VISION ACCOMODATION & PAPILLARY LIGHT REFLEX

Objectives:

- Describe visual acuity.
- 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 and its pathway and relate these to clinical situations as argyl Robertson pupil.
- Identify the lateral geniculate body and visual cortex.

WE STRONGLY ADVISE YOU TO STUDY THE ANATOMY LECTURE (CN 2,3,4,6) FIRST

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★ References:

- 435 girls and boys slides and notes.

Color index: Important - Further explanation - Doctors Notes - Numbers.

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*Please check out this link before viewing the file to know if there are any additions or changes.

VISUAL ACUITY

❖ Definition:

- The degree to which the details and contours of objects are perceived (ادرك).
- it is usually defined in terms of the shortest distance by which **two lines** can be separated and still be seen as 2 lines.
- A 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**[1] .

❖ How to measure visual acuity? → Snellen's chart.

❖ Snellen's chart

- **Normal acuity** = (d/D) = (6/6) = 1
- (**d**: distance of Patient / **D**: distance of normal person)
- A person of 6/12 has **less vision** than normal vision. معناه إن 6 هي المسافة الي يشوفها المريض و 12 هي المسافة الي يشوفه الإنسان الطبيعي

Visual Threshold

❖ Definition:

- Is minimal amount of light that elicit(ظهر للعيان) sensation of light.

Duplicity Theory Of Vision (2 kinds of vision under different conditions)

❖ Differentiate between Cones & Rods[2] vision:

Photopic Vision	Scotopic Vision
bright light vision	**night vision**, dim light(الضوء الخفيف) vision
served by **cones** Which are **concentrated in the middle of retina**	served by **rods** Which are **concentrated in the periphery**
high visual acuity = colors & details	**low** visual acuity = no colors or details
low sensitivity to light = needs high visual threshold to be stimulated	**great** sensitivity to light =low visual threshold

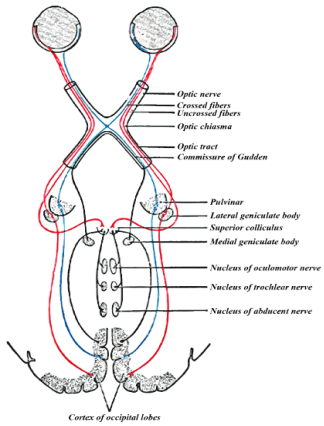
كيف تتذكرها؟ **Scotty rode** the Mercedes in the **night**، بالليل حنا مانشوف الألوان زين، وعيوننا تبي تلقط أي ضوء عشان كذا حساسيتها للضوء عالية

Visual Pathway

[1] is a small, central pit composed of closely packed cones in the eye.
[2] The retina contains two types of photoreceptors, rods and cones.

❖ Main Visual Pathway:

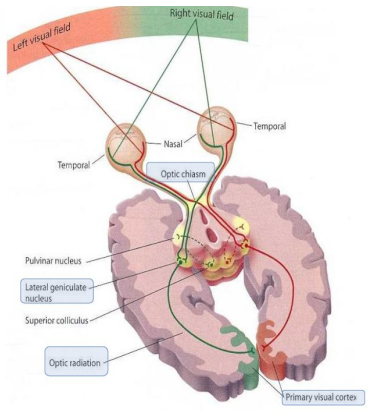
- Cones & rods → bipolar cells → ganglion cells → optic nerve (has the axons of ganglion cells which pass through the Optic disc [Blind Spot]) → optic chiasma → optic tract → **lateral geniculate** body in thalamus → axons of cells form **geniculocalcarine** tract to **optic radiation** → visual cortex in occipital cortex **(Brodmann area 17)**.



❖ Other sub pathways(طرق فرعية):

➔ some ganglion cells axons (which are 2nd order neurons):

- Pass from optic tract to **pretectal region of midbrain WHY? →** for **pupillary reflexes** and eye movement.
- Axons from optic chiasma pass directly to **hypothalamus WHY? →** for **circadian rhythm** (light-dark cycle) that synchronize(تزامن) various physiologic changes of the body with night and day.

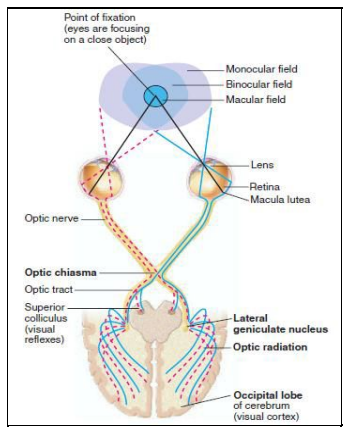


➔ Some axons from lateral geniculate body in thalamus: (3rd order neurons)

- Pass to **superior colliculus in midbrain** for **accommodation reflex** and its **miosis**[3] component & to control rapid directional movements of the **two eyes.**

❖ visual pathway & field:

- قلنا الباثواي الأساسي فوق، الحين بالعين فيه الجزء اليمين والجزء اليسار، يعني نفس الباثواي من الرودز والكونز...إلخ يتكرر بكل الجهتين، وفيه لكل جهة فايبرز، عندنا النيزل والتمبرل.
- بالبداية لازم تعرف، النيزل فايبرز مسؤولة عن النظرة الخارجية بكل عين (عكس مكانها) يعني نقول مسؤولة عن temporal field، والتيمبورل فايبرز مسؤولة عن النظرة الداخلية لكل عين يعني مسؤولة عن الـ nasal field



- **The nasal fibers** (medial) cross to **opposite** side (decussate in the Optic Chiasma).
  - Therefore an **Optic Chiasma lesion** (e,g, Pituitary Tumor) will cause vision loss from the both lateral halves of the Field of Vision
- **The temporal fibers** (lateral) do not cross (Remains **ipsilaterally**).
  - Therefore , **a lesion in optic tract** will cause loss of vision from the ipsilateral nasal field of vision + contralateral temporal field of vision .
- Nasal fibers convey temporal field (outer)of vision. يعني النيزل فايبرز بالعين اليمين بتكون مسؤولة عن الرؤية الخارجية للعين اليمين واللي هي الجهة اليمين، ونفس الفايبرز للعين اليسار بتكون مسؤولة عن اليسار بما أنها الخارجية
- Temporal fibers convey nasal field (inner)of vision.

[3] excessive constriction of the pupil of the eye.

أهم نقطة: كيف نتذكرها؟ Temporal= تبكي= حياة الفهد، وحياة الفهد تعطيك سحبة الجدار وهي تبكي، يعني التيمبورال فايبرز تبقى بنفس الجهة وتسحب على الجدار p: يعني التيمبرل كات يسار بالعين، بتكمل يسار بالنيرف وتكمل يسار حتى بعدما تمر بالكيازما وبرضو يسار بالأوبتك تراكت

❖ Optic Tract: ركزوا أنه التراكت يعني بعد الكيازما والكروسنق

★ **includes:**

- **Lateral (temporal)** fibers of the same side.
- **Medial (nasal)** fibers of the opposite side. **i.e:** temporal field of other eye**(outer)**.

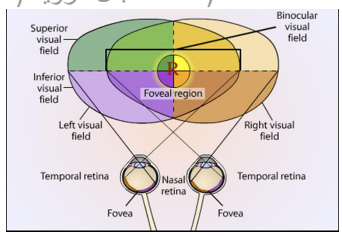
★ **Example: left** optic tract conveys:

- lateral (temporal fibers) of the **left** eye. قلنا التيمبورل حياة الفهد على نفس جهة الجدار
- medial (nasal fibers) of the right eye (opposite side).
- = (RIGHT half of visual field of left eye) يقصدون التيمبورال تعطيك النظرة الخارجية للعين
- + RIGHT half of visual field of right eyes),
- **both form right half of visual field of both eyes.** يعني التراكت اليسار مسؤول عن الرؤية اليمين للعينين (نصف مجال الرؤية)

★ Important Note:

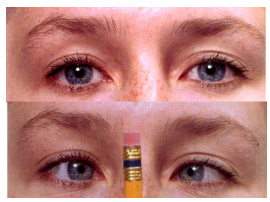
➔ **The left optic tract corresponds to the right 1/2 of the visual field.** (نصف مجال الرؤية (الجزء الأيمن

➔ **The right optic tract corresponds to the left 1/2 of the visual field.**



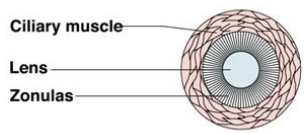
Visual Pathway (Duration:4:00)

Accommodation (focusing)



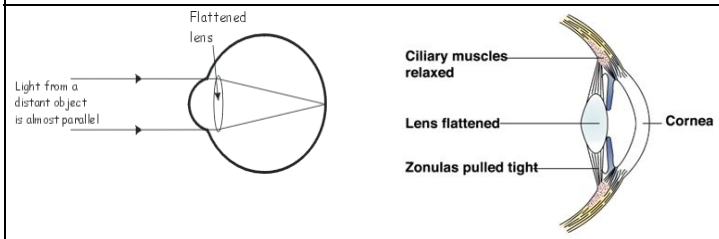
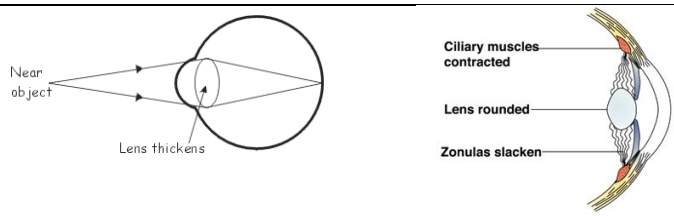
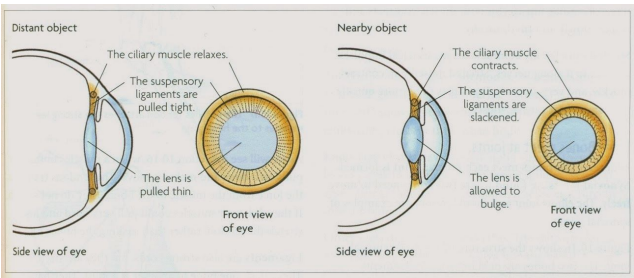
- **Definition:** Is an active process for **modification of the refractive power** of the eye to view a nearby object **by increasing the curvature of lens.**
- Lens changes (accomodation) → Changes in the pupil → Convergence of the eyes → **The near response**

First of all you must have a general idea and an overview of the accommodation process and the eyes components:



- Ciliary muscle has two separate sets of smooth muscle fibers, longitudinal fibers and circular fibers. Their accommodation is **controlled by parasympathetic** nerves transmitted to the eye **through oculomotor nerve.** (**C**iliary = **C**ontraction)
- The elastic **lens** is attached to the circular ciliary muscles by the **zonalus** which is made of inelastic fibres.
- **Contraction** of either set in 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.**

- العين لمن تشوف جسم بعيد تكون مرتاحة و التركيز تبعها يكون على شبكية العين (الريتنا) بالضبط, كل ما الجسم يقرب تكون الأشعة متباينة (divergent rays) فالصورة ممكن تروح خلف الشبكية لأن العدسة ما تقدر تركز الأشعة كويس على الشبكية ونشوف الجسم مو واضح او مشوش عشان كذا في عندنا ال accommodation process.

FAR OBJECT (At Rest)	NEAR OBJECT
When an object is 6m (20ft) or more away from the viewer, the light rays reflected from the object are nearly parallel to one another, the **lens must bend these parallel rays just enough to be focused on the central fovea, where vision is sharpest.**	because the light rays that are reflected from objects closer than 6m (20ft) are **divergent** rather than parallel, the **rays must be refracted** more if they are to be focused On the retina.
• **ciliary muscles: relaxed.** • **Suspensory ligament: taut (tense).** • **Lens: flat.** • **Diopteric power of the eye decreases.** • **Result: Far object focussed on the retina**	• **ciliary muscles: Contracts.** • **Suspensory ligament: Relaxed.** • **Lens: Convex (increased curvature).** • **Diopteric power of the eye Increases.** • **Result: Near object focused on the retina.**
	
في حالة الجسم البعيد (6 أمتار وفوق) الأشعة توصل عيوننا متوازية فما تحتاج العدسم أنها تزيد انحناءها و لا نحتاج عملية الأكومديشن، بذلك الليقامنت بيكون مشدود (تخيل العدسة بلونة و الليقمانتس أطرافها من كل الجهتين، لما تشد الأطراف البلونة بيصير شكلها بيضاوي ومشدود أكثر) -The lens in held under tension by the lens ligaments. Because the lens substance is malleable (flexible) and the lens capsule has considerable elasticity, the lens in pulled into a flattened shape. 	**Without the accommodation (hypothetically):** (if ciliary muscles remain relaxed) At rest, from near object parallel rays focus **behind retina** > blurred vision. **With Normal accommodation process:** solution is to increase curvature and refractive power of lens by **accommodation** to bring focus on retina. -The ciliary muscle contracts, this decrease the distance between the edges of the ciliary body and relaxes the lens ligaments, so that the lens spring into a more convex shape. Mnemonic: CCC (**C**iliary muscles **C**ontract for **C**lose Vision)

❖ Accommodation reflex :

➔ Focusing at near object → increased anterior surface curvature of lens by:

- **ciliary muscles contraction.** (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.)**
- **slack = relaxed ligaments** to increase anterior surface curvature of lens.

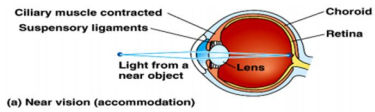
❖ **WHY?** (Goal of accommodation)

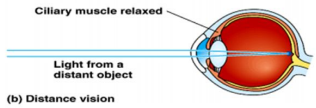
- to add **12D** to refractive power of lens. (normal eye RP is 60D (cornea 40, lens 20)

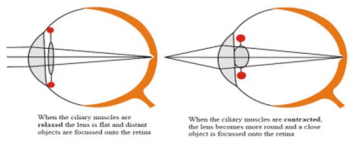
❖ **Test:**

- sanson purkinje image. For more purkinje image

❖ Accommodation & near response :







- When we look at near object 2 things will happen :

1. **Accommodation:** is the focusing of light in the retina.
   We focus by changing the shape of the lens.
   - The lens is **flattened for distant** objects.
   - The lens is **rounded for near** objects
2. **Near response:** looking at a close object will cause :
   - Convergence of both visual axis. Why? In near objects the axis are in divergent pattern for that eye will converge the rays so they line at central fovea (focus on retina).
   - Accommodation. Why? To converge the rays more, because they are divergent.
   - Pupil constriction. Why? The pupil constricts in order to prevent diverging light rays from hitting the periphery of the retina and resulting in a blurred image.

❖ **Amplitude of Accomodation:** The additional diopters added by increasing the convexity of the lens

❖ **Near point :** Nearest point to eye at which object can brought into focus on retina by **ACCOMMODATION.** For example :

- At 10 years → 9 cm.
- At 60 years → 80-100 cm. Why did the distance increase? **due to hardness of lens & loss of accommodation** at old age a physiological condition may develop, which called **presbyopia.** (It's a physiological rather than pathological, normal response of getting older)

1. **Near point and amplitude of accommodation:**
   a. Amplitude of accommodation: The additional diopters added by increasing the convexity of the lens. * numbers are not that important , all you need to know that the amplitude decreases with aging.

Age (years)	Near point (cm)	Amplitude of Accommodation
10	**9.0**	**11.0**
20	**10.0**	**10.0**
30	**12.5**	**8.0**
40	**18**	**5.5**
60	**83**	**1.2**
70	**100**	**1.0**

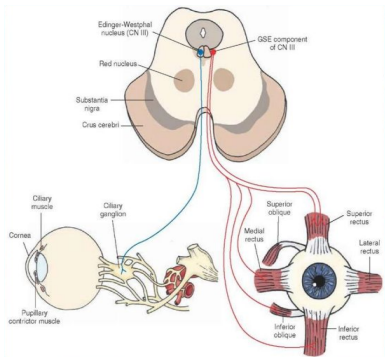
❖ Presbyopia (قصر البصر الشيخوخي) is a Tried of:

1. **loss of accommodation & focus behind retina.**
2. **loss of lens elasticity.**
3. **near point recede.**

- Correction by: biconvex lens .

Pathway of Accommodation

Light on eye → retina → optic nerve → optic chiasma → optic tract → lateral geniculate body in thalamus → **superior colliculus in midbrain** هذا هو السنتر الخاص بهذا الرفليكس → **EWN (Edinger Westphal nucleus) → oculomotor nerve (cranial nerve III) → ciliary ganglion → ciliary body contraction (accommodation reflex) & contraction of iris muscles for miosis of near response.**



(Afferent Efferent)

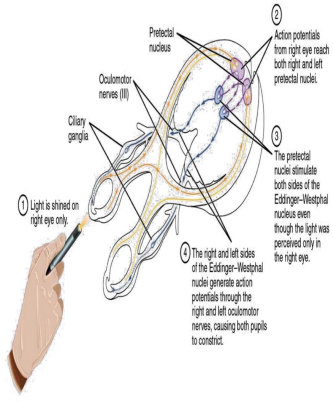
- Center of accommodation: superior colliculus.

Pupillary Light Reflex

- Light on one eye pupil leads to constriction of this pupil (direct) **and the other pupil (indirect or consensual[4]).**

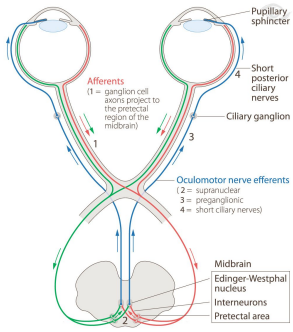
Pathway of consensual Pupillary light reflex (*indirect*):

★ Light on eye → retina → optic nerve → optic chiasma → optic tract → pass through superior colliculus in midbrain (just passing through it and there is no synapses with superior colliculus) → **pretectal nucleus** (Anterior to tectum of midbrain) → both oculomotor nerve nuclei (EWN "Edinger Westphal nucleus) (small group of preganglionic parasympathetic motor neurons) → supply both eyes by oculomotor nerves → both ciliary ganglia → short ciliary nerve to constrictor pupillae → miosis in both eyes.



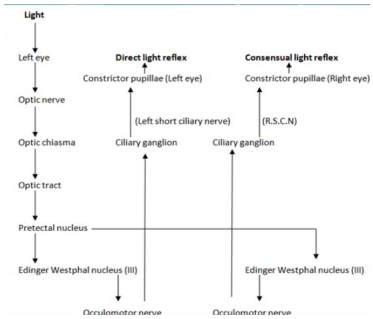
[4] توافقية

We stimulate one eye but the reflex happens in both eyes e.g. stimulation of right eye (nasal fibers cross to opposite side in optic chiasma and temporal fibers run in the same side → action potential from right eye reach both right and left pretectal nuclei)



Afferent Efferent (Centre of pupillary reflex: Pretectal nucleus.)

- conversely , In darkness the reflex becomes inhibited which results in dilation of the pupil. Always in darkness the pupils dilate to capture the light and vise versa.
- EWN: Is the mother of oculomotor.



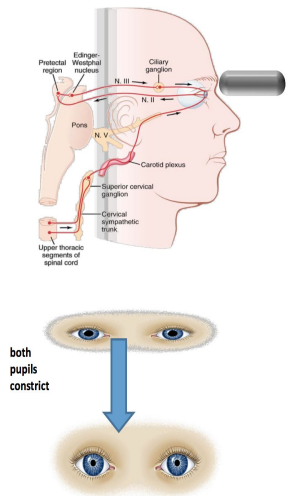
Constriction of the pupil:

- The pupil constricts in response to accommodation & light Reflexes.

Argyll Robertson pupil (Neurosyphilis)	
In syphilis tabes dorsalis which destroy pretectal nucleus	
light reflex is **lost**	Accommodation reflex **remains**
because lesion is in **pretectal nucleus** only away from superior colliculus and fibers of accommodation.	

- Damage of transmission of visual signals from the retinas to the edinger westphal nucleus which block the pupillary reflexes as in **alcoholism encephalitis**.

Autonomic Control of Accommodation and Pupillary Aperture	
Parasympathetic control	**Sympathetic control**
Parasympathetic preganglionic fibers in the Edinger Westphal nucleus → to third nerve → to the ciliary ganglion. Then preganglionic fibers synapse with postganglionic parasympathetic neurons which send in ciliary nerves into the eyeball to:	The sympathetic innervation of the eye originates in lateral horn cells of the first thoracic segment of the spinal cord → to sympathetic chain (the superior cervical sympathetic ganglion) → synapse with postganglionic neurons.
1-the ciliary muscle that controls focusing of the eye lens 2-the sphincter of the iris that constricts the pupil.	sympathetic fibers spread along the surfaces of the carotid artery to innervate the radial fibers of the iris which open(dilate) the pupil



Determination of Distance of an Object from the Eye—"Depth Perception"

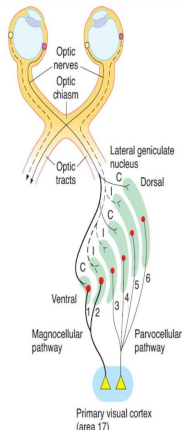
❖ A person normally perceives distance by three major means:

1. **The sizes of the images of known objects on the retina:**
   - ➢ The brain calculate from image sizes the distances of objects. (if the picture in the retina is small the brain think of it as a far object
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**.
3. **The phenomenon of stereopsis[5] or Binocular Vision:**
   - ➢ This binocular parallax or (stereopsis) that gives a person with two eyes far greater ability to judge distances.

Lateral geniculate body (6 layers)

- **left** LGB (similar to left optic tract) has all layers receive from **RIGHT** ½ of visual field
- **Right** LGB (similar to right optic tract) has all layers receive from **LEFT** ½ of visual field.

❖ FUNCTIONS OF LGB:



1. Acts as a **relay station** for visual information from optic tract to cortex.
2. It has **point to point transmission** with high degree of (spatial fidelity).

   يعني ياخذ من كل نقطة من الريتينا ويرسل لكل نقطة في cerebral cortex
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.

❖ 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 areas of the mesencephalon:** Both of these are inhibitory and, when stimulated, can turn off transmission through selected portions of the **dorsal** lateral geniculate nucleus.

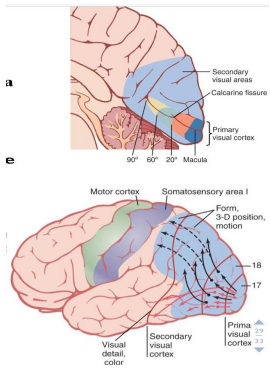
❖ LGB pathways to visual cortex:

The magnocellular pathway	The parvocellular pathway

[5] The ability to see image as 3D by both eyes

From layers 1 and 2, **large cells** and are called **magnocellular.**	From layers 3,4,5,6 which have **small cells** and are called **parvocellular.**
Carries signals for: **Detection of movement, depth, and flicker.**	Carries signals for: **Color vision, texture, shape, and fine detail.**
Rapidly conducting pathway to the visual **cortex**	**Moderate** velocity of conduction.
Color blind, transmitting only **black-and-white information.**	**Colored** vision.

Visual cortex



- **The fovea 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.
- **The Primary Visual Cortex also called visual area I. it Has Six Major Layers of cells arranged vertically each act as a separate functional unit for processing of informations.**
- Signals from the **retinal fovea** transmits its signals terminate **near the occipital pole**, whereas signals from the more **peripheral retina** terminate in concentric half circles anterior to the pole on the medial occipital lobe.
- The upper portion of the retina is represented superiorly and the lower portion inferiorly.

1-Primary visual cortex (braodmann area 17):-

- On **medial aspect of each occipital lobe** and 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) without** knowing the meaning of these objects & has **blobs** for **color detection.**

2-Association visual cortex(area 18&19)(secondary visual areas):-

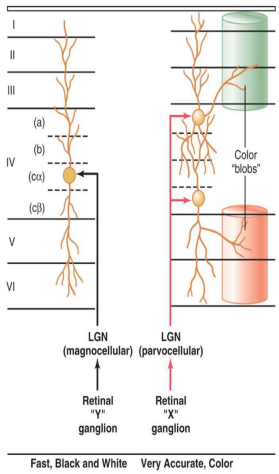
- **located mainly anterior to the primary visual cortex**

- **interpretation of visual stimuli**
- Dealing with **complex perception of patterns &** forms & responsible for object recognition.
  - ➔ the **fixation mechanism** that causes the eyes to "lock" on the object of attention is controlled by secondary visual.
  - ➔ When this fixation area is destroyed bilaterally , causes difficulty keeping its eyes directed toward a given fixation point.

❖ 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 subserved by neuronal pathways that pass from the optic tracts mainly into the superior colliculi.

❖ Color Blobs are column like area they are in the visual cortex interspersed among the primary visual 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)**
- Linear movement: هي للحركات الخطية فقط ، الحركات الدائرية أو الـ ZigZag ماتتفع

Macular sparing = loss of peripheral vision with intact macular vision , because the macular representation is separate from that of the peripheral fields and very large relative to that of the peripheral fields.

If someone got injured in the visual cortex that doesn't mean that he'll become blind completely .