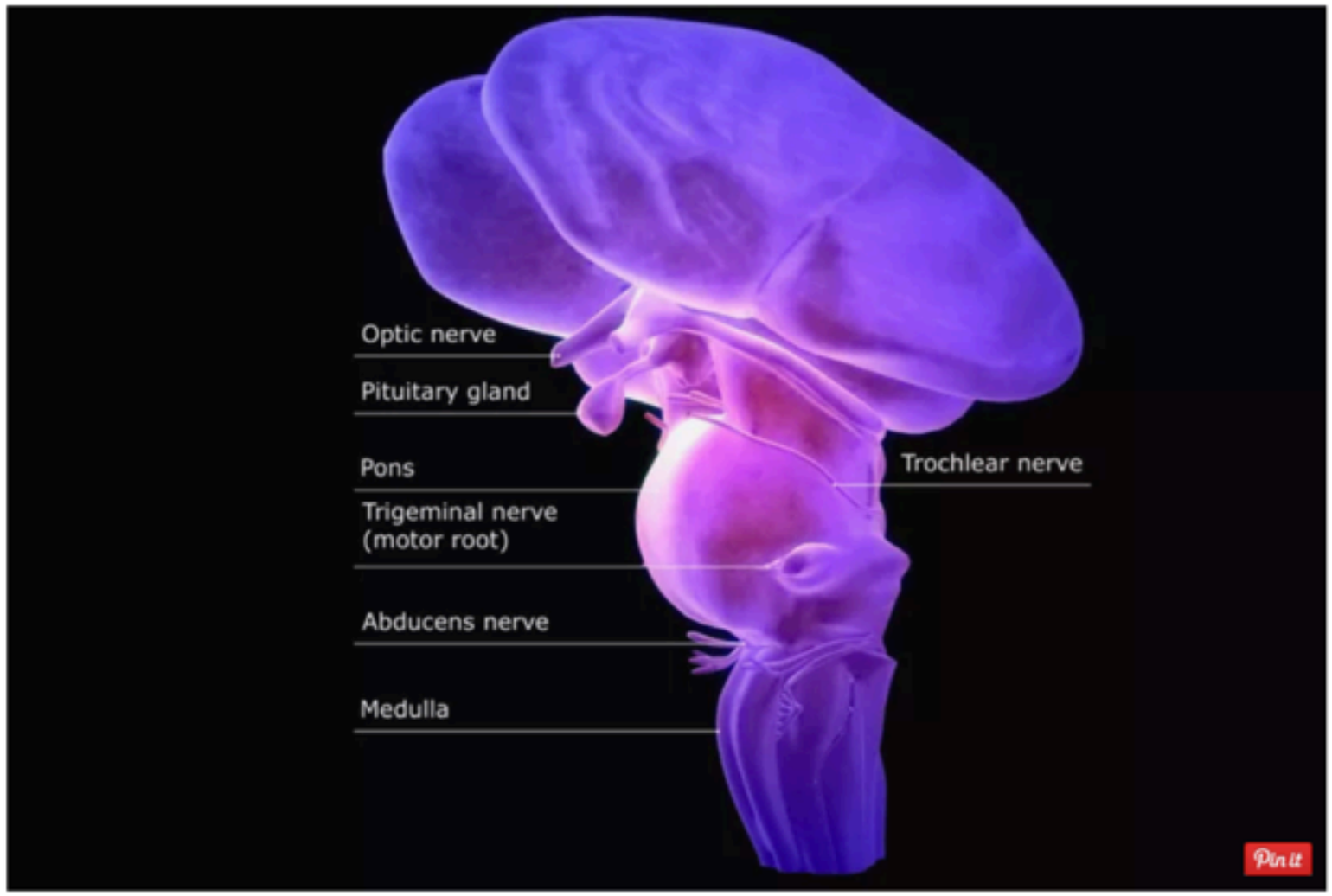
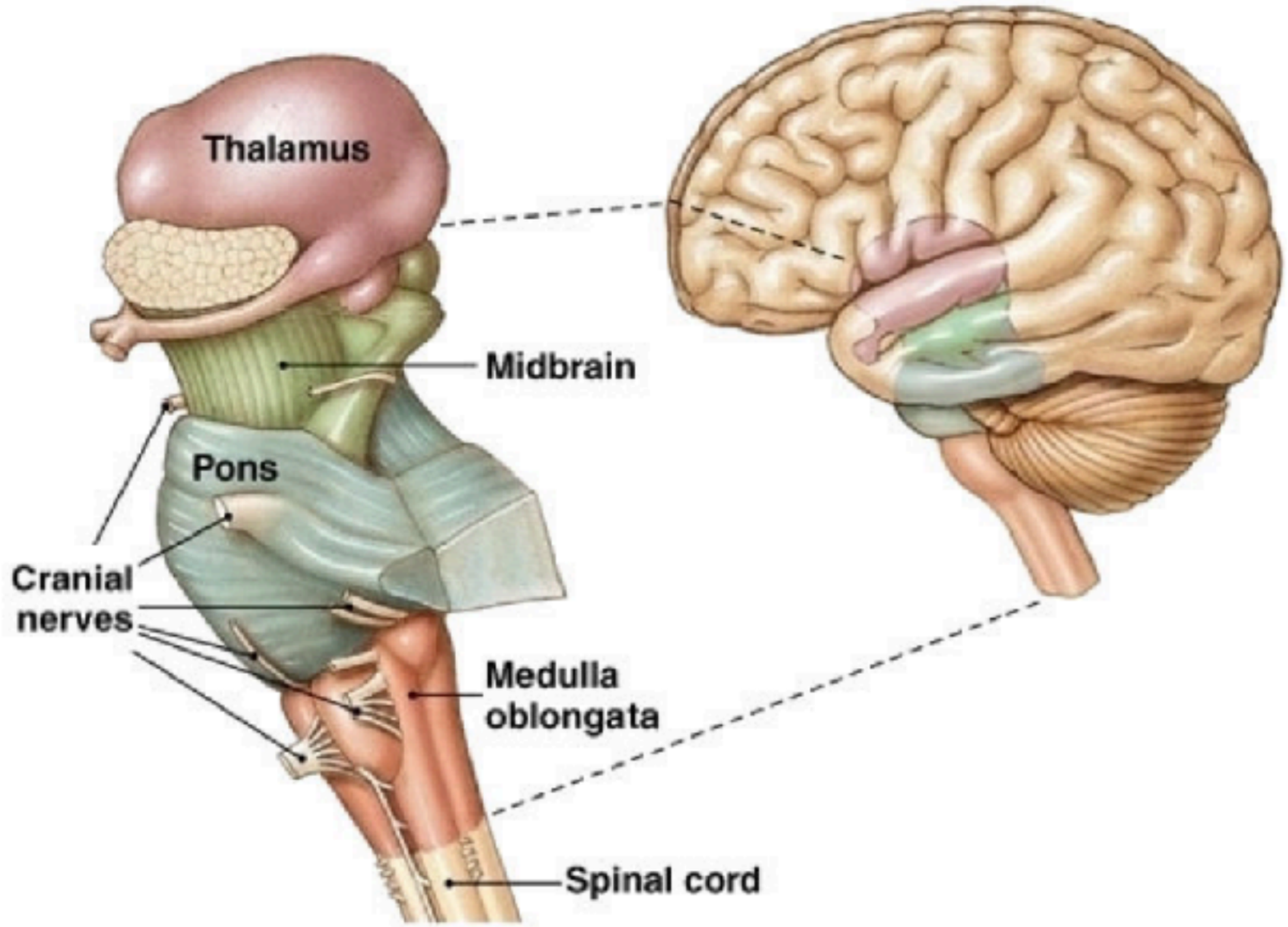
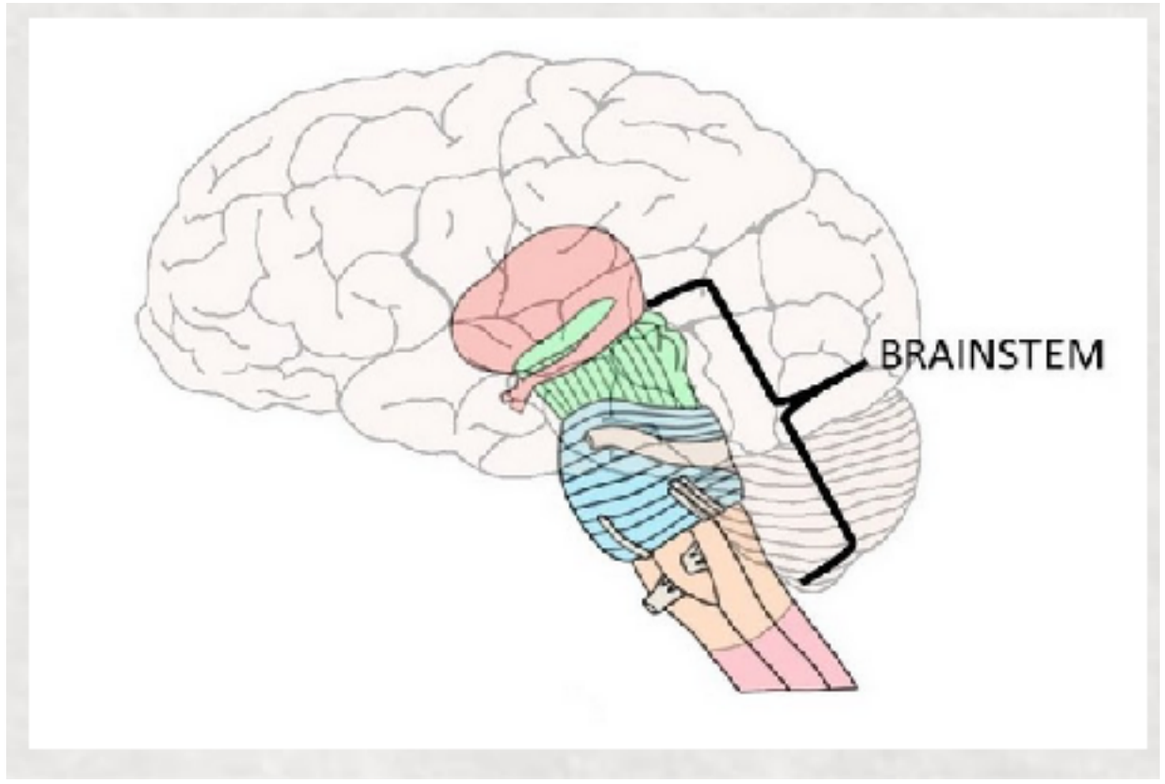



Brainstem Diagram.
MedicalRF.com / Getty Images


Thalamus
Midbrain
Pons
Cranial nerves
Medulla oblongata
Spinal cord




The brainstem is the region of the brain that connects the cerebrum with the spinal cord. It consists of the midbrain, medulla oblongata, and the pons. Motor and sensory neurons travel through the brainstem allowing for the relay of signals between the brain and the spinal cord. Most cranial nerves are found in the brainstem.

The brainstem coordinates motor control signals sent from the brain to the body. This brain region also controls life-supporting autonomic functions of the peripheral nervous system. The fourth cerebral ventricle is located in the brainstem, posterior to the pons and medulla oblongata. This cerebrospinal fluid-filled ventricle is continuous with the cerebral aqueduct and the central canal of the spinal cord.

# Cranial vs Spinal Nerves

More Information Online

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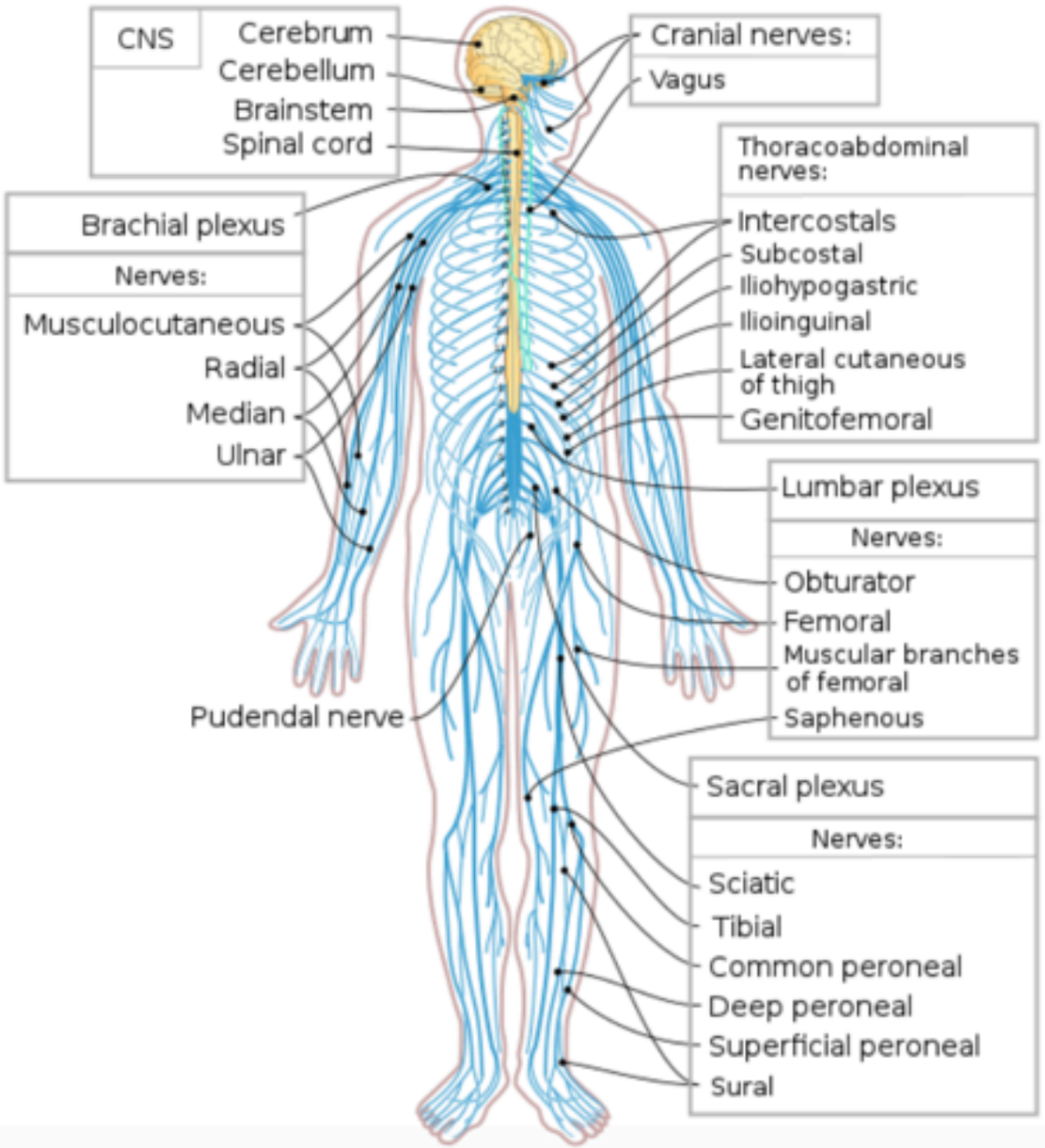
| | Cranial Nerves | Spinal Nerves |
|---|---|---|
| DEFINITION | Nerves connected to the brain are cranial nerves. | Nerves connected with the spinal cord are called spinal nerves. |
| NUMBER OF NERVES | In mammals, there are 12 pairs of cranial nerves. | There are 31 pairs of spinal nerves. |
| FUNCTIONS | Cranial nerves coordinate the activities associated with head and neck (except vagus nerve). | Spinal nerves coordinate the activities associated with all the body parts, below the neck. |
| NUMBERING AND NAMING THE NERVES | Cranial nerves are designated by serial numbers and names. | Spinal cords are named according to their location on the spinal cord. |
| TYPE OF THE NERVES | Most of these nerves are mixed nerves with the exception of olfactory, optic, and vestibulocochlear nerves. | All the spinal nerves are mixed nerves. |

Nerves that are originating from the spinal cord are spinal nerves. There are 31 pairs of spinal nerves that are named in relation to their location on the spinal cord. All of them are mixed nerves so that each nerve consists of both ventral (motor) and dorsal root (sensory) components. These nerves mainly carry nerve impulse to and from the spinal cord to all parts of the body.



## Function

In addition to linking the cerebrum and spinal cord, the brainstem also connects the cerebrum with the cerebellum.

The cerebellum is important for regulating functions such as movement coordination, balance, equilibrium, and muscle tone. It is positioned above the brainstem and beneath the occipital lobes of the cerebral cortex.

Nerve tracts traveling through the brainstem relay signals from the cerebellum to areas of the cerebral cortex that are involved in motor control. This allows for the coordination of fine motor movements needed for activities such as walking or playing video games.

The brainstem also controls several important functions of the body including:

- Alertness
- Arousal
- Breathing
- Blood pressure control
- Digestion
- Heart rate
- Other autonomic functions
- Relays information between the peripheral nerves and spinal cord to the upper parts of the brain

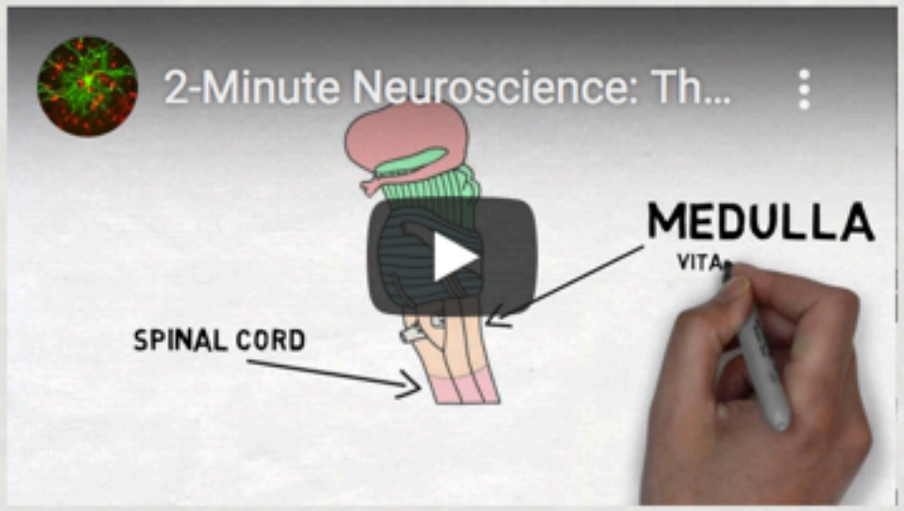
In a summation, the brainstem controls numerous important functions of the body including:

- Breathing
- Blood Pressure Control
- Alertness
- Arousal
- Digestion
- Heart Rate
- Additional Autonomic Functions

The brain stem carries information among the peripheral nerves and spinal cord to the upper portions of the brain.

## Medulla

In addition to being the point where the brainstem connects to the spinal cord, the medulla contains a nucleus called the nucleus of the solitary tract that is crucial for our survival. The nucleus of the solitary tract receives information about blood flow, along with information about levels of oxygen and carbon dioxide in the blood, from the heart and major blood vessels. When this information suggests a discordance with bodily needs (e.g. blood pressure is too low), there are reflexive actions initiated in the nucleus of the solitary tract to bring things back to within the desired range.




WATCH THIS 2-MINUTE NEUROSCIENCE VIDEO TO LEARN MORE ABOUT THE BRAINSTEM.

Thus, the medulla is essential to our survival because it ensures vital systems like the cardiovascular and respiratory systems are working properly. Additionally, the medulla is responsible for a number of reflexive actions, including vomiting, swallowing, coughing, and sneezing. Several cranial nerves also exit the brainstem at the level of the medulla.

## Pons

The next structure on our way up the brainstem is the pons. The pons is hard to miss; it is a large, rounded, and bulging structure just above the medulla. The word "pons" means bridge in Latin, and it resembles a rounded bridge that connects the medulla and the midbrain.

The pons is an important pathway for tracts that run from the cerebrum down to the medulla and spinal cord, as well as for tracts that travel up into the brain. It also forms important connections with the cerebellum via fiber bundles known as the cerebellar peduncles.

The pons is home to a number of nuclei for cranial nerves. Nerves that carry information about sensations of touch, pain, and temperature from the face and head synapse in a nucleus in the pons. Motor commands dealing with eye movement, chewing, and facial expressions also originate in the pons. Additionally, cranial nerve nuclei in the pons are involved in a number of other functions, including swallowing, tear production, hearing, and maintaining balance/equilibrium.

## Midbrain

The final branch of the brainstem as we move toward the cerebrum is called the midbrain. The midbrain contains a number of important tracts running to and from the cerebrum and cerebellum, as well as some key nuclei.

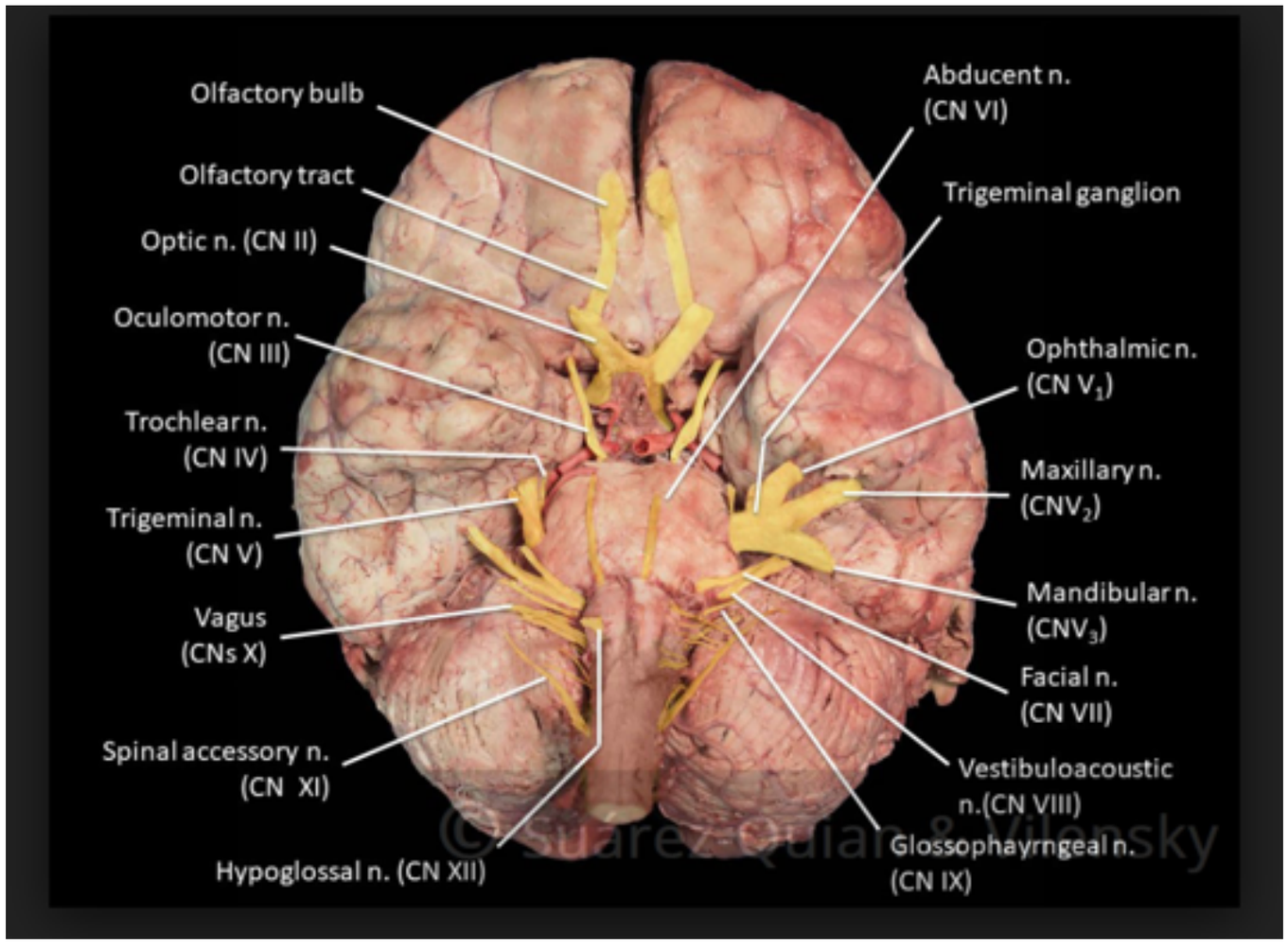
The upper posterior (i.e. rear) portion of the midbrain is called the tectum, which means "roof." The surface of the tectum is covered with four bumps representing two paired structures: the superior and inferior colliculi. The superior colliculi are involved in eye movements and visual processing, while the inferior colliculi are involved in auditory processing.

At about the level of the superior colliculi, but located more anteriorly (i.e. toward the front) is another important nucleus called the substantia nigra. The substantia nigra, which literally means "black substance," was so named because it appears very dark in an unstained piece of tissue. The substantia nigra is rich in dopamine neurons and is considered part of the basal ganglia, which is a collection of nuclei that are crucial to normal motor movement. In patients who are suffering from Parkinson's disease, neurodegeneration occurs in the substantia nigra, and this neurodegeneration is associated with the hallmark movement dysfunction we see in Parkinson's.

## Summary – Cranial vs Spinal Nerves

Nerve or a neuron is the basic structural and functional unit of the nervous system. Nerves mainly facilitate communication and signal transmission throughout the body. Thus, there are around several billions of nerves in our body. Furthermore, the brain is one of the major parts of the central nervous system that locates inside the cranium. Hence, cranial nerves are the nerves that come from the brain. There are 12 pairs of cranial nerves. Moreover, the spinal code is the second major part of the central nervous system, and the spinal nerves are the nerves that come from the spinal cord. There are 31 pairs of spinal nerves. Both the cranial and spinal nerves collectively make the peripheral nervous system. Hence, this is the difference between cranial and spinal nerves.

The **key difference** between Cranial and Spinal Nerves is that the **cranial nerves originate from the brain and carry nerve impulses to the eyes, mouth, face and other parts of the head region while** the **spinal nerves originate from the spinal cord and carry nerve impulses** to **the other parts of the body.**


Olfactory bulb
Olfactory tract
Optic n. (CN II)
Oculomotor n. (CN III)
Trochlear n. (CN IV)
Trigeminal n. (CN V)
Vagus (CNs X)
Spinal accessory n. (CN XI)
Hypoglossal n. (CN XII)
Abducent n. (CN VI)
Trigeminal ganglion
Ophthalmic n. ($CN V_1$)
Maxillary n. ($CNV_2$)
Mandibular n. ($CNV_3$)
Facial n. (CN VII)
Vestibuloacoustic n.(CN VIII)
Glossophayrngeal n. (CN IX)
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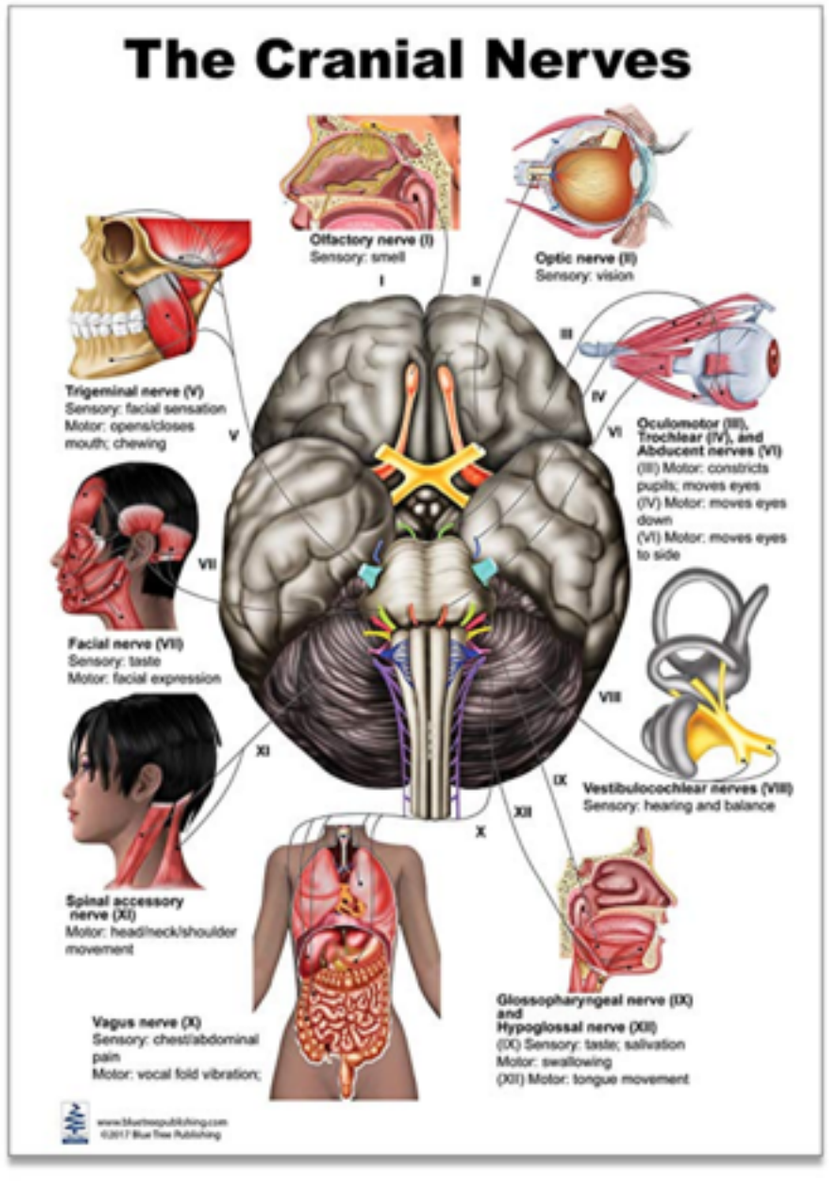
# The Cranial Nerves

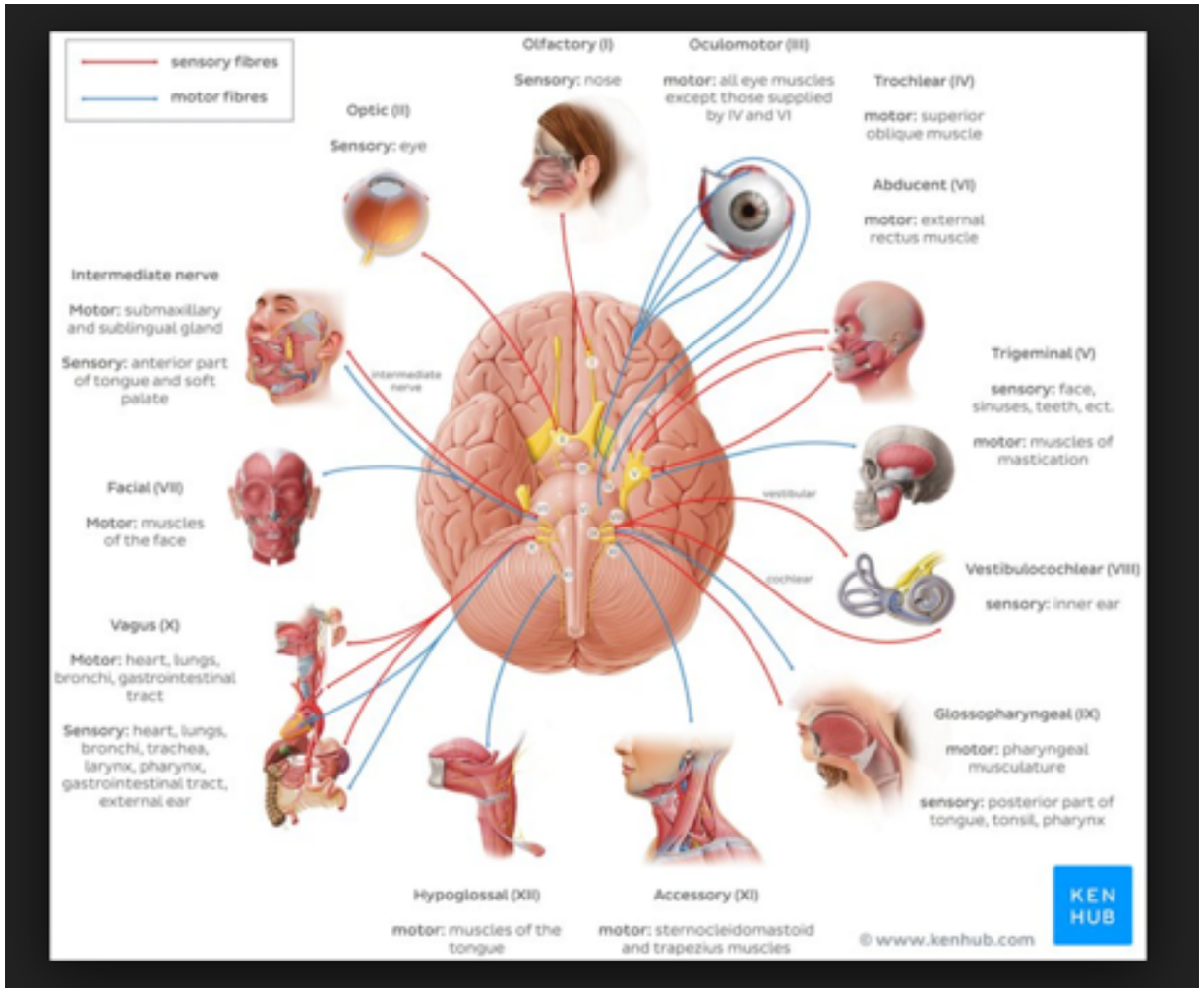


Can't remember the names of the cranial nerves? Here is a handy-dandy mnemonic for you:

**O**n **O**ld **O**lympus **T**owering **T**op **A** **F**amous **V**ocal **G**erman **V**iewed **S**ome **H**ops.

The **bold letters** stand for:

olfactory, optic, oculomotor, trochlear, trigeminal, abducens, facial, vestibulocochlear, glossopharyngeal, vagus, spinal accessory, hypoglossal.


sensory fibres
motor fibres
Olfactory (I)
Sensory: nose
Oculomotor (III)
motor: all eye muscles except those supplied by IV and VI
Trochlear (IV)
motor: superior oblique muscle
Optic (II)
Sensory: eye
Abducent (VI)
motor: external rectus muscle
Intermediate nerve
Motor: submaxillary and sublingual gland
Sensory: anterior part of tongue and soft palate
intermediate nerve
Trigeminal (V)
sensory: face, sinuses, teeth, ect.
motor: muscles of mastication
Facial (VII)
Motor: muscles of the face
vestibular
cochlear
Vestibulocochlear (VIII)
sensory: inner ear
Vagus (X)
Motor: heart, lungs, bronchi, gastrointestinal tract
Sensory: heart, lungs, bronchi, trachea, larynx, pharynx, gastrointestinal tract, external ear
Glossopharyngeal (IX)
motor: pharyngeal musculature
sensory: posterior part of tongue, tonsil, pharynx
Hypoglossal (XII)
motor: muscles of the tongue
Accessory (XI)
motor: sternocleidomastoid and trapezius muscles
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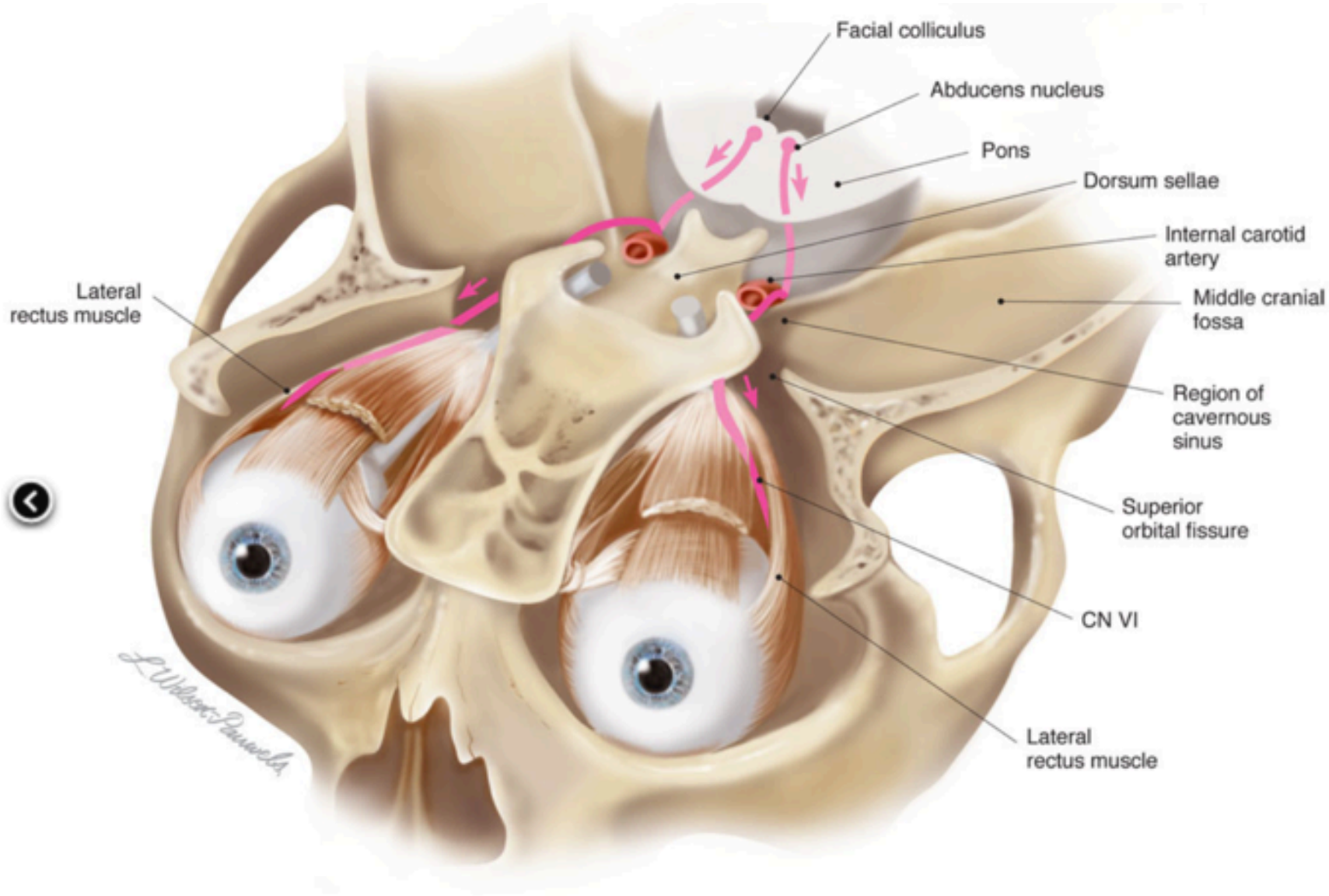



**Figure VI–2** Route of the abducens nerve (cranial nerve VI) from the pons to the lateral rectus muscle.

## List of the Cranial Nerves

1. **I Olfactory** (Smell)
2. **II Optic** (Sight)
3. **III Oculomotor** (Moves eyelid and eyeball and adjusts the pupil and lens of the eye)
4. **IV Trochlear** (Moves eyeballs)
5. **V Trigeminal** (Facial muscles incl. chewing; Facial sensations)
6. **VI Abducens** (Moves eyeballs)
7. **VII Facial** (Taste, tears, saliva, facial expressions)
8. **VIII Vestibulocochlear** (Auditory)
9. **IX Glossopharyngeal** (Swallowing, saliva, taste)
10. **X Vagus** (Control of PNS e.g. smooth muscles of GI tract)
11. **XI Accessory** (Moving head & shoulders, swallowing)
12. **XII Hypoglossal** (Tongue muscles - speech & swallowing)

| | Cranial Nerve<br>Number and Name | Function(s) of Cranial Nerve |
|---|---|---|
| 1. | **I olfactory**<br>*(sensory)* | **Smell** |
| 2. | **II optic**<br>*(sensory)* | **Vision, also called eyesight**. (Each optic nerve contains approx. a million nerve fibres that receive information from the rod and cone cells of the retina.) |
| 3. | **III oculomotor**<br>*(mixed, mainly motor)* | **Moves the eyeball and eyelid, adjusts the lens of the eye for near vision and also constricts the pupil of the eye** via motor fibres distributed to muscles located in and around the eye.<br><br>Parasympathetic fibres<br>adjust the size of the pupil and the shape of the lens of the eye.<br><br>Fibres outside the eye<br>extend to the upper eye-lid and the extrinsic muscles that turn the eyeball in different directions, (incl. the superior rectus, medial rectus, inferior rectus and inferior oblique muscles). |
| 4. | **IV trochlear**<br>*(mixed, mainly motor)* | **Moves the eyeballs** by sending nerve impulses to the superior oblique muscles which are among the group of muscles that rotate the eyeballs in their sockets. (The action of this nerve is coordinated with those of the oculomotor and abducens nerves i.e. cranial nerves III and VI.) |
| 5. | **V trigeminal**<br>*(mixed)* | This is largest cranial nerve and splits into the following 3 divisions, each of which includes both motor and sensory fibres.<br>1. Ophthalmic nerve<br>2. Maxillary nerve<br>3. Mandibular nerve<br><br>**The motor fibres of all 3 divisions control the facial muscles involved in chewing. The sensory fibres convey sensations of touch, pain and temperature** from the front of the head including the mouth and also from the meninges. |

| | | |
|---|---|---|
| 6. | **VI abducens**<br>*(mixed, mainly motor)* | **Moves the eyeballs** outwards by sending nerve impulses to the lateral rectus muscles. |
| 7. | **VII facial**<br>*(mixed)* | Sensory fibres are concerned with **taste** via the taste buds at the front of the tongue.<br>Motor fibres **control secretion of tears** via the lacrimal glands **and saliva** via the sublingual salivary glandsas well as **facial expressions** via some of the muscles of facial expression.<br>A branch of the facial nerve regulates the tension on the ear ossicles. |
| 8. | **VIII vestibulocochlear**<br>*(mixed, mainly sensory)* | Two branches: **Vestibular nerve** (senses equilibrium) and **Cochlear nerve** (hearing)<br><br>Vestibular nerve:<br>Aids **equilibrium** by carrying impulses from the semicircular canals - providing info about posture, movement and balance<br><br>Cochlear nerve:<br>Carries impulses from the cochlea, so is known as the nerve of **hearing**. |
| 9. | **IX glossopharyngeal**<br>*(mixed)* | **Motor Fibres**<br>• Modulate **swallowing** via supply to muscles of the throat (pharynx) area<br>• Parasympathetic control of **secretion of saliva** (via supply to the parotid salivary glands)<br><br>**Sensory Fibres**<br>• Monitors blood pressure<br>• Monitors levels of oxygen and carbon dioxide in blood<br>• Coordination of some muscle activity e.g. in some swallowing muscles<br>• Sensations of **taste, touch, pain and temperature from posterior third of the tongue and tissues of the soft palate** |

| | | |
|---|---|---|
| 10. | **X vagus**<br>*(mixed)* | **Motor Fibres**:<br>• Under conscious control<br>Stimulates voluntary muscles that effect **swallowing, coughing and speech**.<br>• Under unconscious control<br>◦ Stimulates the **contraction and relaxation of smooth muscle in the gastrointestinal tract** (GI, also called the alimentary canal)<br>◦ Can trigger **reduction (slowing) of heart-rate**<br>◦ Stimulates **secretion of digestive fluids**<br><br>**Sensory Fibres**:<br>• Monitors blood pressure<br>• Monitors levels of oxygen and carbon dioxide in blood<br>• Sensations of touch, pain and temperature from thoat area<br>• Sensations from visceral organs in thorax and abdomen |
| 11. | **XI accessory**<br>*(mixed, mainly motor)* | Arises from two roots, **cranial** and **spinal**.<br><br>Cranial parts: **Controls swallowing movements** because nerve fibres (from the cranial root of cranial nerve XI) join the vagus nerve to form the recurrent laryngeal nerve which supplies the internal laryngeal muscles.<br><br>Spinal Parts: **Governs movement of the head and shoulders** by supplying the sternocleidomastoid and trapezius muscles in the (anterior and posterior) regions of the neck. |
| 12. | **XII hypoglossal**<br>*(mixed, mainly motor)* | Supplies the muscles of the tongue - responsible for the tongue movements involved in **speech** and **swallowing** |

The brain is situated inside the cranium. Hence, the nerves originating from the brain are cranial nerves. They mainly associate with the head and neck (with the exception of the vagus nerve) and involve in the transmission of both sensory and motor information to and from the brain to the head, neck and face regions.

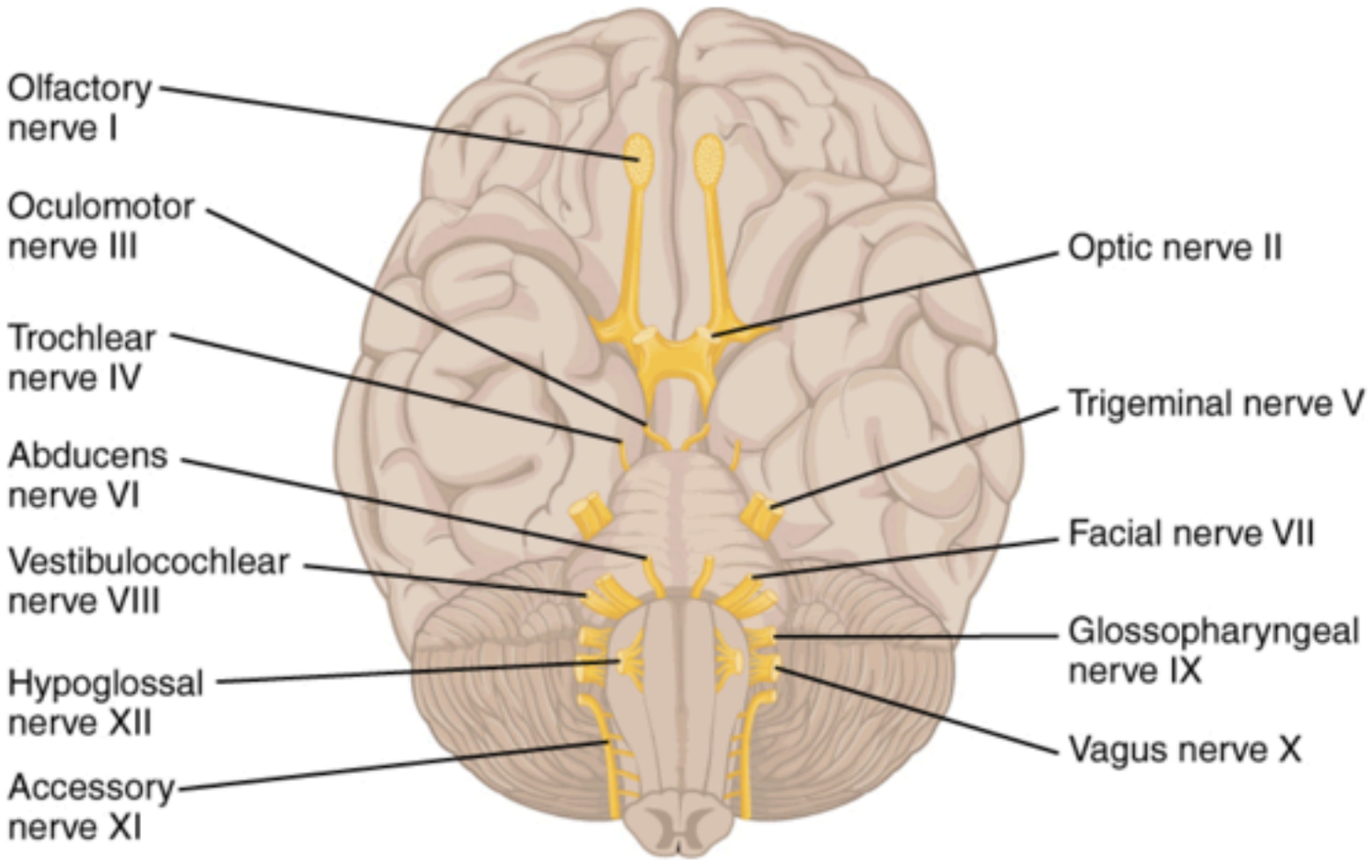
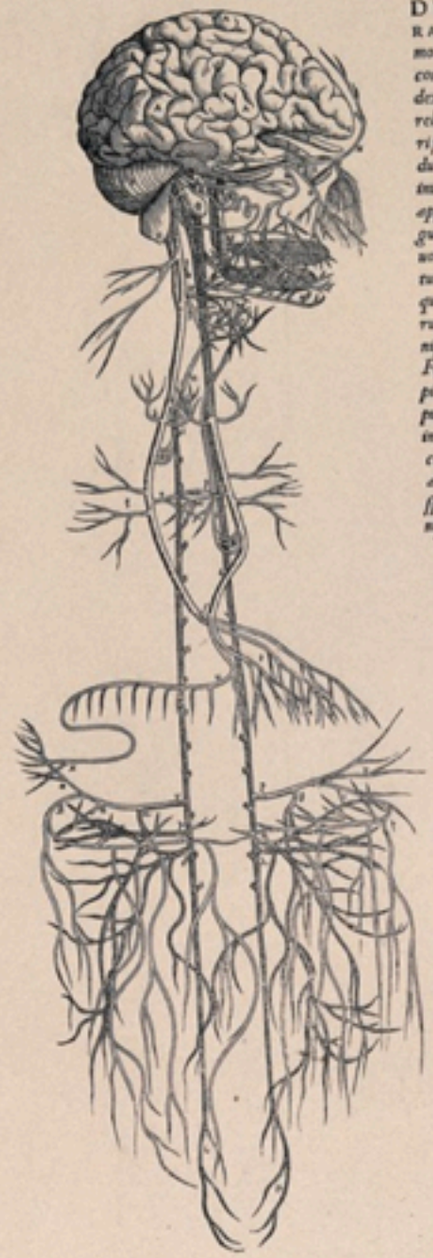



**Figure 01: Cranial Nerves**



DVARVM FIGV-
RARVM QVAE NOVEM
modò subsequentibus Capitibus communes censetur, altera, quæ dexterum latus proponit integri cerebri ac cerebelli, et dictæ in prioris figura dorsalis medullæ partis, dura interim tenuiq; hæc omnia investientibus membranis, nusquam apparentibus. Adhæc præsens figura nudam septem cerebri nervorum priùs seriem in dextero tantum latere commonstrat. quemquam & ubi necessum fuit, nervorum quorundam seriem etiamsi nostro latere hîc delineauerimus. Figuræ huius proportio in ea depicta est magnitudine, in qua corpus circumscriberes, cuius vertex in infima præsentis figuræ sede consisteret, & cuius thorax & abdomen ex anteriori parte conspicerentur, faciesq; versus sinistrum humerum conuersa prorsus ex dextro latere spectaretur.