# ****Cerebellum – Exam Summary****

## 📍 ****General Overview****

**Location**: Lies **inferior & posterior** to cerebrum in cranial fossa

**Size**: 2nd largest brain region

**10%** of brain volume

**50%** of brain neurons

## 📌 ****Functions****

Integrates sensory inputs (incl. special senses)

Coordinates **timing and sequencing** of voluntary movements

Controls **posture, balance**, and **muscle tone**

Receives input from muscles, joints, skin, eyes, and ears

**Does NOT initiate** voluntary movement but coordinates it

## 📐 ****Structure****

**Folded cortex** with folia

Divided into **3 lobes**:

**Anterior lobe**

**Posterior lobe**

**Flocculonodular lobe** (oldest; works with vestibular system)

**Primary fissure** separates anterior & posterior lobes

**Vermis**: Midline groove separating R & L hemispheres

## 🧩 ****Functional Divisions of Each Hemisphere****

| **Region** | **Function** |
| --- | --- |
| **Vermis** | Controls axial muscles (head, neck, trunk) |
| **Intermediate (Paravermis)** | Controls limbs (upper/lower) |
| **Lateral Zone** | Coordinates timing & sequencing of movements |

## 🌀 ****Functional Subdivisions of Cerebellum****

| **Name** | **Region** | **Main Function** |
| --- | --- | --- |
| **Vestibulocerebellum** (Archicerebellum) | Flocculonodular lobe | Equilibrium & posture |
| **Spinocerebellum** (Paleocerebellum) | Vermis + Paravermis | Muscle tone & posture control |
| **Cerebrocerebellum** (Neocerebellum) | Lateral hemisphere | Planning, timing of motor activity |

## 🧠 ****Topographic Representation****

**Vermis**: Axial body (e.g., trunk, head)

**Intermediate zone**: Limbs and face

**Lateral hemisphere**: No body map; connected to **premotor & sensory areas** of cortex → plans sequential movement

Sends motor signals to:

Cerebral cortex

Red nucleus

Reticular formation

## 🧬 ****Cerebellar Cortex Layers****

**Molecular layer** (outer)

**Purkinje cell layer**

**Granule cell layer**

Below cortex: **Deep cerebellar nuclei** → output to other brain regions

## 🔹 ****Deep Cerebellar Nuclei****

| **Nucleus** | **Location** | **Function** |
| --- | --- | --- |
| **Fastigial** | Medial | Output from vermis |
| **Interposed (Emboliform + Globose)** | Intermediate | Output from paravermis |
| **Dentate** | Lateral | Output from lateral hemisphere |

## 🌐 ****Cerebellar Connections****

**Three cerebellar peduncles** (white matter tracts):

**Superior** – connects to midbrain

**Middle** – connects to pons

**Inferior** – connects to medulla

## 🔌 ****Input Fibers to Cerebellum****

| **Type** | **Origin** | **Pathway** |
| --- | --- | --- |
| **Climbing fibers** | Inferior olivary nucleus | → Deep nuclei → Purkinje cells |
| **Mossy fibers** | Inferior olive + other CNS areas | → Granule cells → Purkinje cells |

### ✅ ****Quick Review****

❗ **Cerebellum = Coordinator, not initiator**

❗ Flocculonodular lobe = balance & equilibrium

❗ Dentate nucleus = involved in **motor planning**

❗ Input = via climbing & mossy fibers

# ❗ Output = via deep nuclei → brainstem/cortex ****Neuroanatomy – Cerebellum, Thalamus & Hypothalamus (Exam Notes)****

## ✅ ****I. Cerebellum****

### A. ****Afferent (Input) Connections****

| **Pathway** | **Origin** | **Destination** | **Function** |
| --- | --- | --- | --- |
| **Tectocerebellar** | Superior & Inferior colliculi | SCP → cerebellum | Visual & auditory signals |
| **Corticopontocerebellar** | Motor, sensory & association areas → pontine nuclei | MCP → contralateral cerebellum | Transmit motor plan |
| **Olivocerebellar** | Inferior olivary nucleus | ICP → cerebellum | Modulated by cortex, BG, RF |
| **Vestibulocerebellar** | Vestibular apparatus | ICP → vestibulocerebellum | Posture & equilibrium |
| **Reticulocerebellar** | Reticular formation | MCP/ICP → spinocerebellum | Muscle tone & movement |
| **Dorsal spinocerebellar** | Muscle spindles, GTOs | ICP → cerebellum | Limb position, tension |
| **Ventral spinocerebellar** | From spinal cord (influenced by brain) | ICP | Info about motor commands |

### B. ****Efferent (Output) Pathways****

**All arise from deep cerebellar nuclei**

#### 1. ****Vestibulocerebellum (Flocculonodular lobe)****

**Fastigovestibular tract** → ICP → vestibular nuclei → vestibulospinal tract

Controls posture & equilibrium

#### 2. ****Spinocerebellum (Vermis & Paravermis)****

Nuclei: **Fastigial**, **Interpositus**

Project via SCP & ICP to:

**Thalamus (ventral/medial)** → Motor cortex

**Red nucleus**

**Vestibular nucleus**

**Function**: Reciprocal coordination of limb muscles

#### 3. ****Cerebrocerebellum (Lateral hemispheres)****

**Dentate nucleus** → SCP → crosses midline → thalamus → cortex

Forms the **cortico-ponto-cerebellar-dentate-thalamo-cortical circuit**

**Function**: Planning, timing & sequencing of motor activities

### C. ****Main Functions of Cerebellum****

| **Function** | **Detail** |
| --- | --- |
| **Posture & equilibrium** | Compared vestibular & proprioceptive input |
| **Muscle tone** | ↑ by neocerebellum (facilitatory), ↓ by paleocerebellum (inhibitory) |
| **Voluntary movement control** | Planning, timing, damping, and ballistic movements |

### D. ****Cerebellar Syndrome – "AAA"****

| **Term** | **Manifestation** |
| --- | --- |
| **Atonia** | ↓ tone (flaccidity, pendular reflex) |
| **Asthenia** | Weakness, difficulty initiating movement |
| **Ataxia** | Incoordination: dysmetria, kinetic tremor, dysarthria, rebound, nystagmus, gait instability, adiadochokinesia |

## ✅ ****II. Thalamus****

### A. ****Structure****

Part of diencephalon (80%)

Lies around **third ventricle**

Connected by **massa intermedia**

### B. ****Nuclei Classification****

| **Type** | **Example** | **Function** |
| --- | --- | --- |
| **Specific projection (relay)** | VPL, VPM, MGB, LGB | Sensory relay to cortex |
| **Nonspecific projection** | Anterior, ventroanterior | RAS relay, memory |
| **Association** | Dorsomedial, dorsolateral | High cognition, emotion |
| **Motor** | Ventrolateral (VLN) | Connects cerebellum, BG to cortex |

### C. ****Functions****

Major **sensory relay station** (except olfaction)

Relays info to motor cortex from cerebellum & BG

Final center for **crude touch** and **slow pain**

Involved in **memory**, **consciousness** (RAS)

### D. ****Thalamic Syndrome****

Cause: Stroke/thrombosis of thalamogeniculate artery

Effects: Contralateral **hemianesthesia**, abnormal pain & touch perception

## ✅ ****III. Hypothalamus (HT)****

### A. ****Location & Structure****

Forms **floor & lateral wall of 3rd ventricle**

~5g, <1% of brain but key for **homeostasis**

Divided into:

**Anterior**, **Middle**, **Posterior**, **Lateral**, **Periventricular** nuclei

### B. ****Major Functions****

| **Function** | **Description** |
| --- | --- |
| **ANS regulation** | Ant. HT = Parasymp., Post. HT = Symp. |
| **Endocrine control** | Hypophysis (ant. & post.) & adrenal medulla |
| **Body temperature** | Ant. HT = cooling, Post. HT = heating, preoptic = thermostat |
| **Emotion** | Via limbic system |
| **Food intake** | Lateral = hunger, Ventromedial = satiety |
| **Water balance** | Thirst center (lateral HT, OVLT), osmoreceptors |
| **Sexual behavior** | Libido, sexual responses |
| **Sleep** | Lesion in post. HT → hypersomnolence; HT interacts with RAS |
| **Metabolic rate** | Via thyroid and adrenal stimulation |
| **Milk ejection & uterine contraction** | Via oxytocin (neurohypophysis) |

### C. ****Lesion Effects****

**Diabetes insipidus**, hyper/hypothermia

**Sleep disorders**, **hormonal imbalance**, **hyperphagia**, **emotional instability**