FINAL STORYBOARDS
WBT BATCH #1 – PHYSIOLOGY MICROLEARNING 1
for
Psychophysiological Detection of Deception (PDD) Program

JUNE 12, 2024

Pronunciation Guide

The table below is used by the narrator when recording the course audio.
It does not appear in the actual course.

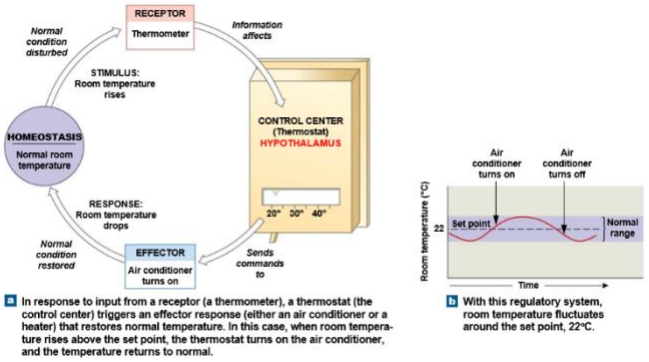
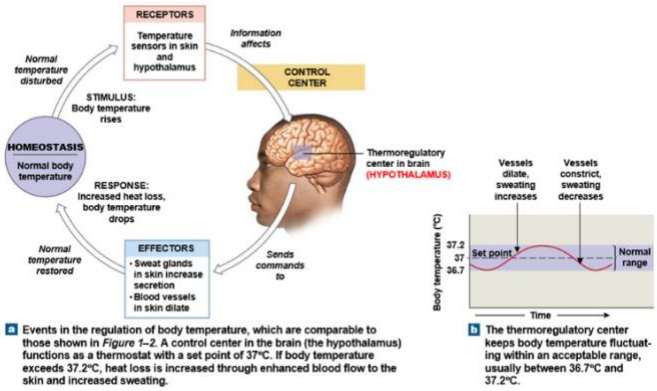
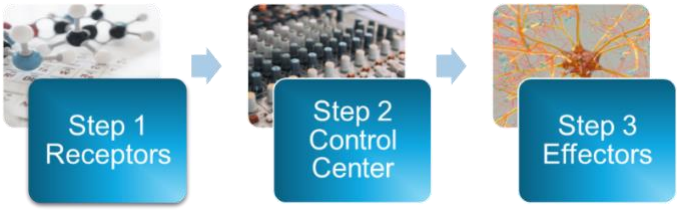
Acronym or Term	Pronunciation	Full Name
ACQT	A-C-Q-T	Acquaintance Test
Amygdala	Uh-migg-duh-luh	Amygdala
Acetylcholine	uh-seet-uhl-KOH-leen	Acetylcholine
Acetylcholinesterase	uh-seet-uhl-koh-luh-NES-ter-ays	Acetylcholinesterase
ANS	A-N-S	Autonomic nervous system
Autonomic	aw-toe-NOM-ik	Autonomic
Basal ganglia	BASE-uhl GANG-lee-uh	Basal ganglia
BBB	B-B-B	Blood Brain Barrier
Cerebellum	sair-uh-BELL-um	Cerebellum
Cholinergic	koh-luh-NUR-jik.	Cholinergic
CI	C-I	counterintelligence
CNS	C-N-S	Central nervous system
Diencephalon	die-enn-SEFF-uh-lahn	Diencephalon
EDA	E-D-A	Electrodermal Activity
Electrodermal	ee-LEK-tro-DERM-al	Electrodermal
F3	F-3	Fight, Flight, or Freeze
gyrus	JIE-riss	gyrus
Hippocampus	HIPP-oh-camp-uhs	Hippocampus
Homunculus	hoe-MUN-kyuh-lus	Homunculus
Hypothalamus	HIGH-poe-THAL-uh-muss	Hypothalamus
Medulla Oblongata	muh-DOOL-uh ob-LONG-gah-ta	Medulla Oblongata
Neurotransmitter	nur-oh-TRANZ-mit-er	Neurotransmitter
Norepinephrine	nor-epin-EF-rin	Norepinephrine
Occipital	ok-SIP-uh-tuhl	Occipital
Parasympathetic	pair-uh-simp-uh-THET-ik	Parasympathetic
Parietal	puh-RY-uh-tuhl	Parietal
PDD	P-D-D	Psychophysiological Detection of Deception
SNS	S-N-S	Sympathetic nervous system
TDA	T-D-A	Test Data Analysis

MICROLEARNING #1: Introduction to Homeostasis

Module 2: Physiology
Topic 2: Homeostasis

INTRODUCTION TO HOMEOSTASIS			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Introduction to Homeostasis ncca_phys_01_01	*Slide Image/Text:* Welcome to the Introduction to Homeostasis  *Audio Narration:* Welcome to Introduction to Homeostasis. Please choose Next to begin.	N/A	0:10
Learning Objective ncca_phys_01_02	*Slide Image/Text:* Learning Objective: • Describe homeostasis including its key steps and importance to polygraph. *Audio Narration:* After completing this module, you will be able to describe homeostasis, including its key steps and importance to polygraph.	N/A	0:10
What is Homeostasis?	*Slide Image/Text:* Homeostasis is the existence of a stable environment within the body.	Content appears in sequence with narration.	1:10

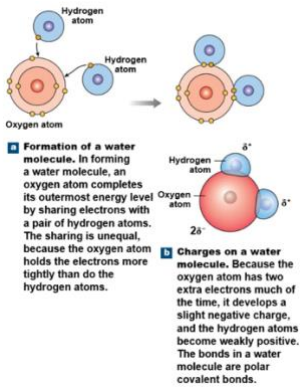
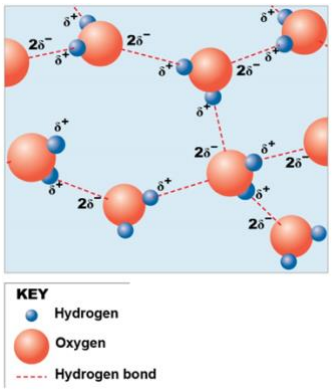
ncca_phys_01_03	The primary mechanism for maintaining homeostasis is through negative feedback loops: • Negative feedback loops provide long-term regulation of the body's internal conditions and systems. • They are internal controls for maintaining the optimal internal state, including the regulation of internal variable levels such as temperature, pH, hormone levels, blood sugar, heart rate, and respiratory rate. • Called "negative" because effectors, like sweat glands or heart rate adjustments, are activated to oppose or negate an original stimulus, such as a rise in body temperature or stress-induced changes in heart rate. *Audio Narration:* Homeostasis is the existence of a stable environment within the body. This stability is primarily achieved through negative feedback loops. These loops work by maintaining the optimal levels of various internal variables such as temperature, pH, hormone levels, and blood sugar, as well as maintaining stable heart rate, and stable respiratory rate. The term "negative feedback" refers to the mechanism by which effectors, like sweat glands or the cardiovascular and respiratory systems, are activated to counteract or negate any deviation from an ideal condition, such as a rise in body temperature, an increase in heart rate, or a change in breathing rate, thereby restoring balance to the system. It is called negative feedback because effectors, such as the sweat glands, heart, and lungs, are activated by the control center to oppose, or negate, an original stimulus, such as the body temperature rising, heart rate speeding up, or breathing becoming too shallow or too deep. As the course progresses, homeostasis will be explained in more depth as it applies to the nervous, cardiovascular, and respiratory systems.		
Steps of Homeostasis	*Slide Image/Text:*	Images are shown in sequence.	2:30

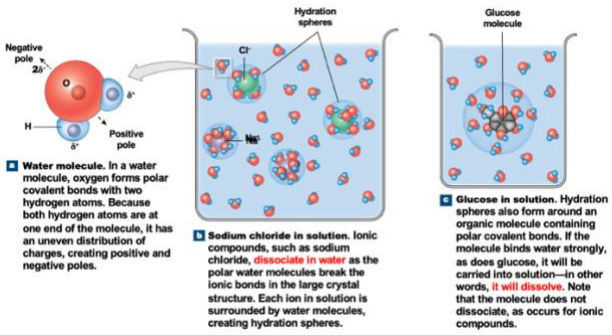
ncca_phys_01_04	 *Figure 1 Control Room*  *Figure 2 Negative Feedback Control of Body Temperature*  [When each step of the step graphic appears, show the corresponding step with their bullets.] Step 1 (Receptors): • Temperature receptors receive information about the temperature change. Step 2 (Control Center): • The hypothalamus, the control center of the brain, receives information about temperature change from the receptors.	Each image replaces the one before it. “Step” graphic appears in sequence, one step after another.	

	• At the normal set point, the body temperature (by an oral thermometer) is approximately 37°C or 98.6°F. Step 3 (Effectors): • When the body temperature rises above the normal set, the hypothalamus sends commands that activate effectors causing blood vessels to dilate and sweat glands to speed up secretions. • The skin acts like a radiator by losing heat to the environment via evaporation of sweat. As a result, body temperature is restored to normal. *Audio Narration:* The hypothalamus functions like a thermostat, monitoring internal conditions. When it detects a deviation, such as an increase in body temperature, it triggers mechanisms that restore the body to its normal state, much like a thermostat activates the air conditioner to bring down the room temperature when it rises. In the brain, the hypothalamus, located around eye or ear level, is the thermostat-like regulator. When temperature goes up in the body, the hypothalamus sends commands to our body to sweat to cool us down. When you are outside exercising in the heat, you sweat to cool down your body. On the other hand, when your body temperature goes down, you shiver to heat up your body. When all is calm in the body, we are in a state of homeostasis. It's important to remember that homeostasis extends beyond regulating body temperature. It encompasses a variety of essential functions, including the regulation of respiratory and heart rates. These functions collectively contribute to maintaining a stable equilibrium within the body. Let’s delve into the process of homeostasis, using thermoregulation—the maintenance of body temperature—as an illustrative example. In Step 1, known as 'Receptors', the body's temperature receptors play a crucial role. These receptors receive information about the temperature change. In Step 2, known as 'The Control Center,' the hypothalamus receives data from the temperature		

	receptors. It then compares the current body temperature to the normal set point, typically around 37°C or 98.6°F when measured orally. In Step 3, known as 'Effectors,' the body's response mechanism kicks in when temperature rises above the normal set point. The hypothalamus triggers the activation of effectors, causing blood vessels to dilate and sweat glands to speed up secretions. The skin acts like a radiator by losing heat to the environment via evaporation of sweat. As a result, body temperature is restored to normal.		
Impact on Polygraph ncca_phys_01_05	*Slide Image/Text:* [Screen open with image of man taking polygraph and header text.]  Homeostasis and its relation to Psychophysiological Detection of Deception (PDD) During a polygraph, an examinee is sitting still in a chair so all reactions to a threat happen *internally*. ▪ These reactions are what create physiological changes which we monitor with PDD. ▪ The impact on body temperature also impacts PDD. ▪ If an examinee experiences stress, it may lead to an increase in body temperature, which activates the sweat glands, a key factor monitored in PDD. ▪ The variations in body type may affect one's ability to establish and maintain homeostasis.	Content appears in sequence with narration.	1:15

	Audio Narration: During a polygraph, the examinee remains seated and stationary; however, internal physiological responses to questions or perceived threats are monitored. For example, lying can trigger stress, which raises body temperature and activates sweat glands. In Psychophysiological Detection of Deception, or PDD, we monitor and record sweat gland activity, as the body seeks to restore homeostasis. We want the examinee in a state of homeostasis, so we can observe deviations caused by stimulus – a polygraph question. This allows us to observe their various physiological responses as controlled stimuli are presented. As a polygraph examiner, it's crucial to consider variations in age and body type since aging affects blood supply to the dermis and the activity of sweat glands, impacting the body's ability to regulate temperature. For example, elderly individuals may feel cold in warm conditions. This is a result of a decrease in blood circulation or flow to the capillaries of the skin. It is important to realize that as we get older, our homeostasis changes. This may impact examinees in PDD who are older, so we have to adjust for that by making sensitivity adjustments based on the examinee's body type.		

Application of Sweat Gland Activity to the Electrodermal Activity (EDA) ncca_phys_01_06	*Slide Image/Text:* [Screen open screen with 1st sentence.] What you need to know about Electrodermal Activity (EDA) and sweat gland activity. [When “consists of water” narration plays, show Figure 3 with label. When “monitoring sweat gland activity” narration plays. show Fig 4. When “Additionally” narration plays, show Fig 5 with label.]  *Figure 3 Water Molecules Contain Polar Covalent Bonds*  *Figure 4 Hydrogen Bonds from Between Water Molecules*	Content appears in sequence with narration.	1:00

	 *Figure 5 Water Molecules Surround Solutes in Aqueous Solutions.* *Audio Narration:* The human body primarily consists of water. Since we monitor sweat gland activity, electrodermal activity, or EDA, in PDD, we are most interested in the function of sweat. Sweat glands activate because the body temperature rises. Sweat rises to the surface of the skin and evaporation cools the body, which assists in thermoregulation. When hydrogen and oxygen atoms bond, they form water, or H2O. Sweat is composed mostly of water. So how is this captured in PDD? Sweat evaporates when it hits the air. In PDD, we use fingerplates or pads on the palms of the hands to monitor and record sweat gland activity. Sweat contacts the plates and causes a reaction or response we can see on the chart. The sweat will then either go back into the pores or evaporate and the response will subside as the body returns to homeostasis. Additionally, the process of dissociation, where charged ions separate in a solution plays a role. Dissociation is a subset of dissolution, or dissolving. For example, salt dissociates in water which is how it dissolves. However, ethanol *dissolves* in water but does not *dissociate*.		
Review ncca_phys_01_07a	*Slide Image/Text:* Knowledge Check What is the primary mechanism by which homeostasis maintains a stable internal environment in the body? • Positive feedback loops • Negative feedback loops (correct)	Knowledge checks with feedback pop-up.	1:30

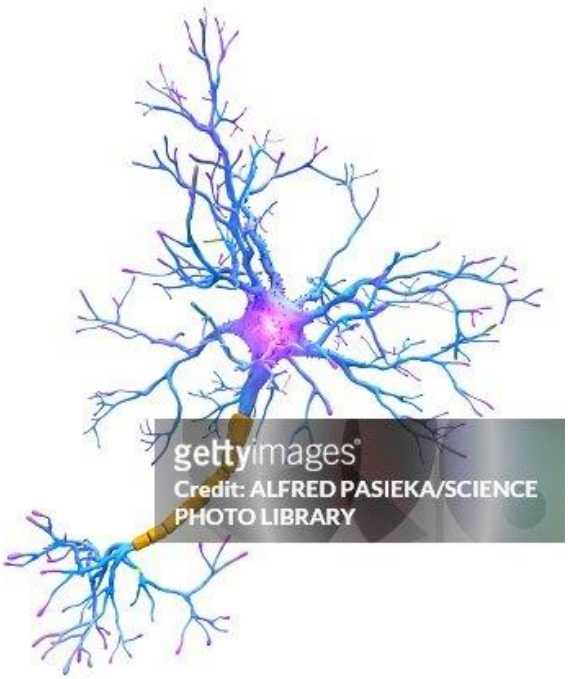
ncca_phys_01_07b ncca_phys_01_07c	• Neural adjustments • Hormonal imbalances [Feedback:] Correct/Incorrect. Negative feedback loops are the primary mechanism by which homeostasis maintains a stable internal environment in the body. How does the hypothalamus contribute to temperature regulation within the homeostasis process? • By signaling the muscles to provide a protective layer for internal organs. • By directly cooling the blood • By comparing current body temperature with the normal set point (correct) • By isolating external temperature influences [Feedback:] Correct/Incorrect. The hypothalamus contributes to temperature regulation by comparing current body temperature with the normal set point. What role do effectors play in the homeostasis of body temperature? • They detect changes in external temperature • They adjust the body's set point temperature • They activate to restore the body's temperature to the desired range (correct) • They send temperature information to the hypothalamus [Feedback:] Correct/Incorrect. Effectors activate to restore the body's temperature to the desired range. *Audio Narration:* Answer the following questions to check your understanding of the key concepts from this module.		
Conclusion ncca_phys_01_08	*Slide Image/Text:* Great job! Learning Objective: • Describe homeostasis including its key steps and importance to polygraph. [Instructional text] Close this module to continue the lesson. *Audio Narration:*	N/A	0:15

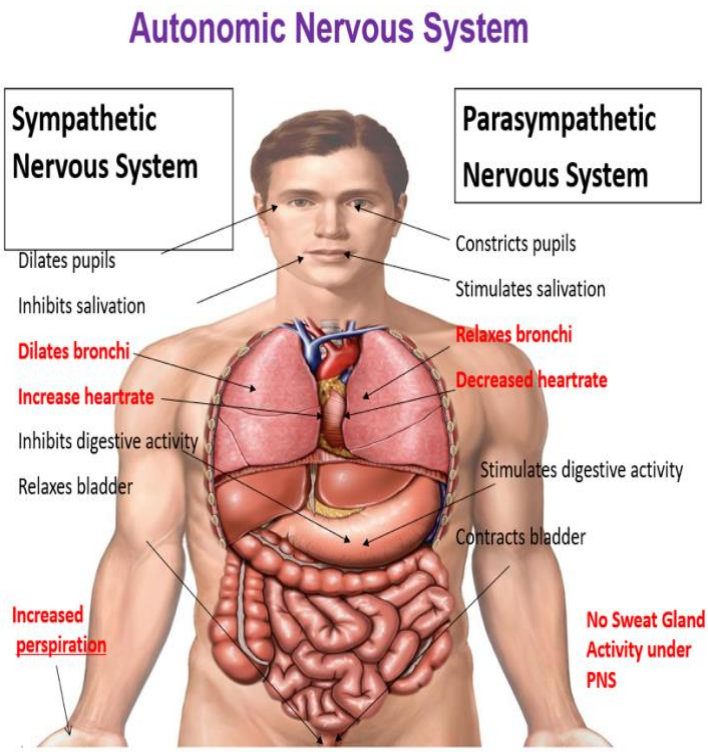
MICROLEARNING #2: Action Potentials and Sweat Glands

Module 2: Physiology
Topic 2: Homeostasis

ACTION POTENTIALS AND SWEAT GLANDS			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_02_01	*Slide Image/Text:* Welcome to the Action Potentials and Sweat Glands  *Audio Narration:* Welcome to Action Potentials and Sweat Glands. Please choose Next to begin.	N/A	0:10
Learning Objective ncca_phys_02_02	*Slide Image/Text:* Learning Objective: • Discuss the relationship of action potentials and sweat glands on polygraph. *Audio Narration:* After completing this module, you will be able to discuss the relationship of action potentials and sweat glands on polygraph.	N/A	0:10
What are Action Potentials? ncca_phys_02_03	*Slide Image/Text:* [Screen Open with header and first image.] What are Action Potentials?	Content appears in sequence with narration.	0:30

	 Action potentials are: • Electrical events, also known as nerve impulses or electrical impulses., • The initiation of an action to take place. Everything we do starts with an action potential. • A message is sent to make the action happen. • Generated by an unequal distribution of ions. • Sodium (Na) ions are most responsible for generating action potentials *Audio Narration:* Action potentials are the spark of our nervous system, electrical events also known as nerve impulses. These impulses are the starting signals for every action we take, from walking to talking. Every movement, every word, begins with an action potential, making them the fundamental drivers of our bodily functions. At the core of these signals is the unequal distribution of ions, with sodium ions playing a pivotal role.		
How Action Potentials Function ncca_phys_02_04	*Slide Image/Text:* [Screen Open with header.] How Action Potentials Function • Our bodies contain billions of neurons, including sensory neurons that detect taste or smell, and motor neurons that control movements of limbs and other body parts. • Neurons communicate with each other via action potentials. • Action potentials transfer neurotransmitters across synapses—the junctions between neurons.	Content appears in sequence with narration.	1:30

	• Neurons feature both passive and gated channels, regulating ion flow based on voltage or chemical signals. • Dendrites in neurons continue to grow throughout life, enhancing the brain's capacity for forming new neurological connections.   *Audio Narration:* Our bodies host billions of neurons that enable senses like taste and smell and control movements. Neurons communicate through action potentials, where electrical		

	signals transfer neurotransmitters between neurons at synapses, akin to a relay race. In this relay, the runner carrying the baton represents the preganglionic neuron. The baton itself symbolizes the neurotransmitter. The runner who receives the baton symbolizes the postganglionic neuron, as the action potential takes place with the handoff of the baton. Neurons also have channels controlling ion flow. Passive channels allow free movement, while gated channels need specific triggers like voltage changes or neurotransmitters, including sodium, potassium, and chloride, to open. Additionally, neuron dendrites grow throughout our lives, enhancing our brain's capacity to form new connections and adapt, highlighting our brain's incredible complexity and learning potential.		
The Autonomic Nervous System (ANS) ncca_phys_02_05	*Slide Image/Text:* [Screen Open with header and first image.] The Autonomic Nervous System (ANS) at Work  *Figure 6 The Autonomic Nervous System*	Content appears in sequence with narration.	2:00

Sympathetic nervous system (SNS): The SNS activates the body's rapid involuntary response to dangerous or stressful situations, priming it for action.

In Psychophysiological Detection of Deception (PDD) these fight, flight, or freeze (F3) activities are monitored and recorded with the polygraph instrument:

- Dilation of the bronchi
- Increased heart rate
- Increased sweat gland activity

Parasympathetic nervous system – "Rest and Digest": Conserves energy in multiple ways, including bronchi and heart rate.

- Relaxation of the bronchi
- Heart rate slows
- No response to sweat gland activity

An F3 response causes the following:

- Increase in heart rate (HR).
- Change in sweat gland activity.
- Bronchial dilation (change in respiratory pattern).

Audio Narration:

The autonomic nervous system, or ANS, is divided into two crucial parts. The sympathetic nervous system, or SNS, kicks into gear to accelerate certain body activities, preparing us for action.

In Psychophysiological Detection of Deception, or PDD, these fight, flight, or freeze, or F3, activities are monitored and recorded with the polygraph instrument. Bronchi dilate, heart rate increases, and sweat gland activity increases.

In contrast, the parasympathetic nervous system is known as the "rest and digest" system. It conserves energy in multiple ways. In terms of polygraph, the bronchi relax again, and heart rate slows down. The parasympathetic nervous system does not respond to sweat gland activity.

	The body responds to perceived threats by initiating a stress response, increasing body temperature and activating sweat glands to restore homeostasis. In PDD, telling a deliberate lie triggers the sympathetic nervous system's F3 response, which includes increased heart rate, heightened sweat gland activity, and bronchial dilation. For instance, a guilty subject asked about stealing money will feel a threat, similar to being caught stealing, with jailtime on the horizon. Their body perceives the threat and responds to it. During such a threat, the neurotransmitter epinephrine/ norepinephrine, also known as adrenaline/noradrenaline, is released, escalating the body's alert state. Postganglionic neurons then spread these signals across the body, leading to an automatic increase in heart rate. Once the threat subsides, the body works to regain balance. Acetylcholine is released, prompting relaxation and returning the body to homeostasis by reducing heart rate and constricting the bronchi.		
Sweat Glands ncca_phys_02_06	*Slide Image/Text:* • Sweat glands are only innervated or supplied by the SNS. • There is no parasympathetic response to shut down the sweat glands. • Postganglionic neurons of the sweat glands release acetylcholine (ACh) for activation of muscarinic receptors. • ACh is the most common neurotransmitter. ACh is secreted at sweat glands. • Sodium chloride (NaCl), or salt, is an electrolyte and will ionize (disassociate) in water. In polygraph, increased sweat increases the amplitude of the electrodermal activity (EDA) tracing on the polygraph chart. *Audio Narration:* Sweat glands are unique in that they are innervated solely by the sympathetic nervous system, unlike most effector organs that receive dual innervation. There is no parasympathetic response to inhibit it.	Content is shown in sequence with narration.	1:00

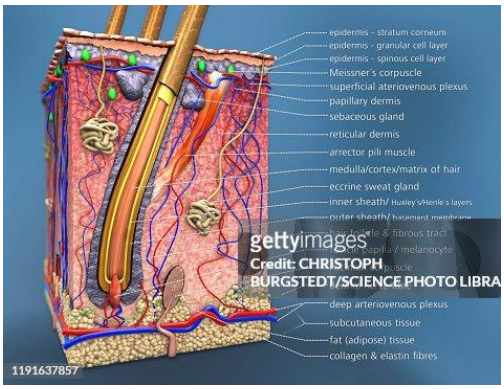
	Postganglionic neurons release acetylcholine to activate muscarinic receptors in these glands. Acetylcholine, the most common neurotransmitter, is found in skeletal-muscular connections and in sweat glands. When sodium chloride dissolves in water, it ionizes into sodium and chloride ions due to their attraction to water molecules. How does this affect polygraph testing? In polygraph testing, increased sweat raises sodium content in pores, enhancing electrical current flow between finger plates or silver-silver chloride pads. This increases the amplitude of electrodermal activity, or EDA, tracing on the polygraph chart.		
Neurotransmitters and Hormones ncca_phys_02_07	*Slide Image/Text:* Neurotransmitters and Hormones • **Neurotransmitters**: Chemical messengers in the nervous system transmitted across neuron synapses. • **Acetylcholine (ACh)**: A common neurotransmitter in the body. • **Hormones**: Chemical messengers of the endocrine system, transmitted through the blood. • **Dual-role Chemicals**: Some substances function as both hormones and neurotransmitters, like epinephrine (E) and norepinephrine (NE), also known as adrenaline and noradrenaline.  *Audio Narration:*	Content appears in sequence with narration.	0:30

	Neurotransmitters are chemical messengers in the nervous system transmitted across neuron synapses. Acetylcholine is a common neurotransmitter in the body. Hormones are chemical messengers of the endocrine system, which are transmitted through the blood. Some substances function as both hormones *and* neurotransmitters. Epinephrine and norepinephrine, also known as adrenaline and noradrenaline, are vital in stress responses observed in polygraphs. These substances play dual roles in the nervous and endocrine systems, influencing both nerve transmission and hormonal release.		
Review ncca_phys_02_08a ncca_phys_02_08b ncca_phys_02_08c	*Slide Image/Text:* Knowledge Check Question: What role do action potentials play in the body's response during a polygraph test? • They trigger a fever. • They initiate electrical impulses that influence sweat gland activity. (correct) • They stop the production of neurotransmitters. • They only affect heart rate and not sweat glands. [Feedback:] Correct/Incorrect. They initiate electrical impulses that influence sweat gland activity. Question: Which statement best describes the relationship between sweat glands and action potentials in the context of a polygraph? • Sweat glands respond independently of action potentials. • Action potentials trigger sweat glands to help the body achieve homeostasis. (correct) • Sweat glands deactivate action potentials. • There is no relationship between sweat glands and action potentials. [Feedback:] Correct/Incorrect. Action potentials trigger sweat glands to help the body achieve homeostasis. Question: How do action potentials contribute to physiological responses measured in polygraph tests? • By altering the role of toxins in the body. • Through the stimulation of sweat glands that can indicate stress. (correct)	Knowledge checks with feedback pop-up.	1:30

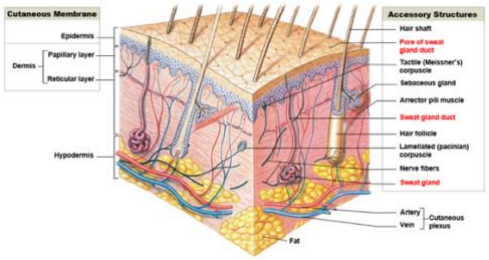
	• By cooling the body directly. • Action potentials have no impact on physiological responses in polygraphs. [Feedback:] Correct/Incorrect. Action potentials contribute to physiological responses measured in polygraph tests through the stimulation of sweat glands that can indicate stress. *Audio Narration:* Answer the following questions to check your understanding of the key concepts from this module.		
Conclusion ncca_phys_02_09	*Slide Image/Text:* Great job! Learning Objective: • Discuss the relationship of action potentials and sweat glands on polygraph. [Instructional text] Close this module to continue the lesson. *Audio Narration:* Great job! You should now be able to discuss the relationship of action potentials and sweat glands on polygraph. Close this module to continue the lesson.	n/a	0:10
		Total Estimated Time:	7:30

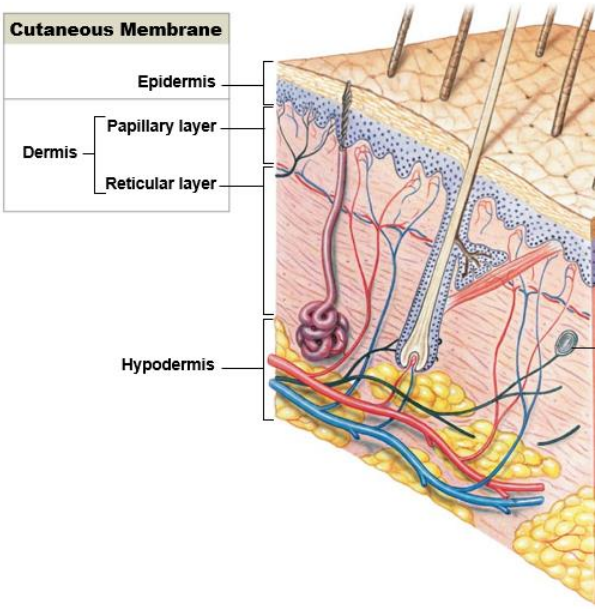
MICROLEARNING #3: Integumentary System Overview

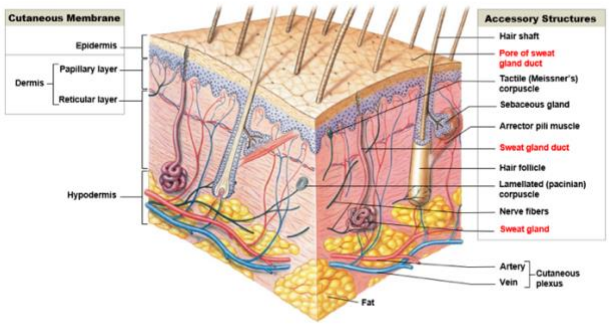
Module 2: Physiology
Topic 3: Integumentary System

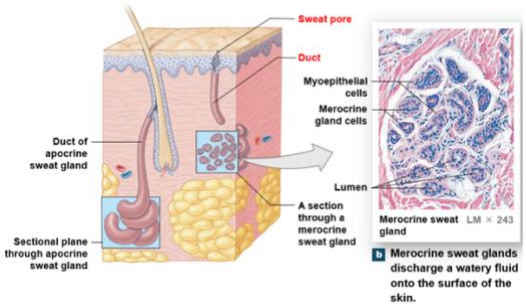
INTEGUMENTARY SYSTEM OVERVIEW			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_03_01	*Slide Image/Text:* Welcome to the Integumentary System Overview *Audio Narration:* Welcome to Integumentary System Overview. Please choose Next to begin.	N/A	0:10
Learning Objective ncca_phys_03_02	*Slide Image/Text:* Learning Objective: • Explain the integumentary system and its relationship to polygraph. *Audio Narration:* After completing this module, you will be able to explain the integumentary system and its relationship to polygraph.	N/A	0:10
Functions of the Integumentary System ncca_phys_03_3	*Slide Image/Text:* [Screen Open with header and first image.] Functions of the Integumentary System (Skin)  The skin has eight key functions: 1. **Protection**: Acts as a barrier against physical injuries, harmful substances, and pathogens. 2. **Sensation**: Contains nerve endings that detect touch, pressure, pain, and temperature changes.	Content appears in sequence with narration.	2:00

	3. **Thermoregulation**: Helps regulate body temperature through sweat production and blood vessel dilation or constriction. 4. **Excretion**: Removes waste products through sweat. 5. **Synthesis**: Produces Vitamin D3 when exposed to sunlight. 6. **Immunity**: Contains cells that help protect against infections. 7. **Storage**: Stores lipids and water, providing energy and hydration. 8. **Melanin production**: Provides pigmentation. Sweat rises in the pores in a fight, flight, or freeze (F3) response. In Psychophysiological Detection of Deception (PDD), this results in an increase in electrodermal activity (EDA). *Audio Narration:* The integumentary system, commonly known as our skin, is a multifunctional organ that serves as our outer protective layer. It regulates body temperature, synthesizes vitamin D3, and excretes waste through sweat. It also supports immune functions and sensory detection, crucial for maintaining homeostasis. The skin is the largest organ system, encompassing approximately 16.1 - 21.5 square feet and representing about 16% of body weight. The skin has eight key functions. First, it acts as a barrier against physical injuries, harmful substances, and pathogens, providing protection. It contains nerve endings that detect touch, pressure, pain, and temperature changes, offering a sense of sensation. In terms of thermoregulation, the skin helps regulate body temperature through sweat production and the dilation or constriction of blood vessels. The skin removes waste products through sweat, a process known as excretion. The skin also engages in synthesis, producing Vitamin D3 when exposed to sunlight. It plays a crucial role in immunity, containing cells that help protect against infections. It serves as a storage unit too, holding lipids and water, which provide energy and hydration. Melanin production serves to protect the underlying tissues from UV radiation and determines skin color.		

	Sweat rises in the pores in a fight, flight, or freeze, or F3, response. In In Psychophysiological Detection of Deception, or PDD, this results in an increase in electrodermal activity, or EDA. Once the response subsides, the sweat withdraws into the pores and a decrease in EDA activity occurs.		
Layers of Skin ncca_phys_03_04	*Slide Image/Text:* [Screen Open with header and first image.]  *Figure 7 The Components of the Integumentary System* The Skin's Layers Let us examine the three layers of skin: 1. Epidermis: Serves as the primary barrier against environmental threats and damage. 2. Dermis: Provides support and nourishment to the epidermis above it. 3. Hypodermis: Functions as a storage for fat and plays a crucial role in insulating the body.	Content appears in sequence with narration.	1:00

	 *Figure 8 Three Layers* *Audio Narration:* The skin is structured into three main layers. The epidermis is the outermost layer of the skin which provides a barrier against bacteria as well as chemical and mechanical injuries, although it is not impenetrable. It includes the stratum corneum which is the tough superficial, top layer of the epidermis. Just beneath the epidermis is the dermis. The dermis is the tissue layer that supports the epidermis. These two layers are separated by basal membrane. The dermis contains smaller blood vessels, the sebaceous gland and hair follicles, and the tightly coiled portion of the eccrine sweat gland. The palms of the hands and soles of feet are thicker and have no hair growth. There are a great number of eccrine or sweat glands at these locations. The eccrine gland is the one most important to PDD. The bottom layer, the hypodermis, lies beneath the dermis. The hypodermis contains larger blood vessels – veins and arteries, as well as fat.		
Accessory Structures	*Slide Image/Text:* [Screen Open with header and first image.]	Content appears in sequence	1:00

ncca_phys_03_05	 Figure 9 A diagram of skin structure Accessory structures of the skin: nails, hair, sweat glands, and sebaceous glands. • Melanocytes produce melanin, responsible for the skin's pigmentation. • The exposed surface of epidermis has 15-30 layers of cells. ○ The deepest are the basal, or germinative cells: stem cells that replace cells above. • Keratin helps form nails, hair, and the outer layer of the skin. It provides much of the skin's resistance. *Audio Narration:* Let's explore the components that contribute to the functionality and sensation of our skin. The accessory structures of the skin include nails, hair, sweat glands, and the sebaceous gland. Melanocytes produce melanin which is responsible for the skin's pigmentation and found in the bottom layer – stratum basale – of the epidermis. The exposed surface of epidermis has 15-30 layers of cells. The deepest are the basal, or germinative cells. Basal cells are stem cells that "move up" replacing cells above until they reach the surface where they are eventually shed. Cells are sloughing off, or shedding, from this layer all the time.	with narration.	

	Keratin helps form nails, hair, and the outer layer of the skin. It provides skin with much of its resistance to physical wear and tear as well as helps to repel water.		
Exocrine Glands Found in Skin ncca_phys_03_06	*Slide Image/Text:* [Screen Open with header and first image.] Exocrine Glands • Sebaceous glands: ○ Produce sebum, an oily substance, which protect skin from water. ○ Usually attached to hair follicles. • Sweat glands: ○ Apocrine glands ○ Merocrine (eccrine) glands *Audio Narration:* Within the domain of exocrine glands, there are two types: sebaceous glands and sweat glands. Sebaceous glands protect skin from water penetrating. These are usually attached to hair follicles which produce sebum, an oily substance. Sweat glands include apocrine glands and merocrine – also known as eccrine – glands. The polygraph detects sweat gland activity through skin conductance or EDA.	Content appears in sequence with narration.	0:30
Apocrine versus Merocrine (Eccrine) Sweat Glands ncca_phys_03_07	*Slide Image/Text:* Understanding Sweat Glands and Perspiration  [Screen Open with header and first image.] Apocrine sweat glands:	Content appears in sequence with narration.	1:30

	• Secrete into hair follicles in armpits and pubic areas. • Produce body odor. Merocrine (eccrine) sweat glands: • Discharge secretions directly onto the skin's surface. • Found in high concentrations on palms, fingertips, soles of feet, and forehead area. • Located in the dermis. <u>Video: How Sweat Glands Work Animation</u> **(1:05)** *Audio Narration:* Apocrine sweat glands secrete into hair follicles found in armpits and pubic areas. They produce body odors. Merocrine/eccrine sweat glands discharge their secretions directly onto the surface of the skin. They are found in high concentrations on the palms of the hand, fingertips, soles of the feet, and in the forehead area. Merocrine sweat glands are located in the dermal layer of skin – the dermis.		
Sweat Glands and Perspiration ncca_phys_03_08	*Slide Image/Text:* [Screen Open with header and first image.]  Sweat Glands and Perspiration • Perspiration: Over 99% water; aids in cooling the body as it evaporates.	Content appears in sequence with narration.	1:00

- Process: Water from interstitial fluids contributes to sweat development in sweat glands. Sweat rises in the pores, reaches the skin's surface, and eventually evaporates.
- Sensible perspiration: Sweat from eccrine (merocrine) sweat glands; can be seen or felt.
- Insensible perspiration: Evaporation through the stratum corneum, mostly pure water, imperceptible; cannot be seen or felt.
- Primary function: Helps reduce body temperature, aiding in homeostasis.
- Fluid loss: Approximately 600 - 900 ml per day through exhalation (insensible perspiration).

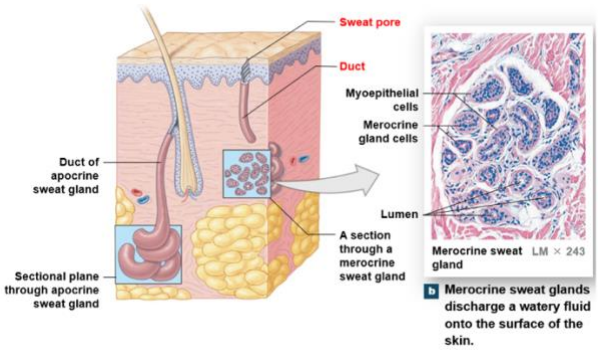


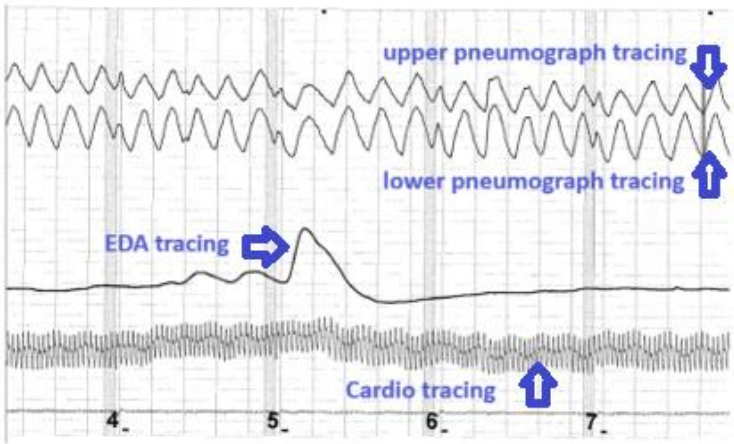
Figure 10 Sweat Glands

Audio Narration:

Perspiration is made up of more than 99% water. Less than 1% is made of electrolytes – salt – and waste material. It helps cool the body through evaporation. Water from surrounding interstitial fluids contributes to sweat development in the sweat glands. This sweat rises in the pores and gradually reaches the skin's surface, where it eventually evaporates.

Perspiration may be either sensible or insensible, that is, able to be seen and felt – or not. Sensible perspiration is from eccrine/merocrine glands, which can be seen or felt. Its primary function is to help reduce body temperature, aiding in homeostasis. Insensible perspiration evaporates from the stratum corneum, which cannot be seen or felt.

We lose approximately 600 - 900 milliliters, or about 1.5 pints, of fluid per day through insensible perspiration and exhalation. For example, when we inhale oxygenated air into the lungs, it circulates in the heart and is then pumped through your body. When we exhale, we expel moisture along with waste.

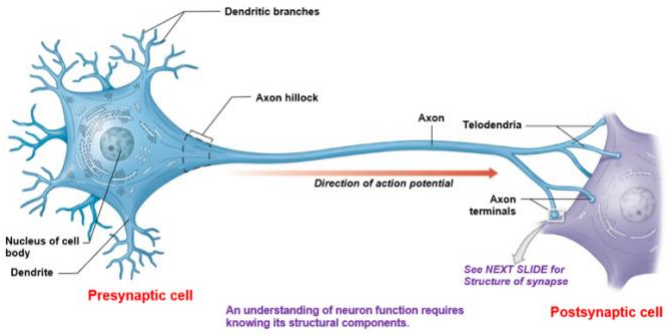
Sweats Glands and PDD ncca_phys_03_09	*Slide Image/Text:* Sweat Glands and PDD • Sweat glands are important in PDD, as we monitor them via EDA. • EDA tracing rises, or increases amplitude, when sweat rises in the sweat gland duct. • Sweat glands are unusual as they: • Are only activated by sympathetic nervous system (SNS) stimulation. • Have no parasympathetic nervous system stimulation to deactivate them following stimulus. • Emotional state can influence sweat gland activity. Any threat to our well-being activates sweat gland activity. • Suppressing the truth and consciously lying causes and causes an F3 response, including sweating. • The polygraph detects a change in electrical skin conductance caused by this sweating.  *Acquaintance Test (ACQT)* *Audio Narration:* Sweat glands are important in PDD, as we monitor sweat glands via the EDA component. The EDA tracing rises, or increases amplitude, when sweat rises in the sweat gland	Content appears in sequence with narration.	1:30

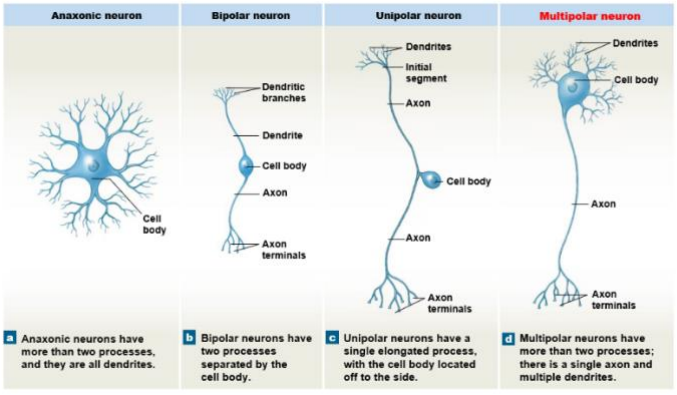
	duct. Research shows that EDA is the most responsive and easily recognizable channel in test data analysis. For example, the figure shows a spike in EDA amplitude, when the examinee lied at question number 5. Sweat glands are unusual in regard to the autonomic nervous system and what neurotransmitters they use. They are activated by only sympathetic nervous system, or SNS, stimulation. Most times, the neurotransmitter associated with the SNS is epinephrine. Their sympathetic neurotransmitter is acetylcholine – and not epinephrine or norepinephrine. They have no parasympathetic nervous system stimulation to deactivate them, following stimulus. One's emotional state can also be an influencing factor for sweat gland activity. Any threat to our well-being activates sweat gland activity. Sweating from merocrine/eccrine glands is precisely regulated, and emotional state is one influencing factor. Presumably, a person who is lying is nervous and sweats more. The polygraph detects a change in electrical skin conductance caused by this sweating. Emotions are psychological states brought on by neurophysiological changes. For instance, when asked on a polygraph, "Did you steal any of that money?", the examinee processes that response in a nanosecond as a yes, if they know they stole the money. When the examinee makes the conscious decision to suppress the truth and to lie, they go into an emotional state which causes stress. That threat becomes physiological and causes an F3 response.		
Review ncca_phys_03_10a ncca_phys_03_10b	*Slide Image/Text:* Knowledge Check Question 1: Which neurotransmitter is primarily associated with the activation of sweat glands by the sympathetic nervous system? A) Epinephrine B) Acetylcholine (correct) C) Norepinephrine D) Dopamine	Knowledge checks with feedback pop-up.	1:00

	[Feedback:] Correct/Incorrect. Acetylcholine is associated with the activation of sweat glands by the sympathetic nervous system. Question 2: What layer of skin acts as the primary barrier against environmental damage? • A) Hypodermis • B) Dermis • C) Epidermis (correct) • D) Basal layer [Feedback:] Correct/Incorrect. The epidermis acts as the primary barrier against environmental damage. *Audio Narration:* Answer the following questions to check your understanding of the key concepts from this module.		
Conclusion ncca_phys_03_11	*Slide Image/Text:* Great job! Learning Objective: • Explain the integumentary system and its relationship to polygraph. [Instructional text] Close this module to continue the lesson. *Audio Narration:* Great job! You should now be able to explain the integumentary system and its relationship to polygraph. Close this module to continue the lesson.	N/A	0:10
		Total Estimated Time:	10:00

MICROLEARNING #4: Anatomy of a Nerve Impulse

Module 2: Physiology
Topic 6: The Nervous System

ANATOMY OF A NERVE IMPULSE			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_04_01	*Slide Image/Text:* Welcome to the Anatomy of a Nerve Impulse *Audio Narration:* Welcome to Anatomy of a Nerve Impulse. Please choose Next to begin.	N/A	0:10
Learning Objective ncca_phys_04_02	*Slide Image/Text:* Learning Objective: • Describe the key elements of a nerve impulse. *Audio Narration:* After completing this module, you will be able to describe the key elements of a nerve impulse.	N/A	0:10
Anatomy of a Neuron ncca_phys_04_03	*Slide Image/Text:* *[Highlighting of neuron parts: cell body, axon hillock, axon, dendrites, telodendrion, in time with narration.]* Anatomy of a Neuron  *Figure 11 Anatomy of a Neuron* A neuron serves as the fundamental unit of the nervous system. Its structural components include: • **Cell body:** The metabolic center or central region of the neuron. • **Axon hillock:** A specialized part of the cell body that connects the axon to the cell body.	Sequential highlighting of neuron parts and text appears in sequence with narration.	0:30

	• **Axon:** A long process extending from the cell body capable of transmitting electrical impulses (action potentials). • **Dendrites:** Extensions from the cell body that receive information from other neurons. • **Telodendrion:** Terminal branches of dendrites connecting to dendrites or the cell body, forming the synaptic cleft. *Audio Narration:* Neurons are a basic unit of the nervous system. Let's identify some of its structural components. The cell body is the metabolic center or central region of the neuron. The axon hillock is a specialized part of the cell body, connecting the axon to the cell body. It acts as a gateway for transmitting signals. The axon is a long process extending from the cell body capable of transmitting electrical impulses, also known as action potentials. Dendrites extend out from the cell body. It is the point at which a neuron receives information from other neurons. The telodendrion are terminal branches of dendrites, which connect to other dendrites or to the cell body and form the synaptic cleft.		
Classifications of Neurons ncca_phys_04_04	*Slide Image/Text:*  *Figure 12 Structural Classification of the Neuron*	Content appears in sequence with narration.	1:00

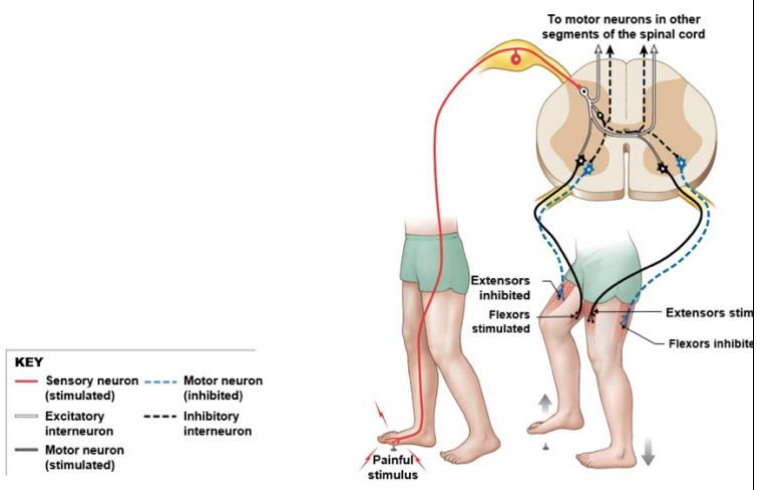


Figure 13 Pain Stimulus

Functional classification: Taking in / receiving information.

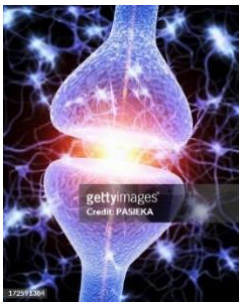
- Sensory (afferent) neurons: Transmit information from sensory receptors of the peripheral nervous system to the central nervous system (CNS).
- Motor (efferent) neurons: Carry instructions from the CNS to peripheral tissues, organs, and organ systems.
- Interneurons: Respond to stimuli and cause a reflex. Located between sensory and motor neurons in the brain and spinal cord (CNS).

Structural classification: Based on the number of processes coming from the cell body.

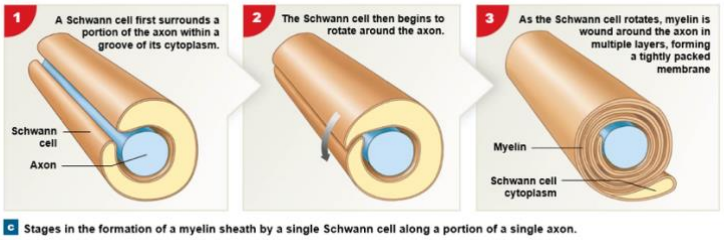
- Anaxonic neurons: Located in the brain and special sense organs.
- Bipolar neurons: Associated with special senses like sight and smell.
- Unipolar neurons: Sensory neurons in the peripheral nervous system within skin, joints, muscles, and internal organs.
- Multipolar neurons: Most common neurons in the CNS. Motor neurons controlling muscle movements.

Audio Narration:

Neurons are classified in two ways, functional and structural.

	The functional classification is for neurons taking in or receiving information. Sensory, or afferent, neurons deliver information from sensory receptors of the peripheral nervous system to the central nervous system, or CNS. Motor, or efferent, neurons carry instructions from the CNS to peripheral tissue, organs, and organ systems. Interneurons respond to stimuli and cause a reflex, such as the patellar, or knee-jerk, reflex, which causes a sudden kicking movement in response to a sharp tap on the knee. Interneurons are located between sensory and motor neurons in the brain and spinal cord of the CNS. The structural classification is based on the number of processes coming off from the cell body. Anaxonic neurons are located in the brain and special sense organs. Bipolar neurons are associated with special senses such as sight and smell. Unipolar neurons are mostly sensory neurons of the peripheral nervous system in the skin, joints, muscles, and internal organs. Multipolar neurons are the most common neurons in the CNS. These are all motor neurons controlling muscle movements.		
Anatomy of a Synapse ncca_phys_04_05	*Slide Image/Text:* Anatomy of a Synapse   **Synapse:** Gap between the neurons and the site of intercellular communication where neurons communicate from one cell to another. **Synaptic cleft:** Neurotransmitters diffuse across the cleft to receptors at the post synaptic membrane.	Content appears in sequence with narration.	0:10

	• Presynaptic Cell: The cell that sends the message. • Postsynaptic Cell: The cell that receives the message. *Audio Narration:* There is a gap between the neurons called a synapse. The synapse is a site of intercellular communication where neurons communicate from one cell to another. There are billions of synapses within the human body, facilitating this communication. The synaptic cleft is where neurotransmitters diffuse from synaptic vesicles across the cleft to receptors at the post synaptic membrane. Every synapse consists of a presynaptic cell and a postsynaptic cell. The presynaptic cell releases the neurotransmitters, sending the message, and the postsynaptic cell receives them, completing the synaptic transmission process.		
Schwann Cells ncca_phys_04_06	*Slide Image/Text:* *[Image appears with title, highlight the box when named in narration.]* • Certain axons are wrapped in myelin sheath: ○ Acts as electrical insulation. ○ Increases the speed of action potential. • Schwann cells: ○ Produce myelin ○ Support the maintenance and regeneration of axons. • Internodes: Large areas of axons wrapped in myelin. • Nodes (nodes of Ranvier): Small gaps separating adjacent internodes. ○ Allow impulses to “skip” across more quickly than passing along the axon.	Content appears in sequence with narration.	1:00

	 *Figure 14 Myelin Sheath Formation* *Audio Narration:* Certain axons are wrapped in myelin sheath, which acts as electrical insulation and increases the speed of action potential along the axon. Schwann cells produce myelin and support the maintenance and regeneration of axons of the neurons in the peripheral nervous system. Internodes are large areas of axons wrapped in myelin. Nodes, also known as nodes of Ranvier, are small gaps separating adjacent internodes. They allow impulses to "skip" across more quickly than passing along the axon.		
The All-or-None Principle ncca_phys_04_07	*Slide Image/Text:*  *Audio Narration:* The all-or-none principle dictates that a given stimulus either elicits a full-fledged action potential or none at all.	Content appears in sequence with narration.	1:00

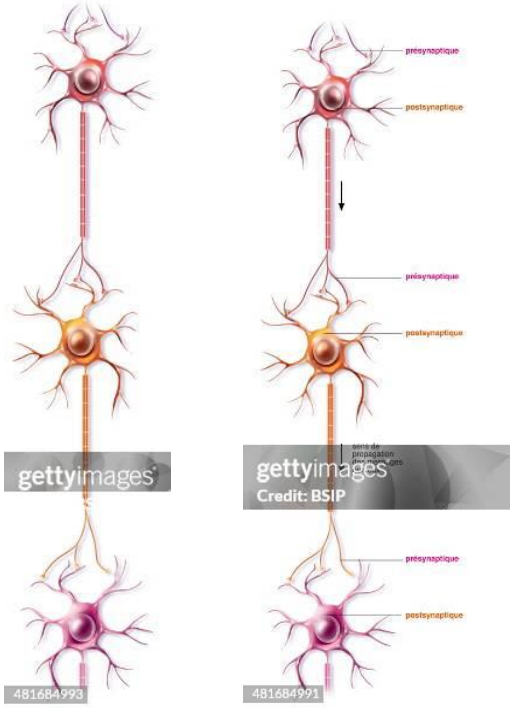
	For example, think about pressure applied to the trigger of a gun. The pressure must reach a certain threshold before the hammer will drop, causing the gun to fire. If that threshold is not reached, the hammer does not fall and there is no firing. Similarly, envision a row of dominos poised for a chain reaction. Push just enough and the cascade begins. A neuron either reaches its threshold to fire, causing the action potential to move to the next neuron, or it does not.		
Review ncca_phys_04_08a ncca_phys_04_08b ncca_phys_04_08c	*Slide Image/Text:* Knowledge Check Which structural component of a neuron is responsible for receiving information from other neurons? A) Axon hillock B) Dendrites (correct) C) Telodendrion D) Nucleus [Feedback:] Correct/Incorrect. Dendrites are the structural component responsible for receiving information from other neurons. What is the primary function of Schwann cells in the nervous system? A) Producing neurotransmitters B) Forming synapses between neurons C) Regulating action potential D) Producing myelin and supporting axon maintenance (correct) [Feedback:] Correct/Incorrect. Schwann cells produce myelin and support axon maintenance. According to the all-or-none principle, what occurs if a stimulus fails to reach the required threshold? A) The action potential is triggered. B) The action potential is not triggered. (correct) C) The stimulus is intensified. D) The action potential is reduced. [Feedback:] Correct/Incorrect. If a stimulus fails to reach the required threshold, the action potential is not triggered. *Audio Narration:* Answer the following questions to check your understanding of the key concepts from this module.	Knowledge checks with feedback pop-ups.	1:30
Conclusion	*Slide Image/Text:*	n/a	0:10

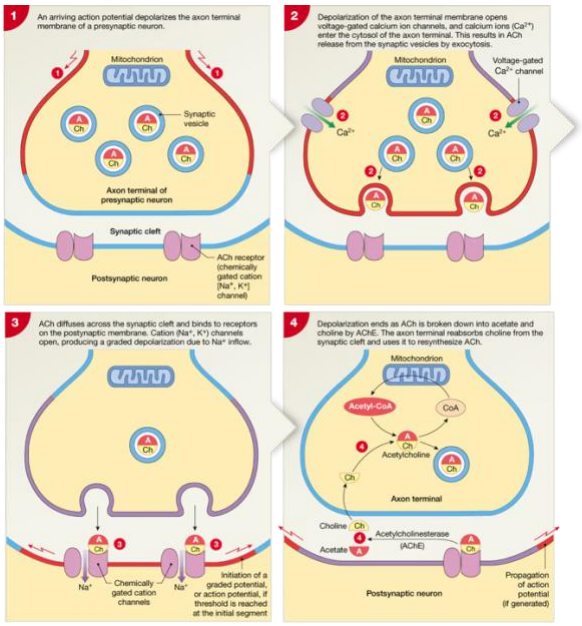
ncca_phys_04_09	Great job! Learning Objective: • Describe the key elements of a nerve impulse. [Instructional text] Close this module to continue the lesson. *Audio Narration:* Great job! You should now be able to describe the key elements of a nerve impulse. Close this module to continue the lesson.		
		Total Estimated Time:	5:30

MICROLEARNING #5: Action Potential Steps

Module 2: Physiology
Topic 6: The Nervous System

ACTION POTENTIAL STEPS			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_05_01	*Slide Image/Text:* Welcome to Action Potential Steps. *[Screen Open: Anatomical man with highlighted nervous system image and slide header]*  *Audio Narration:* Welcome to the Action Potential Steps microlearning. Please choose Next to begin.	n/a	0:10
Learning Objective ncca_phys_05_02	*Slide Image/Text:* Learning Objective: • Describe the four key steps of an action potential. *Audio Narration:* At the conclusion of this module, you will be able to describe the four key steps of an action potential.	n/a	0:10

Neurotransmitters Overview ncca_phys_05_03	*Slide Image/Text:* Neurotransmitters Overview *[Open with slide header and synapse image without labels.* *Display synapse image with labels highlighted when narration plays "Every synapse has a presynaptic cell…"]*  *Audio Narration:* Neurotransmitters are chemical messengers that transmit signals from a nerve cell to target cells. They are released at the synapse. The synapse is a site of intercellular communication where neurons communicate from one cell to another. Every synapse has a presynaptic cell, which sends the message, and a postsynaptic cell, which receives the message. The most widespread neurotransmitter is acetylcholine. Neurotransmitters are used by the brain to help regulate functions such as breathing, digestion, and heartbeat, among others.	Content appears in sequence with narration.	0:30
Steps of An Acton Potential at	*Slide Image/Text:* Steps of an Acton Potential at a Cholinergic Synapse	Content appears in sequence	1:00

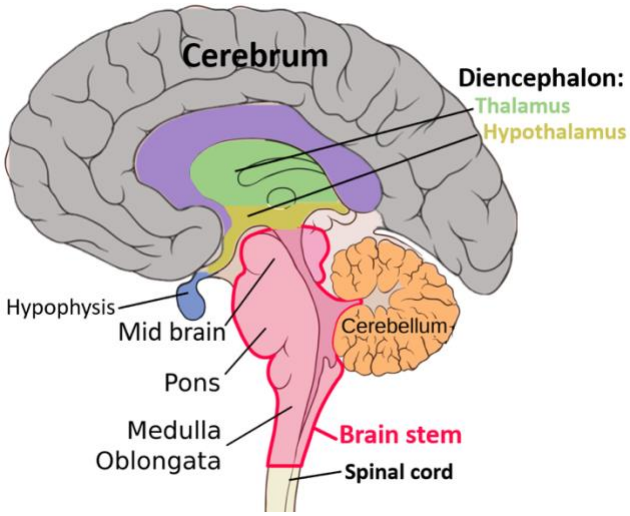
a Cholinergic Synapse ncca_phys_05_04	[*Open with Step 1 image and slide header.* • *Display Step 2 image when narration plays "In step one, an arriving action…"* • *Display Step 3 when narration plays" In step two, calcium ions… "* • *Display Step 4 when narration plays "In step four, depolarization…"]*  *Audio Narration:* Let's break down the action potential process at a cholinergic synapse. In step one, an arriving action potential depolarizes the axon terminal membrane of a presynaptic neuron. In step two, calcium ions enter the cytosol of the axon terminal. This results in acetylcholine release from the synaptic vesicles by exocytosis. The positive calcium charge causes acetylcholine to move out. In step three, acetylcholine diffuses across the synaptic cleft and binds to receptors on the postsynaptic membrane. Sodium channels open, producing a graded depolarization. In step four, depolarization ends as acetylcholine is broken down into acetate and choline by acetylcholinesterase. The axon terminal membrane reabsorbs choline from the synaptic cleft and uses it to resynthesize acetylcholine.	with narration.	

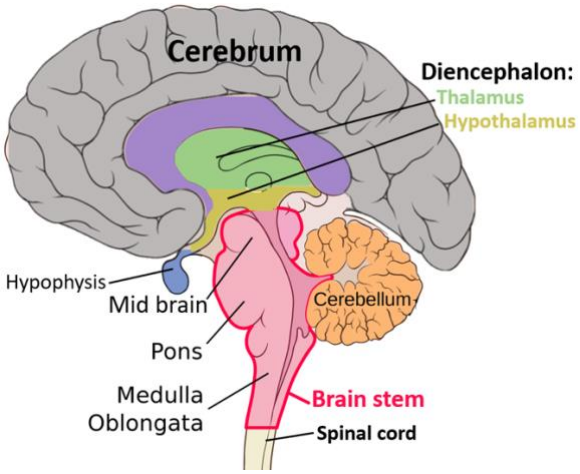
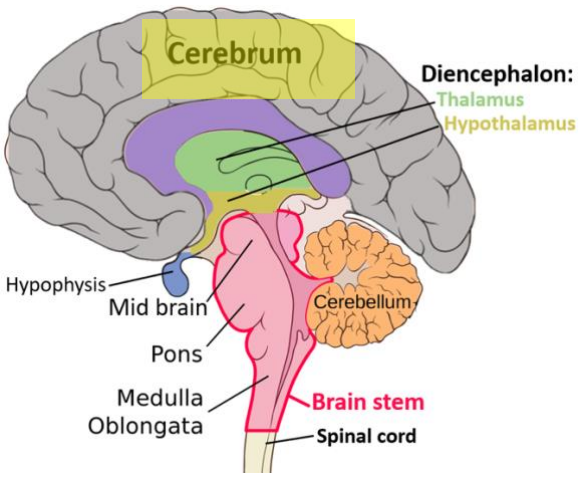
Review ncca_phys_05_05a ncca_phys_05_05b ncca_phys_05_05c	Slide Image/Text: *[Dropdown options: 1, 2, 3, 4]* Knowledge Check Question 1: Select the correct step number for neurotransmitter action at the synapse from the dropdown options. a) Acetylcholine diffuses across the synaptic cleft and binds to receptors on the postsynaptic membrane. (correct: 3) b) An arriving action potential depolarizes the axon terminal membrane of a presynaptic neuron. (correct: 1) c) Depolarization ends as acetylcholine is broken down into acetate and choline by acetylcholinesterase. (correct: 4) d) Calcium ions enter the cytosol of the axon terminal membrane, resulting in acetylcholine release from the synaptic vesicles by exocytosis. (correct: 2) [Feedback:] Correct/Incorrect. First, an arriving action potential depolarizes the axon terminal membrane of a presynaptic neuron. Second, calcium ions enter the cytosol of the axon terminal, resulting in acetylcholine release from the synaptic vesicles by exocytosis. Third, acetylcholine then diffuses across the synaptic cleft and binds to receptors on the postsynaptic membrane. Finally, depolarization ends as acetylcholine is broken down into acetate and choline by acetylcholinesterase. Question 2: What is the role of acetylcholinesterase in the neurotransmission process? a) It synthesizes acetylcholine from acetate and choline. b) It depolarizes the presynaptic neuron. c) It breaks down acetylcholine into acetate and choline. (correct) d) It binds acetylcholine to receptors on the postsynaptic membrane. [Feedback:] Correct/Incorrect: Acetylcholinesterase breaks down acetylcholine into acetate and choline. Question 3: What role do neurotransmitters play?	Knowledge Check with feedback pop-up.	1:00

	a) They are responsible for transporting oxygen in the bloodstream. b) They are chemical messengers. (correct) c) They are the primary components of muscle fibers. d) They store genetic information within the nucleus of cells. [Feedback:] Correct/Incorrect: They are chemical messengers. *Audio Narration:* Answer the following questions to check your understanding of an action potential.		
Conclusion ncca_phys_05_06	*Slide Image/Text:* Great job! Learning Objective: • Describe the four key steps of an action potential. [Instructional text] Close this module to continue the lesson. *Audio Narration:* Great job! You should now be able to describe the four key steps of an action potential. Close this module to continue the lesson.	n/a	0:10
		Total time	**3:00**

MICROLEARNING #6: Major Regions of the Brain

Module 2: Physiology
Topic 7: The Brain and its Impact on PDD

MAJOR REGIONS OF THE BRAIN			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_06_01	*Slide Image/Text:* Welcome to the Major Regions of the Brain *[Screen Open: Slide header with labeled brain image]*  *Figure 1: Regions of the Brain* *Audio Narration:* Welcome to the Major Regions of the Brain microlearning. Please choose Next to begin.	n/a	0:10
Learning Objective ncca_phys_06_02	*Slide Image/Text:* Learning Objective: • Identify the six major regions of the brain. *Audio Narration:* By the end of this module, you will be able to identify the six major regions of the brain.	n/a	0:10
Six Major Regions ncca_phys_06_03	*Slide Image/Text:* Six Major Regions *[Open with brain image (Figure 2) and slide header*	Content appears in sequence with narration.	1:30

	• *Display brain (Figure 3) with cerebrum highlighted when narration plays "The cerebrum, the largest section of the brain…"* • *Display right hemisphere (Figure 4) image and Right hemisphere stem, bullets. when narration plays "The right hemisphere… "* • *Display left hemisphere (Figure 5) image and Left hemisphere stem, bullets when narration plays "The left hemisphere…"* • *Display both hemispheres (Figure 6) and Both hemispheres text when narration plays "Both hemispheres are connected …"]*  *Figure 2 Cerebrum*  *Figure 3 Cerebrum* Right hemisphere: • Controls the left side of the body.		

- Analyzes sensory information and relates the body to sensory information.
- Involved in spatial visualization.
- Analyzes speed, distance, art, music, and “non-language” activity.
- Recognizes faces.
- Analyzes emotional context of conversations.
- Helps us to identify objects through the senses: touch, taste, smell, sight, and feel.

Left hemisphere:

- Controls the right side of the body.
- General interpretive and speech centers.
- Responsible for language-based skills (reading, writing, and speaking).
- Performs analytical tasks, math calculations, and logical decision-making.

Both hemispheres of the cerebrum are connected by the corpus callosum.

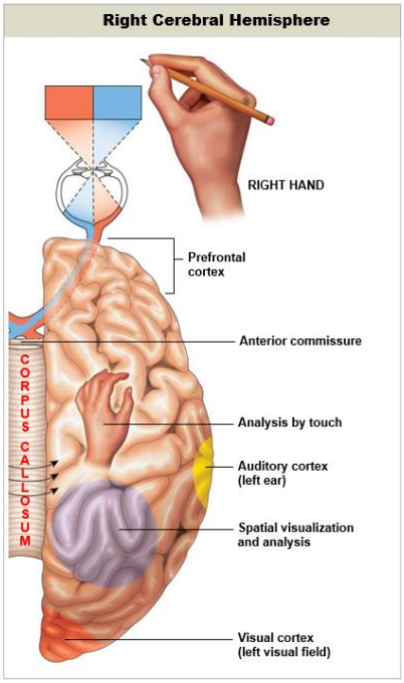


Figure 4 Right Hemisphere

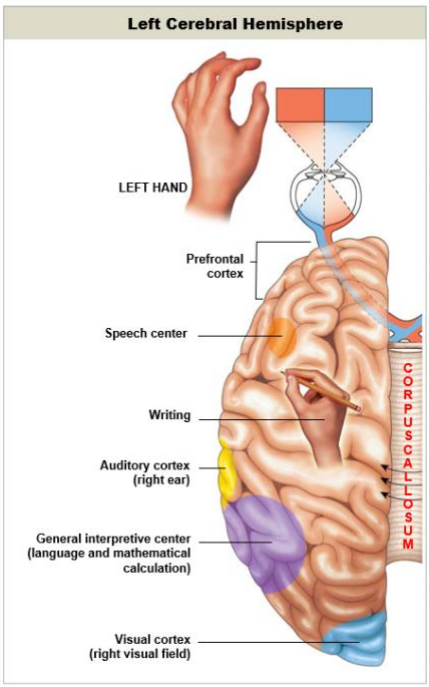


Figure 5 Left Hemisphere

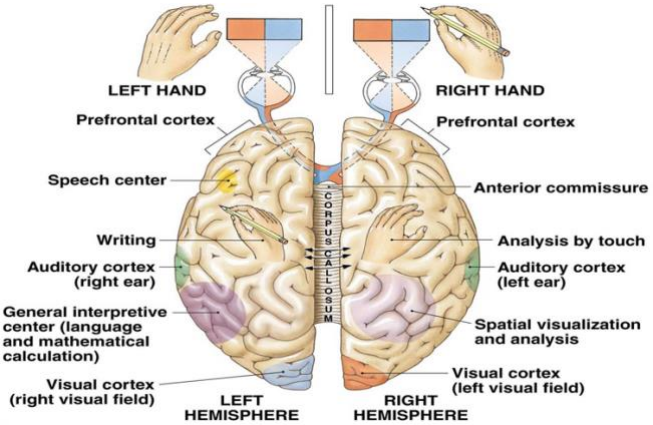
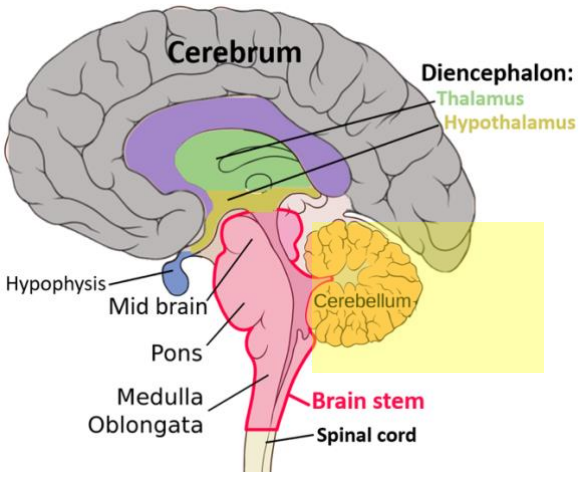


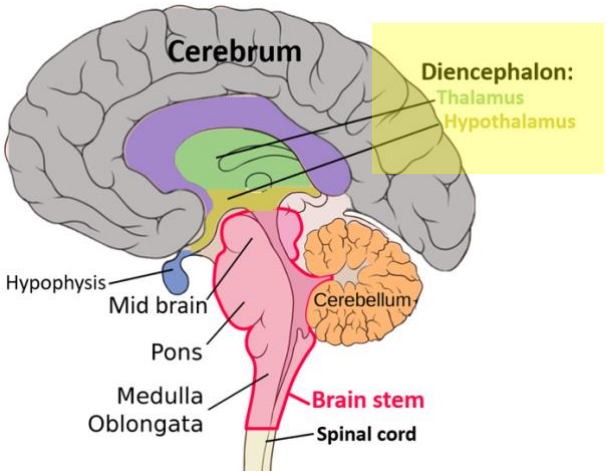
Figure 6 Right and Left Hemisphere

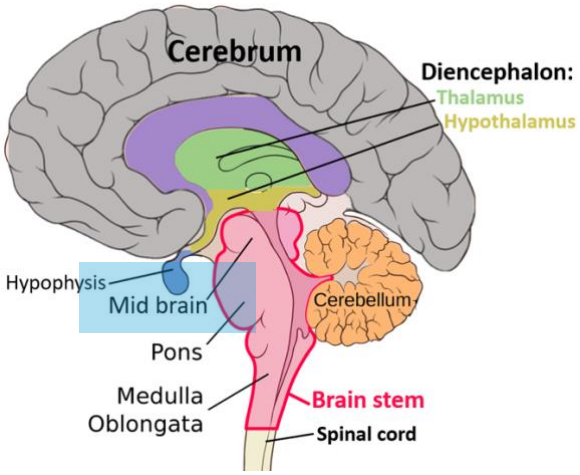
Audio Narration

The six major regions of the brain are the cerebrum, cerebellum, diencephalon, midbrain, pons, and medulla oblongata.

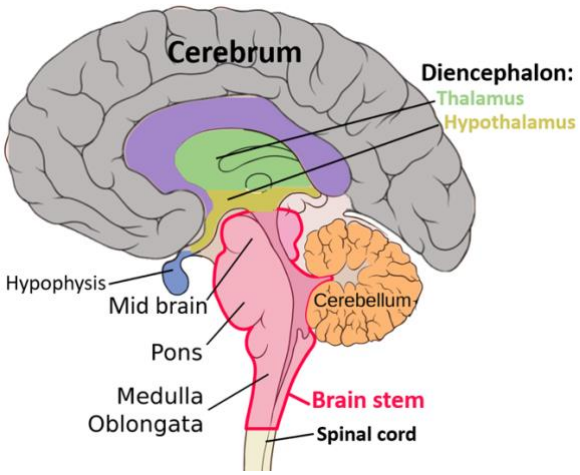
The cerebrum is the largest portion of the brain. It consists of left and right hemispheres, which are anatomically the same but functionally different.

	The right hemisphere of the brain controls the left side of the body. It analyzes sensory information and relates the body to sensory information. The right hemisphere is involved in spatial visualization and analyzes speed, distance, art, music, and “non-language” activity. It helps in recognizing faces and analyzing the emotional context of conversations. It also allows us to identify objects through the senses: touch, taste, smell, sight, and feel. The left hemisphere generally controls the right side of the body. It consists of general interpretive and speech centers, and is responsible for language-based skills, such as reading, writing, and speaking. It also performs analytical tasks, math calculations, and logical decision-making. Both hemispheres of the cerebrum are connected by the corpus callosum, a bundle of nerve fibers that bridges the two hemispheres sending information back and forth.		
Cerebellum and Diencephalon ncca_phys_06_04	*Slide Image/Text:* Cerebellum and Diencephalon *[Slide open with brain image with cerebellum highlighted. Display cerebellum stem and bullets in time with narration.* *Display brain with diencephalon highlighted and diencephalon stem and bullets when narration plays “The diencephalon…”]*  Cerebellum:	Content appears in sequence with narration.	1:30

	• Compares arriving sensations with previously experienced sensations. • Regulates motor coordination (muscular activity) and voluntary movements: ○ Posture, coordination, balance, and speech.  Diencephalon contains: • The right and left thalamus: ○ The body's relay station, or process center, for sensory information. ○ Directs sensory impulses to the cerebrum. • The hypothalamus: Contains important control and integrative functions regarding motions, autonomic functions, and hormone production. • The pituitary gland, part of the endocrine system: Regulates growth, blood pressure, and reproduction. *Audio Narration:* The cerebellum is the second largest part of the brain. Although it is only 10% of its total weight, it contains half of the brain's neurons. It is located in the back of the head, below the cerebrum.		

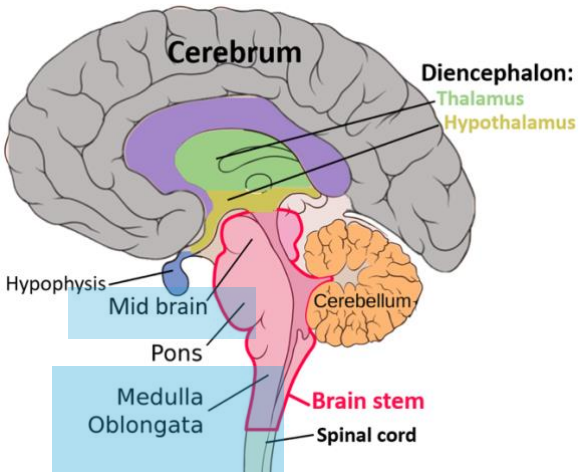
	The cerebellum compares arriving sensory information with previously experienced sensations. It regulates motor coordination and voluntary movements such as posture, coordination, balance, and speech, leading to smooth and balanced muscular activity. The diencephalon is the structural and functional link between the cerebral hemispheres and the brain stem. It contains the right and left thalamus, which is the body's main relay station or process center for sensory information. It directs sensory impulses to the cerebrum. The diencephalon also contains the hypothalamus. The hypothalamus contains important control and integrative functions regarding motions, autonomic functions, and hormone production. The pituitary gland, a part of the endocrine system, is also located in the diencephalon. The pituitary gland regulates growth, blood pressure, and reproduction.		
Brain Stem: Midbrain, Pons, and Medulla Oblongata ncca_phys_06_05	*Slide Image/Text:* Brain Stem: Midbrain, Pons, and Medulla Oblongata *[Open with midbrain highlighted image and Midbrain text with narration.* *Display brain with pons highlighted and Pons text when narration plays "The pons…"* *Display brain with medulla oblongata highlighted and Medulla text when narration plays "The medulla oblongata…"]*  	Content appears in sequence with narration.	2:00

Midbrain: Processes visual and auditory data.



Pons: Bridges the upper and lower parts of the brain.

- Relays sensory information to the cerebellum and thalamus.
- Associated with the subconscious somatic and visceral motor centers.
- Controls reflex actions such as chewing, tasting, and saliva production.



Medulla oblongata, “reptilian brain”: Connects the brain to the spinal cord.

- Contains major centers regulating autonomic functions, including heart rate, blood pressure, digestion, respiration, and reflexes such as swallowing, coughing. ad sneezing.

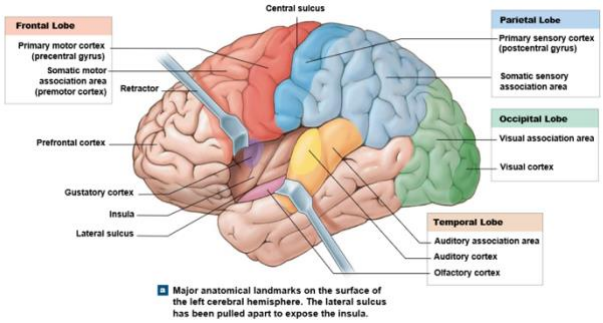
	• Relays sensory information to the thalamus and centers in other brain stem portions. *Audio Narration* The next three regions of the brain, the midbrain, pons, and medulla oblongata, are in the brain stem. The midbrain, located below the cerebrum and on top of the brainstem, is a major connection point. It processes both visual and auditory information, such as loud, unexpected noises. The pons is below the midbrain and above the medulla oblongata. It is just 2.5 cm in length. The pons is like a bridge, connecting the upper and lower sections of the brain. It relays sensory information to the cerebellum and thalamus. The pons is associated with the subconscious somatic and visceral motor centers. It controls reflex actions such as chewing, tasting, and saliva production. The medulla oblongata connects the brain and the spinal cord and is located further down. It is sometimes called the “reptilian brain”. It maintains life support activities, such as breathing and heartbeat, even if one falls into a vegetative state. If someone is in a coma, their heartbeat and breathing continue because of the medulla oblongata. The medulla oblongata contains major centers regulating autonomic functions, such as heart rate, blood pressure, digestion, respiration, and reflex activities such as swallowing, coughing, and sneezing. It is responsible for transmitting sensory information to the thalamus and other parts of the brain stem.		
Review ncca_phys_06_06a ncca_phys_06_06b ncca_phys_06_06c	*Slide Image/Text:* Knowledge Check Question 1: Which part of the brain acts as a bridge connecting the upper and lower parts, and relays sensory information to the cerebellum and thalamus? a) Cerebrum b) Cerebellum c) Pons (correct) d) Medulla oblongata	Knowledge Checks with feedback pop-up.	1:00

	[Feedback:] Correct/Incorrect. The pons acts as a bridge connecting the upper and lower parts and relays sensory information to the cerebellum and thalamus. Question 2: What is the role of the corpus callosum in the cerebrum? a) It processes visual and auditory data. b) It connects the left and right hemispheres and facilitates communication between them. (correct) c) It regulates growth, blood pressure, and reproduction. d) It coordinates voluntary movements such as posture and balance. [Feedback:] Correct/Incorrect. The corpus callosum connects the left and right hemispheres and facilitates communication between them. Question 3: Which brain structure is described as the body's relay station for sensory information and helps direct sensory impulses to the cerebrum? a) Hypothalamus b) Pituitary gland c) Thalamus (correct) d) Pons [Feedback:] Correct/Incorrect. The thalamus acts as a central relay station for sensory information in the body, directing these impulses to the appropriate areas of the cerebrum for further processing. *Audio Narration:* Answer the following questions to check your understanding of the six major regions of the brain.		
Conclusion ncca_phys_06_07	*Slide Image/Text:* Great job! Learning Objective: • Identify the six major regions of the brain. [Instructional text] Close this module to continue the lesson. *Audio Narration:*	N/A	0:10

	Great job! You should now be able to identify the six major regions of the brain. Close this module to continue the lesson.		
		Total time	**6:30**

MICROLEARNING #7: Four Lobes of the Brain

Module 2: Physiology
Topic 7: The Brain and its Impact on PDD

FOUR LOBES OF THE BRAIN			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_07_01	*Slide Image/Text:* Welcome to the Four Lobes of the Brain *[Screen Open: Slide header with labeled brain image]*  *Figure 7: Four Lobes of the Brain* *Audio Narration:* Welcome to the Four Lobes of the Brain microlearning. Please choose Next to begin.	n/a	0:10
Learning Objective ncca_phys_07_02	*Slide Image/Text:* Learning Objective: • Identify the four lobes of the brain. *Audio Narration:* By the conclusion of this module, you will be able to identify the four lobes of the brain.	n/a	0:10
Four Lobes ncca_phys_07_03	*Slide Image/Text* Four Lobes of the Brain *[Open with Figure 7 and slide header* • *Display Figure 8 and Frontal lobe text box when narration plays "The frontal lobe, situated in…"* • *Display Figure 9 and Parietal lobe text box when narration plays "The parietal lobe is located… "*	Content appears in sequence with narration.	0:45

- *Display Figure 10 and occipital lobe text box when narration plays "The occipital lobe is located…"*
- *Display Figure 11 and temporal lobe text box when narration plays "Finally, the temporal lobe, found on the …"]*

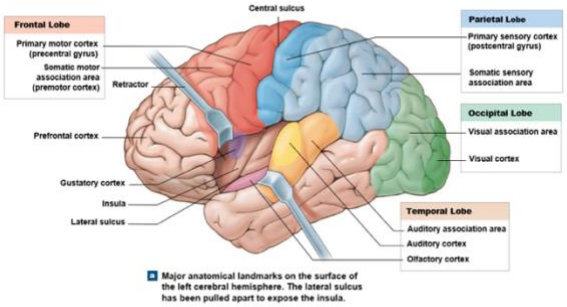


Figure 7 Four Lobes

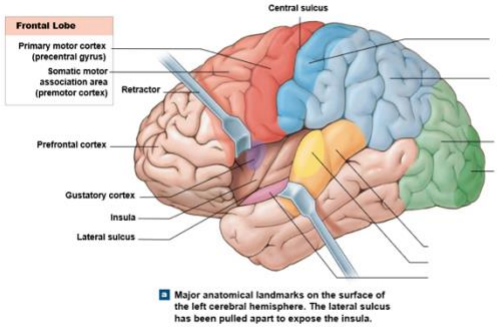


Figure 8 Four Lobes - Frontal Lobe

Frontal Lobe

- Location: Front of the brain.
- Functions:
  - Reasoning.
  - Motor skills.
  - Higher level cognition.
  - Expressive language.

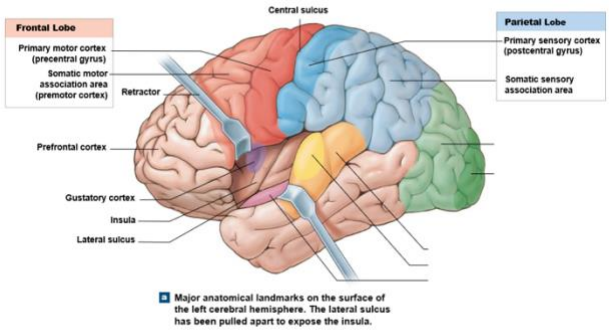


Figure 9 Four Lobes - Parietal Lobe

Parietal Lobe

- Location: Middle of the brain.
- Functions:
    - Processes tactile sensory information including pressure, touch, and pain.

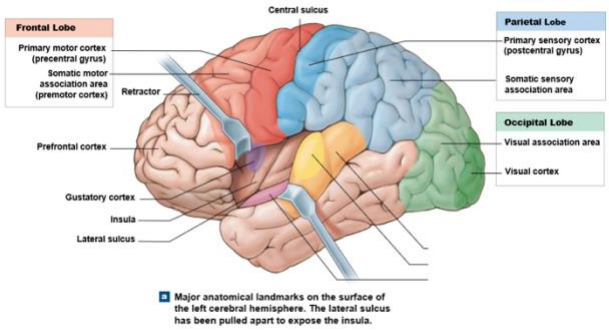


Figure 10 Four Lobes - Occipital Lobe

Occipital Lobe

- Location: Back portion of the brain.
- Functions:
    - Interpreting visual stimuli and information.

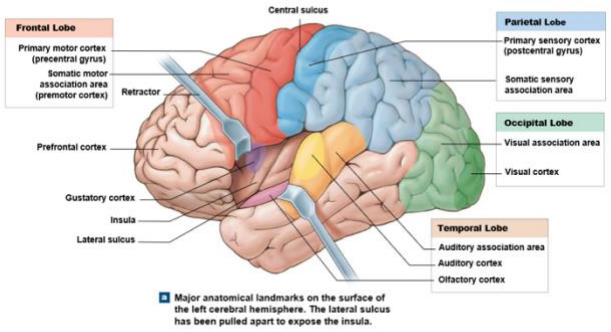


Figure 11 Four Lobes - Temporal Lobe

Temporal Lobe

- Location: Bottom section of the brain.
- Functions:
    - Houses the primary auditory cortex, which interprets sounds and language that we hear.
    - Plays a role in the olfactory (smell) system.
    - Contains the hippocampus, associated with the formation of memories.
    - Contains the amygdala involved in emotional response commonly referred to as the fight, flight, or freeze (F3) response.

Audio Narration:

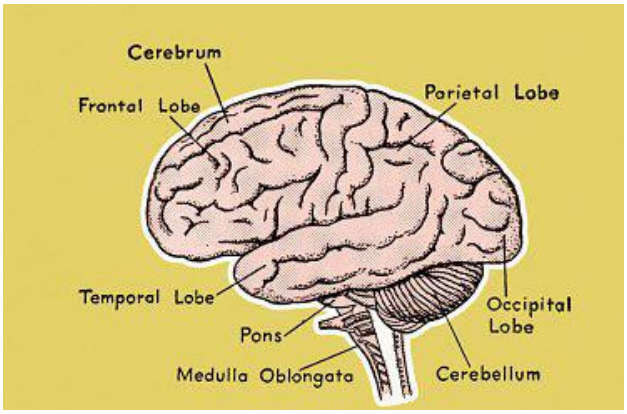
Let's explore each of the four lobes and their functions.

The frontal lobe is located in front of the brain. It is associated with reasoning, motor skills, higher level cognition, and expressive language.

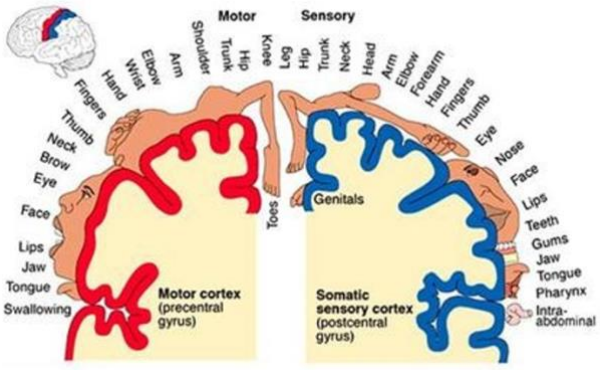
The parietal lobe is located in the middle of the brain. It processes tactile sensory information such as pressure, touch, and pain.

The occipital lobe is located at the back portion of the brain. Its primary function is to interpret visual stimuli and information.

Finally, the temporal lobe is located on the bottom section of the brain. This is the location of the primary auditory cortex, which interprets sounds and language that we hear. The temporal lobe also plays a role in the olfactory system. The hippocampus is located in the temporal lobe.

	The hippocampus is associated with the formation of memories. The amygdala, which is involved in the fight, flight, or freeze, or F3 response, is also located in the temporal lobe.		
Case of Phineas Gage ncca_phys_07_04	*Slide Image/Text:* Understanding the Frontal Lobe with Phineas Gage *[Screen open with image and slide header* • *Display mustard-color brain image first* • *Display injury image when narration plays "He was using a tamping iron to pack explosive"* • *Display Phineas Gage Portrait when narration plays "While his personality changed him…"]*  	Content appears in sequence with narration.	1:15

	 *Audio/Narration:* The case of Phineas Gage demonstrates that damage to the frontal lobe may alter personality, emotions, and social interaction. In 1848, 25-year-old Gage was the foreman of a crew cutting a railroad bed in Cavendish, Vermont. He was using a tamping iron to pack explosive powder into a hole and the power detonated. The rod went through his left cheek, through his brain and out his skull landing several dozen feet away. He was blinded in his left eye but was conscious. His personality changed, most likely due to frontal lobe damage. He became rude, odd, irritable, and unpredictable. He was described as “no longer Gage”, losing balance between intellectual faculties and animal propensities. He could not stick to plans, uttered vulgar profanities, and showed little deference to his fellow coworkers. Towards the end of his life, he recovered		

	somewhat and became a little more like himself. He died at age 36 after a series of seizures.		
Homunculus ncca_phys_07_05	*Slide Image/Text:* *[Screen open with Figure 13 and slide header* • *Display Figure 14 when narration plays "The motor homunculus maps…"* • *Display Figure 15 when narration plays "Similarly, the sensory homunculus…"* • *Display Figure 16 when narration plays "In this representation, parts of the body …"]* Homunculus • The motor and sensory homunculus are two areas that demonstrate neurological connections associating the brain, nerves, and spinal cord. • It shows the areas of the brain and the parts they control. • The "size" of features provides some perspective on the extent of "brain involvement" with specific parts of the body. • The motor homunculus is an imaginary map of neurological connections based on motor processing. • The sensory homunculus is the imaginary map of neurological connections based on sensory processing.  *Figure 1315 Homunculus*	Content appears in sequence with narration.	1:30

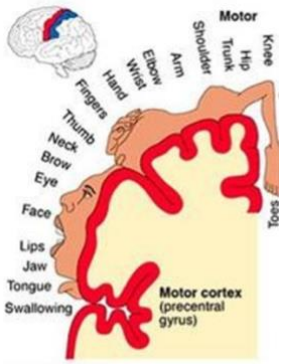


Figure 14 Homunculus- Motor

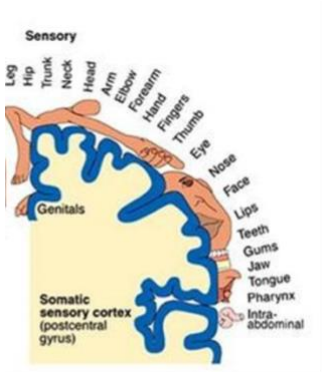


Figure 15 Homunculus – Sensory

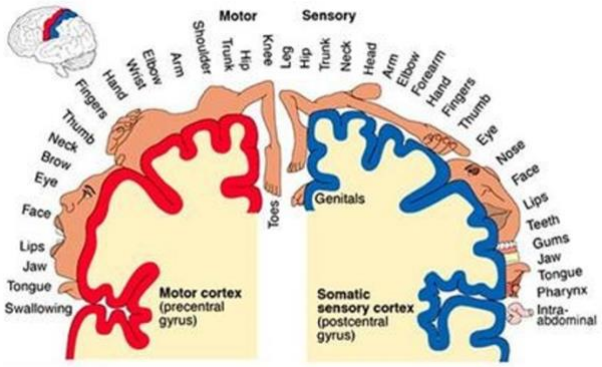


Figure 16 Homunculus

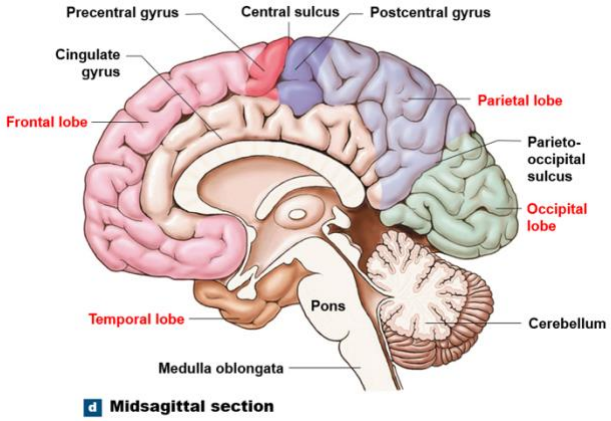
Audio Narration:

The motor and sensory homunculi are visual representations that show the connections between the brain, nerves, and spinal cord. The motor homunculus maps out the areas of the brain responsible for motor functions, indicating which parts of the brain control different body movements.

Similarly, the sensory homunculus maps the areas involved in sensory processing, showing which brain regions correspond to sensation in different parts of the body.

In this representation of the homunculus, parts of the body that require more brain power for movement or sensation appear larger.

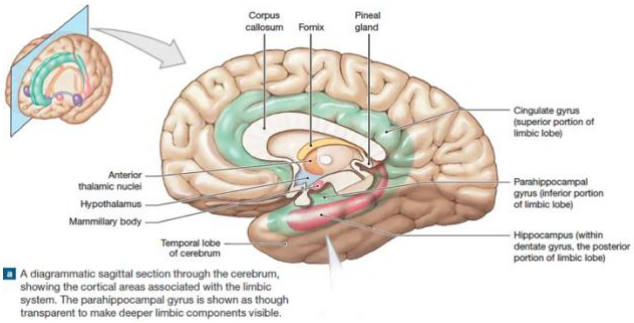
For example, the hands and face, which require fine motor skills and have a high density of sensory receptors, are depicted as disproportionately large compared to less sensitive parts of the body. Thus, the "size" of each body

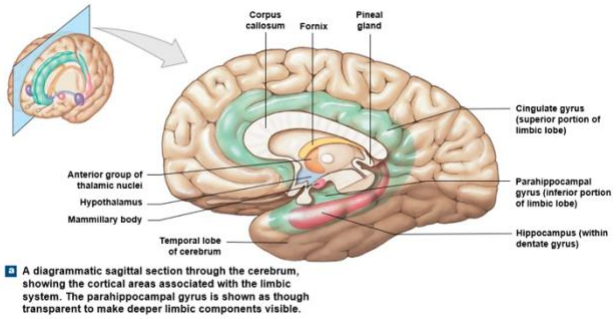
	part in the homunculus highlights the extent of brain involvement or emphasis that particular regions receive in processing sensory or motor functions.		
Key Functions and Features ncca_phys_07_06	*Slide Image/Text:* Key Functions and Features *[Open with slide header and Figure 17. Highlight each lobe in the image when the corresponding narration plays.]*  *Figure 17 Midsagittal Section* *Audio Narration:* The frontal lobe is recognized as the intellectual and thinking region of the brain. The parietal lobe is associated with sensory functions. The occipital lobe is dedicated mostly to vision. The temporal lobe focuses on auditory processing.	Content appears in sequence with narration.	0:15
Review ncca_phys_07_07a ncca_phys_07_07b ncca_phys_07_07c	*Slide Image/Text:* Knowledge Check 1. Which lobe of the brain is primarily responsible for processing visual information? a) Frontal lobe b) Parietal lobe c) Temporal lobe d) Occipital lobe (correct) [Feedback:] Correct/Incorrect: The occipital lobe is primarily responsible for processing visual information. 2. Which lobe of the brain is associated with auditory processing and memory? a) Frontal lobe	Knowledge Checks with feedback pop-up.	1:00

	b) Parietal lobe c) Temporal lobe (correct) d) Occipital lobe Feedback:] Correct/Incorrect: The temporal lobe is associated with auditory processing and memory. 3. Which lobe is involved in higher cognitive functions such as thinking, planning, and decision-making? a) Frontal lobe (correct) b) Parietal lobe c) Temporal lobe d) Occipital lobe Feedback:] Correct/Incorrect: The frontal lobe is involved in higher cognitive functions such as thinking, planning, and decision-making. *Audio Narration:* Answer the following questions to check your understanding of the lobes of the brain.		
Conclusion ncca_phys_ 07_08	*Slide Image/Text:* Great job! Learning Objective: • Identify the four lobes of the brain. *[Instructional text]* Close this module to continue the lesson. *Audio Narration:* Great job! You should now be able to identify the four lobes of the brain. Close this module to continue the lesson.	N/A	0:10
		Total time	**5:15**

MICROLEARNING #8: The Limbic System

Module 2: Physiology
Topic 8: The Brain and Cranial Nerves

THE LIMBIC SYSTEM			
Slide Title	**Screen/Audio Narration**	**Animation**	**Time (min)**
Welcome ncca_phys_08_01	*Slide Image/Text:* Welcome to The Limbic System [*Screen Open: Slide header with labeled limbic system image]*  *Figure 18 Limbic Sagittal Section* *Audio Narration:* Welcome to the Limbic System microlearning. Please choose Next to begin.	n/a	0:10
Learning Objectives ncca_phys_08_02	*Slide Image/Text:* Learning Objective: • Describe the limbic system and its importance to polygraph. *Audio Narration:* By the end of this module, you will be able to describe the limbic system and its importance to polygraph.	n/a	0:10
Overview of the Limbic System	*Slide Image/Text:* Limbic System Overview *[Open on slide header and Figure 19]*	Content appears in sequence with narration.	0:15

ncca_phys_08_03	 *Figure 19 The Limbic System* *Audio Narration:* The limbic system, also known as the motivational system, establishes emotional states such as fear, anger, and love. It is involved with behavioral drives such as hunger and sex. Additionally, this system facilitates memory storage and retrieval.		
Main Structures of the Limbic System ncca_phys_08_04	*Slide Text/Image:* *[Open slide header with Figure 20]* The primary structures of the limbic system include: **Amygdala:** The emotional center of the brain. • It is where the fight, flight, or freeze (F3) response is triggered. **Hippocampus:** Associated with memory, particularly long-term memory. • Injury to the hippocampus may cause loss of new memories while retaining old memories. **Thalamus:** Functions as a sensory relay system. • All information from the senses (except smell) are processed and directed to the proper cortex.	Limbic system illustration with highlights on primary structures as spoken in narration. Content appears in sequence with narration.	1:30

Hypothalamus: Regulates the autonomic nervous system (ANS) which involves F3 and rest and digest.

- It does this by controlling the endocrine system, which triggers the release of hormones into the bloodstream.

Basal ganglia: Nuclei that control motor nerves.

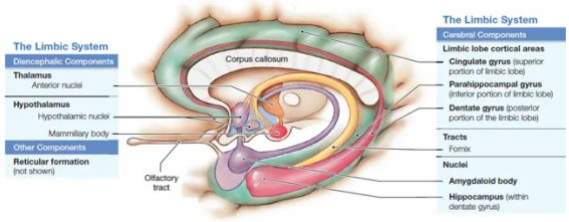


Figure 2016 Limbic System

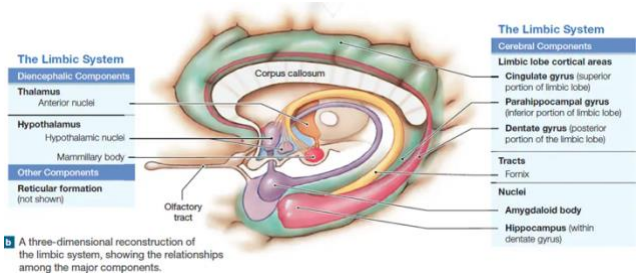
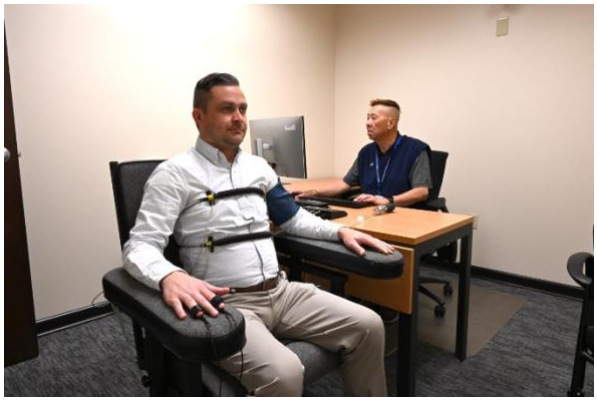
Audio Narration:

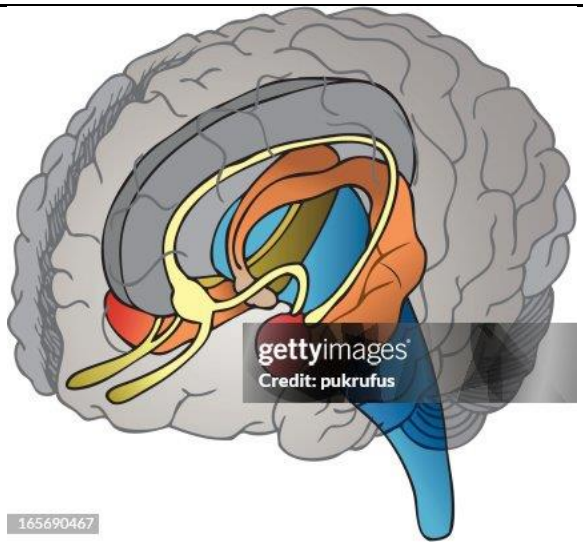
The amygdala serves as the emotional center of the brain. It is the reason we respond significantly to a fight, flight, or freeze, or F3 response. It's where F3 is triggered in the brain.

The hippocampus is associated with memory, particularly long-term memory. Memories can evoke emotions. Injury to the hippocampus may cause loss of new memories while retaining old memories.

The thalamus functions as a sensory relay system. All information from your body's senses, see, hear, taste, touch – except for the sense of smell, are processed through the thalamus which directs the information to the appropriate cortex.

The hypothalamus, although tiny, representing less than 1% of the brain's volume, plays a key role in many functions. Regarding emotion, it regulates the autonomic nervous system, or ANS, which involves F3 and rest and digest responses. It accomplishes this by managing the endocrine system and triggering the release of hormones into the bloodstream.

	Lastly, the basal ganglia are nuclei which control motor nerves.		
Importance to PDD ncca_phys_08_05	*Slide Image/Text:* *[Screen Open: Slide header with Figure 20* • *Display limbic system image when narration plays "The limbic system plays a crucial role in Psychophysiological Detection of Deception (PDD) …"* • *Display polygraph examinee image when narration plays "During PDD, examinees must…"* • *Display colorful brain when narration plays "Thus, the limbic system's ability to…"]* Importance to Psychophysiological Detection of Deception (PDD)  b A three-dimensional reconstruction of the limbic system, showing the relationships among the major components. *Figure 21 Limbic System 3D* 	Content appears in sequence with narration.	0:45

	 *Audio Narration:* Let's take a look at why the limbic system is important in Psychophysiological Detection of Deception, or PDD. In PDD, the examinee's limbic system goes into memory retrieval when discussing case facts or scoping counterintelligence, or CI, issues. This is important in PDD because the examinee needs to *recall* what happened, in order to respond, which causes the threat or fear for the examinee. The greatest concern for the examinee is whatever poses the greatest threat. Thus, the limbic system's ability to manage both the retrieval of critical memories and associated emotional responses is essential for the effectiveness of PDD.		
Review ncca_phys_08_06a ncca_phys_08_06b	*Slide Image/Text:* Knowledge Check Question: Select the correct limbic system structure from the dropdown for each primary function. *[dropdown options:]* a) Amygdala b) Hippocampus c) Thalamus d) Hypothalamus	Knowledge Checks with feedback pop-up.	1:00

	e) Basal ganglia Functions: 1. Controls motor nerves 2. Regulates the autonomic nervous system and hormonal release 3. Emotional center triggering the fight, flight, or freeze response 4. Associated with memory, particularly long-term memory 5. Sensory relay system excluding the sense of smell Answers: a) Amygdala – (correct: 3) b) Hippocampus – (correct: 4) c) Thalamus – (correct: 5) d) Hypothalamus – (correct: 2) e) Basal ganglia – (correct: 1) [Feedback:] Correct/Incorrect: The amygdala triggers essential emotional responses like fight, flight, or freeze, while the hippocampus is vital for forming and retrieving long-term memories. The thalamus serves as a sensory relay center, processing all sensory inputs except smell. The hypothalamus regulates autonomic functions and hormone secretion, and the basal ganglia controls motor nerves. 2. Why is the hippocampus important in PDD? A. It controls the fight, flight, or freeze response. B. It is involved in sensory processing which is crucial during a polygraph. C. It is associated with long-term memory, important for retrieving case facts. (correct) D. It regulates hormonal balances which affect stress levels during a polygraph. [Feedback:] Correct/Incorrect: It is associated with long-term memory, important for retrieving case facts.		

	Audio Narration: Answer the following questions to check your understanding of the importance of PDD and the limbic system.		
Conclusion ncca_phys _08_07	*Slide Image/Text:* Great job! Learning Objective: • Describe the limbic system and its importance to polygraph. *[Instructional text]* Close this module to continue the lesson. *Audio Narration:* Great job! You should now be able to describe the limbic system and its importance to polygraph. Close this module to continue the lesson.	n/a	0:10
		Total time:	**4:00**