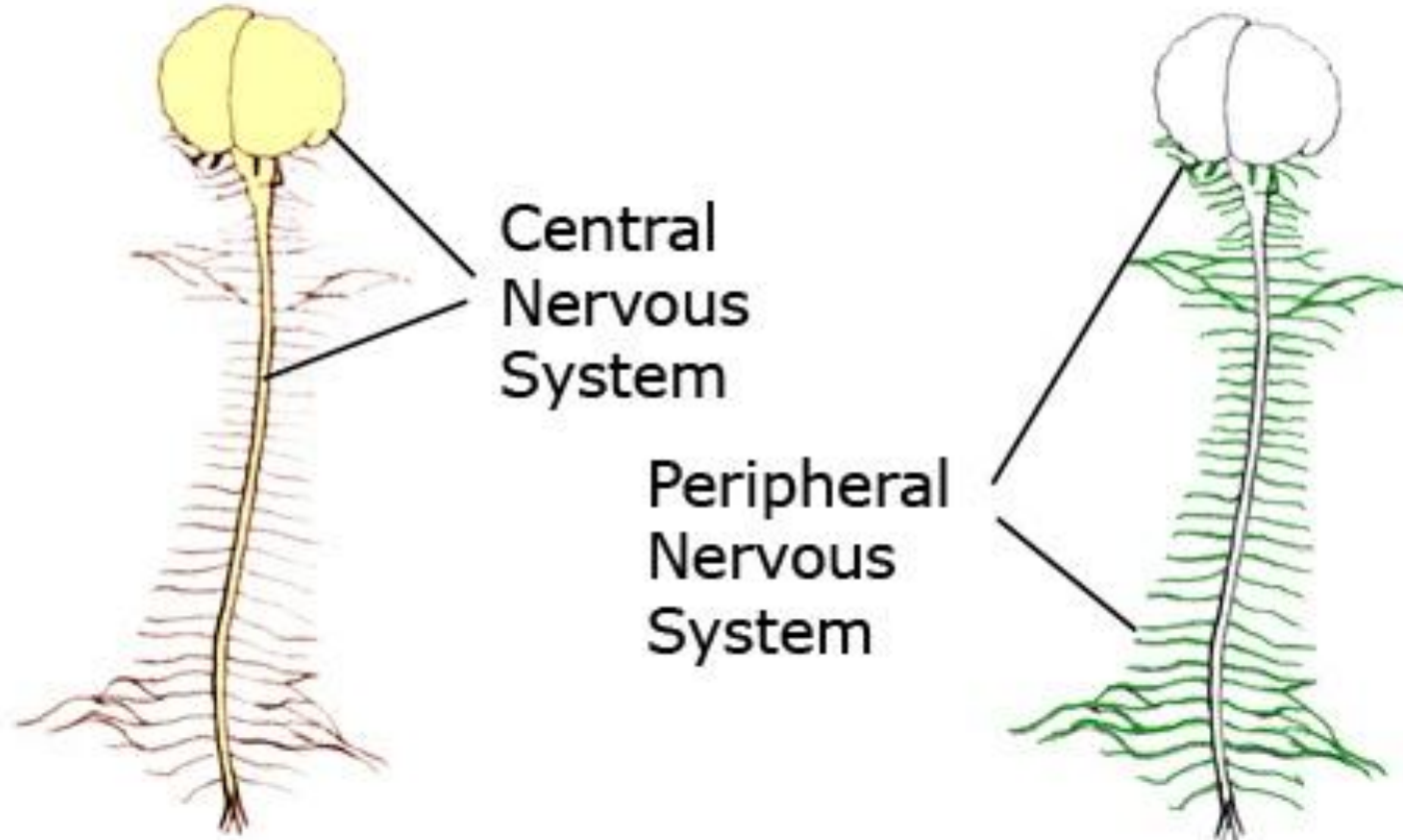


The Nervous System

The Central Nervous System (CNS) is composed of the **Brain** and **Spinal cord**



The Peripheral Nervous System (PNS) is composed of **Ganglia** and **Nerves**

Spotlight on the **Peripheral** Nervous System

Central Nervous System

Peripheral Nervous System

The PNS has 2 components:
The SNS and the ANS

Somatic Nervous System
(SNS)

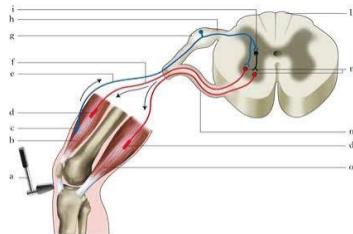
*Voluntary**

Effector Tissue is:

Skeletal Muscle
Only!

**Except for Reflexes*

#Except for Biofeedback mechanisms



Autonomic Nervous System
(ANS) (has 2 divisions)

Involuntary#

(2 divisions)

Parasympathetic

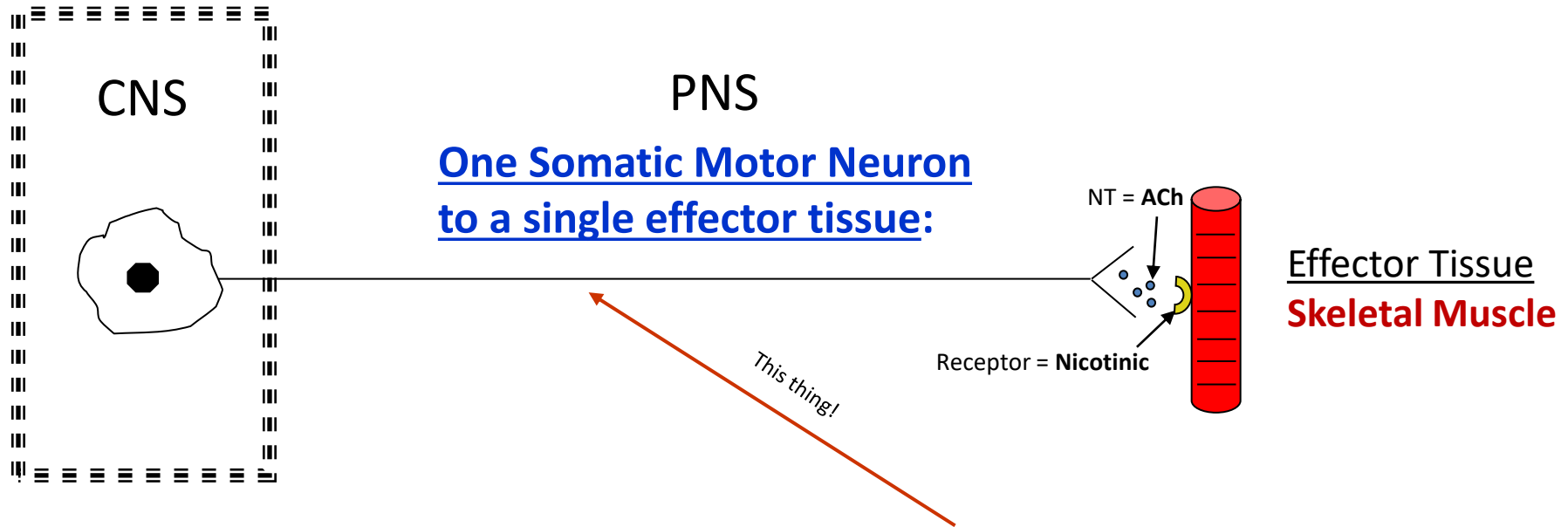
Sympathetic

Effector Tissues are:

1. Cardiac Muscle
2. Smooth Muscle
3. Glands

The Somatic Nervous System (SNS)

This one is simple and easy – so let it be!



All that ever happens is that a **Somatic Motor Neuron** 'fires' a signal to skeletal muscle fibers and then the muscle contracts!

If they do not send a signal, the muscle stays relaxed!

e.g., the musculocutaneous nerve sends a signal and presto, the biceps brachii contract!

Summary Notes on SNS:

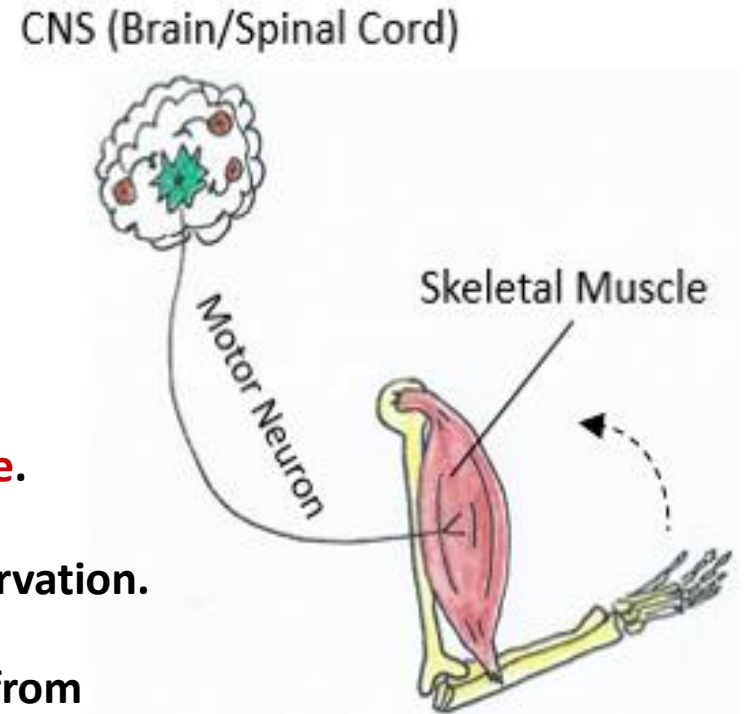
The **Somatic Nervous System** (SNS) is simple anatomically.

It is mostly under **Voluntary** control, meaning we are consciously aware of body movements.

(The *exception* is reflex actions)

Here are the important concepts of SNS:

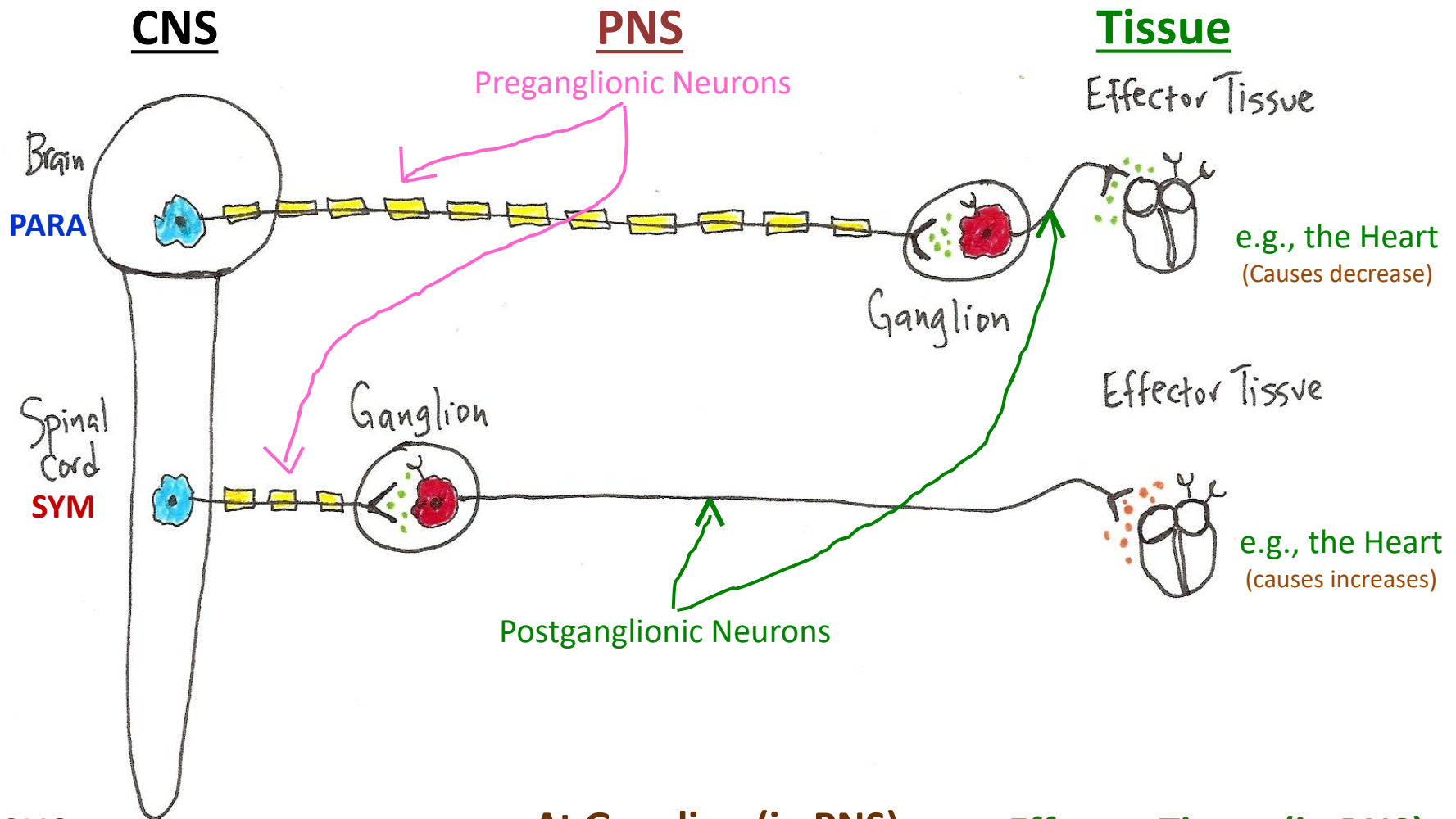
- There is only **1 Somatic Motor Neuron**.
- It acts on **1 Effector Tissue** only = **Skeletal muscle**.
- Skeletal muscle **contracts** as a result of this innervation.
- Skeletal muscle **relaxes** when there is no signal from somatic motor neurons.



We will **not** go into details about neurotransmitters and receptors, but...

At the neuromuscular junction for skeletal muscle, **somatic motor neurons** release **ACh** (acetylcholine) onto **nicotinic** receptors.

The Autonomic Nervous System (the ANS is more complex than the SNS)



In CNS: Preganglionic Neurons

Para = Craniosacral Origin*

Sym = Thoracolumbar Origin*

At Ganglion (in PNS):

Postganglionic

Nerve cell bodies

Effector Tissue (in PNS):

Cardiac Muscle

Smooth Muscle

Glands

*The term 'origin' means where in the CNS do these first ANS neurons come from.

Note that the same actions occur at the ganglion for both divisions, they are identical.

Here at the effector tissue is where the 2 divisions (Para and Sym) of the ANS differ.

Summary Notes on ANS:

The **Autonomic Nervous System** (ANS) is more complex anatomically.

The ANS is mostly under **involuntary** control, meaning we are not consciously aware of these responses.

(The *exception* is **biofeedback** actions)

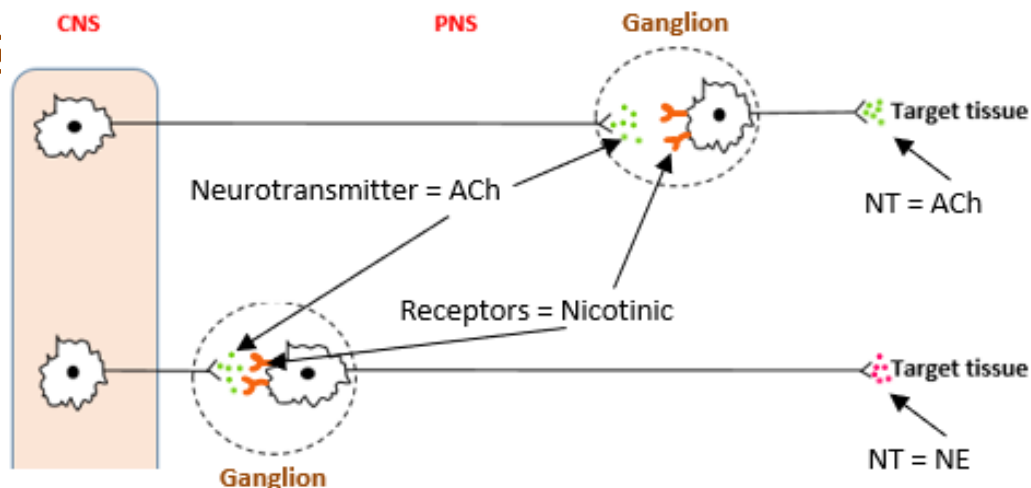
Here are the important concepts of ANS

There are 2 Motor Neurons in the ANS:

- The **preganglionic** neuron
- The **postganglionic** neuron

• **Acts on 3 Effector Tissues:**

- **Cardia muscle** – of the heart.
- **Smooth muscle** – of blood vessel walls, bronchioles, ducts, tracts and organs.
- **Glands** – of exocrine (sweat, salivary, etc.) and endocrine (hormones, etc.) glands.

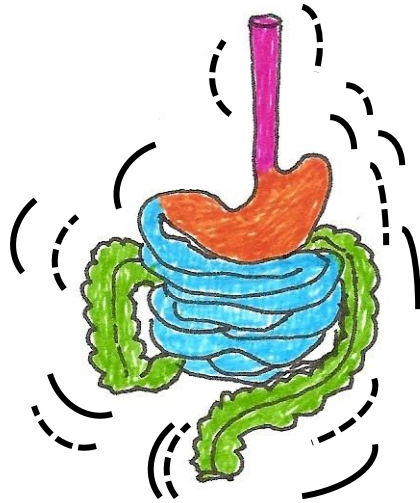


There are **2 divisions** of the ANS, the **Parasympathetic** and the **Sympathetic**

For the most part they oppose each other: Para is for resting and digesting, and Sym is for fast emergency responses to prepare the body for danger or excitement.

PARA

Rest and DIGEST



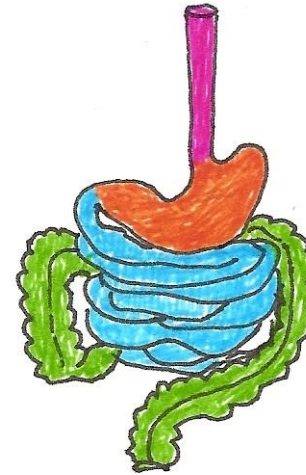
↑ In G. I. Tract **Motility**

↑ In G. I. Tract **Secretions**

G.I. Tract Alimentary Canal?

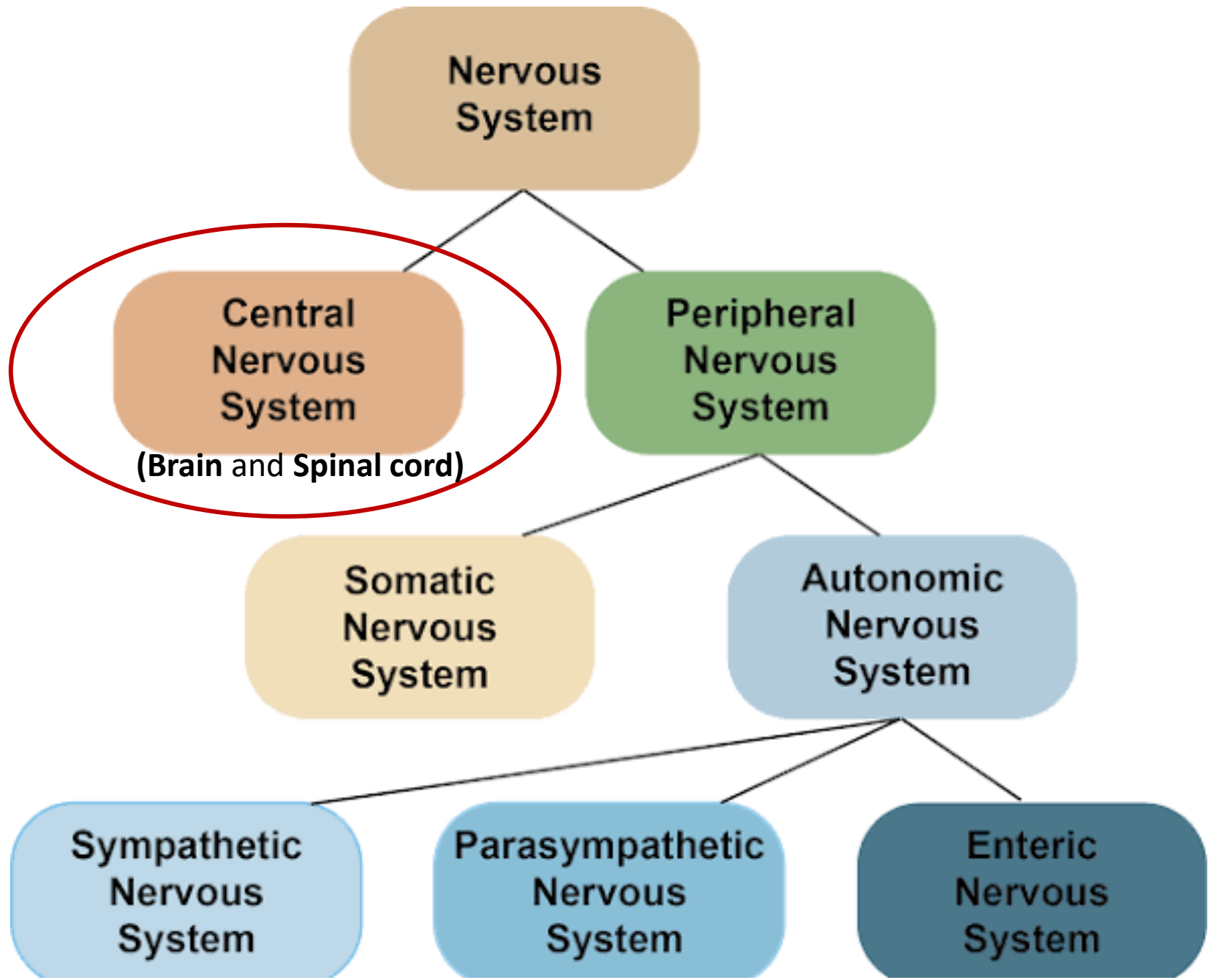
SYM

Emergency - no time to digest!



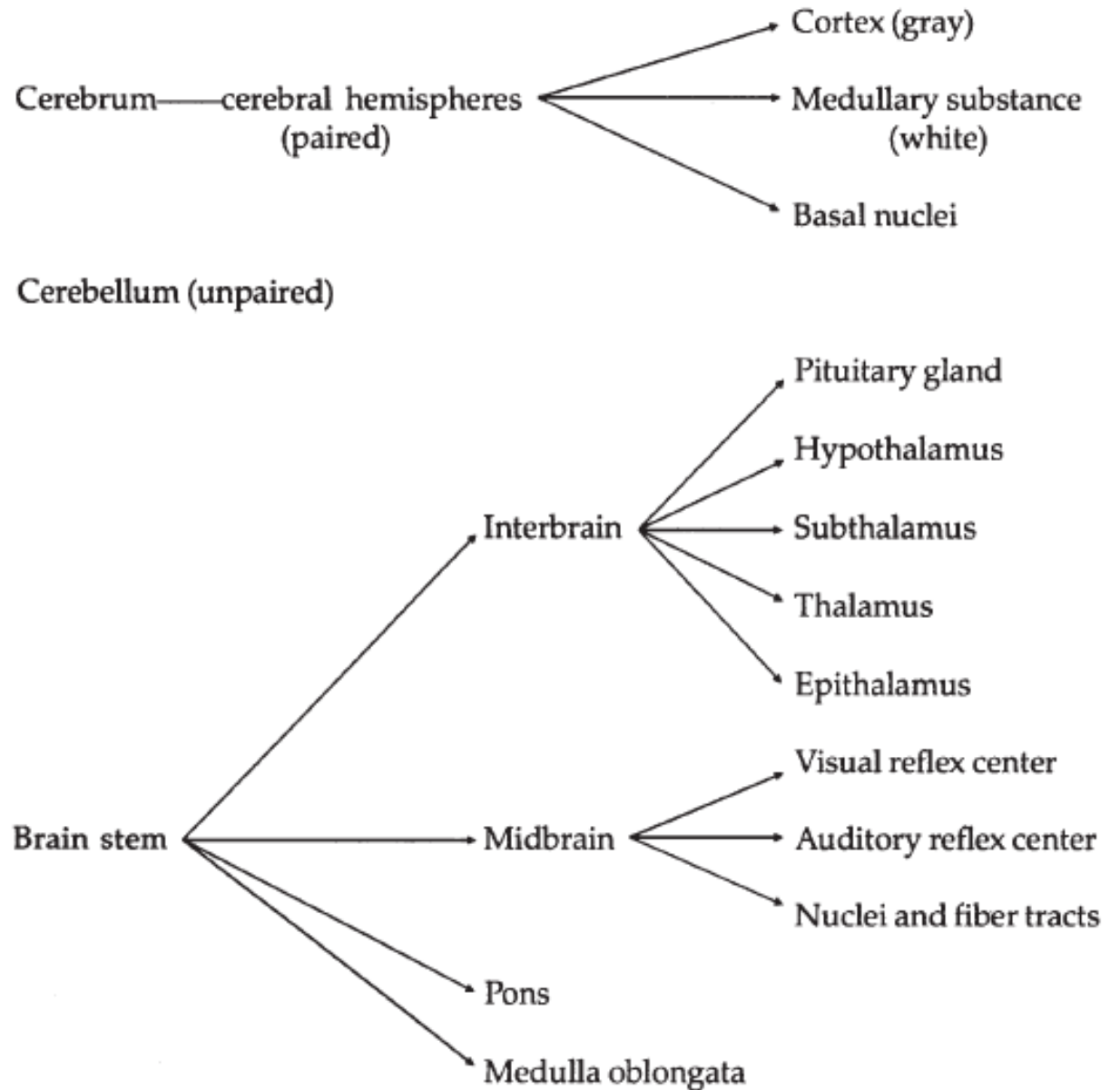
↓ In G. I. Tract **Motility**

↓ In G. I. Tract **Secretions**



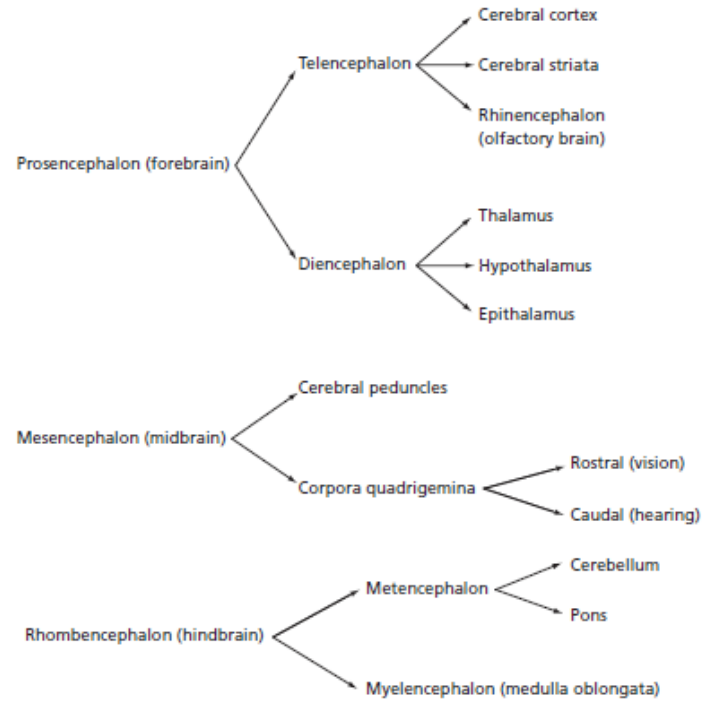
Central Nervous System

The Brain and its Regions

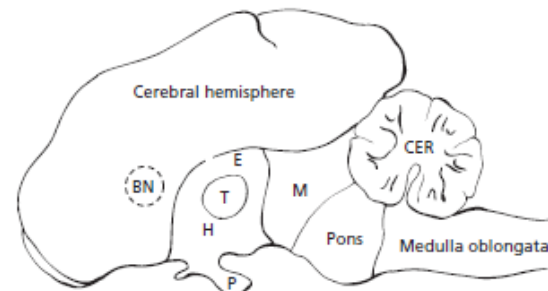


Central Nervous System

The Brain and its Regions



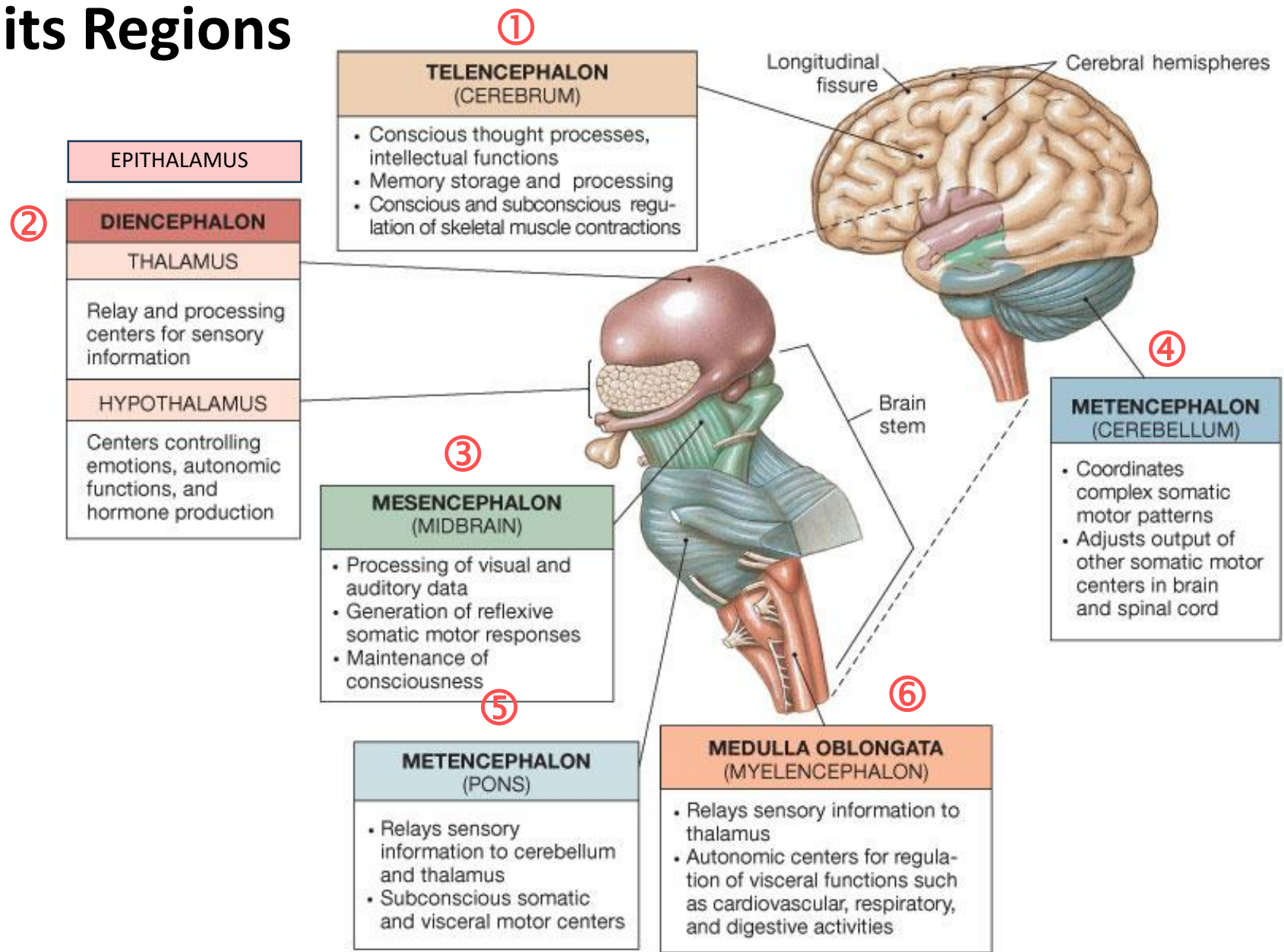
■ **FIGURE 4-6** Subdivisions of the brain according to its development from the primary embryonic vesicles, the prosencephalon, mesencephalon, and rhombencephalon.



■ **FIGURE 4-7** Relative locations of brain subdivisions to each other. BN, basal nuclei; E, epithalamus; T, thalamus; H, hypothalamus; P, pituitary gland; M, midbrain; CER, cerebellum. Dotted line for boundaries of basal nuclei represents its location on the midline.

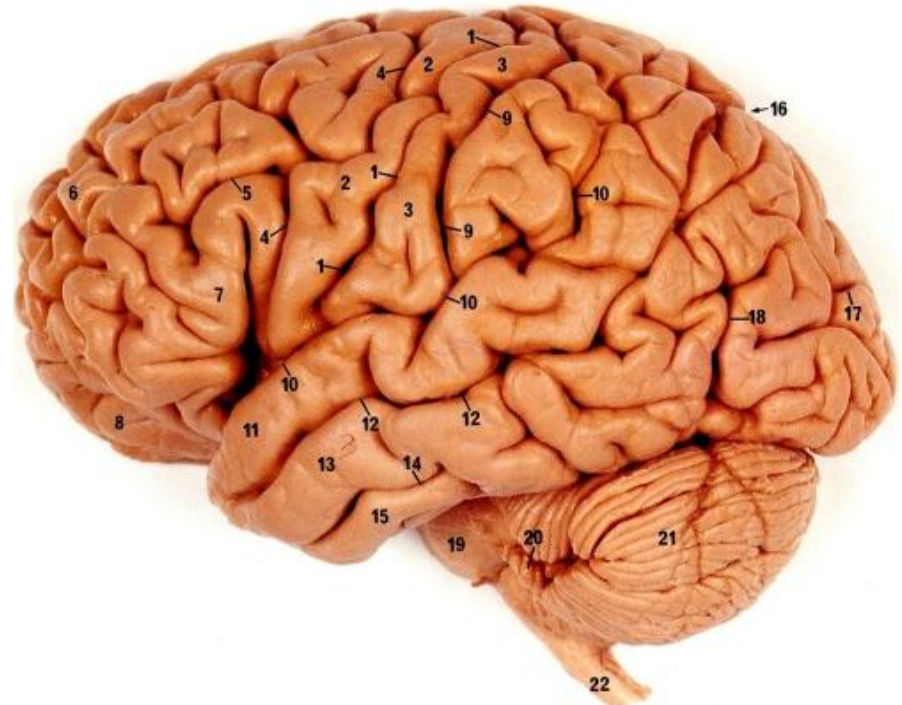
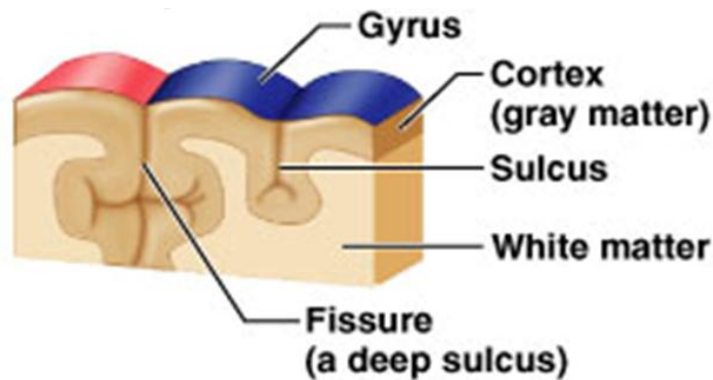
The Brain and its Regions

Central Nervous System



SUPERFICIAL ANATOMY OF THE HUMAN BRAIN

- **Sulci** (sulcus) – grooves on surface of cerebrum.
- **Gyri** (gyrus) – fold of brain tissue between sulci.
- **Fissure** - deep groove, separating hemispheres.



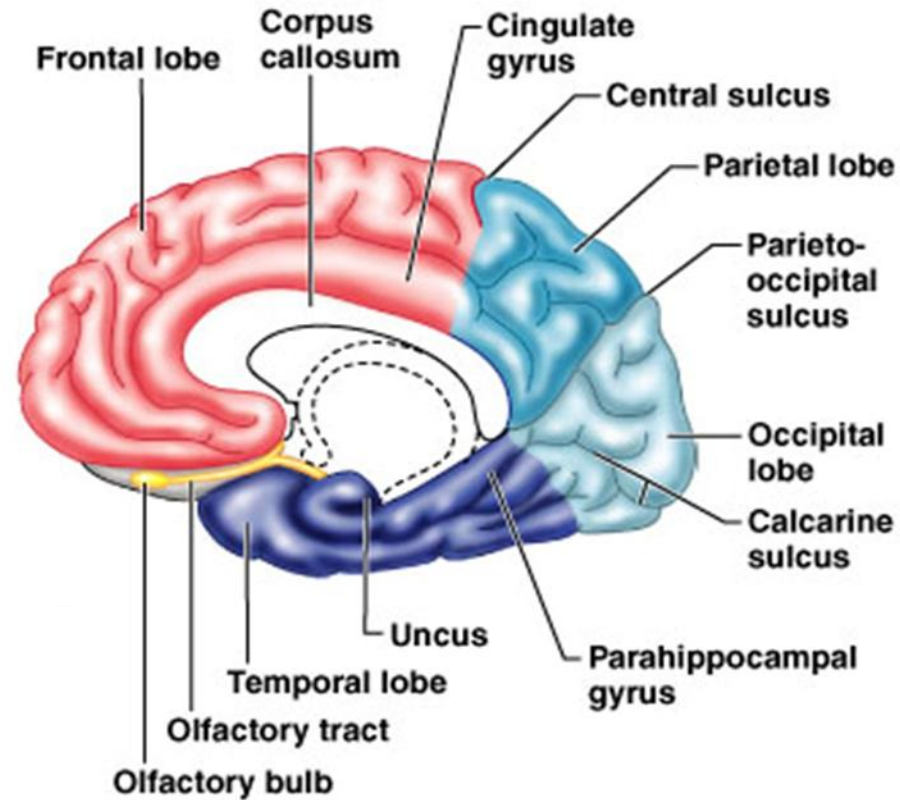
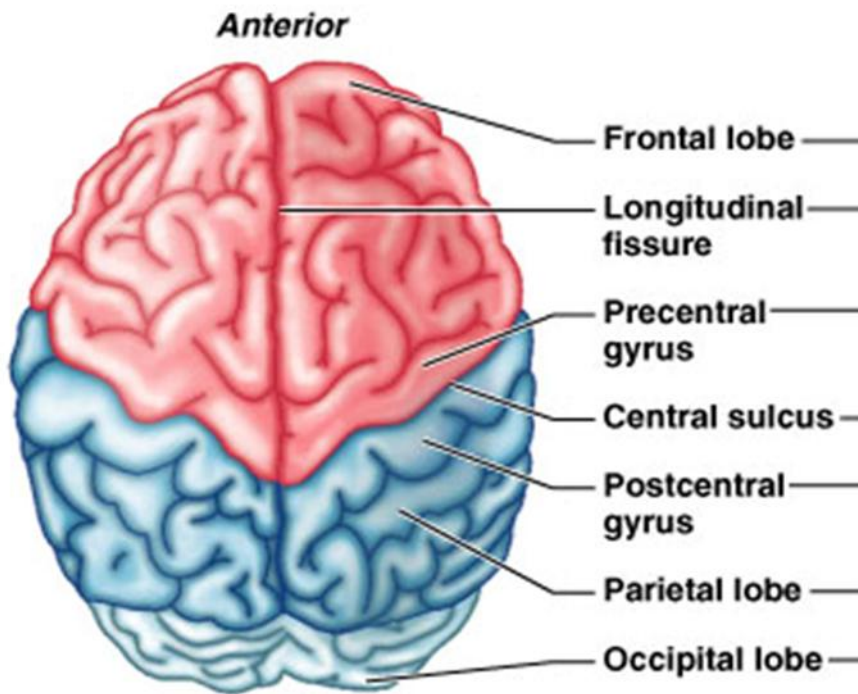
3 kinds of **cerebral** functional areas

- 1) Sensory areas
- 2) Association areas
- 3) Motor areas

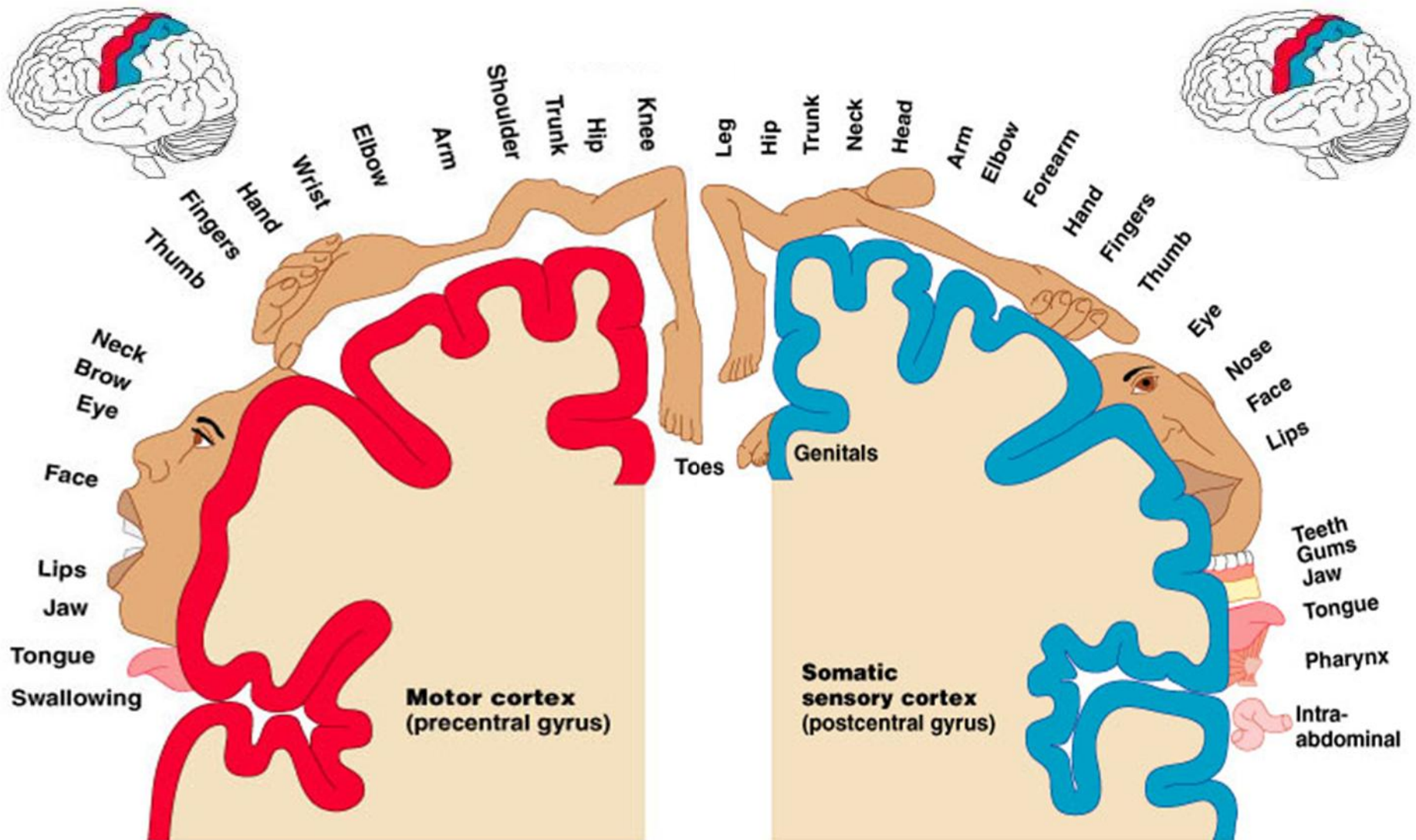
General Anatomy of Cerebrum (telencephalon)

Two Hemispheres - Left and Right.

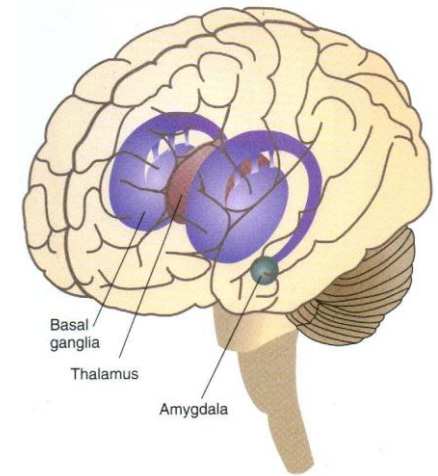
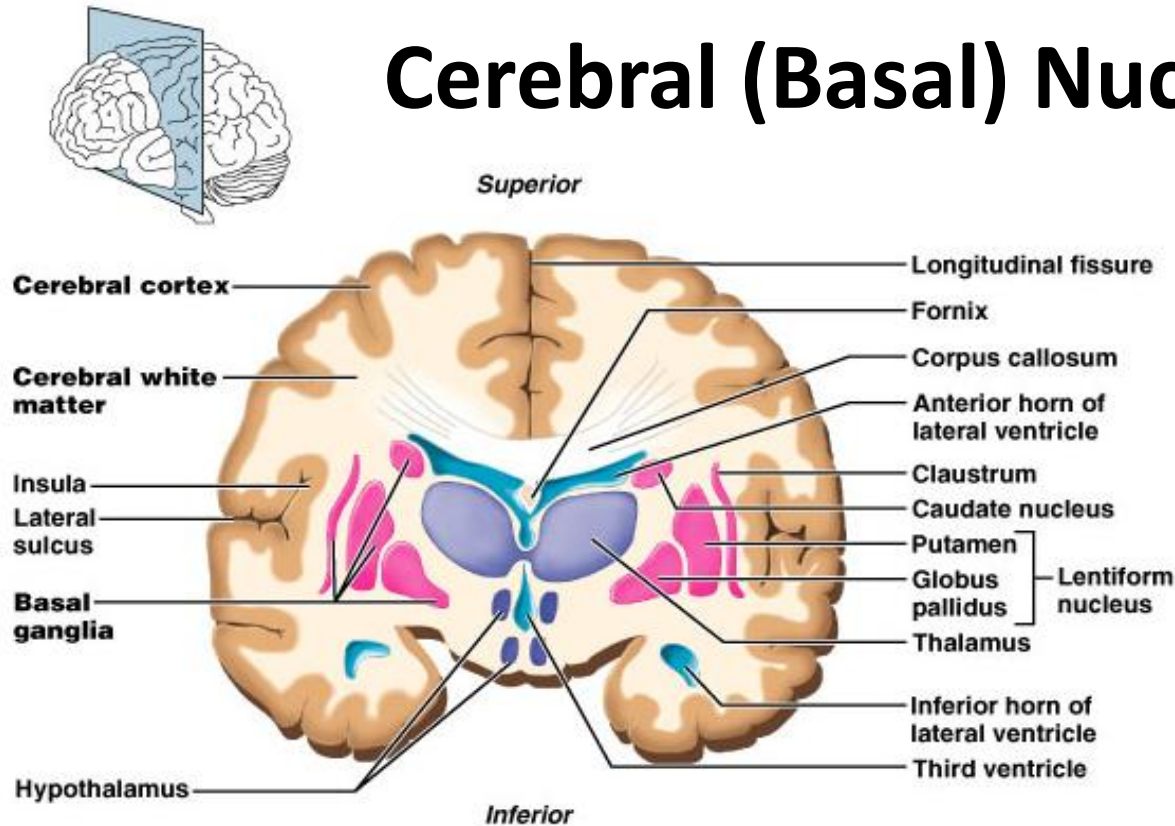
2 significant gyri: **Precentral gyrus (motor).**
 Postcentral gyrus (sensory).



Homunculus - Motor and Sensory



Cerebral (Basal) Nuclei



Consists of 5 pairs of Nuclei

1. Caudate nucleus
 2. Putamen
 3. Globus pallidus
 4. Subthalamic nucleus
 5. Substantia nigra
- } striatum

The **cerebral (basal) nuclei** are groups of subcortical nuclei deep within white matter.

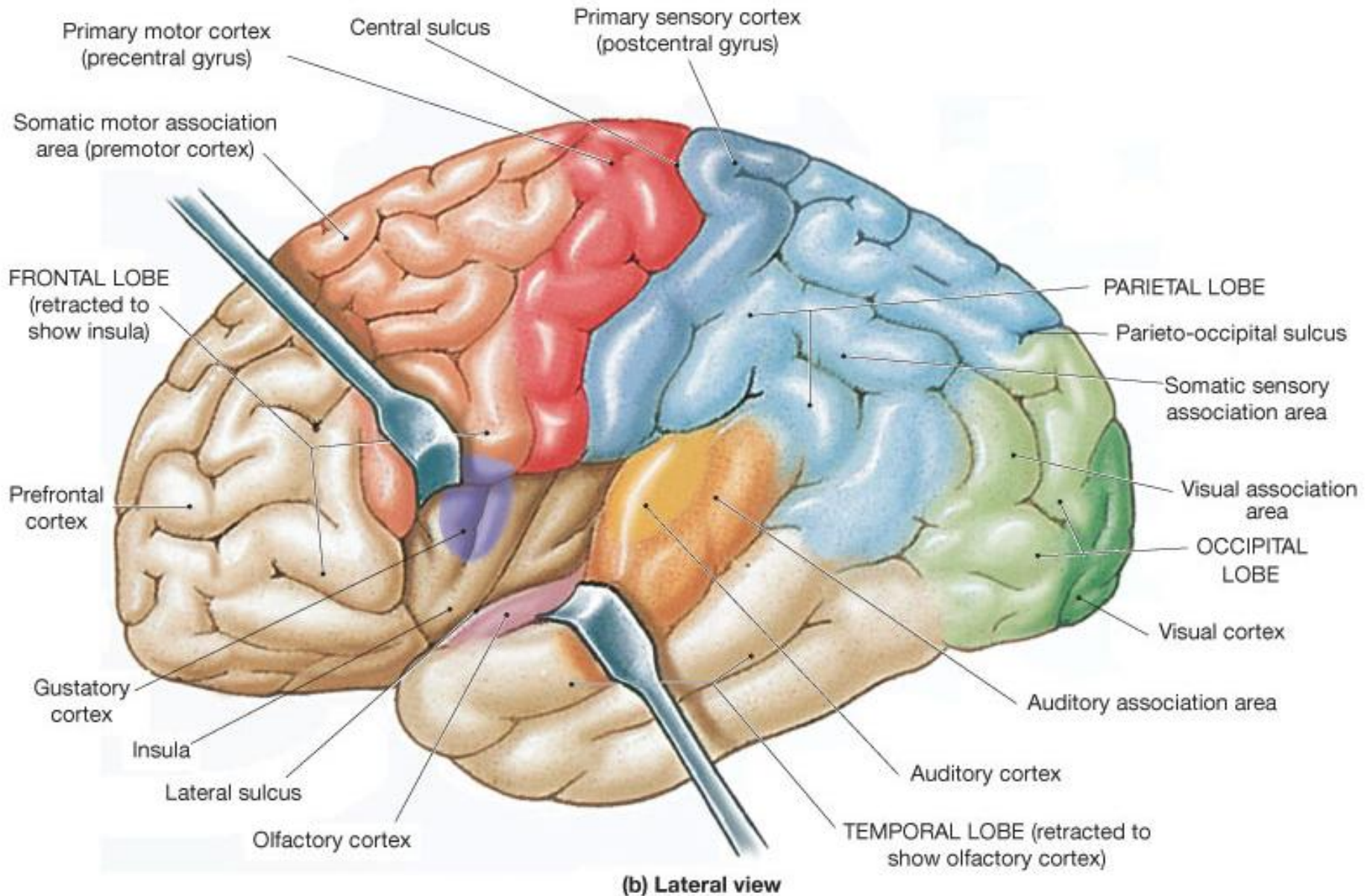
Key Role: Primarily to fine-tune **voluntary body movements**.

Process/signal from cerebral cortex -> conveys instructions to **thalamus** -> then relays back to **cortex**, -> finally sends to **skeletal muscles** via tracts of the pyramidal motor system.

Anatomical Note

- **Lentiform nucleus:** Refers to the combined structure of the **putamen** and **globus pallidus**, named for its lens-like shape.
- **Relation to ventricles:** These structures are positioned around the **lateral ventricles** and the **third ventricle**, lying **lateral to the thalamus**.

Cerebral Lobes



Functions of the Cerebrum

In General - our conscious mind, enables us to:

Be aware of ourselves and sensations.

Initiate and control voluntary movements.

Speak, communicate, reason, remember, predict and understand.

Cerebrum has 5 Lobes

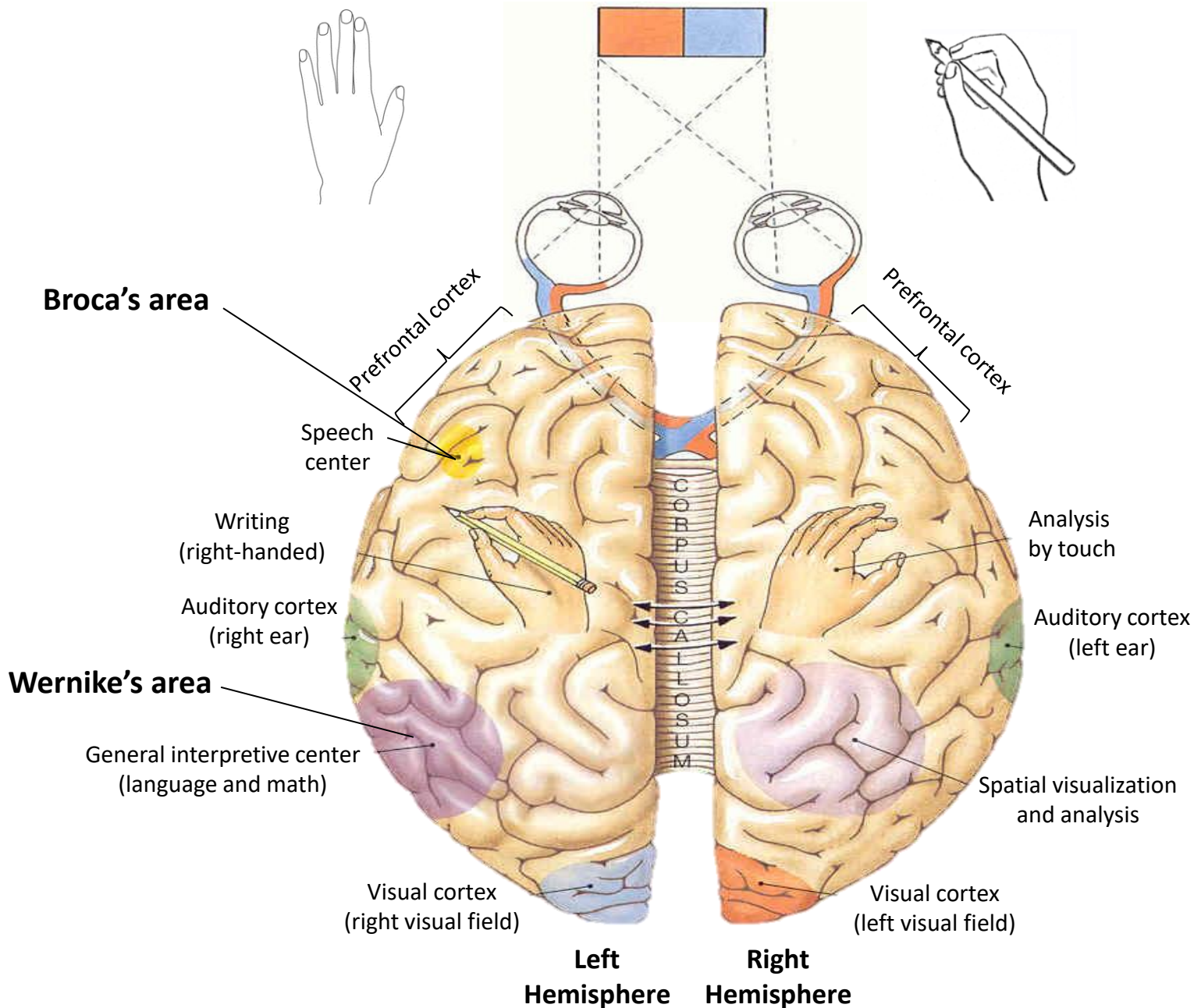
Frontal Lobe - memory, planning, emotional and behavior regulation, language (impulse control), personality, voluntary body movement.

Parietal Lobe - somatic sensory perception, spatial awareness.

Temporal Lobe - auditory and olfactory perception. Language & emotions.

Occipital Lobe - visual perception, visual memory.

Insula Lobe - visceral perception, fear and empathy, gustatory cortex.



Decussation: A crossing of nerve fibers from one side of the CNS to the other.

The Limbic System = “Emotional Brain”

Disparate (dispersed) Anatomical Location
(within cerebral and diencephalon)

Includes: Cingulate gyrus, hippocampus and amygdala.
The **fornix** connects the 2 hemispheres of limbic system.

Cingulate gyrus

Allows us to shift between thoughts.
Interprets pain as unpleasant.

Amygdala

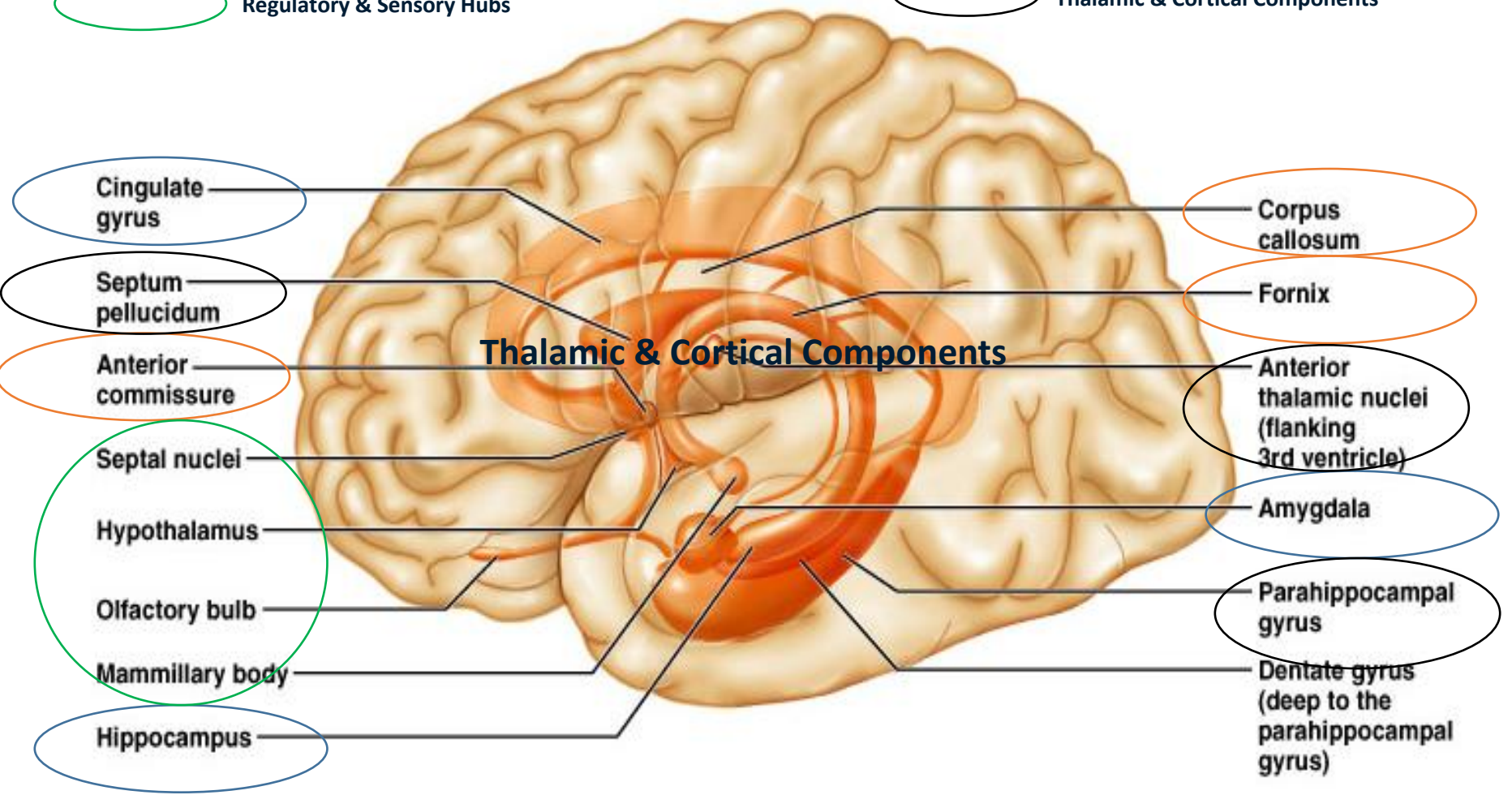
Detects menacing glances from others.
Emotional recognition of faces.

Hippocampus

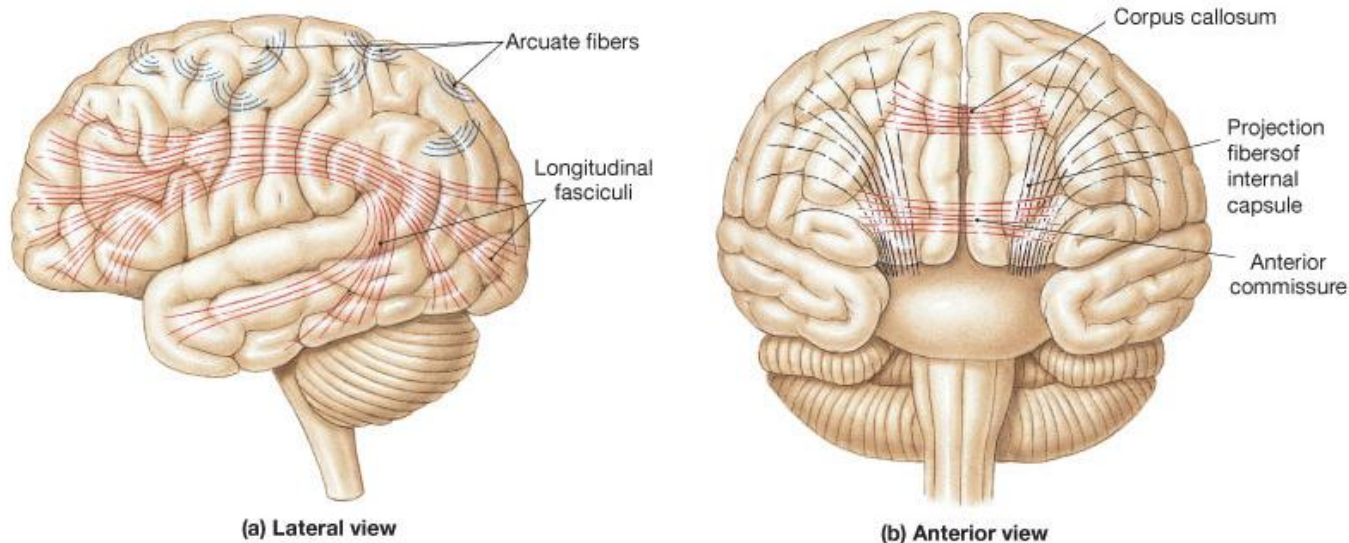
Consolidation of new memories (storage & retrieving)
Navigation and Spatial Orientation.

Anatomical Structures of the Limbic System

- Core Emotional & Memory Centers
- Regulatory & Sensory Hubs
- Signaling & Connecting Pathways
- Thalamic & Cortical Components



The major groups of **axon fibers** and tracts of the central white matter.



(a) Lateral view

(b) Anterior view

a) Association Fibers

These fibers connect different parts of the **same hemisphere** (left to left, or right to right). They allow various cortical areas within one side of the brain to "talk" to each other.

- Arcuate fibers
- Longitudinal fasciculi

b) Commissural Fibers

These fibers cross the midline to connect corresponding areas of the **two hemispheres** (left to right). They allow the two halves of the brain to function as a single unit.

- Corpus callosum
- Anterior commissure

c) Projection Fibers

These fibers connect the **cerebral cortex with lower parts of the CNS**, such as the thalamus, brainstem, or spinal cord. They "project" information over long distances up and down.

- Internal capsule

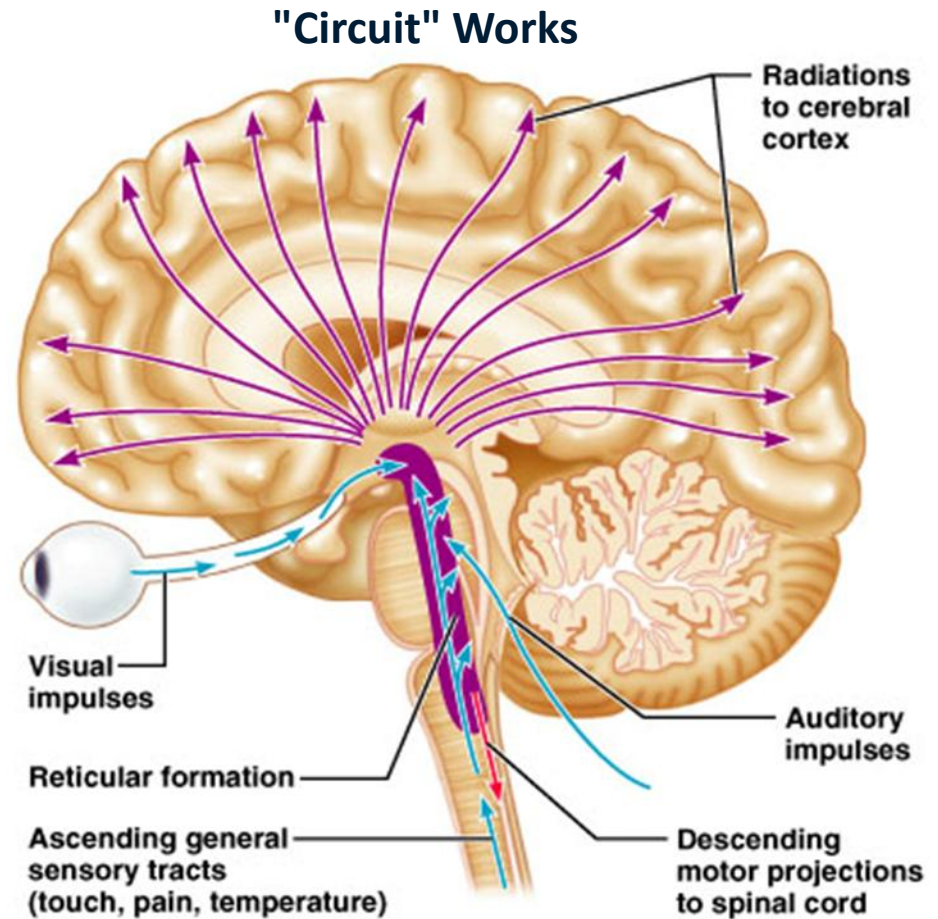
The **Reticular System** - widespread connections, ideal for arousal of the brain as a whole.

The Reticular Activating System (RAS)

The Reticular Activating System is a network of neurons located within the **Reticular Formation** of the brainstem (specifically in the **Pons** and **Medulla Oblongata**). It acts as a filter for the thousands of sensory inputs hitting your body every second.

Maintains **consciousness**
and **alertness**.

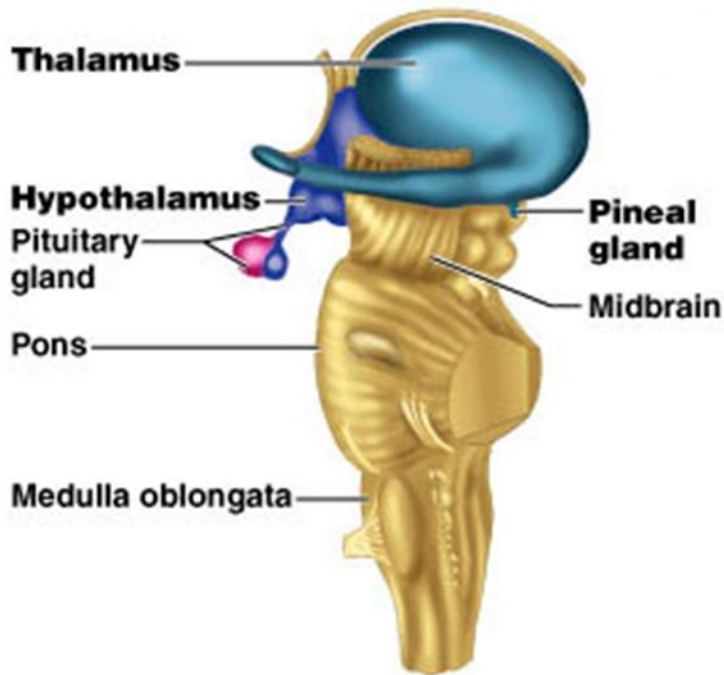
Functions in sleep and
arousal from sleep.



Regions below the Cerebrum

② Diencephalon

= 1) Epithalamus, 2) Thalamus and 3) Hypothalamus



1) Epithalamus

- Includes the **pineal gland (body)**. Secretes hormone **melatonin**, under influence of the hypothalamus.

Note: The significant **Blue Light** emitted from tv, computer and phone screens blocks the hormone **melatonin**, therefore suppressing your body's ability to prepare for sleep.

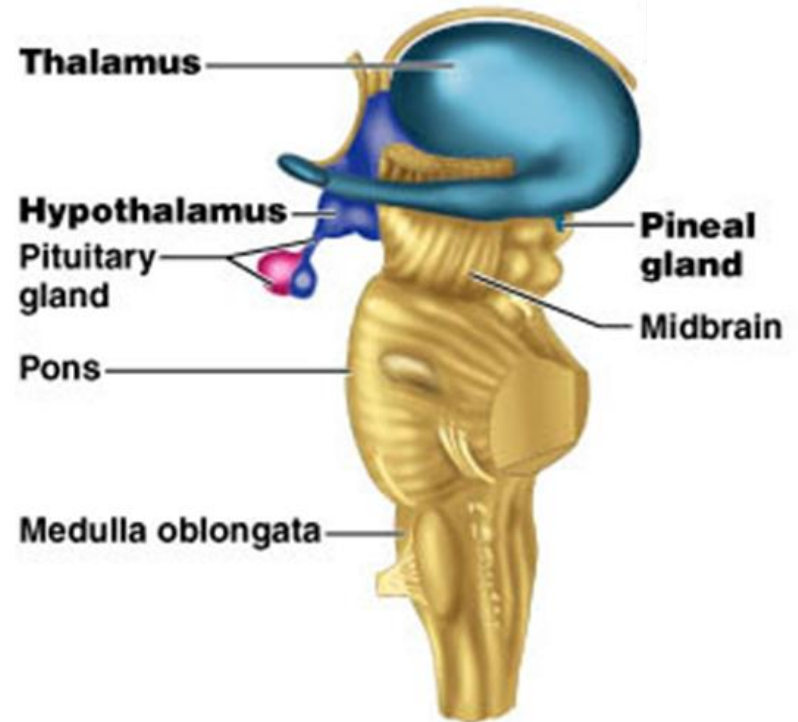
2) Thalamus

Makes up **80%** of the diencephalon.

Nuclei organize and amplify or tone down signals.

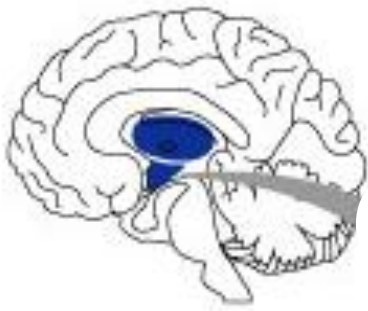
Afferent impulses converge on thalamus.

Many thalamic nuclei act as the “gateway” to cerebral cortex for sensory input.



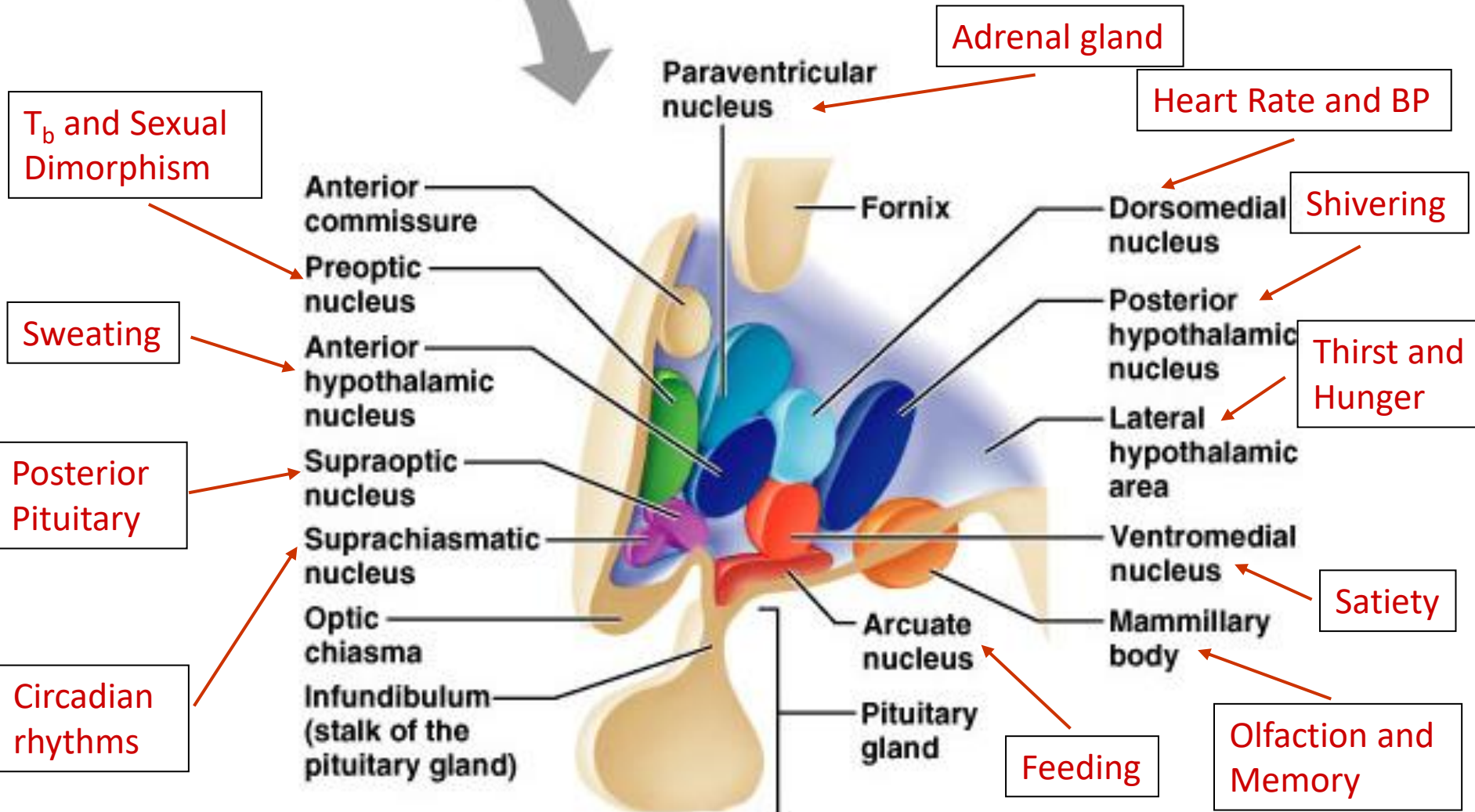
Important Exception

- The only sensory modality that **does NOT** pass through the thalamus is:
☞ Olfaction (sense of smell)



3) Hypothalamus

Main visceral control center of the body



Functions of the Hypothalamus

- 1. Regulation of body temperature (T_b)**
(Nuclei: body thermostat, sweating, shivering)
- 2. Regulation of hunger and thirst sensations**
(Nuclei: Feeding, satiety, thirst)
- 3. Regulation of sleep-wake cycles**
(Nuclei: Circadian rhythms/melatonin release)
- 4. Control of the Endocrine System**
(Nuclei: Controlling endocrine glands)
- 5. Controls Autonomic Nervous System (ANS)**
(Nuclei: Heart rate and blood pressure)

Overall: Controls many important behaviors via emotional responses and formation of memory => Limbic system and the ANS.

③ Midbrain

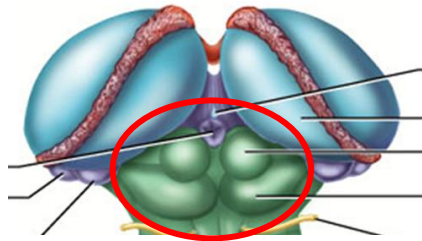
Substantia nigra

(black substance)

Relay to Skeletal Muscle

Corpora quadrigemina

('four bodies', 2 pairs)

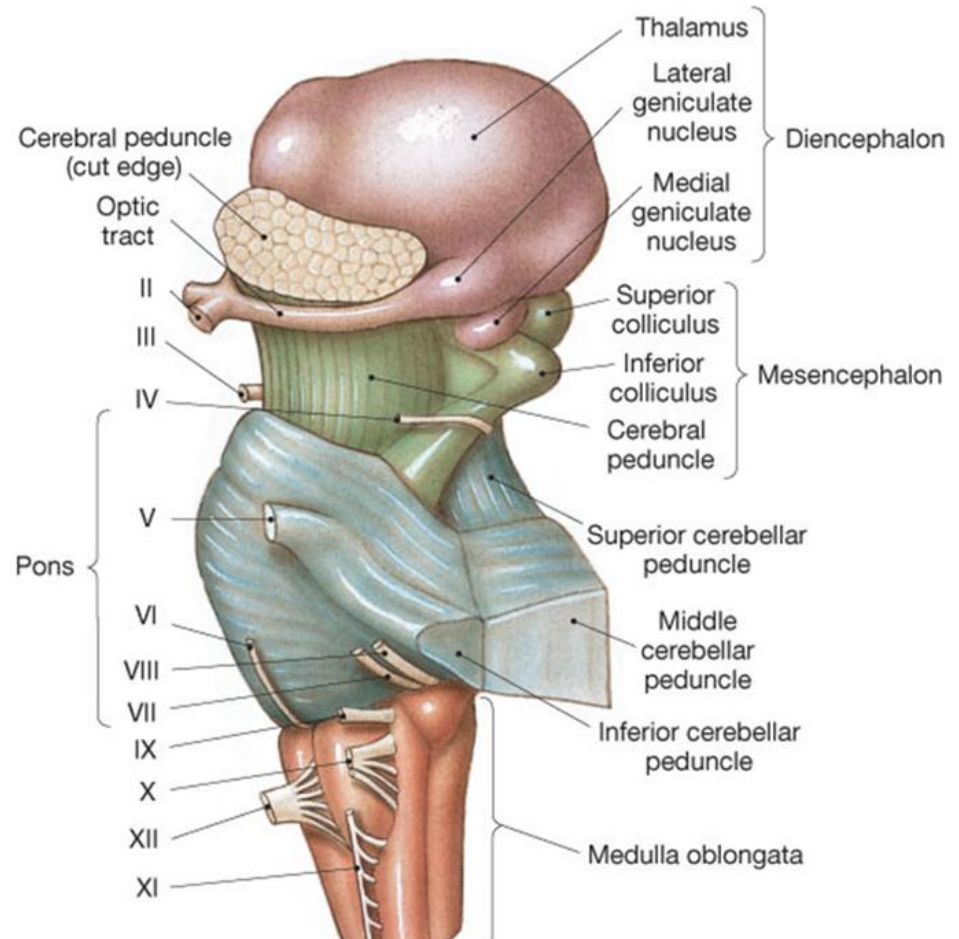


Superior colliculi

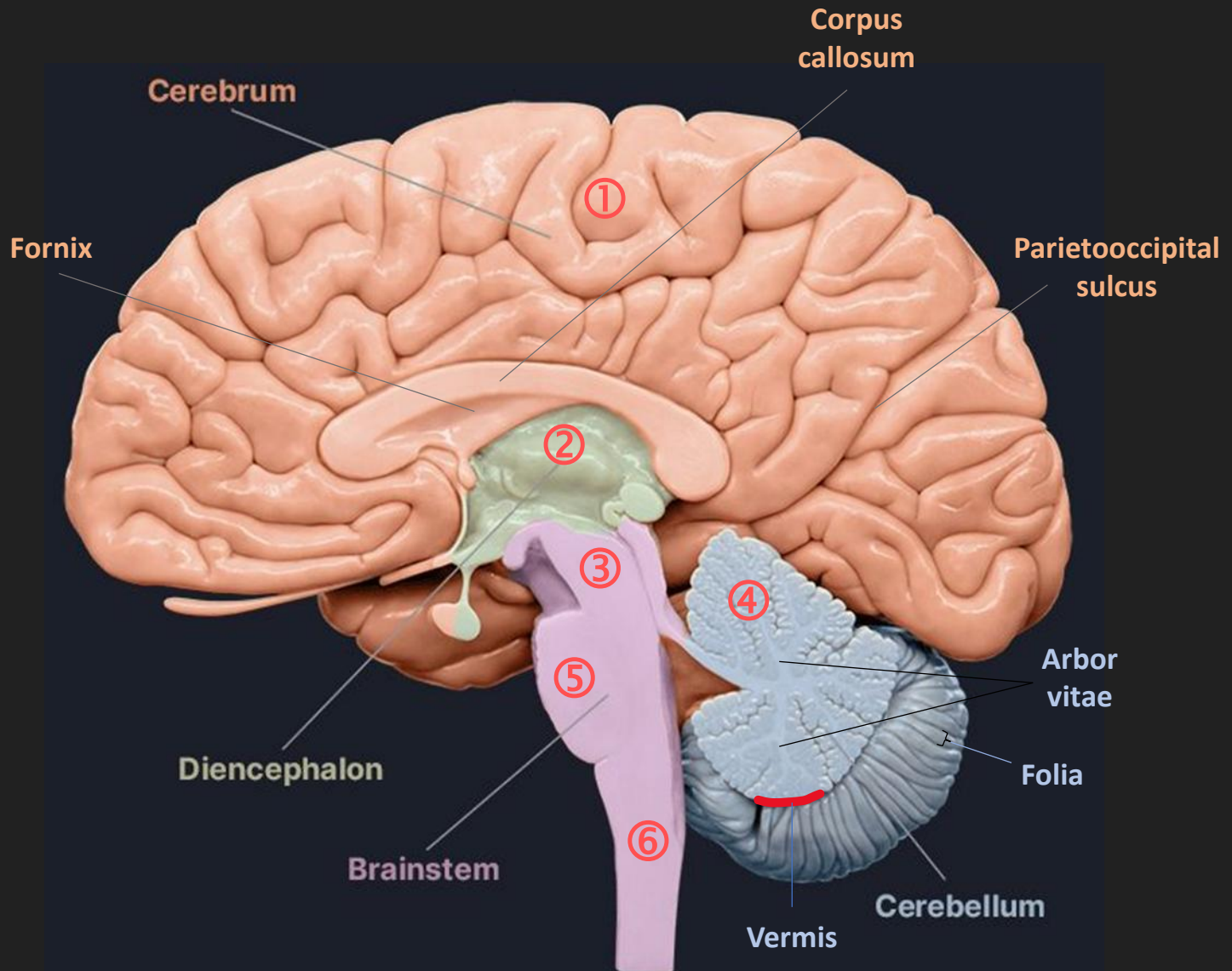
=> nuclei that act in **visual** reflexes.

Inferior colliculi

=> nuclei that act in **auditory** reflexes.



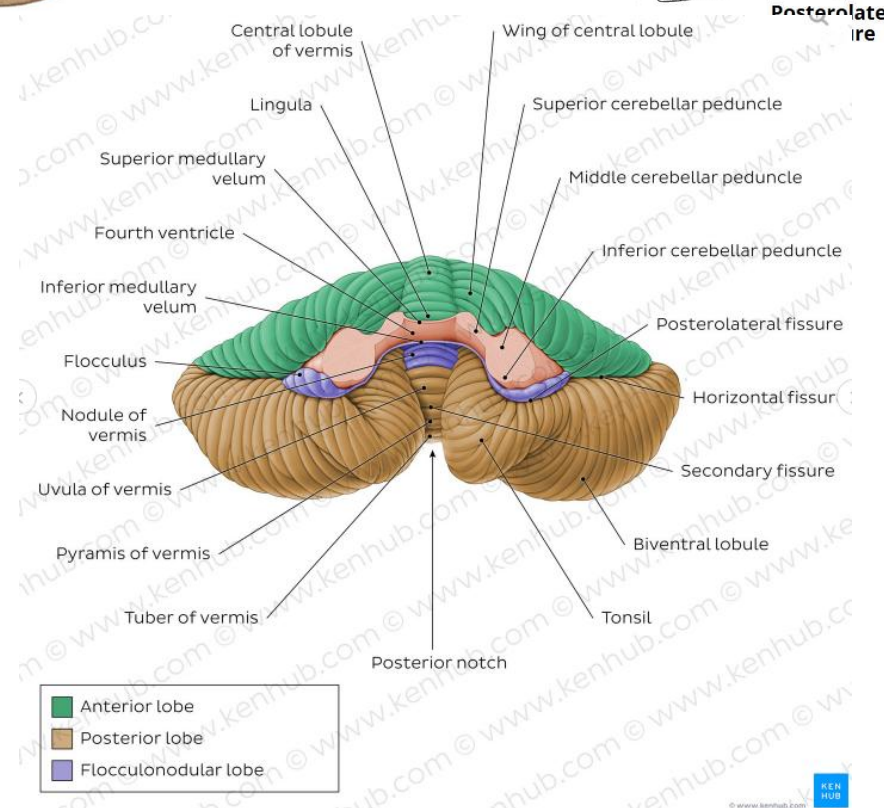
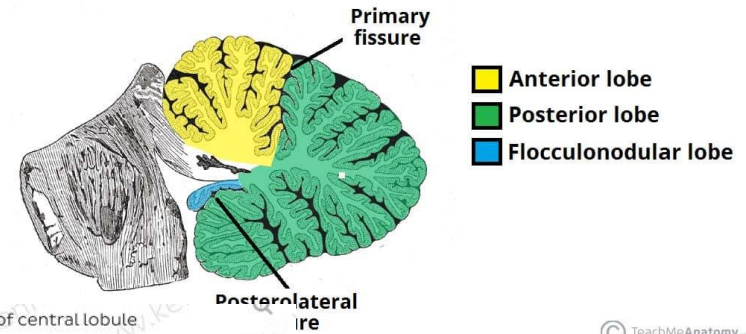
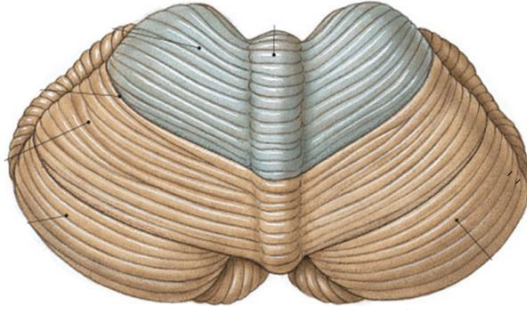
The Brain Stem = Midbrain, Pons and Medulla Oblongata



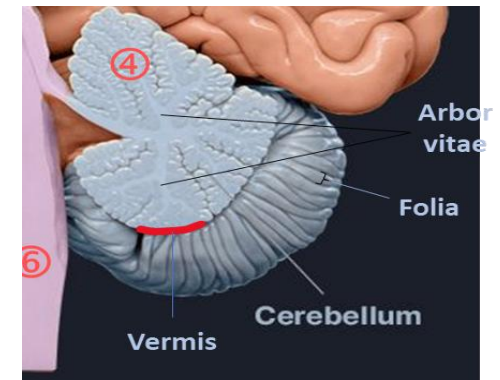
The cerebellum has 2 hemispheres connected by the vermis

Cerebellum

Located dorsal to the pons and medulla



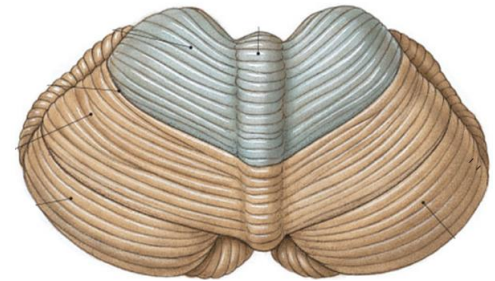
© TeachMeAnatomy



Functions of Cerebellum

1) Controls postural reflexes:

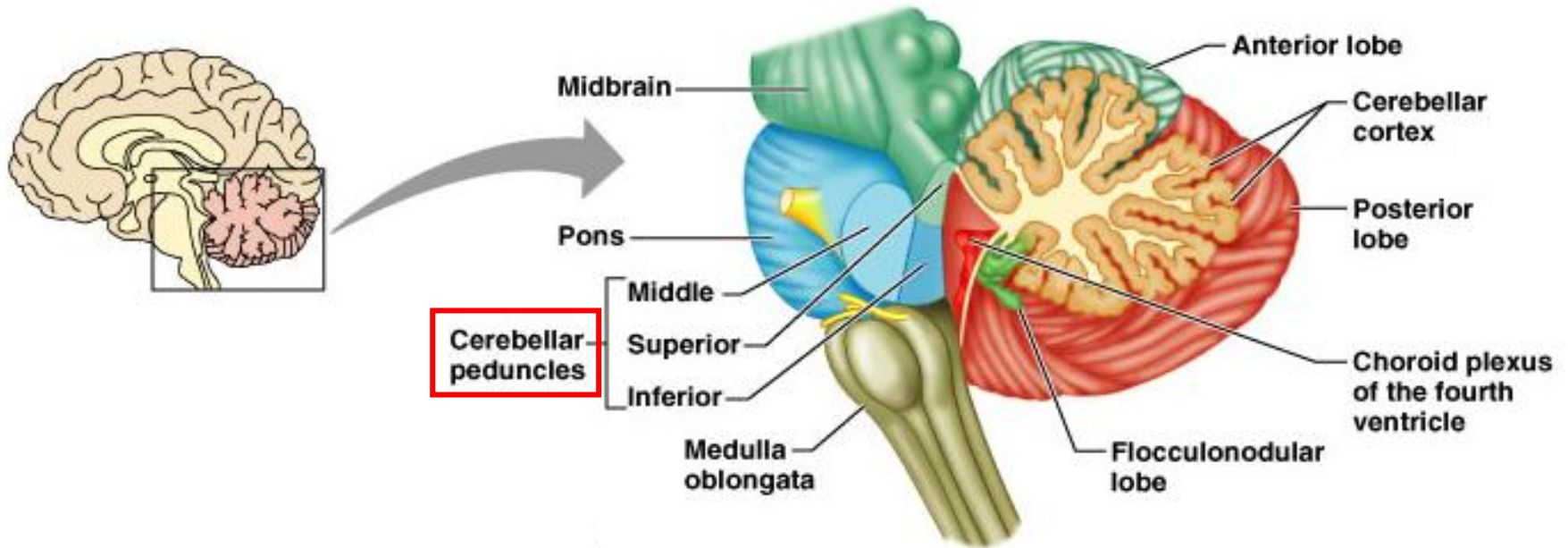
Coordinates rapid, automatic adjustments of muscles in body to maintain equilibrium.



2) Produces skilled movements:-

Implements complex actions for fine tuned movements and refines learned routines until action becomes routine.

The Superior, Middle and Inferior Cerebellar Peduncles

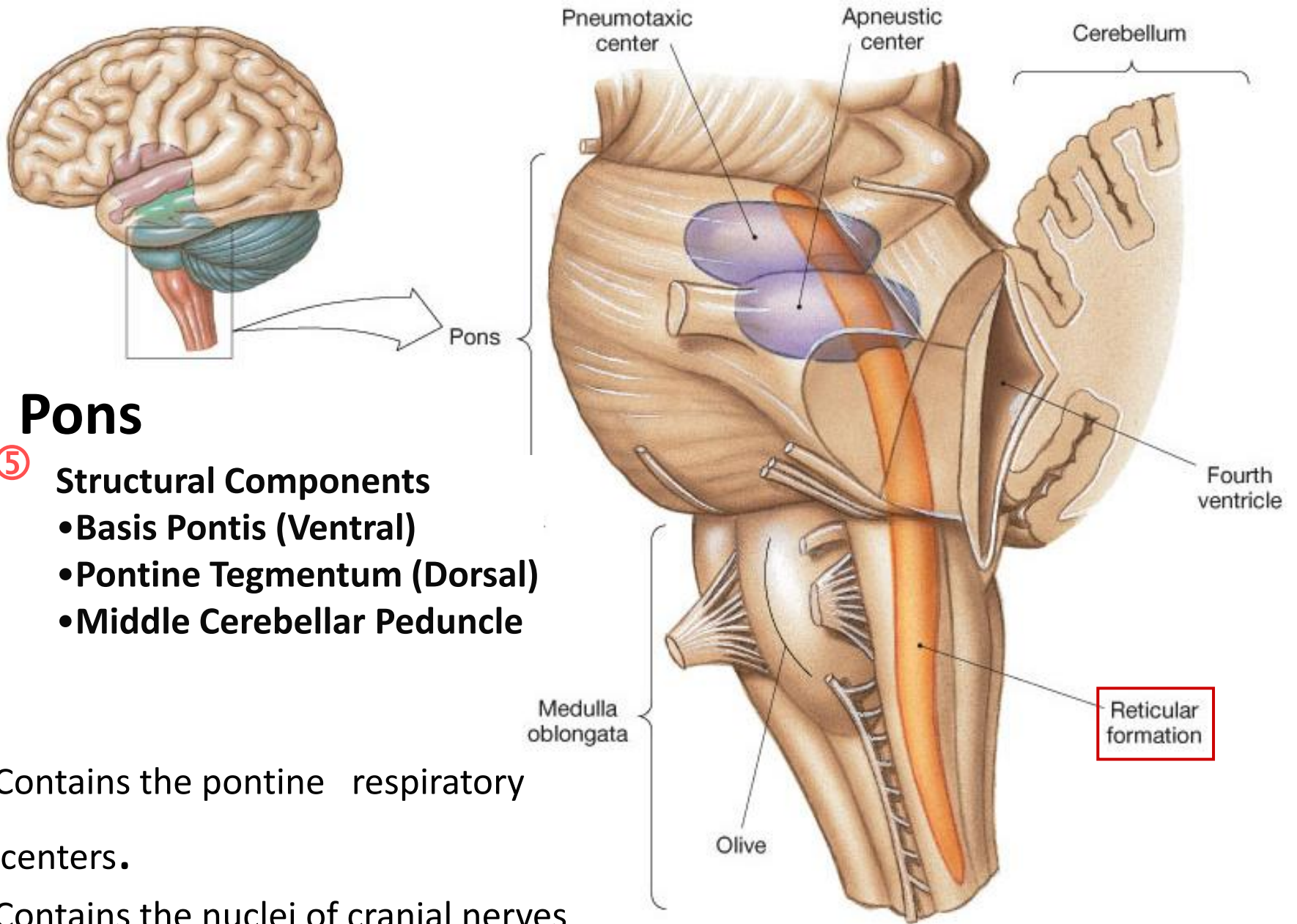


Tracts connecting **Cerebellum** to Brainstem and Cerebrum

Superior - carries outgoing motor commands (+ sensory) info up to midbrain & thalamus.

Middle - relays vast amounts of incoming info from cerebrum to cerebellum.

Inferior - transmits sensory info from the body and spinal cord to the cerebellum, particularly for posture and balance.



Pons

⑤ Structural Components

- Basis Pontis (Ventral)
- Pontine Tegmentum (Dorsal)
- Middle Cerebellar Peduncle

* Contains the pontine respiratory centers.

* Contains the nuclei of cranial nerves

V, VI, and VII

⑥ The Medulla contains:

Much of the reticular formation

Nuclei influence autonomic functions

Vital centers of MO:

- 1) Cardiac Control Center
- 2) Respiratory Control Center
- 3) Vasomotor Control Center

Also contains centers for hiccupping, sneezing, swallowing, vomiting and coughing.

