Arterial blood supply to the brain.

Meninges.

Spinal cord and spinal nerves.

By Glenn André Breivik

Overview

- **Blood supply of the brain**
  - **Gross anatomy**
  - **Homunculus**
  - **Clinical and exam relevant focus**

- Meninges
  - Innervation and hematoma (hemorrhage).

- Spinal cord and spinal nerves
  - Sectioning. Gray matter and white matter.
  - Funiculus and spinal nerves in relation to spinal tracts
  - Spinal nerves overview + anatomy
  - White and gray rami communicantes.

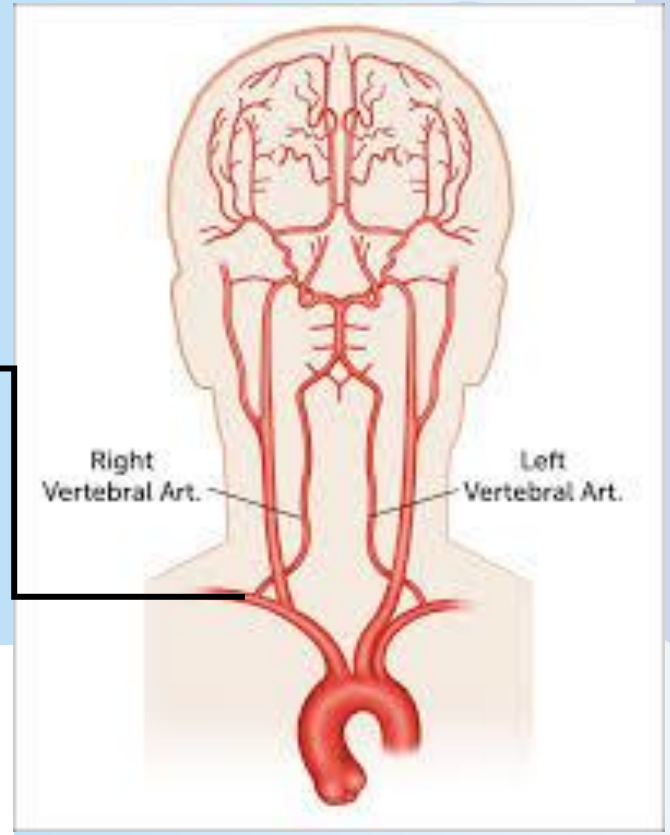
- Recommendation for more reading

- Question bank

What arteries are relevant?

- **Vertebral arteries** and **internal carotid arteries** will course towards the brain and supply the brain with blood.
- Vertebral arteries courses through transverse foramen C6-C2 of cervical vertebrates and then enters *foramen magnum*.
- Vertebral arteries merges to become the ***basilar artery***
- Internal carotid arteries will enter through the ***carotid foramen***.

Branches off the proximal part of subclavian artery



Vertebral arteries run through the transverse foramen

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Vertebral and internal carotid branches

Vertebral branches

- Anterior spinal artery
  → *Motoric area of spinal cord dysfunction*

  (Corticospinal, spinothalamic, dorsal and ventral spinocerebellar tract disturbance).

- Posterior inferior cerebellar artery (PICA)

  → *balance problems (vertigo)*
  (Horner`s syndrome)

(Posterior spinal artery branches off PICA).

Internal carotid branches

- Opthalmic artery
- Posterior communicating artery
- Anterior choroidal artery
- **Middle cerebral artery**
- **Anterior cerebral artery**

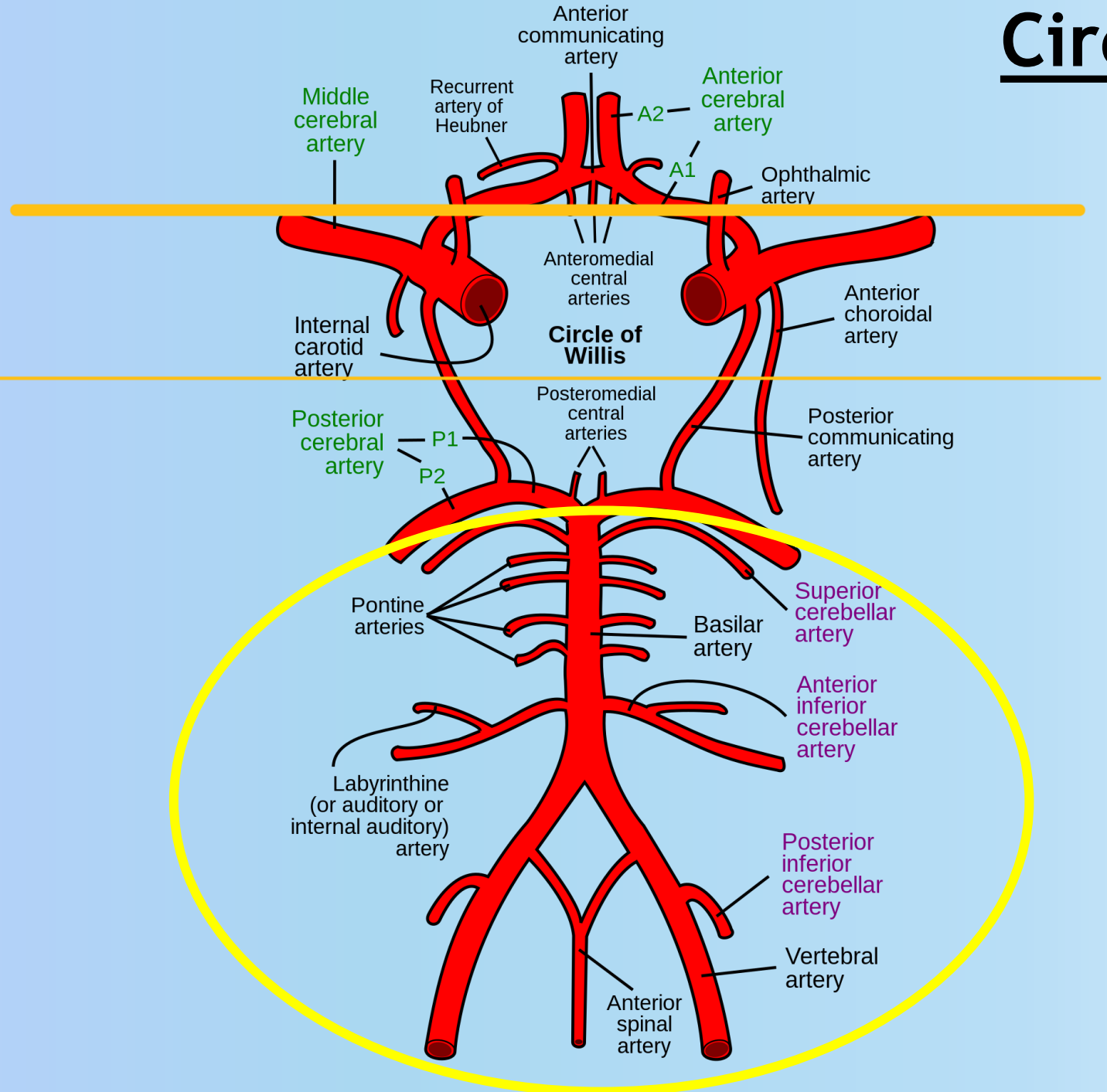
Circle of Willis

Anterior part

Middle part

Posterior part

(Basilar part)



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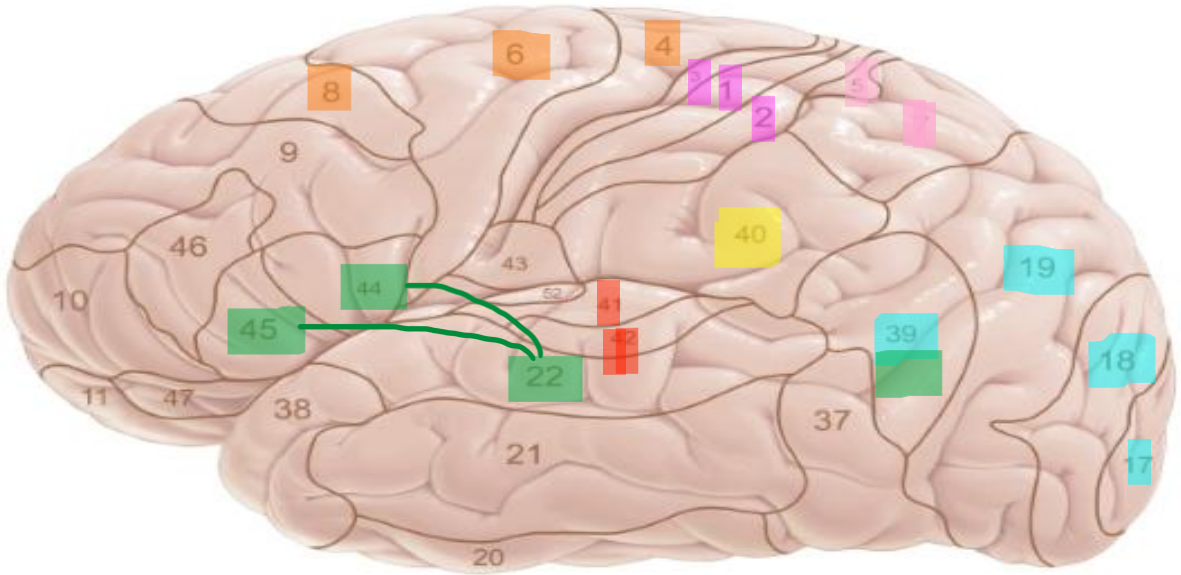
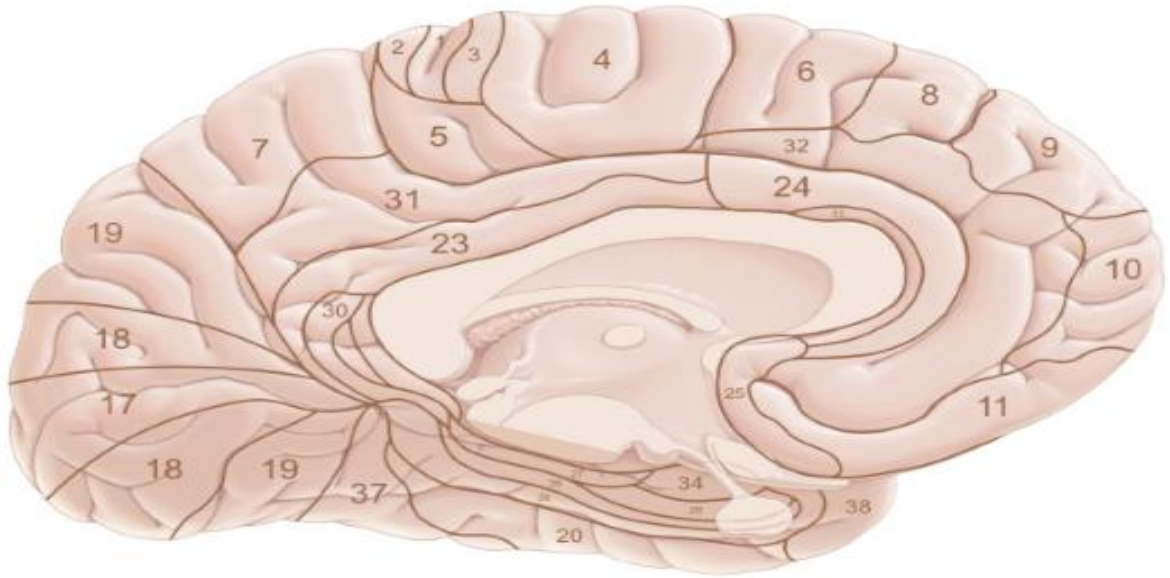
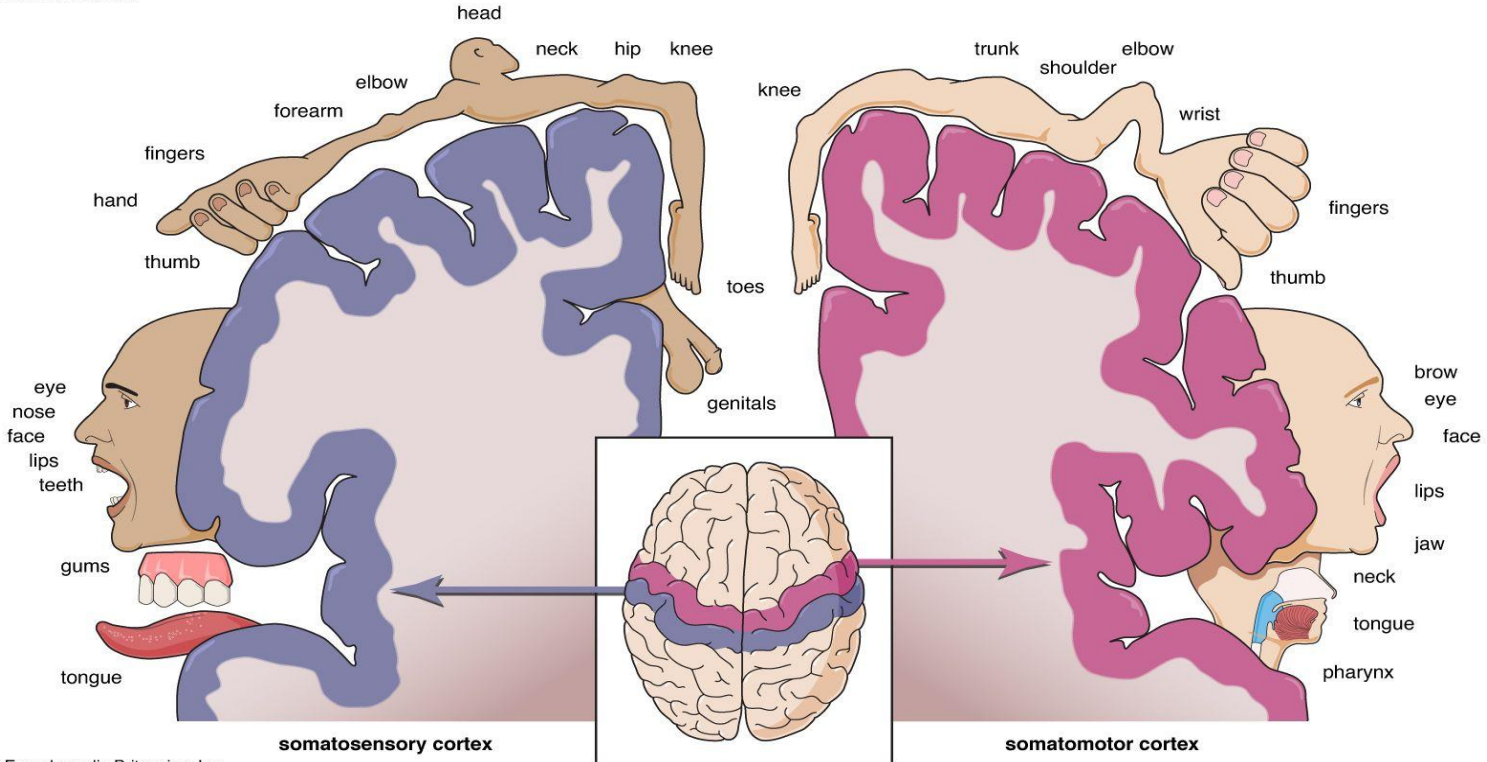
Brodmann area 4 is in charge of all pyramidal tracts





Homunculus



- **Brodmann areas** and the **homunculus** helps to understand the symptoms you get from the arteries of the brain, when there is an occlusion.

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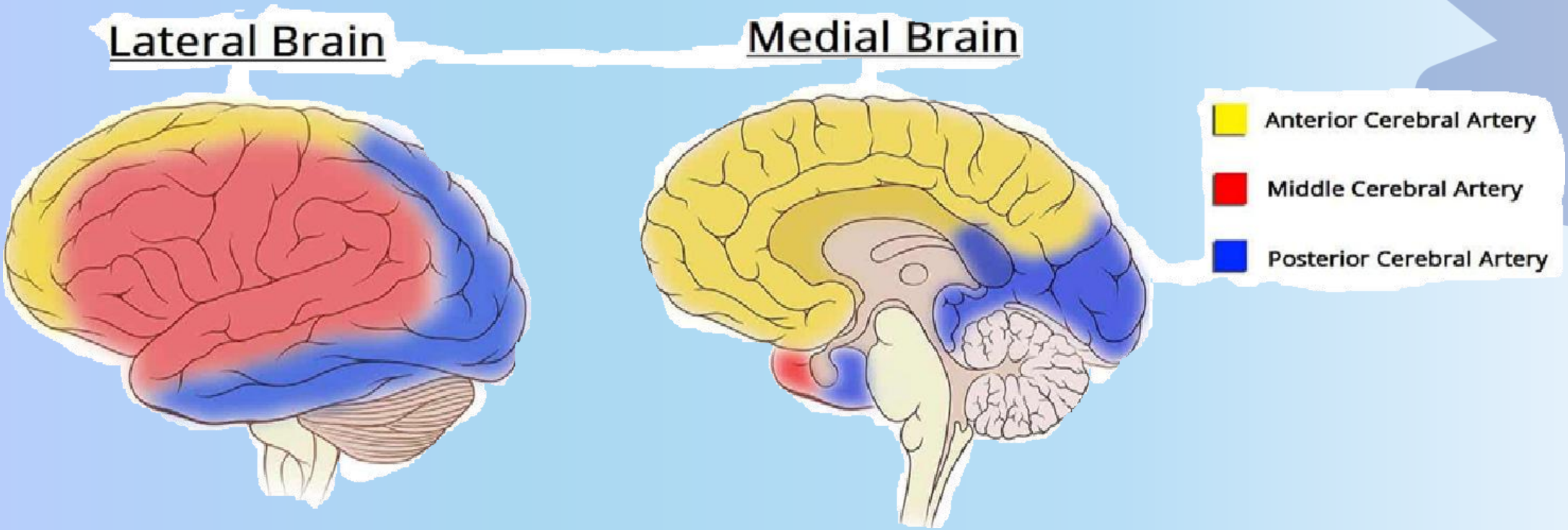


- Anterior cerebral arteries → «In the front and backwards»
- Middle cerebral arteries → «On the sides/lateral portion»
- Posterior cerebral arteries → «Lower sides and the back»

Medial surface of frontal and parietal lobes + corpus callosum

Lateral hemisphere + insula

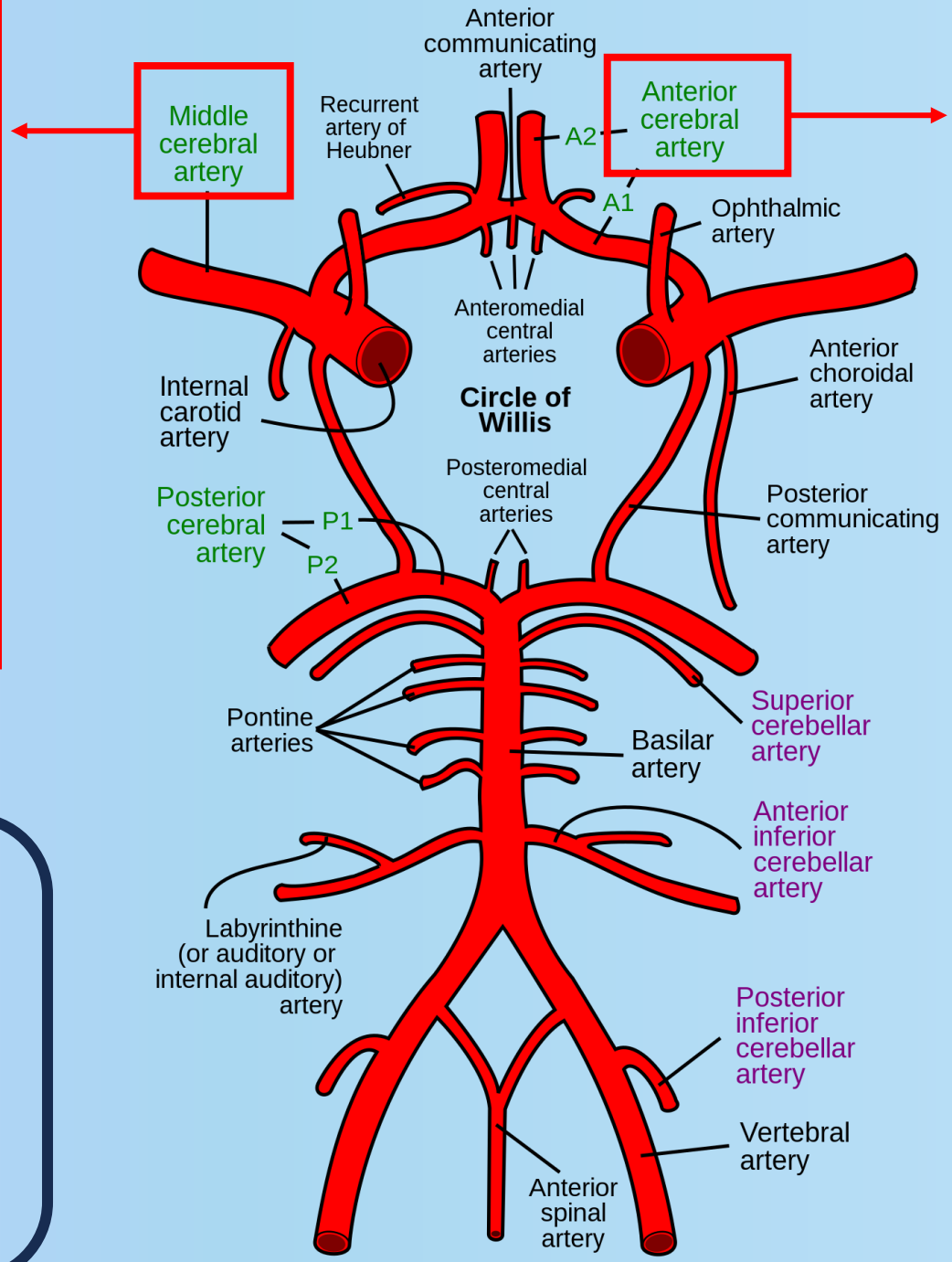
Occipital lobe, thalamus, inferior part of temporal lobe

So what happens if the arteries is not providing proper blood flow?

1. **Speach (aphasia):**
(Wernick`s and Boca`s area)

2. **Hearing:**
(auditory illusions and hallucinations, deafness)

3. **Touch confusion:**
Gerstmann syndrome, sensory discrimination loss and stereognisis.



1. **Somatosensory loss in lower limbs**
(babinski sign)

2. **Dyspraxia and tactile agnosia**

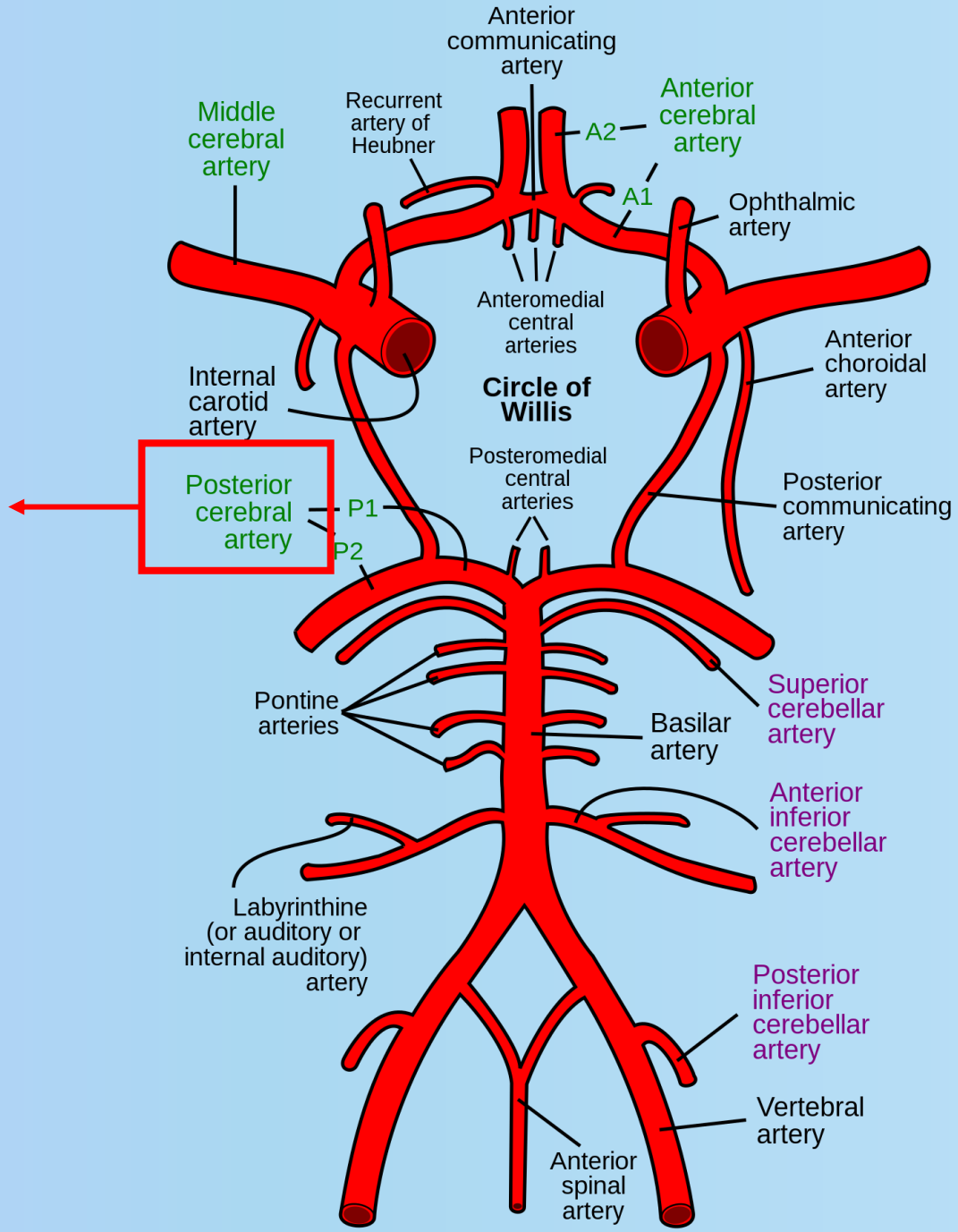
Gerstmann syndrome:
Right-left confusion, name recognization and copying text by handwriting is impossible

Stereognosis:
Loss of 3D perspective

Tactile agnosia:
Cannot recognize objects by touch

Dyspraxia:
Poor coordination (motoric)

1. **Vision problems**
2. **Prosopagnosia and achromatopsia**
3. **Vertigo (dizziness), vomiting, headache.**
4. **Long-term memory deficit**



Prosopagnosia:
Inability to identify faces

Achromatopsia:
Colour blindness

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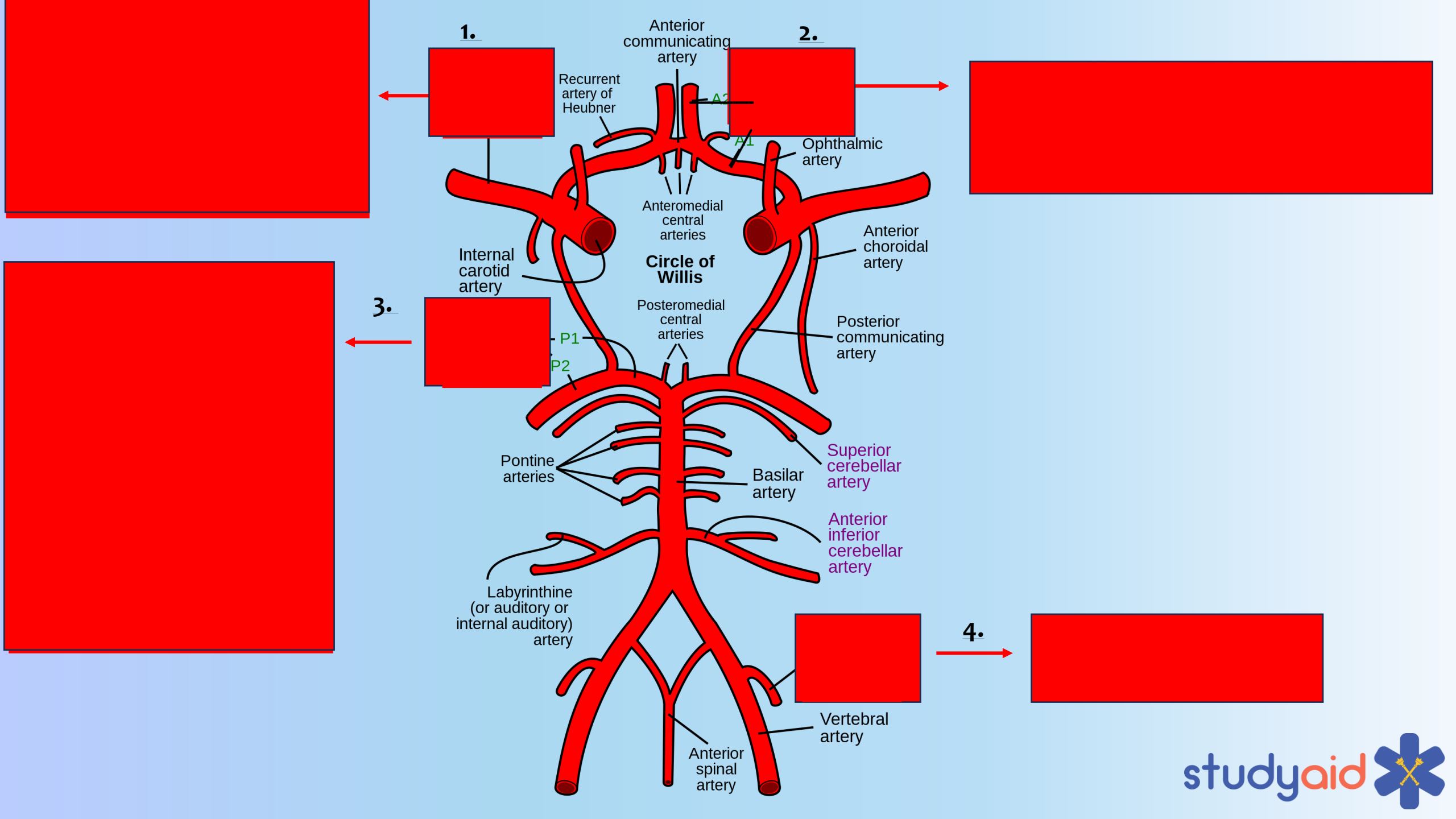
1.
2.
3.
4.
Anterior communicating artery
Recurrent artery of Heubner
A2
A1
Ophthalmic artery
Anteromedial central arteries
Circle of Willis
Anterior choroidal artery
Internal carotid artery
Posteromedial central arteries
P1
P2
Posterior communicating artery
Pontine arteries
Basilar artery
Superior cerebellar artery
Anterior inferior cerebellar artery
Labyrinthine (or auditory or internal auditory) artery
Vertebral artery
Anterior spinal artery

Overview

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  - **Innervation and hematoma (hemorrhage).**

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  - Sectioning. Gray matter and white matter.
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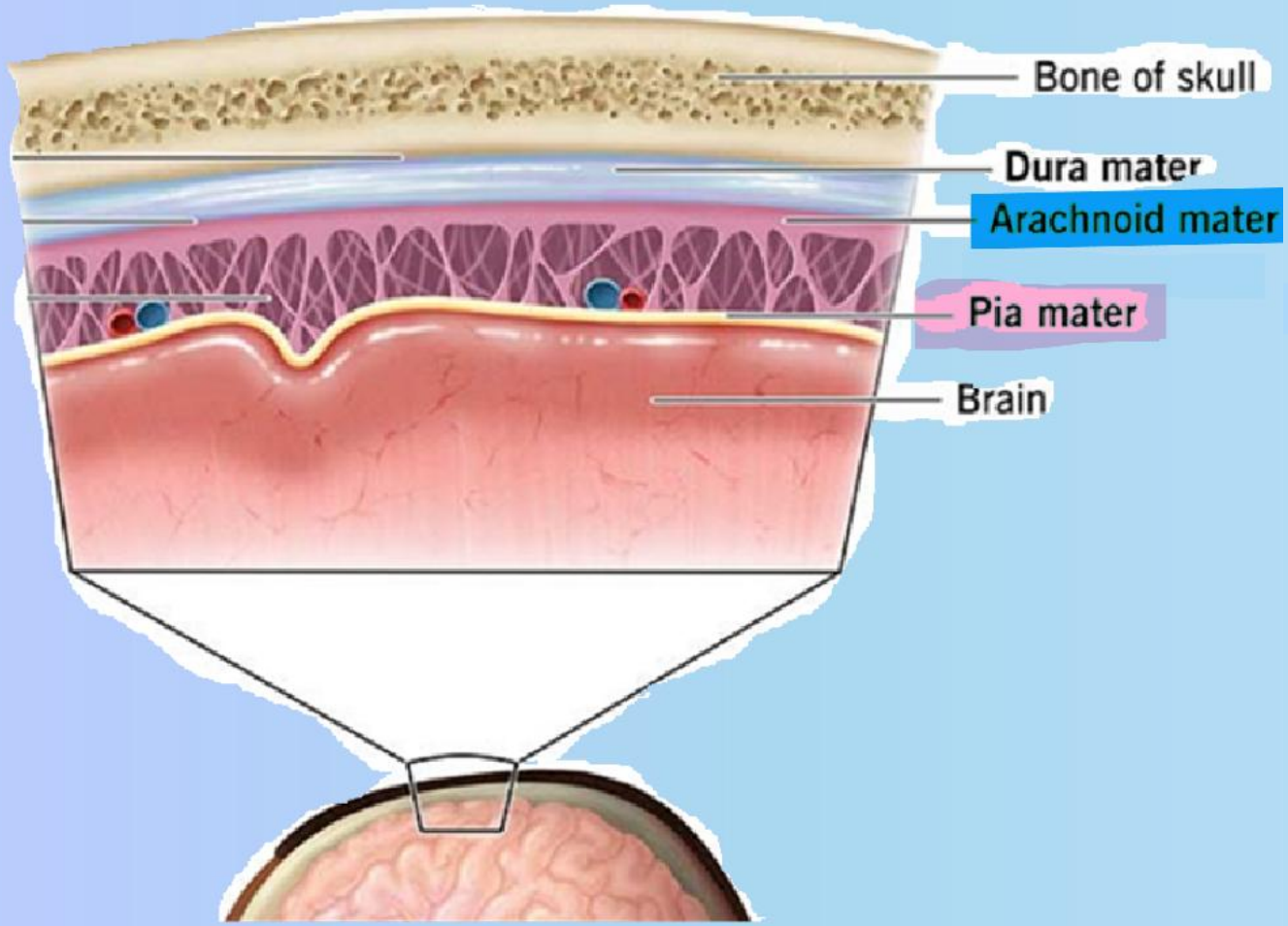
Meninges



1. **Dura mater - (periosteal and meningeal layer)**
   (outermost layer, attached to the skull)
2. **Arachnoid mater**
   (intermediate layer - CSF and arachnoid granulations)
3. **Pia mater**
   (innermost layer, attached to the brain)

- Leptomeninges
  (**Arachnoid** and **Pia** → ***Neural crest cells***)

Nerve innervation of dura mater

Trigeminal nerve (CN V):

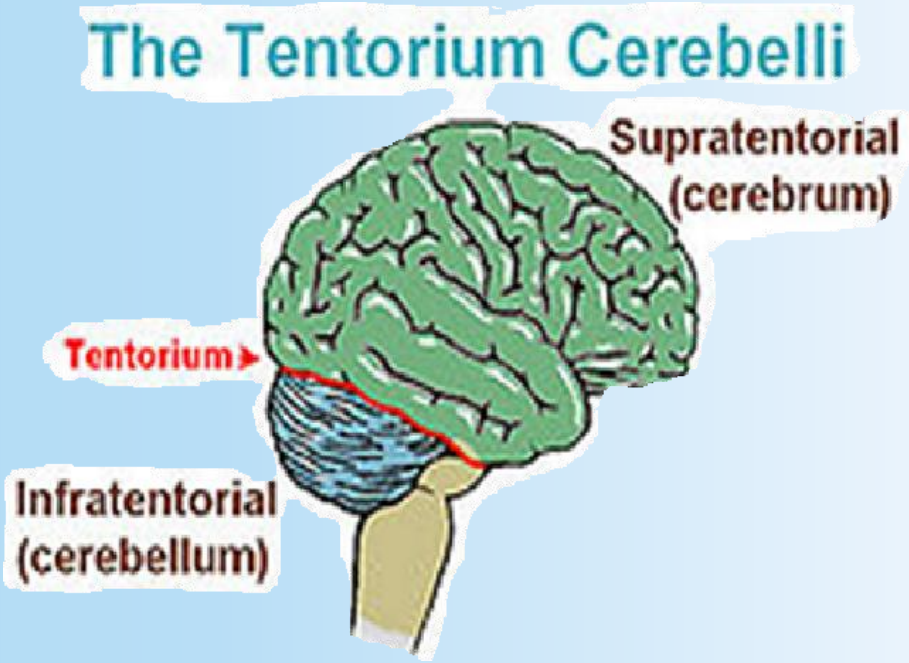
- Opthalmic nerve (V1) – meningeal branches

  - ***Ethmoidal nerves* (anterior meningeal branches)**
  floor of anterior cranial fossa, cribriform plate

  - ***Tentorial nerve***
  (which branches off the ethmoidal nerves) – supratentorial dura mater innervation

- Maxillary nerve (V2) – meningeal branches
  (parietal area and lesser wing of sphenoid bone in the cranial fossa)

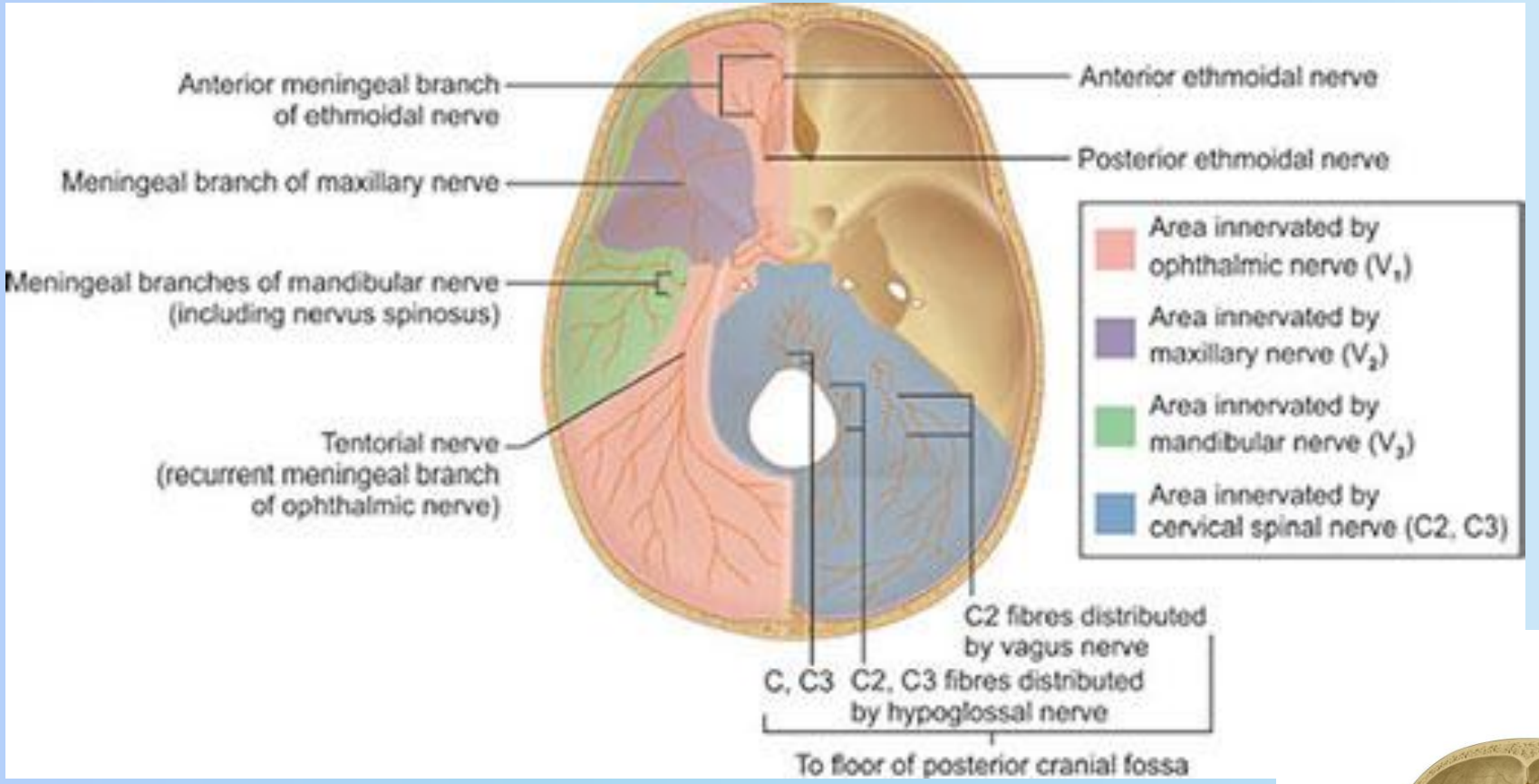
- Mandibular nerve (V3) – meningeal branches
  (Anterior and middle falx cerebri and middle part of cranial fossa, so temporal and anterior part of parietal area).

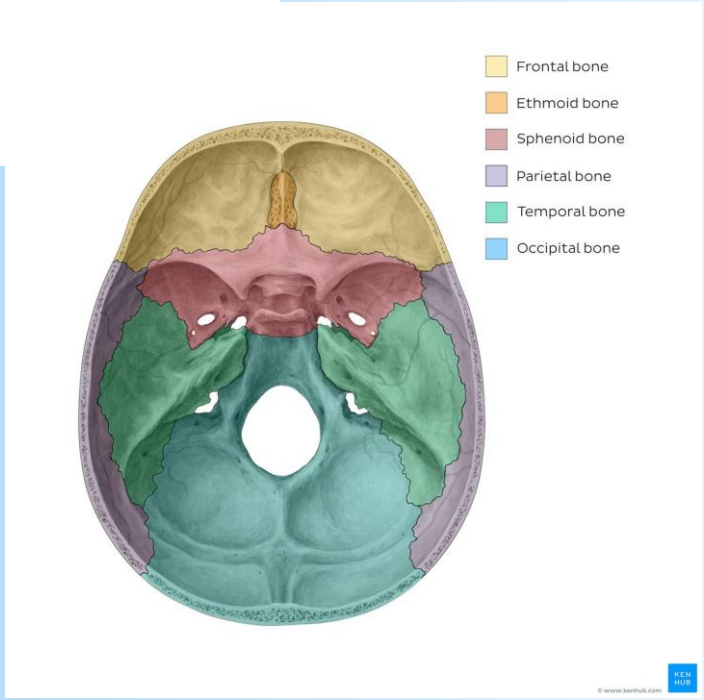


C1, C2 and C3

Floor of cranial fossa around foramen magnum and further posteriorly.

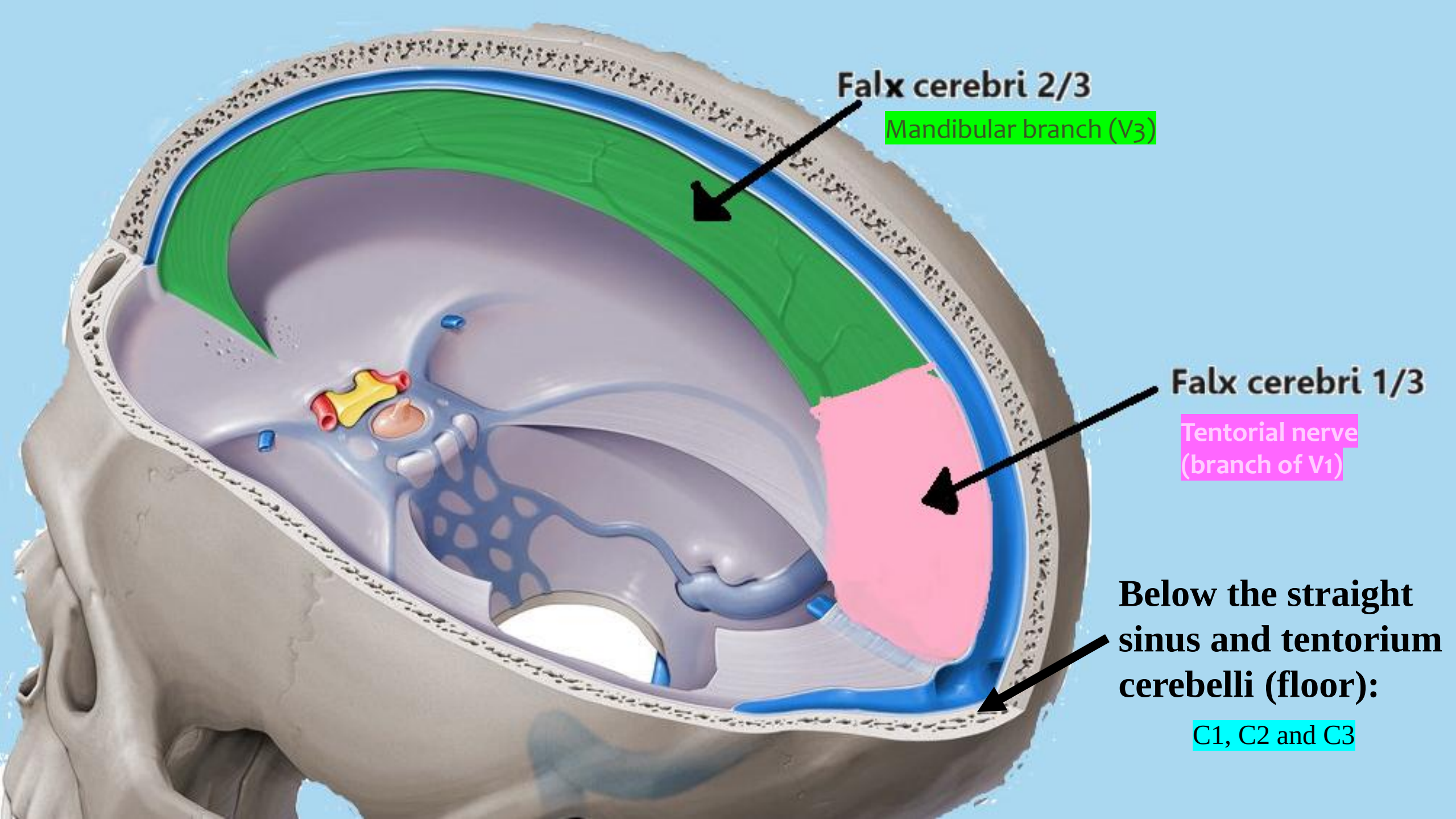
C1, C2 and C3 "takes a taxi" with **hypoglossal nerve and vagus nerve** to the cranial fossa. Respectively hypoglossal canal and jugular foramen to innervate the dura mater in those areas, and then further posteriorly.





Remember that C1, C2 and C3 innervates all of the POSTERIOR FLOOR of cranial fossa (from around foramen magnum and towards the **infratentorial** dura mater). Relate it to the «taxi-cranial nerves» and the foramen they enter/leaves.

Tentorial nerve (branch of V1) will innervate the **supratentorial** dura mater.


Falx cerebri 2/3
Mandibular branch (V3)
Falx cerebri 1/3
Tentorial nerve
(branch of V1)
Below the straight sinus and tentorium cerebelli (floor):
C1, C2 and C3

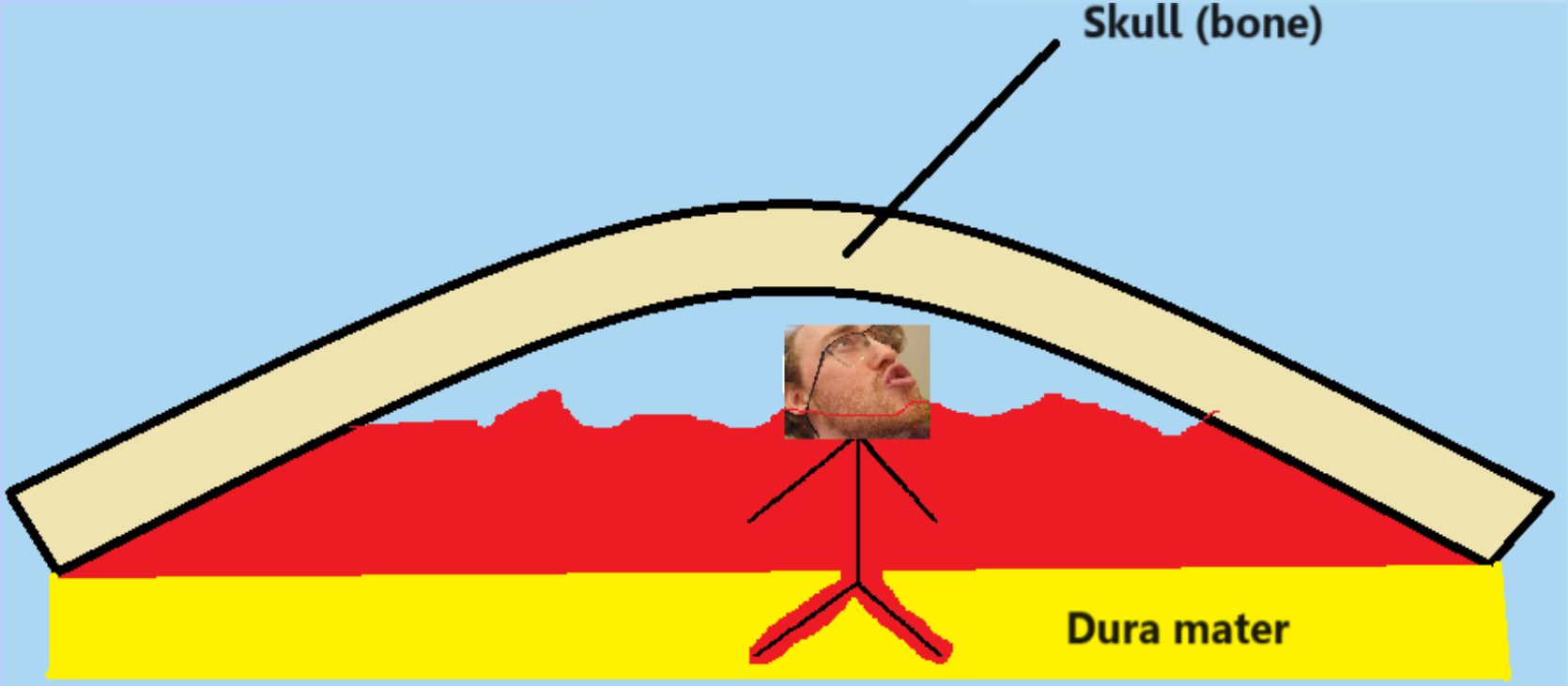
Hematoma of the meninges, how to «name» them:

- Epi = «above»
- Sub = «under»

- Is the bleeding above or under the layer you stand on?

- **Add «epi» or «sub» + the layer you stand on**

Epidural (extradural) hematoma



- Bleeding between the skull and dura mater:

Epidural hematoma

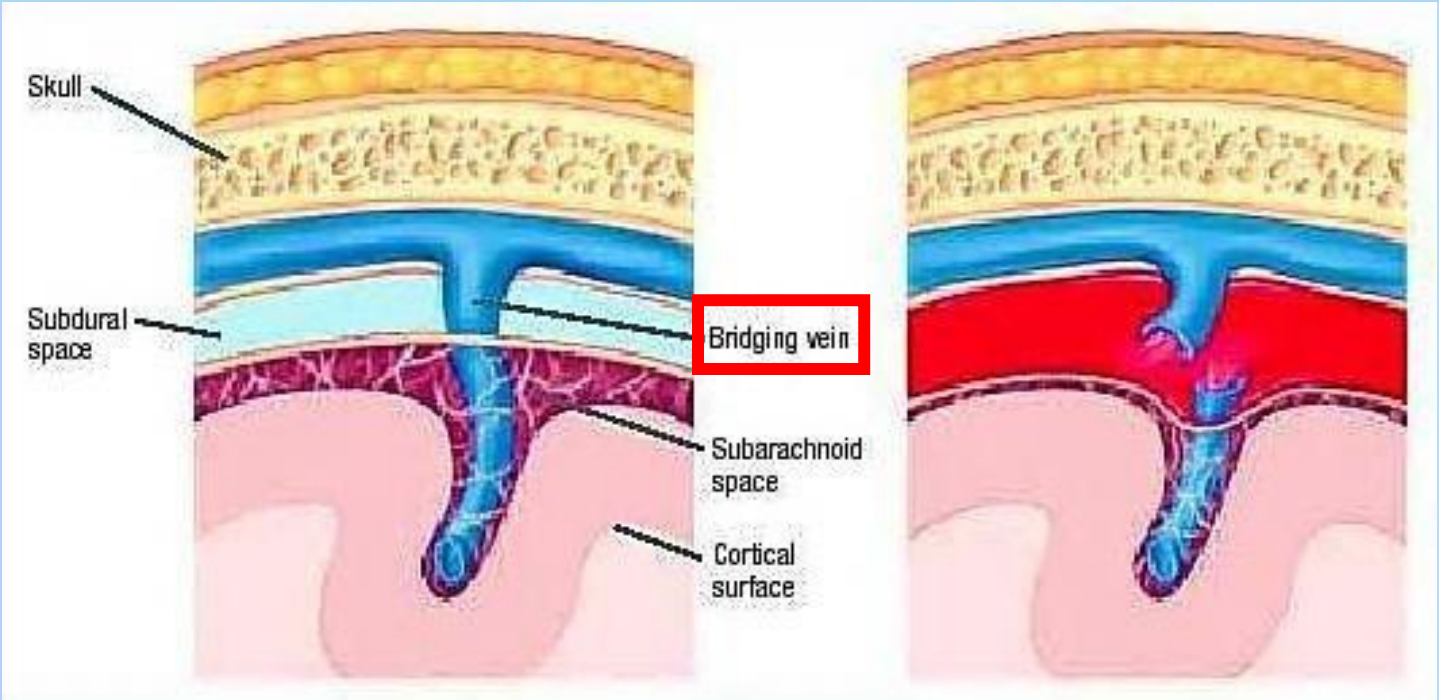
- Artery typically ruptured:

Middle meningeal artery

Subdural hematoma

- Bleeding between dura mater and arachnoid mater:

Subdural hematoma



- Vessels typically ruptured:

Bridging veins

(Clinically important, but rare)

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Subarachnoid hematoma

- **Bleeding between arachnoid mater and pia mater:**

Subarachnoid hematoma

- **Arteries typically ruptured:**

- Proximal part of circle of Willis arteries (anterior, middle and posterior cerebral arteries)

- Anterior and posterior communicating arteries

Arteries that ruptur at the Circle of Willis (proximal part of the arteries).

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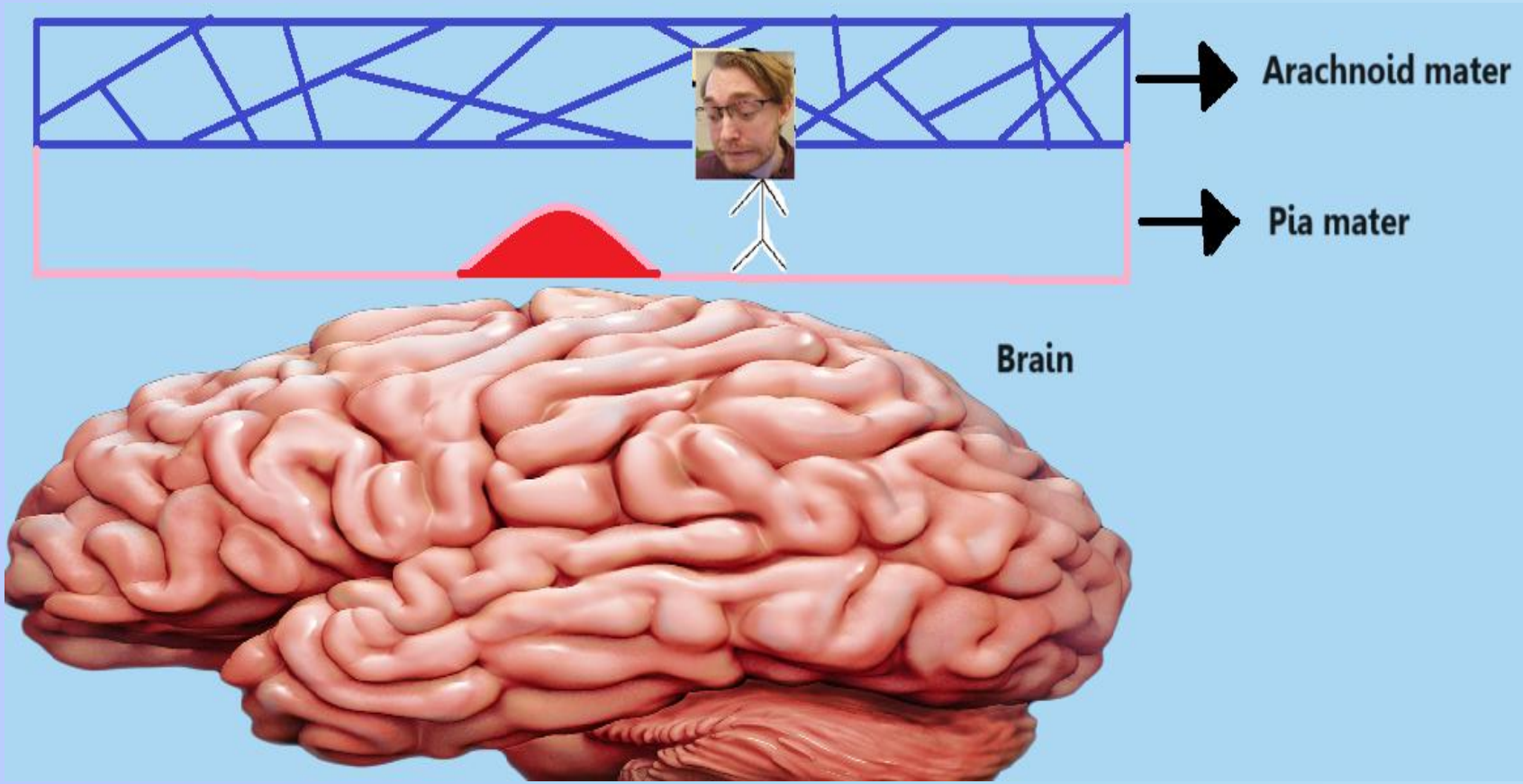
Subpial hematoma



- **Bleeding between pia mater and the brain:**

Subpial hematoma

- **Arteries typically ruptured:**

- Distal part of circle of Willis arteries (anterior, middle and posterior cerebral arteries)

- Distal part of arteries that directly supply the brain

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Overview of the different hematoma

Location of bleeding	Name of the bleeding	Which artery/vein is ruptured
Between the skull and dura mater	Epidural hematoma (extradural hematoma)	Middle meningeal artery
Between the periosteal and meningeal dura mater	Cerebral venous sinus thrombosis (CVST)	Venous dural sinuses
Between dura mater and arachnoid mater	Subdural hematoma	Bridging veins
Between arachnoid mater and pia mater	Subarachnoid hematoma	Arteries that ruptur at the Circle of Willis.
Between pia mater and the brain	Subpial hematoma	Distal part of arteries that directly supply the brain

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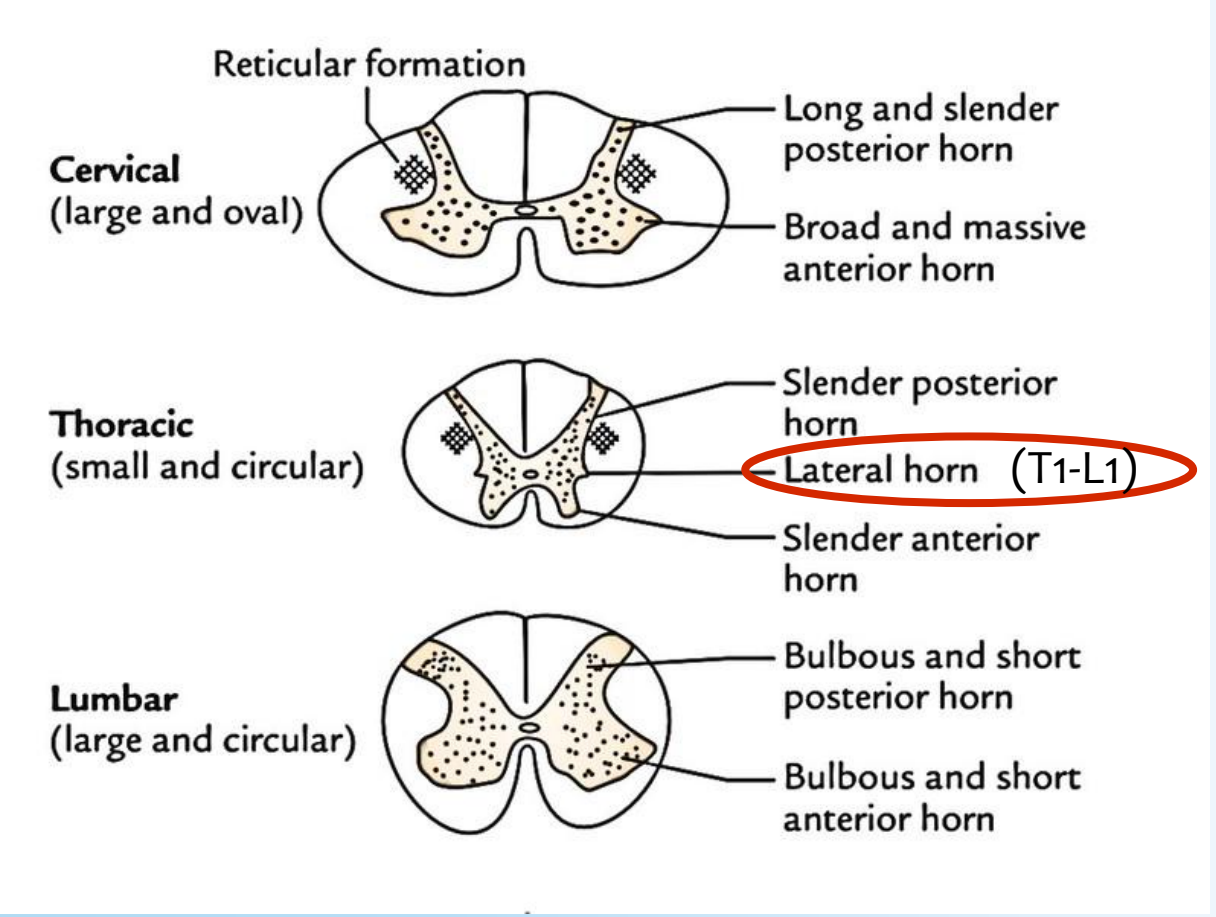
Introduction to gray matter

- Gray matter
  = **un**myelinated/very little myelinated

- **Gray matter is further divided into maximum 3 sections:**

1. Posterior (dorsal) horn
2. Intermediate (lateral) horn
3. Anterior (ventral) horn



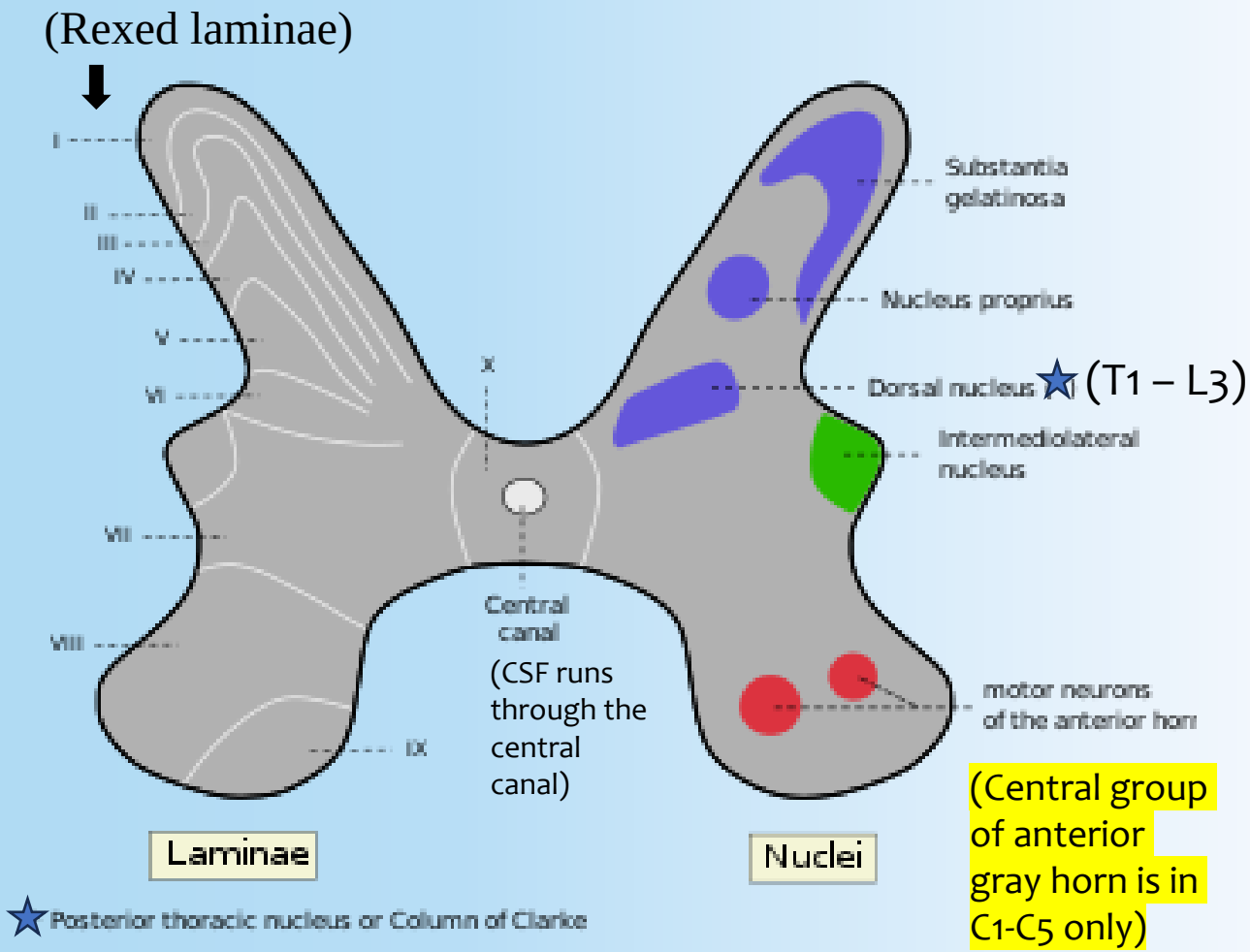
Sectioning of the gray matter T1-L1 levels

- **Posterior horn:**
  Receives "messages" from the «external body» and delivers them to the brain
  (pain sensation or temperature on the skin).
  Afferent fibres
  - **SENSORIC**

- **Intermediate horn:**
  Provides autonomic stimulation based on "messages received"
  - **PARASYMPATHETIC AND SYMPATHETIC**

- **Anterior horn:**
  Receives "messages" from the brain, and then provides that information to a different place (like muscles).
  Efferent fibres.
  *Consists of **medial** and **lateral** (T1-L2)*
  *+ **central** (C1-C5) groups*

  - **MOTORIC**



(Central group of anterior gray horn is in C1-C5 only)

Gray horn nuclei organization

Anterior horn	**Motor function**
1. Medial group (phrenic nucleus, spinal accessory nucleus and lumbosacral nucleus)	**1.** Diaphragm, trapezius and sternocleidomastoid, unknown
2. Lateral group (ventromedial, dorsomedial and retrodorsolateral)	**2.** Supplies upper and lower limbs
3. Central group (ventromedial and dorsomedial parts)	**3.** Innervates muscles in neck and trunk. Only found in C1-C5.
Posterior horn	**Sensory function**
1. Marginal nucleus	**1.** Relay information about pain and thermal stimuli
2. Substantia gelatinosa	**2.** Relaying peripheral pain and thermal stimuli (continuous with nucleus of spinal tract of trigeminal nerve). It also modifies transmission of sensory input.
3. Nucleus proprius	**3.** Is part of the lateral spinothalamic tract (first synapse)
4. Posterior thoracic nucleus	**4.** Receives proprioceptive feedback and gives rise to the dorsal spinocerebellar tract.
Intermediate horn	**Autonomic nervous system (fight or flight - so sympathetic and parasympathetic stimulation)**
1. Intermediomedial nucleus (Sacral parasympathetic nucleus	**1.** Gives rise to preganglionic *parasympathetic* fibres
2. Intermediolateral nucleus	(These fibres leave the spinal cord through the anterior roots of the spinal nerves and separate to form the pelvic splanchnic nerves
	2. Gives rise to preganglionic *sympathetic* fibres and forms the thoracolumbar outflow
	(leaves the anterior nerve root and reaches the ganglia in the sympathetic chain through the white rami communicantes, where the outflow is formed).

Intermediate horn:
Intermediolateral and sacral parasympathetic nucleus
(intermediomedial nucleus)

- Covers sympathetic and parasympathetic innervation (autonomic)

1. IntermedioLATERAL = **Sympathetic**

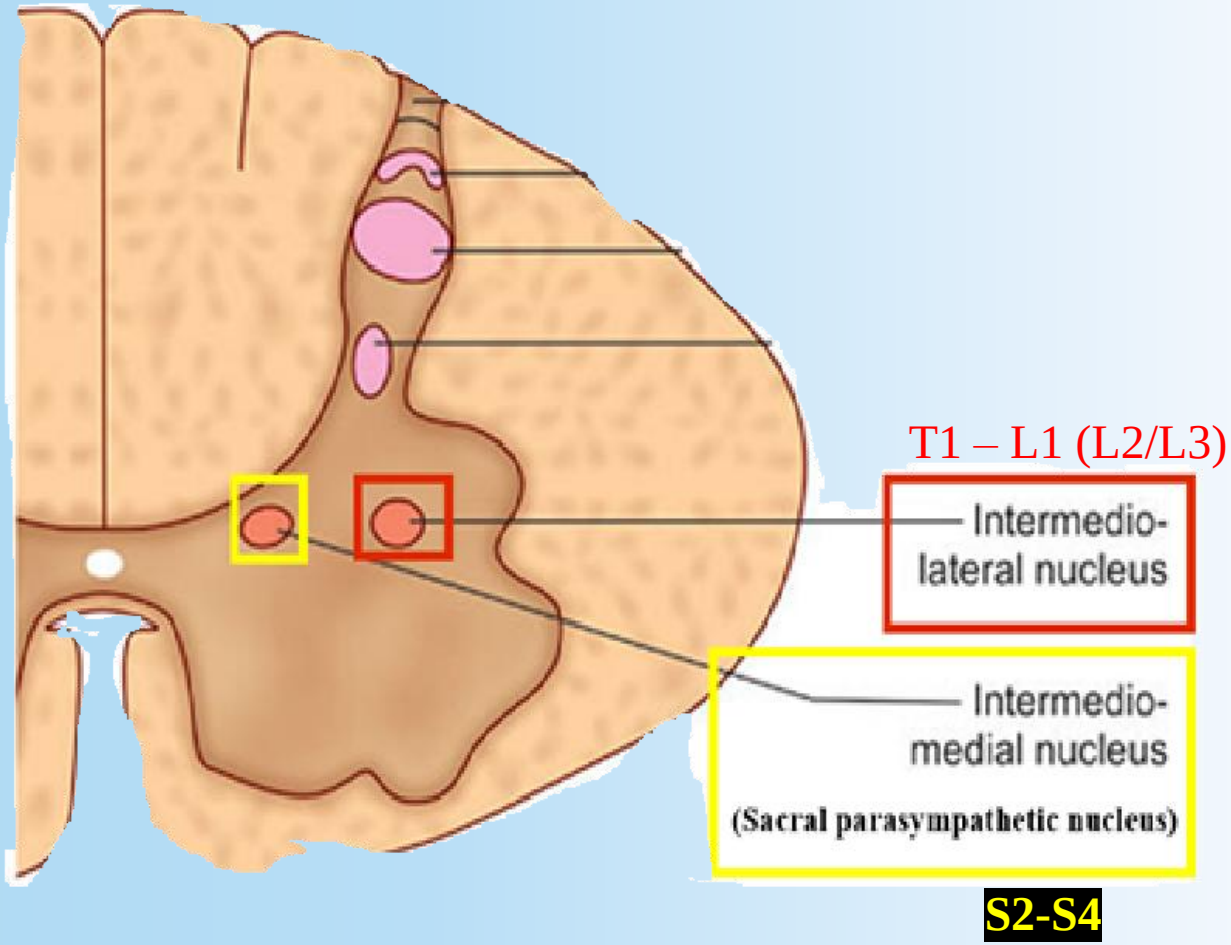
2. Sacral parasympathetic nucleus

(IntermedioMEDIAL = **Parasympathetic**)

- **Both nuclei** give rise to *preganglionic nerve fibres*

Intermediolateral → **T1-L1** (/L2/L3)

Sacral parasympathetic → from S2-S4



- Sympathetic intermediolateral nerve fibres leave the spinal cord through the **anterior** spinal roots (myelinated).

- **Intermediolateral nucleus connects with the sympathetic chain to then give off sympathetic postganglionic nerve fibres**
(can also skip the sympathetic chain and become f.ex splanchnic nerves which are still preganglionic).

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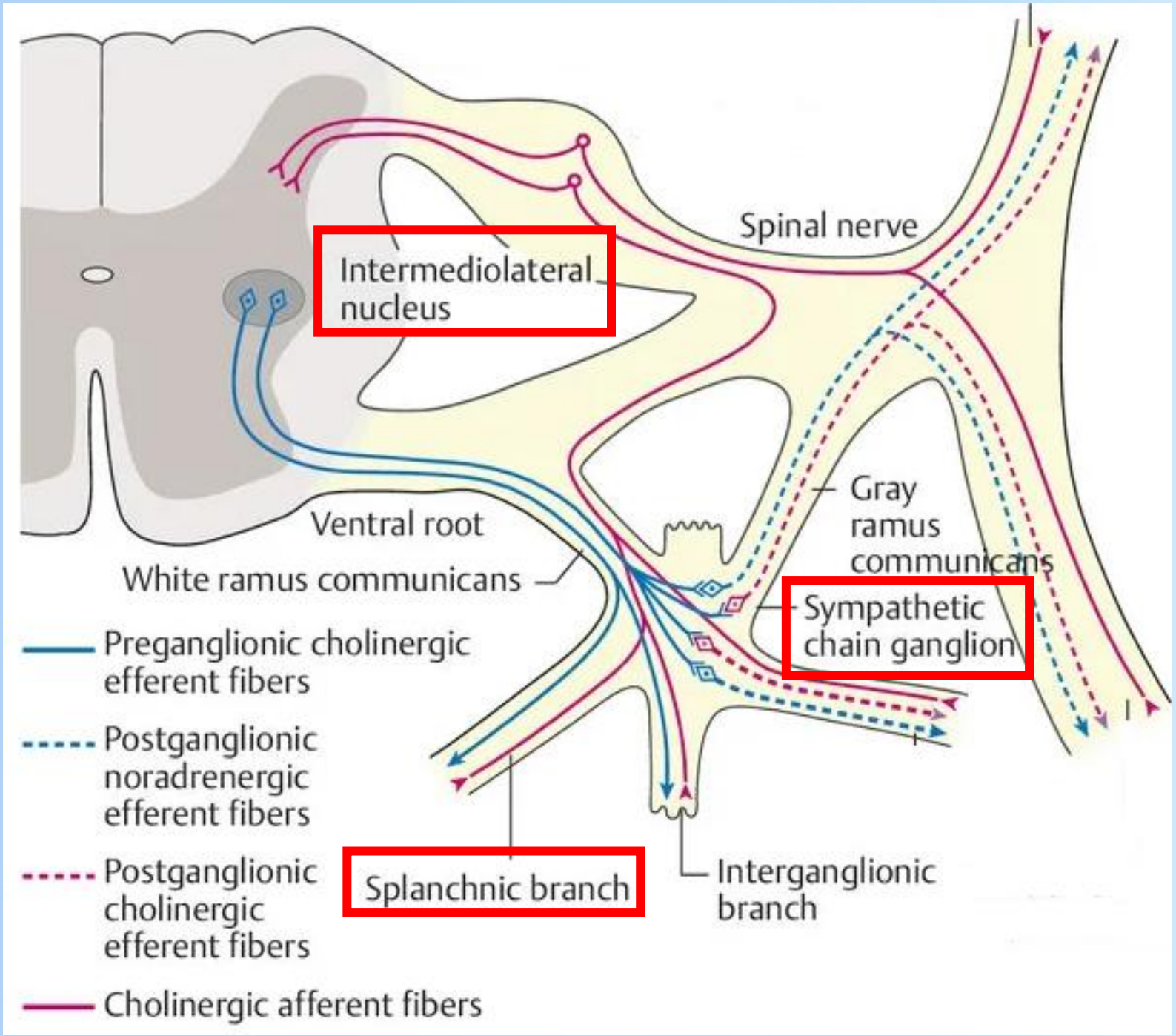

Spinal nerve
Intermediolateral nucleus
Gray ramus communicans
Ventral root
White ramus communicans
Sympathetic chain ganglion
Preganglionic cholinergic efferent fibers
Postganglionic noradrenergic efferent fibers
Postganglionic cholinergic efferent fibers
Splanchnic branch
Interganglionic branch
Cholinergic afferent fibers

Intermediolateral nucleus and ciliospinal centre of Budge

- Intermediolateral nucleus T1-L1
- Ciliospinal centre of Budge T1-T2
- SAME CELL COLUMN – they share a short sequence
- Ciliospinal reflex is sympathetically related to the eye (clinically unimportant)

Introduction to white matter

White matter = heavily myelinated

- Is in charge of ascending and descending tracts as the white matter got the so-called «fibre pathways» for the tracts.
- **Both sensory and motor spinal tracts will often head into the nuclei of the posterior/anterior gray horn, and then move/decussate into the white matter somewhere, depending on which tract it must follow.**
- Dorsal and anterior median sulcus is occupied with the anterior and posterior spinal arteries and veins.
- We have posterolateral sulci separating posterior from lateral, and anterio-lateral sulci separating anterior from lateral.

White matter is divided into 3 sections:

1. Posterior funiculus
2. Lateral funiculus
3. Anterior funiculus

Funiculus = A bundle of nerve fibres, forming a tract

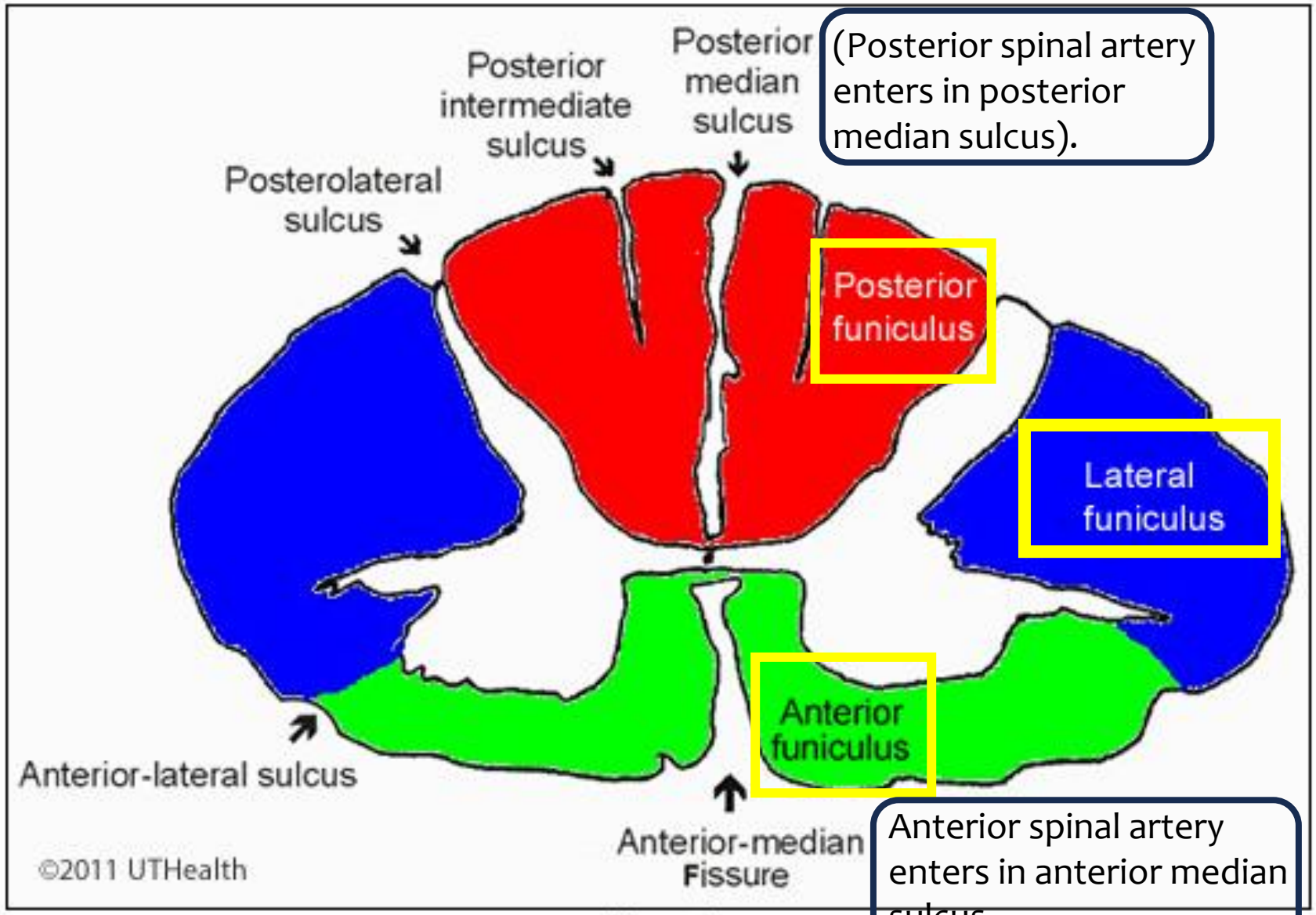


Figure 1

(Posterior spinal artery enters in posterior median sulcus).

Anterior spinal artery enters in anterior median sulcus

Posterior funiculus

- **There are two main sensory fasciculus:**

  1. Fasciculus gracilis
  2. Fasciculus cuneatus

- **Fasciculus gracilis:**
  For lower limb, found at all cord levels (vibration, proprioception)

- **Fasciculus cuneatus:**
  For upper limb (C1-T6)

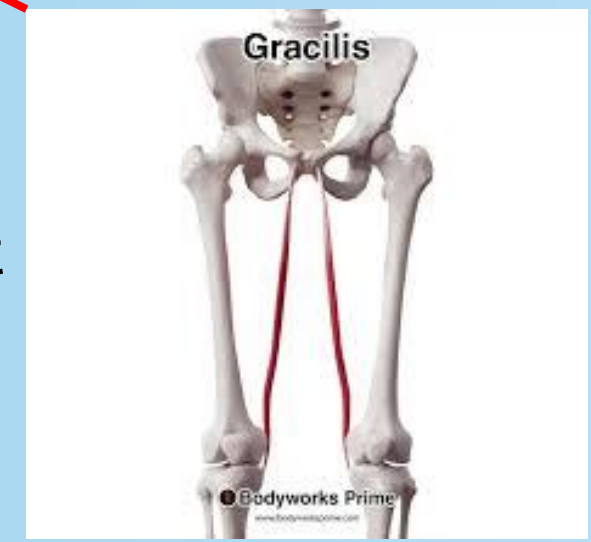
- Fasciculus gracilis is found next to the posterior median sulcus, and fasciculus cuneatus is next to cuneatus gracilis, but closer to the posterior gray horn

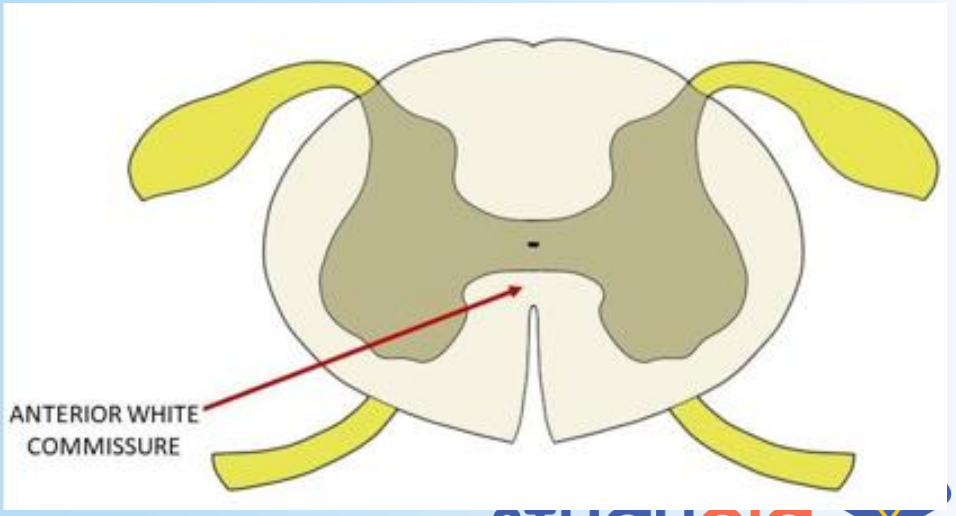
Lateral funiculus

- In charge of different type of movements (muscle groups)
- **Motoric area**

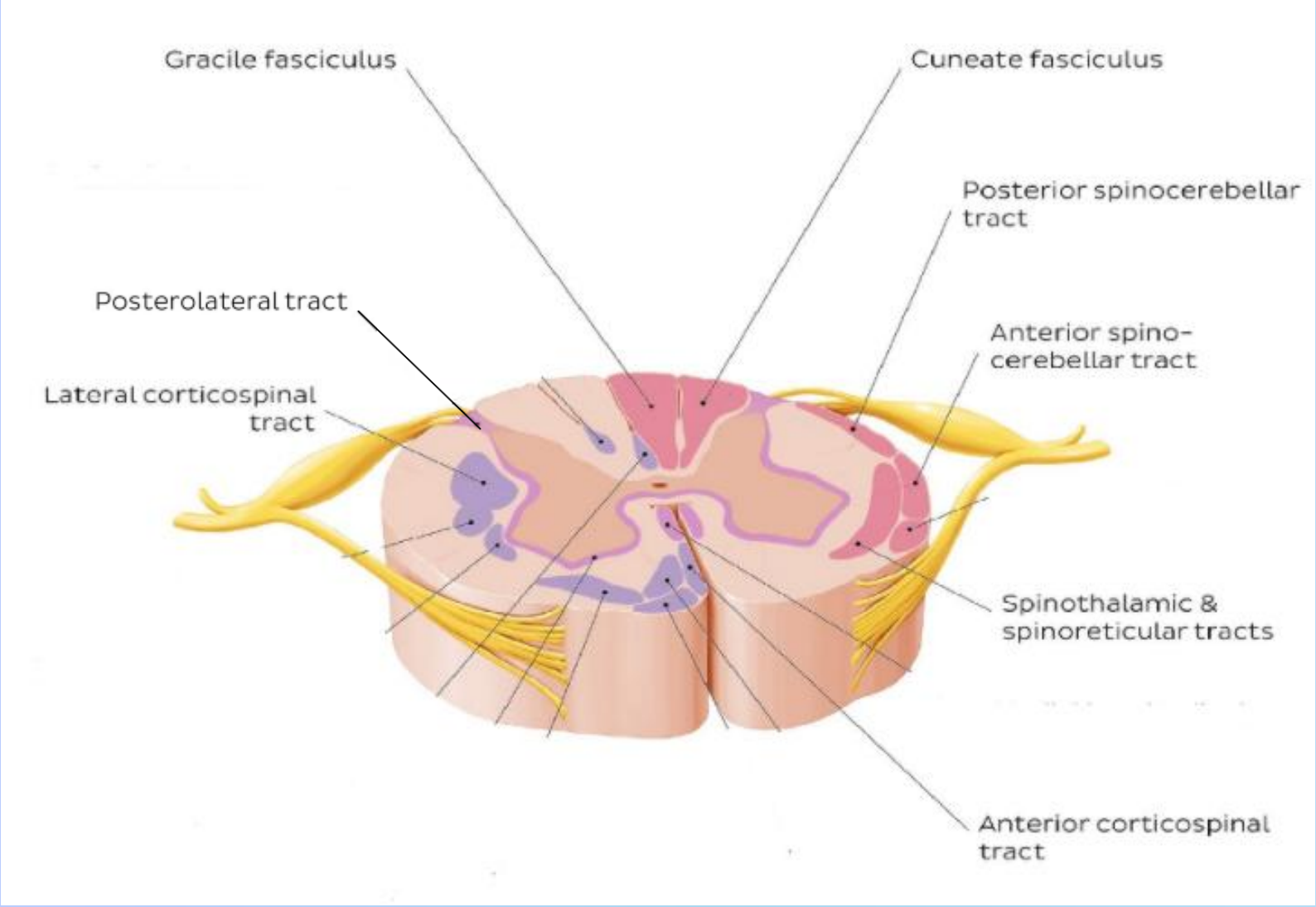
Anterior funiculus

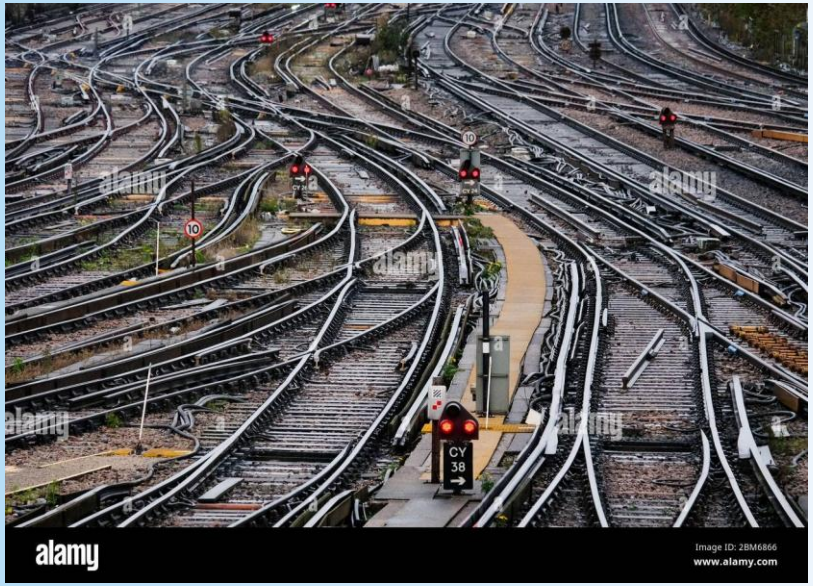
- **In charge of both sensory and motoric tracts (decussations)**
- Contains the **anterior white commissure.**
- Anterior white commissure exists in the whole spinal column





Some relevant tracts for spinal tract presentation. Think about the areas the tracts reside!





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Spinal nerves

The students:

Meanwhile, the presenter:

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Basics of spinal nerves

- The start of the peripheral nervous system
- Rootlets merge to roots, and roots merge to ***spinal nerve proper.***
- Provides sensory information **TO** CNS (afferent), and motoric information **FROM** CNS (efferent).
- **One spinal nerve proper consists of:**
  - Motoric fibres *(anterior spinal column)*
  - Sensoric fibres *(dorsal spinal column)*

  (2 out of 3 autonomic fibres)
- **C1-L2** = exits through intervertebral foramen – short distance
- **L3-S5** = exits through medullary cone (cauda equina) – far distance

- **There is a total of 31 pairs:**
  - 8 cervical spinal nerves
  - 12 pairs of thoracic spinal nerves,
  - 5 pairs of lumbar spinal nerves
  - 5 pairs of sacral spinal nerves,
  - 1 Coccygeal spinal nerve

Posterior and anterior spinal roots

Posterior (dorsal) spinal roots:

- Uses a ganglion where the cell bodies of sensory neurons resides **(dorsal root ganglion, (DRS))**
- The dorsal root ganglion is functioning as a ***FIRST ORDER NEURON***
  → *related to the spinal tracts*
- Provides with sensory registration from peripheral to CNS
- Will receive sensory innervation from a specific area, directly (few sensory nerves synapses)

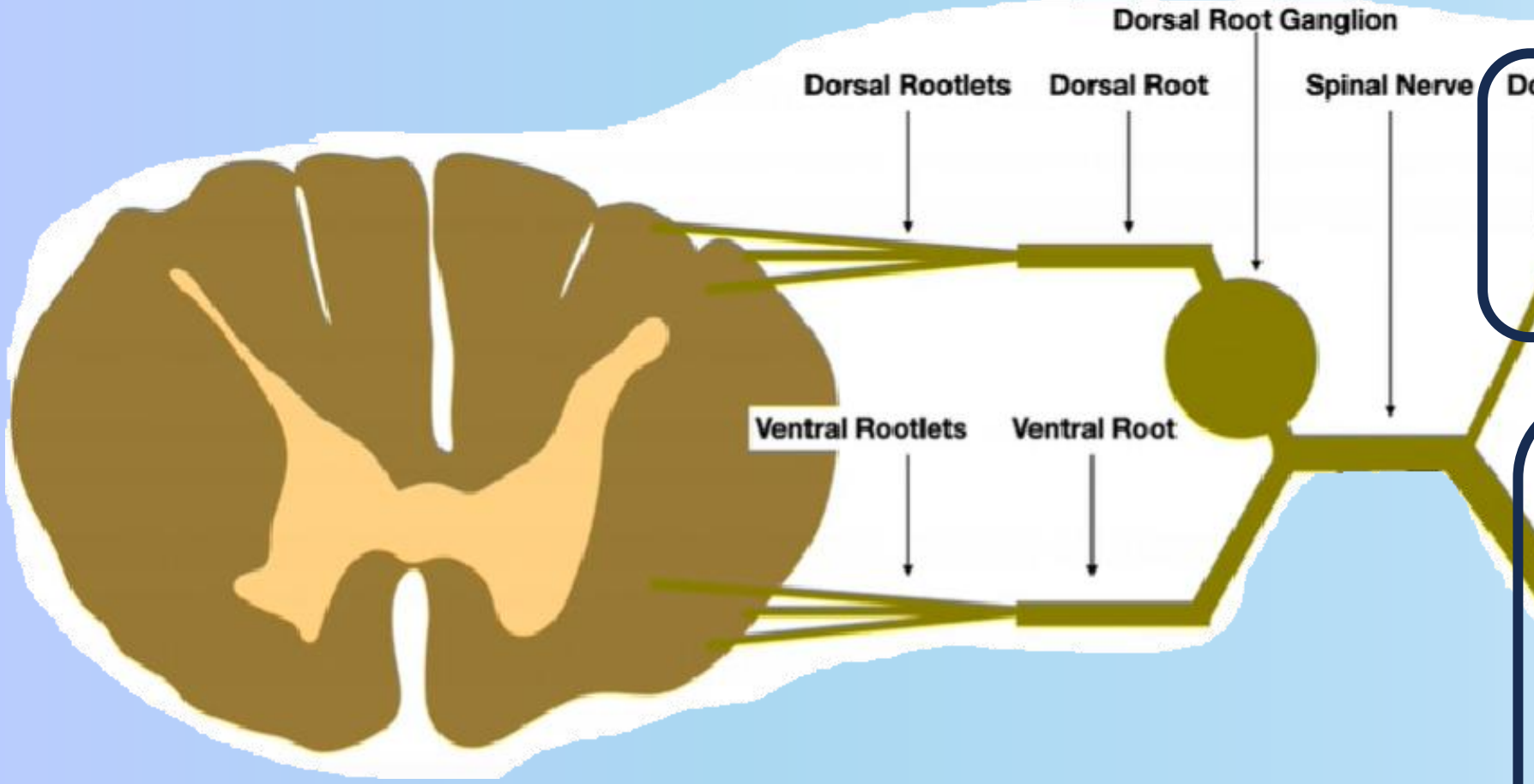
Anterior (ventral) spinal roots:

- Both motoric and autonomic.
- The autonomic (especially sympathetic) will connect with for example the sympathetic ganglion
  - concept of gray and white rami communicans.
- Before white rami communicans, we have preganglionic nerve
- In gray rami communicans, we have postganglionic nerve, ready to innervate for example skeleton muscle or arteries of the skin. The synapse happens between the communicantes

- White rami communicans = myelinated
- Gray rami communicans = **un**myelinated

Spinal nerves leaving/entering the spinal cord

Rootlets ⇨ Roots ⇨ Anterior root +Posterior root = spinal nerve proper



Goes to the back:
Deep spinal muscles, muscles of the back, skin of the back.

Creates plexuses:
- Brachial
- Lumbar
- Sacral

Will therefore provide innervation to anterior part (chest and upper limb (muscles+skin).

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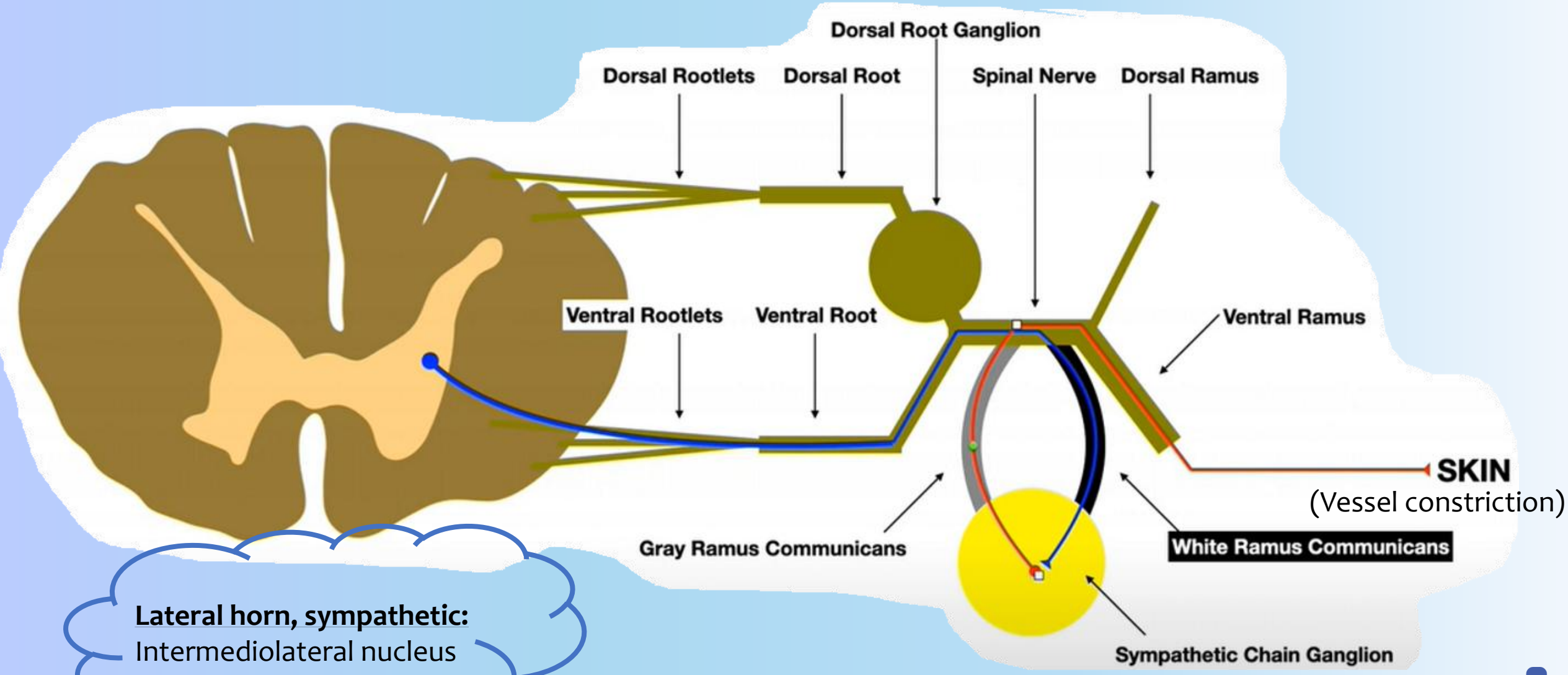


Lateral horn, sympathetic:
Intermediolateral nucleus

Recommendation for further reading

- Arachnoid mater (space): Cerebrospinal fluid, choroid plexus in relation with the ventricles.
- The granulations and villi of arachnoid mater (function).
- Embryology of spinal cord (neural tube, alar and basal plates).

Question bank

Question 1:

Which two arteries branches from the vertebral artery?

A. Posterior inferior cerebellar artery (PICA) and posterior spinal artery

B. Anterior spinal artery and posterior inferior cerebellar artery (PICA)

C. Posterior communicating artery and anterior spinal artery

D. Opthalmic artery and posterior inferior cerebellar artery (PICA)

E. Maxillary artery and opthalmic artery

Answer question 1:

B. Anterior spinal artery and PICA (Posterior Inferior Cerebellar Artery)

Question 2:
How does the vertebral arteries course (through which structures) and which foramen do they enter the cranium?

A. Vertebral foramen, jugular foramen
B. Around the spinous processes of each vertebra C2-C6, Foramen magnum
C. Through transvers foramen C3-C7, foramen magnum
D. Through transverse foramen C2-C6, foramen magnum
E. Foramen ovalis, foramen spinosum

Answer question 2:

- **D.** Through transverse foramen C2-C6, foramen magnum

- Vertebral arteries courses through transverse foramen C6-C2 of cervical vertebrates and then enters foramen magnum.

Vertebral arteries run through the transverse foramen

Question 3:

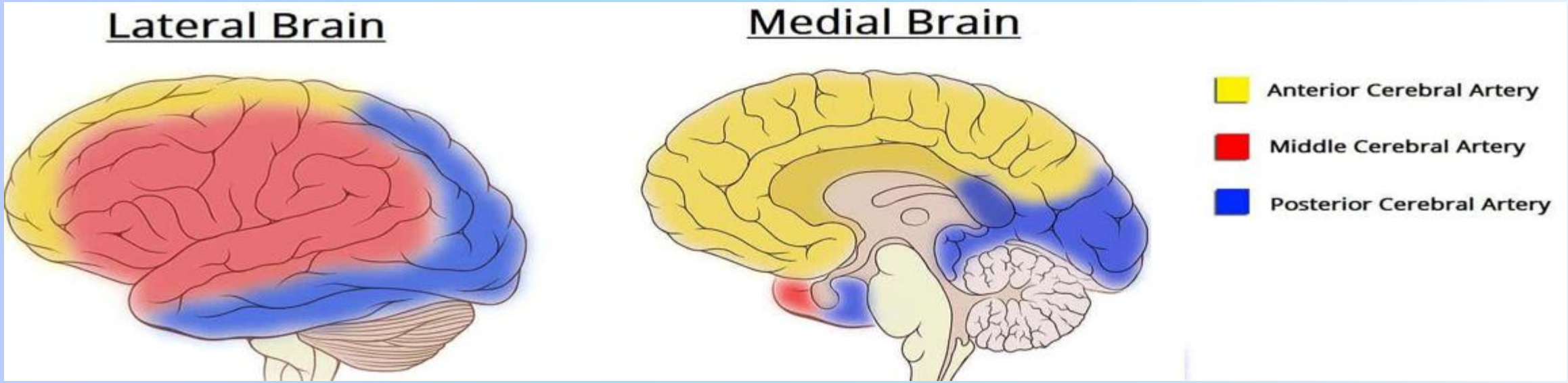
Which artery branches off the internal carotid artery to directly supply the lateral hemisphere and insula?

A. Middle meningeal artery
B. Opthalmic artery
C. Middle cerebral artery
D. Anterior cerebral artery
E. Posterior communicating artery

Answer question 3:

C. Middle cerebral artery

- Middle cerebral arteries → «On the sides/lateral portion» Lateral hemisphere + insula



Question 4:

A patient is diagnosed to be braindead and is hooked up to a ventilator. The dotor believe the cause is because of a rare occlusion in a massive, main artery of the brain. Which main artery is most likely occluded and what is most likely the reason for the patient getting diagnosed as braindead?

Answer question 4:

The occlusion is most likely completely occluding the basilar artery right after the two vertebral arteries merged together. This stopped the blood to go through the pontine arteries and the posteromedial central arteries, which stopped blood supply to pons. Pons is responsible for multiple autonomic innervations (such as breathing and regulating blood pressure, and multiple cranial nerve nuclei are found here).
When the brainstem «dies», the patient is diagnosed as «braindead» and will need help by a ventilator to keep the other organs «alive» for a potential organ donation

Question 5:

A 34 year old man who is actively playing football (soccer…) complains about struggle to move his legs as he wants. At first it was fine, but then he became very limited. The progression happened quickly. The patient had a positive babinski sign during physical examination. Which cerebral artery is most likely occluded?

Answer question 5:

- Anterior cerebral artery

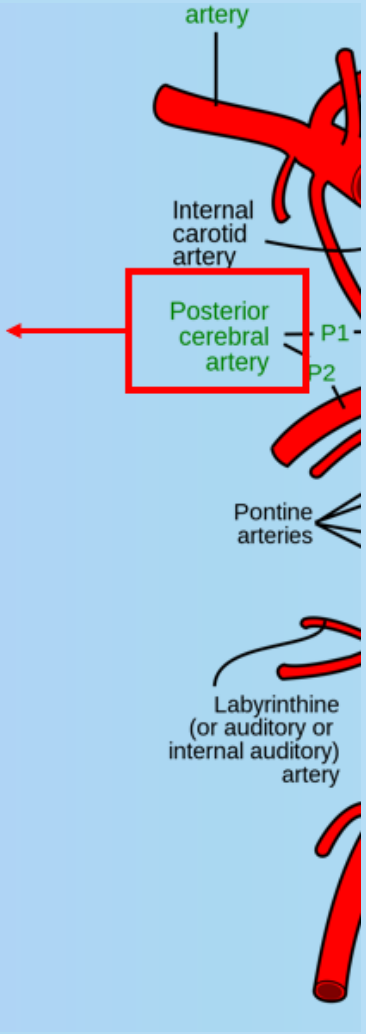
Question 6:

A 48-year-old female patient you`ve been a family medicine doctor to for the last 15 years, comes into your office and complains about vision struggles and dizziness. During examination, you learn that she has achromatopsia (colour blindness) which you know had never been a problem for the past 15 years with this patient. You remembered from last visit, 8 months ago, that she was going on a summer vacation. It was 6 months ago since she went on that vacation. You ask how the vacation was and who she travelled with, but she could not remember the destination or the people she travelled with. Which artery is most likely occluded?

Answer question 6:

- Posterior cerebral artery

1. **Vision problems**
2. **Prosopagnosia and achromatopsia**
3. **Vertigo (dizziness), vomiting, headache.**
4. **Long-term memory deficit**



Prosopagnosia:
Inability to identify faces

Achromatopsia:
Colour blindness

Question 7:

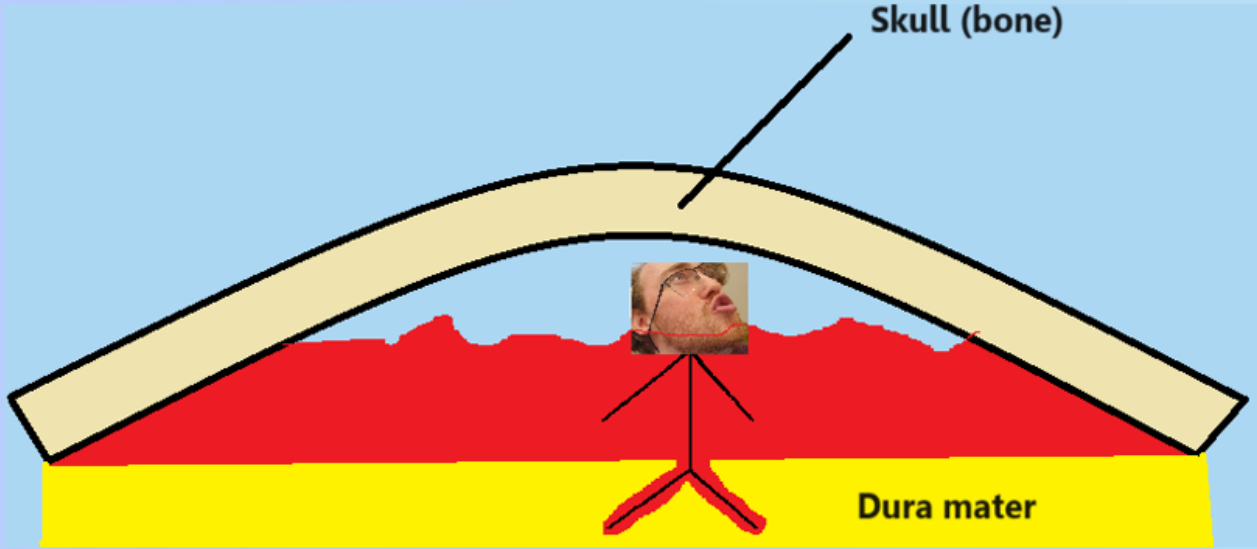
A patient comes to the ER where you work. The patient had been in a car accident with trauma to the anterolateral portion of the head. With imaging, you find a bleeding behind the temporal bone. Which artery is damaged and what is the hematoma/hemorrhage called?

A. Sigmoid sinus, Dural venous sinus bleeding
B. Middle meningeal artery, subdural hematoma
C. Middle meningeal artery, epidural hematoma
D. Opthalmic artery, subdural hematoma
E. Temporal artery, epicranial hematoma

Answer question 7:

C. Middle meningeal artery, epidural hematoma

Epidural (extradural) hematoma



- Bleeding between the skull and dura mater:

Epidural hematoma

- Artery typically ruptured:

Middle meningeal artery

Question 8:

The gray matter of the spinal cord at T1-L1 level is divided into which 3 sections?

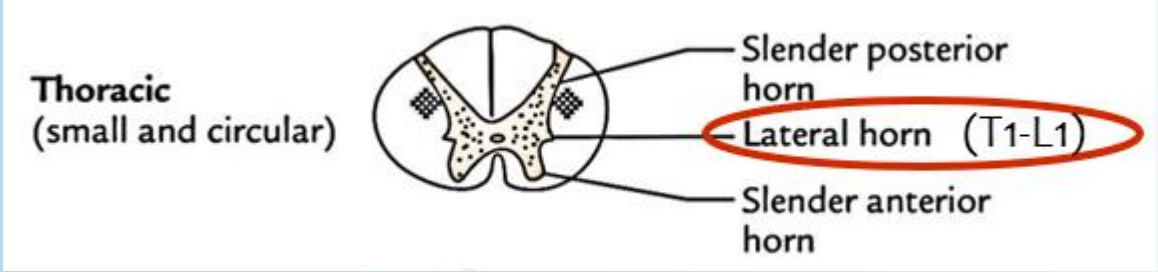
A. Anterior (ventral) horn, intermediate (lateral) horn and posterior (dorsal) horn.
B. Rexed lamina 1-9
C. Anterior (ventral) horn, intermediolateral and intermediomedial area and lateral horn
D. Anterior (ventral) horn and a posterior (dorsal) horn
E. Rexed lamina 1-15

Answer question 8:

A. Anterior (ventral) horn, intermediate (lateral) horn and posterior (dorsal) horn.

- **Gray matter is further divided into maximum 3 sections:**

1. Posterior (dorsal) horn
2. Intermediate (lateral) horn
3. Anterior (ventral) horn



Question 9:

Which part of the gray matter is responsible for motoric information to the muscles?

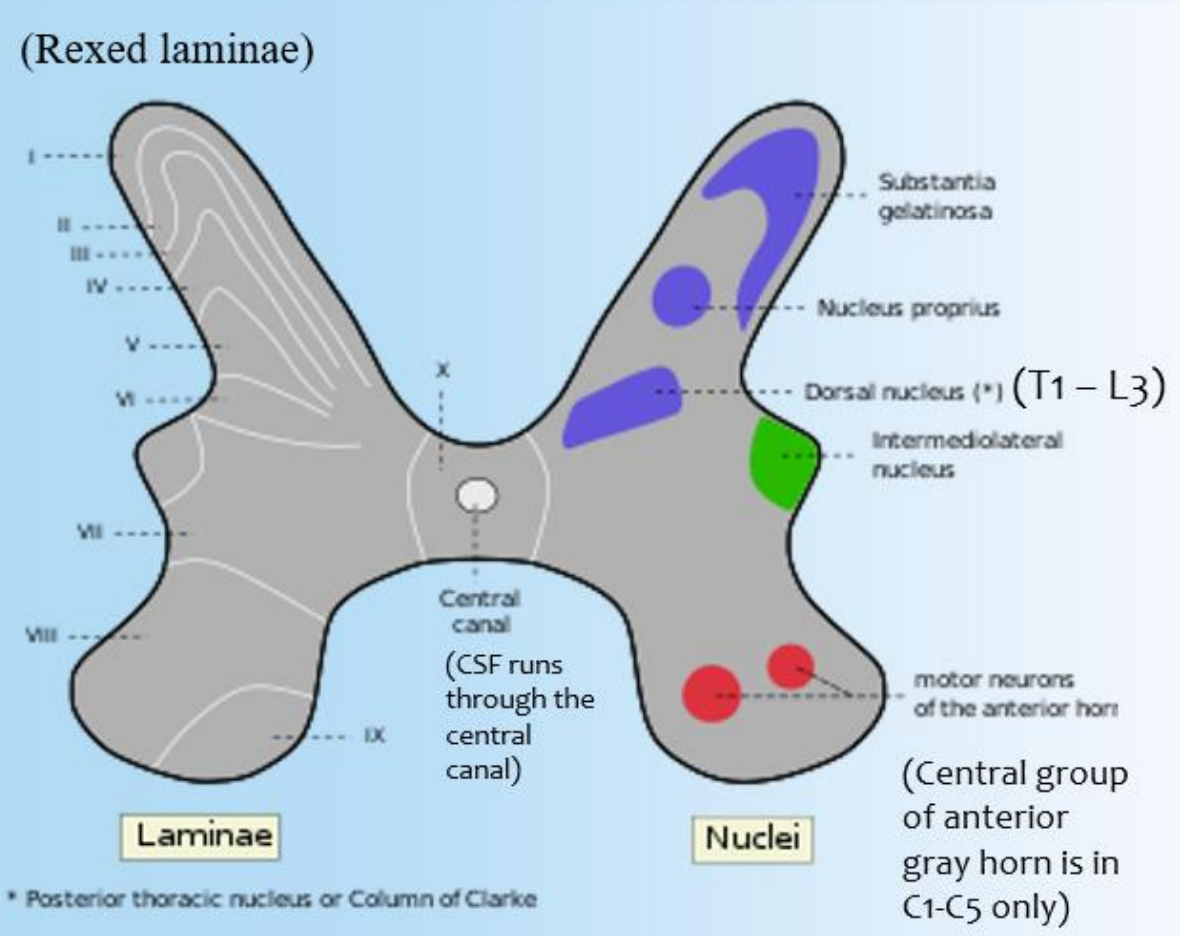
A. Posterior gray horn
B. Intermediate (lateral) gray horn
C. The central canal of gray matter
D. The intermediomedial nucleus
E. Anterior gray horn

Answer question 9:

E. Anterior gray matter

Anterior horn:
Receives "messages" from the brain, and then provides that information to a different place (like muscles).
Efferent fibres.

- **MOTORIC**



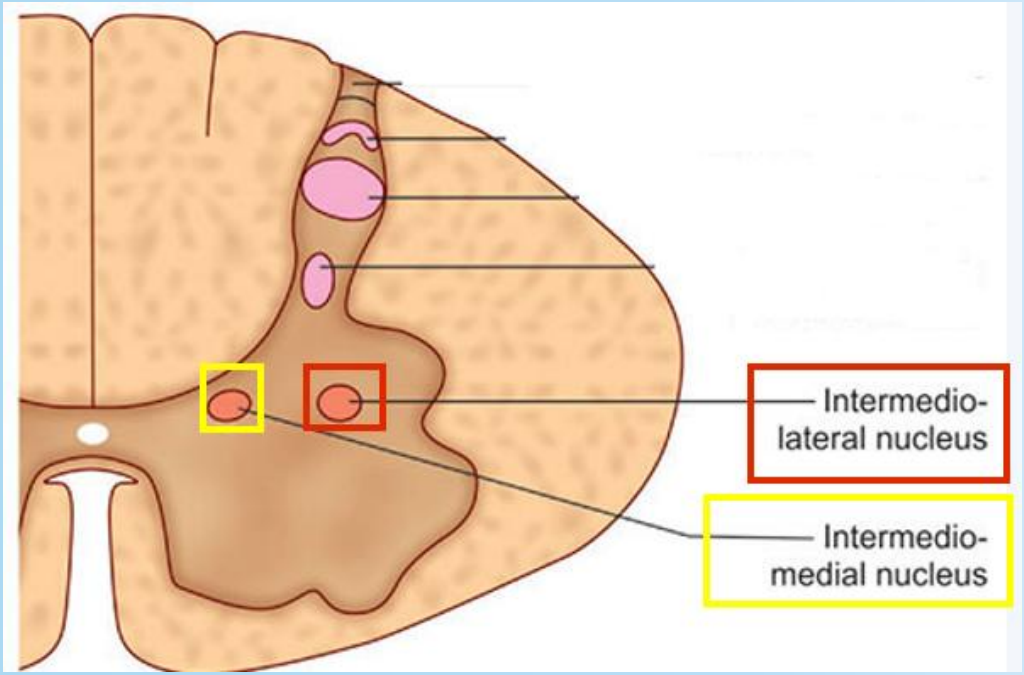
Question 10:

Fill in the blanks.
«The intermediomedial nucleus is responsible for ___ innervation and the intermediolateral nucleus is responsible for____ innervation»

Answer question 10:

- «The intermediomedial nucleus is responsible for **parasympathetic** innervation and the intermediolateral nucleus is responsible for **sympathetic** innervation»

- IntermedioLATERAL = **Sympathetic**
- IntermedioMEDIAL = **Parasympathetic**



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Question 11:

Splanchnic nerves will come out of the spinal cord in the thorax and enter the abdomen as:

A. Postganglionic nerves that have synapsed in the sympathetic chain first. They then supply the abdominal organs.

B. They will undergo a quick fibre-change from parasympathetic to sympathetic by intervening with the sympathetic chain ganglion. They then go through the diaphragm to supply abdominal organs.

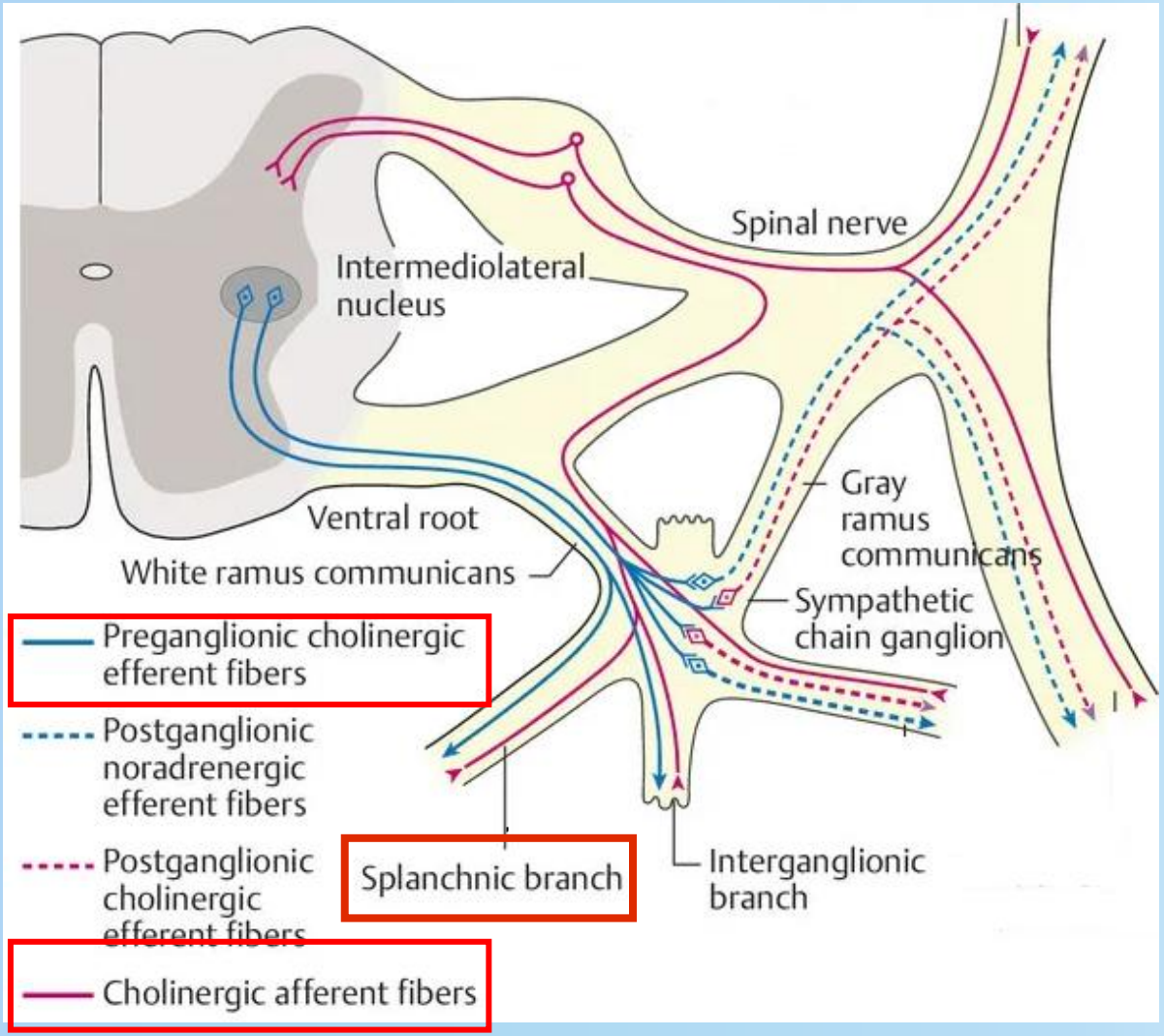
C. Preganglionic nerves that skipped synapsing with the sympathetic chain. They will instead synapse with the celiac ganglion in the abdomen.

D. Preganglionic nerves that skipped synapsing with the sympathetic chain. They will instead synapse with ganglia of the enteric nervous system and provide with parasympathetic innervation.

E. Postganglionic nerves that have synapsed in the sympathetic chain first. They then enter the abdomen through the diaphragm to synapse again in the ganglia of the enteric nervous system.

Answer question 11:

C. Preganglionic nerves that skipped synapsing with the sympathetic chain. They will instead synapse with the celiac ganglion in the abdomen.



Question 12:

White matter is divided into which 3 sections?

A. Posterior, intermediate and anterior funiculus.
B. Anterior, posterior and anteromedial funiculus
C. White matter cannot be divided up in sections
D. Posterior, lateral and anterior funiculus
E. Posterior, intermediate and anterior area

Answer question 12:

D. Posterior, lateral and anterior funiculus

White matter is divided into 3 sections:

1. Posterior funiculus
2. Lateral funiculus
3. Anterior funiculus

Question 13:

Faciculus cuneatus is responsible for which area of the body?

A. Lower limb
B. Upper limb
C. Abdomen
D. Head and neck
E. The back, only.

Answer question 13:

B. Upper limb

- **Fasciculus cuneatus:**
  For upper limb (C1-T6)

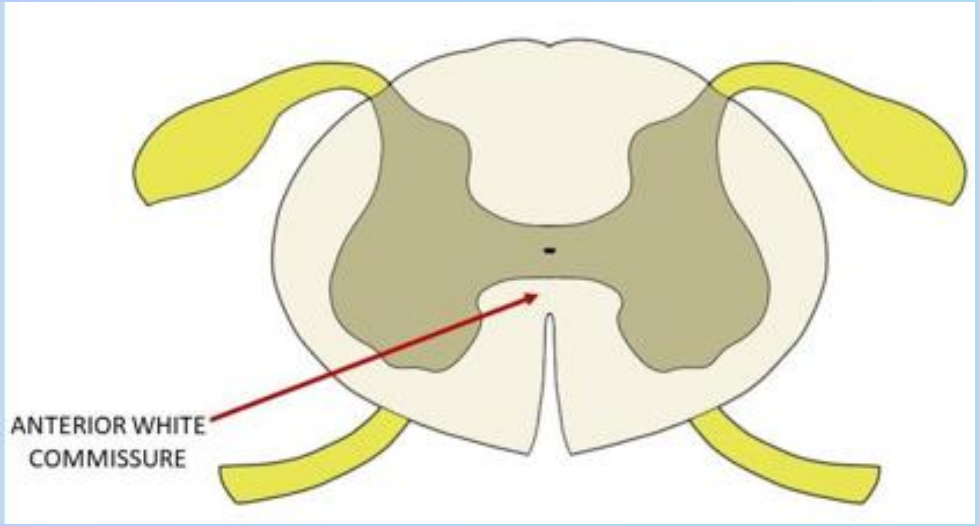
Question 14:

There is an area of the anterior white matter, where many tracts have a tendency to decussate. What is this area called?

A. The anterior white commissure
B. Medial longitudinal commissure
C. Anterior white and gray column
D. Anterior corticospinal commisure
E. Anterior gray commissure

Answer question 14:

A. Anterior white commissure



Anterior funiculus

- **In charge of both sensory and motoric tracts (decussations)**
- Contains the **anterior white commissure.**
- Anterior white commissure exists in the whole spinal column

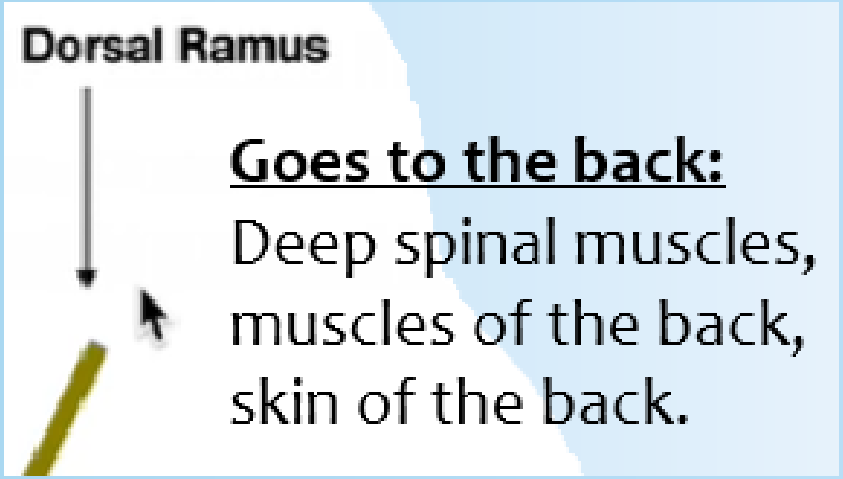
Question 15:

The dorsal rami of spinal nerve is in charge of:

A. Innervating the trunk, head and neck
B. Innervating upper and lower limb by creating plexuses (brachial plexus, lumbar plexus, sacral plexus)
C. Innervating organs which need sensomtoric innervation
D. Innervate only deep spinal muscles
E. Goes to the back and innervates deep spinal muscles, muscles of the back, skin of the back.

Answer question 15:

E. Goes to the back and innervates deep spinal muscles, muscles of the back, skin of the back.



Question 16:

The white ramus communicans is in charge of a nerve that will synapse in the sympathetic chain ganglion. What is that nerve termed as?

A. Postganglionic nerve
B. Presynaptic nerve
C. Preganglionic nerve
D. Postsynaptic nerve
E. Specialized sympathetic nerve

Answer question 16:

C. Preganglionic nerve

- Before white rami communicans, we have preganglionic nerve
- In gray rami communicans, we have postganglionic nerve, ready to innervate for example skeleton muscle or arteries of the skin.