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Histology
Digestive System

The digestive system consists of the digestive tract oral cavity, esophagus, stomach, small and large intestines, rectum, and anus"and its associated glands"salivary glands, liver, and pancreas..

The first step in the complex process known as digestion occurs in the mouth, where food is moistened by saliva and ground by the teeth into smaller pieces; saliva also initiates the digestion of carbohydrates. Digestion continues in the stomach and small intestine, where the food"transformed into its basic components (eg, amino acids, monosaccharides, free fatty acids, monoglycerides)"is absorbed. Water absorption occurs in the large intestine, causing the undigested contents to become semisolid.

THE ORAL CAVITY

The oral cavity is lined with a protective, stratified squamous epithelium, keratinized or nonkeratinized depending on the region. The keratin layer protects the oral mucosa from damage and is present mostly in the hard palate and gingiva (gum). Nonkeratinized squamous epithelium covers the soft palate , lips ,cheeks ,and the floor of the mouth. The oral cavity is divided into:

1- The vestibule: is just internal to the lips and cheeks, extending as far as the teeth.
2- The oral cavity proper: is behind the teeth ,having a roof comprised of the hard and soft palates and a floor from which the tongue projects.

Posteriorly, the oral cavity opens into the oropharynx.

The lips

The outer surface of each lip is covered with skin that contains hair follicles, sebaceous glands, and sweat glands.

The red free margin (vermilion) of the lip is covered with a modified skin which represents a transition from skin to mucous membrane .The connective tissue (C.T.)

papillae of the dermis beneath it are numerous ,high and vascular and as a result ,the blood in their capillaries readily shows through the transparent epidermis to make the lips appear red .

The inner surface of the lip is lined by mucous membrane .The epithelium of this surface is thicker than the epidermis covering the outer surface of the lip and is of the stratified squamous non-keratinized type .High papillae of the C.T. lamina propria extend into it .Small clusters of labial glands are embedded in the lamina propria and connected with the surface by means of little ducts.

The substance of the lips consists of striated muscle fibers (the orbicularis oris muscle).

The Tongue:

The tongue is a mass of striated muscle covered by mucous membrane The muscle is arranged in bundles running in the vertical, transverse and longitudinal directions, and crossing one another at right angles. This arrangement gives the tongue a great mobility .The mucous membrane consists of a thick stratified squamous epithelium and underlying lamina propria containing many blood vessels, lymphatics and nerve fibers .The mucous membrane on the lower surface of the tongue is smooth ,whereas its dorsal surface is irregular ,and covered anteriorly with numerous epithelial elevations called papillae. The posterior one-third of the dorsal surface is separated from anterior two-thirds by a V-shape line (Sulcus Terminalis). Behind this V-line ,the dorsal surface present eminences composed mainly of aggregations of lymphatic nodules in the lamina propria beneath the epithelium (Lingual tonsils).

Papillae: are elevations of the oral epithelium and lamina propria (are mucosal projections).

Types of lingual papillae:

1-Filiform papillae: they have an elongated, conical shape. They are the most numerous and distributed over the dorsum of the anterior two thirds of the tongue. Each

papilla has a thin core of C.T. lamina propria and is covered by a pointed cap of stratified squamous epithelium which is cornified (keratinized). These papillae do not contain taste buds.

2-<u>Fungiform papillae</u>: are fewer and larger than the filiform and are scattered irregularly among them. They have narrow stalk (base) and a dilated upper part with smooth surface in the shape of mushroom. They frequently contain taste buds on their upper surfaces, and they are very vascular.

3-<u>Circumvallate papillae</u>: are 7 to 12 in number, are much larger than fungiform and are arranged along the V-line. They are large circular papillae whose flattened surfaces extend above the other papillae. They are surrounded by a deep groove (trench).They have many taste buds on their lateral surfaces. The ducts of von Ebner's glands (serous gland) open into the bottom of trench and maintain a continuous flow of fluid over the taste buds and this is important in removing food particles from the vicinity of the taste buds so that, they can receive and process new gustatory stimuli. Von Ebn&'s glands secrete a lipase that probably prevents the formation of hydrophobic layer over the taste buds that would hinder their function. Lingual lipase is active in the stomach and can digest up to 30% of dietary triglyceride.

4- <u>Foliate papillae</u>: are rudimentary in human .They consist of two or more parallel ridges and furrows. They are located on the dorsolateral surface of the tongue .Ducts from serous glands drain into the bases of the furrows. Numerous taste buds are present in the walls of the furrows.

<u>Taste Buds:-</u>

They are specialized sensory receptors (chemoreceptors); they are located in the epithelium of the tongue (in all mentioned papillae except filiform), they are also present in soft palate, pharynx & epiglottis. The taste buds are oval in shape, pale in staining (as compared to surrounding epithelium) & they are intra-epithelial & traverse the whole thickness of epithelium (extend from basement membrane to the surface). At the apical part, it opens in a very small/minute opening called "Taste pore" or"Gustatory pore". There are 50-100 cells in each bud . The following types of cells can be

distinguished in the taste bud:

1-Supporting cells

Their function is supporting for taste buds. They are slender cells extending from the basal lamina to the taste pore where they have numerous microvilli. They are dark because they contain large number of fine filaments in the cytoplasm. Also they have granules in the apical part contain GAG (glycosaminoglycans).

2-Taste cells gustatory **cells)**

They are light because their cytoplasm contains few filaments, also the cells have apical microvilli. They are characterized by the presence of numerous synaptic vesicles in their basal cytoplasm. Dendritic processes of sensory nerves are found in close proximity to these vesicles.

3-Undifferentiated basal cells

They are found in the base of the taste buds. They are probably the precursor of the other cells. Turnover of these cells is rapid, every 10-14 days.

Lingual glands:- are glands of the tongue (minor salivary glands).

They can be divided into 3 main groups according to their structure & location.

1-A paired group of mixed mucous & serous glands:- are located in the anterior part of the tongue near the apex. They are embedded in the muscle but are closer to the ventral than to the dorsal surface; they have several ducts which open on the ventral surface.

2- **Von Ebner's** glands:- are located in the region of the circumvallate papillae. They are pure serous glands. Their ducts open into the trenches of circumvallate papillae.

3-Mucous glands of the root of the tongue:- are the most numerous. They lie in the posterior third of the tongue. Their ducts open into the crypts of lingual tonsils and into the depressions between the tonsils.

Teeth:-

In adult human, the 32 permanent teeth are disposed in two bilaterally symmetric arches in the maxillary & mandibular bones. There are 8 teeth in each quadrant: 2 incisors, 1 canine, 2 premolars & 3 permanent molars. Twenty of the permanent teeth are preceded by deciduous (baby) teeth. The permanent molars have no deciduous precursors.

A tooth has 3 **anatomical divisions:-**

1. **Crown:-** the portion that projects above the gingiva (gum).
2. **Root(s):-** one or more below gingiva that hold the teeth in bony sockets called alveoli, one for each tooth.
3. **Neck (cervix):-** where the crown & the root meet.

Structurally, a tooth has the following components:-

l.Enamel:- is the hardest substance in the body. It consists of about 95% ca salts (mainly hydroxy apatite). Structurally it is composed of enamel rods(or prisms) that are bound together by interrod enamel. Both interrod enamel & enamel rods are fomed of hydroxyapatite crystals; they differ only in the orientation of the crystals. Each rod extends through the entire thickness of the enamel layer. Enamel is produced by cells of ectodermal origin (ameloblasts), whereas most of the other structures of the teeth derive from mesodermal or neutral crest cells. Ameloblasts secrete the enamel matrix. Ameloblasts degenerate when the tooth erupts, after which time the enamel cannot be replaced by new synthesis. The enamel is acellular after tooth eruption & therefore cannot repair itself.

2,**Dentin**(e):- is a calcified tissue similar to bone but harder because of its higher content of ca salts (70% of dry weight) in the form of crystals of hydroxyapatite. It forms the bulk of the tooth & gives the main strength to it. It differs from bone in that it contains no cells & no lacunae but has only processes of cells (odontoblasts) whose bodies lie adjacent to the dentin in the pulp cavity. Odontoblasts have slender branched cytoplasmic extensions that penetrate perpendicularly through the width of the dentin. These odontoblasts processes are present in small canals called dentinal tubules. Odontoblasts produce the organic matrix of dentin only at the dentinal surface. Dentin, unlike enamel, forms throughout the life. In contrast to

bone, dentin persists as a mineralized tissue for a long time after destruction of the odontoblasts.

3.Cementum:- is a bone-like tissue secreted by cells of the periodontal ligament which lines the tooth socket. The cementum forms a protective covering over the dentin & serves to attach the tooth to the surrounding structures. This tissue covers the dentin of the root & is similar in composition to bone. It is thicker in the apical region of the root & in this area; there are cells with the appearance of the osteocytes, the cementocytes. Like osteocytes, they are encased in lacunae; unlike those cells, however, cementocytes do not communicate through canaliculi; & their nourishment comes from the periodontal ligament. Like bone tissue, cementum is labile & reacts by resorption or production of new tissue according to the stresses to which it is subjected. Continuous production of the cementum in the apex compensates for the physiologic wear of the teeth & maintains close contact between the roots of the teeth & their sockets. When the periodontal ligament is destroyed the cementum undergoes necrosis & may be resorbed.

4.Pulp:- the pulp fills the pulp cavity. The shape of the pulp cavity is quite similar to that of the tooth in which it occurs. It consists of an expanded pulp chamber & a narrow pulp canal or root canal in the each root. A root canal communicates with periodontal tissues through the apical foramen. The dental pulp is essential to the nourishment & vitality of the tooth. Dental pulp consists of a loose C.T. Its main components are odontoblasts, fibroblast, macrophages, thin collagen fibrils & a ground substance containing glycosaminoglycans. Pulp is a highly innervated & vascularized tissue. It contains both myelinated & unmyelinated nerve fibres.

5.Periodontal ligament:- is composed of a special type of dense C.T whose fibres penetrate the cementum of the tooth & bind it to the bony walls of the socket, permitting limited movement of the tooth. It serves as the periosteum of the alveolar bone. In the periodontal ligament, there are fibroblasts, osteoblasts & cementoblasts. It has a high protein turnover rate & high rate of the collagen renewal. Protein or vit C deficiency (scurvy),may cause atrophy of this ligament, resulting in the loosening

or loss of teeth.

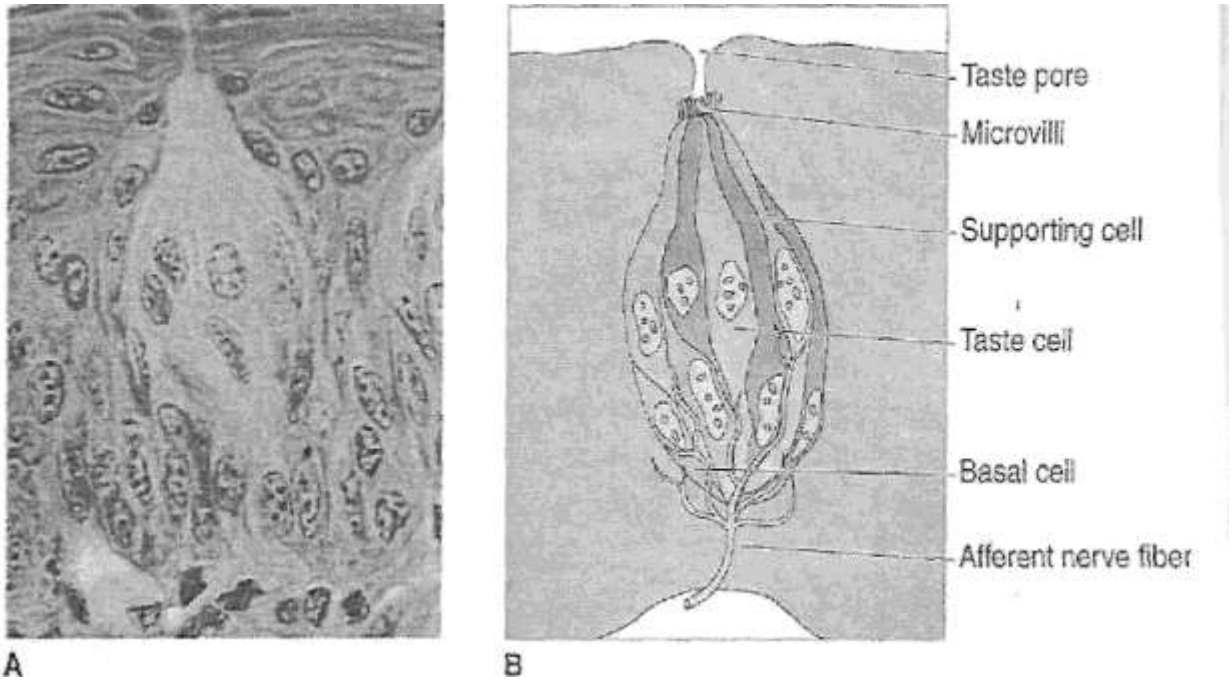
Periodontium:-

Comprises the structures responsible for maintaining the teeth in the maxillary & mandibular bone. It consists of:-

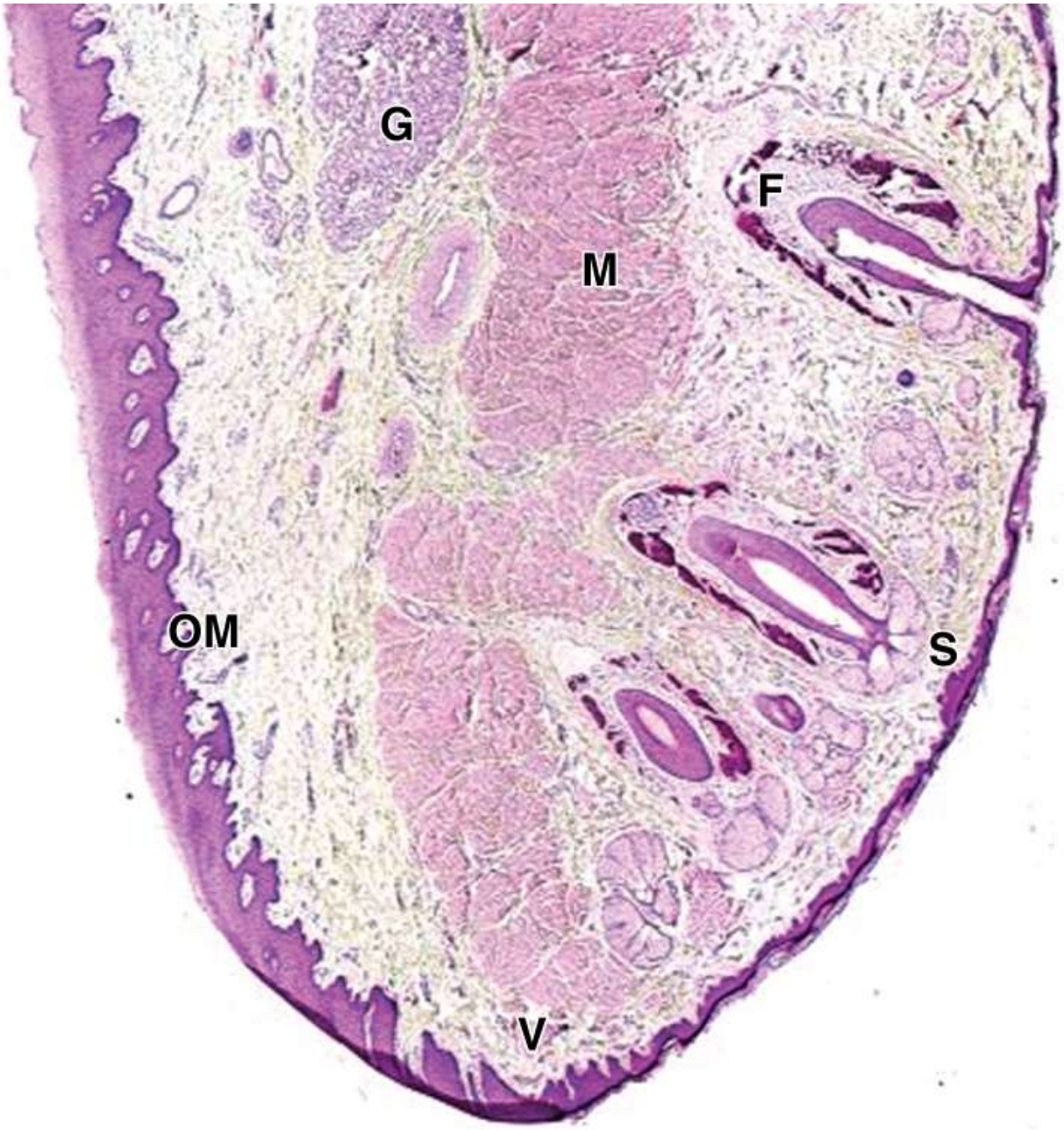
1- Cementum
2- Periodontal ligament (membrane)
3- Alveolar bone
4-Gingiva (gum)

Alveolar bone:- this portion of bone is in immediate contact with the periodontal ligament. It is an immature type of bone(primary-woven bone) in which the collagen fibres are not arranged in the typical lamellar pattern of adult bone. Many of the collagen fibres of the periodontal ligament are arranged in bundles that penetrate this bone & the cementum, forming a connecting bridge between these structures. J

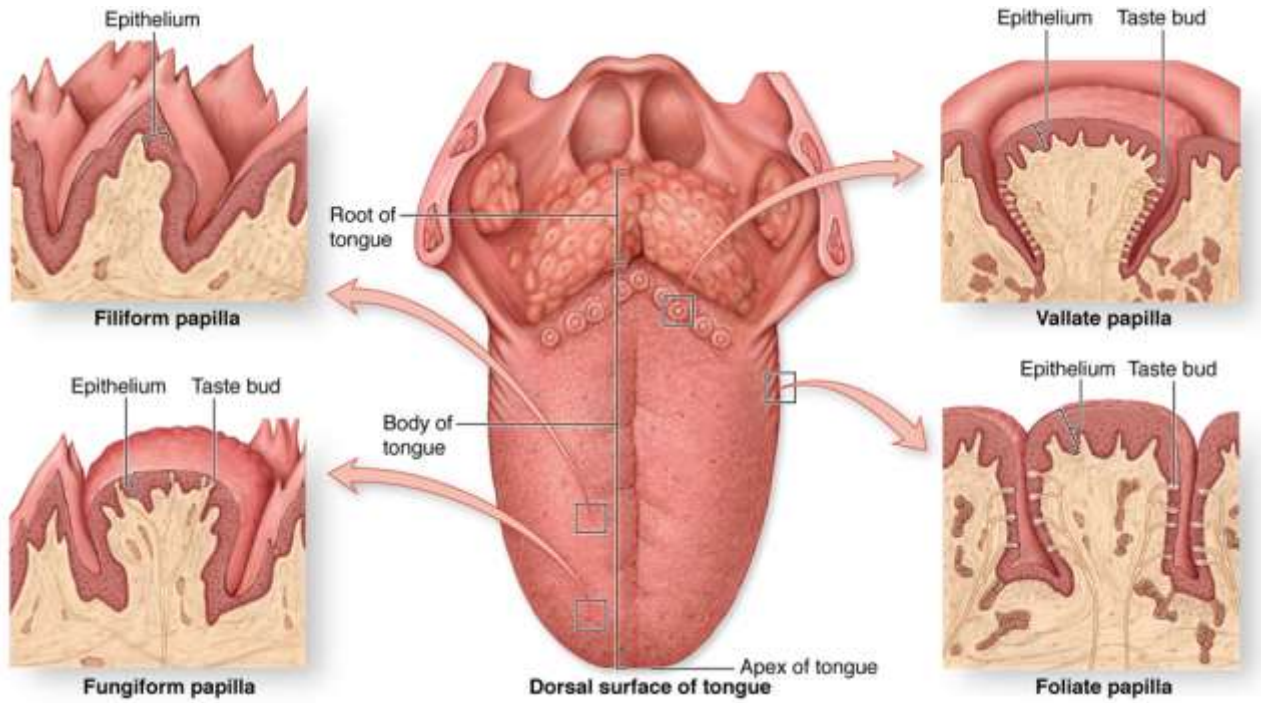
Gingiva(gum):- is a mucous membrane firmly bound to the periosteum of the maxillary or mandibular bone. It is composed of stratified squamous epithelium & lamina propria containing numerous C.T papillae.



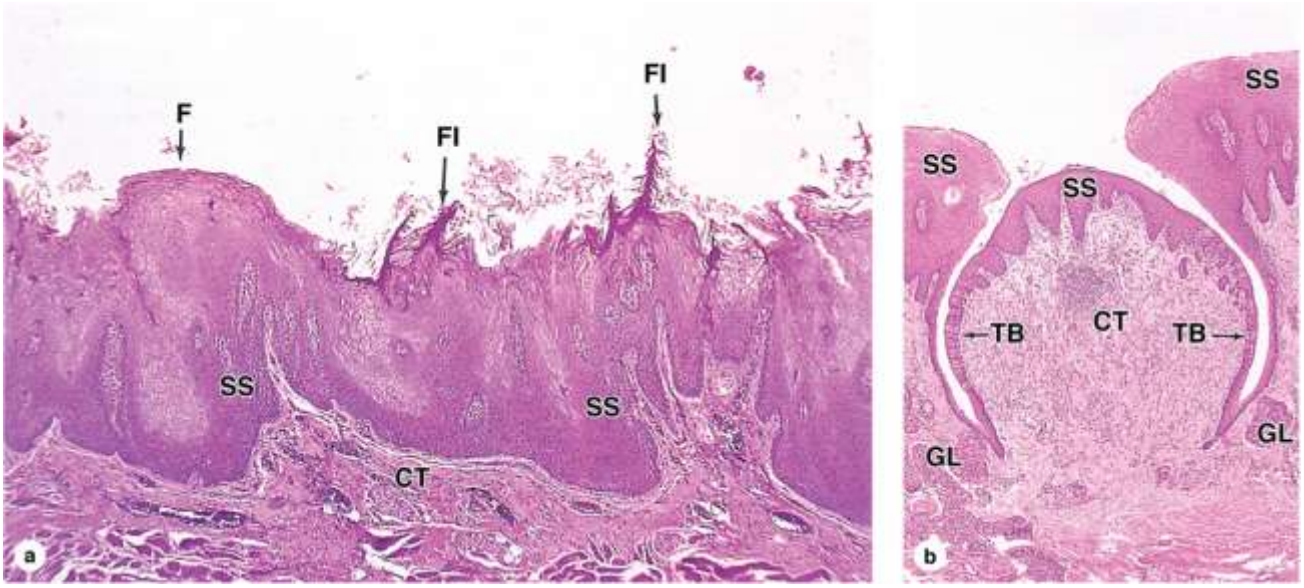
Photomicrograph (A) and drawing (B) of a taste bud, showing the taste cells and the taste pore. The drawing also illustrates several cell types (basal, taste, and supporting) and afferent nerve fibers that, upon stimulation, will transmit the sensory information to the central gustatory neurons. A: Hematoxylin and eosin (H&E) stain. Medium magnification.



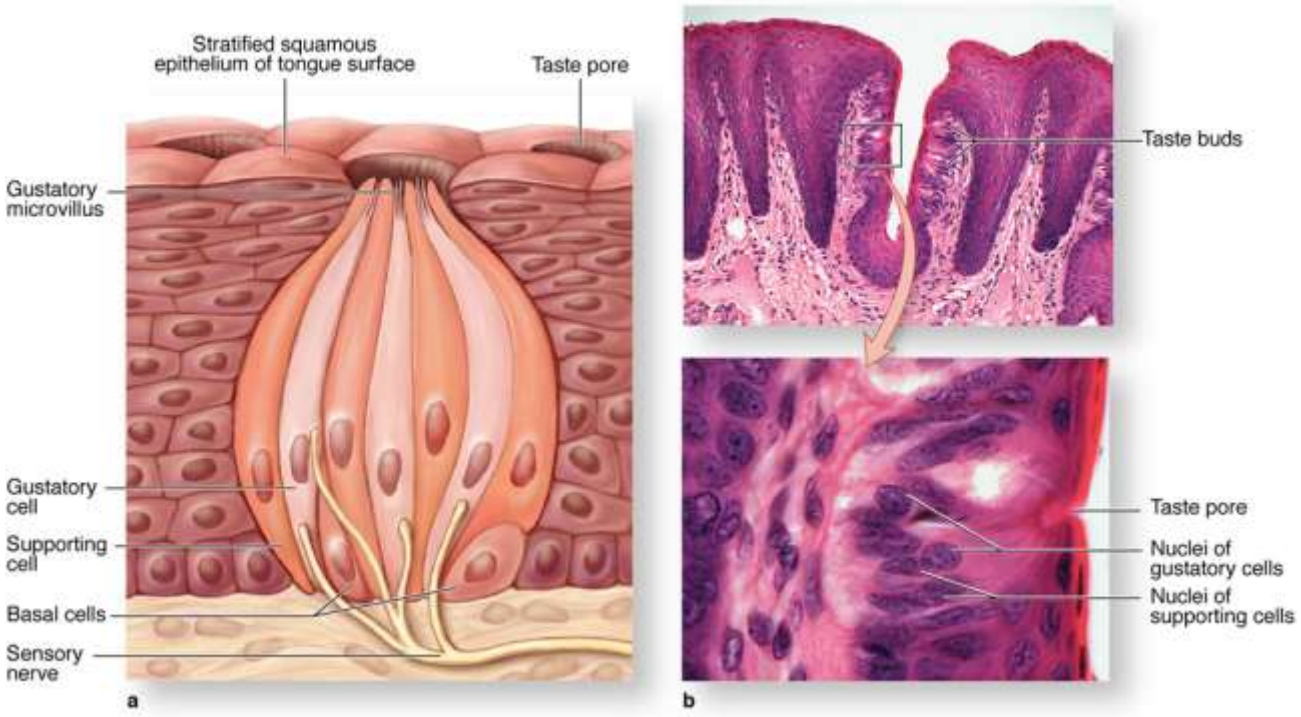
Lip. Low—magnification micrograph of a lip section showing one side covered by typical oral mucosa (OM), the opposite side covered by skin (S) containing hair follicles (F) and associated glands. Between the oral portion of the lips and normal skin is the vermilion (V), or the vermilion zone, where epidermis is very thin, lightly keratinized, and transparent to blood in the rich microvasculature of the underlying connective tissue. Because this region lacks the glands for oil and sweat, it is prone to excessive dryness and chapping in cold, dry weather. Internally, the lips contain much—striated muscle (M) and many minor salivary glands (G). X10. H&E.



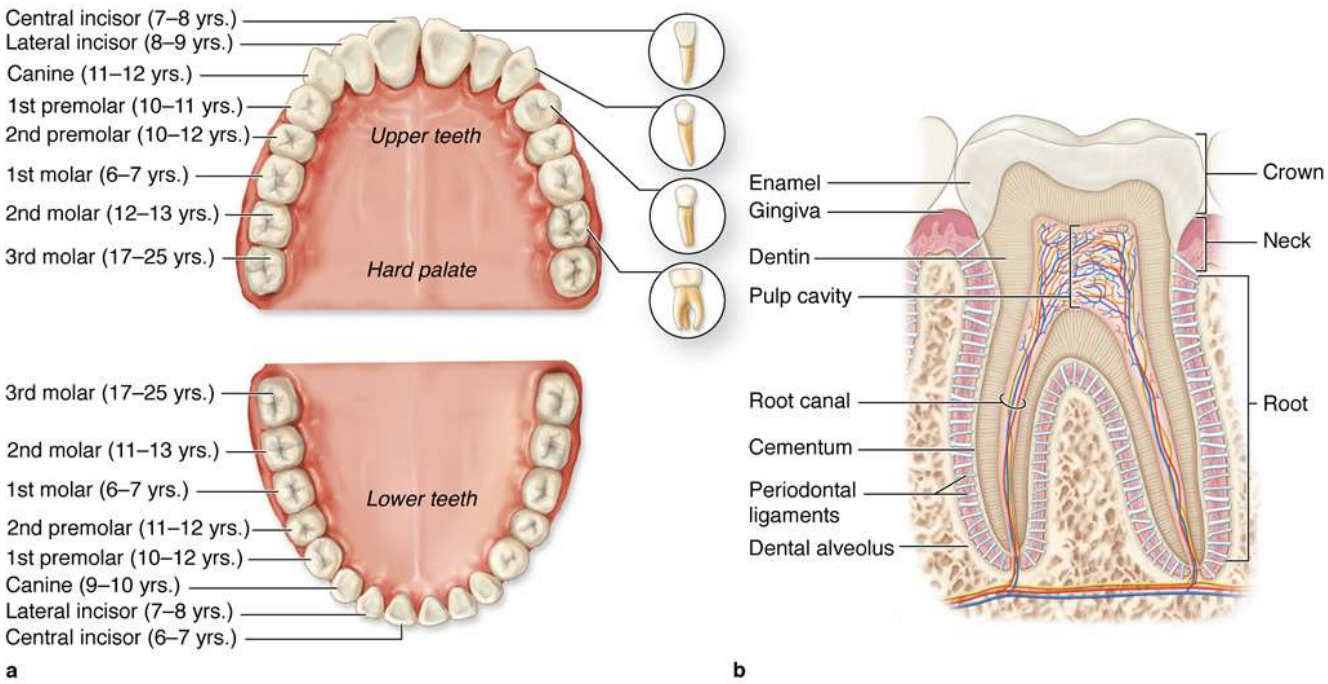
Tongue and lingual papillae. The posterior third of the tongue is the root and the anterior two—thirds the body of the tongue. The mucosa of the root is filled with masses of lymphoid nodules separated by crypts, all of which comprise the lingual tonsils. On the body of the tongue are papillae of four types, all containing cores of connective tissue covered by stratified squamous epithelium. Pointed filiform papillae provide friction to help move food during chewing. Ridge—like foliate papillae on the sides of the tongue are best—developed in young children. Fungiform papillae are scattered across the dorsal surface and 6–12 very large vallate papillae are present in a V—shaped line near the terminal sulcus. Taste buds are present on fungiform and foliate papillae but are much more abundant on vallate papillae.



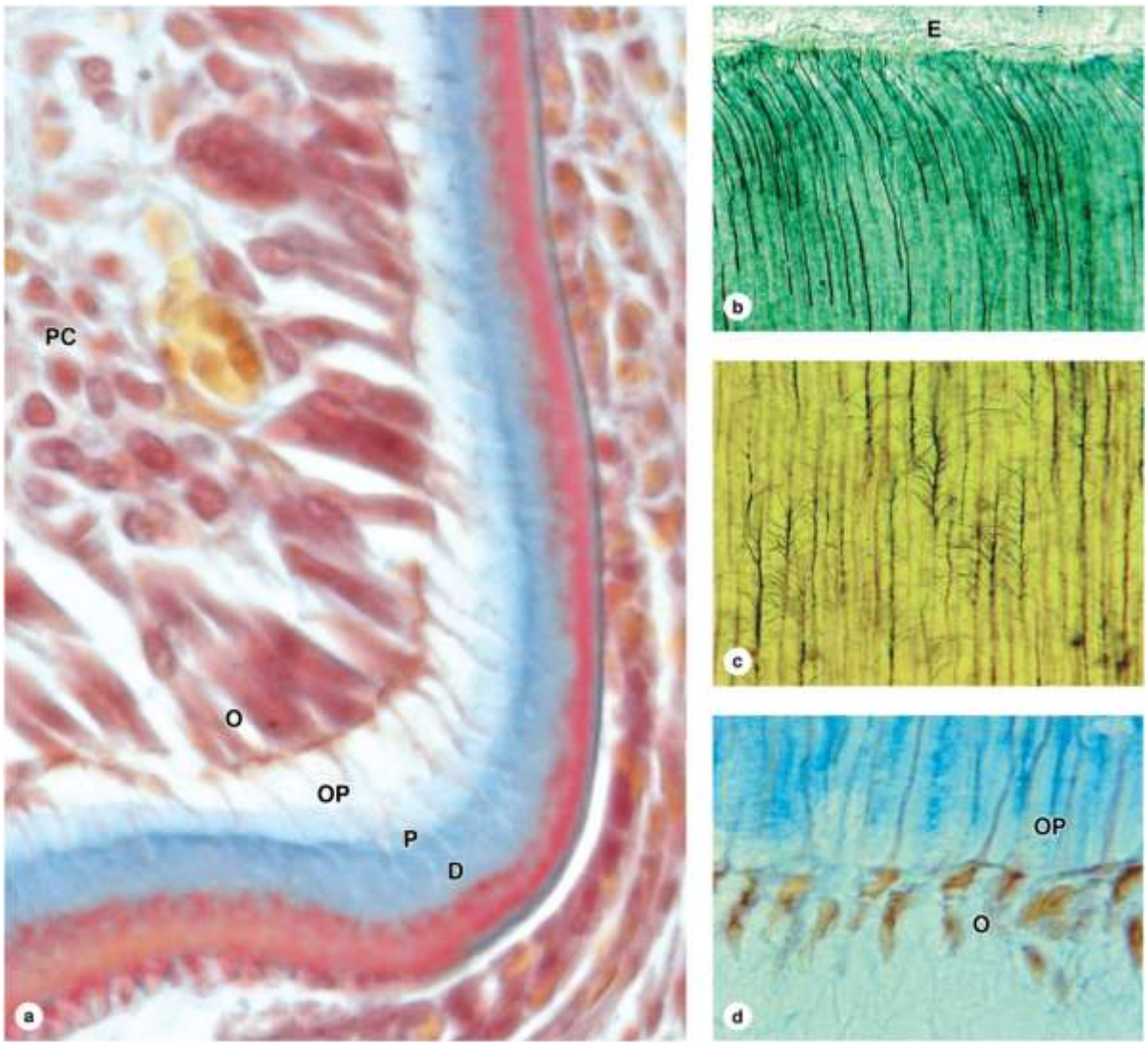
Lingual papillae. (a): Section of the dorsal surface of tongue shows both filiform (FI) and fungiform papillae (F). Both types are elevations of the connective tissue (CT) covered by stratified squamous epithelium (SS), but the filiform type is pointed and heavily keratinized while the fungiform type is mushroom—shaped, lightly keratinized, and has a few taste buds. (b): Micrograph shows a single very large vallate papilla with two distinctive features: many taste buds (TB) around the sides and several small salivary glands (GL) emptying into the cleft or moat formed by the elevated mucosa surrounding the papilla. These glands continuously flush the cleft, renewing the fluid in contact with the taste buds. The 7 to 12 vallate papillae on the tongue contain over half of the 10,000 or so taste buds in the human mouth and pharynx. Both X20. H&E.



Taste buds. (a): Drawing of a single taste bud shows the gustatory (taste) cells, the supporting cells whose function is not well—understood, and the basal stem cells. Microvilli at the ends of the gustatory cells project through an opening in the epithelium, the taste pore. Afferent sensory axons enter the basal end of taste buds and synapse with the gustatory cells. (b): In the stratified squamous epithelium of the tongue surface or oral mucusa, taste buds form as distinct clusters of cells that recognizable histologically even at low magnification. At higher power the taste pore may be visible, as well as the elongated nuclei of gustatory and supporting cells and the fewer, round nuclei of basal stem cells. 140X and 500X. H&E.

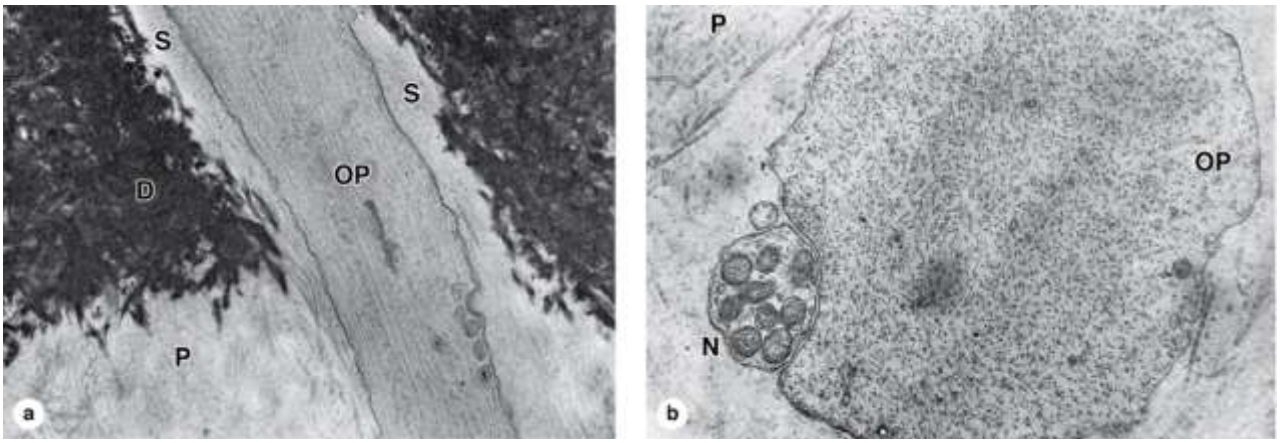


Teeth. All teeth are similar embryologically and histologically. (a): The dentition of the permanent teeth is shown, as well as the approximate age at eruption for each tooth. (b): Diagram of a molar's internal structure is similar to that of all teeth, with an enamel—covered crown, cementum—covered roots anchoring the tooth to alveolar bone of the jaw, and a slightly constricted neck where the enamel and cementum coverings meet at the gingiva. A pulp cavity extends into the neck and is filled with well—vascularized, well—innervated mesenchymal connective tissue. Blood vessels and nerves enter the tooth through apical foramina at the root tips.



Dentin and odontoblasts. (a): Odontoblasts (O) are long polarized cells derived from mesenchyme of the developing pulp cavity (PC). Odontoblasts are specialized for collagen and GAG synthesis and are bound together by junctional complexes as a layer, with no basal lamina, so that a collagen—rich matrix called predentin (P) is secreted only from their apical ends at the dentinal surface. Within approximately one day of secretion predentin mineralizes to become dentin (D) as hydroxyapatite crystals form in a process similar to that occurring in osteoid of developing bones (Chapter 8). In this process the collagen is masked and calcified matrix becomes much more acidophilic and stains quite differently than that of predentin. When predentin secretion begins an apical extension from each cell, the odontoblast process (OP), forms and is surrounded by new matrix. As the dentin—predentin layer thickens, these processes lengthen. When tooth formation is complete odontoblasts persist and their processes are maintained in canals called dentinal tubules which run through the full thickness of the dentin. X400. Mallory trichrome. (b, c): Odontoblast processes can be silver—stained and shown to branch near the junction of dentin with enamel (E) and along their length closer to their source (c), with the lateral branches occupying smaller canaliculi within dentin. Both X400. Silver. (d): These odontoblast process (OP) connections to the odontoblasts (O), shown with stained nuclei here, are

important for the maintenance of dentin in adult teeth. X400. Mallory trichrome. (Figure 15—8b, c and d used, with permission, from M.F. Santos, Department of Histology and Embryology, Institute of Biomedical Sciences, University of São Paulo, Brazil.)



Ultrastructure of dentinal tubule. (a): TEM shows the calcification of dentin (D) at its border with not—yet— calcified predentin (P). An odontoblast process (OP) with microtubules and a few secretory vesicles occupies much of the space (S) in the dentinal tubule. A process extends from each odontoblast and the tubules continue completely across the dentin layer. X32,000. (b): Cross—section of an odontoblast process (OP) near predentin (P) shows its close association with an unmyelinated nerve fiber (N) extending there from fibers in the pulp cavity. These nerves respond to various stimuli, such as cold temperatures, reaching the nerve fibers through the dentinal tubules. X61,000.

Note : These lectures represents only 85% of the informations and the remaining in the text book