

# Neurotransmitters and Synapses

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## WHAT'S COVERED

This tutorial will cover the following main concepts associated with the communication of the body's nervous system:

1. Neurotransmitters and Synapses
2. Types of Neurotransmitters
  - a. Excitatory Neurotransmitters
  - b. Inhibitory Neurotransmitters
  - c. Neuropeptides

## 1. Neurotransmitters and Synapses

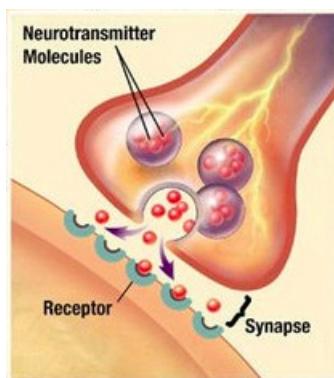
The nervous system is essentially the body's communication system. It allows information to be sent to and from your brain, allowing you to control the rest of your body. These messages allow you to do all of the things that constitute your mind and behavior.

There are two different ways in which the nervous system communicates:

- Impulses are sent within a neuron. Electrical charges are sent from the dendrites all the way down to the axon.
- There is also communication between neurons. Neurons use those electrical charges to transmit information within the cell.

So, how do they actually communicate between other cells to send information to lots of different ones?

Taking a closer look at the areas between different neurons, you can see that at the very end of an axon of one neuron is a little button area, called the axon terminal. Normally, an axon sends an electrical impulse across the cell, but this electrical impulse is not transmitted to other neurons. This is because in between the axon and the dendrites of other neurons there is a space called a **synapse**, which is an actual gap between these different cells. Therefore, the electrical impulse can't jump over to other cells.



This means that another way is needed to communicate with those cells. Therefore, when that electrical impulse reaches the axon terminal, it releases what are called **neurotransmitters**.

Neurotransmitters are chemical messengers that attach themselves to other dendrites of other neurons surrounding them. This is helpful because it allows one neuron to communicate with many different neurons by sending out all of these different chemical messengers. It's not just one-to-one—it could be one to potentially hundreds of neurons.

Next, these neurotransmitters attach themselves to dendrites at what are called **receptor sites**. These receptor sites act as a sort of lock-and-key mechanism, meaning that one neurotransmitter fits that one particular receptor site. It's not a one-size-fits-all situation. All of the different receptor sites receive all of these neurotransmitters and eventually, when the neuron on the other side of the synapse receives enough chemical messengers, it activates itself and releases into an action potential, which fires a different neuron and then potentially other neurons surrounding it. You can imagine how it creates a cascade effect: one neuron potentially affecting a lot of different neurons.



#### TERMS TO KNOW

##### Synapse

The small space between the axon terminal of one neuron and the dendrites of other neurons

##### Neurotransmitter

Chemical messengers that allow neurons to communicate with other neurons across the synapse

##### Receptor Sites

Areas on neurons that connect and respond to neurotransmitters

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## 2. Types of Neurotransmitters

There are many different types of neurotransmitters that are used in the brain and the nervous system. Remember, it's not a one-size-fits-all scenario. The reason for this is to allow for many different effects within the brain and the rest of the body itself.

There are two general types of neurotransmitters:

- Excitatory neurotransmitters
- Inhibitory neurotransmitters

## 2a. Excitatory Neurotransmitters

Excitatory neurotransmitters lead to the firing of neurons, or the **threshold of excitation**, and ultimately, to **action potential**.

The most common type of neurotransmitter is **acetylcholine**, which is abbreviated as ACH. This is an excitatory neurotransmitter, and it is used within the body to help with muscle movement, as well as the activation of the peripheral nervous system in different ways. In the brain itself, it is attached to attention and memory.



### DID YOU KNOW

It is thought that a lack of acetylcholine can contribute to Alzheimer's disease.



### TERMS TO KNOW

#### Threshold of Excitation

The level or point at which a neuron fires, or a neural impulse is triggered.

#### Action Potential

The state in which a neuron reaches its threshold of excitation and fires, or sends an electrical impulse down the axon

#### Acetylcholine

The most common neurotransmitter, which is used in movement in the peripheral nervous system and related to attention and memory in the brain

## 2b. Inhibitory Neurotransmitters

Inhibitory neurotransmitters prevent the firing of neurons, keeping that state of **resting potential** instead. This doesn't allow the other neurons to fire.

One of the more famous neurotransmitters is dopamine, which is actually considered both an excitatory and inhibitory neurotransmitter. Dopamine is particularly used in certain areas of the brain, the frontal cortex and the limbic system. This plays a role specifically in the motivation of people, as well as reward and reinforcement systems within the brain.



### DID YOU KNOW

Dopamine leads to a lot of addictive behaviors. Addiction to gambling or alcohol is generally a result of dopamine being overly activated within the brain. Dopamine is also chemically similar to cocaine; therefore, a lot of drugs will act like dopamine and lead to these same feelings of pleasure.



### TERM TO KNOW

#### Resting Potential

The state in which a neuron is not firing or sending a neural impulse and when there is a negative electrical charge inside the neuron

## 2c. Neuropeptides

Lastly, there is a class of neurotransmitters called **neuropeptides**, which are a special group that regulate certain activities of neurons and systems within the brain itself.

An example of a neuropeptide is an endorphin, which acts to reduce pain and leads to feelings of euphoria or positivity about yourself, especially when you feel pain or are stressed out. Endorphins are what results in a runner's high. When you are running, you may get a sudden sensation of feeling exceptionally good--and good about yourself--which is the result of endorphins being activated within your brain.



#### TERM TO KNOW

### Neuropeptides

A special class of neurotransmitters that regulate the activity of neurons and systems in the brain



#### SUMMARY

The nervous system is the body's communication system. Information is sent to and from the brain, which allows control over the rest of the body. These messages allow you to do all of the things that constitute your mind and behavior.

Between the axon and the dendrites of other neurons there is a space called a **synapse**.

**Neurotransmitters** jump that gap via electrical impulses. Dopamine is a **type of neurotransmitter** that makes people feel good and acetylcholine is a type of excitatory neurotransmitter that assists with muscle control. Lastly, neuropeptides are a class of neurotransmitters which comprise a special group that regulate certain activities of neurons and systems within the brain itself.

Good luck!

Source: This work is adapted from Sophia author Erick Taggart.



#### TERMS TO KNOW

##### Acetylcholine

The most common neurotransmitter, which is used in movement in the peripheral nervous system and related to attention and memory in the brain.

##### Action Potential

The state in which a neuron reaches its Threshold of Excitation and fires, or sends an electrical impulse down the axon.

##### Neuropeptides

A special class of neurotransmitters that regulate the activity of neurons and systems in the brain.

##### Neurotransmitter

Chemical messengers that allow neurons to communicate with other neurons across the synapse.

##### Receptor Sites

Areas on neurons that connect and respond to neurotransmitters.

**Resting Potential**

The state in which a neuron is not firing or sending a neural impulse and when there is a negative electrical charge inside the neuron.

**Synapse**

The small space between the axon terminal of one neuron and the dendrites of other neurons.

**Threshold of Excitation**

The level or point at which a neuron fires, or a neural impulse is triggered.