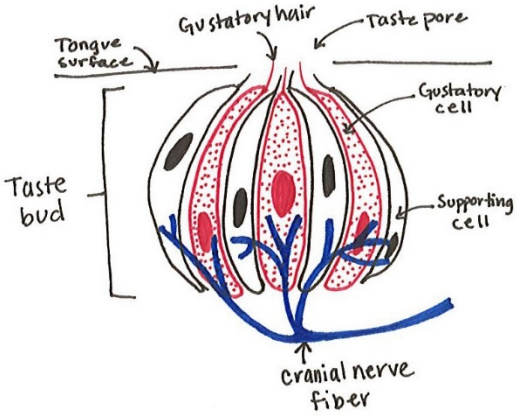
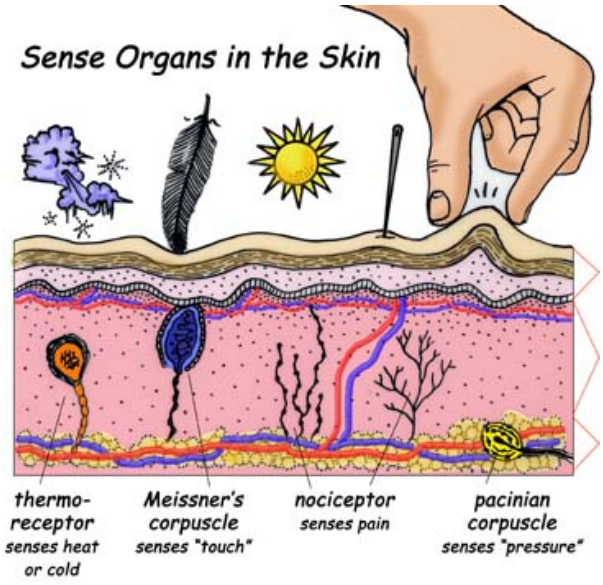
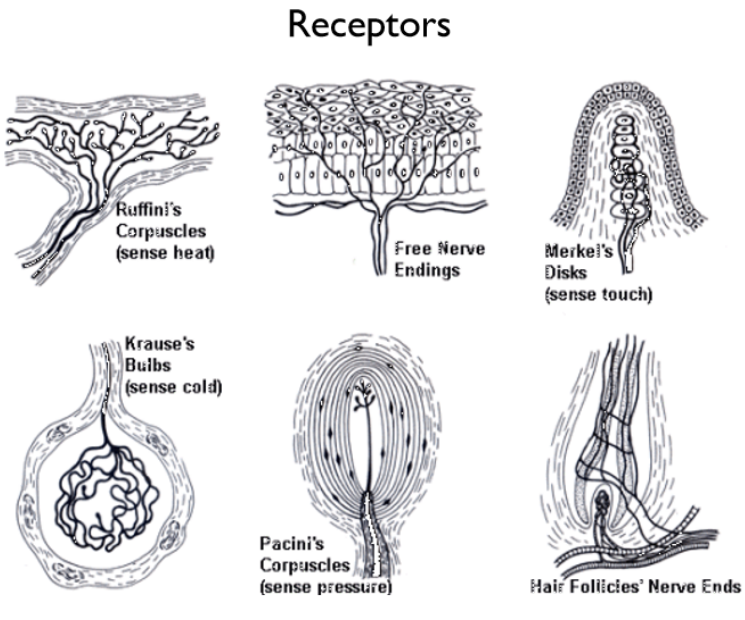
# Orofacial Sensation

| General sensation | Special sensation |
|---|---|
| Nociceptors<br><br>Thermoceptors<br><br>Mechanoreceptors<br><br>Chemoreceptors | Sight<br>Smell<br>Hearing<br>Touch<br>Taste: the chorda tympani ( a branch of the facial nerve ) innervates the taste buds for tatste sensation<br><br>If the facial nerve is damaged at the level of the mastoid region → patient will lose taste sensation in one half of the tongue.<br>  |



## Classification of Sensory Receptors based on the type of Stimulus

- Mechanoreceptors – mechanical stimuli (touch, pressure, vibration, proprioception, hearing and Eq, and stretching of blood vessels and internal organs
- Thermoreceptors – Temp.
- Nociceptors – Pain (via physical or chemical damage)
- Photoreceptors - light
- Chemoreceptors –taste, smell, body fluids
- Osmoreceptors – osmotic pressure of body fluids

Orofacial sensory functions are mediated through highly specific different

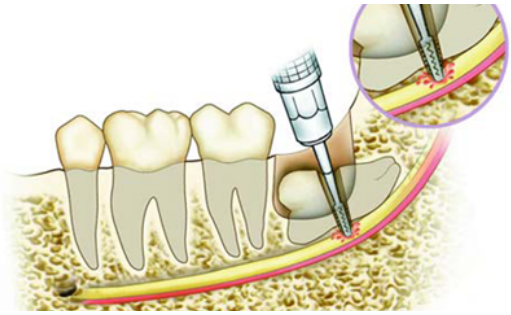
**Types of Receptors**

1. **Proprioceptors (movement, position)**
2. **Mechanoeptors (touch, pressure, distortion)**
3. **Thermoceptors (heat, warmth, cold)**
4. **Nociceptors (pain)**

A proper understanding and appreciation of the neurophysiology is an effective method to control Pain.

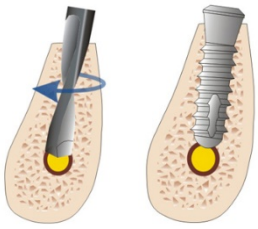
In burning mouth syndrome – the patient will lose the taste sensation

**Case :** an impacted lower 3rd molar – you need to remove off bone and cut the tooth in order to extract it → this might lead to damage to the **inferior Alveolar nerve → paraesthesia (numbness)**



Note : paralysis s loss of ability to move skeletal muscles, while paresthesia is loss of sensation.

Another scenario is during drilling for dental implants the nerve might also be damaged resulting in paresthesia.



Dental procedures mostly affect sensation not the motor ability of the facial muscles ( since the muscles of facial expression are innervated by the facial nerve )

The only exception where dental procedures can cause paralysis is when you are giving anaesthesia and you push the needle further into the parotid region and damage the facial nerve leading to facial palsy.

Proprioception : the sensation of position and movement ( the sense of the relative position of the neighboring parts of the body)

Receptors contributing to proprioception : cutaneous , muscle , joint receptors ( tendons )

NOTE : Pulp has no proprioceptors receptor while the **periodontium has proprioceptor receptors**. ( ie: if the patient is unable to tell you where exactly the pain is , it is mostly pulpitis - the patient will tell you " that this side hurts " )

In order to know which tooth you isolate the teeth and get a source of heat like a heated Guetta percha and apply it onto the tooth and then apply it on the other side for reference

In case the problem was in the periodontium – you can do a percussion test to localize the pain

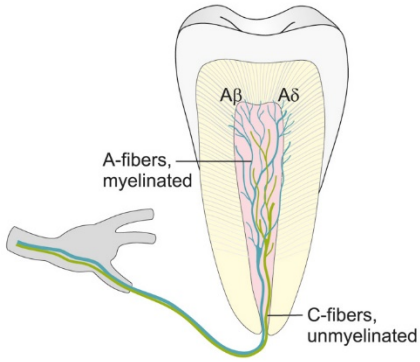
- Periodontal receptors are situated between the roots of the teeth and the alveolar bone.
- Are Ruffini-type endings supplied by **large-diameter** myelinated fibers. (Entirely SA producing action potentials in the absence of any loads)
- Each receptor has a preferred direction where most pulses are generated.
- Tactile thresholds are lower for **labially** directed forces than for axial forces.
- These receptors contribute to oral Stereognosis and tactile sensitivity of the teeth.

**Trigeminal neuralgia** – is when the patient has severe orofacial pain of unknown etiology ( unkown cause)

one of the diagnostic features of trigeminal neuralgia is that the patient has **many teeth extracted** . The patient will go to the dentist with severe pain and points to specific tooth saying that this tooth hurts ( because they get a trigger at a point ) and this results in extracting the tooth but the severe pain remains.

Hyperalgesia : is when the nerve is slightly provoked the pain or the sensation is greatly magnified .

you advice patients after anesthesia to be aware of self induced injury because since they can't feel their lip their will keep on biting on it.




| **The pulp has 2 types of fibers that conduct pain sensation :** | |
|---|---|
| **A fibers** | **C fibers** |
| **Myelinated** | Unmyelinated |
| **Larger diameter** | Thin diameter |
| **Faster conduction** | Slower conduction |
| **Sharp acute pain (ex: pulpitis)** | Mild chronic pain ( ex: in some cases of pulp necrosis the c- fibers remain and that's why the patient still has some pain among doing a vitality test ) |

**Pulp sensitivity tests :**

1. **Electric**
2. **Hot**
3. **Cold**
4. **Drill or vibration**

## Vitality and sensitivity of dentin

Vitality of dentin is its ability to react following physiological or pathological stimuli.

Forming secondary or tertiary dentin, feeling pain are signs of being vital.

Several **theories** have been cited to explain the mechanism involved in dentinal sensitivity & vitality:

- The transducer theory,
- the conduction theory,
- the modulation theory
- the Brännström's hydrodynamic theory.

**Hydrodynamic theory of dental pain :** The dentinal tubules have free nerve endings that will sense pain during the movement of the dentinal fluid .

## 2. The Touch receptors (mechano-receptors) :

Are Innervated by large-diameter, fast-conducting, myelinated Aα fibers.

They are of both types: RA and SA

They function to:

- Transmit textural information

( e.g. crunchy, smooth, chewy,….)

- Provide sensory feedback in the control of motor functions (speech: position of tongue, food manipulation,& mastication,..)

## Stereognosis

Definition:

Is perceiving and understanding the form and nature of objects by the sense of touch.

It is One's ability to recognise and discriminate forms presented as stimulus.

- Manual Stereognosis
  - Used for evaluating functional performance of the hand.
  - Quicker and more accurate than oral stereognosis.
- Oral Stereognosis
  - Used for measuring oral function.
  - Can be used for testing oral dysfunction or for evaluating the effect of therapy.

# Interioception

Sensitive to stimuli arising from internal structures like:

- *Blood vessels*
- *Viscera*
- *skeletal muscles and joints*

*Conducted by NON-CAPSULATED FREE NERVE ENDINGS*

that monitor the internal environment (Vague)

•They function in physiologic visceral reflexes as Blood pressure, Temperature, Heart rate, Respiration

# Exterioception

Sensitive to stimuli arising from outside the body to give the information about external environment (hearing, touch, temperature, smell, taste, vibration,…)

*Conducted by COMPLEX NERVE ENDINGS which are highly specialized and "selective", and mainly "ENCAPSULATED".*

## Functions of perceived Information (internal/external)

- **Homeostasis**
- **Control of movement**
- **Sensation** (awareness, protection, building experience, cognition and recognition,…)
- **Maintaining wakefulness**

## Orofacial sensations possess both types of perception:

Interoceptors through muscles, tendon of TMJ, and PDL and

Exteroceptors through cutaneous, dentinal sensors and through special senses (like taste buds)

How about Dental caries?

## How's the sensory information "Processed"

Sequence of electrical events

- Stimulus
- Sensory receptor
- Sensory neuron triggered from a generated action potential
- Impulse propagation>>reaching a synapse?
- Release of neurotransmitters
- A new action potential of same intensity forms at the interneuron (dendrites and cell body)
- Impulse propagates all the way to the cereberal cortex
- >>>>PERCEPTION (= the conscious awareness of sensation)

## Processing of sensation

Transduction: The process by which stimuli lead to electrical activity in the appropriate sensory nerve ending.

Transmission: neural events that carry the input into CNS

Modulation: The alteration (Change) taking place in neural impulses as they travel up the neuraxis to higher centres.

Perception: Interpretation of incoming data.(and reacting consequently to it). Also termed "neural encoding"

## Neurotransmitters

Are chemicals released across activity of another neurone or a muscle fibre that mediate the faithful transmission of information in the neural network i.e used to "Relay" But they can also Amplify and/or modulate signals between neural cells.

*About 50 neurotransmitters have been identified*

## Types of Neurotransmitters

### 1. Rapid-acting (small molecules):

Mediate the rapid flow of information released from pre-synaptic terminals of one neuron and diffused in a millisecond or so to the post-synaptic receptor of another neuron.

- Responsible for acute (quick) responses in CNS
- Example: Acetyl choline, nor-epinephrine, Glutamate, aspartate, serotonin, GABA, histamine, dopamine,..

### 2. Slow-acting (large molecules)

Cause more prolonged effect, and are not synthesized in presynaptic clefts.

Relatively slower; taking up to seconds to produce effect

- Example: Endorphines,Enkephalins, bradykinin, Substance-P,..

## Synapses:

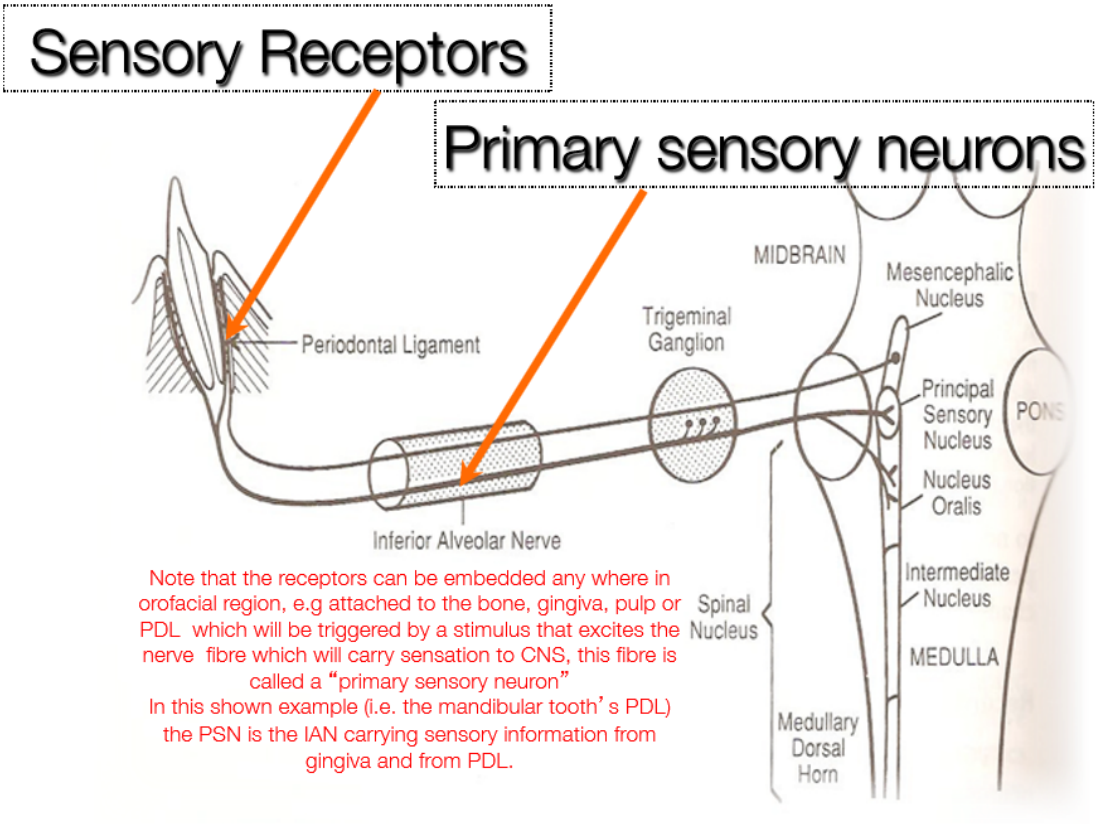
Small gaps of 20 to 50 nanometers

- **Chemical:**

In almost all CNS

- **Electric:**

Cardiac & some smooth muscles.




# Features of Sensory Receptors

- Are responsible for transforming the stimulus energy to electrochemical energy(transduction) .
- Are highly specific (selective to a certain type of stimulus).
- Characterised by "Adaptation" : in which the generator potential decreases in amplitude during maintained constant stimulus.

# ADAPTIVE FIBRES

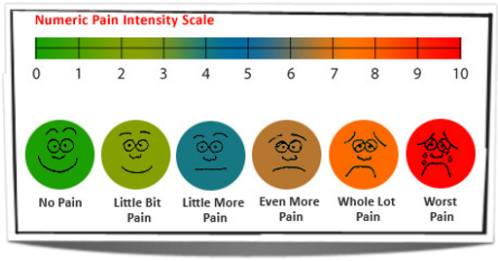
**1-Rapidly Adapting RA** (generate action potentials only during the dynamic phase of the stimulus i.e. responds only transiently, at the beginning and end of a stimulus step)

e.g Pacinian & meissner's corpuscles of the dermis: Responsible for contour and texture, abundant in finger tips

**2-Slowly Adapting SA** (generate action potentials during both the dynamic and static phases of stimulus application i.e.Displays a continuous response to a persistent stimulus)

eg Merkels complex & Rufini endings >> Facial sensation,PDL

Sensors are highly sensitive structures conveying their message to the CNS where it is then interpreted and **manifested depending on the intensity** of the stimulus




# 3. Temperature Receptors

- Currently not known. Could be any including Ruffini & Krause endings.
  The Discharges of cold afferents ↓ during warming (& vice versa)
- Cold receptors are superficial and more numerous, Warmth receptors are deeper.
- Transmit via small diameter afferent nerve fibres (Aδ and C fibres).
- Receptive fields are very localised usually <1mm diameter. "spots"
- Both cold and warm spots have a static discharge (i.e. at constant skin temperature they fire action potentials...SA?)
- Face has the highest density of these spots.(Related to sweat production)
- Sensitive to rate and magnitude of change.

Nervous Tissue Nervous tissue is divided into 2 major cell types:

- Neurons
- Neuroglial cells (the neuroglia)

Neuron : is the basic building block of the nervous system. It is the structural and functional cells in the nervous system that conduct the stimulus along the length of the cell.

**Types of neurons according to tasks in the human body:**

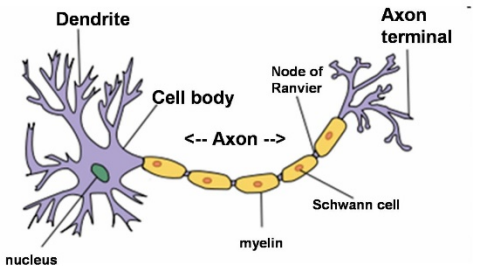
1-Sensory neurons carry information from the sensory receptor cells throughout the body to the brain.

2-Motor neurons transmit information from the brain to the muscles of the body.

3-Interneurons are responsible for communicating information between different neurons in the body.

**Neurons have three basic parts:**

1- cell body ( perikaryon / soma ) : conatins the nucleus which controls the cell's activities and contains the cell's genetic material.




2- Two extensions

A. an axon
B. dendrite

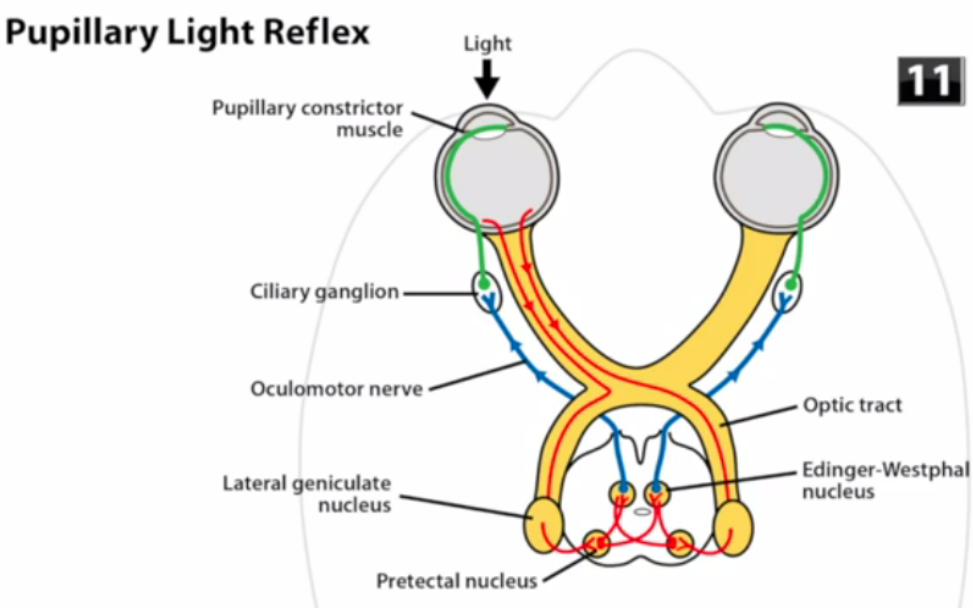
**Cell bodies classifications :**

By their location:

- Ganglion—a collection of nerve cell bodies located in the **peripheral nervous system** (e.g., dorsal root ganglion, trigeminal ganglion, ciliary ganglion)
- Nucleus—a collection of nerve cell bodies located in the **central nervous system** (e.g., Edinger-Westphal nucleus ( related to oculomotor nerve CN III ), chief sensory nucleus of cranial nerve V, motor nucleus of cranial nerve VII)

In the head and neck region we have 4 main PNS ganglia :

- otic ganglion
- ciliary ganglion
- submandibular gangilion
- pterygopalatine




**NOTE : in traumatic Head injuries , the OMFS will have to do a neurological exam to check for deficits .**

**→To check the oculomotor nerve and the Edinger-westphal nucleus , you shine a light on one of the eyes and look at the other eye since we have a direct reflex and a consensual reflex by the opposite eye , to know wether the oculomotor and the optic nerve.**

**Neuron's cellular organelles**

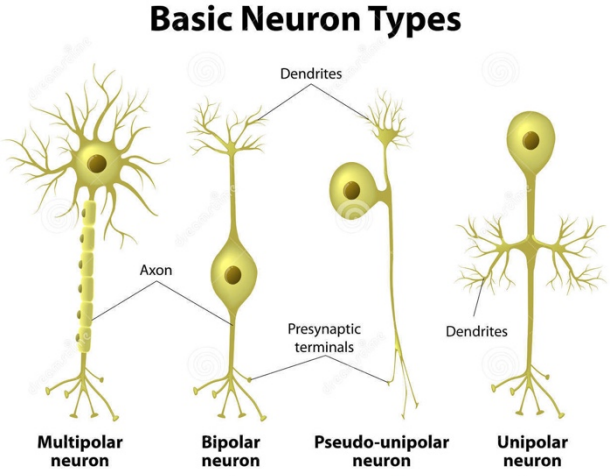
1. Mitochondria
2. Nucleus
3. Nucleolus
4. Ribosomes
5. Rough endoplasmic reticulum (Nissl substance)
6. Neurotubules
7. Golgi apparatus
8. Lysosomes

**Neurons processes**

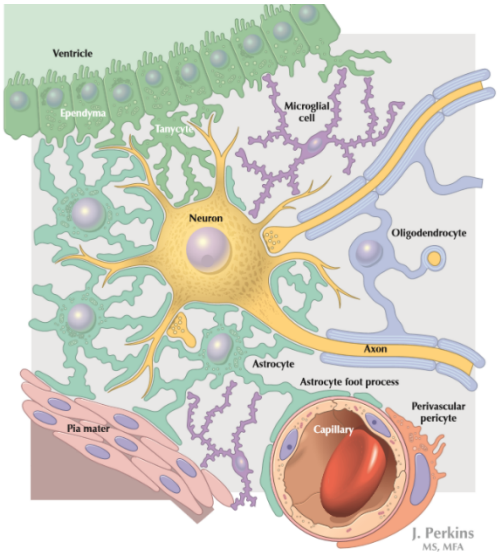
- **Dendrite—process that <u>carries nerve impulses toward the nerve cell body</u>; neurons may have multiple dendrites**
- **Axon—process that <u>carries nerve impulses away from the nerve cell body</u>; neurons can have only 1 axon**

**Types of neurons ( according to shape :**

- **Unipolar—has only 1 process from the cell body (sensory neurons)**
- **Bipolar—has 2 processes from the cell body: 1 dendrite and 1 axon (sensory neurons; located only in the retina, olfactory epithelium, and the vestibular and cochlear ganglia)**
- **Multipolar—has 3 or more processes from the cell body: 2 or more dendrites and 1 axon (motor neurons and interneurons)**
- **Pseudo unipolar : has one axon but 2 processes.**



**Neuroglia:** **Neuroglia is the supporting nervous tissue for neurons, although neuroglial cells also have assistive roles in neuron function, neuroglial cells have only 1 type of process**



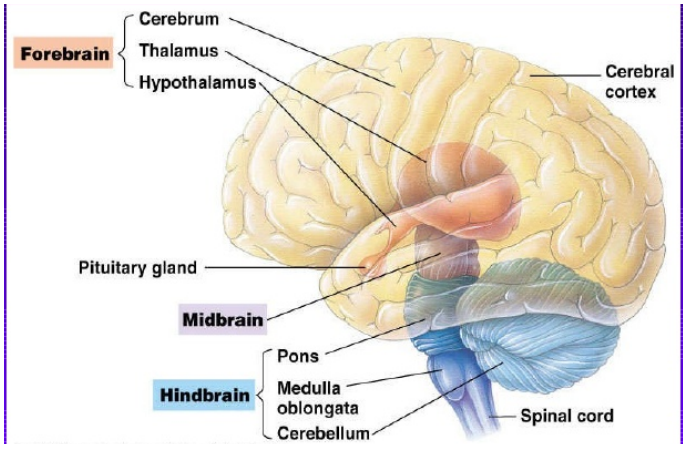

**Types of Neuroglia :**

| CNS | | | |
|---|---|---|---|
| cell | **Astrocytes** | **Oligodendrocytes** | **Microglia** |
| Function | **A. help keep neurons in place**<br>**B. provide nutritional support**<br>**C. regulate the extracellular matrix**<br>**D. form part of the blood-brain barrier** | **responsible for axon myelination in the central nervous system**<br>**NOTE: 1 oligodendrocyte can myelinate 1 segment of multiple axons** | **responsible for phagocytosis to remove waste ( the analogy of this cell is the macrophage)** |

| PNS | | |
|---|---|---|
| Cell | **schwann cells** | **Satellite cells** |
| Function | **responsible for axon myelination in the peripheral nervous system; 1 schwann cell can myelinate 1 segment of 1 axon** | **surround the nerve cell bodies of ganglia , for protection and support .** |

**A begnin tumor in schwaan cells – schwanoma**

**Schwanoma in the mental nerve will appear as a radiolucency near the mental foramen.**




**CNS = brain + spinal cord**

## THE BRAIN

### 1. BRAIN CEREBRUM

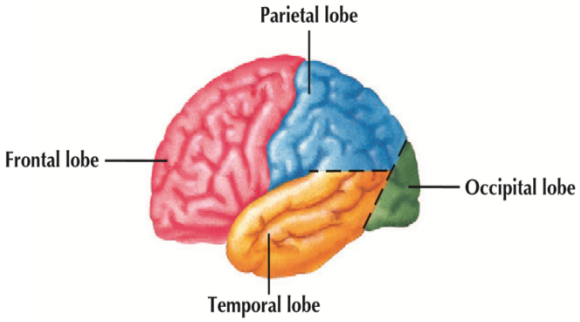
**(third order neuron where perception happens)**

**Cerebral cortex of the brain is divided by:**

- **Gyri (singular gyrus)—the elevations of brain tissue on the surface**
- **Sulci (singular sulcus)—the grooves or fissures located between the gyri**

**The brain is divided into 4 lobes:**

1) **Frontal—motor movement, motor aspect of speech (Broca's area), reasoning, emotions, personality, and problem solving**
2) **Parietal—sensory perceptions related to pain, temperature, touch and pressure, spatial orientation and perception, sensory aspect of language (Wernicke's area)**
3) **Temporal—auditory perceptions, learning, and memory**
4) **Occipital—vision**
5) **Insula—associated with visceral functions including taste**




### 2. DIENCEPHALON

**Composed of 4 parts:**

- **Thalamus—major relay center of the somatosensory system and parts of the motor system ( second order neuron )**
- **Hypothalamus—controls the autonomic nervous system and endocrine system**
- **Epithalamus—major structures include the pineal gland (which controls circadian rhythms)**
- **Subthalamus—an extrapyramidal nucleus of the motor system; if lesioned, will result in a contralateral hemiballismus**

**PTs with hypothalamus defects will lead to endocrine problems and thus those pateints will certain reactions to local anaesthesia**

### 3. BRAINSTEM

**Composed of 3 parts:**

- **Midbrain**
- **Pons**
- **Medulla oblongata ( the first order neuron )**

### 4. CEREBELLUM

**Part of the motor system. Also associated with:**

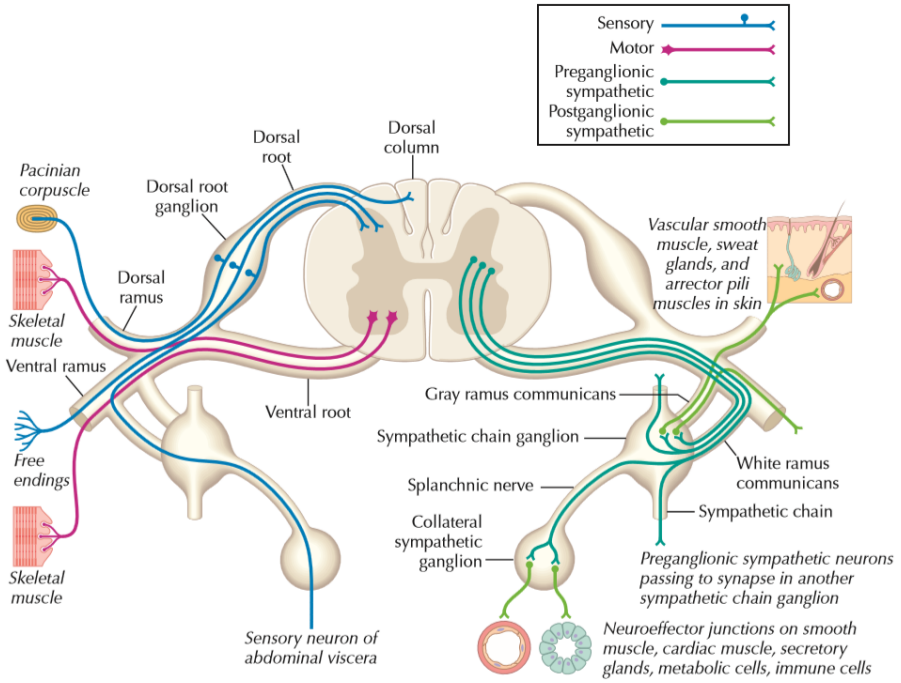
- **Equilibrium**
- **Posture**
- **Tone of axial muscles**
- **Gait**

## THE SPINAL CORD :

**Begins at the caudal end of the medulla. Has 2 enlargements associated with the limbs:**

**● Cervical—associated with the upper limb and found between the spinal cord at levels C4 to T1**

**● Lumbosacral—associated with the lower limb and found between the spinal cord at levels L1 to S2**

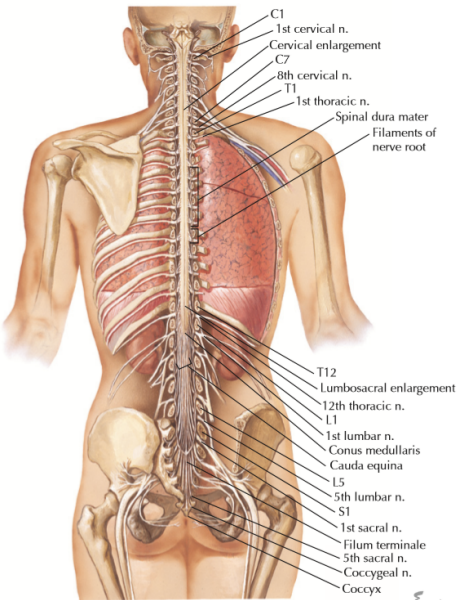



**Composed of:**

- **Gray matter—location of nerve cell bodies and neuroglial cells**
- **White matter—location of the axons and neuroglial cells**

**Has 5 levels (31 nerves):**

- **Cervical—8 spinal nerves**
- **Thoracic—12 spinal nerves**
- **Lumbar—5 spinal nerves**
- **Sacral—5 spinal nerves**
- **Coccygeal—1 spinal nerve**



PNS -Located external to the central nervous system Consists of:

- Cranial nerves—12 pairs

Olfactory CN1 – optic CN2 – oculomotor CN 3 – trochlear CN 4- trigeminal CN 5 – Abducens CN 6 – facial CN7 – vestobulocchoclear CN 8 – glossopharyngeal CN9- Vagus CN10 – Accessory CN 11 – Hypoglossal CN 12

The hypoglossal nerve is responsible for the tongue movement ( it is a pure motor nerve )

- Spinal nerves—31 pairs

**Can be subdivided into:**

- Somatic nervous system—voluntary system associated with afferent (sensory) and efferent (motor) fibers
- Autonomic nervous system—involuntary system associated with homeostasis of the body ( sympathetic and parasympathetic nervous systems)

**Peripheral Nervous System**

**1-General Sensory**

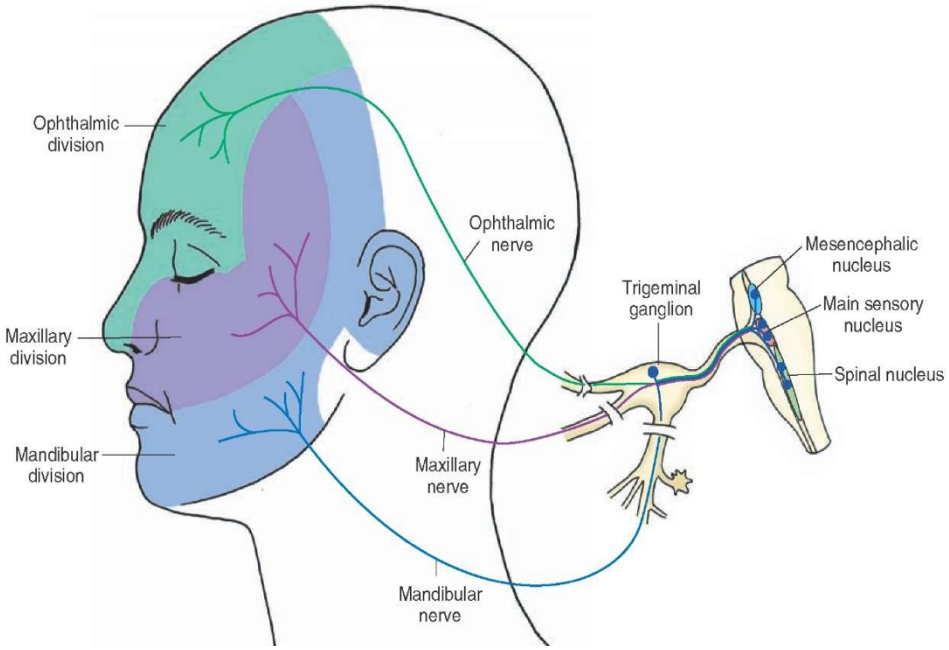
**2-Special Sensory**

**3-Viseral Sensory**

**4-Viseral motor**

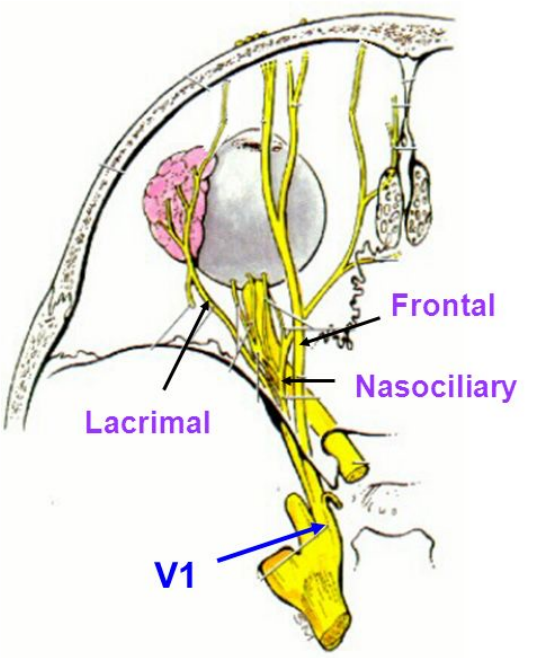
**5-General motor**

**Relay mainly** in a **Sensory Nucleus** At the medulla oblongata (Brainstem)



trigemininal nerve :

- V1 ophthalmic - superior orbital fissure – pure sensory
- V2 maxillary – foramen rotundum – pure sensory
- V3 mandibular – foramen ovale – sensory and motor

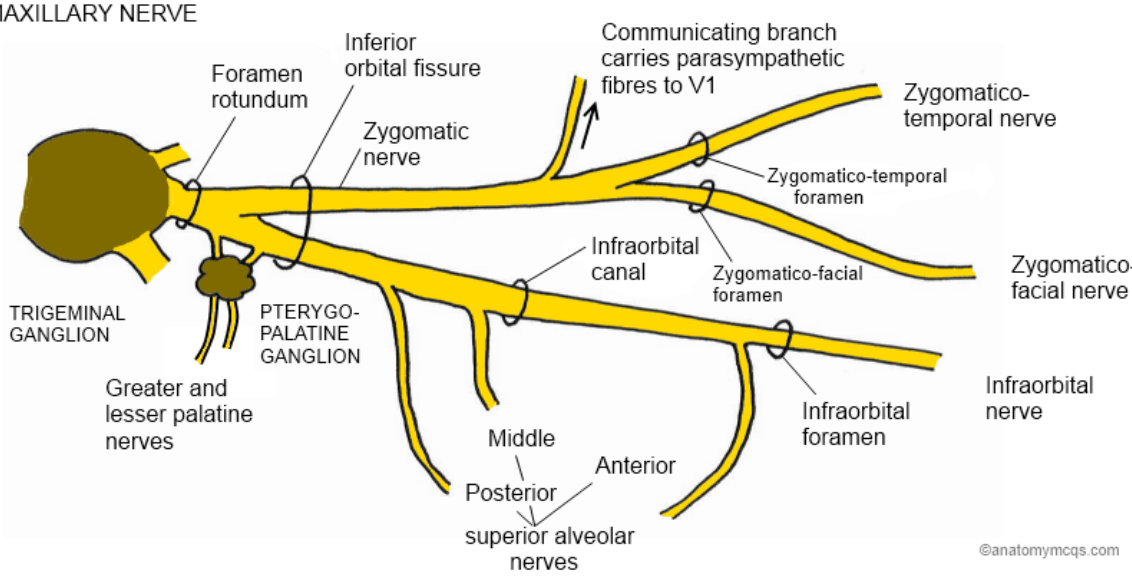



**1. Frontal N.**
**a) Supraorbital N.**
**b) Supratrochlear N.**
**Forehead, Upper Eyelid**

**2. Lacrimal N.**
**Upper eyelid**

**3. Nasociliary N.**
**a) Ant. and Post. Ethmoidal N.**
**Nasal Cavity**
**Ethmoid Sinus , Tip of Nose**
**b) Long Ciliary N.**
**Sensory to Cornea**
**c) Infratrochlear N.**
**Upper eyelid, Nose**

MAXILLARY NERVE




The first molar is supplied by the posterior superior alveolar nerve except for the mesiobuccal root which is supplied by the middle superior alveolar nerve.

Infraorbital nerve's palpebral part will supply the lower eye lid , the lateral part will supply the nose and the labial part will supply the upper part of the lip

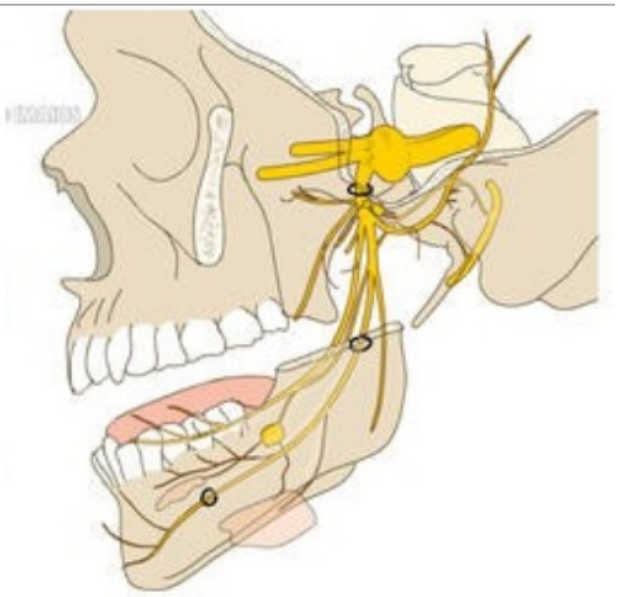
Greater palatine nerve gives sensation to the hard palate up to the canine . and the minor salivary galnds In the palate via the pterygopalatine gangilion.

The soft palate is supplied by the lesser palatine nerve .

**A. Main trunk**
- Medial pterygoid
- Nervus spinosus (meningeal branch)
- Nerve to tensor veli palatine.
- Nerve to tensor tympani

**B. Anterior division-**
- Messetric
- External Pterygoid
- Deep Temporal
- Buccinators

**C. Posterior division.-**
- Auriculotemoral
- Lingual
- Inferior alveolar.



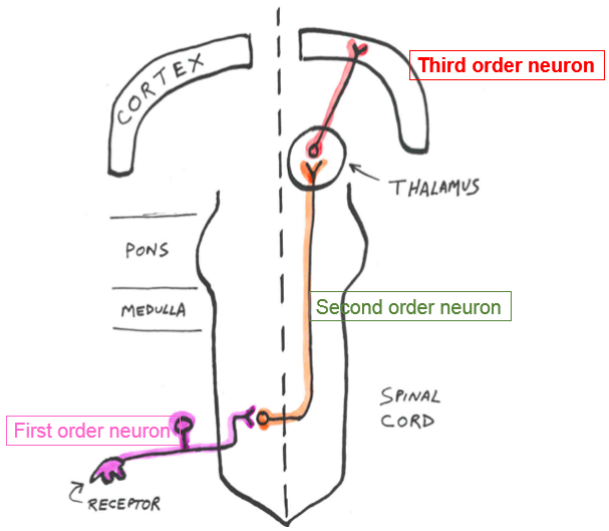
anterior division of the mandibular nerve is mainly motor with one sensory nerve ( the long buccal nerve)

posterior division of the mandibular nerve is mainly sensory with one motor nerve ( the mylohyoid nerve)

## Orofacial perception PATHWAY :

***(Trigeminal Lemniscus)***

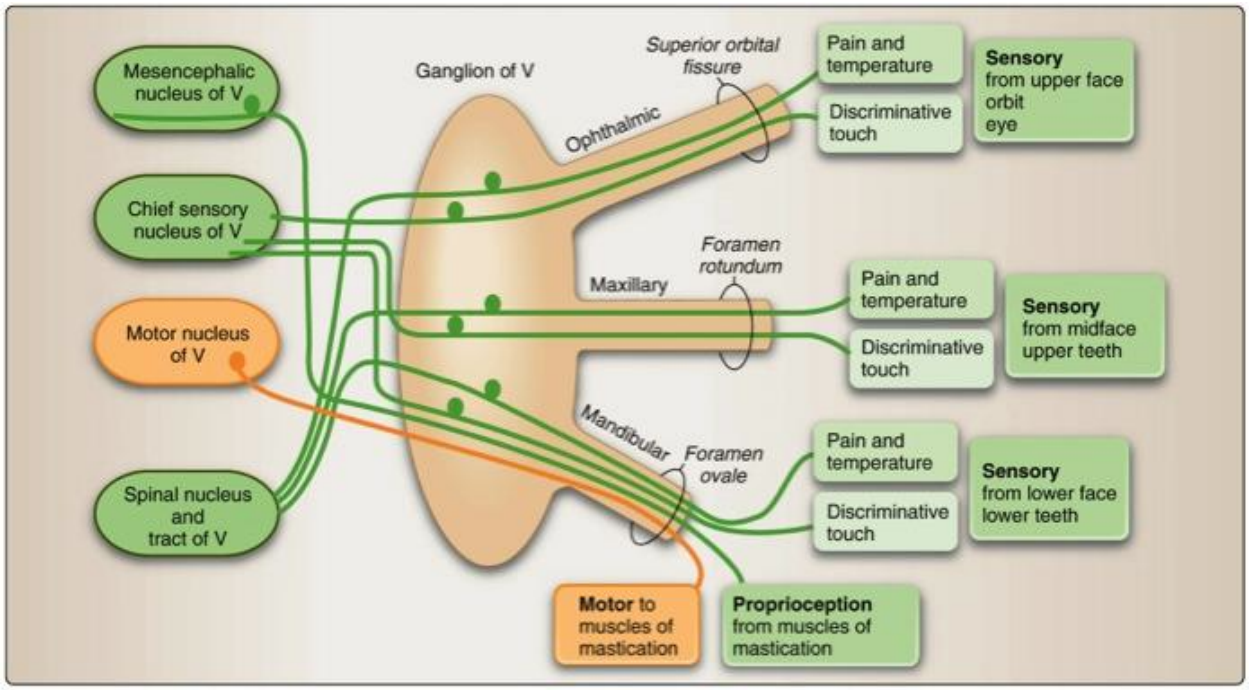
***First neuron***
***Gasserian ganglion***
***Second neuron:***
***Principal Sensory Nucleus***
***Accessory Sensory Nucleus***
***Third neuron***
***Thalamus (postero-ventral nucleus)***
***Post-central Convolutions of the Cortex*** Trigeminal ganglion :




Semilunar ganglion or gasserian ganglion, located within Meckel's cave and containing the cell bodies of incoming sensory-nerve fibers. The trigeminal ganglion is analogous to the dorsal root ganglia of the spinal cord, which contain the cell bodies of incoming sensory fibers from the rest of the body.

| **Sensory Components** | ***Motor components*** |
|---|---|
| 1. **Pontine nucleus**<br>2. **Spinal nucleus**<br>3. **Mesencephalic nucleus** | • *Located medial to PSN*<br>• *Motor fibers join sensory fibers of mandibular N. to form reflexes.*<br>*( e.g.Jaw-opening reflex).* |

Sensory components :




**<u>Pontine trigeminal nucleus</u>**:

(Principal/Chief Sensory Nucleus):

- Large diameter- myelinated
- Discriminative touch

**<u>Spinal trigeminal nucleus:</u>**

**<u>(Accessory sensory nucleus)</u>**

- Intermediate and small unmyelinated fibers
- Extending to caudal limit of the medulla
- Pain, temperature
- **<u>Some sensory fibers terminate in some motor nuclei (of V,VII & XII).</u>**

| | |
|---|---|
| Mesencephalic nucleus | - Cell body of *Pseudounipolar* neuron<br>- Relay ***proprioception*** from muscles of mastication,<br>Extra ocular Muscles,<br>Facial muscles.<br>Situated in Midbrain just latetral to Aqueduct. |

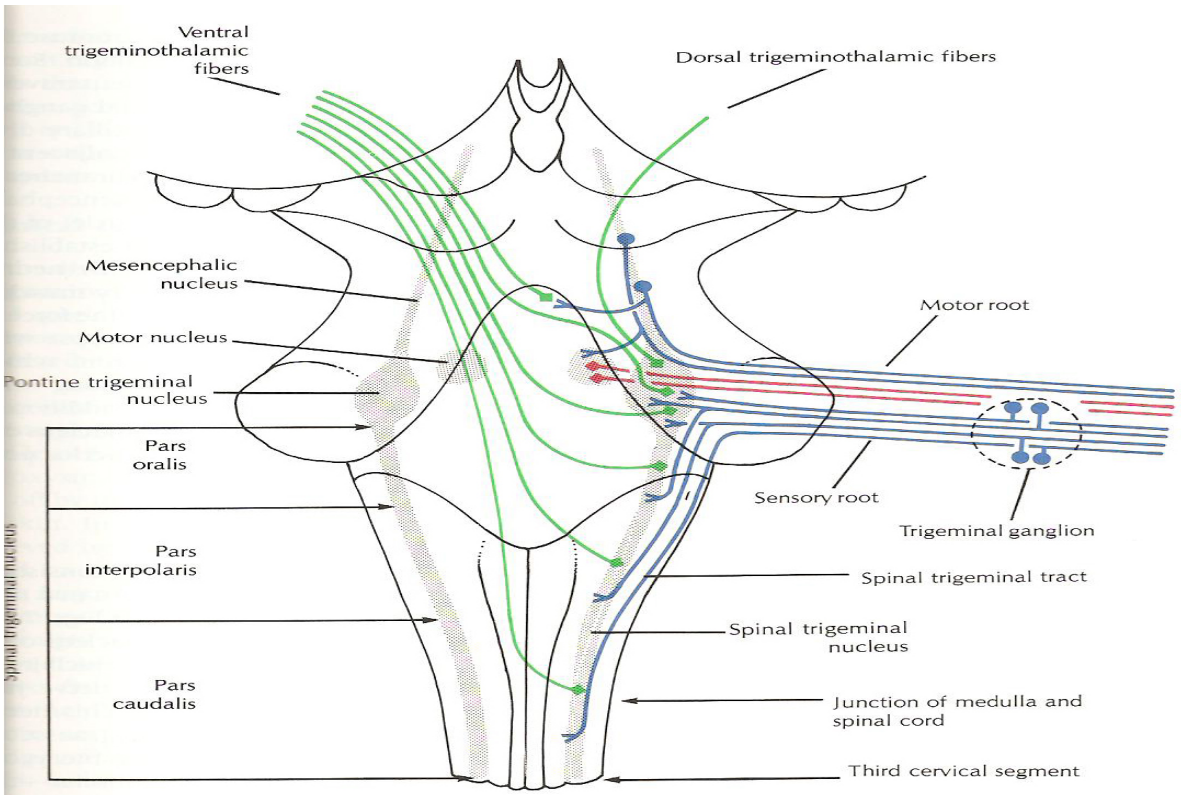
**Trigeminal lemniscus :**

Also called the **trigeminothalamic tract.** is a part of the brain that conveys tactile, pain, and temperature impulses from the skin of the face, the mucous membranes of the nasal and oral cavities, and the eye, as well as proprioceptive information from the facial and masticatory muscles

**The trigeminal lemniscus contains two main divisions :**

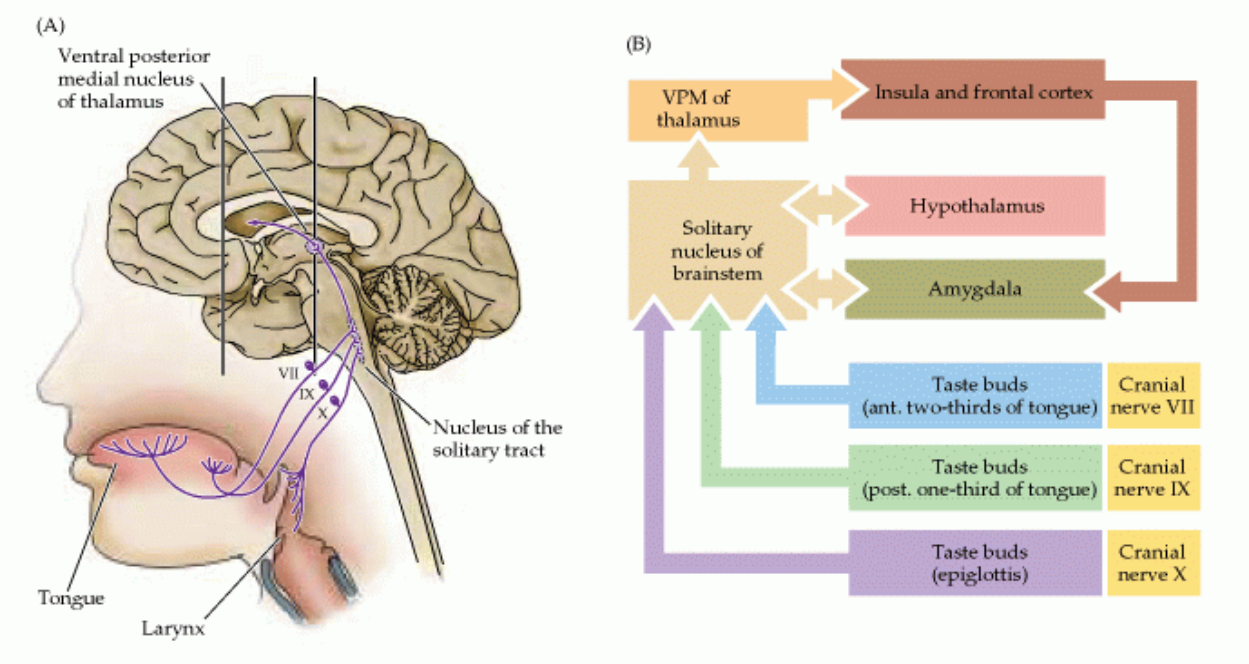
**A**.The anterior (ventral) trigeminothalamic tract, consisting of second order neuronal axons from the principal (chief sensory) nucleus and spinal trigeminal nucleus. These fibers cross the midline and ascend to the contralateral thalamus.

B. The posterior (dorsal) trigeminothalamic tract, consisting of second order neuronal axons from the principal (chief sensory) nucleus. These fibers **do not cross the midline**, and ascend to the ipsilateral thalamus.

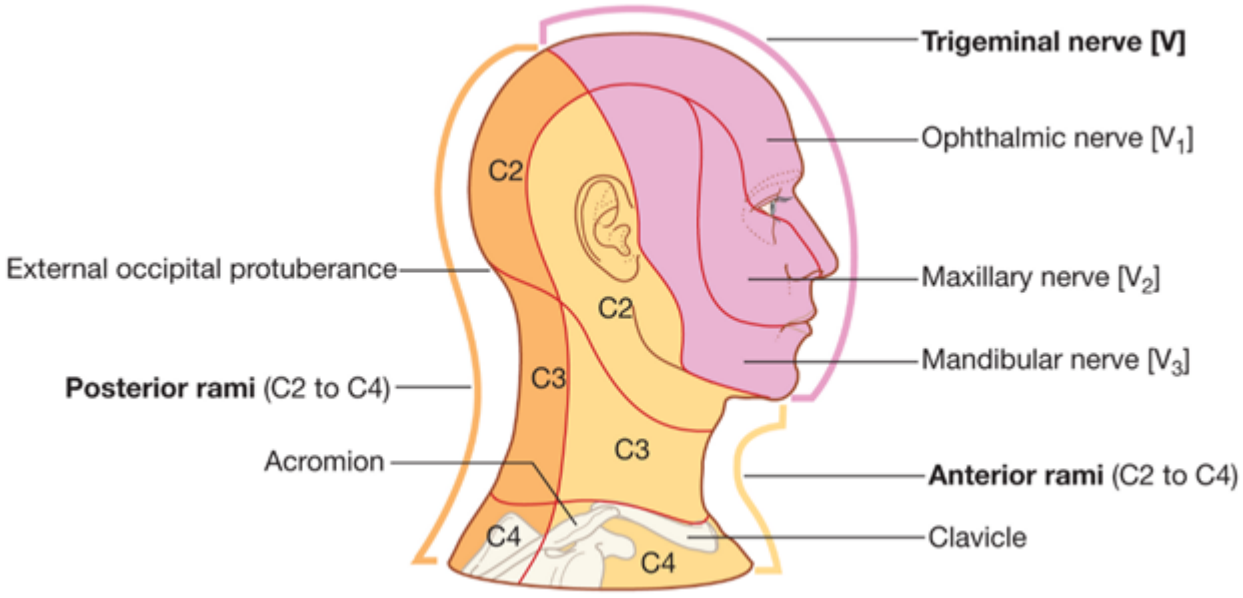


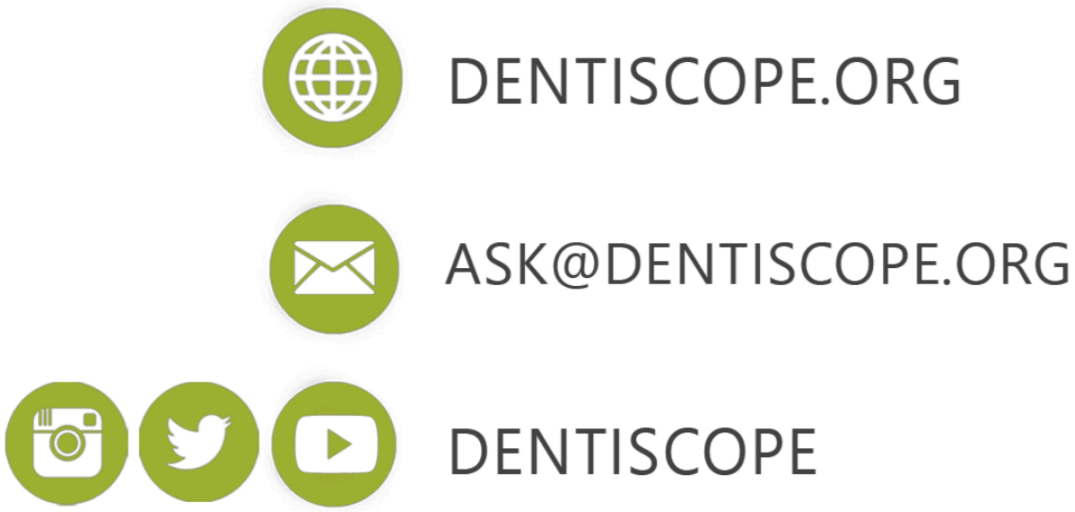

Nuclei of the trigeminal nerve and their connections. (Primary sensory neurons are blue; trigeminothalamic neurons are green; motor neurons are red.)

Gustatory sensation :




Cutaneous sensation :

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