Sense Organs

By:
M. Thiru murugan

Unit – 12:

a) Skin, eye, ear, nose and tongue

b) Physiology of vision, hearing, smell, touch, taste and equilibrium.

Sensory organs or Special senses:

- The nervous system must **receive** and **process** information about the world outside in order to **react**, **communicate**, and **keep** the body healthy and safe.
- **Skin, eye**, **ear**, **nose** & **tongue (taste buds)** are called sensory organ or special senses.
- Sensory organs have **special receptors** that allow us to **smell**, **taste**, **see**, **hear**, **touch** and maintain **equilibrium** or balance.
- Information conveyed from these receptors to the central nervous system is used to help maintain **homeostasis(**self-regulating process by which biological systems help to maintain stability while adjusting to conditions that are optimal for survival).

Skin:

- Skin is the **largest organ** of our body.
- It is related to the **sense** of **touch**. The sense of touch is also referred to as **tactioception**.
- The skin contains general **receptors** which can detect **touch**, **pain**, **pressure & temperature**.
- They are present throughout the skin.
- Skin receptors generate an **impulse**, and when **activated**, is carried to the **spinal cord** and then to the **brain**.

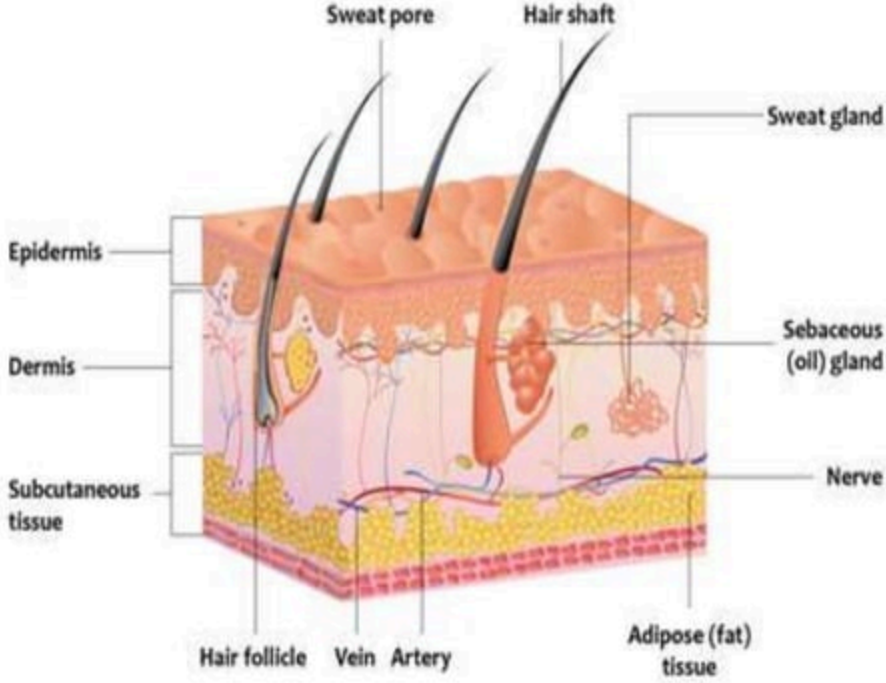
Structure of the skin:

- The skin is composed of **3 major layers** of tissue:

1. **Epidermis layer**
2. **Dermis layer**
3. **Subcutaneous layer**.

- The **epidermis**, the **outermost** layer of skin, provides a waterproof barrier and creates our skin tone.
- The **dermis** - the **middle layer**, under the epidermis, contains tough connective tissue, hair follicles, and sweat glands.
- The **subcutaneous** tissue (**hypodermis**) - **deeper/ innermost layer,** it is made of fat and connective tissue.

Diagram:


Sweat pore
Hair shaft
Sweat gland
Epidermis
Dermis
Sebaceous (oil) gland
Subcutaneous tissue
Nerve
Hair follicle
Vein
Artery
Adipose (fat) tissue

Epidermis:

- The epidermis is the **thin**, **outer** layer of the skin that is visible to the eye.
- Contains **different types of cells:** keratinocytes, melanocytes, Merkel cells and Langerhans cells.
- The **skin's color** is created by special cells called **melanocytes**, which produce the pigment **melanin**. Melanocytes are located in the epidermis. These form a pigment shield **against UV** radiation.
- It does **not** contain **blood vessels**
- The epidermis consists of **4 layers**: Stratum germinativum, Stratum spinosum, Stratum granulosum, Stratum corneum
- **Main functions:** protection, absorption of nutrients and homeostasis.

Dermis:

- The dermis is the **middle** layer of the skin that offers **elasticity**.
- It is composed of **connective** tissues and **collagen** fibers.
- is much **thicker** than the epidermis
- The dermis provides a **site** for the **hair** follicles, **sweat** glands, **sebaceous** glands, **blood** vessels, **lymph** vessels, **sensory** receptors, **nerve** fibers, **muscle** fibers & **specialized** cells (mast cells and fibroblasts).
- **The main functions of the dermis are:**
- Protection
- Cushioning the deeper structures from mechanical injury;
- Providing nourishment to the epidermis;
- Playing an important role in wound healing

Subcutaneous:

- The subcutaneous is the layer of tissue directly **underneath** the **dermis**.
- It is also called **hypodermis**.
- This layer of tissue is composed of **fat cells** and **connective tissue.**
- It is the **thickest layer** of the integumentary system
- **Its functions include:**
- Structural support for the skin,
- **Insulation** - maintaining temperature
- The **storage** of **energy**

The Accessory Organs of the Skin:

- **Nails** are a flat plate of keratin that covers the ends of fingers and toes.
- The **sebaceous** glands secrete the oil sebum, which lubricates the hair and skin, helping prevent drying and cracking.
- The **sweat** glands function is to cool the body.

Functions of the skin:

- Provides a **protective** barrier against mechanical, thermal and physical injury
- Prevents loss of **moisture**.
- **Reduces harmful** effects of **UV** radiation.
- Acts as a **sensory** organ (touch, detects temperature).
- Helps regulate **temperature**.
- An **immune** organ to detect infections etc.
- Production of **vitamin D**.

Eye:

- **Visual** sensory **organ** in our body. These are **sensitive** to **light** images.
- The eyes **vary** in **color** depending upon the amount of **melanin** present in our body.
- It helps in the **sense of sight** by detecting and focusing on the light images.

Visible parts:

- Eyelid
- Pupil
- Sclera
- Iris

Internal parts:

- Cornea
- Lens
- Aqueous humour
- Ciliary muscle
- Retina
- Choroid
- Macula.
- Optic nerve
- Vitreous humour

- **Eyelid:** Your eyelid covers your eye to protect it from dust, grit, and perspiration that could cause damage. It opens and closes both voluntarily and involuntarily, and facilitates blinking to help keep the eye hydrated and well-lubricated.
- **Sclera:** The sclera is outermost layer of the eyeball. It is the white (and opaque) part of the eyeball. Muscles responsible for moving the eyeball are attached to the eyeball at the sclera.
- **Cornea:** clear front window of the eye, Light rays from the outside world first pass through the cornea before reaching the lens. Together with the lens, the cornea is responsible focusing light on the retina.
- **Choroid:** The choroid is the middle layer of the eyeball located between the sclera and the retina. It provides nutrients and oxygen to the outer surface of the retina.
- **Anterior Chamber:** The space between the cornea and the lens is known as the anterior chamber. It is filled with fluid called aqueous humour. The anterior chamber is also known as anterior cavity

- **Aqueous humour:** The Aqueous humour is a transparent watery fluid that circulates in the anterior chamber. It provides O_2 & nutrients to the inner eye & exerts fluid pressure that helps maintain the shape of the eye. It is produced by the ciliary body.
- **Posterior Chamber:** The posterior chamber is a larger area than the anterior chamber. It is located opposite to the anterior chamber at the back of the lens. It is filled with a fluid called vitreous humour. It is also referred to as the Vitreous body
- **The conjunctiva:** The conjunctiva lines the lids & then bends back over the surface of the eyeball, Conjunctiva lubricates the front surface of the eye. It also protects the eyes from debris, dust and infection-causing microorganisms.
- **Vitreous humour:** The vitreous humour is a transparent jelly-like fluid that fills the posterior chamber. It exerts fluid pressure that keeps the retina layers pressed together to maintain the shape of the eye and to maintain sharp focus of images on the retina.

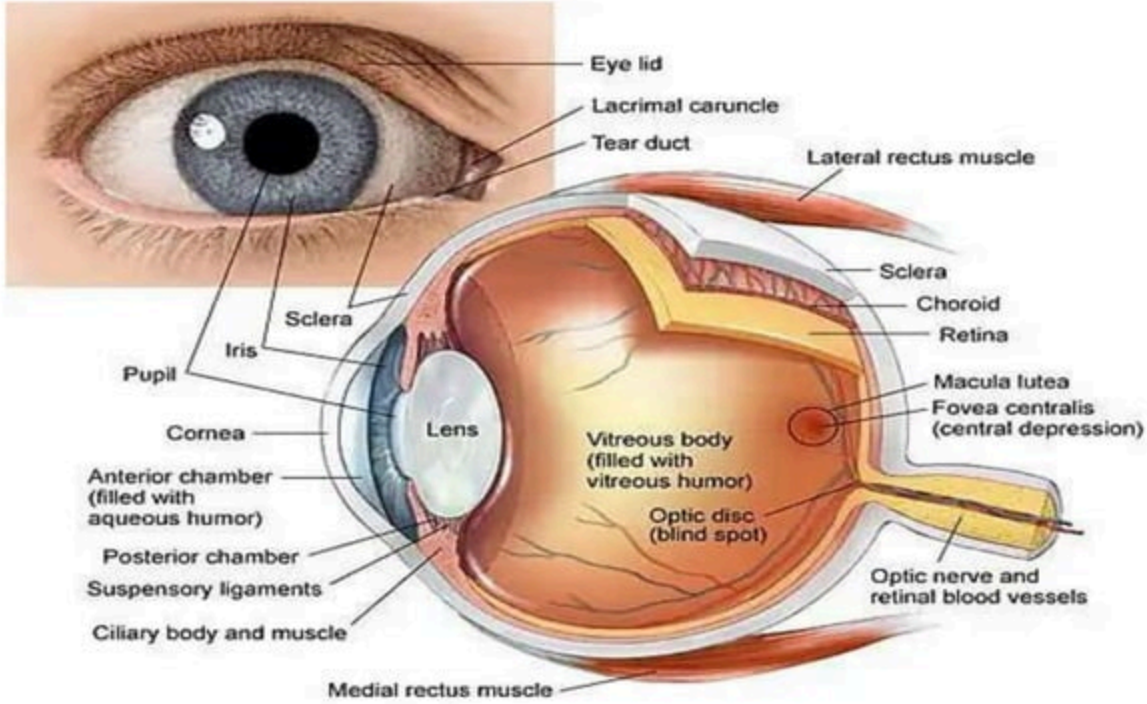
- **Iris**: The choroid continues at the front of the eyeball to form the Iris. The iris is a flat, thin, ring-shaped structure sticking in to the anterior chamber. This is the part that identifies a person's eye colour. The iris contains circular muscles which go around the pupil and radial muscles that radiate toward the pupil. When the circular muscles contract they make the pupil smaller, when the radial muscles contract, they makes the pupil wider.
- **Ciliary muscles**: The cilliary muscles are located inside the ciliary body. These are the muscles that continuously change the shape of the lens for near and distant vision. See diagram anatomy of the eye above.
- **Ciliary Body:** The choroid continues at the front of the eyeball to form the ciliary body. It produces the aqueous humour. The ciliary body also contains the ciliary muscles that contract or relax to change the shape of the lens.
- **Zonules**: The zonule also known as suspensory ligaments is a ring of small fibres that hold the lens suspended in place. It connects the lens to the ciliary body and allows the lens to change shape.

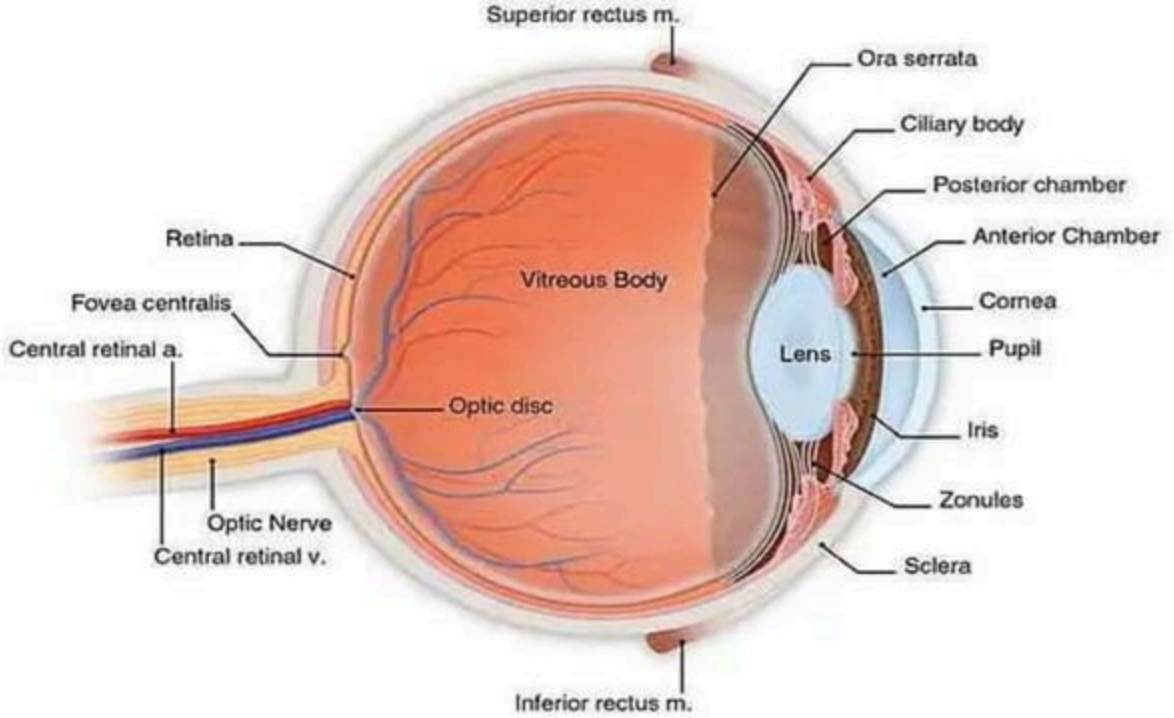
- **Lens**: The lens is a biconvex transparent disc made of proteins called crystallines. It is located directly behind the iris and focuses light on to the retina. In humans, the lens changes shape for near and for distant vision.
- **Pupil**: The pupil is the hole at the center of the iris located in front of the lens. Whenever more light needs to enter the eyeball, the muscles in the iris contract like the diaphragm of a camera to increase or decrease the size of the pupil.
- **Retina**: The retina is the innermost layer lining the back of the eyeball. It is the light sensitive part of the eye. The retina contains photo receptors that detect light. These photo receptors are known as cones and rods. Cones enable us to detect color while rods enable us to see in poor light. The retina contains nerve cells that transmit signals from the retina to the brain.

➢ **Macula:** small central area in retina that contains special light sensitive cells and allows us to see fine details clearly

- **Fovea:** The fovea is a small depression in the retina near the optic disc. The fovea has a high concentration of cones. It is the part of the retina where visual acuity is greatest.
- **Optic nerve**: The optic nerve is located at the back of the eyeball. It contains the axons of retina ganglion cell (nerve cells of the retina) and it transmits impulses from the retina to the brain.
- **Optic disc**: Impulses are transmitted to the brain from the back of the eyeball at the optic disc also called the blind spot. It is called the blind spot because it contains no photoreceptors, hence any light that falls on it will not be detected.
- **Central Artery and Vein**: The central artery and vein runs through the center of the optic nerve. The central artery supplies the retina while the central vein drains the retina.
- **Tear Duct**: This is a small tube that runs from the eye to the nasal cavity. Tear drains from the eyes in to the nose through the tear duct. This is why a teary eye is usually accompanied by a runny nose.

- **Eye muscles**: Muscles of the eye are very strong and efficient, they work together to move the eyeball in many different directions. The main muscles of the eye are Lateral rectus, Medial rectus, Superior rectus and inferior rectus.
- **Medial rectus muscle:** There are six extra ocular movement muscles in your eye (medial rectus, lateral rectus, superior oblique, superior rectus, inferior rectus, and the inferior oblique) and the medical rectus is the largest of them. It moves the pupil closer to the midline of your body (towards your nose) and makes sure that the eye is aligned correctly.
- **Lateral rectus muscle:** This is the muscle which is responsible for lateral or sideways movement of the eye, particularly movements away from the midline.


Eye lid
Lacrimal caruncle
Tear duct
Lateral rectus muscle
Sclera
Choroid
Retina
Macula lutea
Fovea centralis
(central depression)
Sclera
Iris
Pupil
Cornea
Lens
Vitreous body
(filled with
vitreous humor)
Anterior chamber
(filled with
aqueous humor)
Optic disc
(blind spot)
Posterior chamber
Suspensory ligaments
Ciliary body and muscle
Optic nerve and
retinal blood vessels
Medial rectus muscle


Superior rectus m.
Ora serrata
Ciliary body
Posterior chamber
Anterior Chamber
Cornea
Pupil
Iris
Zonules
Sclera
Retina
Vitreous Body
Fovea centralis
Central retinal a.
Optic disc
Lens
Optic Nerve
Central retinal v.
Inferior rectus m.

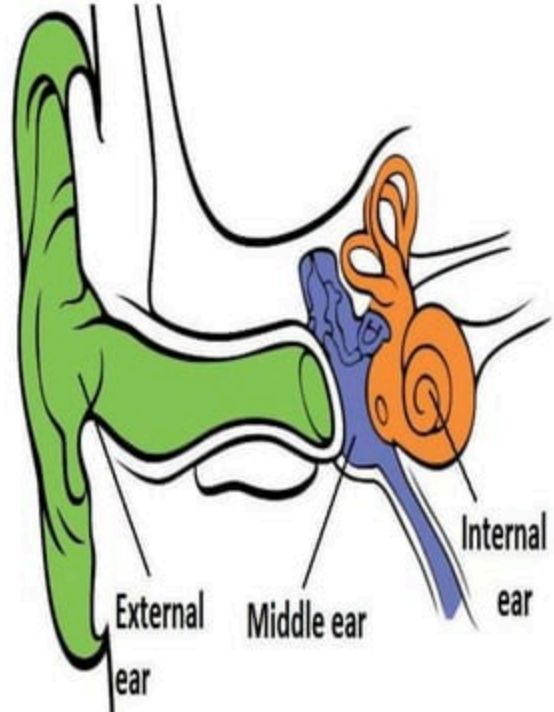
Ear:

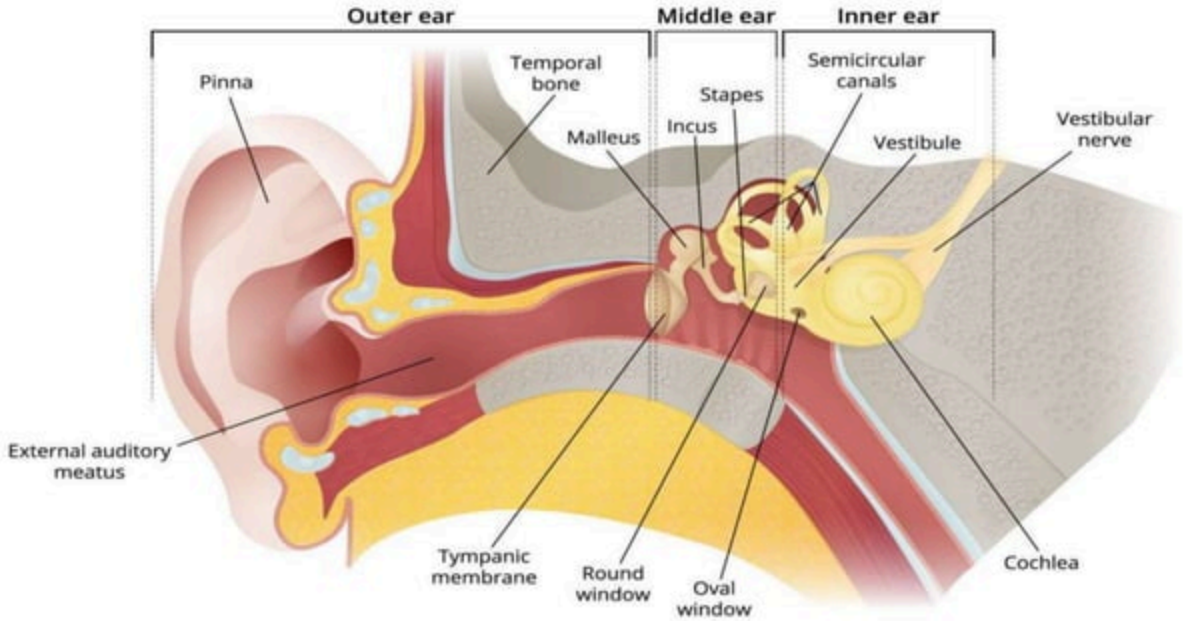
- Ears are the **auditory sense organs** of our body. They help us to perceive sounds.
- Apart from hearing, this sense is also important for **balancing** our body or **equilibrium**.

Anatomy of ear:

- **The ear is divided into 3 main regions**:

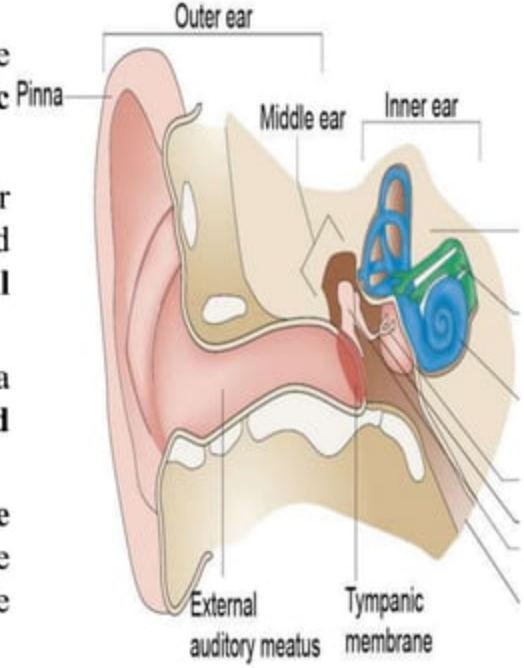
1. The **external** ear, which **collects sound waves** and channels them inward
2. The **middle** ear, which **conveys sound vibrations** to the oval window
3. The **internal** ear, which **houses** the **receptors** for **hearing** and **equilibrium**.



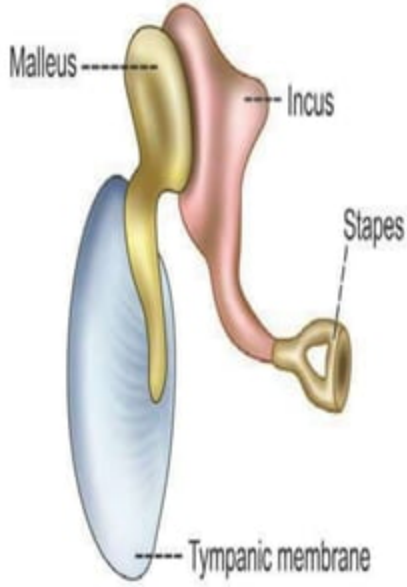

Outer ear
Middle ear
Inner ear
Pinna
Temporal bone
Malleus
Incus
Stapes
Semicircular canals
Vestibule
Vestibular nerve
External auditory meatus
Tympanic membrane
Round window
Oval window
Cochlea

External ear:

- The external ear **consist** of **auricle** (or **pinna**), the **external acoustic meatus** & the **tympanic membrane**
- The **auricle** is a paired structure found on either side of the head. It functions to **capture** and **direct sound** waves **towards** the **external acoustic** meatus
- The **external acoustic meatus** does not have a straight path, and instead travels in an **S-shaped** curve
- The **tympanic membrane** is also called **the eardrum**. It **separates** the outer ear from the middle ear. When sound waves reach the tympanic membrane they cause it to **vibrate**.

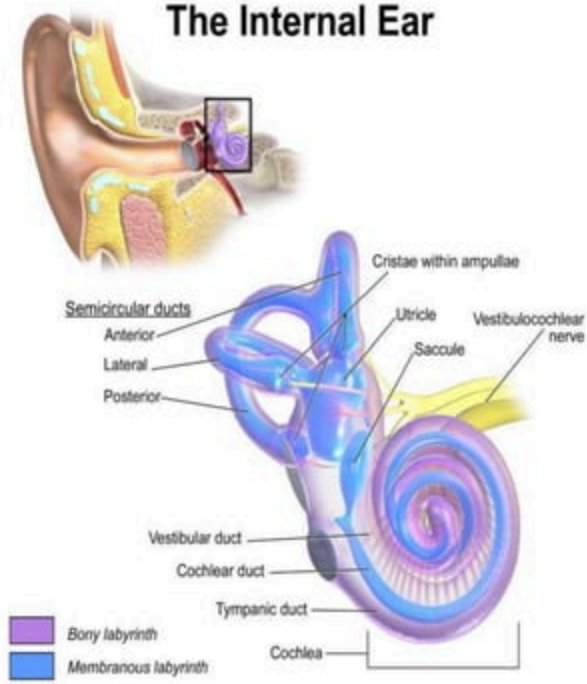


- **Middle ear** or **tympanic cavity** is a small, narrow, irregular, laterally compressed chamber, situated within the temporal bone.
- It is also known as **tympanum.** It is separated from external auditory meatus by **tympanic membrane.**
- Middle ear **consists** of **auditory bones**, **auditory muscles** & **Eustachian tube**.
- **Auditory ossicles (bones)**: Malleus, Incus & Stapes.
- **Auditory muscles:** There are two muscles which serve a protective function in the middle ear; **the tensor tympani and stapedius**
- **Eustachian tube:** (pharyngotympanic tube) connects the middle ear cavity with the nasopharynx



Internal ear:

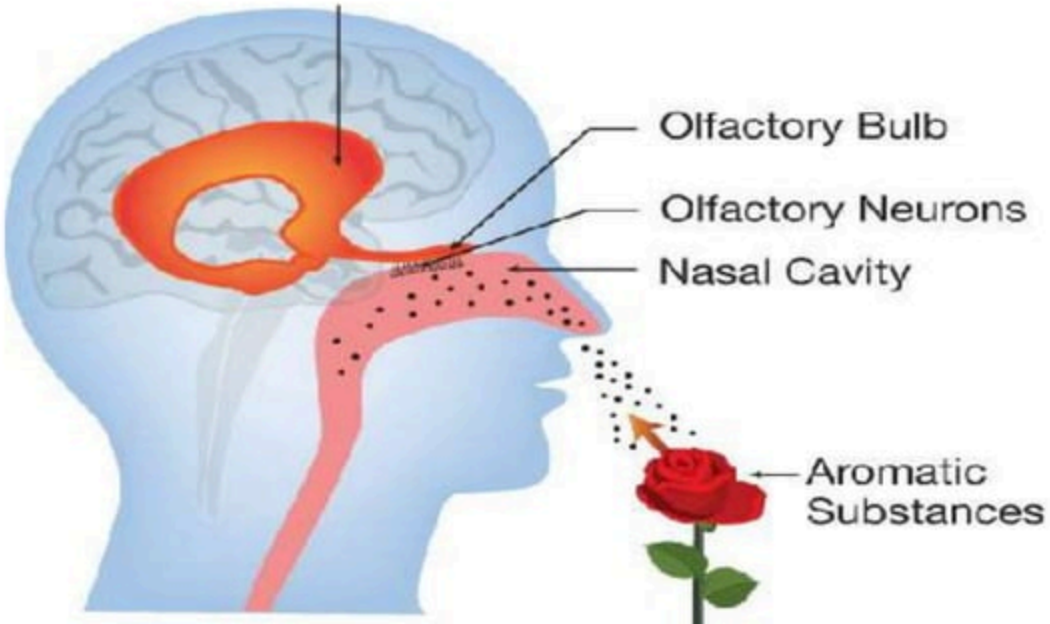
- It consists the sense organs of hearing and equilibrium. Sense organ for hearing is the **cochlea** and the sense organ for equilibrium is the **vestibular apparatus**.
- Inner ear is **the deepest part of your ear**.
- The inner ear has **two** special jobs. It changes sound waves to electrical signals (nerve impulses). This allows the brain to **hear** and understand sounds.
- The inner ear is also important for **balance**.



Nose:

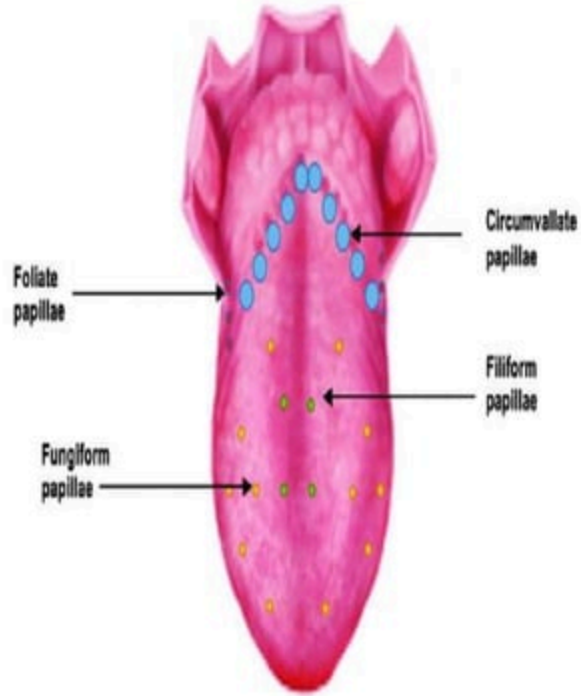
- The nose is an olfactory organ. Our olfactory system helps us to perceive different smells.
- This sense of organ also aids our sense of taste with the help of sensory receptors. The sense of smell is also known as olfaction.
- During a cold, the body produces mucus which blocks the sense of smell, this is the reason why the food which we eat tastes bland.
- In the olfactory (smelling) portion of the nose, most of the lining is mucous membrane. A small segment of the lining contains the nerve cells that are the actual sensory organs.
- Fibres, called dendrites, which project from the nerve cells into the nasal cavity, are covered only by a thin layer of moisture.
- The moisture dissolves microscopic particles that the air has carried into the nose from odour-emitting substances, and the particles dissolved in the fluid stimulate the olfactory nerve cells chemically.

- Human beings can smell thousands of various odors and fragrances.



Tongue:

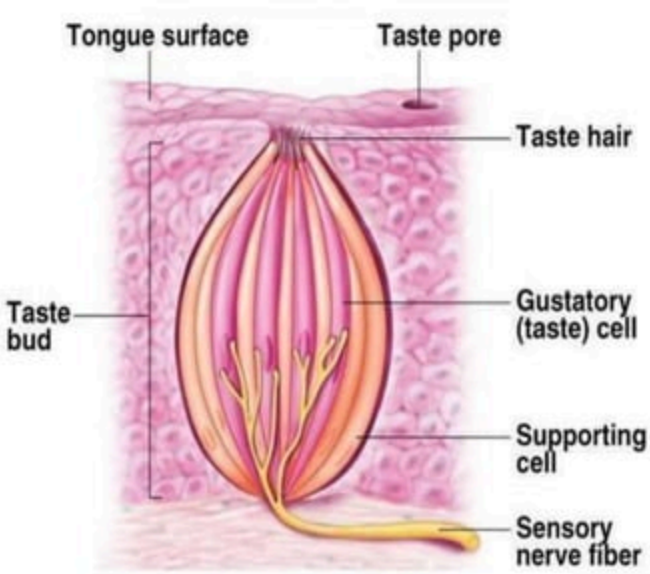
- The tongue helps in perceiving various tastes and flavours.
- The taste buds are present between the papillae on the tongue. These help in sensing different tastes.
- The senses of smell and taste tend to work together.
- If one could not smell something, they could not taste it either. The sense of taste is also known as **gustaoception**.



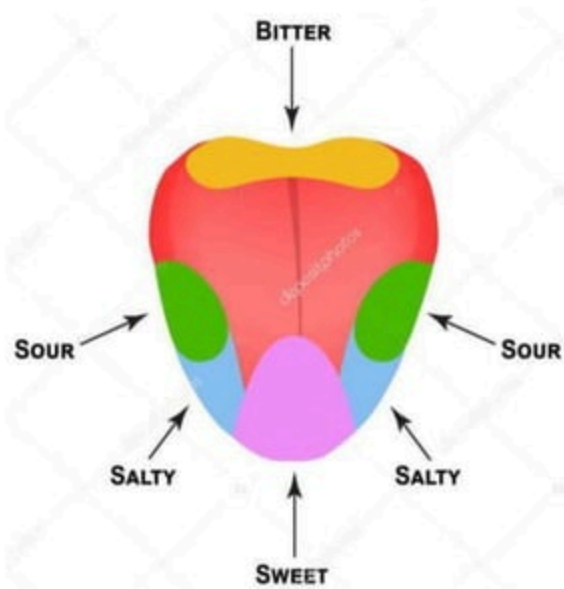
Taste buds

- ✓ Taste buds are sensory organs that are found on your tongue and allow you to experience tastes that are sweet, salty, sour, and bitter
- ✓ The sense of taste called gustation.
- ✓ 10,000 taste buds are present in its papilla.
- ✓ One papilla contains few to 100 taste buds.
- ✓ Taste buds contains sensory receptors found in the papillae of tongue and widely distributed in the epithelium of tongue, soft palate, pharynx and epiglottis.

Structure of Taste Bud

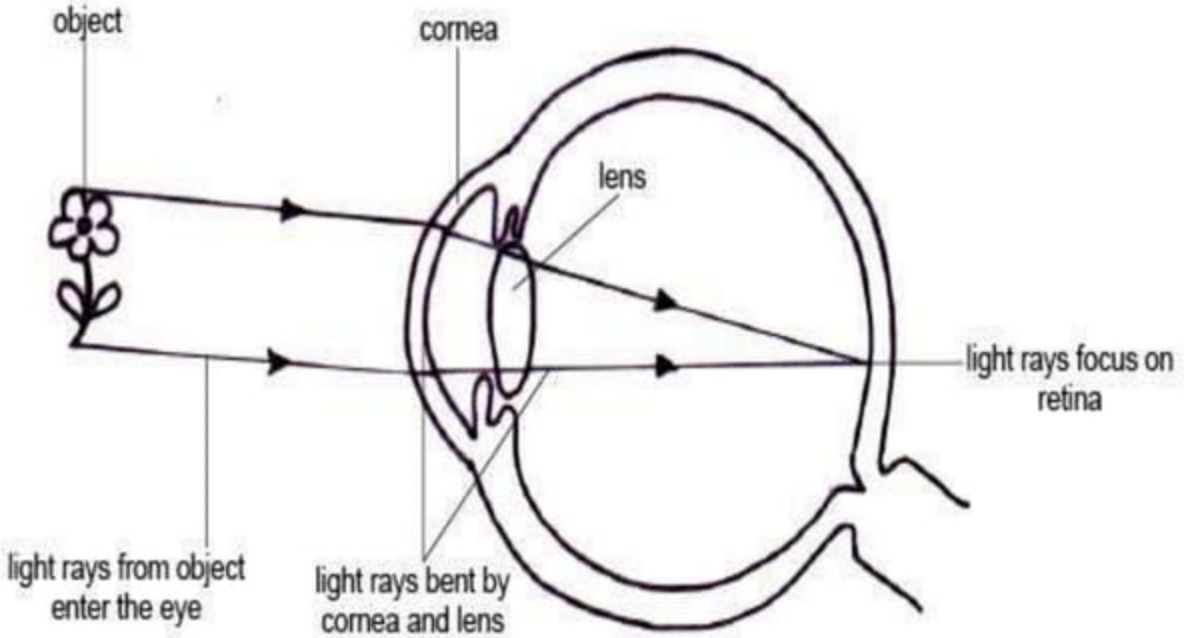


Taste Areas of tongue



Physiology of vision:

- Light enters the eye through the cornea.
- From the **cornea**, the light passes through the **pupil**. The **iris** controls the **amount of light** passing through.
- From there, it then hits the **lens**. Lens focuses light rays onto the retina.
- Light passes through the **vitreous body**
- Finally, the **light** reaches the **retina**. This is the light-sensitive nerve layer that lines the back of the eye. Here the image is **inverted**.
- The **optic nerve** is then **responsible** for carrying the **signals** to the **visual part** of the **brain**. The visual part of brain turns the **signals** into **images** (our vision).


object
cornea
lens
light rays focus on retina
light rays from object enter the eye
light rays bent by cornea and lens

Physiology of hearing:

- The human sense of hearing is attributed to the auditory system, which uses the ear to collect, amplify (increase sound), and converting sound waves into electrical signal that allow the brain to perceive and identify sounds.
- The ear can be divided into the outer ear, middle ear, and inner ear, each of which has a specific function in the process of hearing.
- The outer ear is responsible for the collection and amplification of sound.
- The middle ear transforms sound waves into vibrations, protecting the inner ear from damage.
- The inner ear converting sound vibrations into neural signals that are sent to the brain for processing.
- The cochlea is the major sensory organ of hearing within the inner ear. Hair cells within the cochlea perform the conversion of sound waves into signal.
- Signal sent to brain and perceive the sound

Physiology of smell:

- In order to smell, the substance must be in gaseous state
- Odorant must also be able to dissolve in olfactory epithelium fluid
- Activation of olfactory sensory neurons
- Dissolved odorants bind to receptor proteins in olfactory membranes
- Smell impulses conducted to first relay station in olfactory bulb
- Smell transduction Odorant binds to receptor activating impulse transmission
- Impulses perceived by brain
- Smell transduction influx causes decreased response to a continuous stimulus, referred to as olfactory adaptation
- People can't smell a certain odor after being exposed for long time

Physiology of touch:

- The sense of touch conveys important social information, helping strengthen bonds between people.
- Sensations begin as signals generated by touch receptors in your skin.
- They travel along sensory nerves made up of bundled fibers that connect to neurons in the spinal cord.
- Then signals move to the thalamus, which relays information to the rest of the brain.
- Next is the somatosensory cortex, where signals are translated into a touch perception
- Somatosensory information from all over the body spreads onto the brain
- Brain identify the sense of touch and determine touch, pain, temperature and pressure

- Specialized receptor cells within these layers detect tactile sensations and relay signals through peripheral nerves toward the brain.
- The presence and location of the different types of receptors make certain body parts more sensitive. Merkel cells, for example, are found in the lower epidermis of lips, hands, and external genitalia.
- Meissner corpuscles are found in the upper dermis of hairless skin fingertips, nipples, the soles of the feet.
- Both of these receptors detect touch, pressure, and vibration.
- Other touch receptors include Pacinian corpuscles, which also register pressure and vibration, and the free endings of specialized nerves that feel pain, itch, and tickle.

Physiology of taste:

- Food dissolved in saliva
- Tongue is having papillae that consist of taste buds which is responsible for sense of taste
- The dissolved food enter into pores of taste buds
- It leads to the stimulation of chemoreceptors, which is responsible for sending signal to brain
- Nerve carrying taste impulse to brain
- Brain identify the taste: sweet, salt, sour & bitter

Physiology of Equilibrium:

- The sense of equilibrium consists of **two** parts: **static** and **dynamic** equilibrium.
- The organs of **static equilibrium** help to maintain the **position** of the **head** when the head and body are still.
- The organs of **dynamic equilibrium** help to **maintain balance** when the **head** and **body** suddenly **move** and **rotate**.

Static Equilibrium:

- The **organs of static equilibrium** are **located** within the **bony** vestibule of the **inner ear**, generating a nervous **impulse**,
- Impulses travel to the **brain** via nerve, indicating the **position** of the **head**

Dynamic Equilibrium:

- The organs of dynamic equilibrium **3 semicircular canals** (**cristae Ampullaris**) located in the inner ear. These canals **detect motion** of the **head**, and they help in **balancing** the **head** and **body** during **sudden movement**. **Mechanoreceptors** associated with the **joints**, and the changes detected by the **eyes** also help **maintain equilibrium**.