

# CNS – central nervous system

The spinal cord (medulla spinalis)

The brain (cerebrum, encephalon)

Division of the brain:

The medulla oblongata (medulla oblongata)

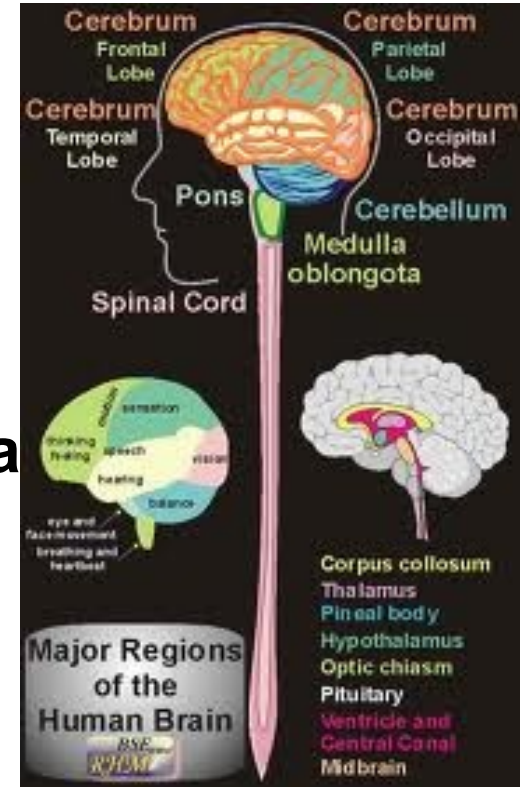
The pons (pons Varoli)

The cerebellum (cerebellum)

The midbrain (mesencephalon)

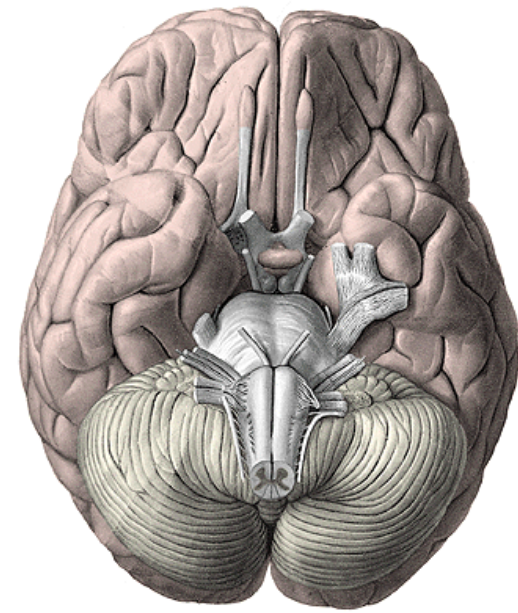
The diencephalon (diencephalon)

The cerebrum (telencephalon)

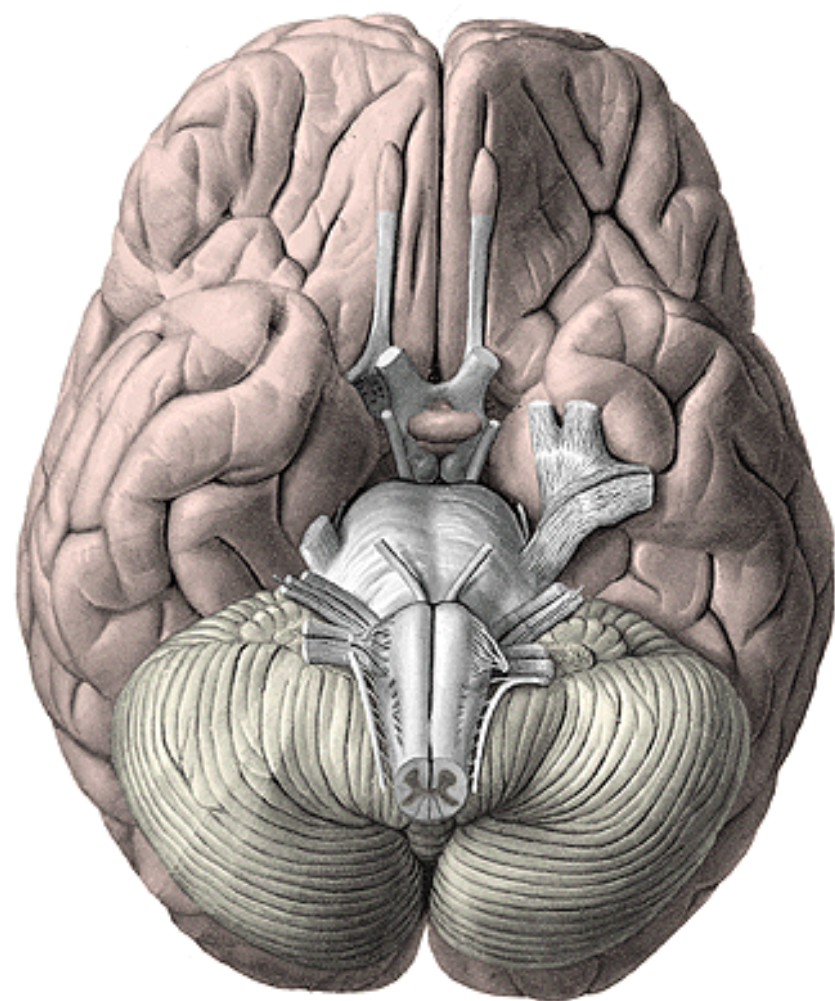
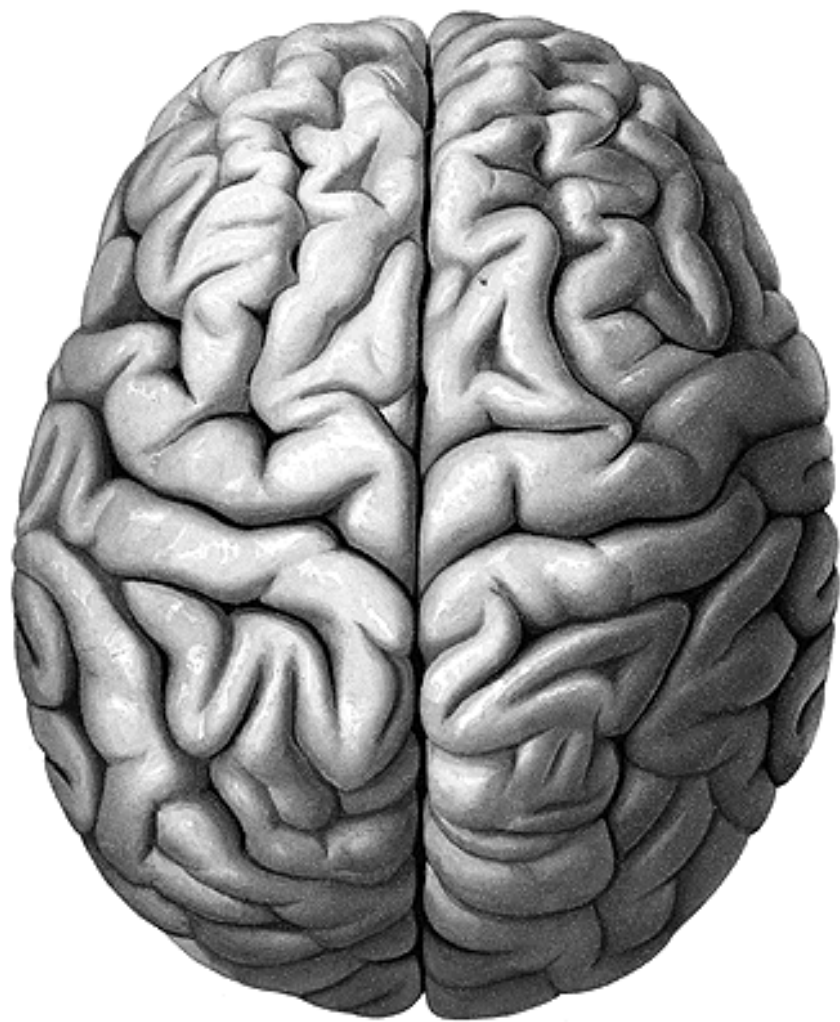


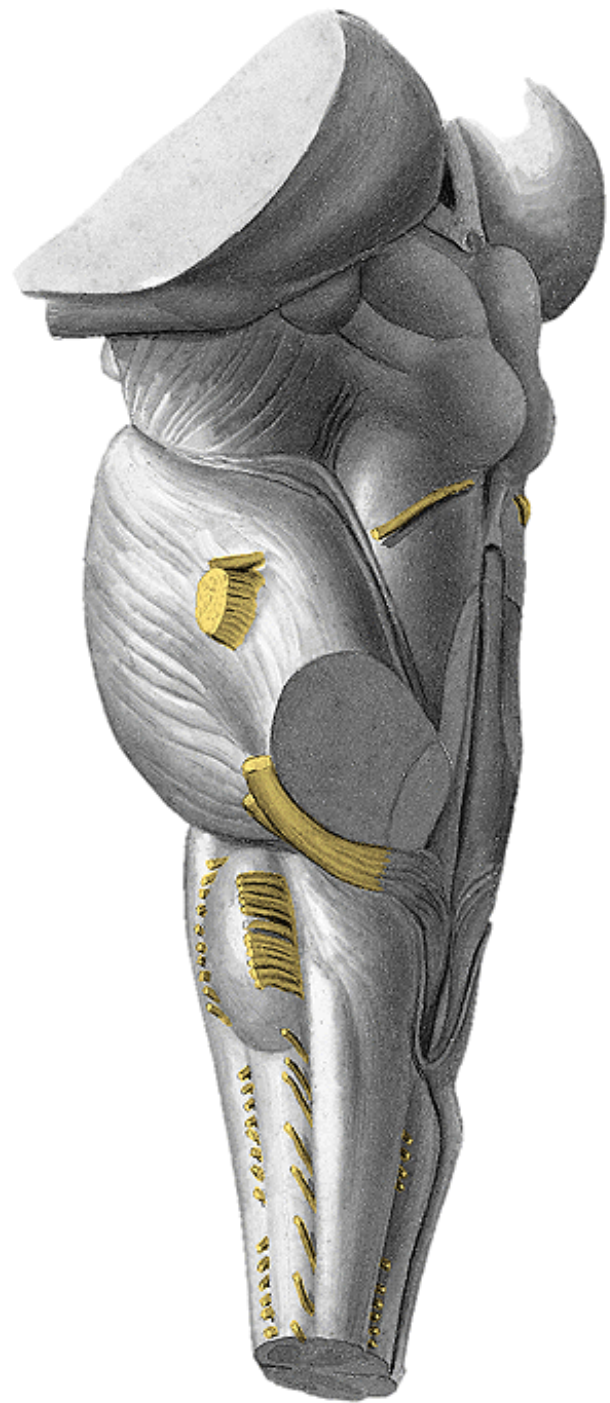
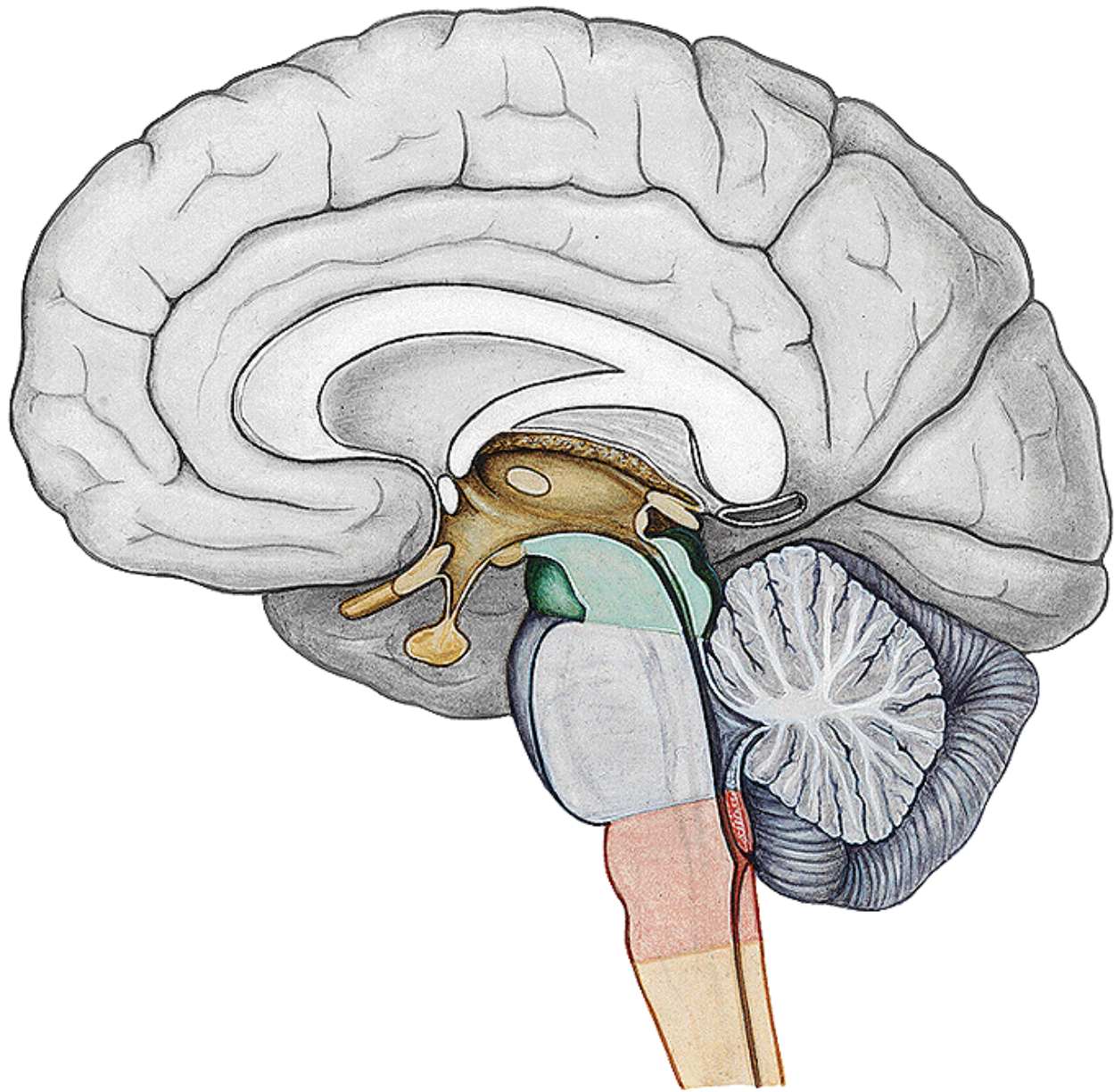
The brain stem = The medulla oblongata, The pons, The cerebellum, The midbrain, The diencephalon

# The cranial nerves– nervi craniales

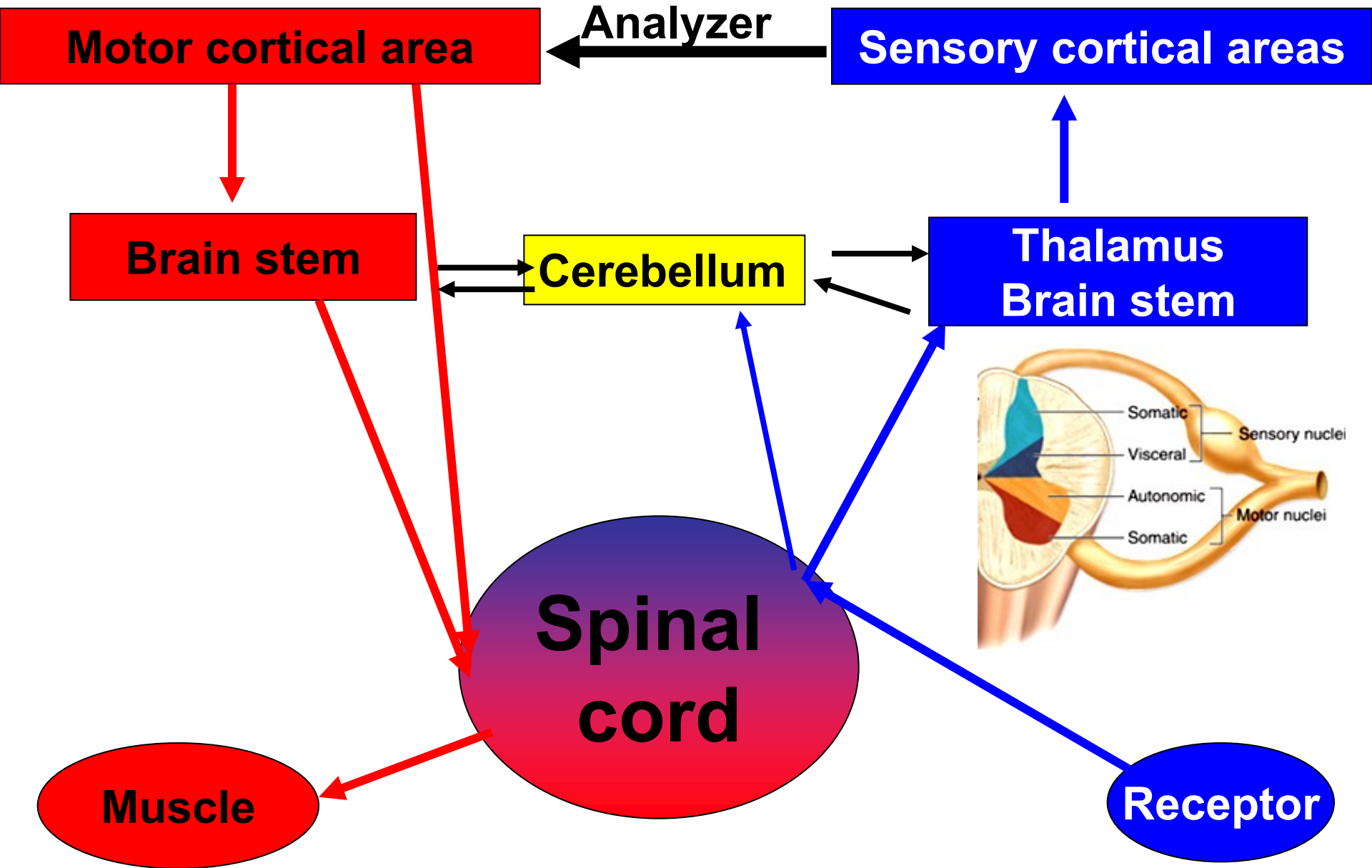


- I. Nervus olfactorius – olfactory nerve***
- II. Nervus opticus – optic nerve***
- III. Nervus oculomotorius – oculomotor nerve***
- IV. Nervus trochlearis – trochlear nerve***
- V. Nervus trigeminus – trigeminal nerve***
- VI. Nervus abducens – abducens nerve***
- VII. Nervus facialis – facial nerve***
- VIII. Nervus vestibulocochlearis – vestibulocochlear nerve***
- IX. Nervus glosopharyngeus – glossopharyngeal nerve***
- X. Nervus vagus – vagus nerve***
- XI. Nervus accesorius – accessory nerve***
- XII. Nervus hypoglossus – hypoglossal nerve***

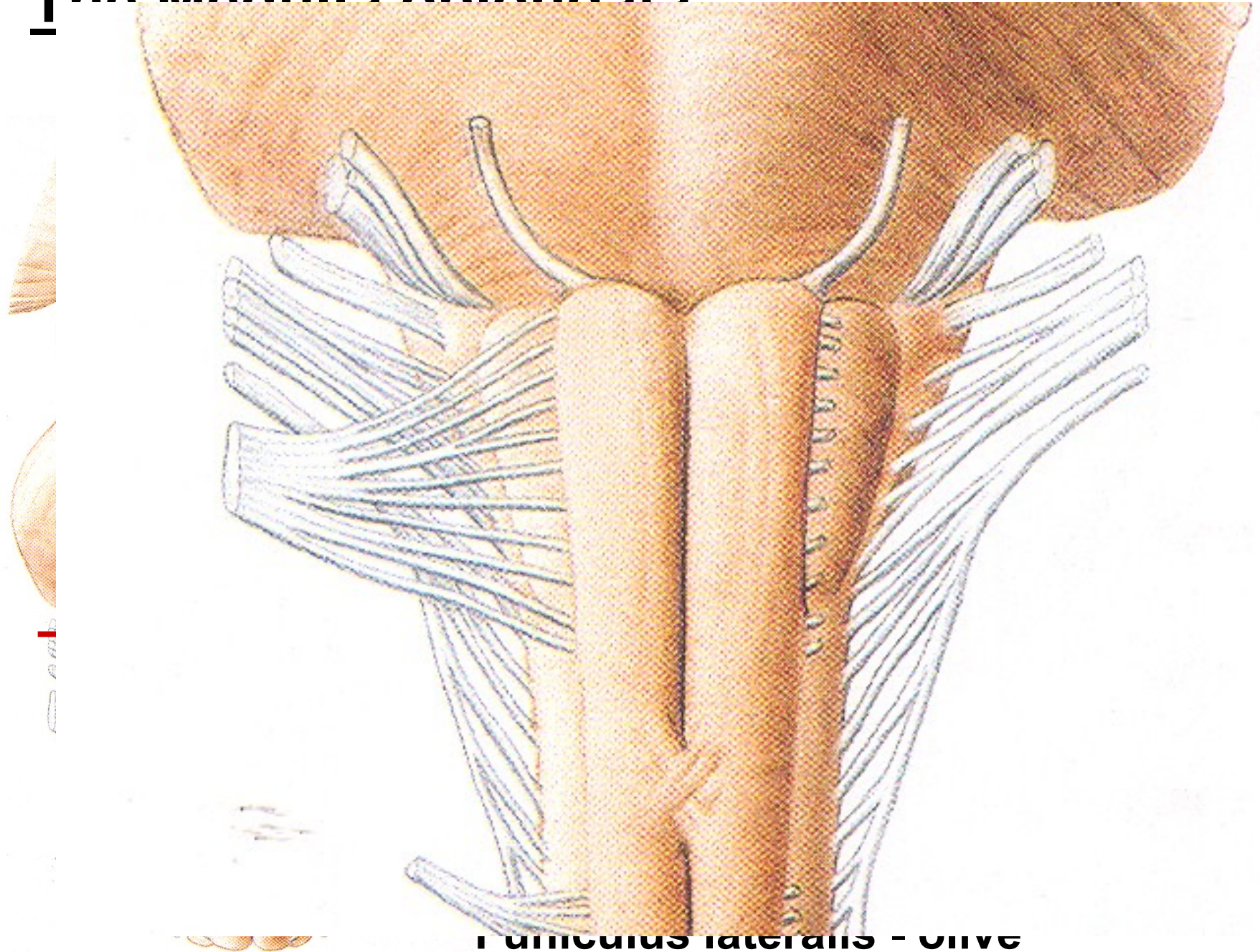








# The Medulla oblongata



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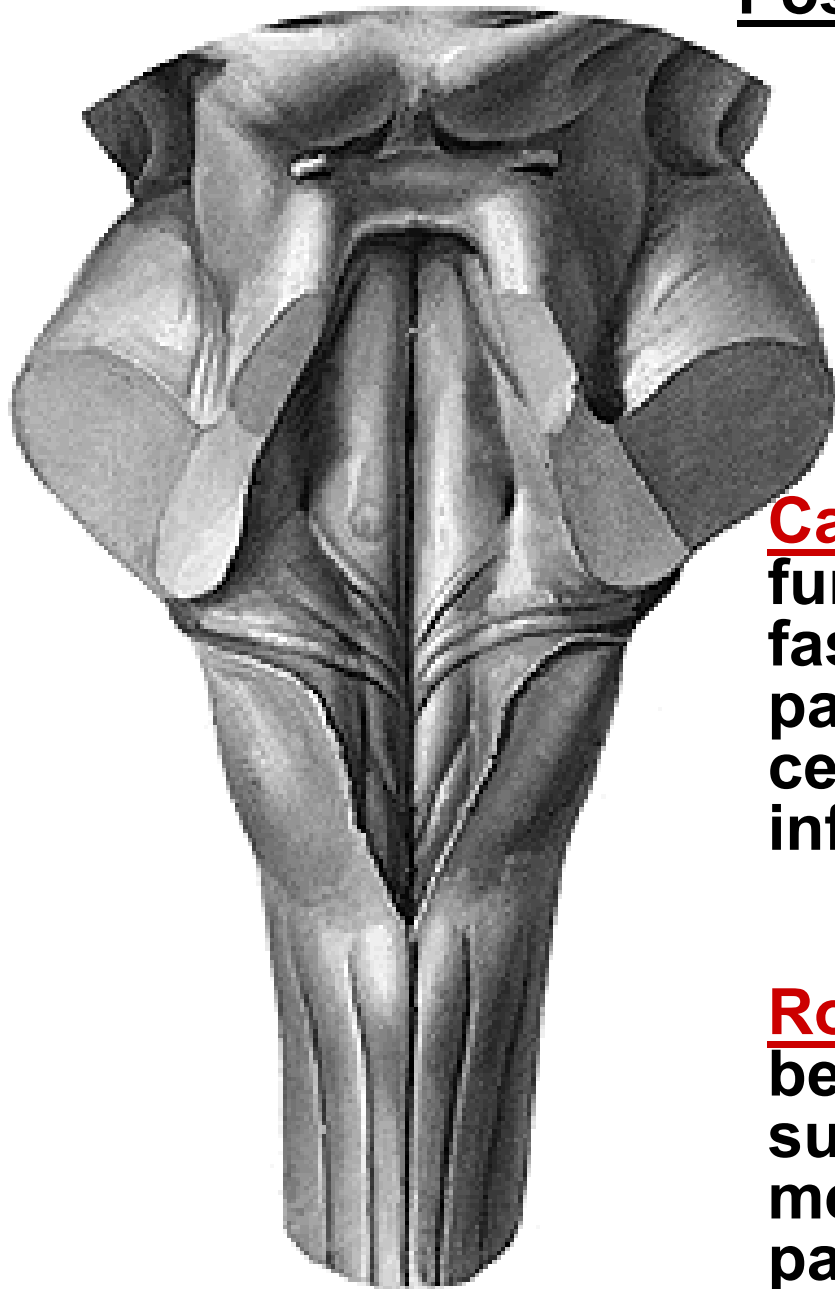
of

-

es

**Trunculus lateralis - Olive**

## Posterior side of medulla oblongata



### Caudal:

funiculi posteriores (parts - fasciculus gracilis and cuneatus) pass into inferior peduncles of cerebellum (pedunculi cerebellares inferiores)

### Rostral:

between divergent inferior and superior peduncles of cerebellum, medulla oblongata forms caudal part of floor of IV. brain ventricle



## Structure of medulla oblongata:

### 1. Grey matter

- Nuclei of cranial nerves (XII.- IX.)
- reticular formation (RF): centres of vital reflexes, interconnection of particular parts of CNS, activating and inhibitory system, motion automatism
- sensory nuclei (ncl. gracilis, cuneatus)

### 2. White matter (contains sensory and motor pathways)

- funiculus anterior (especially motor pathways e.g. pyramidal tract)
- funiculus lateralis (contains e.g. Tracts to cerebellum)
- funiculus posterior (contains especially sensory pathways )



**PONS**

**MIDDLE  
CEREBELLAR  
PEDUNCLE**

**MIDDLE  
CEREBELLAR  
PEDUNCLE**

**OLIVE**

**PIRAMID**

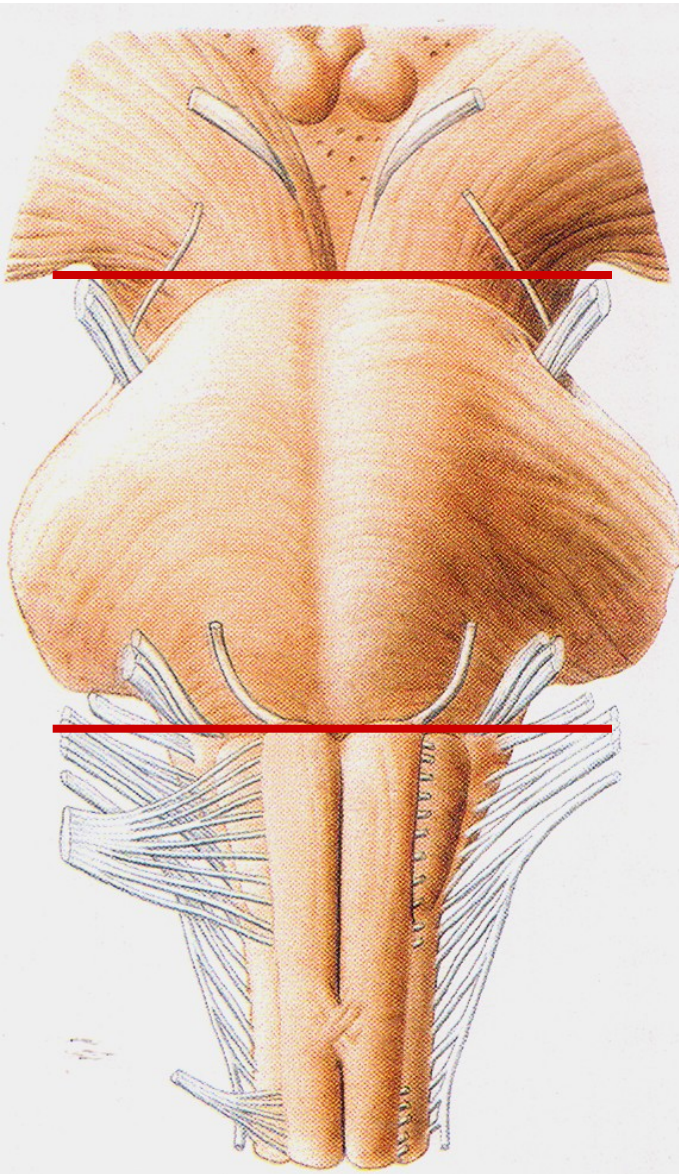
**PIRAMID**

**OLIVE**

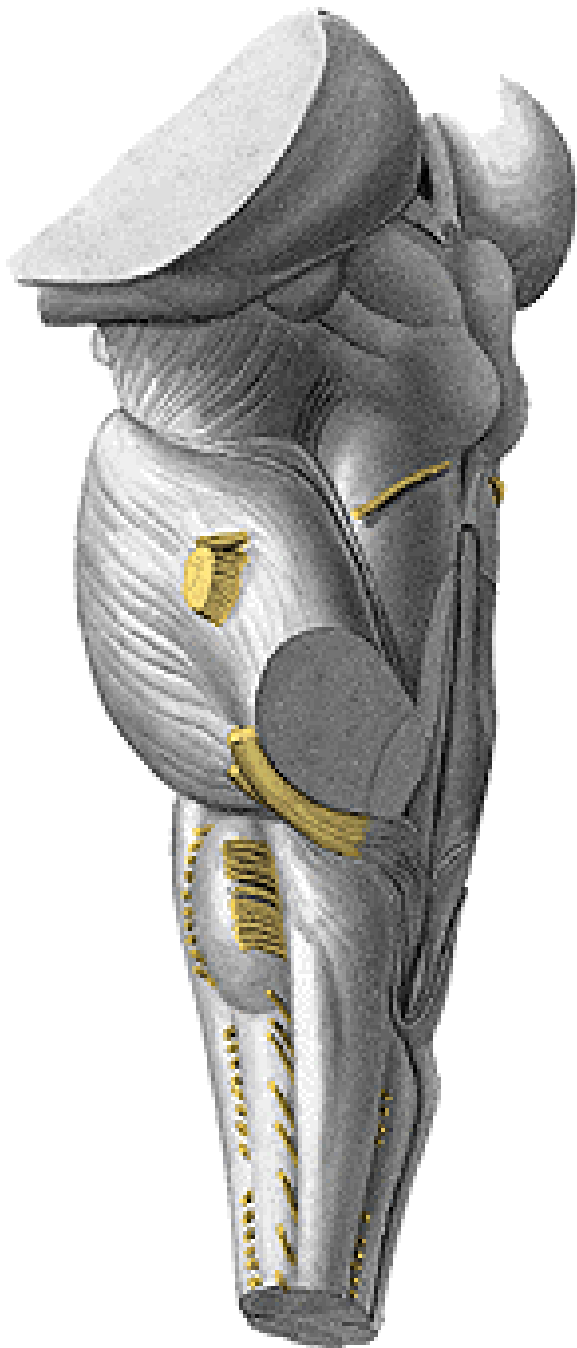
**MEDULLA  
OBLONGATA**



## The pons (Pons Varoli)

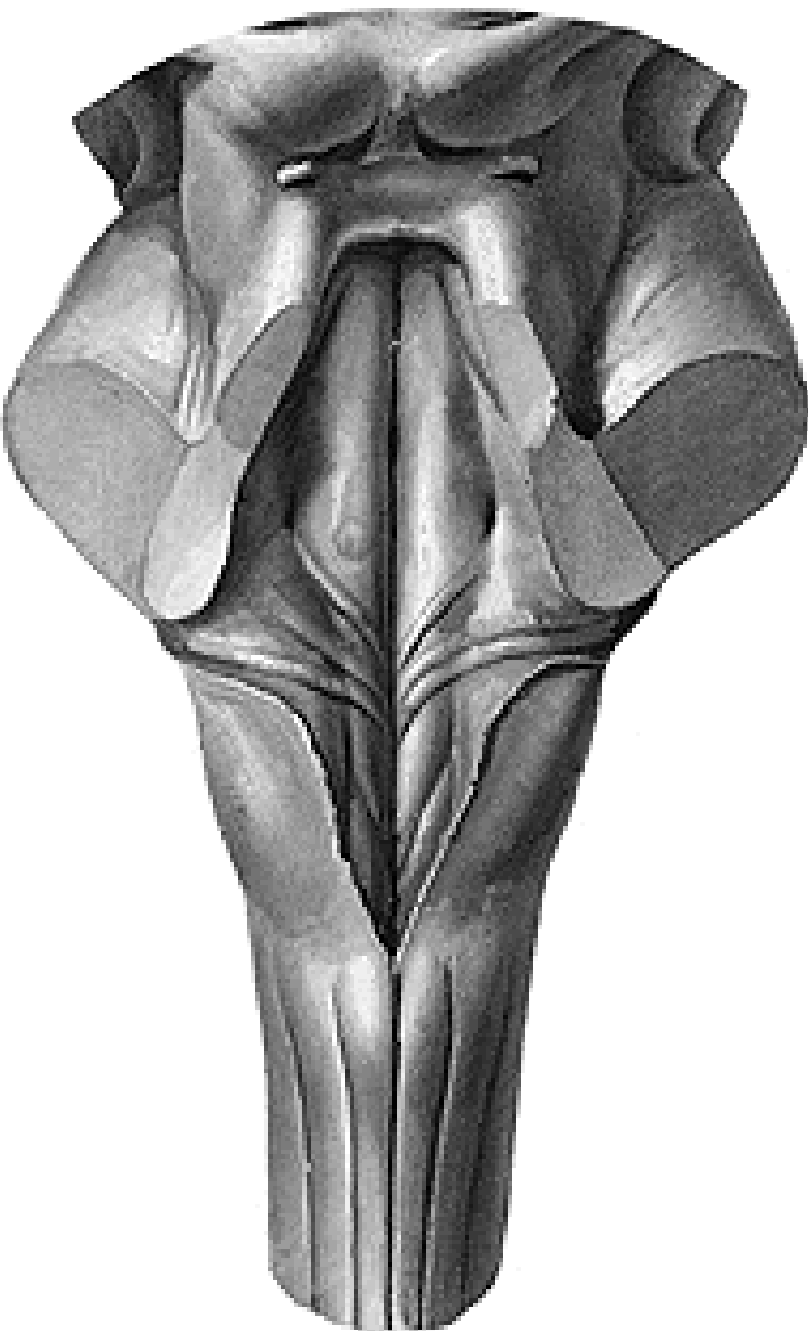


- **Transverse rampart between medulla oblongata and midbrain (length circa 25 mm)**
- **In the median plane sulcus basilaris passes (for a. basilaris)**
- **In the groove between pons and medulla oblongata, VI. – VIII. cranial nerves arise**
- **Pons passes laterally into middle peduncles of cerebellum (pedunculi cerebellares medii)**
- **between pons and pedunculi cerebellares medii, there is V. cranial nerve arising**



## Lateral side of the pons

- Middle peduncle (pedunculus cerebellaris medius) with output of n. V.
  - especially motor pathways



## Dorsal side of the pons

between pedunculi cerebellares medii. There is middle part of floor of IV. brain ventricle

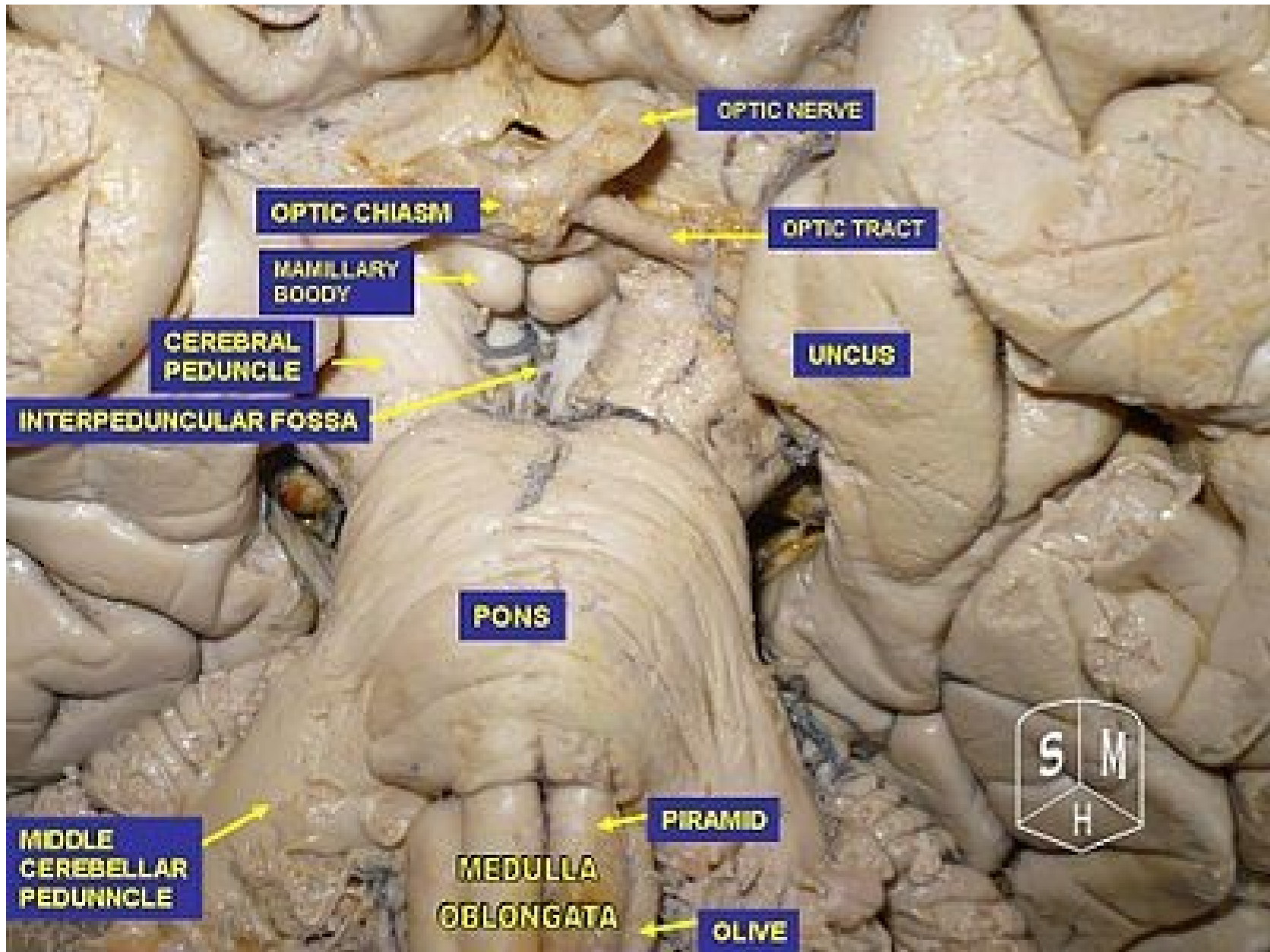
## Struktura pons Varoli

### 1. Grey matter

- nuclei of cranial nerves (VIII. – V.)
- reticular formation (RF)

### 2. White matter

contains sensory and motor pathways (tracts of voluntary and involuntary movements)



OPTIC NERVE

OPTIC CHIASM

OPTIC TRACT

MAMILLARY BOODY

CEREBRAL PEDUNCLE

UNCUS

INTERPEDUNCULAR FOSSA

PONS

MIDDLE CEREBELLAR PEDUNNACLE

PIRAMID

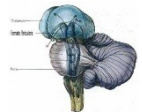
MEDULLA OBLONGATA

OLIVE



# FORMATIO RETICULARIS

- It belongs to the phylogenetically oldest structures of CNS
- It is interconnected with all sections of CNS
- Basic stereotypes (walk, sleep)
- It significantly influences wakefulness, tiredness and motivation
- It is located centrally and dorsally within the brain stem, especially within the pons
- ***ascending activation system*** → waking from sleep, maintaining wakefulness
- ***descending activation system***
- ***Interruption of retikulární formace*** → blackout
- RF provides complex interconnection of cranial nerves between each other and with other areas, it provides vital reflexes since birth (blink, lachrymal, cough, sucking, salivation, swallowing...)



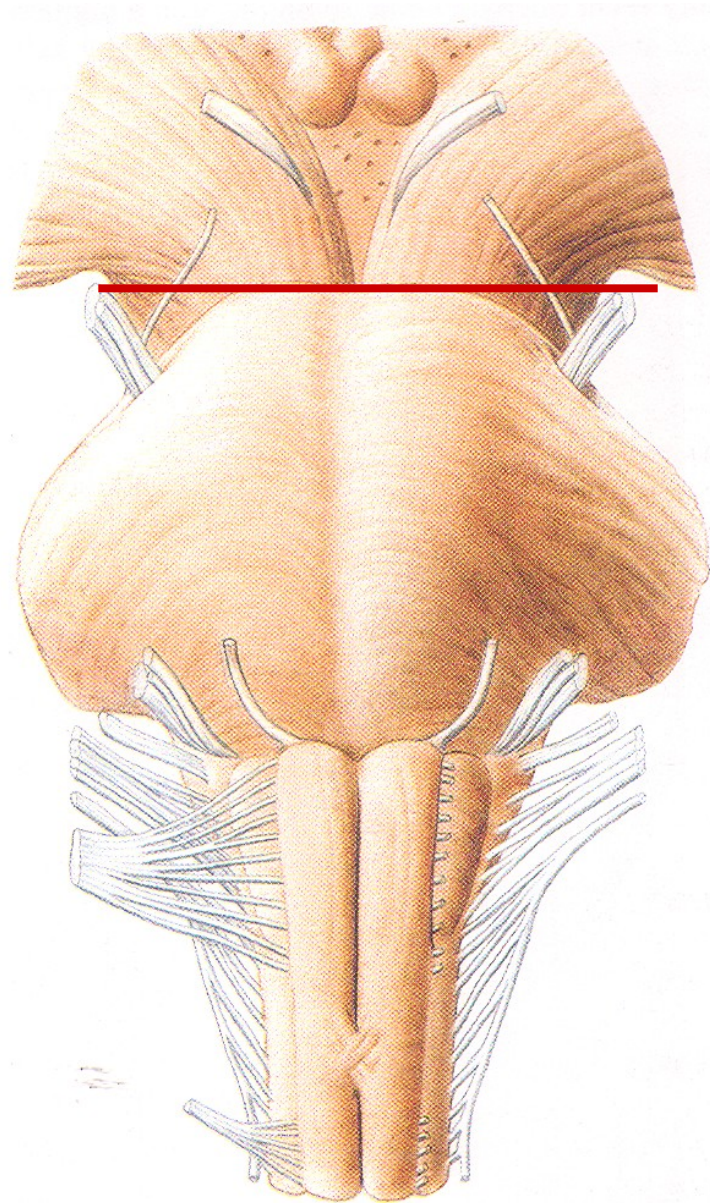
## The midbrain (mesencephalon)

- located between pons and diencephalon

### Ventral side of the midbrain

**crura cerebri** – two ramparts of white matter (motor pathways)

detachment of III. cranial nerve within groove between crura cerebri and fossa interpeduncularis





## Dorsal side of the midbrain

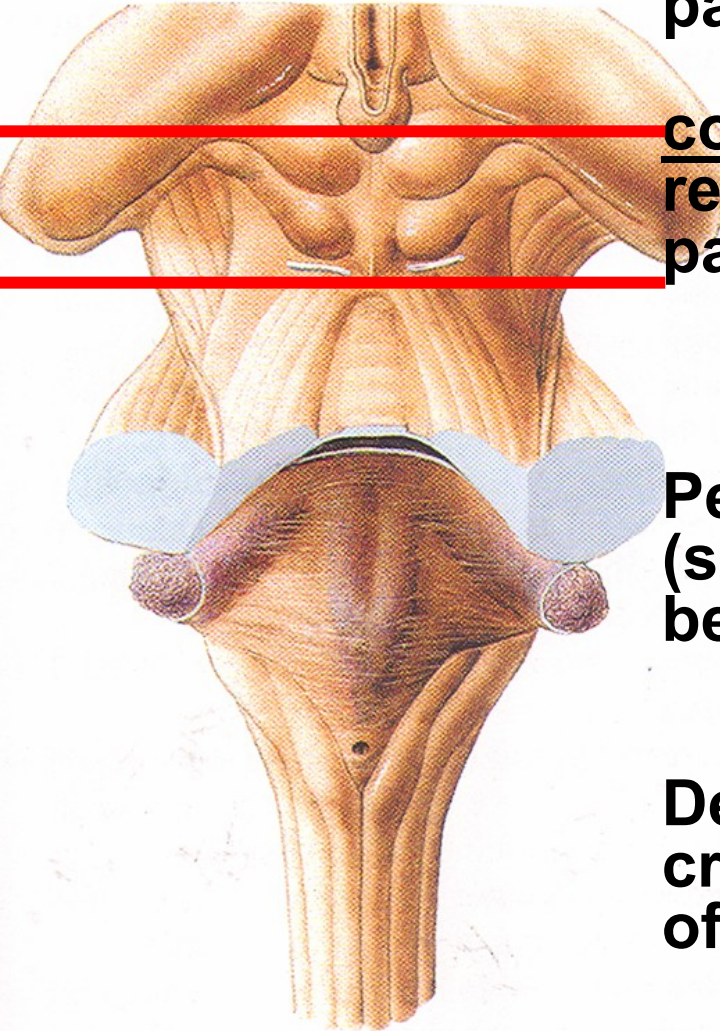
### **corpora quadrigemina**

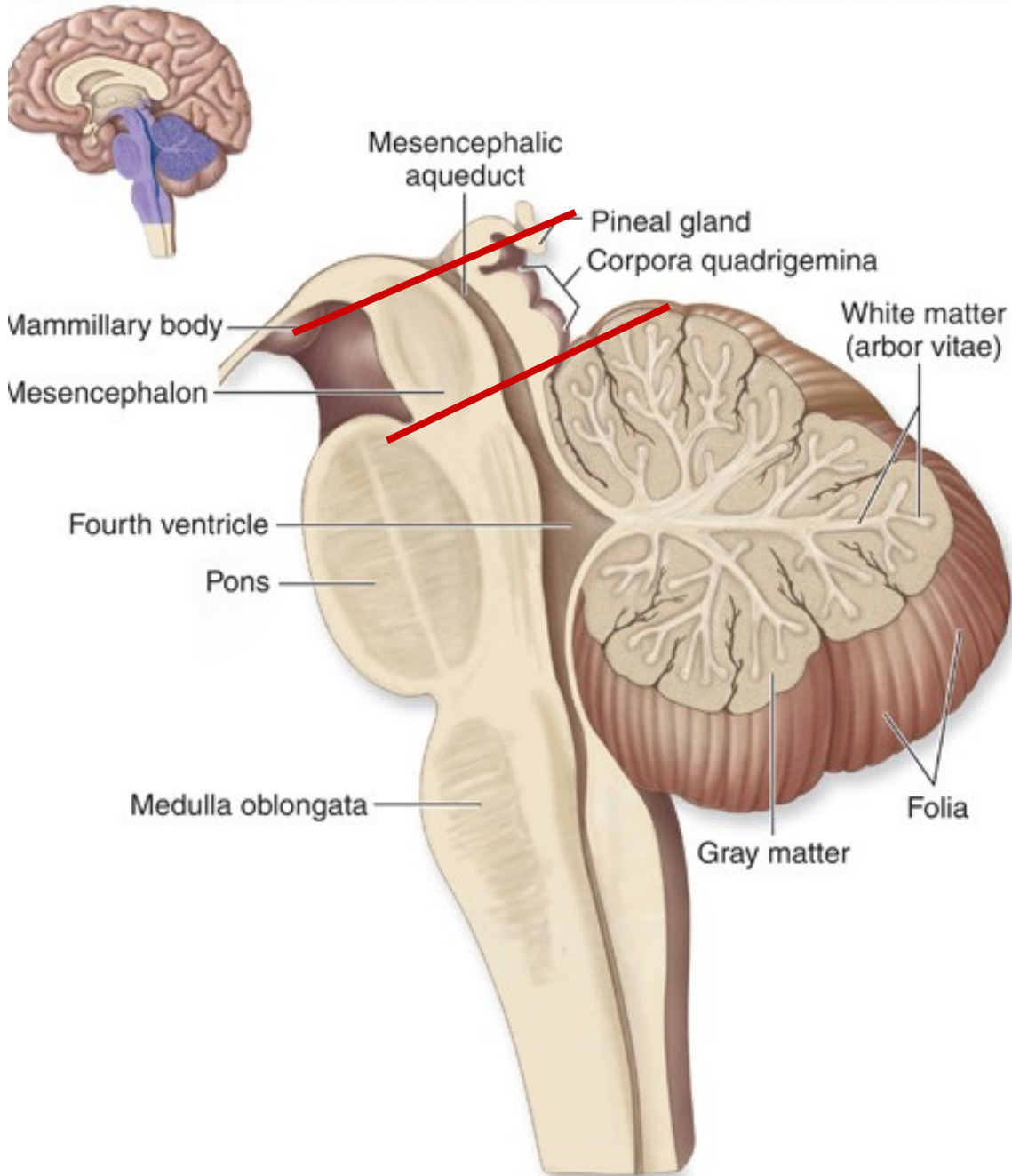
colliculi superiores (optical-motor reflexes) connection to the visual pathway

colliculi inferiores (acoustic-motor reflexes) connection to the auditory pathway

**Pedunculi cerebellares superiores** (superior peduncles of cerebellum) between them – roof of IV. brain ventricle

**Detachment of IV. cranial nerve**– only cranial nerve that arises from dorsal side of brain stem



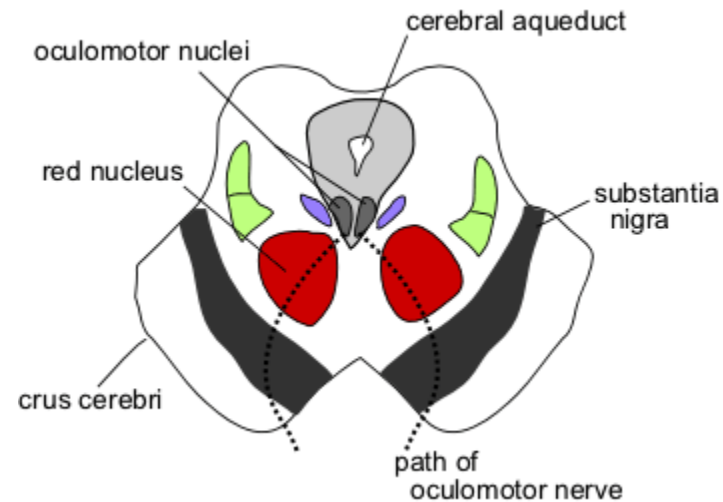
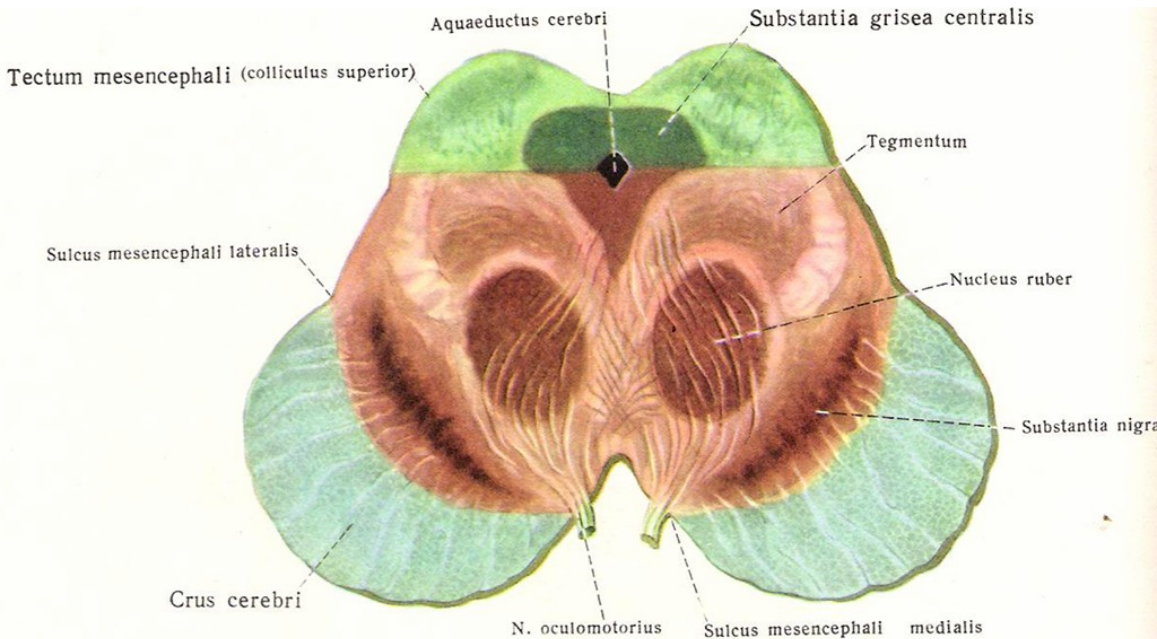


(a) Midsagittal section

# Structure of the midbrain

Three parts:

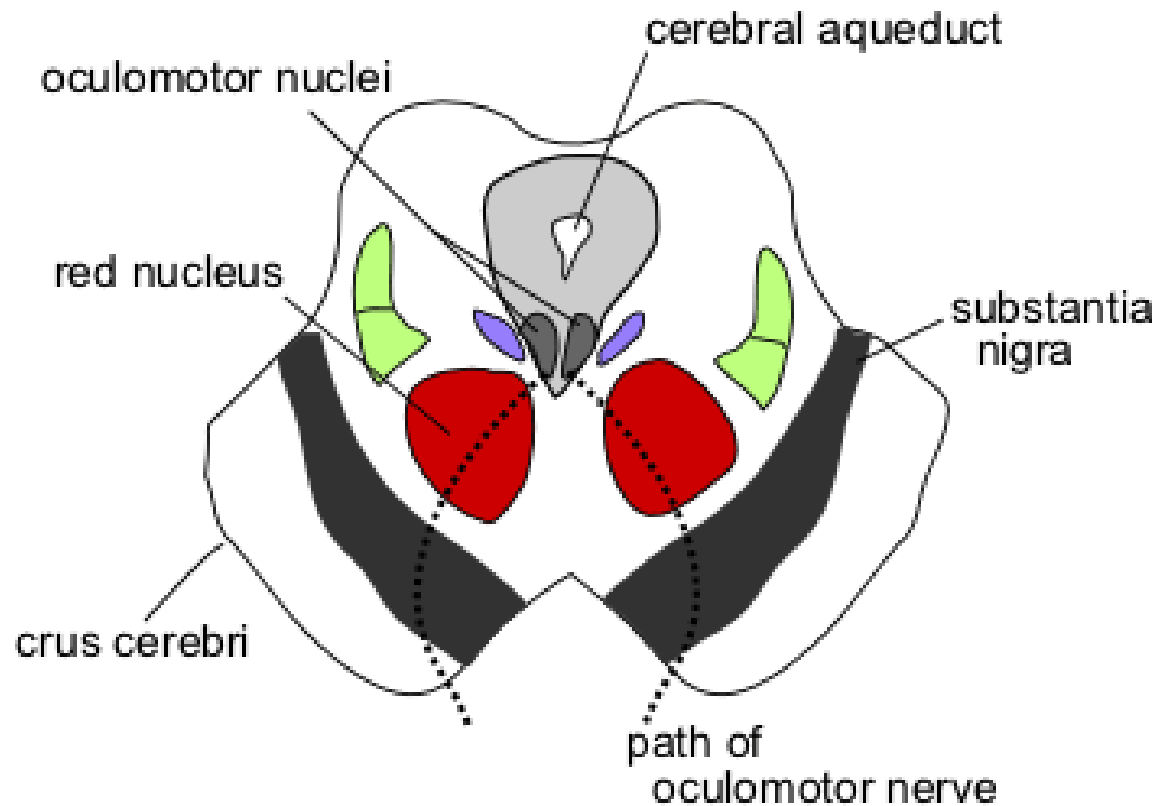
- 1. Tectum** – corpora quadrigemina (centre of optical–motor and acoustic–motor reflexes)
- 2. Tegmentum** – middle part- contains RF, nuclei of III. and IV. cranial nerves, nucleus ruber (red nucleus– motion control), substantia nigra (black substance – motion control)
- 3. Crura cerebri** – anterior part, white matter, motor pathways (descending tracts – corticospinal, corticonuclear)



# The midbrain (střední mozek)

source of III. and IV. cranial nerves

- centre of optical–motor and acoustic–motor reflexes, its nuclei provide coordinated movements of eyes and head



## Fossa rhomboidea

Floor of IV. brain ventricle, rhombus shaped  
Nuclei of III. – XII. cranial nerves

parts:

1. **pars superior**

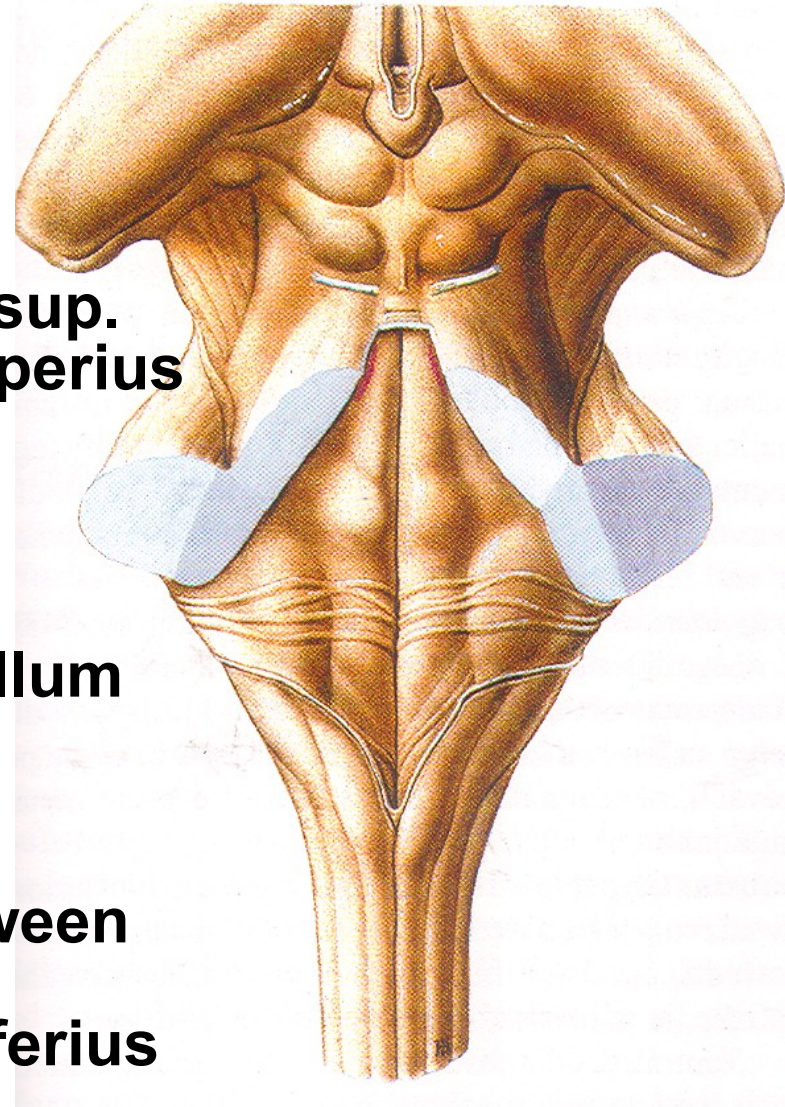
between pedunculi cerebellares sup.  
covered with velum medullare superius

2. **pars intermedia**

dorsal side of pons between  
pedunculi cerebellares med.  
covered with fastigium of cerebellum

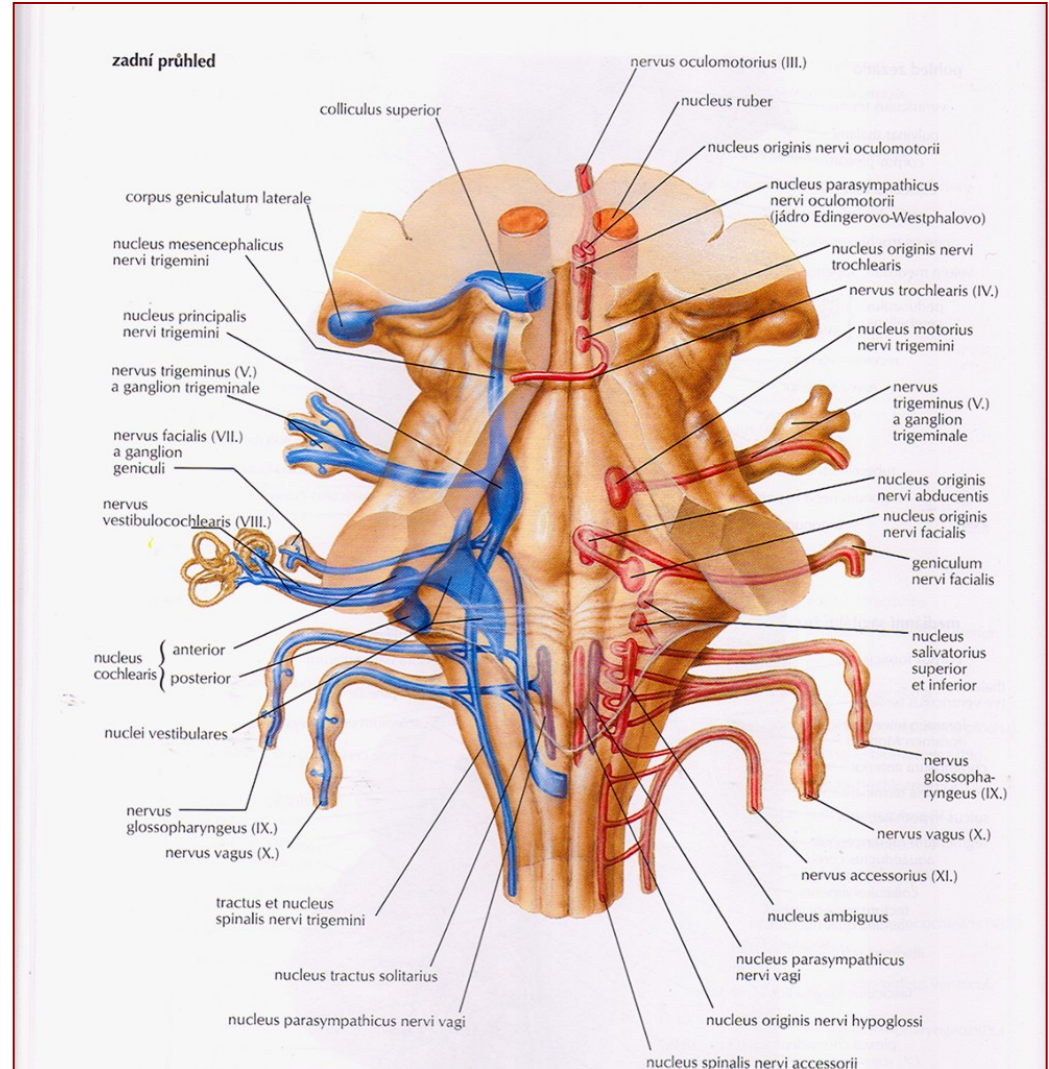
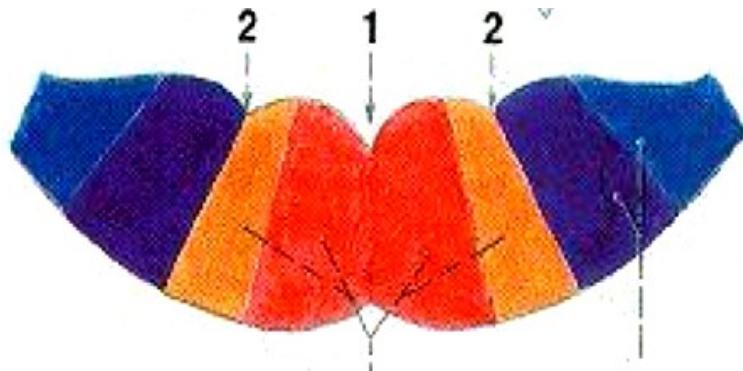
3. **pars inferior**

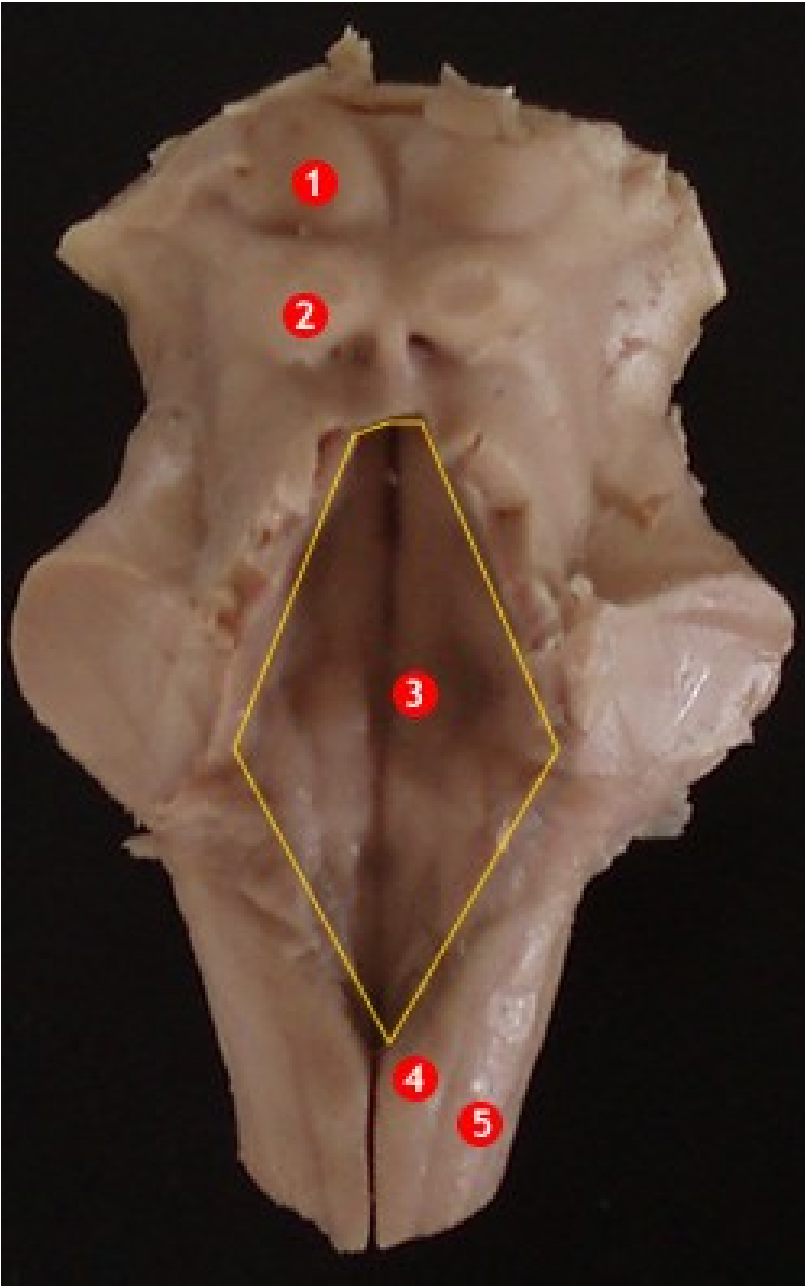
dorsal side of medulla obl. between  
pedunculi cerebellares inf.  
covered with velum medullare inferius



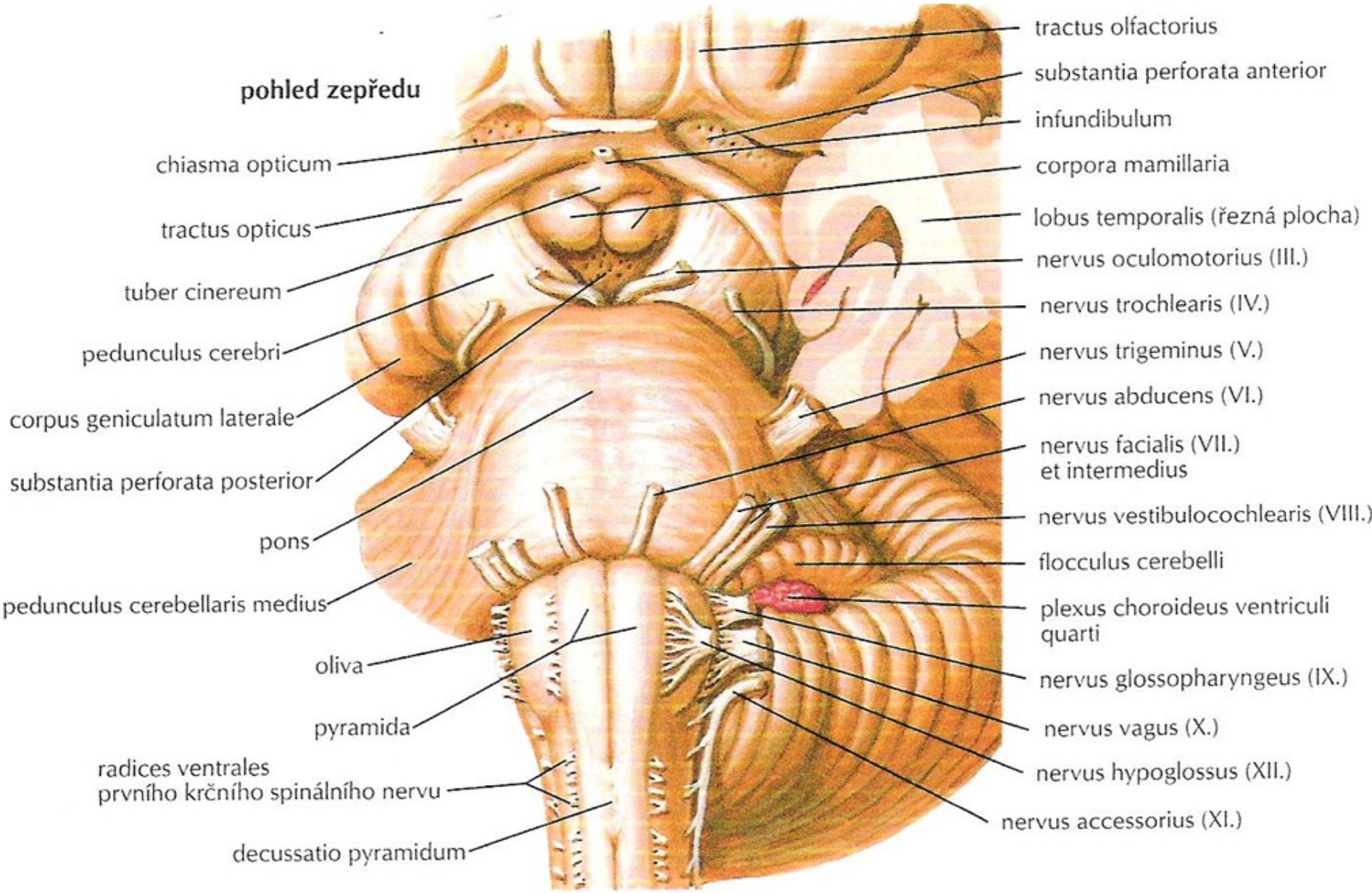
# Fossa rhomboidea builds on:

- **rostrally** on aquaeductus cerebri (channel between III. and IV. brain ventricle)
- **caudally** on canalis centralis of the spinal cord





**pohled zepředu**



chiasma opticum

tractus opticus

tuber cinereum

pedunculus cerebri

corpus geniculatum laterale

substantia perforata posterior

pons

pedunculus cerebellaris medius

oliva

pyramida

radices ventrales  
prvního krčního spinálního nervu

decussatio pyramidum

tractus olfactorius

substantia perforata anterior

infundibulum

corpora mamillaria

lobus temporalis (řezná plocha)

nervus oculomotorius (III.)

nervus trochlearis (IV.)

nervus trigeminus (V.)

nervus abducens (VI.)

nervus facialis (VII.)  
et intermedius

nervus vestibulocochlearis (VIII.)

flocculus cerebelli

plexus choroideus ventriculi  
quarti

nervus glossopharyngeus (IX.)

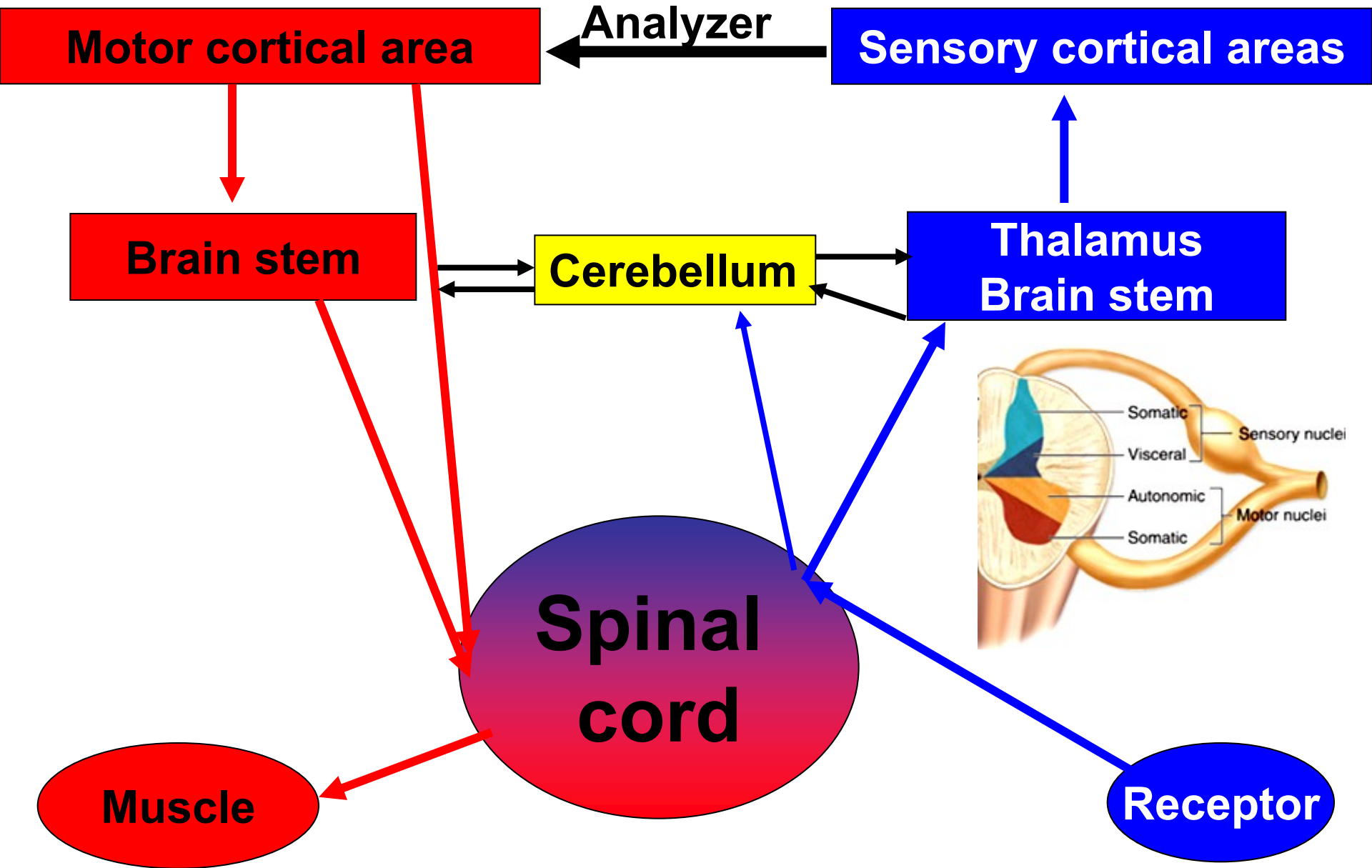
nervus vagus (X.)

nervus hypoglossus (XII.)

nervus accessorius (XI.)







# The cerebellum

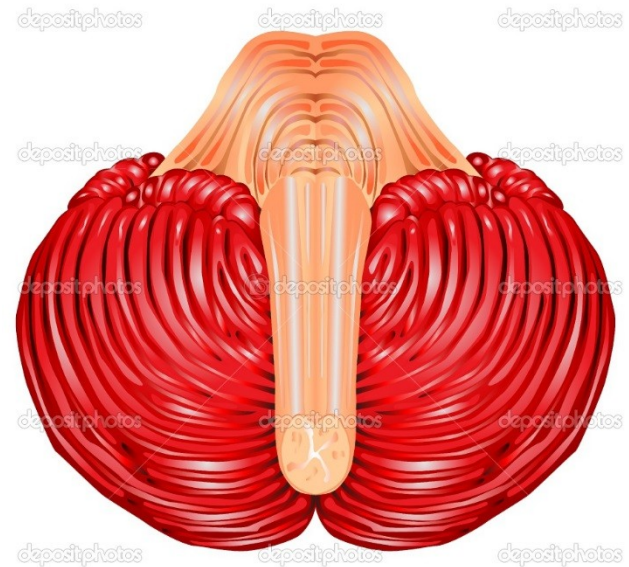
## **Functions:**

**Control of muscle tension of striated muscles, it provides upright posture, balance, it coordinates and specifies movements**

Is in parallel connected into system of motor pathways

important centre of proprioception

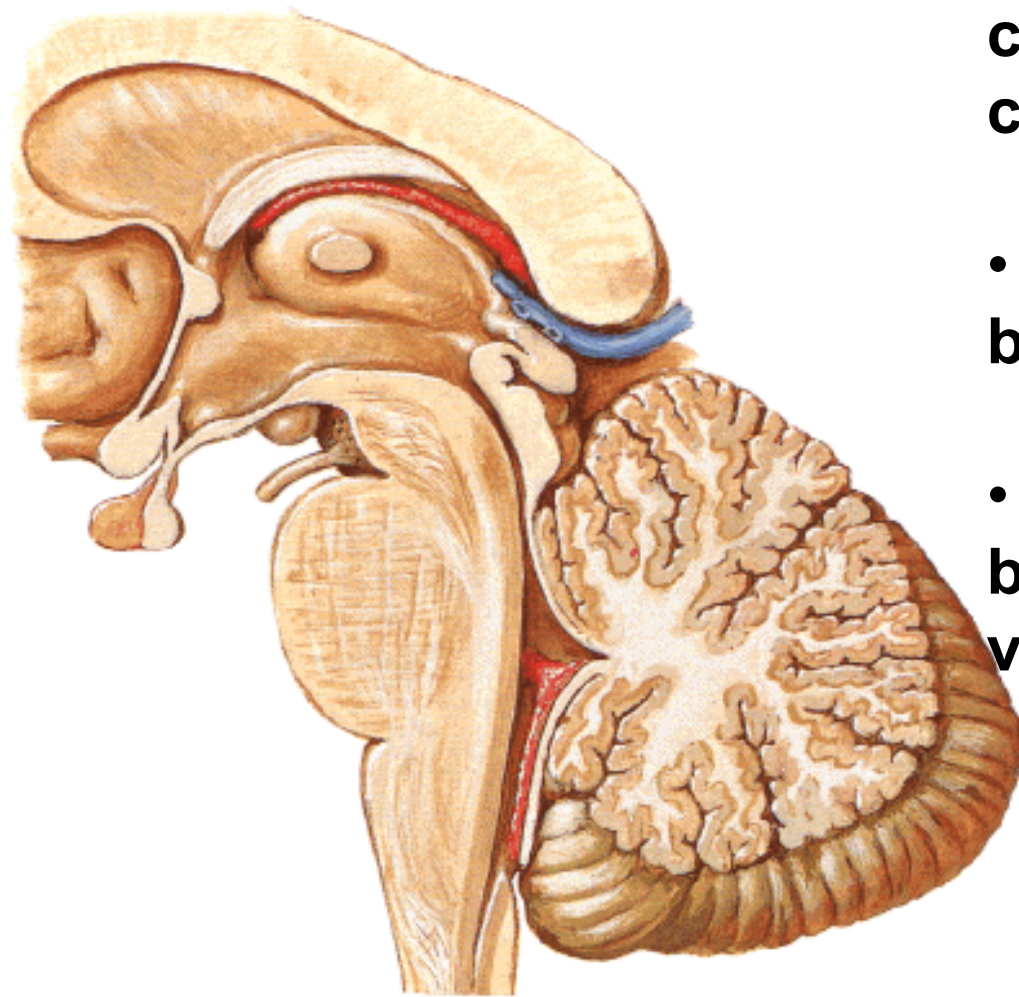
It provides precise coordination of movements



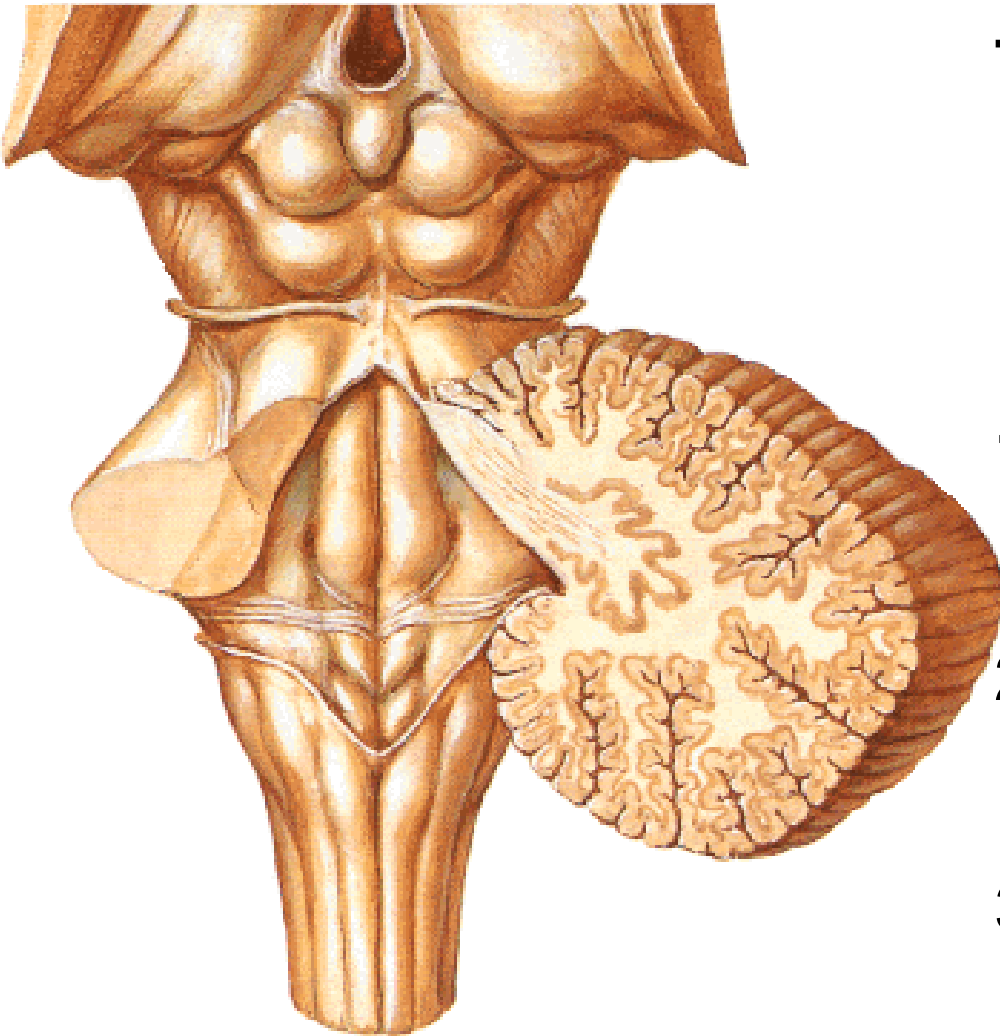
## **At failure:**

**Muscle weakness, unsure poise, uncoordinated walk on the wide base**

# **Te cerebellum**



- **it lies within posterior cranial fossa within fossae cerebellares of occipital bone**
- **it touches dorsal side of brain stem**
- **between cerebellum and brain stem, there is IV. Brain ventricle**



**The cerebellum is interconnected with the brain stem through three peduncles:**

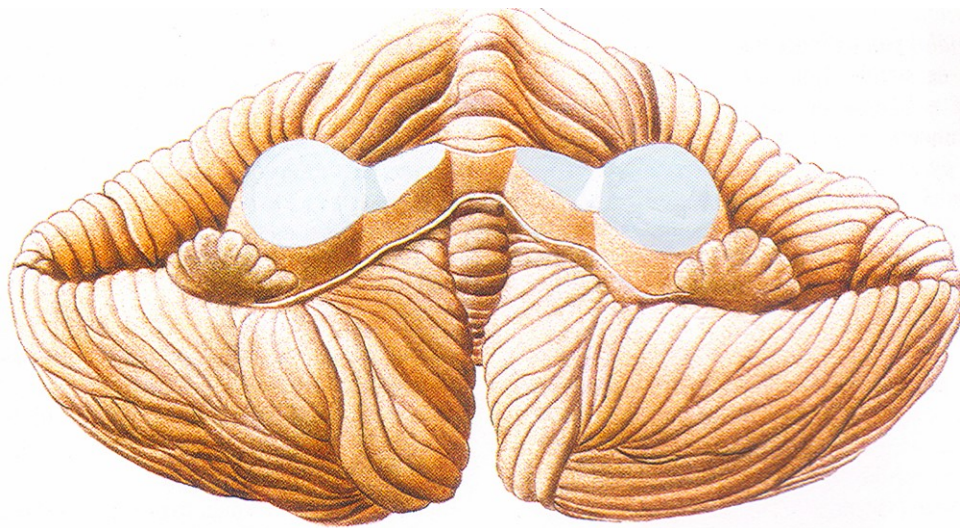
- 1. Pedunculi cerebellares superiores (with midbrain)**
- 2. Pedunculi cerebellares medii (with pons)**
- 3. Pedunculi cerebellares inferiores (with medulla oblongata)**

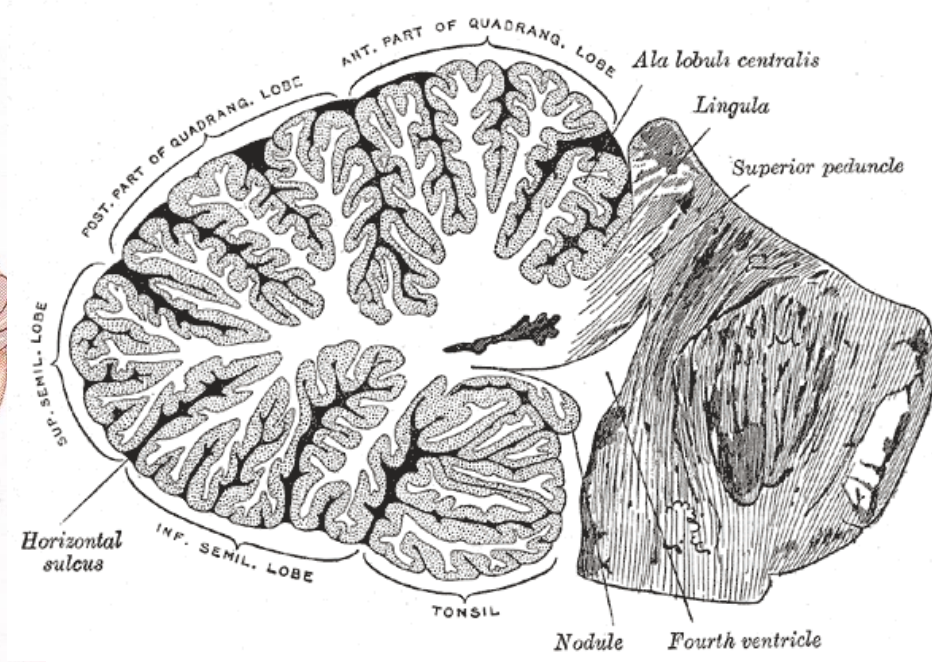
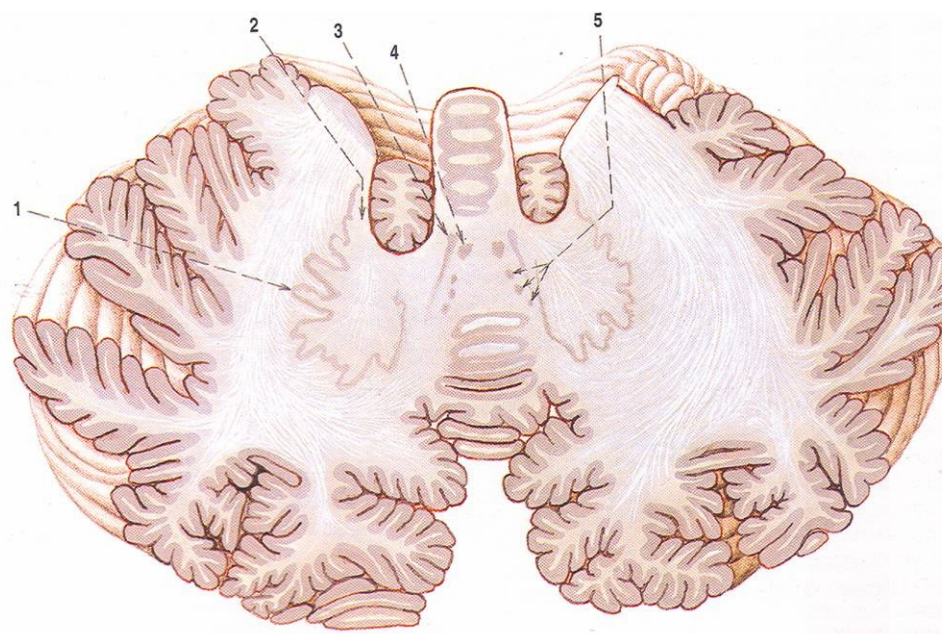
## Structure of the cerebellum:



1. worm - vermis cerebelli  
middle part

2. cerebellar hemispheres  
hemispheria cerebelli (lobus  
anterior, lobus posterior,  
floculus). On the surface of  
vermis and hemispheres,  
there are notches – sulci  
cerebelli, which separate  
particular threads - gyri  
cerebelli





## Grey matter of the cerebellum:

- cortex cerebelli – on the surface of hemispheres and vermis
- nuclei cerebelli – nuclei within cerebellum (ncl. fastigii, ncl. emboliformis, ncl. globosus, ncl. dentatus) involved into motion control system

## White matter of the cerebellum :

- Below the cortex, it creates characteristic drawing - arbor vitae (tree of life)

# Distribution of the cerebellum:

## **1. vestibular cerebellum (archicerebellum)**

- crucial for maintaining balance (information from vestibular apparatus)
- influence on motor nuclei within the spinal cord, which controls movement of axial muscles (erect posture)
- control of eye movement and their coordination with head movements

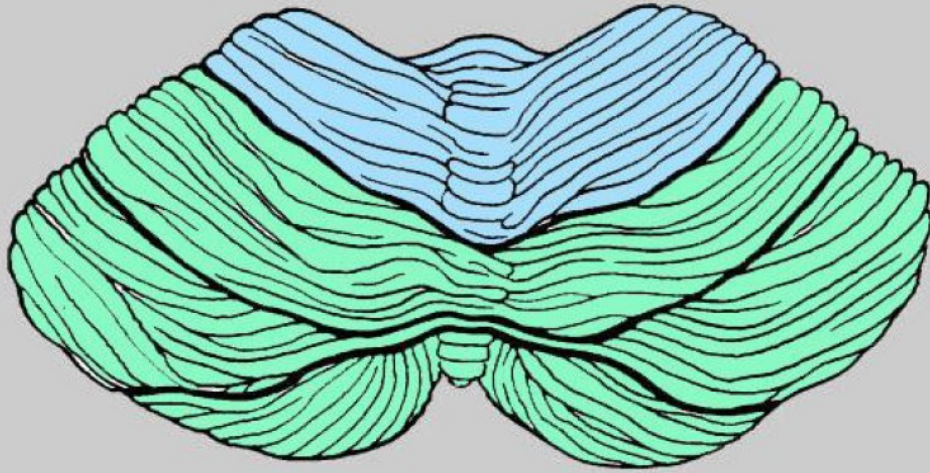
## **2. spinal cerebellum (palaeocerebellum)**

- Control of muscle tension and coordination of movements – regulation of movements

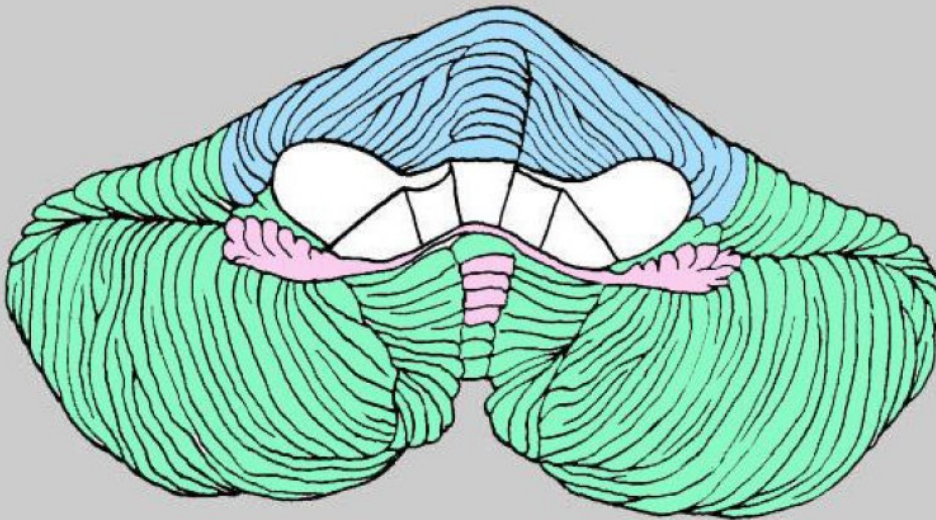
## **3. cerebral cerebellum (neocerebellum)**

- control of planning of movements
- control of voluntary movements in space and time



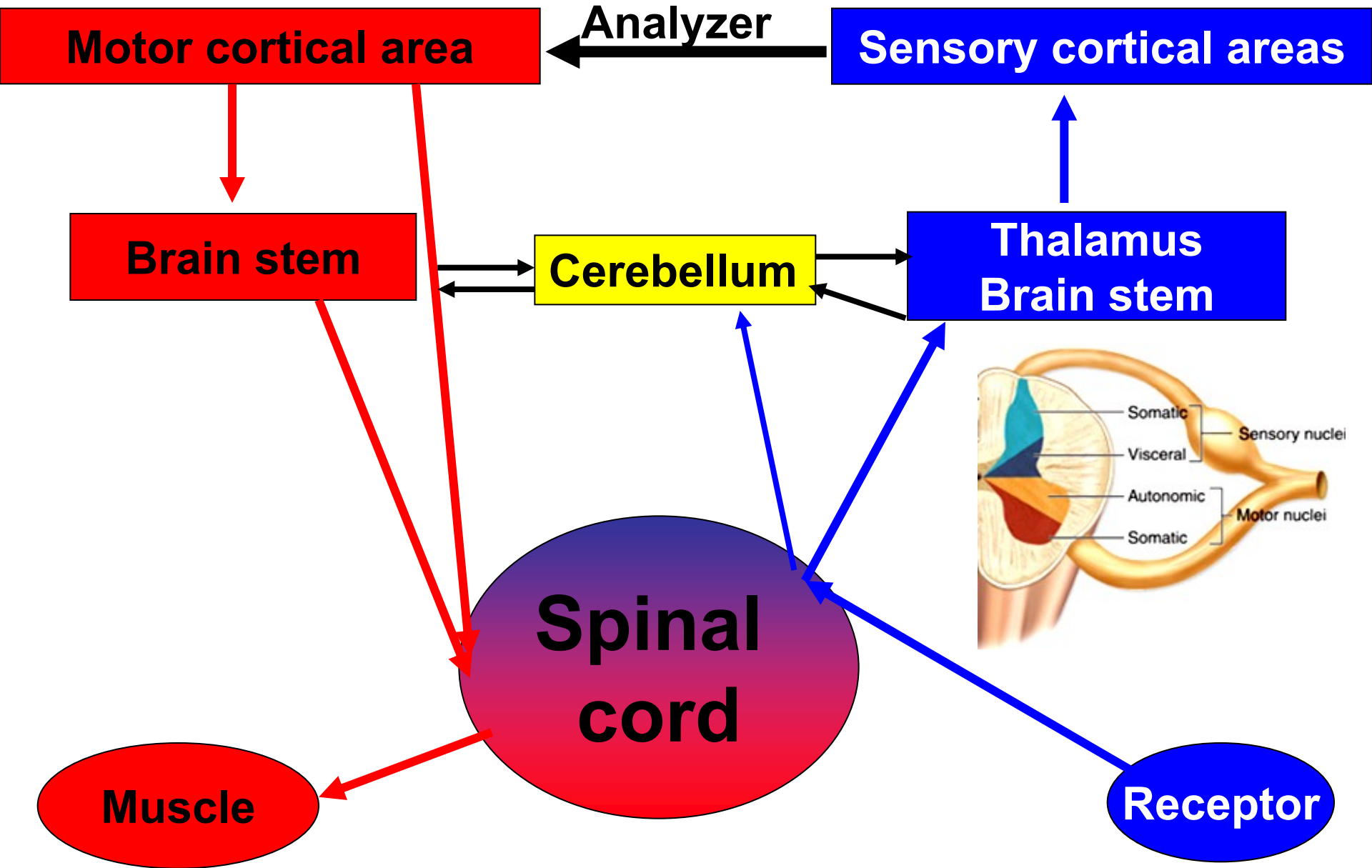


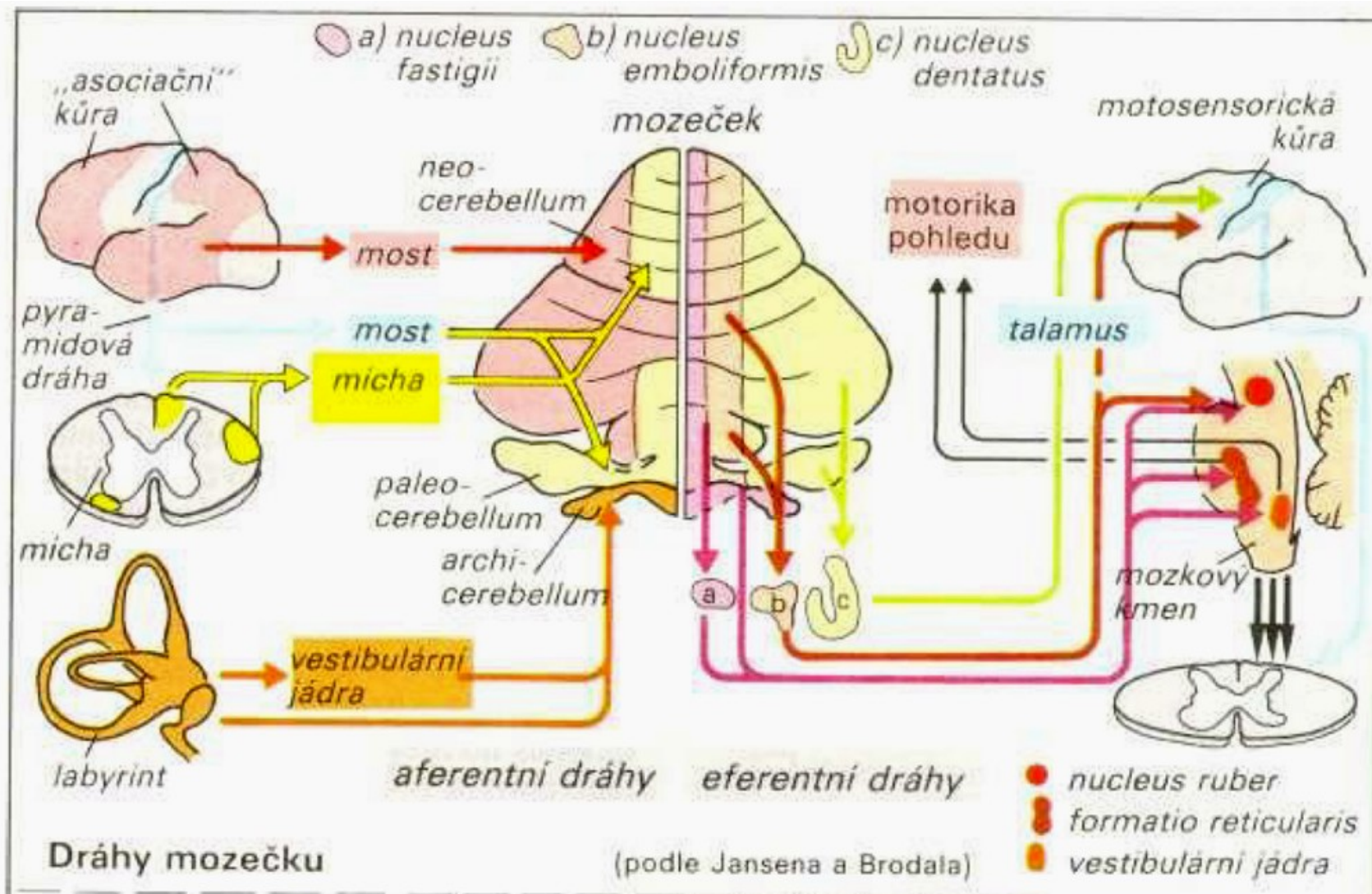
**Lobus anterior -  
spinocerebellum -  
paleocerebellum**



**Lobus posterior -  
pontocerebellum -  
neocerebellum**

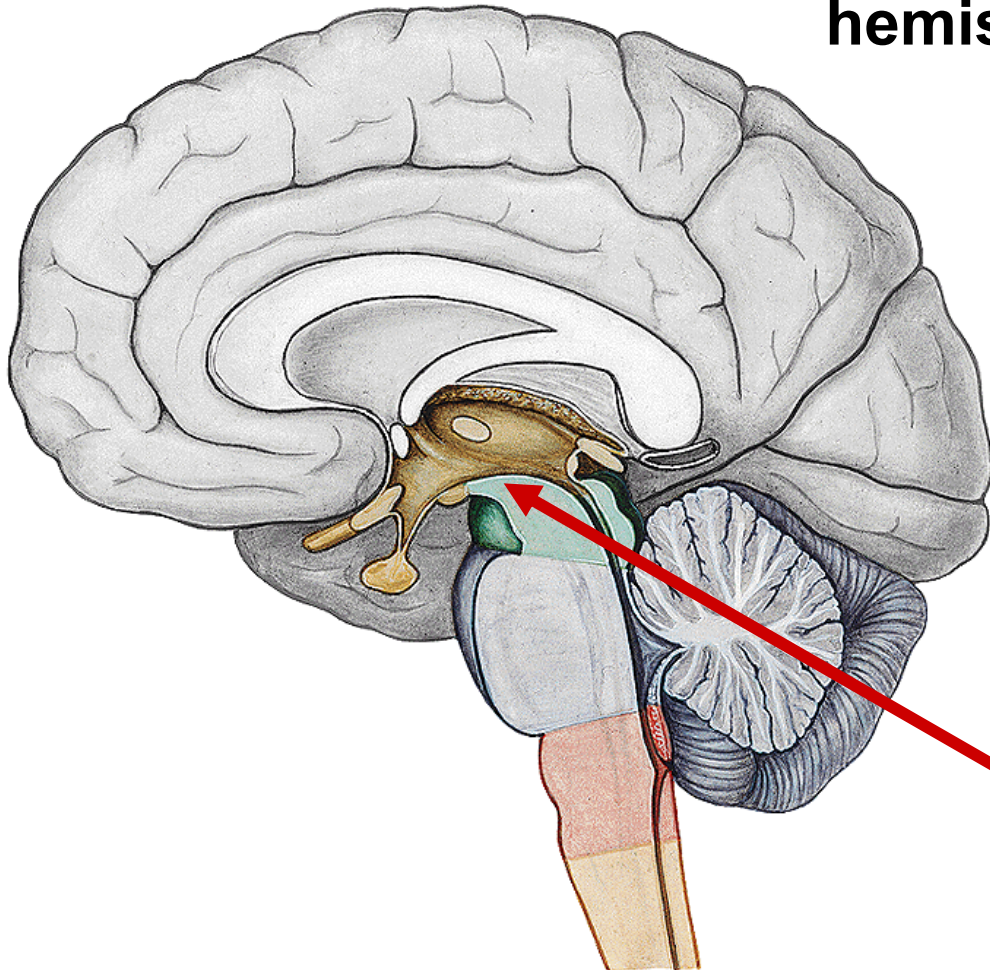
**Lobus  
floculonodularis -  
vestibulocerebellum  
- archicerebellum**





## The diencephalon

- builds on mesencephalon
- covered with cerebral hemispheres



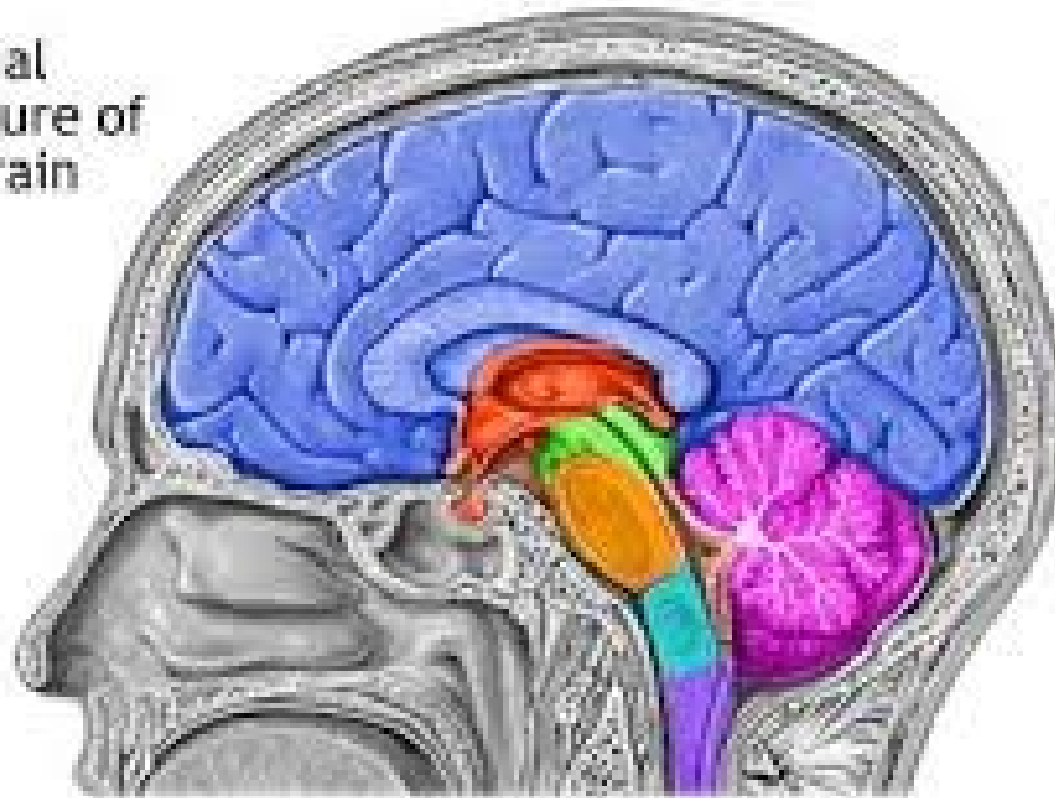
### Distribution of diencephalon:

**Thalamencephalon (thalamus) dorsal part**

**Hypothalamus - basal part (ventral part)**

**(sulcus hypothalamicus – separates both parts)**

## Internal structure of the brain



Spinal cord

Cerebellum

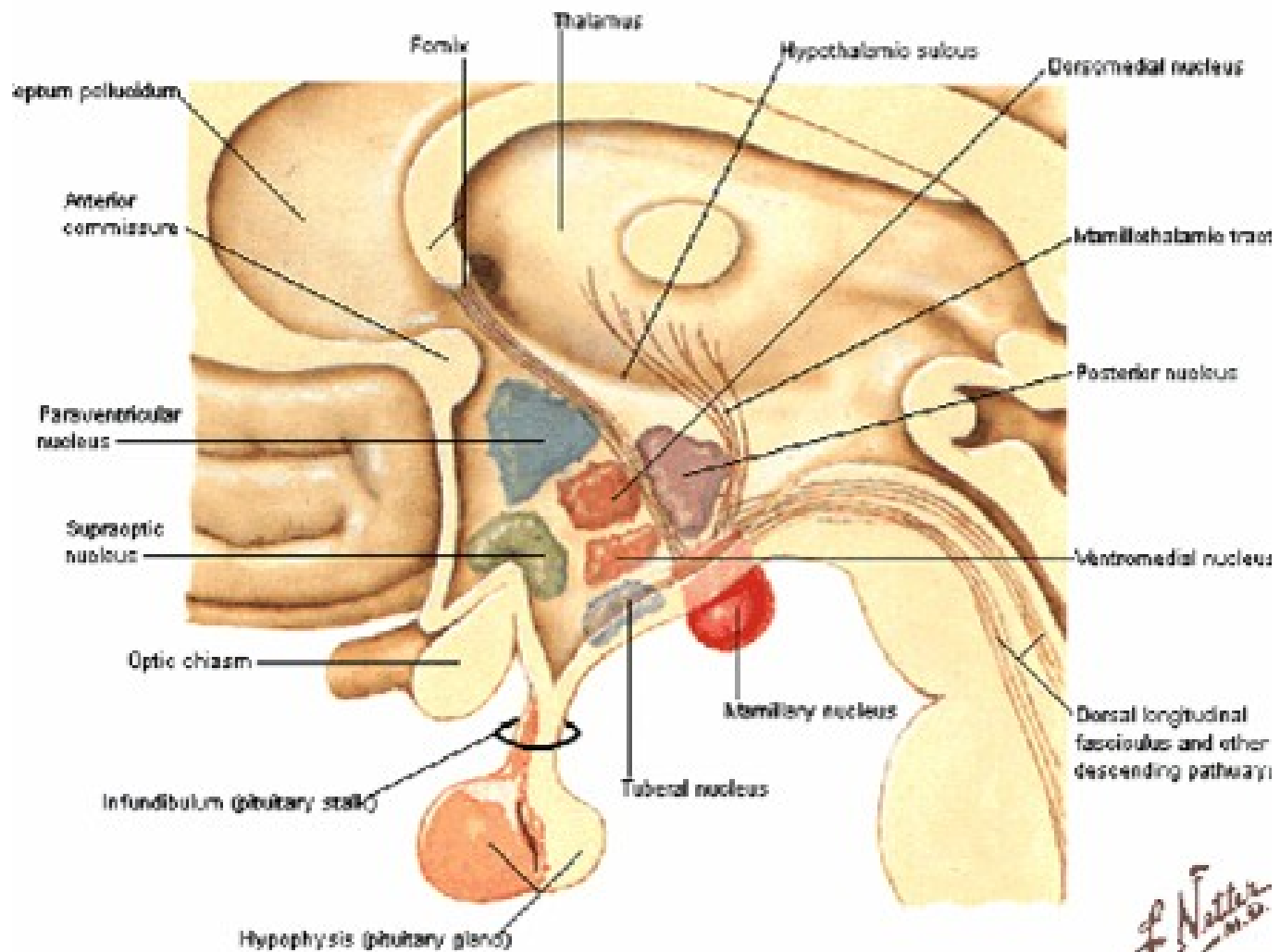
Diencephalon

Pons

Medulla Oblongata

Midbrain

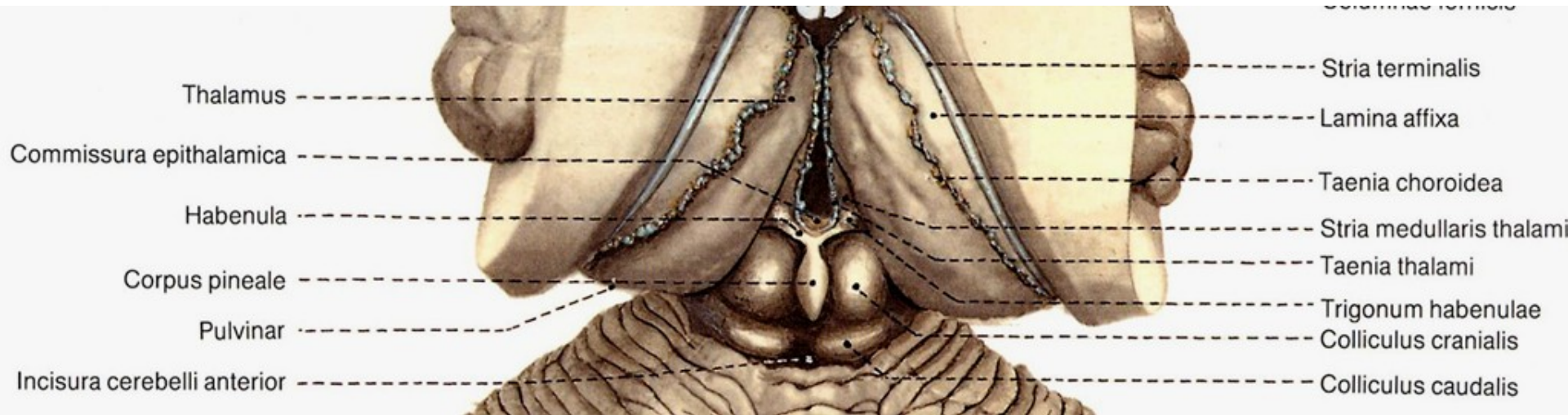
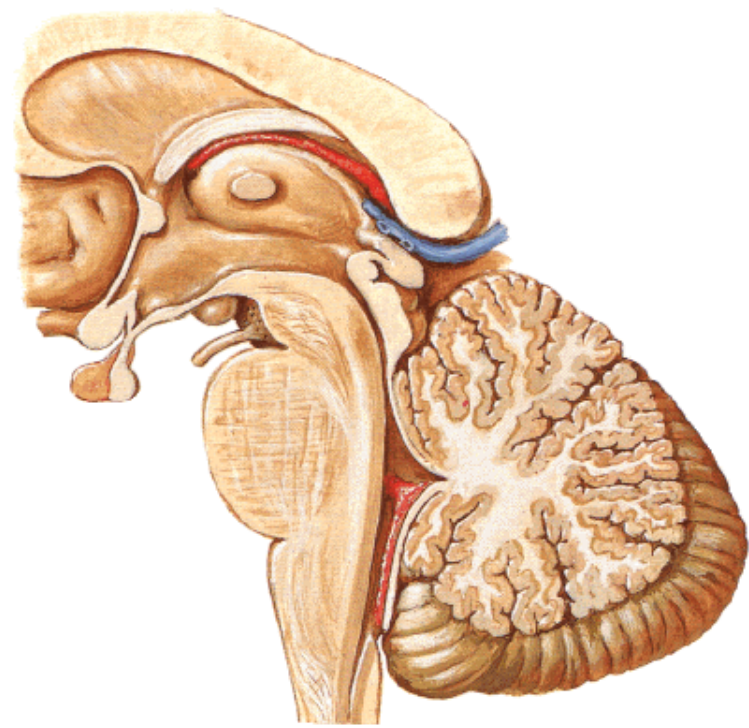
Cerebral hemisphere



*F. Natter*  
 2019

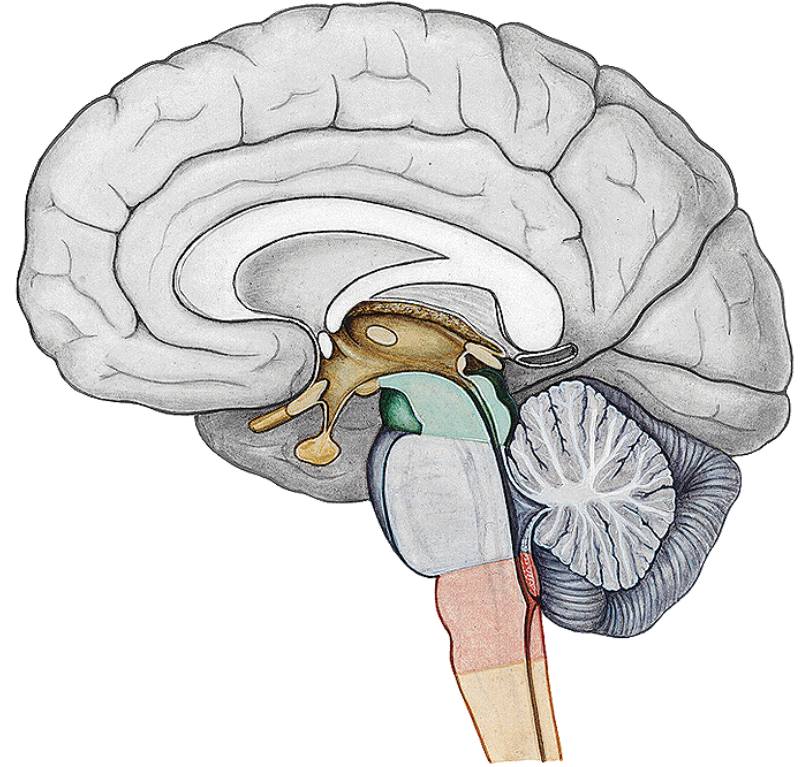
# Thalamencephalon:

1. **thalamus** – accumulation of grey matter on dorsal side of diencephalon (ovoid shape)
2. **epithalamus** – e.g. pineal gland, dorsal side of diencephalon
3. **metathalamus** - corpus geniculatum mediale and laterale
4. **subthalamus** – grey matter located below thalamus



# THALAMUS

- **Accumulation of grey matter (ovoid formation) (to its neurons come impulses from all sensory pathways except olfactory tract)**
- **It contains a large number of nuclei**
- **„gateway of consciousness“ – switching of all sensory pathways and control feedback motor pathways into cerebral cortex**

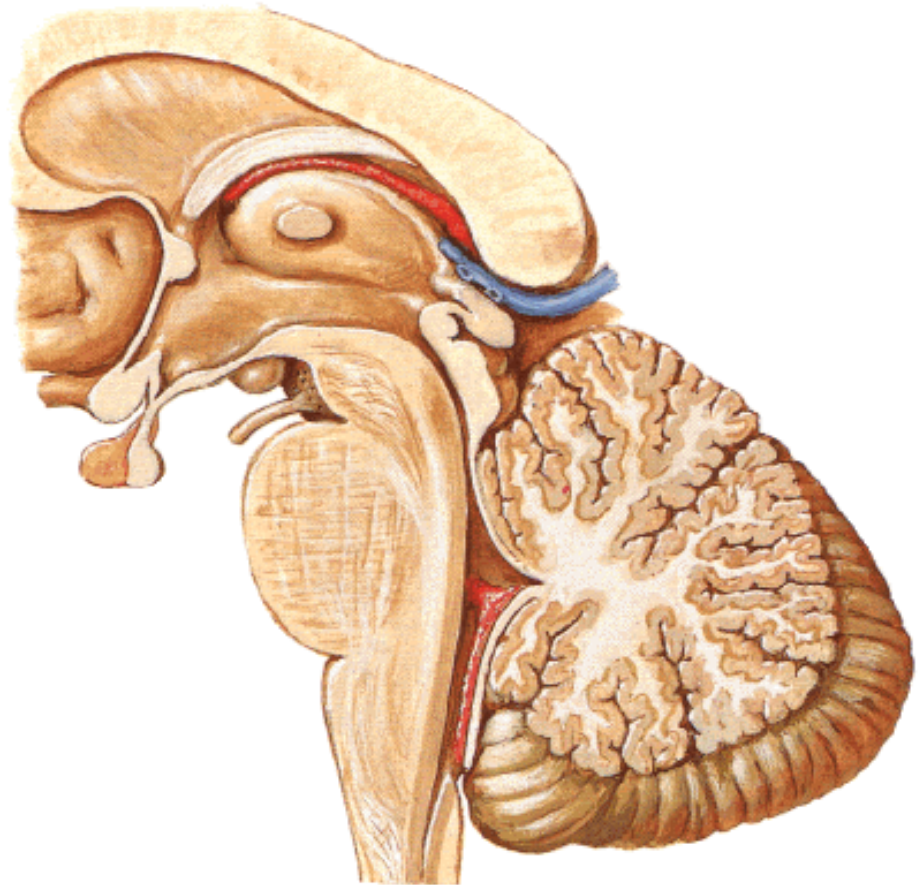




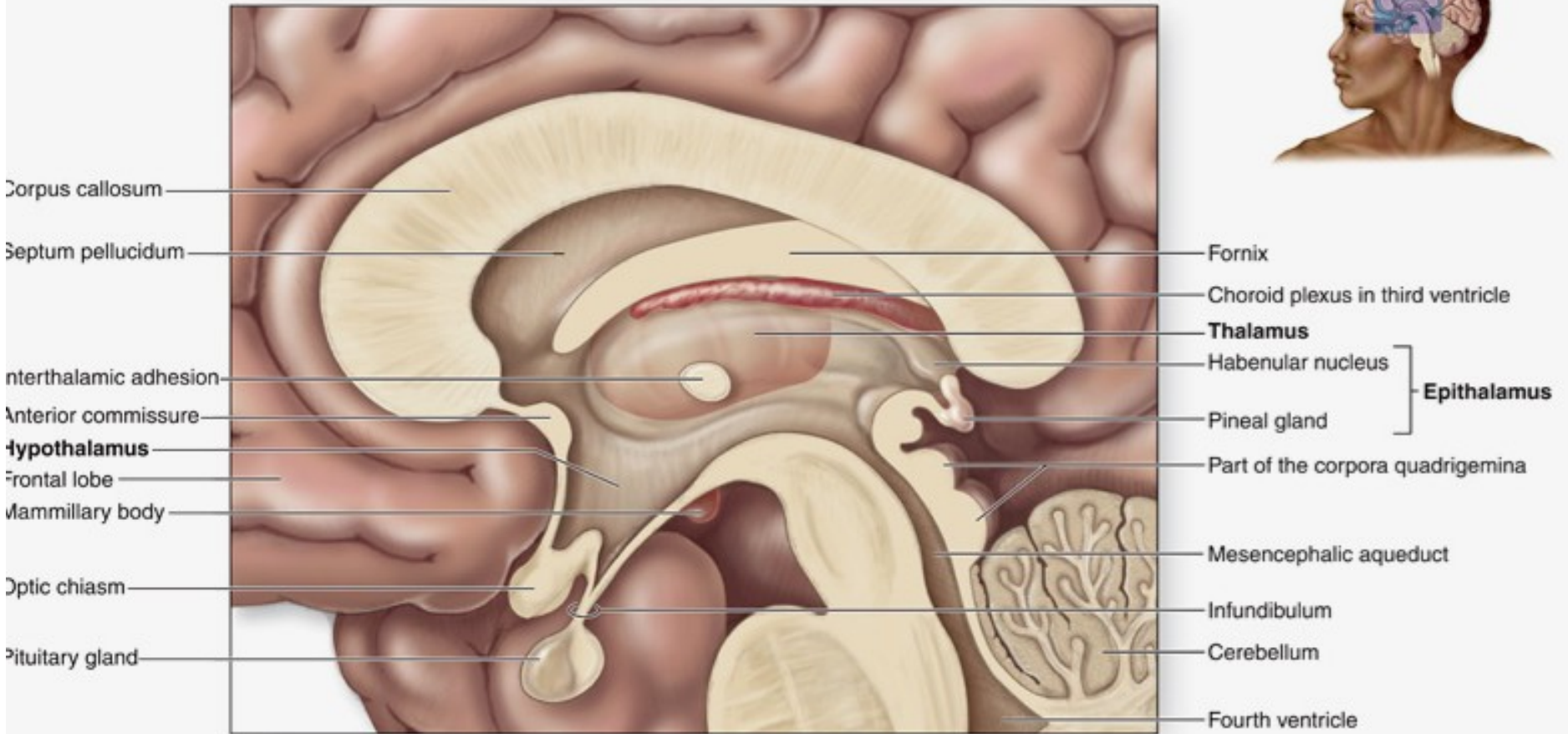


# Epithalamus

- dorsally at roof of III. Brain ventricle
- corpus pineale (pineal gland) – endocrine gland



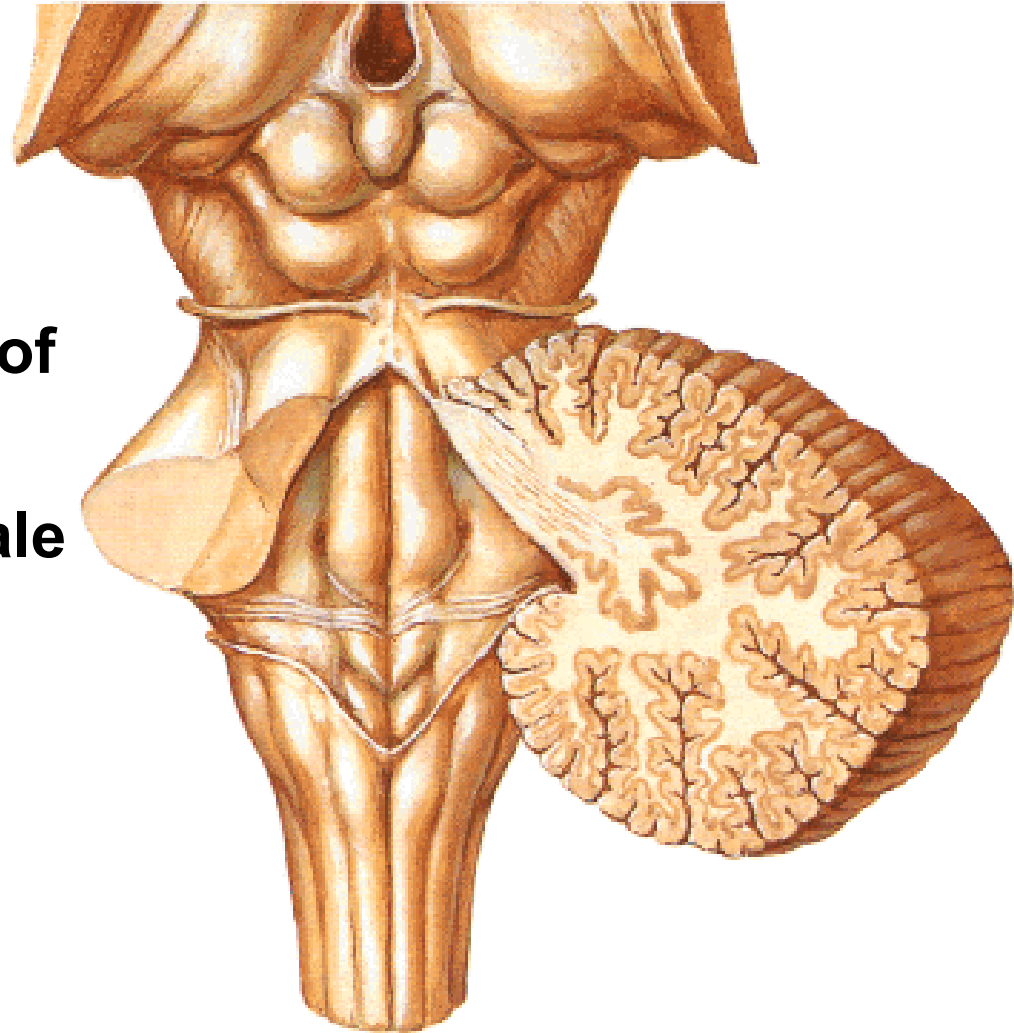
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Midsagittal section

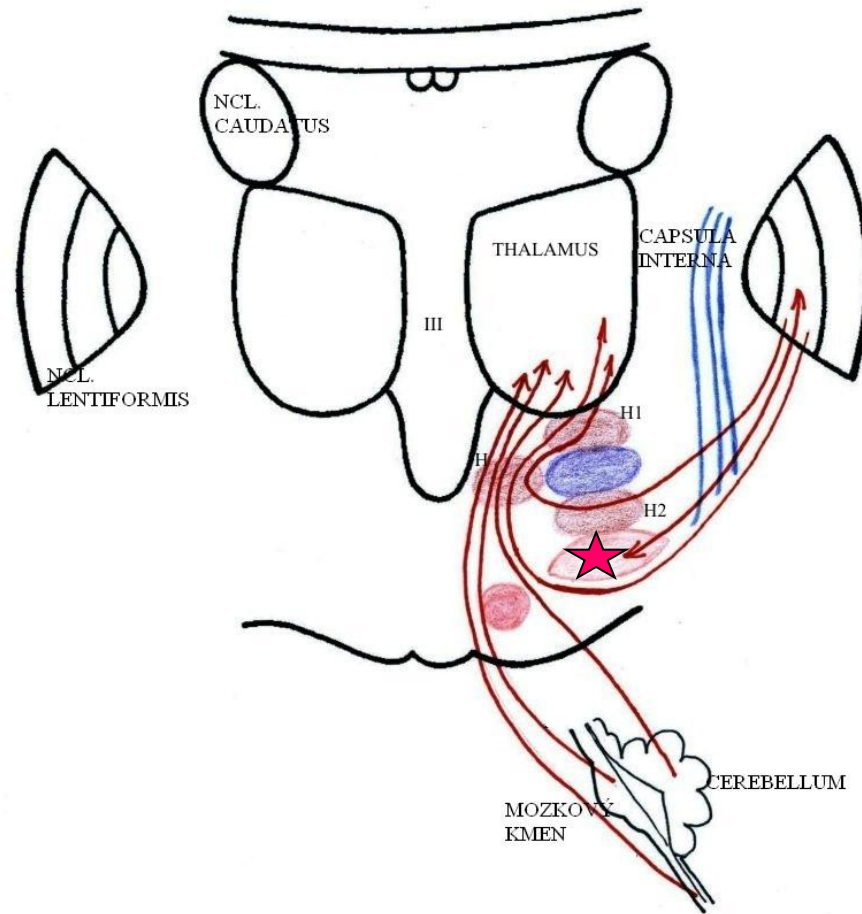
# Metathalamus

- On the posterior side of thalamus
- corpus geniculatum mediale connected with colliculus superior – part of auditory pathway
- corpus geniculatum laterale connected with colliculus inferior – part of visual pathway



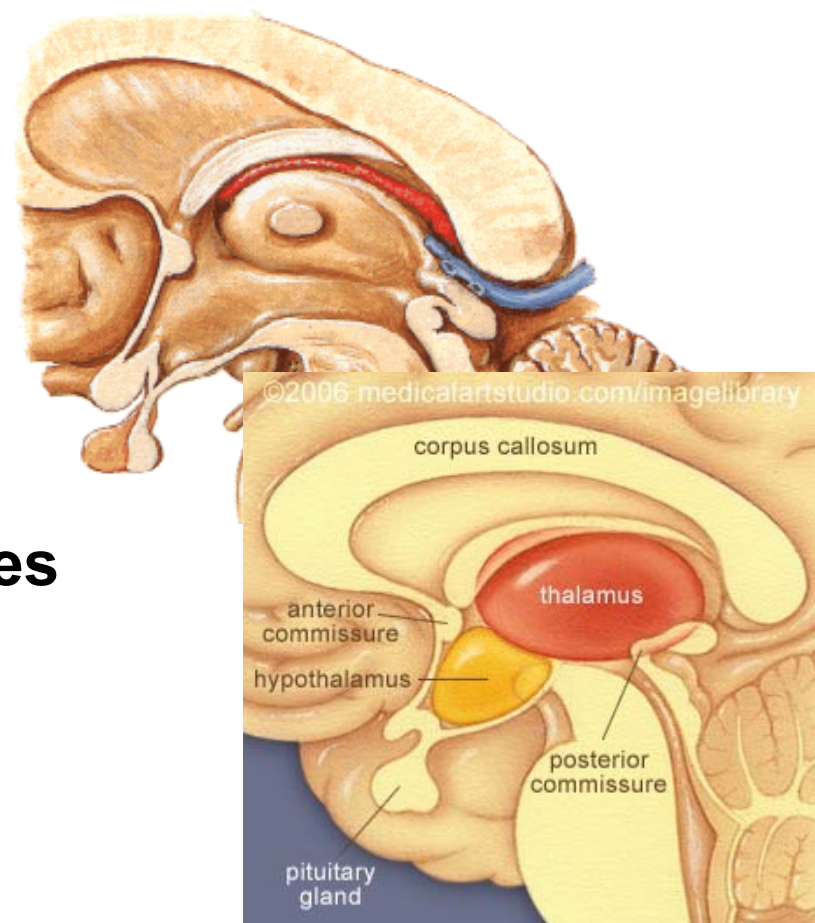
# Subthalamus

- grey matter located ventrocaudally from thalamus and laterally from hypothalamus
- involved into involuntary movements

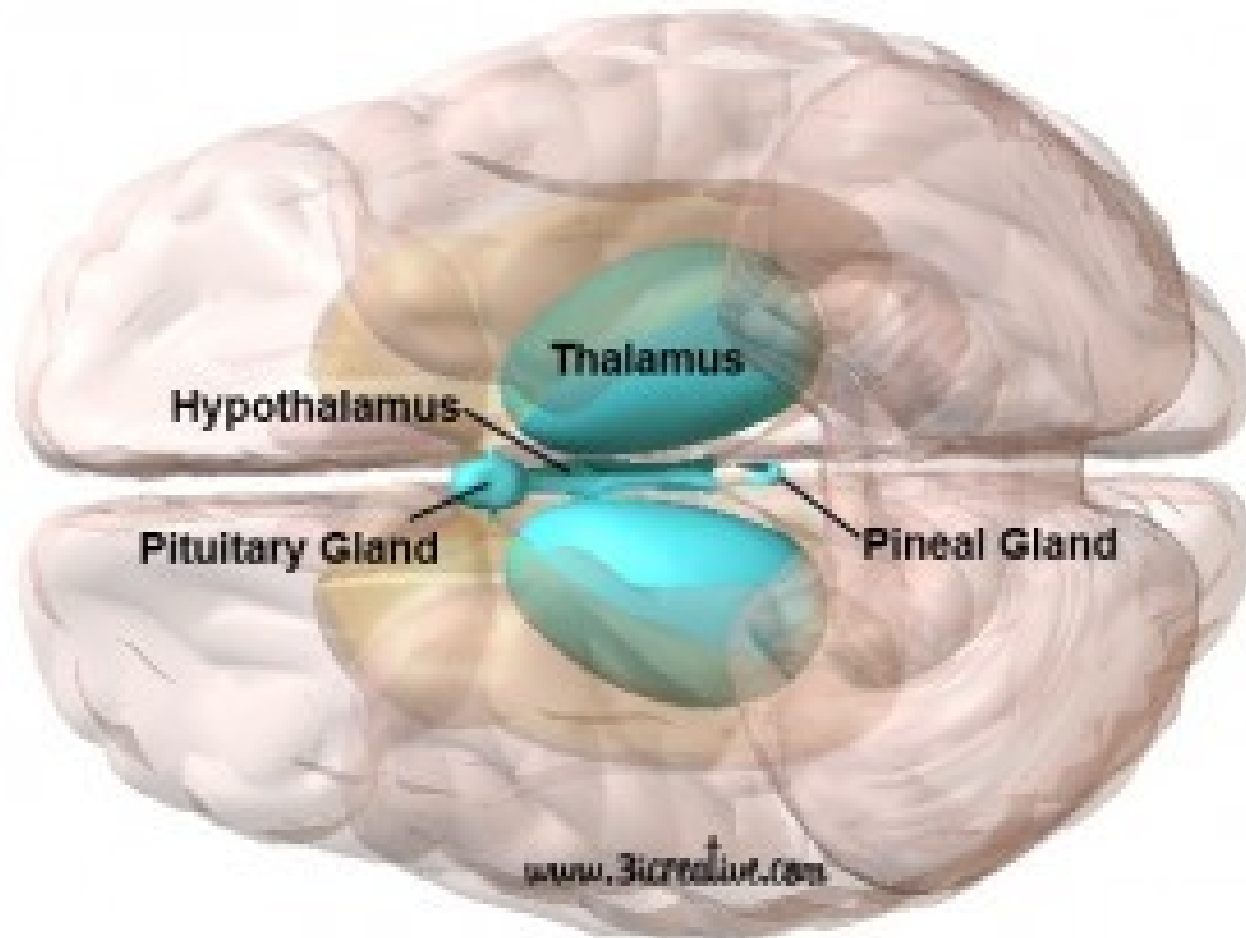


# Hypothalamus

- Originated from motor plate
- A part of hypothalamu is hypophysis
- **Functions:**
- visceral brain controls aktivity of visceral organs through autonomous nerves and hormones of hypophysis (control centre of autonomous system)
- It coordinats neurohumoral control (regulates functions of endocrine system)
- It is essential for preservation of homeostasis



# Forebrain - Diencephalon



Hypophysis

Infundibulum

Tuber cinereum

Fovea interpeduncularis

Substantia perforata interpeduncularis (posterior)

Pedunculus cerebri

Tractus opticus

Corpus mamillare

N. oculomotorius

N. trochlearis

Sulcus basilaris

Pons

N. trigeminus

N. abducens

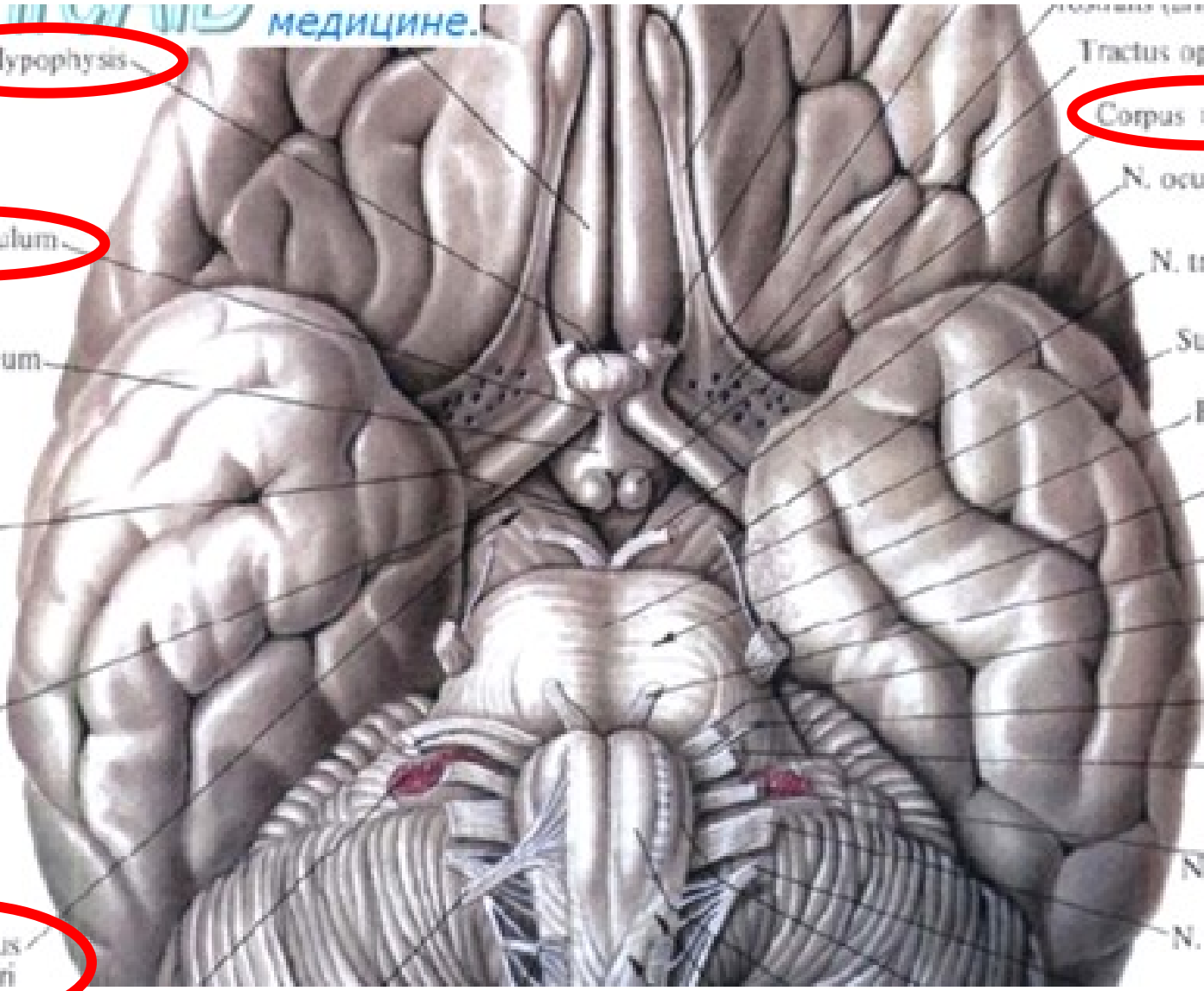
N. facialis

N. intermedius

N. vestibulo-cochlearis

N. glossopharyngeus

N. vagus



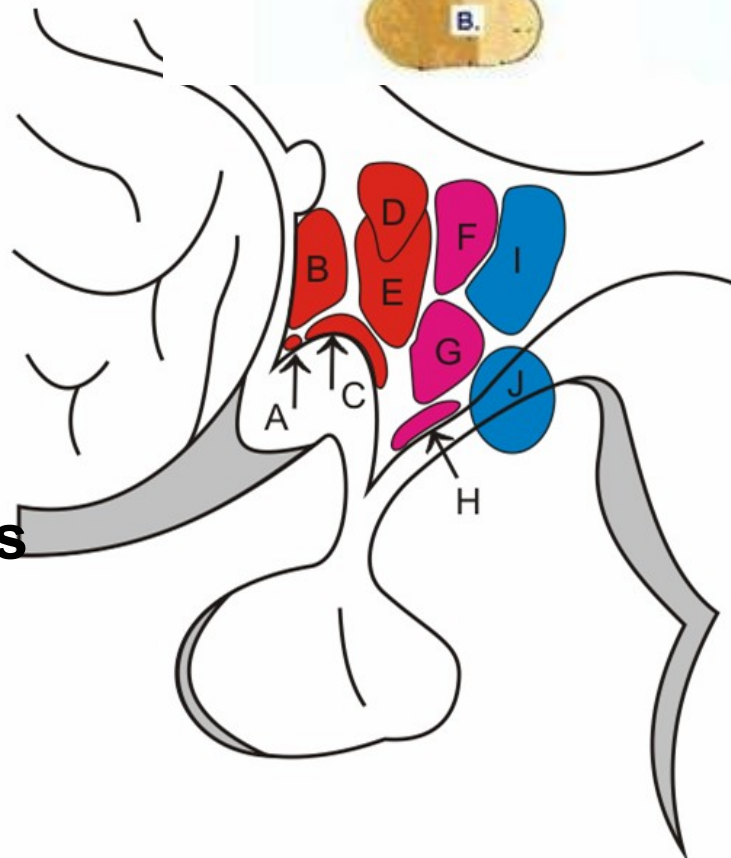
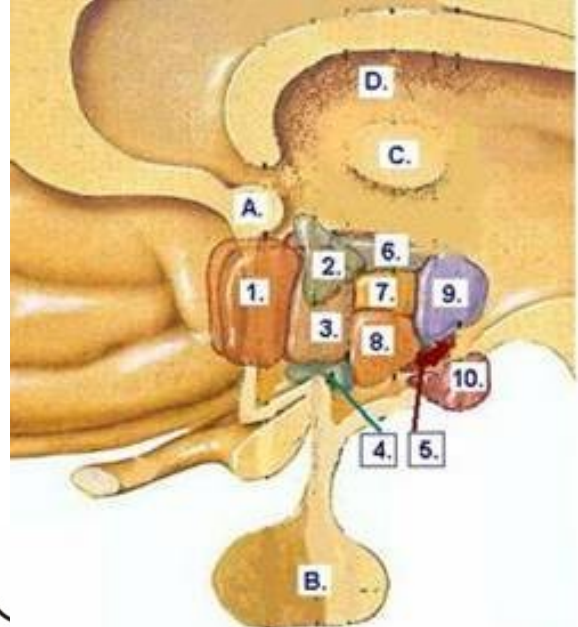


# Nuclei of hypothalamus

- A large number of nuclei (several groups)

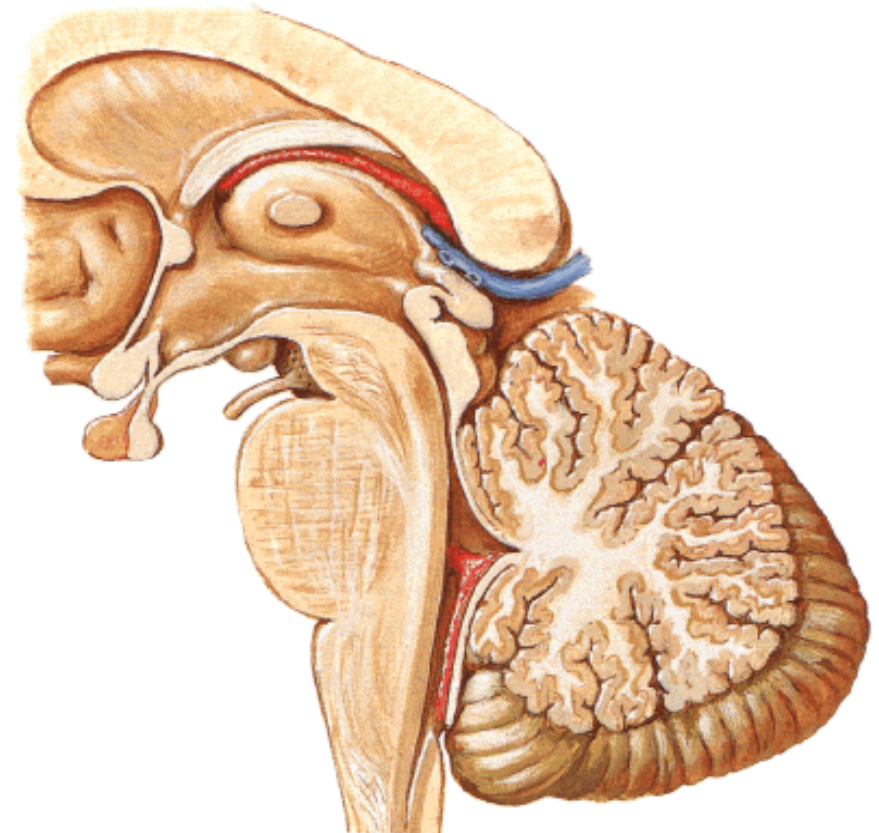
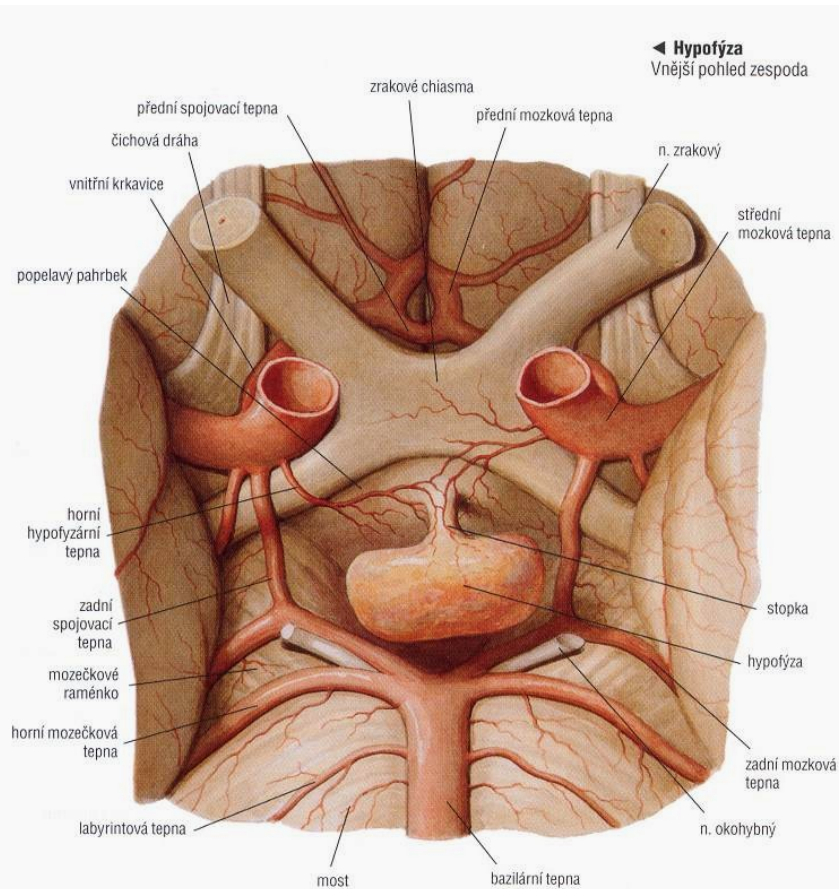
## Division from functional perspective:

- secretory nuclei (at wall of III. ventricle) neurosecretion – control activity of hypophysis
- nuclei that are parent to parasympathicus (anterior group)
- nuclei that are parent to sympathicus (middle group)
- nuclei affecting the instinctive and emotional behavior – serve limbic system (especially posterior group)



# Hypophysis cerebri (pituitary gland, hypophysis)

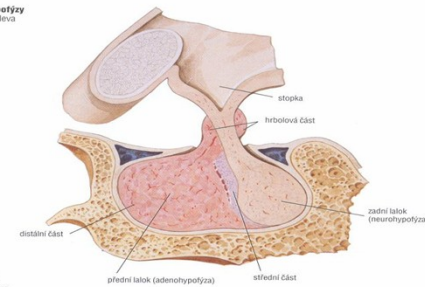
- Endocrine gland, part of diencephalon, located at sella turcica of sphenoid bone
- Superior position to other endocrine glands



# Hypophysis

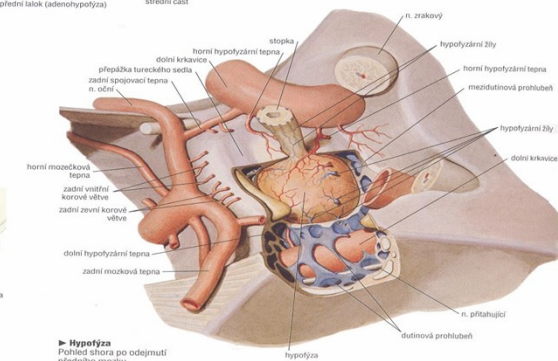
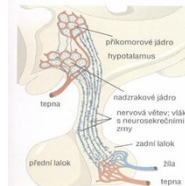
- **adenohypophysis** (lobus anterior) it produces e.g. somatotropic hormone and hormones affecting activity of other endocrine glands (gonadotropin, corticotropin...)
- pars media – produces melanocyte-stimulating hormone
- **neurohypophysis** (lobus posterior) receives hormones (antidiuretic hormone and oxytocin) from nuclei of hypothalamus through axonal flow

► Stavba hypofýzy  
Postranní řez zleva



▼ Vztah mezi  
hypotalamem  
a neurohypofýzou

Neurohypofýza je přímo úlohu zásobního orgánu, který přijímá látky vytvořené závislejšími neurony (oxytocin, antidiuretický hormon neboli ADH) a předává je krvním oběhem do celého organismu.



► Hypofýza  
Pohled shora po odejmutí předního močku

## Anatomy of Pituitary

