MUNI
PHARM

Central and Peripheral Nervous System

lecture from Human Morphology

30.11. 2023

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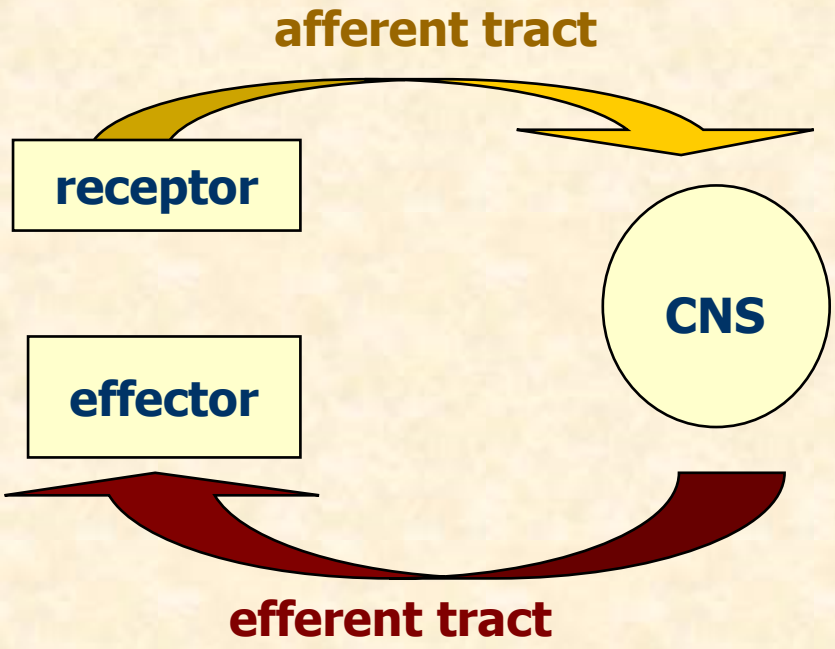
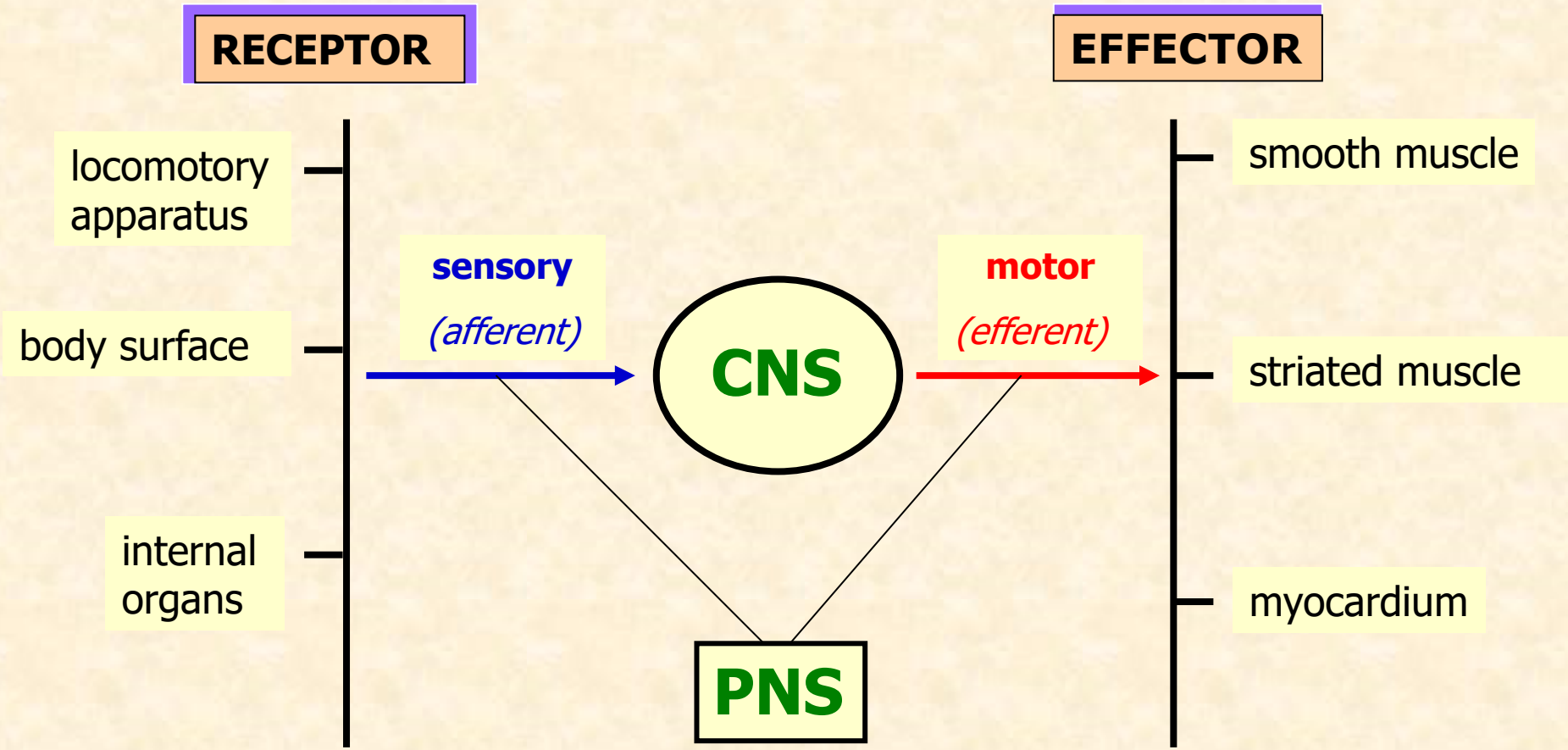
NERVOUS SYSTEM

- CENTRAL
  - brain, spinal cord
- PERIPHERAL
  - cranial and spinal nerves, afferent and efferent nervous tracts
- AUTONOMIC
  - sympathetic
  - parasympathetic

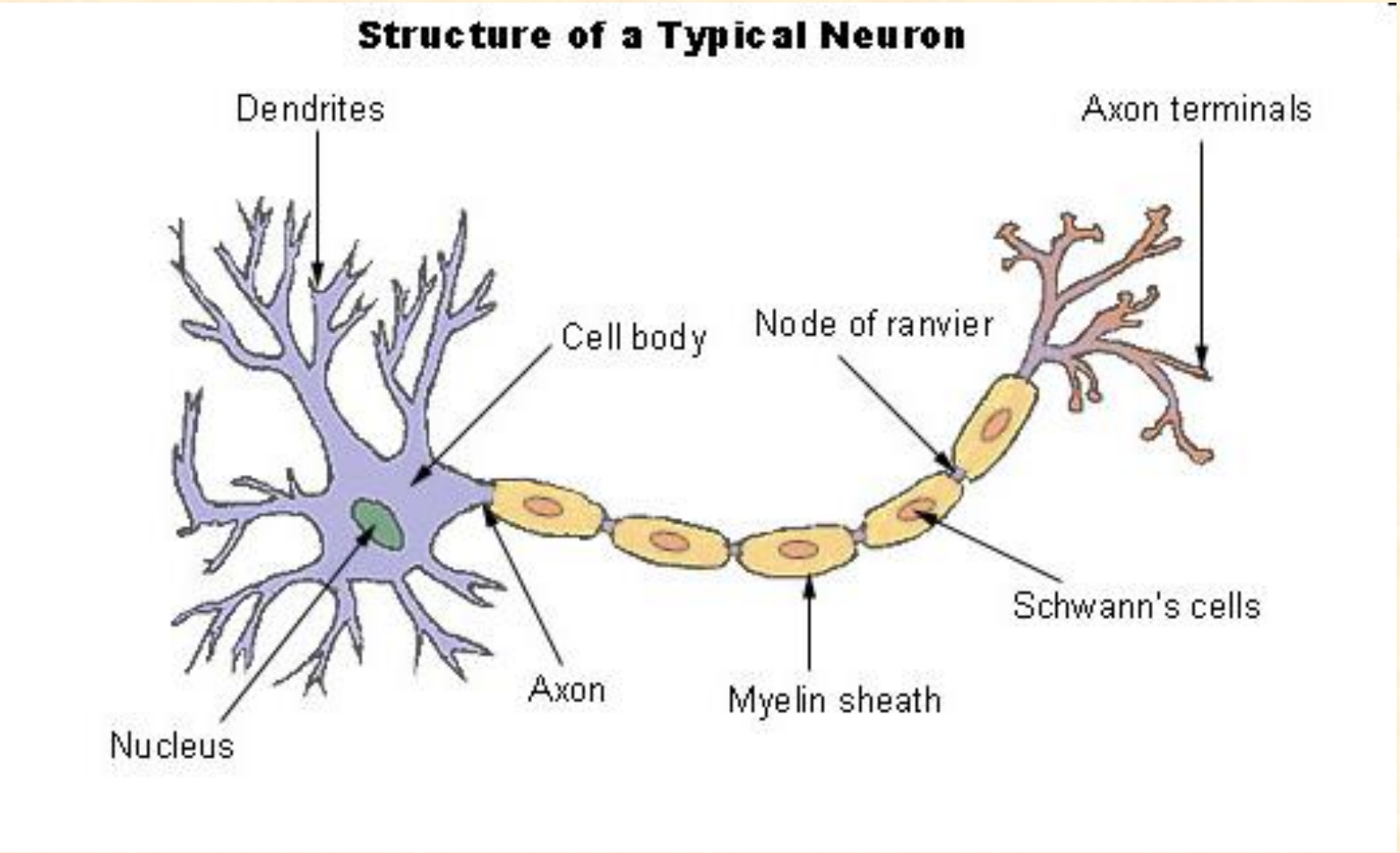
Reflex Arc

1. reception of information by **receptor**
2. transmission to the centre by **afferent tract**
3. processing in the **centre**
4. transmission to effector by **efferent tract**
5. activity of **effector**




RECEPTOR
EFFECTOR
locomotory apparatus
body surface
internal organs
sensory
(afferent)
motor
(efferent)
CNS
PNS
smooth muscle
striated muscle
myocardium

NEURON
basic structure unit of the nervous system



CENTRAL NERVOUS SYSTEM

- SPINAL CORD (medulla spinalis)

- BRAIN (encephalon)
  - brain stem:
    - medulla oblongata
    - pons
    - midbrain (mesencephalon)
  - cerebellum
  - diencephalon
  - cerebrum (telencephalon)

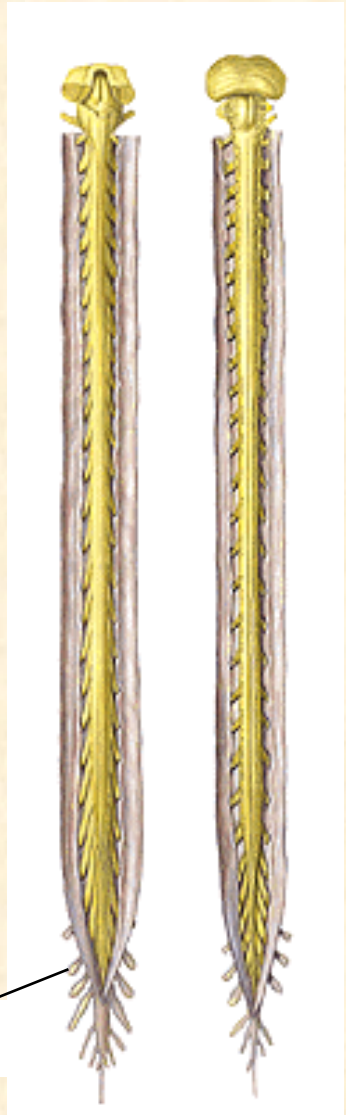
Spinal Cord

- enclosed within vertebral column (40-45 cm long), extends from the medulla oblongata and continues through the conus medullaris near L2 vertebra, terminating in a fibrous extension known as the filum terminale and the bundle of lower spinal nerves – cauda equina
- 31 spinal cord nerve segments
- ventral motor roots
- dorsal sensory roots

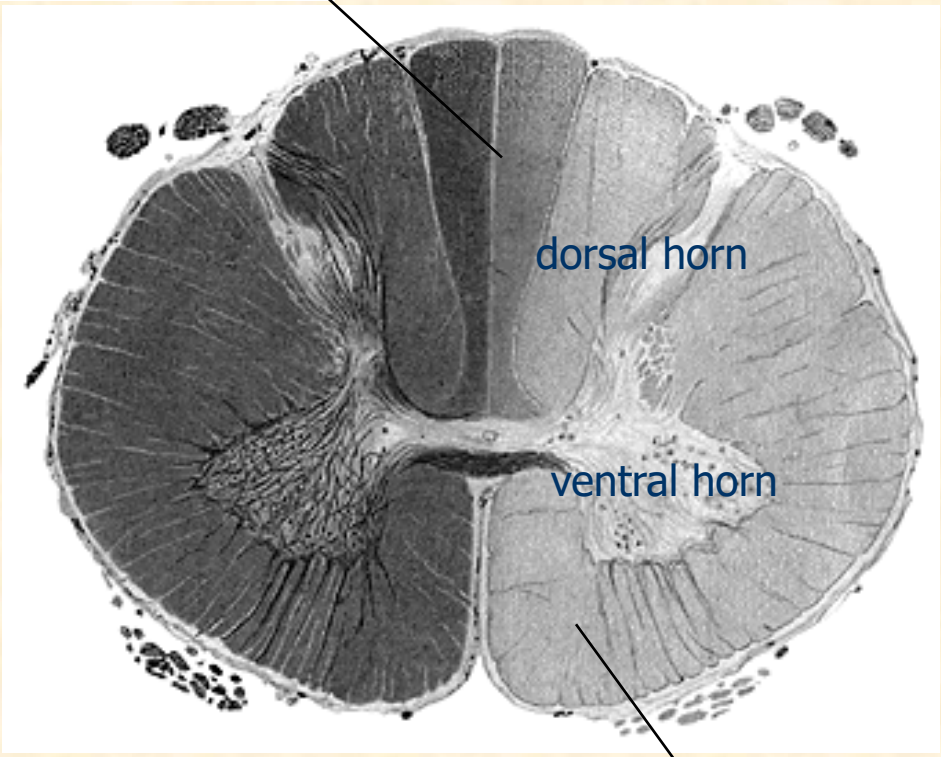
} SPINAL NERVE

- connection of CNS and PNS

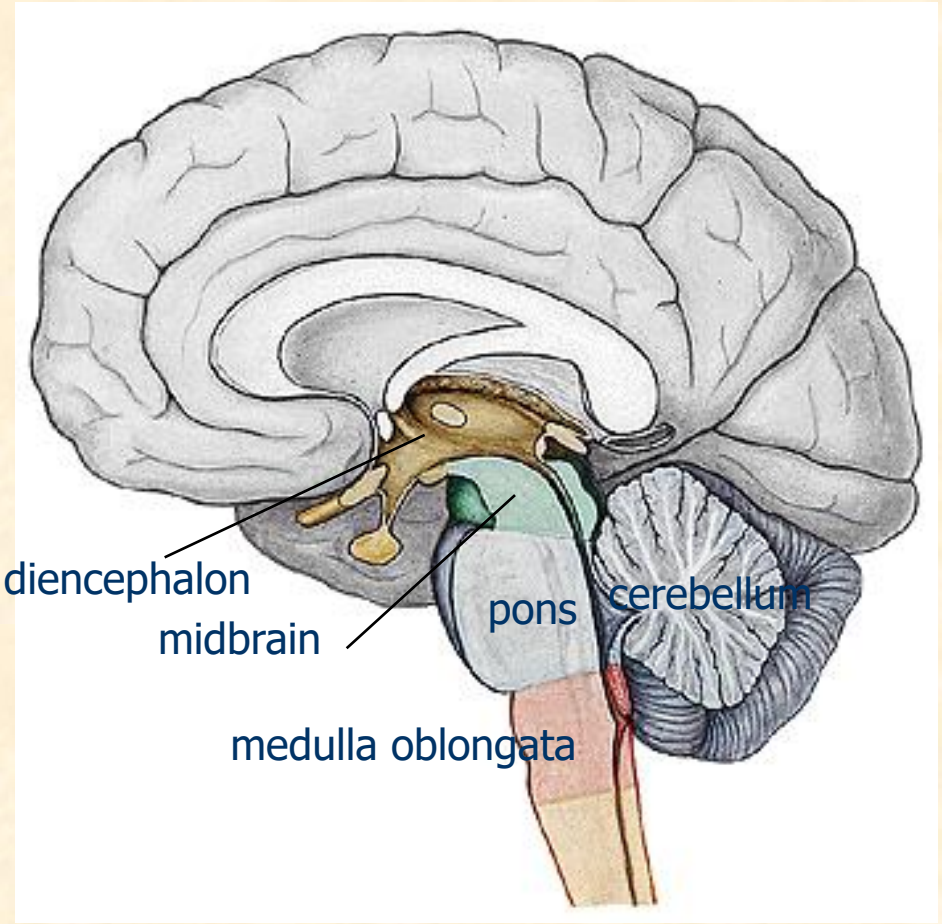
Spinal Cord

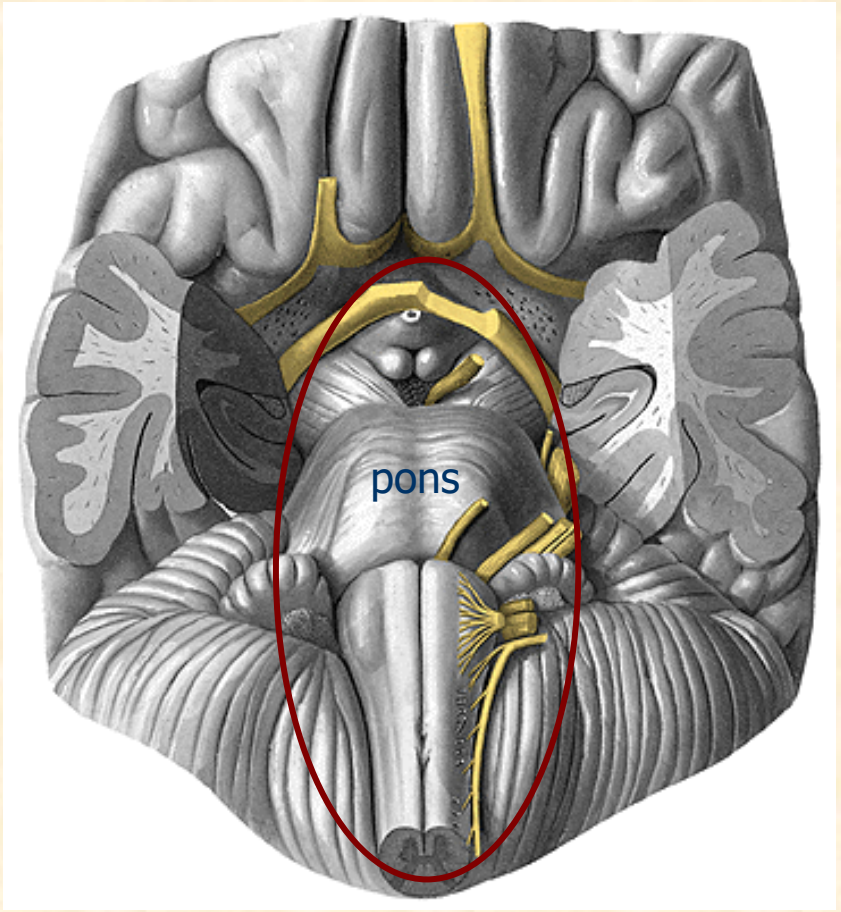


cauda equina



Brainstem


diencephalon
midbrain
pons
cerebellum
medulla oblongata


pons

Brainstem

MEDULLA OBLONGATA

- positioned below the pons and continuous with the spinal cord,
- transmittion of ascending and descending nerve fibers between the spinal cord and the brain
- contains important centres for the control of respiration, cardiac activity and metabolism, centres of defence and food reflexes (blinking, coughing, vomiting, salivation, swallowing, secretion of gastric juices)
- gives rise to the n. hypoglossus and the mixed lateral system (n. glossopharyngeus, n. vagus, n. accesorius)

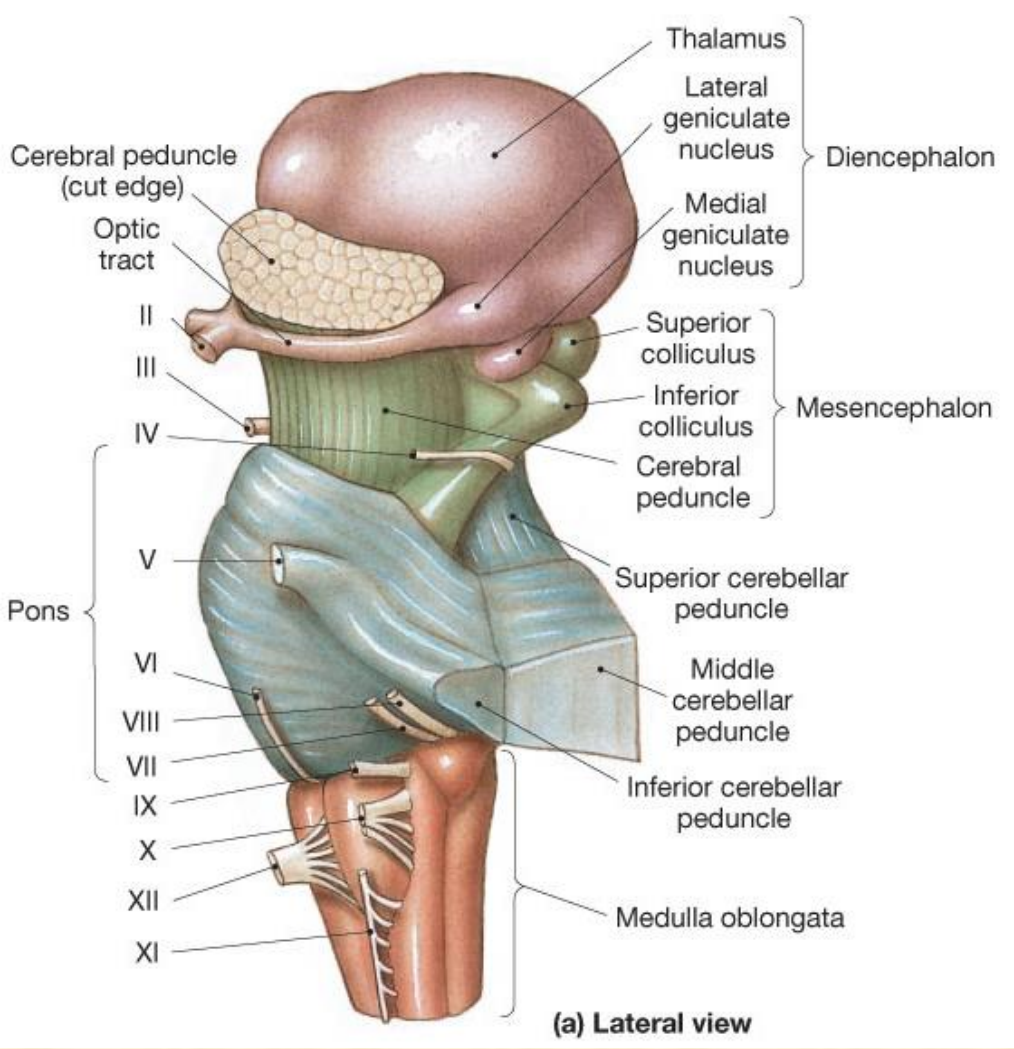
PONS

- the connection between the cerebellum and the cerebrum
- contains the nuclei of the trigeminal nerve, n. abducens, n. facialis, and n. vestibulocochlearis

MIDBRAIN (mesencephalon)

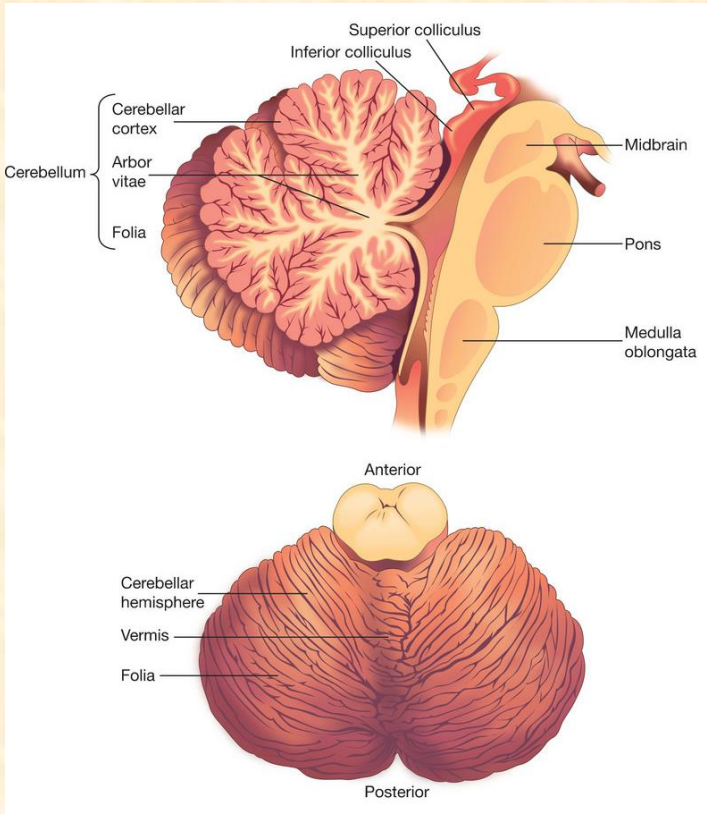
- contains auditory and visual reflex centers
- motor centers (substantia nigra, nucleus ruber)

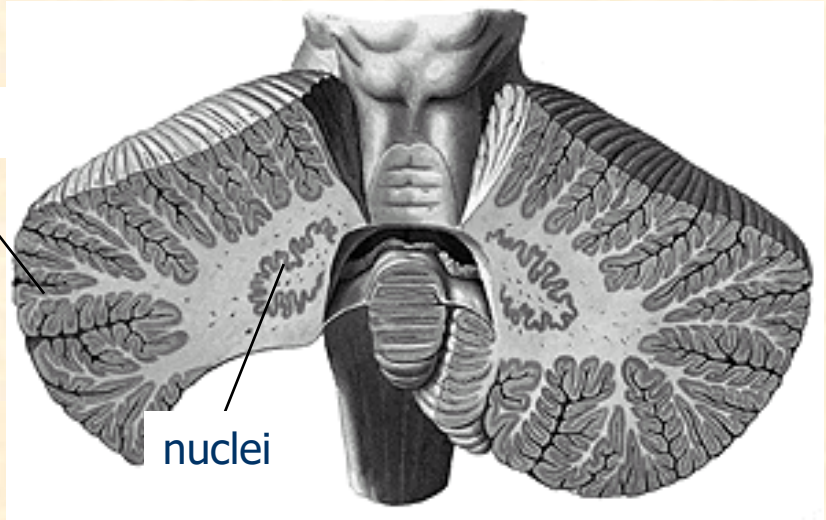
Brainstem


Thalamus
Lateral geniculate nucleus
Medial geniculate nucleus
Diencephalon
Cerebral peduncle (cut edge)
Optic tract
II
III
IV
Superior colliculus
Inferior colliculus
Cerebral peduncle
Mesencephalon
V
VI
VIII
VII
IX
X
XII
XI
Pons
Superior cerebellar peduncle
Middle cerebellar peduncle
Inferior cerebellar peduncle
Medulla oblongata
(a) Lateral view

Cerebellum

- located in the inferior posterior portion of the head (the hindbrain)
- cerebellar hemispheres
- cerebellar vermis
- integration of sensory perception, coordination and motor control of fine and gross body movements, centre of the balance and equilibrium
- neural pathways linking the cerebellum with the cerebral cortex

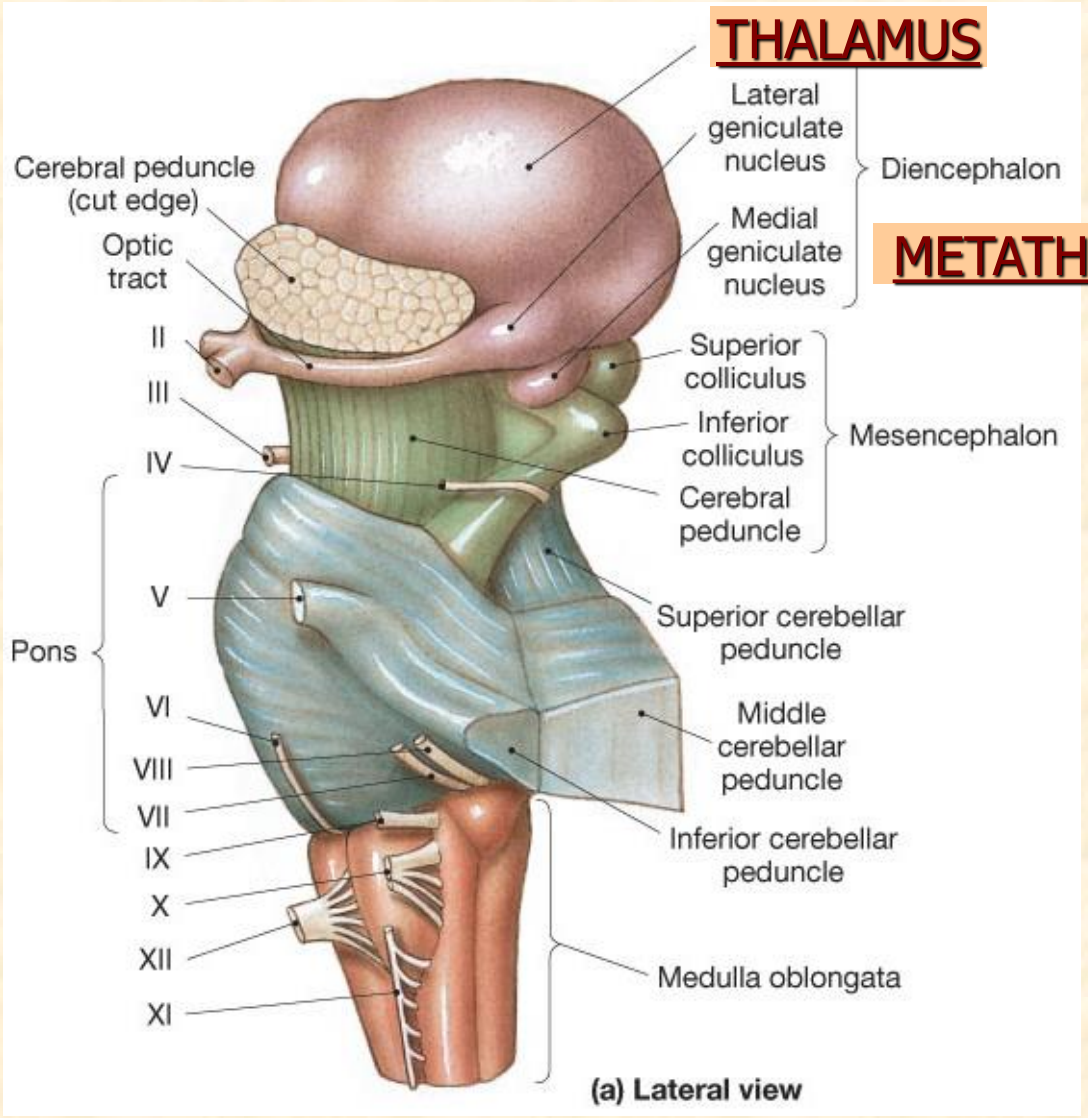




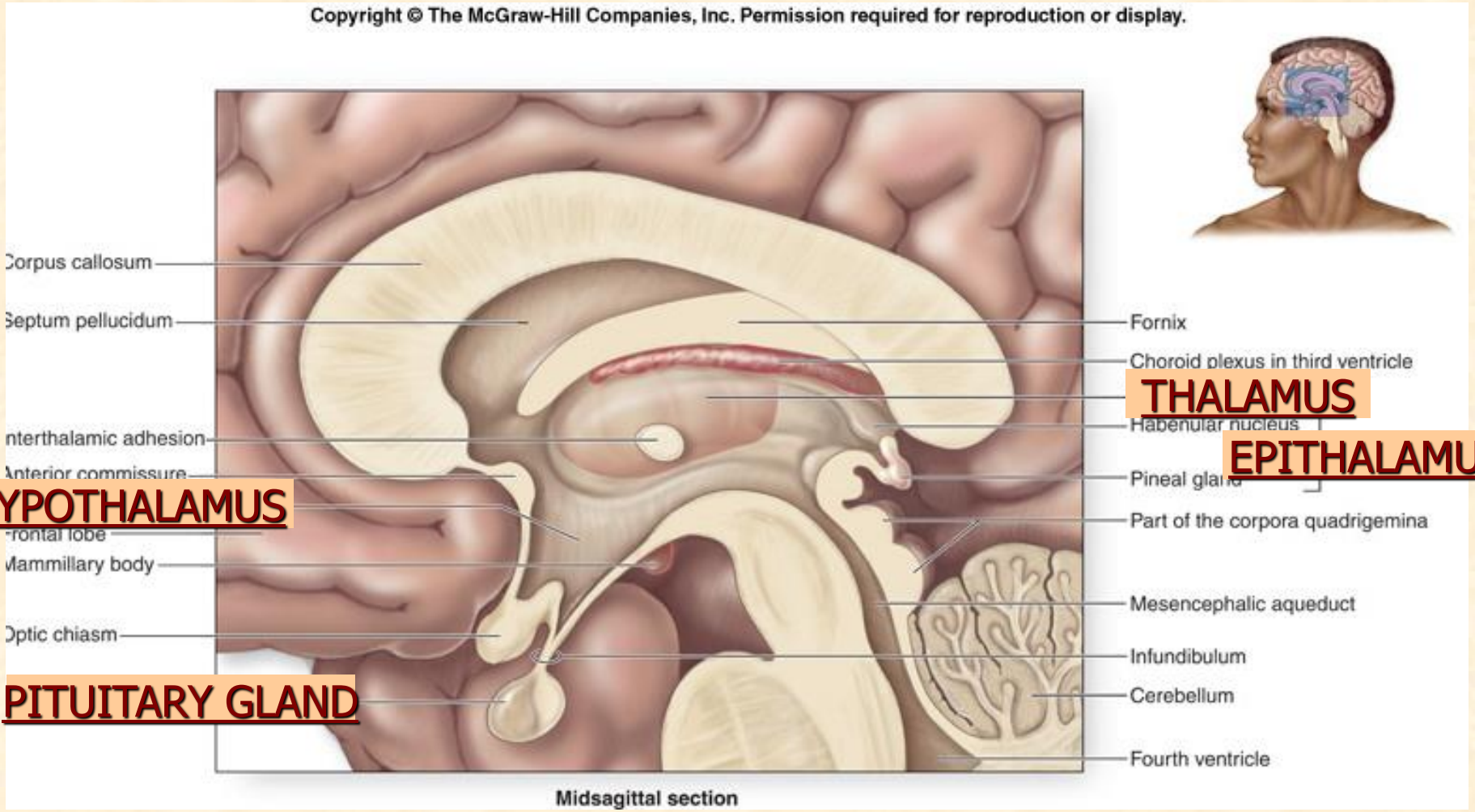
Diencephalon (interbrain)

- **EPITHALAMUS** (pineal gland): the secretion of melatonin, playing a part in circadian rhythms
- **THALAMUS** – relay and processing of sensory information towards the cortex and other parts of the brain reliant on information from external environment
- **METATHALAMUS** – medial and lateral geniculate nucleus, part of auditory and optic pathway
- **HYPOTHALAMUS** – located below the thalamus, links the nervous system to the endocrine one via **the pituitary gland HYPOPHYSIS**
  - superior coordination and movement centre, centre for control of autonomic NS, production of hormones of the posterior pituitary, production of liberins and statins regulating the activity of the anterior lobe of the pituitary
  - regulates and directs behaviours that are fundamental and necessary for survival: feeding, drinking, sleeping, reproduction, temperature control, circadian cycles and emotions

Diencephalon



Diencephalon



THALAMUS

EPITHALAMUS

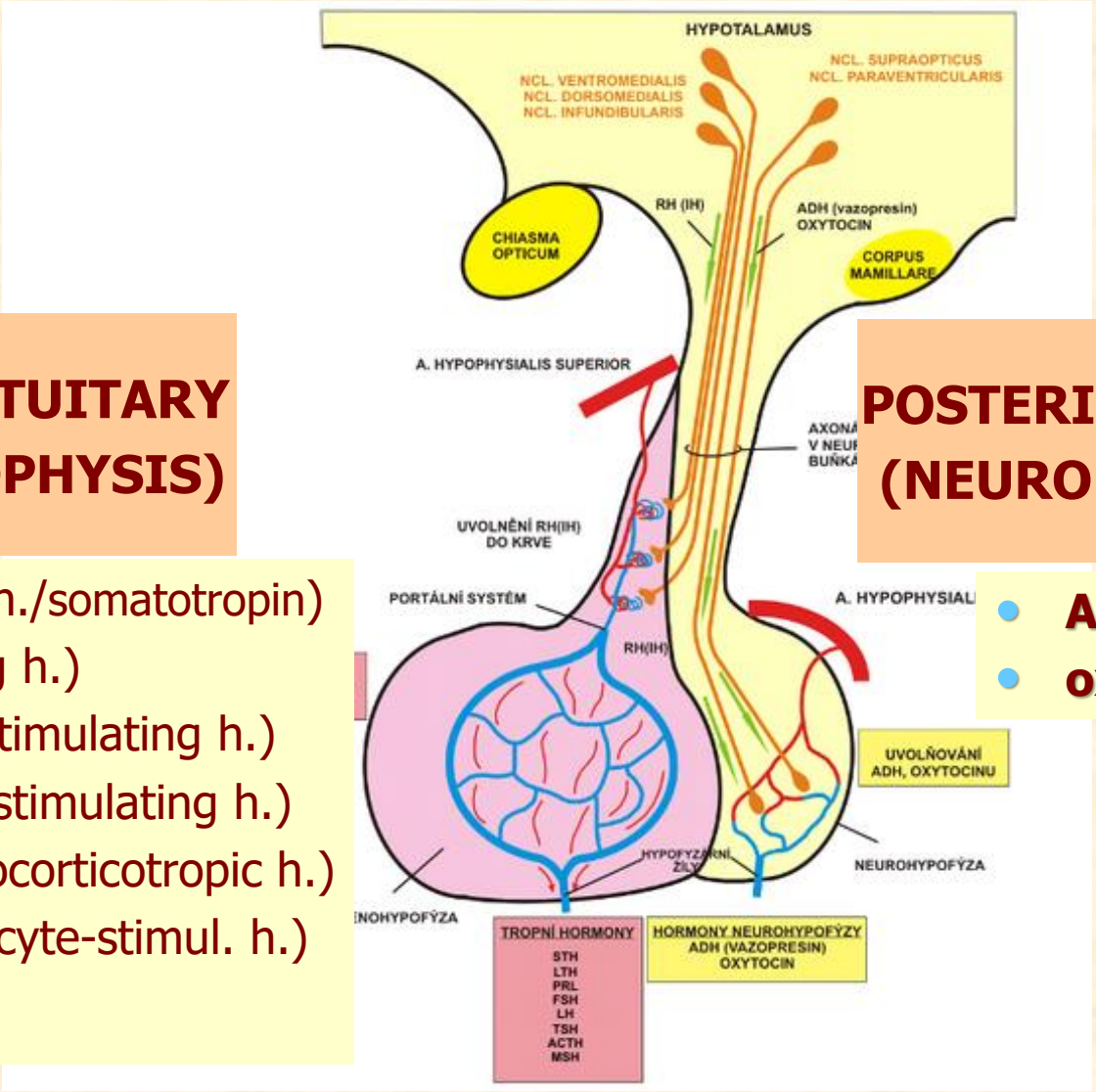
HYPOTHALAMUS

PITUITARY GLAND

Hypophysis

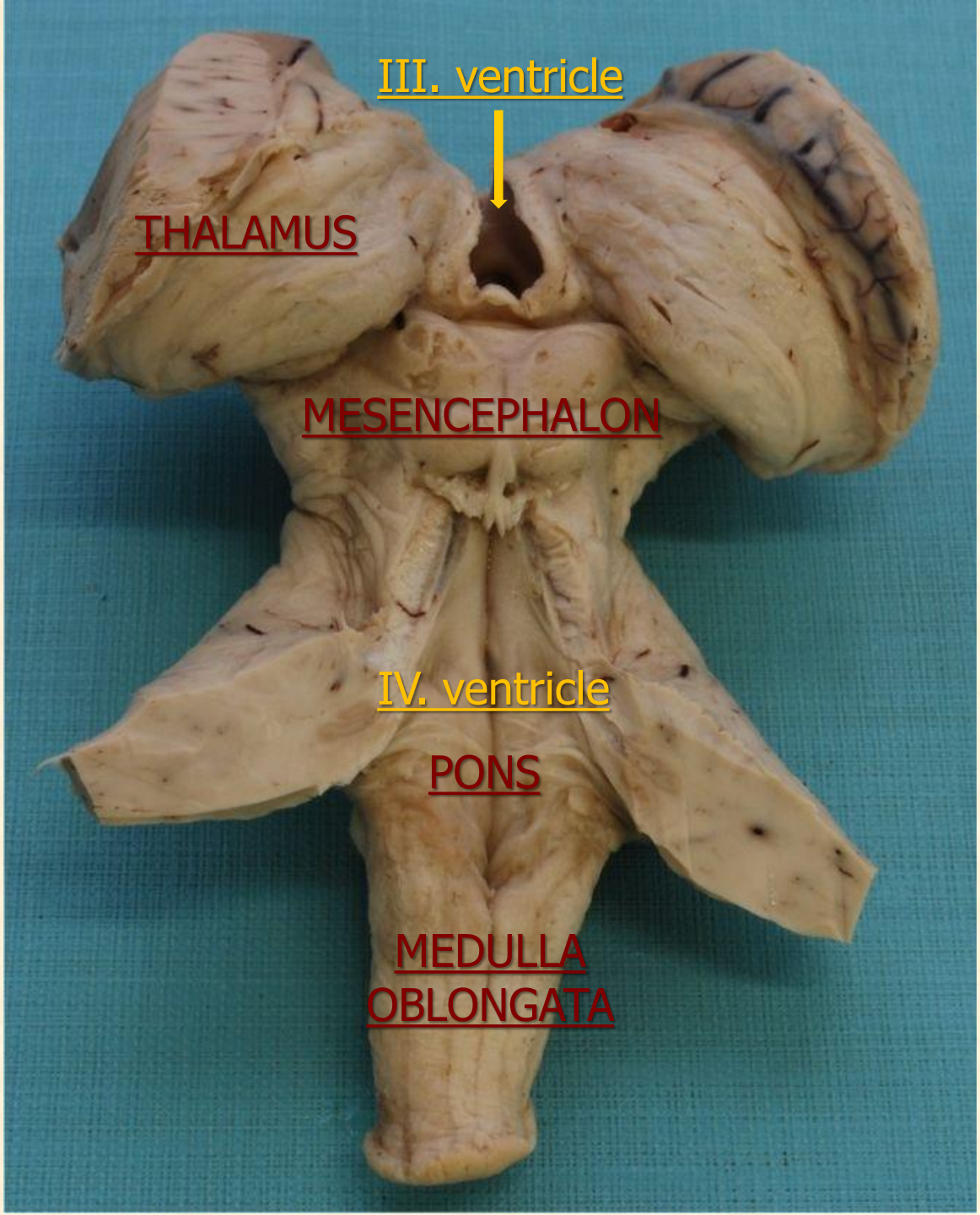
ANTERIOR PITUITARY (ADENOHYPOPHYSIS)

- **STH** (growth h./somatotropin)
- **LH** (luteinizing h.)
- **FSH** (follicle-stimulating h.)
- **TSH** (thyroid-stimulating h.)
- **ACTH** (adrenocorticotropic h.)
- **MSH** (melanocyte-stimul. h.)
- **prolactin**



POSTERIOR PITUITARY (NEUROHYPOPHYSIS)

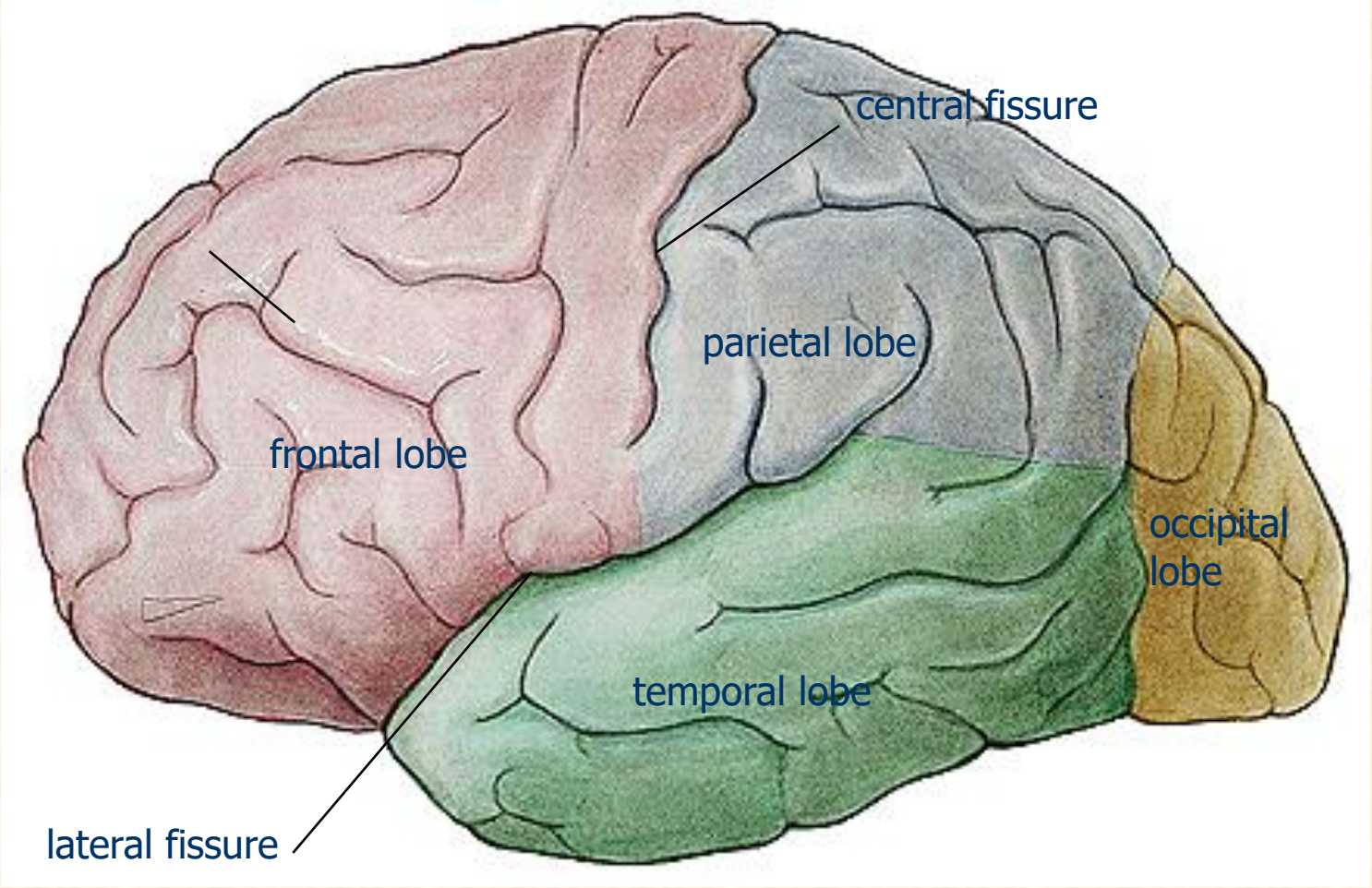
- **ADH** (vasopressin)
- **oxytocin**


III. ventricle
THALAMUS
MESENCEPHALON
IV. ventricle
PONS
MEDULLA
OBLONGATA

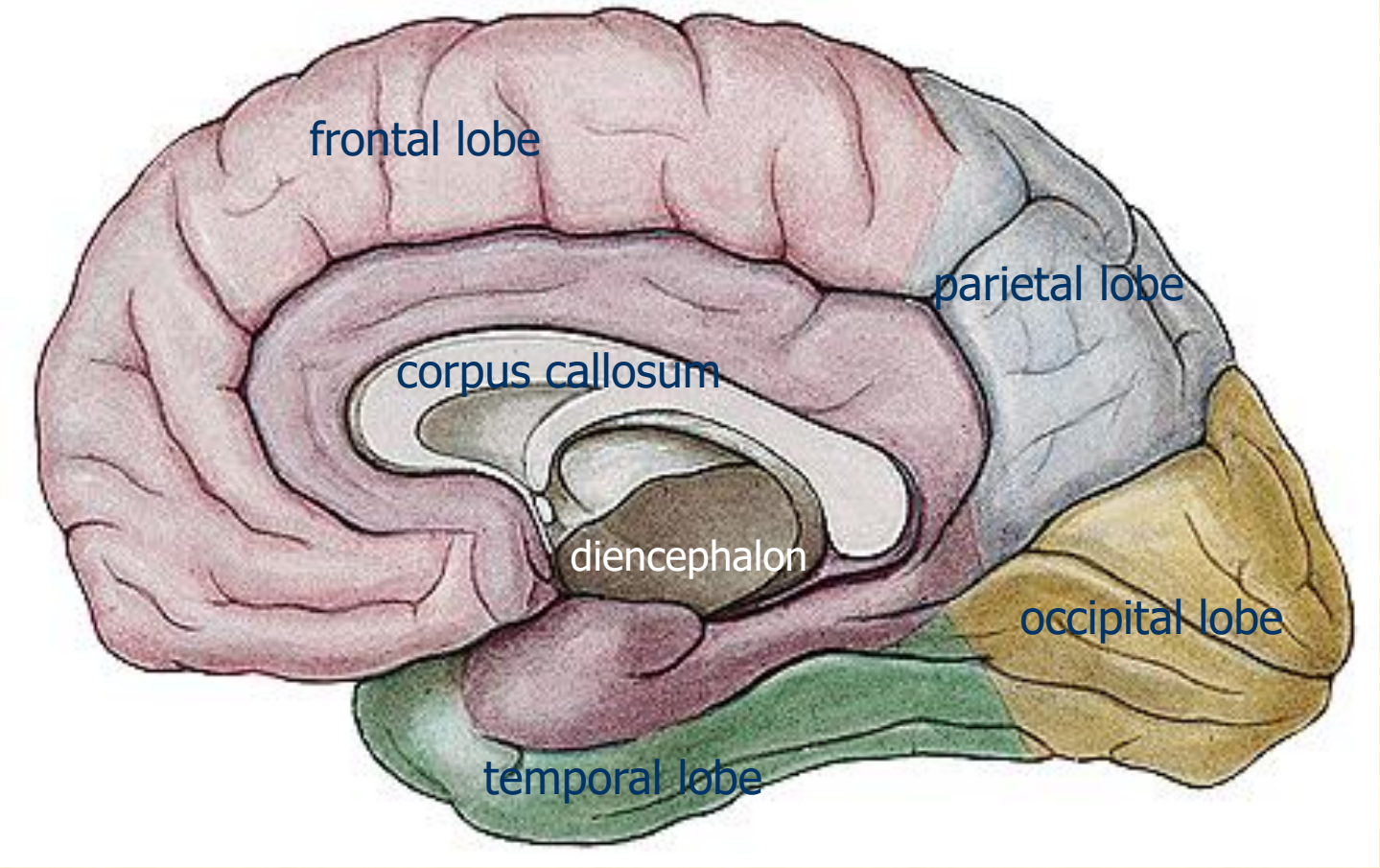
Cerebrum (Telencephalon)

- divided into right and left hemisphere connected by corpus callosum
- cerebral cortex – outer layer composed of grey matter, folded into numerous convolutions called gyri, integrates information from lower systems, allowing to perceive, interpret and react to different stimuli
- **frontal lobe (gyrus frontalis)**
- **parietal lobe (gyrus parietalis)**
- **occipital lobe (gyrus occipitalis)**
- **temporal lobe (gyrus temporalis)**
- **LIMBIC SYSTEM** – consists of several different structures (hippocampus, mamillary bodies, amygdala, septum, fornix, etc.), that together permit the expression of emotions, the establishment of memories, and the coordination of these as a function of cortical awareness
- **BASAL GANGLIA** – these structures control gross motor function such as posture and balance as well as the initiation and management of voluntary movement, e.g., walking, clutching, reaching
- **RHINENCEPHALON** – olfaction, the old part of the brain

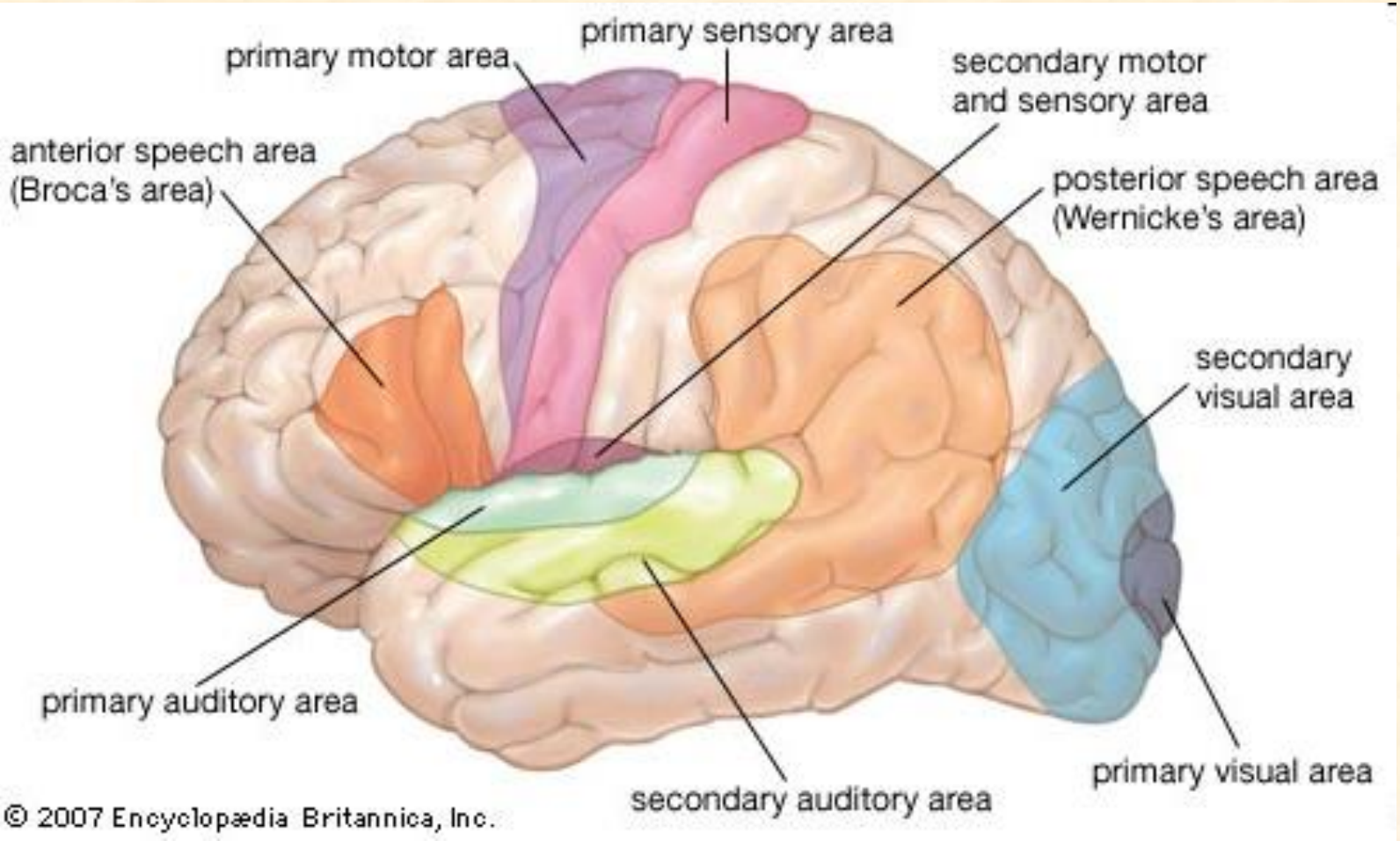
Cerebrum (Telencephalon)



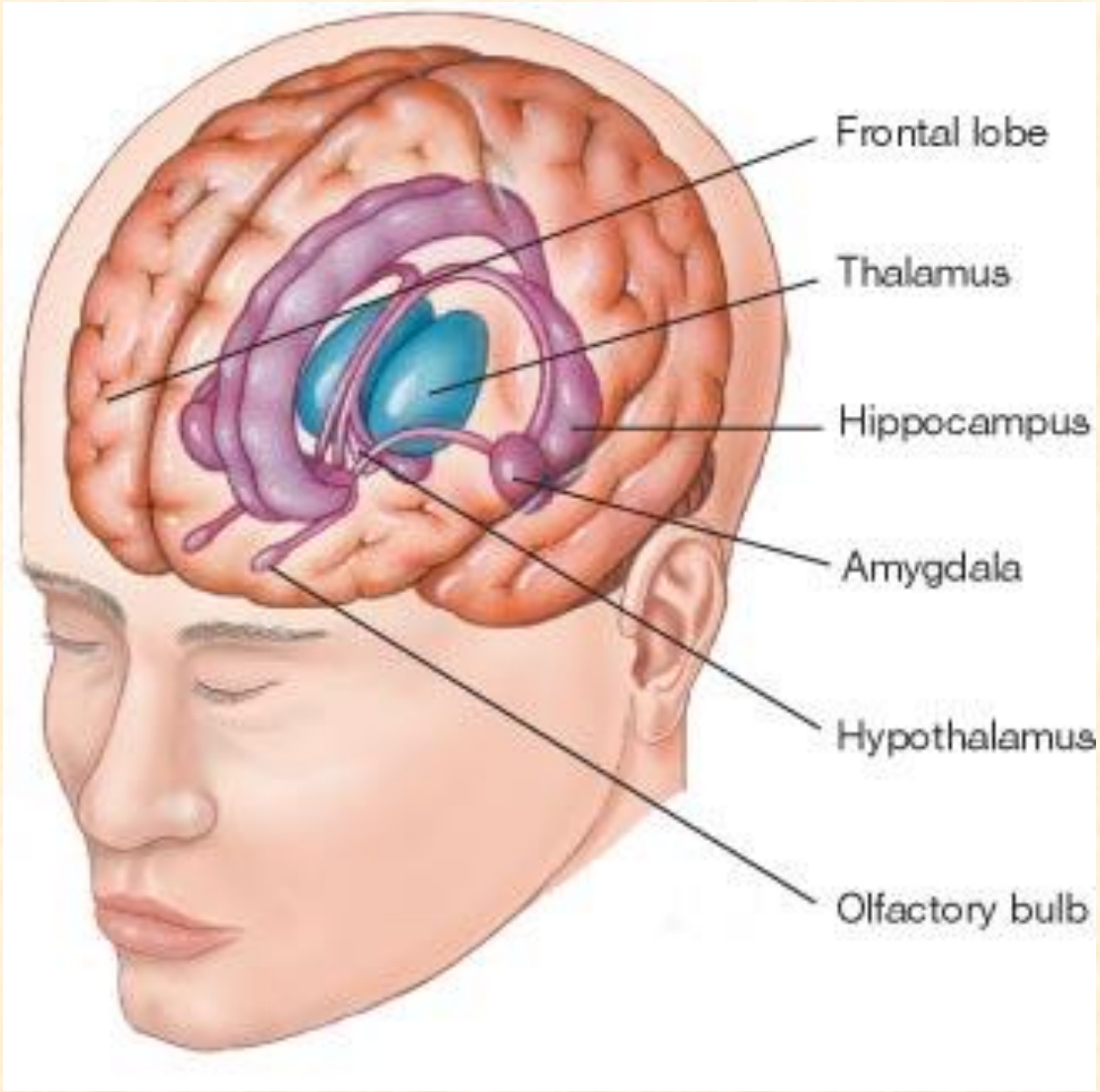
Cerebrum


frontal lobe
parietal lobe
corpus callosum
diencephalon
occipital lobe
temporal lobe

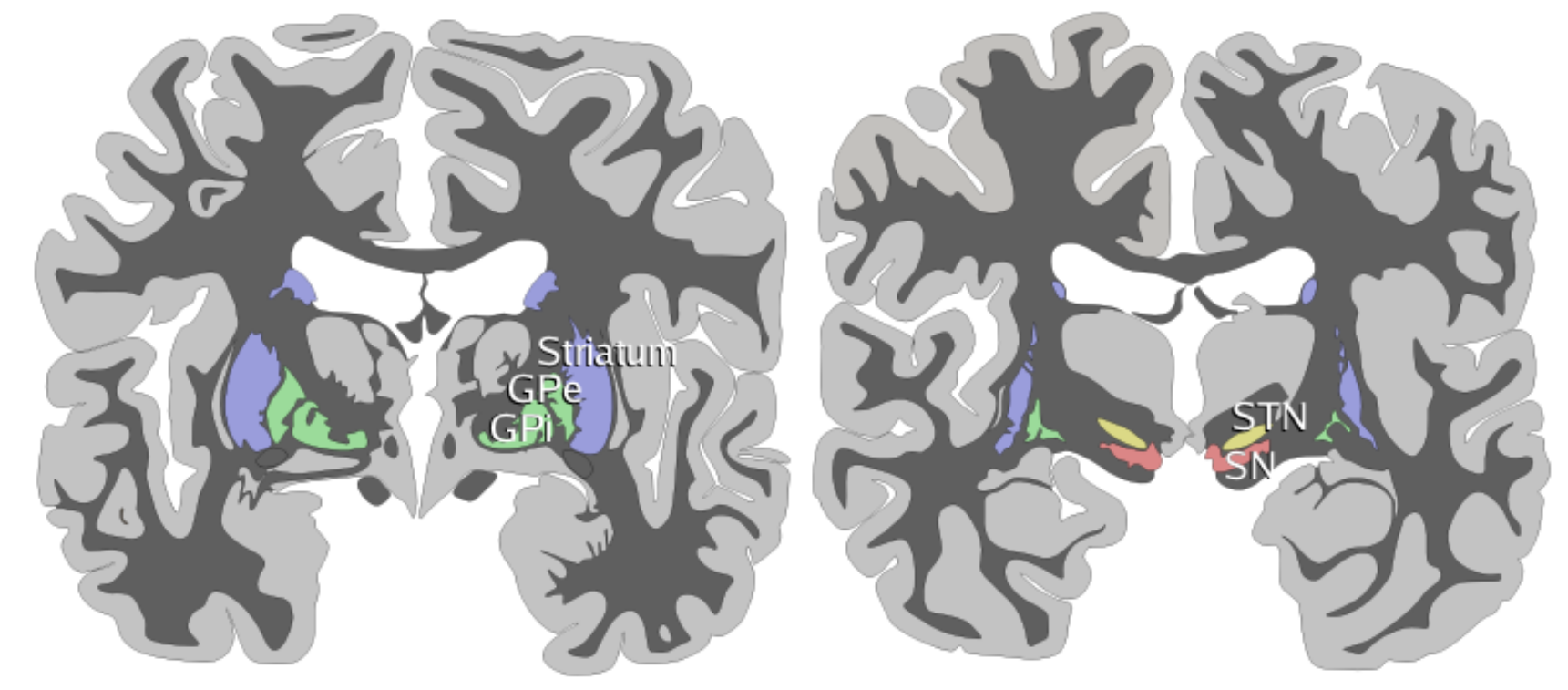
Functional Areas of the Brain



Limbic System



Basal Ganglia



STRIATUM = nucleus caudatus + putamen

GP = globus pallidus

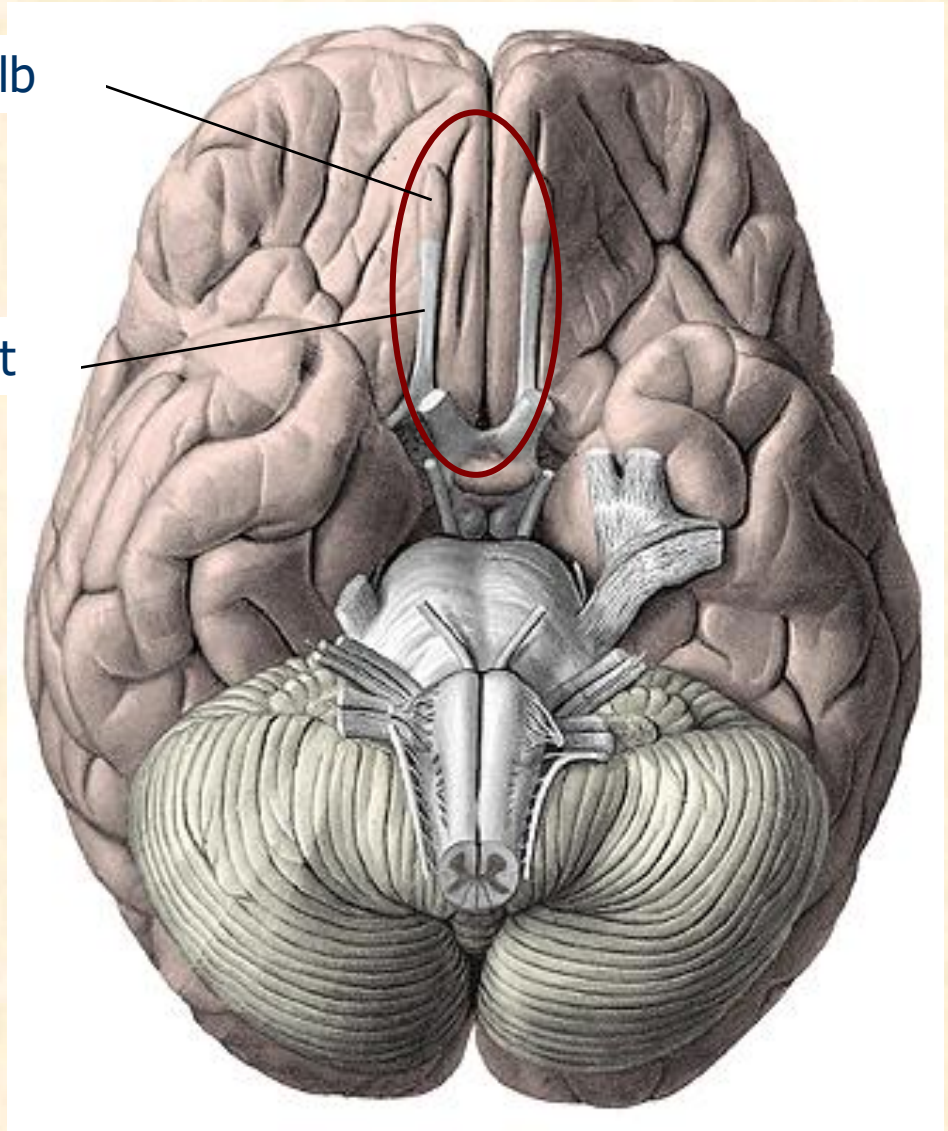
SN = substantia nigra

STN = nucleus subthalamicus Luysi

Rhinencephalon

olphactory bulb

olphactory tract



Meninges

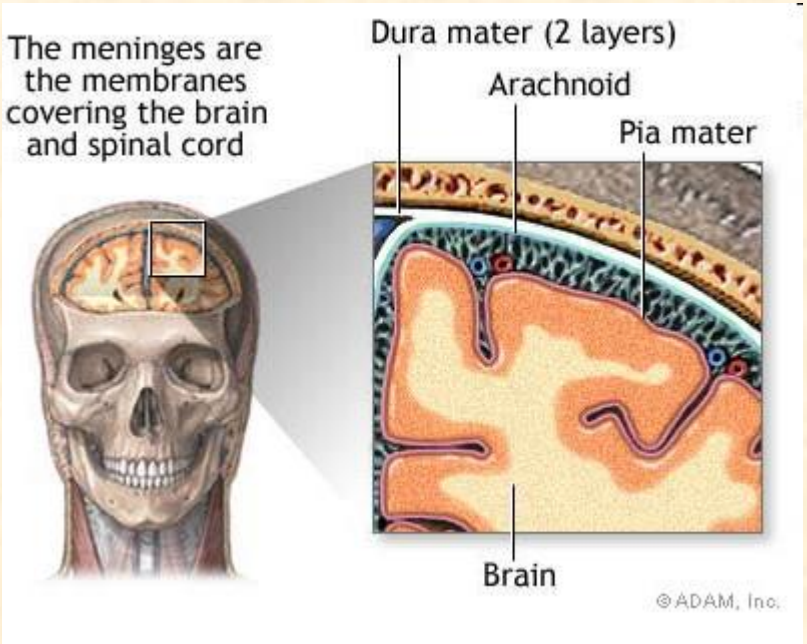
- **DURA MATER**
  - falx cerebri
  - falx cerebelli
  - tentorium cerebelli

SUBDURAL SPACE

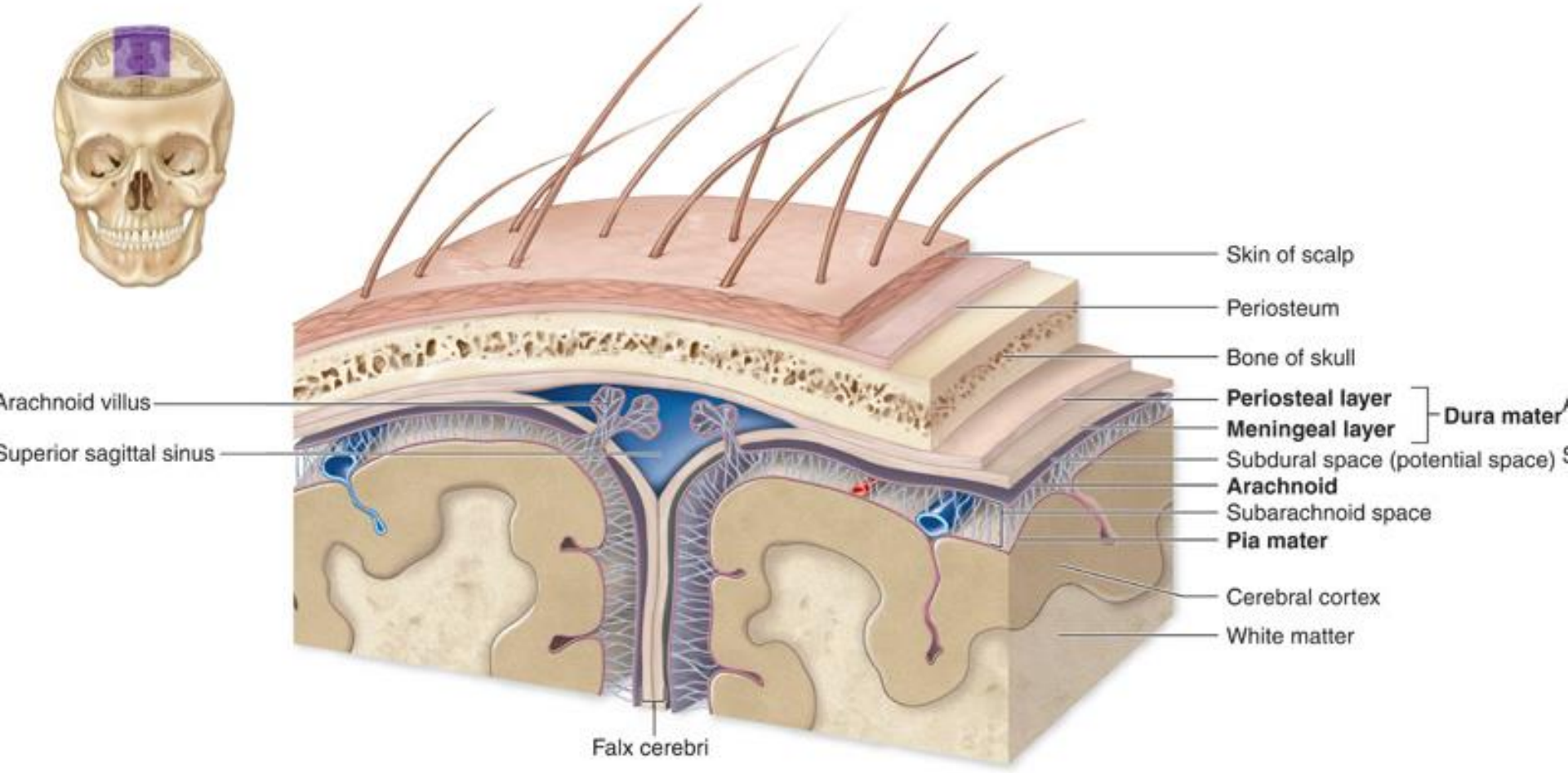
- **ARACHNOID MATER**

SUBARACHNOID SPACE
cerebrospinal fluid

- **PIA MATER**



Meninges

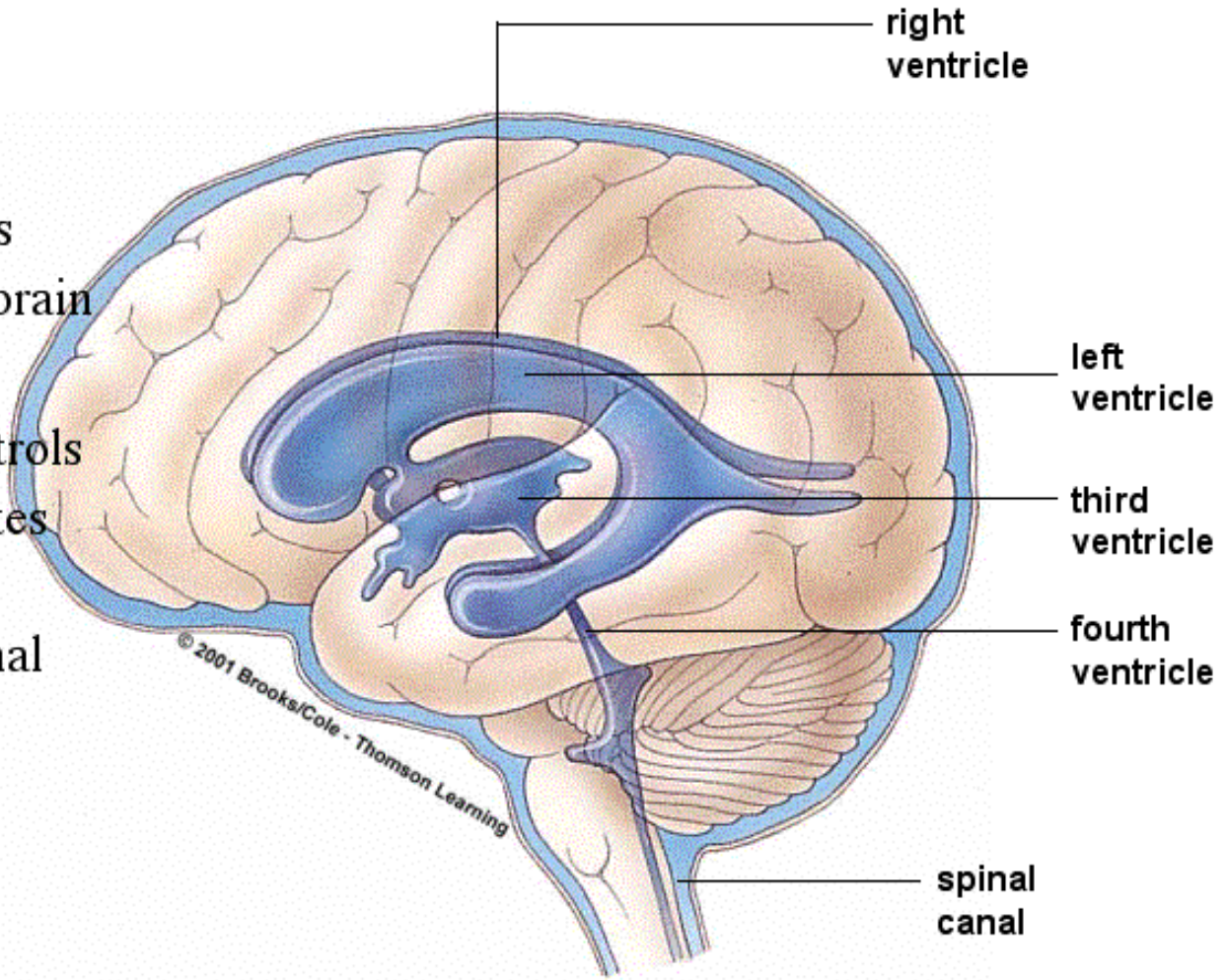


Brain Ventricles

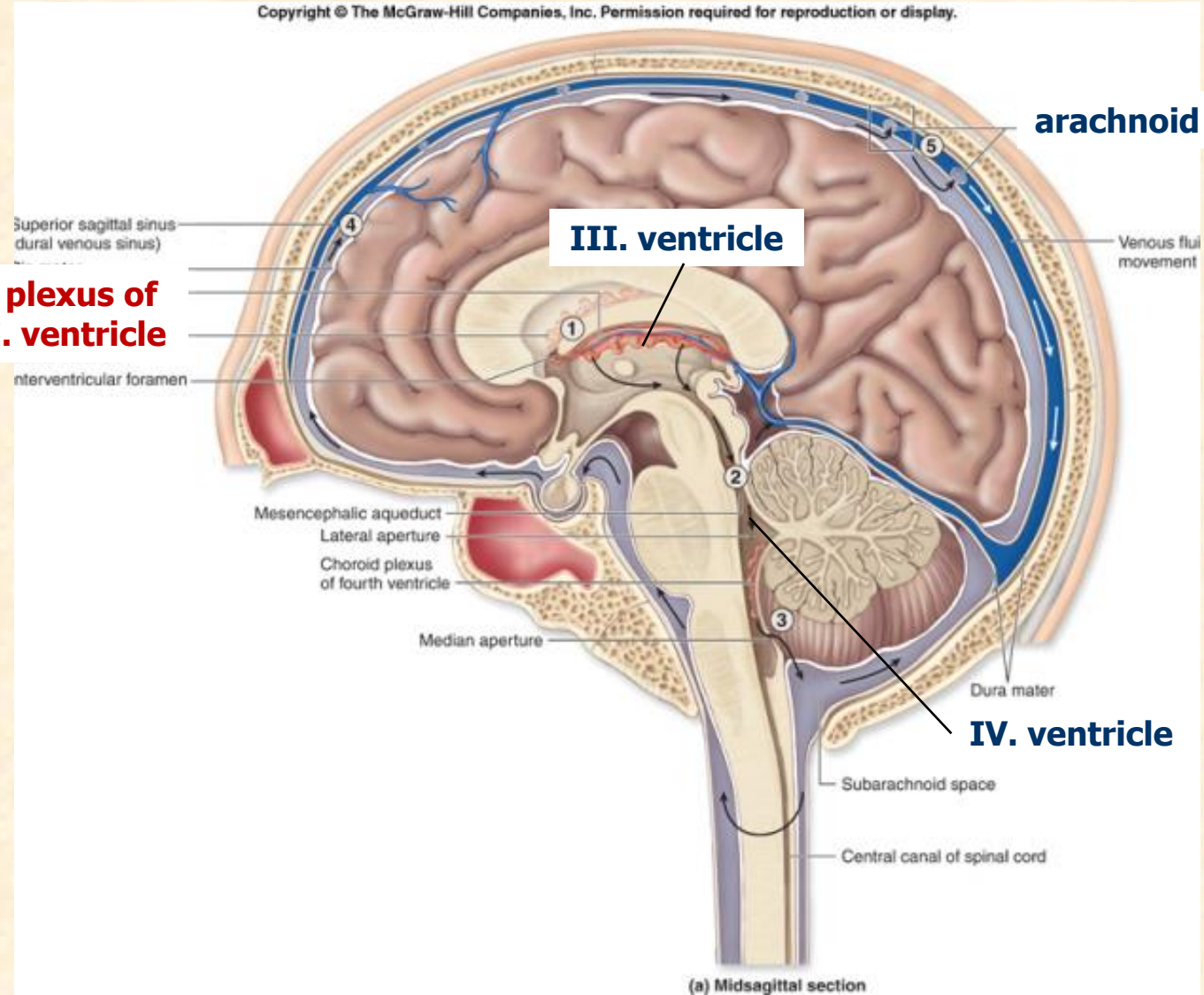
- **I. a II. LATERAL VENTRICLES**
- **III. VENTRICLE** – between the thalami in the diencephalon
- **IV. VENTRICLE** – inside medulla oblongata
- **mesencephalic aqueduct** – connects III. a IV. ventricle, passes through mesencephalon
- ventricles are filled with cerebrospinal fluid (CSF) that is produced by ventricular choroid plexi
- CSF fluids from the lateral ventricles into the third ventricle, and then the fourth via the mesencephalic aqueduct to the central canal of the spinal cord
- fluid is reabsorbed by arachnoid villi to the venous system (brain sinuses)

Cerebrospinal Fluid

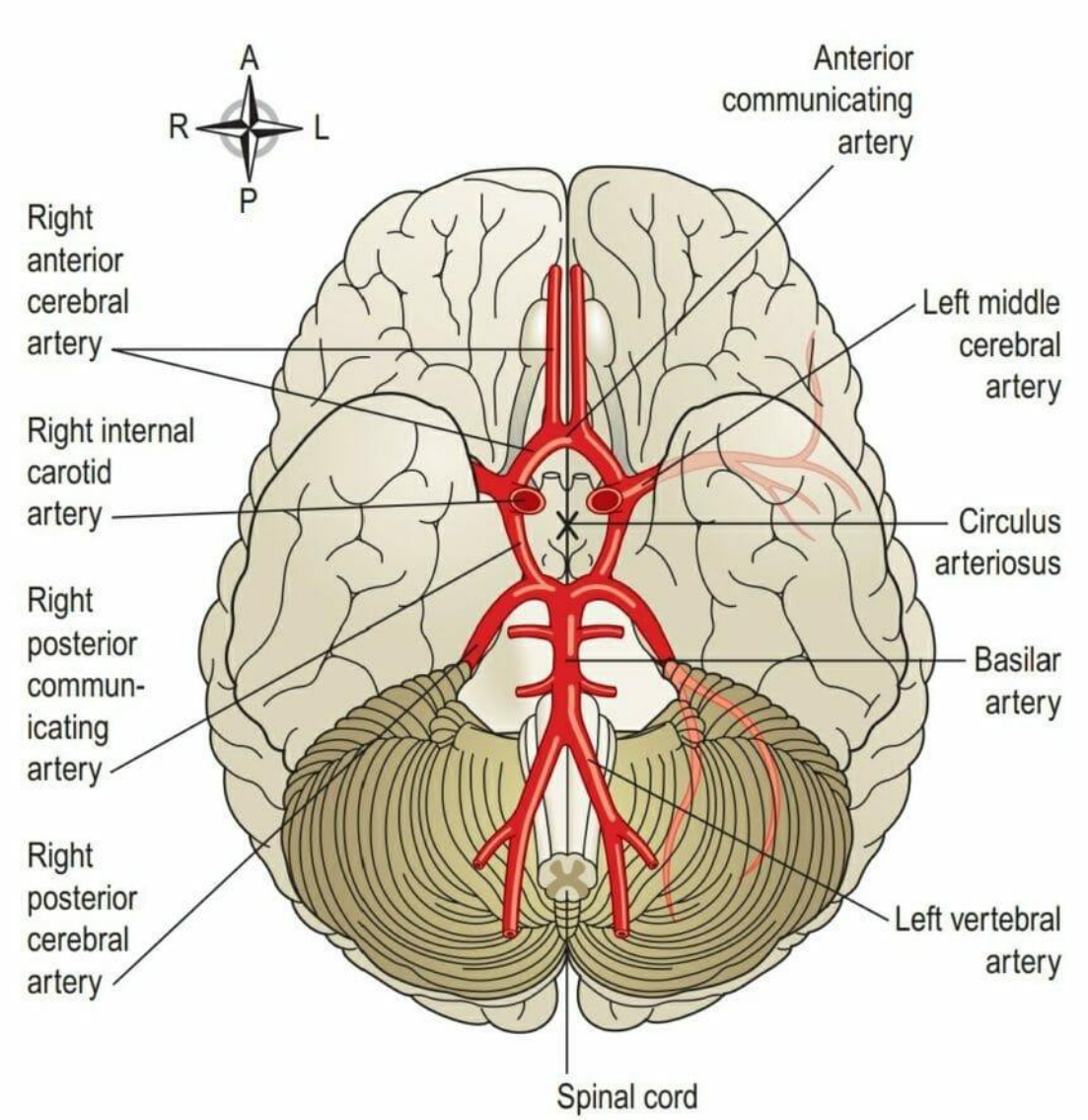
- Surrounds the spinal cord
- Fills ventricles within the brain
- Blood-brain barrier controls which solutes enter the cerebrospinal fluid



CSF Circulation



The Circle of Willis



CNS Imaging

CT (Computer Tomography)

MRI (Magnetic Resonance Imaging)

PERIPHERAL NERVOUS SYSTEM

- SPINAL NERVES
- CRANIAL NERVES

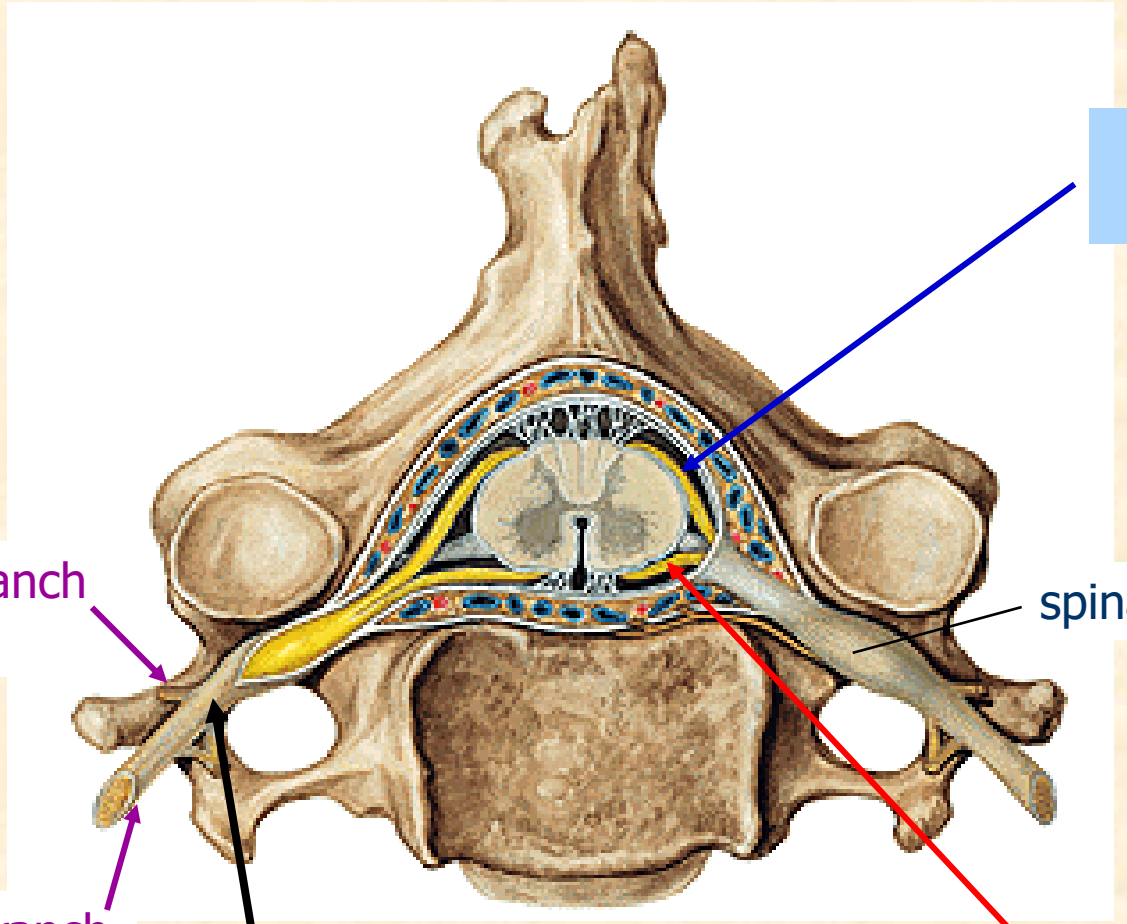
Spinal Nerves

- 31 pairs
  - 8 pairs of cervical nerves (nn. cervicales)
  - 12 pairs of thoracic nerves (nn. thoracicici)
  - 5 pairs of lumbar nerves (nn. lumbales)
  - 5 pairs of sacral nerves (nn. sacrales)
  - 1 pair of coccygeal nerves (n. coccygeus)
- pass through the intervertebral foramen and the sacrum

- arise from two **spinal roots**
  - ventral root (radix ventralis) – anterior motor and autonomic root
  - dorsal root (radix dorsalis) – posterior sensory and autonomic root
  - spinal ganglion (ganglion spinale) – bodies of sensory neuron bodies

- **anterior branch** (ramus ventralis)
- **posterior branch** (ramus dorsalis)

Spinal Nerve



dorsal root – sensory

posterior branch – mixed

spinal ganglion

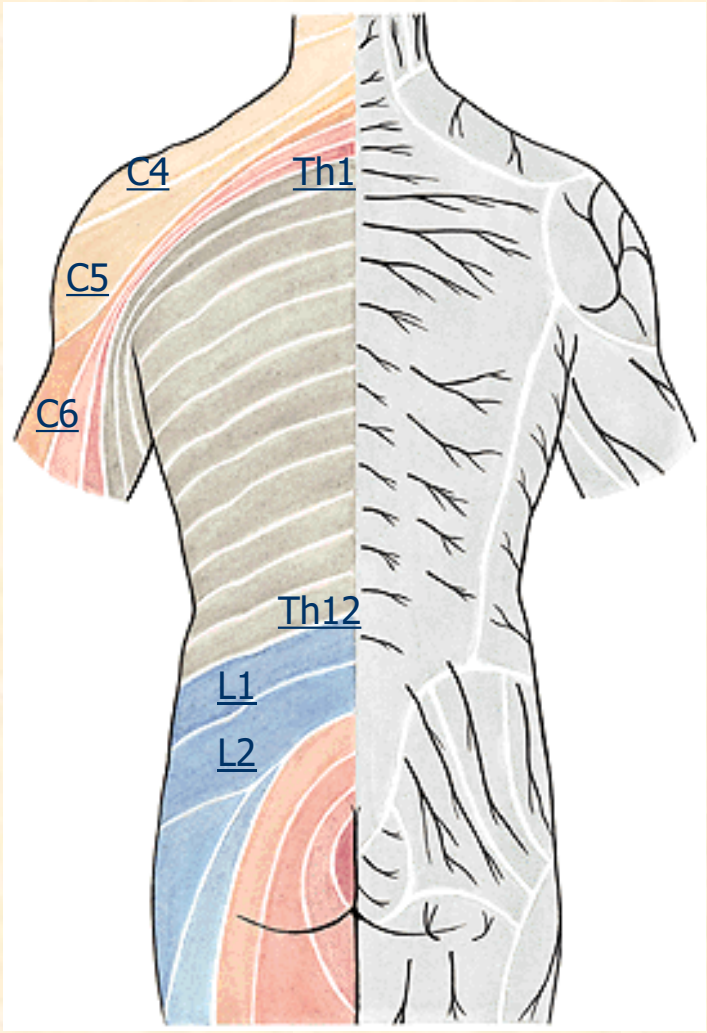
anterior branch – mixed

SPINAL NERVE

ventral root – motor

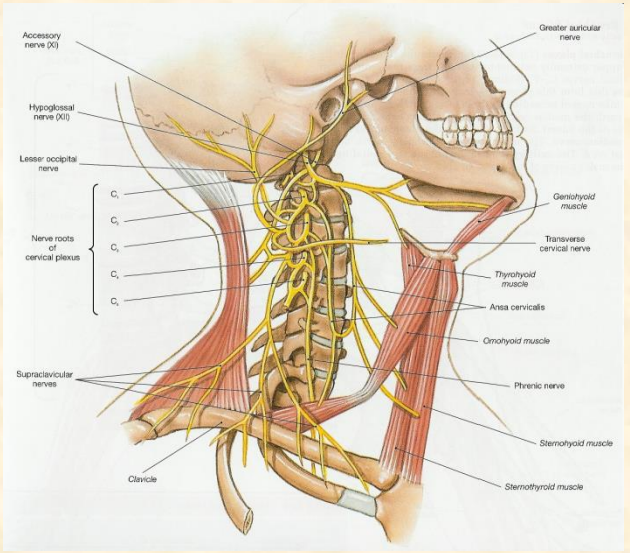
Posterior Branches of Spinal Nerves

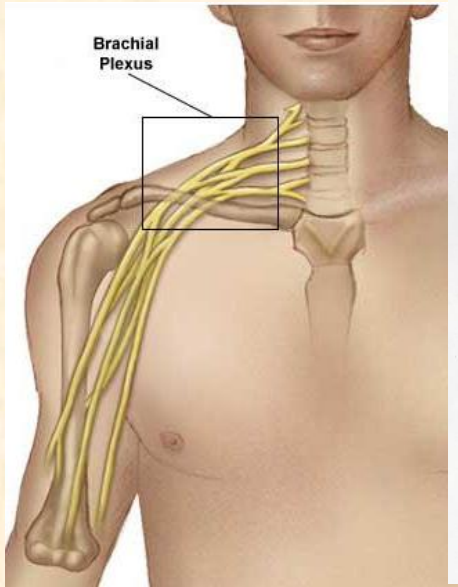
- segmented arrangement
- sensory innervation of the skin and motor innervation of the deep muscles of the neck and back



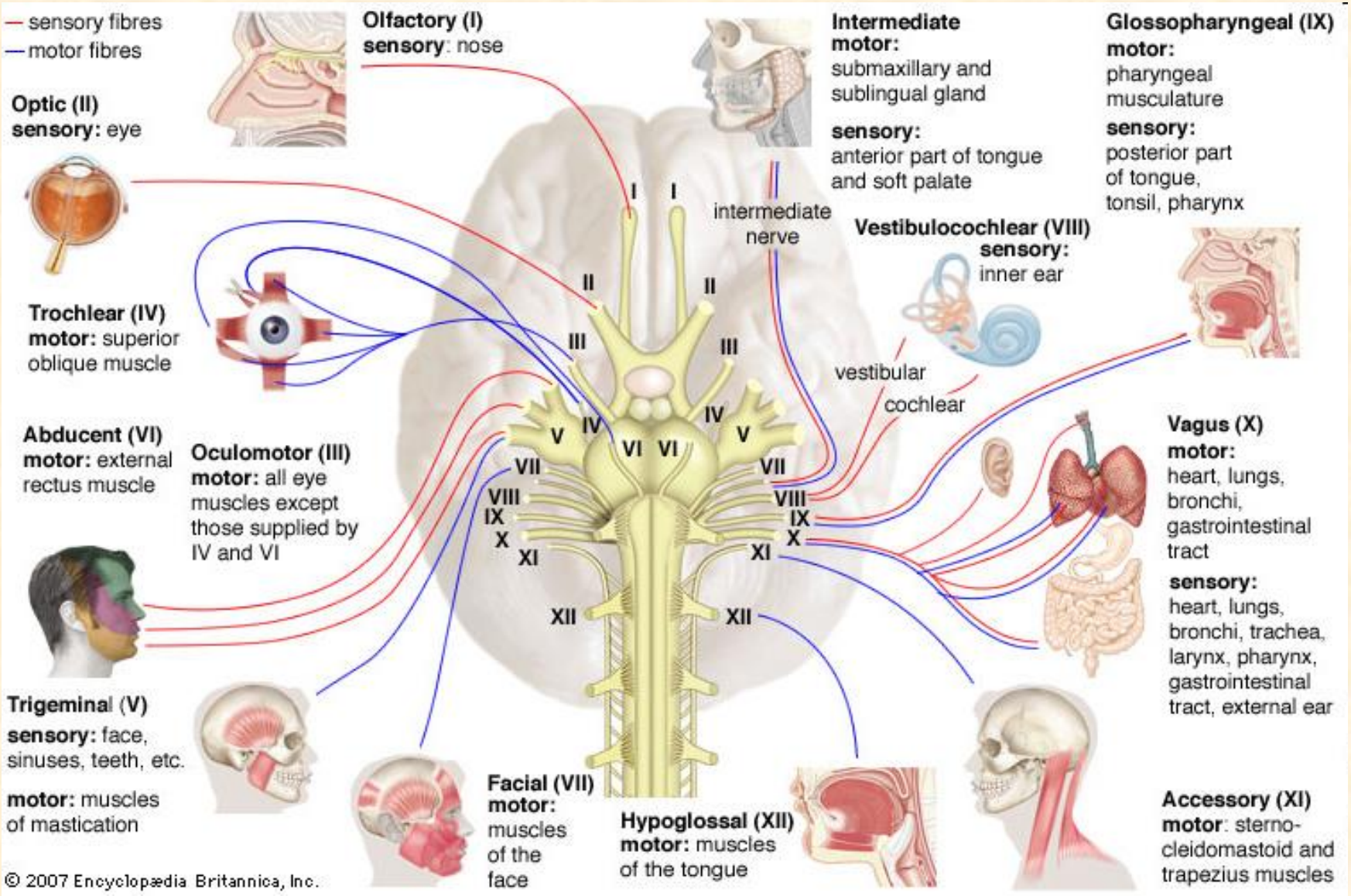
Anterior Branches of Spinal Nerves

- **CERVICAL PLEXUS** (C1-C4)
- **BRACHIAL PLEXUS** (C5-Th1)
- **INTERCOSTAL NERVES**
- **LUMBAR PLEXUS** (L1-L4)
- **SACRAL PLEXUS**(L5-Co)

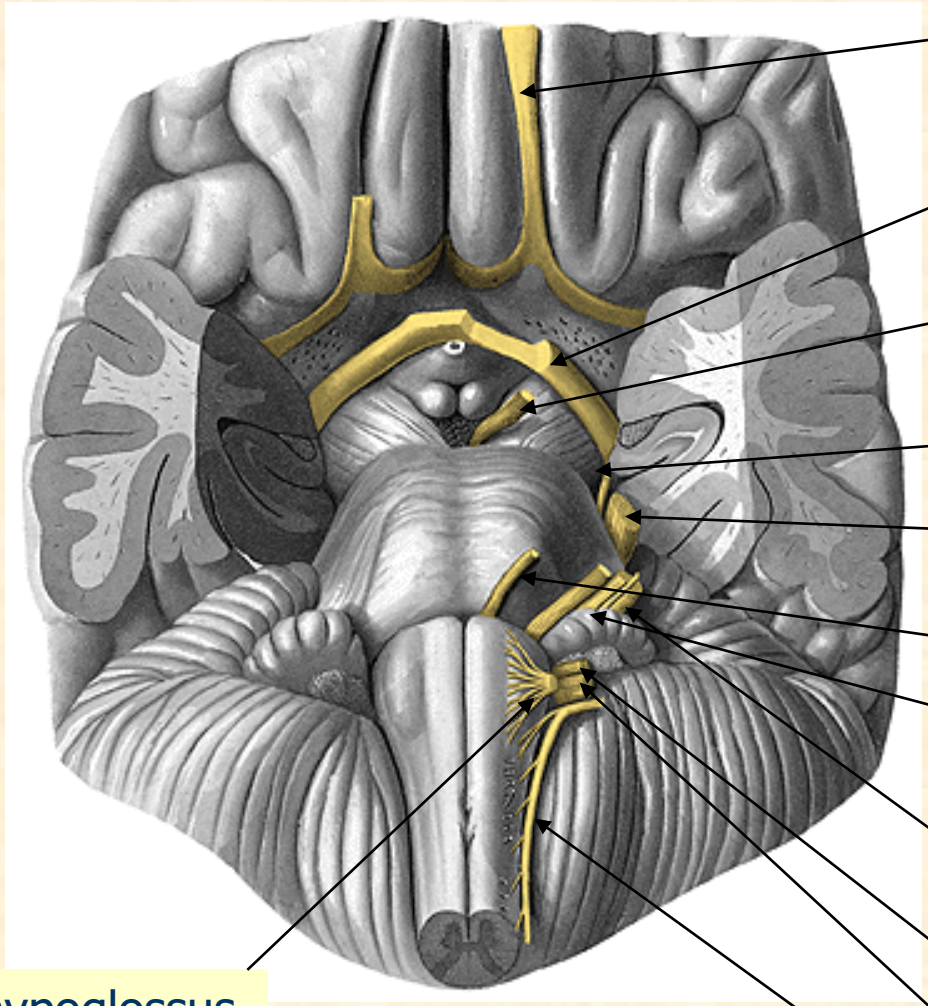




Cranial Nerves



Cranial Nerves



n. I. olphactorius

n. II. opticus

n. III. oculomotorius

n. IV. trochlearis

n. V. trigeminus

n. VI. abducens

n. VII. facialis

n. VIII. vestibulocochlearis

n. IX. glossopharyngeus

n. X. vagus

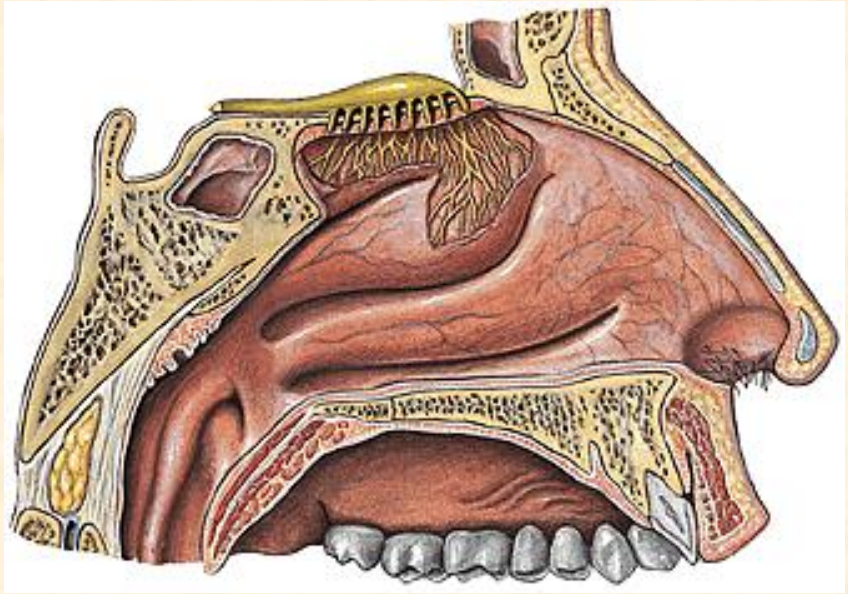
n. XI. accessorius

n. XII. hypoglossus

Cranial Nerves

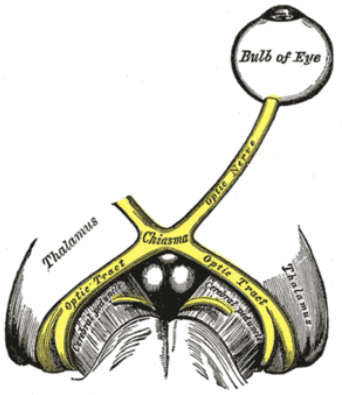
OLPHACTORY NERVE

N. OLPHACTORIUS (I.)

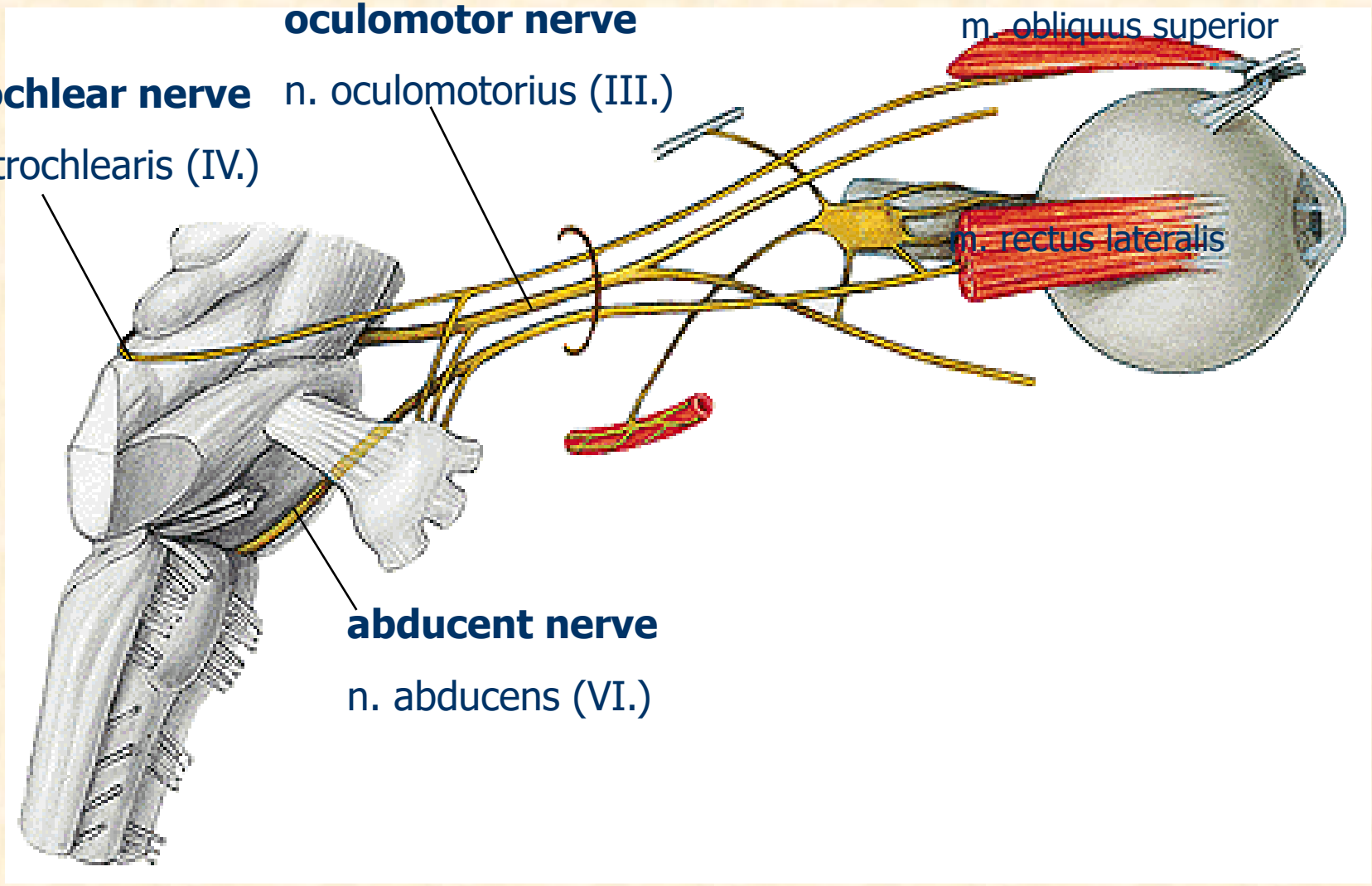


OPTIC NERVE

N. OPTICUS (II.)



Eye-moving Nerves

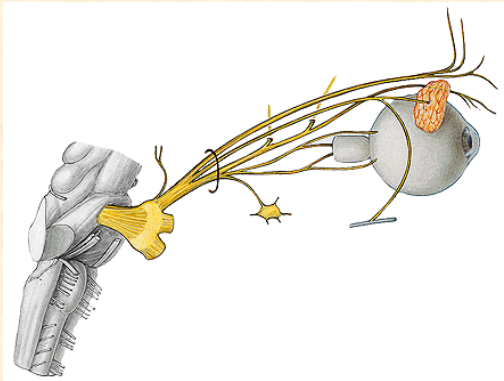


Cranial Nerves

TRIGEMINAL NERVE (n. trigeminus V.)

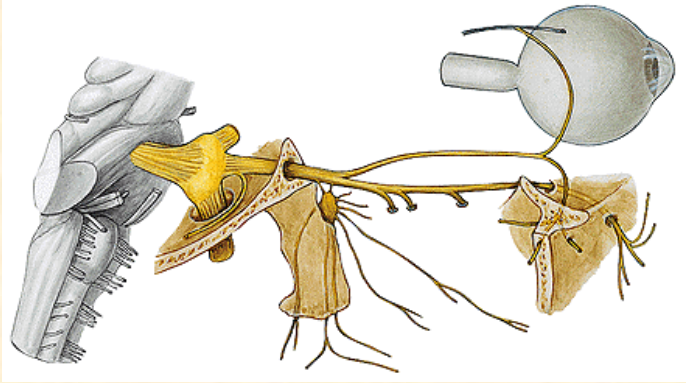
- 1. branch:

  n. ophtalmicus



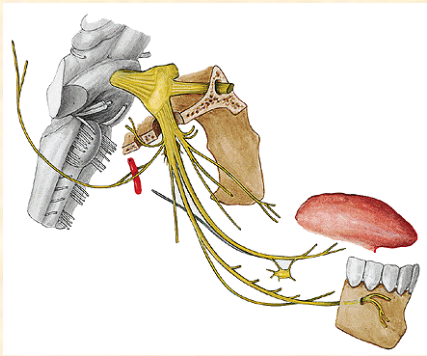
- 2. branch:

  n. maxillaris



- 3. branch:

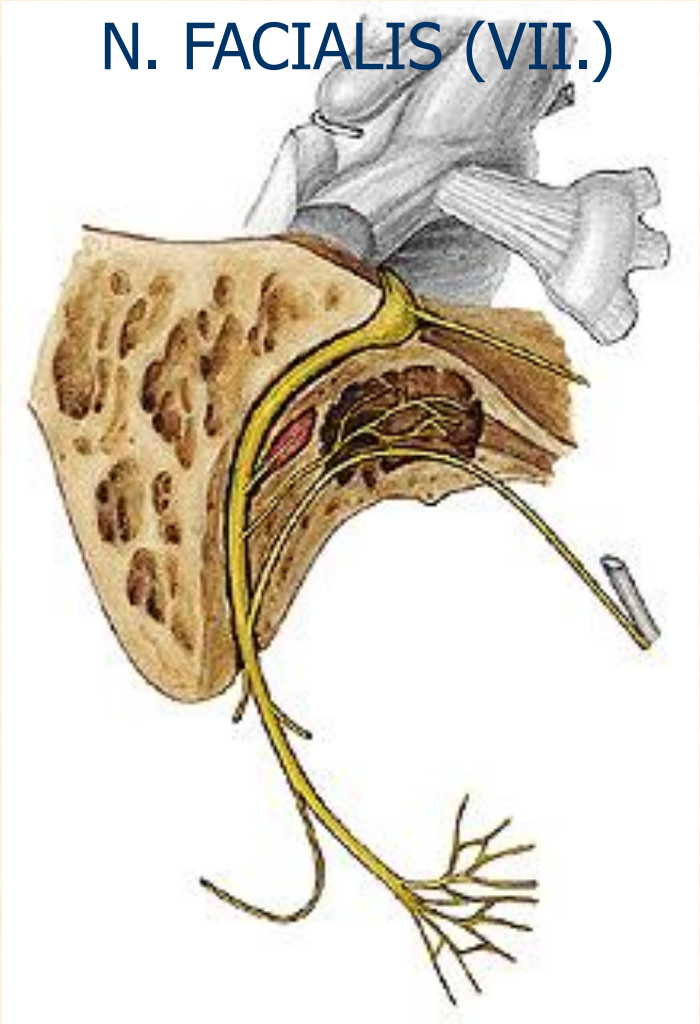
  n. mandibularis



Cranial Nerves

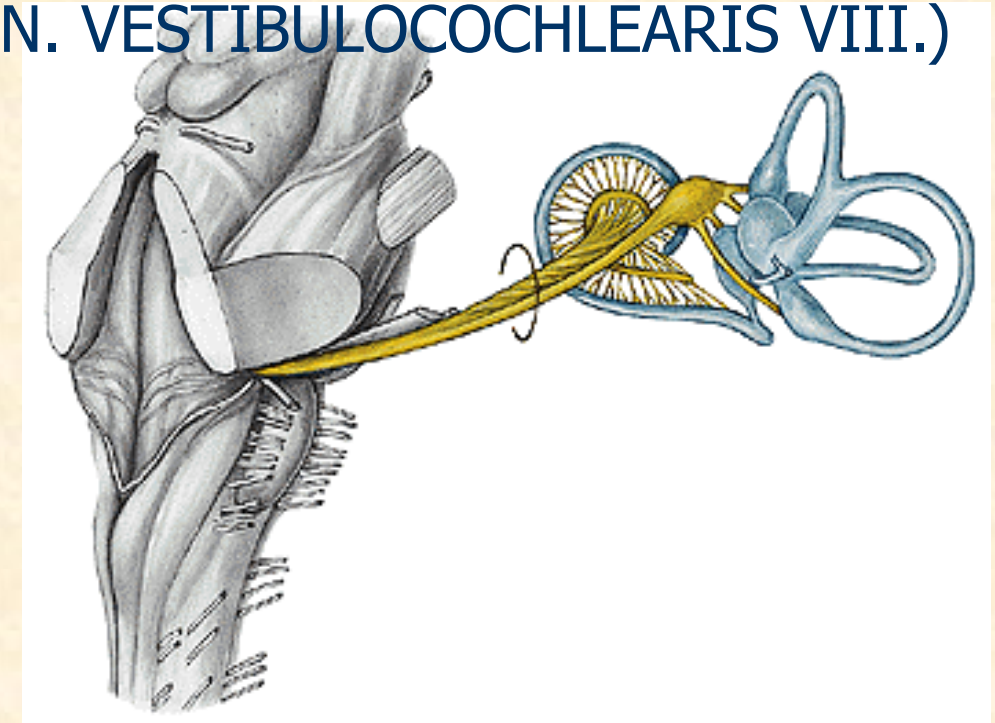
FACIAL NERVE

N. FACIALIS (VII.)



VESTIBULOCOCHLEAR NERVE

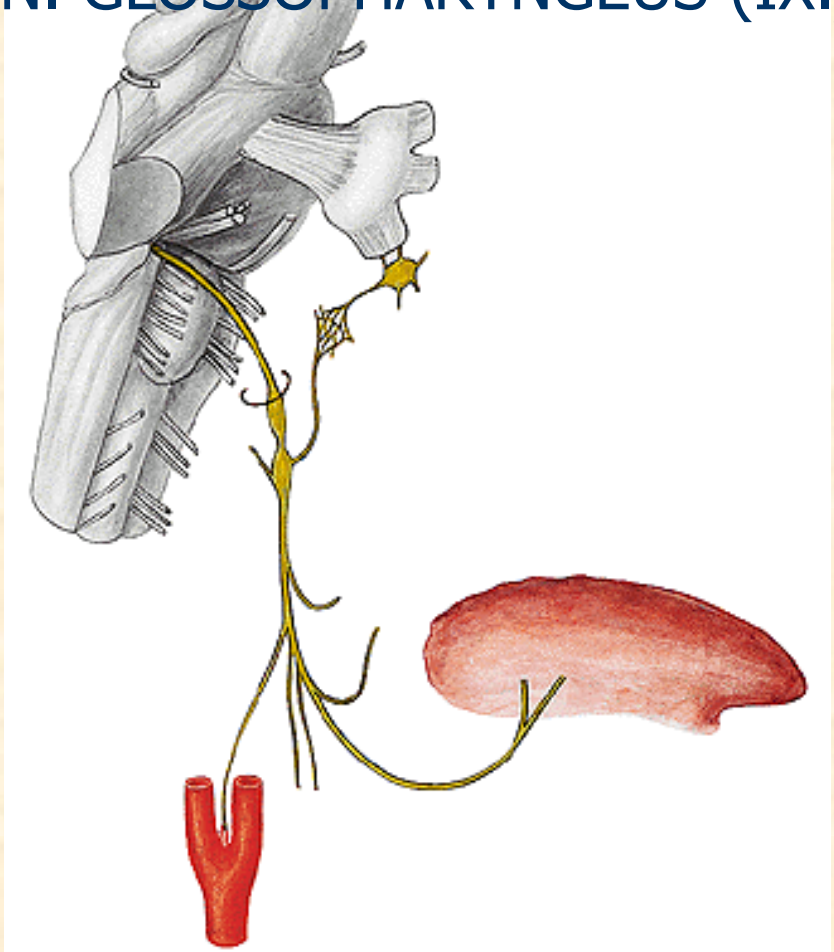
N. VESTIBULOCOCHLEARIS VIII.)



Cranial Nerves

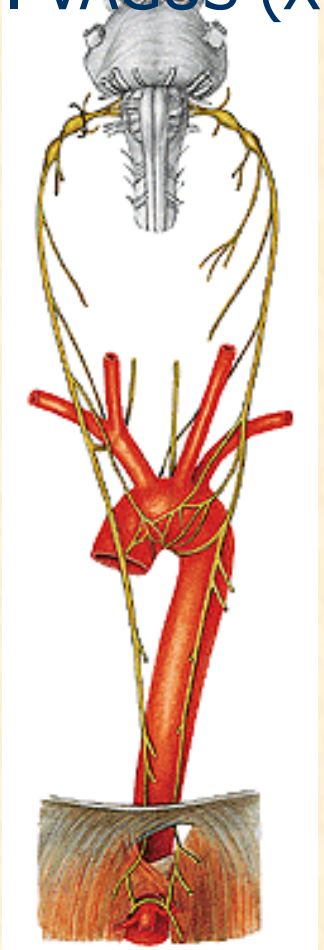
GLOSSOPHARYNGEAL NERVE

N. GLOSSOPHARYNGEUS (IX.)



VAGUS NERVE

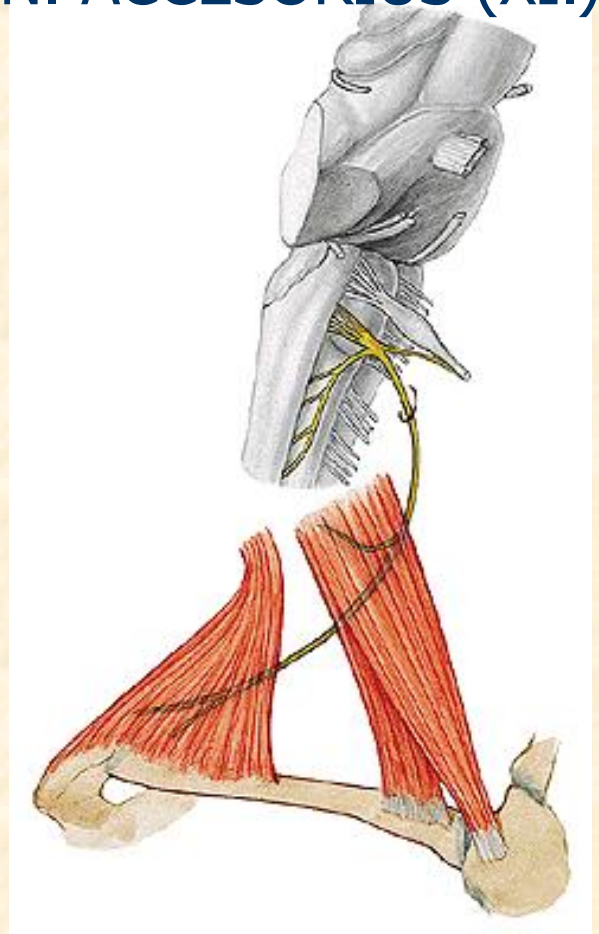
N. VAGUS (X.)



Cranial Nerves

ACCESSORY NERVE

N. ACCESORIUS (XI.)



HYPOGLOSSAL NERVE

N. HYPOGLOSSUS (XII.)