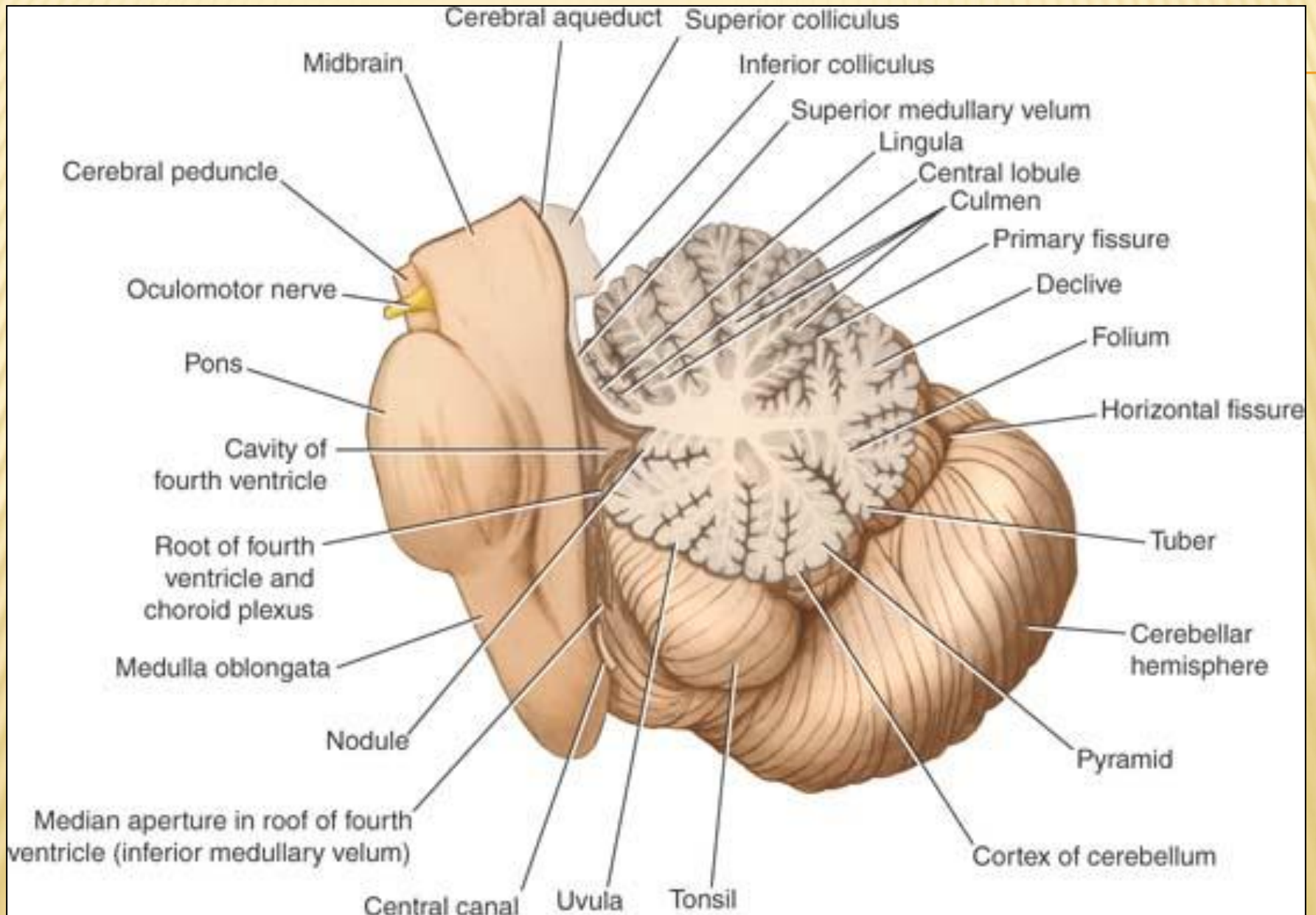




Lecture 6

Cerebellum

Cerebellum



Sagittal section through the brainstem and the vermis of the cerebellum

The cerebellum is situated in the posterior cranial fossa and is covered superiorly by the **tentorium cerebelli**

It is the largest part of the hindbrain and lies posterior to the fourth ventricle, the pons, and the medulla oblongata

Cerebellum consist of three parts:

Two cerebellar hemispheres and the vermis

cerebellar hemispheres joined by a narrow median vermis

Vermis subdivided into three parts: (from anterior to posterior) nodule, uvula and the pyramid

The cerebellum is connected to the posterior aspect of the brainstem by three symmetrical bundles of nerve fibers called the **superior, middle, and inferior cerebellar peduncles**

The cerebellum is divided into three main lobes:

the **anterior** lobe

middle lobe (posterior lobe): is the largest part of the cerebellum, is situated between the primary and uvulonodular fissures

flocculonodular lobe: is situated posterior to the uvulonodular fissure

Three main fissure:

primary fissure: wide V-shaped fissure separate the anterior lobe from the middle lobe

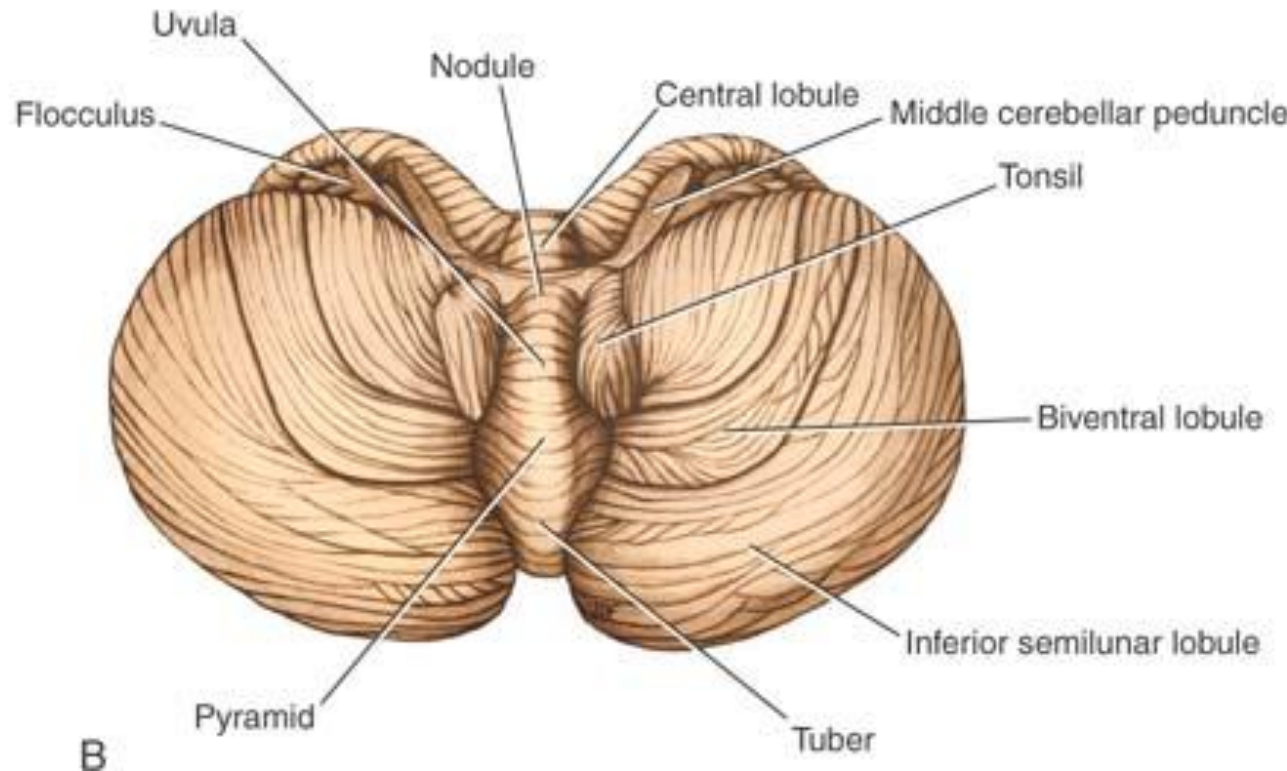
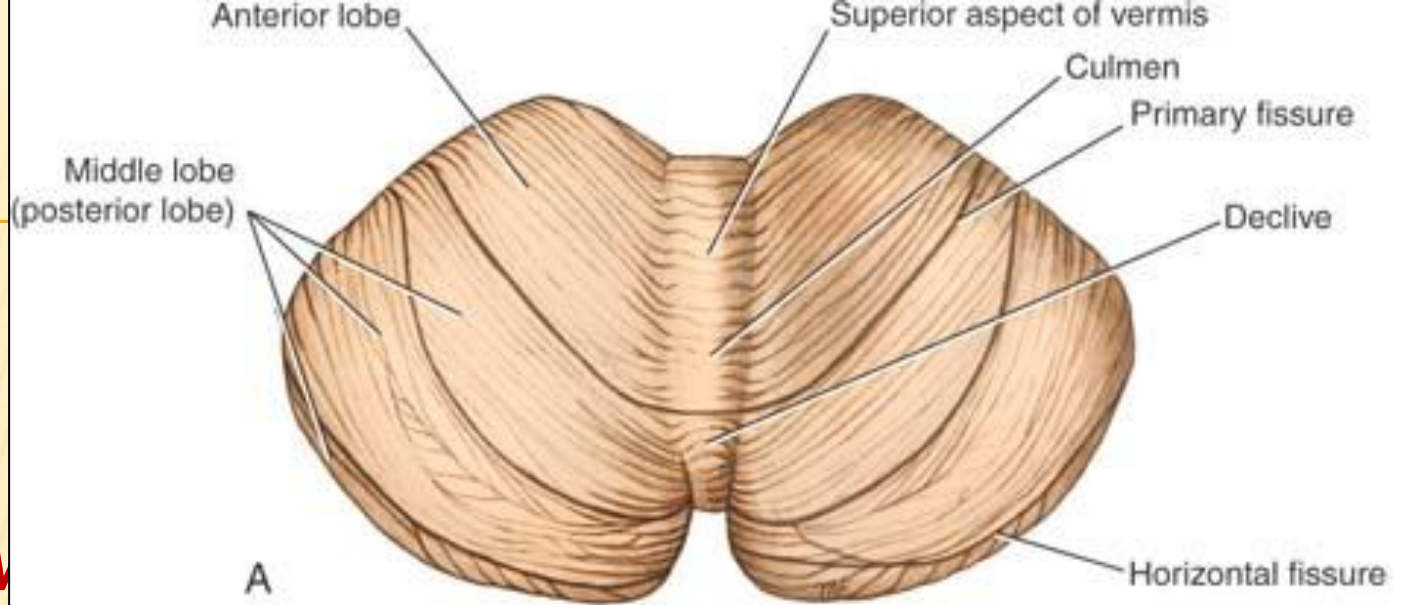
Horizontal fissure: separate the superior from the inferior surface at the level of middle cerebellar peduncles

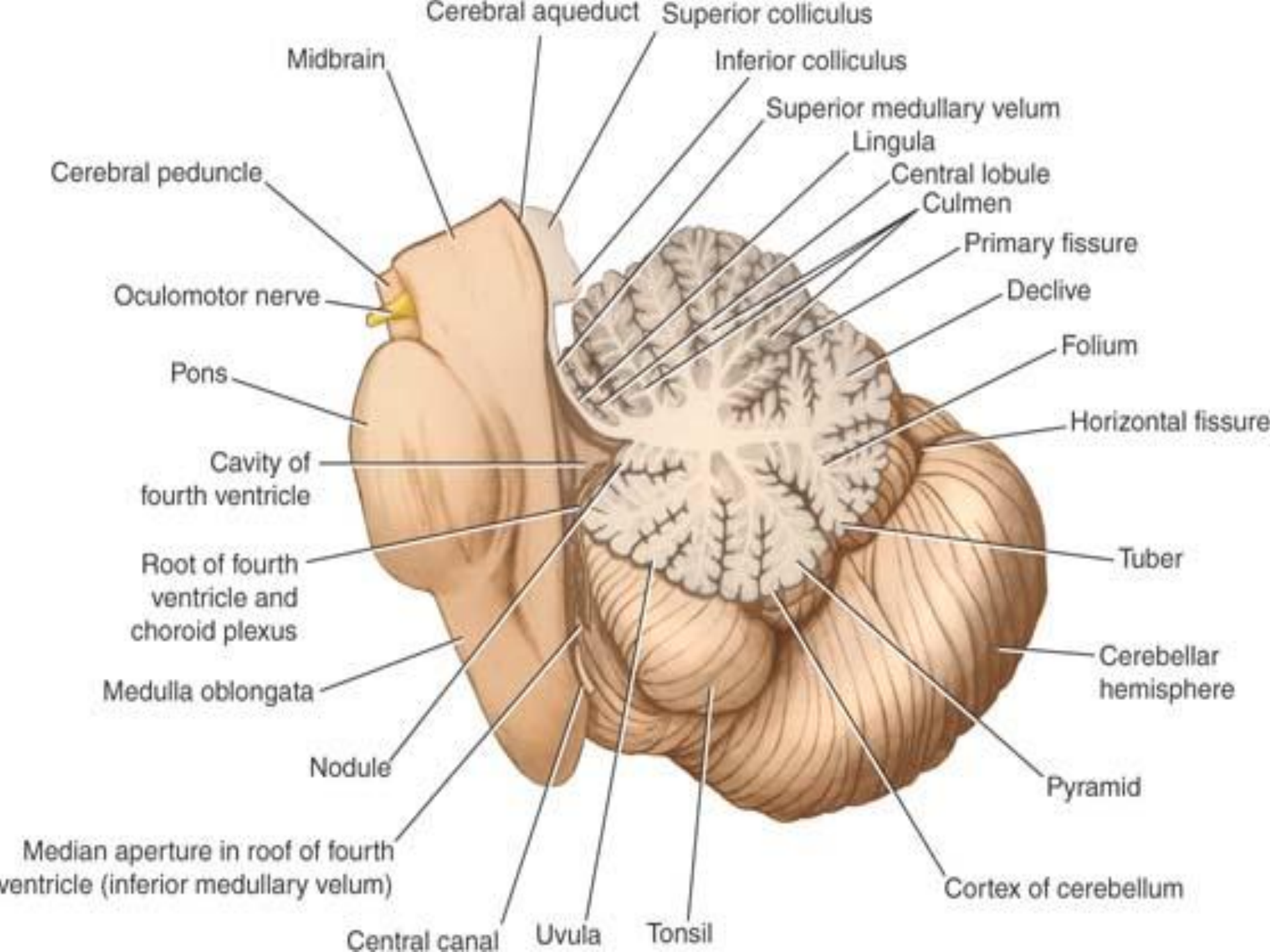
Uvulonodular fissure (posterolateral) : separate the **The flocculonodular lobe** from other lobes

The cerebellum.

A: Superior view.

B: Inferior view.





Structure of the Cerebellum

The cerebellum is composed of an outer covering of gray matter called the cortex and inner white matter. Embedded in the white matter of each hemisphere are masses of gray matter forming the intracerebellar nuclei

Structure of the Cerebellar Cortex

The gray matter of the cortex throughout its extent has a uniform structure. It may be divided into three layers

1) Molecular Layer

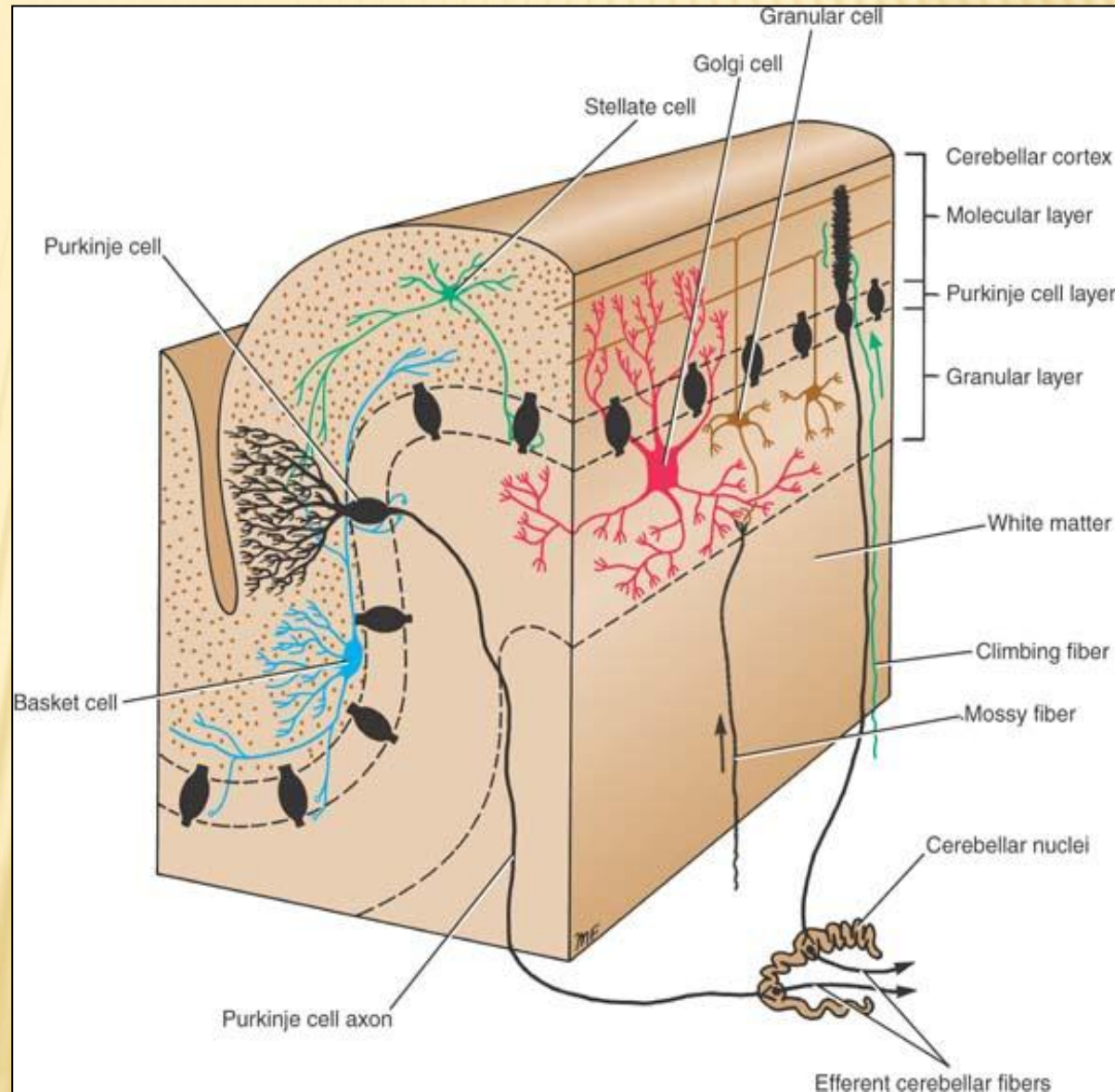
contains two types of neurons: the outer stellate cell and the inner basket cell

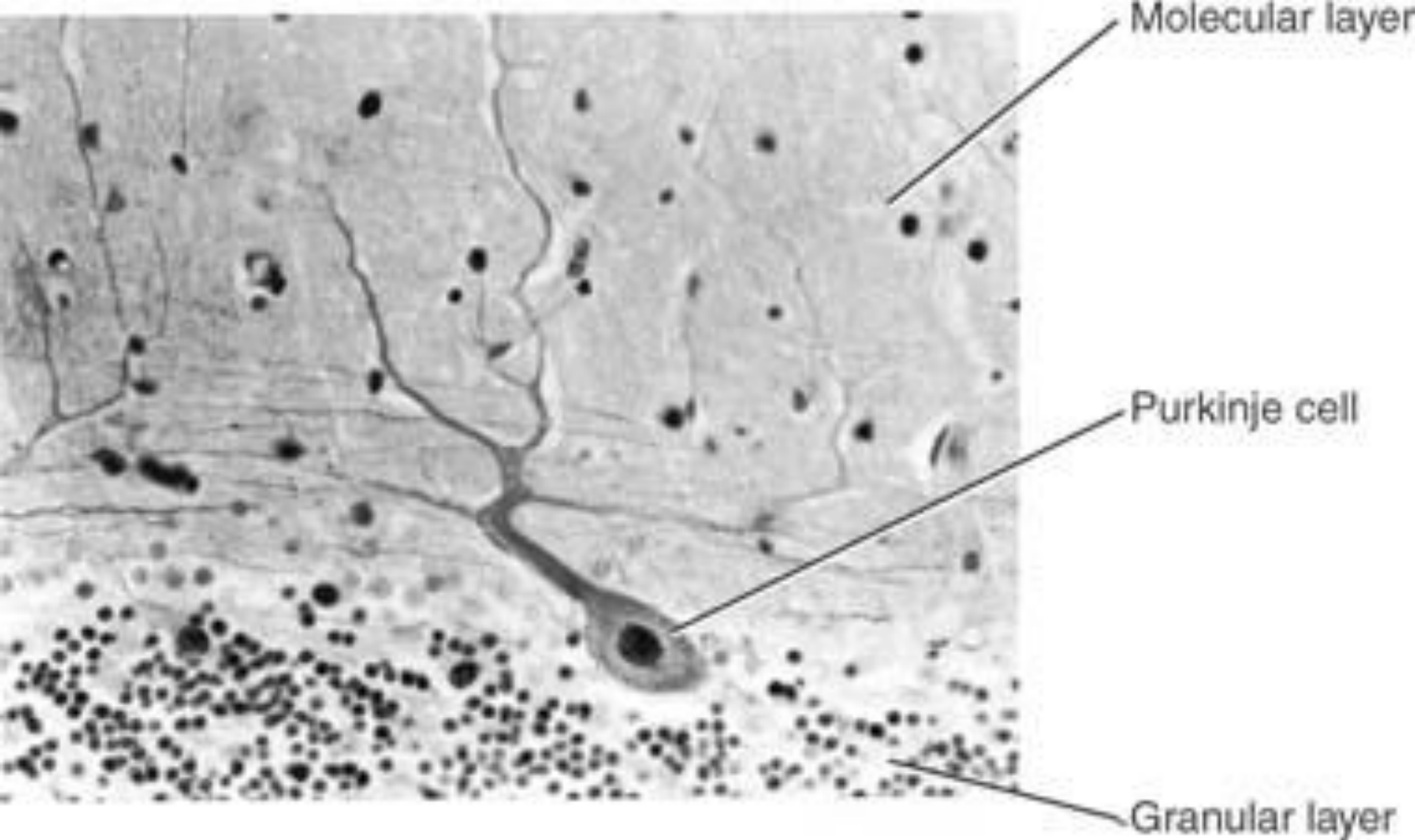
2) Purkinje Cell Layer

are large Golgi type I neurons, They are flask shaped and are arranged in a single layer

3) Granular Layer

is packed with small cells with densely staining nuclei and scanty cytoplasm





Photomicrograph of a cross section of a cerebellar folium, showing the three layers of the cerebellar cortex

Intracerebellar Nuclei

Four masses of gray matter are embedded in the white matter of the cerebellum on each side of the midline. From lateral to medial, these nuclei are the dentate, the emboliform, the globose, and the fastigial.

The dentate nucleus

is the largest of the cerebellar nuclei. It has the shape of a crumpled bag with the opening facing medially. The interior of the bag is filled with white matter made up of efferent fibers that leave the nucleus through the opening to form a large part of the superior cerebellar peduncle.

The emboliform nucleus

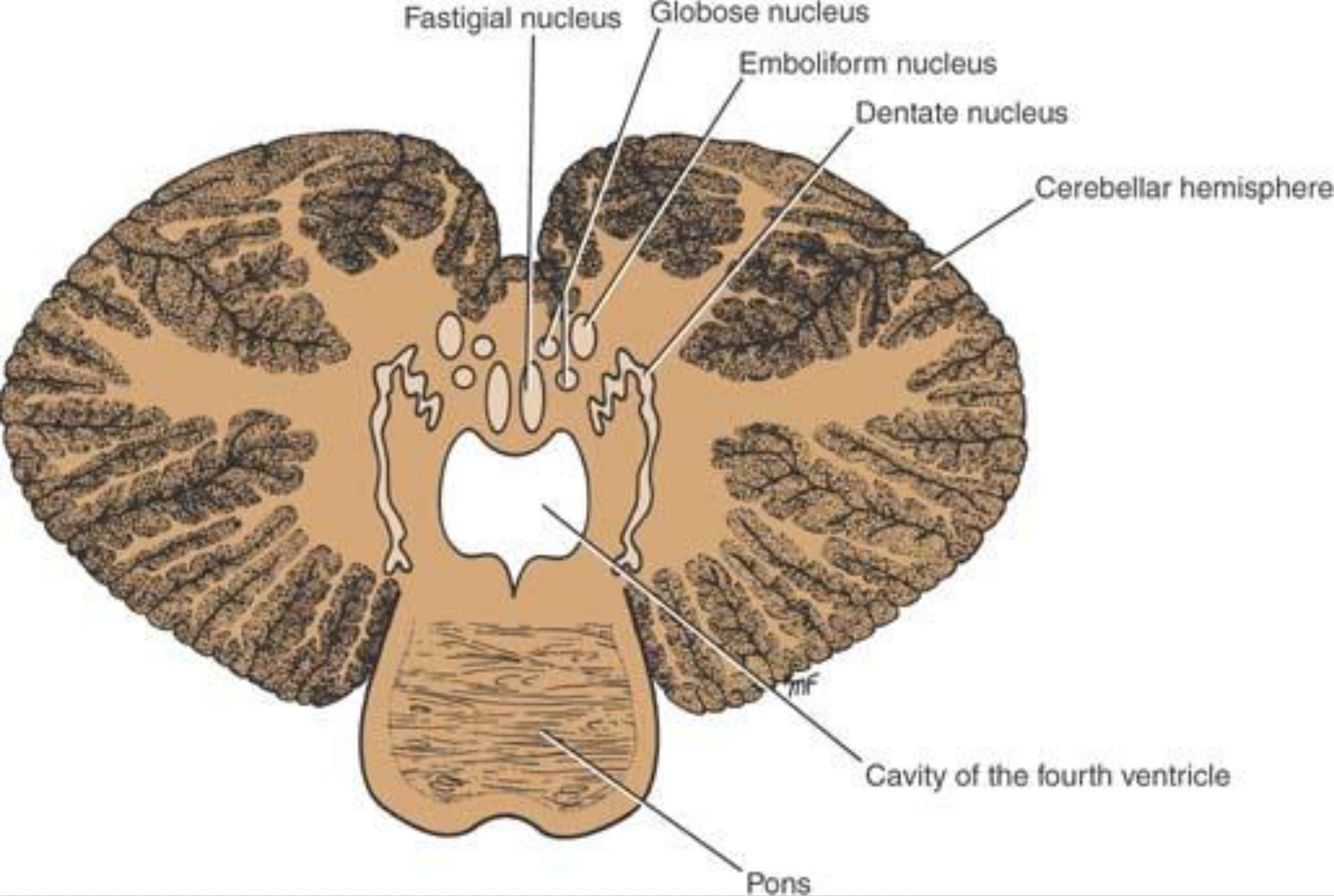
is ovoid and is situated medial to the dentate nucleus, partially covering its hilus.

The globose nucleus

consists of one or more rounded cell groups that lie medial to the emboliform nucleus.

The fastigial nucleus

lies near the midline in the vermis and close to the roof of the fourth ventricle; it is larger than the globose nucleus.



Position of the intracerebellar nuclei

Functional Areas of the Cerebellar Cortex

it is possible to divide up the cerebellar cortex into three functional areas

The cortex of the vermis influences the movements of the long axis of the body

Immediately lateral to the vermis is a so-called **intermediate zone of the cerebellar hemisphere**. This area has been shown to control the muscles of the distal parts of the limbs

- **The lateral zone of each cerebellar hemisphere** appears to be concerned with the planning of sequential movements of the entire body and is involved with the conscious assessment of movement errors

Another description for the functions of the cerebellum:

Anterior and middle lobes responsible mainly for muscle tone and coordination

Flocculonodular lobe Responsible of equilibrium (connected to the vestibular nucleus within the medulla oblongata)

White Matter

There is a small amount of white matter in the vermis; it closely resembles the trunk and branches of a tree and thus is termed the arbor vitae

- There is a large amount of white matter in each cerebellar hemisphere

The white matter is made up of three groups of fibers: (1) **intrinsic**, (2) **afferent**, and (3) **efferent**

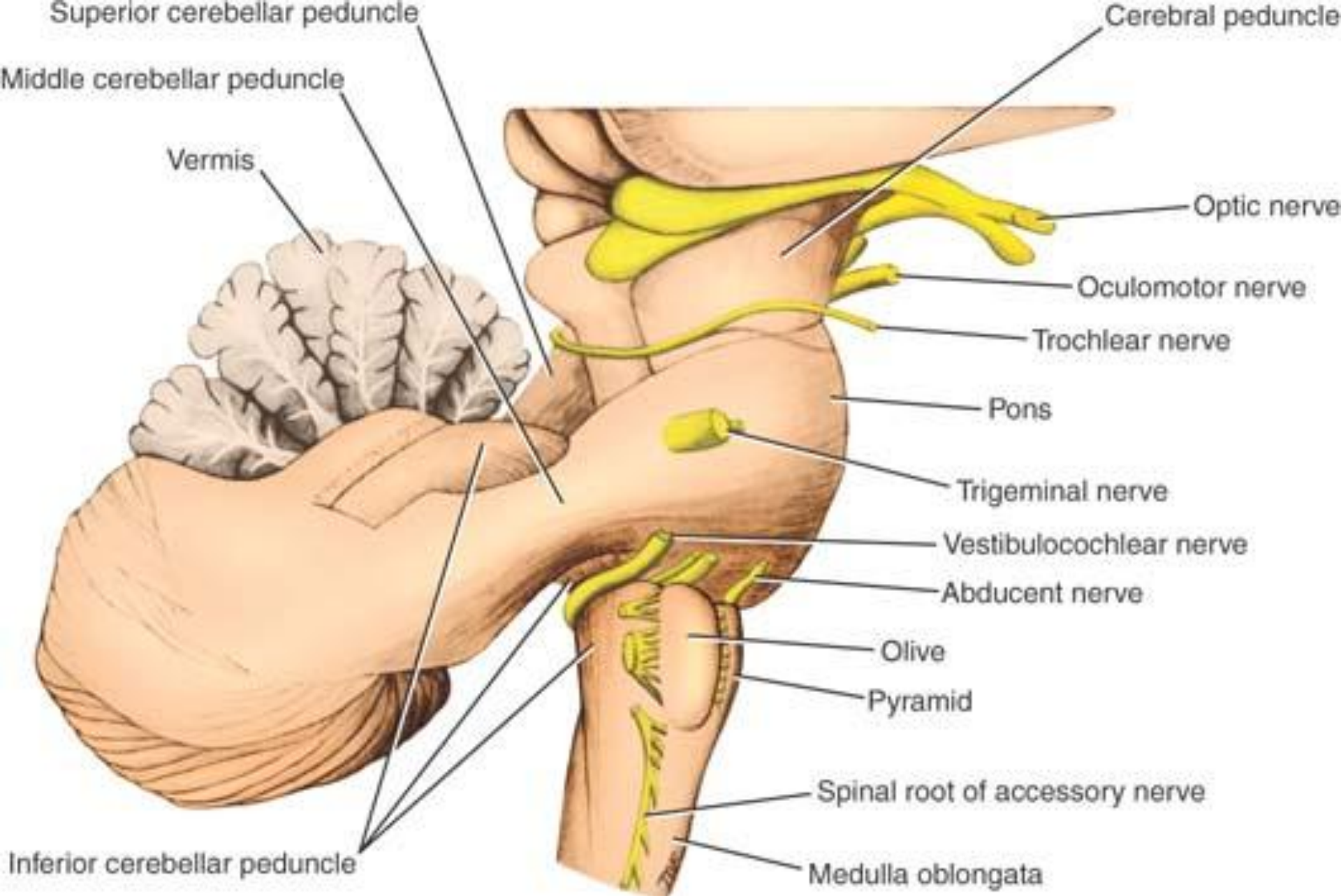
The intrinsic fibers do not leave the cerebellum but connect different regions of the organ

The afferent fibers form the greater part of the white matter and proceed to the cerebellar cortex. They enter the cerebellum mainly through the inferior and middle cerebellar peduncles

The efferent fibers constitute the output of the cerebellum and commence as the axons of the Purkinje cells of the cerebellar cortex. The great majority of the Purkinje cell axons pass to and synapse with the neurons of the cerebellar nuclei (fastigial, globose, emboliform, and dentate). The axons of the neurons then leave the cerebellum. A few Purkinje cell axons in the flocculonodular lobe and in parts of the vermis bypass the cerebellar nuclei and leave the cerebellum without synapsing

Cerebellar Peduncles

The superior cerebellar peduncles connect the cerebellum to the midbrain, the middle cerebellar peduncles connect the cerebellum to the pons, and the inferior cerebellar peduncles connect the cerebellum to the medulla oblongata



Three cerebellar peduncles connecting the cerebellum to the rest of the central nervous system

Cerebellar Afferent Fibers

Cerebellar Afferent Fibers From the Cerebral Cortex

- (1) the corticopontocerebellar pathway
- (2) the cerebro-olivocerebellar pathway
- (3) the cerebrotectocerebellar pathway

Cerebellar Afferent Fibers From the Spinal Cord

from somatosensory receptors by three pathways

- (1) the anterior spinocerebellar tract,
- (2) the posterior spinocerebellar tract
- (3) the cuneocerebellar tract

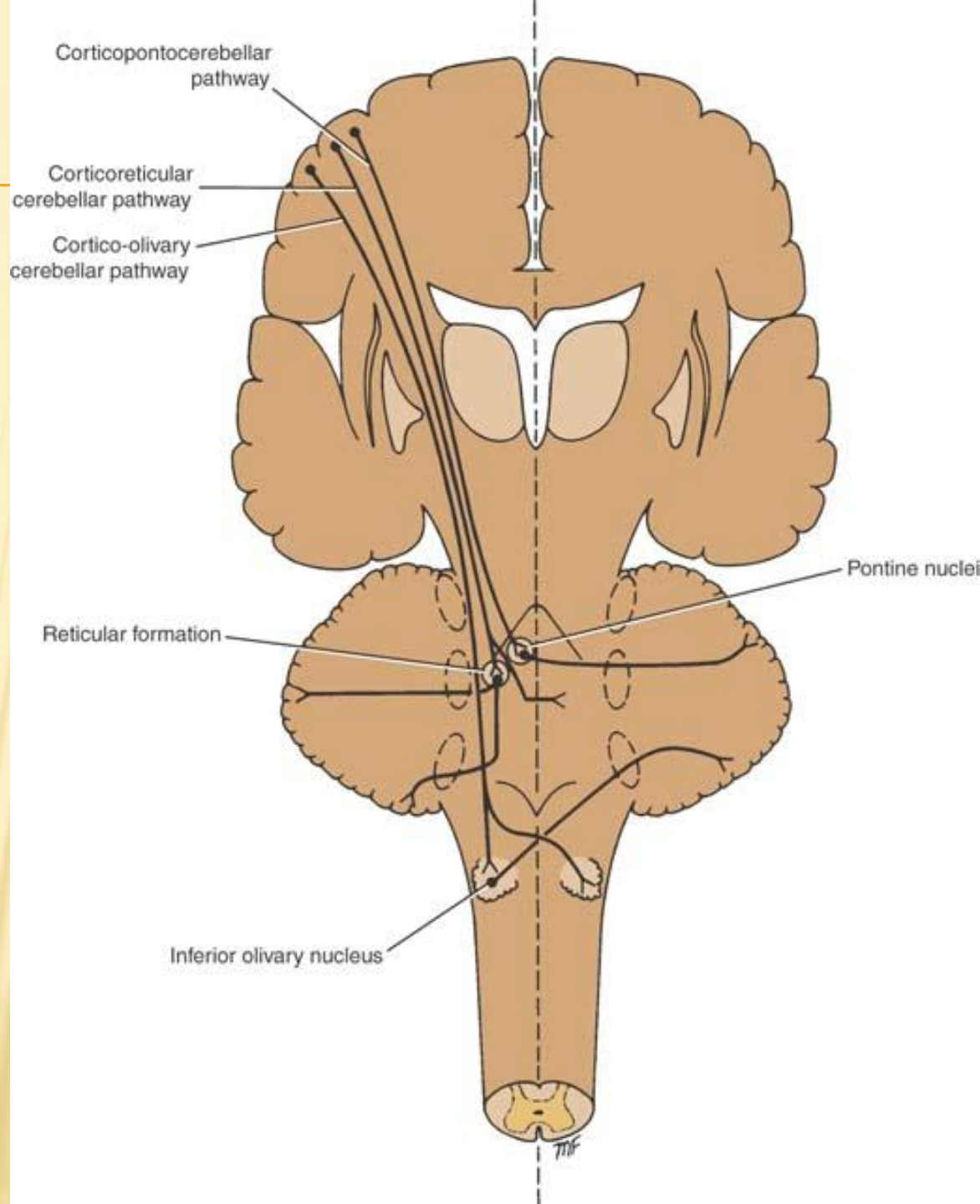
Cerebellar Afferent Fibers From the Vestibular Nerve

The vestibular nerve receives information from the inner ear concerning motion from the semicircular canals and position relative to gravity from the utricle and saccule. The vestibular nerve sends many afferent fibers directly or indirectly to the cerebellum through the inferior cerebellar peduncle on the same side

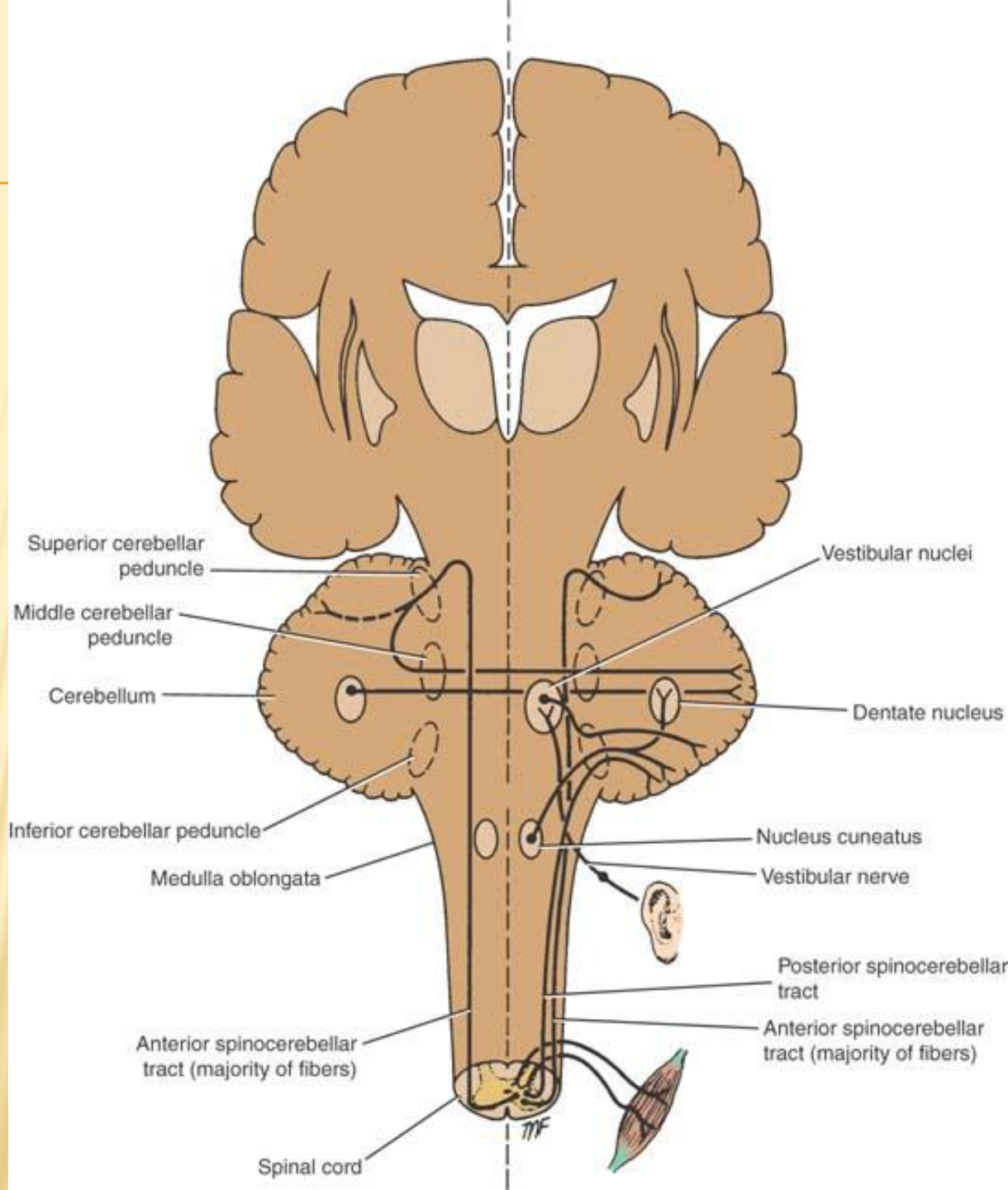
Other Afferent Fibers

In addition, the cerebellum receives small bundles of afferent fibers from the red nucleus and the tectum (visual and auditory reflexes)

Cerebellar afferent fibers from the cerebral cortex. The cerebellar peduncles are shown as ovoid dotted



Cerebellar afferent fibers from the spinal cord and internal ear. The cerebellar peduncles are shown as ovoid dotted lines



Cerebellar Efferent Fibers

(1) Globose-Emboliform-Rubral Pathway

Axons of neurons in the globose and emboliform nuclei travel through the superior cerebellar peduncle and cross the midline to the opposite side in the decussation of the superior cerebellar peduncles. The fibers end by synapsing with cells of the contralateral red nucleus, which give rise to axons of the rubrospinal tract. Thus, it is seen that this pathway crosses twice, once in the decussation of the superior cerebellar peduncle and again in the rubrospinal tract close to its origin. By this means, the globose and emboliform nuclei influence motor activity on the same side of the body.

(2) Dentothalamic Pathway

Axons of neurons in the dentate nucleus travel through the superior cerebellar peduncle and cross the midline to the opposite side in the decussation of the superior cerebellar peduncle (Fig. 6-12). The fibers end by synapsing with cells in the contralateral ventrolateral nucleus of the thalamus.

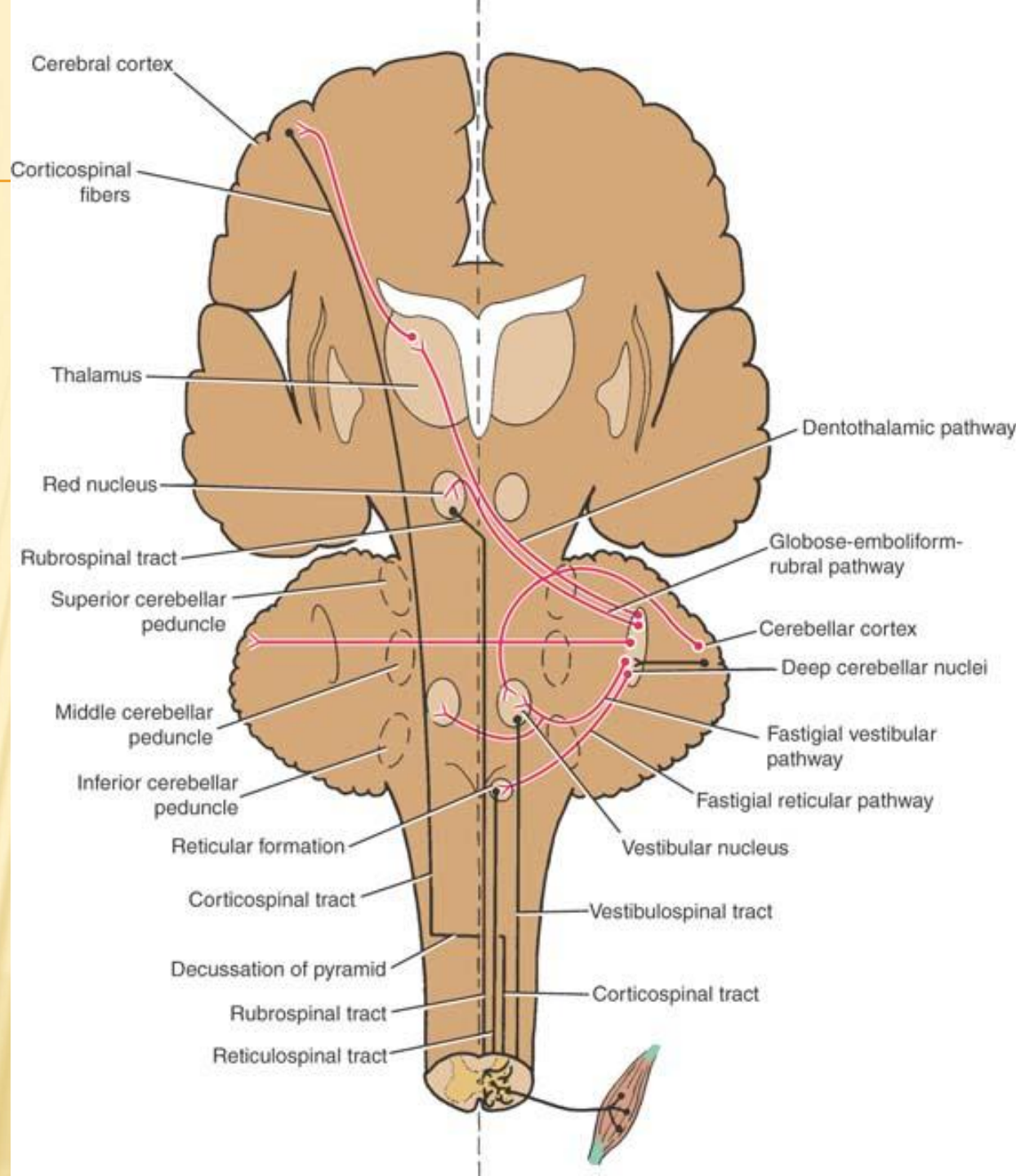
Fastigial Vestibular Pathway

The axons of neurons in the fastigial nucleus travel through the inferior cerebellar peduncle and end by projecting on the neurons of the lateral vestibular nucleus on both sides

Fastigial Reticular Pathway

The axons of neurons in the fastigial nucleus travel through the inferior cerebellar peduncle and end by synapsing with neurons of the reticular formation

Cerebellar efferent fibers. The cerebellar peduncles are shown as ovoid dotted lines



Clinical notes and function

Each cerebellar hemisphere is connected by nervous pathways principally with the same side of the body; thus, a lesion in one cerebellar hemisphere gives rise to signs and symptoms that are limited to the same side of the body

The essential function of the cerebellum is to coordinate, by synergistic action, all reflex and voluntary muscular activity. Thus, it graduates and harmonizes muscle tone and maintains normal body posture. It permits voluntary movements, such as walking, to take place smoothly with precision and economy of effort.

It must be understood that although the cerebellum plays an important role in skeletal muscle activity, it is not able to initiate muscle movement

Other function is to influence the speech by influencing the tone of laryngeal muscle, but not the initiation of speech that occur in speech center in cerebrum

According to those function, a cerebellar dysfunction may lead to one or more of the following:

Anterior and middle lobe dysfunction:

Hypotonia

Disturbances of Voluntary Movement (Ataxia)

Dysdiadochokinesia

Disturbances of Reflexes

Disturbances of Ocular Movement (pendular or jerky)

Disorders of Speech (dysarthria)

Flocculonodular Lobe dysfunction

Postural Changes and Alteration of Gait