

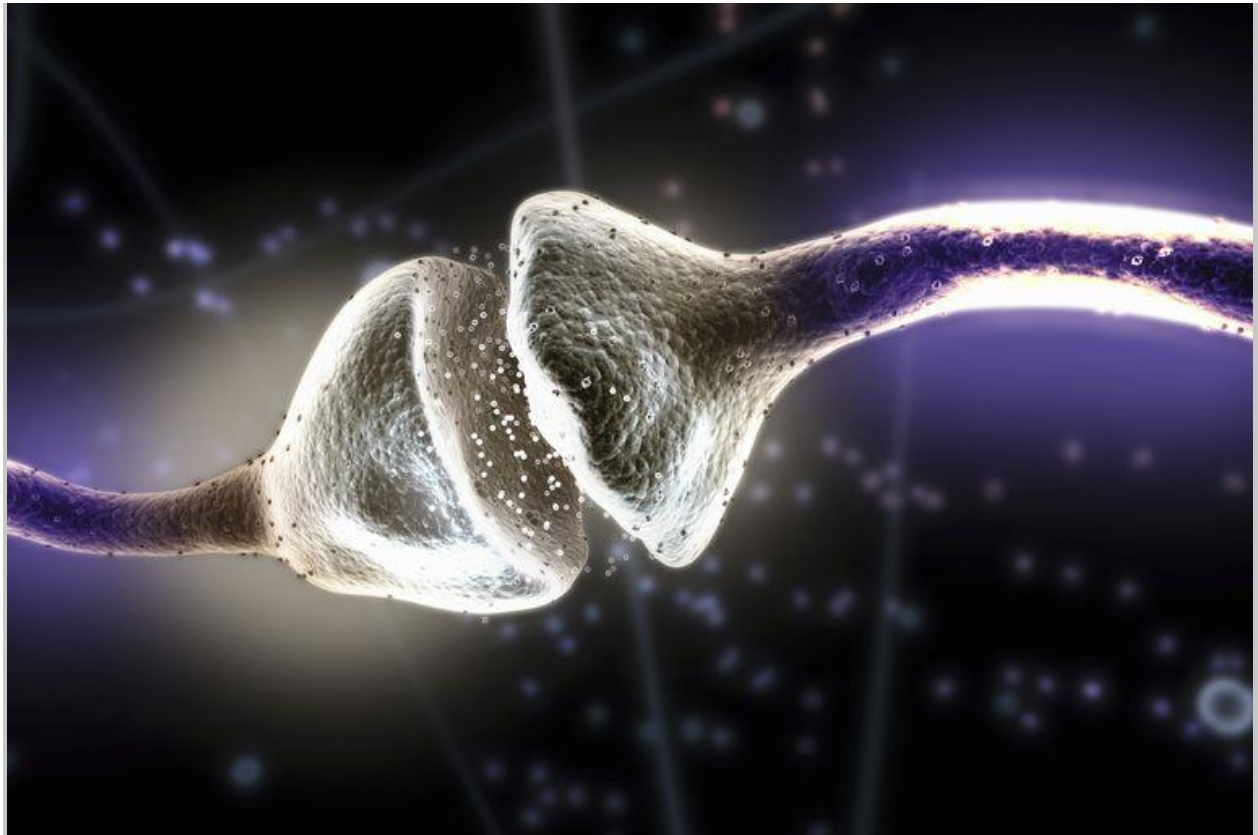
# What You Need to Know About Neurotransmitters

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by Anne Marie Helmenstine, Ph.D.

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## Neurotransmitters Definition and List



Neurotransmitters are chemicals that connect neurons, allowing signals to be sent from one part of the body to another. Science Picture Co / Getty Images

Neurotransmitters are chemicals that cross synapses to transmit impulses from a neuron to another neuron, glandular cell, or muscle cell. In other words, neurotransmitters are used to send signals from one part of the body to another. Over 100 neurotransmitters are known. Many are simply constructed from amino acids. Others are more complex molecules.

Neurotransmitters perform many vital functions in the body.

For example, they regulate heartbeat, tell the lungs when to breathe, determine the set point for weight, stimulate thirst, affect mood, and control digestion.

The synaptic cleft was discovered by Spanish pathologist Santiago Ramón y Cajal in the early 20th century. In 1921, German pharmacologist Otto Loewi verified that communication between neurons was the result of released chemicals. Loewi discovered the first known neurotransmitter, acetylcholine.

## HOW NEUROTRANSMITTERS WORK

The axon terminal of a synapse stores neurotransmitters in vesicles. When stimulated by an action potential, synaptic vesicles of a synapse release neurotransmitters, which cross the small distance (synaptic cleft) between an axon terminal and a dendrite via diffusion. When the neurotransmitter binds a receptor at the dendrite, the signal is communicated. The neurotransmitter remains in the synaptic cleft for a short time.

Then it is either returned to the presynaptic neuron through the process of reuptake, metabolized by enzymes, or bound to the receptor.

When a neurotransmitter binds to a postsynaptic neuron, it can either excite it or inhibit it. Neurons are often connected to other neurons, so at any given time a neuron may be subject to multiple neurotransmitters.

If the stimulus for excitation is greater than the inhibitory effect, the neuron will "fire" and create an action potential that releases neurotransmitters to another neuron. Thus, a signal is conducted from one cell to the next.

## TYPES OF NEUROTRANSMITTERS

One method of classifying neurotransmitters is based on their chemical composition. Categories include:

- Amino acids:  $\gamma$ -aminobutyric acid (GABA), aspartate, glutamate, glycine, D-serine
- Gases: carbon monoxide (CO), hydrogen sulfide (H<sub>2</sub>S), nitric oxide (NO)
- Monoamines: dopamine, epinephrine, histamine, norepinephrine, serotonin
- Peptides:  $\beta$ -endorphin, amphetamines, somatostatin, enkephalin
- Purines: adenosine, adenosine triphosphate (ATP)
- Trace amines: octopamine, phenethylamine, tryptamine
- Other molecules: acetylcholine, anandamide
- Single ions: zinc

The other major method of categorizing neurotransmitters is according to whether they are **excitatory** or **inhibitory**. However, whether a neurotransmitter is excitatory or inhibitory depends on its receptor. For example, acetylcholine is inhibitory to the heart (slows heart rate), yet excitatory to skeletal muscle (causes it to contract).

## IMPORTANT NEUROTRANSMITTERS

- **Glutamate** is the most abundant neurotransmitter in humans, used by about half of the neurons in the human brain. It is the primary excitatory transmitter in the central nervous system. One of its functions is to help form memories. Interestingly, glutamate is toxic to neurons. Brain damage or a stroke can lead to an excess of glutamate, killing neurons.
- **GABA** is the primary inhibitory transmitter in the vertebrate brain. It helps to control anxiety. GABA deficiency may result in seizures.
- **Glycine** is the main inhibitory neurotransmitter in the vertebrate spinal cord.
- **Acetylcholine** stimulates muscles, functions in the autonomic nervous system and sensory neurons, and is associated with REM sleep. Many poisons act by blocking acetylcholine receptors. Examples include botulin, curare, and hemlock. Alzheimer's disease is associated with a significant drop in acetylcholine levels.
- **Norepinephrine** (noradrenaline) increases heart rate and blood pressure. It is part of the body's "fight or flight" system. Norepinephrine is also needed to form memories. Stress depletes stores of this neurotransmitter.
- **Dopamine** is an inhibitory transmitter associated with the reward center of the brain. Low dopamine levels are associated with social anxiety and Parkinson's disease, while excess dopamine is related to schizophrenia.
- **Serotonin** is an inhibitory neurotransmitter involved in mood, emotion, and perception. Low serotonin levels can lead to depression, suicidal tendencies, anger management issues, difficulty sleeping, migraines, and an increased craving for carbohydrates. The body can synthesize serotonin from the amino acid tryptophan, which is found in foods such as warm milk and turkey.
- **Endorphins** are a class of molecules like opioids (e.g., morphine, heroin) in terms of structure and function. The word "endorphin" is short for "endogenous morphine." Endorphins are inhibitory transmitters associated with pleasure and pain relief. In other animals, these chemicals slow metabolism and permit hibernation.