

# Drugs Disrupt Neurotransmission

How do drugs cause their effects on the brain and behavior? A specific reward part of the brain regulates feelings of pleasure. This is the region that is activated by drugs of abuse. But what do drugs actually do in that brain region? Drugs interfere with neurotransmission. They produce feelings of pleasure by changing normal neurotransmission of neurons in the reward part of the brain; specifically, those neurons that release the neurotransmitter called dopamine. So, drugs of abuse alter the communication between neurons that are controlled by dopamine. Because the synapse is so complex, there are many sites at where drugs may affect the synapses.

One way to affect neurotransmission is to increase the amount of neurotransmitter that is released into the synaptic space. Drugs like alcohol, heroin, and nicotine excite the dopamine-containing neurons in the reward part of the brain. This makes them produce more signals. As the number of signals increase, so does the amount of dopamine released into the synapse. Nicotine not only acts at the cell body to increase the number of signals and the number of vesicles released from a neuron, but it also acts by changing dopamine release. When nicotine binds to nicotine receptors on the end of the axon, more dopamine is released with each signal.

Figure 1: Nicotine binds to special receptors on the first neuron. When nicotine binds to receptors at the cell body, it excites the neuron so that it fires more signals that move toward the synapse making more dopamine to be released (not shown in figure). When nicotine binds to nicotine receptors at the axon end (shown above), the amount of dopamine released for each signal is increased.

Another way to affect neurotransmission is to cause neurotransmitters to be released for no reason. Amphetamines (e.g., methamphetamine, crystal, crank) actually cause the release of dopamine from the vesicles; even if there wasn't a signal sent. Depending on the dose, they can cause a relatively quick and long rise of extra dopamine levels.

Figure 2: Methamphetamine change dopamine neurotransmission in two ways. Methamphetamine enters the neuron through nerve cell membranes. In the end of the axon, methamphetamine enters the dopamine-containing vesicles and causes the release of neurotransmitter. Methamphetamine also blocks the dopamine transporter from pumping dopamine back into the first neuron. Methamphetamine acts like cocaine in this way.

A third way to affect neurotransmission is to change the removal of the neurotransmitters from the synapse. Cocaine and amphetamines work this way (this is the second way in which amphetamines can alter neurotransmission). Both drugs block the dopamine transporter that removes dopamine from the synapse to be reused. The result is a fairly rapid rise of dopamine in the synapse, leading to feelings of euphoria and well-being.

Figure 3: When cocaine enters the brain, it blocks the dopamine transporter from pumping dopamine back into the first neuron, flooding the synapse with dopamine. This intensifies and prolongs the stimulation of the neurons in the brain's pleasure circuits, causing a cocaine "high."

Drugs of abuse share a common action: they act on the brain's reward system. Within that system, they all share the ability to increase the levels of dopamine in the reward part of the brain. The effects of drugs are not limited to this part of the brain. Drugs can act in many regions of the brain, but their ability to change dopamine neurotransmission is one of the most important factors that drive continued drug use.

### **QUESTIONS FOR REVIEW:**

1. Name the neurotransmitter that is released in the reward part of the brain?
2. What happens when nicotine binds to nicotine receptors?
3. List three different ways drugs disrupt neurotransmission.
4. Explain what is similar about all three ways listed in number 3.

Bonus: Predict what would happen with continued use of any one of the drugs you read about.