

# Hindbrain

The hindbrain, the rhombencephalon, consists of the following parts: the myelencephalon (elongated spinal cord) and the metencephalon (that is, Varola's bridge and cerebellum).

## Medulla oblongata

*See the Medulla oblongata page for more detailed information .*

Part of the hindbrain and brainstem connects to the spinal cord, 2 cm long, passes through a large occipital foramen. In front is the fissura mediana anterior, on the sides are the pyramids.

- Sulcus anterolateralis – next to the pyramid, XII emerges here. cranial nerve - hypoglossus (sublingual) nerve.
- Olives – bodies lying on the sides of the medulla oblongata.
- Sulcus posterolateralis – exit of IX, X and XI. cranial nerve.
- Structure: gray matter (forms nuclei - huge number, grouping of neurons); white matter (nerve fibers).

## Varoli Bridge (pons Varoli)

*More detailed information can be found on the Varola Bridge page .*

Connects to the medulla oblongata. The white matter represents the trajectories, the gray forms the nuclei. Exit V. - VIII. cranial nerve. Together with the medulla oblongata, it forms the base of the fourth cerebral ventricle.

## Reticular formation

- A structure that penetrates the medulla oblongata and Varola's bridge to the midbrain. It has a net-like appearance, consisting of multiple interconnected cores. The reticular formation is connected to other parts of the CNS.
- Functions: activation and inhibition (activates and suppresses), coordination and connection, center of important reflexes (sucking, swallowing, coughing, vomiting), control center of vital functions (breathing, heart rate, blood pressure).

## Cerebellum

The cerebellum is located in the posterior cranial fossa, its average weight is 130–140 g. It consists of two hemispheres ( *hemispheres* ). The hemispheres are connected by a so-called worm ( *vermis* ). On the section we distinguish:

- gray cerebellar cortex;
- white matter , the so-called tree of life (arbor vitae).

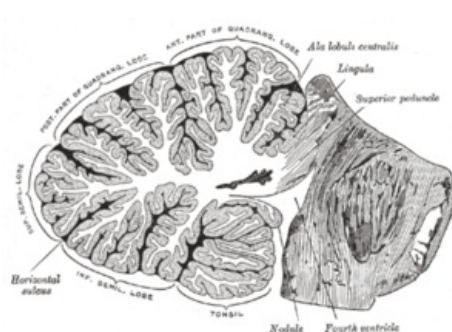
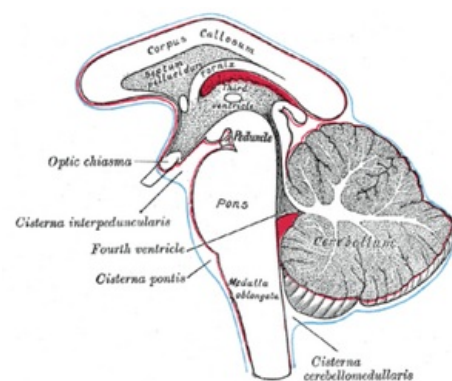
Inside are the cerebellar gray nuclei. The cerebellum is connected to the medulla oblongata, the pons of Varola and the midbrain, information from the balance, auditory, visual system, muscles, tendons, joints and cerebral cortex comes here, it forms the ceiling of the 4th cerebral ventricle.

- Function: involved in controlling precise movements, coordination, orientation in space, important for standing and walking.

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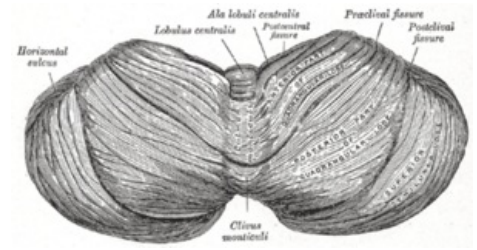
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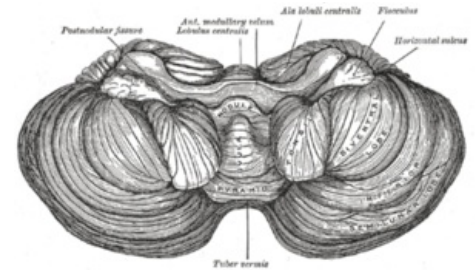


Cerebellum - sagittal section Cerebellum - top view Scum of the cerebellum Cerebellum – histological specimen

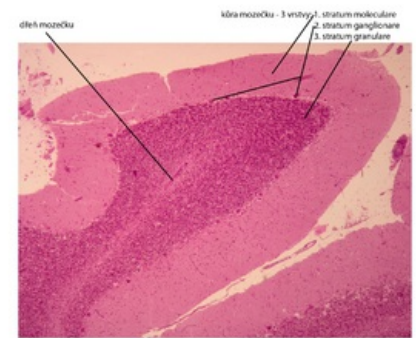
A rounded dorsally arched formation. A round, longitudinal, narrow middle band, separated by sagittal depressions from the lateral parts = vermis cerebelli (cerebral worm). Hemisphaeria cerebelli : 2 lateral, larger, symmetrically constructed hemispheres. The cranial surface is flatter, contact with the roof-like duplication of the dura mater ( tentorium cerebelli ). Dorsal and caudal surfaces arched; stored in the pits of the occipital bone under the transverse arms of the eminentia cruciformis (fossae occipitales cerebellares). The falx cerebri extends between the hemispheres of the cerebellum (from the crista occipitalis interna).



- *Inferiores (corpora restiformia)* – connect the oblongata with the cerebellum; they line the caudal part of the fossa rhomboidea.
- *Media (pontini; brachia pontis)* – connect the pons with the cerebellum; they border the fossa rhomboidea.
- *Superiores (brachia conjunctiva)* – connect the tegmentum mesencephali with the cerebellum; they border the rostral part of the fossa rhomboidea.



On the surface of the cerebellum, numerous transverse furrows - they separate individual sections on the vermis and hemispheres = fissurae cerebelli . The largest and deepest fissures separate 3 hl. sections: lobi cerebelli . Smaller fissures further divide these lobes into lobules: symmetrically placed on the hemispheres; correspond to an odd section on the vermis. The smallest fissures separate the parallel strips of the surface of the cerebellum = folia cerebelli . Surface covered by continuous gray matter: cortex cerebelli . Fissura prima - from the center to both sides, fissura horizontalis - dorsal pole, fissura posterolateralis - separates nodulus and flocculus.



Možeček (cerebellum) - barveno H&E

Paired clusters of gray matter are stored in the white matter: nuclei cerebelli :

- *Ncl. dentatus* – the largest of the cerebellar nuclei. Two parts: dorsomedial (paleocerebellar) with fibers going to the ncl. ruber and ventromedial (neocerebellar) with fibers going to the thalamus. The appearance of a wrinkled pouch with an opening ventromedially against the mesencephalon. Opening of the pouch = hilum (hilus) nuclei dentati. Thence the path contained in the pedunculus cerebellaris superior.
- *Ncl. emboliformis* – an elongated small core, the shape of a blood clot. Filed sagittally at the hilum of the ncl. dentatus.
- *Ncl. globosus* – in pairs, placed medially from ncl. emboliformis. From several small spherical formations of gray matter.
- *Ncl. fastigii* – paired, placed most medially at the fastigii, near the midline.

Ncl. emboliformis, globosus and fastigii efferent to the ncl. ruber, reticular nuclei, mesencephalon, pontus and oblongata. All the cerebellar nuclei are the starting point of the pathways coming out of the cerebellum - through them the cerebellum is involved in the movement control system

The nuclei contain the bodies of multipolar neurons on which the axons of the Purkinje cells terminate.

## Morphological division of the cerebellum

It is divided by transverse grooves into 3 lobes . In each lobe, the lobules are separated by smaller grooves (on the vermis and hemispheres). Morphological division enables a topographical orientation to the cerebellum, but does not correspond to the developmental and functional division.

## Description of formations

Upper surface (front to back)

Vermis ( lobus cerebelli anterior )

- **Lingula cerebelli** – 1 to several foils resting on the velum medullare superius.
- **Lobulus centralis** – a square group of foils in the front incisor. (fissula precentralis)

- Monticulus – the larger part of the upper surface of the vermis, hump-shaped; it is divided into culmen and declive (fissura prima) by a transverse groove
- Folium vermis – the only folium at the incisura cerebelli posterior

## Hemispheres

- Vinculum lingulae cerebelli – narrow white band.
- Ala lobuli centrales – a triangular group of folia in the anterior incisor.
- Lobulus quadrangularis – divided by a transverse groove into pars sup. et inf. (pars inf. otherwise also lobulus simplex).
- Lobulus semilunaris vulture. – crescent shaped.

Lower surface (it is separated from the upper surface by the fissure horizontalis cerebelli)

## Vermis (lobus cerebelli posterior)

- Tuber vermis – protrudes into the incisura cerebelli post. (horizontal fissure)
- Pyramis vermis – the widest part of the worm (fissura prepyramidalis)
- Uvula vermis – elongated elevation of several foils (fissura secunda)
- Nodulus vermis – attached to the uvula, rests on the velum medullare inf.

## Hemispheres

- Lobulus semilunaris inf – lobulus gracilis joins it.
- Lobulus biventer – bulging.
- Tonsila cererebelli – considerably convex groups of horseshoe-shaped folia.
- Flocculus – a stalked group of foils with a curly edge; a rudimentary parafocculus attaches at the posterior margin.

Vermis:	Hemisphere:	
Lingula	Vinculum lingulae	
Lobulus centralis	Ala lobuli centralis	
Culmen monticuli	Lobulus quadrangul. sup.	Lobus anterior s. rostralis
Fissura prima		
Declive monticuli	Lobulus quadrangul. inf.	Lobulus simplex
Folium vermis	Lobulus semilun. sup.	Lobus medius
Tuber vermis	Lobulus semilun. inf.	
	Prepyramidalis	Lobulus complicatus
	Lobulus biventer	
Pyramis	Tonsilla	
Uvula	Flocculus accessorius	Lobus posterior s. caudalis
Fissura uvulonodularis		
Nodulus	Flocculus	Pars nodulofloccularis

## Division of departments according to development relationships

Vestibular cerebellum – the oldest part, the basis of development are the vestibular pathways. It consists of: flocculus, lingula and nodulus.

Spinal cerebellum – the basis of development are the spinocerebellar pathways, it divides the vestibular cerebellum into the front (lingua) and back (nodulus and flocculus) parts. It consists in front: lobulus centralis, culmen, lobulus quadrangularis superior and behind: pyramis, uvula, parafocculus.

Cerebral cerebellum – develops by afferent from the cortex, through the pontocerebellar pathway. It arises in the middle of the older parts of the cerebellum collectively referred to as the palaeocerebellum. It is then called the neocerebellum (seu lobus medius).

The furrowing of the cerebellum happens gradually. Cerebellum - Summary of anatomical description The sulcus primarius (fissura prima) forms the earliest. It separates a part called the anterior lobe (rostralis). This includes the lingula and the anterior part of the spinal cerebellum. The following groove - fissura praepyramidalis defines the lobus medius and lobus caudalis in the area of the vermis. Fissura nodulouvaris - border between lobus caudalis and pars nodulofloccularis.

## Division including anatomical and developmental characteristics

- Lobus rostralis (anterior) – the anterior rudiment of the vestibular cerebellum and the anterior spinal cerebellum.
- Lobus medius – the largest part, includes the cerebral cerebellum.
- Lobus caudalis (posterior) – posterior spinal cerebellum.
- Lobus nodulofloccularis – part of the vestibular cerebellum not included in the lobus rostralis.

## Functional connectivity of the cerebellum

Supply pathways via the pedunculi cerebellares inferiores, medii, superiores to the cerebellar cortex. The exit of fibers from the cerebellar cortex ends in the cerebellar nuclei.

The cerebellar nuclei send axons to the gray matter of the trunk (mainly to the reticular formation, ncl. ruber, to the thalamus). Pathways to the spinal cord originate from the gray matter, which influence the cells, sending their axons as motor fibers to the skeletal muscles. It directs and controls movement activities and muscle tone, when the vermis participates in the coordination of the trunk muscles and the hemispheres of the muscles of the ipsilateral limbs.

## Cerebellar pathways

Afferent pathways mainly go to the cerebellar cortex. Efferentation begins with Purkinje cells (1st neuron) and continues after switching in the cerebellar nuclei (2nd neuron) in the centrifugal pathways going outside the cerebellum.

Vestibulocerebellum - lobus flocculonodularis and lingula vermis are connected to the vestibular nuclei of the rhombencephalon, from the ncc. vestibular and ncc colliculi superiores and visual cortical areas, maintaining body balance, spatial orientation.

Spinocerebellum - lobus cerebelli posterior, anterior except for the rostral section of the lingula connects to the spinal cord, af. fibers go from the trigeminal nerve, auditory and visual structures of the CNS and ef. they go to the motor nuclei of the brainstem, their function is motor coordination and they respond to proprioceptive information.

Cerebrocerebellum - through nuclei pontis connected with cerebral cortex, af. fibers from the cerebral cortex via the ncc. pontis, ef. they are to the motor thalamus (nc. ventralis anterior and lateralis) and to the cerebral cortex, the function is the coordination and timing of muscle movements.

#### A) Tracks of the partis nodulofloccularis:

- Afferentation from ncll. vestibulares as tr. vestibulocerebellares.
- Efferentation goes to Deiters nucleus, according to its origin as tr. nodulovestibularis and flocculovestibularis. From ncl. fastigii goes separately tr. fastigiovestibularis (Russell's bundle) along the pedunculus cerebellaris inf. to the Deiters core.

#### B) Lobi rostralis et lobi caudalis

pathways Afferent pathways:

- *Tr. spinocerebellaris post.* : Stilling-Clark nucleus - pedunculus cerebellaris inf. - cerebellar cortex (and cerebellar nuclei).
- *Tr. spinocerebellaris ant. (Gowersi)* : crossing in the spinal cord - lateral spinal cord (ventral from tr. spinocerebellaris post) - through the pedunculi cerebellares superiores to the cerebellum.
- *Tr. bulbocerebellares* : from the nuclei of the posterior cords of the spinal cord - uncrossed as fibrae arcuatae externae dorsales or crossed as fibrae arcuatae externae ventrales and fibrae arcuatae internae - through the pedunculus cerebellaris inf.
- *Tr. nucleocerebellares* : from the nuclei of sensitive cranial nerves.
- *Tr. olivocerebellares* : from the major olive (older part) and minor olive.
- *Tr. tectocerebellaris* : from the gray matter under the colliculi superiores - velum medullare superius - cortex vermis superior.
- *Tr. reticulocerebellaris* : from the nuclei of the lateral nuclei of the RF - pedunculus cerebellaris inf. - vermis - to the ipsilateral hemisphere.
- *Tr. rubrocerebellaris* : after crossing tr. rubrospinalis branches off into - pedunculus cerebellaris sup.

Efferent pathways:

- *Tr. cerebellotegmentalis (dentatotegmentalis)* : from the cerebellar nuclei (mainly incl. dentatus) - pedunculus cerebellaris sup. - FR nuclei of the pontine and mesencephalon.
- *Tr. cerebellorubralis (dentatorubralis)* : via pedunculi cerebelli sup. to ncl. ruber (then using tr. rubrospinalis and rubroolivaris for olive).
- *Tr. cerebelloolivaris* : via pedunculi cerebelli inf. - contralaterally to the main olive (older part) and secondary olive.
- *Tr. cerebellotectalis* : via pedunculi cerebelli sup.
- *Tr. cerebellothalamicus (embolothalamicus)*: through the central nuclei of the thalamus to the striatum.

#### C) Pathways lobi medii

Afferent pathways:

- *Tr. pontocerebellares* : from ncll. pontis, where they cross - pedunculi cerebelli medii - cortex of the cerebellum; the pathway is a continuation of the corticopontine pathway (tr. frontopontinus et tr. occipitotemporopontinus) and cross-connects the hemispheres of the forebrain and cerebellum.
- *Tr. olivocerebellares* : as in the orbits of the lobi rostralis et caudalis, but it originates from the neoliva (younger part of the ncl. olivaris).
- *Tr. corticocerebellares* : from the motor area of the frontal lobe - pedunculi cerebelli inf. - to the ipsilateral hemisphere of the cerebellum.

Efferent pathways:

- *Tr. cerebellorubrales* : conduction as in the eponymous tract from the previous group of tracts.
- *Tr. cerebrothalamici* : from ncl. dentatus to the ventrolateral nuclei of the thalamus (further as tr. thalamocorticalis to areas 4 and 6).

## Links

### External links

- DUBOVÝ, Petr. *Basics of neuroanatomy and neural pathways: Multimedia support for teaching clinical and health disciplines* [online]. Portal of the Faculty of Medicine of the Masaryk University [online], ©2007. Last revised 3/6/2011, [cit. 2011-11-27]. ISSN 1801-6103. < <http://portal.med.muni.cz/clanek-442-zaklady-neuroanatomie-a-nervovych-drah.html> >.

## Reference

1. ↑ CIHÁK, Radomír. *Anatomy 3*. 2nd ed. Prague: Grada, 2002. 516 pp. ISBN 80-7169-970-5 .