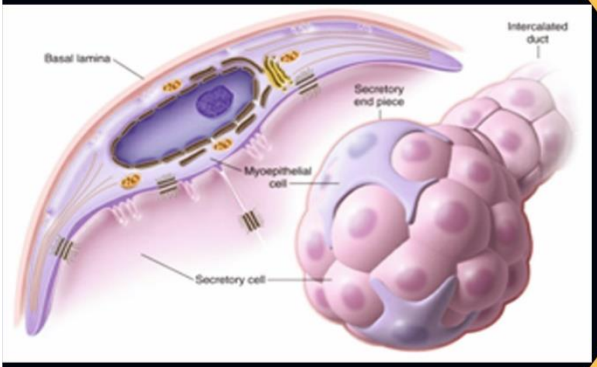
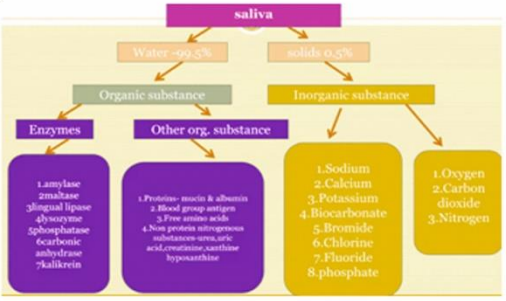
MALLA REDDY INSTITUTE OF DENTAL SCIENCES

SALIVA

By Faculty
Malla Reddy Institute of Dental Sciences





SALIVA

(2020-2021)

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Reader

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PREFACE

Saliva, often referred to as the "guardian of the oral cavity," is a fluid of remarkable complexity and versatility, playing a crucial role in maintaining oral health and overall well-being. Despite its humble appearance, saliva is a dynamic biological fluid with multifaceted functions that extend far beyond mere lubrication. Its composition, flow dynamics, and biochemical properties contribute to a myriad of physiological processes, ranging from digestion and taste perception to oral immunity and microbial homeostasis.

This work delves into the fascinating world of saliva, exploring its diverse roles, mechanisms of action, and clinical implications. Drawing upon the collective expertise of researchers, clinicians, and allied health professionals, we aim to unravel the intricacies of saliva and its significance in oral and systemic health.

Acknowledgement

The completion of this work on saliva has been made possible through the generous support, collaboration, and contributions of numerous individuals and organizations, whose dedication and expertise have enriched its content and scope.

First and foremost, we extend our heartfelt appreciation to the individuals who generously participated in saliva sampling and research studies. Their willingness to donate their time and biological samples has been instrumental in advancing our understanding of saliva and its myriad functions.

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CHAPTER 1
INTRODUCTION TO SALIVA

INTRODUCTION

The oral avity is a moist environment; a film of fluid called saliva constantly coats its inner surfaces and occupies the space between the lining oral mucosa and teeth. Saliva is a complex fluid, produced by the salivary glands, whose important role is maintaining the wellbeing of mouth. Human saliva consist of organic and inorganic components and plays an essential role in mastication, in bolus formation, acts as a lubricant in swallowing, helps in speech production and protecting the mucosal surfaces of the oral cavity from desiccation.

The enzymes found in saliva are essential in beginning the process of digestion of dietary starches and fat.
Saliva circulating in mouth at any given time is termed "whole saliva". ϖ Saliva reflects the physiological state of body including emotional endocrinal nutrional and metabolic variations also known as "THE BODY'S MIRROR"

According to Stedmen's Dictionary

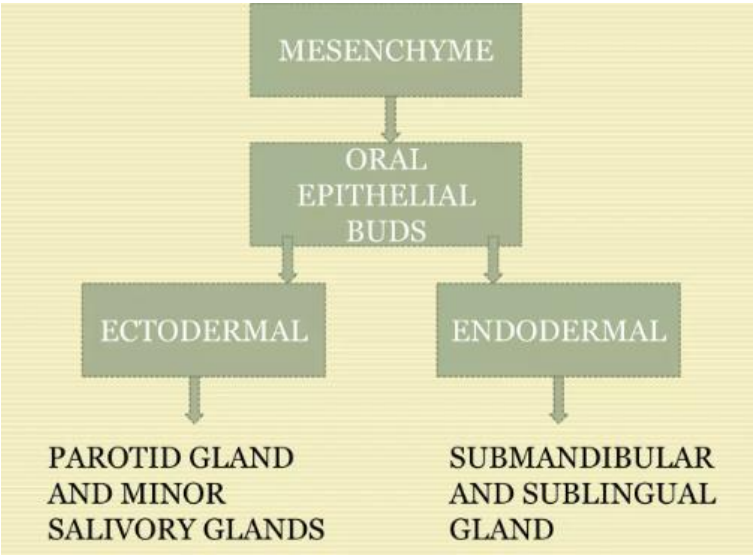
Saliva is a clear, tasteless, odourless slightly acidic (pH6.8), viscid fluid, consisting of secretions from the parotid,

sublingual and submandibular salivary gland and the mucous glands of the oral cavity.

According to Webster Medical Dictionary

The watery tasteless liquid mixture of salivary & oral mucous glands secretion that lubricates the chewing food , wets the oral wall & contains the enzyme ptyalin which function in the pre-digestion of starch.

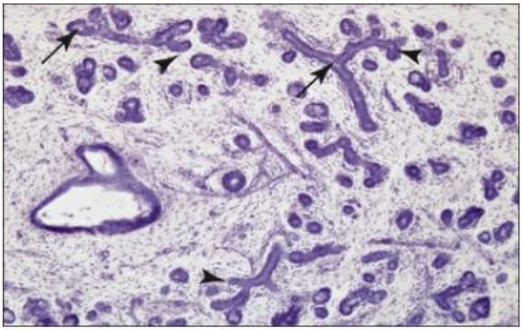
DEVELOPMENT OF SALIVARY GLANDS



- Similar to teeth, the individual salivary glands arise as a proliferation of oral epithelial cells, forming a focal thickening that grows into the underlying ectomesenchyme.
- Continued growth results in the formation of a small bud connected to the surface by a trailing cord of epithelial cells, with mesenchymal cells condensing around the bud
- Clefts develop in the bud, forming two or more new buds; continuation of this process, called branching morphogenesis, produces successive generations of buds and a hierarchic ramification of the gland.
- The development of a lumen within the branched epithelium generally occurs in this order: (1) in the

distal end of the main cord and in branch cords, (2) in the proximal end of the main cord, and (3) in the central portion of the main cord

- After development of the lumen in the terminal buds, the epithelium consists of two layers of cells. The cells of the inner layer eventually differentiate into the secretory cells of the mature gland, mucous or serous, depending on the specific gland.
- Some cells of the outer layer form the contractile myoepithelial cells that are present around the secretory end pieces and intercalated ducts.
- As the epithelial parenchymal components increase in size and number, the associated mesenchyme (connective tissue) is diminished, although a thin layer of connective tissue remains, surrounding each secretory end piece and duct of the adult gland.
- Thicker partitions of connective tissue (septa), continuous with the capsule and within which run the nerves and blood vessels supplying the gland, invest the excretory ducts and divide the gland into lobes and lobules



LUMEN FORMATION

SALIVARY GLAND	DEVLOPMENT
PAROTID GLAND	4-6WEEKS
SUBMANDIBULAR GLAND	6 WEEKS
SUBLINGUAL GLAND	8-12 WEEKS

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CHAPTER **2**

STRUCTURE OF SALIVARY GLAND

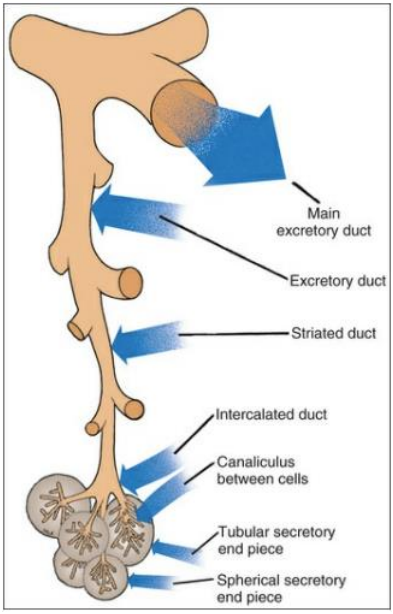
An analogy can be made to a bunch of grapes, with the stems representing the ducts and the grapes corresponding to the secretory end pieces.

The main excretory duct, which empties into the oral cavity, divides into progressively smaller interlobar and intralobular excretory ducts that enter the lobes and lobules of the gland.

The predominant intralobular ductal component is the striated duct, which plays a major role in modification of the primary saliva produced by the secretory end pieces.

Connecting the striated ducts to the secretory end pieces are intercalated ducts, which branch once or twice before joining individual end pieces. The lumen of the end piece is continuous with that of the intercalated duct.

In some glands small extensions of the lumen, intercellular canaliculi, are found between adjacent secretory cells



SECRETORY CELLS

The two main types of secretory cells present in salivary glands are serous cells and mucous cells. Serous and mucous cells differ in structure and in the types of macromolecular components that they produce and secrete.

SEROUS CELLS

Secretory end pieces that are composed of serous cells are typically spherical and consist of 8 to 12 cells surrounding a central lumen.

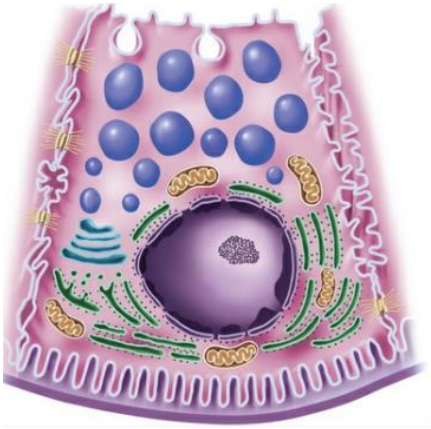
The cells are pyramidal, with a broad base adjacent to the connective tissue stroma and a narrow apex forming part of the lumen of the end piece.

The lumen usually has finger-like extensions located between adjacent cells called intercellular canaliculi that increase the size of the luminal surface of the cells. The spherical nuclei are located basally, and occasionally, binucleated cells are seen.

Numerous secretory granules, in which the macromolecular components of saliva are stored, are present in the apical cytoplasm

The granules may have a variable appearance, ranging from homogeneously electrondense to a combination of electron-dense and electron-lucent regions arranged in intricate patterns.

The basal cytoplasm contains numerous cisternae of rough endoplasmic reticulum, which converge on a large Golgi complex located just apical or lateral to the nucleus



MUCOUS CELLS

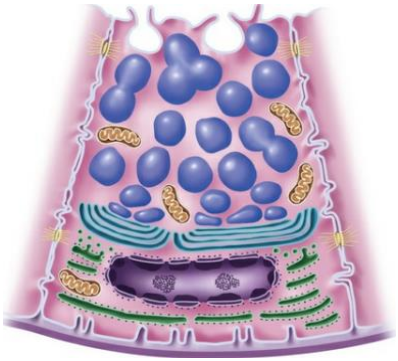
Secretory end pieces that are composed of mucous cells typically have a tubular configuration; when cut in cross section, these tubules appear as round profiles with mucous cells surrounding a central lumen of larger size than that of serous end pieces.

Mucous end pieces in the major salivary glands and some minor salivary glands have serous cells associated with them in the form of a demilune or crescent covering the mucous cells at the end of the tubule.

These serous demilune cells are in all respects similar to the serous end-piece cells present in the same gland.

Their secretions reach the lumen of the end piece through intercellular canaliculi extending between the mucous cells at the end of the tubule.

Mucous cells have a large Golgi complex, located mainly basal to the mass of secretory granules. Small granules form at the trans face of the Golgi complex, increase in size, and join the rest of the granules stored in the apical cytoplasm.



The endoplasmic reticulum and most of the other organelles are limited mainly to the basal cytoplasm of the cell

MYOEPITHELIAL CELLS

Myoepithelial cells are contractile cells associated with the secretory end pieces and intercalated ducts of the salivary glands

These cells are located between the basal lamina and the secretory or duct cells and are joined to the cells by desmosomes.

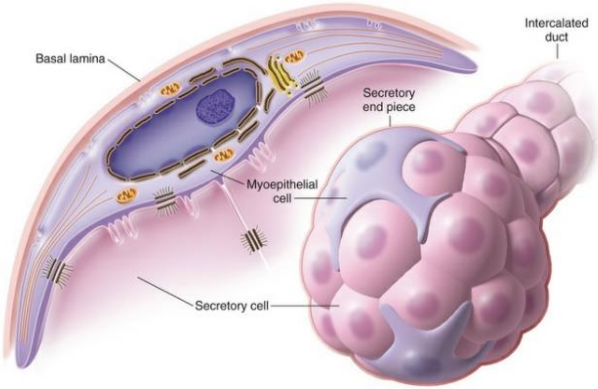
Myoepithelial cells have many similarities to smooth muscle cells but are derived from epithelium.

Myoepithelial cells present around the secretory end pieces have a stellate shape; numerous branching processes extend from the cell body to surround and embrace the end piece.

The processes are filled with filaments of actin and soluble myosin

The cell membrane has numerous caveolae, which presumably function in initiating contraction. Most of the other cellular organelles are located in the perinuclear cytoplasm.

Myoepithelial cells associated with the intercalated ducts have a more fusiform shape with fewer processes and tend to be oriented lengthwise along the duct.



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CHAPTER **3**

SALIVARY DUCTS

INTERCALATED DUCTS

The primary saliva produced by the secretory end pieces passes first through the intercalated ducts.

The first cells of the intercalated duct are directly adjacent to the secretory cells of the end piece, and the lumen of the end piece is continuous with the lumen of the intercalated duct.

The intercalated ducts are lined by a simple cuboidal epithelium, and myoepithelial cell bodies and their processes typically are located along the basal surface of the duct.

The overall diameter of the intercalated ducts is smaller than that of the end pieces, and their lumina are larger than those of the end pieces. Several ducts draining individual end pieces join to form larger intercalated ducts, and these may join again before emptying into the striated ducts. The length of the intercalated ducts in the different major and minor salivary glands varies.

The intercalated duct cells have centrally placed nuclei and a small amount of cytoplasm containing some rough endoplasmic reticulum and a small Golgi complex

A few small secretory granules may be found in the apical cytoplasm, especially in cells located near the end pieces.



STRAITED DUCTS

The striated ducts, which receive the primary saliva from the intercalated ducts, constitute the largest portion of the duct

system. These ducts are the main ductal component located within the lobules of the gland, that is, intralobular

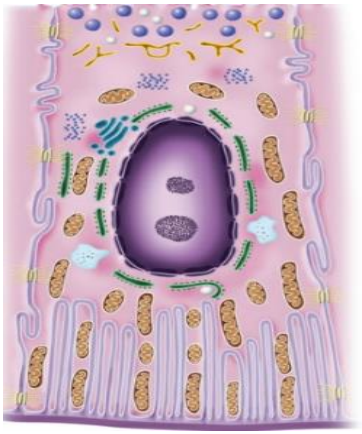
Striated duct cells are columnar, with a centrally placed nucleus and pale, acidophilic cytoplasm

In well-preserved tissue, faint radially oriented lines or striations may be observed in the basal cytoplasm of the ducts.

The overall diameter of the duct is greater than that of the secretory end pieces, and the lumen is larger than those of the secretory end pieces and intercalated ducts.

A basal lamina encloses the striated duct, and a capillary plexus is present in the surrounding connective tissue.

The structure of the duct cells reflects an important function of these cells, which is the modification of the primary saliva by reabsorption and secretion of electrolytes.



EXCRETORY DUCT

The excretory ducts are located in the connective tissue septa between the lobules of the gland, that is, in an extralobular or interlobular location.

These ducts are larger in diameter than striated ducts and typically have a pseudostratified epithelium with columnar cells extending from the basal lamina to the ductal lumen and small basal cells that sit on the basal lamina but do not reach the lumen.

As the smaller ducts join to form larger excretory ducts, the number of basal cells increases, and scattered mucous (goblet) cells may be present.

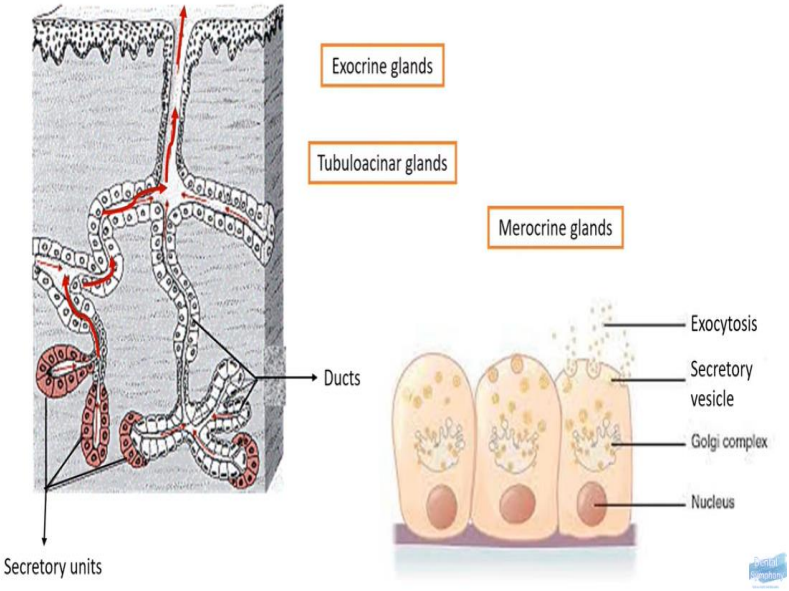
The epithelium of the main excretory duct may become stratified near the oral opening.

In the smaller excretory ducts the structure of the columnar cells is similar to that of the striated duct cells.

As the ducts increase in size, the number of mitochondria and the extent of infolding of the basolateral membranes decrease. The basal cells have numerous bundles of intermediate filaments (tonofilaments) and are attached to the basal lamina by prominent hemidesmosomes.

In some instances, basal cells may contain abundant actin filaments and have elongated processes similar to myoepithelial cells. Studies in experimental animals suggest that the columnar cells and the basal cells have a high rate of proliferation.

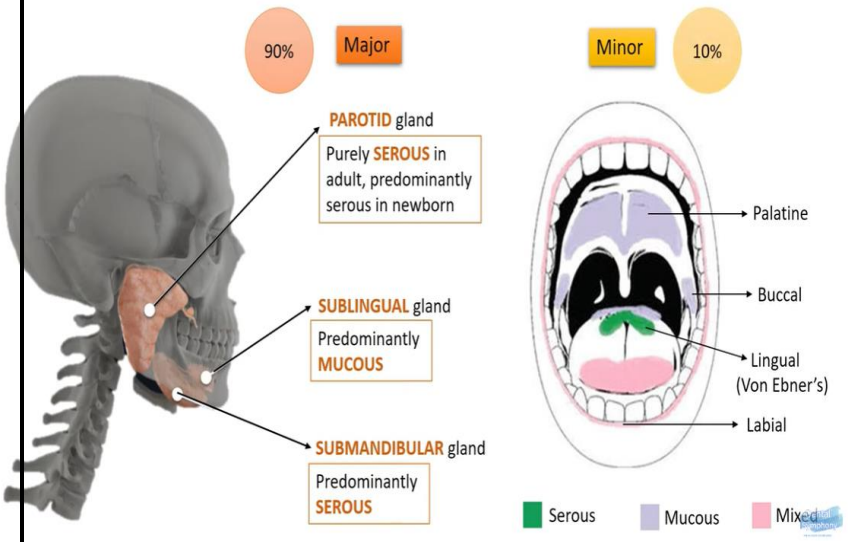
SALIVARY GLANDS



CLASSIFICATION OF SALIVARY GLANDS

BASED ON SIZE AND LOCATION

1) Major salivary glands



2) Minor salivary glands

BASED ON TYPE OF SECRETORYCELLS

1) Serous
2) Mucous
3) Mixed

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CHAPTER **4**

PAROTID GLAND

Largest gland

Purely serous

- WEIGHT: 15gms
- SHAPE: Pyramidal

- EXTENT:

1. Superiorly: to zygomatic arch
2. Inferiorly: to angle of mandible
3. Anteriorly: to overlap posterior border of masseter
4. Posteriorly: to overlap anterior border of sternomastoid

EXTERNAL FEATURES

FOUR SURFACES

- Superior (base of the pyramid)
- Superficial
- Anteromedial

- Posteromedial

Separated by three borders

- Anterior
- Posterior
- Medial

RELATIONS

SUPERIOR SURFACE

Concave

- Cartilaginous part of external acoustic meatus
- Posterior aspect of TMJ
- Auriculotemporal nerve
- Superior temporal vessels

APEX

Overlaps posterior belly of digastric and adhoining part of carotid triangle

SUPERFICIAL SURFACE

Covered by

- Skin
- Superficial fascia containing facial
- branches of great auricular nerve
- Superficial parotid lymph nodes and post fibres of platysma

ANTEROMEDIAL SURFACE

Grooved by posterior border of ramus of mandible

- Masseter
- Lateral surface of TMJ
- Medial pterygoid muscles
- Emerging branches of facial nerve

POSTEROMEDIAL SURFACE

- Mastoid process with sternomastoid and posterior belly of digastric
- Styloid process
- External carotid artery
- Internal carotid artery

BORDERS

ANTERIOR BORDER

Separates superficial surface from anteromedial surface

Structures emerging at the border

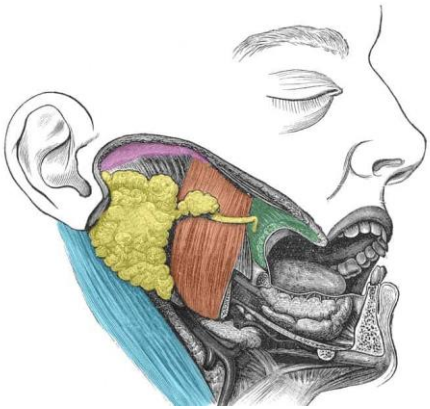
- Parotid duct
- Terminal branch of facial nerve
- Transverse facial vessels

POSTERIOR BORDER

- Separate superficial surface from posteromedial surface
- Overlaps sternomastoid

MEDIAL BORDER

- Separates anteromedial and posteromedial surfaces
- Related to lateral wallof larynx



Parotid gland and duct
Zygomatic arch (superior border)
Sternocleidomastoid (posterior border)
Masseter (anterior border)
Buccinator

SUBDIVISIONS:

1. Main gland
2. Accessory gland: above parotid duct

- CAPSULE:

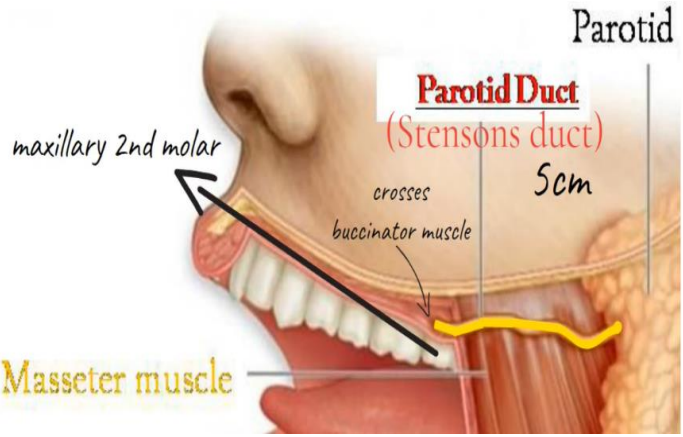
1. Derived from deep fascia of neck (cervical fascia)
2. Its superficial layer is attached to zygomatic arch & extends to cover masseter
3. Its deep layer is attached to mandible, styloid & mastoid processes
4. A thickening of deep fascia extends from styloid process to angle of mandible (stylomandibular

ligament) & separates the capsule of parotid from that of submandibular gland

PAROTID DUCT

Also called as Stenson's duct

5cm long



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CHAPTER **5**

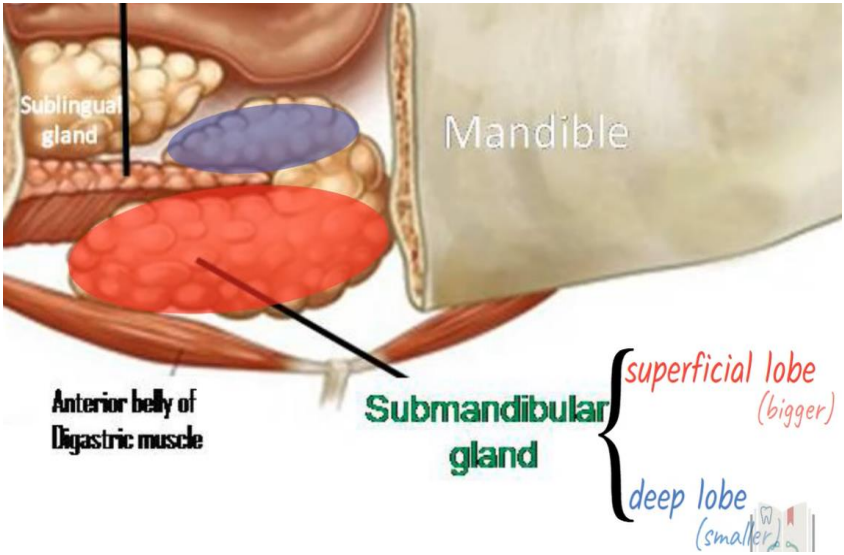
SUBMANDIBULAR GLAND

The submandibular gland is the second largest of the three main salivary glands, which also include the parotid and sublingual glands. The submandibular glands are paired major salivary glands that lie in the submandibular triangle. The glands have a superficial and deep lobe separated by the mylohyoid muscle

The Wharton duct, the submandibular gland's primary excretory duct, drains into the oral cavity at the sublingual caruncle. The sublingual caruncle is a papilla located medial to the sublingual gland and lateral to each side of the frenulum linguae

The submandibular gland is the second largest salivary gland (only the parotid gland is larger). The submandibular gland is in the posterior portion of the submandibular triangle, which is formed by the body of the mandible superiorly, the anterior belly of the digastric muscle medially, and the posterior belly of the digastric muscle inferiorly and laterally.

The submandibular gland is surrounded by a capsule, which is a part of the superficial layer of the deep cervical fascia. Similar to the parotid gland, the submandibular gland subdivides into superficial and deep lobes, which are separated by the mylohyoid muscle. The superficial lobe is larger and lies beneath the deep cervical fascia



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CHAPTER **6**

SUBLINGUAL GLAND

The sublingual gland is the smallest of the three major salivary glands which also include the parotid and submandibular glands.

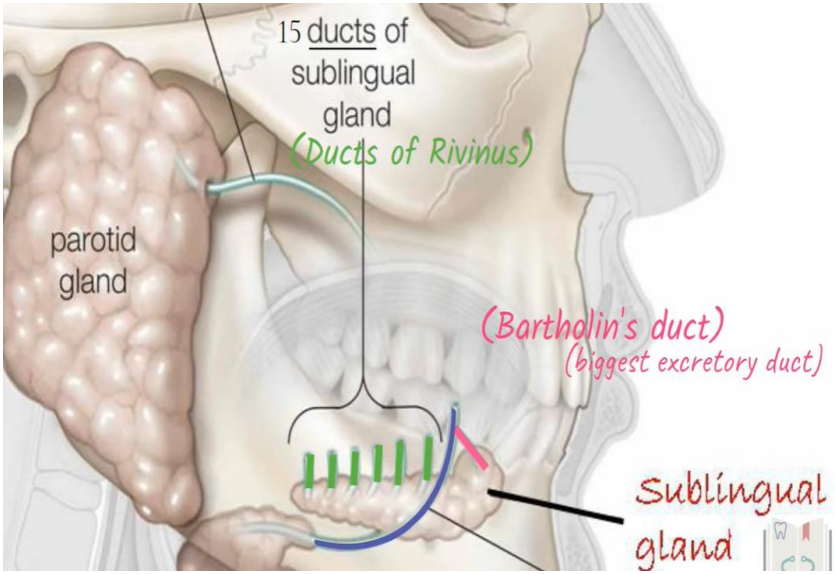
The sublingual gland lies between the muscles of the floor of the oral cavity, which include the geniohyoid muscle, hyoglossus muscle medially, and the mylohyoid muscle inferiorly. The mandible borders the sublingual glands laterally

The sublingual glands lie inferolateral to the tongue, below the mucosa of the floor of the mouth, and above the mylohyoid muscle. Sublingual tissue is palpable behind the mandibular canines.

The sublingual gland acquires an oval shape when sectioned transversely, however, the gland shape is longitudinal and lentiform when sectioned parallel to the body of the mandible

The sublingual tissue is predominantly a mucous gland, however, is considered a mixed serous and mucous gland. It is made up of mainly mucous acini with serous demilunes.

It is the only unencapsulated major salivary gland. Sublingual tissue primarily produces a thick mucinous fluid and lubricates the oral cavity which allows for swallowing, initiating digestion, buffering pH, and dental hygiene



MINOR SALIVARY GLANDS

Minor salivary gland tissue is comprised of 800-1000 small salivary glands dispersed throughout the submucosa of the sinonasal cavity, oral cavity, pharynx, larynx, trachea, lungs, and middle ear cavity. Although minor salivary gland tissue

can be found anywhere along the aerodigestive tract, it is most concentrated along the buccal mucosa, labial mucosa, lingual mucosa, soft/hard palate, and floor of mouth

Minor salivary gland tissue is not normally seen on conventional imaging, but can become apparent when replaced by tumor or benign processes, most commonly mucus retention cysts.

Salivary glands	Type of saliva	Contribution of Saliva
Parotid gland	serous	25%
Submandibular gland	mixed	65%
Sublingual gland	mucous	5%
All minor salivary glands	mucous	5%

PROPERTIES OF SALIVA

- Volume: there is production between 0.75 – 1.5 liter of saliva per day.
- Appearance: a clear colorless fluid.
- pH = 6 – 7.4
- Specific gravity 1.002 -1.012.

In healthy, non-medicated persons, the unstimulated whole saliva flow rates 0.3 – 0.5 ml/min.

stimulated whole saliva flow rate 1.0 – 1.5 ml/min.

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CHAPTER 7

FORMATION OF SALIVA

The formation of saliva occurs in two stages. In the first stage, cells of the secretory end pieces and intercalated ducts produce primary saliva, which is an isotonic fluid containing most of the organic components and all of the water that is secreted by the salivary glands.

In the second stage, the primary saliva is modified as it passes through the striated and excretory ducts, mainly by reabsorption and secretion of electrolytes. The final saliva that reaches the oral cavity is hypotonic.

Like other cells that are specialized for the synthesis and regulated secretion of proteins and glycoproteins, the cells of the secretory end pieces have abundant rough endoplasmic reticula and a large Golgi complex, and they store their products in membrane-bound granules in the apical cytoplasm.

Secretory proteins are synthesized by ribosomes attached to the cisternae of the endoplasmic reticulum and translocated to the lumen of the endoplasmic reticulum. The proteins associate with other molecules (chaperones) that ensure proper folding of the protein, and posttranslational modifications such as disulfide bond formation and N- and O-linked glycosylation are initiated.

The proteins are transferred to the Golgi complex, where they undergo further modification, followed by condensation and packaging into secretory granules.

The secretory granules are stored in the apical cytoplasm until the cell receives an appropriate secretory stimulus. The granule membranes fuse with the cell membrane at the apical (luminal) surface, and the contents are released into the lumen by the process of exocytosis.

. In salivary glands the sympathetic neurotransmitter norepinephrine usually is an effective stimulus of exocytosis. Norepinephrine binds to βadrenergic receptors on the cell

surface. Receptor activation, through guanosine triphosphate-binding proteins, stimulates adenylyl cyclase to produce cAMP. Increased cAMP levels activate protein kinase A, which phosphorylates other proteins in a cascade that eventually leads to granule exocytosis.

The fusion of the granule membrane with the cell membrane is mediated by the formation of a protein complex involving proteins of the granule membrane, proteins of the cell membrane, and proteins in the cytoplasm. After release of the granule content, the granule membrane is internalized by the cell as small vesicles, which may be recycled or degraded

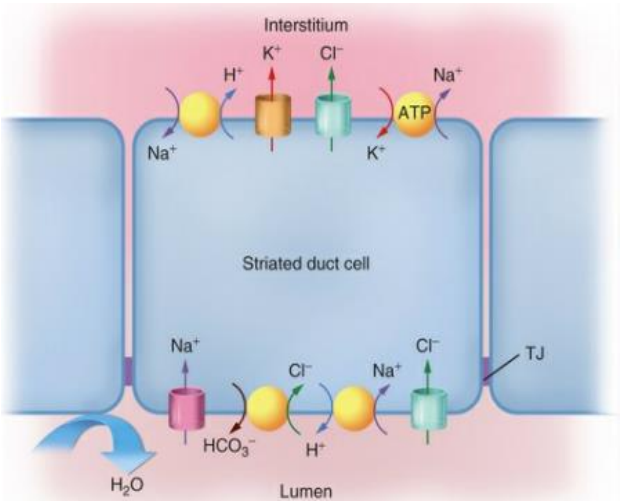
DUCTAL MODIFICATION OF SALIVA

In addition to conveying saliva from the secretory end pieces to the oral cavity, an important function of the striated and excretory ducts is the modification of the primary saliva produced by the end pieces and intercalated ducts occurring principally through reabsorption and secretion of electrolytes.

The luminal and basolateral membranes have abundant transporters that function to produce a net reabsorption of Na + and Cl −, resulting in the formation of hypotonic final saliva. The ducts also secrete K+ and but little if any secretion or reabsorption of water occurs in the striated and excretory ducts.

The final electrolyte composition of saliva varies, depending on the salivary flow rate. At high flow rates, saliva is in contact with the ductal epithelium for a shorter time, and Na + and Cl − concentrations rise and the K+ concentration decreases.

At low flow rates the electrolyte concentrations change in the opposite direction. The concentration, however, increases with increasing flow rates, reflecting the increased secretion of by the acinar cells to drive fluid secretion.



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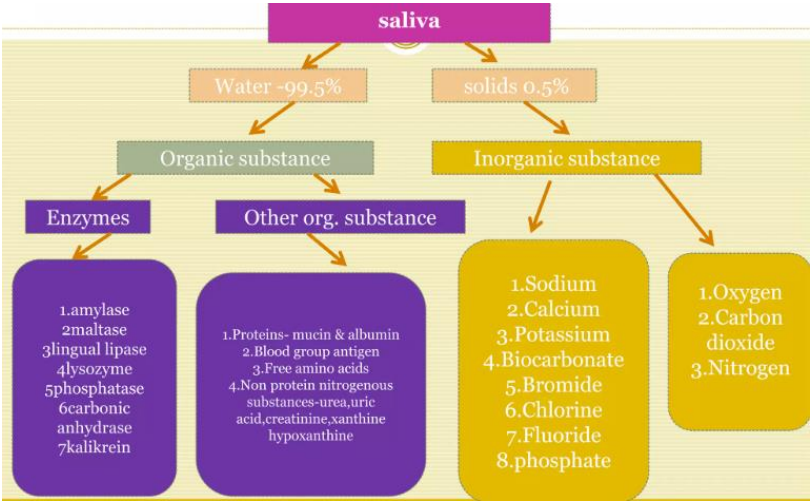
CHAPTER **8**

COMPOSTION OF SALIVA

ORGANIC SUBSTANCES

ENZYMES

1. Amylases Calcium metalloenzyme. Hydrolyzes alpha (1-4)



bonds of starches such as amylase and amylopectin. Several salivary isoenzymes. Maltose is the major-end-product (20% is glucose). Appears to have digestive function.

2. Lactoferin Iron-binding protein. “Nutritional immunity (iron starvation). Some microorganisms (e.g., E. coli) have adapted to this mechanism by producing enterochelins. ϒ bind iron more effectively than lactoferrin. ϒ iron-rich enterochelins are then reabsorbed by bacteria. Lactoferrin, with or without iron, can be degraded by some bacterial proteases.

3. Histatins A group of small histatine-rich proteins Potent inhibitors of Candida albicans growth

4. Cystatins Are inhibitors of cystatine-proteases Are ubiquitous in many body fluids Considered to be protective against unwanted proteolysis ϒ bacterial proteases ϒ lysed leukocytes May play inhibit proteases in periodontal tissues Also have an effect on calcium phosphate precipitation

5. Lingual lipase Secreted by von ebners glands of tongue. Involved in first phase of fat digestion. Hydrolizes medium – to long –chain triglycerides. Important in digestion of milk fat in new-born. it is highly hydrophobic and readily enters fat globules.

6. STATHERINS Calcium phosphate salts of dental enamel are soluble under typical condition of ph and ionic strength. Super saturation of calcium phosphates maintain enamel integrity.

Statherins prevent precipitation or crystallization of supersaturated calcium phosphate in ductal saliva & oral fluid. Produced by acinar cells. Also an effective lubricant.

7. Proline Rich Proteins (PRPs) Like statherins PRPs are also highly asymmetrical Inhibitors of calcium phosphate crystal growth Inhibition due to first 30 residues of negatively charged amino-terminal end Present in the initially formed enamel pellicle & in 'mature' pellicle.

8. Mucins Lacks precise folded structure of globular proteins Asymmetrical molecule with open , randomly organized structure Poly peptide backbone with CHO side chains Side chains may end in negatively charged groups such as sialic acid & bound sulphate Hydrophillic , entraining water Unique rheological properties Two major mucins (MG1 & MG2)

9. Lactoferrin in saliva have a direct antibacterial action on plaque •Salivary proteins could increase the thickness of the acquired pellicle and so help to retard the movement of calcium and phosphate ions out of enamel. lactope roxidas lysozyme

INORGANICS SUBSTANCES

1. Sodium Contributes to osmolarity of saliva(osmolarity is ½-3/4th of blood). Sodium concentration give diagnostic

Proteins	Small organic molecules	Electrolytes
albumin	amino acids	ammonia
amylase	creatinine	bicarbonate
β-glucuronidase	glucose	calcium
carbohydrases	lipids	chloride
cystatins	nitrogen	fluoride
epidermal growth factor	sialic acid	iodine
esterases	urea	magnesium
fibronectin	uric acid	non-specific buffers
gustin		phosphates
histatins		potassium
immunoglobulin A		sodium
immunoglobulin G		sulphates
immunoglobulin M		thiocyanate
kallikrein		
lactoferrin		
lipase		
latic acid dehydrogenase		
lysozyme		
mucins (Glycoproteins)		
nerve growth factor		
parotid aggregins		
peptidases		
phosphatases		
proline-rich proteins		
ribonucleases		
salivary peroxidases		
secretory component		
secretory IgA		
serum proteins (trace)		
tyrosine-rich proteins		
vitamin-binding proteins		
vascular endothelial growth factor		

information relating to the efficiency of ductal transport system.

2. CALCIUM saliva is supesaturated with calcium and hence prevents dissolution of enamel. it also facilitates enamel mineralization.

3. POTASSIUM Contributes to osmolarity of saliva. Potassium reaches saliva by active processes in both acini and ducts. Concentration falls immediately after stimulation and then approximately constant.

4. BIOCARBONATE Most important buffer in saliva [resist change in salivary Ph when acid or alkali added]. Biocarbonates release weak carbonic acid when acid is added;this is rapidly decomposed to H2O and CO2 which leaves the solution resulting in complete removal of acids.

5. CHLORINE Contributes to osmolarity of saliva. Increased flow rate leads to increased chloride reabsorption. 6-fluoride fluoride is well known for its anti-caries property. peak concentration of fluoride in gland saliva are observed some 30-60 minutes after ingestion of fluoride dose. 7-phosphorous it is actively transported into saliva,probably mainly in the acini but possibly also in the duct.

CHAPTER **9**

FUNCTIONS OF SALIVA

SALIVARY PELLICLE FORMATION

Fluid/Lubricant	Coats hard and soft tissue which helps to protect against mechanical, thermal and chemical irritation and tooth wear. Assists smooth air flow, speech and swallowing.
Ion reservoir	Solution supersaturated with respect to tooth mineral facilitates remineralisation of the teeth. Statherin and acidic proline-rich proteins in saliva inhibit spontaneous precipitation of calcium phosphate salts (Ch. 8).
Buffer	Helps to neutralise plaque pH after eating, thus reducing time for demineralisation (Ch. 6).
Cleansing	Clears food and aids swallowing (Ch. 5).
Antimicrobial actions	Specific (e.g. sIgA) and non-specific (e.g. Lysozyme, Lactoferrin and Myeloperoxidase) anti-microbial mechanisms help to control the oral microflora (Ch. 7).
Agglutination	Agglutinins in saliva aggregate bacteria, resulting in accelerated clearance of bacterial cells (Ch. 7). Examples are mucins and parotid saliva glycoproteins.
Pellicle formation	Thin (0.5 μm) protective diffusion barrier formed on enamel from salivary and other proteins.
Digestion	The enzyme α-amylase is the most abundant salivary enzyme; it splits starchy foods into maltose, maltotriose and dextrins (Ch. 7).
Taste	Saliva acts as a solvent, thus allowing interaction of foodstuff with taste buds to facilitate taste (Ch. 3).
Excretion	As the oral cavity is technically outside the body, substances which are secreted in saliva are excreted. This is a very inefficient excretory pathway as reabsorption may occur further down the intestinal tract.
Water balance	Under conditions of dehydration, salivary flow is reduced, dryness of the mouth and information from osmoreceptors are translated into decreased urine production and increased drinking (integrated by the hypothalamus, Ch. 4).

The formation of salivary pellicles is a highly selective adsorption process where macromolecules from whole saliva adsorb onto oral surfaces,

The initial adsorption of the salivary pellicle takes place within seconds of exposure to whole saliva

. The pellicle reaches a thickness of 10–20 nm within a couple of minutes

Phosphoproteins, such as acidic proline-rich proteins, statherins and histatins, have been shown to be among the initially adsorbed proteins onto hydroxyapatite (HA) surfaces in in vitro studies. However, in vivo studies revealed a more diverse and complex pellicle composition, with the presence of high-molecular-weight glycoproteins (MUC5B and MUC7), amylase, cystatins, lysozyme and lactoferrin

The initial adsorption is followed by a second stage or ‘maturation’ where protein aggregates are formed via protein-protein interactions

. Then, the pellicle thickness may increase up to 100 or 1,000 nm, depending on the location within the mouth

The formation of protein aggregates, which could be heterotypic complexes and/or micelle-like structures, has previously been reported and might be an explanation for the reported increased thickness

The formation of salivary pellicles in the oral cavity is a dynamic process, which is continuously altered by many factors, for instance, heterotypic complexing, enzymatic cross-linking, proteolytic degradation as well as the modification of adsorbed molecules by components

originating from oral bacteria, as well as salivary flow and clearance

SALIVARY PELLICLE COMPOSITION

Amylase, albumin, immunoglobulins, the glycoprotein gp340 (salivary agglutinin), proline-rich proteins, statherins, histatin 1, MUC5B, carbonic anhydrases, lactoferrin, lysozyme and cystatins are included in the in vivo pellicle

A study by Svendsen and Lindh [28] indicated that surface free energy, surface chemical composition and surface roughness play important roles in the composition of the salivary pellicles

The major adsorbed proteins are likely carbonic anhydrase VI, cystatin SN, lysozyme and histatins, whereas on (poly)methylmethacrylate the main components are likely lysozyme and histatin.

The lipids in enamel pellicles have been shown to have an acid protection ability on the enamel surface suggested to be caused by retarding the lactic acid diffusion.

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CHAPTER **10**

SALIVARY PELLICLE AND PERIODONTAL DISEASE

An acquired salivary pellicle may exert effects on the progression of periodontal disease by augmenting the

bacterial adhesion on the cervical surface of the tooth and accelerating dental plaque formation.

This effect may due to the change in the composition of acquired salivary pellicles on the cervical surface. The components of the pellicle on the cervical surface come from saliva and gingival crevicular fluid.

A significant change in the gingival crevicular fluid is the increase in the concentration of lactoferrin and plasma proteins.

Acquired salivary pellicles in patients with periodontal disease facilitate the attachment of proteolytic gram-negative species and increase the proportion of these species in dental biofilms.

The enhanced proteolytic reaction may aggravate the inflammatory response of the periodontal tissue

SALIVA WITH REFERENCE TO CALCULUS FORMATION AND INHIBITION

Calculus formation and inhibition is the result of the interaction of certain important components present in saliva, namely orthophosphate, pyrophosphate, and pyrophosphatase.

Enzyme alkaline phosphatase9 present in saliva and in plaque releases inorganic orthophosphate from organic phosphate, increasing concentration of orthophosphate locally, which reacts with calcium ions leading to precipitation of insoluble calcium apatite crystals.

Pyrophosphate, a byproduct of many biosynthetic reactions,10 present in saliva inhibits crystallization and competes with orthophosphate1 for minerals, thus having a strong inhibitory effect on plaque mineralization.

The enzyme pyrophosphatase plays an exciting role in formation of calculus by hydrolyzing9,10 pyrophosphate to orthophosphate, thus removing its inhibitory power and simultaneously converting into ‘‘booster’’ by increasing the concentration of orthophosphate.

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CHAPTER **11**

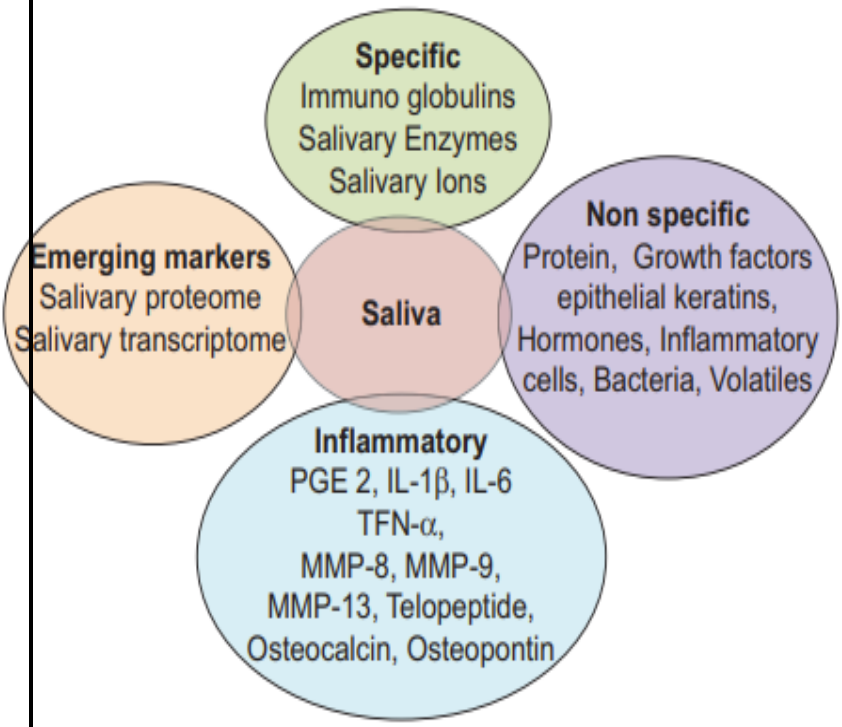
SALIVA AS A DIAGNOSTIC TOOL

Secretions from the major salivary glands (parotid, submandibular and sublingual), which have a large number of proteins and peptides, are responsible for maintaining the integrity of the oral cavity.

Also, because of its importance in oral biofilm formation and host defense, secreted saliva may have a significant role in the establishment and progression of periodontal disease.

- Besides its basic homeostatic functions in the mouth saliva is a very important diagnostic fluid. The reasons behind the usefulness of saliva in this regard are:
- Easy to collect
- Most non invasive fluid to collect
- Abundant in quantity to sample
- Does not need costly equipment for sampling

BIOMARKERS IN SALIVA



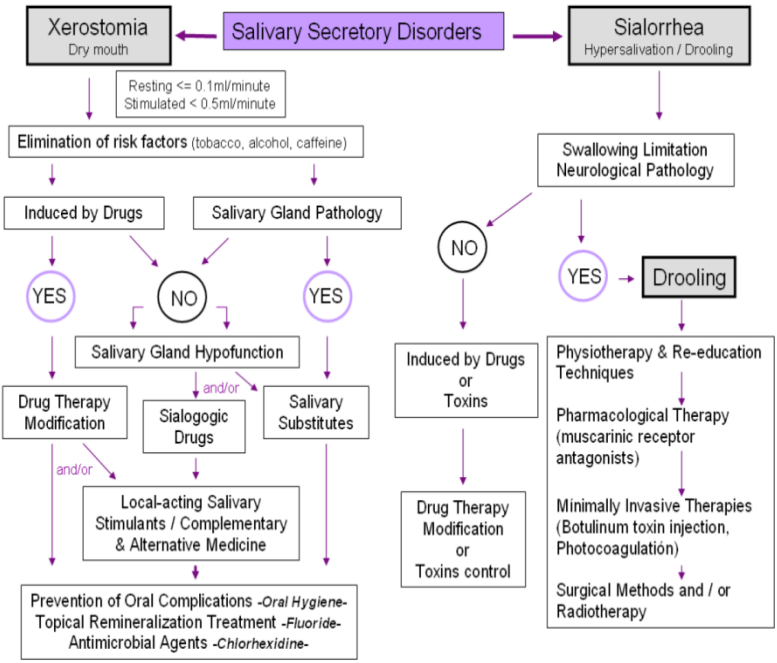
SALIVARY MARKERS FOR PERIODONTAL DIAGNOSIS

Enzymes	Immuno-globulins	Proteins	Phenotypic markers	Host cells	Ions	Hormone	Bacteria	Volatile compounds
α-glucosidase	IgA	cystatins	epithelial keratins	leucocytes (PMNs)	calcium	cortisol	*A. actinomycetem-comitans*	hydrogen sulifde
alkaline phosphatase	IgG	epidermal growth factor					*B. forsythus*	methylmercaptan
aminopeptidases	IgM	fibronectin					*mycoplasmas*	picolines
β-galactosidase	sIgA	lactoferrin					*P. gingivalis*	pyridine
β-glucosidase		platelet activating factor					*P. intermedia*	
β-glucuronidase		vascular endothelial growth factor					*P. micros*	
caprylate esteraselipase							*P. nigrescens*	
collagenase							*C. rectus*	
elastase							*T. denticola*	
esterase								
gelatinase								
kallikrein								
kininase								
lysozyme								
myeloperoxidase								
trypsin								

SALIVARY GLAND SECRETION ASSOCIATED WITH PERIODOTAL DISEASE

Marker	Relationship with periodontal disease	Type of periodontal disease
Specific		
Immunoglobulins (IgA, IgM, IgG)	Interfere in adherence and bacterial metabolism / increased concentration in saliva of periodontal patients	Chronic and aggressive
Nonspecific		
Mucins	Interfere with the colonization of *Aggregatibacter actinomycetemcomitans*	Aggressive
Lysozyme	Regulates biofilm accumulation	Chronic
Lactoferrin	Inhibits microbial growth / increased correlation with *A. actinomycetemcomitans*	Aggressive
Histatin	Neutralizes lipopolysaccharide and enzymes known to affect the periodontium	Chronic and aggressive
Peroxidase	Interferes with biofilm accumulation / increased correlation with periodontal patients	Chronic
Systemic		
C-reactive protein	Increased concentration found in serum and saliva of periodontal patients	Chronic and aggressive

SALIVARY SECRETION DYSFUNCTION



Drugs influencing salivary secretion

Xerostomia

- Anticholinergic/ antimuscarinic agents Atropine
- Diuretic agents Chlorotiazide, triamterene
- Antihipertensive agents Captopril

- Nonsteroidal antiinflammatory agents ibuprofen, naproxen, piroxicam
- Antihistamines chlorpheniramine
- Opioids analgesic agents

Sialorrhea

- Direct cholinergic/ muscarinic agonists pilocrpine
- Indirect cholinergic/ muscarinic agonists (acetylcholinesterase inhibitors) neostigmine, physostigmine
- Sedative medications Benzodiazepines
- Adrenergic antagonists
- Poisons and toxins

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Key features:

- The book is presented in a simple style to help novice students to understand the nuances of saliva
- Useful for UG and PG students.
- The concept- wise organization of the book helps in easy reading.
- The book covers all the aspects required in a dental student in periodontics, including chapters on development of salivary glands, salivary ducts, composition and functions of saliva.
- Suitable illustrations, photographs and tables provide a better understanding of the subject.



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