Sensory Receptors

A sensory system is a part of nervous system responsible for processing sensory information. It enables us to detect changes in our own body objects and events in world around us. The information about the changes within the body is used to maintain **homeostasis**.

⇒ A sensory system consists of sensory receptors, neural pathways and parts of the brain involved in the sensory perception. Commonly recognised sensory systems are those for vision, hearing, touch, taste and olfaction.

⇒ The sensory receptors which report sight, sound, and chemicals in the outer world are used to find food, shelter, mate, safety from enemies, and other adaptive responses to environment.

⇒ The sensory system consists of simple to complex structures called **sensory receptors**. These sensory receptors enables us to detect changes in our own body and objects and events in the world around us.

⇒ All sensory receptors are similar in basic structure. The simplest and most primitive type of sensory receptors is a single unspecialised sensory neuron whose terminal end is capable of detecting stimuli. It is called primary sense cell. **Olfactory cells** belongs to this category.

⇒ The more complex sensory receptors are modified epithelial cells able to detect stimuli. These receptors are termed secondary sense cells. They form synaptic connections with the sensory neurons which transmit impulses to the CNS. Mammalian **taste buds** are receptors of this type.

⇒ The most complex sensory receptors consists of numerous sense cells, sensory neurons and associated accessory structures. They are K/a. **sense organs**. Eye and Ey Ears have a level of complexity of sense organs.

Working of Sensory Receptors:- ⇒ A stimulus is some form of energy:- light, sound, pressure, heat osmotic potential, electric current and chemical changes. Each type of receptor is sensitive to a particular kind of stimulus. An animal responds to a stimulus in a four step process:-

(i) **Sensory transduction**:- ⇒ Sensory receptors transduce (transform) the energy of a stimulus into a localized non-propagated electrical response which initiates nerve impulses in the neuron leaving the receptor.

(ii) **Transmission**:- ⇒ The sensory neuron relays the impulse to the brain directly or through the spinal cord.

(iii) **Integration**:- ⇒ Nerve impulses (action potentials, often called receptor potentials) that reach the brain via sensory neuron are termed Sensations. In the brain, the sensations are analysed and interpreted as perceptions. Thalamus is the main and the --- Cerebral Cortex is the subsidiary centre of this analysis. The brain transmits motor impulses to appropriate **effector** muscles or glands.

(iv) **Response**:- Effectors produce suitable responses. Muscles contract, or glands secrete chemicals, in response to the information sent to the brain by the receptors.

Properties of Receptors :-

(i) **Differential Sensitivity** :- each receptor is sensitive to a specific stimulus. the receptor is designed for sensitivity to this stimulus and does not respond to other types of stimuli in normal strength. This specific stimulus is called as the adequate stimulus for that receptor organ.

(ii) **Relation with strength of Stimulus** :- As strength ↑↑ the freq. of discharge rises and sensation becomes more intense.

(iii) **Adaptation** :- If a sensory organ is stimulated for some time then the frequency of discharge from that organ is gradually declined though the constant stimulation is continued. This phenomenon is K/as adaptation. There are slowly adapting receptors and rapidly adapting receptors. In slowly adapting receptors (also called tonic receptors) like the muscle spindles, with the onset of stimulation the frequency of discharged is increased initially but declines slowly. On the other hand in rapidly adapting receptors (also called phasic receptors) like the hair receptors of the skin or of the Pacinian Corpuscle the frequency of discharge is ↑↑ initially but declines abruptly and become silent although the stimulation is applied constantly.

Classification :- Receptors are classified under two major divisions of sensory system. These are :-

(i) **General sensory System** :- Comprises of receptors in the skin, joints, skeletal muscles and internal organs.

(ii) **Special Sensory System** :- Comprises of receptors present in highly complex organs like eye, ear, nose and tongue.

(A) Classification of receptors according to their location :-

(I) **Exteroceptors** :- they are usually located near the surface of the body and they detect changes in the surroundings. Receptors for touch, heat, cold, light and sound are examples of exteroceptors. Bare nerve endings in the skin that detect pain are also exteroceptors.

(II) **Proprioceptors** :- they are located in the skeletal muscles, joints, tendons etc. the structure in which they lies are not in direct contact with the environment but may be affected by the env. factors. It is from these receptors that we know the position of our arm or leg without having to look at it. two types of muscle receptors are muscle spindle & Golgi tendon organ.

(III) **Viscero receptors or Internal receptors** :- they are located in viscera, they are affected by the stimuli originating within the body itself and cause sensation, such as pain, hunger, thirst, fatigue, nausea, sex etc. they also monitor blood pressure, Co_2 level, body temp, osmotic relationships, pH etc. they are simple and mostly consists of free nerve endings.

(B) Classification of the receptors according to the type of stimuli they receive :-

the receptors are of 5 main types :-

(I) Mechano-receptors (II) Photoreceptors (III) Chemo receptors (IV) Electro-receptors (V) Thermoreceptors

Types of Receptor :→

Name of Receptor.	Types and Stimulated by	Examples.
I. Thermoreceptor they respond to change in temperature.	(A) For Cold :- Low temp (10-20°C) (B) For Heat :- High temp (25-40°C) } Both are more numerous on face and hands than elsewhere	End bulb of Krause in skin (also called frigdoreceptors) Ruffini organs in skin (also called Calo receptors).
II. Mechanoreceptors for mechanical stimuli, they are stimulated by mechanical deformation like touch, pressure	(A) Tangoreceptors (located in the skin) Touch and Pressure	(i) Meissner's Corpuscle. (ii) Merkel's disc. (iii) Basket nerve ending (K/a root hair plexus present in hairy skin area.) } ⇒ For light touch and air movement. (iv) Pacinian Corpuscles :- for pressure (deep).
	(B) Phonoreceptors (sound waves)	→ Organ of Corti in internal ear.
	(C) Statoreceptors (Accelerations and gravity).	→ Hair cells in Cristae and maculae in internal ear.
	(D) Algesireceptors (Pain)	→ Free nerve endings.
	(E) Proprioreceptors (Position of parts of body)	→ Free nerve endings, neuromuscular and neurotendinous spindles.
	(f) Rheoreceptors (Pressure waves and water currents)	→ Lateral line sense organs in fish.
III. Photoreceptors (for visual stimuli, stimulated by light).	Light wave lengths (electromagnetics)	Retina in vertebrate eye, Ommentidia in compound eye of arthropods.
IV. Chemoreceptors stimulated by chemical influences.	(A) Gustato-receptors - taste due to chemical in solution (B) Olfactory receptors :- smell due to volatile chemicals.	taste buds of tongue. Olfactory epithelium. Ampulla of Lorenzini (Scoliodon)
V. Electroreceptors	effective Currents in surrounding water.	Organs in skin of some fishes.

Sensory Receptors:→ Mainly divided into 2 types:-

(A) Chemical receptors:- are also of 2 types.
(i) Taste bud for taste (ii) Olfactory cells for smell

(B) Telereceptors:- distance receptors also of 2 types:-
(i) Rods and cones for vision (ii) Organ of Corti for hearing

Gustatoreceptors (Taste receptors):→ The receptor cells for taste (gustation) occurs in groups called taste buds the taste buds mostly lie in the mucous membrane that lines the grooves around the papillae on the tongue.

⇒ A papilla may contain a few to about a 100 taste buds, and there are about 10,000 taste buds on the entire tongue. Some taste buds also occur in the mucous membrane of the pharynx, palate and epiglottis.

⇒ Receptors for taste buds are innervated by the branches of the facial and glossopharyngeal (cranial nerve VII & IX), the facial nerve innervates the anterior (front) 2/3 of the tongue and the glossopharangeal nerve innervates the posterior 1/3 of tongue. Another cranial nerve Vagus (X) carries taste infor:- from back part of the mouth.

⇒ Another term for taste bud is **Gustatory sensillum**.

Structure of taste bud:→ A taste bud is a barrel-shaped structure about 50 µm in size, it lies embedded in the stratified epithelium of the tongue, opening on the surface by a minute taste pore. It is composed of about 60 to 70 long and narrow crescentic cells.

⇒ The cells are of two types:- receptor and supporting cells both types of cells are replaced from basal cells that lie at the periphery of the bud and move to the middle.

(i) **Receptor cells** (about 5-15):- these are called taste or gustatory cells/gustatoreceptors, they bear at the free end microvilli projecting into the taste pore. the microvilli have receptor sites for taste-producing molecules, and come in contact with the food being eaten. Nerve fibres of the cranial nerves VII, IX or X end around the taste cells, forming synapses with them, the taste cells survive only 7 to 10 days and then replaced by new ones.

(ii) **Supporting cells** (about 40):- These lie between the taste cells in the taste bud. they bear microvilli but lack nerve endings.

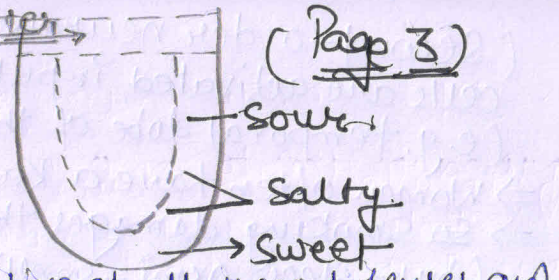
Working:→ the gustatory cells functions as chemoreceptors.

⇒ They are stimulated by specific chemicals in solutions. the solution is formed in the mucous and saliva that covers the tongue. It passes into the taste bud through the taste pore to come in contact with the microvilli of gustatory cells. The latter transform the chemical stimuli into a generator potential, which sets up nerve impulses in the sensory nerve fibres.

⇒ The nerve fibres transmit the impulses assoc:- with the gustatory cells to the brain stem. From here the nerve stimuli are relayed by other neurons to the taste centre located in the cerebral cortex, where the sensation of taste arises.

Basic tasts:→ Only for tasts can be distinguished the 4 basic tasts are:- sweet, sour, salty and bitter. though all of the taste buds are slightly sensitive to each of the 4 basic tasts, those in certain areas of the tongue are particularly sensitive to one type of chemical.

=> The taste buds on the tip of tongue respond best to sweet substances. The taste buds on the tips and sides of the tongue are sensitive to salts. The taste buds on the sides of tongue are most sensitive to acids which the brain interprets as being Sour. The taste buds at the back of the tongue are sensitive to bitter substances such as quining.



Olfactoreceptors (Smell receptors):- Olfactory sensation is the most primitive of all special senses and is much more acute than taste.

=> The receptors for smell occur in a small (about 2.5 cm^2) patch of olfactory neuroepithelium located in the roof of the nasal cavity. The free nerve endings of Cranial nerve V are located diffusely throughout the nasal respiratory epithelium, including regions of the olfactory neuroepithelium.

Rhinology:- is the study of the nose and its diseases (G. rhis = nose, logos = discourses).

Rhinoscope:- Instrument to examine the interior of the nose. In many animals the sensation of smell is much more acute than in man, such animals are called macrosmatic. In such animals the olfactory sense plays an important role in protecting the animals from enemies, search of food and in the reaction of sex, in comparison to them man is microsmatic.

Structure of olfactoreceptor:- Olfactory epithelium (also called Schneiderian membrane) is a modified pseudostratified epithelium, it is yellowish in colour and has 3 types of cells:- receptors cells, Supporting cells and basal cells, resting on a thick lamina propria.

(i) Receptor cells:- these are also called olfactory cells or olfactoreceptors, they act as sensory receptors as well as conducting neurons. they are spindle-shaped bipolar neurons with rounded nuclei in the middle region. olfactory receptor cells are unique in that they are the only neurons that undergo turn over throughout adult life.

(ii) Supporting cells:- these are columnar cells with large oval nuclei. They lie b/w the olfactory cells to support them.

(iii) Basal cells:- These are small cells that do not reach the surface. They give rise to new olfactory cells to replace the worn out ones. The olfactory cells survive only for about 2 months.

Olfactory glands (Bowman's glands):- Many olfactory glands occur below the olfactory epithelium that secrete mucus to spread over the epithelium to keep it moist. The mucus also protects the cells from dust and bacteria.

Working of olfactoreceptors:- The dissolved chemicals stimulate the olfactory receptors by binding to protein receptors in the olfactory hairs (cilia) membranes and opening specific Na^+ and K^+ channels. This leads ultimately to an action potential that is conducted to the first relay station in the olfactory bulb. The fibres of the olfactory nerve synapse with mitral cells

(Second-order neurons) in complex structures called glomeruli (balls of yarn). When the mitral cells are activated, impulses from the olfactory bulbs move via olfactory tracts to main destinations (e.g. temporal lobe of the cerebrum).

⇒ Women often have a keener sense of smell than men, especially at the time of ovulation.

⇒ So smoking damages the olfactory receptors. With ageing the sense of smell deteriorates. Hyposmia (hypo-less, osmi-smell) is a reduced ability to smell.

Jacobson's Organs (Vomero-nasal organs) :→ These are additional olfactory organs that are found in amphibians and reptiles. They are absent in rabbit but occur in certain lower mammals. In man these are vestigial. They are best developed in snakes.

:- Disorders of Smell and taste :→

(I) Anosmia :→ Loss of ability to smell is called anosmia. Head injuries involving the cribriform plate or tumours damaging the sensory pathway may cause anosmia. damage of the olfactory receptors in the nasal mucosa by upper respiratory infections may lead to anosmia. Cribriform plate is the horizontal plate of ethmoid bone perforated with numerous foramina for the passage of the olfactory nerve filaments from the nasal cavity.

(II) Hyperosmia :→ ↑↑ sensitivity to odours.

(III) Dysosmia :→ Disagreeable or distorted sense of smell.

(IV) Hyposmia :→ Diminished sense of smell.

(V) Anosea :→ Lack of sense of smell.

(VI) Hypogeusia :→ Diminished sense of taste.

(VII) Ageusia :→ Loss of the sense of taste. (eg. ↑ whales)

(VIII) Dysgeusia :→ Distorted sense of taste.

(IX) Sinusitis :→ an infection of the sinuses (cavities, or air filled pockets) near the nose. These infections usually occur after a cold or after an allergic inflammation. Sometimes a sinus infection happens after an upper respiratory infection (URI) or common cold.

(X) Rhinitis :→ Inflammation of the nasal mucous membrane.

(XI) Rhinorrhoea :→ Nasal flow.