BRAINSTEM

Comprised of 4 components:
- Grey matter = cranial nerves and nuclei (one nerve can have many nuclei)
- Suprasegmental nuclei – motor/sensory functions or relays to cerebellum
- White matter = fiber tracts
- Reticular formation – interneurons → integration

4 major levels of the brainstem:
- Caudal medulla
  - Pyramidal decussation
    - Tuberculi – bulges formed by nucleus gracilis (<T6) and nucleus cuneatus (>T6) – fine touch, pressure, vibration
- Rostral medulla
  - Olive – lateral protrusion produced by olivary nuclei (motor to cerebellum)
- Pons
  - Axons of pontine nuclei – (motor) bands extending laterally to cerebellum
- Midbrain
  - Inferior colliculus – contains central nucleus of inferior colliculus (auditory)
  - Superior colliculus – contains surface-parallel layers of superior collicular neurons (visual)
  - Red nucleus

Cranial Nerves

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Nucleus</th>
<th>Location of nucleus</th>
<th>Exits</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>Oculomotor&lt;br&gt;Edinger-Westphal (parasympathetic)</td>
<td>Floor of cerebral aqueduct (transverse level of superior colliculus)</td>
<td>Between two cerebral peduncles</td>
<td>Eye muscles&lt;br&gt;Parasymp to iris</td>
</tr>
<tr>
<td>IV</td>
<td>Trochlear nucleus</td>
<td>&quot;dimples the top of the MLF beneath the most caudal aspect of the inf coll&quot;</td>
<td>Caudal to inf coll (jct of pons and medulla)</td>
<td>Superior oblique</td>
</tr>
<tr>
<td>V</td>
<td>-Motor nuc of V&lt;br&gt;-Chief sensory nuc of V&lt;br&gt;-Nuc of Spinal tract of V&lt;br&gt;-Mesencephalic nuc of V</td>
<td>-Medial to chief sensory nuc&lt;br&gt;-Lat to motor nuc of V&lt;br&gt;-Through pons, medulla to SC&lt;br&gt;-Lat wall of rostral end of 4th V, extends in lat wall of cerebral aqueduct into midbr</td>
<td>-Lat to rostral third of pons&lt;br&gt;-Contralateral VPM nuc&lt;br&gt;-Continuous w/ dorsal horn&lt;br&gt;-Projects to motor nuc of V, main sens nuc of V, spinal nuc of V</td>
<td>-Musc of mastic&lt;br&gt;-Pain and temp of face</td>
</tr>
<tr>
<td>VI</td>
<td>Abducens nucleus</td>
<td>Dorsally beneath 4th V</td>
<td>Pontomedullary jct just lateral to pyr</td>
<td>Lateral rectus</td>
</tr>
<tr>
<td>VII</td>
<td>Facial motor nuc&lt;br&gt;Superior salivatory nuclei</td>
<td>Pons?</td>
<td>Pontomedullary jct</td>
<td>Muscles of face</td>
</tr>
<tr>
<td>VIII</td>
<td>Vestibular nucleus&lt;br&gt;Cochlear nucleus</td>
<td>Lateral floor of 4th V&lt;br&gt;Dorsolateral aspect of brainstem</td>
<td>Give rise to many&lt;br&gt;Trapezoid body→superior olive (caudal pons)</td>
<td>Vestibulation&lt;br&gt;Auditory</td>
</tr>
<tr>
<td>IX</td>
<td>Inf salivatory nuclei&lt;br&gt;Nuc of tractus solitarius</td>
<td>Caudal olive in medulla&lt;br&gt;Surr fibers of tractus sol</td>
<td>Emerge as a continuous sheet of small fascicles from groove above olive</td>
<td>Taste, visc sens</td>
</tr>
<tr>
<td>X</td>
<td>Dorsal motor nuc of X&lt;br&gt;Ventral motor nuc of X&lt;br&gt;Nuc of tractus solitarius</td>
<td>Floor of 4th V (lat to XII)</td>
<td></td>
<td>Major organs</td>
</tr>
</tbody>
</table>
BRAINSTEM

<table>
<thead>
<tr>
<th>XI</th>
<th>Accessory nuc of upper cervical cord</th>
<th>Lateral part of cervical SC</th>
<th>Trap and SCM</th>
</tr>
</thead>
<tbody>
<tr>
<td>XII</td>
<td>Hypoglossal nuc</td>
<td>Rostral medulla</td>
<td>Ventral btw pyr, olive</td>
</tr>
</tbody>
</table>

Reticular formation – association interneurons that provide “supramodal” integration across different modalities; 3 different levels:

- Intrinsic
  - Brainstem integration – integrate autonomic outputs (bp, HR, respiration, GI) with somatic and autonomic inputs (pain) and descending motor outputs from midbrain, pons, forebrain
- Descending
  - Reticulospinal control of motor tone and reflexes – balance facilitatory and inhibitory systems; favor inhibitory
  - Reticulospinal control of autonomic functions (bp, HR, respiration, etc)
    - Monoamine control of nociceptive processing – modulate activity in cerebellum and SC, including pain transmission
- Ascending
  - Monoamine control of forebrain excitability – modulate activity of structures controlling attention, cortical arousal, sleep-wake cycles, motor functions
  - Cholinergic control of forebrain excitability – modulate cortical arousal and sleep-wake cycles

Pathways

- Descending reticulospinal pathways
  - Medial and Lateral reticulospinal pathways
    - Regulate muscle tone, reflex, posture
    - Originate in: **Nucleus pontis oralis** (rostral pons), **nucleus pontis caudalis** (caudal pons), **gigantocellular reticular nucleus** (medulla)
  - Raphespinal pathway
    - Modulate pain transmission of nociceptive inputs in the dorsal horn
    - Originate in: **Dorsal Raphe**, **Median Raphe** (midbrain and pons)
- Ascending cholinergic projections
  - Cortical arousal, REM phase
  - Originate in: **pedunculopontine tegmental nucleus**, **laterodorsal tegmental nucleus**, **parabrachial nucleus** (rostral pons)
  - Project into intralaminar nuclei of thalamus
- Ascending and descending monoamine projections
  - Neuromodulators – regulate attention process
    - Rostally directed projections → diencephalon, basal ganglia, limbic system, neocortex
Descending projections → cerebellum and SC – modulate excitability of these structures during sleep-wake cycles
  - Substantia nigra and ventral tegmental area, dorsal raphe, median raphe, locus coeruleus

Functional systems and pathways

- Trigeminal system
  - Mesencephalic tract of V (midbrain) → motor nucleus and nerve (rostral pons) → main sensory nucleus of V (rostral pons, lateral to motor nuc) → descending tract and nucleus of V (pons and medulla) → VPM (trigeminothalamic tracts)
  - Compare to SC tracts

- Corticospinal and corticobulbar systems
  - Cerebral peduncle (midbrain) → corticospinal tract (pons) → pyramids (medulla) →
    - Lateral corticospinal tract (SC)
    - Anterior corticospinal tract (SC)