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ANATOMY

﴿ وَلَقَدۡ خَلَقۡنَا ٱلۡإِنسَٰنَ وَنَعۡلَمُ مَا تُوَسۡوِسُ بِهِۦ نَفۡسُهُۥۖ وَنَحۡنُ أَقۡرَبُ إِلَيۡهِ مِنۡ حَبۡلِ ٱلۡوَرِيدِ ﴾

MID | Lecture 9

Nervous System 2

Written by : Omar Mahmoud
Khaled Abdalla

Reviewed by : Abdallah Saffarini

Color coding used in the modified:

- *Black: the original slides*
- *Blue: the doctor's explanation/words*
- *Gray: additional information and explanation*
- *Red: important information*

Introduction to Anatomy

1st Year Medical Students

2025-2026
Second Semester

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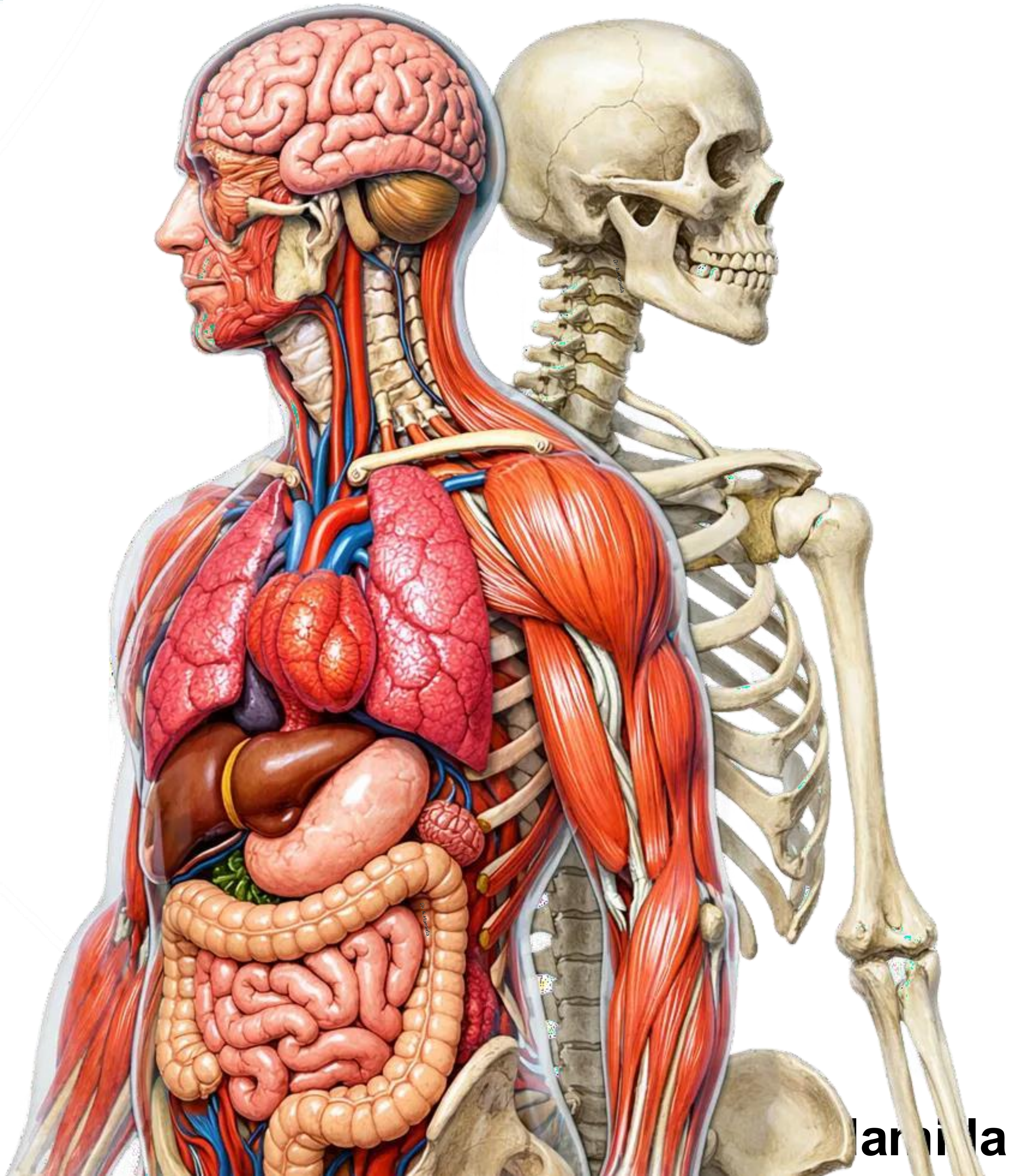
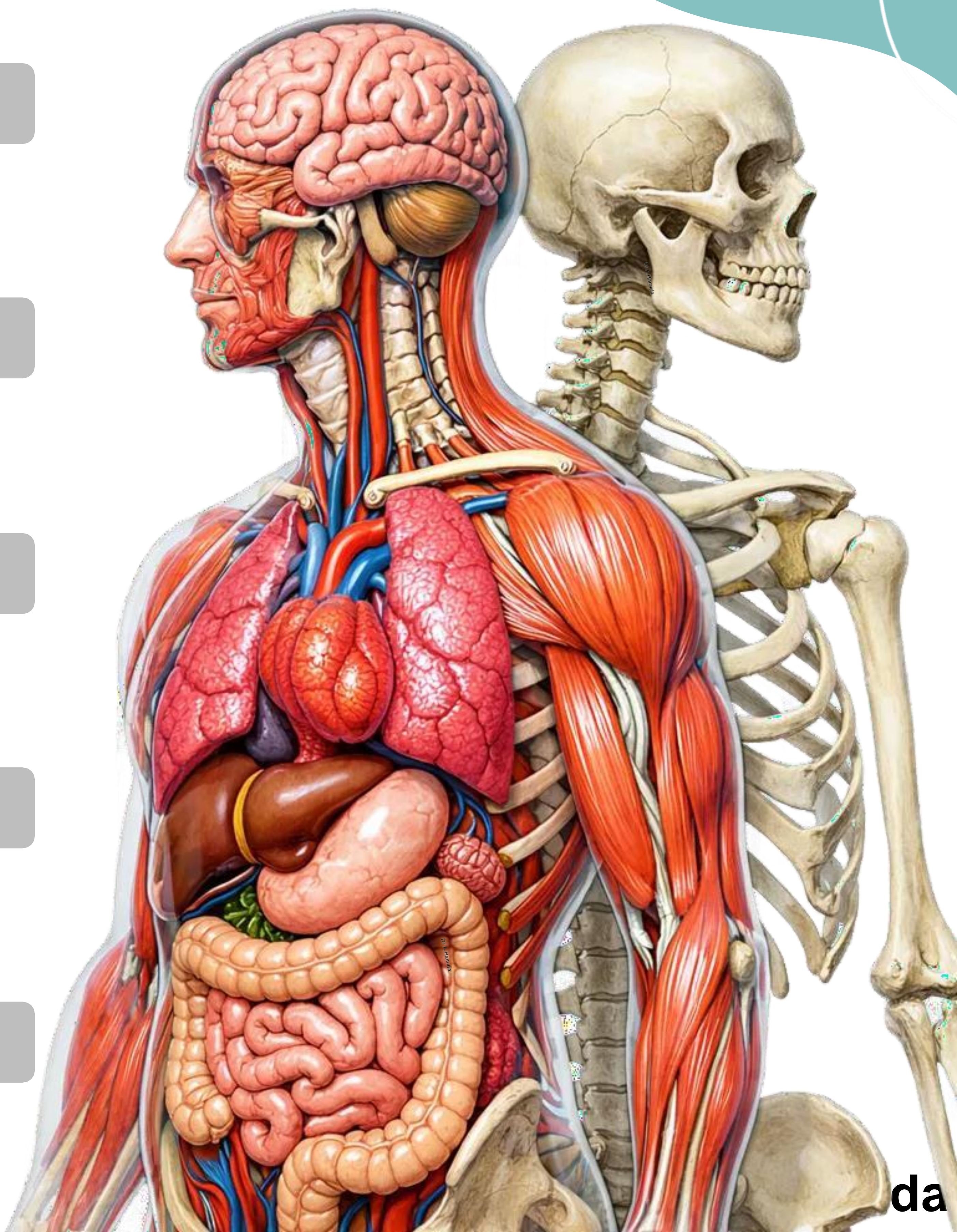


Course Outline:

1. Introduction and Terminology
2. Skeletal System
3. Cardiovascular System
4. Lymphatic System
5. Nervous System
6. Muscular System
7. Respiratory System
8. Digestive System
9. Urinary System
10. Endocrine System



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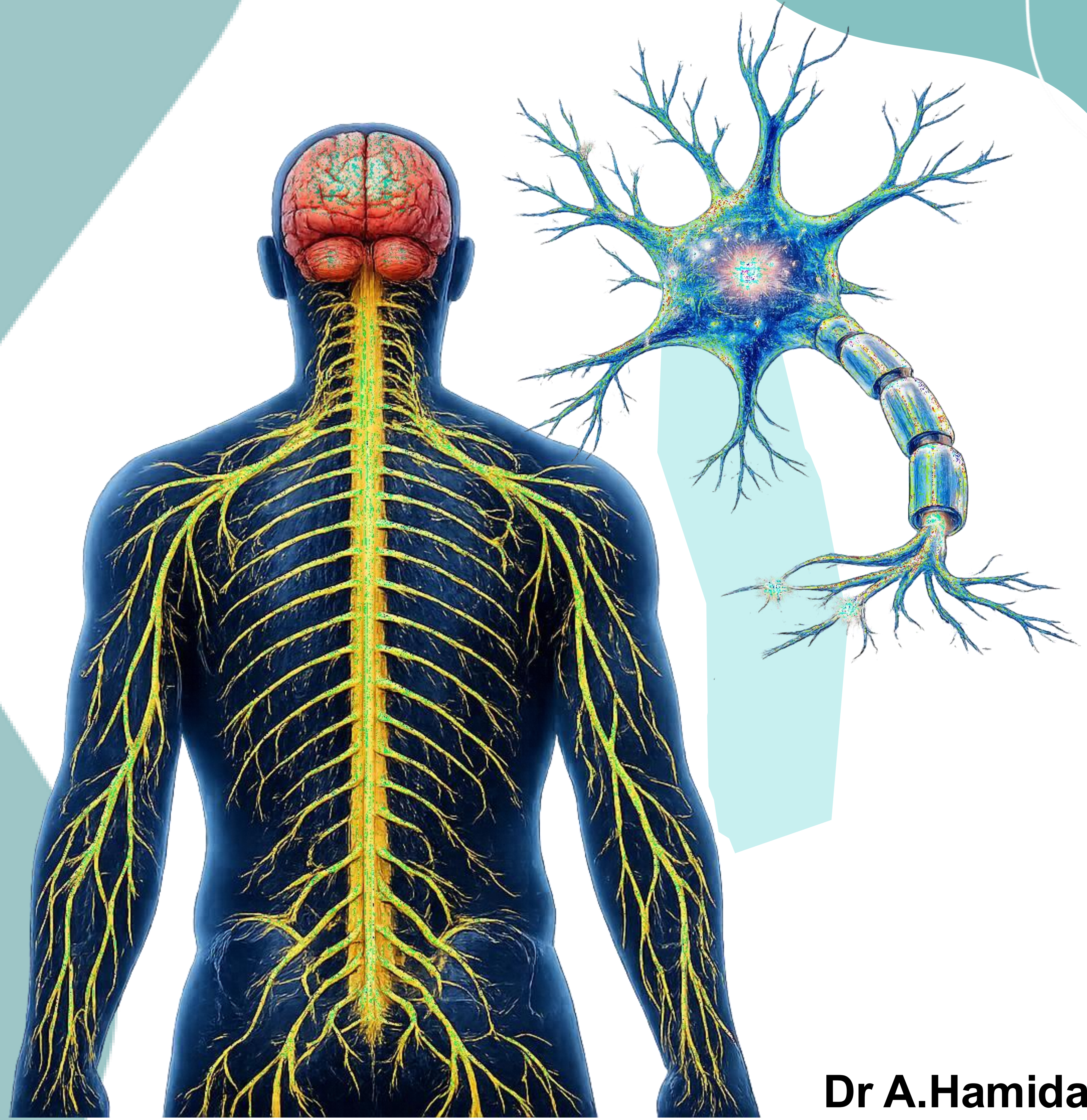
Nervous System



Gross lecture-8

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5 Nervous System

❖ Divisions of the Nervous System

➢ **Anatomically, the nervous system is divided into two parts:**

1. **Central Nervous System (CNS),**

   consists of:

   i. **Brain (located in the cranial cavity)**

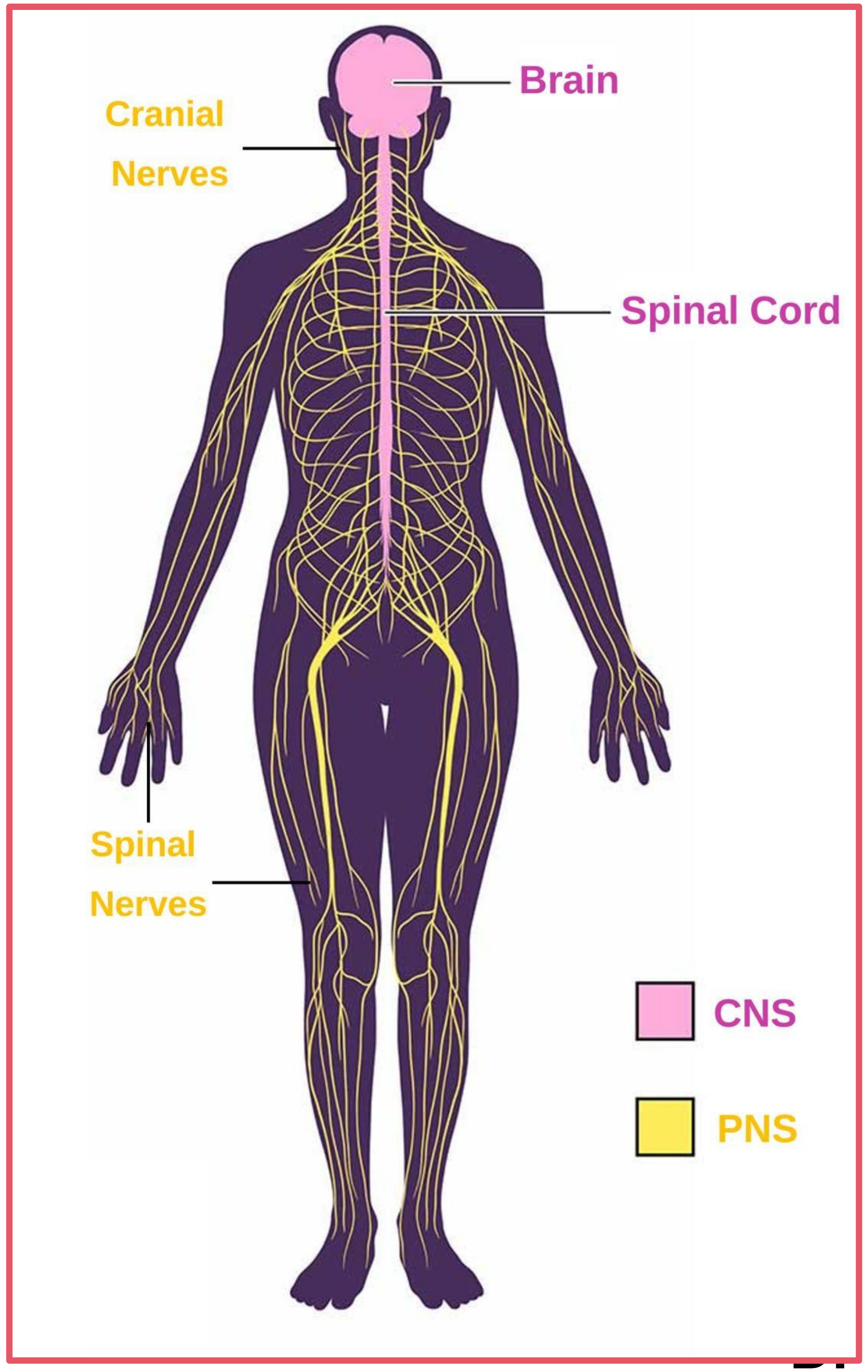
   ii. **Spinal Cord (located in the vertebral canal)**

2. **Peripheral Nervous System (PNS),**

   consists of nerves that exit from CNS:

   i. **Cranial nerves (exit from the brain)**

   ii. **Spinal nerves (exit from the spinal cord)**



5 Nervous System

System Outline:

- 5.1 Nervous Tissue
- 5.2 Central Nervous System - Brain
- 5.3 Central Nervous System - Spinal Cord
- 5.4 Peripheral Nervous System

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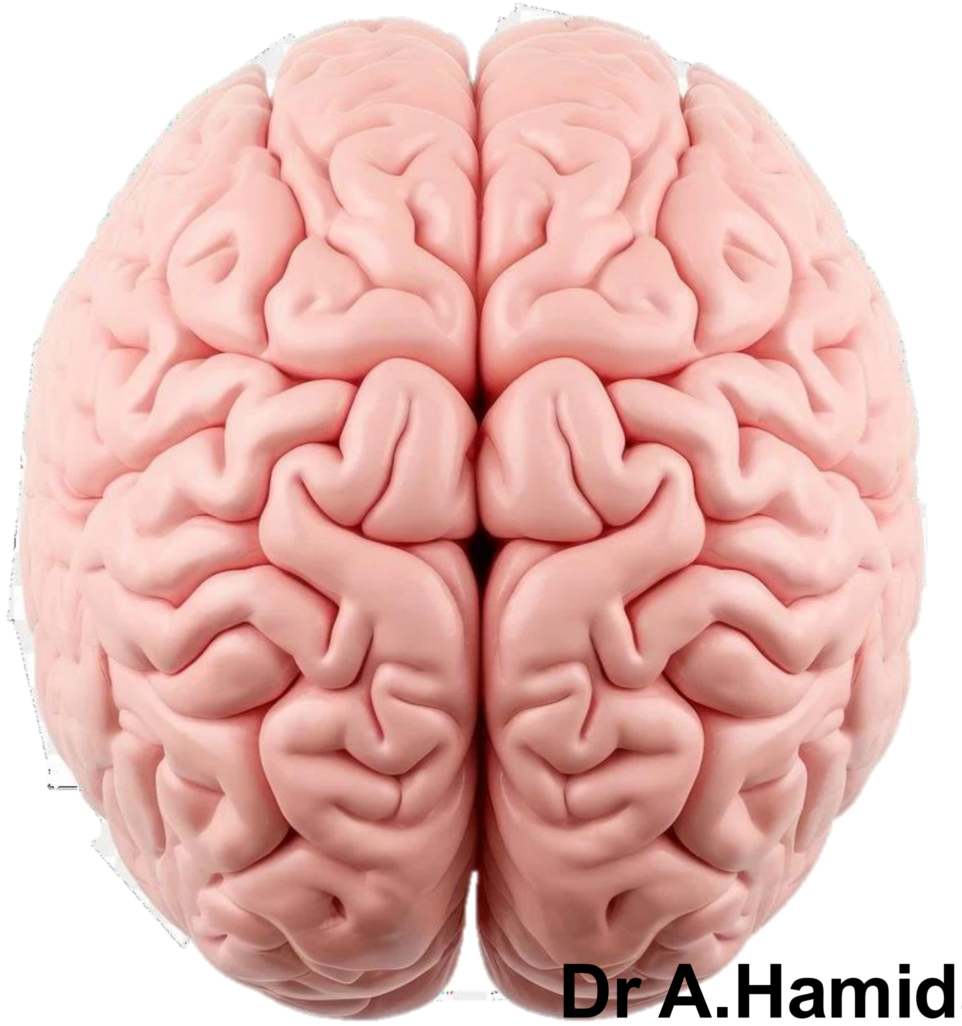
5

Gross lecture-8

Nervous System

2. CNS- Brain



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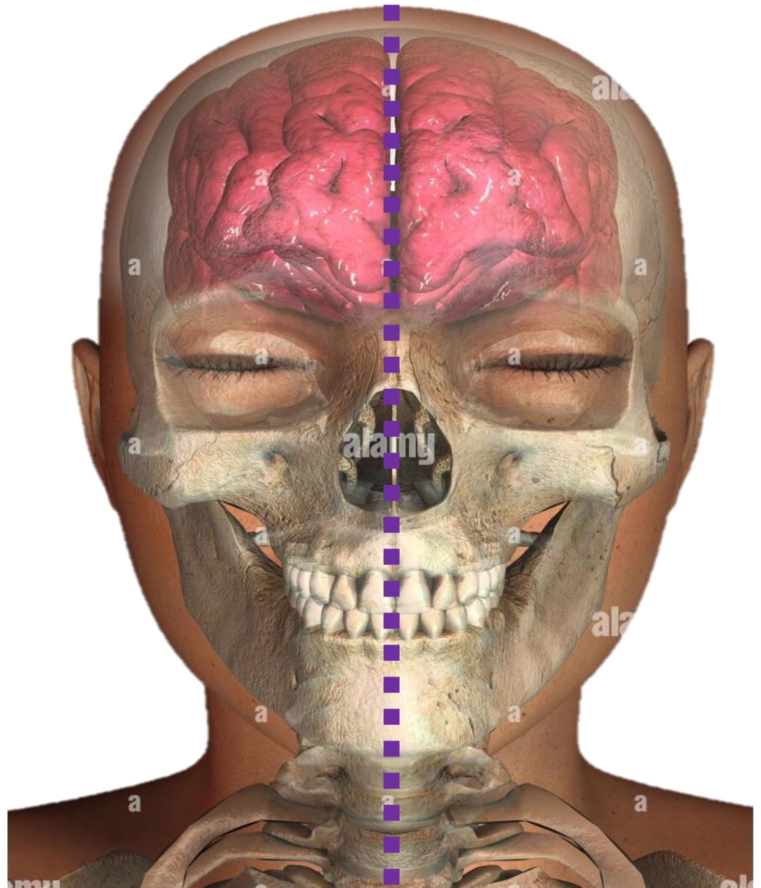
5.2 Nervous System– CNS-Brain

Lecture Outline:

5.2 Nervous System– CNS-Brain

➢ **The brain is divided into three major divisions:**

During embryogenesis, the brain was just a tube known as the **neural tube**.
Neural tube: consists of 3 swellings, the first swelling is known as Forebrain. The second swelling is the Midbrain, and the third swelling is the Hindbrain.

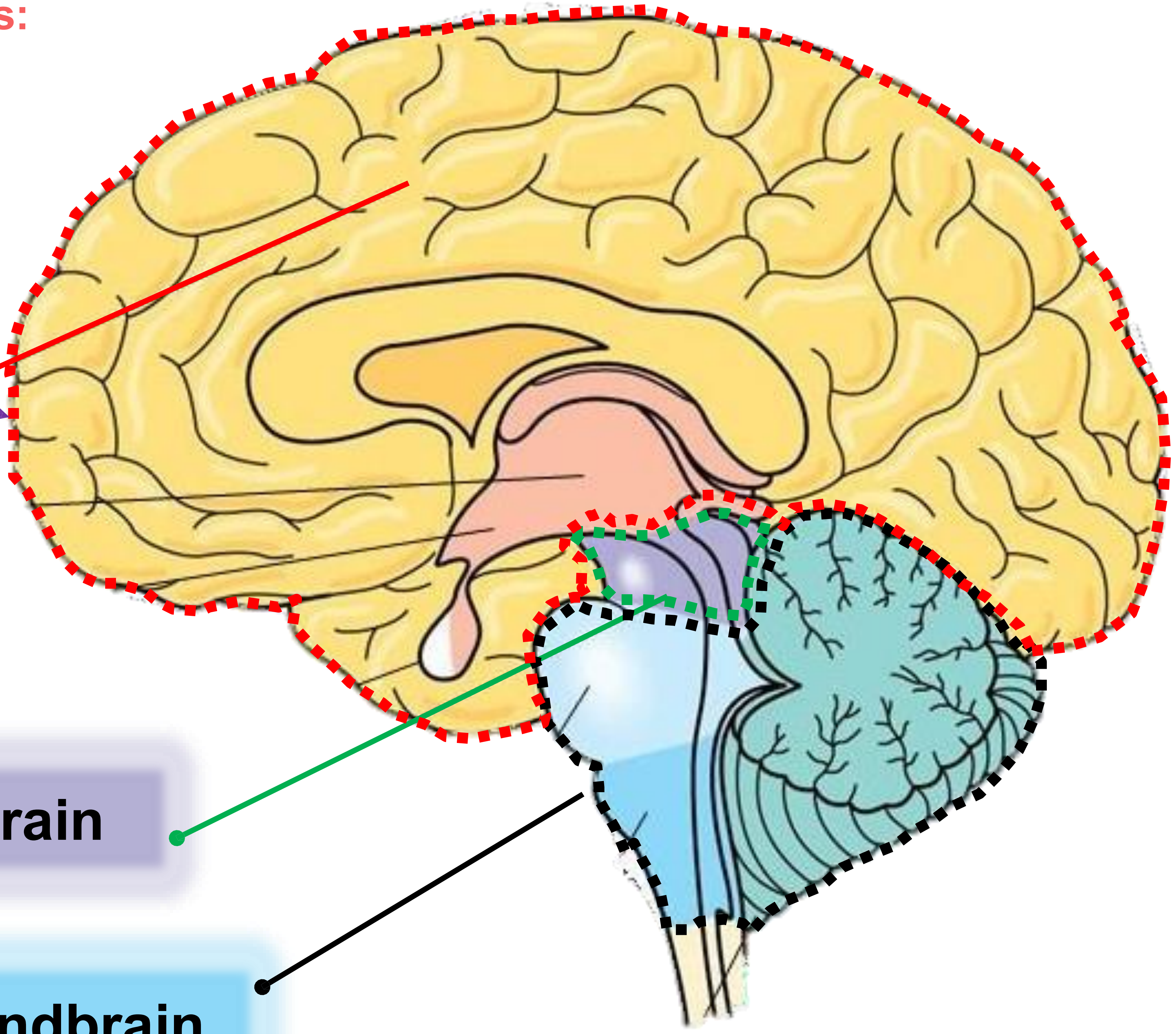


Forebrain

Those terms are called so due to embryological development.

Midbrain

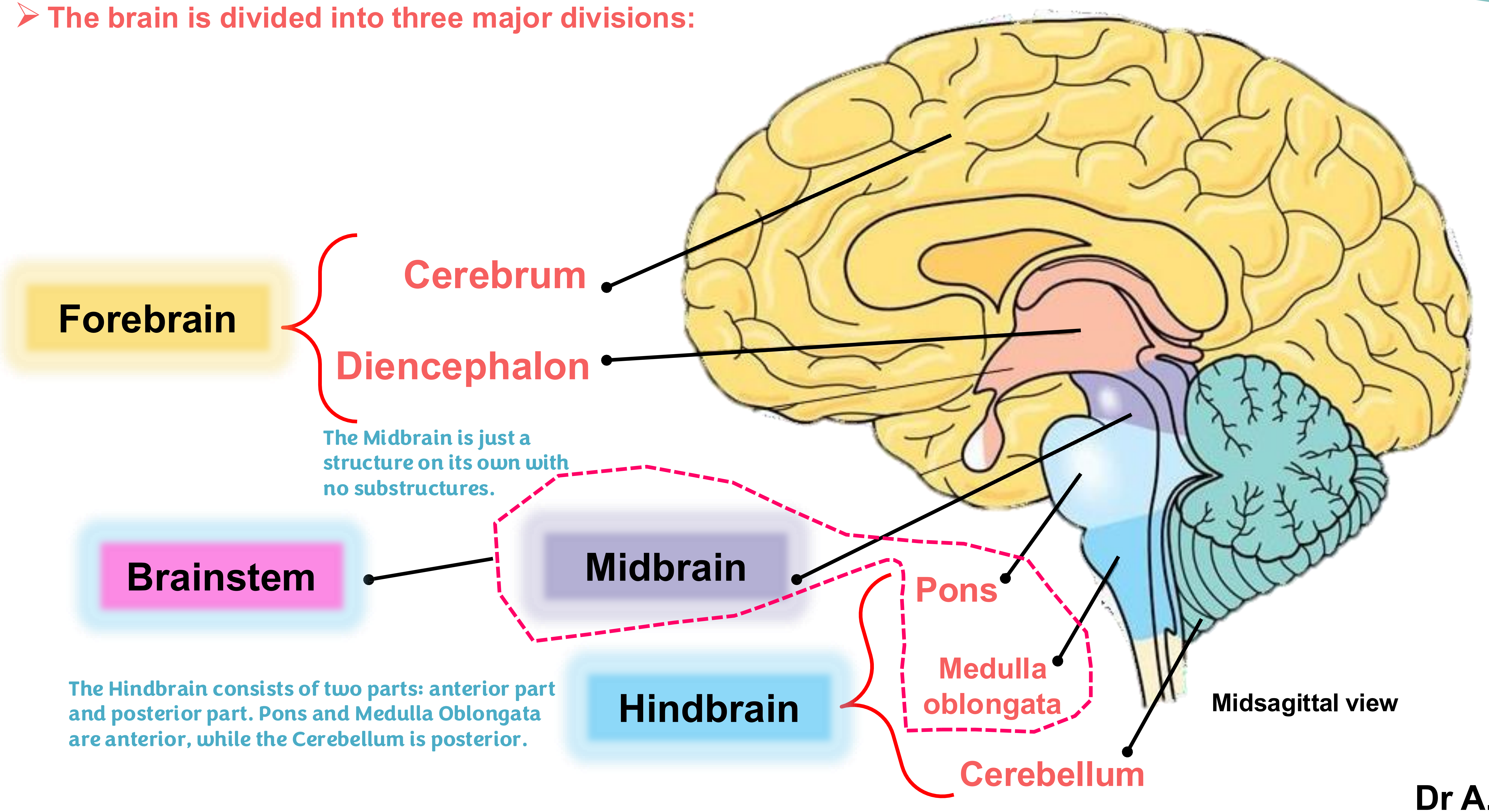
Hindbrain



Midsagittal view

5.2 Nervous System– CNS-Brain

➢ The brain is divided into three major divisions:



5.2 Nervous System– CNS-Brain

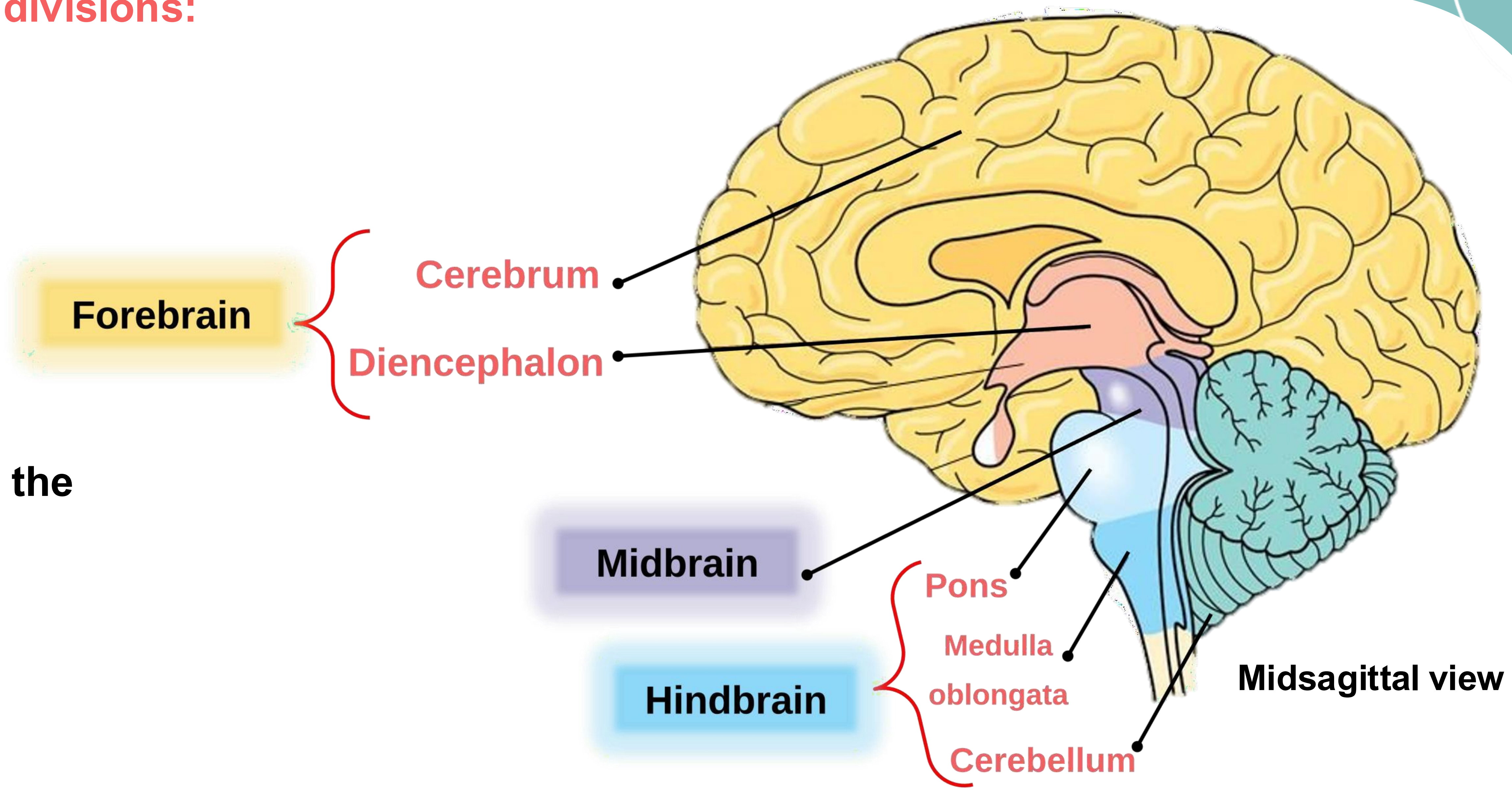
Gross lecture-8

➢ The brain is divided into three major divisions:

1. **Forebrain, consists of:**
   i. Cerebrum.
   ii. Diencephalon

2. **Midbrain**
   - A small region which connects the forebrain with the hindbrain.

3. **Hindbrain, consists of**
   i. Medulla oblongata
   ii. Pons
   iii. Cerebellum



➢ **Brainstem:** is collective term for the following structure : Midbrain, Pons, and Medulla oblongata.

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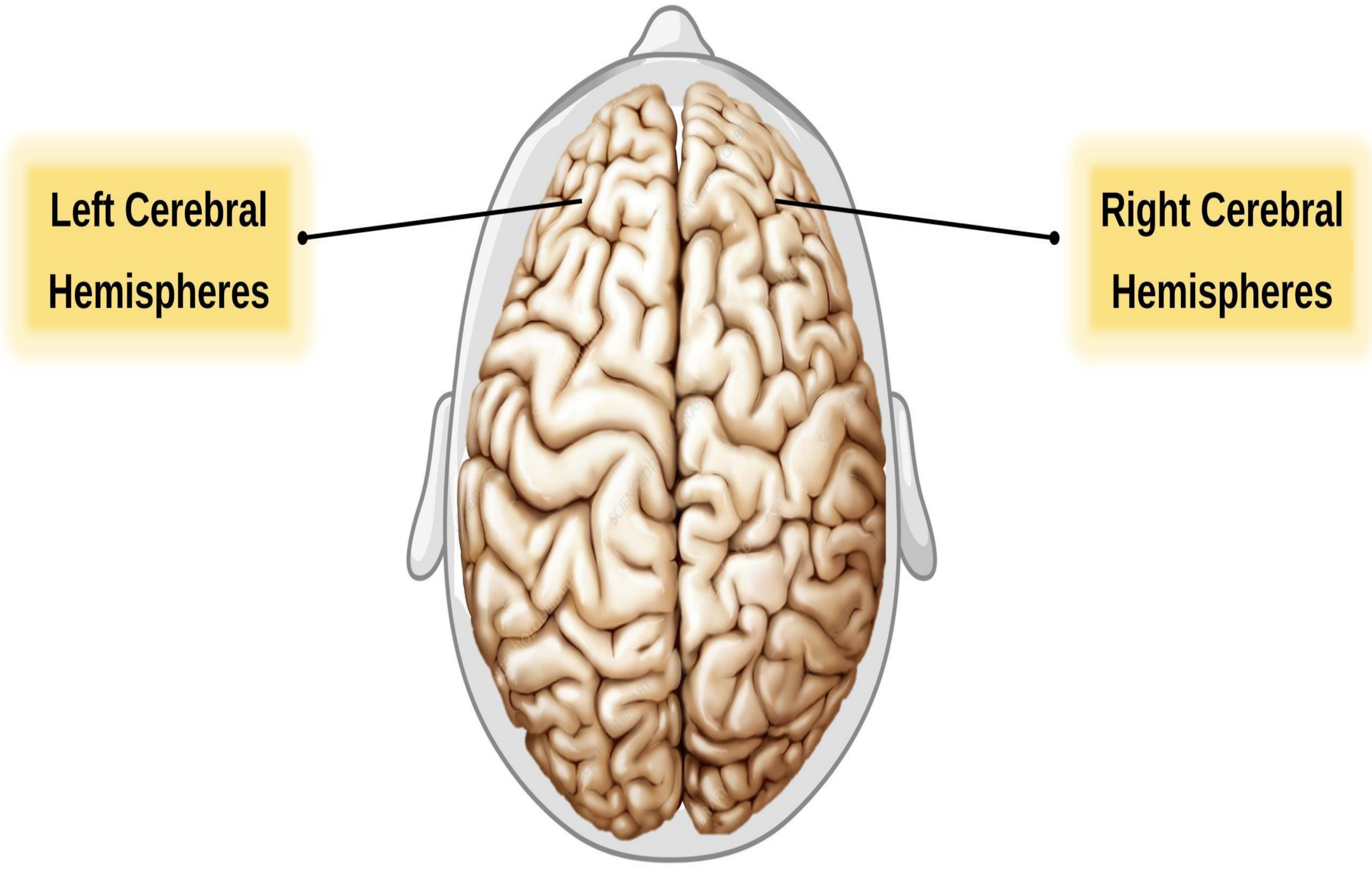
Cerebrum

- **The cerebrum is the largest part of the brain.**
  - **It consists of two large hemispheres (the left and the right cerebral hemispheres)**

The Left Cerebral Hemisphere and the Right Cerebral Hemisphere are connected to each other. They communicate with each other by fibers that move right and left / left and right to allow for integration between the two cerebral hemispheres.

The Right Cerebral Hemisphere controls the left side of the body, while the Left Cerebral Hemisphere controls the right side of the body. This is mainly due to cross-over events.

EXTRA: The crossover process is called decussation (التصالب), and it means that many nerve fibers switch from one side of the nervous system to the other as they travel from the brain to the body.For ex, in the motor system, movement commands begin in the motor central of one cerebral hemisphere, then descend through the brainstem. Most of these fibers cross over in the lower medulla (the bottom part of medulla oblongata). Because of this crossing, the left hemisphere ends up controlling muscles on the right side of the body, and the right hemisphere controls the left side. This is why a stroke or injury affecting one side of the brain often causes weakness or paralysis on the opposite side of the body.

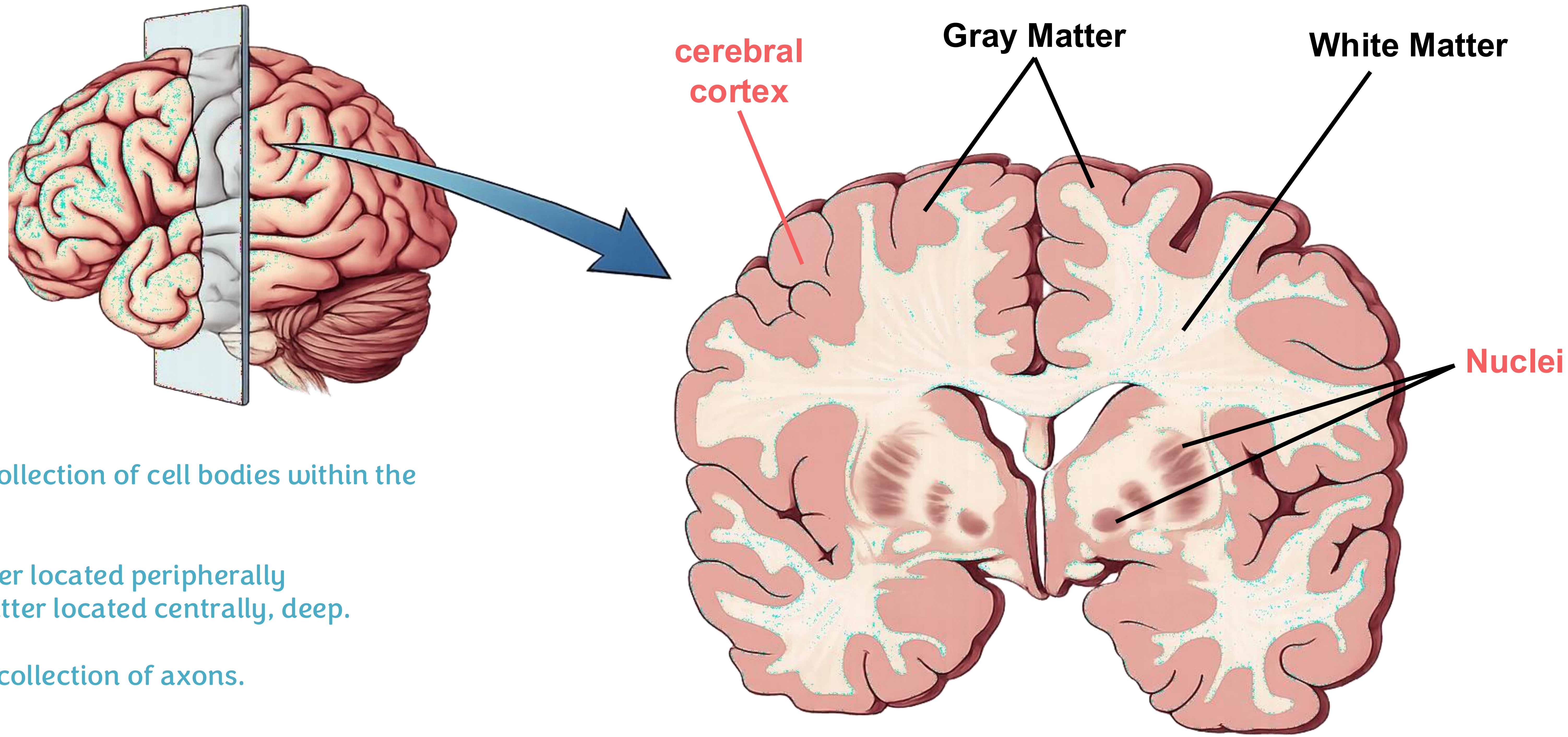


Superior View

Cerebrum

➢ **Each cerebral hemisphere consists of:**

- **Surface layer of grey matter, called cerebral cortex**
- **Central core of white matter.**



Frontal view

Gray matter is a collection of cell bodies within the CNS.

Cortex: gray matter located peripherally
Nucleus : gray matter located centrally, deep.

White matter is a collection of axons.

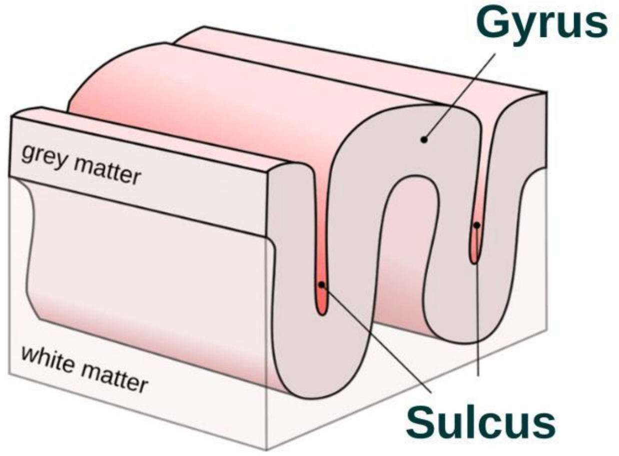
5.2.1 Cerebrum

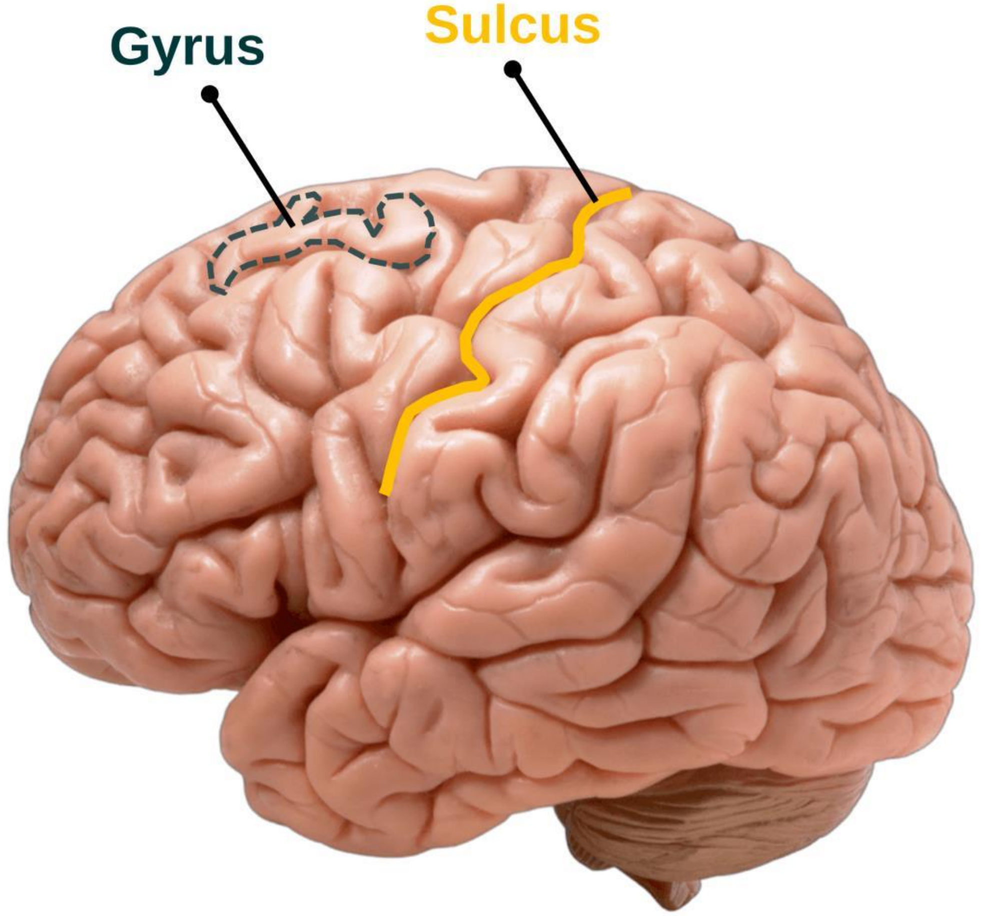
➢ The outer surface of each cerebral hemisphere shows series of elevations called the **<u>gyri</u>**, separated by shallow grooves called the **<u>sulci.</u>**

Why does the brain consist of elevations and depressions ?

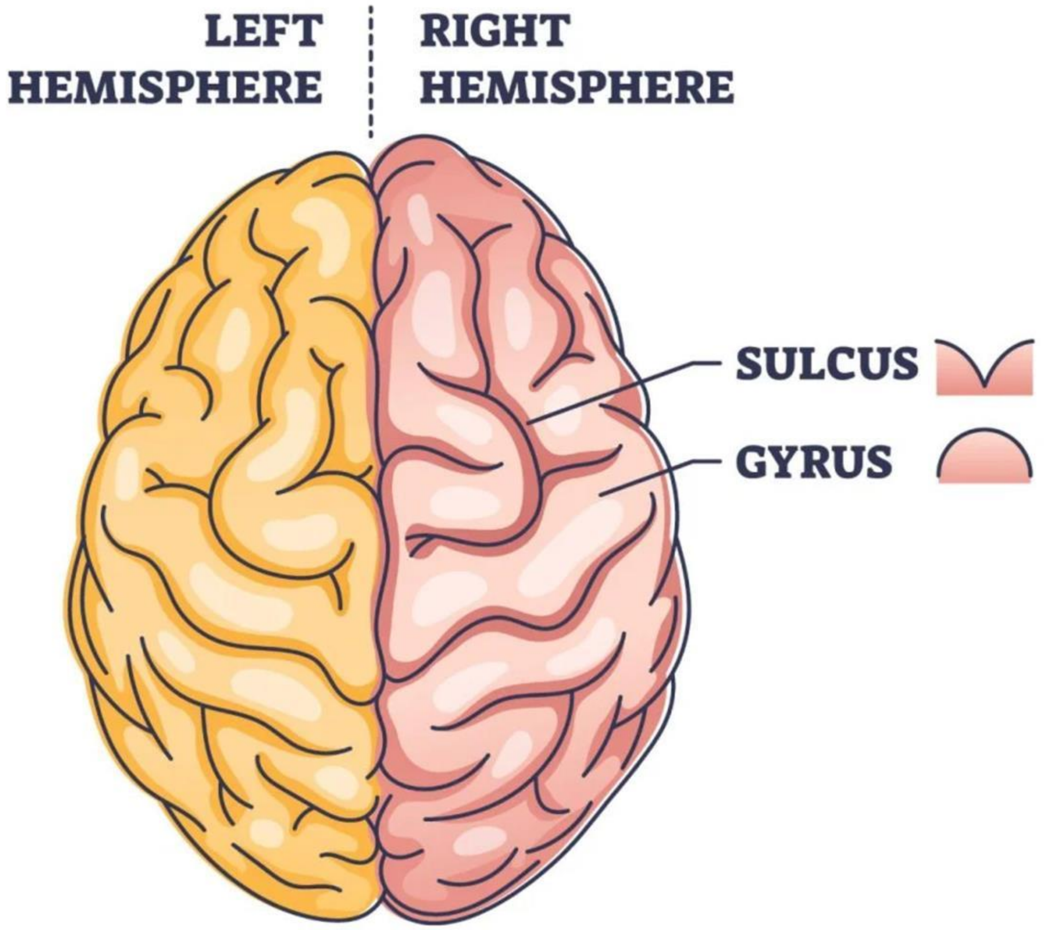
Answer: to increase surface area.

As stated by the Doctor, the brain consists of elevations and depressions to increase surface area, the same concept applies to the small intestines where there are structures known as, Villi or Microvilli, that are mainly responsible to increase surface area for better absorption.





Lateral view



Superior view

5.2.1 Cerebrum

Gross Lecture-8

❖ Lobes of Cerebral Hemisphere

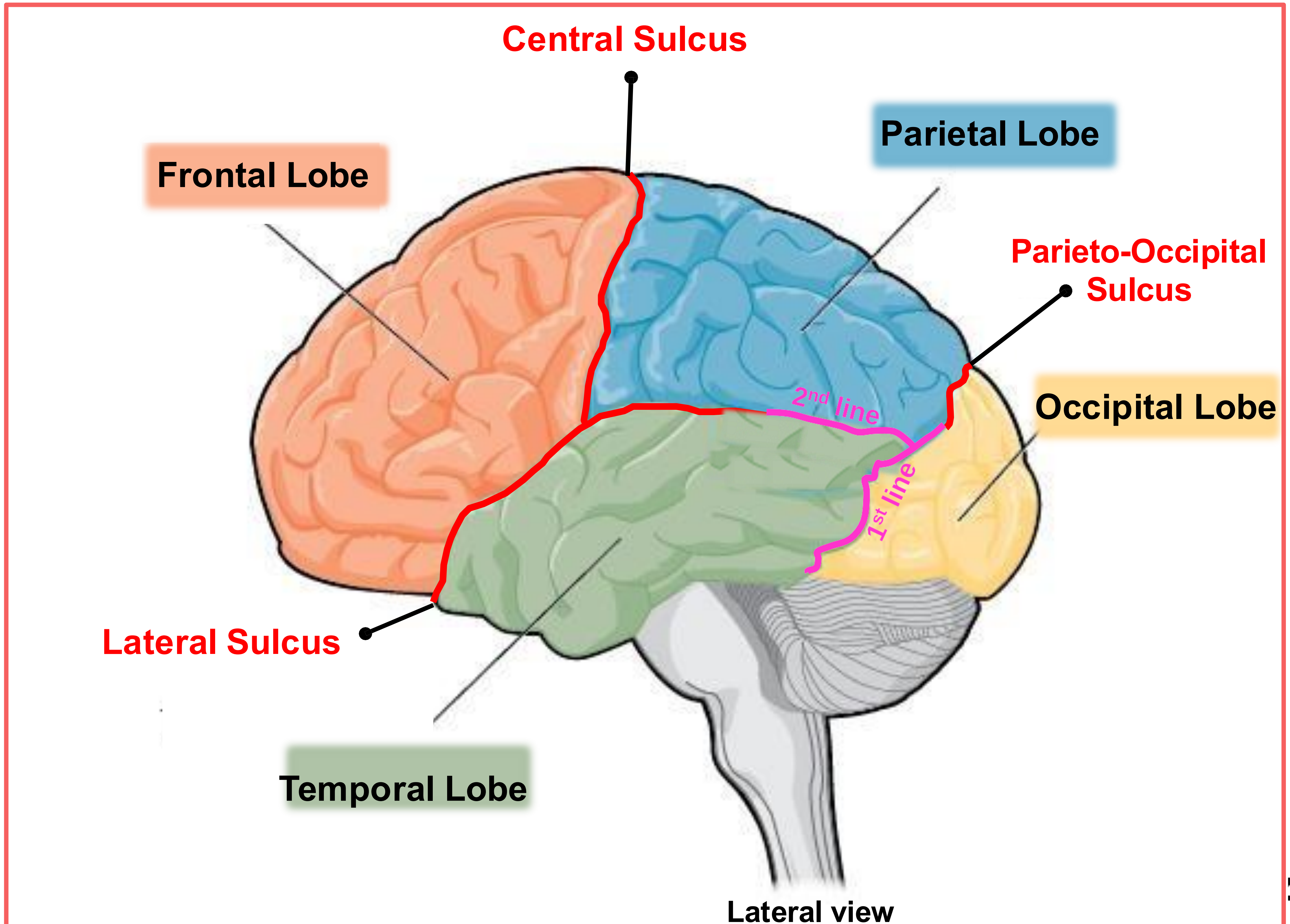
➢ **Each cerebral hemisphere is divided by 3 main sulci into 4 main lobes**

The lobes are named after the names of the bones that cover them.
Each lobe is composed of different centers and areas that give the lobe its specific function.

Central Sulcus: vertical sulcus, situated almost in the middle of the cerebral hemisphere. Separates the Frontal lobe, and Parietal lobe. The Frontal lobe is anterior to the Parietal lobe and superior to the Temporal lobe.

Lateral Sulcus: horizontal sulcus. The Lateral Sulcus separates the temporal lobe from the frontal and parietal lobes. The Frontal Lobe and the Parietal Lobe are superior to the Temporal Lobe.

Parieto-Occipital Sulcus: located posteriorly. The two imaginary lines allow us located the borders of the surrounding lobes.
Two imaginary lines: 1st line: begins at the end of the parieto-occipital sulcus and extends downwards until it reaches the inferior part of the cerebral hemisphere. The 2nd line begins at the posterior part of the lateral sulcus and extends until it reaches the 1st line.



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5.2.1

Cerebrum

❖ Lobes of Cerebral Hemisphere

➢ **Each cerebral hemisphere is divided by 3 main sulci into 4 main lobes**

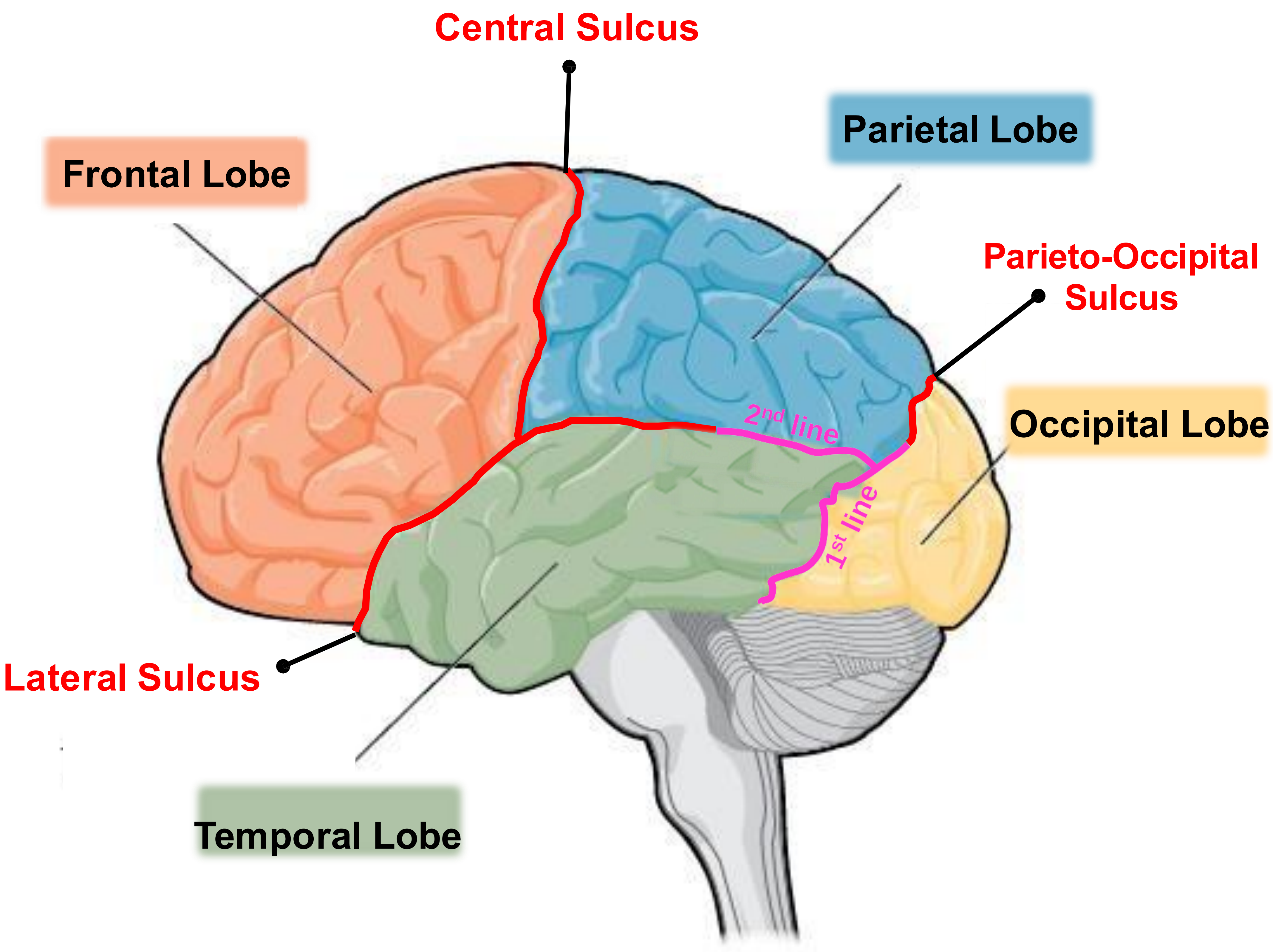
➢ **The 3 main sulci are**

1. **Central Sulcus.**
2. **Lateral Sulcus**
3. **Parieto - Occipital Sulcus**

➢ **The 4 main lobes are**

1. **Frontal Lobe**
2. **Parietal Lobe**
3. **Temporal Lobe**
4. **Occipital Lobe**

These lobes consist of grey and white matter.
The cell bodies of each lobe work together to carry out specific functions



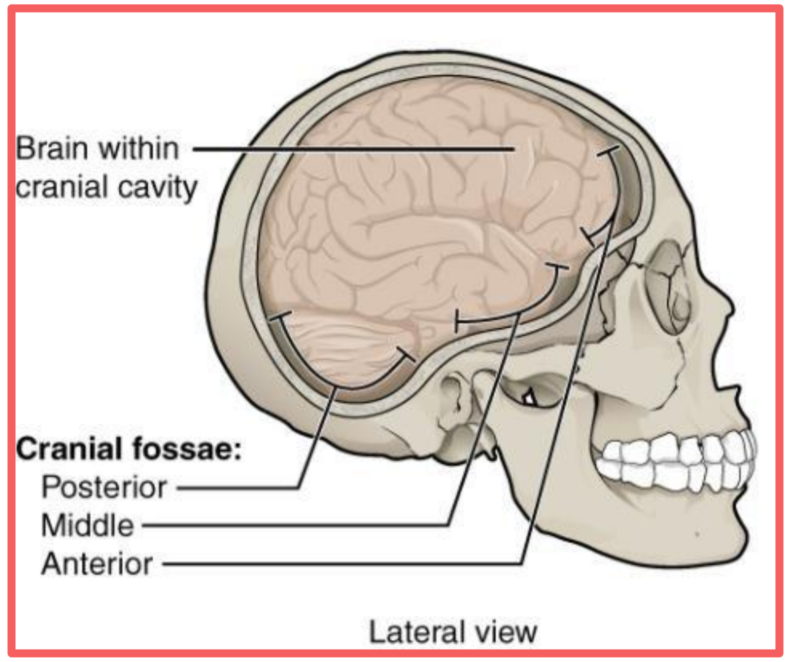
Lateral view

5.2.1 Cerebrum

❖ Lobes of Cerebral Hemisphere

1. Frontal Lobe

- Located anterior to the central sulcus and superior to the lateral sulcus, occupying the anterior cranial fossa.
- Main centers and areas:
  - Motor center: controls voluntary motor activities.
  - Prefrontal area: responsible for thinking, decision making, motivation, and planning.
  - Broca's area: controls motor aspect and is located in the dominant hemisphere (usually the left hemisphere).



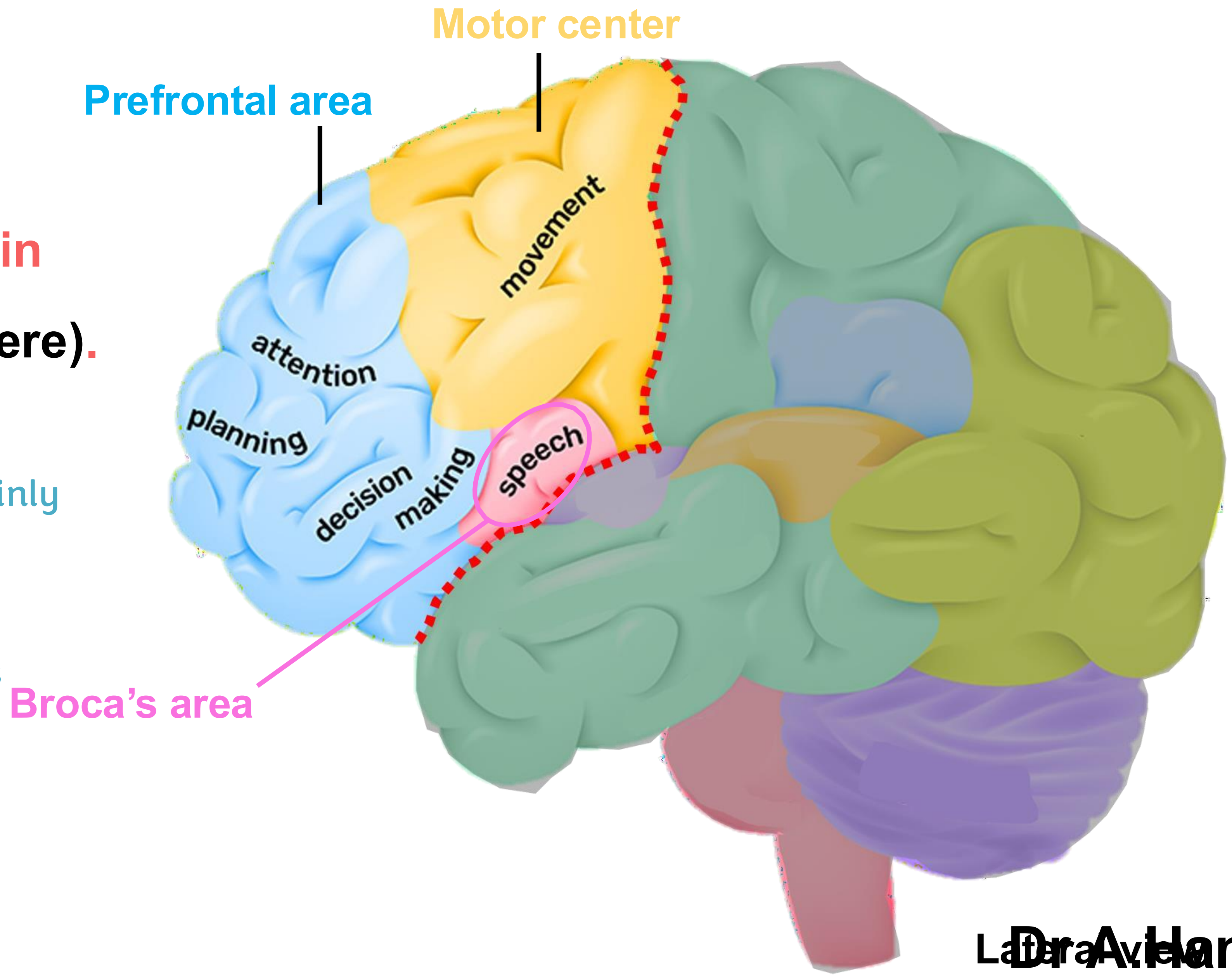
The Frontal Lobe consists of three areas: motor center, Prefrontal area, and Broca's area.

Holding a pencil, walking, or whatever voluntary motor activities you are performing are mainly controlled by the motor center of the frontal lobe. Neurons of the motor area are the ones activated.

Setting an alarm to wakeup next day early morning, planning your day, or whatever involves planning, decision making, and attention are mainly controlled by the anterior part of the frontal lobe which is known as, Prefrontal Area.

Broca's area: once you begin talking, what controls your tongue's motion and vocal cords' motion is known as, Broca's area. Broca's area is responsible for producing speech.

Broca's area is usually located in the dominant hemisphere only.



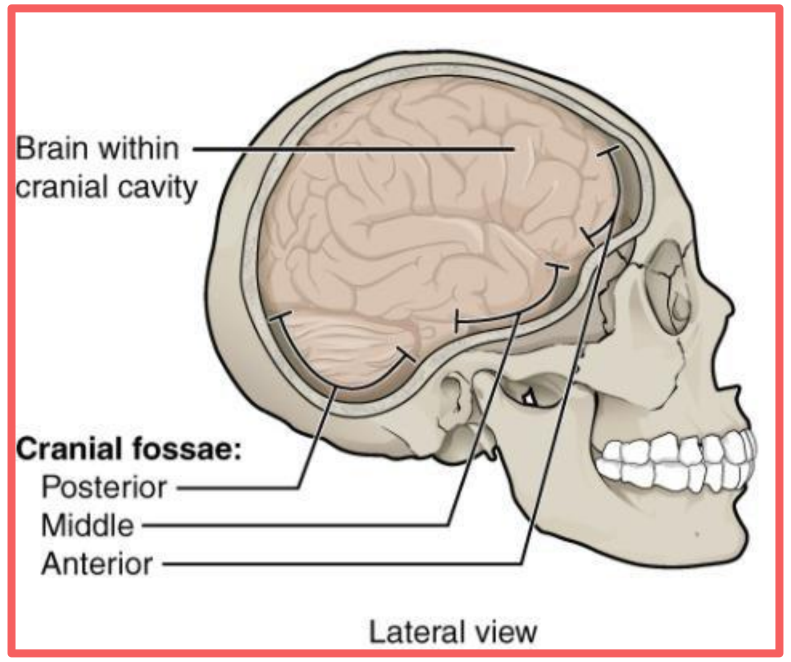
Cerebrum

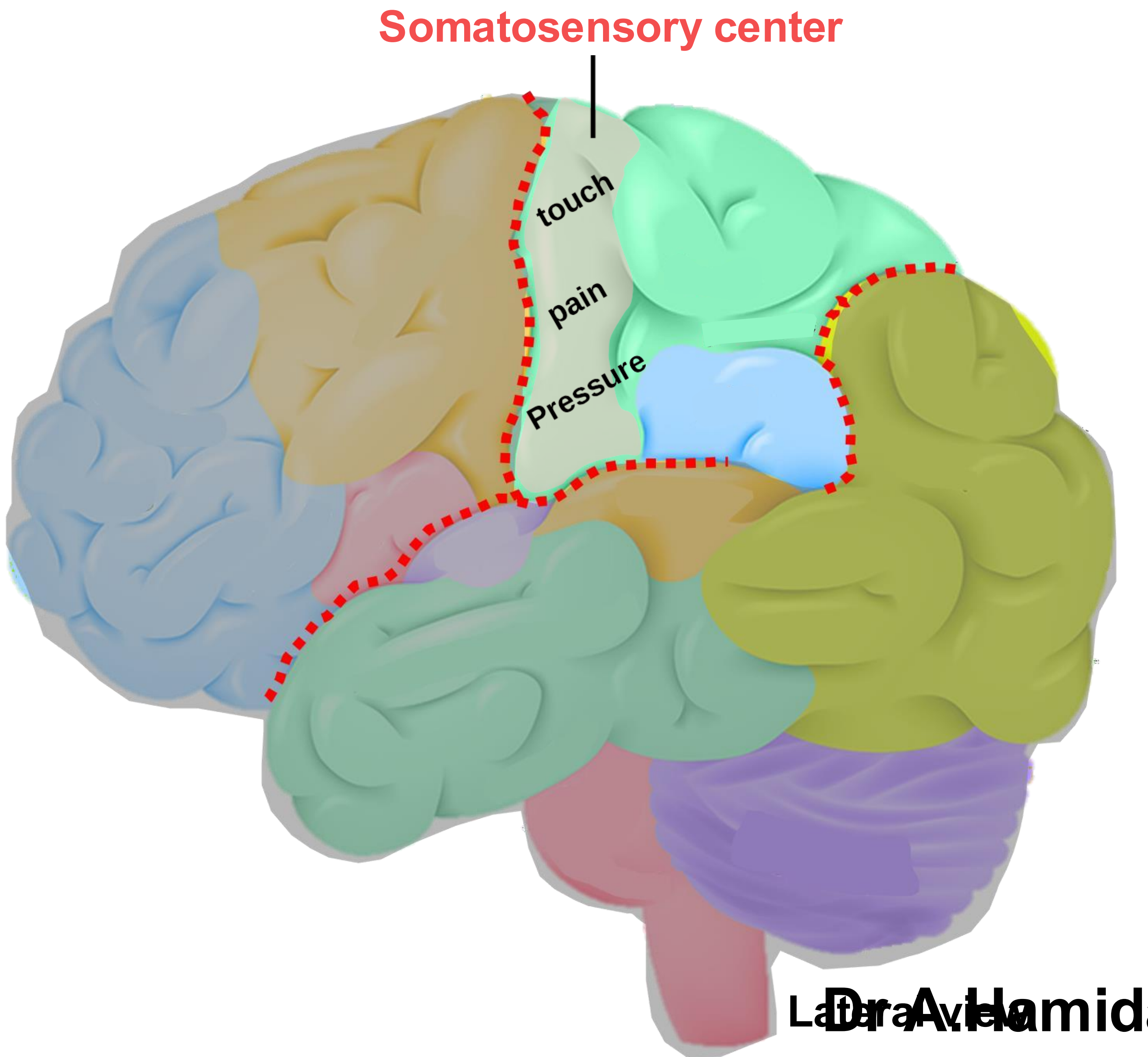
❖ Lobes of Cerebral Hemisphere

2. Parietal Lobe

Anterior to the occipital-parietal sulcus and the first line

- **Located posterior to the central sulcus and superior to the lateral sulcus, occupying the superior part of the cranial cavity**
- **Main centers and areas :**
  - **Somatosensory center: receives sensory information from the body such as touch, pain, pressure, and temperature.**

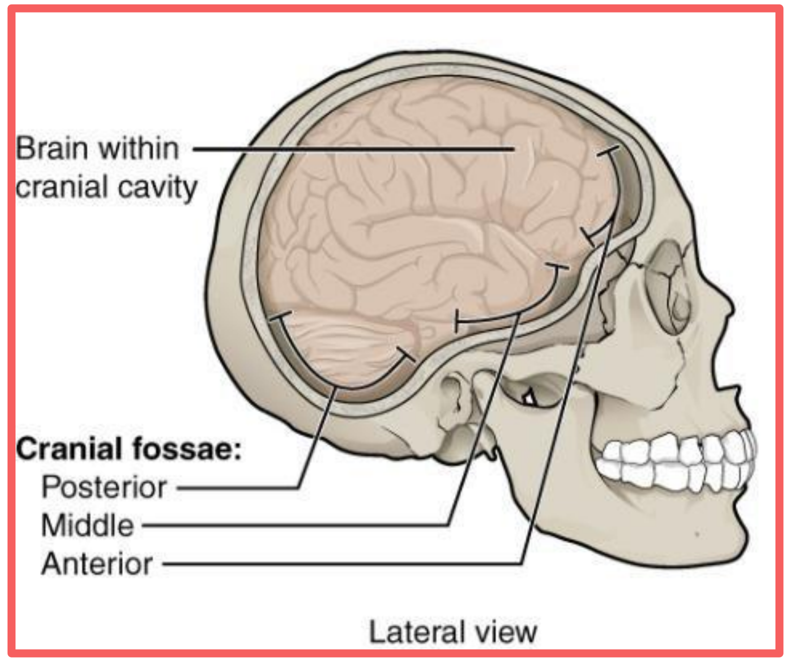




Cerebrum

❖ Lobes of Cerebral Hemisphere

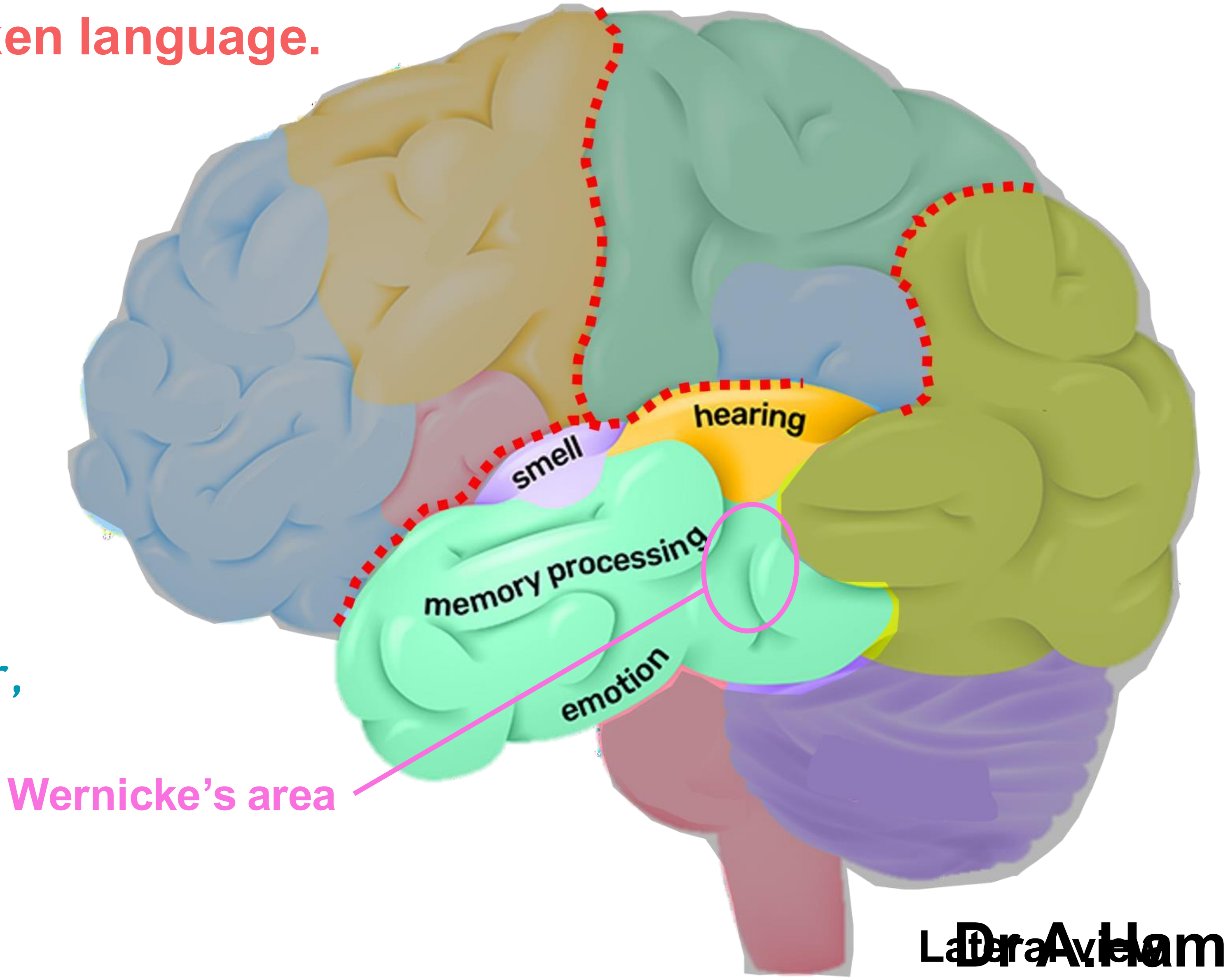
3. Temporal Lobe



- **Located inferior to the lateral sulcus, occupying the middle cranial fossa**
- **Main centers and areas:**
  - **Auditory (hearing) center: receives and processes sound input.**
  - **Wernicke's area: responsible for comprehension of spoken language.**
  - **Olfactory center: perceives smell.**
  - **Areas for memory and emotion.**

The Wernicke's area is responsible for understanding what people say.

For example, when someone talks to you in a language you don't know, you won't understand them (the Wernicke's area). However, notice that you can hear them through your auditory center, this tells us that hearing and the Wernicke's area are unrelated.



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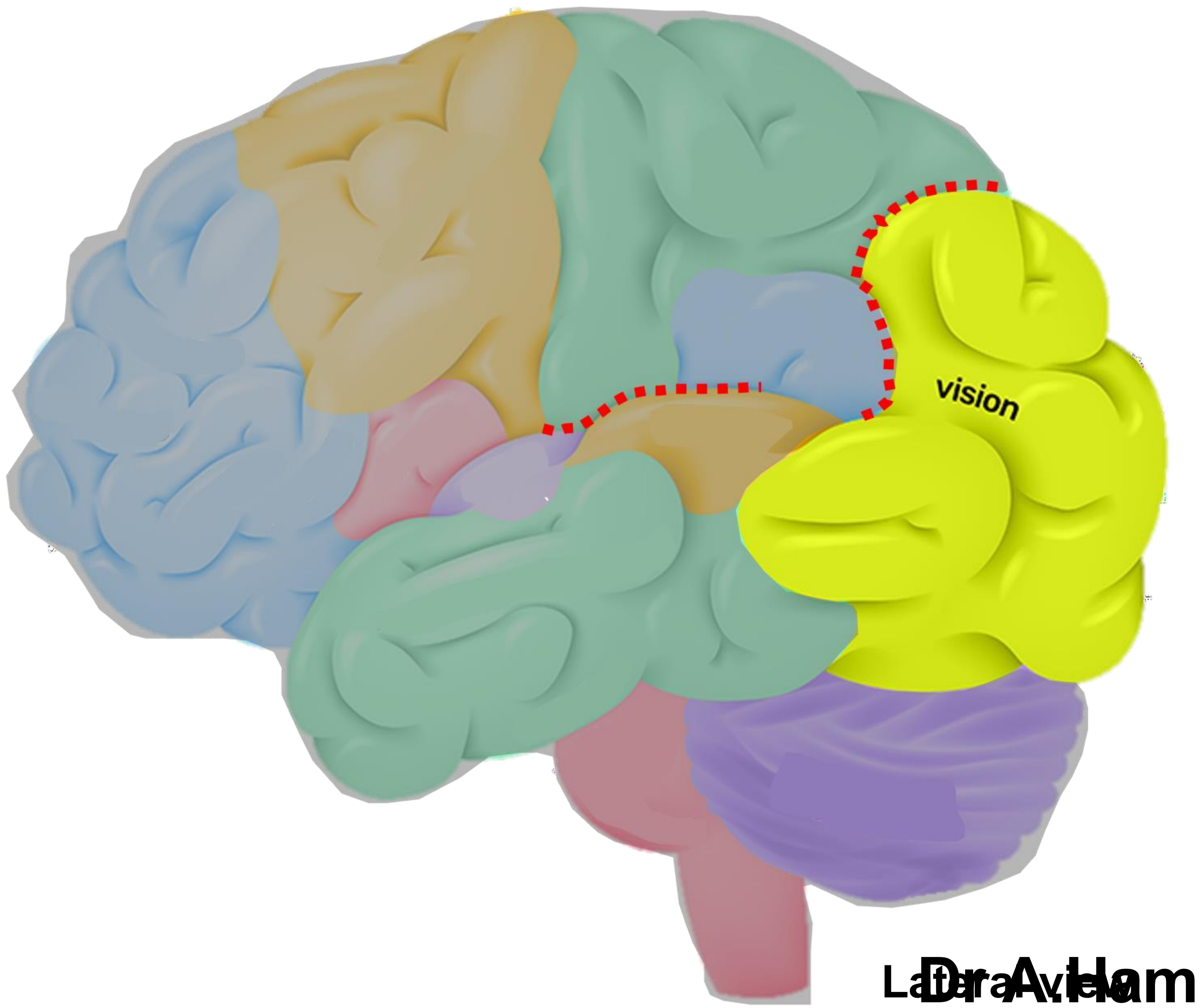
5.2.1 Cerebrum

❖ Lobes of Cerebral Hemisphere

4. Occipital Lobe

- **Located posterior to the parieto-occipital sulcus.**
- **Main centers and areas :**
  - **Visual center: receives and interprets visual information.**

We have optical nerves that collect all the visual information and take them to the occipital lobe



Lateral view

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5.2.2 Diencephalon

Second part of the forebrain

Inferior to the cerebral hemisphere & superior to the midbrain

- It is located between the cerebrum and the brainstem.
- Contains a cavity called the third ventricle.
  Located between the two thalami (thalamus & hypothalamus)
- The diencephalon has two principal parts:

1. **Thalamus:** All the sensory & motor information are gathered up together in the thalamus then it sends It to a specific receiver

   Acts as a relay station for sensory information (except smell) to the cortex and helps in motor control, consciousness, and alertness.

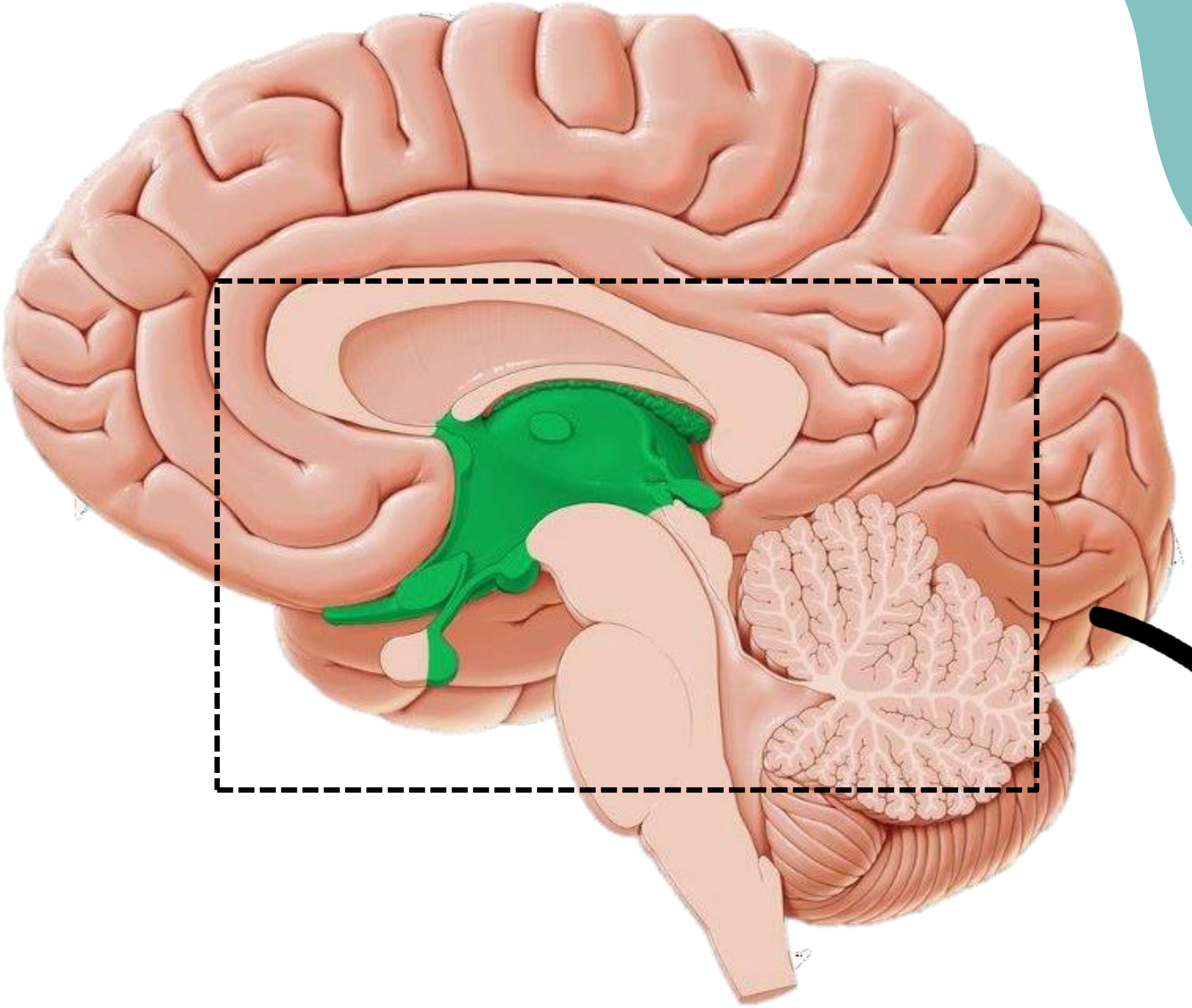
   For example. The thalamus takes the information of special sensations such as hearing and sends it to the temporal lobe, another example, if the information was visual, the thalamus sends it to the occipital lobe.

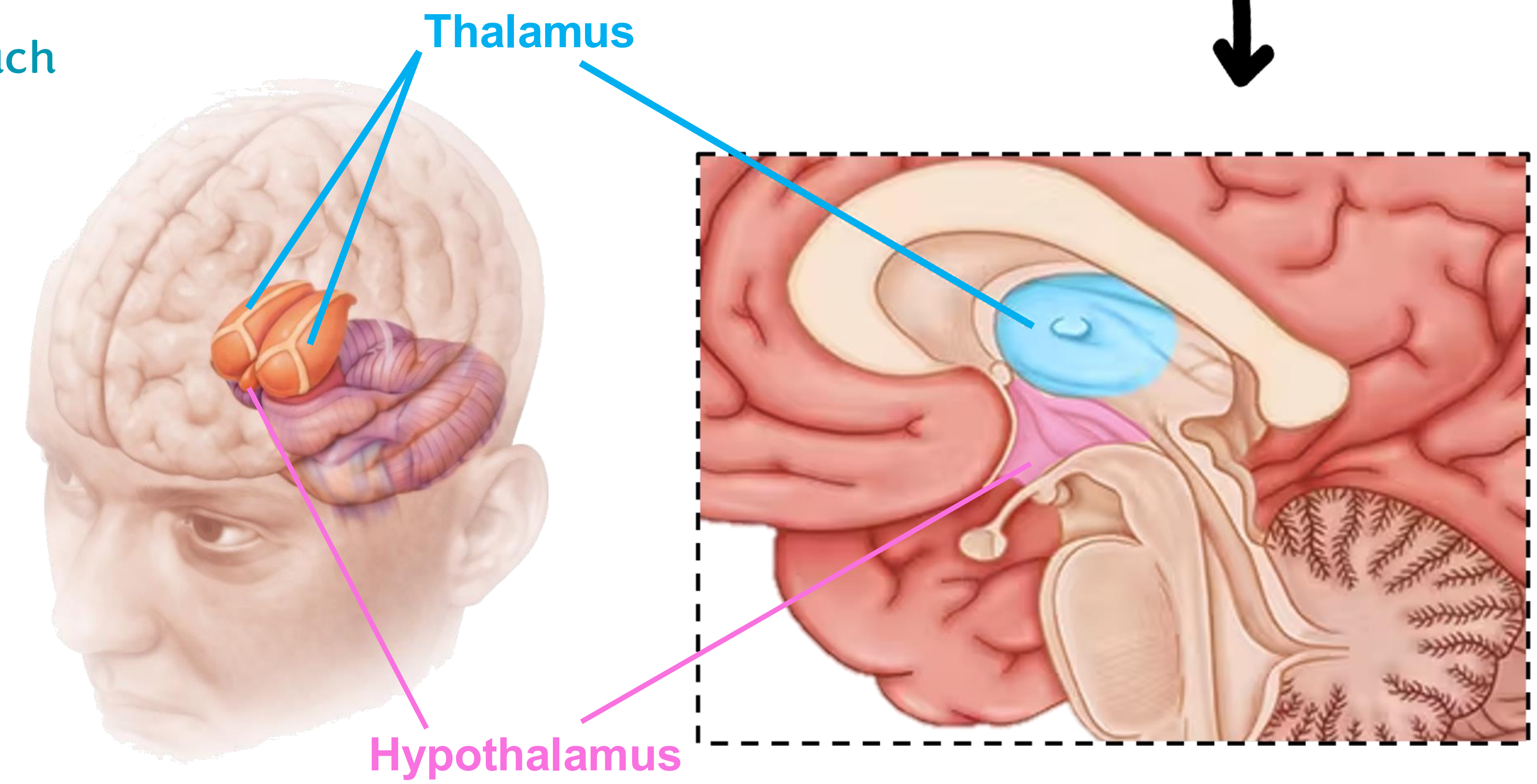
   However, for smelling sensations it goes from the olfactory (smell) nerve into the temporal lobe directly without the thalamus being involved

2. **Hypothalamus:**

   Maintains homeostasis, regulates the autonomic and endocrine systems, controls emotions, sleep, hunger, thirst, and body temperature.

   Inferior to the hypothalamus is the pituitary gland (الغدة النخامية) where hormones are released. The hypothalamus sends excitatory & inhibiting hormones (acting as signals) to the pituitary gland, the pituitary gland receives these orders then it releases hormones.





Gross lecture-8

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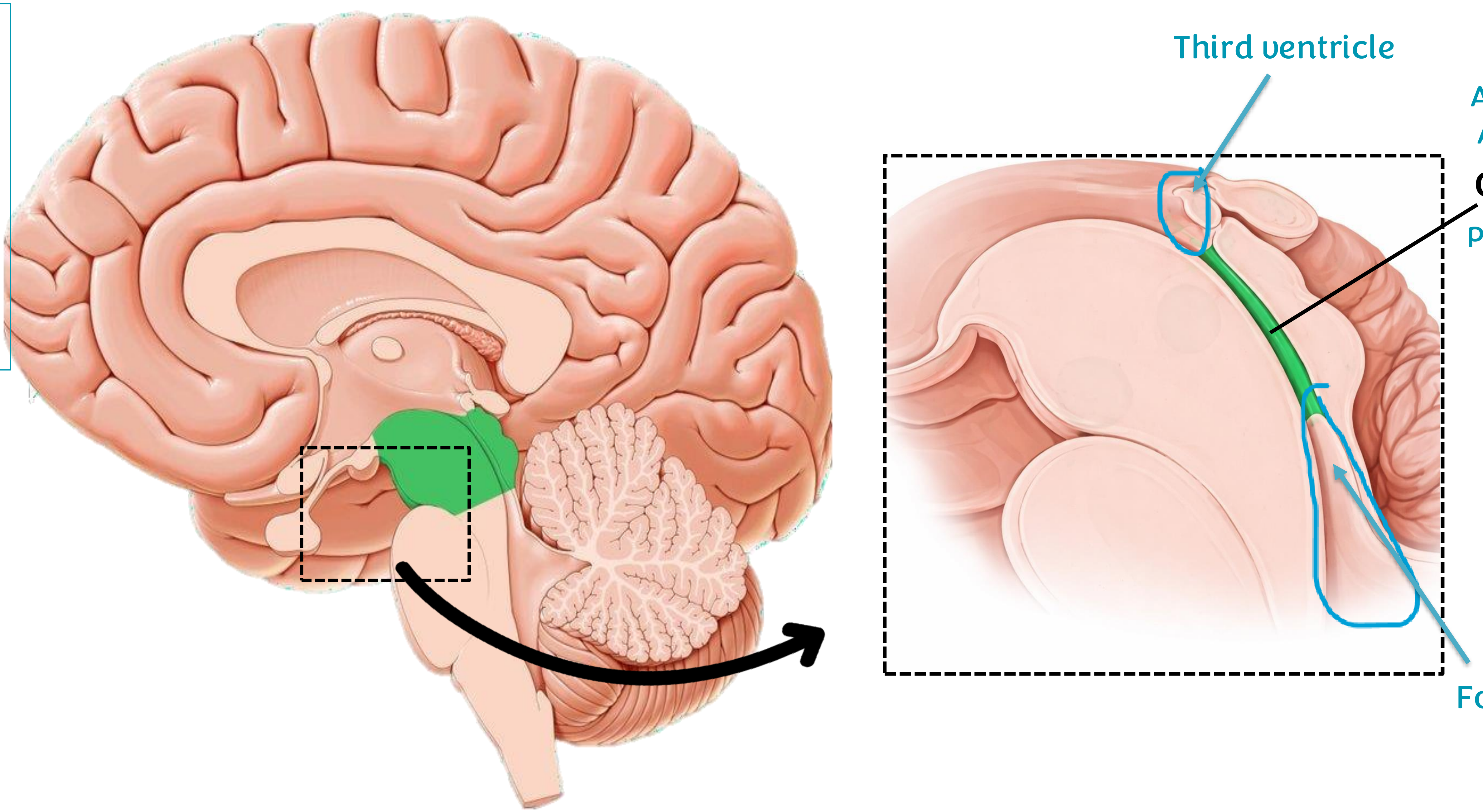
Midbrain

- It is a narrow region connecting the forebrain and the hindbrain.
- Serves as a pathway for ascending and descending tracts.
- Contains the <u>**cerebral aqueduct**</u>, which connects the third and fourth ventricles.

For example, fibers moving to the ascending tract from the spinal cord to the brain must pass the midbrain & same thing for the descending tract

There are 3 cranial nerves that are involved in eye movement: two originate from the midbrain and one from the pons. These nerves travel to the eye, where they control its movements.

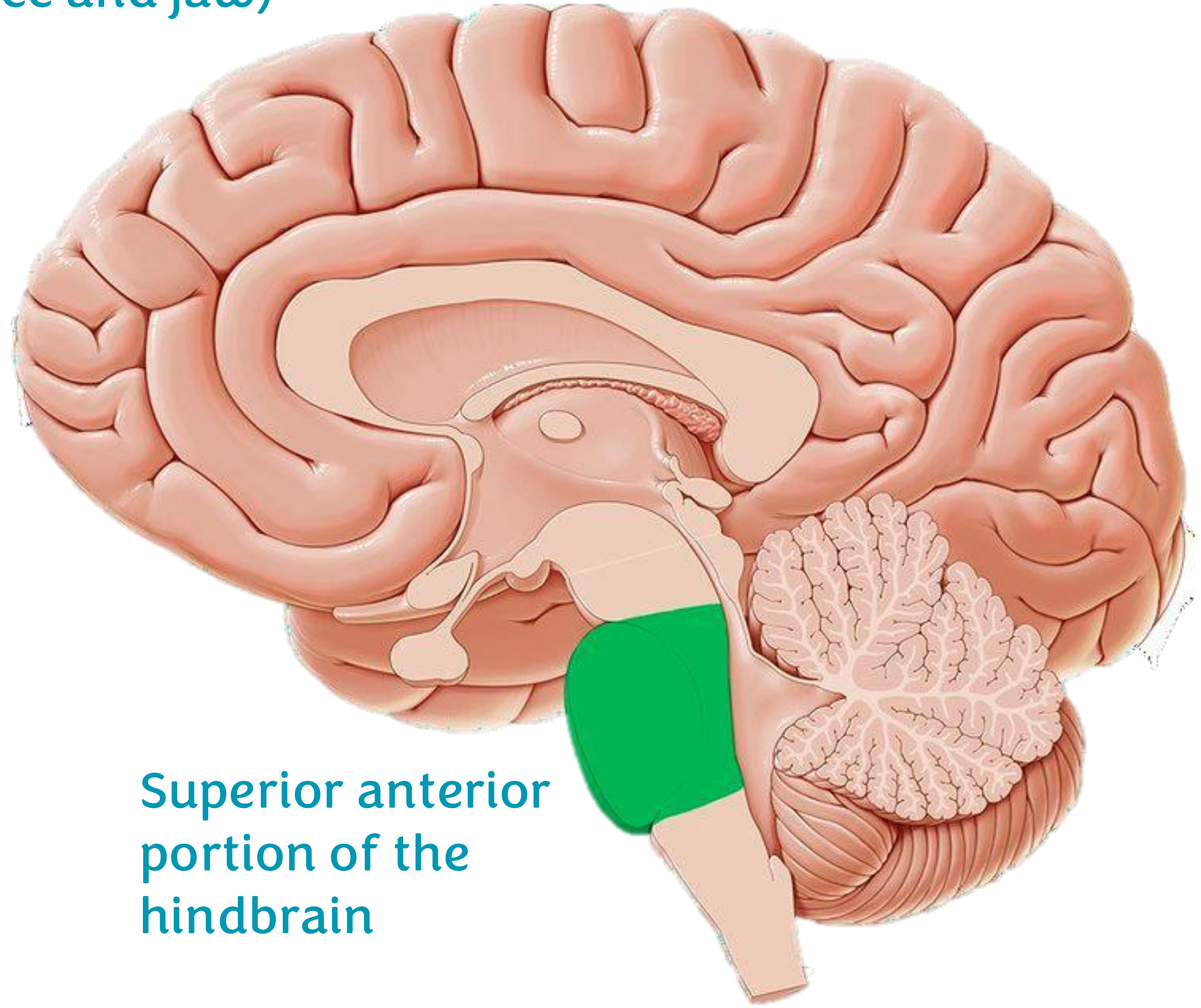


Midsagittal view

Pons

- It is the large middle part of the brainstem.
- Located anterior to the cerebellum, inferior to the midbrain, and superior to the medulla oblongata.
- Acts as a passage for ascending and descending tracts.

Pons have cranial nerves that are responsible for muscle mastication (of the face and jaw)
العضلات المسؤولة عن المضغ:



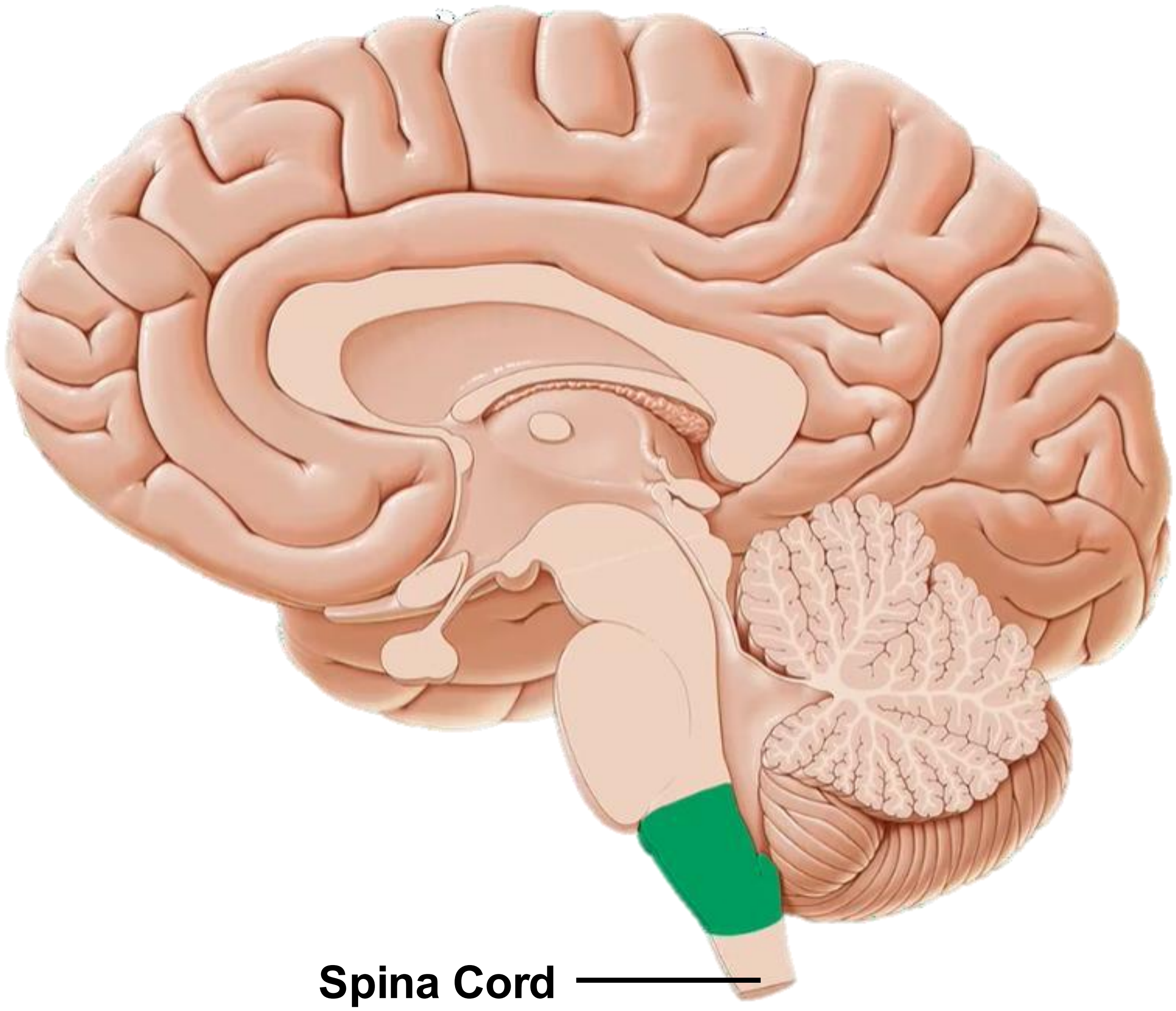
Superior anterior portion of the hindbrain

Midsagittal view

5.2.5 Medulla Oblongata

- It is the lower part of the brainstem, continuous with the spinal cord at the foramen magnum.
- Passage for ascending and descending tracts.
- Houses vital centers: <u>respiratory</u> and <u>cardiovascular centers</u>.

Maintains & controls the heart rate and the respiratory rate (involuntary control)



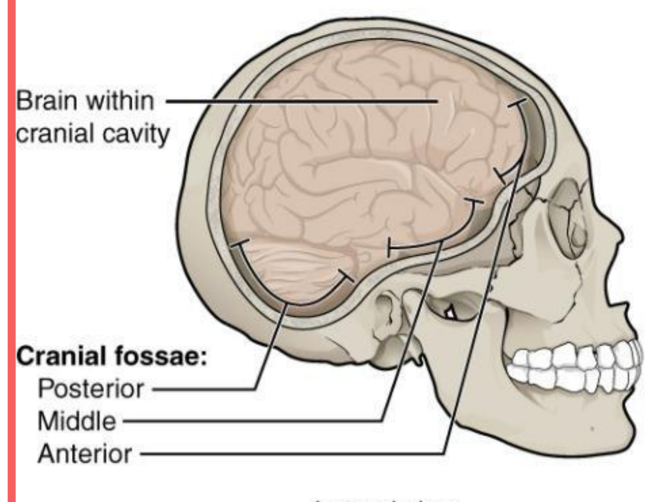
Midsagittal view

5.2.6

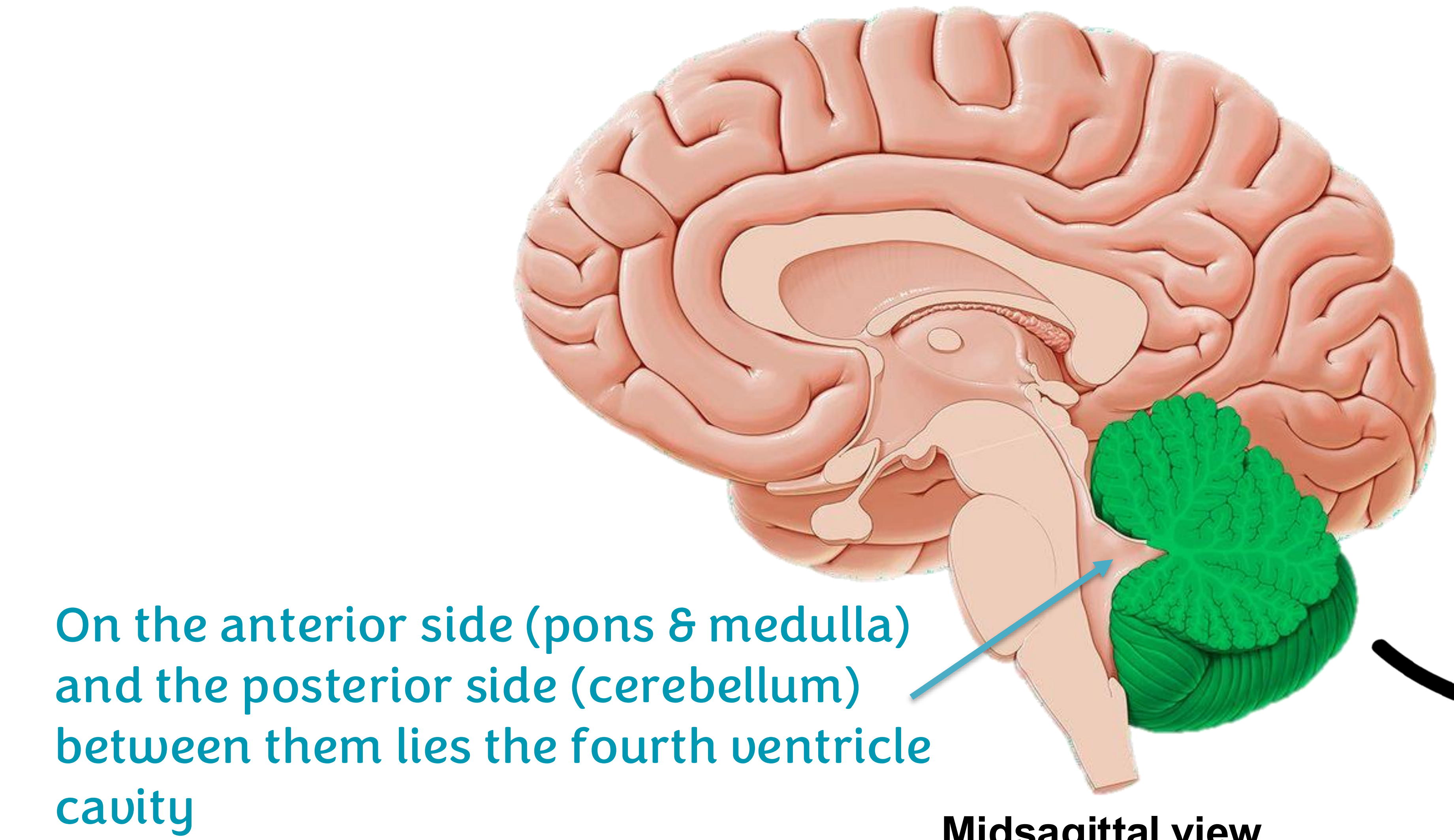
Cerebellum

- It is located in the posterior cranial fossa, behind the pons and medulla oblongata.
- Consists of two lateral cerebellar hemispheres and a median vermis.
- Function:
  1. Coordinates movement. (Accurately touching your nose with your finger)
  2. Maintains muscle tone. (standing upright without collapsing because your muscles are contracting)
  3. Maintains balance.

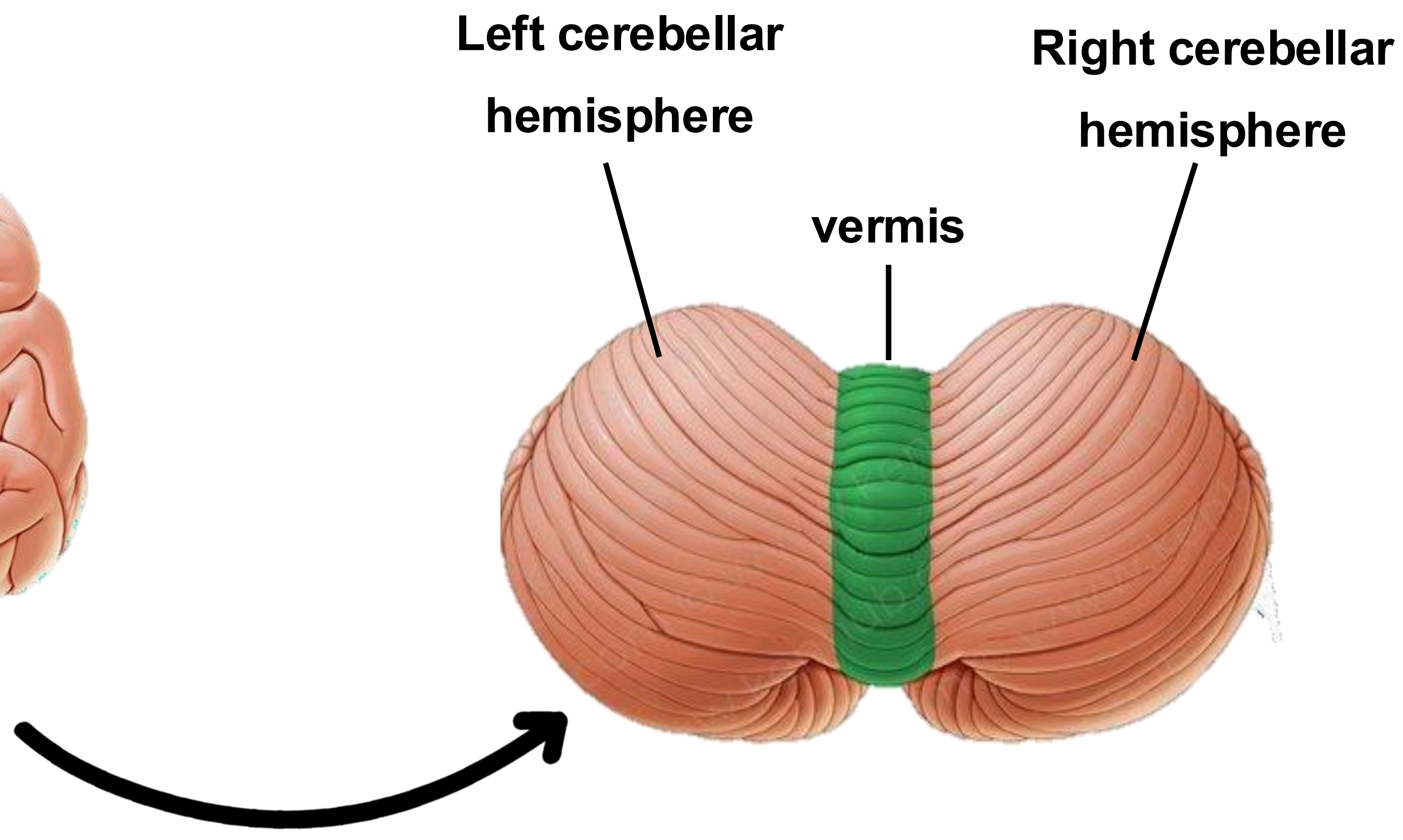
     (standing with one leg)



Lateral view



Midsagittal view



Posterior view

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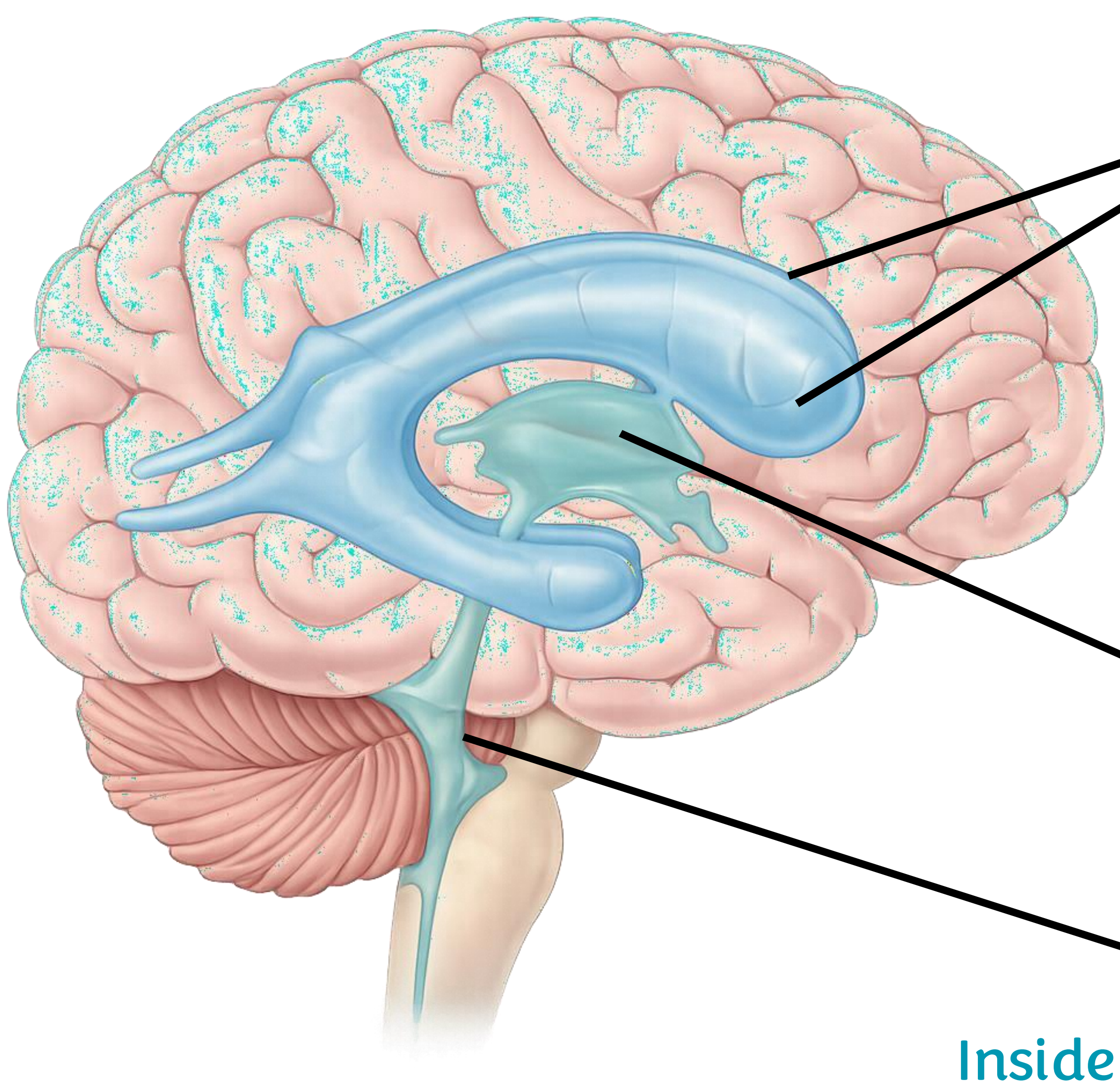
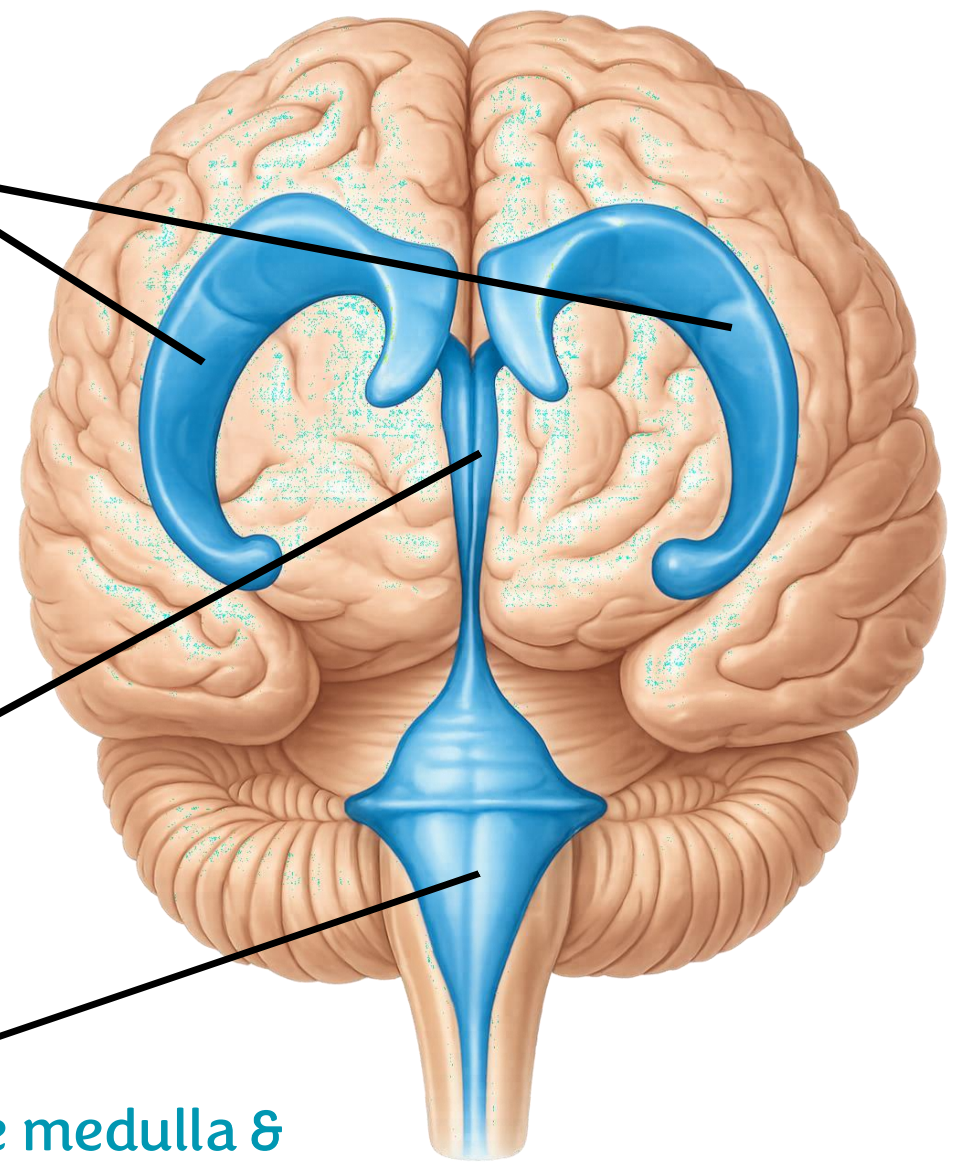
5.2.7 Ventricles of the Brain

- They are four cavities filled with CSF located within the brain:
    1. **Two Lateral Ventricles:** it is the cavity present in each cerebral hemisphere
    2. **Third Ventricle:** it is the cavity present in the diencephalon
    3. **Fourth Ventricle:** it lies between the pons and the medulla anteriorly, and the cerebellum posteriorly

We have two cerebral hemisphere; each one has a cavity where the lateral ventricles lie in



Lateral view



Frontal view

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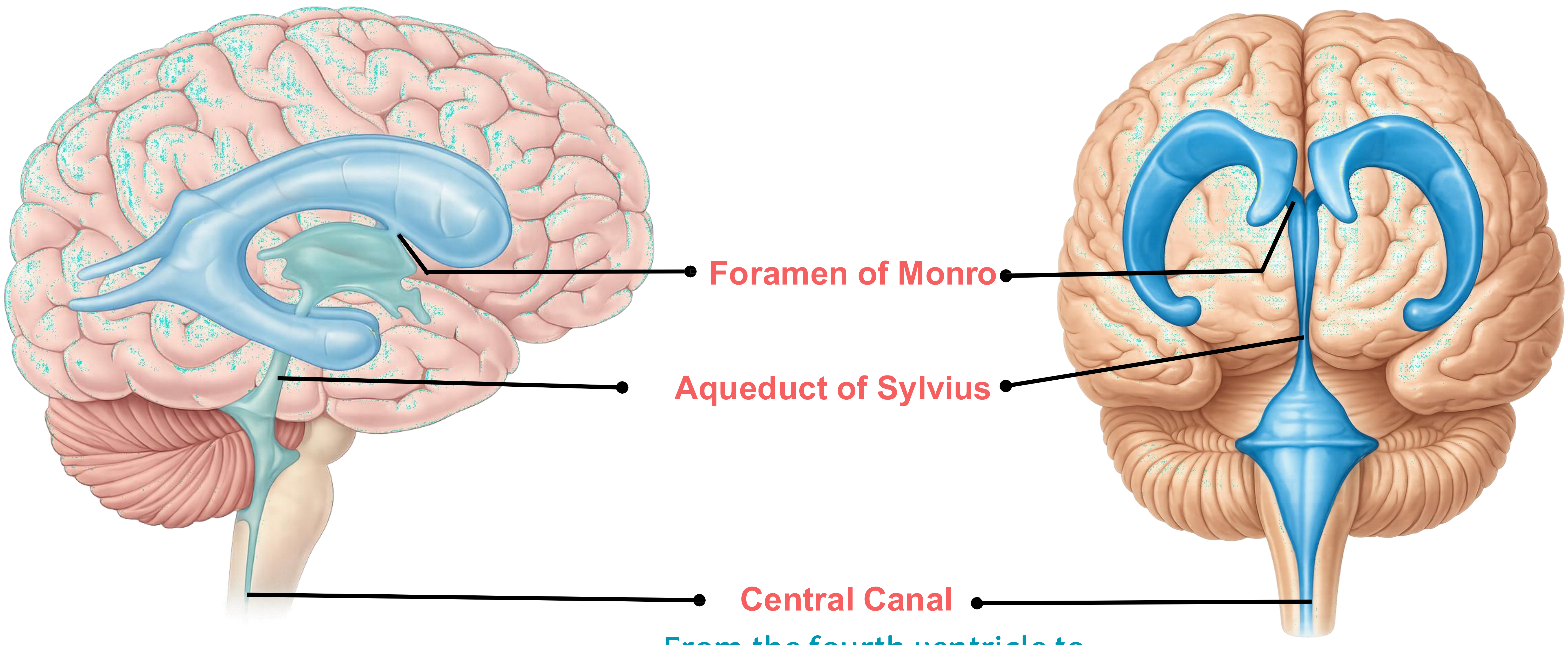
5.2.7 Ventricles of the Brain

➢ **All ventricles are connected together which allow the CSF to circulate between each other:**

- The **two lateral ventricles** communicate with the third ventricle through the **interventricular foramina** (Foramen of Monro)
- The **third ventricle** communicates with the **fourth ventricle** through the **cerebral aqueduct** (Aqueduct of Sylvius)
- The **fourth ventricle** communicates with the **spinal cord** through the **central canal of spinal cord**



From the fourth ventricle to the last spinal cord

Lateral view

Frontal view

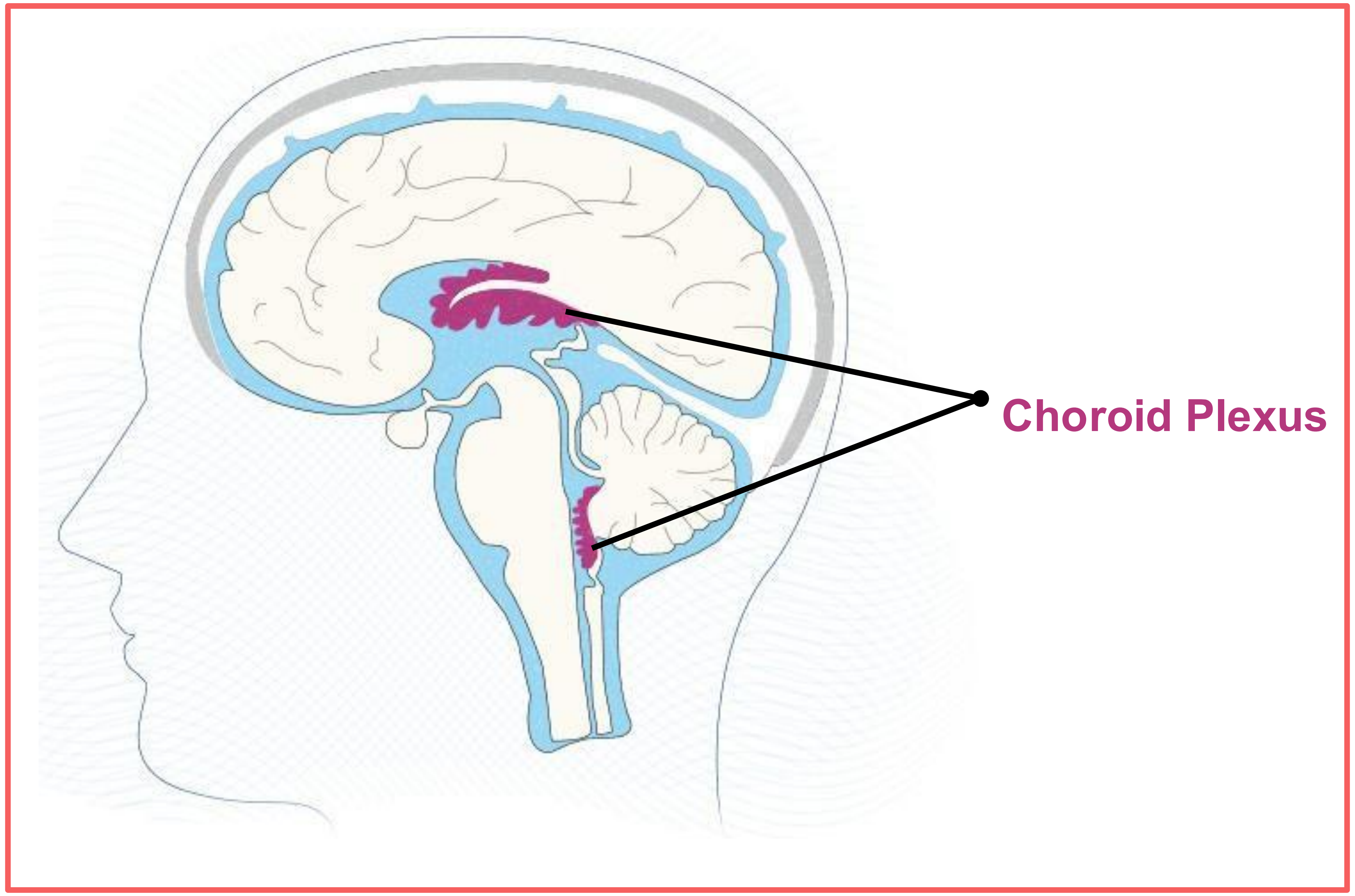
5.2.7

Ventricles of the Brain

➢ The ventricles are lined by ependymal cells.

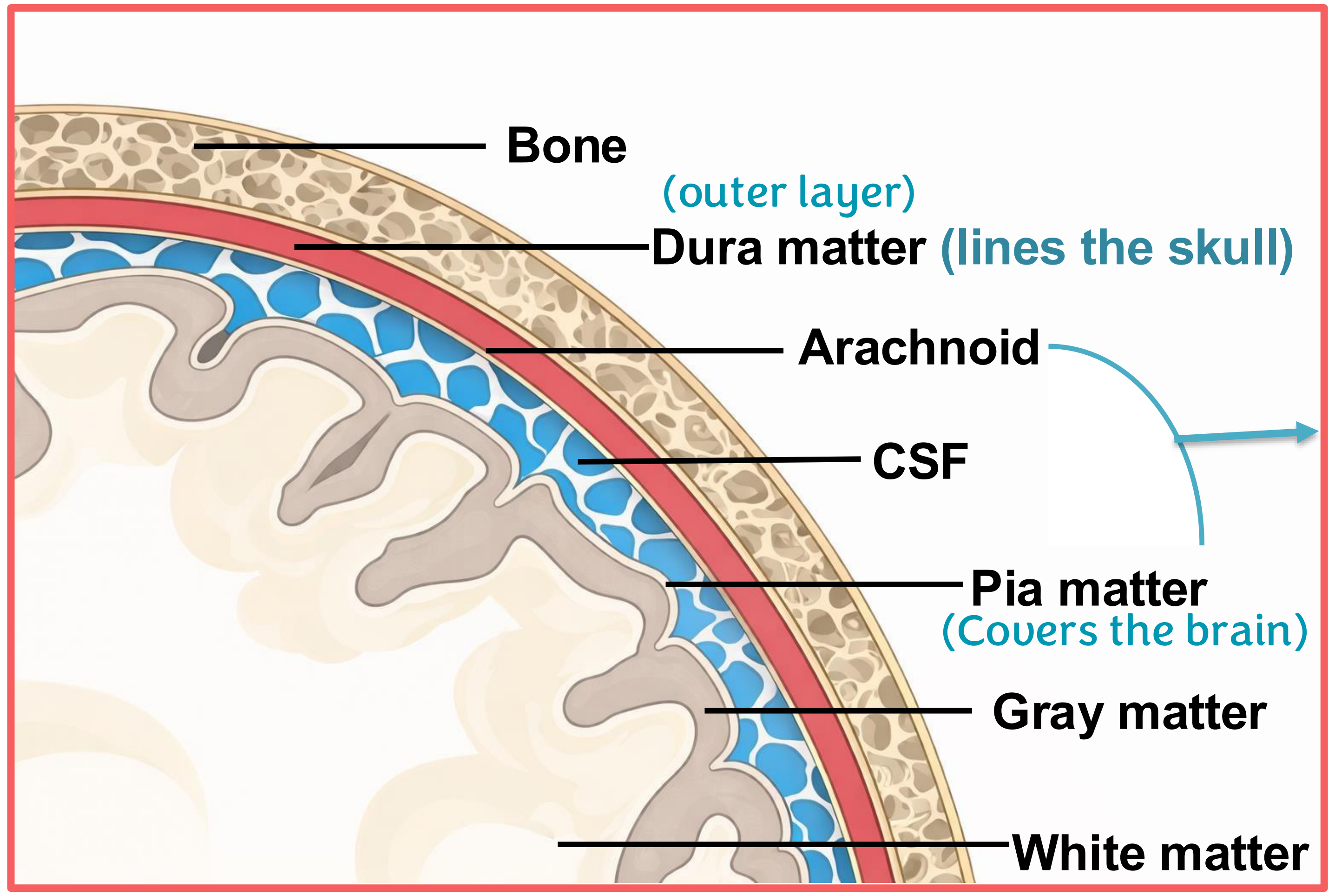
- A collection of modified ependymal cells and capillaries form a structure called the choroid plexus.
- The function of choroid plexus is to produce Cerebrospinal fluid (CSF)

The CSF travels through the subarachnoid space

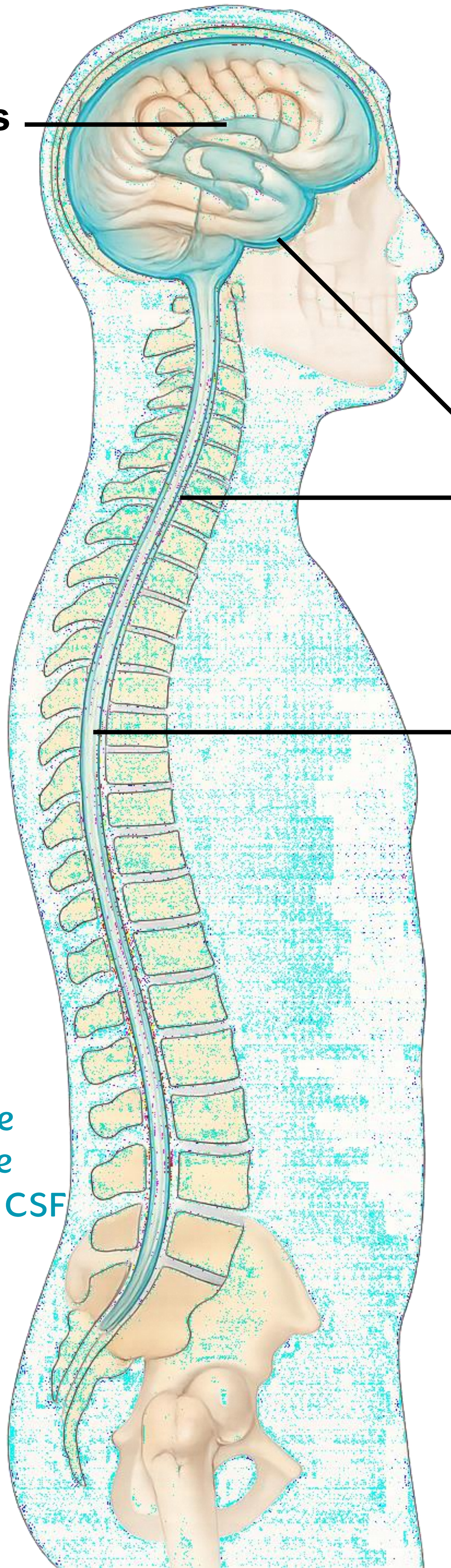


Cerebrospinal Fluid

- It is a clear, colorless fluid found around the brain and spinal cord occupies the **subarachnoid space**.
- It is produced by **choroid plexus** of the lateral, third, and fourth ventricles in the brain.
- It has a volume of about **150 ml**.
- It is composed primarily of water, and it also carries small amounts of oxygen, glucose, and other needed chemicals from the blood.



Between them is the subarachnoid space Which is filled with CSF



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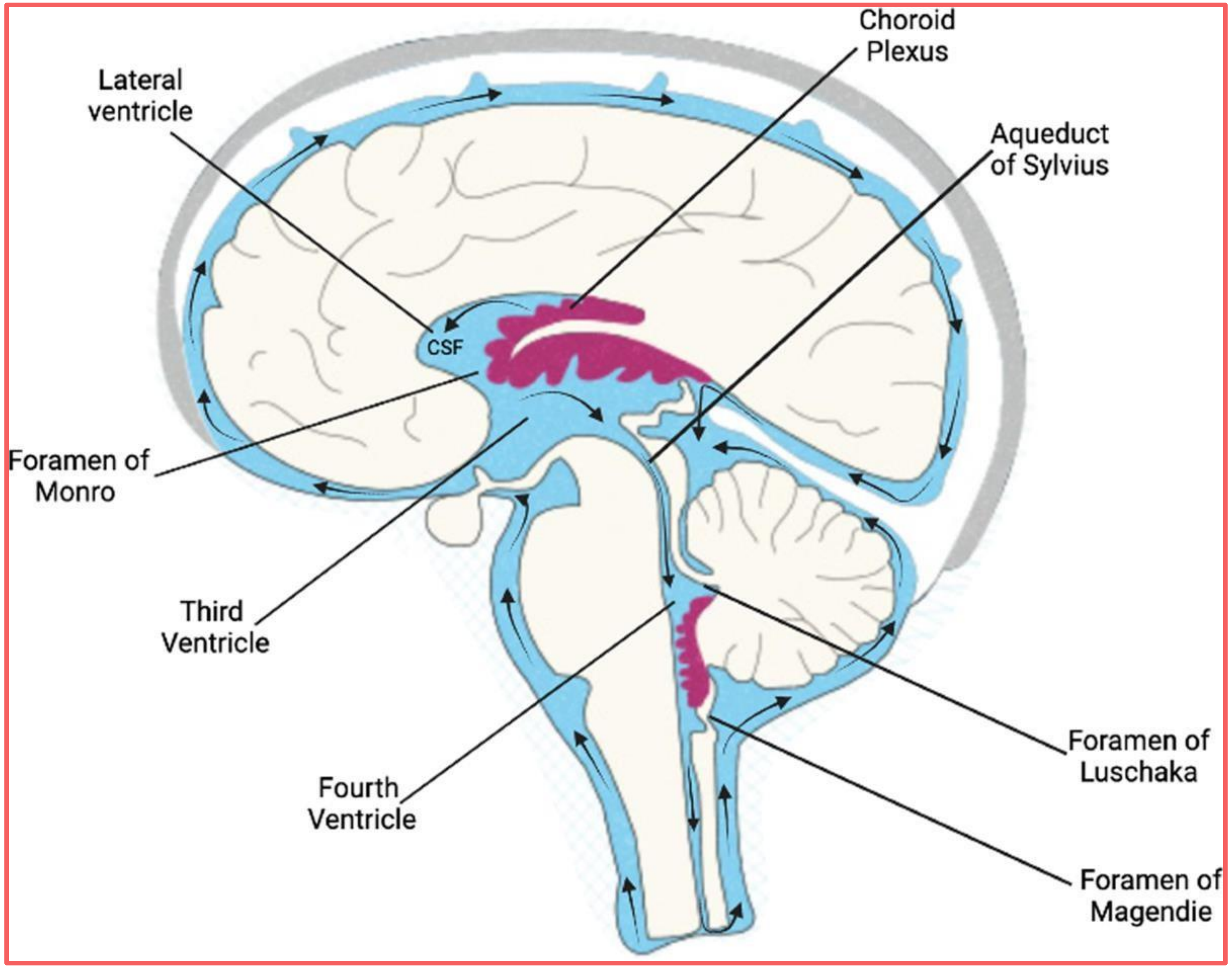
Cerebrospinal Fluid

➢ Circulation Of Cerebrospinal Fluid



Cerebrospinal Fluid

➢ Circulation Of Cerebrospinal Fluid

1. **The CSF is produced primarily by the choroid plexuses of the lateral ventricles.**

   From there, it flows through the interventricular foramina (foramina of Monro) into the third ventricle.

2. **More CSF is added by the choroid plexus in the roof of the third ventricle.**

   The fluid then passes through the cerebral aqueduct (aqueduct of Sylvius) to reach the fourth ventricle.

3. **The choroid plexus of the fourth ventricle secretes more CSF, which then flows into:**

   - The central canal of the spinal cord, and

   - The subarachnoid space through the foramen of Magendie (one median aperture) and the foramina of Luschka (two lateral apertures), allowing CSF to circulate around the brain superiorly and around the spinal cord inferiorly.

➢ **Function:**

1. Mechanical protection

- Acts as a shock absorber to protect the brain and spinal cord from injury.
- Provides buoyancy, allowing the brain to "float" in the cranial cavity.

2. Chemical protection

- **Maintains an optimal chemical environment for neuronal signaling.**
- **Even slight changes in CSF composition can affect action potential generation.**

3. Circulation

- **Allows minor exchange of nutrients and waste products between blood and nervous tissue.**

Test your knowledge

https://forms.gle/YoTU7wVpBKa1cu2J9

رسالة من الفريق العلمي:

الَّذِينَ آمَنُوا وَتَطْمَئِنُّ قُلُوبُهُم بِذِكْرِ اللَّهِ ۗ أَلَا بِذِكْرِ اللَّهِ تَطْمَئِنُّ الْقُلُوبُ (28)

سورة الرعد - آية 28

تفسير السعدي:

الَّذِينَ آمَنُوا } :ذكر تعالى علامة المؤمنين فقال
يزول قلقها :أي - { وَتَطْمَئِنُّ قُلُوبُهُمْ بِذِكْرِ اللَّهِ
أَلَا بِذِكْرِ } .واضطرابها، وتحضرها أفراحها ولذاتها
حقيق بها وحريٌّ أن لا :أي - { اللَّهِ تَطْمَئِنُّ الْقُلُوبُ
تطمئن لشيء سوى ذكره، فإنه لا شيء ألذ للقلوب
ولا أشهى ولا أحلى من محبة خالقها، والأنس به
ومعرفته، وعلى قدر معرفتها بالله ومحبتها له، يكون
ذكرها له، هذا على القول بأن ذكر الله، ذكر العبد
لربه، من تسبيح وتهليل وتكبير وغير ذلك.

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	Slide 23 text box on the left	these neurons "ascend" to the eye	These neurons "travel" to the eye
V1 → V2			