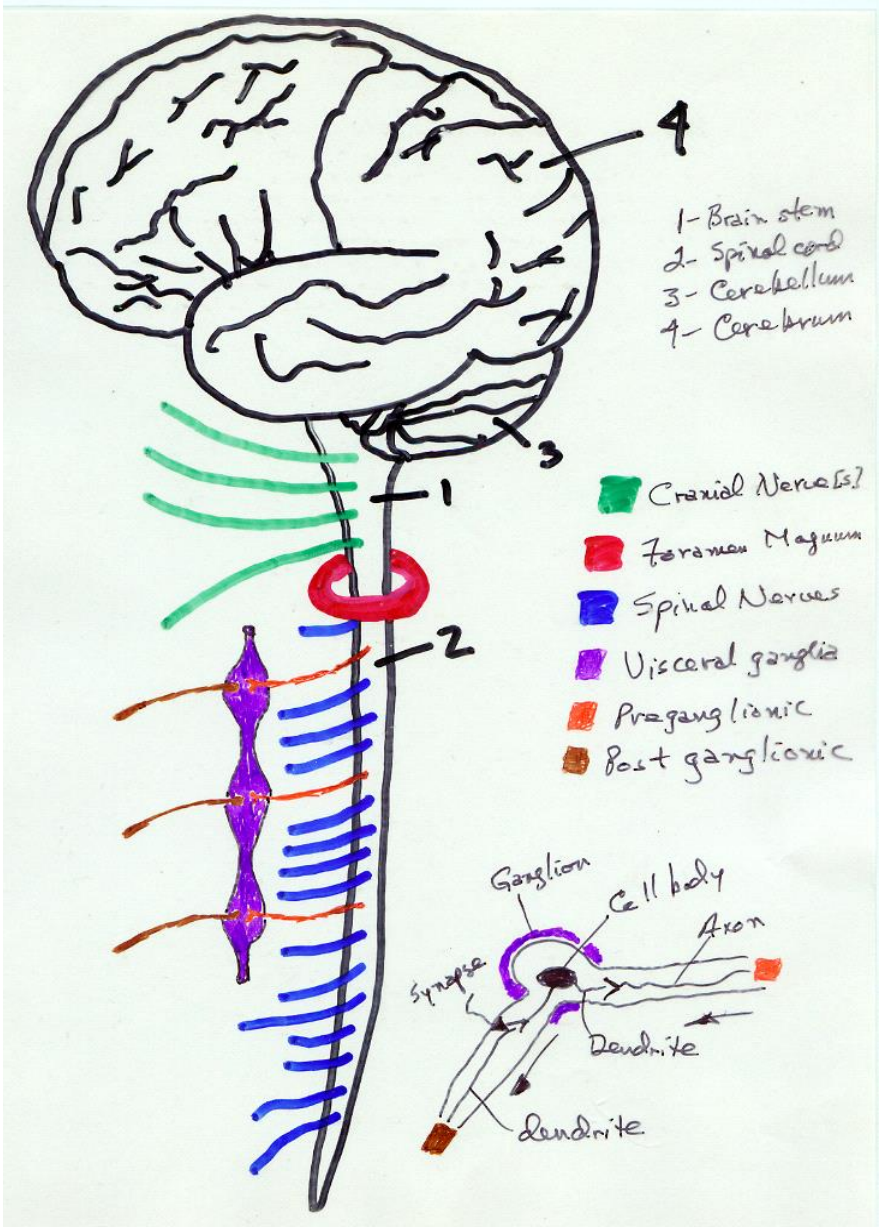
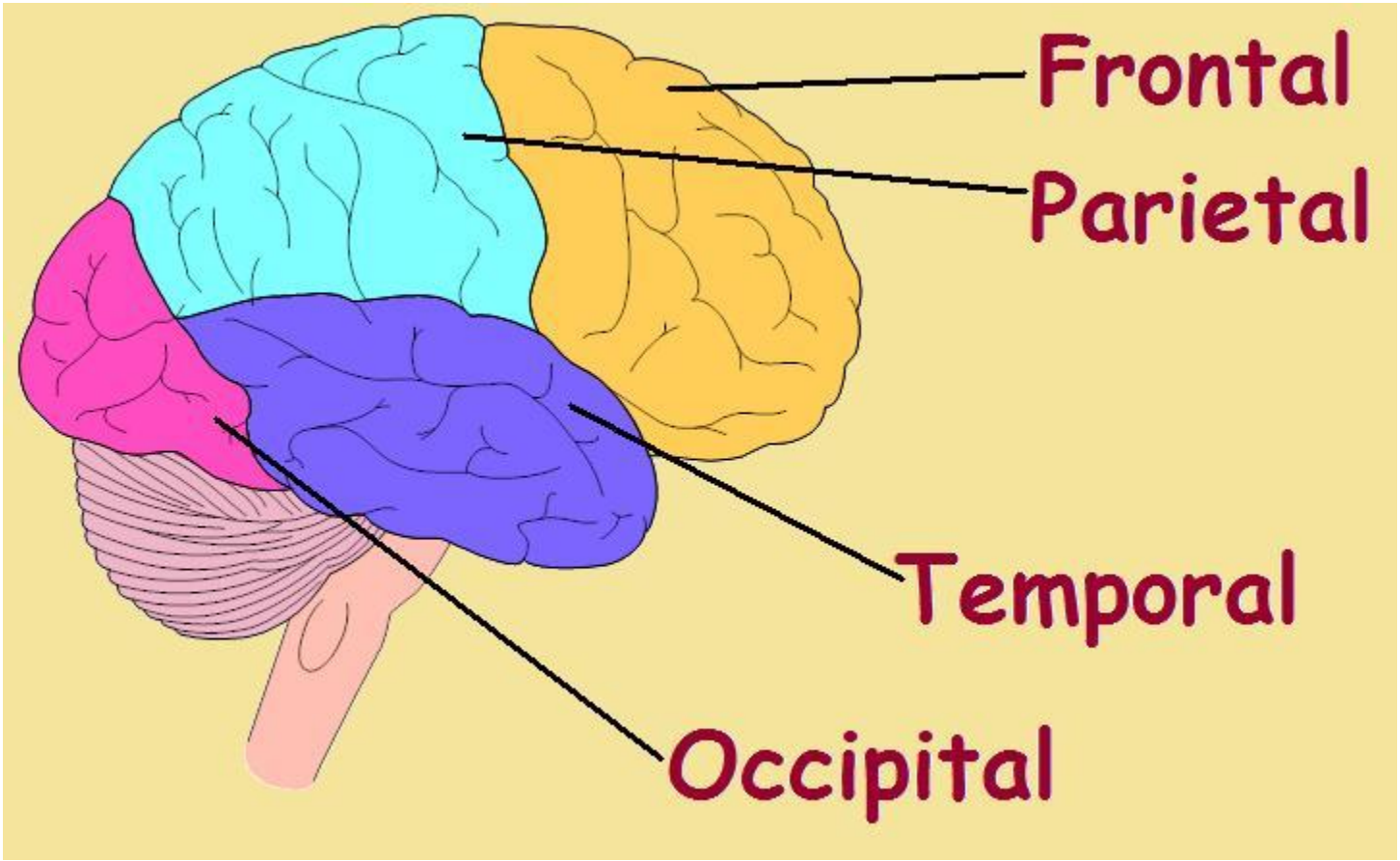
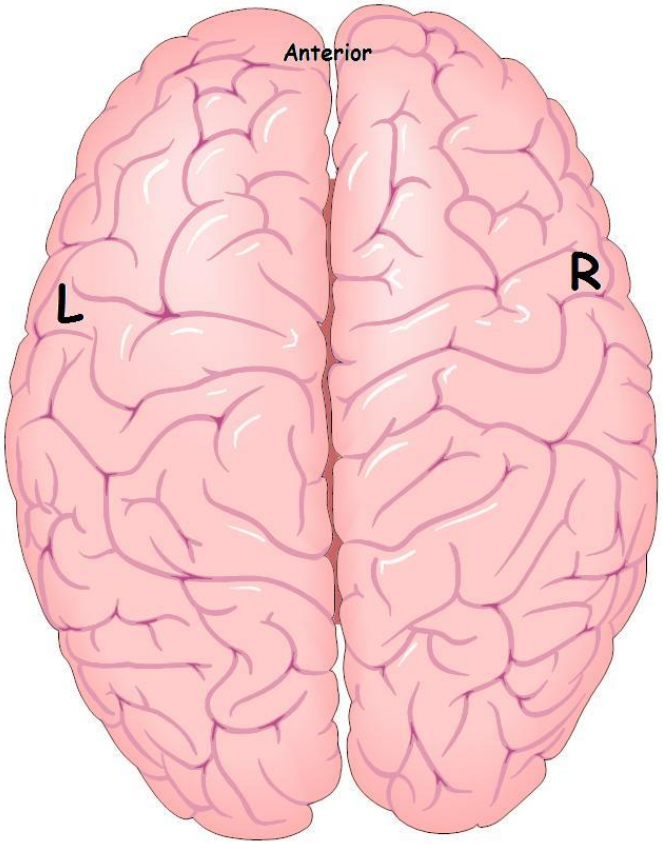
The Human Brain



Ganglion: Singular (ganglia, plural): A mass of nerve tissue; a group of nerve cell bodies, especially nerve cells external to the brain or spinal cord; **an encapsulated neural structure consisting of a collection of cell bodies or neurons.**

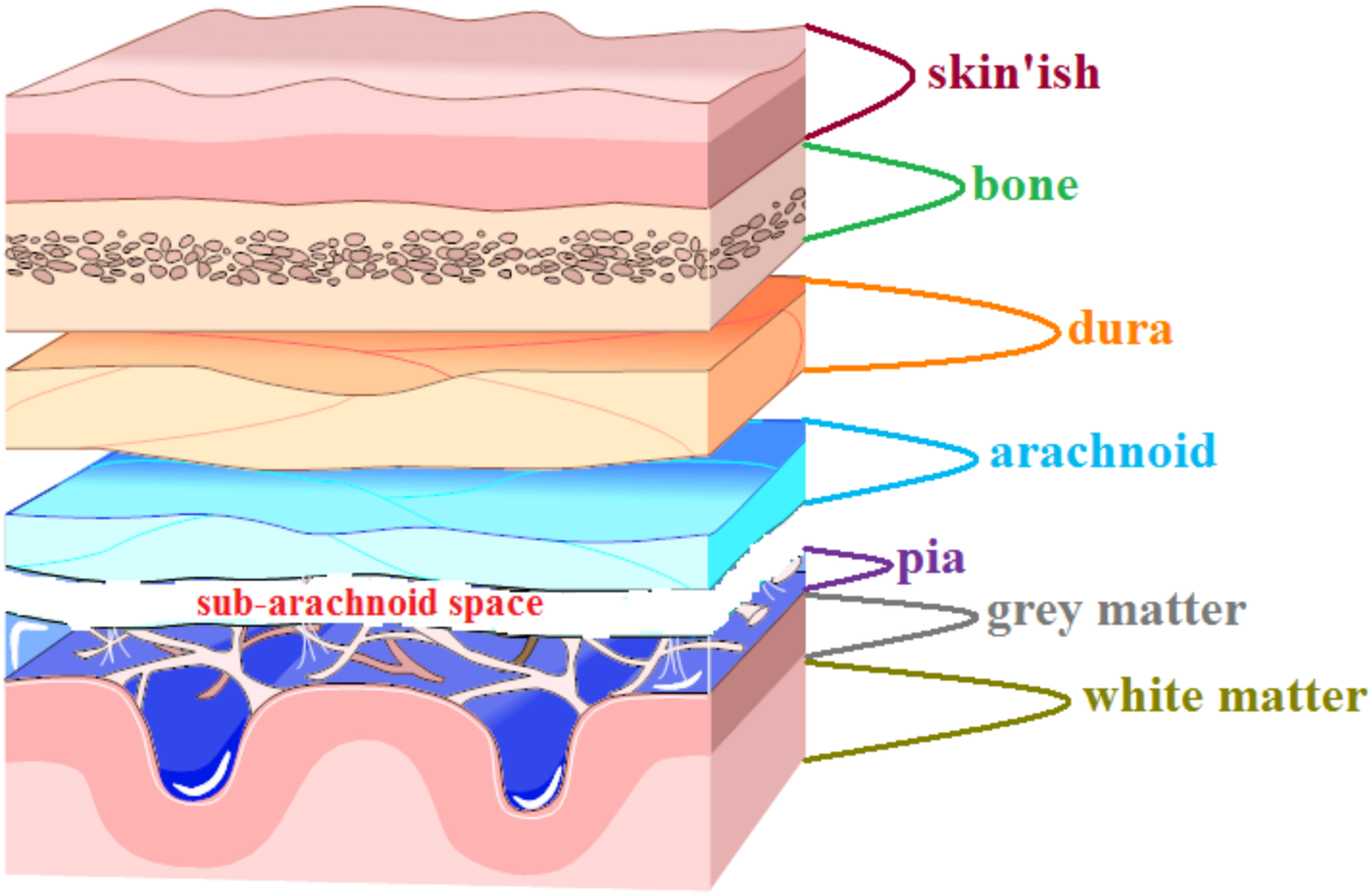

Frontal
Parietal
Temporal
Occipital

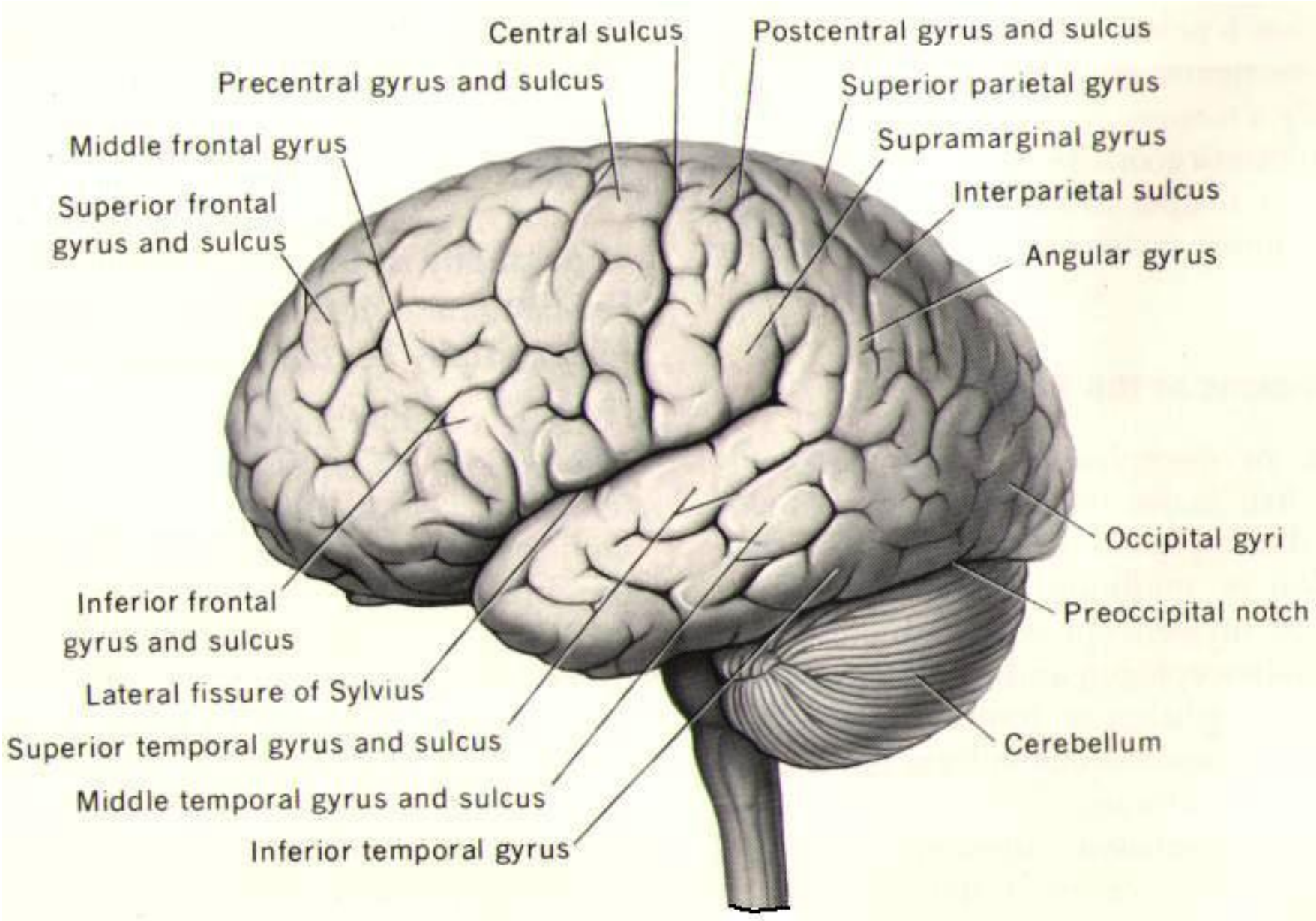
- Left hemisphere
- Controls right hand
- Language – verbal and written
- Logic, reasoning
- Science, Math

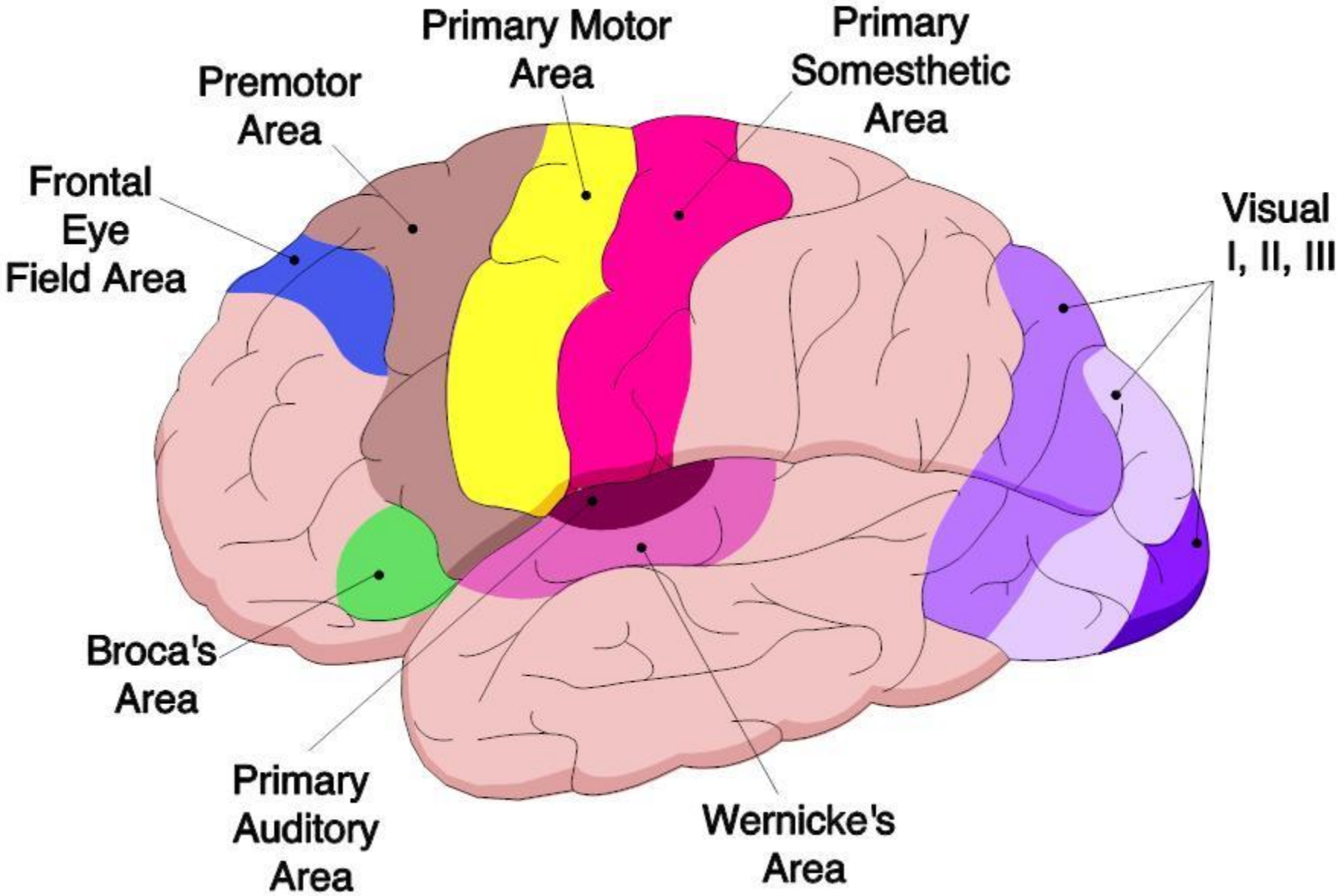


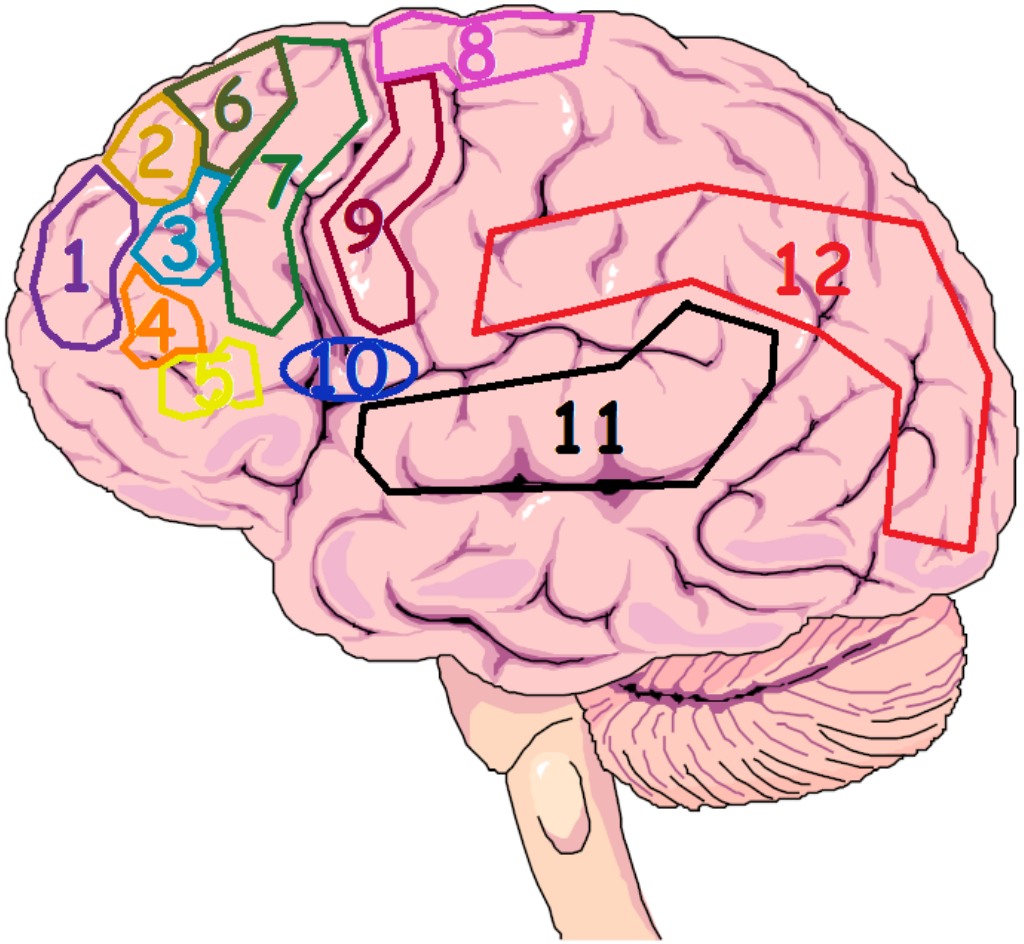
- Right hemisphere
- Controls left hand
- Imagination/creativity
- Spatial images and perception
- Music. Art
- Insight
- Relationship comparisons (objects vs objects)

Mind over “mater”

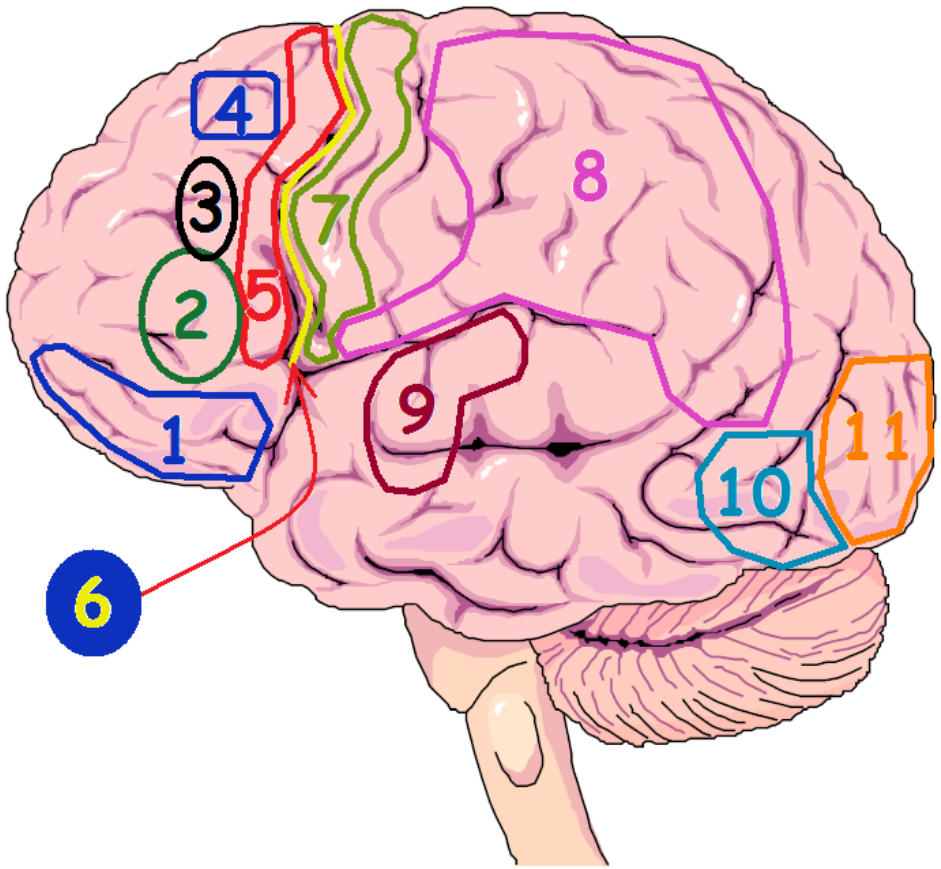



Central sulcus
Postcentral gyrus and sulcus
Precentral gyrus and sulcus
Superior parietal gyrus
Middle frontal gyrus
Supramarginal gyrus
Superior frontal gyrus and sulcus
Interparietal sulcus
Angular gyrus
Occipital gyri
Inferior frontal gyrus and sulcus
Preoccipital notch
Lateral fissure of Sylvius
Superior temporal gyrus and sulcus
Cerebellum
Middle temporal gyrus and sulcus
Inferior temporal gyrus


Primary Motor Area
Primary Somesthetic Area
Premotor Area
Frontal Eye Field Area
Visual I, II, III
Broca's Area
Primary Auditory Area
Wernicke's Area

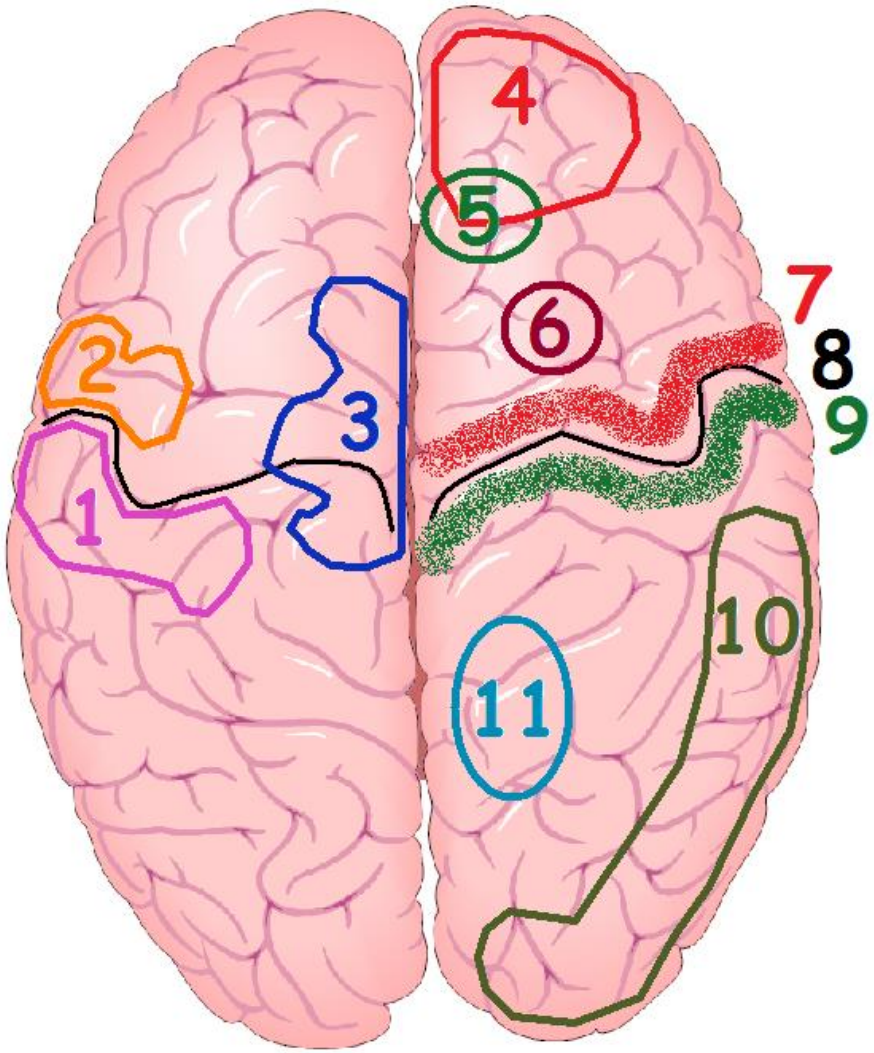


1. Eye movements
2. Arm/hand for'd extension
3. Hand supination; forearm extension
4. Mouth angle elevator/depressor
5. Lip/tongue movement
6. Coordinated arm/leg movements
7. Pre-central gyrus
8. Right leg/foot movement
9. Wrist/finger movement
10. Mouth angle retraction
11. Hearing
12. Vision



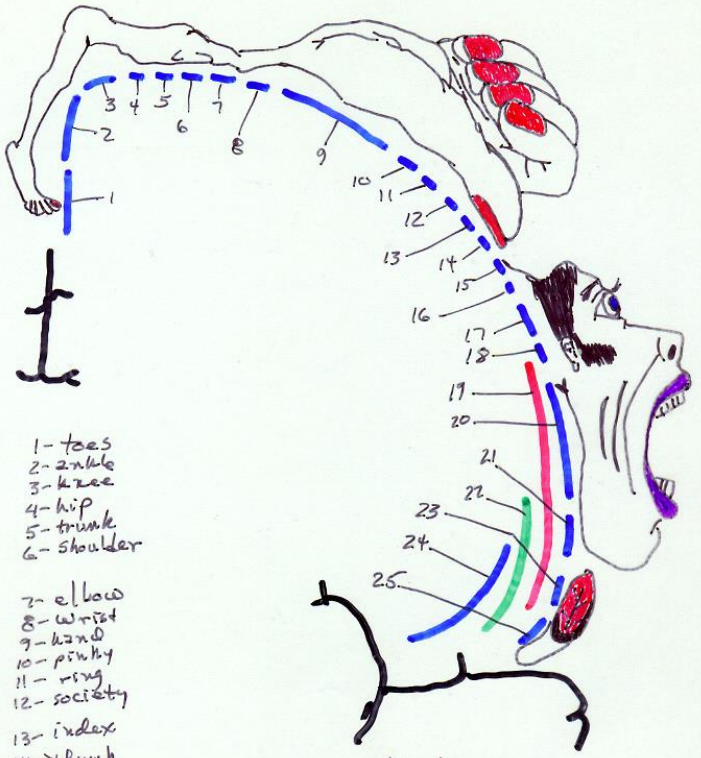
1. Prefrontal cortex – thought and emotion elaboration
2. Broca's area – motor for speech; on left hemisphere only
3. Frontal eye field; voluntary scanning movements of eyes
4. Pre-motor cortex; writing
5. Pre-central gyrus; primary motor area for muscle contraction
6. Central sulcus
7. Post-central gyrus; primary somatosensory center
8. Smell; taste; integrates impulses for other areas so that a common thought can be formed; somatosensory association;
9. Wernicke's area for speech, music or noise; translates words to thoughts; gustatory cortex for taste
9. Primary auditory area; pitch, rhythm association
10. Visual association area; recognition and evaluation
11. Primary visual cortex; shape, color and/or motion

1. Finger and wrist motion
2. Oral angle elevator and depressors
3. Swimming movements; coordinates arms and legs
4. Eye movement
5. Arm/hand for'd extension



6. Supinate hand; flex forearm
7. Pre-central gyrus
8. Central sulcus
9. Post-central gyrus
10. Vision
11. To move Rt leg and foot

Motor Function - Cortex



1- toes
2- ankle
3- knee
4- hip
5- trunk
6- shoulder

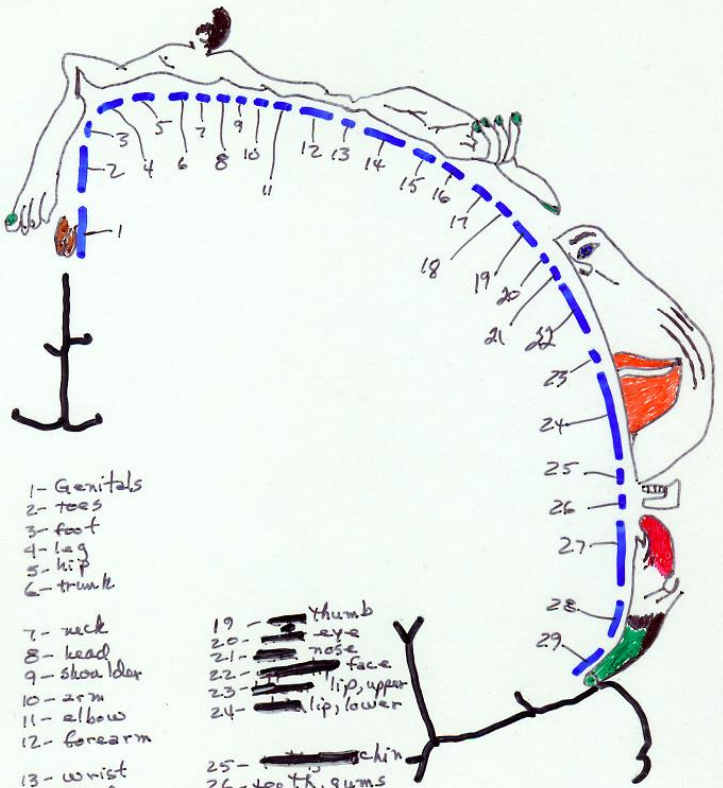
7- elbow
8- wrist
9- hand
10- pinky
11- ring
12- society

13- index
14- thumb
15- neck
16- brow
17- eyelid/ball
18- face

19 - vocalization
20 - lips
21 - jaw
22 - drooling
23 - tongue
24 - chewing

25 - swallowing

Sensory Function - Cortex



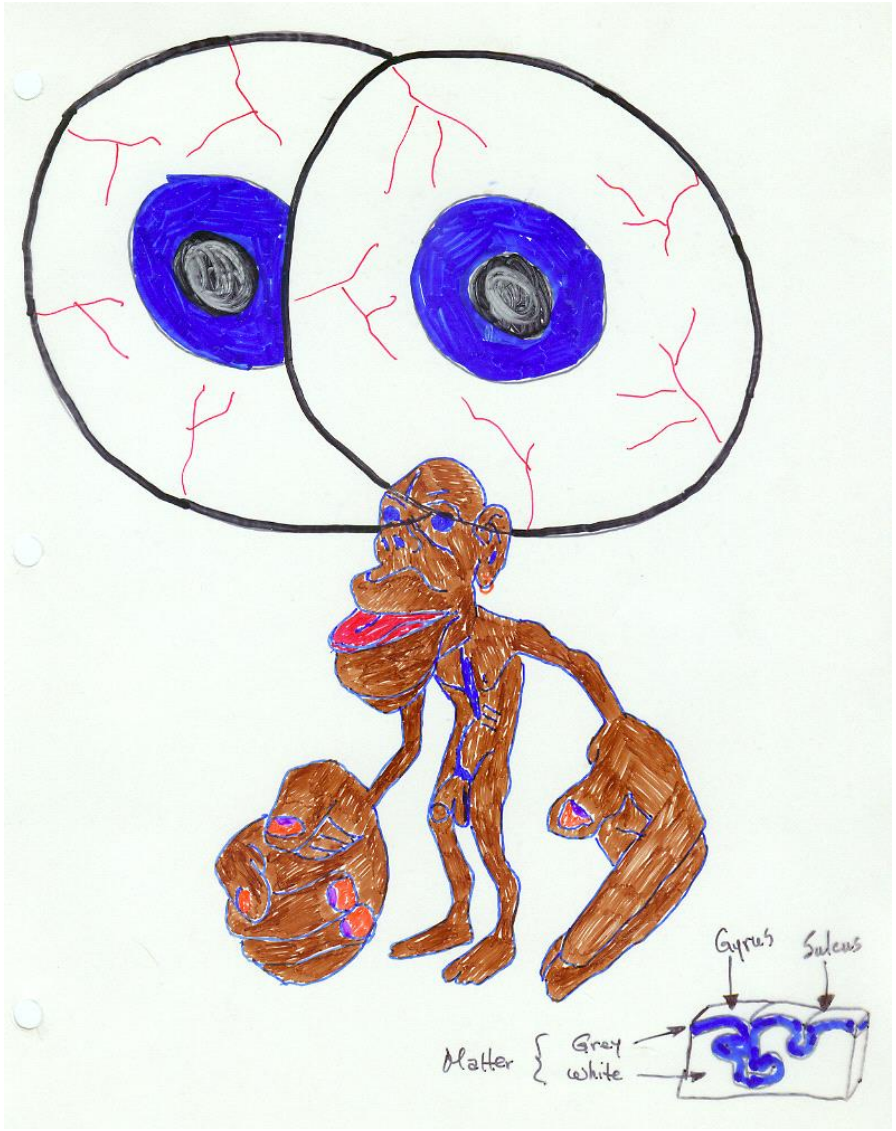
1- Genitals
2- toes
3- foot
4- leg
5- hip
6- trunk

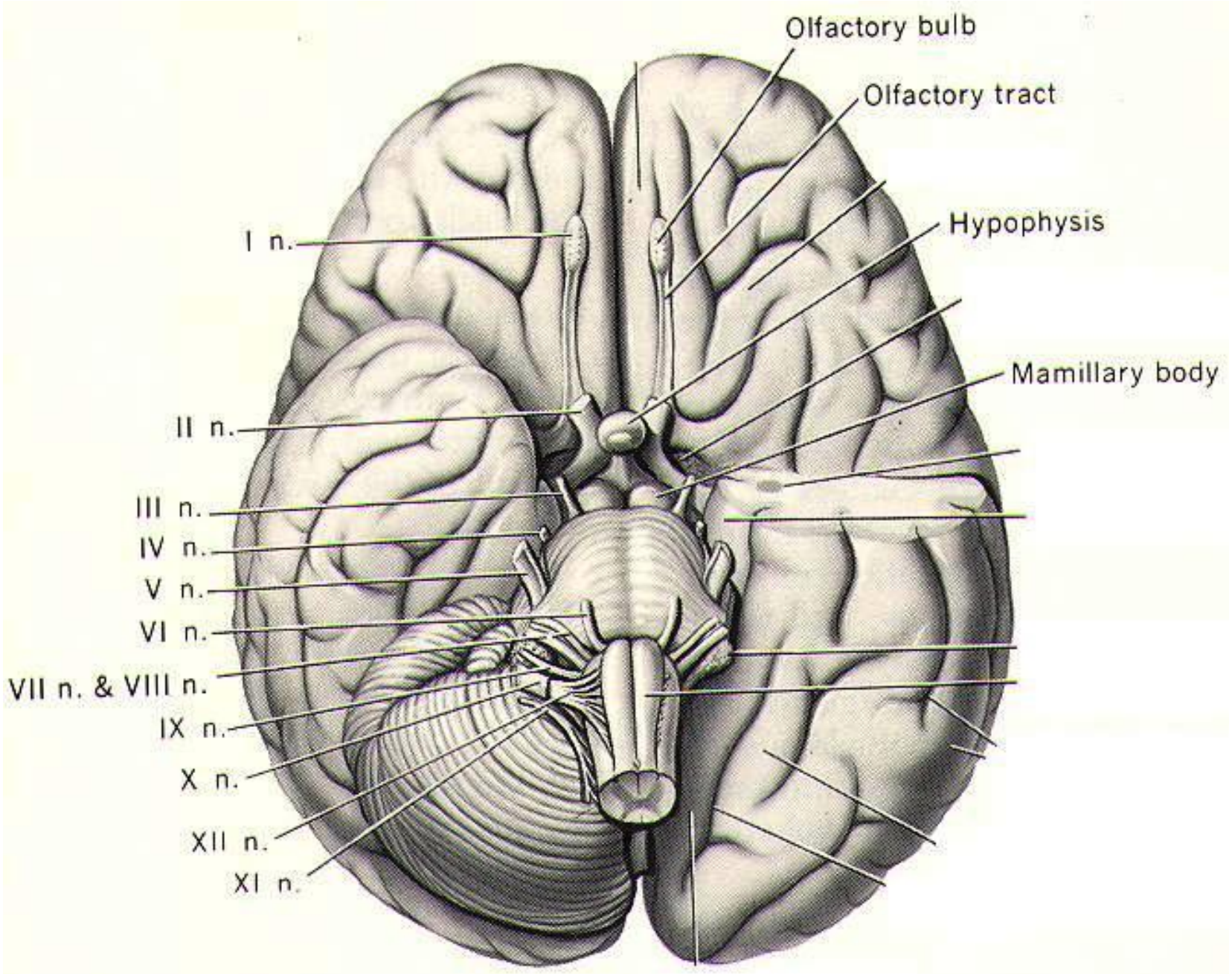
7- neck
8- head
9- shoulder
10- arm
11- elbow
12- forearm

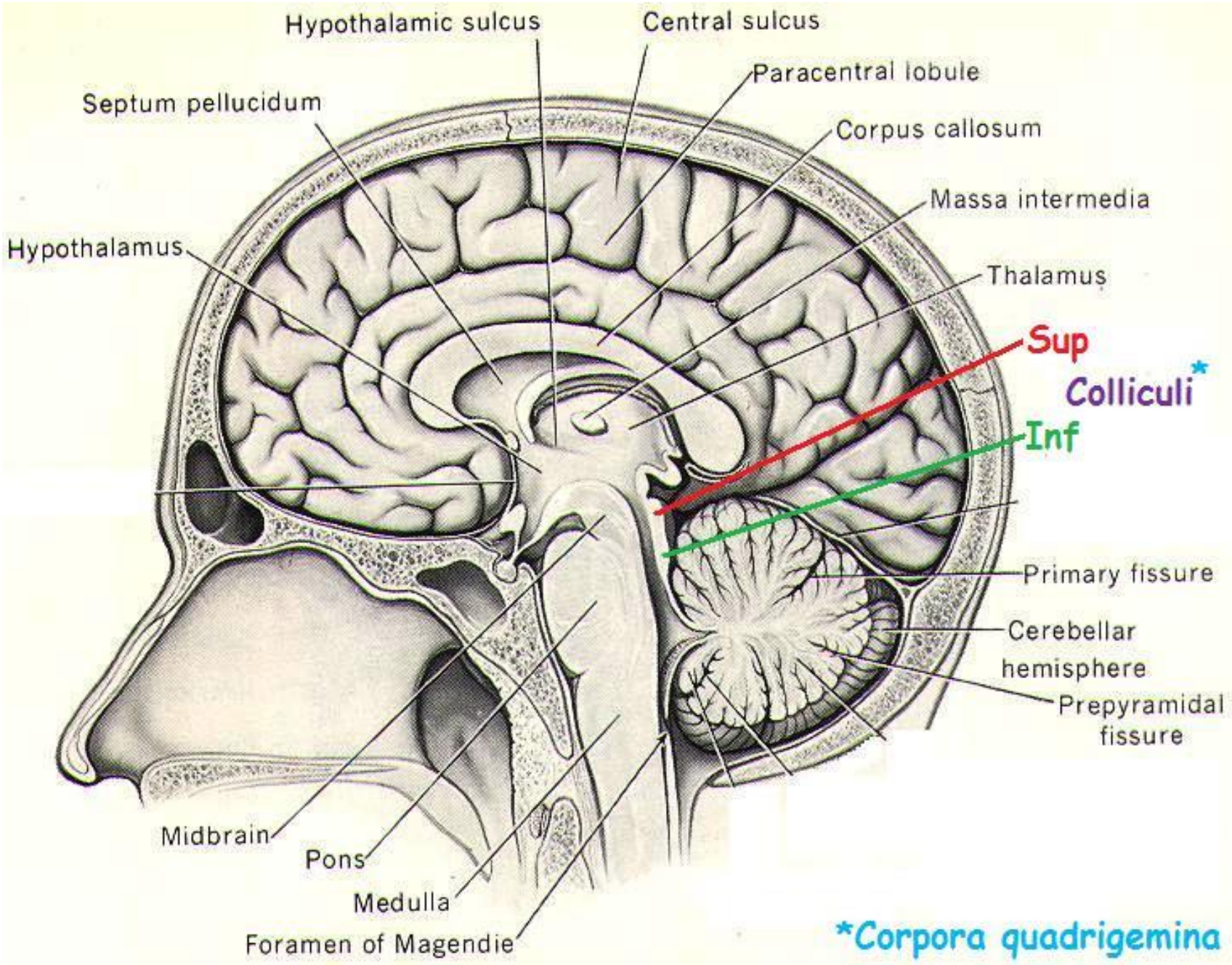
13- wrist
14- hand
15- little
16- ring
17- society
18- index

19 - thumb
20 - eye
21 - nose
22 - face
23 - lip, upper
24 - lip, lower

25 - chin
26 - teeth, gums
27 - tongue
28 - pharynx
29 - viscera


Gyrus
Sulcus
Matter
Grey
White


Olfactory bulb
Olfactory tract
Hypophysis
Mamillary body
I n.
II n.
III n.
IV n.
V n.
VI n.
VII n. & VIII n.
IX n.
X n.
XII n.
XI n.


Hypothalamic sulcus
Central sulcus
Paracentral lobule
Septum pellucidum
Corpus callosum
Massa intermedia
Hypothalamus
Thalamus
Sup
Colliculi*
Inf
Primary fissure
Cerebellar
hemisphere
Prepyramidal
fissure
Midbrain
Pons
Medulla
Foramen of Magendie
*Corpora quadrigemina

Internal Brain Terminology

1) Gyrus rectus: participates in prefrontal associational integration
2) Septum pellucidum: probably has no special functional importance. Separates the R and L ventricles from each other
3) External capsule: function appears to be unknown
4) Extreme capsule: an efferent cortical bundle
5) Internal capsule: function still unclear – may have motor functions as some studies seem to be suggesting in post-CVA patients

Internal Brain Terminology

6) Putamen: seems to be involved in motor activities; cutting paper with scissors, throwing a baseball, hammering a nail or even writing are regulated by the putamen
7) Globus pallidus: presumably assists in the guidance of movements directly controlled by the frontal motor areas
8) Lenticular nucleus: putamen and globus pallidus combined
9) Ansa lenticularis: works with the globus pallidus
10) Caudate nucleus: an extension of the putamen; the caudate nucleus is important for cognitive control & planning of movement sequences and movements executed in parallel (synchronously -- "walking and chewing gum at the same time"). Running to a tree and climbing it to escape from a wild beast is another example of the caudate nucleus in action.

Internal Brain Terminology

11) Amygdaloid nucleus: central structure of the limbic system; stimulation may result in smacking, salivation, licking and chewing movements. There may also be emptying of the bladder and rectum.
    - ✓ Stimulation increases food intake, whereas stimulation of the basolateral region reduces feeding behavior. Stimulation of the basolateral region results in arousal and attention. Strong stimulation of the same group can produce powerful fear or rage. Destruction of this nucleus of violent criminals has reduced their aggressiveness. Seems to be important for learning to associate objects with reward or punishment.
    - ✓ Is also a key structure for fear learning. Fear conditioning has been demonstrated to have many effects on hypothalamic and brain stem centers mediated by the central amygdaloid nucleus. Is among the brain areas with the highest density of receptors for sex hormones.
    - ✓ Stimulation of the corticomedial region may cause ovulation in the female, but cutting the stria terminalis abolishes this effect. The range of emotions associated with this nucleus is really quite wide.
12) Terminalis striae and vena: may play a role in mediating male sexual behavior

Internal Brain Terminology

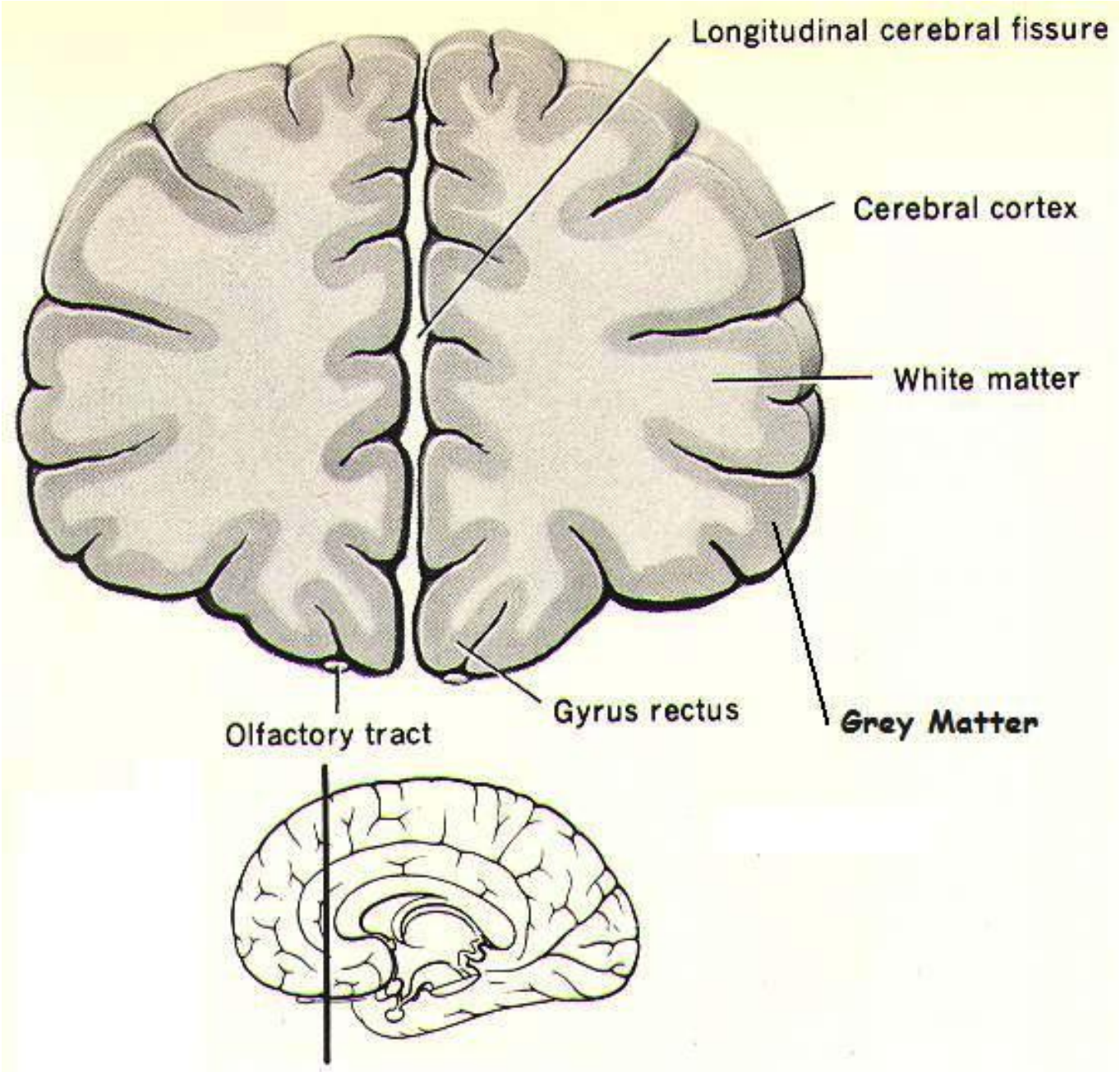
13) Claustrum: seems to have visual sensory functions
14) Calcarine sulcus: location of primary visual cortex; aka calcarine groove
15) Lateral geniculate body: uncertain; may be involved in visual perception; optic tract terminates here; retinal nerve impulses received here
16) Insula: associated with visceral functions; = Island of Reil

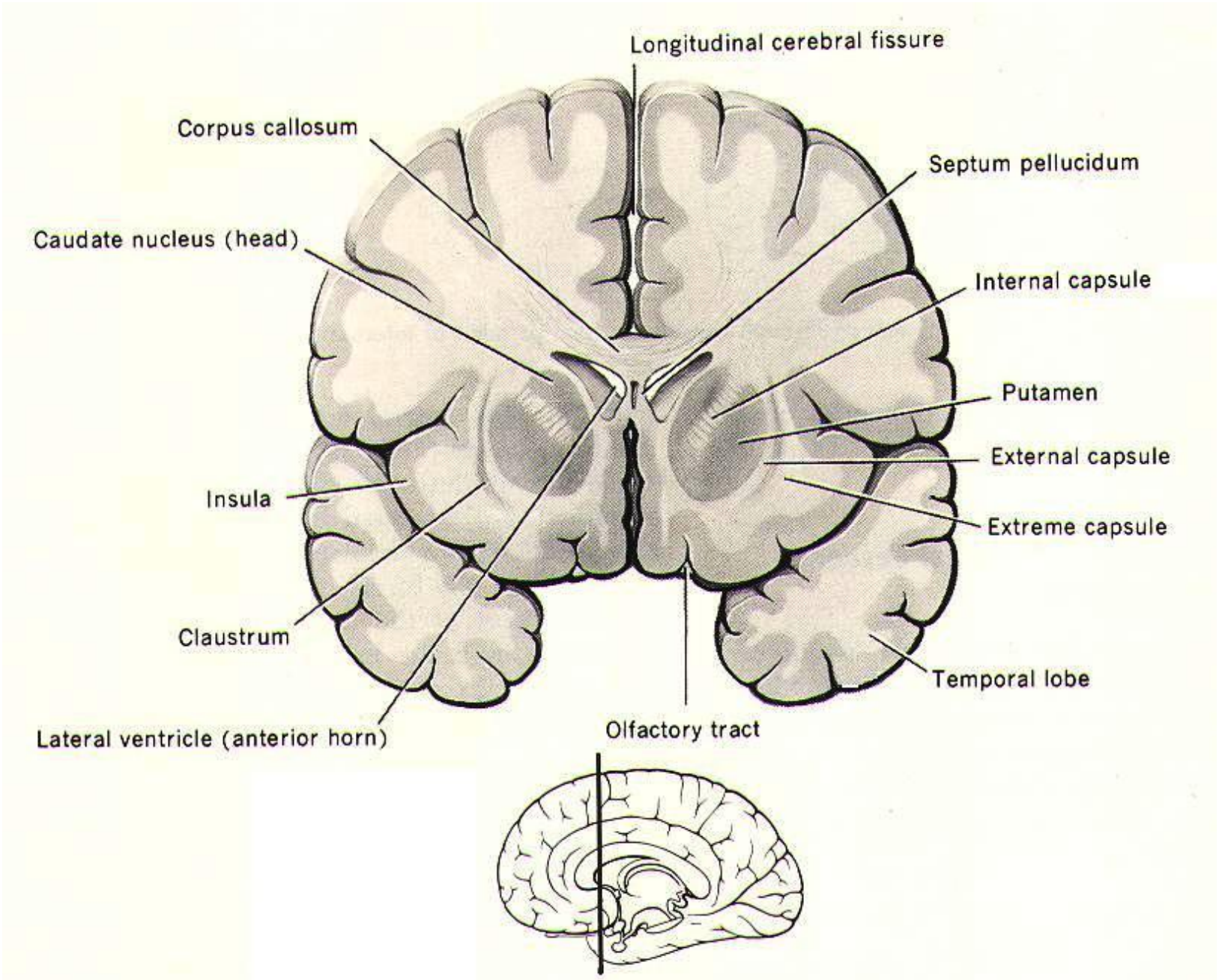
Internal Brain Terminology

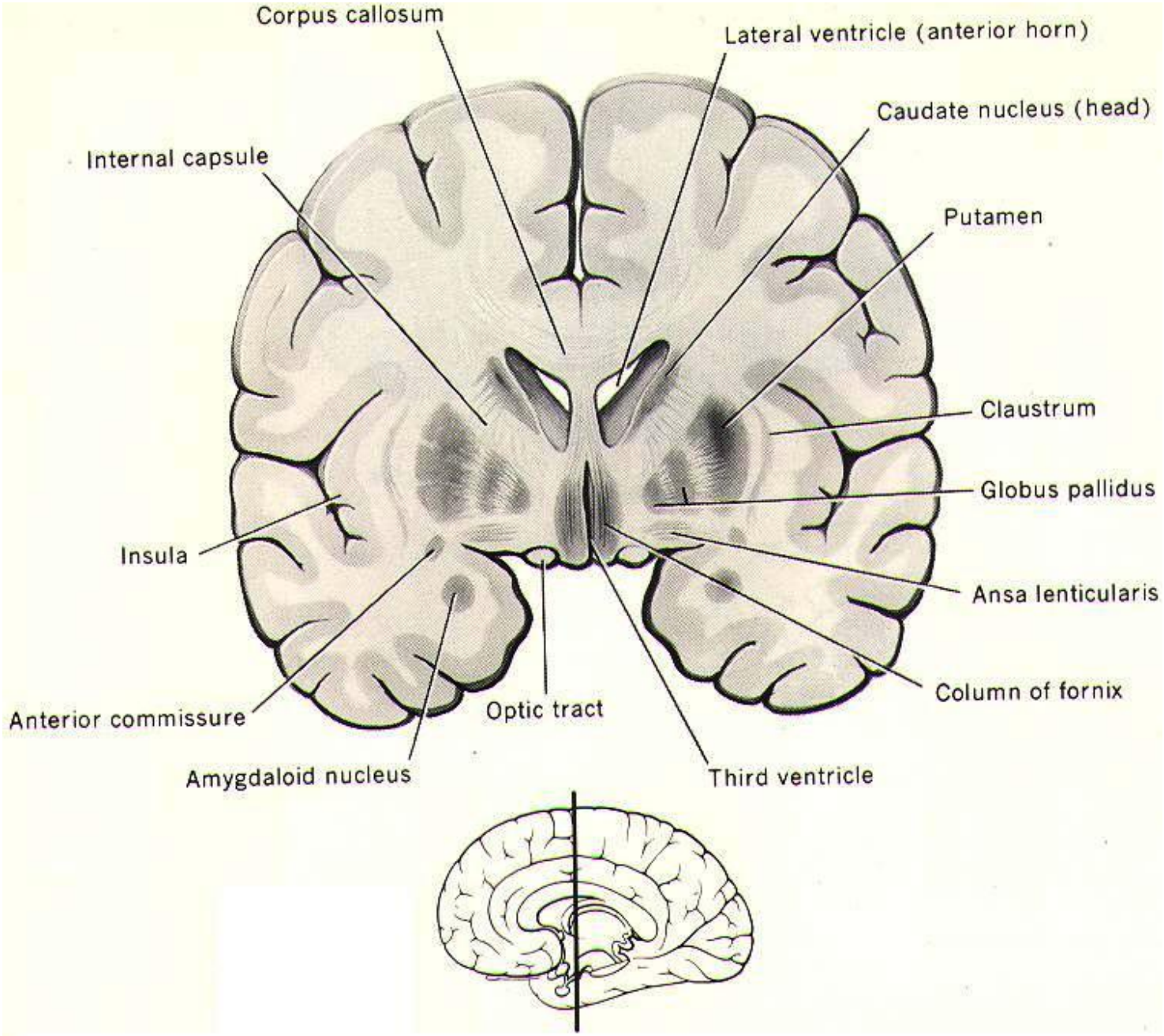
17) Ganglion: a collection of cell bodies in the peripheral nervous system (PNS). (Early anatomists referred to the nuclei in the brain as "ganglia").
18) Anterior commissure: commissures are collections of axons in the CNS that interconnect symmetrical structures in both halves of the brain; the anterior interconnects the anterior temporal lobes and olfactory structures
19) Velum interpositum: is the membranous roof of the 3d ventricle of the brain; seems to be involved in filtering the blood/CSF; involves 2 layers of pia with blood vessels sandwiched between them.
20) Tapetum: forms part of the roof of the lateral ventricles
21) Cerebral peduncles: function remains unelucidated

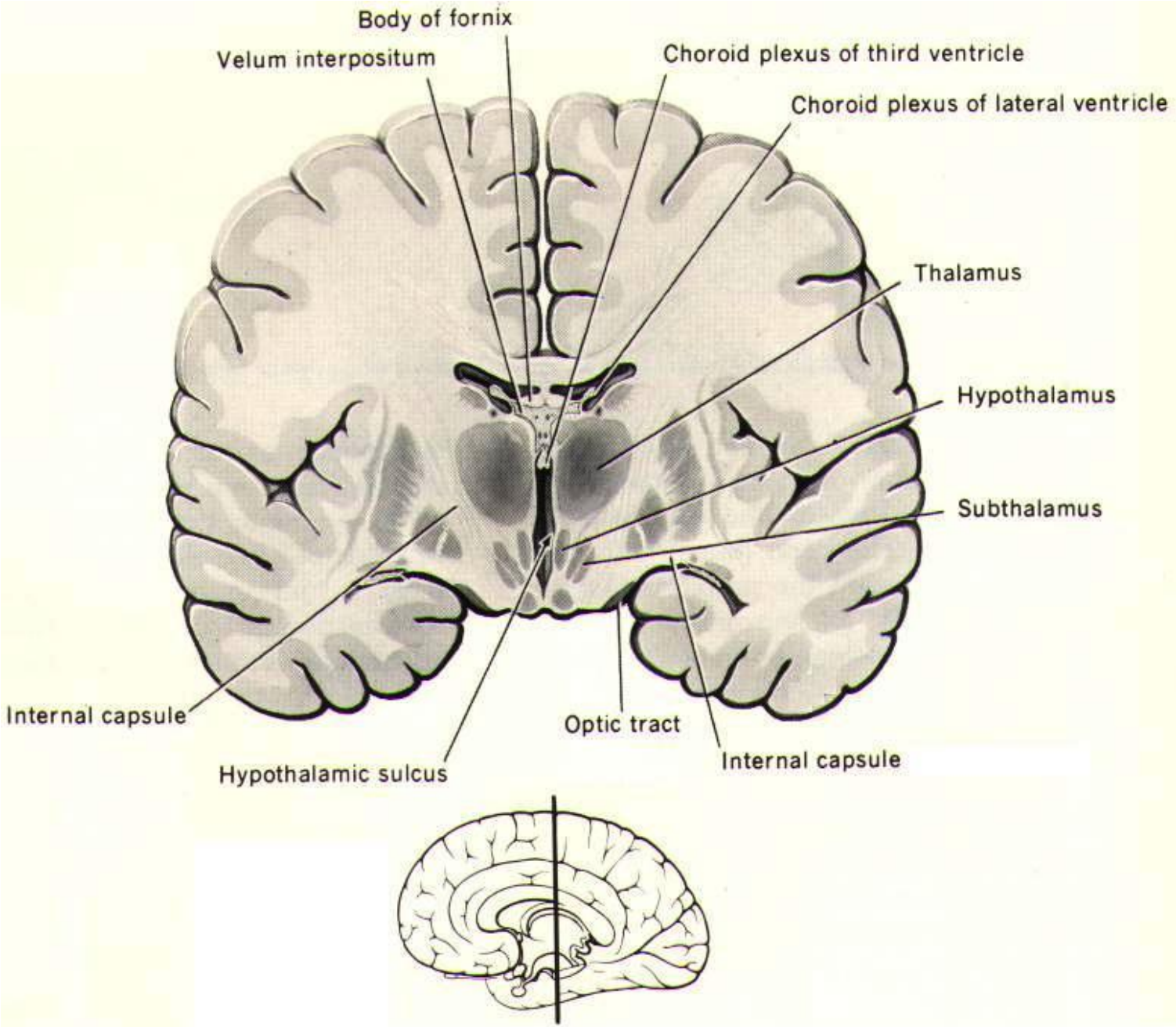
Internal Brain Terminology

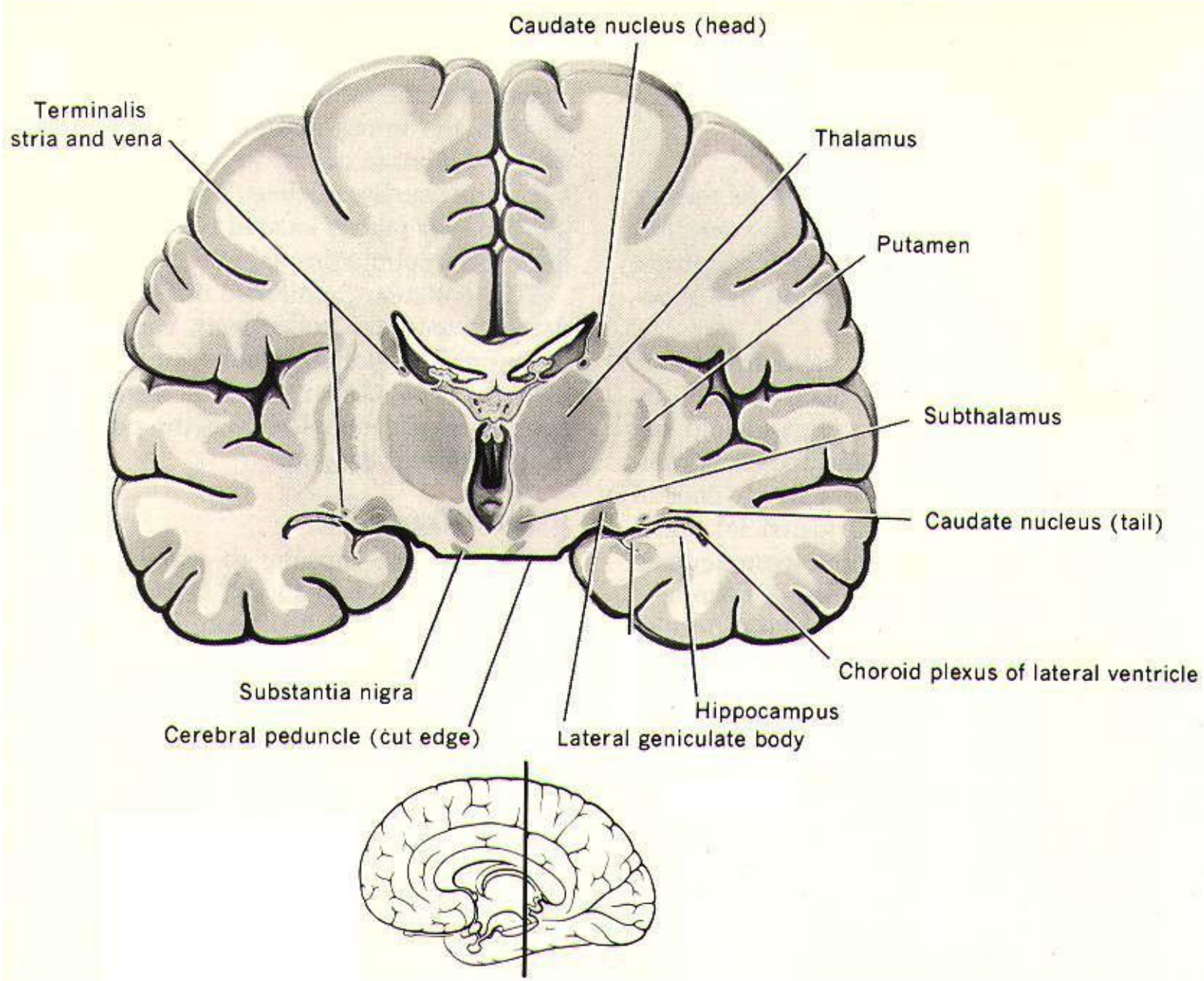
22) Substantia nigra: seems to be primarily dopaminergic; degeneration of this tissue is observed in patients who /develop have Parkinson's disease
23) Locus ceruleus: seems to be primarily noradrenergic
24) Hippocampus: hippocampus is currently regarded as an organ of learning rather than an organ of emotion; long term memory and spatial navigation; exercise seems to improve function and size

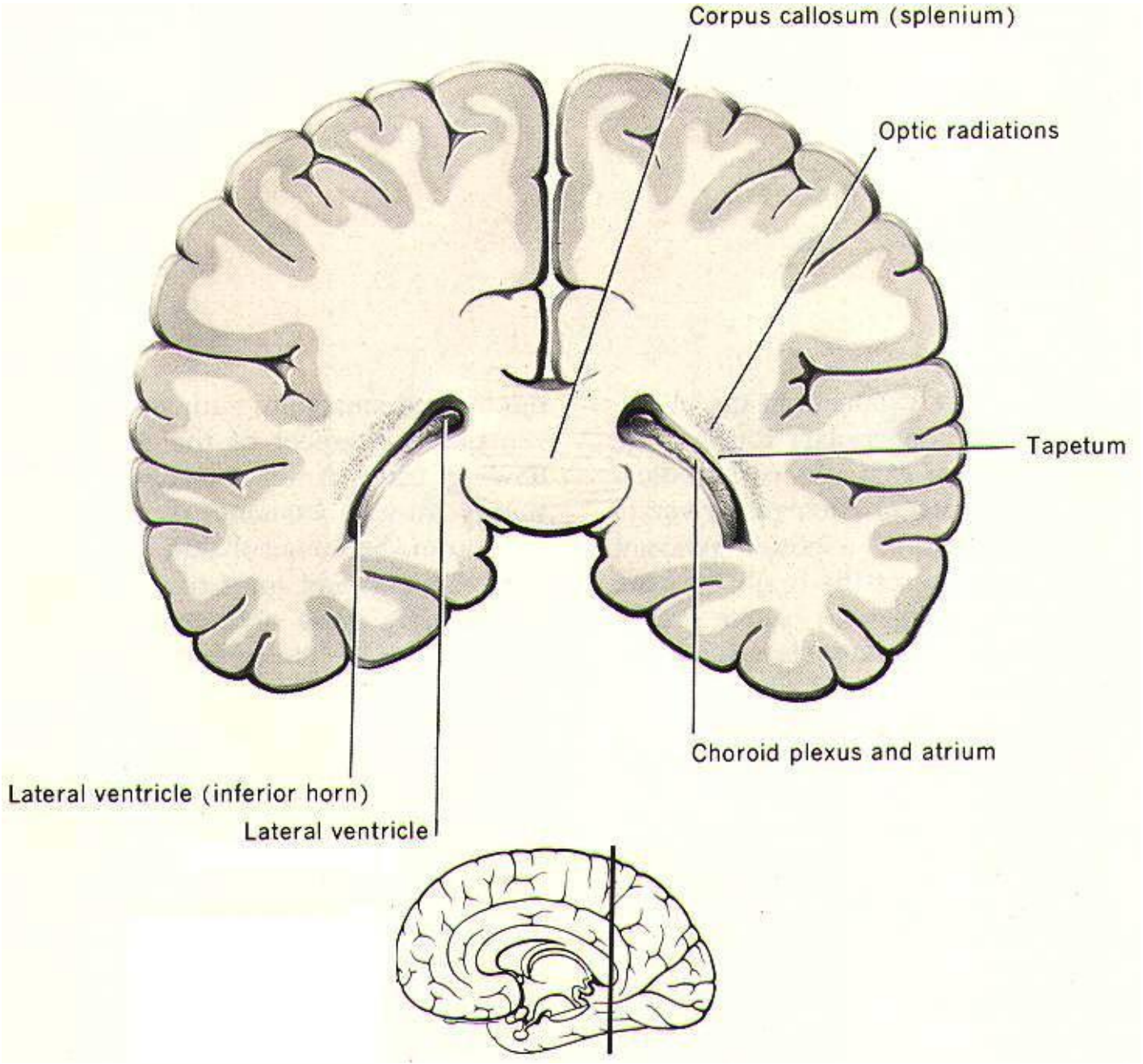

Longitudinal cerebral fissure
Cerebral cortex
White matter
Grey Matter
Gyrus rectus
Olfactory tract

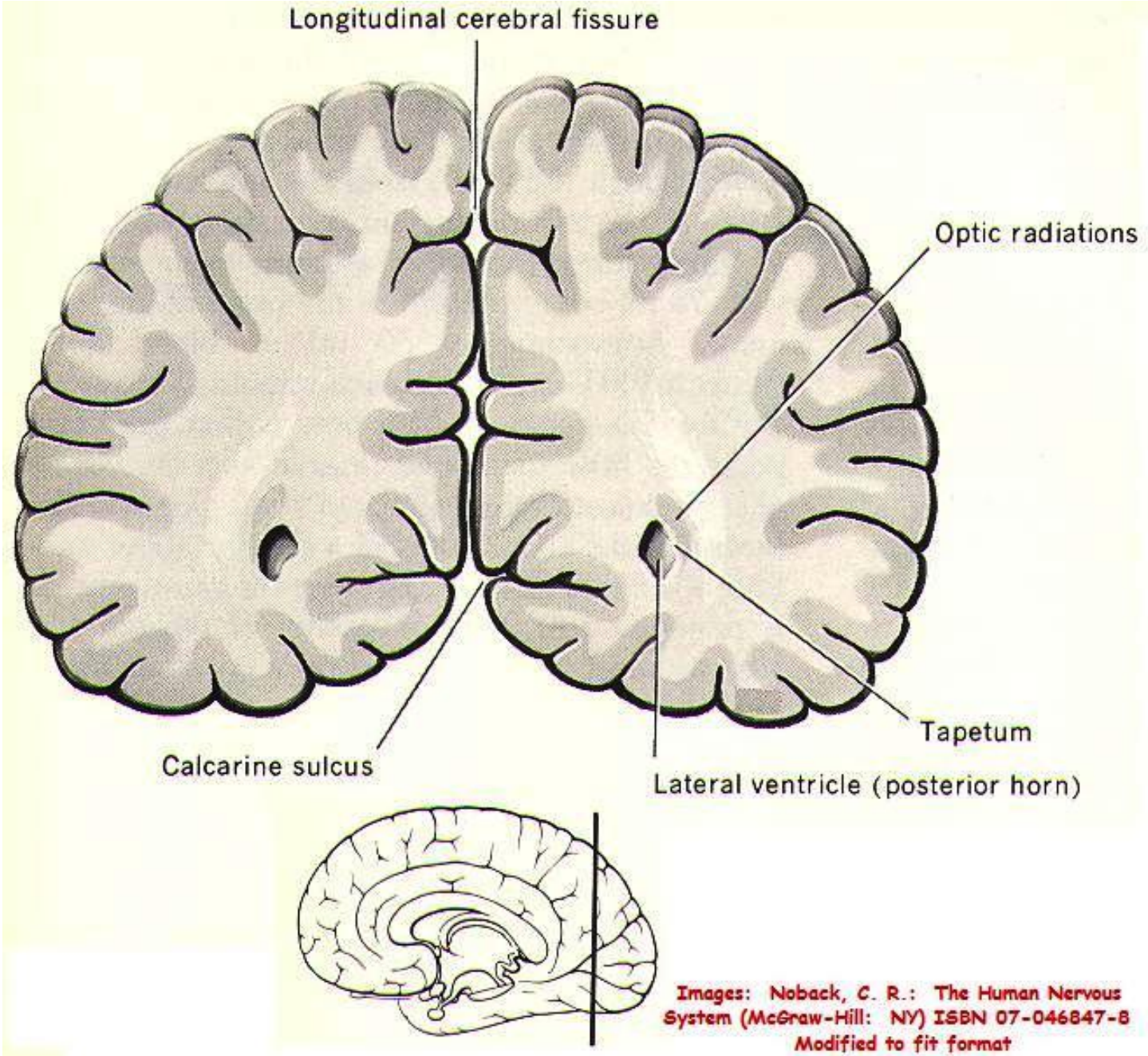

Longitudinal cerebral fissure
Corpus callosum
Septum pellucidum
Caudate nucleus (head)
Internal capsule
Putamen
External capsule
Insula
Extreme capsule
Claustrum
Temporal lobe
Lateral ventricle (anterior horn)
Olfactory tract


Corpus callosum
Lateral ventricle (anterior horn)
Caudate nucleus (head)
Internal capsule
Putamen
Claustrum
Globus pallidus
Insula
Ansa lenticularis
Column of fornix
Anterior commissure
Optic tract
Amygdaloid nucleus
Third ventricle


Body of fornix
Velum interpositum
Choroid plexus of third ventricle
Choroid plexus of lateral ventricle
Thalamus
Hypothalamus
Subthalamus
Internal capsule
Optic tract
Internal capsule
Hypothalamic sulcus

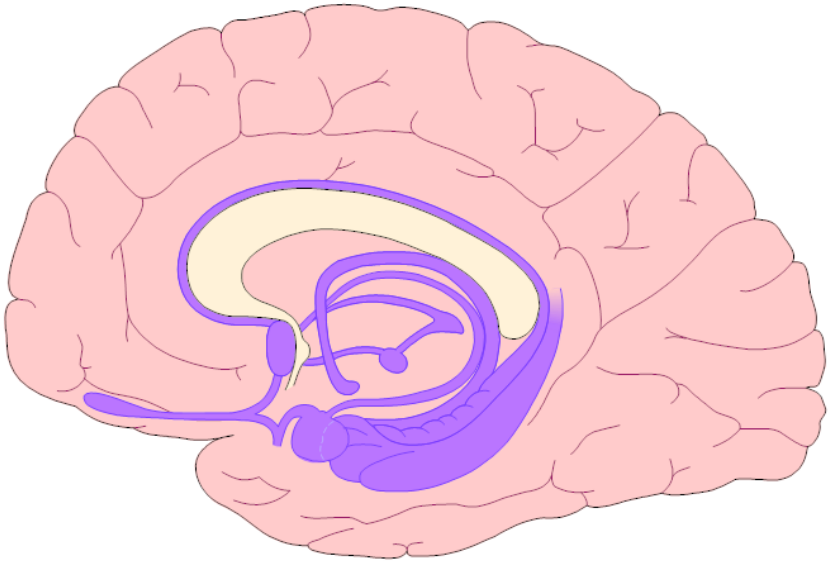

Caudate nucleus (head)
Terminalis stria and vena
Thalamus
Putamen
Subthalamus
Caudate nucleus (tail)
Choroid plexus of lateral ventricle
Substantia nigra
Cerebral peduncle (cut edge)
Hippocampus
Lateral geniculate body


Corpus callosum (splenium)
Optic radiations
Tapetum
Choroid plexus and atrium
Lateral ventricle (inferior horn)
Lateral ventricle



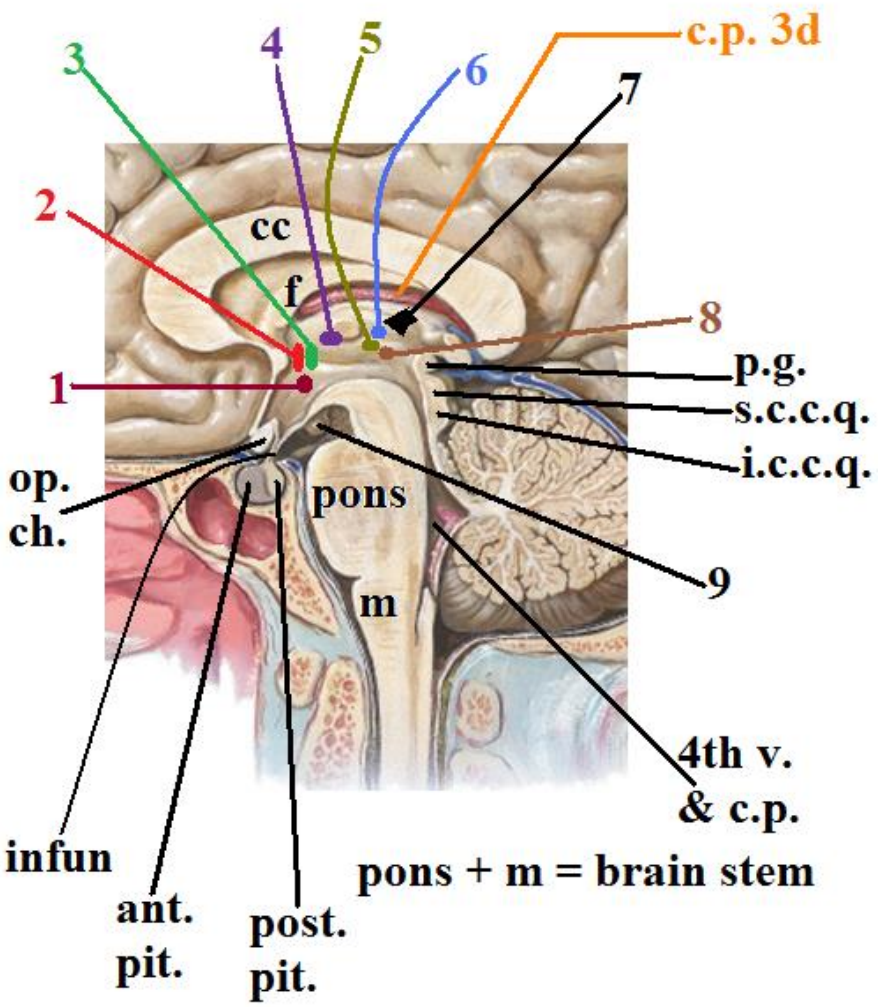
Images: Noback, C. R.: The Human Nervous System (McGraw-Hill: NY) ISBN 07-046847-8
Modified to fit format

The Limbic System

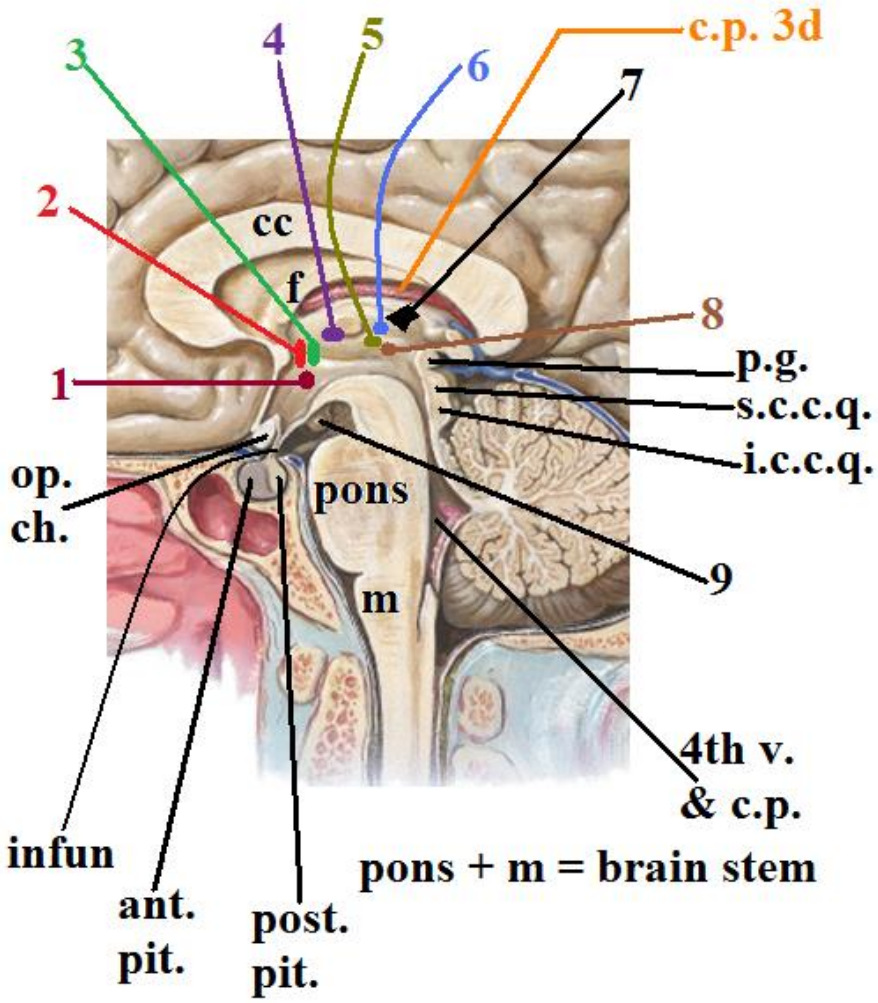


- Emotional experience and expression, fear, anger, pleasure, sorrow
- Recognizes upsets that threaten a person's life: physical OR psychological
- With unpleasant feelings, guides person into behavior that is aimed at improving/increasing survival
- Self-preservation, feeding, flight or fight (or freeze)
- Species' preservation: mating, procreation, care of offspring

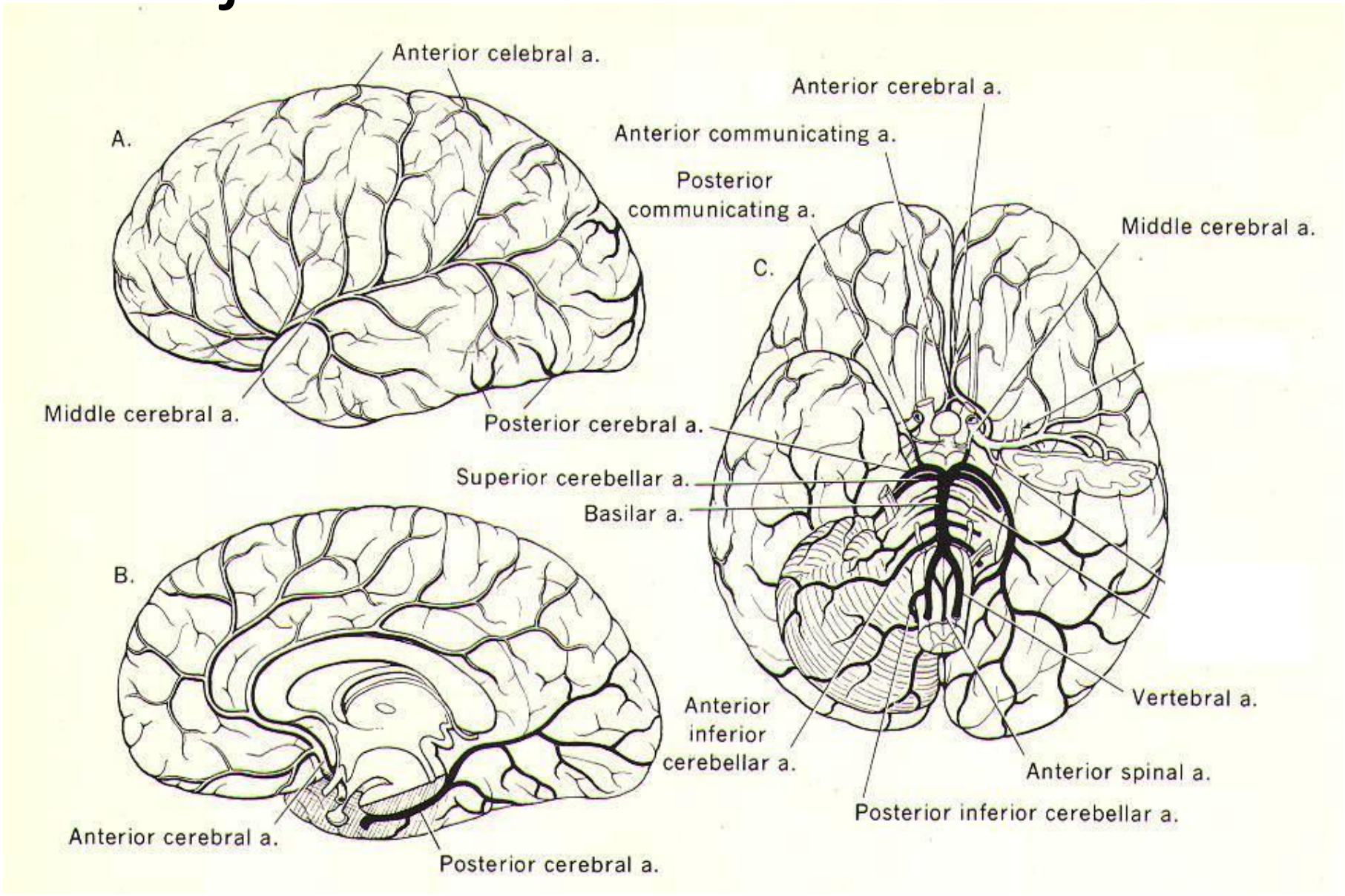
1. SON – AVP secreted; conserves water
2. Medial Pre-optic area – contracts bladder, lowers BP and HR
3. Posterior pre-optic and ant. Hypothalamic area– regulates body temperature; panting/sweating area, TRH inhibition
4. PVN – OT release; water conservation ±, satiety
5. Perifornical nucleus – hunger, elevates BP, rage



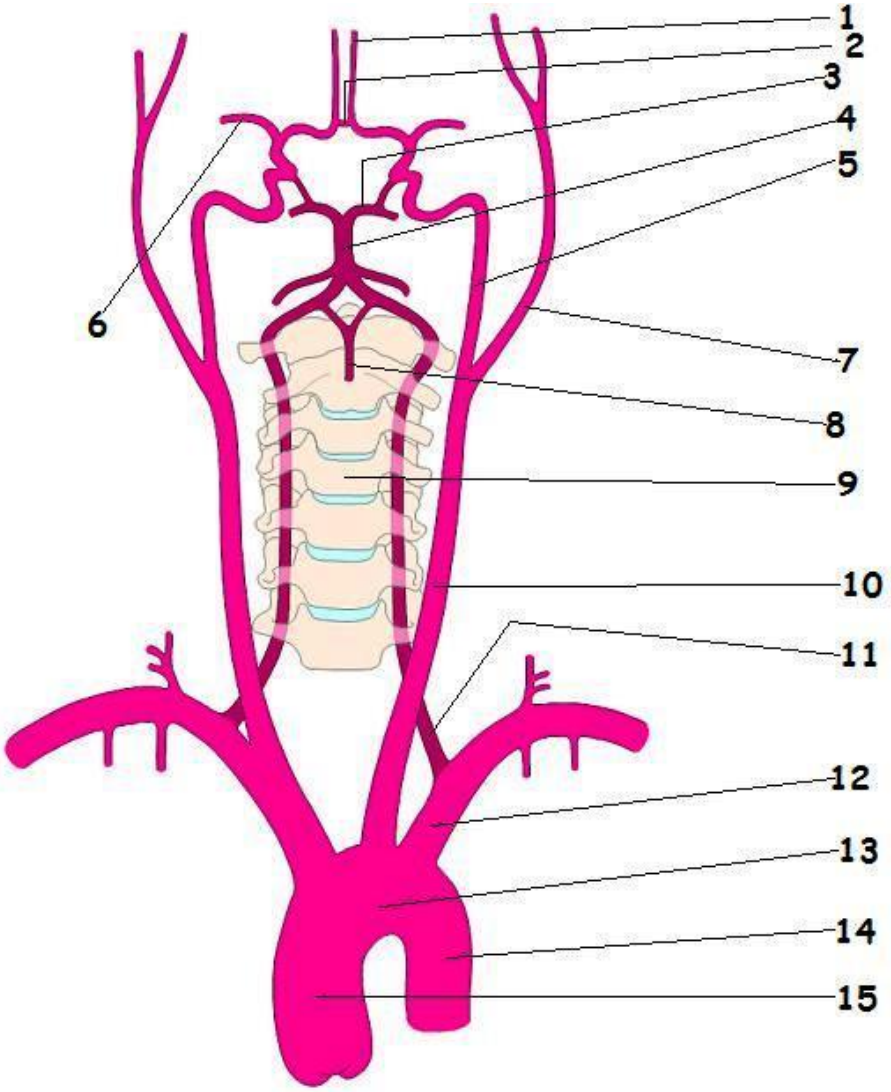
6. Dorso-medial nucleus – stimulates GI centers
7. Posterior hypothalamus – elevates BP; dilates pupils; shiver center; CRH release
8. Ventro-medial nucleus – satiety center
9. Mammillary body – feeding reflexes
10. NOT SHOWN: lateral hypothalamic area – thirst and hunger centers



Major Arteries Outside the Brain

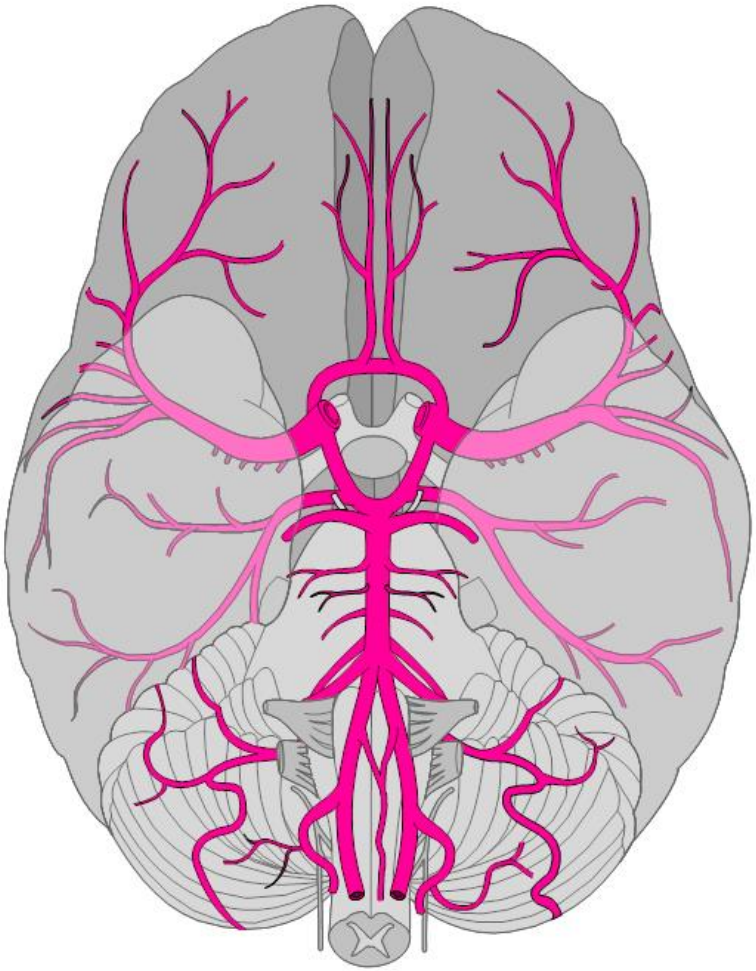


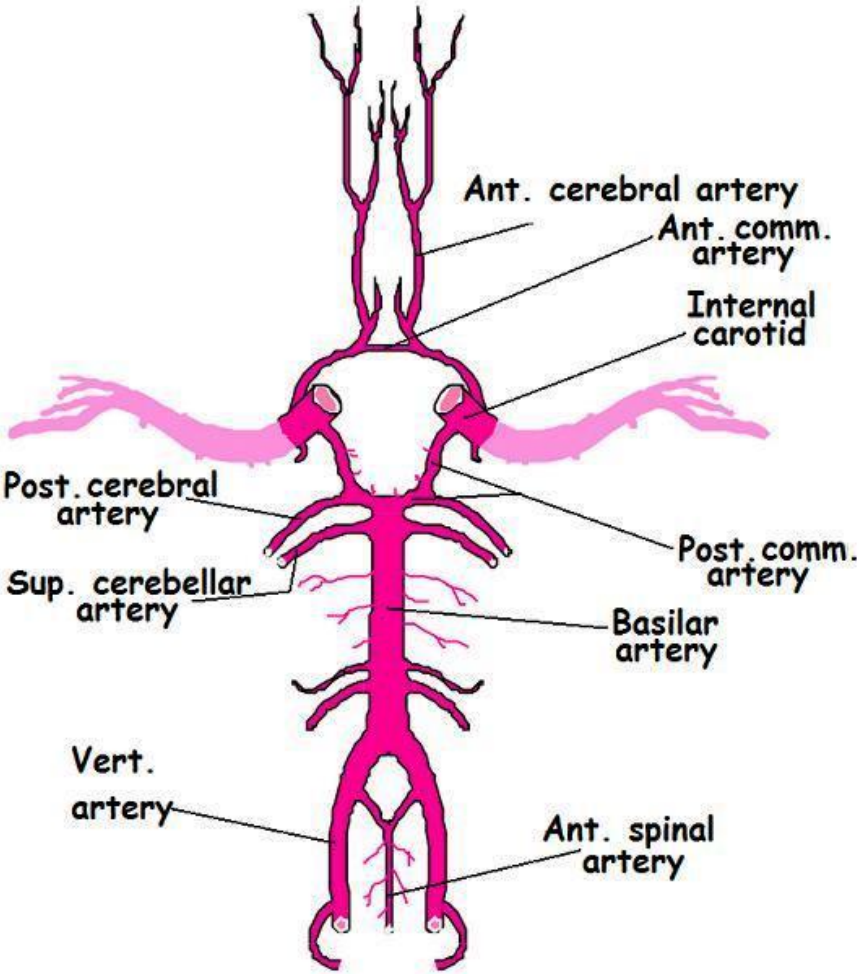
Vascular Supply to Brain

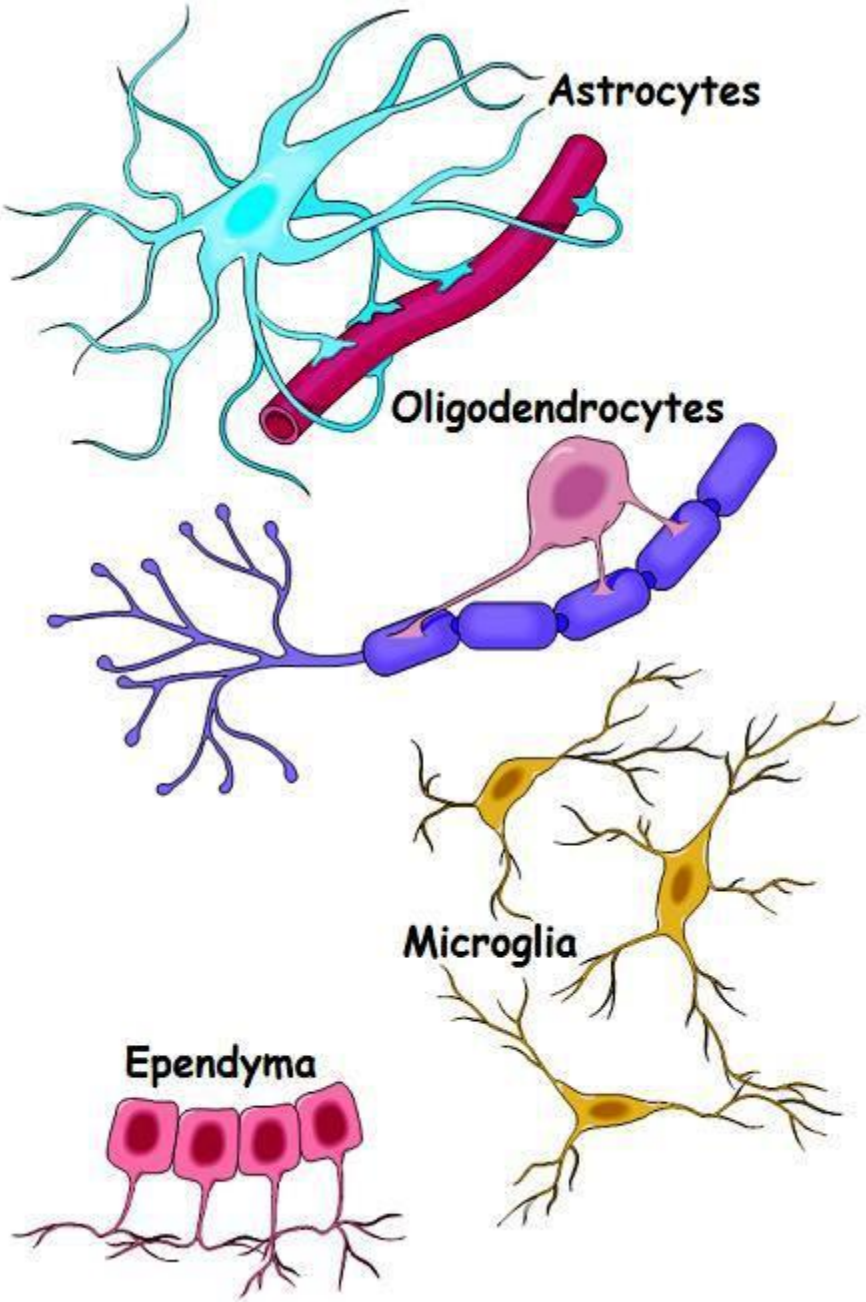


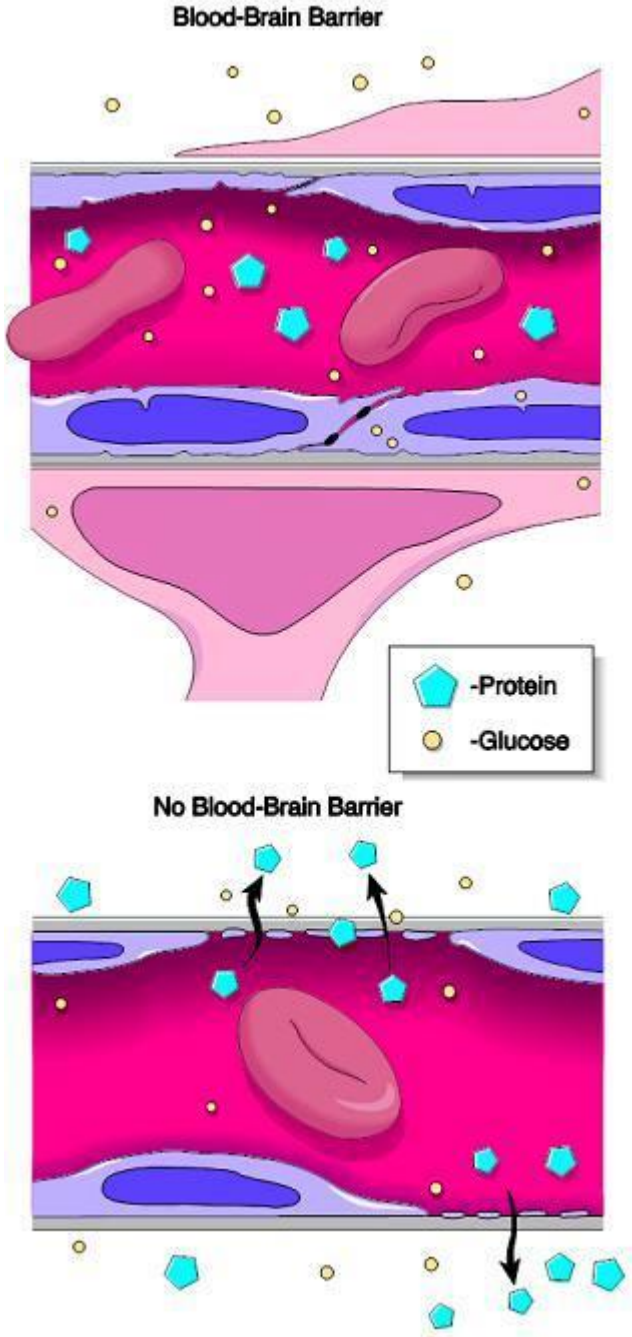
1 Ant. cerebral art.
2 Ant. comm. art.
3 Post. comm. art.
4 Basilar art.
5 Int. carotid art.
6 Mid. cerebral art.
7 Ext. carotid art.
8 Ant. spinal art.
9 Cervical vert.
10 L. common carotid art.
11 Vertebral art.
12 L. subclavian art.
13 Aortic arch
14 Descending aorta
15 Ascending aorta

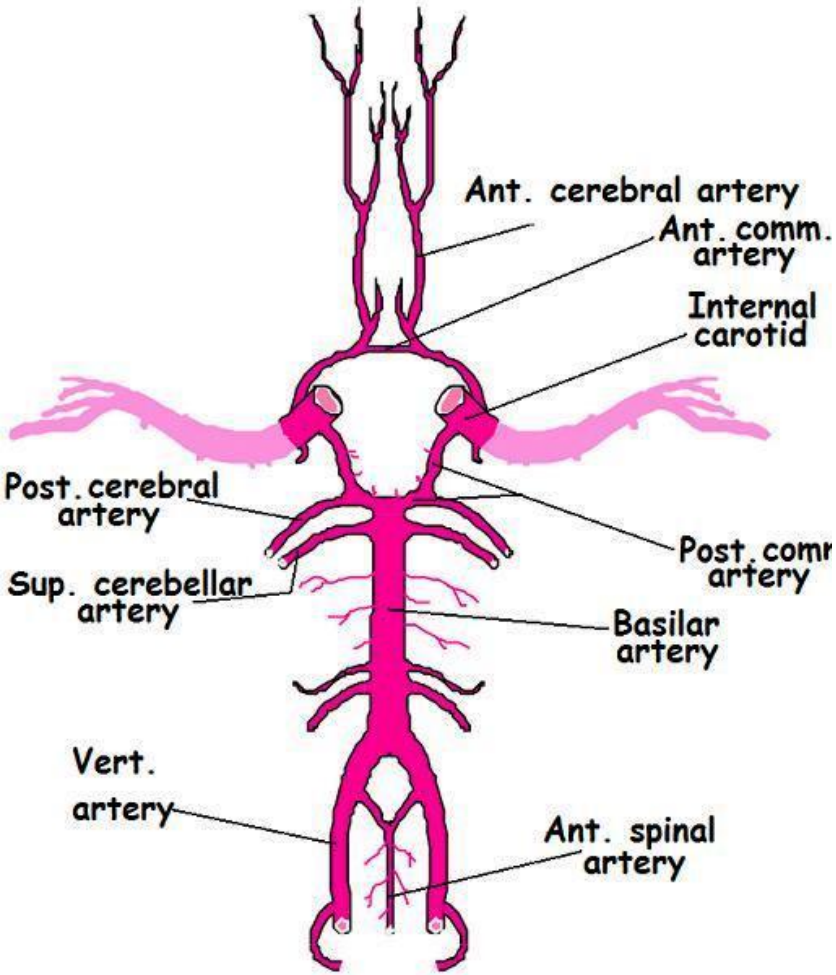
Cerebrovascular Arrangement

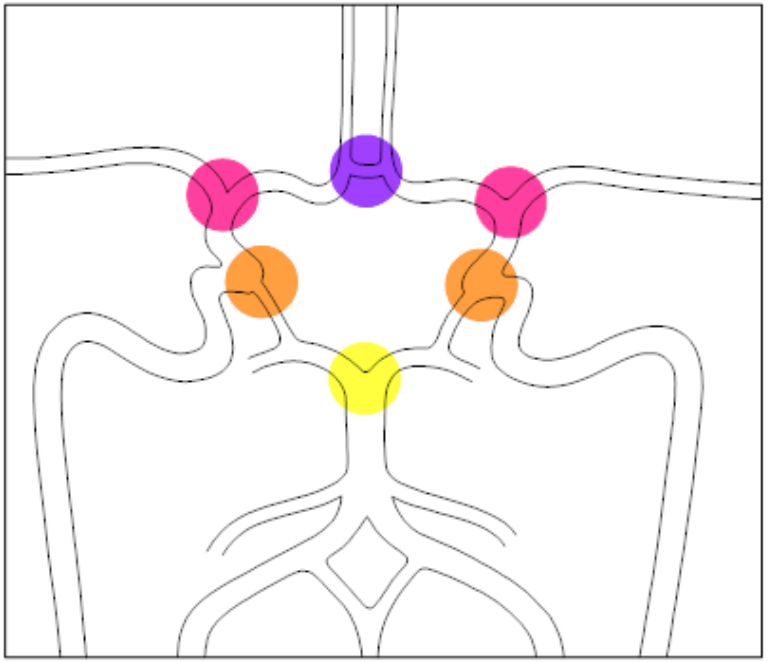





Astrocytes
Oligodendrocytes
Microglia
Ependyma

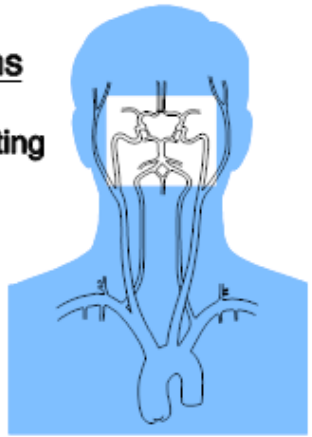

Blood-Brain Barrier
-Protein
-Glucose
No Blood-Brain Barrier



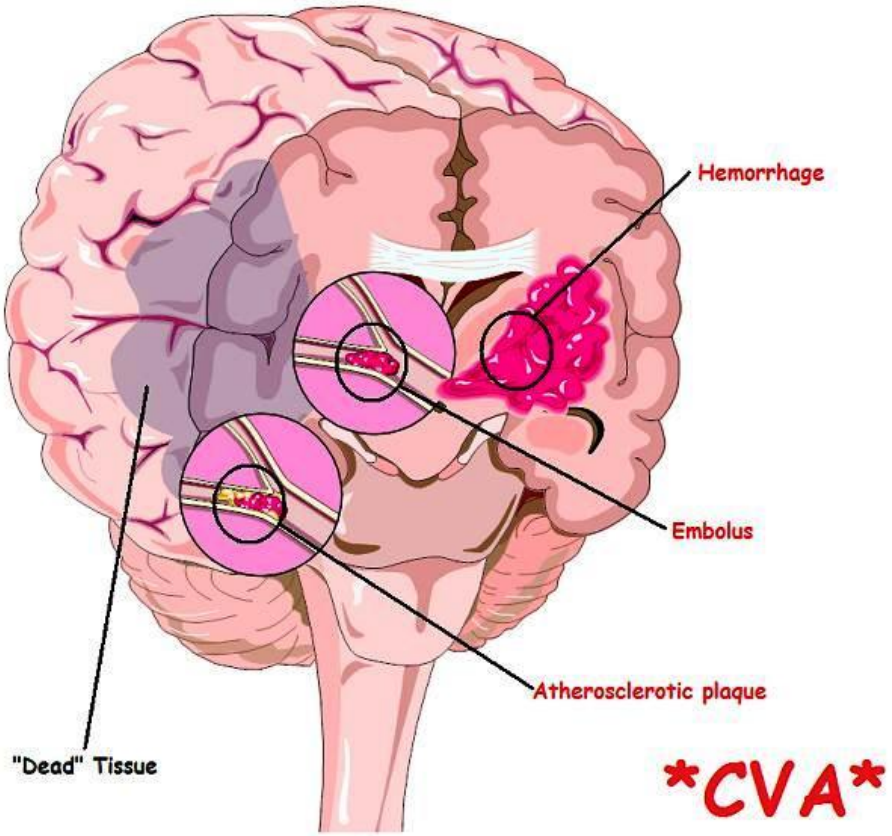


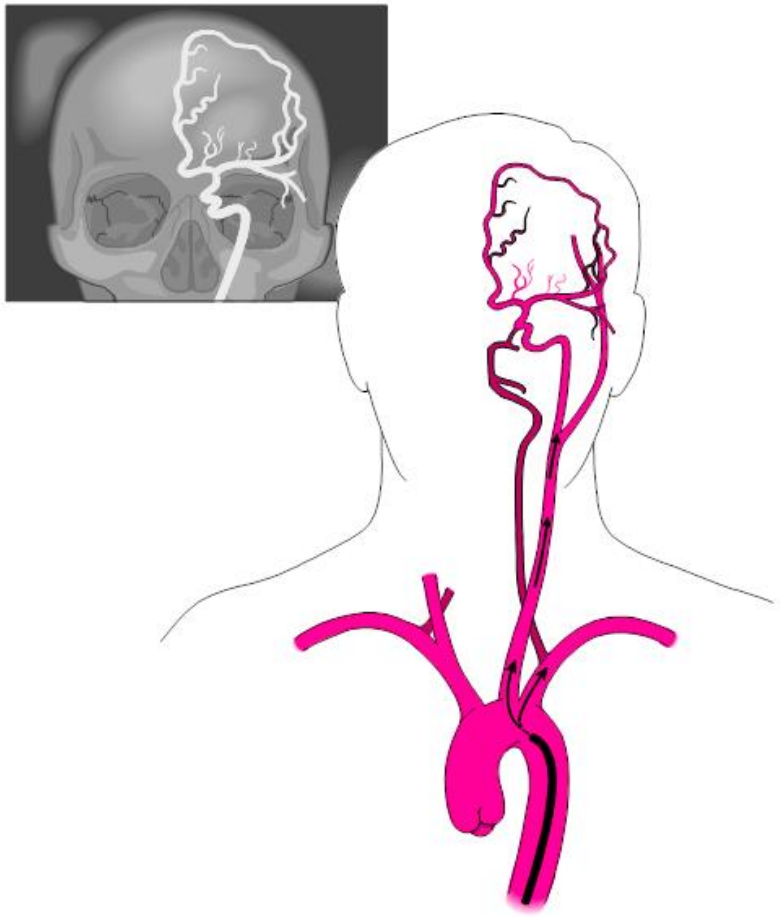
Distribution of Aneurysms

- 30% Anterior Communicating
- 30% Internal Carotid
- 30% Middle Cerebral
- 10% Vertebrobasilar



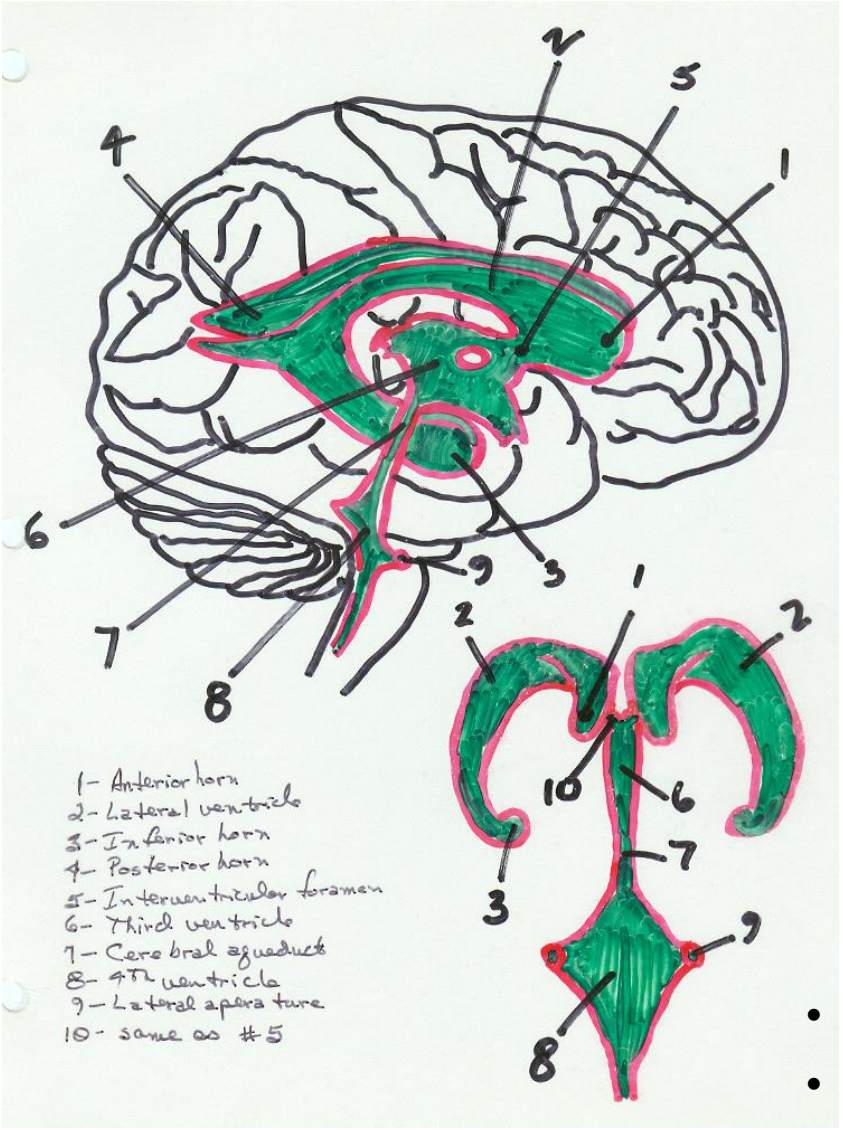
Cerebrovascular Accident (CVA): Stroke

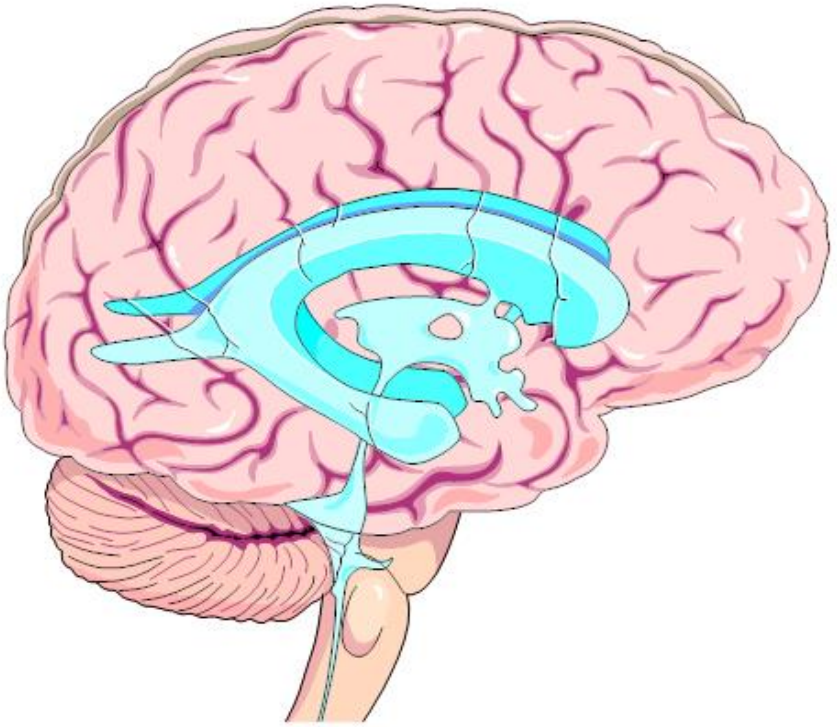




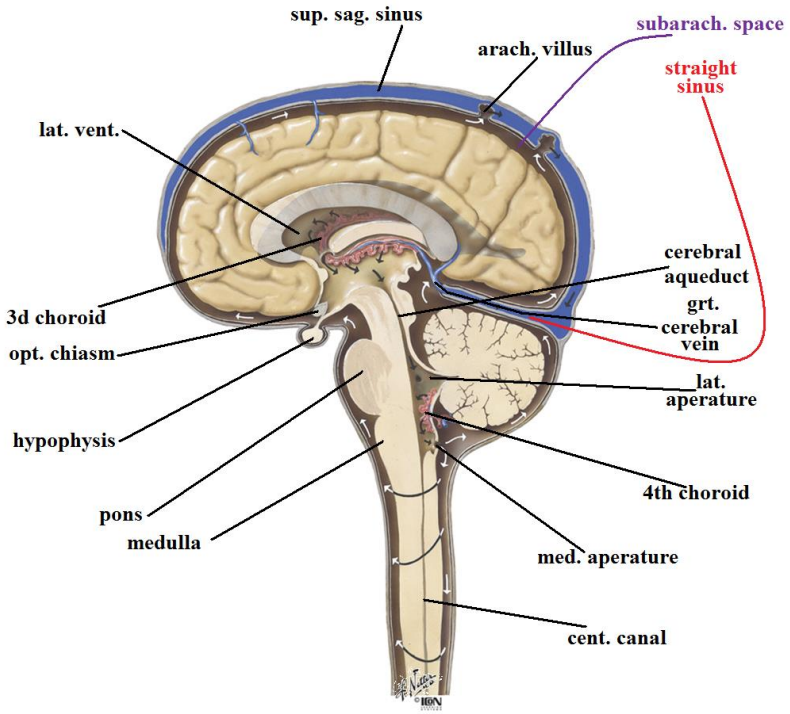
Death: EEG vs Cerebral Arteriogram

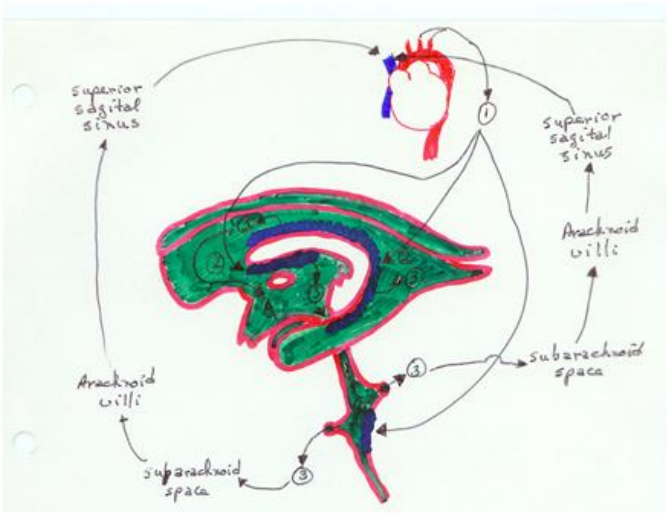
CSF: Ventricles and Flow

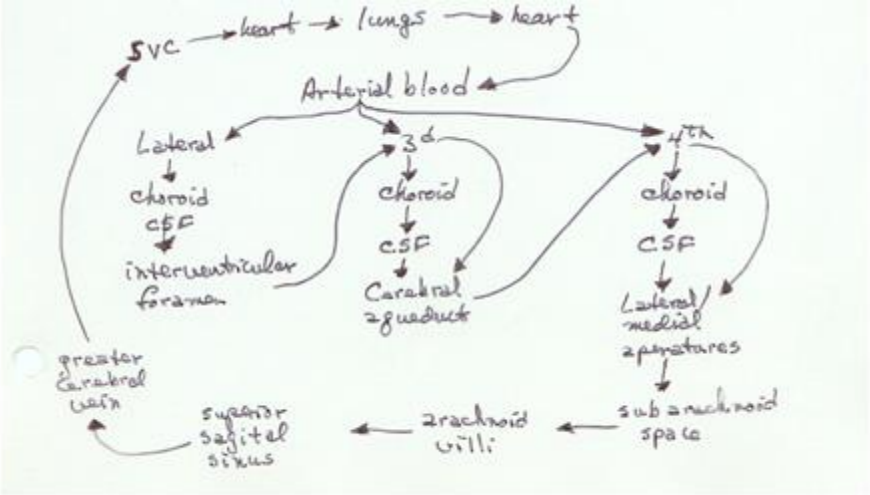




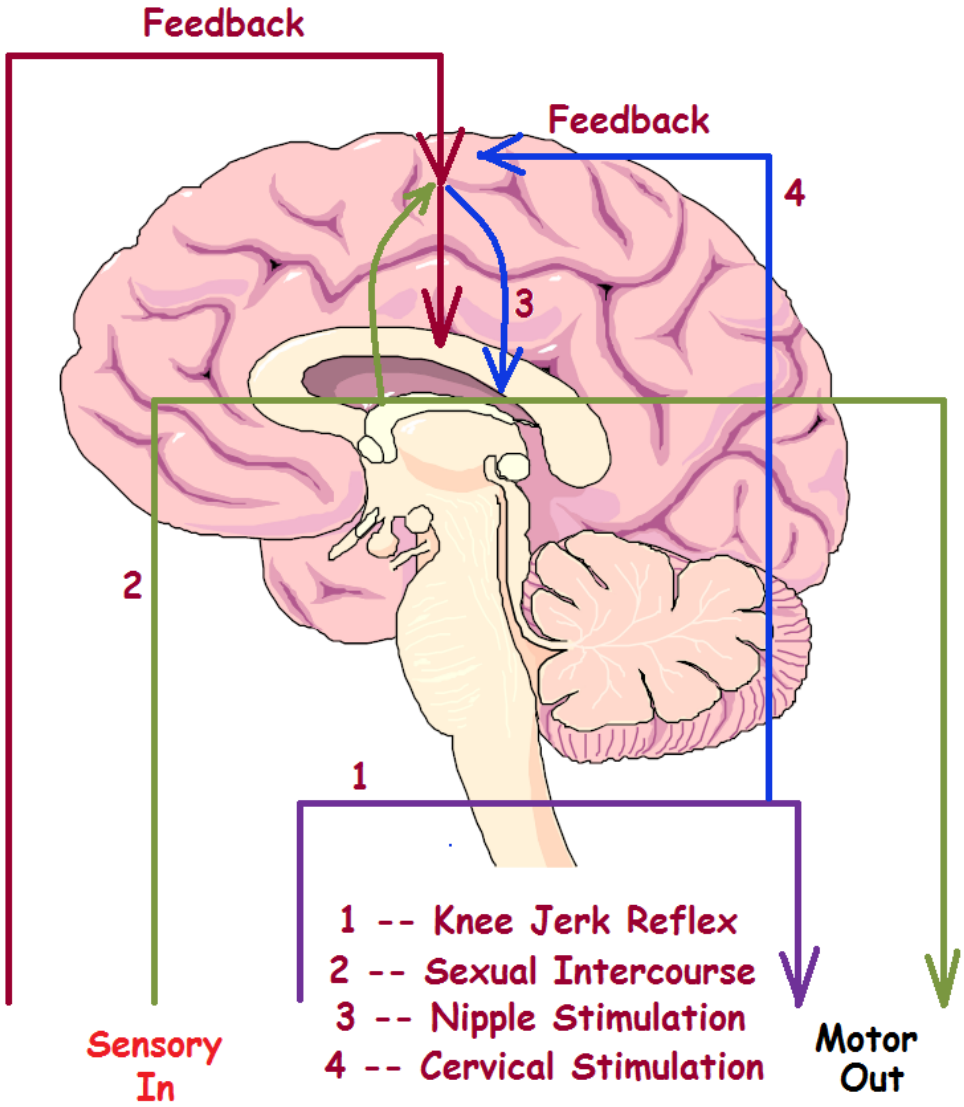
- Median aperature = Foramen of Magendie
- Lateral aperature = Foramen of Luschka


sup. sag. sinus
arach. villus
subarach. space
straight sinus
lat. vent.
cerebral aqueduct
grt. cerebral vein
3d choroid
opt. chiasm
lat. aperature
hypophysis
4th choroid
pons
medulla
med. aperature
cent. canal

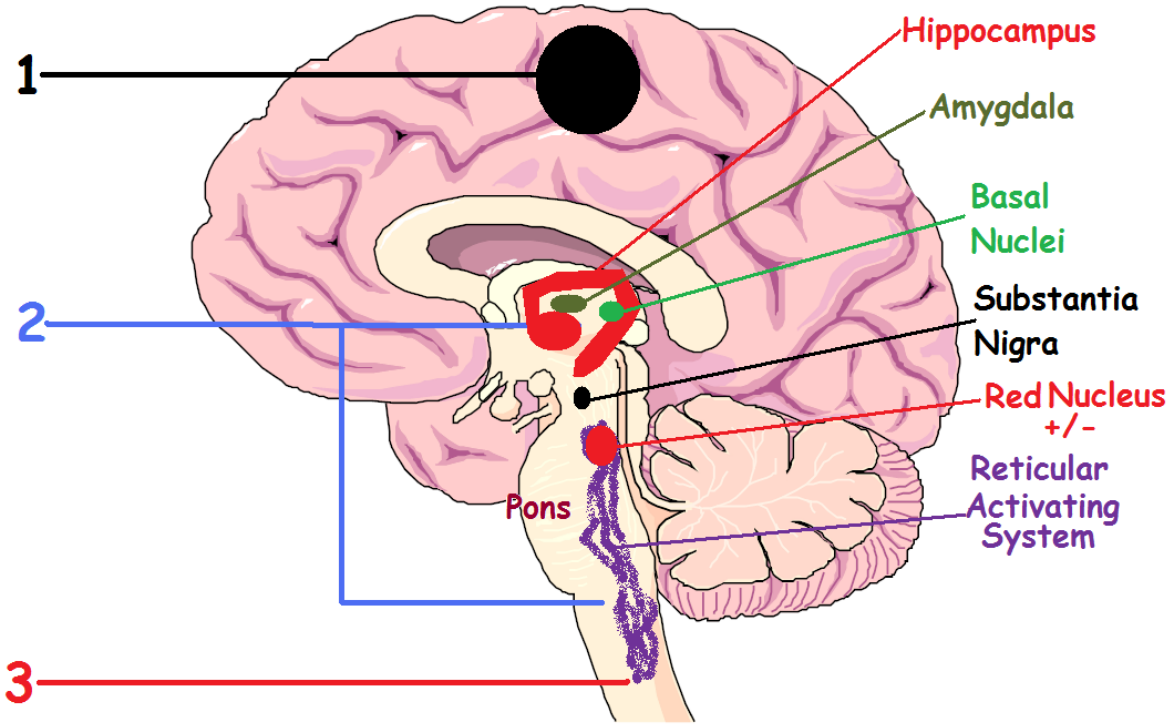

superior sagital sinus
superior sagital sinus
Arachnoid villi
subarachnoid space
Arachnoid villi
subarachnoid space


SVC
heart
lungs
heart
Arterial blood
Lateral
3d
4th
choroid
CSF
interventricular foramen
choroid
CSF
Cerebral aqueduct
choroid
CSF
Lateral/medial apertures
greater Cerebral vein
superior sagital sinus
arachnoid villi
subarachnoid space

Interactions Within Level of Control

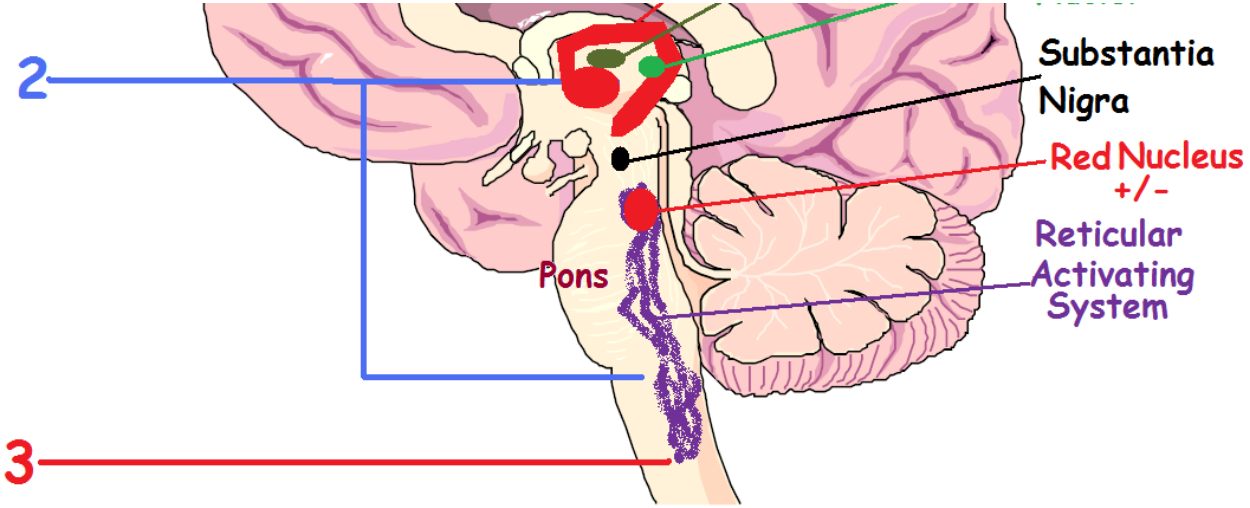


Motor Control Level -- 1



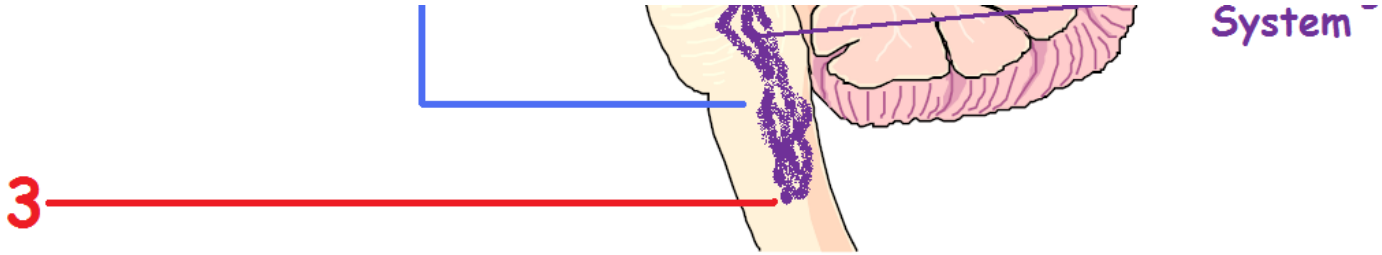
Highest level – cortical level. Vast information storage area; ~75% of entire nervous system neurons are in cerebral cortex. Stored memories of past experiences; interfaces with thalamus (corticothalamo tract); destruction of sensory cortex does not necessarily destroy touch, but DOES destroy stereognosis; prefrontal lobe destruction does not destroy one's ability to think, but it does destroy the ability to think in <u>abstract terms</u>

Motor Control -- 2

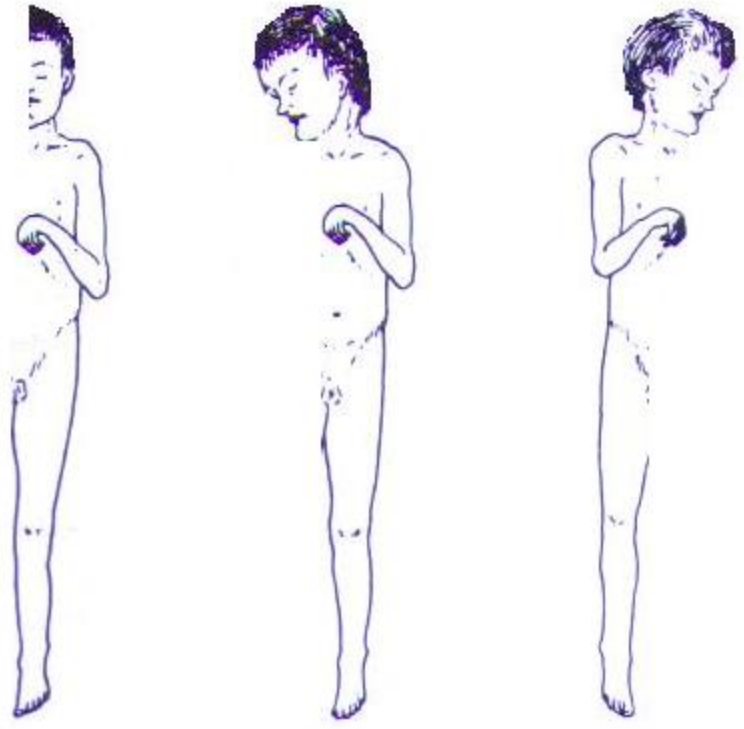


- Mid-level; medulla, pons, mid-brain, hypothalamus, thalamus, cerebellum, basal ganglia; functions without upper brain;
- Medulla/Pons: function with arterial BP, respirations, equilibrium, feeding reflex (salivating/licking);
- Cerebellum: equilibrium;
- Mid-Brain: mesencephalon; equilibrium, coordinated head, body, eye turns; feeding reflex;
- Lower basal ganglia: coordinated head, body, eye turns;
- Reticular activating system: sends broad signals to cortex: 1) directly and 2) via thalamus to activate cortex with wakefulness; with inactive RAS = SLEEP;
- Amygdala and hypothalamus give feeding reflex;
- Anger, excitement, sexual activity, pain reactions and pleasure reactions CAN occur without a cerebral cortex!

Motor Control -- 3



- Lowest level – spinal cord level with automatic reflexes, e.g., stretch, withdrawal;
- Cord functions after brain removal!!
  - 1) can stand via foot pad sensory signals → tightened extensors
  - 2) limb movements occur when in a sling, i.e., basic movements of locomotion in the cord
  - 3) can ID and localize an itch and scratch it
  - 4) cord reflexes allow bowel and bladder emptying
  - 5) segmental temperature reflexes: local cooling → vasoconstriction and heat conservation and *vice versa*



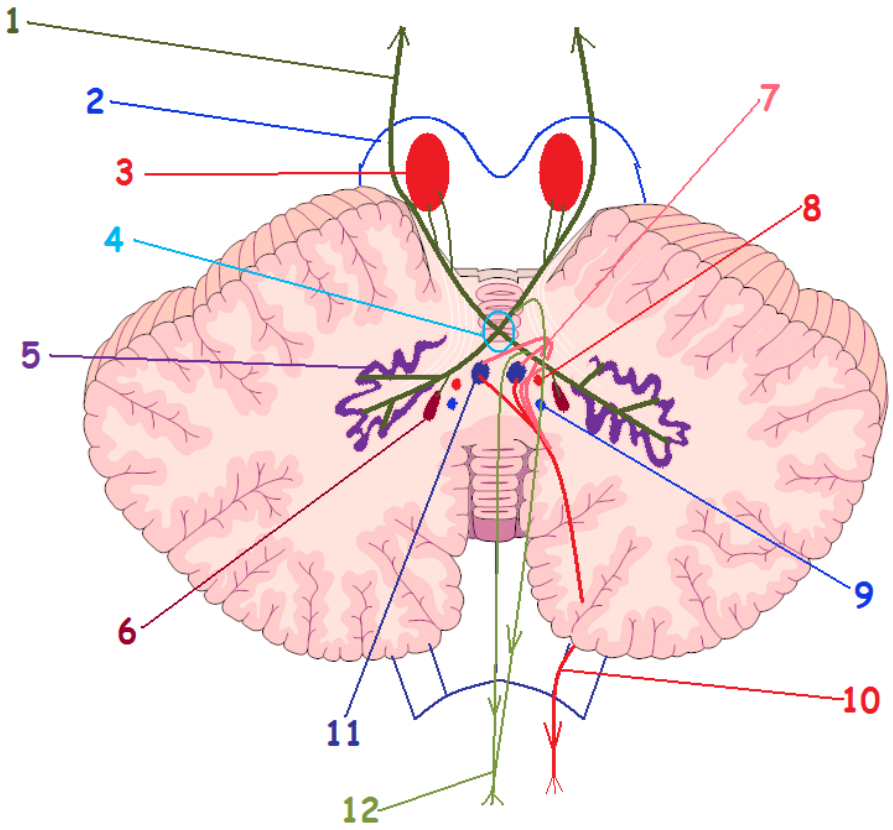
- Decorticate Rigidity/posture/response
- Loss of cortical layer's activity which results in posture where patient is rigidly still, arms flexed, fists clenched, legs extended, feet plantar flexed

- Decerebrate Rigidity/posture/response
- Brain separated from spinal cord at level of brain stem, aka pithing
- ≡≡ sustained extensor contractions in limbs due to decerebration between superior colliculi and vestibular nuclei.

Images derived from Fulton, JF: Textbook of Physiology, 17th Ed.

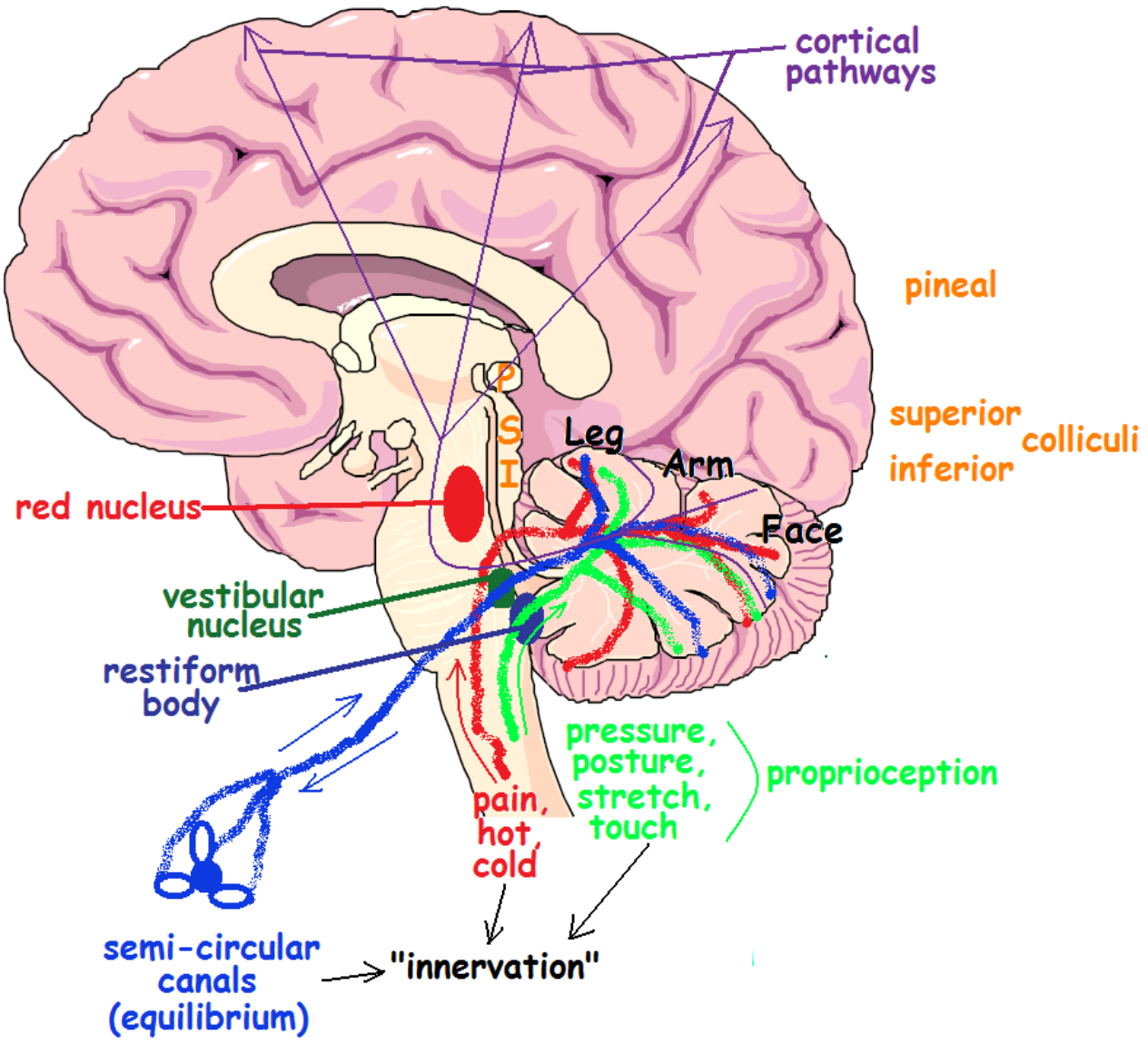
Cerebellum: A Fine Tuner

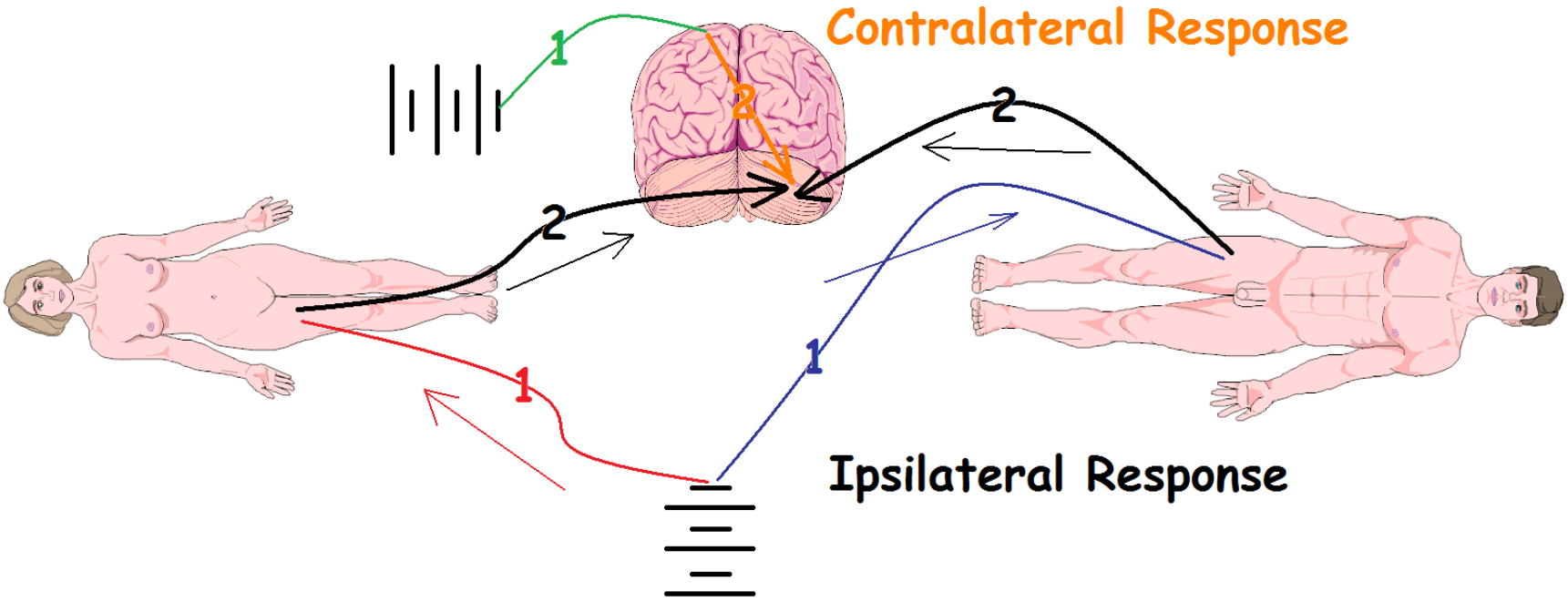
Transverse Section



1. **Ascending fibers to thalamus and globus pallidus**
2. Cerebral peduncles
3. Red Nucleus
4. Decussation
5. Dentate nucleus
6. Emboliform nucleus
7. Descending fibers
8. Globose nucleus
9. Globose nucleus
10. Same as #7
11. Fastigial nucleus
12. Descending fibers

Cerebellar Physiology – Fine Tuner – Lateral View





Stimulate R leg nerves → **ipsilateral cerebellar response**

Stimulate L leg nerves → ipsilateral cerebellar response

Stimulate L cerebral cortex for R leg → **contralateral cerebellar response**

Stimulate R cerebral cortex for L leg → contralateral cerebellar response