Oral Biology
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Specialised mucosa

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Welcome to the lecture cast on Specialised oral mucosa. Oral mucosa is the moist mucous membrane that lines the oral cavity. It performs the function of protection, sensation, secretion and thermal regulation. Oral cavity consists of two parts, the vestibule and the oral cavity proper.

Vestibule is confined by the lips and the cheeks whereas, the oral cavity proper has the superior zone as the hard and soft palate, inferiorly it is bordered by the floor of the mouth and base of the tongue. Posteriorly it has faucial pillars and the tonsils. Oral mucosa is distinct in different parts of the oral cavity. Based on the primary function, it can be categorized into masticatory mucosa, lining mucosa and specialised mucosa.

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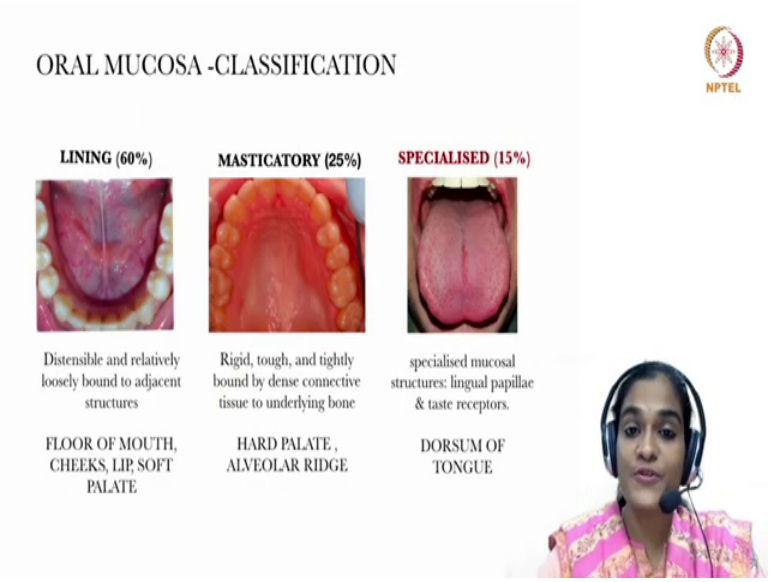

The lining mucosa mounts to 60 % of the oral mucosa. It is distensible and relatively loosely bound to the adjacent structure. Floor of the mouth, cheek, lip and soft palate are examples of lining mucosa. Masticatory mucosa constitutes about 25 % of oral mucosa. It is rigid, tough and tightly bound to the underlying bone by means of dense connective tissue.

Hard palate and the alveolar ridges are the examples of masticatory mucosa. Specialised mucosa comprises 15 % of the oral mucosa, it has specialised mucosal structures like lingual papillae and the taste receptors. Dorsum of the tongue is the characteristic example of specialised mucosa.

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Histologically, when you take the tissue sections of the oral mucosa - you find two distinct tissue components; they are the overlying epithelium and the underlying connective tissue. The overlying epithelium is stratified squamous epithelium, which is stacked into different layers. Based on cornification- they can be keratinized, which is seen in the masticatory mucosa and non-keratinized, which is seen in the lining mucosa.

The underlying connective tissue is divided into lamina propria, which bears the grunt of the overlying epithelium and the submucosa, which connects the epithelium with the deeper structures.

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Histology of specialised oral mucosa is also similar. It has got the overlying epithelium and the connective tissue core. There are taste buds which are interspersed into the keratinized layer of the epithelium, which opens to the exterior with means of taste pores.

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The mucosa of the dorsum of the tongue is unlikely anywhere else in the oral cavity. Why is it so? Why is it so specialised? Although it is lined by functionally a masticatory mucosa, it has

also got a highly extensible lining. In addition, there is presence of lingual papillae - these lingual papillae have masticatory function. They are also provided with some taste buds for performing a sensory function.

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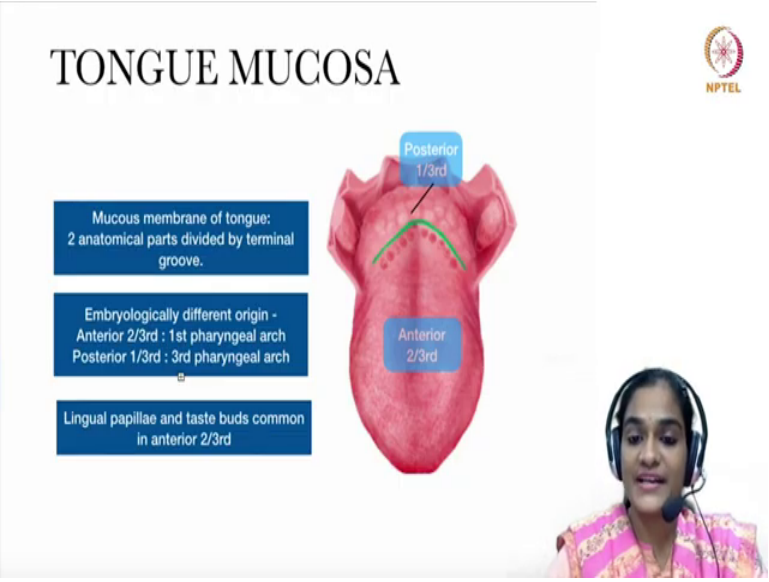

The mucous membrane of the tongue is divided into two parts by means of a v- shape sulcus called sulcus terminalis or terminal groove. The anterior two-third of the tongue which is derived from the first pharyngeal arch forms the body of the tongue. The posterior one-third derived from the third pharyngeal arch forms the base of the tongue. Lingual papillae and the taste buds are commonly present in the anterior two-third of the tongue.

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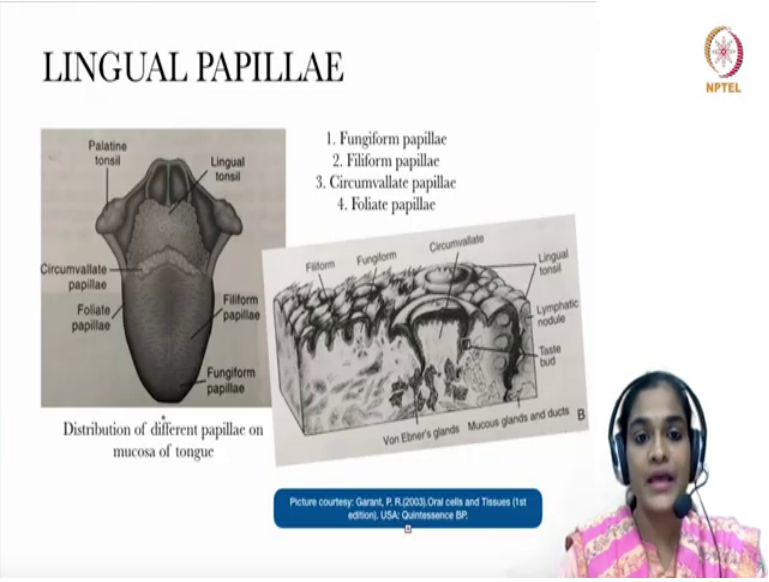

There are various lingual papillae present on the tongue, which are the fungiform, filiform, circumvallate and foliate papillae. Regarding the distribution of these papillae - the anterior two-third has the filiform papillae which is completely present in them. The fungiform papillae is almost present at the tip of the tongue. The foliate papillae is present on the sides of the tongue whereas the circumvallate papillae are arranged anterior to the sulcus terminalis.

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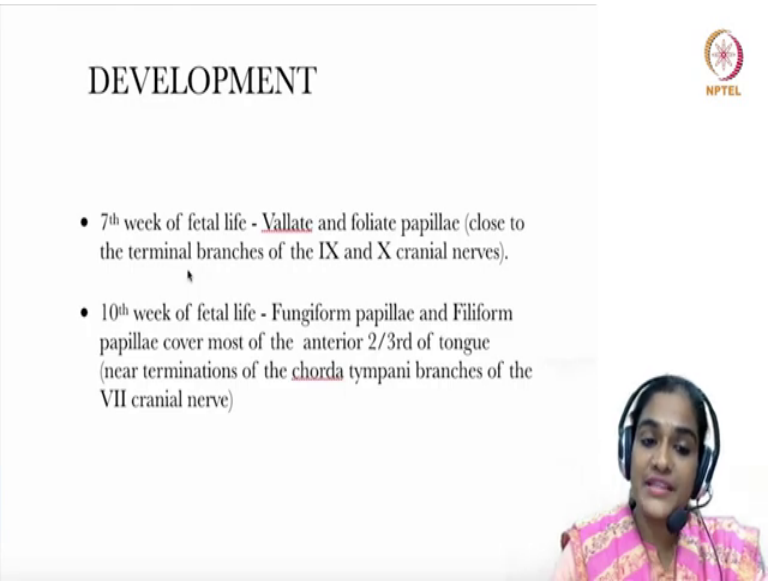

At about 7th week of fetal life, the vallate and the foliate papillae develop very close to the terminal branches of the glossopharyngeal and the vagal nerves. By the 10th week of fetal life, the fungiform and filiform papillae cover almost the entire anterior two-third of the tongue. They are seen developing near the terminal branches of chorda tympani, which is a branch of the facial nerve.

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Coming into details of each individual papillae Fungiform papillae are mushroom shaped - due to the rich vascular network, large size and the sparse distribution, it has been identified as reddish dots. Each individual is estimated to have about 200 fungiform papillae. They are so numerous or denser at the tip of the tongue than the middle region. They are scattered in between the numerous filiform papillae.

They have a smooth, round structure, the reddish appearance is due to the high vascular connective tissue core. The epithelium is thin, non keratinized stratified squamous epithelium. taste buds are present on the superior surface. On an average, they have two to four taste buds - some of the fungiform papillae do not even have taste buds. The fungiform papillae count is used to estimate the taste sensitivity.

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The picture shows the histological appearance of fungiform papillae, you have an overlying epithelium and underlying connective tissue core. The electron microscopic picture shows the fungiform papillae surrounded by numerous filiform papillae. The taste pore is seen opening into the exterior amidst the surrounding epithelial cells.

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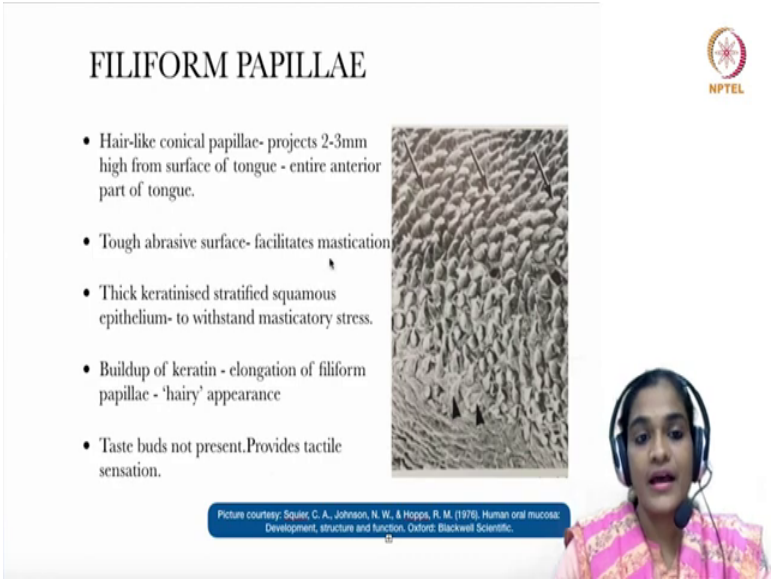

The filiform papillae is a hair like conical structure which projects 2 to 3 mm high from the surface of the tongue. It covers almost the entire anterior part of the tongue. It has got a tough abrasive surface . When the food particles are compressed against the palate, it facilitates the breakdown of food and the masticatory process. The epithelium is thick keratinized stratified squamous epithelium. The keratinization of epithelium helps to withstand the masticatory stress.

In some individuals, the buildup of keratin and the failure of their desquamation leads to the elongation of the filiform papillae giving a hairy appearance to the tongue. The taste buds are not present in the filiform papillae, they provide for the touch, temperature and the pain sensations.

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The picture shows the histological appearance of the filiform papillae. You can see the hair like projections of the papillae. The keratinized projections are interspersed with the non keratinized areas. While the keratinization helps in to withstand the masticatory forces, the non keratinized part helps in the extension of the tongue.

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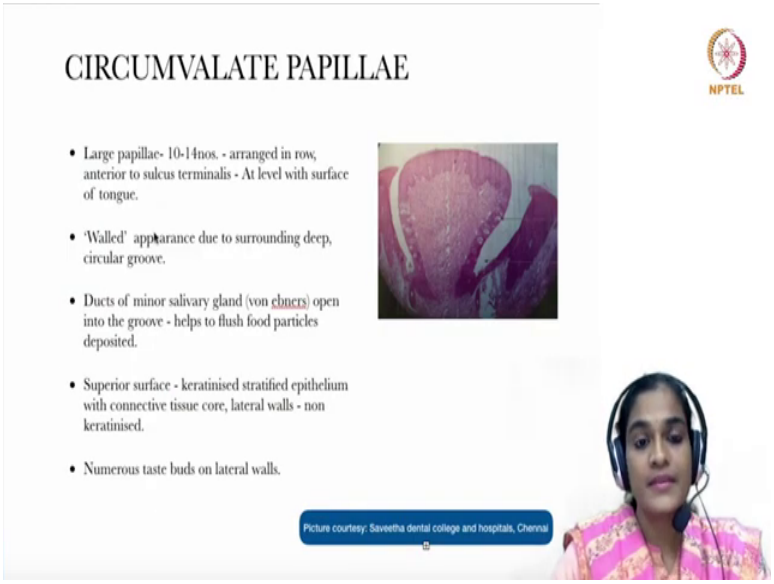

Moving on to the circumvallate papillae, these are large papillae -10 to 14 in number arranged in a row, adjacent and anterior to the sulcus terminalis. They are at level with the surface of the tongue. These have a characteristic walled appearance, they are surrounded by deep grooves on all sides Giving a walled appearance. The duct of the minor salivary gland also known as the von ebner's gland opens into the groove.

The secretions of the gland, which are serous (watery) type, help to flush the food particles deposited in the groove. The superior surface of the papillae is keratinized stratified squamous epithelium whereas the lateral portions are non keratinized. These lateral walls also have the presence of numerous taste buds.

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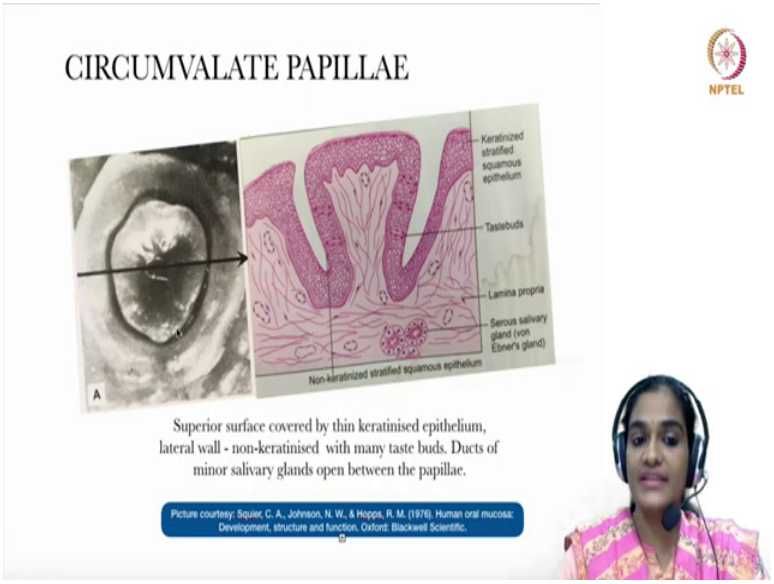

The ultramicroscopic picture shows the groove surrounding the papillae and the histological picture shows the keratinized superior surface and a non keratinized part on the lateral wall. The lateral wall are studded with taste buds that extends to the entire thickness of the epithelium.

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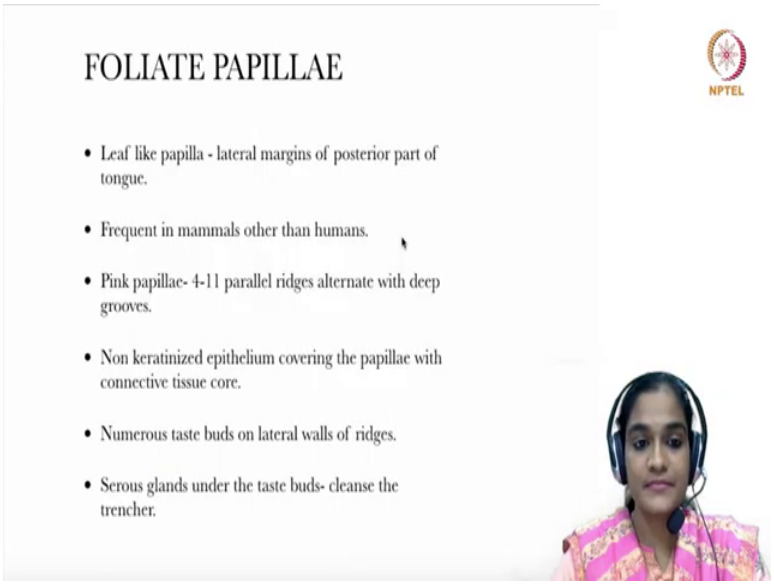

Foliate papillae: these are leaf-like papillae which are present in the lateral margins of the posterior part of the tongue. They are frequent in mammals other than humans, these are pink

colored papillae with four to eleven parallel ridges alternating with deep grooves. Non keratinized stratified squamous epithelium covers the entire papillae and has also got a connective tissue core.

There are numerous taste buds present on the lateral walls of the ridges. Like circumvallate papillae, the serous glands also surround under the taste buds to cleanse the trencher of the papillae.

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The picture shows the ridged appearance of the foliate papillae. Histologically it has got a non keratinized epithelium with the lateral walls showing the taste buds.

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What are taste buds? These are the organs that perceive the taste sensation. They are seen developing at about 11 to 13 week of fetal life. The evidence shows that the taste responses develop as early as 26 to 28 weeks of gestation. On an average, an adult shows 3000 to 10000 taste buds, children have more than that. Beyond 45 years, the taste buds degenerate leading to a decreased taste sensation in older age.

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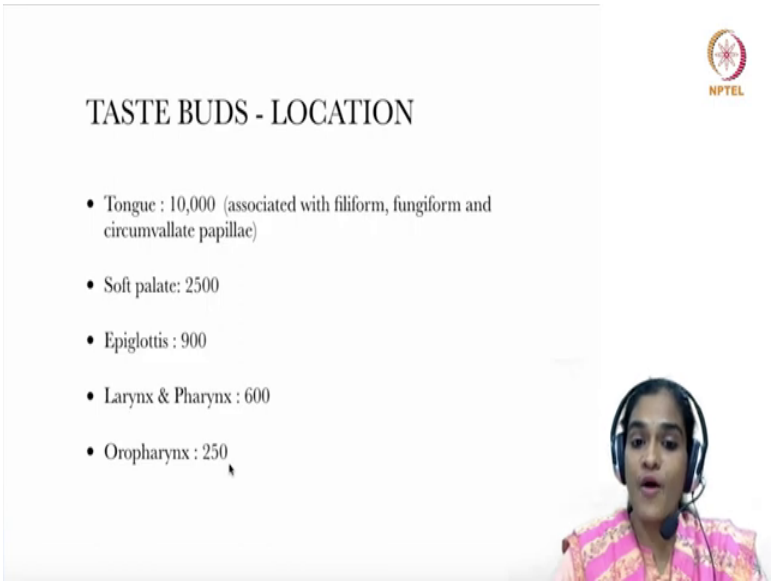

The taste buds are more predominantly found associated with the lingual papillae of the tongue. They are also present in the soft palate and pharyngeal area.

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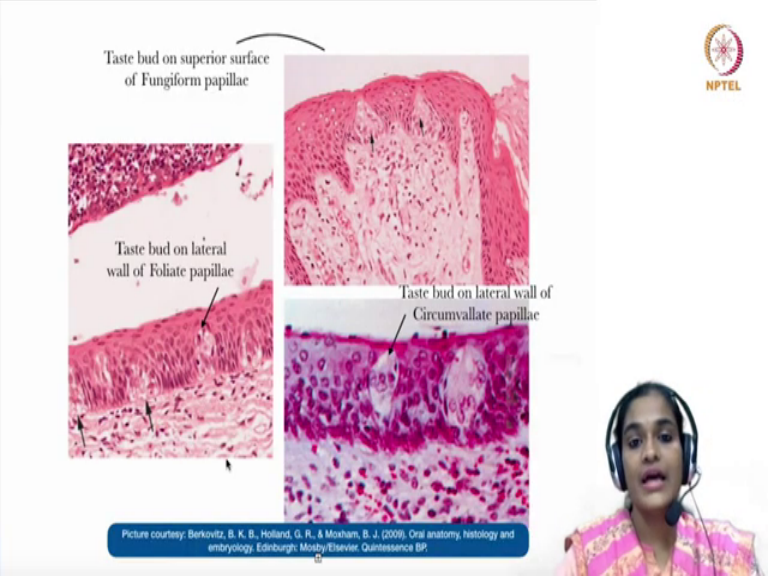

The histological picture shows the distribution of taste buds in different papillae, they are seen in the superior surface of the fungiform papillae whereas they are also present in the lateral aspects of the foliate and circumvallate papillae.

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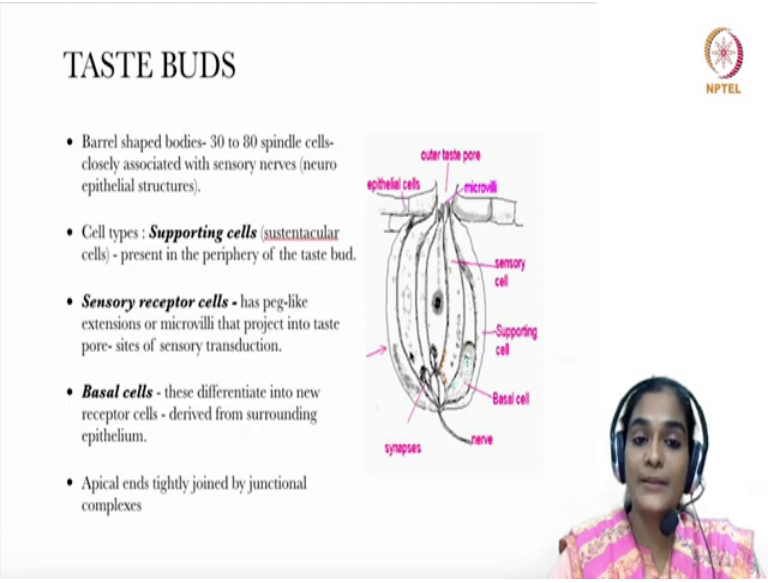

The taste buds are the barrel shaped bodies composed of 30 to 80 spindle shaped cells. They are closely associated with sensory nerves, thus they are called the neuro epithelial structure. If you see a taste bud it has got a basal portion which has been delineated from the underlying structure by means of a basal lamina.

Apically they end into a taste pit that opens to the exterior as a taste pore., The taste cells can be a supporting cell, which are found in the periphery of the taste bud and some of them are the sensory cell which are the cell of taste transduction.

These sensory cells extend their small projections called the microvilli into the taste pore. There are some cells called basal cells, these do not extend to the entire thickness of the taste bud, but differentiate into the new receptor cells. Basal cells are said to be derived from the surrounding epithelial cells. The apical ends of the taste bud are tightly bound by means of junctional complexes.

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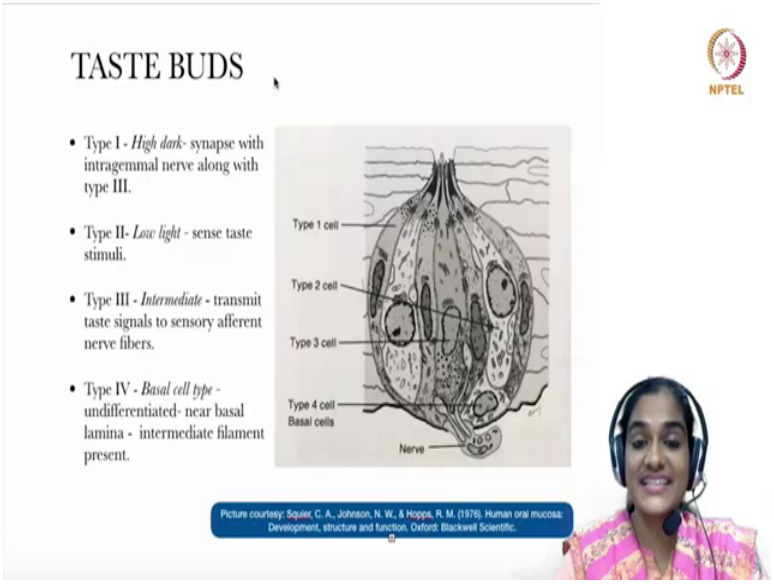

Based on electron density, the taste cells are classified into type 1, type 2, type 3 and type 4. Type 1 cells are highly dark; these are abundantly present cells. They extend the cytoplasmic extensions or the lamellae to engulf the other cells. They exhibit ionic currents implicated in the salt taste transduction and express glast transporter for glutamate. They are involved in

terminating the synaptic transmission, restricting the spread of transmitters, thus they act as glial cells of the brain.

The type 2 cells are morphologically similar to type 1 cells, they have the embedded receptors for sweet, bitter and umami compounds. These receptors are G protein coupled receptors with 7 transmembrane proteins. They express voltage gated sodium and potassium channels essential for producing action potential. They also have hemichannel subunits, which are the key players in taste evoked secretion of ATP.

The type 3 cells are those cells which express proteins associated with synapses. Thus they are called presynaptic cells. They form synaptic junction with the nerve. Apart from the neuronal function, the type 3 cells also have receptors for sour taste and carbonated solutions and are presumably the cell responsible for signaling these sensations.

The type 4 cells or undifferentiated cells are present near the basal lamina, which contain the intermediate filament and are derived from the surrounding epithelial cells. These cells when need occurs differentiate into receptor cells.

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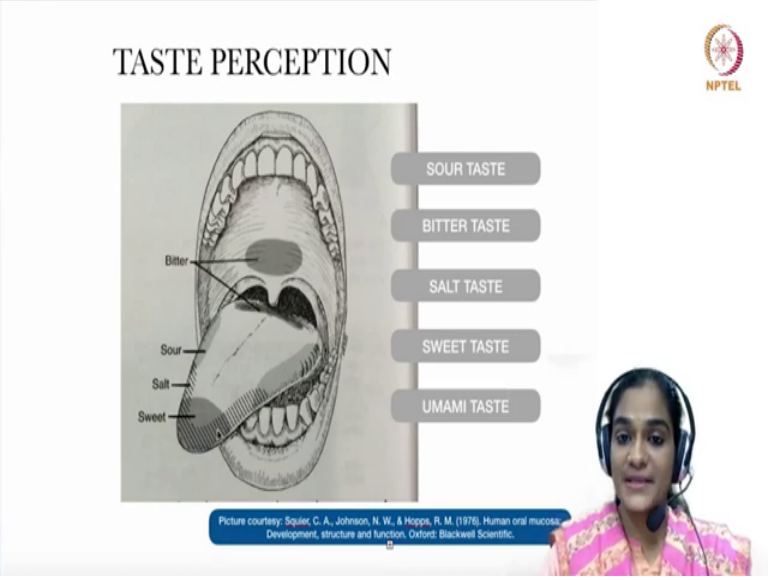

There are five basic taste perceptions: They are sour , bitter, salt, sweet and umami.

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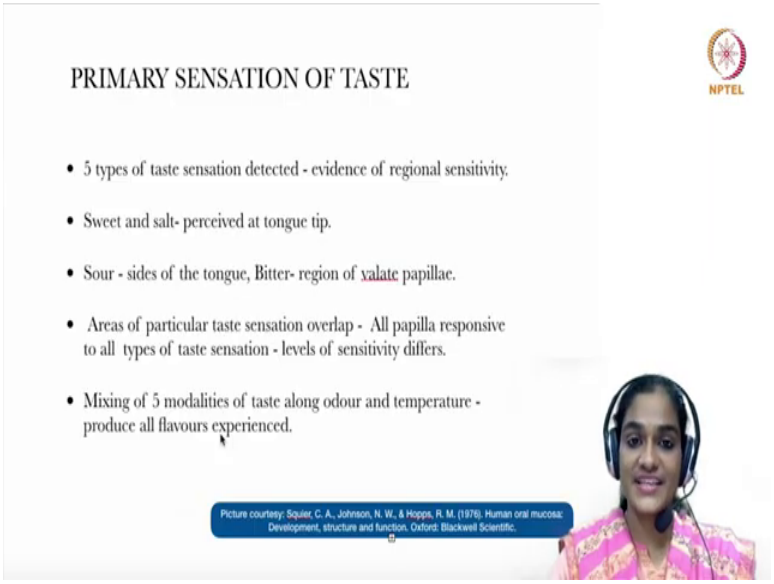

These five types of taste sensation are detected with evidence of regional sensitivity : sweet and salty taste are perceived at the tip of the tongue, \ sour taste on the side of the tongue and bitter taste on the region of vallate papillae. The areas of particular taste sensation overlap i.e all papillae are responsive to all types of taste sensation but the level of sensitivity differs.

Mixing five primary modalities of taste along with other taste sensations like fatty and metallic taste sensations coupled with odor and temperature produces all the flavors we experience.

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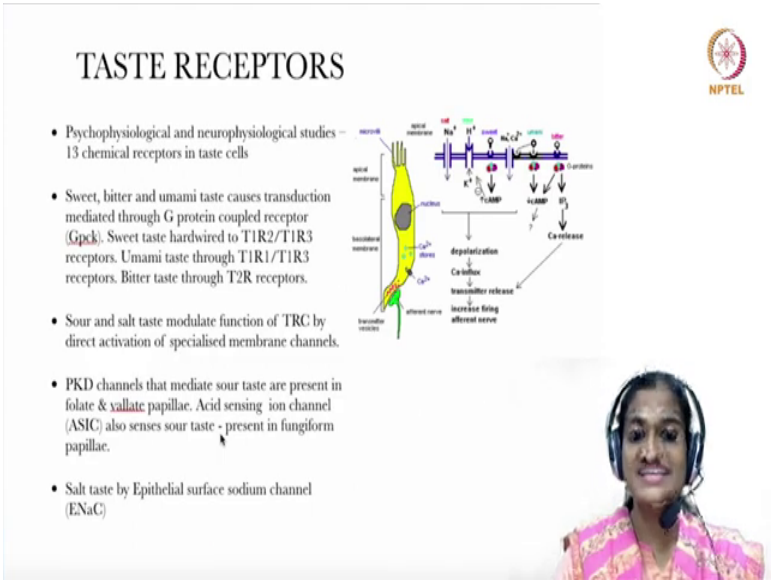

The taste receptors - these are the chemical receptors studded into the taste cells. There are about thirteen chemical receptors in taste cells which are identified. sweet, bitter and umami tastes cause transduction mediated through G protein coupled receptors. The sweet taste is hardwired to T1R2 or T1R3 receptors, umami taste through T1R1 and T1R3 receptors and bitter taste transduced to T2R receptors.

The sweet, bitter and the umami taste receptors are found in the type 2 taste cells. The sour and the salt tastes function by direct activation of specialised membrane channels, they are not associated with the G protein coupled receptors. The PKD channels, (in foliate and the vallate papillae) and acid sensing ion channels (in fungiform papillae) - mediate the sour taste.

The salt taste is mediated by epithelial surface sodium channels. The salt taste receptors are present in the type one cells whereas, the sour taste receptors are found in the type 3 cells.

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Moving on to the taste pathway - when a food is being taken inside the mouth it is masticated well with the help of the tooth and its supporting apparatus. . The broken down molecules occupy the taste pit. The microvilli moves the molecule towards the taste receptors which get adsorbed onto the membrane receptors. As soon as they get attached to the taste receptors, there is a conformational change which changes the ion flow across the taste membrane.

The activation of the signaling cascade through the downstream molecules happens with the help of membrane associated proteins like transducin and gustducin. This causes the change in membrane depolarization and release of neurotransmitter substances, mainly serotonin. This activates the associated unmyelinated afferent nerve fibers - facial nerve, glossopharyngeal nerve and vagus nerve.

These rely on the higher centers for taste perception. The higher centers are solitary nucleus present in the medulla oblongata, ventral posterior medial nucleus found in thalamus. Finally, the region of insula in the gustatory cortex, which consciously perceives the taste sensation and stores the taste memory.

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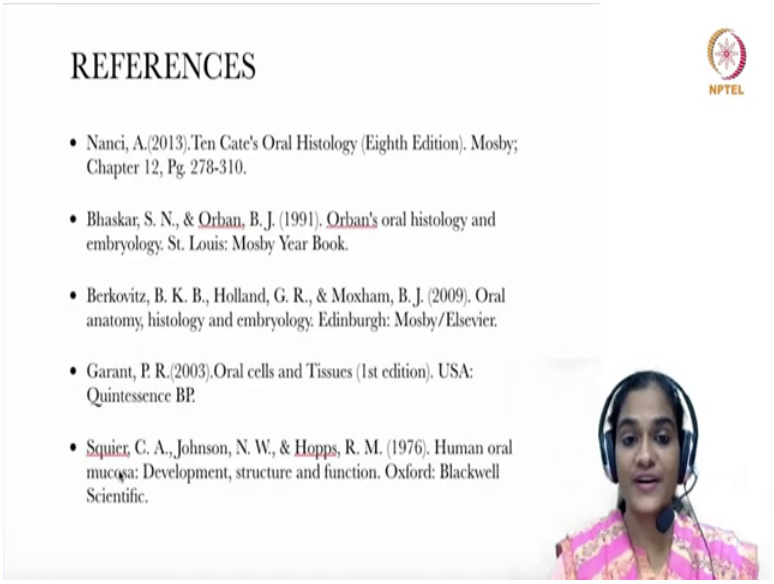

These are the references for further study.

Thank you.