9.03 Neural Basis of Learning and Memory: Lecture 2
Introduction to behavioral learning paradigms

**Forms of behavioral learning**

**Instrumental conditioning**
- *avoidance learning* - receive an unpleasant stimulus when the animal fails to make a response
  - 2-sided shock chamber
- *learned helplessness* - inescapable shock results in freezing
  - used in context dependent fear conditioning
- *reward training* - receive reinforcement when response is made
  - shaping
- *escape* - inevitable unpleasant stimulus continued unless response is made
- *punishment* - receive an unpleasant stimulus when a response is made

**Classical conditioning**
can be subdivided into *appetitive* conditioning when the unconditioned stimulus is rewarding, or *defensive* conditioning if the stimulus is aversive.
Examples of classical conditioning paradigms are
- eyeblink/nictitating membrane
- taste aversion
- GSR

**Discrimination learning** - positive and negative stimuli, must identify the positive stimulus

**Serial learning**
- lists
- sequences
- mazes

**Spatial learning** - positive and negative stimuli.
- radial maze

**Biological constraints**

**Conditioning**
- stimulus/response preferences - some stimuli are more easily associated with some responses
- easy to jump or bar press for food; hard to condition to grooming or scratching
- shock produced fear easily paired with visual/auditory stimuli; difficult to pair with taste
- illness easily associated with taste but not visual/auditory stimuli
- avoidance of shock easily paired with barrier jumping but not bar pressing.

**Discrimination learning**
- easy for dogs to associate voice tone but not location

**Spatial memory**
- rats are good at radial maze but pigeons are poor, yet pigeons are good in open field tasks.
- foraging patterns in rodents takes relative food quantity into consideration
- instinctive drift observed in highly trained animals
- imprinting
Ethology
- study of behavior in relation to the environment; innate behavior
- neuroethology - the study of the neural basis of innate behavior
  - echolocation in bats
  - electroreception in fish
  - sound localization in owls

Biological mechanisms which may underlie learning and memory
- activity dependent synaptic modification
- presynaptic enhancement of release - facilitation/sensitization
- presynaptic suppression of release - habituation
- postsynaptic enhancement of response
- alteration in membrane properties
- enhancement of action potential transmission reliability
- changes in neural excitability
- structural changes

Techniques for studying the role of neural systems in learning and memory

1) pharmacological manipulation
   - agonists/antagonists
   - systemic/local infusion

2) electrophysiology
   - field potentials
   - multiple unit activity
   - single units
   - ensemble activity

3) lesions
   - resection/transection
   - electrolytic - focal
   - neurotoxic - selective (kill cells leaving fibers intact)

4) imaging
   - PET - detection of small quantities of labelled compounds. radiolabelled glucose utilization
   - MRI - differences in molecular composition - blood oxygenation
   - optical dyes - electrical neural activity
   - optical imaging of intrinsic signal - blood oxygenation

5) anatomy
   - staining
   - tracing
   - electron microscopy (EM)
   - metabolic labeling

6) genetic manipulation
   - inducible (invertebrates)
   - selective