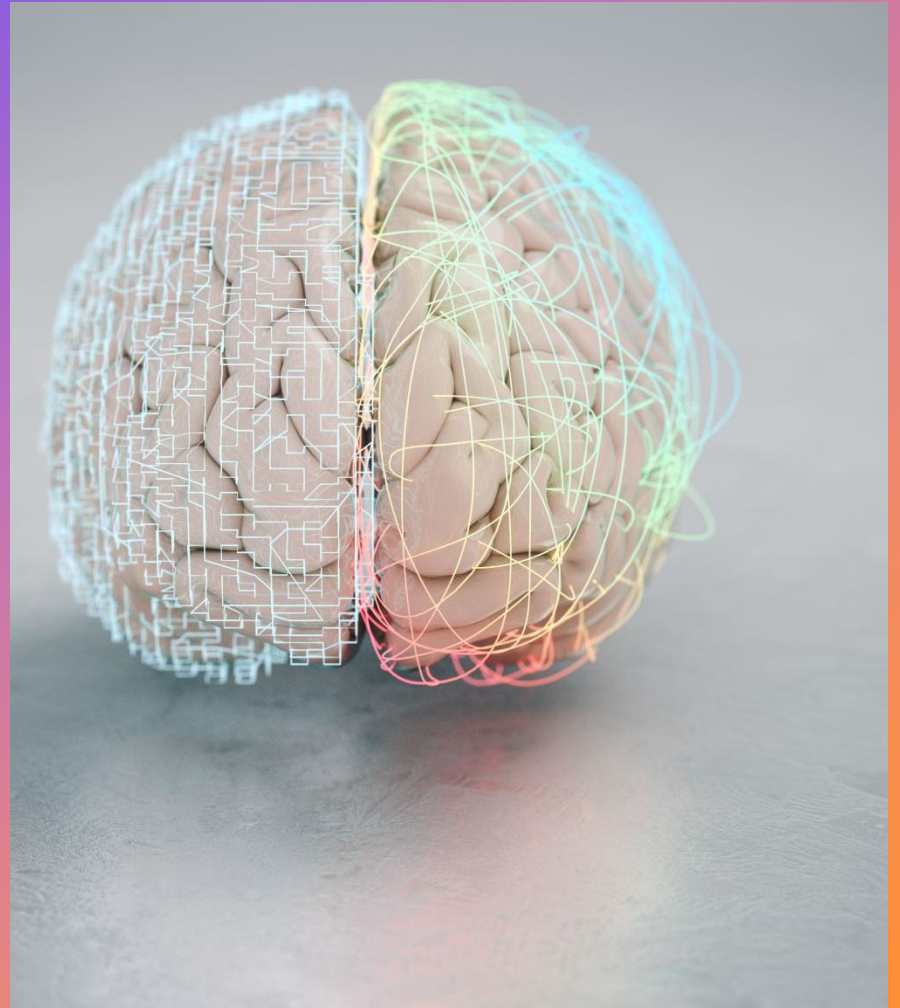

THE BRAIN, BIOLOGY⁺ AND COGNITION

The Brain Worksheet –
Correct Answers

COMPLETE 'THE BRAIN' WORKSHEET

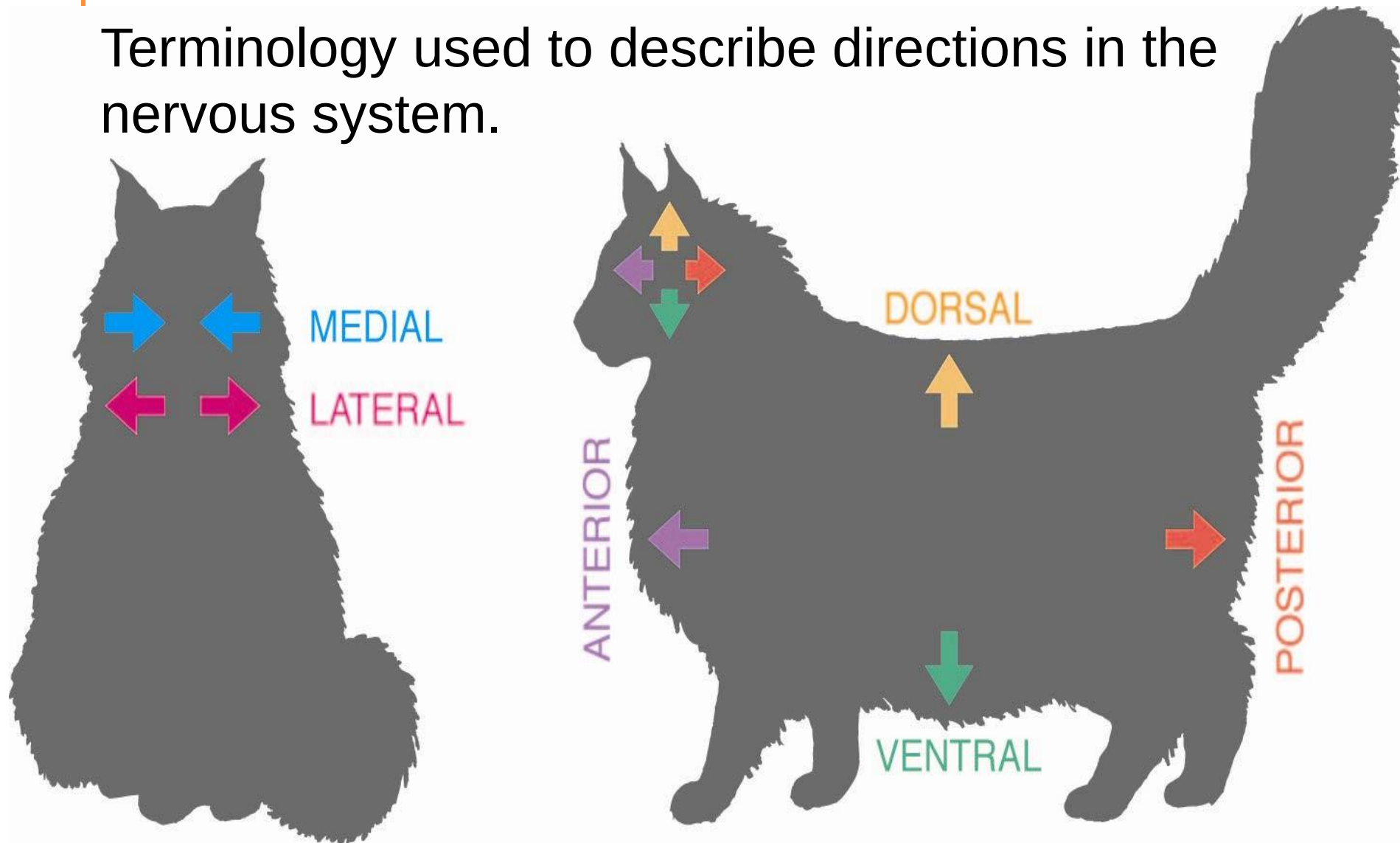


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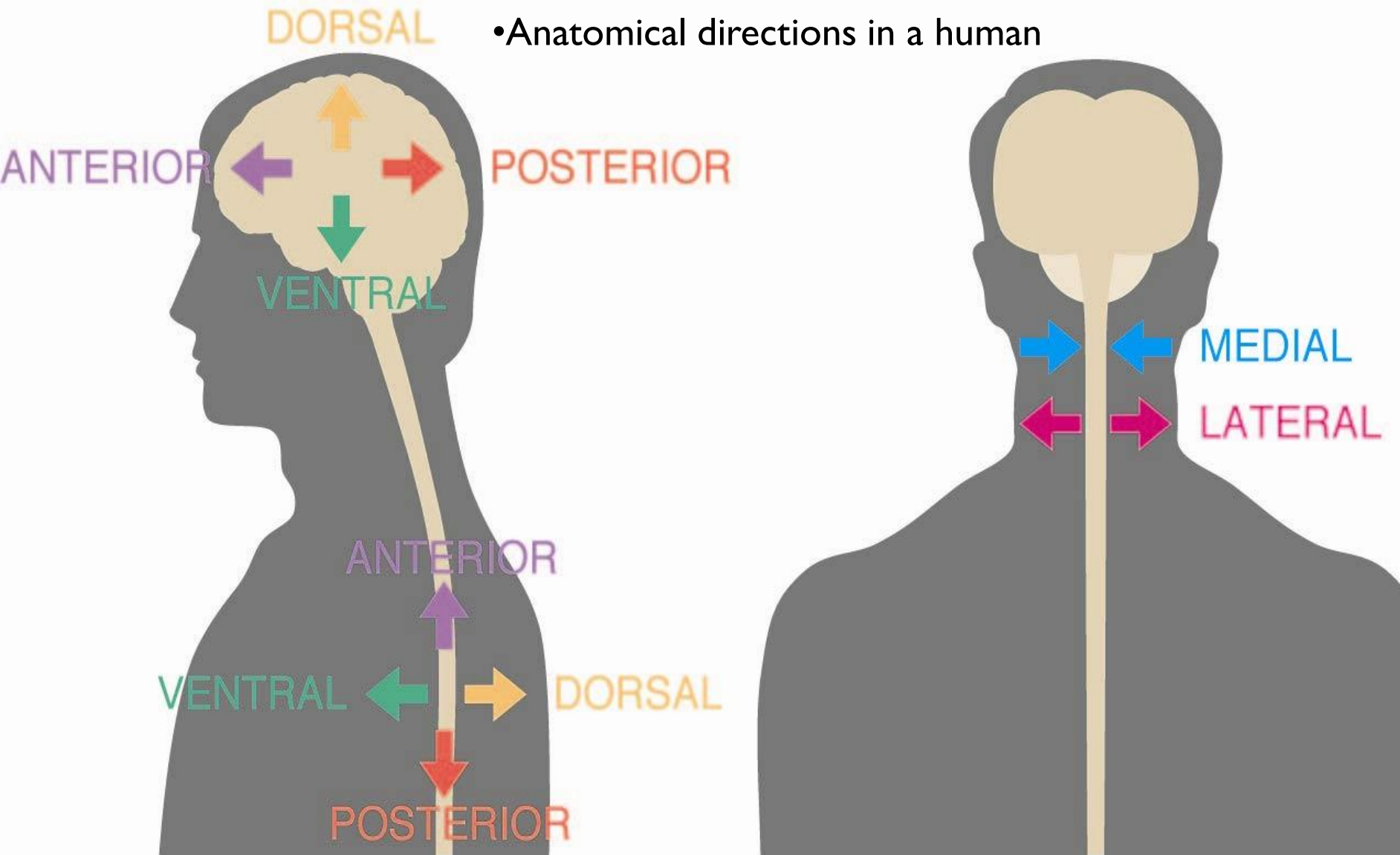
Directions in the Vertebrate Nervous System

Terminology used to describe directions in the nervous system.



- Anatomical directions in a representative vertebrate (cat).

Directions in the Vertebrate Nervous System

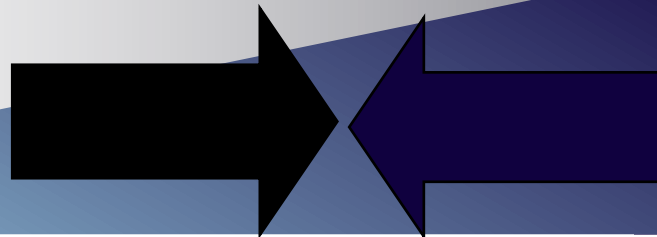


Same terms but we walk upright, so directions differ between head & body.

Directions in the Vertebrate Nervous System



- Anatomical directions ignore fact that humans walk upright.
- Therefore, top of the head is both “dorsal” (back) and “superior” (top)
- Other directions:
 - Proximal – close
 - Distal – far



Techniques used to view neurons.

- 1. Golgi stain: allows visualization of individual neurons, used when only overall shape of neuron is of interest.**
 - Italian physician discovered that silver chromate produced by chemical reaction of two substances found their way to some of the neurons in the sample and stained them black.
- 2. Nissl stain: – selectively stains cell bodies**
 - uses a dye called Cresyl violet which penetrates all cells, used to estimate no. of cell bodies in an area by counting no. of stained dots.
- 3. Electron microscopy: details neuronal structure**
 - thin slices of tissue coated with an electron absorbing substance that is taken up by different parts of the neuron to different degrees then beam of electrons is passed through the tissue on to a photographic film.

Examples of images produced by these on P.60 in Pinel book.

Neuroanatomical Tracing Techniques

ANTEROGRADE

Anterograde (forward)

**Tracing to where
axons project away
from an area**

RETROGRADE

Retrograde (backward)

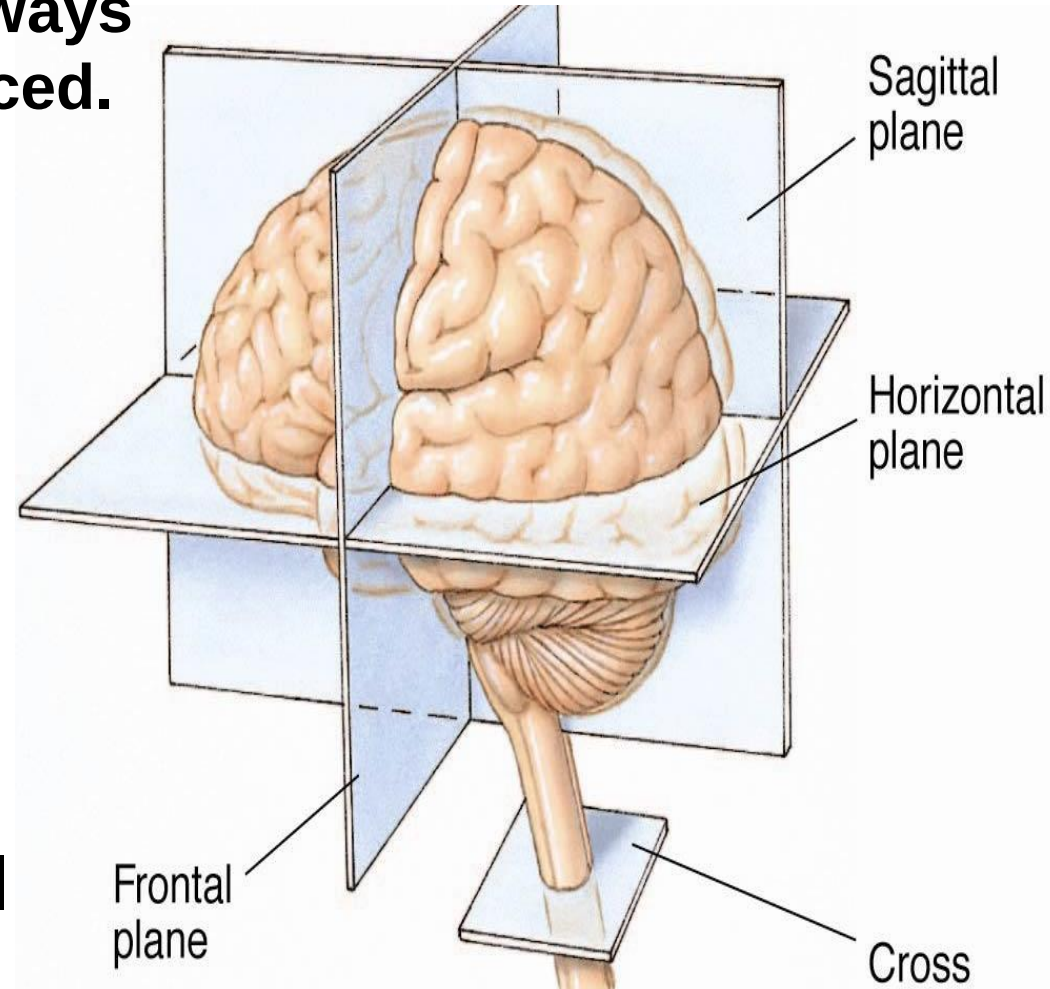
**Tracing from where
axons are projecting
into an area**

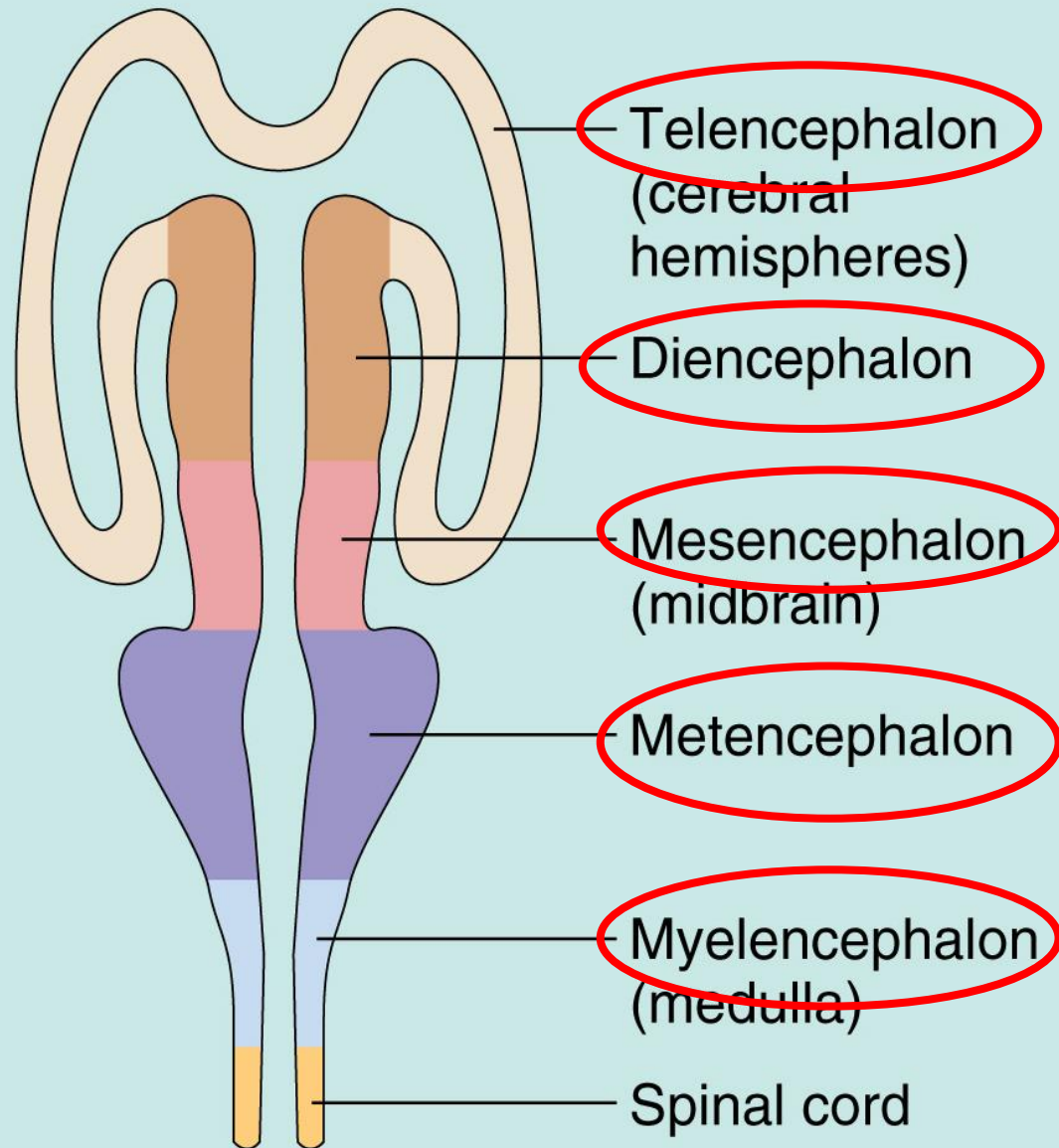
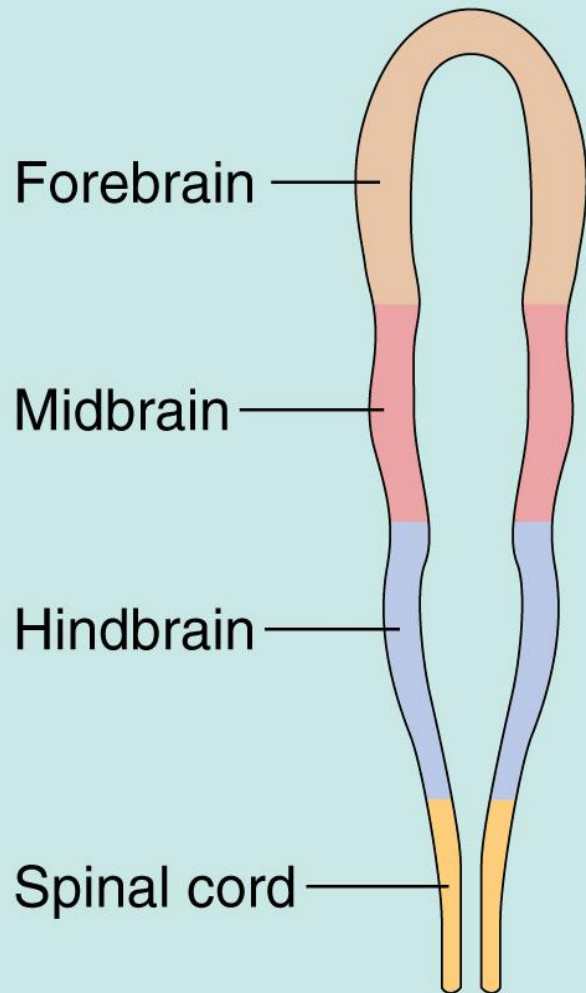
Both work by injecting tracing chemicals taken up by the system and transported around.

After a few days, brain is removed, sliced, and treated to reveal the location of the injected chemical.

Specific terms to describe ways the brain can be cut or sliced.

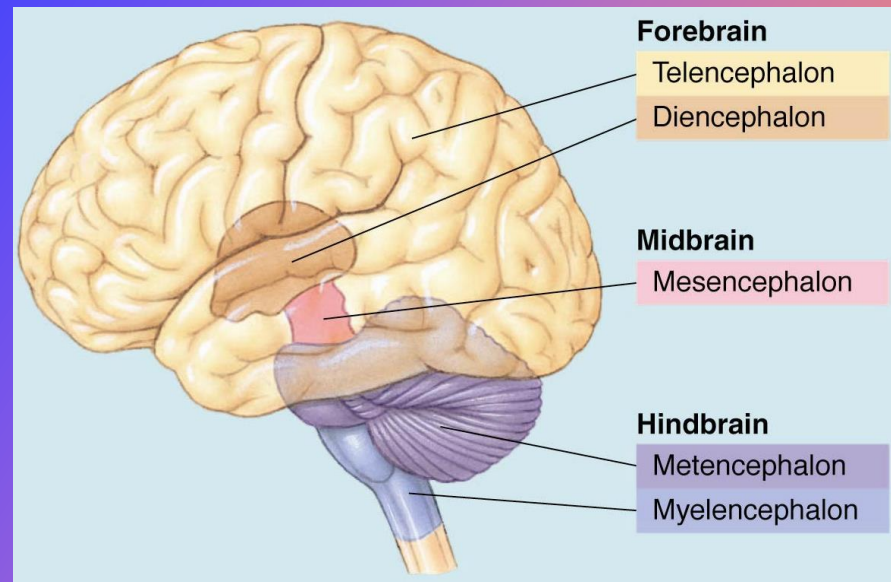
- **Horizontal** – slice parallel to the ground
- **Frontal** (coronal) – slicing bread
- **Sagittal** – a midsagittal section separates the left and right halves





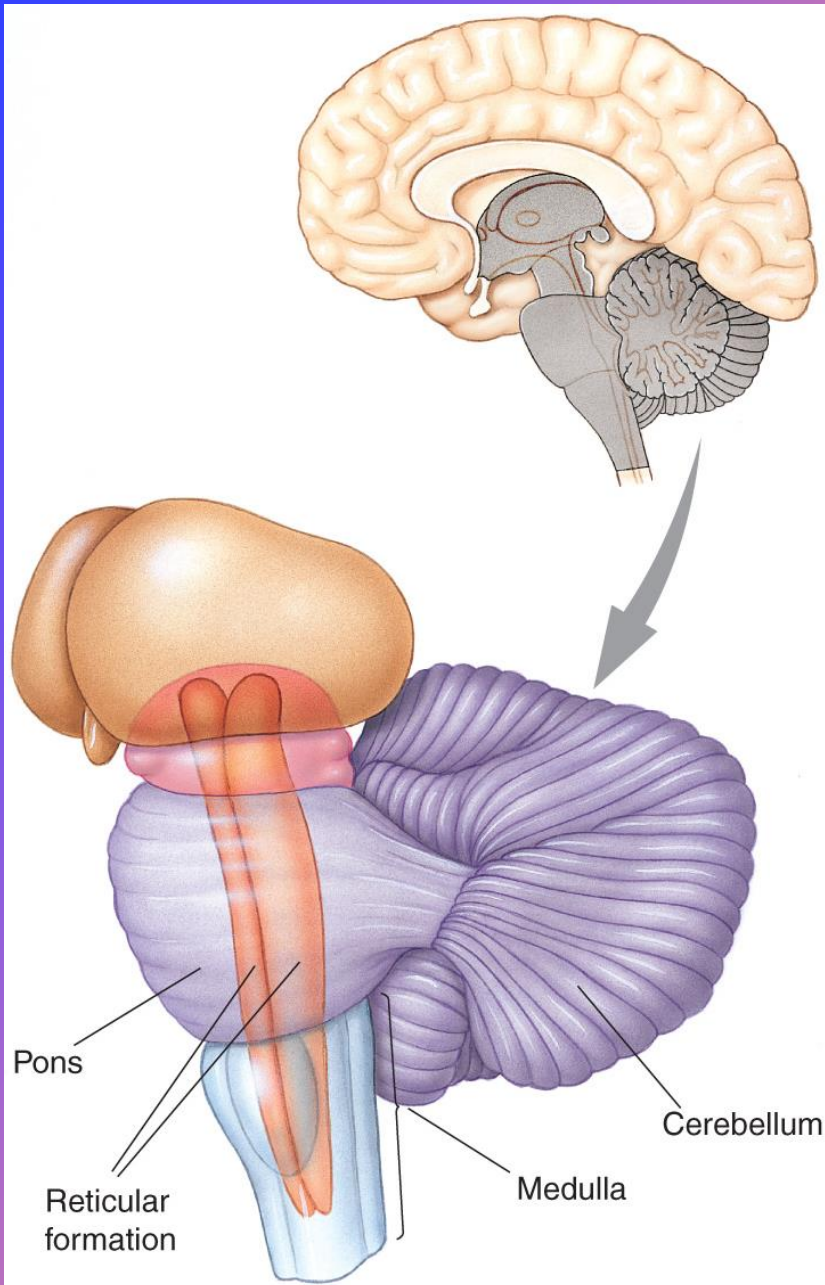
Five Major Divisions of the Brain

- Telencephalon goes through most growth during development.
- Other 4 regions may be referred to as the brain stem



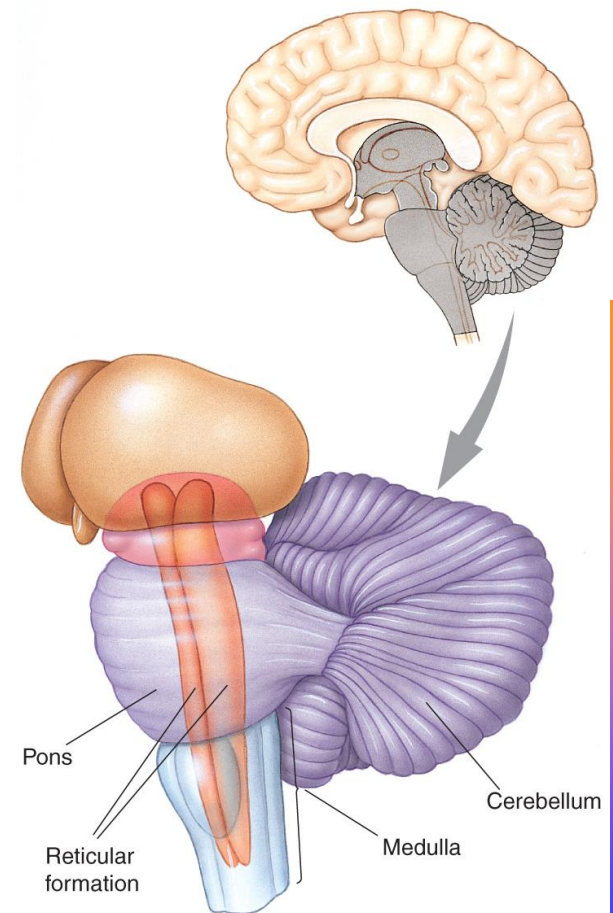
Major Structures of the Brain

- Myelencephalon = medulla
- Has many tracts to carry signals between brain & body.
- Includes reticular formation: network of ~100 very small nuclei in central core of the brain stem.
- Referred to as reticular activating system because some parts are thought to play role in arousal.
- Other nuclei are involved in sleep, attention, and cardiac reflexes.



Major Structures of the Brain

- Metencephalon
- Many tracts that create a bulge called:
 - The Pons (ventral surface)
- Also has the Cerebellum:
 - Linked to:
 - coordination,
 - sensorimotor function
 - and cognitive functioning.



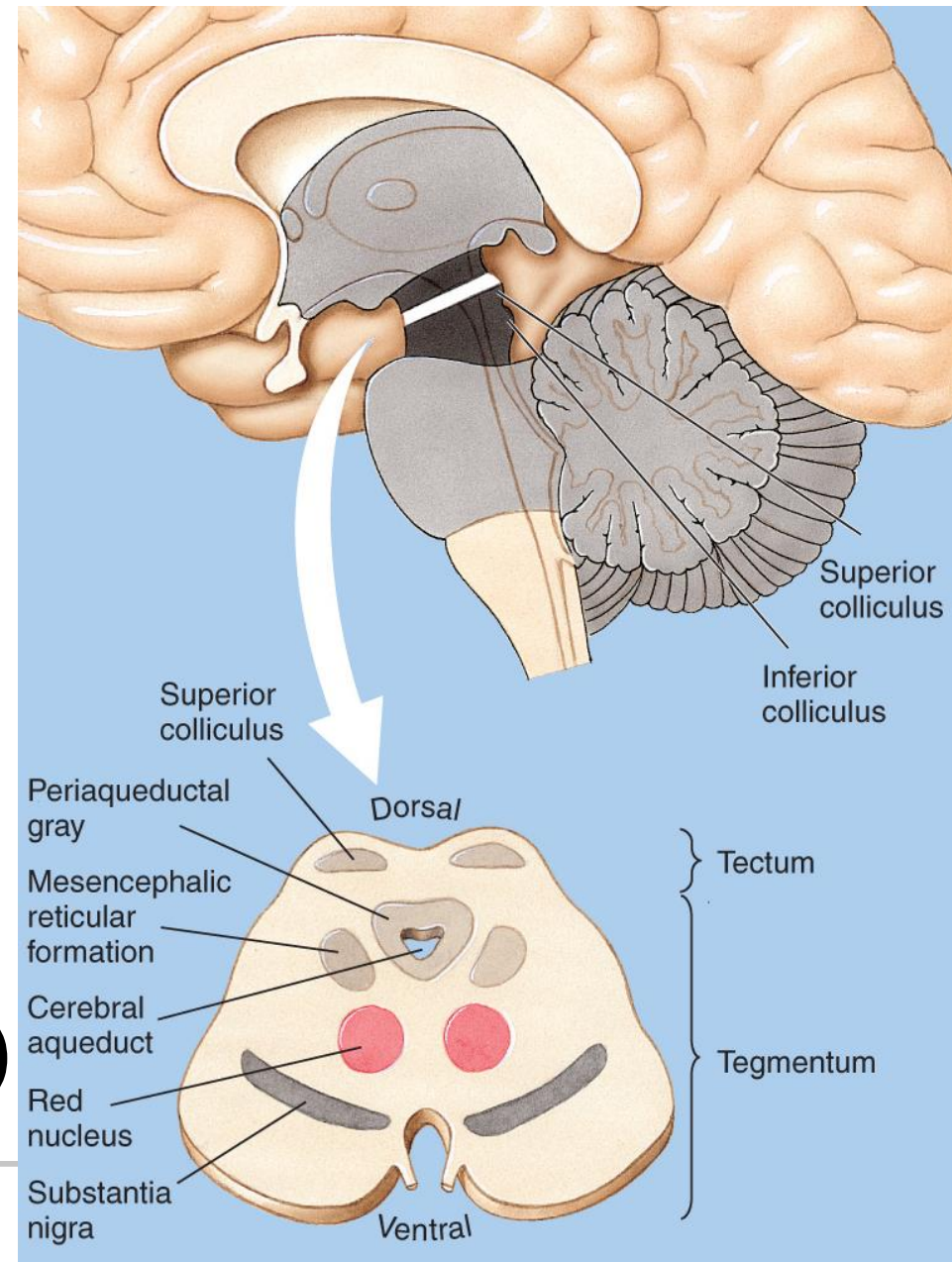
Mesencephalon

Has 2 divisions:

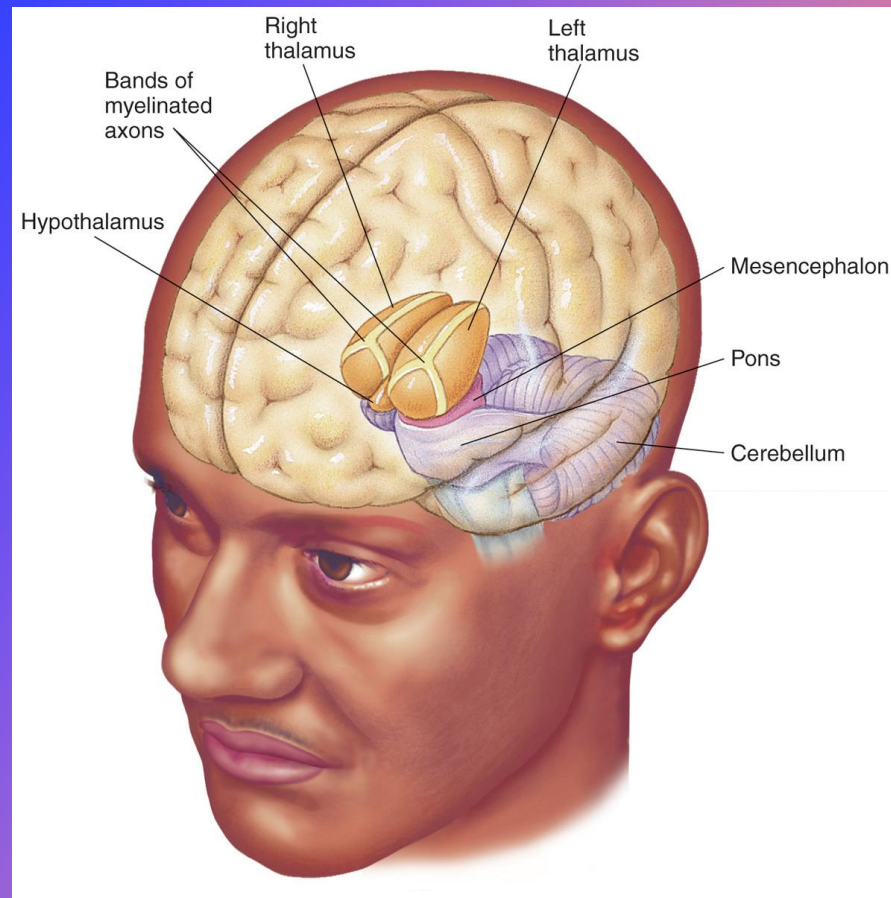
1. Tectum:

- which has inferior (auditory functioning) & superior (visual functioning) colliculi

2. Tegmentum: has periaqueductal gray (mediates pain), substantia nigra & red nucleus (sensorimotor)



Major Structures of the Brain



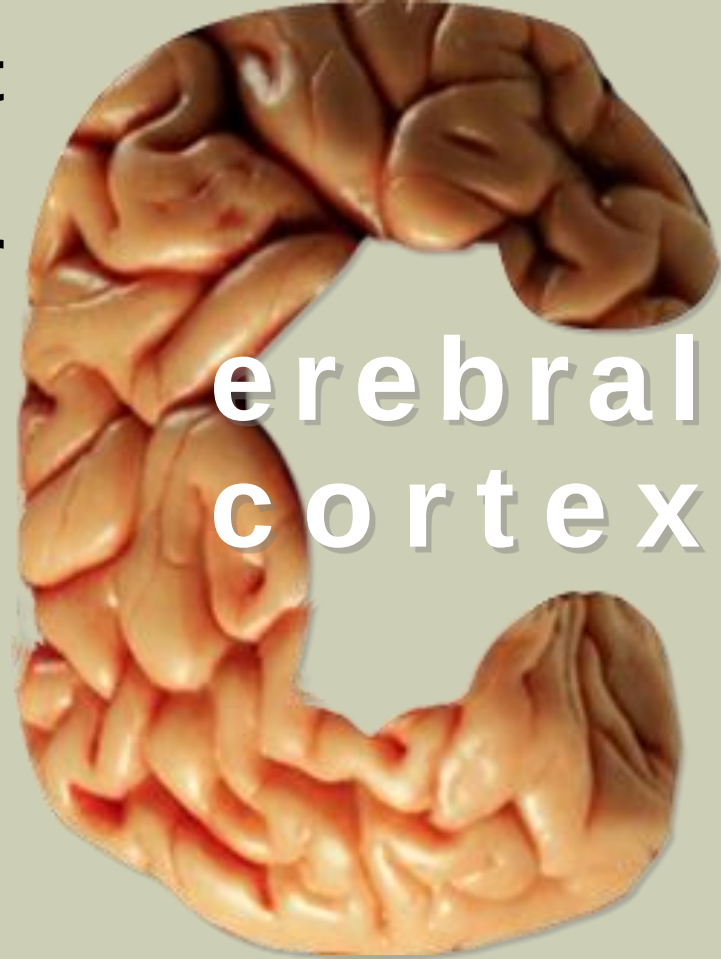
- Diencephalon: composed of
- **Thalamus:**
- **Two lobbed structure joined by mass intermedia.**
- **Has many different pairs of nuclei that project to cortex.**
 - **E.g., sensory relay nuclei**
- **Hypothalamus**
- **Plays role in motivation behavior**
- **Regulates release of hormones**

- **+ Telencephalon – Cerebral Cortex**

- **Largest division**
- **Involved in the brain's most complex functions**
- **Convolutions serve to increase surface area**
- **Longitudinal fissure – a groove that separates right and left hemispheres**
- **Corpus callosum – largest hemisphere-connecting tract**

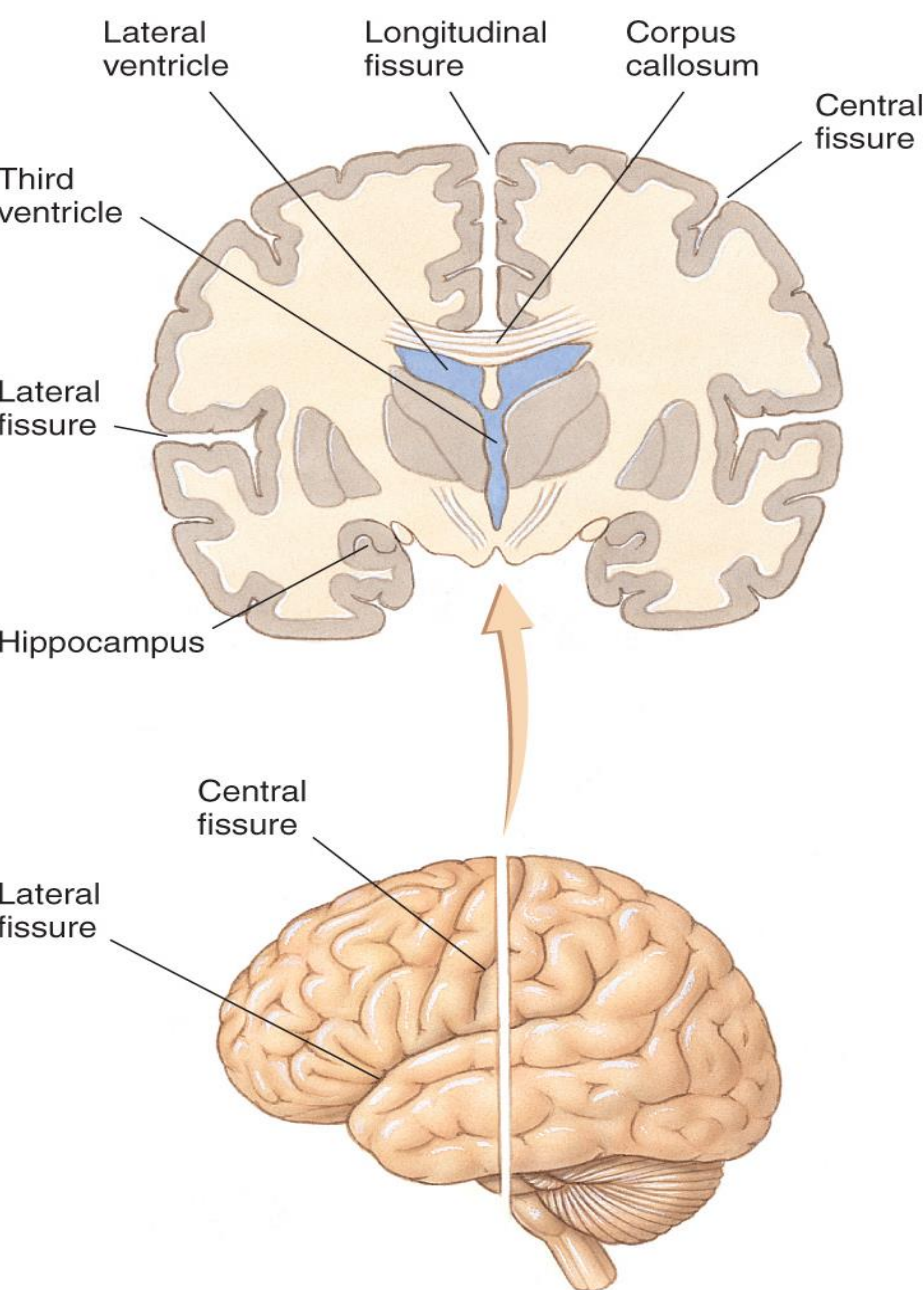


**Outermost part
of forebrain,
responsible for
analyzing
sensory
processing &
higher brain
functions**

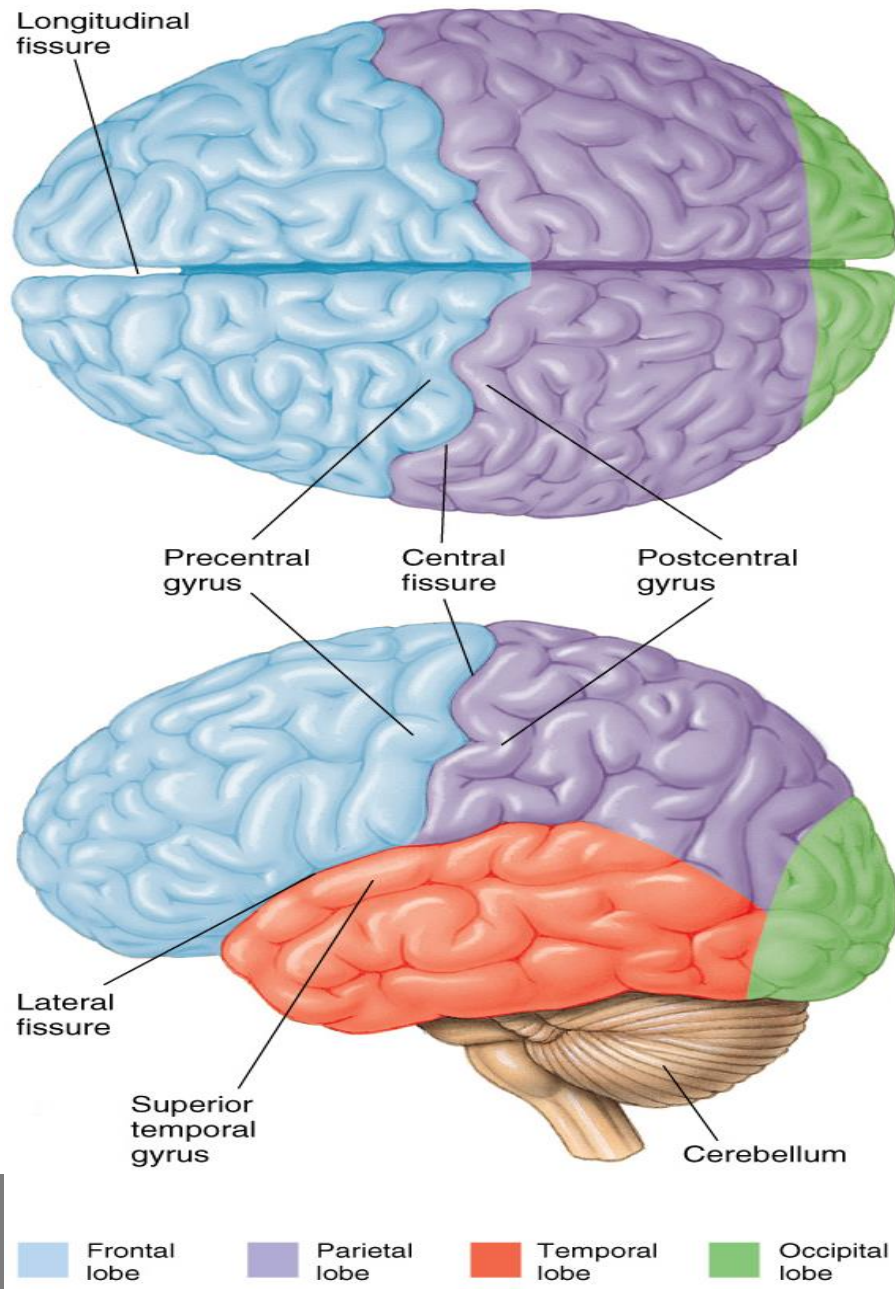


**The hemispheres of the brain are
covered by the cerebral cortex, which
is mainly composed of small
unmyelinated neurons & known as
Gray matter.**

The major fissures of the human cerebral cortex



The lobes of the cerebral hemisphere

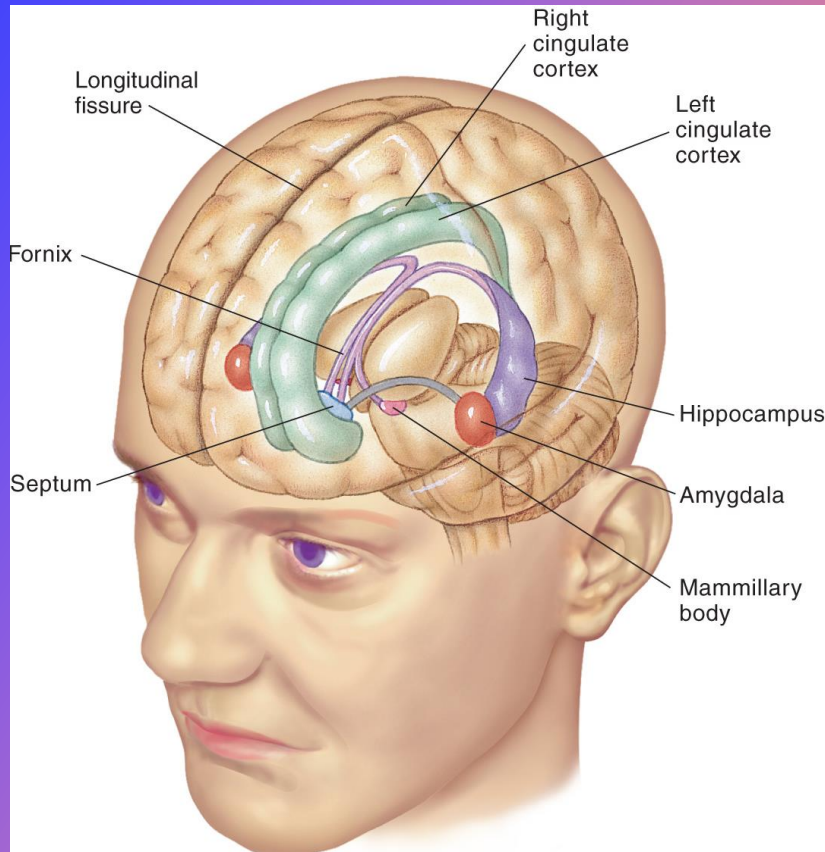


Telencephalon – Subcortical Structures



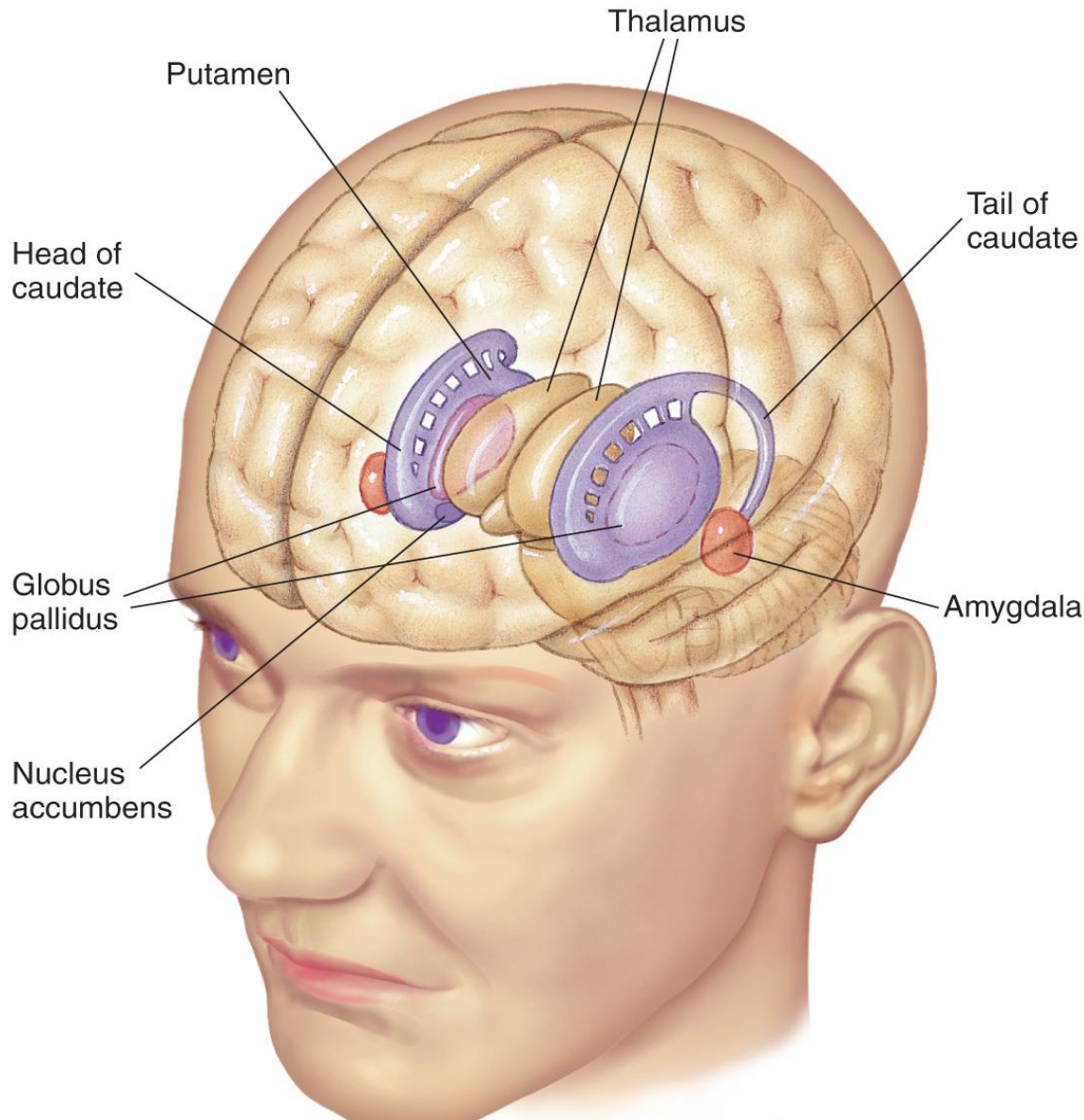
- In the telencephalon there are several large subcortical nuclear groups considered part of either the limbic or basal ganglia motor system.
- Limbic system:
 - Involved in regulating motivational behaviour
 - A circuit of midline structures that circle the thalamus and include the mammillary bodies, the hippocampus, the amygdala, the fornix, the cingulate cortex, and the septum.
- Basal ganglia motor system:
 - Amygdala, striatum (caudate nucleus + putamen), globus pallidus

The Limbic System



- **The major structures of the limbic system: amygdala, hippocampus, cingulate cortex, fornix, septum, and mammillary body**

The Basal Ganglia



Structures in the forebrain that help to control movement

- Damage to the basal ganglia contributes to Parkinson's disease.
- The basal ganglia also allow us to perform movements to obtain rewards.

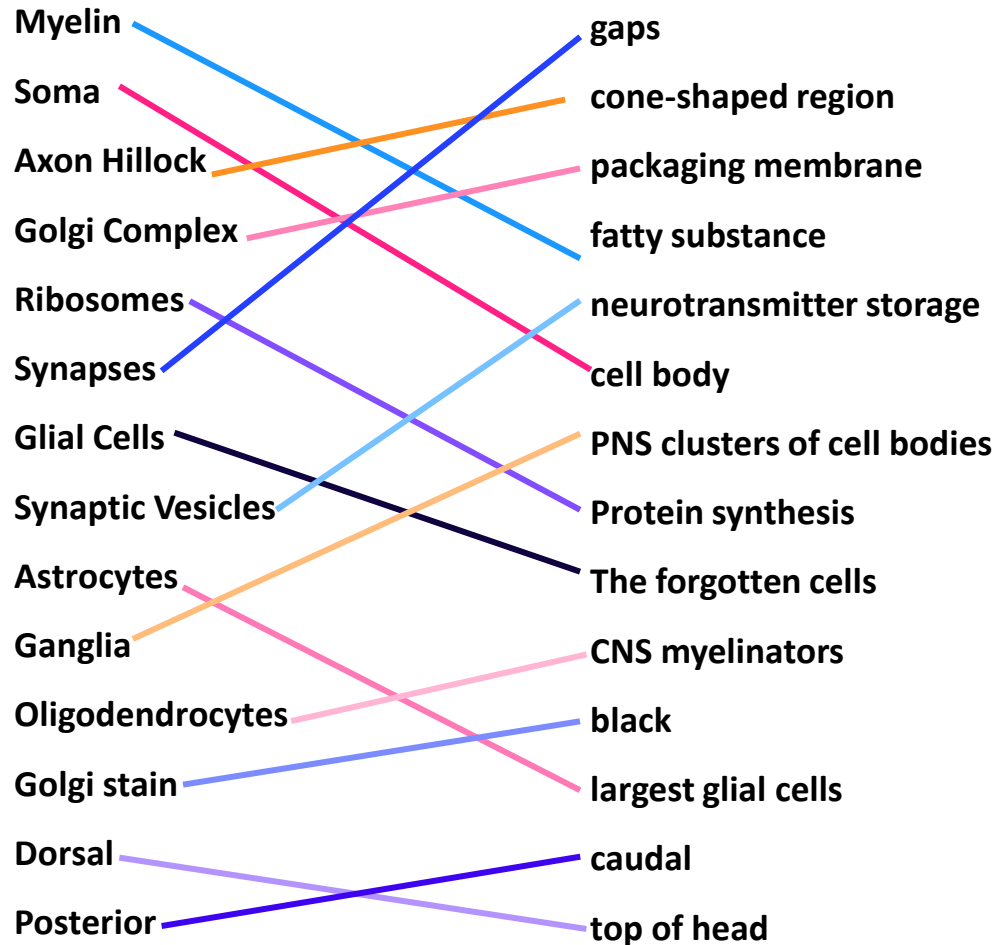
The basal ganglia: amygdala, striatum (caudate plus putamen) and globus pallidus

Summary of major brain structures

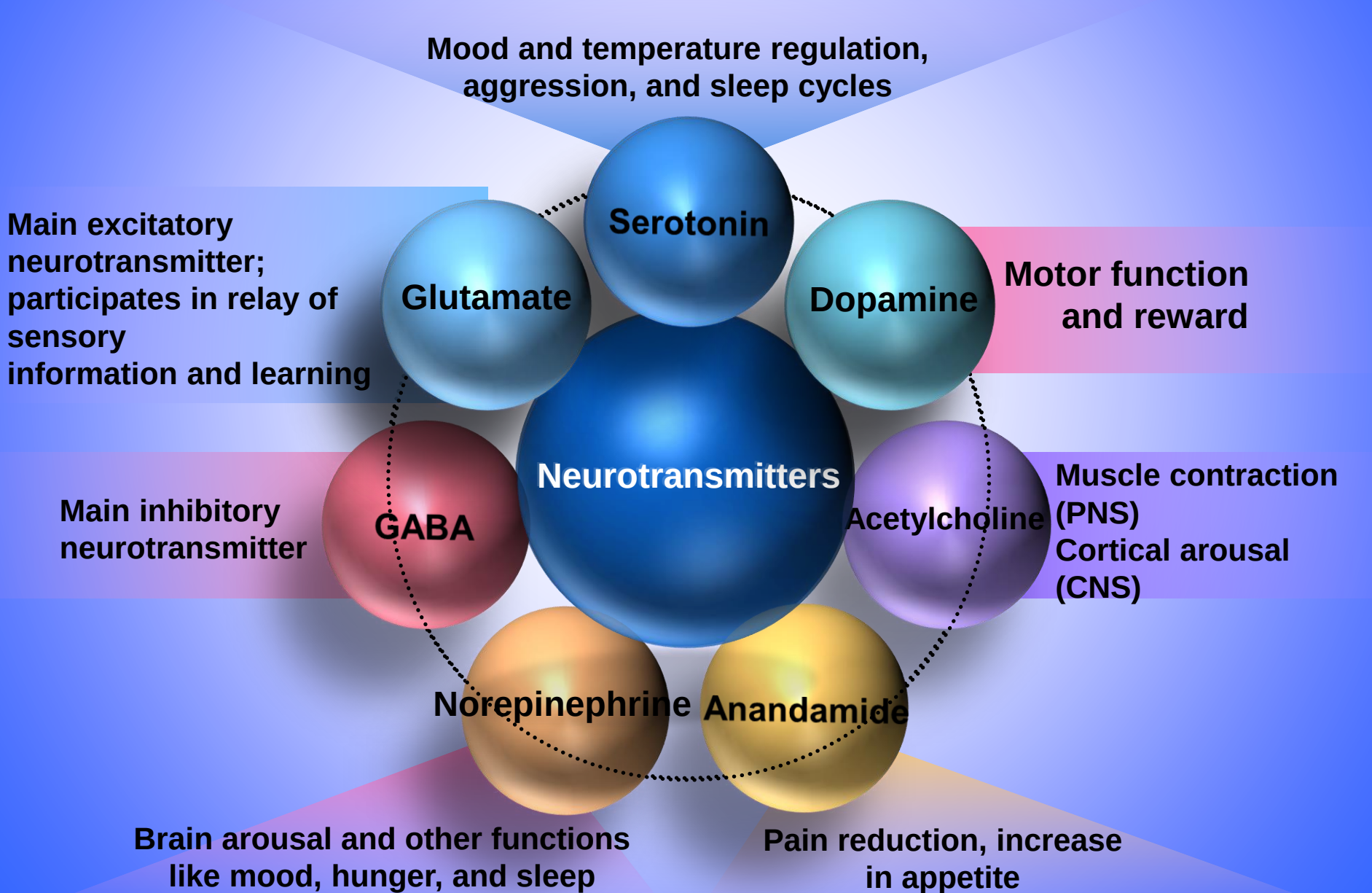
Telencephalon	Cerebral cortex	Neocortex Hippocampus
	Major fissures	Central fissure Lateral fissure Longitudinal fissure
	Major gyri	Precentral gyrus Postcentral gyrus Superior temporal gyrus Cingulate gyrus
	Four lobes	Frontal lobe Temporal lobe Parietal lobe Occipital lobe
	Limbic system	Amygdala Hippocampus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

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	

Term and corresponding phrase answers



Over 100. These 7 are small-molecule NTs & are divided in to 3 classes: amino acids, monoamines, and acetylcholine. This figure provides information about what each are involved in/what they regulate.



Amino Acid Neurotransmitters

- Usually found at fast-acting directed synapses in the CNS
- Glutamate – Most prevalent excitatory neurotransmitter in the CNS
- GABA
 - Synthesized from glutamate
 - Most prevalent inhibitory NT in the CNS
- Aspartate and glycine



Monoamines and Acetylcholine

- Monoamines: synthesized by single amino acid & diffused effects.



- Sub-divided into 2 groups:
- Catecholamines – synthesized from tyrosine (Dopamine, Norepinephrine, Epinephrine)
- Indolamines – synthesized from tryptophan (Serotonin)



- Acetylcholine (Ach)
 - Acetyl group + choline molecule
 - First identified at neuromuscular junction





Unconventional Neurotransmitters

- Soluble gases – exist only briefly
 - Nitric oxide and carbon monoxide
 - Retrograde transmission – backwards communication
- Endocannabinoids
 - anandamide is one of the two known endocannabinoids.

Neuropeptides

- Large molecules: Over 100 identified with actions dependent on amino acid sequence
- Example – endorphins
 - “Endogenous opioids”
 - Produce analgesia (pain suppression)
 - Receptors were identified before the natural ligand was



PAIN

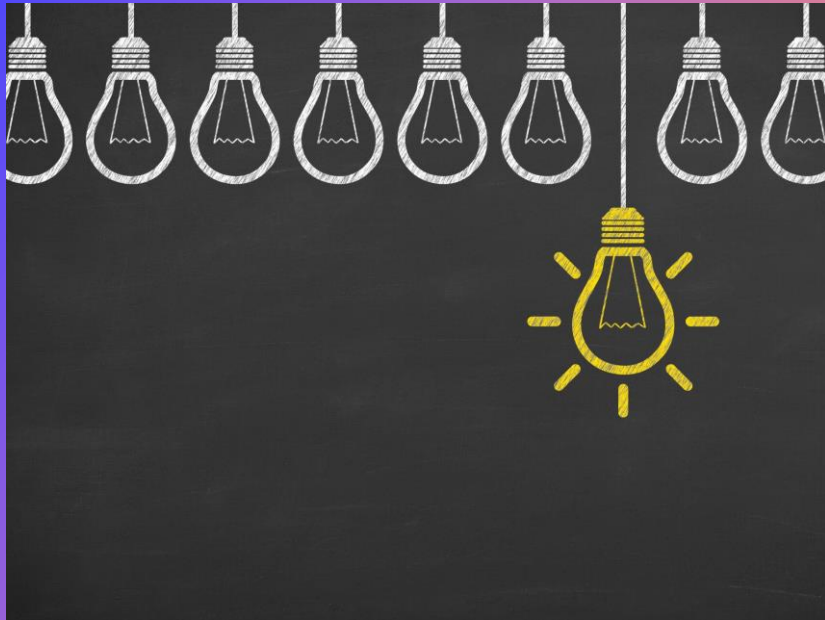


Approaches in Cognitive Psychology

- **Cognitive Experimental Psychology:**
 - Uses experiments conducted in highly controlled lab environments to infer cognitive processes based on behavioural performance on various tasks – e.g.,
 - Mental Rotation (Shepard & Metzler, 1971)
 - Inattention blindness: Neisser & Becklen, 1975
 - Change blindness
 - Methods for studying perceptual attention.
 - Involves manipulating research variables:
 - IVs & DVs
 - Aims to test cognitive theories regarding how the mind functions.

Approaches in Cognitive Psychology

- **Cognitive Neuropsychology:**
 - Involves studying brain-damaged patients – both intact and impaired performance
 - Key developments:
 - Brain composed of cells with different functions
 - Staining (Golgi), network of communication (Cajal), electrical conduction (Helmholtz), chemical sites.
 - Colthearts (2001) theoretical assumptions
 - Research uses dissociation & double-dissociation case studies: but each have their issues





Approaches in Cognitive Psychology

- **Cognitive Neuroscience:**
 - Studying the brain, in detail
 - Hemispheres, lobes, anatomical directions, Brodman's Cytoarchitectonic map, etc.
 - Techniques for studying the brain: Single-unit recordings, EEG, ERPs, CT, PET, MRI, fMRI, efMRI, MEG, TMS.
- Does brain imaging tell us anything about cognition?
 - Gap between physical and psychological processes
 - Brain-imaging techniques only reveal associations



Approaches in Cognitive Psychology

- **Computational Cognitive Science:**
 - Try to understand the human mind through examining how a computer carries out functions.
 - Relies on computer metaphor
 - Encoding & coding, Information-processing, Channel capacity, Retrieval & output
 - Hardware and software + Serial vs. parallel processing comparisons between humans and computers
- Cognitive Models: computations, operating principles, control structure, processing codes, functional architecture
- Artificial intelligence
 - Turing test, Eliza, Searle's Chinese room argument



SESSION CLOSE
Any final questions?