DESCENDING TRACTS
At the end of lecture, students should be able to know:
Upper/lower motor neuron.
Pyramidal tracts.
Basal nuclei.
Basal ganglia.
Generalizations: Motor Paths

Typical descending pathway consists of a series of two motor neurons:
Upper motor neurons (UMNs)
Lower motor neurons (LMNs)

**Upper Motor Neurons:**
- Are entirely within the CNS.
- Originate in:
  - Cerebral cortex
  - Cerebellum
  - Brainstem
- Form descending tracts

**Lower Motor Neurons**
- Begin in CNS.
- From anterior horns of spinal cord.
- From brainstem cranial nerve nuclei.
- Made up of alpha motor neurons (A-α).
- Make up spinal and cranial nerves.

**UMN Classification**
- Classified according to where they synapse in the ventral horn:
  - Medial activation system:
    - Innervate postural and girdle muscles
  - Lateral activation system:
    - For fine movements
    - Associated with distally located muscles used for fine movements
  - Nonspecific activating system:
    - Facilitate local reflex arcs

**Pyramidal System**

Characteristics:
- Upper motor neurons:
  - 75 – 85% Decussate in pyramids.
  - Remainder decussate near synapse with lower motor neurons.
- Most synapse with association neurons in spinal cord central gray.
Components: •
Corticospinal Tract
Corticobulbar Tract

Corticospinal Tract Divisions
Lateral corticospinal tract: •
crossed in made up of corticospinal fibers that have medulla.
Supply all levels of spinal cord.
Anterior corticospinal tract: •
that cross near made up of uncrossed corticospinal fibers level of synapse with LMNs.
Supply neck and upper limbs.

Corticospinal Tract Lesions
Reduced muscle tone •
Clumsiness •
Weakness •
Not complete paralysis •
Note: complete paralysis results if both pyramidal and extrapyramidal systems are involved (as is often the case).

Extrapyramidal System
Includes descending motor tracts that do not pass through medullary pyramids or corticobulbar tracts.
Includes: •
Rubrospinal tracts
Vestibulospinal tracts
Reticulospinal tracts

Rubrospinal Tract
Begin in red nucleus. •
Decussates in midbrain. •
Descends in lateral funiculus (column). •
Function closely related to cerebellar function. •
Lesions: •
Impairment of distal arm and hand movement.
Intention tremors (similar to cerebellar lesions)
Vestibulospinal Tract
Originates in vestibular nuclei: •
Receives major input from vestibular nerve:
(CN VIII)
Descends in anterior funiculus (column). •
Synapses with LMNs to extensor muscles: •
posture. Primarily involved in maintenance of upright

Reticulospinal Tract
Originates in various regions of reticular formation. •
Descends in anterior portion of lateral funiculus (column). •
Thought to mediate larger movements of trunk and limbs that do not require balance or fine movements of upper limbs.

**BASAL NUCLEI**

Basal Ganglia Functions
Compare proprioceptive information and movement commands.
Sequence movements. •
Regulate muscle tone and muscle force. •
May be involved in selecting and inhibiting specific motor synergies.

Basal Ganglia Functions
Basal ganglia are vital for normal movement but they have no direct connections with lower motor neurons. Extrapyramidal disorders are associated with basal nuclei pathology:

**Negative symptoms of underresponsiveness:**
Akinesias
i.e. Parkinson disease

**Positive symptoms of over-responsiveness:**
Choreas, athetoses, ballisms
i.e. Huntington’s chorea
Basal Nuclei Components

- Corpus striatum
- Substantia nigra (within the midbrain)
- Subthalamic nuclei (diencephalon)
- Red nucleus (?)
- Claustrium (?)
- Nucleus accumbens (?)

Corpus Striatum

- Composed of caudate nucleus + lentiform nucleus:
  - Striatum = caudate nucleus + putamen.
  - Pallidum = globus pallidus.
  - Putamen + globus pallidus = lentiform
- Controls large subconscious movements of the skeletal muscles.
- The globus pallidus regulates muscle tone.

Substantia Nigra Subdivisions

- Dorsal pars compacta: dopaminergic neurons. Has melanin containing neurons and
- Ventral pars reticularis: Has iron-containing glial cells. Has serotonin and GABA (no melanin).

INPUT NUCLEI.

<table>
<thead>
<tr>
<th>Striatum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caudate nucleus</td>
</tr>
<tr>
<td>Putamen</td>
</tr>
<tr>
<td>Nucleus accumbens</td>
</tr>
<tr>
<td>Neocortex</td>
</tr>
<tr>
<td>Intralaminar nuclei</td>
</tr>
<tr>
<td>Substantia nigra</td>
</tr>
</tbody>
</table>

OUTPUT NUCLEI.

<table>
<thead>
<tr>
<th>Globus pallidus (medial part)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantia nigra</td>
</tr>
<tr>
<td>Pars reticularis</td>
</tr>
<tr>
<td>Ventral pallidum</td>
</tr>
<tr>
<td>Fibers project to:</td>
</tr>
<tr>
<td>VA/ VL nucleus</td>
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<tr>
<td>Mostly inhibitory</td>
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</tbody>
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Substantia Nigra

- Mesencephalon

Dorsal Pars compacta

- Melanin containing neurons
- Dopaminergic neurons

Ventral Pars reticularis

- Iron-containing glial cells
- Serotonin and GABA
Thalamic Fasciculi

Ansa lenticularis: •
globus pallidus. Consists of fibers from dorsal portion of Loops under internal capsule. To VA/VL complex.

Lenticular fasciculus: •
of globus Consists of fibers from ventral portion pallidus.
Passes across the internal capsule. To VA/VL complex.

Direct Basal Ganglia Circuit

Motor cortex projects to putamen: •
Excitatory (glutamate)

Putamen projects to output nuclei (globus pallidus internus • and substantia nigra reticularis):
Inhibitory (GABA and substance P)

Basal Ganglia Connections
Red = excitatory; Black = Inhibitory

Direct Basal Ganglia Circuit

Output nuclei project to motor thalamus (VA-VL) and pedunculopontine nuclei:
Inhibitory (GABA)

Ventrolateral (VA-VL) thalamus projects to motor cortex. •
Pedunculopontine nuclei project to reticulospinal and vestibulospinal pathways.
Stimulation of pedunculopontine nuclei elicit rhythmical behaviors • such as locomotor patterns.

Indirect Basal Ganglia Circuit

Motor cortex to putamen: •
Excitatory (glutamate)

Putamen to globus pallidus externus: •
Inhibitory (GABA and enkephalins)

Globus pallidus externus to subthalamic nuclei: •
Inhibition (GABA)

Subthalamic nuclei to output nuclei (substantia nigra reticularis) •
Excitatory (glutamate)
Output nuclei to VA-VL complex (motor thalamus) •
Inhibitory (GABA)
VA-VL complex to motor cortex: •
Excitatory
Therefore: decrease in corticofugal pathways. •

Input from Substantia Nigra Compacta

Projects to putamen: •
Excitatory (dopamine)
Two kinds of receptors in basal ganglia circuit:
D1: facilitates activity in direct pathway
D2: inhibits activity in indirect pathway