Neurons; semi-permeable membrane

Neurons are covered by a semi-permeable membrane that contains Ion Channels. These ion channels open and close to let positive ions, such as sodium (Na+) and potassium (K+), and negative ions, like chlorine (Cl-), enter the neuron. Ion channels are closed when the neuron is not transmitting information or is resting. Using a device called the oscilloscope, neuroscientists have found that the Resting Potential of a neuron (or the electrical charge of a resting neuron) is -70 millivolts (mV). Thus, an electric eel having 8, 400 neurons can generate up to 588 V!

Because a resting neuron is negatively charged in relation to its positive surrounding (that is, more negative ions are present inside the cell body of the neuron), a resting neuron is said to be polarized. However, when dendrites receive neurotransmitters from neighboring neurons, the ion channels open up and let positive ions depolarize the neuron. The Action Potential of a neuron (or the electrical charge of an activated neuron) depends upon the kind of neurotransmitter housed by the neuron. The qualitative differences between neurons result to variation in their voltage threshold. A depolarized neuron that has reached its voltage threshold “ fires” at a level of intensity that remains unchanged, called the All-or-None principle, and as fast as 0. 001 second. The brief wave of positively charged ions inside the neuron pushes the synaptic vesicles at the end of the terminal buttons, thereby releasing the neurotransmitters to the Synapse or the Synaptic Gap, the small gap between neurons. Neurotransmitters that are released in the synapse do not move in a predictive manner; rather, they randomly wander along the synaptic gap. Different neurotransmitters have different shapes, and the shapes serve as keys for opening the receptor sites

at the dendrites of the receiving neuron. After the neurotransmitter activates the receiving neuron, they are then reabsorbed back in the synaptic vesicles of the terminal buttons of the releasing neuron. The re-absorption causes the neuron to get polarized and rest once again.

In summary, the pre-synaptic neuron releases neurotransmitters that activate the post-synaptic neuron, which, in turn, releases neurotransmitters that can further activate other neighboring neurons. In this manner, electrical transmission is converted into chemical code, and back to electricity. This is the reason why the nervous system is characterized with electrochemical transmission. However, communication between neurons is not a linear path. Known as the Volley principle, a firing neuron can activate many neurons at once; vice versa, a neuron can be activated by the simultaneous firing of neurons that have different neurotransmitter types.

Neurotransmitters are the chemicals released by a neuron to communicate with another neuron. They may be excitatory or inhibitory. Excitatory Neurotransmitters are those that activate other neurons to fire, while Inhibitory Neurotransmitters are those that restrain neurons to fire. There are currently fifty (50) discovered neurotransmitters. The six (6) types of neurotransmitters featured below are those that have major effects on behavior.

* Acetylcholine or Ach is an excitatory neurotransmitter involved in muscular action, learning and memory. It is located throughout the central and peripheral nervous system. Low level of acetylcholine is associated with Alzheimer’s Disease, a degenerative disease wherein neurons die at a rate

faster than normal. Up to date, no treatment has been found to cure this deadly disease. Drugs that supply ACh are only used to delay or reduce the rate of neuronal death.

* Dopamine is an inhibitory neurotransmitter that controls voluntary movement, sleep, mood, attention and learning. Inhibition is a very important element for controlled action. Low level of dopamine is associated with Parkinson’s Disease, wherein patients shake uncontrollably on different parts of the body. The disease is also degenerative, so that the shaking can range from mild to extremely uncomfortable. On the other hand, high level of dopamine is observed among schizophrenic patients.

* Endorphinis an excitatory neurotransmitter involved in feelings of pleasure. Endorphins are called the natural opiates in the body and serve as pain killers especially on pregnant women during labor and delivery. High level of endorphins is also observed among long-distance runners and persons shocked from a traumatic accident.

* Gamma Amino Butyric Acid or GABA is an inhibitory neurotransmitter that controls the electrochemical communication among neurons. It is located only in the central nervous system, and fills one-third (1/3) of the brain’s synapses. Low level of GABA is associated with anxiety.

* Norepinephrine is both inhibitory and excitatory. It controls alertness and regulates sleep and wakefulness with ACh. As an inhibitory neurotransmitter, norepinephrine acts like GABA in preventing neurons from firing uncontrollably. As an excitatory neurotransmitter, it activates the heart muscles, the intestine and the neuro-genital tract. (For more information on

how norepinephrine affects the body, consider reading about the endocrine system from the article “ What are the Biological Foundations of Behavior?”) Low level of norepinephrine is linked with depression, while high level of norepinephrine is associated with agitation and mania.

* Serotonin is an inhibitory neurotransmitter that works with Ach and norepinephrine in regulating sleep, mood, attention and learning. Just like norepinephrine, low level of serotonin is associated with depression.