

Taste and smell

Smell and taste are phylogenetically old senses. Signals from these areas are important from the point of view of the individual's survival as well as the perception of pleasant experiences. Associated with these experiences is a vast area of associative learning.

Smell

In terms of physiology, we divide animals into microsmata (primates, humans) and macrosmata (e.g. canids). While sight is the most important sense in humans, animals that also have it well developed (cats, dogs) orientate themselves most by smell. A person is able to distinguish about **10 000 smells**.

The olfactory epithelium is in a small area in the nasal cavity, only a little air flows around it during inhalation, so we feel better when we simply "sniff" - a short turbulent flow of air. Sensations also reach the olfactory epithelium during chewing. **Taste and smell are connected**. If a person loses their sense of smell, they cannot adequately distinguish tastes with their eyes closed.

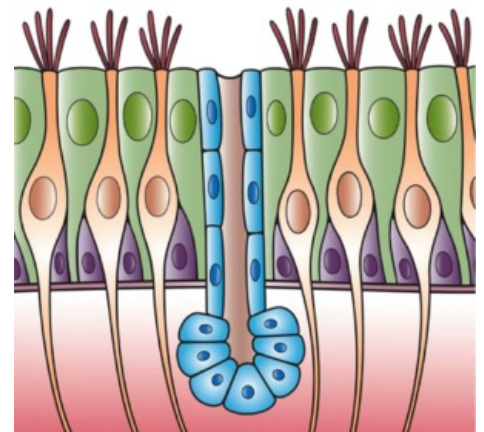
The olfactory epithelium contains supporting cells and mucus-forming cells. It helps to clean the surface of the mucous membrane. The cells are **bipolar neurons**. Their single dendrite points to the mucosal surface. The surface is covered with fine cilia that are **wetted with mucus**. Axon on the other hand, goes to the olfactory bulb. Cells are **replaced every 60 days** (as single neurons).

Mechanism of transduction

First, the odorant binds to **OBP (odorant binding protein)**, making it **soluble in water**. Next, OBP binds to a G protein-coupled receptor. The G-protein subunit **G_{olf}** (binding GDP) is activated. In this process, the exchange for GTP is catalyzed. This will **activate adenylyl cyclase**. The resulting cAMP **opens non-selective channels**, allowing mainly **Ca²⁺ and Na⁺** ions to enter intercellular space. The transfer of these ions leads to **membrane depolarization**. Depolarization spreads through the dendritic part of the neuron. After reaching the initial segment, an action potential is generated.

The increased concentration of calcium ions **activates phosphodiesterase**, which inactivates adenylyl cyclase. This conditions the return transfer of calcium ions from the cell and **the return to the original state**.

One receptor cell carries many receptor molecules for different odors. Receptors are encoded by 1% of the genome, which is even more genes than are needed for Ig. The receptor crosses the membrane seven times and subunits III, IV and V are variable. About 1,000 different olfactory receptors are formed. Humans are also very sensitive to smells. Some gases in higher concentrations (ammonia) can directly irritate the trigeminal nerve.



Structure of the olfactory epithelium: bipolar receptor cells with cilia, support cells (green) and stem cells (purple) in between

Scent

Complex mixtures of volatile substances. Quality is determined by the presence of various substances and their ratios. We distinguish 8-30 basic types of olfactory qualities. Their **combination** (unpleasant smells together can be pleasant), and **concentration** (indole is contained in a high concentration in dog excrement, in small quantities it smells like flowers) also play a role.

Adaptation to olfactory stimuli is fast - limiting the perception of some smells. In old age, the sensitivity of smell decreases. Smokers' sense of smell worsens.

Olfactory tract

In the bulb there are mitral cells whose axons continue as the tractus olfactorius. The olfactory pathways from the bulb go to different areas - the piriform cortex area. Some of the fibers go to the entorhinal cortex and also to the amygdala. Those areas of the cortex that receive direct fibers from the tract = primary olfactory cortex. From the primary cortical olfactory area further to the hippocampus, hypothalamus, septum verum.

The strength of olfactory traces is the most prominent of all sensory perceptions (we remember that we smelled a scent when we were small). The sense of smell is closely related to human survival - it helps us find food and plays a role in reproduction.

Smell disorders

- *Anosmia* – absence of smell.
- *Hypo- and hyperosmia* – reduced and increased ability to smell.
- *Phantosmia* – the olfactory perception of something that has no basis, is not given by an external stimulus.
- *Unciform crisis* – a sensation when a person smells unpleasant odors such as burnt tar, etc., we should suspect a tumor in the area of the uncus hippocampi.

Taste

Taste receptors are located at the point of food entry, i.e. on the tongue, on the palate of pharynx and even in the upper part of the esophagus. The receptors are found in the **taste buds**. They are renewed from the basal cells every 14 days.

As for taste, 4 basic tastes were traditionally mentioned – **salty, sweet, sour and bitter**. In 2000, the Japanese introduced the taste of "umami", which in Japanese means delicious taste, most likely it is the taste of glutamate.

It is possible that there are also other tastes, for example fat (fats), thermal tastes (hot food tastes different and cold food tastes different), etc.

Also, there are two different opinions where the perception of tastes is located - sweet taste should be at the tip, sour and salty at the sides, and bitter at the base of the tongue. Some authors claim that the flavors are evenly distributed.

In order for a substance to be perceived as a taste, it must be **soluble in water**.

Transduction

- **Sour taste** – given by H^+ ions, they block K^+ outflow ion channel in the apical membrane.
- **Salty taste** – Na^+ ions, higher concentration → pass passively through the still open Na^+ channels into the cells and on the other side are actively pumped by ATPase.
- **Sweet taste** – sugars activate the receptor, adenylyl cyclase is activated and cAMP blocks K^+ channels on the basolateral membrane.
- **Bitter taste** – release of intracellular Ca^{2+} .

All these events ultimately lead to an influx of Ca^{2+} and the formation of a receptor potential. AP frequency reflects the intensity of the stimulus. The formation of perception is complicated. Cells respond to more than one taste stimulus and to different types of stimuli respond differently. Receptor potential can manifest itself as:

- hyperpolarization;
- hyperpolarizing – depolarizing;
- depolarizing.

The evaluation of the resulting taste impression takes place only in the brain.

The flavor track

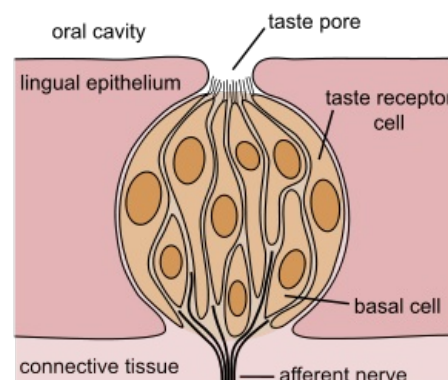
At the basal end, receptor cells are in contact with a unipolar neuron located in the ggl. geniculi (n. facialis). GGgl. inferior IX. et X. are terminated in the taste centers of the brain stem (ncl. gustatorius). Further to the thalamus, to the VPM and from there to the cortex, to the taste area, which is located in the insula area. Another part projects to the RF nuclei in the brain stem and to the limbic system (especially the hypothalamus).

These pathways also control reflexes (salivation, swallowing, secretion of other glands, motility of the digestive tract). Limbic system is connected with experience and also, for example, with the search for food.

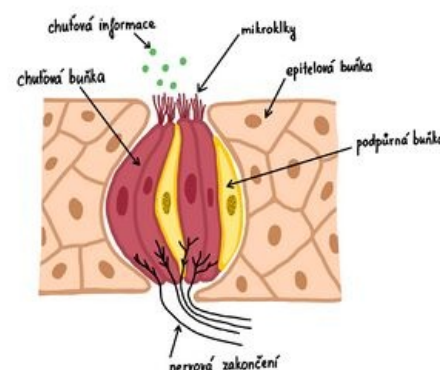
In old age, with smoking and also with pathological processes, the taste may be less perceived.

Disorders

- *Ageusia* – we do not perceive some substances at all, others normally.
- *Hypo- a hypergeusia*.
- *Dysgeusia* – a change in the perception of certain tastes.
- *Taste pseudohallucinations*



Taste bud structure in the epithelium of the tongue: hair receptor cells receiving signals from the taste bud, with supporting and basal cells in between



Taste bud

Links

Related articles

- Olfactory tract
- The flavor track
- Smell disorders

References

- MYSLIVEČEK, Jaromír. *Chuť a čich* [lecture for subject Fyziologie, specialization Všeobecné a zubní lékařství, 1.LF Univerzita Karlova]. Praha. 3.4.2013.
- TROJAN, Stanislav, et al. *Lékařská fyziologie*. 4. edition. Grada, 2003. 772 pp. ISBN 80-247-0512-5.

recommended literature

- MYSLIVEČEK, Jaromír. *Základy neurověd*. 2. edition. Triton, 2009. ISBN 978-80-7387-088-1.