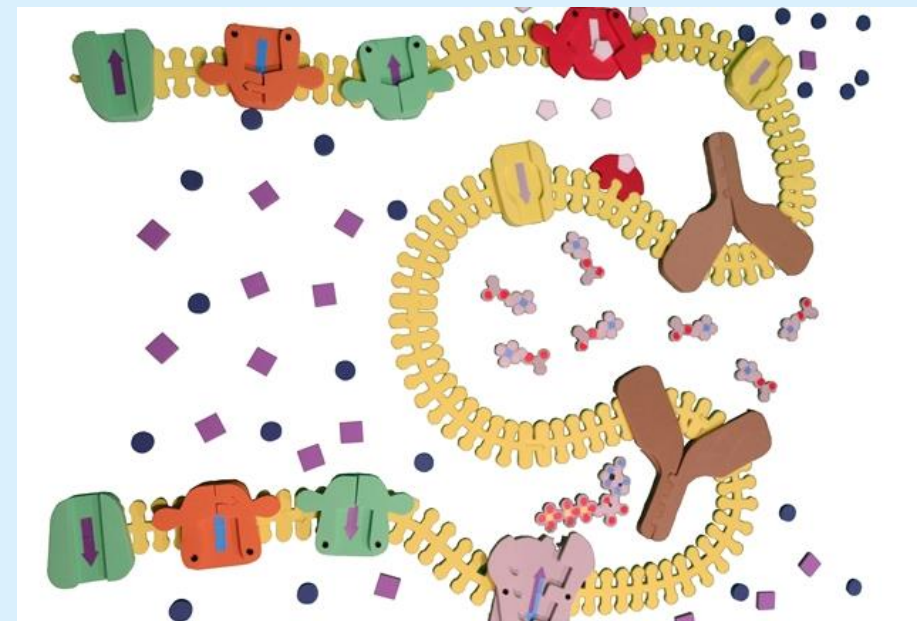
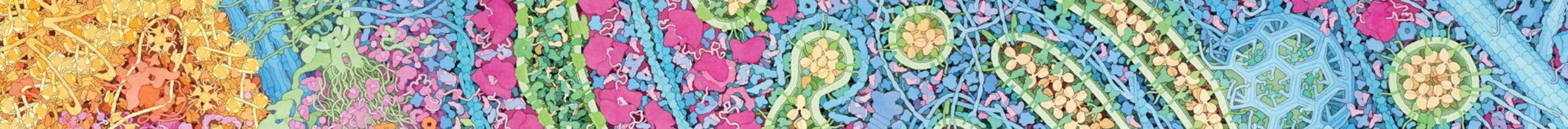


Hands on Modeling Cell Synapse

Tanya Monet-Bakken



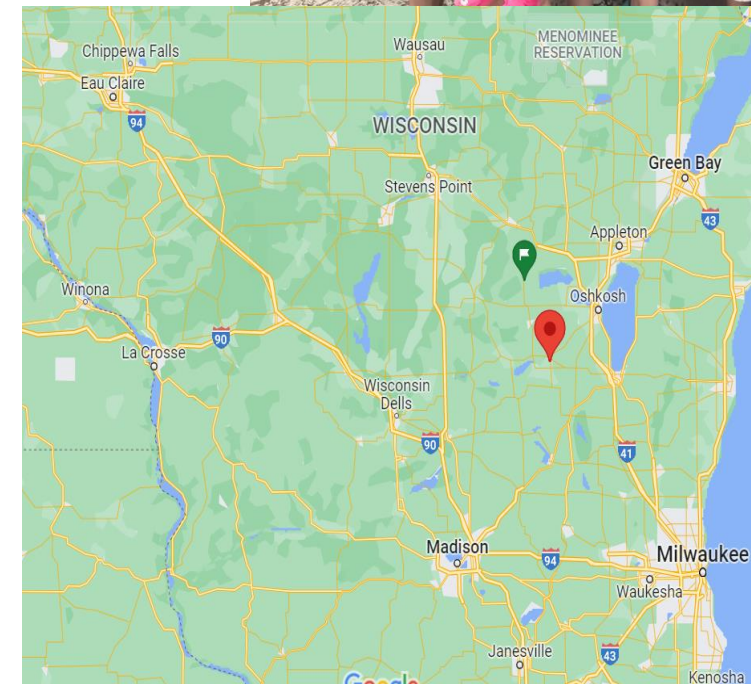


Hands on Modeling Cell Synapse

Tanya Monet-Bakken

A little about me-Tanya Monet-Bakken

- 20 years teaching high school life science
- Currently at Ripon High School
- Sophomore biology
- CAPP Bio 105
- CAPP Bio 104
- Genetics
- Anatomy/Physiology

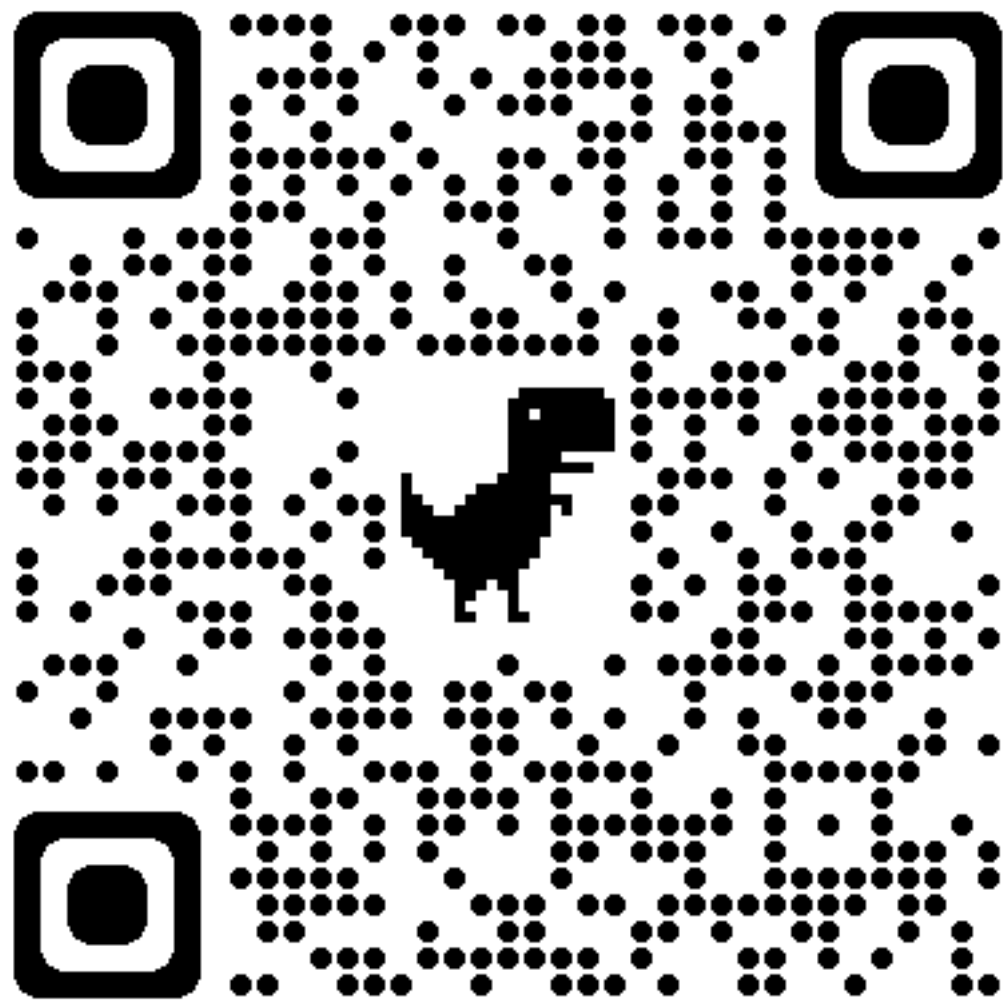


My Background

- BS in Biology Education from UW-Eau Claire 2003
- Starting teaching with transparencies and textbooks.
- MS in Environmental Science in 2007
- Moved away from textbook teaching to digital and hands on models (slow transition).
- Switched school districts in 2014-no more textbooks, one:one with chromebooks.
- Attended Modeling in the Molecular World in 2018-fell in love with products
- Grant money to buy lots of models:)
- Started the shift to skills based grading in 2020
- CRISPR cohort 3 through 3D Molecular Designs
- Bought even more models
-

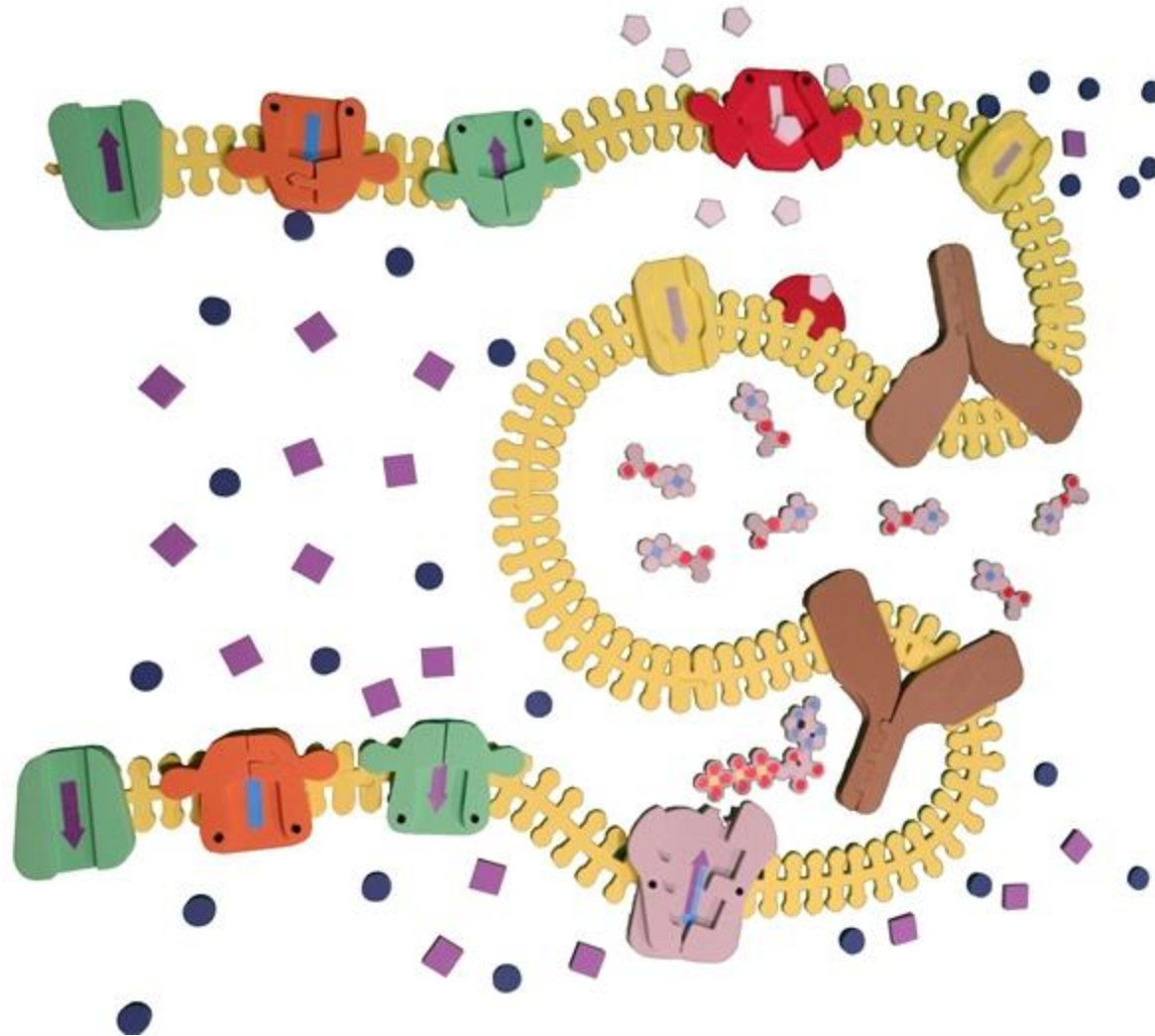
Workshop Learning Goals

- Become familiar with resources at 3D Molecular Designs.
- Become familiar with using Cell Synapse kit.
- Visualize how the Cell Synapse kit can enhance your curriculum.



Navigate the
site and see
how many
wonderful
resource exist.

Synapse Construction Kit[©]



Teacher Guides

[Synapse Construction Kit[©] Contents](#)

[Synapse Construction Kit[©] Assembly Instructions](#)

[Teacher Notes](#)

[Voltmeter](#)

[NGSS Connections](#)

Student Handouts

[Cholinergic Synapse Assembly](#)

[Cholinergic Synapse Guide](#)

[Dopaminergic Synapse Assembly](#)

[Dopaminergic Synapse Guide](#)

[GABAergic Synapse Assembly](#)

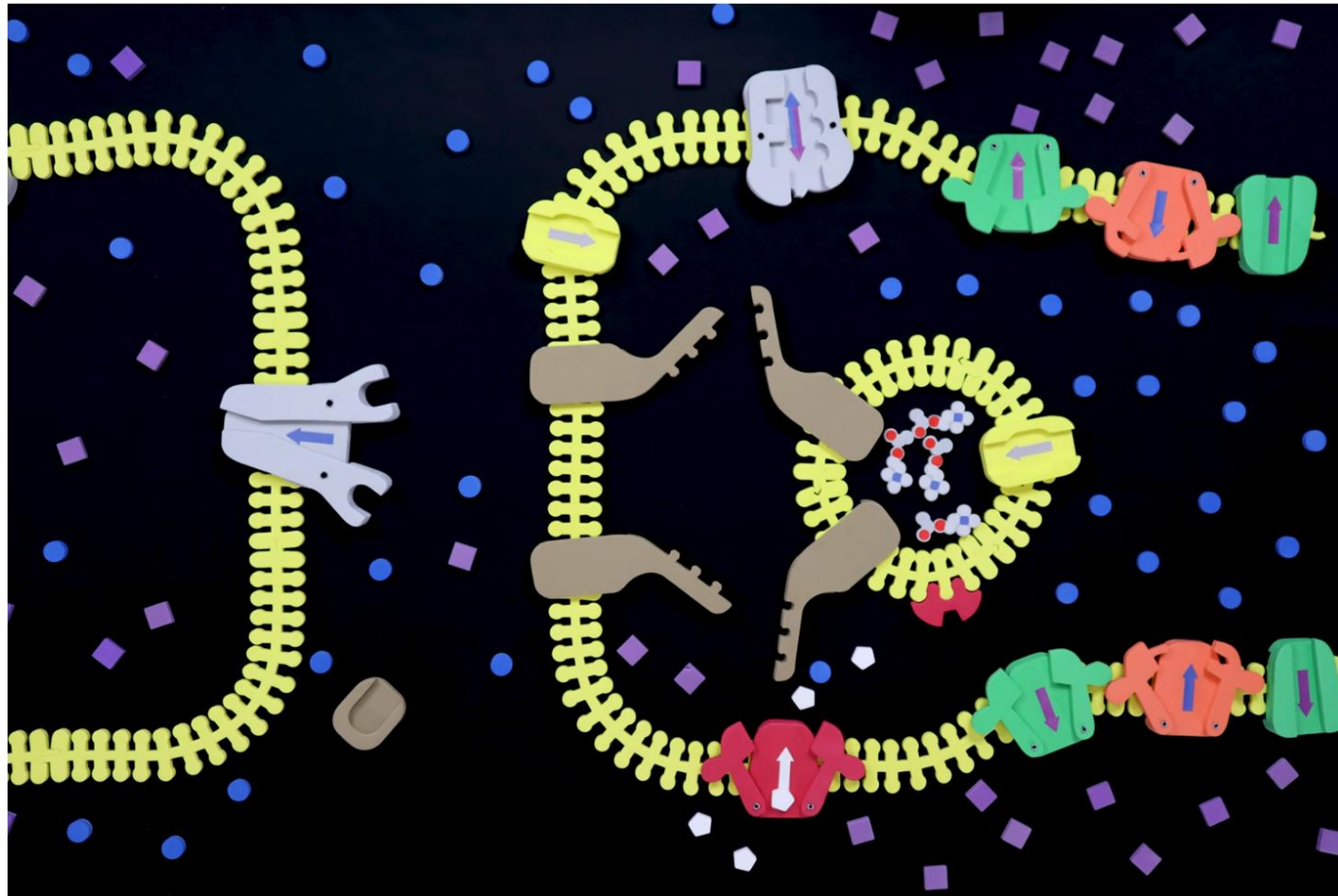
[GABAergic Synapse Guide](#)

[Maintaining the Resting Potential](#)

[Modeling the Action Potential](#)

[Cholinergic Synapse Neurotransmission](#)

Stop Motion video



Cholinergic Synapse Stop Motion Video



3D Molecular Designs
710 subscribers

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1



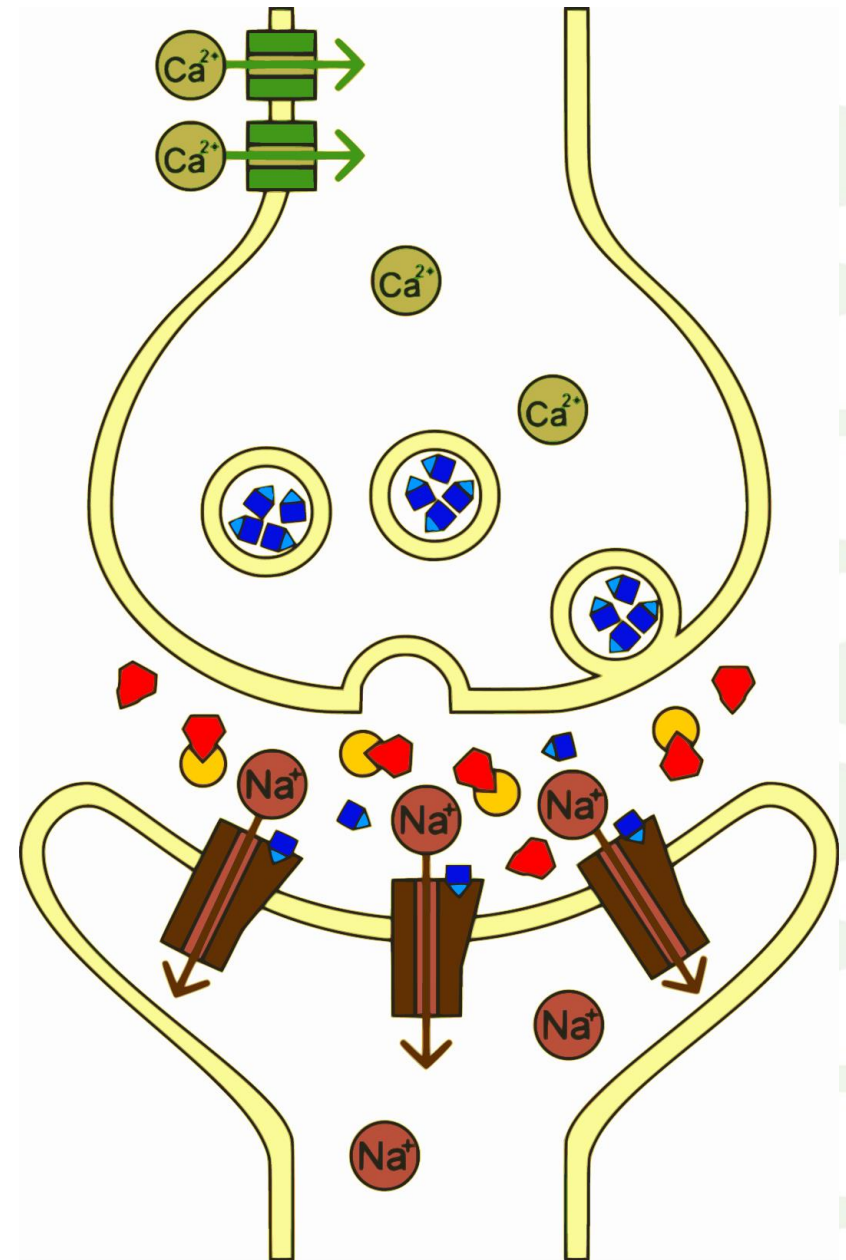
Share



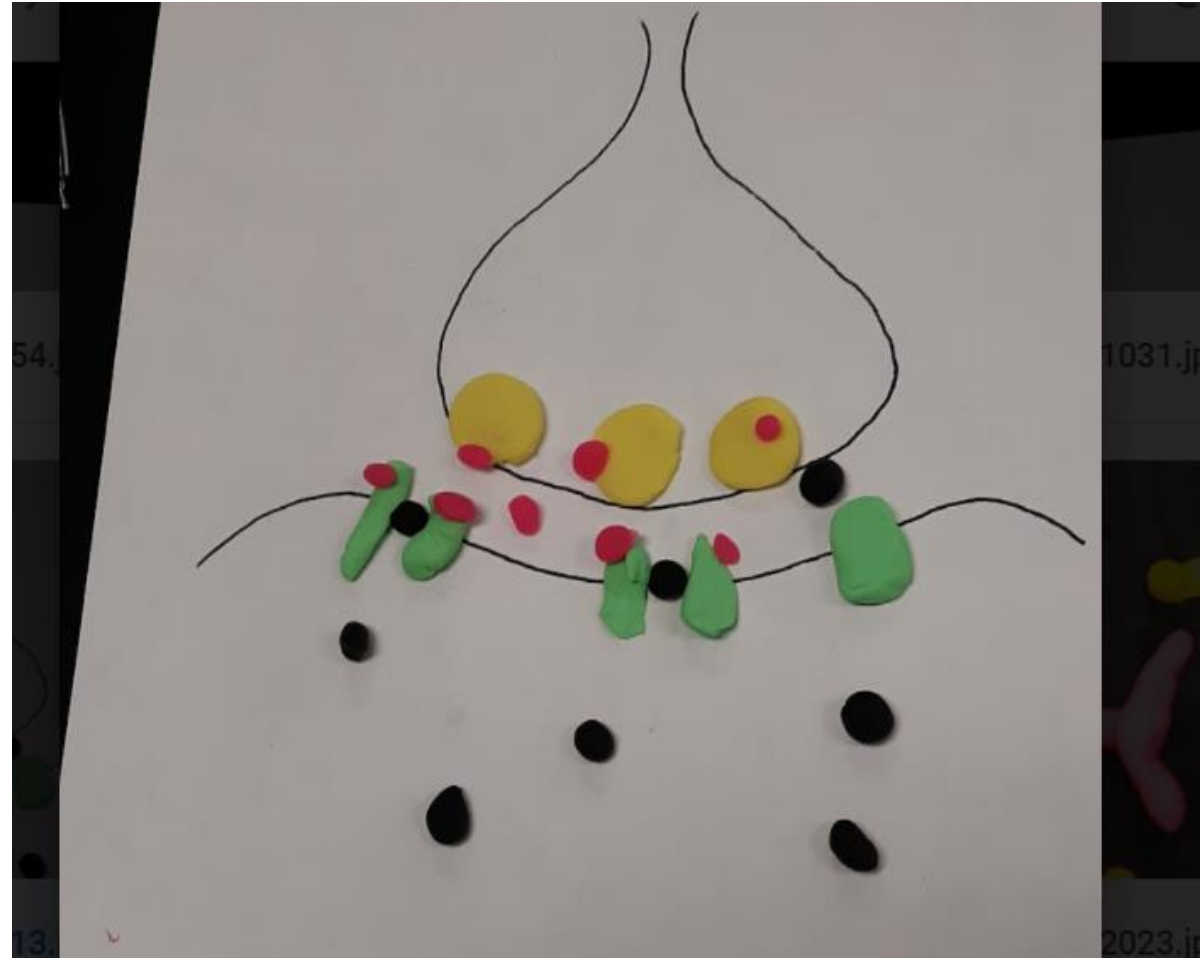
Background on this topic

- Before going into the sliding filament theory, we start with neuromuscular junction.
- Students should be familiar with:
- vesicles, exocytosis, protein channels, receptor proteins, diffusion

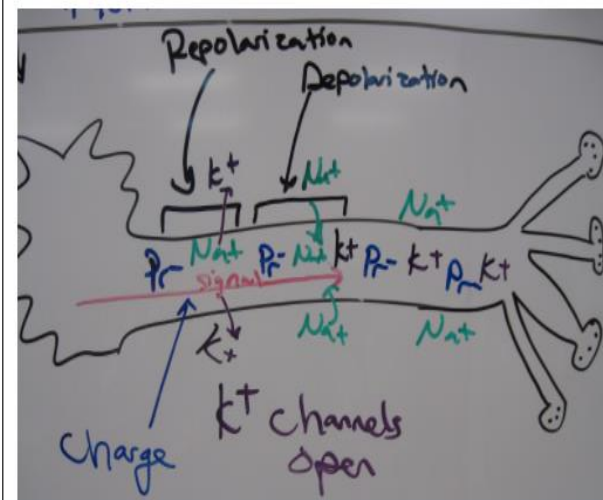
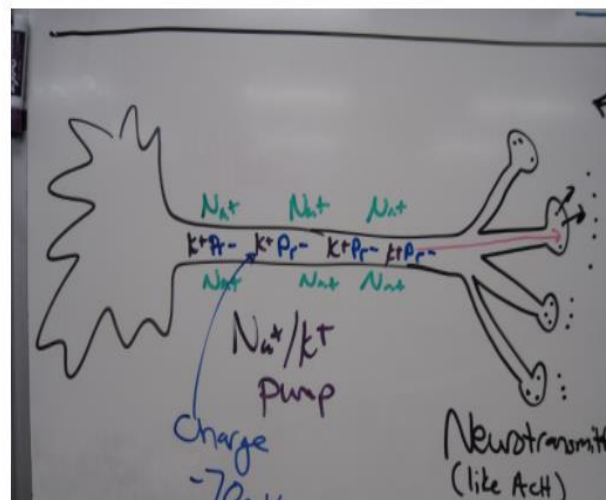
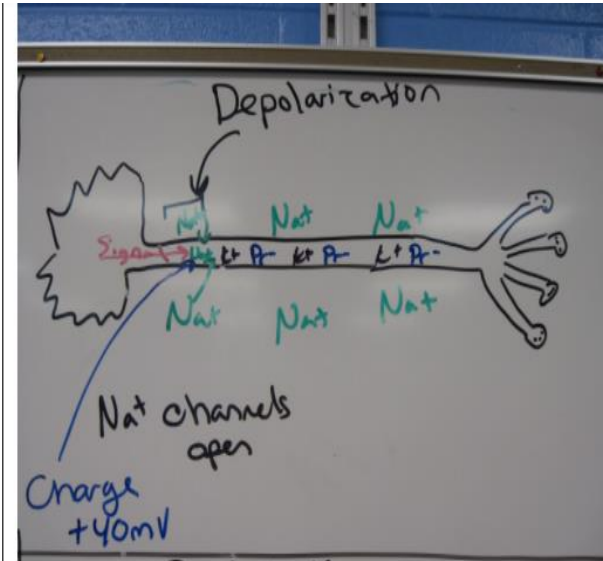
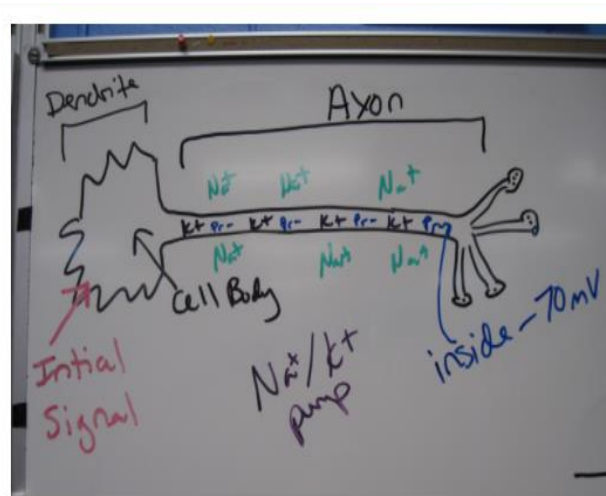
• https://upload.wikimedia.org/wikipedia/commons/b/b8/Sarin_Biological_effects.svg



I have my students use playdough to do a “stop animation” of what happens at the neuromuscular junction.



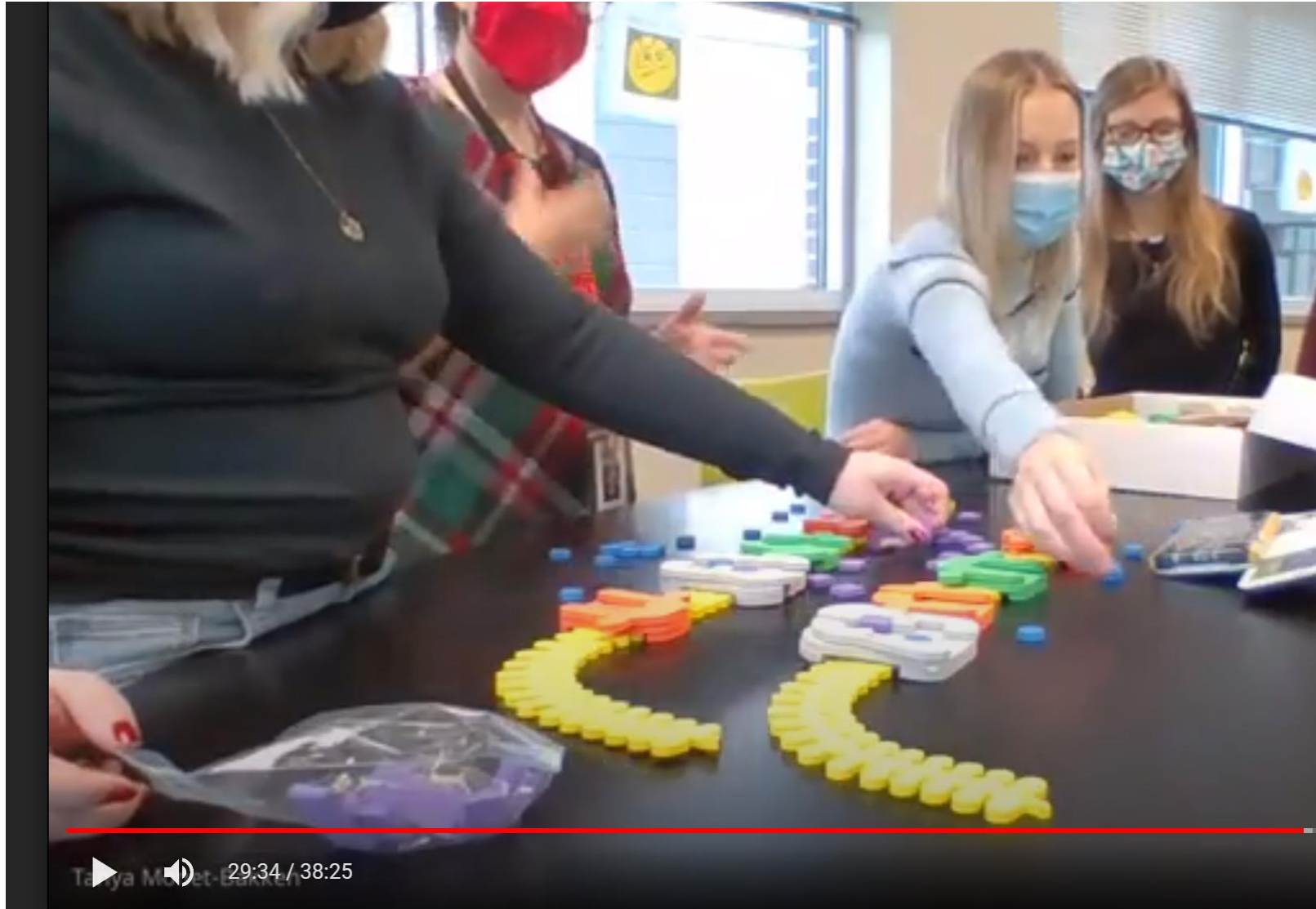
I have my students sketch out (comic book style) nerve propagation.



Evidence of use of the kit

[Video](#) of kit being used in my room. FF to 29:30

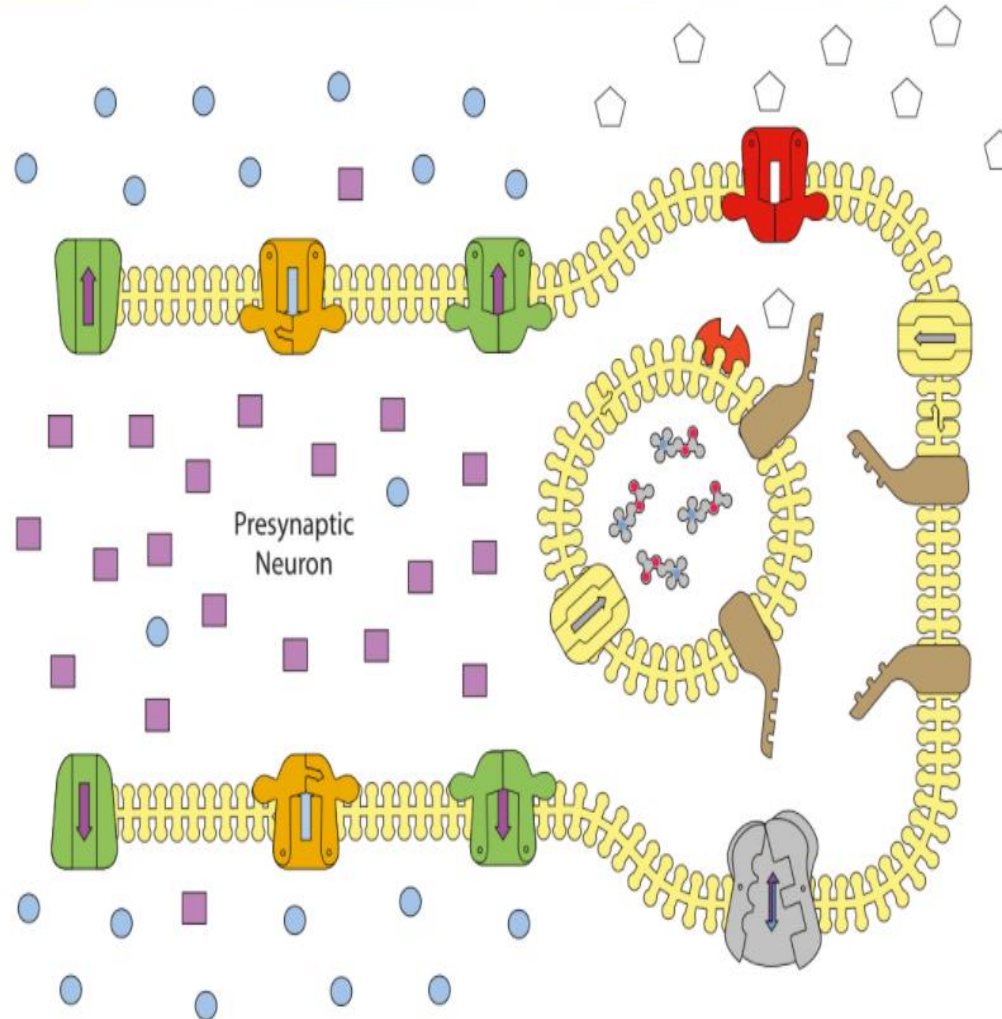
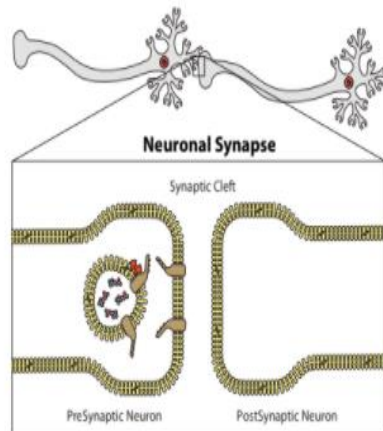
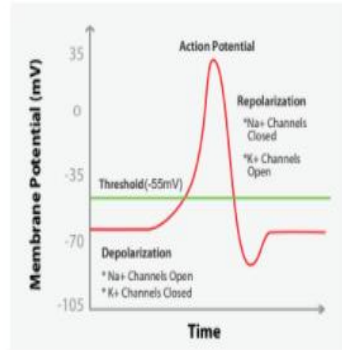
Students are reinforcing their knowledge on how nerve send a signal.





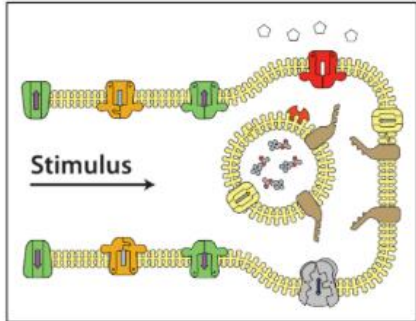
Try the kit out, work in groups to set up the kits and explore:)

Cholinergic Synapse Guide

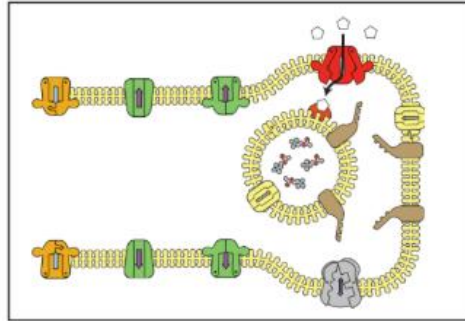




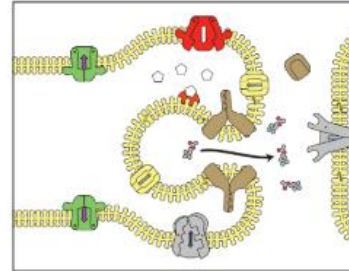
Step by step instructions



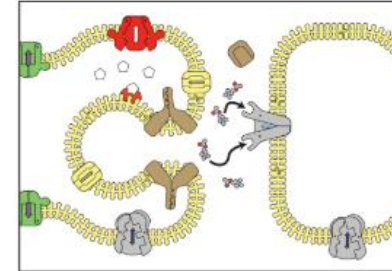
Step 1 - Action potential arrives at the terminal end of the presynaptic cell.



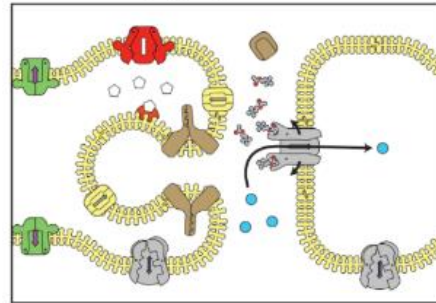
Step 2 - Calcium channels open in the presynaptic axon terminal. Open the calcium channels (red) and move some calcium ions to the interior of the neuron. Calcium ions bind to synaptotagmin.



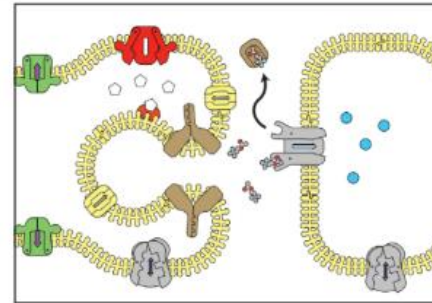
Step 3 - Bound Ca^{2+} triggers SNAP/SNARE protein interaction to bring the vesicle in position for fusion with the presynaptic cell membrane. Acetylcholine is released into the synaptic cleft.



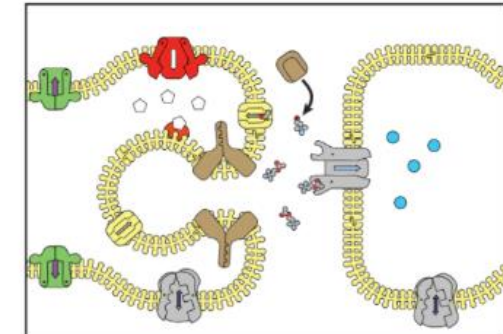
Step 4 - Acetylcholine traverses the synaptic cleft to bind to the acetylcholine receptor embedded in the postsynaptic membrane. Both binding sites must be occupied by acetylcholine for the channel to open.



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.

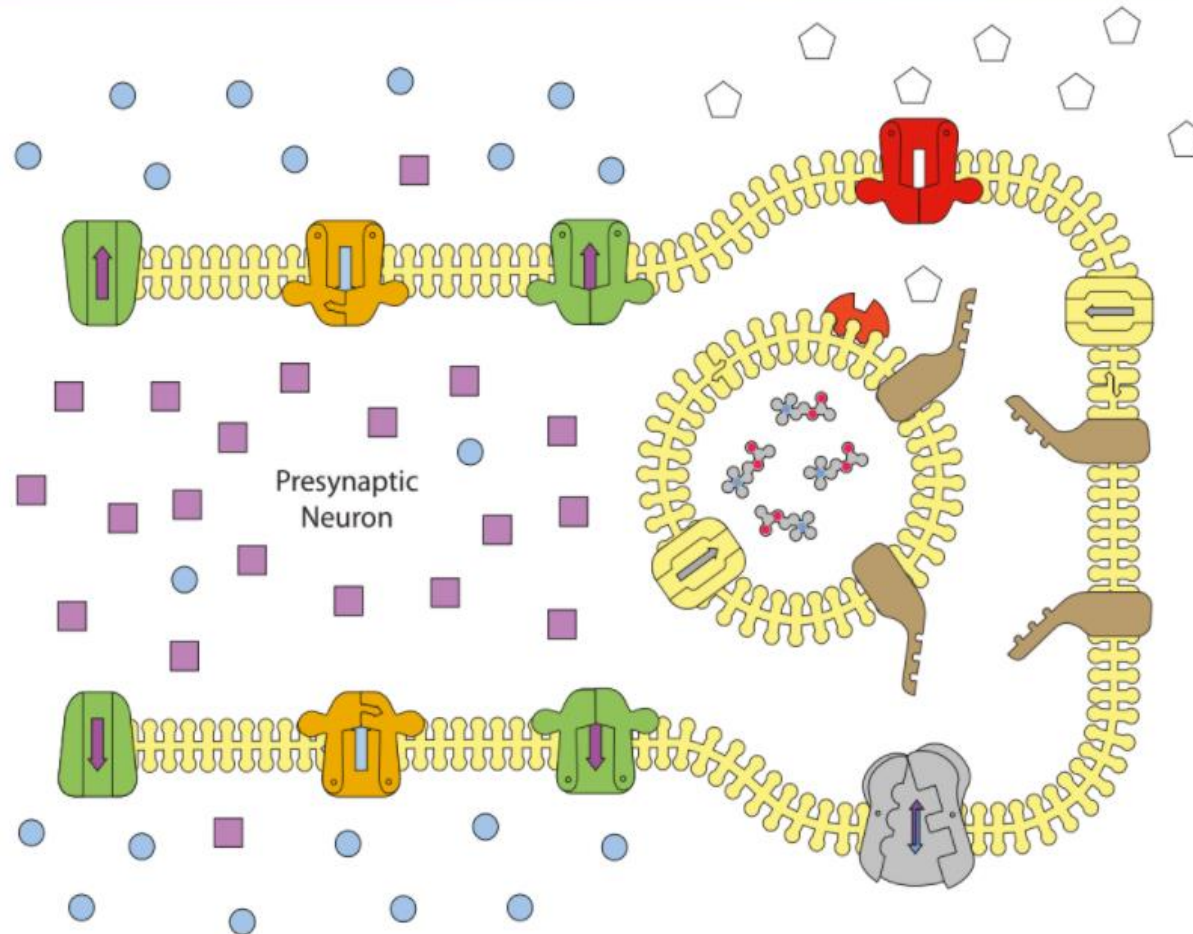
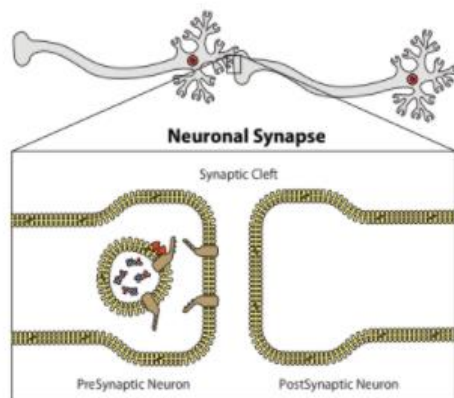
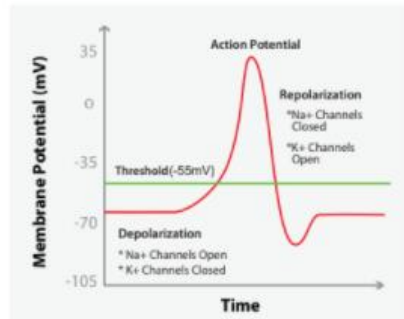


Step 7 - An uptake transporter moves choline back into the presynaptic cell for use in the synthesis of more acetylcholine in the presynaptic cell. A vesicular transport protein moves synthesized acetylcholine into the vesicle.



Another option, give students the general setup. Have them explain the parts and infer what happens.

Cholinergic Synapse Guide

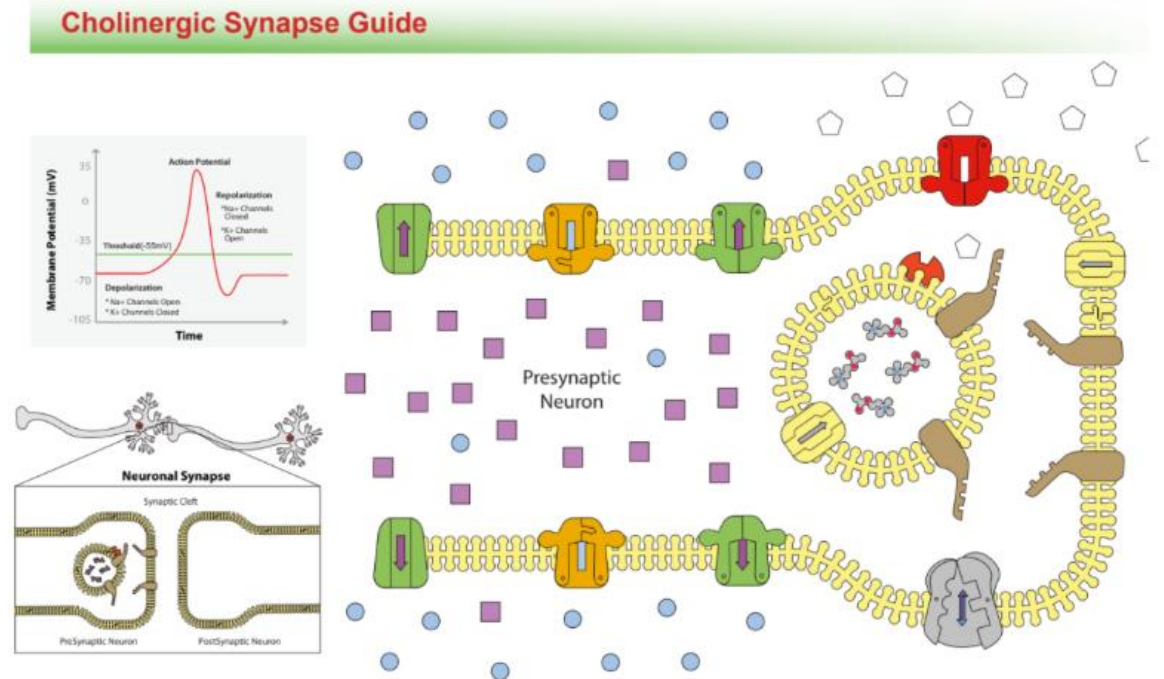




Asking questions

What are the yellow pieces representing? Why do they look the way they do?

Phospholipid bilayer, represents phosphate groups (circle) and lipids (rectangle)

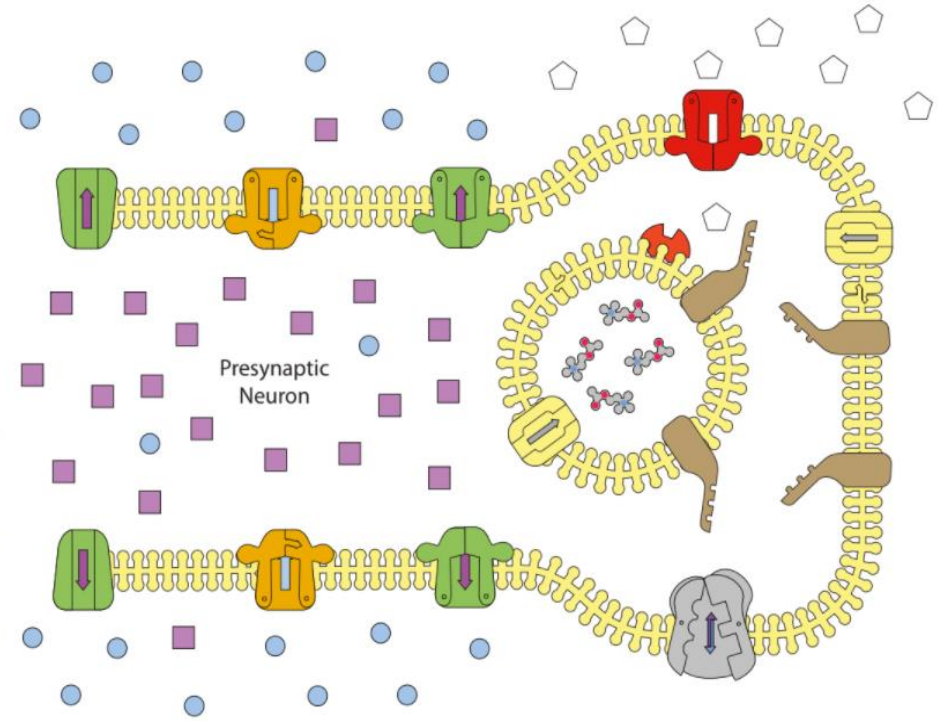
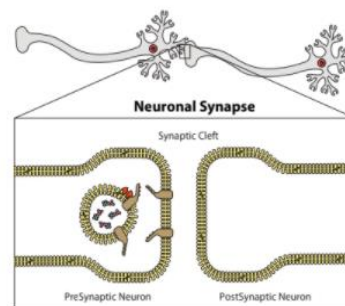
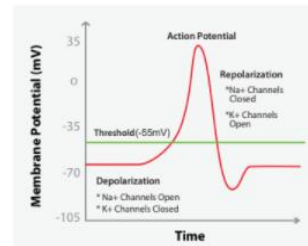




Recall what can go through a phospholipid bilayer?

Small, nonpolar molecules

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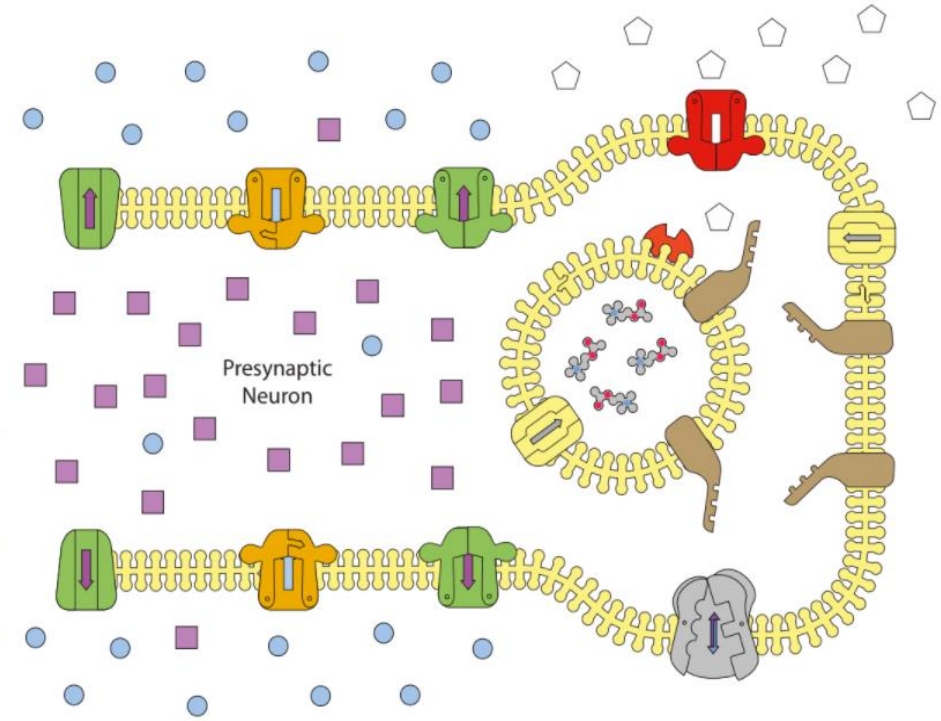
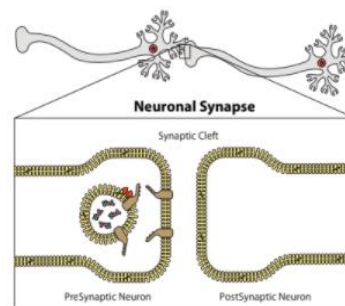
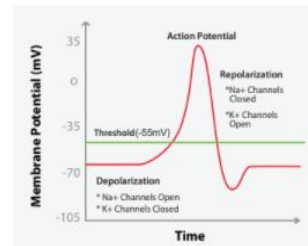




Why is it important that both cell membranes and the vesicle membrane are made of these same molecules?

So they can blend into each other.

Cholinergic Synapse Guide





What do the arrows represent on the different colored pieces? (color and direction)

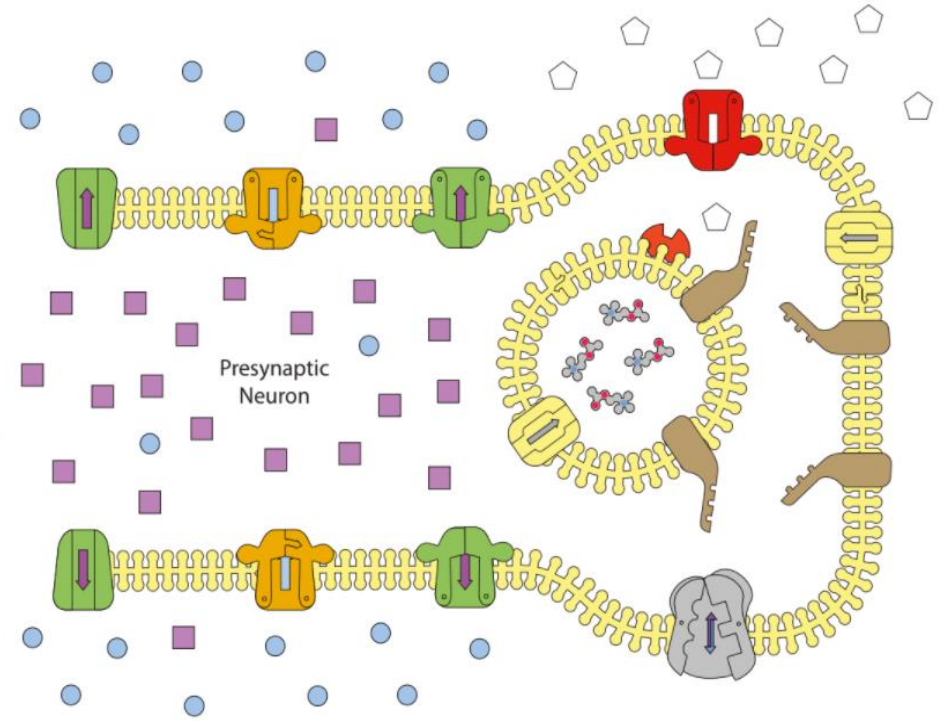
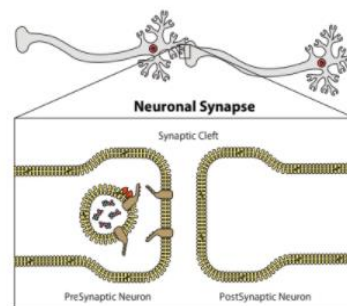
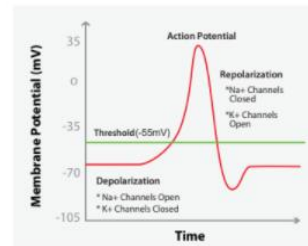
Color for the type of molecule they allow through, direction for direction of movement.

Blue=Sodium

Purple=potassium

White=calcium

Cholinergic Synapse Guide

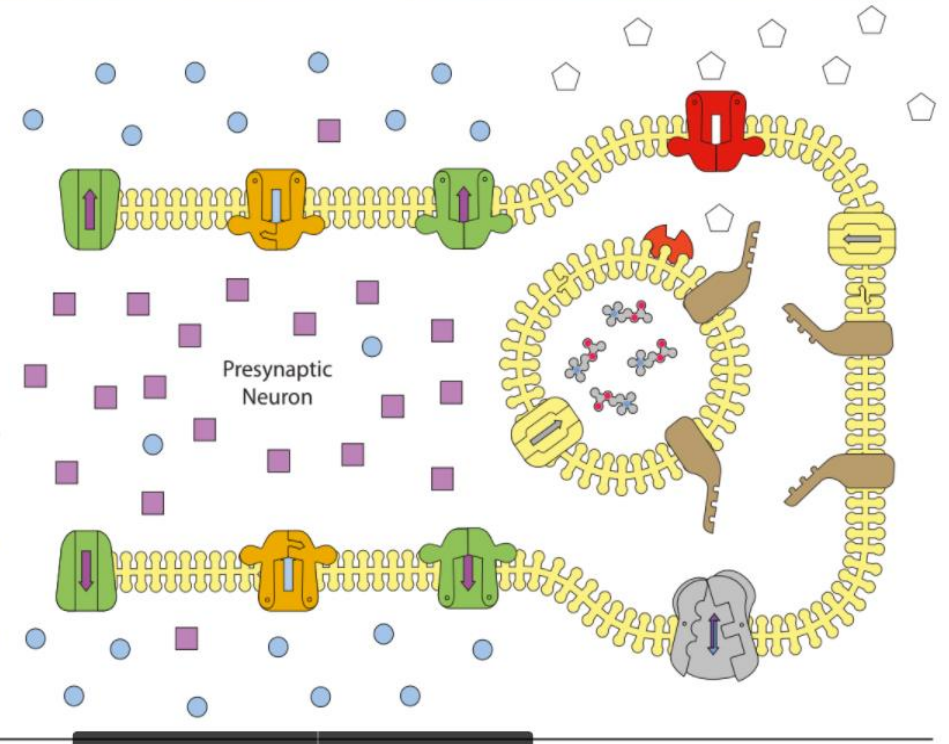
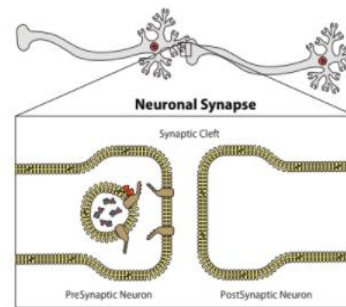
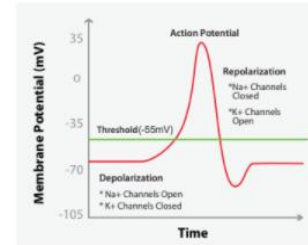




Think back to what we learned about nerve transmission, which of the protein channels are always functioning and which need to be triggered?

Sodium/Potassium pump (double arrow) is always working.
Calcium, Sodium channels and potassium channels need to be stimulated.

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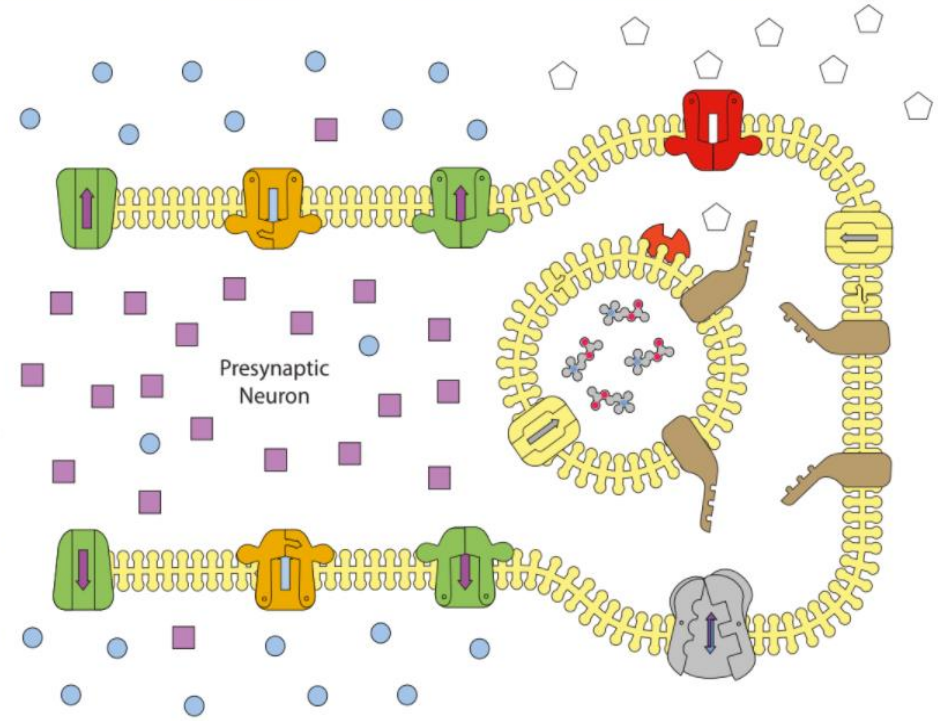
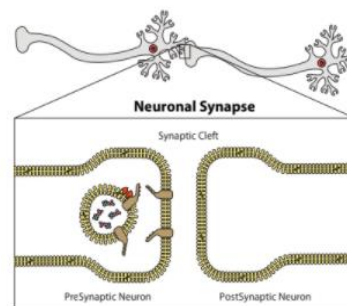
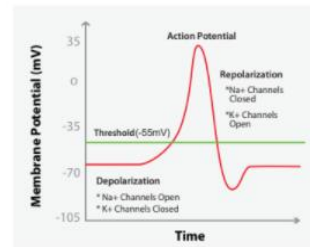




What is the importance of calcium?

Calcium triggers the vesicle to attach and release ACh

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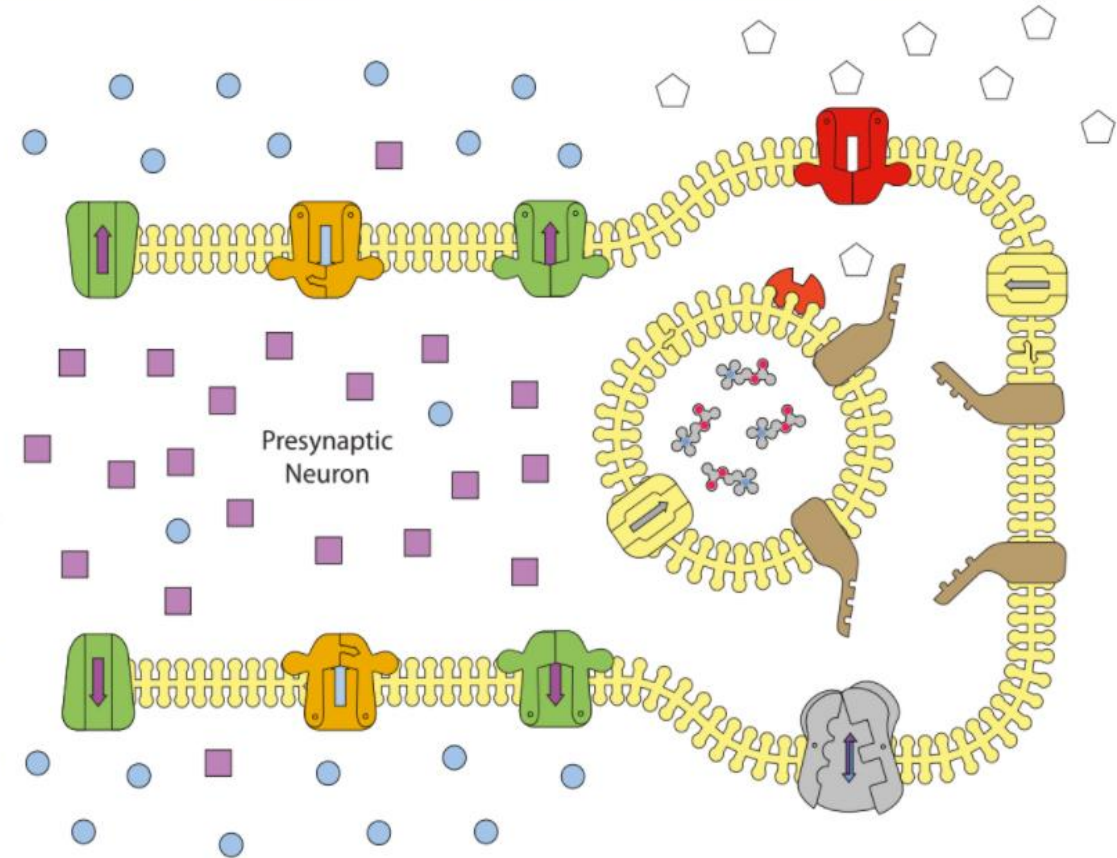
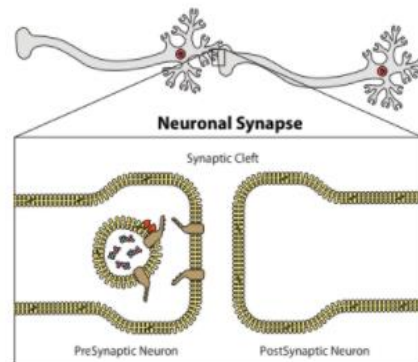
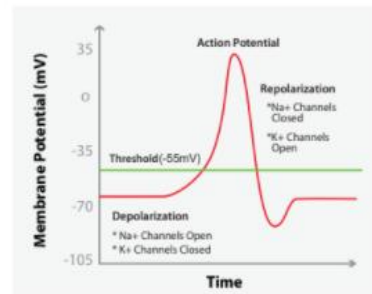




Why are some channel proteins always open?

Leak channels

Cholinergic Synapse Guide

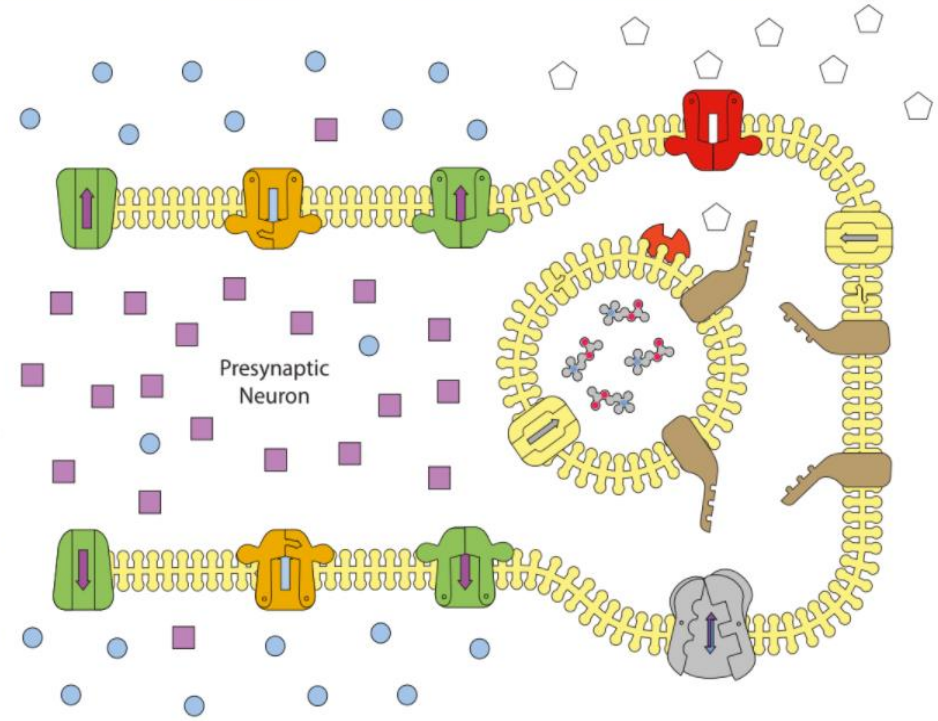
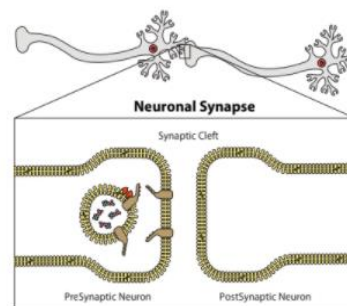
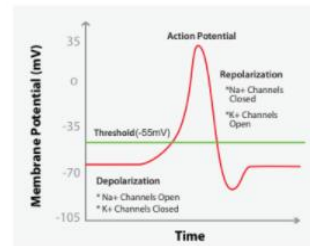




How is this related to how the ACh gets in (or back in) the vesicle?

There are ACh leak channels in both the cell membrane and vesicle membrane.

Cholinergic Synapse Guide





How could you see using this kit in your classroom? Chat with your neighbors, then we will share out.

**Biology class? Ecology? Anatomy systems?
Genetics? Biochemistry?**

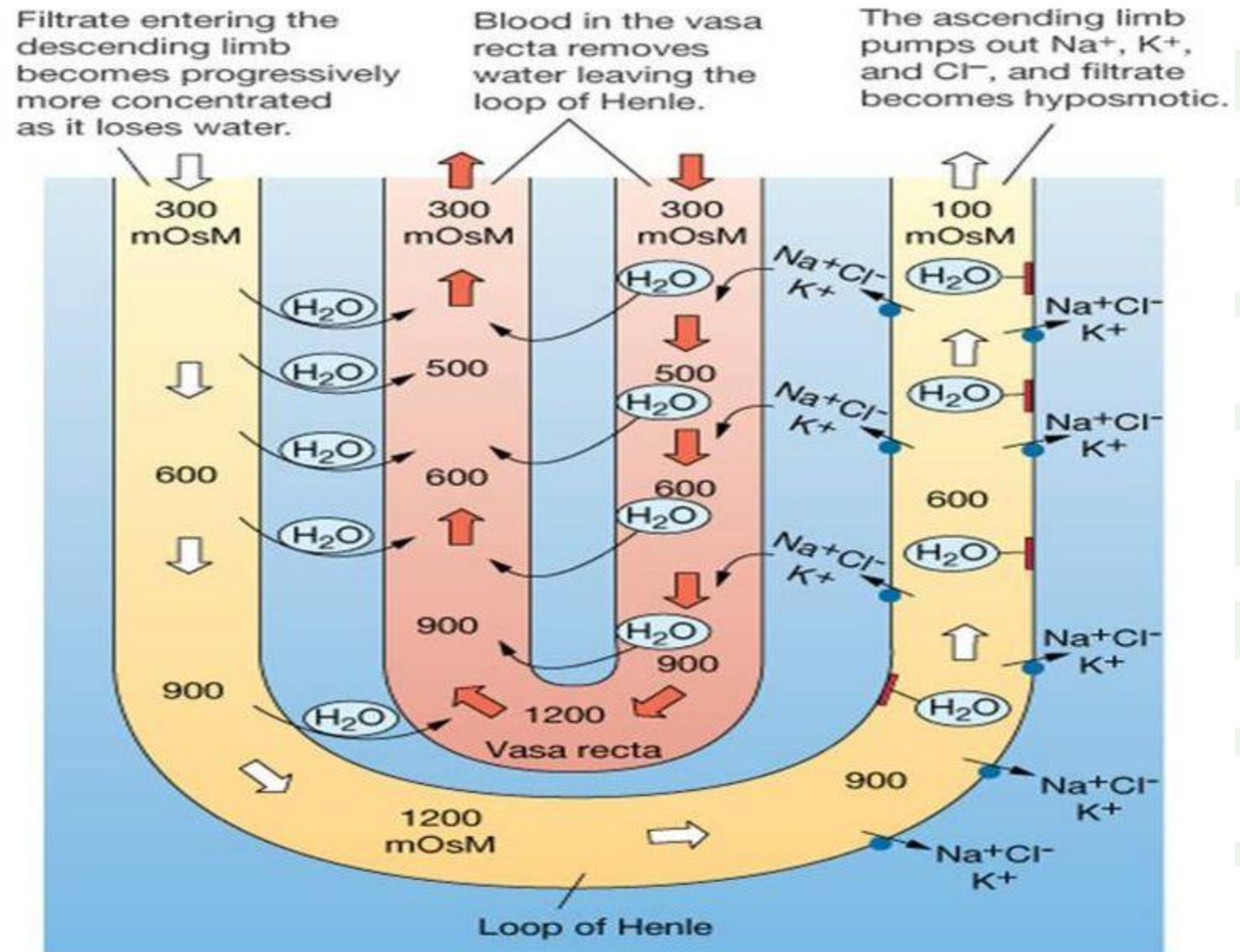


Table tasks, you will each get an example of how to expand this kit, make it at your table then we will gallery walk:) Feel free to make it your own, the ideas given are just an option of how to use the kit.



Build a nephron-loop of Henle

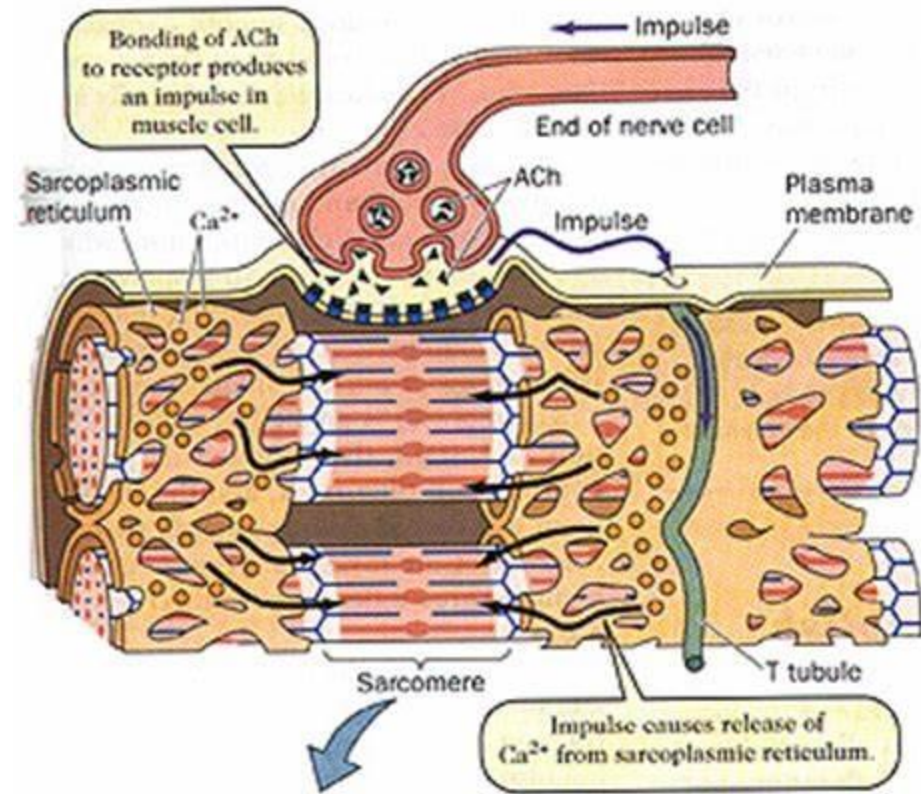
You either need to add your own Cl^- ions or have kids pretend the Calcium is Cl^-





Muscle cell: Have some sort of template printed for the background.

Students can move the Na⁺ and Cl⁻ around. Good practice for t-tubule and SR



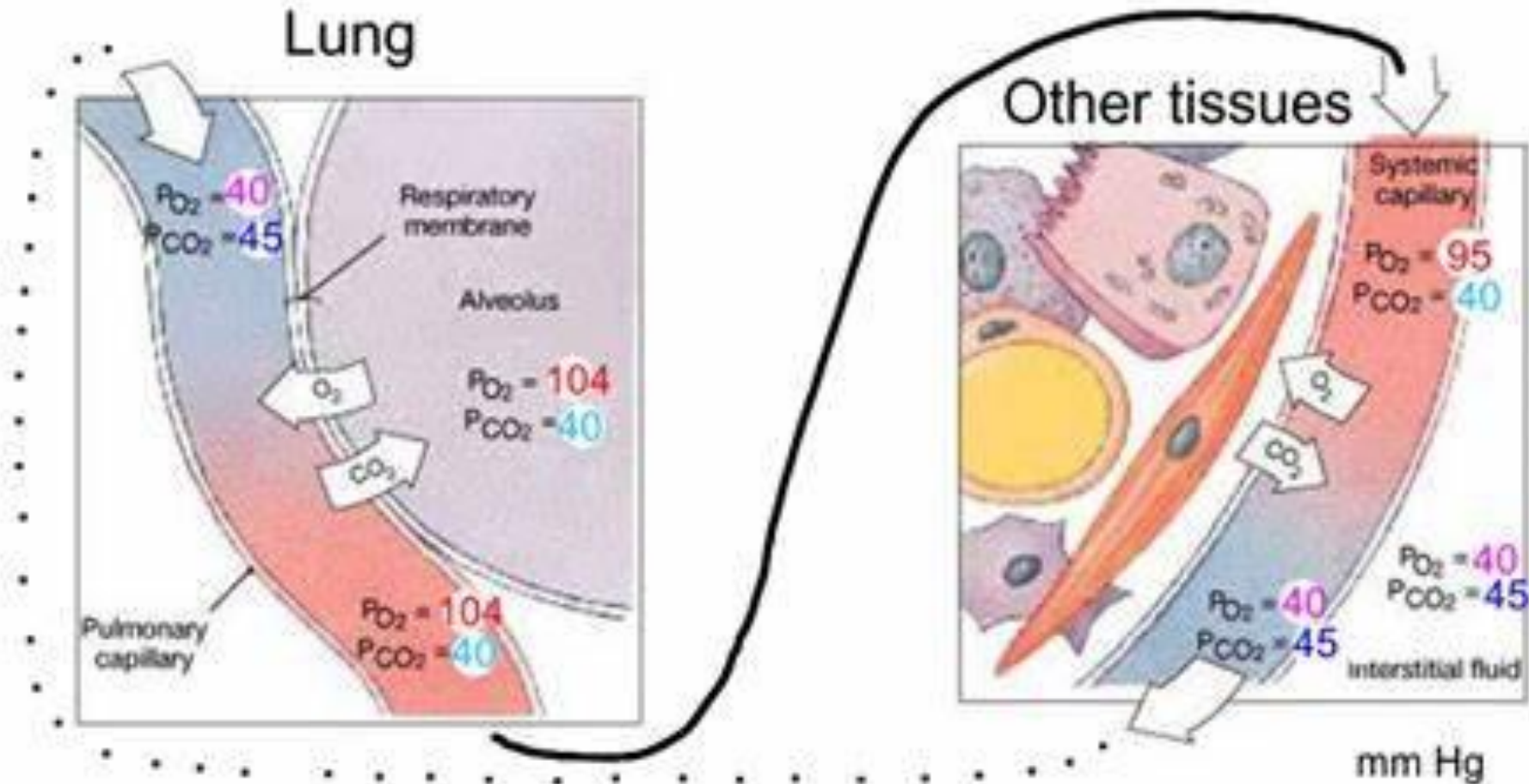




Respiratory System, gas exchange

Set up phospholipid bilayers for blood vessels and alveoli. Make O₂ and CO₂ molecules (can use hole punch cutouts of different colors).

Have phospholipid bilayer for capillaries and template of other tissues to show movement throughout the body.





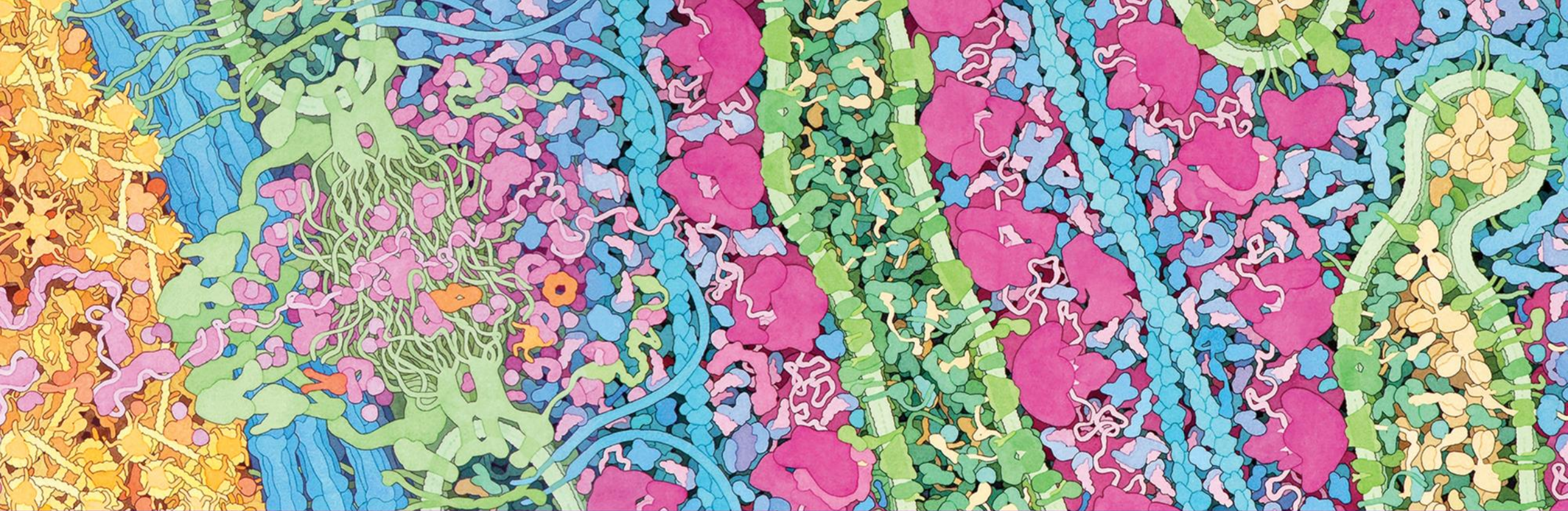
Any Final Questions or Ideas to share?

Scan the QR code and fill out the survey to get the discount code and be entered to win \$250 of product from 3DMD.

Thank you for your time:)







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