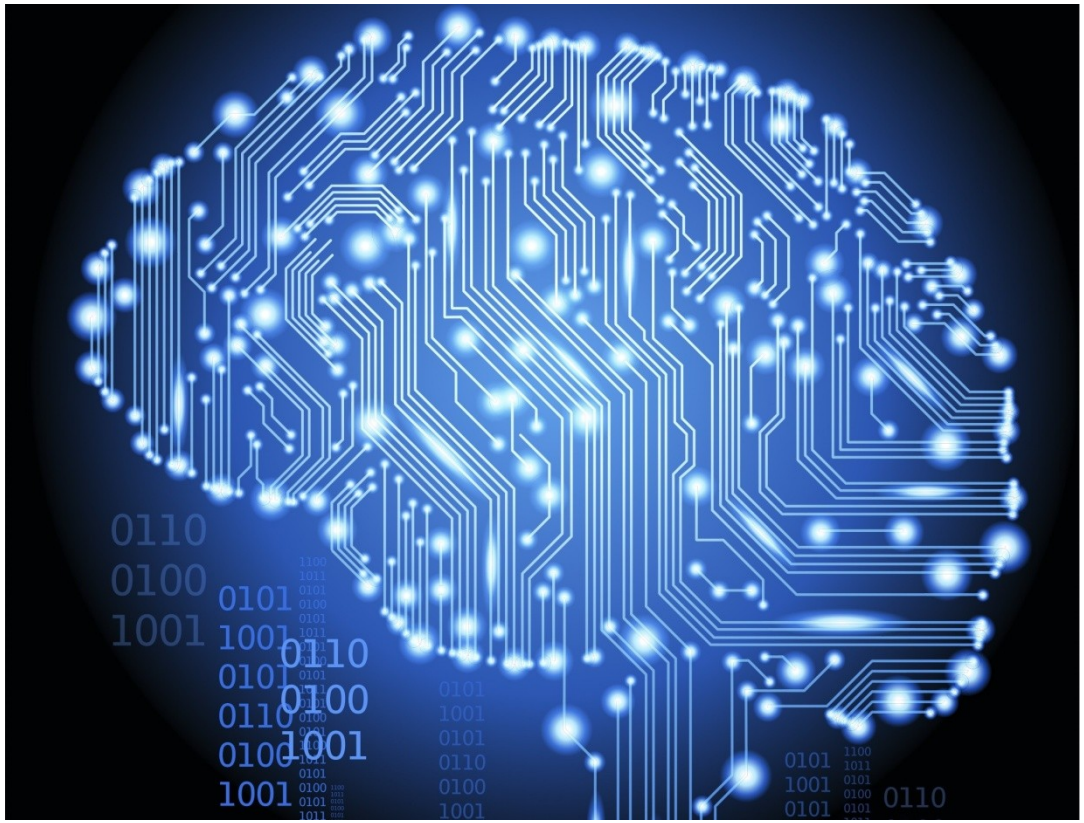
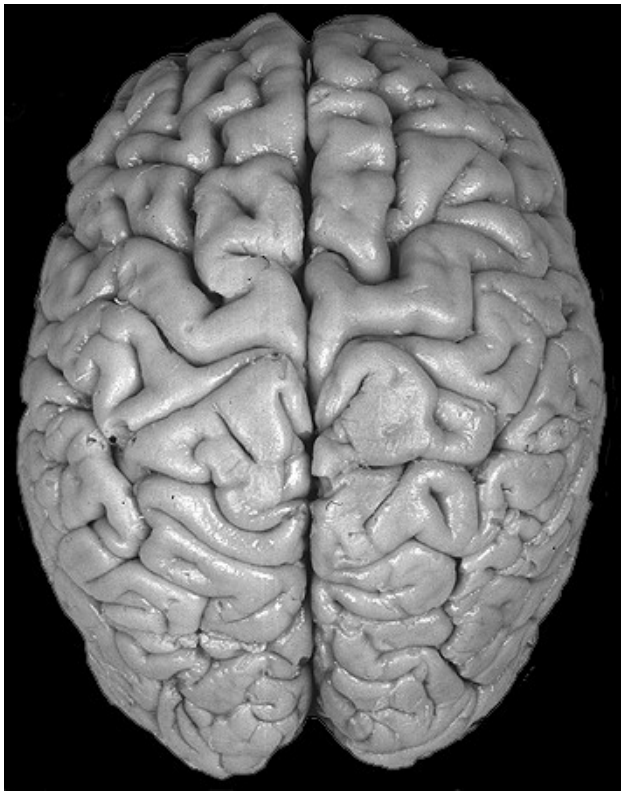
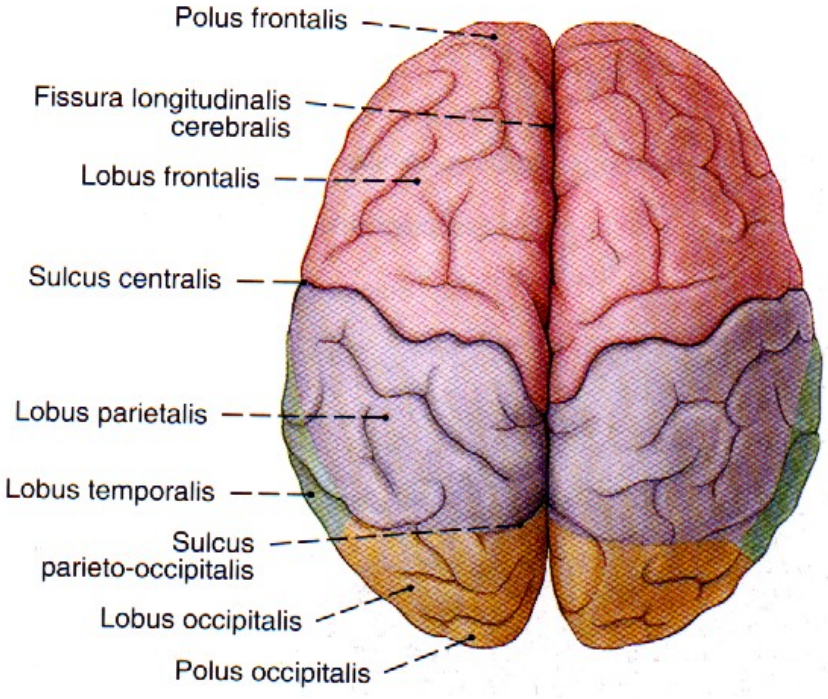
THE CEREBRUM *(telencephalon)*



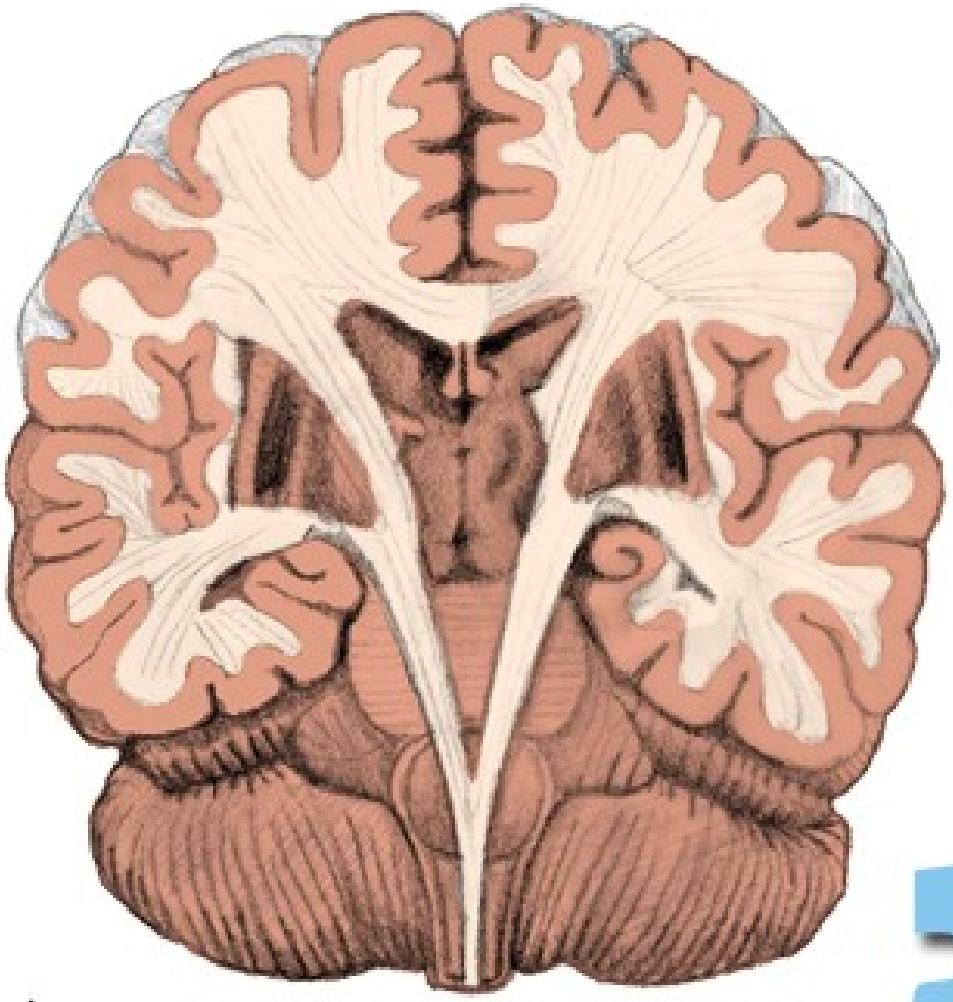
THE CEREBRUM *(telencephalon)*

- **Developmentally most advanced part of the CNS**
- The largest part of the brain, which gives shape and size





The outer structure of the cerebrum



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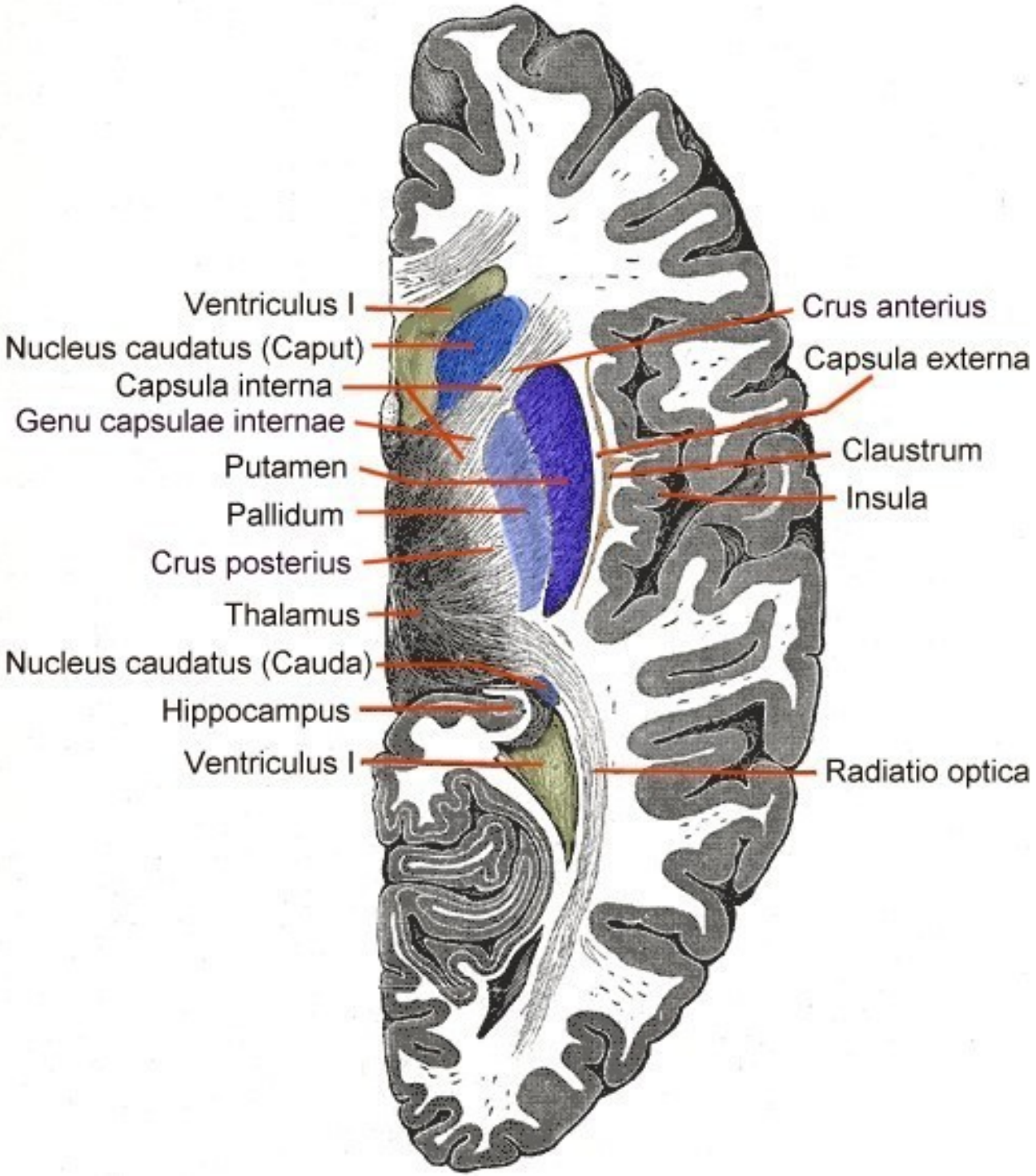
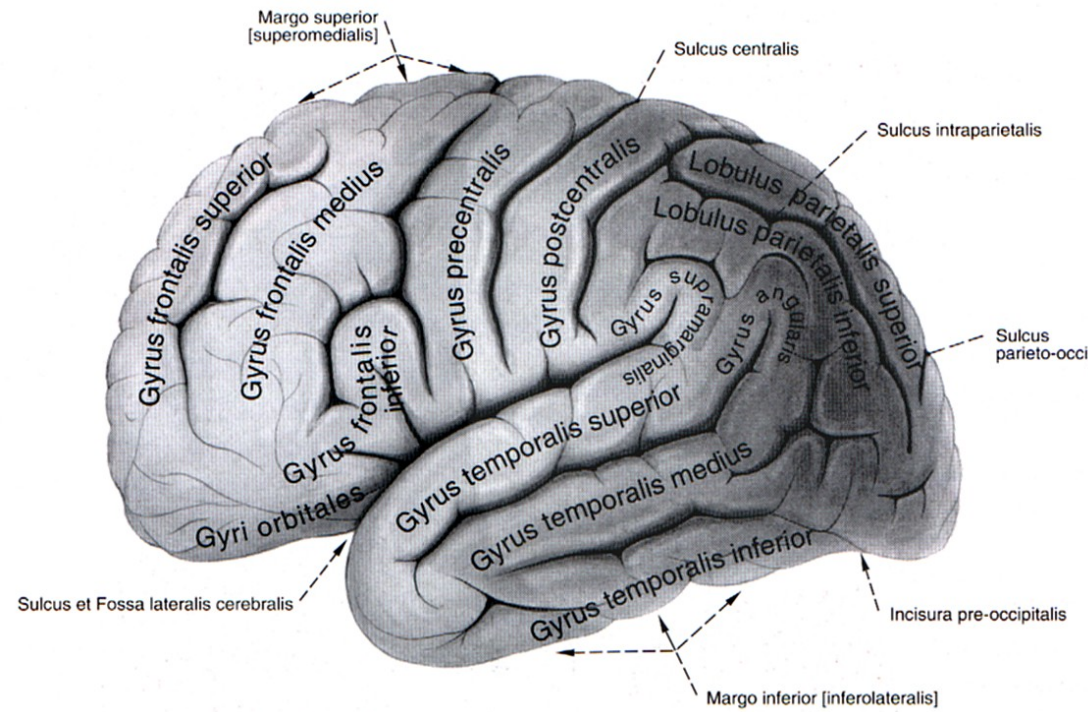

Ventriculus I
Nucleus caudatus (Caput)
Capsula interna
Genu capsulae internae
Putamen
Pallidum
Crus posterius
Thalamus
Nucleus caudatus (Cauda)
Hippocampus
Ventriculus I
Crus anterius
Capsula externa
Claustrum
Insula
Radiatio optica

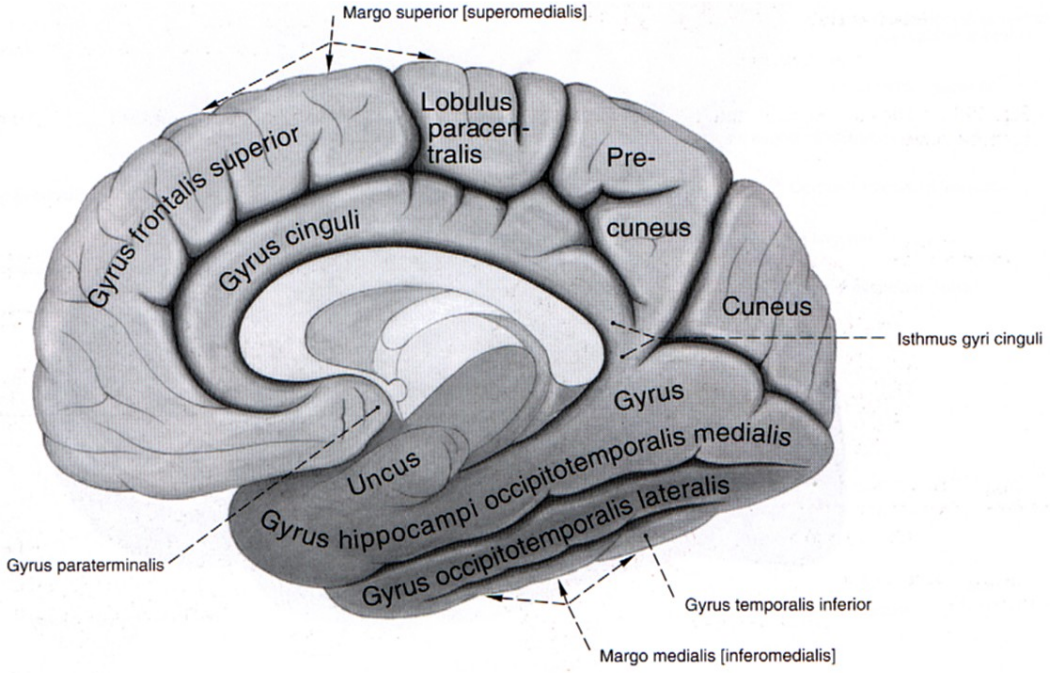
- Cerebral hemisphere is antero-posterior elongated quarter-sphere, both hemispheres form together half-sphere
- Right and left hemisphere are separated from each other in the median plane through a deep fissure *(**fissura longitudinalis cerebri**)*
- The cerebral hemispheres are separated from cereberall hemispheres through transversally oriented fissure *(**fissura transversa cerebri**)*
- We distinguish three surfaces on the hemispheres:

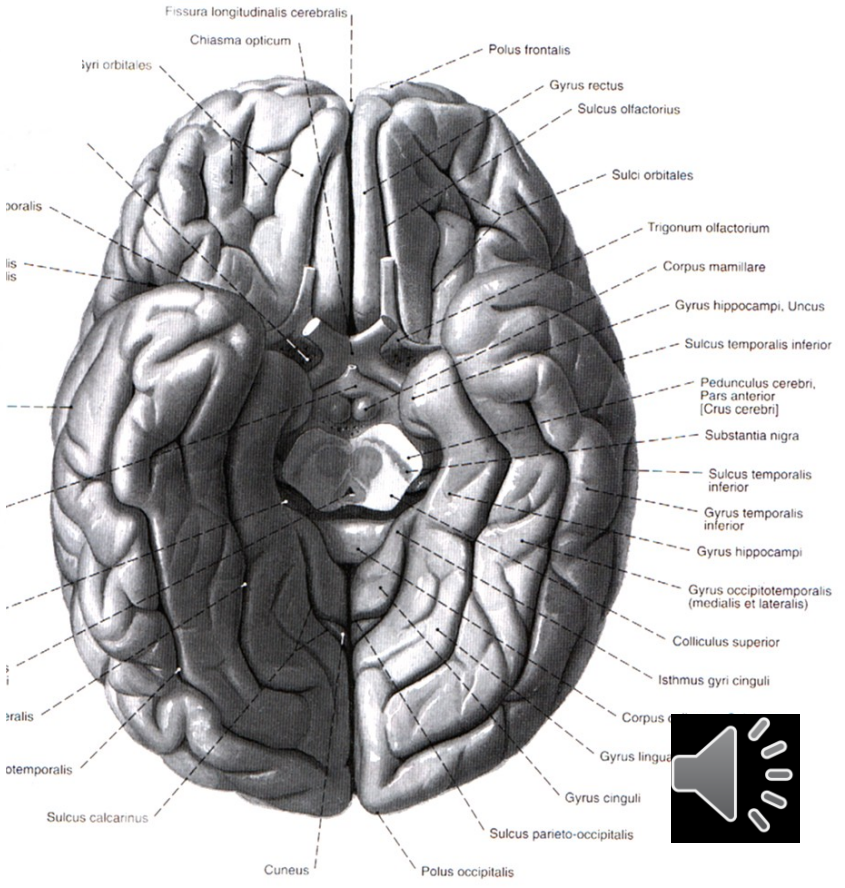
  facies inferior (inferior surface)

  facies medialis (inner surface)

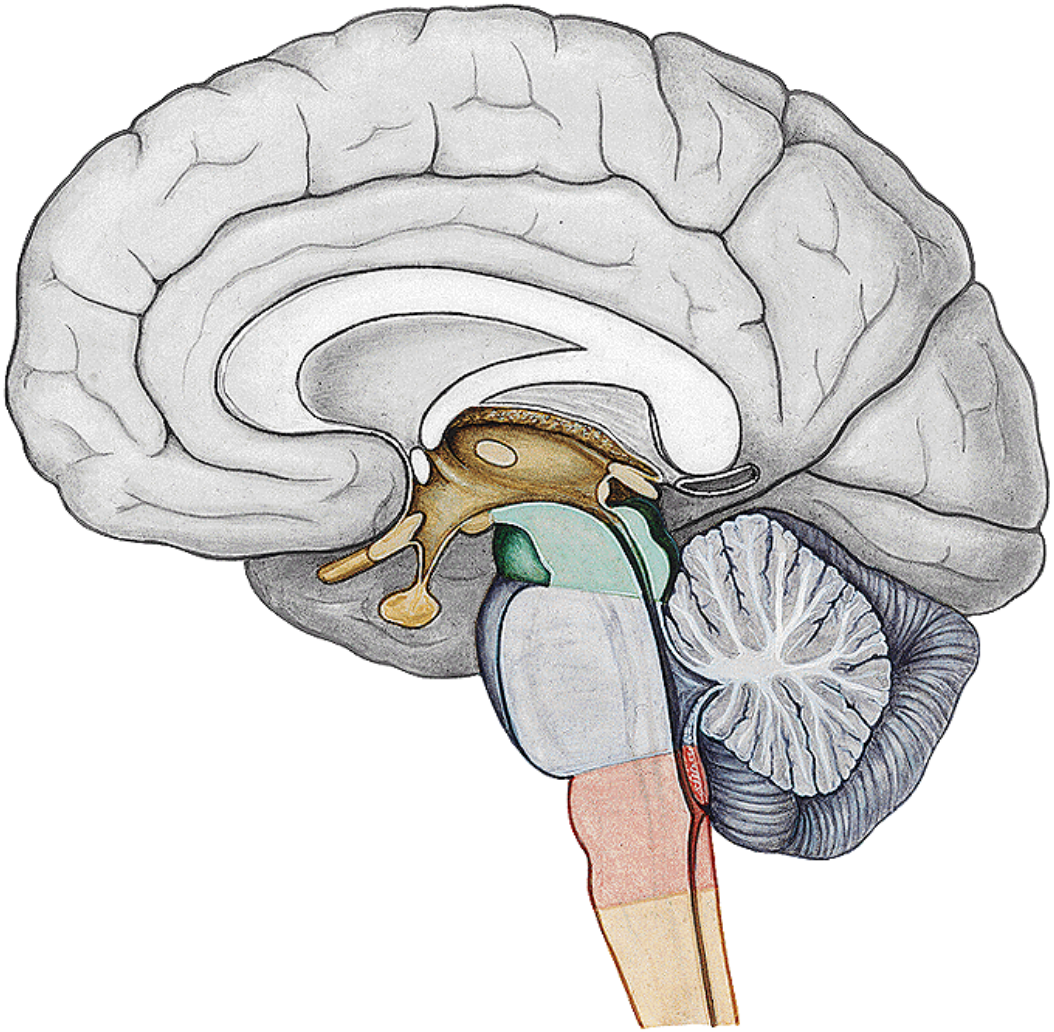
  facies superolateralis (outer convex surface)

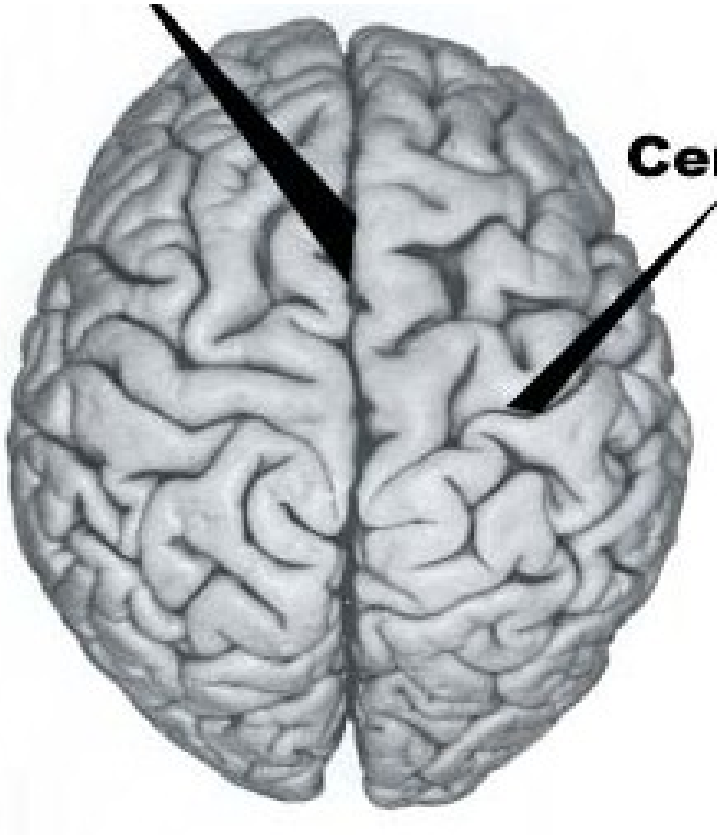

Margo superior [superomedialis]
Sulcus centralis
Sulcus intraparietalis
Gyrus frontalis superior
Gyrus frontalis medius
Gyrus frontalis inferior
Gyrus precentralis
Gyrus postcentralis
Lobulus parietalis superior
Lobulus parietalis inferior
Gyrus supramarginalis
Gyrus angularis
Sulcus parieto-occipitalis
Gyrus temporalis superior
Gyrus temporalis medius
Gyrus temporalis inferior
Gyri orbitales
Sulcus et Fossa lateralis cerebralis
Incisura pre-occipitalis
Margo inferior [inferolateralis]


Margo superior [superomedialis]
Lobulus paracentralis
Gyrus frontalis superior
Pre-cuneus
Gyrus cinguli
Cuneus
Isthmus gyri cinguli
Gyrus
Uncus
Gyrus hippocampi occipitotemporalis medialis
Gyrus occipitotemporalis lateralis
Gyrus paraterminalis
Gyrus temporalis inferior
Margo medialis [inferomedialis]

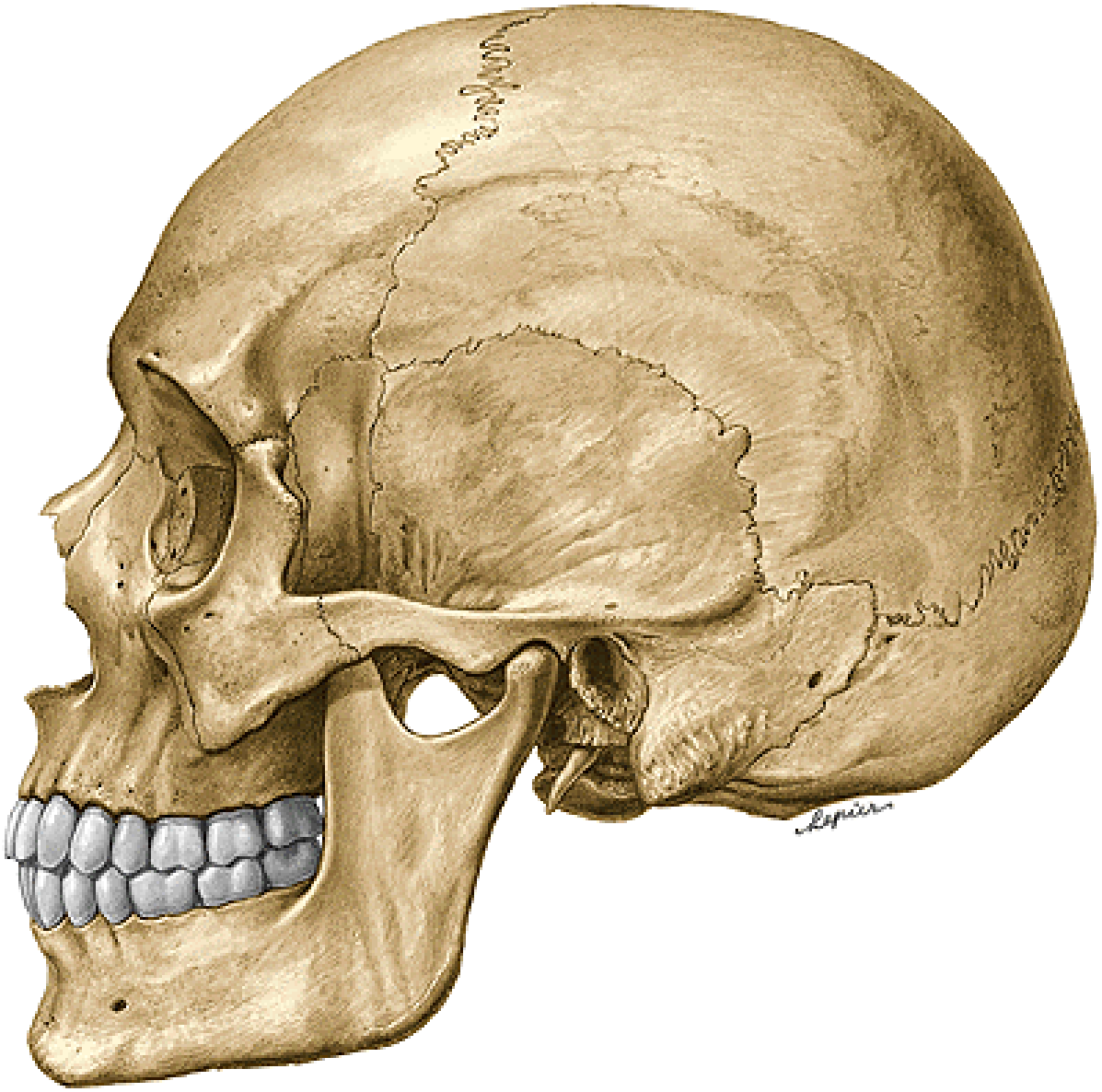

Fissura longitudinalis cerebralis
Chiasma opticum
Polus frontalis
Gyrus rectus
Sulcus olfactorius
Sulci orbitales
Trigonum olfactorium
Corpus mamillare
Gyrus hippocampi, Uncus
Sulcus temporalis inferior
Pedunculus cerebri, Pars anterior [Crus cerebri]
Substantia nigra
Sulcus temporalis inferior
Gyrus temporalis inferior
Gyrus hippocampi
Gyrus occipitotemporalis (medialis et lateralis)
Colliculus superior
Isthmus gyri cinguli
Gyrus cinguli
Sulcus parieto-occipitalis
Polus occipitalis
Cuneus
Sulcus calcarinus

- on the bottom of fissura longitudinalis cerebri, there is **corpus callosum** (it presents the main and largest commissure of the cerebrum)





The cerebral lobes



Each hemisphere is divided into five lobes:

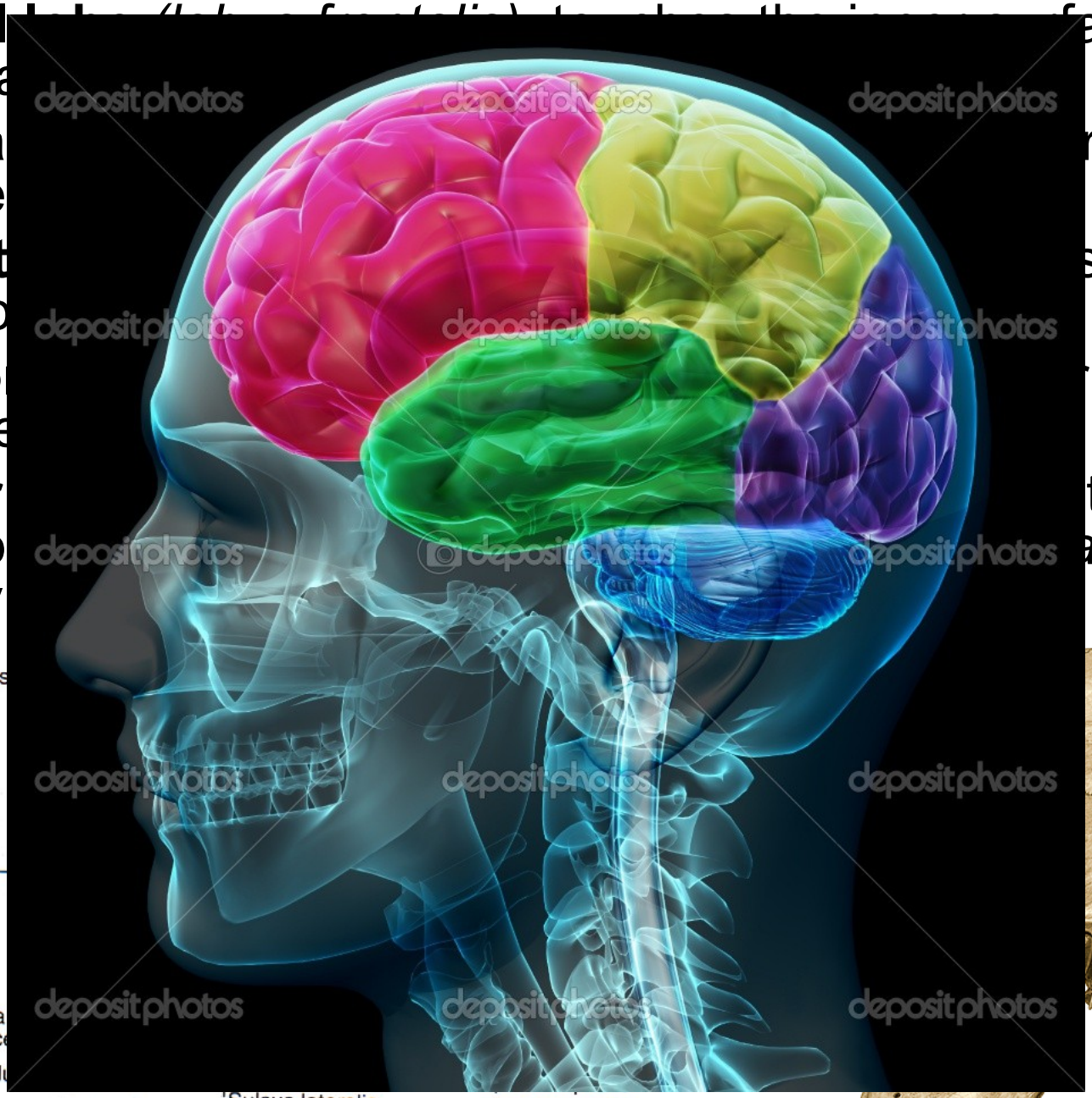
Frontal *(lobus frontalis)* to…ace of the fronta…

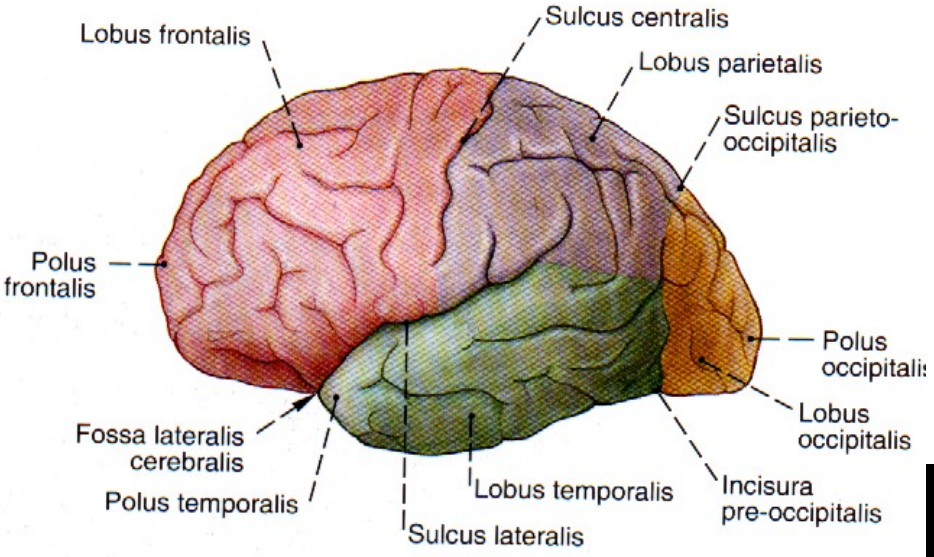
Parieta… …rface of the parie…

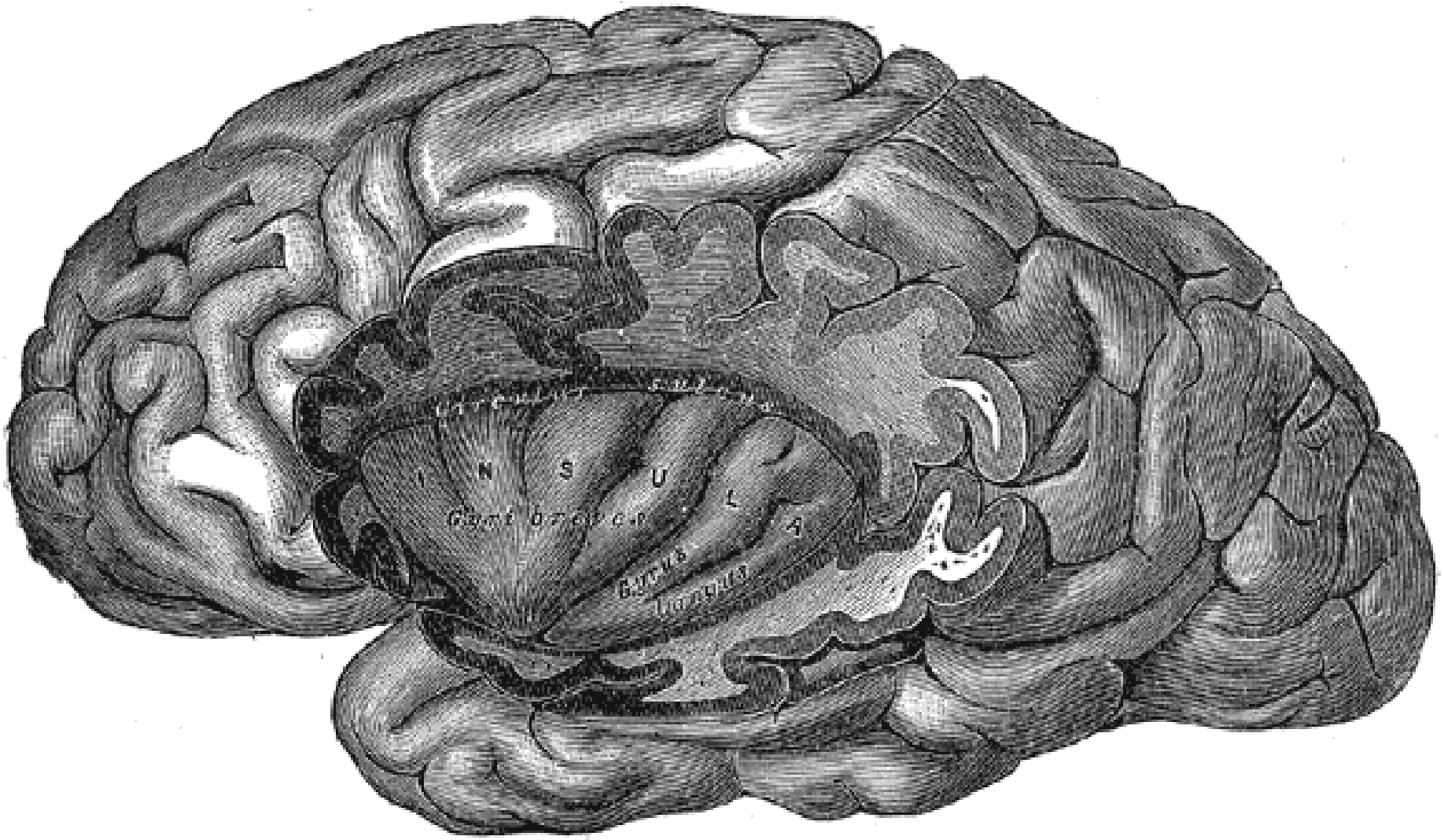
Occipit… …surface of the occip…

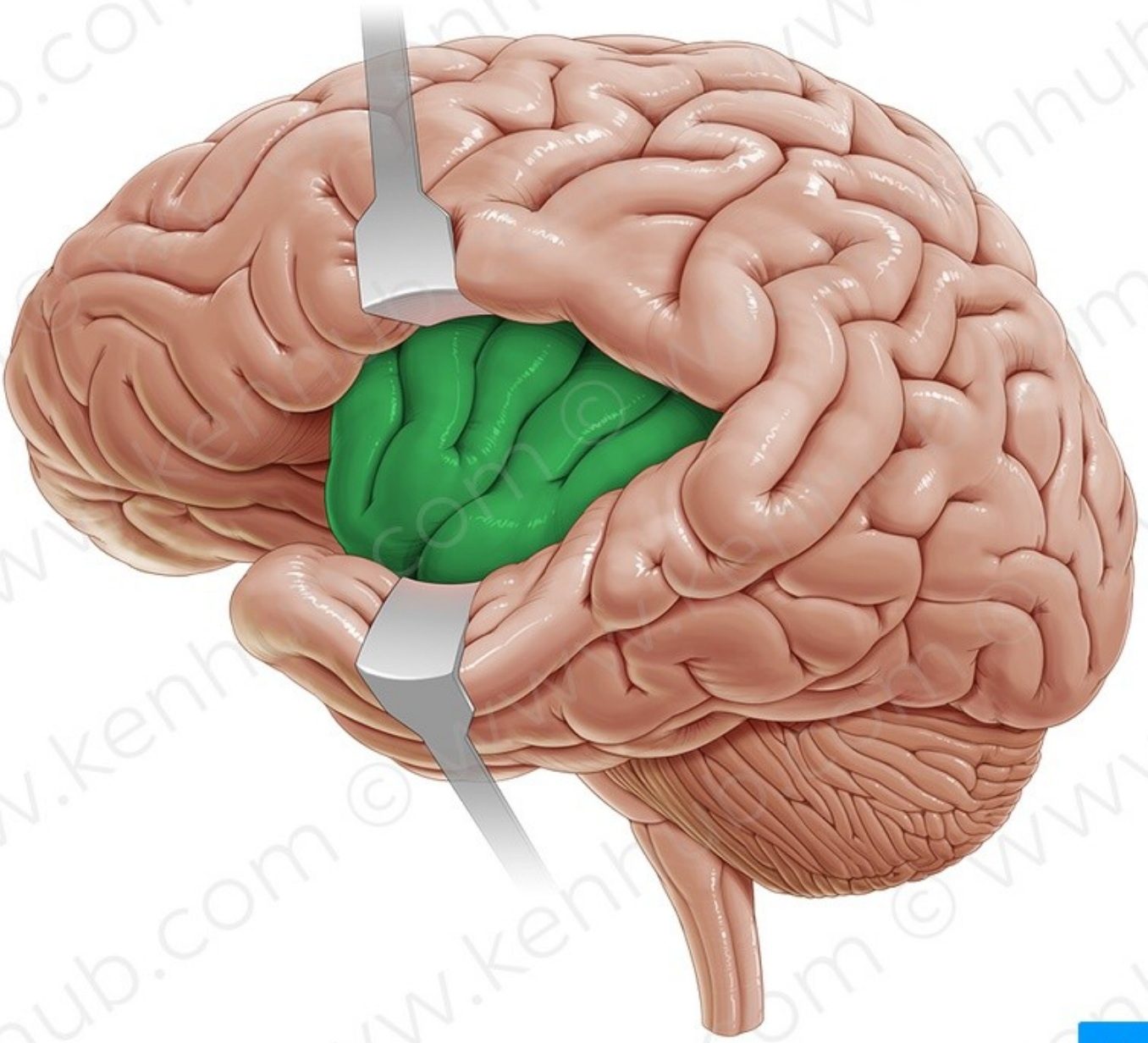
Tempo… … surface of the te…

Insular… …tween temp… *…teralis*), it is not v…

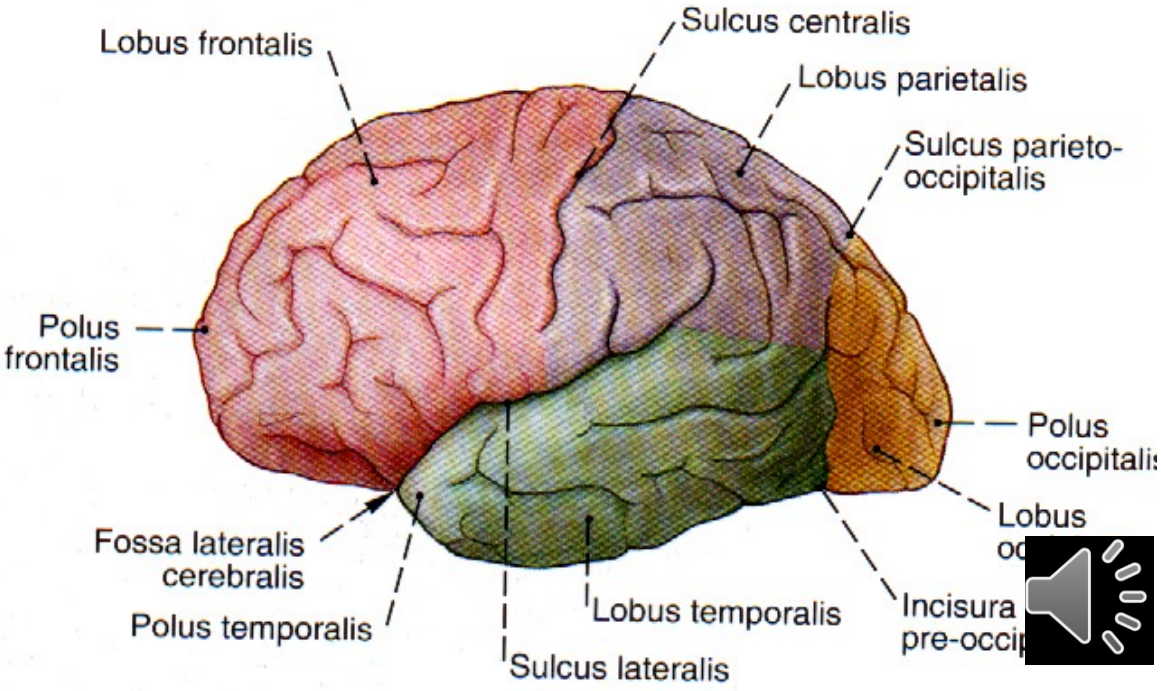


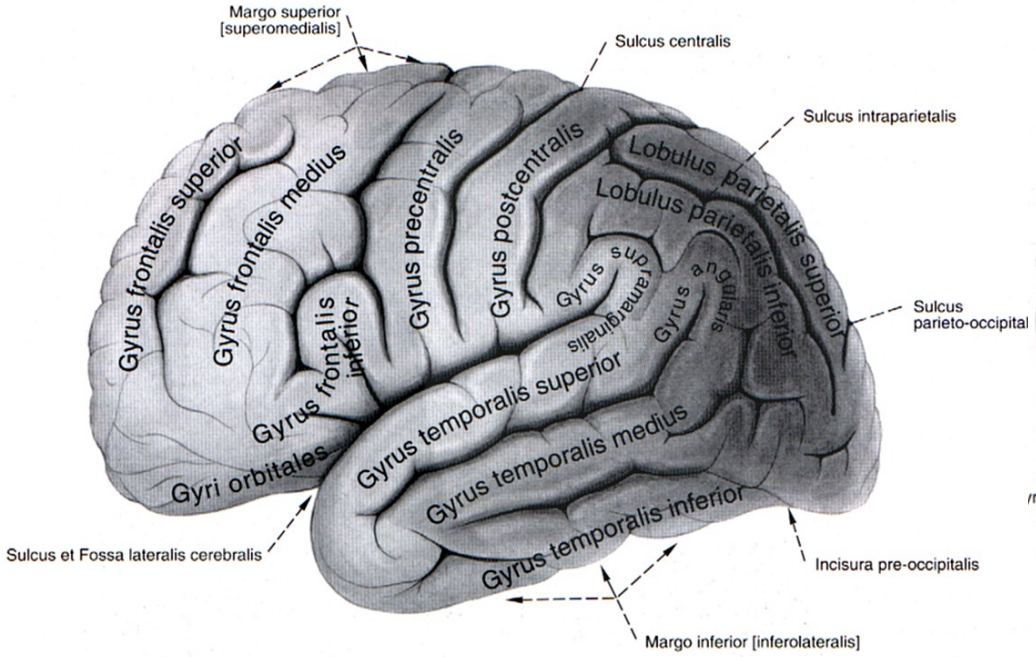

Lobus frontalis
Sulcus centralis
Lobus parietalis
Sulcus parieto-occipitalis
Polus frontalis
Polus occipitalis
Lobus occipitalis
Fossa lateralis cerebralis
Polus temporalis
Lobus temporalis
Sulcus lateralis
Incisura pre-occipitalis

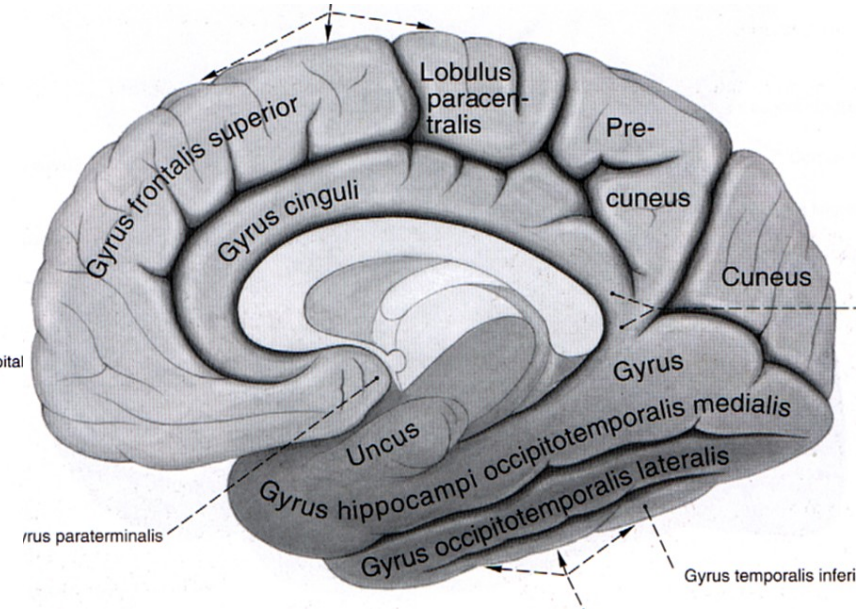

I N S U L A

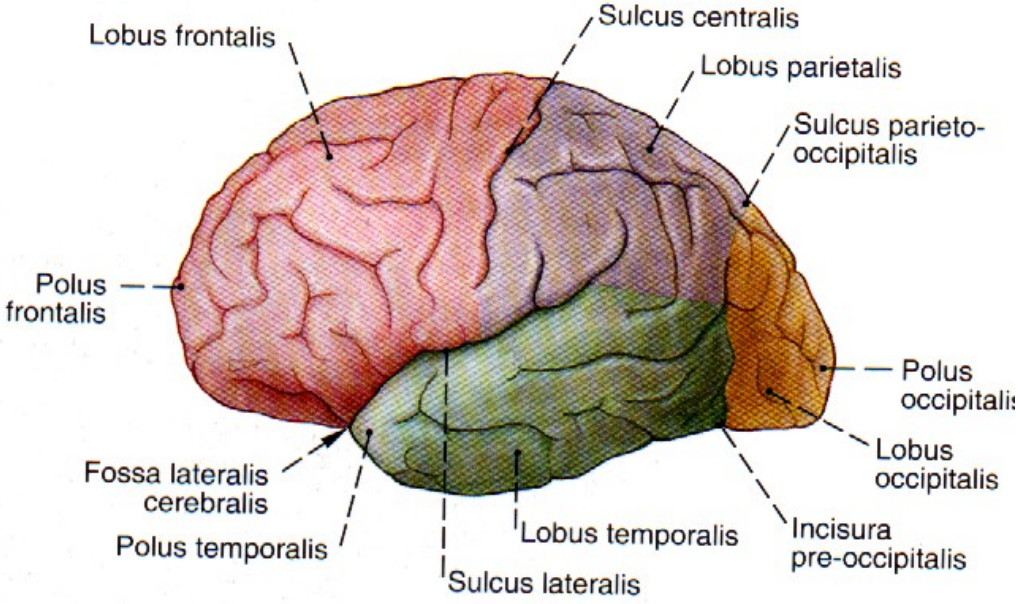


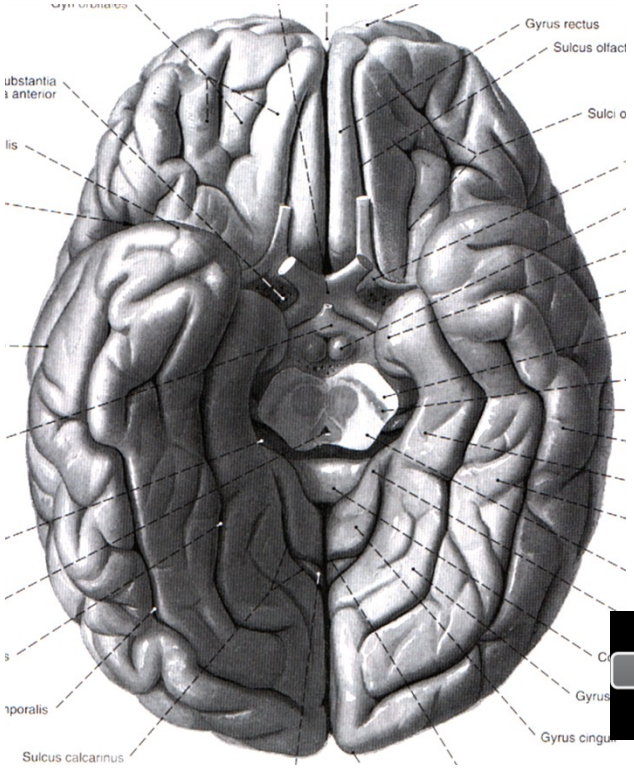
- The hemispheres are furrowed on their surface with numerous grooves *(**sulci**)* and there are created ridges *(**gyri**)*, the process of forming grooves and ridges is called **gyrification** and serves for enlargement of surface of the cerebral cortex and icreasing the number of neurons, to the main grooves belong:
  - **sulcus centralis**
  - **sulcus parietooccipitalis**
  - **fissura cerebri lateralis**




Margo superior [superomedialis]
Sulcus centralis
Sulcus intraparietalis
Gyrus frontalis superior
Gyrus frontalis medius
Gyrus frontalis inferior
Gyrus precentralis
Gyrus postcentralis
Lobulus parietalis superior
Lobulus parietalis inferior
Gyrus supramarginalis
Gyrus angularis
Sulcus parieto-occipital
Gyrus temporalis superior
Gyrus temporalis medius
Gyrus temporalis inferior
Gyri orbitales
Sulcus et Fossa lateralis cerebralis
Incisura pre-occipitalis
Margo inferior [inferolateralis]

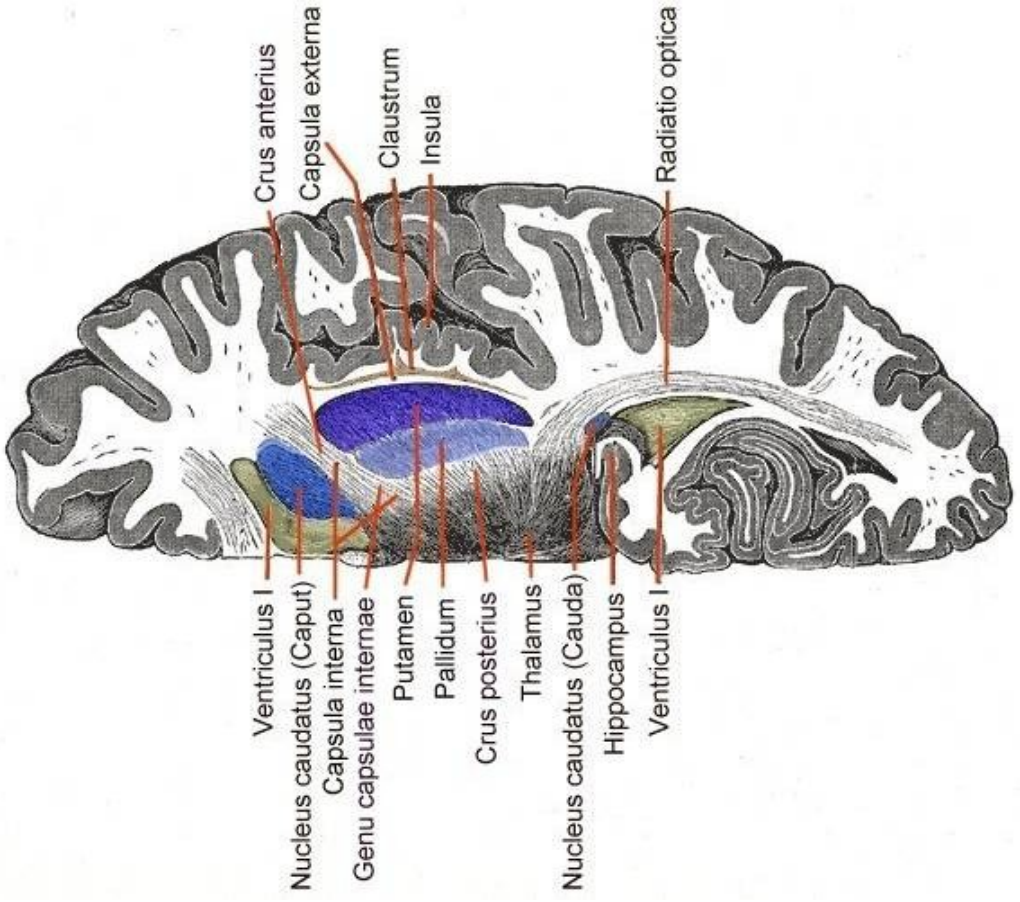

Gyrus frontalis superior
Lobulus paracentralis
Pre-cuneus
Gyrus cinguli
Cuneus
Gyrus
Uncus
Gyrus hippocampi
occipitotemporalis medialis
occipitotemporalis lateralis
rrus paraterminalis
Gyrus temporalis inferi


Lobus frontalis
Sulcus centralis
Lobus parietalis
Sulcus parieto-occipitalis
Polus frontalis
Polus occipitalis
Lobus occipitalis
Fossa lateralis cerebralis
Polus temporalis
Lobus temporalis
Incisura pre-occipitalis
Sulcus lateralis


Gyrus rectus
Sulcus olfact
Sulci o
Gyrus
Gyrus cingu
Sulcus calcarinus

Internal structure of the cerebrum

- **Cerebral cortex** *(cortex):* outer layer of pallium, component of *pars pallialis*
- **Body of white matter** *(corpus medullare):* inner layer of pallium, component of *pars pallialis*
- **basal ganglia** *(striatum):* structures corresponding to *pars basilaris*

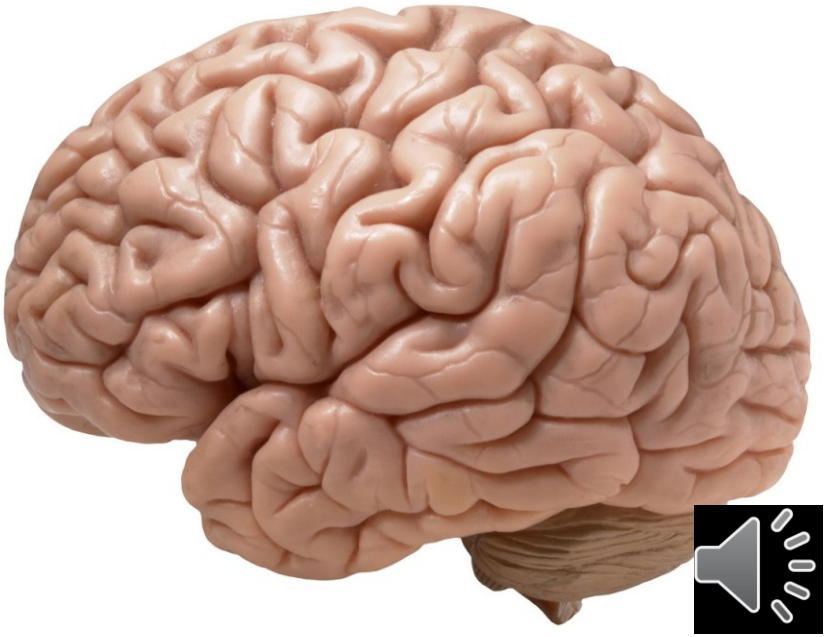


1. Cerebral cortex

- **Cerebral cortex is a layer of grey matter covering cerebral hemispheres**
- **It forms the outer layer of pallium, it is gyrificated, its surface has circa 0.25 m^2. Cerebral cortex contains 3 – 6 layers of neurons on the cross-section,**
- **from morphological and phylogenetic aspects we distinguish the following sections of the cerebral cortex**

Allocortex (paleocortex, archicortex)

Neocortex



1. allocortex

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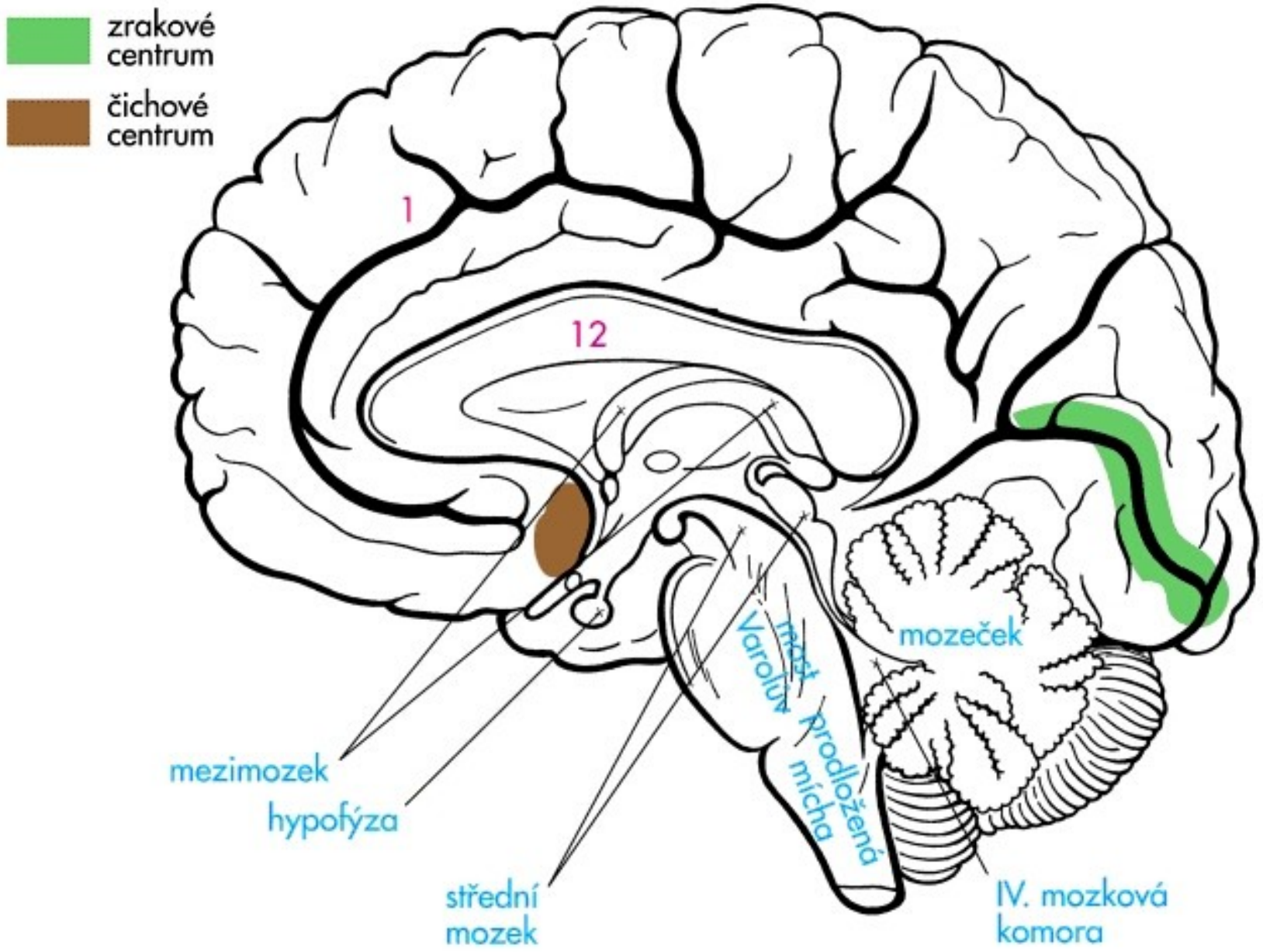
- f
  c



a) lled
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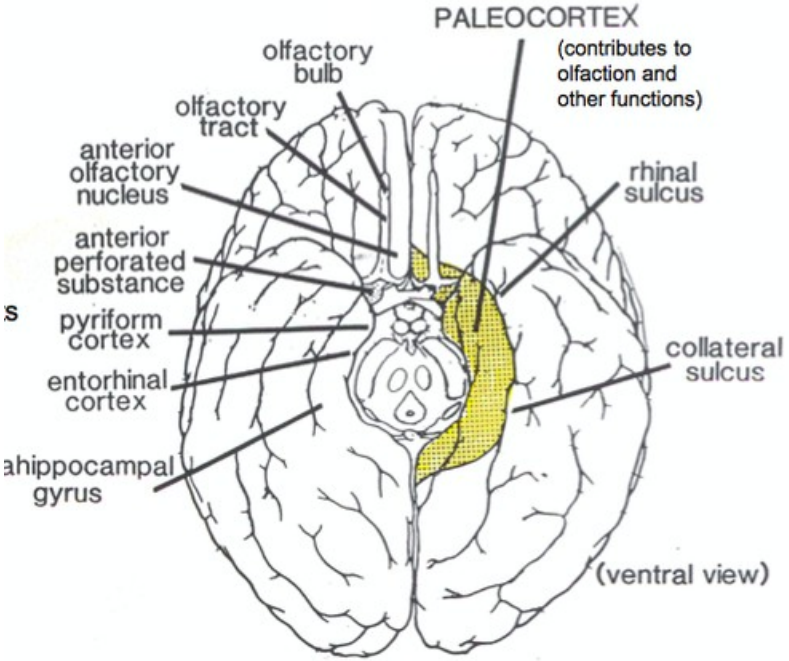
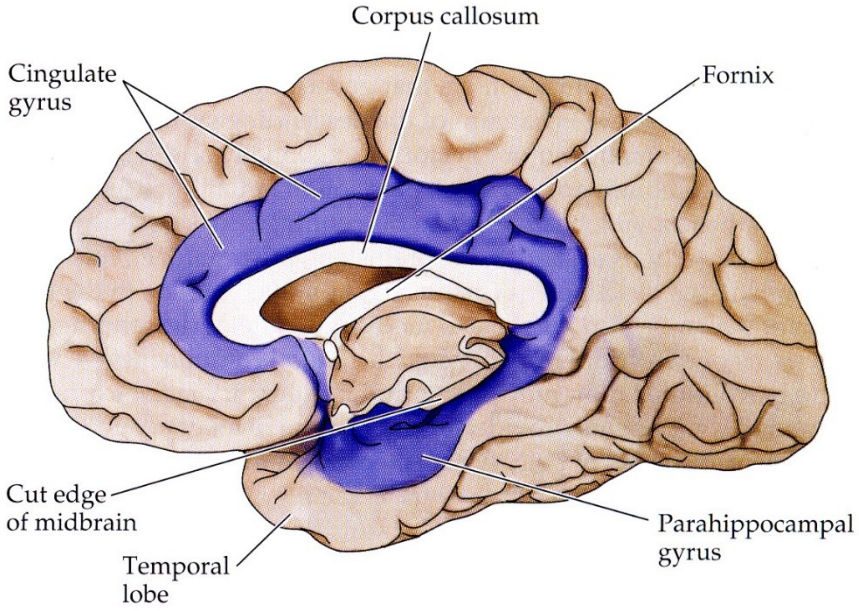
cerebral cortex on the base of hemispheres and in adjacent a


PALEOCORTEX
(contributes to olfaction and other functions)
olfactory bulb
olfactory tract
anterior olfactory nucleus
anterior perforated substance
pyriform cortex
entorhinal cortex
ahippocampal gyrus
rhinal sulcus
collateral sulcus
(ventral view)

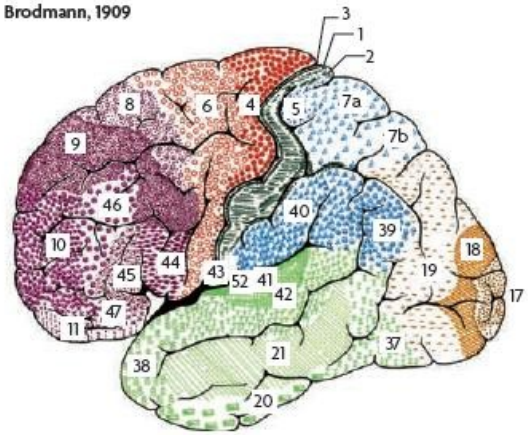

Corpus callosum
Cingulate gyrus
Fornix
Cut edge of midbrain
Temporal lobe
Parahippocampal gyrus

2. neocortex

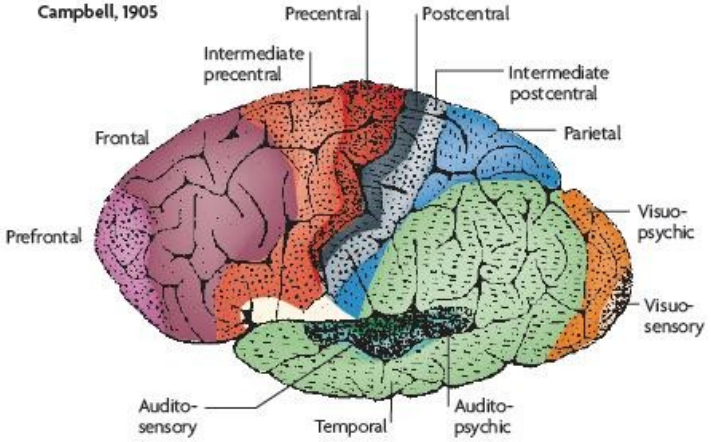
- **developmentally younger part of cerebral cortex**
- **It contains six morfologically different layers of neurons**
- **In human neocortex covers circa 95% of surface of cerebral cortex and it is a seat of the highest control functions, the basic six-layer structure of neocortex differs at various places of hemispheres**

- We know so-called **cytoarchitectonic maps** dividing cerebral cortex into several areas with approximately the same internal structure, the most widely used is **Brodmann´s map**, which divides (whole) cerebral cortex into 11 areas *(regiones)* and 52 surfaces *(areae)*
- From the functional point of view, we can divide cerebral cortex into so-called **functional areas of cerebral cortex** – districts, which represent the seats of the highest processing and integration of motor and sensory information (motor cortex, sensory, visual, auditory etc.)

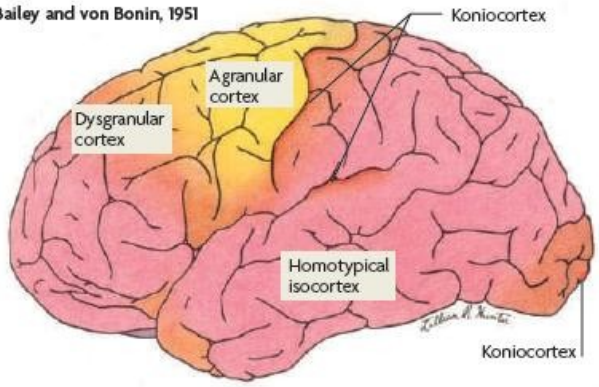
Brodmann, 1909



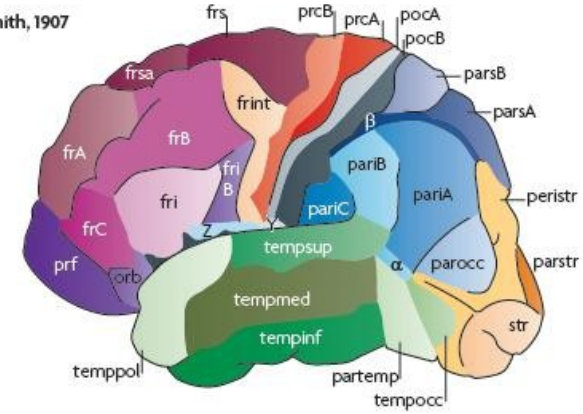
Campbell, 1905



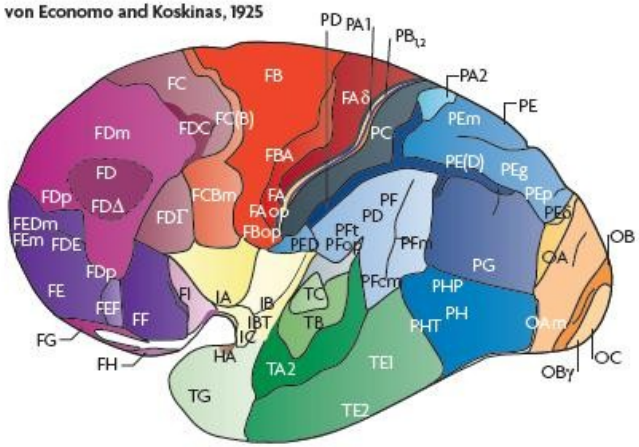
Bailey and von Bonin, 1951



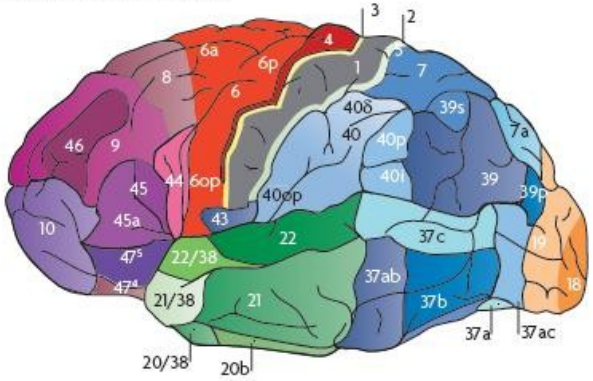
Smith, 1907



von Economo and Koskinas, 1925

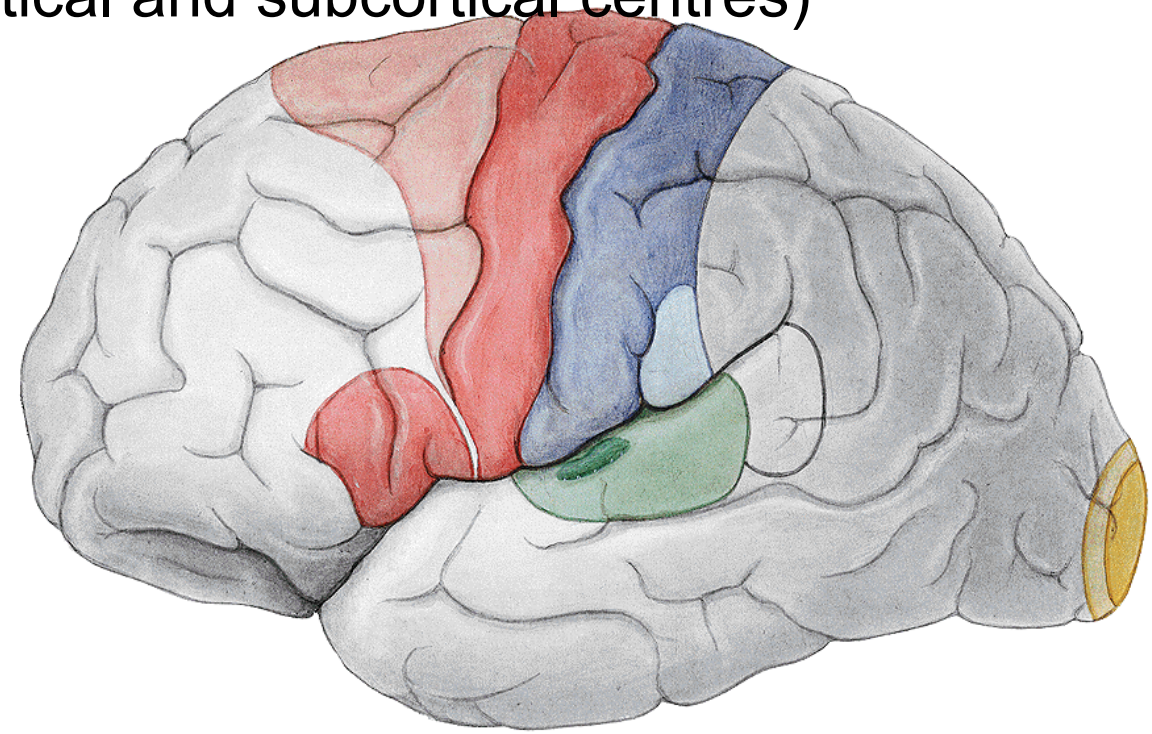


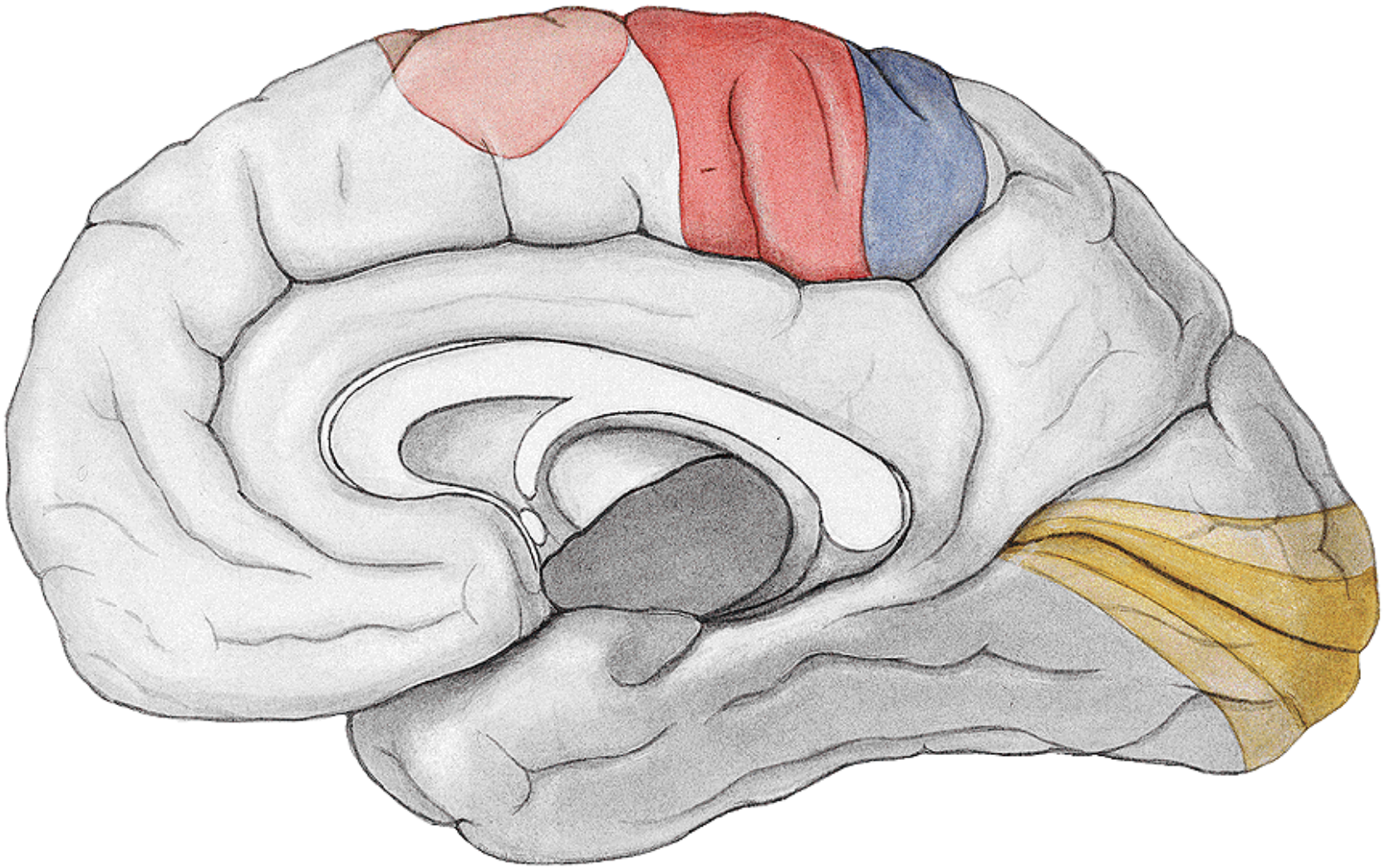
Russian school (Sarkisov), 1949



Functional areas of the cerebral cortex

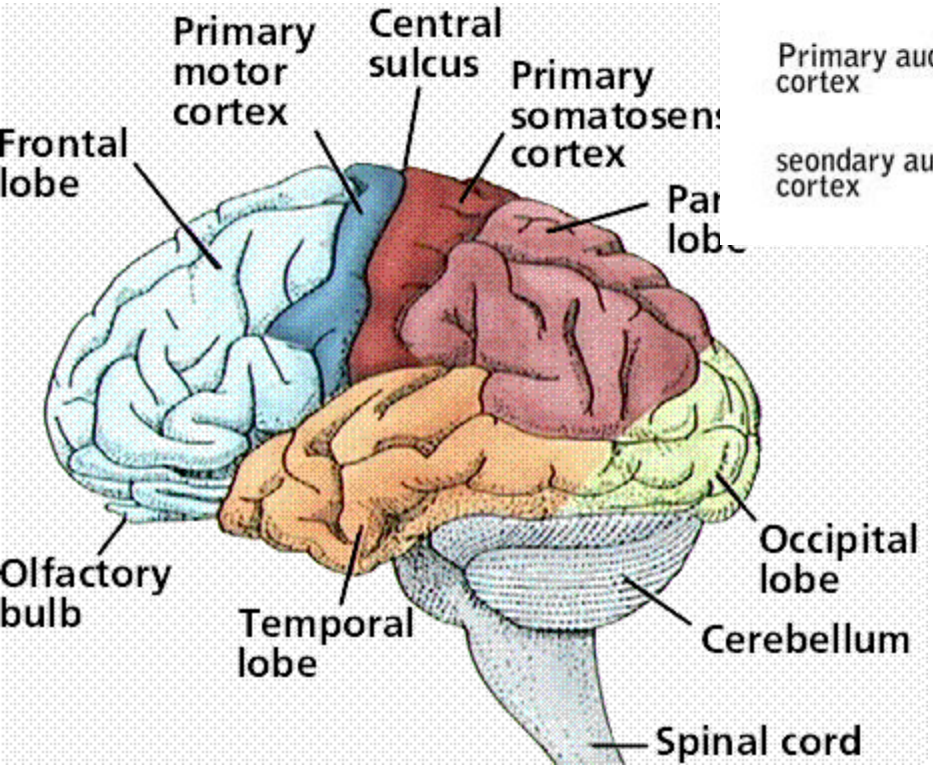
- almost every functional area has two components – **primary** (it accepts information from receptors or emits commands for the muscle activity) and **secondary (association)** (it provides deeper analysis of specific functions and an integration with other cortical and subcortical centres)

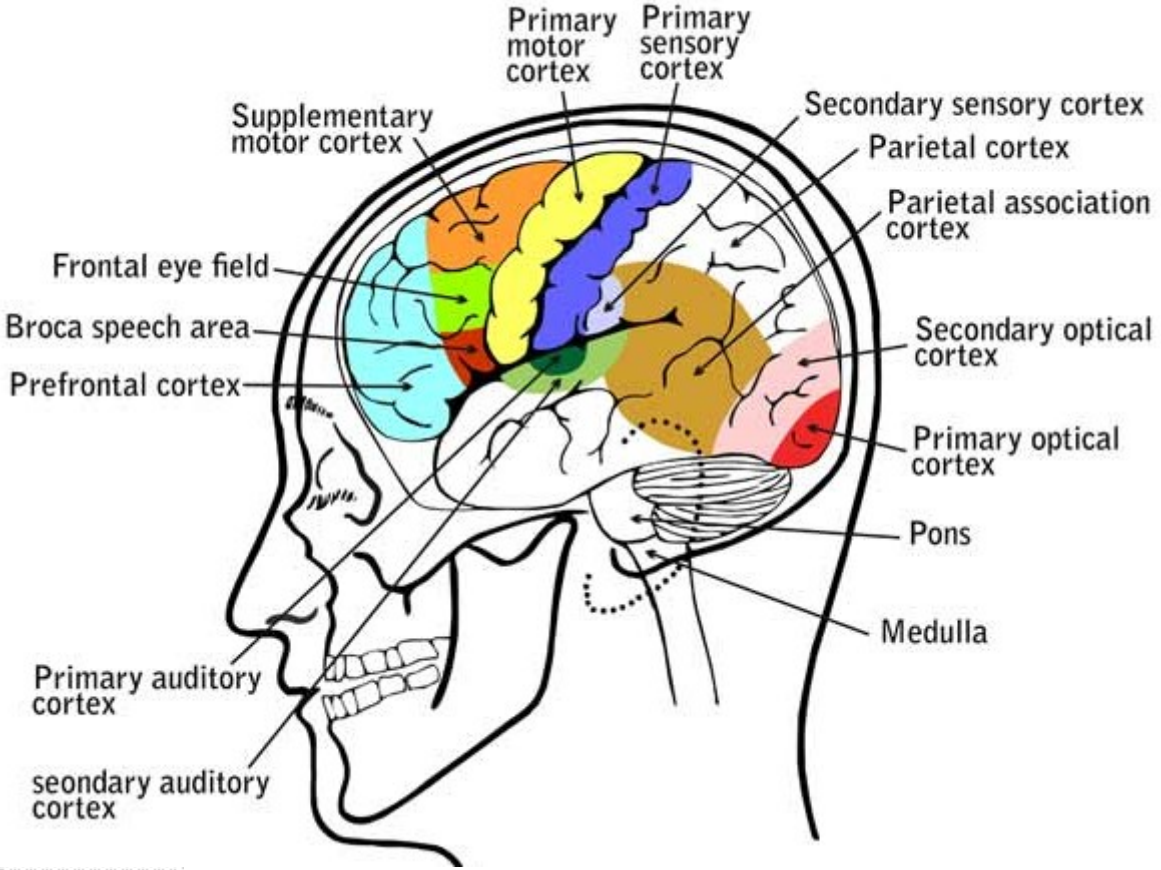


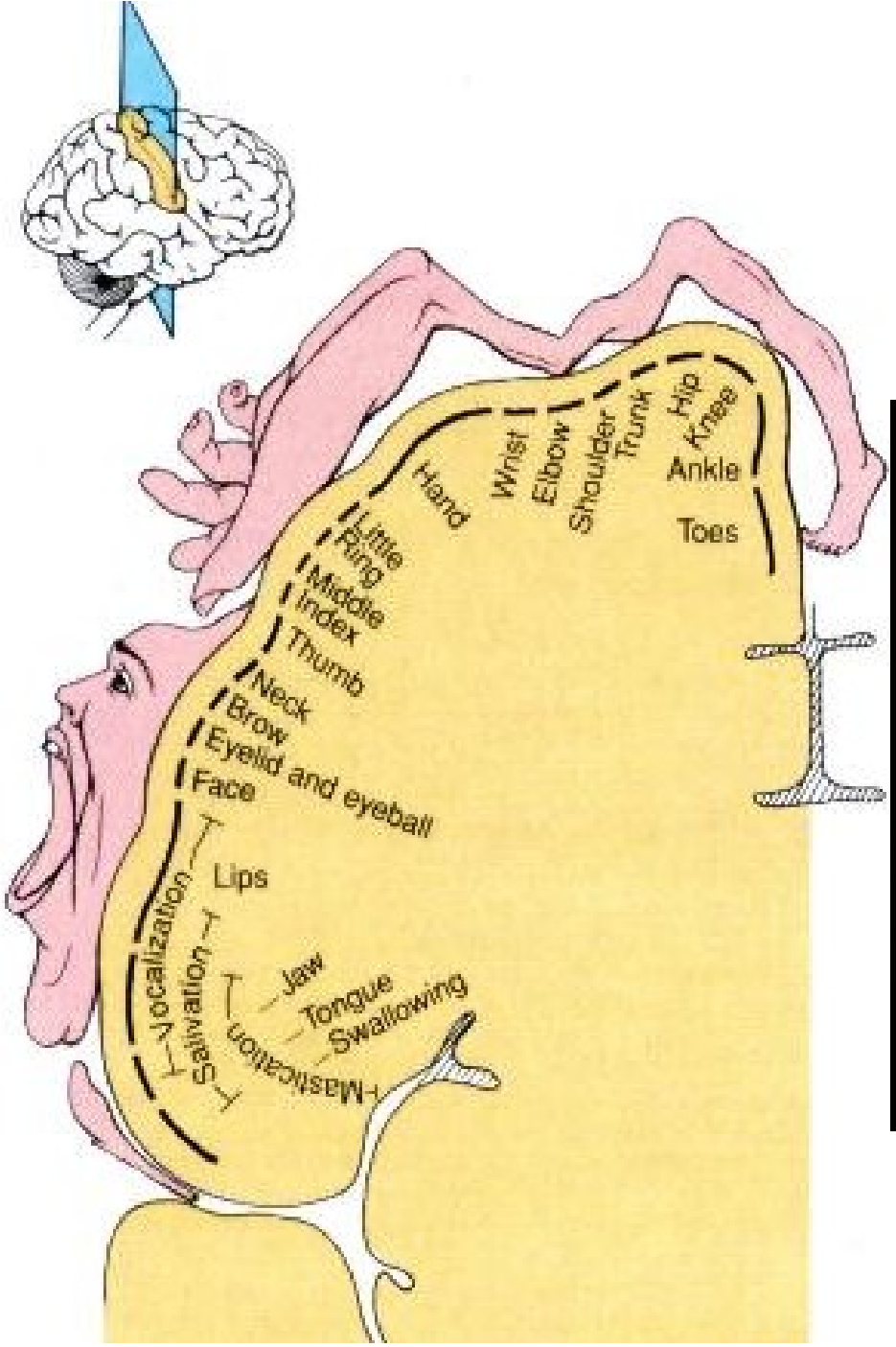

Motor areas
Sensory areas
Visual areas

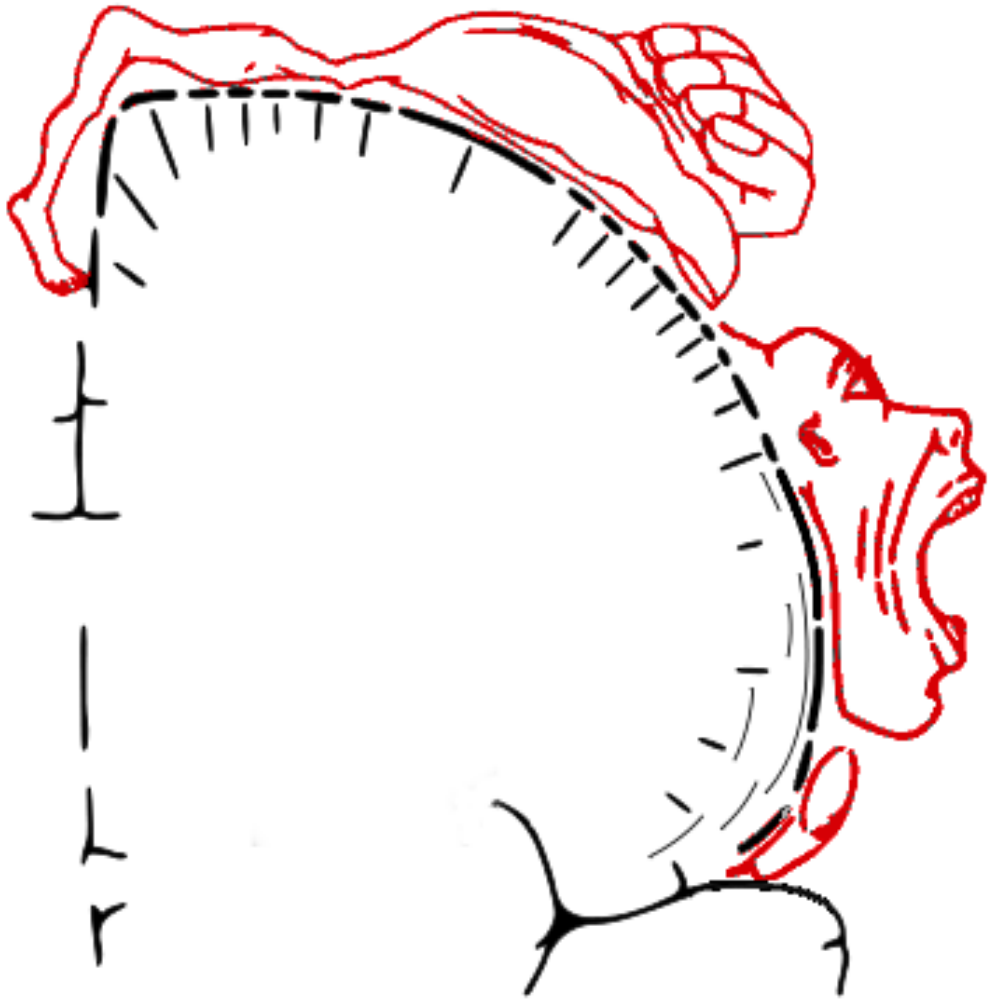
The cortical motor centres

- It is about the areas of cerebral cortex, whose neurons emit impulses for muscle activity
- their axons therefore continue into lower levels of CNS as descending (motor) pathways
- Within the cerebral cortex, there are especially located specific control areas for functions controlling striated muscle
- **primary motor area-** voluntary movement- pyramidal tract
- **secondary (association) motor area-** more complicated movements, preparation of movement
- **premotor area-** preparation of motion – cooperation with movements of eye bulb


Primary motor cortex
Central sulcus
Primary somatosens cortex
Frontal lobe
Par lobe
Occipital lobe
Olfactory bulb
Temporal lobe
Cerebellum
Spinal cord


Primary motor cortex
Primary sensory cortex
Supplementary motor cortex
Secondary sensory cortex
Parietal cortex
Parietal association cortex
Frontal eye field
Broca speech area
Prefrontal cortex
Secondary optical cortex
Primary optical cortex
Pons
Medulla
Primary auditory cortex
seondary auditory cortex

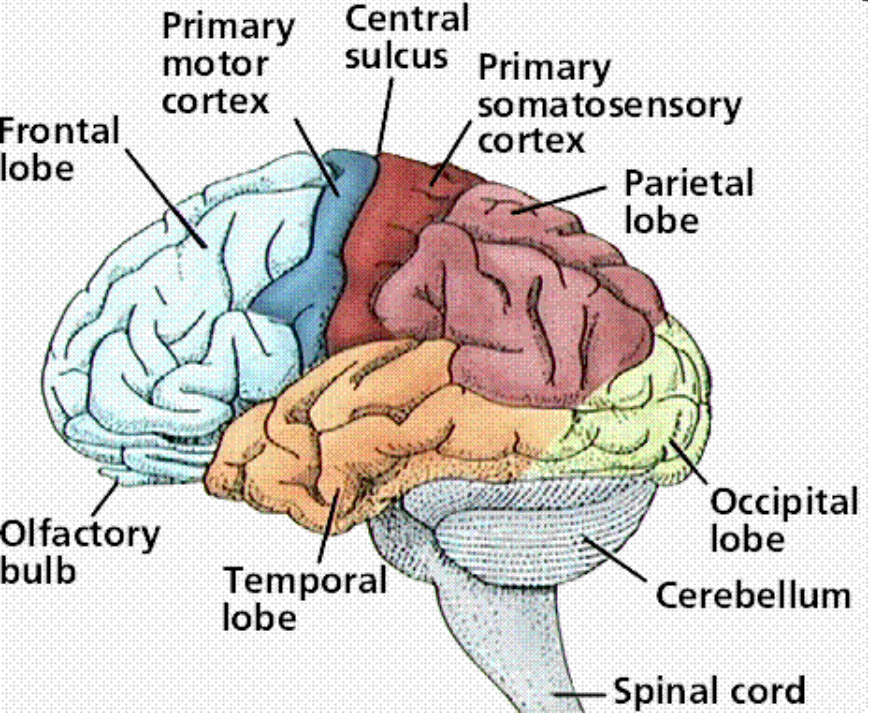

Hand
Wrist
Elbow
Shoulder
Trunk
Hip
Knee
Ankle
Toes
Little
Ring
Middle
Index
Thumb
Neck
Brow
Eyelid and eyeball
Face
Lips
Vocalization
Salivation
Mastication
Jaw
Tongue
Swallowing

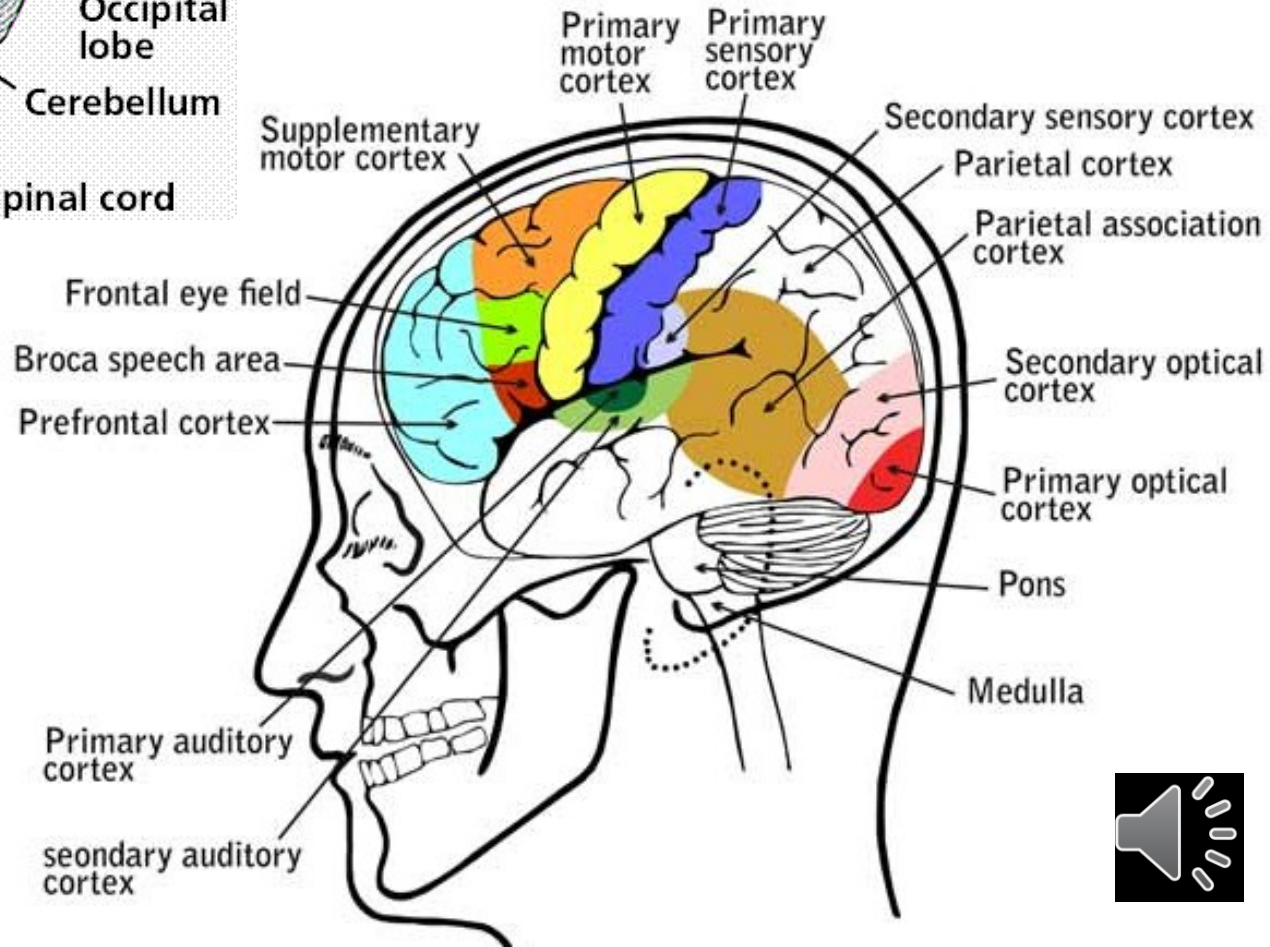


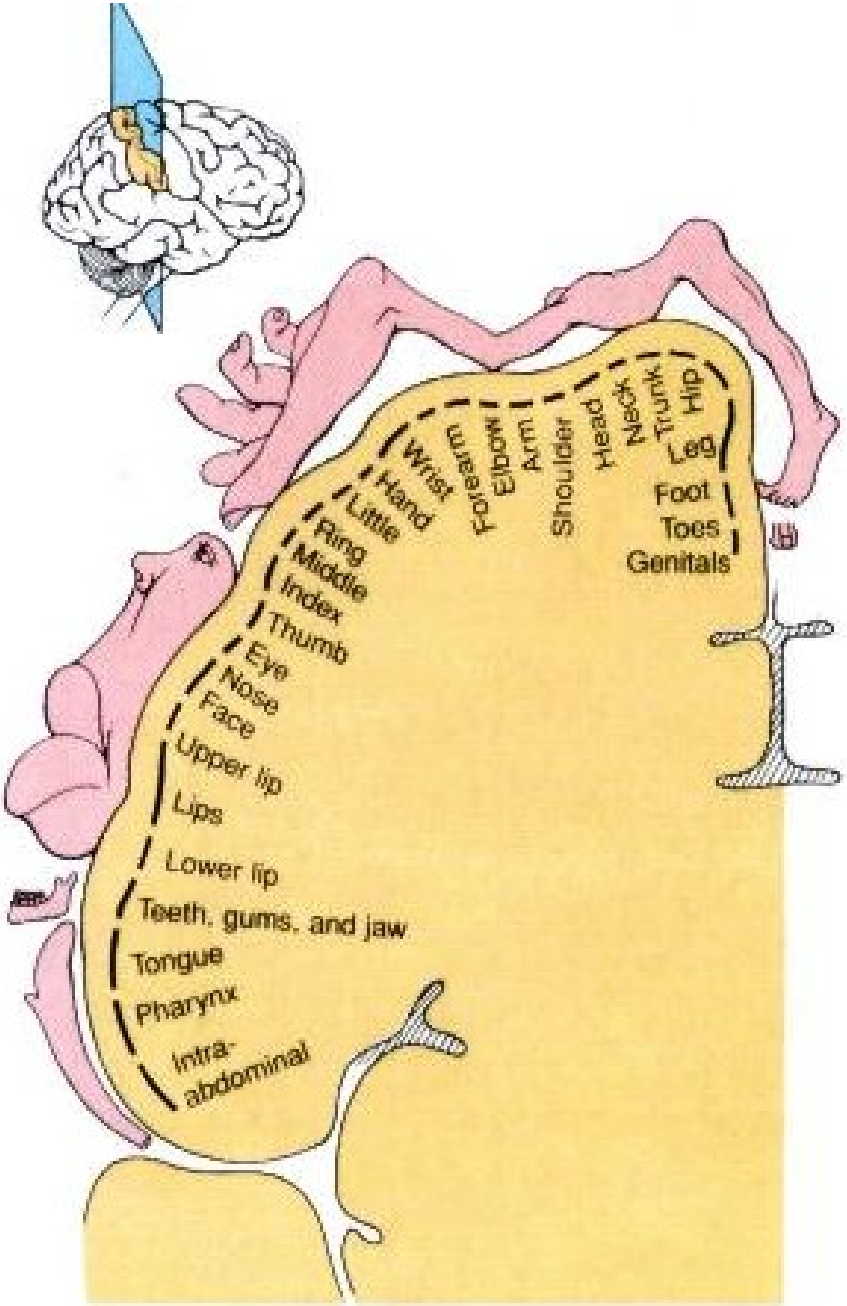
The cortical sensory centres

- Accept information from skin receptors, about locomotor system and visceral organs through the sensory tracts
- It goes about a centre of somatosensory system and viscerosensory system as well
- **primary sensory area-** the sense of touch - damage = hypesthesia (a decrease in sensation) (***gyrus postcentralis***)

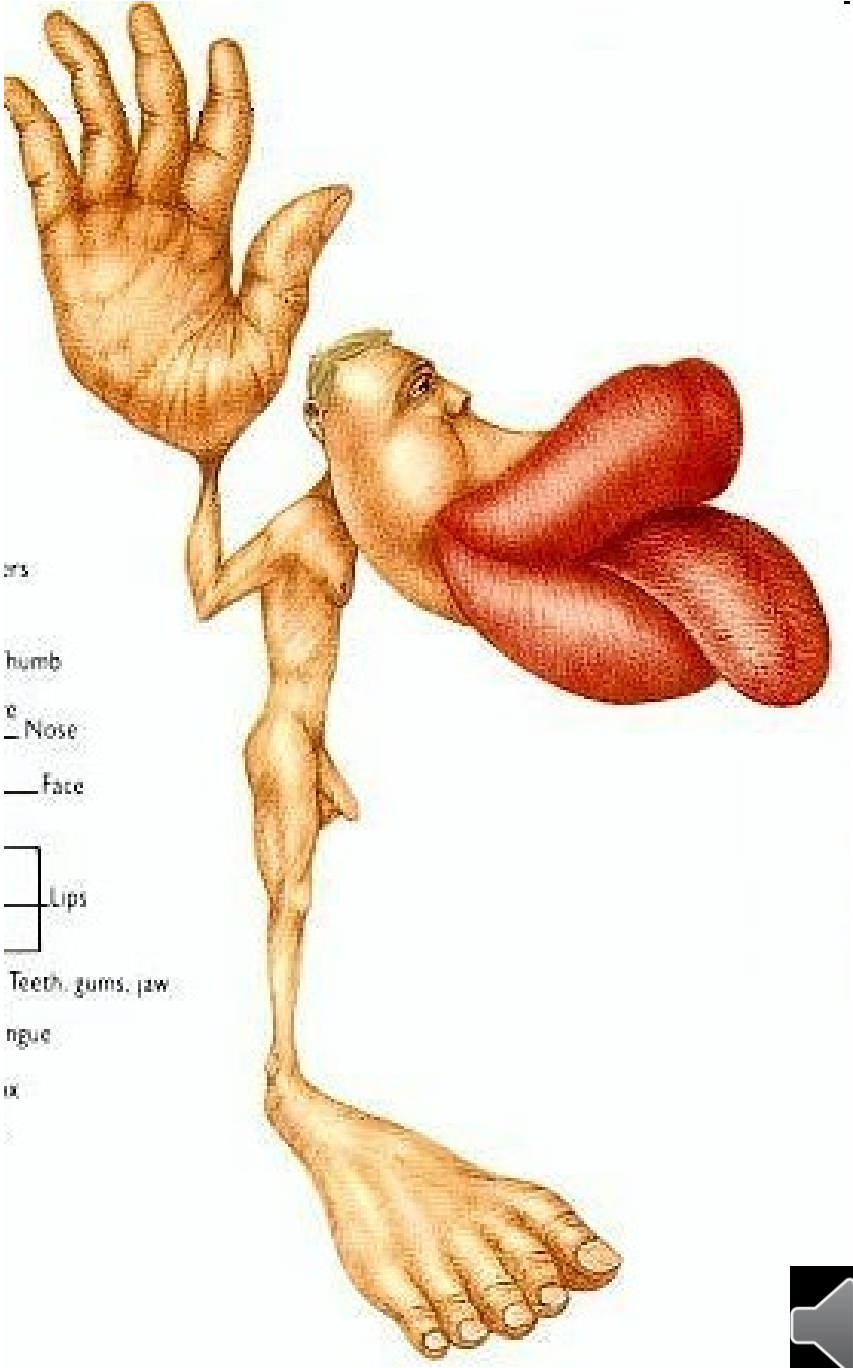
- **secondary (association) sensory area-** less precise sensation – recognizing of objects through touch (parietal lobe – superior part of ***fissura lateralis***)

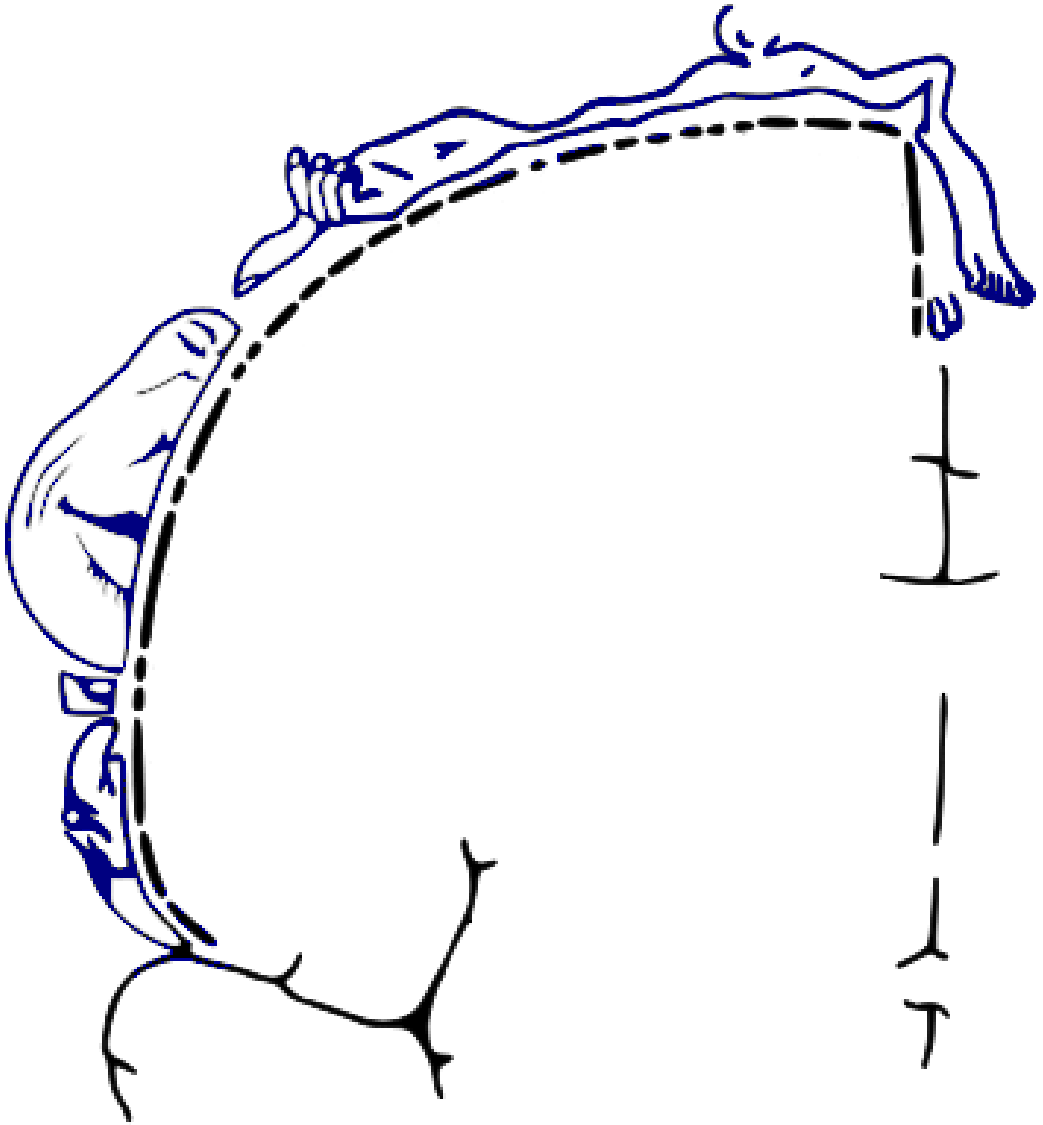

Primary motor cortex
Central sulcus
Primary somatosensory cortex
Frontal lobe
Parietal lobe
Occipital lobe
Olfactory bulb
Temporal lobe
Cerebellum
Spinal cord


Primary motor cortex
Primary sensory cortex
Supplementary motor cortex
Secondary sensory cortex
Parietal cortex
Parietal association cortex
Frontal eye field
Broca speech area
Prefrontal cortex
Secondary optical cortex
Primary optical cortex
Pons
Medulla
Primary auditory cortex
seondary auditory cortex



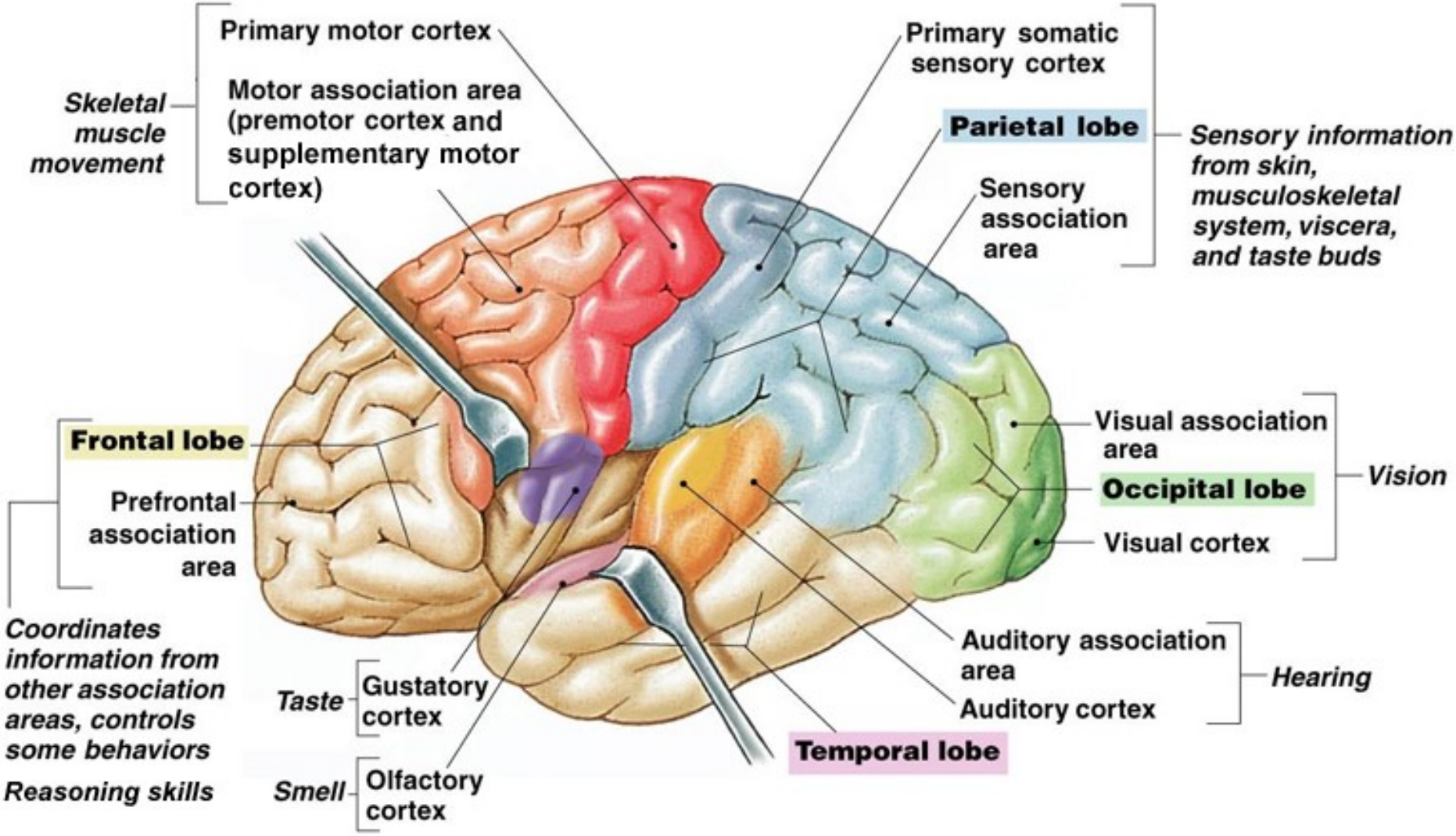
(a) Somatosensory cortex in right cerebral hemisphere





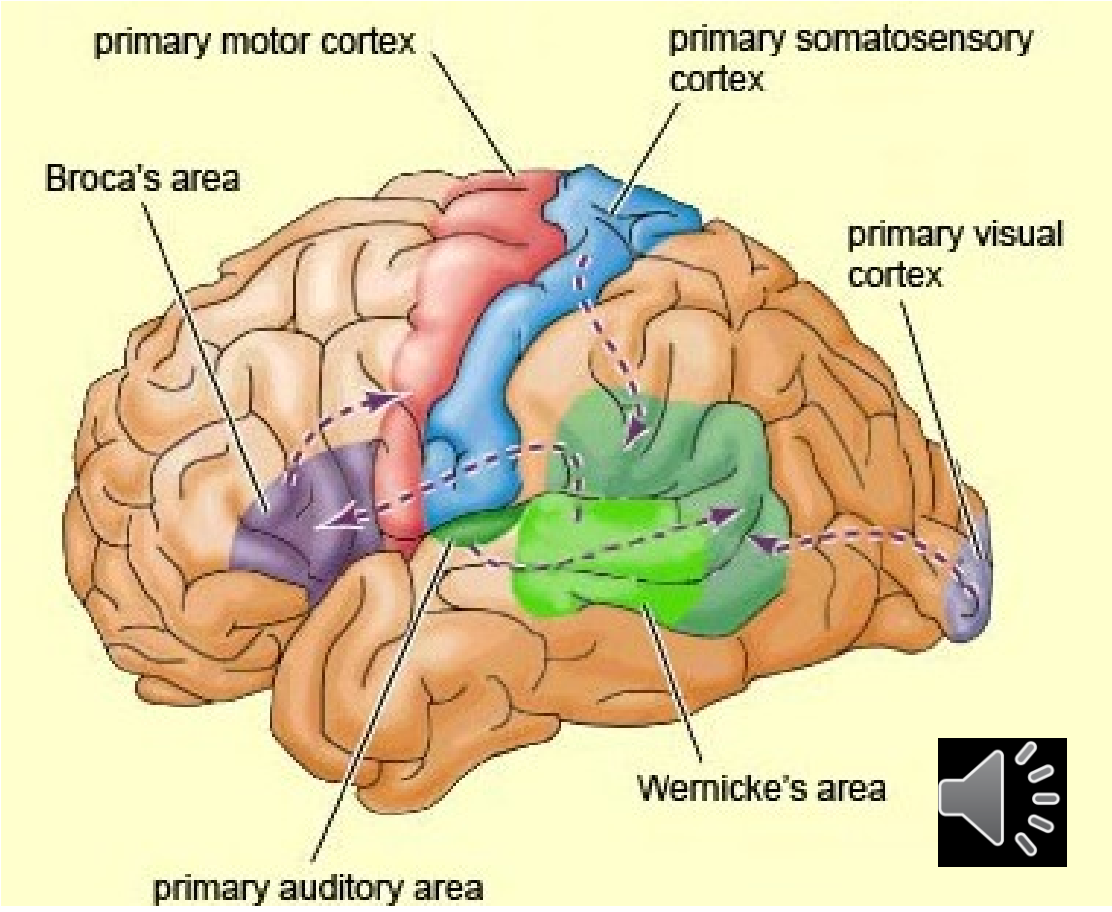
The cortical sensory areas (in the stricte sense)

- Centres of sensory perception (it goes about the specialized sensory organs)
- information come from receptors within sensory organs through appropriate sensory nerves
- Olfactory area
- Gustatory area
- Visual area
- Auditory area
- Vestibular area


Primary motor cortex
Skeletal muscle movement
Motor association area (premotor cortex and supplementary motor cortex)
Primary somatic sensory cortex
Parietal lobe
Sensory association area
Sensory information from skin, musculoskeletal system, viscera, and taste buds
Frontal lobe
Prefrontal association area
Coordinates information from other association areas, controls some behaviors
Reasoning skills
Visual association area
Occipital lobe
Visual cortex
Vision
Taste
Gustatory cortex
Smell
Olfactory cortex
Auditory association area
Auditory cortex
Hearing
Temporal lobe

Language centers

- **speech (ability of language, spoken and written) is specific property only in human. We have two control centres– motor and sensory, which cooperate very closely and are interconnected through a bundle of nerve fibers (so-called fasciculus arcuatus)**
- **Both control centers are located within dominant (i. e. mostly left) hemisphere**

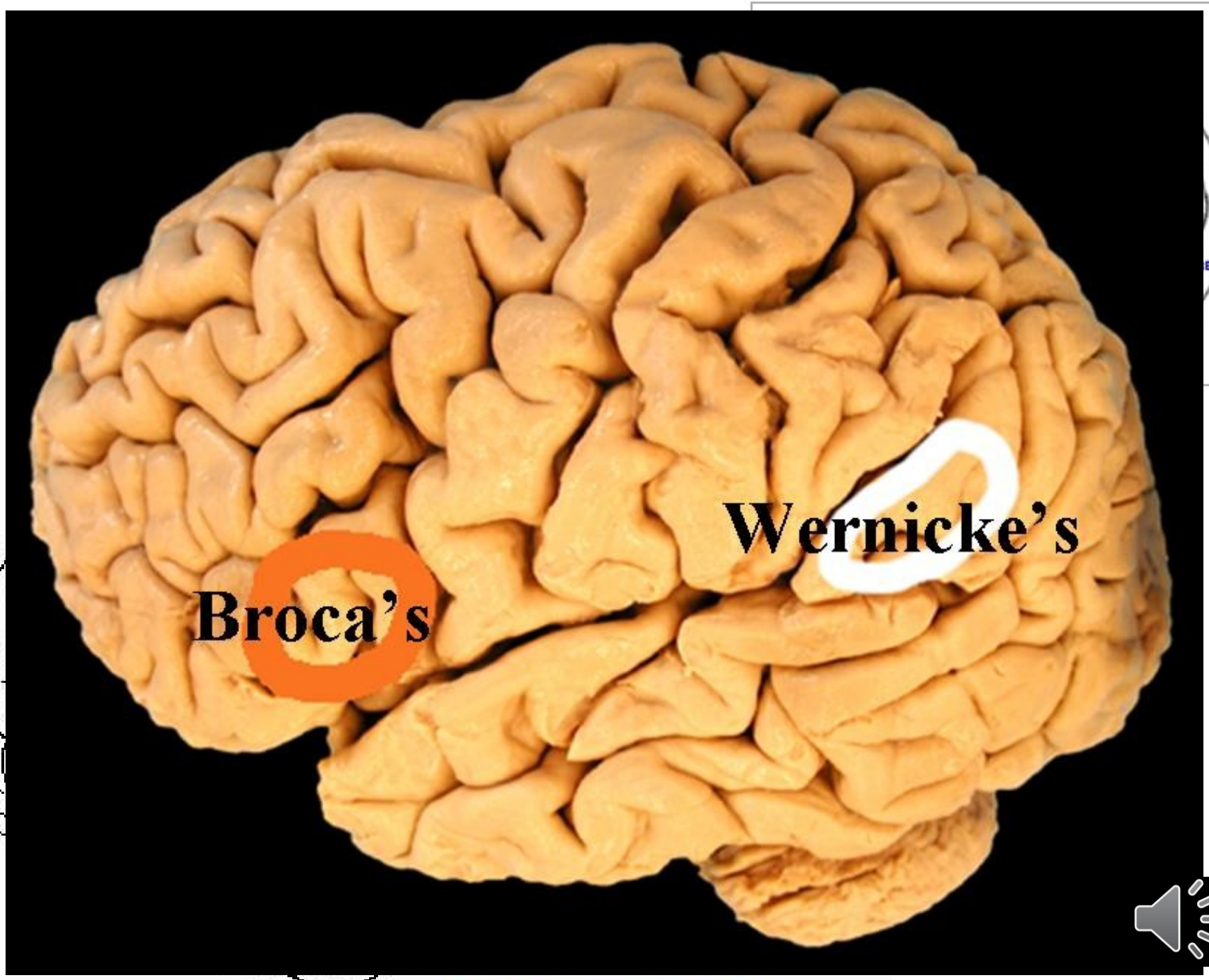


<u>Broca´s (motor) cortical area</u>- in right-handers in L-hemisphere, in left-anders in R-hemisphere

- It is located in frontal lobe in front of primary motor cortex
- This center controls movements of muscles, which are used by spoken speech and written speech as well, gives one the ability to express oneself
- damage – you understand the speech, but you can´t speek

<u>Wernicke´s (sensory) cortical area</u> - in dominant hemisphere

- It is located in posterior part of temporal lobe, next to association auditory area, with which it has very close functional relation
- It allows to understand to spoken speech also written speech (ability to read) and meaning of mimic expression (gesticulation)
- damage – you don´t understand the speech, you can speek but unintelligibly (you don´t know what you are saying), you can make strenge shrieks and sounds


Wernicke's
Broca's

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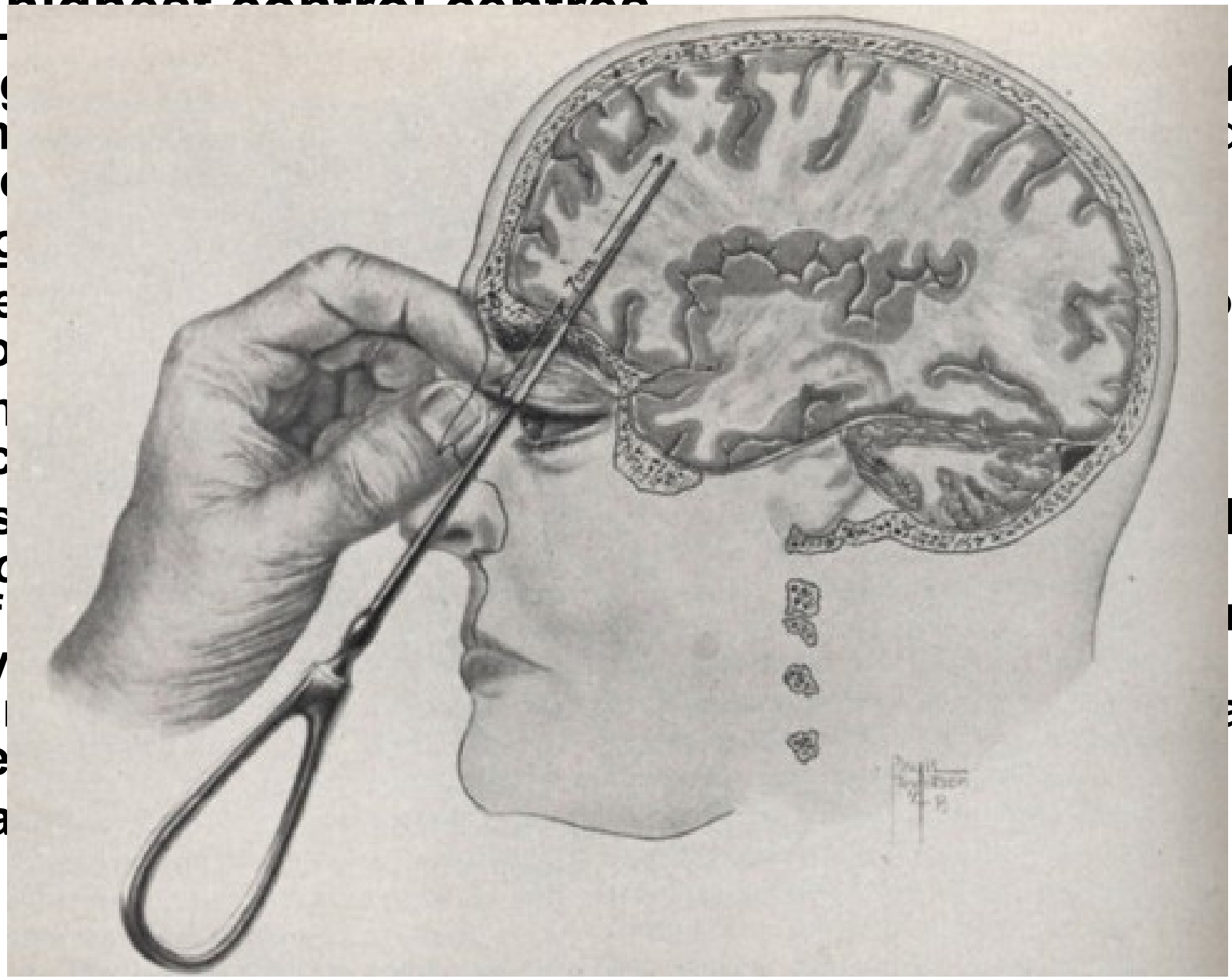

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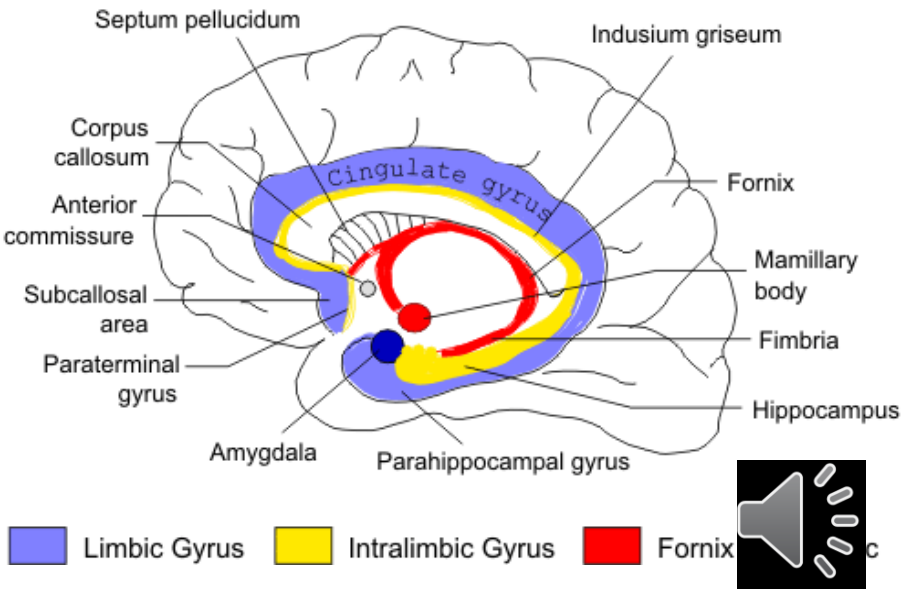
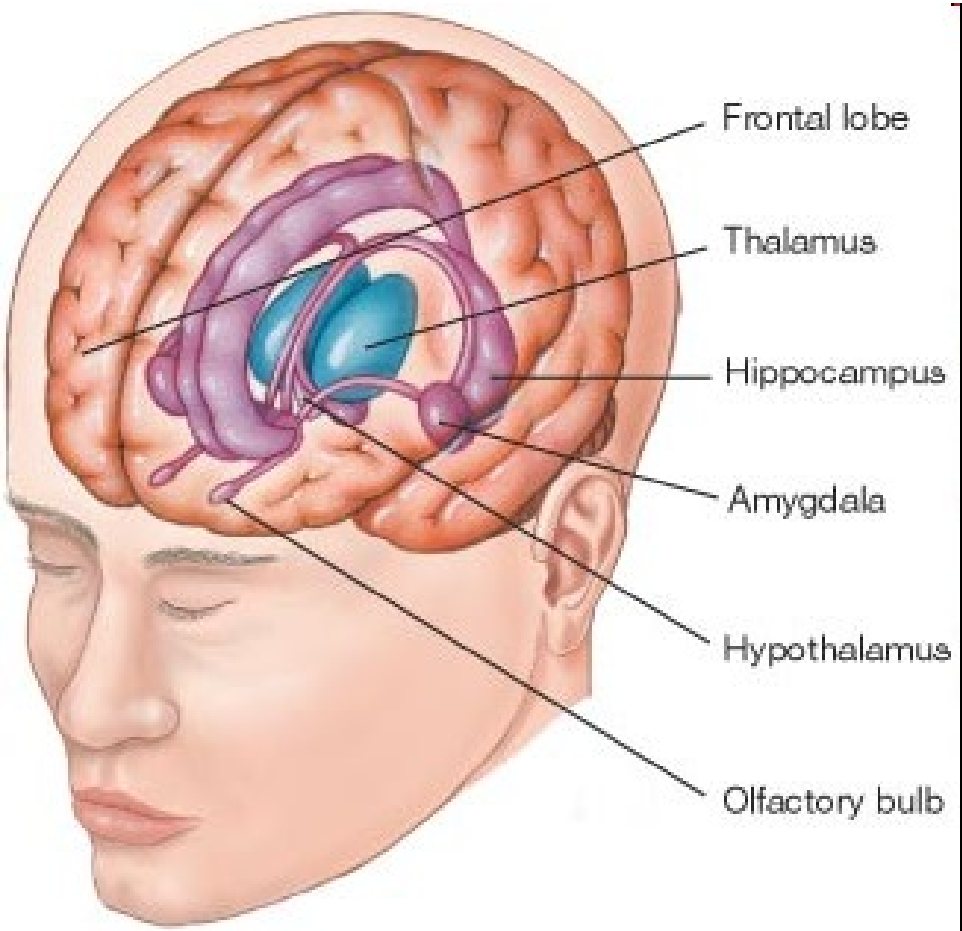
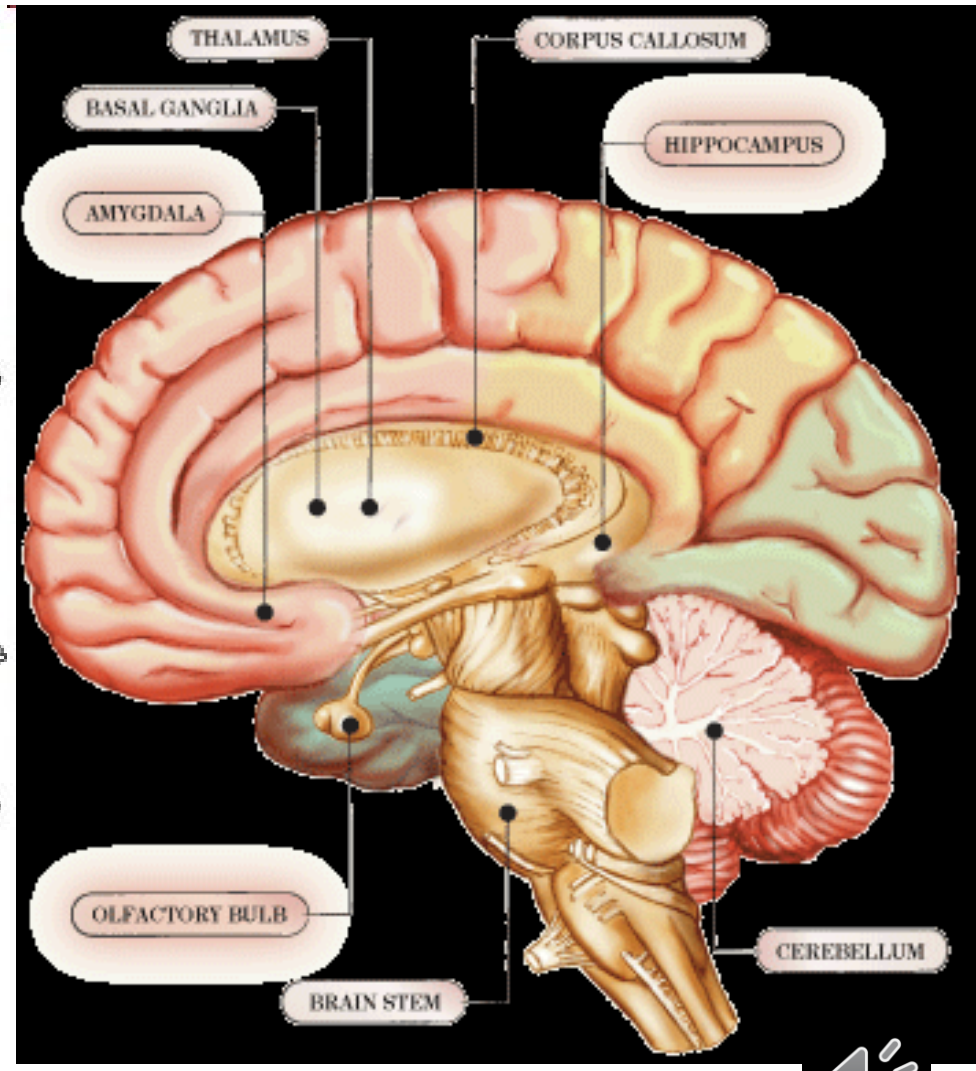
Limbic system

- Seat of memory and source of emotion and motivation
- Response of limbic system – affective behavior - fear, anger, aggression, plaesure, disgust
- motivation - hunger, thirst, sexual and reproductive behavior
- cortical structures (preservation of life and genus)
- Nuclei within cerebrum- amygdala
- Nuclei of diencephala and brain stem – nuclei of thalamus and hypothalamus
- Connections of limbic system

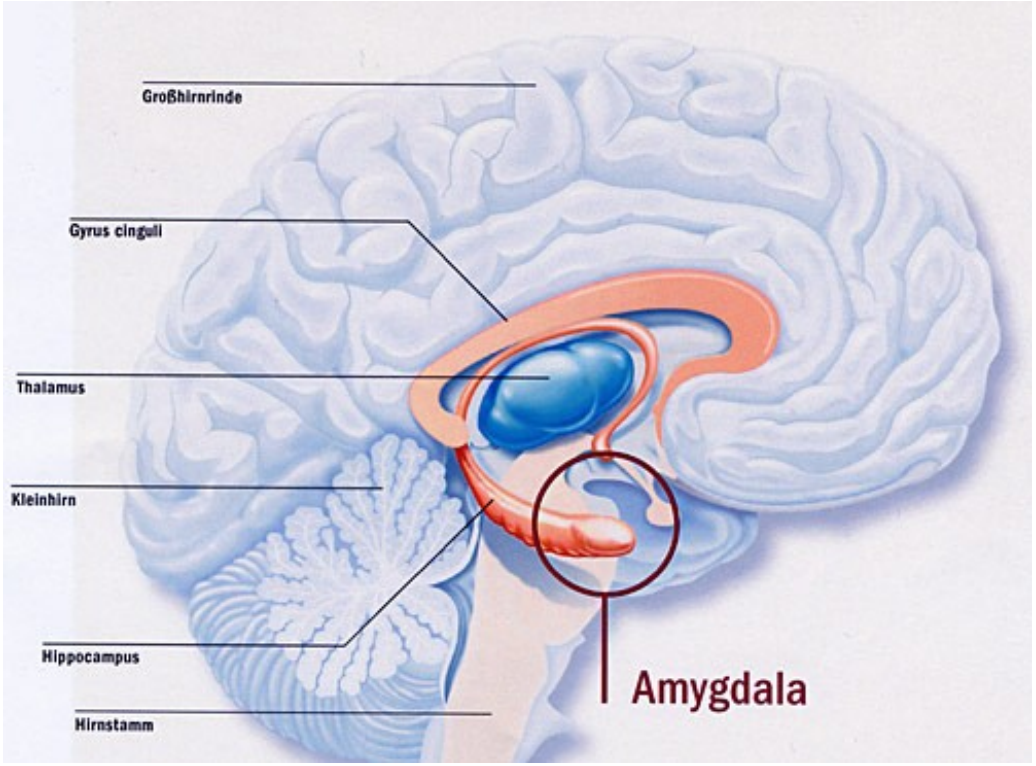


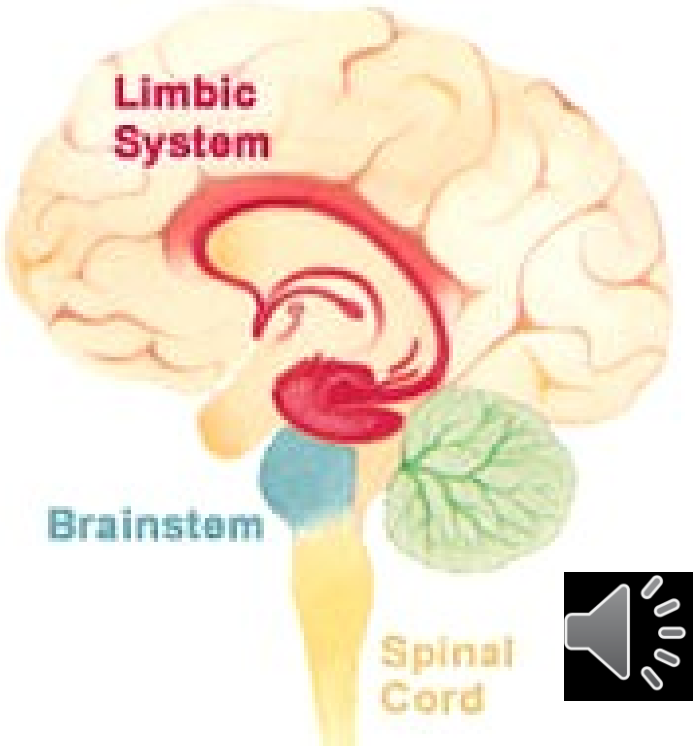

Frontal lobe
Thalamus
Hippocampus
Amygdala
Hypothalamus
Olfactory bulb


THALAMUS
CORPUS CALLOSUM
BASAL GANGLIA
HIPPOCAMPUS
AMYGDALA
OLFACTORY BULB
CEREBELLUM
BRAIN STEM

Amygdala

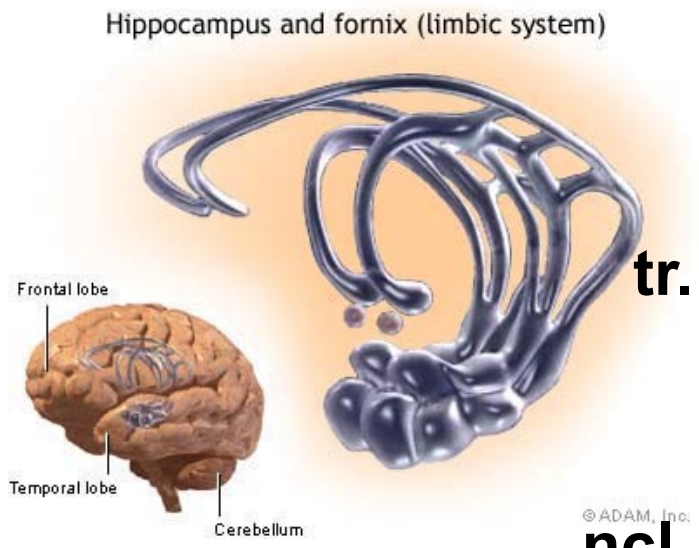
- The largest complex of grey matter, temporal lobe
- Aferent information – from cortex (smell, taste) and from BG, hypotalamus and RF
- Eferent information – hypotalamus, BG, thalamus, brain stem
- Integration of sensory information – it is able to affect somato- and visceromotor systems
- damage- calming- disorders of emotional experiences
- irritation- increased attention, fear, anxiety, aggression

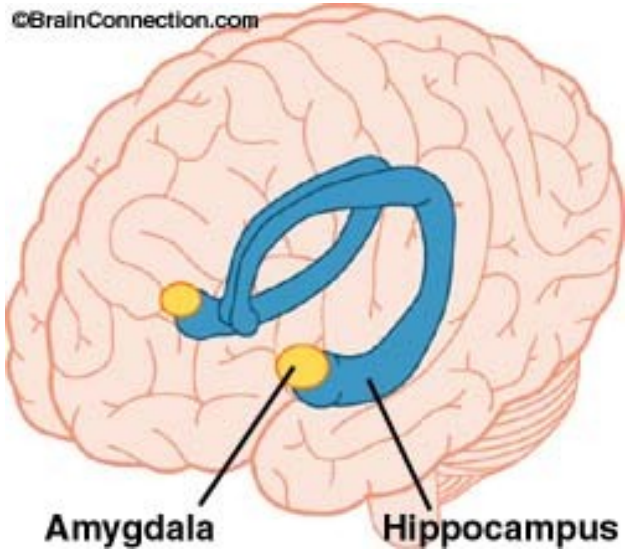




Hippocampus

- **damage -** loss of ability to learn and to remember





Papez circuit (James Papez 1939)

ncl. anterior thalami

tr. mammilo-thalamicus

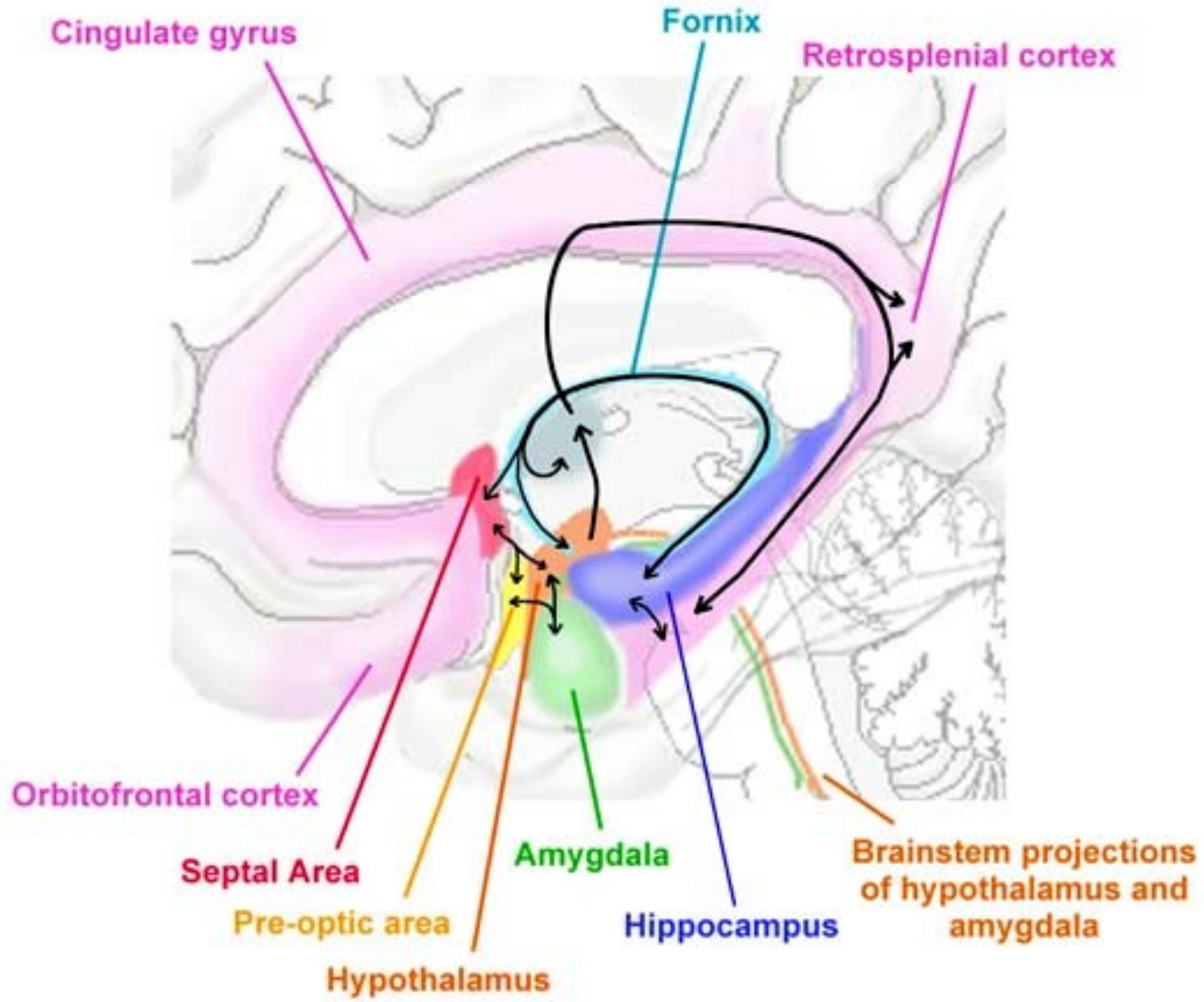
ncl. mamillaris

gyrus cinguli

fornix

gyrus parahippocampalis
hippocampus

- it has not specific fu n



"Limbic" areas

2. THE WHITE MATTER OF THE CEREBRUM

- **The white matter of the cerebrum is called *corpus medullare,* it is formed by numerous nerve fibers (tracts), which connect various places in hemispheres or lead from hemispheres into other parts of nervous system**

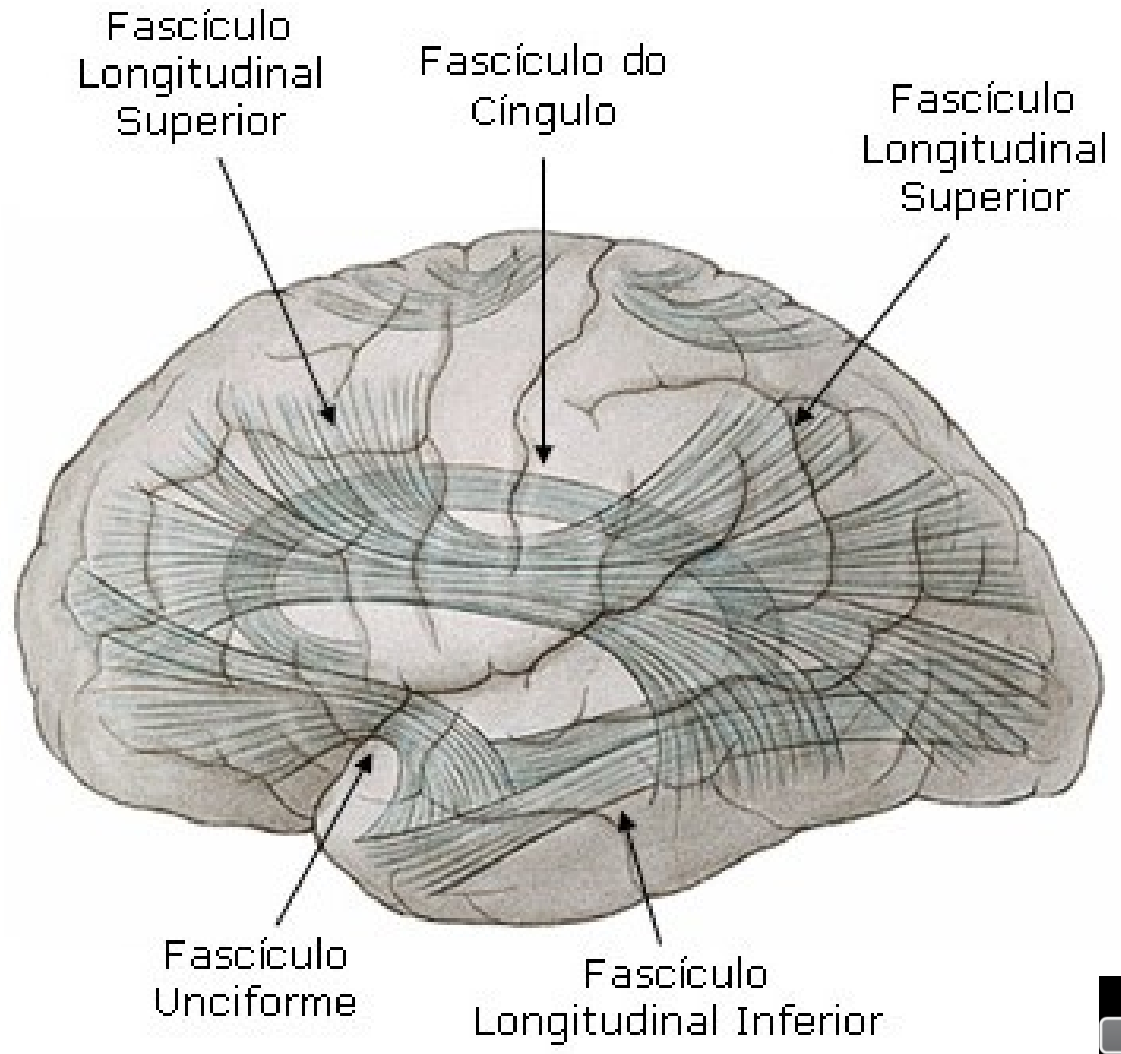
association tracts: tracts, which connect two different places in the same hemisphere, e.g. *fasciculus arcuatus* – tract connecting Broca´s and Wernicke´s centre of speech

comissural tracts: tracts connecting two places in opposite hemispheres, they provide coordinated action of both hemispheres, the largest comissure is ***corpus callosum***

projection tracts: tracts connecting cerebral cortex with lower levels of CNS (or vice versa), they arise (or enter) from brain stem through crura cerebri into hemispheres and here they fanlike diverge to cortex – this fan-shaped structure is formed by nerve fibers and called - *corona radiata*

Association tracts - connect variable distant cortical areas of hemisphere

- Short fibers
- Long fibers



Comissural tracts

- H
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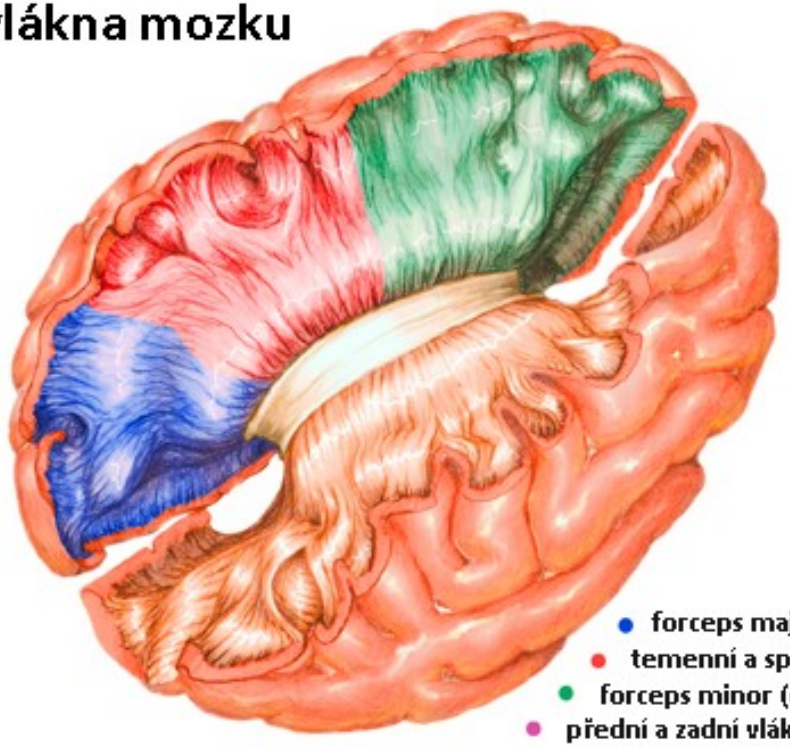
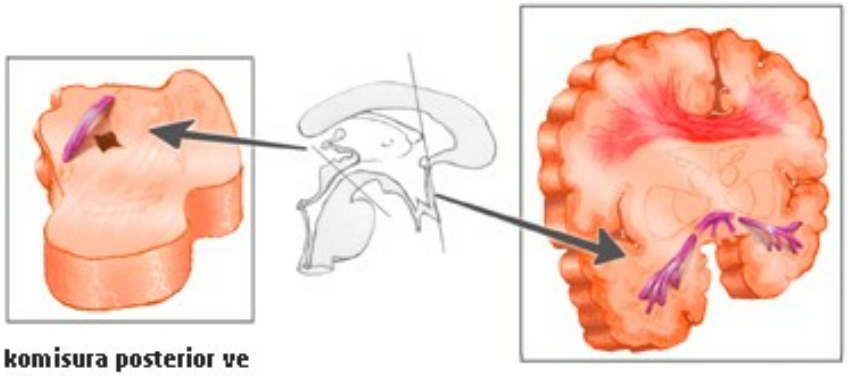
regions of hippocampus

Komisurální vlákna mozku

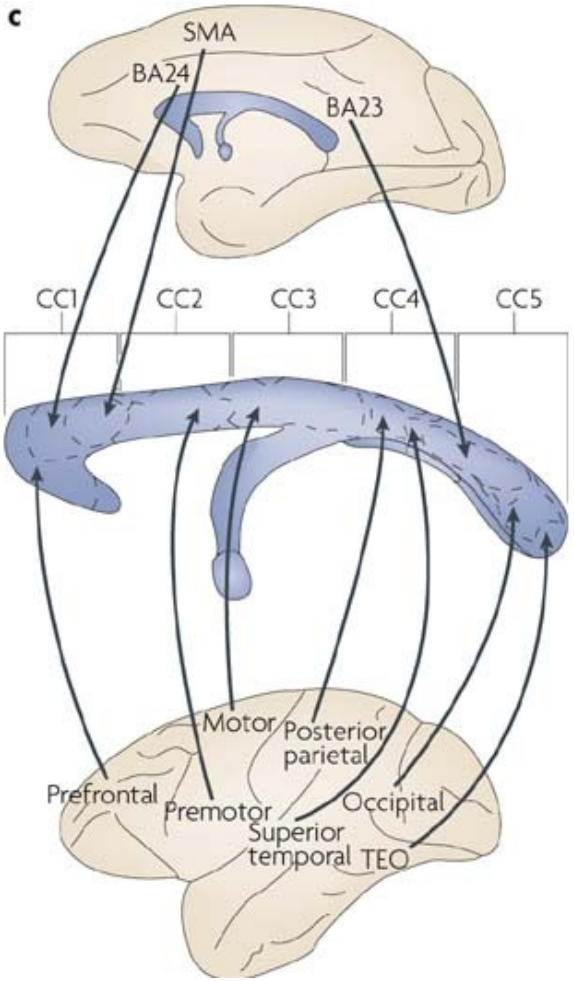


- forceps major (týlní)
- temenní a spánková vlákna
- forceps minor (čelní)
- přední a zadní vlákna



komisura posterior ve středním mozku

komisura anterior spojující spánkové laloky a bulbus olfactorius

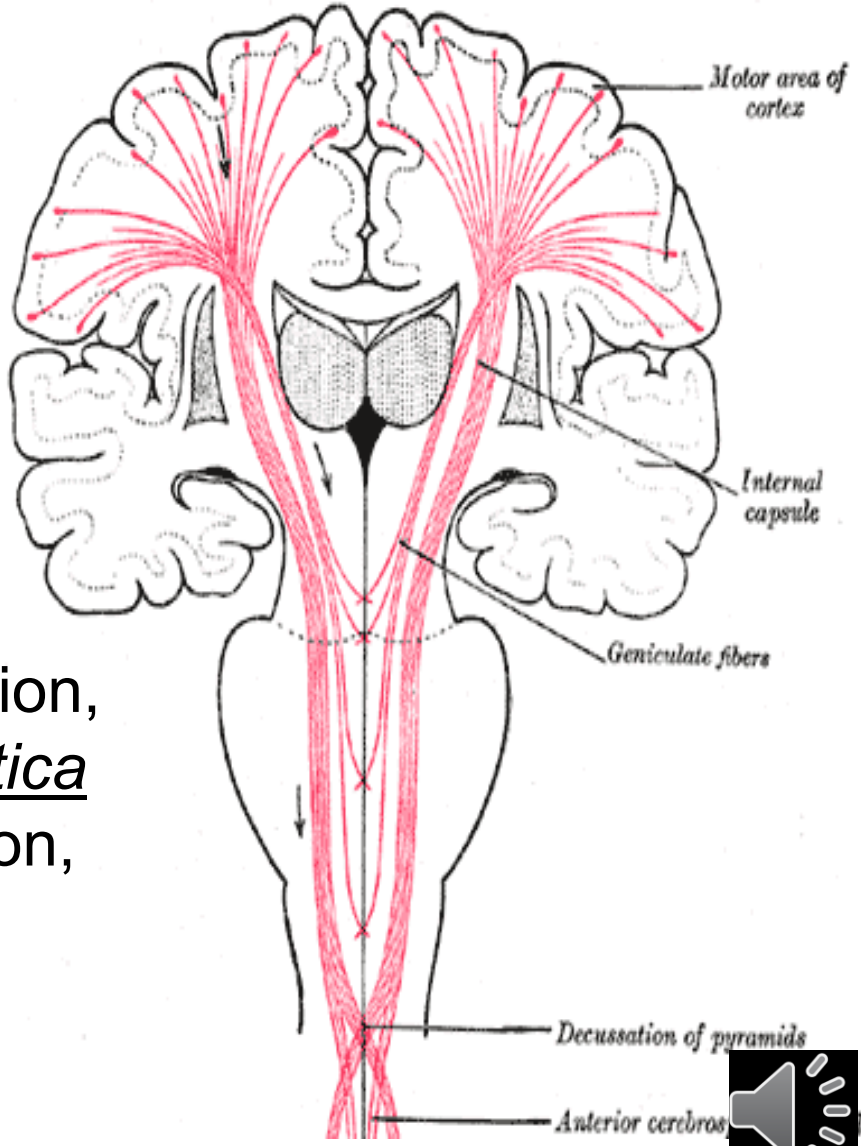


Projection tracts – bundles of axons, form connection between cerebral cortex and lower located structures

Short projection tracts

Long projection tractss

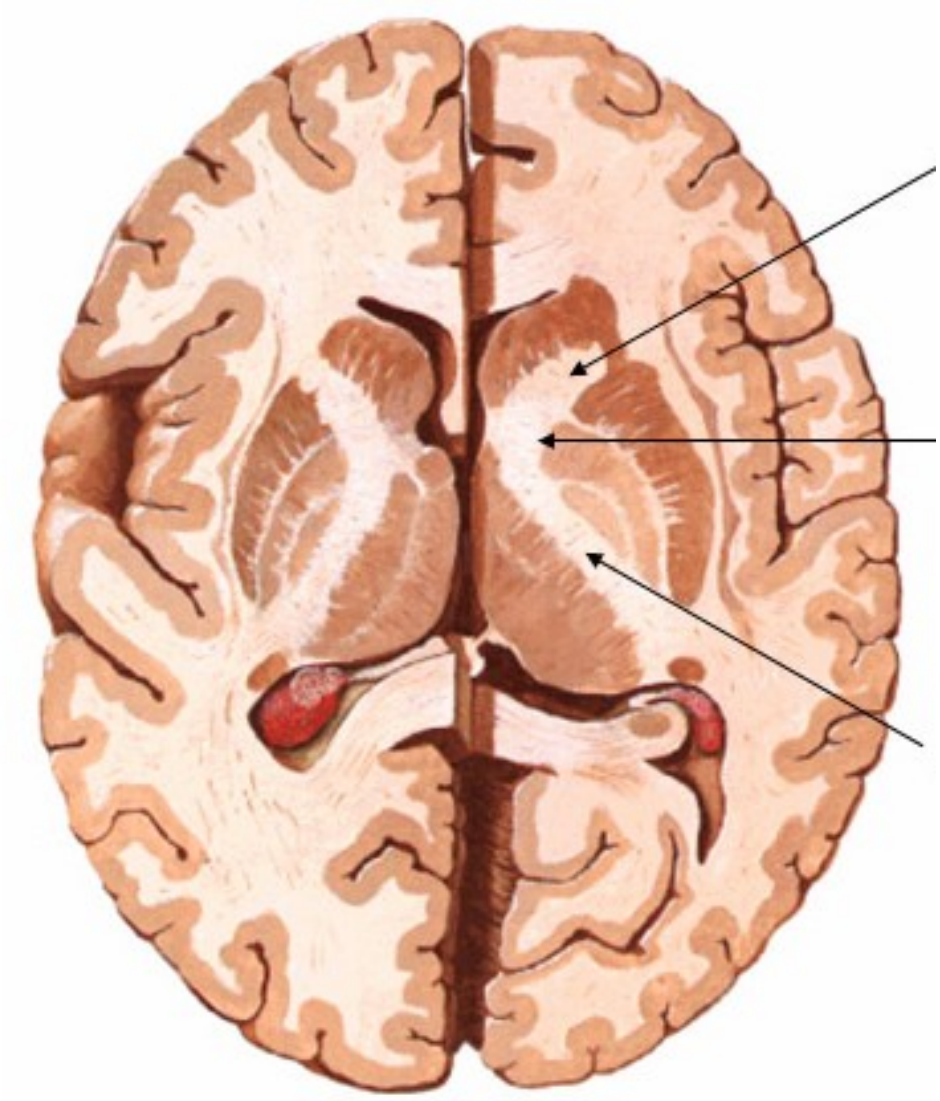
capsula interna

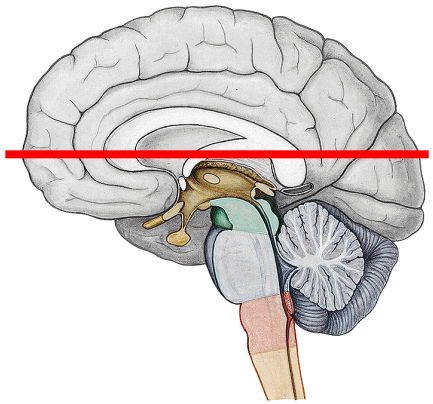


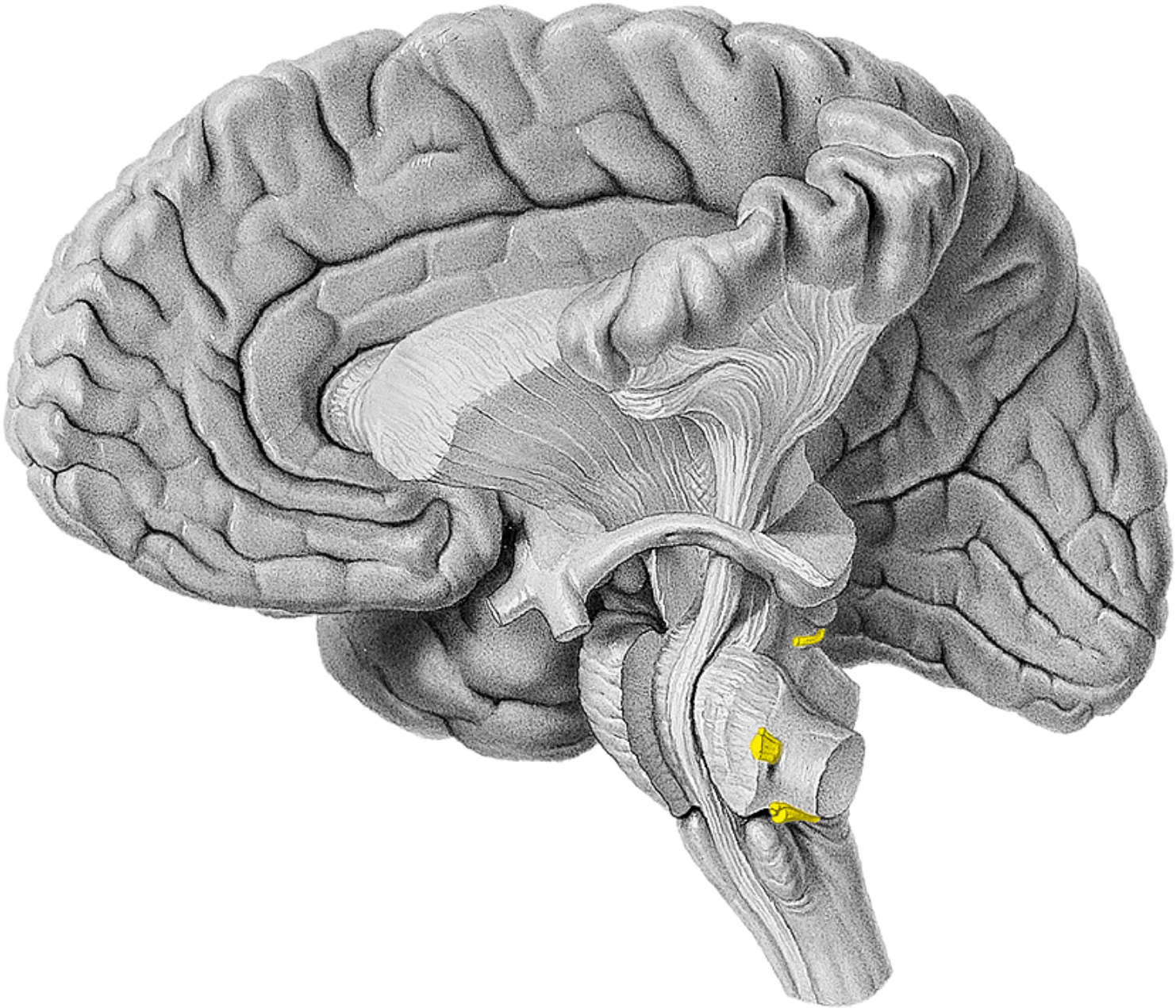
Ascending - lead sensory information, cross - *radiatio talami, optica, acustica*

Descending - lead motor information, cross - *tractus corticospinalis*

Capsula interna







CAPSULA INTERNA

- accumulation of neural tracts between thalamus and BG

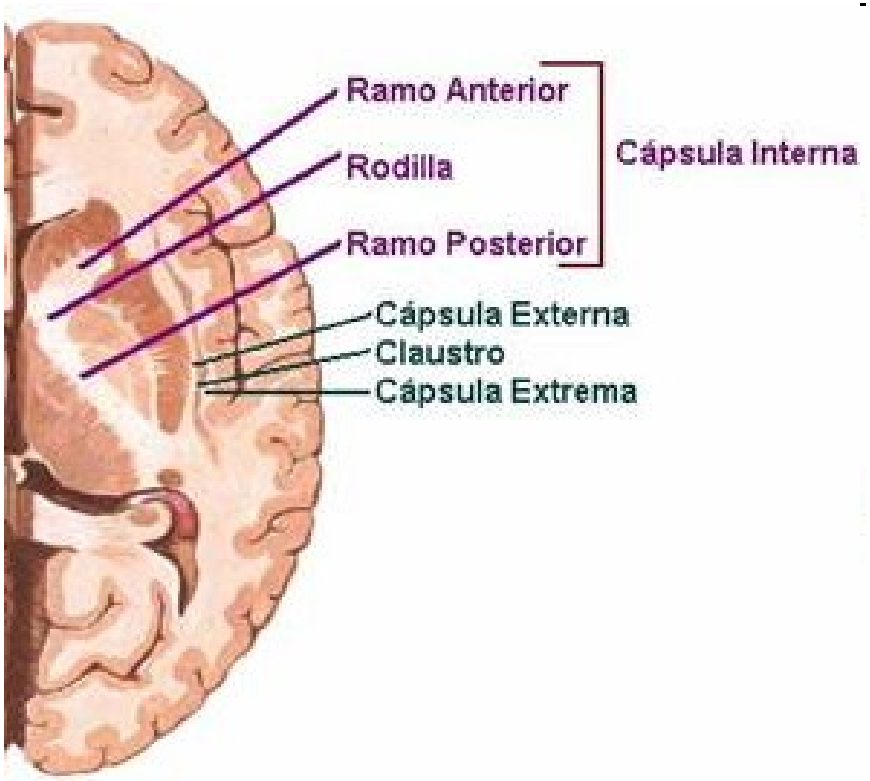
crus anterius – fibers of anterior tr. thalamocorticalis and tr. frontopontinus

genu - tr. corticonuclearis (for muscles of head and neck)

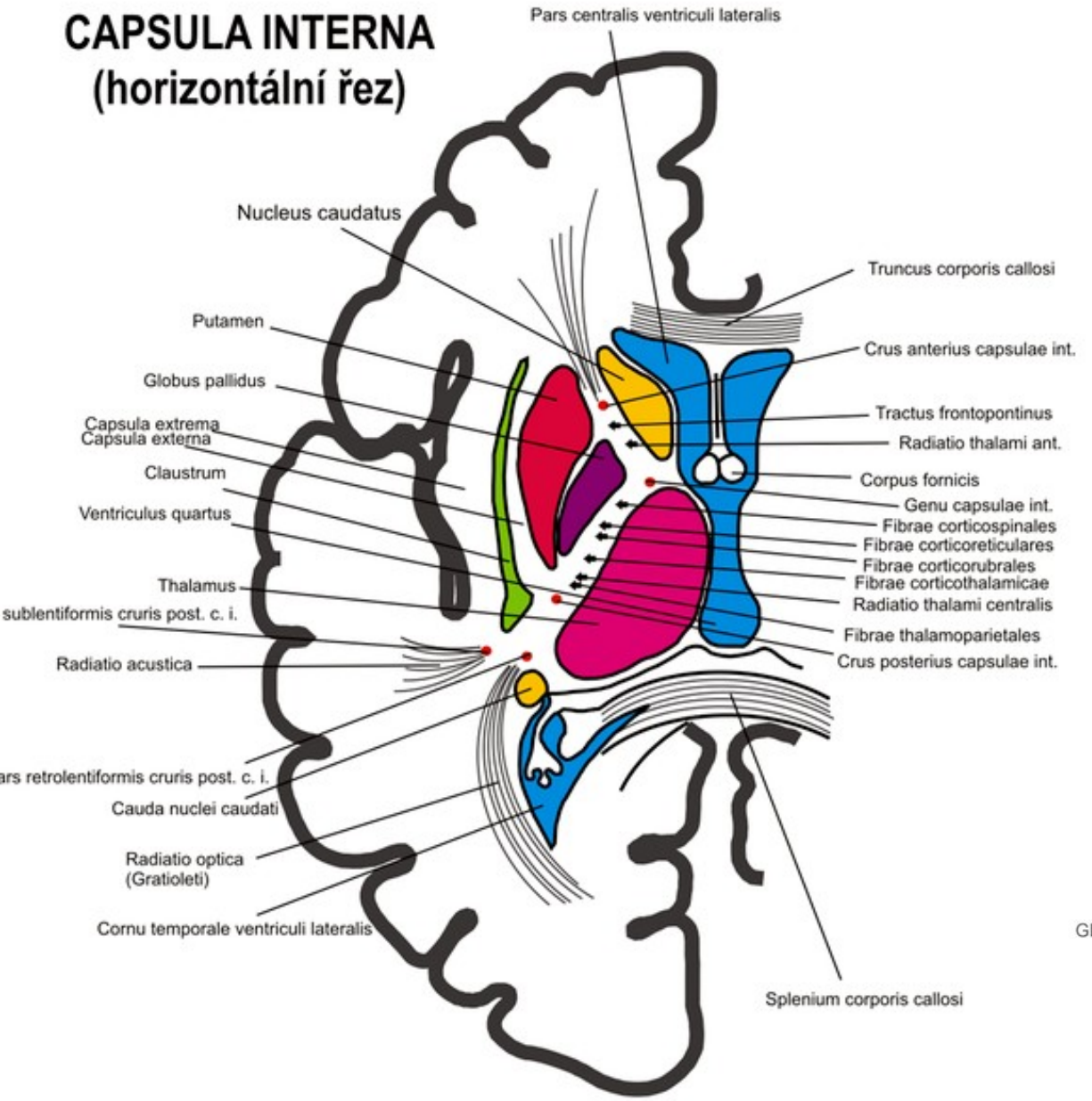
crus posterius - tr. corticospinalis (topographically) tr. corticoreticularis, tr. corticorubralis tr.talamocorticalis, tr. parieto- , temporo-occipitopontinus

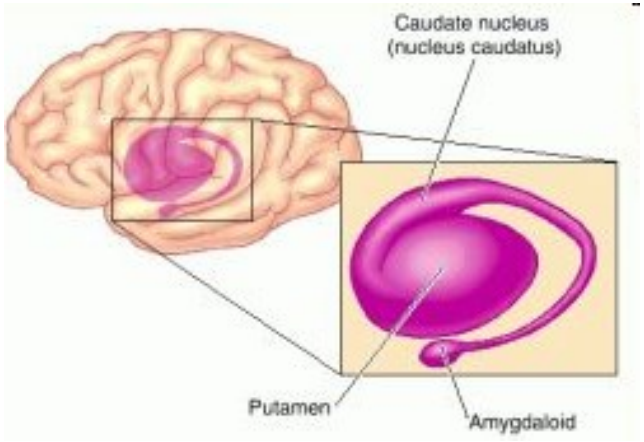
radiatio optica – end of visual pathway

radiatio acustica – end of auditory pathway

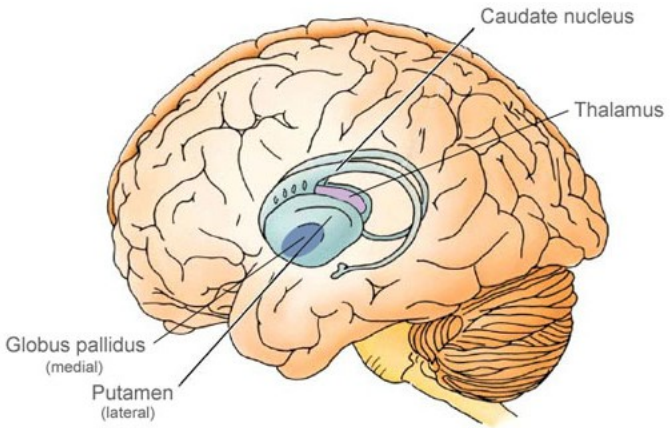


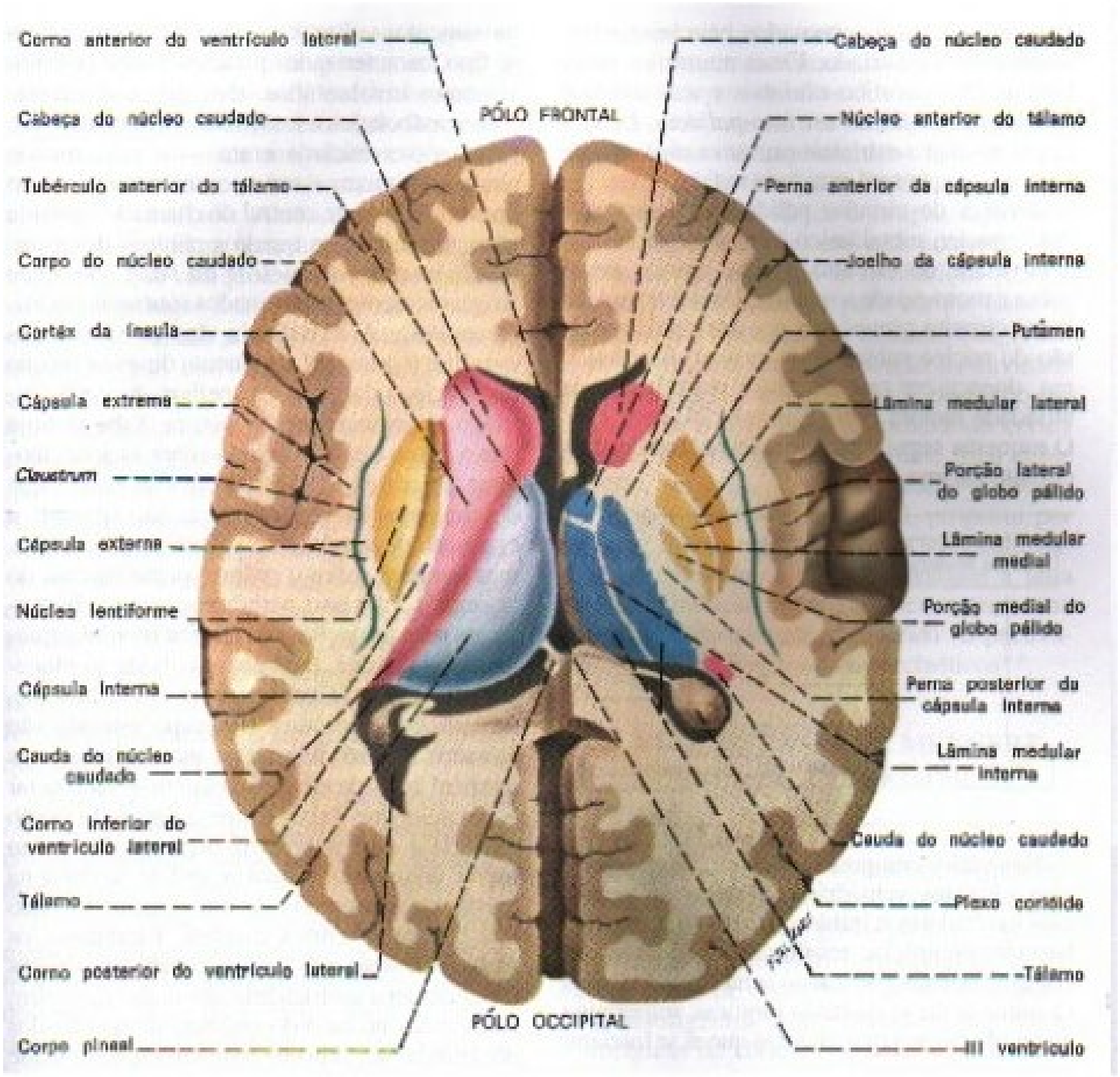
CAPSULA INTERNA
(horizontální řez)





Basal Ganglia

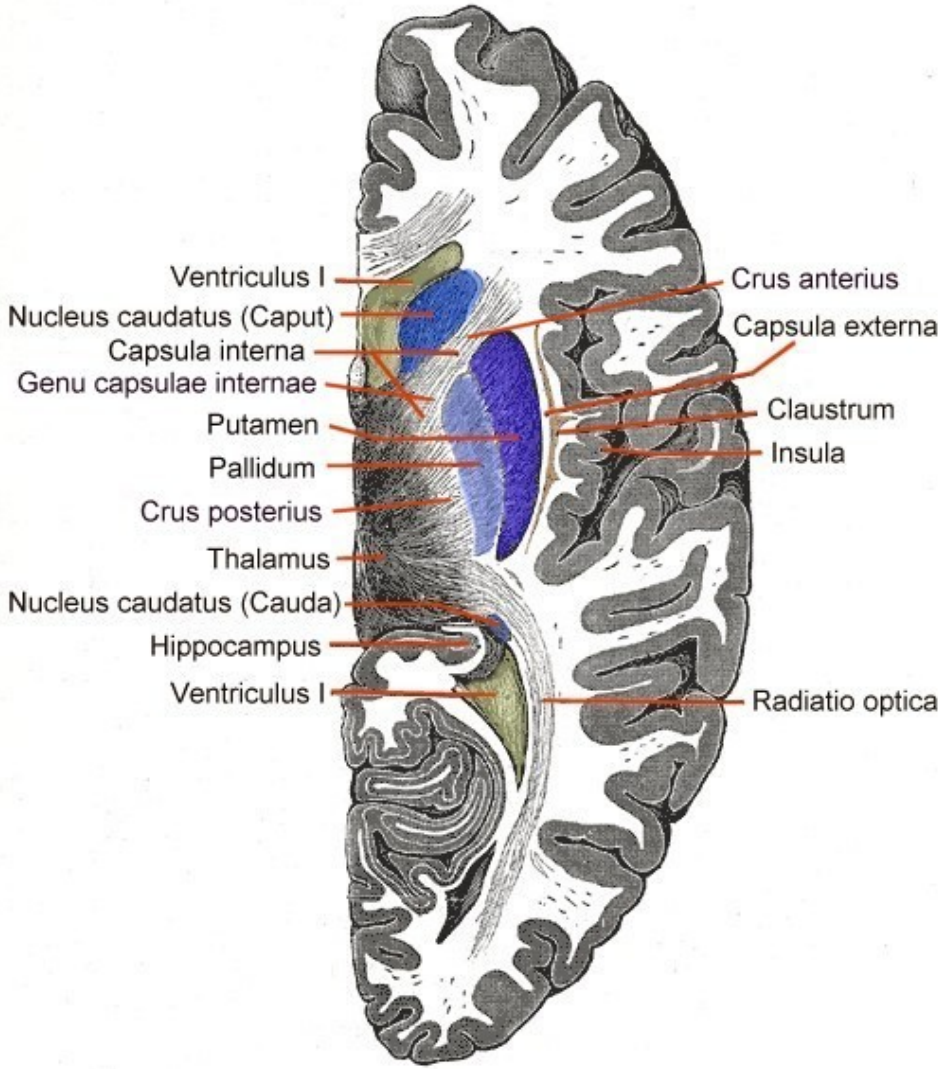


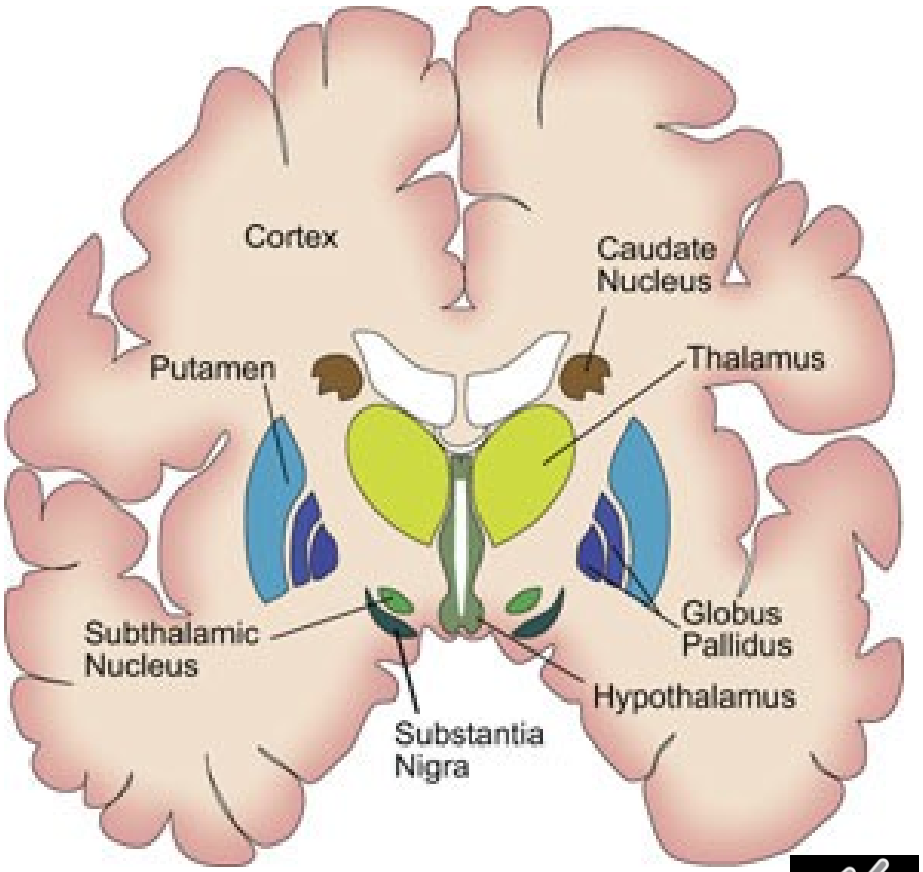

Corno anterior do ventrículo lateral
Cabeça do núcleo caudado
Tubérculo anterior do tálamo
Corpo do núcleo caudado
Córtex da ínsula
Cápsula extrema
Claustrum
Cápsula externa
Núcleo lentiforme
Cápsula interna
Cauda do núcleo caudado
Corno inferior do ventrículo lateral
Tálamo
Corno posterior do ventrículo lateral
Corpo pineal
PÓLO FRONTAL
PÓLO OCCIPITAL
Cabeça do núcleo caudado
Núcleo anterior do tálamo
Perna anterior da cápsula interna
Joelho da cápsula interna
Putâmen
Lâmina medular lateral
Porção lateral do globo pálido
Lâmina medular medial
Porção medial do globo pálido
Perna posterior da cápsula interna
Lâmina medular interna
Cauda do núcleo caudado
Plexo coróide
Tálamo
III ventrículo

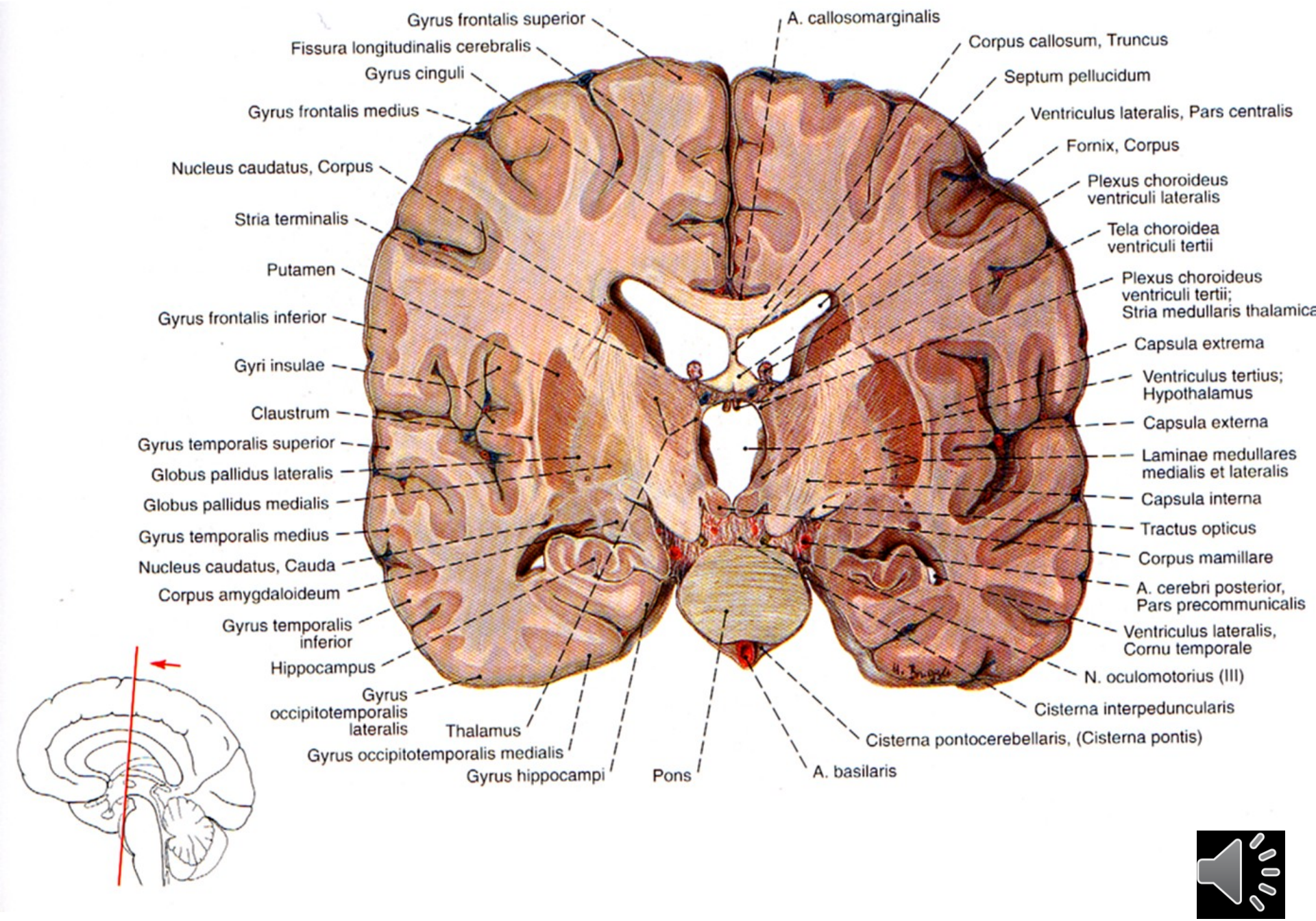
3. BASAL GANGLIA

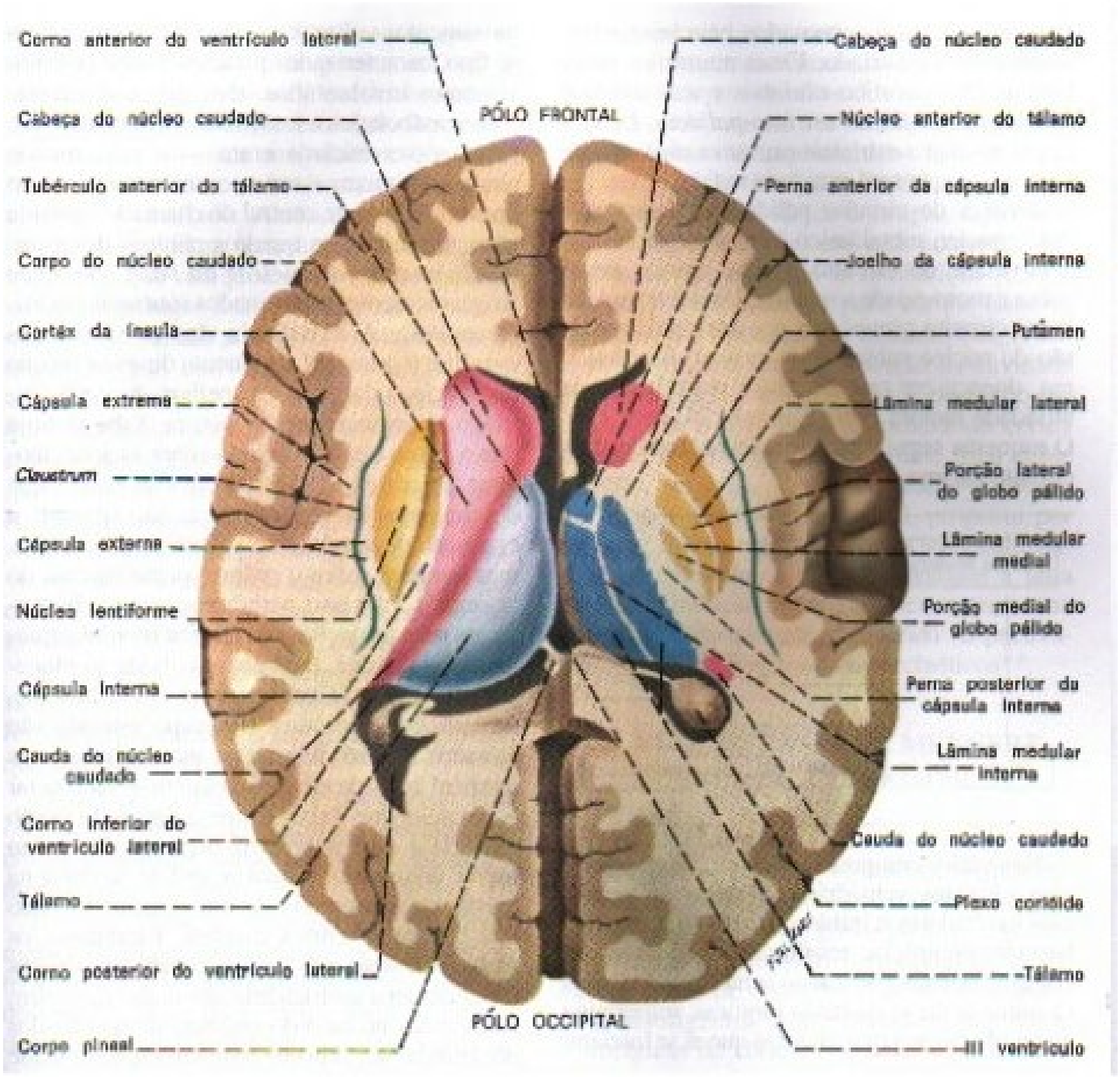
- It goes about large nuclei of grey matter, which are located laterally to thalamus, they are embedded into depth of white matter
- basal ganglia are functionally **involved into motor neuronal circuits** (like motor cerebral cortex, large nuclei of grey matter of mesencephalon and cerebellum) – basal ganglia are interconnected with all these parts
- They participate especially in forming of programs for intended movements, **coordination betwen reflecting and intentional activity**
- They are not able to generate input information for movement
- **They are crucial for integration of motor functions**
- **They form together with cerebellum connection between sensory and motor system**
- **emotion, cognitive functions**

- **Corpus striatum**= nucleus caudatus + putamen
- **Nucleus lentiformis**= globus pallidus (pallidum) + putamen
- **Claustrum**
- **Nucleus amygdalae** (almond), which is functionally involved in limbic system






Gyrus frontalis superior
Fissura longitudinalis cerebralis
Gyrus cinguli
Gyrus frontalis medius
Nucleus caudatus, Corpus
Stria terminalis
Putamen
Gyrus frontalis inferior
Gyri insulae
Claustrum
Gyrus temporalis superior
Globus pallidus lateralis
Globus pallidus medialis
Gyrus temporalis medius
Nucleus caudatus, Cauda
Corpus amygdaloideum
Gyrus temporalis inferior
Hippocampus
Gyrus occipitotemporalis lateralis
Thalamus
Gyrus occipitotemporalis medialis
Gyrus hippocampi
Pons
A. basilaris
Cisterna pontocerebellaris, (Cisterna pontis)
Cisterna interpeduncularis
N. oculomotorius (III)
Ventriculus lateralis, Cornu temporale
A. cerebri posterior, Pars precommunicalis
Corpus mamillare
Tractus opticus
Capsula interna
Laminae medullares medialis et lateralis
Capsula externa
Ventriculus tertius; Hypothalamus
Capsula extrema
Plexus choroideus ventriculi tertii; Stria medullaris thalamica
Tela choroidea ventriculi tertii
Plexus choroideus ventriculi lateralis
Fornix, Corpus
Ventriculus lateralis, Pars centralis
Septum pellucidum
Corpus callosum, Truncus
A. callosomarginalis


Corno anterior do ventrículo lateral
Cabeça do núcleo caudado
Tubérculo anterior do tálamo
Corpo do núcleo caudado
Córtex da ínsula
Cápsula extrema
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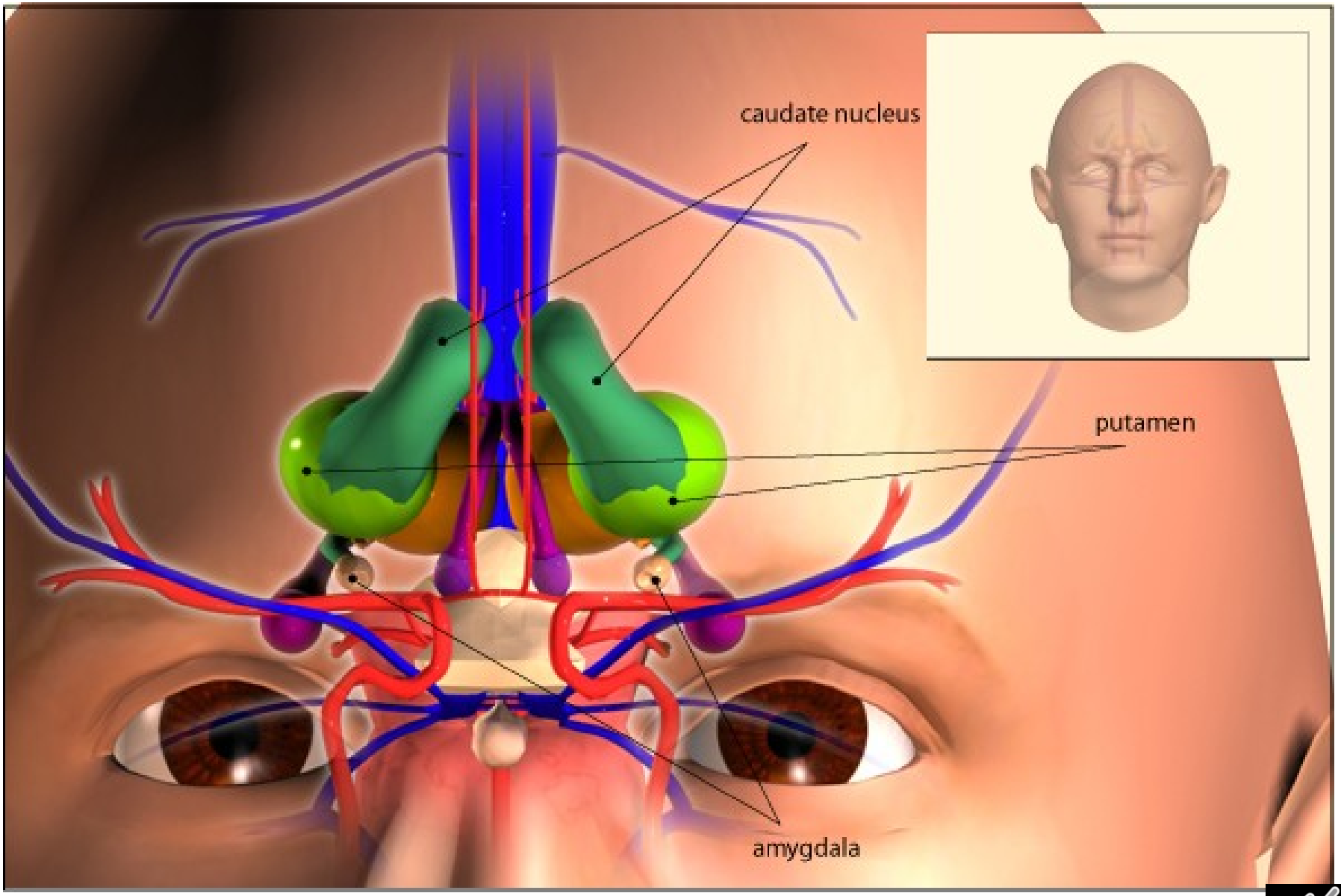
Lâmina medular medial
Porção medial do globo pálido
Perna posterior da cápsula interna
Lâmina medular interna
Cauda do núcleo caudado
Plexo coróide
Tálamo
III ventrículo


caudate nucleus
putamen
amygdala

Damage of basal ganglia

- **Chorea**- involuntary movements at rest and at motion as well, disappears in sleep
- **Athetosis**- slow twisting movements of the distal parts of extremities, grimaces, unclear speech
- **Ballism**- involuntary movements of large amplitude- flying movements
- **Parkinsonism**- muscle hypertonia, worsened motion, resting tremor disappearing in sleep, silent speech, small handwriting

Brain ventricles

Ventriculus lateralis

- In hemispheres

Foramen interventriculare

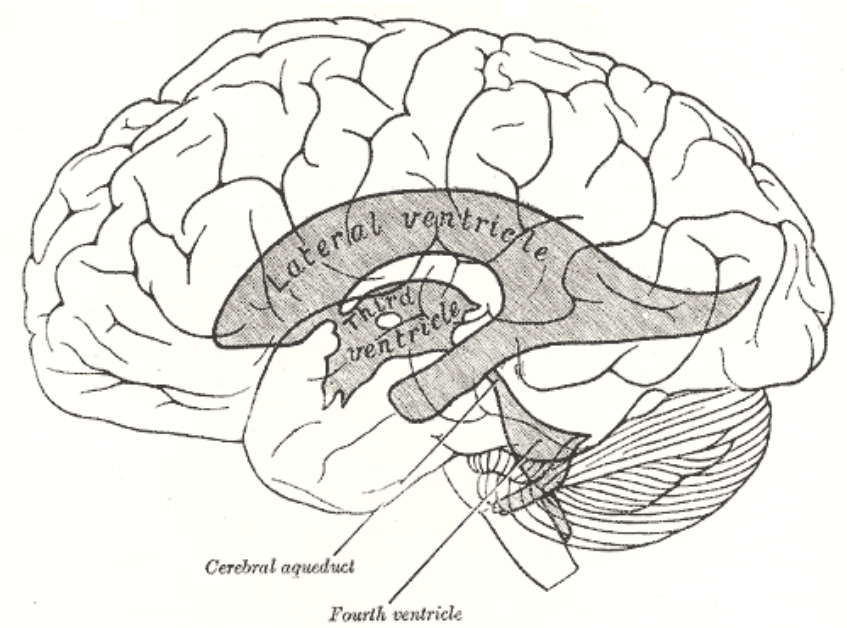
Ventriculus tertius

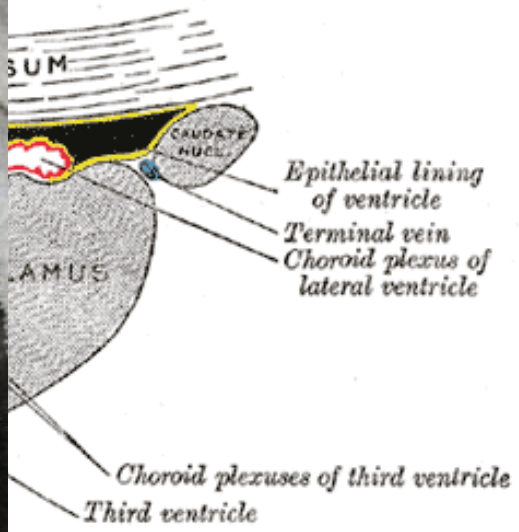
- Between both thalamus

Aqueductus mesencephali

Ventriculus quartus

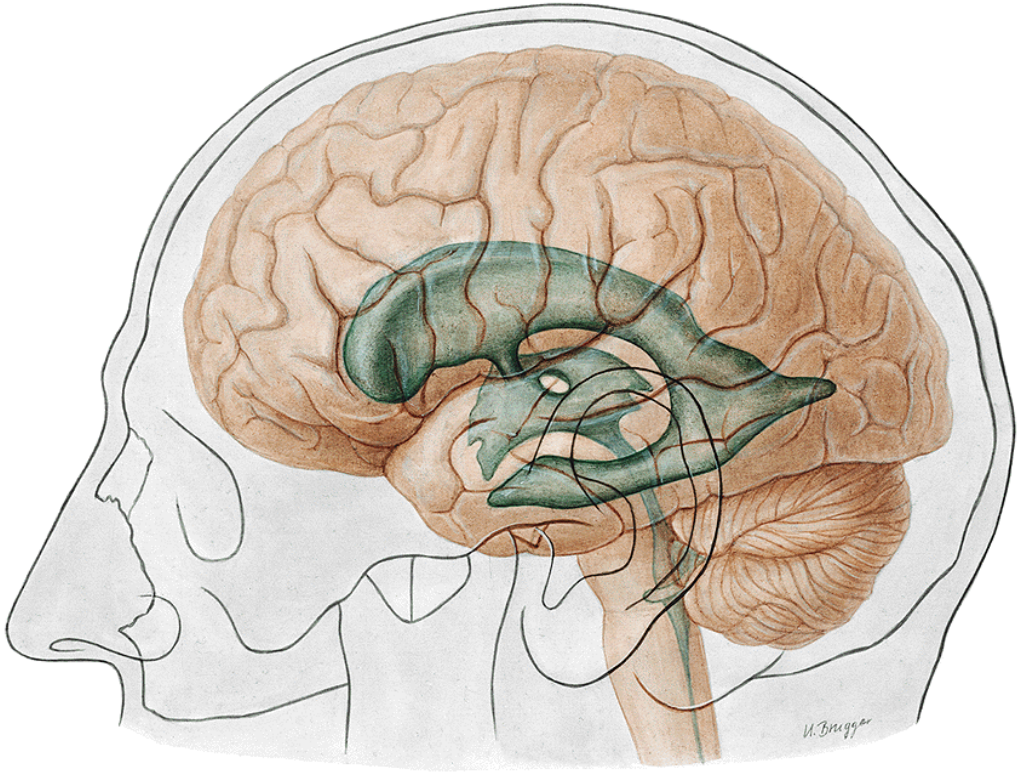
- Between brain stem and cerebellum

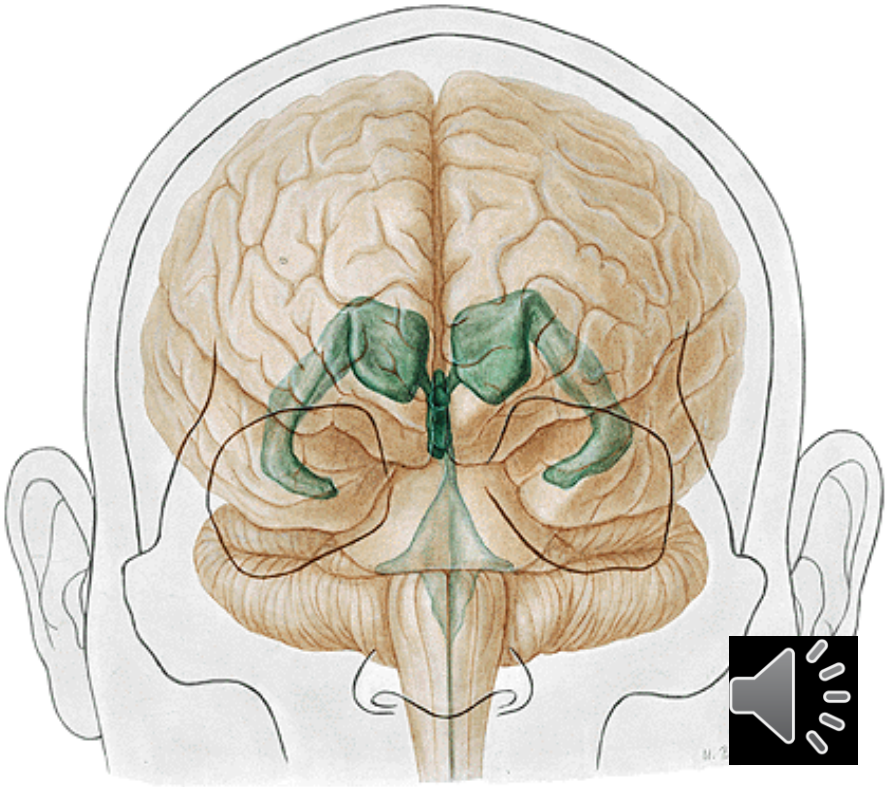




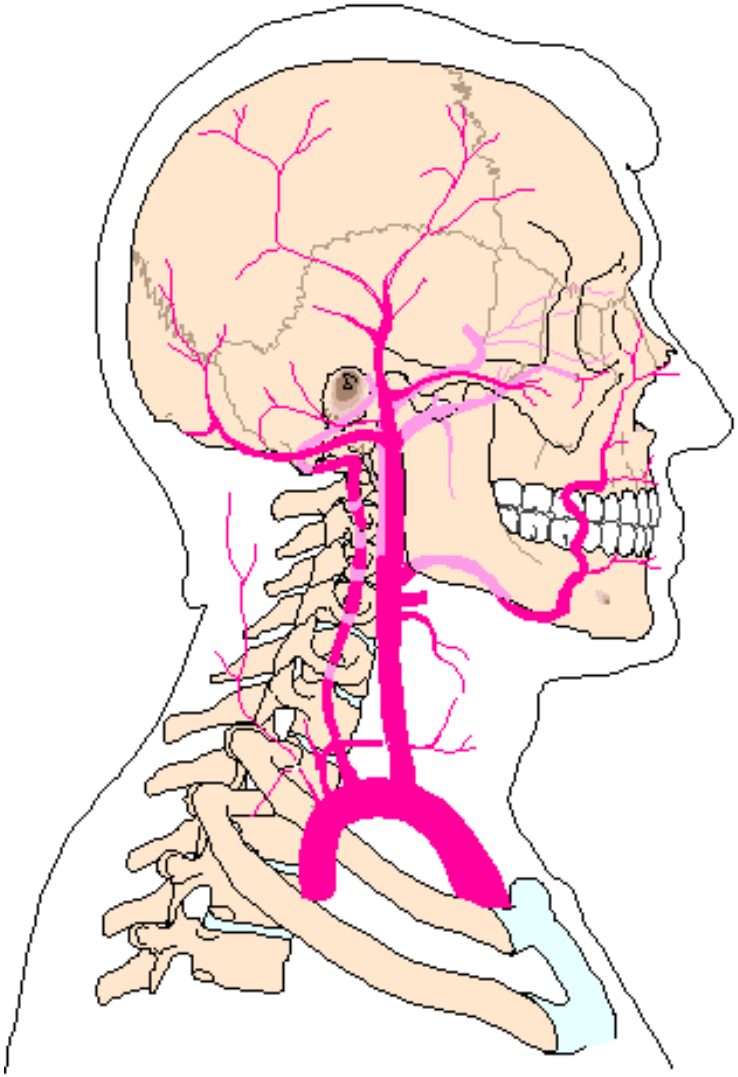
- liquor cere
- apertura m subarachnoid space

Lumbar pu
Hydrocep

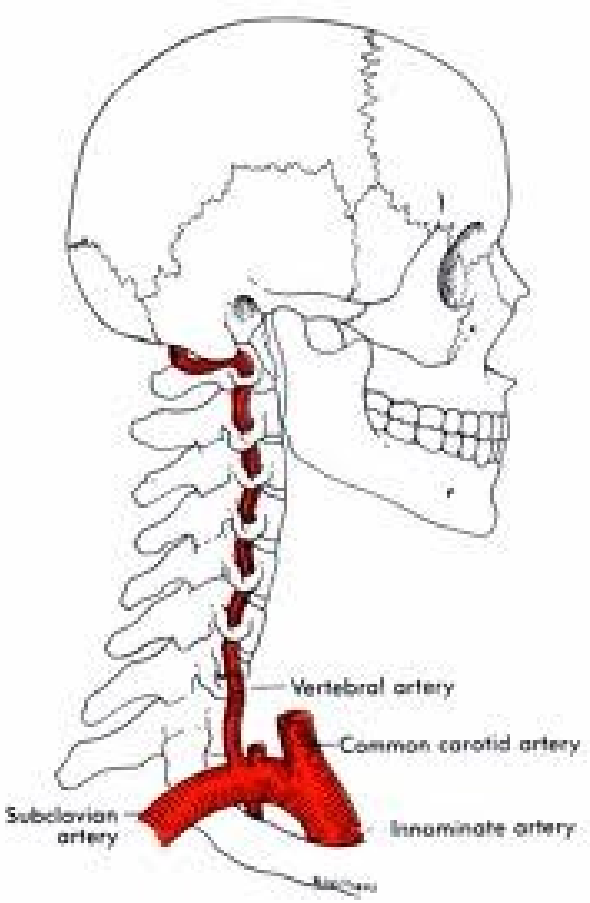

U. Brugger

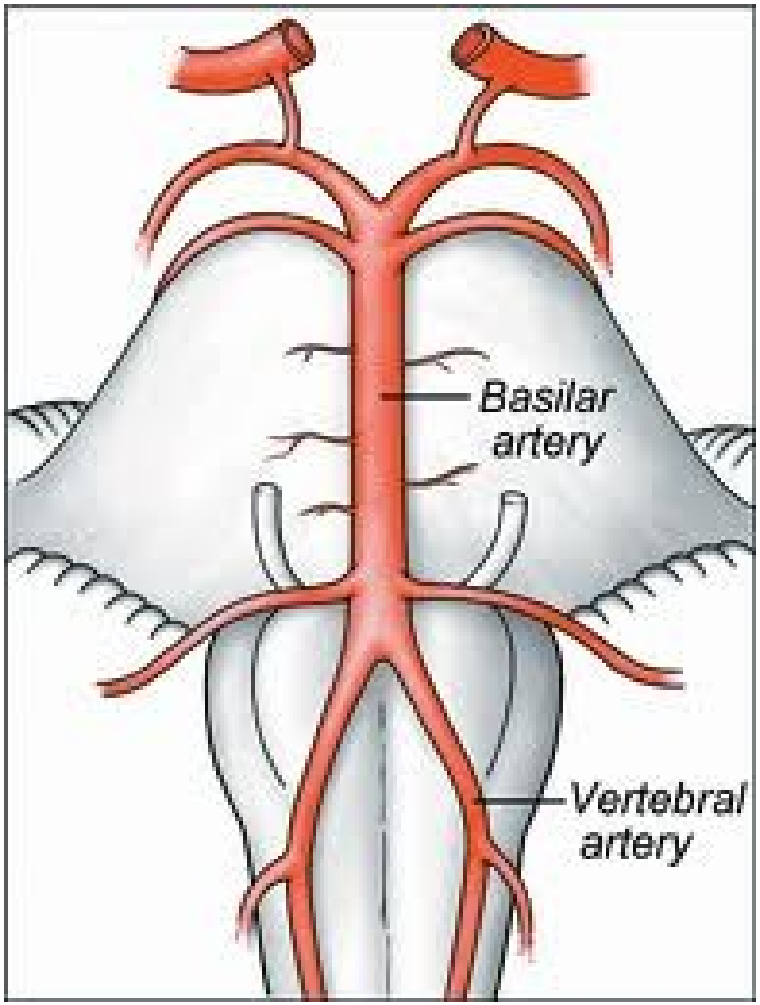


Blood supply of the brain

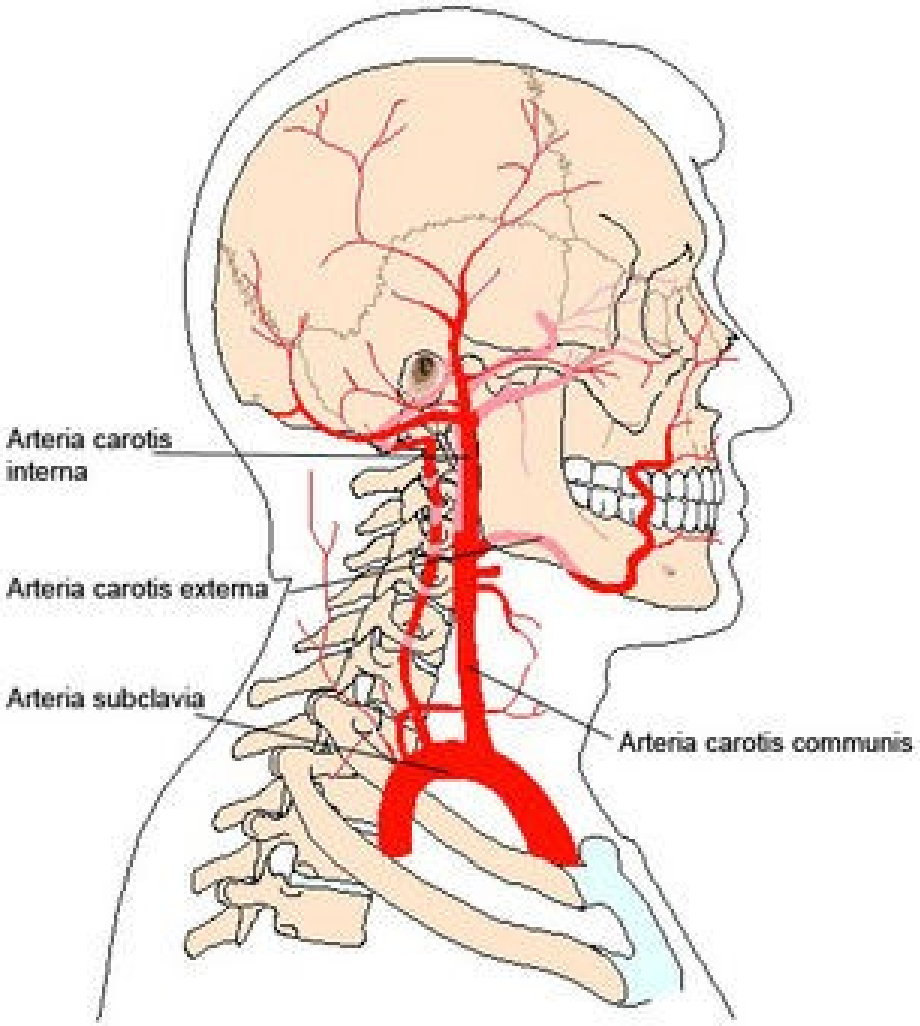


A. vertebralis

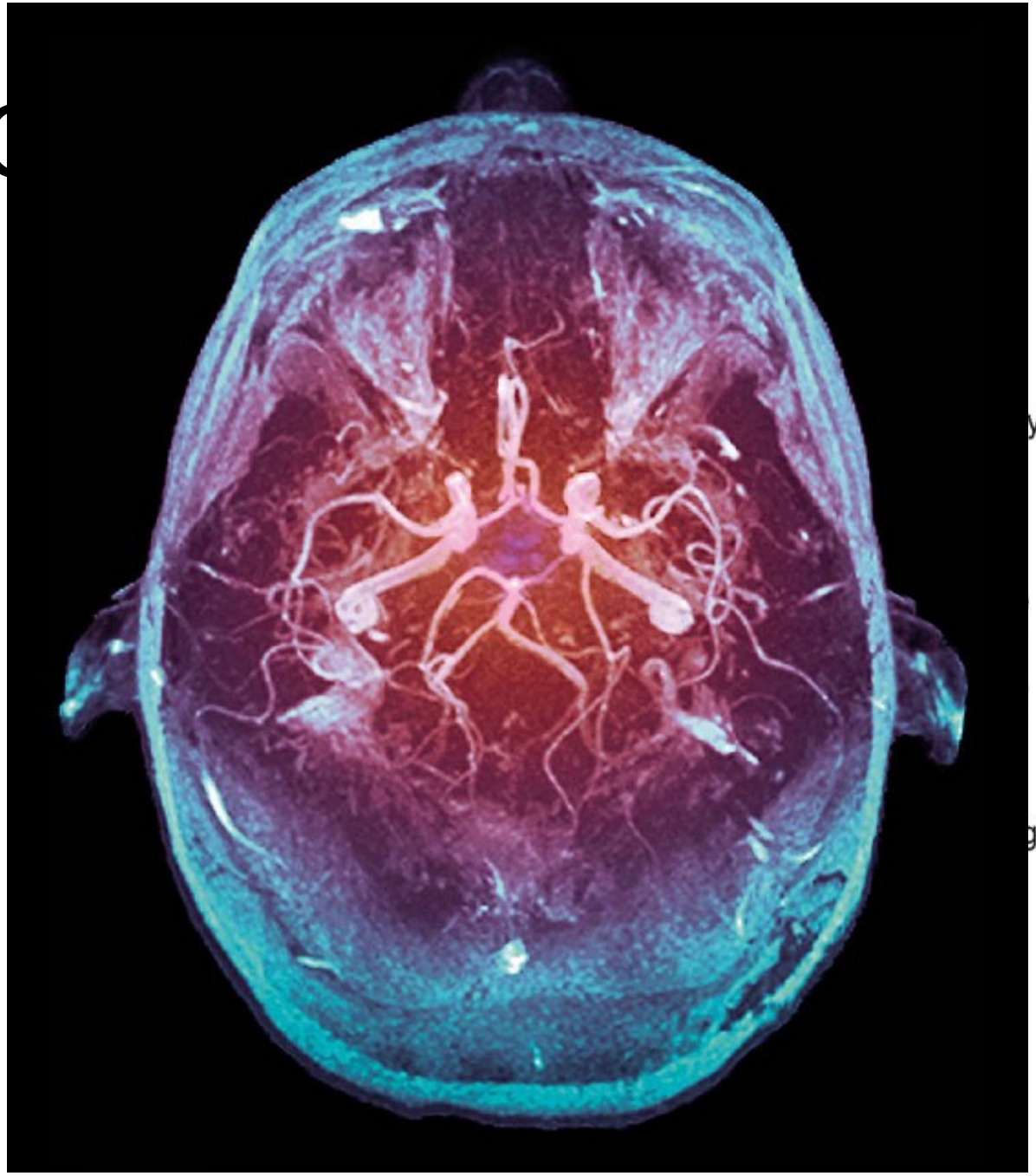


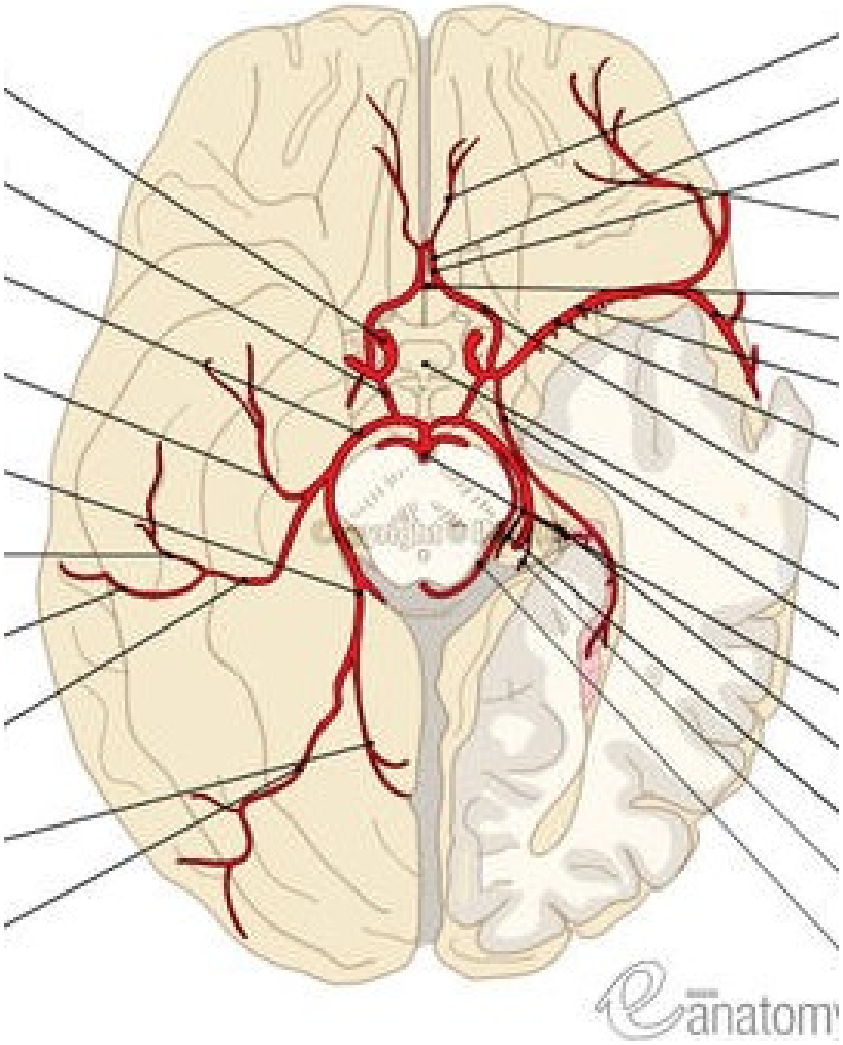


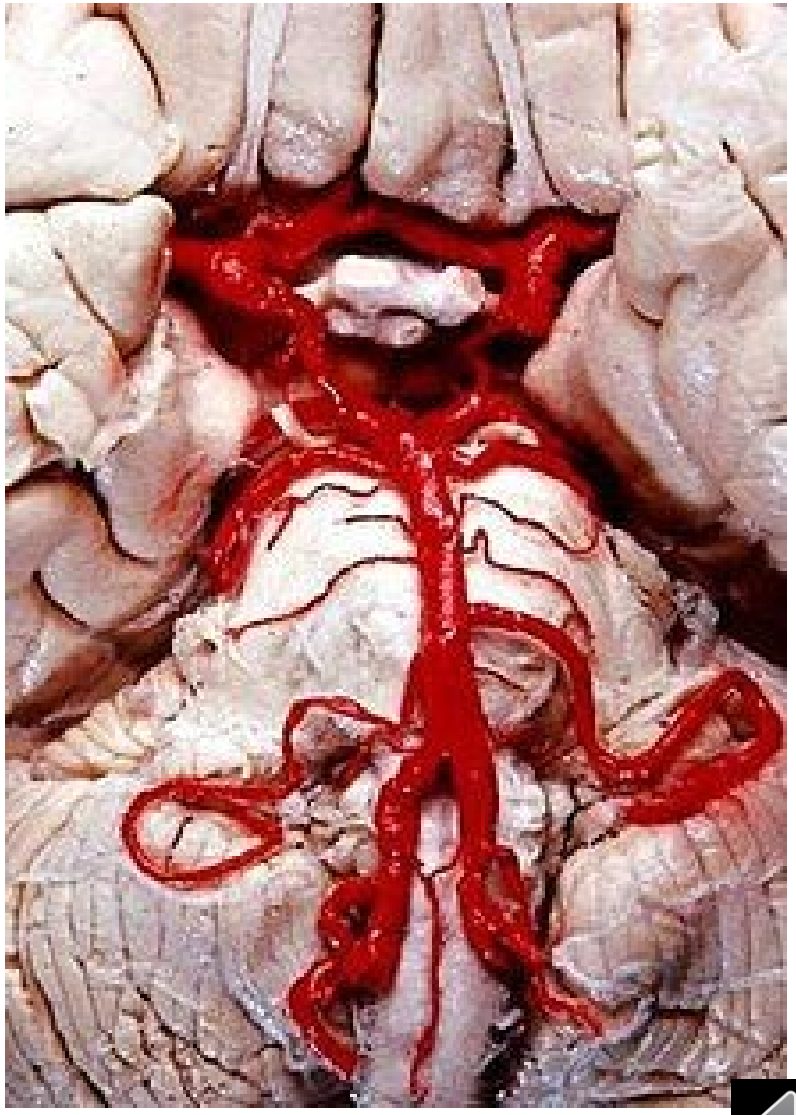
A. carotis interna

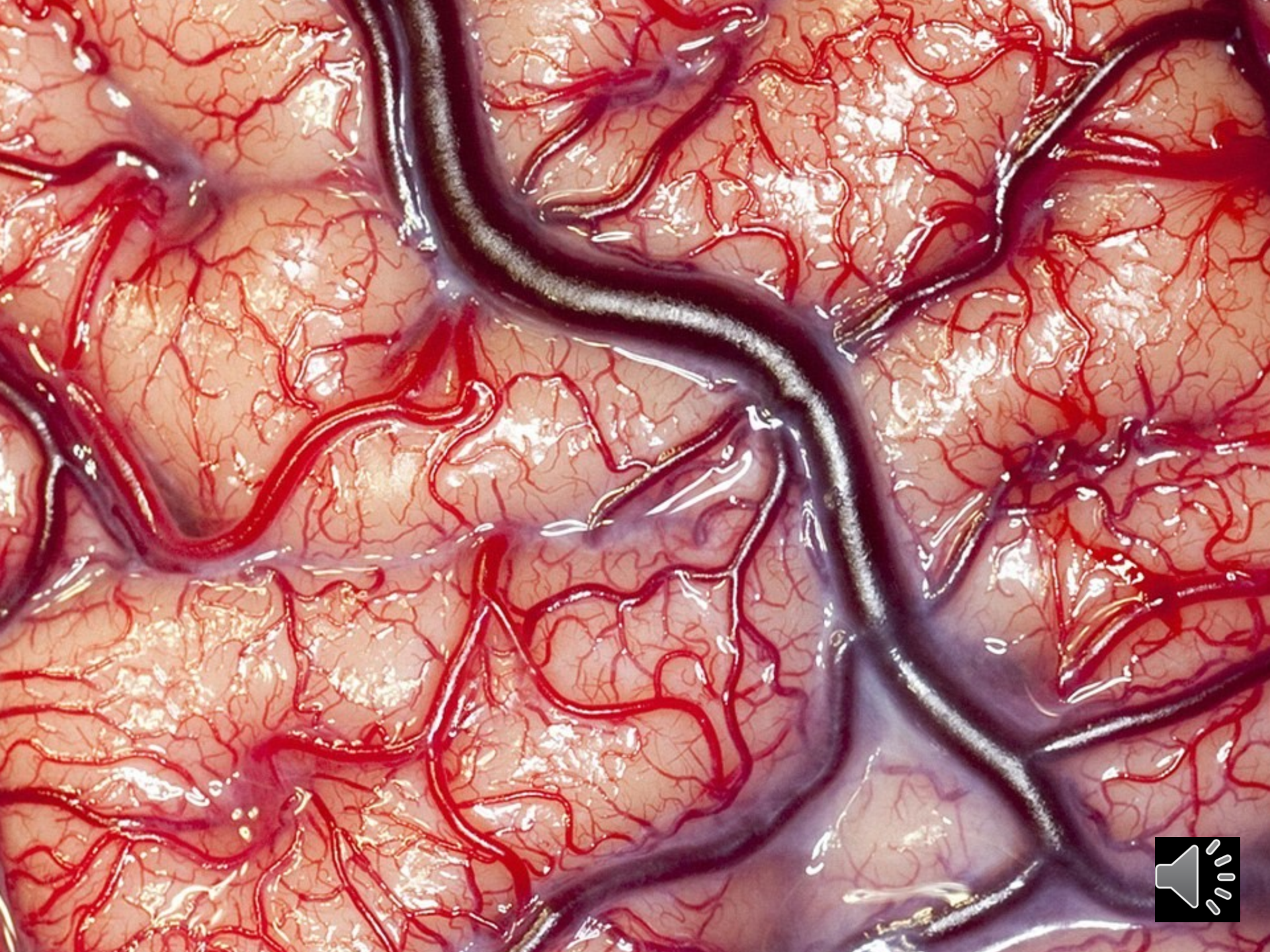


C si

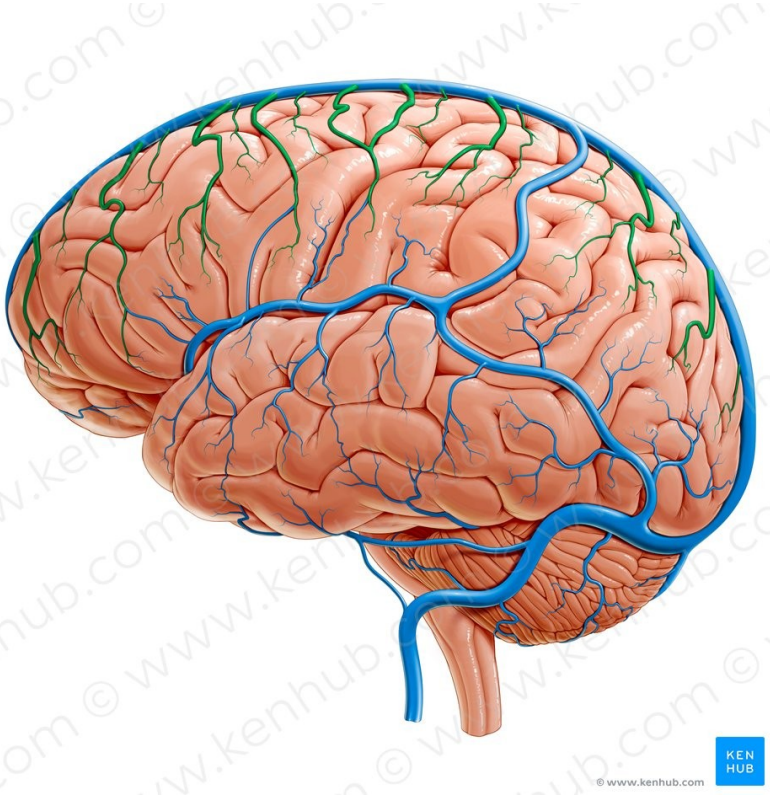


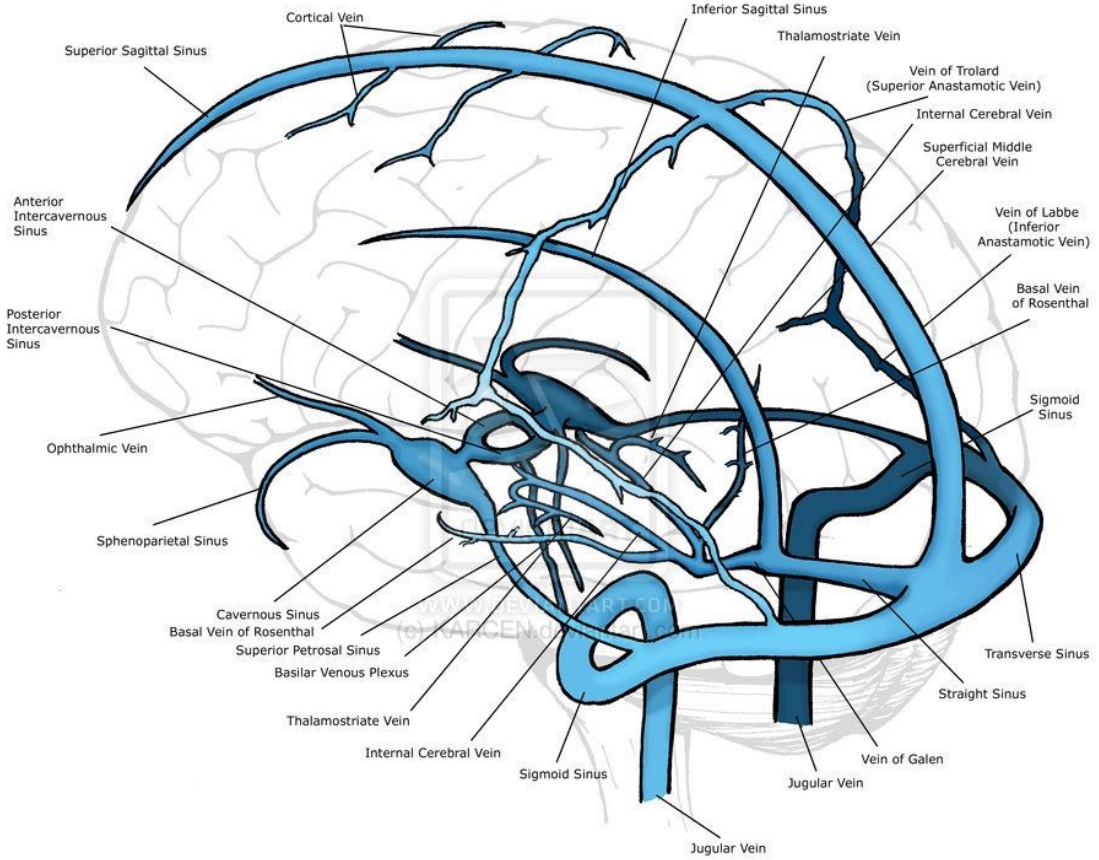

anatom



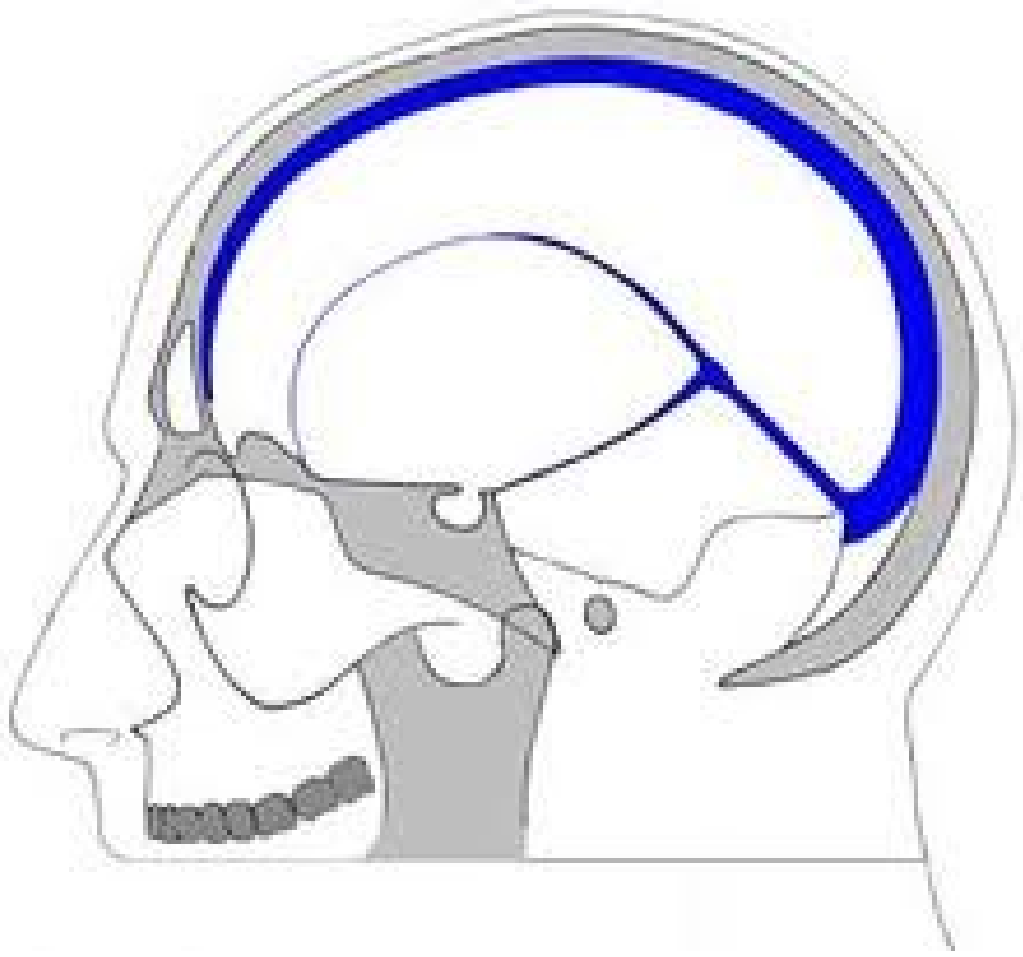


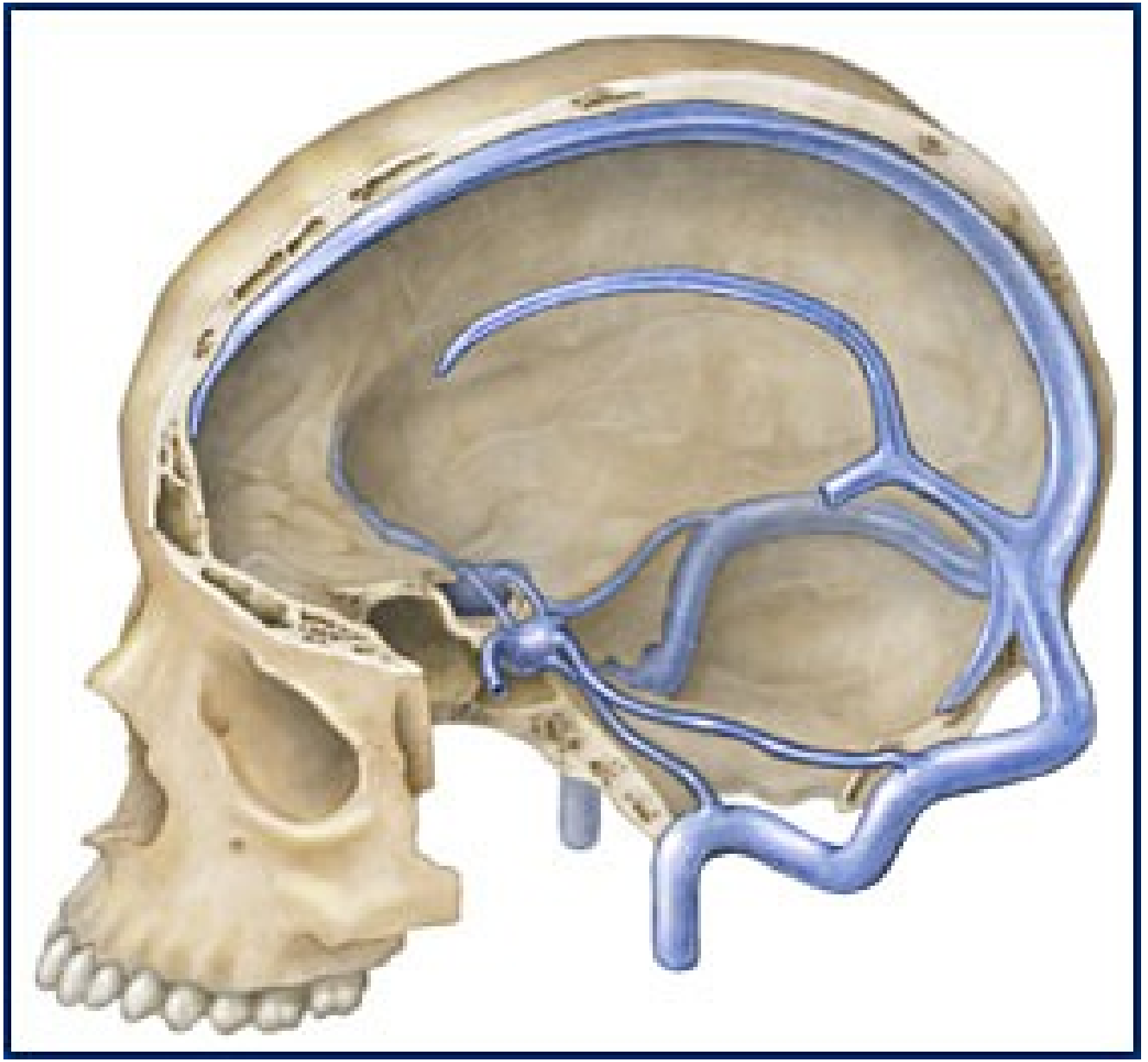
Venous dreinage

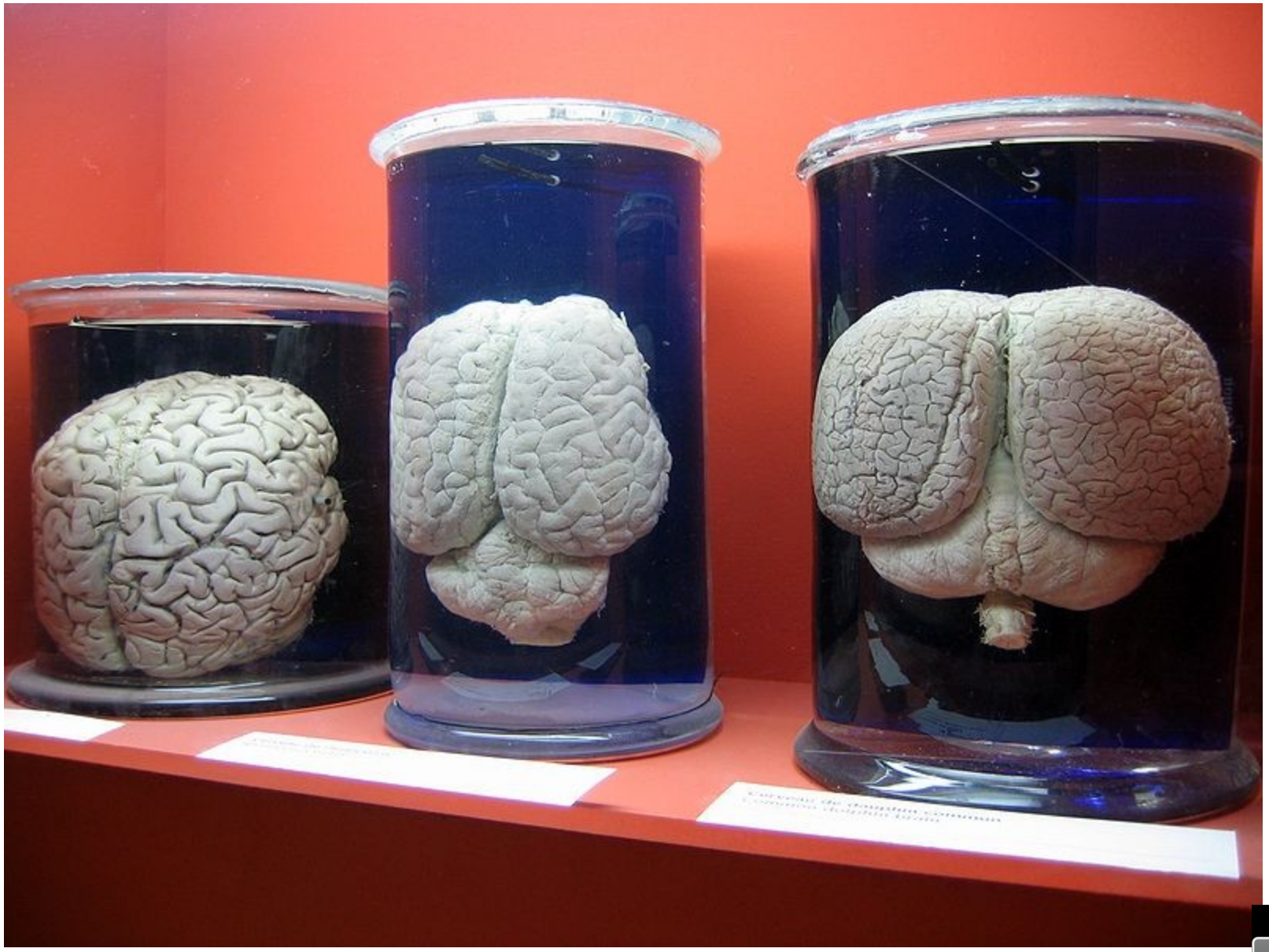




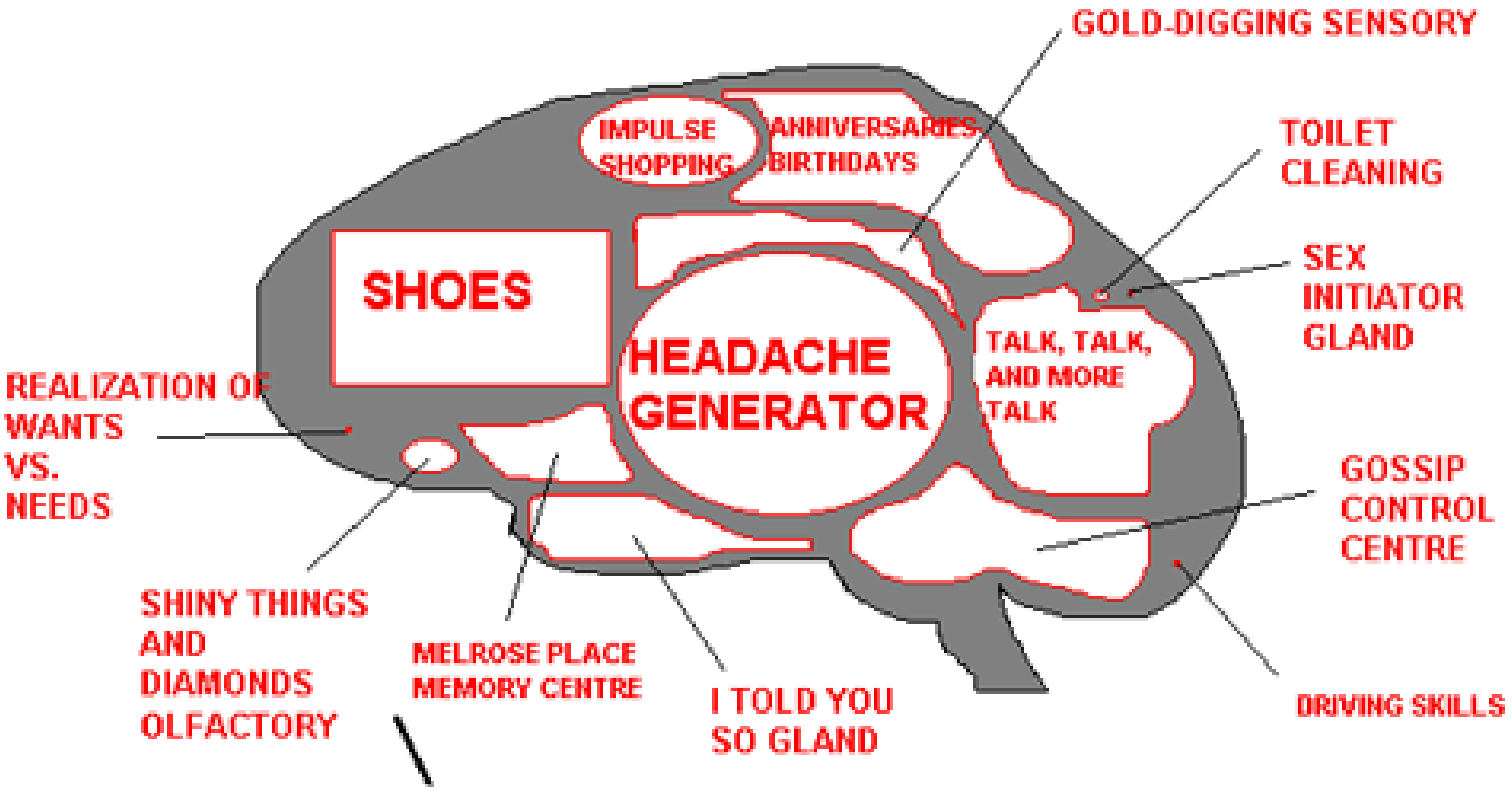
Sinus durae matris





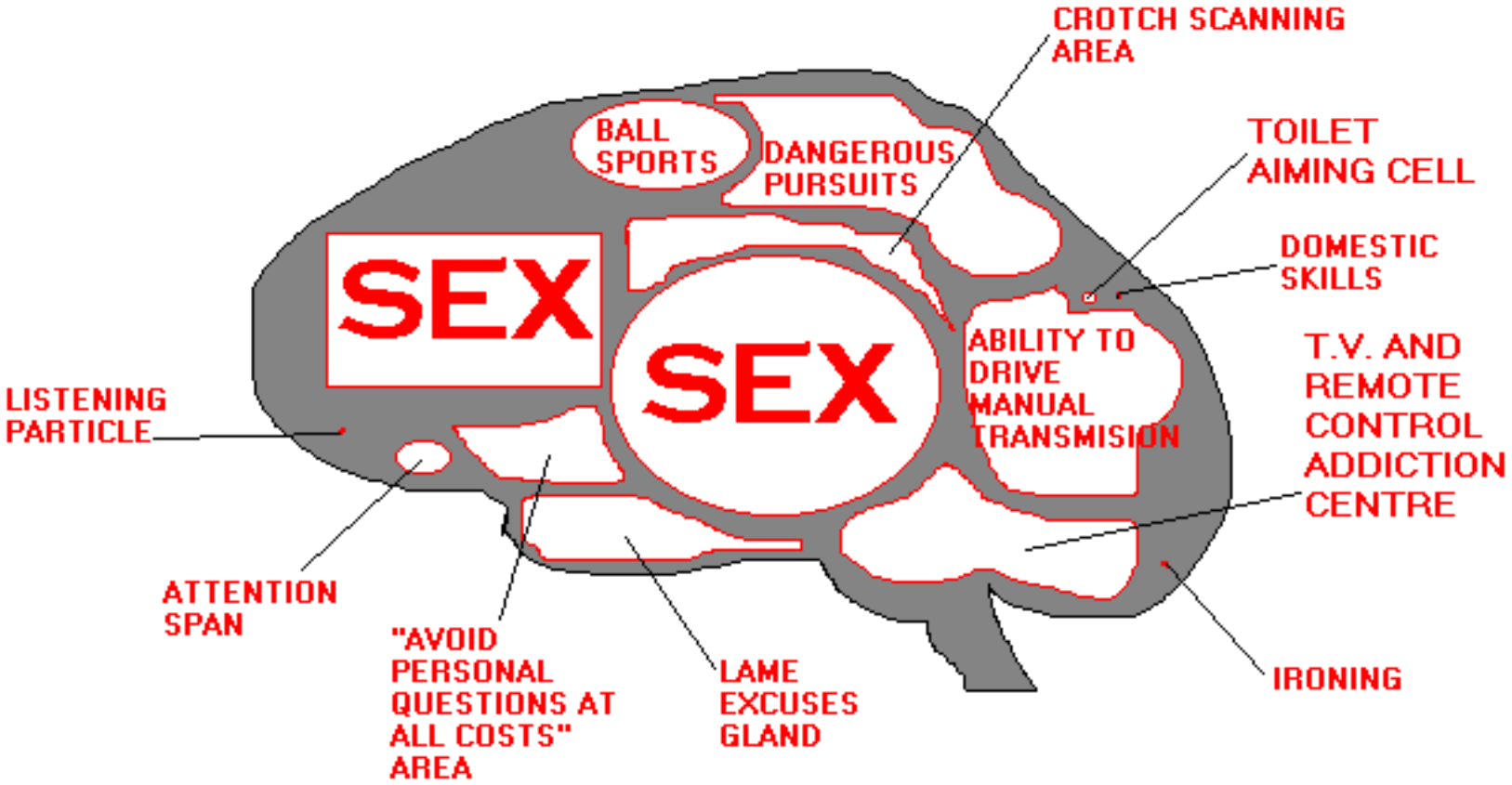


THE FEMALE BRAIN



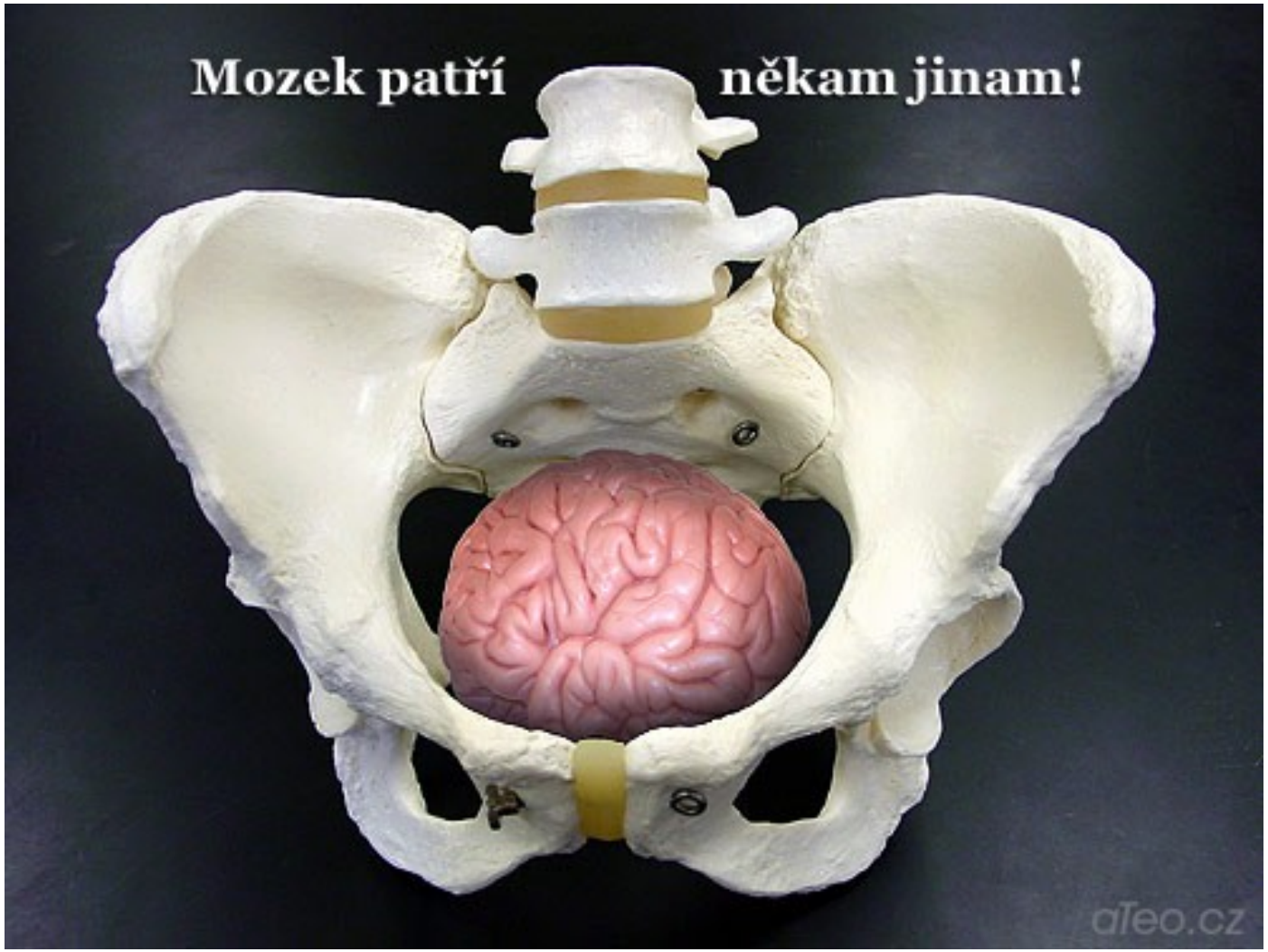
FOOTNOTE: The "Put Oil into the Car" and "Be Quite During the Game" glands are active only when the "SHINY THINGS AND DIAMONDS" OLFactory has been satisfied or when there is a shoe sale.

THE MALE BRAIN



FOOTNOTE: the "Listening to children cry in the middle of the night" gland is not shown due to it's small and underdeveloped nature. Best viewed under a microscope.

Thank you for yout attention.



- **Obrázky**:
- **Atlas der Anatomie des Menschen/Sobotta. Putz,R., und Pabst,R. 20. Auflage. München:Urban & Schwarzenberg, 1993**
- **Netter: Interactive Atlas of Human Anatomy.**
- **Naňka, Elišková: Přehled anatomie. Galén, Praha 2009.**
- **Čihák: Anatomie I, II, III.**
- **Drake et al: Gray´s Anatomy for Students. 2010**

It is true, that:

1 ganglion spinale lies on the anterior root of the spinal nerve

2 the posterior root of the spinal nerve contains only afferent fibers

3 from the spinal cord arise 32 pairs of the spinal nerves

4 cauda equina is located in the area of the cervical vertebral column

5 no answer is correct