Olfaction

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A primal sense for all animals, smell is a very intricate, complicated, and complex system. In terms of evolution smell is one of the first senses developed to allow vertebrates and other organisms with olfactory receptors to identify food, mates, predators, as well as provide sensual pleasure and warnings of danger. It is an important interaction humans perform in their surrounding environments.

The major anatomical part of the body involved in the mechanical process of smell is the nose and within it lies an intricate analyzing network. On the ceiling of the nasal cavity lies the olfactory mucosa (Region olfactoria), a 3-cm^2 patch of mucosa which contains three cell types. These cells include the olfactory receptor cells, supporting cells, and basal cells. The supporting cells secrete mucus to coat the nasal passages, the basal cells are precursors for new olfactory receptor cells. The olfactory receptor cell is an afferent neuron that has a receptor portion that lies in the olfactory mucosa of the nose and whose afferent axon transverses into the brain. The axons associated with the olfactory receptor cells makes up the olfactory nerve.[2]

The olfactory receptor cells are were the chemical For a Eacsynapse of smell begins. They are bipolar nerve cells with a peripherally directed dendrite which terminates in a knob that projects numerous cilia.[3] Extending to the surface of the mucosa the cilia contain binding sights for attachment of odorants, or inhaled aromatic molecules.[3] The process of using the odorants as chemical messengers varies depending on the flow and rate of air into the nasal passages.

During relaxed breathing, odorants reach the sensitive receptors by diffusion because the olfactory mucosa is above the normal path of air flow. Actively controlling breathing to force air through the nasal passages draws air current upwards within the nasal cavity, exponentially increasing the number of odiferous molecules that come into contact with the olfactory mucosa. Another passage includes odorants being wafted into the olfactory cilia through the pharynx while eating. For a substance to be identified it must be sufficiently volatile (easily vaporized) that some of it molecules can enter the nose in the inspired air and sufficiently hydrophilic so that the odorants can dissolve in the mucus coating of the olfactory[2], low polarity, and some lipophilicity.[1] It is necessary for the odorants to be dissolved if they are to be detected.

After the molecules have been dissolved the olfactory receptor cells initiate action potentials in response to the now dissolved chemical stimuli. "Intracellular studies show the presence of a slow rising receptor (generator) potential followed by a spike discharge from the receptor cell."[3] The human nose contains five million olfactory receptors, of which there are 1000 different types that dissect the odorant into various components.[1] As a scent signal attaches to its appropriate receptor an action potential is generated in the afferent fiber. The frequency of the potential is depended on the concentration of the chemical odor.[2] Each olfactory receptor neuron has 8-20 cilia[1] which assemble into small bundles and pass through the cribiform plate of the ethmoid bone reaching the olfactory bulb of the brain where they converge to terminate with the post-synaptic cells to form glomeruli. Odor discrimination is coded by patterns of activity in the olfactory bulb glomeruli, which allows for the distinction between over 10,000 scents. The glomeruli converge to form mitral cells from which the neural message is sent directly to the higher levels of the central nervous system in the cortico-medial amygdale portion of the brain where signaling process is decoded and olfactory interpretation and response occurs.[1]

Beyond the olfactory mucosa there are two sensory systems that are considerations in olfaction, the trigeminal or 5th cranial nerve and the vomeronasal organ. Trigeminal nerve receptors are involved with the olfactory epithelium. The fifth cranial nerve is responsible for sensory nerve of the tactility, pressure, pain and temperature sensation face, teeth, mouth, and most of the scalp provides neural information in relation to tactility, pressure, pain and temperature sensation. About 70% of all odors are said to stimulate the trigeminal nerve.[1] The vomeronasal organ (VNO) which has just recently been observed in humans is located about a half inch inside the human nose next to the vomer bone. It detects pheromones which are chemical signals that pass subconsciously from one individual to another. The role of the VNO in human behavior has not been validated but research suspects that it is responsible for spontaneous feelings between people, such as "love at first sight" or "bad chemistry."[2]

Resources:

1. Leffingwell, John C. "http://www.leffingwell.com/olfaction.htm" accessed 11/07. Leffingwell & Associates.
2. Sherwood, Lauralee. "Fundamentals of Physiology – A Human Perspective". 3rd ed. Brooks/Cole 2006.
3. "Olfactory Nerve". "http://www.med.yale.edu/caim/cnerves/cn1/cn1_5.html" Yale University School of Medicine. March 22, 1998. Accesses 11/07.