

# NEUROTRANSMISSION VS NEUROMODULATION

**Neurotransmission** is the process by which an incoming electrical signal, or action potential, in a neuron is converted into a chemical message at the synapse. Vesicles containing molecules of neurotransmitter dump their cargo into the synaptic cleft<sup>1</sup>. The molecules then bind to their receptors on the postsynaptic membrane and induce their effect, usually the opening of postsynaptic ligand-gated ion channels and the excitation, or inhibition, of the postsynaptic neuron.



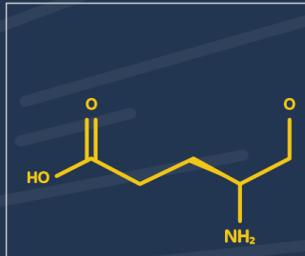
**THIS RAPID SIGNALLING MECHANISM TAKES PLACE ON THE MILLISECOND TIMESCALE.**

**Neuromodulation** is a slower mechanism by which molecules of neuromodulators are released by neurons at a synapse, but act on G-protein coupled receptors and voltage-gated ion channels on the postsynaptic neuron to modulate its activity. Neuromodulation is a change in the state of a neuron, or group of neurons, which alters its response to subsequent stimulation<sup>2</sup>. They are also diffusible and can act at adjacent synapses.



**THIS SLOWER SIGNALLING MECHANISM TAKES PLACE OVER SECONDS TO MINUTES.**

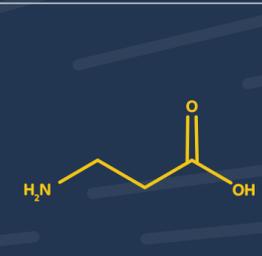
## BRAIN NEUROTRANSMITTERS



### GLUTAMATE\*

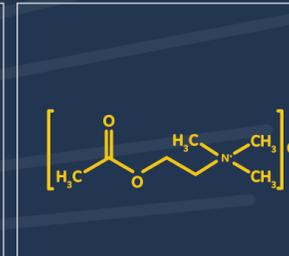
Excitatory amino acid neurotransmitter ubiquitous throughout the brain, activates NMDA, AMPA and kainate receptors.

\*Also a neuromodulator via metabotropic glutamate receptors



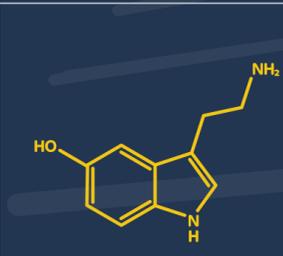
### GABA

Inhibitory amino acid neurotransmitter, activates GABA receptors throughout the brain, causing hyperpolarisation and inhibition of the postsynaptic neuron.



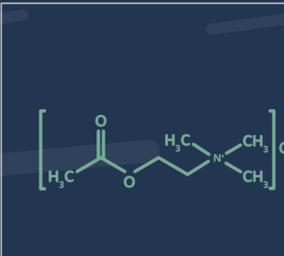
### ACETYLCHOLINE

Acts as a neurotransmitter in the peripheral nervous system causing muscles to contract.



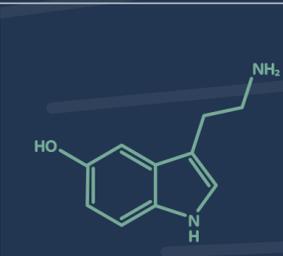
### SEROTONIN

Acts as a neurotransmitter in the peripheral nervous system.



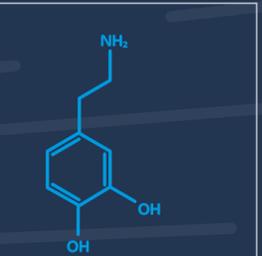
### ACETYLCHOLINE

A neuromodulator in the central nervous system involved in behaviors related to drug abuse, attention, food intake, and memory.



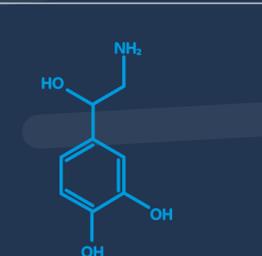
### SEROTONIN

A neuromodulator in the central nervous system than has been identified as important for regulating sleep quality, mood, depression and anxiety.



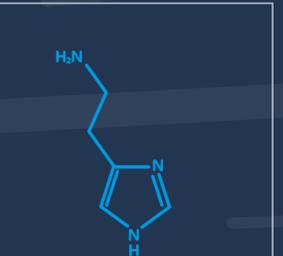
### DOPAMINE

Important neuromodulator for movement, dopaminergic cells are concentrated in the basal ganglia. Also important for enhancing addictive behaviors.



### NORADRENALINE/ NOREPINEPHRINE

Important neuromodulator of wakefulness and arousal. In the sympathetic nervous system, noradrenaline regulates heart rate and blood pressure.



### HISTAMINE

Neuromodulator involved in wakefulness and alertness.

#### References

1. Fatt, P. & Katz, B. (1952). Spontaneous subthreshold activity at motor nerve endings. *The Journal of physiology*, 117(1), 109-128.
2. Picciotto, M. R., Higley, M. J., & Mineur, Y. S. (2012). Acetylcholine as a neuromodulator: cholinergic signaling shapes nervous system function and behavior. *Neuron*, 76(1), 116-129.
3. Passani, M. B., Panula, P., & Lin, J. S. (2014). Histamine in the brain. *Frontiers in systems neuroscience*, 8, 64.
4. <http://www.brainfacts.org/brain-anatomy-and-function/cells-and-circuits/2012/classical-neurotransmitters-brain-communicators>. accessed 3/2018

## BRAIN NEUROMODULATORS