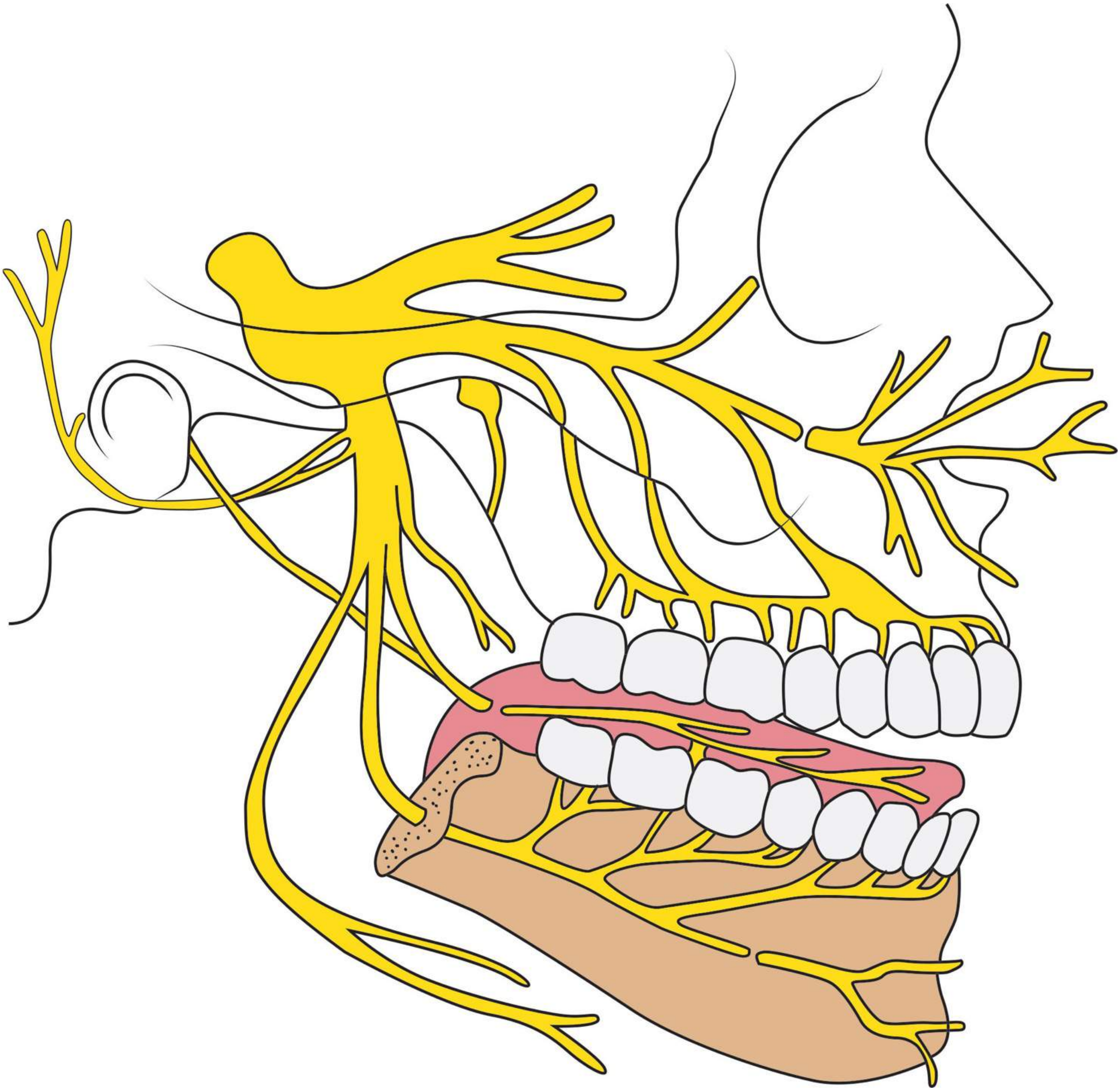

ATLAS OF ANATOMY OF CRANIAL NERVES FOR DENTISTRY

KEY CONCEPTS AND ILLUSTRATIVE TABLES

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Introduction

There has been an interest in anatomy since ancient times. The skull and its precious content have always been some of the most fascinating and complex anatomic elements. The head and the neck include highly specialized parts of the body. The structures contained in them are closely related, being packed in an extremely small area. Plus, the head and neck area have an innervation that concerns the work of the dentist. Dentists deal with some nerves regularly; it is, therefore, important for the dentist to know the anatomical aspect linked with the head and neck. Anesthesia allows us to avoid any painful stimulus during the treatment. It was the basis for this Anatomy Compendium of the Nerves, focused on the ones of the oral cavity.

Cranial Nerves

There are twelve pairs of cranial nerves. Originating from the brain, they pass through some foramina of the skull and distribute to the head-neck area. The cranial *vagus nerve* continues in the thorax and abdomen, innervating some entrails. The cranial nerves are named and numbered in sequence with Roman Numbers, proceeding in the craniocaudal direction.

I. Olfactory Nerve
II. Optic Nerve
III. Oculomotor Nerve
IV. Trochlear Nerve
V. Trigeminal
VI. Abducens Nerve
VII. Facial nerve
VIII. Vestibulocochlear Nerve
IX. Glossopharyngeal Nerve
X. Vagus Nerve
XI. Accessory Nerve
XII. Hypoglossal Nerve

The cranial nerves have seven specific functional components that can be passed within them. No cranial nerve has all the function within it. Each cranial nerve has specific patterns responsible for receiving sensory input through the receptors or producing the motor function's outputs. An additional component is that of proprioception, which can be traced back to a sensory input that presents the muscles that are innervated by cranial nerves [1].

Motor Functions – Output

Somatic Efferent: the motor innervation of the skeletal muscles developed by somitis.

General Visceral Efferent: the motor fibers that innervate smooth muscles, heart muscles, and glands.

Only four cranial nerves transmit parasympathetic fibers: the oculomotor, facial, glossopharyngeal and vagus nerves.

Sensory Functions – Input

General Somatic Afferent: the general sensation (touch, pressure, temperature, pain) of the skin around the front and side of the face. An example of this function is given by the trigeminal nerve when it covers a wide part of the skin and mucous membranes of the face, while the facial, glossopharyngeal and vagus nerves cover the area of the ear.

General visceral afferent: composed of the fibers that carry the general sensation of the viscera, generally perceived as pressure and pain.

Special somatic afferent: carries the sensations coming from the eye and ear.

Special visceral afferent: these fibers are associated with the special senses of smell, carried in the olfactory nerve and taste, transmitted in the facial, glossopharyngeal and vagus nerves.

Cranial nerves and oral cavity functions

Let's now review the main features of the nerves in the oral cavity: trigeminal, facial, glossopharyngeal, vagus, accessory, hypoglossal.

TRIGEMINAL NERVE

The fifth pair of cranial nerves (V), the trigeminal nerve, carries this name because it is divided into three main branches: **ophthalmic** (V1), **maxillary** (V2) and **mandibular** (V3). The latter represents the main branch because, unlike the other two carrying only afferent fibers, it also carries efferent fibers: it is, therefore, due to the mandibular nerve alone that the trigeminal can be called a mixed nerve. The V is also the largest of all the cranial nerves, being responsible for serving—with an eminently sensory role—a large part of the face, the dental arches and the supporting structures, a large part of the oral cavity and, in general, of the mucous lining structures of the head.

The apparent origin of the nerve is located in the **brainstem**, exactly on the anterior face of the bridge near the middle cerebellar peduncles. The **large, flattened sensory root** is located laterally to the thin motor root, which is responsible for innervating the masticatory musculature, the anterior belly of the digastric muscle, the tensor of the tympanum and that of the soft palate, as well as transporting **facial nerve** fibers (VII pair of cranial nerves) through the buccal nerve.

The neurons that make up the **sensitive fibers** have a trophic center located at the level of the Trigeminal ganglion, located in a subdural dimple (called the Meckel) near the apex of the petrosal part of the temporal bone. From an embryological viewpoint, the trigeminal forms the nerve of the first pharyngeal arch, the same origin of all the tributary muscles mentioned above.

The nerve leaves the endocranial space through the **oval foramen** located in the middle cranial fossa (sphenoid bone) and emerges in the infratemporal fossa. Still close to the base of the skull, the main trunk releases the sensory meningeal branch and some of the motor fibers, and then divides into a smaller anterior branch and a larger posterior branch.

Ophthalmic branch

The ophthalmic nerve provides the bulb and palpebral conjunctiva, the tear gland, the skin of the head and nose and the mucous membranes of the paranasal sinuses with sensory innervation. Before entering the upper orbital fissure, it releases three terminal branches, the tear nerve, the frontal nerve, and the nasociliary nerve.

The tear branch is of great interest concerning the ophthalmic branch when it comes to the oral cavity. The tear nerve is the smallest branch of the ophthalmic division; it runs along the lateral rectum muscle distributing itself to the tear gland and the adjacent conjunctiva. While in the eye socket, **it communicates with the zygomatic-temporal branch of the zygomatic nerve of the maxillary division of the trigeminal nerve**, which carries **postganglionic parasympathetic fibers** from the pterygopalatine ganglion. These parasympathetic fibers are then transmitted to the tear gland through the tear nerve, thus providing secretomotor innervation.

Maxillary Branch

The second trigeminal nerve branch, the maxillary nerve, is only sensory and serves the skin of the side of the nose, cheek, eyelids, central part of the face, nasopharynx, tonsils, palate, maxillary sinus, gum, teeth and structures associated with the upper jaw. The nerve emerges from the cranial vault through the round foramen after passing through the back of the cavernous sinus. The nerve flows out of the round foramen through the pterygopalatine fossa to enter the floor of the orbit at the bottom of it. Here, the nerve becomes the infraorbital nerve and enters the infraorbital canal of the same and comes out of the infraorbital hole. This nerve can be anaesthetized if an upper arch procedure is required, including the sinus lift. A publication [2] has precisely evaluated the anesthetic effectiveness of The Wand in this procedure, finding excellent results.

Let's see which branches it releases during its course.

- **Medium meningeal nerve:** detaches before the maxillary nerve engages in the round hole; follows the middle meningeal artery in its ramifications in the dura mater.
- **Zygomatic nerves:** releases the zygomatic-facial branch that provides the sensitivity of the cheek and the zygomatic-temporal branch that innervates the side of the forehead. The forehead side releases a branch directly to the tear nerve before leaving the orbit. This carries postganglion parasympathetic fibers derived from cranial nerve VII from the pterygopalatine ganglion.
- **Pterygopalatine nerves: they emerge near the homonymous ganglion.**
    - **Orbital nerve**: the orbital branches enter the orbit to supply the periorbite and the posterior ethmoidal and sphenoidal sinus.
    - **Greater palatine nerve**: comes out from the homonymous hole located in the palate about 1 cm apically to the upper molars; it goes forward to the midline to serve the entire palate. The major palatine nerve divides while it is in the canal to form a minor palatine nerve, which comes out to the palate through two or three homogeneous foramins serving the soft palate, the tonsil and the uvula.
    - **Upper posterior nasal branches**: they enter the nasal cavity from the foramen sfenopalatino. The nasopalatino nerve emerges.
- **Foramina of Scarpa**: the nerve nasopalatine or foramina of Scarpa is a collateral branch of the pterygopalatine nerve; the internal branch of division of the maxillary branch of the trigeminal nerve (V pair of cranial nerves). It runs along the floor of the nasal cavity, attached to the periosteum of the septum, moving from the back of the septum forward. It then enters the foramina of Scarpa to access the oral cavity through the incisor hole (or anterior palatine). Here we observe a confluence between the two nasopalatine nerves, which, in turn, can anastomize with the major palatine branch. The nasopalatine nerve serves the anterior third of the hard palate with its mucosa. It may involve the gum and support structures of the interchain region. The nerve block of this structure, indicated in interesting mucous and periosteal interventions and also in periodontal treatments at the same area. Dental pulp is not involved and anesthesia is not recommended when treatment is focused on one or two elements. [3]

Consequences of the block of the foramina of Scarpa

The method is beneficial because it allows the anesthesia of a large portion of the palate with a minimum amount of local anesthetic. At the same time, it can be problematic, as the injection procedure is often painful in this area. The main anatomical finding is represented by the interincisive papilla, under whose palatal continuation lies the foramen itself. Malamed recommends the use of a 27 or 25-gauge needle, preferably short for greater stability and, to approach the area in the least invasive way possible, suggests to consider two different methods of operation.

The first is the single injection technique to be performed with the patient lying open-mouthed and with the neck stretched out. With a cotton swab, ideally soaked in a topical anesthetic solution, the area adjacent to the papilla is pressed to blanch the tissue. On the other hand, the needle is made to enter: during the deepening, small quantities of solution are released. As soon as the bone is reached (at a 5 mm depth), the needle is recoiled by about one millimeter and, after aspiration (the positive rate is almost zero), another anesthetic is given. With a quarter of a vial tube, on average, the tissue appears stiffened as well as further blanched.

- **Pharyngeal branch**: leaves the rear aspect of the pterygopalt ganglion to enter the pharyngeal canal. It serves the mucous membrane and the rhinopharynx up to the acoustic meato.
- **Upper posterior alveolar nerves:** derived from the main trunk of the maxillary nerve, while still in the pterygopalatine fossa. They pass over the tuberosity of the upper jaw providing branches to the mucous membrane of the cheek and the adjacent gum. The posterior alveolar nerves then enter the foramen of the same name to provide the innervation of the maxillary sinus and the molar teeth where they form the dental plexus, with the exception of the buccal mesial root of the first molar. Sensory innervation of this root is provided by the upper middle alveolar nerve from the infraorbital.
- **Infraorbital branch:** this is the terminal branch of the maxillary nerve. After passing through the pterygopalatine fossa, the maxillary nerve enters the floor of the orbit, thus becoming the infraorbital nerve. Upon entering the floor of the orbit, the infraorbital nerve sends a branch, called the upper middle alveolar, to the lateral wall of the maxillary sinus, innervating it. The branches of this nerve also innervate the mesial buccal root of the first molar and all the roots of the upper premolars. The infraorbital nerve is a branch of the maxillary nerve, the second branch of the V pair of cranial nerves. It emerges from a hole of the same name on the malarial surface and conducts the sensitivity of the skin and mucous membranes of the middle third of the face. Once out, it is divided into four distal branches, dedicated to the specific skin areas, and three proximal ones: the latter correspond to the upper, anterior, middle and posterior alveolar nerves, which together form the plexus that serves the entire upper dental arch. An anatomical peculiarity of this nerve is represented by the so-called canalis sinuosus. It was first described in 1939 by Jones as a nerve file that emerges from the posterior portion of the infraorbital hole, and then runs into a tortuous bone channel, about 2 mm in diameter, next to the nasal cavity. The canal originates from the terminal tract of the infraorbital canal (i.e., before it flows into the respective hole), initially running forward towards the nasal cavity, and then moving downwards after passing through an "S". The term "canalis sinuosus" [4] refers to this characteristic segment. The canal, after an intraosseous path of more than 5 cm, finally emerges from a secondary hole at the palatal level: the latter tract is subject to important anatomical variability. The structure houses the course of the anterior superior alveolar nerve (with the respective comitant vessels) and is, therefore, not underestimated, especially in the area's implant surgery. Fortunately, the final tract of the nerve, which, as mentioned, participates in the plexus dedicated to the upper arch, presents a series of anastomoses able to vicariaire any damage: in some cases, however, it is possible to find neurological disorders related to traumatic events. Moreover, the-

se symptoms are often difficult to interpret from a clinical viewpoint , as they are not better evaluated previously. Ferlin's group has conducted a systematic review of the subject, obtaining from the Scopus, Medline and Web Of Science databases a total of seventy records, eleven of which have been evaluated qualitatively. Most of the studies consist of CT cone beams to evaluate accessory channels. However, 90% of the evidence relating to these documents was evaluated as being of moderate or high quality. The study concluded by observing the possible variability of the canalis sinuosus in terms of position, diameter, route and presence of accessory channels. The canalis sinuosus is present between 88 and 100% and its accessories between half and 70% of the time. As far as clinical management in surgical cases is concerned, the authors underline the importance of not underestimating the problem, especially during the surgical programming phase: the most recommended diagnostic measure, from this viewpoint, is CT cone beam.

Mandibular branch

It's the only branch that contains both a sensory and a motor component. In addition to the mandibular nerve, the otical, submandibular and sublingual ganglion are attached.

The **mandibular nerve leaves the skull through the oval hole in the large sphenoid wing**. Before the division from the main trunk occurs, the recurrent meningeal nerve and the **medial pterygoid nerve** are detached.

Sensory component	Motor component
Sensory fibers serve the skin around the lower third of the face, the cheek, the lower lip, the ear, the external acoustic meatus, the temporomandibular joint and the temporal region. It also innervates the mucous membrane of the cheek, the mucous membrane of the anterior two-thirds of the tongue, the mandibular teeth, the gingiva, the mastoid and the body of the mandible.	The motor component provides all the muscles developed within the first pharyngeal arch: the mastication muscles, including the temporal, masseter, medial and lateral pterygoid muscles, as well as the timpani and palatine veils tensors and the anterior belly of the digastric and milooideian muscles.

From the latter emerge the **palatine tensor** and **palatine veil tensor** branches.

After leaving the oval hole, it divides into its two terminal branches:

- **Anterolateral: almost exclusively motor, composed of temporo-buccinator nerves, medium deep temporal, temporo-masseterine and external pterygoid, buccal nerve.**
- **Posteromedial: almost exclusively sensory. It breaks down into auriculo-temporal, lingual, lower alveolar, internal pterygoid nerves, the tensor muscle of the palatine veil and the tensor muscle of the tympanum.**

Of the **anterolateral** component we see in detail the buccal nerve. **The buccal nerve**, also called ***long buccal nerve*** in the English literature, represents one of the two terminal branches of the inner trunk of the mandibular branch of the trigeminal nerve (V3). This structure collects and conducts the sensitivity of the mucosa of the posterior area of the cheek; it also serves the vestibular side of the gingiva of the molar region. In some cases, it may contribute to the innervation of the skin of the corresponding **extraoral region**.

The origin is rather high at the level of the infratemporal fossa and the course is in good caudal and lateral substance. After the origin, the nerve has an initially horizontal trajectory, running between the two ends of the lateral pterygoid muscle. It then effectively moves downwards against the medial face of the mandibular branch. Finally, it crosses the retromolar trigon, moving towards the cheek. **It innervates the external pterygoid muscle, mucous membrane of the cheek, gum of the external surface of the lower alveolar process.**

The **buccal nerve** is an important structure from the anesthesiologic viewpoint: by adopting the common technique of lower alveolar blockage, in fact, it is not possible to reach the area of the gingiva served by the nerve.

For this reason, the procedure is integrated with an administration of anesthetic distally to the lower molar region. On the contrary, the **Gow Gates** technique involves upstream the **mandibular nerve** and, consequently, its main branches, including the **lower and buccal alveolars** themselves. Sicher and Dubrul (1991) [5] state that the nerve crosses the upper part of the retromolar fossa and it is in this area that the nerve can be exposed to the anesthetic solution. Malamed defines the long vestibular injection technique and ensures an almost absolute success rate. From a surgical viewpoint, it is now established that the buccal nerve does not present any particular criticality. It may actually be affected during **third molar** extraction operations included if the release incision is conducted too deeply. For this reason, the manuals recommend that the flap be set up in full thickness only in correspondence of the retromolar trigon, and then continue to half thickness along the upright mandibular branch. According to Hendy (1996), an incision more than 12 mm below the major concavity of the oblique line puts the buccal nerve at risk [6]. The not complete reliability of this finding, especially in edentulous subjects , means that today the main reference is the anterior margin of the branch of the mandible. The nerve usually crosses the upper half of this line.

Let us now focus on some of the main structures of the **posteromedial** component. The only element responsible for motor innervation is the **miloioid nerve that leads to the muscle of the same name.**

The three terminal branches of the mandibular branch are: the **auriculo-temporal nerve**, **the lingual nerve** and the **lower alveolar nerve.**

After having emerged at the level of the neck of the mandible, the nerve rotates above with the superficial temporal artery and penetrates within the parotid gland structure. It continues to rise, exiting the gland to pass over the zygomatic arch to distribute sensory fibers as a superficial temporal nerve to the skin of the temporal region. In its course, the auriculo-temporal nerve sends articular branches to the **temporomandibular joint**, anterior auricular branches to the anterior portion of the outer ear, to the outer acoustic meatus and with some branches to the parotid gland. These are made up of postganglion parasympathetic fibres from the otic ganglion.

Lingual nerve

The **lingual nerve** is one of the two terminal branches of the inner trunk of the mandibular branch of the trigeminal nerve [7]. It conducts the **somatic sensitivity** of the anterior **2/3 of the tongue**—to which is added the special gustatory sensitivity conducted via the tympanum string—of the sublingual mucosa, the oral floor and part of the lingual aspect of the gingiva. The tympanum cord **also carries preganglial parasympathetic fibers** to the **submandibular** and **sublingual** ganglia. It innervates the mucous membrane of the lower and upper surface of the lingual body.

This nerve structure is of great importance in oral and maxillo-facial surgery. Temporary or permanent damage is an infrequent but nevertheless contemplable eventuality in a series of operations at the level of the regions of the third mandibular molar and of the oral floor. **The extraction of the lower third molar** is the most routine of the surgical acts involving this anatomical region. In the case of implant surgery, on the other hand, direct involvement of the structure is less frequent, which may be involved if it is necessary to extend the surgical access to the site by setting up release incisions. For this reason, protocols always recommend conducting such incisions with a clear vestibular pattern.

The **lingual nerve** detaches from **the lower alveolar nerve** before it enters the mandibular canal. Three anatomical patterns have been identified depending on the height of the bifurcation, to which a fourth one with a plexiform appearance has been added. Starting from the origin, the lingual nerve runs between the external and internal pterygoid muscles in an **infratemporal fossa**, and then continues forward and down along the medial surface of the internal pterygoid itself, the relationship with which it is variable. It is also close to the internal surface of the upright branch, and then moves not far (postero-inferiorly) from the junction with the body of the mandible. It enters the submandibular region after having moved forward and medially, close to the lower margin of the upper constrictor muscle of the pharynx. From here it will be in close relationship with the region of the lower third molar. It declines adhered to the periosteum on the medial surface of the mandible, protected only by the mucoperiosteal tissues. It is in contact with the lingual cortical in 20-62% of cases and is located at or above the alveolar crest in 4.6-21% of cases. If it is not found at the level of the lingual cortical, 0.57-7.10 mm median to this and below (2.28-16.8 mm) the alveolar crest runs. The retromolar trigon proper is actually an infrequent site (0.15-1.5% of cases). The average distance from the retromolar region is 7.2 mm. The nerve can emit here a collateral, also called "gingival branch," which extends up to the fifth-sixth dental element area.

The course of the main nerve moves towards the tongue decisively, running in an antero-medial direction on the upper surface of the milioid muscle. Then, **it crosses the Wharton's duct**, running laterally first, then below, and then resorting antero-medially. Next, it turns towards the surface of the halibut muscle. Studies on corpses report this ratio in 62.5% of cases. However, it is inverted; i.e., the nerve passes above the duct in a considerable number of cases, equal to the remaining 37.5%. Current evidence suggests that the point of intersection is inconstant.

Before resolving in the terminal branches along the lingual belly, the nerve may present further variations: it may communicate, for example, with the **miloideo nerve** (dependence on the mandibular branch) or even with the **hypoglossal nerve** (XII pair of cranial nerves).

Lower alveolar nerve

The **lower alveolar nerve** is the middle branch of the mandibular branch and emerges above the spine of the Spix. It is carried behind and to the side of the lingual nerve between the two pterygoid muscles and penetrates the mandible body through the mandibular body. Before penetrating the canal it releases the **miloioid nerve**.

The **lower alveolar nerve** runs through the canal until it reaches the foramen mentoniero near the roots of the premolars; from here it is divided into three branches that innervate the skin of the chin, the mucosa of the lip and the lower alveolar surface. The lower dental plexus innervates the gums and dental elements. A significant surgical risk is represented by the iatrogenic trauma—and the possible neuropathic consequences: **paresthesia-distesthesia**, etc.—and by the subsequent neuropathic outcomes. The trauma is caused by the inferior alveolar nerve, or better, by its terminal tract, in the case of a loop inside the canal, just before it emerges from the **mental foramen**. The resulting chinner nerve—directed to the lower lip, skin of the chin guard region and part of the vestibular gum—is generally considered the main terminal branch of the lower alveolar nerve, which usually continues with a small incisor branch directed precisely to the frontal elements of the lower arch. It is possible that the main branch, before emerging as a chinner nerve, passes through the hole, describing an anterior convex loop, then returning towards the hole and, finally, coming out. In the texts we commonly speak of "**anterior loop**" of the nerve. The study by Velasco-Torres (2017) proposed, among other evaluations, to estimate on CT cone beam the prevalence and extension of the **anterior loop**, in a sample of 348 patients. The analysis showed a negative correlation (lower prevalence and extension) with age growth. This is potentially an indication of great clinical interest: making an example of treatment at risk, Todorovic, in his very recent work, refers to full-arch rehabilitation with four to five interforaminal implants. Approaching the foramen, the coverage area is extended in an antero-posterior direction and the cantilever is reduced. The study in question aims to quantify prevalence and size through reformatted multislice CT investigations (retrospective study on examinations required for other clinical reasons). Unlike the previously mentioned study, which focused on Caucasian subjects, the latter deliberately did not consider possible racial differences (it is also a sample of 188 South African patients). In this case, a statistically significant difference in sex was reported (higher prevalence in males). It can already be said that the **anterior loop** is an anatomical event to be considered in the context of implant preoperative, much more than other much rarer variables, such as the doubling of the hole.

FACIAL NERVE

The components of the facial nerve and their functions are: **special visceral motor, general sensory, visceral sensory, special sensory, parasympathetic** [8]**.**

The nerve has two roots, a large motor root and a smaller root, called the intermediate nerve, containing the special sensory fibers for taste, parasympathetic fibers and sensory fibers. The two roots emerge from the brain between the bridge and the lower cerebellar peduncle.

The course through the skull ends when the facial emerges from the **stilomastoid foramen**. The ganglion that accompanies the nerve is called the **geniculate**.

Numerous branches rise from the nerve as it flows through the temporal bone, including:

- **major petroso nerve**: it carries motor and parasympathetic fibers (respectively from the facial nerve nucleus and from the muco-lacrimatory nucleus); along its route it contracts anastomosis with the deep petroso nerve (originating from the internal carotid plexus, mainly sympathetic vasomotor), thus giving rise to the pterygoid canal nerve (or vidian nerve). This nerve thus arrives at the pterygo-palatine ganglion (or sfenopalatine), from which these fibers, which have become postganglionic, will join the zygomatic nerve (branch of the maxillary nerve, second branch of the trigeminal nerve) leading first to the zygomatictemporal nerve, terminal branch of the zygomatic, and then, due to an anastomosis, to the tear nerve, finally reaching the tear gland. From the pterygo-palatine ganglion will also originate post-ganglion parasimpathetic fibers directed to the glands of the nasal mucosa and the palatine glands.

- **nerve for the stapedium muscle: provides for the motor innervation of the stapedium muscle.**

- **tympani chord**: the tympani chord slowly moves towards a separate channel. Leaves the tympanic cavity to enter the petroympanic fissure, then exits the skull at the level of the posterior spine of the sphenoid bone. The nerve receives communication from the otic ganglion and joins the lingual branch of the mandibular division of the trigeminal nerve. It contains special sensory fibers intended for the taste buds on the anterior two-thirds of the tongue and pregangular parasympathetic fibers intended for the submandibular ganglion. The submandibular gland receives the preganglial parasympathetic fibers of the tympani chord nerve through the parasympathetic root. The postganglion parasympathetic fibers from the submandibular gland pass to the submandibular gland or return to the lingual nerve to be distributed to the sublingual gland and the minor salivary glands in the floor of the mouth, providing them with secretomotor innervation.

- When the **facial nerve leaves the stilomastoid foramen**, the posterior auricular nerve that passes between the auricle and the mastoid process begins, dividing into occipital and auricular branches.

- They originate from the same area where sometimes with a single emergency **the nerves for the motor component of the posterior belly of the diga-**

stric muscle and styloid for the homonymous muscle.

- **Parotid plexus**: after entering the parotid gland, the facial nerve divides into temporo-facial and cervical-facial divisions that join into the parotid plexus. From here emerge the branches that provide motor innervation to the muscles of facial expression, called branches:

  - **Temporal**
  - **Zygomatic**
  - **Buccal**
  - **Mandibular**
  - **Cervical**

GLOSSOPHARINGEAL

The glossopharyngeal nerve has fibers that carry signals of type:

- **Special visceral differentiator.**

- **Efferent visceral parasympathetic**: for the parotid gland, other minor salivary glands of the posterior area of the tongue and the adjacent area of the pharynx.

- **Special visceral afferents**: for the papillae of the posterior third of the tongue and the circumvallate ones.

- **General visceral afferents**: provides the papillae of the posterior third of the tongue and the palatine tonsil.

- **Somatic afferent generals.**

Dwelling on the branches of greatest interest in the dental field, it is possible to observe that the main trunk of the glossopharyngeal nerve ends as several pharyngeal branches to enter the posterior wall of the pharynx; some of these branches then lead to the tongue as lingual branches providing a general sensation to the posterior third of the tongue and bringing special sensory fibers to the taste buds on that portion of the tongue and to the circumvallated buds. Other branches communicate with the lower palatine nerve of the maxilla and lead to the tonsils.

VAGUS NERVE

The vagus nerve is important and has a longer course than other cranial nerves. The vagus nerve also enters the chest to serve the heart and lungs and continues in the abdomen. Despite its many functions, compared to the oral cavity, it carries **special visceral afferent fibers for the base of the tongue.**

It also has fibers with special visceral efferent function, general somatic afferent, visceral somatic afferent, and general visceral efferent.

HYPOGLOSSAL NERVE

The most caudal of the cranial nerves is the hypoglossal nerve, the motor nerve of the tongue muscles. It enters the muscle structure of the tongue, which it provides, proceeding towards the ventral part of the tongue.

NERVE INJURIES RELATED TO DENTAL PROCEDURES

Lower alveolar nerve

Neuropathic damage is undoubtedly a form of iatrogenic damage that is not common but, at the same time, frightening, precisely because of its rarity as well as the difficulty of its diagnostic and therapeutic approach. Most of the time, these are transitory conditions that tend to resolve autonomously within a certain period of time. In some cases, however, the damage may require invasive treatments of a neurological and neurosurgical nature. The variability of the type of damage is reflected in the clinical picture, which ranges from hypo-anesthesia, to different degrees of paresthesia, up to allodynia-hyperalgesia. In 70% of cases, a painful symptom is observed.

In the case of the lower alveolar nerve, the possible causes of iatrogenic involvement in dentistry can be traced back to **four main categories**:

- damage caused by local injective anesthesia technique.

- damage caused by endodontic therapy.

- damage on a surgical basis by implanting and avulsion of the third molar.

According to the 2011 Renton and Yilmaz study, the latter is the most common cause (alone covering 60% of cases), followed by local anesthesia techniques (19%), on a par with implant surgery. Only 8% of the episodes would represent the complication of an endodontic treatment.

Starting from these data and considering these same broad categories, Martinez and colleagues (2014) have conducted a review of the literature referring to the period 2008-2013. The evidence collected, the main points of which are reported below, refer to a corpus of forty-five scientific articles, selected from an initial pool of almost four hundred.

Damage to the lower alveolar nerve in endodontics

As anticipated, **neuropathic damage of the lower alveolar nerve** does not represent a common complication of canal treatment. On the contrary, the rupture of an instrument is a feared but contemplated possibility for the endodontist, especially when it comes to rotating instruments and especially in the presence of thin channels and important curvatures. However, it is difficult for the instrument to go beyond the apex until it engages the mandibular canal where the nerve runs, since the fracture follows precisely on contact with a sudden obstacle.

It is more likely that the complication follows the extrusion from the apex of canal cement, hot gutta-percha or other endodontic materials. It is, therefore, important to know **the potential neurotoxicity** of some of these products.

As regards localization, the length of the roots of the first premolar, first and second molars should be evaluated. A second aspect to be evaluated in the growing patient is the degree of patency of the apexes.

Damage to the lower alveolar nerve due to anesthesia

Anesthetic techniques at the level of the lower alveolar nerve may represent a significant clinical problem, especially considering the rate of failure that affects the most common technique, namely the **lower alveolar block**. However, cases are described, certainly rarer, in which the technique is associated with real complications, some of which are severe and not entirely imponderable [9].

This is the case of **neuropathic damage secondary to anesthetic procedure**: as already mentioned in the first part of the text, it would be the cause of almost two out of ten episodes in this field. Regardless of the anesthesiologic technique used—lower alveolar nerve block, Gow-Gates technique or Vazirani-Akinosi technique—the repetition of anesthesia can be useless in a context of refractoriness to pharmacological action, as can be the acute pulpitis. More useful in these cases is the use of different additional techniques, primarily intraligamentous anesthesia.

The higher the number of injecting procedures, the higher the risk that one of them will favor the onset of a complication, even a remote one. When using a computerized anesthesia device such as The Wand, the position for the injection is not changed for the aspiration test. Simply ask the machine to aspirate, and check that the aspiration test is negative and inject. This avoids a second injection, which will inevitably be a few millimeters displaced from the first, thus making the clinician really sure they are not inside a blood vessel and reducing the risk of "hitting" the lower alveolar nerve and lingual.

[Movement control during aspiration with different injection systems via video monitoring-an in

vitro model. Kämmerer PW1, Schneider D2, Pacyna AA3, Daubländer M4. Clin Oral Investig. 2017 Jan;21(1):105-110.]

Although rare, cases of permanent damage to the lower alveolar nerve have been reported. This structure would be at lower risk than the lingual nerve, which runs much more superficially and, therefore, would be more often affected; the painful symptom, however, would be systematically more severe in the case of the lower alveolar nerve.

Fortunately, the anesthetic solutions currently used ensure high standards of safety. According to the six-year study conducted by Progrel and colleagues, however, any molecule would be able to lead to paresthesia: the classic lidocaine would be linked to 25% of cases of paresthesia, articain 33% and the now outdated prilocaine 34%. These differences would not be significant and, therefore, not be useful to define the causal relationship with the individual species of anesthetic. Hillerup, on the contrary, indicates in the articaine the drug with the highest neurotoxicity.

The complication referred to follows a procedure, at least in appearance, conducted regularly. Apart from possible secondary lesions to events such as needle rupture during injection, this possibility occurs more frequently in children and anxious subjects, being systematically secondary to sudden and unexpected patient movements.

In addition, accuracy during the needle insertion phase is a factor to be considered. When trying to perform conventional anesthesia, in many cases the deflection of the needle does not allow to reach the position that was set. Using a bi-directional technique during insertion and advancement allows greater precision to be achieved; this type of technique is allowed by the use of a device with a shape similar to that of a pen such as The Wand Handpiece [10, 11] .

In the final analysis, it should be considered that an anesthetic technique can lead to complications, including neuropathic damage, even in the presence of anatomical variations: the most significant, in this sense, is the possible bifid course of the nervous trunk.

Neuropathic damage of the lower alveolar nerve during surgery

The last cause treated is represented by the compartment of surgical damage which, in reality, represents the most numerically relevant possibility, able to cover almost eight cases out of ten of damage to the lower alveolar nerve.

The traumatic outcome of implant surgery is, in many cases, the expression of deficient planning and, in particular, of an imperfect phase of radiological diagnosis. If, on the contrary, the planning is correct, the nerve damage is a rare complication and, if it occurs, not serious, because it is secondary to the inflammatory state or to the bone remodeling following the surgery. Such involvement tends to resolve spontaneously, at the latest within a few months.

From an anatomical viewpoint, it is difficult to think that a trauma of this type can manifest in a jaw, edentulous aside, that is healthy. More likely to be an acquired aspect, as typically happens in the presence of complete undefeated edentulousness, associated with severe bone base resorption. **A process of this type leads to a relative approach of the mandibular canal to the alveolar crest. Even during anesthesia it is advisable to evaluate the thinning of the tissues to avoid getting too close to the nerve component even with a simple plexus injection at the site of the lower premolars where there is the emergence of the nerve from the mental foramen.**

In cases like this, the use of **short implants** may be a viable option for the prevention of alveolar nerve complications. It should be remembered, however, that short implants are arousing clinical interest in wider fields of application than the one under examination: once again, therefore, the preventive measure is not justified solely on the basis of complication, which remains in all cases a rare event.

In the surgical field and also in absolute terms, however, the main cause of involvement of the lower alveolar nerve (as, in fact, also of the previously mentioned lingual nerve) is represented by the **surgery of the third molar.**

Smith observes that some of the most common procedures of aggression to the malpositioned third molar, ostectomy, dentitomy or lingual separation of the element are able to induce excessive bleeding, which, in turn, can cause transient deficits in neurosensory conduction. Jerjes has defined the anatomical risk factors underlying lower alveolar nerve paresthesia: horizontal position of the element and proximity to the alveolar canal. To this the author adds the little experience on the part of the clinician. As far as the anatomical aspect is concerned, Park indicates as a critical factor the loss of cortical bone near the mandibular canal. Aspects concerning root morphology can also be added.

These indications also seem to underline the importance of the case study, especially from the radiographic viewpoint: in the face of a concrete suspicion of proximity between element and canal, deepening through the execution of a **TC cone beam** can correctly direct the surgical approach to the case.

Bell's palsy

Atypical orofacial pains constitute a broad syndromic compendium of considerable clinical importance and commitment. The lesion to the lower facial motor neuron is commonly known as Bell's palsy. It manifests "in the fridge"; i.e., after exposure to the cold, typically during the mid-season. It can also occur as a result of infections or as a result of surgery.

The deficit may also be associated with its analgesia during dental therapies that may occur when working in the parotid area.

Paralysis of the facial muscles causes ptosis of the eye, depression of the corner of the mouth with spit out of saliva, and speech disorder.

The **treatment** normally implemented in the most severe cases, **involves the administration of systemic corticosteroids.** One of the existing protocols uses prednisone to the extent of 1mg/kg/day.

DENTAL ANAESTHESIA AND NERVE ANATOMY

Most dental procedures are carried out after proper administration of local anesthetic. Let's briefly see the nerves involved during conventional anesthesia techniques:

- Upper arch vestibular plexic anesthesia: this is the technique most frequently used to obtain anesthesia of the dental element, the buccal periosteum, the connective tissue and the mucosa. The large terminal branches of the dental plexus are anaesthetized.

- Infraorbital nerve anesthesia: used when more than two maxillary teeth and their respective vestibular tissues need to be treated. Anesthetized nerves are the anterior, middle and infraorbital upper alveolars (involving the areas below the eyelid, laterally to the nose and above the lip).

- Palatine major nerve anesthesia: Used for procedures at the level of the areas distal to the canine, involving soft and hard tissues. It is required for conservative procedures involving more than two dental elements and for surgical and periodontal procedures at the palatal level.

- Nasal-palatine nerve anesthesia: indicated for restorative treatments involving more than two dental elements and for surgical and periodontal therapies from canine to canine.

- Lower arch buccal infiltration anesthesia: similar to what happens in the case of the upper infiltration, with the only difference that the terminal branches of the dental plexus of the lower alveolar are anaesthetized.

- Lower alveolar nerve block anesthesia: The nerves involved are the lower alveolar, the incisor, mentaland the lingual, thus anaesthetizing the teeth, the body of the mandible, the vestibular mucosa anterior to the mental foramen the two-thirds anterior of the tongue, the oral floor, the periosteum and the lingual mucosa.

- Gow Gates truncular anesthesia: affects the entire third branch of the trigeminal nerve, including the lower alveolar, lingual, miloioid, mental, incisor, auricular-temporal and buccal.

- Long Buccal nerve anesthesia: used to anaesthetize mucous membrane and vestibular periosteum distally from the mandibular molars [12].

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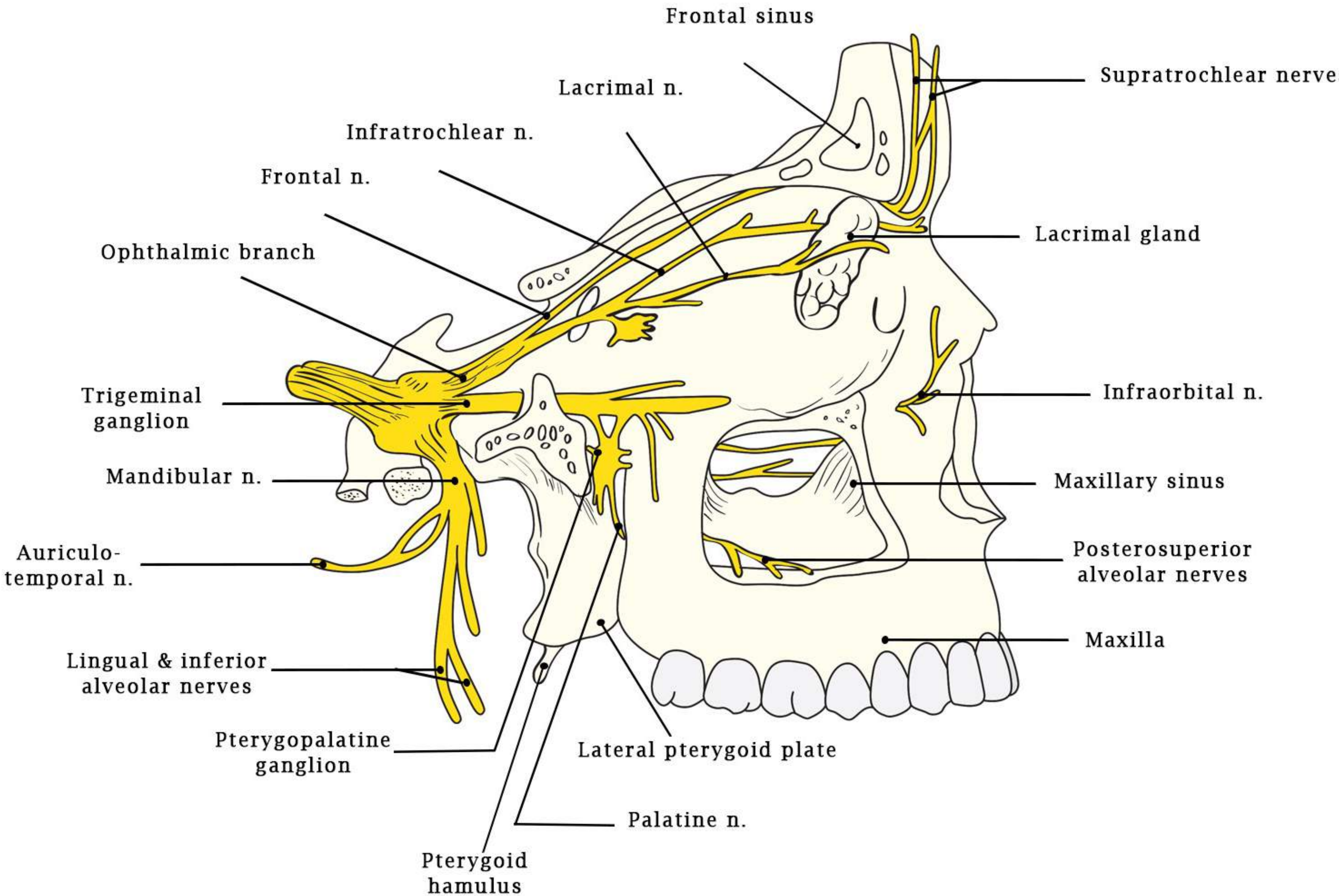
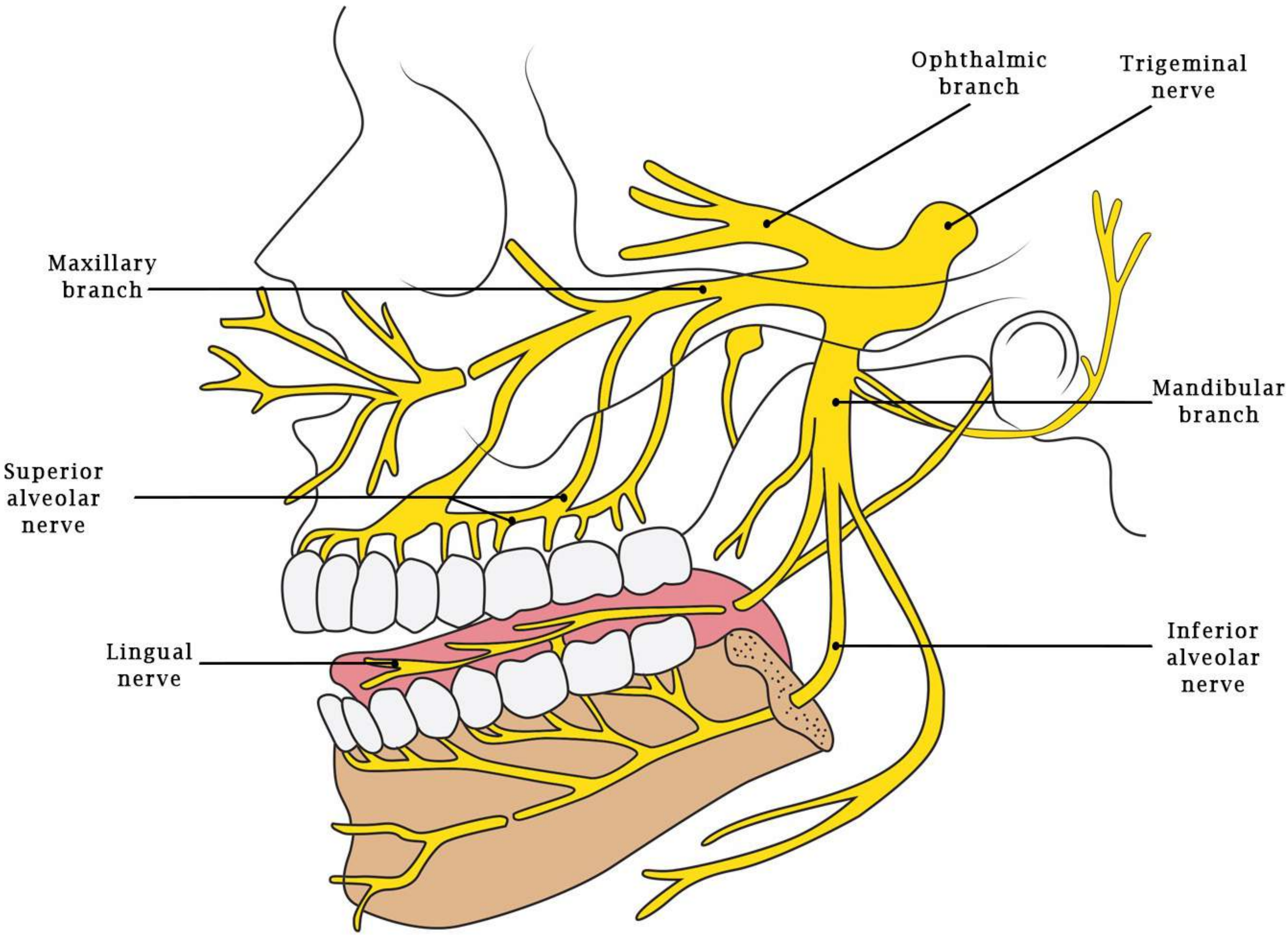
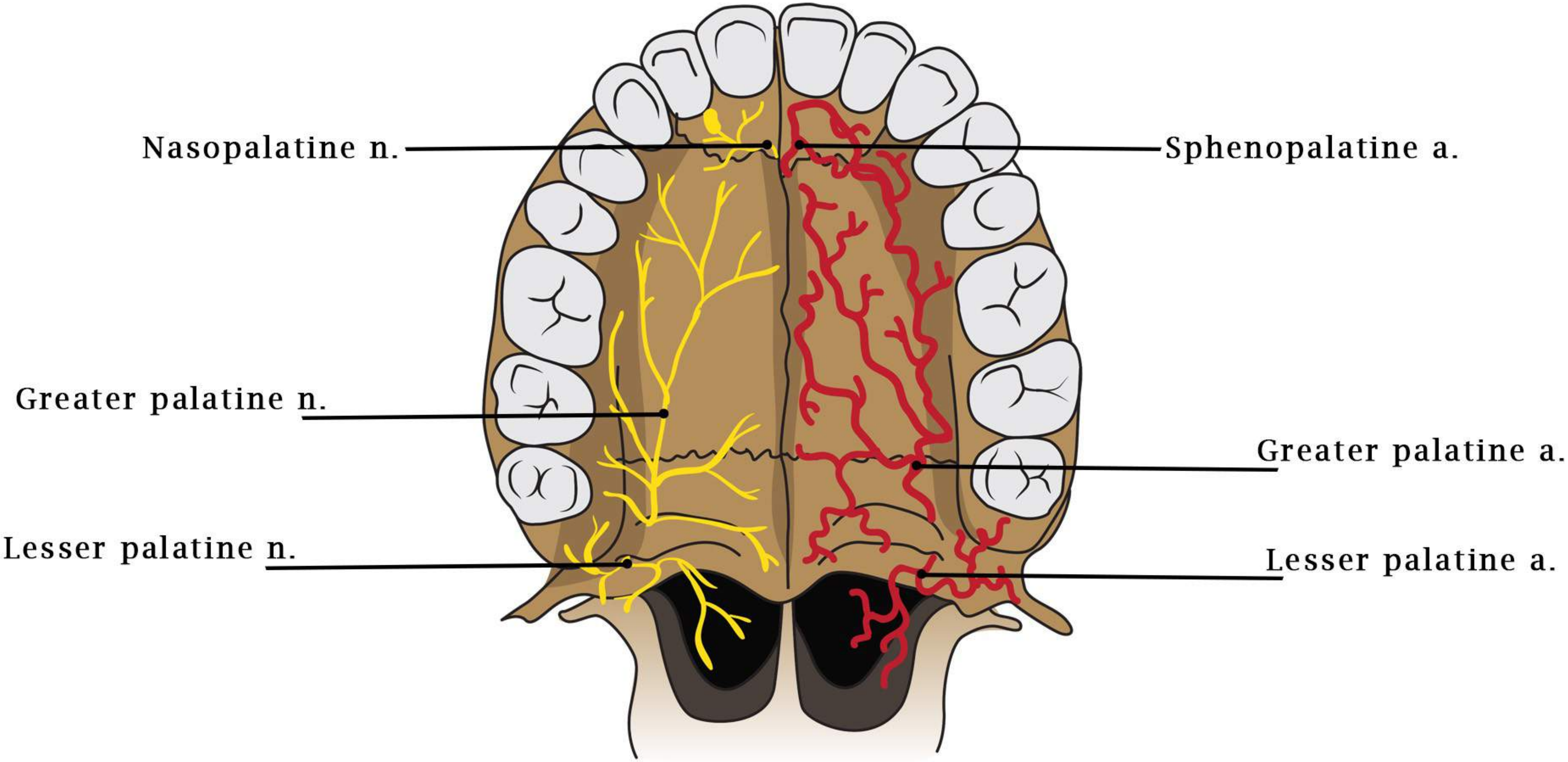
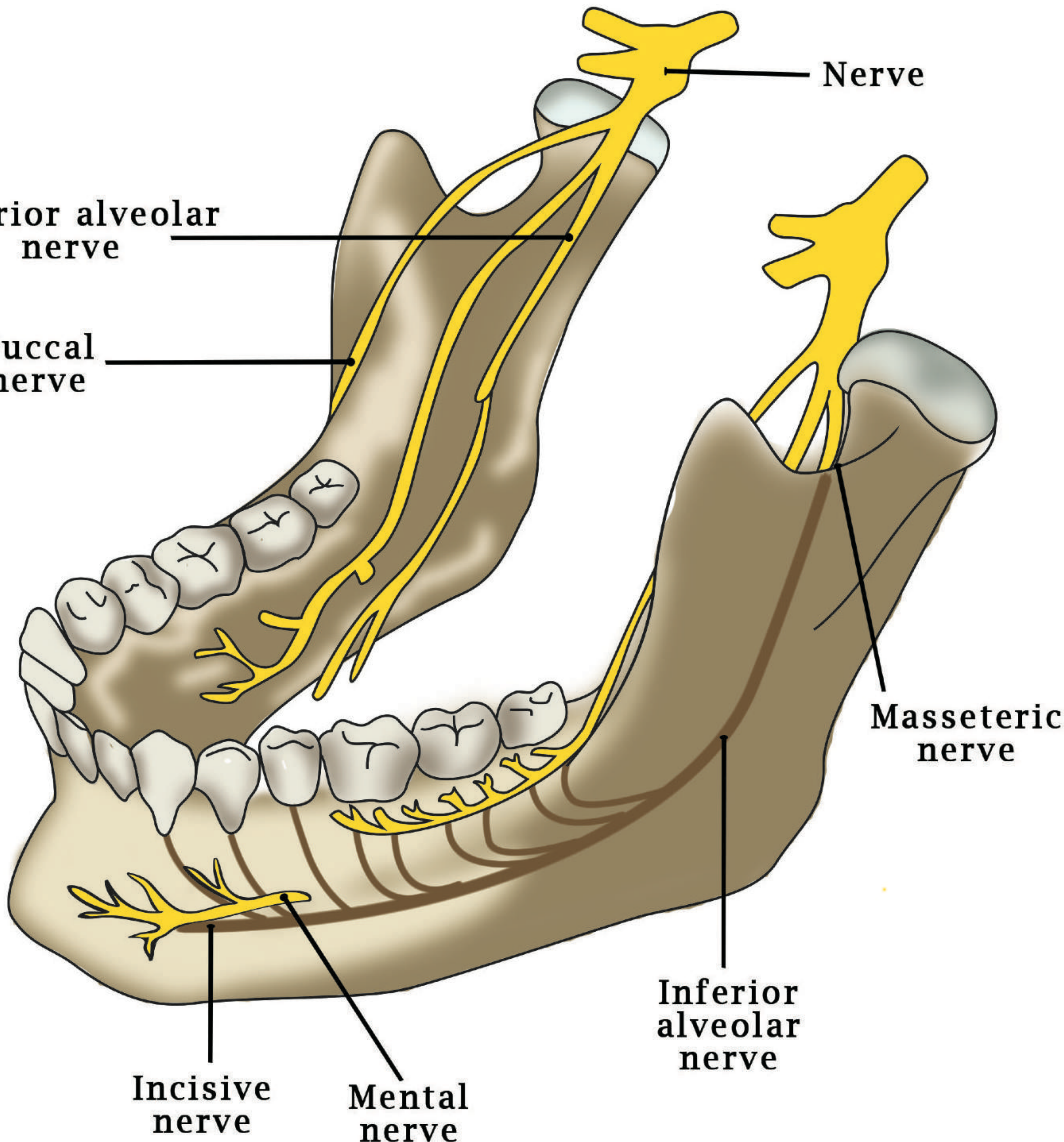
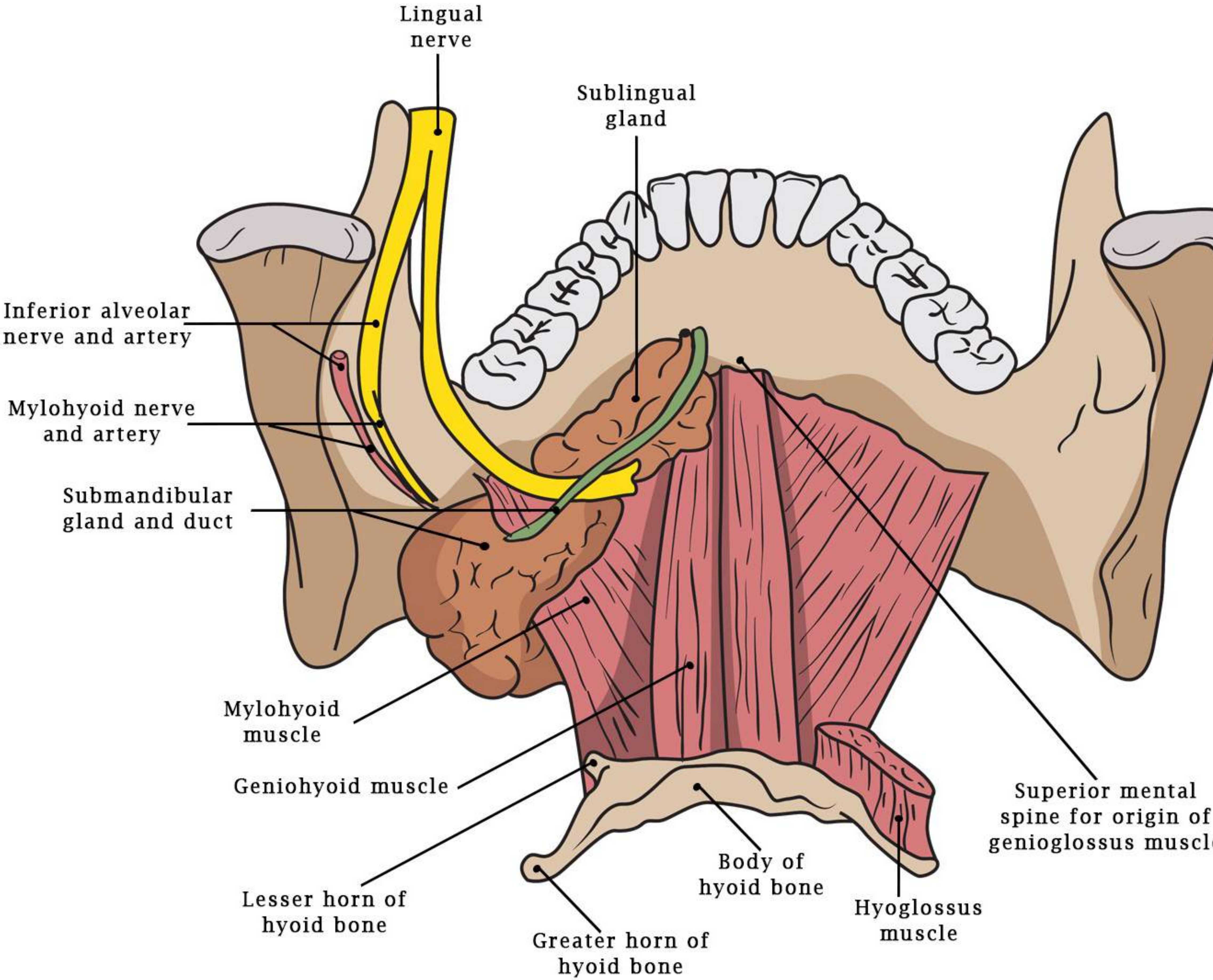

Frontal sinus
Supratrochlear nerves
Lacrimal n.
Infratrochlear n.
Frontal n.
Lacrimal gland
Ophthalmic branch
Trigeminal ganglion
Infraorbital n.
Mandibular n.
Maxillary sinus
Auriculo-temporal n.
Posterosuperior alveolar nerves
Maxilla
Lingual & inferior alveolar nerves
Pterygopalatine ganglion
Lateral pterygoid plate
Palatine n.
Pterygoid hamulus

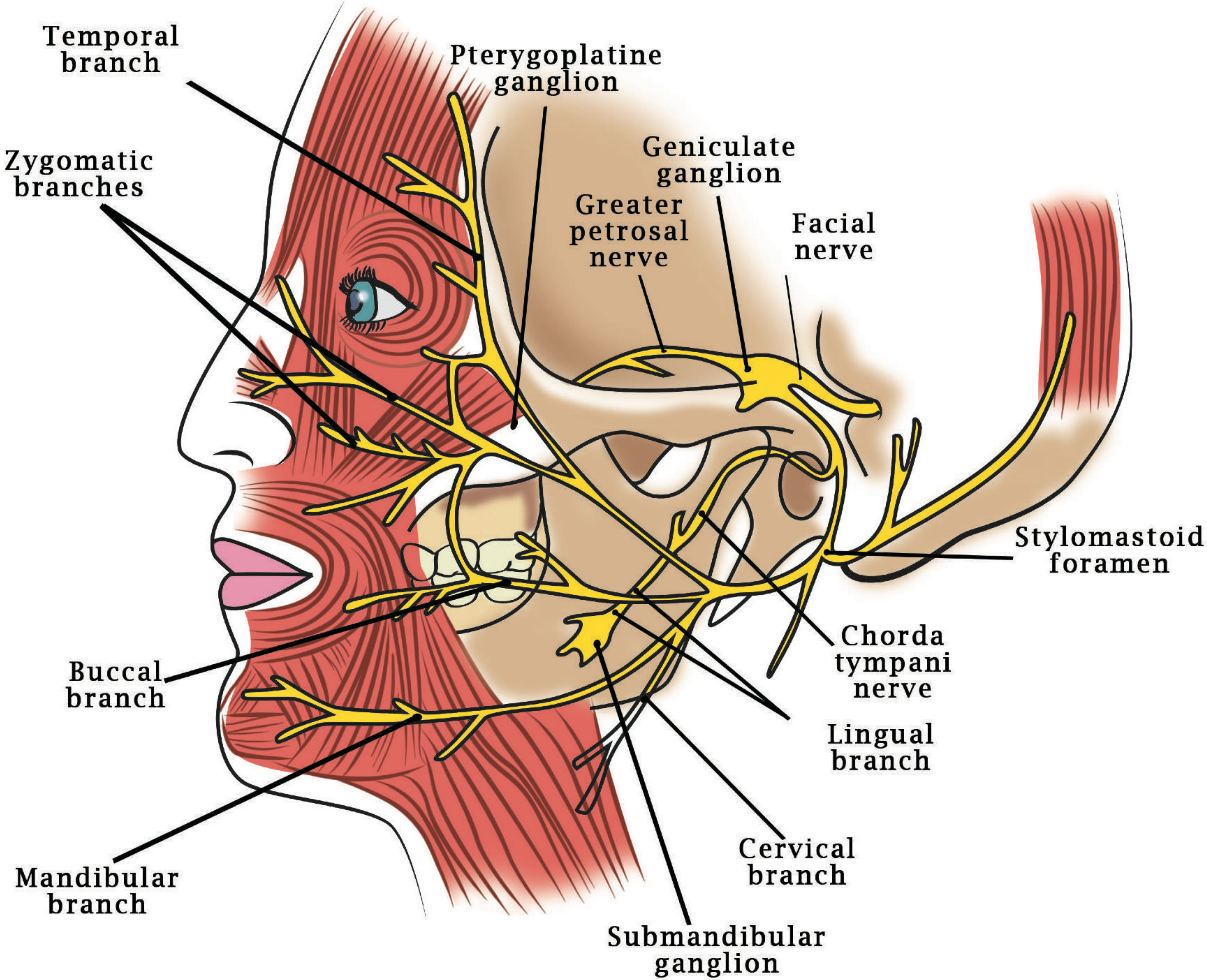

Ophthalmic branch
Trigeminal nerve
Maxillary branch
Mandibular branch
Superior alveolar nerve
Lingual nerve
Inferior alveolar nerve

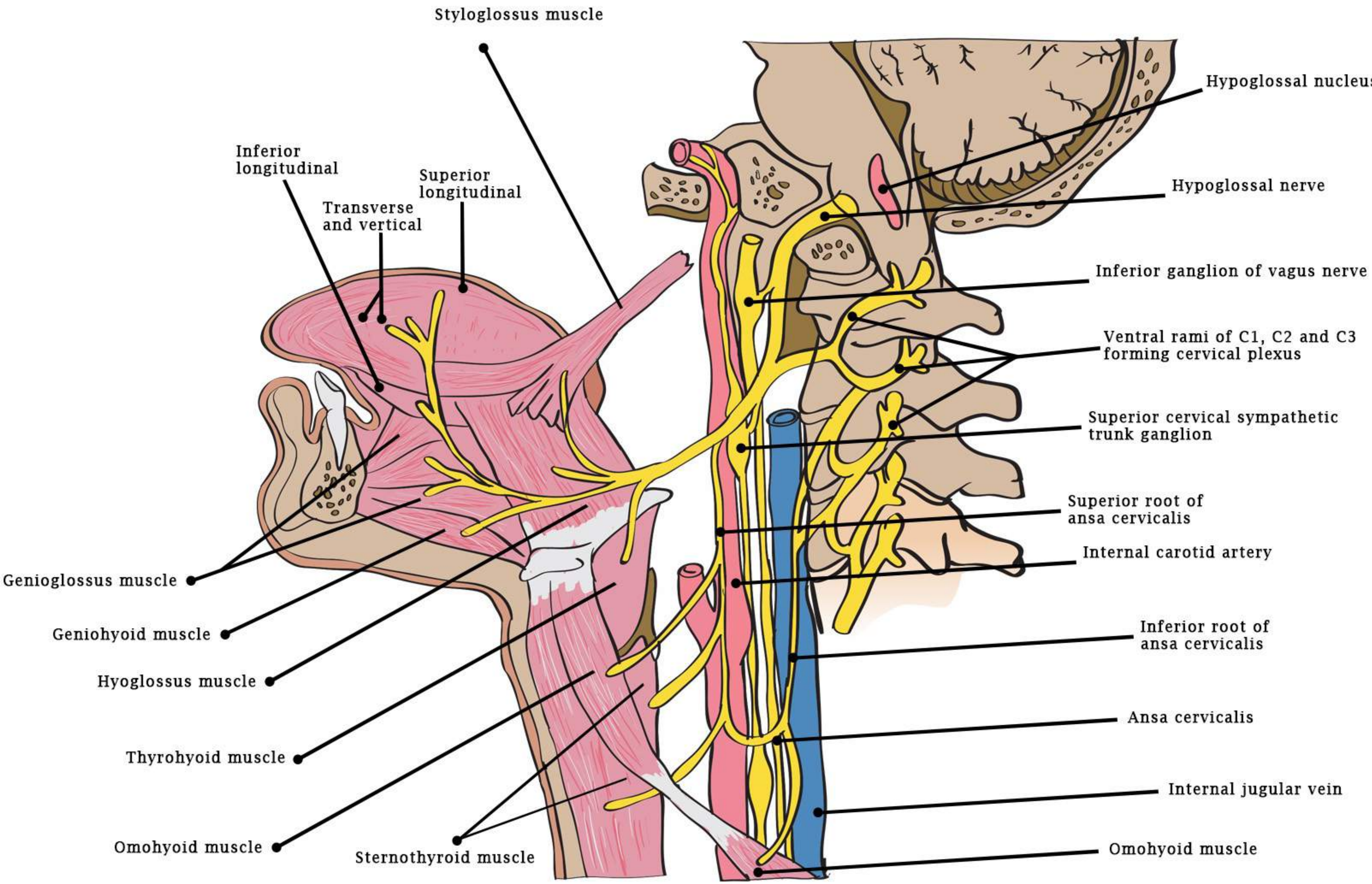

Nasopalatine n.
Sphenopalatine a.
Greater palatine n.
Greater palatine a.
Lesser palatine n.
Lesser palatine a.


Nerve
Inferior alveolar nerve
Buccal nerve
Masseteric nerve
Inferior alveolar nerve
Incisive nerve
Mental nerve

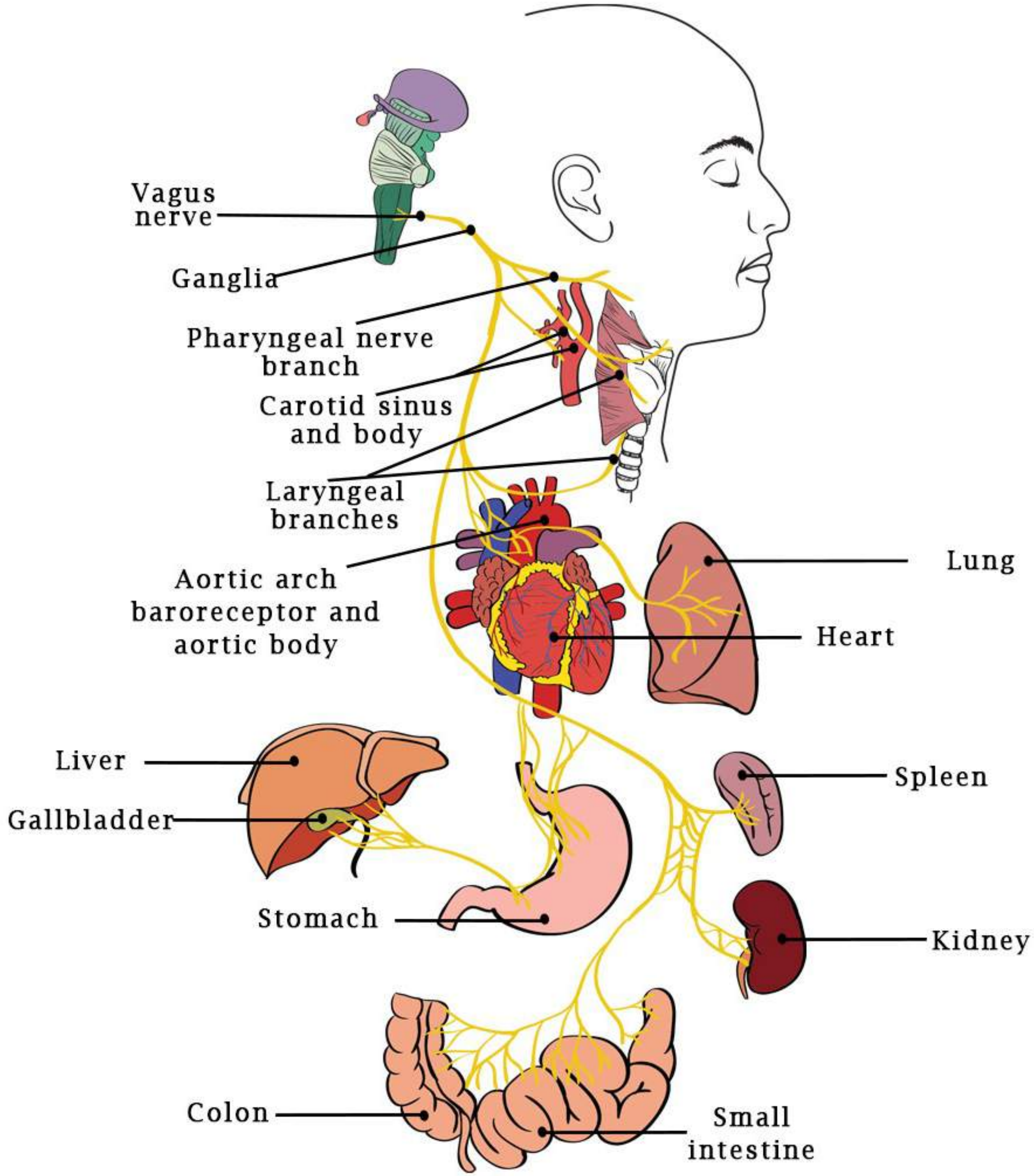


Lingual nerve
Sublingual gland
Inferior alveolar nerve and artery
Mylohyoid nerve and artery
Submandibular gland and duct
Mylohyoid muscle
Geniohyoid muscle
Lesser horn of hyoid bone
Greater horn of hyoid bone
Body of hyoid bone
Hyoglossus muscle
Superior mental spine for origin of genioglossus muscle


Temporal branch
Zygomatic branches
Pterygoplatine ganglion
Geniculate ganglion
Greater petrosal nerve
Facial nerve
Stylomastoid foramen
Chorda tympani nerve
Lingual branch
Buccal branch
Mandibular branch
Cervical branch
Submandibular ganglion



Styloglossus muscle
Inferior longitudinal
Superior longitudinal
Transverse and vertical
Hypoglossal nucleus
Hypoglossal nerve
Inferior ganglion of vagus nerve
Ventral rami of C1, C2 and C3 forming cervical plexus
Superior cervical sympathetic trunk ganglion
Superior root of ansa cervicalis
Internal carotid artery
Genioglossus muscle
Geniohyoid muscle
Hyoglossus muscle
Inferior root of ansa cervicalis
Ansa cervicalis
Thyrohyoid muscle
Internal jugular vein
Omohyoid muscle
Sternothyroid muscle
Omohyoid muscle


Vagus nerve
Ganglia
Pharyngeal nerve branch
Carotid sinus and body
Laryngeal branches
Aortic arch baroreceptor and aortic body
Lung
Heart
Liver
Gallbladder
Spleen
Stomach
Kidney
Colon
Small intestine