VISWASS SCHOOL & COLLEGE OF NURSING

GNM 1ST YEAR
ANATOMY AND PHYSIOLOGY
UNIT-12
SENSE ORGANS
SHORT QUESTIONS AND ANSWERS

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1)Explain about physiology of taste.(5)

<u>Physiology of taste:</u>

- The sense of taste affords the ability to evaluate what it eats and drinks.
- At the most basic level, this evaluation is to promote ingestion of nutritious substances and prevent consumption of potential poisons or toxins.
- taste preference often changes in conjunction with body needs.
- Food preferences and aversions involve the sense of taste, but these phenomena are almost certainly mediated through the central nervous system.

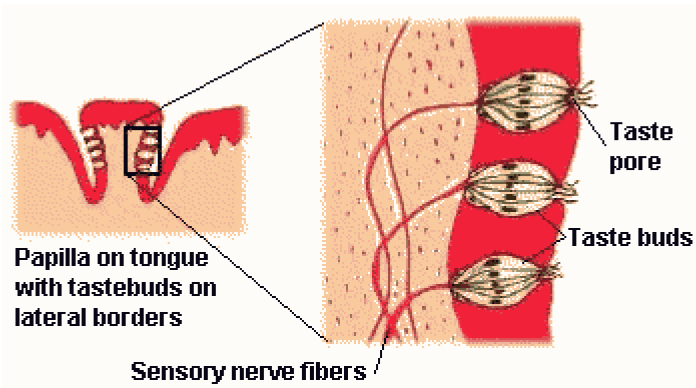
Taste Receptor Cells, Taste Buds and Taste Nerves

- The sense of taste is mediated by **taste receptor cells** which are bundled in clusters called **taste buds**.
- Taste receptor cells sample oral concentrations of a large number of small molecules and report a sensation of taste to centers in the brainstem.
- taste buds are most prevalent on small pegs of epithelium on the tongue called papillae.
- The taste buds themselves are too small to see without a microscope, but papillae are readily observed by close inspection of the tongue's surface.

- Taste buds are composed of groups of between 50 and 150 columnar taste receptor cells bundled together like a cluster of bananas.

- The taste receptor cells within a bud are arranged such that their tips form a small taste pore, and through this pore extend microvilli from the taste cells.

- The microvilli of the taste cells bear taste receptors.
- Interwoven among the taste cells in a taste bud is a network of dendrites of sensory nerves called "*taste nerves*".
- When taste cells are stimulated by binding of chemicals to their receptors, they depolarize and this depolarization is transmitted to the taste nerve fibers resulting in an action potential that is ultimately transmitted to the brain.
- One interesting aspect of this nerve transmission is that it rapidly adapts - after the initial stimulus, a strong discharge is seen in the taste nerve fibers but within a few seconds, that response diminishes to a steady-state level of much lower amplitude.



- Once taste signals are transmitted to the brain, several efferent neural pathways are activated that are important to digestive function.
- For example, tasting food is followed rapidly by increased salivation and by low level secretory activity in the stomach.
- Among humans, there is substantial difference in taste sensitivity.
- Roughly one in four people is a "supertaster" that is several times more sensitive to bitter and other tastes than those that taste poorly.
- Such differences are heritable and reflect differences in the number of fungiform papillae and hence taste buds on the tongue.
- In addition to signal transduction by taste receptor cells, it is also clear that the sense of smell profoundly affects the sensation of taste.
- Think about how tastes are blunted and sometimes different when your sense of smell is disrupted due to a cold.

Taste Sensations

- The sense of taste is equivalent to excitation of taste receptors, and receptors for a large number of specific chemicals have been identified that contribute to the reception of taste.
- Despite this complexity, five types of tastes are commonly recognized by humans:

- Sweet - usually indicates energy rich nutrients
- Umami - the taste of amino acids (e.g. meat broth or aged cheese)
- Salty - allows modulating diet for electrolyte balance
- Sour - typically the taste of acids
- Bitter - allows sensing of diverse natural toxins

- Perception of taste also appears to be influenced by thermal stimulation of the tongue.
- In some people, warming the front of the tongue produces a clear sweet sensation, while cooling leads to a salty or sour sensation.

Taste Receptors

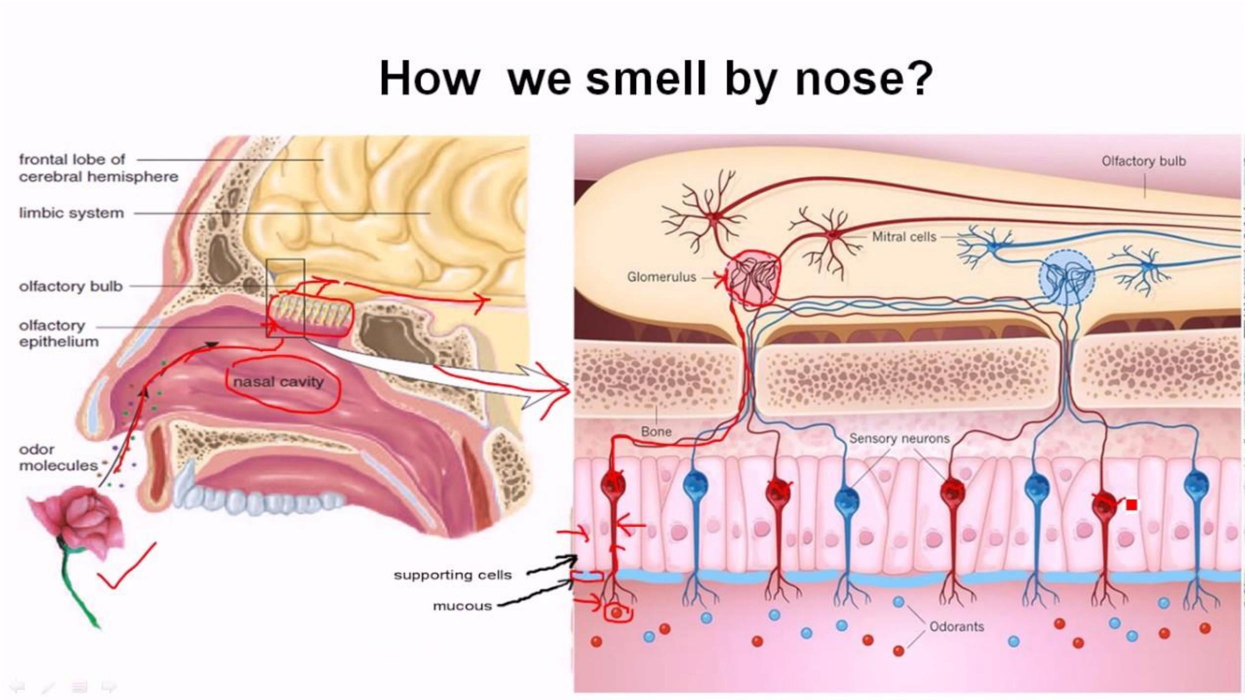
- A very large number of molecules elicit taste sensations through a rather small number of taste receptors.
- Furthermore, it appears that individual taste receptor cells bear receptors for one type of taste.
- In other words, within a taste bud, some taste receptor cells sense sweet, while others have receptors for bitter, sour, salty and umami tastes.
- Much of this understanding of taste receptors has derived from behavioral studies with mice engineered to lack one or more taste receptors.

2)Describe physiology of smell.(5)

Physiology of smell:

- Olfaction is the chemical sensation of gaseous odorants colloquially referred to as the ability to smell.

- The olfactory nerve (cranial nerve one) in coordination with other neuroanatomical structures in the nasal passages, neurotransmitters, and the cerebral cortex is responsible for carrying out this intricate chemosensory process.
- In humans, olfaction closely couples to other complex functions such as gustation (taste) and involuntary memory formation.
- From an evolutionary standpoint, an intact sense of smell is critical for evaluating the safety of ingestible substances, assessing impending danger, and recognizing social relationships.
- The ability to perceive and detect orders tends to decline with normal aging.
- The olfactory system is at the roof of the nasal cavity at the cribriform plate - a perforated portion of the ethmoid bone separating the frontal lobe of the cerebrum from the nasal cavity.
- Odorant molecules within the nasal passages first encounter receptors on the primary cilia of olfactory sensory neurons.
- Each neuron expresses a single type of protein receptor on these dendritic extensions.
- However, individual odorants can bind to many different receptor proteins.
- The dendritic ends of these first-order neurons are within a thin layer of mucus with adjacent supporting epithelium.
- Bowman glands secrete serous fluid rich in glycoprotein which warms, moistens, and traps air helping dissolve gaseous odorant particles.
- The axonal components of individual olfactory sensory neurons then combine to form neurovascular bundles that project through the cribriform plate.
- These collective bundles of axons form olfactory nerves. Axonal projections of olfactory nerves synapse with the dendrites of mitral and tufted cells in spherical structures known as glomeruli.
- Glomeruli are found on the surface of the olfactory bulb and are critical structures for transducing olfaction.
- Each glomerulus receives converging axons from olfactory neurons that express the same specific protein receptors.
- Humans are estimated to have 1100 to 1200 glomeruli within each olfactory bulb.



Mechanism:

- The process of olfaction involves the conversion of a chemical stimulus, an odorant, into an electrical signal sent to the brain for interpretation.
- This mechanism begins after olfactory sensory neurons depolarize in response to binding of an odorant molecule to G-protein coupled receptors (GPCR).
- The dissociated G protein activates an intracellular cascade via adenylyl cyclase producing a molecule of cyclic adenosine monophosphate (cAMP) that binds and opens ion channels within the neuron's plasma membrane.
- Subsequently, an influx of positive sodium and calcium ions and an efflux of negative chloride ions occurs. Neuronal depolarization continues until the threshold potential occurs, firing a resulting action potential.
- The action potential travels down the olfactory nerves through the cribriform plate towards glomeruli in the olfactory bulb.
- The glomeruli then project to specific areas within the brain where higher level processing, modulation, and interpretation occur.

Adaptation:

- When an individual is continuously exposed to an odour, perception of it decreases and stops with in a few minutes. This loss of perception affects only that specific odour.

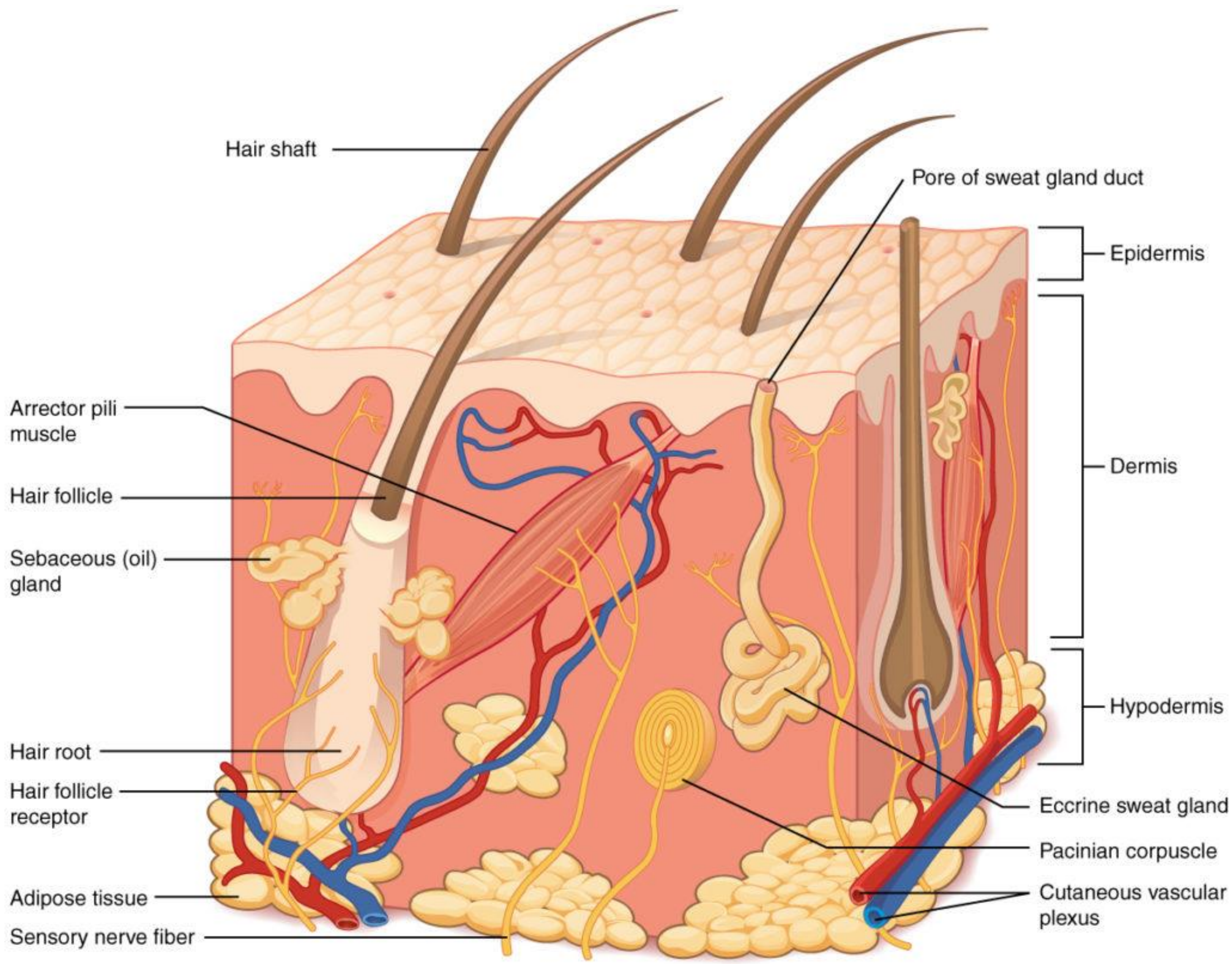
3)Explain the structure and function of skin.(5)

SKIN

The skin is one of the largest organs in the body in surface area and weight.

Skin is completely covers the body and is continuous with the membranes lining the body orifices.it:

- Protects the underlying structures from injury and from invasion by microbes.
- Contains sensory nerve endings that enable discrimination of pain , temperature and touch.
- Is involved the regulation of body temperature.



STRUCTURE:

- Skin has a surface area of about 1.5-2 square metres in adults.
- In many parts of the body, it contains accessory structures; glands, hair and nails.
- It varies in thickness, being thickest on the palms of the hands and soles of the feet.
- There are two main layers: the superficial layer is called the **epidermis,** and the layer below is the **dermis**.
- Between the dermis and underlying structures is a subcutaneous layer composed of areolar tissue and adipose (fat) tissue.

❖ <u>Epidermis:</u>

  - this is composed of stratified keratinised squamous epithelium
  - there are no blood vessels or nerve endings in the epidermis, but its deeper layers are bathed in interstitial fluids from the dermis, which provides oxygen and nutrients and drains away as lymph.
  - There are several layers of cells in the epidermis, which extended from the deepest basal layer to the most superficial stratum corneum(a thick horny layer)
  - The cells of the epidermis originate in the basal layer, which is made up of cuboidal, nucleated, highly active epithelial cells that are constantly dividing.
  - As new cells are formed, they are pushed upwards, away from the basal layer and further from their blood and nutrient supply.
  - As they progress towards the skin surface, their shape and structure gradually change.
  - By the time they reach the skin surface, they are flat, thin, non-nucleated, dead cells, or squames, in which the cytoplasm has been replaced by the fibrous protein keratin.
  - The surface cells are constantly rubbed off and replaced by those beneath.
  - Complete replacement of the epidermis takes about a month.
  - Hairs, secretions from sebaceous glands and ducts of sweat glands pass through the epidermis to reach the skin surface.
  - Upward projections of the dermal layer, the dermal papillae, anchor the dermis securely to the epidermis and allow passage and exchange of nutrients and wastes to the lower part of the epidermis.
  - This arrangement stabilises the two layers, preventing damage due to shearing forces.

- Blisters develop when trauma separates the dermis and epidermis, and serous fluid collects between the two layers.
- Where the skin is subject to greater wear and tear.
- Skin colour is affected by various factors.
  - Melanin, a dark pigment derived from amino acid tyrosine and secreted by melanocytes in the deep germinative layer, is absorbed by surrounding epithelial cells. The amount is genetically determined and varies between different parts of the body, between people of the same ethnic origin and between ethnic groups. The number of melanocytes is fairly constant, so the differences in colour depend on the amount of melanin secreted. It protects the skin from the harmful effects of ultraviolet rays in sunlight. Exposure to sunlight promotes synthesis of melanin.
  - Normal saturation of haemoglobin and the amount of blood circulating in the dermis give white skin its pink colour. When oxygen saturation is very low, the skin is white people may appear bluish(cyanosis)
  - Excessive levels of bile pigments in blood and carotenes in subcutaneous fat gives the skin a yellowish colour.

❖ Dermis:

- The dermis is tough and elastic.
- It is formed from connective tissue, and the metrix contains collagen fibres interlaced with elastic fibres.
- Rupture of elastic fibres occurs when the skin is overstretched, resulting in permanent striae, or stretch marks, which are typically found in pregnancy and obesity.
- Collagen fibres bind water and give the skin its tensile strength, but as this ability declines with age, wrinkles develop.
- Fibroblasts, macrophages and mast cells are the main cells found in the dermis.
- The subcutaneous layer, containing areolar tissue and varying amounts of adipose tissue, lies under the dermis.
- Structure founds in the dermis are:
  - small blood and lymph vessels
  - sensory nerve endings
  - sweat glands and their ducts

- hairs, arrector pili muscles and sebaceous glands.

Blood and lymph vessels:Arterioles form a fine network with capillary branches supplying sweat glands, sebaceous glands, hair follicles and the dermis. Lymph vessels also form a network throughoutthe dermis.

Sensory nerve endings: Sensory receptors sensitive to touch, temperature, pressure, and pain are widely distributed in the dermis.

Sweat glands:These are widely distributed through out the skin and are most numerous in the palms of the hands, soles of the feet, axillae and groins. They are formed from epithelial cells.

There are two types of sweat gland:

Eccrine sweat glands are the more common type and open on to the skin surface through tiny pores.

Apocrine sweat glands open into hair follicles and become active at puberty.

The most important functions of sweat is in the regulation of body temperature.

Hairs: these grow outwards from hair follicles, downgrowths of epidermal cells into the dermis or subcutaneous tissue. At the base of the follicle is a cluster of cells called the hair papilla or bulb.

A hair is formed by multiplication of cells of the bulb and as the hairs are pushed upwards, away from their source of nutrition, the cells die and become keratinised.

Arrector pili: arrector pili are little bundles of smooth muscle fibres attached to the hair follicles.

Sebaceous glands: sebaceous glands consist of secretory epithelial cells derived from the same tissue as the hair follicles. They secret an oily antimicrobial substances, sebum, into the hair follicles and are present in the skin of all parts of the body expect the palms of the hands and the soles of the feet.

Nails: human nails are equivalent to the claws, horns and hooves of animals. Derived from the same cells as epidermis and hair, these are hard, horny keratin plates that protect the tips of the fingers and toes.

FUNCTION

- Protection
- Regulation of body temperature
- Formation of vitamin-D
- Cutaneous sensation
- Absorption
- Excreation

4)Structure and function of nose.(5)

Structure and function of Nose:

The nostrils are the opening into the nose and are the main route of air entry into the respiratory system.

• It provides an entrance for air in which air is filtered by hairs inside the nostrils.
• It has two portions : the external and internal.
– **External nares (choanae) -** opening to exterior
– **Internal nares** opening to pharynx

- The external portion is supported by a framework of bone and cartilage covered with skin and lined with mucous membrane.
- The internal portion is a large cavity in the skull, merging with the external nose anteriorly and communicating with the throat posteriorly.

Nasal cavity**:** It is a large space in the anterior aspect of the skull that lies interior to the nasal bone and superior to the nasal cavity. It is pyramidial in shape .

Anteriorly ,the nasal cavity merges with the external nose, posteriorly it communicate with the pharynx through two openings called the internal nares or conchae.

Structure forming nasal cavity:

1.Roof**:** Formed by cribriform plate of ethmoid , sphenoid ,frontal and nasal bones.

2.Floor**:** Formed by roof of mouth consists of hard palate in front and soft palate behind.

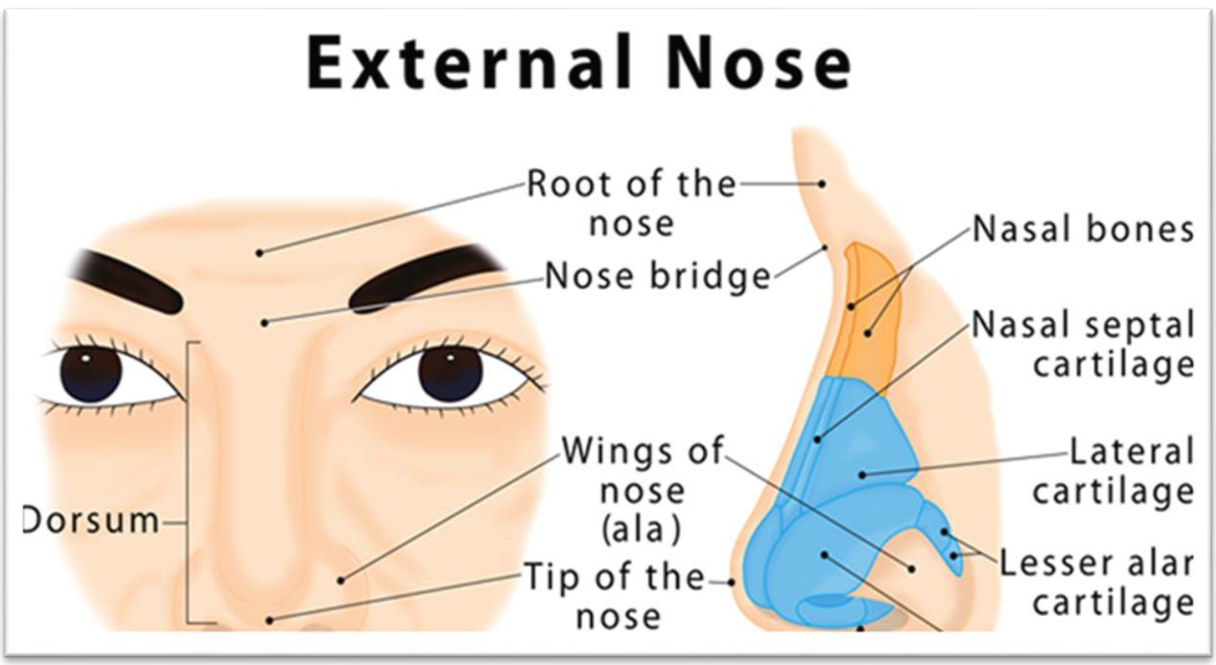
3.<u>Medial wall</u>**:** Formed by nasal septum.

4.<u>Lateral wall</u> **:** Formed by hyaline cartilage, ethmoid, maxilla, inferiorchonchae.

5.<u>Posterior wall:</u> Formed by the posterior wall of Pharynx.

<u>Functions of Nose:</u>

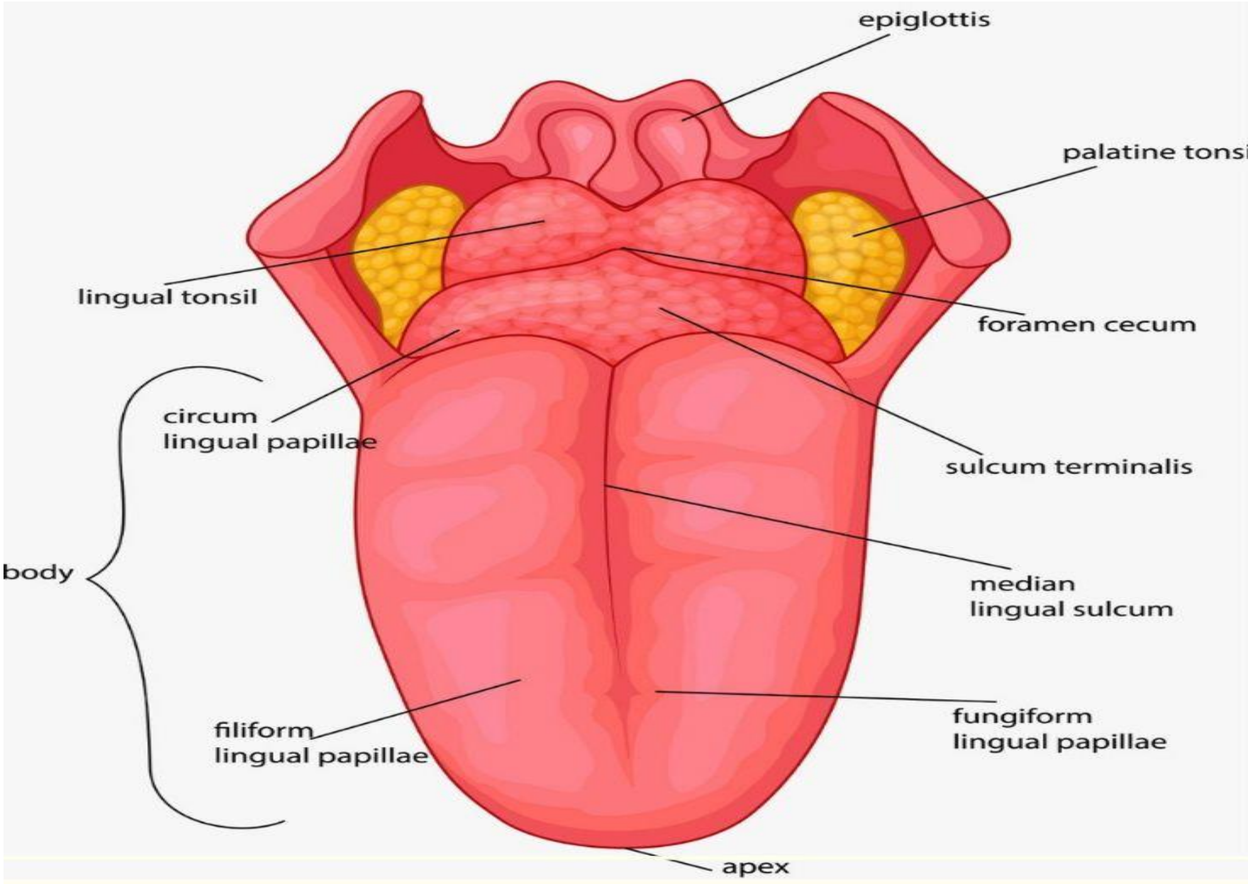
- Breathing
- Air conditioning of inspired air
- Protection of lower airway
- Olfaction
- Nasal resistance
- Vocal resonance
- Nasal reflexes
- Ventilation and Drainage of PNS



5)Structure and function of tongue.(5)

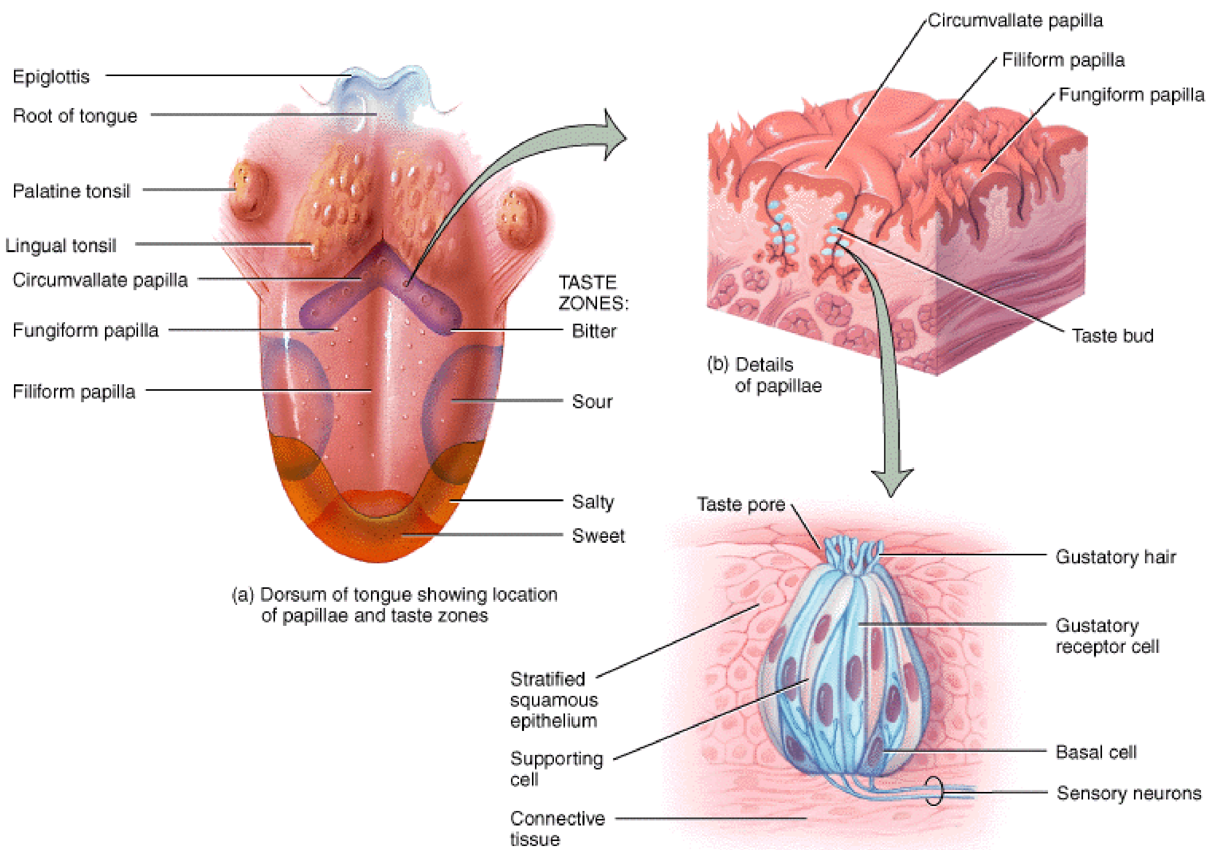
Structure and function of tongue:

- The **tongue** is a muscular organ in the mouth of most vertebrates that manipulates food for mastication and is used in the act of swallowing.
- It has importance in the digestive system and is the primary organ of taste in the gustatory system.
- The tongue's upper surface (dorsum) is covered by taste buds housed in numerous lingual papillae.
- It is sensitive and kept moist by saliva and is richly supplied with nerves and blood vessels.
- The tongue also serves as a natural means of cleaning the teeth.
- A major function of the tongue is the enabling of speech in humans and vocalization in other animals.
- The human tongue is divided into two parts, an oral part at the front and a pharyngeal part at the back.
- The left and right sides are also separated along most of its length by a vertical section of fibrous tissue (the lingual septum) that results in a groove, the median sulcus, on the tongue's surface.
- There are two groups of muscles of the tongue.
- The four intrinsic muscles alter the shape of the tongue and are not attached to bone.
- The four paired extrinsic muscles change the position of the tongue and are anchored to bone.



<u>Structure:</u>

- The tongue is a <u>muscular hydrostat</u> that forms part of the floor of the <u>oral cavity</u>. The left and right sides of the tongue are separated by a vertical section of fibrous tissue known as the <u>lingual septum</u>.
- This division is along the length of the tongue save for the very back of the pharyngeal part and is visible as a groove called the median sulcus.
- The human tongue is divided into <u>anterior and posterior</u> parts by the terminal sulcus which is a V-shaped groove.
- The apex of the terminal sulcus is marked by a blind foramen, the foramen cecum, which is a remnant of the median <u>thyroid diverticulum</u> in early <u>embryonic development</u>.
- The anterior *oral* part is the visible part situated at the front and makes up roughly two-thirds the length of the tongue.
- The posterior *pharyngeal* part is the part closest to the <u>throat</u>, roughly one-third of its length. These parts differ in terms of their <u>embryological development</u> and <u>nerve supply</u>.



(a) Dorsum of tongue showing location of papillae and taste zones

Nerve supply

- Innervation of the tongue consists of motor fibers, special sensory fibers for taste, and general sensory fibers for sensation.

- Motor supply for all intrinsic and extrinsic muscles of the tongue is supplied by efferent motor nerve fibers from the hypoglossal nerve (CN XII), with the exception of the palatoglossus, which is innervated by the vagus nerve (CN X).

Innervation of taste and sensation is different for the anterior and posterior part of the tongue because they are derived from different embryological structures (pharyngeal arch 1 and pharyngeal arches 3 and 4, respectively).

- Anterior two thirds of tongue (anterior to the vallate papillae):
  - Taste: chorda tympani branch of the facial nerve (CN VII) via special visceral afferent fibers
  - Sensation: lingual branch of the mandibular (V3) division of the trigeminal nerve (CN V) via general visceral afferent fibers
- Posterior one third of tongue:

- Taste and sensation: glossopharyngeal nerve (CN IX) via a mixture of special and general visceral afferent fibers

- Base of tongue
    - Taste and sensation: internal branch of the superior laryngeal nerve (itself a branch of the vagus nerve, CN X)

Lymphatic drainage

The tip of tongue drains to the submental nodes. The left and right halves of the anterior two-thirds of the tongue drains to submandibular lymph nodes, while the posterior one-third of the tongue drains to the jugulo-omohyoid nodes.

Function

- Taste
- Chemicals that stimulate taste receptor cells are known as tastants.
- Once a tastant is dissolved in saliva, it can make contact with the plasma membrane of the gustatory hairs, which are the sites of taste transduction.[1]
- The tongue is equipped with many taste buds on its dorsal surface, and each taste bud is equipped with taste receptor cells that can sense particular classes of tastes.
- Distinct types of taste receptor cells respectively detect substances that are sweet, bitter, salty, sour, spicy, or taste of umami.
- Umami receptor cells are the least understood and accordingly are the type most intensively under research.
- Mastication
- The tongue is an important accessory organ in the digestive system.
- The tongue is used for crushing food against the hard palate, during mastication and manipulation of food for softening prior to swallowing.
- The epithelium on the tongue's upper, or dorsal surface is keratinised.
- Consequently, the tongue can grind against the hard palate without being itself damaged or irritated.
- Speech

- The intrinsic muscles of the tongue enable the shaping of the tongue which facilitates speech.