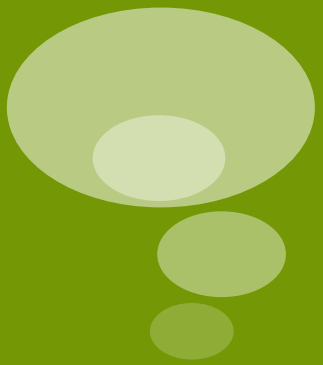


Cerebellum

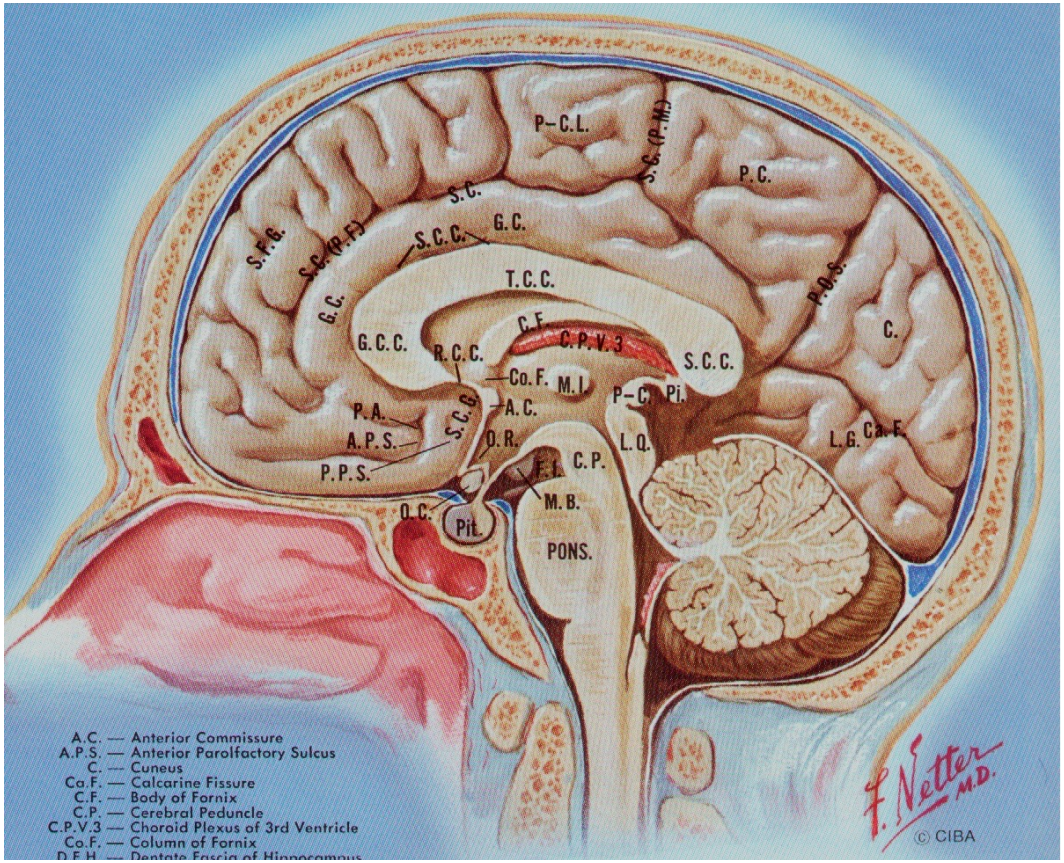
Prof. M. GAVRILIUC

Cerebellum

- The cerebellum is a central organ for **fine motor control.** It processes information from multiple sensory channels (particularly vestibular and proprioceptive), together with motor impulses, and modulates the activity of motor nuclear areas in the brain and spinal cord.

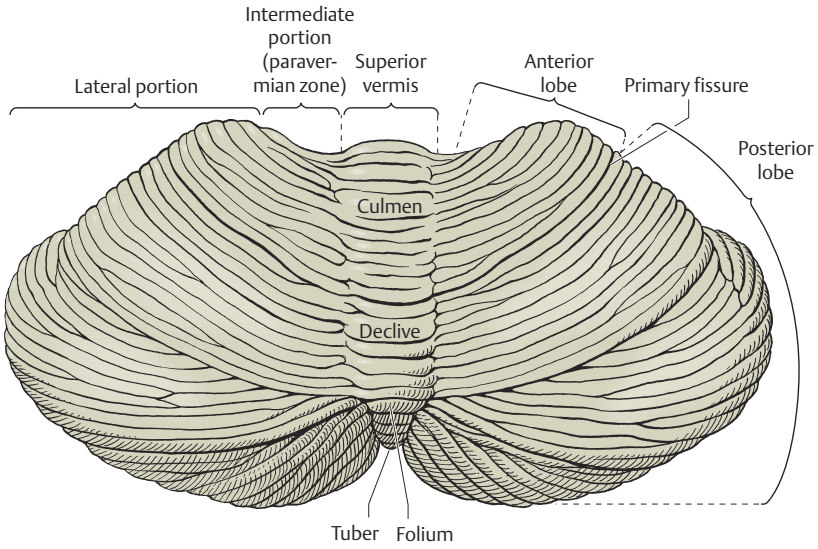
Cerebellum

- The cerebellum lies in the *posterior fossa.* Its superior surface is covered by the *tentorium cerebelli,* a tentlike double fold of the dura mater that separates the cerebellum from the cerebrum.



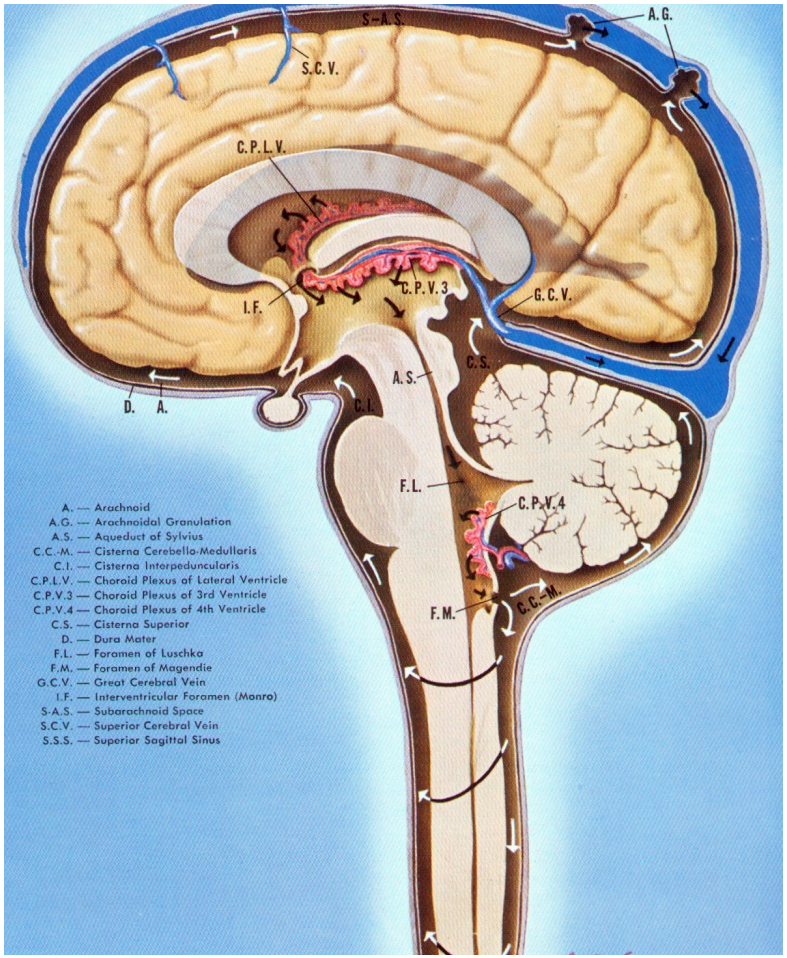
Surface Anatomy

- The **surface** of the cerebellum, unlike that of the cerebrum, displays numerous small, horizontally running convolutions (folia), which are separated from each other by *fissures.* The narrow central portion of the cerebellum connecting the two hemispheres on either side is called the *vermis* because of its fancied resemblance to a worm.



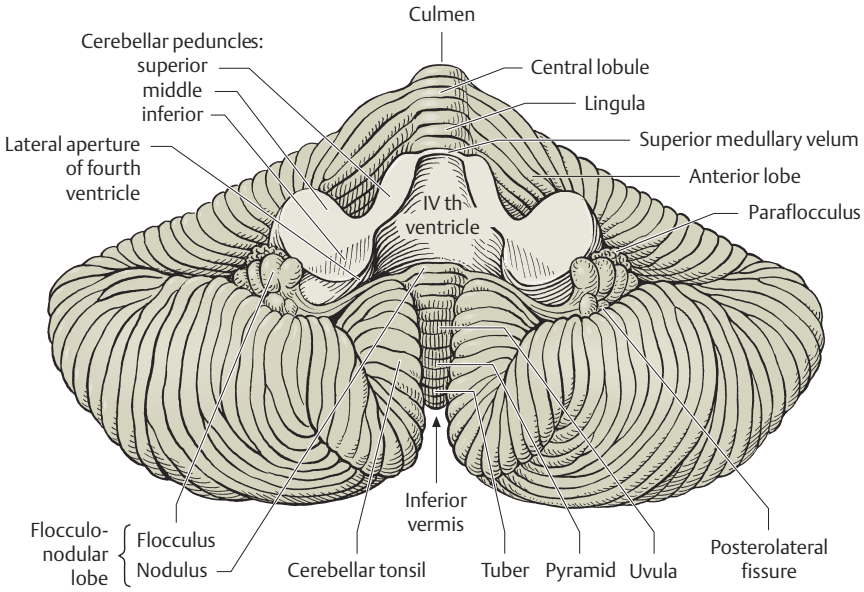
Surface Anatomy

- **A view of the cerebellum from below** reveals the upper portion of the fourth ventricle lying between the cerebellar peduncles. The fourth ventricle communicates with the subarachnoid space through a single *median aperture* (foramen of Magendie) and two *lateral apertures* (foramina of Luschka).



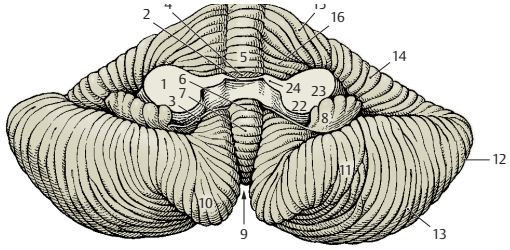
Surface Anatomy

- Caudal to the inferior and middle cerebral peduncles, there is a structure on either side called the *flocculus;* the two flocculi are connected across the midline through a portion of the vermis called the *nodulus.* Together, these structures constitute the *flocculonodular* lobe.

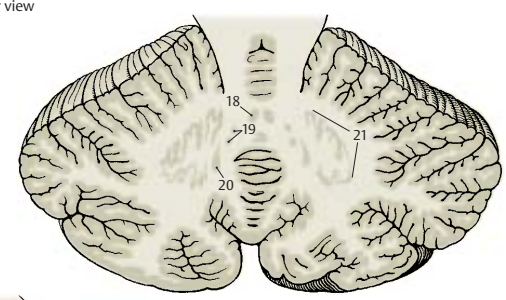


Three major components of the cerebellum on phylogenetic and functional grounds:

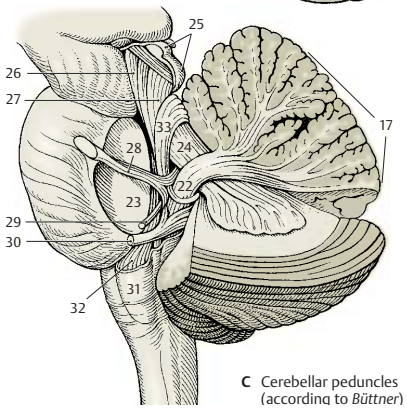
- The **archicerebellum**
- The **paleocerebellum**
- The **neocerebellum**



A Anterior view



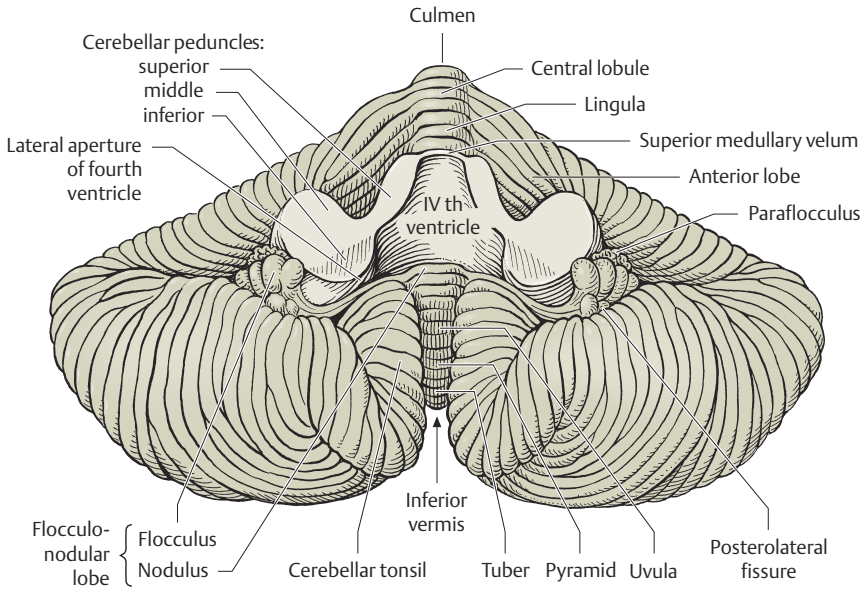
B Cerebellar nuclei



C Cerebellar peduncles (according to *Büttner*)

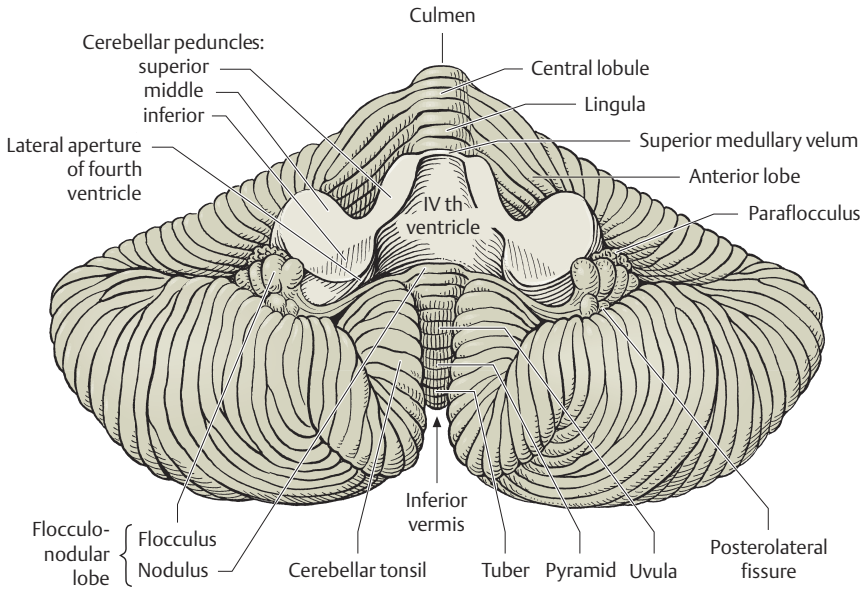
archicerebellum

The **archicerebellum** (phylogenetically oldest portion of the cerebellum) is intimately related to the vestibular apparatus. It receives most of its afferent input from the vestibular nuclei of the brainstem and is thus also called the **vestibulocerebellum.** Anatomically, it consists mainly of the flocculus and nodulus (flocculonodular *lobe).*



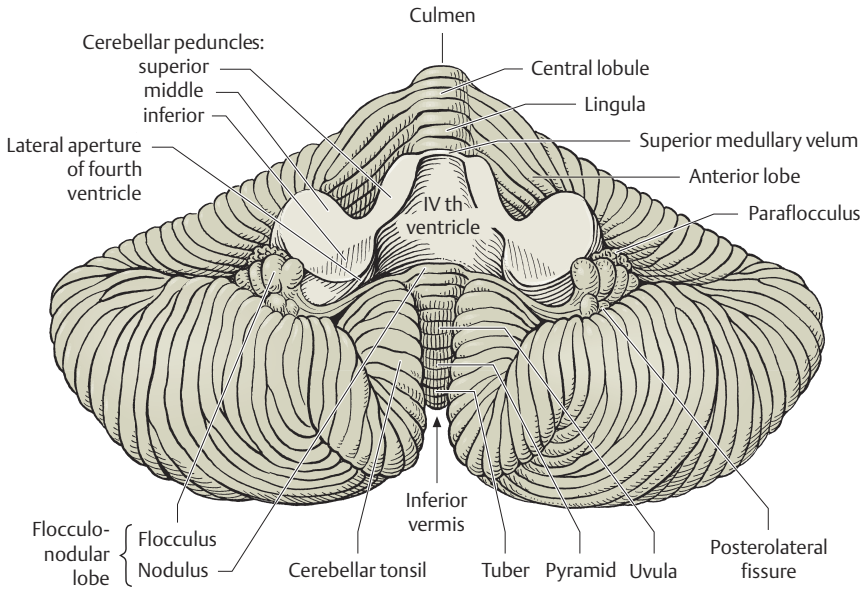
paleocerebellum

- The **paleocerebellum** (next oldest portion of the cerebellum, after the archicerebellum) receives most of its afferent input from the spinal cord and is, therefore, also called the **spinocerebellum**. It is composed of most of the vermis and paravermian zone (pars intermedialis).



neocerebellum

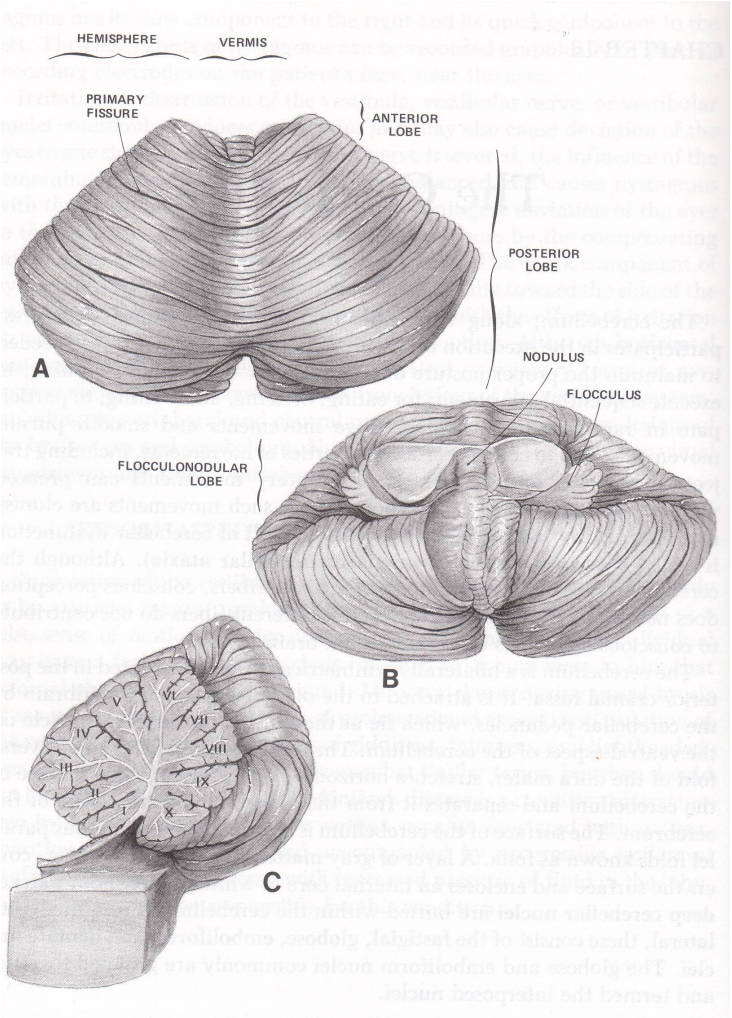
- The **neocerebellum** is its largest part. Its phylogenetic development occurred together with the expansion of the cerebrum and the transition to an upright stance and gait. It is formed by the two cerebellar hemispheres and has an intimate functional connection to the cerebral cortex, which projects to it by way of the pontine nuclei. Thus, the neocerebellum is also termed the pontocerebellum or **cerebrocerebellum.**



- **Anatomically,** the cerebellum is made up of **two hemispheres** and the **vermis** that lies between them.
- It is connected to the brainstem by **the three cerebellar peduncles.** An anatomical section reveals the cerebellar cortex and the underlying white matter, in which the deep cerebellar nuclei are embedded. The **cerebellar cortex** is primarily responsible for the integration and processing of afferent impulses. It projects to the **deep cerebellar nuclei,** which then emit most of the efferent fibers that leave the cerebellum.

Cerebellum

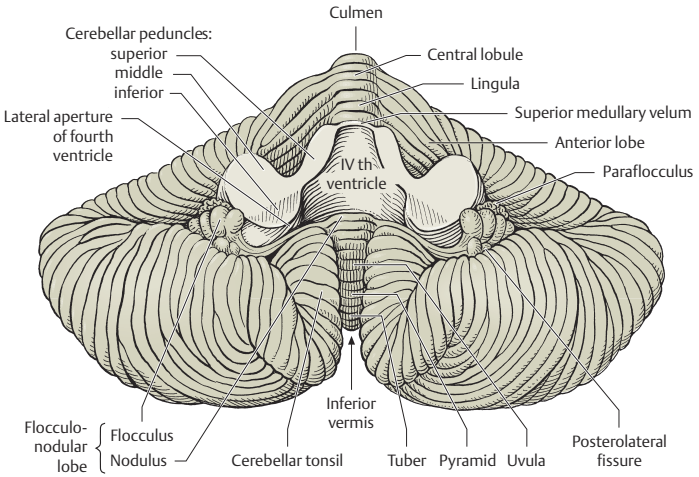
- **Functionally** (and phylogenetically), the cerebellum is divided into three components: the vestibulocerebellum, spinocerebellum, and cerebrocerebellum.



Cerebellum

- **Internal Structure**

Although the cerebellum accounts for only about 10 % of the brain by weight, it contains more than 50 % of all the brain's neurons. The neurons of the cerebellum are located in the gray matter of the highly convoluted cerebellar cortex and in the four deep cerebellar nuclei on either side (see below).



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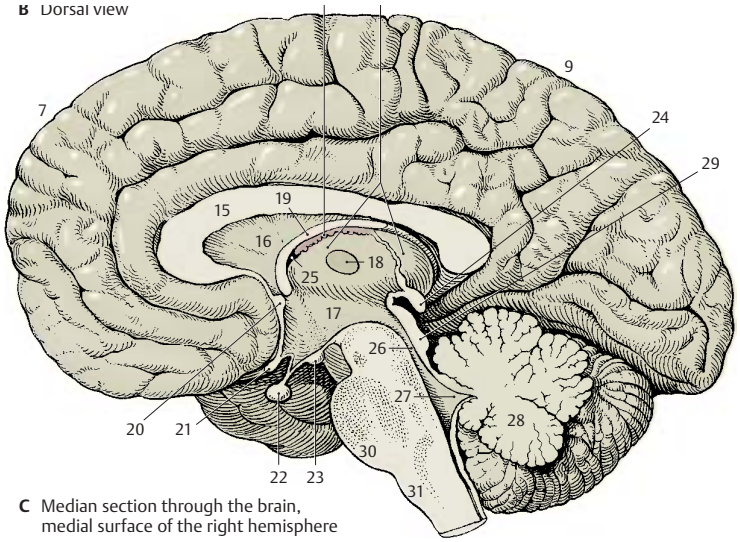
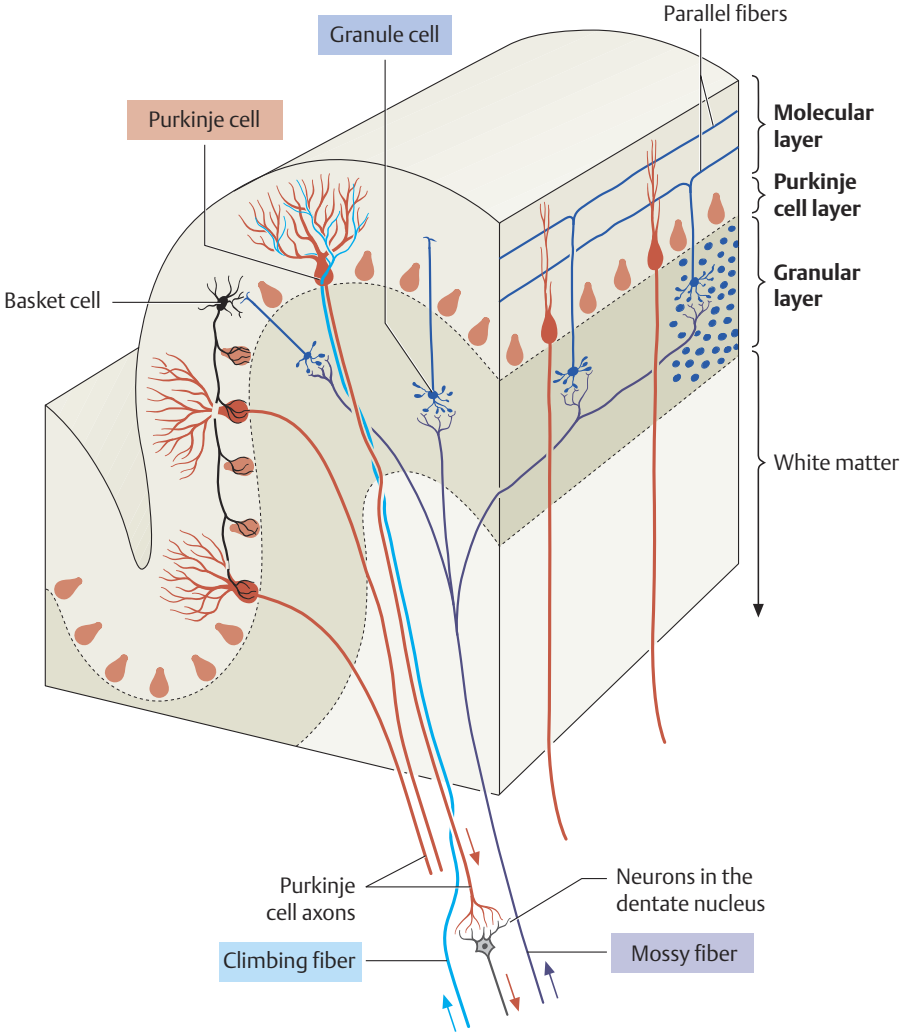


C Median section through the brain, medial surface of the right hemisphere

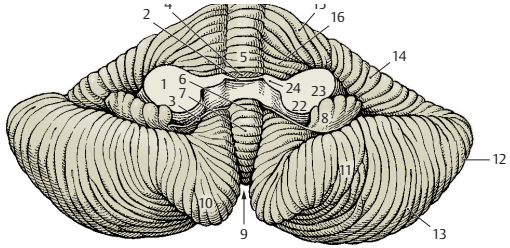
Cerebellar Cortex



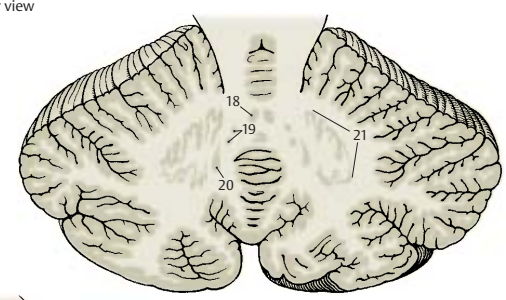
- **Molecular layer (*stratum moleculare*).**
- **Pukinje cell layer (**stratum ganglionare**).**
- **Granule cell layer (**stratum granulosum**).**
- **climbing fibers,**
- **mossy fibers.**

Cerebellar Nuclei

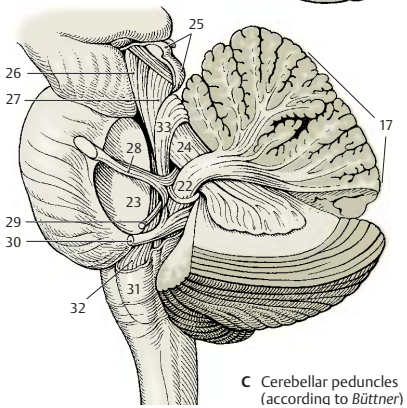
- the **fastigial nucleus** (“roof nucleus”)
- the **globose nucleus** (usually divided into two or three subnuclei)
- the **emboliform nucleus**
- the **dentate nucleus.**



A Anterior view



B Cerebellar nuclei

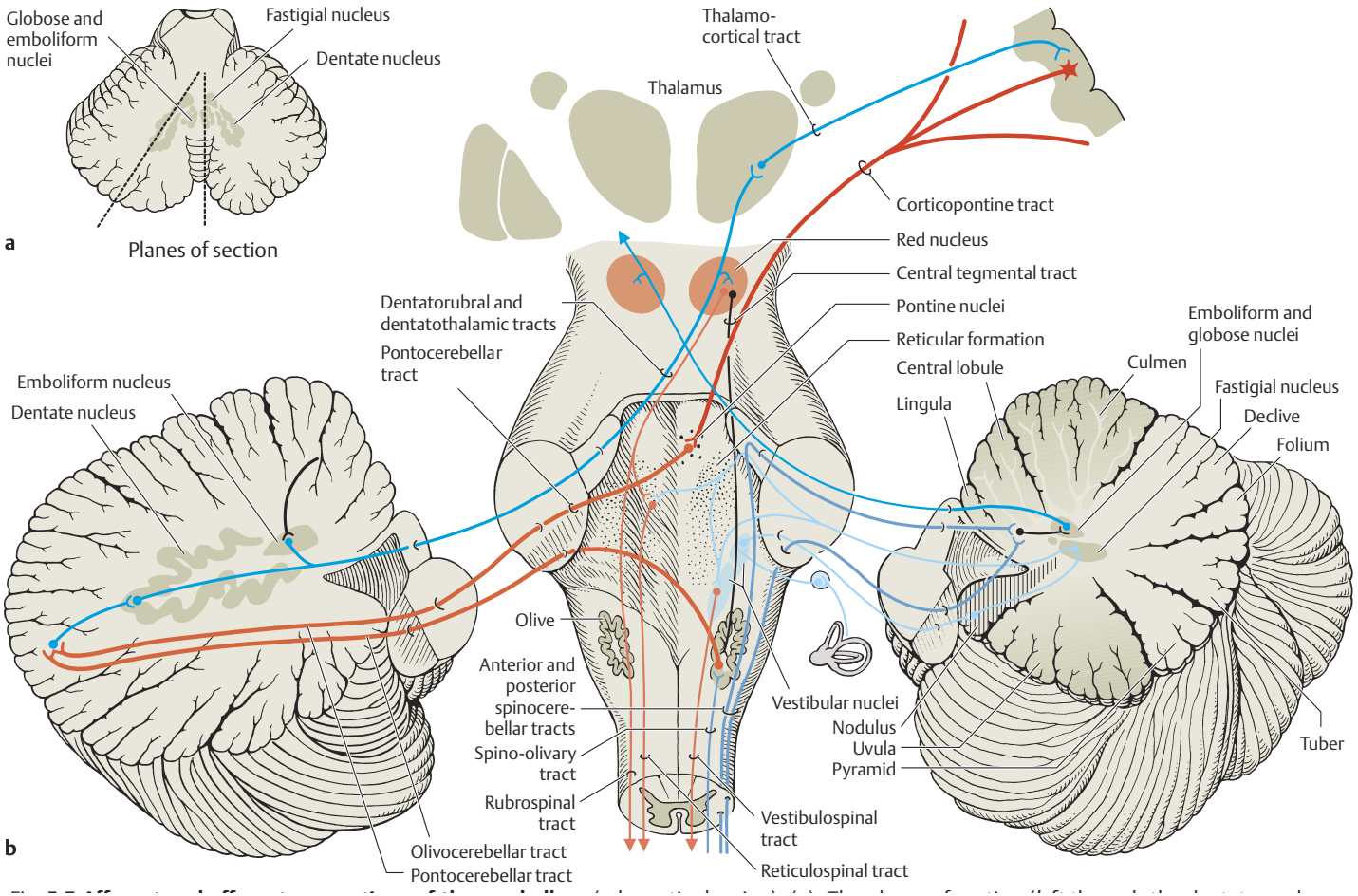


C Cerebellar peduncles (according to *Büttner*)

Cerebellum

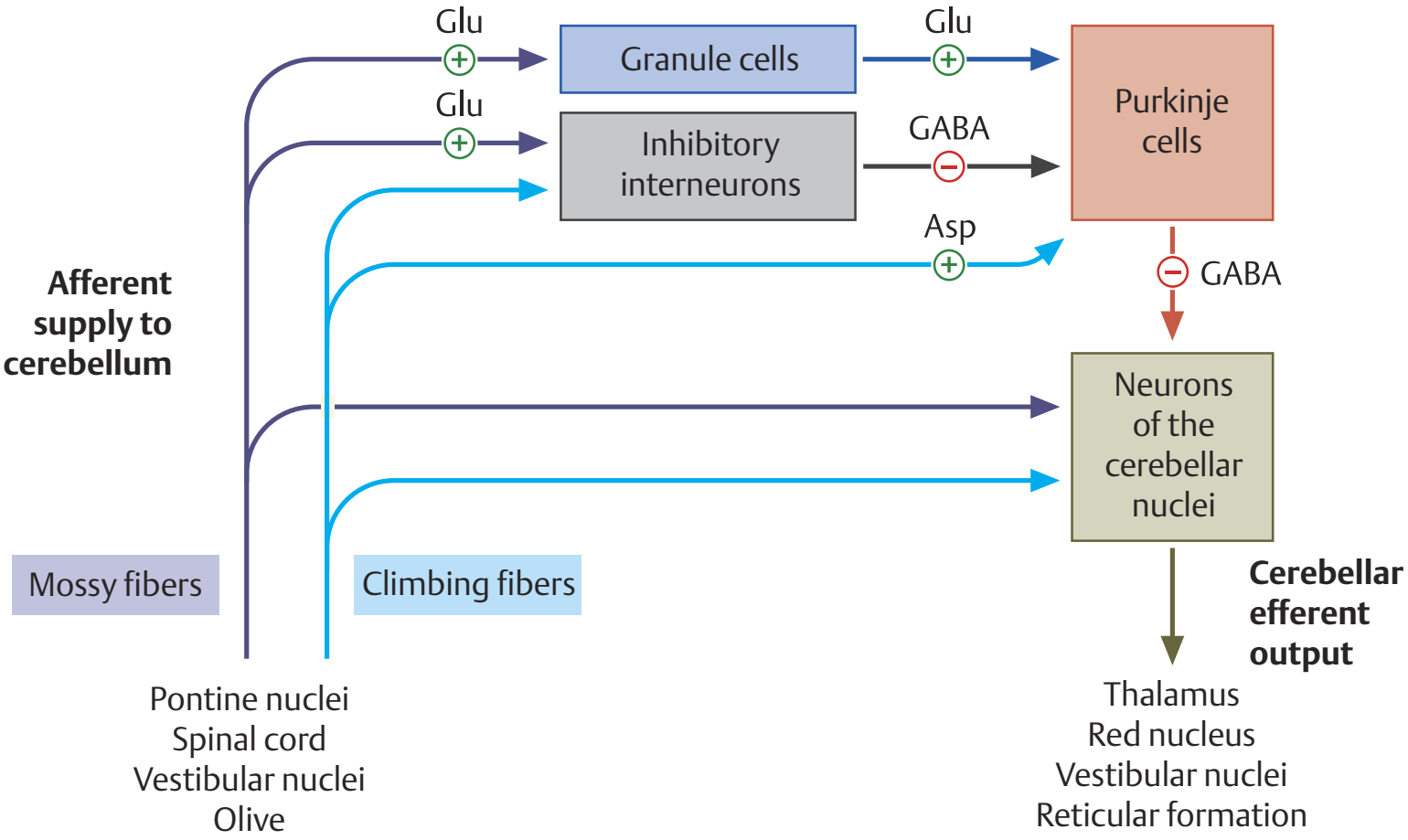
Afferent and efferent connections of the cerebellum

(a): The planes of section (left through the dentate nucleus, *right* through the vermis).



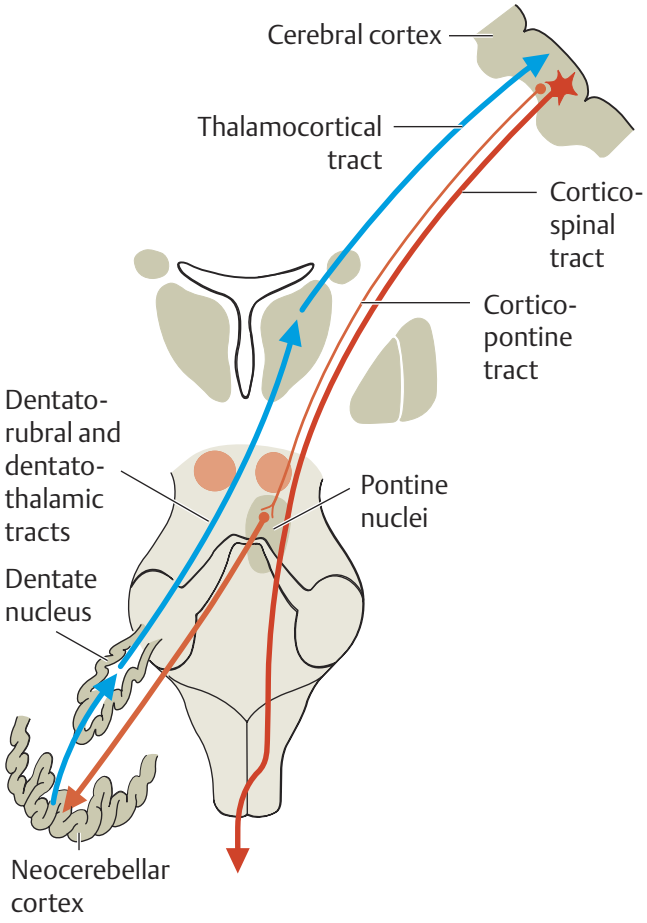
Cerebellum

The basic scheme of neuronal connections within the cerebellum

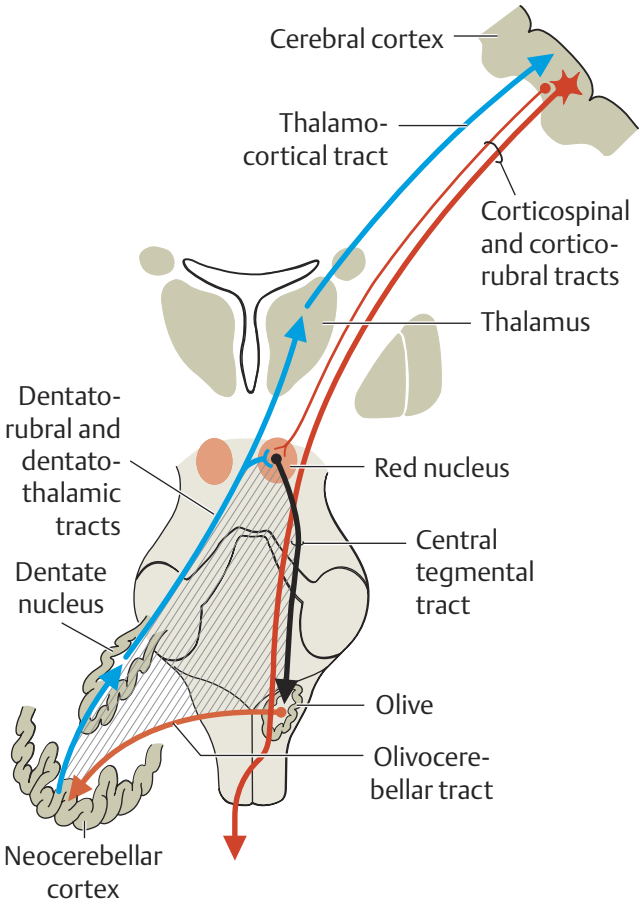


Cerebellum

Cerebellar regulatory circuits involving the pontine nuclei



Cerebellar regulatory circuits involving the olive



Cerebellar Function and Cerebellar Syndromes

Essentially, the cerebellum is a coordination center that

- **maintains balance** and
- **controls muscle tone** through regulatory circuits and complex feedback mechanisms, and
- **assures the precise, temporally well-coordinated execution of all directed motor processes.** Cerebellar coordination of movement occurs unconsciously.

Cerebellar Function and Cerebellar Syndromes

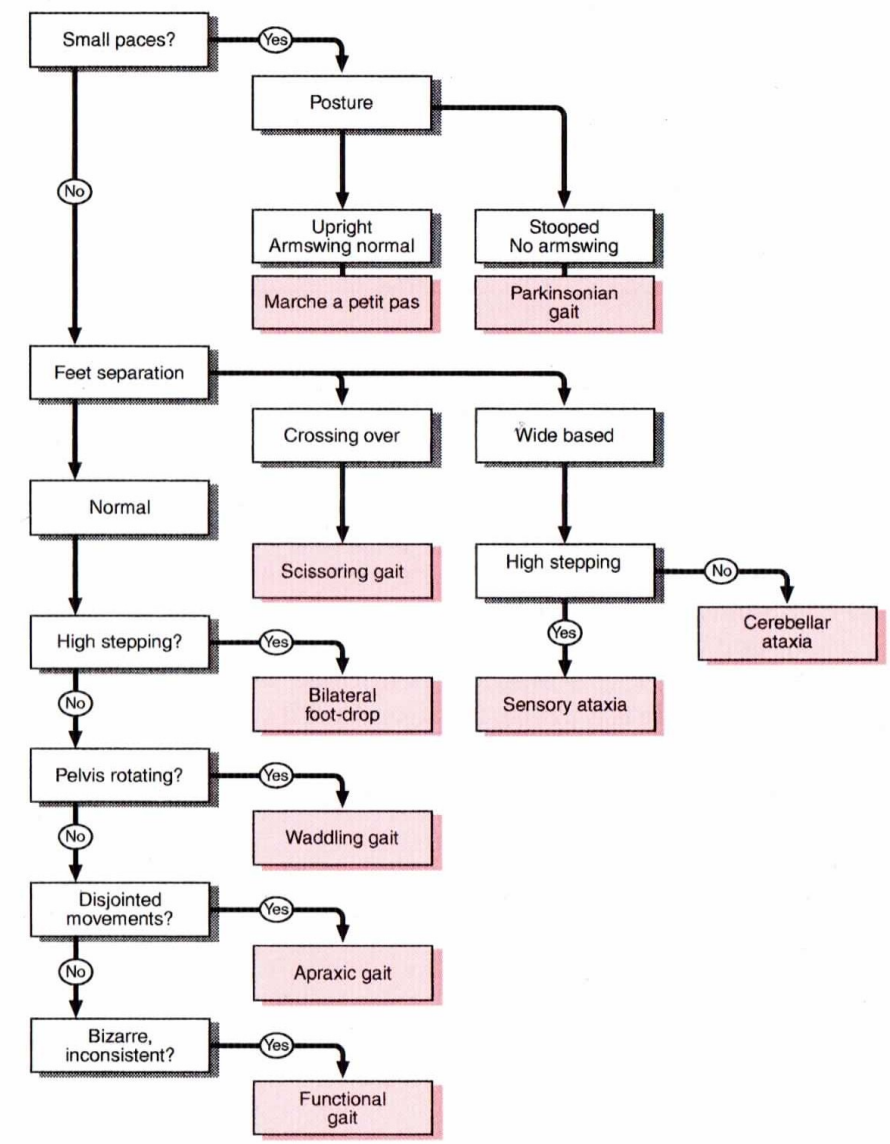
Three important points must be grasped for a proper understanding of cerebellar function:

- The cerebellum receives a very large amount of general and special sensory input, but does not participate to any significant extent in conscious perception or discrimination.

- Although the cerebellum influences motor function, cerebellar lesions do not produce paralysis.

- The cerebellum is unimportant for most cognitive processes but nonetheless plays a major role in motor learning and memory.

TEST THE GAIT



TEST THE GAIT

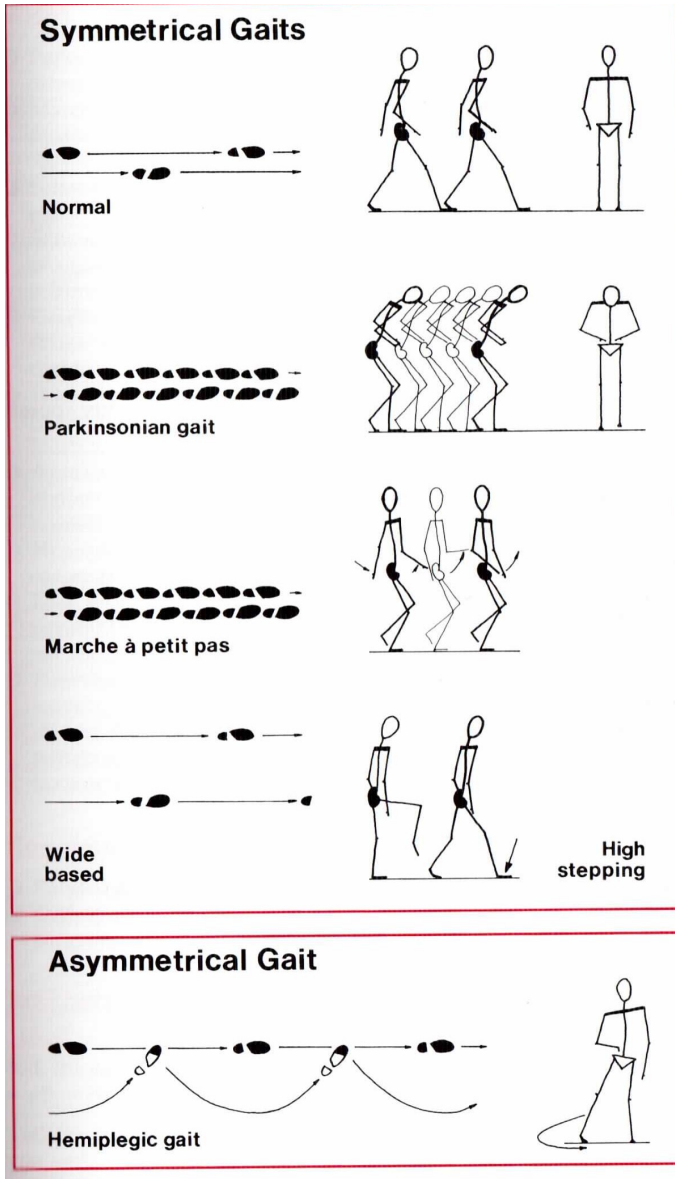
- **Cerebellar ataxia:** veers towards side of lesion – *common causes:*

- drugs (e.g. phenytoin)

- alcohol

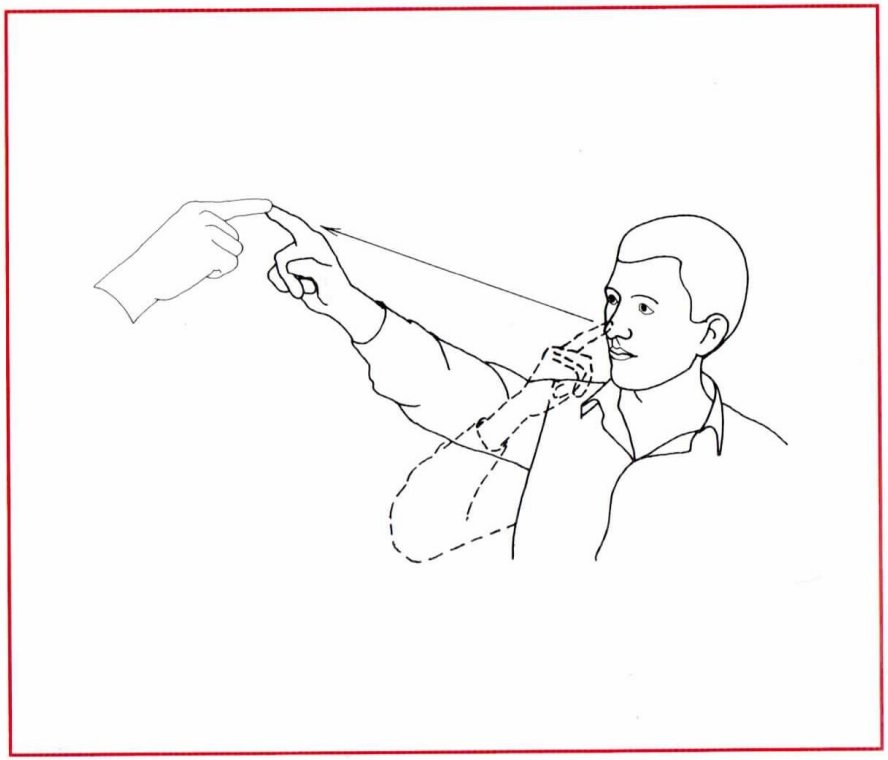
- multiple sclerosis

- cerebrovascular disease



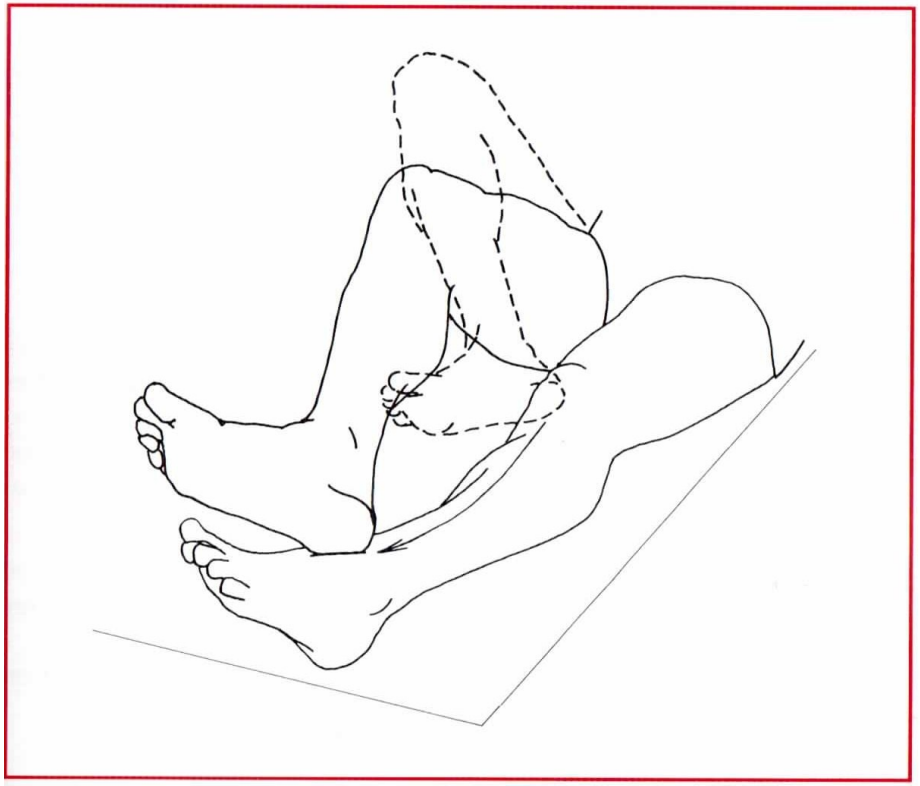
Finger-nose test

- The patient is able to complete the task quickly and accurately – *normal*
- The patient develops a tremor as his finger approaches its target – *intention tremor;* finger overshoots its targets – *past pointing* or *dysmetria.*



Heel-shin

- Disorganization of movement with heel falling off the anterior part of the shin, knee falling from side to side.



N.B. The finger-nose and heel-shin test can be used as an indication of loss of joint position sense. The original movements are accurate but when repeated with the eyes closed are substantially worse – this indicates impairment of joint position sense.

Examination of cerebellar function

Repeated movements

- Disorganization of the movement of the hands and the elbows taking wider excursion than expected; irregularity of the movements which are performed without rhythm. Compare the two sides – these changes indicate *cerebellar incoordination.*
- When there is disorganization of tapping the hand and then turning it over this is referred to as *dysdiadochokinesia.*

Trunk

- Patient is unable to sit from lying without falling to one side = *truncal ataxia.* Associated with gait ataxia.

WHAT IT MEANS

- **Unilateral inco-ordination** – ipsilateral cerebellar syndrome.
- **Bilateral inco-ordination** – bilateral cerebellar syndrome.
- **Truncal ataxia, gait ataxia, without limb inco-ordination** – midline cerebellar syndrome

- **Unilateral cerebellar syndrome** – *common causes:* demyelination, vascular disease; *rare causes:* trauma, tumor or abscess.
- **Bilateral cerebellar syndrome** – *common causes:* drugs (anticonvulsants), alcohol, demyelination, vascular disease; *rare causes:* hereditary cerebellar degenerations, paraneoplastcic disorders, hypothyroidism.
- **Midline cerebellar syndrome:** lesion of the cerebellar vermis – *causes* as for bilateral cerebellar syndrome.

OTHER ANORMALITIES OF CEREBELLAR FUNCTION

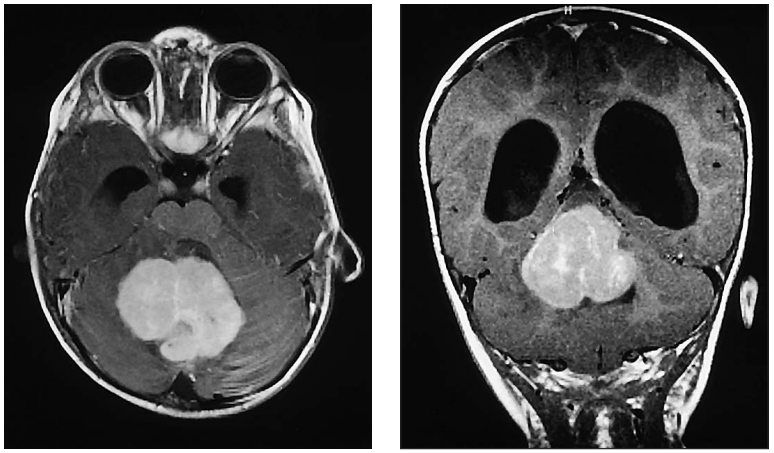
1. **Speech**
2. **Nystagmus**
3. **Hypotonia**
4. **Pendular reflexes**
5. **Tremor**

Cerebellar Disorders

Cerebellar Ischemia and Hemorrhage

Cerebellar Hemorrhage

Cerebellar Tumors



a **b**

Fig. 5.**8 Medulloblastoma**, seen in T1-weighted MR images after intravenous administration of contrast material. **a** A large, markedly and homogeneously contrast-enhancing tumor is seen in the superior portion of the vermis. The tumor compresses the fourth ventricle and causes occlusive hydrocephalus, as manifested by the enlarged temporal horns of the lateral ventricles. **b** The coronal image shows the origin of the tumor from the superior vermis and reveals marked dilatation of the lateral ventricles.

THE END

QUESTIONS ???