Outcomes you want to accomplish

**Basal ganglia review**
- Define and identify the major divisions of the basal ganglia
- List the major basal ganglia functional loops and roles
- List the components of the basal ganglia functional “circuitry” and associated neurotransmitters
- Describe the direct and indirect motor pathways and relevance/role of the substantia nigra compacta
Basal Ganglia Terminology

Striatum
- Caudate nucleus
- Putamen
- Nucleus accumbens

Globus pallidus (pallidum)
- External segment (GPe)
- Internal segment (GPi)

Subthalamic nucleus

Substantia nigra
- Compact part (SNc)
- Reticular part (SNr)

Caudate nucleus

Nucleus accumbens

Putamen

Basal ganglia “circuitry”

- **BG have no major outputs to LMNs**
  - Influence LMNs via the cerebral cortex
- **Input** to striatum from cortex is **excitatory**
  - Glutamate is the neurotransmitter
- **Principal output** from BG is **via GPi + SNr**
  - Output to thalamus, GABA is the neurotransmitter
- **Thalamocortical projections are excitatory**
  - Concerned with motor “intention”
- **Balance of excitatory & inhibitory inputs to striatum, determine whether thalamus is suppressed**

BG circuits are parallel loops

- **Motor loop**
  - Concerned with learned movements
- **Cognitive loop**
  - Concerned with motor “intention”
- **Limbic loop**
  - Emotional aspects of movements
- **Oculomotor loop**
  - Concerned with voluntary saccades (fast eye-movements)
**BG – Direct & Indirect Pathway**

- Identify cerebellar peduncles and the names/projections of the deep cerebellar nuclei
- List afferent and efferent components of the cerebellar peduncles
- Define the origins of the mossy and climbing fibers
- Define the functional components of the cerebellum (e.g., how would an injury to the cerebellar hemisphere differ from one to the flocculonodular lobe?)
- Describe the “wiring diagram” of the cerebellum and the different terminations of the mossy and climbing fibers
Cerebellum overview – gross anatomy

**Inputs**
- Cerebellar Cortex
- Nuclei

**Outputs**
- “Afferent” information
  - Vestibular
  - Proprioceptive & skin
  - Auditory information
  - Somatosensory cortex
  - Visual systems

**Motor Systems**
- Vestibular nuclei
- Red nucleus
- Reticular formation

**Information Processing**
- Mossy & Climbing fibers
- Enter the Cerebellar cortex
- Purkinje cells
- Deep nuclei

**Coordination**
- Comparison of current movements to those intended

**Inferior Cerebellar Peduncle**

**Afferents**
- Inferior olivary nucleus
- Vestibular nuclei

**Efferents**
- Vestibular nuclei
- Reticular formation

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**Middle Cerebellar Peduncle**

- **Afferents:**
  - Cerebral cortex

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“For the detailed minded among you”

<table>
<thead>
<tr>
<th>Tract</th>
<th>Origin</th>
<th>Termination</th>
<th>Peduncle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vestibulocerebellar</td>
<td>Vestibular nuclei</td>
<td>Superior vestibular nuclei - lateral</td>
<td>Lateral</td>
</tr>
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<td>Vestibular nuclei</td>
<td>Superior vestibular nuclei - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Anterior spinocerebellar</td>
<td>Anterior spinocerebellar nuclei (ventral horn)</td>
<td>Ventral and intermediate zones - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Posterior spinocerebellar</td>
<td>Cuneate nuclei (C2,3)</td>
<td>Ventral and intermediate zones - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Crus cerebellar</td>
<td>Lateral pontine nuclei (medulla)</td>
<td>Ventral and intermediate zones - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Nucleo-pontinecline</td>
<td>Pons and medulla nuclei - lateral</td>
<td>Ventral and intermediate zones - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Reti cerebellar</td>
<td>Vestibular nuclei, reticular mesencephalic</td>
<td>Ventral and intermediate zones - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Superior cerebellar</td>
<td>Spinal and medulla sensory nuclei of C2</td>
<td>Ventral and intermediate zones - lateral</td>
<td>Lateral</td>
</tr>
<tr>
<td>Olivocerebellar</td>
<td>Inferior olive, accessory olivary nucleus</td>
<td>All hemispheric zones</td>
<td>Inferior</td>
</tr>
<tr>
<td>Pontocerebellar</td>
<td>Pontine nuclei</td>
<td>Arterial and pontine fibers - Corona radiata/Vermis - lateral</td>
<td>Inferior</td>
</tr>
</tbody>
</table>

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Cerebellum overview – somatotopic anatomy

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1/2/2019
Cerebellum overview – Peduncles and deep nuclei

Superior Cerebellar Peduncle

Afferents:
- Anterior spinocerebellar tract
- Cerebellar afferents
- Originate from the deep cerebellar nuclei

Cerebellum – flocculonodular lobe (input & output)
Cerebellum – vermis (input & output)

- Cerebellum
- Medial Vestibulospinal Tracts (Descending MLF)
- Interposed nucleus

Cerebellum – hemisphere (input & output)

- Cerebellum
- Medial Vestibulospinal Tracts (Descending MLF)
- Interposed nucleus

Cerebellum overview – microscopic anatomy

- Molecular layer
  - Basket cells – send axons to the Purkinje cell bodies
  - Stellate cells – send axons to the Purkinje cell dendrites

- Purkinje cell layer
  - Purkinje cells – only axons that leave the cerebellar cortex

- Granular layer
  - Granular cells – send their axons into the molecular layer as parallel fibers

- White matter
Cerebellum overview – microscopic anatomy

Granule cells
Mossy fibers
Climbing fibers
Purkinje cells
Parallel fibers
Inferior Olivary nucleus
Deep cerebellar nuclei

Cerebellum overview – microscopic anatomy

Cerebellum overview – microscopic anatomy

Cerebellum overview – microscopic anatomy