SITN
science in the news

October 27, 2010
Forget-Me-Not: How Memories are Formed and Lost

Introduction:

We all have memories of events and facts, and we have all forgotten something at one time, but how does this happen? In this lecture we address the questions of "what is memory" and how scientists found some of the parts of the brain that are used to form memories. We go on to discuss how scientists investigate questions regarding memory and what processes play roles in better or worse memory. Finally, we will discuss how we forget, lose memories, or have faulty ones. Throughout we discuss how scientists today are investigating memory. We encourage you to ask questions of the speakers both during and after their presentations. After the lecture, there will be a brief tour of one of the Harvard University laboratories where you can see first-hand the equipment and tools that allow biomedical scientists to expand our knowledge about memory and forgetting.

Speakers:

Allison Nishitashi grew up in Portland, Oregon and studied neuroscience as an undergraduate at USC. She is currently a 3rd year graduate student in the Program in Neuroscience at Harvard Medical School where she studies the development of the inner ear in Dr. Lisa Goodrich's laboratory.

Alix Lacoste is a 2nd year Ph.D. student in the laboratory of Alex Schier at Harvard, working on understanding what controls sleep and wake states in the brain. She grew up in France and earned her undergraduate degree at Berkeley but decided to leave the wine countries for the rich atmosphere of Boston. She enjoys watching the behavior of tiny transparent zebrafish larvae in the lab, traveling, as well as discussing movies and poetry.

Heather McLaughlin is a 3rd year graduate student working in the lab of Bruce Yankner, studying Alzheimer's disease. She grew up in Vermont, where a love of outdoor recreation was instilled at an early age. She is currently a passionate runner, who just signed up for her first Boston Marathon, but also enjoys hiking, triathlons, backpacking, sailing, and rock climbing.

Next Week's Seminar:
Our Microbial Organ: The Good and Bad Bugs of the Human Gut
http://sitn.hms.harvard.edu

Glossary:

Memory- An organism's ability to store, retain, and recall information and experiences

Neuron- Cells of the nervous system, called nerve cells or **neurons**, are specialized to carry "messages" through an electrochemical process. The human brain has approximately 100 billion neurons.

Axon- The long, extension off of a neuron that carries information from that neuron to another neuron or a functional target. It is like an electrical wire for the neuron.

Dendrite- A short, branched extension off of a neuron, along which information from other neurons are receive and brought to the neuron cell-body.

Synapse- A junction between two neurons that consists of a minute gap through which neurotransmitters are released by the axon of one neuron and recognized by the dendrite of another.

Neurotransmitter: A chemical substance that neurons release to communicate with other neurons or with muscles or other functional targets.

Aplysia- A family of sea slugs with an involuntary, defensive gill and siphon withdrawal reflex when the animal is disturbed. This neural circuit has been studied to help understand memory.

Short Term Memory- Memory that lasts for a relatively short time (seconds to hours) and is due to changes at an existing synapse

Long Term Memory- Memory that lasts for a relatively long time (months to years) and is due to the creation of a new synapse

Memory Consolidation- A process that stabilizes a memory after it is acquired by making short-term memories go to long-term storage places.

Neural Circuit- a population of physically interconnected neurons communicating with each other that forms a coherent network.

HM- Pseudonym for a patient, Henry Gustav Molaison (1926-2008), who was widely studied after he underwent invasive brain surgery for epilepsy that damaged his hippocampus, among other brain regions. He had amnesia, whereby he could remember childhood, but had no long-term memory for events after the surgery.

Hippocampus- A deep region of the brain that plays important roles in long-term memory and spatial navigation. A part of the hippocampus, the *dentate gyrus*, makes new neurons throughout adult life.

Frontal Cortex- The part of the brain near the forehead. Among other functions, it plays key roles in choosing, defining differences and similarities, recognizing consequences, and storing long-term memories, especially those associated with emotions.

Forgetting- The process of no longer being able to recall a portion of memory. Could happen by active suppression of a memory, by under-use of the memory circuit, or by neuron cell death.

Amyloid Plaques- Tangles of proteins in the brain between cells that are out of place and harden.

Neurofibrillary Tangles- Tangles of large in brain neurons that are out of place and harden

Alzheimer's Disease- The most common cause of premature senility. A progressive mental deterioration that can occur at middle or old age. Involves protein plaques in the brain, but it is inconclusive whether or not they are the cause.

Cross sectional Studies- Research studies that involve observation of a representative subset of a population, at a single, defined time.

Longitudinal Studies- Research studies that involve repeated observations of the same individuals over long periods of time.

Amnesia- A condition in which memory is disturbed or lost. It can affect the ability to learn/ remember new things (anterograde) and/or disable recollection of existing memories (retrograde).

Functional MRI- A medical imaging technique that allows visualization of soft tissue, like brain, that is combined with the ability to look at different parts with high activity by revealing usage of oxygen.

For more information:

- Understanding Science: http://undsci.berkeley.edu/
- H.M.'s Brain: http://thebrainobservatory.ucsd.edu/hm

Forget Me Not: How Memories are Formed and Lost

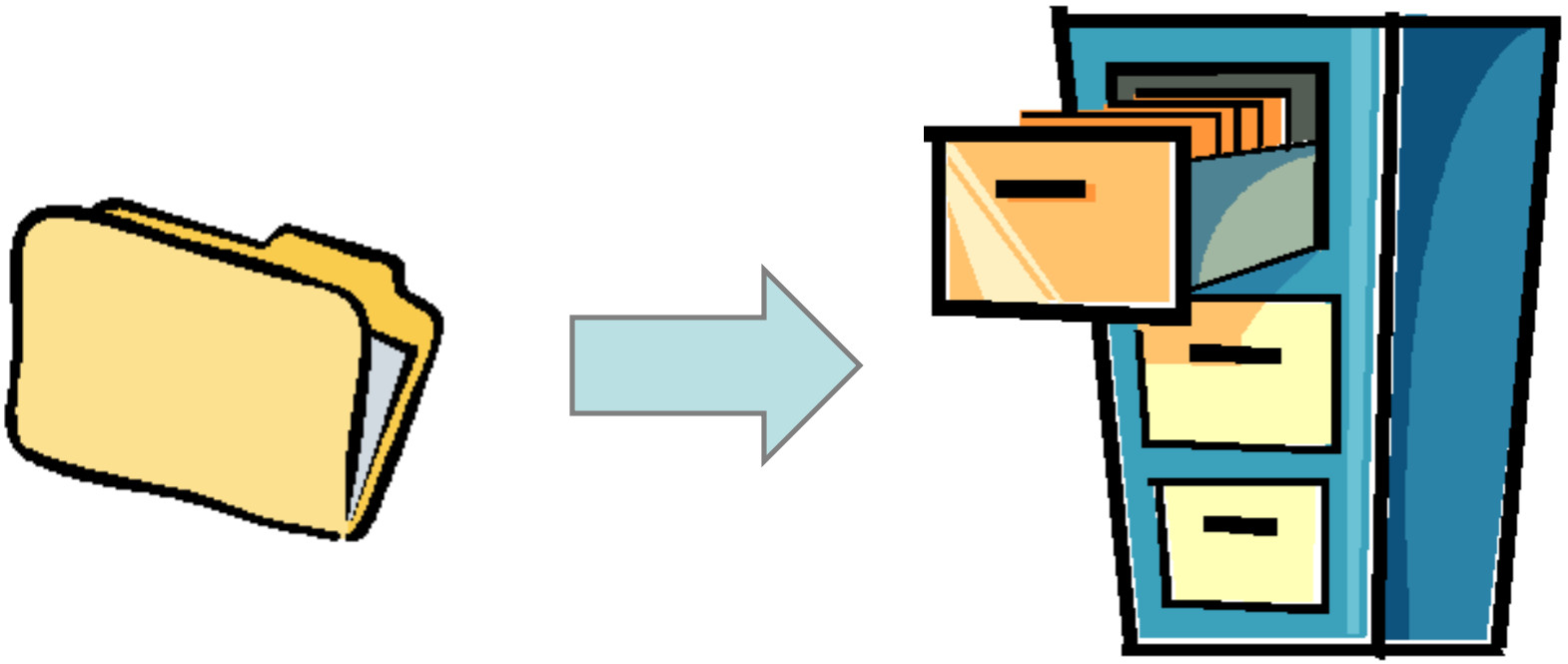
Allison Nishitani
Alix Lacoste
Heather McLaughlin

Lecture outline

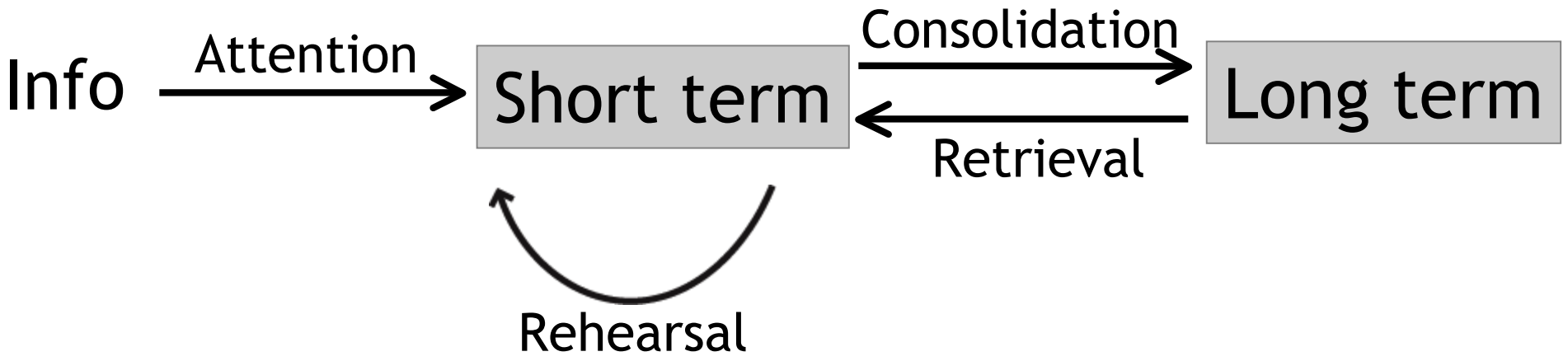
- Part 1: Introduction
  - What is memory?
  - What parts of the brain are involved in memory?
  - How does our brain form memories?
- Part 2: How do scientists study memory?
- Part 3: Memory loss

What is memory?

The ability to store, retain, and recall information and experiences

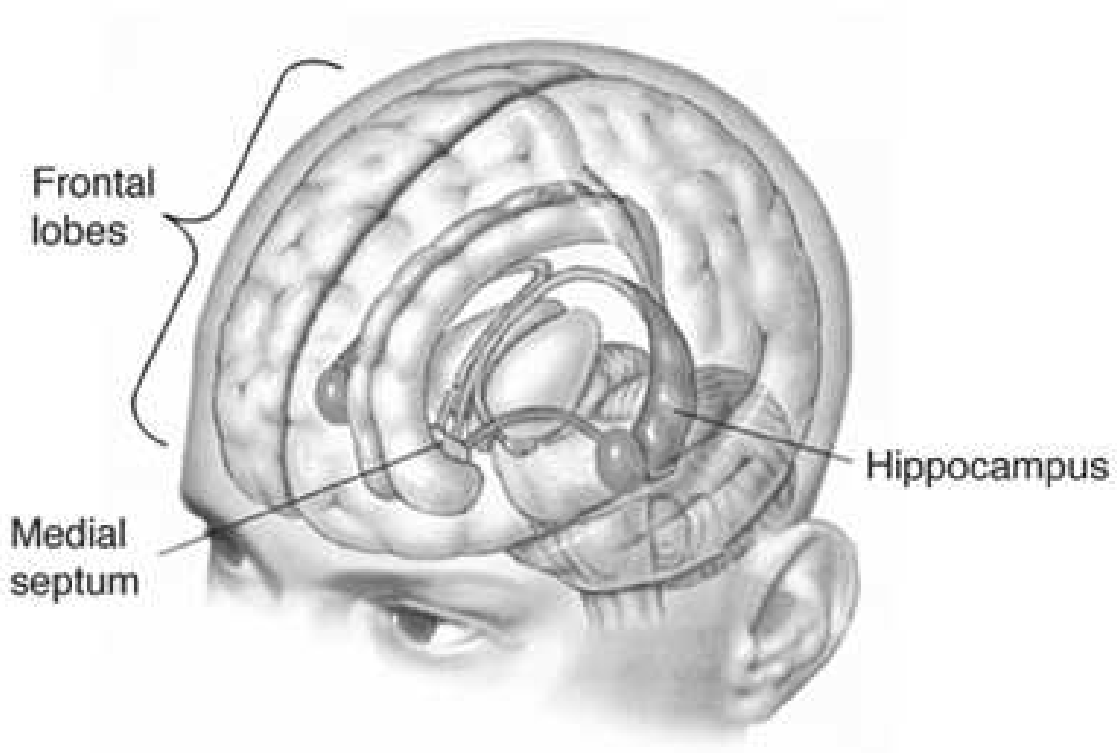


Multi-store memory model



Memory in the human brain: H.M. and the hippocampus

- Due to epilepsy, H.M. had a large portion of his brain removed on both sides in 1953
- This area contain a structure called the hippocampus



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H.M.’s memory deficits

- Long term memories from before the surgery intact
- Short term memory intact
- Inability to form most new long term memories
- Could learn new motor tasks

Different types of memory

- Explicit/declarative: factual knowledge, consciously recalled
- Implicit/non-declarative: knowledge of how to do something, unconsciously recalled
- H.M. taught us that the hippocampus is important for the formation of long term explicit/declarative memories but not implicit/non-declarative memories

Different types of memory

Barack Obama is the president of the US

EXPLICIT

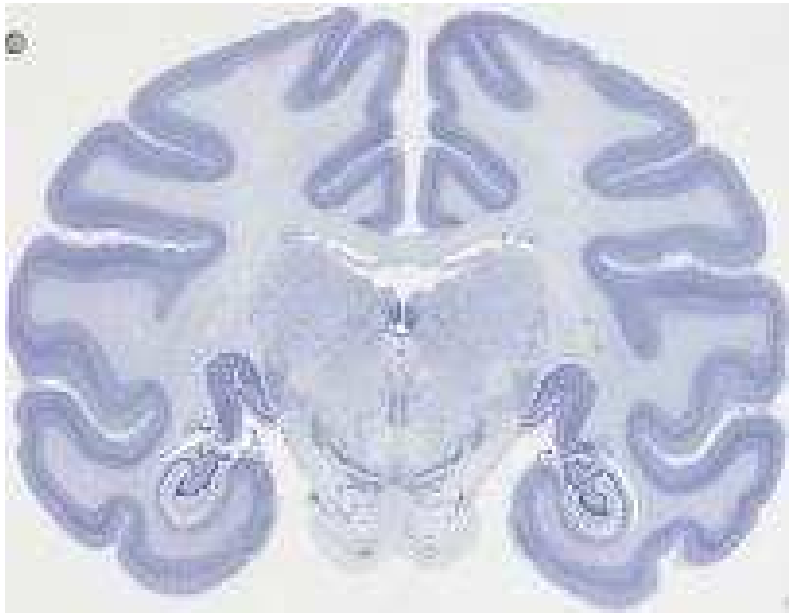
Obama knowing how to shoot a basket

IMPLICIT

http://change.gov/newsroom/entry/new_official_portrait_released/
Official White House Photostream

The future of H.M.’s brain

- H.M. donated his brain to The Brain Observatory at UCSD
- His brain was preserved and sliced into thin sections mounted onto glass slides
- Different stains and dyes will be used to reveal structure and neural connections



What could a slug teach us about memory?

- The sea slug aplysia
- Despite a simple nervous system, aplysia can form memories

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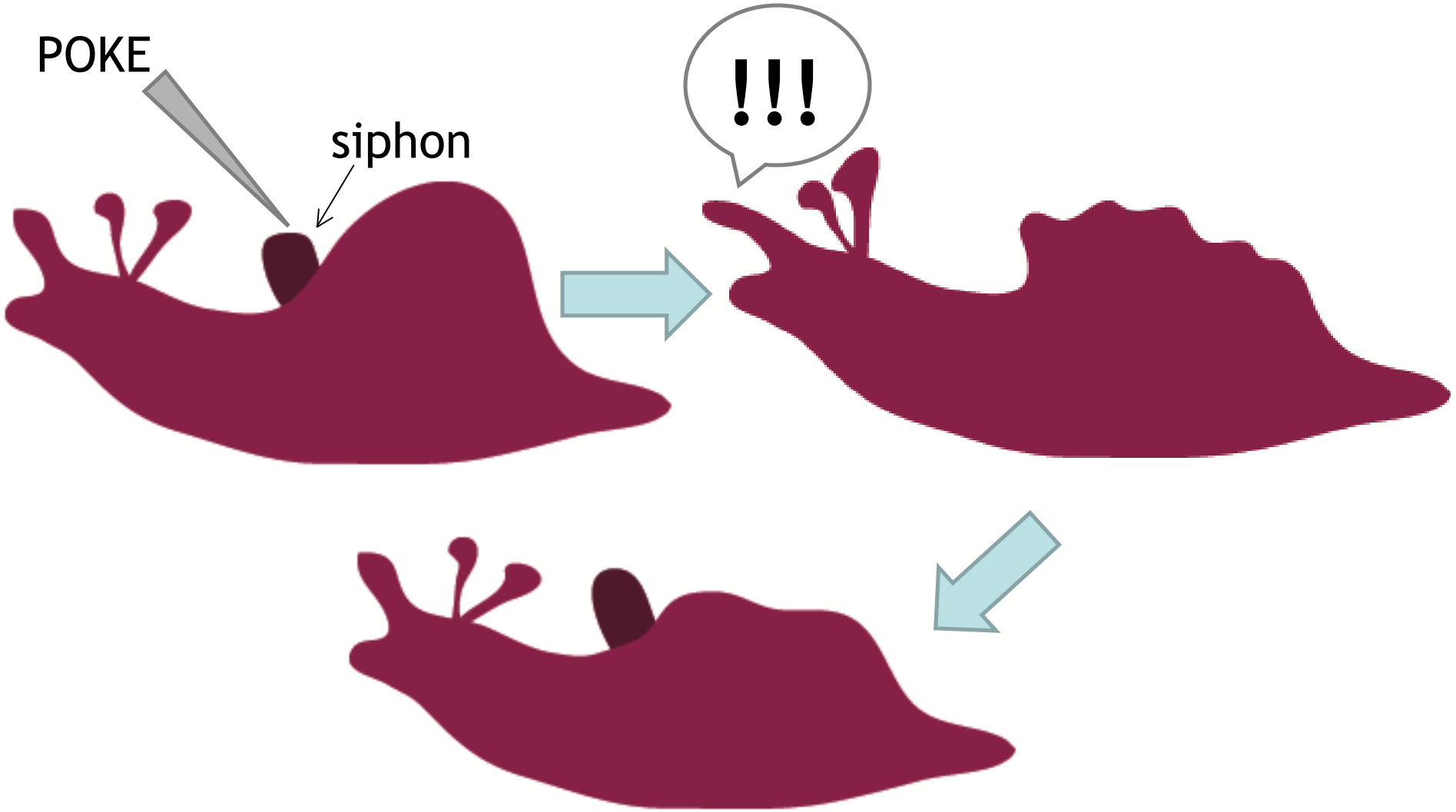
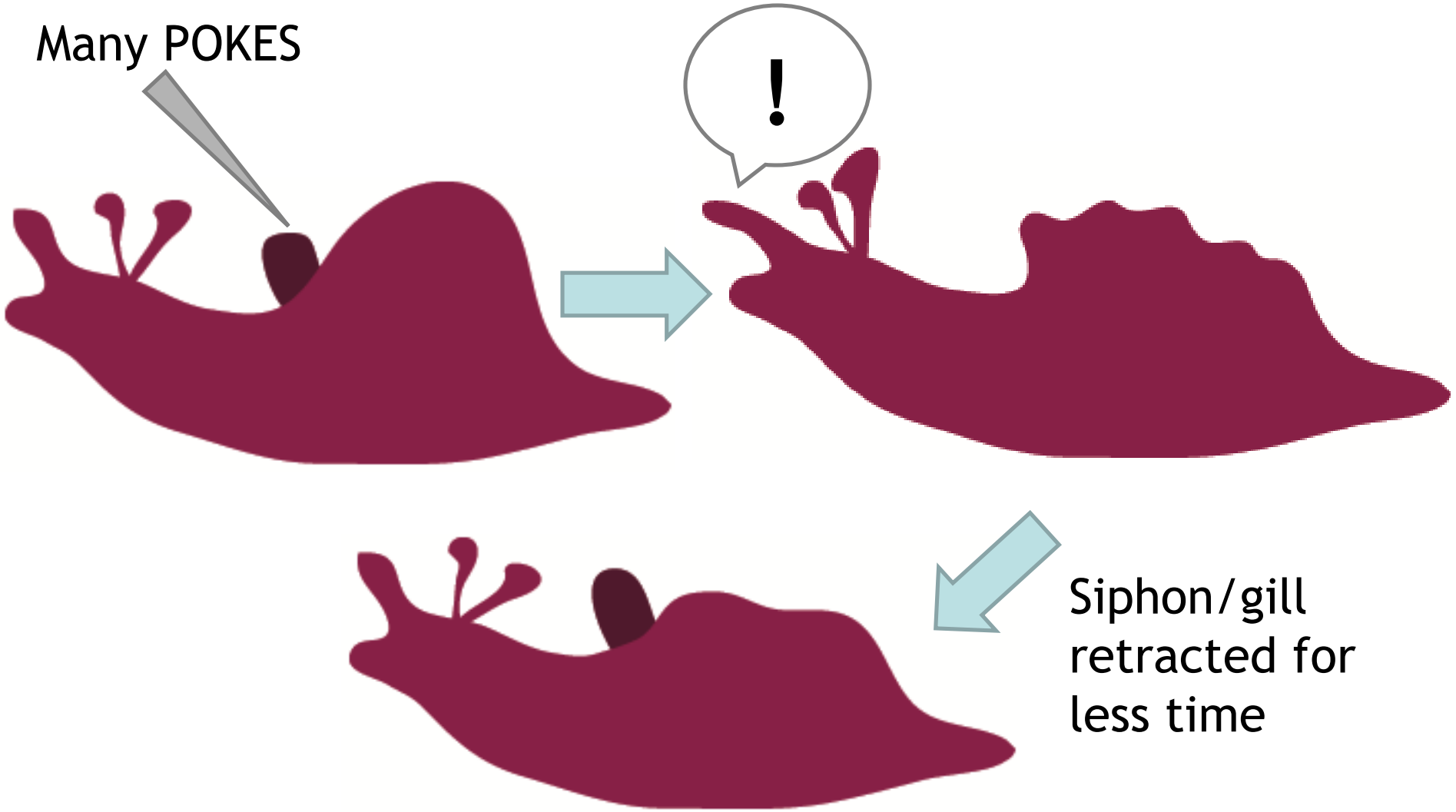
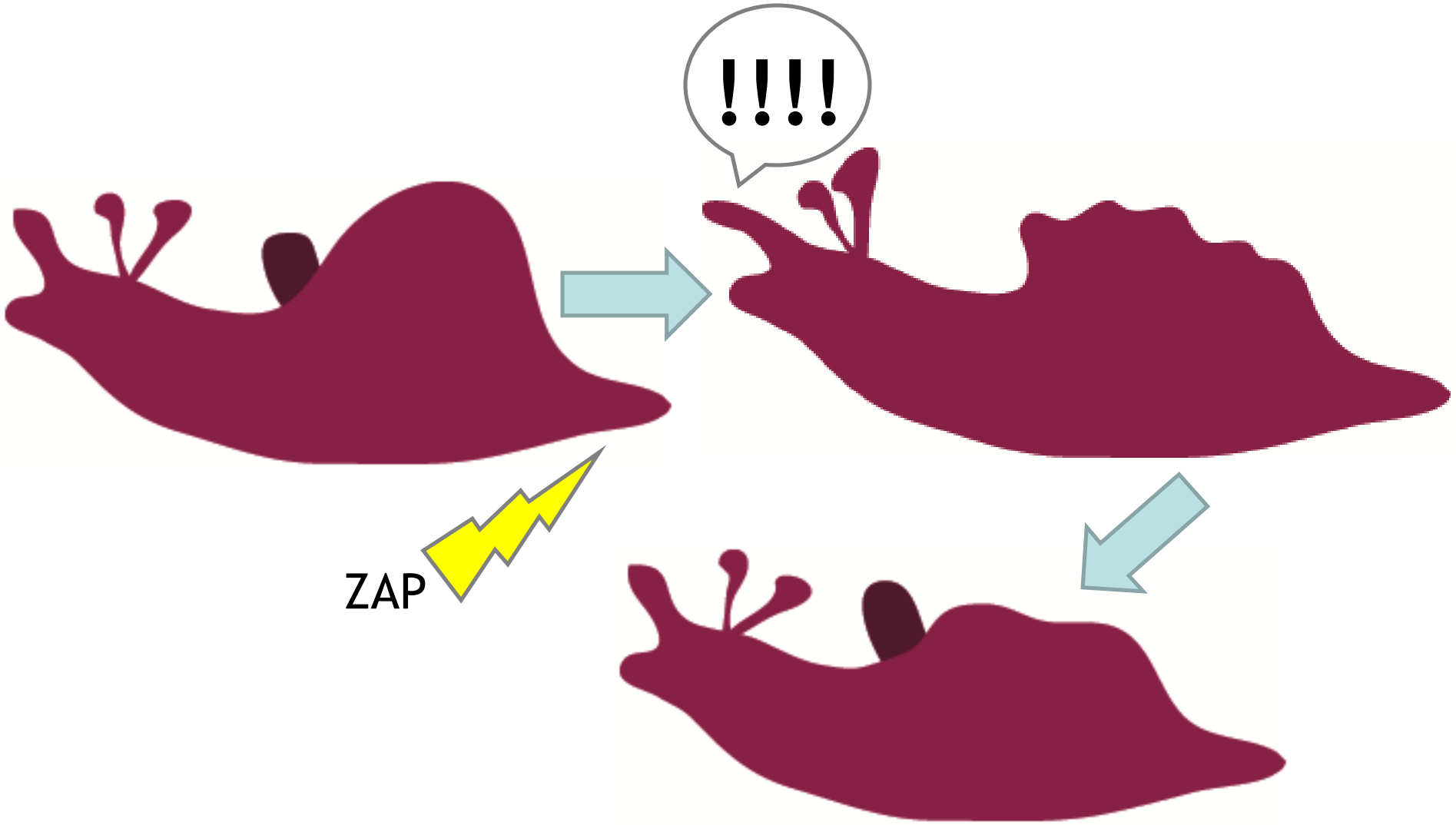
Siphon withdrawal reflex



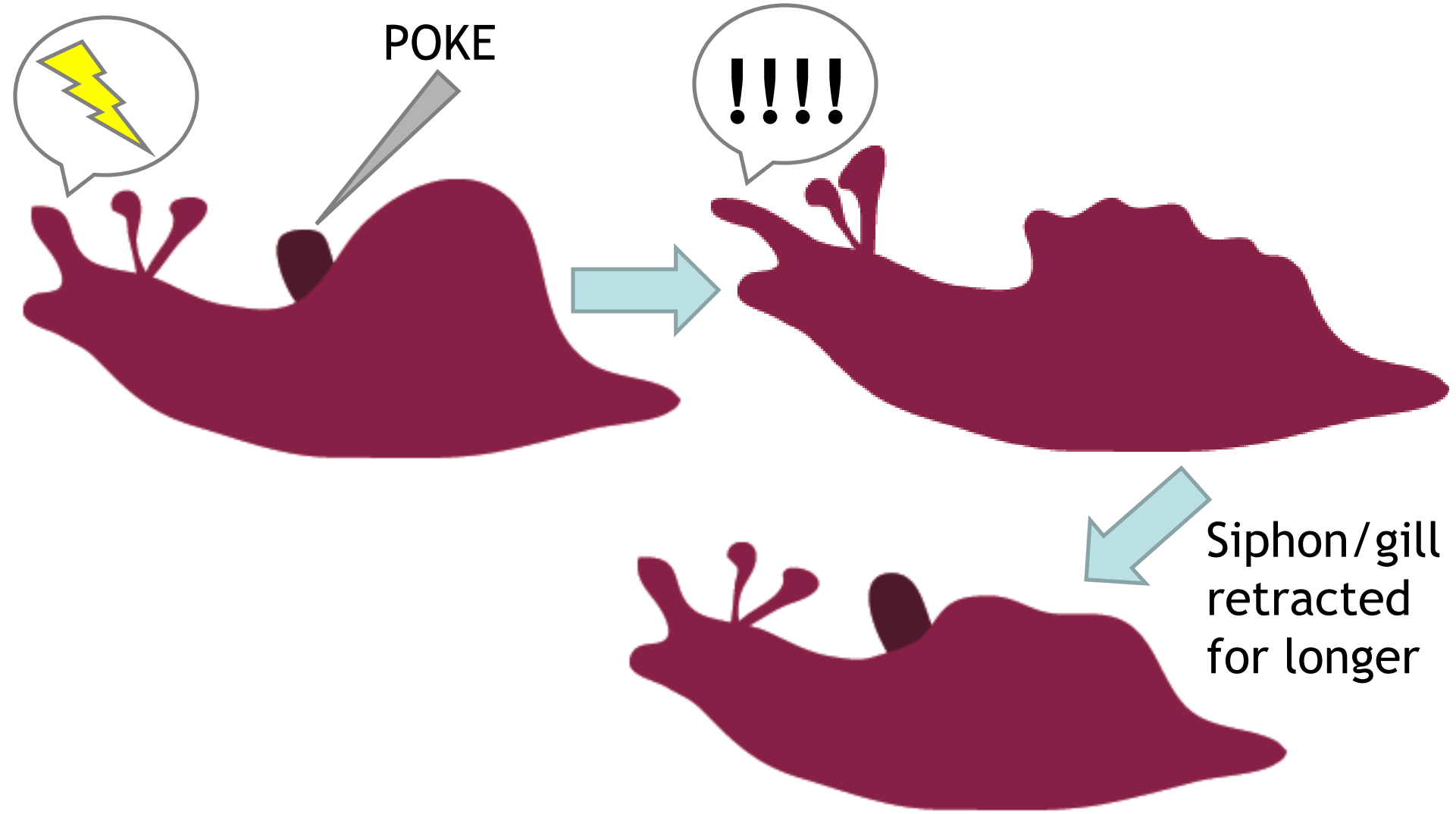
Siphon withdrawal reflex



Siphon withdrawal reflex

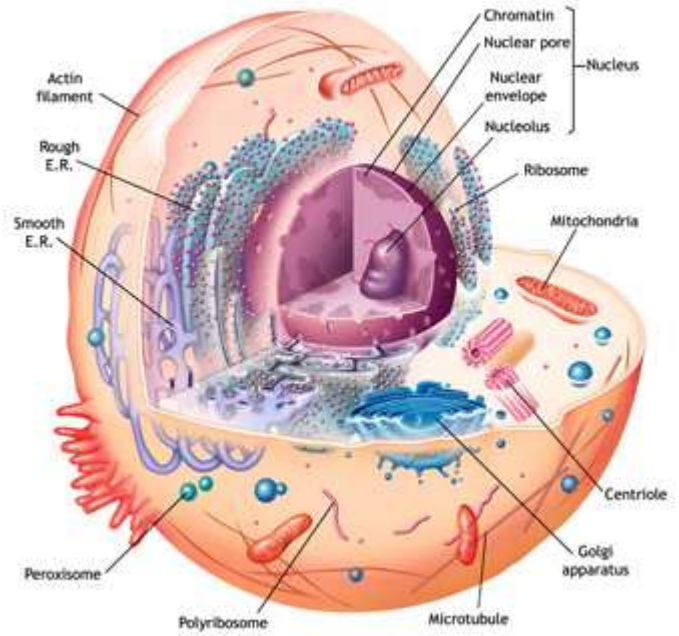


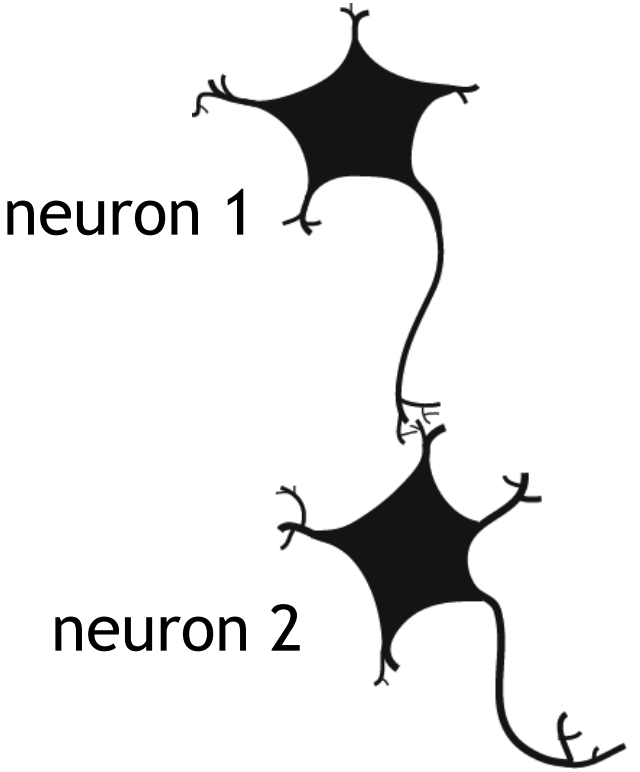
Siphon withdrawal reflex



Neurons and the brain

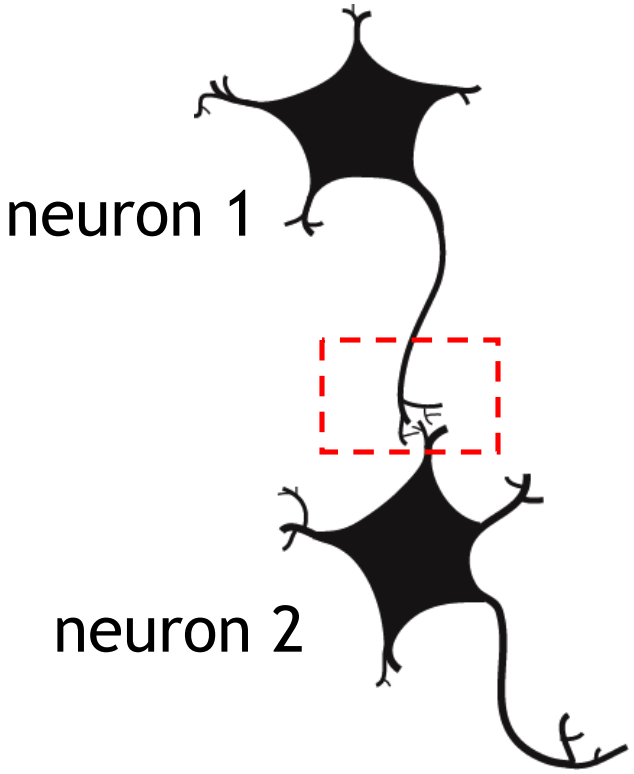
- Cells are the basic functional unit in living things
- Neurons are specialized cells

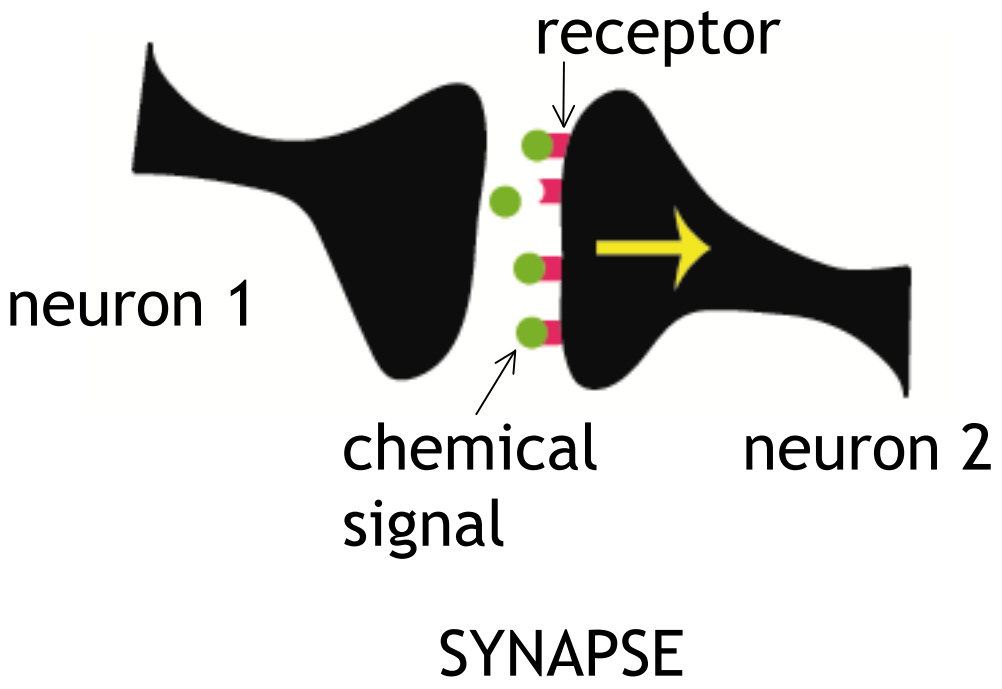




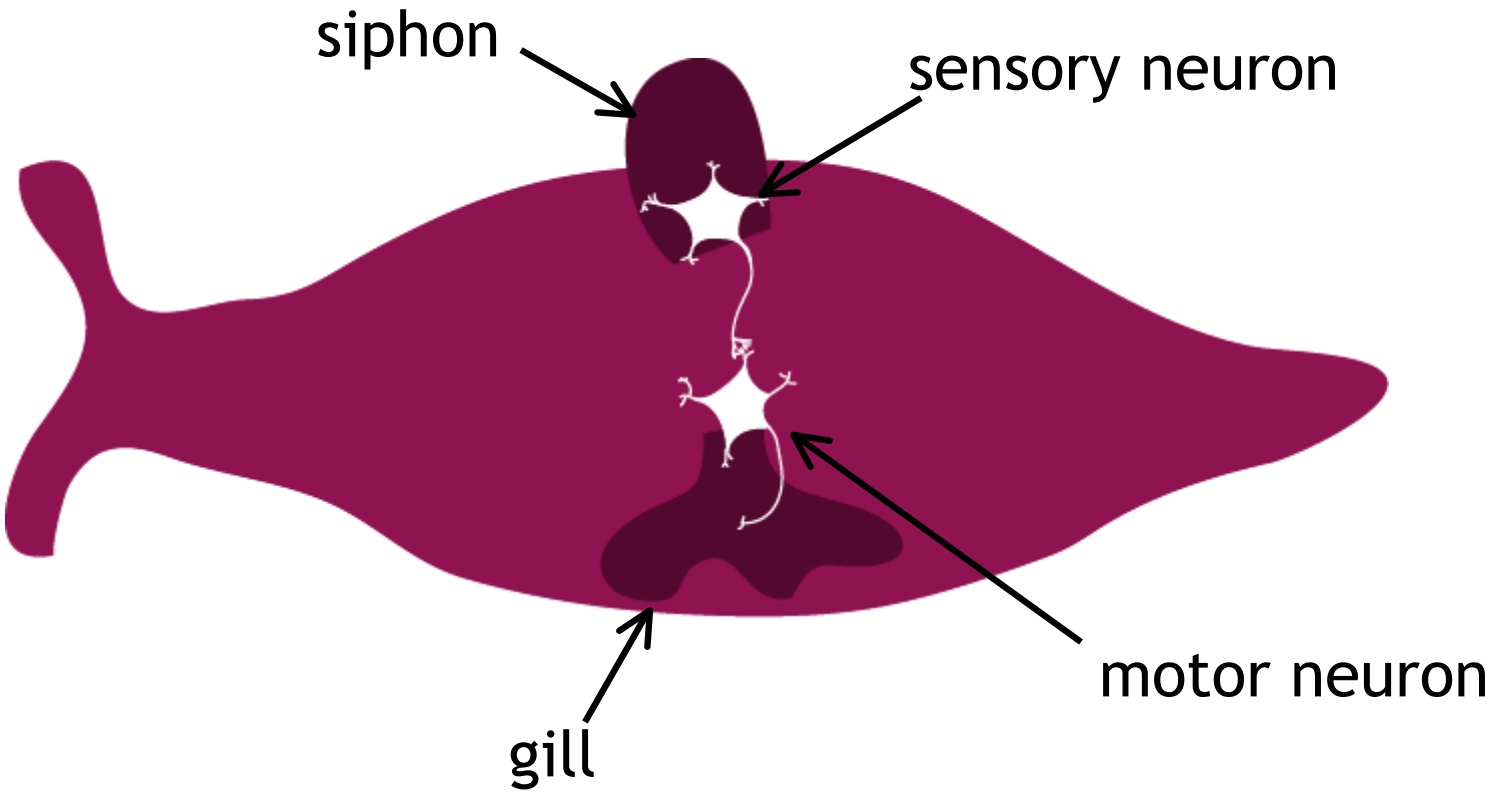
Neurons and the brain

- Neurons send signals to each other via synapses, specialized junctions between neurons





Simple aplysia neural circuit



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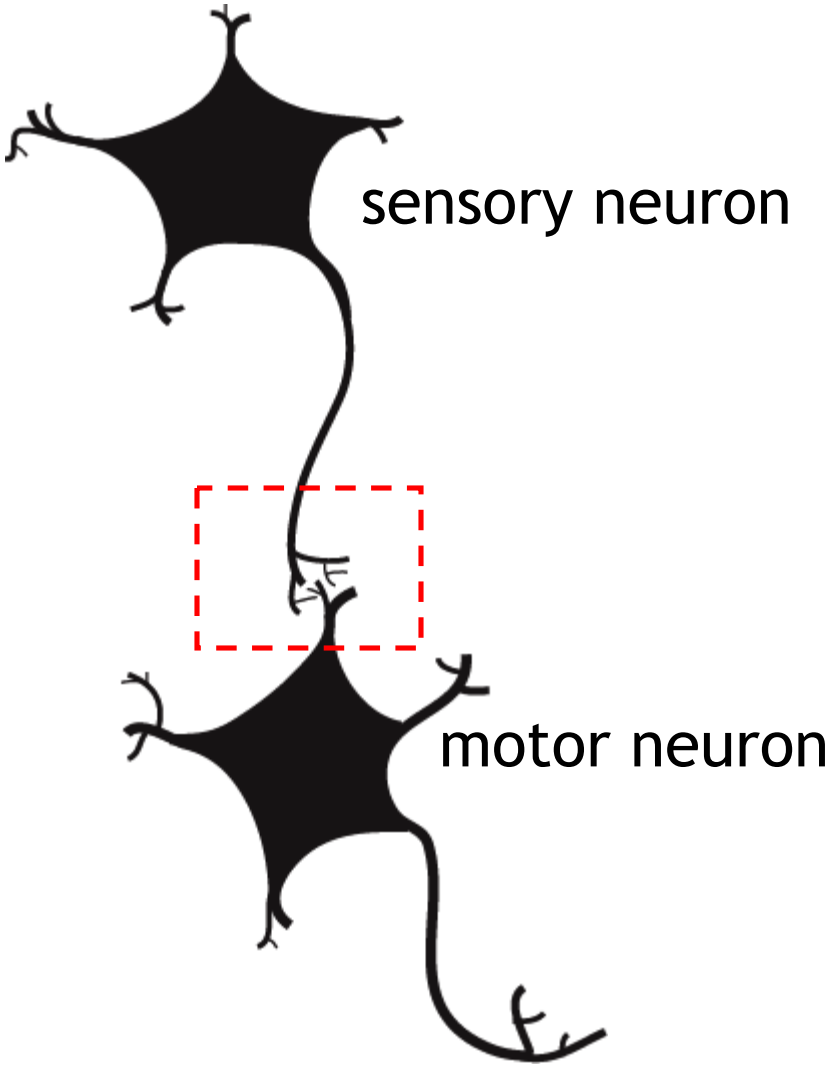
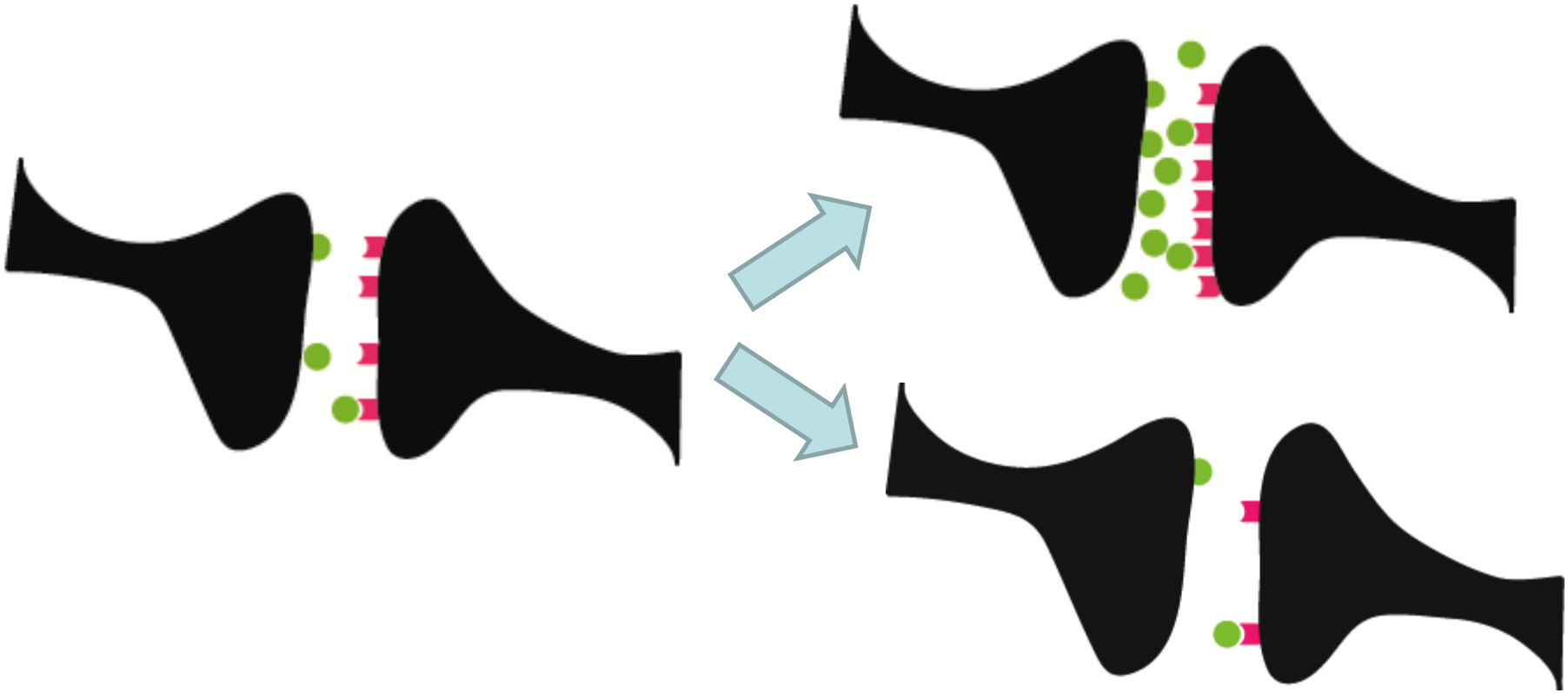


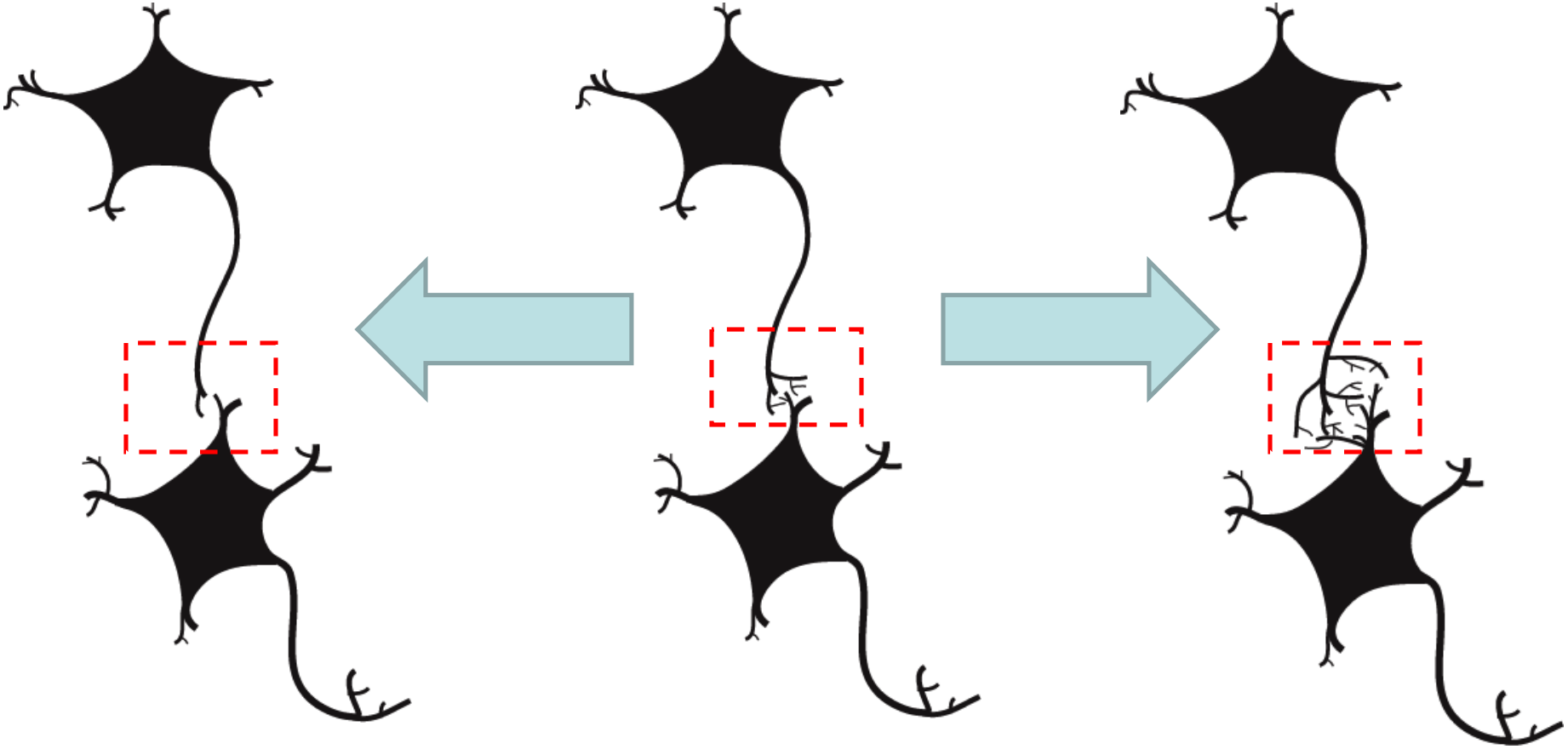
Memory at the synaptic level

- When a “memory” is induced, changes at existing synapses take place
- This happens quickly, but doesn’t last forever



Memory at the synap tic level

- After a longer amount of time, new synapses are created or existing synapses are pruned



Main points

- Our understanding of memory is still developing
- Different areas in the brain are important for different types of memory
- Changes in existing neural connections underlie memory