PHYSIOLOGY

FACULTY OF PHARMACEUTICAL SCIENCES

DR. AMJAAD ZUHIER ALROSAN

LECTURE 6- PARTS (1) AND (2)

PHYSIOLOGY

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LECTURE 6- PART (1)

Objectives

1. Discuss **sensation**.

2. Discuss **somatic sensation.**

(Pages 547-455 of the reference).

SENSATION

- ✓ is the **conscious or subconscious awareness** of **changes in the external or internal environment**.
- ✓ The nature of the sensation and the type of reaction generated **vary according to the ultimate destination of nerve impulses** that convey sensory information to the CNS.

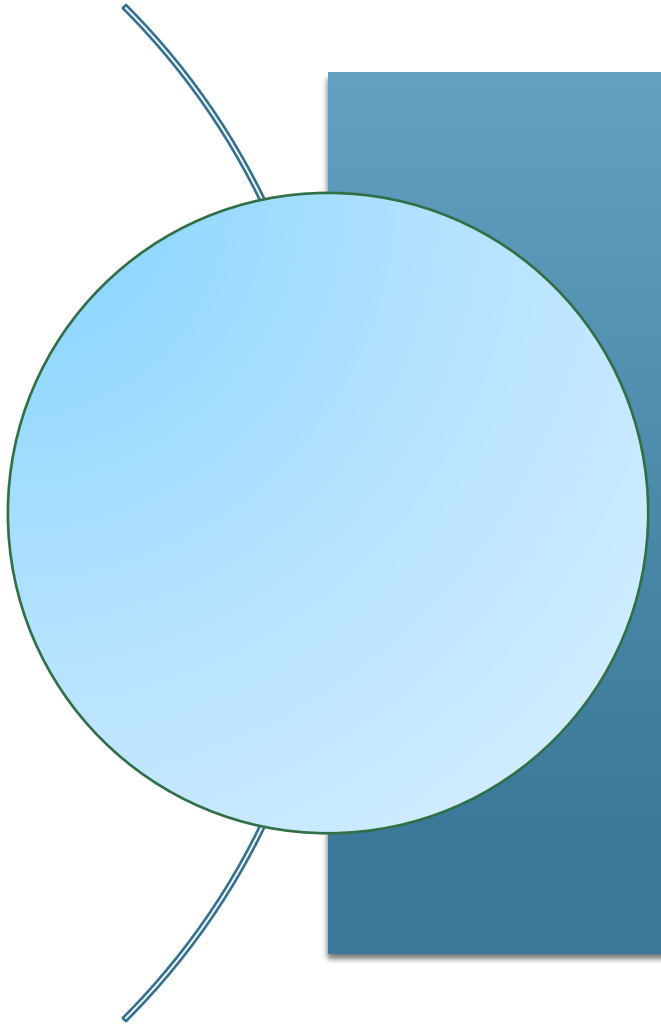
SENSATION

- ✓ **Perception** is the **conscious interpretation of sensations** and is primarily a function of the **cerebral cortex** (the outer layer of neural tissue of the cerebrum of the brain in humans and other mammals.).
- ✓ **We have no perception of some sensory information because it never reaches the cerebral cortex.**

SENSORY MODALITIES

- Each unique type of sensation—such as touch, pain, vision, or hearing—is called a **sensory modality**.
- A **given sensory neuron** carries information for **only one sensory modality.**

THE PROCESS OF SENSATION



You seem to see with your eyes, hear with your ears, and feel pain in an injured part of your body because sensory impulses from each part of the body arrive in a specific region of the cerebral cortex, which interprets the sensation as coming from the stimulated sensory receptors.

LOCATION OF RECEPTORS AND ORIGIN OF ACTIVATING STIMULI

1- **Exteroceptors:** are located at or near the **external surface of the body**; they are sensitive to stimuli originating outside the body and provide information about the external environment.

2-**Interoceptors:** are located in blood vessels, visceral organs, muscles, and the nervous system and monitor conditions in the **internal environment**.

LOCATION OF RECEPTORS AND ORIGIN OF ACTIVATING STIMULI

3- **Proprioceptors:** are located in muscles, tendons, joints, and the inner ear. They provide information about body position, muscle length and tension, and the position and movement of your joints.

TYPE OF STIMULUS DETECTED

1-**Mechanoreceptors:** are sensitive to mechanical stimuli.

2-**Thermoreceptors:** detect changes in temperature.

3-**Nociceptors:** respond to painful stimuli resulting from physical or chemical damage to tissue.

4-**Photoreceptors:** detect light that strikes the retina of the eye.

TYPE OF STIMULUS DETECTED

5- **Chemoreceptors:** detect chemicals in the mouth (taste), nose(smell), and body fluids.

6- **Osmoreceptors:** detect the osmotic pressure of body fluids.

SOMATIC SENSATIONS

- They arise from stimulation of sensory receptors embedded in the skin or subcutaneous layer; in mucous membranes of the mouth, vagina, and anus; in muscles, tendons, and joints; and in the inner ear.

TACTILE SENSATIONS

- The tactile sensations include **touch, pressure, vibration, itch, and tickle.**

TOUCH

- Sensations of touch generally result from **stimulation of tactile**.
- **Rapidly adapting touch receptors**, they generate nerve impulses mainly at the onset of a touch .
- **Slowly adapting touch receptors,** keep firing as long as the stimulus is present.

PRESSURE

- Is a sustained sensation that is **felt over a larger area than touch**, occurs with deformation of deeper tissues.

VIBRATION

- Sensations of vibration, such as those you feel when you use an electric knife to carve a turkey, **result from rapidly repetitive sensory signals from tactile receptors**.

ITCH

- The itch sensation results by **certain chemicals**, such as bradykinin or antigens in mosquito saliva injected from a bite, often **because of a local inflammatory response**.

TICKLE

- This intriguing sensation typically arises only **when someone else touches you**, not when you touch yourself.

THERMAL SENSATIONS

- Two distinct thermal sensations—**coldness and warmth**—are detected by different receptors.

THERMAL SENSATIONS

- Cold and warm receptors both **adapt rapidly at the onset of a stimulus**, but they continue to generate impulses at a lower frequency throughout a prolonged stimulus.
- **Temperatures below 10 Celsius and above 48 Celsius primarily stimulate pain receptors**, rather than thermoreceptors, producing painful sensations.

PAIN SENSATIONS

- Pain is indispensable for survival.
- **It serves a protective function by signaling the presence of noxious, tissue-damaging conditions.**
- Subjective description and indication of the location of pain may help pinpoint the underlying cause of disease.
- **Pain may persist even after a pain-producing stimulus** is removed **because pain-mediating chemicals linger.**

TYPES OF PAIN

- Pain that arises from **stimulation of receptors in the skin** is called **superficial somatic pain**.
- **Stimulation of receptors in skeletal muscles, joints, tendons, and fascia** causes **deep somatic pain**.
- **Visceral pain** results from **stimulation of receptors in visceral organs**.

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LECTURE 6- PART (2)

Objectives

1. Discuss **major parts of the brain**.

2. Discuss **brain blood flow, the blood–brain barrier as well as cerebrospinal fluid.**

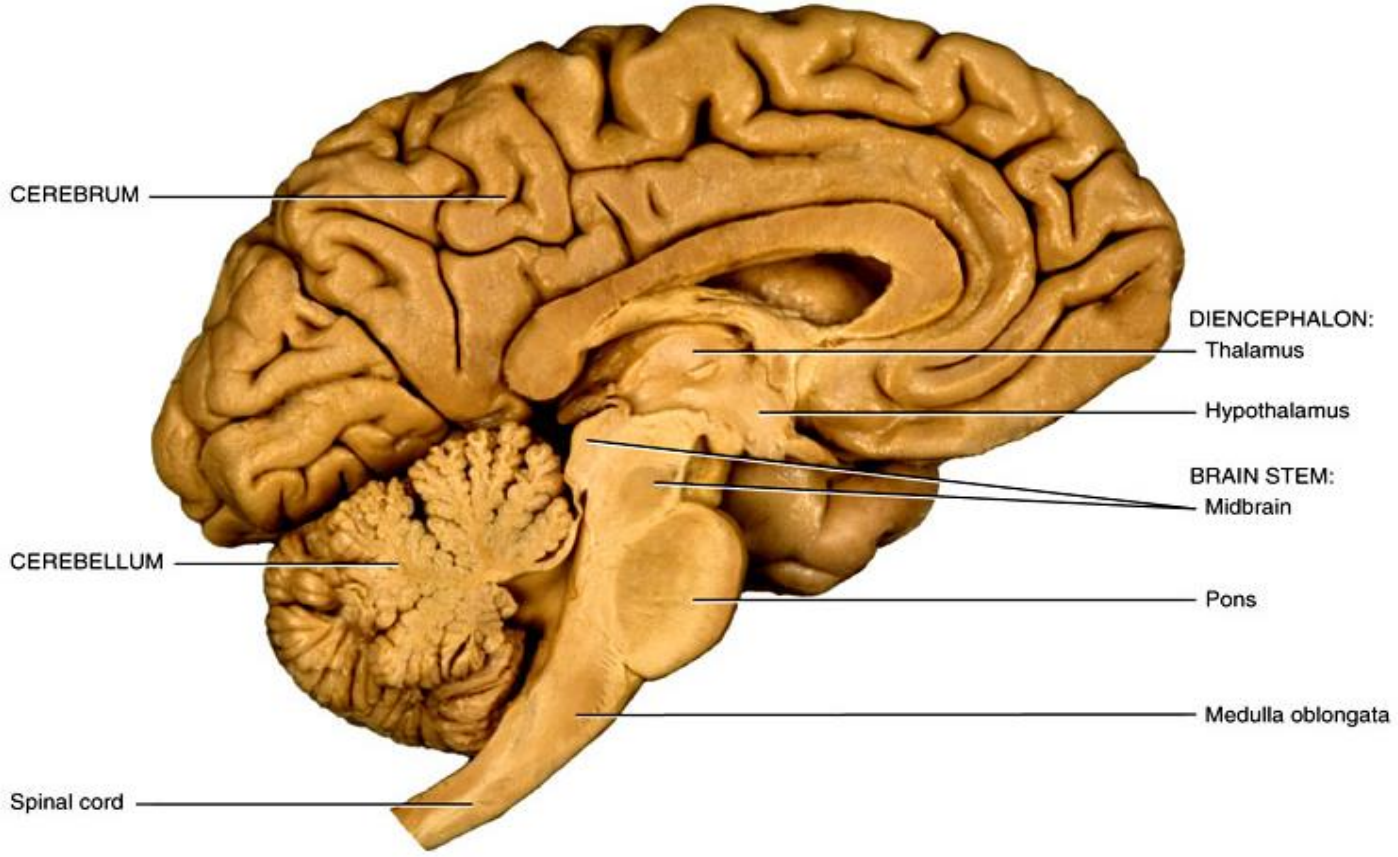
3. Describe **somatic motor pathways.**

(Pages 448-449, 474-494, 497-501, 560-568 of the reference).

MAJOR PARTS OF THE BRAIN

- **Brain stem-** is a continuation of the spinal cord; consists of the medulla oblongata, pons and midbrain.
- **Cerebellum-** is the second largest part of the brain.
- **Diencephalon**- gives rise to thalamus, hypothalamus and epithalamus.
- **Cerebrum**- is the largest part of the brain.

MAJOR PARTS OF THE BRAIN



(b) Medial view of sagittal section

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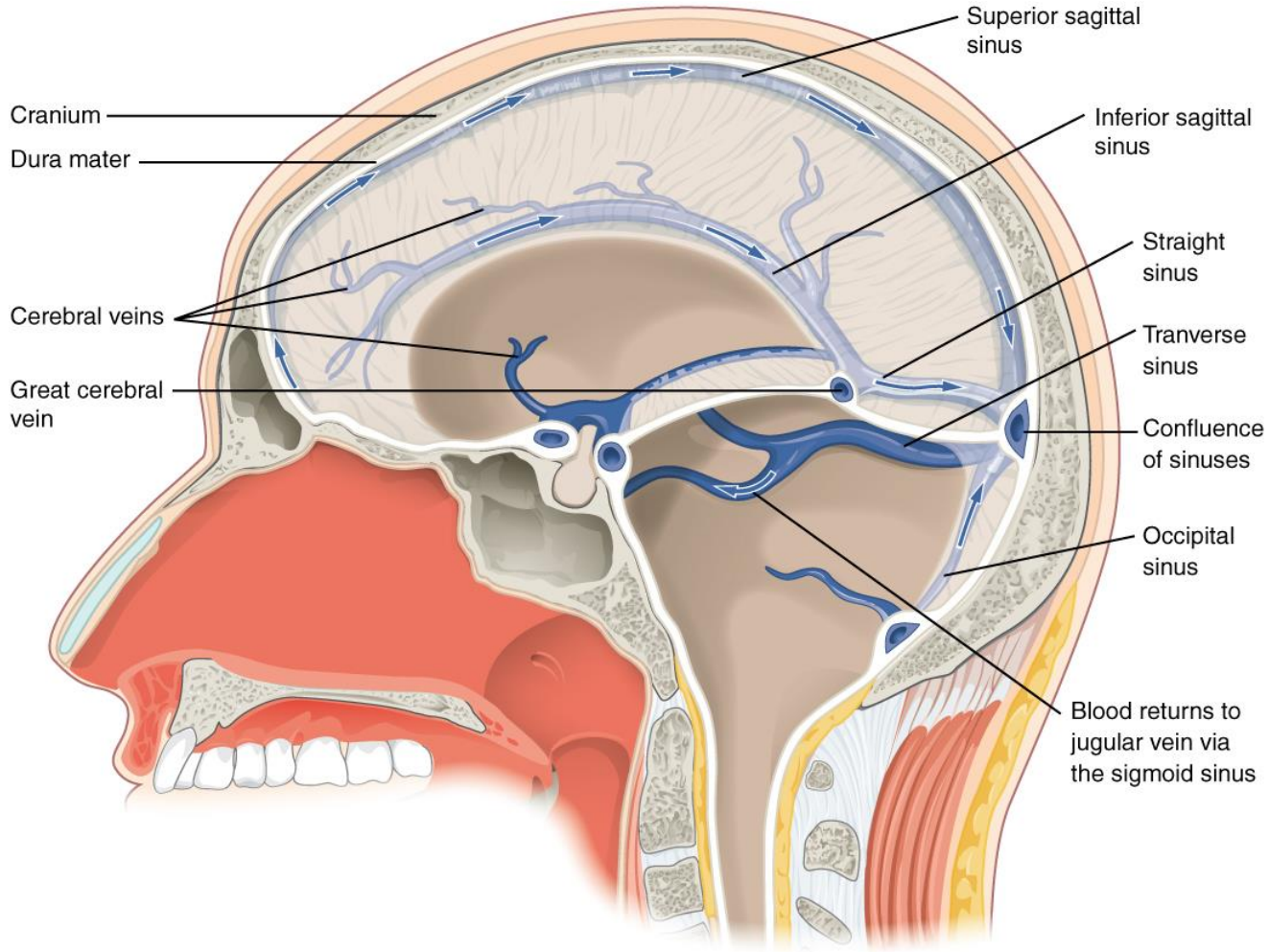
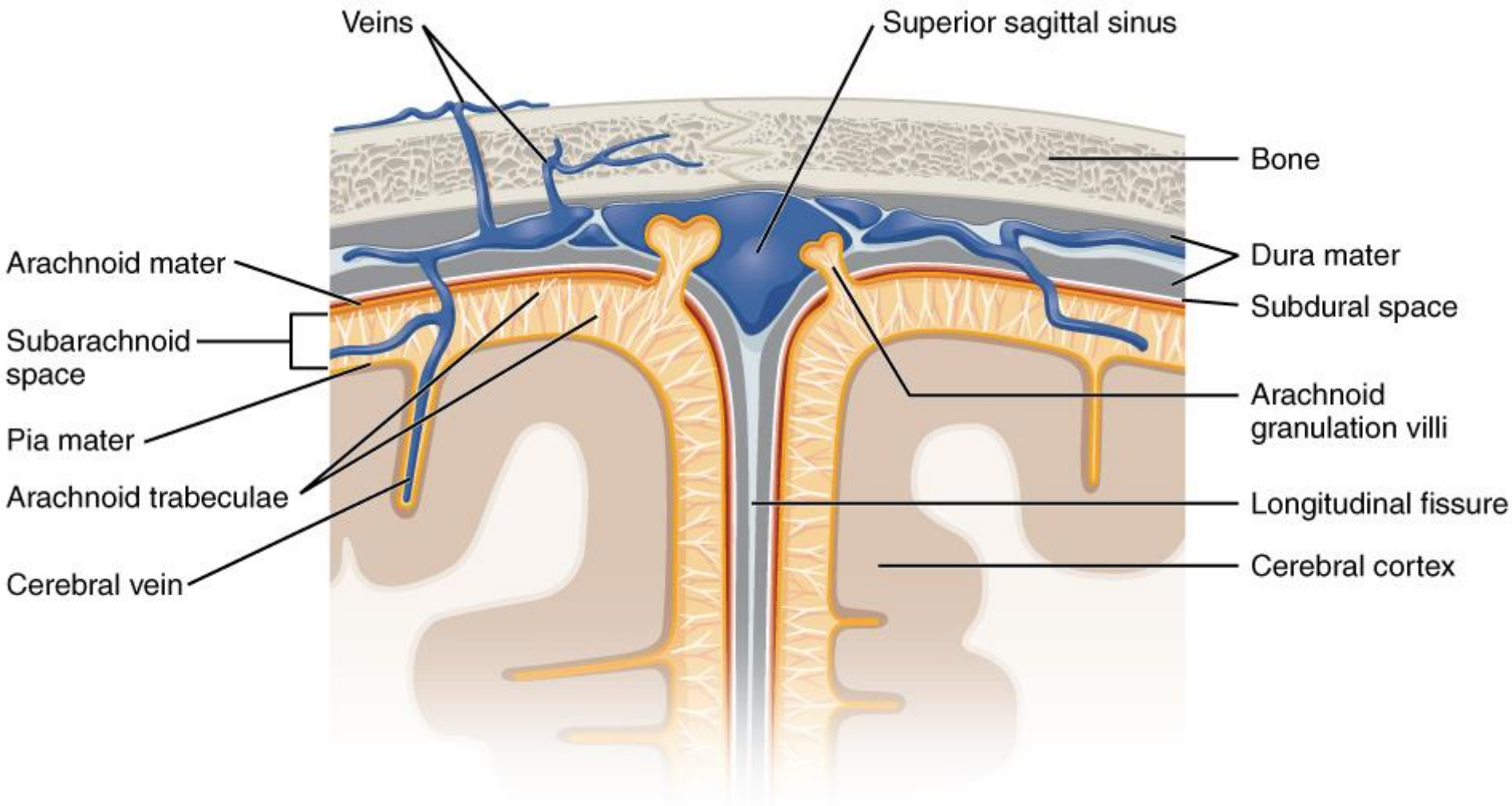
PROTECTIVE COVERINGS OF THE BRAIN

- The **cranium (skull).**
- The **cranial meninges**: **dura mater, arachnoid mater and pia mater.**



PROTECTIVE COVERINGS OF THE BRAIN



CEREBROSPINAL FLUID (CSF)

- Is clear, colorless liquid composed primarily of water that **protects the brain and spinal cord** from **chemical and physical injuries.**
- It also **carries small amounts of oxygen, glucose, and other needed chemicals from the blood to neurons and neuroglia.**
- Circulates through **cavities in the brain (ventricles) and the spinal cord (central canal)** and also **in the subarachnoid space**.
- Absorbs shock and **protects the brain and the spinal cord (Mechanical protection)**. It is also important in maintaining homeostatic controls for brain tissue.
- Helps **transport nutrients and wastes from the blood and the nervous tissue**.

VENTRICLES
FORMATION AND CIRCULATION OF CSF IN THE VENTRICLES

- ✓ **The majority of CSF production is from the choroid plexuses, networks of blood capillaries in the walls of the ventricles (membranelike).**

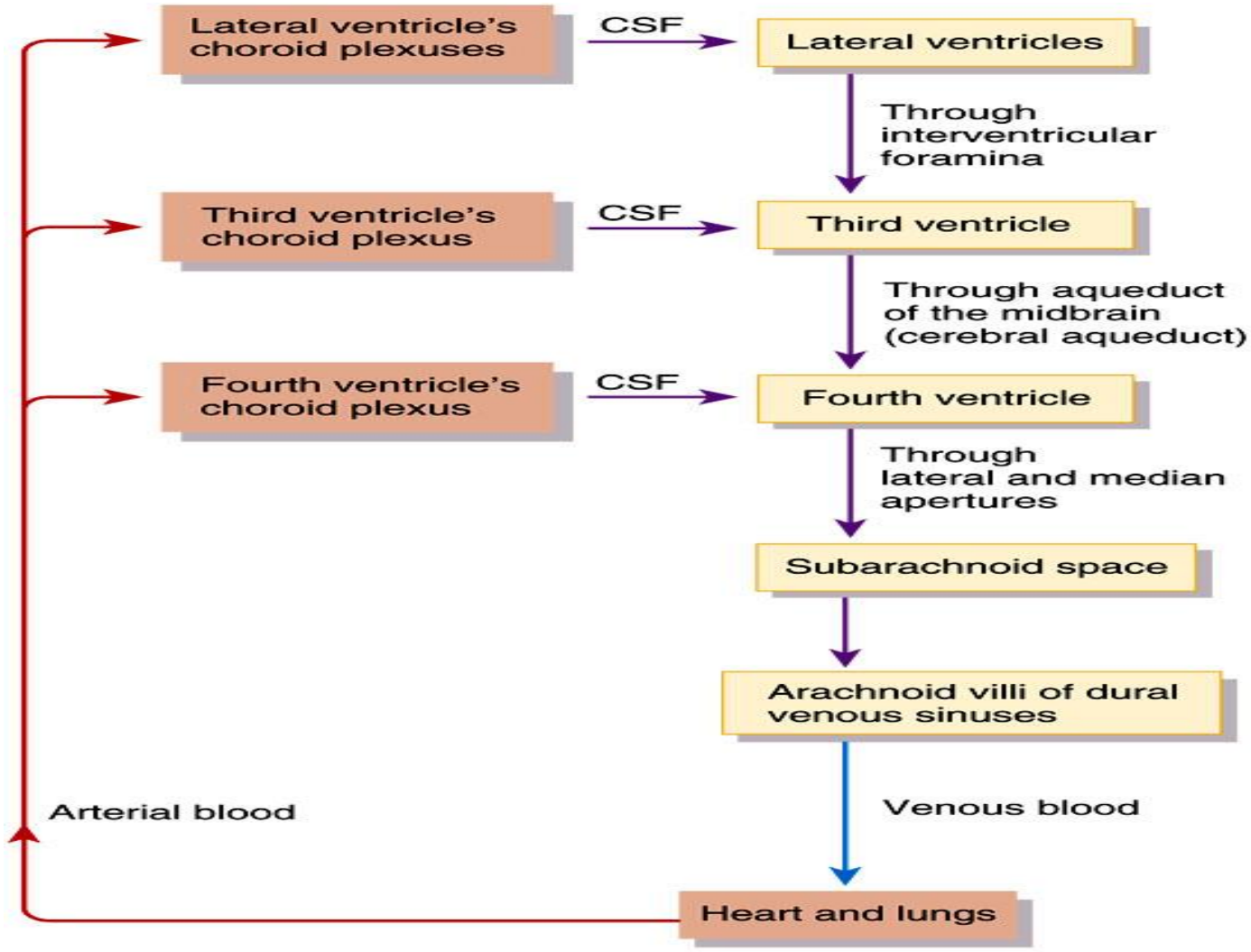
- ✓ **CSF-filled cavities within the brain.**

- ✓ **Lateral ventricles:** cerebral hemispheres.
- ✓ **Third ventricle:** diencephalon.
- ✓ **Cerebral aqueduct**: midbrain.
- ✓ **Fourth ventricle**: brain stem and the cerebellum.

CIRCULATION OF CSF

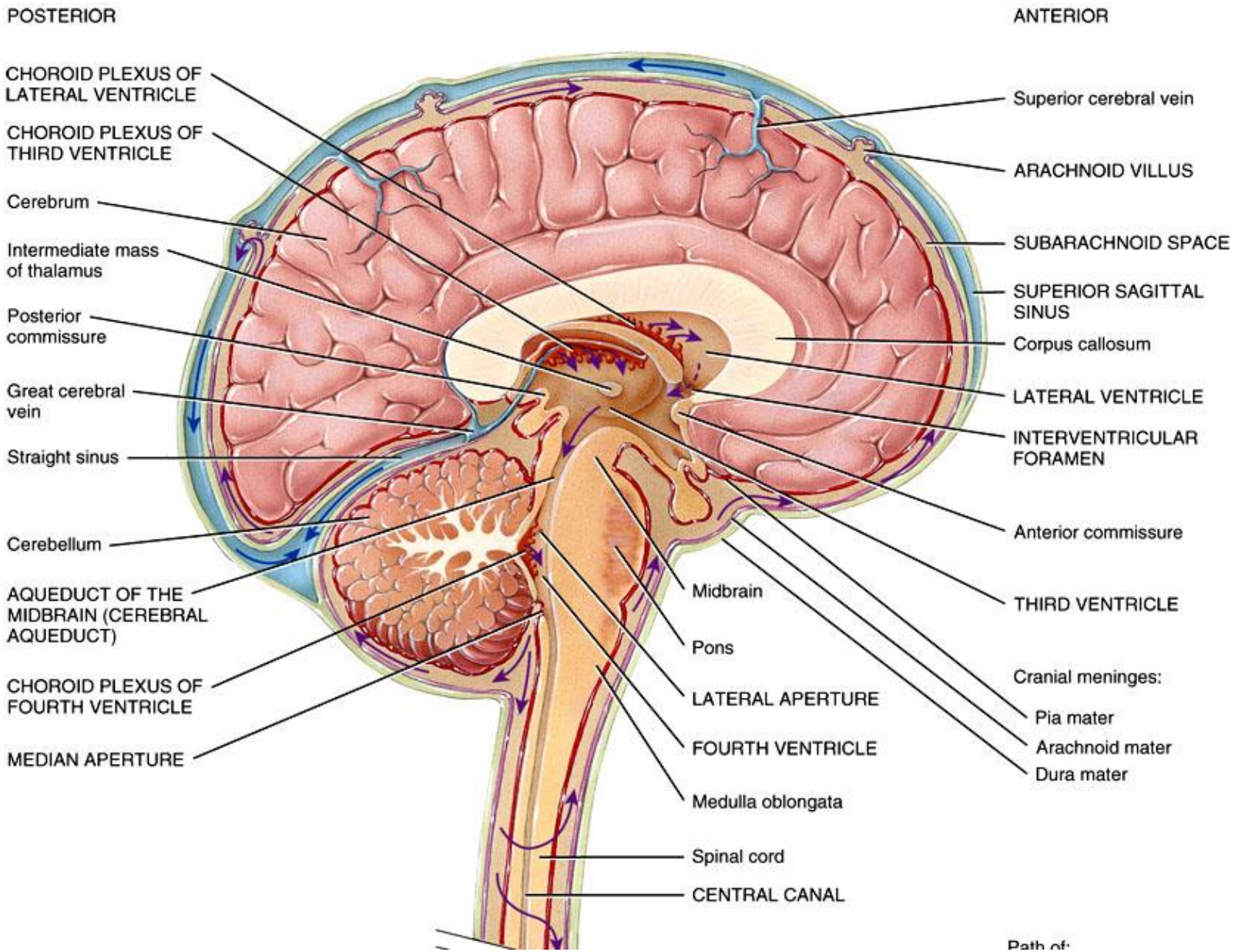
- CSF from the lateral ventricles → interventricular foramina → third ventricle → cerebral aqueduct → fourth ventricle → subarachnoid space or central canal.

- CSF is reabsorbed into the blood by arachnoid villi, fingerlike extensions of the arachnoid mater.



(d) Summary of the formation, circulation, and absorption of cerebrospinal fluid (CSF)

Figure 14.04d Tortora - PAP 12/e



CIRCULATION OF CSF

SPINAL CORD

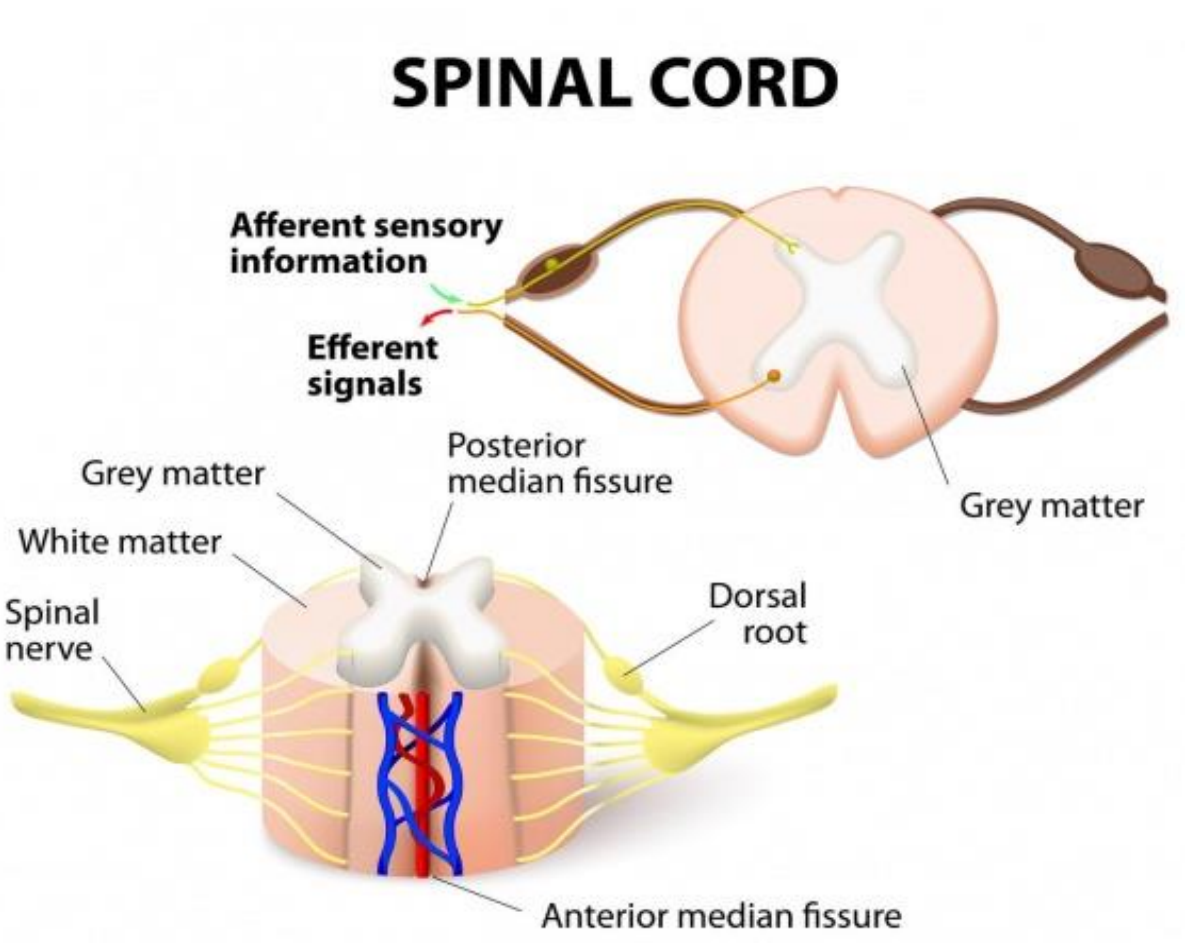
- Is the part of the central nervous system that extends from the brain. The spinal cord and its associated spinal nerves contain neural circuits that control some of your most rapid reactions to environmental changes.

- If you pick up something hot, the grasping muscles may relax and you may drop the hot object even before you are consciously aware of the extreme heat or pain. This is an example of **a spinal cord reflex**—a quick, automatic response to certain kinds of stimuli that involves neurons only in the spinal nerves and spinal cord.

SPINAL CORD

Besides processing reflexes, the gray matter of the spinal cord also is a site for integration (summing) of excitatory postsynaptic potentials (EPSPs) and inhibitory postsynaptic potentials (IPSPs).

The white matter of the spinal cord contains a dozen major sensory and motor tracts, which function as the "highways" along which sensory input "ascending" travels to the brain and motor output " descending" travels from the brain to skeletal muscles and other effectors. Note: track's name contains firstly the origin, secondly the destination (i.e., spinothalamic).



THE DIENCEPHALON

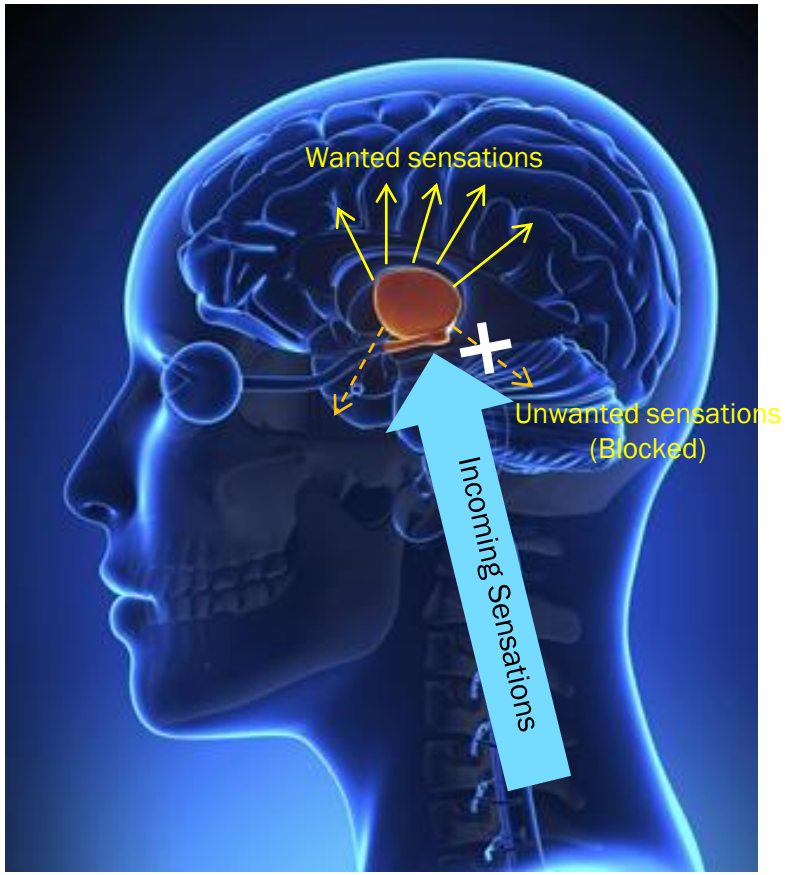
- **Forms a central core of brain tissue just superior to the midbrain.**

- **The components of the diencephalon:**

1. Thalamus.
2. Hypothalamus.
3. Epithalamus.

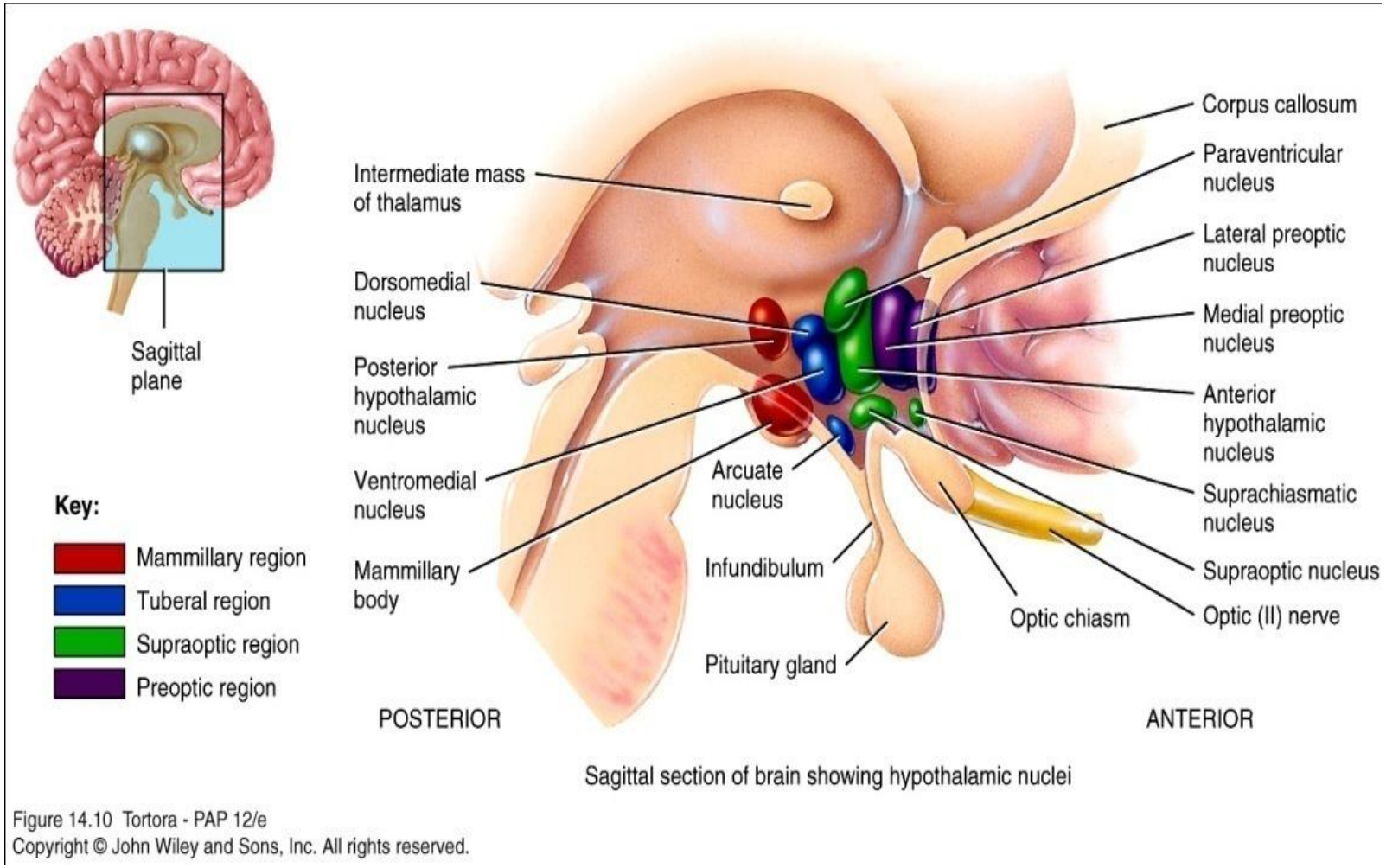
THALAMUS

- **Makes up 80% of the diencephalon.**
- **Major relay station for most sensory impulses (preliminary processing of all sensory input on its way to the cortex.**
- **It screens out insignificant signals and routes the important sensory impulses to appropriate areas of the somatosensory cortex (e.g., attention to stimuli of interest).**



HYPOTHALAMUS

- is a small part of the diencephalon located inferior to the thalamus.
- Important link between the autonomic nervous system and the endocrine system via the pituitary gland.



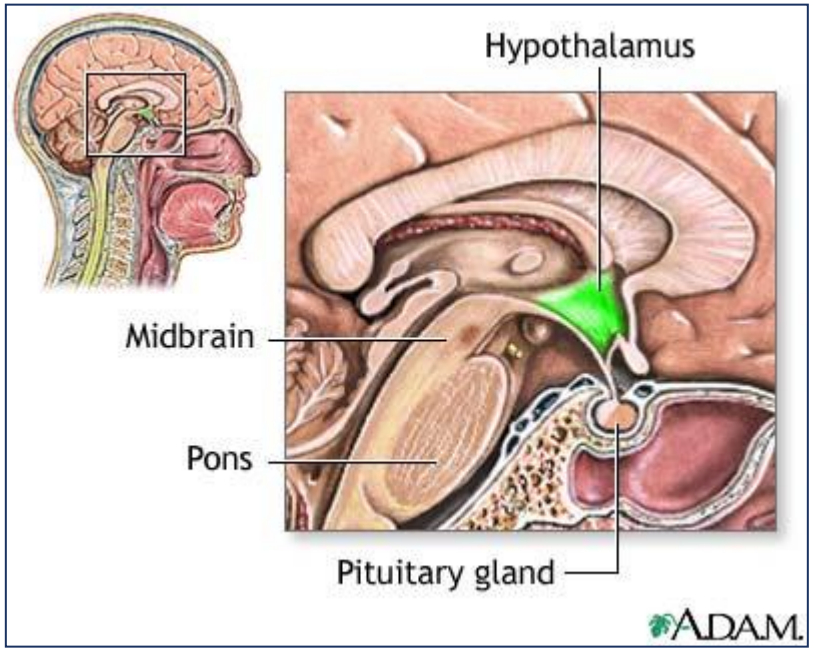
Sagittal section of brain showing hypothalamic nuclei

Figure 14.10 Tortora - PAP 12/e

Hypothalamus

*** Brain area most involved in directly regulating internal environment:**

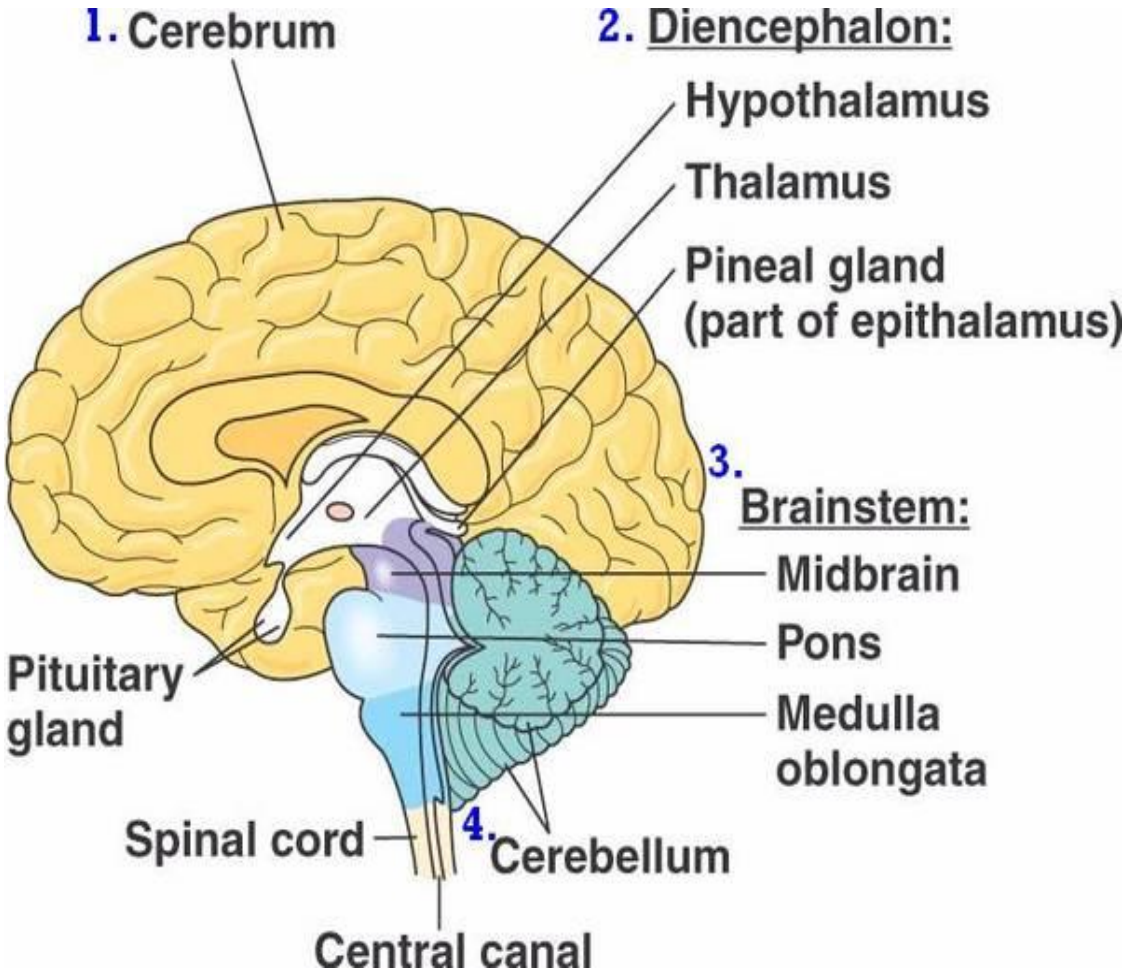
- Controls body temperature (the body's thermostat).
- Controls thirst and urine output.
- Controls food intake.
- Controls anterior pituitary hormone secretion.
- Produces posterior pituitary hormones.
- Controls uterine contractions and milk ejection.
- Serves as a major ANS coordinating center.
- Plays role in emotional and behavioral patterns (participates in expressions of rage, aggression, pain, and pleasure).
- Participates in sleep-wake cycle (Regulation of circadian rhythms).



THE BRAIN STEM

- The brain stem is the part of the brain **between the spinal cord and the diencephalon**.

- It consists of **three structures:** (1) medulla oblongata, (2) pons, and (3) midbrain.



THE BRAIN STEM

- **Main functions:**

✓ **Centers** to control body functions.

✓ The majority of the 12 pairs of **cranial nerves** arise from the brain stem.

✓ **Reticular formation** within brain stem receives and integrates all incoming sensory synaptic input; important for brain arousal (being awake & alert).

MEDULLA OBLONGATA

- **Continuous with the spinal cord.**

- **Lowest portion of brainstem.**

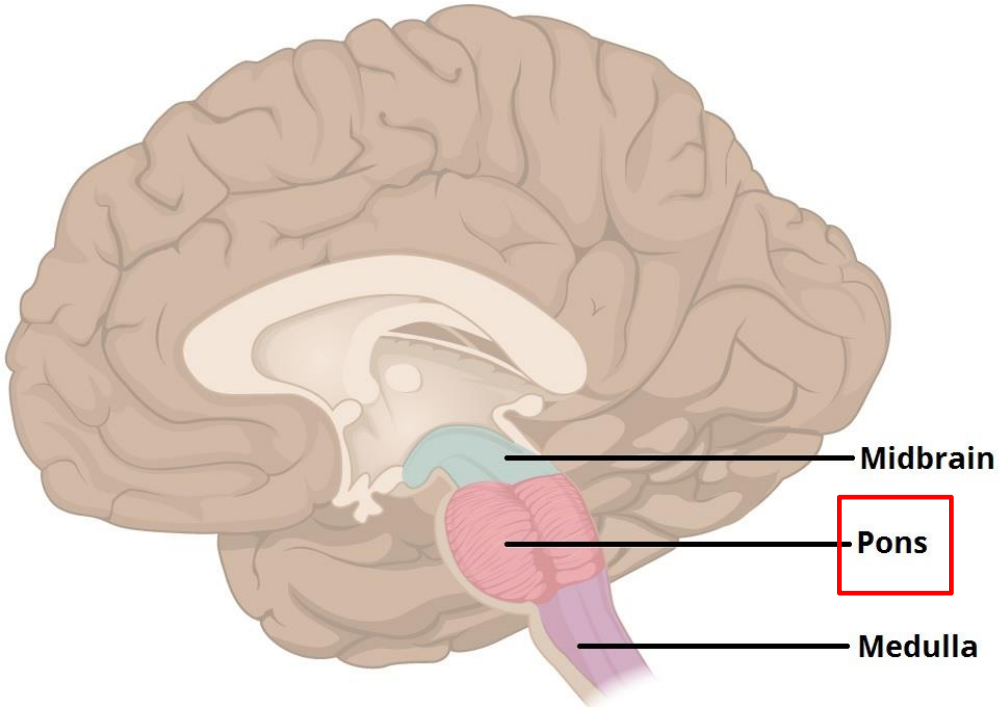
- **Centers of the Medulla Oblongata :**

- It **regulates vital activities** include **the cardiovascular center** (**regulates the rate and force of the heartbeat**) and **the respiratory center** (**adjusts the basic rhythm of breathing**).

- Also includes centers for **vomiting, swallowing, sneezing, coughing, and hiccupping**. It also controls sensory pathways for gustation **(taste),** audition **(hearing)**, and equilibrium **(balance).**

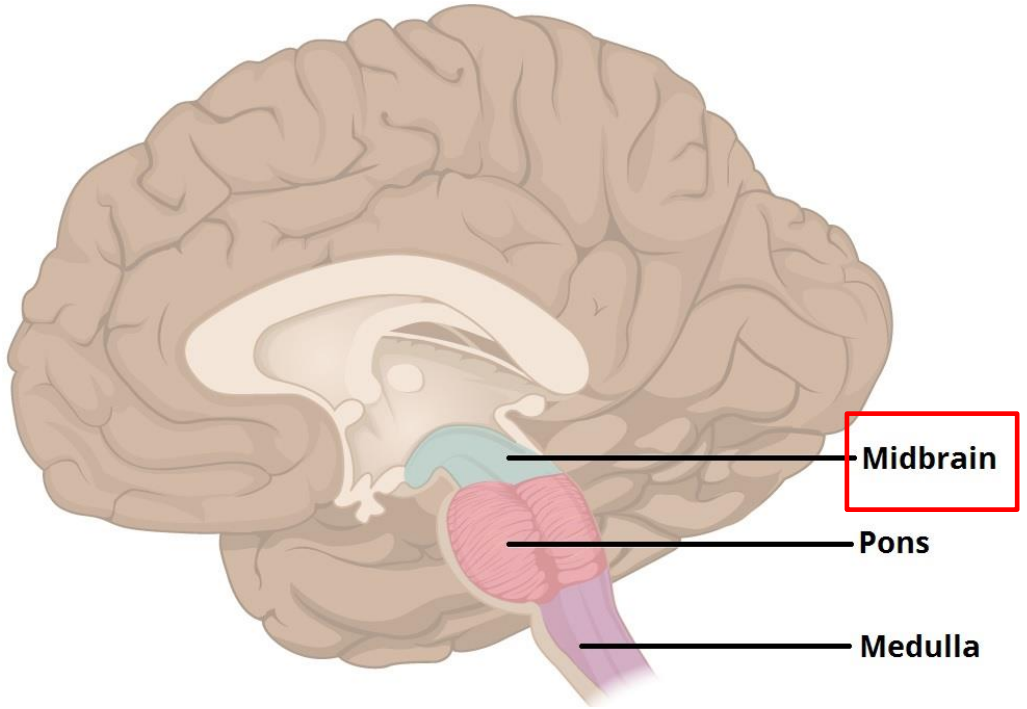
Pons

- Just above medulla.
- Contains 2 centers that help to regulate breathing.
- Also contains nuclei that affect sleep and bladder control.



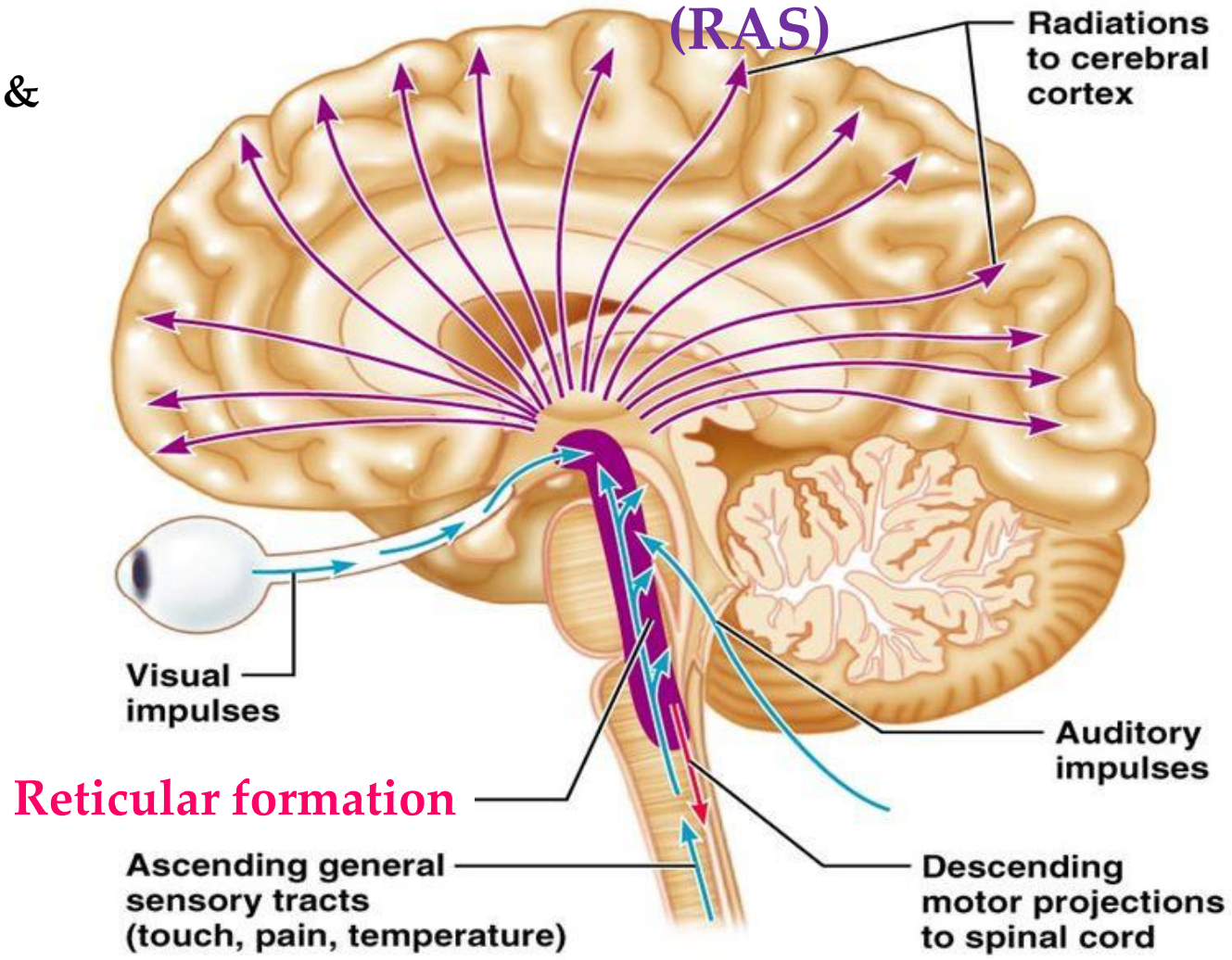
Midbrain

- **Controls visual & auditory reflexes.**



Reticular Activating System (RAS)

Maintaining consciousness & awakens from sleep "alarm clock".



RETICULAR FORMATION

- Extends from the upper part of the spinal cord, throughout the brain stem, and into the lower part of the diencephalon.

RETICULAR FORMATION

- **Part of the reticular formation called the reticular activating system (RAS) consists of sensory axons that project to the cerebral cortex.**

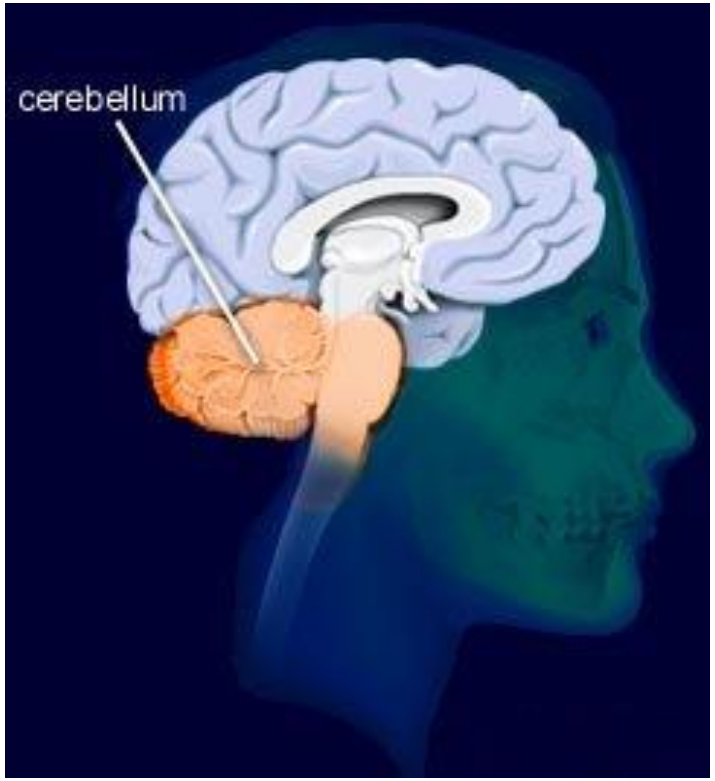
- Among these sensory stimuli are visual and auditory stimuli; mental activities; stimuli from pain, touch, and pressure receptors; and receptors in our limbs and head. Thus, it helps maintain consciousness.

- **Inactivation of the RAS produces sleep**, a state of partial consciousness.
- **Damage to the RAS, on the other hand, results in coma,** a state of unconsciousness.

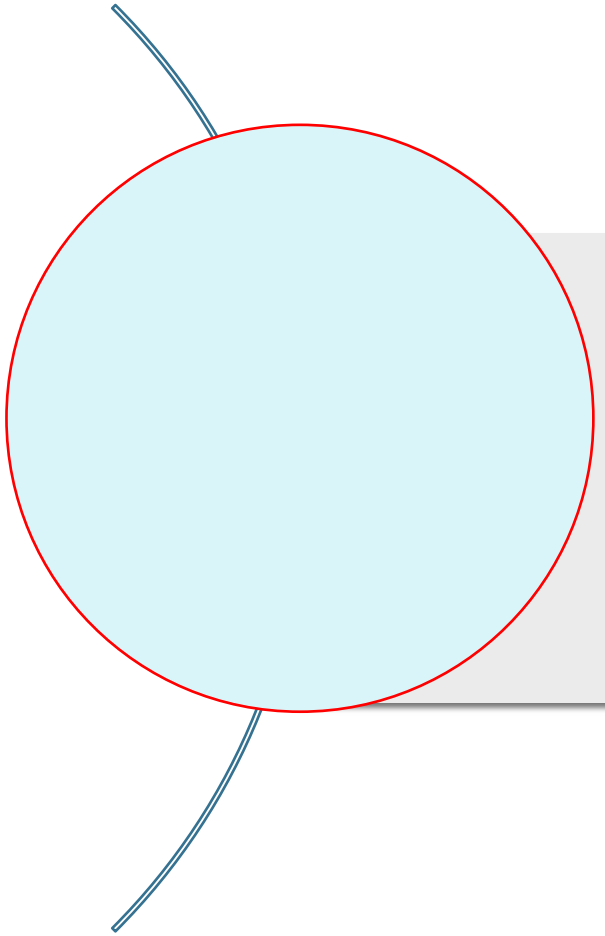
THE CEREBELLUM

- **Functions** coordinates and smoothes contractions of skeletal muscles during skilled movements and helps maintain posture and balance.

- Does not initiate movement, but contributes to coordination, precision, and accurate timing.

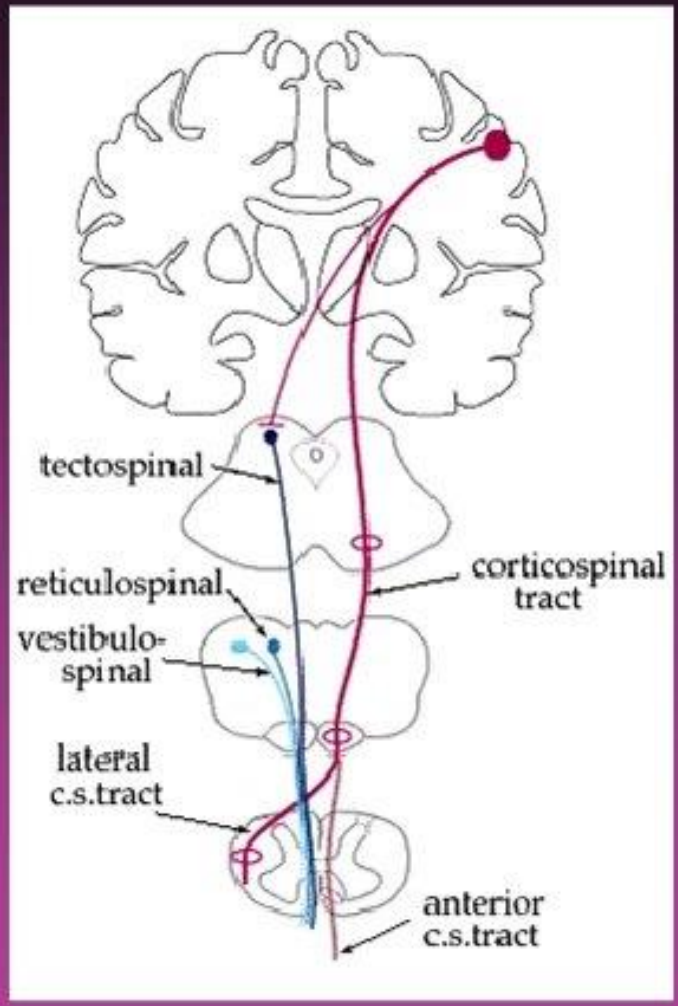


CEREBELLAR NEURONS



The cerebellum thus **coordinates body movements and helps maintain normal posture and balance.**

- The motor pathways are divided into two groups
  - Direct pathways (voluntary motion pathways) - the pyramidal tracts
  - Indirect pathways (postural pathways), essentially all others - the extrapyramidal pathways



DIRECT MOTOR PATHWAYS

Corticospinal Pathways: Conducting impulses for the control of muscles of the limbs and trunk.

Corticobulbar Pathway: Conducting impulses for the control of skeletal muscles in the head.

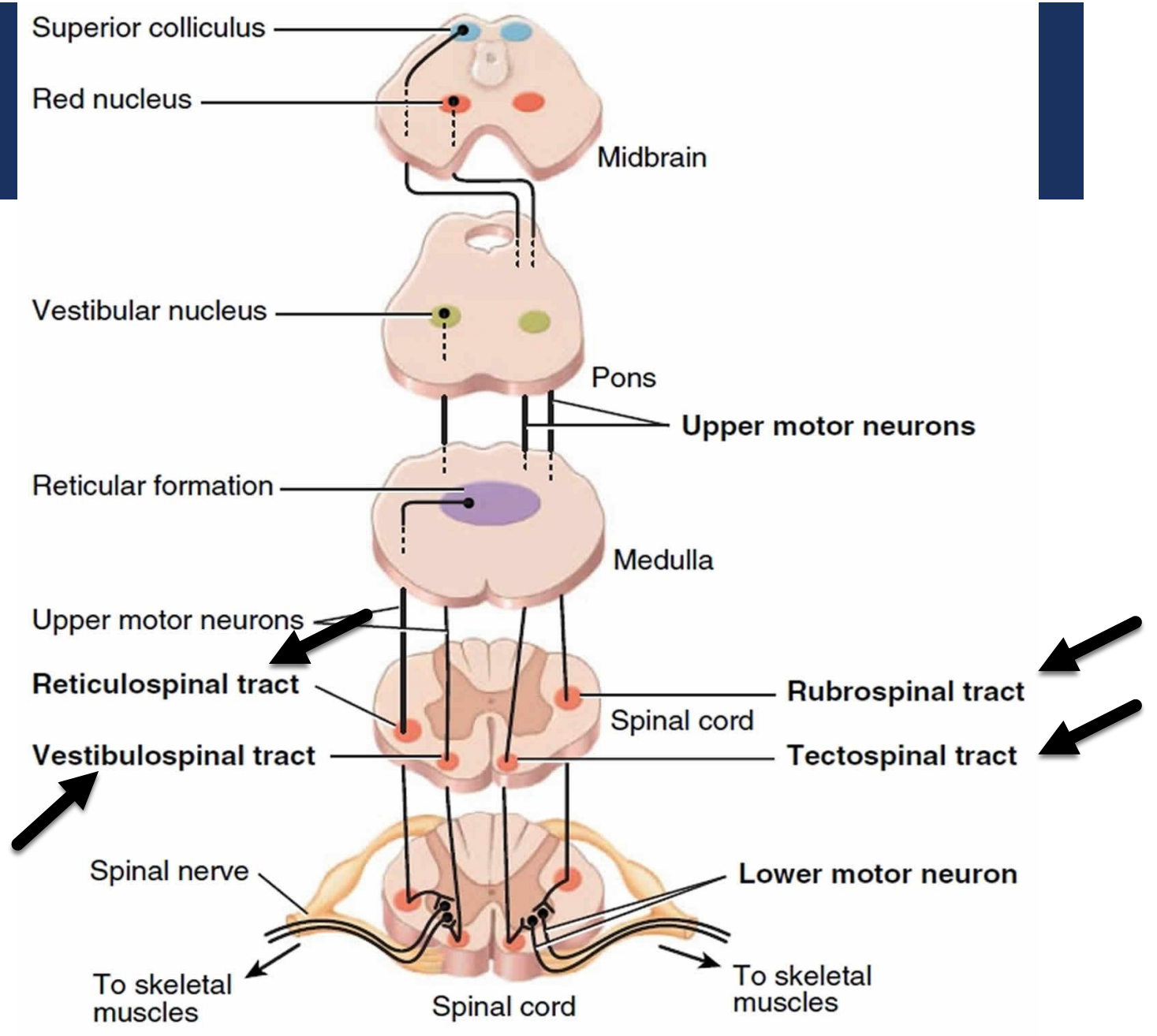
INDIRECT MOTOR PATHWAYS

Rubrospinal: For precise, voluntary movements of distal parts of upper limbs.

Tectospinal: For moving head, eyes, and trunk in response to visual or auditory stimuli.

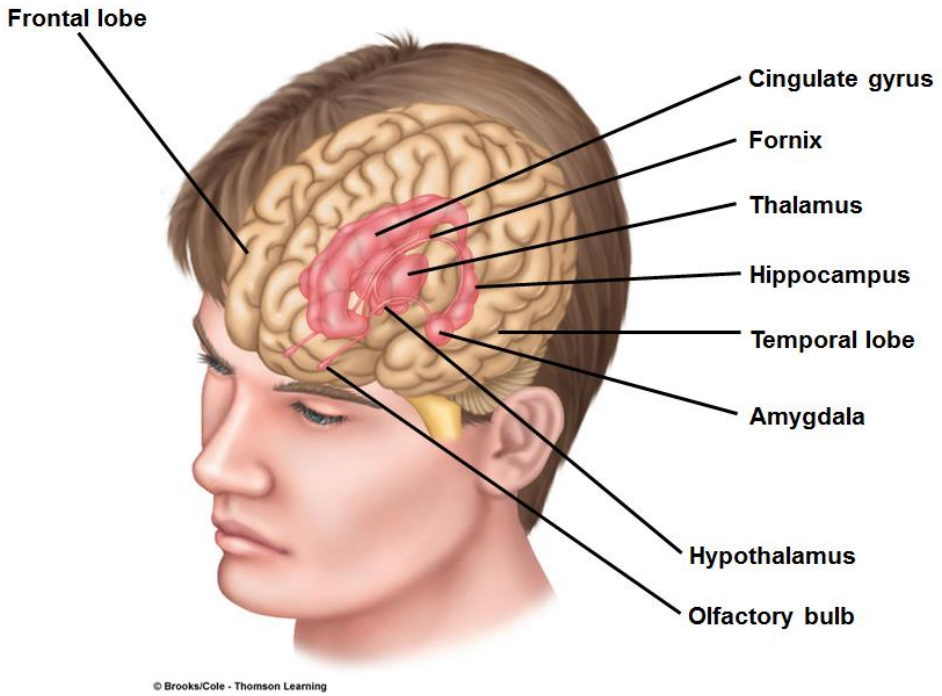
Vestibulospinal: For receiving input about head movements from inner ear and maintaining posture and balance in response to head movements.

Medial and lateral reticulospinal: For maintaining posture and regulating muscle tone in response to ongoing body movements.



Limbic System

- Not a separate structure but a ring of forebrain structures.
- Includes portions of the hypothalamus and other forebrain structures that encircle brain stem.



- Plays a key role in
  1. Emotion; pain, anger, fear, pleasure (reward and punishment centers).
  2. Basic survival and socio-sexual behavioral patterns.
  3. Motivation & learning.

THE CEREBRUM

- **“Seat of intelligence”,** provides us with the ability to read, write, and speak; to make calculations and compose music; and to remember the past, and plan for the future.

INTEGRATIVE FUNCTIONS OF THE CEREBRUM

- **Wakefulness and sleep**
- **Learning and memory**

SLEEP

- **A state of altered consciousness.**
- Two components: non-rapid eye movement (NREM) sleep and rapid eye movement (REM) sleep.

❖ NREM sleep consists of four stages:

- **Stage 1**-is a transition stage between wakefulness and sleep that normally lasts 1–7 minutes.
- **Stage 2**-is the first stage of true sleep.
- **Stage 3**-is a period of moderately deep sleep.
- **Stage 4**-is the deepest level of sleep

➢ **Typically, a person goes from stage 1 to stage 4 of NREM sleep in less than an hour. During a typical 7- or 8-hour sleep period, there are three to five episodes of REM sleep, during which the eyes move rapidly back and forth under closed eyelids.**

LEARNING AND MEMORY

- **Learning** is the ability to acquire new information or skills through instruction or experience.

- **Memory** is the process by which information acquired through learning is stored and retrieved.

MEMORY TYPES

- **Immediate memory-** recall for a few seconds.
- **Short-term memory-** temporary ability to recall.
- **Long-term memory-** more permanent.
- **Memory consolidation-** is the reinforcement that results from the frequent retrieval of a piece of information.

HEMISPHERIC LATERALIZATION

Functional Differences Between the Two Cerebral Hemispheres

LEFT HEMISPHERE FUNCTIONS	RIGHT HEMISPHERE FUNCTIONS
Receives somatic sensory signals from and controls muscles on right side of body.	Receives somatic sensory signals from and controls muscles on left side of body.
Reasoning.	Musical and artistic awareness.
Numerical and scientific skills.	Space and pattern perception.
Ability to use and understand sign language.	Recognition of faces and emotional content of facial expressions.
Spoken and written language.	Generating emotional content of language.
	Generating mental images to compare spatial relationships.
	Identifying and discriminating among odors.

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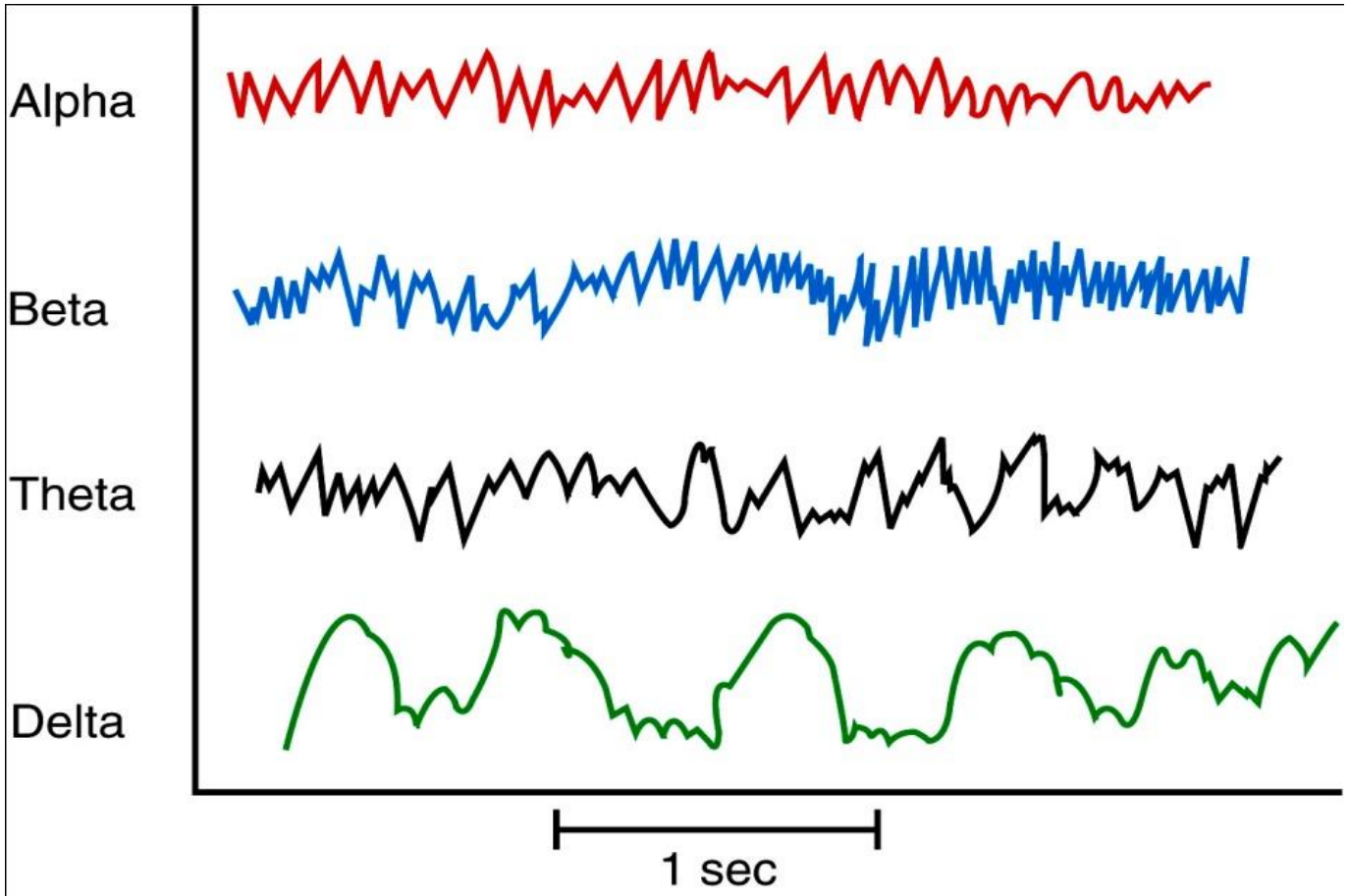
BRAIN WAVES

- At any instant, brain neurons are generating millions of nerve impulses (action potentials). Taken together, these electrical signals are called brain waves.
- **Electroencephalogram EEG:** Recording of the electrical activity within the brain.

BRAIN WAVES

- **Electroencephalogram EEG:** Recording of the electrical activity within the brain.
- **Alpha waves** (are present in the EEGs of nearly all normal individuals when they are awake and resting with their eyes closed. These waves disappear entirely during sleep).
- **Beta waves** (generally appear when the nervous system is active—that is, during periods of sensory input and mental activity).
- **Theta waves** (normally occur in children and adults experiencing emotional stress).
- **Delta waves** (occur during deep sleep in adults, but they are normal in awake infants. When produced by an awake adult, they indicate brain damage).

BRAIN WAVES



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THANK YOU

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