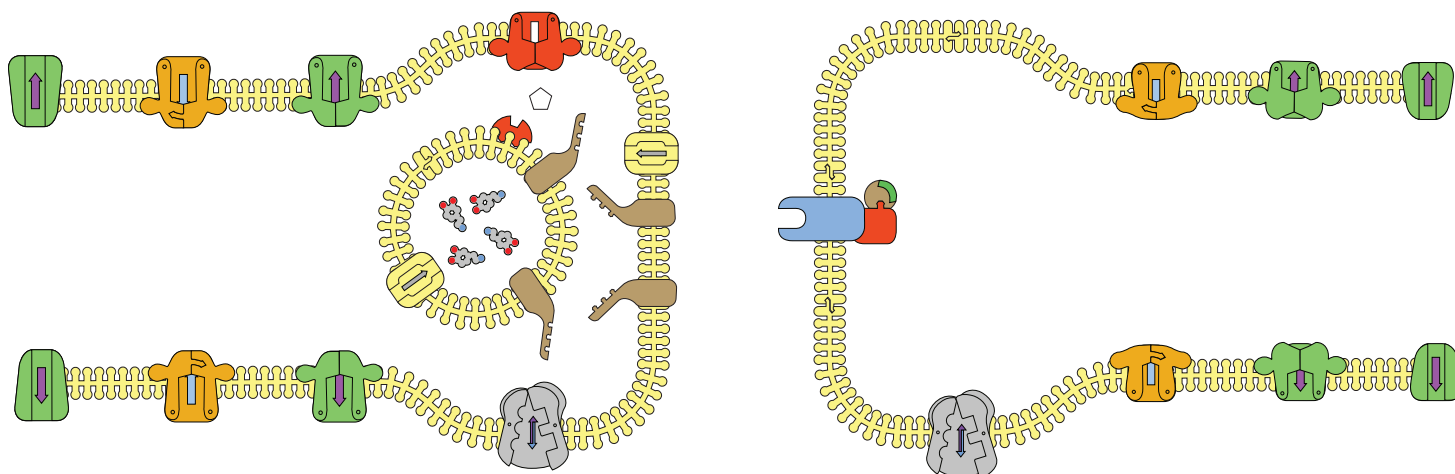


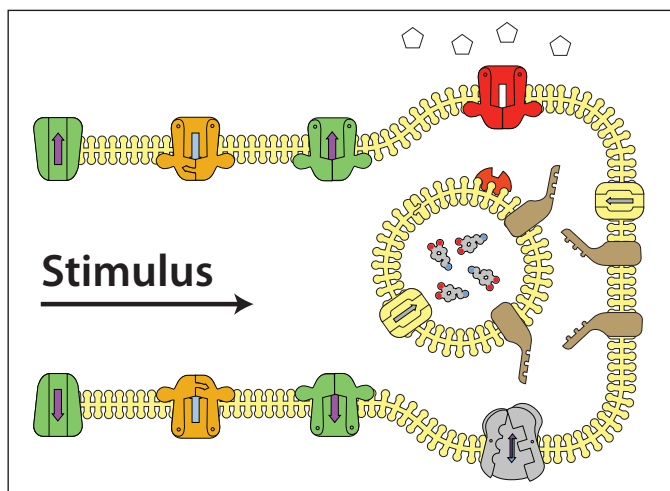
Part V: Modeling Neurotransmission - A Dopaminergic Synapse

1a. Model the **metabotropic dopaminergic** synapse shown below. Be sure to label all of the following: voltage-gated sodium channel, voltage-gated potassium channel, voltage-gated calcium channel, synaptotagmin, dopamine, synaptic vesicle, presynaptic cell, postsynaptic cell, potassium leak channel, sodium-potassium pump, synaptic cleft, G protein-coupled receptor, SNAP/SNARE proteins, dopamine reuptake transporter, and vesicular transporter

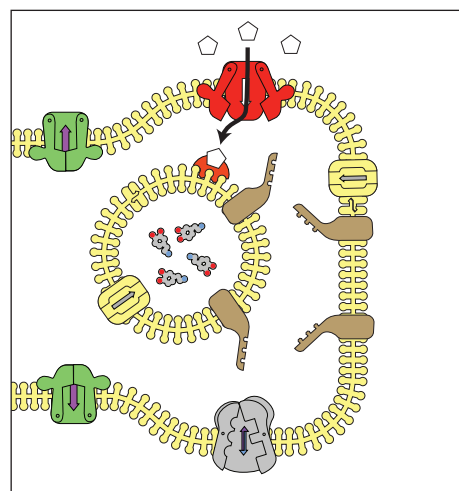


When a nerve impulse (action potential) reaches the axon terminal, it sets into motion a chain of events that triggers the release of neurotransmitter. You will next model the events of neurotransmission at a dopaminergic synapse.

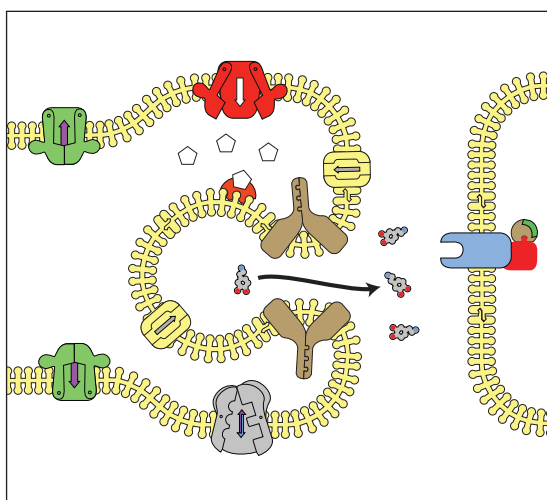
Part V: Modeling Neurotransmission - A Dopaminergic Synapse



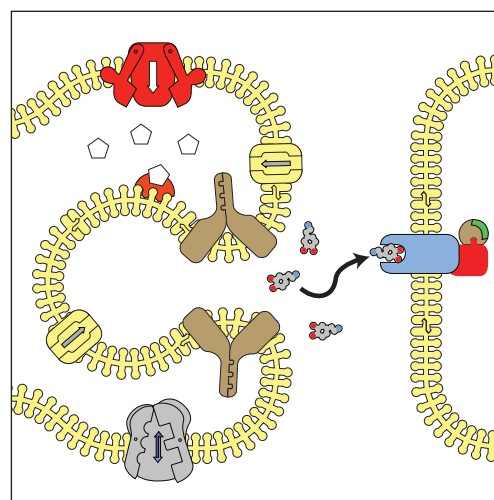
Step 1 - Action potential arrives at the terminal end of the presynaptic cell.



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.

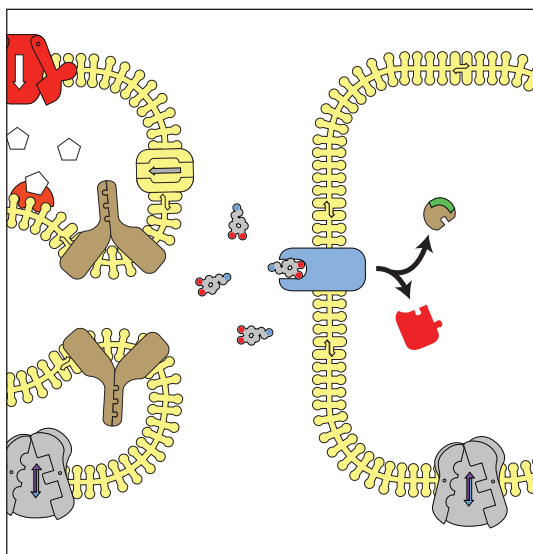


Step 3 – Bound Ca^{2+} triggers SNAP/SNARE protein interaction to bring the vesicle in position for fusion with the presynaptic cell membrane. Dopamine is released into the synaptic cleft

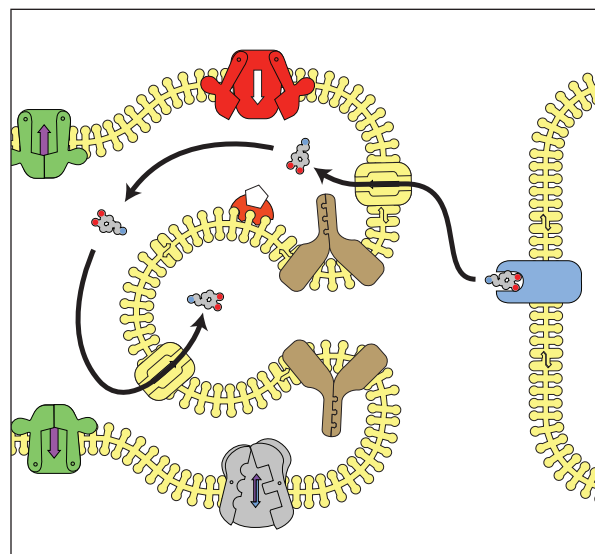


Step 4 - Dopamine traverses the **synaptic cleft** to bind to the extracellular domain of the metabotropic receptor in the postsynaptic membrane. The intracellular domain of the metabotropic receptor binds to G proteins. The G protein has three subunits: **alpha(α)**, **beta(β)**, and **gamma(γ)**.

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Step 5 - Bound dopamine activates the metabotropic receptor. The α subunit dissociates from the beta-gamma complex. The α subunit triggers a signal cascade that ends in the opening of ion channels, depolarizing the postsynaptic cell.



Step 6 - The effects of dopamine are terminated when dopamine is removed from the synaptic cleft by the dopamine reuptake transporter and returned to the vesicle via the vesicular transport protein.

Note: Dopamine may also be broken down by the enzymes monoamine oxidase (MAO) in the cytoplasm of the presynaptic neuron and catechol-O-methyl transferase (COMT) embedded in the postsynaptic membrane.

1b. How is the dopamine receptor different from the acetylcholine receptor?

1c. What neurotransmitter is released into the synaptic cleft in this model?

1d. Identify the dopaminergic synapse modeled as excitatory or inhibitory. Explain your choice.

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1e. Describe how an ionotropic receptor differs from a metabotropic receptor.

1f. Do ions move through this metabotropic receptor?

1g. Identify the subunits of the G-protein. Which of these triggers the opening of ion channel in the postsynaptic cell?

1h. Propose a molecular mechanism for how the postsynaptic cell is depolarized after activation of the G protein-coupled receptor.

1i. How is termination of neuronal signaling different in this dopaminergic synapse model compared to the cholinergic synapse model?
