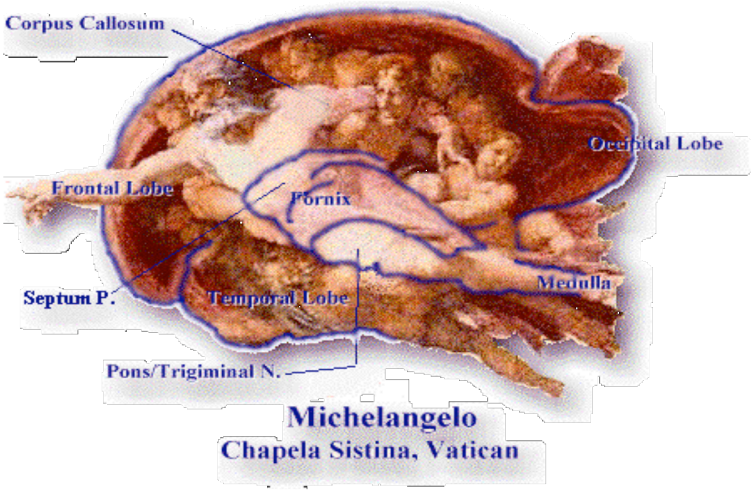
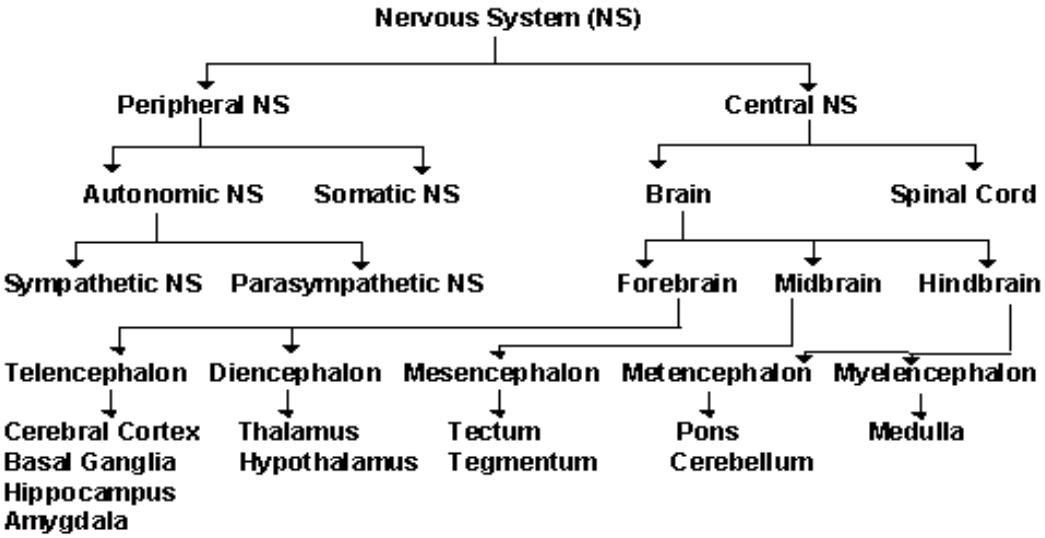
I. INTRODUCTION TO NEUROSCIENCE

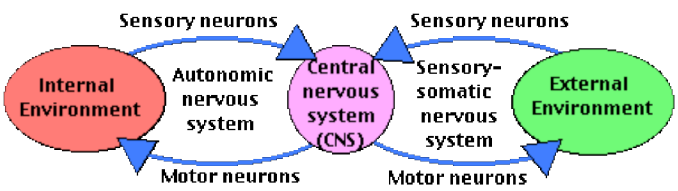


THE NERVOUS SYSTEM (NS) CONSISTS OF

- Peripheral Nervous System (PNS)
  - Divided into Autonomic and Somatic Nervous System.
  - **Autonomic** subdivided into Sympathetic (**SNS**) and Parasympathetic Nervous System (**PSNS**).
  - **Somatic** contains **Cranial Nerves** (except the Optic Nerve - **CN II**, which is a continuation of the Brain), and all 31 pairs of **Spinal Nerves**.
- Central Nervous System (CNS)
  - Contains **Brain** and **Spinal Cord**.



PERIPHERAL NERVOUS SYSTEM (PNS)



AUTONOMIC -VS- SOMATIC NERVOUS SYSTEMS

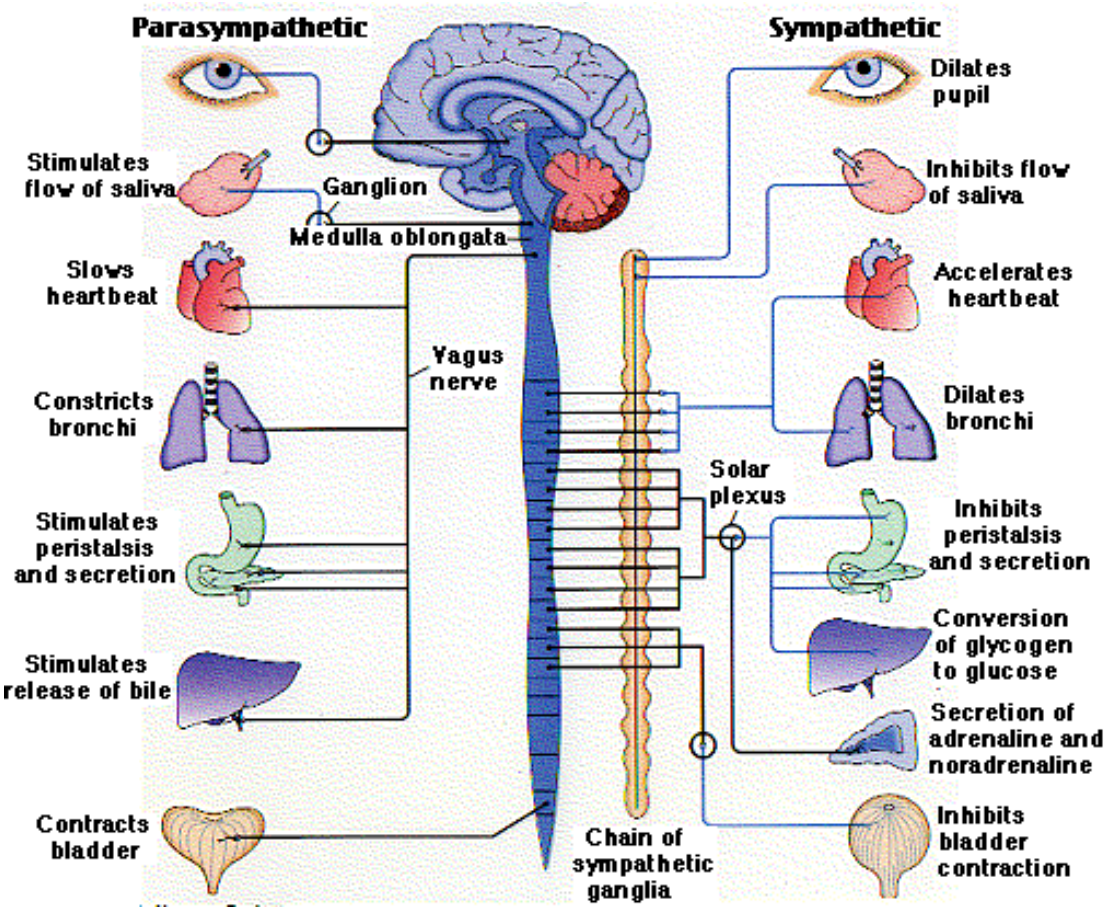
- The autonomic system generally acts slower.
- The last inter-neuronal synapse of a somatic nerve is in the CNS (in the spinal column), while the last inter-neuronal synapse of an autonomic nerve is in a **peripheral ganglion**.

THE AUTONOMIC NERVOUS SYSTEM

Consists of **Sensory** and **Motor** Neurons and their Axons that communicate the CNS with internal organs, muscles and glands.

Autonomic Reflex: Autonomic efferent fibers can be initiated in response to different types of afferent signals:

- Visceral Afferent Fibers: Transmission of visceral pressure, stretch, and noxious-stimuli.
  - Cell bodies of these sensory neurons are located in the sensory ganglia of **CN VII, IX, and X**.
  - **Enteroreceptors** are specialized fibers to transmit these visceral signals.
- Somatic Afferent Fibers: Transmition of Temperature, pain, and light.
- Cognitive Input from higher learning centers: Perceived threats, anxiety, excitement, and sexual arousal can all influence autonomic motor responses.



Property	PARASYMPATHETIC	SYMPATHETIC
Anatomical Origin	CRANIO-SACRAL: CN III, VII, IX, X, and the Pelvic Splanchnic Nerves	THORACO-LUMBAR
Preganglion Axon: Postganglionic Axon	Long Preganglion Axon and short postganglionic Axon; Ratio is nearly 1:1, yielding **discrete** effects	Short Preganglionic Axon and long postganglionic axon; ratio is 1:many, yielding **diffuse** effects.

Location of Upper Cell Bodies	Brainstem nuclei and sacral segments	**Intermediolateral** segments of the thoracolumbar spinal cord
Location of Interneuronal Ganglia	In or very near the target organ	Paravertebral and Prevertebral Ganglia, far away from target organs
Principle Neurotransmitter	Acetylcholine	Norepinephrine
Other Neurotransmitters found	**Vasoactive Intestinal Peptide (VIP)**, which results in synthesis of NO ------> vasodilation	Neuropeptide Y Somatostatin Enkephalins
Principle Neurotransmitter Receptors at target organs:	**Muscarinic** acetylcholine receptors, at the end organs. Also **Muscarinic Autoreceptors** on the postganglionic terminal, providing feedback inhibition for release of Ach.	**β-Adrenergic Receptors** (cAMP secondary pathway) **α-Adrenergic Receptors** (IP_3/DAG secondary pathway)
Neurotransmitter Inactivation	**Acetylcholinesterase** is the primary way	**Reuptake** is the primary method of getting rid of NorE.
Ocular Reflex	**Miosis:** constriction of pupil is a reflex to light **Accommodation:** Initiated by afferent signals from optic nerve ------> Contract ciliary muscle ------> increase natural curvature of lens ------> focus for near vision **Lacrimation** via Facial VII.	**Pupillary Dilation**: Radial smooth muscle of pupil contracts **Ciliary Muscle Relaxation** These neurons for these reflexes come from **Superior Cervical Ganglion ------> Carotid Plexus**
Digestive Reflex	**Salivation** via Chorda Tympani (VII) and Lingual (IX) General increase in GI smooth muscle tone **Liver** promotion of glycogenesis	**Salivation** via sympathetics from external carotid plexus General Relaxation of GI smooth muscle tone **Liver** induction of glycogenolysis and gluconeogenesis **Anal Sphincter** contraction
Respiratory Reflex	**Bronchoconstriction** Vagal innervation of smooth muscle in trachea and bronchi.	**Bronchodilation**
Cardiac Reflex	Decrease heart rate by vagal innervation SA node	Increase heart rate by innervation of SA Node Increase heart contractility
Sexual Reflex	Penile Erection—vasodilation involved NO and possible VIP	Ejaculation

SYMPATHETIC NERVOUS SYSTEM

- Pathway of sympathetic spinal nerves out of the spinal cord:
  - From spinal cord, the **dorsal root** and **ventral root** of each sympathetic nerve join to form the **White Communicating Ramus**.
  - The White Communicating Ramus goes to the **Paravertebral Ganglia,** on either side of the spinal cord.
  - PREGANGLIONIC NERVE: Once in the **Paravertebral Chain**, it can do one of four things:
    - **Prevertebral Ganglia:** The prevertebral ganglia receive *preganglionics* from the **Thoracic Splanchnic Nerves**.
    - There are four major prevertebral ganglia:
    - **Celiac Ganglion**
    - **Superior Mesenteric Ganglion**
    - **Inferior Mesenteric Ganglion**
    - **Aorticorenal Ganglion**
    - There are four major thoracic splanchnic nerves, which *go straight through* the paravertebral chain to synapse in the prevertebral ganglia.
    - **Greater Thoracic Splanchnic** (T10)
    - **Lesser Thoracic Splanchnic** (T11)
    - **Least Thoracic Splanchnic** (T12)
  - POSTGANGLIONIC NERVE: For those nerves that synapse in the paravertebral chain, they can do one of two things afterwards:
- ADRENAL MEDULLA: Releases 80% Epi and 20% NorEpi into bloodstream.
  - It is innervated by sympathetic **preganglionics**, which have come by way of the celiac ganglion, but they didn't synapse there.
  - It is **sympathetic cholinergic**, with **nicotinic ganglionic** acetylcholine receptors.
- ADRENERGIC RECEPTORS:
  - **Beta Receptors:** Activated by **Isoproterenol**
  - **Alpha Receptors:** Activated by **Phenylephrine**

GANGLIONIC NICOTINIC CHOLINERGIC RECEPTORS: Both sympathetic and parasympathetic neurons use acetylcholine. Their receptors are of the nicotinic type, but they are *different* structurally in that they respond differently to drugs.

GROUND PLEXUS: Autonomic postganglionics are **unmyelinated**. Near the target organ they divide to form a meshwork-like web called a ground-plexus.

Axonal Varicosity: The autonomic axon becomes wider near the target.

NEUROEFFECTOR JUNCTION: The name of an autonomic synapse. It is not proper to call it a synapse.

- It is not called a synapse because there are no ultrastructural membrane specializations between the neuron and the target cell. Thus it not a synapse.
- **Prejunctional Element:** Autonomic name for the presynapse.
- **Postjunctional Element:** Autonomic name for the postsynapse.

Autonomic Tone: The continual visceral innervation of target organs. It is the job of autonomic nerves to modulate, either up or down, the tone of the target organ, rather than to discretely stimulate it.

Denervation Supersensitivity: As a compensatory mechanism, a target loses autonomic innervation; it becomes hypersensitive to said neurotransmitter.

- Hypersensitivity due to increased synthesis of neuroreceptors.
- SYMPATHETIC LESIONS:
  - **Preganglionic Lesion:** Not so much hypersensitivity at target.
  - **Postganglion Lesion:** *Pronounced Hypersensitivity* because there is no longer a way for neurotransmitter reuptake to occur!!

FIVE WAYS TO AUTONOMICALLY REGULATE END-ORGAN ACTIVITY

- *Antagonistic Effects on the same organ:* Sympathetic and Parasympathetic have same effect.
  - Heart, Respiratory Passages
  - Urinary Bladder
  - Gut

- *Antagonistic Effects through opposing organs:* Sympathetic and Parasympathetic innervate different targets to achieve antagonistic effects.
  - Pupil (Pupil dilator and pupil constrictor)
  - Anal Sphincter
- *Agonistic Effects on complementary organs*: Salivary glands
- *Agonistic Effects on the same target organ*:
- *Innervation by only one component:* Lots of end organs
  - PARASYMPATHETIC ONLY: Lacrimal glands (CN VII), Nasopharyngeal Glands (CN VII), Tracheal / Bronchial Glands
  - SYMPATHETIC ONLY: Tarsal Muscles of eyelid. Loss of this function (drooping eyelids) is called **Ptosis**, a component of lost sympathetic innervation, or **Horner's Syndrome**.
    - **Ecocrine Sweat Glands** are cholinergic sympathetic. They are present all over and are responsible for thermoregulation.
    - **Apocrine** Glands = Sebaceous Sweat Glands. Mainly in axilla. They receive adrenergic innervation.

PENILE ERECTION:

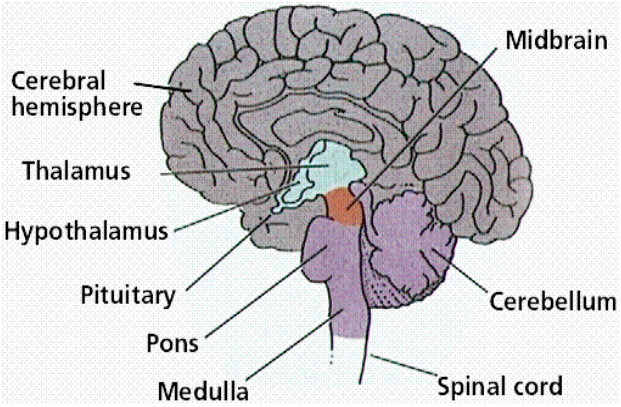
- **Parasympathetic** vasodilation of penile arteries to yield erection.
- **Sympathetic** constriction of vas deferens and seminal vesicles for ejaculation.

SYMPATHETIC CIRCULATORY REFLEXES: Conform to the needs of **fight or flight**.

- Vasodilation of pathways leading to the heart and lungs.
- Vasoconstriction of pathways in the portal / GI system.

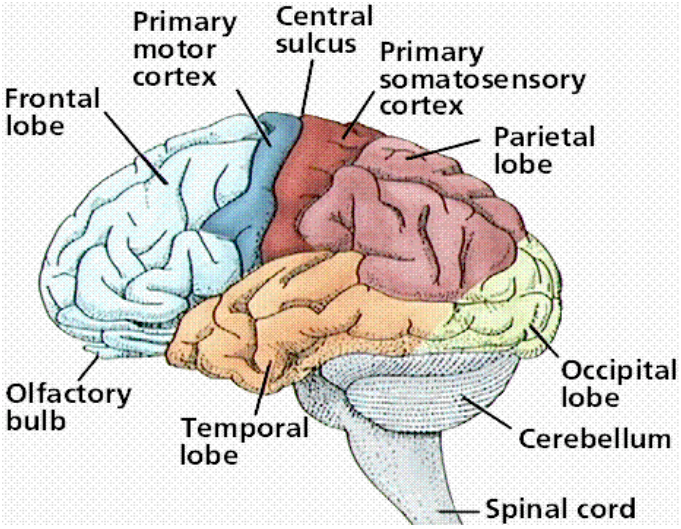
CENTRAL NERVOUS SYSTEM (CNS)

FIVE MAIN DIVISIONS OF THE CNS



- **Cerebral Hemispheres (Telencephalon)**: Higher perceptual, cognitive, and motor functions
  - **White Matter**—myelinated, in the center
  - **Grey Matter:** Cell bodies composing the cerebral cortex.
  - **Lateral Ventricles:** Filled with cerebrospinal fluid.
  - **Basal Ganglia:** Important role in modulating motor activity and emotional tone.
- **Diencephalon:** Integrates and routes sensory and motor information
  - **Dorsal Thalamus**
  - **Subthalamus**
  - **Epithalamus**
  - **Hypothalamus**
- **Brainstem**—divided into three divisions
  - **Medulla Oblongata (Myelencephalon)**: Associated with part of CN XIII, and CN IX, X, XI, and XII.
  - **Pons (Metencephalon):** Associated with CN V, VI, VII, and part of CN VIII.
  - **Midbrain (Mesencephalon):** Associated with CN III and IV
- **Cerebellum:** Coordination of skeletal muscle activity
- **Spinal Cord** -- 31 pairs of spinal nerves give SEGMENTATION to the body
  - **Dorsal Root -------> Dermatomes**
  - **Ventral Root ------> Myotomes**
  - Developmentally, they originate from formation of the somites.

FUNCTIONAL DIVISIONS OF THE BRAIN



PRE-CENTRAL GYRUS - Cerebral Cortex in front of the **Central Sulcus**:

- FRONTAL LOBES - Responsible for effecting voluntary motor activities, and foresight and judgment.

POST-CENTRAL GYRUS - The other cerebrocortical lobes (SENSORY LOBES) are responsible for one or another sensory

- PARIETAL LOBES - Primary Somatosensory Cortex (Touch).
- TEMPORAL LOBES - Primary Auditory Cortex (Hearing)
  - Dominant Temporal Lobe is responsible for Language (**Broca**'s and **Wernicke**'s areas).
- OCCIPITAL LOBES - Primary Visual Cortex (Sight).

CROSSING OF FUNCTION: The left side of the brain controls the right half of the body.

- Stimulation of the PRE-CENTRAL GYRUS will cause motor stimulation on the opposite side of the body.
- Stimulation of the POST-CENTRAL GYRUS will cause sensation to occur on the opposite side of the body.

SENSORY TRACTS: Sensory highways go up the spinal cord, converge on the **Thalamus**, and are then distributed to the proper location in the **Post-Central Gyri** of the opposite side of the body.

- There are considered to be two different sensory systems:
  - Primary Sensory Tracts - Somatic sensation
  - Discriminative Touch and Proprioception information.

MOTOR TRACTS: There are two different motor tracts that convey information from the **Pre-Central Gyri** to the destination motor units.

- **Corticospinal Fiber System:** Travels down spinal cord to influence motor units on the opposite side of the body.
- **Corticobulbar Fiber System:** Influences the head and neck via the **four cranial nerves** that provide parasympathetic motor innervation to the head and beck region.

CRANIAL NERVES

Nerve	CN	Source	Branches	Motor	Sensory	Notes
Olfactory	I	Filaments of the bipolar olfactory epithelial cells constitute the Olfactory n.	Second order Olfactory nerve cell bodies located in the olfactory bulb	None	Smell (SVA)	Multiple olfactory filaments pass through the cribriform plate to exit the

						anterior cranial fossa and synapse in the olfactory bulb; the olfactory tract carries the signal from the bulb to olfactory cortex of the forebrain
Optic	II	Ganglion layer of the retina to the forebrain.	None	None	Vision (SSA)	The course of the optic nerve is: through the optic canal to the optic chiasma, then the optic tract to the lateral geniculate body and optic radiation
Oculomotor	III	Oculomotor nuclei of the midbrain (extraocular muscles); accessory oculomotor nucleus (nucleus of Edinger-Westphal - preganglionic para-sympathetic)	Superior br., Inferior br.	GSE: * Superior br.: levator palpebrae, superioris m. & superior rectus m. * Inferior br: medial rectus m., inferior rectus m., inferior oblique m.; GVE: Ciliary m. & sphincter pupillae m. (preganglionic para-sympathetic axons go to the ciliary ganglion via the para-sympathetic root, post-ganglionic para-sympathetic go from the ciliary ganglion to the eyeball via short ciliary nn.)	None	Passes through the superior orbital fissure to exit the middle cranial fossa

Trochlear	IV	Trochlear nucleus of the midbrain	None	Superior oblique m. of the eye (GSE)	None	Passes through the superior orbital fissure to exit the middle cranial fossa; it is the smallest cranial nerve and the only cranial nerve to arise from dorsum of brainstem
Trigeminal	V	Motor root arises from the trigeminal motor nucleus in the pons (SVE). Sensory part arises from the trigeminal ganglion (GSA) and projects into the pons to the primary sensory nucleus of V or more inferiorly to the nucleus of the spinal root of V (medulla and upper spinal cord)	Ophthalmic, Maxillary & Mandibular divisions	SVE: anterior belly of the digastric m., mylohyoid m., tensor veli palatini m., tensor tympani m.; muscles of mastication: temporalis m., masseter m., lateral pterygoid m., medial pterygoid m.	Skin of the face; mucous membranes of the nasal and oral cavities; general sensation (GSA) to the anterior 2/3 of the tongue	Some brs. carry pre- or postganglionic para-sympathetic fibers; the trigeminal n. divides into three divisions at the trigeminal ganglion; SVE supplies muscles of 1st pharyngeal arch origin
Ophthalmic division of the trigeminal n.	V1	Trigeminal ganglion	Meningeal br., lacrimal n., frontal n., nasociliary n.	None	(GSA) skin of the forehead, upper eyelid and nose; mucous membrane of the upper nasal cavity, frontal sinus, ethmoid air cells and sphenoid sinuses	Passes through the superior orbital fissure to exit the middle cranial fossa; The lacrimal n. receives postganglionic para-sympathetic axons to the lacrimal gland from the zygomatico-temporal br. of zygomatic n.
Maxillary division of the trigeminal n.	V2	Trigeminal ganglion	Meningeal br., posterior superior alveolar n., pharyngeal,	None	GSA: skin of the upper lip, cheek, lower eyelid; mucous	Passes through the foramen rotundum to enter the pterygopalatine

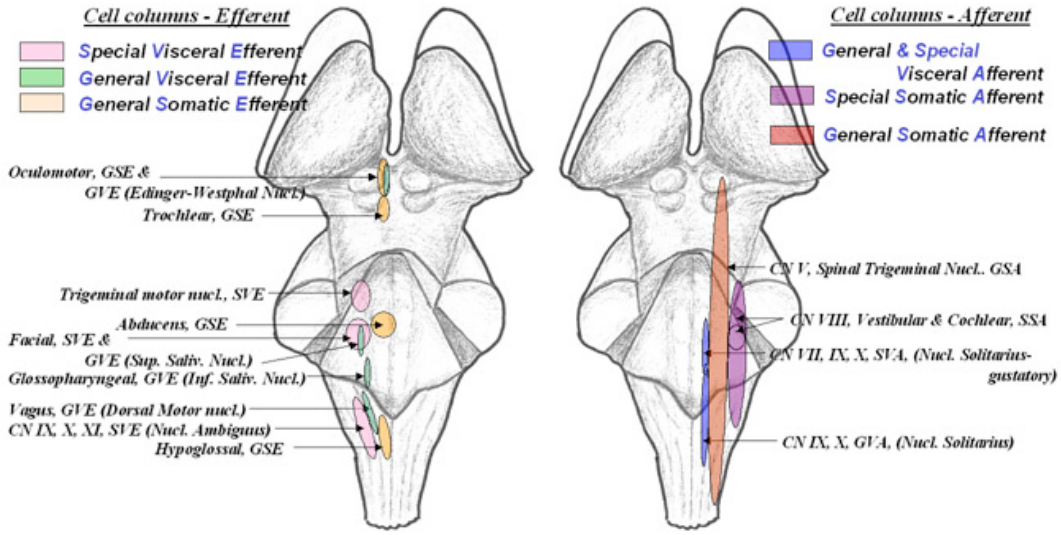
			posterior superior medial and lateral nasal brs, nasopalatine n, greater and lesser palatine nn, zygomatic n., infra-orbital n.		membrane of the palate; teeth and gingiva of the maxillary alveolar arch; the mucous membrane lining most of the nasal cavity; the mucous membrane lining the maxillary sinus	fossa; the pterygopalatine ganglion is associated with it in the pterygopalatine fossa; postganglionic para-sympathetic fibers distribute with branches of the maxillary division to mucous glands of the nasal cavity and palate; the zygomatic n. & its brs. carry postganglionic parasympa-thetic axons to the orbit to reach the lacrimal n. and lacrimal gland
Mandibular division of the trigeminal n.	V3	Trigeminal ganglion; motor root arises from the pons	Meningeal br., medial pterygoid and lateral pterygoid nn., masseteric n., anterior and posterior deep temporal nn., buccal n., auriculotempor al n., lingual n., inferior alveolar n.	SVE: mylohyoid m., anterior belly of the digastric m.; tensor tympani m., tensor veli palatini m.; muscles of mastication (temporalis, masseter, medial pterygoid and lateral pterygoid)	GSA: skin of the lower lip and jaw extending superiorly above level of the ear; mucous membrane of the tongue and floor of the mouth; lower teeth and gingiva of the mandibular alveolar arch	Passes through the foramen ovale to exit the middle cranial fossa. The otic ganglion is associated with the medial side of V3 below the foramen ovale; the auriculo-temporal n. carries postganglionic para-sympathetic axons to the parotid gland. The sub-mandibular ganglion is associated with the lingual n. near the submandibular gland.

						Postganglionic para-sympathetics from the submandibular ganglion supply the submandibular gland and the sublingual gland
Abducens	VI	Pons: abducens nucleus	None	GSE: lateral rectus m.	None	Passes through the superior orbital fissure
Facial	VII	Pons and medulla: nucleus solitarius of medulla via nervous intermedius (SVA sensory root) from geniculate ganglion; superior salivatory nucleus (GVE preganglionic para-sympathetic) of pons via nervus intermedius; facial motor nucleus of pons via motor root	Greater petrosal n. (Pre-ganglionic para-sympathetic to pterygo-palatine ganglion, Post-ganglionic par-asympathetic travels with brs. of maxillary division of V). Chorda tympani (SVA taste from anterior 2/3 of the tongue; pre-ganglionic para-sympathetic to the sub-mandibular ganglion, post-ganglionic para-sympathetic to the sub-mandibular and sublingual glands). Nerve to stapedius. Posterior auricular n. Intraparotid plexus with temporal, zygomatic, buccal, marginal mandibular & cervical brs.	Stapedius m, stylohyoid m, posterior belly of digastric m, muscles of facial expression; secretomotor to lacrimal, sub-mandibular, sublingual, and mucous glands of the nasal and oral cavities	Taste (SVA) from the anterior 2/3 of the tongue; part of the skin of the external auditory meatus	Exits the posterior cranial fossa by passing into the internal acoustic meatus, goes through the facial canal; motor to muscles of facial expression exits the skull at the stylomastoid foramen

Vestibulo-cochlear	VIII	Pons & medulla: vestibular nuclei from the vestibular ganglion of the semicircular ducts; cochlear nuclei in the inferior cerebellar peduncle	Divides within the temporal bone into vestibular and cochlear parts	None	Vestibular: balance/proprioception (SSA); cochlear: hearing (SSA)	Auditory nerve; passes into the internal auditory meatus
Glosso-pharyngeal	IX	Medulla: spinal trigeminal nucleus from the superior ganglion (GVA); nucleus solitarius from the inferior ganglion (SVA); nucleus ambiguus (GVA); inferior salivatory nucleus (GVE - preganglionic para-sympathetic)	Tympanic nerve to the tympanic plexus and lesser petrosal n., carotid sinus n., stylo-pharyngeus brs., pharyngeal brs.	GSE: stylo-pharyngeus; GVE: secretomotor to the parotid gland (pre-ganglionic para-sympathetic via the tympanic n. to the lesser petrosal n. to the otic ganglion; post-ganglionic para-sympathetic via the auriculo-temporal n.)	GVA: carotid body, carotid sinus, pharynx, middle ear; GSA: skin of the external ear; SVA: taste from the posterior 1/3 of the tongue	Exits the posterior cranial fossa by passing through the jugular foramen. It may penetrate the stylo-pharyngeus m.
Vagus	X	Medulla: dorsal motor nucleus (GVE preganglionic parasympathetic); inferior ganglion (GVA); nucleus ambiguus (SVE); superior ganglion (GSA); inferior ganglion (SVA)	Auricular br., pharyngeal br., superior laryngeal, superior and inferior cervical cardiac brs., recurrent laryngeal n., thoracic cardiac brs., brs. to the pulmonary plexus, brs. to the esophageal plexus, anterior and posterior vagal trunks	SVE: intrinsic muscles of the larynx, pharynx (except stylo-pharyngeus), and palate (except tensor veli palatini); GVE: smooth muscle of the respiratory tree & gut (proximal to the left colic flexure), heart;	GSA: skin of the external auditory meatus; GVA: viscera of head, neck, thorax & abdomen proximal to the left colic flexure; SVA: taste from the epiglottis	Passes through the jugular foramen to exit the posterior cranial fossa; vagus means "wanderer" in reference to its extensive distribution to the body cavities

				secretomotor : mucous glands of the larynx, respiratory tree, pharynx and gut; secretomotor to digestive glands		
Accessory	XI	Cranial root: medulla - nucleus ambiguous. Spinal root: spinal nucleus of the upper cervical spinal cord	None	GSE: sterno-cleidomastoid and trapezius mm.	None	Spinal root enters cranial cavity by passing through the foramen magnum. Exits skull by passing through the jugular foramen. Accessory n. is motor only; the subtrapezial plexus of nerves receives proprioceptive fibers: for the sternocleido-mastoid m. From the ventral primary rami of spinal nn. C2 and C3 for trapezius via ventral primary rami of C3 and C4
Hypoglossal	XII	Medulla: hypoglossal nucleus	No named branches. Branches of the ventral primary ramus of spinal nerve C1 are carried by this nerve and are not considered to be branches of the hypoglossal nerve	Intrinsic and extrinsic muscles of the tongue (except the palato-glossus m.)	None	Exits the posterior cranial fossa by passing through the hypoglossal canal; the superior root of the ansa cervicalis travels with the hypoglossal n. for a short distance

CRANIAL NERVE NUCLEI



CN NUCLEUS	LOCATION
Spinal Trigeminal Nucleus (V)	Medulla: It's right next to the Inferior Cerebellar Peduncle Pons: It's right next to the Middle Cerebellar Peduncle
Spinal Trigeminal Tract (V)	Throughout the Brainstem Lateral to the Spinal Trigeminal Nucleus
Hypoglossal Nucleus (XII)	**Closed Medulla** Dorsal to the MLF, Central in the internal arcuate decussation
Dorsal Motor Nucleus (X)	**Early Open Medulla** Dorsolateral to Hypoglossal Nucleus, in Central Grey
Solitary Tract and Nucleus (IX, X)	**Early Open Medulla** The Tract is a dark spot in the Reticular Formation
Nucleus Ambiguus (IX, X, XI)	**Early Open Medulla** Laterally in the Reticular Formation, near the Inferior Cerebellar Peduncle
Spinal Vestibular Nucleus (VIII)	**Open Medulla** It's more pigmented; located just medial to inferior Cerebella Peduncle, on dorsal surface.
Medial Vestibular Nucleus (VIII)	**Open Medulla** It's less pigmented; medial to Spinal Vestibular Nucleus
Dorsal Cochlear Nucleus (VIII)	**Open Medulla** Lateral to Inferior Cerebellar Peduncle, just proximal to nerve

Ventral Cochlear Nucleus (VIII)	**Open Medulla** Almost in the nerve
COCHLEAR NERVE (VIII)	**Open Medulla** It exits lateral to the Inferior Cerebellar Peduncle
Facial Nucleus (VII)	**Pontomedullary Junction** Floor of the Fourth Ventricle, just lateral to Abducens Nucleus
FACIAL NERVE (VII)	**Pontomedullary Junction** It can be seen crossing the Reticular Formation on right side, and coursing more laterally through Pons
Abducens Nucleus (VI)	**Pons** Very dorsal surface of Pons; floor of the fourth ventricle medially
ABDUCENS NERVE (VI)	**Pons** Can be seen coursing medially through Pons
Main Sensory Trigeminal Nucleus (V)	**Pons** Right next to Middle Cerebellar Peduncle
Motor Trigeminal Nucleus (V)	**Pons** Just medial to Main Sensory of V
Mesencephalic Trigeminal Nucleus (V)	**Pons** Right below the Superior Cerebellar Peduncle
TRIGEMINAL NERVE (V)	**Pons** (caudal Pons) Can be seen exiting off the CN-V Nuclei, near the MCP
TROCHLEAR NERVE (IV)	**Pontomesencephalic Junction** (After MCP) It can be seen exiting dorsally
Trochlear Nucleus (IV)	**Mesencephalon** (Inferior Colliculus) Central Gray, above MLF
Oculomotor Nucleus (III)	**Mesencephalon** (Superior Colliculus) Central Gray, inside the “V” of the MLF
Edinger-Westphal Nucleus (III)	**Mesencephalon** (Superior Colliculus) Central Gray, directly dorsal to Oculomotor Nucleus
OCULOMOTOR NERVE (III)	**Mesencephalon** (Rostrum) Can be seen coursing between Red Nuclei, and exiting out of Interpeduncular Fossa