellum
  - perceptual representation system (perceptual priming)
    - mediated by cortex
  - classical conditioning (e.g. tone reward pairing)
    - affected by damage to the amygdala
  - nonassociative learning (e.g. habituation & sensitization
- Declarative memory
  - mediated by the medial temporal lobe (hippocampus and associated cortices)
  - episodic memory
    - ongoing record of experience
  - semantic memory
    - memory for facts

Patient H.M had damage to the medial temporal lobe and had intact working memory and procedural memory, but impaired declarative memory

Patient M.S. has damage to the cortex and has a deficit in perceptual priming

Retrograde amnesia affects previously stored memories

Anterograde amnesia affects the storage of new memories

Medial temporal lobe damage causes profound anterograde amnesia and graded retrograde amnesia (recall old memories better)

Korsakoff's syndrome results from a vitamin deficiency due to alcoholism and affects the mamillary bodies and dorsomedial nucleus of the thalamus
- Causes anterograde amnesia for declarative memories

Some investigators hypothesize that declarative memories involve complex representations of relationships between different aspects of the memory

In rodents, relational odor tasks and spatial tasks require the hippocampus

The hippocampus may initially guide learning of a task while the striatum may take over as the task becomes well learned

Long Term Potentiation (LTP) is thought to be the cellular basis of learning

Hebb's Law:

If a synapse is active when a postsynaptic neuron is active, the synapse will be strengthened (i.e. Cells that fire together, wire together.)

- Cooperativity
    - More than one input must be active at the same time
- Associativity
    - Weak inputs are potentiated when paired with stronger inputs
- Specificity
    - Only active synapses are potentiated

LTP (at least some forms) is mediated by NMDA glutamate channels

Mg++ blocks the channel when the cell is hyperpolarized, so glutamate binding doesn't affect the postsynaptic cell

When the postsynaptic cell is depolarized, glutamate binding allows the Mg++ block to escape and ions, including Ca++, to enter the cell and trigger LTP of the synapse