Three Types of Behavior
_______________________: involuntary responses to stimuli
_______________________: stereotyped responses triggered by environmental stimuli
_______________________: a relatively permanent change in behavior due to experience

Types of Learning
_______________________: a change in the magnitude of response to environmental events
   Habituation
   Sensitization
_______________________: a connection between two elements or events
   Classical conditioning

Habituation and Sensitization
__________________________________________
   The response to steady or repeated stimulus decreases over time
   Example: You don’t hear your air conditioner after it’s been running awhile
__________________________________________
   The experience of one stimulus heightens the response to a subsequent stimulus
   Example: People are “jumpy” following natural disasters, like earthquakes

Classical Conditioning and Pavlov
Dogs eating habits
   Noticed that the dogs salivate ________________________________
   Measured the amount of salivation that occurs when the dogs are anticipating food
   ________________________________ were Pavlov at first
   Changed to a tone

Pavlovian Conditioning
Before Training
______________________________ to a tone
   Salivation to meat only
After Training
_______________________________________________________________________

Classical Conditioning
A ________________________________ (CS) is an initially neutral stimulus that acquires the ability to signal important biological events
An unconditioned stimulus (UCS) is an event that elicits a response without prior experience
A ________________________________ (CR) is a learned reaction to a CS
An unconditioned response (UCR) is an unlearned reaction to a UCS

Using Aplysia Californica to Study Learning
The gill is used for breathing
The gill can be covered with the ____________________
Waste and seawater are released through the siphon
The gill-withdrawal reflex occurs when touching the siphon produces a retraction of the gill. Touching the siphon repeatedly yields a decrease in the __________________________: Habituation

**Eric Kandel and Habituation in Aplysia**
The siphon is served by 24 sensory neurons, whose cell bodies are in the abdominal ganglion. __________________________ form synapses with:

- excitatory and inhibitory interneurons
- six motor neurons serving the gill

**Possible Hypotheses for Habituation**
Do sensory neurons become less responsive?
Single cell recordings from sensory neurons __________________________ with repeated touching of the siphon

**More Hypotheses**
Does the gill muscle lose its ability to contract?
Electrical stimulation of the motor neurons produced __________________________, even after habituation

Do changes occur at the synapses between the sensory and motor neurons?

**Kandel's Explanation of Habituation**
Repeated siphon touches reduce entry of __________________________ into sensory neurons, which release less neurotransmitter
Smaller __________________________ occur in interneurons and motor neurons
Motor neurons produce weaker response, leading to less gill withdrawal

**Aplysia also show sensitization**
After an electrical shock to the head or tail, there is an increased __________________________ when the siphon is touched

**Sensitization in Aplysia**
Shocking the tail stimulates interneurons that __________________________ with sensory neurons serving the siphon
Sensory neurons release __________________________ onto motor neurons, and the gill retracts strongly

**Long-term Changes**
Normal *Aplysia* showed __________________________ terminals on sensory neurons
*Aplysia* experiencing sensitization had __________________________
*Aplysia* experiencing habituation had __________________________

**Classical Conditioning in Aplysia**
Electrical shock to the tail leads to __________________________
Touching the mantle alone does not trigger anything __________________________ with the shock leads to gill-withdrawal reflex
After learning, touching the mantle alone leads to gill-withdrawal reflex
Classical Conditioning

Mechanisms for Classical Conditioning
Touching the _________________________leads to NT release
Amount released is too small to get a ______________________
Touching the tail leads to an increase in the NT released at the gill-withdrawal reflex
After ______________________________
More NT is released when the mantle is touched by itself

Conditioned Emotional Responses and the Amygdala
Typical Paradigm:
Tone (CS+) followed by shock (UCS) results in reduced feeding (CR) in rats
Recording during training shows an increased response of the ________________________
to the tone
Lesions of the ________________________ of the amygdala prevent the learning of
emotion responses
Blocking NMDA receptors in the amygdala prevents learning of conditioned emotional
responses
Thus: the amygdala is involved in ______________________________

Learning and the Cerebellum
Cerebellum is involved in ________________________
Also probably involved in motor learning
_________________________________________ of neurons controls learning

Long Term Depression
Long term depression
A ____________________________of a synapse that lasts hours or days
Thought to be associated with learning
Found in the ______________________________
Long term potentiation
A long lasting __________________________ of a synapse
Thought to be associated with memory

Classical Conditioning of the Rabbit’s Nictitating Membrane
A tone (CS) followed by a puff of air to the eye (UCS) leads to closure of the nictitating
membrane (UCR)
Activity in the ________________________________ (LIP) of the
cerebellum increases in response to the tone over trials

Human Research and the LIP
Humans learn classically conditioned ________________________
PET scans show __________________________ during
classical conditioning
Individuals with cerebellar damage have difficulty learning conditioned eyeblink
responses

Memory
Memory refers to the ________________________________ of information
No _________________________________ between learning and memory
Learning and memory may be viewed as a continuum

**The Atkinson-Shiffrin Model of Memory**

**Divisions of Long-term Memory**

**Locating the Memory Trace (Engram)**
Karl Lashley observed the effects of lesions on rats’ ________________________________
The larger the amount of cortex damaged, the more errors the rats made
Lashley believed that the ________________________________ was distributed across the cortex

**Brain Stimulation and Memory**
Wilder Penfield stimulated the cortex of patients undergoing surgery for epilepsy
8% of the patients experienced specific memories when their ________________________________ were stimulated
Lead to the theory that memories could be ________________________________
Penfield’s results may have been influenced by the patients’ epilepsy

**Patient H.M. and Memory**
Large areas of H.M.’s temporal lobes were ________________________________
H.M.’s ________________________________ were not affected
H.M. experienced profound anterograde amnesia
Inability to learn ________________________________

**Amnesias**

Loss of memories of the past
Inability to form new memories

**H.M.’s Memories Are Not Equally Affected**
______________________________ allowed H.M. to converse
H.M. retained the ability to learn ________________________________
H.M.’s deficits appear in explicit memory tasks

**The Delayed Nonmatching to Sample Task**
Monkeys with ________________________________ damage do poorly on the DNMS task
The DNMS task requires the ability to form long-term memories

**Conclusion thus far**
The ________________________________ and the ________________________________ seem to play a role in forming associations (very basic learning)
Animal studies
The ________________________________ seems to play some role in memories
HM and Monkeys
What about the Hippocampus?
The Hippocampus and Memories
HM had major lesions to his _______________________
   Anterograde amnesia
LTP occurs in the hippocampus
LTP results when synapses become more _______________________
LTP can be demonstrated indefinitely in living animals and for hours in slices of hippocampus

LTP Shares Characteristics with Long-term Memory
Unsure of whether LTP is the mechanism for Long term memories BUT
   Both LTP and long-term memories last _______________________
   Both LTP and long-term memories result from very brief input
   LTP is consistent with cellular ______________________ proposed by Donald Hebb
NMDA receptors (Glutamate) closely associated with LTP

The Hippocampus and Human Memory
The right hippocampus is active during ________________ processing and the left hippocampus is active during verbal memory processing ________________________ of the hippocampus are more active during encoding, and caudal portions are active during retrieval
The hippocampus does not ______________________ , but transfers them from short to long-term storage

Patient N.A.
A fencing foil produced a lesion to N.A.’s left dorsomedial thalamus
N.A. experienced profound ______________________ and some retrograde amnesia
N.A.’s memory loss was similar to H. M.’s

The Diencephalon and Memory
Korsakoff’s patients show ______________________ and retrograde amnesia ______________________ deficiencies result from chronic alcoholism
   Untreated thiamine deficiencies damage dorsomedial thalamus and mamillary bodies
Monkeys with lesions in the dorsomedial thalamus have difficulties with the DNMS test
Temporal-diencephalic circuits may process _______________________

Localization of Semantic Memories
Semantic memories are ______________________ in the cortex ______________________ : inability to recognize common faces
Localization of Memories
Encoding and retrieval may activate different areas

Episodic Memory and the Cortex
Greater ______________________ and temporal activity is associated with hearing your own story rather than another person’s
In ______________________ , a patient forgets when and where a memory was formed
Episodic memory is superior in families where left-handedness is common
Short-term Memory and the Cortex
The ___________________________ may be involved with short-term memory
Patients with prefrontal damage do poorly on the Wisconsin card-sorting task
____________________________ tasks:
- Are mastered by infants at the age of 7 or 8 months
- Adult monkeys with prefrontal lesions respond like immature human infants

The Basal Ganglia and Procedural Memory
Lesions of the ___________________________ impaired declarative memories (remember where you went last time)
Lesions of the ___________________________ (basal ganglia) impaired procedural memories
Patients with Huntington’s disease and Parkinson’s disease have procedural memory deficits, but not declarative memory deficits

Genetic Manipulation of Learning Ability
*Drosophila* can learn to avoid odors associated with electric shock
Blocking the expression of the ___________________________ gene prevents learning and formation of short-term memories
Too much CREB-2 blocks long but not short-term memories
Extra CREB-1 produces immediate long-term memory

Unusual Memory Phenomena

______________________________
Flashbacks

______________________________
Stress affects the amygdala and hippocampus
Cortisol may damage the hippocampus

Eye Witness Testimony
Beth Loftus: __________________________
Had students go home and ask younger siblings: Hey, do you remember that time when you got lost in the mall?
The siblings had never been lost in the mall
The siblings conjured up ____________________________
Bugs Bunny at Disneyland

Memory and Normal Aging
In healthy adults, most measures of ___________________________ remain stable
Memory loss may accompany changes in brain systems that utilize the neurotransmitter ___________________________ (ACh)
Attaining an ___________________________; engaging in complex, non-routine professions; and earning high income appear to protect against cognitive decline