**Neural Communication**

***The Neuron***

Our Nervous System is basically made up of billions of nerve cells called **neurons**. Each neuron is composed of the following:

1. **Dendrites**: bushy ends that receive messages.

2. **Cell** **Body:** the cells control center.

3. **Axon:**a branching fiber thatsends messages away from the cell body to the next neuron, muscle, or gland.

4. **Myelin Sheath:**layer of fatty *tissue* also known as Schwann cells that help speed up impulses by insulating the axon and providing *Nodes of Ranvier* (gaps between the cells) that allow for quick node to node hopping. **Glial cells**guide neural connections and provide nutrients to nerve cells in the brain. Myelinated axons form the *white* matter of the nervous system while the non-myelinated axons, dendrites and cell bodies form the *gray* matter.

An impulse or an **action potential**is a brief electrical charge that is received by the dendrites, simulates the cell body and travels the length of the axon by *depolarizing the normally polarized axon.*A neuron at rest has a positive-inside/negative-inside charge differential. This is called the cells **resting potential**. Because the cells membrane is selectively permeable, a neuron is stimulated and positive ions are able to rush in and depolarize the axon. During the refractory period, the neuron will pump the positive ions back outside to restore the cells resting potential.

**\*Note:** neural messages usually travel in one direction only, from the dendrites to the cell body and down the length of the axon.

The intensity of a stimulus is called the **threshold**. A stimulus must exceed the threshold in order for a transmission to occur*.*Much like a gun, the neuron either fires or it doesnt, there are no half-fires. This is called the *all-or-none-response*. To differentiate between a really strong stimulus and a weak one, only the *number of neurons* firing will increase and not their speed.

***How Neurons Communicate***

The axon terminal of the sending neuron is separated from the receiving neuron by a tiny gap called the **synapse**(or **synaptic cleft**). Once the action potential reaches the synapse,**neurotransmitters**, or *chemical messengers*, are released into the gap where they will bind onto*specific* receptor sites on the receiving neuron. These chemicals can either induce or inhibit neural firing.

Scientists have isolated more than sixty neurotransmitters and a few of the more well-known will be described throughout this course (acetylcholine, norepinephrine, serotonin, Dopamine, Endorphins). **Note**: You will need to know their function and to with which disorders their under-abundance or over-abundance has been associated.

For example:

**Acetylcholine** (ACh): This is the most well know neurotransmitter and causes muscles to contract in movement.

**Endorphins:**neurotransmitters that are similar to morphine and are a natural opiate.  They are released in response to pain and heavy exercise and induce pleasure (explaining runners high, etc.).

The following types of drugs can alter neurotransmission:

1. **Agonists:**molecules that *mimic*the shape of natural neurotransmitters and thereby mimic its effects. An example would be morphine binding to the same receptor sites to which endorphins bind.

2. **Antagonists:** molecules that *block*neurotransmitters from binding to receptor sites. It mimics a natural neurotransmitter but is not similar enough to stimulate the receptor and mimic the effect. An example would be curare, a poison used by South American hunters, mimic and block Ach sites thereby paralyzing prey.

3. **Others:**There are a variety of drugs that inhibit the natural breakdown or re-absorption of the neurotransmitter. An example would be Prozac, an anti-depressant drug that prevents the re-absorption of serotonin from the synapse allowing it to linger longer in the synapse thereby enhancing serotonins mood-lifting effect.

The brain has a **Blood-brain barrier** that filters out unwanted chemicals in blood stream. This has its down side as well- When trying to treat chemical disorders of the brain researchers must develop a drug that must pass through the blood-brain barrier. For example, Parkinsons patients show reduced levels of dopamine due to death of the neurons that produce it. Dopamine as a drug cannot pass through the barrier but given as L-dopa it can sneak through and be converted to dopamine in the brain.

***Neural and Hormonal Systems***

The Nervous System is composed two main systems:

1. 1. **Central Nervous System**(CNS) the brain and spinal cord.
   2. **Peripheral Nervous System**(PNS) This system connects the CNS to bodys muscles and glands by means of **nerves**which are bundles of **sensory**and **motor neurons**(they carry incoming and outgoing information respectively) via **interneurons**which enable internal communication. Its two main divisions are:
      1. The **skeletal (somatic) system**: This system controls voluntary movement of our skeletal muscles.
      2. The **autonomic nervous system (ANS)**: This system controls the muscles of our internal organs and our glands. It is further subdivided into the**sympathetic nervous system**(**arouses**the body for defense (increase heartbeat, dilating pupils, inhibit digestion etc.) and the **parasympathetic nervous system**(**calms**the body after stress).

**Please note: The Somatic Nervous System is also called the Skeletal Nervous System.**

A simple **reflex**is coordinated by the nervous system and is an automatic response to stimuli (like knee-jerk) involving messages from **sensory** to **interneuron**(Spinal Cord) to **motor**Neuron.

**The** **Endocrine System:**It is the comparatively*slow* response system and it communicates by releasing **hormones**(chemical messengers) into the bloodstream.

In times of stress the autonomic nervous system will signal the **adrenal Glands**(found above kidney) to release **epinephrine**and **norepinephrine**hormones (also called ***adrenaline***and***noradrenaline***) which cause blood to be diverted to the bodys skeletal system to prepare for *fight or flight*.

The **pituitary gland**is the most powerful endocrine gland, and under the influence of hypothalamus in brain, pituitary releases hormones that regulate glands and growth. It also stimulates the adrenal gland to release the stress hormone **cortisol.** This stress response system is a good example of the interdependence between the nervous system and the endocrine system.