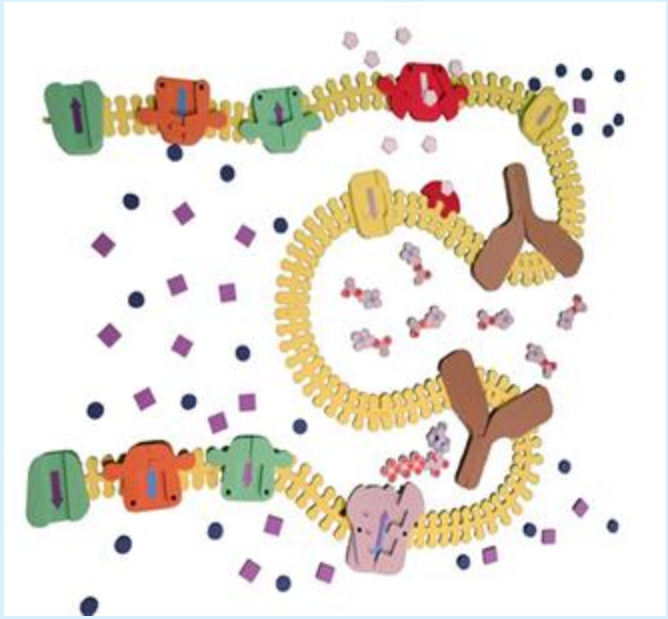
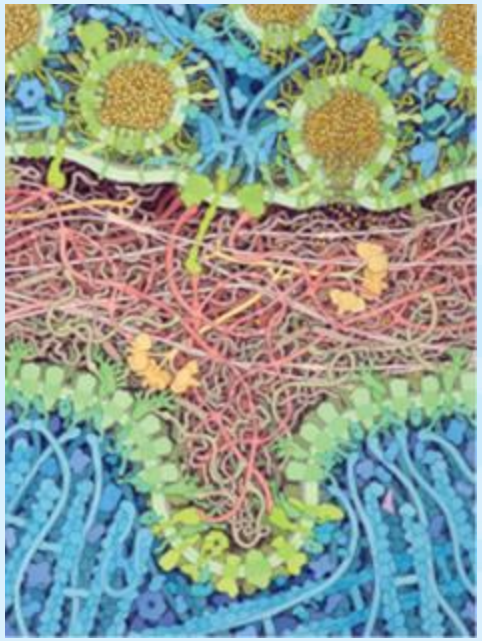
3d molecular designs

Transforming Science Learning

When Cells Talk Things Happen: Cell Signaling





Kim Parfitt

Kim Parfitt

Cheyenne Central High School (18 years)

And after 11 years of using 3D models and attending CBM summer courses, I am now working full-time for this amazing company.

Kim.Parfitt@3dmoleculardesigns.com

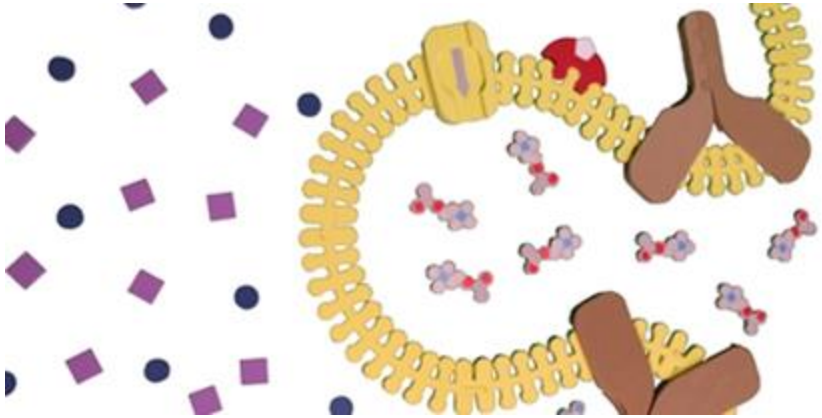
NABT OBTA | National Board for Professional Teaching Standards | BSCS Science Learning Leadership Academy | hhmi BioInteractive Ambassador

Now, about you…

Workshop Learning Goals

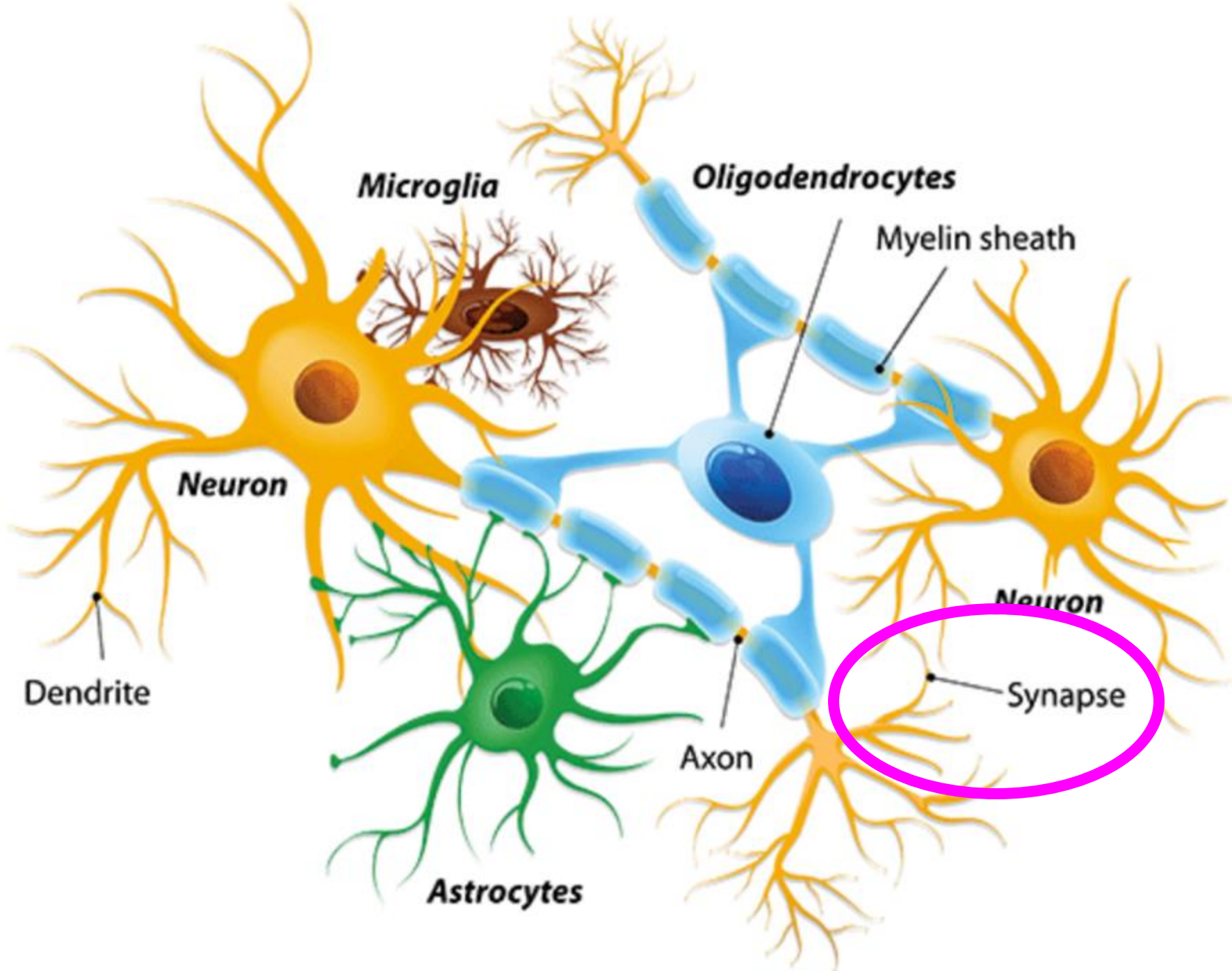
You will

- Wonder how messages get sent between cells (and do my students understand).
- Explore how models help students gather **evidence** for their own explanation for signal transduction between two neurons.
- Explain how modeling with the synapse kit can extend understanding in your classroom.



Think about what your students might be thinking when you ask them about neurons.

Discuss your ideas with a partner (groups of 3 ok).


Microglia
Oligodendrocytes
Myelin sheath
Neuron
Neuron
Dendrite
Synapse
Axon
Astrocytes

Systems of specialized cells within organisms help them perform the essential functions of life. (HS-LS1-1)

Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-2)
- Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-4),(HS-LS1-5),(HS-LS1-7)

Systems and System Models

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. (HS-LS1-2),(HS-LS1-4)

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (HS-LS1-1)

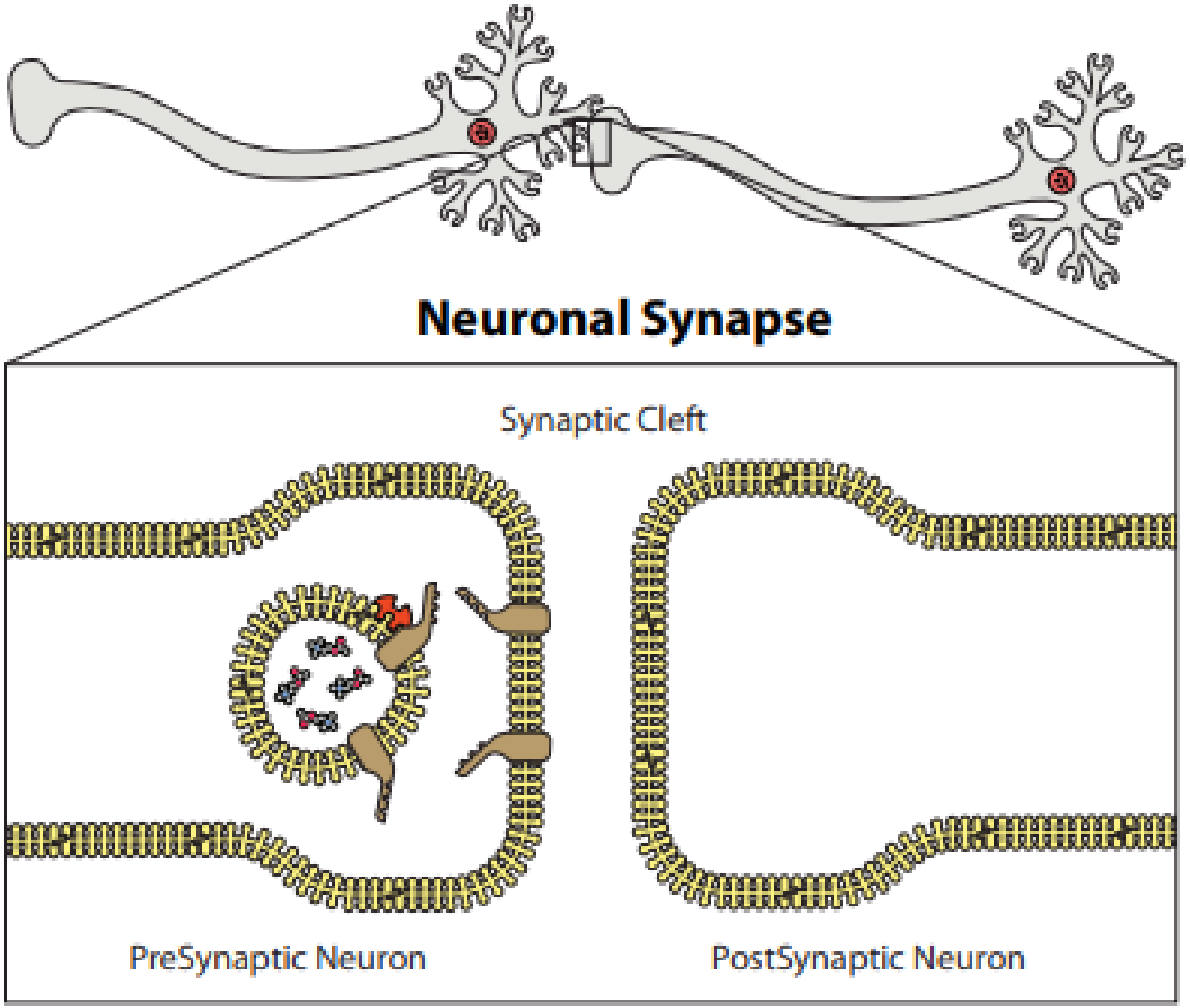
Stability and Change

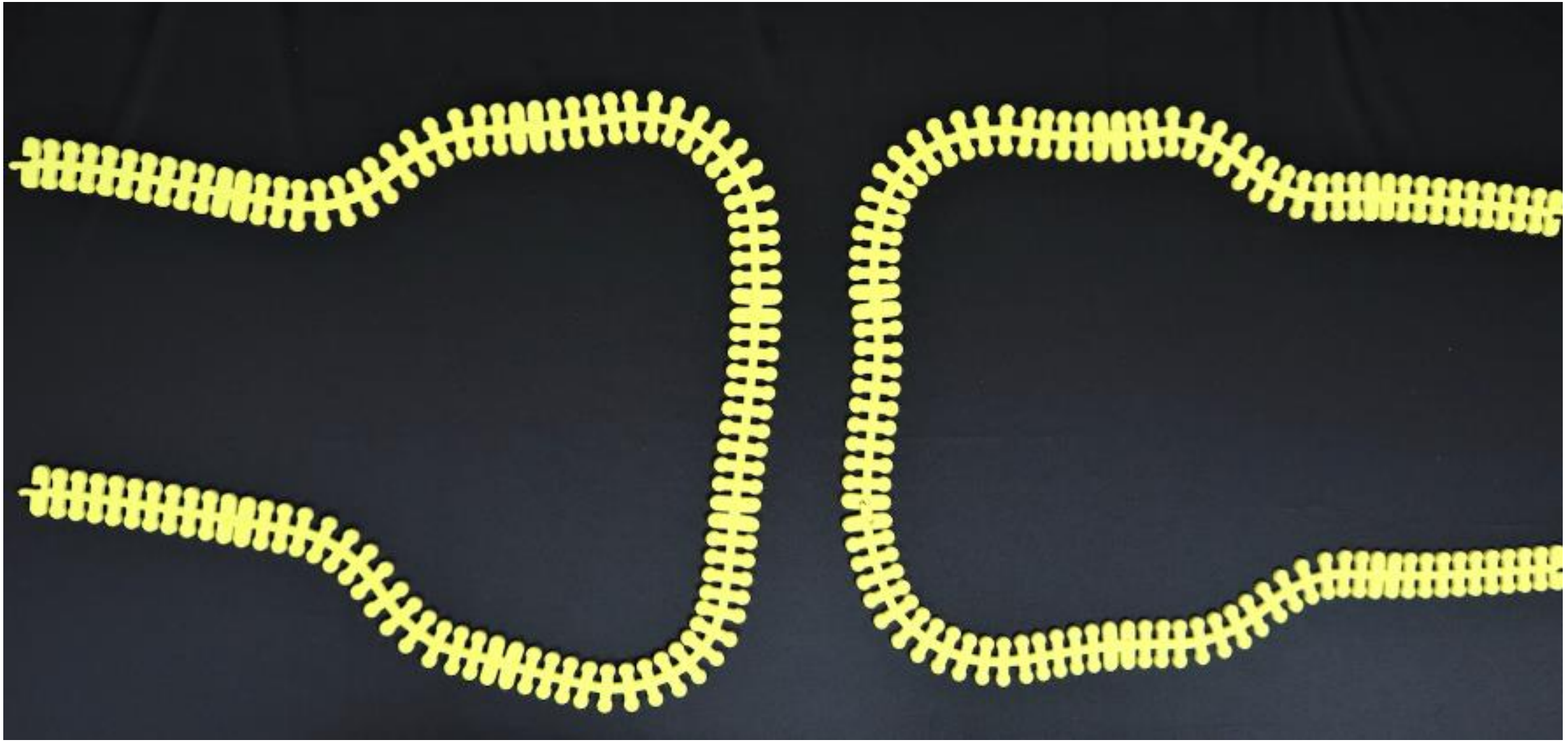
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-LS1-3)

Change scales!

Cellular to molecular

Put your molecule glasses on and use the yellow “train track” pieces to create a presynaptic neuron and a postsynaptic neuron





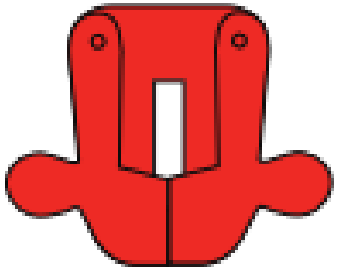
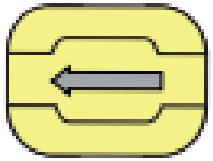
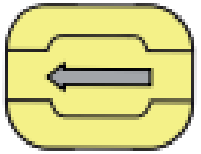
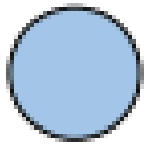
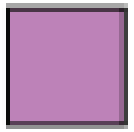
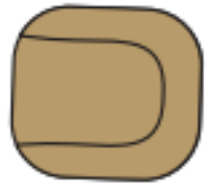
What would be familiar to your students?
What might be unfamiliar?

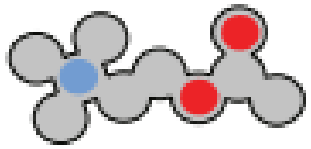
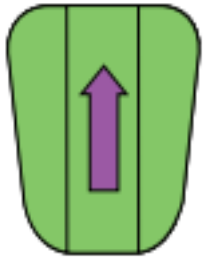
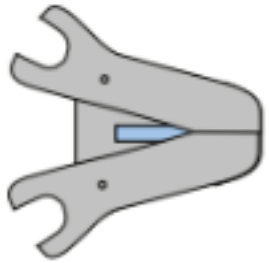
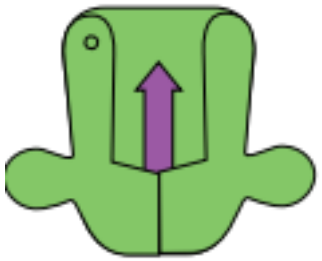
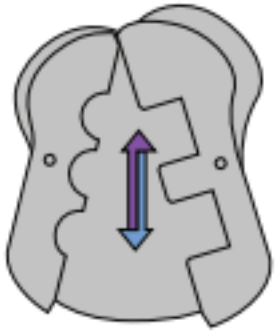
Students may encounter some text that describes what happens.

When two or more neurons are networked together, they come in close contact with each other, but they do not actually touch. Somehow, the signal crosses the gap between the two neurons.

Neurons communicate using both electrical signals and chemical messages. Information in the form of an electrical impulse is carried away from the neuron's cell body along the axon of a presynaptic neuron toward the axon terminal. When the electrical signal reaches the terminal, it cannot cross the synaptic space, or cleft.

Models help students gather **evidence** for their own explanation

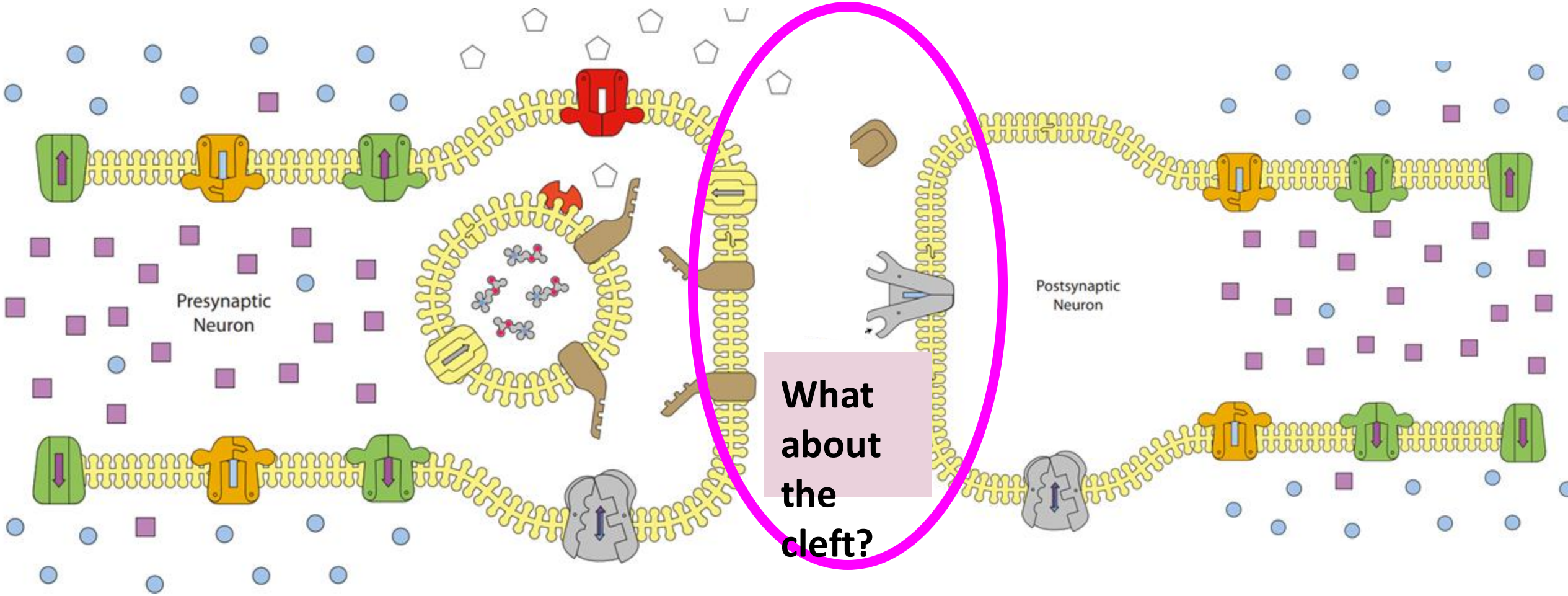








Cholinergic Synapse Guide

One group build Presynaptic neuron

One group build Postsynaptic neuron

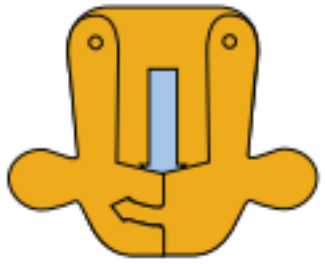
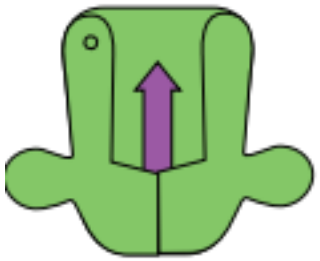
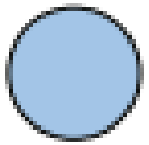
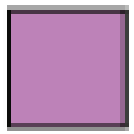


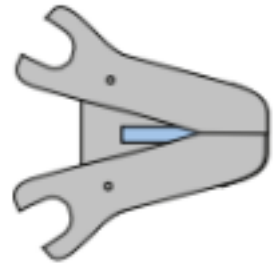
What do you notice? What do you wonder?

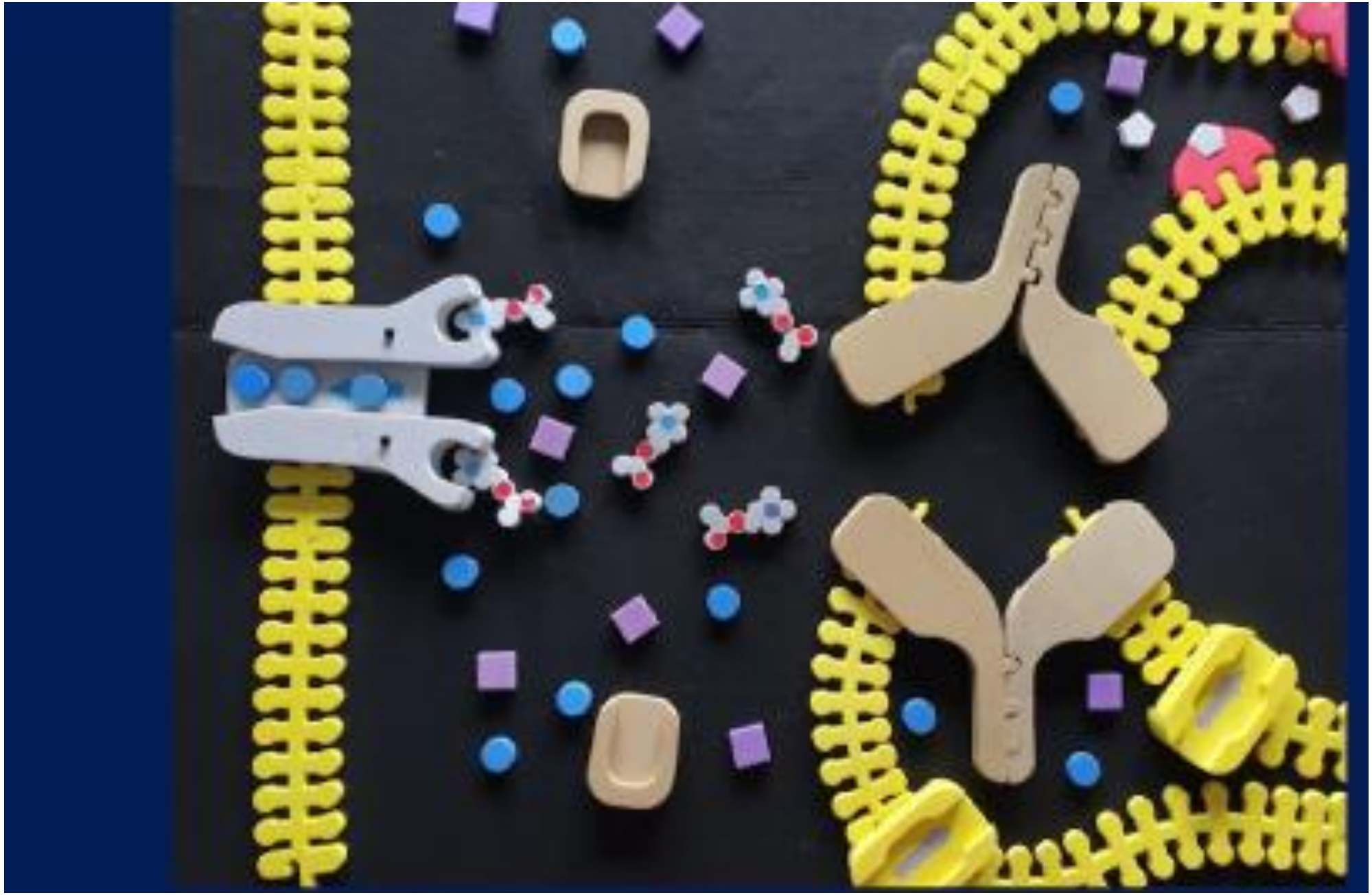
We need to differentiate between a few things:

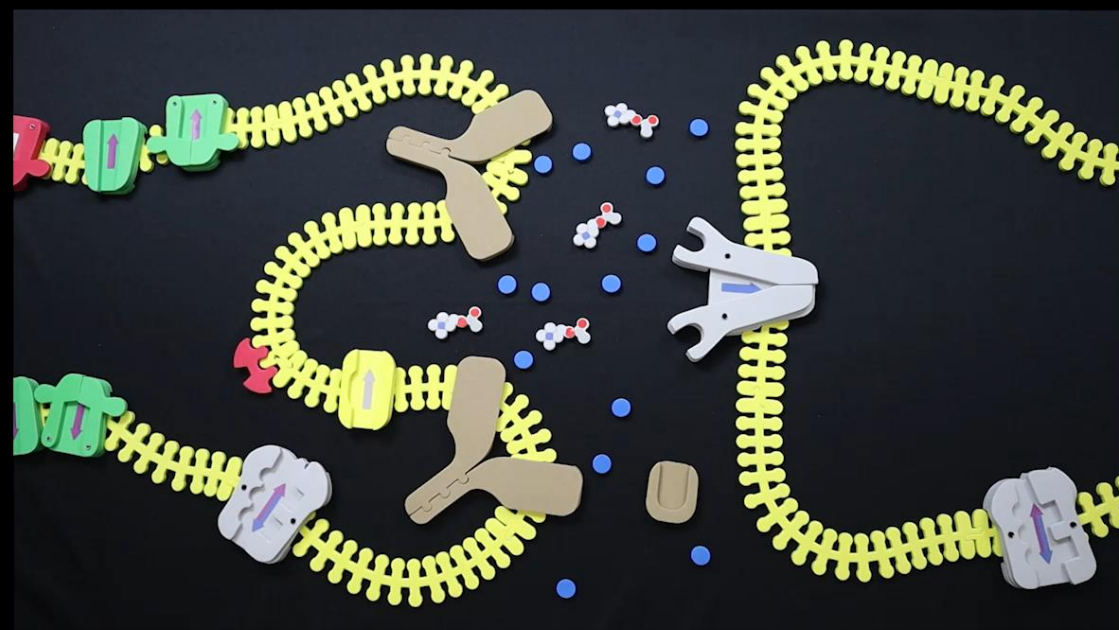
Electrical signals =
Chemical messages =

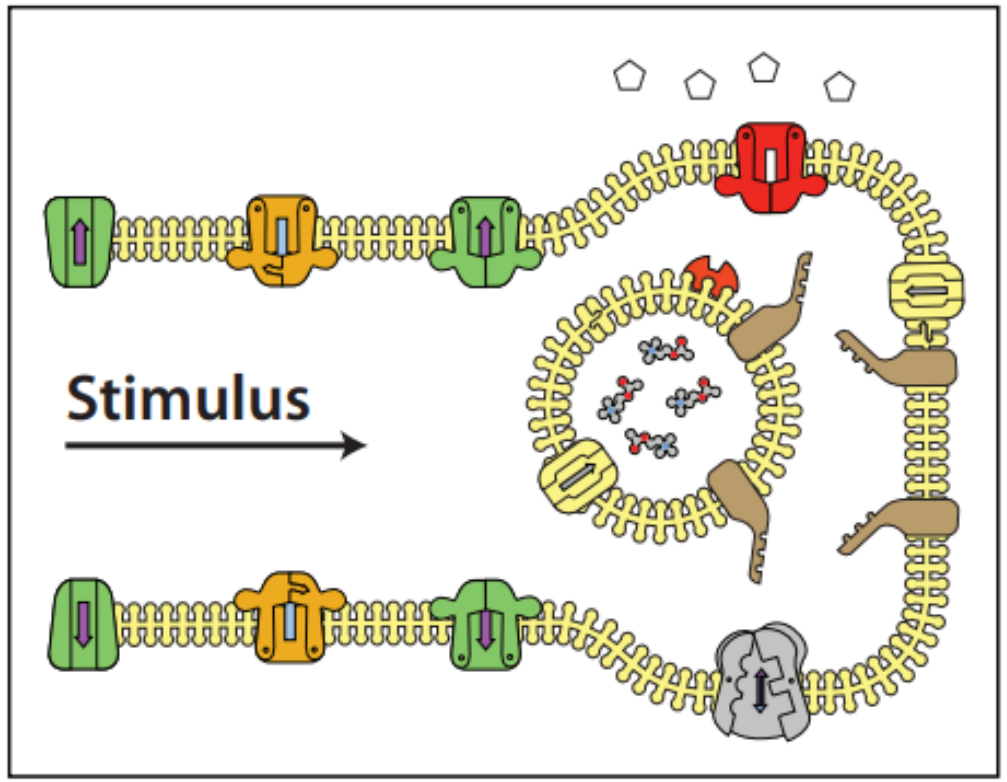
How do voltage gated ion channels and ligand gated ion channels differ? Where do we see these and what is associated with them?

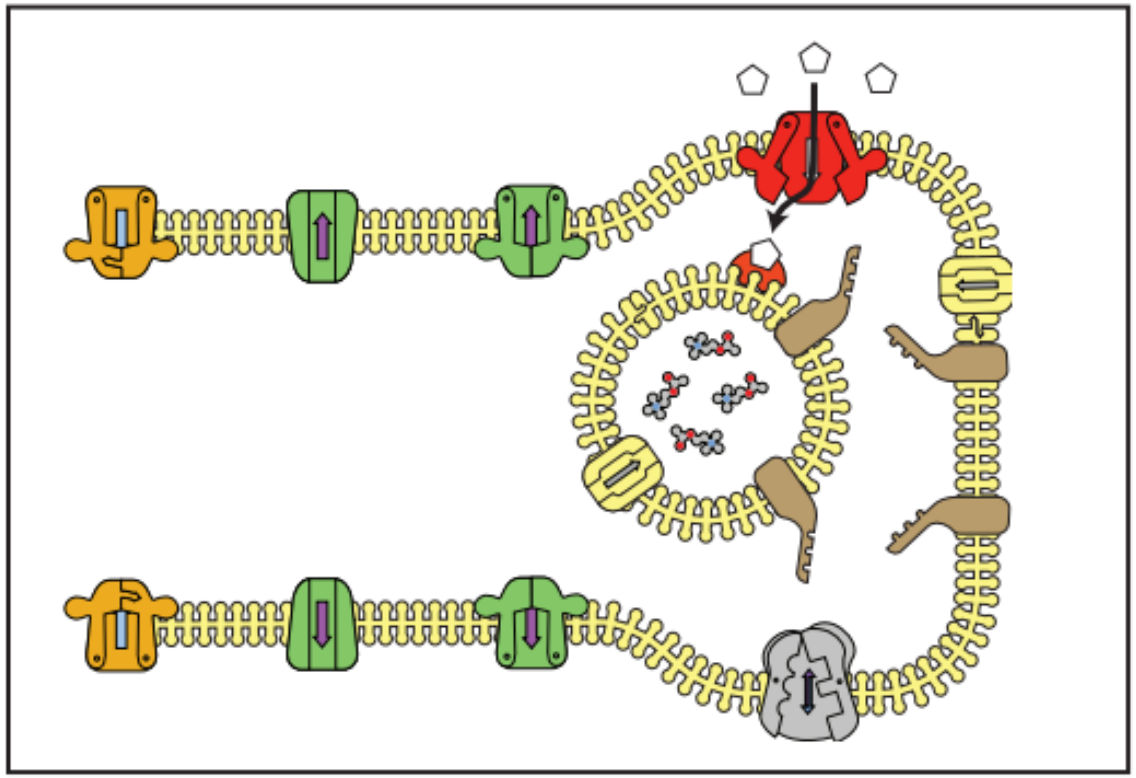




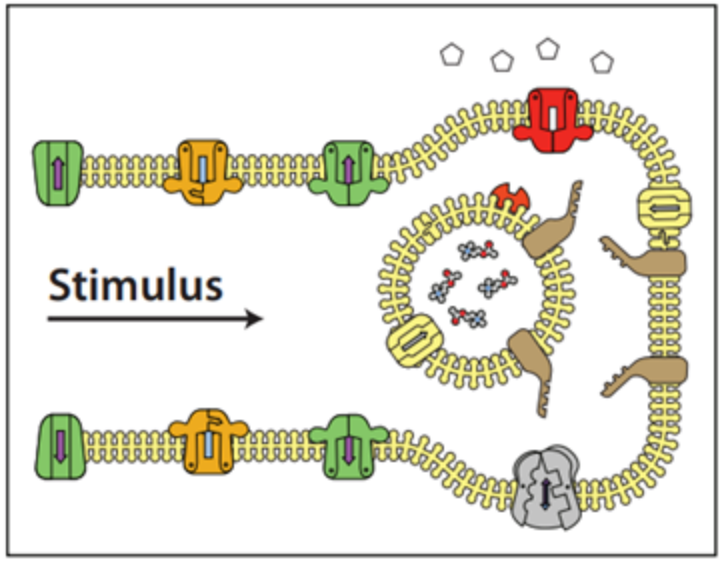




Step 1 - Action potential arrives at the terminal end of the presynaptic cell.



Step 2 - Calcium channels open in the presynaptic axon terminal. Open the calcium channels (red) and move some calcium ions to the interior of the neuron. Calcium ions bind to synaptotagmin.



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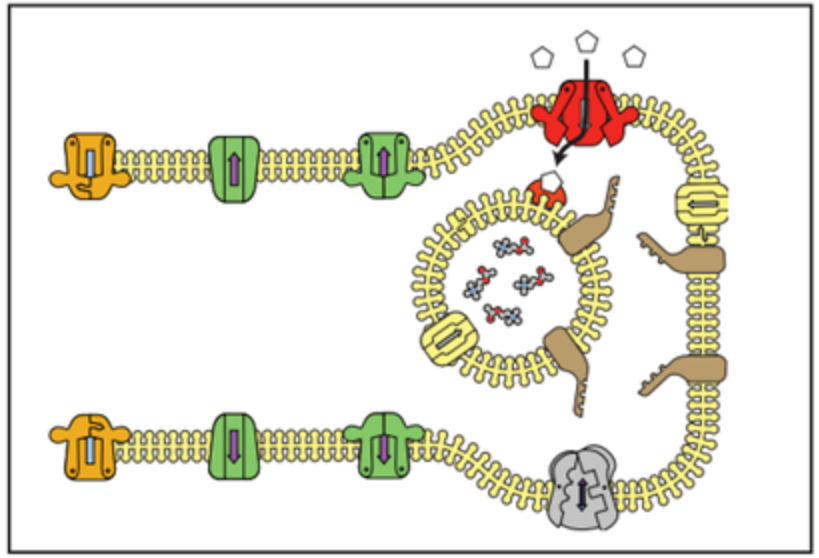

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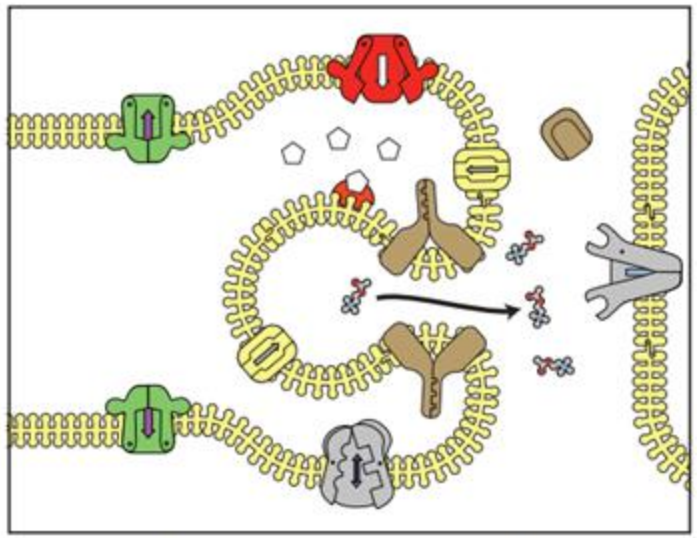
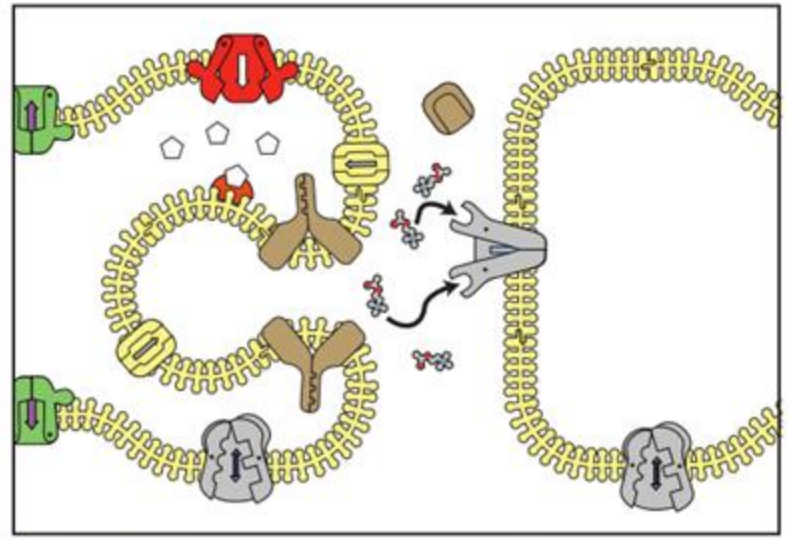
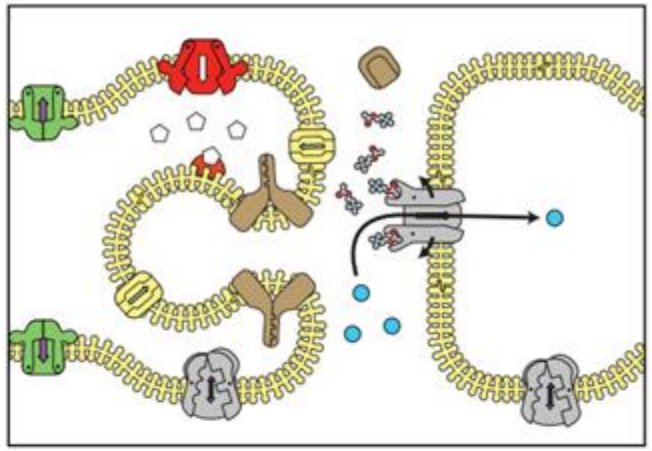


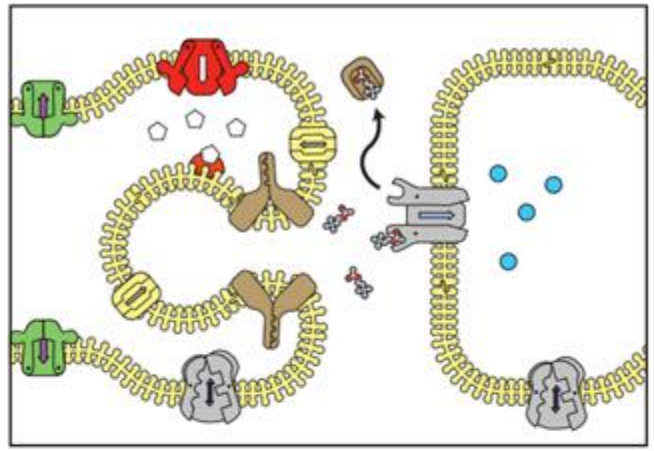
Step 3 - Bound Ca^{2+} triggers SNAP/SNARE protein interaction to bring the vesicle in position for fusion with the presynaptic cell membrane. Acetylcholine is released into the synaptic cleft.



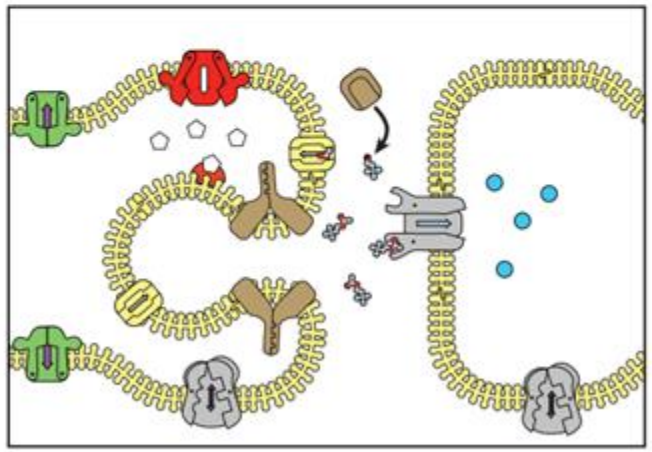
Step 4 - Acetylcholine traverses the synaptic cleft to bind to the acetylcholine receptor embedded in the postsynaptic membrane. Both binding sites must be occupied by acetylcholine for the channel to open.



Step 5 - The acetylcholine receptor opens to allow sodium ions to follow their concentration gradient into the postsynaptic cell. Depolarization of the postsynaptic cell occurs and an action potential may be generated in the post synaptic cell. Note: the receptor also allows passage of Ca^{2+} and K^{+}.

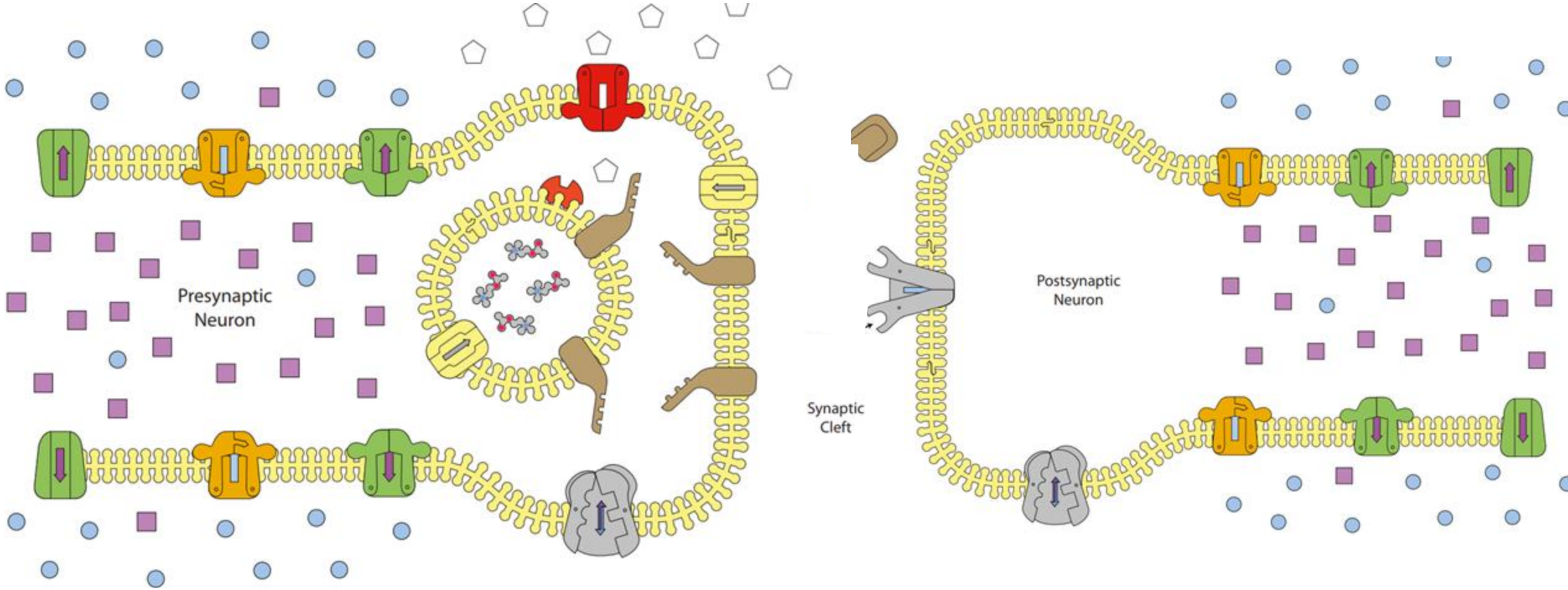


Step 6 - The enzyme acetylcholinesterase breaks the neurotransmitter down into acetic acid and choline.

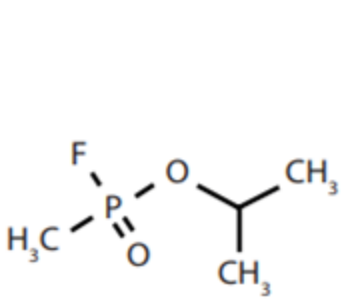


Step 7 - An uptake transporter moves choline back into the presynaptic cell for use in the synthesis of more acetylcholine in the presynaptic cell. A vesicular transport protein moves synthesized

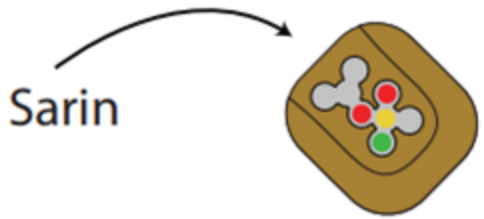
The electrical signal or the chemical message: How can this be disrupted

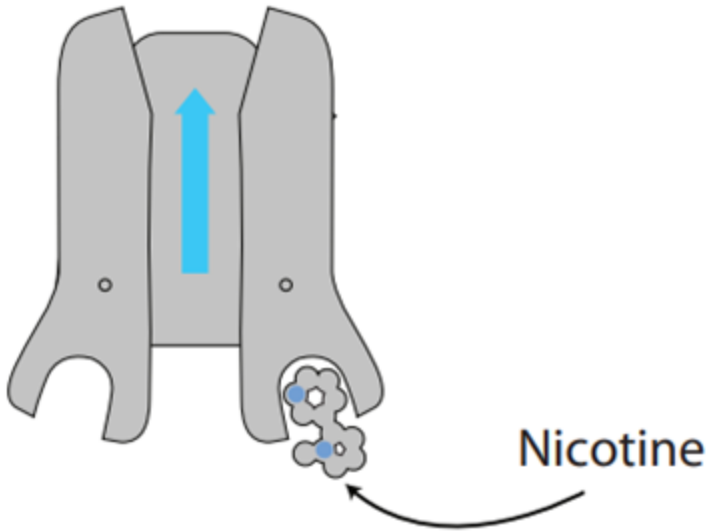


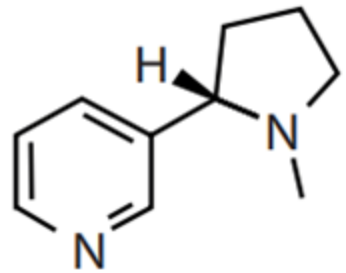
Next you will introduce two substances that perturb neural transmission in the cholinergic synapse. **Nicotine** binds to the acetylcholine receptor to open the channel. **Sarin** binds to acetylcholinesterase. Model where these substances bind in your synapse.



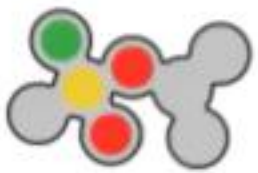
Sarin



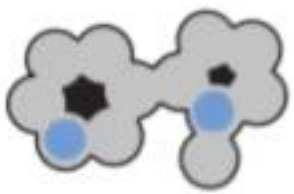




Nicotine

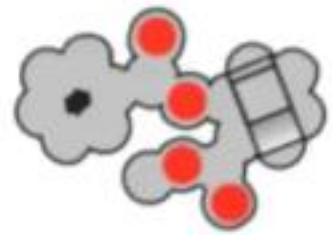


2x Sarin



2x Nicotine

2x Propofol



2x Cocaine

2x Toxins

What might you do in your classroom to deepen understanding?

Incredible resources on our website

Workshop NGSS Connections

SEPs	CCCs	DCIs
Asking Questions and Defining Problems	Patterns	LS1.A: Structure and Function
Developing and Using Models	Cause and Effect: Mechanism and Explanation	LS1.B: Growth and Development of Organisms
Constructing Explanation and Designing Solutions	Scale, Proportion, and Quantity	LS3.A: Inheritance of Traits
Engaging in Argument from Evidence	Structure and Function	LS3.B: Variation in Traits
Analyzing and Interpreting Data	Stability and Change	

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Enter to win a **$500 gift card** by completing this short survey.

This will also allow us to email you the resources associated with this session.

THANK YOU FOR ATTENDING!

Kits and models used in this session:

Neuron Modeling Kit

Synapse Construction Kit

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