e.Learning

by Dr. M.G.R EDUCATIONAL AND RESEARCH INSTITUTE



# Dr. M.G.R

## EDUCATIONAL AND RESEARCH INSTITUTE

(Deemed to be University with Graded Autonomy Status)

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Maduravoyal, Chennai - 600 095, Tamilnadu, INDIA

# SPECIAL SENSES

# STRUCTURE OF EYE

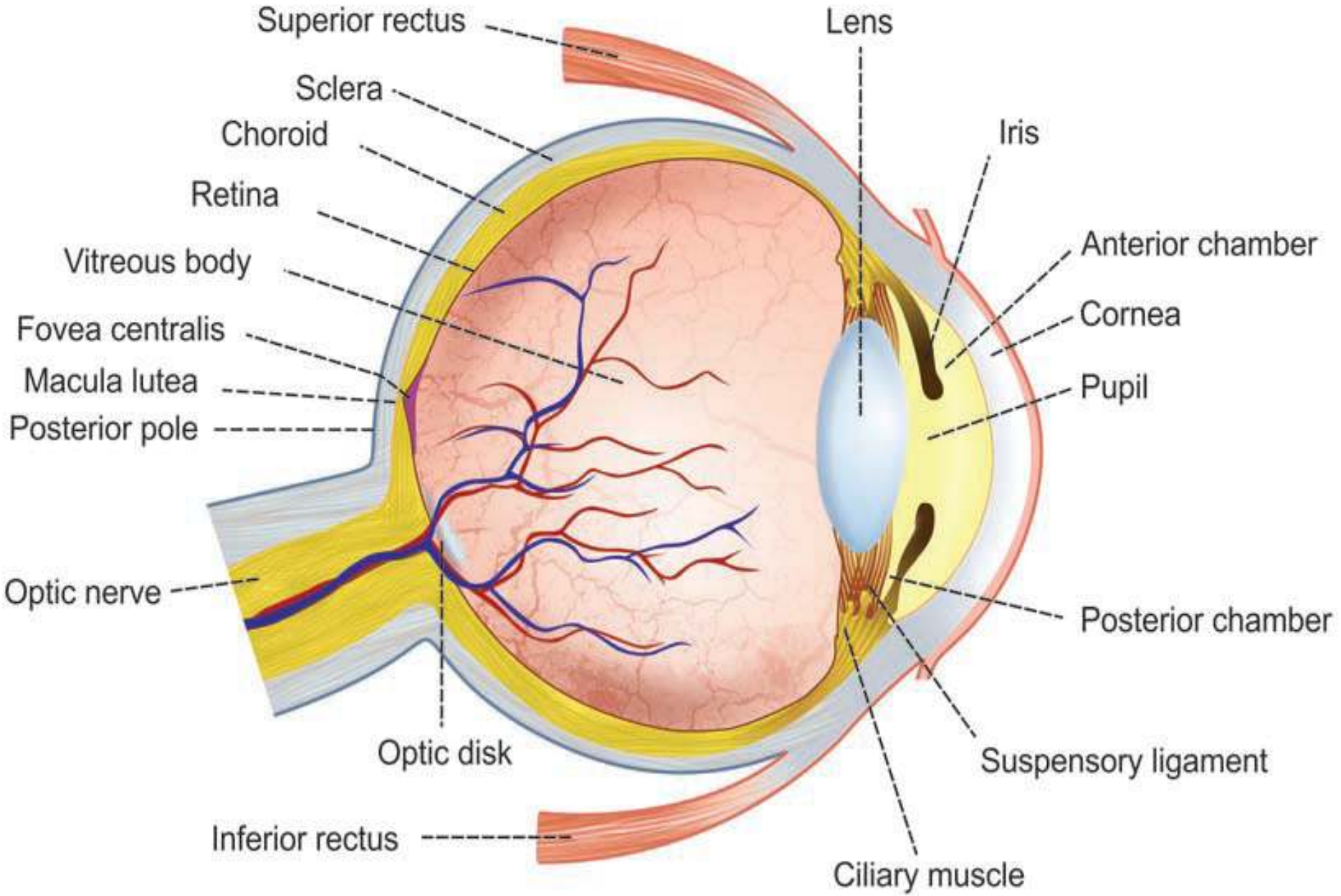
- The eye is protected from mechanical injury by being enclosed in a socket, or orbit, which is made up of portions of several of the bones of the skull to form a four-sided pyramid, the apex of which points back into the head.

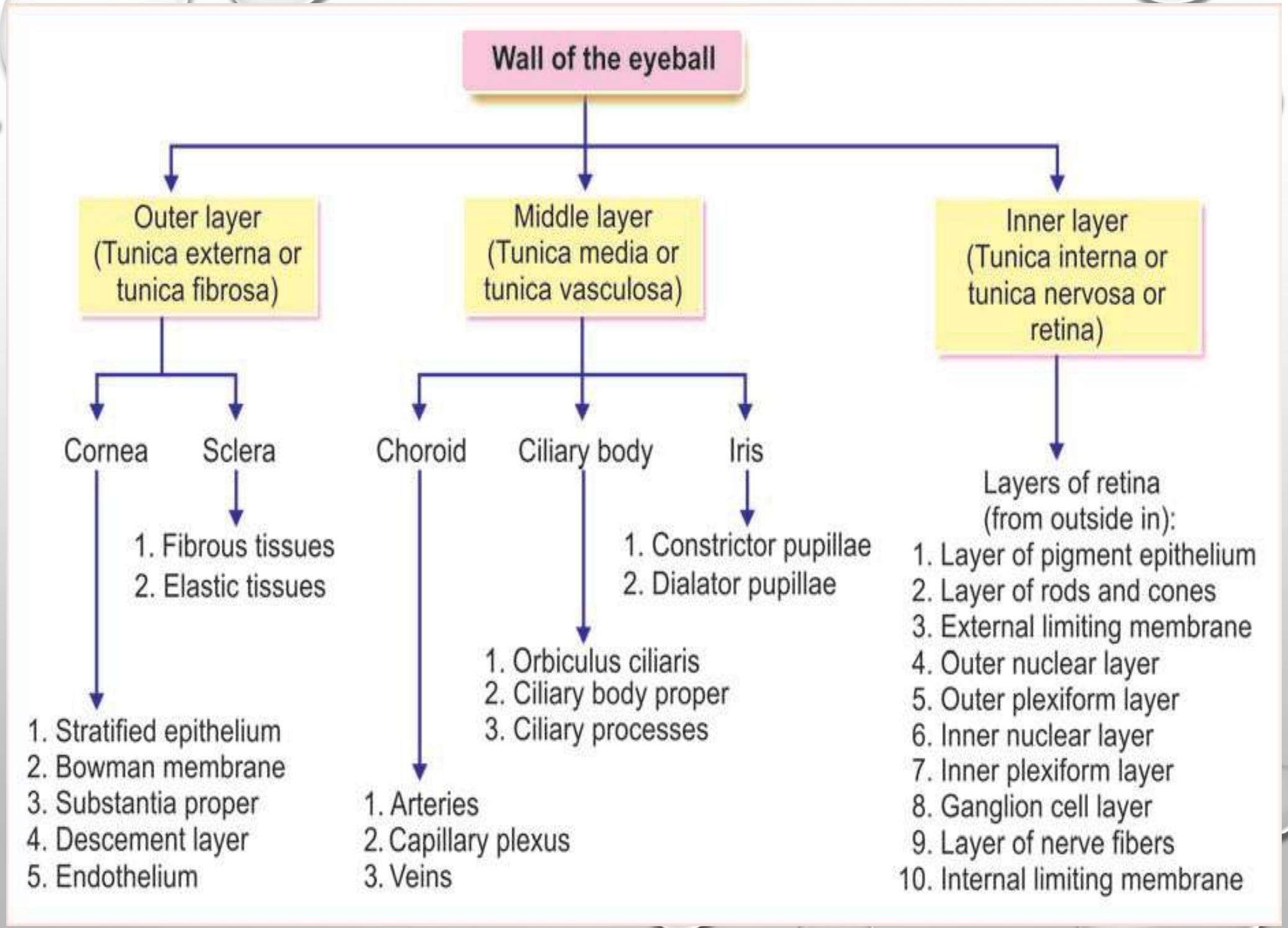
- The small piece, occupying about one-sixth of the whole, has a radius of 8 mm (0.3 inch); it is transparent and is called the cornea; the remainder, the scleral segment, is opaque and has a radius of 12 mm (0.5 inch). the ring where the two areas join is called the limbus.

- The iris is the structure that determines the colour of the eye. the centre of this ring is called the pupil.

- It appears dark because the light passing into the eye is not reflected back to any great extent.

# STRUCTURE OF EYE




Wall of the eyeball
Outer layer (Tunica externa or tunica fibrosa)
Middle layer (Tunica media or tunica vasculosa)
Inner layer (Tunica interna or tunica nervosa or retina)
Cornea
Sclera
Choroid
Ciliary body
Iris
1. Fibrous tissues
2. Elastic tissues
1. Constrictor pupillae
2. Dialator pupillae
1. Orbiculus ciliaris
2. Ciliary body proper
3. Ciliary processes
Layers of retina (from outside in):
1. Layer of pigment epithelium
2. Layer of rods and cones
3. External limiting membrane
4. Outer nuclear layer
5. Outer plexiform layer
6. Inner nuclear layer
7. Inner plexiform layer
8. Ganglion cell layer
9. Layer of nerve fibers
10. Internal limiting membrane
1. Stratified epithelium
2. Bowman membrane
3. Substantia proper
4. Descement layer
5. Endothelium
1. Arteries
2. Capillary plexus
3. Veins

# LAYERS OF RETINA

- The retina is the innermost of the three coats of the eye. this layer is responsible for converting relevant information from the image of the external environment into neural impulses that are transmitted to the brain.

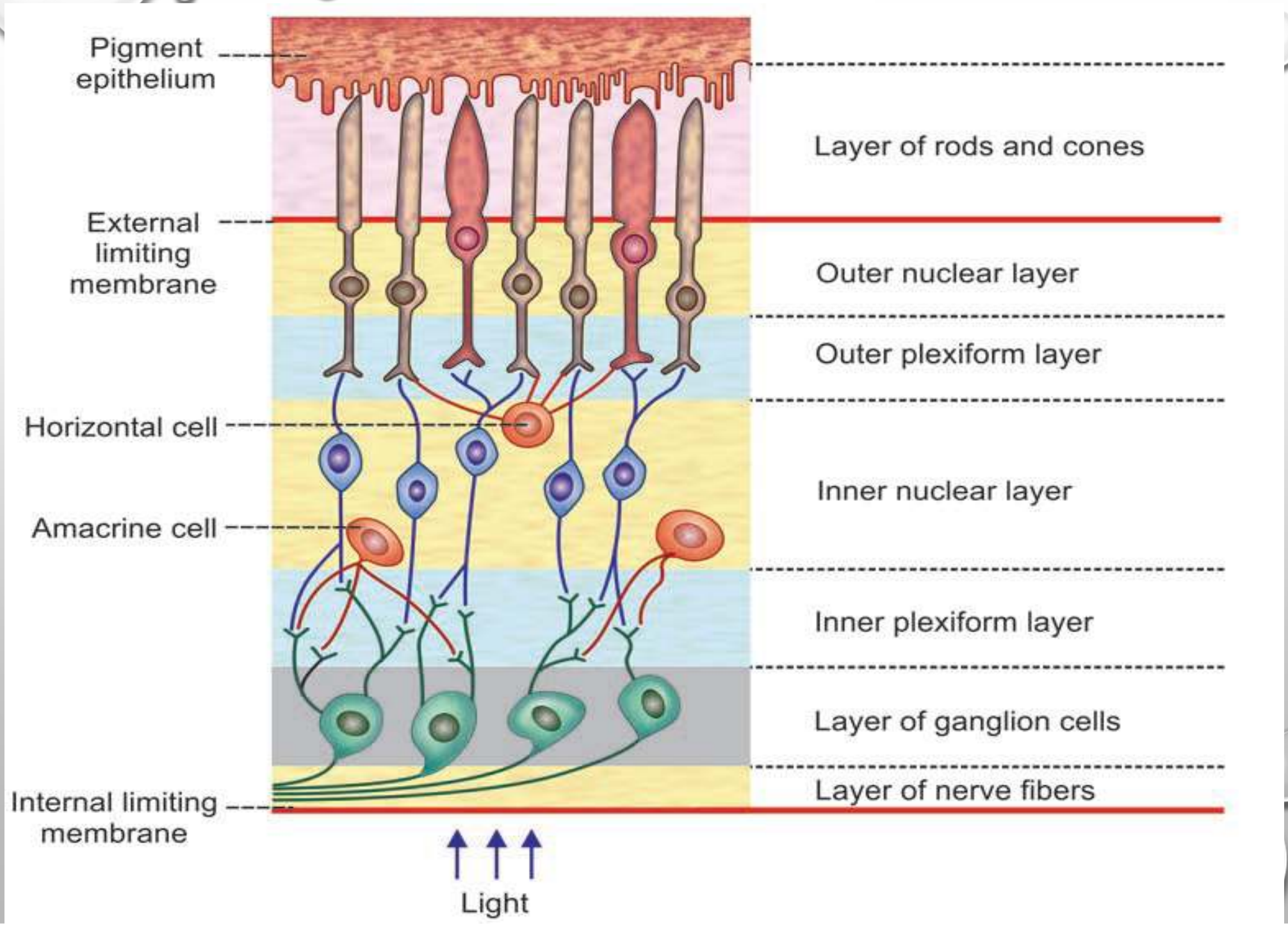
- The neurosensory retina is mainly made up of three groups of neurons: photoreceptors, bipolar cells, and ganglion cells.

- Other important neurons like amacrine cells, horizontal cells have supporting roles.

- The photoreceptor cells, bipolar cells, and ganglion cells carry the neural signal in a three-step pathway through the retina. photoreceptors are sensory receptors.

- Bipolar cells are first-order cells and ganglion cells form second-order neurons. in this section, we will discuss the anatomy of the cells present in the retina.

# LAYERS OF RETINA



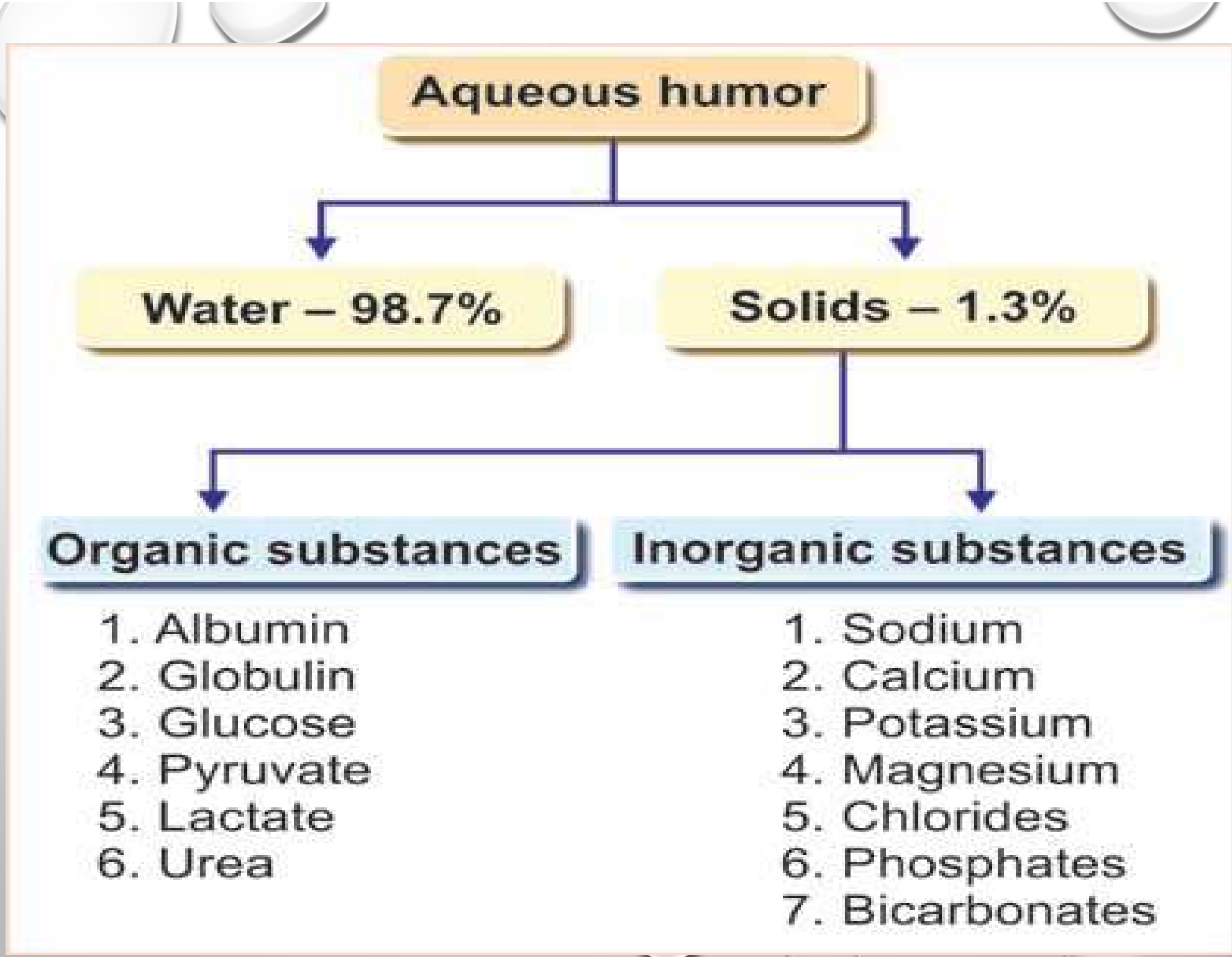
# FLUIDS PRESENT INSIDE THE EYE

- Intraocular fluid is produced in outcrops of the ciliary body.
- It circulates in the anterior segment of the eye. it fills the anterior and posterior chamber of the eye and is drained into the scleral blood vessels.
- The intraocular fluid is hypertonic with high concentrations of ascorbic acid.

- Fluid fills most of the inside of the eye. the chambers in front of the lens (both the anterior and posterior chambers) are filled with a clear, watery fluid called aqueous humor.

- The large space behind the lens (the vitreous chamber) contains a thick, gel-like fluid called vitreous humor or vitreous gel.

- The majority of fluid draining out of the eye is via the trabecular meshwork, then through a structure called Schlemm's canal, into collector channels, then to veins, and eventually back into body's circulatory system.

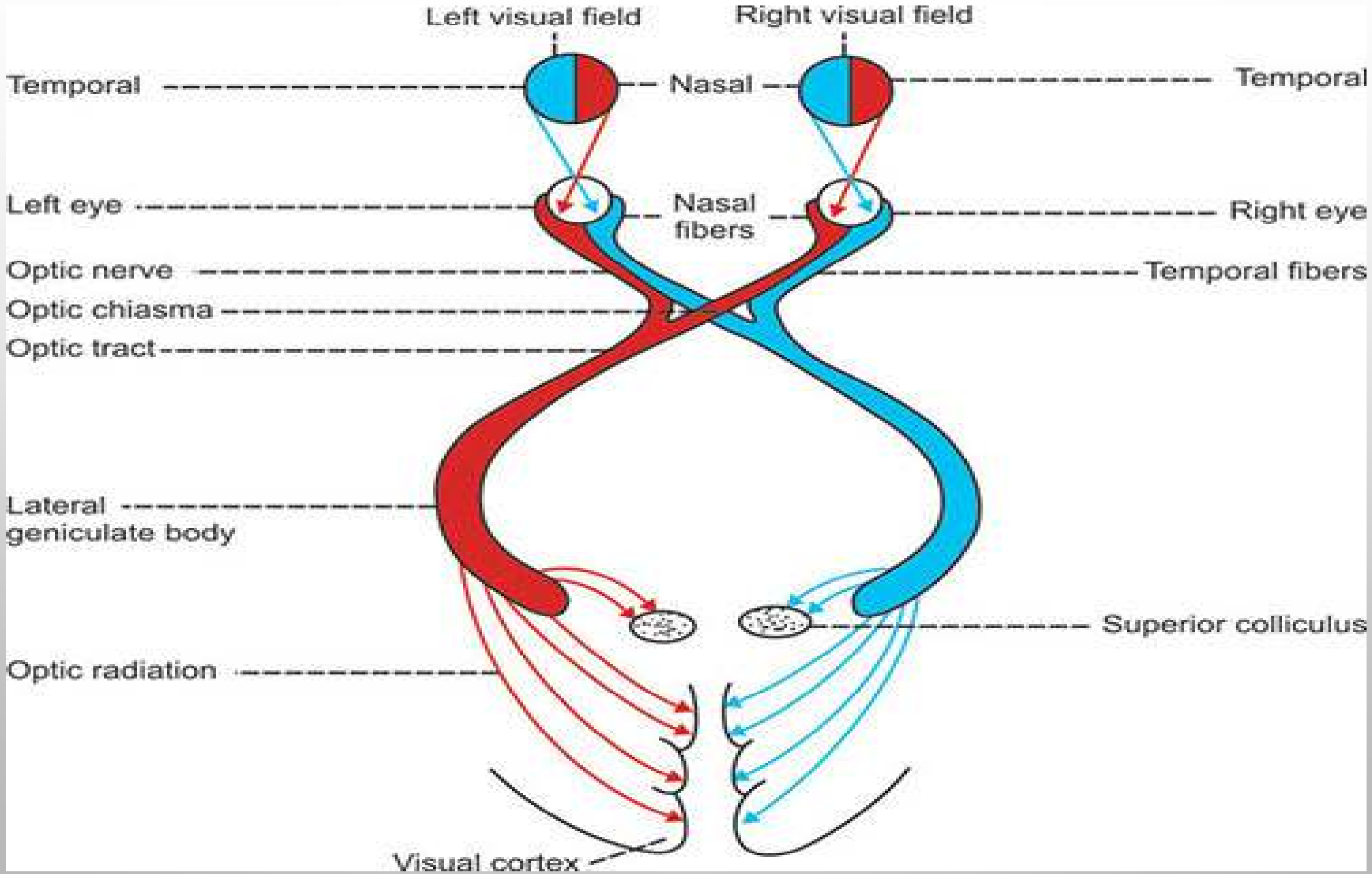

Aqueous humor
Water – 98.7%
Solids – 1.3%
Organic substances
Inorganic substances
1. Albumin
2. Globulin
3. Glucose
4. Pyruvate
5. Lactate
6. Urea
1. Sodium
2. Calcium
3. Potassium
4. Magnesium
5. Chlorides
6. Phosphates
7. Bicarbonates

# FUNCTIONS OF INTRAOCULAR FLUID

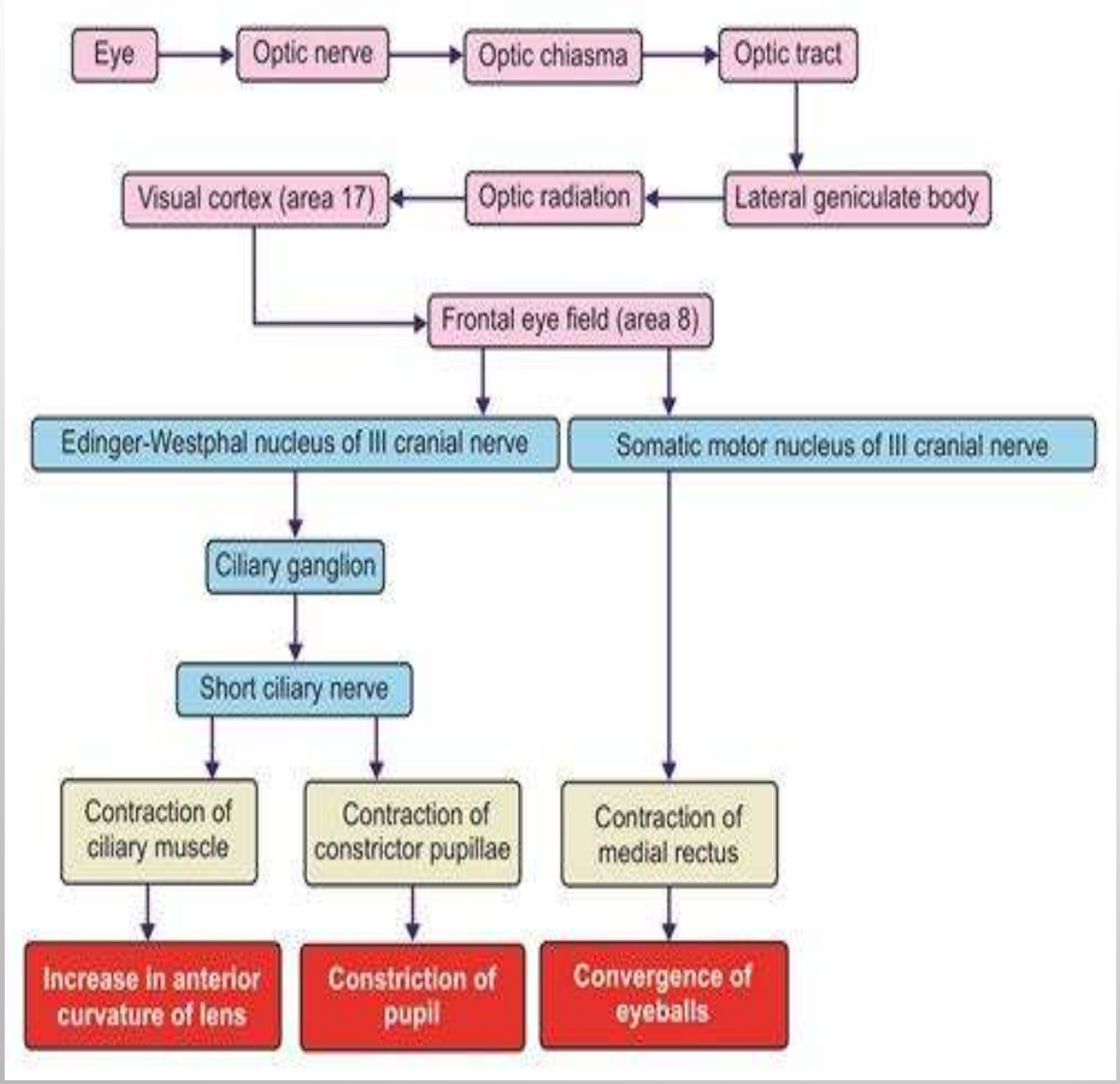
- The aqueous humor bathes and nourishes the lens and maintains pressure within the eye.
- Since the lens and cornea have no blood supply, the aqueous humor performs the blood's job of carrying nutrients to those structures.
- Maintains the intraocular pressure and inflates the globe of the eye.
- It is this hydrostatic pressure which keeps the eyeball in a roughly spherical shape and keeps the walls of the eyeball taut.
- May serve to transport ascorbate in the anterior segment to act as an antioxidant agent.

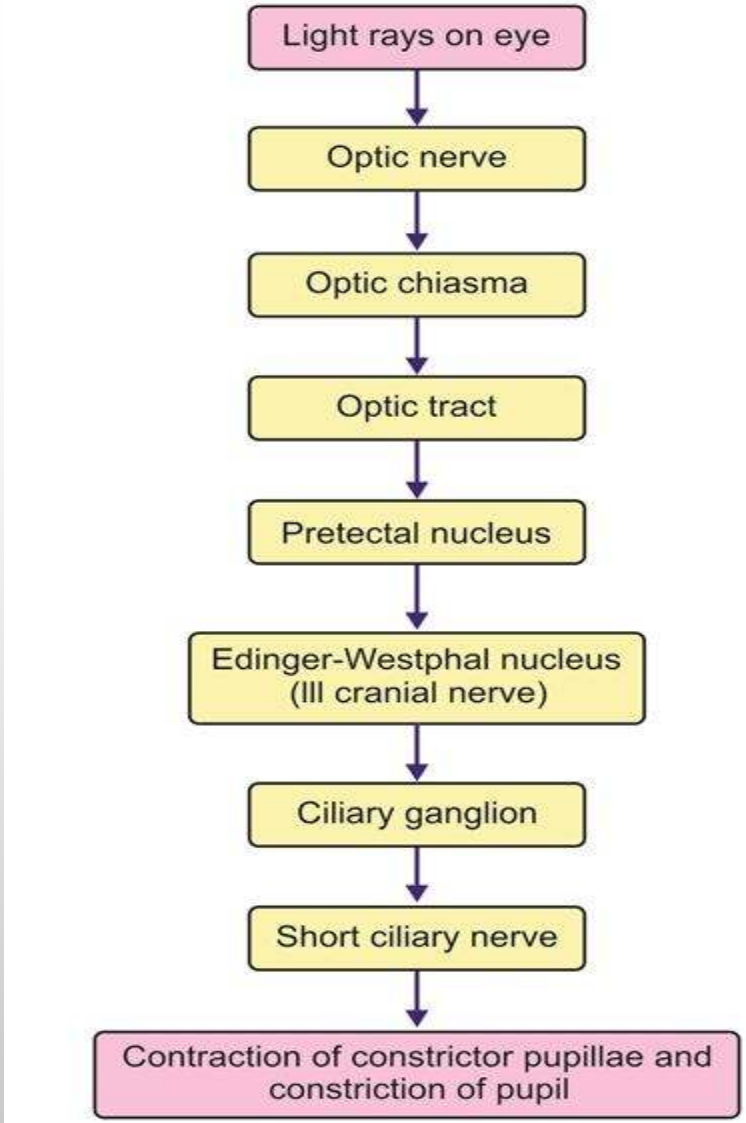
- Presence of immunoglobulins indicate a role in immune response to defend against pathogens.
- Provides inflation for expansion of the cornea and thus increased protection against dust, wind, pollen grains and some pathogens.
- For refractive index.
- Prevents eye dryness.

# ACCOMDATION PATHWAY

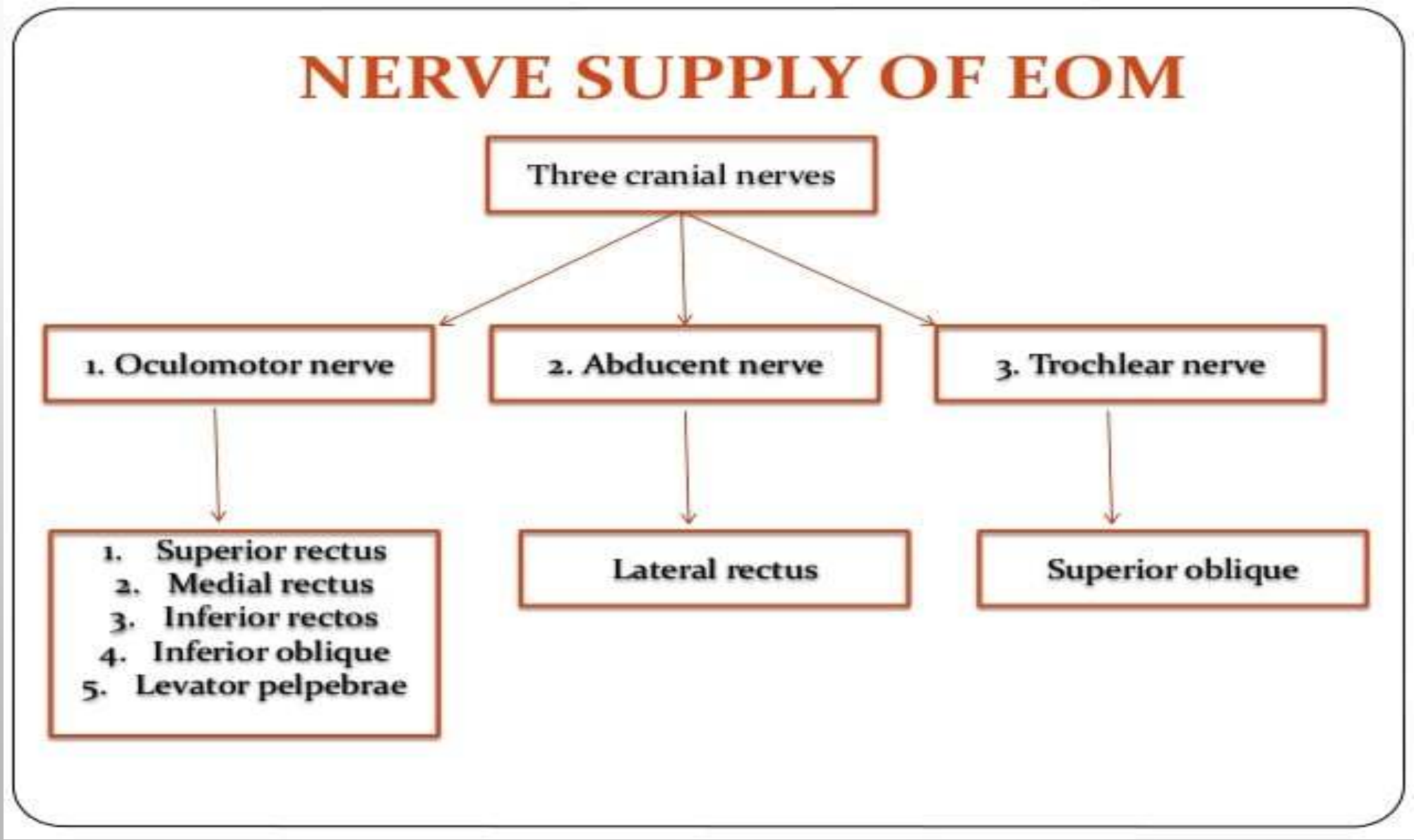


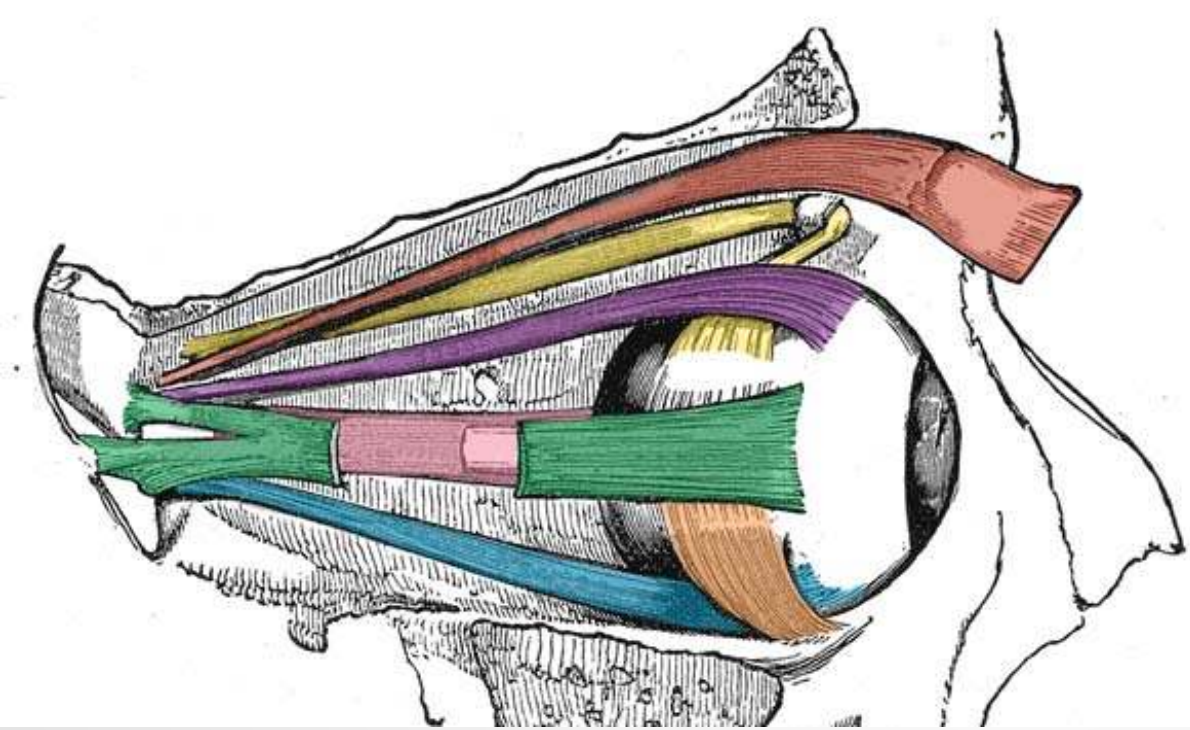
# ACCOMDATION AND PUPPILARY REFLEXES



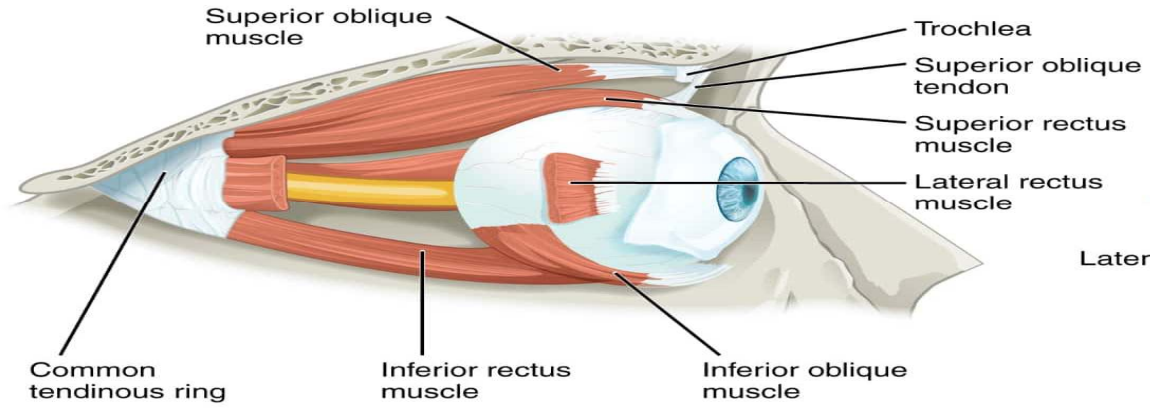



# OCULAR MUSCLES & INNERVATION

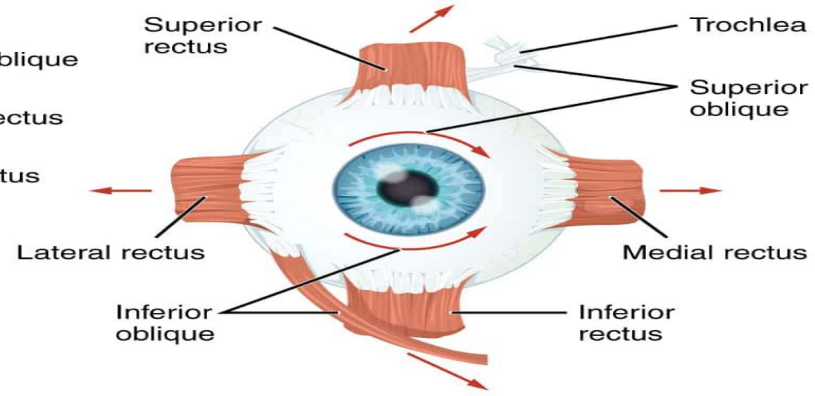




- Levator palpebrae superioris
- Superior oblique
- Inferior oblique
- Superior rectus
- Medial rectus
- Lateral rectus
- Inferior rectus

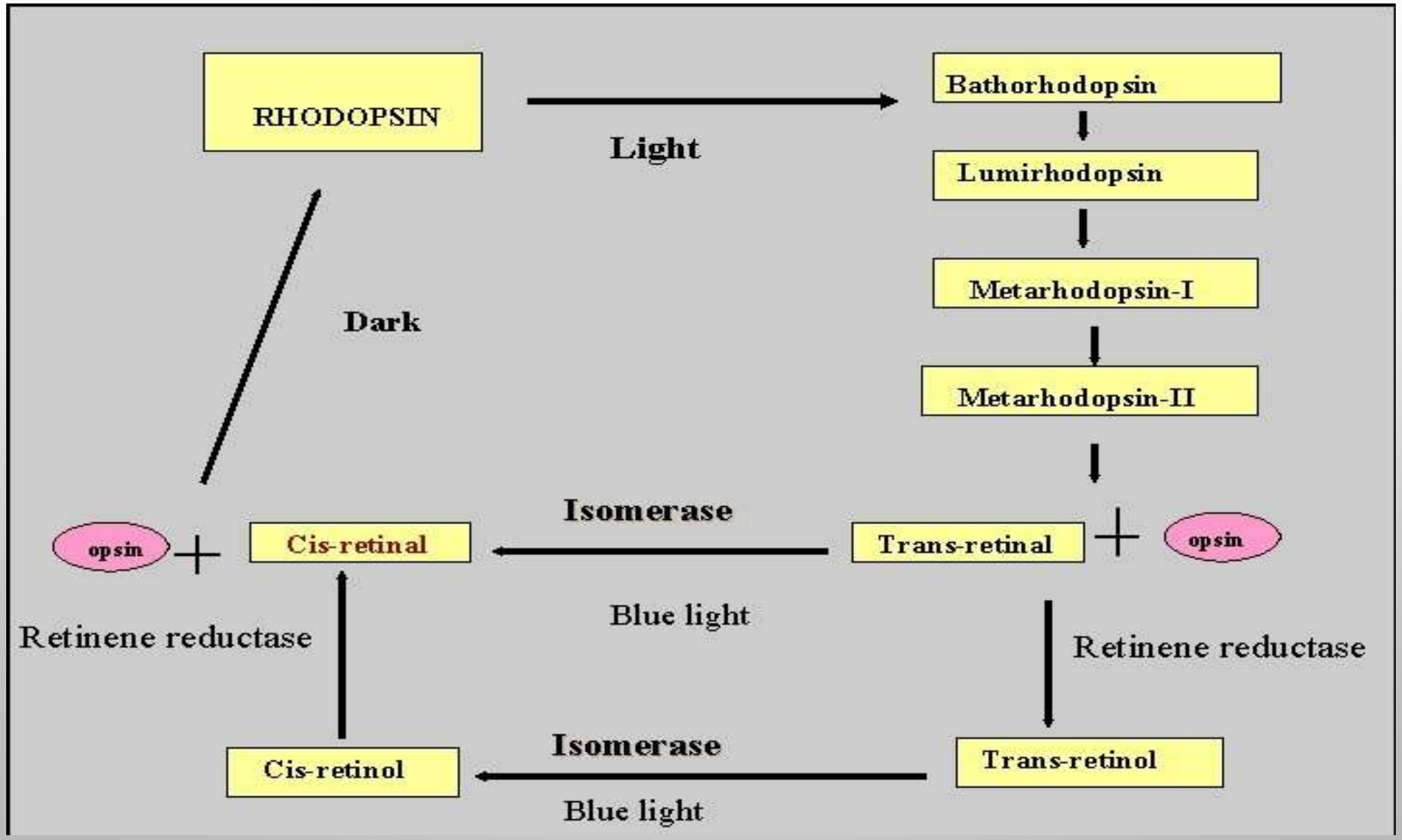



Lateral view of the right eye




Anterior view of the right eye

# WALD'S VISUAL CYCLE



# APPLIED

- Glaucoma:

  Glaucoma is a group of eye conditions that damage the optic nerve, the health of which is vital for good vision. this damage is often caused by an abnormally high pressure in your eye.

  Glaucoma is one of the leading causes of blindness for people over the age of 60. it can occur at any age but is more common in older adults.

- Cataract:

  Cataract is the opacity or cloudiness in the natural lens of the eye. it is the major cause of blindness worldwide.

  When lens becomes cloudy, light rays cannot pass through it easily and vision is blurred. cataract develops in old age after 55 to 60 years.

  Lens is situated within the sealed capsule. old cells die and accumulate within the capsule. over years, the accumulation of cells is associated with accumulation of fluid and denaturation of proteins in lens fibers, causing cloudiness of lens and blurred image.

# ERRORS OF REFRACTION

| Type of error | Cause | Correction |
|---|---|---|
| Myopia | Increase in anteroposterior diameter of the eyeball | Biconcave lens |
| Hypermetropia | Decrease in anteroposterior diameter of the eyeball | Biconvex lens |
| Anisometropia | Difference in refractive power of both eyes | Separate lens (biconcave or biconvex) for each eye as required |
| Astigmatism | Refractory power of lens is different in different meridians | Cylindrical lens |
| Regular astigmatism | Refractory power of lens is unequal in different meridians but uniform in one single meridian | |
| Irregular astigmatism | Refractory power of lens is unequal in different meridians as well as in different points in same meridian | |
| Presbyopia | Loss of elasticity in lens and weakness of ocular muscles due to old age | Biconvex lens |

# VISUAL DEFECTS

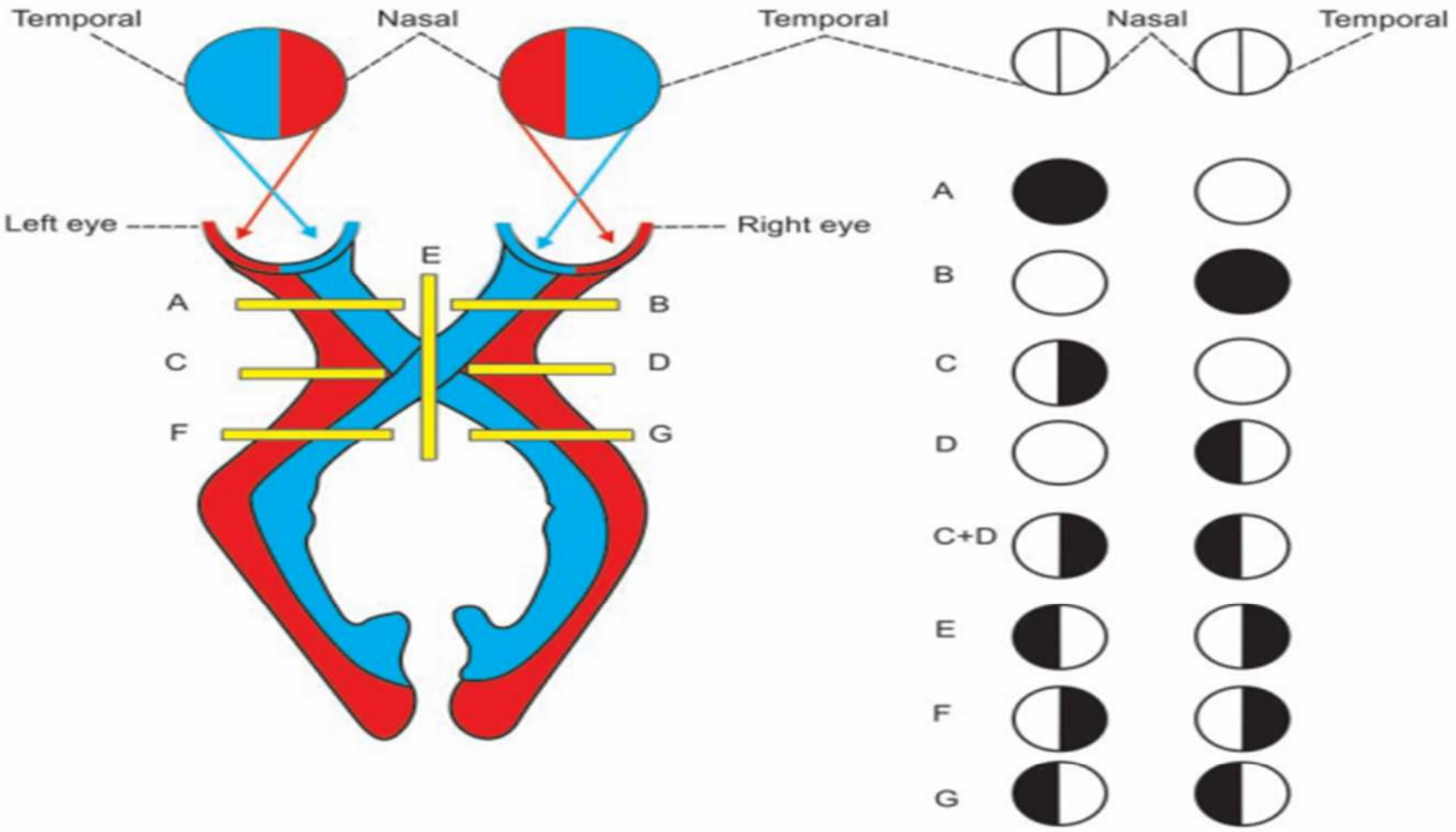
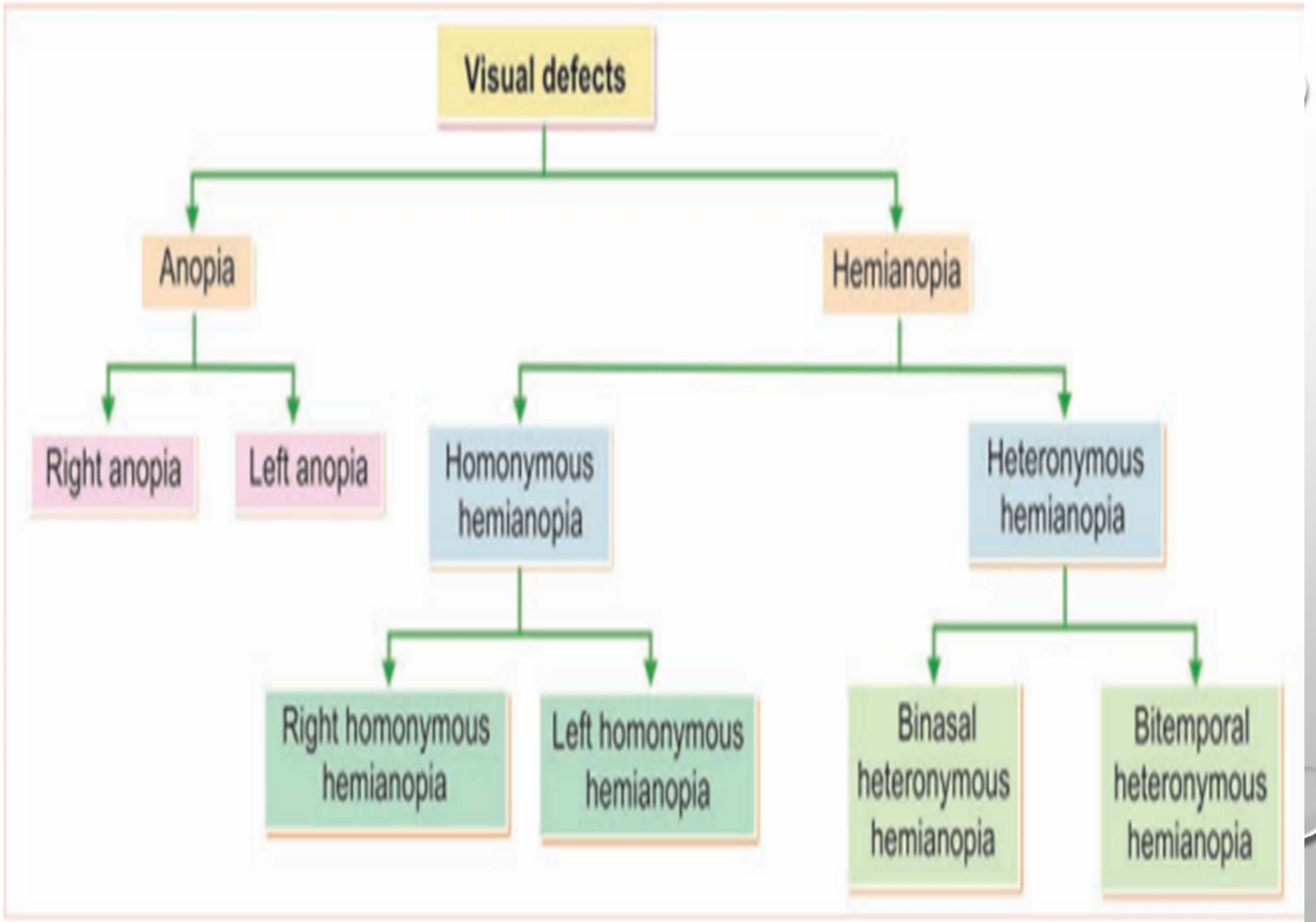
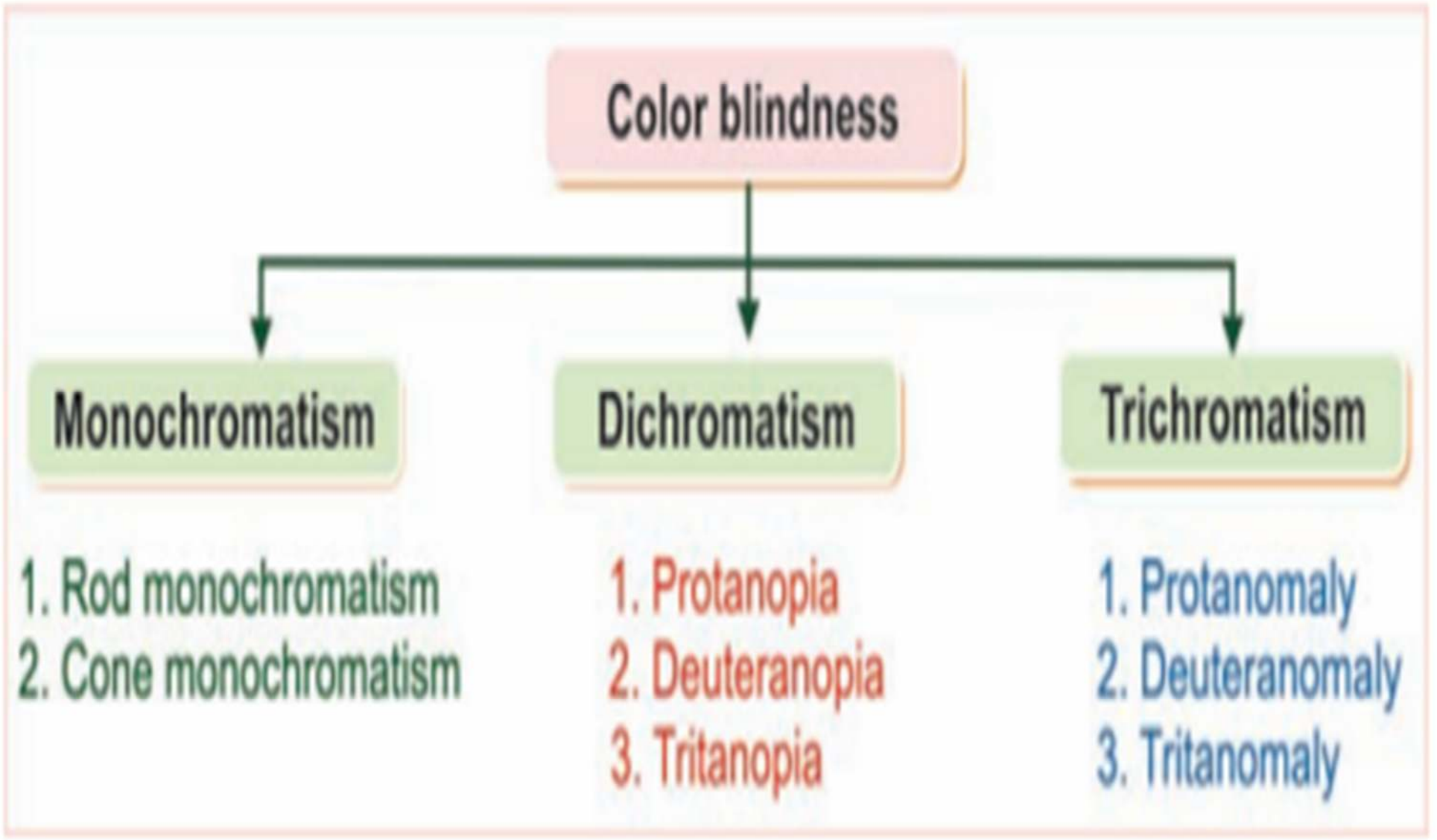


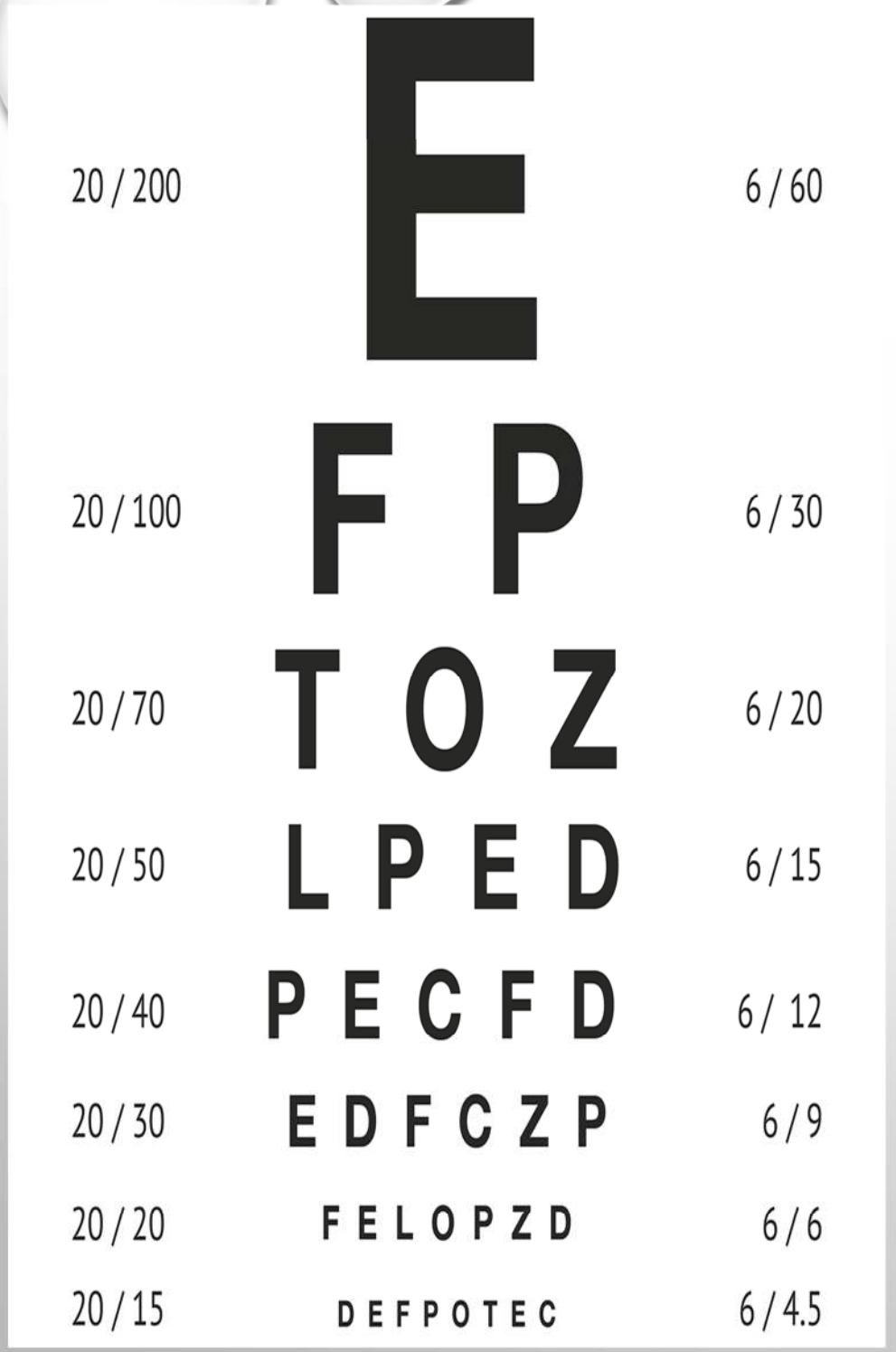

**FIGURE 168.4:** Effects of lesions of optic pathway. Dark shade in circles indicates blindness.

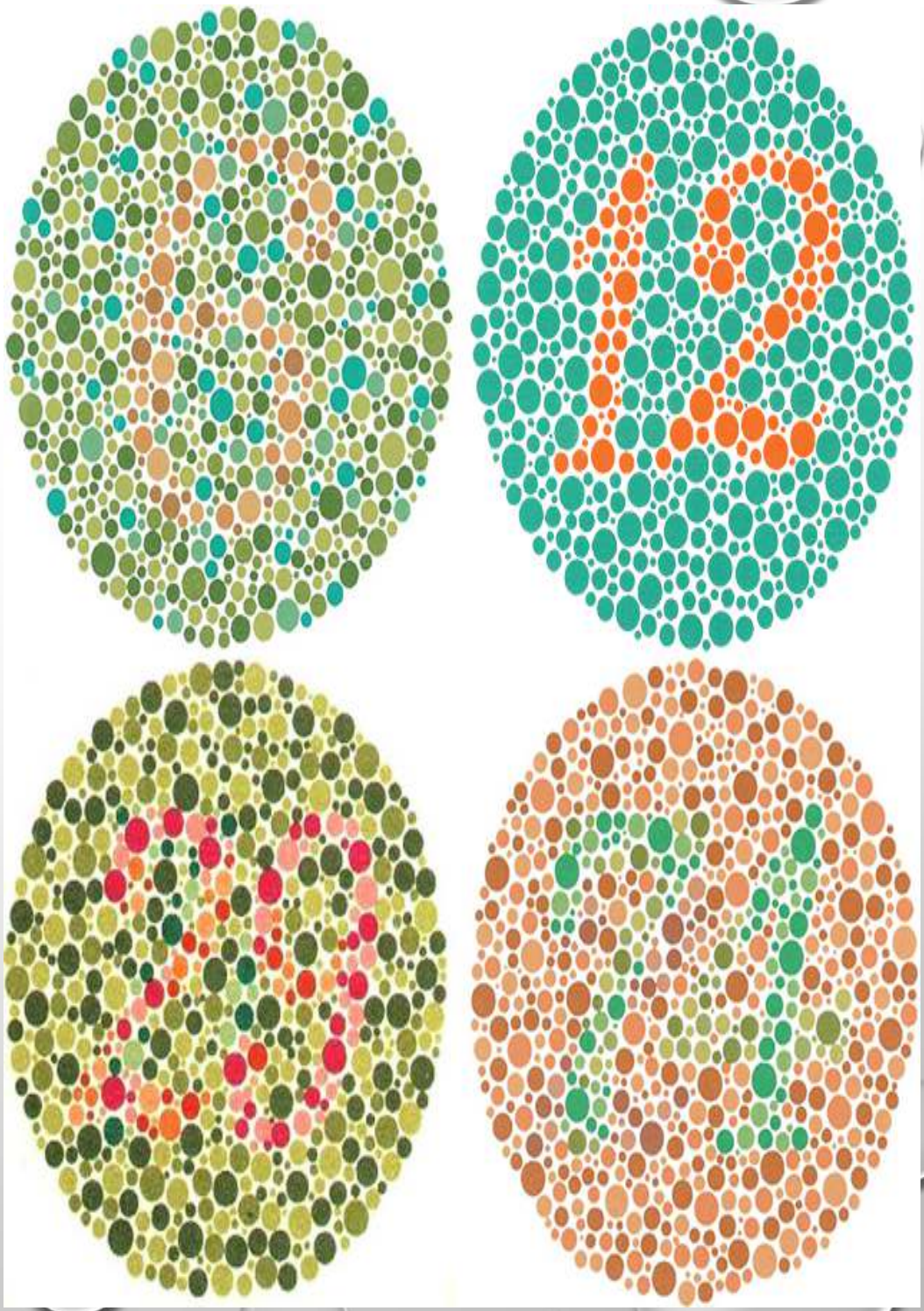
A. Lesion of left optic nerve: Total blindness of left eye
B. Lesion of right optic nerve: Total blindness of right eye
C. Lesion of lateral fibers in left side of optic chiasma: Left nasal hemianopia
D. Lesion of lateral fibers in right side of optic chiasma: Right nasal hemianopia
C + D. Lesion of lateral fibers in both sides of optic chiasma: Binasal hemianopia
E. Lesion of medial fibers in optic chiasma: Bitemporal hemianopia
F. Lesion of left optic radiation: Right homonymous hemianopia
G. Lesion of right optic radiation: Left homonymous hemianopia.


Visual defects
Anopia
Hemianopia
Right anopia
Left anopia
Homonymous hemianopia
Heteronymous hemianopia
Right homonymous hemianopia
Left homonymous hemianopia
Binasal heteronymous hemianopia
Bitemporal heteronymous hemianopia

# COLOUR BLINDNESS




20 / 200
E
6 / 60
20 / 100
F P
6 / 30
20 / 70
T O Z
6 / 20
20 / 50
L P E D
6 / 15
20 / 40
P E C F D
6 / 12
20 / 30
E D F C Z P
6 / 9
20 / 20
F E L O P Z D
6 / 6
20 / 15
D E F P O T E C
6 / 4.5



- Human ear, organ of hearing and equilibrium that detects and analyzes sound by transduction (or the conversion of sound waves into electrochemical impulses) and maintains the sense of balance (equilibrium).

- The ear has three distinguishable parts:

  The outer, middle, and inner ear.

  The outer ear consists of the visible portion called the auricle, or pinna, which projects from the side of the head, and the short external auditory canal, the inner end of which is closed by the tympanic membrane, commonly called the eardrum.

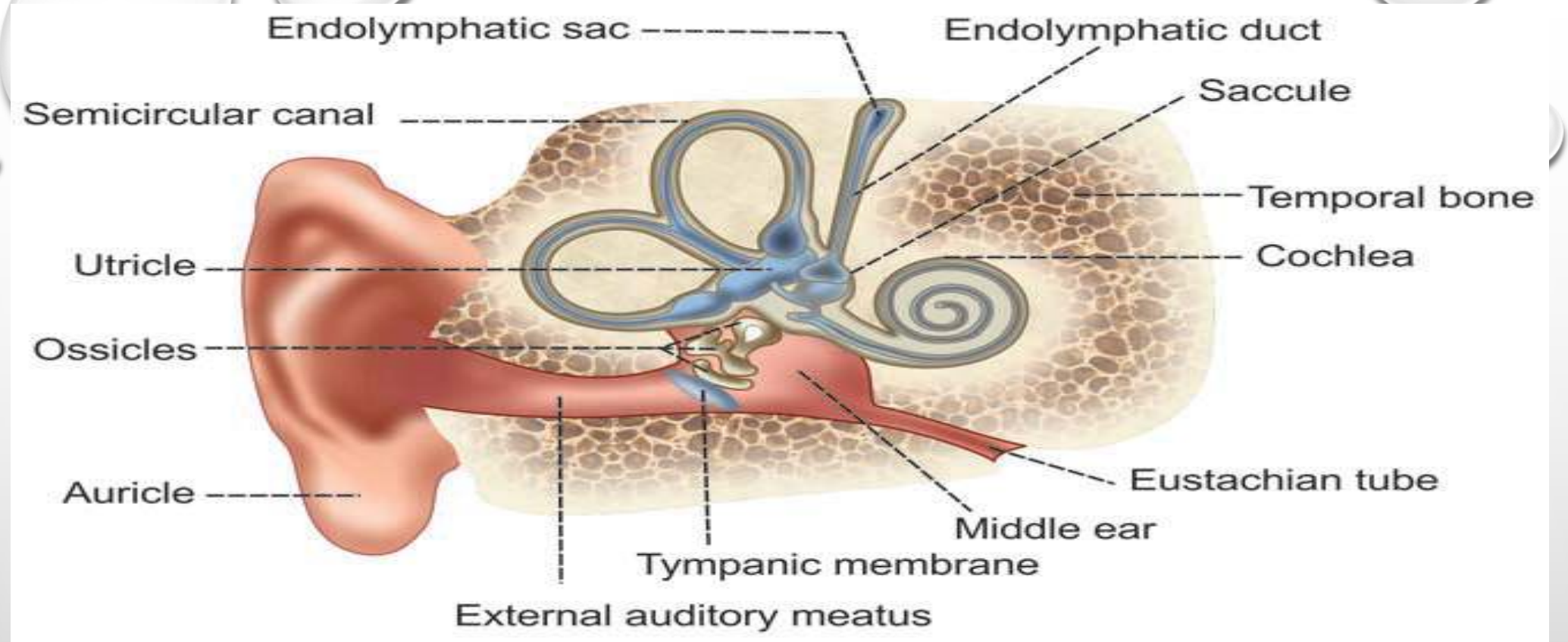
- The middle ear is a narrow air-filled cavity in the temporal bone.

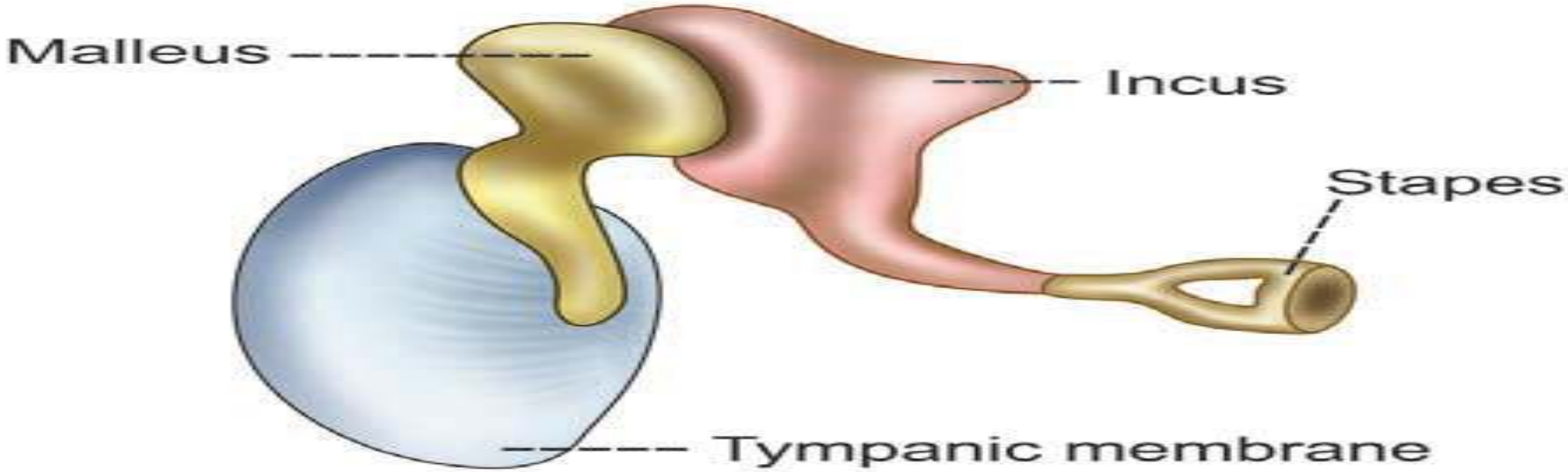
  It is spanned by a chain of three tiny bones—the malleus (hammer), incus (anvil), and stapes (stirrup), collectively called the auditory ossicles.

- The inner ear consists of two functional units:

  The vestibular apparatus, consisting of the vestibule and semicircular canals, which contains the sensory organs of postural equilibrium; and the snail-shell-like cochlea, which contains the sensory organ of hearing.

- These sensory organs are highly specialized endings of the eighth cranial nerve, also called the vestibulocochlear nerve.


Endolymphatic sac
Endolymphatic duct
Saccule
Semicircular canal
Temporal bone
Utricle
Cochlea
Ossicles
Auricle
Eustachian tube
Middle ear
Tympanic membrane
External auditory meatus

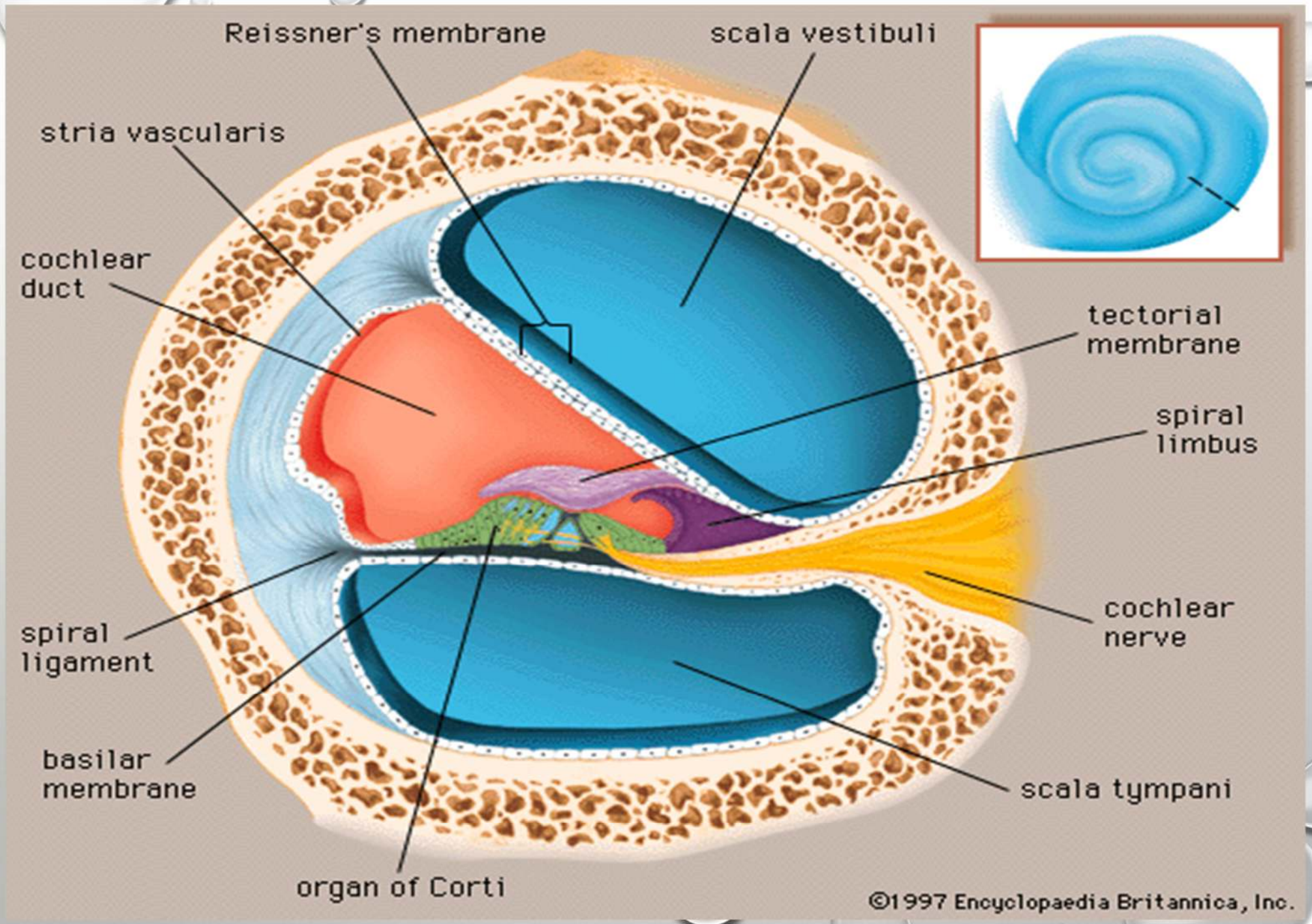

Malleus
Incus
Stapes
Tympanic membrane

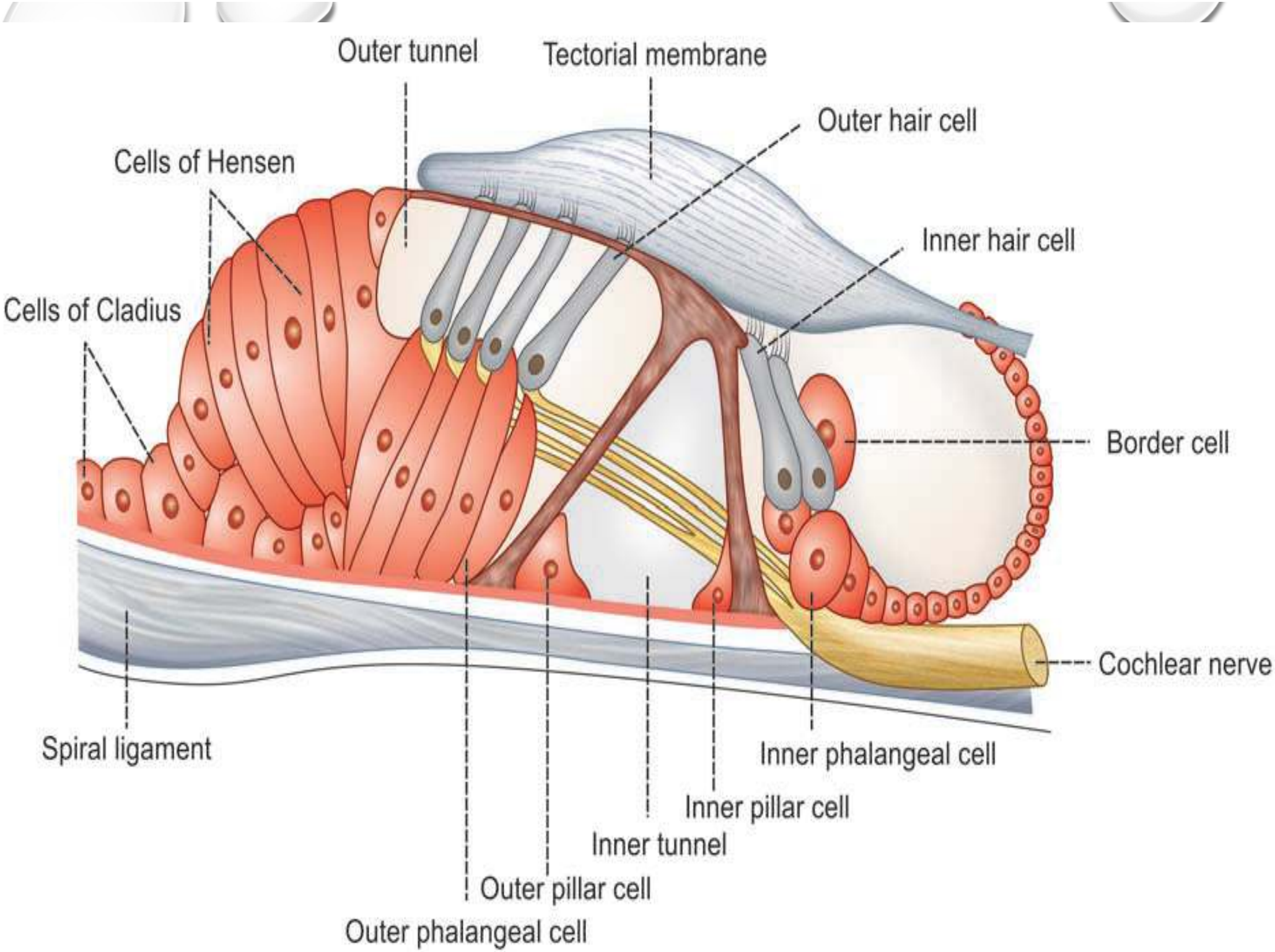
# COMPARTMENTS OF COCHLEAR

- The cochlear duct is subdivided into three compartments (**scala vestibuli, scala media, and scala tympani**) by two membranes:

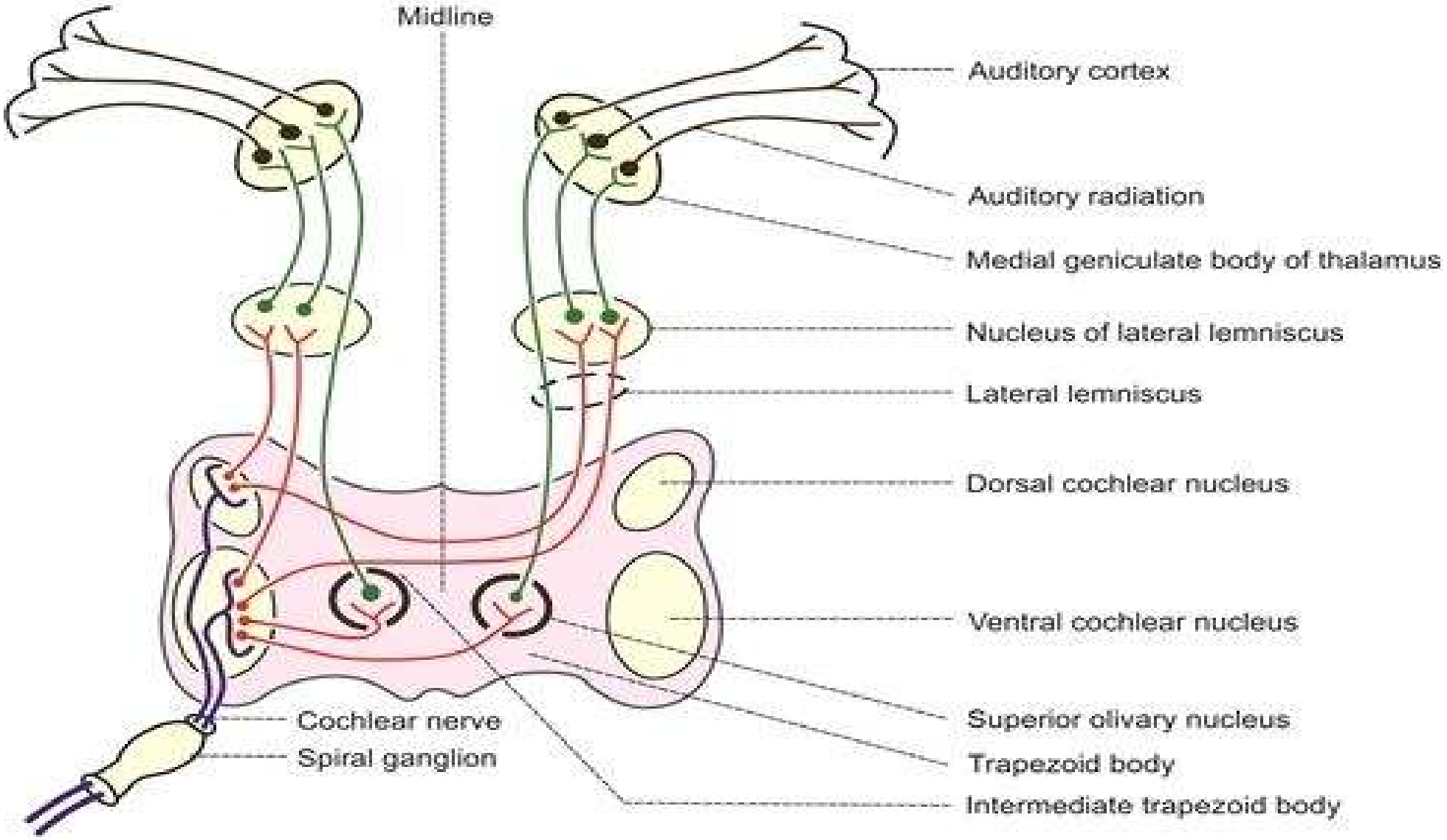
  The basilar membrane, which separates scala tympani from scala media.

- Reissner's membrane, which separates scala media from scala vestibuli


Reissner's membrane
scala vestibuli
stria vascularis
cochlear duct
tectorial membrane
spiral limbus
spiral ligament
cochlear nerve
basilar membrane
scala tympani
organ of Corti
©1997 Encyclopaedia Britannica, Inc.


Outer tunnel
Tectorial membrane
Outer hair cell
Cells of Hensen
Inner hair cell
Cells of Cladius
Border cell
Cochlear nerve
Spiral ligament
Inner phalangeal cell
Inner pillar cell
Inner tunnel
Outer pillar cell
Outer phalangeal cell

# AUDITORY PATHWAY



# AUDITORY DEFECTS AND TEST FOR HEARING

- Auditory defects may be either partial or complete. auditory defects are of two types
  1. conduction deafness.
  2. nerve deafness.

- Conduction deafness is the type of deafness that occurs due to impairment in transmission of sound waves in the external ear or middle ear.

- Nerve deafness is the deafness caused by damage of any structure in cochlea, such as hair cell, organ of corti, basilar membrane or cochlear duct or the lesion in the auditory pathway.

- There are various tests to assess the sensation of hearing. however, some simple tests called bedside tests are usually carried before doing conventional types of hearing tests

- Such simple tests are useful to know whether the hearing is normal or less.

- Bedside tests:
  1. whispering test.
  2. tickling of watch test.

- Routine tests for hearing are of three types:
  1. rinne test
  2. weber test
  3. audiometry

# TICKLING OF WATCH

- Wrist watch with tickling sound is kept near the ear of the subject.

- The subject suffering from hearing defects cannot hear the tickling sound of watch.

# WHISPERING TEST

- The examiner stands about 60 cm away from the subject at his side and whispers some words.

- If the subject is not able to hear the whisper, then hearing deficit is suspected.

# RINNIE'S TEST

- Base of a vibrating tuning fork is placed on mastoid process, until the subject cannot feel the vibration and cannot hear the sound.
- When the subject does not hear the sound any more, the tuning fork is held in air in front of the ear of same side.
- Normal person hears vibration in air even after the bone conduction ceases because, in normal conditions, air conduction via ossicles is better than bone conduction.
- But in conduction deafness, the vibrations in air are not heard after cessation of bone conduction.
- Thus in conduction deafness, the bone conduction is better than air conduction. in nerve deafness, both air conduction and bone conduction are diminished or lost.

# AUDIOMETRY

- Audiometry is the technique used to determine the nature and the severity of auditory defect. an instrument called audiometer is used.
- This instrument is an electronic function generator or oscillator, connected to an ear phone.
- This instrument is capable of generating sound waves of different frequencies from lowest to highest.
- Intensity (loudness or volume) of sound at each frequency is adjusted on the basis of previous studies in normal persons.

- Thus, before calibrating the instrument, minimum (threshold) volume or intensity or loudness, for each frequency of sound heard by normal persons is determined. minimum intensity is set in the instrument as zero.

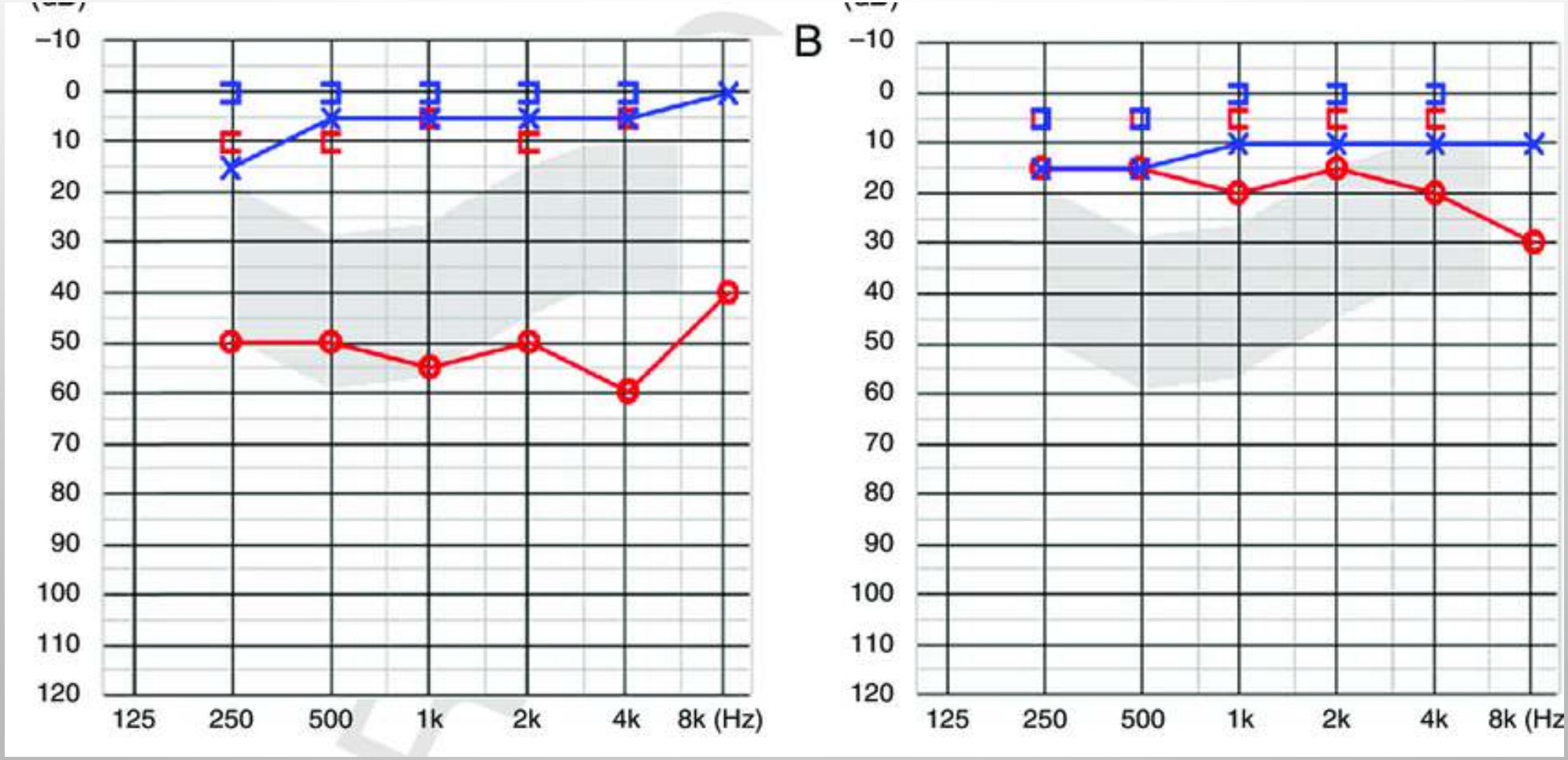
- Now, while testing the patient, the loudness is increased above zero level).

- Intensity of sound is expressed in decibel (db).

- At a particular frequency, if the patient hears the sound with loudness of 30 db above zero level, the person is said to have hearing loss of 30 db for that particular frequency.

- During the tests by audiometer, the subject's ability to hear the sounds with 8 to 10 different frequencies is observed and the hearing loss is determined for each frequency. by using these values, the audiogram is plotted.

- Audiometer has an electronic vibrator also.
- It is used to test the bone conduction from mastoid process into the cochlea.



# OLFACTION

- Olfactory receptors are situated in olfactory mucus membrane, which is the modified mucus membrane that lines upper part of nostril.
- Olfactory mucus membrane consists of 10 to 20 millions of olfactory receptor cells supported by the sustentacular cells.
- Mucosa also contains mucus-secreting bowman glands
- Olfactory receptor cell is a bipolar neuron.
- Dendrite of this neuron is short and it has an expanded end called olfactory rod.

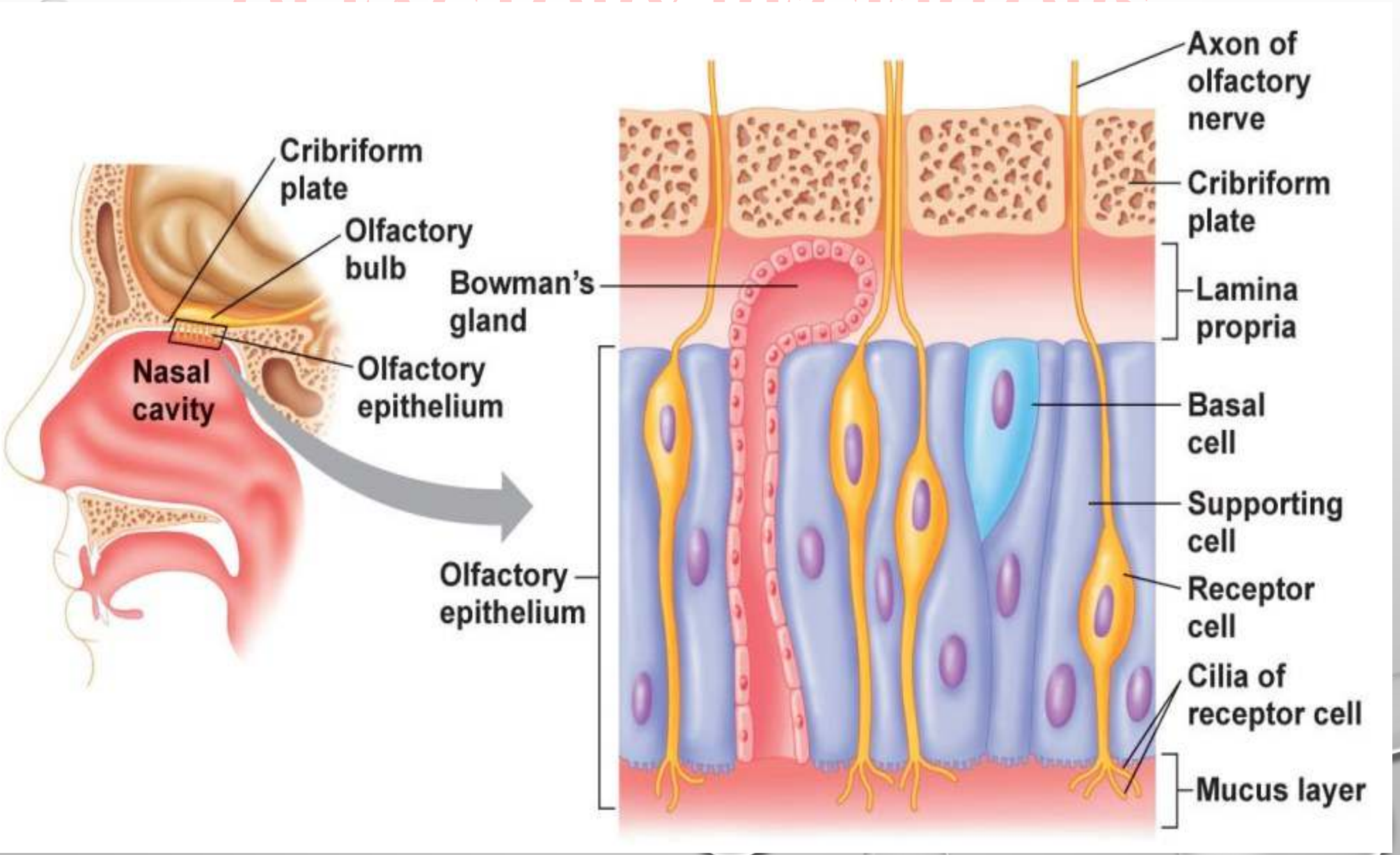
- From olfactory rod, about 10 to 12 cilia arise. cilia are non-myelinated, with a length of 2 μ and a diameter of 0.1 μ.

- These cilia project to the surface of olfactory mucus membrane.

- Mucus secreted by bowman glands continuously lines the olfactory mucosa.

- Mucus contains some proteins, which increase the actions of odoriferous substances on receptor cells.

# OLFACTORY RECEPTORS



# CLASSIFICATION OF ODOUR

- Odor is classified into various types. substances producing different types of odor are:

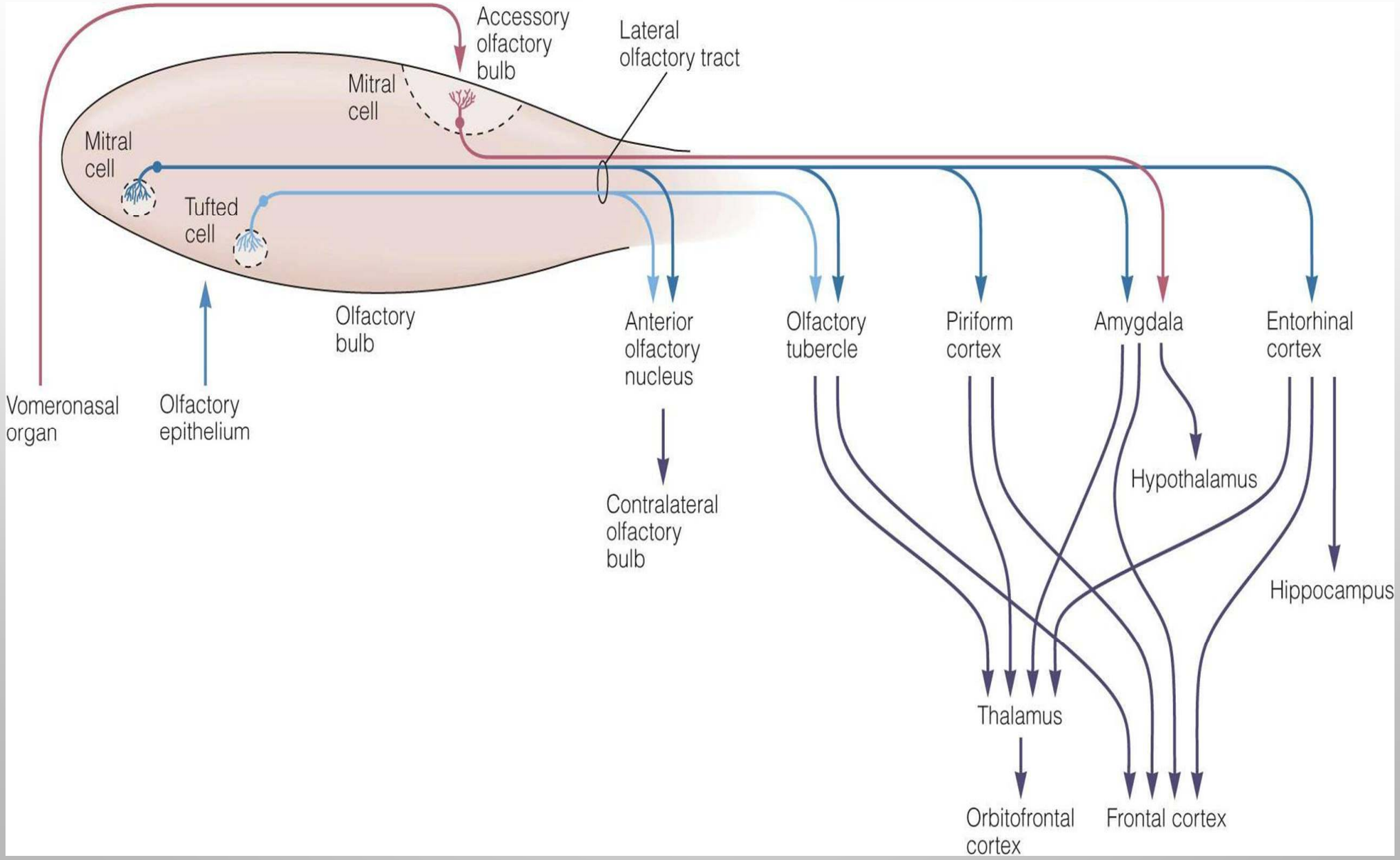
1. Aromatic or resinous odor: camphor, lavender, clove and bitter almonds.
2. Ambrosial odor: musk.
3. Burning odor: burning feathers, tobacco, roasted coffee and meat.
4. Ethereal odor: fruits, ethers and beeswax.
5. Fragrant or Balsamic odor: flowers and perfumes.
6. Garlic odor: garlic, onion and sulfur.
7. Goat odor: caproic acid and sweet cheese.
8. Nauseating odor: decayed vegetables and feces.
9. Repulsive odor: bed bug.

# THRESHOLD FOR OLFACTORY SENSATION

- Ethyl ether : 5.8 mg/l of air.
- Chloroform : 3.3 mg/l of air.
- Peppermint oil : 0.02 mg/l of air.
- Butyric acid : 0.009 mg/l of air.
- Artificial musk : 0.00004 mg/l of air.
- Methyl mercaptan : 0.0000004 mg/l of air.

Thus, methyl mercaptan produces olfactory sensation even at a low concentration of 0.0000004 mg/l of air

# OLFACTORY PATHWAY



# APPLIED

- ANOSMIA:

Anosmia refers to total loss of sensation of smell, i.e. inability to recognize or detect any odor.
it may be temporary or permanent.

Temporary anosmia is due to obstruction of nose, which occurs during common cold, nasal sinus and allergic conditions.

Permanent anosmia occurs during lesion in olfactory tract, meningitis and degenerative conditions such as Parkinson disease and Alzheimer disease.

- Hyposmia:

Hyposmia is the reduced ability to recognize and to detect any odor.

The odors can be detected only at higher concentrations. it is the most common disorder of smell.

Hyposmia also may be temporary or permanent.

It occurs due to same causes of anosmia.

- HYPEROSMIA:

  Hyperosmia is the increased or exaggerated olfactory sensation. It is also called olfactory hyperesthesia.

- it occurs in brain injury,
- epilepsy and
- neurotic conditions.

# GUSTATION

- Sense organs for taste or gustatory sensation are the taste buds.
- Taste buds are ovoid bodies with a diameter of 50 μ to 70 μ.
- In adults, about 10,000 taste buds are present and the number is more in children.
- In old age, many taste buds degenerate and the taste sensitivity decreases.

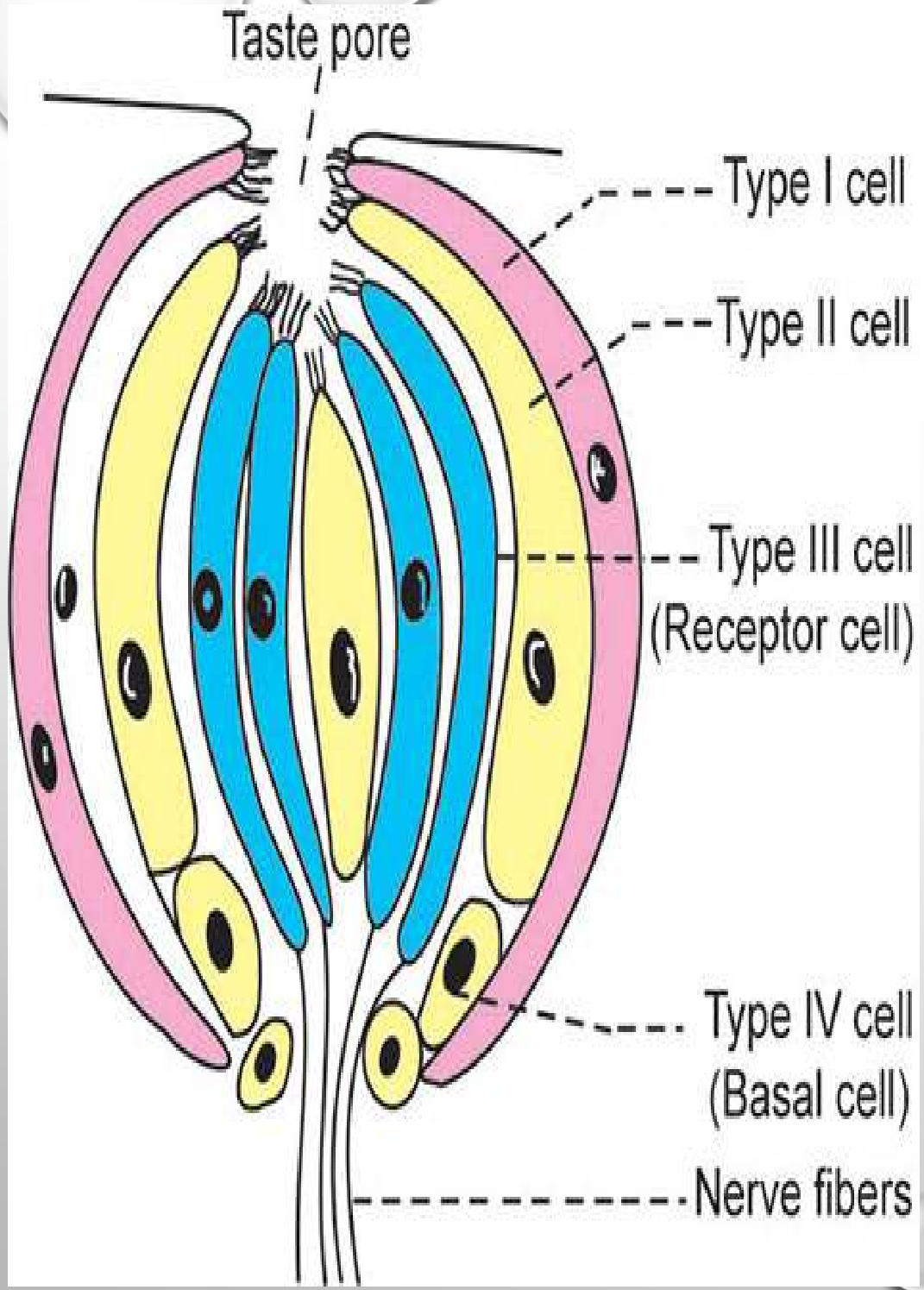
# SITUATION OF TASTE BUDS

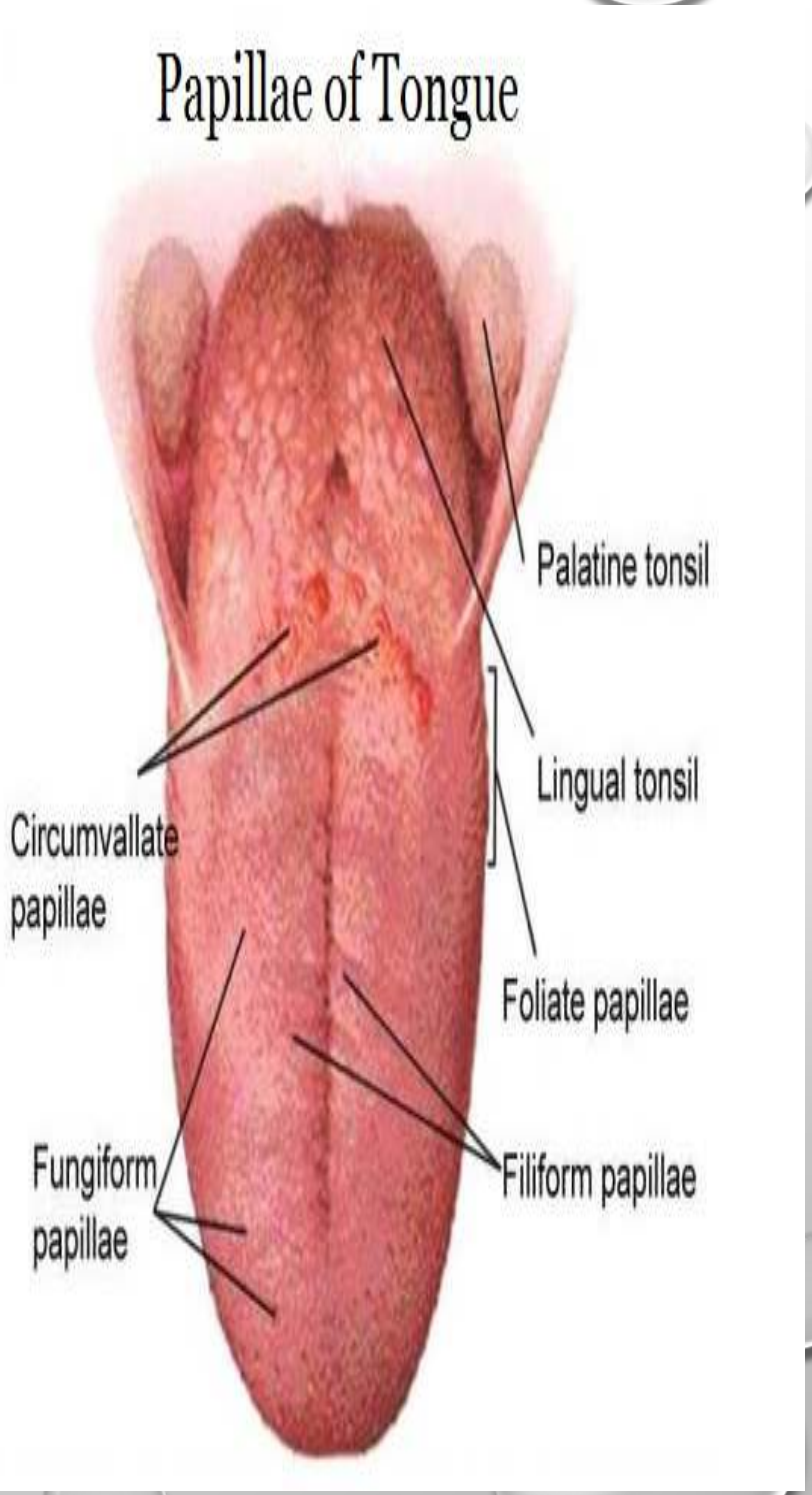
- Most of the taste buds are present on the papillae of tongue.

- Taste buds are also situated in the mucosa of epiglottis, palate, pharynx and the proximal part of esophagus.

- Types of papillae located on tongue:

  1. filiform papillae.
  2. fungiform papillae.
  3. circumvallate papillae.


Taste pore
Type I cell
Type II cell
Type III cell
(Receptor cell)
Type IV cell
(Basal cell)
Nerve fibers


Papillae of Tongue
Palatine tonsil
Lingual tonsil
Circumvallate papillae
Foliate papillae
Fungiform papillae
Filiform papillae

- Filiform papillae are situated over the dorsum of the tongue. The papillae contains less number of taste buds.

- Fungiform papillae are situated over the anterior surface of tongue near the tip .the number of taste buds in each is moderate.

- Circumvallate papillae are situated posterior part of the tongue and are many in number each papillae contains many taste buds. these papillae arranged in a shape of ‘v’.

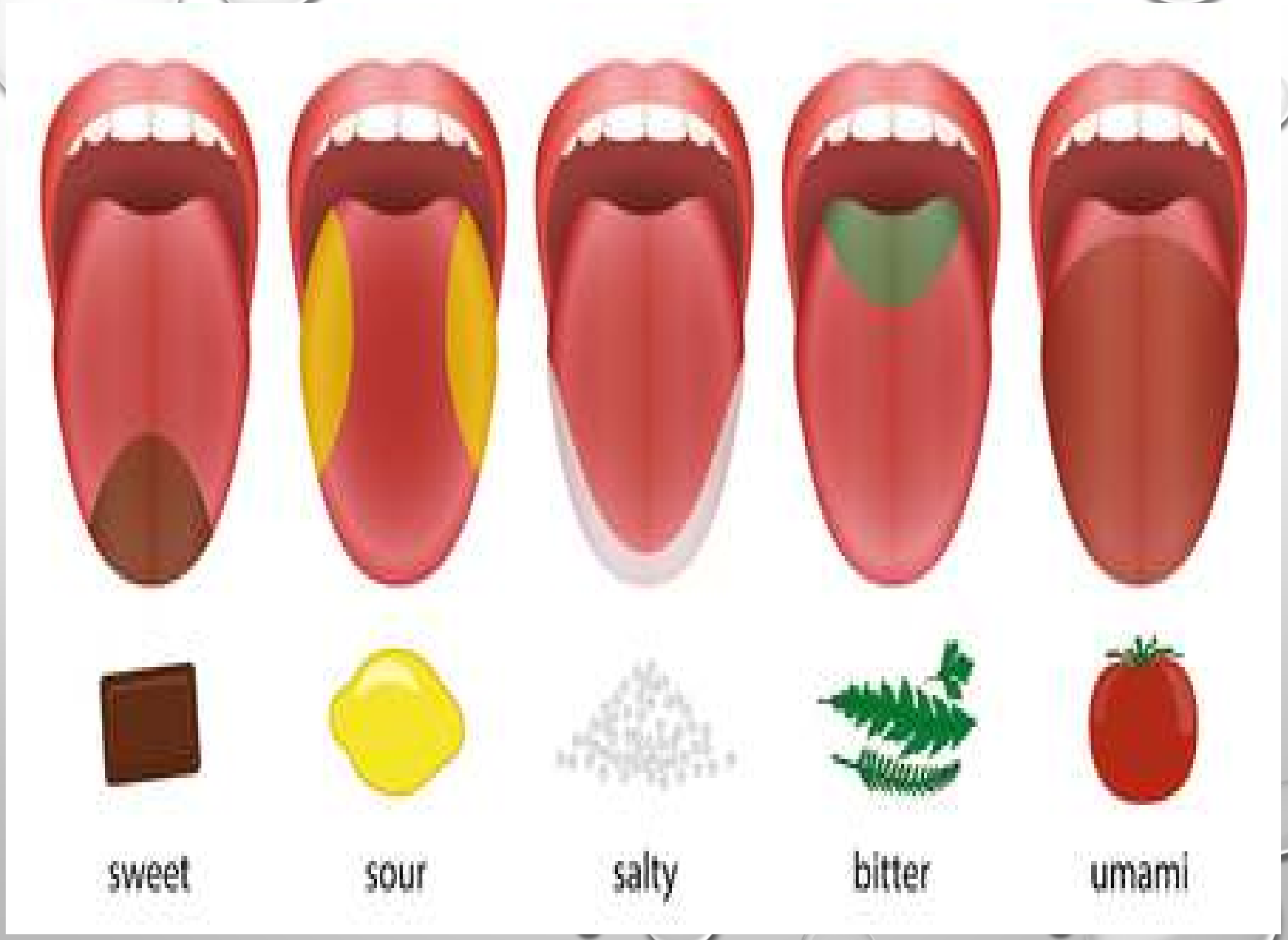
# TYPES OF TASTE

- There are five kind of taste we can sense it they are:
  1.sour
  2.salty
  3.umami
  4.bitter
  5.sweet.

- The fifth taste sense umami, was recently added to the four classic tastes.

- This taste has actually been known for almost 100 years. it was triggered by glutamate and particularly by the monosodium glutamate.

- The taste is pleasant and sweet but differs from the standard sweet taste.


sweet
sour
salty
bitter
umami

# RECEPTORS OF TASTE

- Sweet receptor ;  receptor for sweet taste is gpcr. the sweet substance binds to receptor and causes depolarisation via camp.

- Salt receptor; receptor for salt taste is epithelium sodium channel(enac).when sodium enters this receptor releases glutamate which causes depolarisation.
- Sour receptor: receptor for the sour taste is same enac receptor and hyperpolarisation-activated cyclic nucleotide-gated cation channel(hcn).when proton(h+) ions enters the receptor gets depolarised.

- Bitter receptor: bitter receptor is a gpcr. the sour substance activate phospholipase c through g proteins it causes the production of ip3 which causes depolarisation by releasing ca+ ions
- Umami receptor: it is a metabotropic glutamate receptor (mglur4).glutamate causes depolarisation of this receptor.

  the exact mechanism of depolarisation is not understood .activation of umami taste receptor is intensified by the presence of gmp and imp.

- **TASTE SENSATION AND CHEMICAL CONSTITUENTS**

  1.sweet taste: monosaccharides,polysaccharides,glycerol,alcohol,aldehydes,ketones,and chloroform.

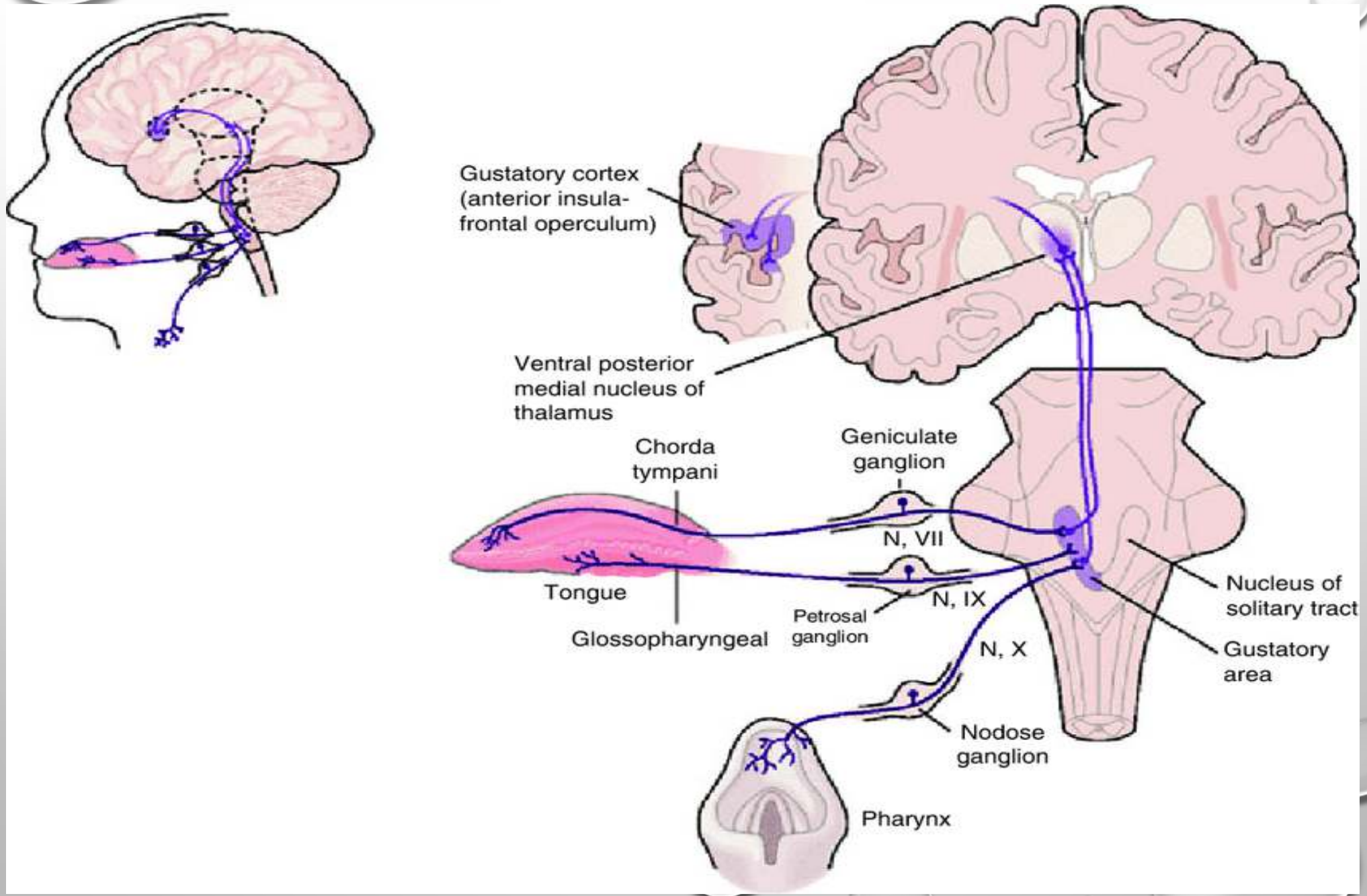
  2.salt taste: chlorides and nitrates of sodium, potassium and ammonium and some sulfates, bromides and iodides.

  3.sour taste: sour taste is produced because of hydrogen ions in acids and acids salts.

  4.bitter taste: it is produced by quinine, morphine, glucosides, picric acids, strychnine, and bile salts.

  5.umami taste: it is produced due to the monosodium glutamate. umami is a japanese word meaning ‘delicious’. the msg is a common ingredient in asian foods.

# TASTE PATHWAY



- **Ageusia:**

- Loss of taste sensation is called ageusia. it is due to the lesion in the facial nerve ,chorda tympani, or mandibular division of trigeminal nerve causes loss of sensation in the anterior one third of the tongue.

- Lesion in the glossopharyngeal nerve causes loss of sensation in the posterior one third of tongue.

- Temporary loss of sensation is occurs due to drugs like captopril and penicillamine, which contain sulfhydryl group of substances.

- **Taste Blindness:**

  Taste blindness is a rare genetic disorder in which the ability to recognize the substances by taste is lost

- **Hypogeusia:**

  The decrease in the taste sensation is known as hypogeusia.

  It is due to increase in the threshold for different taste sensations. however, the taste sensation is not completely lost.

- **Dysgeusia:**

  The disturbance in the taste sensation is called as dysgeusia it is found in temporal lobe syndrome, particularly when anterior region of temporal lobe is affected.

  In this condition the paroxysmal hallucinations of smell and taste occur which are usually unpleasant.


Thank you!


# Dr. M.G.R

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