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Chapter 1 : The Location, Structure and Function of Olfactory and Taste Receptors

On the basis of chemical analysis of a bouillon, the taste qualities and taste thresholds of the non-volatiles were estimated and the results used for stepwise imitation of a bouillon.

Specific questions should be asked about dryness of the mouth, periodontal disease, foul breath odor, recent dental procedures, recent radiation exposure, gastric reflux and medication use. Questions should also be directed at identifying any family history of systemic disease such as diabetes mellitus or hypothyroidism. Mucous membranes should be evaluated for dryness, leukoplakia and exudate. Oral candidal infections in immunocompromised patients e. The neurologic examination should include a careful evaluation of cranial nerve function. Specific signs of damage to cranial nerve VII may include taste alterations in the anterior two thirds of the tongue, decreased salivation, auditory hyperacusis resulting from paralysis of the stapedius muscle and facial paralysis on the ipsilateral side. Although the history is routinely used to screen for cranial nerve I impairment, specific olfactory testing may be helpful in evaluating the patient with suspected loss of smell. The most widely available olfactory test is the Smell Identification Test. The odors are released by rubbing the microencapsulated strips with a pencil. A detailed history is generally the best screening tool. Research centers often use four ready-made solutions containing sucrose sweet , sodium chloride salty , quinine bitter and citric acid sour to obtain information about taste discrimination. Plain radiographs have substantial limitations. These images do not provide sufficient detail for structures such as the osteomeatal complex. In particular, more detailed images are needed when endoscopic surgery is to be performed. Computed tomographic CT scanning is the most useful and cost-effective technique for assessing sinonasal tract inflammatory disorders. Coronal CT scans are particularly valuable in assessing paranasal anatomy. Scanning with thin cuts 5 mm is useful in identifying bony structures in the ethmoid, cribiform plate and olfactory cleft, as well as the temporal bone in proximity to cranial nerve VII or chorda tympani nerves; however, CT scanning is less effective than magnetic resonance imaging MRI in defining soft tissue disease. MRI is superior to CT scanning in the evaluation of soft tissues, but it poorly defines bony structures. MRI is the technique of choice for assessing the olfactory bulbs, olfactory tracts, facial nerve and intracranial causes of chemosensory dysfunction. It is also the preferred technique for evaluating the skull base for invasion by sinonasal tumors. Gadolinium enhancement is useful for detecting dural or leptomeningeal involvement at the skull base. Studies such as positron emission tomography and single photon emission computed tomography do not play a significant diagnostic role outside of major academic institutions.

Chapter 2 : Chemical Senses: Gustation

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Olfactory system In vertebrates , smells are sensed by olfactory sensory neurons in the olfactory epithelium. The olfactory epithelium is made up of at least six morphologically and biochemically different cell types. This may occur by diffusion or by the binding of the odorant to odorant-binding proteins. The mucus overlying the epithelium contains mucopolysaccharides , salts, enzymes , and antibodies these are highly important, as the olfactory neurons provide a direct passage for infection to pass to the brain. This mucus acts as a solvent for odor molecules, flows constantly, and is replaced approximately every ten minutes. In insects , smells are sensed by olfactory sensory neurons in the chemosensory sensilla , which are present in insect antenna, palps, and tarsa, but also on other parts of the insect body. Odorants penetrate into the cuticle pores of chemosensory sensilla and get in contact with insect odorant-binding proteins OBPs or Chemosensory proteins CSPs , before activating the sensory neurons. Receptor neuron[edit] The binding of the ligand odor molecule or odorant to the receptor leads to an action potential in the receptor neuron, via a second messenger pathway, depending on the organism. A calcium- calmodulin complex also acts to inhibit the binding of cAMP to the cAMP-dependent channel, thus contributing to olfactory adaptation. This mechanism of transduction is somewhat unusual, in that cAMP works by directly binding to the ion channel rather than through activation of protein kinase A. It is similar to the transduction mechanism for photoreceptors , in which the second messenger cGMP works by directly binding to ion channels, suggesting that maybe one of these receptors was evolutionarily adapted into the other. There are also considerable similarities in the immediate processing of stimuli by lateral inhibition. Averaged activity of the receptor neurons can be measured in several ways. In vertebrates, responses to an odor can be measured by an electro-olfactogram or through calcium imaging of receptor neuron terminals in the olfactory bulb. In insects, one can perform electroantennography or calcium imaging within the olfactory bulb. These nerve fibers, lacking myelin sheaths, pass to the olfactory bulb of the brain through perforations in the cribriform plate , which in turn projects olfactory information to the olfactory cortex and other areas. Mitral cells , located in the inner layer of the olfactory bulb, form synapses with the axons of the sensory neurons within glomeruli and send the information about the odor to other parts of the olfactory system, where multiple signals may be processed to form a synthesized olfactory perception. A large degree of convergence occurs, with 25, axons synapsing on 25 or so mitral cells, and with each of these mitral cells projecting to multiple glomeruli. Mitral cells also project to periglomerular cells and granular cells that inhibit the mitral cells surrounding it lateral inhibition. Granular cells also mediate inhibition and excitation of mitral cells through pathways from centrifugal fibers and the anterior olfactory nuclei. Neuromodulators like acetylcholine , serotonin and norepinephrine all send axons to the olfactory bulb and have been implicated in gain modulation, [8] pattern separation, [9] and memory functions, [10] respectively. The mitral cells leave the olfactory bulb in the lateral olfactory tract , which synapses on five major regions of the cerebrum: The anterior olfactory nucleus projects, via the anterior commissure , to the contralateral olfactory bulb, inhibiting it. The piriform cortex has two major divisions with anatomically distinct organizations and functions. The anterior piriform cortex APC appears to be better at determining the chemical structure of the odorant molecules, and the posterior piriform cortex PPC has a strong role in categorizing odors and assessing similarities between odors e. The orbitofrontal cortex mediates conscious perception of the odor citation needed. The three-layered piriform cortex projects to a number of thalamic and hypothalamic nuclei, the hippocampus and amygdala and the orbitofrontal cortex, but its function is largely unknown. The entorhinal cortex projects to the amygdala and is involved in emotional and autonomic responses to odor. It also projects to the hippocampus and is involved in motivation and memory. Odor information is stored in long-term memory and has strong connections to emotional memory. Since any one receptor is responsive to various odorants, and there is a great deal of convergence at the level of the olfactory bulb, it may seem strange that human beings are able to distinguish so many different odors. It seems that a highly complex form of processing must be occurring; however, as it can be shown that, while many neurons in the olfactory bulb and even the pyriform cortex and amygdala are responsive to many different odors, half the neurons in the orbitofrontal cortex are responsive to only one odor, and the rest to only a few. It has been shown through microelectrode studies that each individual odor gives a particular spatial map of excitation in the olfactory bulb. It is possible that the brain is able to distinguish specific odors through spatial encoding, but temporal coding must also be taken into account. Over time, the spatial maps change, even for one particular odor, and the brain must be able to process these details as well. Inputs from the two nostrils have separate inputs to the brain, with the result that, when each nostril takes up a different odorant, a person may experience perceptual rivalry in the olfactory sense akin to that of binocular rivalry. Accessory olfactory system[edit] Many animals, including most mammals and reptiles, but not humans, have two distinct and segregated olfactory systems: Behavioral evidence suggests that these fluid-phase stimuli often function as pheromones , although pheromones can also be detected by the main olfactory system. In the accessory olfactory system, stimuli are detected by the vomeronasal organ , located in the vomer, between the nose and the mouth. Snakes use it to smell prey, sticking their tongue out and touching it to the organ. Some mammals make a facial expression called flehmen to direct stimuli to this organ. The sensory receptors of the accessory olfactory system are located in the vomeronasal organ. As in the main olfactory system, the axons of these sensory neurons project from the vomeronasal organ to the accessory olfactory bulb , which in the mouse is located on the dorsal-posterior portion of the main olfactory bulb. Human incest avoidance[edit] See also: Body odor The MHC genes known as HLA in humans are a group of genes present in many animals and important for the immune system ; in general, offspring from parents with differing MHC genes have a stronger immune system. Fish, mice, and female humans are able to smell some aspect of the MHC genes of potential sex partners and prefer partners with MHC genes different from their own. Pre-adolescent children can olfactorily detect their full siblings but not half-siblings or step siblings, and this might explain incest avoidance and the Westermarck effect. When an odorant is detected by receptors, they in a sense break the odorant down, and then the brain puts the odorant back together for identification and perception. Because several receptor types are activated due to the different chemical features of the odorant, several glomeruli are activated as well. All of the signals from the glomeruli are then sent to the brain, where the combination of glomeruli activation encodes the different chemical features of the odorant. The brain then essentially puts the pieces of the activation pattern back together in order to identify and perceive the odorant. It demonstrates that the human olfactory system, with its hundreds of different olfactory receptors, far out performs the other senses in the number of physically different stimuli it can discriminate. During the process of mastication , the tongue manipulates food to release odorants. These odorants enter the nasal cavity during exhalation. The human tongue can distinguish only among five distinct qualities of taste, while the nose can distinguish among hundreds of substances, even in minute quantities. It is during exhalation that the olfaction contribution to flavor occurs, in contrast to that of proper smell, which occurs during the inhalation phase of breathing. The following are disorders associated with olfaction: Anosmia â€” inability to smell Hyperosmia â€” an abnormally acute sense of smell Hyposmia â€” decreased ability to smell Presbyosmia â€” the natural decline in the sense of smell in old age [37] Dysosmia â€” distortion in the sense of smell Parosmia â€” distortion in the perception of an odor Phantosmia â€" distortion in the absence of an odor, "hallucinated smell" Heterosmia â€" inability to distinguish odors [37] Olfactory reference syndrome â€" psychological disorder that causes the patient to imagine he or she has strong body odor Osmophobia â€" aversion or psychological hypersensitivity to odors Quantification in industry[edit] Nasal Ranger , an olfactometer, in use Scientists have devised methods for quantifying the intensity of odors, in particular for the purpose of analyzing unpleasant or objectionable odors released by an industrial source into a community. Since the s industrial countries have encountered incidents where proximity of an industrial source or landfill produced adverse reactions among nearby residents regarding airborne odor. The basic theory of odor analysis is to measure what extent of dilution with "pure" air is required before the sample in question is rendered indistinguishable from the "pure" or reference standard. Since each person perceives odor differently, an "odor panel" composed of several different people is assembled, each sniffing the same sample of diluted specimen air. A field olfactometer can be utilized to determine the magnitude of an odor. Many air management districts in the US have numerical standards of acceptability for the intensity of odor that is allowed to cross into a residential property. For example, the Bay Area Air Quality Management District has applied its standard in regulating numerous industries, landfills, and sewage treatment plants. In plants and animals[edit] The tendrils of plants are especially sensitive to airborne volatile organic compounds. Parasites such as dodder make use of this in locating their preferred hosts and locking on to them. Threatened plants are then able to take defensive chemical measures, such as moving tannin compounds to their foliage. The importance and sensitivity of smell varies among different organisms; most mammals have a good sense of smell, whereas most birds do not, except the tubenoses e. Among mammals, it is well developed in the carnivores and ungulates , which must always be aware of each other, and in those that smell for their food, such as moles. Having a strong sense of smell is referred to as macrosmatic. Figures suggesting greater or lesser sensitivity in various species reflect experimental findings from the reactions of animals exposed to aromas in known extreme dilutions. These are, therefore, based on perceptions by these animals, rather than mere nasal function. They were bred for the specific purpose of tracking humans, and can detect a scent trail a few days old. The second-most-sensitive nose is possessed by the Basset Hound , which was bred to track and hunt rabbits and other small animals. Bears , such as the Silvertip Grizzly found in parts of North America, have a sense of smell seven times stronger than that of the bloodhound, essential for locating food underground. Using their elongated claws, bears dig deep trenches in search of burrowing animals and nests as well as roots, bulbs, and insects. Bears can detect the scent of food from up to eighteen miles away; because of their immense size, they often scavenge new kills, driving away the predators including packs of wolves and human hunters in the process. The sense of smell is less developed in the catarrhine primates , and nonexistent in cetaceans , which compensate with a well-developed sense of taste. In many species, olfaction is highly tuned to pheromones ; a male silkworm moth, for example, can sense a single molecule of bombykol. Fish, too, have a well-developed sense of smell, even though they inhabit an aquatic environment. Salmon utilize their sense of smell to identify and return to their home stream waters. Catfish use their sense of smell to identify other individual catfish and to maintain a social hierarchy. Many fishes use the sense of smell to identify mating partners or to alert to the presence of food. Insect olfactory system[edit] Inbreeding avoidance[edit] Since inbreeding is detrimental, it tends to be avoided. In the house mouse, the major urinary protein MUP gene cluster provides a highly polymorphic scent signal of genetic identity that appears to underlie kin recognition and inbreeding avoidance. Thus, there are fewer matings between mice sharing MUP haplotypes than would be expected if there were random mating. Early scientific study of olfaction includes the extensive doctoral dissertation of Eleanor Gamble , published in , which compared olfactory to other stimulus modalities , and implied that smell had a lower intensity discrimination. A modern demonstration of that theory was the cloning of olfactory receptor proteins by Linda B. Buck and Richard Axel who were awarded the Nobel Prize in , and subsequent pairing of odor molecules to specific receptor proteins. Each odor receptor molecule recognizes only a particular molecular feature or class of odor molecules. Mammals have about a thousand genes that code for odor reception. Humans have far fewer active odor receptor genes than other primates and other mammals. There are, at present, a number of competing theories regarding the mechanism of odor coding and perception. According to the shape theory , each receptor detects a feature of the odor molecule. The weak-shape theory, known as the odotope theory , suggests that different receptors detect only small pieces of molecules, and these minimal inputs are combined to form a larger olfactory perception similar to the way visual perception is built up of smaller, information-poor sensations, combined and refined to create a detailed overall perception [citation needed]. According to a new study, researchers have found that a functional relationship exists between molecular volume of odorants and the olfactory neural response. However, the behavioral predictions of this theory have been called into question.

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Chapter 3 : Taste and Olfaction

Olfaction and Taste study guide by Cassandra_Law includes 33 questions covering vocabulary, terms and more. Quizlet flashcards, activities and games help you improve your grades.

In this article we will discuss about the Smell Receptors and Taste Receptors. The taste receptors are specialized cells that detect chemicals present in quantity in the mouth itself, while smell receptors are modified sensory neurons in the nasal passage which detect the volatile chemicals that get wafted up the nostrils from distant sources. These two types of receptors complement each other and often respond to the same stimulus. We can now guess why a very strong perfume leaves a peculiar taste in your mouth. The smell receptors can be as much as 3, times more sensitive than the taste receptors. The receptors of smell occur in a small patch of olfactory epithelium pseudo stratified epithelium located in the roof of the nasal cavity. The olfactory epithelium is yellowish in colour and consists of three types of cells. They act as sensory receptors as well as conducting neurons. Each cell is spindle shaped and has a thin apical dendrite that terminates in a knob which bears non motile cilia called olfactory hairs. Olfactory receptor cells are unique in that they are the only neurons that undergo turnover throughout adult life. These are columnar cells which lie between the olfactory receptor cells to support them. They have brownish yellow pigment similar to lipofuscin which gives the olfactory epithelium its yellowish colour. Anatomical cells that support other cells are called sustentacular cells. These are short cells that do not reach the surface. They give rise to new olfactory receptor cells to replace the worn out ones. This is an exception to the fact that neurons are not formed in the postnatal after birth life. The olfactory receptor cells survive only for about two months. The mucus also protects the cells from dust and bacteria. This leads ultimately to an action potential that is conducted to the first relay station in the olfactory bulb. The fibres of the olfactory nerves synapse with mitral cells second- order neurons in complex structures called glomeruli balls of yam. When the mitral cells are activated, impulses from the olfactory bulbs via olfactory tracts to main destinations e. Women often have a keener sense of smell than men, especially at the time of ovulation. Smoking damages the olfactory receptors. With ageing the sense of smell deteriorates. Hyposmia hypo- less, osmi- smell is a reduced ability to smell. The receptors for taste are found in the taste buds, mostly located on the tongue but also found on the palate, pharynx and epiglottis and even in the proximal part of oesophagus. The number of taste buds declines with age. Each taste bud is an oval body consisting of three kinds of cells. They bear at the free end microvilli projecting into the taste pore. The microvilli have special protein receptor sites for taste-producing molecules and come in contact with the food being eaten. The gustatory receptor cells taste cells survive only about 10 days and are then replaced by new cells. These cells lie between the gustatory receptor cells in the taste bud. They bear microvilli but lack nerve endings. These cells are found at the periphery of the taste bud. They produce supporting cells, which then develop into gustatory receptor cells. Specific chemicals in solution pass into the taste bud through the taste pore to come in contact with the protein receptor sites on the microvilli of the gustatory receptor cells. The latter set up nerve impulses in the sensory nerve fibres. The nerve fibres transmit the impulses to the taste centre in the brain e. The facial nerve VII serves the anterior two-thirds of the tongue, the glossopharyngeal nerve IX serves the posterior one-third of the tongue and the vagus nerve X serves the pharynx and epiglottis. Human tongue has four basic taste areas:

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Chapter 4 : Neural Pathways of Smell, Taste, and Touch

olfactory pathway is a major route for the penetration of neurotropic viruses into the central nervous system Currently, clinical diagnosis of SDAT in living persons is based largely upon.

Disorders of Taste And Smell The sensory receptors for special senses are localized rather than widely distributed, and they, like all sensory receptors, are specialized to respond to only certain types of stimuli. There are three different kinds of sensory receptors for the special senses. Taste and olfactory receptors are chemoreceptors, which are sensitive to chemical substances. Sensory receptors for hearing and equilibrium are mechanoreceptors, which are sensitive to vibrations formed by sound waves and movement of the head. Sensory receptors for vision are photoreceptors, which are sensitive to light energy. Taste The chemoreceptors for taste are located in specialized microscopic organs called taste buds. Most taste buds are located on the tongue in small, raised structures called lingual papillae, though some can be found in areas such as the soft palate , pharynx , and esophagus. A taste bud consists of a bulblike arrangement of rapidly adapting taste receptors, called gustatory epithelial cells, located within the epithelium of the lingual papillae. The taste bud possesses an opening called a taste pore. Taste receptors have hair like projections called gustatory hairs that extend through the pore and are exposed to chemicals on the tongue. Sensory axons leading to the brain are connected to the opposite end of the taste receptors. In order to activate the taste receptors, a substance must be dissolved in a liquid such as saliva. There are five confirmed basic tastes that can be detected by the tongue: The receptors for each basic taste are located across the tongue surface, which disproves the earlier belief that the basic tastes were mapped to specific regions of the tongue. It has been suggested that water is also a basic taste; however, not enough experimental data has been produced to support this claim. The many flavor sensations of food result from the stimulation of one or more taste receptors and, more importantly, the activation of olfactory receptors. The pathway of nerve impulses from taste receptors to the brain depends on where the taste receptors are located. Nerve impulses created by taste receptors on the anterior two-thirds of the tongue are carried by the facial nerve CN VII , while those created on the posterior one-third travel over the glossopharyngeal nerve CN IX. Nerve impulses created at the base of the tongue are carried by the vagus nerve CN X. These cranial nerves carry the nerve impulses to the medulla oblongata , from which the nerve impulses travel to the thalamus and on to the taste areas in the parietal lobes of the cerebrum. Smell The olfactory receptors are located in the superior portion of the nasal cavity , including the superior nasal conchae and nasal septum. The olfactory receptors, also called olfactory sensory neurons, are surrounded by the supporting epithelial cells of the olfactory epithelium. The distal ends of the olfactory receptors are covered with cilia that project into the nasal cavity, where they can contact airborne molecules. Chemicals in inhaled air are in a gaseous state and must dissolve in the mucus layer covering the olfactory epithelium in order to stimulate nerve impulse formation. The nerve impulses are carried by axons of the olfactory receptors, which form the olfactory nerves CN I , to the olfactory bulbs. Here they synapse with neurons that form the olfactory tract and relay the nerve impulses to the olfactory areas deep within the temporal lobes and at the bases of the frontal lobes of the cerebrum. It is common for a person to sniff the air when trying to detect faint odors. This is because the olfactory receptors are located superior to the usual path of inhaled air and additional force is needed to send larger amounts of air over the olfactory epithelium. Like taste receptors, olfactory receptors rapidly adapt to a particular stimulus. The human olfactory epithelium possesses approximately functional types of olfactory receptors. However, the average person can distinguish between 2, and 4, different odors. The ability to detect so many types of odors largely depends upon how the temporal lobes process the nerve impulses from various combinations of olfactory receptors. Studies have shown that women can detect, discern, and identify a wider range of odors than men. It is also possible with training to enhance your olfactory ability and potentially discern up to 10, different odors, an ability important for those in the wine industry. The decrease in odor detection that occurs with age, which is why the elderly tend to use more cologne and perfume, is a result of receptor loss and desensitization rather than temporal lobe dysfunction. Research suggests that the olfactory epithelium is capable of detecting human pheromones. Human pheromones, which have been found in apocrine sweat and vaginal secretions, have been shown to have influence over reproductive functions. For example, pheromones from one female have been shown to lengthen or shorten the menstrual cycle of exposed females. The olfactory epithelium is also highly regenerative owing to its direct exposure to the external environment. On average, an olfactory receptor lives only approximately 60 days before being replaced. Disorders of Taste And Smell Ageusia is a loss of taste function, meaning there is no perception of the five basic tastes, and is rare. Hypogeusia, or a reduced ability to taste, is more common and can be caused by zinc deficiency and chemotherapy. Dysgeusia, which is a distortion or impaired perception of taste, can be caused by taste bud distortion, pregnancy, diabetes, allergy medications like albuterol, zinc deficiency, and chemotherapy. Anosmia is the inability to detect odor. The loss can be for one odor or all odors. It may also be permanent or temporary depending upon the cause. Typical causes are inflammation of the nasal mucosa, blockage of the nasal pathways, damage to the olfactory nerve , or head trauma leading to temporal lobe damage. Hyposmia is a decrease in the ability to detect odors. Hyposmia is common with advanced age due to a decrease in olfactory epithelium regeneration or smoking. Dysosmia is distorted sense of smell. Parosmia, a type of dysosmia, occurs when an individual has altered smell perception, meaning that something normally pleasant is perceived as being unpleasant. Phantosmia occurs when an individual perceives an odor that is not present. These phantom smells can be clinical signs of migraine , mood disorders, schizophrenia , or epilepsy.

Chapter 5 : Olfaction And Taste (sensory System) Part 1

*Olfaction and Taste IX: Annals of the New York Academy of Sciences, Volume [Stephen D. (editor); Atema, Jelle (editor) Roper] on calendrierdelascience.com *FREE* shipping on qualifying offers.*

Each food activates a different combination of basic tastes 2. Most foods have a distinctive flavor as a result of their taste and smell occurring simultaneously 3. Other sensory modalities may contribute to a unique food-tasting experience a. Texture, temperature, pain sensitivity some hot and spicy flavors are actually a pain response C. Organs of taste a. Pharynx, palate and epiglottis have some sensitivity 3. Nasal passages are located so that odors can enter through the nose or pharynx and contribute to the perception of flavor D. Anatomy of the tongue 1. Bitter across the back b. Sour on side closest to the back c. Salty on side more rostral than sour d. Sweet across front a. Most of the tongue is receptive to all basic tastes i. Regions are most sensitive to a given taste 3. Each papillae has one to several hundred taste buds 4. Each taste bud has taste cells 5. Taste receptor cells 1. Form synapses with the endings of gustatory afferent axons near the bottom of the taste bud III. When taste receptor is activated by the appropriate chemical, its membrane potential changes a. Triggers the release of NT 3. Pass directly through an ion channel salt and sour b. Bind to and block ion channels sour and bitter c. Bind to and open ion channels some sweet amino acids d. Bind to membrane receptors that activate 2nd messenger systems that in turn open or close ion channels sweet and bitter B. Foods that are sour have high acidity low pH a. Causes NT release D. Molecules that are sweet bind to specific receptor sites and activate a cascade of 2nd messengers in certain taste cells 2. Molecules bind receptor 3. G-protein activates an effector enzyme-adenylate cyclase cAMP produced 4. Chemicals in the environment that are deleterious often have a bitter flavor a. Senses have evolved primarily to protect and preserve b. Ability to detect bitter has two separate mechanisms i. May result from this evolutionary pressure 2. Bitter tastant binds bitter receptor b. G-protein activates an effector enzyme-phospholipase C c. Taste Neural Pathway A. NT release from taste cells causes an AP in the gustatory afferent axon 2. Three different cranial nerves VII, IX and X innervate the taste buds and carry taste information from the tongue, palate, epiglottis and esophagus a. Efferent target of this information is gustatory nucleus in the medulla 3. Information is relayed to the thalamus VPM--ventral posterior medial nucleus 4. Information then goes to the primary gustatory cortex parietal lobe Chemical Senses:

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Chapter 6 : Free Unfinished Flashcards about Olfaction and Taste

Enter your mobile number or email address below and we'll send you a link to download the free Kindle App. Then you can start reading Kindle books on your smartphone, tablet, or computer - no Kindle device required.

This page contains a few, relatively straightforward points about taste and olfaction. Taste As shown to the right, each taste bud consists of a cluster of sensory cells forming synapses with neurons with long axons. The sensory cells release glutamate when stimulated by their corresponding taste. Scattered over the tongue, there are five classical types of taste buds: Salt and sweet are self-explanatory. The bitter respond to various plant alkaloids, sour to acid such as might be found in spoiled foods , and the umami to glutamate and some related substances. The receptors for sweet and bitter are in the category of 7 transmembrane domain proteins, which activate trimeric G proteins. The other types each has its own special type of receptor mechanism. Olfaction The olfactory system is far more sophisticated than taste. The sensory dendrites of the afferent neurons are in the nasal epithelium at the top of the nasal passages, just under the cribriform plate. Their axons extend through the olfactory foramina to the olfactory bulb. There are approximately different types of olfactory neurons, each with its own receptor. The receptors are again 7 transmembrane domain proteins, each coded by its own gene, of course. The axons from all the olfactory neurons of one type converge on one cluster in the olfactory bulb. There they form synapses with neurons with axons in the olfactory tract. The olfactory bulb actually is a lobe of the brain. You might not guess this in a human brain, but in lower vertebrates it is obvious, with the olfactory bulbs often being larger than the cerebral hemispheres. Taste information enters the brainstem and evokes rather simple behaviors, such as secreting saliva, or perhaps spitting something bitter out. Smell information, by contrast, projects into the medial temporal lobe near the midline of the cerebrum. This places it close to areas important in emotions and motivations. And corresponding to this, smells often call up complex, emotionally rich thoughts. For example, when I was a child, people burned leaves after raking them. Even today, the smell of a burning leaf calls up childhood images of fall days. I am sure you also can think of similar smells from your own life.

Chapter 7 : Smell and Taste Disorders: A Primary Care Approach - - American Family Physician

This page contains a few, relatively straightforward points about taste and olfaction. Taste. As shown to the right, each taste bud consists of a cluster of sensory cells forming synapses with neurons with long axons.

Like other sensory systems, olfactory and taste systems provide information regarding the external environment. The two sensory systems are anatomically and morphologically distinct. They are discussed together in this topic because their specialized sensory receptors are stimulated by chemical molecules, and the functions of the two systems often complement each other as special visceral afferents. For example, wine tasters typically depend on the sensation of taste flavor and olfaction smell to distinguish between different wines. Olfactory System Stimulus Chemicals that generate odors stimulate specialized receptors of the olfactory system. Human beings can detect these odors at very low concentrations a few parts per trillion ; thousands of such chemicals can be distinguished. Receptors Unlike in other sensory systems, the bipolar olfactory sensory receptor neurons are not located in a ganglion. Instead, these neurons, along with their processes, are present in the specialized olfactory mucosa of the nasal cavity just below a thin sheet of bone called the cribriform plate of the ethmoid bone of the skull Fig. The olfactory sensory neurons have single dendrites on one end that terminate in the surface of the olfactory mucosa as expanded olfactory knobs Fig. A single unmyelinated axon arises on the opposite end of the sensory neuron. Collectively, these axons are called the olfactory nerve cranial nerve [CN] I. The axons of olfactory sensory neurons do not form a single nerve as in other cranial nerves. Instead, small clusters of these axons penetrate the cribriform plate and synapse in the ipsilateral olfactory bulb. Sustentacular supporting cells present in the olfactory epithelium help in detoxifying chemicals that come in contact with the olfactory epithelium Fig B. A The bipolar olfactory sensory neurons are present in the olfactory mucosa just below the cribiform plate. B Note the location of olfactory receptor cells, including their expanded ends olfactory knobs , cilia arising from the olfactory knobs, the olfactory nerve, and supporting sustentacular cells. The steps involved in the sensation of olfaction are shown in Figure At least two second-messenger systemsâ€”cyclic adenosine monophosphate cAMP and inositol triphosphate IP3 â€”are involved in the transduc-tion of olfactory signals. When an odorant molecule binds to the receptor protein on the cilia, a receptor-odorant complex is formed, which activates a G protein. The olfactory binding protein carries odorant molecules to the cilia of the olfactory sensory neurons. A receptor-odorant complex is formed, which activates a G protein. This depolarization is conducted to the axon hillock of the olfactory sensory neuron where action potentials are generated, which are conducted along the axons of the olfactory sensory neurons. This depolarization is conducted passively from the cilia to the axon hillock of the olfactory sensory neuron. When the axon hillock reaches a threshold, action potentials are generated, which are conducted along the axons of the olfactory sensory neurons. These signals are processed in the central olfactory pathways for the sense of smell. Central Pathways The olfactory bulb lies bilaterally on the ventrorostral aspect of the forebrain Fig. It is the first region of the central nervous system where sensory signals from olfactory sensory neurons are processed. As noted earlier, the axons of the olfactory sensory neurons travel in olfactory nerves and spread over the surface of the ipsilateral olfactory bulb, forming an olfactory nerve layer Fig. Located near the surface of the olfactory bulb is the glomerular layer. Each glomerulus contains clusters of nerve terminals from olfactory sensory neurons, dendrites of the tufted cells located in the external plexi-form layer of the olfactory bulb , mitral cells located in the mitral cell layer , and y-aminobutyric acid GABA -ergic interneurons, called the periglomerular cells located in the glomerular layer of the olfactory bulb. The terminals of first-order olfactory sensory neurons form synapses with the dendrites of the tufted, mitral, and peri-glomerular neurons. The transmitters released at the terminals of olfactory sensory neurons are believed to be peptides. The inner plexiform layer of the olfactory bulb contains GABAergic interneurons called granule cells. The mitral and tufted cells discharge spontaneously. They are excited by the inputs from the olfactory sensory neurons. The inhibitory interneurons periglomerular and granule cells modulate the activity of the mitral and tufted cells. The signals from mitral and tufted cells are then conducted to forebrain structures for further processing. The projections of the axons of the mitral and tufted cells are shown schematically in Figure C. Olfactory tracts, located on the ventral inferior surface of the frontal lobe, arise from their enlarged ends known as the olfactory bulbs. The largest bundle of axons from the mitral and tufted cells exit from the olfactory bulb in the lateral olfactory tract, and their functions are mediated by the excitatory neurotransmitters, glutamate or aspartate. These axons project to the primary olfactory cortex pir-iform or pyriform cortex , amygdala, and entorhinal cortex. The entorhinal and piriform cortices, hippocampus,and amygdala are located in the temporal lobe; the hippocampus lies in the medial temporal lobe. The neurons in the piriform cortex, amygdala, and entorhinal cortex project to the prefrontal cortex. Note that the olfactory projection system differs from other sensory systems in that the projection pathway can reach the prefrontal cortex without having to make a synapse in the thalamus first, which is typical of other sensory systems. Neurons in the entorhinal cortex project to the hippocampus a major limbic structure via a fiber bundle called the perforant fiber pathway. Therefore, olfactory inputs can play an important role in modulating hippocampal functions in a manner similar to that for the amygdala. Although olfactory projections can reach the prefrontal cortex without making a synapse in the thalamus, there are direct tertiary inputs from the piriform cortex to the mediodorsal thalamic nucleus, which projects to wide areas of the frontal lobe, including the prefrontal cortex. A The axons of the olfactory sensory neurons project to the ipsilateral olfactory bulb via the olfactory nerve. C The axons of mitral and tufted cells in the olfactory bulb form the olfactory tracts. The largest bundle of fibers from mitral and tufted cells exit from the olfactory bulb in the lateral olfactory tract and project to the primary olfactory cortex piriform cortex , amygdala, and entorhinal cortex. The entorhinal and piriform cortices are located in the temporal lobe. The hippocampus lies in the medial temporal lobe. The amygdala lies just rostral to the hippocampus in the temporal lobe. The prefrontal cortex is located in the frontal lobe. Some fibers from the mitral and tufted cells exit the olfactory tract via the medial olfactory tract. For other details, see text. Some fibers from the mitral and tufted cells exit the olfactory tract via the medial olfactory tract Fig C. These axons project ipsilaterally to basal limbic forebrain structures, such as the substantia innominata, medial septal nucleus, and bed nucleus of the stria terminalis. Other fibers in the medial olfactory stria arise from the contralateral anterior olfactory nucleus. This nucleus, located in the posterior part of each olfactory bulb, receives sensory signals from mitral and tufted cells and relays them to the contralateral olfactory bulb via the anterior commissure. Spatial Organization A basic question concerns how we discriminate and become aware of different kinds of odors. While little is basically known about this process, it is believed that olfactory discrimination takes place, at least in part, within the olfactory bulb. It has been suggested that different glomer-uli that are located in spatially distinct parts of the olfactory bulb respond to specific odorants. In this manner, olfactory signals become topographically organized within the olfactory bulb much the same as other sensory modalities are topographically arranged i. This topographical arrangement, with respect to olfactory signals, provides a basis by which neuronal pools within the prefrontal cortex can receive and transform such signals into a conscious awareness of a specific odorant. From a functional perspective, we can, thus, say that affective and emotional aspects of olfactory sensation are mediated by olfactory projections to the limbic system entorhinal cortex, hippocampal formation, medial septal nuclei, and amygdala. Autonomic responses to olfactory stimuli are mediated via descending projections to the hypothalamus, midbrain periaqueductal gray, and auto-nomic centers of the lower brainstem and spinal cord. Clinical Conditions in Which the Olfactory Sensation is Altered In some cases of head trauma, the olfactory bulb moves with respect to the cribriform plate, and the axons projecting from the sensory neurons located in the olfactory mucosa to the olfactory bulb may be damaged. This results in a loss anosmia or reduction hyposmia of olfactory function. These conditions may also result from damage to the olfactory mucosa due to infections. Seizure activity involving parts of the temporal lobe produce olfactory hallucinations of unpleasant smells cacosmia. This condition is referred to as an uncinate fit. The neural structures affected in this condition are the uncus, parahippocampal gyrus, amygdala, and piriform and entorhinal cortices. Taste Stimulus As mentioned in the beginning of the topic, sensory receptors in this system are stimulated by chemical molecules. Basic sensations of taste include sweet, bitter, salty, and sour. The areas of the tongue most sensitive to different taste sensations are: The concept that specific areas of the tongue mediate specific taste sensations so called "taste map" of the tongue is not universally accepted, and it is currently believed that taste sensation arises from all regions of the oral cavity. Receptors The receptor cells that mediate the sensation of taste are located in taste buds, which are the sensory organs for the taste system. Taste buds are located in different types of papillae, which are protrusions on the surface of the tongue. The types of papillae include: The filiform and fungi-form papillae are scattered throughout the surface of the anterior two thirds of the tongue, especially along the lateral margins and the tip. The foliate papillae are present on the dorsolateral part of the posterior part of the tongue. The circumvallate papillae are larger than other papillae and are located in a V-shaped line, which divides the tongue into two portions: The taste buds are located in the lateral margins of the papillae that are surrounded by a deep furrow bathed by fluids in the oral cavity Fig. Each taste bud has a pore at its tip through which fluids containing chemical substances enter Fig. The taste bud contains taste receptor cells in different stages of development. The taste receptor cells live for about 10 days and have to be replaced. Small cells at the base of the taste bud basal cells divide to replace the taste receptor cells. Afferent nerve terminals make contact with the base of the taste receptor cells. A The regions of the tongue that are most sensitive to different taste sensations are: B The filiform and fungiform papillae are scattered throughout the surface of the anterior two thirds of the tongue. The circumvallate papillae are located in a V-shaped line that divides the tongue into the anterior two thirds and the posterior one third. C The taste buds are located in the lateral margins of the papillae. D Each taste bud has a pore at its tip through which fluids containing chemical substances enter.

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