



STRESS AND THE NERVOUS SYSTEM


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Discussion Topics

1. The Nervous System
2. Stress and the Endocrine System
3. Traumatic Stress and the Brain
4. Posttraumatic Growth

THE NERVOUS SYSTEM

THE NERVOUS SYSTEM



The Nervous System

- The human nervous system is divided into the central nervous system (CNS) and the peripheral nervous system (PNS)

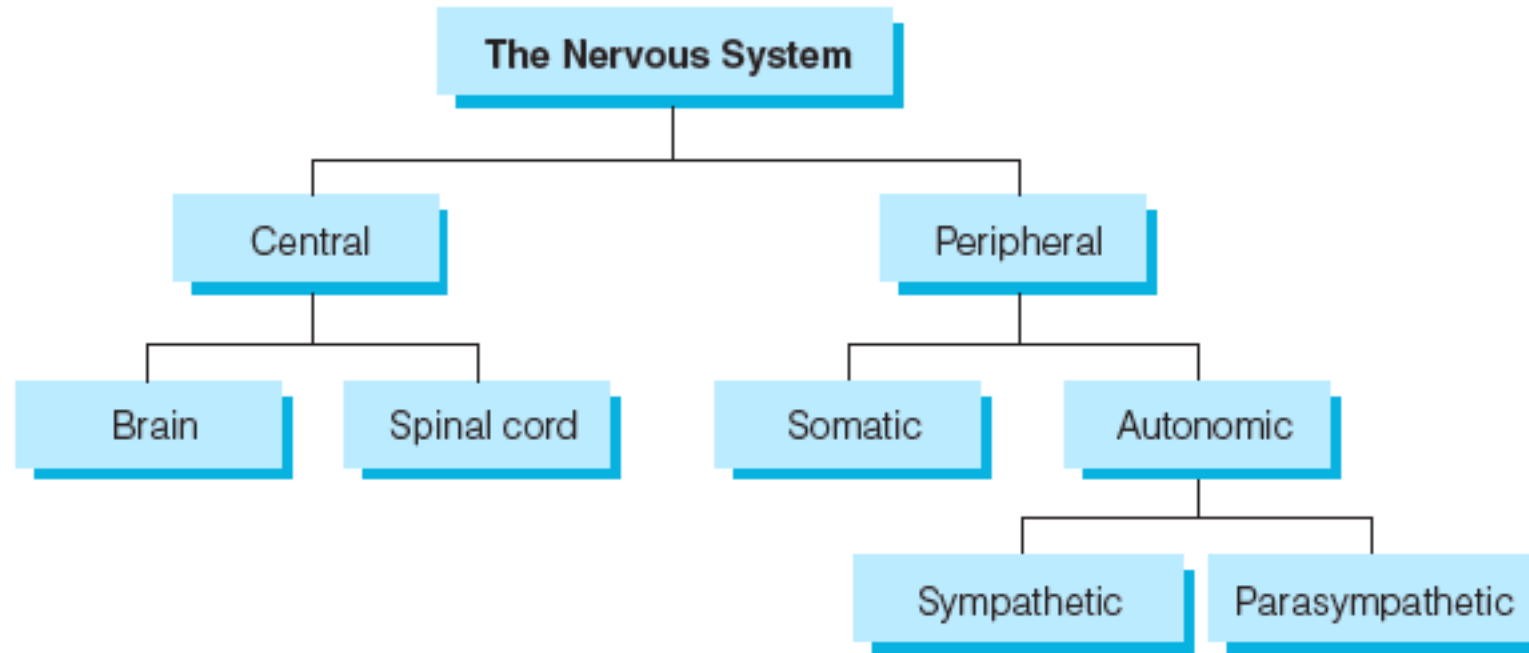


Figure: The human nervous system. The central nervous system consists of the brain and spinal cord and the peripheral nervous system consists of the nerves that cover the rest of the body (i.e., the periphery). The peripheral nervous system has somatic and autonomic subdivisions. The Autonomic nervous system consists of the sympathetic and parasympathetic branches.

The Nervous System (cont'd.)

- CNS includes the brain and spinal cord
- PNS includes neural pathways and is divided into the somatic and autonomic branches
 - A third, smaller branch of the PNS is the **enteric nervous system**
 - Enervates organs of digestion



Central Nervous System

- CNS divided into the spinal cord and major regions of the brain

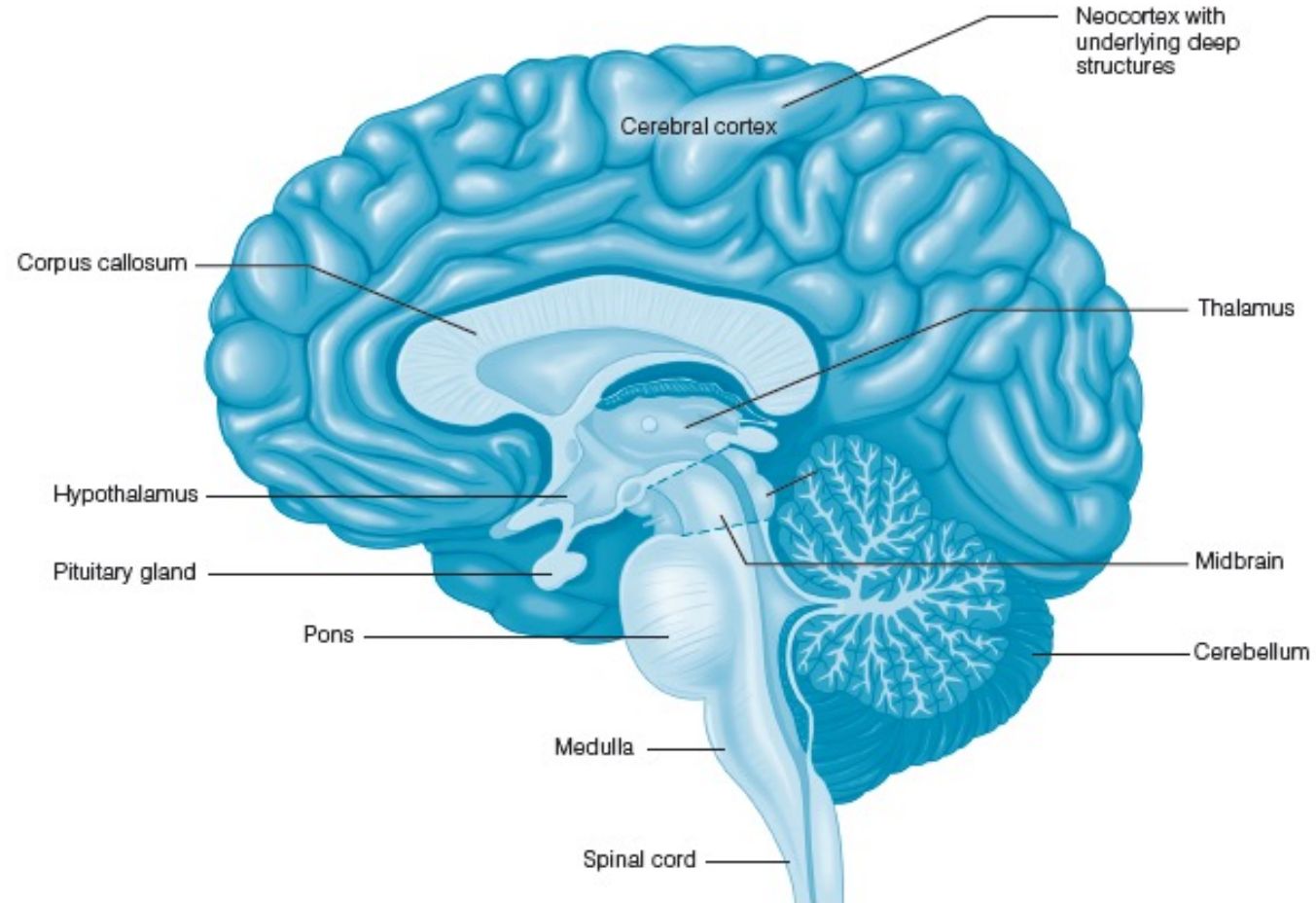
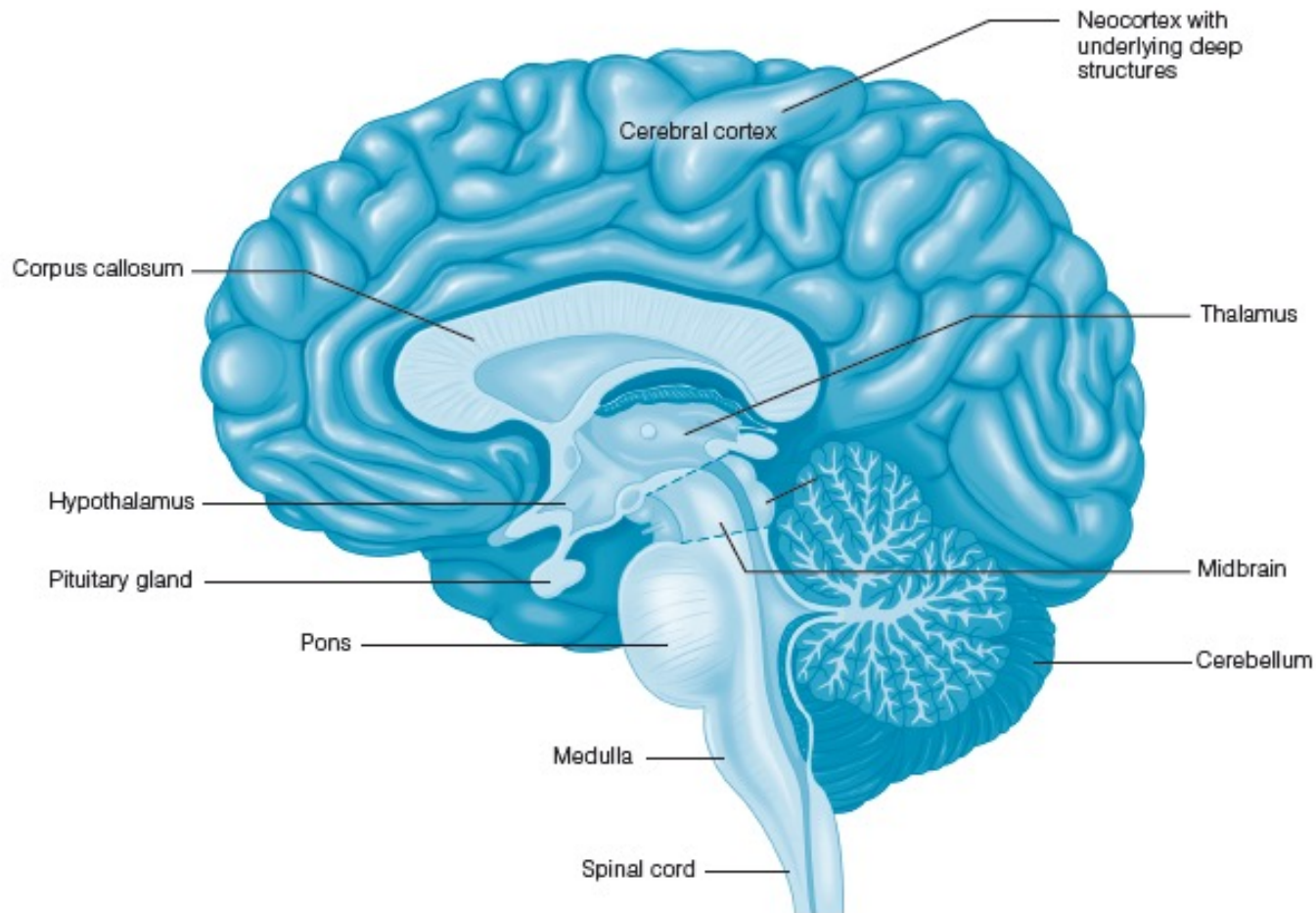


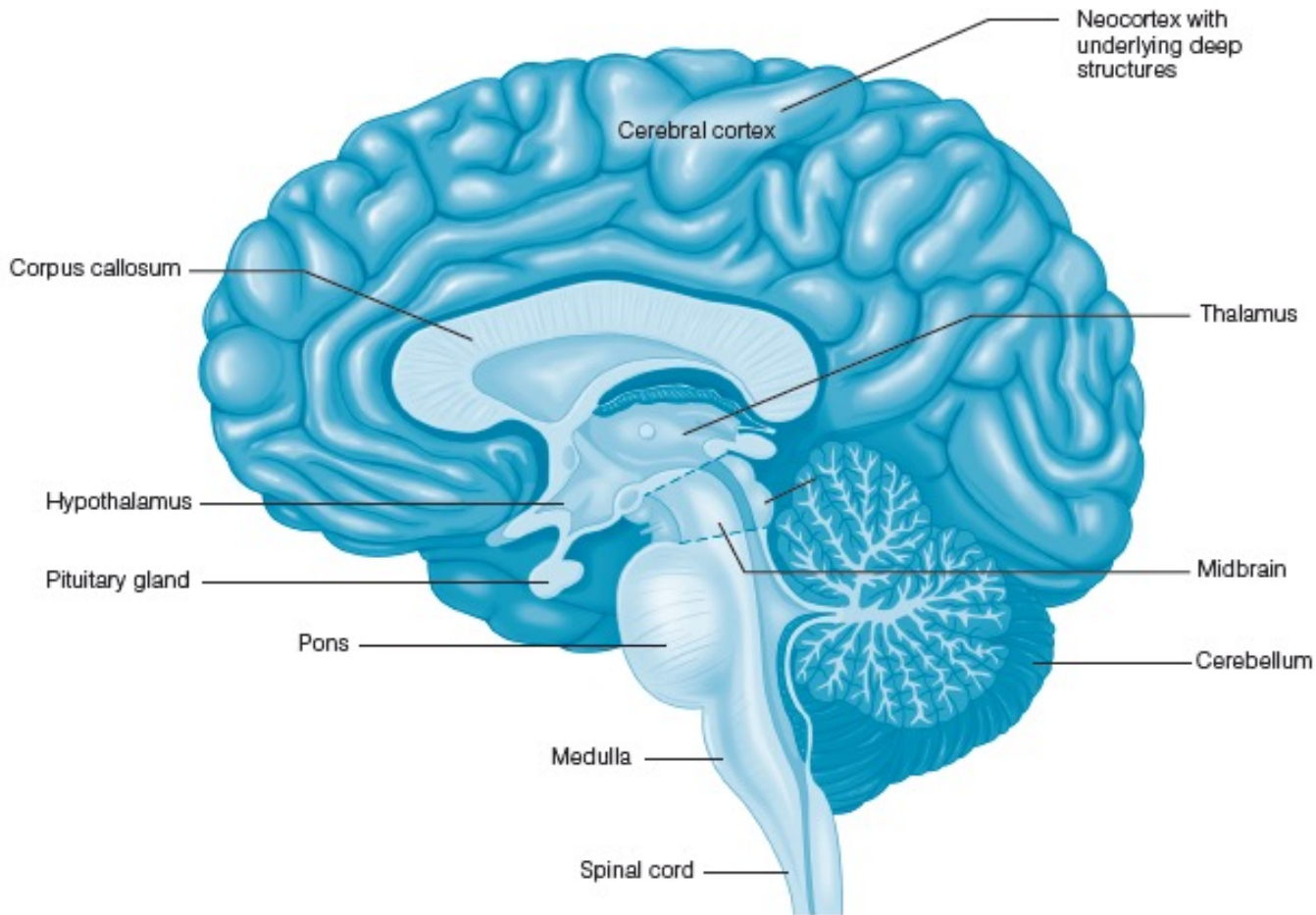
Figure: A cross-section of the human brain. Note the **brain stem** consists of the medulla, the pons, and the midbrain; the **cerebellum** is a distinct area; the **diencephalon** consists of the thalamus and hypothalamus; and the **cerebral hemispheres** consist of the neocortex (cerebral cortex) and their underlying white matter and deeper structures (including the amygdala and hippocampus not shown here). SOURCE: Garrett, *Brain and Behavior*, 2003, p. 197 (Wadsworth/Thompson Learning).

Central Nervous System (cont'd.)



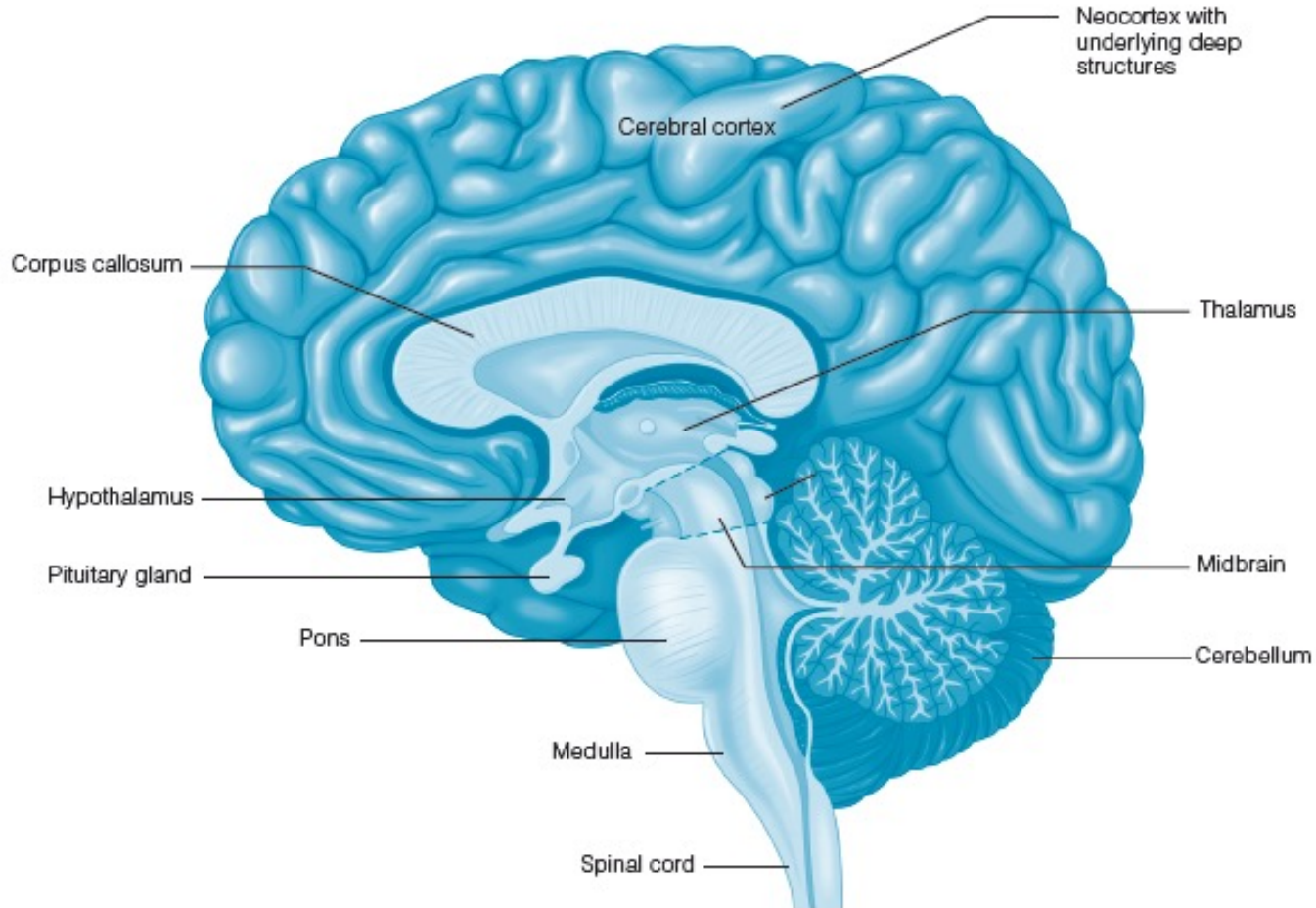
- **Reticular formation (RF) and limbic system** are tied to the fight-or-flight response
- **Parallel distributed processing:** brain has more than one functional region or pathway to achieve its ends
- **The brain stem** is responsible for vegetative functions (i.e., heartbeat, respiration, etc.)
- **Medulla:** part of the brain stem that contains vital life support centers

Central Nervous System (cont'd.)



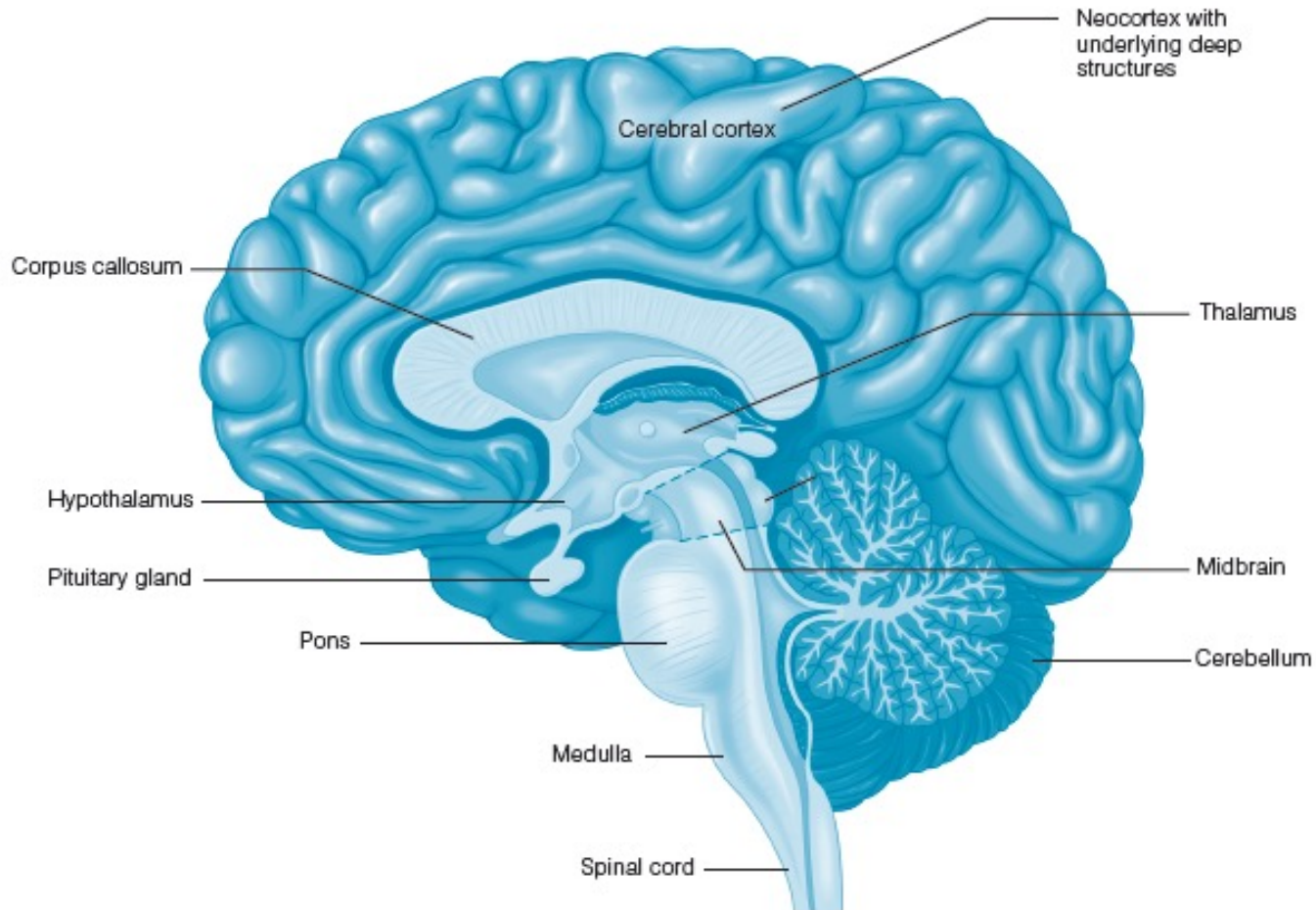
- **Pons:** transmits information regarding body's movement from the cerebral hemisphere to the cerebellum
- **Midbrain:** controls and coordinates many sensory and motor activities
- **Substantia nigra:** transmits information for regulating voluntary motor movement to the basal ganglia
- **Dopamine:** neurotransmitter important for regulating motor movement and "feeling good"

Central Nervous System (cont'd.)



- **Thalamus:** located in the brain's central region, it amplifies signals to make them stand out against background noise (signal to noise ratio)
- **Hypothalamus:** center for the fight-or-flight reaction that becomes activated when you become consciously aware of a threat
 - Also involved in motivational roles, homeostasis, and skeletal motor functions

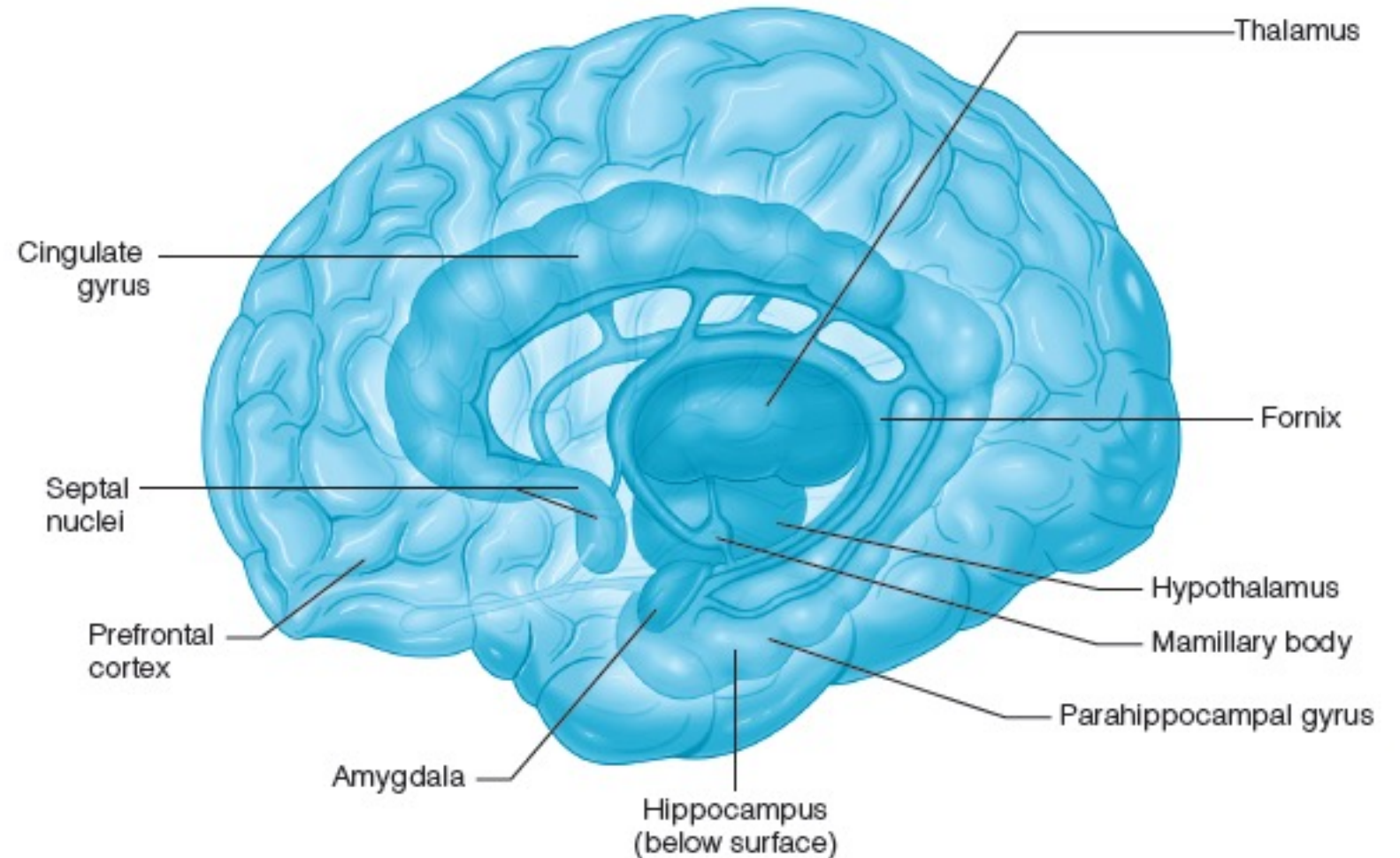
Central Nervous System (cont'd.)



- The neocortex is the highest center of the brain, contains many neurons used for sensation, perception, emotion, etc.
- Associated with conscious awareness and the mind

Central Nervous System (cont'd.)

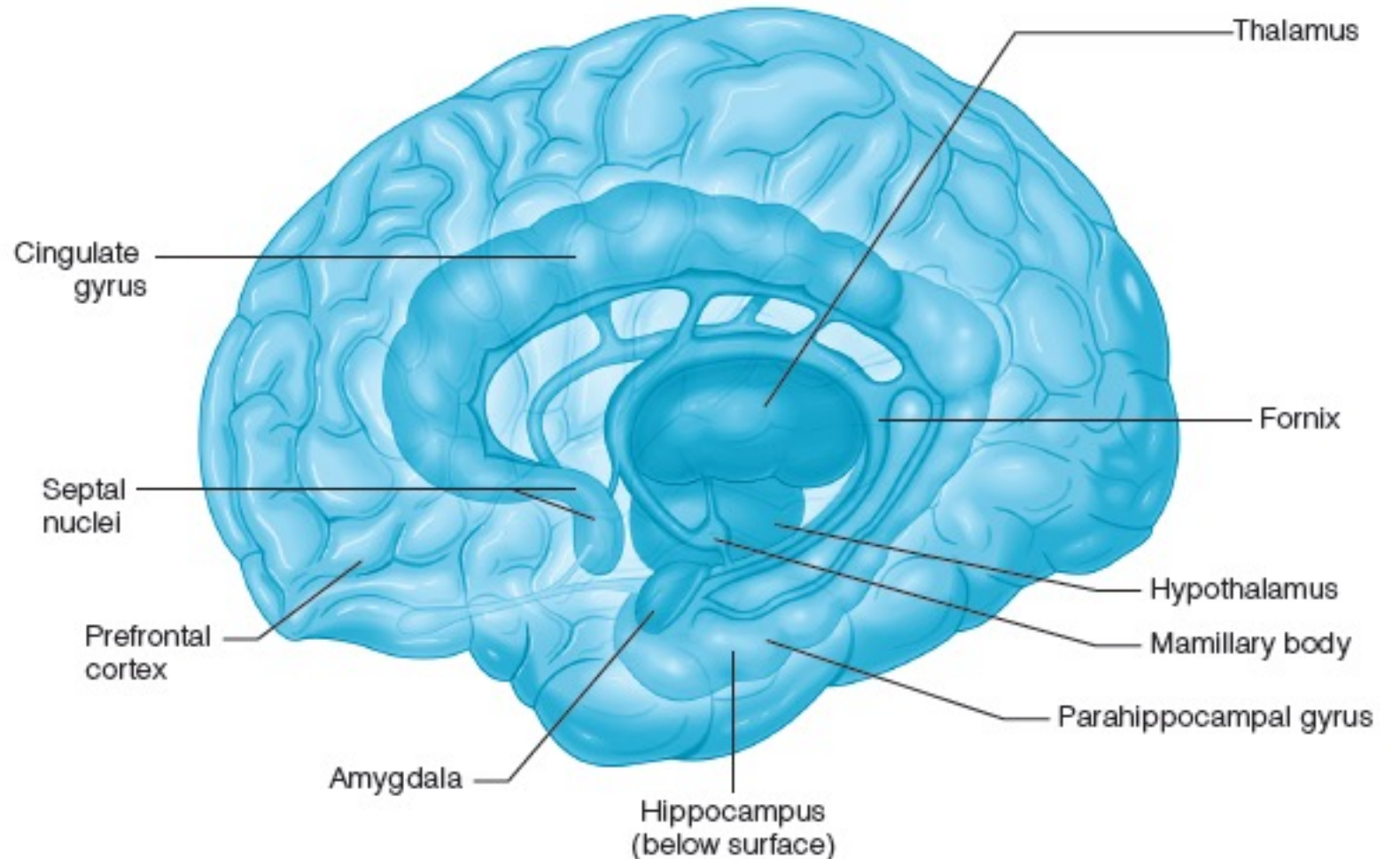
- **Limbic system:** the brain's neural circuit for emotion
- **Amygdala:** part of the limbic system that mediates emotional responses
- **Hippocampus:** involved in encoding long-term memories



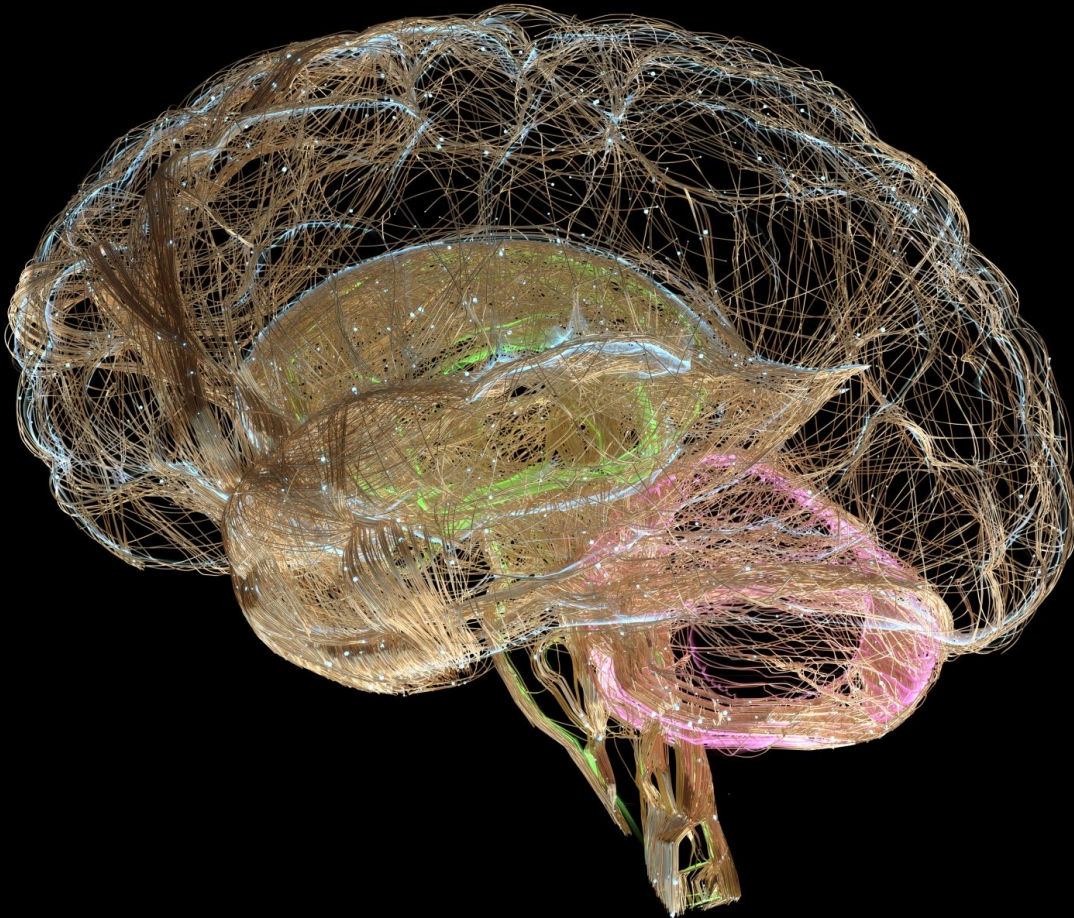
The limbic system consists of structures that form a ring around the inner core of the brain.

This system is believed to be the brain's neural circuit for emotion.

The limbic system includes the amygdala, hippocampus, thalamus, pre-frontal cortex, parts of the hypothalamus, and other structures such as the cingulated gyrus.



The Peripheral Nervous System



- **Somatic nervous system:** innervates the skeletal muscles, the skin, and the sense organs
- Neural pathways that send signals to the brain are **efferent** and those that send signals from the periphery to the brain are **afferent**
- Fight-or-flight response activates the striated muscles
- Too much stress can lead to over-activation and muscle pain and tension

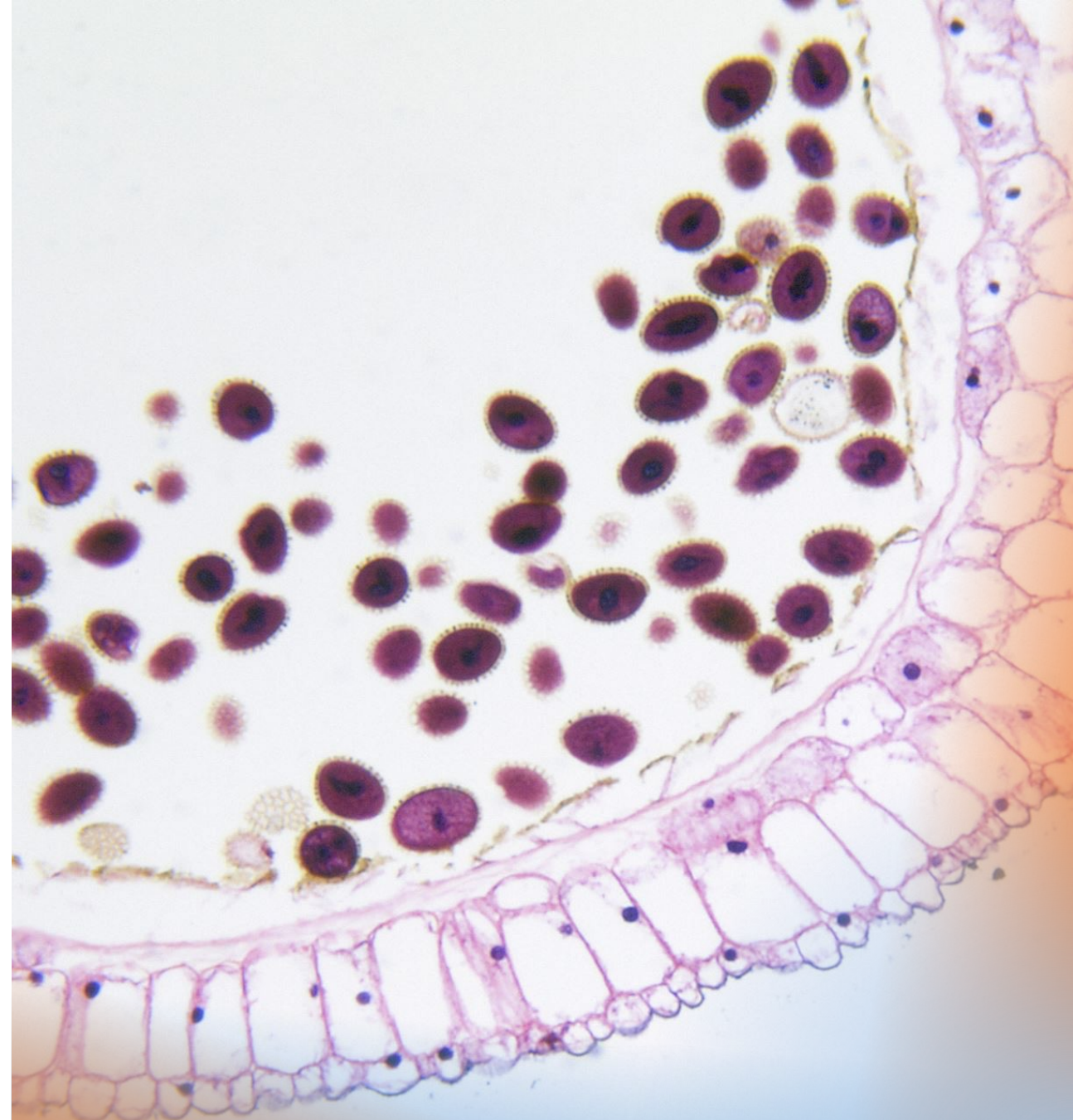
The Peripheral Nervous System (cont'd.)

- **Autonomic nervous system:** innervates the body's viscera through pre- and post-ganglionic neurons
- **Viscera** consists of the organs, ducts and glands, smooth muscles, and blood vessels
- **The sympathetic branch** of the autonomic nervous system is responsible for activating the fight-or-flight response
- **The Parasympathetic branch** is associated with relaxation




The Peripheral Nervous System (cont'd.)

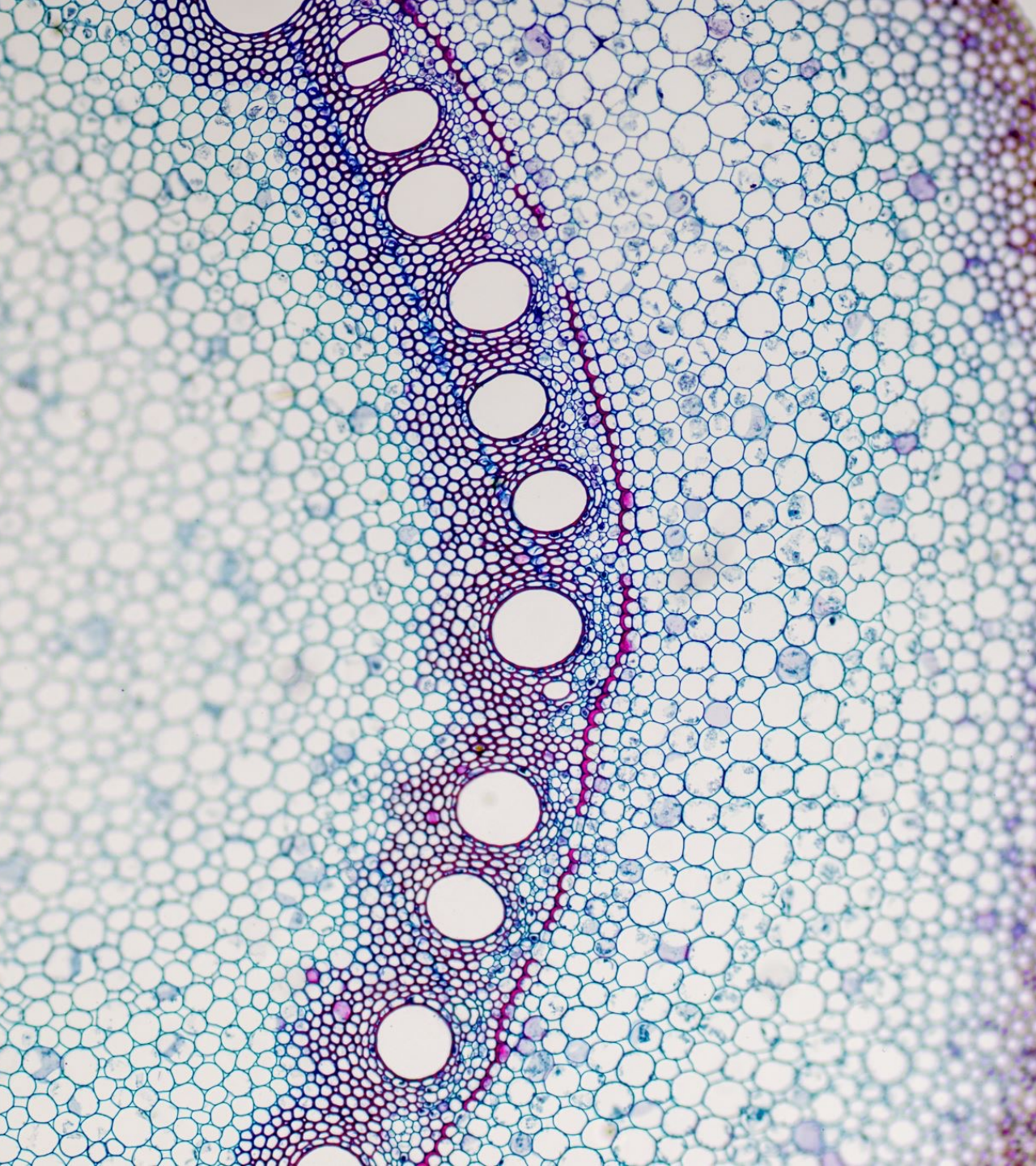
- Activation of the parasympathetic nervous system dampens the fight-or-flight response
- Parasympathetic branch incites the gastrointestinal system
- During fight-or-flight, the sympathetic nervous system activation causes pupils to dilate, bronchial dilation of the lungs, and increased heart rate



STRESS AND THE ENDOCRINE SYSTEM



STRESS AND THE ENDOCRINE SYSTEM



Stress and the Endocrine System

- **Endocrine system:** a system of organs and glands that secrete hormones into the blood stream to send messages to cells and organs
- Hormonal action is slower than neural activation, but longer lasting
- Endocrine system works with sympathetic nervous system during fight-or-flight activation to reach a common outcome

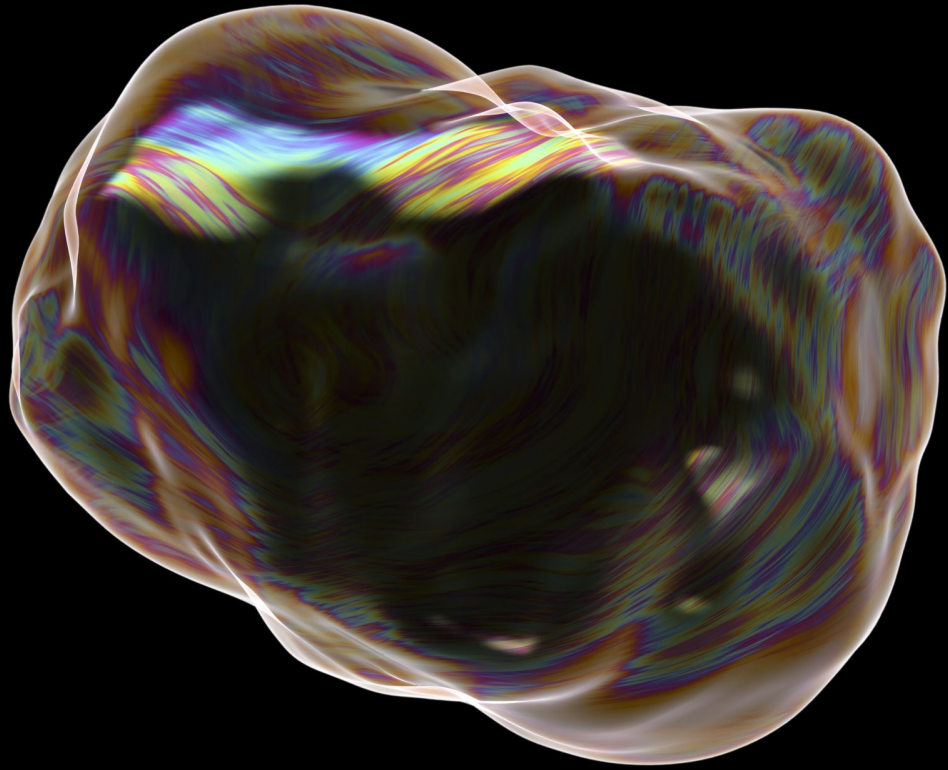
The Sympathetic-Adrenal Medulla Axis

- Primary command center for endocrine's stress response is in the hypothalamus; a primary target organ is the adrenal gland
 - Known as the **sympathetic-adrenal medulla axis (SAM)**
 - Forms one of the primary systems of the fight-or-flight response
- **Adrenals:** glands on top of the kidneys; their core is the adrenal medulla



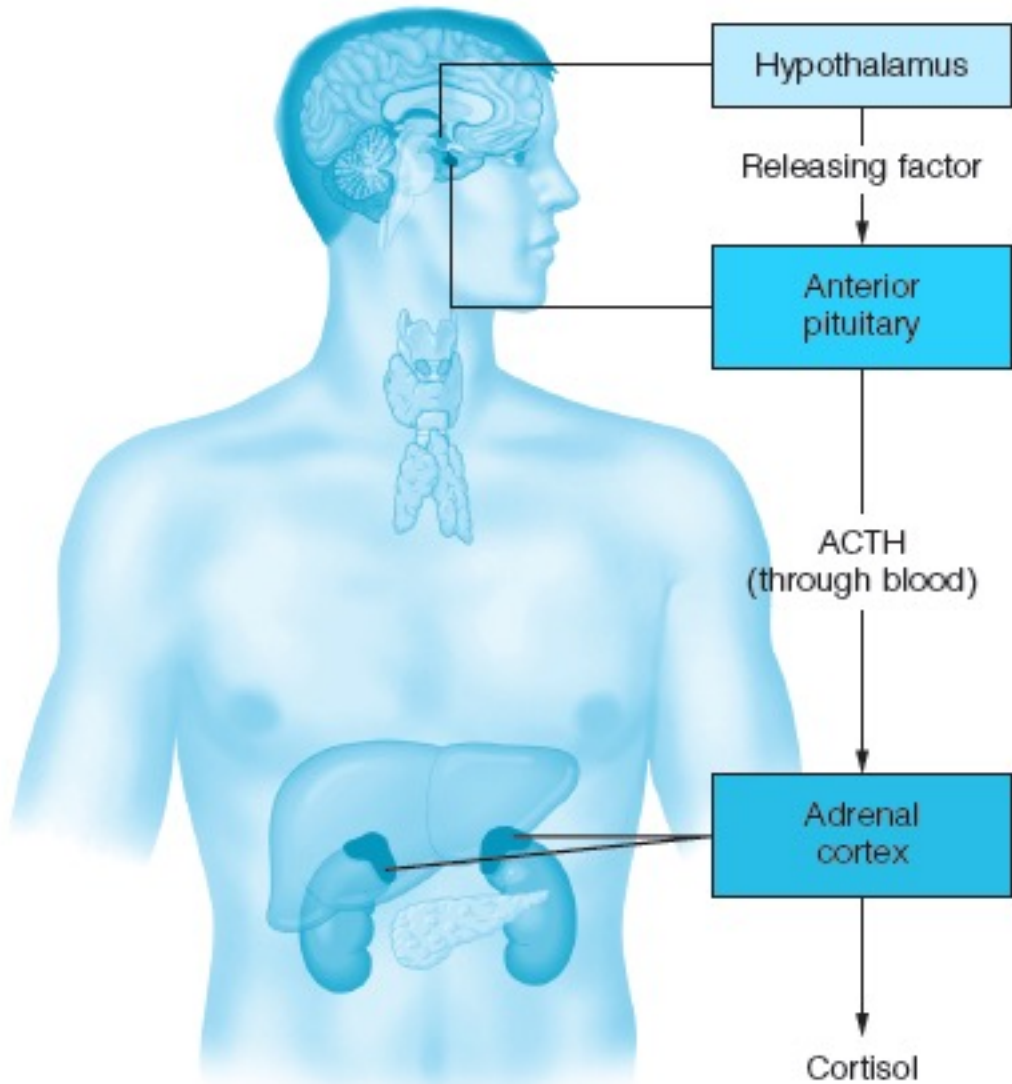
- **Epinephrine:** neurotransmitter that causes increased heart rate and constriction and dilation of certain blood vessels
- Epinephrine stimulates the process of gluconeogenesis
- Basically, same effect that sympathetic N.S. has on target organs

The Sympathetic- Adrenal Medulla Axis (cont'd.)



- **Pituitary gland:** pea-sized master gland at the base of the brain

The Hypothalamic- Pituitary-Adrenal Axis

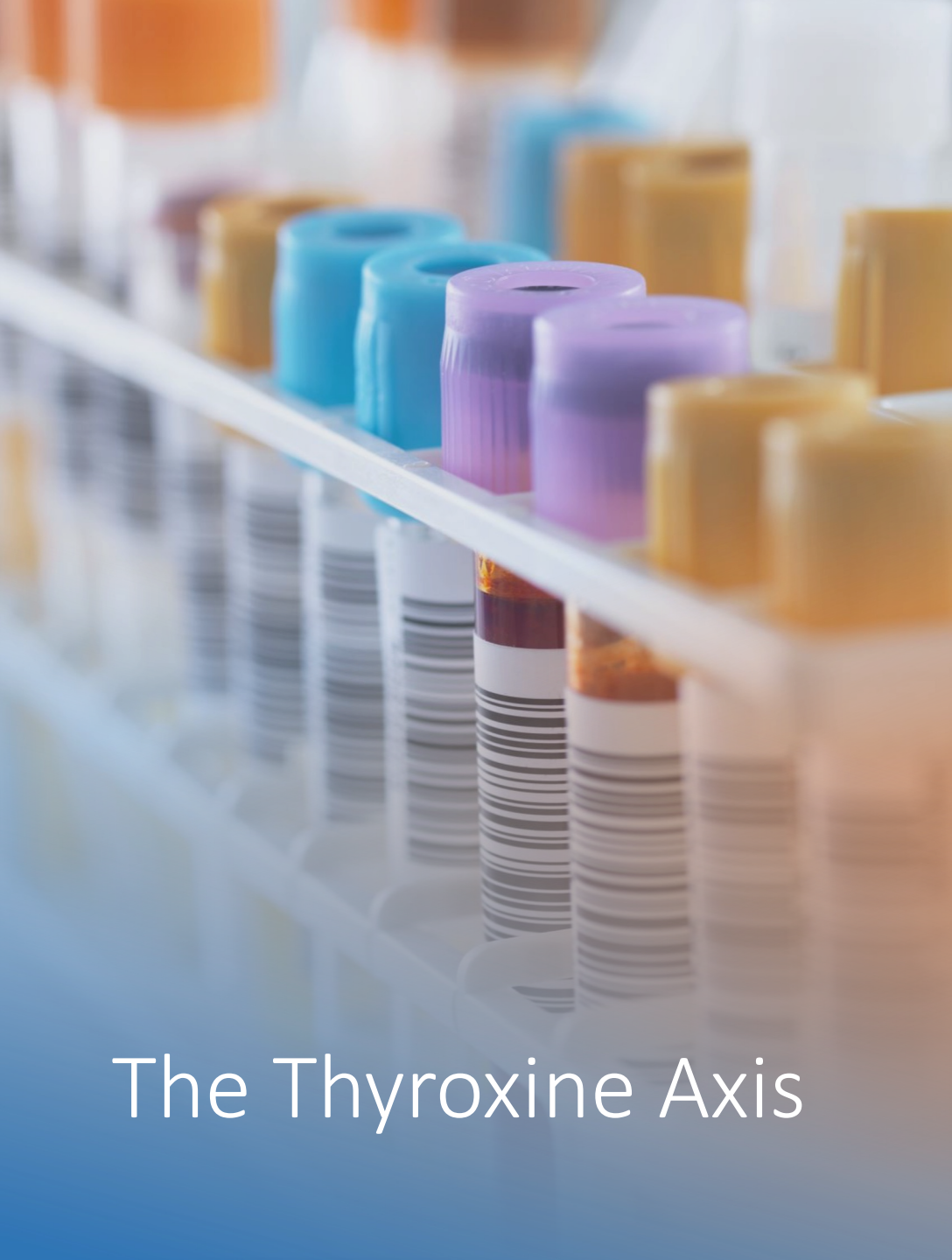


The hypothalamic-pituitary-adrenal (HPA) axis network.

The hypothalamus via the pituitary portal system of the anterior pituitary causes the release of ACTH, which stimulates the adrenal cortex to release cortisol, which through a process called gluconeogenesis increases the overall glucose concentration in the bloodstream and speeds metabolism.

The Hypothalamic-Pituitary-Adrenal Axis (cont'd.)

- HPA axis activation can temporarily inhibit pain so a person can escape danger
- Release of cortisol readies stress responses



The Thyroxine Axis

- **Thyroxine:** a strong thyroid gland hormone that can double basal metabolic rate
 - A polypeptide messenger goes from the hypothalamus to the anterior pituitary, which releases a thyroid stimulating hormone (TSH)
 - **High levels produce nervousness, insomnia, shortness of breath, sweating, and diarrhea**
 - Can stay in the body for a long time when stress is chronic

Traumatic Stress and the Brain

- Traumatic stressors are events such as combat, disasters, violence, rape, kidnapping, torture, having a friend or relative die unexpectedly, etc.
- A person's reaction to stressors is subjective
- A traumatic stressor can challenge a person's worldview
- Some people develop post-traumatic stress disorder (PTSD)

Traumatic Stress and the Brain (cont'd.)

- Evidence shows that the limbic system, especially the **amygdala**, is most affected by PTSD
- Seem to be abnormalities of limbic structures and functions, though hard to tell whether this is a result of or a predisposition to PTSD
- Amygdala involved in assessing threat stimuli
 - **In people with PTSD, it is hyperresponsive**
- ACC and hippocampus seem to under-respond

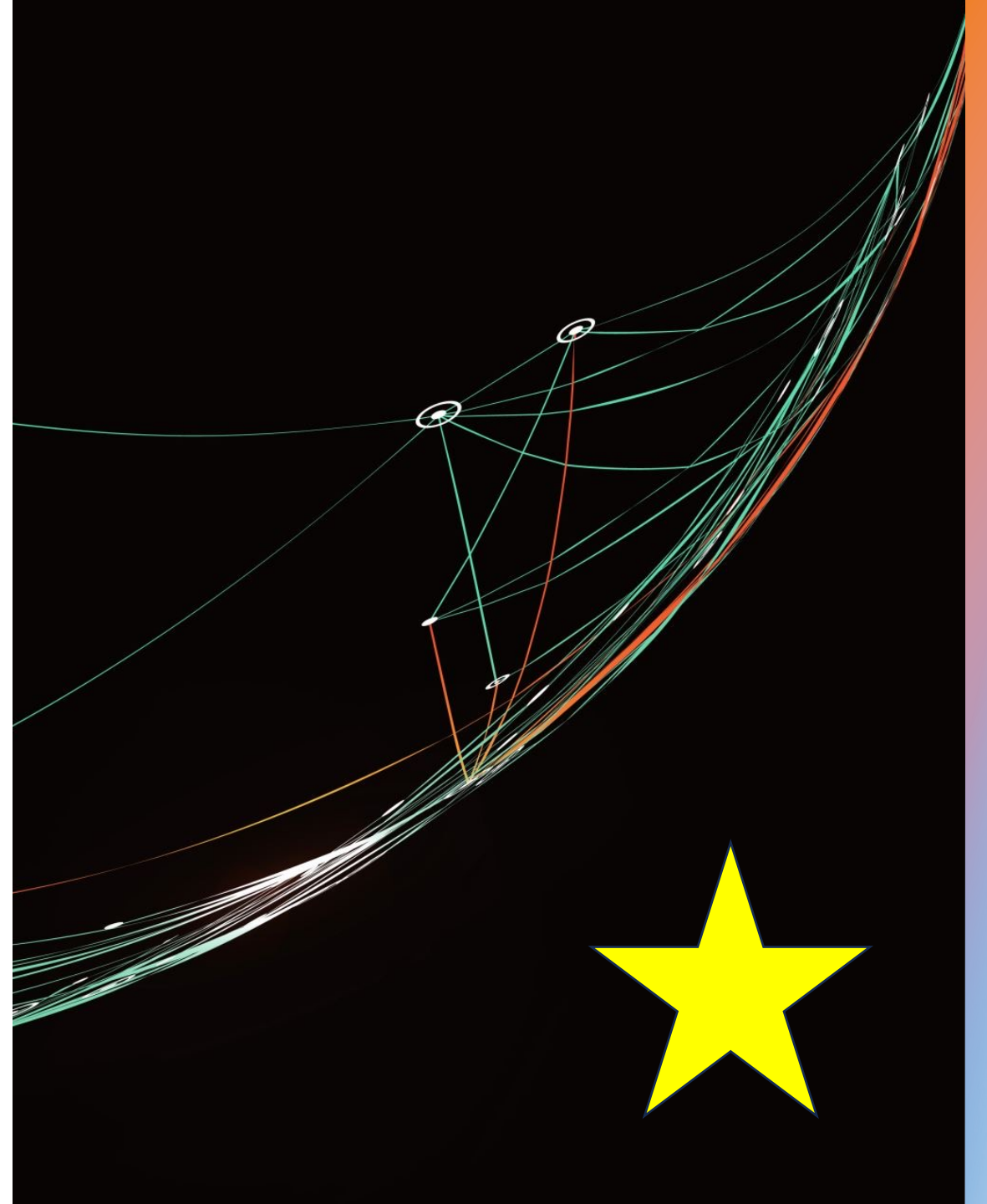
Traumatic Stress and the Brain (cont'd.)

- Symptoms are insomnia, irritability, and also problems with memory, and more
- A hyporesponsive (under responsive) hippocampus could account for the memory problems: involved in encoding declarative memories
- Symptom improvement after therapy shows increased amygdala activity and decreased ACC activity
 - Provides more evidence of a causal pathway
- Only a minority of people develop PTSD in response to trauma

POSTTRAUMATIC GROWTH

POSTTRAUMATIC GROWTH

SOMETIMES TRAUMATIC
EVENTS CAN STRENGTHEN
OUR WORLD VIEW AND
OUTLOOK ON LIFE



Posttraumatic Growth

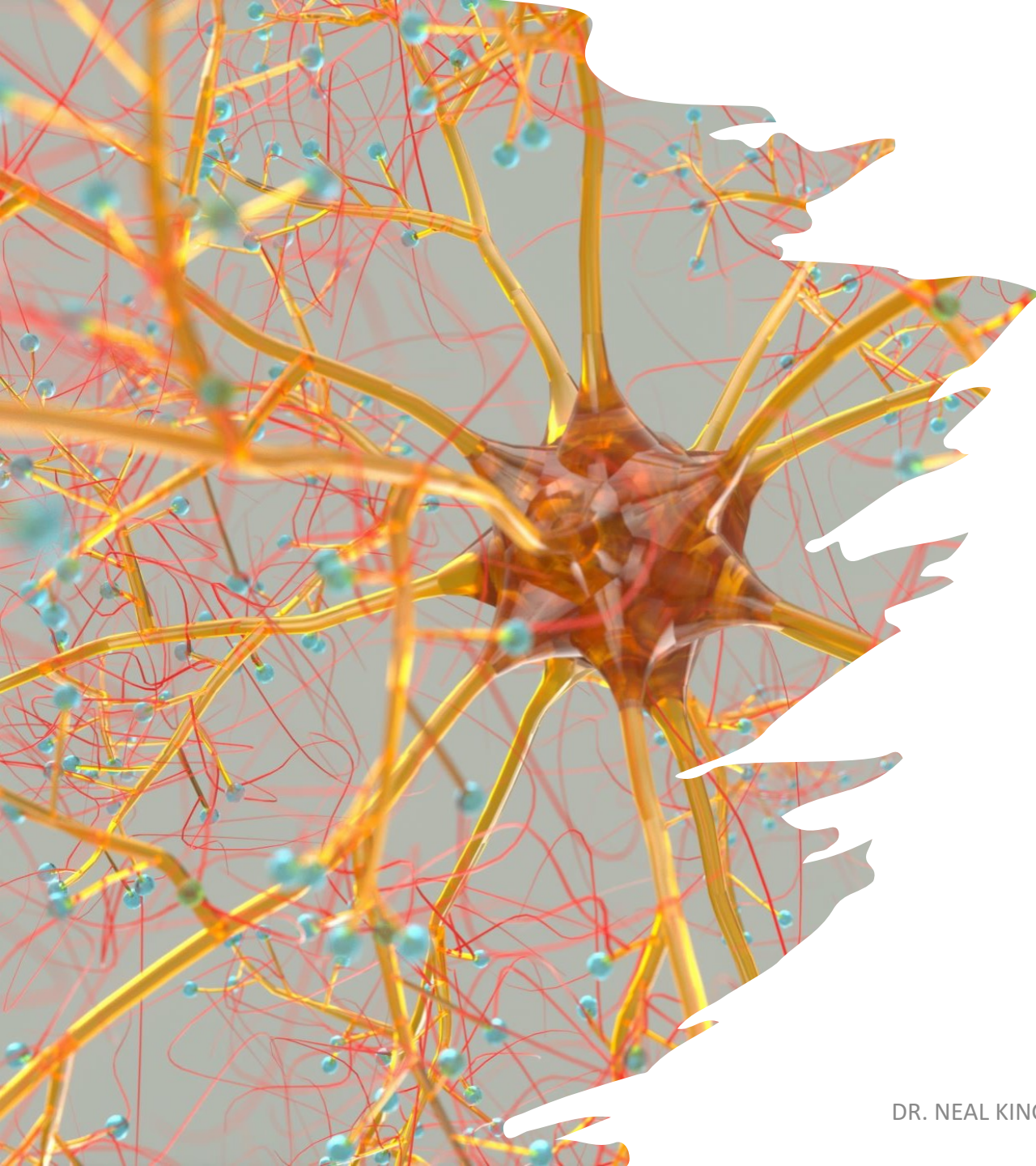
- **Posttraumatic growth:** positive growth in response to trauma in three related themes
 - Relationships are strengthened
 - Self views become more positive
 - World views / life philosophies are changed in positive directions
- This is a product of **successful adaptation**
- Methods of measuring posttraumatic growth are not reliable



Posttraumatic Growth

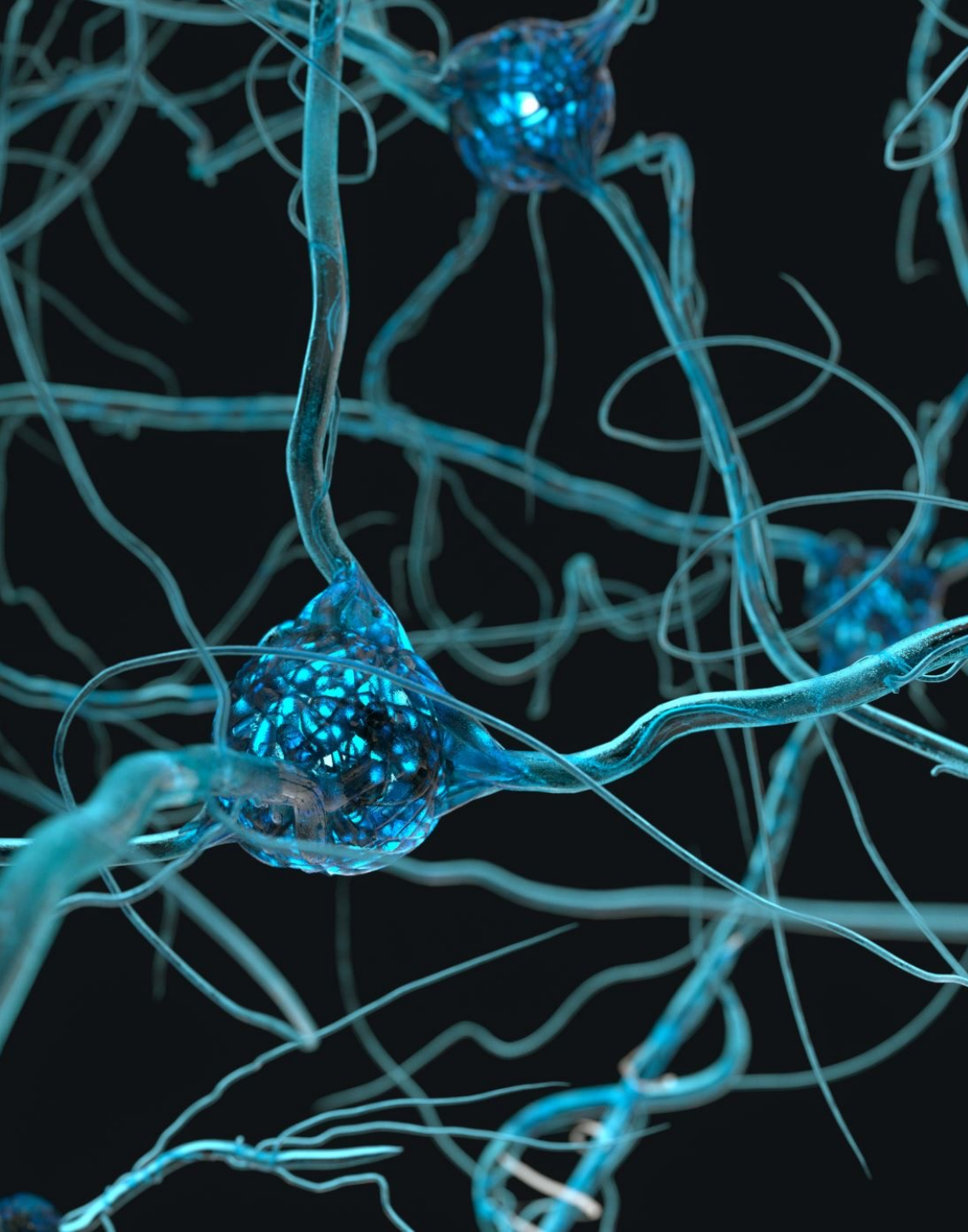
- Positive illusions may make a person believe that there has been positive change when there has not been
- Still a relatively new field of study
- Research does show promising new directions for understanding the effects of traumatic stressors
- **Logotherapy**: a type of psychotherapy that helps people find meaning out of tragedy
- When we can't change a situation, we have to change ourselves





Summary

- Two main branches of the nervous system: CNS and PNS
- CNS is the brain and spinal cord; PNS is all other neural pathways divided into the somatic N.S. and autonomic N.S.
- Two branches of the autonomic N.S.: sympathetic and parasympathetic branches
- Reticular formation and limbic system are tied to the fight-or-flight response



Summary (cont'd.)

- RF sends signals to the cerebral hemisphere and down through the brain stem
- Endocrine system secretes hormones into the blood stream, hypothalamus and adrenal system key areas
- Two axes of hypothalamic influence are SAM and the HPA axis
- PTSD and posttraumatic growth are two possible outcomes of traumatic stress experiences