*Document Overview*

Within this document, you will find a connection to the MN state standards, Next Generation Science Standards, activity objectives, type of activity, duration of activity, connection to the Nobel Conference 2015 speaker, keywords/concepts, target audience, description of activity, materials list, teacher tips, the activity, extensions and follow-up activities, and reference section.

*Standards*

*Minnesota State Academic Science Standards*

- 7.4.1.1.1 Recognize that all cells do not look alike and that specialized cells in multicellular organisms are organized into tissues and organs that perform specialized functions.
- 7.4.1.1.2 Describe how the organs in the respiratory, circulatory, digestive, nervous, skin and urinary systems interact to serve the needs of vertebrate organisms.
- 7.4.3.2.2 Use internal and external anatomical structures to compare and infer relationships
- 9.1.3.1.1 Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs
- 9.1.3.1.2 Identify properties of a system that are different from those of its parts but appear because of the interaction of those parts
- 9.1.3.4.3 Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results

*Next Generation Science Standards*

MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

*Other Standards:*

*Objective*

The purpose of this lesson is to provide students with an understanding of neuron parts and functions, synapses, communication within the nervous system, and changes that occur when learning takes place as well as when learned information is no longer used.

*Type of Activity*

*Interactive Videos, Notebook Diagramming, Analysis Questions*

*Suggested Duration*

*50-60 minutes*

*Connection to Nobel Speakers*

***Eric Kandel*** *Area of Research: Biophysics/Ion Channels, Synapses & Circuits, Neurobiology of Learning & Memory, Animal Models of Psychiatric Disorders, Neurogenetics*

*Concepts/Keywords/Appropriate Classes*

*Appropriate Classes: Middle School/High School Life Science, High School Psychology*

*Key Concepts:*

- *Parts of a Neuron*
- *Communication between Neurons*
- *Electrical/Chemical Signals in the Brain*
- *What happens when we LEARN*
- *"Use it or lose it" phenomena*

*Keywords:*

- *Neuron*
- *Dendrite*
- *Axon*
- *Cell body (soma)*
- *Axon Terminal*
- *Nucleus*
- *Dendritic Spine*
- *Synapse*
- *Synaptic Vesicles*
- *Neurotransmitter*
- *Ions-Na+, K+, Cl-, Ca+*
- *Ion channels*
- *Receptor proteins*

*Description of Activity*

*In this activity, students will watch interactive videos (either as a large group or individually) and diagram, label, and/or color-code the parts, functions, and interaction between two neurons, including occurrences at the synapse. Students will answer analysis questions in their notebook. The teacher may follow up with a large group discussion.*

*Materials*

- Notebook
- Colored Pencils
- Computer/Device with Internet
- Video Links
- Ear Buds (if individual project)

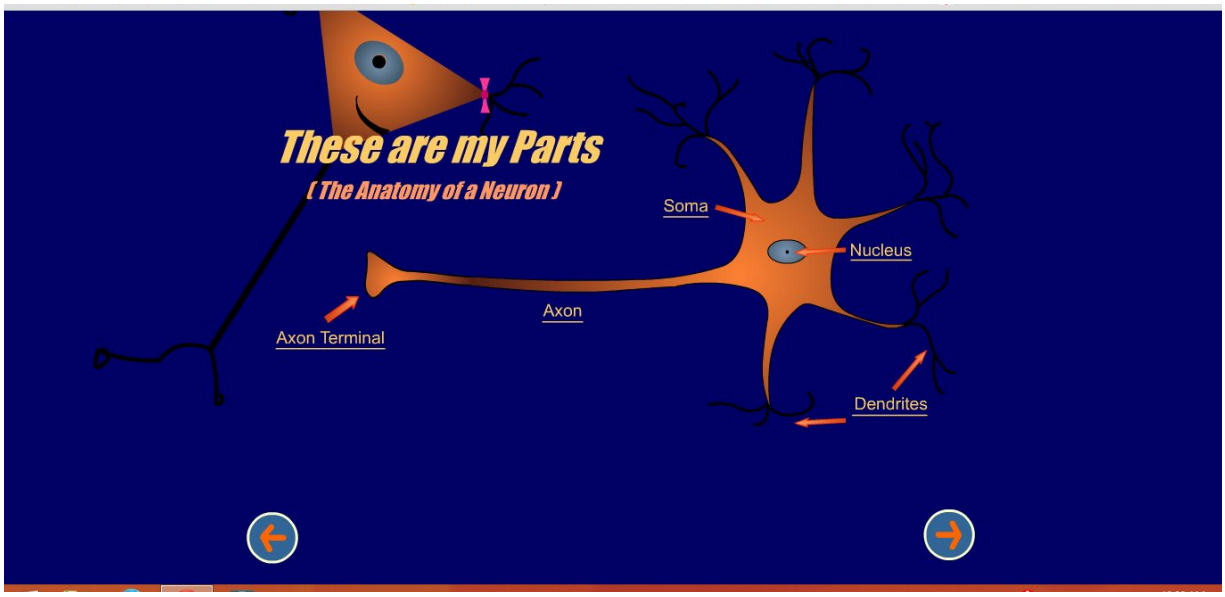
*Teacher Tips*

- *Students have heard that "you shouldn't kill brain cells because you won't get them back". So, propose to students, "If you cannot get MORE brain cells, what happens when we LEARN?"*
- Have students answer questions in their notebooks so that each student has enough "think time". Then, have the large group discussion so that everyone can contribute.
- *Watch this video for teachers on brain science and the impact this understanding has on teaching and learning: http://tedxtalks.ted.com/video/Teachers-know-your-brain-Sandra*

*Activity*

Play the Synapse Video: http://brainu.org/files/movies/synapse_pc.swf
While viewing this interactive video, have students create a labeled, color-coded diagram of two neurons in their science notebooks (or on a sheet of paper to be handed in). Include a space between the two neurons, the synapse. *Feel free to use additional resources including*

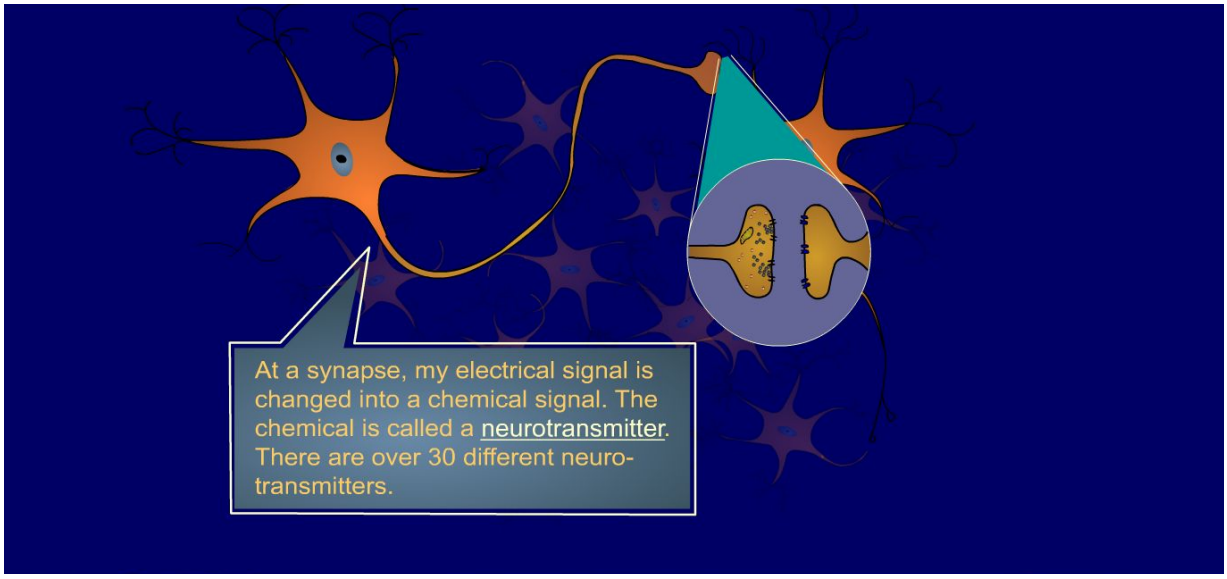
*your textbook as needed.*

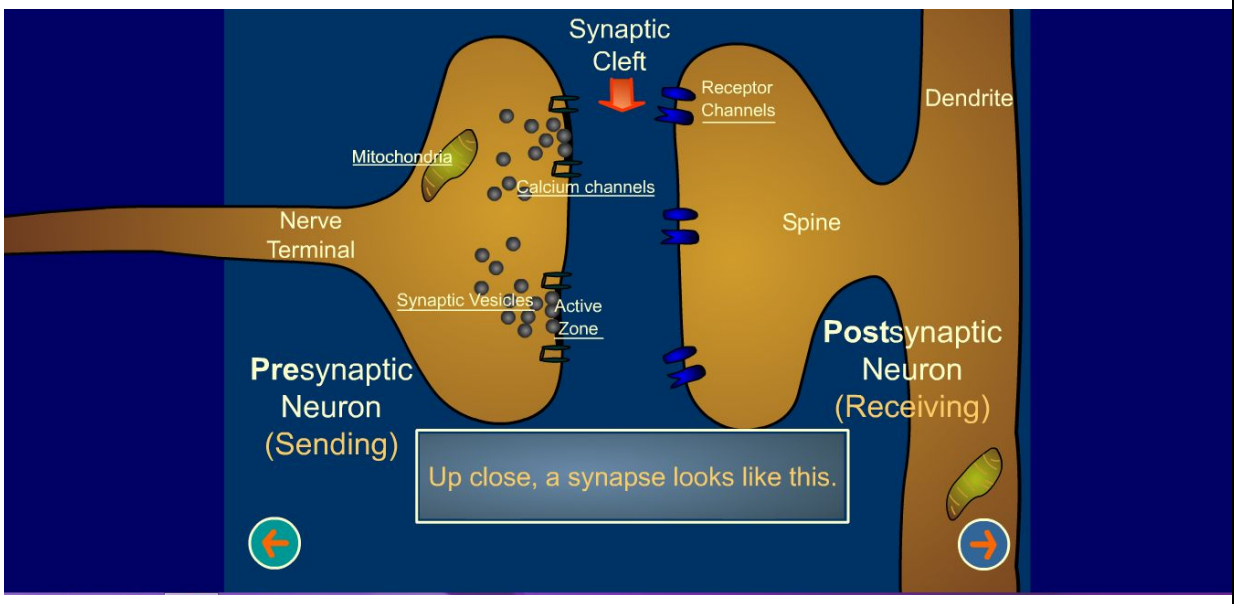



Include:

- cell body (soma)-orange
- nucleus-red
- dendrites-black
- axon-green
- axon (nerve) terminals-yellow
- label where the signal (action potential) is chemical, and where it is electrical.
- synapse-no color

**Add a blow up section to show and label/color code detail of what is occurring at the <u>synapse</u>.**



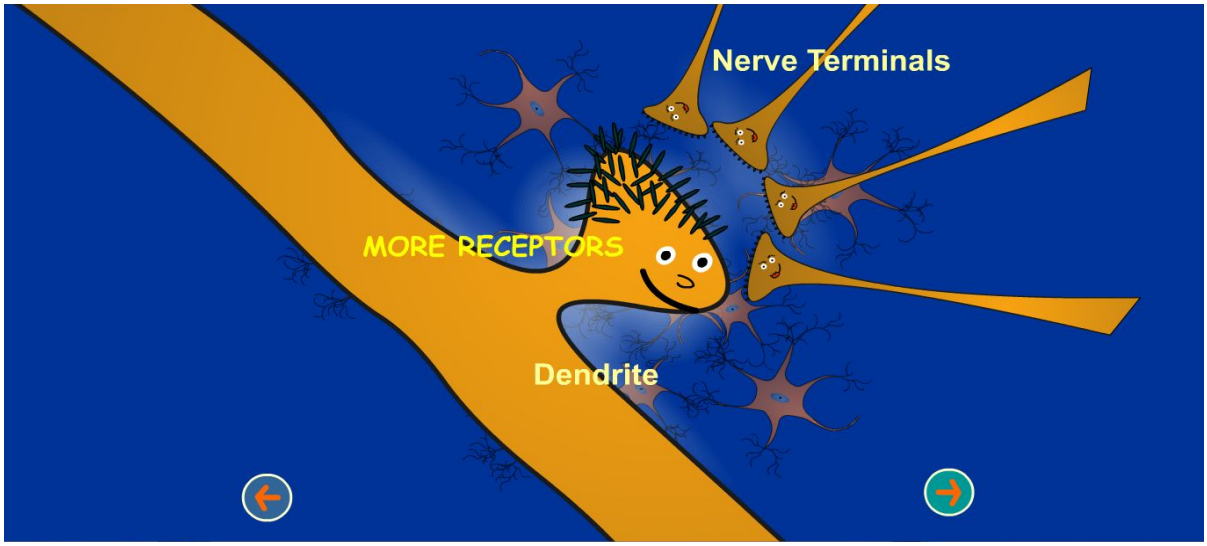



Label the parts of the synapse:

| | |
|---|---|
| • Presynaptic Neuron<br>• Postsynaptic Neuron<br>• Dendritic Spine<br>• Neurotransmitter (ex. Dopamine)<br>• Synaptic Vesicles | • Receptor Proteins<br>• Na+<br>• K+<br>• Pumps (for Neurotransmitter)<br>• Calcium Channels |

**<u>What happens when we LEARN</u>**

After completing the Notebook Neuron Drawing, show students the following interactive video: http://brainu.org/files/movies/synapseschange_pc.swf



Students should answer the following questions in their notebooks near their drawings. The teacher may conduct a large group discussion after, asking students to share out their answers to these questions.

1. Make a list of **changes** that occur at the synapse when **learning** takes place. Answers should include:
    a. More receptors
    b. More neurotransmitter
    c. More axon terminals coming in
    d. More dendrites
    e. More dendritic spines
    f. New synapses

2. Explain what changes can occur at a synapse when there is not enough stimulation. Answers should include:
    a. Receptors get absorbed
    b. Dendrites get absorbed
    c. Axon Terminals get absorbed
    d. The synapse disappears ("use it or lose it")

3. Explain why "Practice Makes Perfect". You may include a drawing to help explain this concept.
   Answers should include:
    a. Connections/pathways in the brain get very strong (refer to #1) as these circuits repeat over and over.

*Extension and Follow-up Activity*

*Learn Genetics puts out a fantastic site called "Exploring the Science of Addiction" with printable worksheets for students*

*http://teach.genetics.utah.edu/content/addiction/webquest/Exploring%20The%20New%20Science%20of%20Addiction.pdf*

*Sources/Bibliography*

*Movies | BrainU. (n.d.). Retrieved June 30, 2015. http://brainu.org/movies*

EXPLORING THE NEW SCIENCE OF ADDICTION. (n.d.). Retrieved June 30, 2015. http://teach.genetics.utah.edu/content/addiction/webquest.html