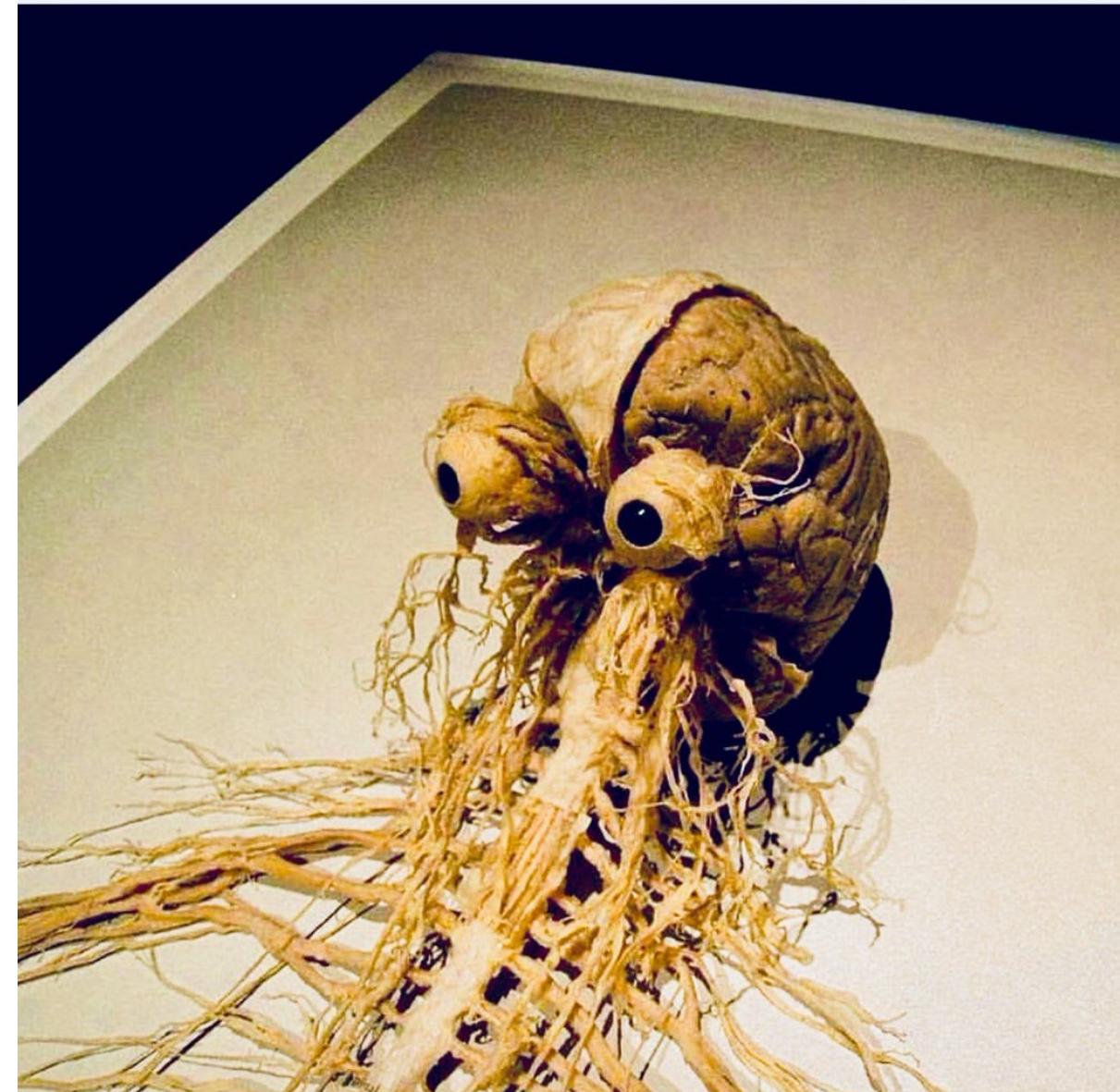


PSYC304: Neuroanatomy

Jay Hosking, PhD

The nervous system. That is us...the rest of the body is an organic spacesuit worn by this creature to live on this particular rock revolving around a star.



Overview

- A. Nervous system layout
- B. Terminology and directions
- C. Spinal cord
- D. Major divisions of the brain
- E. The telencephalon: cortex and deeper structures
- F. Blood flow, skull, meninges, CSF



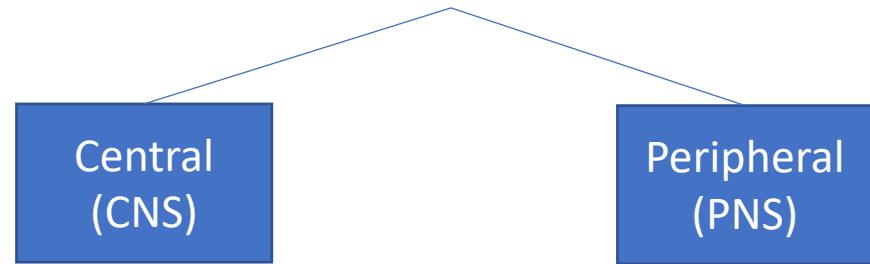
Learning objectives

1. Know the major divisions of the nervous system. What symptoms might you expect with damage at each particular division?
2. Know all the neuroanatomical directional terms and apply them when talking about brain structures.
3. Draw and label a cross section of the spinal cord.
4. List the descending sections of the spinal cord in order. Where would damage cause a greater loss of function, and why?
5. List and discuss the divisions of the human brain, both in 3 divisions and in 5 divisions.
6. Know brain structures within each of the myelencephalon, metencephalon, mesencephalon, diencephalon, and telencephalon. Coarsely, describe what damage to these areas might produce in terms of dysfunction.
7. Describe the location and function of the corpus callosum.
8. Know the major fissures.
9. Know the major components of the limbic system and basal ganglia.
10. Know the lobes of the cerebral cortex.
11. Know the anatomical features that protect the brain.



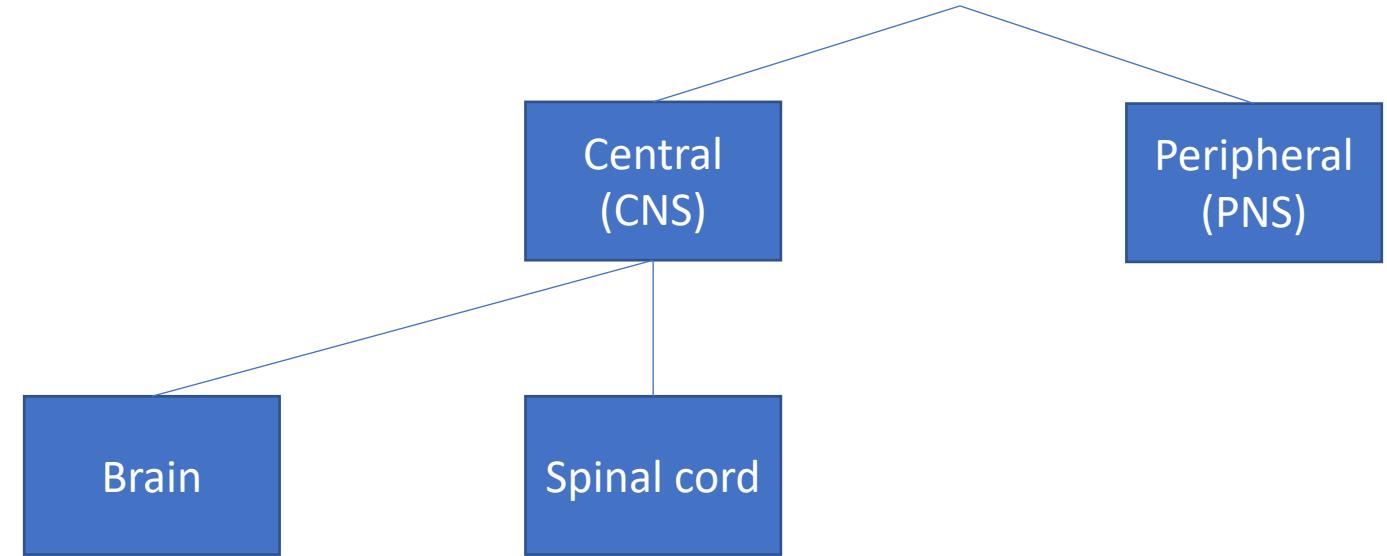
The nervous system

(Well, the vertebrate nervous system)



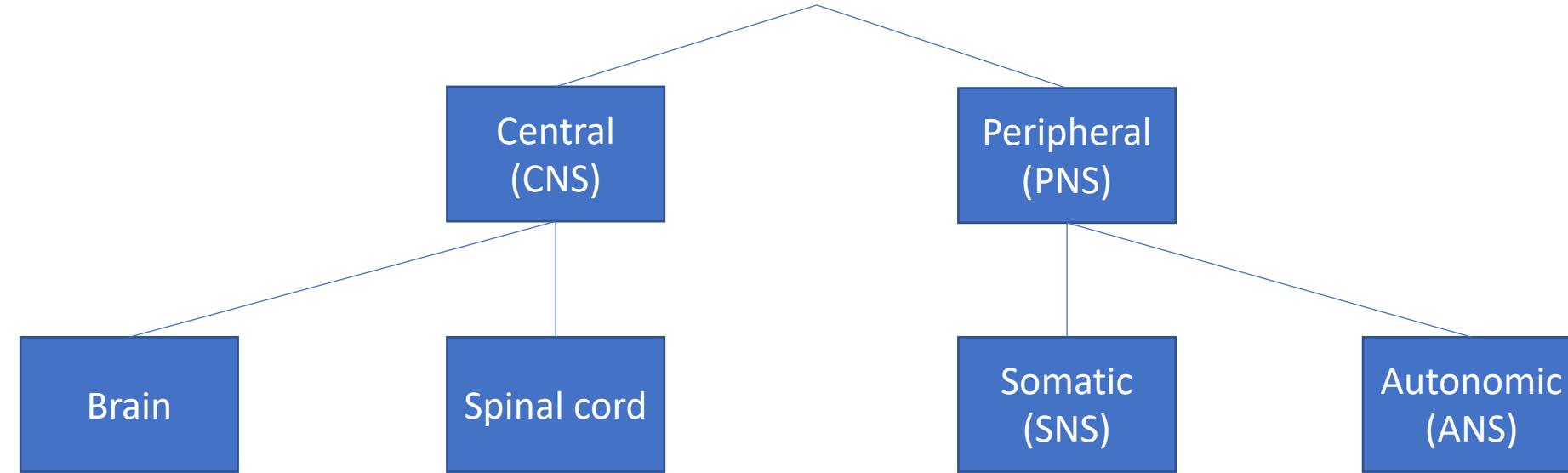
The nervous system

(Well, the vertebrate nervous system)



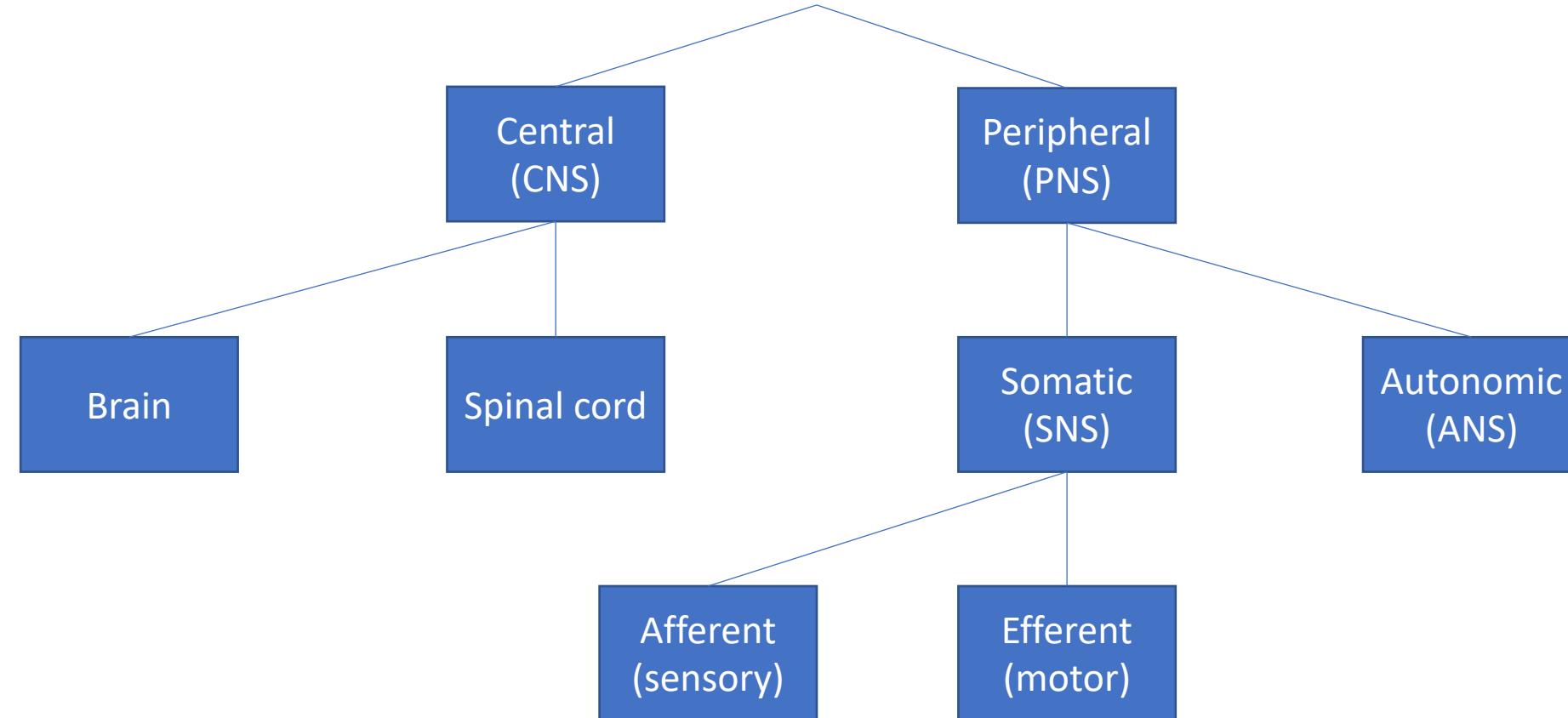
The nervous system

(Well, the vertebrate nervous system)



The nervous system

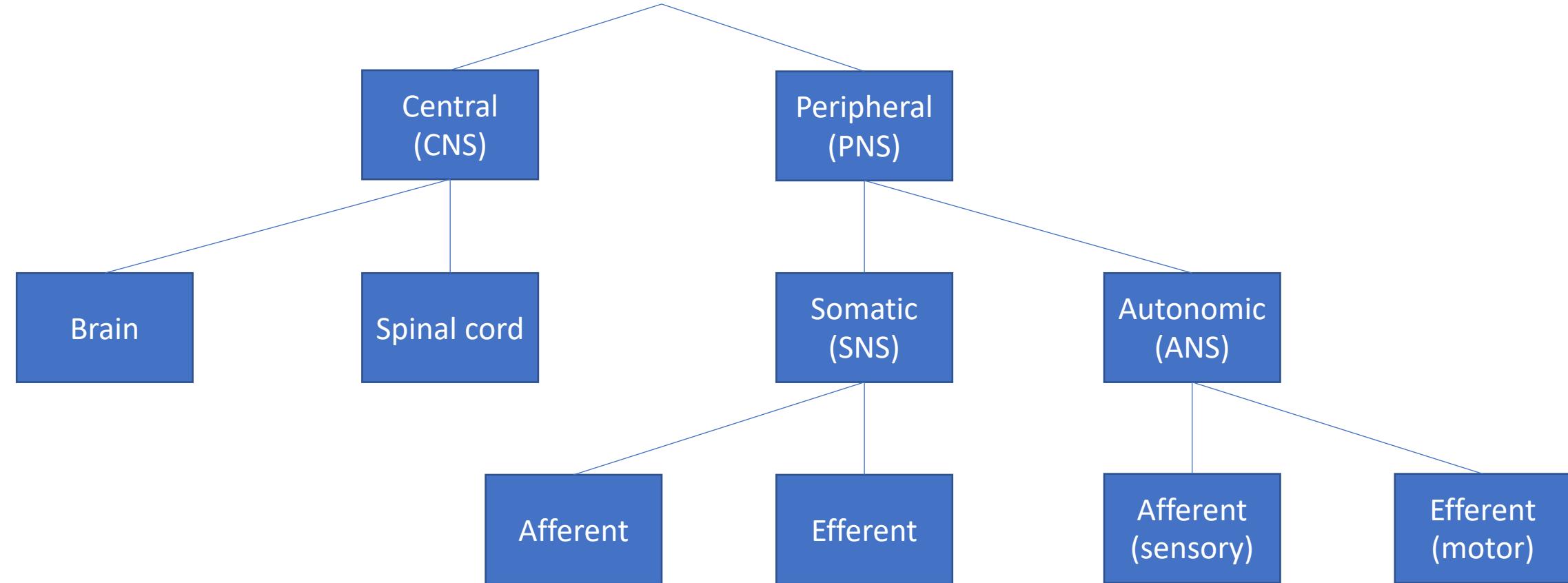
(Well, the vertebrate nervous system)



SNS: external environment, (mostly) conscious

The nervous system

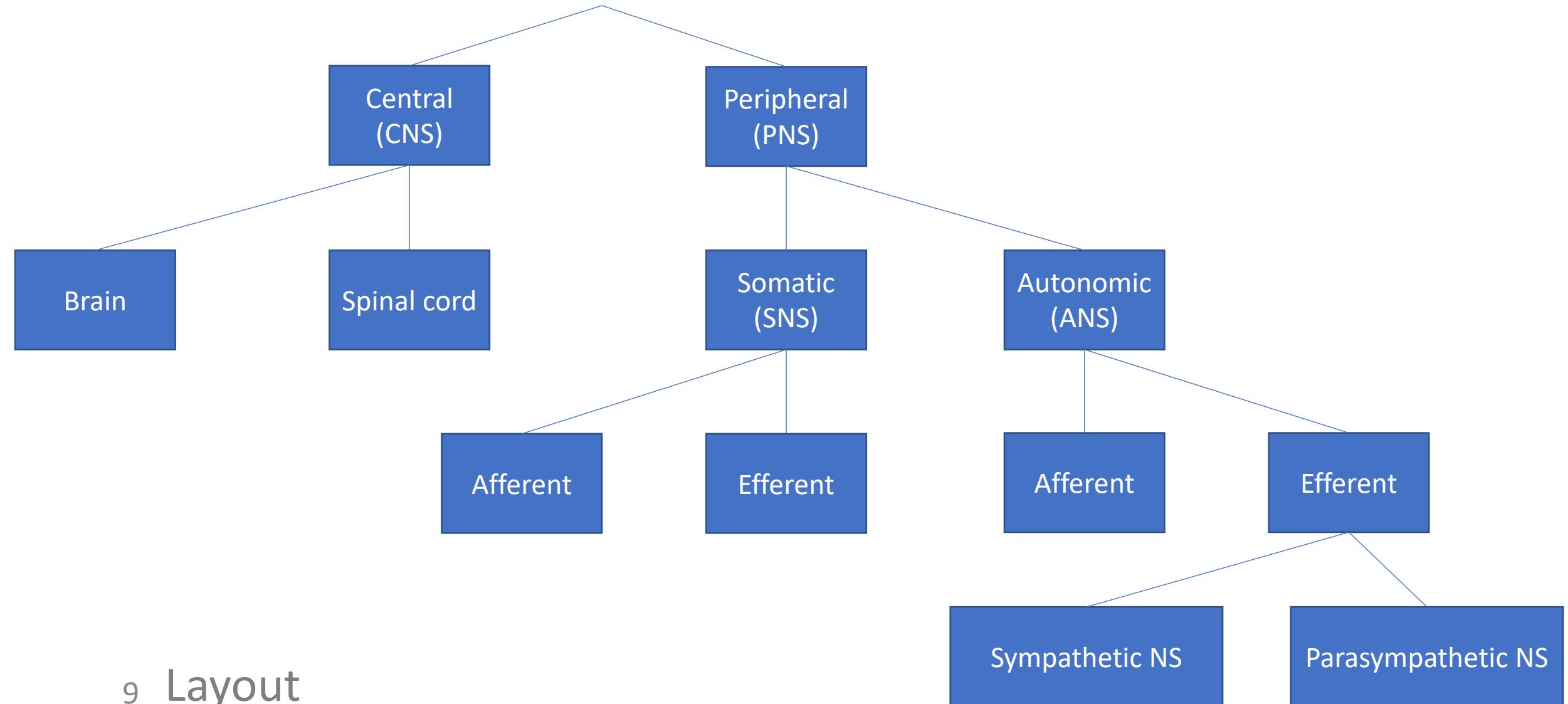
(Well, the vertebrate nervous system)



ANS: internal environment, (mostly) non-conscious

The nervous system

(Well, the vertebrate nervous system)

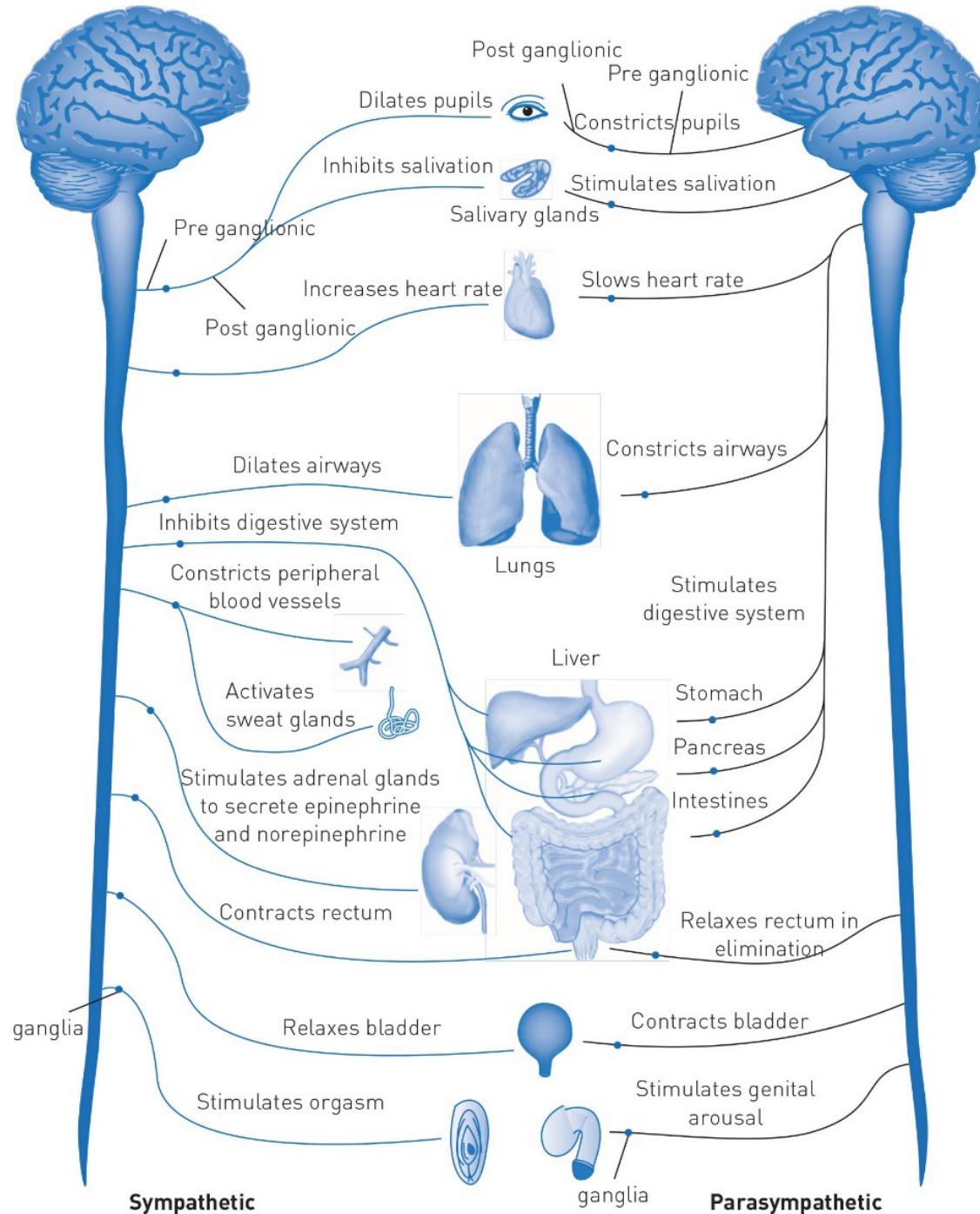


ANS efferents

Sympathetic: mobilize energy

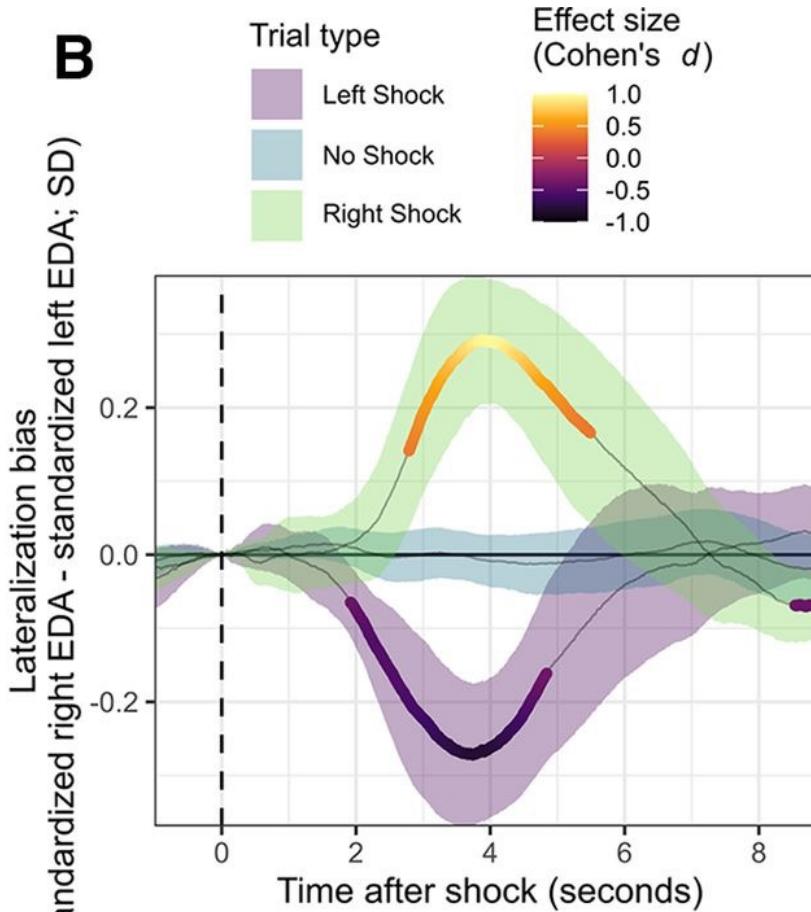
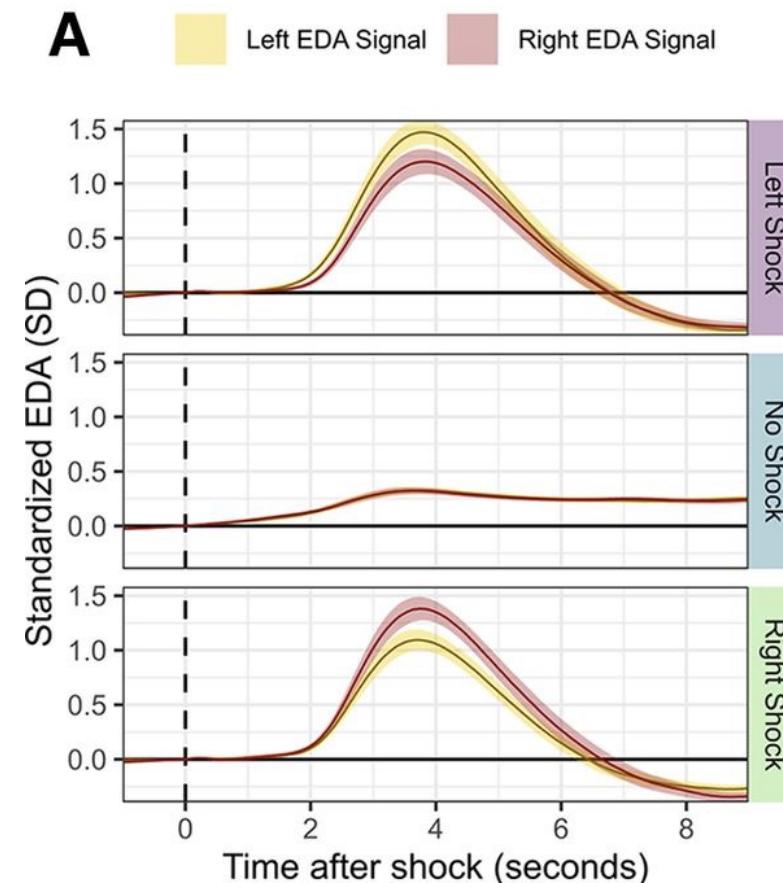
Parasympathetic: conserve energy

Not always mutually exclusive /
in opposition to one another



ANS effects aren't always generalized across the body?!?

Work from Dr. Rebecca Todd's lab
in the Department of Psychology
at UBC!



Kryklywy *et al.* 2022

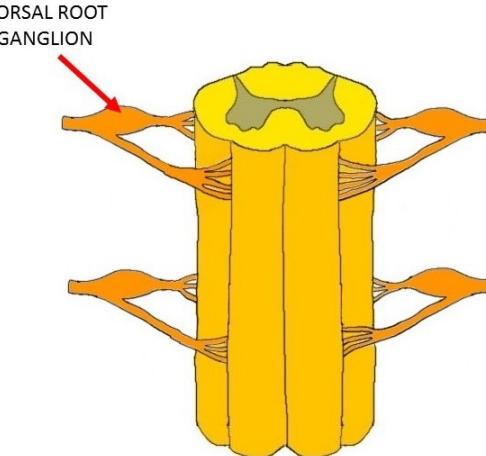
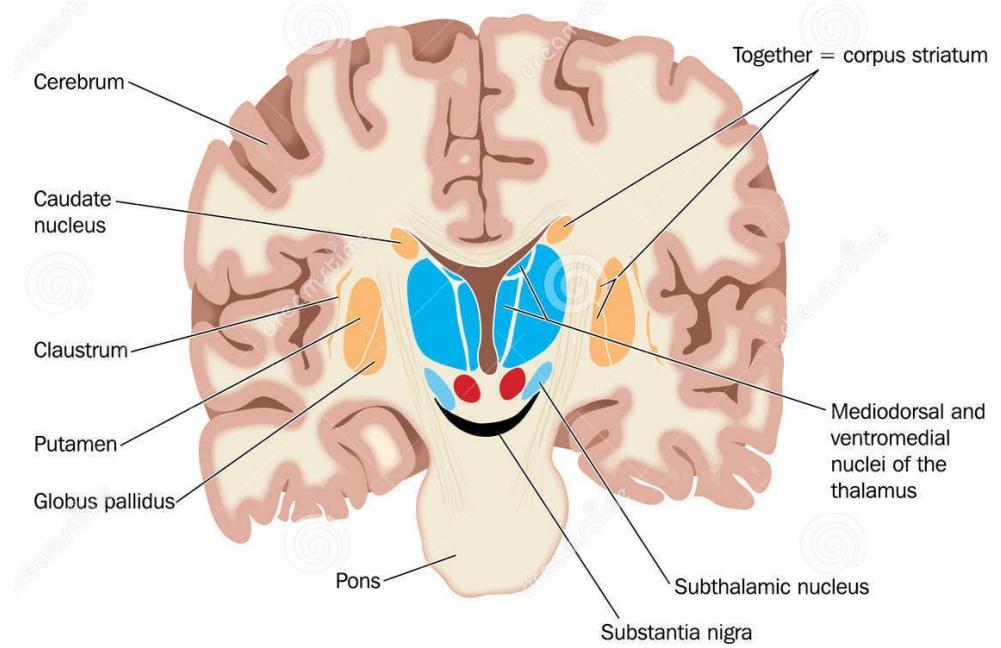
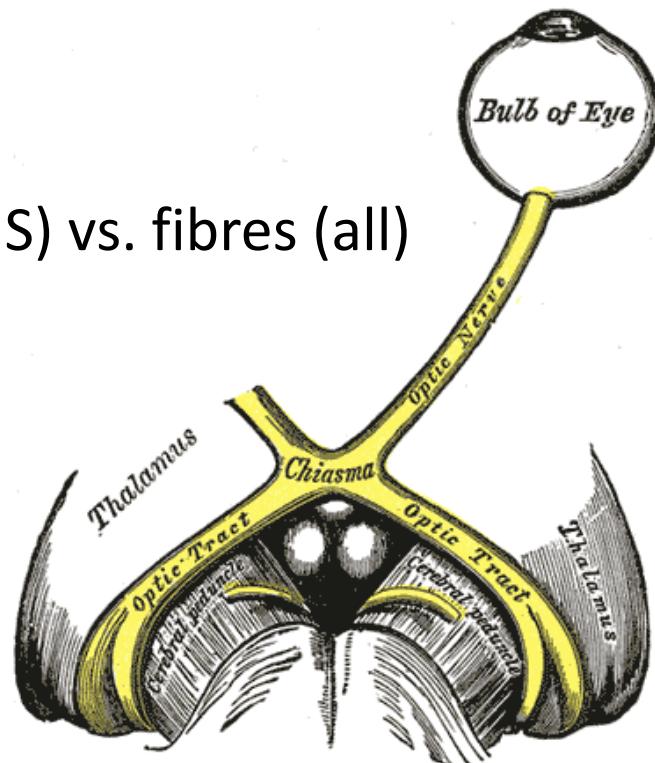
Clusters and bundles

Cell clusters:

Nucleus/nuclei (CNS) vs. ganglion/ganglia (PNS)
(except when the old anatomists screw it up)

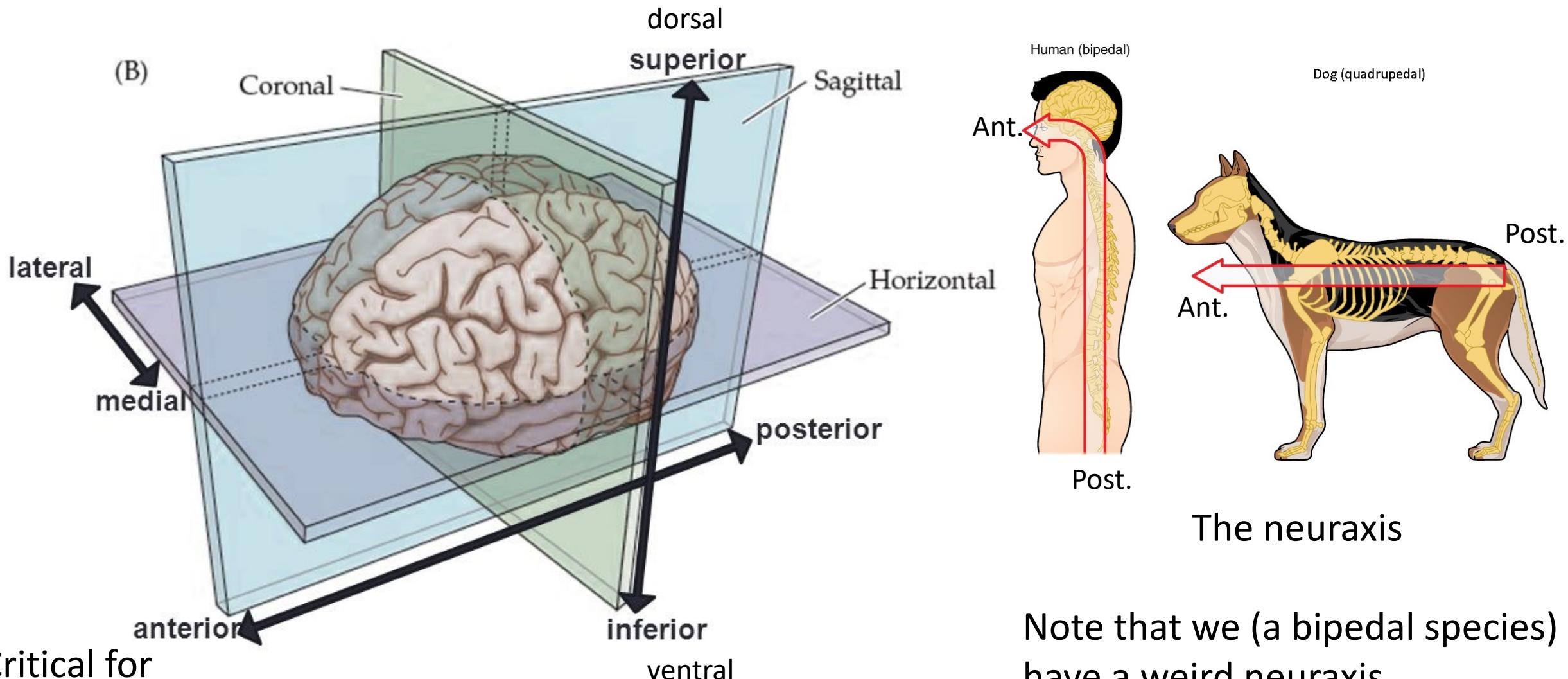
Bundle of axons:

Tract (CNS) vs. nerve (PNS) vs. fibres (all)



Terminology

Anatomical dimensions

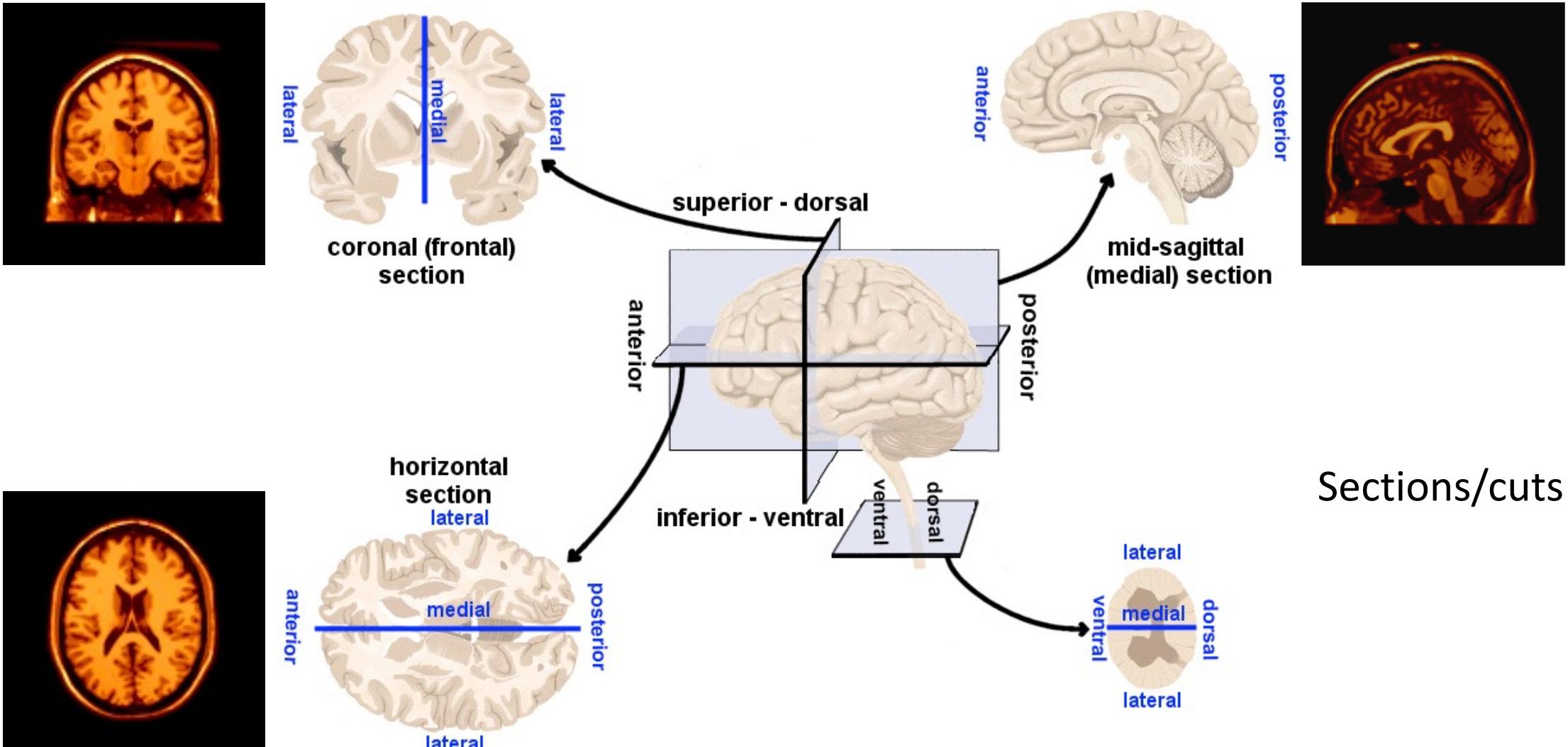


Critical for
describing brain regions!

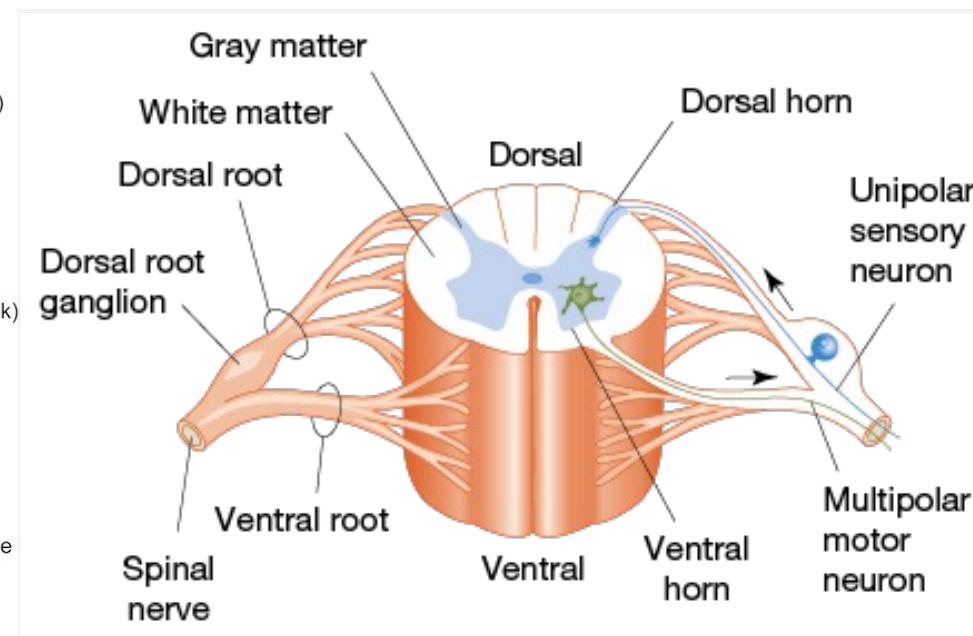
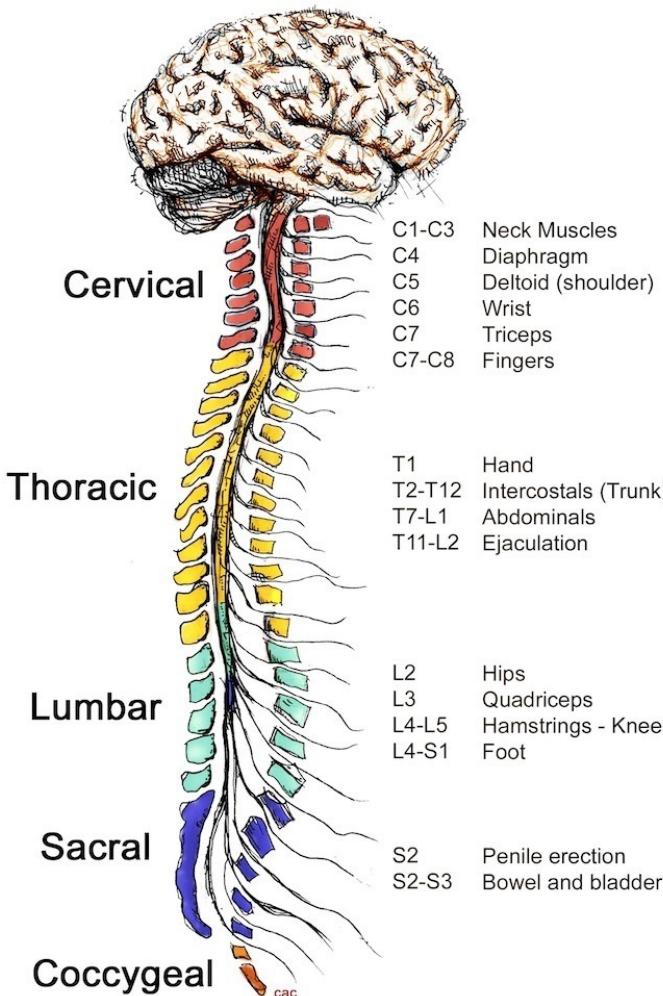
Note that we (a bipedal species)
have a weird neuraxis

Terminology

Anatomical dimensions



Spinal cord



Intermittent projections
from spinal cord – why?

Narrows/tapers when from
cervical to coccygeal – why?

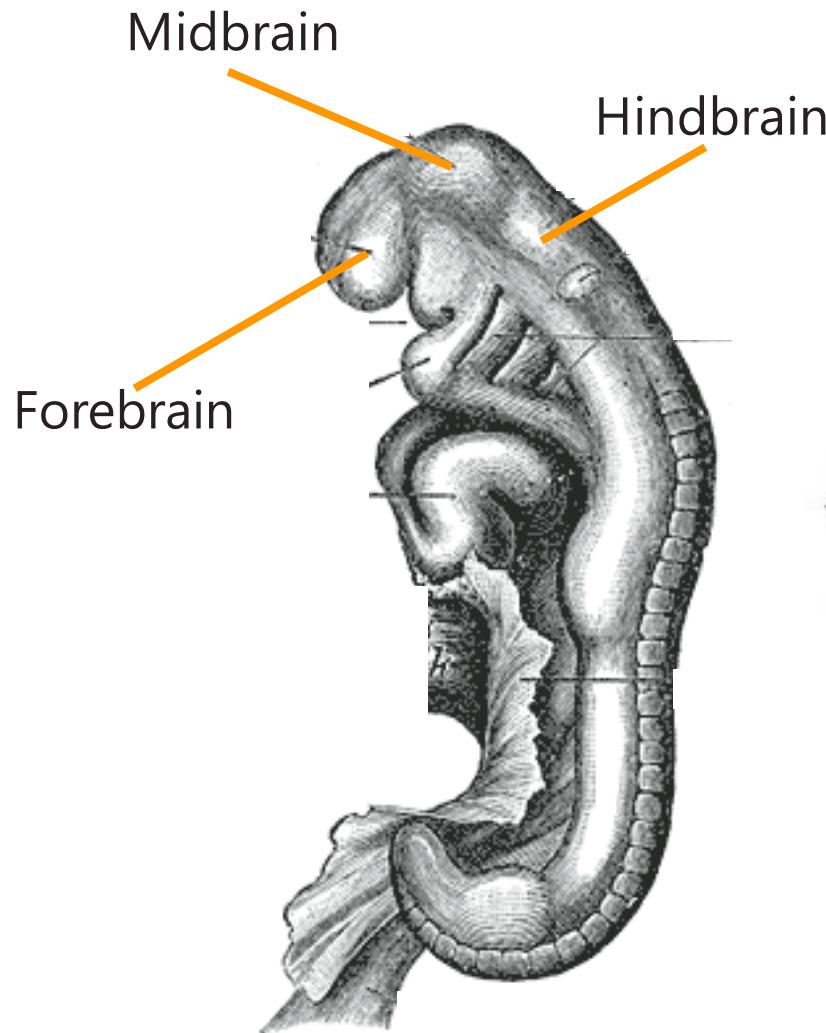
Ends in *cauda equina*

Grey/white matter divisions
(Grey is inner “H”)

Dorsal/ventral organization

Spinal cord damage: loss of function related to segment of damage!

Major divisions of the brain (3)



16

18-21-day-old embryo



28 Days

Appear early in development
Termed the **forebrain**, **midbrain**,
and **hindbrain**



49 Days

Divisions

Major divisions of the brain (3)



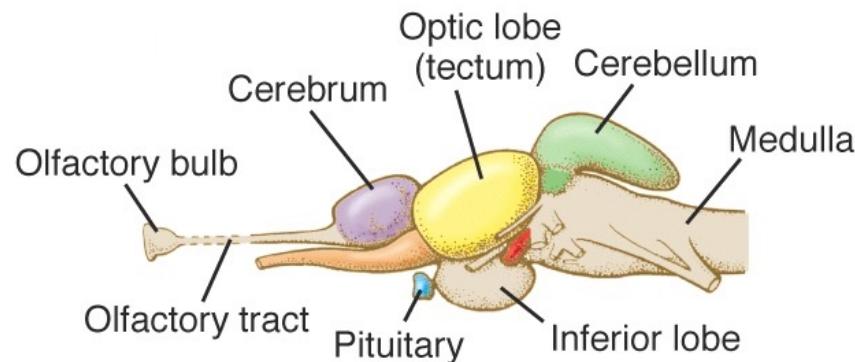
Forebrain



Midbrain

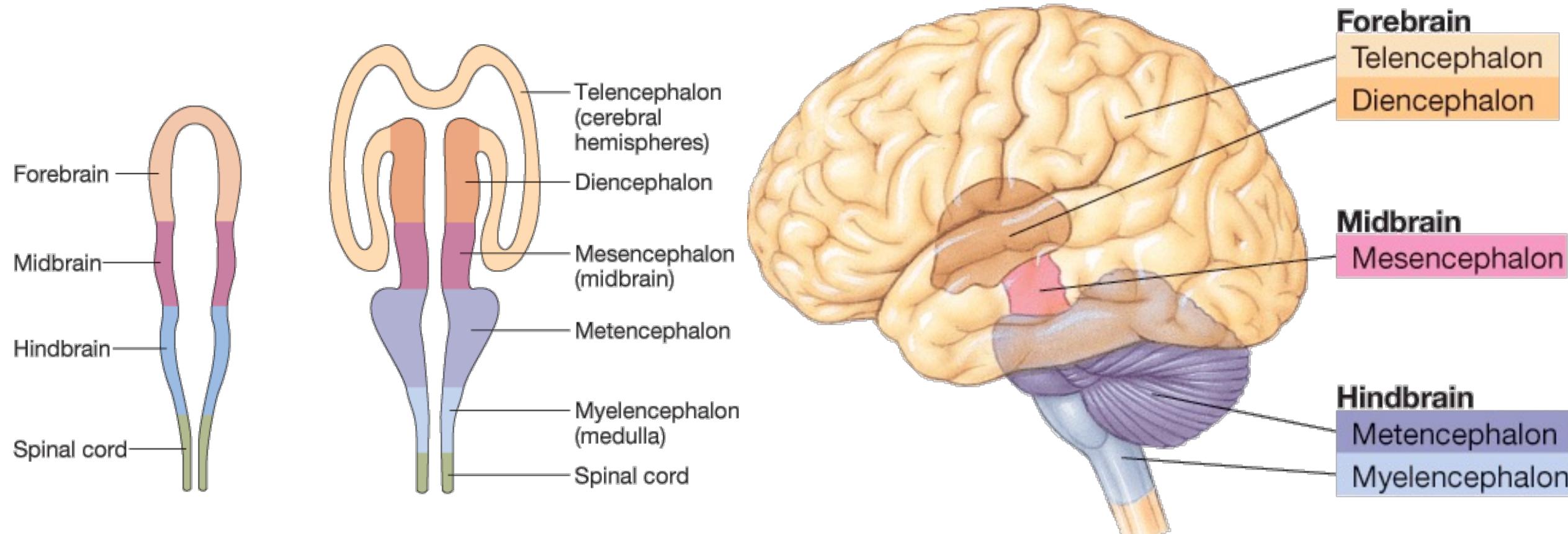


Hindbrain



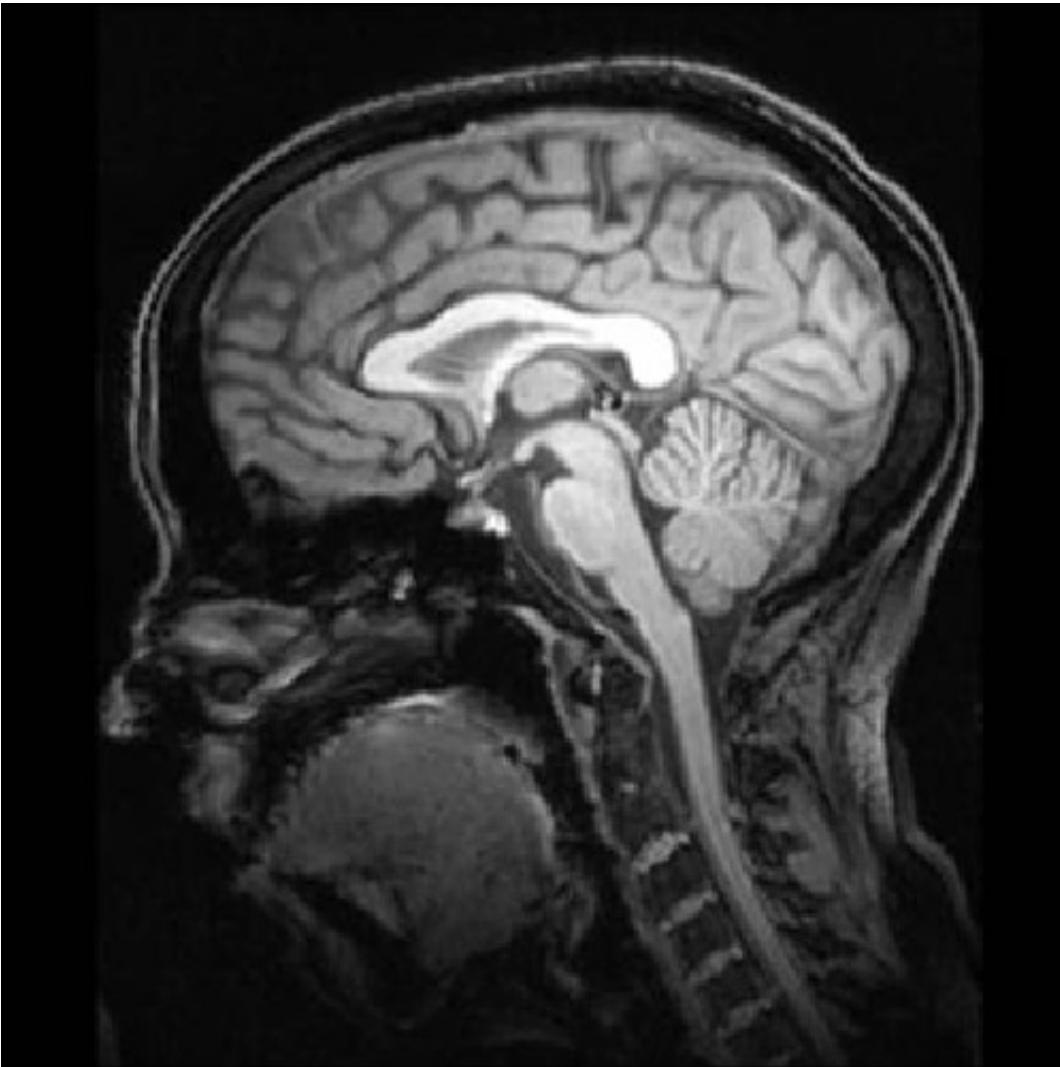
We have disproportionately large forebrains as compared to, say, fish

Major divisions of the brain (5)



Arguably more useful than three-division map

Our roadmap



A structural MRI
What kind of section?

Myelencephalon (aka the medulla)



Or *medulla oblongata* (go wild)

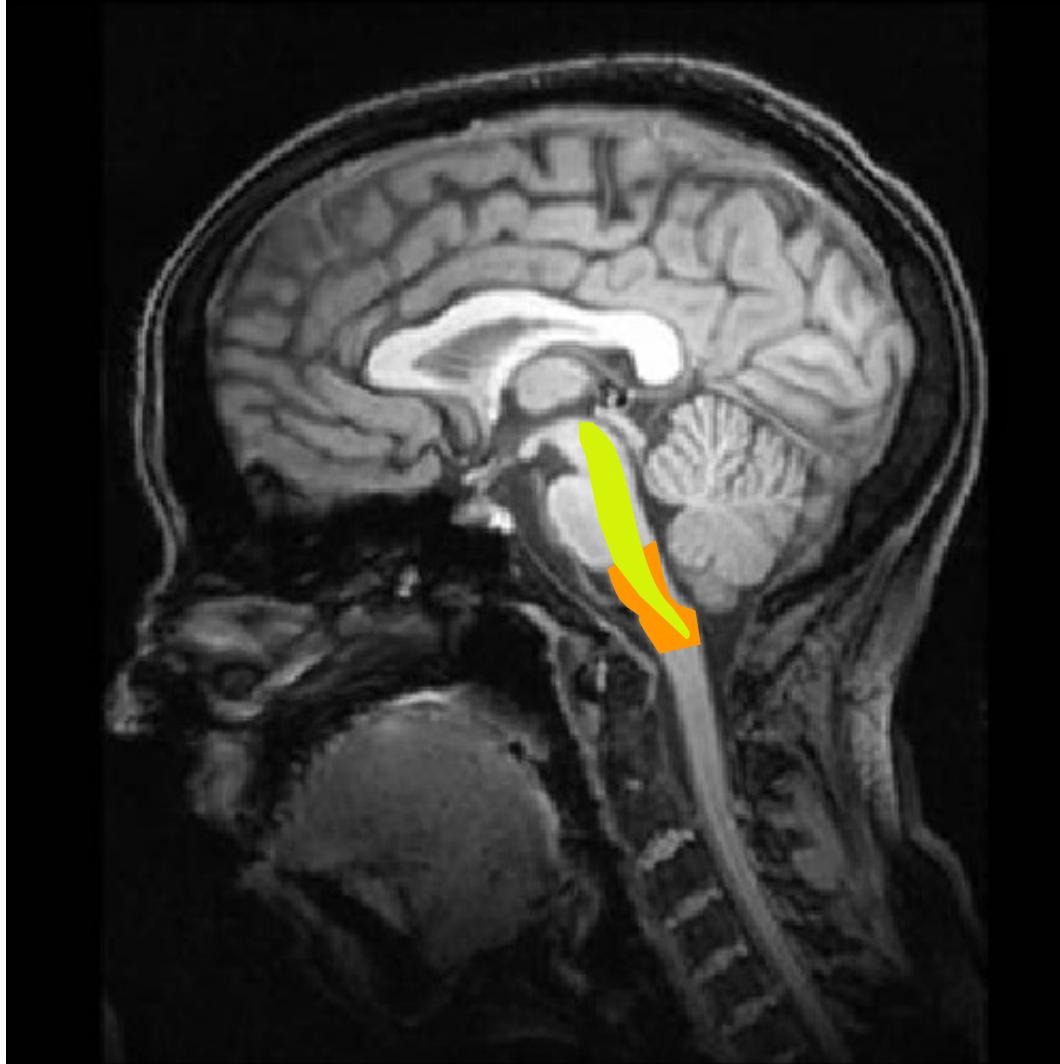
Lots of tracts

Involuntary control of
life-sustaining functions

Doctors reluctant to perform
surgery here

Insults here are often fatal

The reticular formation



aka The **reticular activating system**

~100 nuclei

Runs from myelencephalon to mesencephalon

Critical for arousal, wakefulness, attention, sleep

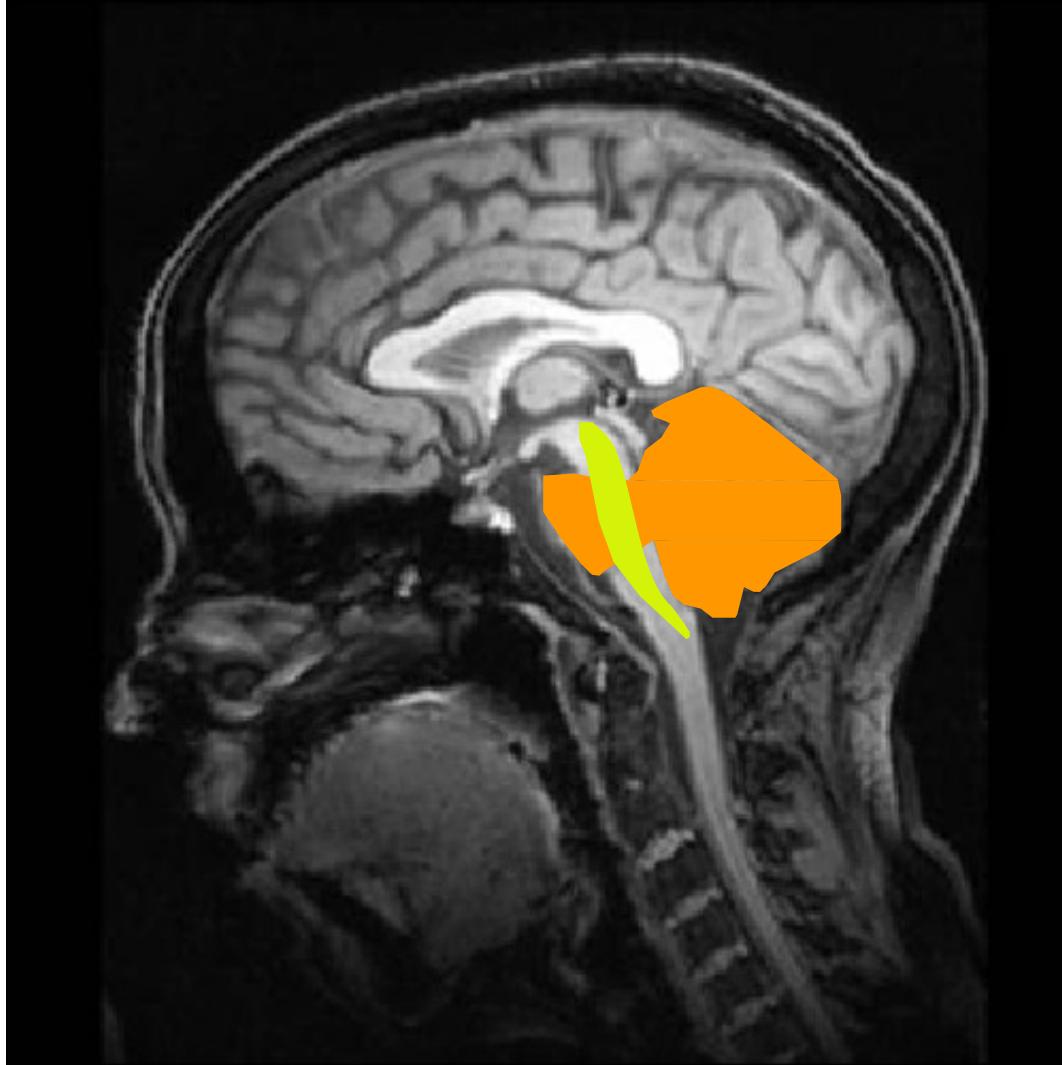
Damage to this region causes major disruptions to life, and/or can be fatal

Metencephalon



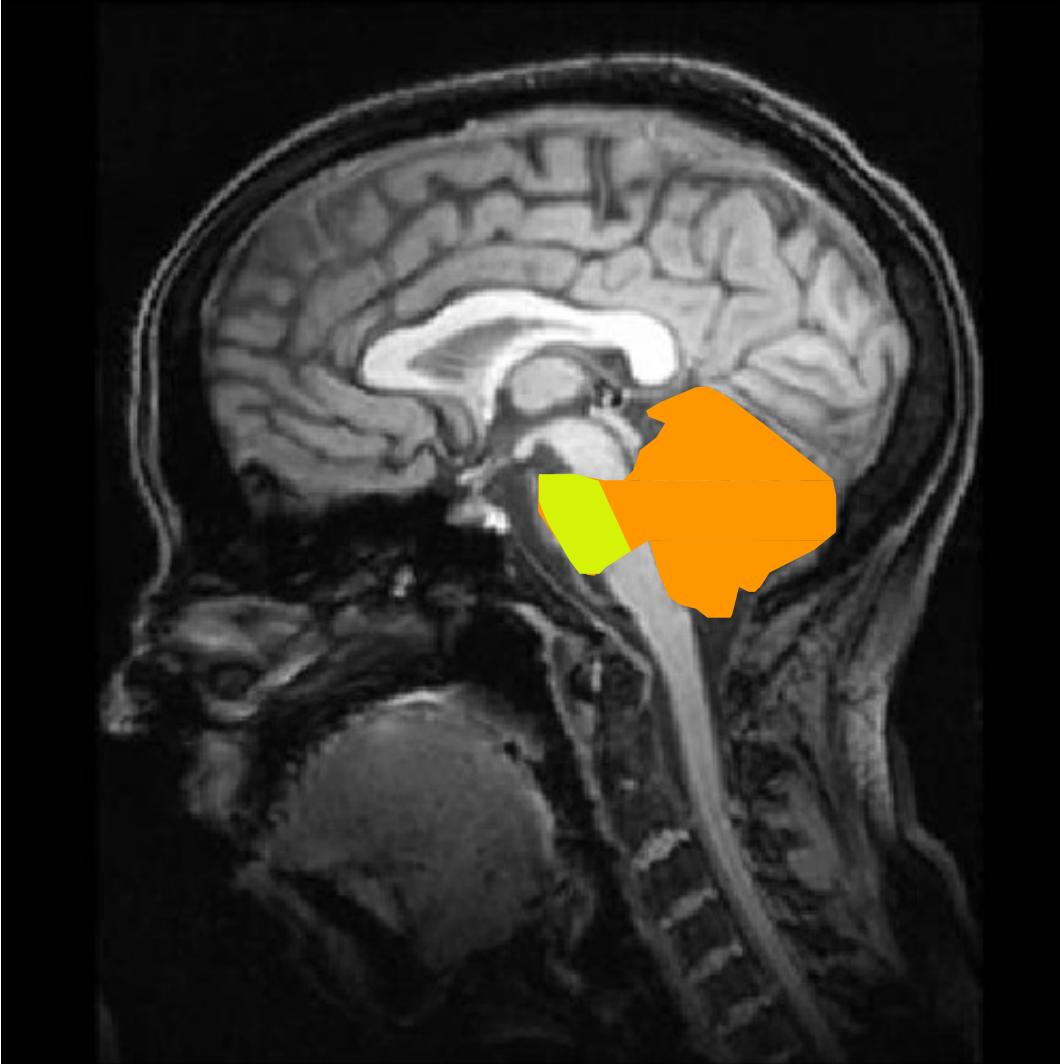
Again, lots of tracts
Comprised of multiple regions

Metencephalon



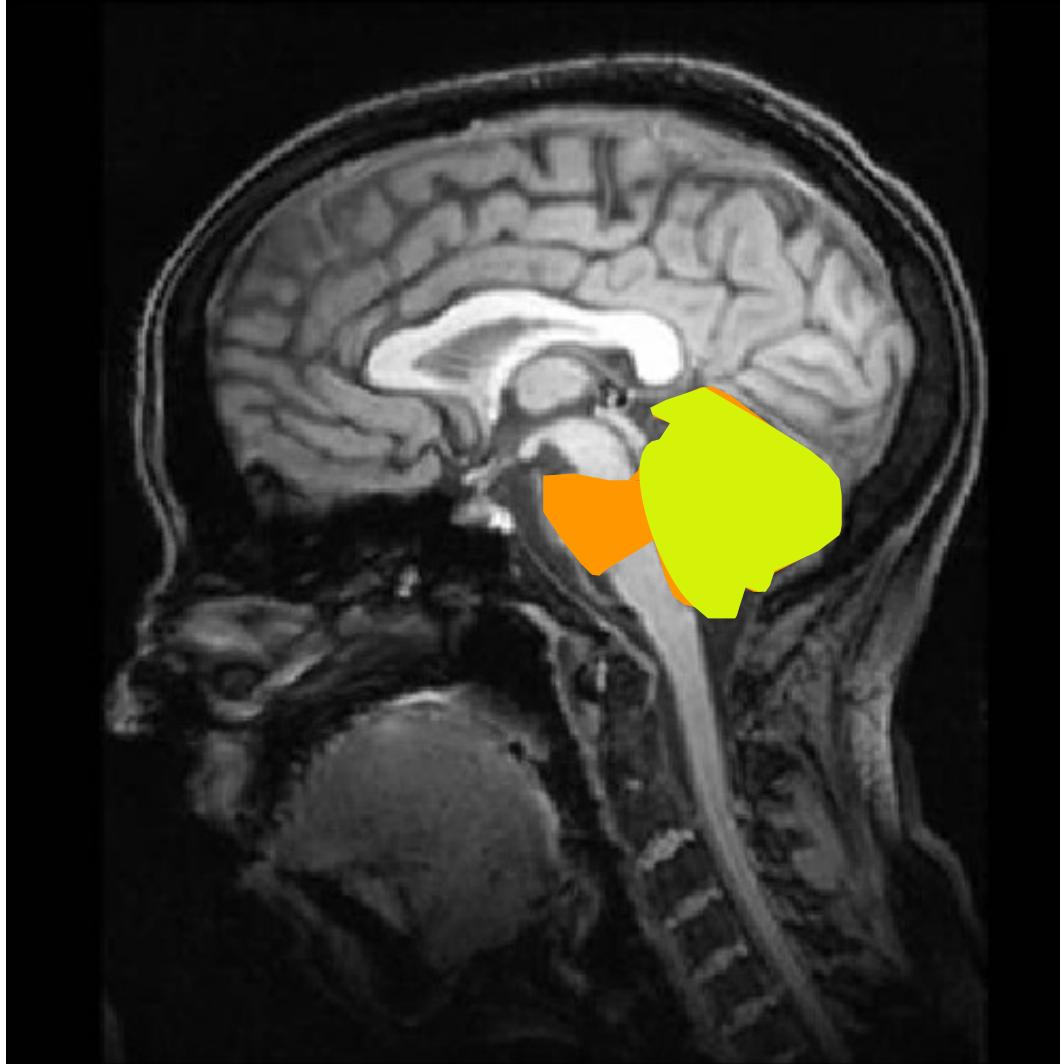
Also houses reticular formation

Metencephalon



The **pons**: large white-matter bulge,
continuing from spinal cord/medulla
Damage to this region?

Metencephalon



The **cerebellum**:

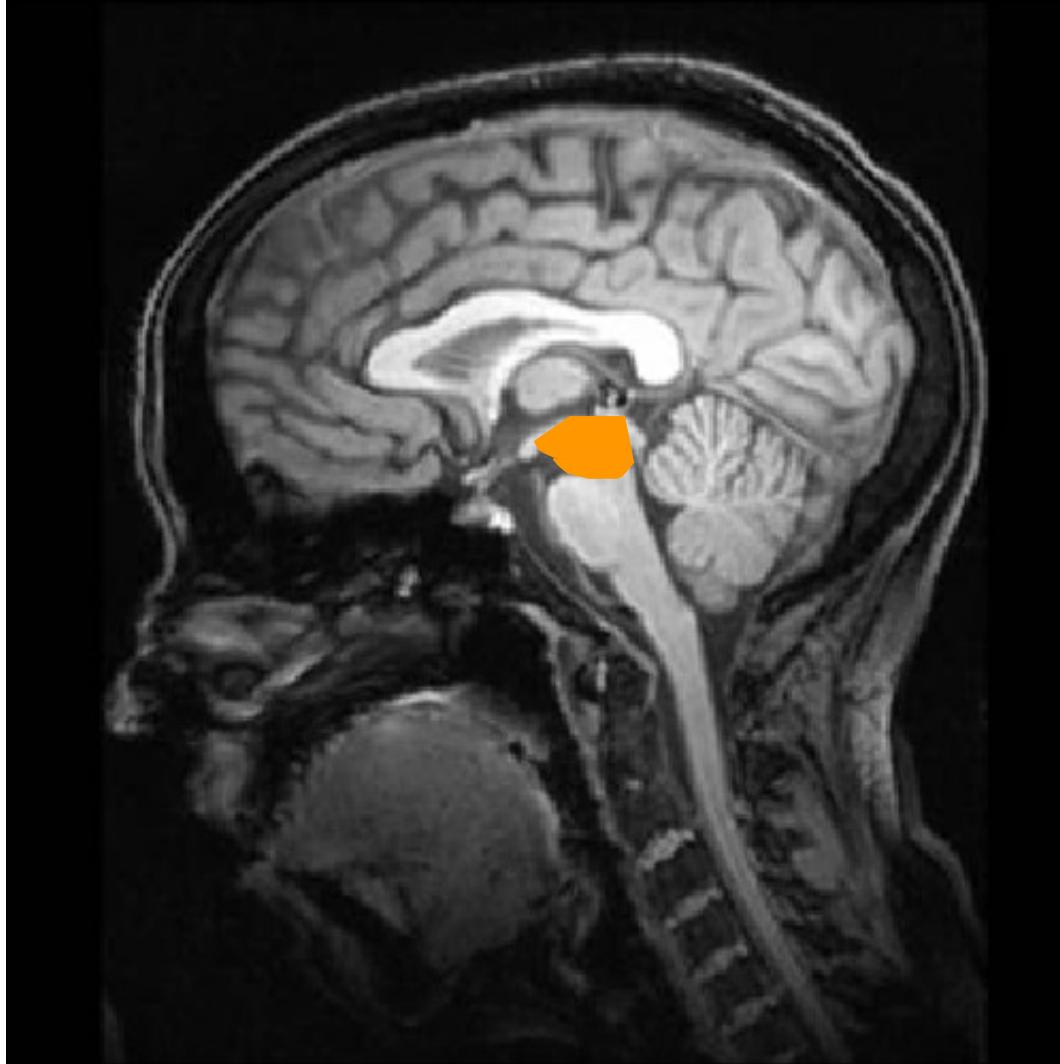
10% of brain volume,

>50% of neurons

Critical for motor coordination, more

Damage to this region?

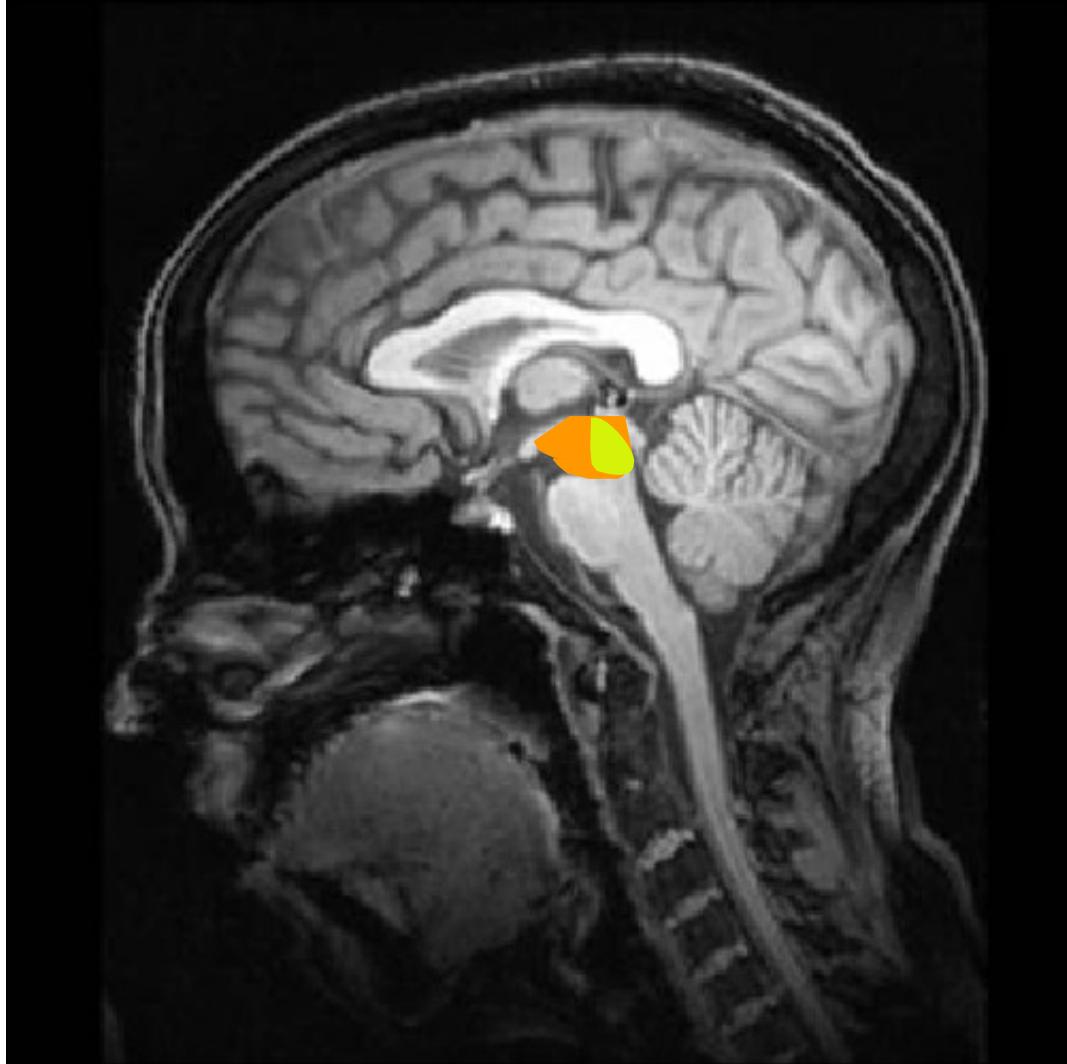
Mesencephalon



aka The midbrain

Comprised of a roof (**tectum**)
and a floor (**tegmentum**)

Mesencephalon



Tectum:

Comprised of two pairs of bumps (*colliculi*)

aka The Boston Pizza Part of Your Brain

Superior colliculi: vision with respect to eye movement

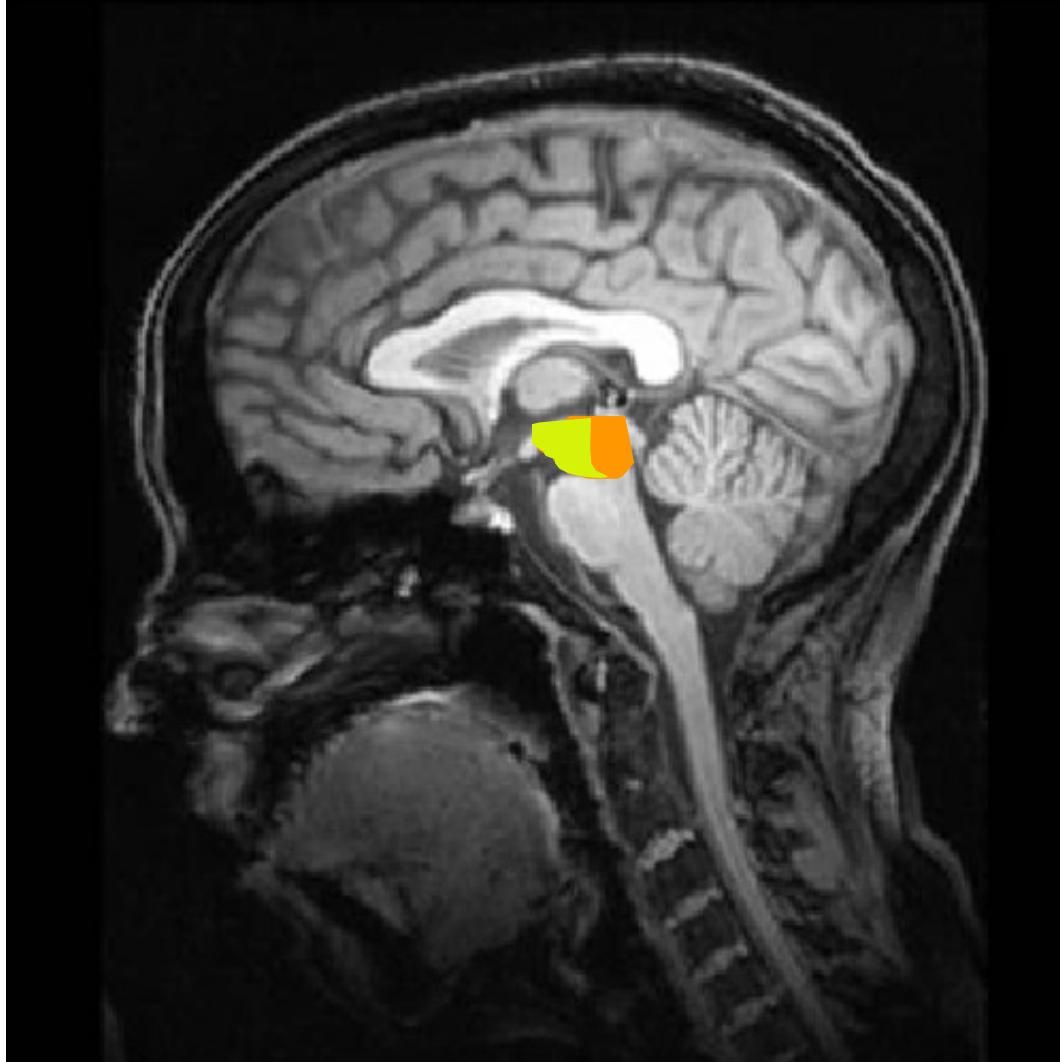
Inferior colliculi: audition with respect to head/body orientation

Outside of conscious access

Damage to these regions?

(e.g. Parinaud's syndrome)

Mesencephalon



Tegmentum:

Contains top of reticular formation

More fibres

Periacqueductal grey

Dopamine-producing regions

Substantia nigra

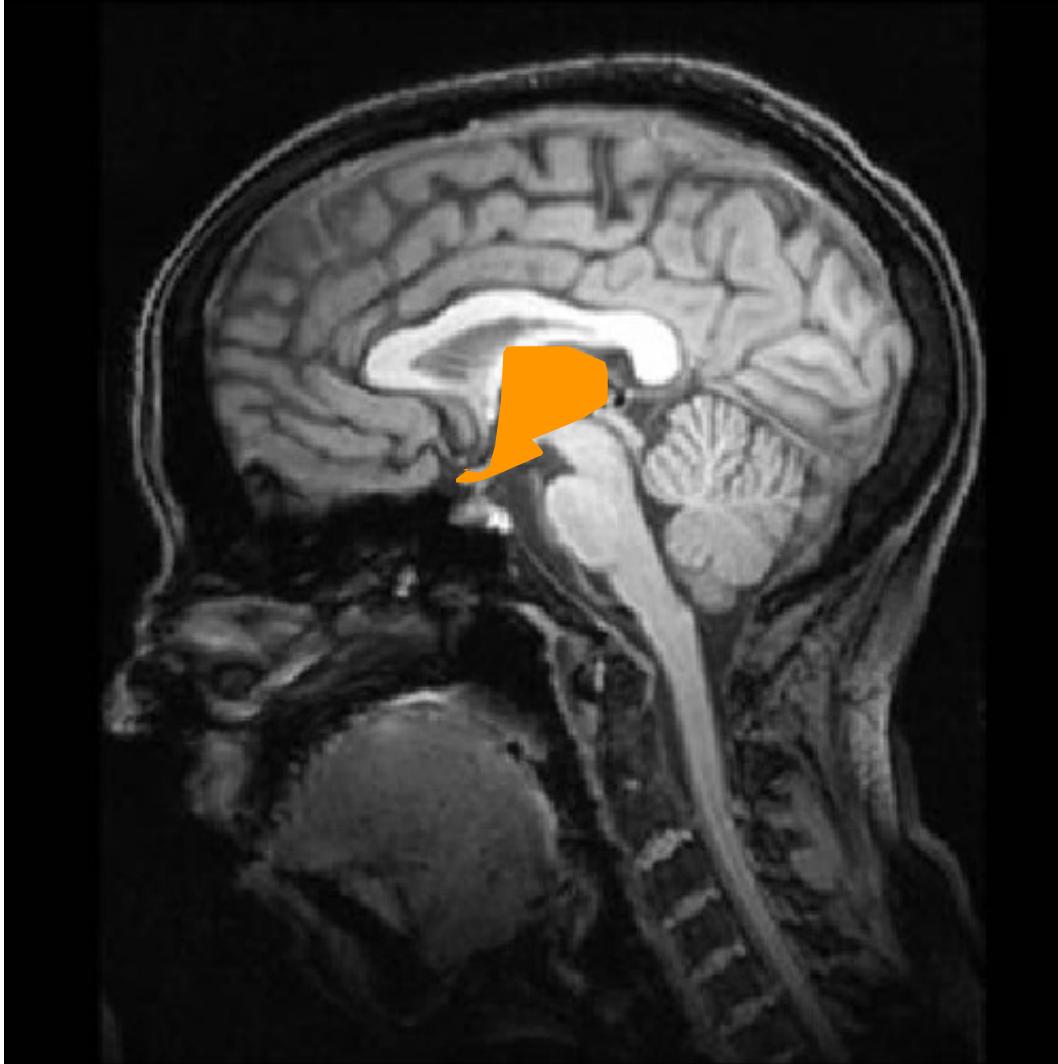
Ventral tegmental area (VTA)

Red nucleus

Pattern of function for these?

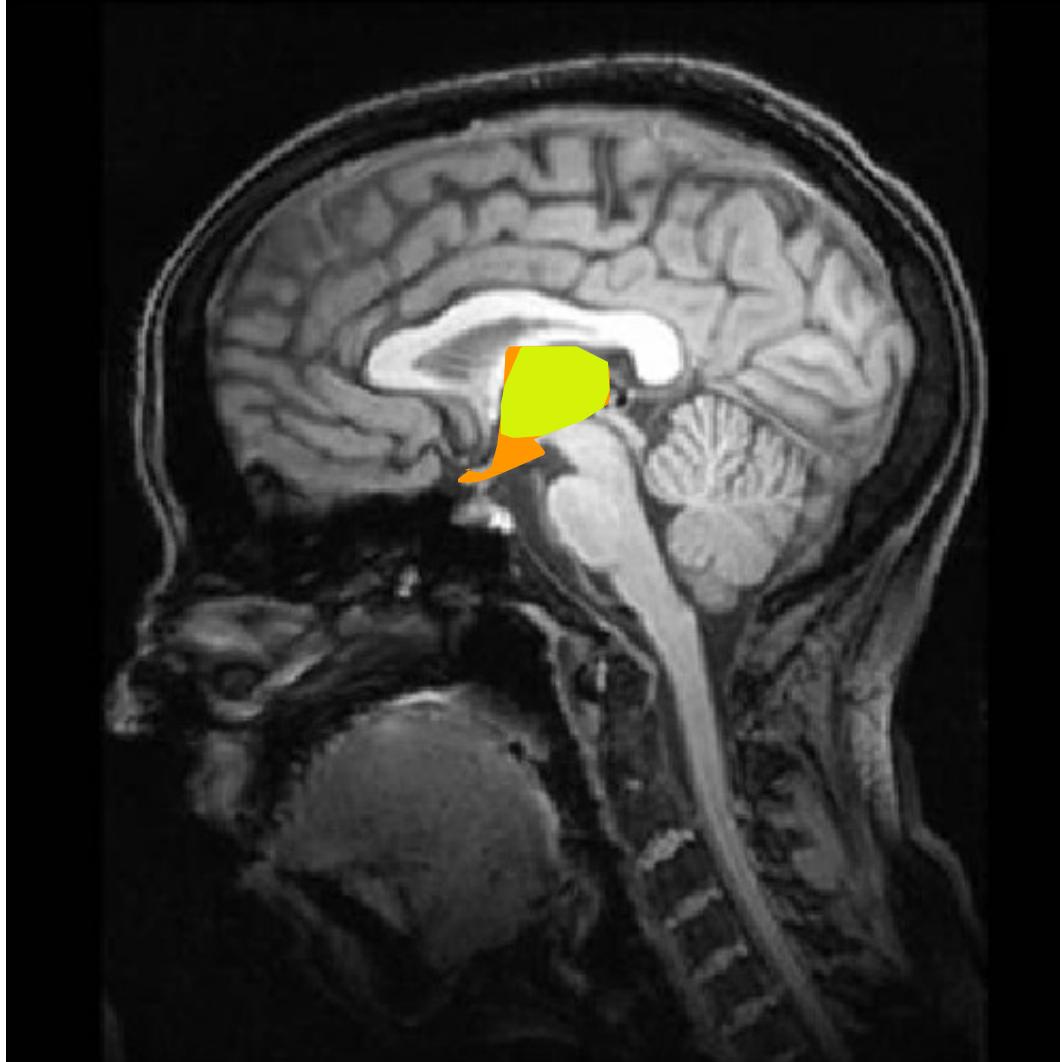
Damage to these?

Diencephalon



Comprised of two structures:
The **thalamus** and **hypothalamus**

Diencephalon



Thalamus:

Many nuclei: inputs from sensory systems, cerebellum, basal ganglia

Often called a “relay centre” for sensory information

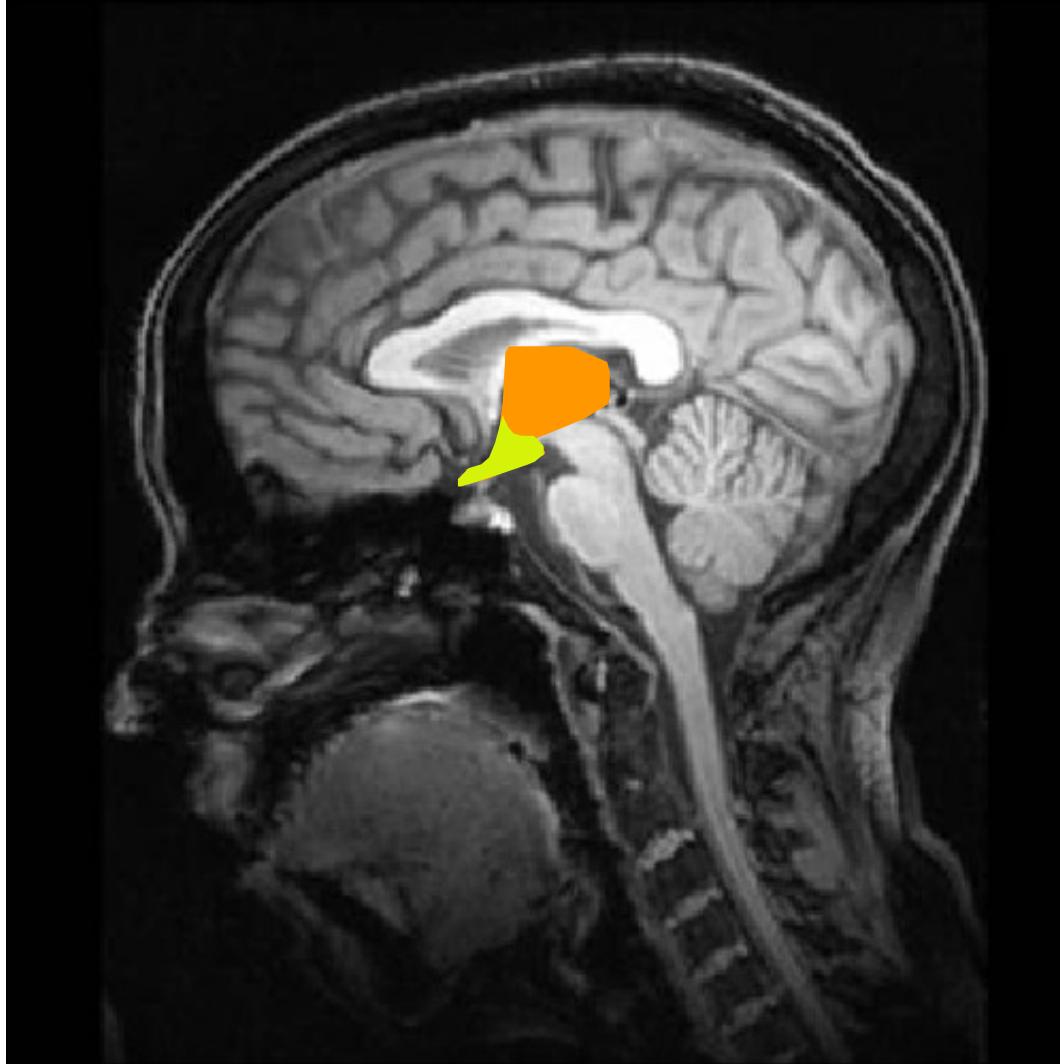
True, but: receives almost as much *from* cortex as it sends *to* cortex

And so many other inputs

Corticothalamic loops?

Damage to this region?

Diencephalon



Hypothalamus:

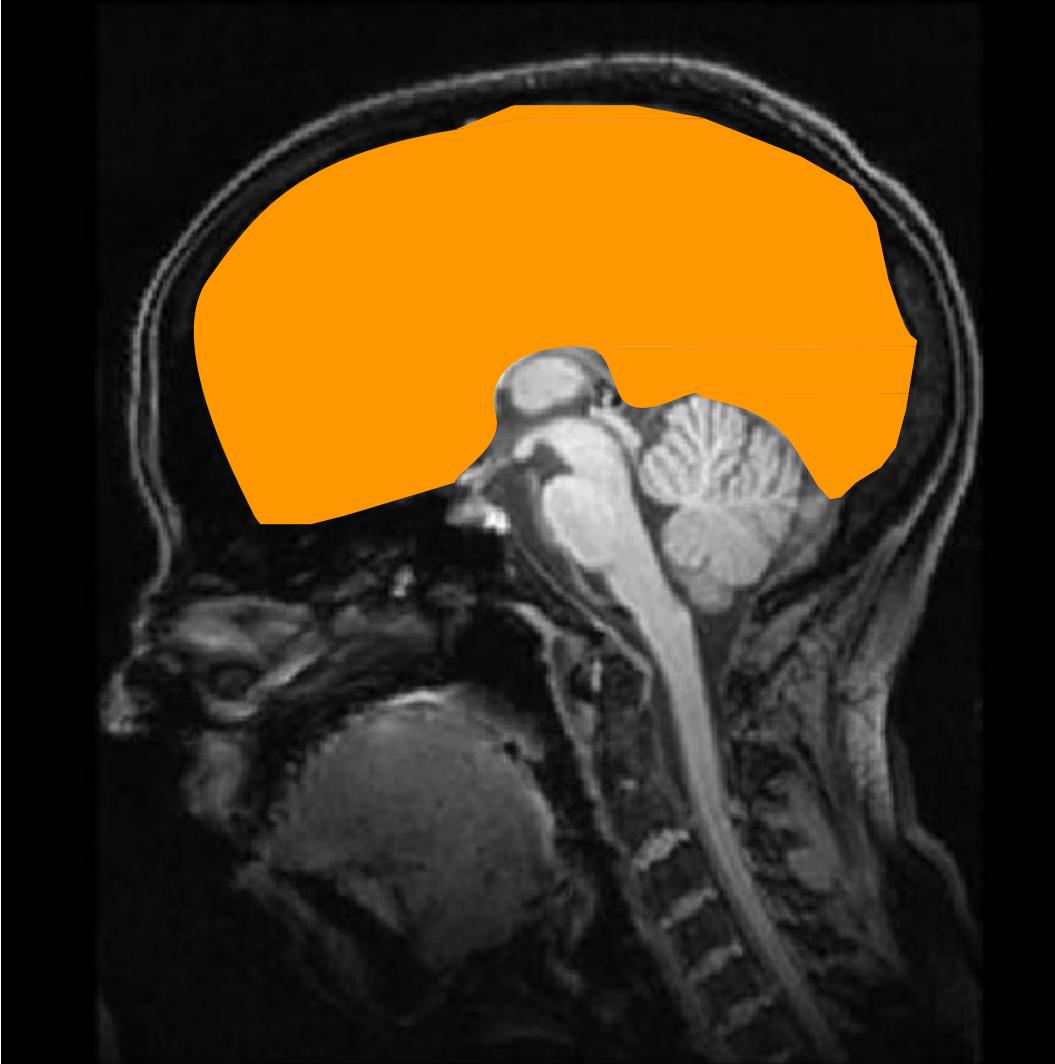
Many nuclei

Key intersection with endocrine system via the pituitary gland

Diverse functions: sex, aggression, feeding, sleep/wake, more

Damage to this region?

Telencephalon



The largest division of the human brain

Not just the cortex,
but also the underlying structures

Damage here is wide-ranging in its
symptoms, and is much of what we'll
be discussing in this course

Telencephalon

The **cerebral cortex**:

aka The cortex, neocortex

The largest and most prominent
feature of the human brain



Telencephalon

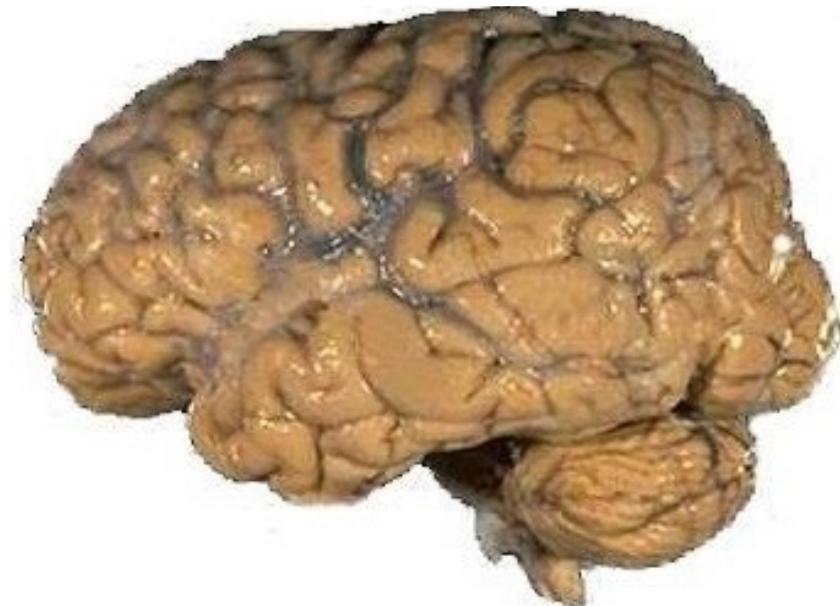
The **cerebral cortex**:

aka The cortex, neocortex

The largest and most prominent feature of the human brain

The cortex is highly convoluted — why?

cf. The *lissencephalic* (smooth) cortices of other mammals, birds, etc.

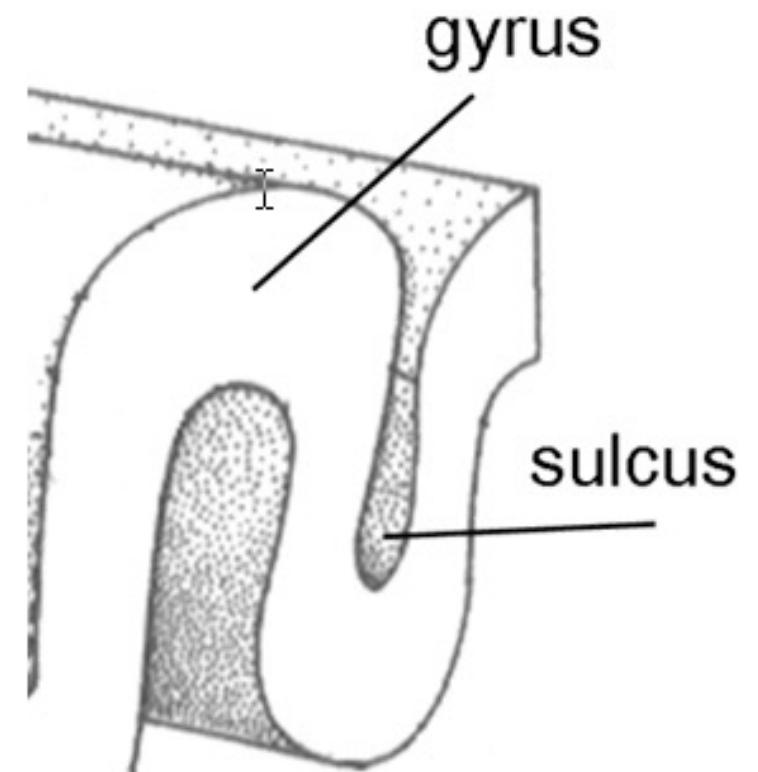


Convolutions

Gyrus/gyri and sulcus/sulci

Sulci sometimes called *fissures*

Not functionally meaningful, per se



Telencephalon

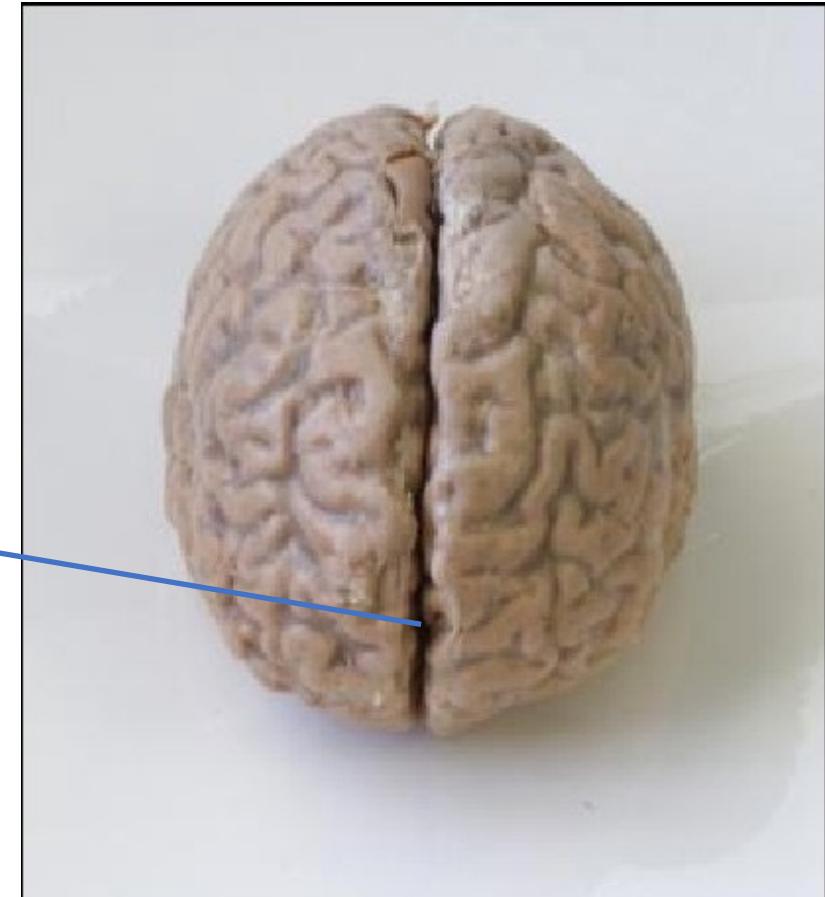
Hemispheres

The cerebrum is divided into two hemispheres

Separating the hemispheres:

The longitudinal fissure

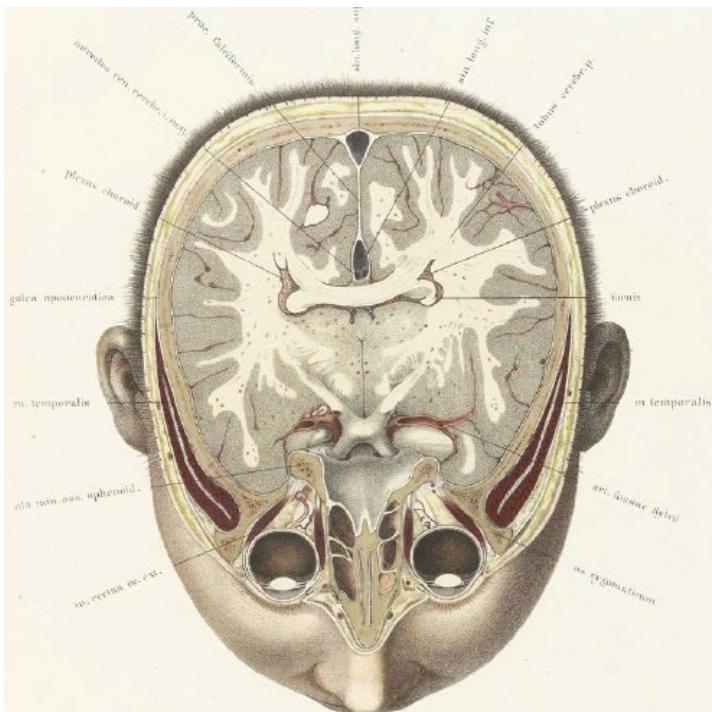
Contralateral organization



Connecting the hemispheres

Left and right hemispheres are only connected by a few tracts (commissures)

Largest: the **corpus callosum**



Telencephalon

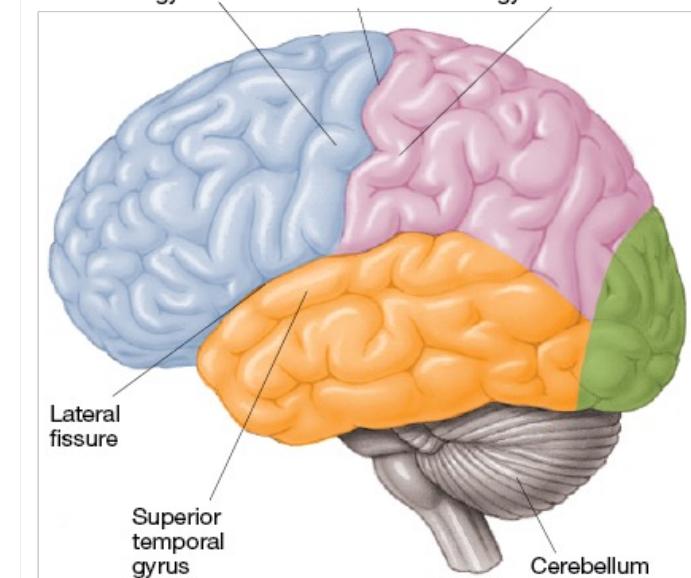
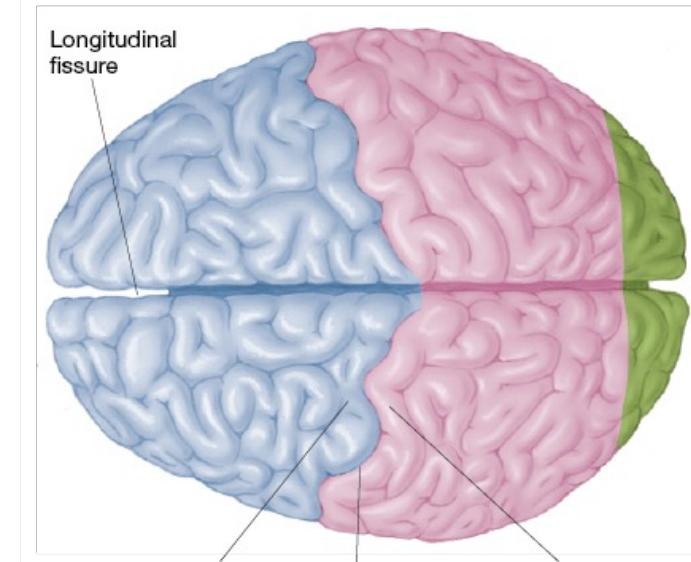
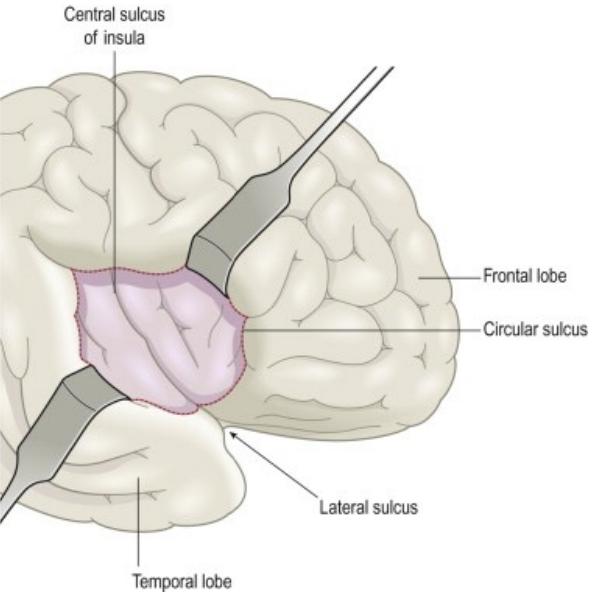
More fissures, and lobes

Four lobes of the brain — where do they get their names?

Central fissure separates frontal and parietal lobes

Lateral fissure separates temporal lobe from frontal/parietal

Deep in the lateral fissure: the insula



Frontal lobe Parietal lobe Temporal lobe Occipital lobe

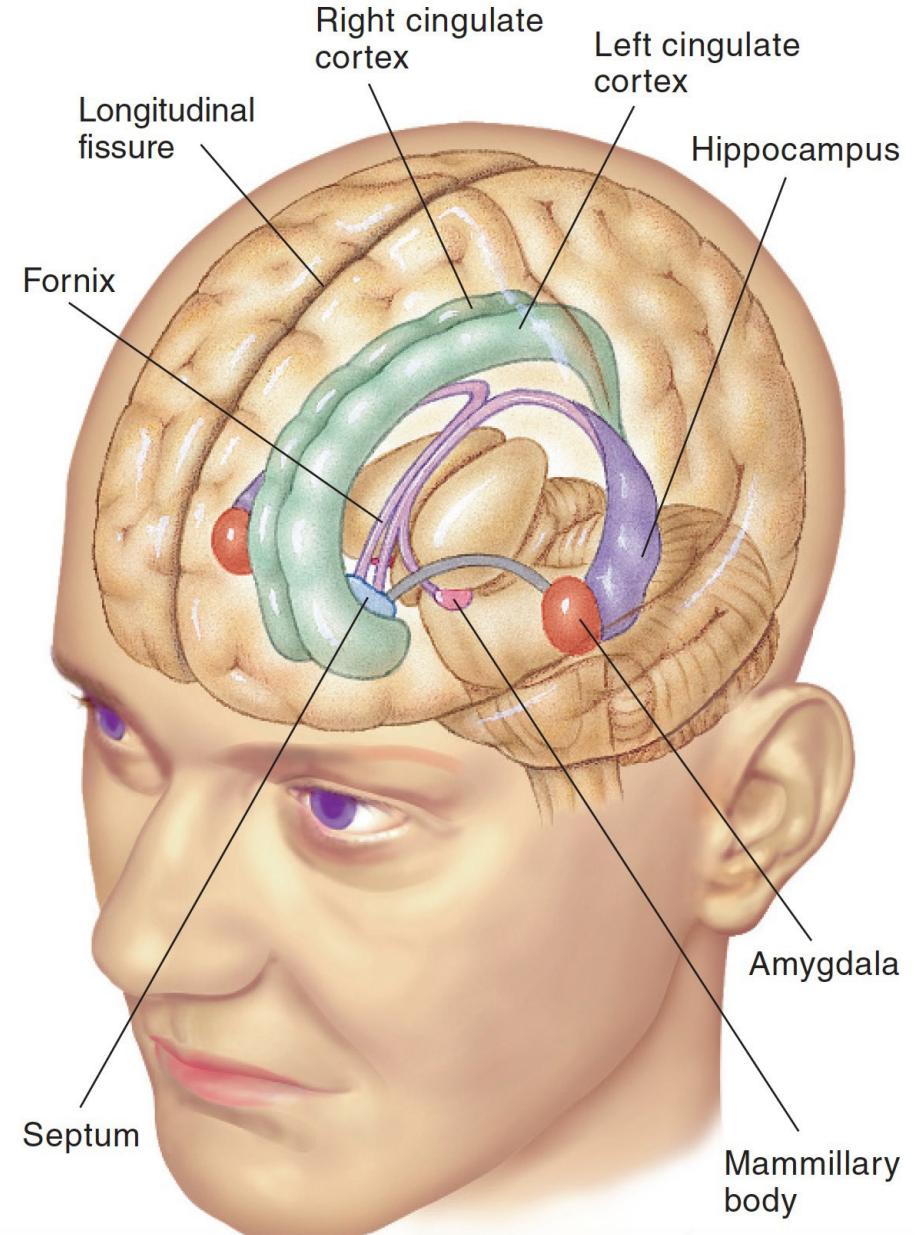
Telencephalon

The limbic “system”: not a system

The Papez “Circuit”, aka the Limbic “System”

→ **Amygdala, HTh, mammillary body, hippocampus, fornix, cingulate cortex, septum, olfactory bulb**

Again, symptoms from damage can vary from region to region (we'll come back to these)



Telencephalon

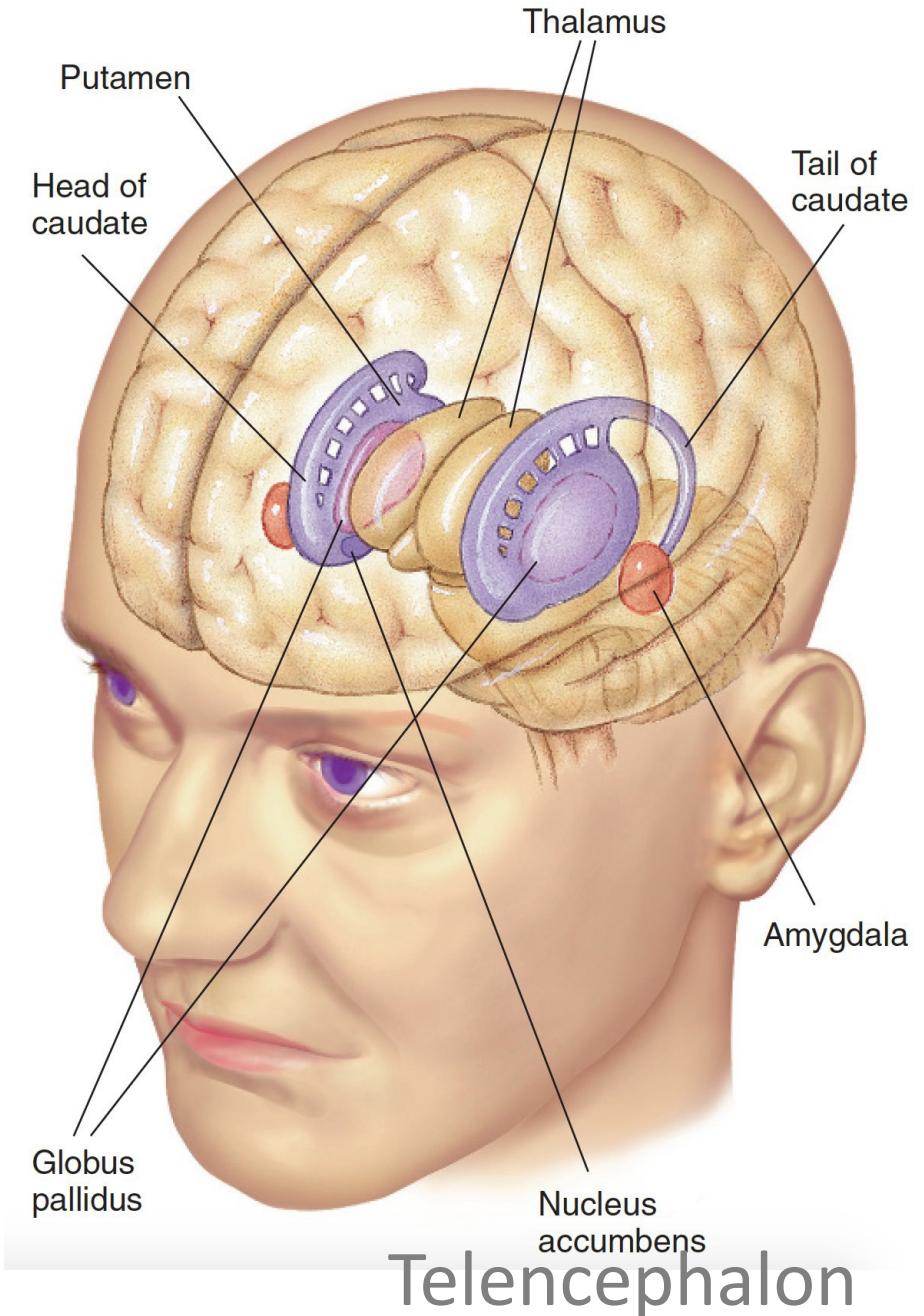
Basal ganglia

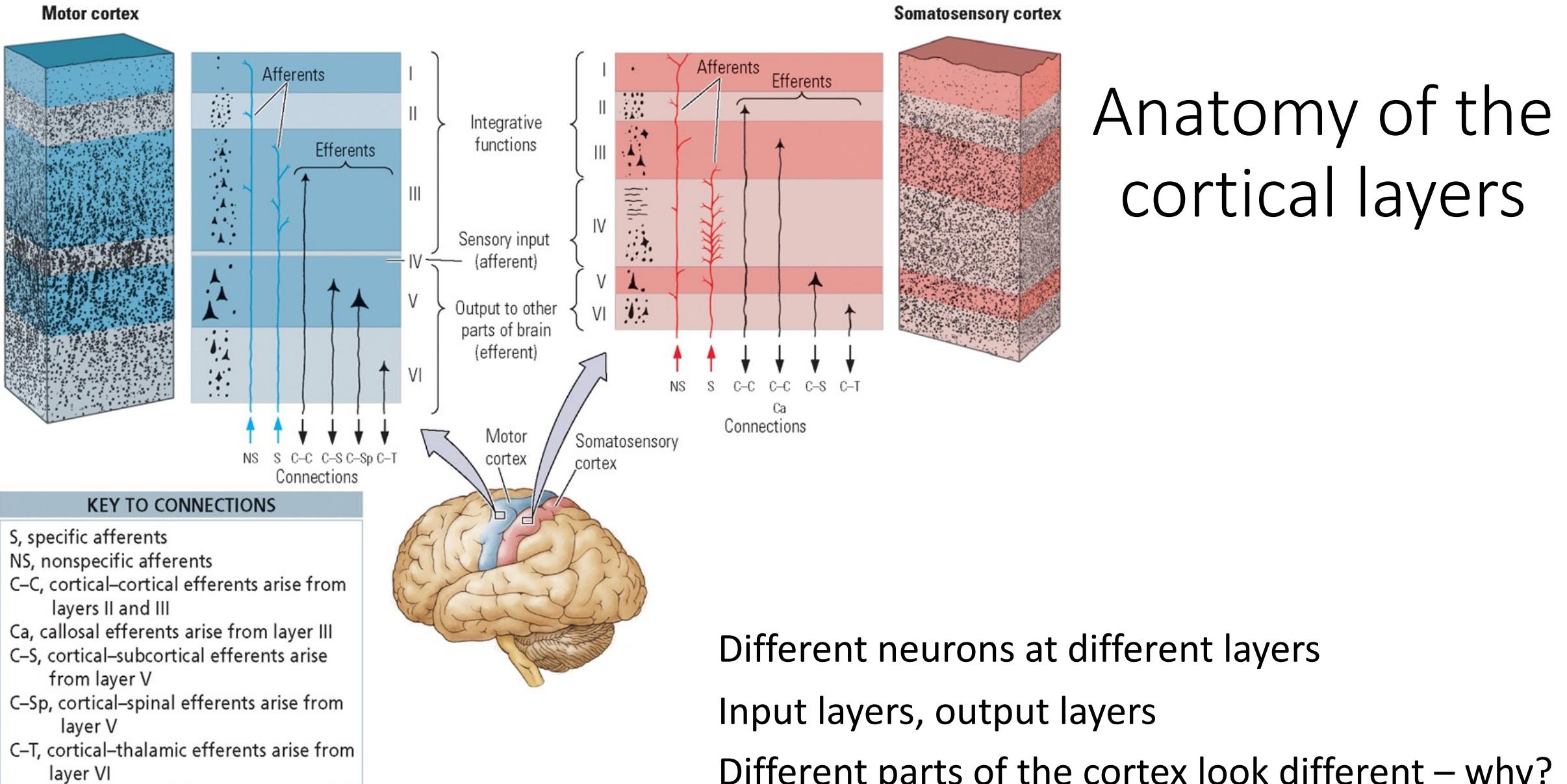
Includes **striatum (caudate + putamen)** and **globus pallidus**, sometimes others (e.g. **subthalamic nucleus**)

Nucleus accumbens is a subregion of striatum/caudate, sometimes called **ventral striatum**

Critical in movement, skills, habits, decision making

Again, more on this later





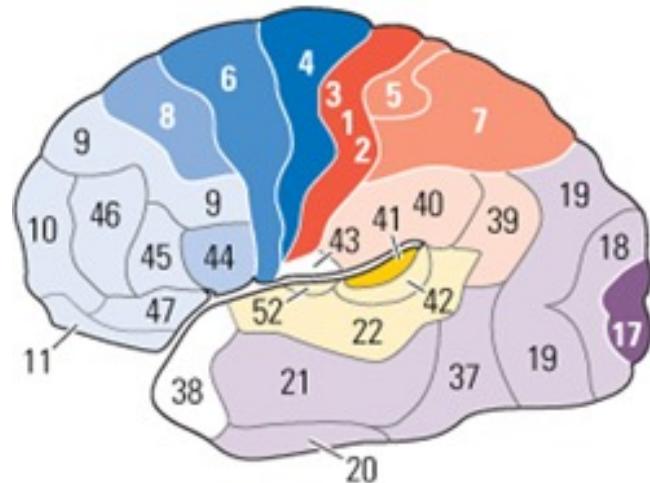
Anatomy of the cortical layers

Telencephalon

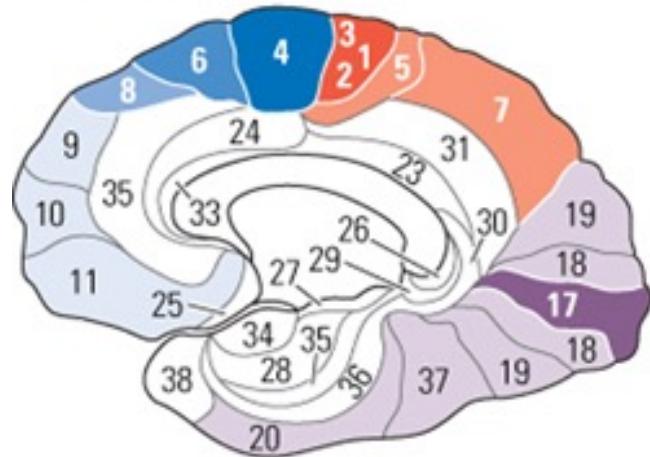
Research from Shepherd, 1979.

Anatomy of the cortical layers

(A) Lateral view



Medial view



(B)

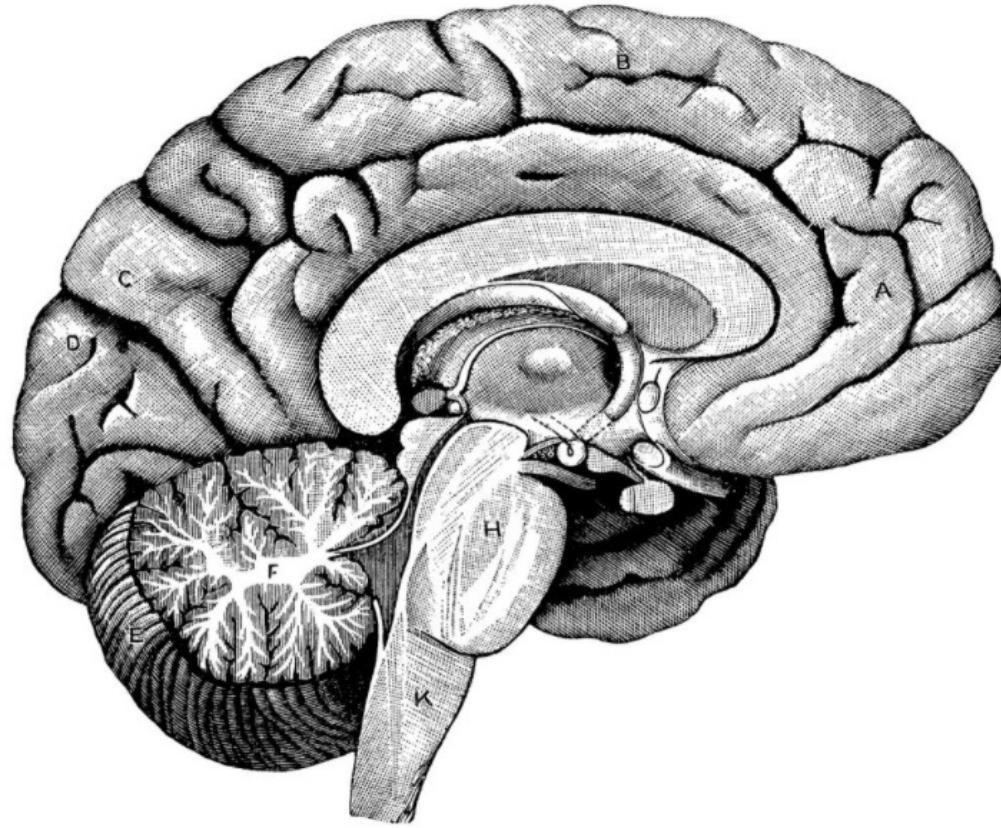
Function	Map code	Brodmann area
Vision primary secondary		17
		18, 19, 20, 21, 37
Auditory primary secondary		41
		22, 42
Body senses primary secondary		1, 2, 3
		5, 7
Sensory, tertiary		7, 22, 37, 39, 40
Motor primary secondary eye movement speech		4
		6
		8
		44
Motor, tertiary		9, 10, 11, 45, 46, 47

These differences between parts of the cortex can be used to make maps

e.g. **Brodmann areas**

Do we only use 5%/10%/etc. of our brains?

No.



Telencephalon

e.g. Controlling voluntary movement

Prefrontal cortex

Premotor areas

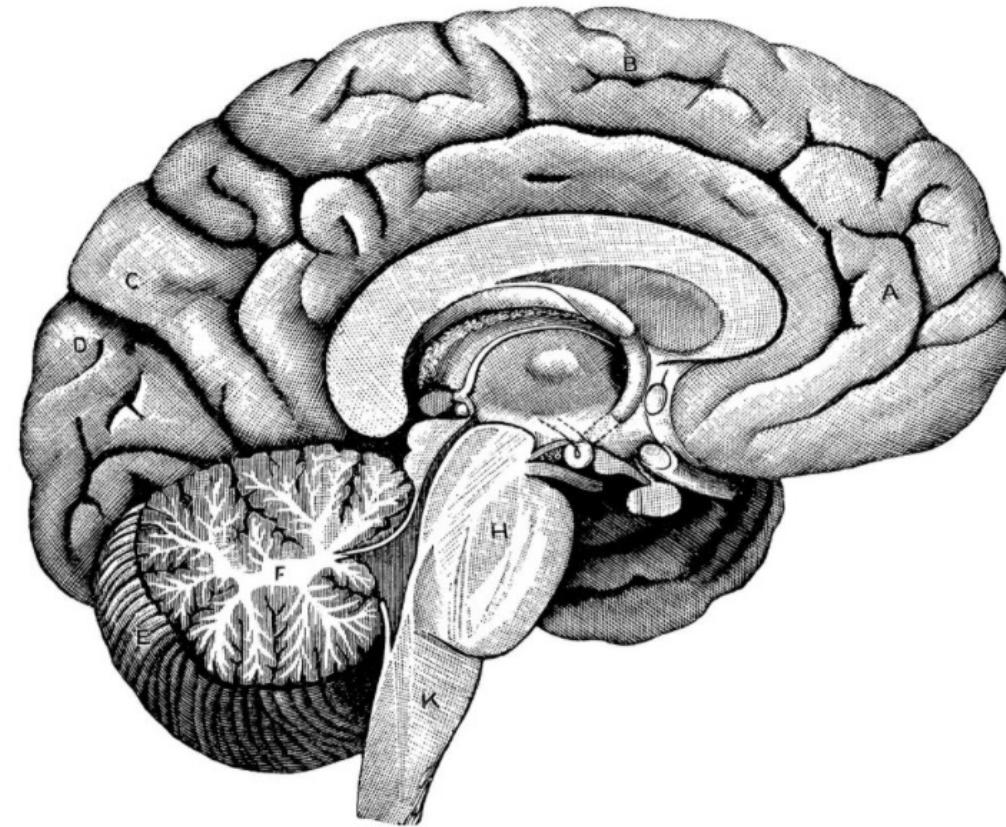
Motor cortex

Basal ganglia

Pons

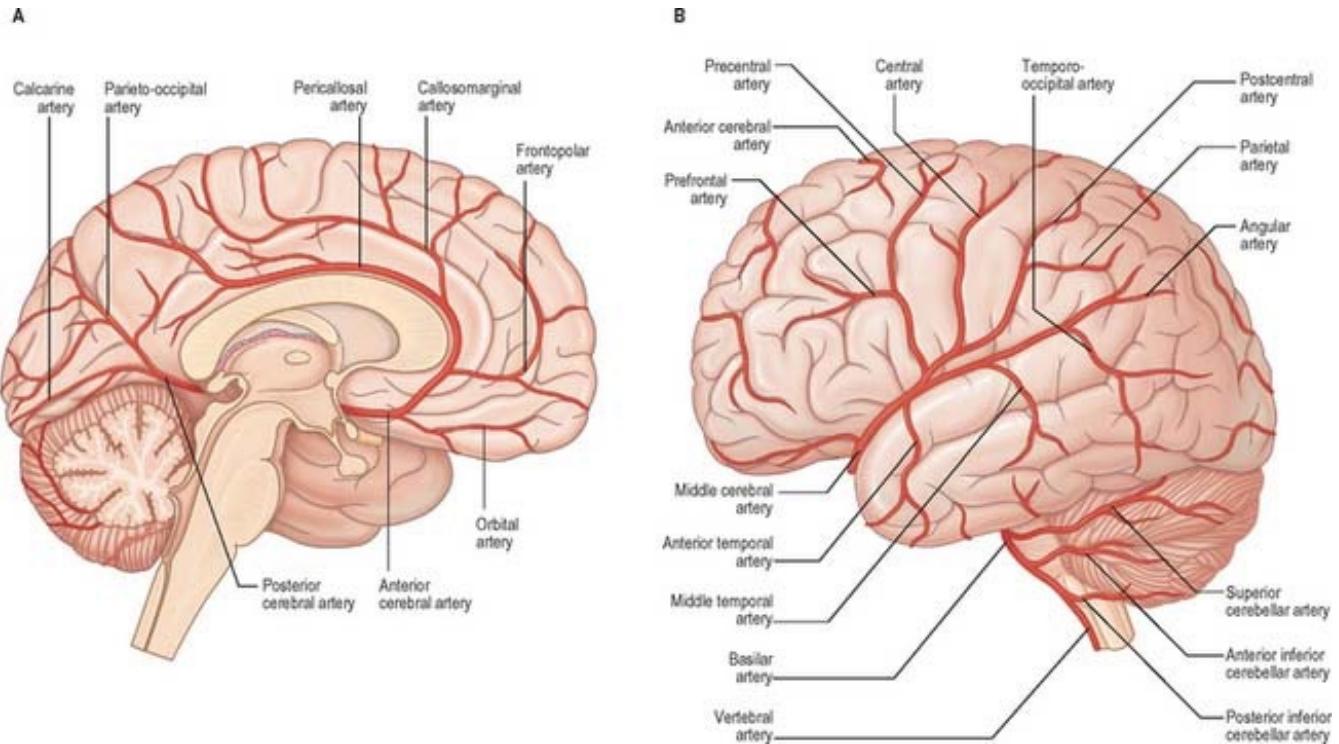
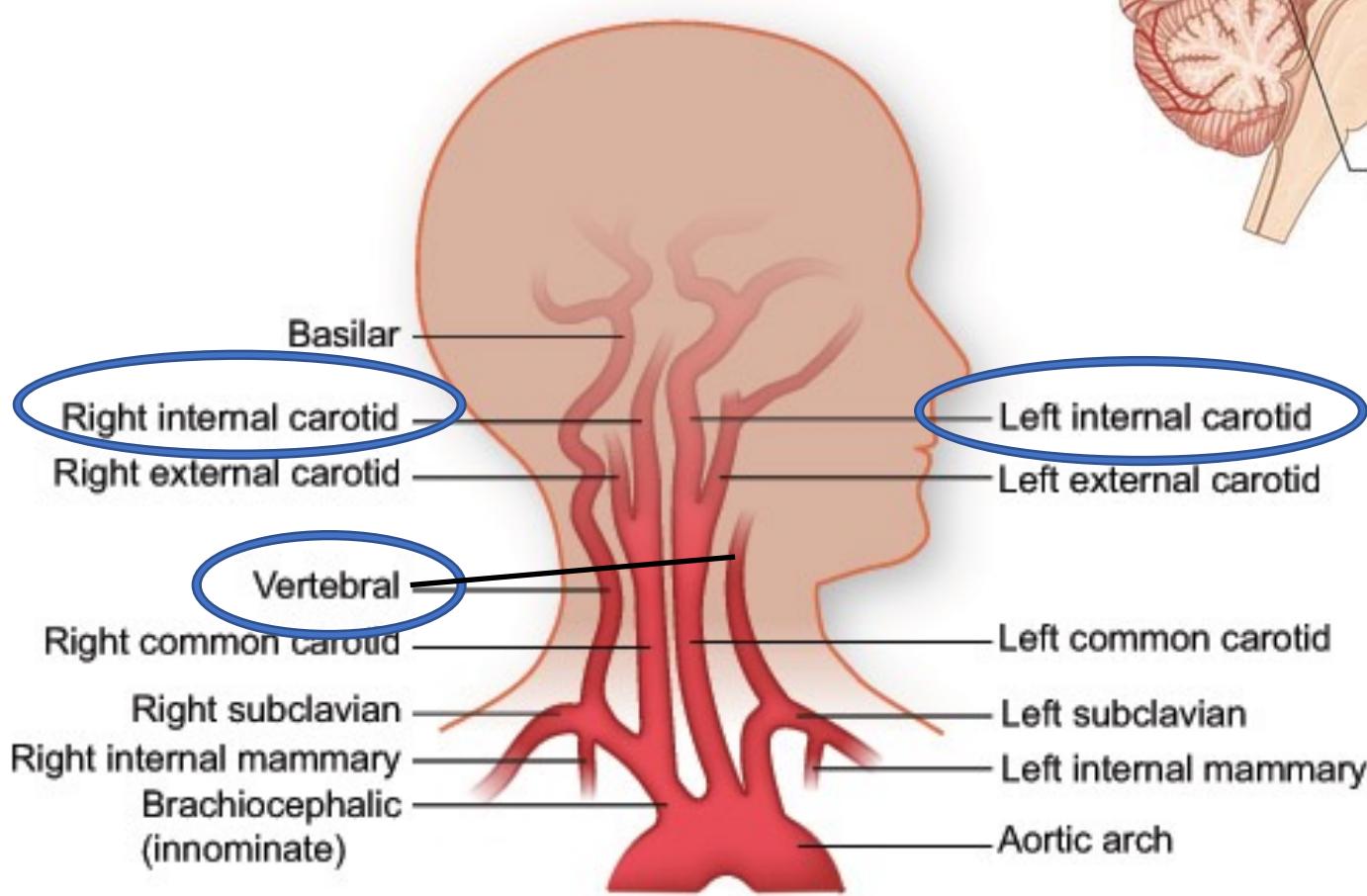
Cerebellum

More



Telencephalon

Cerebral blood flow



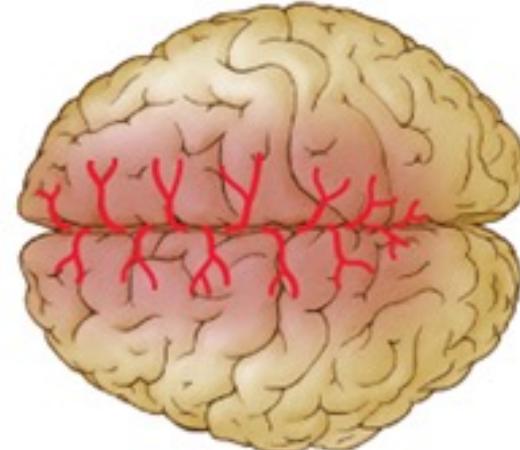
Limited supply
No reserves
No redundancy

Implications for brain dysfunction?
Support

Cerebral blood flow

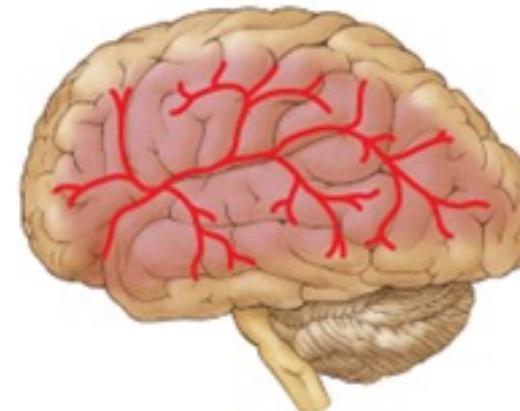
Limited supply
No redundancy
No reserves

Anterior cerebral artery



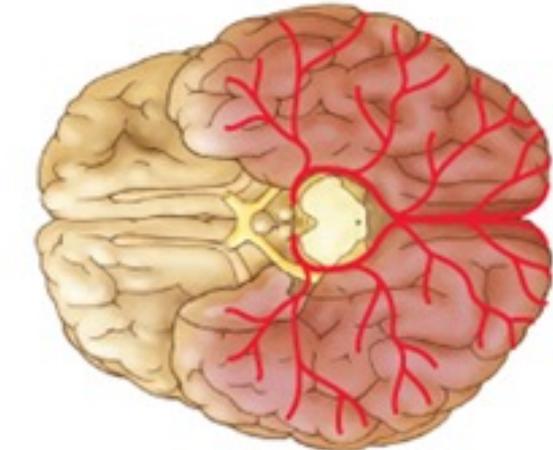
Dorsal view

Middle cerebral artery

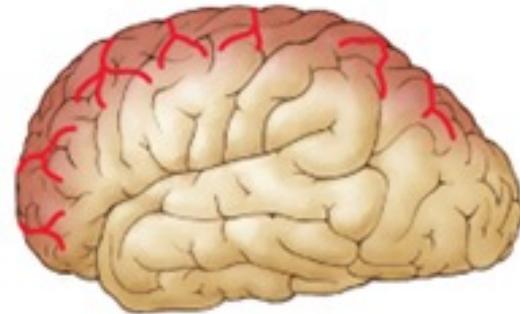


Lateral view

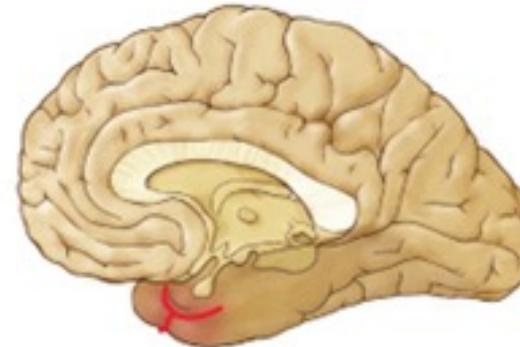
Posterior cerebral artery



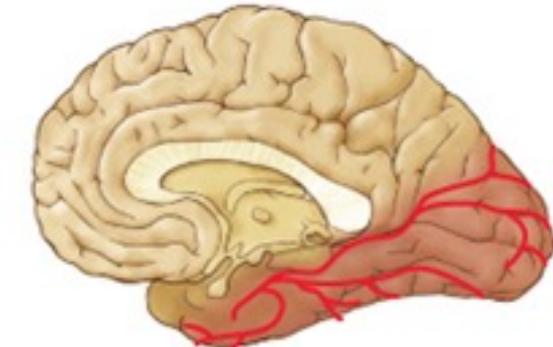
Ventral view



Lateral view



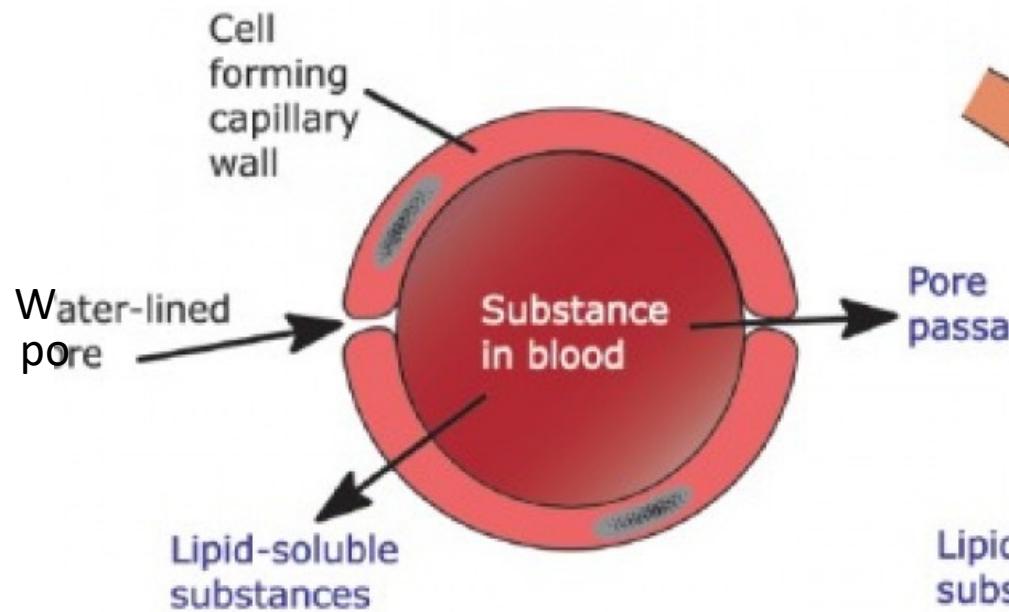
Medial view



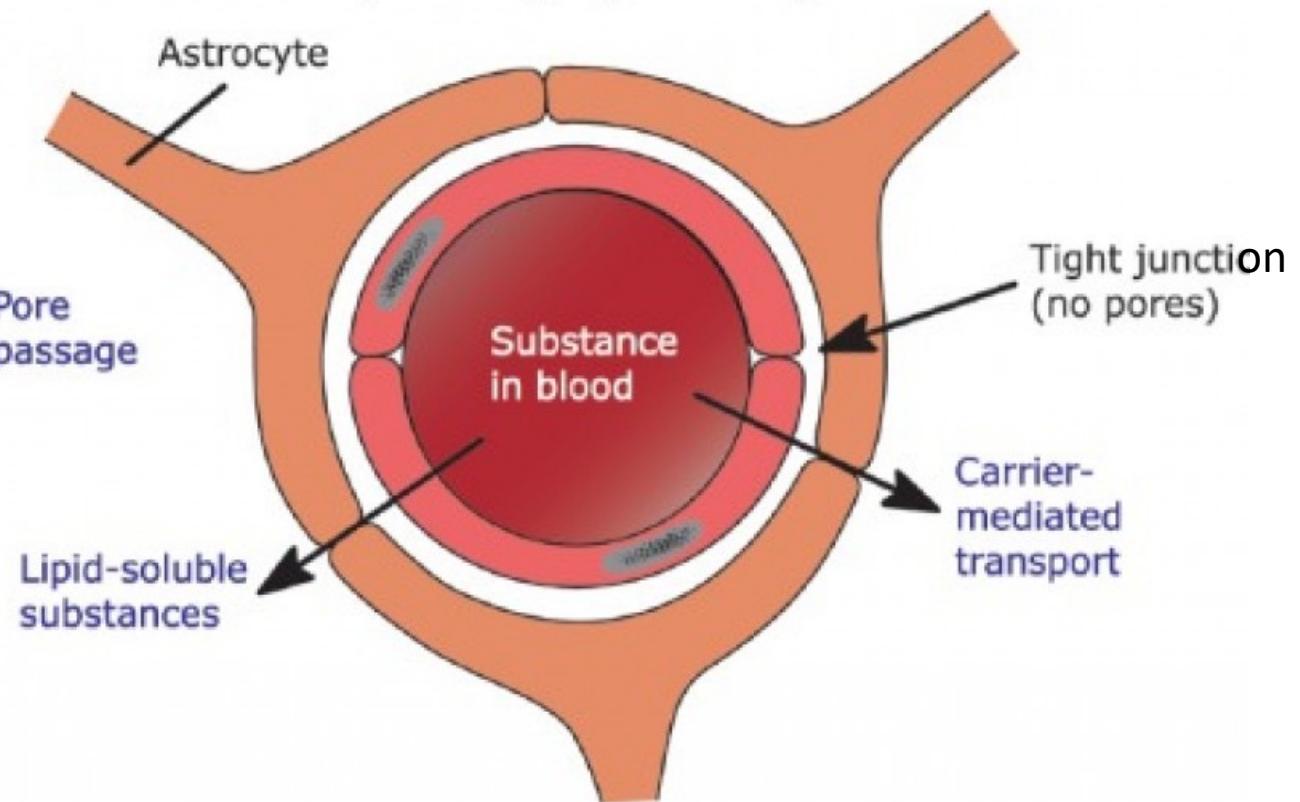
Medial view

The blood-brain barrier (BBB)

Capillary (general)



Capillary (brain)

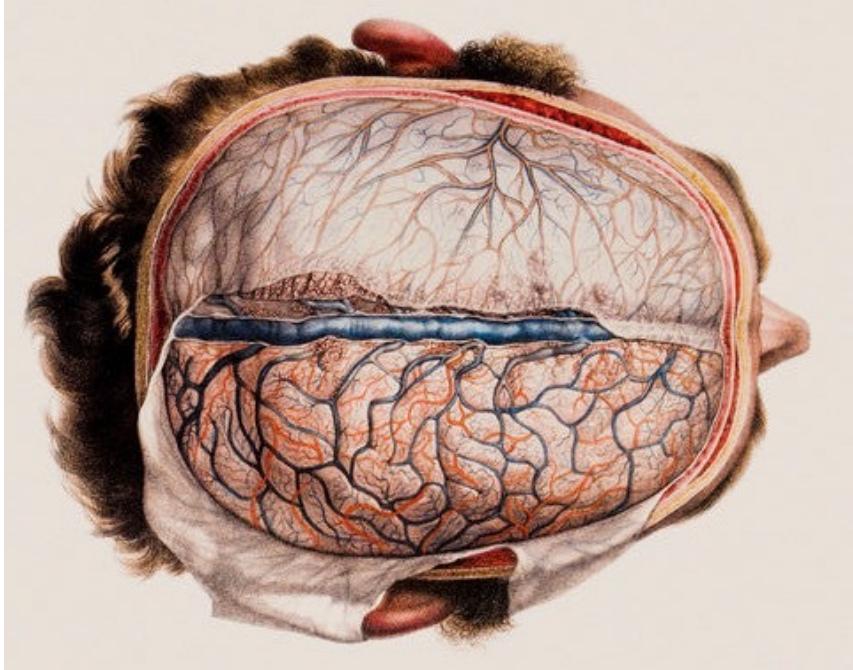


Tightly packed

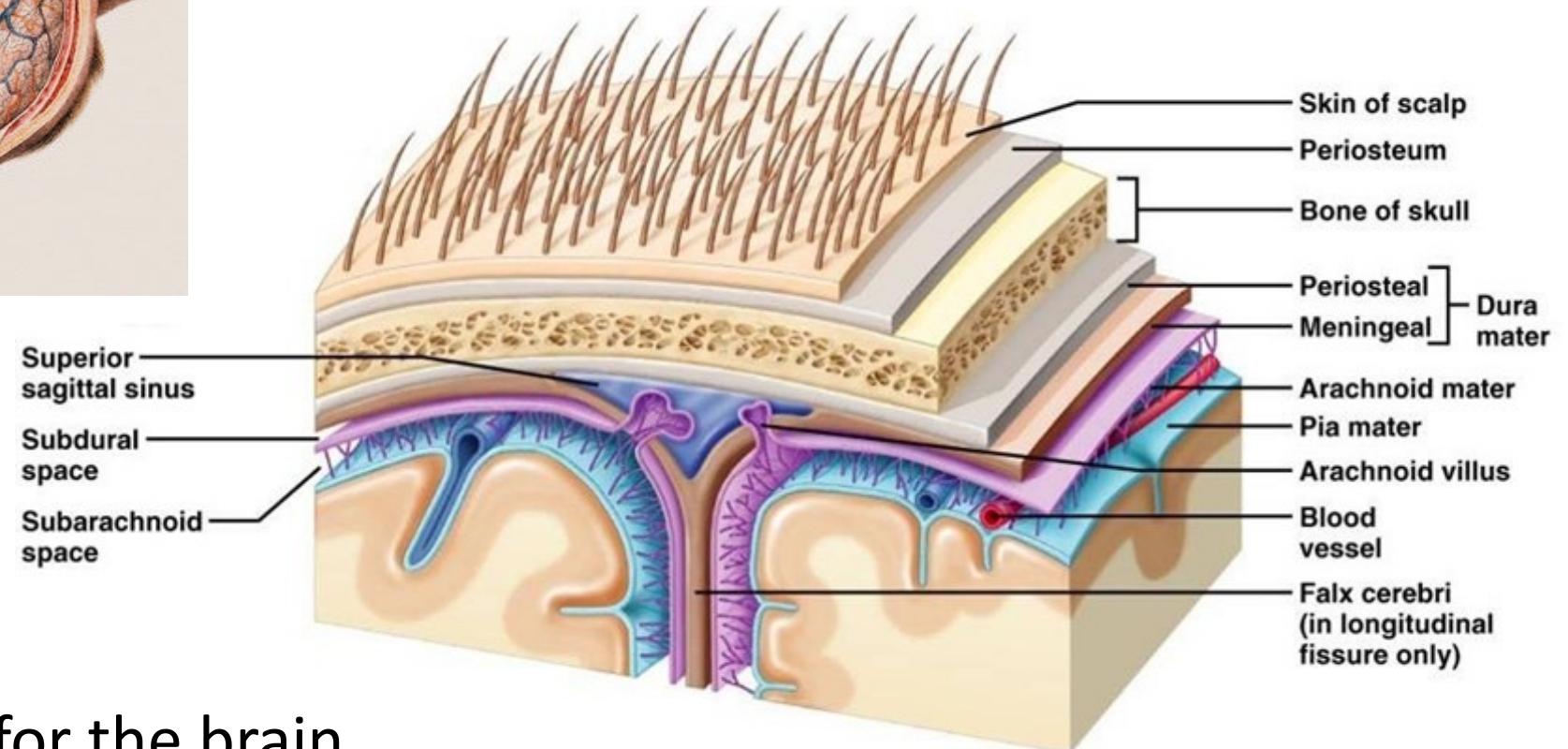
Protects brain

Active transport for large molecules

Support



Skull and meninges



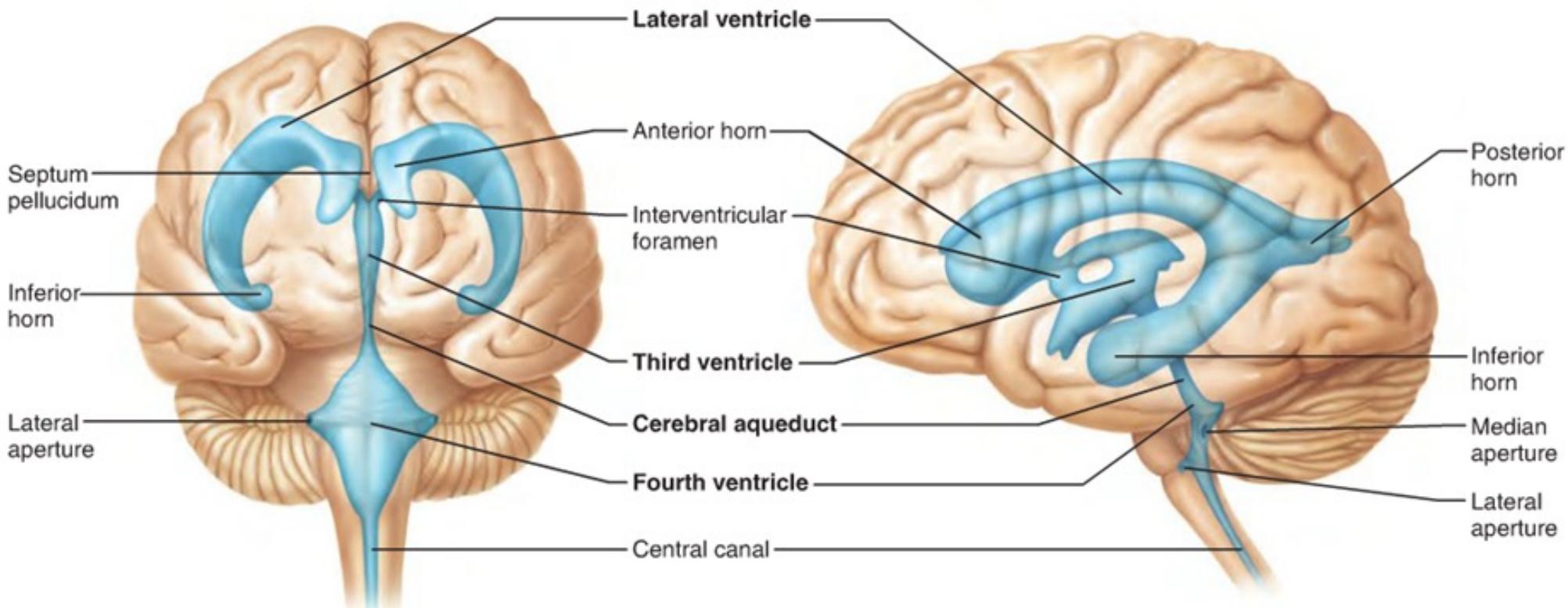
Primarily protection for the brain

Skull and meninges



Primarily protection for the brain

Cerebrospinal fluid (CSF) and ventricles



(a) Anterior view

(b) Left lateral view

Support, protection, nutrition

Summary of brain structures

Diencephalon	Thalamus	Massa intermedia Lateral geniculate nuclei Medial geniculate nuclei Ventral posterior nuclei
	Hypothalamus	Mammillary bodies
	Optic chiasm	
	Pituitary gland	
Mesencephalon	Tectum	Superior colliculi Inferior colliculi
	Tegmentum	Reticular formation Cerebral aqueduct Periaqueductal gray Substantia nigra Red nucleus
Metencephalon	Reticular formation Pons Cerebellum	
Myelencephalon or Medulla	Reticular formation	

Telencephalon	Cerebral cortex	Neocortex Hippocampus
	Major fissures	Central fissure Lateral fissure Longitudinal fissure
	Major gyri	Precentral gyrus Postcentral gyrus Superior temporal gyrus Cingulate gyrus
	Four lobes	Frontal lobe Temporal lobe Parietal lobe Occipital lobe
	Limbic system	Amygdala Hippocampus Fornix Cingulate cortex Septum Mammillary bodies
	Basal ganglia	Amygdala Caudate } Striatum Putamen } Globus pallidus
	Cerebral commissures	Corpus callosum

It's a lot, but you can do it!