

Comprehensive Guide to Motor Tracts in the Nervous System

Introduction

The motor system is responsible for controlling both voluntary and involuntary movements. It is divided into two main pathways: **pyramidal tracts** (conscious control) and **extrapyramidal tracts** (subconscious control). This guide provides a detailed explanation of these tracts, their pathways, functions, and clinical significance.

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1. Overview of Motor Tracts

The **motor system** is responsible for controlling **skeletal muscles**, allowing us to perform **voluntary movements** (such as walking and writing) and **subconscious adjustments** (such as posture control and reflexive movements).

To achieve this, the nervous system utilizes two major **motor pathways**:

1. Pyramidal System (Direct, Conscious Control)

- Responsible for **voluntary movements**
- Includes the **Corticospinal Tract** (for body muscles) and **Corticobulbar Tract** (for cranial nerves)
- Originates in the **primary motor cortex (Area 4)**

2. Extrapyramidal System (Indirect, Subconscious Control)

- Responsible for **automatic postural control, coordination, and balance**
- Includes **Rubrospinal, Reticulospinal, Vestibulospinal, and Tectospinal Tracts**
- Originates in the **brainstem** but is influenced by the cortex and cerebellum

Tract Type	Function
Pyramidal	Conscious control of voluntary movements (e.g., lifting your arm).
Extrapyramidal	Subconscious control of posture, balance, and coordination (e.g., walking).

2. Pyramidal Tracts

2.1 Corticospinal Tracts

The corticospinal tracts are the primary pathways for voluntary motor control. They originate in the motor cortex and descend to the spinal cord.

Pathway of Corticospinal Tracts:

1. **Origin:** Precentral gyrus (Primary motor cortex, Area 4).
2. **Descend through:** Corona radiata → Internal capsule → Crus cerebri (midbrain) → Pons → Medulla oblongata.
3. **Decussation:** At the lower medulla, 85% of fibers cross to the opposite side (lateral corticospinal tract), while 15% remain ipsilateral (anterior corticospinal tract).
4. **Termination:** Lateral corticospinal tract supplies lateral muscles (skilled movements), while the anterior corticospinal tract supplies axial muscles (posture and balance).

Tract	Decussation Level	Muscles Supplied
Lateral Corticospinal	Lower medulla	Lateral muscles(skilled movements).
Anterior Corticospinal	Spinal cord level	Axial muscles(posture and balance).

Key Points:

- **Lateral Corticospinal Tract:** Responsible for fine, skilled movements (e.g., writing, playing piano).
- **Anterior Corticospinal Tract:** Maintains posture and balance.

2.2 Corticonuclear (Corticobulbar) Tracts

These tracts control the muscles of the head and neck via cranial nerves.

Pathway of Corticonuclear Tracts:

1. **Origin:** Lower 1/4 of the motor cortex.
2. **Descend to:** Motor nuclei of cranial nerves in the brainstem.
3. **Bilateral Input:** Most cranial nerves receive input from both hemispheres, except for the lower facial muscles (contralateral) and the genioglossus muscle (contralateral).

Cranial Nerve	Muscles Supplied
Hypoglossal (12)	Tongue muscles.
Facial (7)	Muscles of facial expression(e.g.,orbicularis oris,orbicularis oculi).
Trigeminal (5)	Muscles of mastication(e.g.,masseter,temporalis).
Oculomotor (3)	Most eye muscles(except superior oblique and lateral rectus).

Key Points:

- **Bilateral Control:** Most cranial nerves receive input from both hemispheres.
- **Exceptions:** Lower facial muscles and genioglossus muscle are contralaterally controlled.

3. Extrapyramidal Tracts

3.1 Rubrospinal Tracts

- **Origin:** Red nucleus in the midbrain.
- **Function:** Facilitates flexor muscles and inhibits extensor muscles, mainly in distal limbs.
- **Pathway:** Descends through the lateral white column of the spinal cord.

Tract	Function
Rubrospinal	Facilitates flexor muscles(e.g.,bending the arm).

3.2 Reticulospinal Tracts

- **Origin:** Reticular formation in the brainstem.
- **Function:** Controls axial and proximal limb muscles for posture and balance.
- **Types:**
 - **Pontine Reticulospinal Tract:** Activates extensor muscles (antigravity muscles).
 - **Medullary Reticulospinal Tract:** Inhibits extensor muscles.

Tract	Function
Pontine Reticulospinal	Activates extensor muscles(e.g.,standing upright).
Medullary Reticulospinal	Inhibits extensor muscles(e.g.,relaxing the legs).

3.3 Vestibulospinal Tracts

- **Origin:** Vestibular nuclei in the brainstem.
- **Function:** Facilitates extensor muscles and inhibits flexor muscles to maintain balance.
- **Pathway:** Descends uncrossed through the anterior white column.

Tract	Function
Vestibulospinal	Maintains balance by activating extensor muscles.

3.4 Tectospinal Tracts

- **Origin:** Tectum (posterior midbrain).
- **Function:** Controls head and neck movements in response to visual stimuli.
- **Pathway:** Descends in the anterior white column, mainly to upper cervical segments.

Tract	Function
Tectospinal	Reflex movement of the head and neck(e.g.,turning head towards a sound).

4. Motor Horns and Lamina

4.1 Anterior Horn

- **Medial Part:** Supplies axial muscles (trunk and shoulder).
- **Lateral Part:** Supplies distal muscles (hand, forearm).

4.2 Lamina of the Spinal Cord

- **Lamina 8:** Motor interneurons.
- **Lamina 9:** Contains lower motor neurons (LMNs) that supply skeletal muscles.

Lamina	Function
8	Motor interneurons.
9	Lower motor neurons(LMNs).

5. Summary of Motor Pathways

5.1 Medial Motor System

- **Function:** Controls axial and proximal muscles.
- **Includes:**
 - Anterior corticospinal tract.
 - Extrapyramidal tracts (e.g., reticulospinal, vestibulospinal).

5.2 Lateral Motor System

- **Function:** Controls distal muscles (skilled movements).
- **Includes:**
 - Lateral corticospinal tract.
 - Rubrospinal tract.

Motor System	Function
Medial	Controls posture and balance(axial muscles).
Lateral	Controls skilled movements(distal muscles).

6. Key Points

Pyramidal Tracts

1. Corticospinal Tracts:

- Responsible for **conscious control** of voluntary movements.
- **Lateral Corticospinal Tract:** Controls skilled movements (e.g., writing, playing piano).
- **Anterior Corticospinal Tract:** Maintains posture and balance (axial muscles).
- 85% of fibers decussate at the lower medulla (lateral tract), while 15% remain ipsilateral (anterior tract).

2. Corticonuclear (Corticobulbar) Tracts:

- Controls muscles of the head and neck via cranial nerves.
- **Bilateral Input:** Most cranial nerves receive input from both hemispheres.
- **Exceptions:** Lower facial muscles (contralateral) and genioglossus muscle (contralateral).

Extrapyramidal Tracts

1. Rubrospinal Tract:

- Facilitates flexor muscles and inhibits extensor muscles (distal limbs).
- Originates in the red nucleus (midbrain).

2. Reticulospinal Tracts:

- **Pontine Reticulospinal:** Activates extensor muscles (antigravity muscles).
- **Medullary Reticulospinal:** Inhibits extensor muscles.
- Controls posture and balance.

3. Vestibulospinal Tract:

- Facilitates extensor muscles and inhibits flexor muscles to maintain balance.
- Originates in the vestibular nuclei (brainstem).

4. Tectospinal Tract:

- Controls head and neck movements in response to visual stimuli.
- Originates in the tectum (posterior midbrain).

Motor Horns and Lamina

1. Anterior Horn:

- **Medial Part:** Supplies axial muscles (trunk and shoulder).
- **Lateral Part:** Supplies distal muscles (hand, forearm).

2. Lamina of the Spinal Cord:

- **Lamina 8:** Motor interneurons.
- **Lamina 9:** Contains lower motor neurons (LMNs) that supply skeletal muscles.

Clinical Relevance

- Lesions in **Area 4** (primary motor cortex) cause **paralysis**.
- Lesions in **Area 6** (premotor cortex) cause loss of coordination but no paralysis.
- **Upper Motor Neuron (UMN) Lesions:** Spastic paralysis, hyperreflexia.
- **Lower Motor Neuron (LMN) Lesions:** Flaccid paralysis, hyporeflexia.

VI. Key Points to Remember

- ✓ **Pyramidal Tracts** → Conscious, voluntary movement (**Corticospinal & Corticobulbar**).
- ✓ **Extrapyramidal Tracts** → Subconscious control, coordination, balance (**Rubrospinal, Reticulospinal, Vestibulospinal, Tectospinal**).
- ✓ **Motor Cortex (Area 4)** → **Origin of Pyramidal Tracts**.
- ✓ **Lesions in Pyramidal System** → Paralysis (loss of voluntary movement).
- ✓ **Lesions in Extrapyramidal System** → Loss of coordination (still able to move but with difficulty in fine control).