UNIT – IV
PERIPHERAL NERVOUS SYSTEM

Presented By

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INTRODUCTION

- The peripheral nervous system (PNS) is one of the two main parts of the nervous system, the other part is the central nervous system (CNS).
- The PNS consists of the nerves and ganglia outside of the brain and spinal cord.
- The main function of the PNS is to connect the CNS to the limbs and organs, essentially serving as a relay between the brain and spinal cord and the rest of the body.
- These nerves extend from the central nervous system to the outmost areas of the body.

- The nervous system is divided into the
  - Peripheral nervous system (PNS)
  - Central nervous system (CNS)

- The peripheral nervous system is divided into the somatic nervous system and the autonomic nervous system. In the somatic nervous system, the cranial nerves are part of the PNS.

- The Somatic nervous system is voluntary.

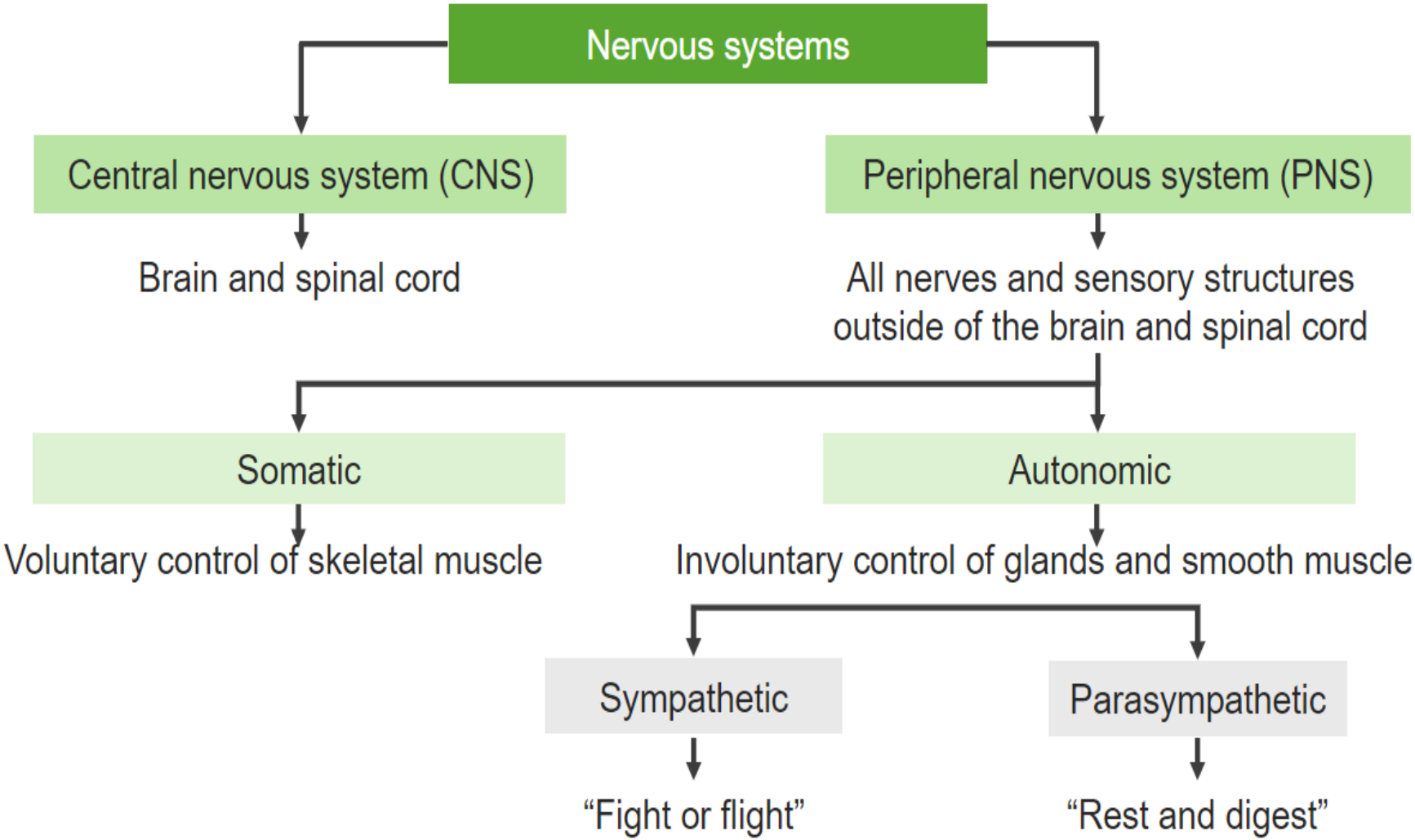
- The SNS consists of sensory neurons and motor neurons.

- Sensory neurons: They convey information from somatic receptors in the head, body wall, limbs and from receptors of special senses of vision, hearing, taste and smell to the CNS.

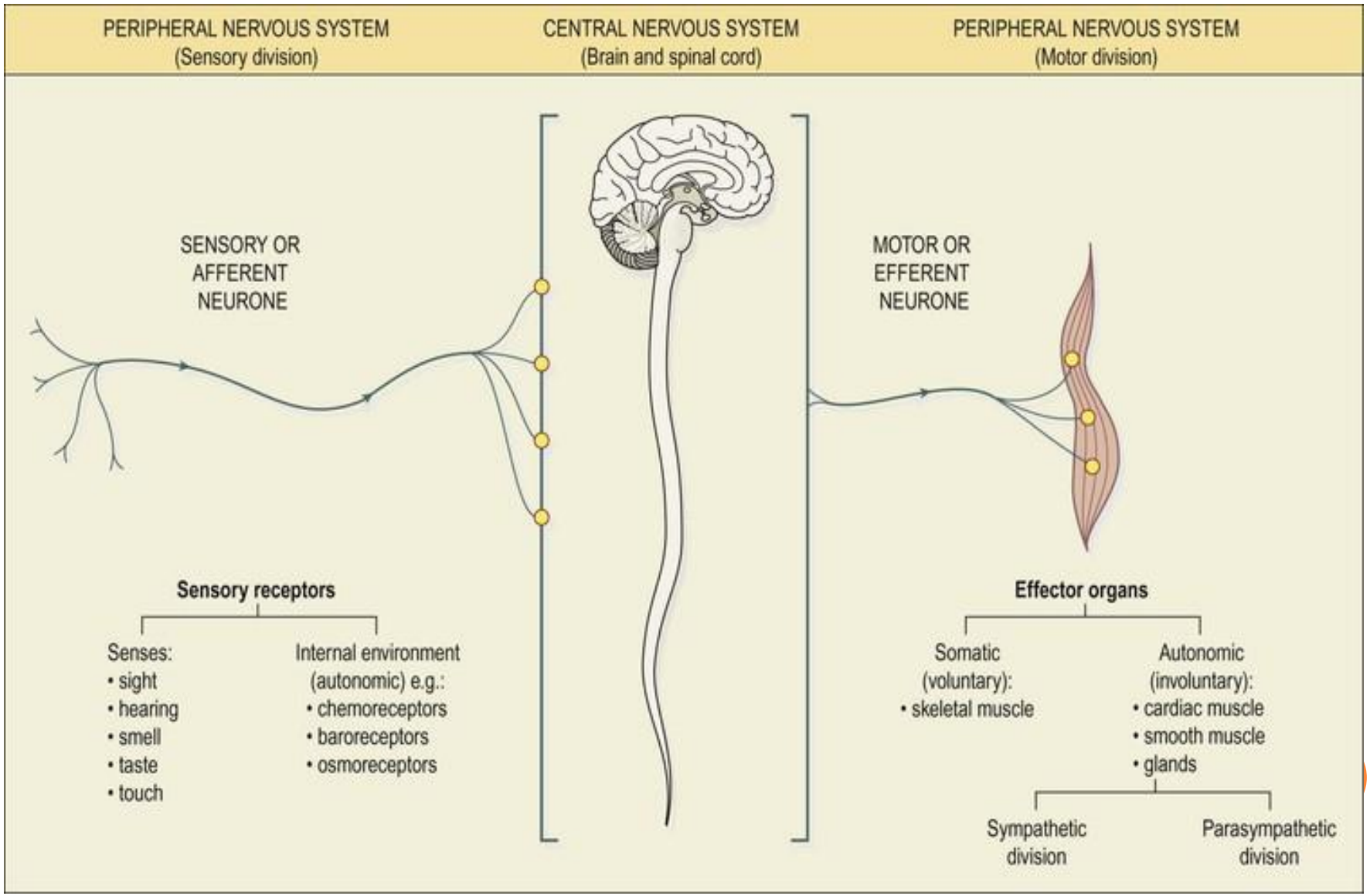
- Motor neuron: They conduct impulses from the CNS to skeletal muscles.

- The ANS is involuntary
- The ANS consists of sympathetic and parasympathetic division.
- Sensory neuron: They convey information from autonomic sensory receptors, located primarily in the visceral organs such as stomach and lungs to the CNS.
- Motor neuron: They conduct nerve impulses from the CNS to smooth muscles, cardiac muscles and glands.

Organization of nervous system



Functional components



Autonomic nervous system

- The autonomic or involuntary part of the nervous system controls the autonomic function of the body. i.e. initiated below the level of the cerebrum. The effect of autonomic activity are rapid and the effectors organs are:

- It consists of two types of neurons:

- Autonomic sensory neuron
- Autonomic motor neuron

Autonomic sensory neuron (Afferent):

- These neurons are associated with interoceptors which are sensory receptors located in blood vessels, visceral organs and muscles.

- Sensory neurons are responsible for receiving information from sensory receptors to the central nervous system.

Autonomic motor neuron (Efferent):

- These regulates visceral activities by either increases or decreases in ongoing activities in their effector tissues (cardiac muscle, smooth muscles or glands). E.g. change in diameter of pupil, dilation or constriction of blood vessels, adjusting the rate and force of heart rate.

Divisions of ANS

- The autonomic nervous system is separated into two divisions:
  - Sympathetic division (Thoraco lumbar outflow)
  - Parasympathetic division (Cranio sacral outflow)

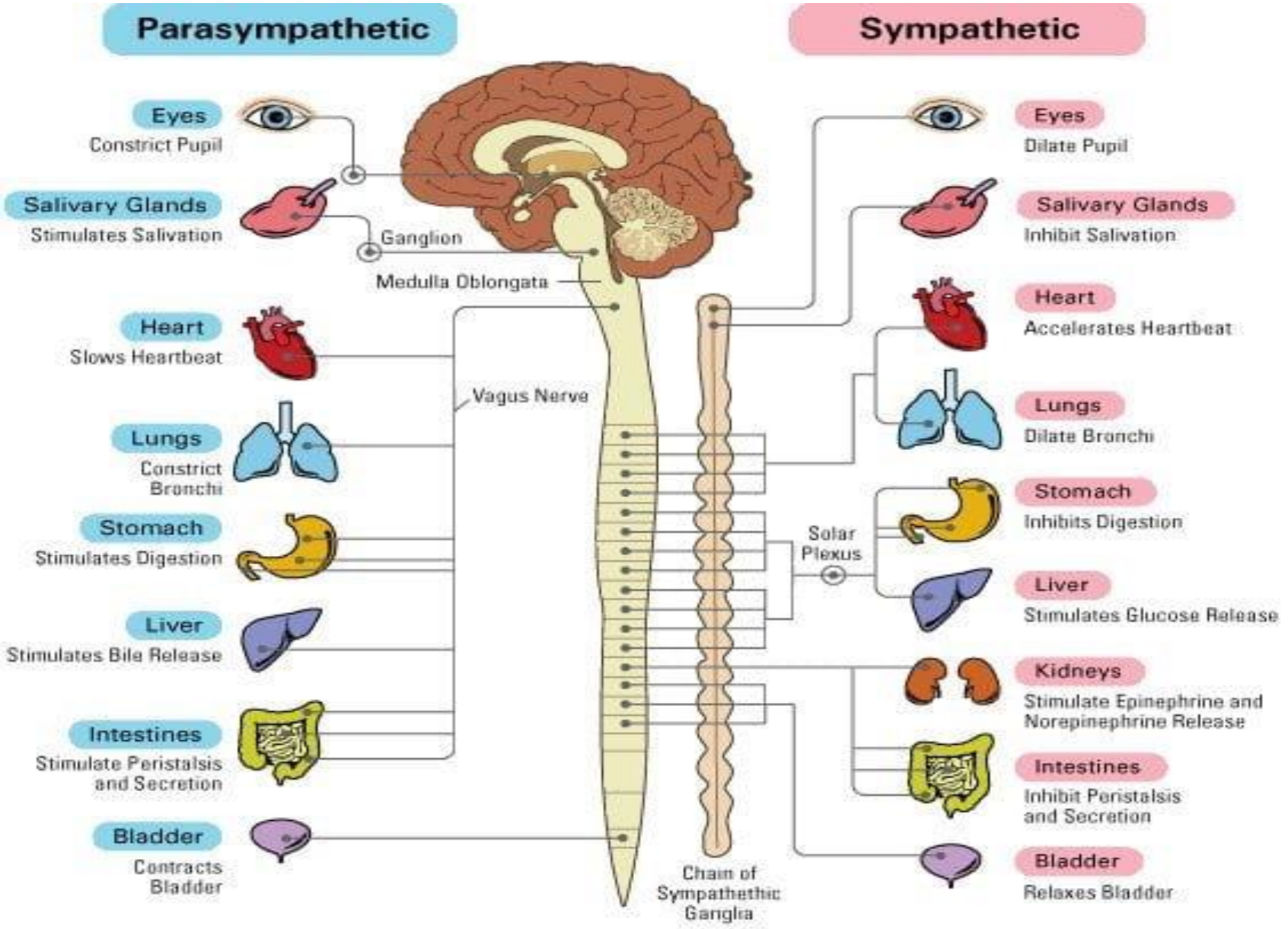
- These two divisions have both structure and functional differences.

- Each division has two motor neurons, autonomic ganglia and effector organs.

- Pre-ganglionic neurons: The first motor neurons which lies before the ganglion is called as pre-ganglionic neuron. The myelinated axon is called as pre-ganglionic fibre.

- Post-ganglionic neurons: The second motor neuron which lies after the ganglion and terminates in the effector organ is called as post-ganglionic neuron. Its axon is called as post ganglionic fibres.

- The autonomic ganglion is the collection of the bodies outside the CNS.



Schema Explaining How Parasympathetic and Sympathetic Nervous Systems Regulate Functioning Organs

Sympathetic Division

- It is called as thoraco lumbar division.
- It consists of two types of autonomic ganglia.
- Sympathetic trunk ganglia
- Prevertebral ganglia

Sympathetic trunk ganglia

- These are the ganglia lie in a vertical row on either side of the vertebral column.
- These lies close to the spinal cord and therefore the pre-ganglionic fibres are short.

Prevertebral ganglia

- These are three types of ganglion:
  - ✓ Coeliac ganglion
  - ✓ Superior mesenteric ganglion
  - ✓ Inferior mesenteric ganglion

- Most of the ganglia of sympathetic trunk are arranged on both sides of the spinal cord.
- The pre-ganglionic nerve fibres are shorter, neurotransmitter is acetylcholine.
- The post-ganglionic nerve fibres are longer, adrenergic.

Parasympathetic Division

- It is called as cranio-sacral division.
- It contains parasympathetic ganglia.
- The parasympathetic ganglia are dispersed.
- The ganglia are near or within the wall of the visceral effectors.
- The pre-ganglionic nerve fibres are longer, acetylcholine.
- The post-ganglionic nerve fibres are shorter, cholinergic.
- The distribution is limited, particularly to heart, viscera of thorax, abdomen and pelvis.

Cranial Nerves

- There are 12 pairs of cranial nerves originating from the nuclei in the inferior surface of the brain.
- Some are sensory, some are motor and some are mixed.
- Their names and numbers are as follows:

Types of Cranial Nerves

Cranial nerves		
Number	*Name*	*Function*
I	olfactory	smell
II	optic	Sight
III	oculomotor	moves eye, pupil
IV	trochlear	moves eye
V	trigeminal	face sensation
VI	abducens	moves eye
VII	facial	moves face, salivate
VIII	vestibulocochlear	hearing, balance
IX	glossopharyngeal	taste, swallow
X	vagus	heart rate, digestion
XI	accessory	moves head
XII	hypoglossal	moves tongue

Olfactory nerves

- It is sensory type of nerve with afferent fibre.
- It originated in the olfactory lobe i.e. root of nose and terminates in the temporal lobe of cerebrum.
- It is associated with sense of smell.

Optic nerves

- It is sensory type nerve with afferent fibre.
- It originated in the retina of eyes and terminates in the vision area of occipital lobe of cerebrum.
- It is related with sense of vision.

Oculomotor nerves

- It is mixed type of nerve with efferent as well as afferent fibre, but primarily it is motor originated in the mid-brain.

- ✓ Efferent portion (motor): It innervates the skeletal muscles it moves the eyeball and innervates the smooth muscles that constrict pupil and lens shape for far and near vision.

- ✓ Afferent portion (Sensory): it is related to movement of eyeball and regulating the size of pupil.

Trochlear nerves

- It is mixed type of nerve but primarily motor and originated in the midbrain.
- It is the smallest of the 12 cranial nerves.
- The motor portion is ralated to the movement of eyeball and sensory vision carries information from muscles of eye to midbrain.

Abducens nerve

- A mixed type of nerve, but 1 degree motor that originated in the pons.
- Motor function: movement of eyeball.
- Sensory function: proprioception.

Trigeminal nerves

- It is a mixed type of nerve fibre.
- It is the largest among all the cranial nerves.
- The sensory portion consists of three branches:

✓ Opthalmic nerve: It Contains axon from skin of eyelids, eyeball, lacrimal glands, nasal cavity, nose and forehead.

✓ Maxillary nerve: It contains axons from the mucosa of nose, parts of pharynx, upper teeth, upper lip and lower eyelid.

✓ Mandibular nerve: It contains axon from tongue, lower teeth, skin over mandible, and cheek.

- Motor function: chewing
- Sensory function: conveys impulses for touch, pain and temperature.

Facial nerve

- The motor fibre originateds from pons and innervates the skeletal muscle of face, nose, palate, lacrimal and salivary gland.
- Motor function: facial expression
- Sensory function: Proprioception and taste

Vestibulocochlear nerve

- It is sensory type of nerve that transmits information from receptor in ear.
- It consists of two nerves:

- Vestibular nerve: It arises from semicircular canals of the inner ear and conveys impulses to the cerebellum. They are associated with maintenance of posture and balance.

- Cochlear nerve: It originates in the spiral organ of the inner ear and conveys impulses to the hearing area of cerebral cortex. Cochlear nerve is responsible for hearing.

Glossopharyngeal nerve

- It is a mixed type of nerve.
- The motor fibres originate from medulla oblongata and innervate the tongue and pharynx.
- The sensory fibres originate from salivary glands and terminate in the medulla oblongata.
- Motor function: elevates the pharynx during swallowing and speech.
- Sensory function: taste, touch, pain and temperature sensations, monitoring of blood pressure.

Vagus nerve

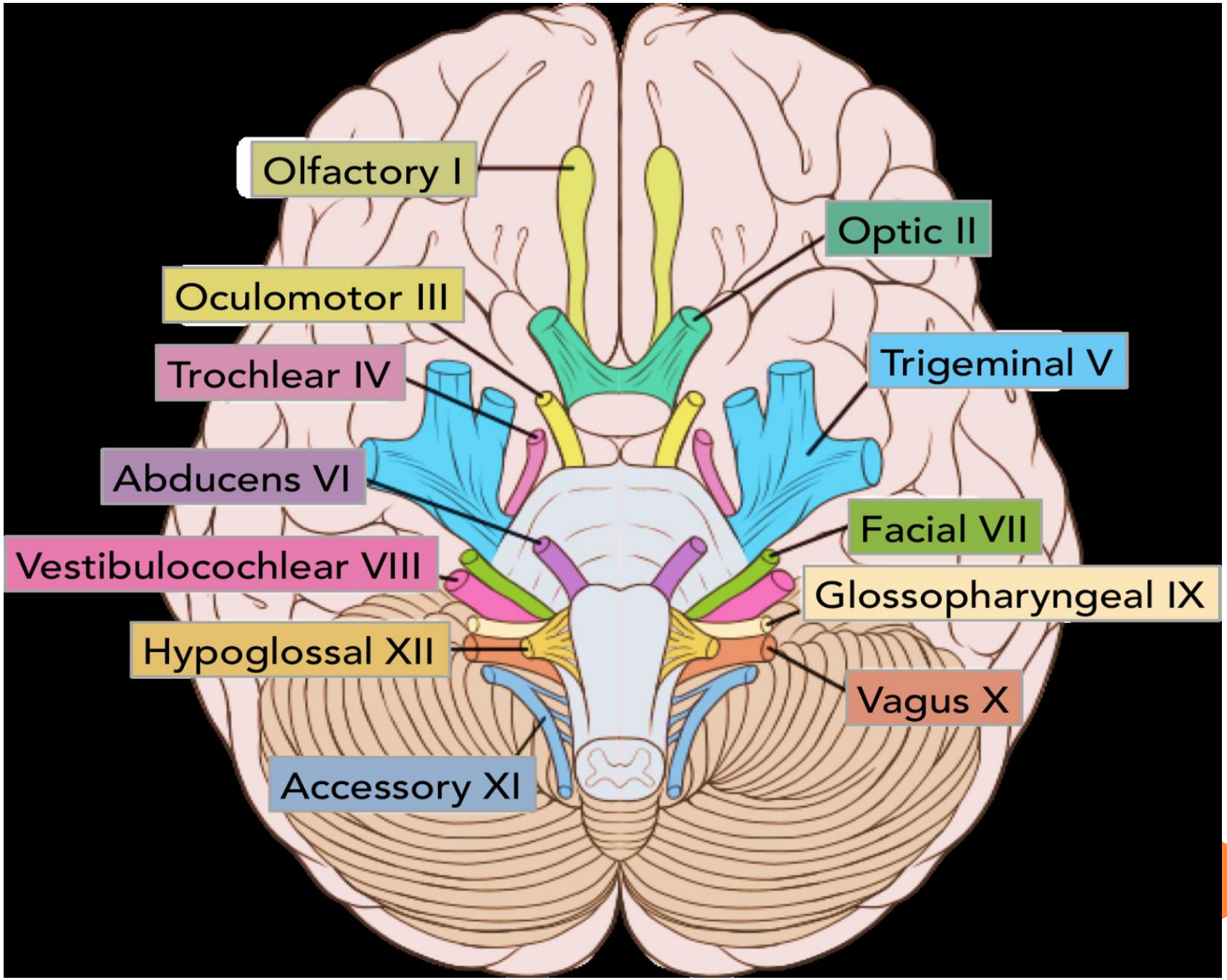
- The motor fibres originates in the medulla oblongata and innervated the smooth muscles of pharynx, larynx, trachea, heart, oesophagus, stomach, intestine, pancreas, gall bladder, bile duct, spleen, kidney, ureter, blood vessels in thoracic and abdominal cavities.
- The sensory fibres convey impulses from same organs to brain.
- Motor function: swallowing, coughing and voice production
- Sensory function: taste, touch, pain and temperature sensations, monitoring of blood pressure.

Accessory nerve

- It is a mixed type of nerve, primarily motor nerve.
- It originates from the medulla oblongata and innervates the voluntary muscles of pharynx and skeletal muscle of neck.
- Motor function: neck controls swallowing movements and movement of head and shoulders.

Hypoglossal nerve

- It originated in the medulla oblongata and supplies to the muscle of tongue.
- The sensory function is gives sensation to tongue.
- Sensory function: proprioception
- Motor function: movement of tongue during speech and swallowing


Olfactory I
Optic II
Oculomotor III
Trochlear IV
Trigeminal V
Abducens VI
Facial VII
Vestibulocochlear VIII
Glossopharyngeal IX
Hypoglossal XII
Vagus X
Accessory XI

Spinal nerves

- Peripheral nervous system consist of:
- 31 pairs of spinal nerves
- 12 pairs of cranial nerves
- There are 31 pairs of spinal nerves that leaves the vertebral canal (formed by 33 vertebrae) by passing through the intervertebral foramina.
- They are named and grouped according to the vertebrae with which they are associated:
- ✓ 8 cervical
- ✓ 12 thoracic
- ✓ 5 lumbar
- ✓ coccygeal

- A typical spinal nerve has two connections to the cord: Posterior root and Anterior root.

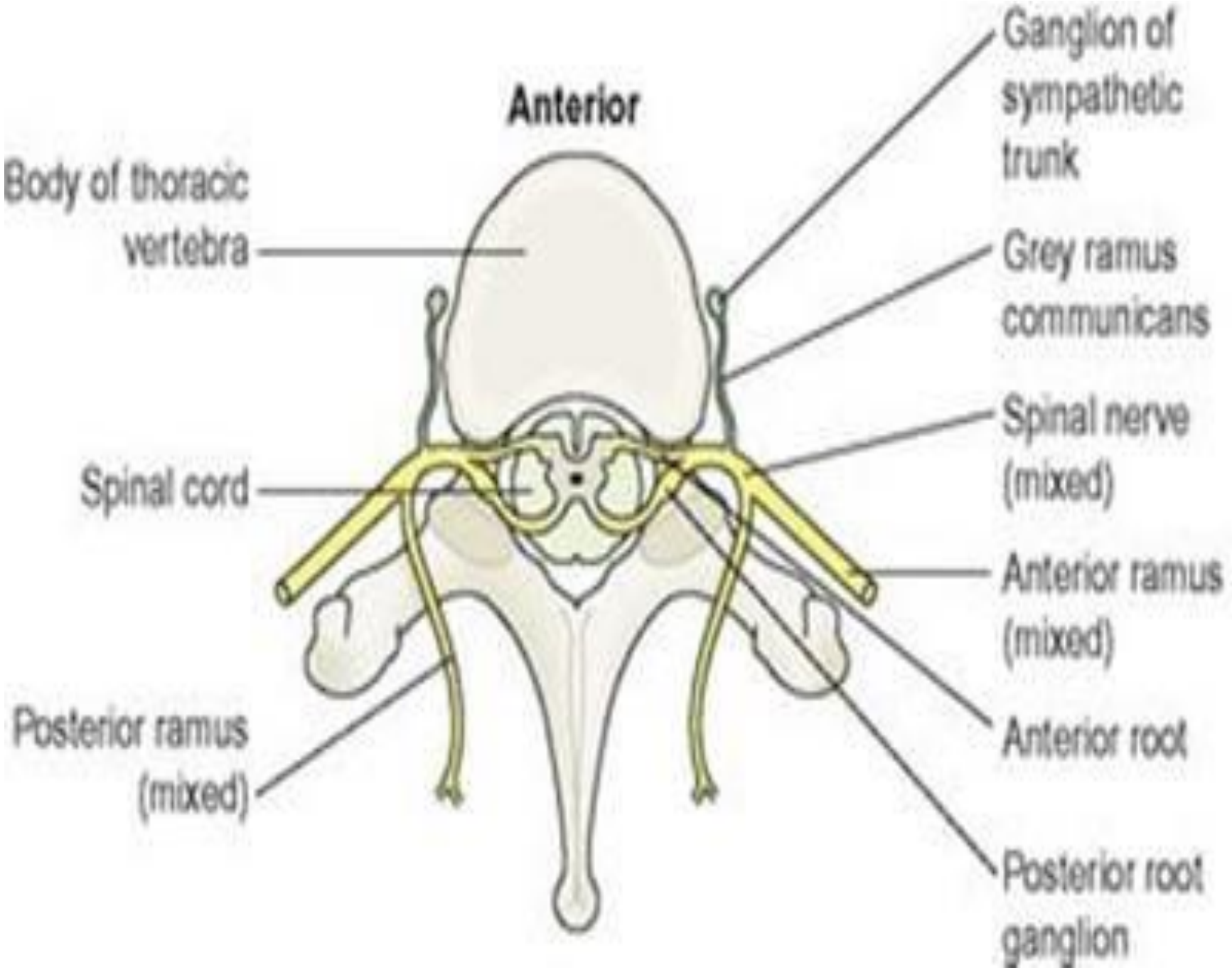
ANTERIOR NERVE ROOT

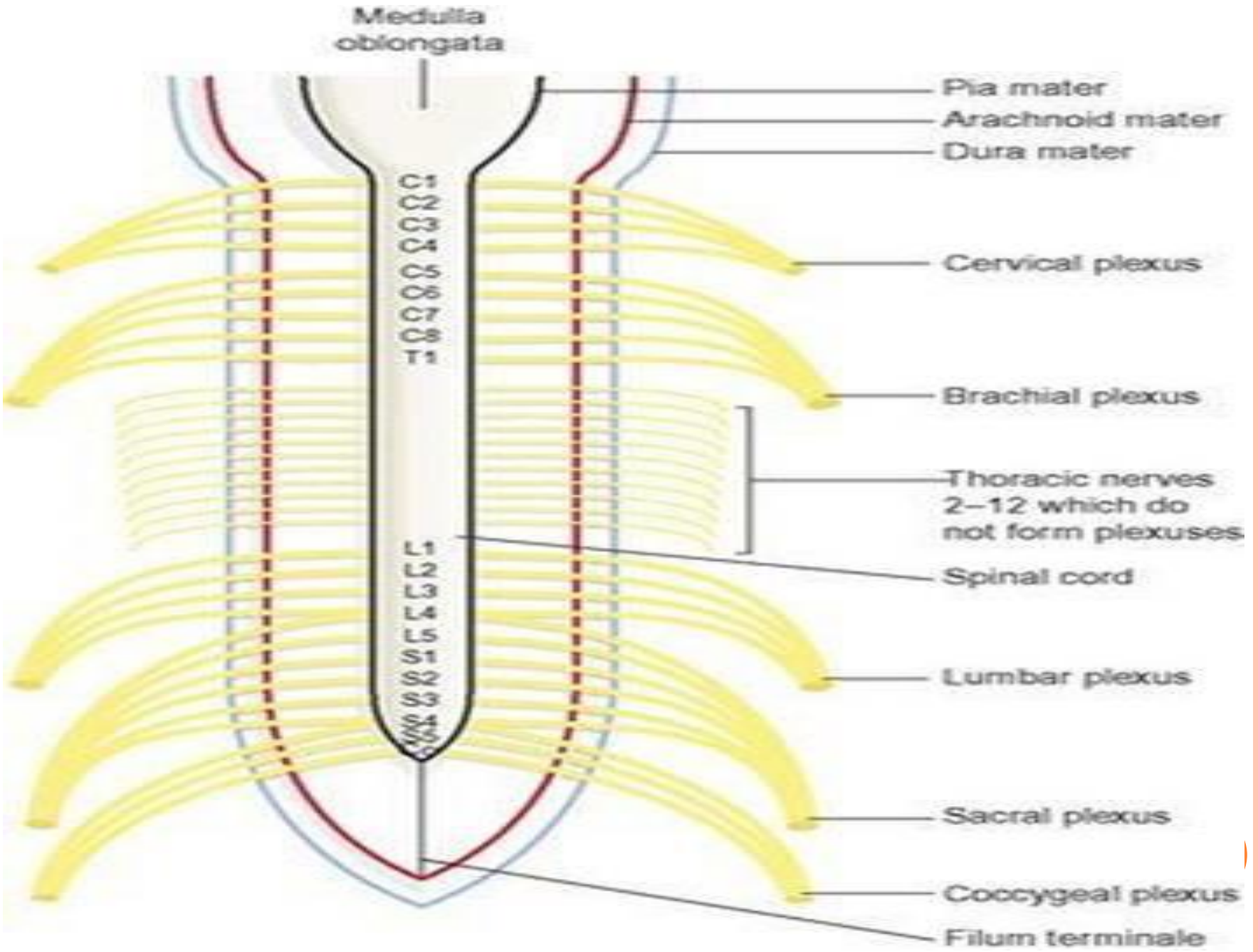
- It consists of motor nerve fibres which are the axons of nerve cells in the anterior column of grey matter in the spinal cord and in the thoracic and lumbar regions, sympathetic nerve fibres which are the axons of cells in the lateral columns of grey matter.

Posterior nerve root

- It consists of sensory nerve fibres.
- Just outside the spinal cord there is a spinal ganglion (posterior root ganglion), consisting of a little cluster of cell bodies.
- Sensory nerve fibres pass through these ganglia before entering the spinal cord.
- There are five large plexuses of mixed nerves formed on each side of the vertebral column.

- Cervical plexuses: it is formed by the anterior rami of the first four cervical nerves.
- Brachial plexuses: the anterior rami of the lower four cervical nerves and a large part of the first thoracic nerve form the brachial plexus.
- Lumbar plexuses: it is formed by the anterior rami of the first three and part of the fourth lumbar nerves.
- Sacral plexuses: it is formed by the anterior rami of the lumbosacral trunk and the first, second and third sacral nerves.
- Coccygeal plexuses: the coccygeal plexus is a very small plexus formed by part of the fourth, fifth sacral and the coccygeal nerves.


Anterior
Body of thoracic vertebra
Spinal cord
Posterior ramus (mixed)
Ganglion of sympathetic trunk
Grey ramus communicans
Spinal nerve (mixed)
Anterior ramus (mixed)
Anterior root
Posterior root ganglion


Medulla oblongata
Pia mater
Arachnoid mater
Dura mater
C1
C2
C3
C4
C5
C6
C7
C8
T1
Cervical plexus
Brachial plexus
Thoracic nerves 2–12 which do not form plexuses
L1
L2
L3
L4
L5
S1
S2
S3
S4
S5
Spinal cord
Lumbar plexus
Sacral plexus
Coccygeal plexus
Filum terminale


thank you

UNIT – IV
SPECIAL SENSES

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INTRODUCTION

* The body has an innate ability to sense change in its internal and external environment, which enable it to maintain a state of homeostasis and continued survival.
* Special sense organs are characterized by large and complex organs, each with a unique function.
* Sensory organs have special receptors that allow us to smell, taste, seen, hear and maintain equilibrium or balance.
* Information conveyed from these receptors to the central nervous system is used to help to maintain homeostasis.

OPHTHALMOLOGY

* It is the branch of science that deals with the study of eyes and their disorders.

OTORHINOLARYNGOLOGY

* It is the branch of science that deals with the study and treatment of diseases of the ear, nose, and throat.

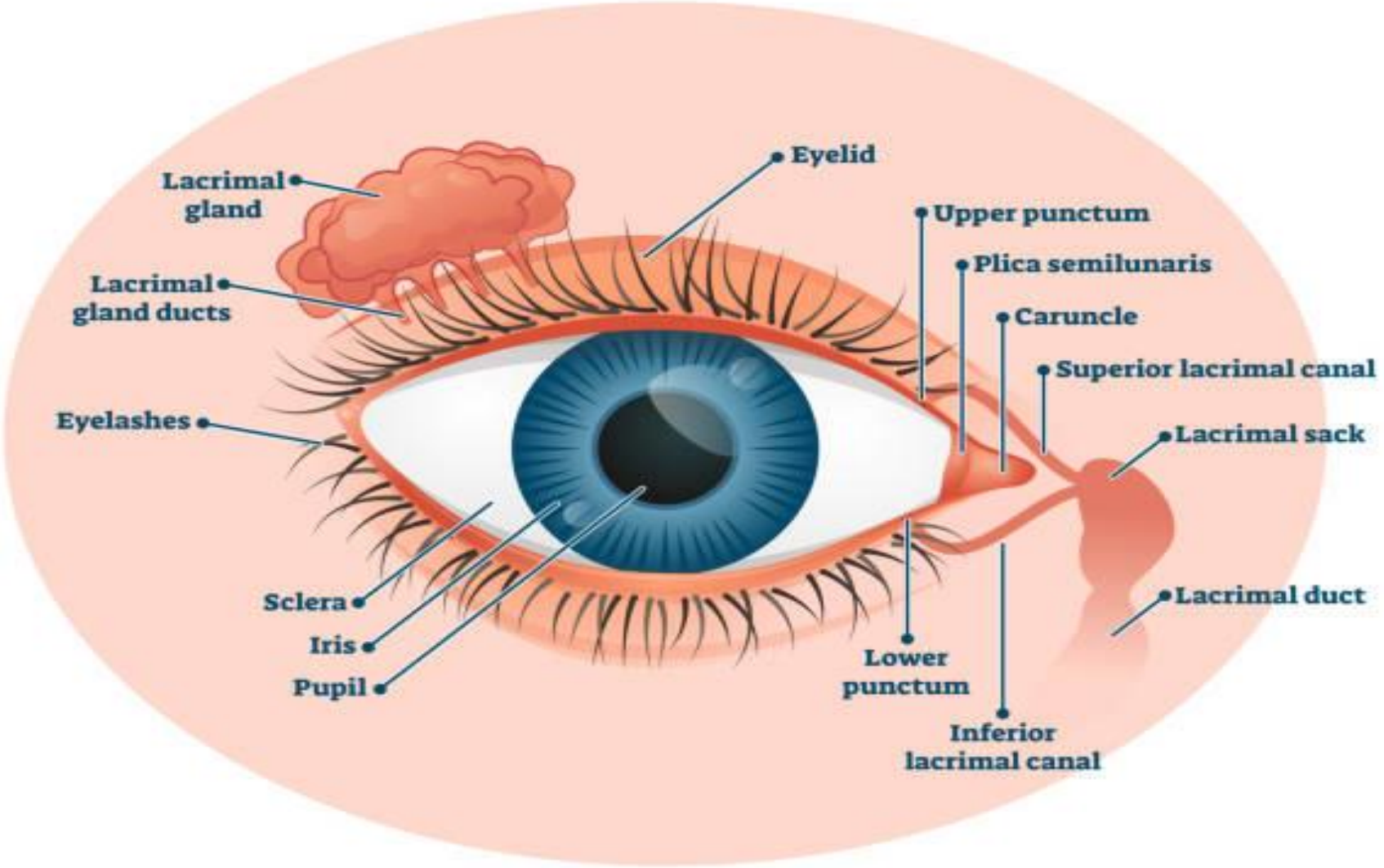
EYE

* Vision is extremely important for the human survival.
* More than half of the sensory receptors are located in the eyes.
* The eye is situated in the orbital cavity and is supplied by the optic nerves.
* It is spherical in shape and about 2.5 cm in diameter.
* The eye is located in bony socket called as orbit.

ACCESSORY STRUCTURE OF THE EYE

* Eyelids
* Eyelashes
* Eyebrows
* Lacrimal apparatus
* Extrinsic eye muscles

PARTS OF THE EYE



EYELIDS

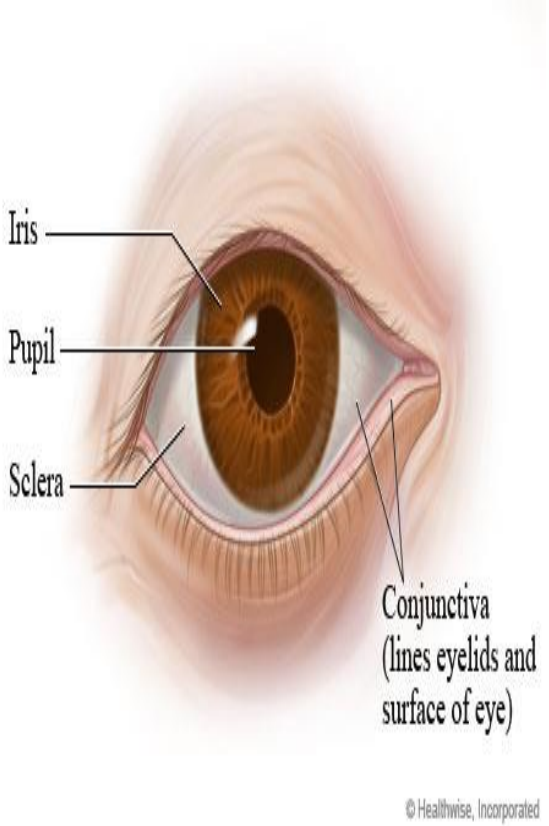
* These are two movable folds of tissue situated above and below the front of each eye.
* On their free edges there are short, curved hairs called as eyelashes.

FUNCTION

* The eyelids and eyelashes protect the from injury.
* The eyelids protect the front surface of eyes from excessive wind, small particles in the air and from minor mechanical injury.
* Blinking at about 3-7 sec intervals spreads tears and oily secretions over the cornea, preventing injury to eye.

CONJUNCTIVA

* It is a thin, transparent membrane that lines the eyelids and the front of eyeball.
* The corneal conjunctiva consists of avascular stratified epithelium i.e. epithelium without blood vessels.
* When the eyelids are closed, the conjunctiva becomes a closed sac.
* It protects the delicate cornea and the front of eye.

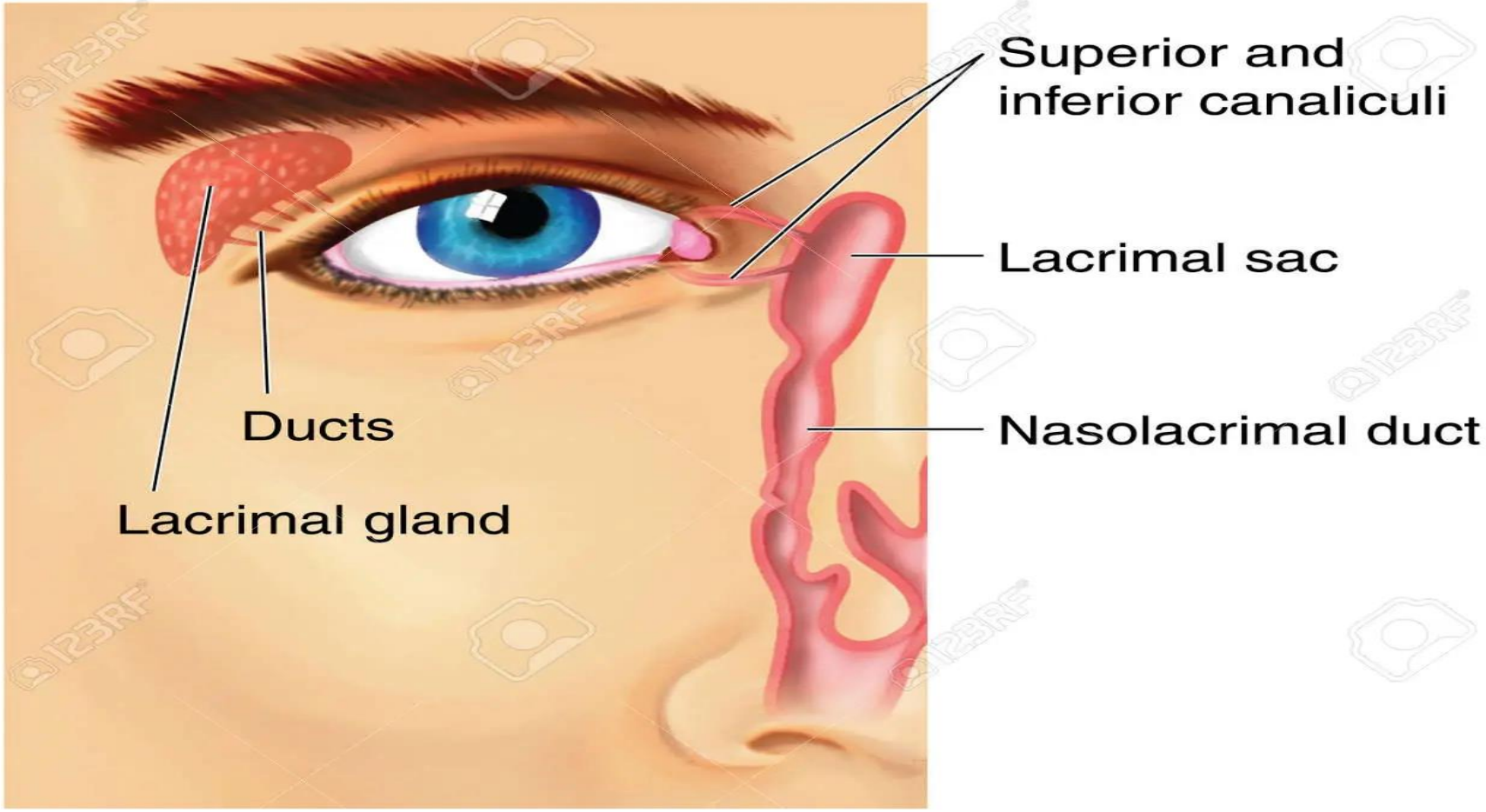


EYEBROWS

* Numerous hairs (eyebrows) projects obliquely from the surface of the skin.

* They protect the eyeball from sweat, dust and other foreign bodies.

LACRIMAL APPARATUS



LACRIMAL APPARATUS

* It consists of
  - ✓ 1 lacrimal gland and its ducts
  - ✓ 2 lacrimal canaliculi
  - ✓ 1 lacrimal sac
  - ✓ 1 Nasolacrimal duct

* The produces and drains lacrimal fluid (tears).

* It has size and shape of an almond, secrete lacrimal fluid which drains into lacrimal ducts that empty tears onto the surface of conjectiva.

FUNCTION

* The lacrimal fluid is watery solution containing salts, mucus and lysozyme a bactericidal enzyme.

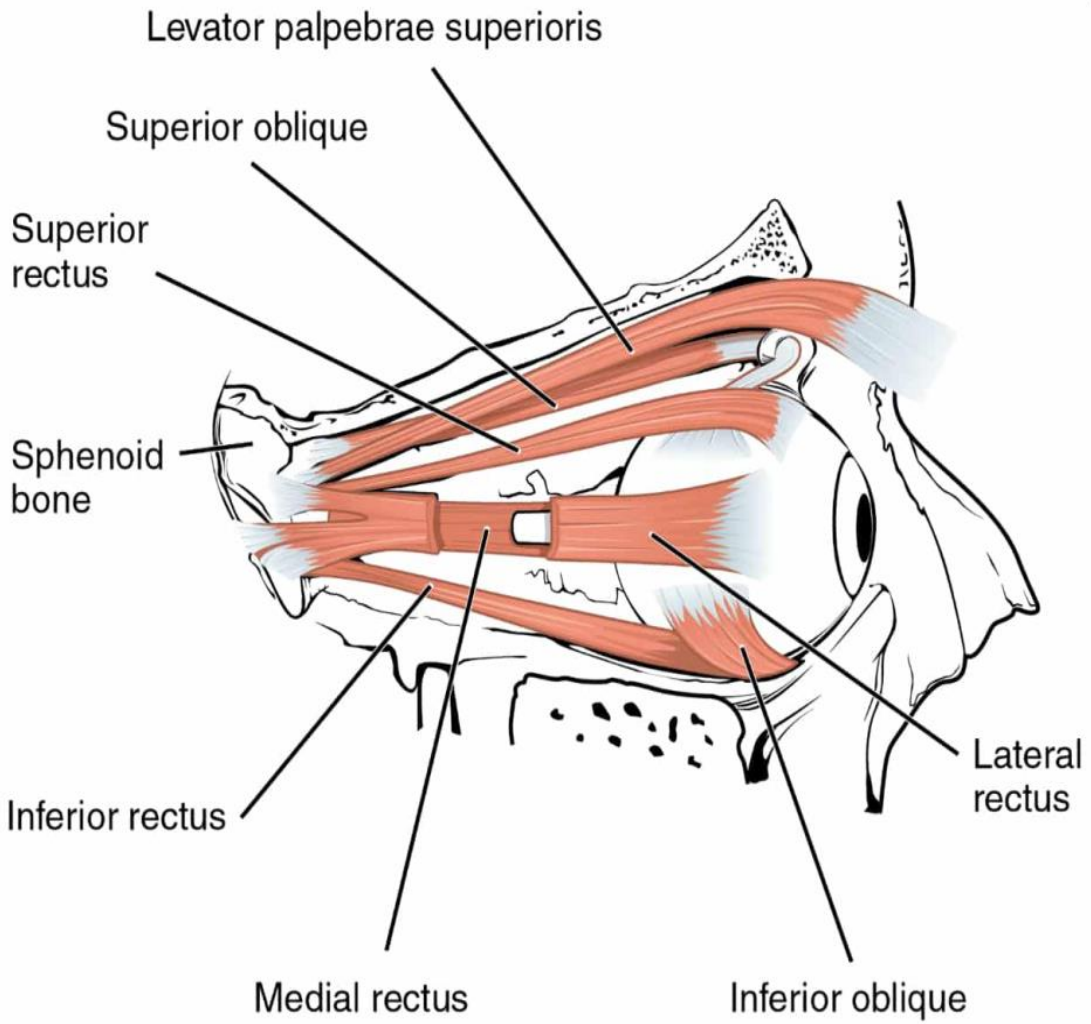
* The fluid protects, clean, lubricates and moistens the eyeball.

EXTRINSIC EYE MUSCLES

* Six extrinsic muscles move the eye together.

- ✓ Superior rectus
- ✓ Inferior rectus
- ✓ lateral rectus
- ✓ Medial rectus
- ✓ Superior oblique
- ✓ Inferior oblique

EXTRINSIC EYE MUSCLES



ANATOMY OF THE EYEBALL

* The adult eyeball measures about 2.5 cm in diameter.

* Only the anterior 1/6th part is exposed, the rest is protected in bony socket of the orbit.

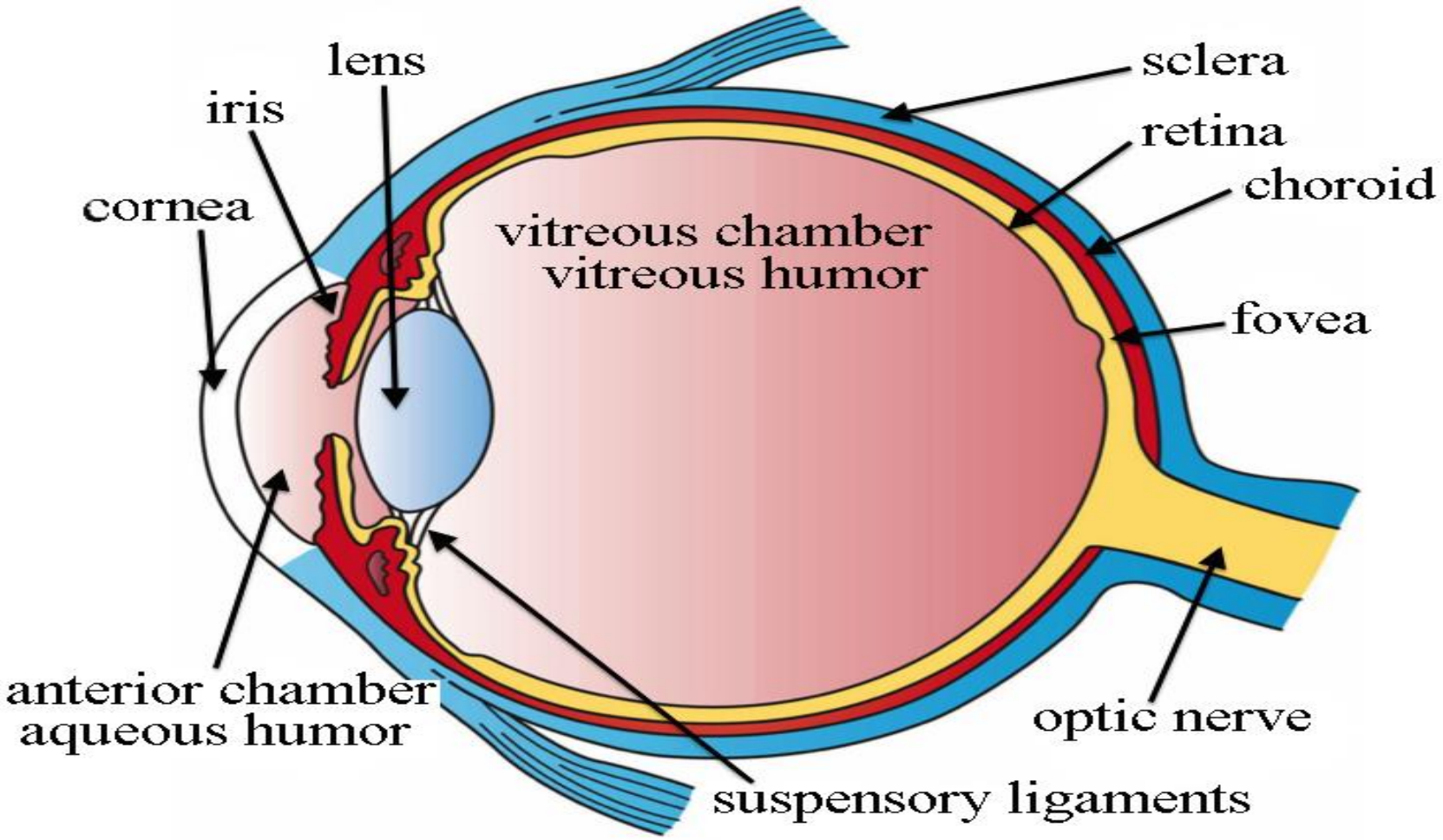
* The wall of eyeball consists of three layers.

✓ Fibrous tunic

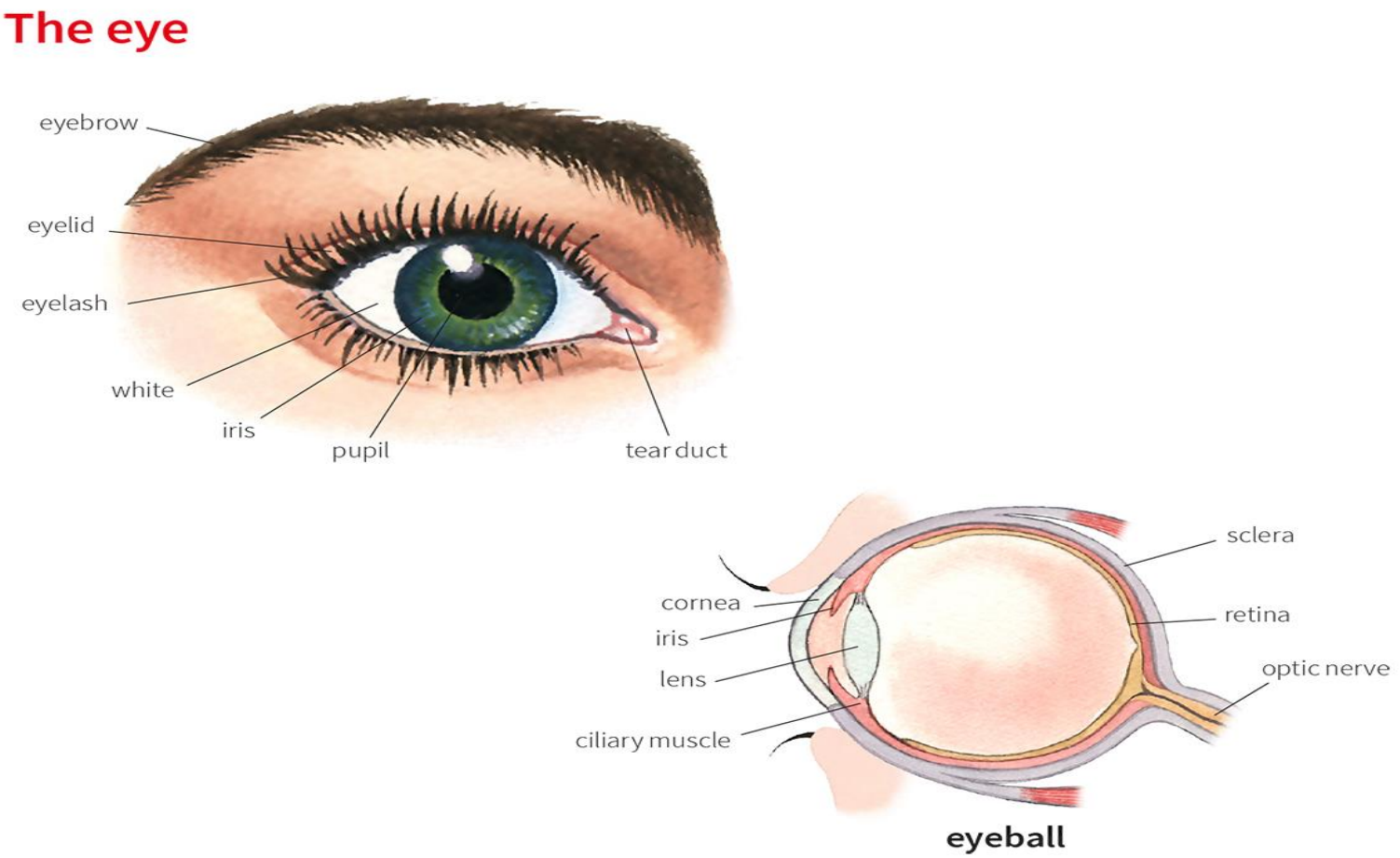
✓ Vascular tunic

✓ Retina

Anatomy of the Eyeball



Anatomy of the eyeball



FIBROUS TUNIC

* It is the superior layer of eyeball.
* It consists of anterior cornea and posterior sclera.
* The cornea is transparent coat that covered the coloured iris.
* Because it is curved, the cornea helps to focus the light onto the retina.

* The sclera: the white of the eye is a layer of dense connective tissue made up of collagen fibres and fibroblasts.

* The sclera covers the entire eyeball except the cornea.

* It gives shapes to the eyeball, makes it more rigid and protects its inner parts.

Vascular tunic

* The vascular tunic is the middle layer of eyeball.
* It is composed of three parts.
  - ✓ Choroid
  - ✓ Ciliary body
  - ✓ Iris
* Choroid is present below the sclera.
* Its numerous blood vessels provide nutrients to the posterior surface of retina.

* The choroid also contains melanocytes that produce the pigment melanin which appear dark brown in colour.
* At the anterior portion, the choroid becomes the ciliary body.
* Like the choroid the ciliary body appears dark brown in color as it contains melanin.
* Iris is colored portion of eyeball.
* It is suspended between the cornea and lens.

* It also consists of melanocytes.
* The amount of melanin in the iris determines the eye colour.
* High concentration: brown/black eye colour.
* Moderate concentration: Green eye colour.
* Low concentration: Blue eye colour.

RETINA

* The third & inner coat of eyeball.
* Extremely thin & transparent.
* Optic disc is the site where the optic (II) nerve exits the eyeball.
* It consist of:

✓ Retina artery

✓ Retina vein

* The retina consists of a pigmented layer & neural layer.
* The pigmented layer of a sheet of melanin-containing cells.

* The melanin in pigmented layer helps to absorb the light rays.

* The neural layer is a multilayered outgrowth of brain.

* It consist of 3 layers,

- ✓ photoreceptor layer
- ✓ Bipolar cell layer
- ✓ Ganglion cell layer

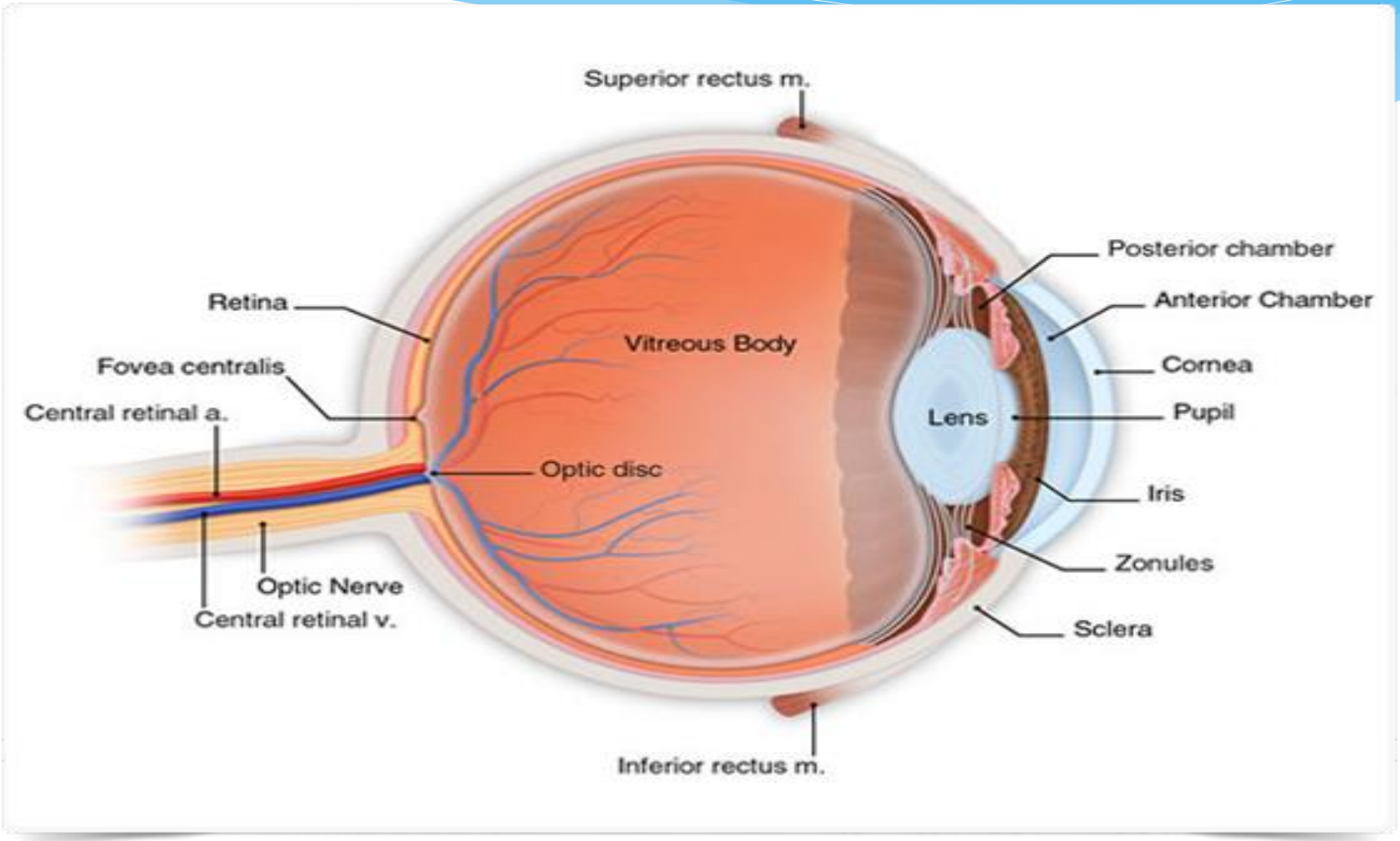
LENS

* The lens is present behind the pupil & iris within the cavity of the eyeball.

* A protein crystalline, arranged like the layers of an onion, make up the lenses transparent and lacks blood vessels.

* The lens help to focus images on the retina to facilitate the clear vision.

INFERIOR OF THE EYEBALL



INFERIOR OF THE EYEBALL

* The lens divides the interior of eyeball into two cavities;
  - ✓ The anterior cavity
  - ✓ The vitreous chamber

* The anterior cavity consists of two chambers.

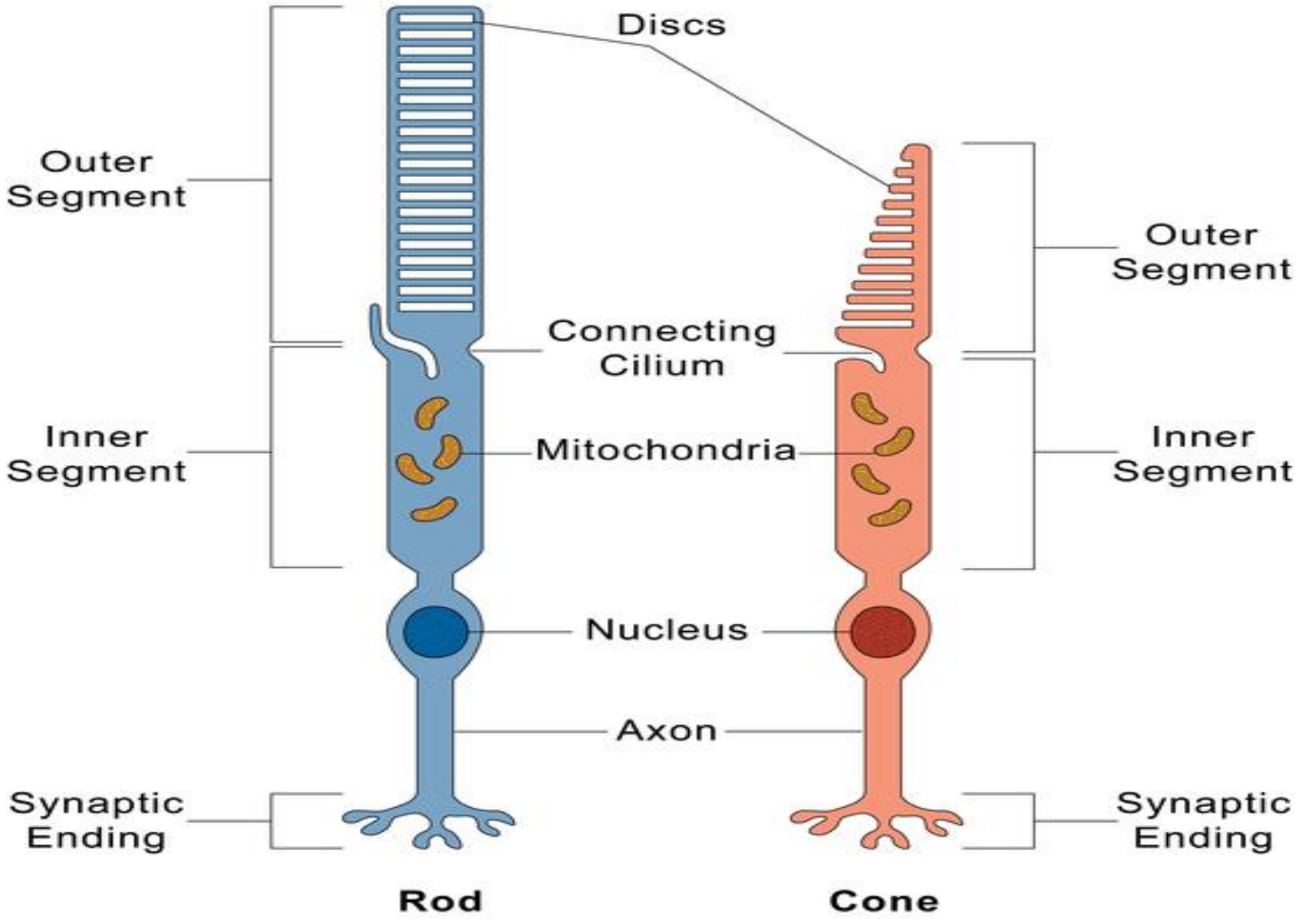
* Anterior chamber: It lies between iris & in front of lens
* Posterior chamber: It lies behind iris & in front of lens
* Both the chambers of anterior cavity are filled with aqueous humour- a watery fluid that nourishes the lens & cornea.

* The second & larger cavity of eyeball is vitreous chamber which lies between the lens & the retina.
* It is never replace throughout the life.
* This substance contributes the intraocular pressure (16 mm of Hg).
* The intraocular pressure maintains the shape of the eyeball & prevents it from collapsing.

PHYSIOLOGY OF VISION

* The rods & cones are two types of photoreceptors cells present in the eye.
* The retina of each eye contains about 6 millions of cones & 120 millions of rods.
* Rods: They works in dim light and are responsible for observing shapes & movements.
* Cones: They provide colour vision in bright light.
* The rods & cones are named because of their shapes.

Rod and Cone Cells



* The rods and cones are made up of two parts.
- ✓ Outer segment
- ✓ Inner segment
* The outer segments of cones are cone shaped whereas those of rods are rod shaped.
* The outer segment of rods as well as cones contains invaginated membranes called as discs.
* The first step in visual transduction in absorption of light by a photo pigments a coloured protein that undergoes structural changes when it absorbs light, in the outer segment of photoreceptor.

* The pigment present in the rods is rhodopsin and the cone is iodopsin.
* Both rhodopsin as well as iodopsin contains retinal (derivatives of vitamin-A).
* The photo pigments consists of two parts.
* A glycoprotein known as opsin.
* Derivative of vitamin-A known as retinal
* Good vision depends on adequate dietary intake of carotene-rich vegetables such as carrots, spinach, broccoli or foods containining vitamin-A such as liver.

LIGHT AND DARK ADAPTATION

* When you enter from a dark surroundings (a tunnel) into the sunshine, visual system undergoes light adaptation occurs by decreasing its sensitivity.

* When you enter a darkened room such as a theatre from sunshine, visual system undergoes dark adaptation by increasing its sensitivity.

RELEASE OF NT BY PHOTORECEPTORS

cGMP-gated
Na^+ channels open
↓
Inflow of Na^+
(dark current)
↓
Membrane potential
of – 30 mV
↓
Glutamate released
at synaptic terminals
inhibits bipolar cell

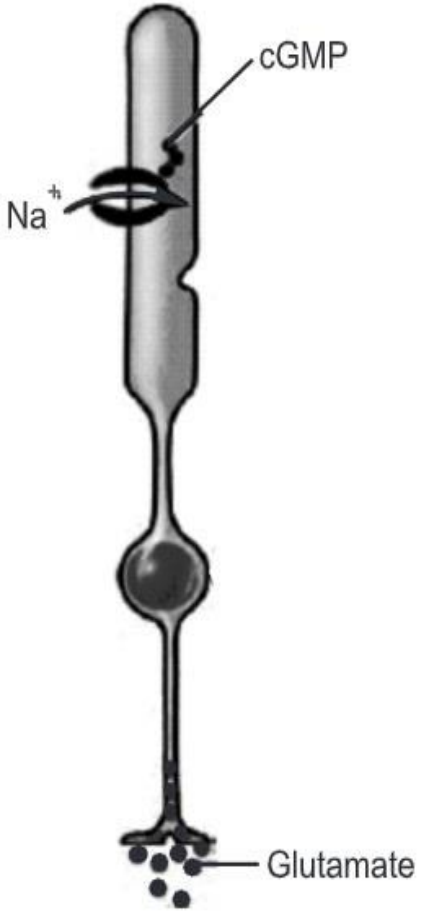


Fig. : Operation of photoreceptor in darkness

Isomerisation of retinal
activates enzyme that
breaks down cGMP
↓
cGMP-gated
Na^+ channels close
↓
Inflow of Na^+ slows
↓
Hyperpolarising
receptor potential
↓
Glutamate release
turned off, which excites
bipolar cell

Fig. : Operation of photoreceptor in light

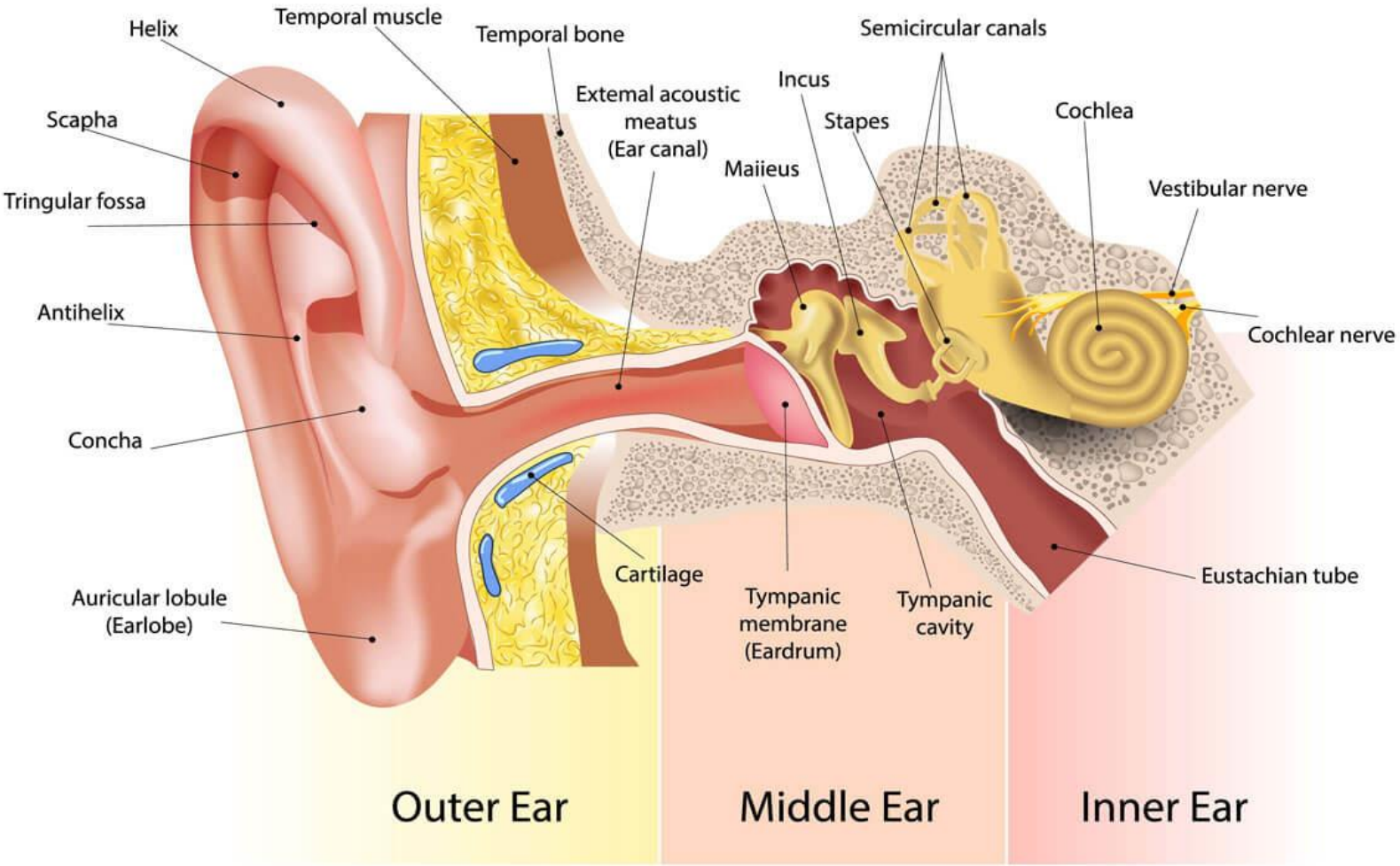
OPERATION OF ROD PHOTORECEPTOR IN DARKNESS

* Operation of photoreceptor in darkness
* In darkness the cyclic GMP levels of photoreceptors are high.
* This GMP levels opens the ligand gated sodium channels.
* Inflow of Na+ ions through the channel takes place called as dark current which partially depolarize the photoreceptor.
* In darkness the membrane potential of photoreceptor is -30 mv which is much closer to -70 mv.
* This partial depolarization during darkness triggers the release of glutamate at the synaptic terminals.
* This glutamate inhibits the bipolar cells that synapse with rods.

OPERATION OF ROD PHOTORECEPTOR IN LIGHT

* In light the cyclic GMP levels of photoreceptors are low which closes the sodium channels.
* So, inflows of Na+ ions through the photoreceptor get decreases.
* The membrane potential becomes more negative -70 mv (hyperpolarizing receptor potential).
* There is decrease in release of glutamate.
* This results in excitation of bipolar cell that synapse with the rod

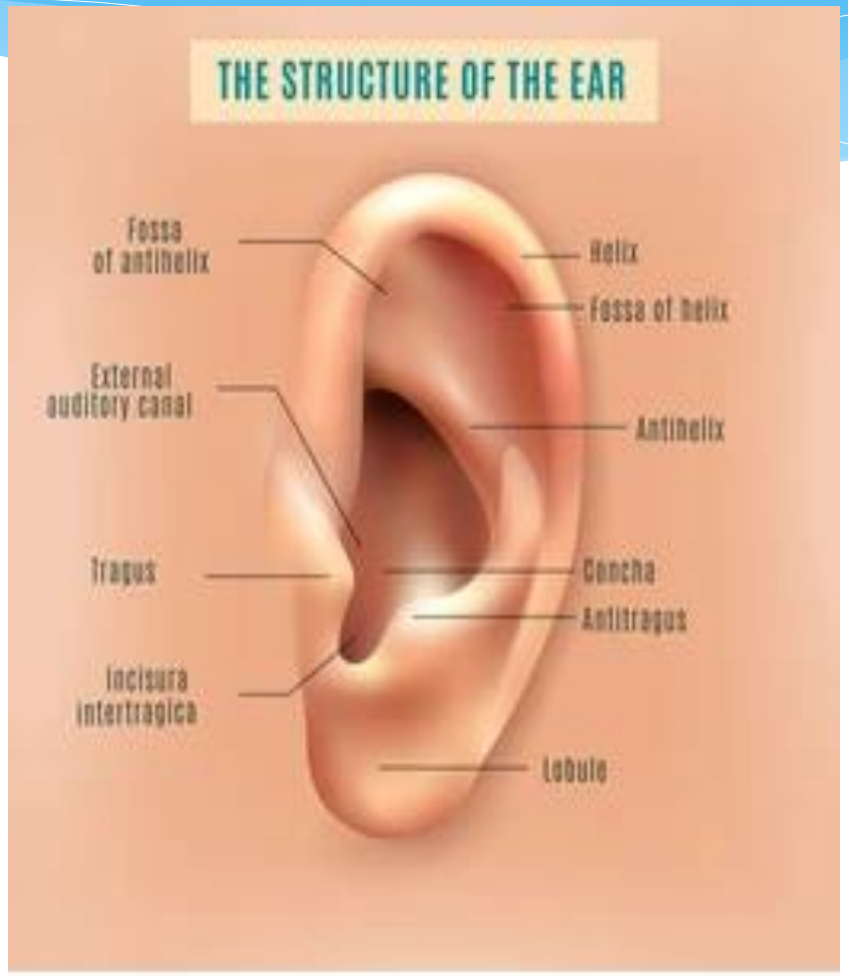
EAR


Helix
Temporal muscle
Temporal bone
Semicircular canals
Incus
Extemal acoustic meatus (Ear canal)
Stapes
Cochlea
Scapha
Maiieus
Vestibular nerve
Tringular fossa
Antihelix
Cochlear nerve
Concha
Cartilage
Eustachian tube
Auricular lobule (Earlobe)
Tympanic membrane (Eardrum)
Tympanic cavity
Outer Ear
Middle Ear
Inner Ear

ANATOMY OF EAR

Parts of ear

* External ear
* Middle ear
* Internal ear



EXTERNAL EAR

* It collects the sound waves & channels them inwards.
* It consists of 3 basic parts.
  - ✓ Auricle (Pinna)
  - ✓ External auditory canal
  - ✓ Tympanic membrane (Ear drum)
* Auricle is a sheet of elastic cartilage covered with skin.
* Superior portion is called as helix & the inferior portion is called as lobule.
* External auditory canal is 2.5 cm long.
* Pinna opens into the external auditory canal.

* The external auditory canal extends from pinna to eardrum.
* External auditory canals contain many specialized sebaceous glands which secrete wax called as ceruminous glands.
* Hairs are present in this canal along with earwax; they prevent the entry of dust & foreign particles in the ear.
* The external auditory canal ends at the tympanic membrane called as eardrum.
* Eardrum is a thin, semitransparent membrane between the external auditory canal & middle ear.

MIDDLE EAR

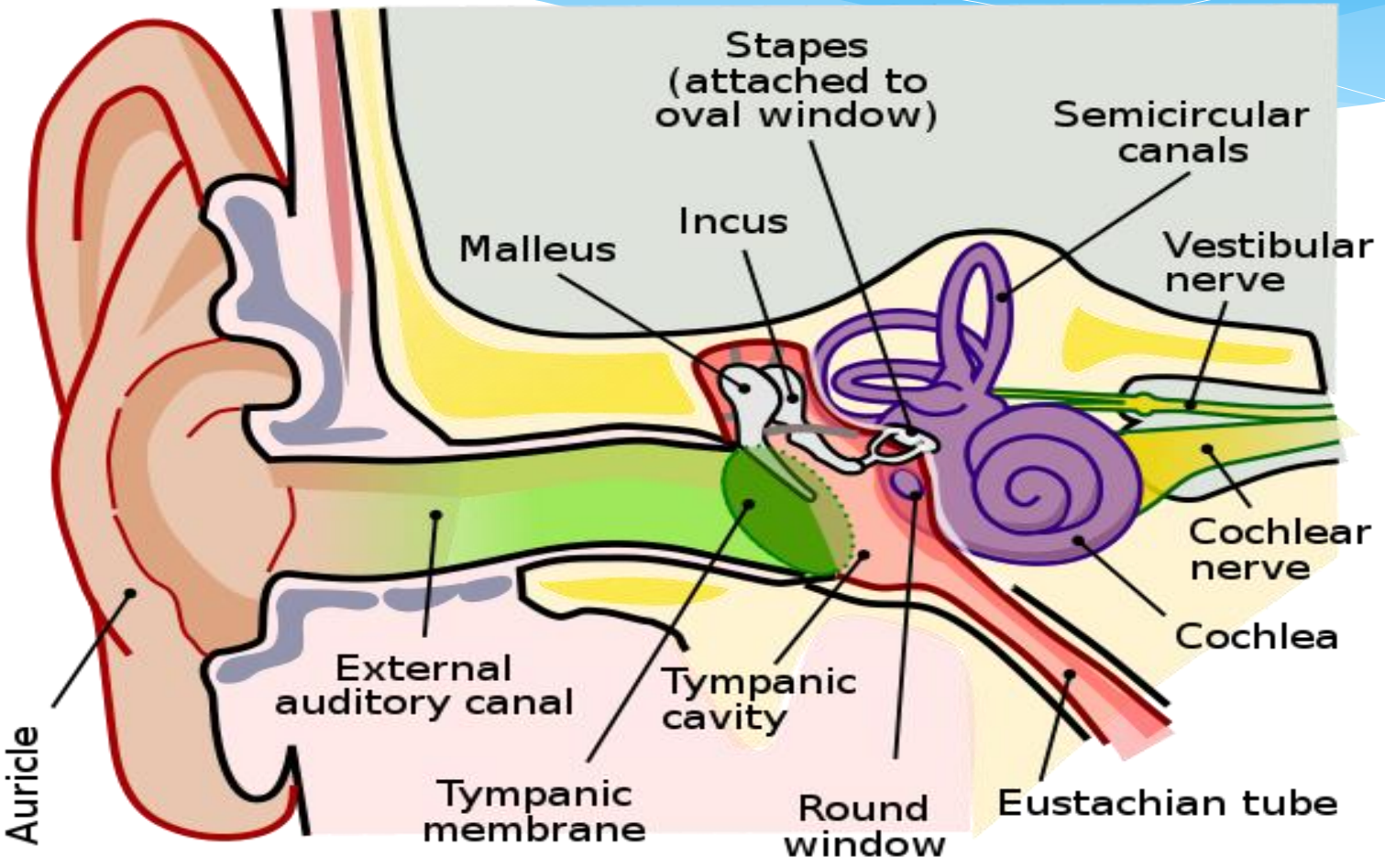
* It coveys sound vibration to the oval window.

* The middle ear is also called as tympanic cavity.

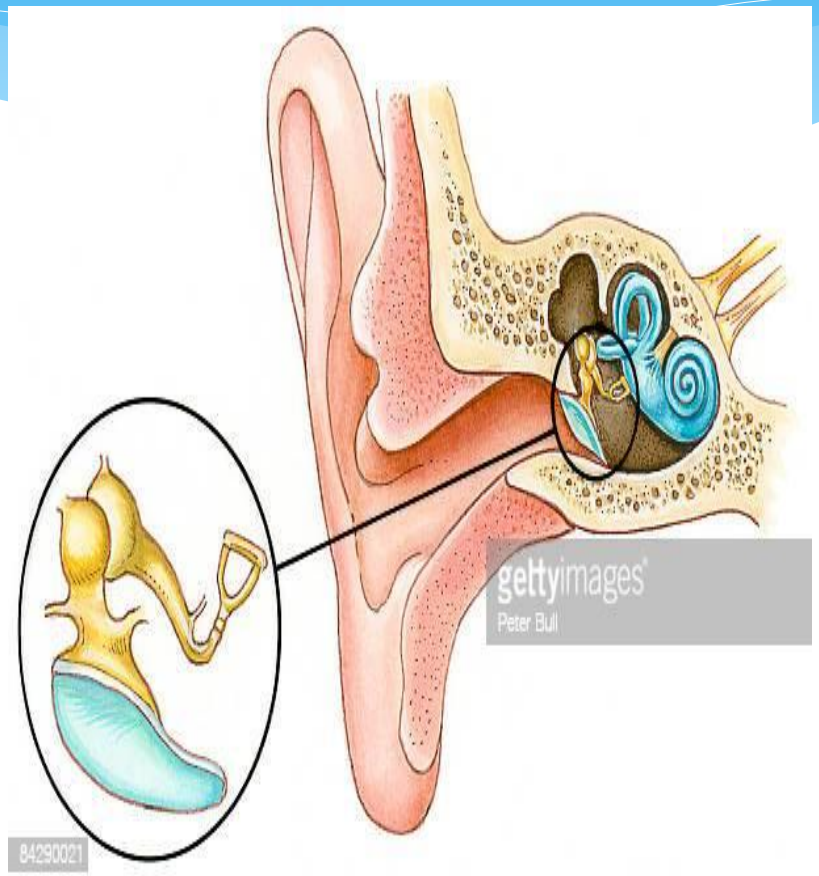
* It is separated from the external ear by a thin partition that contains two small openings.

✓ Oval window

✓ Round Window


Stapes
(attached to
oval window)
Semicircular
canals
Incus
Malleus
Vestibular
nerve
Cochlear
nerve
Cochlea
External
auditory canal
Tympanic
cavity
Auricle
Tympanic
membrane
Round
window
Eustachian tube

* 3 bones are present called as auditory ossicles.
* These are named according to their shapes.
* The malleus or hammer
* The incus or anvil
* The stapes or stirrup



INTERNAL EAR

* The internal ear is also called as labyrinth.
* Structurally it consists of 2 parts.
* Bony labyrinth: Outer part of labyrinth
* Membranous labyrinth: Inner part of labyrinth
* It is divided into 3 parts.

✓ The semicircular canals
✓ The vestibule
✓ The cochlea

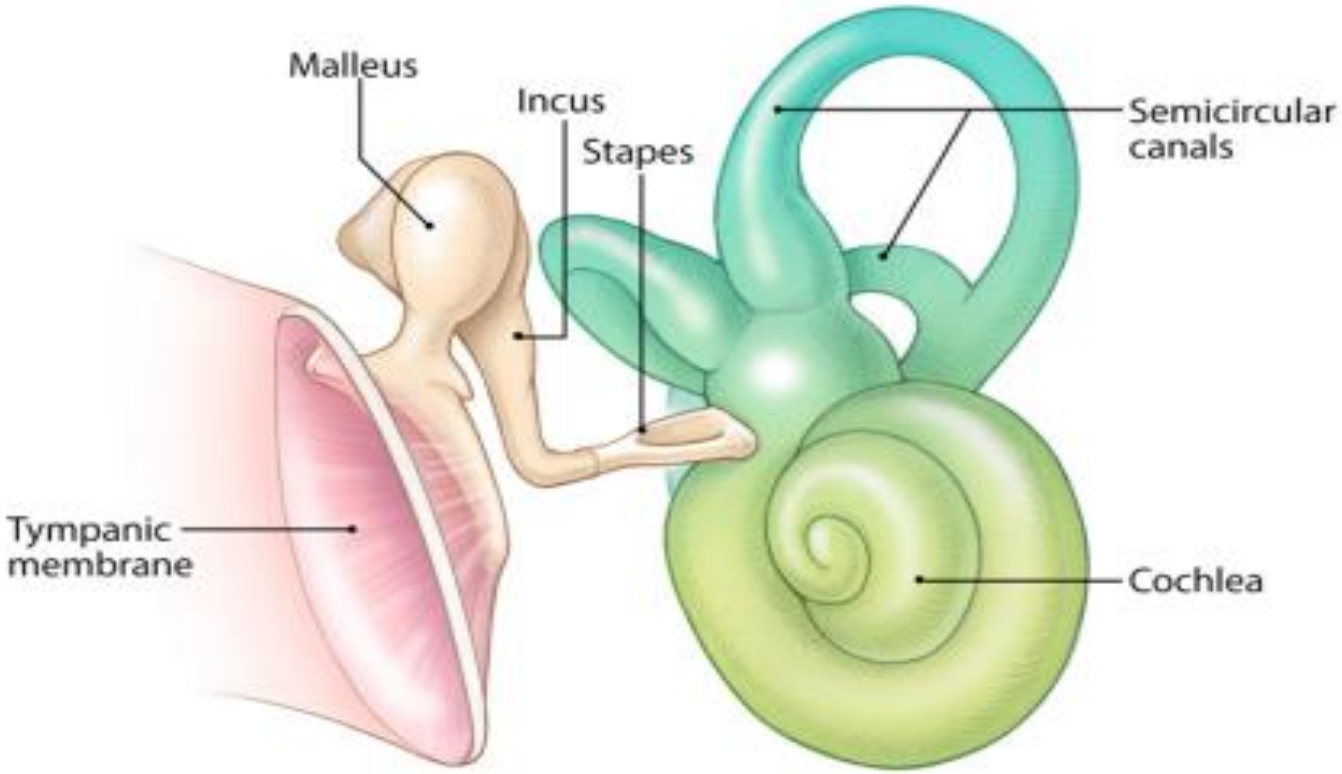
* The receptors for equilibrium are located in the semicircular canals.
* The receptors for hearing are located in cochlea.
* The fluid present in bony labyrinth called as perilymph.
* The fluid present in membranous labyrinth called as endolymph.
* The central portion of bony labyrinth is the vestibule.

* The 3 semicircular canals are;
- ✓ Anterior semicircular canal
- ✓ Posterior semicircular canal
- ✓ Lateral semicircular canal

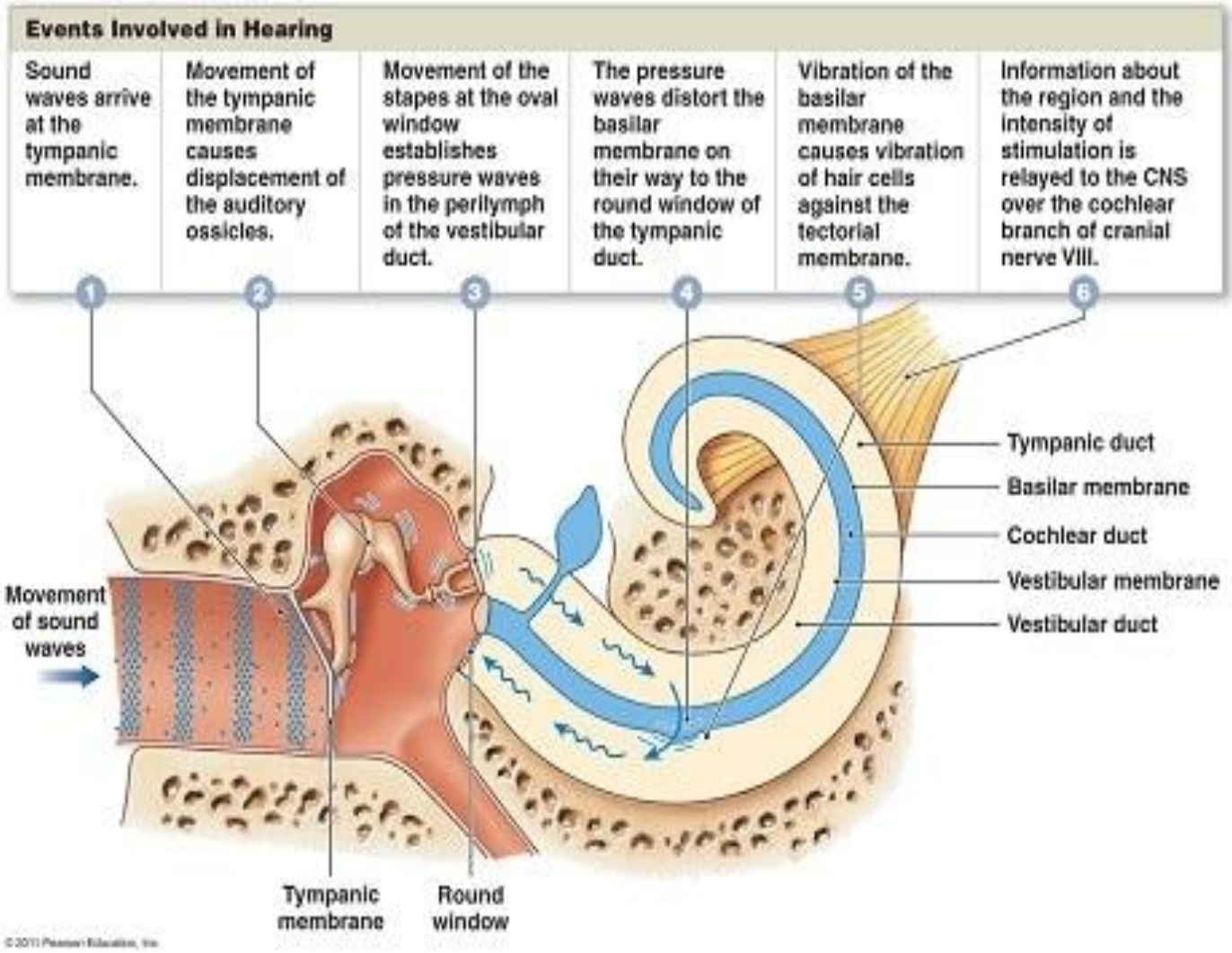
* The vestibule consists of two sacs these are;
- ✓ Utricle
- ✓ Saccule

* Each semicircular canal lies at approximately right angles to the other two.
* At one end of each canal is a swollen enlargement called as ampulla.

INTERNAL EAR



PHYSIOLOGY OF HEARING



PHYSIOLOGY OF HEARING

* The following events occurs in hearing;
* The auricle directs sound waves into the external auditory canal.
* When sound waves strike the tympanic membrane, the alternating high and low pressure of the air causes the tympanic membrane to vibrate back and forth.
* The distance it moves, which is very small, depends on the intensity and frequency of the sound waves. The eardrum vibrates slowly in response to low-frequency (low-pitched) sounds and rapidly in response to high-frequency (high-pitched) sounds.

* The central area of the eardrum connects to the malleus, which also starts to vibrate. The vibration is transmitted from the malleus to the incus and then to the stapes.
* As the stapes moves back and forth, it pushes the membrane of the oval window in and out.
* The movement of the oval window sets up fluid pressure waves in the perilymph of the cochlea. As the oval window bulges inward, it pushes on the perilymph of the scala vestibuli.
* Pressure waves are transmitted from the scala vestibuli to the scala tympani and eventually to the round window

* Physiology of Hearing causing it to bulge outward into the middle ear.
* As the pressure waves deform the walls of the scal vestibuli and scala tympani, they also push the vestibular membrane back and forth, creating pressure waves in the endolymph inside the cochlear duct.
* The pressure waves in the endolymph cause the basilar membrane to vibrate, which moves the hair cells of the spiral organ against the tectorial membrane. This leads to bending of the hair cell stereocilia, which produces receptor potentials that ultimately lead to the generation of nerve impulses.

OLFACTION: SENSE OF SMELL

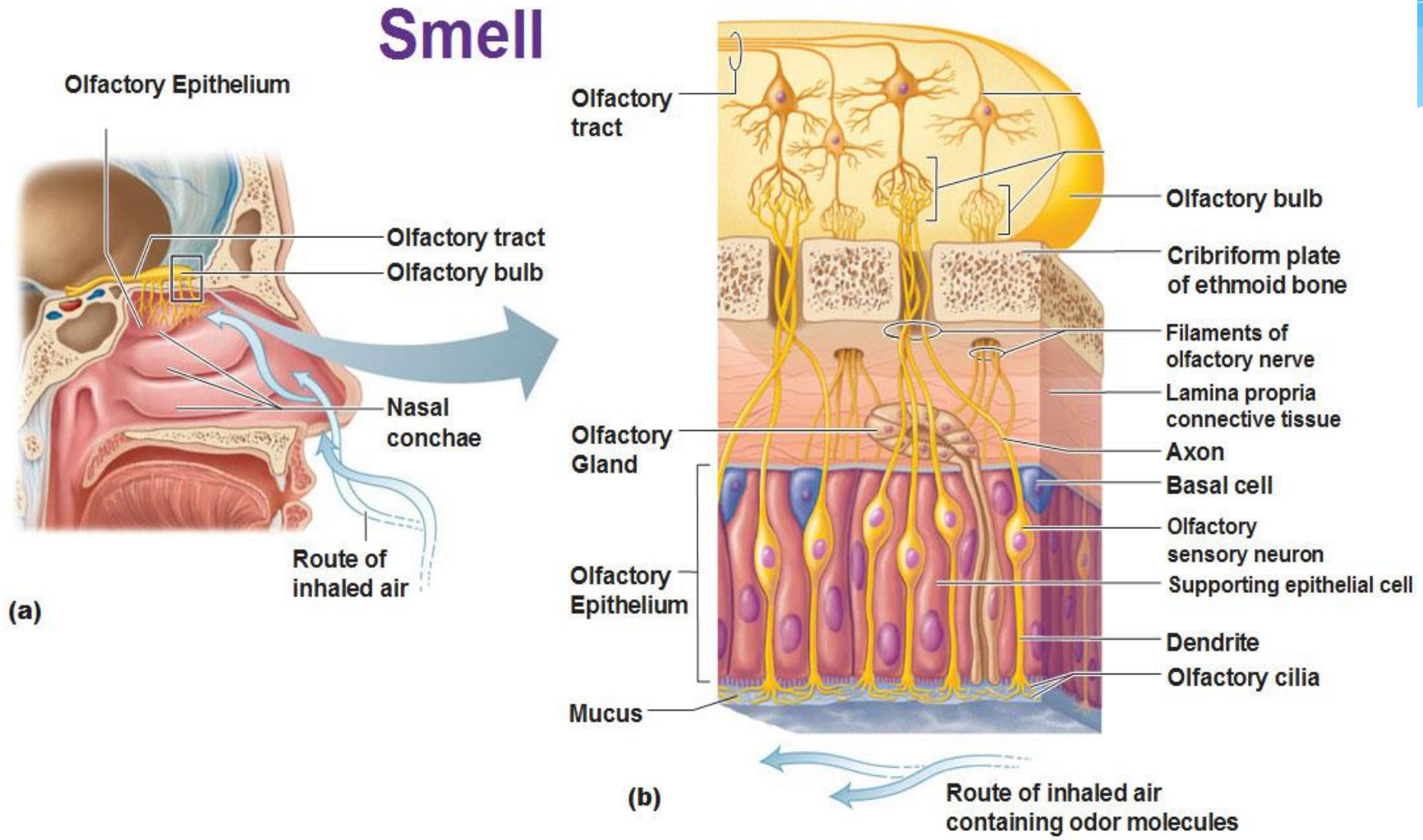
* Smell & taste both are chemical senses, because the sensations arise from the interaction of molecules with smell or taste receptors.
* Anatomy of Olfactory Receptors:
* The nose contains 10–100 millions of smell receptors in olfactory epithelium.
* The olfactory epithelium consists of three kinds of cells:

✓ Olfactory receptors

✓ Supporting cells

✓ Basal cells

OLFACTION: SENSE OF SMELL



OLFACTORY RECEPTORS

* Olfactory hairs or cilia that project from the dendrite responds to inhaled chemicals.

* Chemicals having odour & can stimulate the olfactory hairs are called as odorants.

* Olfactory receptors respond to an odorant molecule by producing a generator potential, thus initiating the olfactory response.

✓Supporting cells:

* These are columnar epithelial cells of mucous membrane lining the nose.
* They provide physical support, nourishment, & electrical insulation to the olfactory receptors.

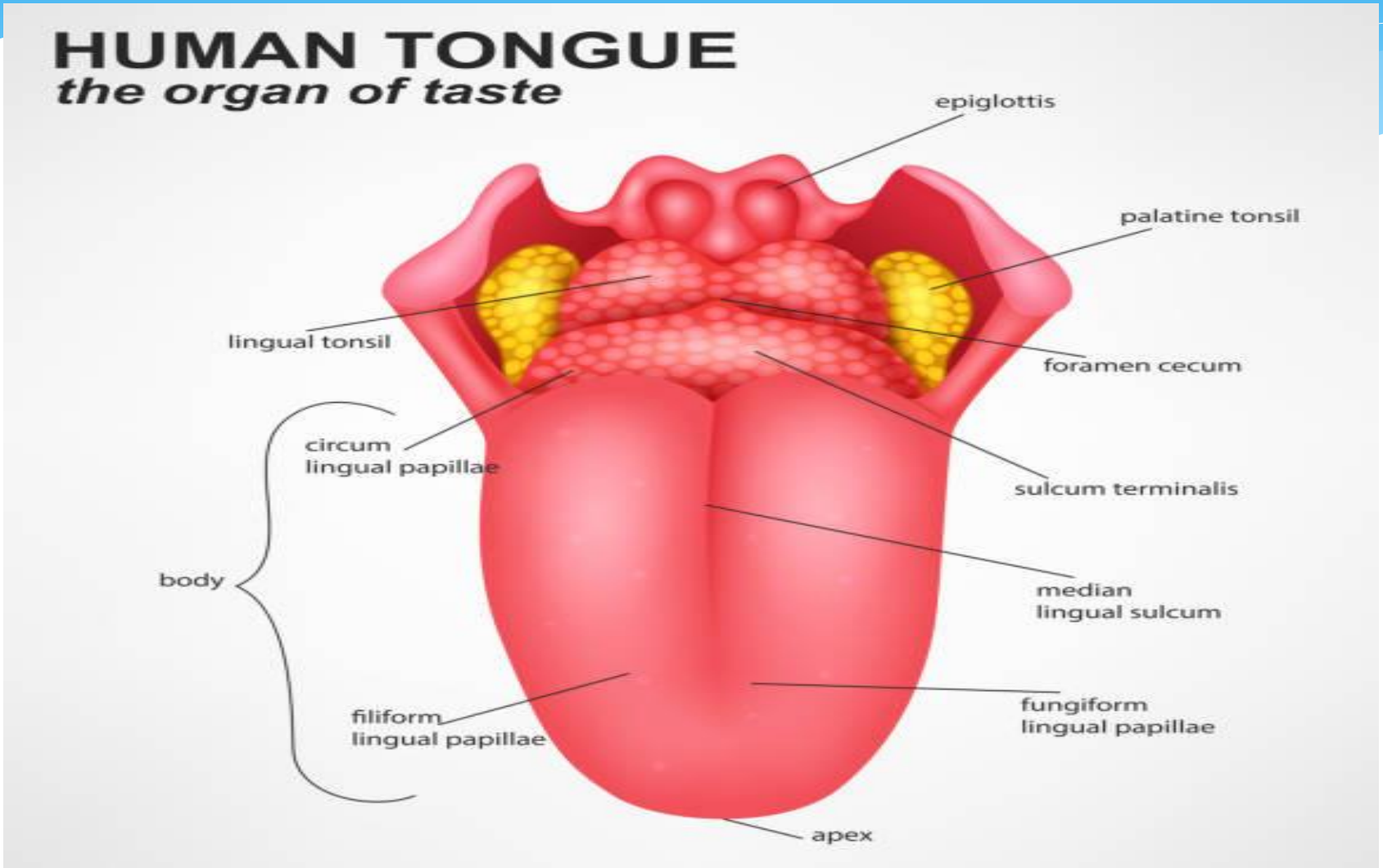
✓Basal cells:

* These are stem cells located between the bases of the supporting cells.
* They continually undergo cell division to produce new olfactory receptors, which live for only a month.

GUSTATION: SENSE OF TASTE

* Taste or gustation is a chemical sense.
* It consist of five primary tastes:
  - ✓ Sour
  - ✓ Sweet
  - ✓ Bitter
  - ✓ Salty
  - ✓ Umami (savory taste)
* The umami taste, recently reported and is described as meaty taste.
* Odours of food can passes from mouth to nasal cavity, where they stimulate olfactory receptors.

TONGUE


HUMAN TONGUE
the organ of taste
epiglottis
palatine tonsil
lingual tonsil
foramen cecum
circum
lingual papillae
sulcum terminalis
body
median
lingual sulcum
filiform
lingual papillae
fungiform
lingual papillae
apex

* Taste Bud The receptors for taste are located in the taste buds. Nearly 10,000 taste buds are present on the tongue. The number of taste buds declines with age.

ANATOMY OF TASTE BUDS & PAPILLAE

- Each taste bud is an oval shape consisting of 3 kinds of cells:

✓ Supporting cells:

* The supporting cells supports the gustatory receptor cells in each taste bud.

✓ Gustatory receptor cells:

* A single, long microvillus, called as gustatory hair, projects from each gustatory receptor cell to the external surface through the taste pore (opening in the taste bud).
* Each gustatory receptor cell has a life span of about 10 days.

✓ Basal cells :

* Found at the base of taste bud produces supporting cells, which then develop into gustatory receptor cells.

ANATOMY OF TASTE BUDS & PAPILLAE

* Taste buds are found in elevations on tongue called papillae which provide a rough texture to the upper surface of the tongue.
* Four types of papillae contain taste buds.
* Circumvallate papillae: It form an inverted V-shaped row at the back of the tongue, contains 100–300 taste buds.
* Fungiform papillae: Mushroom-shaped elevations scattered over the entire surface of the tongue, contain 5 taste buds each.
* Foliate papillae: These are located on the lateral margins of the tongue.
* Filiform papillae: These pointed, threadlike structures contain tactile receptors but no taste buds. Entire surface of the tongue has filiform papillae.

DISORDERS OF SENSE ORGANS

CATARACT

* A common cause of blindness is a loss of transparency of the lens known as a cataract.

* The lens becomes cloudy (less transparent) due to changes in the structure of the lens proteins.

* Cataracts often occur with aging but may also be caused by injury, excessive exposure to ultraviolet rays, certain medications (such as long-term use of steroids), or complications of other diseases (for example, diabetes).

GLAUCOMA

- Glaucoma is an abnormally high intraocular pressure due to a buildup of aqueous humor within the anterior cavity.

- The fluid compresses the lens into the vitreous body and puts pressure on the neurons of the retina.

- Persistent pressure results in a progression from mild visual impairment to irreversible destruction of neurons of the retina, damage to the optic nerve, and blindness.

DEAFNESS

- Deafness is significant or total hearing loss.

* Sensorineural deafness is caused by either impairment of hair cells in the cochlea or damage of the cochlear branch of the vestibulocochlear (VIII) nerve.

* This type of deafness may be caused by atherosclerosis, which reduces blood supply to the ears; by repeated exposure to loud noise, which destroys hair cells of the spiral organ; and/or by certain drugs such as aspirin and streptomycin.

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