Functional Unit Of Cerebellar Cortex
The Functional Unit Of Cerebellar Cortex

- Purkinje cell
- Climbing fiber
- Deep nuclear cell
- Inhibition
- Excitation
- Molecular layer
- Purkinje cell layer
- Granule cell layer
- Deep nuclei
- Input (inferior olive)
- Output
- Input (all other afferents)
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

Key:
- Red: Excitatory
- Green: Inhibitory

Diagram showing the layers and cellular structures of the cerebellar cortex, including Purkinje cells, stellate cells, basket cells, granule cells, mossy fibers, and climbing fibers.
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

Deep cerebellar nuclei and vestibular nuclei

Cerebellar outputs

Mossy fibers

Climbing fibers

Cerebellar inputs

Cerebellar cortex

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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
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


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 what time.
General Functions Of Cerebellum

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

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