Today, we are going to talk about the chemical sensations which include olfaction and gustation.

§ Olfaction: is The ability to sense odors through the detection of substances which have been aerosolized into the environment. in common words, its smell. § While,

Gustation: is The sensation which is produced by the interaction of taste receptors with solubilized chemical stimuli in the oropharyngeal cavity. in common words, that is taste

Lets start with olfactory system

Olfactory system start in the roof of the nasal cavity on the inferior surface of the cribriform plate where is The olfactory mucosa. It is composed of a superficial acellular layer of mucus that covers the olfactory epithelium and underlying lamina propria. The olfactory epithelium is contains three main cell types: olfactory receptor neurons, supporting cells, and basal cells.

Olfactory receptor neurons are bipolar neurons that has a single thin apical dendrite and a basally located unmyelinated axon. The apical dendrite extends to the surface of the epithelium, where it from cilia that protrude into the overlying mucus layer. These olfactory cilia contain receptors for odorant molecules. On the cell membrane of these cilia are odorant receptors, which are G protein coupled receptors that interacts with odorants and initiate the olfactory signal by generating graded potential or action potential. Humans has almost 1000 different types of odorant receptors which can bind and recognize 1000 different odorant.

all odorant receptors are 2nd-messenger type of receptors. As you know, One of the most important characteristics of the 2nd-messenger is signal amplification, which allows detection of lower thresholds of sensations since it is going to be amplified. And that's why olfaction is almost the most potent sensation in our body. Another characteristic of second messenger receptor is no adaptation, hence olfaction sensation has almost no receptor adaptation, and any adaptation is central adaptation.

The supporting cells are columnar epithelium cells that provide mechanical as well as environmental and chemical support for the olfactory receptor neurons. In addition, they contribute to the secretions of the overlying mucus that may play a role in the binding or inactivation of odorant molecules.

Finally, Basal cells: are undifferentiated stem cells that are responsible for the regeneration of both the neuronal and supporting cells. In fact, olfactory receptor cells undergo continuous turnover, with an average life Of one to two months. And They are replaced by new receptors arising from undifferentiated basal cells by mitotic division

The unmyelinated axon of an olfactory receptor neuron pass through the lamina propria and group together into bundles called olfactory fila, which collectively make up the olfactory nerve (cranial nerve 1) . these olfactory fila pass through the cribriform plate to terminate in the olfactory bulb.

The olfactory bulb, is a forebrain structure, that consists of five well-defined layers of cells

and fibers, which give it a laminated appearance. These layers and the names of the cells are not required to me memorized, again, it's not important to memorize the names of the layers or the cells in the olfactory bulb.

To continue with the olfactory pathway, the axons of the olfactory receptor neurons synapses with the second order neurons found in the olfactory bulb. However, these connections happen in a unique manner which has both convergence and divergence. The axons of several receptor neurons will converge on single second order neuron, which form what called glomeruli or a glomerulus as single, however, the same type of receptor neuron can also target several glomeruli. This formation will increase the complexity of olfactory sensation by making a combination of different receptor and let us recognize millions of smells. All this happen and processed at the level of olfactory bulb.

Also, in the olfactory bulb you can find fibers called centrifugal fibers. These fibers provide feedback to the olfactory bulb from the central nervous system and influence the processing taking place in the olfactory bulb by either sensitization or desensitization (in other word, adaptation).

If you put some perfume in the morning, you smelled it for couple of minutes, then you don't smell it any more. This is due to these fibers coming from the central nervous system to the olfactory bulb and performs inhibition of the glomeruli at the second-order neurons stopping it from sending signals , and hence you stop smelling the perfume any more. Many of these centrifugal fibers are originated from the sub-cortical division of the central nervous system , hence this process happen in unconscious or involuntary manner .

Continuing with the olfaction pathway,
the axons of second order neurons in the olfactory bulb will form the olfactory tract. The axons in the olfactory tract can be divided onto two different parts
first: the medial part which synapses with what called the anterior olfactory nucleus. This nucleus and its fibers will project to both the ipsilateral and contralateral olfactory bulb and influence the processing happen there

Second: The lateral part which will project directly to the central areas.

Several olfactory projections to the central will target subcortical areas such as, olfactory tubercle, piriform cortex, anterior cortical amygdaloid nucleus, periamygdaloid cortex, and lateral entorhinal, later ending up in the hypothalamus. Keep in mind that although these areas has the word cortex in their names, they are unconscious part of the brain as they are paleocortex, which phylogenetically older type of cortex that has three cell layers. These areas will be responsible for the involuntarily aspect of smell sensation such as emotions associated with certain smells, feeding reflexes and sexual behaviors. Never the less, almost 2 thirds of the olfactory track will go to the dorsomedial thalamic nucleus and terminate in the primary olfactory cortex located at Inferior and medial surface of temporal lobe. This neocortical connection of olfaction is important for conscious discrimination and identification of odors.

Complete The loss of smell sensation is called anosmia, while decreased sensitivity to odorants is called hyposmia olfactory hypesthesia. The most common cause is upper respiratory tract infections, and sinus disease. Nasal and paranasal diseases such (rhinitis, sinusitis) may block the access of odorants to the olfactory epithelium, leading to decrease olfactory sensation. In addition edema of the olfactory epithelium may be partly responsible for the olfactory dysfunction.

Head trauma can produce olfactory deficits by damaging central olfactory pathways or olfactory receptor axons as they pass through the cribriform plate. blows to the head can produce shearing movements of the olfactory bulb relative to the cribriform plate. Transection of the thin axons comprising the olfactory fila may result in a partial or total loss of smell. In many cases, this is temporary condition as the basal cells will form new receptor and regenerate the pathway and sensation will regain in couple of months, but in some cases the sensation loss will be permanent condition.

Olfactory hyposmia can also be associated with nasal polyps. Nasal polyps are noncancerous growths that occur in the nasal cavity or within the sinuses; a growth in a sinus may extend into the nasal cavity. Nasal polyps may result from inflamed mucous membranes or allergic reactions and can obstruct the nasal cavities. In these locations, polyps obstruct the flow of air and may cause a number of clinical problems, including a significant compromise of olfactory sense

Now

Lets talk about the taste sensation.

Taste start in taste receptor cells located in sensory organs called taste buds. Although they are found throughout the oropharyngeal cavity, taste buds are most obvious on the tongue. There are five types of taste receptors which can detect five different taste modalities which are, sweet, salty, sour, bitter, and umami.

It was once believed that different regions of the tongue were specialized for the detection of particular taste qualities. It is now known that all taste qualities are detected in all regions of the tongue, although sensitivity to the different taste qualities and taste transduction mechanisms may vary by tongue region

After the activation of taste receptor by the chemical stimuli, the taste information is carried to the central nervous system by the first order neurons of the taste pathway via three cranial nerves, the facial (cranial nerve 7), the glossopharyngeal (cranial nerve 9), and the vagus (cranial nerve 10).

Taste fibers traveling in cranial nerves 7, 9, and 10 will terminate in the brain stem and synapses with the second order neurons found primarily in the rostral portions of what called Solitary nucleus. The axons of these neurons will travel in ipsilateral manner via the solitary track to be part of the ipsilateral central tegmental tract and terminate on third order neurons in the ventral posteromedial nucleus of the thalamus. Axons from these neurons of the thalamus will then travel to the primary taste cortex found in the inner portion of the frontal operculum and anterior insular cortex. This pathway is responsible for the discriminative aspects of taste and.

Disorders of taste sensation
a complete loss of taste sensation is called Ageusia, which is rarely happened, in part because of the large numbers of nerves that relay taste information to the central nervous system. While decrease in taste sensitivity is what more frequently happen and called hypogeusia. Among the most common causes of hypogeusia is decreasing of saliva. Saliva isan important medium for the relay of chemical information to taste receptors. Diseases that affect the production of saliva will have an impact on taste sensation, including certain medications or radiation and chemo therapy for cancer treatments.

Taste changes have also been documented in the elderly as numbers of taste buds decrease and taste transduction mechanisms become less effective. These changes are often accompanied by alterations in eating habits. For example, a person may use more sugar in his or her coffee to compensate for reduced acuity of sweet stimuli.

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Flavor

Although we have only five taste modalities, we can still differentiate thousands of flavors. Flavor is commons misconception that taste equal flavor, while in reality taste and flavor are not the same thing.

taste is signaled by the action in the gustatory system, while flavor is complex perception that results from a combination of multiple sensations including olfaction, taste, somatosensory, and visual cues found in food and beverages. Flavor is maily processed in the orbitofrontal area, more specifically in the medial orbitofrontal cortex and lateral posterior orbitofrontal cortex, which recives processed information from several sensory cortical areas as well as emotional influencies and play important role in integrating these information in one experience which is flavor , that’s why you don’t appreciate the flavor of food while you are sick with cold, or why the potato chips does not feel delecios or the same when they are moist