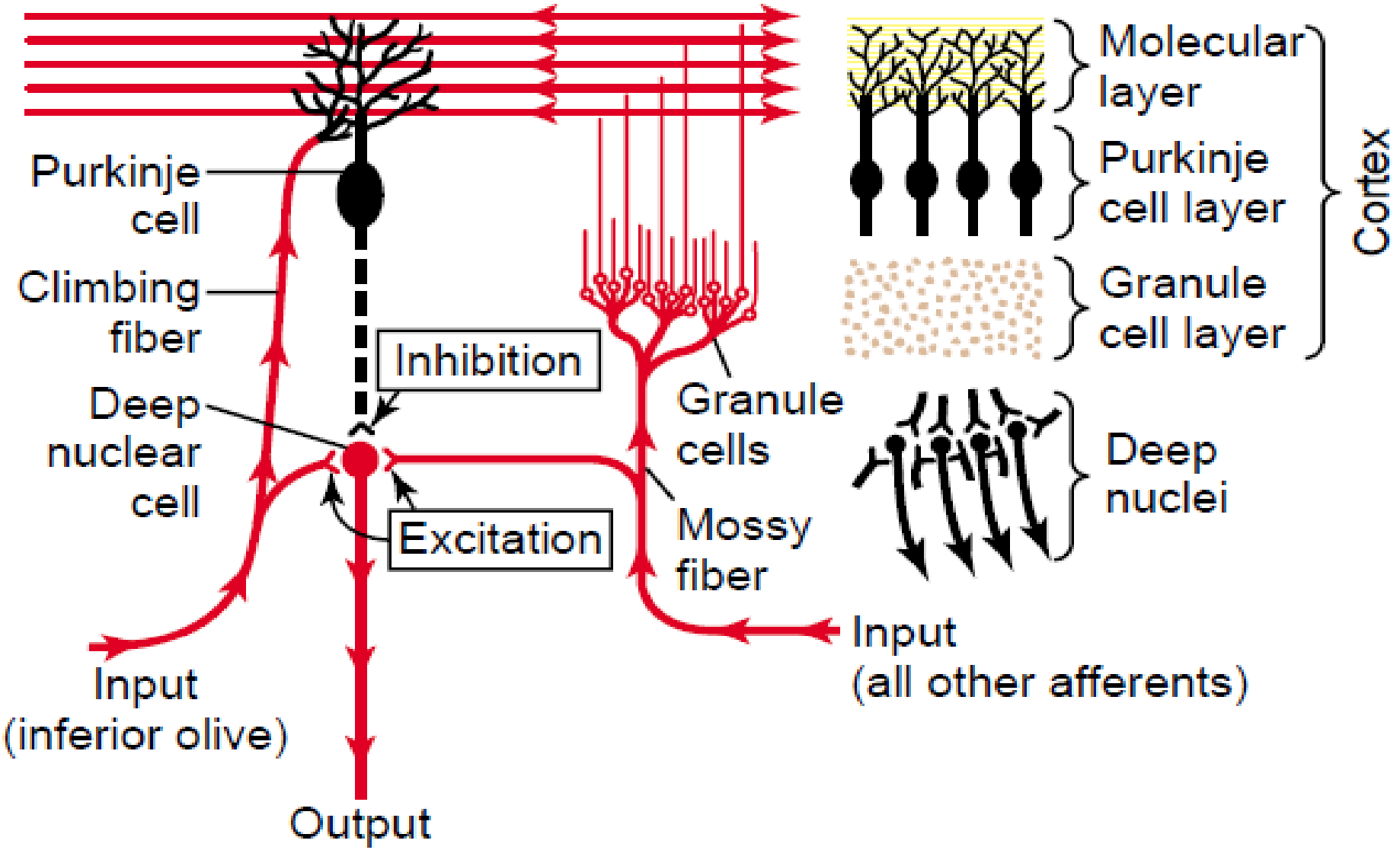
Functional Unit Of Cerebellar Cortex

The Functional Unit Of Cerebellar Cortex



Layers Of Cerebellar Cortex

- 3 Layers

1. **Molecular Layer (outer)**
2. **Purkinje Cell Layer (middle)**
3. **Granule Cell Layer (inner)**

1. Molecular Layer

- Outermost layer of cerebellar cortex

- 2 types of cells
  i) **Basket Cells**
  ii) **Stellate Cells**

Axons of **granule cells** from innermost layer project vertically into molecular layer where they bifurcate in a T like manner to form **parallel fibers**

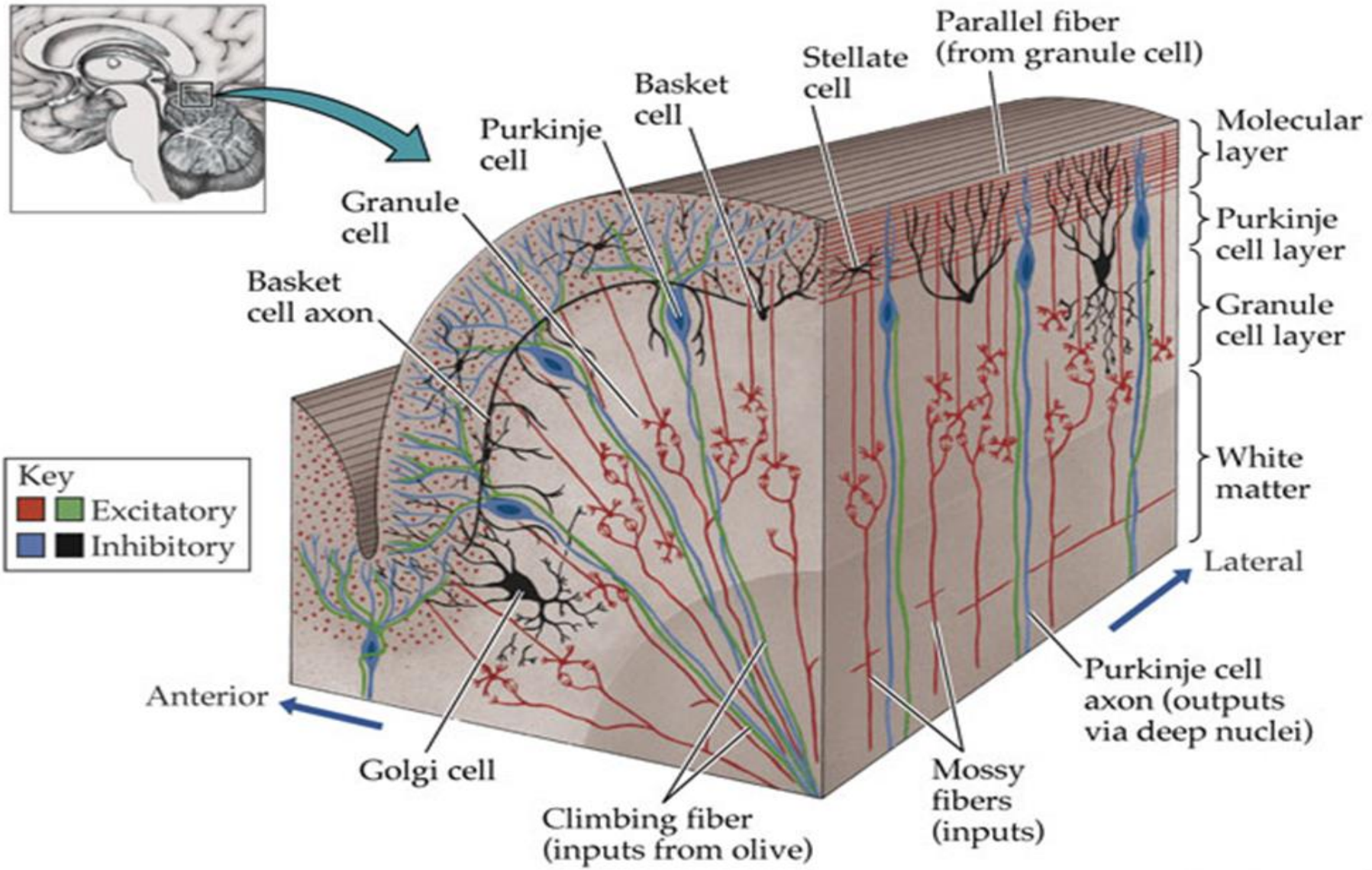
2. Purkinje Cell Layer

- **Middle Layer** of cerebellar cortex
- Contains **Purkinje cells** which are highly branched and project in outer cortex
- The axons of Purkinje cells form synaptic **connections** with neurons in one of the deep **cerebellar nuclei**

3. Granule Cell Layer

- Innermost Layer
- Contains **10 billion** granule cells and **interneurons** called **Golgi Cells**

Layers of Cerebellar Cortex

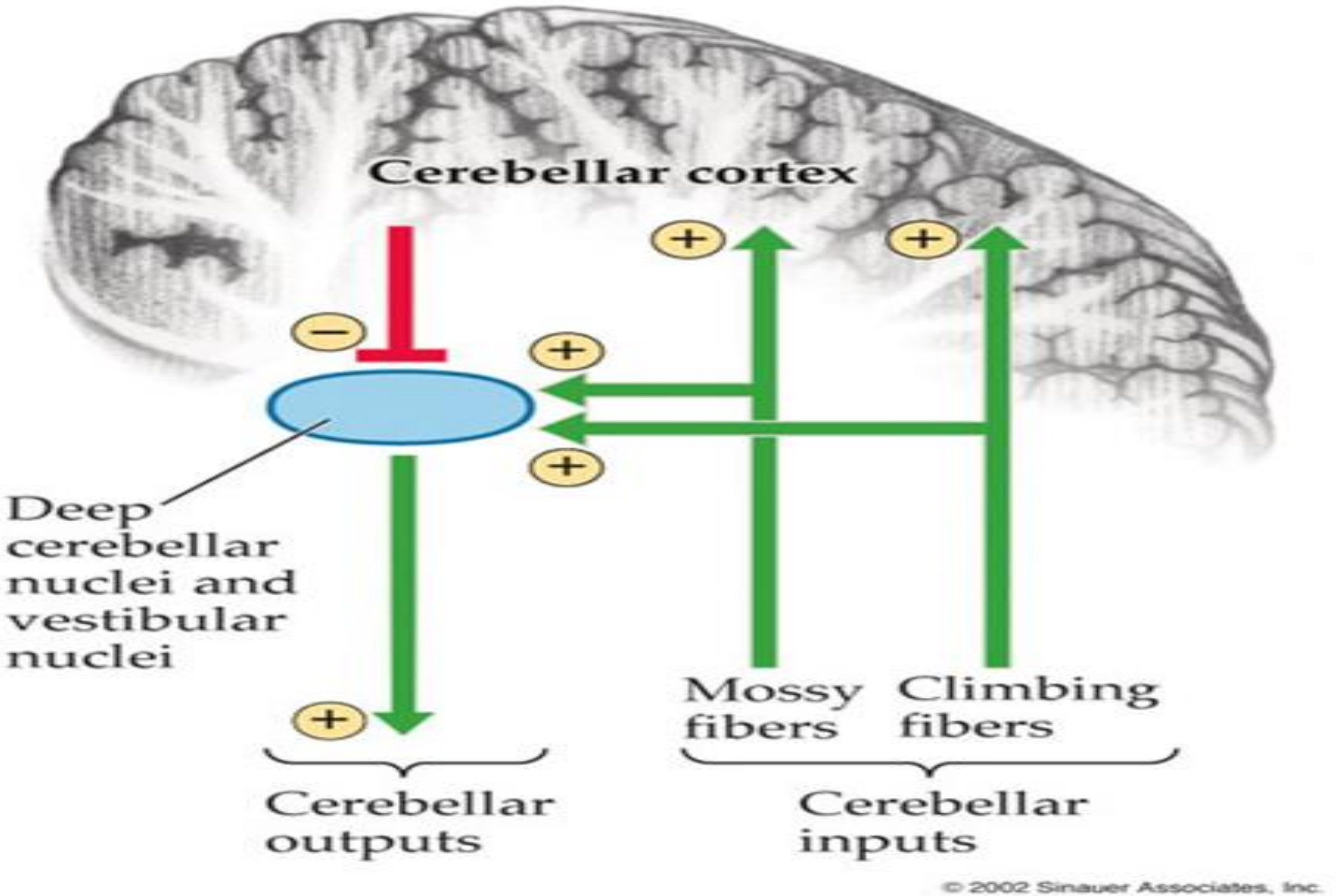


2 kinds of extrinsic synaptic inputs to cerebellar cortex

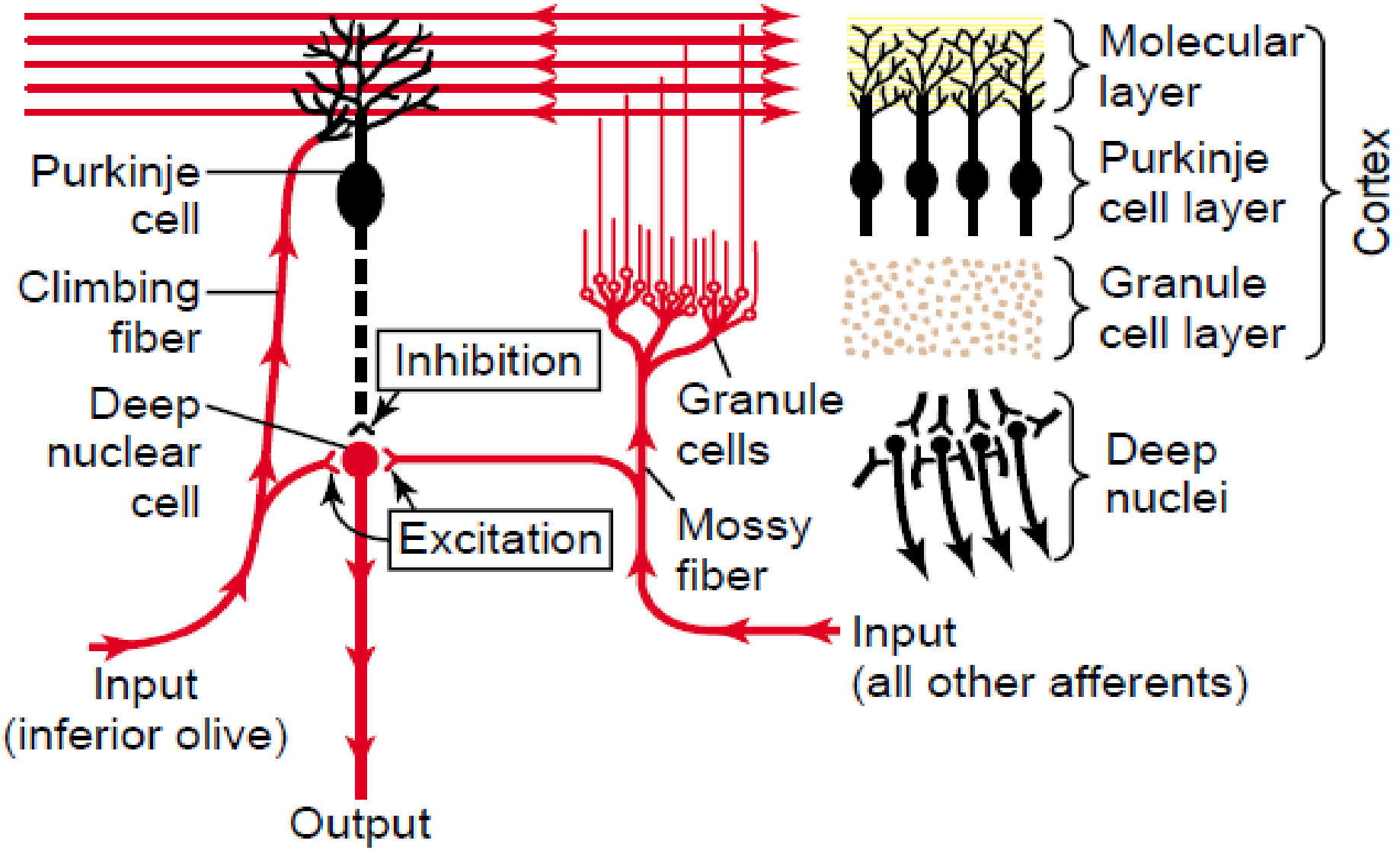
Mossy fibers – originate from several locations (neocortex and spinal cord) and terminate on **granule cell dendrites** forming excitatory synapses; branches to deep nuclei

Climbing fibers – originate in the **inferior olivary nucleus** and **wrap around** the **Purkinje cell body** and proximal dendrite forming excitatory synapses; branches to deep nuclei.

Cerebellar Inputs and Outputs



The Functional Unit Of Cerebellar Cortex



The Functional Unit Of Cerebellar Cortex

- Has **30 million** functional units
- Each unit centres on a **Purkinje Cell**
- **Afferent Fibres** Are **Climbing** And **Mossy**
- **Efferent Fibres** are **Purkinje Cell Axons**
- **Glomerulus** connections between **Mossy Fibres** and **Granule Cells**

Purkinje Cells

- Most **prominent nerve cells**
- are a class of **GABAergic neurons** located in the cerebellum
- Named after Czech anatomist Jan Evangelista Purkyne
- Found **throughout** cerebellum packed in a single layer

- Make synaptic connections with cerebellar nuclei and **GABA is released** between these two

- Effect of Purkinje Cells in deep cerebellar nuclei is **Inhibitory**

Medical conditions related to Purkinje cells

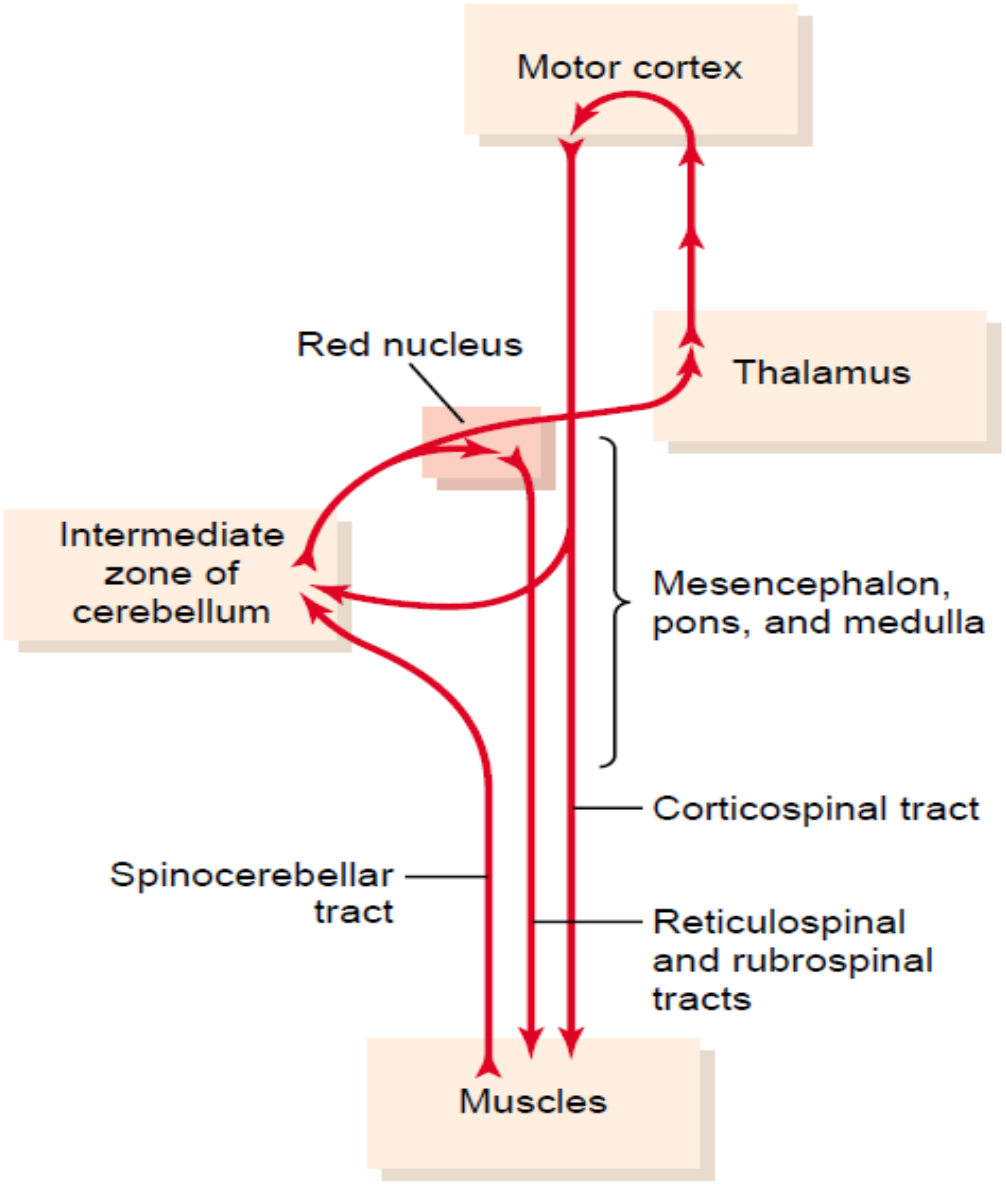
In humans, Purkinje cells can be harmed by many causes like

- **toxic exposure**, e.g. to alcohol or lithium
- **autoimmune diseases**;
- **genetic mutations** causing spinocerebellar ataxias,
- **autism**; and
- **neurodegenerative diseases** that are not known to have a genetic basis, such as the cerebellar type of multiple system atrophy or sporadic ataxias

Function of cerebellum

1. vestibulocerebellum.
   consist of flocculonodular lobe and adjacent portion of vermis.
   control of body equilibrium.
2. Spinocerebellum.
   consist of vermis and adjacent intermediate zones on both sides of vermis.
   coordinating movements of the distal portions of limbs-hands and fingers.damping, ballistic movements.
3. Cerebrocerebellum. Lateral zones of cerebellar hemispheres.
   plan the sequential voluntary movements and their timing, like writing ,running, typing etc. know what will happen next and at whats time.

Cerebral and Cerebellar Control of Voluntary Movement



General Functions Of Cerebellum

- **Planning , Coordination** And **Posture**

1. Acts with cerebral cortex to produce **skilled movements**
2. **Planning of** movement on getting information from motor and parietal cortices
3. It coordinates the fine motor movements and helps the **control of Posture** → smooth & coordinated
4. Primary function is **coordination** of somatic muscle activity, regulation of muscle tone and maintenance of balance and equilibrium

Clinical Manifestations Cerebellar Lesions

- Mostly due to damage to deep nuclei especially **DENTATE nucleus**
- **Tumors, hemorrhage, cerebellar infarction**
- **Motor disorders –**
  lesions in vermis → Ataxia

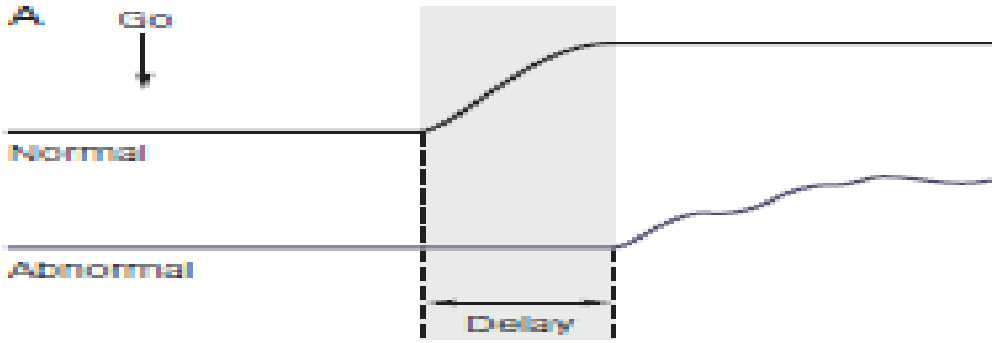
lesions in flocullonodular lobe → disturbed equilibrium + Ataxia

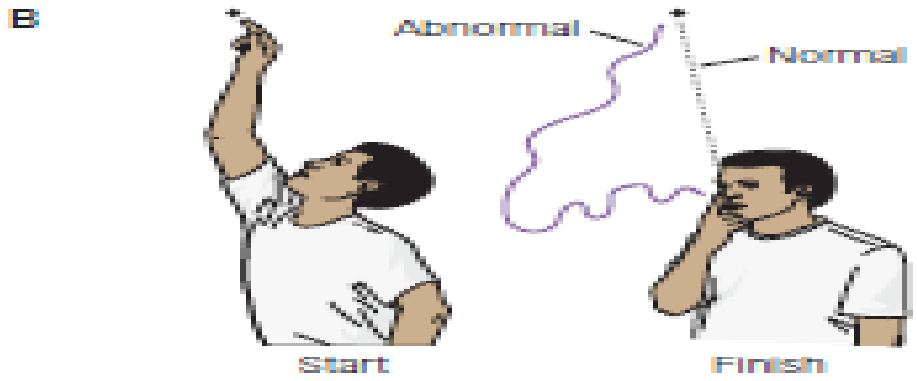
- Clinical features occur on **same side of lesion**

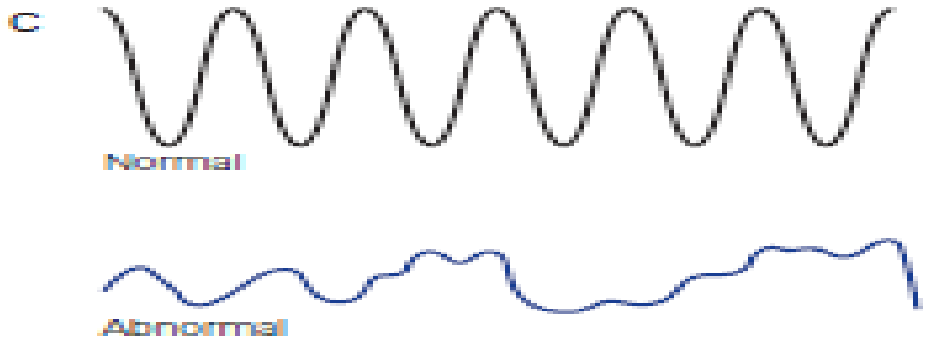
Cerebellar Dysfunction: Anatomy

Cerebellar lesion	Signs
Posterior (Flocculo-nodular lobe Archicerebellum)	**Eye movement disorders: Nystagmus; Vestibulo-ocular reflex (VOR) Postural and gait dysfunction**
Midline (Vermis; Paleocerebellum)	**Truncal & gait ataxia**
Hemisphere (Neocerebellum)	**Limb ataxia: Dysmetria, Dysdiadochokinesis, "intention" tremor Dysarthria Hypotonia**

a. Delay due to cerebellar lesion, b. Dysmetria, c. Dysdiodochokinesia







Clinical Manifestations of Cerebellar Lesions

1. Hypotonia
2. Attitude
3. Dysmetria
4. Dysarthria
5. Decomposition of movement
6. Intention tremor
7. Dysdiodochokinesia
8. Rebound Phenomenon
9. Nystagmus
10. Cerebellar Ataxia
11. Disturbance of Posture And Gait

1. Hypotonia

- **Most characteristic sign** of cerebellar disease in human
- Hypotonia **on the side of lesion**
- Person with cerebellar disease shows no abnormality while at rest but abnormalities **become apparent** on movement

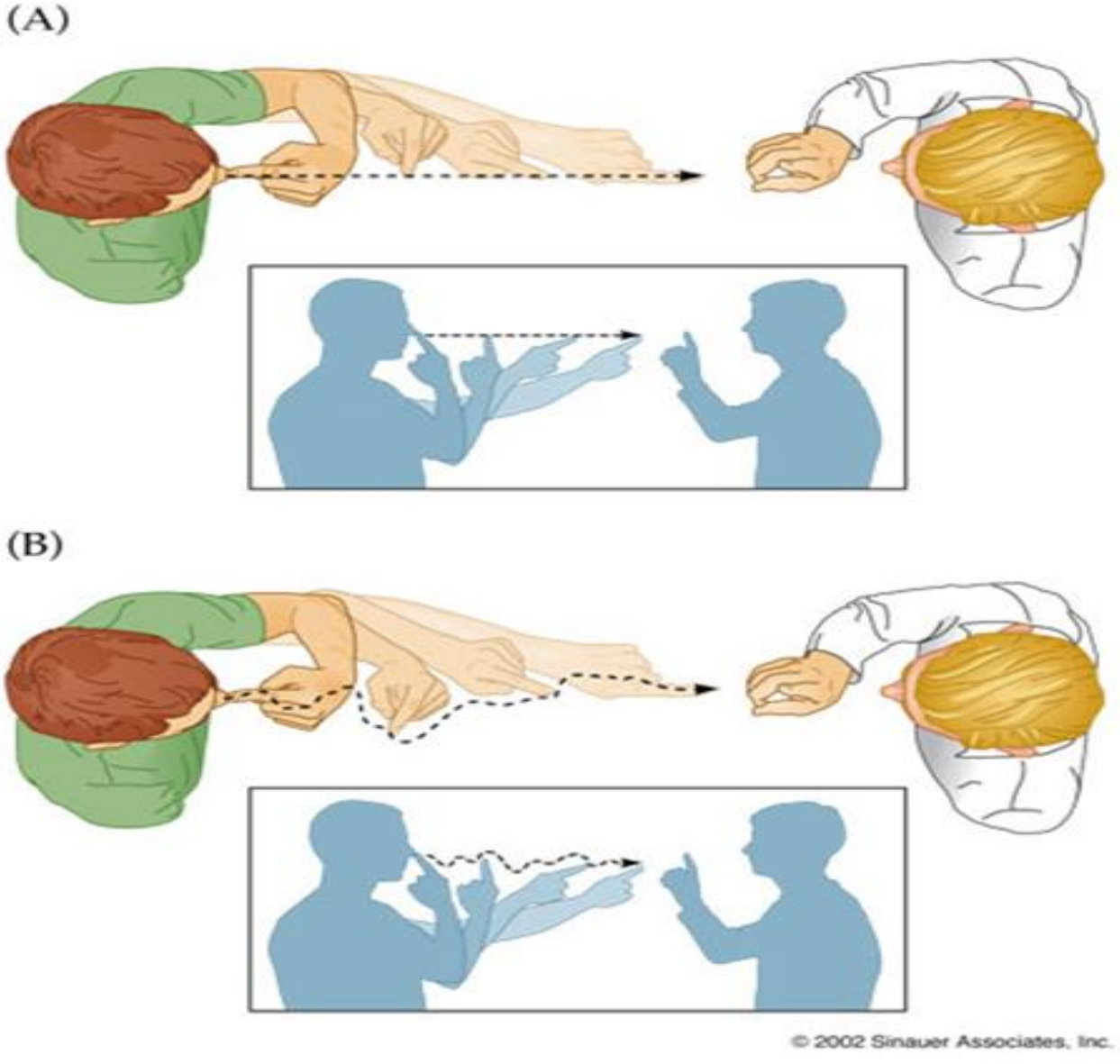
2. Attitude

- ***Face rotated to the normal side***
- **Shoulder on** the affected side is slightly raised and in front of opposite side
- **Same side leg is** adducted and rotated outward.
- The entire weight of body is thrown **on leg of normal** side

3. Dysmetria

- Inability to place an extremity at a **precise point in** space
- **Loss of sense of distance**
- **Finger nose test** → inaccuracy in range and direction of movement, unsmooth and tremors

Finger Nose Test



4. Dysarthria

- **Defective Speech**

- **Word articulation is jerky** and syllables are separated from one another → **Scanning Speech**

5. Decomposition of Movement

- Patients **decompose movements** into component parts – cannot measure rate, direction and extent of force of movement

6. Intention Tremor

- Tremors on movement like drinking a glass of water damping function.

7. Dysdiodochokinesia

- **Inability to make rapidly, alternating or successive** movements → inability to perform rapid pronation and supination

8. Rebound Phenomenon

Elicited by asking the patient to flex his forearm against resistance; the resistance is suddenly removed → the limb **overshoots the normal range** and is likely to strike the patients face

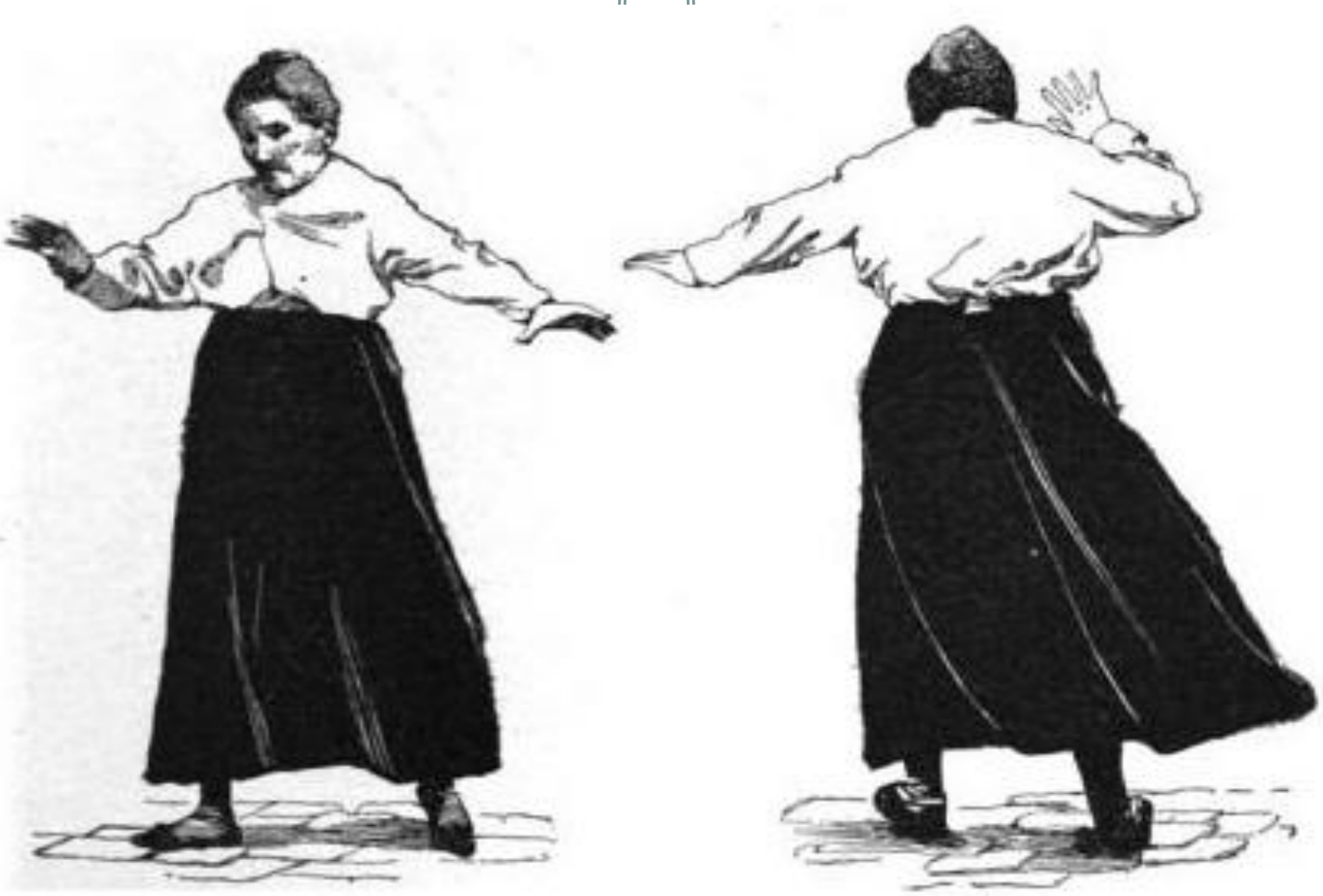
9. Nystagmus

- **Tremor of eyeball**

10. Cerebellar Ataxia

Incoordination of voluntary muscular action (like walking) → disease in cerebellum or its connections.

Cerebellar Ataxia



Cerebellar Ataxia

11. Disturbance of Posture and Gait

- **Head is tilted to the side of lesion**
- **Gait is unsteady** → walks in a drunken fashion and tends to fall to the side of lesion