

PHYSIOLOGY

Lecture : 5

DONE BY : BASHAR SMADI

The Eye III

Central Neurophysiology of Vision

(lecture 4 slide 32) الدكتورة ذكرت خطأ موجود في سلايدات المحاضرة السابقة

bipolar cells provides lateral inhibition (a much **lesser** distance than H. cells). : ✓ الجملة الصحيحة

Visual fields

Temporal and nasal fields

- ▶ the nasal fibers in the eye (retina) receives from the temporal visual field of the eye
- ▶ the temporal fibers in the eye (retina) receives from the nasal visual field of the eye

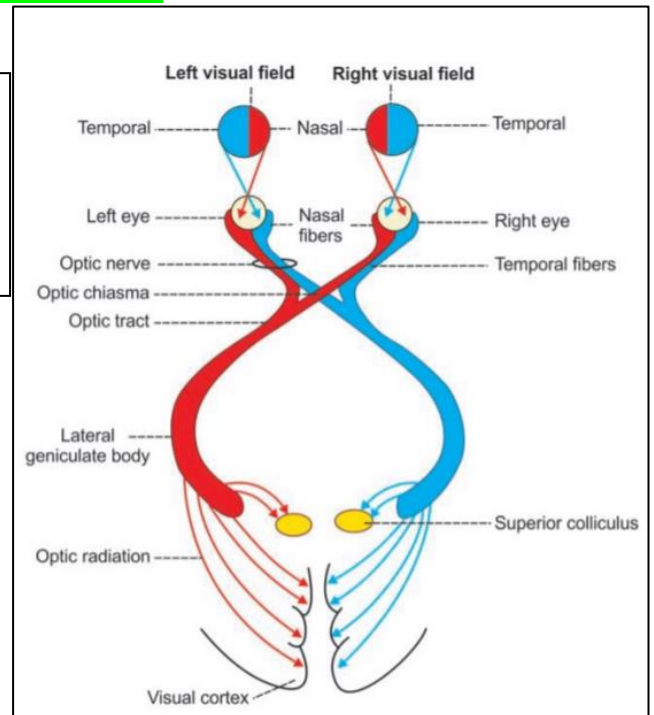
- unequal
- nasal field is restricted by nose.

Light rays from temporal part of visual field
→ ipsilateral nasal half of retina

Light rays from nasal part of visual field
→ ipsilateral temporal half of retina

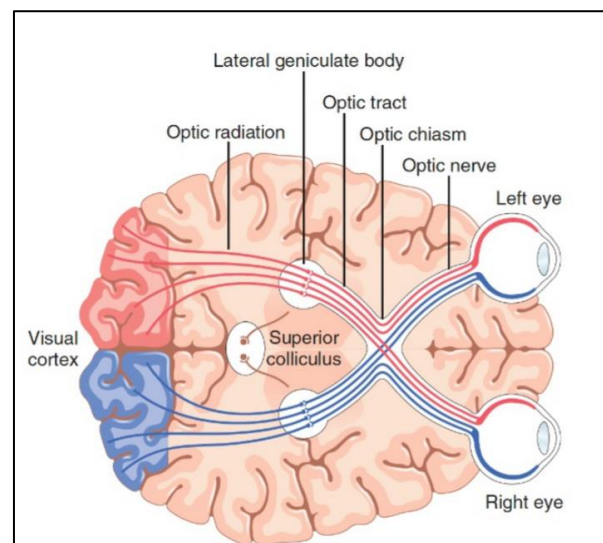
Upper and lower fields

- upper → restricted by eyelid & orbital margin,
- lower → restricted by cheek



Visual Pathways to the Brain

- ▶ The fibers that arise in the **temporal half** of the retina **do not cross** the midline. so that their information is sent to the visual cortex of the same side.
- ▶ The fibers that arise in the **nasal half** of the retina **cross** in the optic chiasm, and the information they send reaches the opposite visual cortex.



optic nerve.

- axons of ganglion cells of the retina.

optic chiasm.

- all fibers from the nasal halves of the retina cross to the opposite side and join fibers from the opposite temporal retina to form the optic tracks.
- synapse in the dorsal lateral geniculate nucleus (LGN).
 - from LGN → geniculocalcarine fibers to primary visual cortex by way of the optic radiation (geniculocalcarine tract).
 - visual cortex in calcarine fissure in medial occipital lobe.

Optic tract Projections to Subcortical Regions

- **suprachiasmatic nucleus of the hypothalamus.**

- control of circadian rhythms

- **pretectal nuclei.**

- pupillary light reflex.
- accommodation of the lens.

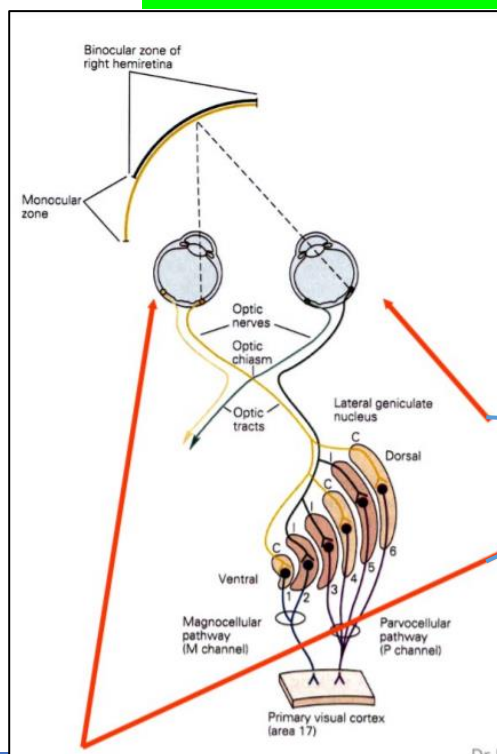
- **superior colliculus**

- rapid directional movement of both eyes.

- **ventral lateral geniculate**

- control of bodies behavioral functions

Lateral Geniculate Nucleus (LGN)



Half of the fibers in each optic tract are derived from one eye, and half from the other eye.

Signals from the two eyes are kept apart in the LGN.

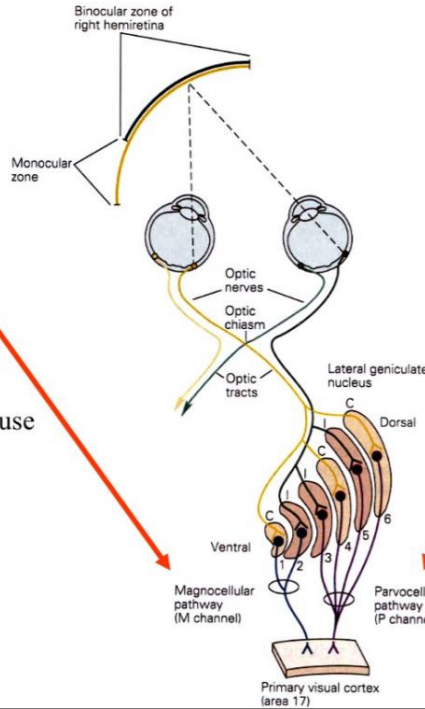
Layers 2, 3, and 5 receive input from lateral half of ipsilateral eye

Layers 1, 4, and 6 receive input from medial half of contralateral eye

Organization of the LGN

magnocellular layers

- Layers 1-2
- Large neurons
- Input from M retinal ganglion cells
- Rapid conduction
- Black & white vision
- Magnocellular pathway
- poor point-to-point transmission because of limited number of M cells & wide dendritic spread in retina.



parvocellular layers

- Layers 3-6
- Small-medium neurons
- Input from P type ganglion cells
- Moderate conduction
- Color vision
- Parvocellular pathway
- Accurate point-to-point transmission

Function of the Dorsal Lateral Geniculate

• Two principle functions.

● receives visual information from retina and sends it to primary visual cortex for processing.

إذا هي حلقة وصل بين الاشارات من ال retina الى primary visual cortex

● “gate control” of information to primary visual cortex.

مثل "البواب" بتحكم بكمية الإشارات التي تذهب الى visual cortex

“Gate” Function of the LGN

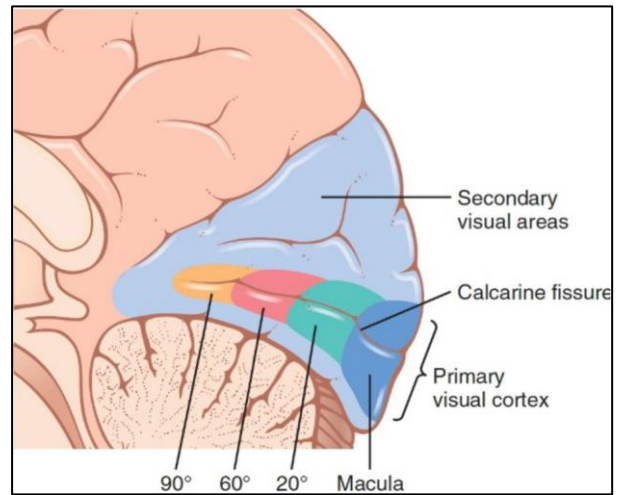
● LGN receives **inhibitory** inputs from

1. corticofugal fibers from primary visual cortex.
2. reticular areas of the midbrain.

● inhibitory inputs control the visual input that is allowed to pass to the cortex.

Primary Visual Cortex/visual area I/striate cortex

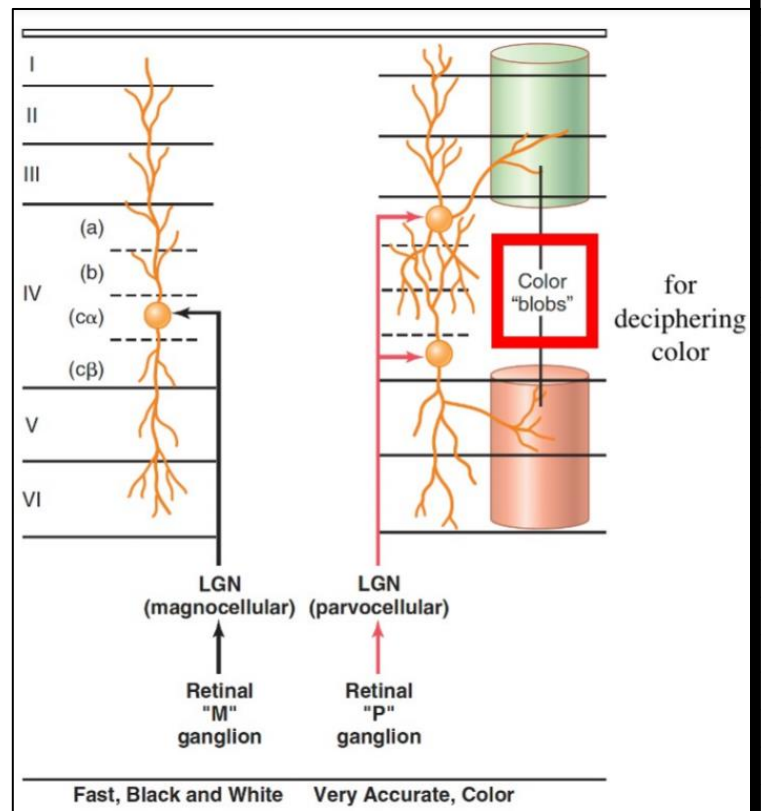
- Area 17 اسم ثاني لها
- large representation in visual cortex for the macula (region for highest visual acuity) near occipital pole.
- upper portion of retina is represented superiorly
- lower portion is represented inferiorly.
- receives the primary visual inputs → perception of visual impulses.
- main function of the primary visual cortex is “perception of visual impulses.”



احيانا يتعرض شخص الى اذى في رأسه من الخلف في (منطقة ال occipital lobe) ويفقد بصره السبب هو ان منطقة التي تعمل لل processing لل visual information موجودة في ال occipital lobe

Layered/columnar structure of primary visual cortex

- 6 layers/several million vertical columns
- geniculocalcarine fibers terminate mainly in layer IV- subdivisions.
- signals from M ganglion cells → IV α → cortical & deeper levels.
- signals from P cells → layer IV α & IV β → cortical & deeper levels.
- cortical surface & deeper levels → further processing
- signals to layers I, II, and III eventually transmit signals for short distances **laterally** in the cortex.
- signals to layers V and VI excite neurons that transmit signals much greater distances.



Interaction of Visual Signals from the Two Separate Eyes.

- images on the two retinas are not exactly the same
 - the closer the object, the greater the disparity
 - Signals from 2 eyes remain separated from each other when they arrive in layer IV
 - layer IV deciphers whether the respective areas of 2 visual images from 2 eyes are matching each other 'in-register' → fused
 - if not matching → directional gaze of separate eyes are adjusted to obtain matching images
 - Strabismus/diplopia/Squint/cross-eye
 - lack of fusion of eyes in one or more of the visual coordinates: horizontal, vertical, or rotational, types of strabismus
1. horizontal →
 2. vertical →
 3. torsional →
 4. Combinations →

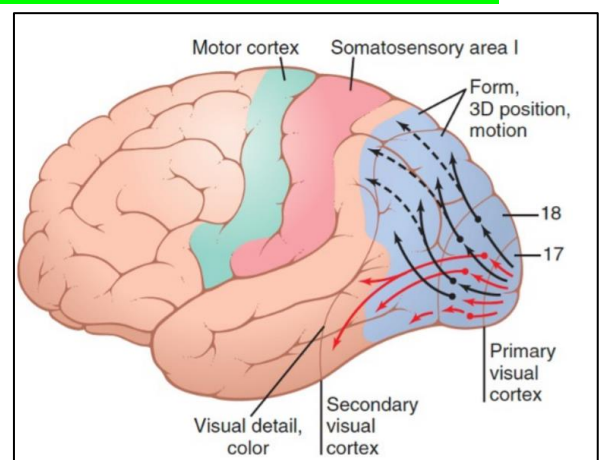


كل عين بتشوف صورة مختلفة قليلا عن العين الاخرى , وكل ما نظرنا الى شيء قريب سيكون الاختلاف اكثر يبقى الانفصال بال visual images بينهم لحتى يصل الى layer IV في ال layer IV تستقبل معلومات من العينين ويتقرر اذا معلومات عين اليمين بتتطابق مع العين اليسار ؟ are they in register ?

لو كانت غير متطابقين not register يعني اختلاف كبير بصورة كل عين
 ← بتضبط العضلات يلي بتتحكم بال gaze لغاية ما تعطي العينين صور متطابق
 اذا صار عنا خلل بالعملية وما نجح التوافق بصير عنا حول Strabismus/diplopia/Squint/cross-eye

Secondary Visual Areas/visual association areas

- Brodmann's area 18 اسم ثاني لها
- Surrounds Primary Visual Cortex
- Analysis of secondary signals → interpretation of visual impulses
- signals representin form, 3D & motion
 → transmitted into superior portions of occipital and posterior portions of parietal lobe.
- signals for visual detail (recognizing letters, texture and & color=deciphering from all this information what the object is and what it means)
 → anteroventral portion of occipital & ventral portion of posterior temporal

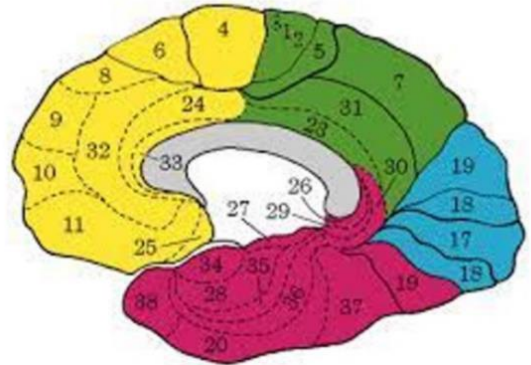


مثلا اذا انا شاهدت حيوان مفترس من بعيد..

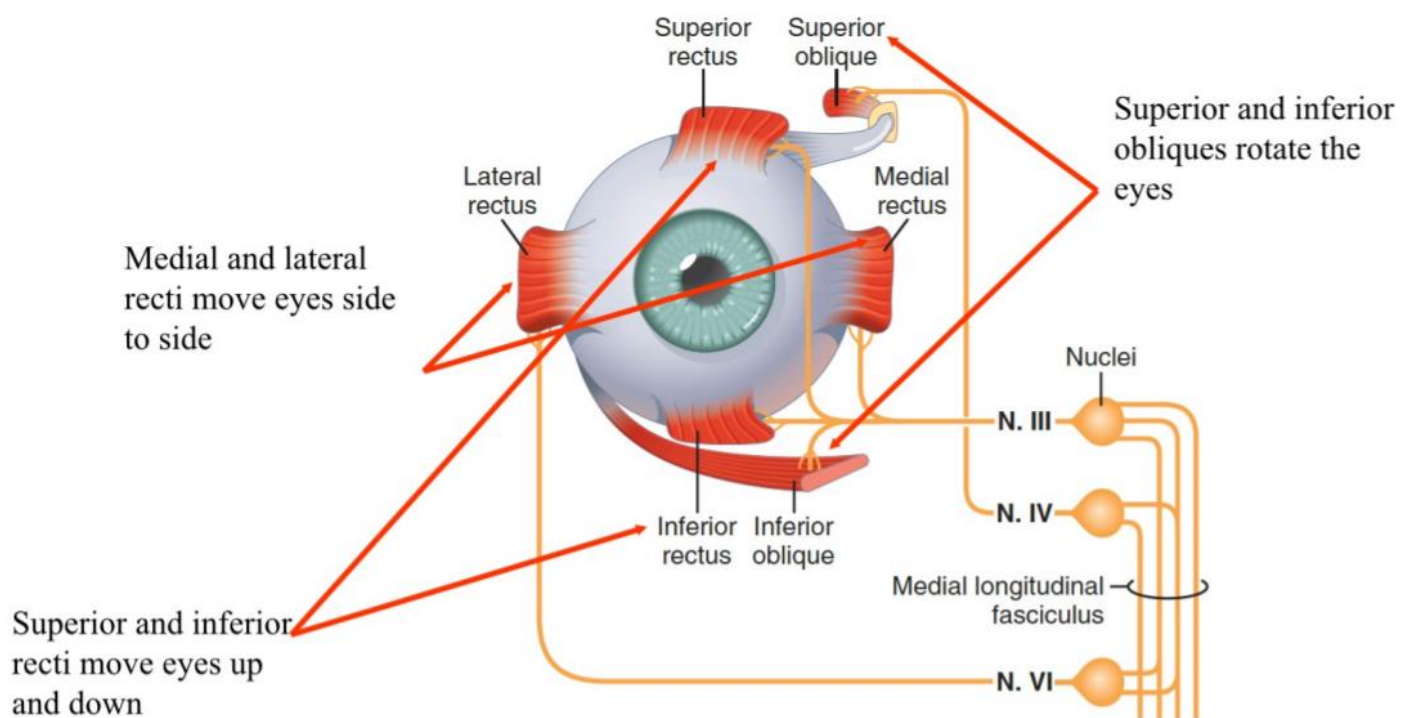
ال primary visual cortex حلت المعلومات اعطتني شكل وموصفات الحيوان وبترسالها الى ال secondary اذا ركض الحيوان باتجاهي ال secondary visual cortex بتعطي معلومات مفصله اكثر وبترجم ان هذا خطر

Occipital eye field (area 19)

Concerned with the movement of eyes



Eye movements are controlled by 3 separate pairs of muscles.



Movement	Primary muscle	Secondary muscle
1. Abduction	Lateral rectus	Superior oblique Inferior oblique
2. Adduction	Medial rectus	Superior rectus Inferior rectus
3. Elevation	Superior rectus	Inferior oblique
4. Depression	Inferior rectus	Superior oblique
5. Extorsion	Inferior oblique	Inferior rectus
6. Intorsion	Superior oblique	Superior rectus

Eye movements

1. Conjugate movement → both eyeballs move in same direction-medial rectus of one eye and lateral rectus of the other eye.
تتحرك العينين بنفس الاتجاهة

2. Disjugate Movement → both eyeballs move in opposite direction-convergence and divergence.
تتحرك العينين باتجاهات مختلفة عن بعضها

3. **Convergence** → movement of both eyeballs towards nose حركة العينين نحو الأنف

- Simultaneous **contraction** of medial rectus and simultaneous relaxation of lateral rectus of both eyes
- Accomodation

4. Pursuit Movement → when eyeballs follow a moving object.

5. Saccadic/ optokinetic Movement

Saccadic movement is the quick jerky movement of both eyeballs when the fixation of eyes (gaze) is shifted from one object to another object.

Neural Pathways Controlling Eye Movement

• **fixation movements** of the eyes controlled by two neuronal mechanisms, voluntary and involuntary.

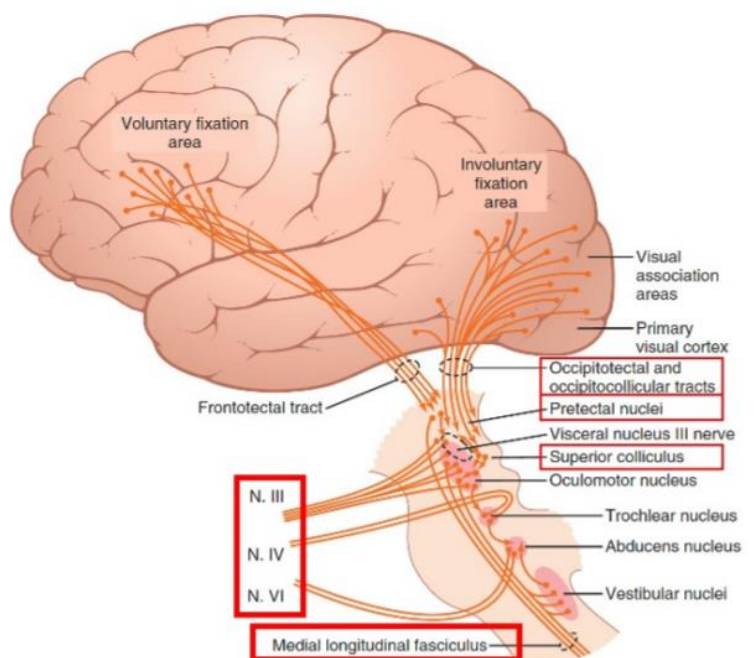
- voluntary fixation movements

“unlocking”:

allows person to move eyes voluntarily to find an object

controlled by an area in the **premotor cortex (frontal lobes)**.

مثلا لو دخلت انا الى تجمع وبحثت عن اخوي بينهم
رح احرك عيوني لحتى اجده ..
هذا يسمى بvoluntary fixation movements
او unlocking



fixation movements

- *involuntary fixation*
- mechanism causes eyes to “lock” on object of attention found with the voluntary fixation mechanism.

مثلا انا دخلت الى تجمع وبحثت عن اخوي بينهم ووجدته
رح اركز عليه واثبت نظري عليه
هذا يسمى ب involuntary fixation

- three types of continuous but almost imperceptible movements:
 - Continuous tremor → 30 -80 cycles/sec caused by successive contractions of the motor units in the ocular muscles;
 - slow drift
 - sudden flicking movements
- controlled by **secondary visual areas** of the occipital cortex.
- results from negative feedback mechanism controlled at the level of the superior colliculus that prevents objects of attention from leaving the foveal portion of the retina.

THANK YOU AND GOOD LUCK