



UNLOCKING  
CONSCIOUSNESS



## BRIAN MIND FORUM

### Appendix 004

#### Examples of The Endocrine System Hormones, Neurotransmitters and the Endocrine System

This list is reprinted from Wikipedia to give an idea of the complexity of the Hormone, Neurotransmitter and Endocrine System

Major neurotransmitters:

- **Amino acids:** glutamate,<sup>[4]</sup> aspartate, D-serine,  $\gamma$ -aminobutyric acid (GABA), glycine
- **Gasotransmitters:** nitric oxide (NO), carbon monoxide (CO), hydrogen sulfide (H<sub>2</sub>S)
- **Monoamines:** dopamine (DA), norepinephrine (noradrenaline; NE, NA), epinephrine (adrenaline), histamine, serotonin (SER, 5-HT)
  - **Trace amines:** phenethylamine, N-methylphenethylamine, tyramine, 3-iodothyronamine, octopamine, tryptamine, etc.
- **Peptides:** somatostatin, substance P, cocaine and amphetamine regulated transcript, opioid peptides<sup>[9]</sup>
- **Purines:** adenosine triphosphate (ATP), adenosine
- Others: acetylcholine (ACh), anandamide, etc.

In addition, over 50 neuroactive peptides have been found, and new ones are discovered regularly. Many of these are "co-released" along with a small-molecule transmitter. Nevertheless, in some cases a peptide is the primary transmitter at a synapse.  $\beta$ -endorphin is a relatively well known example of a peptide neurotransmitter because it engages in highly specific interactions with opioid receptors in the central nervous system.

Single ions (such as synaptically released zinc) are also considered neurotransmitters by some, as well as some gaseous molecules such as nitric oxide (NO), carbon monoxide (CO), and hydrogen sulfide (H<sub>2</sub>S). The gases are produced in the neural cytoplasm and are immediately diffused through the cell membrane into the

extracellular fluid and into nearby cells to stimulate production of second messengers. Soluble gas neurotransmitters are difficult to study, as they act rapidly and are immediately broken down, existing for only a few seconds.

The most prevalent transmitter is glutamate, which is excitatory at well over 90% of the synapses in the human brain. The next most prevalent is Gamma-Aminobutyric Acid, or GABA, which is inhibitory at more than 90% of the synapses that do not use glutamate. Although other transmitters are used in fewer synapses, they may be very important functionally: the great majority of psychoactive drugs exert their effects by altering the actions of some neurotransmitter systems, often acting through transmitters other than glutamate or GABA. Addictive drugs such as cocaine and amphetamines exert their effects primarily on the dopamine system. The addictive opiate drugs exert their effects primarily as functional analogs of opioid peptides, which, in turn, regulate dopamine levels.

Here are a few examples of important neurotransmitter actions:

- Glutamate is used at the great majority of fast excitatory synapses in the brain and spinal cord. It is also used at most synapses that are "modifiable", i.e. capable of increasing or decreasing in strength. Modifiable synapses are thought to be the main memory-storage elements in the brain. Excessive glutamate release can overstimulate the brain and lead to excitotoxicity causing cell death resulting in seizures or strokes. Excitotoxicity has been implicated in certain chronic diseases including ischemic stroke, epilepsy, Amyotrophic lateral sclerosis, Alzheimer's disease, Huntington disease, and Parkinson's disease.
- GABA is used at the great majority of fast inhibitory synapses in virtually every part of the brain. Many sedative/tranquilizing drugs act by enhancing the effects of GABA. Correspondingly, glycine is the inhibitory transmitter in the spinal cord.
- Acetylcholine was the first neurotransmitter discovered in the peripheral and central nervous systems. It activates skeletal muscles in the somatic nervous system and may either excite or inhibit internal organs in the autonomic system. It is distinguished as the transmitter at the neuromuscular junction connecting motor nerves to muscles. The paralytic arrow-poison curare acts by blocking transmission at these synapses. Acetylcholine also operates in many regions of the brain, but using different types of receptors, including nicotinic and muscarinic receptors.
- Dopamine has a number of important functions in the brain; this includes regulation of motor behavior, pleasures related to motivation and also emotional arousal. It plays a critical role in the reward system; people with Parkinson's disease have been linked to low levels of dopamine and people with schizophrenia have been linked to high levels of dopamine.<sup>[18]</sup>
- Serotonin is a monoamine neurotransmitter. Most is produced by and found in the intestine (approximately 90%), and the remainder in central nervous system neurons. It functions to regulate appetite, sleep, memory and learning,

temperature, mood, behaviour, muscle contraction, and function of the cardiovascular system and endocrine system. It is speculated to have a role in depression, as some depressed patients are seen to have lower concentrations of metabolites of serotonin in their cerebrospinal fluid and brain tissue.

- Norepinephrine which focuses on the central nervous system, based on patients sleep patterns, focus and alertness. It is synthesized from tyrosine.
- Epinephrine which is also synthesized from tyrosine takes part in controlling the adrenal glands. It plays a role in sleep, with one's ability to stay become alert, and the fight-or-flight response.
- Histamine works with the central nervous system (CNS), specifically the hypothalamus (tuberomammillary nucleus) and CNS mast cells.

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