Module 3 Lecture - Biopsychology

Introductory Psychology

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1 Overview and Introduction

1.1 Textbook Learning Objectives

- Explain how scientific research addresses questions about behavior
- Discuss how scientific research guides public policy
- Appreciate how scientific research can be important in making personal decisions
- Describe the different research methods used by psychologists
- Discuss the strengths and weaknesses of case studies, naturalistic observation, surveys, and archival research
- Compare longitudinal and cross-sectional approaches to research
- Compare and contrast correlation and causation
- Explain what a correlation coefficient tells us about the relationship between variables
- Recognize that correlation does not indicate a cause-and-effect relationship between variables
- Discuss our tendency to look for relationships between variables that do not really exist
- Explain random sampling and assignment of participants into experimental and control groups
- Discuss how experimenter or participant bias could affect the results of an experiment
- Identify independent and dependent variables
- Discuss how research involving human subjects is regulated
- Summarize the processes of informed consent and debriefing
- Explain how research involving animal subjects is regulated

1.2 Instructor Learning Objectives

- Understand the critical role research plays in solidifying psychology as a science
- Understand the pitfalls and dangers of unethical research
- Be able to identify the core components and features of a described research design

1.3 Introduction

- Brains and nerves are strange things, but they are the _____ basis for our thoughts and behaviors - so it behooves us to study and >understand them
- This module will help introduce the many physiological and _____ processes that are associated with what we do, think, and feel

Discuss: There is a broader philosophical debate on whether humans are purely biological and chemical beings, i.e., do we have a soul? or are we just being driven by chemical equations and processes - what do you think?

2 Human Genetics

2.1 Introduction

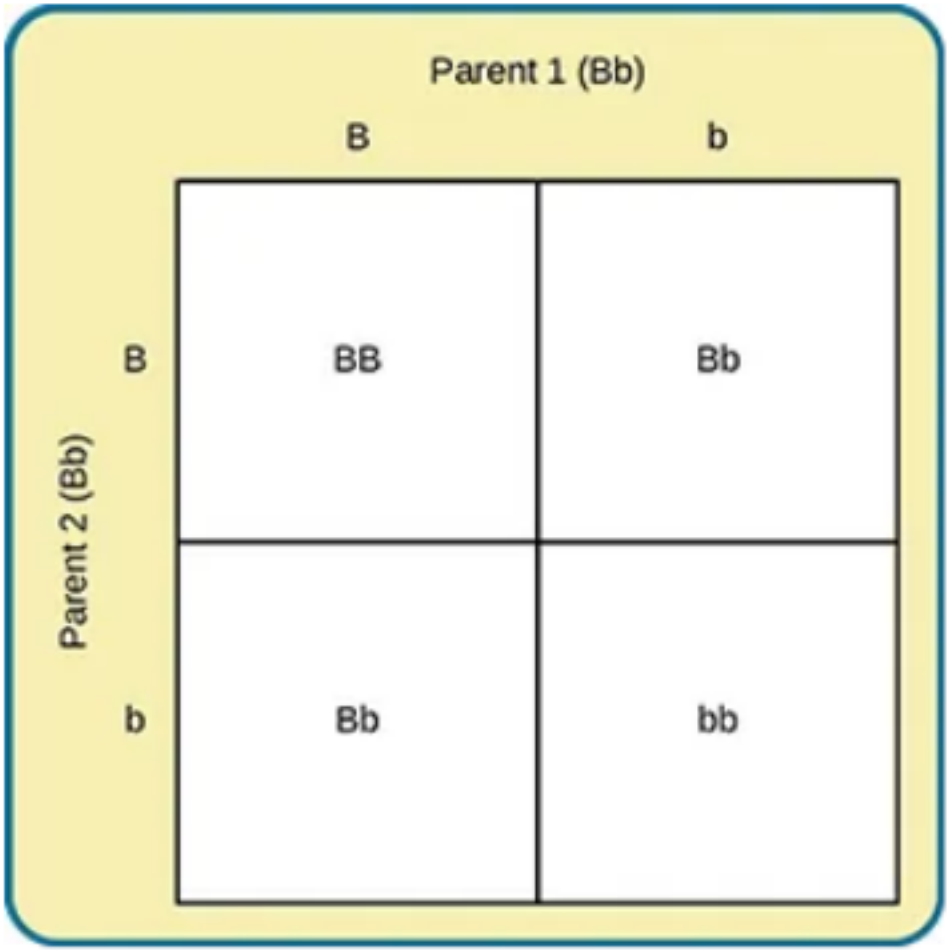
- Our genetics are the traits we _____ from our biological parents, that play into the specific and unique code that make up the basis of cells in our body
  - In this case, I'm using "parents" to refer to those who contribute the _____, i.e., sperm and egg, that create the zygote
- Understandably, genetics play a very _____ role in our physical health and characteristics, but also are associated with our psychological make-up as well
  - A basic _____ example: height - if you have two tall parents, you are likely to be tall, if you have two shorter parents, you are likely to be short
  - A _____ example: If both of your parents have bipolar disorder, are you more likely to? It's complicated…

2.2 Genetic Variation

- Variation in our genetics contributes to the _____ differences that we notice between each person
  - Our hair, skin, and eye color
  - The dimensions and structure of our face
  - _____ diseases or conditions
- The specific _____ that each person has is a function of the sperm and egg cells that come together at the beginning of pregnancy
  - Both the _____ and sperm cells have 23 **chromosomes** made up of **DNA**, the building blocks of our being
  - The sperm and egg cells combine for a total of 46 _____ into a zygote, which has a specified **genotype**, or genetic make up. That genotype

contributes to the **phenotype**, or the apparent physical characteristics that manifest.
  - Specific _____ and sections of that DNA make up **genes**, which function sort of like switches that produce certain outcomes. These genes can be in different variations, or **alleles**, thus resulting in different effects

- Most physical traits are complex and result from _____ different genes, which would be called **polygenic** traits
  - However some genes are slightly _____, such as having a cleft chin, in which there is only one gene that contributes.
  - Having two of the _____ allele from both parents is called **homozygous**, whereas having two _____ alleles is referred to as being **heterozygous.**
  - A **dominant** allele is one that "overrides" a **recessive** allele to become the phenotype; a _____ allele will only reflect in a phenotype if both alleles are recessive.



- **Mutation** comes from a sudden and change to the genes that result in _____ changes to the genotype - which could manifest as disadvantageous, deadly, or useful

phenotypes

? Mutation can lead to increased 'fitness' or ability to adapt / survive. Which psychological perspective would focus intensely on this, outside of biopsychology?

- (●) A) Cogntive
- ( ) B) Beharvioral
- ( ) C) Gestalt
- ( ) D) Evolutionary

Explanation:

2.3 Gene-Environment Interactions

- Genes are not _____ deterministic - while they do have a meaningful impact, they only explain one part of our being

! Important

There are several different perspective on how genes and the environment interact with one another - carefully consider the following as different perspectives, and think about which you may align with

- Genes can understood as setting a **range of reaction**, or effectively, a range of _____ outcomes based on our environment. This means that genes, in a way, express what our potential is.
  - It is believed that our _____ plays into how much of that potential is realized or not
- Others may posit that genes and the environment are _____ , so that our genes drive us towards a certain environment, which in turn reinforces a certain expression of our genes
  - This sort of _____ relationship means that both our genes and environment play an equal role in our outcomes
- Yet another perspective comes from the field of **epigenetics**, which is concerned with how the _____ genotype can give rise to different phenotypes, as a result of our environment
  - Example: instructor's identical twin
- Many students are introduced to genes by studying and practicing on physical characteristics, largely because they are relatively _____ to identify and

measure
  - However, genes also play a role in the mental, like our intellect, mental health, personality, etc.
  - But, given the _____ of mental characteristics, the direct impact of genes can be much harder to parse out

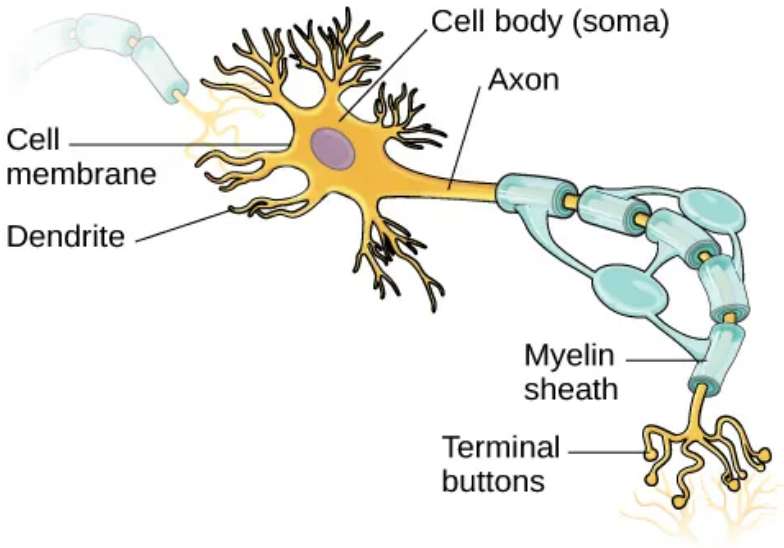
3 Cells of the Nervous System

3.1 Introduction

- The human nervous system is comprised of two types of specialized cells:
  - The **neuron**: which is the _____ communication unit which conveys signals to other neurons and organs
  - The **glial cell**: which supports neurons cell functions
- There is roughly an equal amount of these two types of cells through the nervous system in humans
  - Give or take, around 100 _____ neurons in an adult brain

3.2 Neuron Structure

- A neuron is a _____ cell that has a **semi-permeable membrane** allowing certain molecules to pass through its outer surface to create a charge



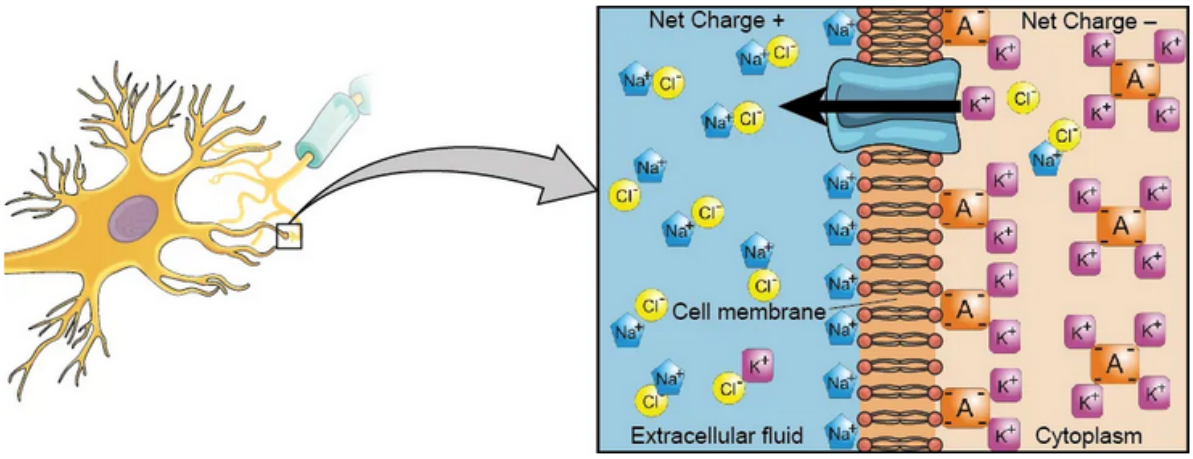
- The elongated **axons** are covered in a **myelin sheath**, separated by **Nodes or Ranvier**. The myelin sheath serves a purpose to _____ and preserve the special electric signal traveling through the axon.

  - _____ such as Multiple sclerosis are called “demyelinating diseases” because they degrade this insulation, which has compounding negative physical impacts
- The **terminal buttons** at the end of each neuro contains **synaptic vessels**, which in turn, have **neurotransmitters** that serve as a method of communication with other neurons’ _____.
  - When a charge _____ down the length of the axon, it triggers actions in the terminal buttons
- When triggered, neurotransmitters are released into the **synaptic cleft**, between the synaptic vessels of the transmitting neuron, and the dendrites with **receptors** on the receiving neuron(s)
  - Specific neurotransmitter bind to _____ sites on the receptors, like a key going into a keyhole

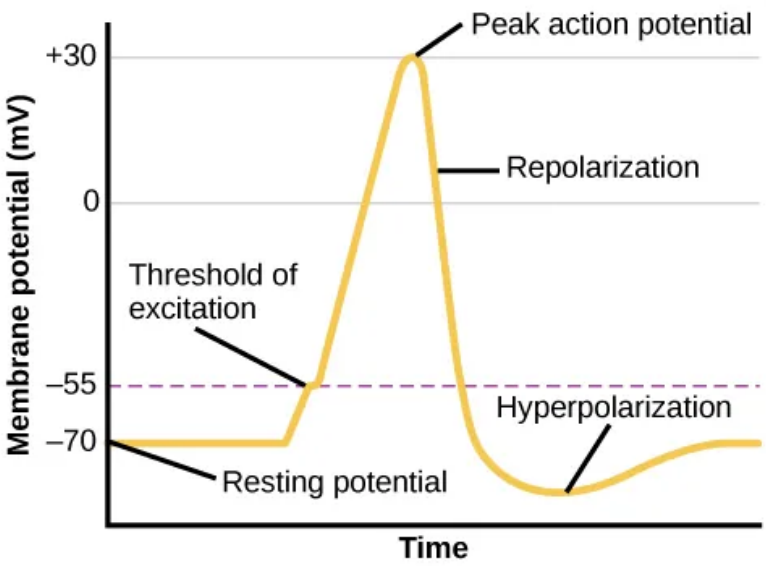
3.3 Neuronal Communication

> **Important**
>
> Get ready for some light chemistry y’all - from your chemistry-incompetent instructor

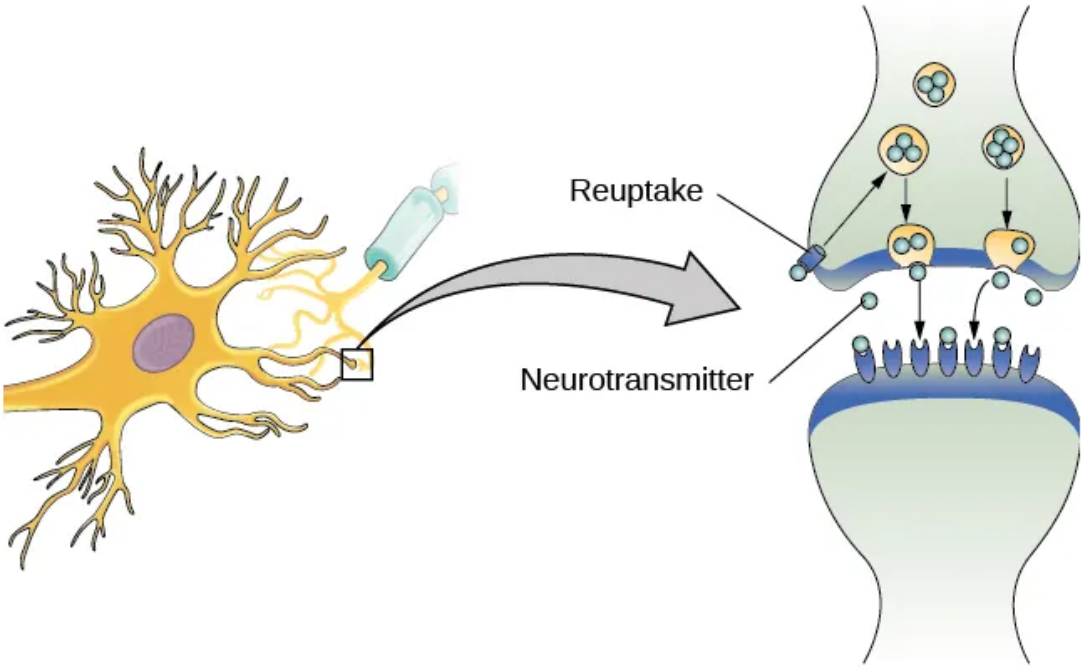
- A signal from the neuron is created by a **membrane potential** resulting from a change in concentration of charged particles across the semi-permeable membrane
- At a baseline, the neuron holds a **resting potential** where there is an imbalance of _____ particles on one side of the membrane, so that the neuron remains “ready” to fire
  - The primary particles for us to pay attention to are the positively-charged sodium ions (Na+) and the positively-charged potassium ions (K+), and their relative concentrations inside and outside the cell



- The neuron receives a _____ via it dendrites, and quickly undergoes rapid change to allow an influx of Na+, greatly increasing the positive energy of the cell - this is an **all-or-nothing** process



- The action potential reaches the terminal buttons, triggering neurotransmitters to push into the synaptic cleft, where they are received by other neurons, which in turn push their own _____ potential
  - Unused particles in the synaptic cleft return to the original neuron, during **reuptake**



3.4 Neurotransmitters and Drugs

- There are many types of neurotransmitters, which serve _____ purposes and are launched for specific types of signals

Major Neurotransmitters and How They Affect Behavior

Neurotransmitter	Involved in	Potential Effect on Behavior
Acetylcholine	Muscle action, memory	Increased arousal, enhanced cognition
Beta-endorphin	Pain, pleasure	Decreased anxiety, decreased tension
Dopamine	Mood, sleep, learning	Increased pleasure, suppressed appetite
Gamma-aminobutyric acid (GABA)	Brain function, sleep	Decreased anxiety, decreased tension
Glutamate	Memory, learning	Increased learning, enhanced memory
Norepinephrine	Heart, intestines, alertness	Increased arousal, suppressed appetite
Serotonin	Mood, sleep	Modulated mood, suppressed appetite

- Certain medication work to modify behavior in the synaptic cleft:
  - **Agonist** medications _____ and recreate neurotransmitters so that neurons recieve greater signals
  - **Antagonists** _____ binding of neurotransmitters to receptors to prevent over-consumption
  - **Reuptake inhibitors** _____ reuptake, to help certain neurotransmitter remain longer in the cleft

4 Parts of the Nervous System

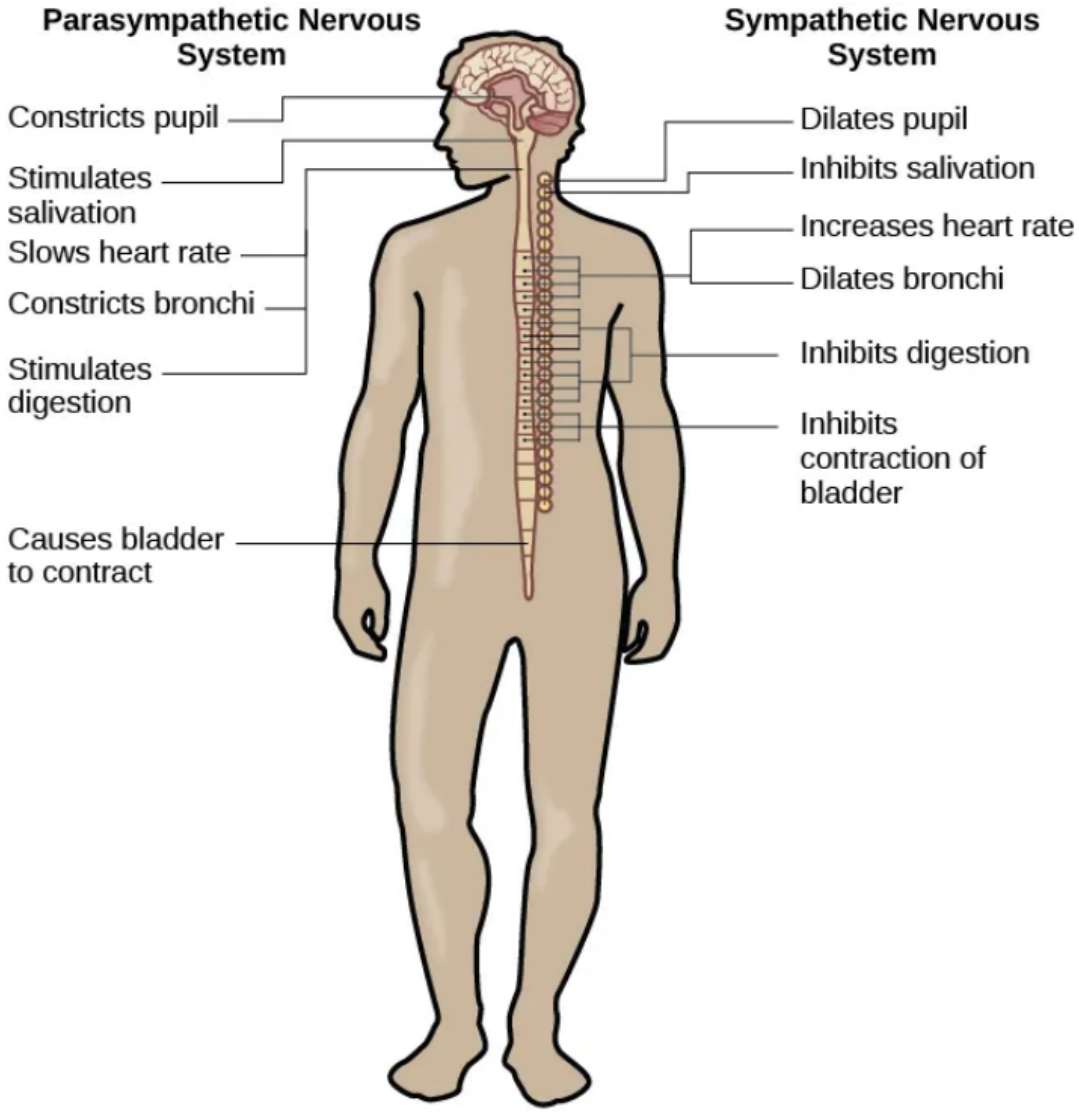
4.1 Introduction

- The human nervous system is described between two _____ systems:
  - The **central nervous system (CNS)** housing The Brain and Spinal Cord

  - The Peripheral Nervous System (PNS), which is basically everything else in the body that connects back to the CNS

4.2 Peripheral Nervous System (PNS)

- The peripheral nervous system has _____ of axons called **nerves** which ensure signals from our body are carried to the spine and brain for messaging
- Within the PNS there are two further _____:
  - The **somatic nervous system**, which deals with _____ or voluntary actions, such as most movements
  - The **autonomic nervous system**, which is related to _____ and automatic processes like organ control.
- The somatic nervous system will contain _____ neurons that are exiting from the CNS to deliver messages to PNS, to do things like move muscles.
  - On the other hand, there are _____ neurons that carry sensory signals back into the CNS to be received in the brain and spinal cord
- The autonomic nervous system has two _____ in it as well, the **parasympathetic** and **sympathetic nervous systems**



? Which action would be most associated with the sympathetic nervous system?

- (●) A) Talking to a friend casually
- ( ) B) Your stomach processing food
- ( ) C) Your hand sending a signal of pain due to being put on a stove
- ( ) D) Running from a lion

Explanation:

5 The Brain and Spinal Cord

5.1 Introduction

- Making up the CNS, the brain and spinal cord serve essential, core functions in the _____ and regulation of our body.
  - The brain can be understood as _____ the many different signals, messages, and commands that the body must follow - and has a necessarily complex layout to help accomplish this!

5.2 The Spinal Cord

- The spinal cord is the _____ and relay station that receives signals from the PNS, but also transmit signals from the brain to the PNS
- It also has it's own built-in system of **reflexes**, which can act without input from the brain

> Discuss: What is an example of a reflex you can think of?

- The spine is _____ by vertebrae (bones) and has two types of nerve bundles exiting from it, **sensory** nerves which are ready to receive information and **motor** nerves which connect to muscles and send signals to move

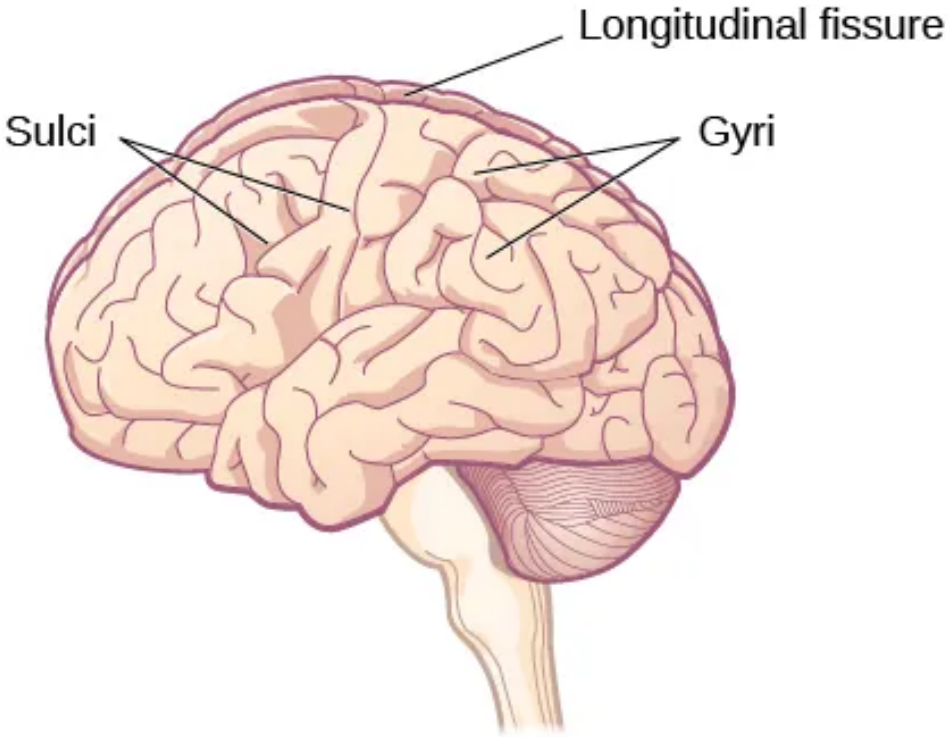
5.3 Neuroplasticity

- Injury or problems in development of the CNS can lead to extensive _____ in cognition and functioning
  - However, our CNS (and body in general) has a remarkable ability to _____ and adapt to damage - this is called **neuroplasticity**
- As a rule of thumb, our brains are able to _____ the best when we are young, as our brains are still developing.
  - As we _____, our neuroplasticity decreases, but some repair is still possible.

- Neuroplasticity is why some folks can recover a surprising amount of skills after brain _____

5.4 The Two Hemispheres

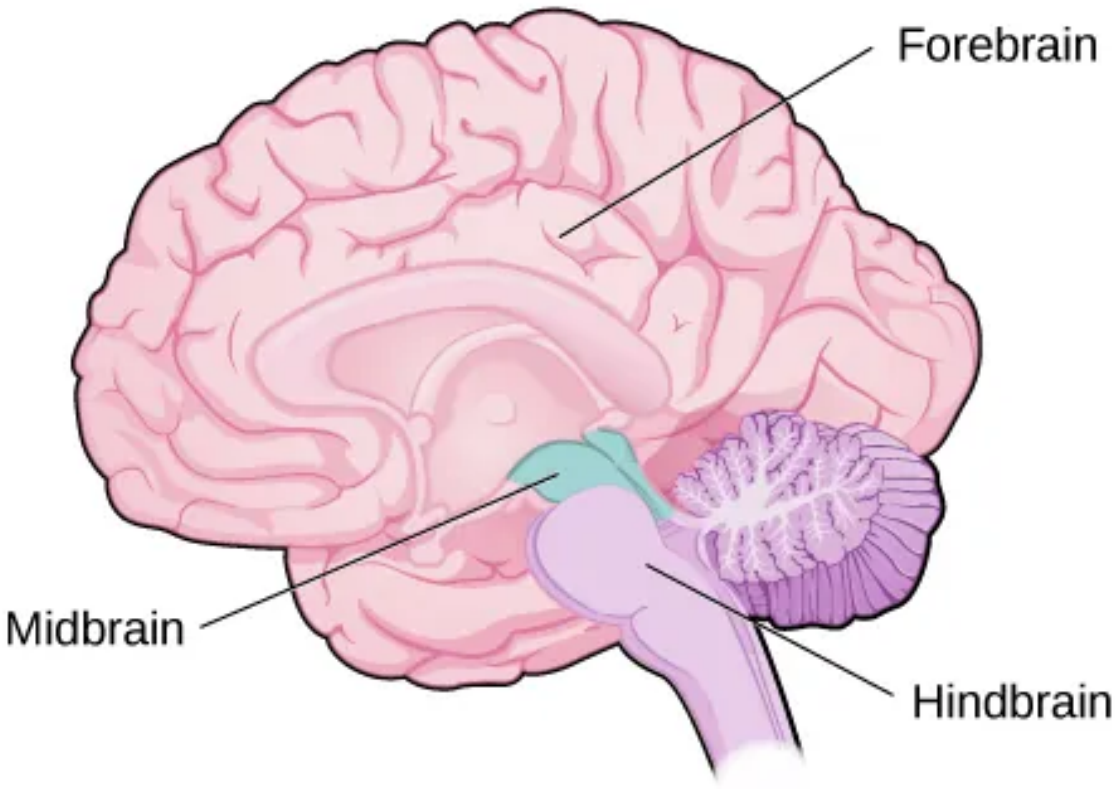
- The outside surface of the brain is the **cerebral cortex**, which many uneven grooves and ridges, which allow are cortex to have a large _____ area.
  - The bumps are called **gyri** and the valleys in between **sulci**, with the most prominent sulcus being the longitudinal fissue that bisect the brain into a left and right half, or **hemisphere**



- There is reasonable evidence that certain skills and functions are somewhat _____ to a specific region or hemisphere of the brain
  - As a somewhat reductionist example: the left hemisphere generally is more associated with _____ emotions and the right hemisphere, more associated with _____ emotions

> **Important**
>
> One should be cautious in definitively saying that certain functions only ever exist on one side of the brain - especially on an individual basis

- The _____ are connected via the neuron bundle of the **corpus callosum**, which allow communication between the otherwise separate halves of our brain
  - In some cases, this connection may be _____ resected or may not develop at all!
  - If the corpus callosum does not form, it results in “split-brain”-ness, which can manifest as poor coordination between separate cognitive skills that are partially lateralized.
- Ironically, most research on the brain’s more _____ functions is done on individuals that have suffered damage to that area of the brain, and show symptoms that suggest what cognitive abilities may be related to the damaged area

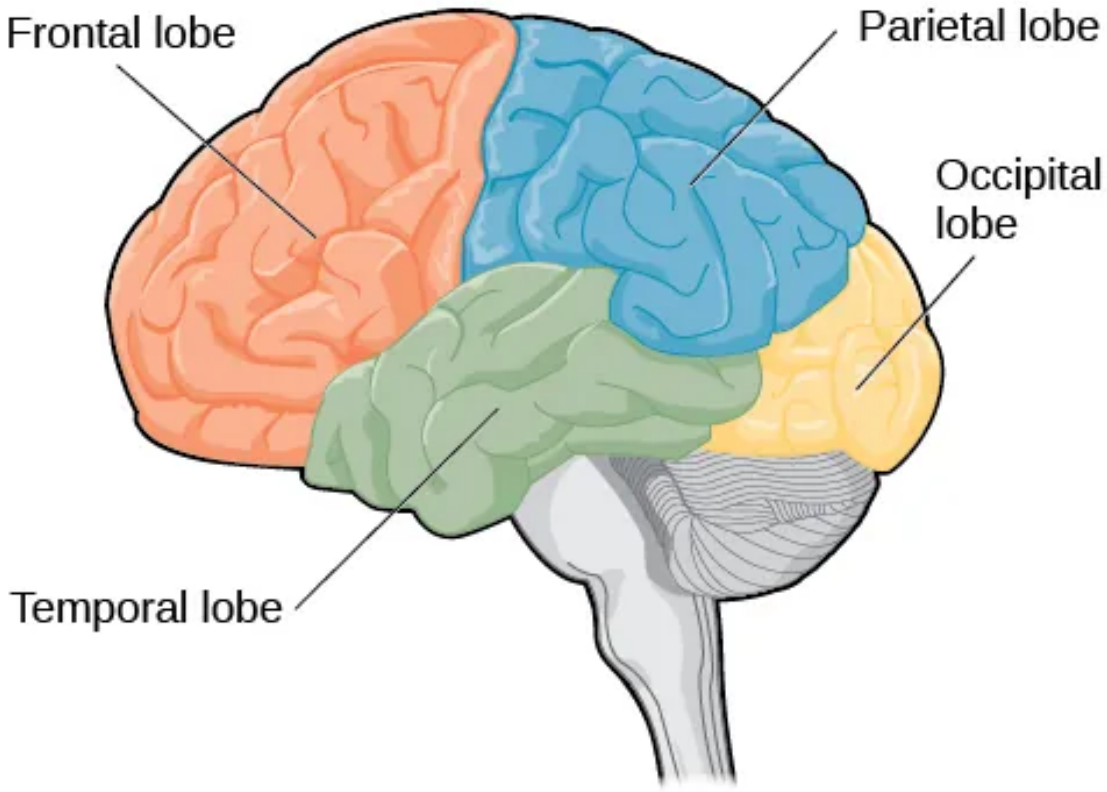


5.5 Forebrain Structures

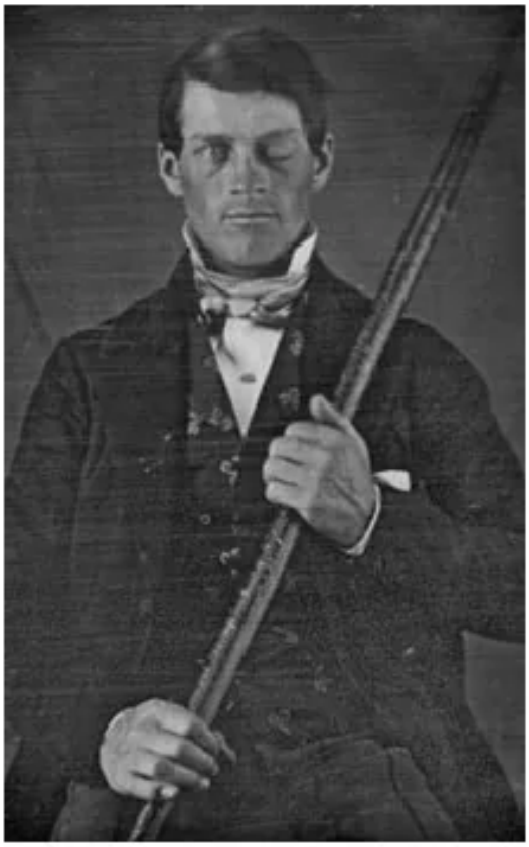
- The **forebrain** is the physically _____ part of the brain, visible on the top, front, and most of the side of the brain, and covers the more inner portions
- The following sections will cover the individual components of the forebrain

5.6 Lobes of the Brain

- The outermost layer of the forebrain, with the gyri and sulci, is called the **cerebral cortex**, and can be separated into 4 distinct **lobes:**
  - The **frontal lobe**
  - The **parietal lobe**
  - The **occipital lobe**
  - The **temporal lobe**



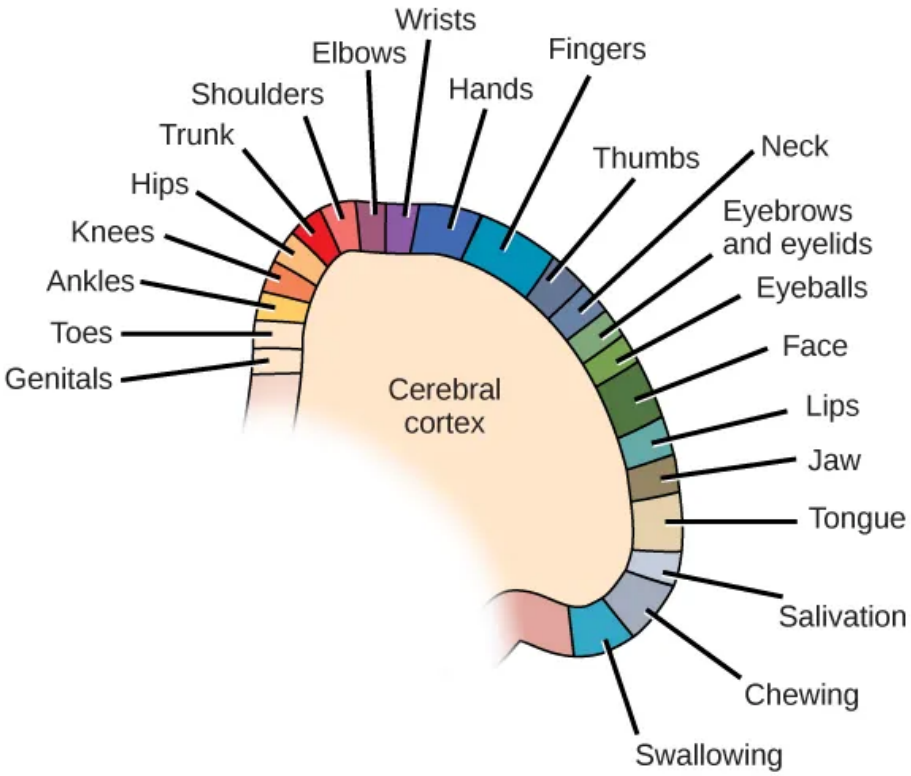
- The frontal lobe is in the front of the brain, behind the _____.
  - It is generally involved in "higher-order" processing, intentional movement, language, and emotion
  - There are three particularly important areas usually in this area:
    - **The motor cortex** which communicates signals to move
    - The **prefrontal cortex** which is involved in reasoning and decision-making
    - **Broca's area**, which is necessary for the production of speech
- Damage to these area (or the frontal cortex as a whole), is likely to disrupt these functions (see Phineas Gage)



(a)

(b)

- The **parietal lobe** is primarily used for integration of sensory information via the **somatosensory cortex** - info such as temperature, pain, pressure, etc. is understood here



- The **temporal lobe** is to each side of the head, and closely related to hearing and memory.
  - It contains the **auditory corex** which processes incoming auditory information, and the **Wernicke's area**, which deals in speech comprehension.
- Finally, **occipital lobe** is at the back of the brain and is responsible for integrating visual information

5.7 Other Areas of the Forebrain

- Underneath the forebrain are the **subcortical structures** that also serve important roles in cognition
- The **thalamus** handle routing information about senses (except smell) to the correct areas of the cortex for further processing
- The **limbic system** is made up of several different components, all related to emotion and memory.
  - The **hippocampus** is used for learning and memory
  - The **amygdala** is necessary for connecting memory and emotions
  - The **hypothalamus** helps regulate homeostatis, especially via sending signals to The Endocrine System.

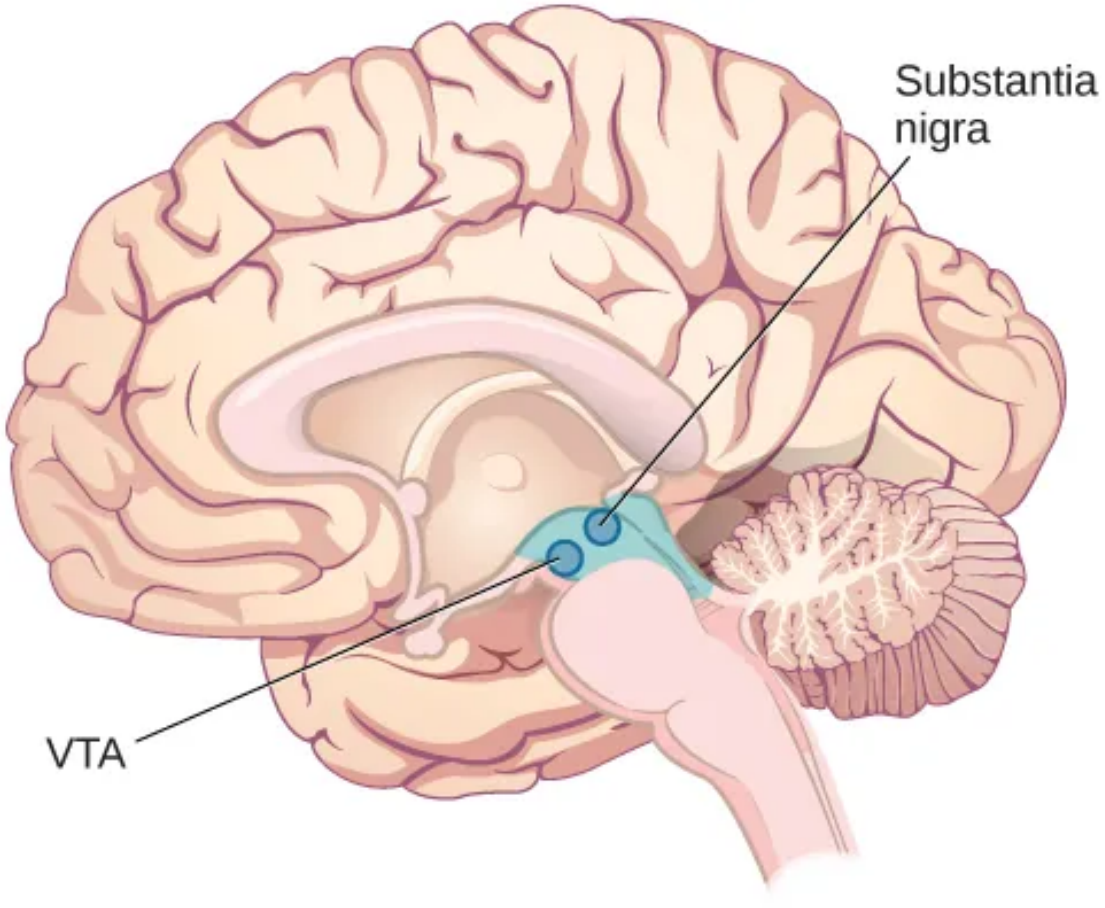
? A child runs away from their parent across a busy street, a very poor and dangerous decision - what are of the brain is likely undeveloped in the child?

- (•) A) Thalamus
- ( ) B) Hypothalamus
- ( ) C) Prefrontal Cortex
- ( ) D) Somatosensory Cortex

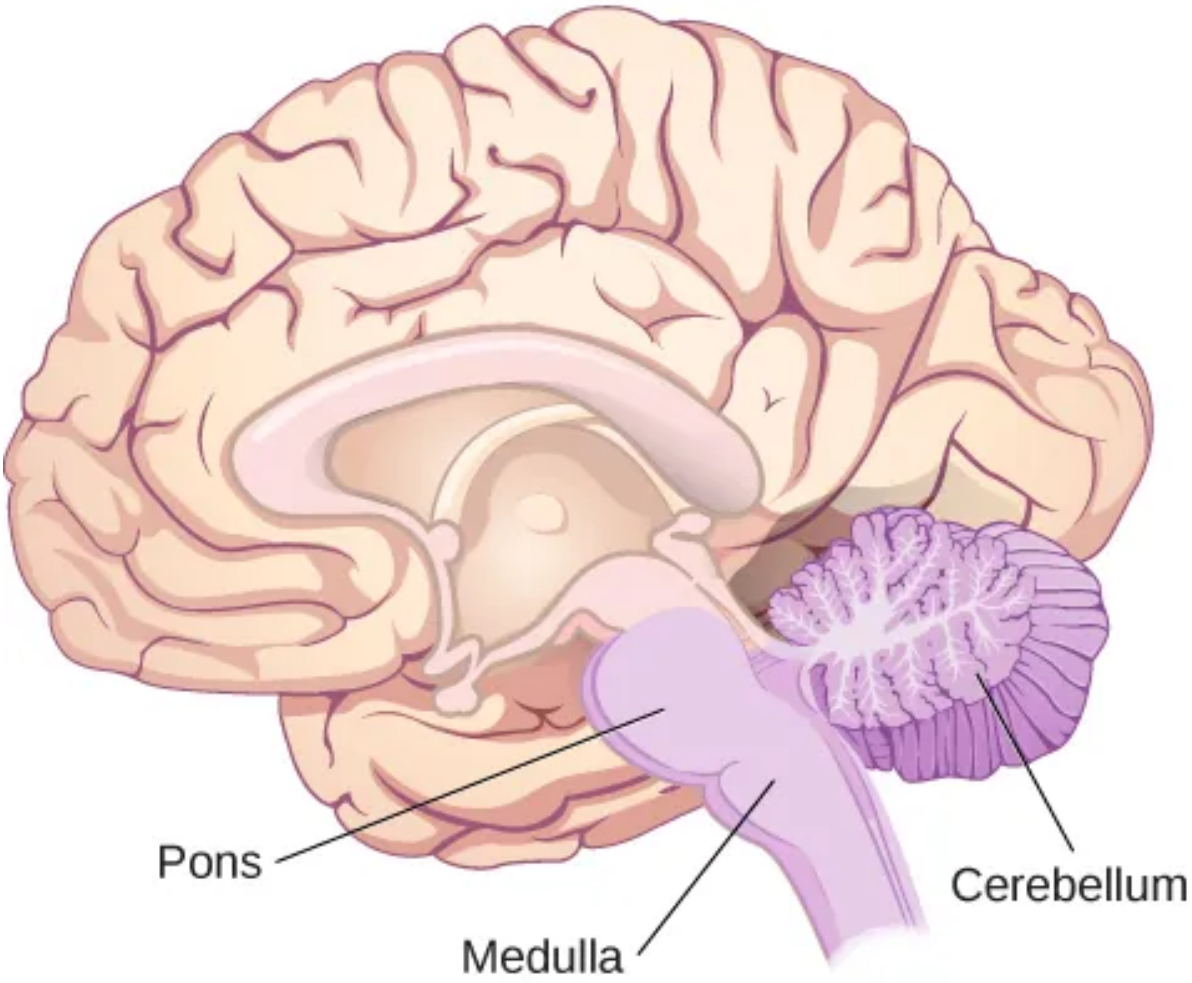
Explanation:

5.8 Midbrain and Hindbrain Structures

- The **midbrain** rests below the forebrain, and in front of the **hindbrain**.
  - The **reticular formation** extend all the way to the edge of the forebrain, and goes down to the start of the hindbrain - it plays an important role in alertness, sleep, and arousal
  - The **substania nigra** and **ventral tegmental area (VTA)** indirectly help ensure movement goes smoothly, by producing the dopamine neurotransmitter
    - These structures become degraded in Parkinson's disease, contributing to the movement problems associated with that disorder



- The **hindbrain** is effectively the connecting point between the spine and brain, and contains several specific structures
  - The **medulla oblongata** (also just called the medulla) handles essential breathing, blood pressure, and heart rate
  - The **Pons** is most involved in regulation of sleep
  - The **Cerebellum** hangs of the back of the brainstem, and mostly helps coordination, balance, proprioception - but also some motor-based procedural memory



5.9 Brain Imaging

- Brain imaging has _____ greatly in the last several decades; which has allowed researchers to establish a much better understanding of structural change in the brain while a person is still alive
  - While autopsy was always an option, it was/is _____ to see how the brain works when it is non-functioning

5.10 Techniques Involving Radiation

- A **Computerized tomography (CT)** scan is effectively a series of _____ across the layers of the brain, eventually resulting in a complete image of the brain structures
  - This was one of the _____ technologies to scan brains, and continues to see use today despite being less detailed than MRIs.

- A **Positron emission tomography (PET)** uses a _____ "tracer" that flows with the blood in the brain to determine how certain areas "activate" i.e., get more blood - it is not used as much on it's own now, given that it can't visualize structure very well, but is sometimes used in conjunction with CTs.

📢 Discuss: If a CT scan is less detailed that newer methods, why do you think it would be used so commonly?

5.11 Techniques Involving Magnetic Fields

- **Magnetic Resonance Imaging (MRI)** uses the existing _____ within us and a magnetic field to detect tissue density and visualize structures.
  - In concept, they produce a similar static, structural image of the brain as a _____ scan, but are more detailed.
- **Functional magnetic resonance imaging (fMRI)** are even more detailed and show activity over _____ in the brain, much like with a PET scan, but with far more structural detail at the same time.
  - Like with PET scans, fMRIs use blood flow to track movement, but also use the MRI _____ imaging at the same time

📢 Discuss: Why don't we just do fMRIs on everyone to check how healthy people's brain are? What barriers exist to that plan?

5.12 Techniques Involving Electrical Activity

- **Electroencephalography (EEG)** scans use _____ on the skull to track electrical activity in certain areas of the brain

  - Used a conductive gel and skull cap, and the individual electrodes can show areas of _____ high and low energy
  - Especially useful in sleep and _____ analysis, as it can be useful to see what areas of the brain are showing an excess or absence of activity

6 The Endocrine System

6.1 Introduction

- The **endocrine system** is responsible for the _____ and regulation of chemical **hormones** throughout the body.
  - Hormones do not travel via neuron action _____, but instead travel in the bloodstream, having systemic effects across the body
  - The **hypothalamus** (in the CNS) and the _____ gland (of the endocrine system) work together to ensure hormones are in the correct concentration - as imbalance can be harmful/dangerous

6.2 Major Glands

> **Important**
>
> Dysfunction in any of these glands can cause major disruption to mood, fatigue, and other mental functions

- The **pituitary gland** serves as the _____ to all the hormone creation occurring in the other endocrine system glands, working on instructions from the hypothalamus
  - It _____ how the instructions are sent and carried to the other glands
- The **thyroid gland** plays an important role in _____ growth, metabolism, and appetite
- The **adrenal glands** _____ produces epinephrine and norepinephrine, to control our adrenaline levels
- The **pancreas** is responsible for regulation of blood _____ and insulin throughout the body
  - Poor regulation in the pancreas or it's products results in **diabetes**, meaning the additional _____ must be taken by the person or medicine to maintain homeostasis.

- The **gonads** are sex-specific, and create hormones appropriate to the sexual function of the _____ that are produced in one's body

Major Endocrine Glands and Associated Hormone Functions

Endocrine Gland	Associated Hormones	Function
Pituitary	Growth hormone, releasing and inhibiting hormones (such as thyroid stimulating hormone)	Regulate growth, regulate hormone release
Thyroid	Thyroxine, triiodothyronine	Regulate metabolism and appetite
Pineal	Melatonin	Regulate some biological rhythms such as sleep cycles
Adrenal	Epinephrine, norepinephrine	Stress response, increase metabolic activities
Pancreas	Insulin, glucagon	Regulate blood sugar levels
Ovaries	Estrogen, progesterone	Mediate sexual motivation and behavior, reproduction
Testes	Androgens, such as testosterone	Mediate sexual motivation and behavior, reproduction

? Using the table and information above, what is the pathway for messaging the release of glucagon?

- (●) A) Pituitary -> Thyroid -> Pineal
- ( ) B) Pituitary -> Thyroid -> Pancreas
- ( ) C) Hypothalamus -> Pituitary -> Testes
- ( ) D) Hypothalamus -> Pituitary -> Pancreas

Explanation:

7 Conclusion

7.1 Recap

- While it may feel somewhat removed from what we talk about in future modules, it is important to understand that our genetics, anatomy, and physiology play a crucial role in our behaviors and cognition
- The Biopsychology perspective is one that is often integrated closely with neuroscience, chemistry, and biology; as you take classes in these other domains, you'll likely see overlap between what we talked about and those other disciplines
- Try not to get too weighed down in the biological and chemical terminology when studying this module - primarily know what sorts of cognition, processing, and behaviors are associated with which structures

7.2 Lecture Check-in

- Get into assigned groups for our weekly group work activity!