

# [Aplysia – learning and memory](https://assignbuster.com/aplysia-learning-and-memory/)

Synaptic PlasticityActivity dependent changes in synaptic transmission that can alter the normal circuitry and thus behavioral responseWhat did Santiago Ramon y Cajal think? Mechanisms underlying learning does not require formation of new neurons, but strengthening connections between existing neurons ONAPLYSIA – LEARNING AND MEMORY SPECIFICALLY FOR YOUFOR ONLY$13. 90/PAGEOrder NowHebbian Plasticity + what else did Hebb contribute? Neurons that fire together wire together
-Proposed synaptic plasticity as a theoretical mechanism for learning and memorySynaptic Plasticity leads to change in \_\_\_\_\_\_\_\_ at what two locations? Circuit Function
Both Pre-and Post synaptic locationsShort-term synaptic plasticity (Time course and how it occurs)-Seconds to minutes
1. Post-translational modification of existing proteinsLong-Term Synaptic Plasticity (Time course and how it occurs)-Hours/Days/Years
1. Changes in Gene expression
2. Protein Synthesis
3. Growth of new synapsesFunctional Roles of Synaptic Plasticity1. Development
2. Learning
3. Memory
4. Motor ControlMolecular Mechanisms of Synaptic Plasticity (6)1. NMDA Receptor Activation
2. Protein Kinase Activation
3. Phosphatase Activation
4. AMPA Receptor Insertion
5. Gene expression and protein synthesis
6. Growth/Loss of synapsesOne major advantage of using AplysiaHuge neurons - over 100 microns in diameter
You can stick an electrode in with your handSimple Learning Examples1. Habituation
2. Sensitization
3. Classical Conditioning2 Neural Mechanisms for Learning and who advocated for themPresynaptic - Kandelians
Postsynaptic - GlanzmanWhat kind of approach was taken with aplysia? Reductionist!
This is a simpler system with a simpler NSHow many neurons are in Aplysia brain? Compared to Human? 2x10^4
Human has 10^12Describe the Gill Withdrawal ReflexTactile or electrical stimulation of the siphon or mantle elicits withdrawal of the gill & siphon into the mantle cavityNon-Associative LearningReflective mechanism - not associating a stimulus with anything

Poke in the eye is going to cause you to reflexively avoid that in the future

Example of non-associative learningHabituation - a meaningless stimulus might startle someone the first time (clap) but get less reaction laterWhat does habituation need? A consistent interval within a short period of timeHabituationReduction of a response with repeated presentation of a stimulusHabituated Gill Withdrawal - what else could be be due to? Muscle Fatigue
Change in motor neuron responseHow do we know that habituated gill withdrawal is not due to those things? A touch on the head (not siphon) produces a full response after habituation has occurredKandel's Proposed mechanism of habituationReduction of synaptic release of NT at some point in the neural networkHow do you experiment on habituation with the gill withdrawal reflex? Keep NS intact, cut away most of body, leave the siphon skin & tail still connected together and to the system
-Map the synaptic connectivityWhat is the system between the siphon skin and the gill? Sensory neuron to interneuron
Interneuron to motor neuron to gill
\*\*Sensory neuron also goes straight to motor neuronWhat is the system between the tail skin and the gill? Sensory neuron to modulatory interneuron
Modulatory neuron to interneuon
Interneuron to motor neuron to gill
\*\*Modulatory interneuron also goes straight to motor neuronWhat was occurring during habituation? Presynaptic Phenomenon
-Depression of NT release between the siphon afferent and the motor neuron

\*\*NOT synaptic fatigue, bc that behavior comes back when you re sensitize the animal

Habituation Experiment - What did the depression do? How long did it last? Lasts for Minutes
-Presynaptic
-Reduction in strength of excitatory synapses between sensory neuron and motor neuron
-Decrease in number of synaptic vesicles available for releaseSensitizationGeneralization of an aversive response elicited by a noxious stimulus to another non-noxious stimuliShort Term Sensitization - What form of facilitation is this? Presynaptic
-Recruitment of additional synaptic elements that modulate synaptic transmission at sensory neuron-motor neuron synapse
-Enhancement of NT release onto motor neuronsSensitization - What is responsible for short and long term? Short - Presynaptic
Long - Becomes both pre and post synapticWhat does the sensory neuron release on the motor neuron? GlutamateHow does sensitization happen? What NT is responsible? Serotonin is released presnaptically & acts through adenylyl cyclase to ultimately close K+ channelsHow serotonin acts in sensitization (Short Term!)1. Serotonin binds to receptor on sensory neuron
2. Activates adenylyl cyclase
3. ATP to cAMP
4. cAMP activates PKA
5. PKA closes K+ channels
6. Depolarizes the cell
7. VG Ca2+ channels open
8. Ca2+ comes in
9. Increase in vesicle release
10. Increases response of a motor neuron to the same stimulusDescribe Long Term Sensitization steps1. Same steps with serotonin & eventual PKA activity
2. Sustained PKA activity - gets translocated to the nucleus
3. Ultimately binds to TF in nucleus
4. Activates transcription of genes
5. Some of those are enzymes that keep PKA in activate state
6. Leading to an increase in Ca2+ concentration & bigger post synaptic responseWhat other long term change occurs in sensitization? Structural! Number of synapse is increasing as well as the efficacy of those synapsesClassical ConditioningChange in responsiveness to one stimulus (CS) based on association with another stimulus (US)Describe Classical Conditioning in AplysiaUS - Shock
CS - Lightly touching the siphon

Eventually, touching the siphon will lead to a strong withdrawal reflex

Proposed mechanism for classical conditioningEnhanced presynaptic facilitation
-Ca2+ channels open bc CS already fired the sensory neuron
-Serotonin effect is enhanced bc Ca2+ binds to calmodulin - binds to adenylyl cyclase, etcWhich two types of learning depend on presynaptic facilitation? Classical Conditioning
SensitizationRole of NMDA receptors in classical conditioning in AplysiaCoincidence Detectors on the motor neuron3 steps of post synaptic depolarization1) LTP
2) Upregulation of AMPA receptor function
3) Stimulation of retrograde signal2 Parts of Presynaptic Activation1) Late Phase presynaptic facilitation
2) Late-Phase hyperexcitability