ANATOMY & PHYSIOLOGY II

GHC 2013 / NMS 2012 / OHC 3013 / PTAP 1123

CHAPTER 3
SPECIAL SENSE ORGANS

Topic Outlines

3.1 Introduction to Special Sense Organs

3.2 Olfaction

3.3 Gustation

3.4 Vision

3.5 Hearing & Equilibrium

3.6 General Senses

Learning Outcomes

At the end of this chapter, students should be able to:

- Describe the structures of special sense organs
- Explain the main functions for each structures of special sense organs
- Explain the basic physiological process of special sense organs

3.1 Introduction to Special Sense Organs

- The sensory system protects a person by detecting changes in the environment.
- A **special sense** have specialised sensory receptors, located within specific sense organs:

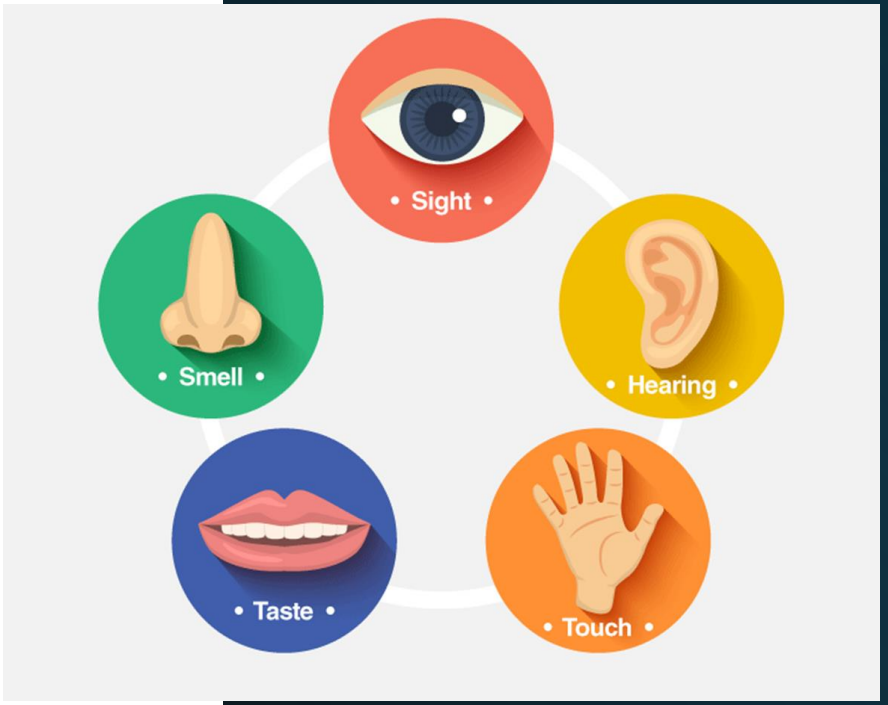
❑ **Vision** from receptors in the eye

❑ **Hearing & Equilibrium** from receptors in the internal ear

❑ **Taste** from the tongue receptors

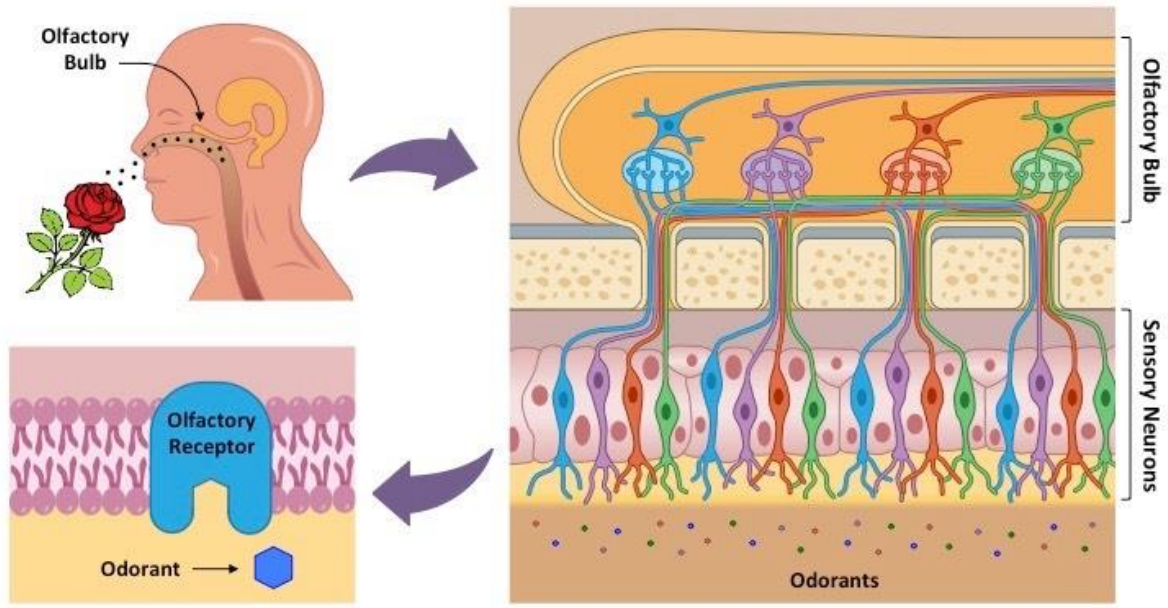
❑ **Smell** from receptors in the upper nasal cavities

❑ **Pressure, temperature, pain** and **touch** from receptors in the skin & internal organs



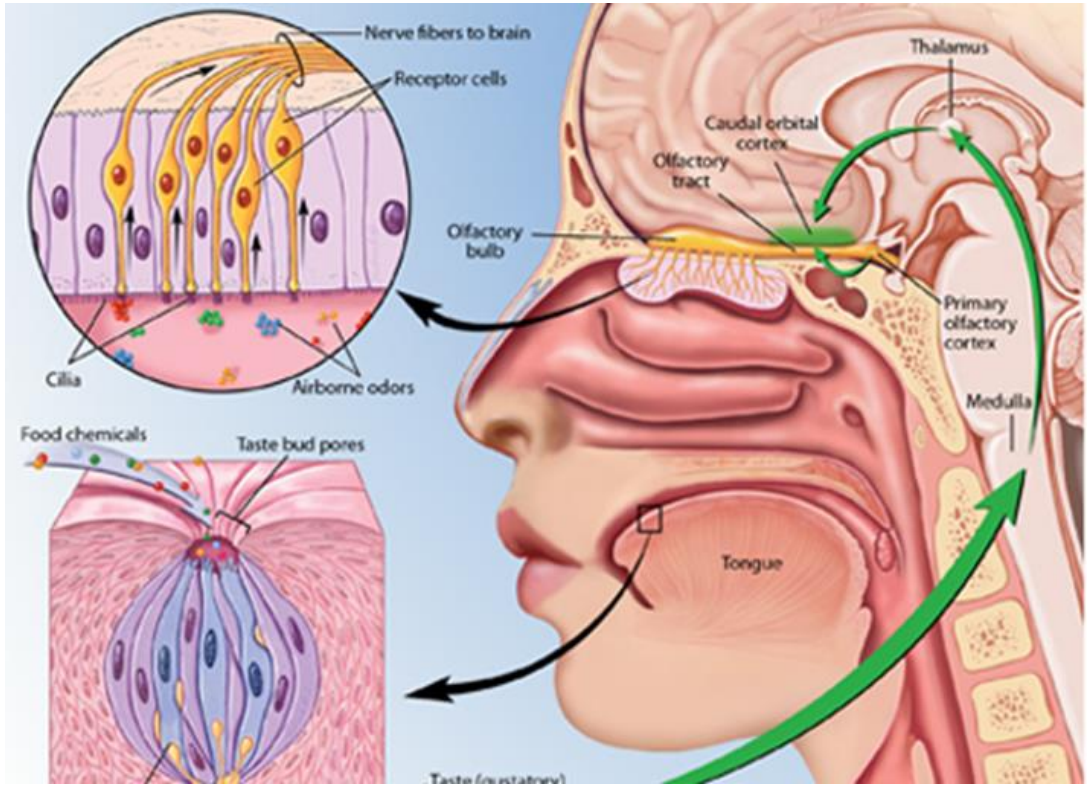
3.2 Olfaction (Sense of Smell)

- Receptor for the sense of smell = **olfactory**
- Receptors located in the epithelium of the superior part of the nasal cavity
- Helps to detect gases and other harmful substances (are in spoiled food)
- Impulses from receptors for smell are carried by olfactory nerve which leads to olfactory centre in the brain (temporal cortex)



3.2 Olfaction (Sense of Smell)

- Smell stimulates appetite and flow of digestive juice.
- Inflammation of the nasal mucosa prevent smells from reaching the olfactory centre. Common cause is a cold.
- Olfactory receptors deteriorate with age.
- Closely linked to the sense of taste



3.2 Olfaction (Sense of Smell)

Remember the cranial nerve number I = **Olfactory nerve**

Passageway of Olfactory Nerve

↓

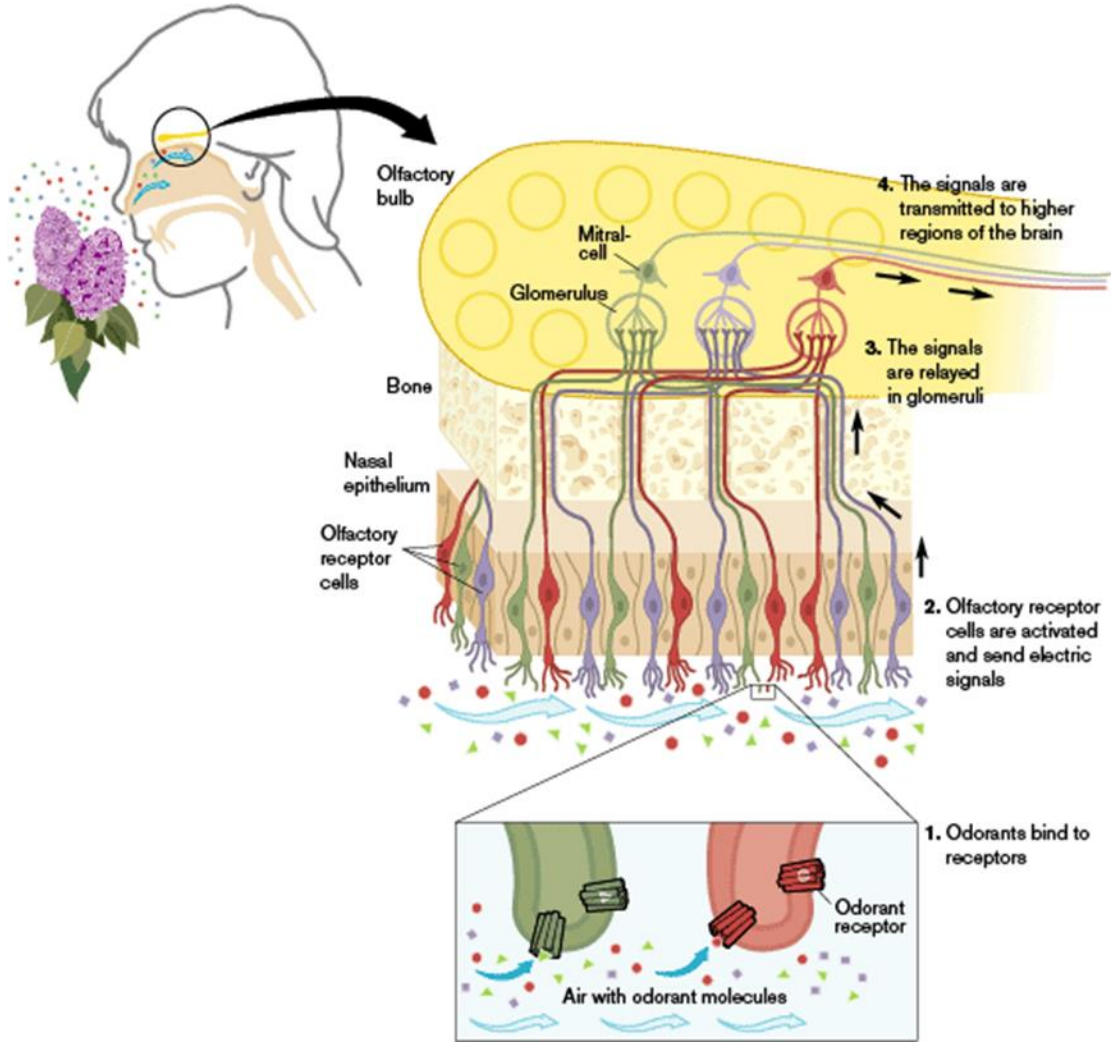
Olfactory Bulb

↓

Olfactory Tract

↓

Brodmann's area (Temporal Lobes)

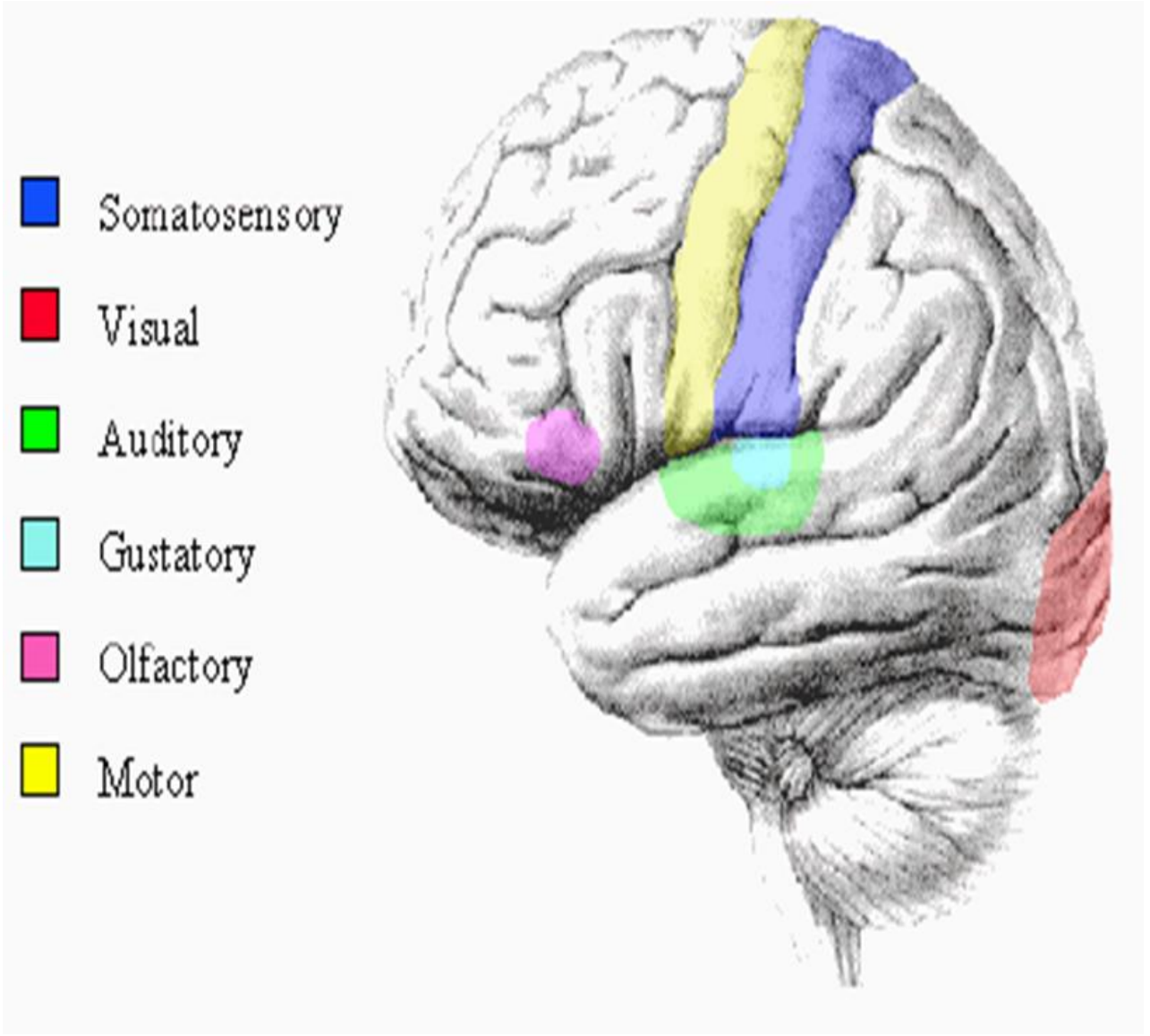


3.2 Olfaction (Sense of Smell)

Brodmann's area

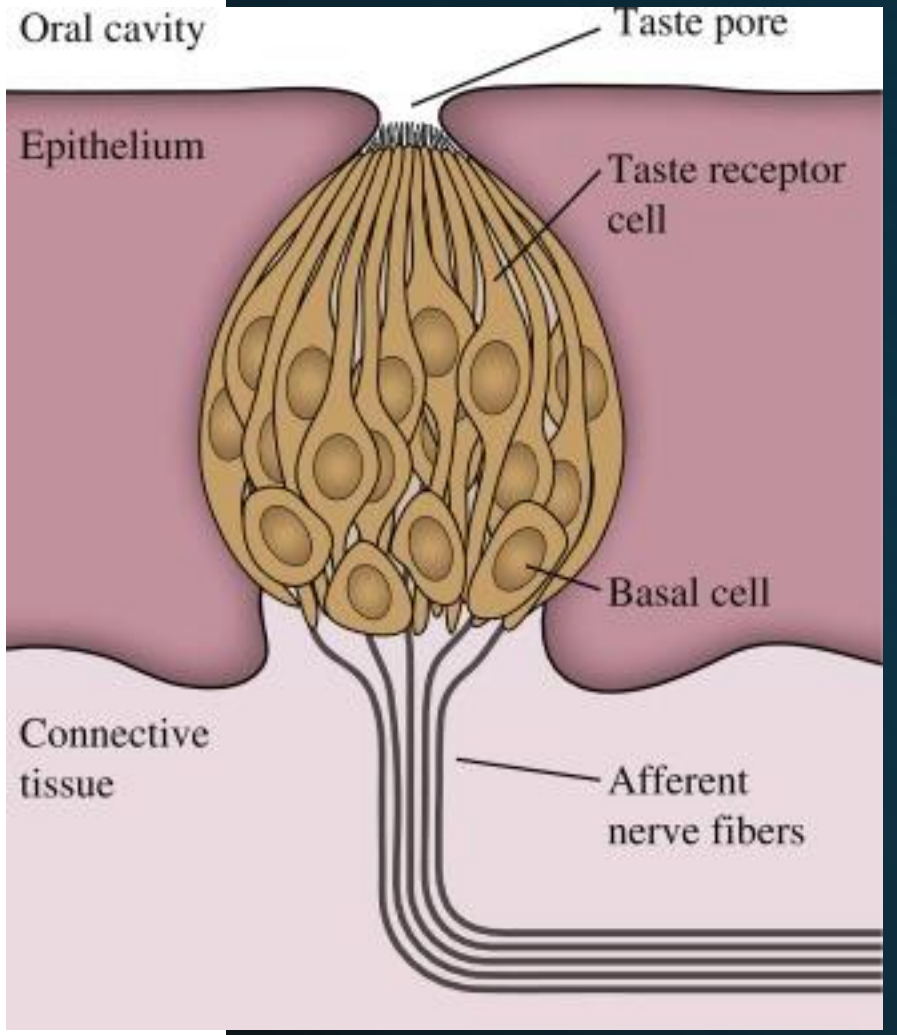
- receive impulse of smell & process it

We can detect **10,000 odors**



3.3 Gustation (Sense of Taste)

- Receptor for the sense of taste = **gustatory receptor cells**
- Gustatory receptor cells locate inside taste buds
- Involves receptors in the tongue and two different nerves that carry taste impulses to the brain.
- Taste receptors are known as taste buds, located along the edges of the tongue.
- Taste buds is stimulated when the substance to be tasted is in solution or dissolves in fluids of the mouth (saliva)

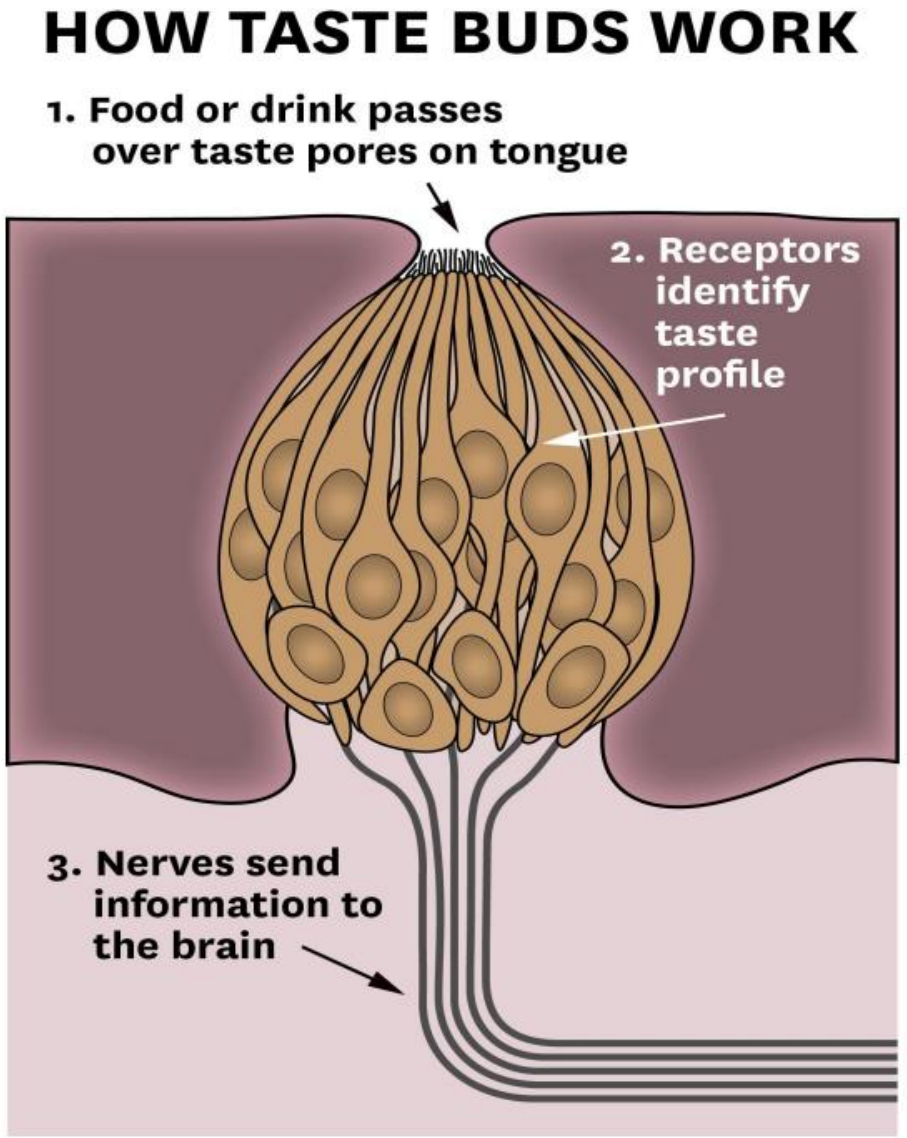


3.3 Gustation (Sense of Taste)

- FOUR (4) major classes of stimuli:
  1) **sweet =** most acute at tip
  2) **salty =** most acute at the anterior sides
  3) **sour =** located laterally
  4) **bitter =** located at the posterior

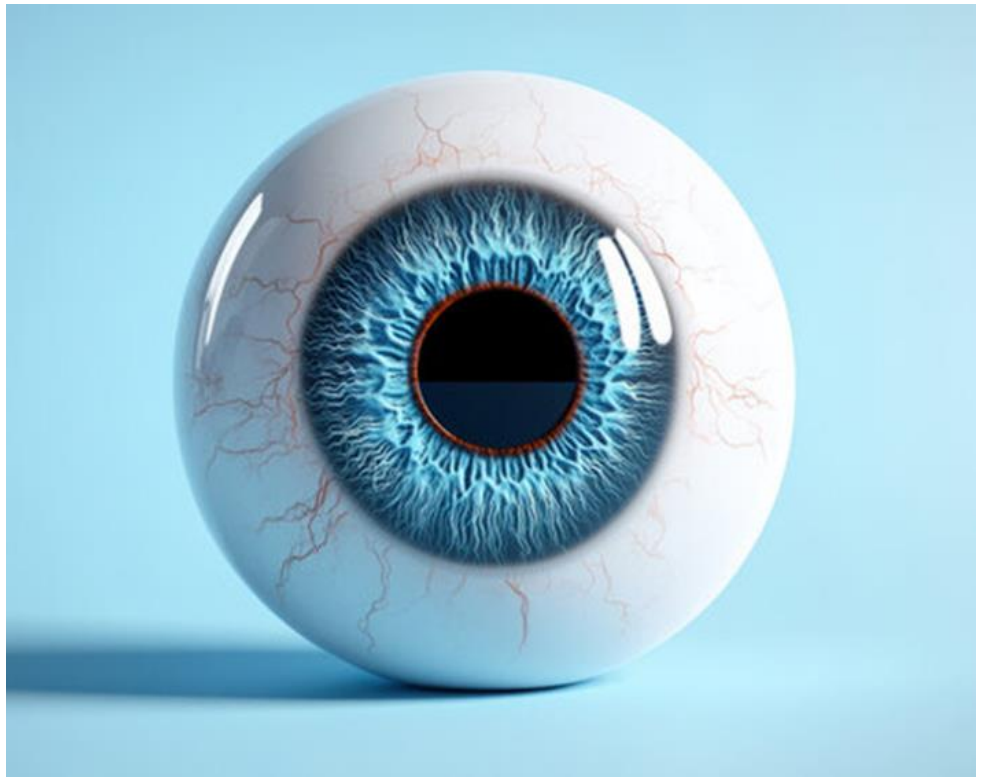
#nearly 10000 taste buds on the tongue

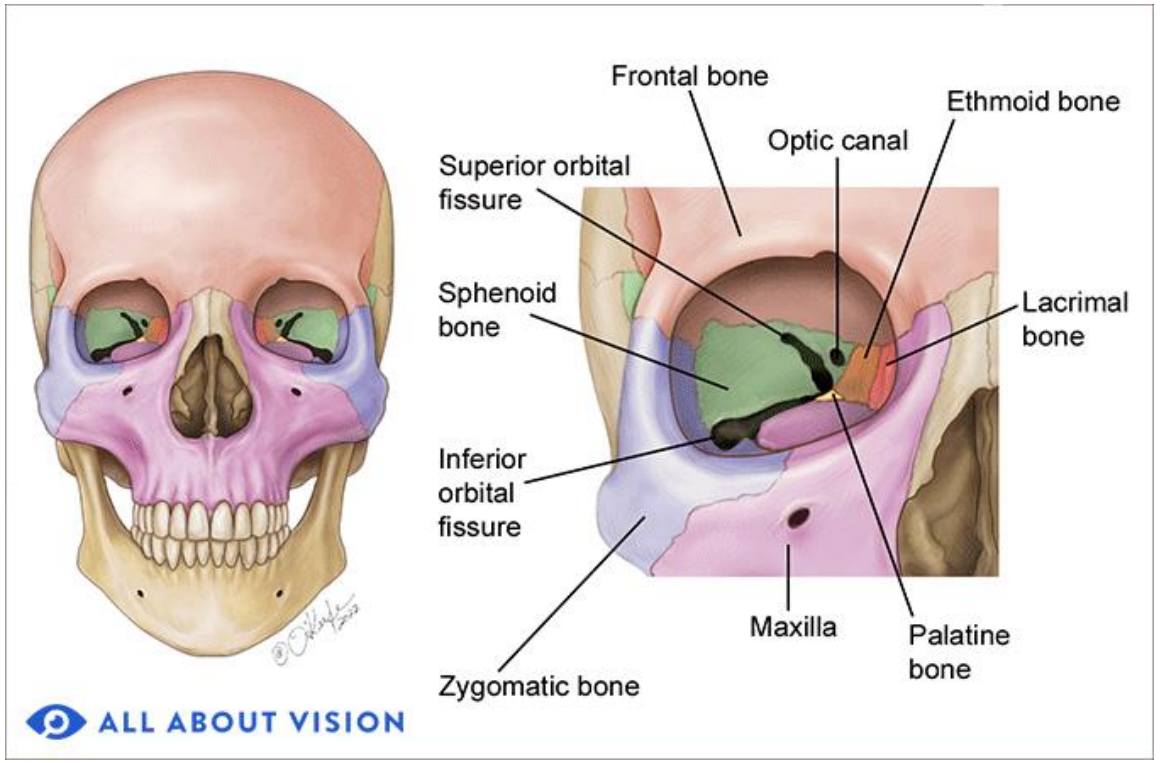
3.3 Gustation (Sense of Taste)



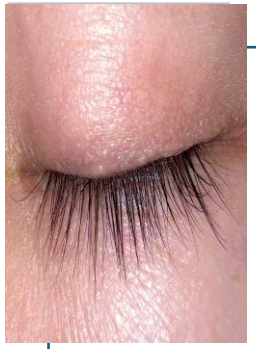
3.4 Vision

- A delicate and spherical organ protected by a number of structures
- The skull bones form the walls of the eye orbit (cavity) and protect the posterior part of the eyeball





3.4.1 Structures of the Eye

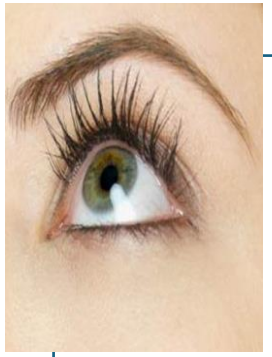


Eyelid

- protect the anterior part during sleep and protects the eyes from excessive light & foreign object

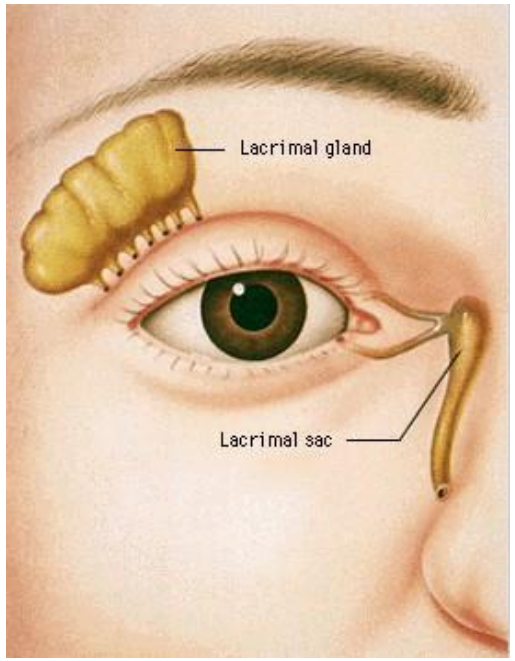
Conjunctiva

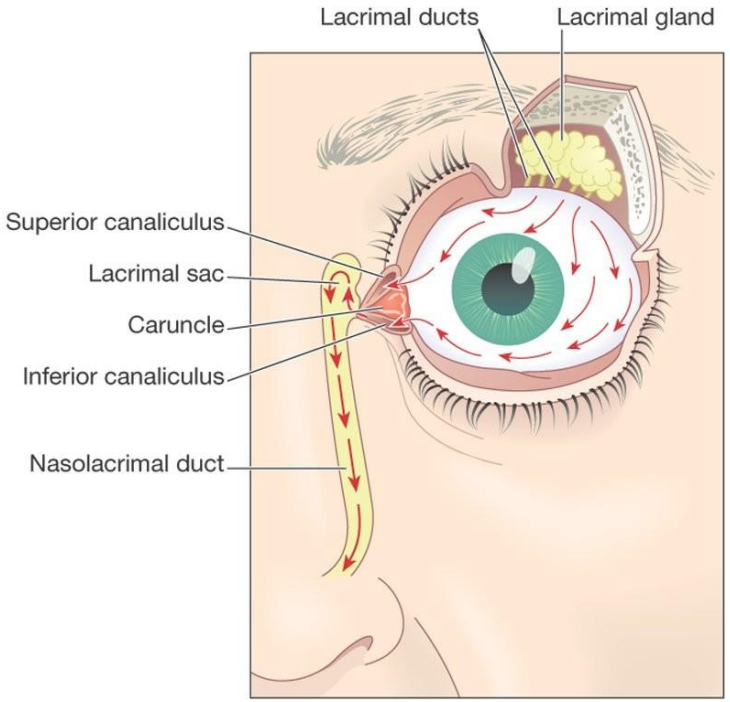
- lines the inner surface of the eyelids and covers the visible white of the eye (sclera)
- secretes mucus, which helps to lubricate the eye (blinking)



Eyelashes/ Eyebrow

- help to keep foreign matter out of the eye





3.4.1 Structures of the Eye

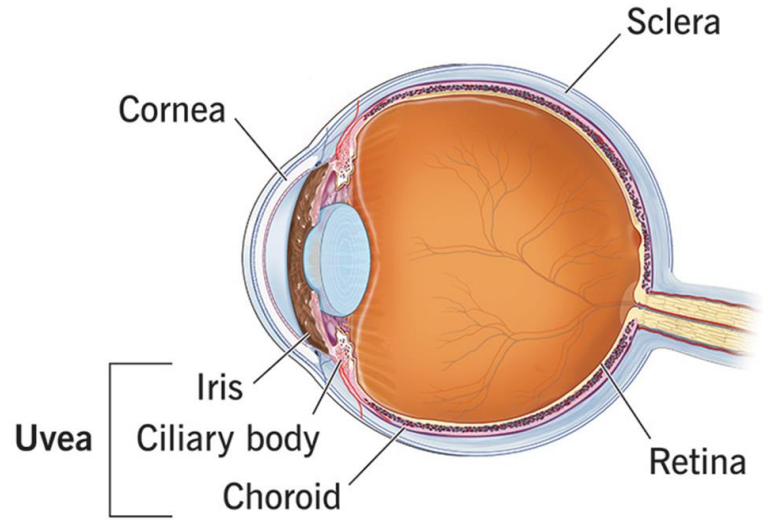
Lacrimal Apparatus

- A group of structures that **produces & drains tears**
- The **lacrimal glands** are located above the lateral end of each eye
- They secrete a salt solution (tears) onto the anterior surface of eyeball
- Tears flow across the eye to lacrimal duct and then into the nasolacrimal duct and then into nasal cavity.
- Tears consists of **salt, mucus and lysozyme**

3.4.1 Structures of the Eye

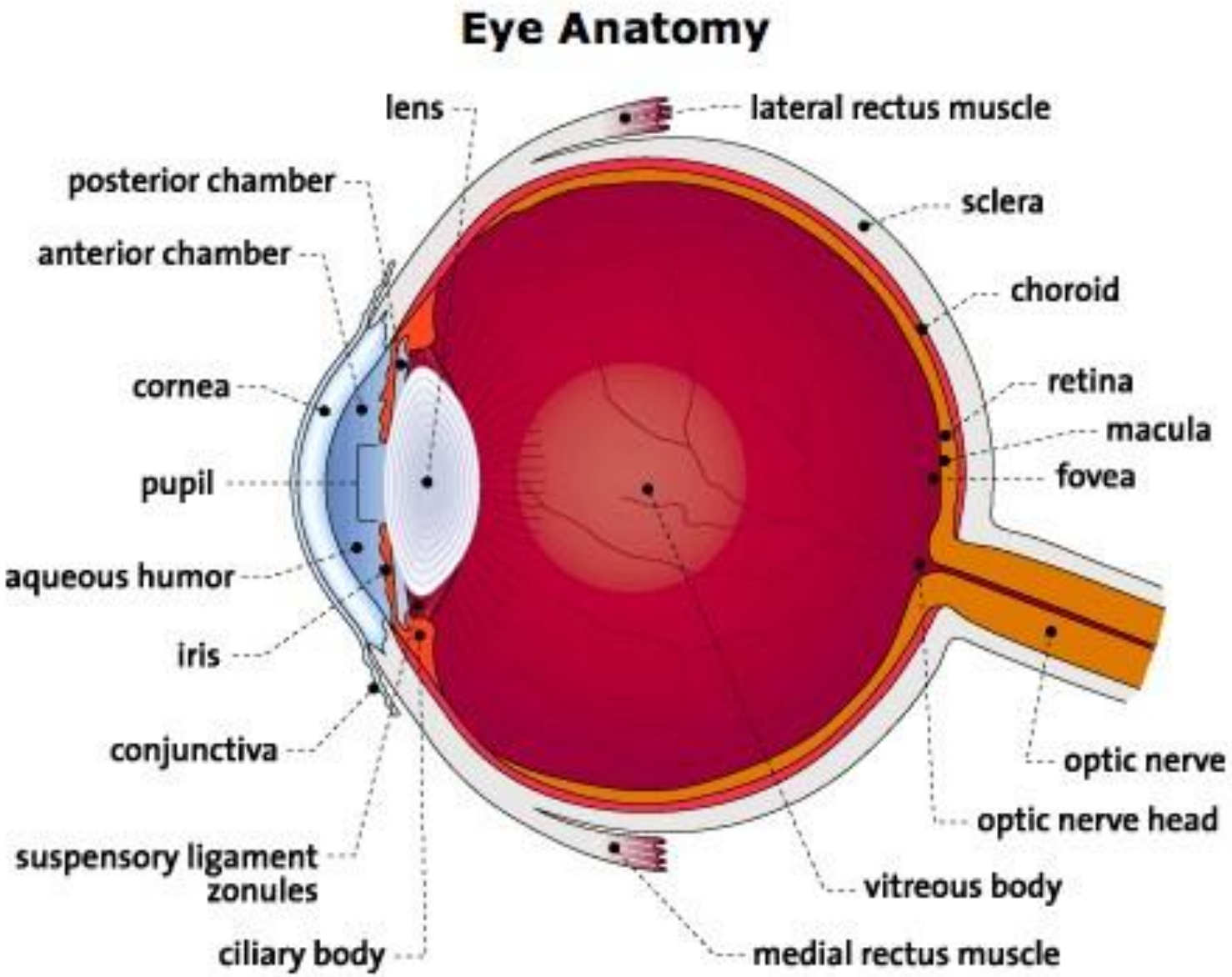
THREE (3) layers of tissue in the wall of eye

- Outer fibrous layer
  - Sclera
  - Cornea
- Middle vascular layer
  - Choroid
  - Ciliary Body
  - Iris
- Inner nervous tissue layer
  - Retina



Inside eyeball:
Lens, Aqueous fluid & Vitreous body

3.4.1 Structures of the Eye



3.4.1 Structures of the Eye

Sclera

- Posterior part
- Helps maintain the eye's shape and protects it from injury

Cornea

- Anterior part
- Allows light rays to enter the eye
- Bending light rays to focus on the retina (refraction)

Choroid

- Lines all but the front of the eye
- Supplied blood to other layers, especially to the retina

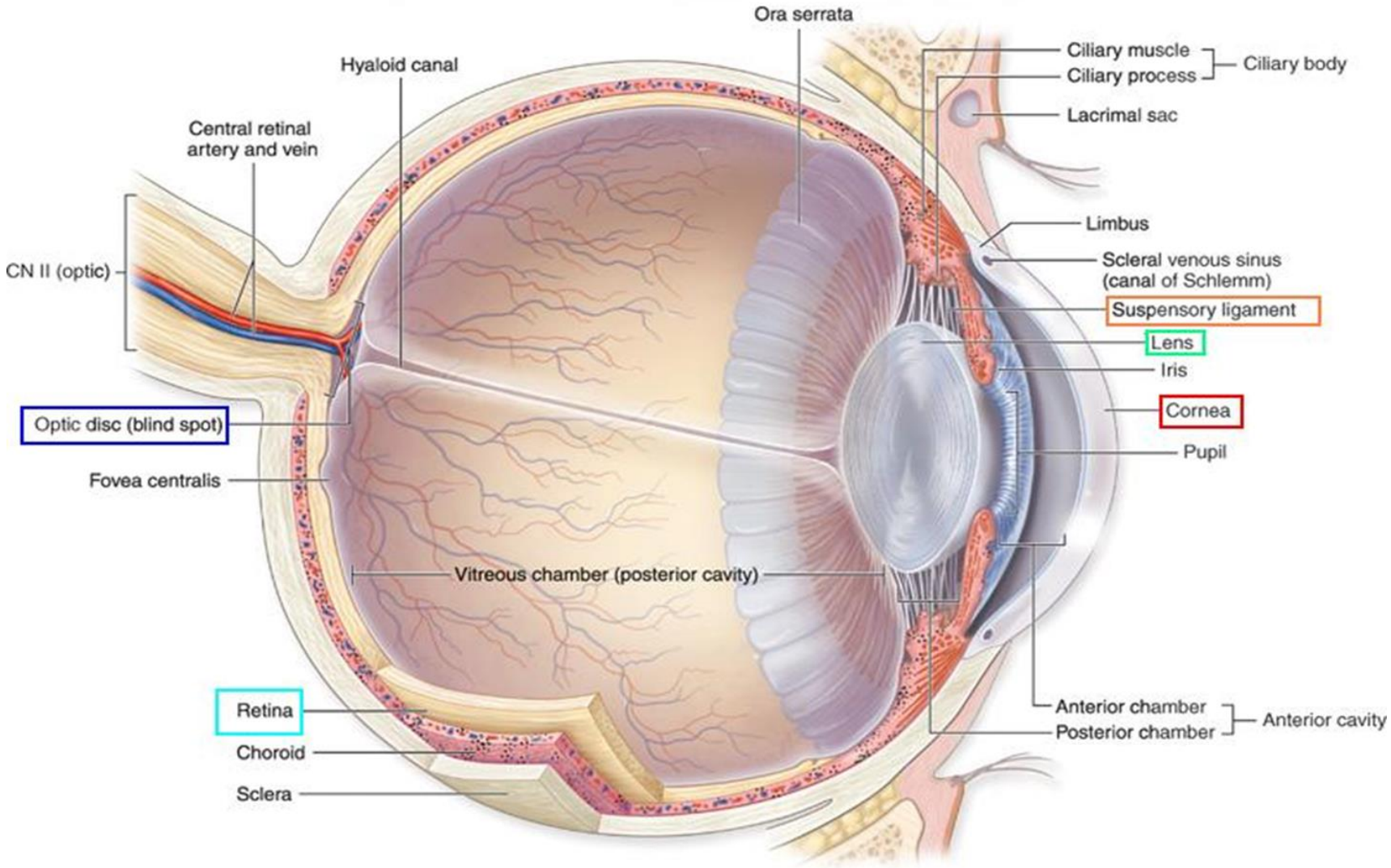
3.4.1 Structures of the Eye

Ciliary muscles	• Control the shape of the lens
Ciliary glands	• Produce aqueous humour
Iris	• Coloured part of eye • Contains circular muscular tissues • Regulates amount of light that enters eyeball
Pupil	• Opening in the centre • Contract in bright light and dilate in poor light

3.4.1 Structures of the Eye

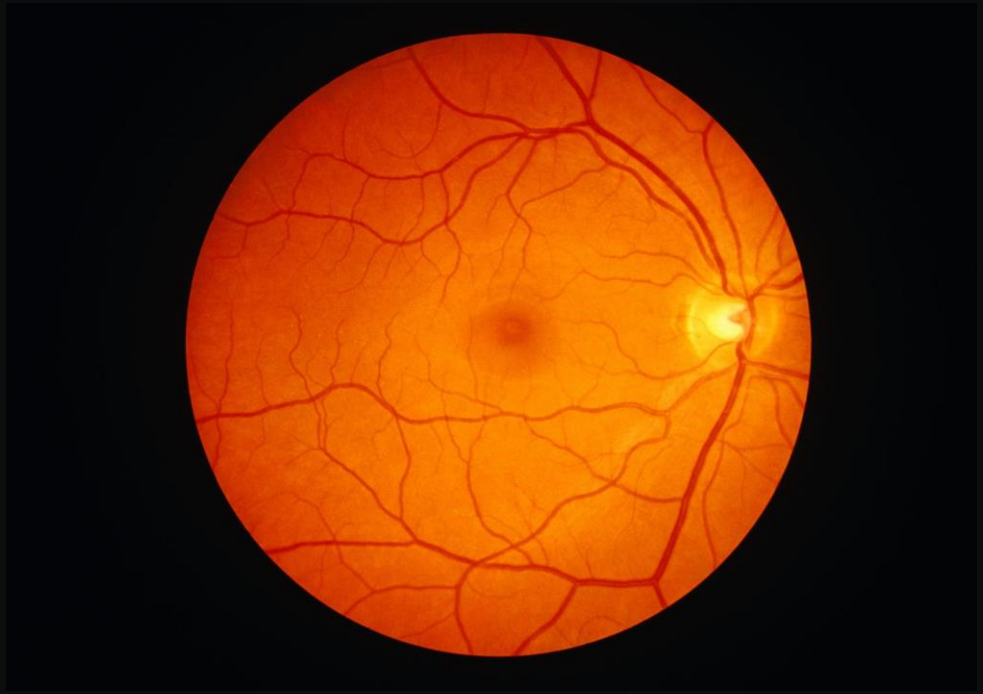
Aqueous humour	• Maintains the intraoccular pressure and provides nutrition
Vitreous humour	• Colourless, transparent jelly-like substance which maintains shape of eye
Lens	• Transparent, biconvex body enclosed in a transparent, elastic capsule

3.4.1 Structures of the Eye



3.4.1.1 Retina

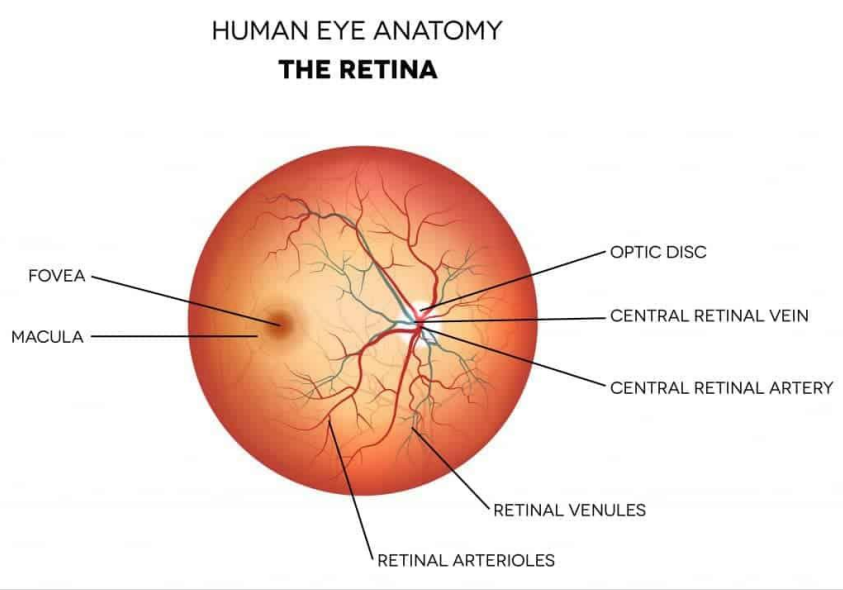
- The inner coat of the eyeball
- Surface landmark → optic disc (blind spot)
  → fovea centralis



- 3 layers of retinal neurons:
  1) photoreceptor layer (Rods & Cones)
  2) bipolar cell layer
  3) ganglion cell layer

- Other types of cells present in retina are horizontal cells & amacrine cells
- Nerve impulses from rods and cones flow into sensory neurons that merge to form the optic nerve

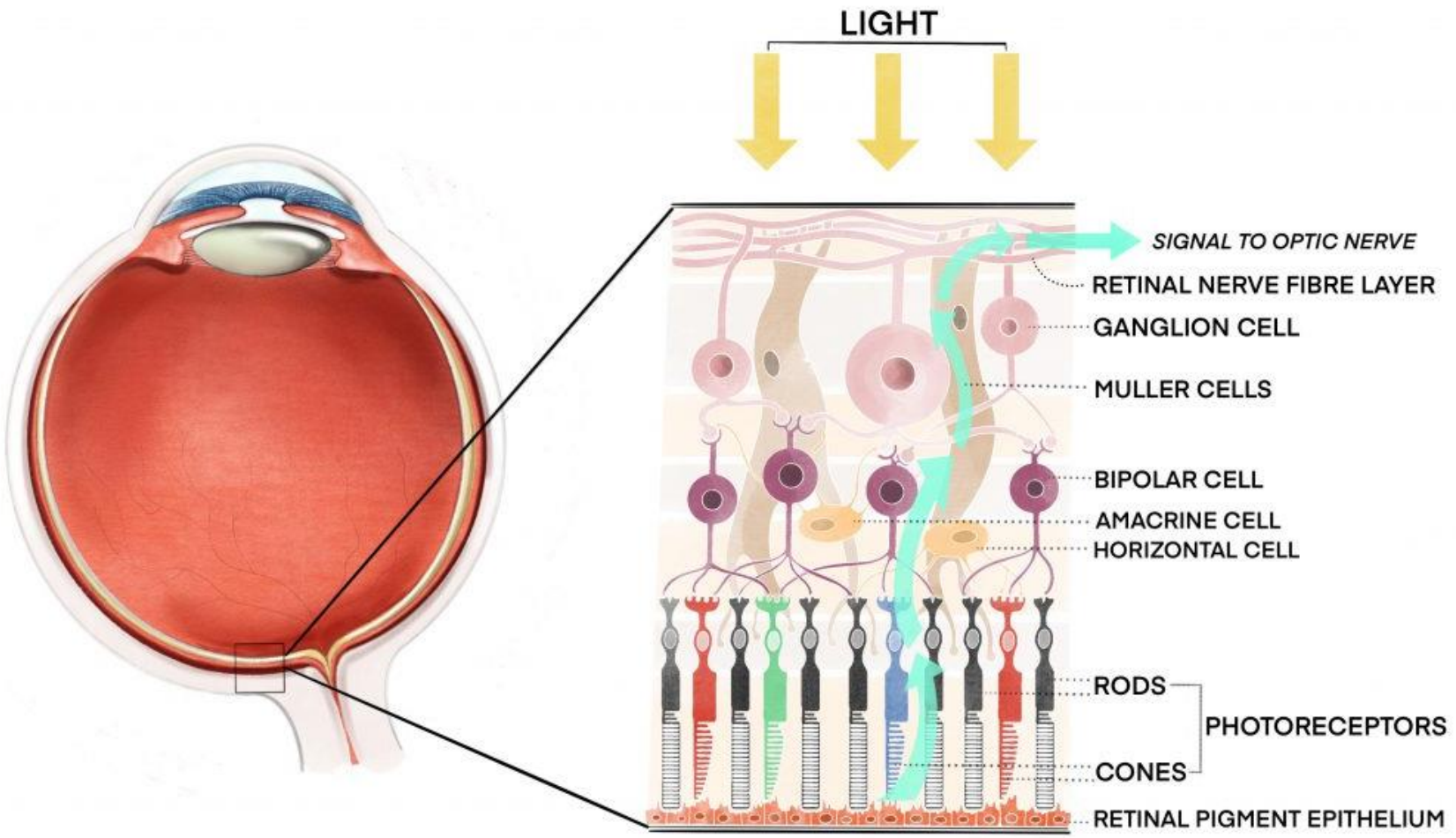
3.4.1.1 Retina



RETINA (physiology)

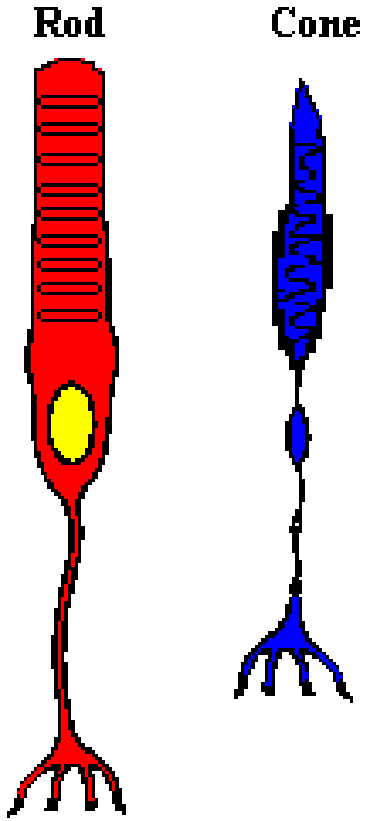
- **Optic disc**
  - site where the optic nerve exits the eyeball. Contains no rods or cones. Cannot see image that strike optic disc.
- **Fovea centralis**
  - contains only cones. Area of highest acuity or resolution (sharpness of vision)
- **Photoreceptor layer**
  - transduce light ray into receptor potentials.
- **Rods cells**
  - low light threshold, allowing us to see in dim light. Do not provide colour vision.
- **Cones cells**
  - high light threshold, produce colour vision.
- Each retina contain 6 million cones & 120 million rods

3.4.1.1 Retina


LIGHT
SIGNAL TO OPTIC NERVE
RETINAL NERVE FIBRE LAYER
GANGLION CELL
MULLER CELLS
BIPOLAR CELL
AMACRINE CELL
HORIZONTAL CELL
RODS
CONES
PHOTORECEPTORS
RETINAL PIGMENT EPITHELIUM

3.4.1.1 Retina

Rod
Sensitive to light
Function in dim light
Locate at anterior portion of the retina
Dark adaptation
Images are blurred and appear gray
Unable to differentiate colors



Cones
Sensitive to color (either red, green or blue light)
Function in bright light
Locate at the centre of the retina
Light adaptation
Images are sharp
Able to differentiate colors

Color blindness – *lack of retinal cones*

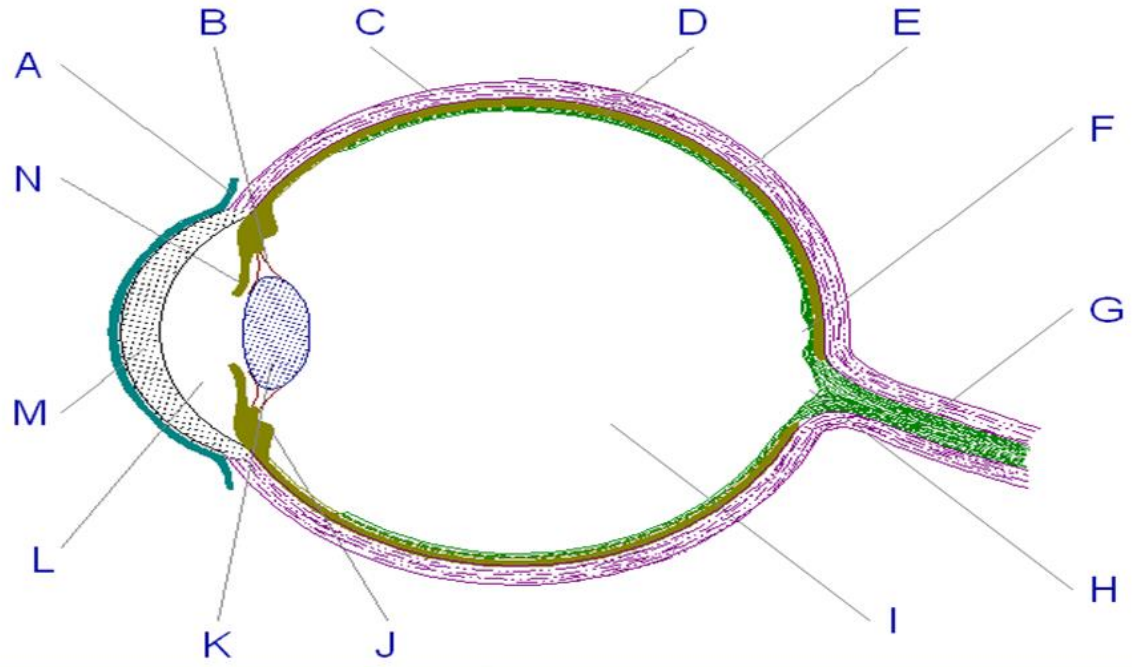
3.4.1.1 Retina

Light Adaptation

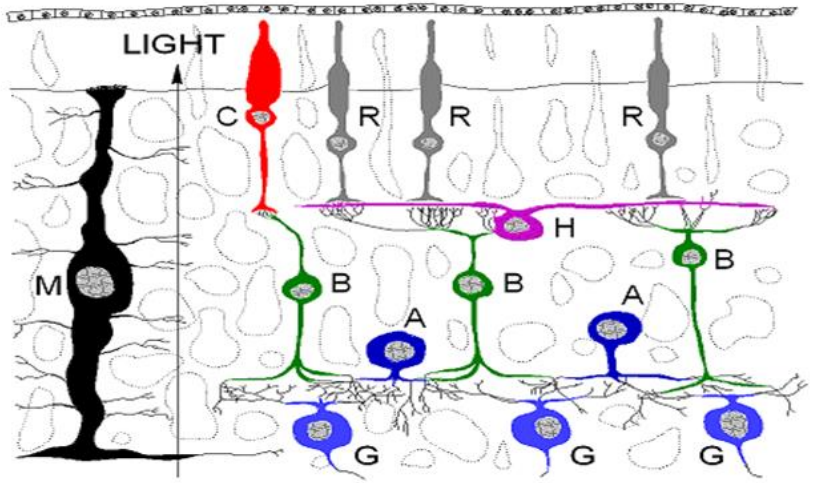
- Suddenly from dark surrounding to light surrounding
- Visual system adjusts in seconds to the brighter environment by decreasing its sensitivity.
- Circular muscles of eye contract = pupil constrict
- Activate of cones.

Dark Adaptation

- Suddenly from light surrounding to dark surrounding.
- Visual system adjusts in seconds to the darker environment by increasing its sensitivity.
- Radial muscles contract = pupil dilate
- Activate of rods.

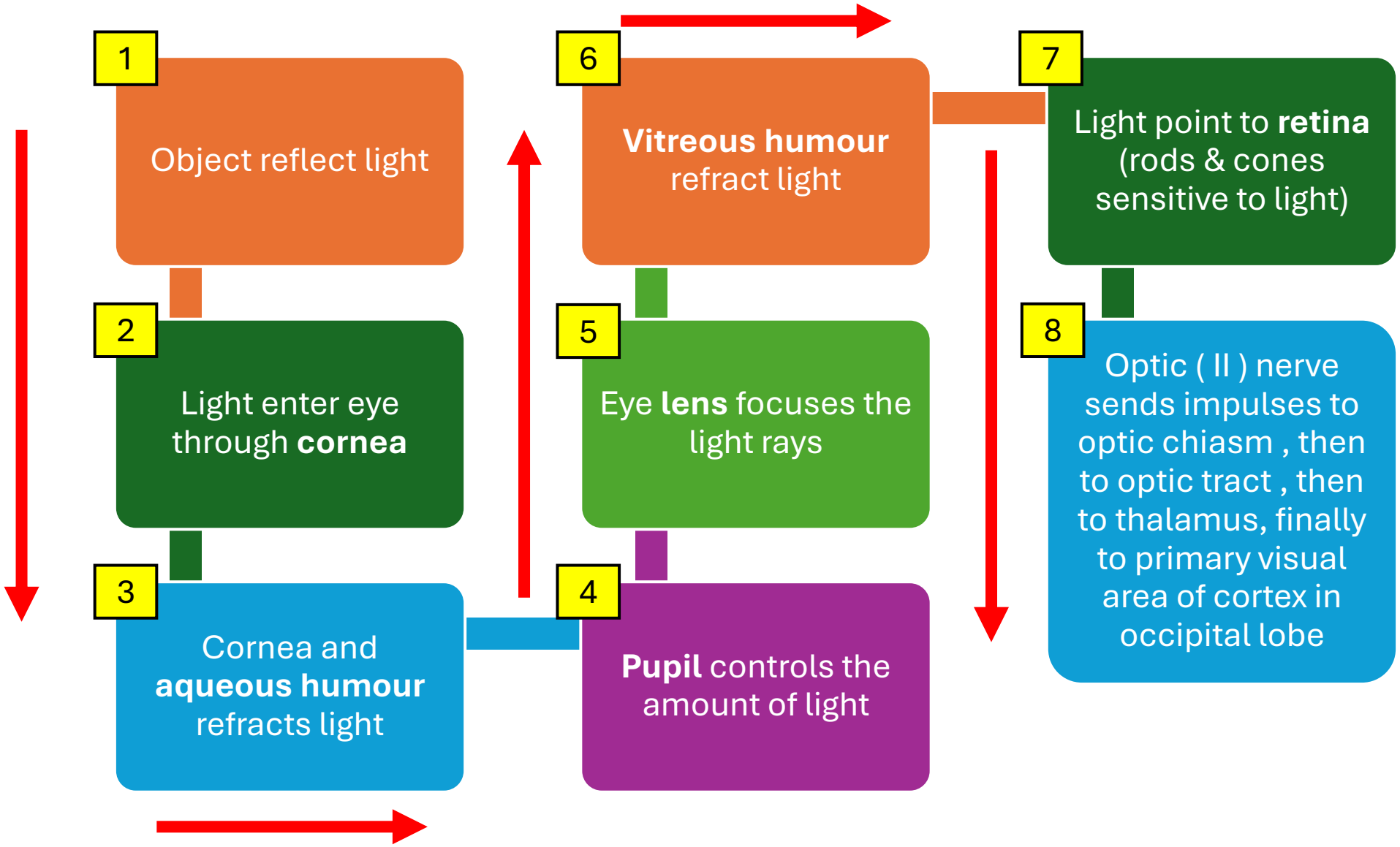


A-CONJUNCTIVA
B-SUSPENSORY LIGAMENT
C-SCLERA
D-CHOROID
E-RETINA
FOVEA CENTRALIS
G-OPTIC NERVE
H-BLIND SPOT
I-POSTERIOR CHAMBER
J-CILIARY BODY
K-LENS
L-ANTERIOR CHAMBER
M-CORNEA
N-IRIS

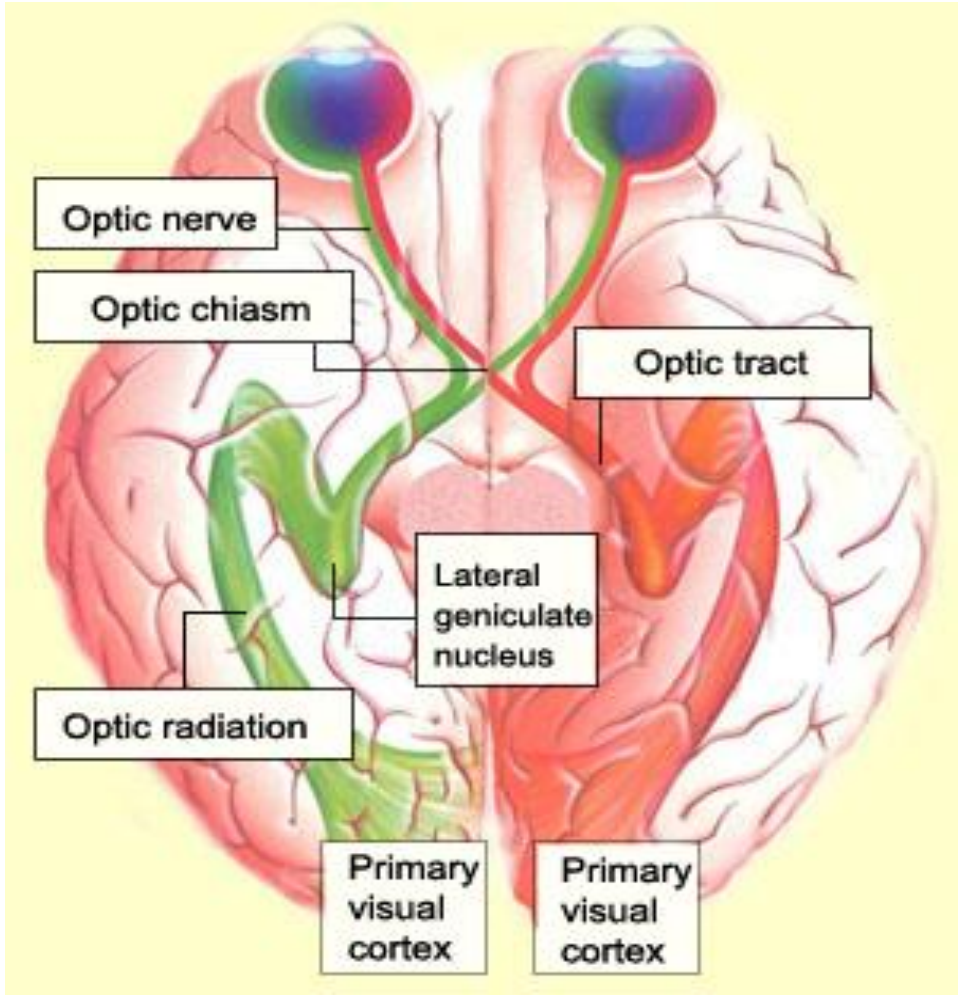


C-CONE CELL
R-ROD CELL
H-HORIZONTAL CELL
B-BIPOLAR CELL
A-AMACRINE CELL
G-GANGLION CELL
M-MELANOCYTE

3.4.2 Basic Sequences Of Image Formation



3.4.3 Optic Pathway



Optic (II) nerve

↓

Optic chiasm

↓

Optic tract

↓

Lateral geniculate nucleus of thalamus

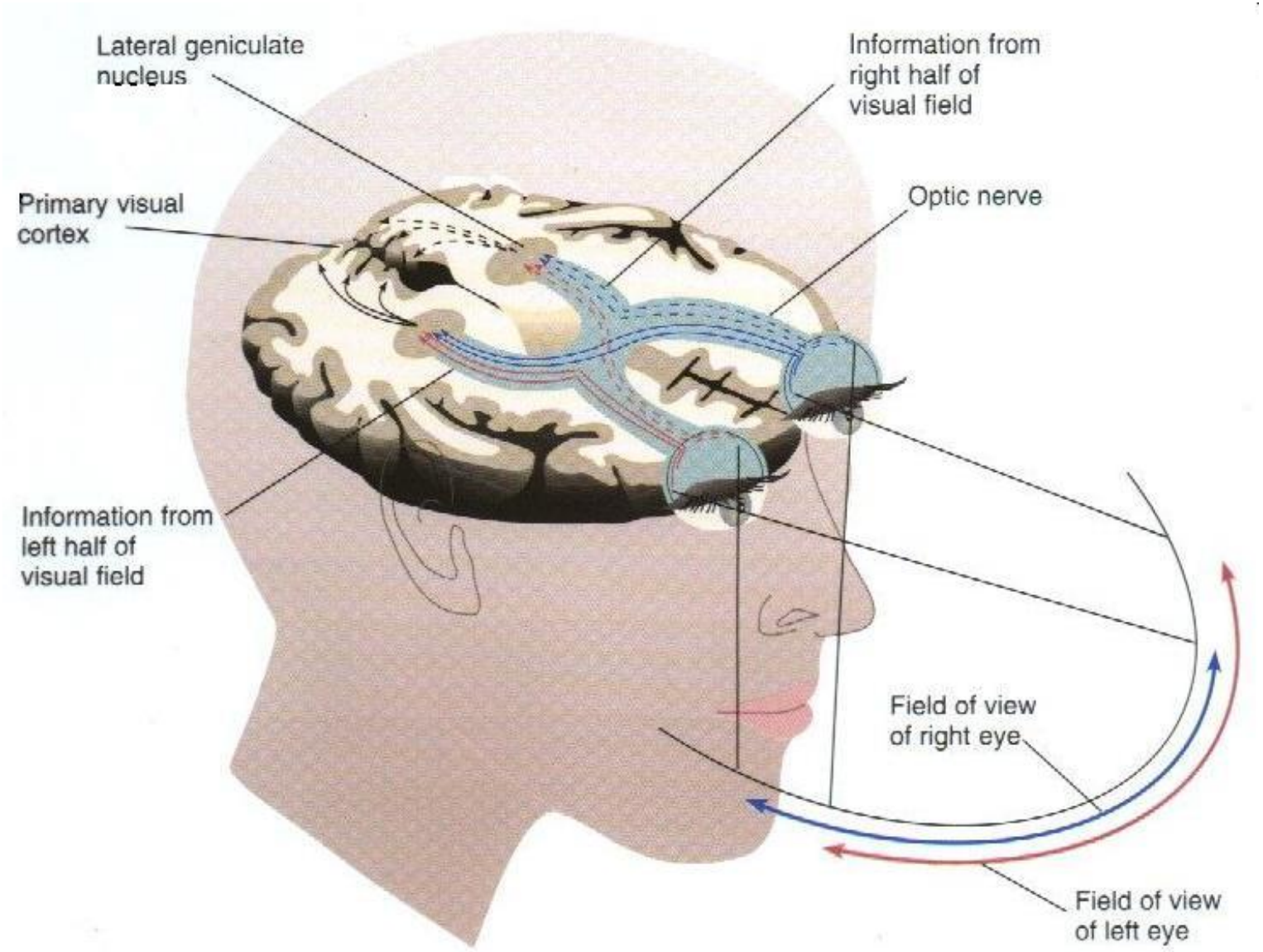
↓

Optic radiations

↓

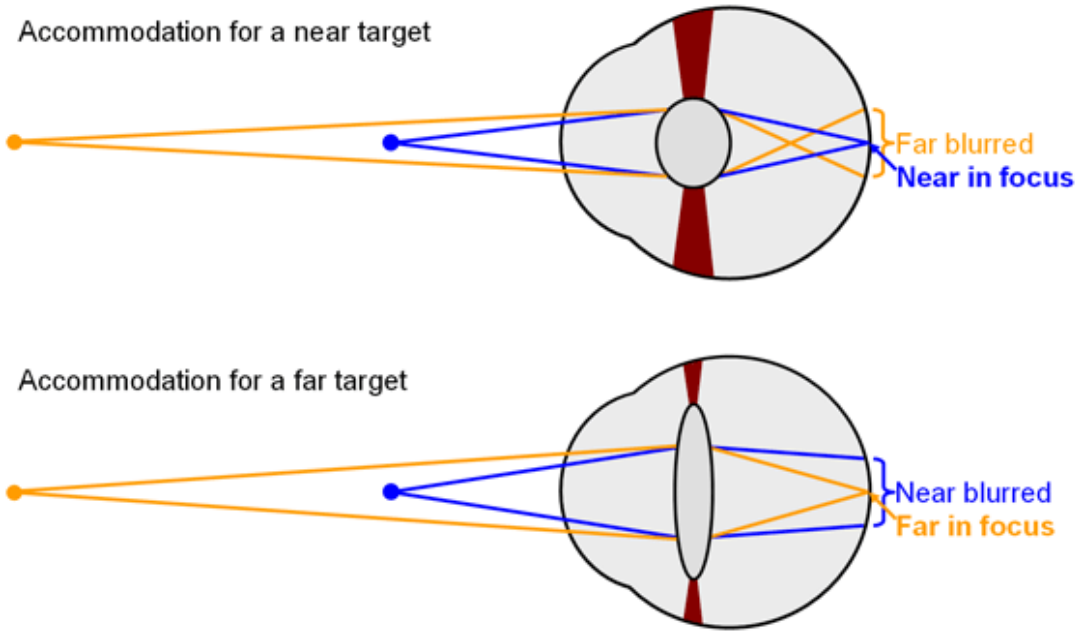
Primary visual cortex

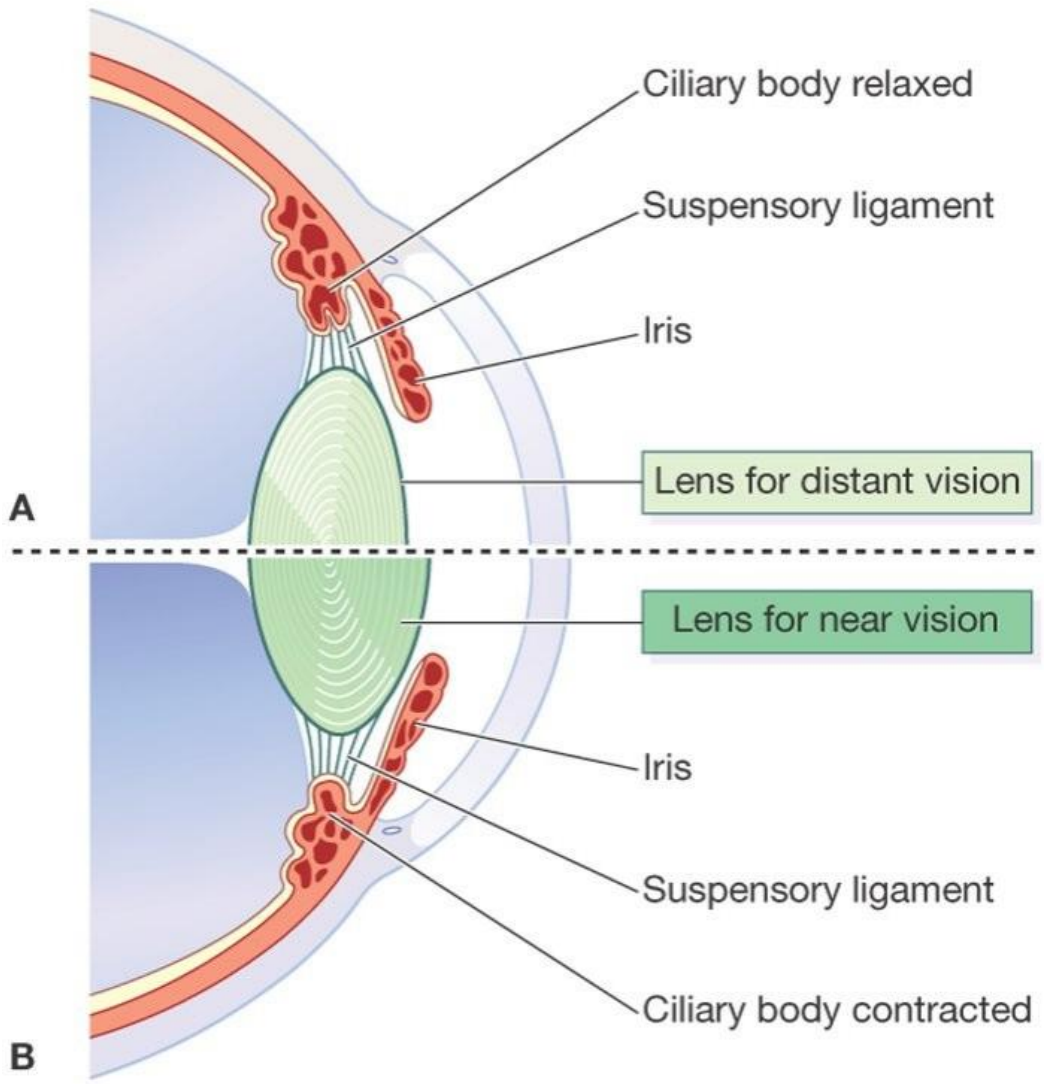
3.4.3 Optic Pathway



3.4.4 Mechanism of Sight

- Effective vision is dependent upon the coordination of refraction, change in size of pupils and accommodation (adjustment of the lens for near vision)





3.4.4 Mechanism of Sight

3.4.5 Vision Abnormality

Myopia = near-sightedness

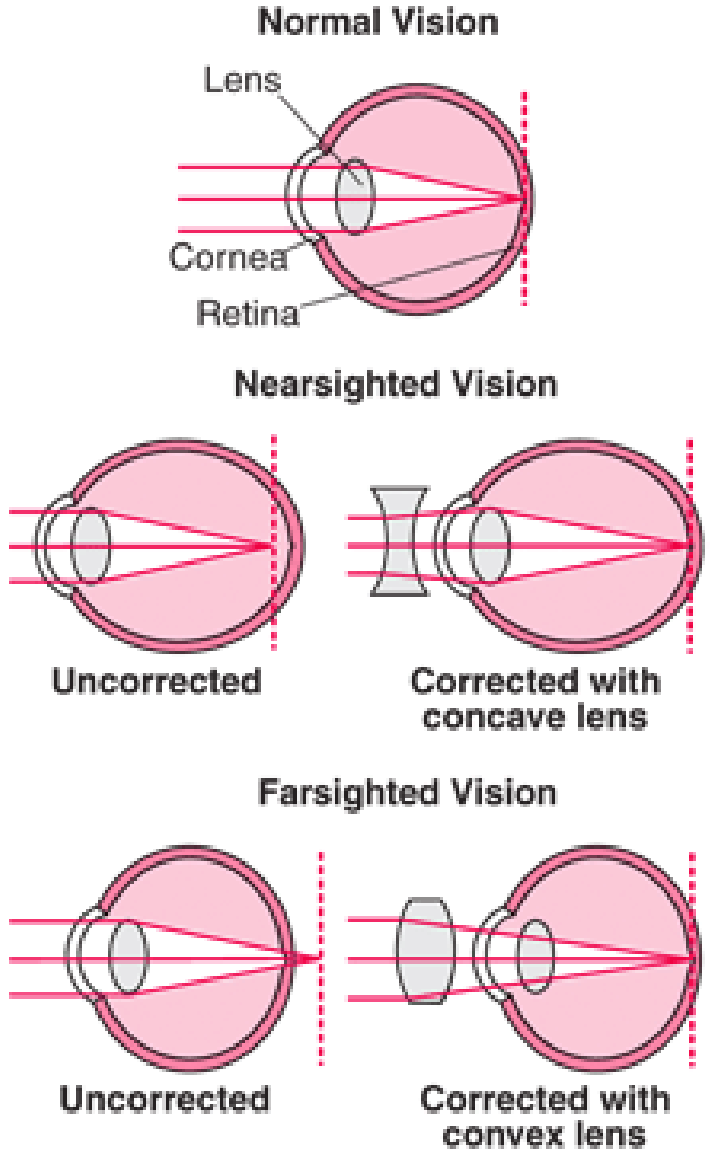
Hyperopia = far-sightedness

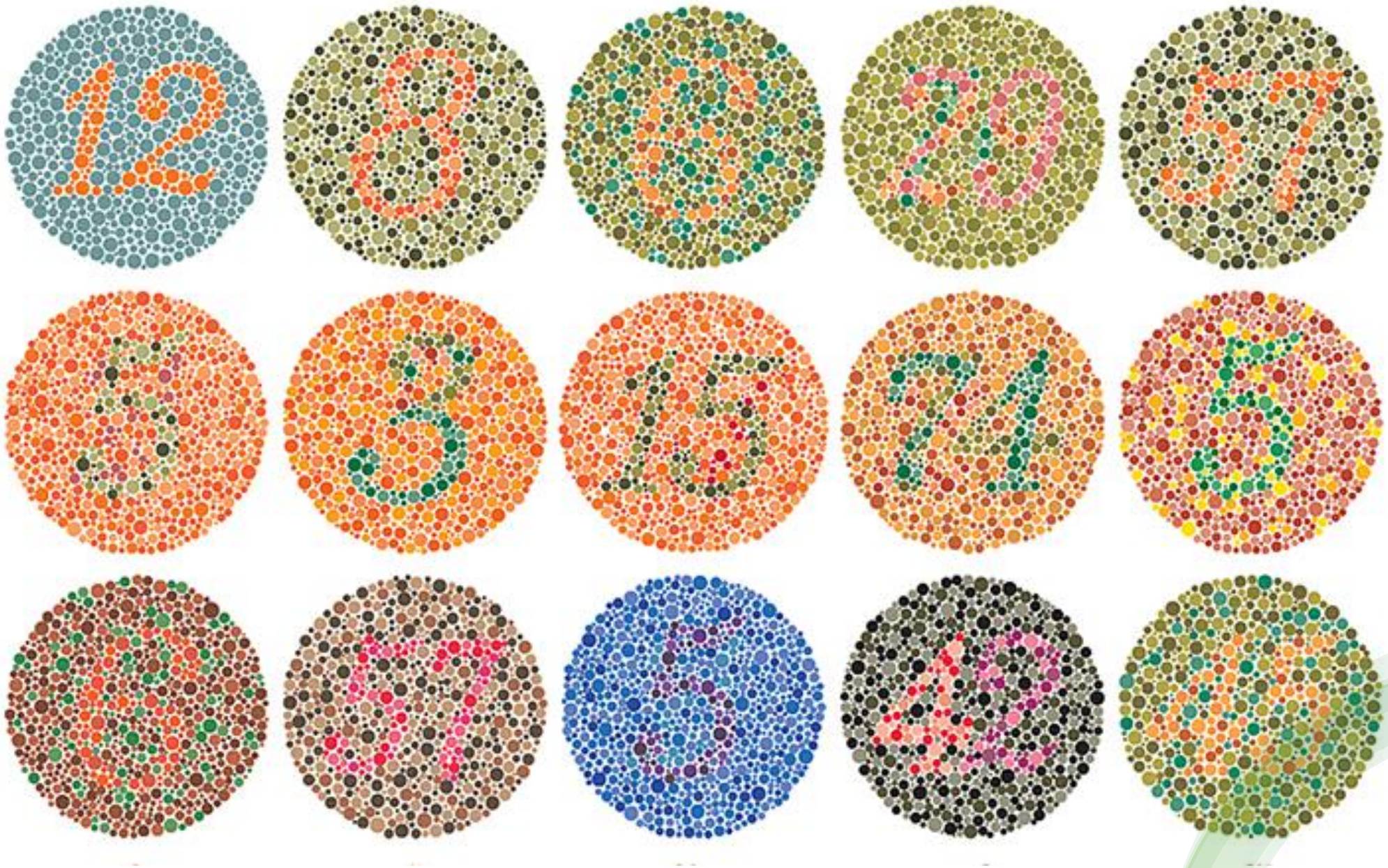
Color-blindness

Nyctalopia = night blindness

Cataract = loss of transparency of the lens

Glaucoma = an abnormally high intraocular pressure (IOP ↑)

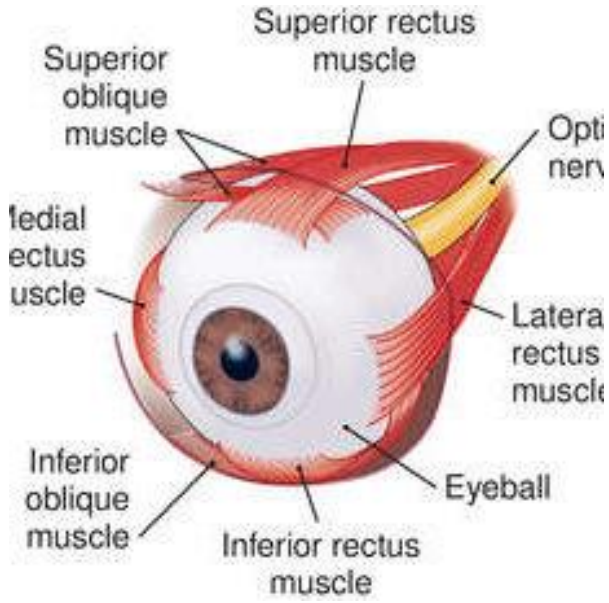




Color - blindness Test

3.4.5 Extraocular Muscles of the Eye

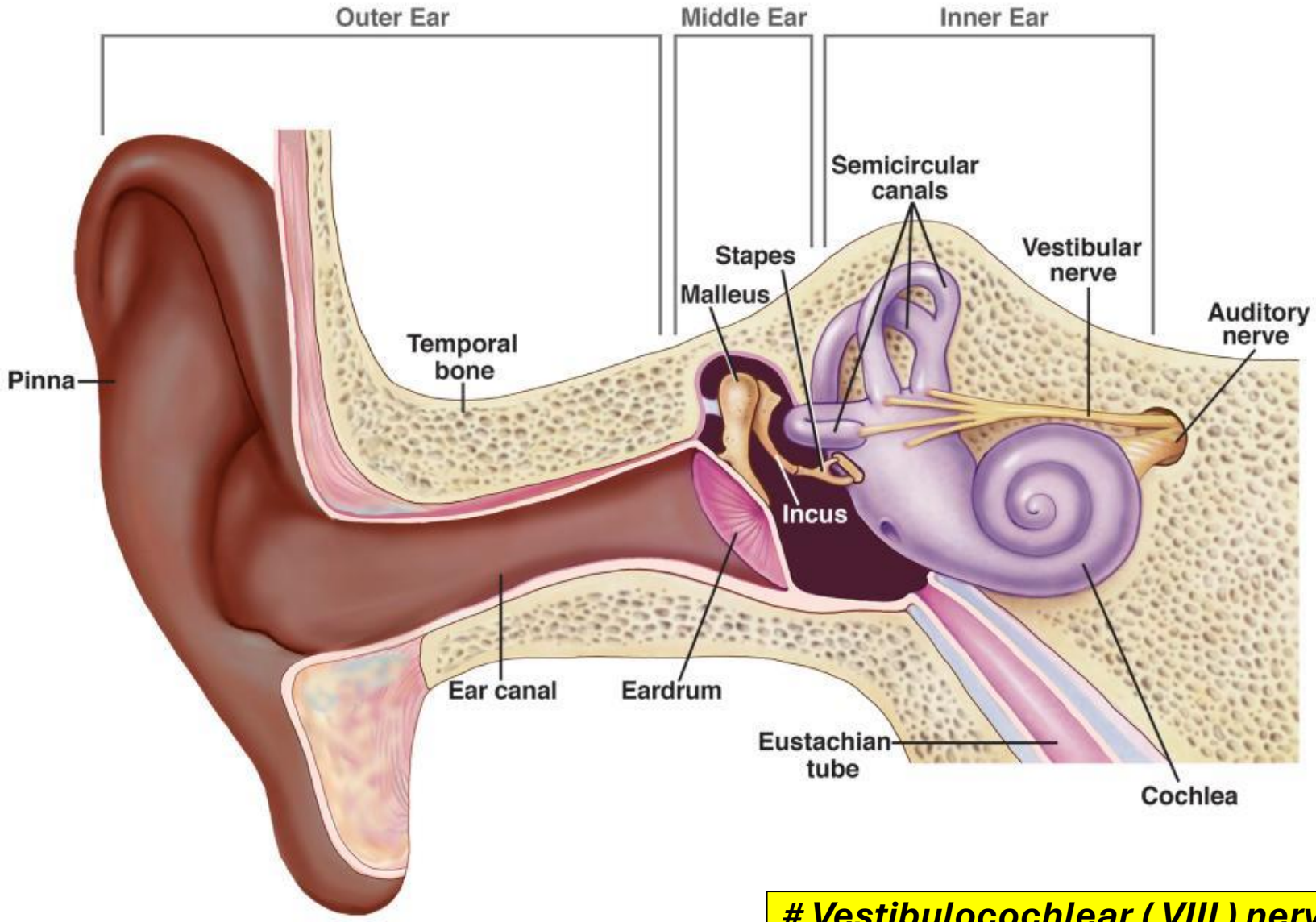
Eye Muscles	Action
Medial rectus	Rotates eyeball inwards
Lateral rectus	Rotates eyeball outwards
Superior rectus	Rotates eyeball upwards
Inferior rectus	Rotates eyeball downwards
Superior oblique	Rotates eyeball downwards and outwards
Inferior oblique	Rotates eyeball upwards and outwards



3.5 Hearing & Equilibrium

- The ear is the sense organ for both **hearing** and **equilibrium (balance)**
- Divided into **three main** sections:
- **a) Outer ear** (pinna and auditory canal)
- **b) Middle ear** (air space with 3 small bones - malleus, incus and stapes)
- **c) Inner ear** (sensory receptors for hearing and equilibrium, *divide into vestibule, semicircular canals, cochlea*)

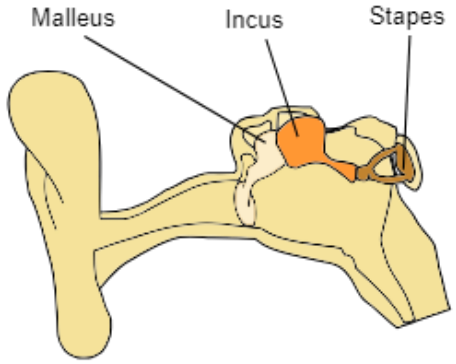
3.5.1 Structures of the Ear



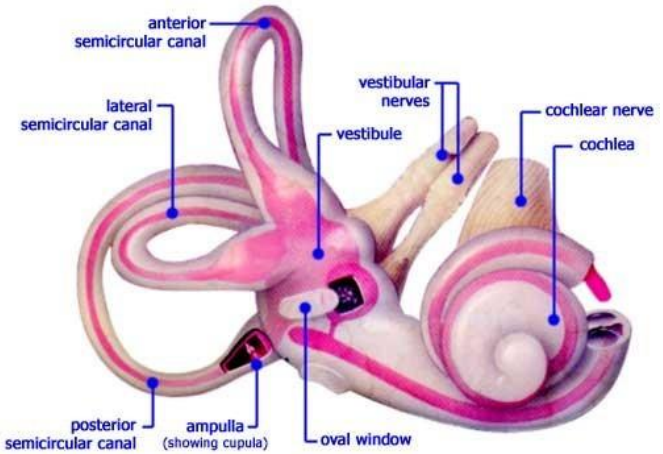
 # Vestibulocochlear (VIII) nerve

3.5.1 Structures of the Ear

Structure	Function
Auricle (Pinna)	Collect sound waves
External auditory canal (meatus)	Direct sound waves to eardrum
Eardrum (tympanic membrane)	Sound wave make it to vibrate, then malleus will vibrate
Auditory ossicles (malleus, incus and stapes)	Transmit & amplify vibrations from eardrum to oval window (transmit sounds to the inner ear)
Eustachian tube	Equalizes air pressure on both side of eardrum
Cochlea	Transmit vibrations to the spiral organ (organ of Corti)
Hair cells in organ of Corti	Produce receptor potentials (nerve impulses)



Auditory ossicles



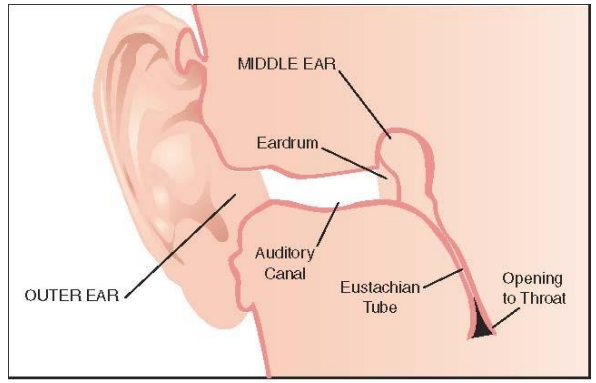
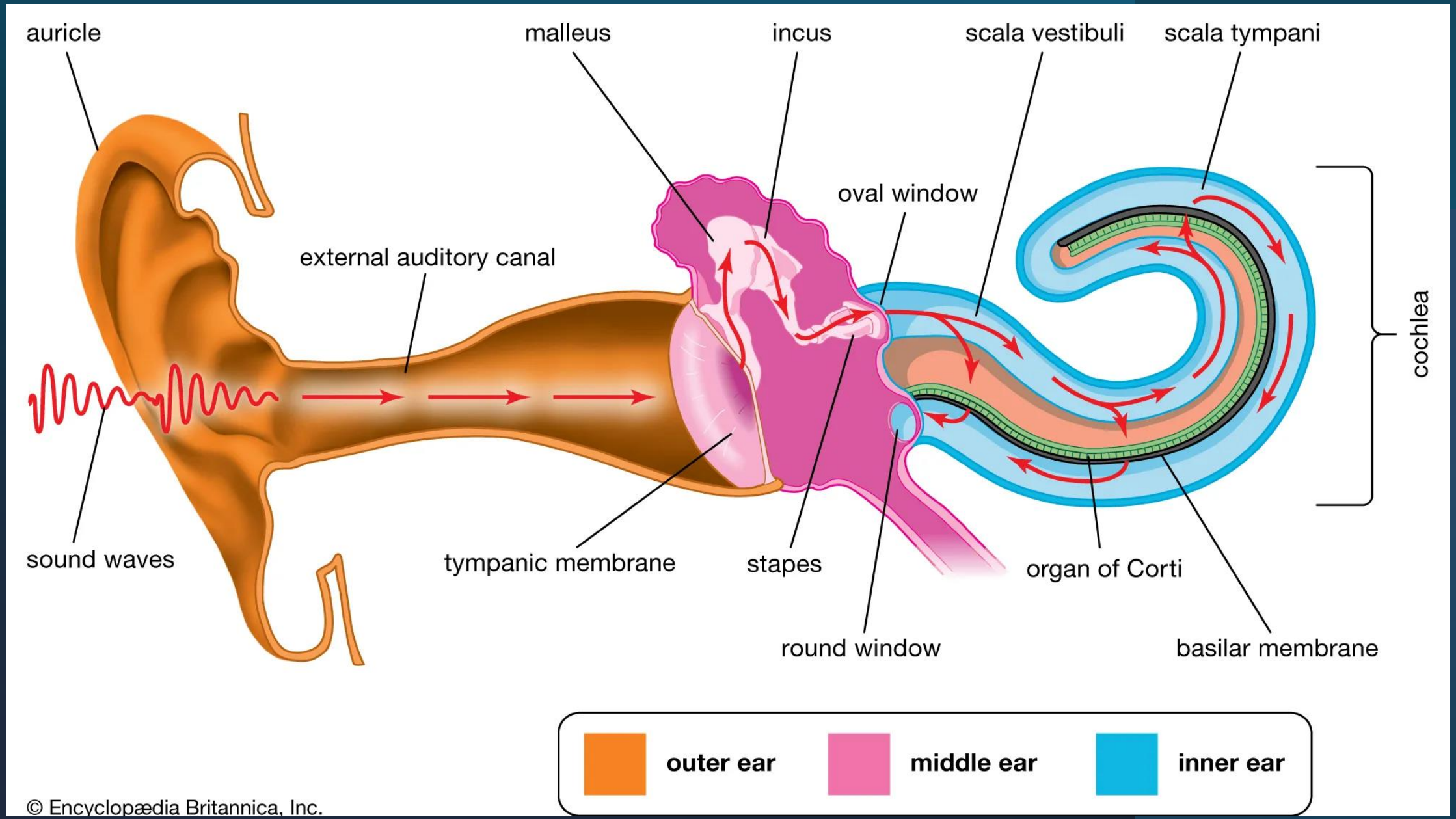


Figure 15-2. The eustachian tube allows air pressure to equalize in the middle ear.

3.5.2 Mechanism of Hearing

1. Sounds wave are directed by the **pinna** into the **auditory canal**.
2. When sound waves strike the **eardrum**, the air causes eardrum to vibrate.
3. The central area of the eardrum connects to the **malleus**, which also starts to vibrate.
4. Vibration is transmitted from the malleus to the **incus** and then to the **stapes**.
5. As the stapes moves back and forth, it pushes the **membrane of the oval window** in and out.
6. Sound wave energy is then transmitted to the fluid of the cochlea and converted by the hair cells of the **organ of Corti** into nerve impulses.
7. The nerve impulses are transmitted via the auditory nerve to the brain.


auricle
malleus
incus
scala vestibuli
scala tympani
oval window
external auditory canal
cochlea
sound waves
tympanic membrane
stapes
organ of Corti
round window
basilar membrane
outer ear
middle ear
inner ear
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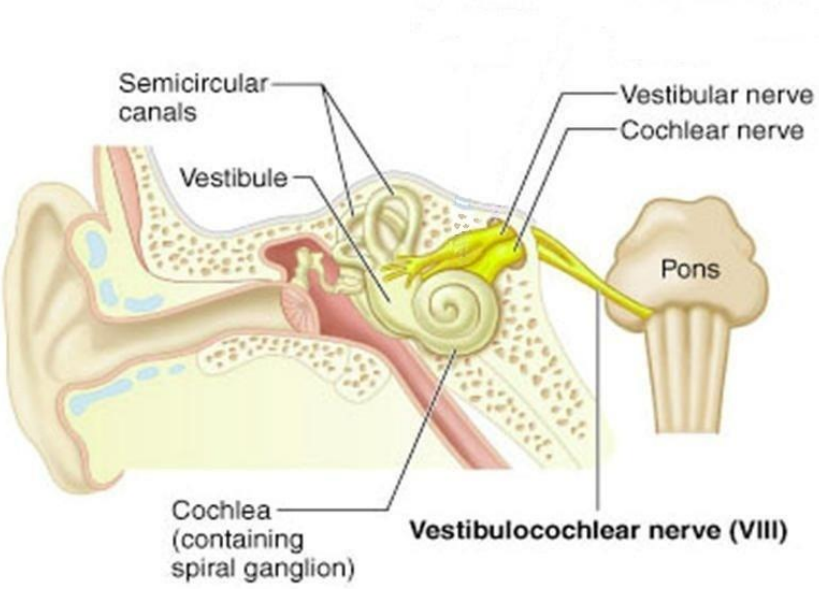
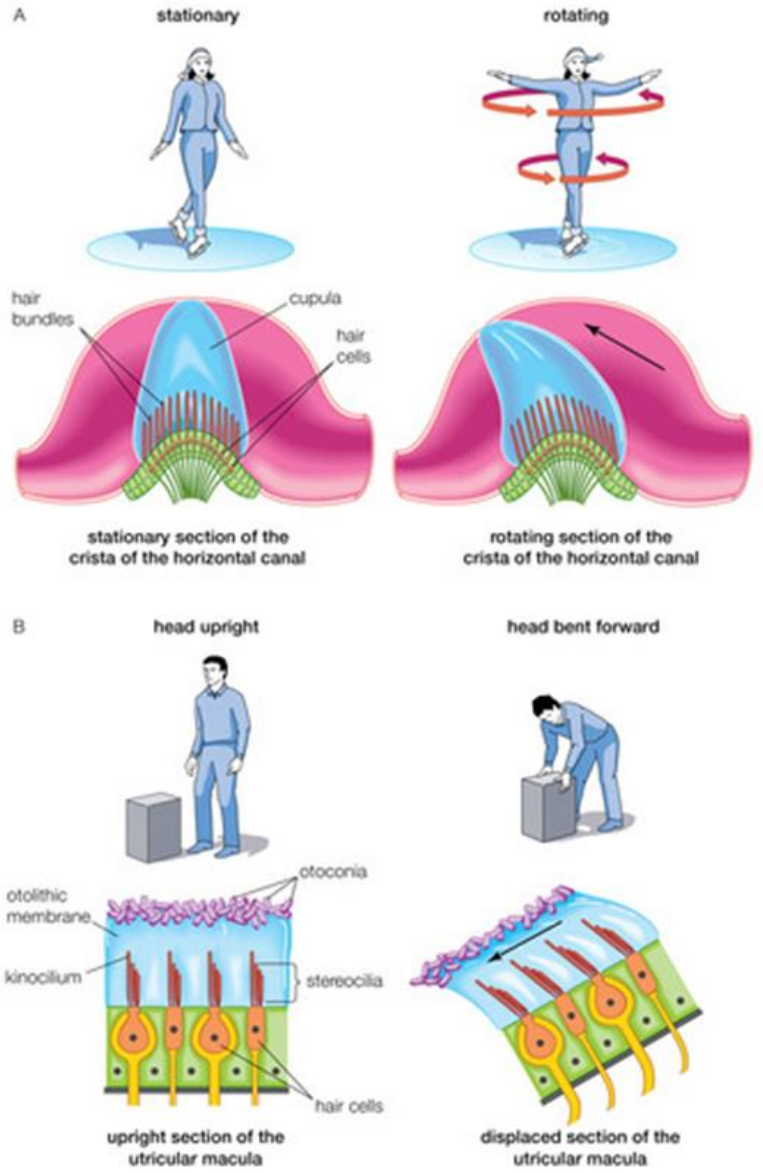
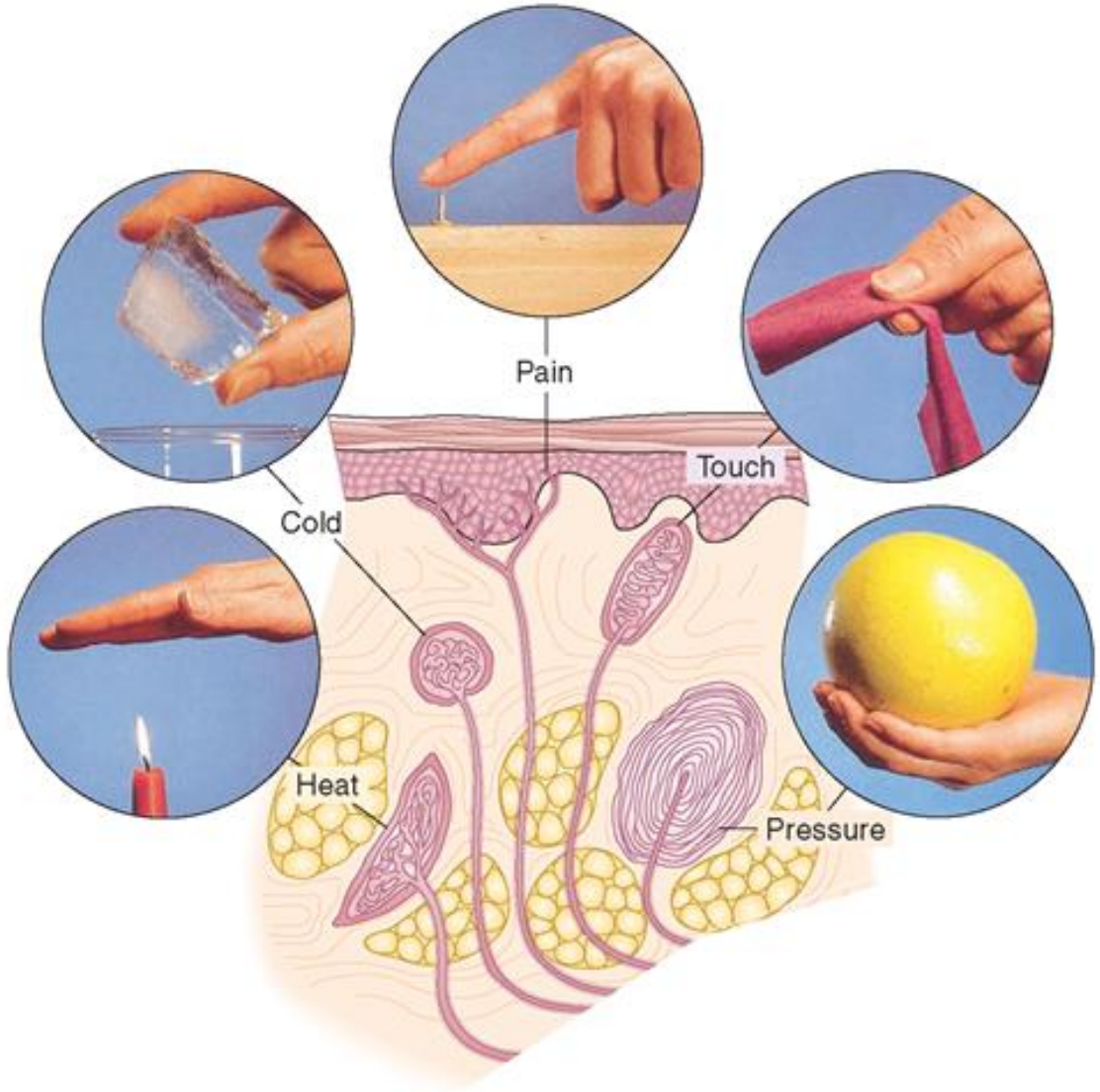
3.5.3 Physiology of Balance

- The **semicircular canals** and the **vestibule** are concerned with **balance**.
- Any **change of position of the head** causes **movement** and **stimulates the sensory receptors** in the utricle, saccule and ampullae.
- The nerve impulses are then pass to cerebellum.
- The cerebellum also receives nerve impulse from the eyes and sensory receptors of skeletal muscles and joints
- Impulses from the three are coordinated and pass to the cerebrum and to skeletal muscles.
- This results in awareness of body position, maintenance of upright position and fixing of eyes on one point, regardless of head movements

3.5.3 Physiology of Balance



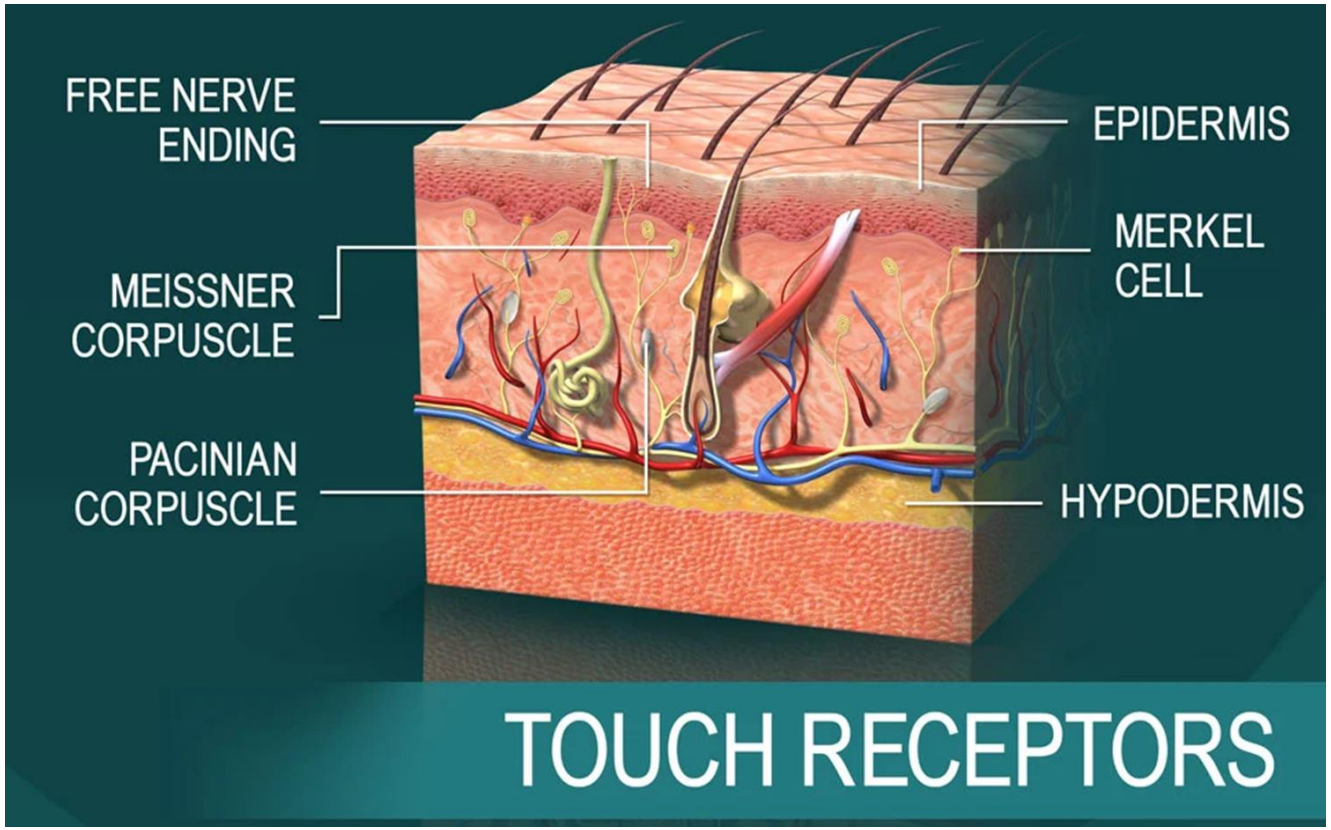




3.6 General Senses

- The general sensory receptors are scattered throughout the body.
- These includes receptors for **touch, pressure, heat, cold and pain**.

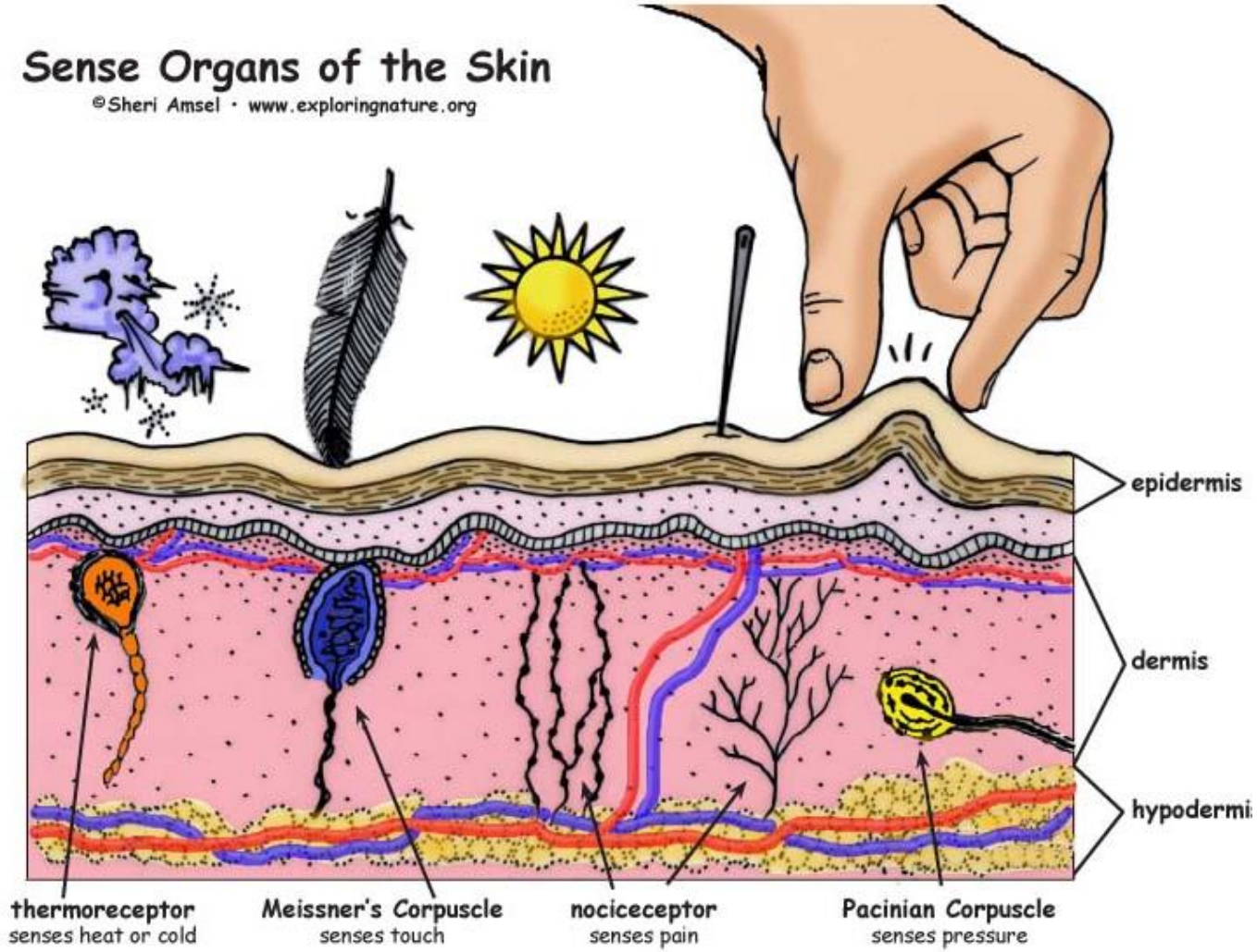
3.6.1 Sense of Touch



- Touch receptors, tactile corpuscles (Meissner's corpuscle), are found mostly in the dermis of the skin and around hair follicles.
- Numerous in the tips of the fingers and the toes

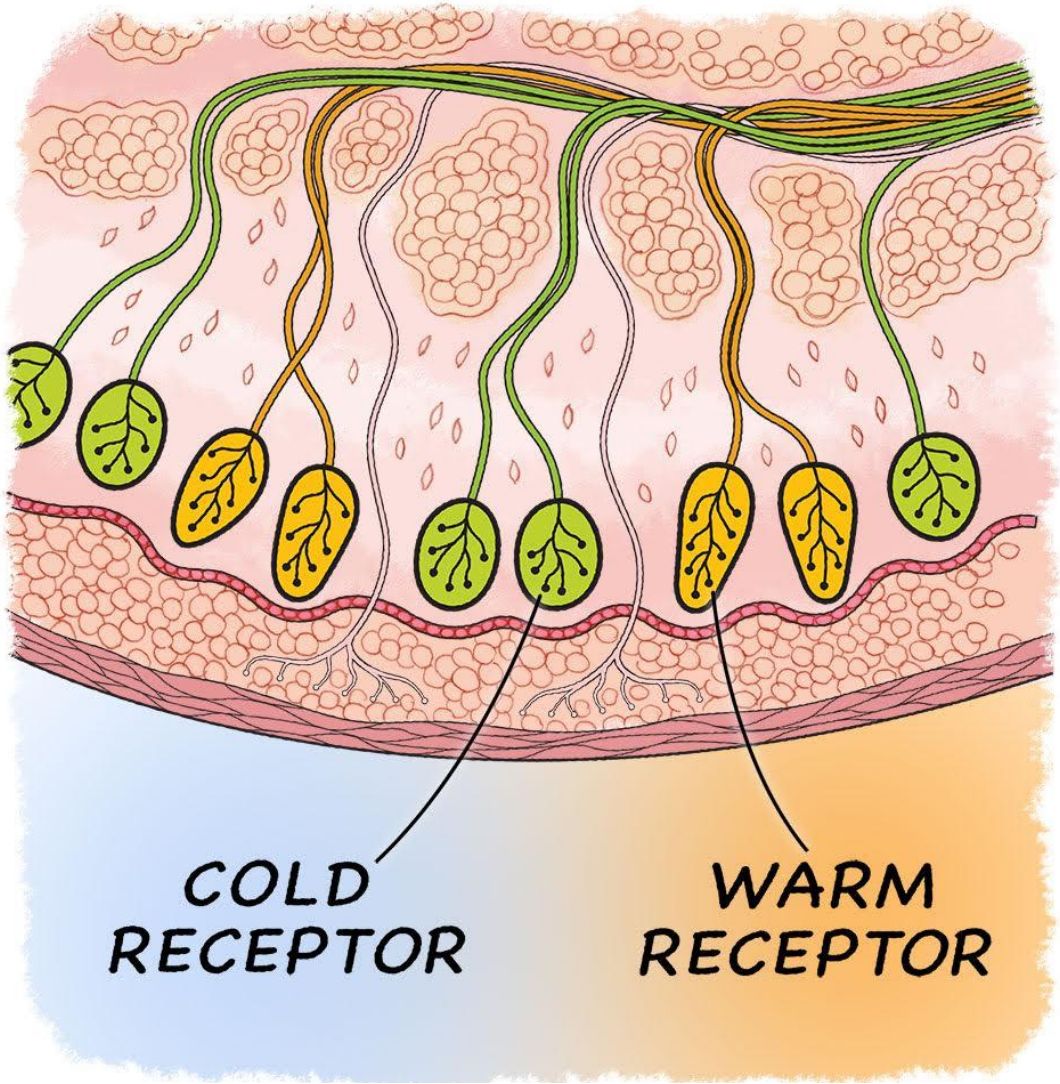
3.6.2 Sense of Pressure

- Receptors for deep pressure are in the subcutaneous tissues and near joints, muscles and other deep tissues.
- Even when the skin is anesthetized, it can still respond to pressure stimuli



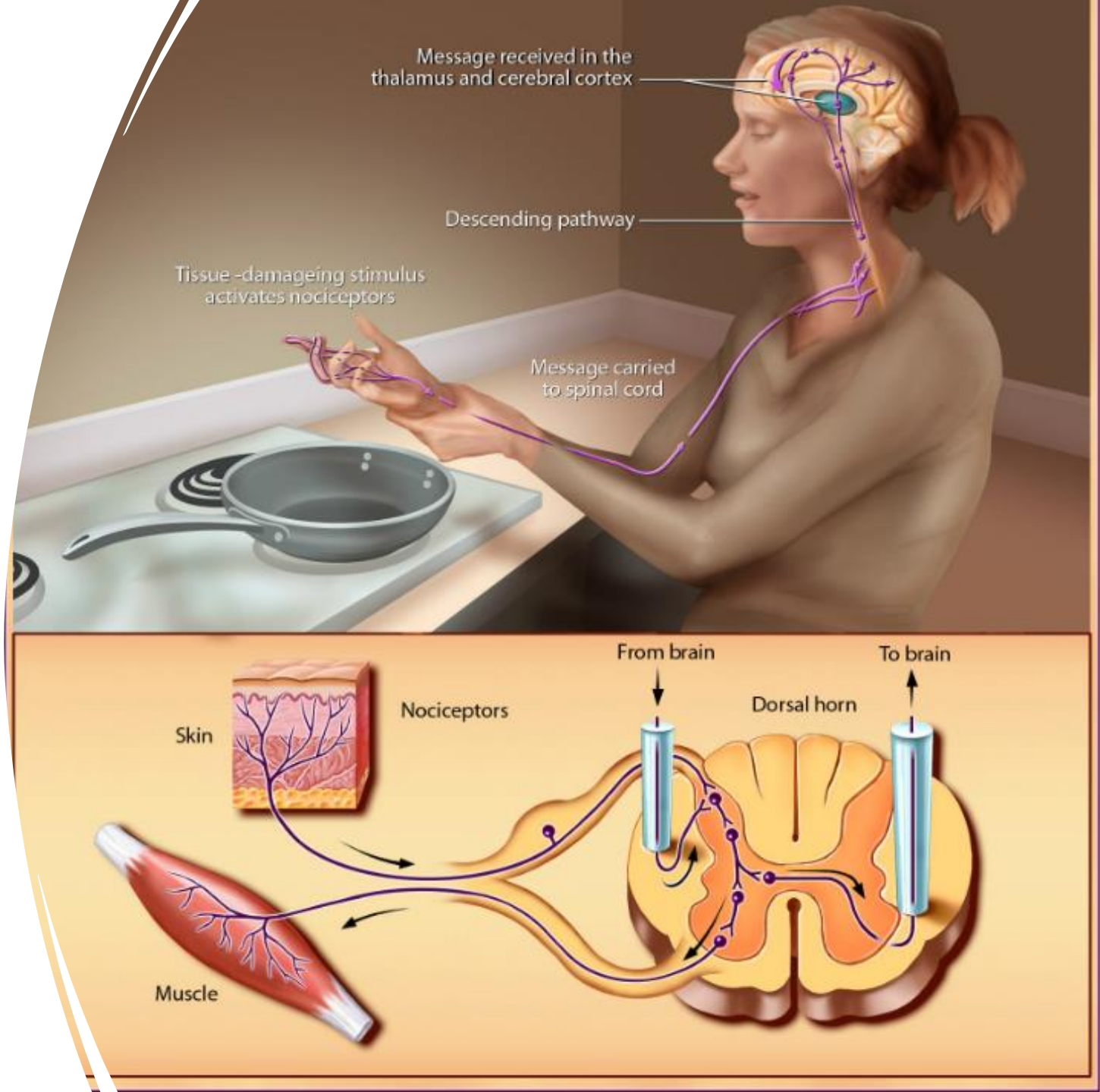
3.6.3 Sense of Temperature

- Temperature receptors are free nerve endings, widely distributed in the skin.
- There are separate receptors for heat and cold.
- Internally, there are temperature receptors in the hypothalamus of the brain, which help to adjust body temperature according to blood temperature.



3.6.4 Sense of Pain

- Pain is the most important protective sense.
- Receptors for pain are widely distributed free nerve endings
- Found in skin, muscles, joints and most internal organs.
- Two pathways transmit pain to CNS. One is for acute sharp pain and the other for slow, chronic pain



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THANK YOU