ZOOCC-408

SL

B.Sc. 2nd year (IVth Sem)

Classification of Receptors

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RECEPTORS

SENSATION – conscious or subconscious awareness of external or internal stimuli.

RECEPTORS – sensory nerve terminals that receives stimuli & relays them to the CNS (brain & spinal cord).

- any structure specialized to detect a stimulus.

- ***General Properties of Receptors:***

- All sensory receptors are transducers.

- Transducer – is any device that converts one form of energy to another.

- Sensory transducers – converts stimulus energy into electrochemical energy = ***action potential***

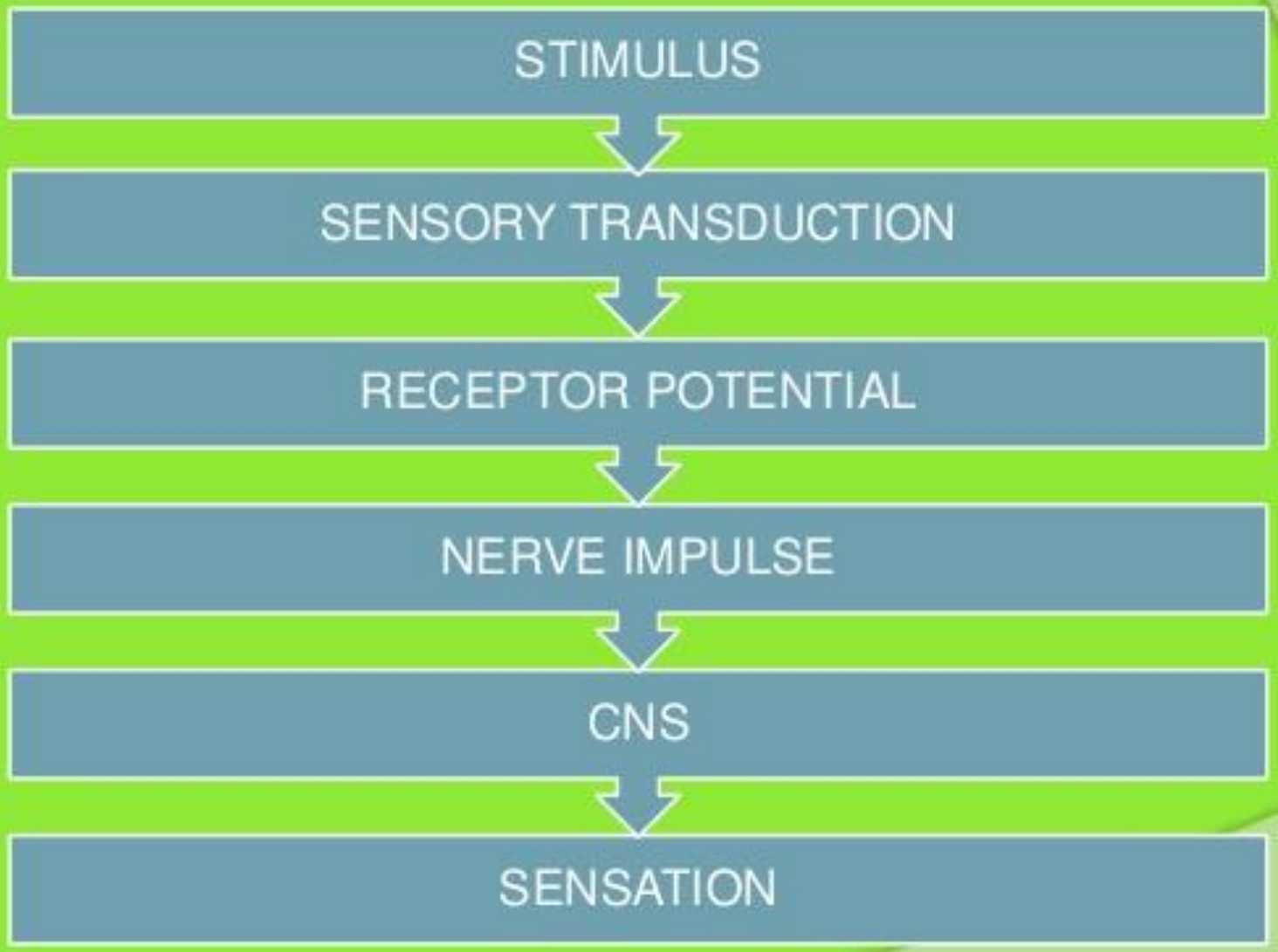
- Action potentials – a meaningful pattern of electrochemical energy from the converted stimulus.

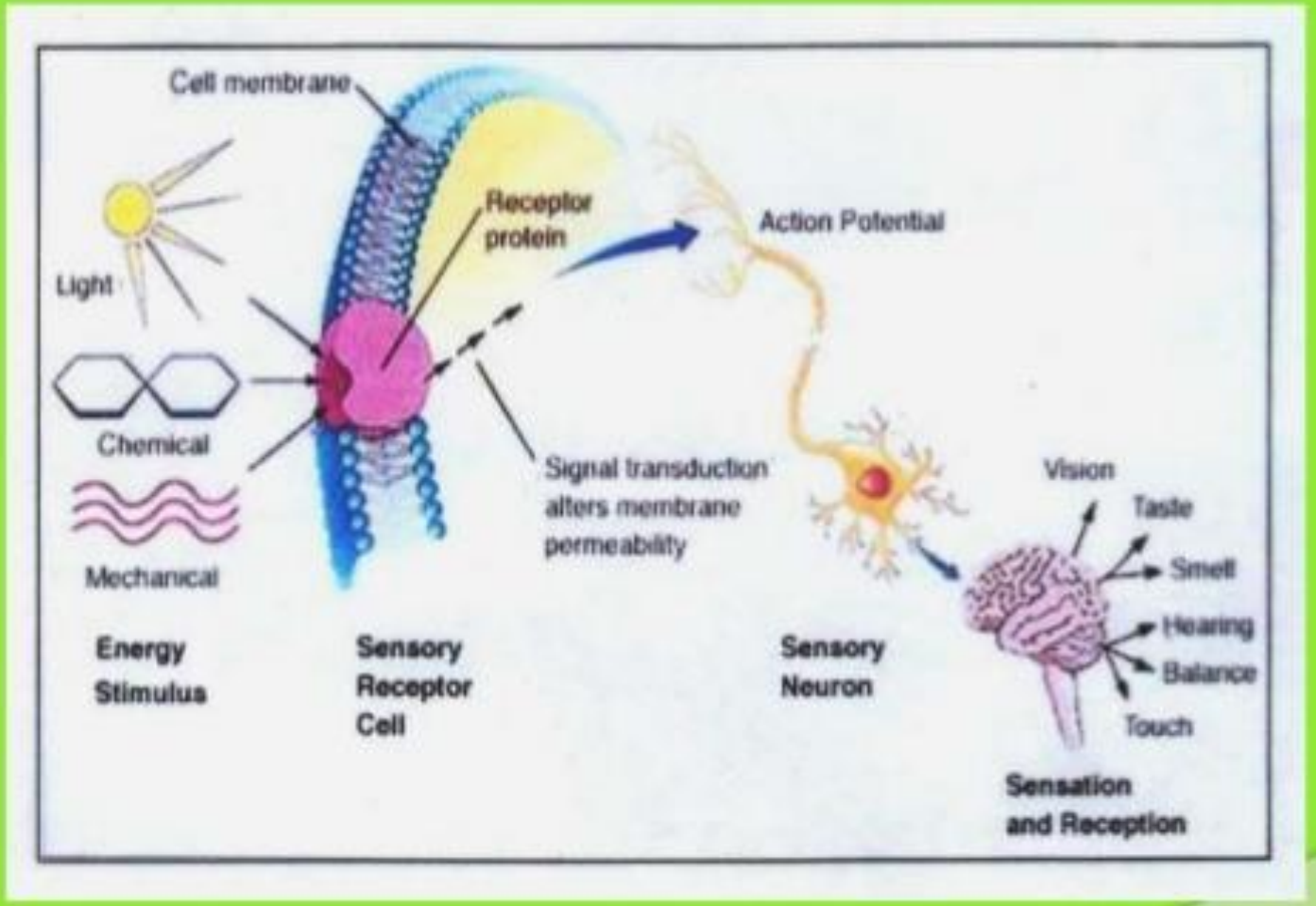
- Sensory transduction – process of conversion.

- Receptor potential – a type of local potential produced as an effect of a stimulus.

  - a graded voltage change across the plasma membrane of the receptor cell.

- The receptor potential causes a receptor cell to release a neurotransmitter that stimulates an adjacent neuron.
- When the voltage of the neuron reaches threshold, the neuron fires impulses to the CNS.
- Sensation


STIMULUS
SENSORY TRANSDUCTION
RECEPTOR POTENTIAL
NERVE IMPULSE
CNS
SENSATION


Cell membrane
Receptor protein
Action Potential
Light
Chemical
Mechanical
Signal transduction alters membrane permeability
Vision
Taste
Smell
Hearing
Balance
Touch
Energy Stimulus
Sensory Receptor Cell
Sensory Neuron
Sensation and Reception

- ***Events for Sensation to Occur:***
- 1. Stimulation of sensory receptor.
- 2. Transduction – stimulus converted to graded potential.

- 3. Impulse Generation & Conduction
  - if the graded potential reaches threshold strength,
  - a nerve impulse results.
  - This impulse travels to the CNS.
- 4. Integration – CNS translates the impulse into a sensation.

- ***Kinds of Information Transmitted by the Sensory Receptor:***

1. Modality
2. Location
3. Intensity
4. Duration

- ***Classification of Receptors:***

  - can be classified by several overlapping systems:

1. By stimulus modality:
    a. Chemoreceptors
    b. Thermoreceptors
    c. Nociceptors
    d. Mechanoreceptors
    e. Photoceptors

2. By the origin of the stimuli:
    a. Exteroceptors
    b. Interoceptors
    c. Proprioceptors

3. By the distribution of receptors in the body:
    a. General (Somesthetic) senses
    b. Special senses

General Senses:

- Types according to structure & physiology:

A. Unencapsulated Nerve Endings
   1. Free Nerve Endings
   2. Tactile (Merkel) Discs
   3. Hair (Peritrichial Endings)

B. Encapsulated Nerve Endings

1. Tactile (Meissner) Corpuscles
2. Krause End Bulb
3. Lamellated (Pacinian) Corpuscles
4. Ruffini Corpuscles

PAIN RECEPTORS

PAIN RECEPTORS

Pain – is a discomfort caused by tissue injury or noxious stimulation & typically leading to evasive action.

Nociceptors – specialized nerve fibers that mediate pain.

Types:

1. **Myelinated**
2. **Unmyelinated**

Somatic Pain – pain from the skin, muscles & joints.

Visceral Pain – pain from the viscera (internal organs of the 3 great body cavities-thoracic, abdominal & pelvis).

Referred Pain – perception of pain coming from parts of the body that are not actually stimulated.

- **Classification of Pain Receptors**

  (Origin of Stimulus)

1. Exteroceptors – stimulated by immediate external environment with most of the impulses being sensed at conscious levels.

a) ***Free nerve endings*** – tactile & superficial pain

b) ***Krause's corpuscles*** – cold receptors

c) ***Meissner's corpuscles*** – tactile skin receptors

d) ***Merkel's corpuscles*** – tactile receptors in the oral mucosa & submucosa of the tongue

e) ***Ruffini's corpuscles*** – pressure & warmth receptors

2. Interoceptors – located in body cavities; these serves involuntary bodily functions below conscious levels.

a) ***Free nerve endings*** – perception of visceral pain

b) ***Pacinian corpuscles*** – perception of pressure

3. Proprioceptors – chiefly involved in automatic functioning & perceive movement, pressure & position.

a) ***Free nerve endings*** – perception of deep somatic pain & other sensations

b) ***Golgi tendon organs*** – mechanoreceptors between muscle tendons relaying data concerning muscle length & tension

c) ***Muscle spindles*** – mechanoreceptors between muscle fibers responsive to passive muscle stretch

d) ***Pacinian corpuscles*** – perception of pressure

e) ***Periodontal receptors*** – perception of tooth movement

SKIN RECEPTORS

SKIN RECEPTORS

Types According to Function/ Stimulus Modality:

1. Thermoreceptors – for temperature changes

2. *Mechanoreceptors* – for mechanical stimulation.

a) ***Tactile receptors*** – touch

b) ***Baroreceptors*** – pressure

c) ***Proprioceptors*** – distortion

3. *Nociceptors* – for injuries leading to pain sensation.

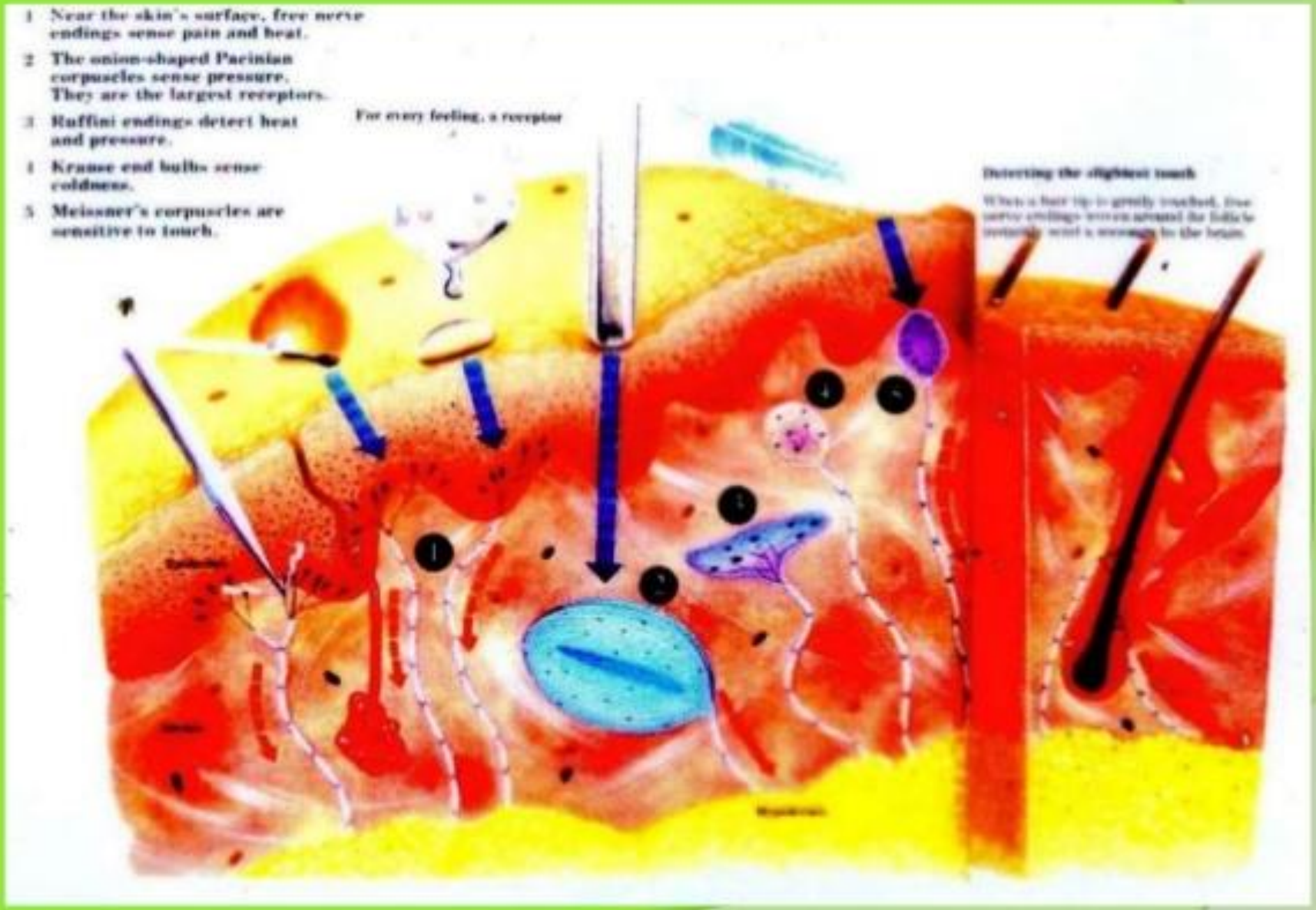
Types According to Morphology:

1. ***Free nerve endings*** – nonmyelinated fibers that enters the epidermis, extending as far as the stratum granulosum.

   a) ***Merkel's ending*** – free nerve ending attached to modified epidermal cells, found in the stratum germinativum layer.

2. Encapsulated nerve endings

a) ***Pacinian corpuscles*** – deep pressure
b) ***Meissner's corpuscles*** – touch
c) ***Ruffini's corpuscles*** – heat/warmth
d) ***Krause's corpuscles*** - cold


1 Near the skin's surface, free nerve endings sense pain and heat.
2 The onion-shaped Pacinian corpuscles sense pressure. They are the largest receptors.
3 Ruffini endings detect heat and pressure.
4 Krause end bulbs sense coldness.
5 Meissner's corpuscles are sensitive to touch.
For every feeling, a receptor
Detecting the slightest touch

TASTE RECEPTORS

TASTE RECEPTORS

Taste (Gustation)

> a sensation that results from the action of chemicals on the taste buds.

> the detection & recognition of liquid phase stimuli.

> a sensation developed well before birth.

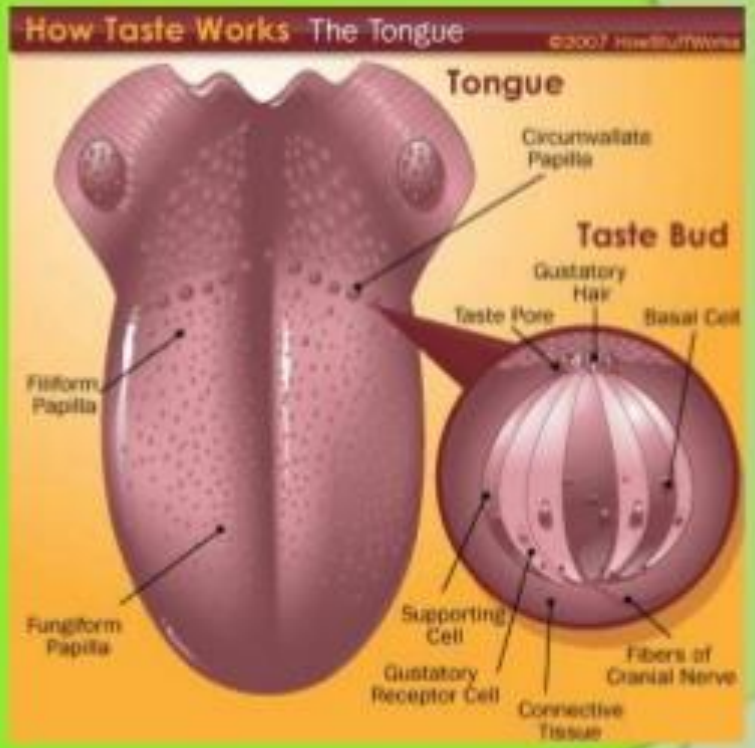
- **** Taste is detected only when food is dissolved in saliva.***
- **** Mouth that is dry affects sense of taste.***

Taste buds

> taste receptors

> goblet-shaped epithelial cells with small pore opening to the mucosal surface.

> lemon shaped



> measures to about 70 microns in length & 40 microns in diameter.

> approximately 10,000 buds in man

> located on the *edges & dorsum of the tongue*, *epiglottis*, *soft palate*, *pharynx* & *inside the cheeks*

> life span is 10-12 days & are constantly replaced by cell division (taste cell-mitotic division).

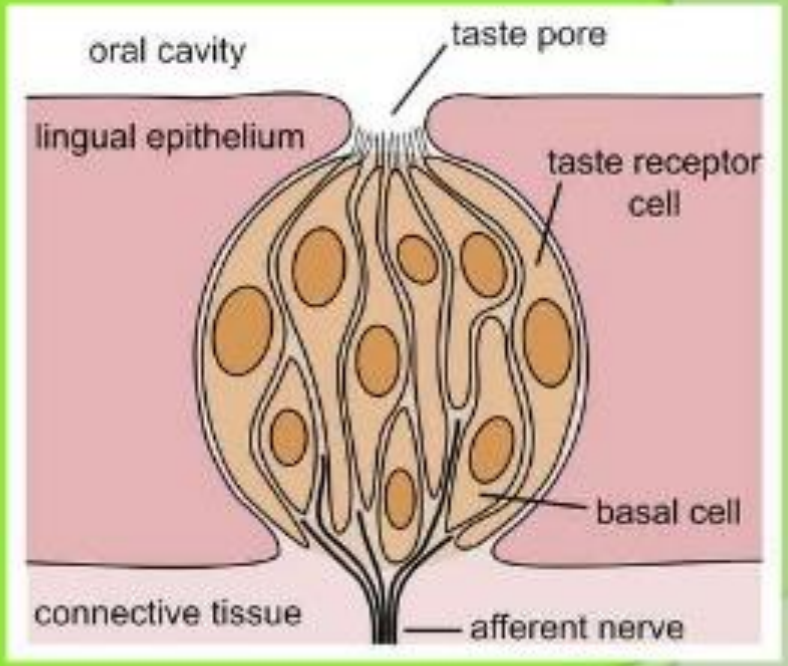
> composed of 40-60 cells of three kinds:

a. Taste/ Receptor/ Gustatory cell

- sensory cell (banana shaped)

b. Supporting/ Sustentacular cell

c. Basal cell

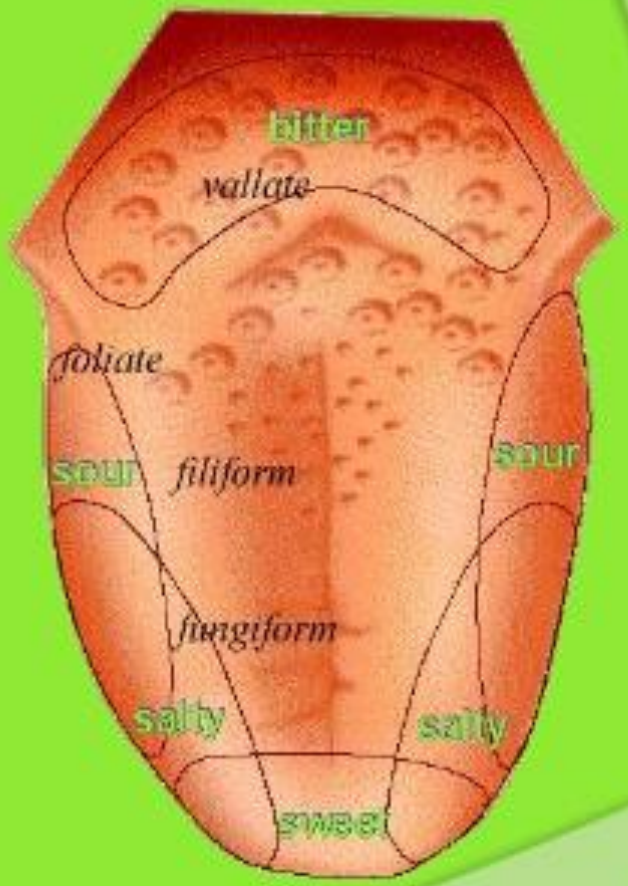


> taste hair – slender microvilli extension of the taste cell.

> taste pore – narrow opening from where taste hairs are projected.

> *Geographic distribution:*

1. tip of the tongue
   – sweet
2. side near the tip
   – salty
3. side near the back
   – sour
4. back/rear of the tongue
   – bitter



> *Primary taste sensation:*

(Taste Modalities)

1. Sweet
2. Salty
3. Sour
4. Bitter
5. Umami

Generally, each taste modality is associated with organic compounds such as:

1. SWEET

- associated with organic compounds such as polysaccharide like sugar, glycerol, dulcin, chloroform & amino acid.

2. SOUR

- associated with hydrogen ions as acid & acid salts.
- not all acids are sour

    e.g. amino acid – sweet

3. SALTY

- associated with positive & negative ions, inorganic compounds such as, chlorides of sodium, ammonium & iodine.

4. BITTER

- associated with inorganic salts of increasing molecular weight like alkaloids (nicotine & caffeine).

5. UMAMI

- “meaty” taste produced by amino acids such as aspartic & glutamic acids.

- the taste is best known from the salt of glutamic acid, monosodium glutamate (MSG).

-pronounced as “ooh-mommy”

- the word is Japanese slang for “delicious” or “yummy”

- specific area on the tongue sensitive to umami is not yet known.

>Taste buds present in papillae:

1. Fungiform papillae
2. Circumvallate papillae
3. Palatal papillae
4. Other papillae and taste buds may occur in other oral & pharyngeal locations, including the lips, inner surface of the lingual mucosa, epiglottis, various pharyngeal regions of the upper 1/3 of the esophagus as well as the pharynx.

* Filiform papillae – do not contain taste buds

> Taste buds are capable of responding to each quality, but their response characteristics are concentration dependent:

1. Taste buds in Fungiform papillae – respond in uniform manner to low concentration of both sweet and salty taste substance.

2. Taste buds in Circumvallate papillae - respond in uniform manner to low concentration of sweet substances and only to higher concentrations of salt, sour & bitter stimuli.

3. Taste buds in Palatal papillae – respond in uniform manner to both sour & bitter substances, although they respond to salt in relatively high concentrations.

PHYSIOLOGIC PROPERTIES OF TASTE RECEPTORS:

1. ADAPTATION

- diminution in the intensity or sensation or even disappearance of sensation even with continued stimulation of receptors

- reduction in sensitivity in the presence of a constant stimulus.

2. AFTER TASTE/ AFTER DISCHARGE OF TASTE RECEPTORS

- taste still lingers even if the stimulus has been removed.

3. CONTRAST

a. Successive contrast

- eat sweet then sour food, sourness is intensified

b. Simultaneous contrast

- if one border of the tongue is rubbed with sugar, the other border will enhance the sweet taste.

4. DUAL TASTE

- some substances can elicit 2 tastes or they can stimulate 2 different types of receptors.

5. EFFECT OF CERTAIN DRUGS

- when cocaine, an anesthetic solution is applied to the tongue the sensation is abolished.

- sequence of disappearance:

a. pain
b. bitter
c. sweet
d. salty
e. sour

OLFACTORY RECEPTORS

OLFACTORY RECEPTORS

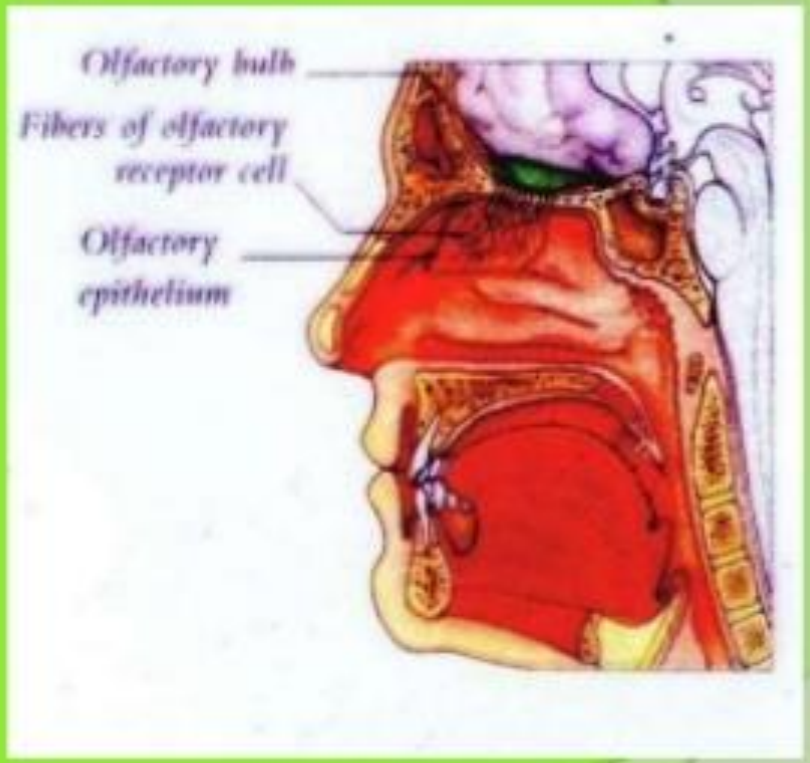
Olfaction

> closely related to taste

> flavors of various food are largely due to the combination of taste & smell.

Olfactory receptors

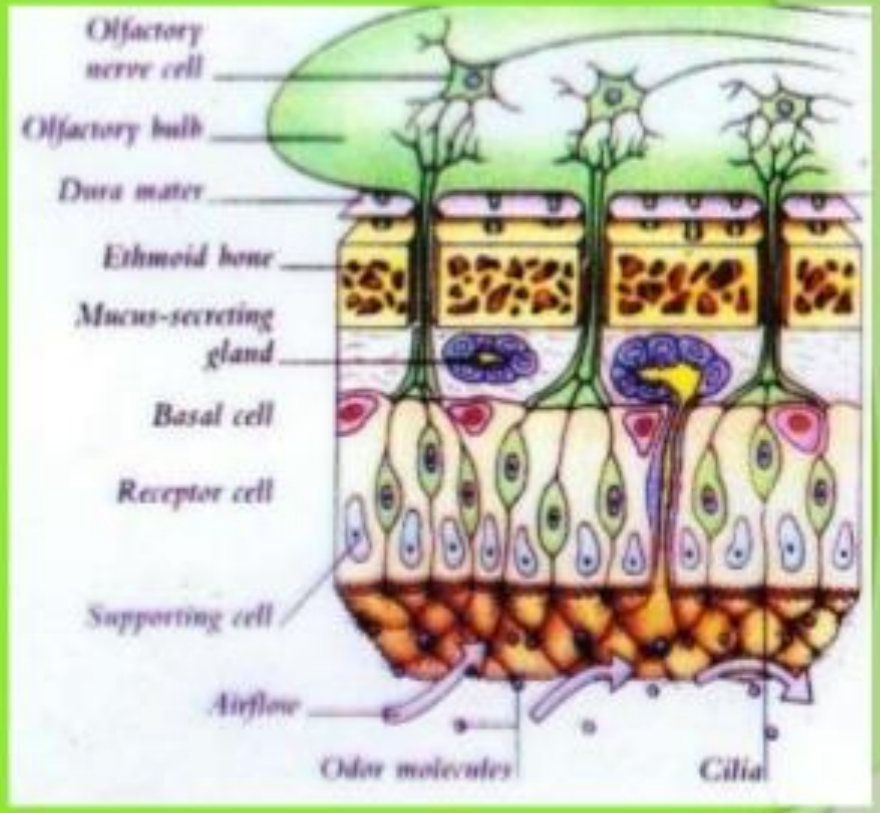
> located on the *olfactory mucous* which lies on the posterodorsal part of the nasal cavity. It has an area of about *2.5 cm²*. It includes the upper 3rd nostril, septum & superior conchae.



> composed of:

a. Olfactory cell

b. Supporting cell



Primary Odors:

1. CAMPHORACEOUS

- tough volatile fragrant compound from the wood & bark of camphor tree used in medicine as plasticizer and insect repellant.

2. MUSKY

- substance with a penetrating odor obtained from a sac beneath the abdominal skin of male musk deer & used as perfume fixation.

3. FLORAL

- flower

4. PEPPERMINTY

- minty aroma/ fresh

5. ETHEREAL

- ether is a light volatile inflammable liquid obtained by the distillation of alcohol with sulfuric acid & used chiefly as solvents and anesthetic.

6. PUNGENT

- stinging or biting quality

7. PUTRID

- rotten, foul odor
- decomposing organic matter

PHYSIOLOGIC PROPERTIES OF OLFACTORY RECEPTORS:

1. ADAPTATION

- it is well known experience that an odor which at first seems to be quite strong or even noxious, after a few minutes is hardly noticed.

2. EFFECT OF ONE ODOR ON THE OTHER ODOR

- strong odors tend to musk weaker ones. If appropriate amount is applied, one odor antagonizes the other odor.

Anomalies in Olfaction:

1. Excessive smoking.
2. Temporary loss of sense of smell may be the result of inflammation of the nasal mucosa.
3. Disease of the nervous system may affect olfaction either unilaterally/ bilaterally.
4. Hypernosmia – acute sensitivity of the sense of smell due to some diseases of the CNS.

Parasympathomimetics

Direct Acting

1- Acetylcholine (M & N)
2- Carbachol (M & N)
3- **Metha**choline (N)
4- **Betha**necol (N)
5- Pilocarpine (M)

Indirect Acting (Anti-cholinesterases)

Reversible

1- Physo**stigmine** (eserine)
2- Neo**stigmine**
3- Edrophonium

Irreversible

1- Echothiopate
2- Isoflurophate
3- Parathione

Parasympatholytics

1- Atropine
2- Eucatropine
3- **Homa**tropine
4- **Hyo**scine
5- Scoplamine
6- Tropicamide
7- Ipratropium (bronchial asthma)
8- Cyclopentolate

Ganglion blockers

Nicotinic anatgoinsts on both Symp. & Parasymp

9- Nicotine & Lobeline **(large dose)**
10- **Mecamylamine**
11- **Chlorisondamine**
12- Hexamethonium
13- Trimthaphan
14- TetraAthylAmmonium chloride

Sympathomimetics

Catecholamine

α & β Agonists	β1,β2 non-selective Agonists
1- Epinephrine	1- **Iso**prenaline
α & β1 only Agonists	2- **Iso**proterenol
2-Nore-epinephrine	
Others	β2 Agonists
3-Dopamine (α1-β1,2-D1,2)	Short acting:
4-Dobutamine (α1 -β1,2)	1- Sal**buta**mol
5- Methoxamine (α1)	2- Al**buta**rol
	3- Ter**buta**line
	4- Hexoprenaline
	5- Fen**ote**rol
	6- Rimi**ote**rol
	7- pirbuterol.
	Long acting:
	1- Salmeterol
	2- Formoterol

Non-Catecholamine

1- **Phenylephrine** (α1)
2- **Metaproterenol** (β2)
3- Ephedrine (α1 β1,2 - CNS stimulant)
4- Orciprenaline (β2)
5- Amphetamine (α1 β1 - CNS stimulant)

Sympatholytics

α - Blockers

Non-selective blockers	selective competitive blockers	
	α1- blockers	α2 - blockers
Phenoxybenz**amine**	Pra**zosin**	Yohimbine
Phento**lamine**	Tera**zosin**	
	Tamsulo**sin**	
	..... any drug **zosin**	

β - Blockers

Non-selective blockers	selective competitive blockers		
	β1 - blockers	β2 - blockers	Antagonist with partial agonist
Propra**nolol**	Acebu**tolol**	Butoxamine	Pind**olol**
Ti**molol**	Aten**olol**		Acebu**tolol**
nado**lol**	Metopr**olol**		
	Esm**olol**		

Antagonist of both α & β

Labeta**lol** - Carved**ilol**

Histamine

Agonist

Histamine

Antagonists

H 1	H 2
Chlorpheniramine	Cime**tidine**
Diphenhydramine	Rani**tidine**
Loratidine	Famo**tidine**
Mepyramine	Niza**tidine**
Pheneramine maleate	
Antazoline	

Serotonin 5-HT2

Agonist	Agonists-HT.
Serotonin	**Buspirone** → anxiolytic **Sumatriptan** → in migrane
5-HT2 Antagonist	**5-HT3 Antagonist**
Cyproheptadine Methysergide Ketanserin	**Ondan**setrone "anti-emetic action"

Angiotensin II

Agonist	Antagonist
Angiotensin	**Saralasin**

Vasopressin

Agonist	Antagonist
Vasopressin	----------

Anti-Arrhythmics

Quinidine - Verapamil - Disopyramide

Slow Ca++ channels blockers

Verapamil - Diltiazem - **Nifedipine** - **Nitrendipine**

General anesthetics

Halothane - Chloroform

Surface anesthetics

Cocaine

Heart

Direct myocardial depressants	Direct Myocardial Stimulants
1- Anti-Arrhythmic drugs	1- Cardiac Glycosides .
2- Anti-Histaminics(H1)	2- Phosphodiesterase Inhibitors (Aminone)
3- General anesthetics	3- Xanthine (Aminophylline).
4- Emetine Hydrochoride	4- Caffeine.

Blood Vessels

Direct Hypotensive effect on vascular smooth muscles (Direct vasodilators)

1- Direct Veno-dilators → Nitrites - Nitrates
2- Direct arterio-dilators → Hydralazine - Minoxidil
3- Mixed-dilators → Sodium Nitroprusside
4- Slow Ca++ channels blockers

Intestine

Direct Spasmolytic

1- **Papaverine**
2- **Volatile oils e.g. Peppermint**
3- **Nitrites & nitrates**
4- **Aminophylline**

Action of drugs on Isolated Toad's Heart

Inhibitory drugs on the heart

1- M2
2- Ganglion stimulant **(Nn)**.
3- Direct myocardial depressants

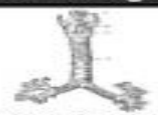
Stimulatory drugs on the heart

1- β1
2- H2
3- Direct myocardial stimulants

Action of drugs on Isolated guinea pig trachea

Bronchoconstrictors

1- M3
2- H1



Dose response curve of Ach on trachea.

Bronchodilators

β2

Effect of drugs on arterial blood pressure of anaesthetized cat

Hypertensive drugs

1- Ganglion stimulant **(Nn)** as NSD & NLD
2- Both α & β agonists
3- α1 agonist (without effect on β2) as: Noradrenaline , phenylephrine, methoxamine, amphetamine, ephedrine.
4- Angiotensin II
5- Vasopressin

Hypotensive drugs

7- Parasympathomimetic with M3 action only.
8- Parasympathomimetic with both M3 & N actions.
9- β2 agonist.
10- Histamine H1 mainly , H2
11- Direct vasodilators

Action of drugs on Isolated rabbit's intestine

Stimulant

1- Ganglion stimulant **(Nn)** as NSD & LSD
2- M3
3- H1
4- 5-HT2
5- Angiotensin II
6- Vasopressin

Inhibitory

1- Sympathomimetic
1- α only
2- β only
3- Both α & β agonists
2- Direct spasmolytics

See above

N.B.

NSD → stimulation of nicotinic receptors in parasympathetic ganglia → inhibition of the heart
NLD → initial stimulation followed by blocking of the parasympathetic ganglia (depolarizing blocker) → initial inhibition of the heart then cardiac contraction become normal.

- **NSD** is added to test the block of the **nicotinic** receptors in the ganglia ... if the block is complete, NSD → has no effect.
- **Ach** is added to test the block of the **M** receptors produced by atropine ... If the block is complete, Ach → has no effect.
- **Adrenaline** is added to test the block of **β** receptors produced by blockers ... if block is complete, adrenaline → has no effect.