



# Somatic Sensations

# Component of Sensory System

**Centers**



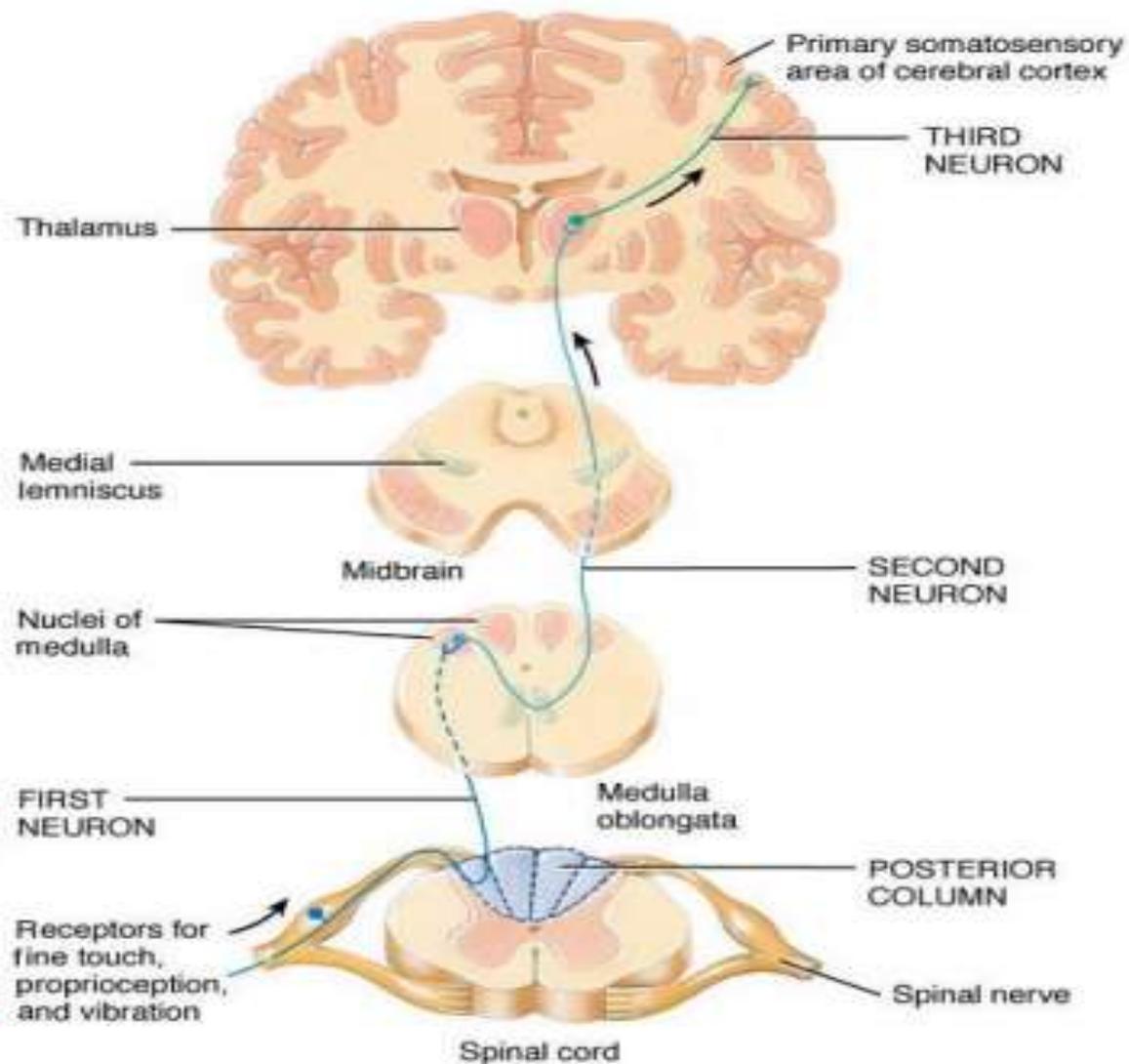
**Pathway**



**Afferents**

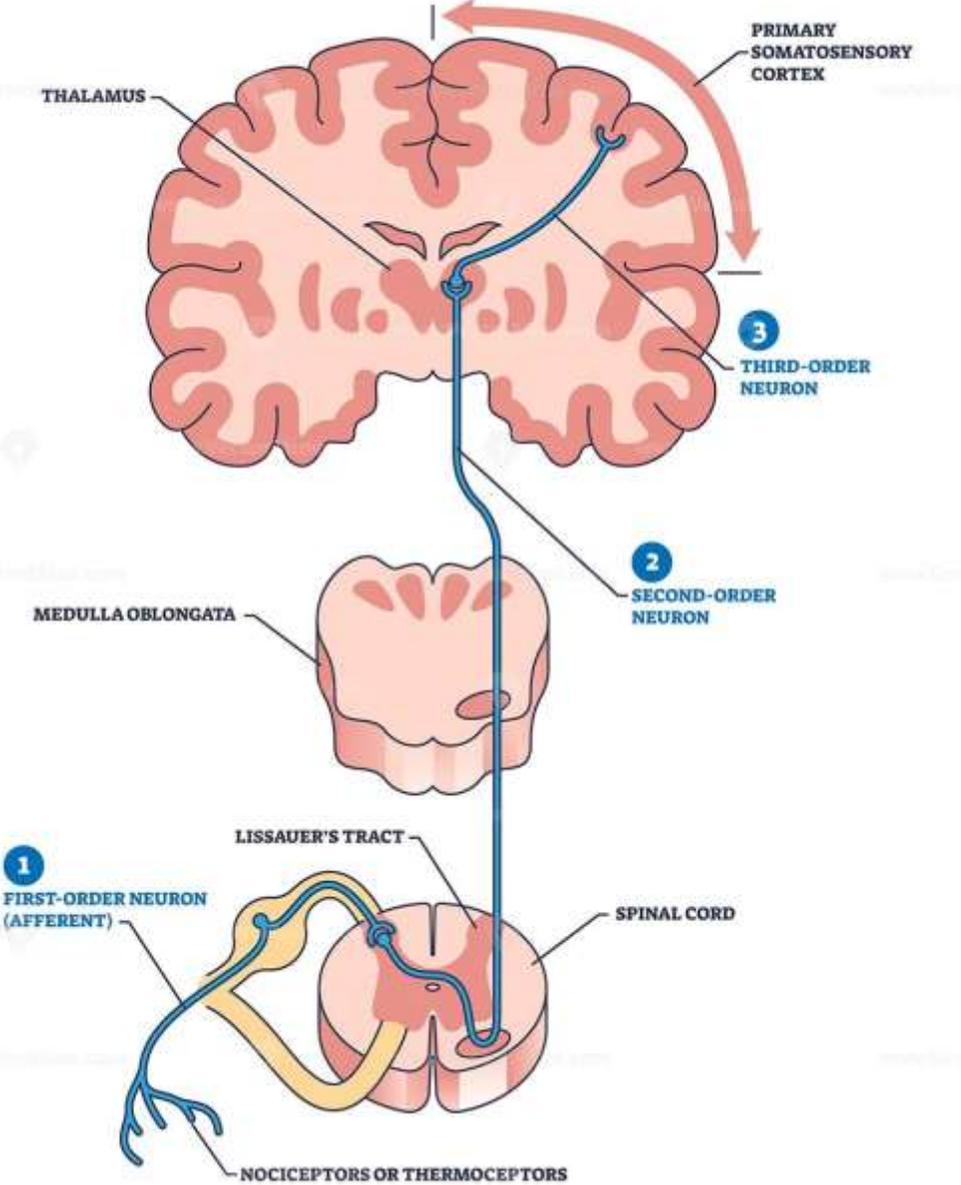


**Receptors**

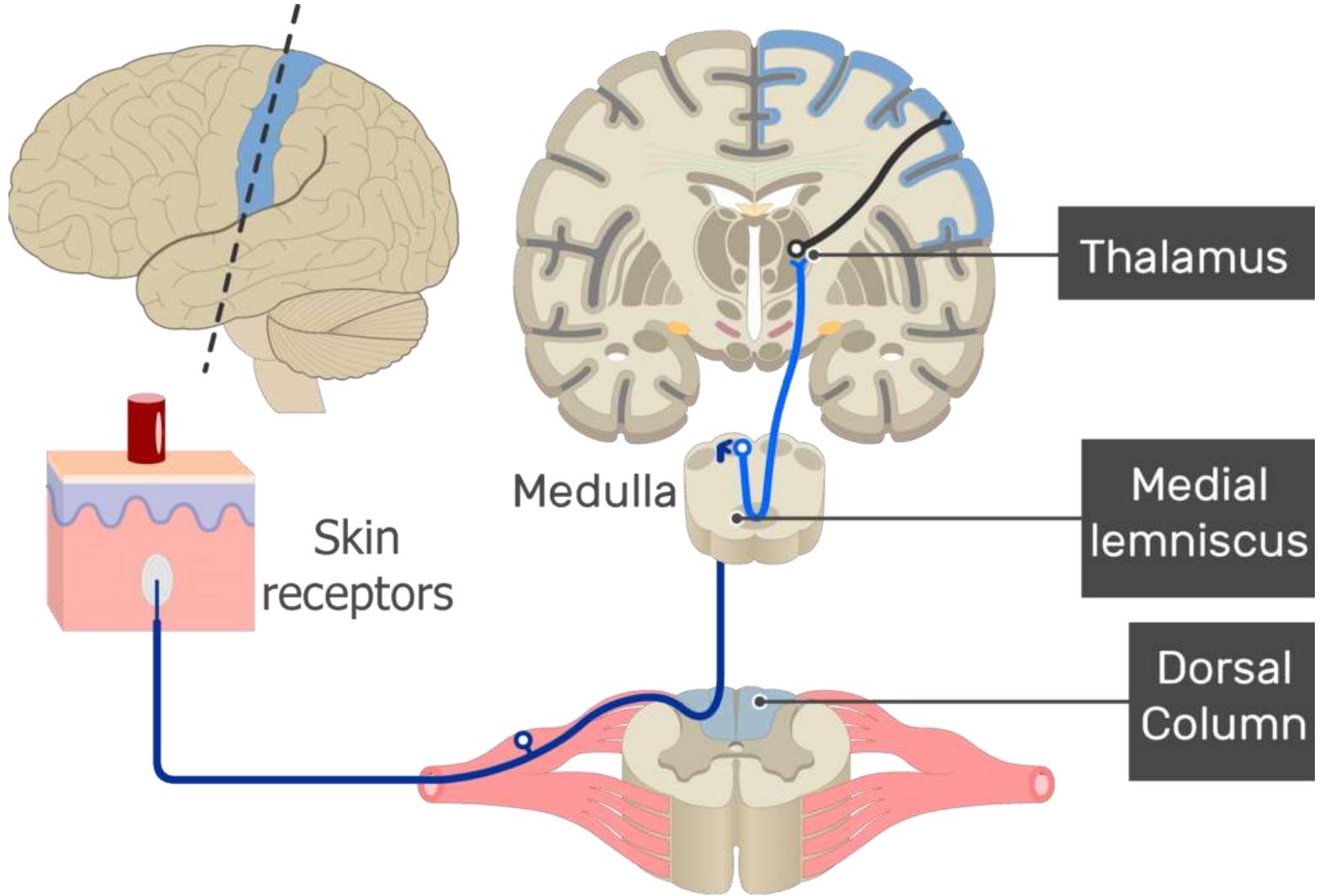


(a) Posterior column–medial lemniscus pathway

# SPINOTHALAMIC TRACT

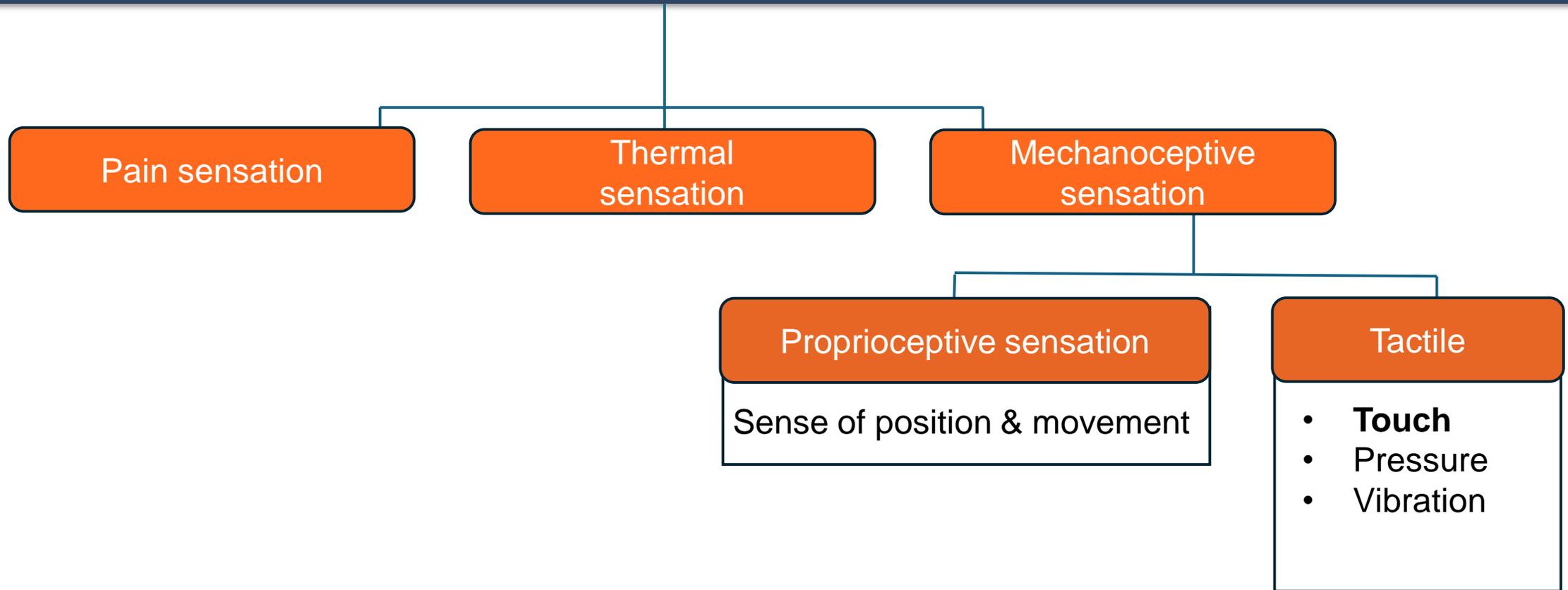


Anterolateral pathway



Dorsal column medial lemniscus pathway

# Somatic Sensations



	Fine touch	Crude touch
<b>Definition</b>	It is produced by application of <b>a well localized</b> object to the skin e.g. a tip of a pencil or a head of a pin or teeth of a comb.	It is a <b>poorly localized gross</b> touch sensation, which needs a relatively strong touch stimulus to be elicited.
<b>Receptors</b>	a. Meissner's corpuscles (rapidly adapting) b. Merkel's discs (slowly adapting)	a. Less differentiated free nerve endings b. Hair end organs
<b>Afferent</b>	<b>A-beta</b> nerve fibers	A- $\delta$ nerve fibers <b>C</b> -non myelinated nerve fibers
<b>Pathway</b>	<b>dorsal column medial leminiscal system (DCML)</b> or gracile and cuneate tracts	<b>Ventral spinothalamic tract (VST)</b>
<b>Test and types</b>	1. tactile localization (topognosis) 2. tactile discrimination (two-point discrimination) 3. Stereognosis and texture of material	Cotton Wool Test

# Fine Touch

## 1. Tactile Localization (Topognosis):

### ➤ Definition:

The ability of the person to localize exactly the point touched with eyes closed.

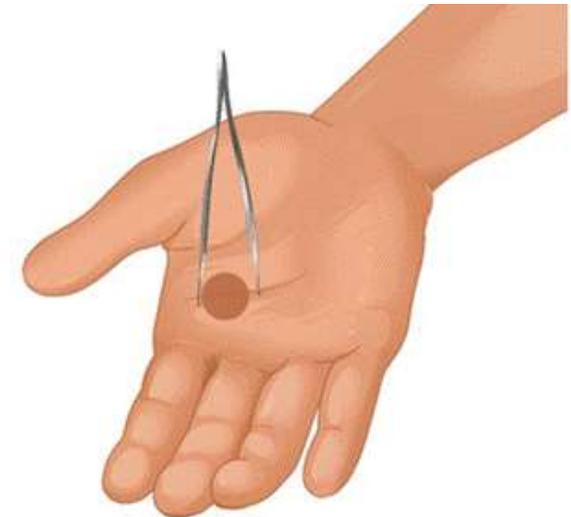


# Fine Touch

## 2. Tactile discrimination (two-point discrimination)

### ➤ Definition:

The ability of the person to perceive **two stimuli** applied **simultaneously** as **two separate points** of touch provided that both eyes are closed.



# Fine Touch

## 2. Tactile discrimination (two-point discrimination)

### ➤ Minimal Distance:

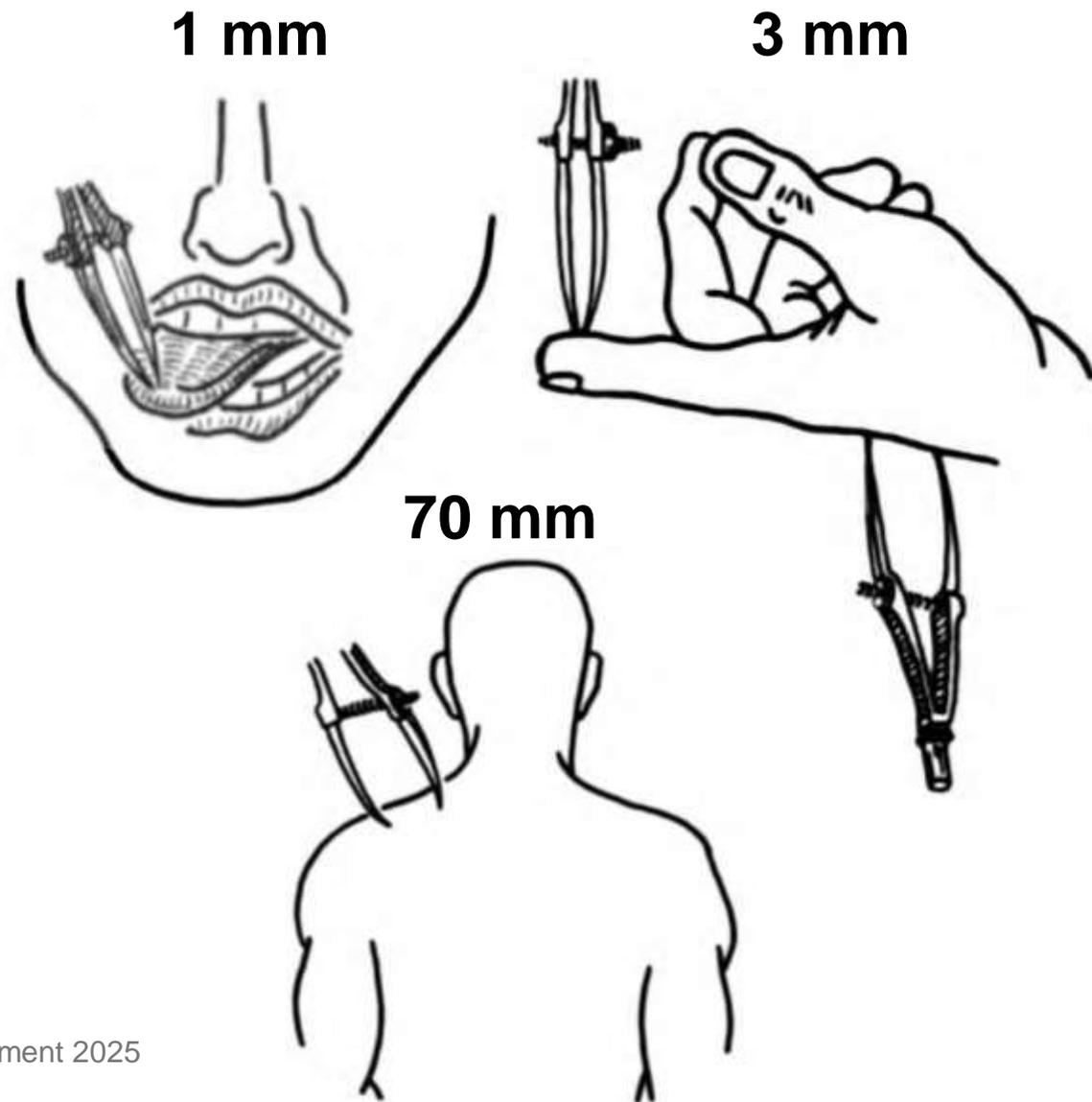
the shortest distance between 2 points to be felt as 2 separate points.

### ➤ Factors decreasing it:

1. ↑ Number of receptors
2. ↑ Number of afferents
3. ↑ size of represented cortical area
4. ↓ convergence of afferents

### ➤ Value:

- 1 mm in the tip of the **tongue**,
- 2 mm in the **lips**,
- 3 mm in the tip of **the fingers**,
- 70 mm in the **back**.



## 3. Stereognosis

### ➤ Definition:

The ability of the person with his eyes closed to **recognize an object** by touching it. e.g. recognition of a key, a pen or a coin.



# Pressure Sensation

## ➤ Definition:

a feeling produced by the application of heavy mechanical stimuli to the skin (which can cause deformation of the different skin layers).



## ➤ Receptors:

- Rapidly adapting receptors (**Pacinian** corpuscles).
- Slowly adapting receptors (**Ruffini's** nerve endings).

## ➤ Pathway:

Dorsal Column Medial Lemniscus Pathway

## ➤ Equipment:

Monofilament **OR** weights



# Vibration Sensation

## ➤ Definition:

a feeling of **rhythmic pressure changes** produced by the rapid repetitive stimulation of mechanoreceptors.

## ➤ Receptors:

- Present in the subcutaneous tissues and muscle fibers.
- Respond to different frequencies:
  - a. Meissner's corpuscles: up to **200** cycles/second.
  - b. Pacinian corpuscles: up to **700** cycles/second.

## ➤ Pathway:

Dorsal Column Medial Lemniscus Pathway  
(Gracile and Cuneate tracts)



# Vibration Sensation

## ➤ How to test:

1. Ask the patient to close his eyes
2. Apply the end of a tuning fork (**128 Hz**) to the superficial bones in any part of the body. e.g. toe tips, medial or lateral malleoli, tibial tuberosity, lower end of radius and ulna, olecranon, and clavicle
3. Check that patient reports feeling of vibration or thrill.
4. Ask the patient to identify as soon as the tuning fork stops.
5. Compare the left and right sides.



# Proprioceptive Sensation

## ➤ Definition:

a feeling of the **position and movements** of the body.

## ➤ Receptors:

Muscle proprioceptors	Joint proprioceptors
Muscle spindles	<b>Rapidly adapting Receptors</b> “Pacinian corpuscles”
Golgi tendon organs	<b>Slowly adapting Receptors</b> Ruffini corpuscles Golgi tendon organs

## ➤ Pathway:

Dorsal Column Medial Lemniscus Pathway  
(Gracile and Cuneate tracts)



# Pain Sensation

## ➤ Definition:

An unpleasant sensory and emotional experience associated with actual tissue damage.

## ➤ Significance:

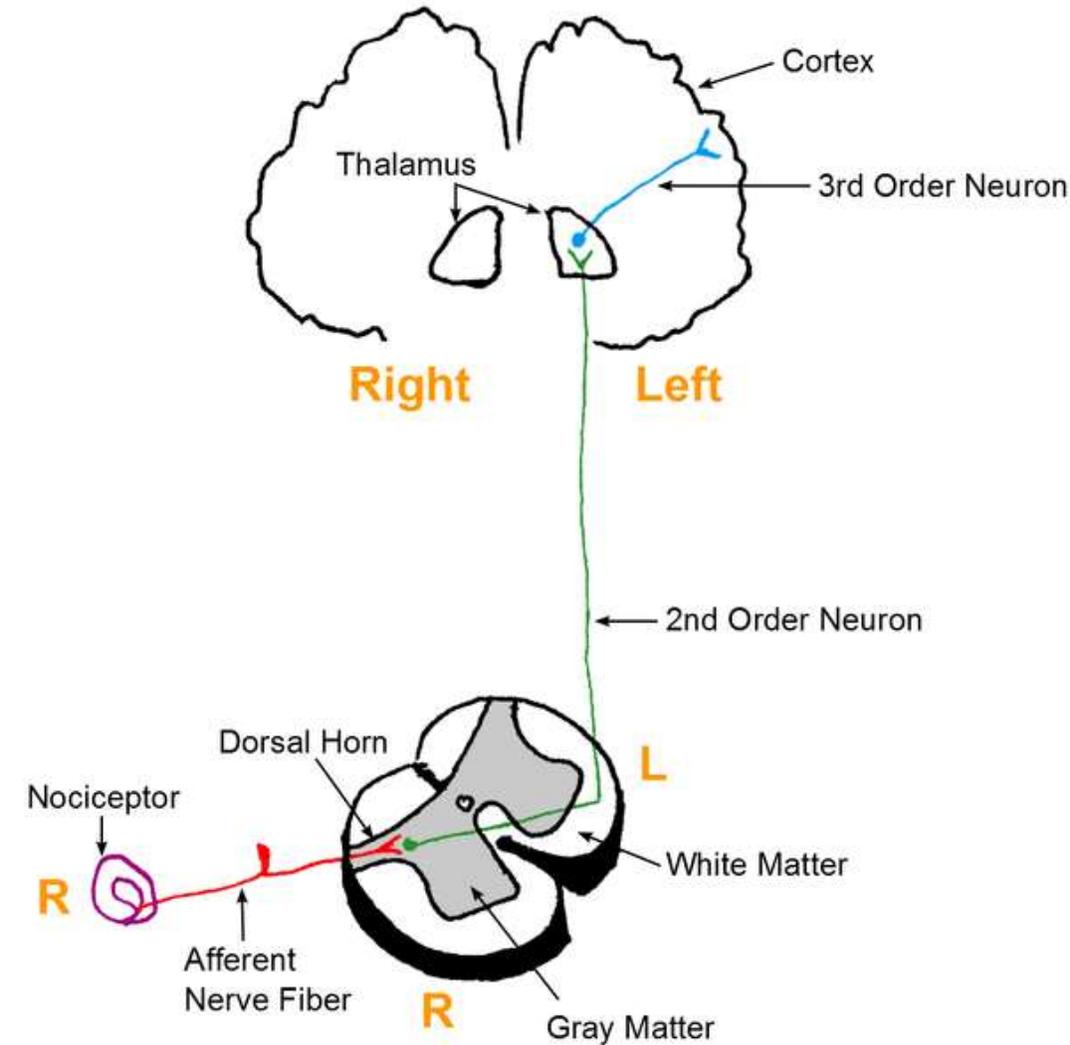
Pain is a protective mechanism for the body.

## ➤ Receptors:

free nerve endings.

## ➤ Pathway:

Lateral spinothalamic tract.



# Thermal Sensation

## ➤ Definition:

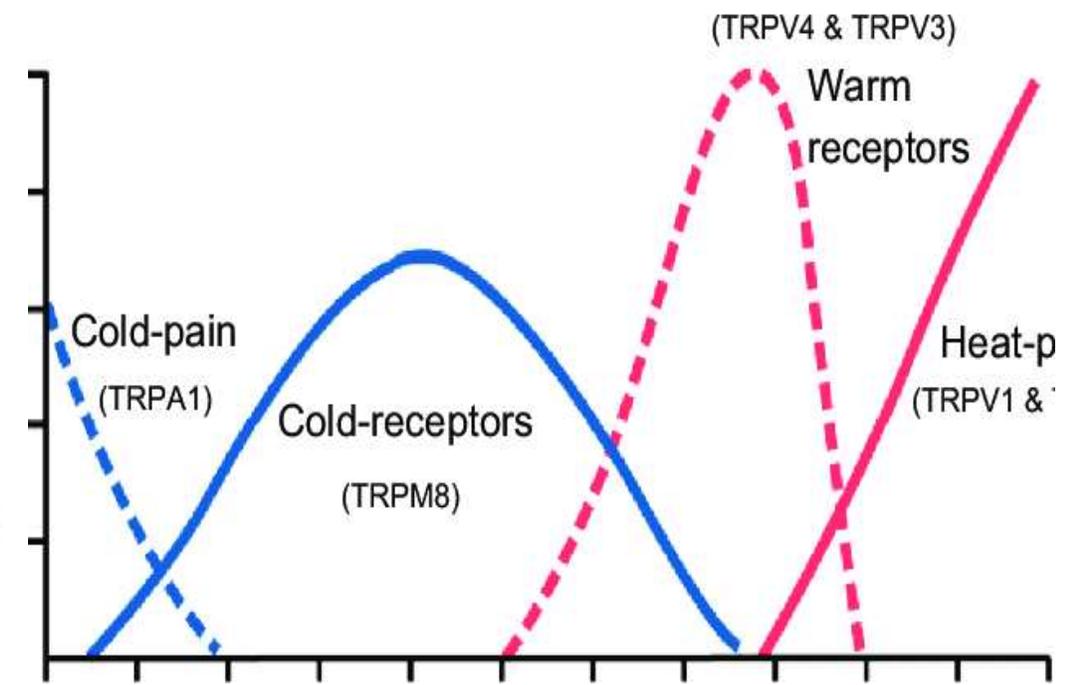
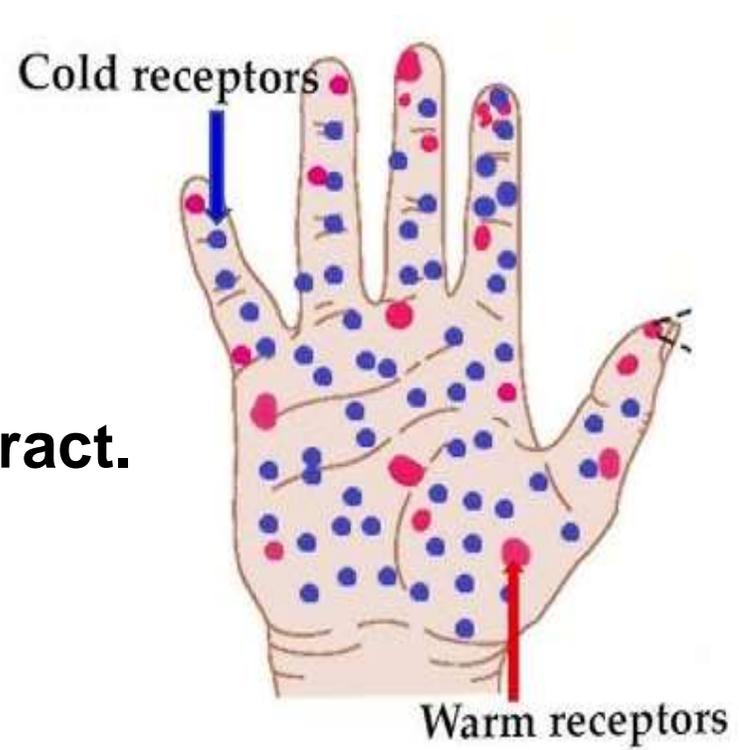
The sensation that enables us to detect temperature change.

## ➤ Receptors:

- a. Cold receptors
- b. Warm receptors

## ➤ Pathway:

Lateral spinothalamic tract.





Faculty of Medicine  
Physiology Department

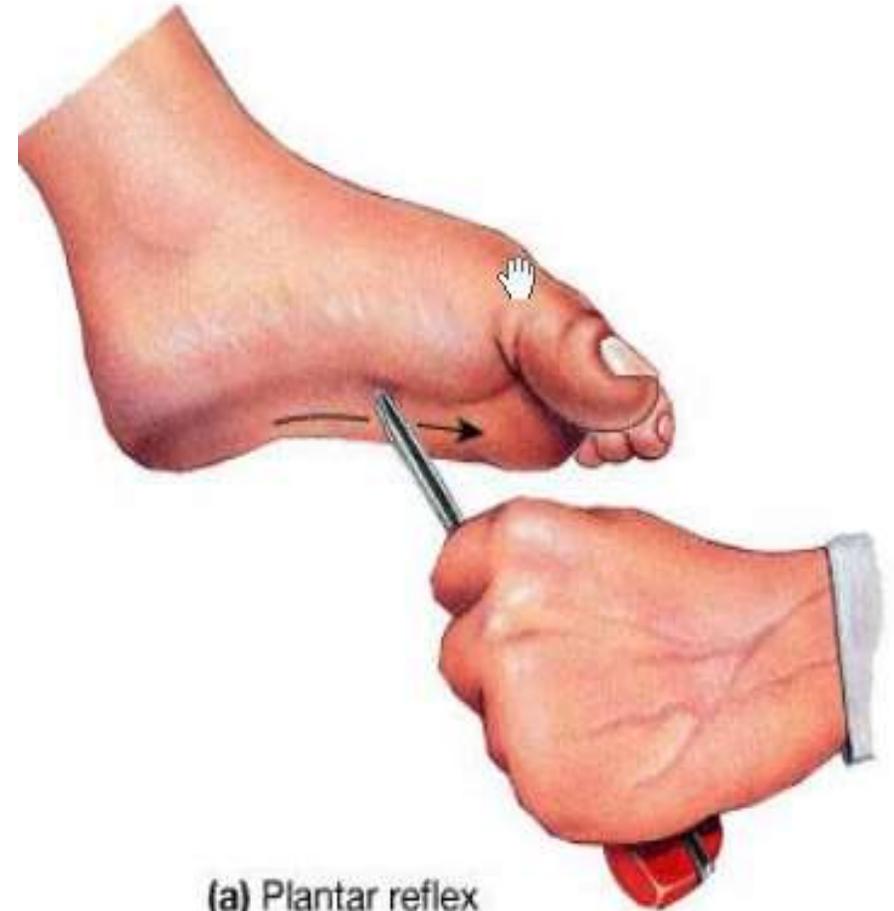
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# ***Superficial reflexes and deep reflexes***



# Plantar Reflex

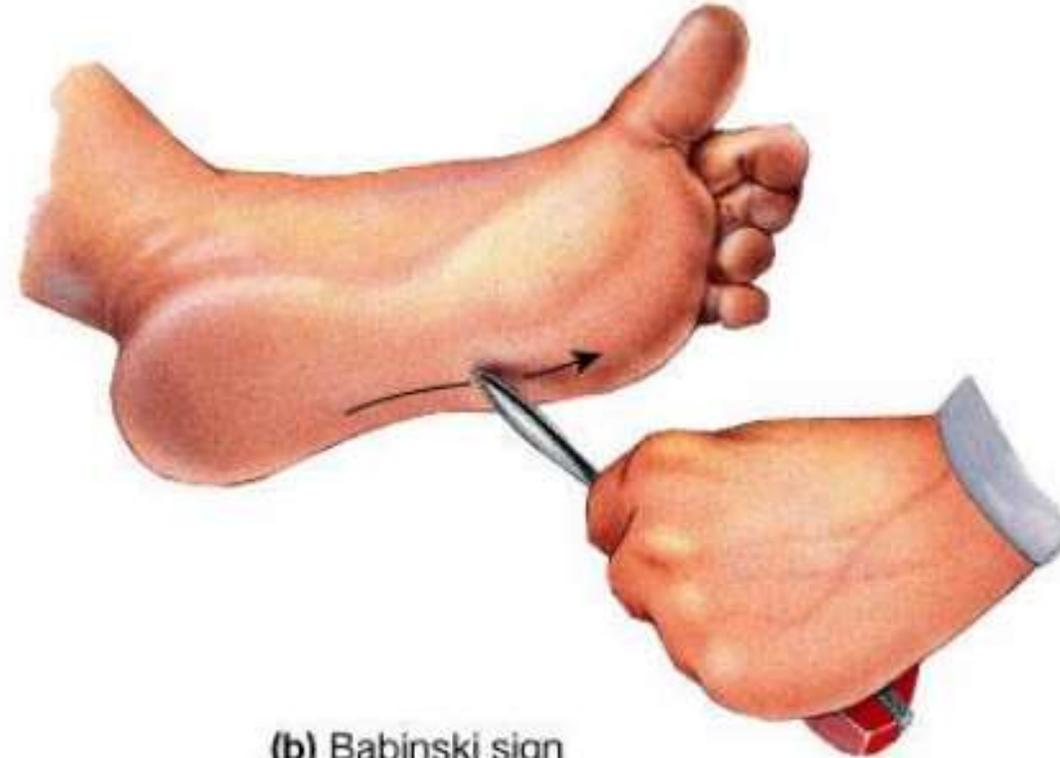
- **Definition:** Scratching the sole of the foot along its lateral margin from the heel toward the toes causes a plantar flexion of all the toes.
- **Center: S1 and S2**
- **Procedure:**
  - Raise the heel of the subject with your left hand.
  - Then scratch the outer edge of the sole of the foot with your nail or your key.
  - The big toe and the other toes show planter flexion.



(a) Plantar reflex

# Babinski sign

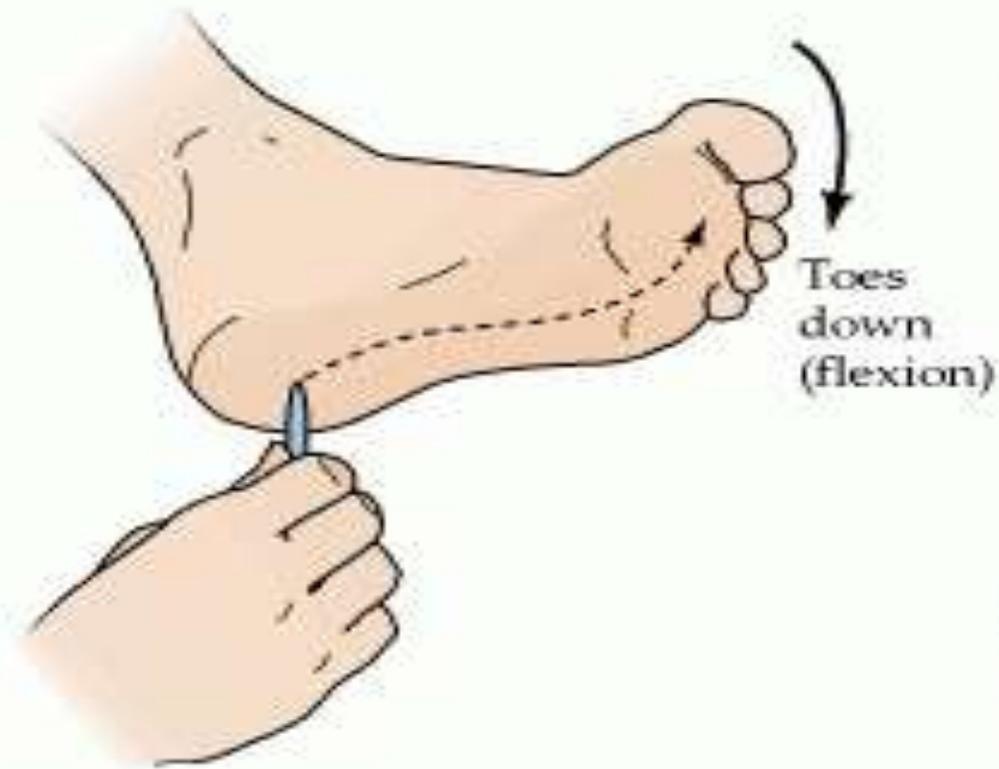
- Scratching the sole of the foot along its lateral margin from the heel toward the toes causes:
  - **Dorsiflexion of the big toe** (due to pyramidal tract lesion) and/or
  - **Separation (or fanning out)** of the other four toes (due to extrapyramidal tract lesion).



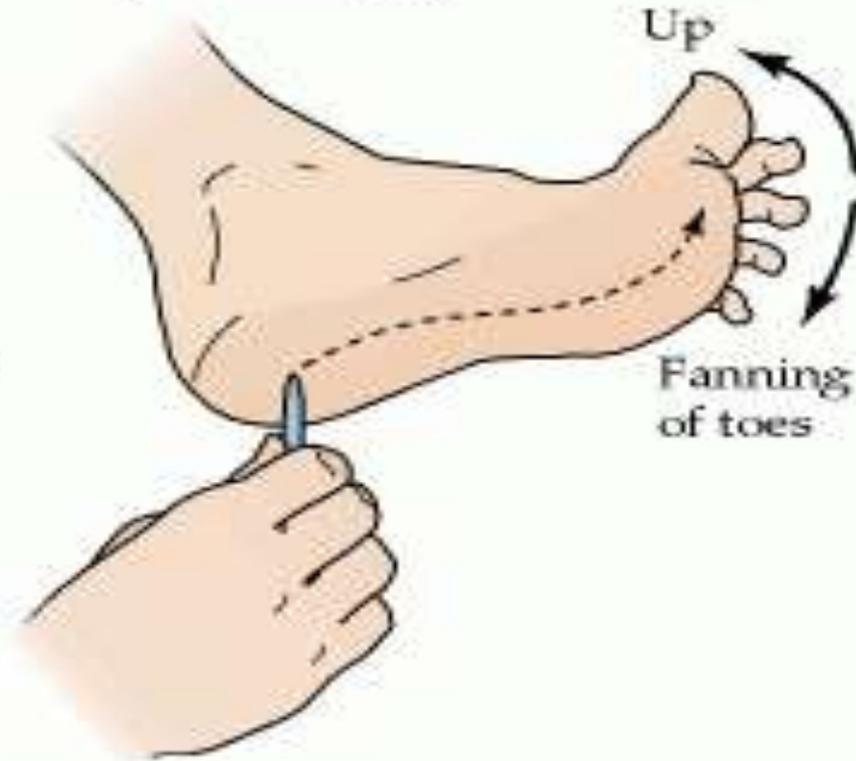
(b) Babinski sign

# Normal Plantar Response and Babinski Sign

(A) Normal plantar response



(B) Extensor plantar response (Babinski sign)



# Babinski Sign

- **Causes of Babinski sign:**

a) Physiological causes:	b) Pathological causes:
<b>Newly born infants:</b> during the 1st few months of their life due to incomplete myelination of pyramidal tract.	<b>UMNL.</b>
Normal adults: during <b>deep sleep</b> or during general <b>anesthesia</b> .	When the cerebral cortical function is depressed as in <b>coma</b>

# Babinski Sign



**In adults**



**In infants**

# Tendon Jerk

## Def:

It is a brief contraction of a skeletal MS to sudden stretch produced by tapping its tendon sharply & strongly (using a reflex hammer).

• Mechanism: It is a dynamic type of the stretch reflex.

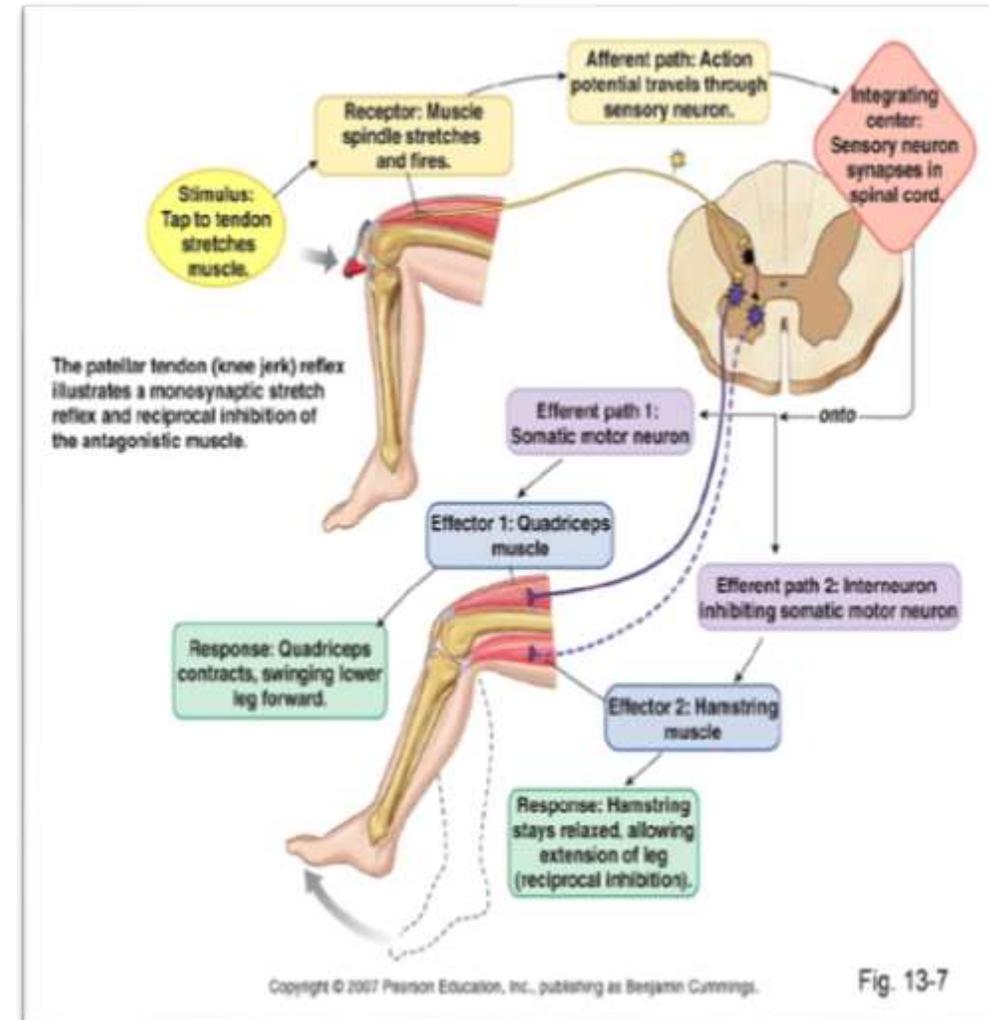
**Receptor:** Nuclear bag fibers of muscle spindle

**Afferent:** Iry endings.

**Center:**  $\alpha$ -MNs of the stretched skeletal muscle

**Efferent:** Thick myelinated type A $\alpha$  nerve fiber

**Response:** brief contraction followed by rapid relaxation.



# Examples of tendon jerks

- Knee jerk
- Ankle jerk
- Biceps jerk
- Triceps jerk
- Jaw jerk

# Medical hammer



# Examples of tendon jerks

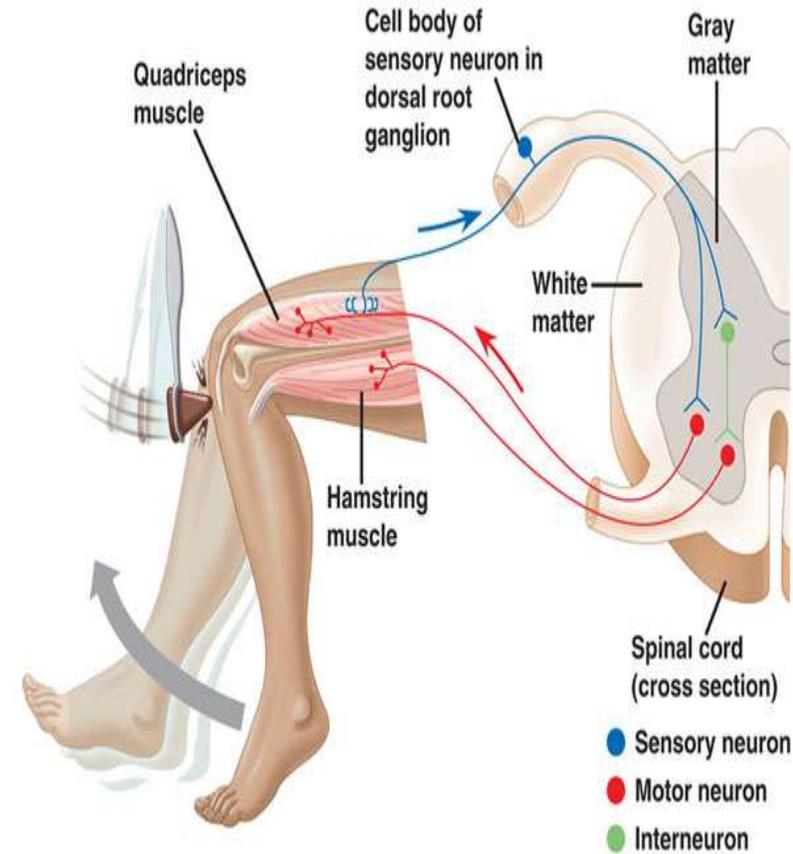
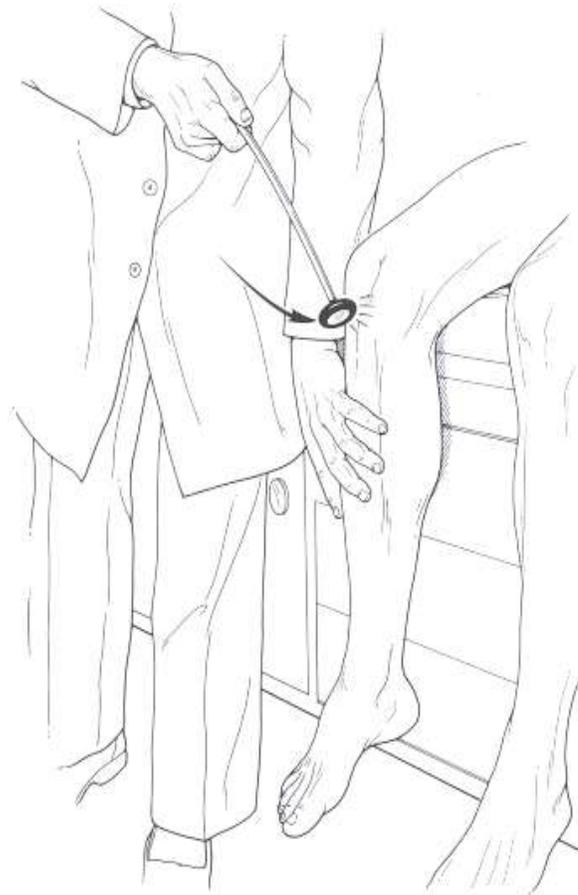
## • **Knee jerk:**

**Center:** **L-2-3-4**

**Muscle Tendon:** Tapping on patellar tendon

**Movement:** Extension of the knee

**Contraction of muscle:**  
Quadriceps femoris



# Examples of tendon jerks

## ■ **Ankle jerk:**

**Center:** S1-2

**Muscle Tendon:** Tapping on tendoachilles

**Movement:** Plantar flexion.

**Contraction of muscle:**  
Gastrocnemius and soleus



# Examples of tendon jerks

## ■ **Biceps jerk:**

**Center:** C5-6

**Muscle Tendon:** Tapping on biceps tendon.

**Movement:** Flexion of the forearm.

**Contraction of muscle:**  
Biceps muscle.



# Examples of tendon jerks

## ■ **Triceps jerk:**

**Center:** C 6-7

**Muscle Tendon:** Tapping on triceps tendon directly.

**Movement:** Extension of the forearm.

**Contraction of muscle:** Triceps muscle.



# Summary of tendon jerks

<b>Jerk</b>	<b>Center</b>	<b>Muscle Tendon</b>	<b>Movement</b>	<b>Contraction of muscle</b>
<b>Biceps jerk</b>	<b>C5,6</b>	Tapping on biceps tendon	Flexion of the forearm	<b>Biceps muscle</b>
<b>Triceps jerk</b>	<b>C6,7</b>	Tapping on triceps tendon directly	Extension of the forearm	<b>Triceps muscle</b>
<b>Knee jerk</b>	<b>L2, 3 &amp; 4</b>	Tapping on patellar tendon	Extension of the knee	<b>Quadriceps femoris</b>
<b>Ankle jerk</b>	<b>S1,2</b>	<b>Tapping on tendo-Achilles</b>	<b>Plantar flexion.</b>	<b>Gastrocnemius and soleus</b>

# Reinforcement of the tendon jerks

- The response of the tendon jerks can be **reinforced by facilitating the spinal centers.**
- This can be done by either ;
  - a. Jendrassik's maneuver** → ask the patient to hook his fingers or to clench his teeth → send signals from the contracted ms which stimulating  $\gamma$ -MNs.
  - b. Distracting patient's attention** → prevents any voluntary inhibition of the reflex.

# Clinical Significance of Tendon Jerk

- Examination of the tendon jerks is important in:
- **1. Localization of spinal cord lesions:** Loss of TJ means the lesion in its center e.g., ankle jerk is lost in sacral region lesion.
- **2. Assessment of the ms tone :**
  - In hyperreflexia (exaggerated tendon jerks)→ hypertonia ( ↑ms tone).
  - In hyporeflexia (↓ed tendon jerks)→ hypotonia (↓ms tone).
  - In areflexia (lost tendon jerks)→ atonia ( lost ms tone).

# Clinical Significance of Tendon Jerk

- **3. Assessment of the integrity of pathway of stretch reflex:**
- Lost TJ means lesion in its arc, as follow:

Site of lesion	Condition
Afferent lesion	Tabes dorsalis
Center (AHC) lesion	Poliomyelitis
Efferent lesion	Trauma or neuritis

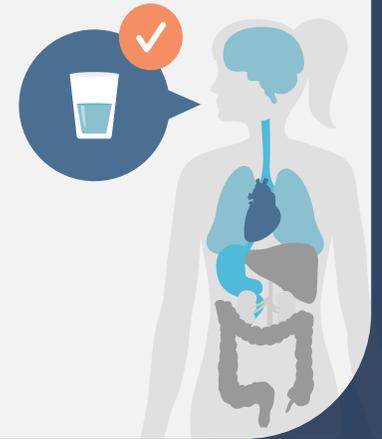
# Clinical Significance of Tendon Jerk

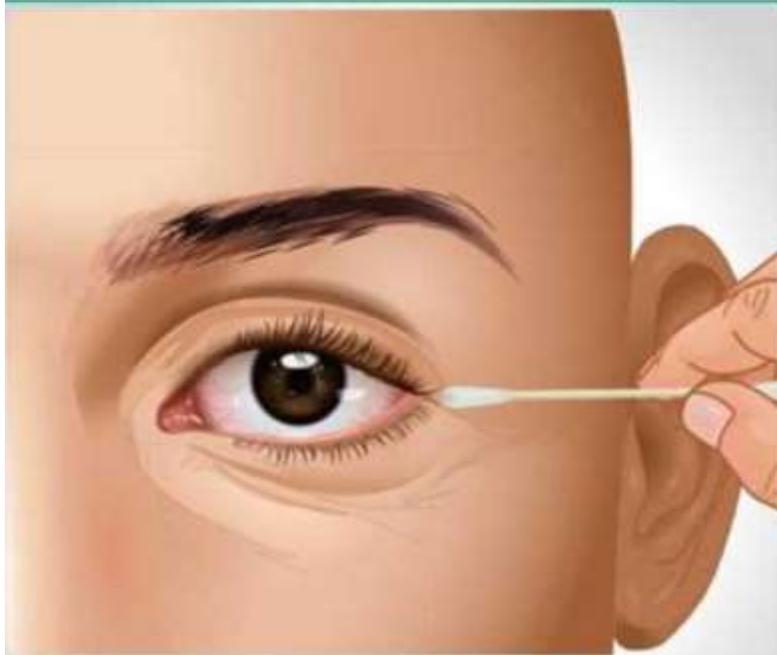
## • 4. Assessment of the state of Supraspinal centers:

	<b>Hyperactive(exaggerated) TJ</b>	<b>Hypoactive (decreased) TJ</b>
<b>Physiological causes</b>	Anxiety and nervousness	Sleep and anesthesia
<b>Pathological causes</b>	-UMNL -Lesion in area 6 -tetany and hyperthyroidism -lesion of paleocerebellum	-LMNL -Lesion in area 4 -hypothyroidism -neocerebellar syndrome



# Visual reflexes





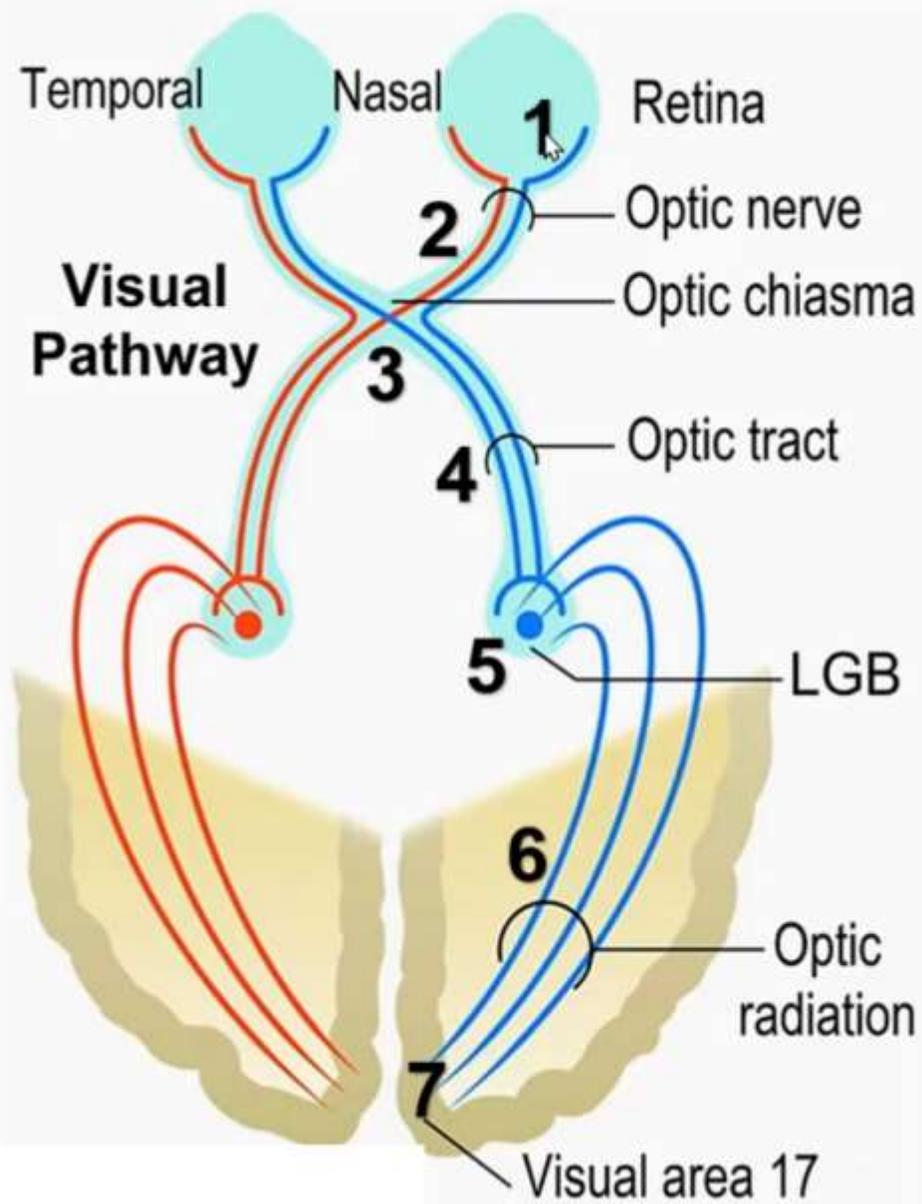
***Corneal  
Reflex***



***Pupillary Light  
reflex***



***Accommodation  
reflex***



**Retina:** rods & cones → rods & cone cells → synapse with bipolar cells → with ganglion cells

**Optic nerve:** formed of axons of ganglion cells

**Optic chiasma:** T fibers enter the ipsilateral optic tract. The *Nasal fibers cross* to enter the opposite optic tract

**Optic tract:** contains temporal fibers of the same side and nasal fibers of the opposite side

**LGB:** axons form optic radiation

**Optic radiation:** has 2 parts; pass through the retrolenticular part of the internal capsule

**Primary visual area 17:** in the upper and lower lips of the calcarine sulcus → **area 18 & 19**

# Corneal Reflex

- **Definition :**

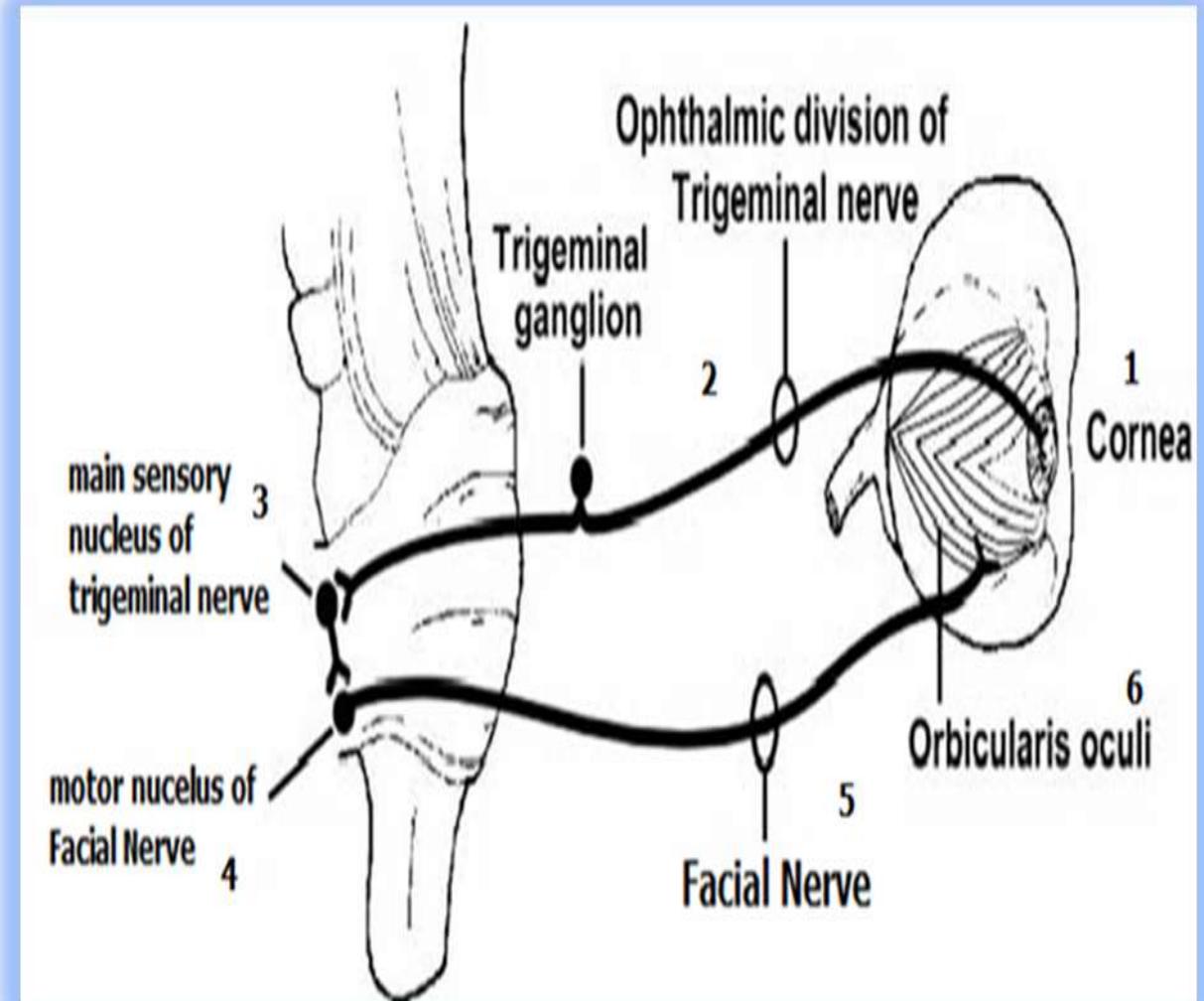
It is **reflex closure of both eyes** on touching the cornea of one eye with any foreign body. e.g., piece of cotton results in reflex blinking of both eyes.



# Corneal Reflex

## • Pathway :

<b>Receptors</b>	Touch receptors.
<b>Afferent</b>	Ophthalmic division of trigeminal nerve which relay in sensory nucleus of trigeminal nerve.
<b>Center</b>	Main facial nucleus in the pons.
<b>Efferent</b>	Facial nerve.
<b>Effector</b>	Orbicularis oculi muscle.
<b>Response</b>	Closure of the eyelids.



# Corneal Reflex

## • Significance :

### *Physiological:*

- 1) It is **protective** that protect cornea from foreign bodies.
- 2) **Loss** of corneal reflex leads to corneal **ulceration**.

### *Medical or*

- 1) It is used to detect the **pathway integrity**.
- 2) Test for functions of trigeminal and facial nerves.

# Pupillary Light Reflex

- **Definition :**

Exposure of one eye to light leads to:

- **Direct light reflex:**

- Reflex constriction of that eye.

- **Indirect or consensual light reflex:**

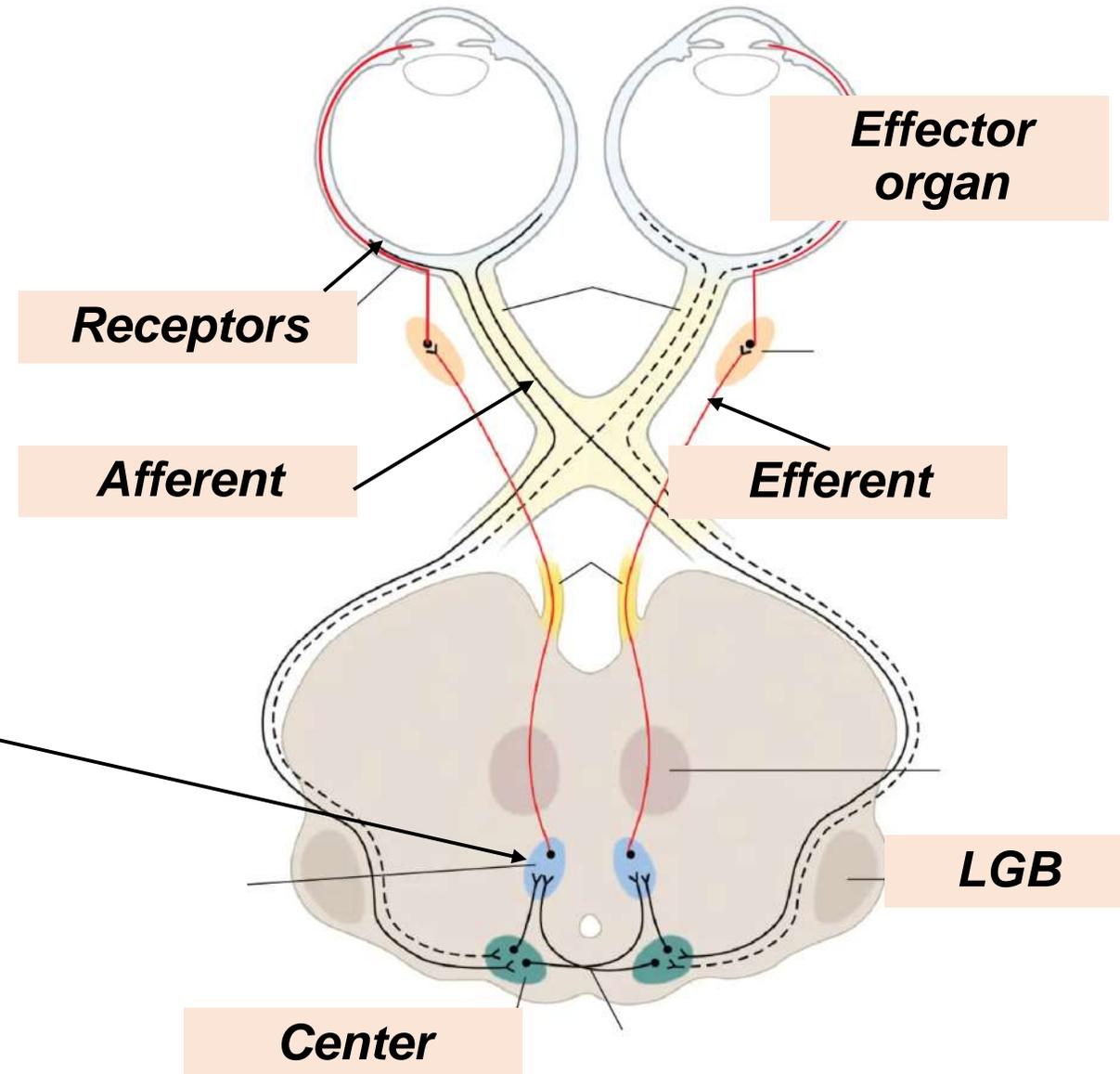
- Reflex constriction of the other eye.



# Pupillary Light Reflex

## • Pathway :

Stimulus:	Light
Receptors:	Visual receptors
Afferent:	Optic pathway before it reaches <b>LGB</b> .
Center:	<b>Pretectal nucleus</b> of the same side
Efferent:	<b>Tectonuclear tract</b> to Edinger Westphal nuclei of the oculomotor nerve on <b>both sides</b> .
Effector organ:	<b>Sphincter pupillae</b> muscles of both eyes
Response:	Constriction ( <b>miosis</b> ) of pupils of both sides.

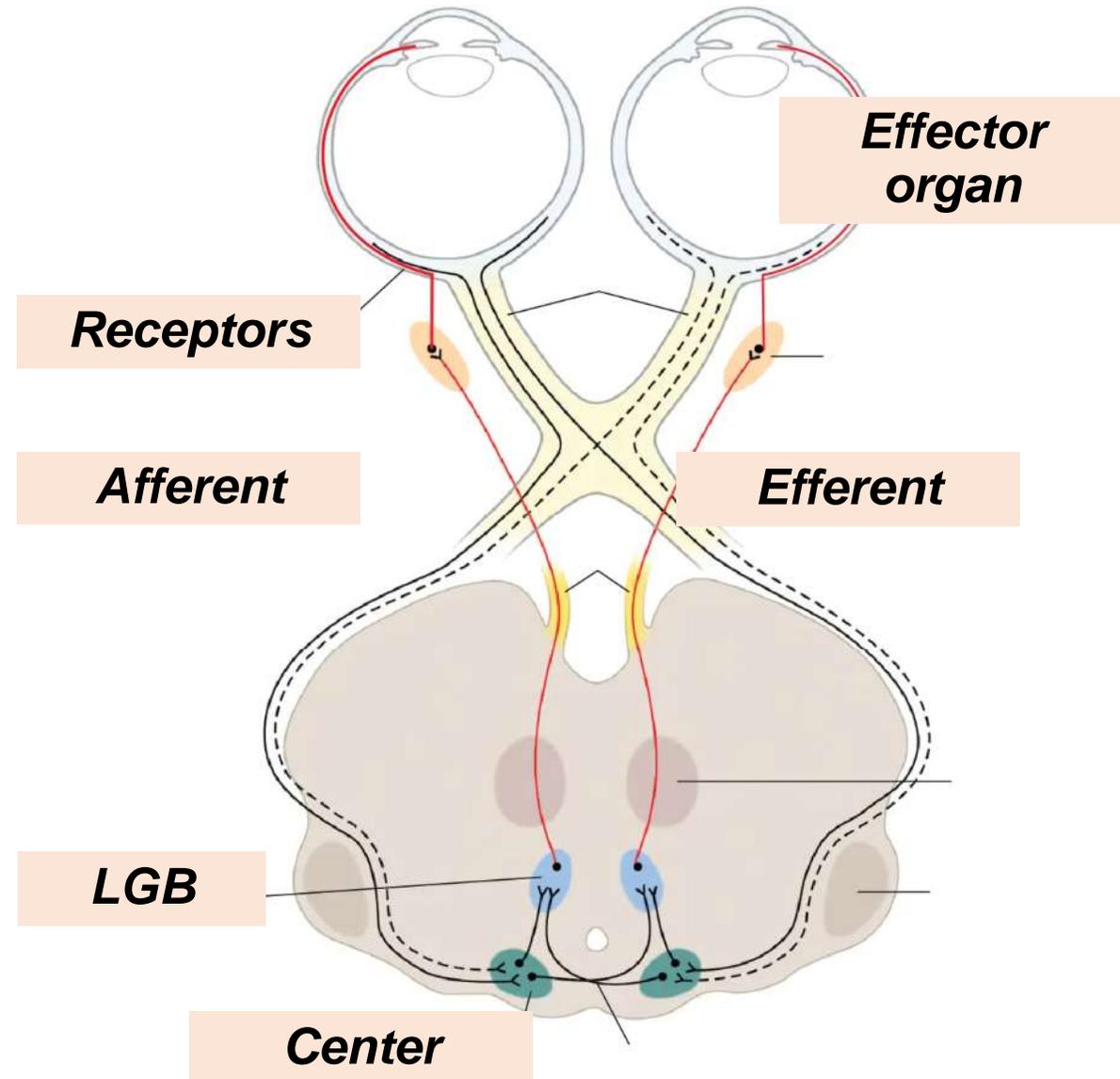


# Pupillary Light Reflex

• Consensual light reflex is explained by

∴

- 1) **Partial decussation** at the optic chiasma.
- 2) **Bilateral innervation** of the Edinger Westphal nuclei from each pretectal nucleus.



# Pupillary Light Reflex

## • Significance :

### *Physiological:*

- ✓ It is **protective reflex** which prevents over exposure of the retina to harmful excessive illumination.
- ✓ **By controlling the amount of light entering the eye.**

### *Medical or*

- ✓ Diagnosis and localization of lesions in the pathway of the reflex.
- (See next)



**Visual Acuity**

**Visual Field**

**Colour Vision**

# Visual Acuity



# Measurement of Visual Acuity

There are many clinical methods for stating visual acuity;

**1. Charts**

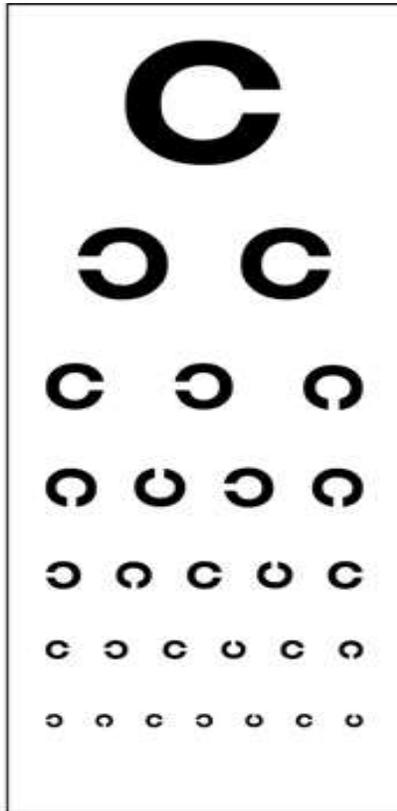
**2. Counting fingers**

**3. Hand movement**

**4. Perception of light**

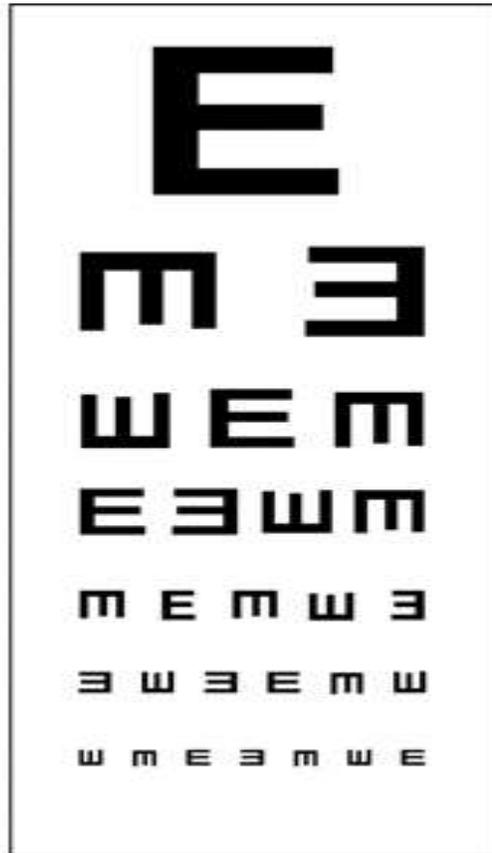
# Clinical Charts

- There are **many charts** that are used in testing VA



**Landolt's C charts**

Formed of Broken circle or C



**Snellen's letter charts**

Formed of English Letters



**Emarah arabic chart**

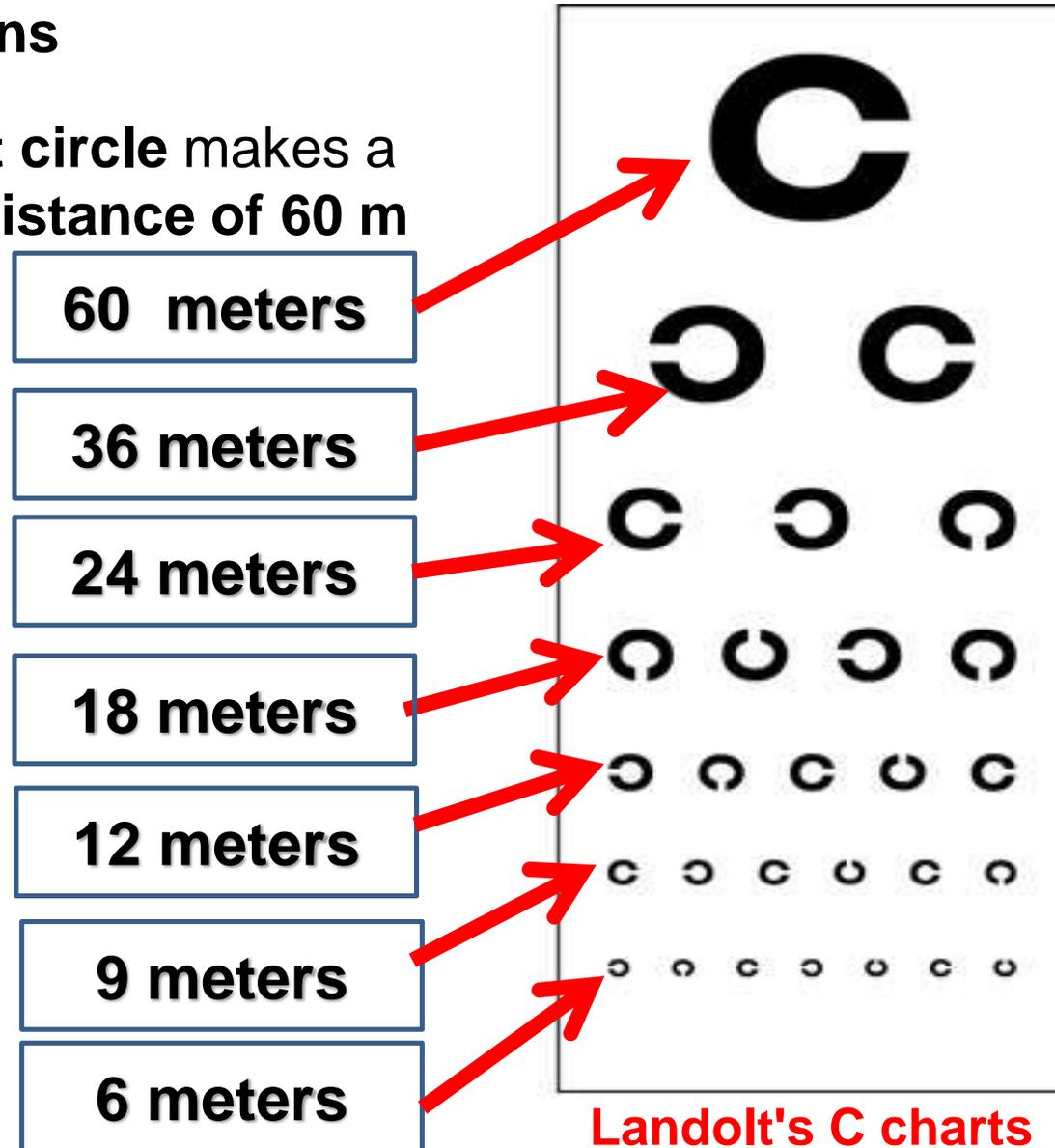
Formed of arabic letters

# Landolt's Chart

consists of **7 rows of incomplete circles** with the openings of the circles in **different directions**

The opening of the **biggest circle** makes a visual angle of **1 min** at a distance of **60 m**

The openings in the **lower rows** of circles make the same angle at distances of **36 m, 24m, 18m, 12m, 9m and 6 meters** respectively



# Clinical Expression of Visual Acuity

Visual acuity is a mathematical fraction that expresses the **ratio of two distances**, or the ratio of one's visual acuity to that of a person with normal visual acuity

$$\text{Visual acuity} = \frac{\text{Distance at which the patient sees the chart}}{\text{Distance at which the normal person sees the chart}}$$

- If the patient **cannot see** the **big** row at **6 meters**, he is asked to **move nearer** by one meter in each time i.e. at a distance of 5 meters where his visual acuity equals (5/60) or (4/60) or (3/60) or (2/60) and lastly at one meter (1/60).
- If the patient **cannot see** the **big** row at **1 meter**, shift to the following tests

# Measurement of Visual Acuity

## a) Counting fingers

- Ability to count fingers at a given distance

## b) Hand movements

- Ability to distinguish a hand if it is moving or not in front of the face of the patient

## c) Perception of light

- Ability to distinguish if the eye can perceive any light
- If no perception of light = totally blind



# Factors Affecting Visual Acuity

**Degree of illumination** of the chart; bad illumination impair visual acuity

**Fovea centralis:** it is the most sensitive point in the retina having the maximal visual acuity.

**Age:** visual acuity decreases in old age.

**Spherical and chromatic aberrations** caused by dilated pupil impair visual acuity.

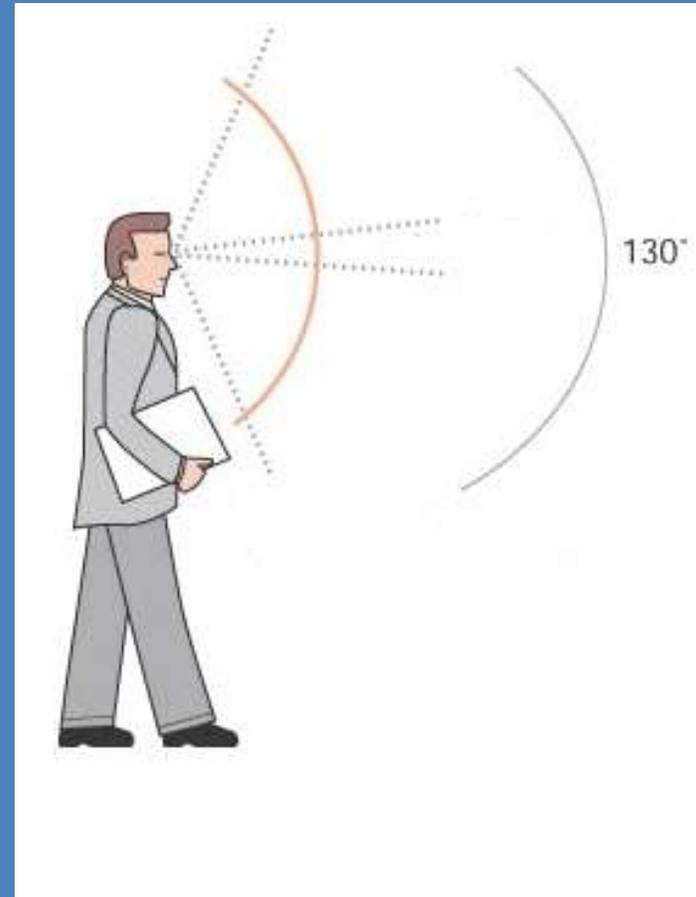
**Errors of refractions** e.g. myopia, hypermetropia and astigmatism decrease visual acuity.



# Field of Vision

# Field of vision:

It is the part of environment around us which can be seen without moving the eye.



## Types of visual field:

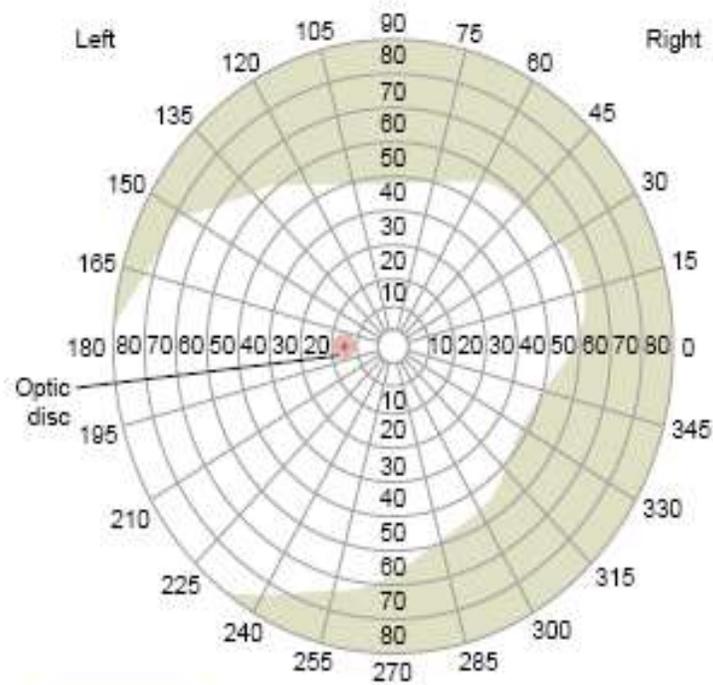
**Monocular**

Field of one eye only

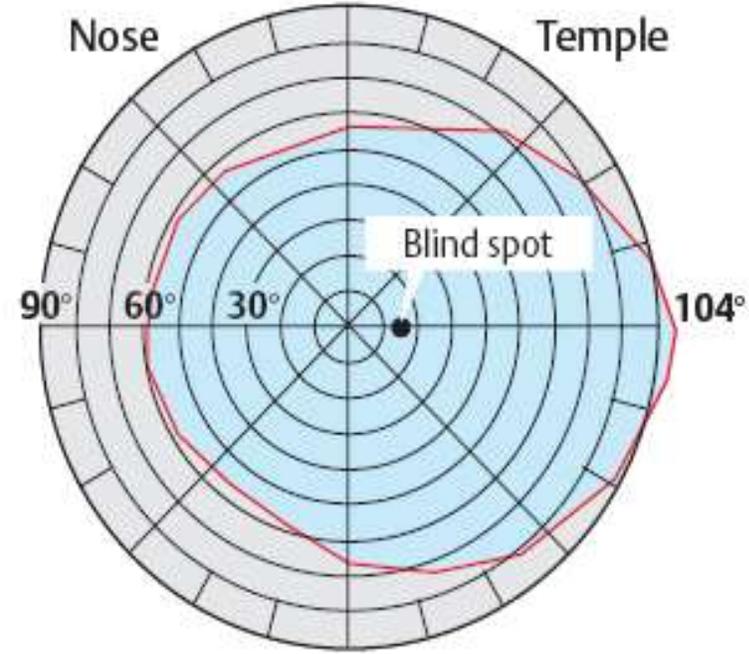
**Binocular**

Field of both eyes together

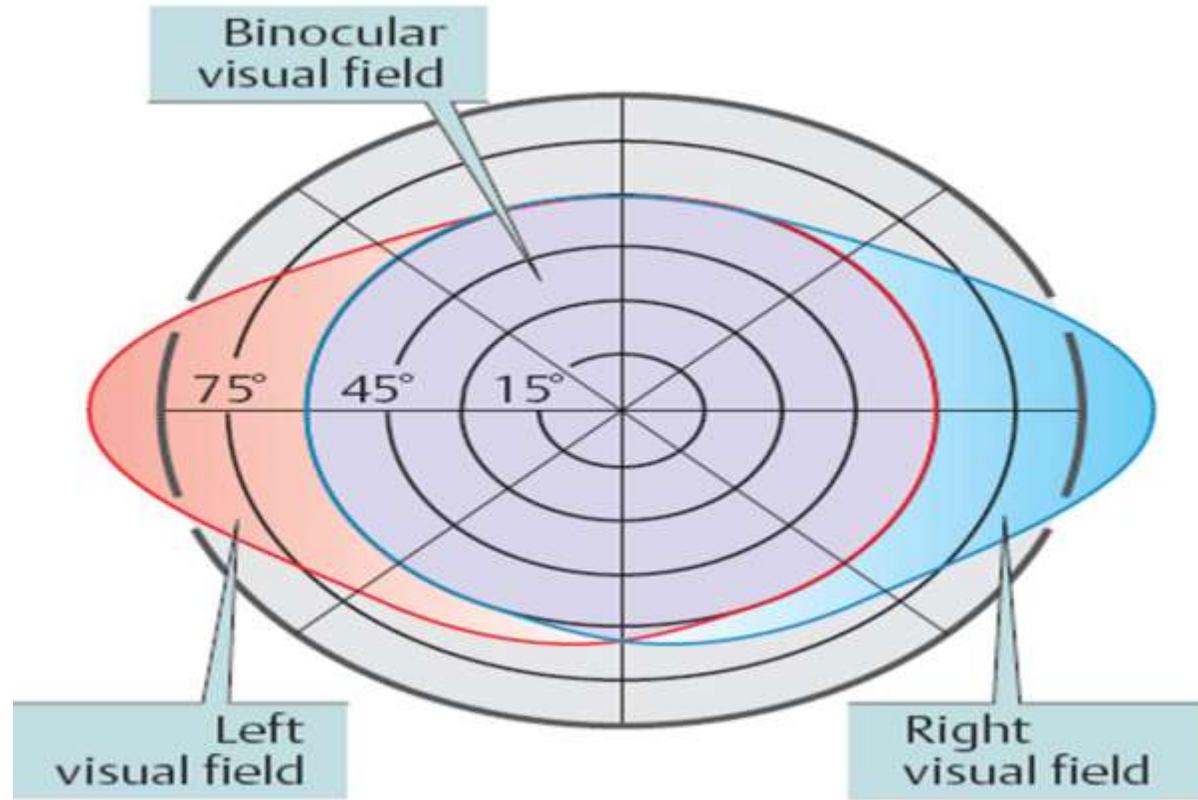
**Field of vision for the left eye**



**Field of vision for the right eye**



# Field of monocular vision

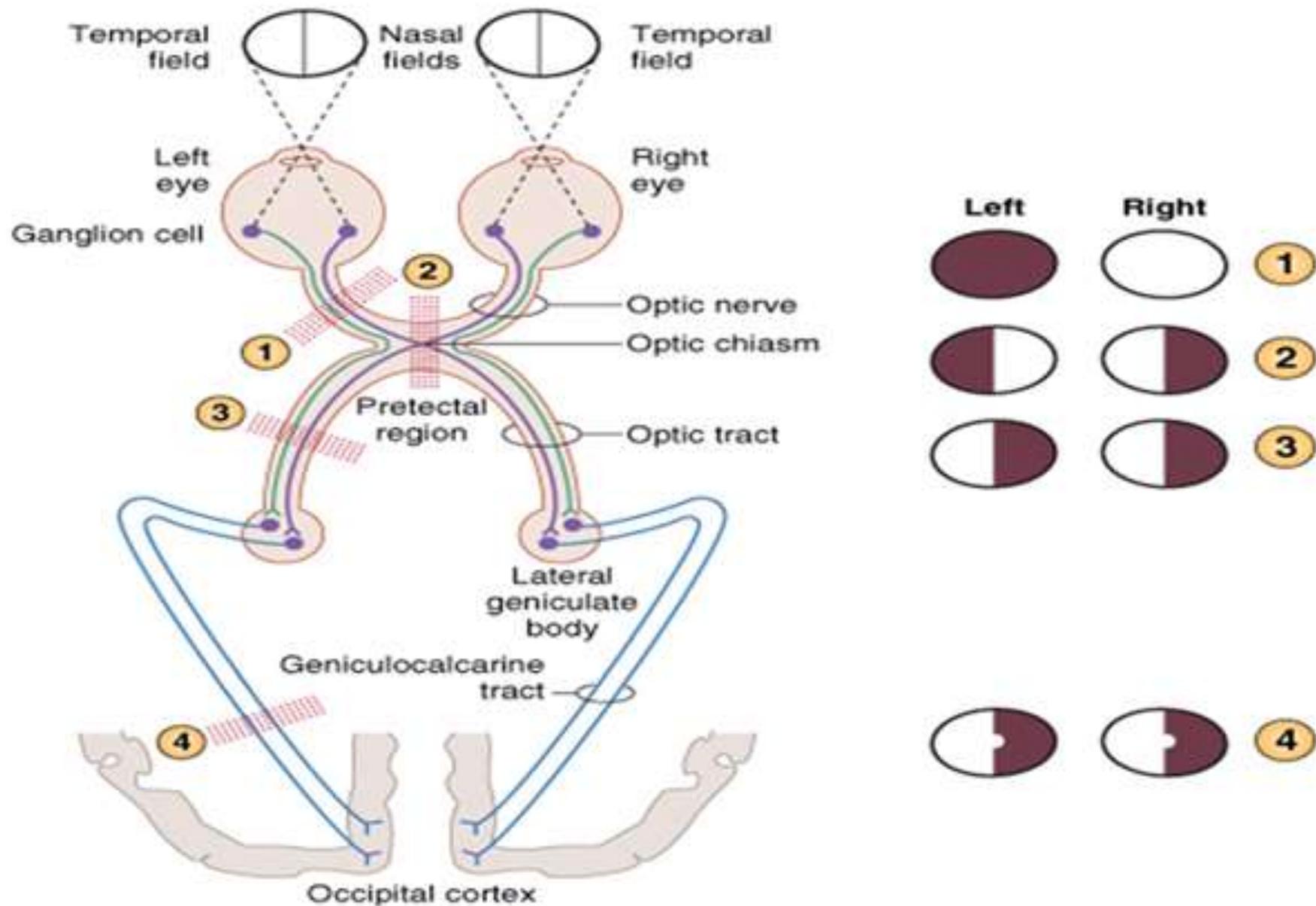


# Field of binocular vision

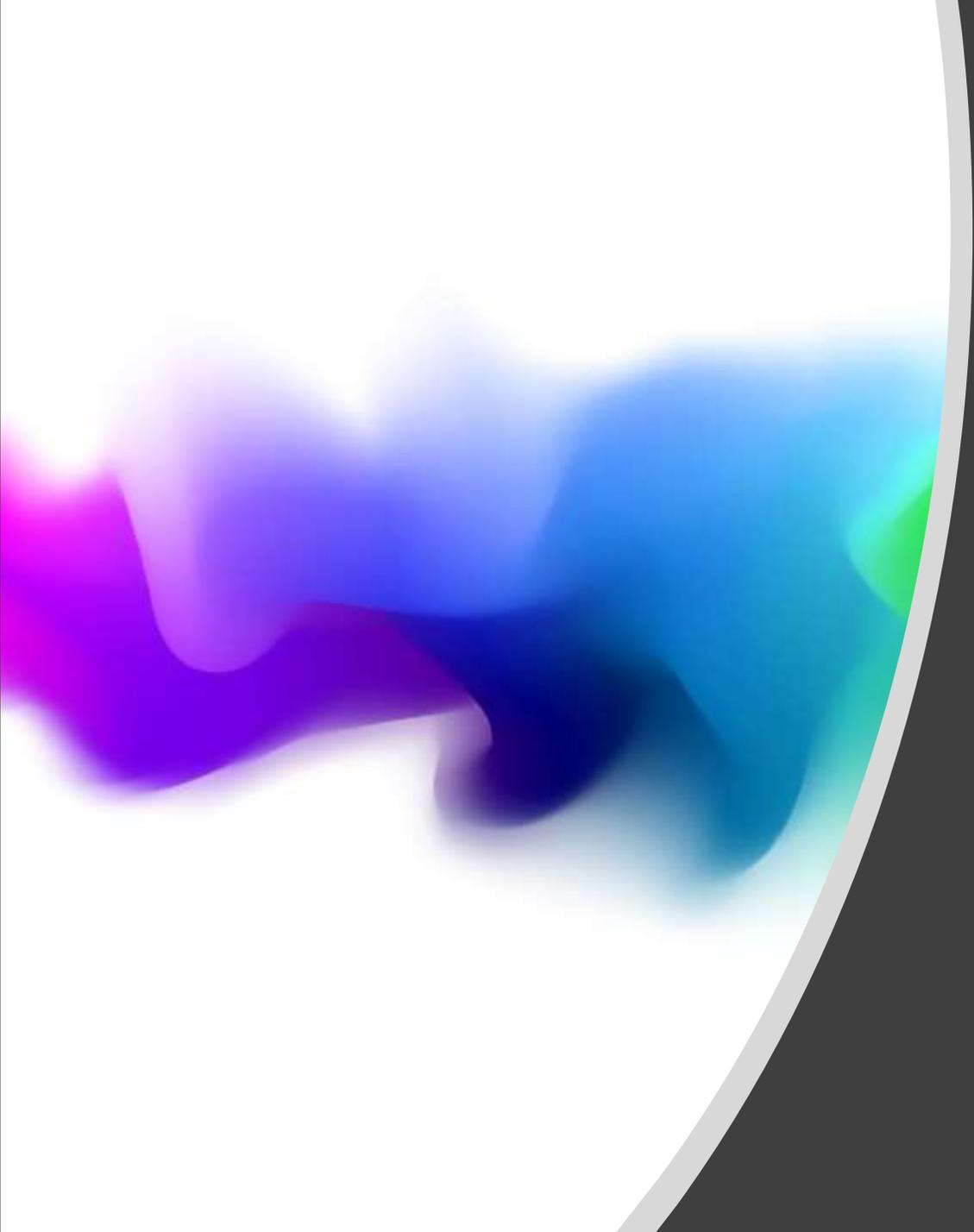
# Determination of visual field:

**Confrontation test**

**Perimeter**



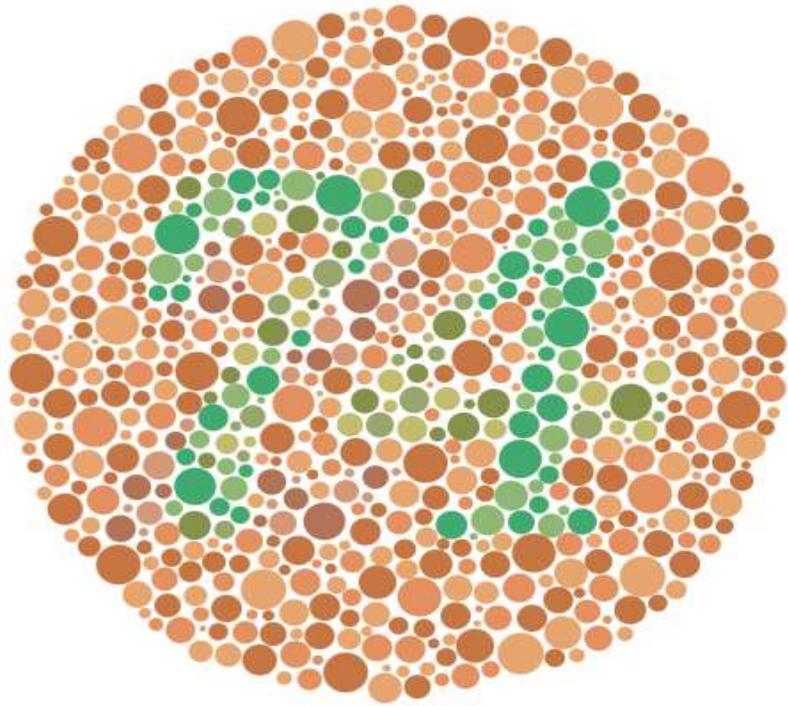
# Lesion in visual pathway



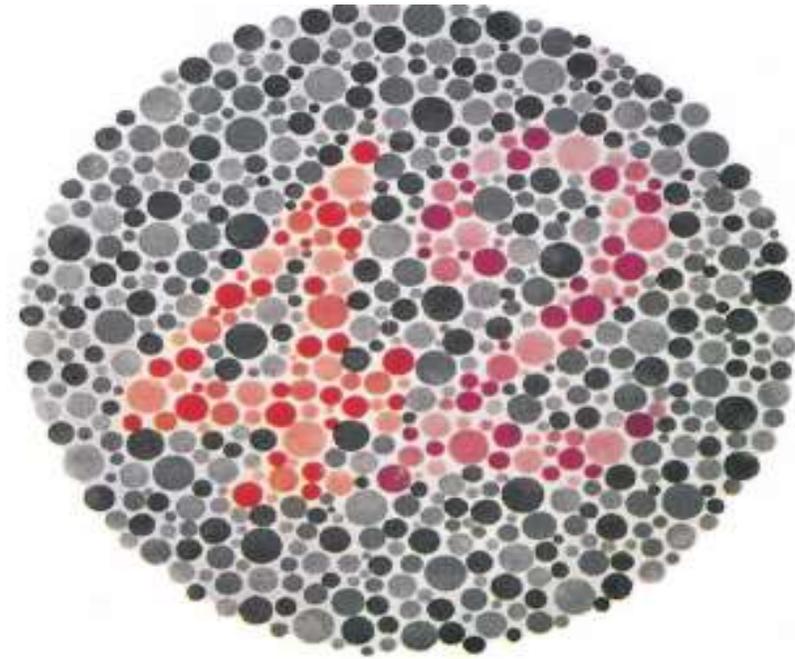
# Colour Vision



**Ishihra chart**



Normal person reads “74,” but the red-green color-blind person reads “21.”



Normal person reads “42.” Red-blind person (protanope) reads 2 green-blind person (deuteranope) reads “4.”

# Ishihara chart



## Wool classification & matching test

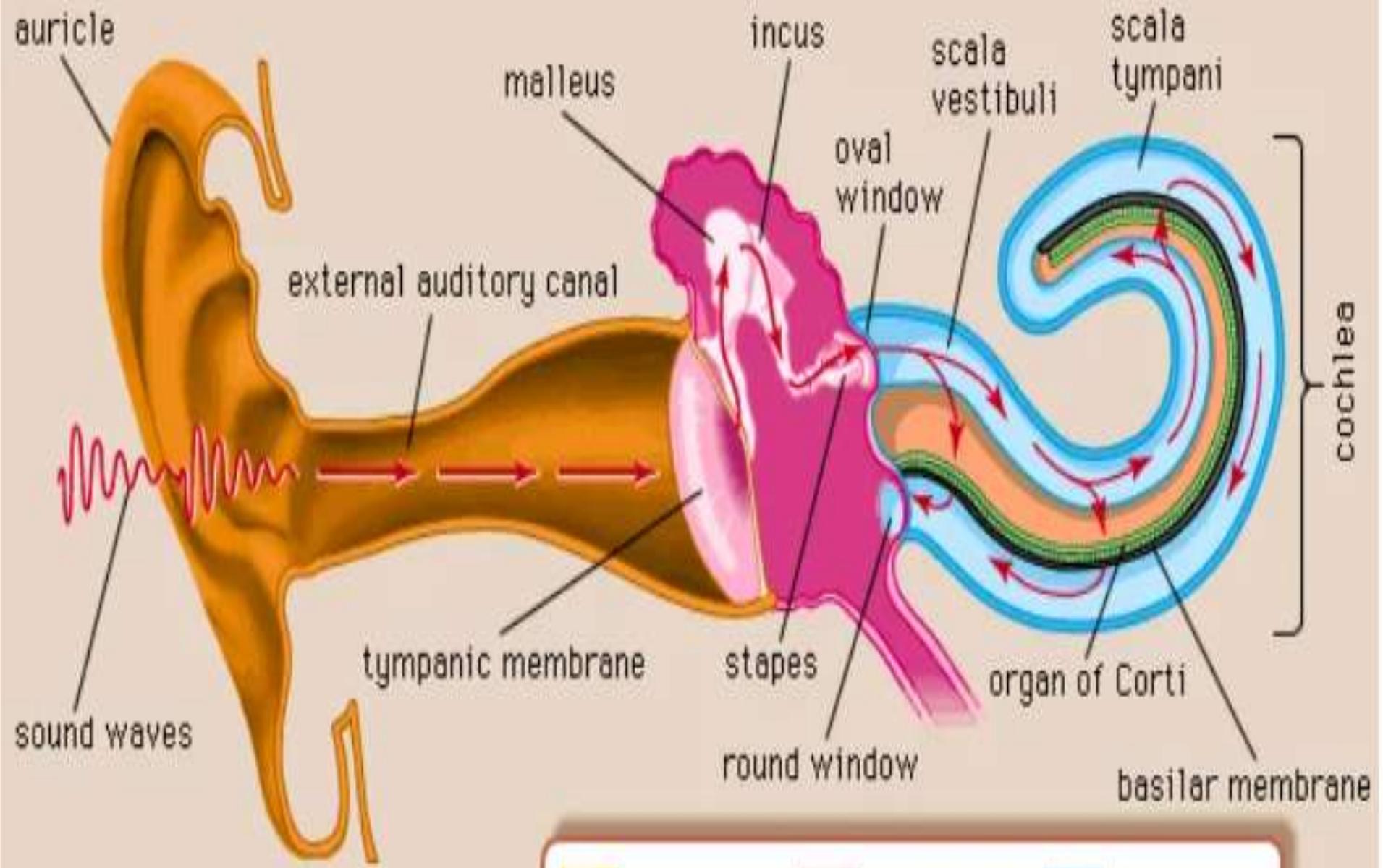


**Edridge Green Lantern test**



# Hearing Tests





	outer ear		middle ear		inner ear
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# Deafness

## Types of deafness

### 1) Conductive deafness:

It results from interference with the proper conduction and amplification of sound waves through the external and middle ears.

### 2) Sensorineural deafness:

It results from a lesion in the receptive part of the inner ear or the auditory pathway (basilar membrane, organ of Corti, auditory nerve or auditory cortex).

# Deafness

	<b>Conductive Deafness</b>	<b>Sensorineural Deafness</b>
<b><u>Causes</u></b>	<p><b>a) Causes in the external ear:</b></p> <ul style="list-style-type: none"> <li>•Obstruction of the ext. meatus by accumulation of wax, foreign body, inflammation or tumour.</li> </ul> <p><b>b) Causes in the middle ear:</b></p> <ul style="list-style-type: none"> <li>• Tympanic membrane perforation</li> <li>• Middle ear inflammation (acute and chronic otitis media).</li> <li>• Bony ossicles otosclerosis</li> <li>• Eustachian tube obstruction as in common cold.</li> </ul>	<p><b>a) Damage of hair cells</b> due to:</p> <ul style="list-style-type: none"> <li>✓Prolonged use of antibiotics e.g. streptomycin.</li> <li>✓Prolonged exposure to high intensity sounds as in airports and noisy factories.</li> </ul> <p>b) Meneier's disease</p> <p>c) Damage of the cochlear nerve or auditory cortex due to severe head injuries or tumors.</p>
<b><u>Character</u></b>	<p>-Air conduction is more affected than bone conduction</p> <p>-All frequencies are affected equally.</p>	<p>-Both air conduction and bone conduction are affected equally</p> <p>-Some frequencies are affected more.</p>

# Hearing Tests

**1- Whispered voice test:**→ detect the presence of hearing impairment.

**2-Tuning Fork tests** → differentiate between types of deafness

**3- Pure Tone Audiometry (PTA)**→

- ❖ Detect the presence of deafness
- ❖ Differentiate between types
- ❖ Determine the degree of hearing loss and speech discrimination

# Tuning Fork tests

- The frequency of fork may be 128,256, 512, 1024, 2048.
- The most common frequency used is 512 Hz



# Weber Test

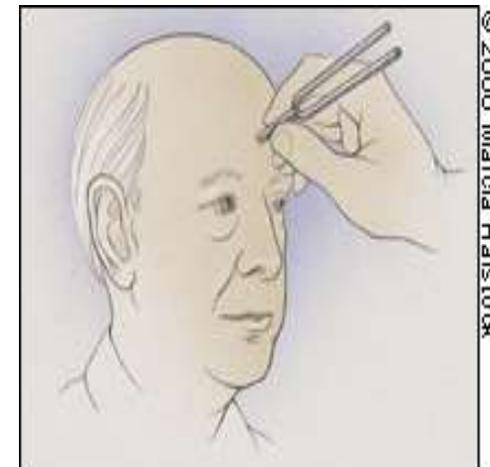
**Principle:** It can detect unilateral (one-sided) conductive hearing loss and unilateral sensorineural hearing loss

**Procedure:**

- A vibrating tuning fork is placed in the middle of the forehead, or on top of the head equi-distant from the patient's ears, in contact with the bone.
- The person is asked to report in which ear the sound is heard louder.

**Interpretation:**

- a. Normal person → hears equally on both sides.
- b. Conductive deafness → sound in diseased ear is louder than normal ear
- c. Perceptive deafness → sound in normal ear is louder than diseased ear.



# Rinne Test

## Interpretation:

- a. Normal hearing persons will note air conduction twice as long as bone conduction ( $AC > BC$ ; Rinne positive)
- b. With conductive hearing loss, bone conduction sound is heard longer than or equally as long as air conduction ( $BC > AC$ ; Rinne's negative)
- c. With sensorineural hearing loss, air conduction is heard longer than bone conduction in affected ear, but less than 2:1 ratio (reduced +ve Rinne)



# Schwabach Test

**Principle:** compare bone conduction of patient with that of physician.

**Procedure :** Strike a 512 Hz tuning fork softly

and place it on the mastoid of patient and then place it on mastoid process of physician

**Results:**

- Normal person  $\rightarrow$  patient = physician.
- Conduction deafness (one ear)  $\rightarrow$  patient  $>$  physician.
- Nerve deafness (one ear)  $\rightarrow$  patient  $<$  physician.

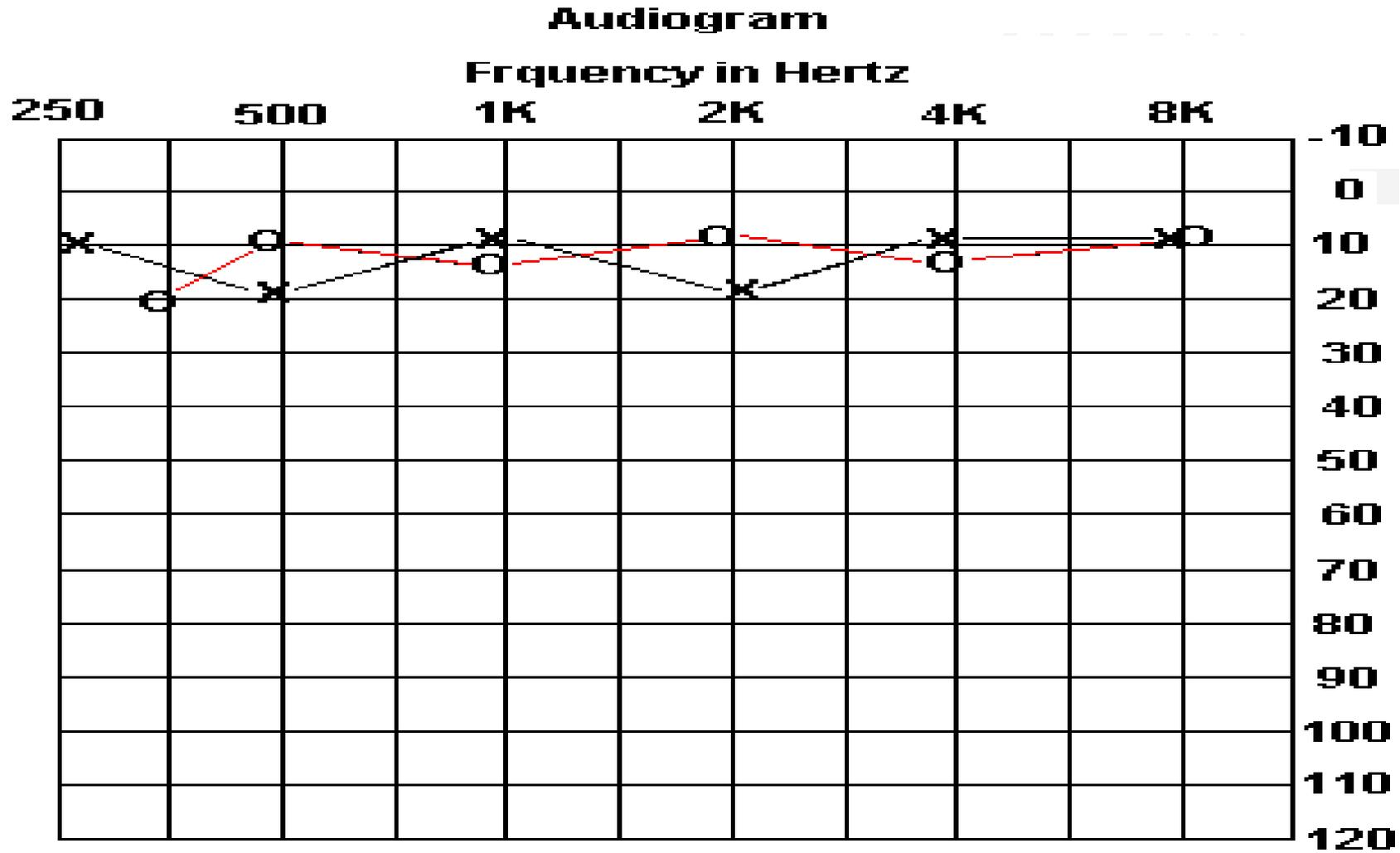


# Pure Tone Audiogram (PTA)

- Pure tone audiometry (PTA) tests the hearing of both ears
- During PTA, a machine called an audiometer is used to produce sounds at various intensity (measured in decibels) and frequency (measured in Hz).
- Each ear is tested separately
- The person being tested listens to the sounds **once through headphones (testing air conduction)** and **then once through a vibrator on mastoid process (testing bone conduction)** and responds when they hear them by pressing a button.
- The doctor will reduce the intensity of a tone until the patient can not hear it then increases it gradually until the patient hears it again
  - When the intensity of sound is very low, it is not heard, but if it is increased slowly till a certain value at which the sound is heard, this is the **threshold of hearing.**
  - **The higher the threshold of hearing, the lower the acuity of hearing and the more the degree of deafness**

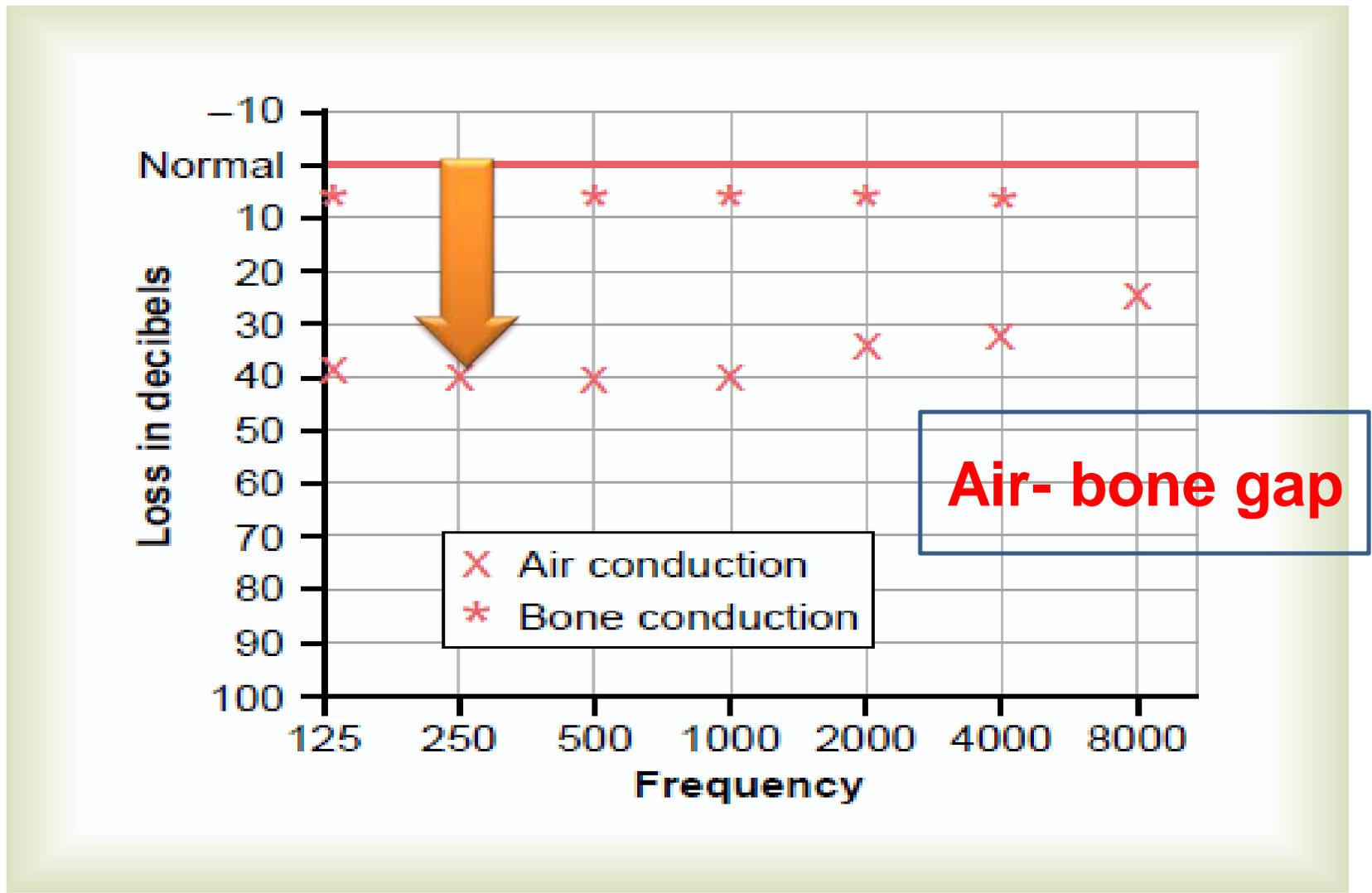


# Pure Tone Audiogram (PTA)



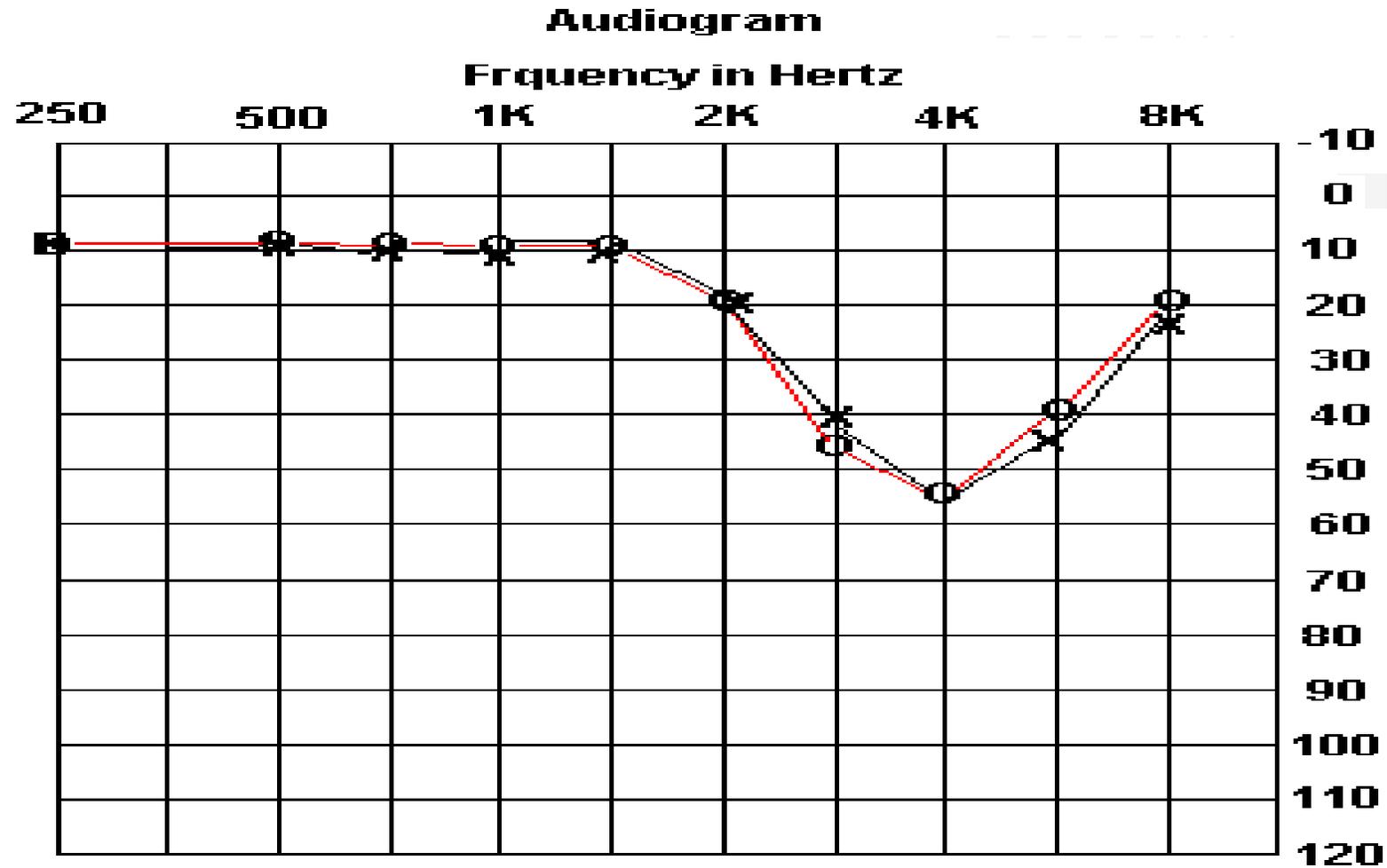
**Normal person**

# Pure Tone Audiogram (PTA)



**Conductive deafness**

# Pure Tone Audiogram (PTA)



**Sensorineural deafness**