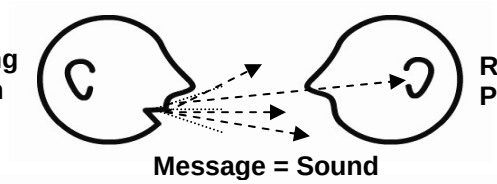
Modeling Effects of Drugs on Neuron Communication

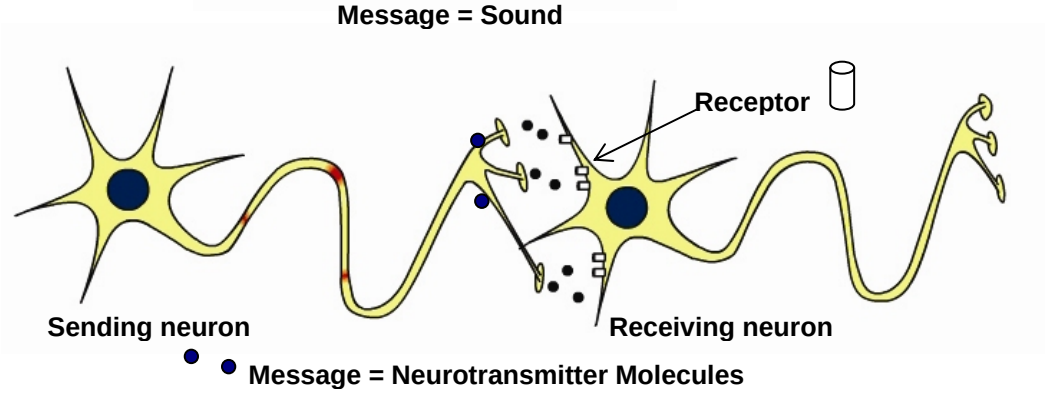
How do neurons communicate?

Your nervous system is made of nerve cells called neurons. Neurons do not touch each other. They are separated by a small gap called a **synapse**. To send a message, a **sending neuron** releases chemical message molecules called **neurotransmitters** into the synapse (gap). The neurotransmitters diffuse across the synapse and bind to **receptors** on the surface of a **receiving neuron**. When neurotransmitters bind to receptors, they trigger a nerve impulse (an electrical message) that travels along the receiving neuron.

How people communicate



How neurons (nerve cells) communicate



1. What is the message that travels from a sending neuron to a receiving neuron?

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2. What part of a neuron is like the ears of a person who is listening to a sound message?

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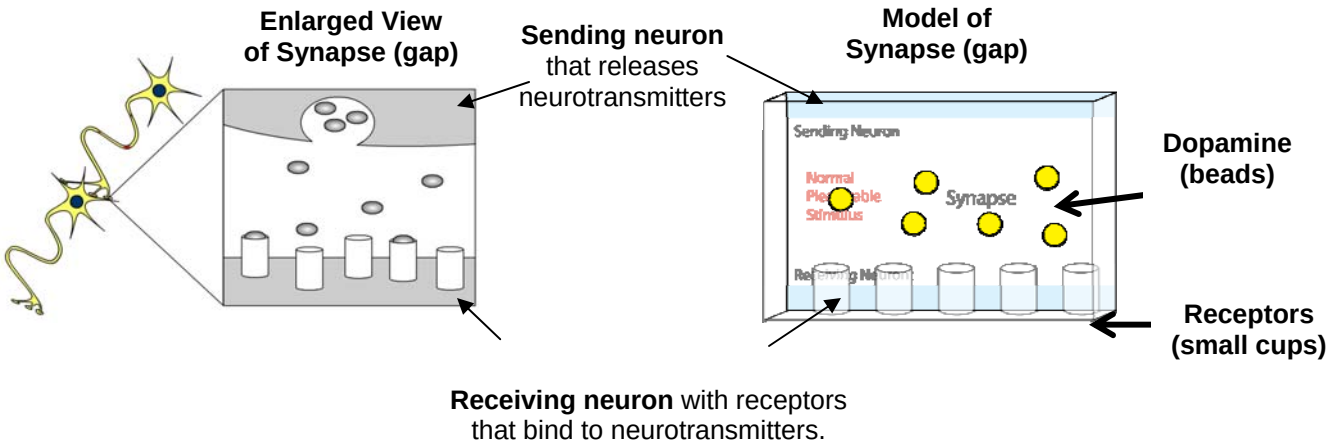
How do drugs interfere with neuron communication?

Drugs affect how neurons (nerve cells) in the brain communicate with each other by changing the chemical messages in the synapse. In this activity, you will observe models that illustrate communication between neurons that occurs at synapses.



Model 1: Neuron communication with normal rewarding activity

First, you will look at the model labeled **Model 1: Normal Pleasurable Stimulus**. This model illustrates what happens in synapses when there is a normal rewarding (pleasant) activity such as eating or listening to music.

1. Set the model labeled **Normal Pleasurable Stimulus** so that the beads are on sending neuron side as shown in Figure 1.

2. Count the number of beads. The beads represent dopamine molecules. Record the number of beads in the Data Table. *The data table is on the last page of this handout.*

3. Notice that the other side of the model has small cups. These small cups represent receptors on the receiving neuron. Count the number of small cups (receptors) in the model. Record the number of cups in the Data Table.

4. When a nerve impulse reaches the sending end of the first neuron, dopamine molecules are released as shown in Figure 2. Model this by shaking and then quickly flipping the model over so that the beads move toward the end of the model with receptors.

Figure 1

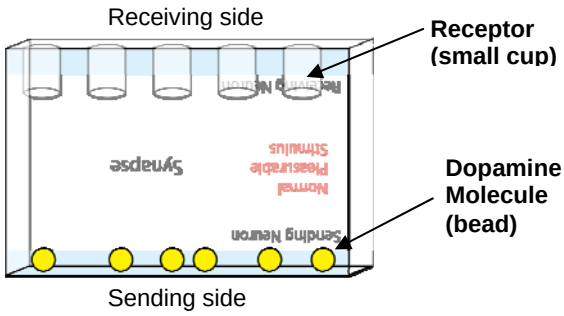
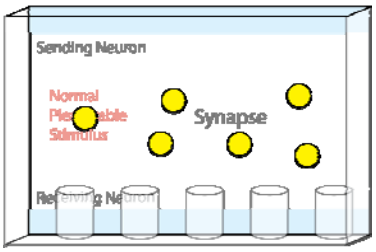
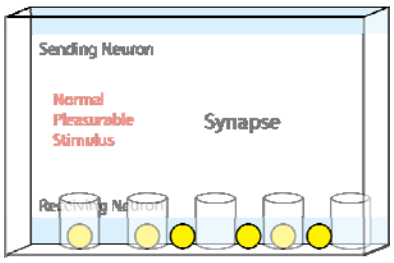


Figure 2



5. When the beads reach the receiving end of the next neuron, some may enter the receptors (small cups) on this neuron as shown in Figure 3.
   - o Count the number of receptors (cups) that have dopamine molecules (beads) in them.
   - o Record the number of cups with beads in them on the Data Table in Trial 1.

Figure 3



6. Repeat steps 4 and 5 to complete four additional trials.

7. Calculate and record the <u>average</u> number of beads (dopamine) that entered the receptors.

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Model 2: Neuron communication with first drug use.

Next, you will observe the model labeled **Model 2 – First Drug Use.** This model illustrates what happens in synapses when a person uses drugs for the first time.

1. Describe how the model labeled **First Drug Use** different from model labeled **Normal Pleasurable Stimulus**.

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2. Use the model labeled **Model 2 – First Drug Use** to repeat the steps that you used with Model 1:
   - Count and record the number of dopamine molecules.
   - Count and record the number of receptors.
   - Shake and flip the model, then count and record the number of receptors that contain dopamine molecules.
   - Do five trials, then calculate the average for the five trials.

3. Explain how this model illustrates why a person feels “high” with first drug use.

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Model 3: Neuron communication after continued drug use.

What do you do if you're listening to an iPod and the volume is too loud? You turn the volume down.

What does the brain do if continued drug use results in too much dopamine? To maintain homeostasis, brain neurons change to reduce the amount of dopamine stimulation.

Observe the model labeled **Model 3 - Continued Drug Use** that illustrates how neurons change when a person continues to use drugs.

1. Describe how the model labeled **Continued Drug Use** is different from the model labeled **First Drug Use**.

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2. Use the model labeled **Continued Drug Use** to repeat the steps that you used with the **Synapse with <u>first</u> drug use** model.
   - Count and record the number of dopamine molecules.
   - Count and record the number of receptors.
   - Shake and flip the model, then count and record the number of receptors that contain dopamine molecules.
   - Do five trials, then calculate the average for the five trials.

3. Describe how the **Synapse after <u>continued</u> drug use** illustrates <u>two</u> changes that brain neurons make to adapt to abnormally high levels of dopamine associated with drug abuse.

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4. Explain how this model shows why a drug abuser becomes less able to enjoy normal pleasant activities such as eating or listening to music.

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Drug Tolerance

When people abuse drugs they often find that they no longer respond to the drugs in they way they initially did. To feel "high" they need to use larger amounts of drugs and use drugs more frequently. This is called **drug tolerance**.

5. Explain how this model shows why a drug abuser develops drug tolerance - will need to use larger amounts of drugs and use drugs frequently to feel happy.

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6. Describe the changes in the neurons that lead to drug tolerance.

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Data Table:

Neuron Communication

	Number of Beads (Dopamine) in model	Number of Cups (Receptors) in model	Number of Receptors with Dopamine Bound					Average number of Receptors with bound Dopamine	Sensation experienced by person
			Trial 1	Trial 2	Trial 3	Trial 4	Trial 5		
Model 1 Synapse with normal rewarding stimulus									**Happy**
Model 2 Synapse with <u>first</u> drug use									**"High"**
Model 3 Synapse after <u>continued</u> drug use									**Unhappy!**