Lecture : 14

Vision, Accommodation, & Pupillary Light Reflex

Done By: Nada Alouda
Reviewed By: Abdullah Al-Hyaimi

Physiology Team

OBJECTIVES

At the end of this lecture, student should be able to describe:

1. Describe visual acuity.
2. Contrast photopic & scotopic vision.
3. Know visual pathway & field of vision.
4. Describe the process of accommodation reflex & its pathway, contrasting the refraction of light by the lens in near vision & in far vision.
5. Identify & describe pupillary light reflex & its pathway & relate these to clinical situations as Argyll Robertson pupil.
6. Identify the lateral geniculate body & visual cortex.

Physiology Team

MIND MAP

Vision	Accommodation	Pupilary light reflex (light reflex)
Visual acuity: • Definition • Visual threshold • How to measure visual acuity?	**Process of accommodation:** • At rest (looking at far objects). • Looking at near objects.	**Description of pupillary light reflex**
Duplicity theory: • Photopic vision (cones). • Scotopic vision (rods).	**Accommodation reflex** • The reflex • Test used to detect accommodation	**Pupillary light reflex pathway**
Visual pathway	• Near response • Near point •Presbyopia (triad)	**Related clinical situations:** • Atropine drops. • Argyll Robertson pupil
Field of vision	**Accommodation pathway**	----------

- Lateral geniculate body & its function.
- Visual cortex (primary & association areas).

Slides | Important | Doctor's Notes | Explanation | Boy's Slides

Visual Acuity

Definition

- Degree to which **details** of objects are **perceived**.

Visual threshold

- It is the minimal amount of light that elicit sensation of light.

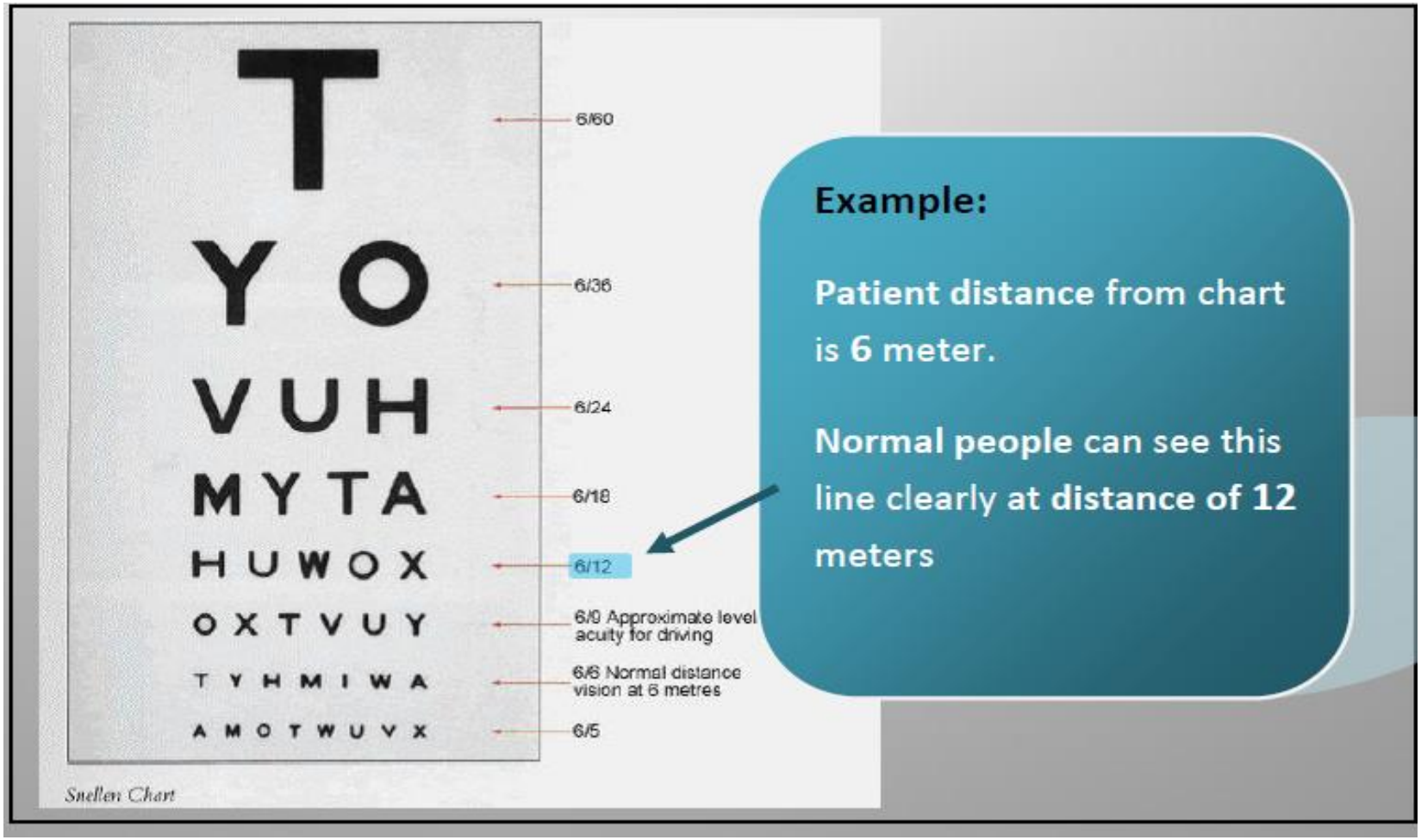
How to measure visual acuity?

- By using Snellen chart.
- Normal acuity = **d/D** (d → distance of patient / D→ distance of normal person = 6/6)

- I.e. a person of 6/12 has less vision than normal vision means that a patient can see an object from a distance 6m while the normal person can see the same object but from 12m, so the fraction doesn't mean something mathematical; it only tells the visual acuity of a patient compared with normal individual.
- Another example: A person of 12/6 has better vision than normal vision (not hyperopic).

Slides | Important | Doctor's Notes | Explanation | Boy's Slides

Visual Acuity: Snellen chart



Slides | Important | Doctor's Notes | Explanation | Boy's Slides

Duplicity Theory of Vision

Duplicity theory: 2 kinds of vision under different conditions:

#	1- Photopic vision	2- Scotopic vision
Condition of vision	Bright light vision.	Night vision, dim light vision.
Photoreceptor	Served by **cones**.	Served by **rods**.
Visual acuity (high or low)	**HIGH** visual acuity = colors & details.	**LOW** visual acuity = **NO** colors or details.
Visual threshold (sensitivity to light)	**LOW** sensitivity to light = needs **HIGH** visual threshold to be stimulated.	**GREAT** sensitivity to light = needs **LOW** visual threshold to be stimulated.

Visual Pathway

Light on eye → Retina (cones & rods) → bipolar cells → (ganglion cells)

↓

Optic nerve (axons of ganglion cells)

↓

Optic chiasma

↓

Optic tract

↓

Lateral geniculate body in thalamus

↓

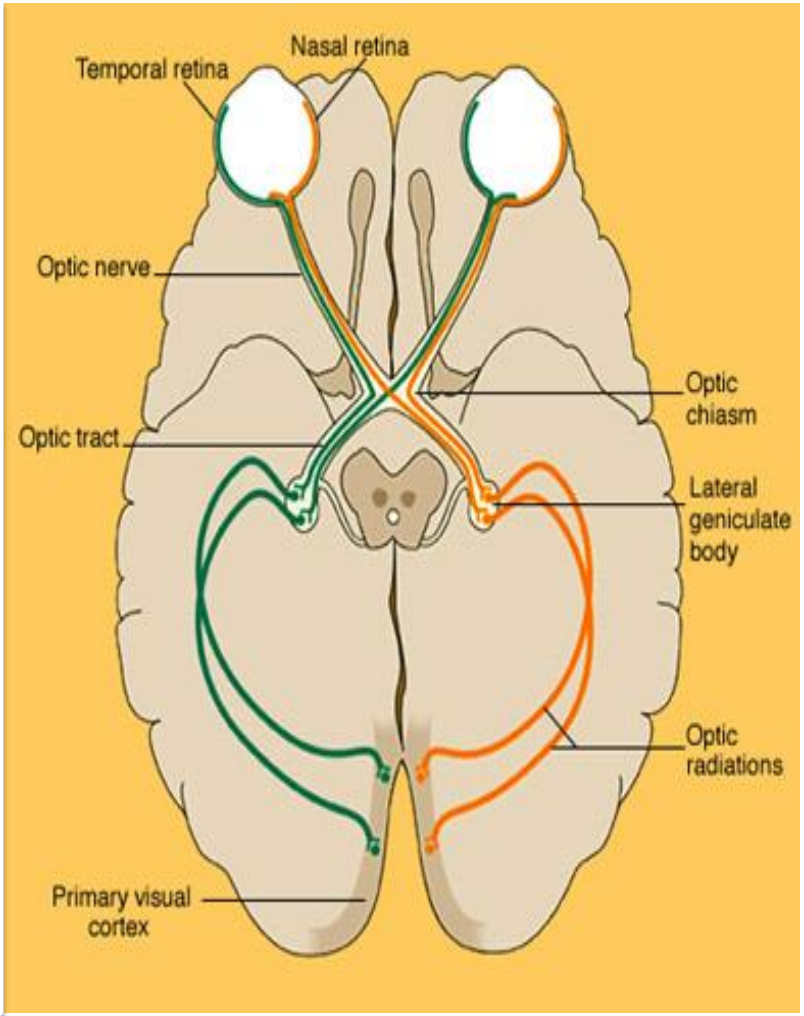
Axons of cells from geniculocalcarine tract

↓

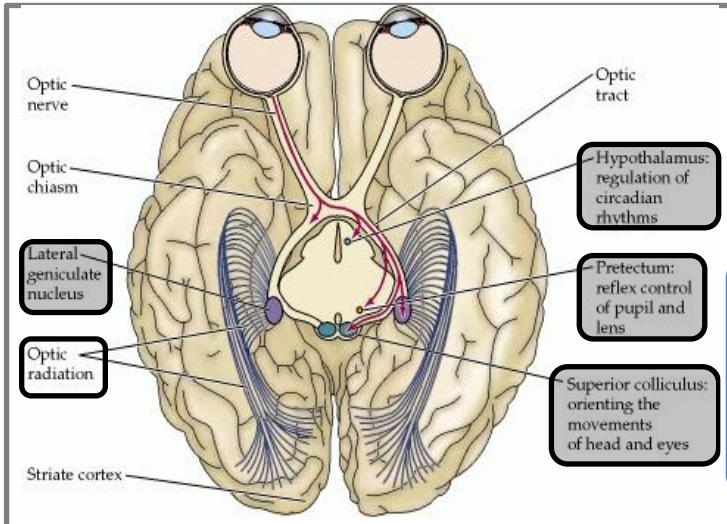
Optic radiation

↓

Visual cortex in occipital cortex (Broadmann area 17 on sides of calcarine fissure)



Visual Pathway (cont.)

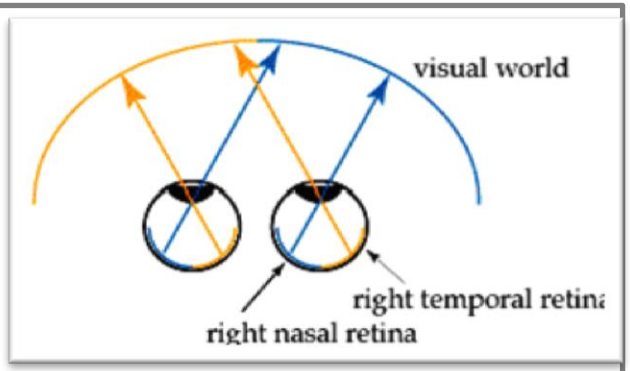


Some optic nerves (axons of ganglion cells) pass:

- TO **pretectal region** of midbrain FOR:
  - **1-** Pupillary reflexes.
  - **2-** Eye movement (nuclei of extraocular muscles).
- FROM optic chiasma pass directly to **hypothalamus** FOR:
  - Circadian rhythm (light-dark cycle).
- TO **superior colliculus** in midbrain FOR:
  - Accommodation reflex & its miosis component.

Slides | Important | Doctor's Notes | Explanation | Boy's Slides

Field of Vision



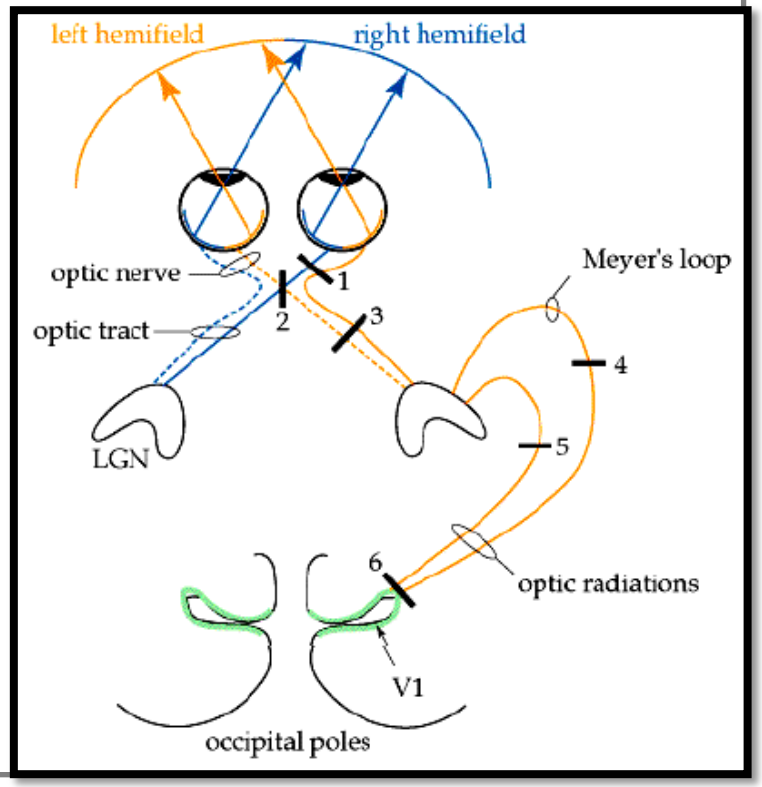
- The **nasal fibers** (medial) **cross** to opposite side in optic chiasma.
- The **temporal fibers** (lateral) **do not** cross.
- The **nasal fibers** convey **temporal field** (outer) of vision.
- The **temporal fibers** convey **nasal field** (inner) of vision.

Optic tract:

➢Includes **temporal fibers** of **the same side** i.e. nasal field of same eye (inner) **+ nasal fibers** of **the opposite side** i.e. temporal field of other eye (outer).

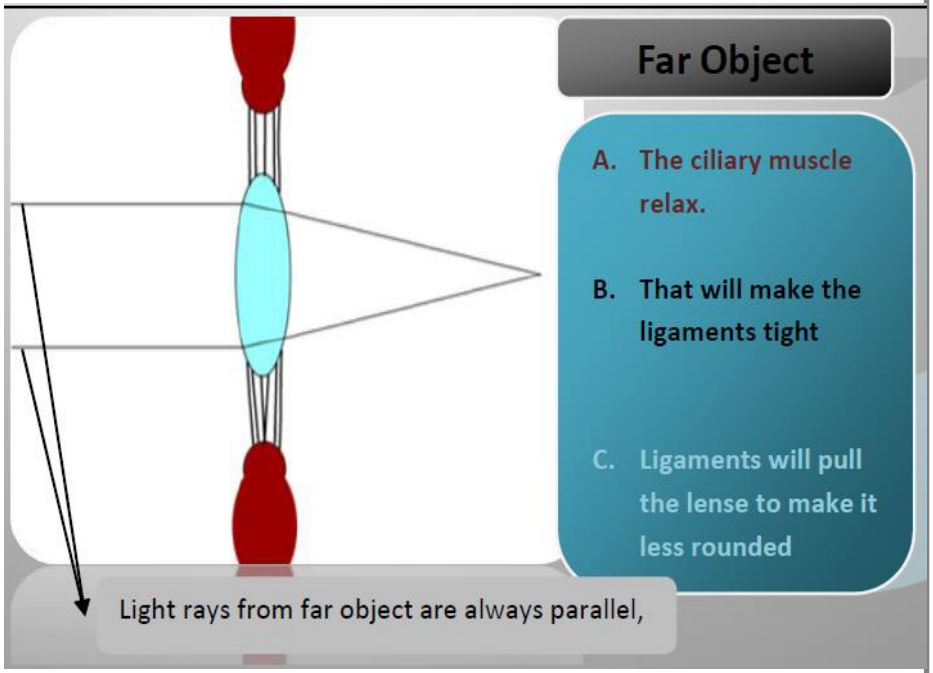
➢The left optic tract (left temporal fibers from left eye + right nasal fibers from right eye) corresponds to the right half of the visual field.

➢The right optic tract corresponds to the left half of the visual field.



■ Slides ■ Important ■ Doctor's Notes ■ Explanation ■ Boy's Slides

Accommodation



At rest (looking at far objects):

1. Ciliary muscles are relaxed.
2. Taut (tense) ligaments.
3. Flat lens.
4. The focus will be on retina.

Looking at near objects:

- If ciliary muscles remain relaxed → parallel rays from near objects focus behind retina → blurred vision **(NO accommodation)** .

Solution:
Increase the curvature of the lens & its refractive power **by accommodation** to bring focus on retina.

■ Slides ■ Important ■ Doctor's Notes ■ Explanation ■ Boy's Slides

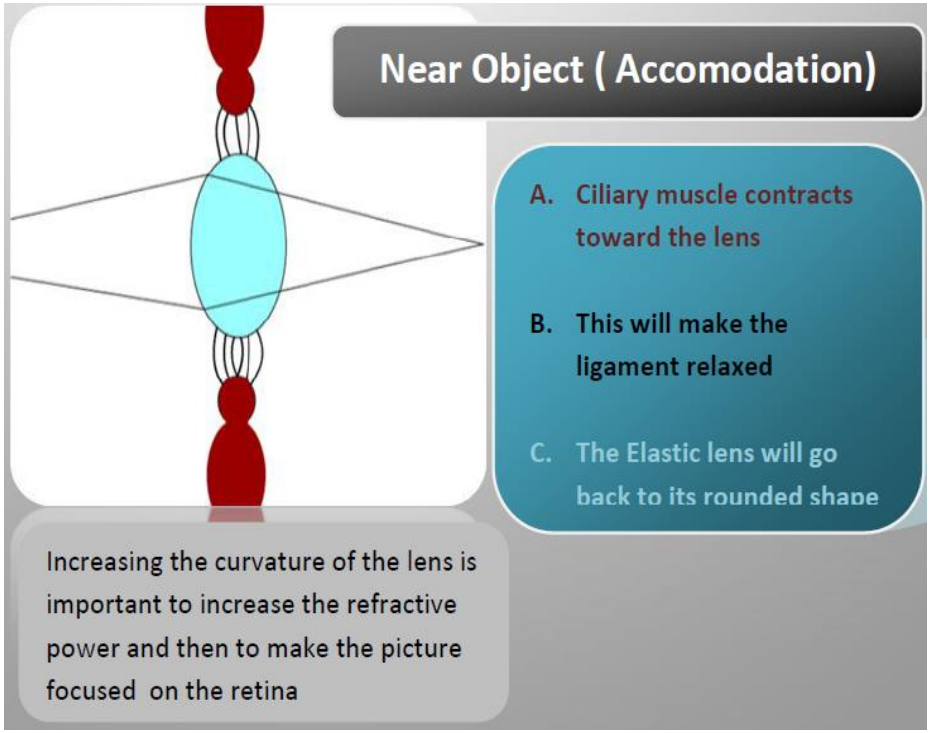
Accommodation Reflex

Physiology Team

Focusing at near objects:

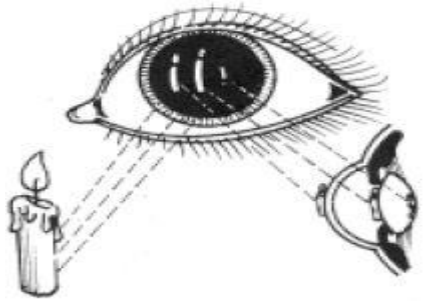
1. Contraction of ciliary muscles.
2. Relaxation (slacking) of ligaments.
3. Increasing **anterior** surface curvature of lens.

- Ciliary muscles contract → ciliary muscles edges come close to each other to **increase** anterior surface curvature of lens & its refractive power by **12D** to bring focus on retina.



Test:

Sanson purkinje image.



Accommodation Reflex (cont.)

Near Response {Looking at a near object}

(there are other things that occur along with accommodation when looking at close objects):

1. Accommodation **TO bring focus on retina.**
2. Convergence of both eyes **TO properly focus an image on retina of both eyes in the same point, if not, there will be double vision.**
3. Pupil constriction (miosis) **To protect the eye from extra light & minimize the amount of light entering the eye.**

Near Point:

- It's the nearest point to eye at which object can brought into focus on retina **by accommodation.**
- **Near point is near to the eye in young age & becomes farther gradually with age:**

1. 10 years → 9cm.
2. At 60 years → 80 – 100cm.

Presbyopia (triad):

1. Loss of accommodation.
2. Loss of lens elasticity.
3. Near point recedes (becomes far).

→ **Correction:** by biconvex lens

Accommodation Pathway

Physiology Team

Light on eye → Retina (cones & rods → bipolar cells → ganglion cells)

↓

Optic nerve (axons of ganglion cells)

↓

Optic chiasma

↓

Optic tract

↓

Lateral geniculate body **in thalamus** **AND** to **superior colliculus** in midbrain for EWN (mother cells of oculomotor nerves)

↓

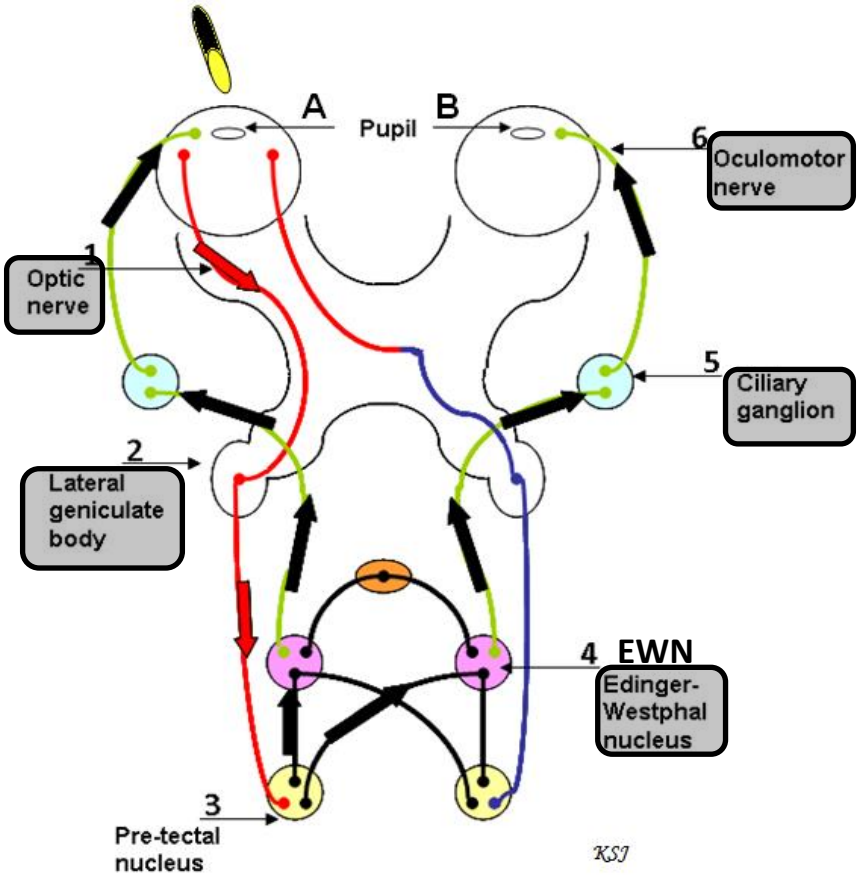
Ciliary ganglion

↓

Oculomotor nucleus

↓

Ciliary body



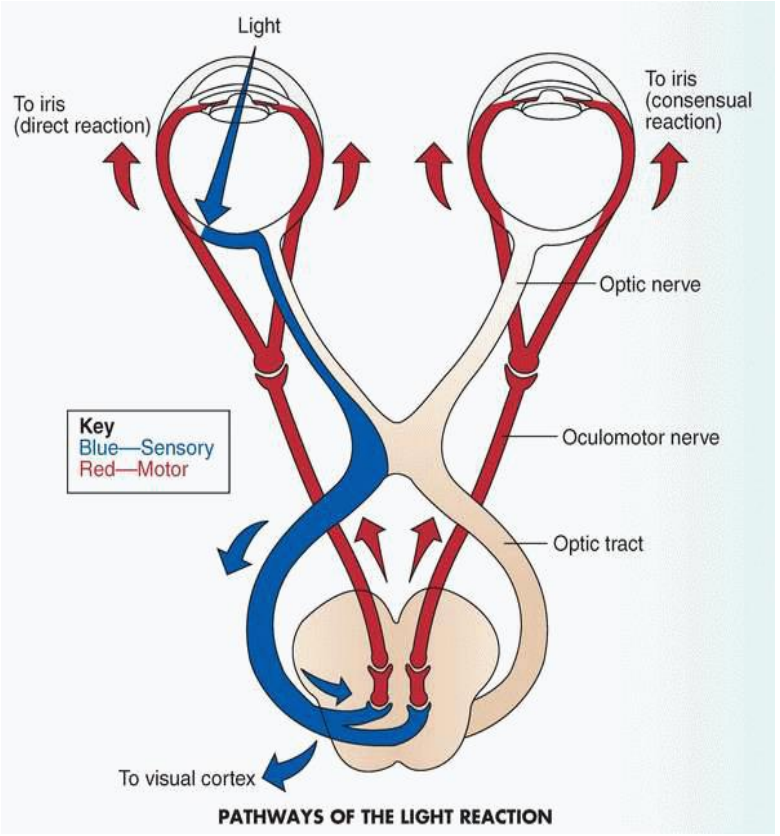
Oculomotor nerves supply both eyes & responsible for near response:

1. **Accommodation by ciliary muscles contraction.**
2. **Convergence by extraocular muscles.**
3. **Miosis by muscles of iris.**

■ Slides ■ Important ■ Doctor's Notes ■ Explanation ■ Boy's Slides

Pupillary Light Reflex

• Light on ONE eye pupil → constriction of this pupil (DIRECT) & constriction of the other pupil (**INDIRECT** or **consensual** pupillary light reflex).



Important:

• **The pathway of pupillary light reflex is posterior to accommodation pathway.**

• **OR in other words, The pathway of accommodation pathway is anterior to pupillary light reflex.**

Pathway of Consensual Pupillary Light (indirect)

Light on eye ⟶ Retina (cones & rods → bipolar cells → ganglion cells)

↓

Optic nerve (axons of ganglion cells)

↓

Optic chiasma

↓

Optic tract

↓

End in **pretectal nucleus** (posterior to superior colliculus)

↓

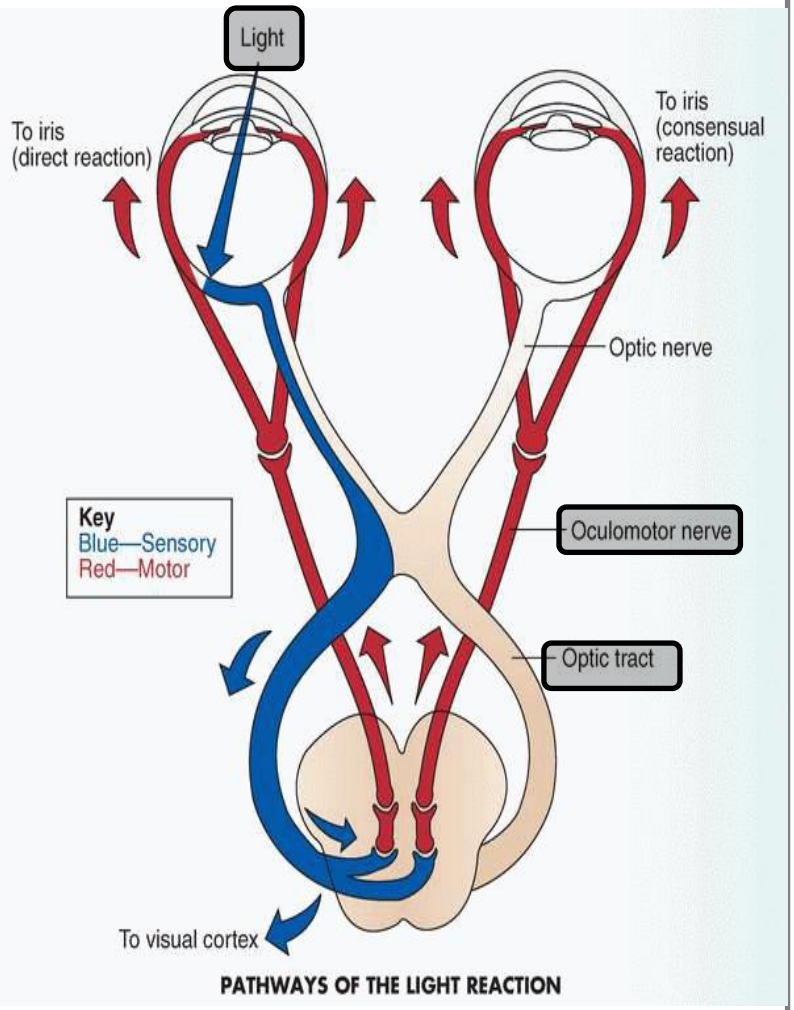
Both oculomotor nerve nuclei (EWN)

↓

Supply both eye by oculomotor nerves

↓

Miosis in **both eyes** (by circular muscles of iris)

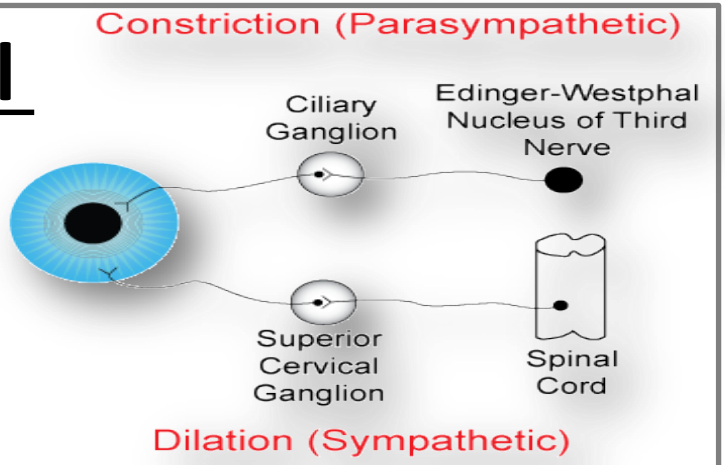


PATHWAYS OF THE LIGHT REACTION

■ Slides ■ Important ■ Doctor's Notes ■ Explanation ■ Boy's Slides

Physiology Team

Related Clinical Situations:



❑ Atropine Drops: It blocks pupillary light reflex

- It's used in profundus examination of eye.

1. The parasympathetic supply of circular muscles of iris → miosis (constriction).
2. **Block** parasympathetic supply of oculomotor ⟶ mydriasis (dilation).

❑ Argyll Robertson Pupil (ARP):

1. In syphilis, tabes dorsalis which **destroy pretectal nucleus** **BUT not superior colliculus.**
2. Light reflex is lose BUT accommodation reflex remains.

■ Slides ■ Important ■ Doctor's Notes ■ Explanation ■ Boy's Slides

Lateral Geniculate Body (LGB)

❑ Lateral Geniculate Body (6 layers in thalamus):

1. Left LGB (similar to left optic tract) has all layers receive from right half of visual field.
2. Right LGB (similar to right optic tract) has all layers receive from left half of visual field.

❑ Function of LGB:

1. Acts as **relay station** for visual information from optic tract to cortex.
2. It has **point to point transmission** (spatial fidelity) = space exactness.
3. Acts as **gate controls signal transmission to visual cortex** i.e. control how much signals reach visual cortex.
4. **Color vision & detect shapes & texture**.

Visual Cortex

❑ **Visual Cortex has 6 layers:**

1. **Primary visual cortex (Broadmann area 17):**

Perceive sensation of vision (movement, shapes, stereoscopic vision {3D}, brightness) & has blobs for color detection.

2. **Association visual cortex (area 18 & 19):**

Interpretation of visual stimuli.

Physiology Team

SUMMARY

- **SNELLEN CHART** is used to measure **visual acuity.**
- **SANSON PURKINJE IMAGE** is used to test **accommodation reflex**.
- **PHOTOPIC** vision is served by **cones** while **scoto**pic by **rods**.
- **ACCOMMODATION REFLEX** depends on ciliary muscles contraction & curvature of lens (refractive power); the stimulus is near object.
- **PUPILLARY LIGHT REFLEX** depends on circular muscles of iris; the stimulus is light toward the pupil.
- Near point becomes farther by aging due to loss of lens elasticity & accommodation leading to presbyopia.
- Pupillary light reflex occurs to both eyes (not only the stimulated eye) due to oculomotor nerve supply to both eyes.
- **HELPFUL VIDEO** about Ciliary Muscle Contraction: http://www.youtube.com/watch?v=aQlCnM0TiRY

Physiology Team

QUESTIONS

Q1: B
Q2: A
Q3: A
Q4: C

Q1: In patient with syphilis, which reflex is lost?

A) Accommodation reflex.
B) Pupillary light reflex.
C) Corneal reflex.

Q2: Which structure is responsible for controlling signal transmission to visual cortex?

A) Lateral geniculate body.
B) Association area of visual cortex.
C) Optic chiasma.

Q3: Which one of the following is the center of visual pathway?

A) Thalamus.
B) Hypothalamus.
C) Superior colliculus in midbrain.

Q4: Which one of the following is responsible for ciliary muscles contraction with miosis?

A) Thalamus.
B) Hypothalamus.
C) Superior colliculus in midbrain.

Physiology Team

THE END

If there are any Problems or Suggestions,
Feel free to contact:

Physiology Team Leaders

Mohammed Jameel & Shaimaa Al-Refaie

432100187@student.ksu.edu.sa
432200643@student.ksu.edu.sa

THANK YOU