Introduction to Head and Neck Anatomy
Nervous Tissue

• Controls and integrates all body activities within limits that maintain life

• Three basic functions
  1. sensing changes with sensory receptors
  2. interpreting and remembering those changes
  3. reacting to those changes with effectors (motor function)
Cranial nerves: 12 pairs
Spinal nerves: 31 pairs
The PNS is divided into:
1- **Somatic nervous system** (SNS)
2- **Autonomic nervous system** (ANS)
Sensory (Afferent) vs. Motor (Efferent)

Sensory (afferent) nerve

(pseudo-) unipolar neurons conducting impulses from sensory organs to the CNS

e.g., skin

Motor (efferent) nerve

multipolar neurons conducting impulses from the CNS to effector organs (muscles & glands)

e.g., muscle

Gray’s Anatomy 38 1999
Neurons

- Dendrites: carry nerve impulses toward cell body
- Axon: carries impulses away from cell body
- Synapses: site of communication between neurons using chemical neurotransmitters
- Myelin & myelin sheath: lipoprotein covering that increases axonal conduction velocity
Structural classification of neurons

1. **Multipolar neurons**
   - Usually have several dendrites and one axon
   - Motor neurons

2. **Bipolar neurons**
   - Have one main dendrite and one axon
   - The retina of the eye

3. **Unipolar neurons (pseudounipolar neurons)**
   - Sensory neurons
1. **Ganglion** (plural is ganglia) a cluster of neuronal cell bodies located in the PNS.

2. **Nucleus** (plural is nuclei) : a cluster of neuronal cell bodies located in the CNS.

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**Bundles of Axons**

A **nerve**: is a bundle of axons that is located in the PNS.
- Cranial nerves connect the brain to the periphery
- Spinal nerves connect the spinal cord to the periphery

A **tract**: is a bundle of axons located in the CNS.
Bundles of Axons

Clusters of Neuronal Cell Bodies

Cell body

Axon
Structure of Spinal Nerves: Somatic Pathways

- dorsal root
- dorsal ramus
- ventral root
- ventral ramus
- Sensory ganglion
- spinal nerve

Mixed Spinal Nerve
Structure of Spinal Nerves: Dorsal & Ventral Rami

- **dorsal root**
- **Sensory ganglion**
- **dorsal ramus**
- **spinal nerve**
- **somatic sensory nerve**
- **ventral ramus**

** Territory of Dorsal Rami**
(everything else, but head, innervated by ventral rami)

*Stern Essentials of Gross Anatomy*
Impact of Lesions

Disruption of motor (efferent) neurons (paralysis)

somatic sensory nerve

somatic motor nerve
Impacts of Lesions

Disruption of sensory (afferent) neurons (paresthesia)
Impact of Lesions

Disruption of sensory (afferent) neurons (paresthesia)

Disruption of motor (efferent) neurons (paralysis)
Impact of Lesions

Disruption of sensory (afferent) neurons *(back paresthesia)*

Disruption of motor (efferent) neurons *(paralysis of deep back muscles)*
Autonomic nervous system

- ANS is the subdivision of the peripheral nervous system that regulates body activities that are generally **not under conscious control**

- **Visceral motor** innervates **non-skeletal (non-somatic) muscles**

- Composed of a special group of neurons serving:
  - Cardiac muscle (the heart)
  - Smooth muscle (walls of viscera and blood vessels)
  - Glands
Divisions of the autonomic nervous system

• Parasympathetic division
• Sympathetic division

Serve most of the same organs but cause opposing or antagonistic effects

Parasympathetic: routine maintenance
“rest & digest”

Sympathetic: mobilization & increased metabolism
“fight, flight or fright” or “fight, flight or freeze”
Basic anatomical difference between the motor pathways of the voluntary somatic nervous system (to skeletal muscles) and those of the autonomic nervous system

- **Somatic division:**
  - Cell bodies of motor neurons reside in CNS (brain or spinal cord)
  - Their axons (sheathed in spinal nerves) extend all the way to their skeletal muscles

- **Autonomic system:** chains of two motor neurons
  - $1^{st}$ = preganglionic neuron (cell body in brain or cord)
  - $2^{nd}$ = postganglionic neuron (cell body in ganglion outside CNS)
• Axon of 1\textsuperscript{st} (preganglionic) neuron leaves CNS to synapse with the 2\textsuperscript{nd} (ganglionic) neuron
• Axon of 2\textsuperscript{nd} (postganglionic) neuron extends to the organ it serves

Diagram contrasts somatic and autonomic

This dorsal root ganglion is sensory

This autonomic ganglion is motor

Autonomic
Somatic
Ganglia

• Ganglia Are Masses Of Neuronal Cell bodies, Usually Defined As Being Outside The Central Nervous System. They Seem To Act As Coordinating Way Stations.

• Two type Ganglia:

• 1. Sensory.  2. Autonomic
Sensory ganglia do not receive synapses
Autonomic ganglia do contain synapses
Autonomic Nervous System
Similarities between Sympathetic & Parasympathetic

- Both are efferent (motor) systems: “visceromotor”
- Both involve regulation of the “internal” environment generally outside of our conscious control: “autonomous”
- Both involve 2 neurons that synapse in a peripheral ganglion
- Innervate glands, smooth muscle, cardiac muscle
Autonomic Nervous System
Differences between Sympathetic & Parasympathetic

Relative Lengths of Neurons

**Sympathetic**
- CNS
- short preganglionic neuron
- ganglion
- long postganglionic neuron
- target

**Parasympathetic**
- CNS
- long preganglionic neuron
- ganglion
- short postganglionic neuron
- target
Overview of the Autonomic Nervous System

Differences between Sympathetic & Parasympathetic

Types of neurotransmitters

Parasympathetic

Sympathetic

Physiological effect
Autonomic Nervous System
Differences between Sympathetic & Parasympathetic

Location of Preganglionic Cell Bodies

**Sympathetic**
Thoracolumbar
T1 – L2 levels of the spinal cord

**Parasympathetic**
Craniosacral
Brain: CN III, VII, IX, X
Spinal cord: S2 – S4
Structure of Spinal Nerves: Somatic Pathways

- dorsal root
- Sensory ganglion
- ventral root
- spinal nerve
- dorsal ramus
- ventral ramus

Mixed Spinal Nerve
Structure of spinal nerves: Sympathetic pathways

- Dorsal ramus
- Spinal nerve
- Gray ramus communicans
- Sympathetic ganglion
- Ventral ramus
- White ramus communicans
Sympathetic ganglia are the ganglia of the sympathetic nervous system. They are located close to and on either side of the spinal cord in long chains.
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There are usually 22-23 pairs of paravertebral sympathetic ganglia:

- 3 in the cervical region (cervical ganglia)
- 11 in the thoracic region
- 4 in the lumbar region
- 4-5 in the sacral region
- 1 unpaired coccygeal ganglion

Preganglionic nerves from the spinal cord synapse at one of the chain ganglia, and the postganglionic fiber extends to an effector.
**Parasympathetic ganglia** lie near or within the organs they innervate

<table>
<thead>
<tr>
<th>Number</th>
<th>Ganglion</th>
<th>Innervation</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Ciliary ganglion</td>
<td>sphincter pupillae, ciliary muscle</td>
</tr>
<tr>
<td>2</td>
<td>Pterygopalatine ganglion</td>
<td>lacrimal gland, glands of nasal cavity</td>
</tr>
<tr>
<td>3</td>
<td>Submandibular ganglion</td>
<td>submandibular and sublingual glands</td>
</tr>
<tr>
<td>4</td>
<td>Otic ganglion</td>
<td>parotid gland</td>
</tr>
</tbody>
</table>
Cranial nerves

- Olfactory (I)
- Oculomotor (III)
- Trigeminal (V)
- Facial (VII)
- Glossopharyngeal (IX)
- Hypoglossal (XII)
- Accessory (XI)
- Vagus (X)
- Optic (II)
- Trochlear (IV)
- Abducens (VI)
- Vestibulocochlear (VIII)
The numbering of the cranial nerves is based on the order in which they emerge from the brain, front to back.
Foramina of skull and cranial nerves passing through:

- Cribiform plate
- Optic canal
- SOF
- F. rotundum
- F. ovale
- F. lacerum
- F. spinosum
- IAM
- Clivus
- Jugular F.
- Hypoglossal canal

Nerves:
- I
- II
- III, IV, V₁, VI
- V₂
- V₃
- VII, VIII
- IX, X, XI
- XII
1. Olfactory nerve  
Component: sensory  
Function: smell  
Origin: Olfactory receptor nerve cells  
Opening of the Skull: *Openings in cribriform plate of ethmoid*

2. Optic nerve  
Component: sensory  
Function: vision  
Origin: Back of the eyeball  
Opening of the Skull: *Optic canal*

3. Oculomotor nerve  
Component: motor  
Function:  
- Turns eyeball upward, downward and medially, upward and laterally  
- Raises upper eyelid  
- Constricts pupil  
- Accommodates the eye  
Opening of the Skull: *Superior orbital fissure*

*Dr. Heba Kalbouneh*
4. Trochlear nerve
Component: motor
Function: Turns eyeball downward and laterally
Opening of the Skull: Superior orbital fissure

6. Abducent nerve
Component: motor
Function: Turns eyeball laterally
Opening of the Skull: Superior orbital fissure
5. Trigeminal Nerve
Component: mixed (motor and sensory)
Function: General sensation from the face, supplies muscles of mastication

Large sensory root  Small motor root
V1. Ophthalmic Nerve
Component: sensory
Function: sensation from: cornea, skin of forehead, scalp, eyelids and nose, mucous membranes of paranasal sinuses and nasal cavity
Opening of the Skull: Superior orbital fissure

V2. Maxillary Nerve
Component: sensory
Function: sensation from: skin over maxilla, upper lip, teeth of the upper jaw, mucous membrane of the nose, the maxillary sinus and palate
Opening of the Skull: Foramen rotundum

V3. Mandibular Nerve
Component: sensory and motor
Function: sensation from: skin of cheek, over mandible and side of head, teeth of lower jaw and TMJ, mucous membrane of mouth and anterior 2/3 of tongue
Motor to: Muscles of mastication, Mylohyoid, Anterior belly of digastric, Tensor veli palatine, Tensor tympani
Opening of the Skull: Foramen ovale

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Trigeminal ganglion
Ophthalmic division
Maxillary division
Mandibular division
7. Facial Nerve
Component: mixed (sensory and motor)
Function: taste sensation from the anterior 2/3 of the tongue
General sensation from a small area around the concha of the auricle, EAM
Motor to: muscles of the face and scalp, stapedius, posterior belly of digastric, stylohyoid
Parasympathetic to: Sublingual and submandibular glands, lacrimal gland
Opening of the Skull: Internal acoustic meatus, facial canal, stylomastoid foramen

8. Vestibulocochlear Nerve
Component: sensory
Origin: Vestibular: utricle , saccule, semicircular canals
Cochlear: Organ of Corti
Function: balance and hearing
Opening of the Skull: Internal acoustic meatus
9. Glossopharyngeal Nerve
Component: mixed (sensory and motor)
Function: General sensation and taste from post. 1/3 of the tongue and oropharynx, carotid sinus and carotid body
Motor to: stylopharyngeus
Parasympathetic to: Parotid gland
Opening of the Skull: Jugular foramen

10. Vagus Nerve
Component: mixed (sensory and motor)
Function: Motor: Constrictor muscles of pharynx and intrinsic muscles of larynx; involuntary muscle of trachea and bronchi, heart, alimentary tract from pharynx to splenic flexure of colon; liver and pancreas
Sensory: Taste sensation from epiglottis and vallecula and afferent fibers from structures named above, General sensation from skin of EAM
Opening of the Skull: Jugular foramen

11. Accessory Nerve
Component: motor
Function: Cranial root: Pharyngeal plexus (Muscles of soft palate, pharynx, and larynx)
Spinal root: motor to Sternocleidomastoid and trapezius
Opening of the Skull: Jugular foramen
12. Hypoglossal Nerve
Component: motor
Function: Motor to muscles of the tongue
Opening of the Skull: Hypoglossal canal

Hypoglossal Nerve
The olfactory, optic, and vestibulocochlear nerves are entirely sensory; the oculomotor, trochlear, abducent, accessory, and hypoglossal nerves are entirely motor; and the remaining nerves are mixed.

All the nerves are distributed in the head and neck except the vagus, which also supplies structures in the thorax and abdomen.

The cranial nerves emerge from the brain and are transmitted through foramina and fissures in the base of the skull.
**Pure sensory:**
- Olfactory
- Optic
- Vestibulocochlear

**Pure motor:**
- Oculomotor
- Trochlear
- Abducent
- Accessory
- hypoglossal

**Mixed (motor and sensory):**
- Trigeminal
- Facial
- Glossopharyngeal
- Vagus

**Contains parasympathetic (secretomotor):**
- Oculomotor
- Facial
- Glossopharyngeal
- Vagus