Structure of the Nervous System

The Central nervous System (CNS)

Parts of the nervous system that are *encased in bone*

1. Brain

2. Spinal Cord

The Peripheral nervous System (PNS)

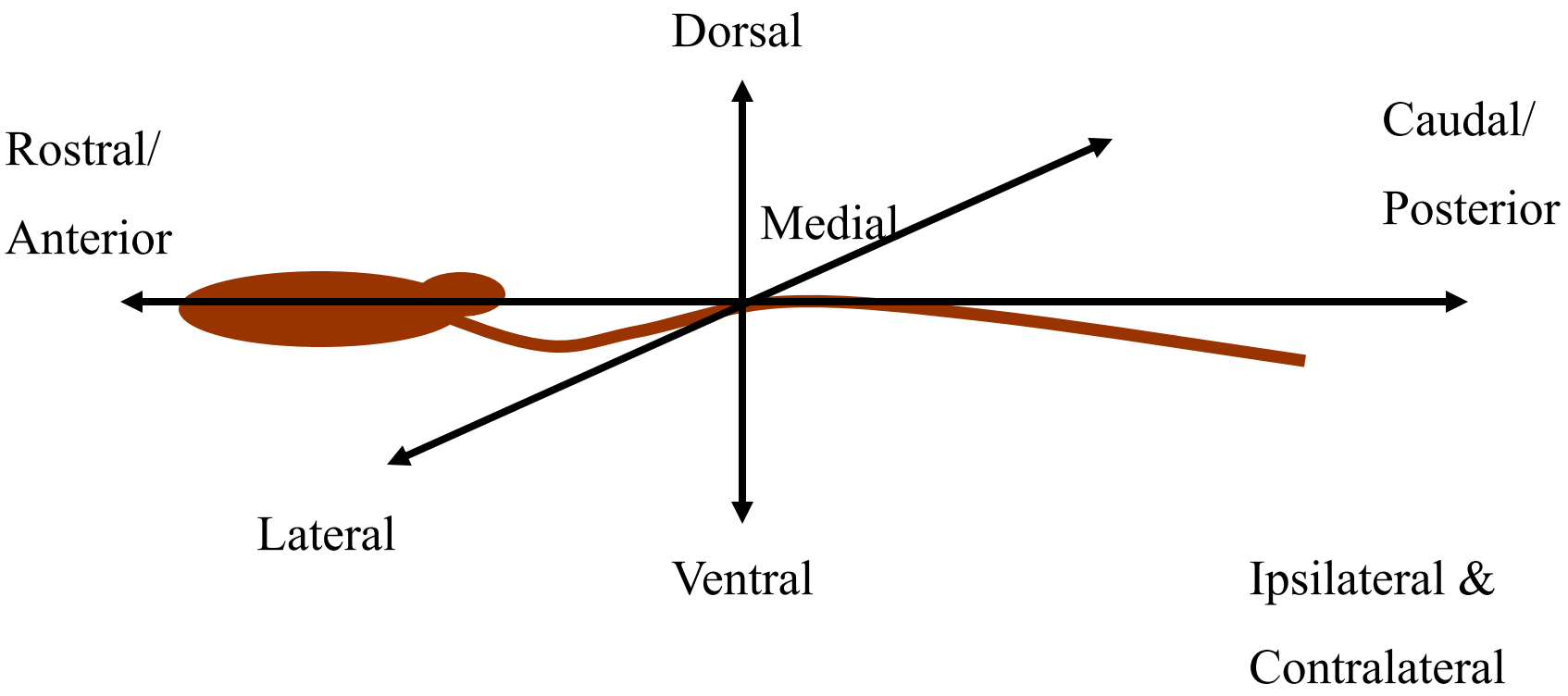
All the spinal nerves that *innervate the skin, joints, muscles, etc.* and under voluntary control:

Somatic PNS

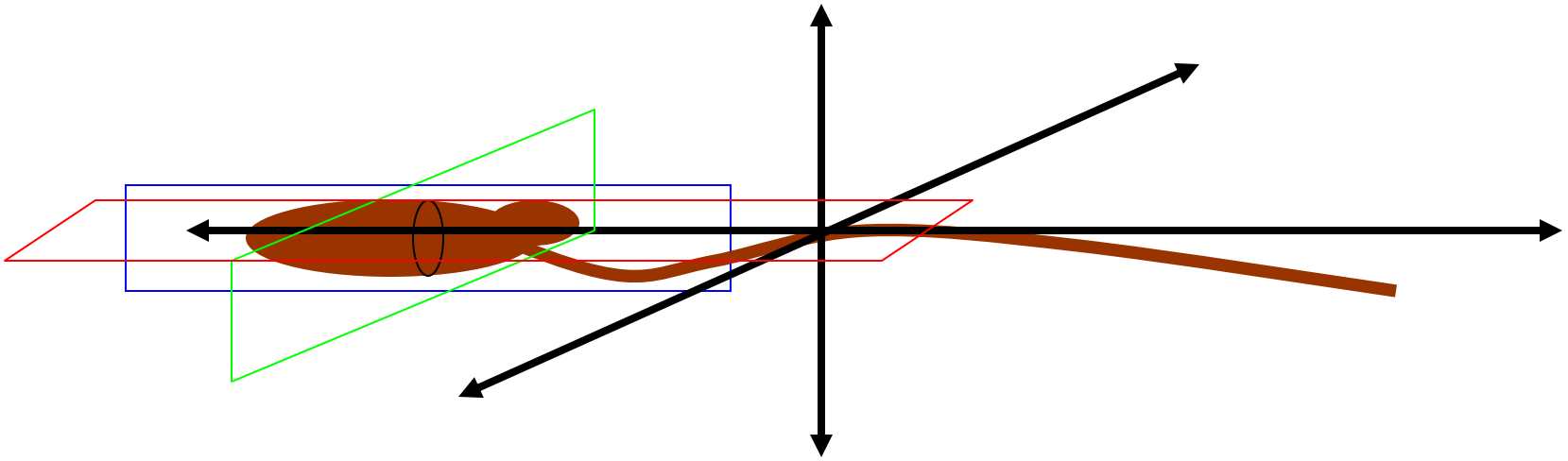
Neurons that *innervate internal organs, blood vessels, glands, etc.* and are involuntary:

Visceral PNS or Autonomic Nervous System (ANS)

Anatomical Reference



Anatomical Reference

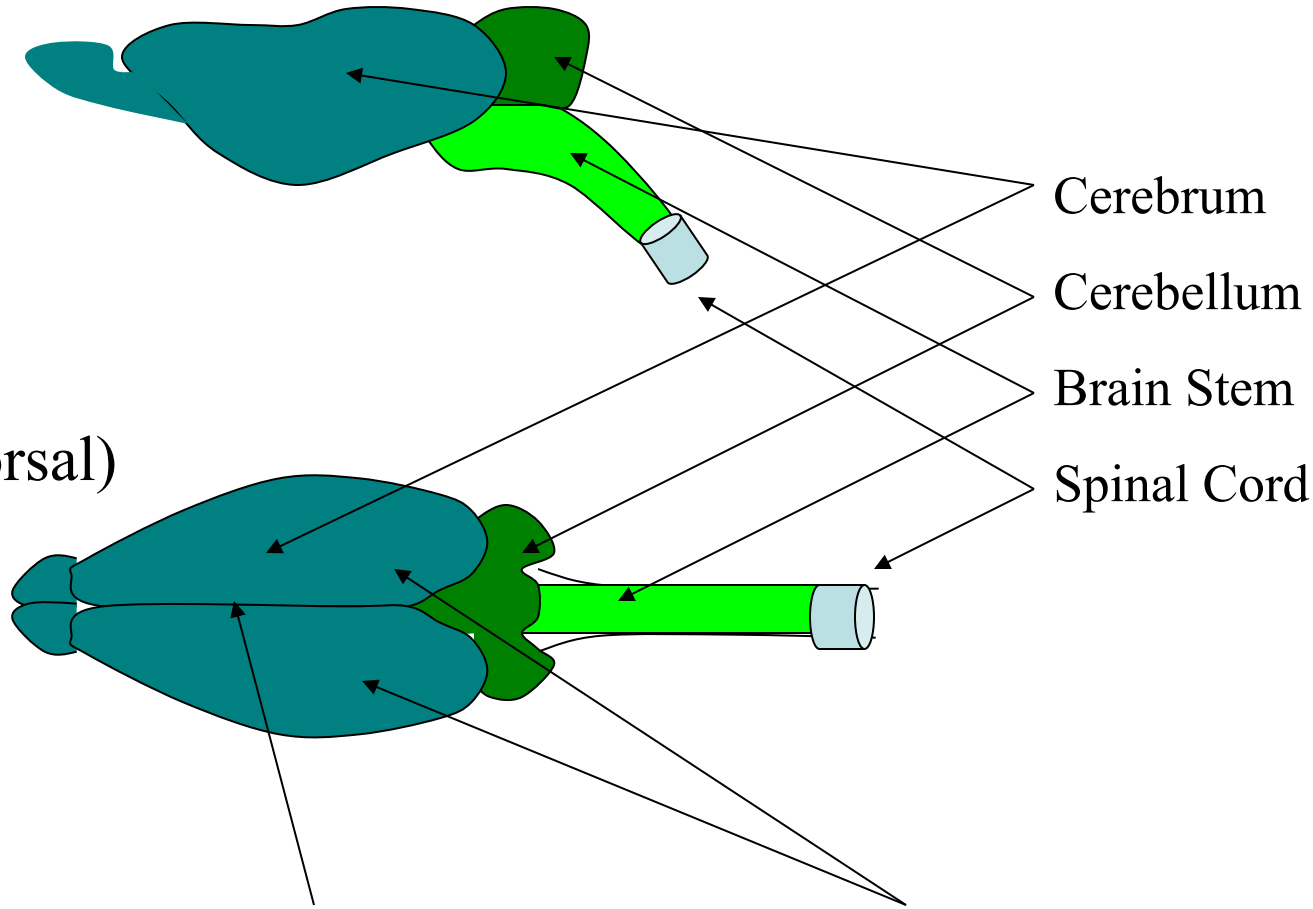


Horizontal Section

Midsagittal Section

Coronal/Transverse Section

Side (Lateral) view



Top (Dorsal) view

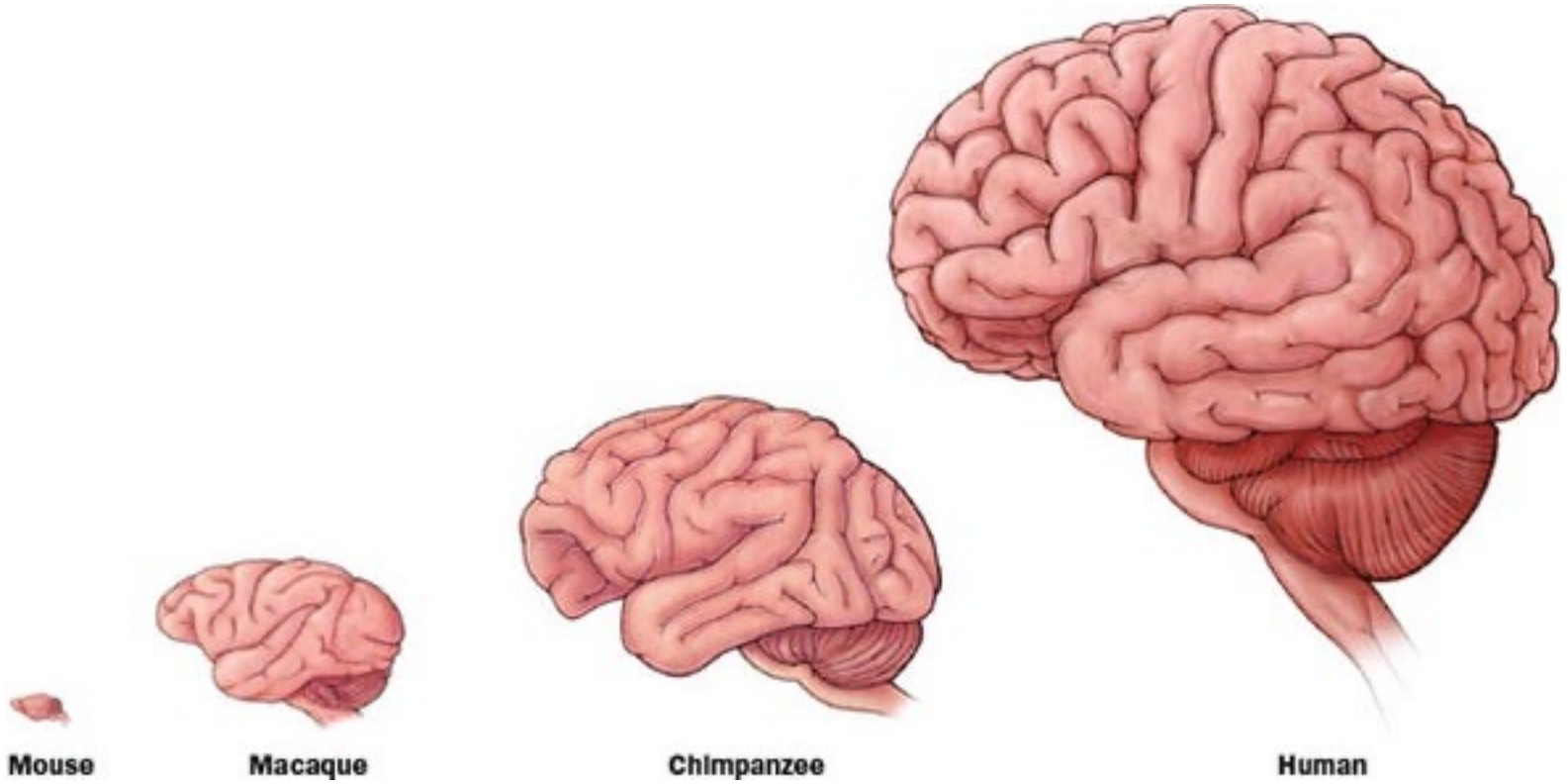
Sagittal fissure

Cerebral hemispheres

What would a Midsagittal view be?

Mouse brain

Human brain


Mouse
Macaque
Chimpanzee
Human

Dura mater (Hard Mother)

Subdural space

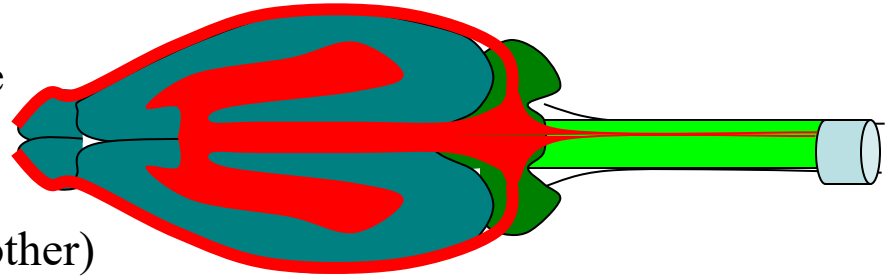
Arachnoid membrane

Subarachnoid space

Pia mater (Gentle Mother)

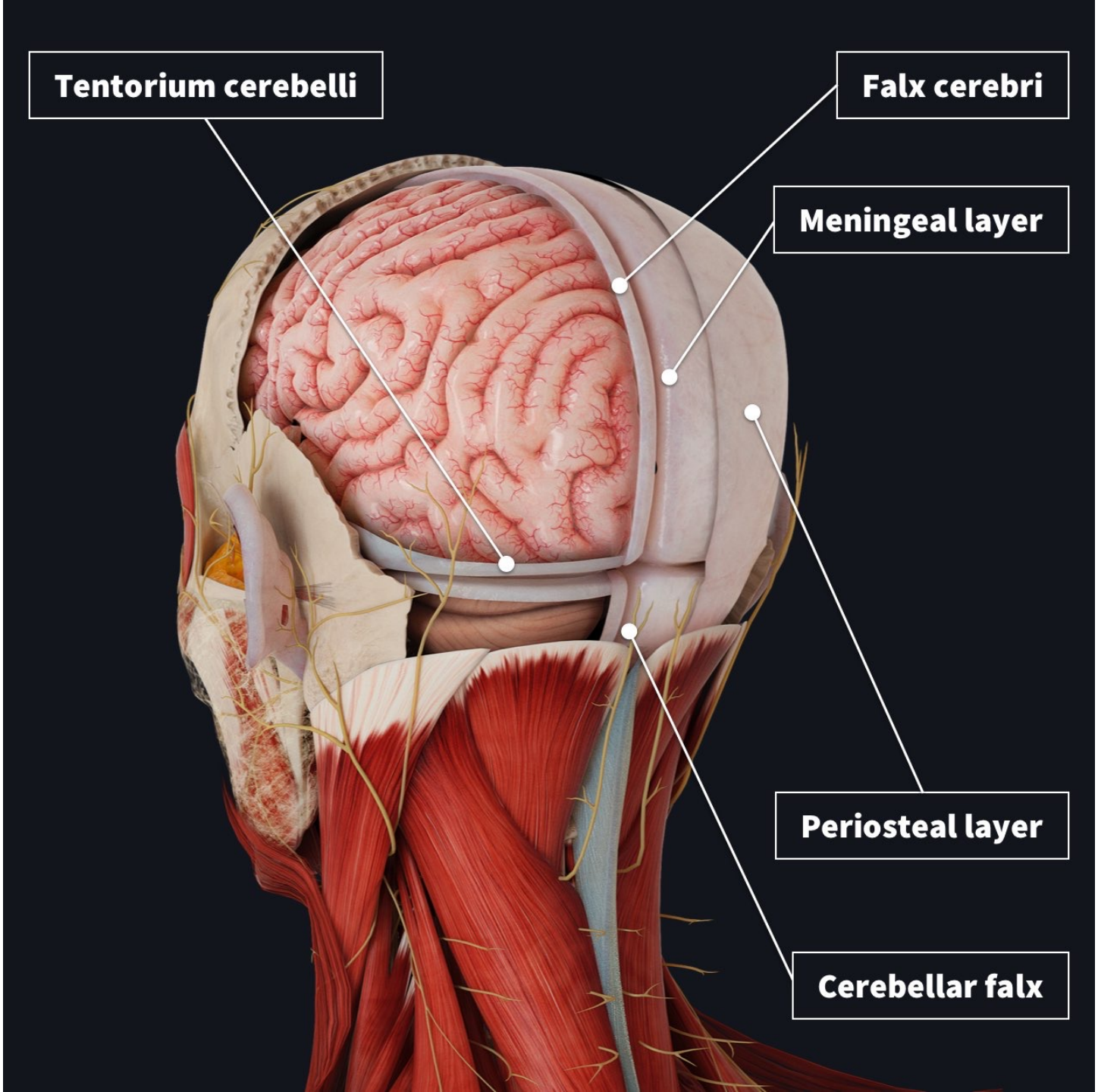
Artery

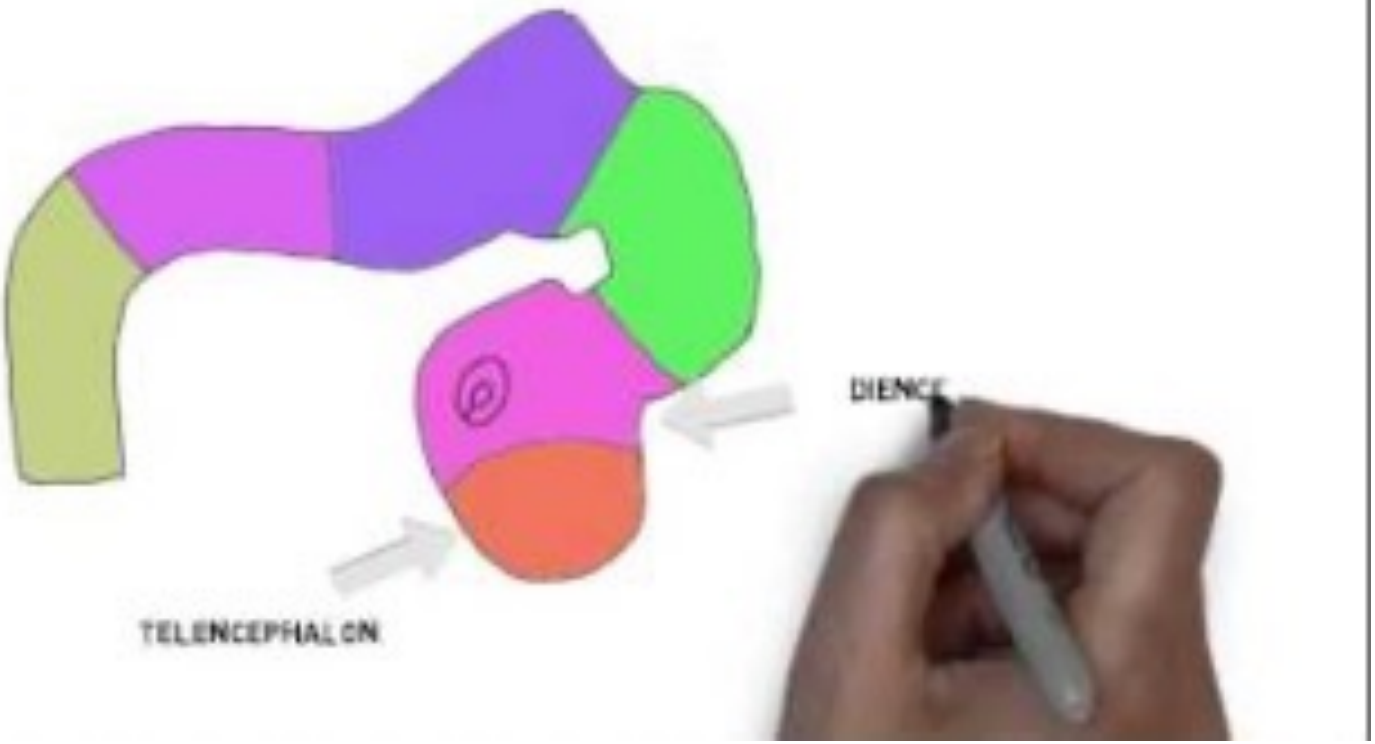
Brain



Ventricles

CSF (Cerebro-spinal Fluid)

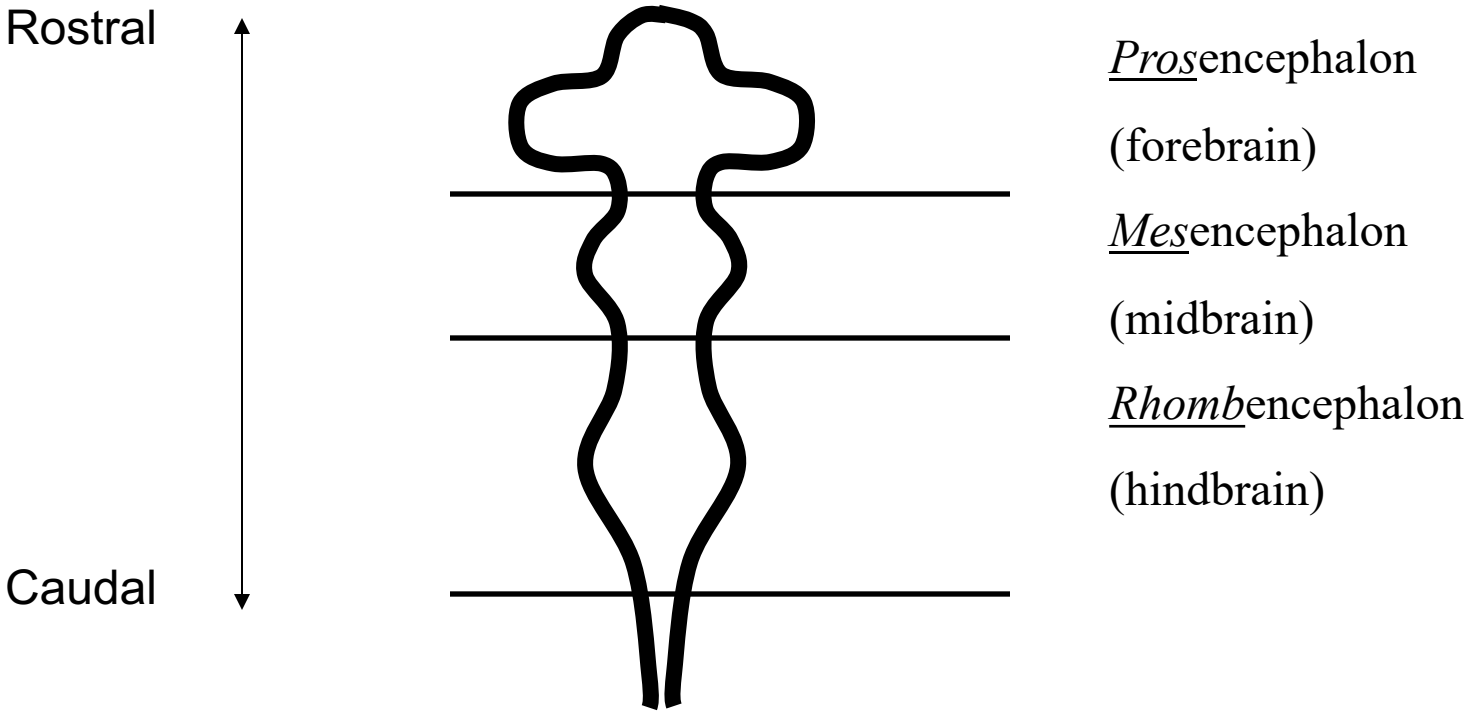

Tentorium cerebelli
Falx cerebri
Meningeal layer
Periosteal layer
Cerebellar falx


DIENCE
TELENCEPHALON

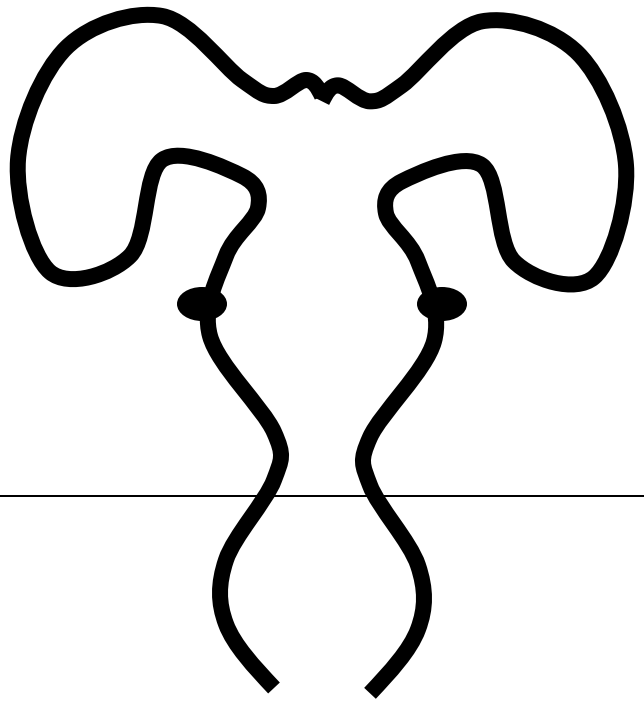
Early development of nervous system in embryo

Neural Plate → Neural Groove → Neural Tube

Fuse Dorsally



Development of nervous system in embryo



*Tel*encephalon

(2 cerebral hemespheres)

*Di*encephalon

(between brain)

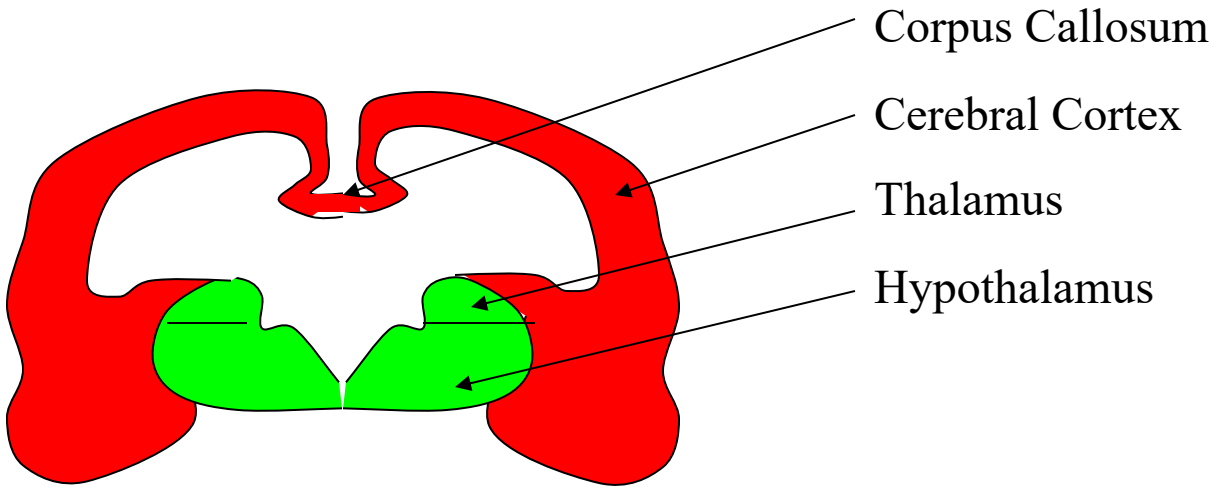
Mesencephalon

(Midbain)

Development of nervous system in embryo

Telencephalon

Diencephalon



Coronal Section

Lateral Ventricles &

Third Ventricle

Development of nervous system in embryo

Midbrain:

becomes ***Tectum*** (roof)

Tegmentum (floor)

Hindbrain:

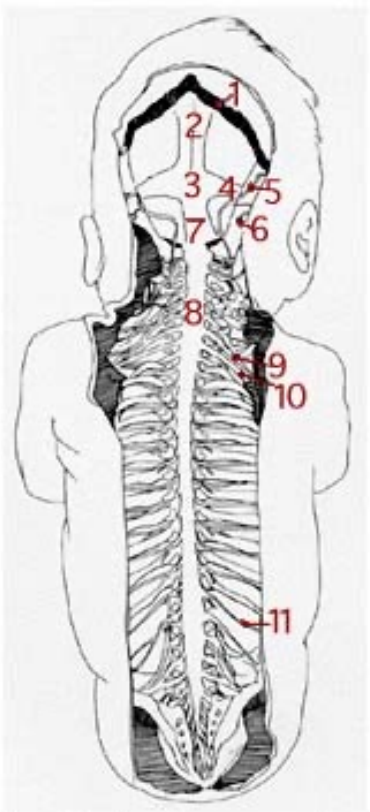
becomes ***Cerebellum***

Pons

Medulla

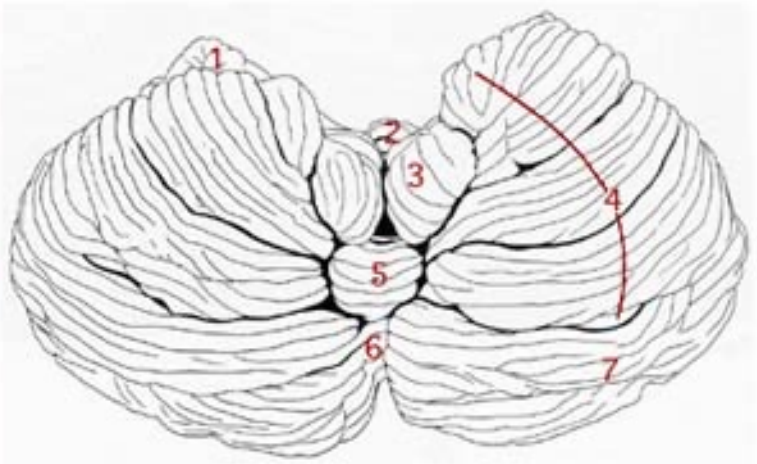
The Human Brain

Spinal Cord



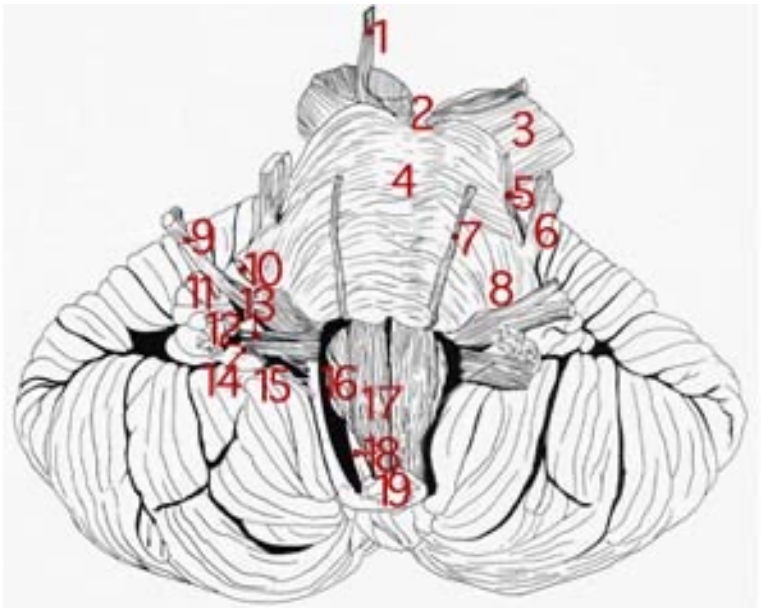
1. Posterior margin of parietal bone
2. Superior sagittal sinus
3. Confluence of sinuses
4. Transverse sinus
5. Greater occipital nerve
6. Lesser occipital nerve
7. Occipital sinus
8. Spinal dura mater
9. Superior trunk of brachial plexus*

Cerebellum



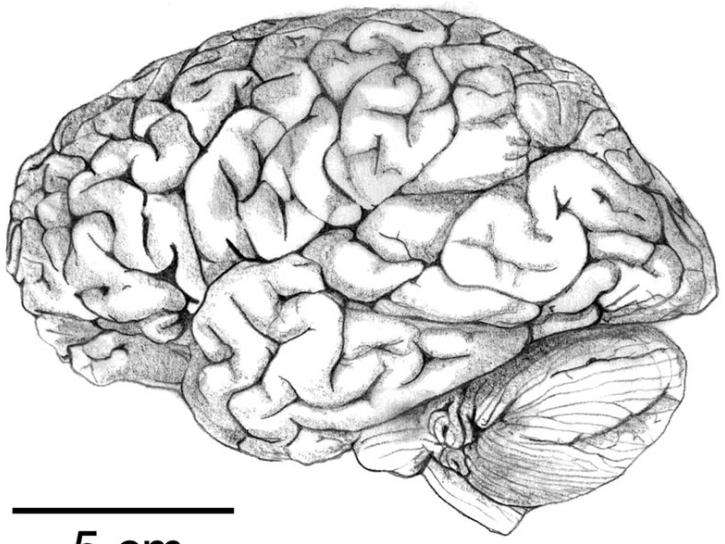
1. Flocculus **2.** Uvula of vermis **3.** Tonsil **4.** Biventral lobule **5.** Pyramis of vermis **6.** Tuber of vermis **7.** Inferior semilunar lobule

Brain Stem & Cerebellum



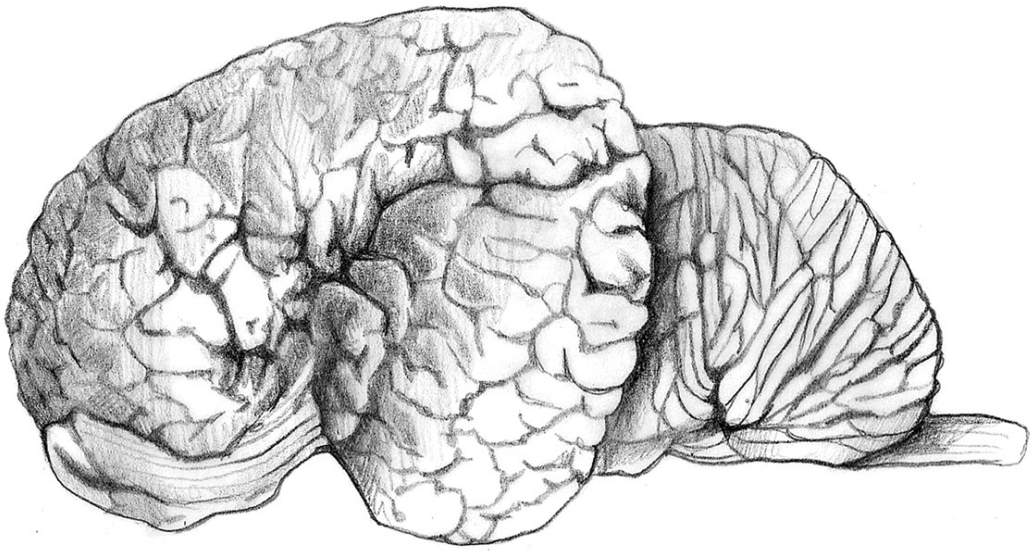
1. Oculomotor nerve **2.** Interpeduncular fossa **3.** Basis pedunculi **4.** Basilar sulcus of pons **5.** Motor (minor) root of trigeminal nerve **6.** Sensory (major) root of trigeminal nerve **7.** Abducens nerve **8.** Middle cerebellar peduncle **9.** Vestibulocochlear nerve **10.** Facial nerve **11.** Flocculus **12.** Choroid plexus protruding through lateral aperture of 4th ventricle (foramen of Luschka) **13.** Glossopharyngeal nerve **14.** Vagus nerve **15.** Accessory nerve **16.** Olivary nucleus **17.** Pyramidal tract **18.** Hypoglossal nucleus **19.** Pyramidal decussation

human

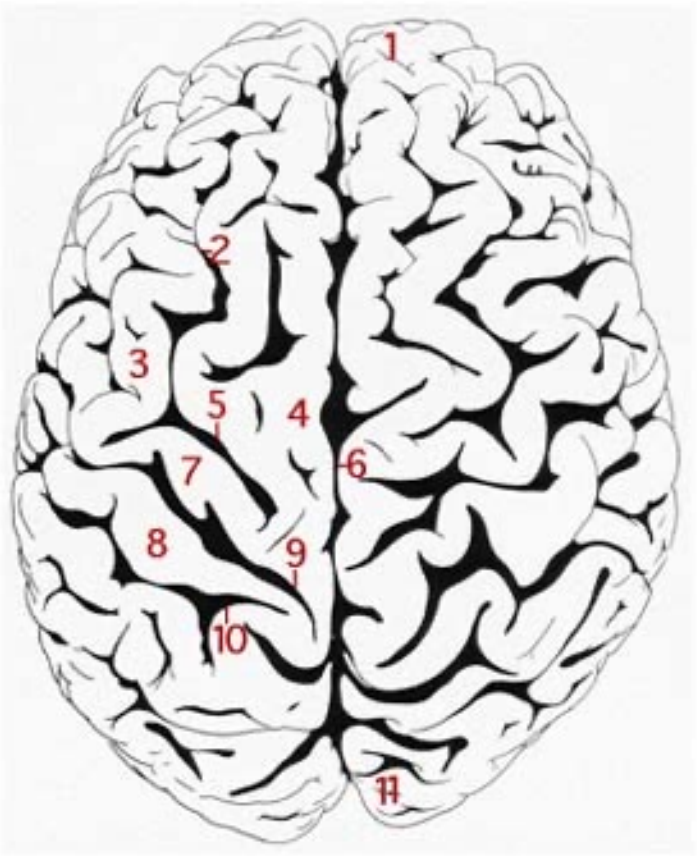


5 cm

African elephant

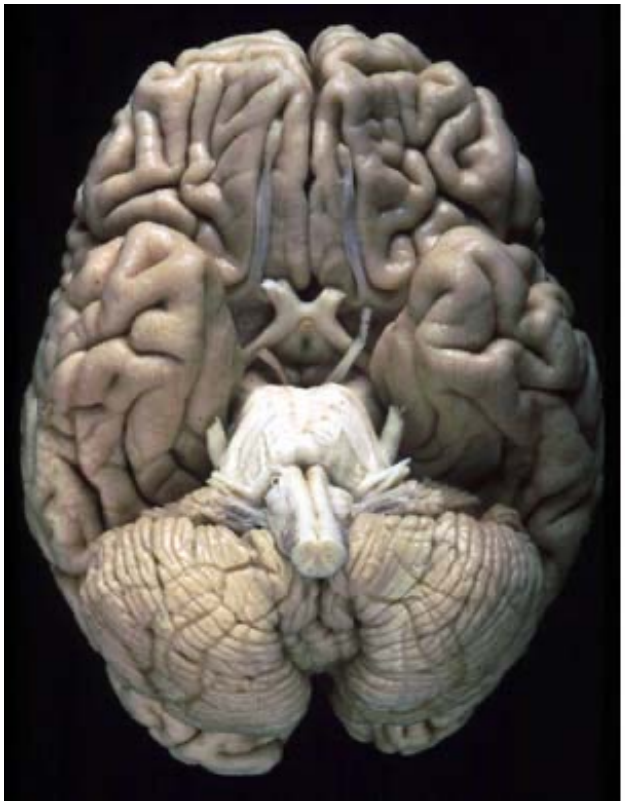


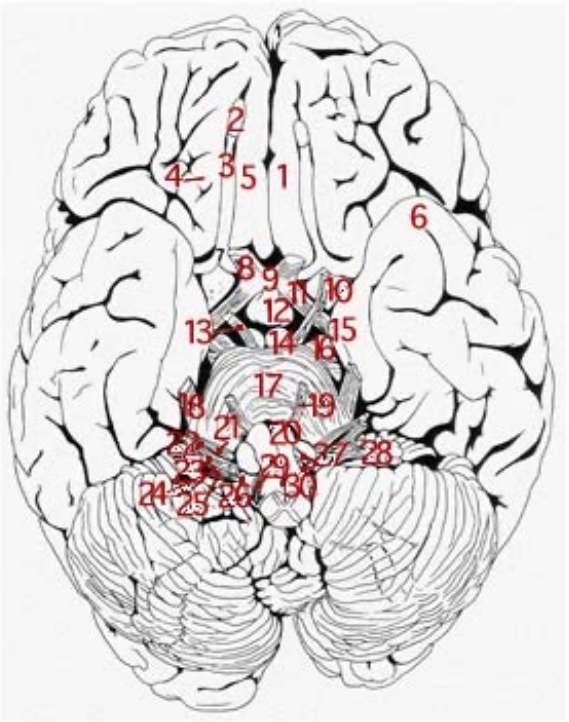
Cerebral hemisphere Dorsal View



1. Frontal pole **2.** Superior frontal sulcus **3.** Middle frontal gyrus **4.** Superior frontal gyrus **5.** Precentral sulcus **6.** Longitudinal cerebral fissure **7.** Precentral gyrus **8.** Postcentral gyrus **9.** Central sulcus **10.** Postcentral sulcus **11.** Occipital pole

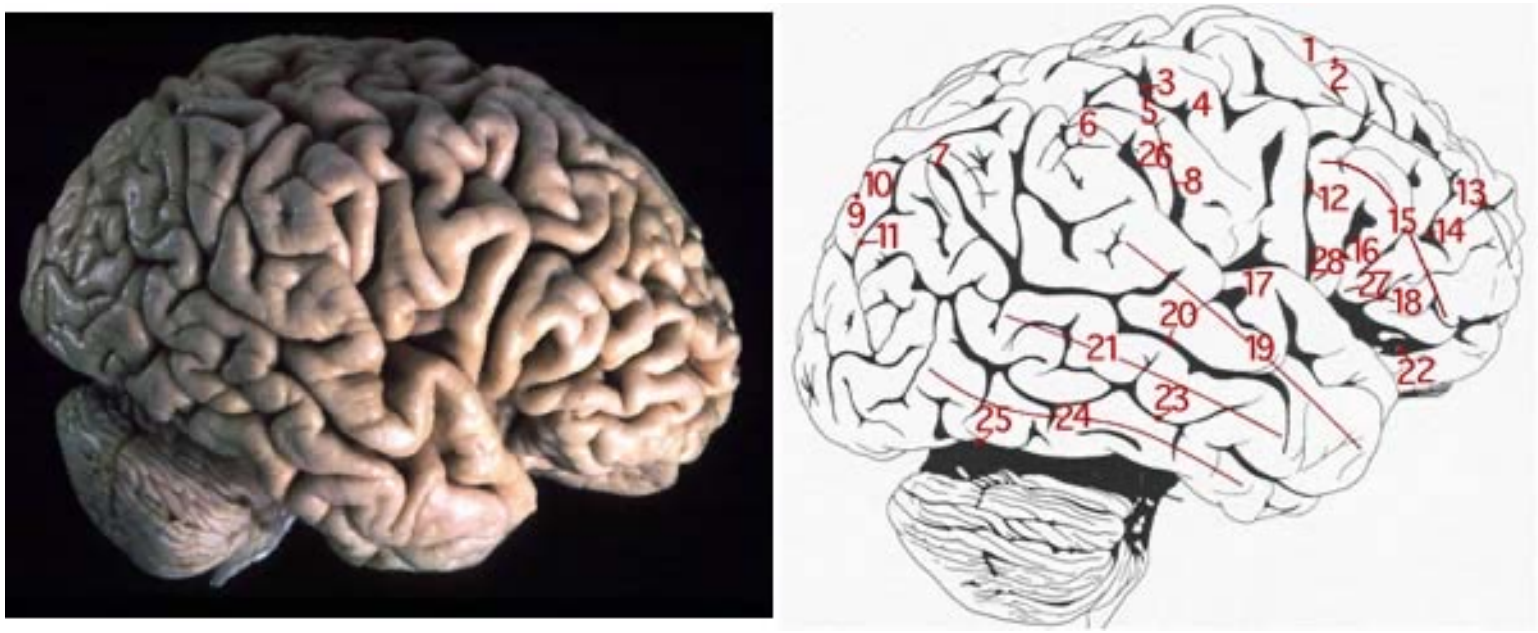
Cerebral hemisphere Ventral View





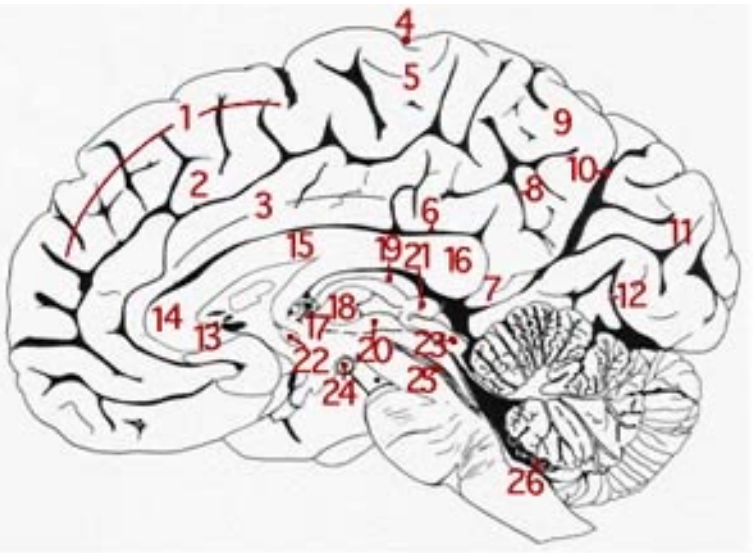
1. Frontal pole of left cerebral hemisphere **2.** Olfactory bulb **3.** Olfactory tract **4.** Orbital gyri and sulci **5.** Straight gyrus **6.** Temporal pole of left cerebral hemisphere **7.** Olfactory trigone **8.** Optic nerve **9.** Optic chiasma **10.** Anterior (rostral) perforated substance **11.** Optic tract **12.** Tuber cinereum with infundibulum **13.** Oculomotor nerve **14.** Mamillary body **15.** Uncus of parahippocampal gyrus **16.** Basis pedunculi **17.** Basilar sulcus of pons **18.** Trigeminal nerve **19.** Abducens nerve **20.** Pyramid of medulla oblongata **21.** Facial nerve **22.** Vestibulocochlear nerve **23.** Glossopharyngeal nerve **24.** Vagus nerve **25.** Cranial roots of accessory nerve **26.** Spinal roots of accessory nerve **27.** Rootlets of hypoglossal nerve **28.** Flocculus **29.** Ventral rootlets of 1st cervical spinal nerve **30.** Pyramidal decussation

Cerebral hemisphere Lateral View



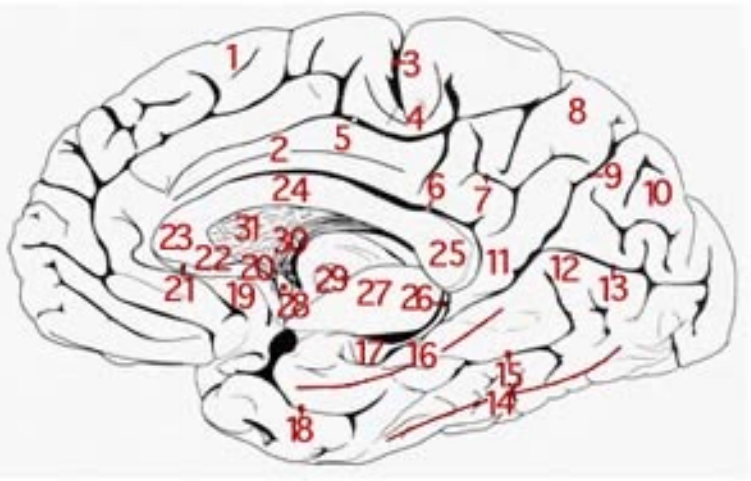
1. Superior frontal gyrus **2.** Superior frontal sulcus **3.** Central sulcus **4.** Precentral gyrus **5.** Postcentral gyrus **6.** Supramarginal gyrus **7.** Angular gyrus **8.** Postcentral sulcus **9.** Parieto-occipital sulcus **10.** Superior parietal lobule **11.** Intraparietal sulcus **12.** Precentral sulcus **13.** Middle frontal gyrus **14.** Inferior frontal sulcus **15.** Inferior frontal gyrus **16.** Anterior ascending ramus of lateral sulcus **17.** Transverse temporal gyrus **18.** Anterior horizontal ramus of lateral sulcus **19.** Superior temporal gyrus **20.** Superior temporal sulcus **21.** Middle temporal gyrus **22.** Stem of lateral sulcus **23.** Inferior temporal sulcus **24.** Inferior temporal gyrus **25.** Preoccipital notch **26.** Posterior branch of lateral sulcus **27.** Triangular part of inferior frontal gyrus **28.** Opercular part of inferior frontal gyrus

Cerebral hemisphere Midsagittal View



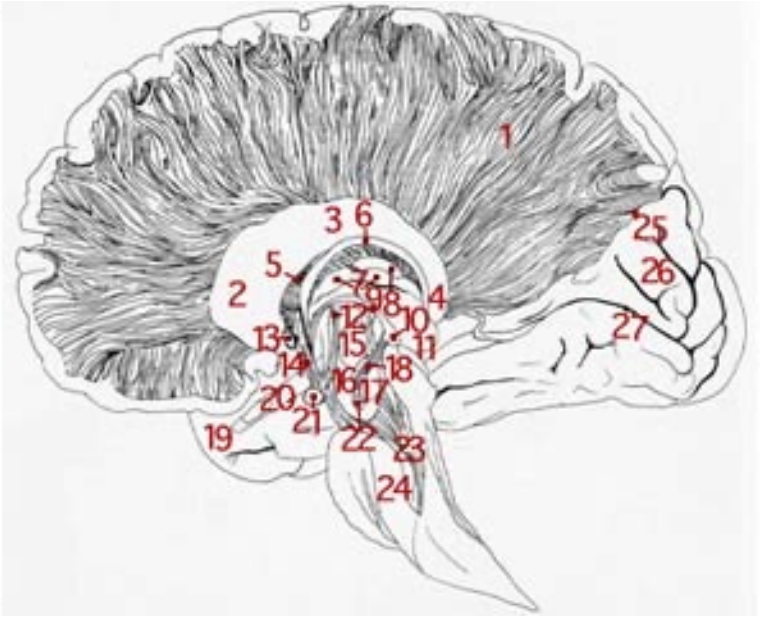
1. Medial frontal gyrus **2.** Cingulate sulcus **3.** Cingulate gyrus **4.** Central sulcus **5.** Paracentral lobule **6.** Callosal sulcus **7.** Isthmus of cingulate gyrus **8.** Subparietal sulcus **9.** Precuneus **10.** Parieto-occipital sulcus **11.** Cuneus **12.** Calcarine sulcus or fissure **13.** Rostrum of corpus callosum **14.** Genu of corpus callosum **15.** Trunk of corpus callos **16.** Splenium of corpus callosum **17.** Choroid plexus in interventricular foramen **18.** Interthalamic adhesion **19.** Habenular trigone **20.** Hypothalamic sulcus **21.** Pineal body **22.** Anterior (rostral) commissure **23.** Tectum of midbrain **24.** Mamillary body **25.** Medial longitudinal fasciculus **26.** Choroid plexus of 4th ventricle

Cerebral hemisphere Midsagittal View



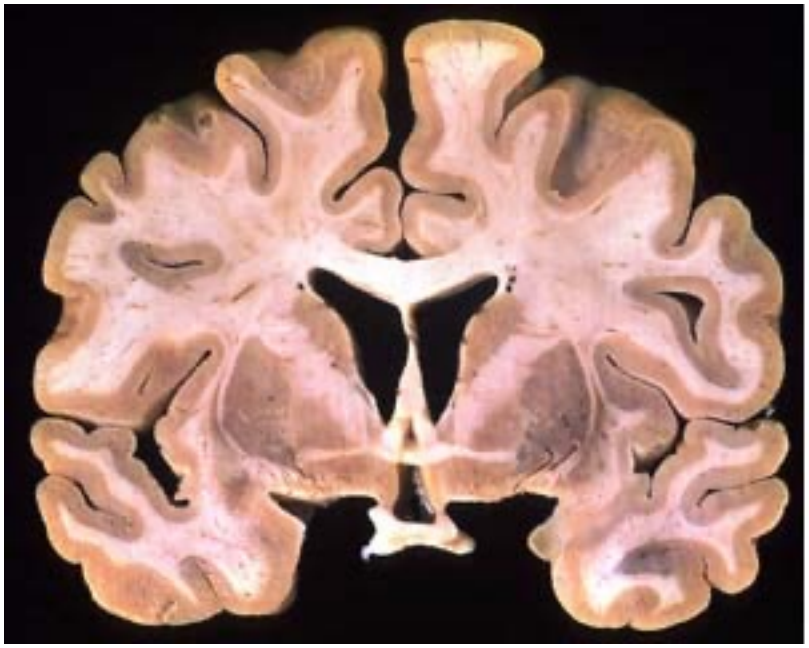
1. Medial frontal gyrus **2.** Cingulate gyrus **3.** Central sulcus **4.** Paracentral lobule **5.** Cingulate sulcus **6.** Callosal sulcus **7.** Subparietal sulcus **8.** Precuneus **9.** Parieto-occipital sulcus **10.** Cuneus **11.** Isthmus of cingulate gyrus **12.** Lingual gyrus **13.** Calcarine sulcus or fissure **14.** Medial occipitotemporal gyrus **15.** Collateral sulcus **16.** Parahippocampal gyrus **17.** Uncus of parahippocampal gyrus **18.** Rhinal sulcus **19.** Subcallosal area **20.** Paraterminal gyrus **21.** Indusium griseum **22.** Rostrum of corpus callosum **23.** Genu of corpus callosum **24.** Trunk of corpus callosum **25.** Splenium of corpus callosum **26.** Fimbria of hippocampus **27.** Cut surface of thalamus **28.** Anterior (rostral) commissure **29.** Interthalamic adhesion **30.** Column of fornix **31.** Septum pellucidum

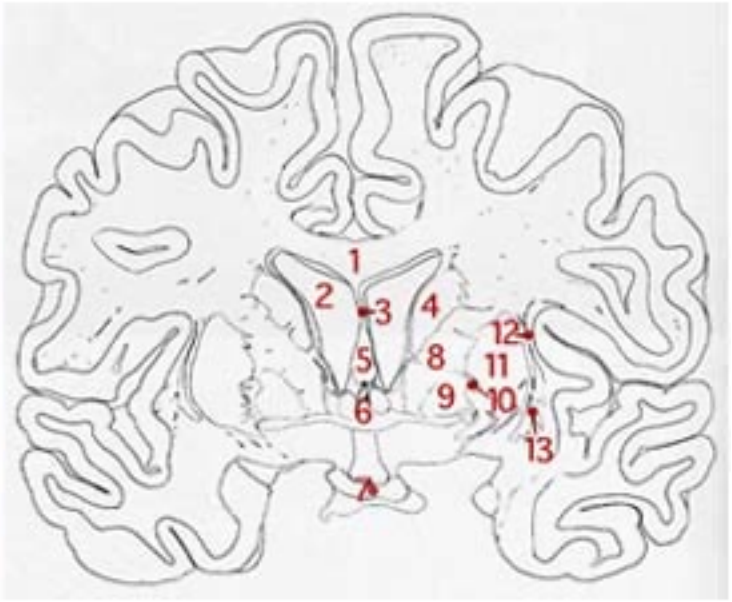
Cerebral hemisphere Midsagittal View



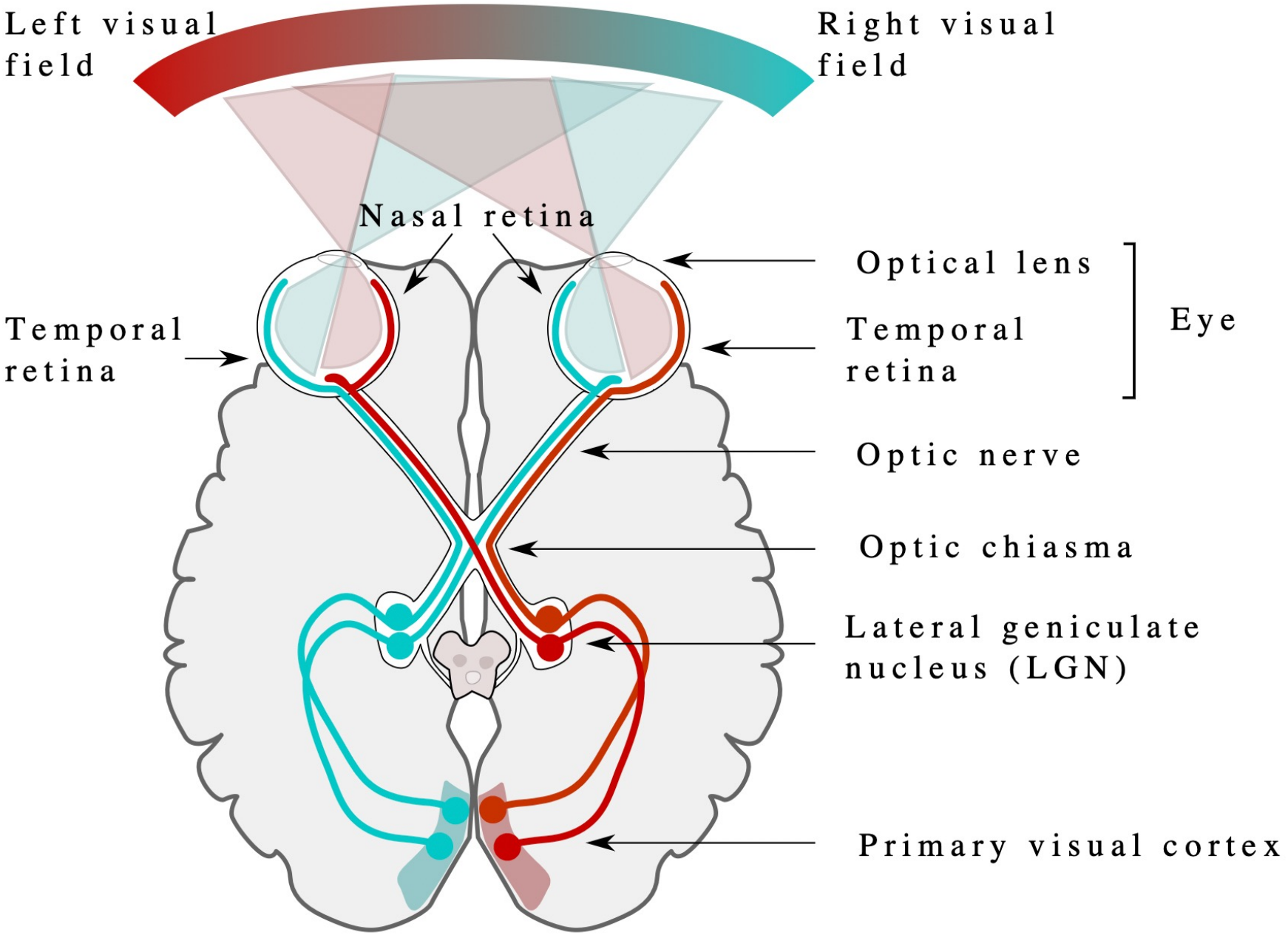
1. Corona radiata **2.** Head of caudate nucleus **3.** Body of caudate nucleus **4.** Tail of caudate nucleus **5.** Anterior thalamic peduncle **6.** Stria terminalis **7.** Anterior nuclear group of thalamus **8.** Dorsal lateral thalamic nucleus **9.** Stria medullaris thalami **10.** Habenular nucleus **11.** Pulvinar **12.** Mamillothalamic fasciculus **13.** Anterior (rostral) commissure **14.** Column of fornix **15.** Hypothalamic nuclei **16.** Substantia nigra **17.** Red nucleus **18.** Habenulo-interpeduncular tract **19.** Temporal pole **20.** Optic tract **21.** Mamillary body **22.** Interpeduncular nucleus **23.** Medial lemniscus **24.** Median section of pons **25.** Lower lip of parieto-occipital sulcus **26.** Cuneus **27.** Calcarine sulcus

Cerebral hemisphere Coronal View





1. Body of corpus callosum **2.** Frontal horn of lateral ventricle **3.** Septum pellucidum **4.** Body of caudate nucleus **5.** Columns of fornix **6.** Anterior (rostral) commissure **7.** Optic chiasma **8.** Anterior limb of internal capsule **9.** Globus pallidus **10.** Lateral medullary lamina **11.** Putamen **12.** External capsule **13.** Claustrum

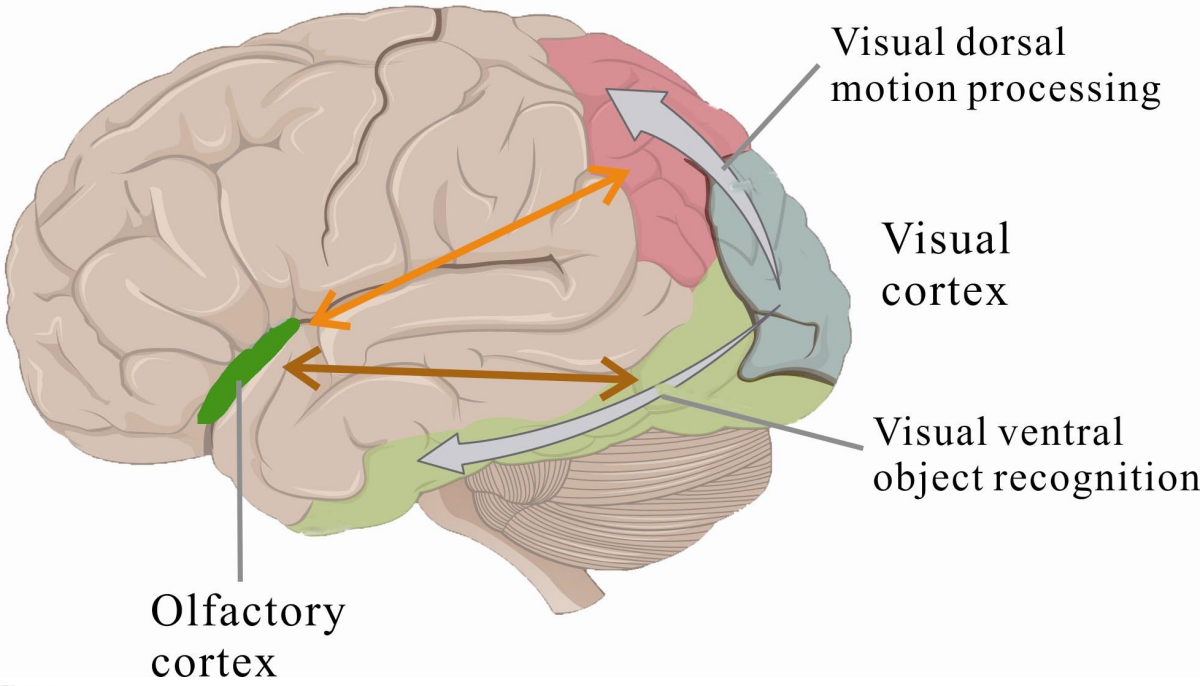

Left visual field
Right visual field
Nasal retina
Temporal retina
Optical lens
Temporal retina
Eye
Optic nerve
Optic chiasma
Lateral geniculate nucleus (LGN)
Primary visual cortex

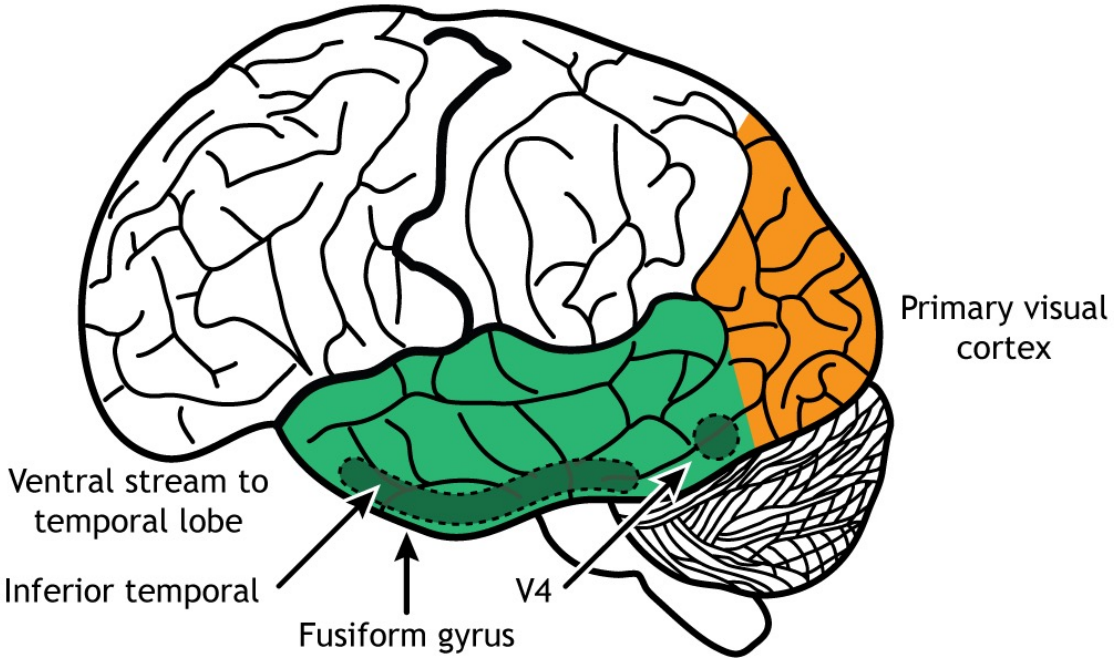
On the dorsal and ventral streams

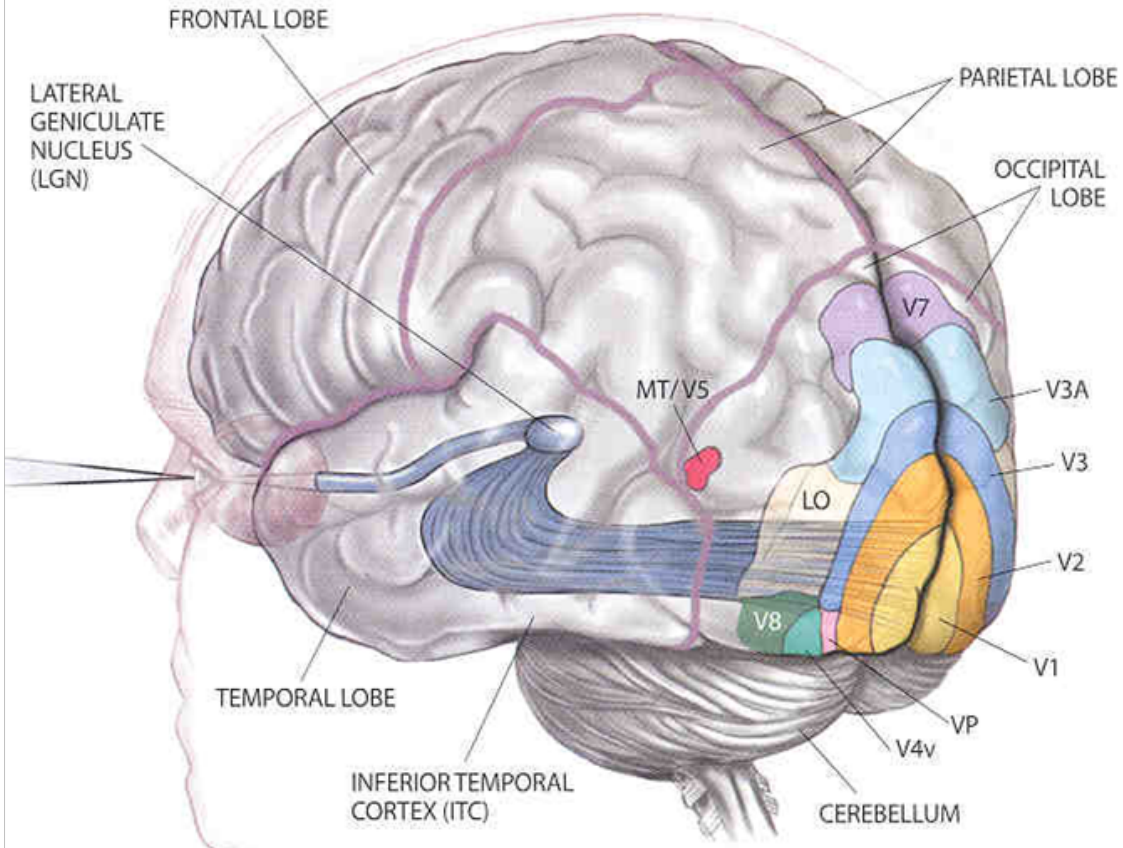
https://www.youtube.com/watch?v=nOdXzVL5YKo

Lesions

Acute vs. Chronic


Visual dorsal
motion processing
Visual
cortex
Visual ventral
object recognition
Olfactory
cortex

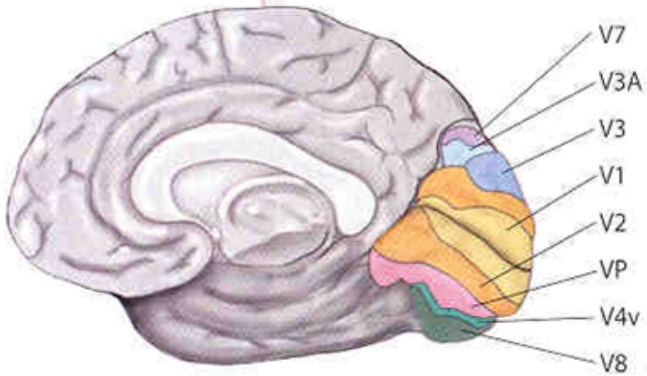

Primary visual
cortex
Ventral stream to
temporal lobe
Inferior temporal
Fusiform gyrus
V4

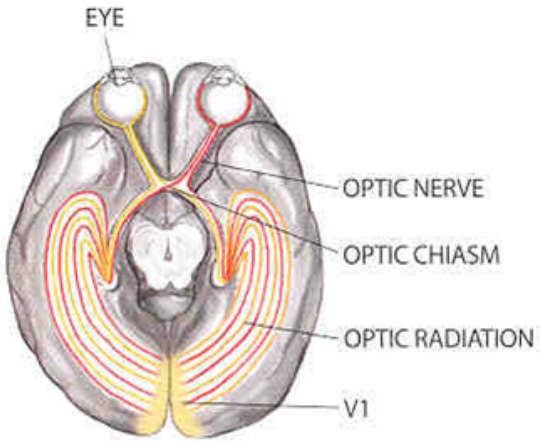


KEY TO FUNCTION

- **V1:** Primary visual cortex; receives all visual input. Begins processing of color, motion and shape. Cells in this area have the smallest receptive fields.
- **V2,** **V3** and **VP:** Continue processing; cells of each area have progressively larger receptive fields.
- **V3A:** Biased for perceiving motion.
- **V4v:** Function unknown.
- **MT/V5:** Detects motion.
- **V7:** Function unknown.
- **V8:** Processes color vision.
- **LO:** Plays a role in recognizing large-scale objects.

Note: A V6 region has been identified only in monkeys.





TERESE WINSLOW, WITH ASSISTANCE FROM NOUCHINE HADJIKHANI AND ROGER TOOTELL *Harvard Medical School*

Hubel & Wiesel

https://www.youtube.com/watch?v=IOHayh06LJ4

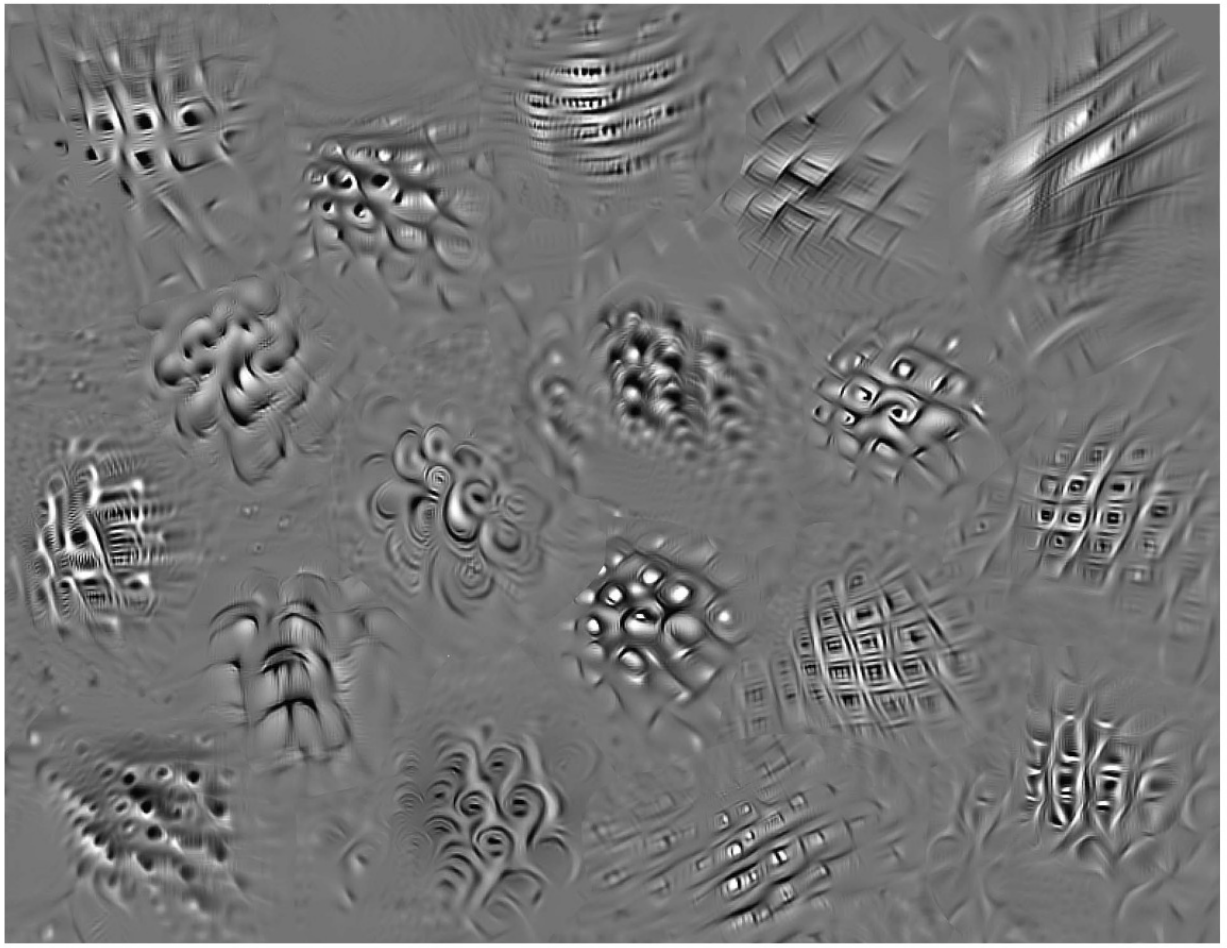
https://www.youtube.com/watch?v=8VdFf3egwfg

RESEARCH ARTICLE

NEUROSCIENCE

Neural population control via deep image synthesis

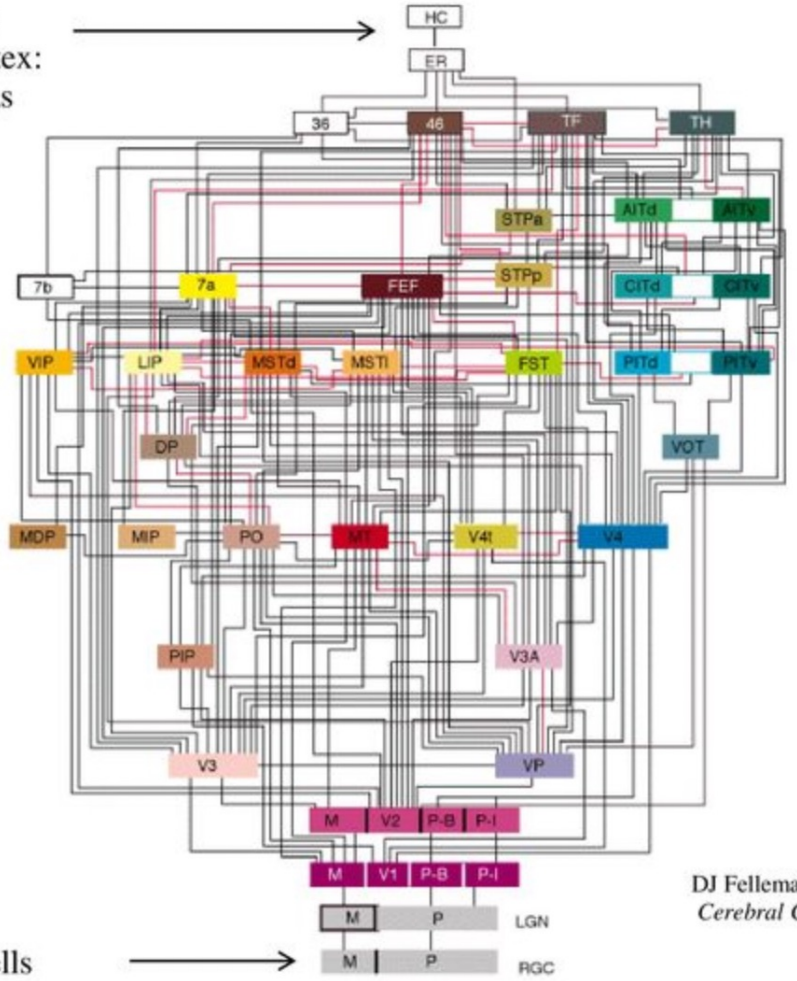
Pouya Bashivan*, Kohitij Kar*, James J. DiCarlo†



Collection of images synthesized by a deep neural network model to control the activity of neural populations in primate cortical area V4. We used a deep artificial neural network to control the activity pattern of a population of neurons in cortical area V4 of macaque monkeys by synthesizing visual stimuli that, when applied to the subject's retinae, successfully induced the experimenter-desired neural response patterns.

The Macaque "Vision Pipeline" as of December 1990

HC = hippocampus;
ER = entorhinal cortex:
high level brain areas



DJ Felleman and DC Van Essen (1991), *Cerebral Cortex* **1**:1-47.

RGC = retinal ganglion cells