**Biopsychology Guided Notes - PART 1**

**The Nervous System, Endocrine System, and the Brain**

**Biopsychologists** often study the **nervous and endocrine** systems because they are the human **body’s means of communication and information processing**. The nervous system is your body’s electrochemical communication system. **Your brain, spinal cord, and nerves** are formed from nerve cells called neurons. **Neurons** are the basic building blocks of the nervous system, yet they are highly specialized cells. The neuron’s job is to **receive information** from other neurons via electrochemical impulse, carry it through its own cell body and **pass it on to other neurons**. Every emotion and thought you have in addition to every step you take is entirely dependent on the neuron’s ability to do its job. The ability to transmit this electronic impulse is often called **firing, or action potential**.

**Parts of a Neuron:**

**Dendrites** are extensions branching out from the cell body that receive information from other neurons and send it towards the cell body. **The cell body** is also known as the **soma**. It contains the **nucleus** and other primary parts of the cell that allow it to function normally. Once information is received by the soma, it is sent along the **axon**, the part of the neuron that **passes messages away from the cell body**, and on to other neurons, muscles, or glands. The length of the axon varies for neurons in different parts of the body. For example, in your brain they are relatively short, whereas in your leg they can be over three feet long. The axon is covered by the **myelin sheath**, which helps protect it, and **aids in transmitting neural impulses**. Once information travels through the axon, it reaches the **axon terminal**, where **neurons form junctions** with other cells. It is important to know that **neurons are not actually connected**. There is a tiny, fluid-filled gap between the axon terminal of one neuron and the dendrite of another. In this gap, called the **synapse,** chemical messengers called **neurotransmitters** travel across between nerves sending information from the axon terminal of one sell to the dendrites of the next cell. It is important to know that **not all neurotransmitters are the same**, and certain cells will only respond to specific neurotransmitters. Some neurotransmitters **have an excitatory effect**, one that makes it more likely that the next neuron will fire, while **others have an inhibitory effect**, making it less likely that the receiving neuron will fire.

**Neural Impulse:**

**When a neuron fires,** **the moment of that electrical charge is called an action potential**. After each action potential, there is a **refractory period**. This is a period of time where the neuron cannot generate another action potential. After the refractory period, the neuron enters a state of **resting potential,** where it is capable once again of firing. It is important to know that all neurons fire with the **exact same intensity** every time. This is known as the **all-or-none principle**.

**How we process information:**

**Receptor cells** are specialized cells in every sensory system of the body that **turn other kinds of energy into neural impulses** (action potentials) that the brain can process. Your eyes, ears, nose, tongue, and skin are all filled with receptor cells to interpret what we experience and turn it into a neural impulse. Your eyes transform light energy; your ears transform sound waves, etc. Once all that information is gathered, **sensory nerves carry information from receptor cells to the brain and the spinal cord**. The brain continually processes a plethora of sensory data that is brought from sensory nerves, and uses that data to make appropriate decisions. The billions of **neurons in your brain and spinal cord that process information are called interneurons**. Once the brain decides what course of action to take, it triggers **motor nerves**, which take the information away from the brain and spinal cord to your **muscles and glands** so that they can take action.

**Structure of the Nervous System:**

When we take all these small pieces and processes and combine them, we begin to see the structure of the nervous system. Our nervous system is split into two major components: **the central nervous system and the peripheral nervous system**. The **central nervous system is comprised of the brain and the spinal cord**, both of which are so essential to our body’s functioning that they are encased in bone for protection. The brain is the main center for processing and the spinal cord is the main pathway for information flowing in and out of the brain. **The peripheral nervous system contains all the sensory and motor neurons that connect the brain and the spinal cord with the rest of the body**. Within the peripheral nervous system, there are two subsystems: the somatic nervous system and the autonomic nervous system. **The somatic nervous system controls the body’s skeletal muscles.** **The autonomic nervous system controls the glands and muscles of your internal organs**. The autonomic nervous system, therefore, controls the basic functions of your body, such as breathing, digestion, and your heart rhythm. The autonomic nervous system is further subdivided into the sympathetic nervous system and the parasympathetic nervous system. The **sympathetic nervous system arouses the body to deal with perceived threats.** Your “fight or flight” responses will come from the sympathetic nervous system. In contrast, **the parasympathetic nervous system calms the body down.**

**The impact of chemicals on your nervous system:**

As stated before, neurotransmitters cross the synapse between nerve cells and pass information from cell to cell. When chemical substances enter the body, they impact the ability of neurotransmitters to do their job. A substance that **blocks the effect of a neurotransmitter is called an antagonist**, whereas a substance that **boosts the effects of a neurotransmitter is called an agonist**. For example, if someone were to get bitten by a black widow spider, the venom would mimic a type of neurotransmitter called acetylcholine. This would cause excessive neuron firing, leading to uncontrollable movement in the form of convulsions. Another example involves exploring the **chemical root of certain mental illnesses**. Many who have **schizophrenia** are said to have high levels of the neurotransmitter **dopamine**. Medications that are often prescribed for schizophrenia are often antagonists that block dopamine receptors. Those diagnosed with clinical **depression** are often found to have low levels of the neurotransmitter **serotonin.** Many anti-depressants serve as agonists and enhance the availability of serotonin at the synapse. Amazingly, approximately **90% of our emotional responses are purely chemical reactions** funneled through our nervous system. That is why medication can help those with chemic al imbalances. It is important to know that many substances, from **alcohol, to caffeine, to cocaine** can have a strong impact on various neurotransmitters.

**The Endocrine System:**

The **endocrine system** **is a set of glands that produce hormones**. Hormones are **chemical messengers** that circulate throughout the body **through the blood**. The most important gland in the endocrine system is the **pituitary gland**. In conjunction with the brain, **it controls the other endocrine glands**. This pea sized gland is located at the base of the brain and is **connected to the hypothalamus**. The tissue is part glandular and part neural, which illustrates the close relationship between the nervous and endocrine system. Another gland in the endocrine system is the **thyroid gland**, which is located in the neck, and **helps regulate energy level and metabolism**. In addition, the **adrenal glands**, which are on top of the kidneys, **release two hormones called epinephrine and norepinephrine**. These hormones increase strength and endurance during a **“fight or flight” response**. The sex glands release hormones that influence emotion and physical development. The sex glands for **females** are the **ovaries**, and the primary hormone is **estrogen**. The sex glands for **males** are the **testes**, and the primary hormone is **testosterone**. It is important to know that we all have both testosterone and estrogen present in our systems.

**The Brain:**

Lower level brain structures are common to all mammals. They are more basic. The complex structures of the human brain are layered on top. The **brainstem** **is the oldest part and central core of the brain**. It begins where the spinal cord swells and enters the skull. Located at the base of the brain stem, the **medulla controls the basic life-support functions such as the heartbeat, breathing, circulation, and swallowing**. Damage to this part of your brain would be deadly. Also located in the brainstem, the **reticular formation is a nerve network that plays an important role in controlling wakefulness** and arousal. The reticular formation follows the back of the spinal cord as it rises into the brain. Damage to this region of the brain would cause someone to be in a coma. The thalamus is located at the top of the brainstem in the middle of the brain. The **thalamus is the brain’s sensory switchboard**, and directs messages throughout the brain. Indeed, information from every sense except smell is funneled through the thalamus to other regions of the brain for processing. The cerebellum looks like an extra little brain, and is located behind the brainstem. The **cerebellum works with other parts of the brain to control voluntary movements and balance**. In addition, the cerebellum **controls memories for knowing how to use your body and ambulate**. It also plays a role in **governing emotions, hearing, and touch**. The **limbic system is a ring of structures that border the brainstem and the cerebral cortex.** As a group, the limbic system helps regulate memory, fear, aggression, hunger, and thirst. The limbic system includes the hypothalamus, the hippocampus, and the amygdala. The hypothalamus is beneath and in front of the thalamus, and is arguably the most important part of the limbic system. The **hypothalamus helps regulate many of your body’s maintenance functions, including hunger and thirst, the “fight or flight” reaction to stress, and body temperature.** The hypothalamus **also plays a large role in the experience of emotion, pleasure, and sexual function**. The **hippocampus** resembles a seahorse, and is the **neural center that helps process new memories for permanent storage.** Finally, the **amygdala is an almond shaped structure that controls emotional responses such as fear and anger**.

**Cerebral Cortex:**

When you visually imagine a brain, what you are seeing is the **cerebral cortex.** This wrinkled outer surface of the brain is divided by fissures into four major lobes, and is **the body’s ultimate control and information processing center**. The cerebral cortex covers all of the lower-level brain structures, and although it is only an eighth of an inch thick, it **contains 20-23 billion neurons**. The most dramatic feature of the cerebral cortex is the **longitudinal fissure**, the crevice that divides the cerebral cortex into two halves called **hemispheres**. The **corpus callosum** **is a large band of neural tissue that connects the two brain hemispheres and allows them to communicate with each other**. There are additional fissures, both lateral and central, that create more lobes of the brain. These include the frontal, parietal, occipital, and temporal lobes. Right behind your forehead, you will find your frontal lobe. **The frontal lobes enable your most advanced cognitive abilities, such as judgment and planning**. They sit on top of the limbic system, where the roots of emotion are found. This means that your decisions are based on a combination of reason and emotion. On the rear edge of the frontal lobe is the **motor cortex. This narrow band controls voluntary movements throughout your body.** Different points on the motor cortex control different parts of the body. Although one might think that larger parts of the body demand more brain tissue, it is instead based on the ability to make intricate movements. Just behind the motor cortex is another strip of tissue called the somatosensory cortex. This is in the front part of the parietal lobes, located on the top of the head, slightly towards the rear. The **somatosensory cortex registers and processes body sensations**. While the somatosensory cortex has a very specific job, overall, the **parietal lobes are known for general information processing**. At the rear of the cerebral cortex are the **occipital** **lobes, the primary visual processing areas of the brain**. Finally, there are the **temporal lobes**, which lie directly above your ears, and **house the sound processing areas of the brain**.

**Right Brain vs. Left Brain:**

While the right vs. left brain idea is a part of pop psychology and has some myth to it, there is truth in the notion that certain areas of the brain perform certain functions, and are location specific. **Language** is the best example of a clear-cut difference in the functions of your brain’s two hemispheres. In most people, **language functions are located primarily in the left hemisphere**. Two important areas within the language center are Broca’s area and Wernicke’s area. **Broca’s area** is located in the left frontal lobe, and **directs the muscle movements involved in speech**. Stroke victims often have damage in Broca’s area, which results in them being able to formulate ideas, but unable to translate set ideas into speech. **Wernicke’s area** is located in the left temporal lobe, and **allows someone to interpret language**. Someone with damage to Wernicke’s area would be able to hear speech, but would not be able to comprehend the words or their meaning. The **right brain houses most of your brain’s spatial abilities**, such as judging distance. The right hemisphere **also aids in building connections**.

**Split Brain:**

In the 1960’s doctors began treating patients with severe epilepsy by **severing their corpus callosum**. **Epilepsy** is a condition that causes **seizures**, and for the most severe cases, this drastic surgery would curb their seizures, but not without side-effects. While their **personality and intellect remained unchanged**, patients who had this surgery had **altered perceptions**. First it is important for us to remember that the **right half of the brain controls the left half of the body, and vice versa**. With a split corpus callosum, the left hand no longer knows what the right hand is doing. Psychologist have performed several scientific tests on split brain patients to better understand how each of the brain hemispheres functions. For example, when showing a split brain patient a word that only the right side of his brain (left eye) can see, set patient would not be able to articulate that word. They would be able to draw a picture of the word, then articulate it, but not until the left brain saw the image would an articulation be made. It’s as if communication between the two halves of the brain occurs outside the brain, not inside.

**Case Studies:**

**Case studies** are where one person is studied in depth in hopes of revealing useful information for the scientific and psychological community. Among the most famous brain case studies is that of **Phineas Gage**. While working for the railroad, an accidental explosion blew a 4 ft. long medal rod through his cheek, behind his eye, and out the top of his head. Gage never lost consciousness, and lived for twelve years after the accident. There were **notable changes in his behavior**, however. His injury **damaged his frontal lobe**, as well as his **ability to make good decisions and process emotion**. Gage and many other case studies of brain injury patients help psychologists add another piece to the puzzle of how the brain operates, and how the brain is impacted when certain areas are damaged.