

Physiology Lab. 1

VISION

By

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① Corneal reflex

- **Stimulus:** touch cornea or limbus, eye lashes or eye lids by a cotton.
- **Afferent:** trigeminal nerve (V)
- **Center:** pons -**Efferent** facial nerve (VII)

Response: blinking of both eyes.

Importance : Protective & indicate degree of anesthesia.



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② Pupillary light reflex:



- **Stimulus:** one eye is exposed to light.
- **Response:** pupil of same eye constricts (**direct pupillary light reflex**). Also, the pupil of the other eye constricts at the same time (**indirect or consensual light reflex**).



Medical Torch

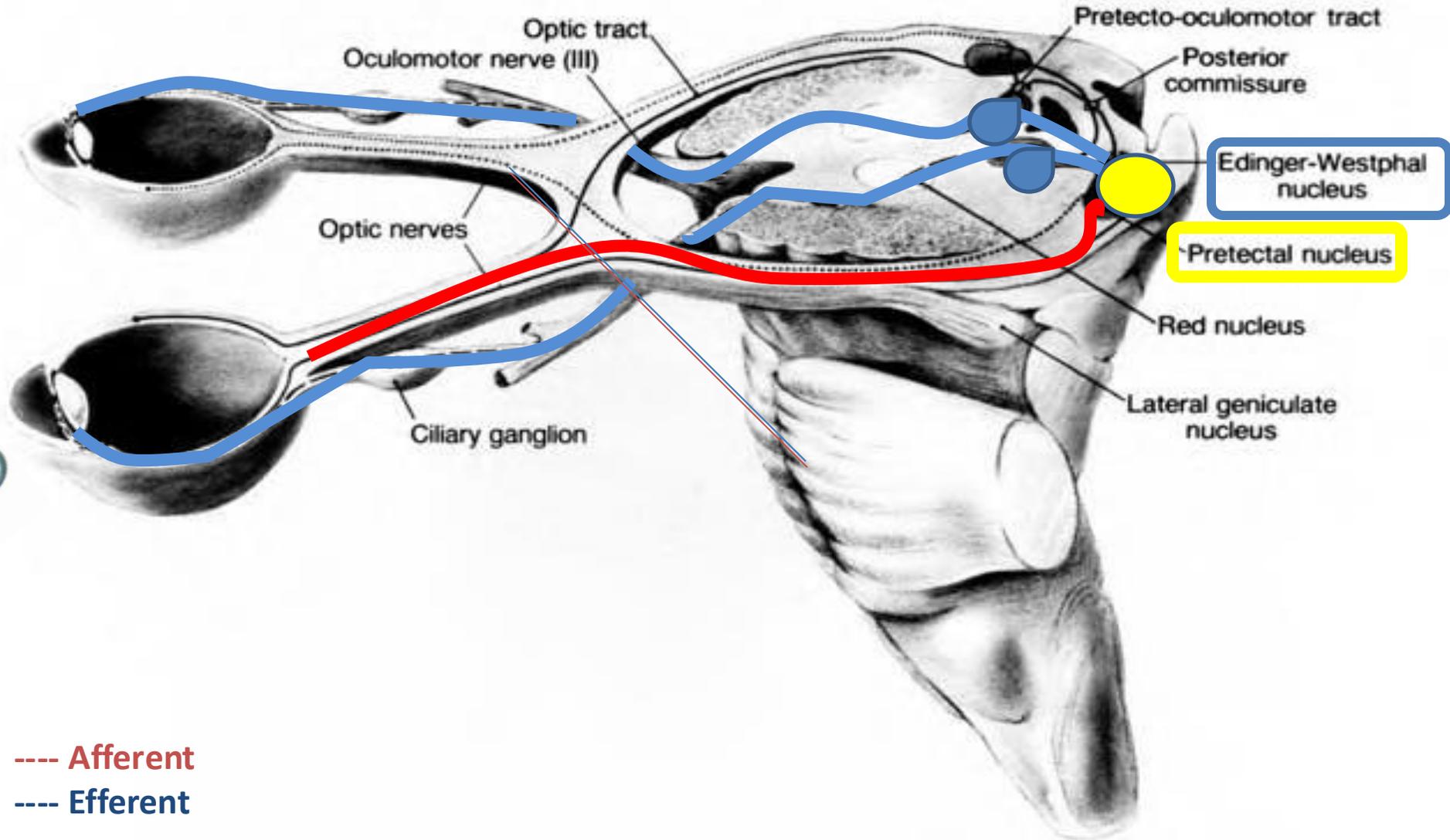
How to be done?



Nervous pathway of light reflex

- When light falls on the retina, the resulting impulses pass through the optic nerve, optic chiasma to the optic tract.
- Collateral fibers from the optic tract end in the *Pretectal nucleus* in the mid brain (center of the reflex).
- Here, impulses pass to the *Edinger-Westphal nuclei* of *oculomotor nerves* of **both sides** and through the parasympathetic nerves to constrict both eye pupils.
- In darkness, the reflex becomes inhibited, which results in dilatation of pupil.

Nervous pathway of light reflex



Abnormal pupillary light reflex:

1. **Encephalitis and alcoholism;** the pupillary light reflex is lost.
2. **Argyll Robertson pupil;** a pupil that fails to respond to light but respond to accommodation. Due to lesion in the **pretectal region of the brain stem** in neurosyphilis.
3. **Reverse Argyll Robertson pupil,** a pupil reacts with light but does not react with near accommodation. Due to lesion affecting the **occipitotectal tract**.
4. **In Horner's syndrome,** the pupil remains persistently constricted due to paralysis of the dilator pupillae muscle as a result of lesion in the sympathetic nerves to the eye.

Changes in the pupils during anesthesia

	Size of pupil	Cause	Light reflex Corneal reflex
First stage (Induction)	Normal or Slightly dilated.	Sympathetic stimulation.	Intact.
Second stage (Induction)	Dilated more.	Sympathetic stimulation.	Intact.
Third stage (Surgical)	Constricted.	Release of E-W nucleus from normal cortical inhibition.	Absent.
Deep anesthesia	Fully dilated.	Paralysis of E-W nucleus.	Absent.

③ Accommodation Reflex

- **Definition:** changes occurs in the eye & leads to changes in its dioptric power to focus near object (less than 6 meters).
- In emmetropic eye, far objects focused on retina without accommodation, while near objects focused on retina with accommodation.



■ The **stimulus** for the near accommodation reflex is the formation of a blurred (not clear) image on the retina.

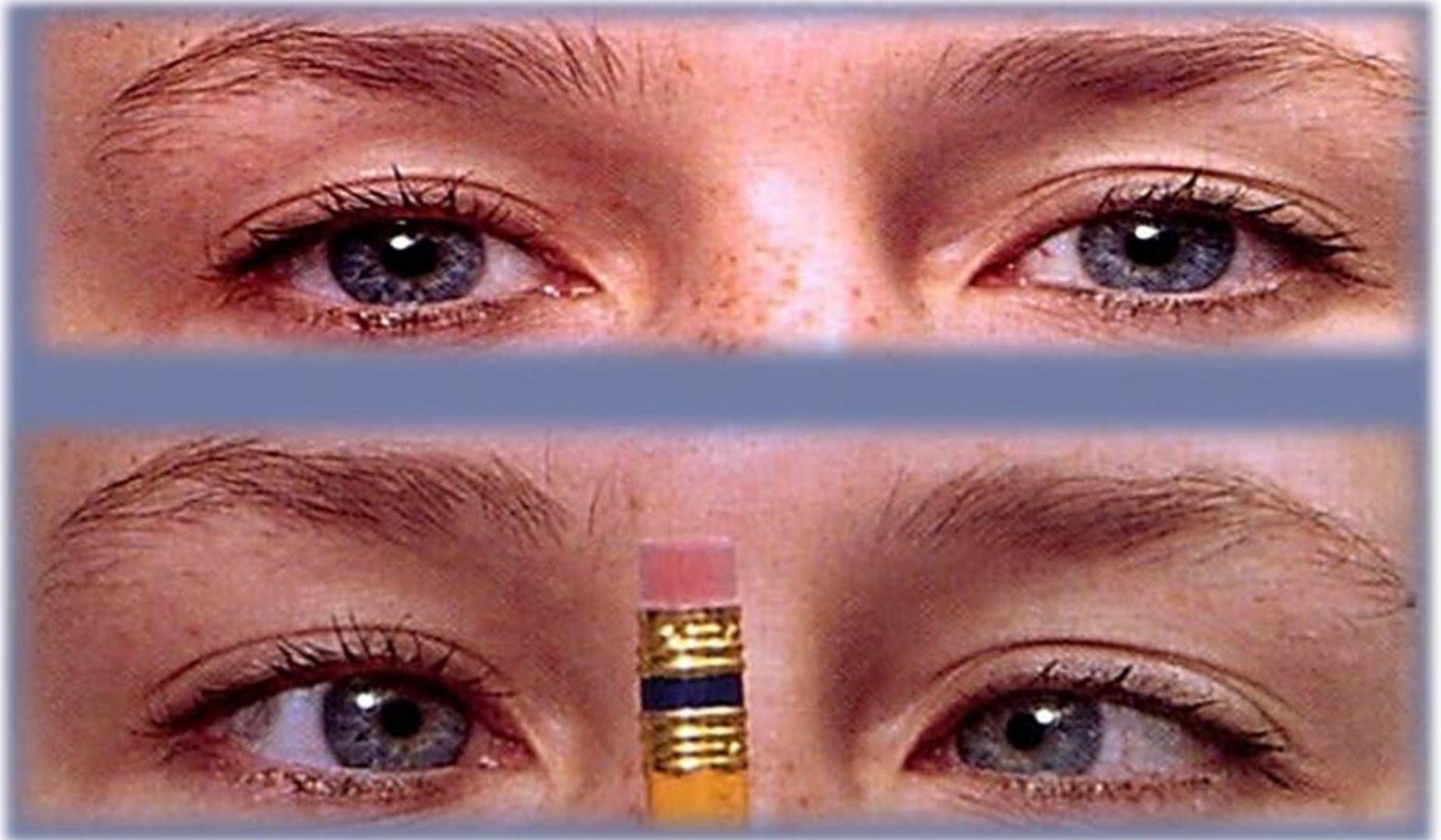
Response = Components of accommodation reflex:

1. Constriction of both pupils (miosis) due to contraction of constrictor pupillae muscle.
2. Medial convergence of both eyes, due to contraction of both medial recti muscle.
3. Increase in the convexity of the lens (mainly the anterior surface) to increase its dioptric power. It is due to contraction of ciliary muscle.

Nervous pathway of near accommodation reflex

- From retina → optic nerve → optic chiasma → optic tract
- → lateral geniculate body of the thalamus
- → optic radiation → area 17 → area 18, 19
- → fibers pass as **occipitotectal tract** to the midbrain (**Edinger–Westphal nucleus**).
- From this nucleus fibers pass to **ciliary ganglia** to relay in it then postganglionic fibers pass in **short ciliary nerve**
- Then reach **ciliary muscle** → contraction,
- and **constrictor pupillae muscles** → contraction → miosis.

How to be tested?



Value of each components:

1. Constriction of both pupils (miosis):

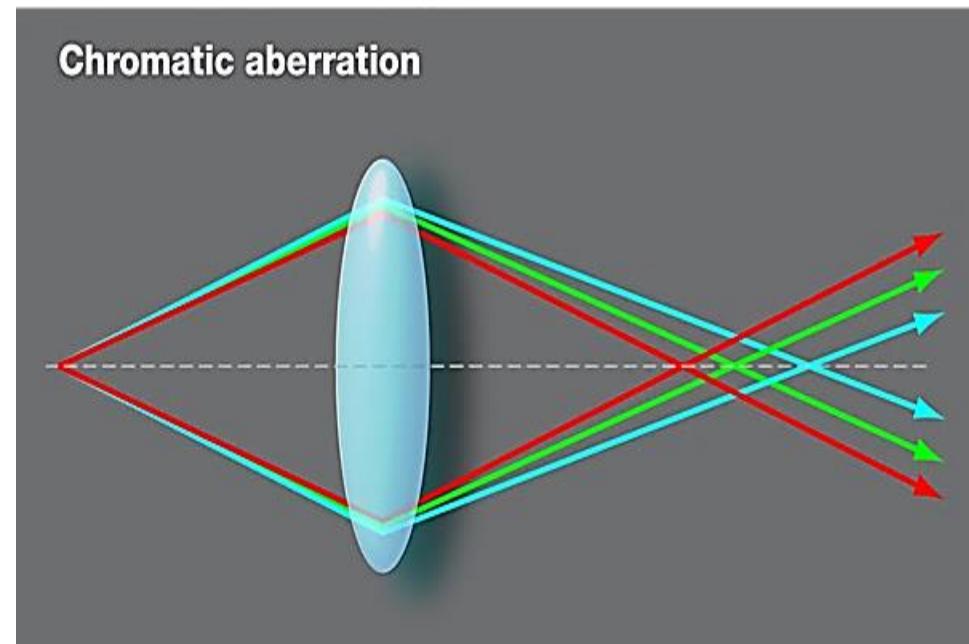
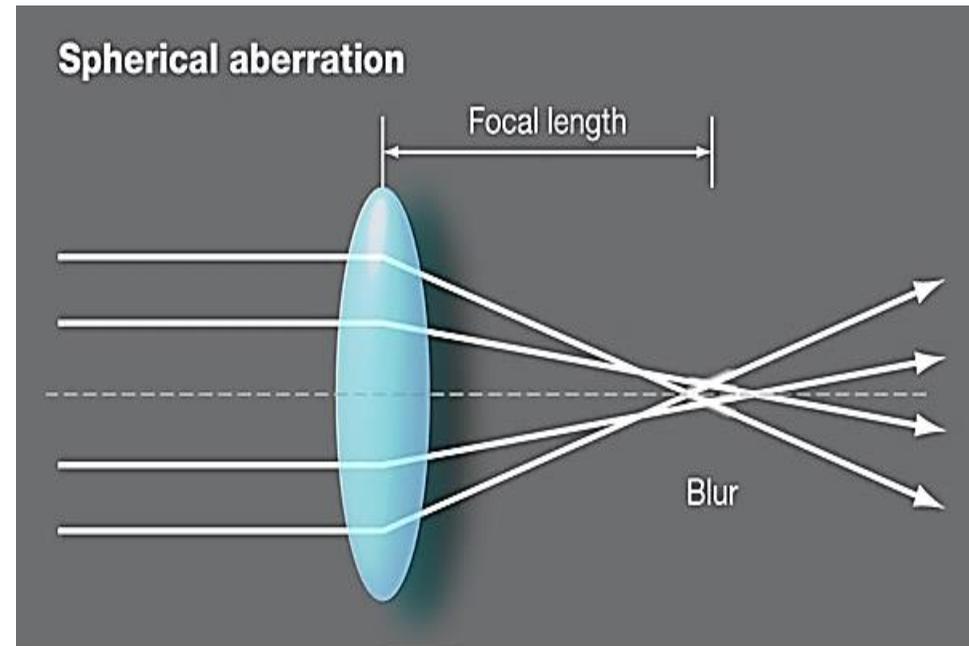
A- Miosis increases the depth of the focus i.e. enable object to move and still its image is focused in retina without new accommodation.

B- Miosis makes image to be focused in fovea centralis which is the most visual acuity area in the retina.

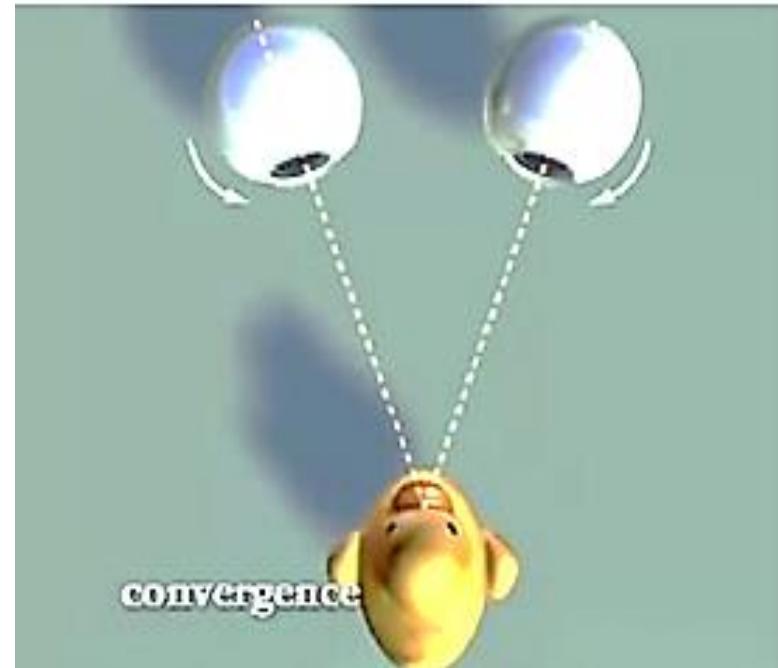
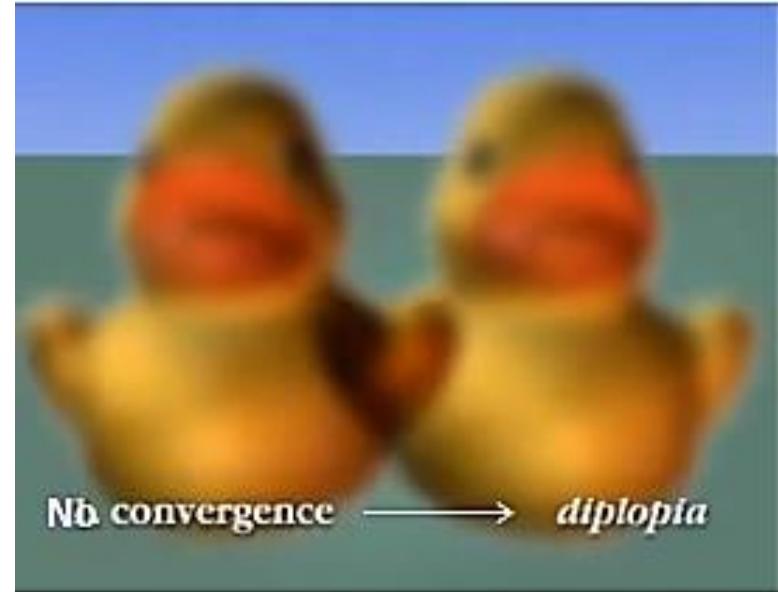
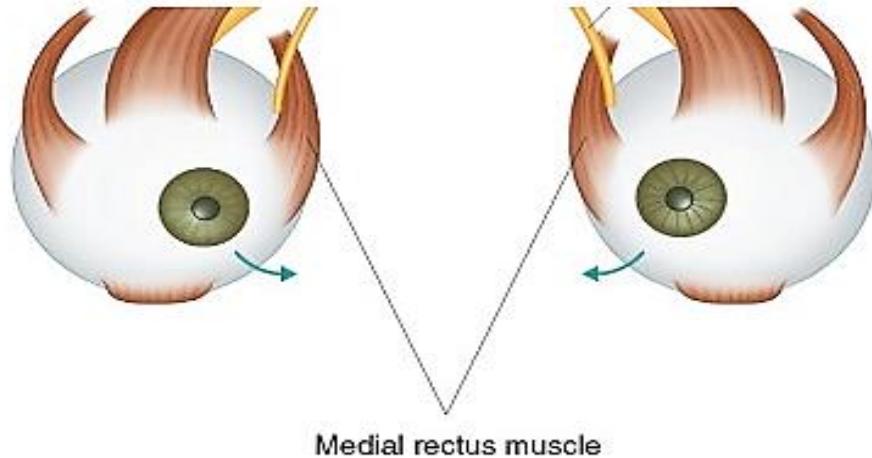
C- Bilateral miosis in near vision allows light rays to fall on the corresponding retinal points.

D- Preventing excess light entry to fall on retina (protective function).

E- Covering the periphery of the lens preventing chromatic and spherical aberration,



2. Medial convergence of both eyes to bring images on fovea centralis.



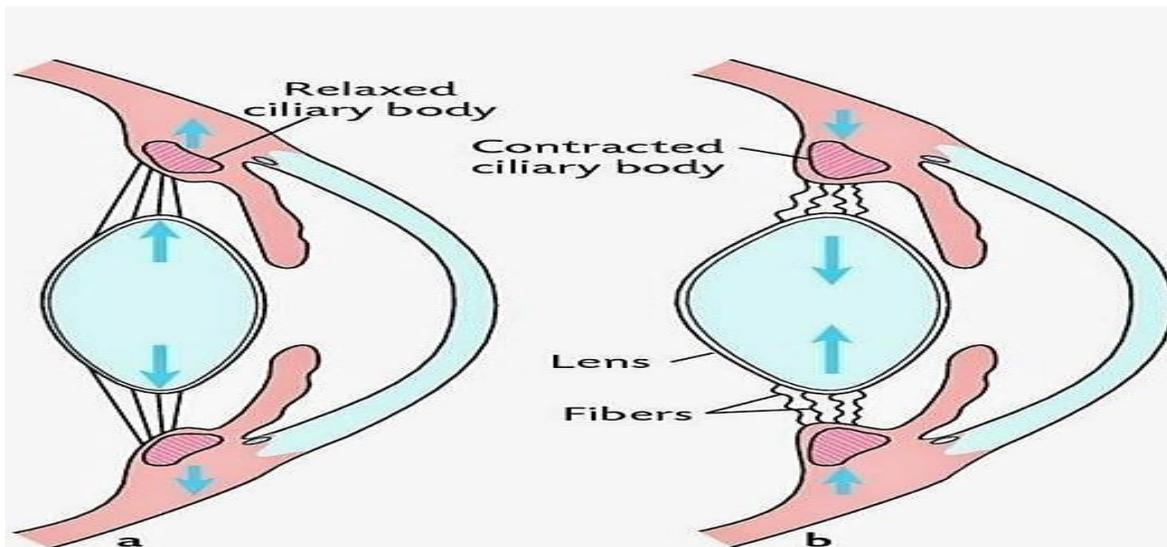
Medial convergence of both eyes

due to:

- a) direct stimulation from area "19" to oculomotor nucleus in midbrain which innervate medial recti.
- b) or stimulation of area "8" (frontal eye field area) which in its turn stimulate oculomotor nucleus in the mid brain.

3. Increase in the convexity of the lens

Contraction of the ciliary muscle → relaxation of suspensory ligament that holds lens → lens becomes more spherical (the curvature of **anterior surface** is increased in comparison to the posterior surface). Increasing curvature of the lens → increase in its dioptric power.



Nervous pathway accommodation reflex

- From retina → optic nerve → optic chiasma where crossing occurs → optic tract → lateral geniculate body of the thalamus → optic radiation to visuo-sensory area (area 17) in the occipital lobe → visuo- psychic area (area 18) → occipital eye field area (area 19).

- From area 19 efferent fibers pass as occipitotectal tract to Edinger-Westphal nucleus in midbrain → III nerve fibers to ciliary ganglia to relay → short ciliary nerves →

a) Contraction of constrictor pupillae muscle → miosis.

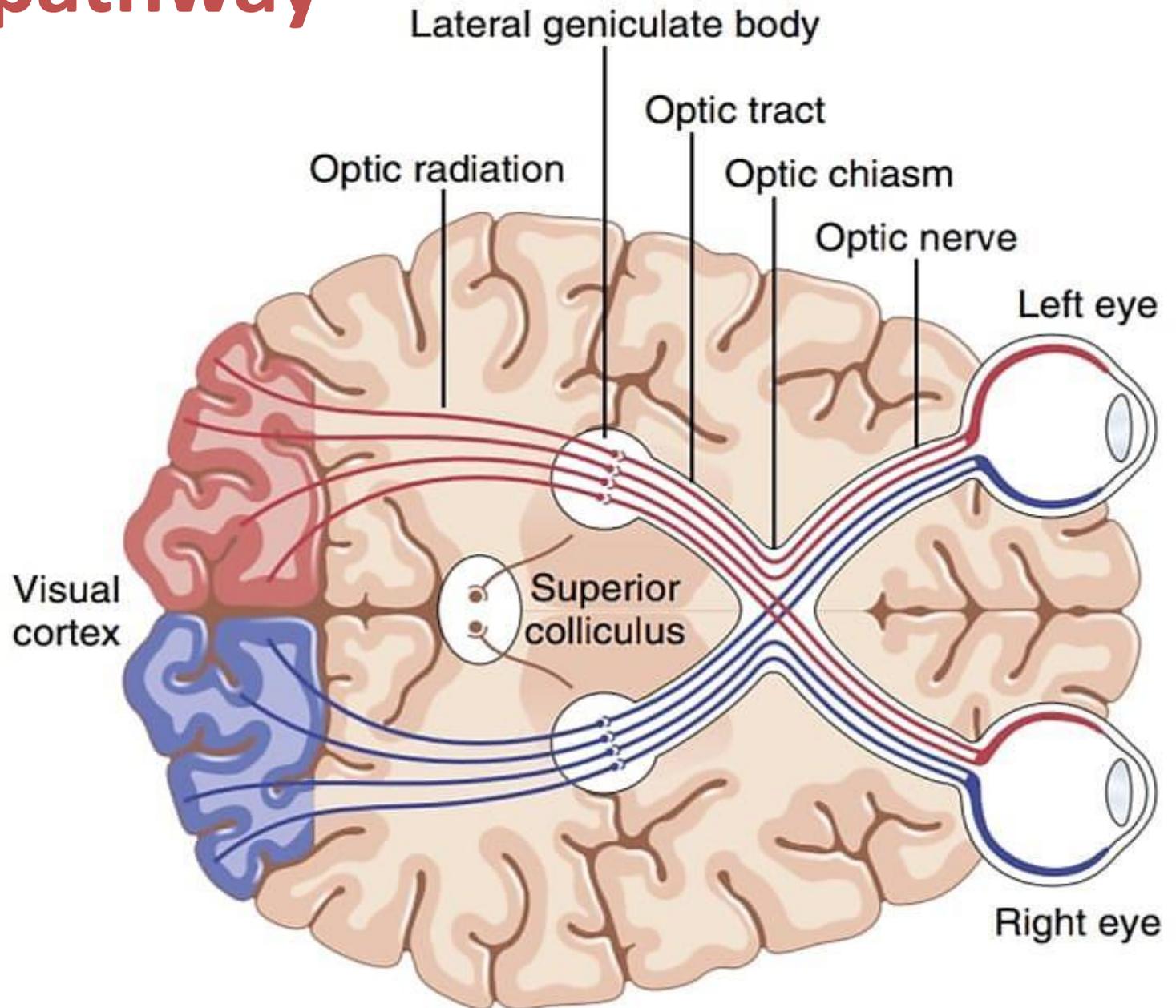
b) Contraction of ciliary muscle → ↑↑ Convexity of mainly anterior surface of lens → increasing its dioptric power.

- Impulses from area 19 → area 8 → corticonuclear tract → somatic part of III nerve → contraction of medial recti → convergence of both eyes.

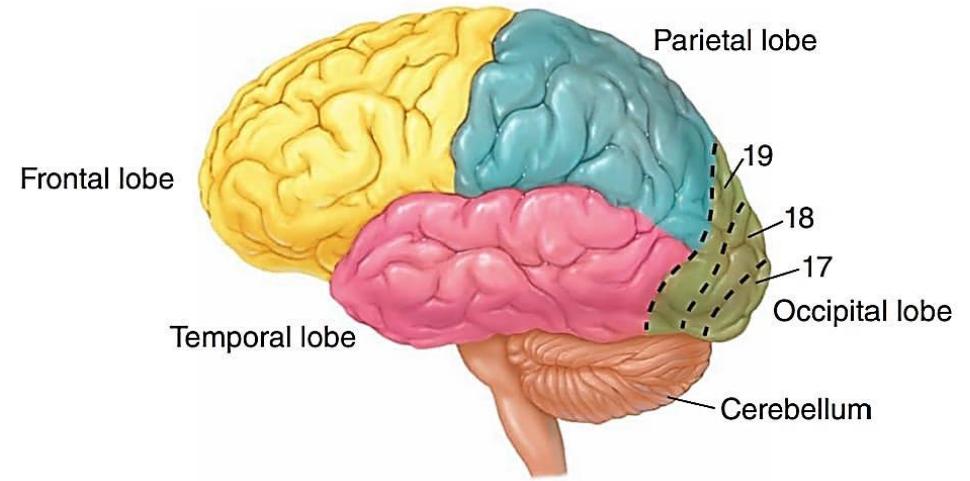
N.B.:

Amplitude (power) of accommodation	Range of accommodation
Difference between refractive power of eye: <ul style="list-style-type: none">- When accommodation is relaxed (during far vision)- When accommodation is maximal (during near vision).	Distance between the far & near points: <ul style="list-style-type: none">- Far point: at which accommodation is completely relaxed (6 meters).- Near point: at which objects seen clear by maximum accommodation.
Power = 15 diopters at age of 20 years. Power = 2 diopters at age of 50 years. Power = 1 diopter at age of 60 years.	Near point = 10 cm at age of 20 years. Near point = 40 cm at age of 50 years. Near point = 100 cm at age of 60 years.
The power decreases with age due to loss of the lens elasticity.	The near point becomes away from eye with age.

Visual pathway



Visual cortex



Impulses from the **primary visual cortex (area 17)** on the medial aspect of the occipital lobe which is responsible for perception of visual sensations.

TO

The visual association areas (18 & 19)

To Understand the meanings of the seen objects

The functions of area 17 (the primary visual area):

- 1- Perception of visual sensations.
- 2- Fusion of the 2 images formed on both retinas.
- 3- Localization of objects in space in relation to each other.
- 4- Perception of color vision.

The functions of area 18 (visuo- psychic area):

1. Understanding the meanings of the seen objects,
2. Understanding the significance of the written words.
3. Determination of relative positions of objects to each other.

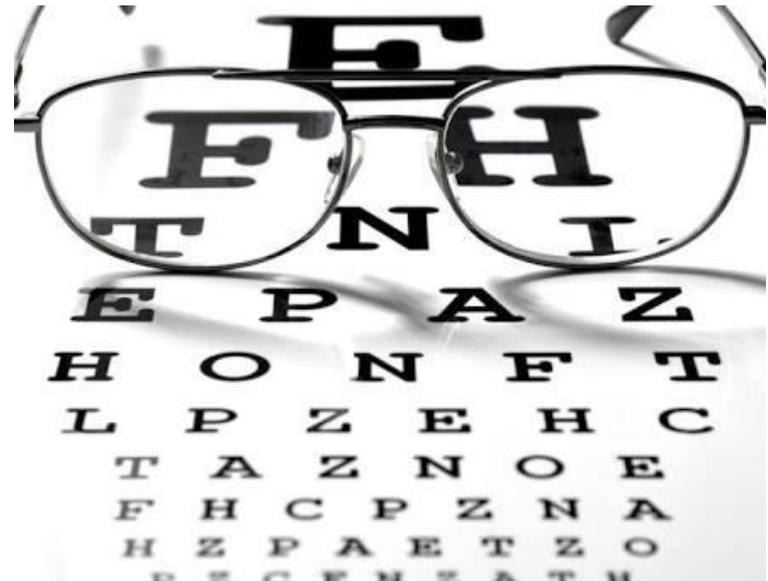
The functions of area 19 (occipital eye field area):

1. It shares area 18 its functions.
2. It sends information to other parts of the cerebral cortex e.g. frontal eye field area (area 8) during accommodation.
3. Integration of visual sensations with other forms of sensations.

Visual acuity

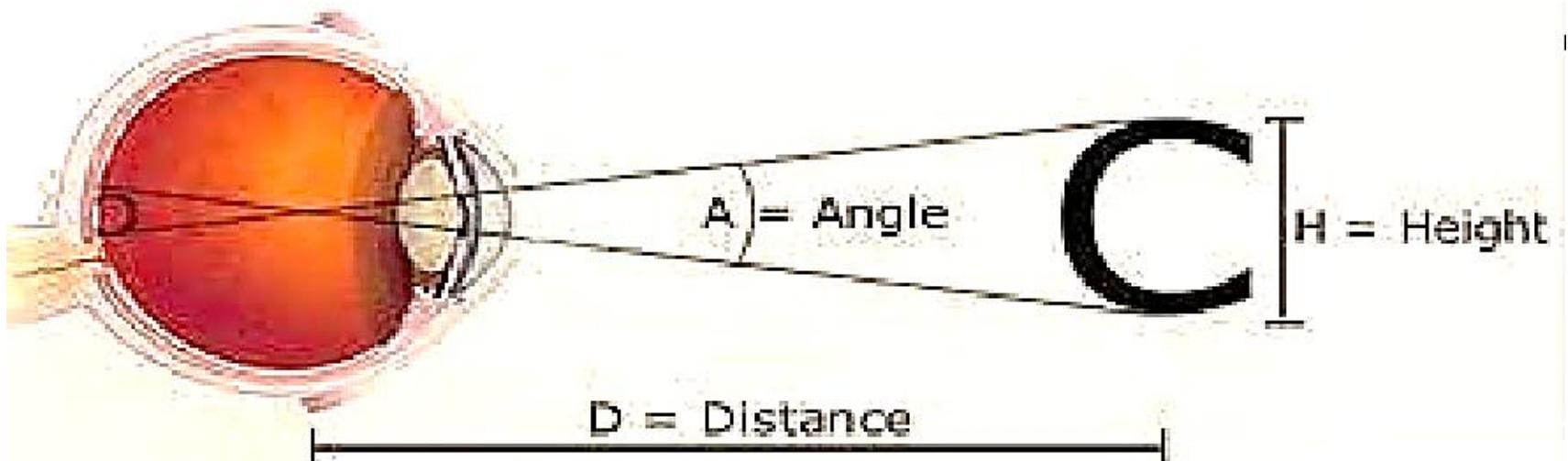
Definition:

It is the ability of the eye to differentiate between two separate points and to detect fine details of objects.

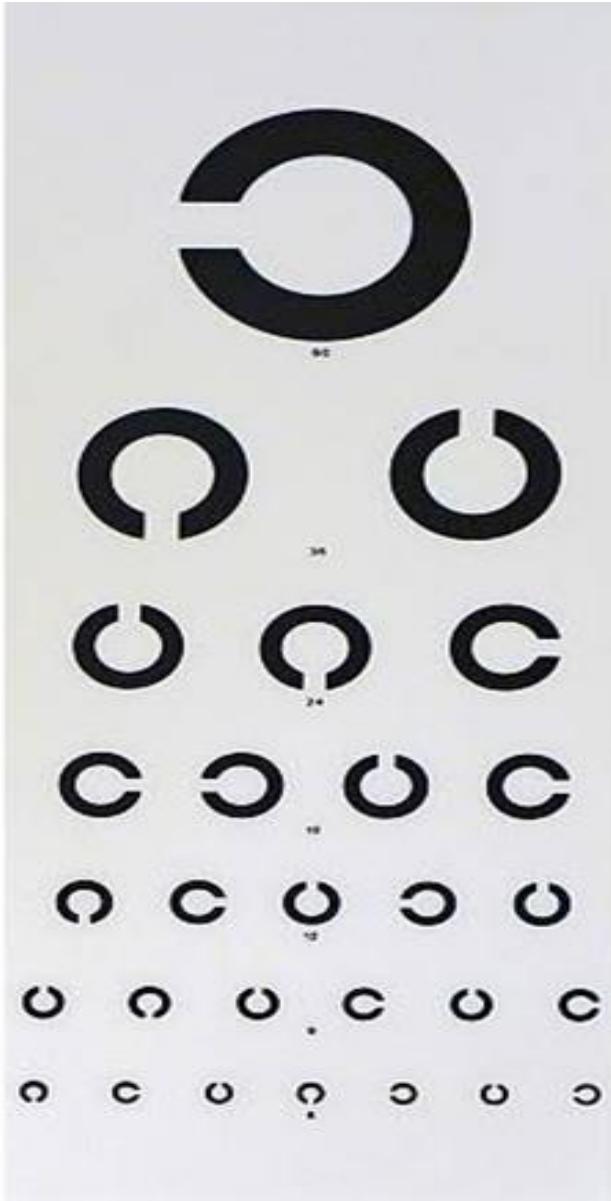


Requirements

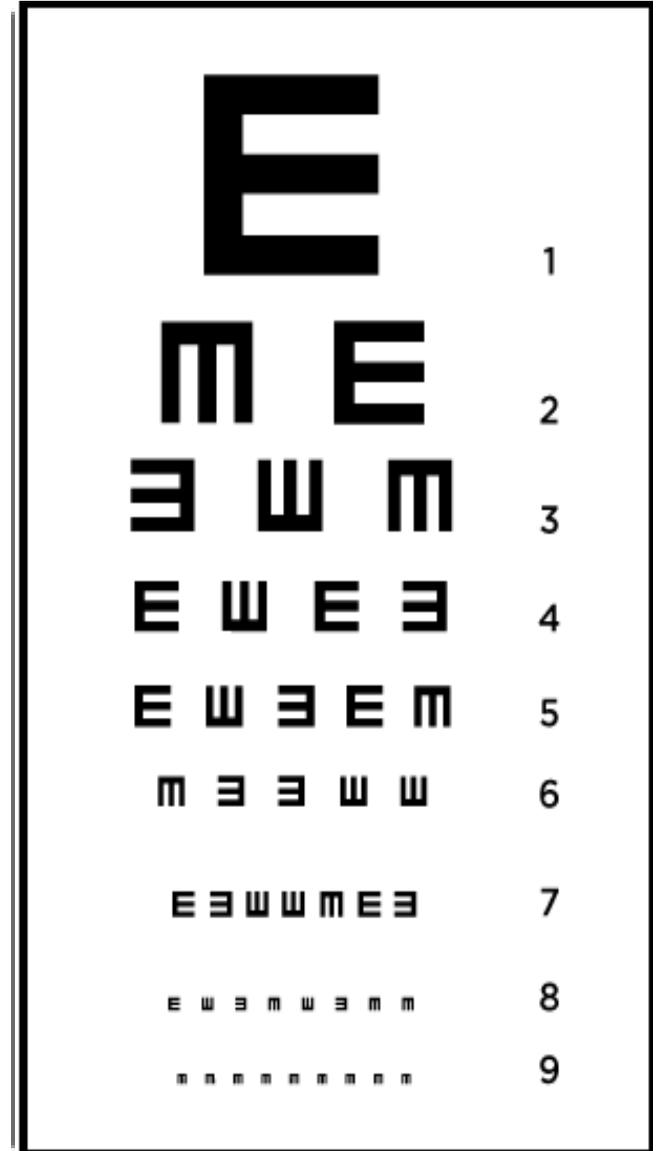
- These **two points** must stimulate **two separate cones** with **one un-stimulated** cone in between.
- when the **two rays** from the **two points intersect** with each other at **nodal point** of the lens, form a **visual angle = 1 minute ($1/60^\circ$)**



Measurement



Landolt's broken circle chart.



Snellen's letter chart

Landolt's broken circle chart

- formed of 7 rows of broken circles
- These rows are graduated in size
- The first line which contain the biggest broken circle can be seen by the normal eye at a distance of 60 meter, the second at 36 m and so on till the seventh smallest line which can be seen at only 6 m.

How to examine ?

- Each eye must be tested separately.
- The patient is tested from above downward.
- At distance of 6 meter to avoid any accommodation.



How to express the result ?

The visual acuity is expressed as fraction: (N/D)

- Numerator:

Represents the **distance** between the patient and the chart.

- Dominator:

represents the **maximum distance** at which **normal person** can **see** the broken **circles**.

What does this mean that the normal visual acuity is 6/6?

Notice that:



- If the patient cannot see the largest row at 6 meters he is moved at 5 meters, then 4 meters till 1 meter.
- If patient is unable to see at 1 meter he is tested by counting finger "CF", if he is unable to count finger he is tested by hand movement and lastly by perception of light "PL".

Factors affecting visual acuity:



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- Illumination (amount of **light**).
- Chart colours **contrast**.
- Eye diseases such as:
 - 1.Errors of refraction diminish visual acuity e.g. myopia.
 - 2.Retinal diseases.
 - 3.Cataract.
 - 4.Glaucoma.

CONTRAST



ERRORS OF REFRACTION

These are groups of disorders affecting mostly the optical system of the eye (lens and cornea) and result in diminution of visual acuity and failure of accurate focusing of rays on the retina.

They includes:-

A-Myopia or short sight

B-Hyper metropia or far sight

C-Astigmatism

D- Presbyopia

A-Myopia

Light rays focused in a point in front of the retina, objects appear blurred and cannot be seen accurately

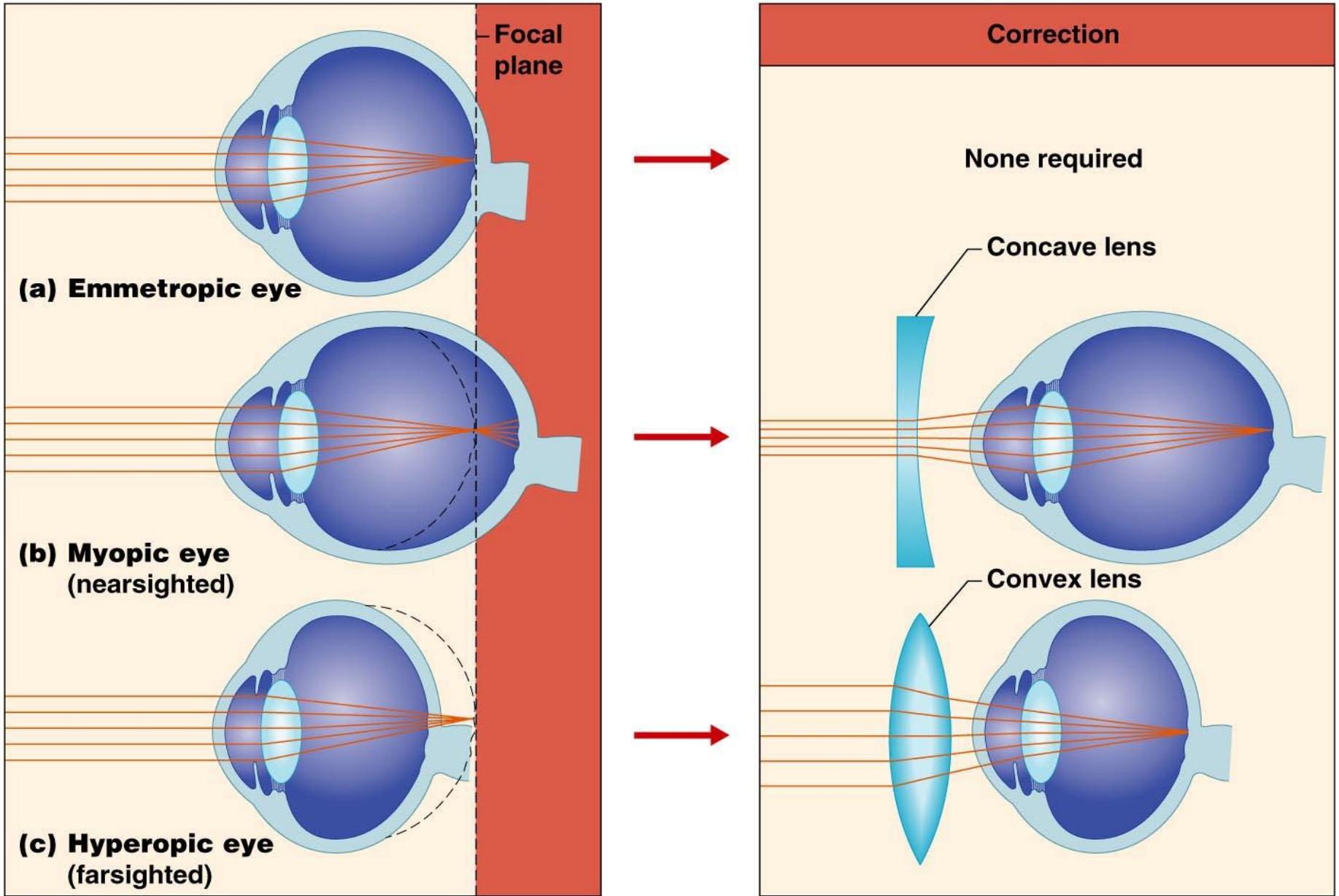
Causes of myopia:-

- 1- large elongated eye ball.
- 2- increase curvature of cornea or the lens
- 3- strong ciliary muscle.

Myopia is corrected by wearing glasses of concave lenses (diverging lens).

B-Hyper-metropia or far sight

- Here, the rays are focused in a point behind the retina.
- Patients can see the far objects (with accommodation)
- **Causes :-**
 - 1- Abnormal short eye ball
 - 2- Flat cornea or flat lens
 - 3- Weak ciliary muscle
- Hyper metropia is treated by wearing glasses of convex (converging) lens.



C-Astigmatism

- In normal eye the curvatures of all planes in the cornea are the same (cornea resembles as a cut part of a ball).
- In astigmatism, there are differences in the curvatures of different planes.
- cornea here resembles as a cut part of an egg
- Rays never focused in one point in the retina and there will be two or more than focusing points which greatly disturb the vision.
- Astigmatism is usually accompanied by myopia or hyper metropia.
- Disturbance in curvature may affect any plane.
- **Treatment:** by cylindrical lenses, Contact lenses are preferred

Presbyopia

- It is an aging process starts above the age of forty, due to loss of elasticity of the lens.
- Failure of accommodation to near vision occurs and person finds great difficulty in reading and he tends to hold every thing away from his eyes.
- The condition is treated by wearing glasses with convex lenses during reading.

Tests of color vision

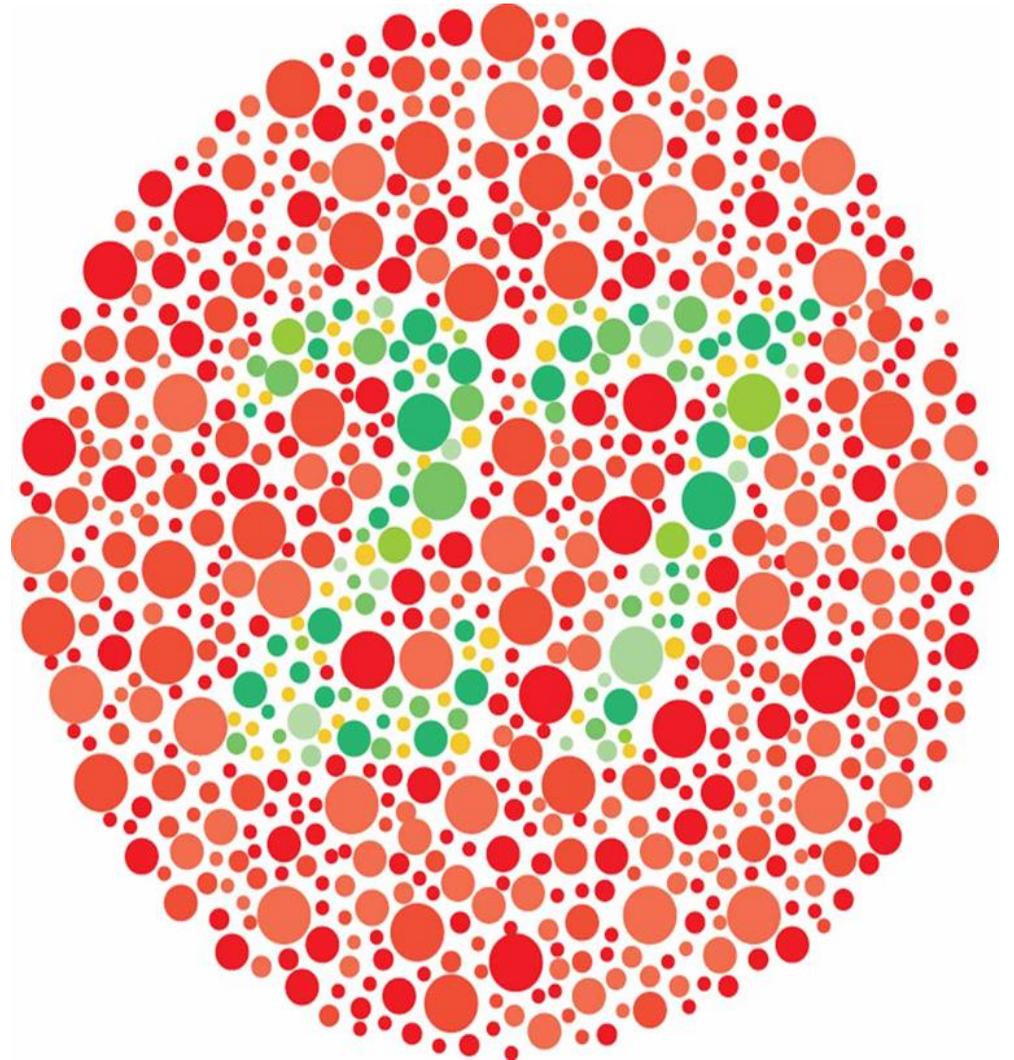
1-Colour matching test:-

Patient is given group of colored tufted wool and is asked to separate similar colored pieces together.

2-Ishihara's chart test:-

These are colored printed figures and each figure is printed by many different colored small circles on a background of colored circles also. Only normal person can read the figure.

Ishihara's chart





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