White Matter of the Cerebrum

The **white matter of the cerebrum** lies deep to the cerebral cortex and consists predominantly of **myelinated nerve fibers**, supported by neuroglia. It connects different parts of the cerebral cortex with one another and connects the cortex with subcortical structures, brainstem and spinal cord.

The cerebral white matter is classically divided into **three types of fibers**:

1. Association fibers

Connect **different cortical areas within the same cerebral hemisphere**.

A. Short association fibers

- Connect adjacent gyri.
- Also called **U-fibers** because they pass beneath the sulci in a U-shaped manner.

B. Long association fibers

Connect distant cortical areas of the same hemisphere.

Important examples:

- **Superior longitudinal fasciculus** — connects frontal, parietal and temporal regions.
- **Inferior longitudinal fasciculus** — connects occipital and temporal regions.
- **Uncinate fasciculus** — connects orbital/inferior frontal cortex with the anterior temporal lobe.
- **Cingulum** — connects cortical areas of the cingulate and parahippocampal regions.

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2. Commissural fibers

These connect corresponding or functionally related areas of the **two cerebral hemispheres**.

The major commissural fibers are:

Corpus callosum

The largest commissural bundle.

It consists of:

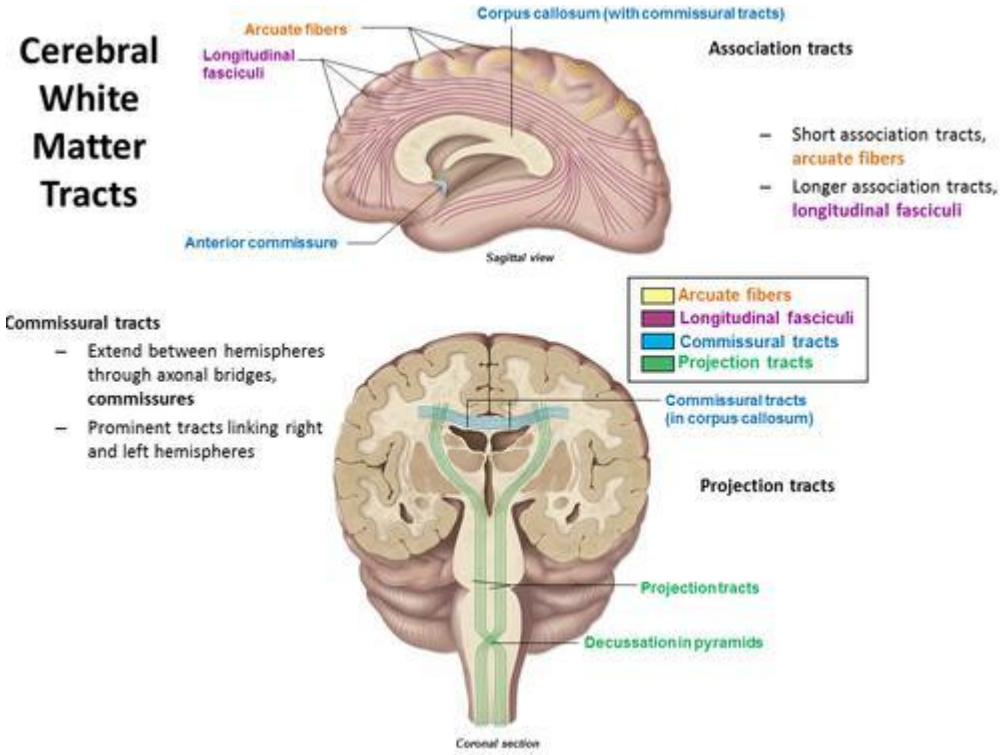
1. **Rostrum**
2. **Genu**
3. **Body**

4. **Splenium**

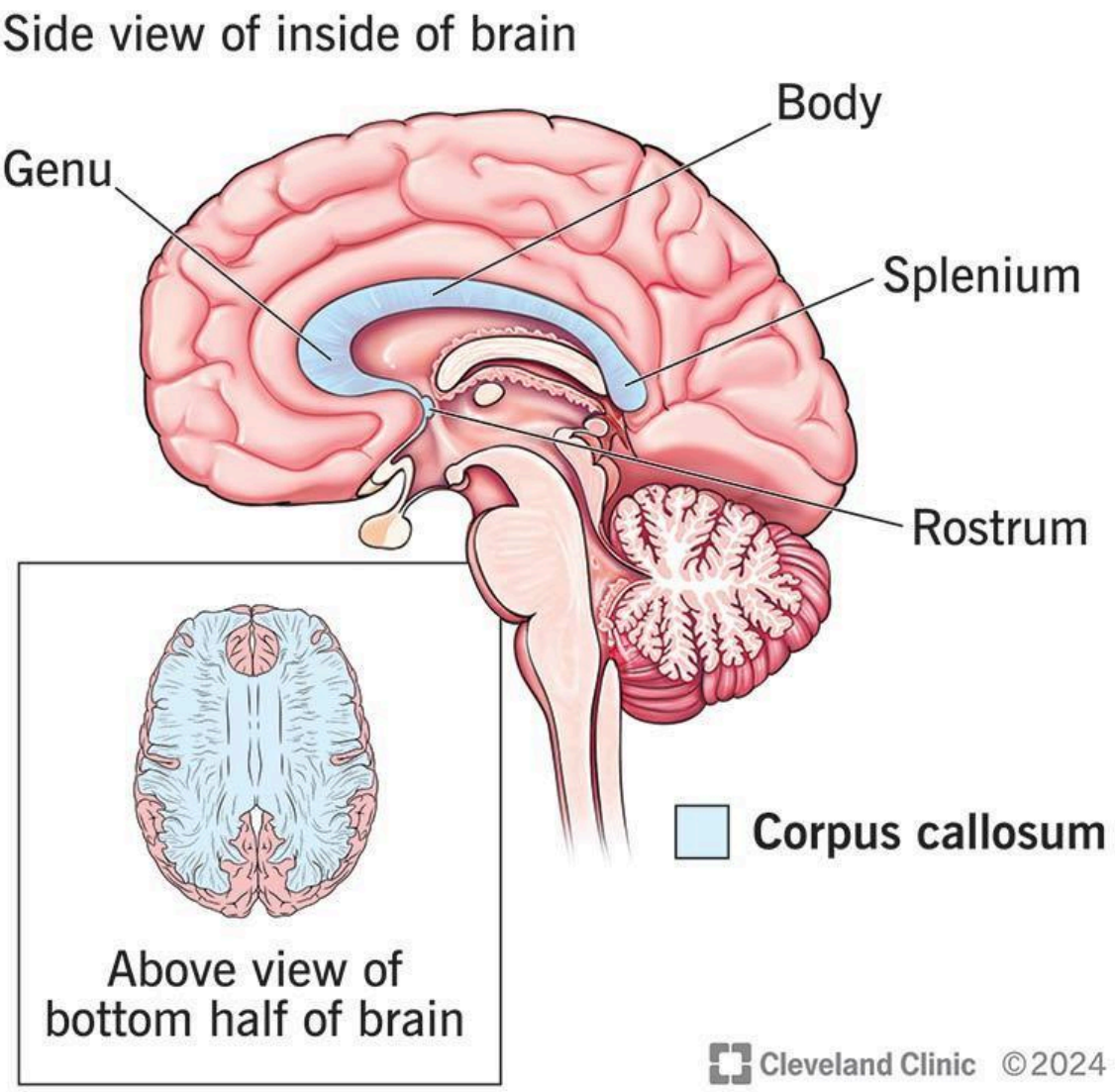
It connects corresponding cortical areas of the two hemispheres and permits interhemispheric integration.

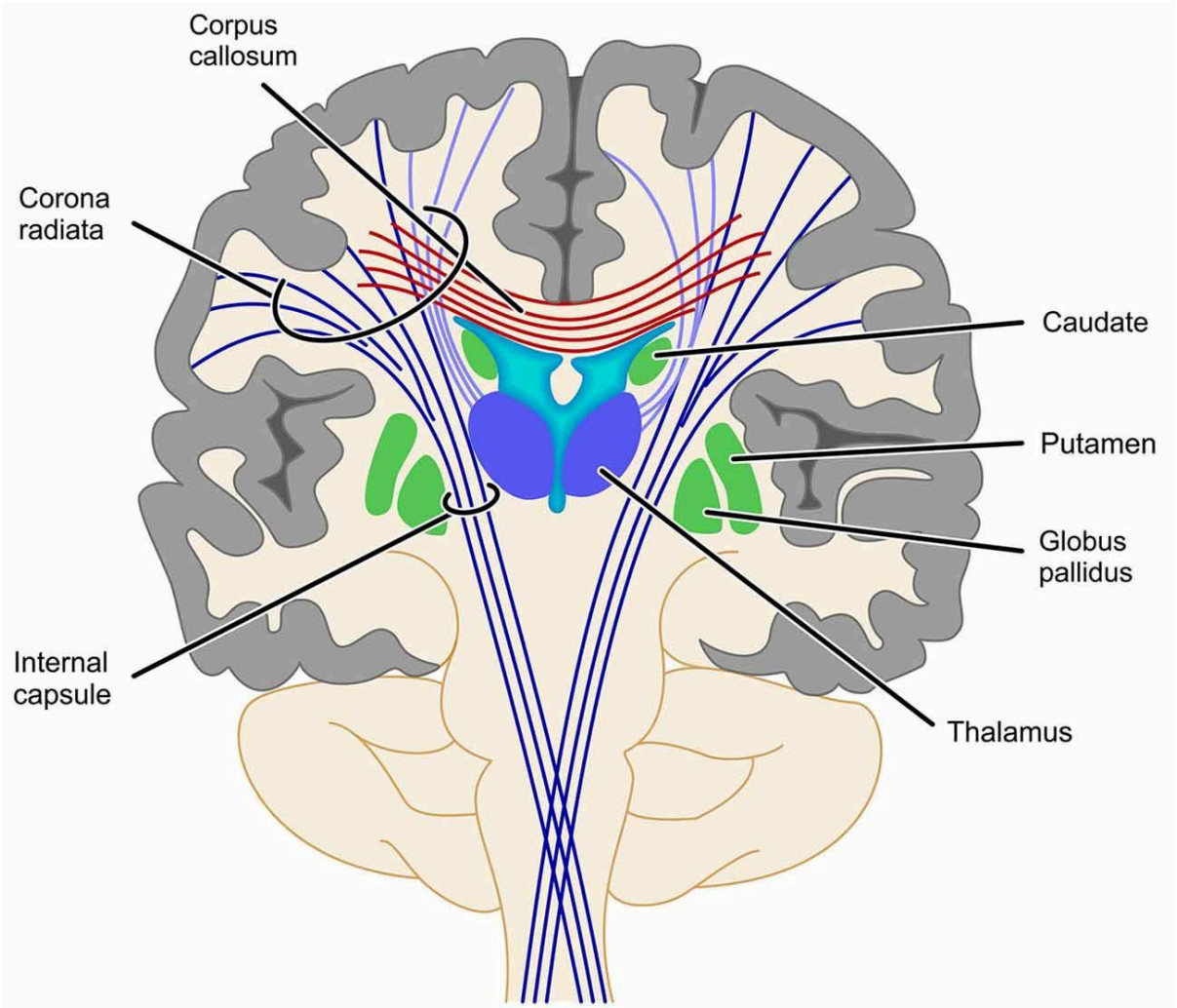
Other commissures include:

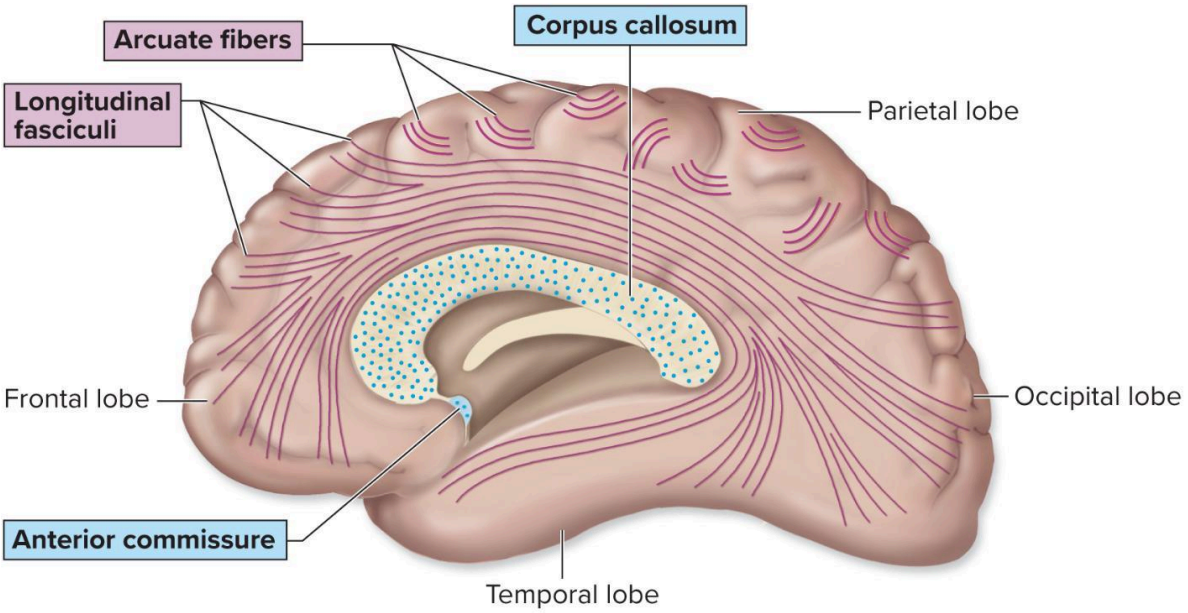
- Anterior commissure
- Posterior commissure
- Hippocampal commissure



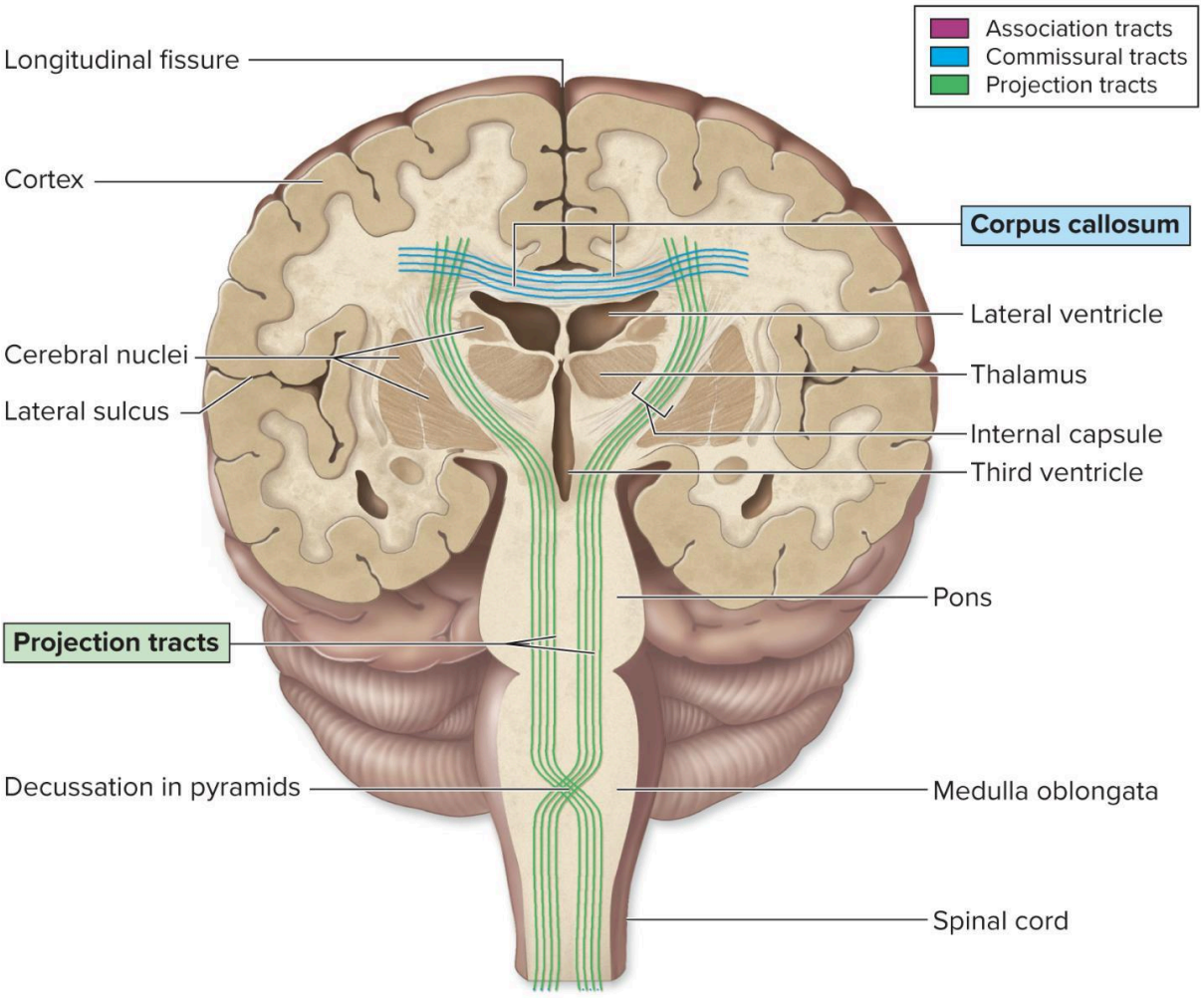
Corpus callosum



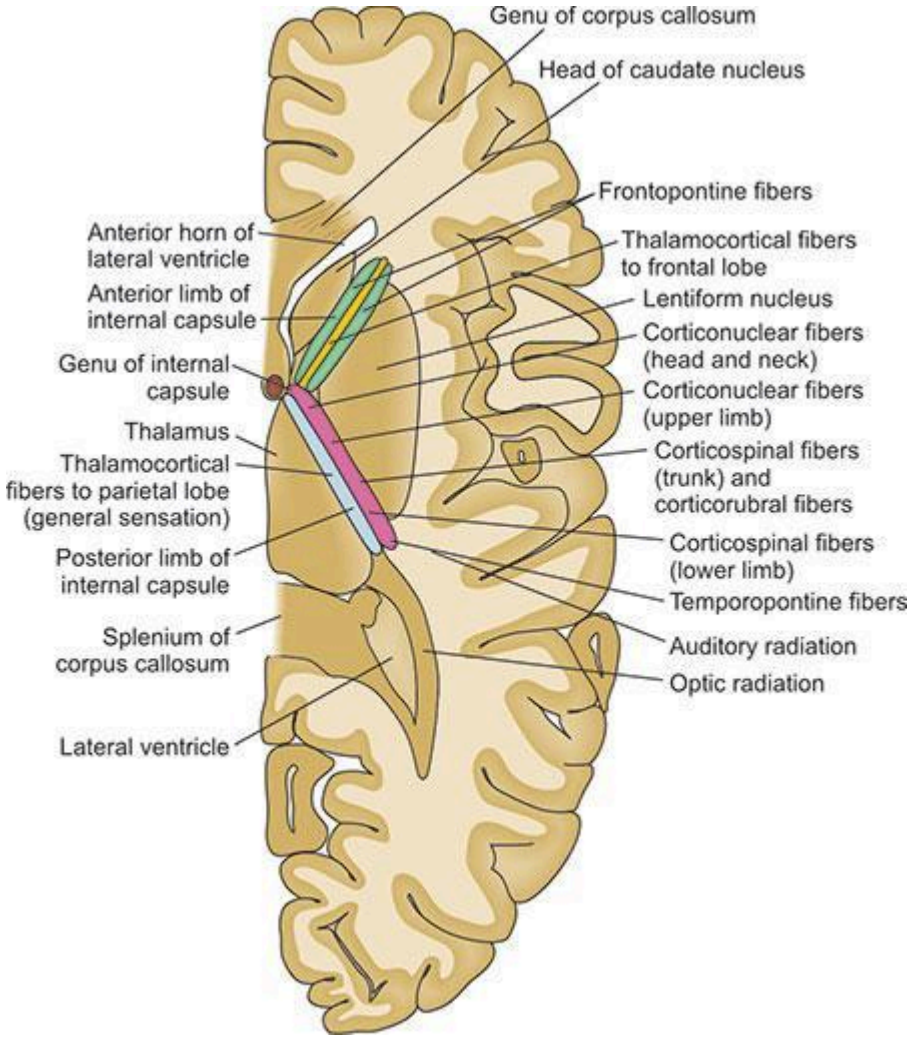

Corpus
callosum
Corona
radiata
Caudate
Putamen
Globus
pallidus
Internal
capsule
Thalamus



(a) Sagittal view



(b) Coronal section



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3. Projection fibers

These connect the cerebral cortex with **subcortical structures, brainstem and spinal cord**.

They converge through the **corona radiata** and become compact in the **internal capsule**.

Important projection pathways include:

- Corticospinal fibers
- Corticobulbar fibers
- Thalamocortical fibers
- Corticopontine fibers
- Corticothalamic fibers

Corona radiata

- Fan-shaped arrangement of projection fibers.

- Lies between the cerebral cortex and internal capsule.
- Fibers converge inferiorly to form the internal capsule.

Internal Capsule

The **internal capsule** is a compact V-shaped sheet of projection fibers situated between:

- **Caudate nucleus and thalamus medially**
- **Lentiform nucleus laterally**

It has five parts:

1. **Anterior limb**
2. **Genu**
3. **Posterior limb**
4. **Retrolentiform part**
5. **Sublentiform part**

Important fibers

Part	Important fibers
Anterior limb	Frontopontine and anterior thalamic radiations
Genu	Corticobulbar fibers
Posterior limb	Corticospinal, corticopontine and somatosensory fibers
Retrolentiform part	Optic radiation
Sublentiform part	Auditory radiation

Effects of Damage to the Corpus Callosum

A lesion of the corpus callosum interferes with communication between the two cerebral hemispheres. This produces various forms of **disconnection syndrome**.

1. Split-brain/disconnection phenomena

Information received by one hemisphere may not be effectively transferred to the other hemisphere.

2. Left-hand apraxia

In a typical left-dominant brain:

- The left hemisphere contains major language areas.
- The right hemisphere receives sensory information from the left hand.
- Damage to the corpus callosum may prevent the right hemisphere from communicating the information appropriately to the language-dominant left hemisphere.
- The patient may therefore have difficulty verbally identifying or using an object placed in the **left hand**, despite intact basic sensation and strength.

3. Anomia for objects presented to the left visual field

Visual information from the left visual field reaches predominantly the right visual cortex. With callosal disconnection, this information may not reach the dominant language hemisphere efficiently.

4. Difficulty transferring learned information between hemispheres

Tasks requiring integration of information processed separately by the two hemispheres may become impaired.

5. Alien-hand phenomenon

Some patients with callosal lesions may develop involuntary or seemingly independent movements of a hand, particularly with more extensive medial frontal/callosal lesions.

Clinical principle:
Corpus callosum lesion → interhemispheric disconnection rather than a simple motor or sensory deficit.

Effects of Damage to Different Parts of the Internal Capsule

Because many important projection fibers are packed closely together, a relatively small lesion can produce **major neurological deficits**.

1. Anterior limb lesion

May interrupt:

- Frontopontine fibers
- Anterior thalamic radiations

Possible effects include:

- Disturbance of frontal-subcortical functions
- Changes in attention, motivation or executive functions
- Cognitive/behavioral abnormalities, depending on extent and associated structures

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2. Genu lesion

The genu contains predominantly **corticobulbar fibers**.

Damage may produce:

- **Contralateral weakness of muscles supplied through corticobulbar pathways**
- Facial and lower facial weakness
- Dysarthria
- Difficulty with voluntary movements of the tongue and other cranial-nerve-innervated muscles

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3. Posterior limb lesion

This is clinically very important because it contains:

- Corticospinal fibers
- Corticobulbar fibers in neighboring regions
- Major ascending sensory thalamocortical fibers

A significant lesion can produce:

Contralateral hemiplegia

Damage to corticospinal fibers produces:

- Weakness/paralysis of the opposite upper and lower limbs.

Contralateral hemisensory loss

Damage to ascending sensory fibers produces loss or impairment of:

- Touch

- Pain
- Temperature
- Proprioception

Combined sensorimotor deficit

A large posterior-limb lesion can therefore cause **contralateral sensorimotor hemiplegia**.

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4. Retrolentiform part lesion

Contains the **optic radiation**.

Damage can produce:

- **Contralateral homonymous visual field defect**
- The exact visual field deficit depends on which portion of the optic radiation is affected.

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5. Sublentiform part lesion

Contains the **auditory radiation**.

Damage may cause:

- Impairment of auditory processing
- Because auditory pathways have substantial bilateral representation, a unilateral lesion usually does **not** cause complete unilateral deafness.

Clinical Correlation: Internal Capsule Stroke

The internal capsule is supplied by small penetrating arteries, particularly the **lenticulostriate arteries** and branches of the anterior choroidal artery.

Occlusion of these vessels can produce a **lacunar infarct**.

A lesion involving the posterior limb may cause:

Contralateral face + arm + leg weakness

and, if sensory fibers are involved:

Contralateral face + arm + leg sensory loss.

A useful practical memory aid is:

> **Genu → face**
> **Posterior limb → body movement & sensation**
> **Retrolentiform → vision**
> **Sublentiform → hearing**

Demonstration on a specimen

On a medial brain section, demonstrate:

Cerebral cortex → corona radiata → internal capsule

Then identify the internal capsule in relation to:

Caudate nucleus + thalamus medially
Lentiform nucleus laterally

Finally identify its:

Anterior limb → genu → posterior limb → retrolentiform → sublentiform parts.

This anatomical arrangement explains why **small internal-capsule lesions can produce extensive contralateral neurological deficits**.