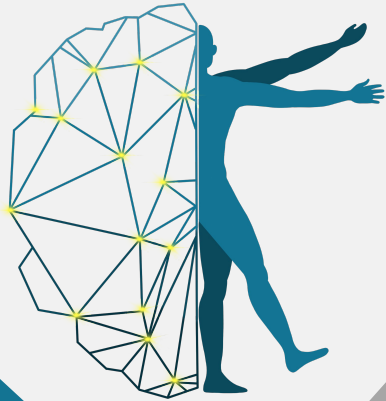


Revised & Approved



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Vision, Accommodation & the light pathways and effects of lesions

Objectives:

- ❖ Describe visual acuity & depth perception.
 - ❖ Contrast photopic and scotopic vision
 - ❖ To know visual pathway and field of vision
 - ❖ Describe the process of accommodation reflex and its pathway, contrasting the refraction of light by the lens in near vision and in far vision
 - ❖ Identify and describe pupillary light reflex , its pathway and relate these to clinical situations as argyll Robertson pupil
 - ❖ identify the lateral geniculate body and visual cortex functions
-

Color index:

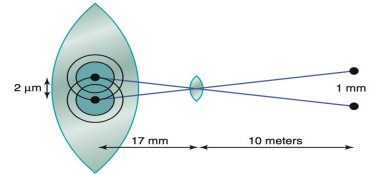
- ❖ **Important.**
- ❖ **Girls slide only.**
- ❖ **Boys slide only.**
- ❖ **Dr's note.**
- ❖ Extra information.



Editing File

VISUAL ACUITY

- ❖ **Degree to which details of objects are perceived.**
- ❖ It is usually defined in terms of the **shortest distance** by which two lines can be separated and still be seen as 2 lines
- ❖ Person can normally distinguish two separate points if their centers lie up to 2 micrometers apart on the retina, which is slightly greater than the width of a foveal cone
which is approximately 1.5 micrometers
- ❖ **Visual acuity** measure by Snellen chart
- ❖ **Normal acuity = (d/D) = (6/6).**
d distance of Patient / D distance of normal person
- ❖ A person of 6/12 has less vision than normal vision
which mean you see 6 meter apart what the normal person able to see it 12 meter apart
- ❖ **Visual threshold** Is minimal amount of light that elicit sensation of light
(أقل كمية ضوء تشوفي فيها، تستفز العين وتعمل لها excitement)



IMP note

- fovea has the maximum acuity for the following reasons:
- 1- it has cones rather than rods
 - 2- cons in fovea are small in diameter so they're packed
 - 3- fovea represents a large area in the primary visual cortex (area 17)
 - 4- cons has 1 to 1 representation meaning that each con synapse with one bipolar neuron and each bipolar neuron synapse with 1 ganglion cell
 - 5- the fibers around cons are pushed aside in fovea so that the light goes directly to the cons



6 meter

less than 6 meter cause accommodation

Duplicity Theory of Vision

Q. Differentiate

2 kinds of vision under Different conditions

SCOTOPIC VISION (night vision, dimlight vision)

- ❖ served by **Rods**
- ❖ low visual acuity = no colours or details
- ❖ great sensitivity to light = low visual threshold

أكيد لذلك يشوفون بالليل

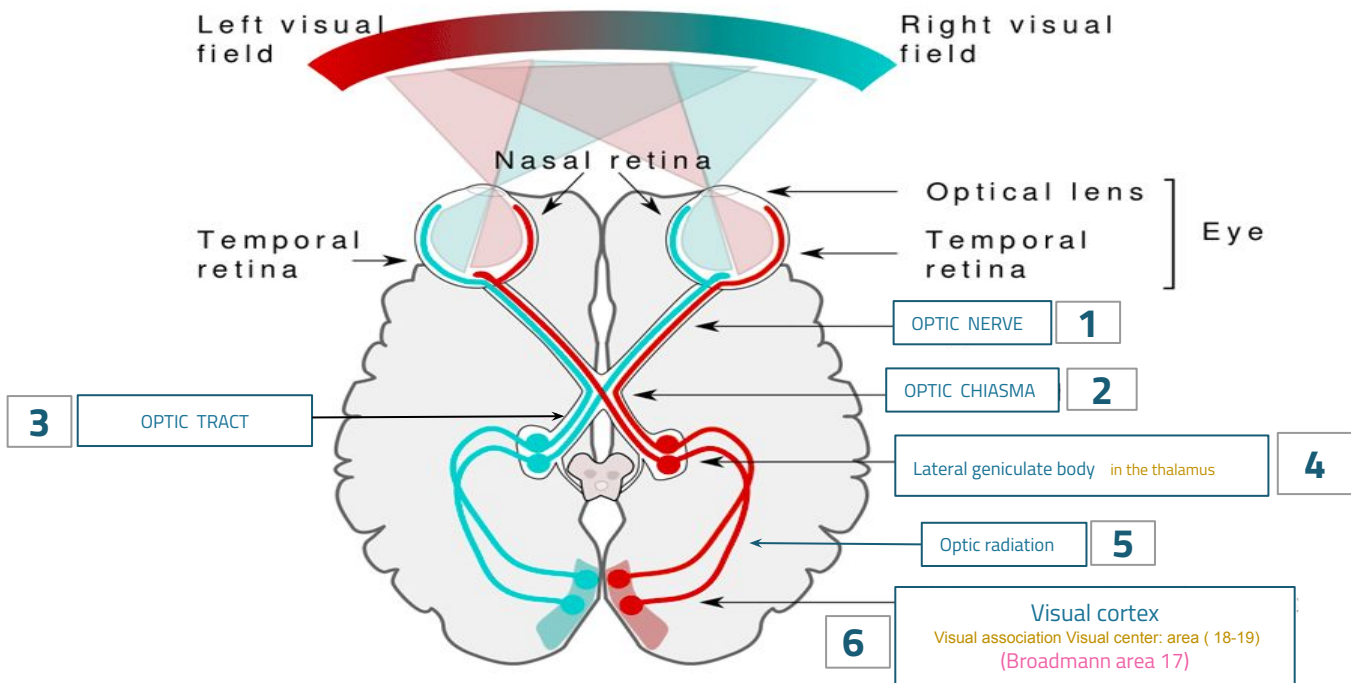
أو يمكن بس يشوفون
الابيض والاسود والgray

PHOTOPIC VISION (bright light vision)

- ❖ served by **Cones**
- ❖ high visual acuity = colours & details
- ❖ low sensitivity to light = needs high visual threshold to be stimulated

Visual Pathway

- ❖ Pathway from **Retina** to the **Visual Centers** in the Brain
- ❖ **Photoreceptors** : Rods and Cones synapse on Bipolar Cells , which in turn , synapse on Ganglion Cells .
- ❖ Axons of **Ganglion Cells** constitute the Optic Nerve .
- ❖ These axons converge at the Optic disc ,which is also called Blind Spot
(Why ?) ... **Because there are no photoreceptor only way for optic nerve to pass through**
- ❖ Passing through the Blind Spot they leave the eye , constituting the Optic Nerve



1

Some ganglion cells axons pass from optic tract to pretectal region of midbrain for pupillary reflexes & eye movement

راح midbrain أيضًا لكن عشان pretectal nucleus (جنب ال colliculus superior) مسؤولة عن: reflex light pupillary) تتوسع العين أو تضيق حسب الضوء زي إذا كان الضوء ضعيف مرة تتوسع عشان تجمع أكثر قدر ممكن من الضوء بعكس لو كان الضوء كثير مرة بتضيق

2

Some axons of ganglion cells from optic chiasma pass directly to hypothalamus for circadian rhythm (light-dark cycle)

النوع الثالث بيروح directly to hypothalamus مسؤولة عن rhythm circadian و تخلينا ننام بالليل ونصحى بالنهار

3

Some axons from lateral geniculate body in thalamus to superior colliculus in midbrain to control rapid directional movements of the two eyes and accommodation. R & its miosis component

راح midbrain تحديداً colliculus superior مسؤول عن أيش؟ accommodation reflex and miosis of pupil

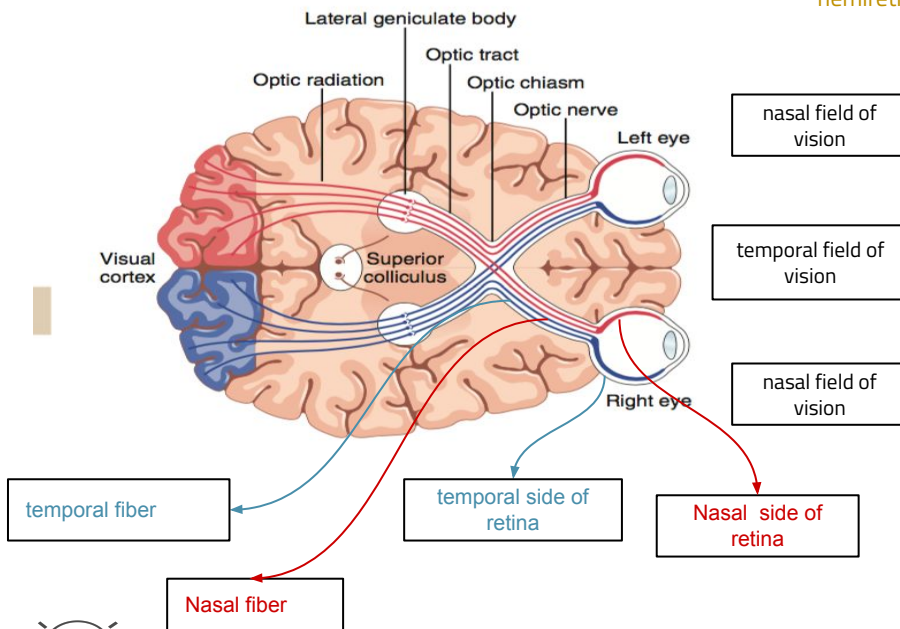
VISUAL Pathway

- ❖ Optic nerve fibers from the medial (nasal) side of retinae decussate **Optic Chiasma**
- ❖ Therefore an Optic Chiasma lesion (e.g. Pituitary Tumor) will cause vision loss from the both.. lateral(temporal) halves of the Field of Vision (bitemporal hemianopia)
- ❖ Optic nerve fibers from the lateral (temporal) parts of the retinae do not decussate
- ❖ Therefore , each optic tract carries fibers from the both the temporal side of the ipsilateral retina + nasal side of the contralateral retina.
- ❖ Therefore , a lesion in optic tract will cause loss of vision from the ipsilateral nasal field of vision + contralateral temporal field of vision .

There are two vision fields 1-temporal 2-nasal, the temporal visual field is represented on the nasal hemiretina while the nasal visual field is represented on the temporal hemiretina.

the nasal hemiretina (temporal visual field) decussate in the optic chiasm -> a lesion here can cause loss of the temporal visual field called bitemporal hemianopia (tubal vision), the temporal hemiretina (nasal visual field) doesn't decussate so a lesion in the optic tract can cause problems with both fields called homonymous hemianopia

تسمى المشكلة حسب اللي يشوفه المريض وليس حسب ال hemiretina



تطلع منه فايبرز تنشوف الجزء الخارجي Nasal fibers see the outer portion only.

بالاضافة لو تتبعون nasal fibers بتلاحظون هي اللي تسبب crossing فقط

Temporal fibers DON'T involve in decussation

each optic tract carry:
1- Crossed Nasal fiber
2- Uncrossed Temporal fiber



Dr.Faten important Note:

طبيب لو صار في chiasm مشكلة؟ خاصة مشاكل pituitary gland .Because the pituitary gland located beneath the chiasm
> So pituitary tumor for example will cause injury for optic chiasm > cause injury to nasal fibers
طبيب أي field ماعاد راح ينشاف؟ أكيد outer (lateral) part of each field
(Pts loss half of each eye)

VISUAL PATHWAY & FIELD

Girls slide only.

- ❖ The nasal fibers (medial) cross to opposite side at optic chiasma
- ❖ The temporal fibers (lateral) do not cross □
- ❖ Nasal fibers conveys temporal field (outer)of vision □
- ❖ Temporal fibers conveys nasal field (inner)of vision

OPTIC TRACT :

- ❖ The left optic tract corresponds to the right ½ of the visual field
- ❖ The right optic tract corresponds to the left ½ of the visual field

Accommodation

Modification of the refractive power of the eye
(curvature of the lens)

the goal: clearing the vision view of a nearby object

by increasing the curvature of the lens

- ❖ Ciliary muscle has two separate sets of smooth muscle fibers
longitudinal fibers and circular fibers
- ❖ Contraction of either set in the ciliary muscle relaxes the ligaments to the lens capsule, and the lens assumes a more spherical shape, because of the natural elasticity of the lens capsule & and increase its refractive power up to 12 diopter
- ❖ The ciliary muscle of accommodation is Controlled by Parasympathetic Nerves transmitted to the eye through Oculomotor nerve

Distance Vision

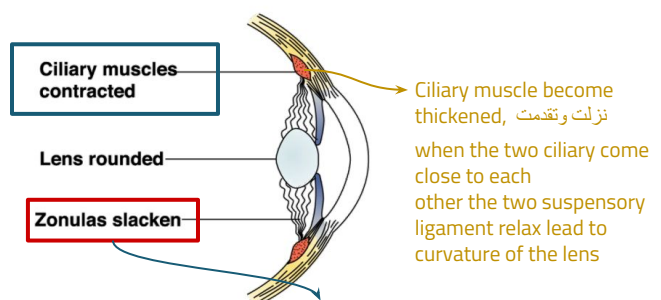
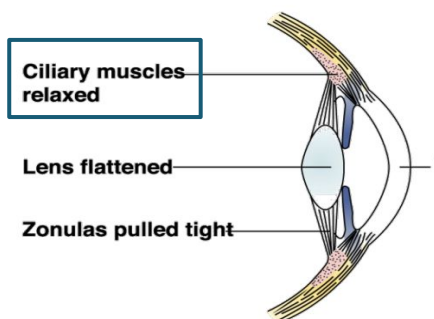
Accommodation

هذي متى تصير؟ لما نشوف القريب ولا البعيد؟ القريب. لاننا نخاف ان focus
ترجع ورا، بخلف لا نشوف مكان بعيد الفوكس في مكانها الصحيح "Retina"

1	Ciliary Muscle Relaxed
2	Suspensory Ligaments Under Tension
3	Lens is Flattened
4	Focus on Distant Objects

1	Ciliary Muscle Contracts
2	NO Tension on Suspensory Ligaments
3	Lens becomes Round (more convex)
4	Focus on Near Objects both circular & longitudinal ciliary muscles contract to pull ciliary

when both of these contract ciliary muscle will move inward and forward



Slack or Slacken or LAX all of them mean relaxation of suspensory ligament

zonulas = Suspensory Ligaments

Accommodation Cont...

At rest (looking at far objects):-

- ❖ Ciliary muscles are relaxed + taut (tense) ligaments + flat lens

looking at near objects:- □

- ❖ from near (close) objects parallel rays focus behind retina (if ciliary muscles remain relaxed) Cause blurred vision
- ❖ Solution is to increase curvature & refractive power of lens by accommodation to bring focus on retina.

Dioptric power of the eye:

Cornea: 40-45 D □

Lens : 15-20 D

Accommodation +12 D □ the lens is more important than cornea for accommodation because it will increase the dioptric power

Near response

convergence of both visual axis. WHY ?

لما ننظر شيء قريب كل العينين تشوف medial side ، ناحية الأنف
س: ليه العينين كلهم يناظرون لنفس الكان؟ اللي نسميه convergence
ج: عشان نجيب corresponding point of the image on same focus for both eye
يعني العينين يجيبون ال focus لنفس الكان

pupil constriction. Why?

protection from excess light

Accommodation. Why?

To increase the refractive power and bring the focus on the retina

Accommodation reflex:- Girls slide only.

- ❖ Focusing at near object by increased anterior surface curvature of lens by ciliary muscles contraction → slack = relaxed ligaments & increased anterior surface curvature of lens . why? to add 12D to refractive power of lens
- ❖ both circular & longitudinal ciliary muscles contract to pull ciliary muscle forwards & inwards → ciliary muscles edges come close to each other to increase anterior surface curvature of lens.

Test sanson purkinje image

اختبار كانوا يسوونه زمان، يجيبون شموع ويحطونها قدام العين ويشوفون ثلاث صور تتبع accommodation ال

- 1-cornea image
- 2-anterior surface of the lens
- 3-posterior surface of the lens

Near Point

Nearest point to eye at which object can brought into focus on retina by ACCOMODATION

اللي عمره ١٠ سنوات يشوف حتى لو الاوبجكت قريب منه الى حدود ٩cm
 أما كبار السن يحتاجون يبعدون عن الاوبجكت 100cm عشان يشوفون

10 years → 9 cm

60 years → 80 - 100 cm, due to hardness of lens & loss of accommodation

Presbyopia Ciliary muscle become hard

1- loss of accommodation & focus behind retina

2- loss of lens elasticity dr.faten : weakness not loss

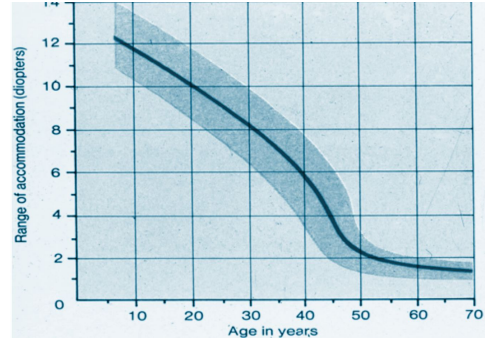
Hardness of lens, CAN NOT increase the convexity; cannot increase the dioptric power

3- near point recede

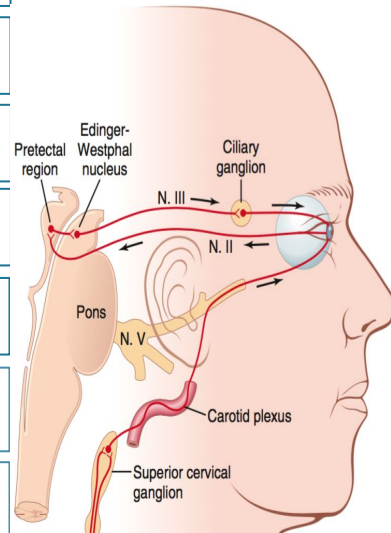
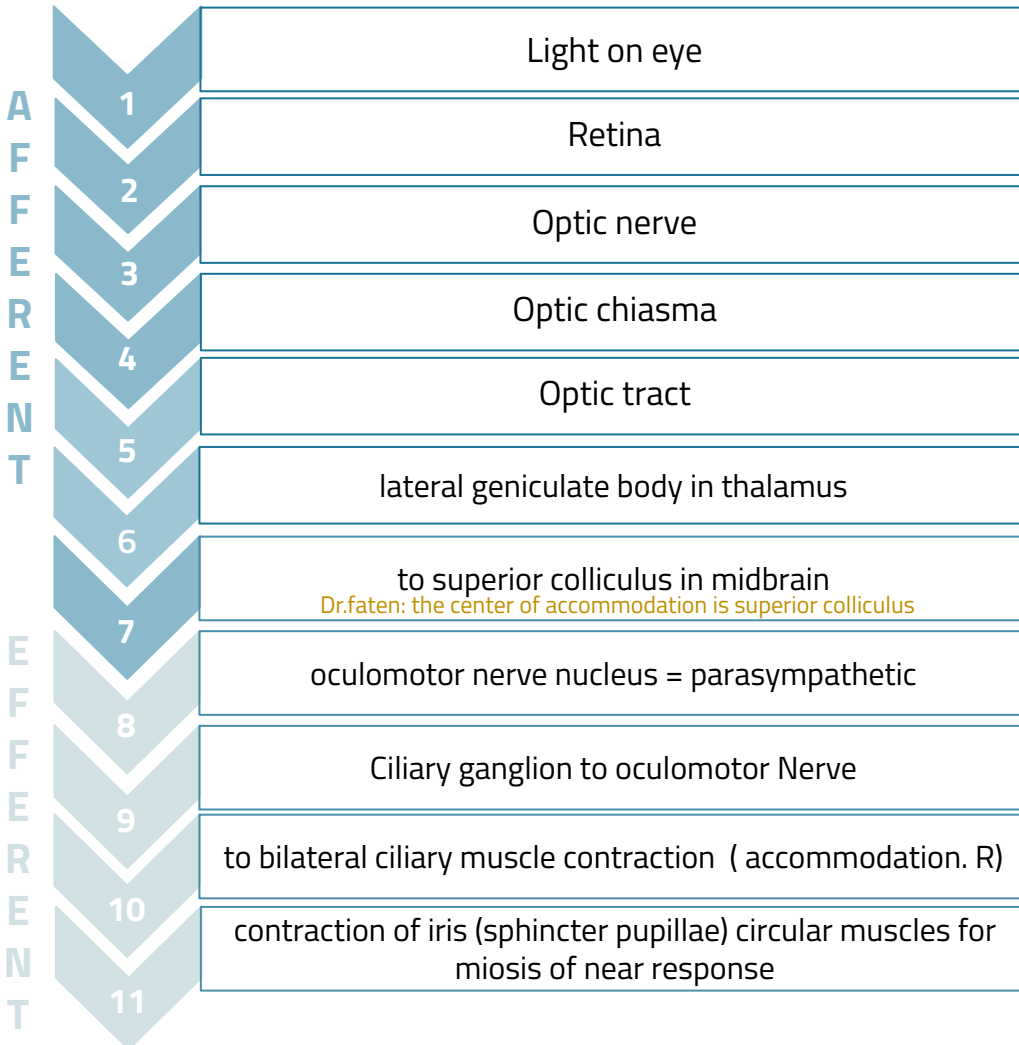
نرجع الاوبجكت، لان هو قريب ال focus ورا ال retina
 فنبعد الاوبجكت عشان الفوكس تراجع مكانها الطبيعي

-correction by biconvex lens

To decrease the focal distance by increase the convexity of lens



Accommodation Pathway Girls slide only



Pupillary light reflex (استجابة العين للضوء)

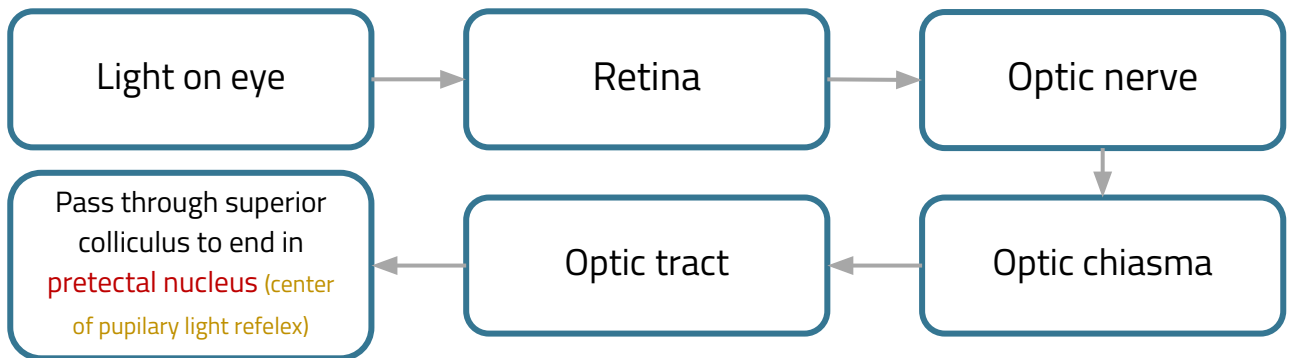
- ❖ Light fall on one eye pupil → constriction of this pupil (**direct pupillary reflex**) and the other pupil **indirect or consensual** (مصاحب للأساسي). when eye (left) is subject to bright light, a direct light reflex occurs (constriction of the pupil) as well as a Consensual (indirect) reflex of the other * Right" pupil.

both eyes respond to the light why?

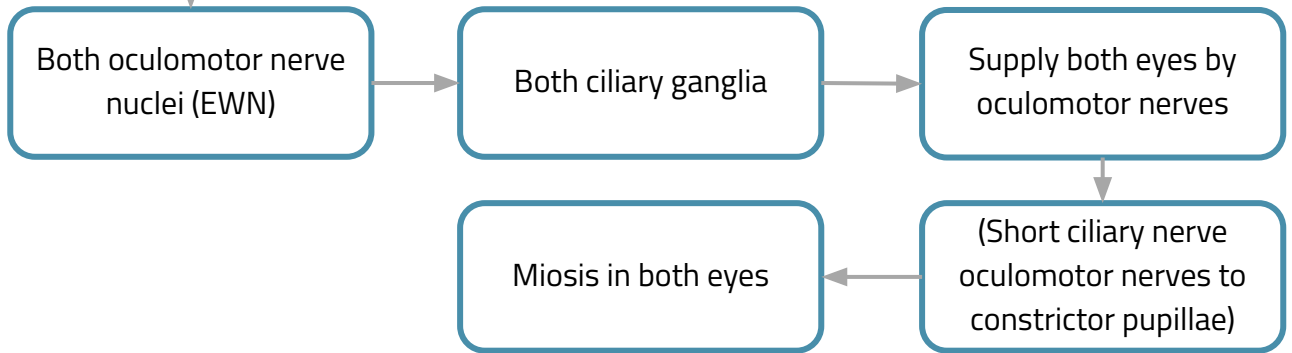
because 1- the afferent fibers will decussate 2- the efferent (nucleus of edinger westphal) is to both eyes

Pathway of Pupillary light reflex (indirect):- girls slide only

Afferent pathway



Efferent pathway



- ❖ Conversely, in darkness, the reflex becomes inhibited, which results in dilation of the pupil.

The pupil constricts in response to:

- ❖ The **accomodation Reflex** Its center: superior colliculus
- ❖ The **light reflex** ts center: pretectal nuclus

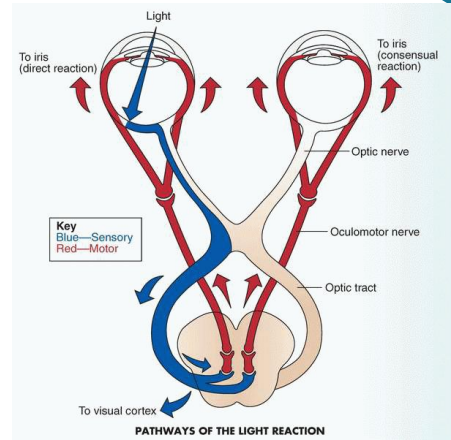
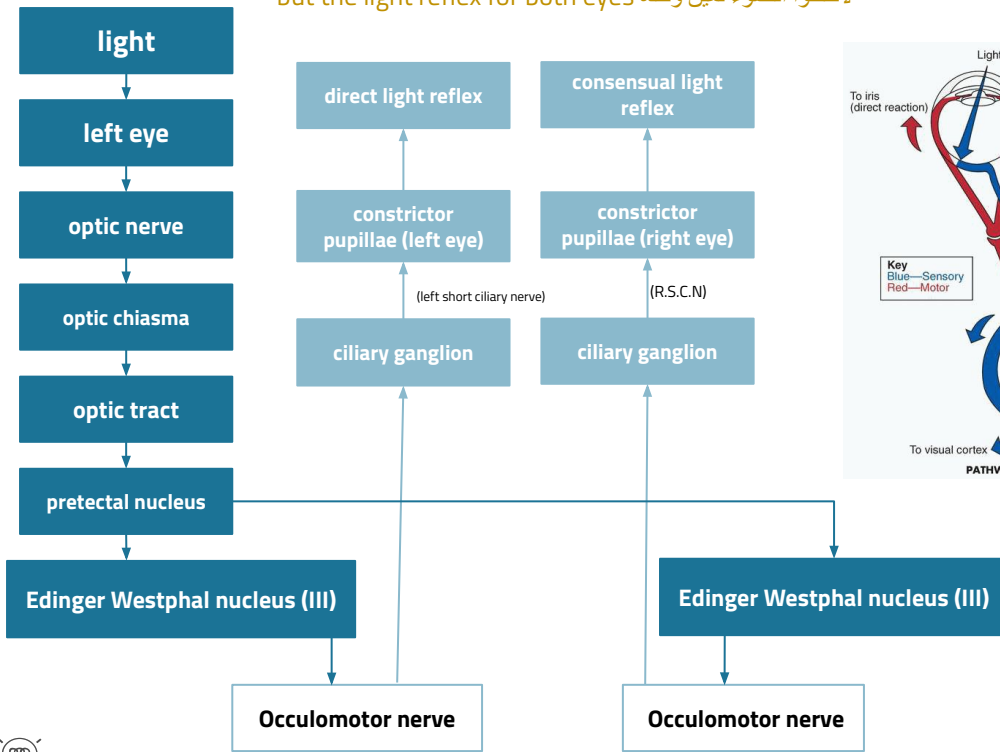
Argyll Robertson pupils (Neurosyphilis) الزهري مرض تناسلي

- ❖ Pupils constrict in response: to accomodation reflex ,but not to the light reflex
- ❖ In syphilis tabes dorsalis which destroy pretectal nucleus only, away from superior colliculus & fibers of accomodation.
- ❖ light .R is lost but accomodation R remains can be seen in SLE and DM2 as well

Direct reflex on right & Consensual reflex on left

Girls slide only

but the light reflex for both eyes لاحظوا الضوء لعين وحدة



The light enter on pretectal nucleus and superior colliculus
 There is ganglia for motor nerve nuclei and there's ciliary ganglia for motor nerve fiber
 then will give oculomotor nerve for both eyes
 then will be miosis in the eyes muscles so direct pupillary light reflex for the eye which see
 the light, indirect to the other eye will occur



Three types of retinal ganglion cells and their respective fields

boys doctor said its for your knowledge

1

W cells: 40% with small diameter, sensitive or detecting **directional movement** in the field of vision, and they are probably important for much of our **rod** vision under dark. تشيل الفايرز بتاع ال rods اكثر

2

X Cells: 55% has a medium size diameter Transmission of the Visual Image and Color Vision

تخدم ال cones اكثر لانها تاخذ اغلب الفايرز منه وهي المسؤولة عن الالوان

3

Y Cells: 5% only with large diameter to Transmit Instantaneous & rapid Changes in the Visual Image, either rapid movement or rapid change in light intensity

Lateral geniculate body LGB (found in thalamus)

- ❖ Left LGB (similar to left optic tract) has all layers receive from RIGHT 1/2 of visual field.
- ❖ Right LGB (similar to right optic tract) has all layers receive from LEFT 1/2 of visual field.
- ❖ LGB has 6 layers.



مثل ما قلنا في optic nerve tract علاقة عكسية بين اسم LBG and visual field

Function of LGB:

- 1 acts as a relay (synapse يعني بنعمل جواه) station for visual information from optic tract to cortex
- 2 Acts as gate controls signal transmission to visual cortex i.e control how much signals reach visual cortex.
(المشكلة أن ال visual impulses <<تجينا من ال visual pathway بأعداد هائلة يمكن توصل ملايين هو يرتبها ويحدد مين يدخل قبل الثاني" كانه security "
- 3 It has point to point transmission with high degree of spatial fidelity (تحديد المكان بدقة).
(يعني ب point to point أن كل fiber تجي تخش على synapse one)
- 4 color vision & detect shapes & texture
is consider some source of processing of color vision, shapes, texture الكورتكس قبل ما تدخل.
- 5 It receives gating control signals from two major sources:
 - Corticofugal fibers returning in a backward direction from the primary visual cortex to the lateral geniculate nucleus.
 - Reticular area of the mesencephalon. Both of these are inhibitory and ,when stimulated, can turn off transmission through selected portions of the dorsal lateral geniculate nucleus.

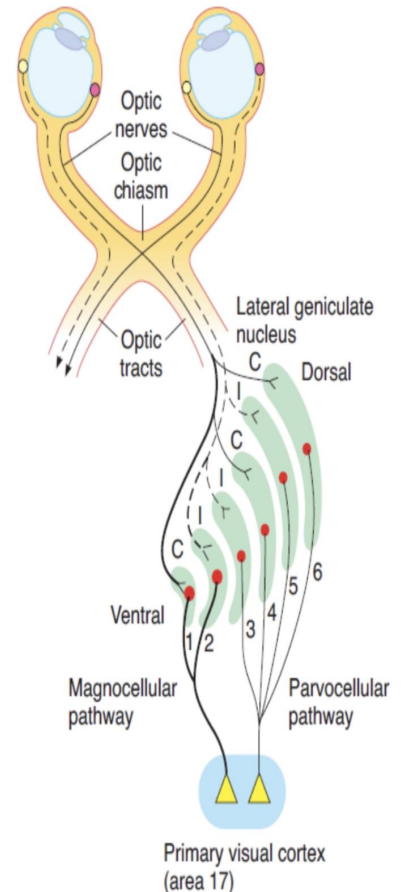
LGB pathways to visual cortex

1 The magnocellular pathway (primary cerebral cortex يأخذ ال signals بسرعة يودبها ال)

- from layers 1 and 2 which have large cells and are called magnocellular, carries signals for detection of movement, depth, and flicker.
- These receive their input almost entirely from the large type M retinal ganglion cells.
- a rapidly conducting pathway to the visual cortex. but, this system is colour blind, which project to magnocellular layer of LGB, and they are high sensitive to low contrast stimuli and to rapid movement visual signals.

2 The parvocellular pathway

- From layers 3,4,5,6 which have small cells and are called parvocellular, carries signals for color vision, texture, shape, and fine detail.
- These neurons receive their input almost entirely from the type P retinal ganglion cells that transmit colour and convey accurate point-to- point spatial information.
- moderate velocity of conduction ينقل المعلومات ببطئ شوي rather than at high velocity.
- cells which project to parvocellular layer of LGB, conducting signal of fine details & colors

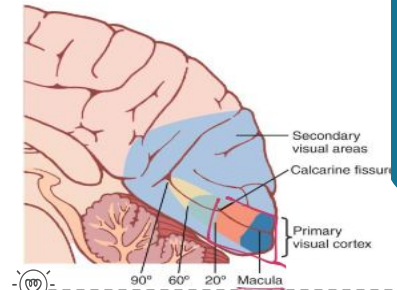


Cortical Visual areas:

- ❖ Primary (area 17) (اخر محطة) signals اخر شيء توصل له ال
- ❖ Secondary association area, (areas 18, 19) primary 17 يكونون قدام فوق ال near the parietal and temporal lobe

visual cortex

The Primary Visual Cortex Has Six Major Layers of cells arranged vertically each act as a separate unit for processing of informations
 The fovea have large area of representation من احتلت كمية كبيرة من neuron
 visual acuity is responsible for the highest degree of visual acuity, so it has larger representation in the primary visual cortex than the most peripheral portions of the retina.



منطقة ال fovea
 مكتوب macula وش دخل ال fovea ؟
 Fovea is the center of macula
 الماكويلا الحفرة كلها و الفوقيا في الوسط
 حقه المجوف وجواه ال focus



عشان نشوف الصورة بأوضح رؤية processing كل واحد يسلك المعلومات اللي جات له ويعمل عليها

Primary visual cortex (braodmann area 17)

- ❖ On medial aspect of each occipital lobe
- ❖ Its neurons arranged in the form of columns forming 6 distinct layers
- ❖ Fovea has broad presentation
- ❖ Perceive sensation of vision (movement + shapes + stereoscopic vision + brightness) & has blobs for color detection
- ❖ Perception of visible objects without knowing the meaning of these objects
- ❖ Effect of removing the primary visual cortex removal of the primary visual cortex causes loss of conscious vision, (blindness) هذا سبب انه خلال العملية ممكن يفقد النظر او السمع
- ❖ **Effect of Removing the Primary Visual Cortex:**

Removal of the primary visual cortex causes loss of conscious vision, (blindness) (but patient react subconsciously to changes in light intensity, to movement in the visual scene.) These reactions include turning the eyes, turning the head, and avoidance. This vision is believed to be sub served by neuronal pathways that pass from the optic tracts mainly into the superior colliculi but still they will respond to light reflex even with blindness

Association visual cortex (area 18&19) (secondary visual areas) : منطقة التفسير

- ❖ located mainly anterior "lateral, inferior, and superior to the primary visual cortex extend to parietal & temporal lobes
- ❖ **function:-**
- ❖ Interpretation of visual stimuli
- ❖ dealing with complex perception of patterns & forms & responsible for object recognition
- ❖ The fixation mechanism that causes the eyes to lock subject لعيني على ايني اوقف واعمل fixation
 لو فقدنا هذه المنطقة مراح meaning بش نشوف بش نفقد blindness معين يعني نشوف بش ما ندري وش نشوف
- ❖ we said before this areas are extended to the parietal and temporal lobes why? this areas have memory so to explain and understand the photo you need to back to your experience and join the photo you see to your memory e.g this is Sara , mouse , book and so on .

Visual projection to area 17

يقولكم الفايبرز اللي جت من LBG
They will synapse in the visual cortex

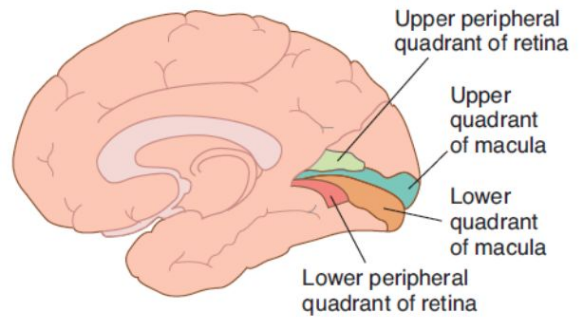
- ❖ **Color Blobs** are in the Visual Cortex. Interspersed among the primary visual columns & among the columns of the secondary visual areas clusters of cells responsible for **color detection**
- ❖ **Simple cells** detect color contrast details, bars of light, **lines**, **borders** and **edges**
- ❖ **Complex cells** detect Line Orientation When a Line Is Displaced Laterally or Vertically in the Visual Field (**linear movements of a stimulus**)

Macular sparing :

Loss of peripheral vision with intact macular vision because the macular representation is separate from that of the peripheral fields and is very large relative to that of the peripheral fields .



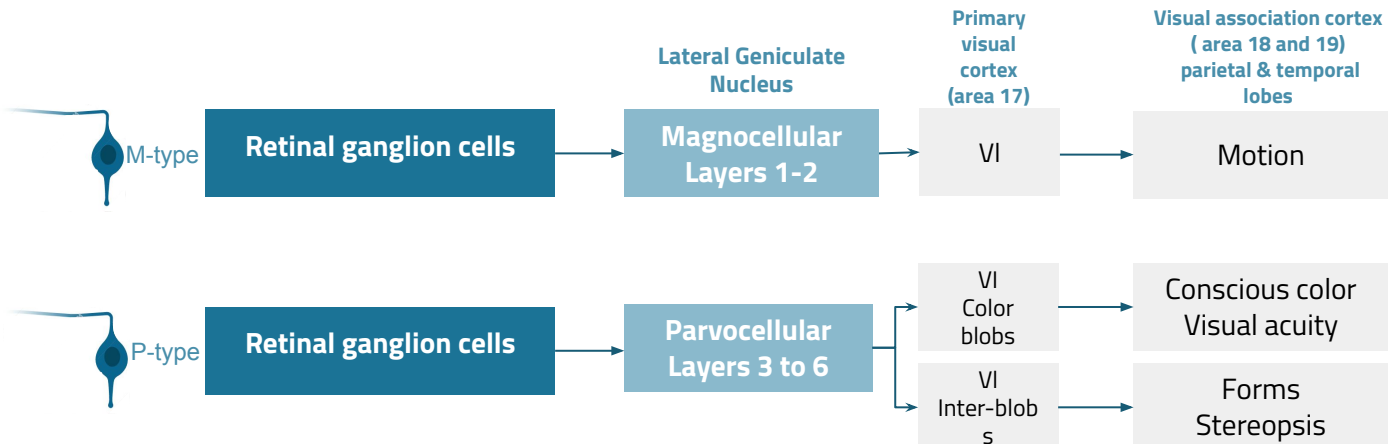
،لاحظوا الاماكن تبع periphery صغيرة لذلك فالنيورنز حقتها شوية
وصغيرة فأني trauma or tumor بيسببون فقدان وظيفتهم،
بعكس الfovea او الماكويولا كبار جدا والنيورنز حقتها كثيرة لذلك حتى
لو صار trauma ما راح تفقد كل وظيفتها
Macular sparing الكونسبت اللي شرحناه هذا هو ال



Girls slide only

Retinotopic Organization & Processing of visual information

يطلع من (axon) ganglion fibers
to the LBG nucleus



Determination of Distance of an Object from the Eye

-"depth perception"

A person normally perceives distance by three major means :

1 the **sizes** of the images of known objects on the retina

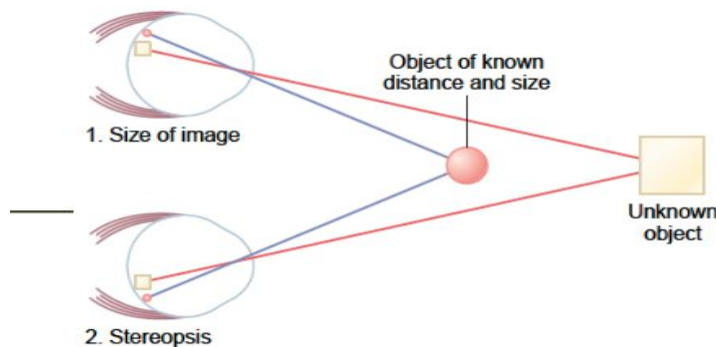
2 the **phenomenon of moving parallax** :

when the person moves his head to one side or the other, the images of close-by objects move rapidly across the retinas, while the images of distant objects remain almost completely stationary like when ur inside a car and ur trying to see treas or any thing beside the road

تخيلوا إننا نمشي في الطريق وقدامنا مزرعة، اشجارها ممتدة كل الطريق، فطبعا فيه شجر قريب من عينونا وفيه شجر بعيد تقولك الشجر القريب بتشوفينه وبتعدينه فيقولون move rapidly across the retina ويجي اللي بعدوا وهكذا لكن الاجسام البعيدة طول وقتها منعكسة على عينونا لذلك يوصفونها Remain almost completely stationary

3 the **phenomenon of stereopsis or Binocular** : لما نشوف شي قريب نحدد ابعاده

The perception of depth and 3-dimensional structure obtained on the basis of visual information deriving from two eyes by individuals with normally developed binocular vision



MCQ & SAQ:

Q1: minimal amount of light that elicit sensation of light, is definition of ?

- A. Visual acuity
- B. Dioptric power
- C. Visual threshold
- D. Accommodation

Q3: Which processes is required for accommodation of near vision

- A. Lens is Flattened
- B. Ciliary Muscle Relaxed
- C. Increase anterior curvature of the lens
- D. Dilation of Pupil

Q5: Small cells carries signals for color vision , texture , shape and fine detail:

- A. magnocellular
- B. parvocellular
- C. X cells
- D. Y cells

Q2: the medial (nasal) side of retinae decussate in ?

- A. Optic tract
- B. Lateral geniculate body
- C. Optic radiation
- D. Optic Chiasma

Q4: Dealing with complex perception of patterns & object recognition is the function of :

- A. Primary visual cortex (area 17)
- B. Area 19
- C. Area 18
- D. B and C

Q6: Is more important in our rod vision under dark :

- A. W cells
- B. X cells
- C. Y cells
- D. none of above

6: A
5: B
4: D
3: C
2: D
1: C
key:
answer

1- Enumerate the three action involve in Near response

2- what is the two kinds of vision and what it is served by ?

3-What are the visual projection in Area 17 and their function?

4- the pupil constricts in response to what ?

A1: 1-convergence of both visual axis 2-pupil constriction 3-Accommodation

**A2: 1- SCOTOPIC VISION (night vision) served by Rods
2- PHOTOPIC VISION (bright light) served by Cones**

A3: slide 14

A4: 1 - accommodation reflex 2- light reflex

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