

Functions of Saliva:

1. antibacterial :
 - a) Lactoferrin: Scavenges the free iron in the fluid & inflamed areas so:
 - suppress the free radical-mediated damage
 - decrease the availability of the metal to invading microbial & neoplastic cells
 - a) IgA :
 - the **predominant** immunoglobulin in saliva
 - contributes to the local immunity & exerts its anti-inflammatory protective functions by inhibiting IgG & IgM modulated functions
 - in the form of **dimer**
 - role IgA as a protective agent against the formation of **dental** plaque is unknown
 - IgG, IgM also contributes to the immunity
 - a) Lysozyme:
 - aid in breaking down **cell walls** leading to **bacterial** cell **lysis**
 - a) ABO isohemagglutinogens
 - b) Peroxidases: Helps breakdown salivary thiocyanate into products that interfere with bacterial cell metabolism.
1. digestion :
 - amylase : 40 % of body amylase, helps in starch digestion & has antibacterial effect
 - lingual Lipase
1. **lubricating** the food bolus and **lavaging** the oral cavity surfaces with a **biofilm** barrier:
 - mucins** are the best lubricating substance in saliva, forming a biofilm that protects the mucosa and dentition from chemical irritants, carcinogens
1. maintaining tooth integrity: prevents caries and promotes dental **calcification**
2. modulation of taste: most gustatory & olfactory stimulation is parotid secretions
3. providing buffering capacity ; buffering system in saliva consists of:
 - bicarbonate
 - phosphate
 - urea
 - amphoteric proteins.

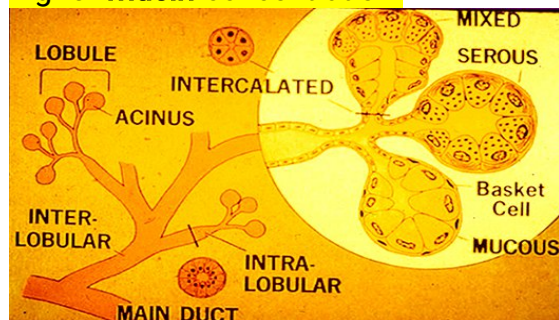
Saliva Composition:

>99% water; salts (calcium phosphate, calcium carbonate); (amylase, albumin, lysozyme, lactoferrin, **Ig A**)

hypotonic to plasma (Hypotonic saliva improves taste by decreasing the masking effect of normal plasma sodium levels)

Ph: 6.2-7.4

the **submandibular calcium** concentration in the saliva is **higher** than in the parotid saliva which leads to higher rate of stone formation in addition to the more dependent location + higher **mucin** concentration



enzymes

The most important ion in secretion of amylase is **Ca**

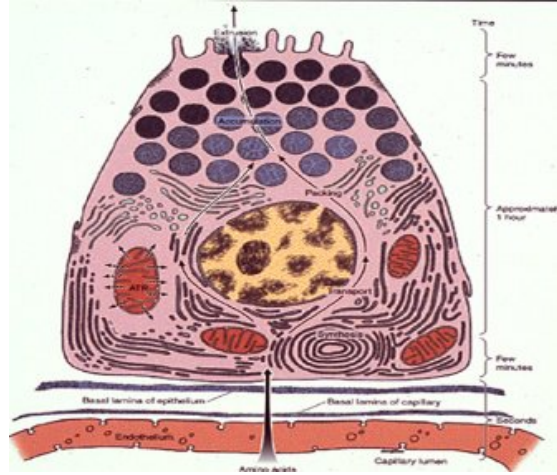
plasma iodine ratio for mixed saliva under physiological condition is greater than 20

Secretory unit of salivary gland:

Secretory unit is made of:

- a) Acinus
- b) Secretory ducts(interlobular):

1)



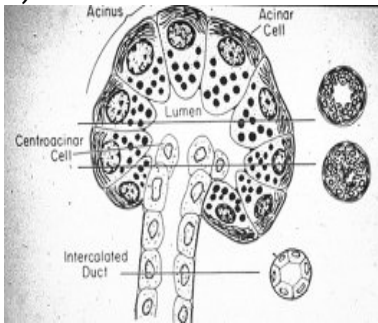
Intercalated duct

2) Intralobular/striated duct

a) Collecting duct(extralobular)

Salivary acini are classified into:

- 1) Serous
- 2) Mucinous
- 3) Mixed



Acini leads to **intercalated** duct which is made of **single cuboidal** cell
Intercalated duct leads into **intralobular** duct which also known as **striated** duct

Serous cells are filled with **basophilic** secretory granules

Serous acinar cells produce secretory granules with **amylase**

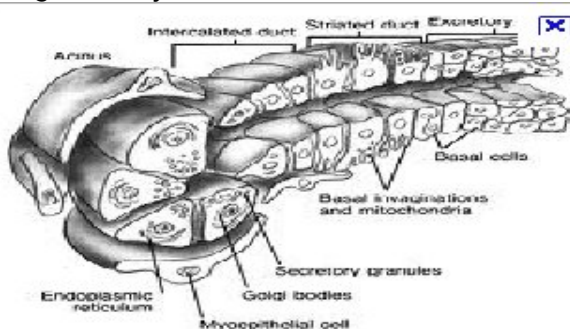
Myoepithelium cells:

- ✓ elongated/star shap
- ✓ nonsecretory cells
- ✓ long branching processes that surrounds the **acini** & the **proximal** duct
- ✓ it has **contractile** properties & play role in expelling preformed secretions:
 - a) Adenosinetriphosphate activity
 - b) Intercellular gap junction

Salivary secretions:

- ✓ main **triggers** for salivary production:
 - mastication
 - gustatory stimuli: **Acidic** foods are the **best** stimulus and **sweet** tastes the least.

✓



Note: **Olfaction** is surprisingly a **poor** secretory

stimulus

- ✓ The **production** of saliva is an **active** process involving:
 - 1) cell synthesis
 - 2) active transport.
- ✓ Saliva **secretion** is **active** too, intercalated stage process composed of:
 1. **Primary** acinar secretions
 2. Ductal secretions (modification)

- 1) Primary secretion is by the **acinus** which is the site of:
 - a. **all** fluid generation
 - b. **Most** (approximately 85%) **exocrine protein** secretion.
 - o The fluid component is derived from the **local** vascular bed in the form of an **isotonic** solution and secreted into the acinar lumen.
 - o The fluid secretion occur by way of **osmotic coupling** of transepithelial fluxes of NaCl & water (water is drawn into the acinar lumen by osmotic gradient of NaCl)
 - o It is **dependant** on the activity of Na-k ATPase which is located on the **basolateral** domain of the acinus
 - o The Na-K ATPase maintain a high intracellular [k] & low [Na] which contributes to the resting membrane potential

- 1) The secretory ducts:
 - o It is water-**impermeable** In contrast to the water-permeable cells of the acinus
 - o Most of the sodium (Na^+) and chloride (Cl^-) in the primary secretion is reabsorbed in the duct, and a **small** amount of potassium (K^+) and bicarbonate (HCO_3^-) is secreted.
 - o This makes the saliva **more alkali & less isotonic (hypotonic)**
 - o **Some** proteins are added to the salivary fluid as it traverses the secretory duct

The degree of hypotonicity depends on flow rate:

Rapid flow rates decrease transport time resulting in lower hypotonicity.

Slower flow rates provide greater transit time increasing hypotonicity.

Gland	Acinar type	Viscosity	Percentage of Whole Unstimulated Daily Saliva
Parotid	Serous	Watery	25
Submandibular	Mixed	Semi-viscous	71
Sublingual	Mucous	Viscous	3-4
Minor	Mucous	Viscous	Trace

% of salivary gland secretions contribution to the

saliva:

1. Without stimulation (base line secretions):
 - submandibular gland secretes 60 -70% of saliva
 - parotid gland: 20-30%
 - sublingual & minor gland: 5-10 %
1. With gustatory & Olphactory stimulation of the ANS:
 - parotid gland secretes 75% of the saliva
1. Minor salivary glands regardless of the state of stimulation contributes to 7-8 % of total saliva

control of salivatory secretions:

Resting acinar cells show a membrane potential of -20 to -35 mV.

On **stimulation** by the autonomic nervous system, the cells **hyperpolarize** (become more negative) as a result of the **efflux of K^+** and the **influx of Cl^-** .

This hyperpolarization, which occurs contrary to other excitable cells that depolarize on stimulation, is known as the **secretory potential**

combination of sympathetic and parasympathetic systems :

- 1) **parasympathetic** being the dominant
- 2) Sympathetic stimulation of the salivary glands tends to be more intermittent

parasympathetic:

dominant neurotransmitter: acetylcholine

so the atropine is anti-sialagogue because it competes with acetylcholine for receptor sites

2nd messenger: ca

Functions: Fluid formation, Transport activity in the acinar & ductal cells

parotid gland: medulla oblinigata **inferior** salivatory nuclus **glossopharyngeal** nerve jacobson's Nerve tympanic plexus lesser petrosal nerve **otic ganglion** postganglionic parasympathetic fibers carried by **auriculotemporal branch of V3**

Submandibular & sublingual gland: Medulla oblinigata **superior** salivatory nuclus nervus intermedius of **facial** nervechordi tympani **lingual** nerve **submandibular ganglion** postganglionic parasympathetic fibers submandibular & sublingual glands

Sympathetic:

Dominant **beta** adrenergic neurotransmitter: **norepinephrine**

2nd messenger: **cAMP**

Functions:

- 1) Exostosis
- 2) Protein metabolism

So it modulate the composition of saliva by increasing exocytosis from certain cells

Originate from superior cervical ganglion

Sympathetic stimulation produce scanty viscous saliva

Salivary flow Rate:

1–1.5 L of saliva/day

steadily increase as the child grows & reach a max value by the age of 3-4 yr

Hyposalivation: unstimulated salivary flow less than 0.25 ml/min

The most important factor in oral hygiene is salivary flow rate

Factors affecting the rate

A. **Increase** the rate:

- 1) Mastication
- 2) Before an episode of vomiting

A. **Decrease** the rate:

- 1) During sleep
- 2) Before & During exercise: due to vasoconstriction (sympathetic)+ dehydration

Excessive salivation in cerebral palsy can be treated by **lateral tympanic neurectomies** (resection of **inferior** tympanic nerve of glossopharyngeal nerve)

conditions predisposing to xerostomia:

- 1) uremia
- 2) sjogren syndrome
- 3) antimuscarinic & sympathomimetic drugs

Minor vs major salivary glands:

Major salivary glands:

located distant from the oral mucosa

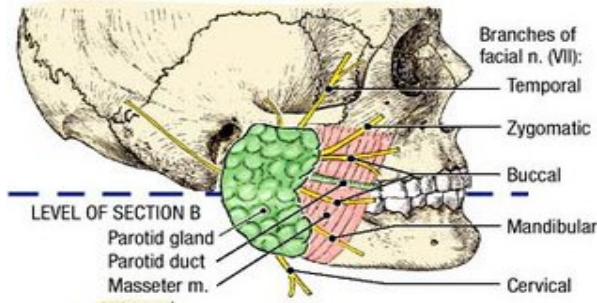
Connected to the mucosa by excretory ducts.

All of the major salivary glands are derived from oral cavity epithelium which proliferates and burrow into the surrounding mesenchyme to form a solid cord.

The minor glands:

lie within the mucosa or submucosa of the oral cavity and oropharynx

Either open directly onto the surface of the mucosa or are connected to it via short excretory ducts.



Embryology of salivary glands:

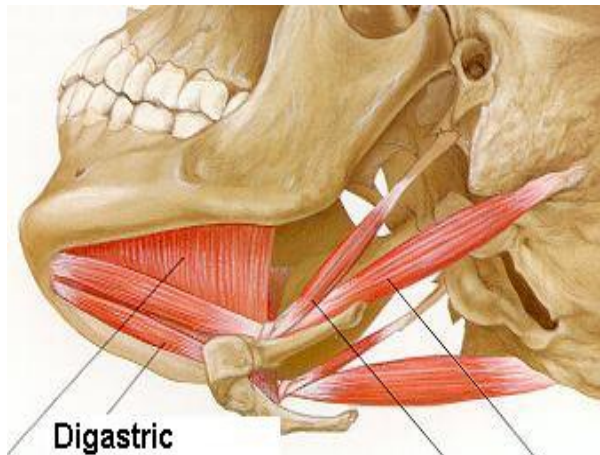
Major salivary glands:

outpouchings of oral ectoderm into the surrounding mesenchyma

The primordia originate at the sites of the eventual duct orifices

Parotid: 5.5 wk

Submandibular : 6wk



Digastric

Sublingual: 8wk

Minor salivary glands: arise from oral ectoderm and nasopharyngeal endoderm and form simple tubuloacinar systems

Parotid Gland

Largest of major salivary glands

Entirely serous secretions, high enzymes

lies in the pre-auricular area deep to the skin & subcutaneous tissue:

75% of the gland overlies the Masseter muscle

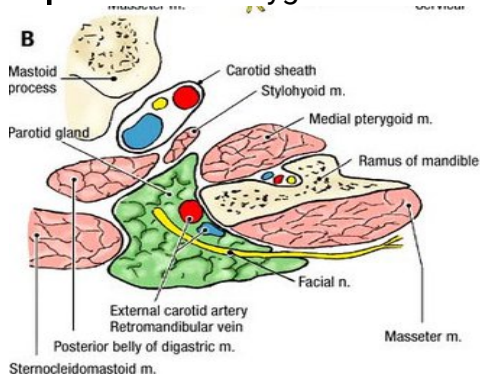
25% retromandibular

Borders:

Anterior border: Masseter muscle

Posterior border: EUC & SCM

Superior border: zygomatic arch



Inferior tail: lies between the **ramus** of the mandible and scm
over the **posterior** belly of digastrics muscle

o Styloid process, styloid muscles, carotid artery, jugular vein

Relations:

Directly related to:

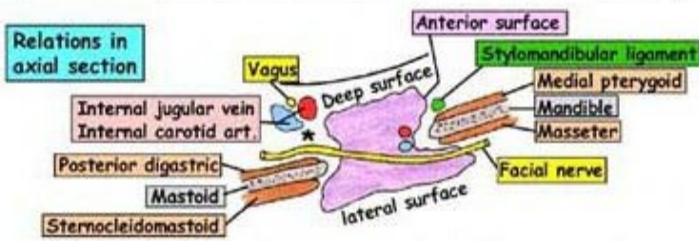
Masseter muscle + medial pterygoid

Mandibular ramus + mastoid process

Within the gland:

1) Facial nerve

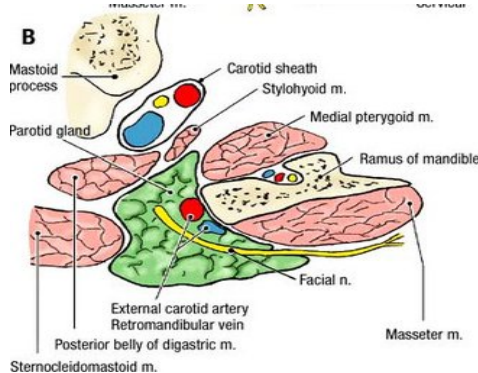
- 2) Retromandibular vein
- 3) **External** carotid artery
- 4) L.N
- 5) Fibers of auriculotemporal nerve fibers



The deep lobe is related to:

Internal jugular vein
Internal carotid artery
Styloid process
Muscles associated with the styloid process

Note that:

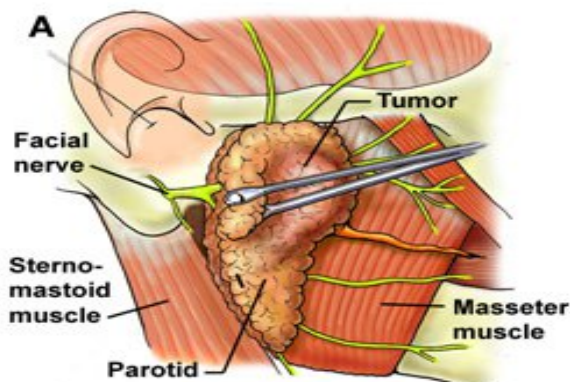
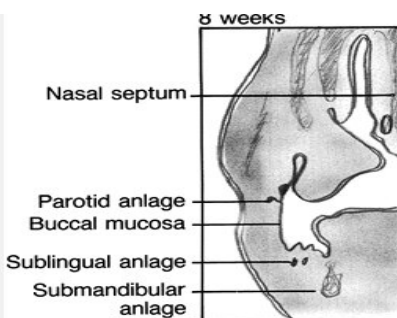
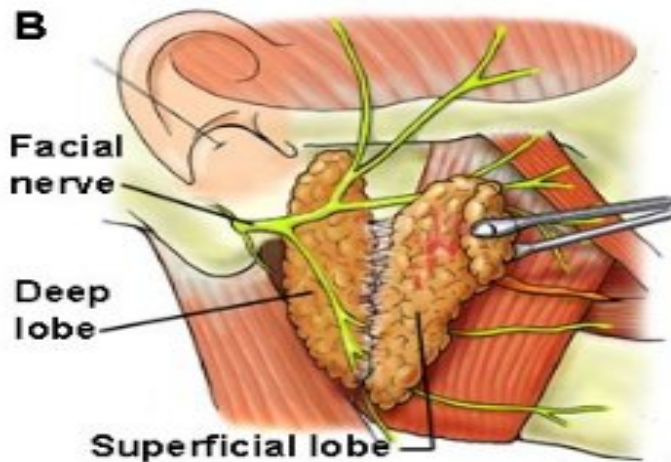


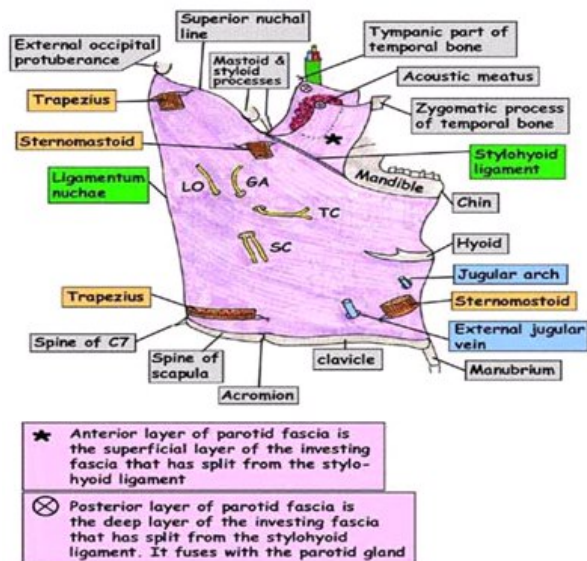
The **external** carotid artery lies **within** the parotid gland
internal carotid artery is related to the **deep** parotid
no relationship between the nerves in the carotid sheath and the parotid gland The facial nerve enters the parotid fossa between the **posterior belly** of digastrics muscle and **stylohyoid muscle**

The facial nerve subdivides **within the gland**

Facial nerve splits the gland into superficial (larger) and deep lobe (smaller)

facial nerve is superficial to the retromandibular vein & external carotid artery





Parotid gland capsule:

The gland is enclosed by superficial investing layer of deep cervical fascia, which splits to surround the gland forming the capsule.

Superficially The fascial envelope is continuous:

anteriorly with the fascia covering the **masseter** muscle

posteriorly with fascia enveloping **sternocleidomastoid** muscle.

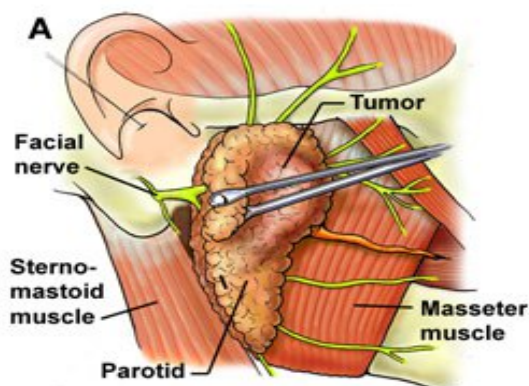
The **deep** layer of parotid fascia forms the **unyielding stylomandibular membrane** stretches from the:

- anteriorly** : mandible
- inferiorly** : stylomandibular ligament
- Posteriorly** : styloid process

Occasionally, parotid tissue can herniate through a weakness in the stylomandibular membrane and lie in the **lateral** pharyngeal wall.

For this reason, **tumors deep** in the parotid gland can present as **parapharyngeal** masses

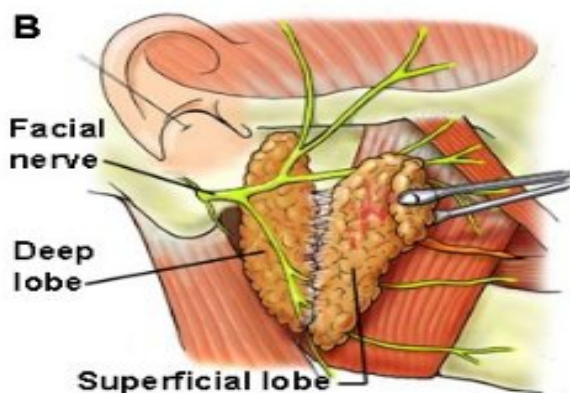
But this membrane is **not** considered a barrier between the **deep** lobe of the parotid & **parapharyngeal space**



The fascia sends **septa** into the **glandular** tissue, which prevents **separation** of a surgical plane between the gland and its fascia.

This fascial layer is largely **tough** and **inelastic**, but this gland is largely constrained by the capsule, leading to:

- Severe** pain occurring in advance of **overt** enlargement of the gland.
-



Prevent the parotid gland from becoming

obvious until it has reached a **large size**

3. suppurative or other **expansive** process in the parotid gland requires **surgical drainage**.
The capsule also can determine the position and expansion of tumors arising within the gland:
the superficial lobe:

The majority of tumors arise in superficial lobe
expand towards the superficial surface of the gland

deep lobe tumors:

constrained by the stylomandibular ligament
expand into the parapharyngeal space

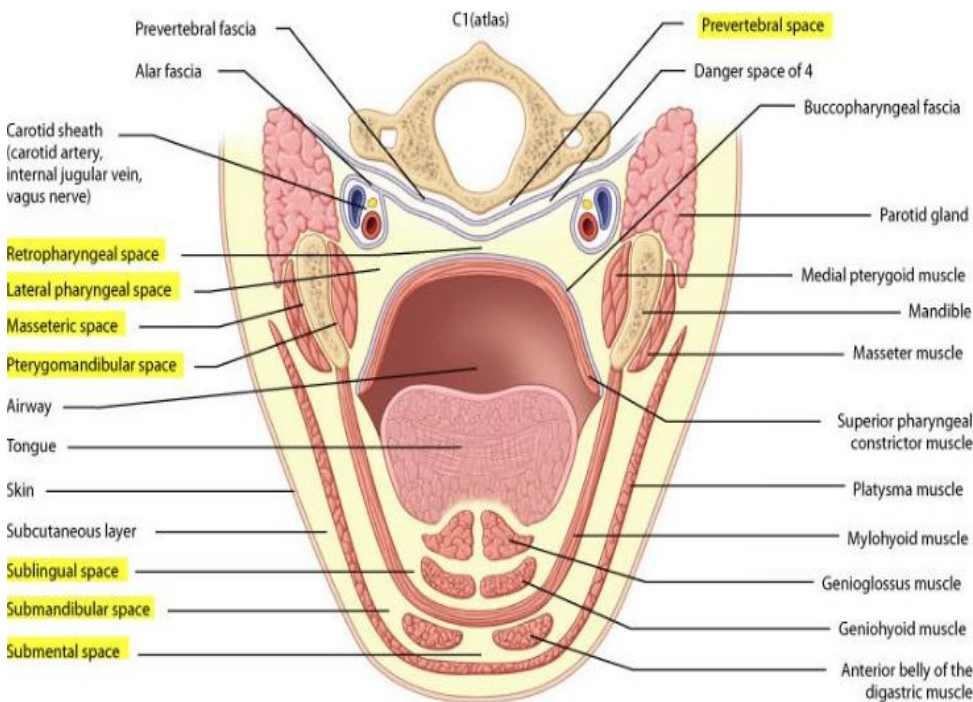
distorting the lateral pharyngeal wall.

Tumors originating in both deep & superficial lobe:

may be restrained by stylomandibular ligament and the posterior aspect of the mandibular ramus to form a dumb bell-shaped mass

Note:

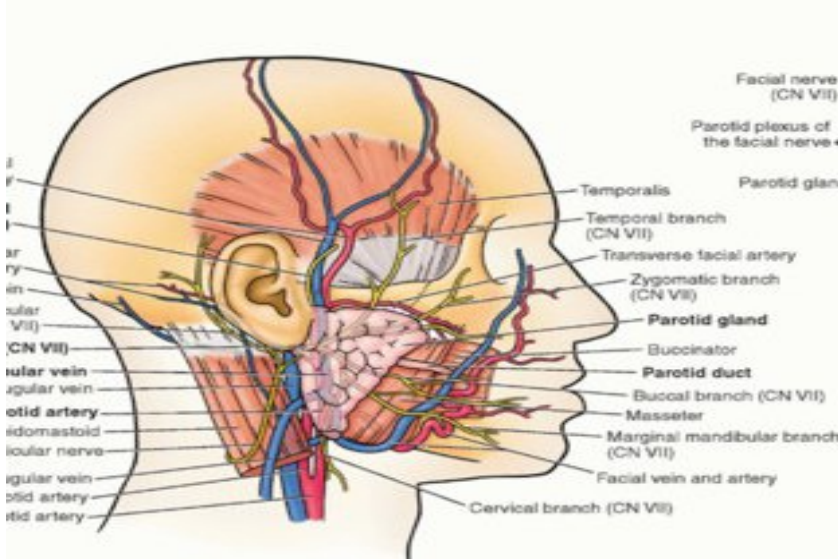
✓



Stylomandibular ligament

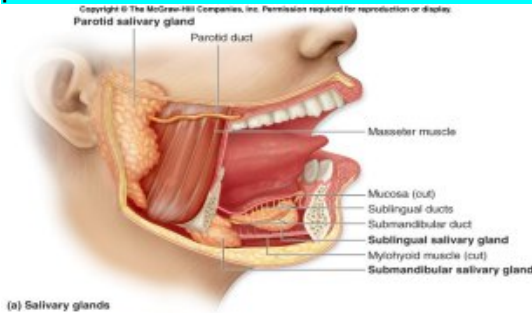
runs **within** the gland separate the deep & superficial lobe **anteriorly**

- ✓ Stylomandibular ligament should be **divided** to access the deep lobe; Separates the parotid gland from the submandibular gland
- ✓ **No** significant barrier between the **deep** lobe & **parapharyngeal** space:
- ✓ The relatively **thin** fascia covering the **apex** of the gland can lead to the spread of sepsis into the **parapharyngeal** (note that the **medial aspect of the deep lobe forms the lateral wall of the parapharyngeal space**)
- ✓ **Deep** lobe lies in the **prestyloid** compartment of **parapharyngeal** space.



Stenson duct:

- ✓ Made of low cuboidal cells which are surrounded by the smooth muscles
- ✓ Originates from the extraglandular ductules from deep & superficial lobe
- ✓ Originates from the deep lobe
- ✓ 1.5 cm below the zygomatic arch
- ✓ 4-6 cm in length
- ✓ Transverses over the Masseter muscle
- ✓ The duct goes below & parallel with transverse facial artery
- ✓ parallel to the buccal branch of the facial nerve (it is either above/below it)
- ✓



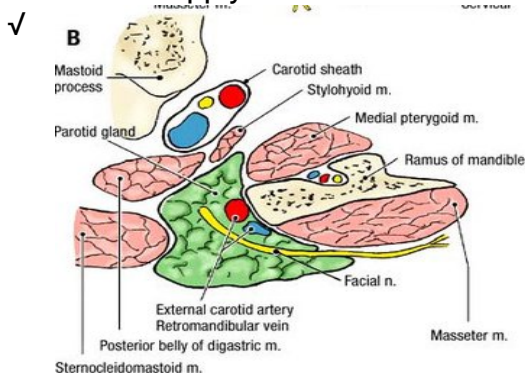
at the anterior edge of the Masseter muscle it Goes medially through the buccinator and Pierces the oral mucosa opposite to 2nd upper molar

Major stimulus of parotid gland secretions:

1. gustatory stimulation
2. mechanical stimulation of chewing

Blood supply:

Arterial blood supply:



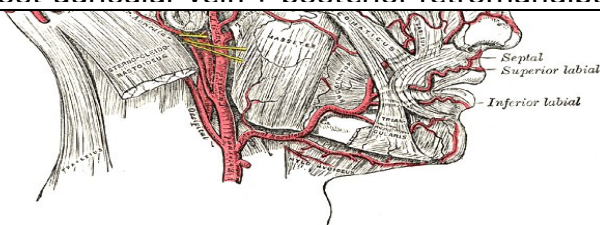
External carotid artery courses medial to the parotid gland and bifurcates into superficial temporal artery and maxillary artery

- ✓ The superficial temporal artery gives off Transverse facial artery which parallels the parotid duct slightly superior
- ✓ This artery supplies:
 - o Parotid gland
 - o Parotid duct
 - o Masseter muscle

Venous drainage:

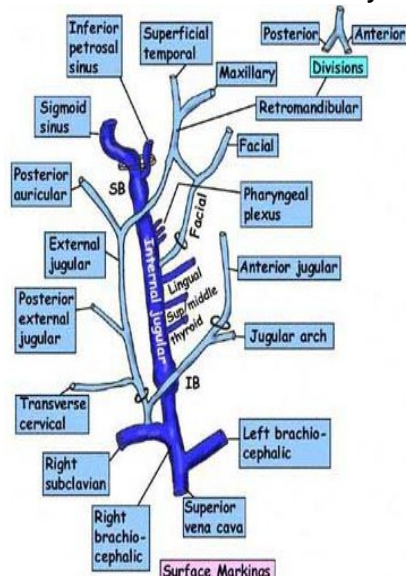
- ✓ the main venous drainage of parotid gland is posterior facial vein

- ✓ Superficial temporal vein + internal maxillary vein = retromandibular vein
- ✓ Retromandibular vein has 2 branches (anterior & posterior)
- ✓ Facial vein + anterior retromandibular vein = common facial vein
- ✓ Common facial vein drain into the internal jugular vein
- ✓ Post-auricular vein + posterior retromandibular vein = external



so ultimately the venous drainage of the parotid gland is into both external & internal Jugular veins

Location of the retromandibular vein:
lateral to the carotid artery



in 90 % it lies deep to both facial nerve trunks
in 10 % it crosses either trunk laterally
exists the parotid gland at the **lower pole**

Lymphatic drainage:

Unique features of parotid gland lymphatic drainage:

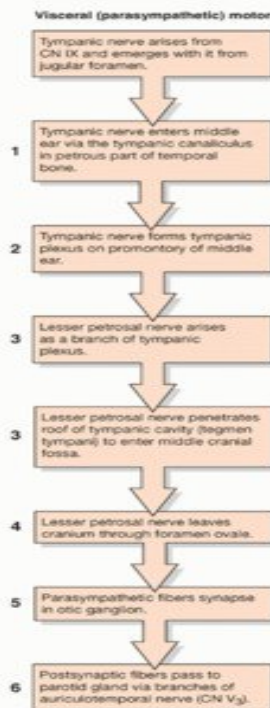
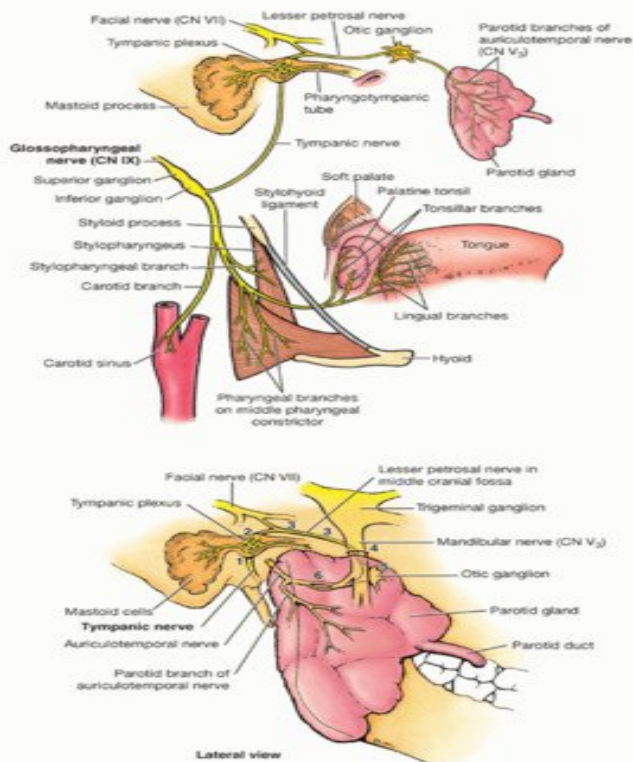
- o Lymph nodes are contained within the gland
- o It is the only gland with two layers of lymph node:
 - a) Superficial : between the gland & capsule
 - b) Deep: within the gland
- o # of superficial L.N is more than the deep L.N
- o Both of them drain into superficial & deep cervical lymph node

Nerve supply:

Autonomic supply:

Sympathetic: superior cervical ganglion

Parasympathetic: glossopharyngeal nerve Inferior Tympanic tympanic plexus superior tympani
lesser petrosal otic ganglion auriculotemporal nerve



Frey's syndrome:

gustatory sweating (sweating in response to gustatory stimulus) occurs over the **pre-auricular skin** secondary to cross re-innervation of the **divided** auriculotemporal nerve post parotidectomy with the **cutaneous** nerve

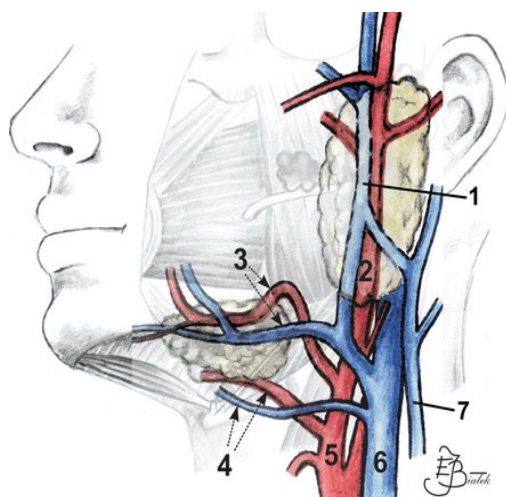
So aberrant cross innervations of **postganglionic parasympathetic cholinergic** fibers from the auriculotemporal nerve of the parotid gland To **postganglionic sympathetic** fibers to the **sweat** glands; So sweat glands will be stimulated by acetylcholine can be treated by **section of Jacobson's nerve**

Sensory innervations:

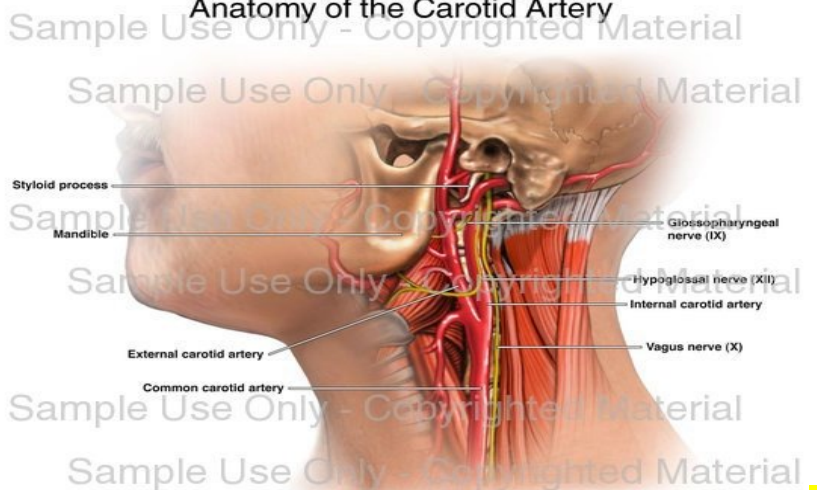
Greater auricular nerve:

arises from C3

Has anterior + posterior divisions

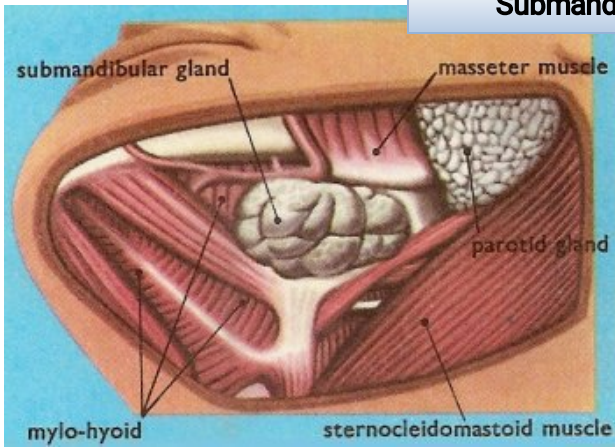


Anatomy of the Carotid Artery



The **posterior** division can occasionally be preserved to avoid Auricular numbness

Submandibular gland



The border of the gland:

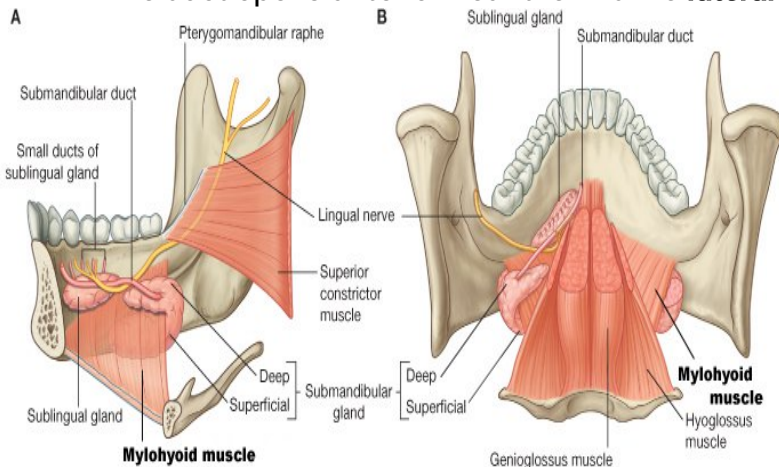
Superiorly: inferior margin of the mandible

Inferiorly: anterior & posterior belly of the digastrics muscle

the **posterior** border of the **Mylohyoid** muscle divides the submandibular gland into **superficial & deep lobes** (the mylohyoid is retracted during surgical excision)

Ducts originate from the **anterior** aspect of the **deep** submandibular gland between the **mylohyoid** muscle & **hypoglossal** muscle

The duct opens anterior near the midline **lateral** to the **frenulum**



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Blood supply of the submandibular gland

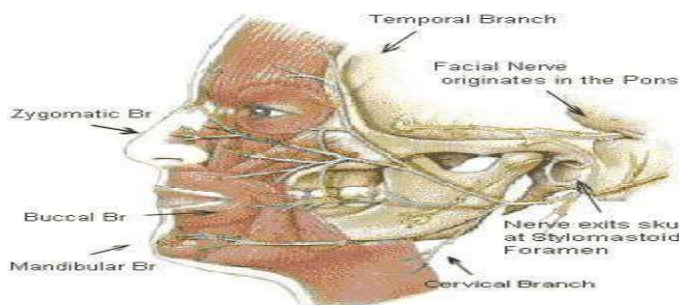
Facial artery:

It runs **forward & upward** over the **superficial** lobe

Deep to the **posterior** belly of **digastrics** muscle

It is normally should be divided & ligated in 2 places

Facial vein:



Lies lateral to the gland

Nerve supply:

1. Facial nerve:

- o via chorda tympani nerve carries the secretory innervations to the submandibular gland (preganglionic parasympathetic fibers)

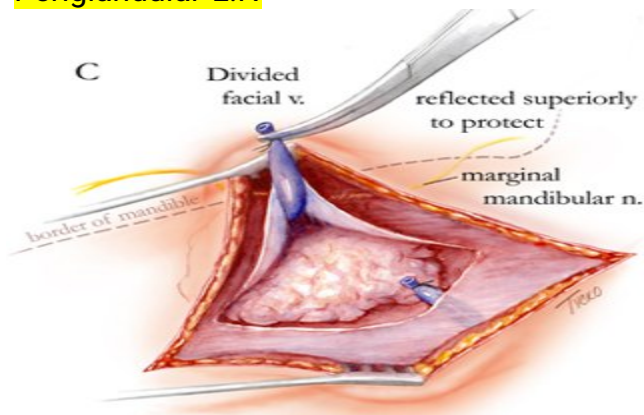
1. Lingual nerve:

- o a branch from mandibular division of the trigeminal nerve
- o provides sensory innervations
- o attach to the deep superior surface of the submandibular gland via nerve fibers of the submandibular ganglion
- o so the flat lingual nerve is pulled into an easily identifiable angular shape by retraction of

the submandibular gland

Lymph nodes:

Periglandular L.N



& intraglandular

Unlike parotid gland which has both periglandular

Relation of Mandibular branch of the trigeminal nerve to the submandibular gland:

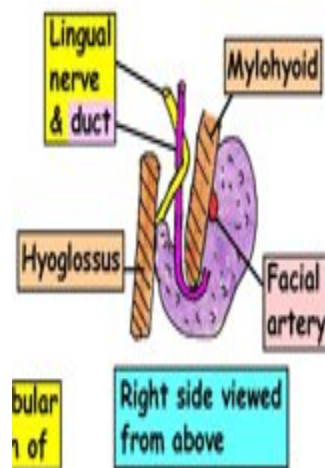
Supply the **corner** of the mouth

Lies **superficial** to the **capsule** of the gland

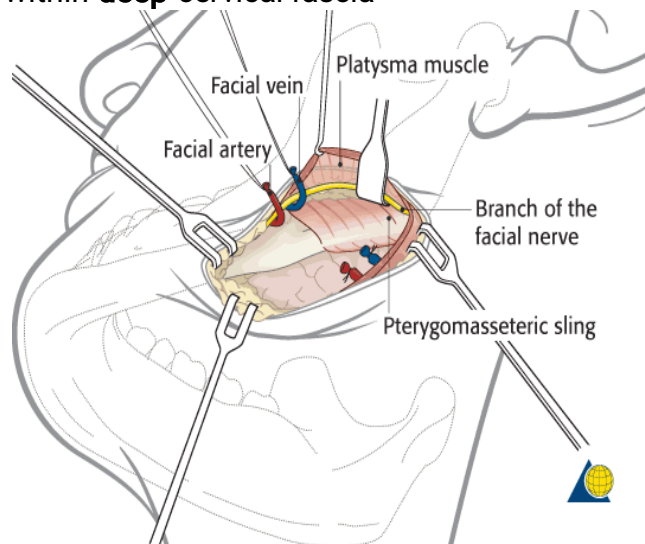
At risk during excision of the gland

It can be protected by making the incision just **above** the hyoid bone and doing the dissection in the plane between the **gland** & the **capsule**

The neurovascular bundle relationship to submandibular gland:



The **mandibular nerve + facial vein** lie **deep** to the platysma muscle within **deep** cervical fascia



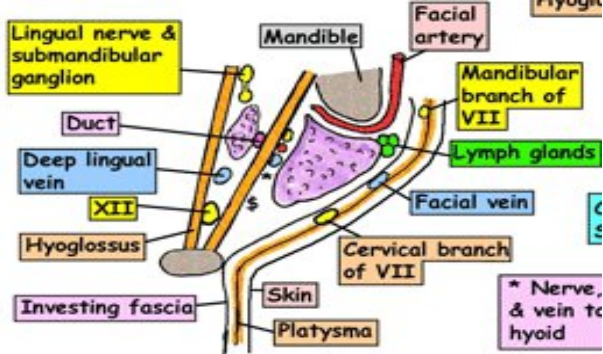
anterior facial vein

Facial artery lies **deep** and **anterior** to the

Marginal branch of facial nerve lies **superficial to** the artery and vein

Protection of the marginal branch during submandibular gland:

By **ligating** and **dividing** the facial **artery** and **vein** and then **retracting** the vessels **superiorly**, the marginal mandibular branch of the facial nerve remains included in the **superior** flap and is thus **protected**.



Sublingual gland duct:

Typically there are about 10 ducts of Rivinus that drain the gland but occasionally several of these small ducts may join to form a larger sublingual/Bartholin's duct.

Half of the sublingual gland duct opens directly into the submandibular duct

Hypoglossal nerve relation : (inferior to Wharton's duct)

Provides motor supply to the tongue

It is **medial** to the posterior belly of the digastrics muscle which is medial to the submandibular gland

Lingual Nerve relationship to the submandibular gland (Wharton's) duct:

Superior to Wharton's duct

it crosses the duct on its **lateral** surface near its origin

The lingual nerve re-cross the duct on its **medial** surface near its termination

Lingual nerve (branch of the trigeminal) attaches to the deep lobe by nerve fibers via **submandibular ganglion**

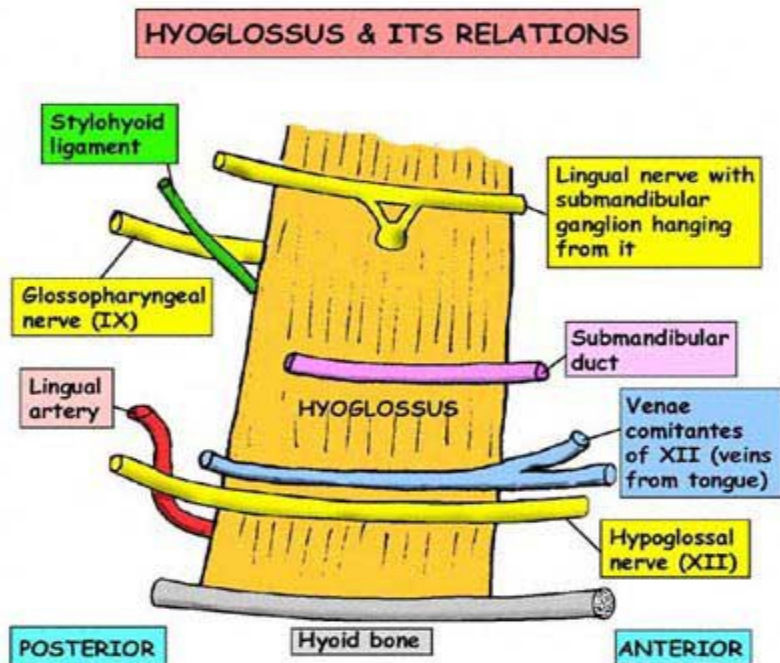
With what other organs do the salivary glands share the same embryologic origin?

Liver, gallbladder, and pancreas (all come from mesodermal buds of the foregut).

When does the parotid gland encase the facial nerve? Third month gestation.

What membrane separates the parotid gland from the submandibular gland? Stylomandibular membrane.

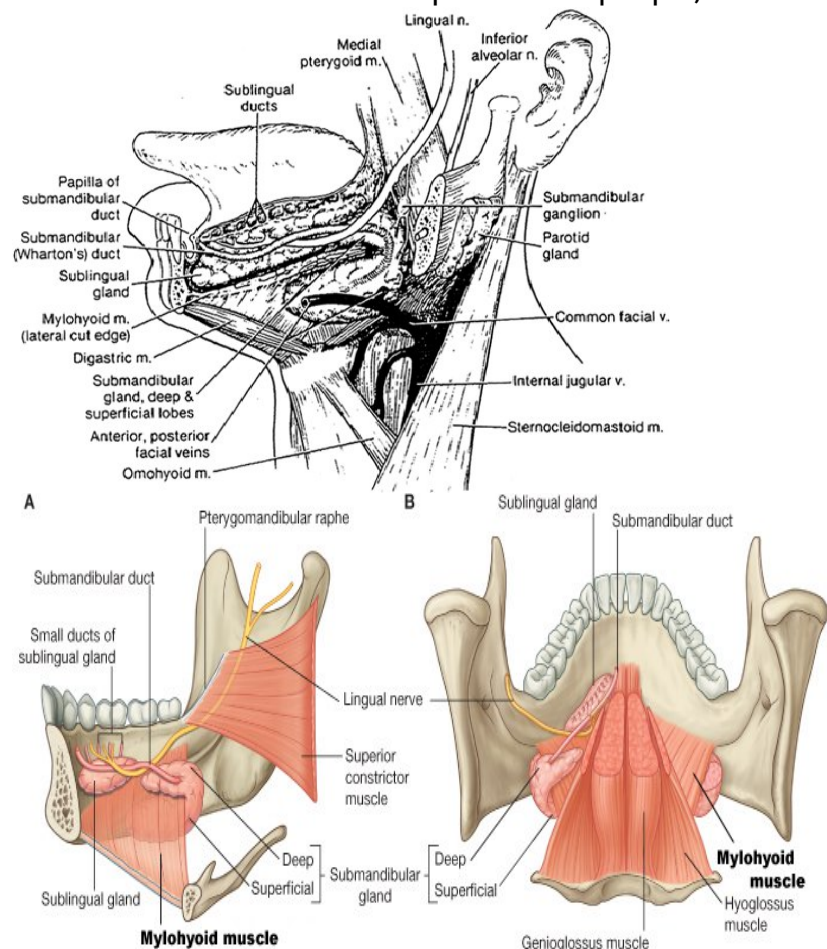
Where does the retromandibular vein lie in relation to the facial nerve?



- The mylohyoid muscle (not shown) overlaps the anterior edge of hyoglossus
- Hyoglossus is supplied by the hypoglossal nerve as are all the muscles of the tongue except palatoglossus (pharyngeal plexus)
- Further anteriorly, under the mylohyoid, the lingual nerve passes lateral to the submandibular duct, then dips under it to appear on its medial side to enter the tongue
- The venae comitantes of the hypoglossal nerve pass posteriorly to join the facial vein

In most people, it courses deep to both

trunks of the facial nerve. In up to 10% of people, the vein crosses either trunk laterally.



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