SALIVA

- Figures in this ppt are from guyton, google images

Salivary glands

- **small intrinsic salivary glands- buccal glands, scattered throughout the oral cavity mucosa.**
- **extrinsic salivary glands -produce most of the saliva .**
- **lie out side the oral cavity and empty their secetions into it.**
- **They are paired compound tubuloalveolar glands that develop from the oral mucosa and remain connected to it by ducts.**

saliva

- Secreted by three pairs of salivary glands.
- 1. parotid glands
- 2. submandibular glands
- 3. sublingual glands

Parotid gland(25%)

- Largest among all.
- Situated – below and anterior to the ear.
- opens into the vestibule next to the second upper molar.
- Branches of the facial nerve run through the parotid gland on their way to the muscles of facial expression. For this reason, surgery on this gland can result in facial paralysis.

Applied

Mumps, a common children's disease,

-inflammation of the parotid glands caused by the mumps virus

(myxovirus), which spreads from person to person in saliva.

Sign and symptoms

-Discomfort-opening the mouth

-moderate fever and pain when swallowing acid foods (sour pickles, grapefruit juice, etc.).

In Mumps adult males carry a 25% risk that the testes may become infected as well, leading to sterility.

Submandibular gland(70%)

- Flat oval shaped.
- Weight- 8 to 20 gms. About the size of a walnut,
- lies along the medial aspect of the mandibular body, in the mandibular triangle
- Its duct runs beneath the mucosa of the oral cavity floor and opens at the base of the lingual frenulum .

Sub lingual gland(5%)

- Small glands
- 2-3gms in weight
- lies anterior to the submandibular gland under the tongue .
- opens via 10–12 ducts into the floor of the mouth.

Lingual gland

- **Lingual lipase:**
- **Causes digestion of dietary Triglycerides into fatty acids and monosaccharide.**
- **This enzyme becomes activated in the acidic medium of the stomach and thus starts to work after food is swallowed.**

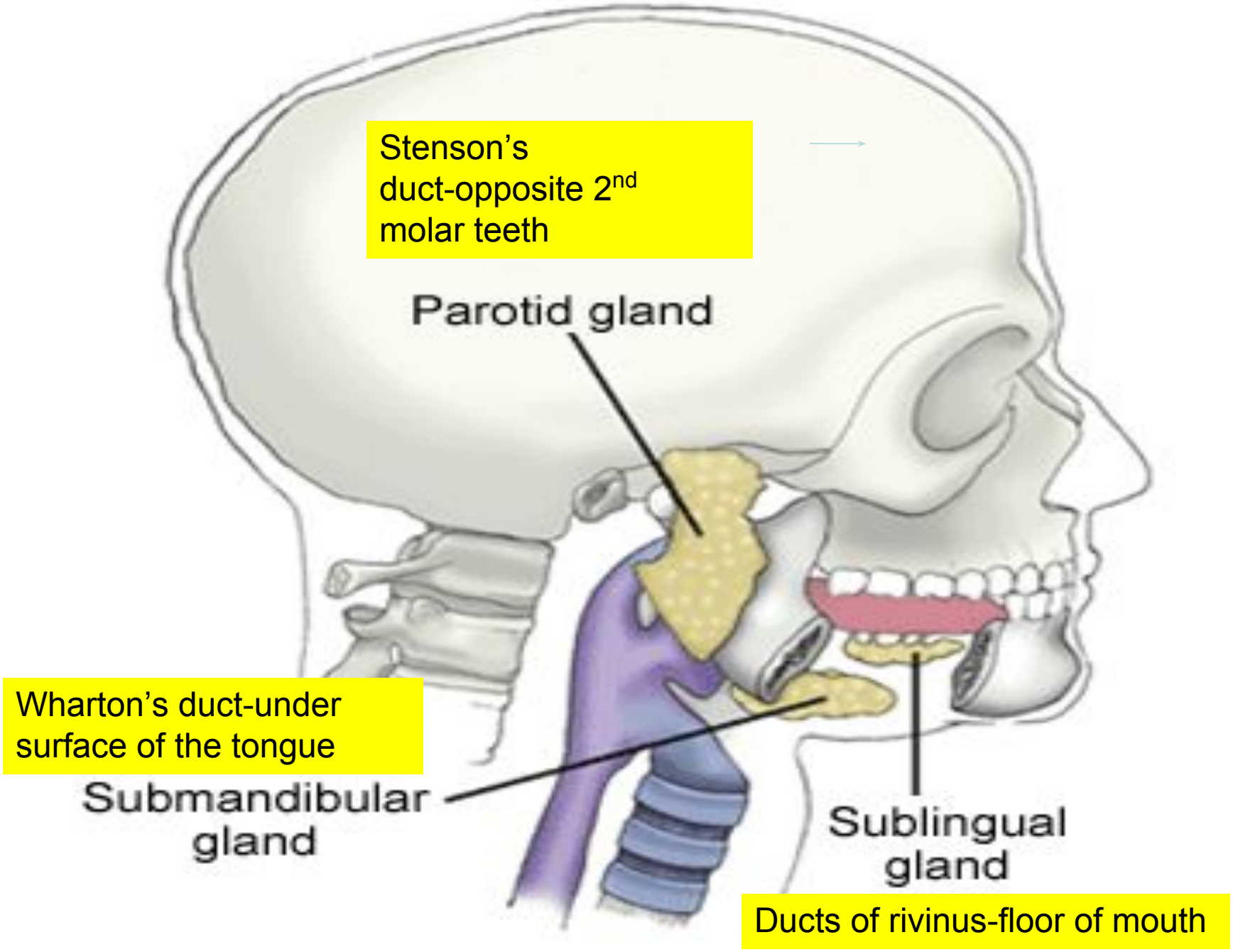
Salivary glands

- Glands are of two types:
- 1. serous type
- 2. mucus type

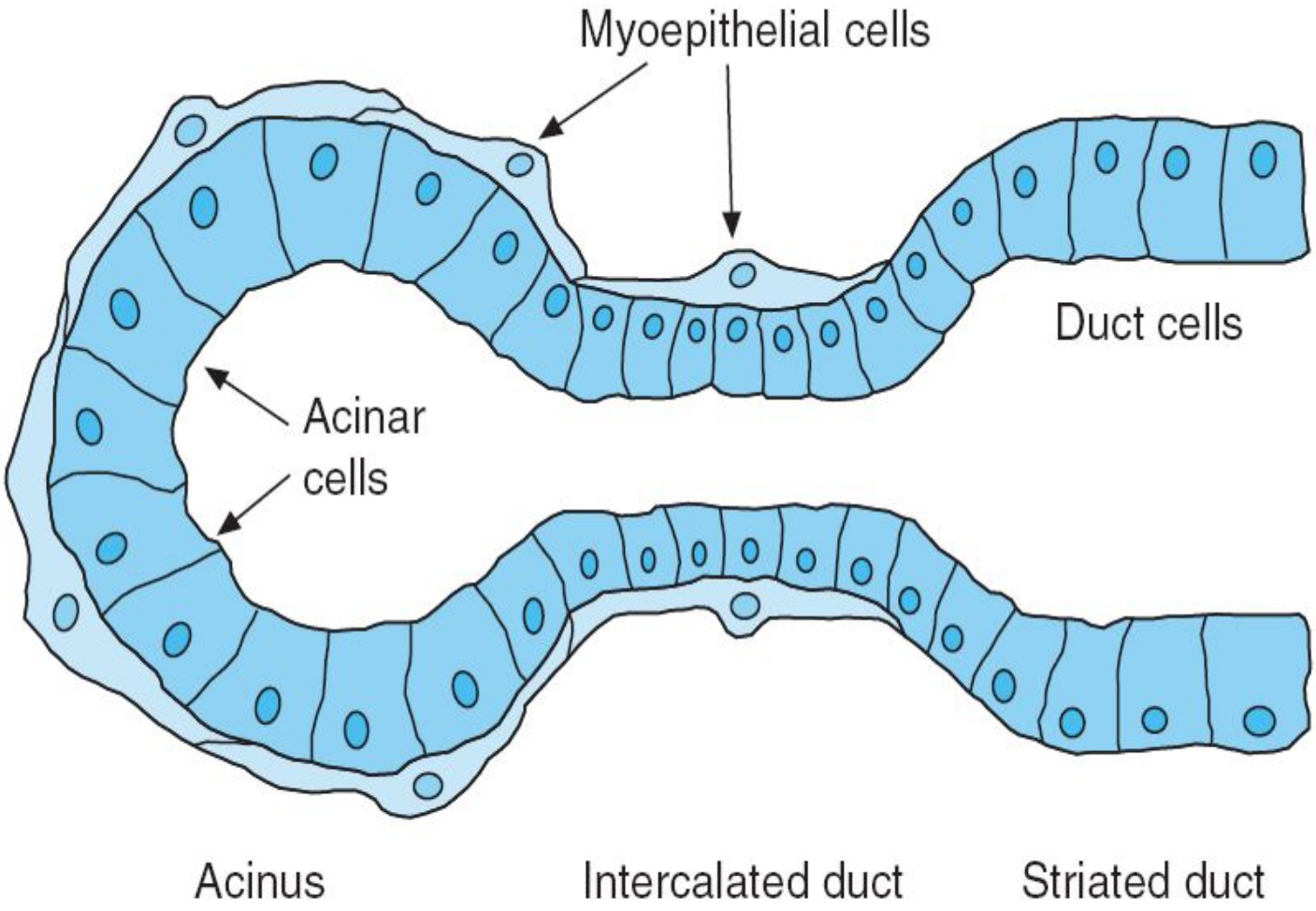
- Parotid- serous
- Submandibular gland- mixed
- Sublingual gland- mucus

- **Serous gland-**
- secretion is thin, watery.
- Poor in solid but rich in enzymes

- **Mucus glands-**
- Secretion is thick and viscid containing mucus.


Stenson's duct-opposite 2nd molar teeth
Parotid gland
Wharton's duct-under surface of the tongue
Submandibular gland
Sublingual gland
Ducts of rivinus-floor of mouth

The functional histology of the salivon, the secretory unit of the salivary glands



Mechanism of secretion

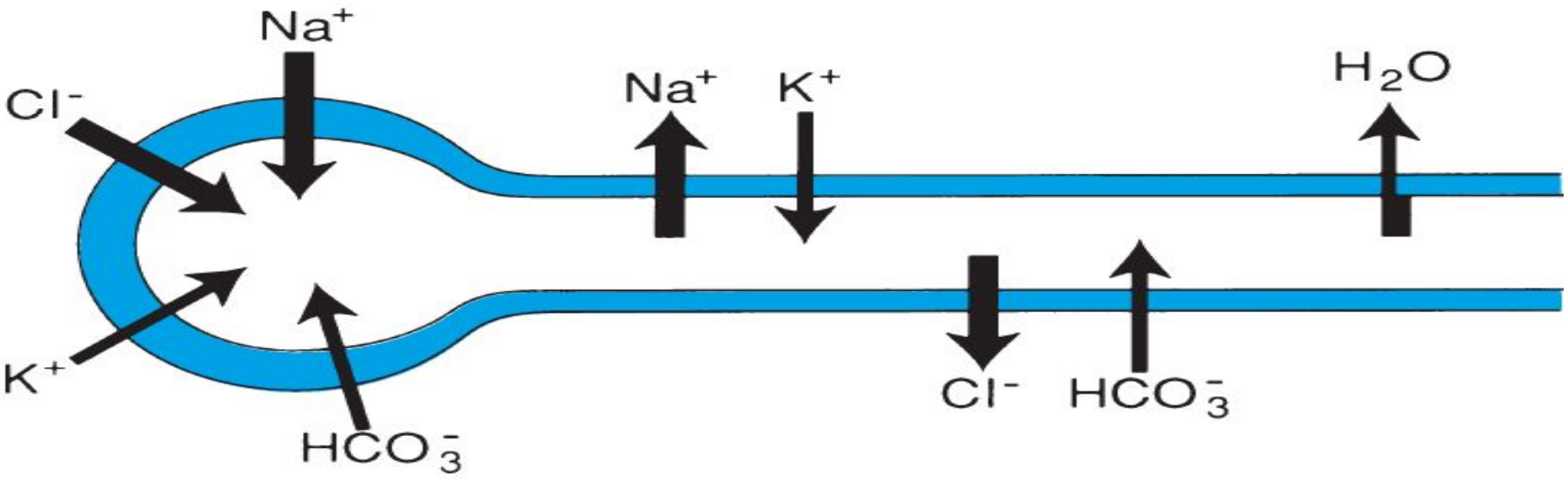
Primary secretion-

Salivary glands have racemose structure. they contain acini and ducts.

Acini secrete a primary secretion, containing ptyalin, mucin, and ions in concentration same that in plasma.

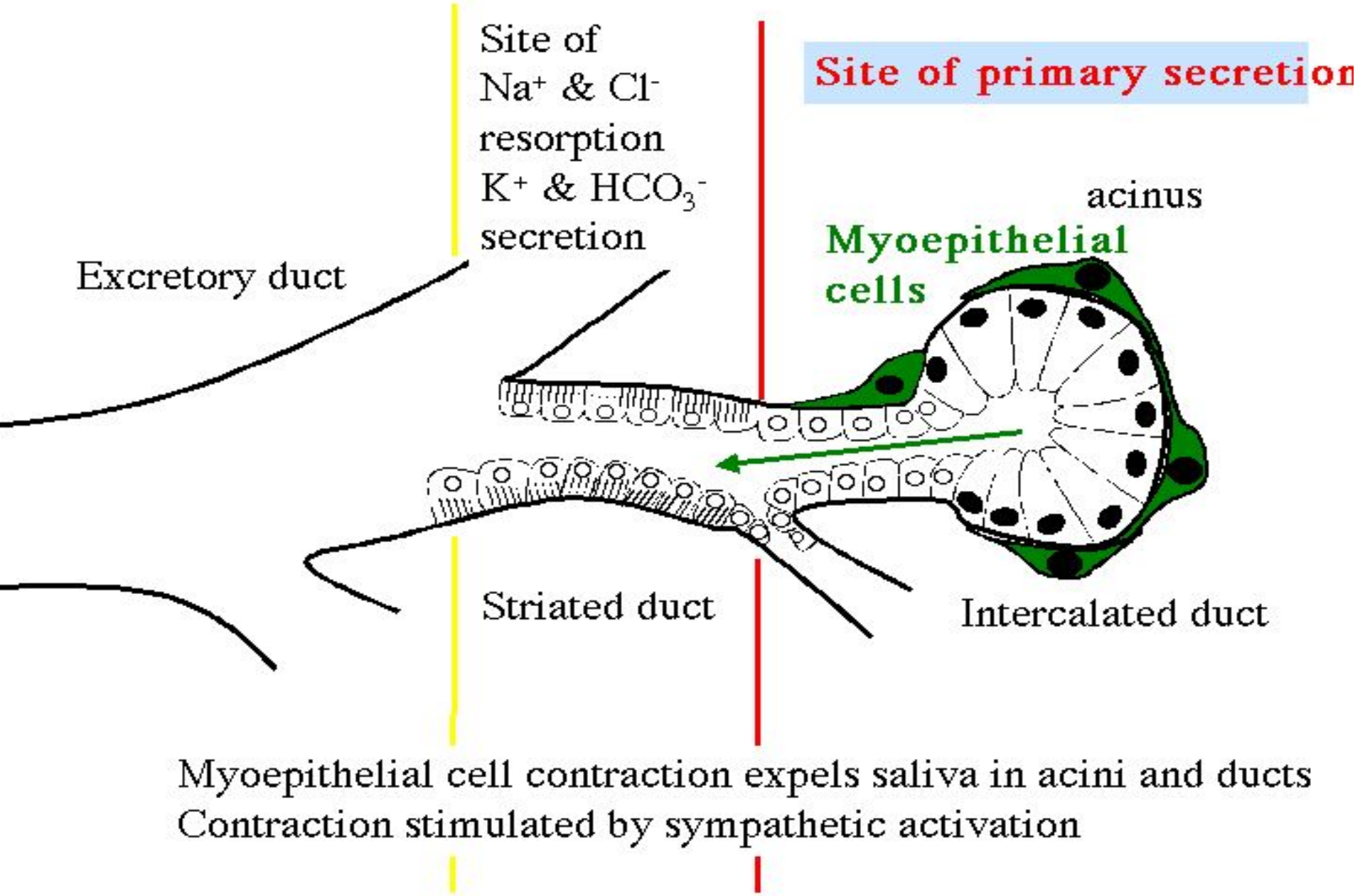
Primary secretion is isotonic.

Fluxes of the primary ions and water across the salivon. the fluid leaving the acinus is isotonic to plasma. Na+ and cl- leave the duct, and K+ and HCO3- Enter. The thickness of the arrows indicates that more Na+ and Cl- leave the Duct than K+ and HCO3- enter. Because the membrane is relatively impermeable to water, the saliva becomes hypotonic.

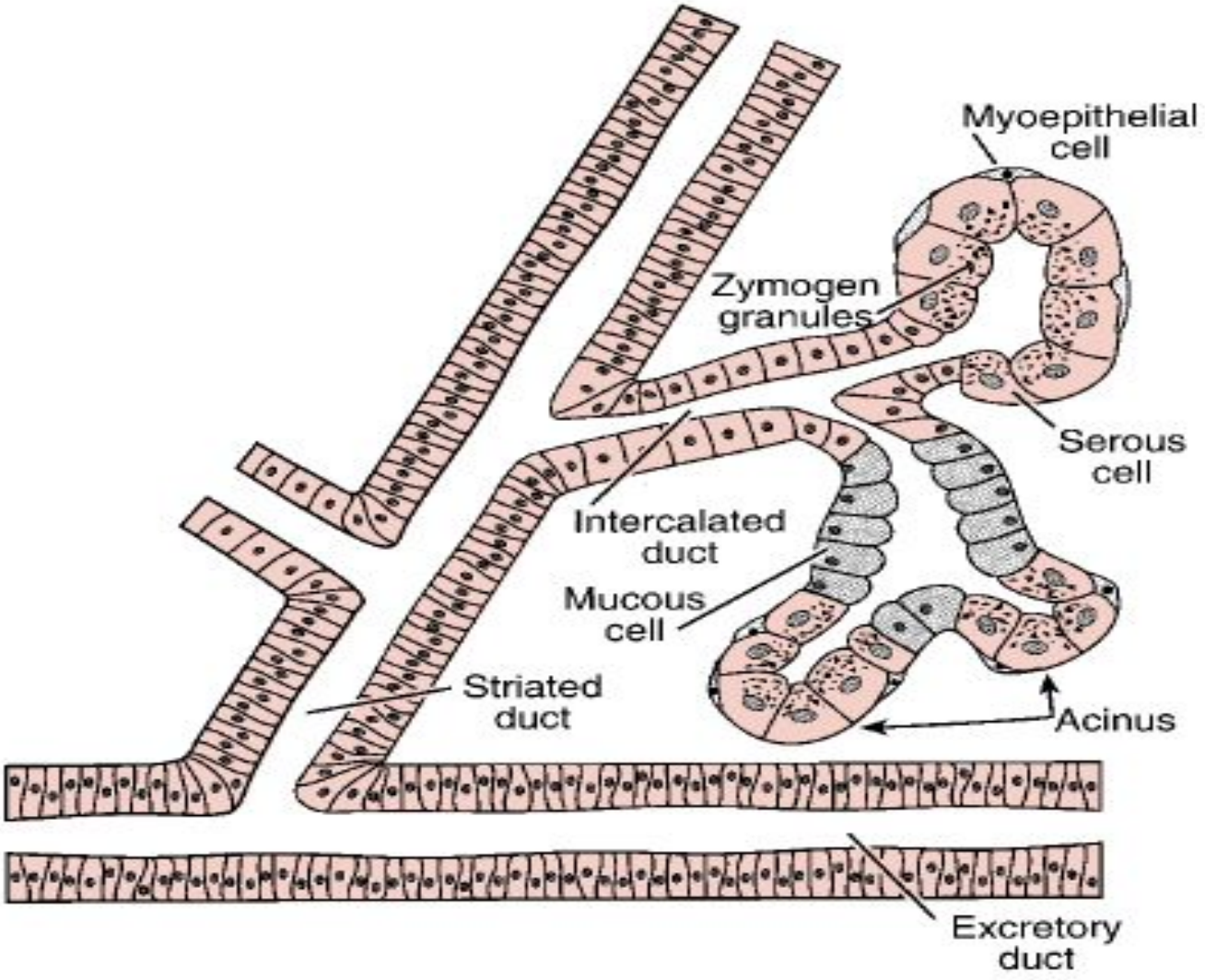


Secondary secretion

- The secretion is modified as it passes through the ducts.
- Na+ and CL- are reabsorbed –actively
- K+ and HCO3- are secreted – actively
- The epithelium of the ducts is impermeable to the water saliva remains hypotonic.(dilute relative to plasma).



Myoepithelial cell contraction expels saliva in acini and ducts
Contraction stimulated by sympathetic activation


Myoepithelial cell
Zymogen granules
Serous cell
Intercalated duct
Mucous cell
Striated duct
Acinus
Excretory duct

Composition of saliva

- **Saliva is largely water—97 to 99.5%—hypo-osmotic. Its osmolarity depends on the nature of the stimulus .**
- **As a rule, saliva is slightly acidic (pH 6.75 to 7.00), but its pH may vary.**
- **solutes include electrolytes (Na^+, K^+, Cl^-, PO_4^-, and HCO_3^-);**
- **the digestive enzyme salivary amylase;**
- **the proteins mucin , lysozyme, and IgA; and**

- **metabolic wastes (urea and uric acid).**
- **secretions of the intrinsic salivary glands contain lingual lipase, a fat-digesting enzyme that is optimally active at an acid pH.**
- **When dissolved in water, the glycoprotein mucin forms thick mucus that lubricates the oral cavity and hydrates foodstuffs.**

- Protection against microorganisms is provided by
- (1) IgA antibodies;
- (2) lysozyme, a bacteriostatic enzyme that inhibits bacterial growth in the mouth and may help to prevent tooth decay;
- (3) a cyanide compound; and
- (4) defensins. Besides acting as a local antibiotic, defensins function as cytokines to call defensive cells (lymphocytes, neutrophils, etc.) into the mouth for battle.

- **the friendly bacteria - live on the back of the tongue convert food-derived nitrates in saliva into nitrites which, in turn, are converted into nitric oxide in an acid environment.**
- **This transformation occurs around the gums, where acid-producing bacteria tend to cluster, and in the hydrochloric acid–rich secretions of the stomach.**
- **The highly toxic nitric oxide is believed to act as a bactericidal**

Organic compounds: α- amylase(ptyalin)
- lingual lipase
- kallikrein
- lysozyme
- Urea, uric acid,
- cholesterol, mucin

Inorganic compounds:

Na^+,
Cl^- -activate salivary amylase
k^+ ,
$Hco3^-$ and phosphate-buffer acidic foods

- Varies with salivary flow rate.

Under resting condition:

- Na+-- 15meq/lit
- K+--- 30meq/lit
- Hco3--- 50-70meq/lit

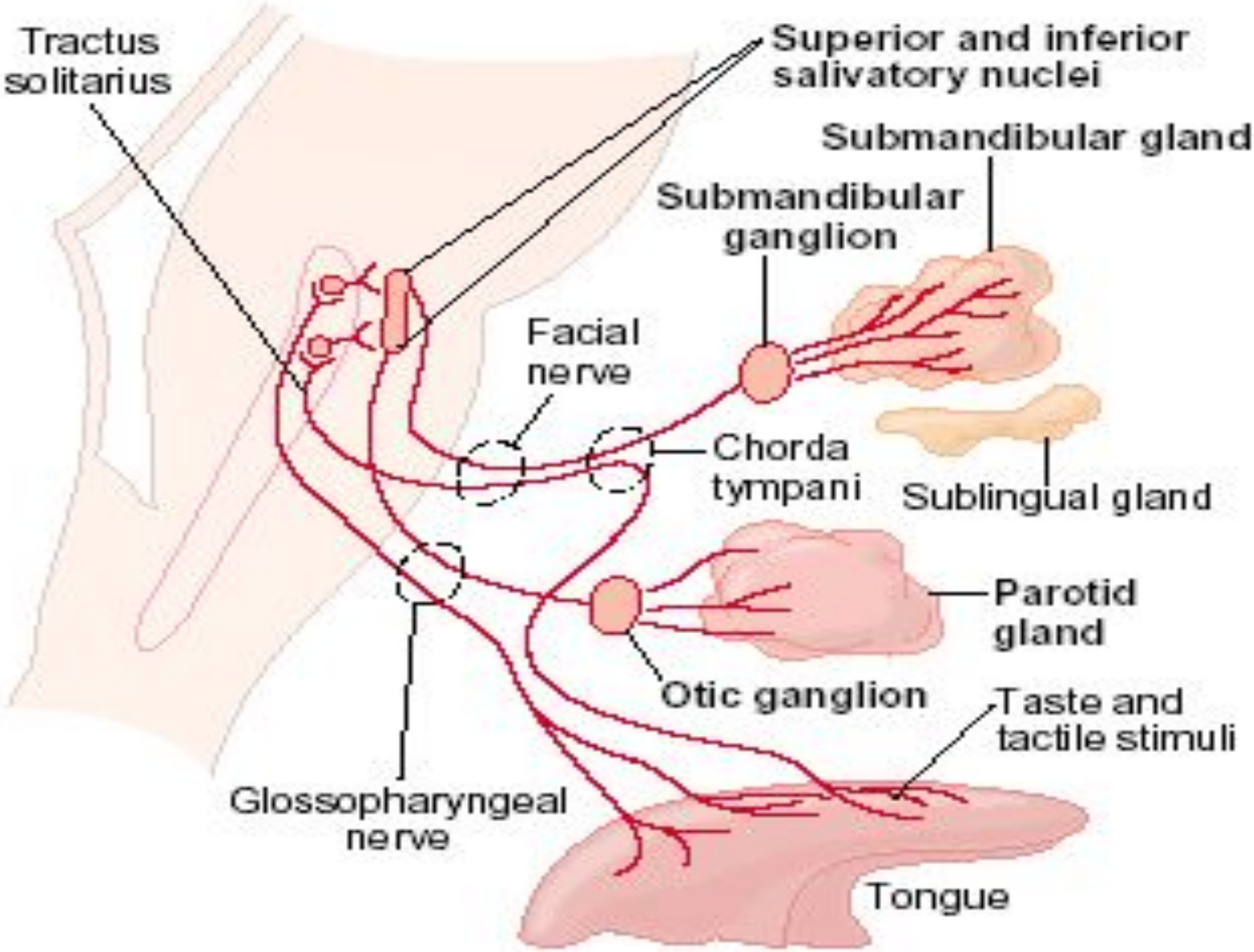
During maximum salivation:

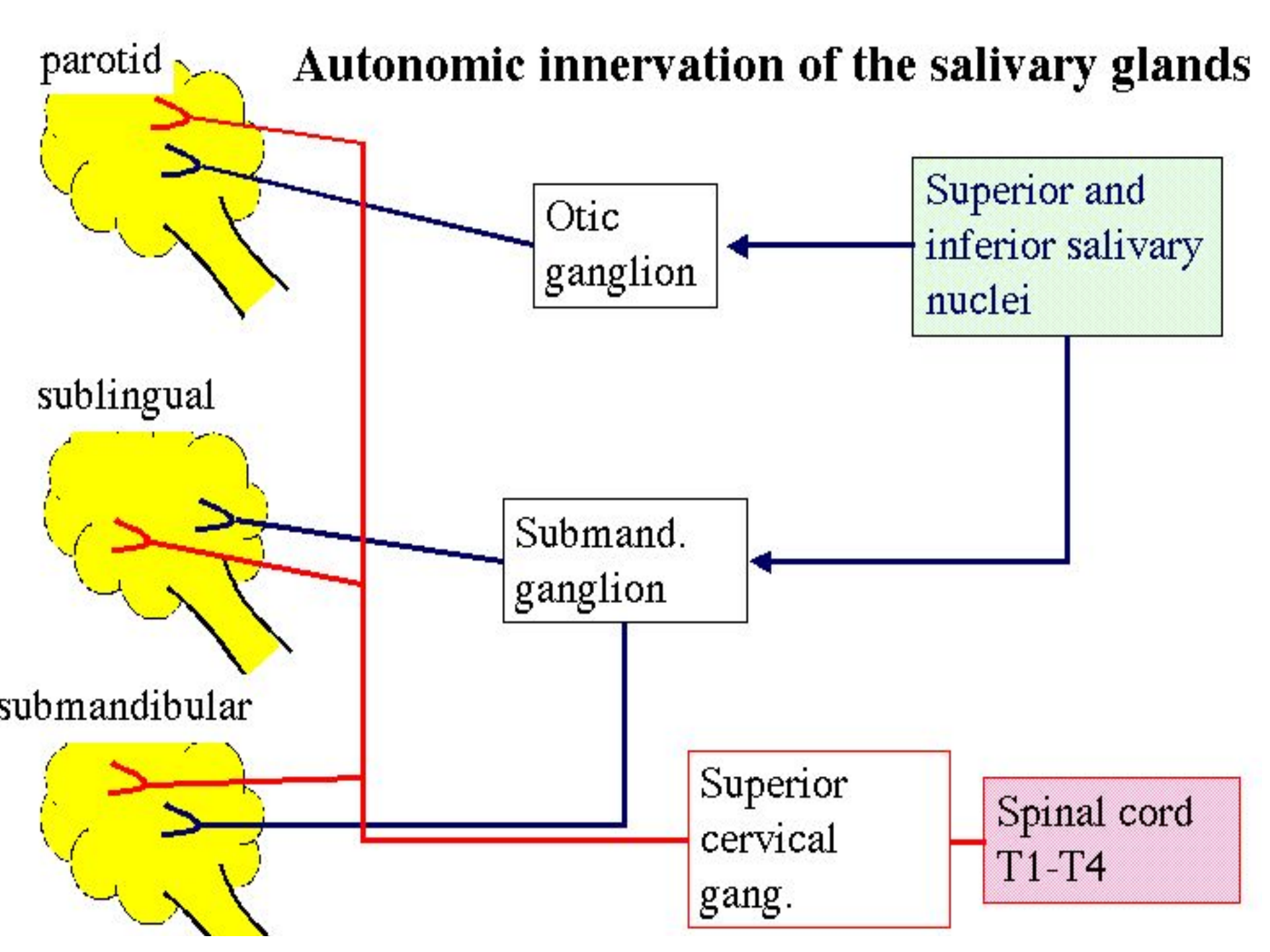
- Primary secretion increases by 20 folds
- Flow is rapid and reabsorption is less
- secretion is also rapid -Na+ &CL- rises
  - K+ decreases
- Aldosterone-

increased reabsorption of Na+ and Cl-

Innervations of salivary glands

- **The salivary glands are innervated by both the divisions of ANS:**
- **sympathetic and parasympathetic**


Tractus solitarius
Superior and inferior salivatory nuclei
Submandibular gland
Submandibular ganglion
Facial nerve
Chorda tympani
Sublingual gland
Parotid gland
Otic ganglion
Taste and tactile stimuli
Glossopharyngeal nerve
Tongue


Autonomic innervation of the salivary glands
parotid
sublingual
submandibular
Otic ganglion
Superior and inferior salivary nuclei
Submand. ganglion
Superior cervical gang.
Spinal cord T1-T4

Effects of parasympathetic and sympathetic stimulation on salivary secretion response

Response	parasympathetic	Sympathetic
Saliva output	copious	Scanty
Temporal response	sustained	transient
composition	Protein poor, high K+ and HCO3-	Protein rich, low- K+ and HCO3-
Response to denervation	Decreased secretion, atrophy	Decreased secretion

- Salivation is controlled primarily by the parasympathetic division of the autonomic nervous system.
- When we ingest food, chemoreceptors and mechanoreceptors in the mouth send signals to the salivatory nuclei in the brain stem (pons and medulla).
- As a result, parasympathetic nervous system activity increases and impulses sent via motor fibers in the facial (VII) and glossopharyngeal (IX) nerves trigger a dramatically increased output of watery (serous), enzyme-rich saliva.
- The chemoreceptors are activated most strongly by acidic substances such as vinegar and citrus juice. The mechanoreceptors are activated by virtually any mechanical stimulus in the mouth—even rubber bands.

- Sometimes just the sight or smell of food is enough to get the juices flowing.
- Irritation of the lower regions of the GI tract by bacterial toxins, spicy foods, or hyperacidity—particularly when accompanied by a feeling of nausea—also increases salivation. This response may help wash away or neutralize the irritants.

  In contrast to parasympathetic controls, the sympathetic division (specifically fibers in T_1–T_3) causes release of a thick, mucin-rich saliva. Extremely strong activation of the sympathetic division constricts blood vessels serving the salivary glands and almost completely inhibits saliva release, causing a dry mouth (xerostomia). Dehydration also inhibits salivation because low blood volume results in reduced filtration pressure at capillary beds.

Applied

- Any disease process that inhibits saliva secretion causes a marked increase in dental caries (cavities) and difficulty in talking, swallowing, and eating. Because decomposing food particles are allowed to accumulate and bacteria flourish, halitosis (“bad breath”) can result.
- The odor is caused mainly by the metabolic activity of anaerobic protein-digesting bacteria at the back of the tongue that yields hydrogen sulfide (rotten egg smell), methyl mercaptan (also in feces), cadaverine (associated with rotting corpses), and others.

Regulation of salivary secretion

- It is a purely reflex phenomenon &
- Regulated by superior and inferior salivary nuclei
- They in turn stimulated or inhibited by impulses coming from higher centers.
- i.e. -appetite area in hypothelamus.
- - taste and smell centres
- - cortex

Unconditioned reflex

- It is inborn reflex– present since birth.
- Presence of food in mouth or any non-edible material stimulates salivary secretion.
- It is due to stimulation of nerve endings in the mucus membrane of the oral cavity.
- This reflex doesn't need previous experience.
- Stimuli- chewing
- - sensation of taste
- - irritation mucosa due to food.
- Acts as sensory stimuli which reflexly produce salivary secretion.

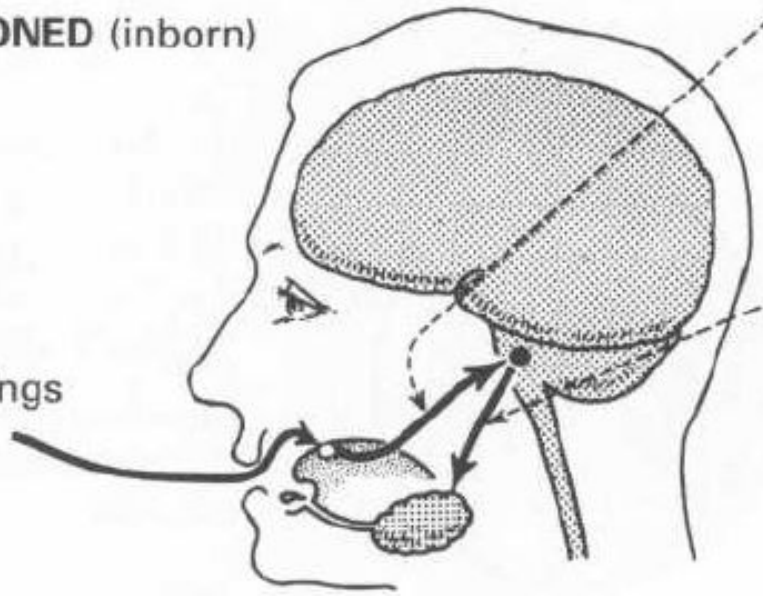
Control of salivation

- **The intrinsic salivary glands** secrete saliva continuously in amounts just sufficient to keep the mouth moist.
- **The extrinsic glands** are activated only when food enters the mouth and copious amounts of saliva pour out.
- 1000–1500 ml per day.

Control of salivary secretion

Increased secretion at meal times is **reflex** (involuntary).
Salivary reflexes are of two types:–

(a) **UNCONDITIONED** (inborn)



INGOING nerve impulses along **taste** nerves to salivary nuclei in the medulla oblongata and pons

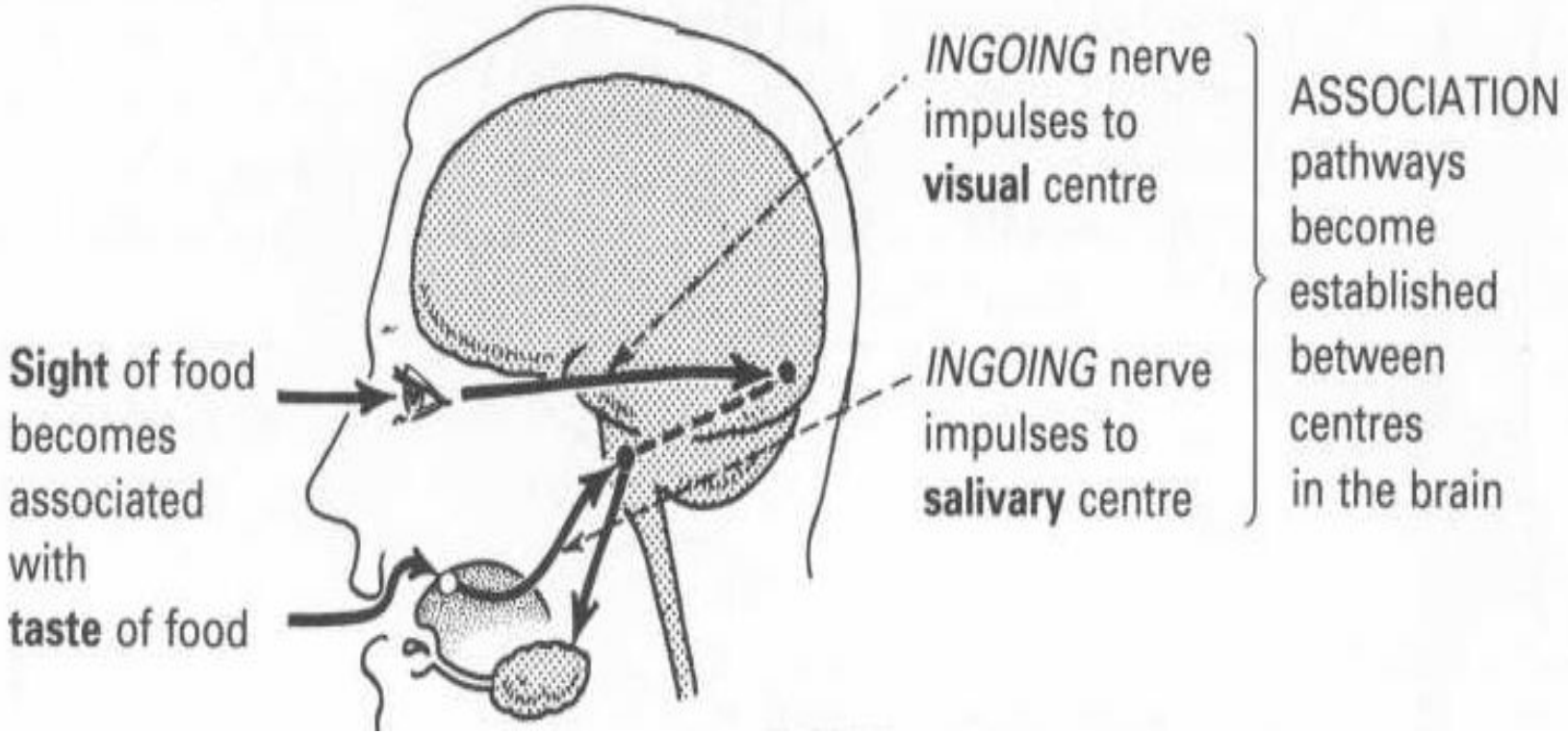
FOOD stimulates nerve endings in mouth

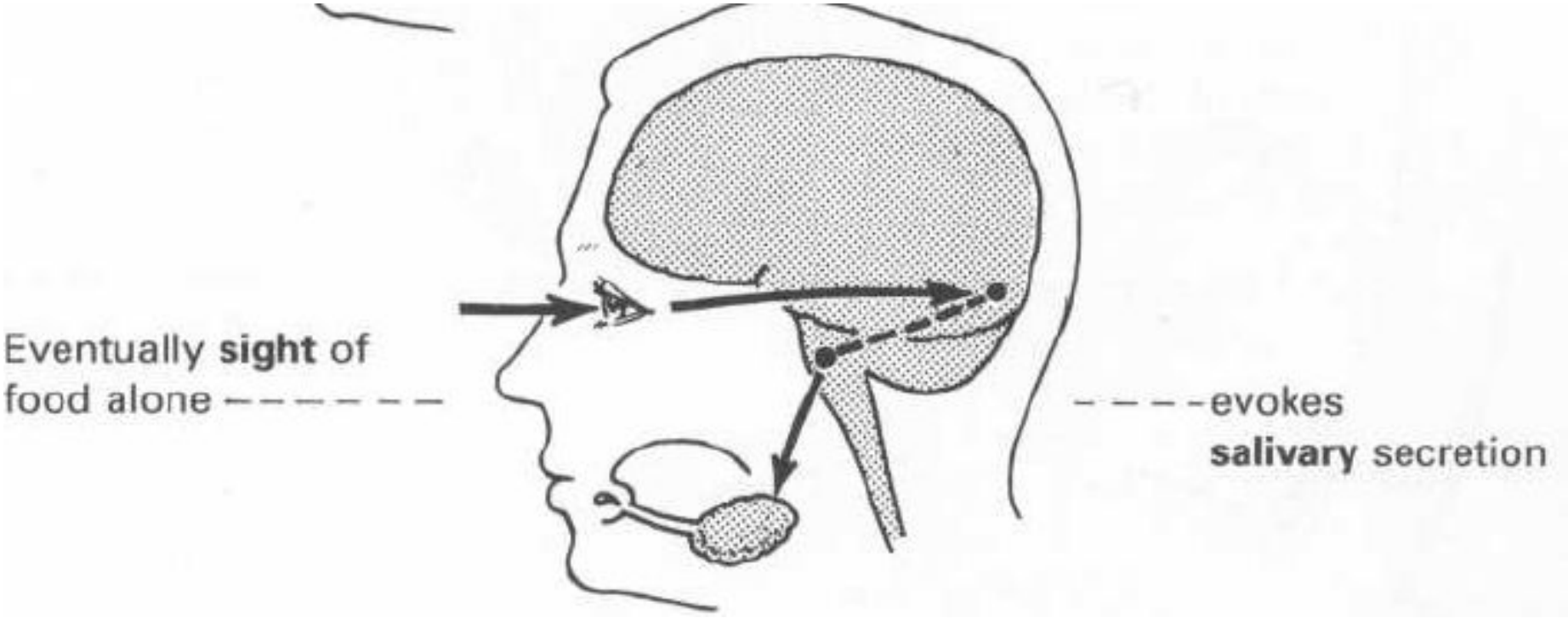
OUTGOING nerve impulses of **secretomotor** nerves from the **autonomic** nervous system to glands evoke secretion of **saliva**.

Conditioned reflex

- It is initiated when receptors in brain are stimulated by sight, smell, taste.
- Also initiated by emotional state.
- Conditioned reflex-this is not an inborn reflex but it is acquired reflex.
- It needs previous experience
- New neuronal circuit develops between receptors of special senses, cerebral cortex and salivary centers.
- First studied by russisan scientist- Ivon Pavlov.

(b) **CONDITIONED** (depend on experience)

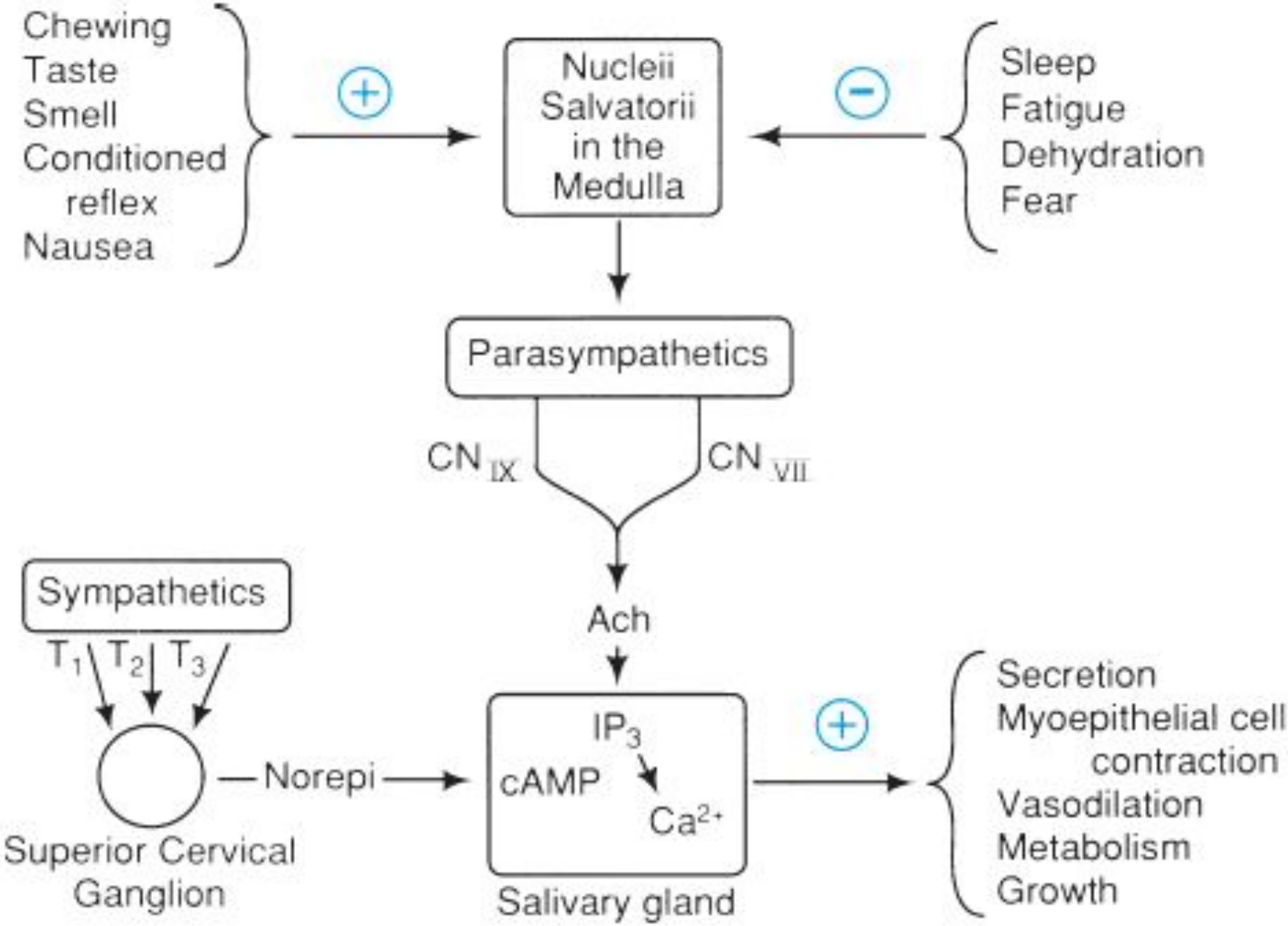




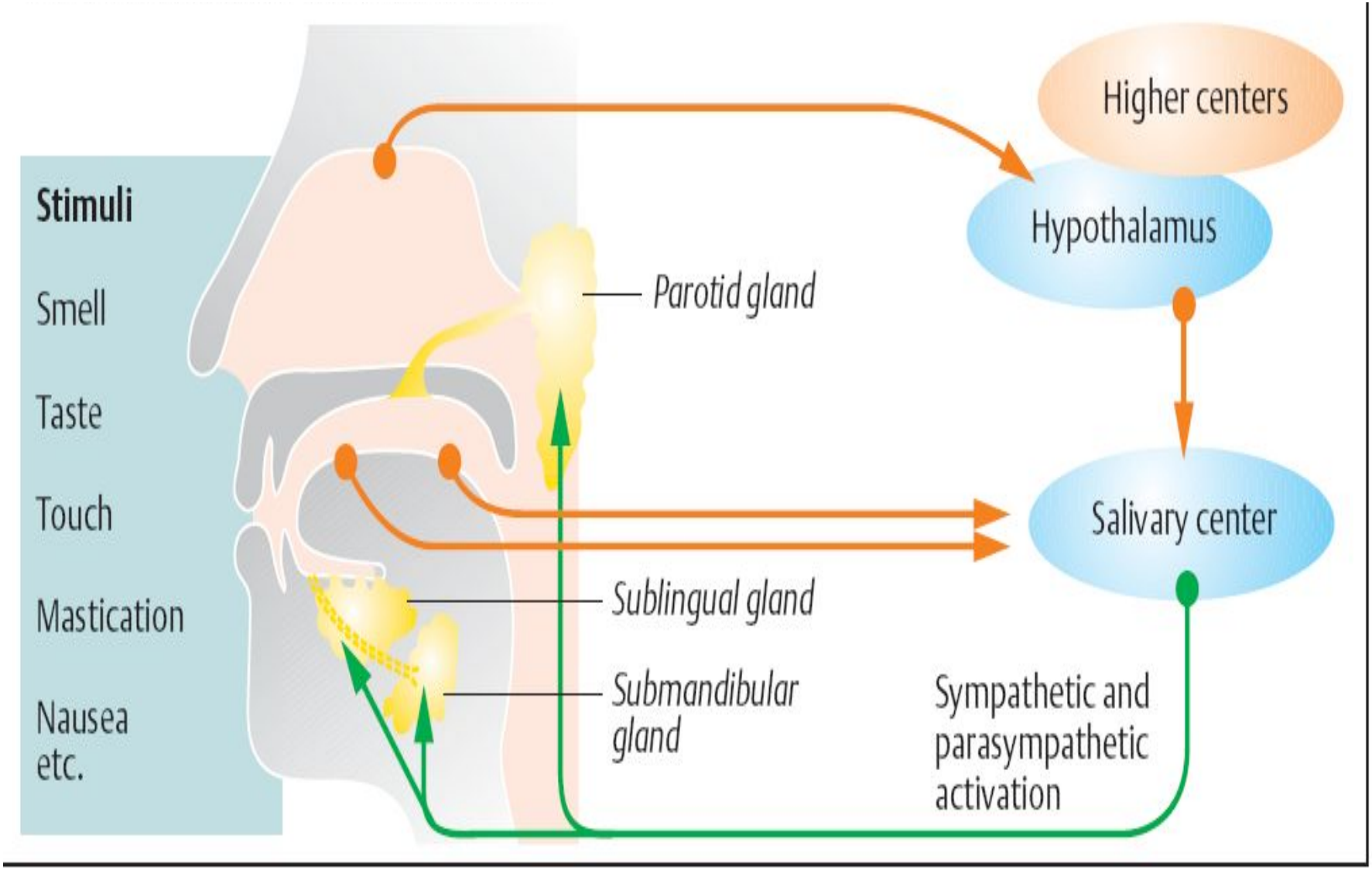
Similar conditioned reflexes are established by smell, by thought of food, and even by the sounds of its preparation.

Parasympathetic nerve releases (a) **acetylcholine** which greatly increases salivary secretion and (b) **vasoactive intestinal polypeptide (VIP)** which dilates the salivary gland blood vessels.

Sympathetic nerves cause secretion of small amounts of saliva rich in protein and glycoprotein.


Chewing
Taste
Smell
Conditioned reflex
Nausea
+
Nucleii Salvatorii in the Medulla
−
Sleep
Fatigue
Dehydration
Fear
Parasympathetics
CN IX
CN VII
Ach
Sympathetics
T1
T2
T3
Norepi
Superior Cervical Ganglion
IP3
cAMP
Ca2+
Salivary gland
+
Secretion
Myoepithelial cell contraction
Vasodilation
Metabolism
Growth

Stimulation of saliva secretion



Functions of saliva

Digestive function:

mixes with food forming bolus, assists mastication.

- **Dilute hot and irritant food substances thus preventing injury to mucous membrane of the mouth.**
- **Contain salivary amylase or Ptyalin, an enzyme that initiates chemical digestion of certain carbohydrates.**

- **Lingual lipase, initiate digestion of fat.**
- **Helps in taste sensation.**

Non digestive functions of saliva

- **Cleansing**- mouth and teeth kept free of debris.
- **Protection**- the enzyme lysozyme and antibodies act against Some bacteria
- Decrease the risk of buccal infection and dental caries and maintain oral hygiene

.

Moistening and lubricating- soft parts of mouth kept pliable for speech. Cells of Oral mucosa protected from drying.

Excretory-many organic substances(urea, sugar) and inorganic substances(e.g. mercury, lead, thiocynate ions) can be excreted in saliva

Regulation of water- produce the sensation of thirst

Applied physiology

- 1. hypo secretion-
- obstruction of salivary duct,
- congenital absence of salivary glands,
- paralysis of facial nerve.

- 2. hyper secretion (sialorrhea)-
- Nausea
- vomiting

Applied

- **3.chorda tympani syndrome-**
- **fibers misdirected and joins the sweat glands.**

- **4. paralytic secretion of saliva.-**
- **increased sensitivity of salivary glands to adrenaline.**

Applied or clinical physiology

- Sialadenitis
- Sialolithiasis
- Sjogrens syndrome

Phases of salivary secretion

1. cephalic phase.
2. Buccal phase
3. Oesophageal phase
4. Gastric phase
5. Intestinal phase

THANK YOU