



## Brain and Addiction

EXPAND ALL

Revised December 2014

### Your Brain



Your brain is who you are. It's what allows you to think, breathe, move, speak, and feel. It's just 3 pounds of gray-and-white matter that rests in your skull, and it is your own personal "mission control." Information from your environment—both outside (like what your eyes see and skin feels) and inside (like your heart rate and body temperature)—makes its way to the brain, which receives, processes, and integrates it so that you can survive and function under all sorts of changing circumstances and learn from experience. The brain is always working, even when you are sleeping. (Learn more about the [brain-body connection](#).)

The brain is made up of many parts that all work together as a team. Each of these different parts has a specific and important job to do.

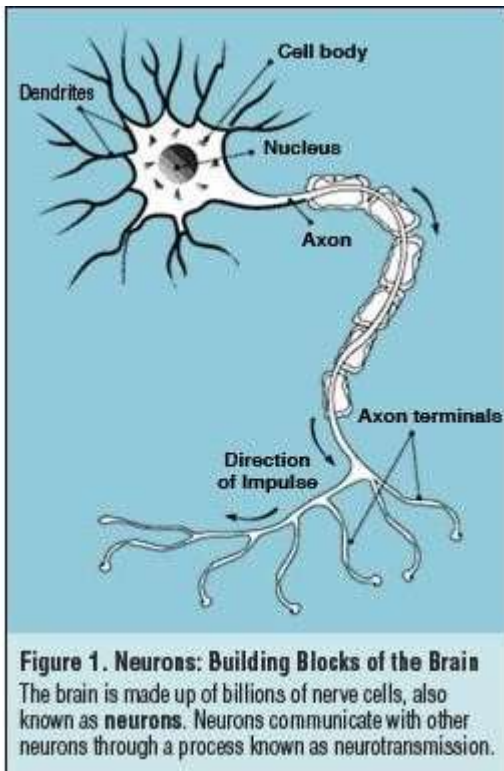
When drugs enter the brain, they interfere with its normal processing and can eventually lead to changes in how well it works. Over time, drug use can lead to addiction, a devastating brain disease in which people can't stop using drugs even when they really want to and even after it causes terrible consequences to their health and other parts of their lives.

Drugs affect three primary areas of the brain:

- **The brain stem** is in charge of all the functions our body needs to stay alive—breathing, moving blood, and digesting food. It also links the brain with the spinal cord, which runs down the back and moves muscles and limbs as well as lets the brain know what's happening to the body.
- **The limbic system** links together a bunch of brain structures that control our emotional responses, such as feeling pleasure when we eat chocolate. The good feelings motivate us to repeat the behavior, which is good because eating is critical to our lives.
- **The cerebral cortex** is the mushroom-shaped outer part of the brain (the gray matter). In humans, it is so big that it makes up about three-fourths of the entire brain. It's divided into four areas, called lobes, which control specific functions. Some areas process information from our senses, allowing us to see, feel, hear, and taste. The front part of the cortex, known as the frontal cortex or forebrain, is the thinking center. It powers our ability to think, plan, solve problems, and make decisions.

## How does your brain communicate?

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The brain is a complex communications network of billions of neurons, or nerve cells. Networks of neurons pass messages back and forth thousands of times a minute within the brain, spinal column, and nerves. These nerve networks control everything we feel, think, and do. Understanding these networks helps in understanding how drugs affect the brain. The networks are made up of:

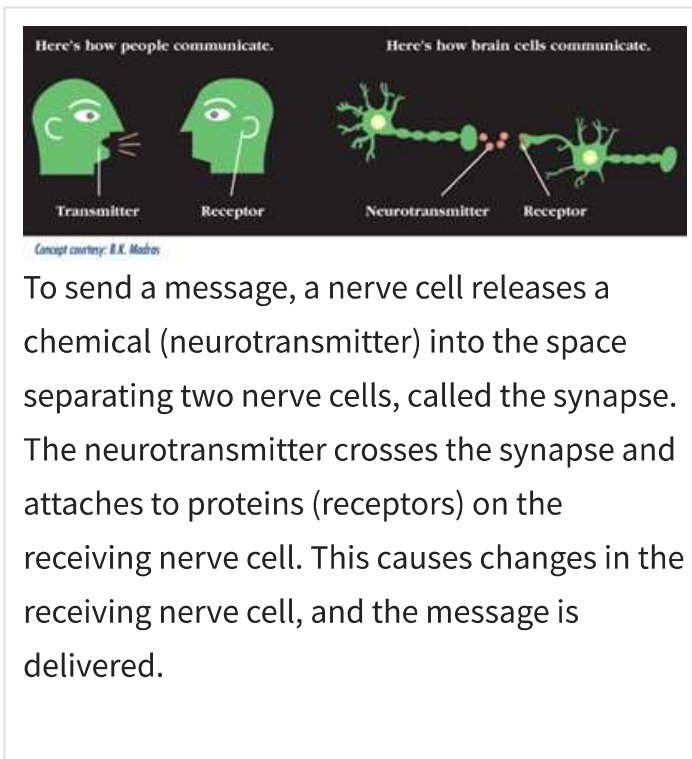
- **Neurons**

Your brain contains about 100 billion neurons—nerve cells that work nonstop to send and receive messages. Within a neuron, messages travel from the cell body down the axon to the axon terminal in the form of electrical impulses. From there, the message is sent to **other** neurons with the help of neurotransmitters.

- **Neurotransmitters—The Brain's Chemical Messengers**

To make messages jump from one neuron to another, the neuron creates chemical messengers, called neurotransmitters. The axon terminal releases neurotransmitters that travel across the space (called the synapse) to nearby neurons. Then the transmitter attaches to receptors on the nearby neuron.

- **Receptors—The Brain's Chemical Receivers**



To send a message, a nerve cell releases a chemical (neurotransmitter) into the space separating two nerve cells, called the synapse. The neurotransmitter crosses the synapse and attaches to proteins (receptors) on the receiving nerve cell. This causes changes in the receiving nerve cell, and the message is delivered.

As the neurotransmitter approaches the nearby neuron, it attaches to a special site on that neuron called a receptor. A neurotransmitter and its receptor operate like a key and lock, in that a very specific mechanism makes sure that each receptor will forward the right message only after interacting with the right kind of neurotransmitter.

- **Transporters—The Brain’s Chemical Recyclers**

Once neurotransmitters do their job, they are pulled back into their original neuron by transporters. This recycling process shuts off the signal between the neurons.

## How do drugs affect your brain?

Drugs are chemicals. When someone puts these chemicals into their body, either by smoking, injecting, inhaling, or eating them, they tap into the brain’s communication system and tamper with the way nerve cells normally send, receive, and process information. Different drugs—because of their chemical structures—work differently. We know there are at least two ways drugs work in the brain:

- Imitating the brain’s natural chemical messengers
- Overstimulating the “reward circuit” of the brain

Some drugs, like [marijuana](#) and [heroin](#), have chemical structures that mimic that of a neurotransmitter that naturally occurs in our bodies. In fact, these drugs can “fool” our

receptors, lock onto them, and activate the nerve cells. However, they don't work the same way as a natural neurotransmitter, and the neurons wind up sending abnormal messages through the brain, which can cause problems both for our brains as well as our bodies.

Other drugs, such as [cocaine](#) and [methamphetamine](#), cause nerve cells to release too much dopamine, which is a natural neurotransmitter, or prevent the normal recycling of dopamine. This leads to exaggerated messages in the brain, causing problems with communication channels. It's like the difference between someone whispering in your ear versus someone shouting in a microphone.

### **The “High” From Drugs/Pleasure Effect**

Most drugs of abuse—[nicotine](#), [cocaine](#), [marijuana](#), and others—affect the brain's “reward” circuit, which is part of the limbic system. Normally, the reward circuit responds to feelings of pleasure by releasing the neurotransmitter [dopamine](#). Dopamine creates feelings of pleasure. Drugs take control of this system, causing large amounts of dopamine to flood the system. This flood of dopamine is what causes the “high” or intense excitement and happiness (sometimes called euphoria) linked with drug use.

### **The Repeat Effect**

Our brains are wired to make sure we will repeat healthy activities, like eating, by connecting those activities with feeling good. Whenever this reward circuit is kick-started, the brain notes that something important is happening that needs to be remembered, and teaches us to do it again and again, without thinking about it. Because drugs of abuse come in and “hijack” the same circuit, people learn to use drugs in the same way.

After repeated drug use, the brain starts to adjust to the surges of dopamine. Neurons may begin to reduce the number of dopamine receptors or simply make less dopamine. The result is less dopamine signaling in the brain—like turning down the volume on the dopamine signal. Because some drugs are toxic, some neurons also may die.

As a result, the ability to feel any pleasure is reduced. The person feels flat, lifeless, and depressed, and is unable to enjoy things that once brought pleasure. Now the person needs drugs just to bring dopamine levels up to normal, and more of the drug is needed to create a dopamine flood, or “high”—an effect known as “tolerance.”

Watch our video [Why Are Drugs So Hard To Quit?](#) to learn more.

## Long-Term Effects

Drug use can eventually lead to dramatic changes in neurons and brain circuits. These changes can still be present even after the person has stopped taking drugs. This is more likely to happen when a drug is taken over and over.

## What is drug addiction?

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Addiction is a chronic brain disease that causes a person to compulsively seek out drugs, despite the harm they cause. The first time a person uses drugs, it's usually a free choice they've made. However, repeated drug use causes the brain to change which drives a person to seek out and use drugs over and over, despite negative effects such as stealing, losing friends, family problems, or other physical or mental problems brought on by drug use—this is addiction.

## What factors increase the risk for addiction?

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Although we know what happens to the brain when someone becomes addicted, we can't predict how many times a person must use a drug before becoming addicted. A combination of factors related to your genes, environment, and development increase the chance that taking drugs can lead to addiction:

- **Home and family.** Parents or older family members who abuse alcohol or drugs, or who are involved in criminal behavior, can increase young people's risks for developing their own drug problems.
- **Peers and school.** Friends and acquaintances who abuse drugs can sway young people to try drugs for the first time. Academic failure or poor social skills can also put a person at risk for drug use.
- **Early use.** Although taking drugs at any age can lead to addiction, research shows that the earlier a person begins to use drugs, the more likely they are to progress to more serious use. This may reflect the harmful effect that drugs can have on the developing brain. It also may be the result of early biological and social factors, such as genetics, mental illness, unstable family relationships, and exposure to physical or sexual abuse.

Still, the fact remains that early use is a strong indicator of problems ahead—among them, substance abuse and addiction.

- **Method of use.** Smoking a drug or injecting it into a vein increases its addictive potential. Both smoked and injected drugs enter the brain within seconds, producing a powerful rush of pleasure. However, this intense "high" can fade within a few minutes, taking the person down to lower levels. Scientists believe that this low feeling drives individuals to repeat drug use in an attempt to recapture the high pleasurable state.

Learn more about what puts you at risk, view our video [Anyone Can Become Addicted to Drugs](#).

### Anyone Can Become Addicted to Drugs

## Can you die if you use drugs?

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Yes, deaths from drug overdose have been rising steadily over the last decade. In 2015 alone, more than 52,400 people died from a drug overdose. More than three out of five drug overdose deaths involve some type of opioid, either prescription pain reliever, heroin, or man-made opioids like fentanyl. Among young people, just over 4,200 deaths from a drug overdose occurred that year.<sup>1</sup> Young males were two times more likely to die from a drug overdose than were females. Learn more about [drug overdoses in youth](#).

In addition, death can occur from the long-term effects of drugs. For example, use of tobacco products can cause cancer, which may result in death.

<sup>1</sup> Centers for Disease Control and Prevention, National Center for Health Statistics. Underlying Cause of Death 1999-2015 on CDC WONDER Online Database, released 2016. Available at <http://wonder.cdc.gov>.

## Are there effective treatments for drug addiction?

Yes, there are treatments, but there is no cure for drug addiction yet. Addiction is often a disease that is long-lasting (sometimes referred to as chronic). As with other chronic diseases, like diabetes or heart disease, people learn to manage their condition. Scientific research has shown that 13 basic principles are the foundation for effective drug addiction treatment. Find out more in [NIDA's Principles of Drug Addiction Treatment: A Research-Based Guide](#) or from [Principles of Adolescent Substance Use Disorder Treatment: A Research-Based Guide](#).

### Types of Treatment

Treatment will vary for each person, depending on the type of drugs used and the person's specific circumstances. Generally, there are two types of treatment for drug addiction:

- **Behavior change**, in which people learn to change their behavior
- **Medications**, which can help treat addictions to some drugs, such as tobacco, alcohol, heroin, or other opioids

### Length of Treatment

Like diabetes and even asthma, drug addiction typically is a long-lasting disorder. Most people who have become addicted to drugs need long term treatment and, many times, repeated treatments—much like a person who has asthma needs to constantly watch changes in medication and exercise. The important point is that even when someone [relapses](#) and begins abusing drugs again, they should not give up hope. Rather, they need to go back to treatment or change their current treatment. In fact, setbacks are likely. Even people with diabetes may go off their diet or miss an insulin injection, and their symptoms will recur—that's a cue to get back on track, not to view treatment as a failure.

### Motivation for Treatment



Most people go into drug treatment either because a court ordered them to do so or because loved ones wanted them to seek treatment. The good news is that, according to scientific studies, people can benefit from treatment regardless of whether or not they chose to go into treatment.

## How do I know if someone has a drug problem?

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There are questions people can ask to gauge whether or not a person has a drug problem. These may not mean that someone is addicted, but answering yes to any of these questions may suggest a developing problem, which could require followup with a professional drug treatment specialist. These include:

1. Have you ever ridden in a car driven by someone (including yourself) who had been using alcohol or drugs?
2. Do you ever use alcohol or drugs to relax, to feel better about yourself, or to fit in?
3. Do you ever use alcohol or drugs when you are alone?
4. Do you ever forget things you did while using alcohol or drugs?
5. Do family or friends ever tell you to cut down on your use of alcohol or drugs?
6. Have you ever gotten into trouble while you were using alcohol or drugs?

## What should I do if someone I know needs help?

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If you see or hear about someone misusing opioids, talk to a coach, teacher, or other trusted adult.

If you, or a friend, are in crisis and need to speak with someone now, please call:

- **National Suicide Prevention Lifeline at 1-800-273-TALK** (they don't just talk about suicide—they cover a lot of issues and will help put you in touch with someone close by).

If you need information on treatment and where you can find it, you can call:

- **Substance Abuse Treatment Facility Locator at 1-800-662-HELP** or visit [www.findtreatment.samhsa.gov](http://www.findtreatment.samhsa.gov).

For more information on how to help a friend or loved one, visit our [Have a Drug Problem, Need Help? page](#).

## Where can I get more information?

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### Drug Facts

#### NIDA:

- [Drugs, Brains, and Behavior: The Science of Addiction](#)
- [Research Report Series: Comorbidity: Addiction and Other Mental Illnesses](#)
- [The Brain: Understanding Neurobiology Through the Study of Addiction, Educator Curriculum](#)
- [The Brain: Understanding Neurobiology Through the Study of Addiction, Teen Activities](#)

### Treatment

#### NIDA:

- [DrugFacts: Treatment Approaches for Drug Addiction](#)
- [Principals of Drug Addiction Treatment: A Research-Based Guide](#)

### Statistics and Trends

#### NIDA:

- [DrugFacts: High School and Youth Trends](#)

### Monitoring the Future (University of Michigan):

- [Monitoring the Future](#)

### Substance Abuse and Mental Health Services Administration:

- [National Survey on Drug Use and Health](#)

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Site last updated September 04, 2017

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