The Peripheral Nervous System (PNS)

Peripheral Nervous System (PNS)
- PNS – all neural structures outside the brain and spinal cord
- Includes sensory receptors, peripheral nerves, associated ganglia, and motor endings
- Provides links to and from the external environment

PNS in the Nervous System
Sensory Receptors
- Structures specialized to respond to stimuli
- Activation of sensory receptors results in depolarizations that trigger impulses to the CNS
- The realization of these stimuli, sensation and perception, occur in the brain

Receptor Classification by Stimulus Type
- Mechancoreceptors – respond to touch, pressure, vibration, stretch, and itch
- Thermoreceptors – sensitive to changes in temperature
- Photoreceptors – respond to light energy (e.g., retina)
- Chemoreceptors – respond to chemicals (e.g., smell, taste, changes in blood chemistry)
- Nociceptors – sensitive to pain-causing stimuli

Receptor Class by Location: Exteroceptors
- Respond to stimuli arising outside the body
- Found near the body surface
- Sensitive to touch, pressure, pain, and temperature
- Include the special sense organs

Receptor Class by Location: Interoceptors
- Respond to stimuli arising within the body
- Found in internal viscera and blood vessels
- Sensitive to chemical changes, stretch, and temperature changes
**Receptor Class by Location: Proprioceptors**
- Respond to degree of stretch of the organs they occupy
- Found in skeletal muscles, tendons, joints, ligaments, and connective tissue coverings of bones and muscles
- Constantly “advise” the brain of one’s movements

**Receptor Classification by Structural Complexity**
- Receptors are structurally classified as either simple or complex
- Most receptors are simple and include encapsulated and unencapsulated varieties
- Complex receptors are special sense organs

**Simple Receptors: Encapsulated**

<table>
<thead>
<tr>
<th>STRUCTURAL CLASS</th>
<th>ILLUSTRATION</th>
<th>FUNCTIONAL CLASSES ACCORDING TO LOCATION (L) AND STIMULUS TYPE (S)</th>
<th>BODY LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meissner’s corpuscles (tactile corpuscles)</td>
<td><img src="image" alt="Meissner's Corpuscles" /></td>
<td>L: Exteroceptors, S: Mechanoreceptors (light pressure, discriminative touch, vibration of low frequency); rapidly adapting</td>
<td>Dermal papillae of hairless skin, particularly nipples, external genitalia, fingertips, soles of feet, eyelids</td>
</tr>
<tr>
<td>Pacinian corpuscles (lamellated corpuscles)</td>
<td><img src="image" alt="Pacinian Corpuscles" /></td>
<td>L: Exteroceptors, interoceptors, and some proprioceptors, S: Mechanoreceptors (deep pressure, stretch, vibration of high frequency); rapidly adapting</td>
<td>Dermis and hypodermis; periostea, mesentry, tendons, ligaments, joint capsules; most abundant on fingers, soles of feet, external genitalia, nipples</td>
</tr>
<tr>
<td>Ruffini endings</td>
<td><img src="image" alt="Ruffini Endings" /></td>
<td>L: Exteroceptors and proprioceptors, S: Mechanoreceptors (deep pressure and stretch); slowly or nonadapting</td>
<td>Deep in dermis, hypodermis, and joint capsules</td>
</tr>
<tr>
<td>Muscle spindles</td>
<td><img src="image" alt="Muscle Spindles" /></td>
<td>L: Proprioceptors, S: Mechanoreceptors (muscle stretch, length)</td>
<td>Skeletal muscles, particularly those of the extremities</td>
</tr>
<tr>
<td>Golgi tendon organs</td>
<td><img src="image" alt="Golgi Tendon Organs" /></td>
<td>L: Proprioceptors, S: Mechanoreceptors (tendon stretch, tension)</td>
<td>Tendons</td>
</tr>
<tr>
<td>Joint kinesthetic receptors</td>
<td><img src="image" alt="Joint Kinesthetic Receptors" /></td>
<td>L: Proprioceptors, S: Mechanoreceptors and nociceptors</td>
<td>Joint capsules of synovial joints</td>
</tr>
</tbody>
</table>

**Simple Receptors: Unencapsulated**
- Free dendritic nerve endings
  - Respond chiefly to temperature and pain
- Merkel (tactile) discs
- Hair follicle receptors
- Meissner’s corpuscles (tactile corpuscles)
- Pacinian corpuscles (lamellated corpuscles)
- Muscle spindles, Golgi tendon organs, and Ruffini’s corpuscles
- Joint kinesthetic receptors
Simple Receptors: Unencapsulated

**TABLE 13.1 General Sensory Receptors Classified by Structure and Function**

<table>
<thead>
<tr>
<th>STRUCTURAL CLASS</th>
<th>ILLUSTRATION</th>
<th>FUNCTIONAL CLASSES ACCORDING TO LOCATION (L) AND STIMULUS TYPE (S)</th>
<th>BODY LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UNENCAPSULATED</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Free nerve endings of sensory neurons         | ![Illustration](image1.png) | L: Exteroceptors, interoceptors, and proprioceptors  
S: Thermoreceptors (warm and cool), chemoreceptors (itch, pH, etc.), mechanoreceptors (pressure), nociceptors (pain, hot, cold, pinch, and chemicals) | Most body tissues; most dense in connective tissues (ligaments, tendons, dermis, joint capsules, periosteal) and epithelia (epidermis, cornea, mucosae, and glands) |
| Modified free nerve endings: Merkel discs (tactile discs) | ![Illustration](image2.png) | L: Exteroceptors  
S: Mechanoreceptors (light pressure); slowly adapting | Basal layer of epidermis of skin |
| Hair follicle receptors                        | ![Illustration](image3.png) | L: Exteroceptors  
S: Mechanoreceptors (hair deflection); rapidly adapting | In and surrounding hair follicles |

**From Sensation to Perception**
- Survival depends upon sensation and perception
- Sensation is the awareness of changes in the internal and external environment
- Perception is the conscious interpretation of those stimuli

**Organization of the Somatosensory System**
- Input comes from exteroceptors, proprioceptors, and interoceptors
- The three main levels of neural integration in the somatosensory system are:
  - Receptor level – the sensor receptors
  - Circuit level – ascending pathways
  - Perceptual level – neuronal circuits in the cerebral cortex
Processing at the Receptor Lever
- The receptor must have specificity for the stimulus energy
- The receptor’s receptive field must be stimulated
- Stimulus energy must be converted into a graded potential
- A generator potential in the associated sensory neuron must reach threshold

Adaptation of Sensory Receptors
- Adaptation occurs when sensory receptors are subjected to an unchanging stimulus
  - Receptor membranes become less responsive
  - Receptor potentials decline in frequency or stop

Adaptation of Sensory Receptors
- Receptors responding to pressure, touch, and smell adapt quickly
- Receptors responding slowly include Merkel’s discs, Ruffini’s corpuscles, and interoceptors that respond to chemical levels in the blood
- Pain receptors and proprioceptors do not exhibit adaptation

Processing at the Circuit Level
- Chains of three neurons conduct sensory impulses upward to the brain
- First-order neurons – soma reside in dorsal root or cranial ganglia, and conduct impulses from the skin to the spinal cord or brain stem
- Second-order neurons – soma reside in the dorsal horn of the spinal cord or medullary nuclei and transmit impulses to the thalamus or cerebellum
- Third-order neurons – located in the thalamus and conduct impulses to the somatosensory cortex of the
The thalamus projects fibers to:
- The somatosensory cortex
- Sensory association areas
- First one modality is sent, then those considering more than one
- The result is an internal, conscious image of the stimulus

Main Aspects of Sensory Perception
- Perceptual detection – detecting that a stimulus has occurred and requires summation
- Magnitude estimation – how much of a stimulus is acting
- Spatial discrimination – identifying the site or pattern of the stimulus
- Feature abstraction – used to identify a substance that has specific texture or shape
- Quality discrimination – the ability to identify submodalities of a sensation (e.g., sweet or sour tastes)
- Pattern recognition – ability to recognize patterns in stimuli (e.g., melody, familiar face)

Structure of a Nerve
- Nerve – cordlike organ of the PNS consisting of peripheral axons enclosed by connective tissue
- Connective tissue coverings include:
  - Endoneurium – loose connective tissue that surrounds axons
  - Perineurium – coarse connective tissue that bundles fibers into fascicles
  - Epineurium – tough fibrous sheath around a nerve

Classification of Nerves
- Sensory and motor divisions
- Sensory (afferent) – carry impulse to the CNS
- Motor (efferent) – carry impulses from CNS
- Mixed – sensory and motor fibers carry impulses to and from CNS; most common type of nerve
- Mixed nerves – carry somatic and autonomic (visceral) impulses
- The four types of mixed nerves are:
  - Somatic afferent and somatic efferent
  - Visceral afferent and visceral efferent
- Peripheral nerves originate from the brain or spinal column

Regeneration of Nerve Fibers
- Damage to nerve tissue is serious because mature neurons are amitotic
- If the soma of a damaged nerve remains intact, damage can be repaired
- Regeneration involves coordinated activity among:
  - Macrophages – remove debris
  - Schwann cells – form regeneration tube and secrete growth factors
  - Axons – regenerate damaged part

Cranial Nerves
### Cranial Nerve:

<table>
<thead>
<tr>
<th>Cranial Nerve</th>
<th>Major Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>• smell</td>
</tr>
<tr>
<td>II Optic</td>
<td>• vision</td>
</tr>
<tr>
<td>Nerves in Order</td>
<td>Modality</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Olfactory</td>
<td>Special Sensory</td>
</tr>
<tr>
<td>Optic</td>
<td>Special Sensory</td>
</tr>
<tr>
<td>Oculomotor</td>
<td>Somatic Motor</td>
</tr>
<tr>
<td></td>
<td>Visceral Motor</td>
</tr>
<tr>
<td>Trochlear</td>
<td>Somatic Motor</td>
</tr>
<tr>
<td>Trigeminal</td>
<td>Branchial Motor</td>
</tr>
<tr>
<td>Cranial Nerves</td>
<td>十二对颅神经从大脑发出</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------</td>
</tr>
</tbody>
</table>

"On Old Olympic Towering Tops A Finn And German Viewed Some Hops"
Cranial Nerves

Summary of Function of Cranial Nerves

<table>
<thead>
<tr>
<th>Cranial nerves</th>
<th>Sensory function</th>
<th>Motor function</th>
<th>PS* fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Olfactory</td>
<td>Yes (smell)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>II Optic</td>
<td>Yes (vision)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>III Oculomotor</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>IV Trochlear</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>V Trigeminal</td>
<td>Yes (general sensation)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>VI Abducens</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cranial nerves</th>
<th>Sensory function</th>
<th>Motor function</th>
<th>PS* fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII Facial</td>
<td>Yes (taste)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VIII Vestibulocochlear</td>
<td>Yes (hearing and balance)</td>
<td>Some</td>
<td>No</td>
</tr>
<tr>
<td>IX Glossopharyngeal</td>
<td>Yes (taste)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>X Vagus</td>
<td>Yes (taste)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>XI Accessory</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>XII Hypoglossal</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

*PS = parasympathetic
**Cranial Nerve I: Olfactory**

- Arises from the olfactory epithelium
- Passes through the cribriform plate of the ethmoid bone
- Fibers run through the olfactory bulb and terminate in the primary olfactory cortex
- Functions solely by carrying afferent impulses for the sense of smell

**Olfactory Epithelium**

The olfactory epithelium is located in the roof, superior conchae, and septum of the nasal cavity.

The epithelium is kept moist by the secretions of olfactory glands.

Olfactory receptor cells are bipolar nerve cells with a peripherally directed dendrite which terminates in a knob from which project numerous cilia.
The olfactory chemoreceptors are located on these cilia.

**Sensory Transduction**

and Peripheral Course of the Olfactory Nerve

Inhaled aromatic molecules dissolve in the moisture lining the olfactory epithelium and stimulate its chemoreceptors.

Olfactory receptor cells initiate action potentials in response to these chemical stimuli. Intracellular studies show the presence of a slow rising receptor (generator) potential followed by a spike discharge from the receptor cell.

The peripheral processes of the receptor cells assemble into small bundles and pass through the cribiform plate of the ethmoid bone to synapse on secondary sensory neurons in the olfactory bulb.
Olfactory Receptors

Figure 15.21

Cranial Nerve II: Optic

- Arises from the retina of the eye
- Optic nerves pass through the optic canals and converge at the optic chiasm
- They continue to the thalamus where they synapse
- From there, the optic radiation fibers run to the visual cortex
- Functions solely by carrying afferent impulses for vision

Sensory Transduction

Light passing through the cornea and aqueous humor and entering the pupil travels through the lens and
Vitreous body to reach the retina at the back of the eye.

The process of converting photons of light into electrical signals occurs in a deep layer of the retina which contains the photoreceptor cells - the rods and cones.

Rods and cones are specialized cells which have stacks of plasma membrane associated with visual pigments making them sensitive to light.

The differences between the rod system and the cone system are described in the table below:

<table>
<thead>
<tr>
<th>Rod system</th>
<th>Cone system</th>
</tr>
</thead>
<tbody>
<tr>
<td>High sensitivity, specialized for night vision</td>
<td>Lower sensitivity, specialized for day vision</td>
</tr>
<tr>
<td>Saturate in daylight</td>
<td>Saturate only in intense light</td>
</tr>
<tr>
<td>Achromatic</td>
<td>Chromatic, mediate color vision</td>
</tr>
<tr>
<td>Low acuity</td>
<td>High acuity</td>
</tr>
<tr>
<td>Not present in central fovea</td>
<td>Concentrated in central fovea</td>
</tr>
<tr>
<td>Present in larger number than cones</td>
<td>Present in smaller number than rods</td>
</tr>
</tbody>
</table>

*Sensory Transduction*

Light incident on the photoreceptor cells triggers a series of chemical reactions which alter plasma membrane permeability resulting in a hyperpolarization of the rod or cone.

This hyperpolarization of the photoreceptor cell can produce either an excitatory (depolarization) or inhibitory (hyperpolarization) response by the bipolar cell dependent on the nature of the synapse between the two cells.

The bipolar cells are the primary sensory neurons of the visual pathway. They synapse with and either excite or inhibit the action potential firing rate of the secondary sensory neurons - the ganglion cells.

The axons of the ganglion cells converge at the optic disc near the center of the retina to exit the eye as the optic nerve.

At the optic chiasm approximately 1/2 of the fibers from each optic nerve cross the midline and exit the chiasm in the opposite optic tract.

The fibers of the optic tracts continue posteriorly around the cerebral peduncles of the midbrain with most synapsing in the lateral geniculate nucleus of their respective thalamus. A small portion of the fibers enter the pretectal region of the midbrain and participate in the pupillary light reflex.

Cells of the lateral geniculate nuclei are tertiary sensory neurons which project to the primary visual cortex in the occipital lobe via the optic radiation (geniculocalcarine tract). Note that the axons of the
optic radiation fan out to pass above and lateral to the inferior horn of the lateral ventricles enroute to the visual cortex. The fibers that course anteriorly toward the pole of the temporal lobe before turning posteriorly are referred to as Meyer's loop.

Central course

The entire area seen by an eye when it is focused on a central point is called the visual field of that eye.

Because rays of light reach the retina by converging and passing through the small opening of the pupil, the image of the entire visual field is projected onto the retina upside-down and reversed.

Therefore:

- The right half of the retina receives stimuli from the left visual field.

- The left half of the retina receives stimuli from the right half of the visual field.

- The upper half of the retina receives stimuli from the lower half of the visual field.

- The lower half of the retina receives stimuli from the upper half of the visual field.

Retinal Projections to the Primary Visual Cortex

Because fibers from different quadrants of the retina project to the primary visual cortex via predictable portions of the optic nerves, chiasm, and tracts it is convenient and clinically useful to divide the retina (and therefore the visual field) of each eye into nasal and temporal halves as well as superior and inferior halves yielding four quadrants.

The regions of the retina are referenced to the midline. The nasal hemiretina lies medial to the fovea, while the temporal hemiretina lies lateral to the fovea. The superior and inferior halves of the retina are also referenced to the fovea.

Axons of ganglion cells from the nasal hemiretina (lateral visual field) decussate at the optic chiasm and project to the contralateral lateral geniculate nucleus and midbrain.

Axons from the temporal hemiretina (medial visual field) remain ipsilateral throughout their course.

Axons from the inferior half of the retina (upper visual field) project via the Meyer's loop/temporal lobe portion of the optic radiation to the primary visual cortex below the calcarine fissure.

Axons from the superior half of the retina (lower visual field) project via the parietal lobe portion of the optic radiation to the primary visual cortex above the calcarine fissure.

Ganglion cells from the center of the retina (fovea) project to the tip of the occipital pole.
Clinical Correlation - Visual Deficits & Damage to the Retina

Visual Deficits

Armed with knowledge of the anatomy of the visual system, one can predict the deficits associated with a lesion at a particular point in the central visual pathway.

Damage to the retina

Results in a loss of input from the affected portion of the retina leading to a monocular field deficit.

Since axons of the ganglion cells converge toward the optic disc, damage to a portion of the retina closer to the optic disc will affect a greater number of neurons than would the same amount of damage in the peripheral retina leading to a larger visual field defect in that eye.

Since the cones are concentrated in the fovea, damage to the fovea results in a greater visual handicap than
damage to peripheral regions of the retina.

Damage to the optic nerve will also result in a monocular visual defect due to loss of input from the ipsilateral eye. The patient will complain of blindness in that eye.
Visual Pathways

Damage to the optic nerve will also result in a monocular visual defect due to loss of input from the ipsilateral eye. The patient will complain of blindness in that eye.

Damage to the optic nerve - ipsilateral blindness.

Cranial Nerve III: Oculomotor
- Fibers extend from the ventral midbrain, pass through the superior orbital fissure, and go to the extrinsic eye muscles
- Functions in raising the eyelid, directing the eyeball, constricting the iris, and controlling lens shape
- Parasympathetic cell bodies are in the ciliary ganglia
Cranial Nerve III: Oculomotor

- Medial rectus muscle
- Superior rectus muscle
- Levator palpebrae muscle
- Inferior oblique muscle
- Ciliary ganglion
- Inferior rectus muscle
- Superior orbital fissure
- Parasympathetic motor fibers
- Oculomotor nerve (III)
- Midbrain
- Pons

**Cranial Nerve IV: Trochlear**
- Fibers emerge from the dorsal midbrain and enter the orbits via the superior orbital fissures; innervate the superior oblique muscle
- Primarily a motor nerve that directs the eyeball

**Cranial Nerve V: Trigeminal**
- Three divisions: ophthalmic ($V_1$), maxillary ($V_2$), and mandibular ($V_3$)
- Fibers run from the face to the pons via the superior orbital fissure ($V_1$), the foramen rotundum ($V_2$), and the foramen ovale ($V_3$)
- Conveys sensory impulses from various areas of the face ($V_1$) and ($V_2$), and supplies motor fibers ($V_3$) for mastication
Cranial Nerve V: Trigeminal

Superior orbital fissure
Ophthalmic division (V\textsubscript{1})
Trigeminal (semilunar or gasserian) ganglion
Trigeminal nerve (V)
Maxillary division (V\textsubscript{2})
Mandibular division (V\textsubscript{3})
Foramen ovale
Foramen rotundum
Anterior trunk to chewing muscles
Mandibular foramen

Distribution of sensory fibers of each division

Mental foramen
Supraorbital foramen
Infratrochlear foramen
Infratrochlear nerve
Superior alveolar nerves
Lingual nerve
Inferior alveolar nerve

Inset shows motor branches of the mandibular division (V\textsubscript{3})

Temporalis muscle
Medial pterygoid muscle
Masseter muscle
Anterior belly of digastric muscle

V\textsubscript{1}
V\textsubscript{2}
V\textsubscript{3}
- The trigeminal nerve as the name indicates is composed of three large branches.

- They are the opthalmic ($V_1$, sensory), maxillary ($V_2$, sensory) and mandibular ($V_3$, motor and sensory) branches.

- The large sensory root and smaller motor root leave the brainstem at the midlateral surface of pons.

- The sensory root terminates in the largest of the cranial nerve nuclei which extends from the pons all the way down into the second cervical level of the spinal cord. The sensory root joins the trigeminal or semilunar ganglion between the layers of the dura mater in a depression on the floor of the middle cranial fossa.

- This depression is the location of the so-called Meckel's cave.

- The motor root originates from cells located in the masticator motor nucleus of trigeminal nerve located in the midpons of the brainstem.

- The motor root passes through the trigeminal ganglion and combines with the corresponding sensory root to become the mandibular nerve. It is distributed to the muscles of mastication, the mylohyoid muscle and the anterior belly of the digastric.

- The mandibular nerve also innervates the tensor veli palatini and tensor tympani muscles.

- The three sensory branches of the trigeminal nerve emanate from the ganglia to form the three branches of the trigeminal nerve.

- The opthalmic and maxillary branches travel in the wall of the cavernous sinus just prior to leaving the cranium.

- The opthalmic branch travels through the superior orbital fissure and passes through the orbit to reach the skin of the forehead and top of the head.

- The maxillary nerve enters the cranium through the foramen rotundum via the pterygopalatine fossa. Its sensory branches that enter the trigeminal ganglion within the cranium.

- The sensory part of the mandibular nerve is composed of branches that carry general sensory information from the mucous membranes of the mouth and cheek, anterior two-thirds of the tongue, head and scalp and meninges of the anterior and middle cranial fossae.
Maxillary Nerve Branches

A. Zygomaticotemporal  
B. Zygomaticofacial  
C. Post. Sup. Alveolar Brs  
D. Nasopalatine  
E. Greater Palatine  
F. Lesser Palatine  
G. Mid. & Ant. Alveolar Brs  
H. Infraorbital
Cranial Nerve VI: Abducent
- Fibers leave the inferior pons and enter the orbit via the superior orbital fissure
- Primarily a motor nerve innervating the lateral rectus muscle

Cranial Nerve VII: Facial
- Fibers leave the pons, travel through the internal acoustic meatus, and emerge through the stylomastoid foramen to the lateral aspect of the face
- Mixed nerve with five major branches
- Motor functions include facial expression, and the transmittal of autonomic impulses to lacrimal and salivary glands
- Sensory function is taste from the anterior two-thirds of the tongue
Cranial Nerve VIII: Vestibulocochlear
- Fibers arise from the hearing and equilibrium apparatus of the inner ear, pass through the internal acoustic meatus, and enter the brainstem at the pons-medulla border
- Two divisions – cochlear (hearing) and vestibular (balance)
- Functions are solely sensory – equilibrium and hearing

Cranial Nerve IX: Glossopharyngeal
- Fibers emerge from the medulla, leave the skull via the jugular foramen, and run to the throat
Nerve IX is a mixed nerve with motor and sensory functions. Motor – innervates part of the tongue and pharynx, and provides motor fibers to the parotid salivary gland. Sensory – fibers conduct taste and general sensory impulses from the tongue and pharynx.

Cranial Nerve X: Vagus
- The only cranial nerve that extends beyond the head and neck
- Fibers emerge from the medulla via the jugular foramen
- The vagus is a mixed nerve
- Most motor fibers are parasympathetic fibers to the heart, lungs, and visceral organs
- Its sensory function is in taste
Cranial Nerve XI: Accessory
- Formed from a cranial root emerging from the medulla and a spinal root arising from the superior region of the spinal cord
- The spinal root passes upward into the cranium via the foramen magnum
- The accessory nerve leaves the cranium via the jugular foramen
- Primarily a motor nerve
  - Supplies fibers to the larynx, pharynx, and soft palate
  - Innervates the trapezius and sternocleidomastoid, which move the head and neck
Cranial Nerve XII: Hypoglossal
- Fibers arise from the medulla and exit the skull via the hypoglossal canal
- Innervates both extrinsic and intrinsic muscles of the tongue, which contribute to swallowing and speech