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Vision Anatomy

Juliana Coleman
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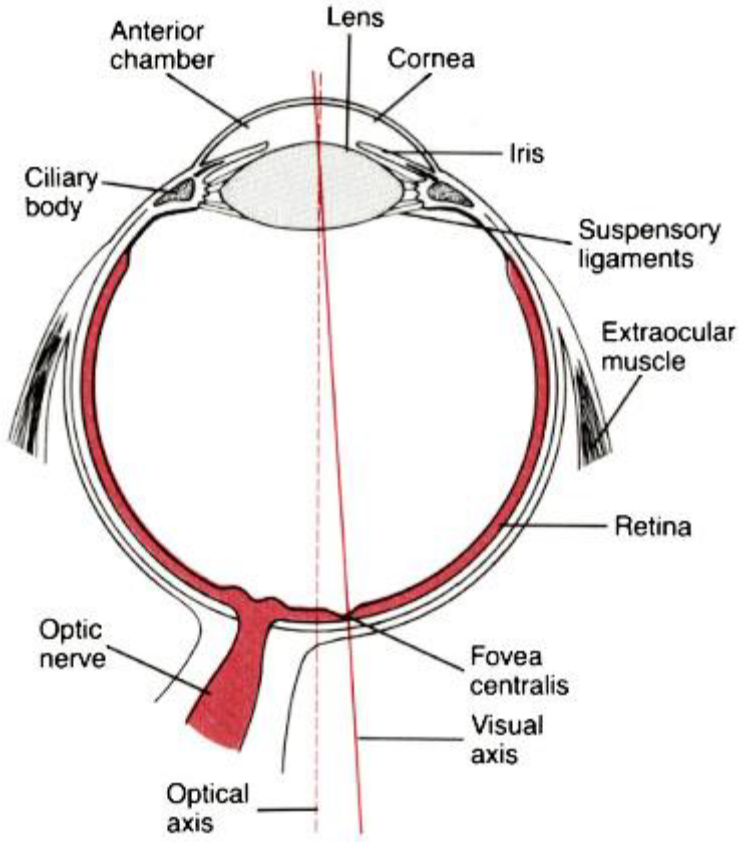
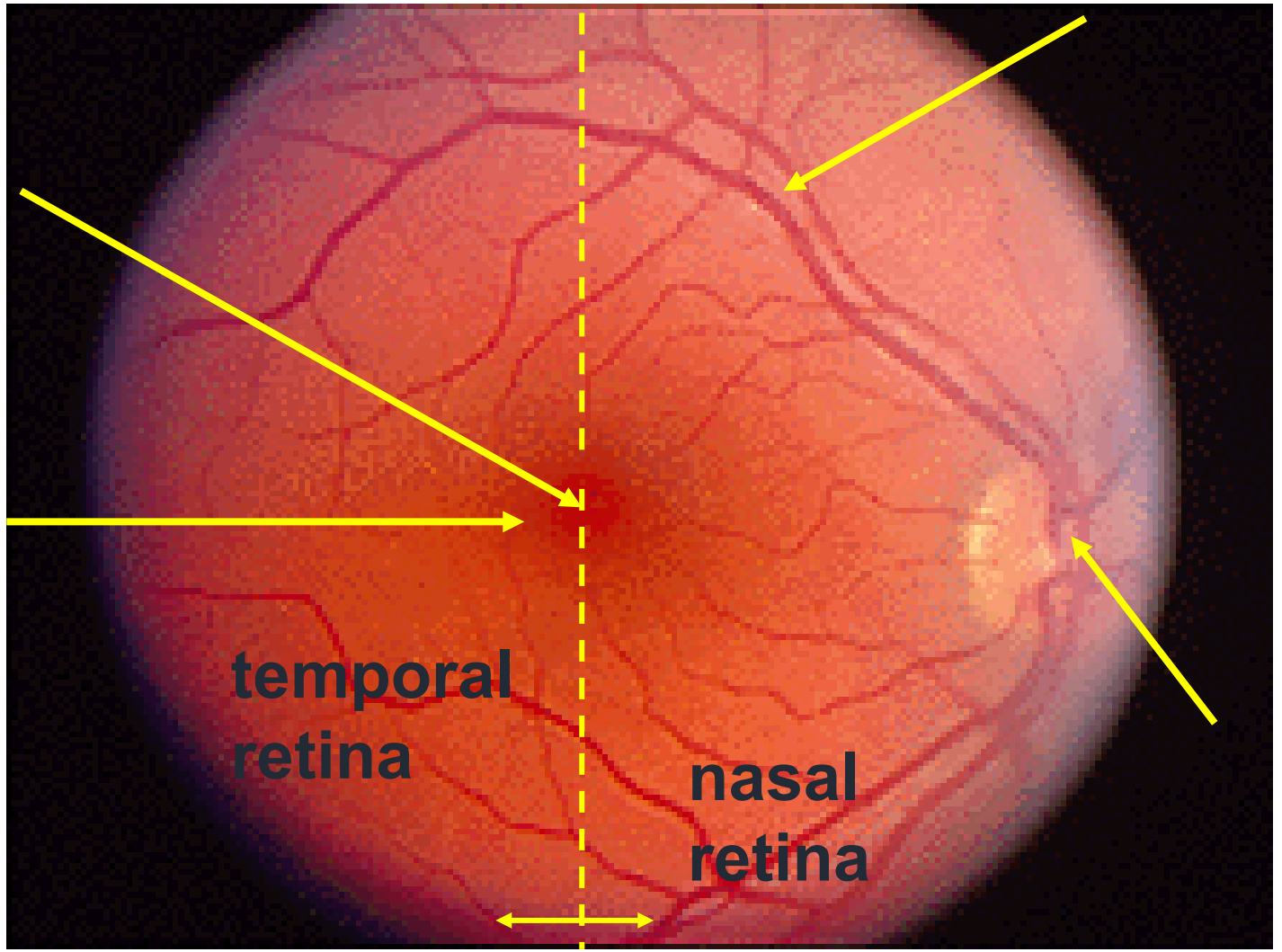


Figure from Burt

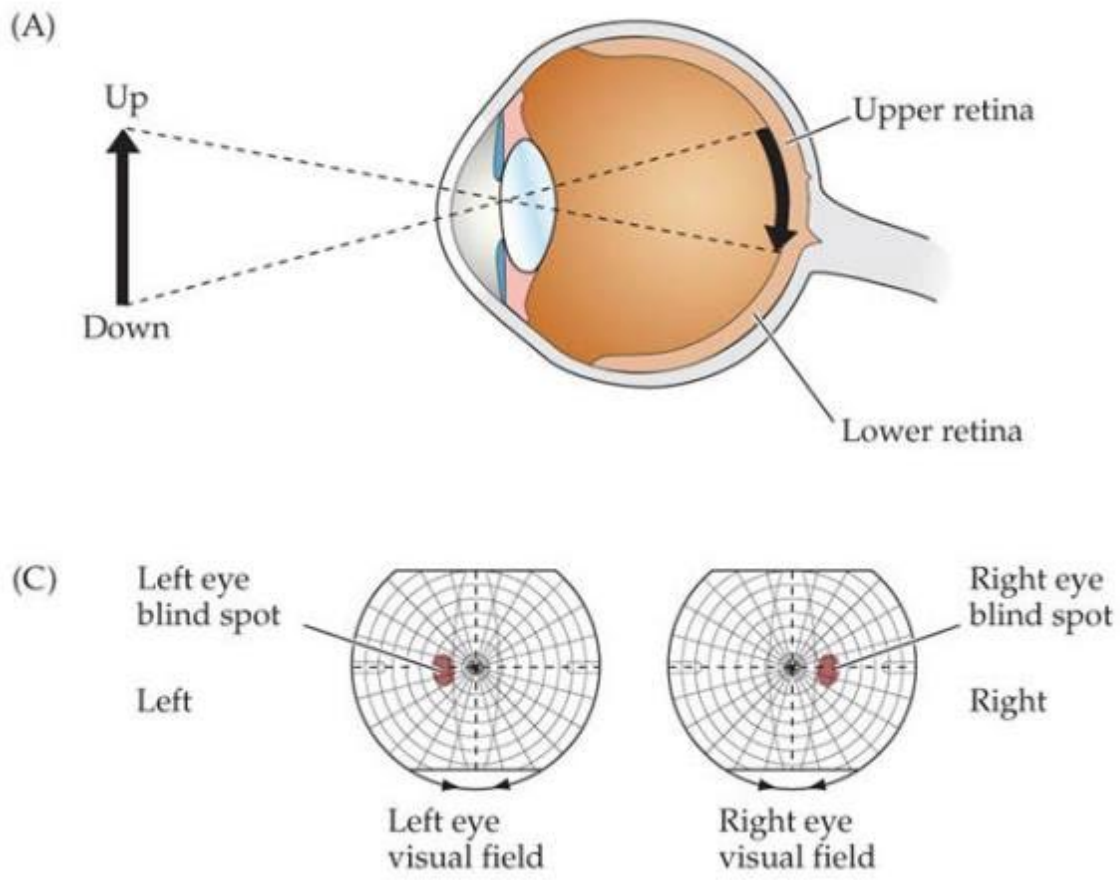
About 1/3 of the brain is devoted to vision or visual processing

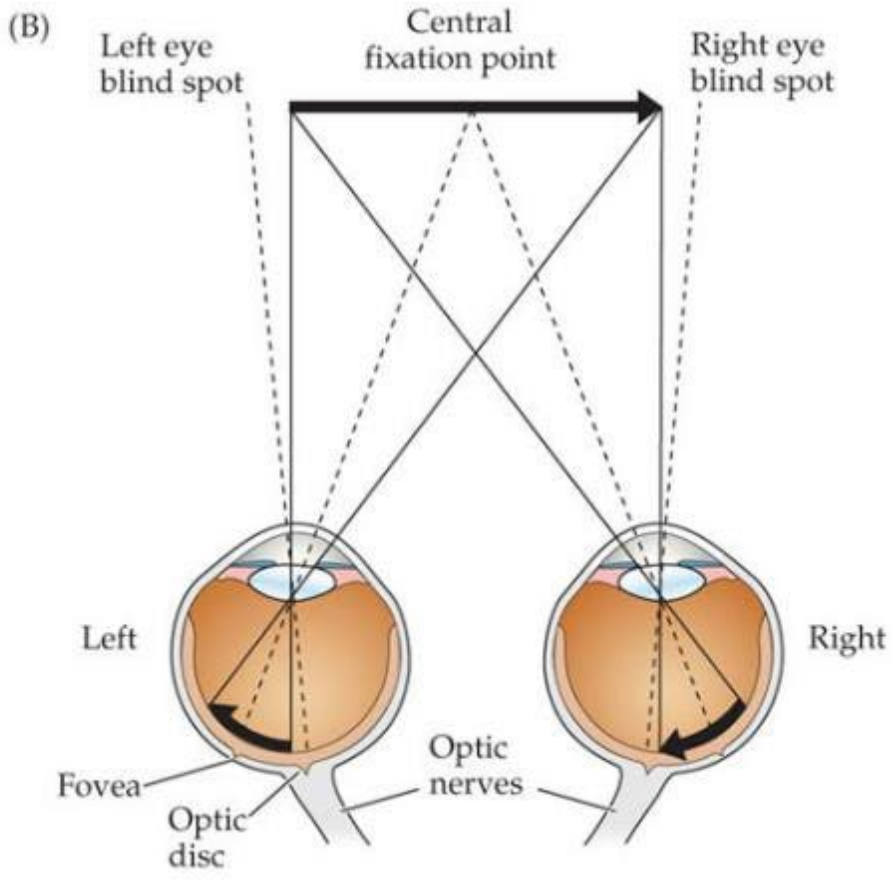
- Vision
  - Light turning into image perception
- Visual Processing
  - What is the image
  - Understanding the image within the context of spatial world
- Eye Movement
  - Coordinating conjugate movements
  - Generating FAST movements (saccades)
  - Generating TRACKING movements (smooth pursuits)
- Pupils

View of Retina through an Ophthalmoscope

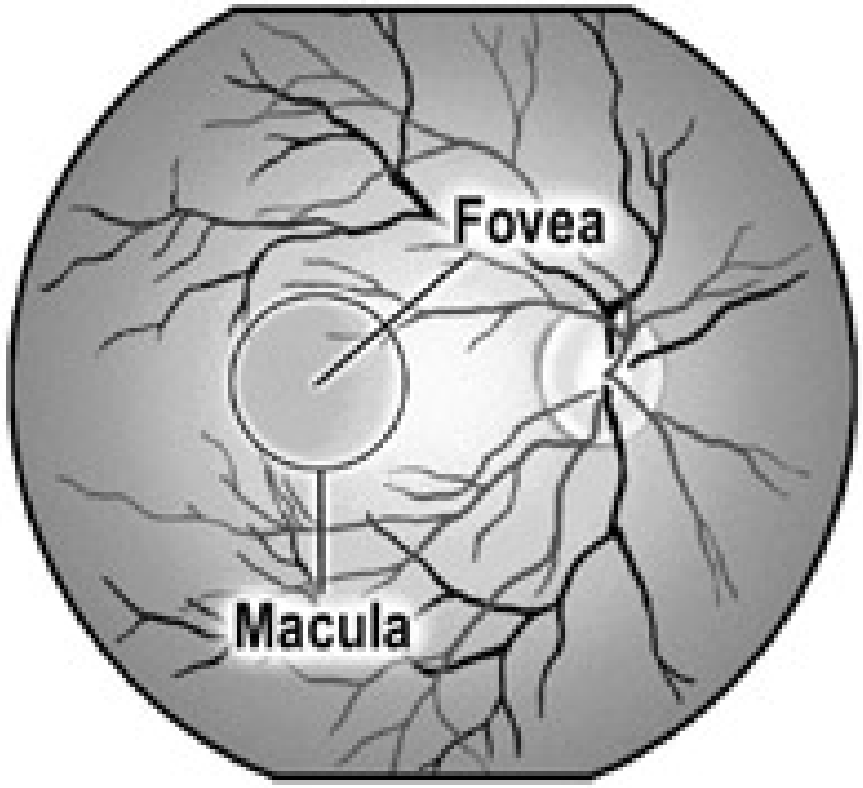


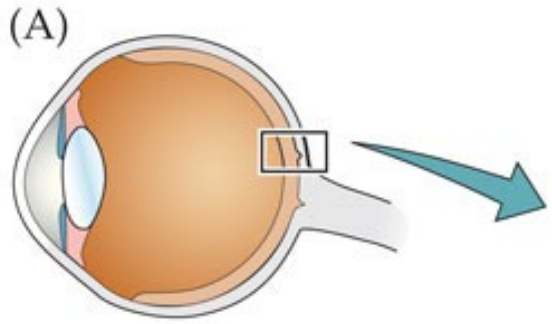
Vision: Pathways of Light

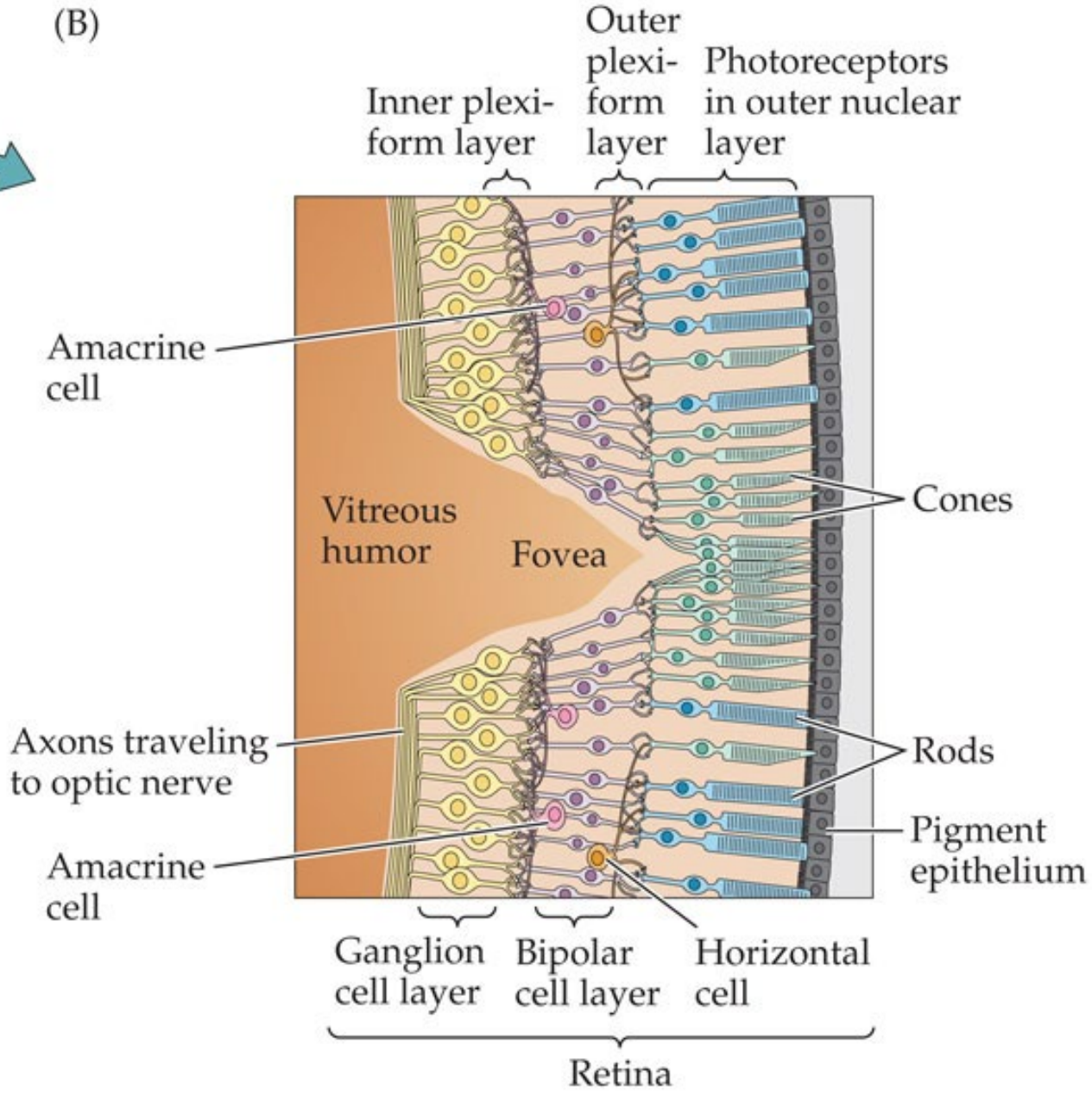




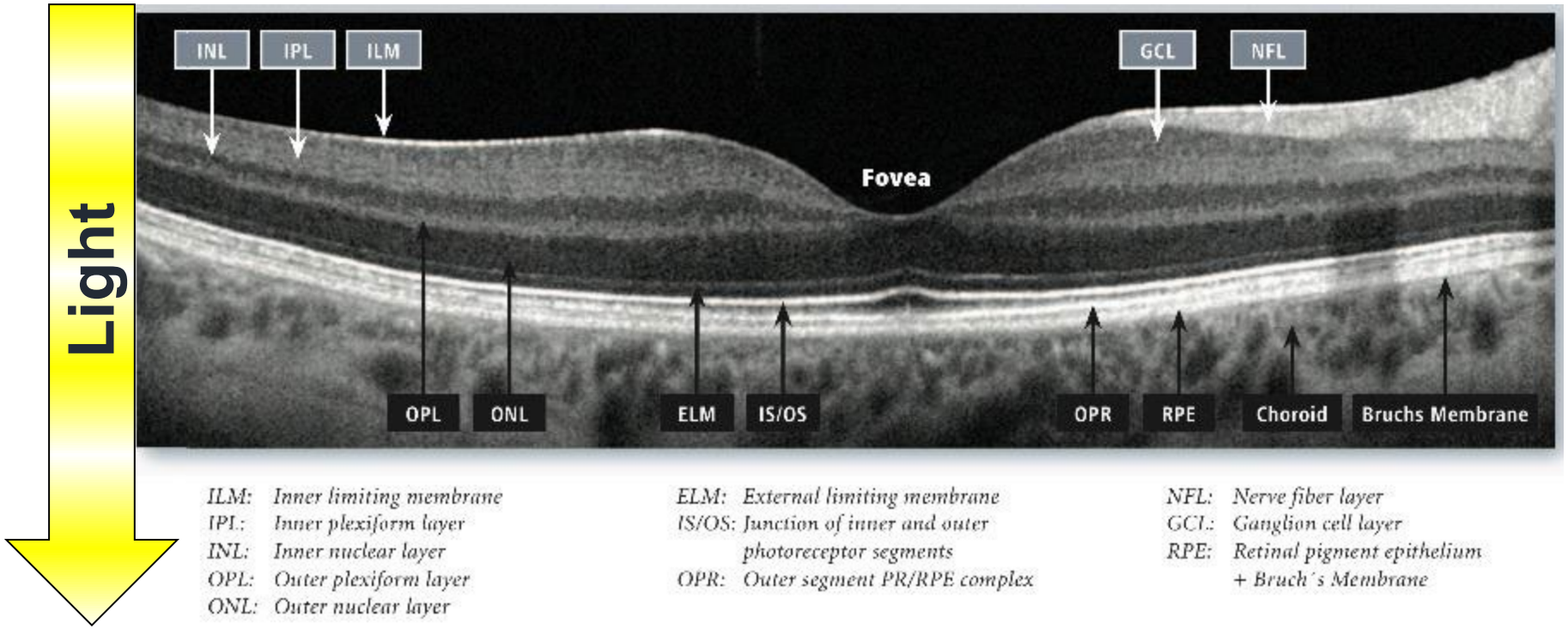
Retina


Fovea
Macula


(A)


(B)
Inner plexi-form layer
Outer plexi-form layer
Photoreceptors in outer nuclear layer
Amacrine cell
Vitreous humor
Fovea
Cones
Axons traveling to optic nerve
Rods
Amacrine cell
Pigment epithelium
Ganglion cell layer
Bipolar cell layer
Horizontal cell
Retina

Layered Organization of Retina: Optical Coherence Tomograhy Imaging



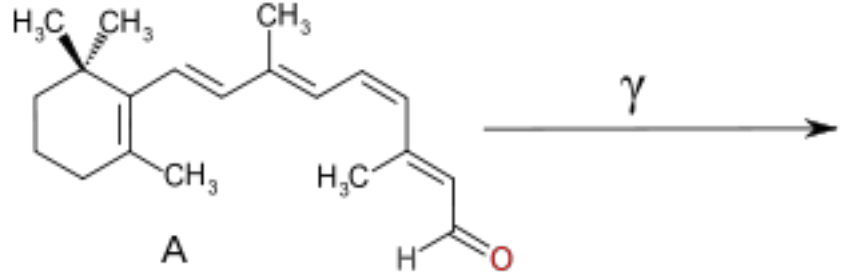
ILM: *Inner limiting membrane*
IPL: *Inner plexiform layer*
INL: *Inner nuclear layer*
OPL: *Outer plexiform layer*
ONL: *Outer nuclear layer*

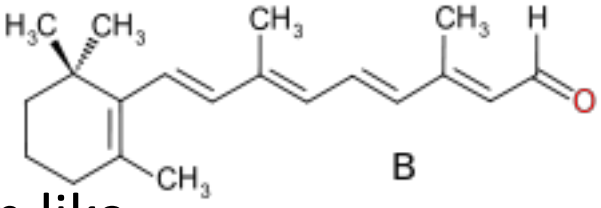
ELM: *External limiting membrane*
IS/OS: *Junction of inner and outer photoreceptor segments*
OPR: *Outer segment PR/RPE complex*

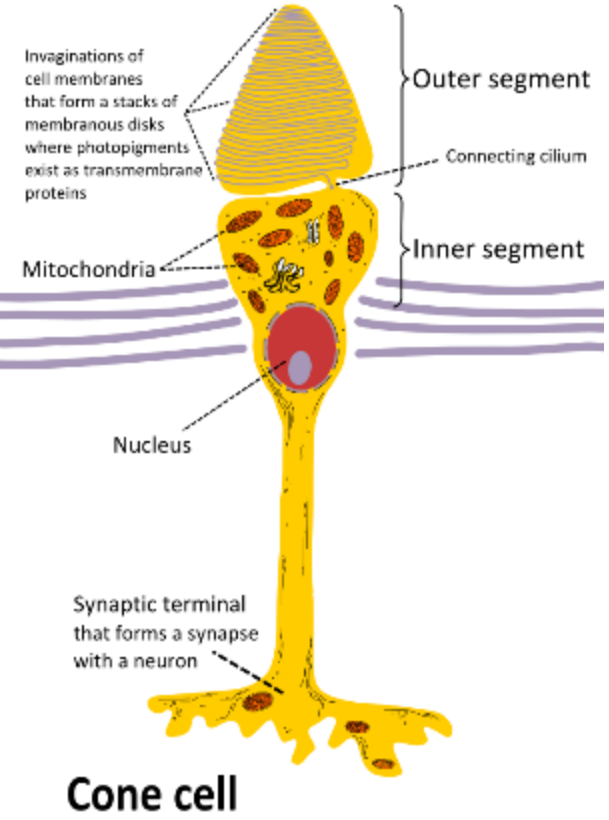
NFL: *Nerve fiber layer*
GCL: *Ganglion cell layer*
RPE: *Retinal pigment epithelium + Bruch´s Membrane*

- **Light flow from inner toward outer layers**
- **Light passes through multiple layers before reaching photoreceptors**

Photons to Perceptions





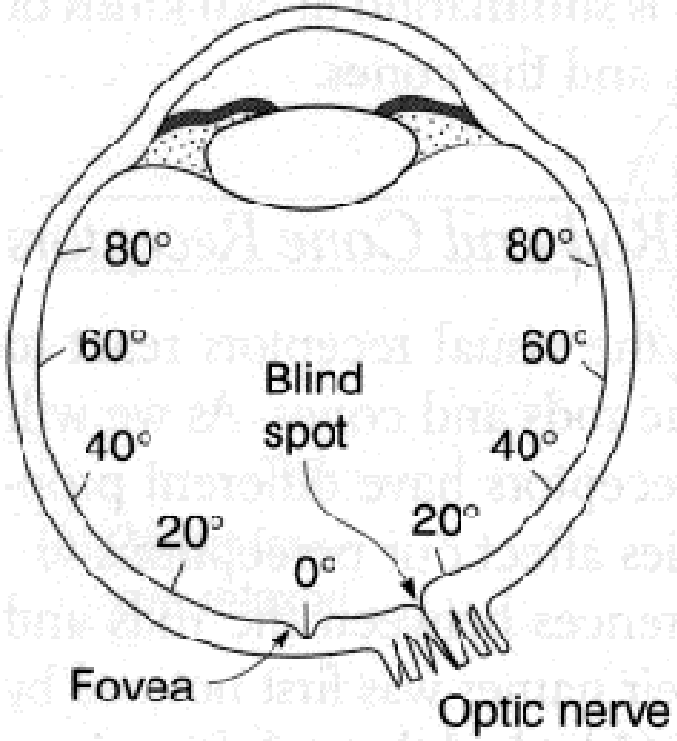


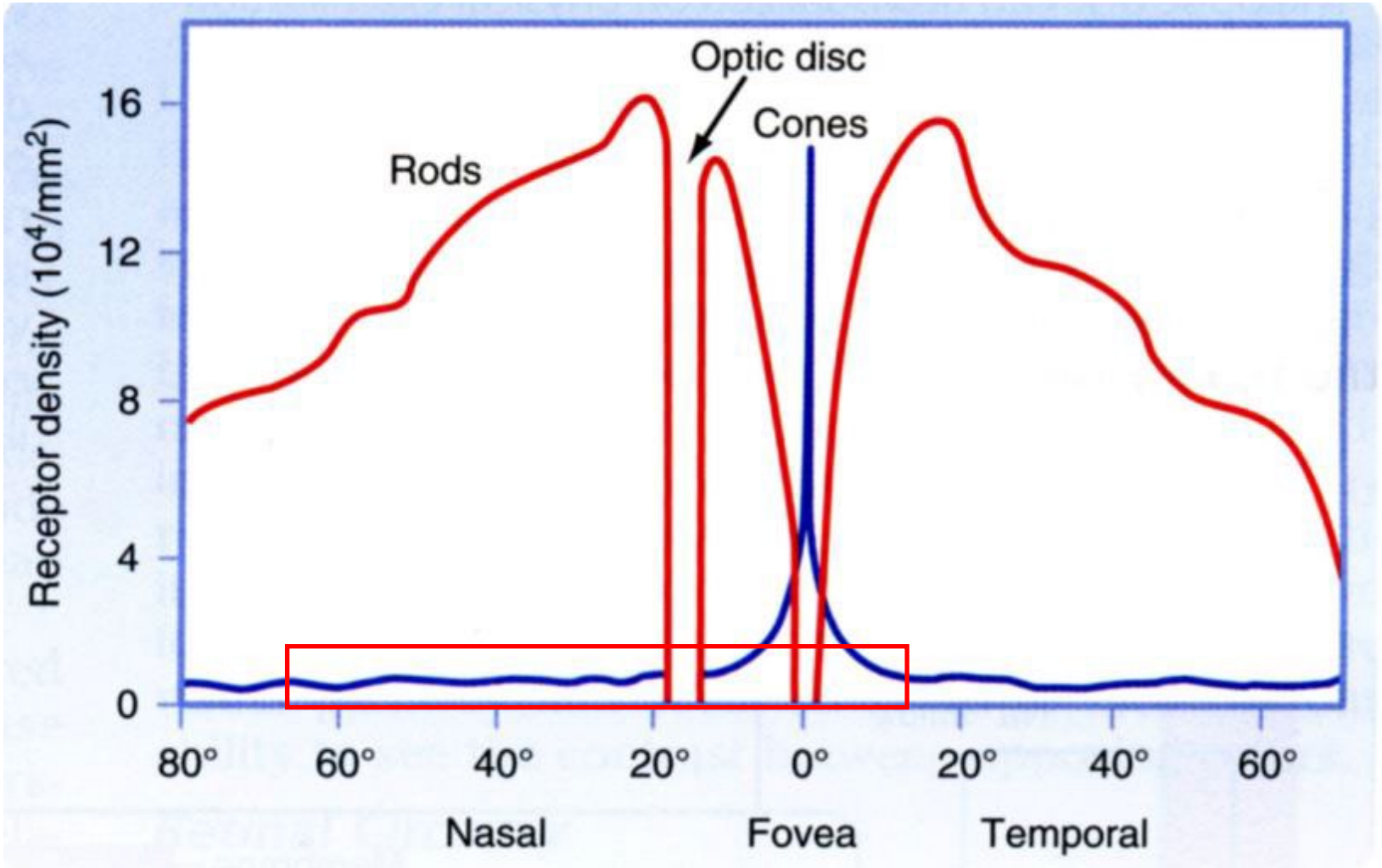
- Rods
  - Retinal plus opsin= rhodopsin
  - Low light situations
  - Poor spatial resolution
  - Poor temporal resolution
  - 20:1 ratio with cones
  - Synapse with parasol cells (Pα or A cells) which then go to the magnocellular layer in the LGN
- Cones
  - Retinal plus opsin like protein=photopsin
  - Three types for short, medium, and long wavelengths
  - Excellent spatial and temporal resolution
  - Taken by midget cells (Pβ or B cells) to the parvocellular layer of the LGN

Distribution of Rods & Cones Across Retina

Photopic vision - fovea

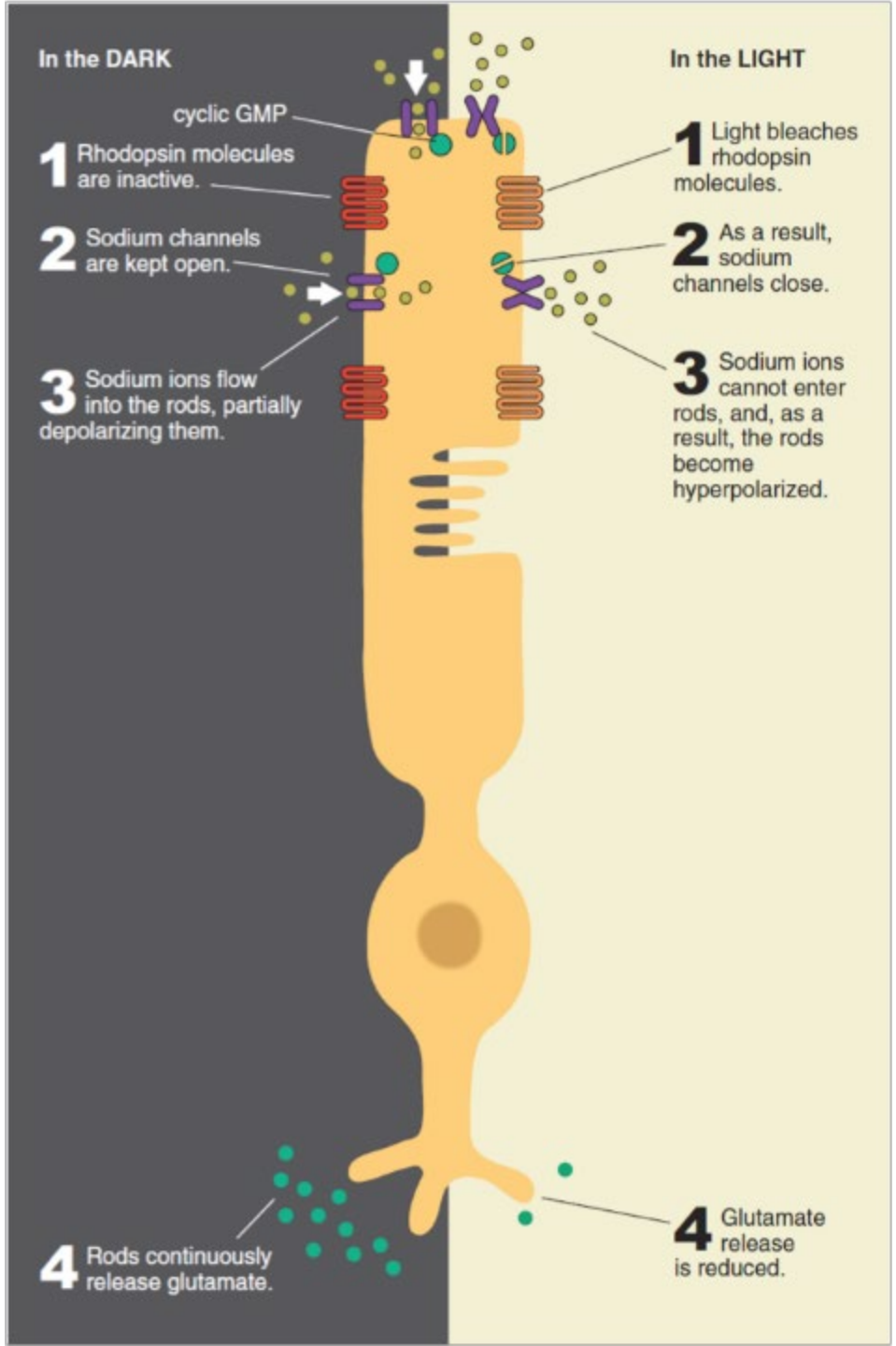
Scotopic vision - peripheral > 10˚





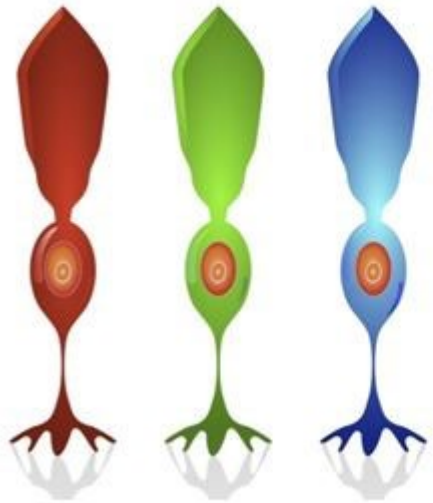
Photons to Perceptions

- Rods and Cones are always releasing glutamate.
- They synapse on Bipolar cells which then synapse on retinal ganglion cells.
- Each of these synapses cause neurotransmitter gradients not action potentials
- The inhibitory and excitatory regulation of these junctions is provided by amacrine cells and horizontal cells.

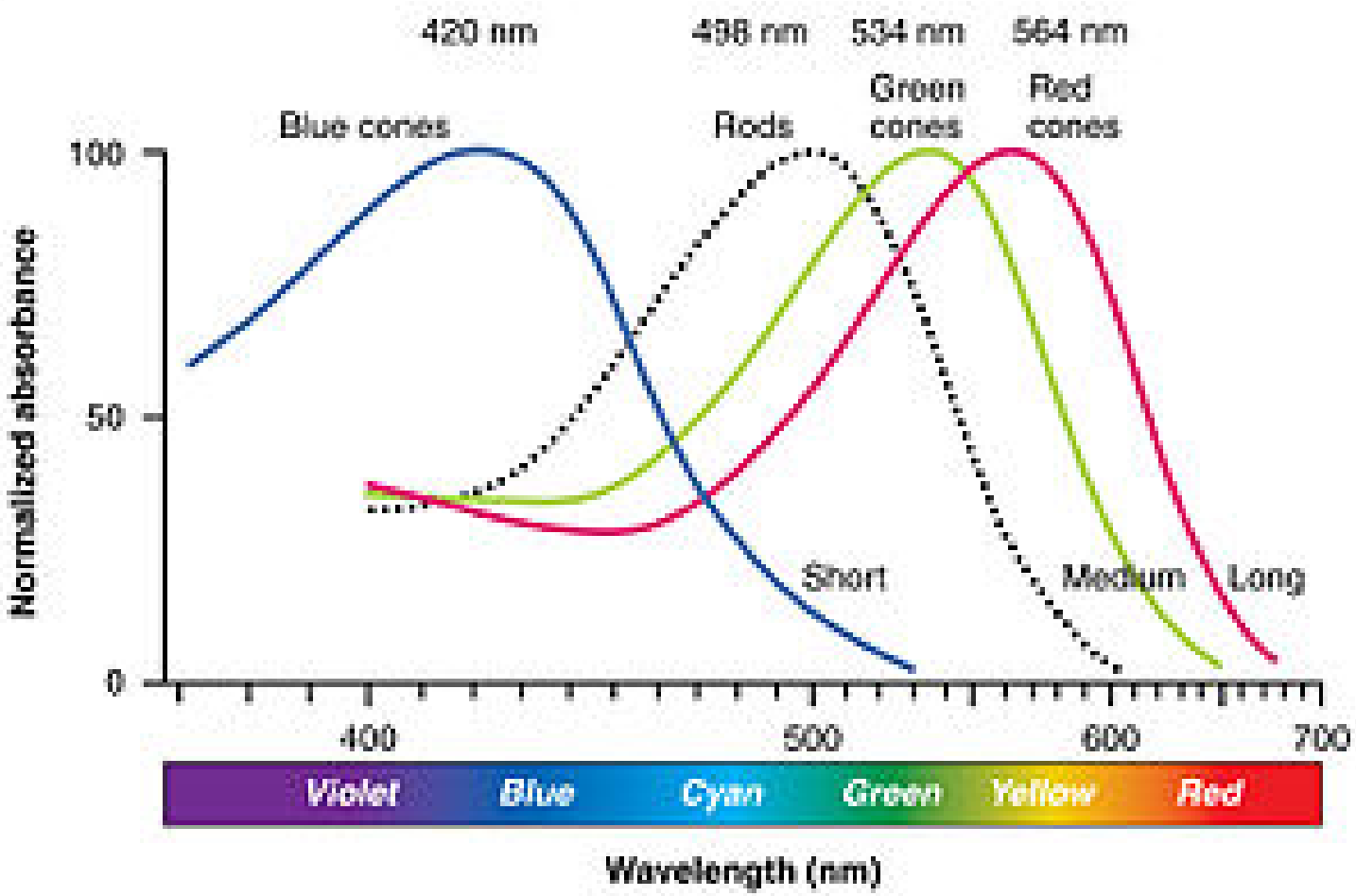


Getting from Three Discrete Types of Cells to the Whole Visible Spectrum

Cone cell



Rod cell

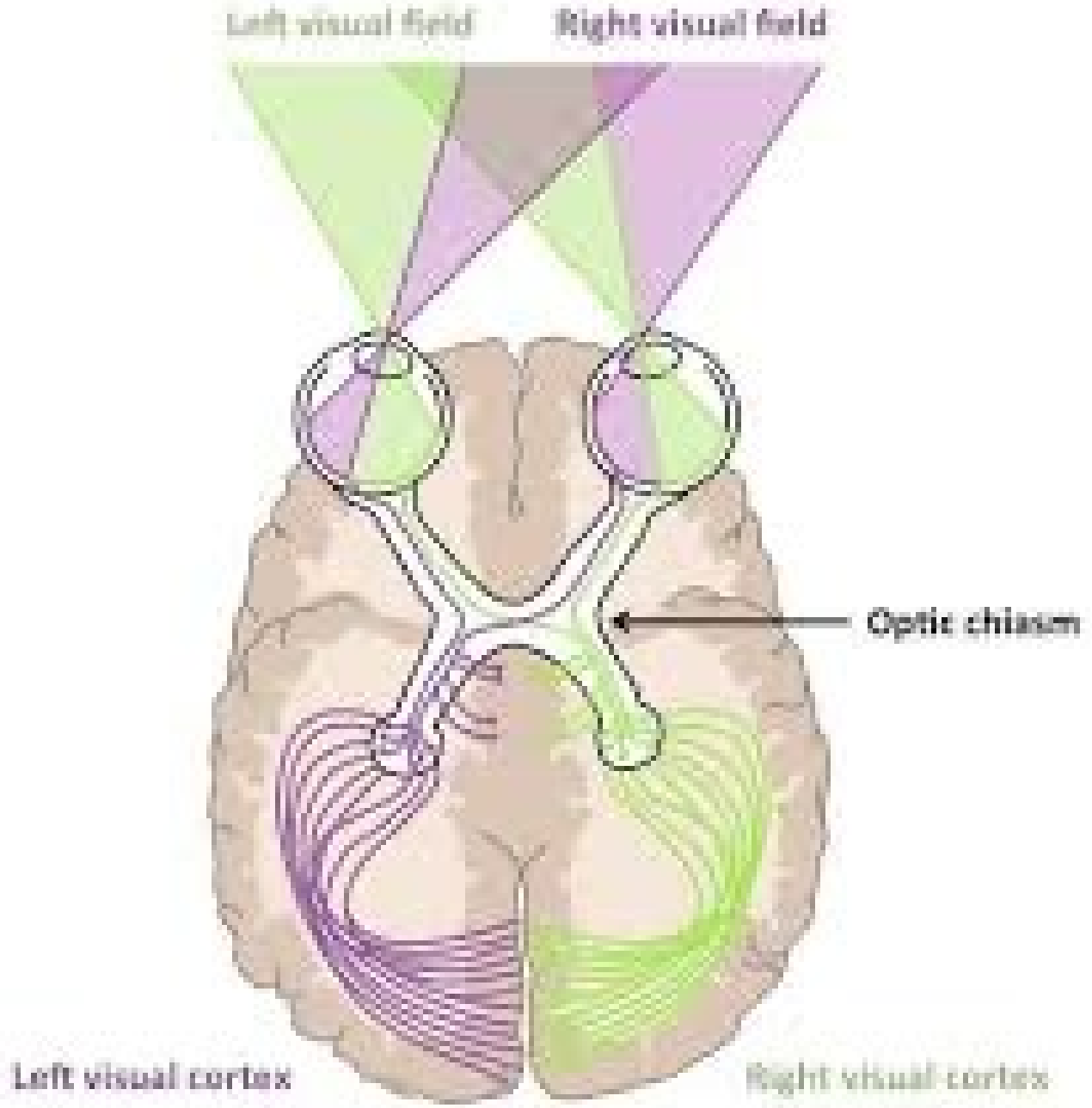


What visual disability results from genetically lacking one type of cone cell?

A. Macular Degeneration
B. Quadrantanopsia
C. Color Blindness
D. Achromatopsia

Vision: Optic Nerve

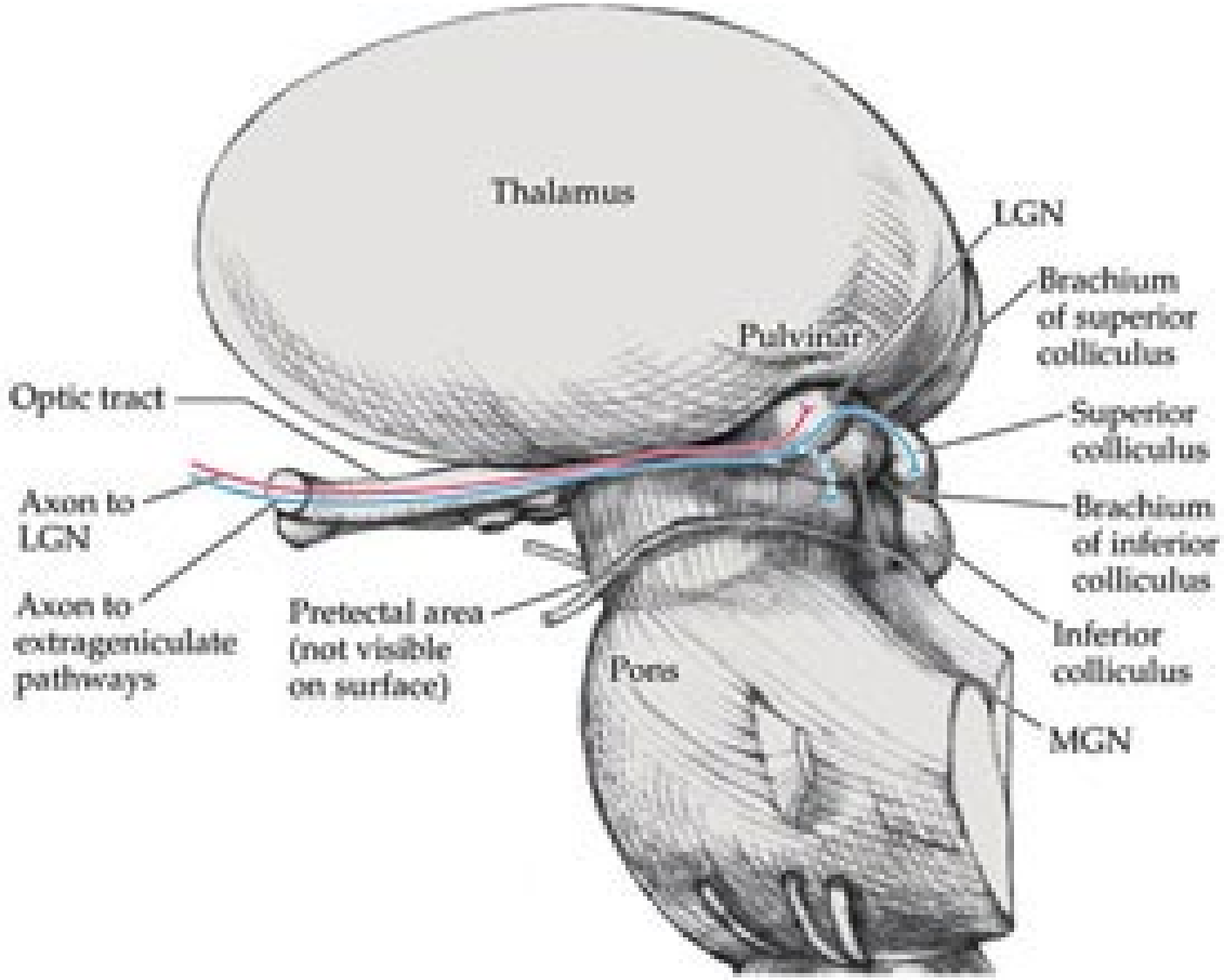
- Images remain inverted!
- Optic chiasm – visual fields are sorted onto contralateral side
- Temporal Lobe - superior visual field information
- Parietal Lobe - inferior visual field information



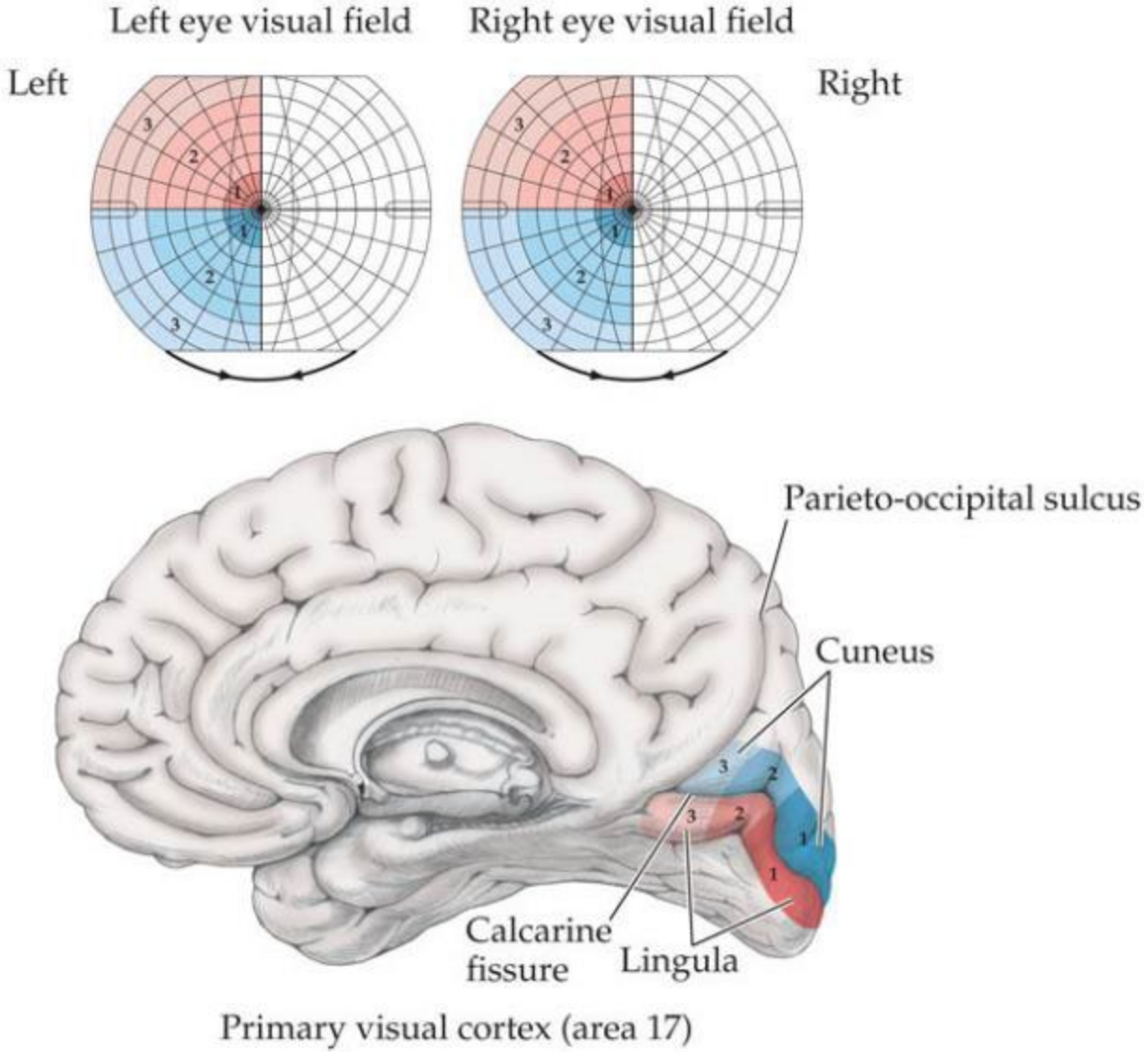
Retinal detatchment in the upper temporal aspect of retina results in what visual field defect?

A. Inferior nasal quadrant defect
B. Central Vision Loss
C. Superior Nasal quadrantanopsia
D. Superior Temporal quadrantanopsia

First Synapse of Vision Pathway after Globe

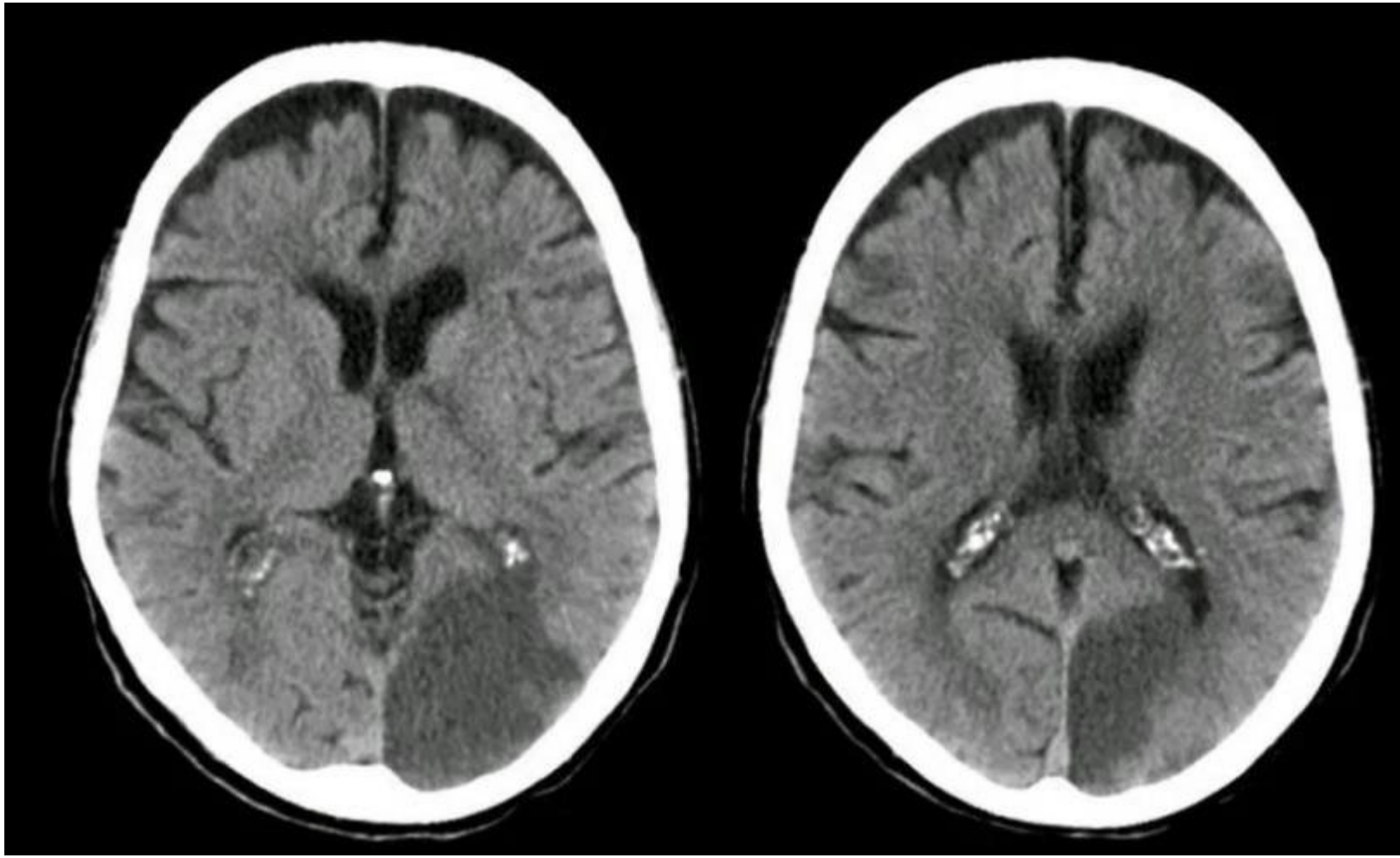


Primary Visual Cortex



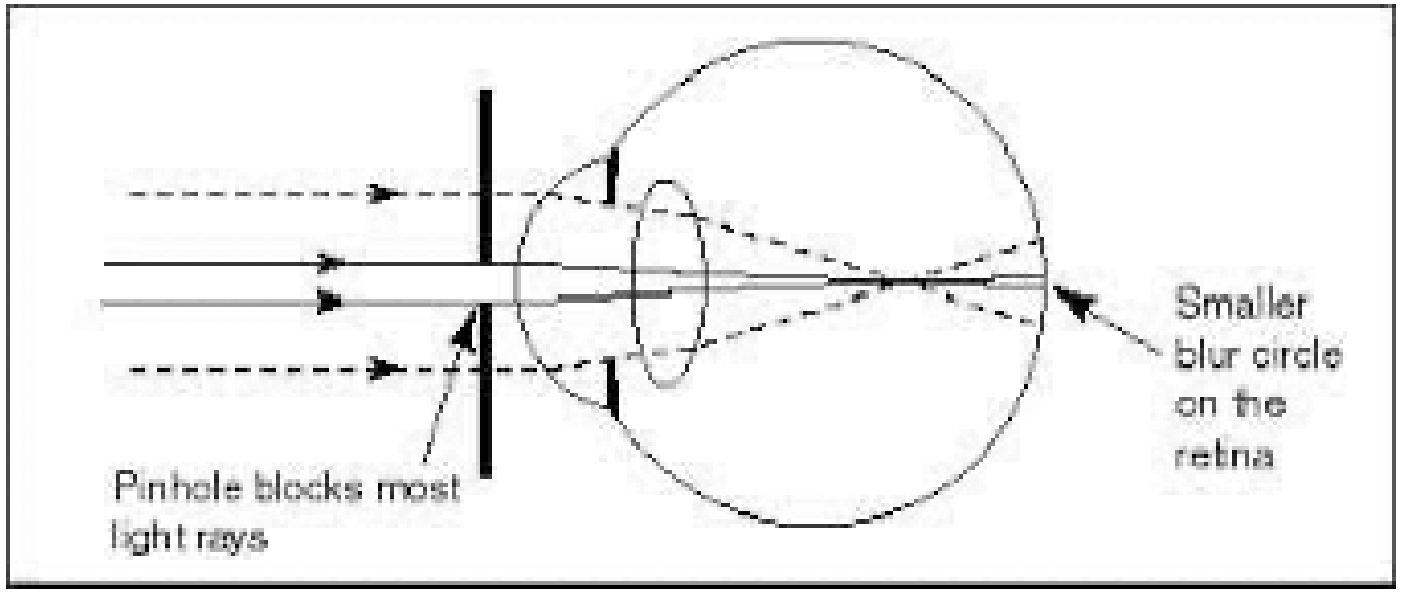
What visual field loss will this pathology cause?

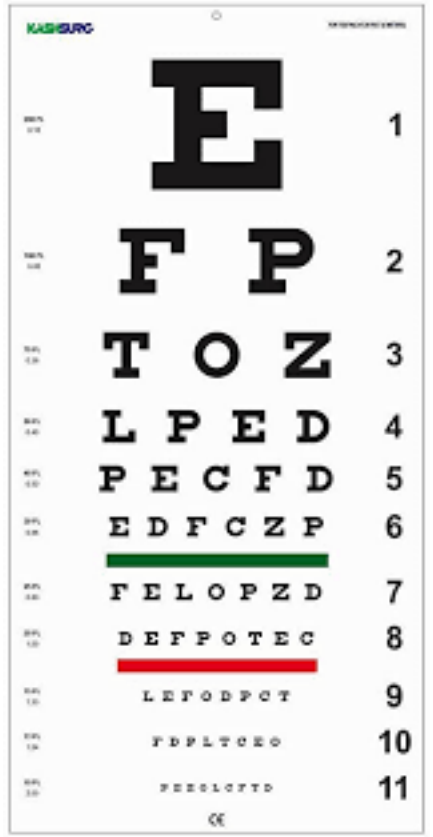
A. Right eye blindness
B. Right hemianopia
C. Left eye blindness
D. Cortical blindness



How do you test Vision?

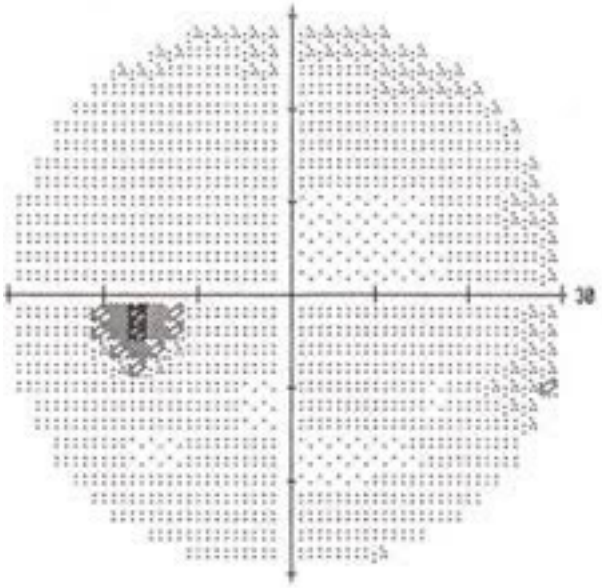
- Most “Vision” Testing is for the Fovea





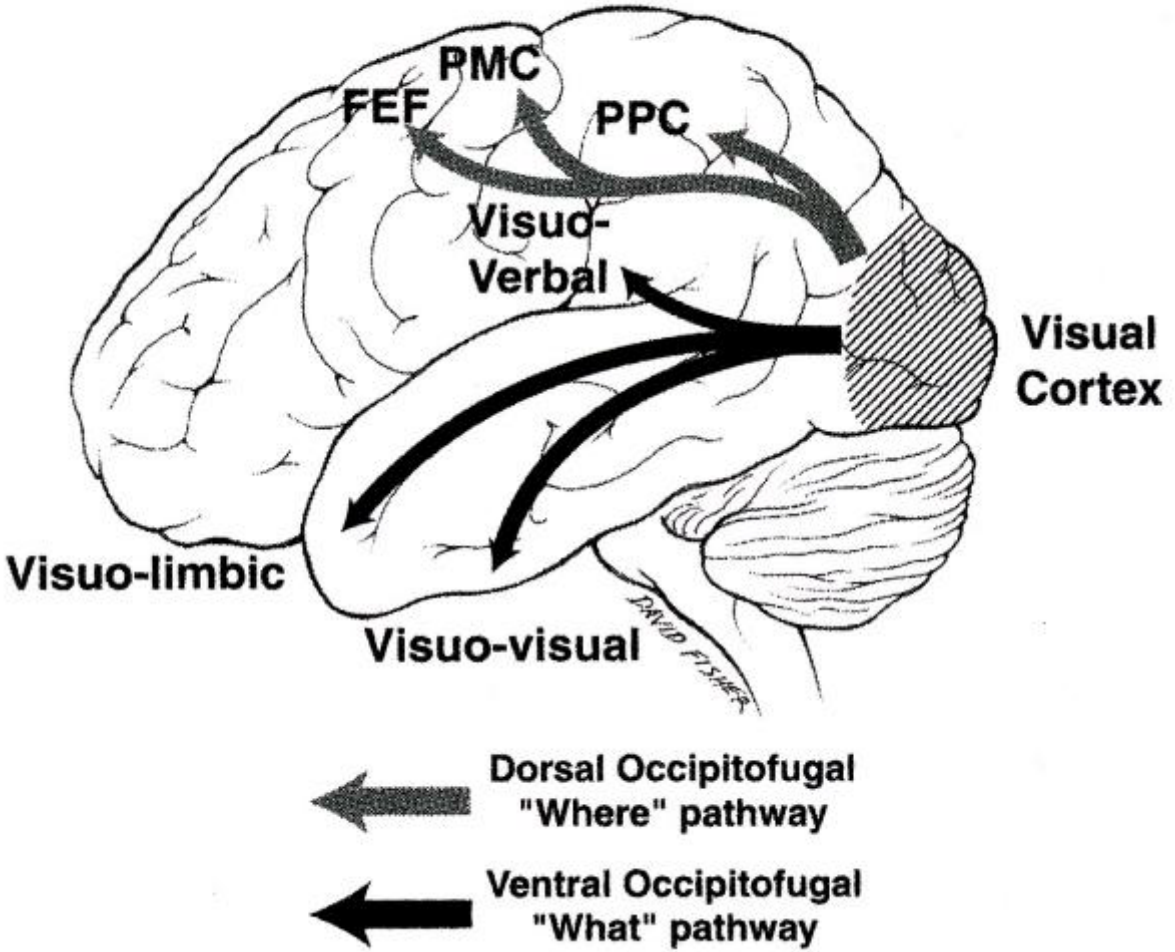
Peripheral Vision Testing

- Finger Count or Finger Wiggle

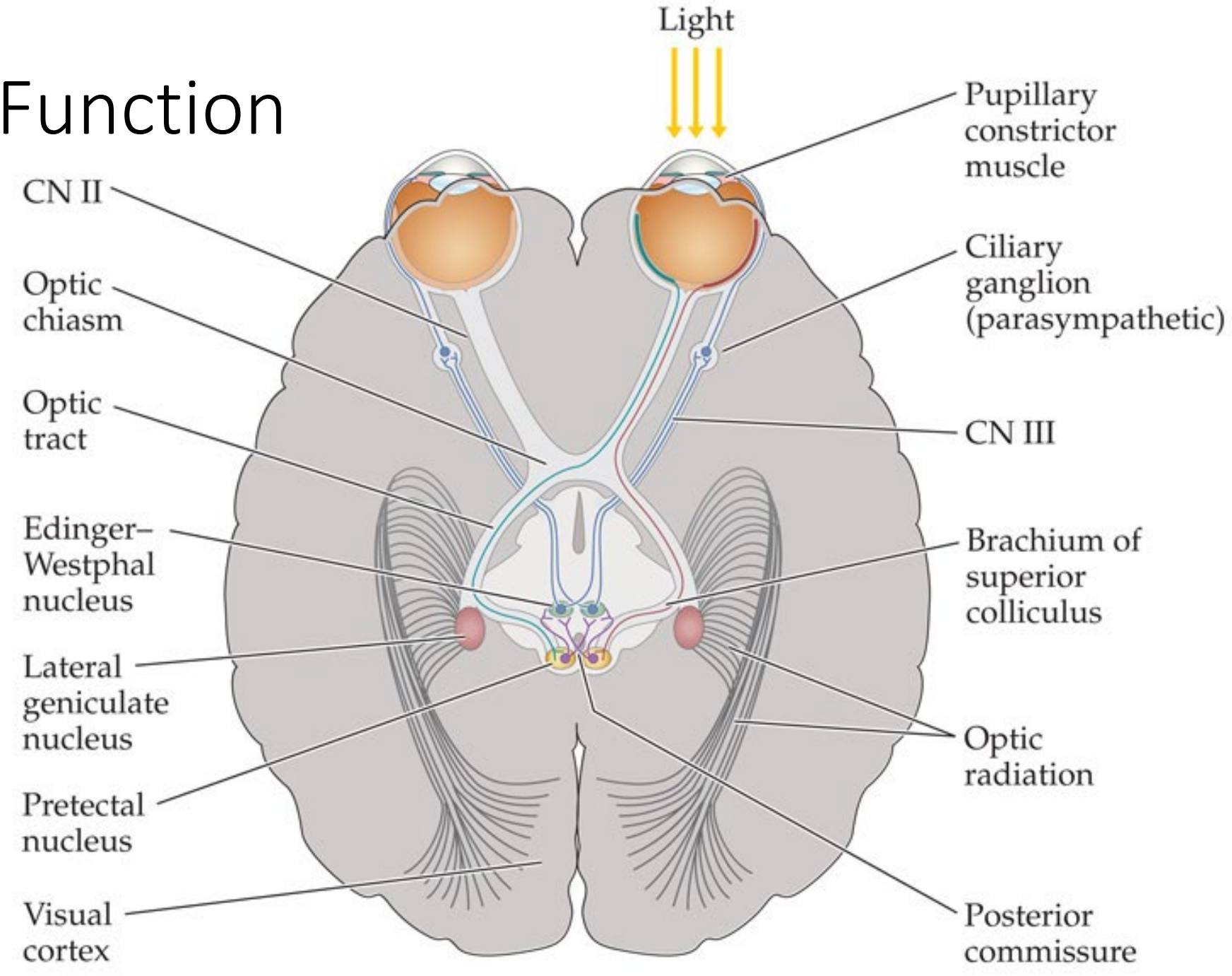


Visual Processing

- The WHERE
  - Catching a moving object
  - Seeing a whole room at the same time (not just what you are focusing on at that moment)
- The WHAT
  - Identification of objects
  - Knowing what an object is for

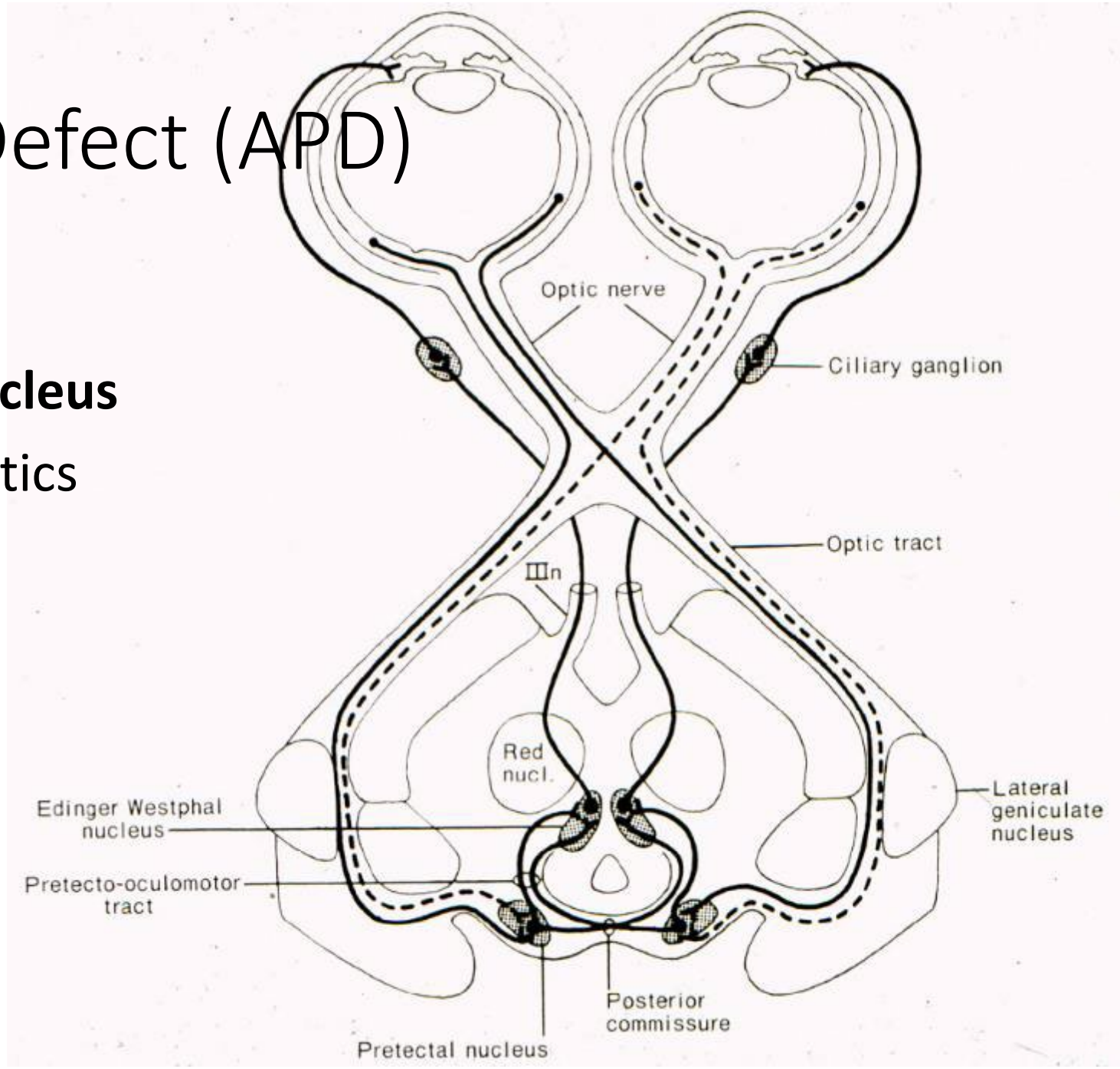


Pupillary Function



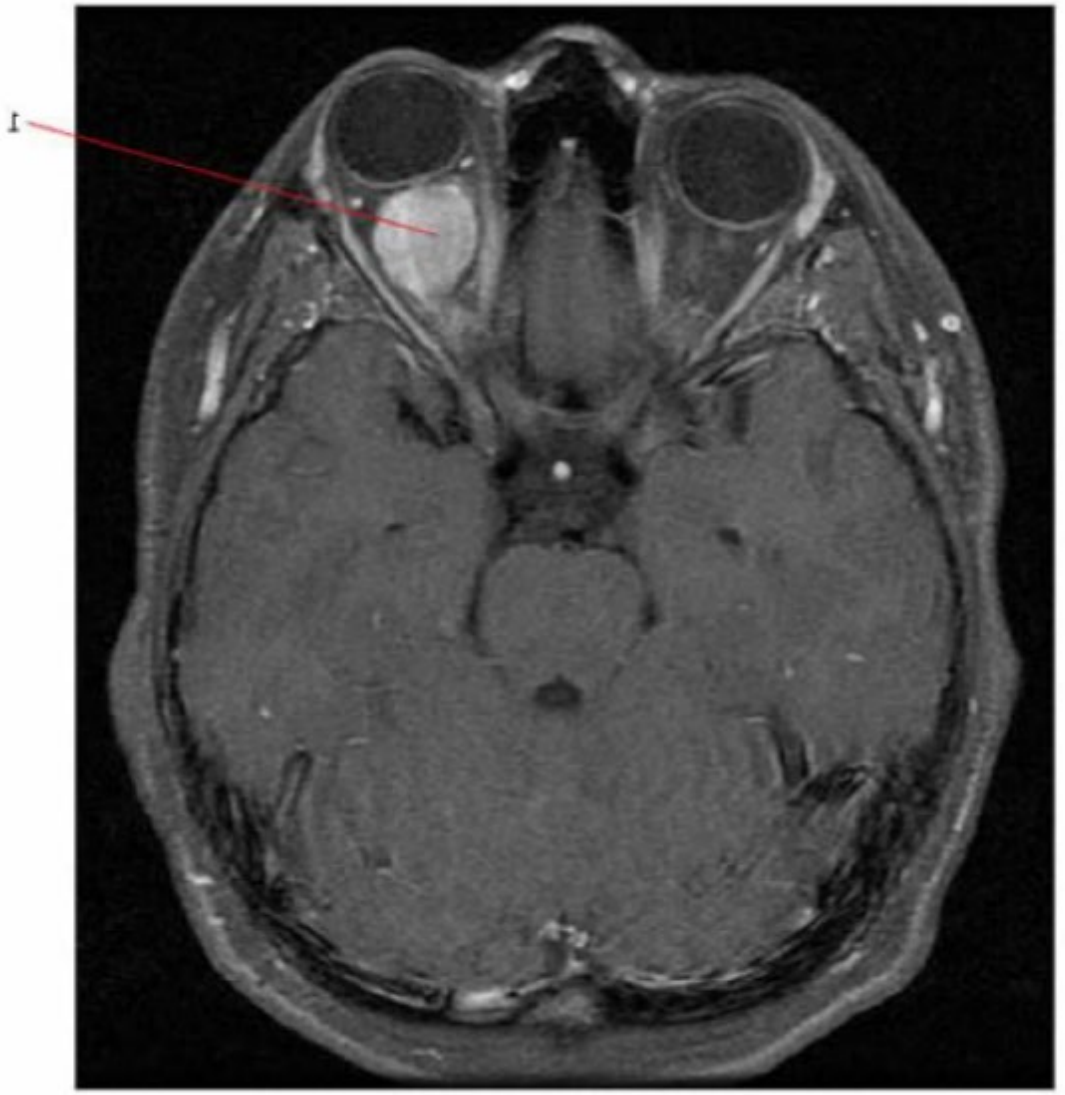
Afferent Pupillary Defect (APD)

- **CN II** carries light
- To the **Edinger Westphal Nucleus**
- Synapse onto parasympathetics
- Carried on **CN III**

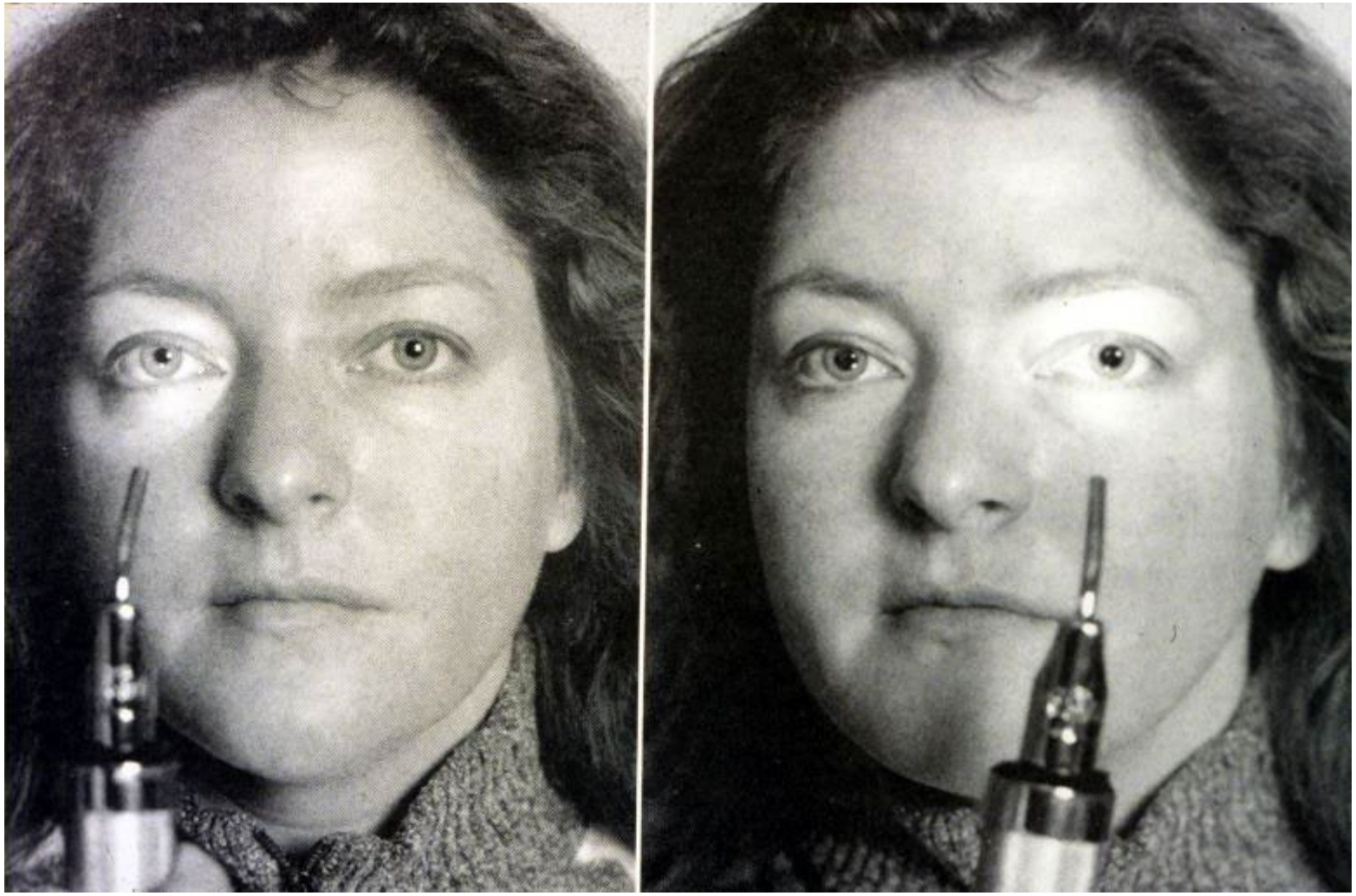


What visual field loss will this optic glioma cause?

- Right hemianopia
- Diplopia
- Anisocoria (unequal pupils)
- Monocular visual loss



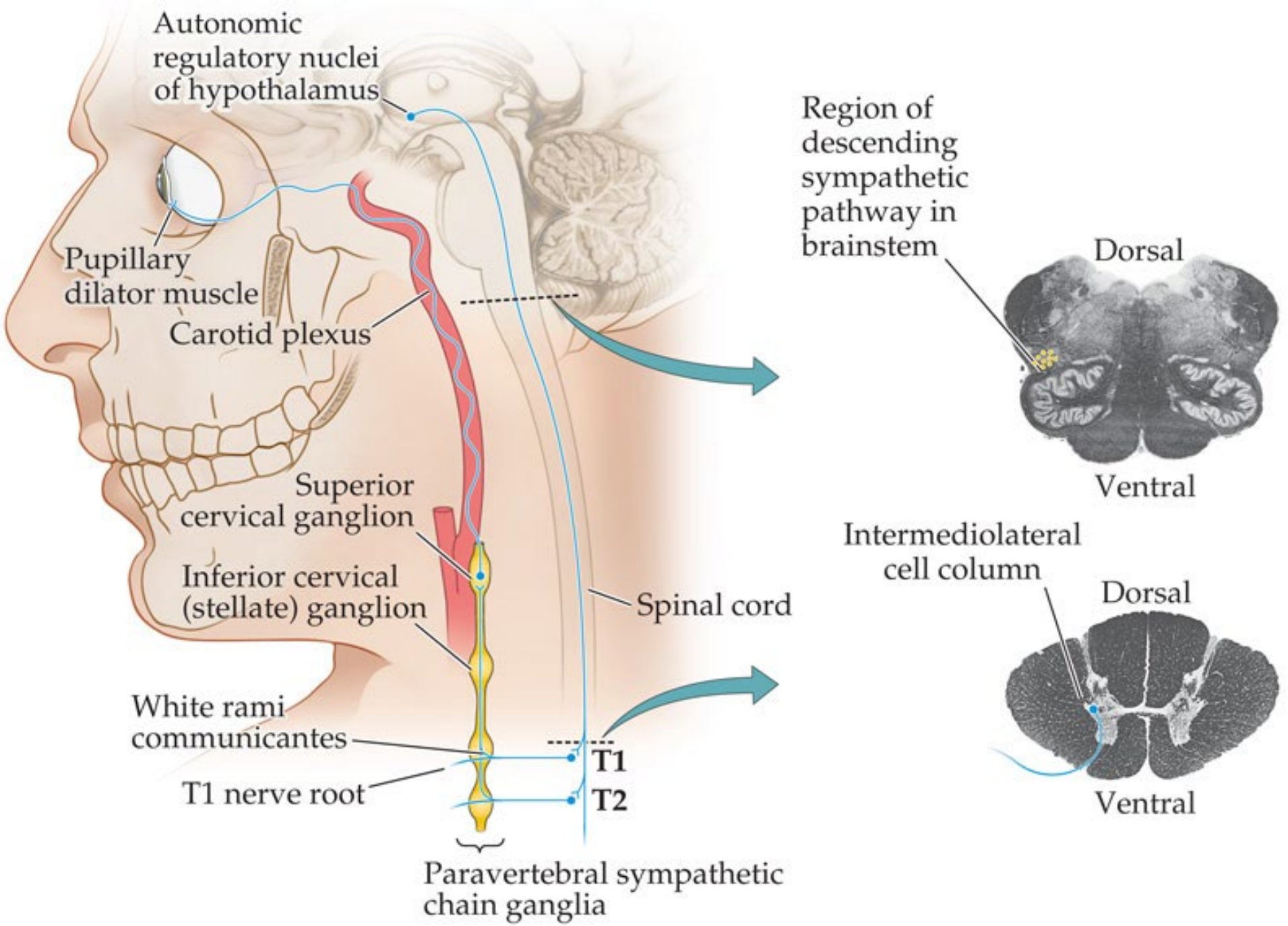
Relative Afferent Pupil Defect



Highly sensitive and specific for optic nerve disease

Sympathetic problem - Horner's Syndrome

The eye will not dilate completely



Which Cranial Nerve is NOT involved in eye movement?

- Oculomotor (III)
- Abducens (VI)
- Trigeminal (V)
- Trochlear (IV)

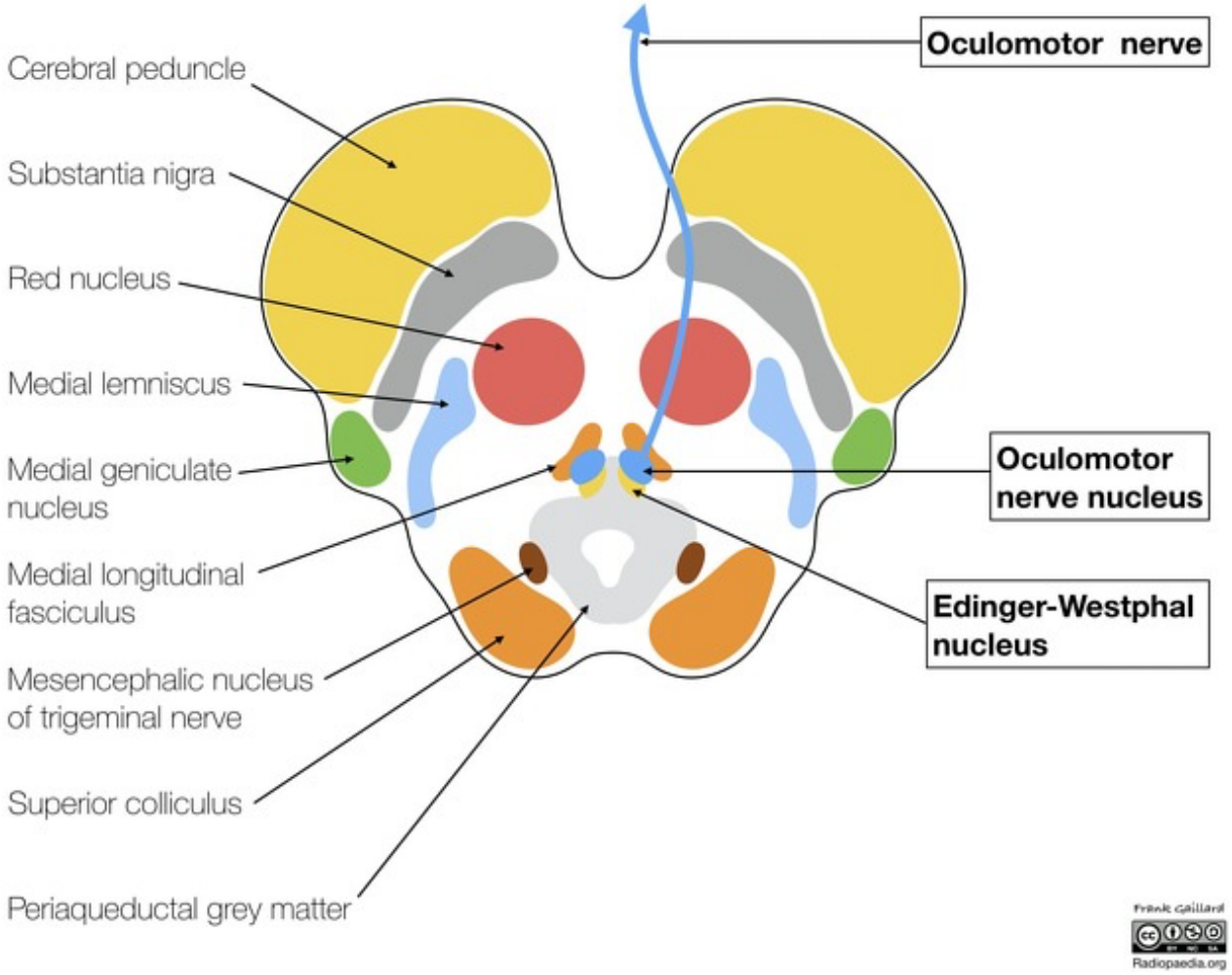
Eye Movements

- Symptoms of eye movement problems
  - Double vision
  - (Sometimes blurry vision if the two images are close to each other)

- Rudimentary Eye Movement Coordination
  - Midbrain (CN III and IV)
  - Pons (CN VI)

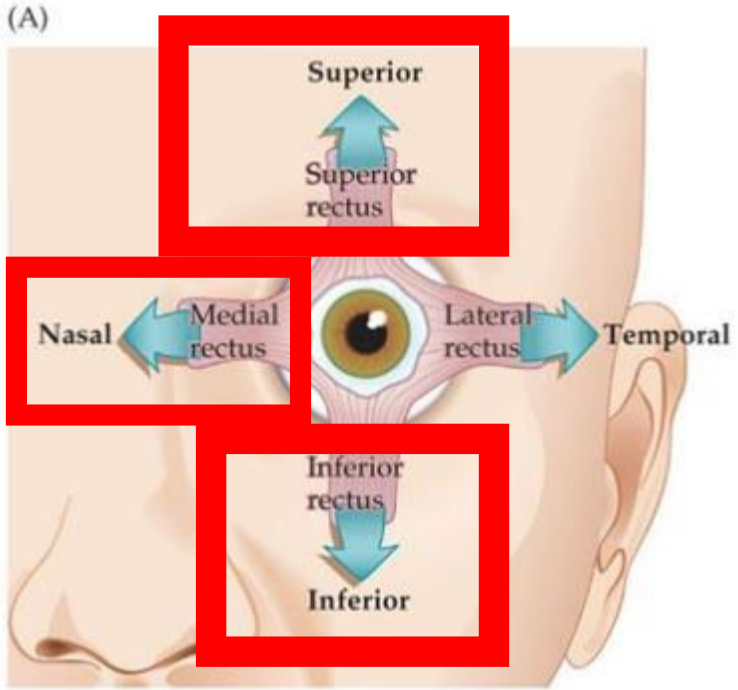
Oculomotor nerve

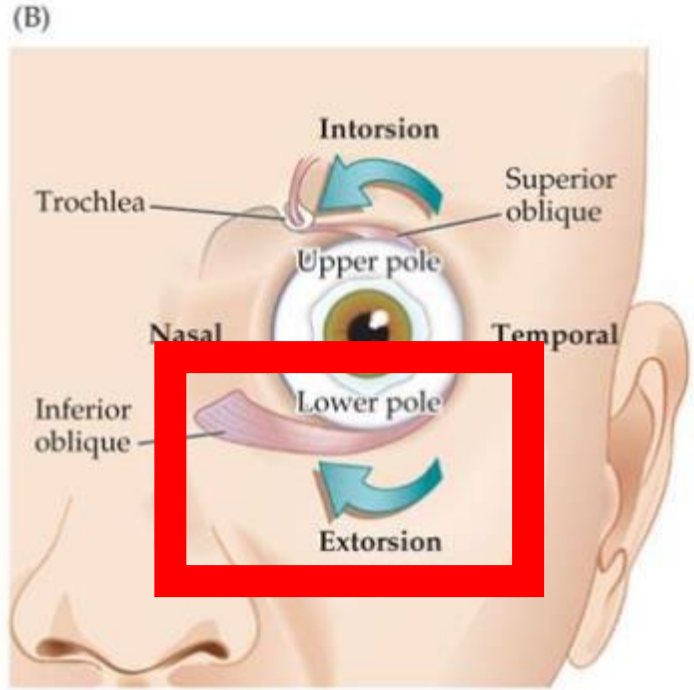
CN III

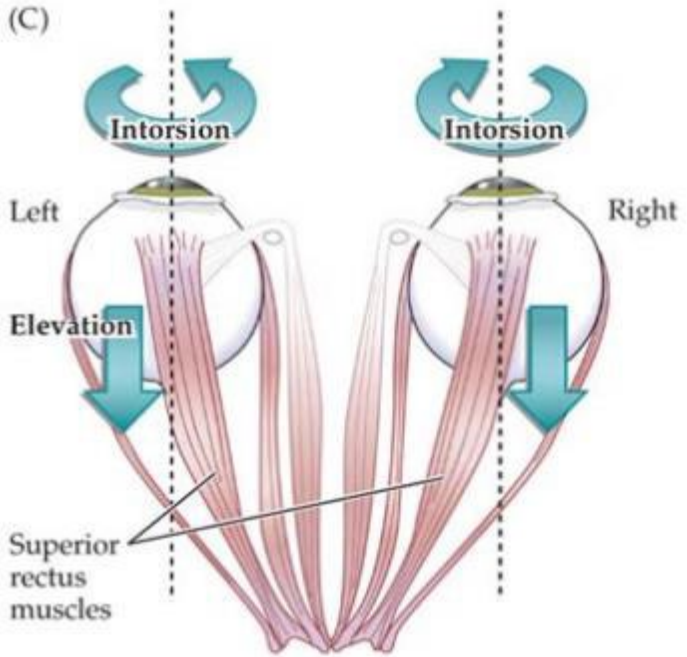


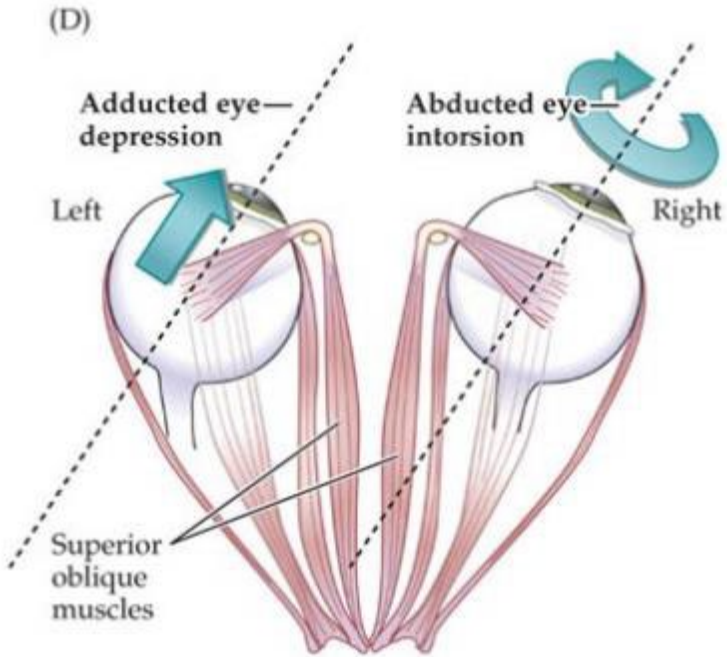
- Damage to the nerve causes:
  - Blown pupil
  - Down and Out eye

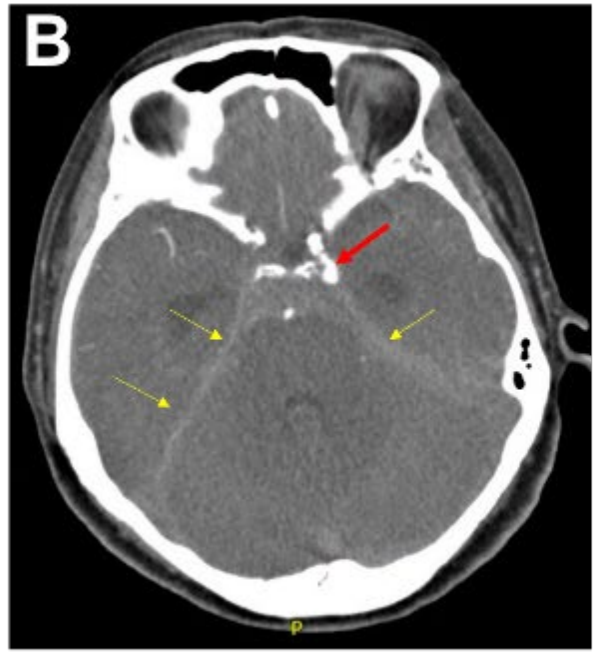
CN III


(A)
Superior
Superior rectus
Nasal
Medial rectus
Lateral rectus
Temporal
Inferior rectus
Inferior


(B)
Intorsion
Trochlea
Superior oblique
Upper pole
Nasal
Temporal
Lower pole
Inferior oblique
Extorsion

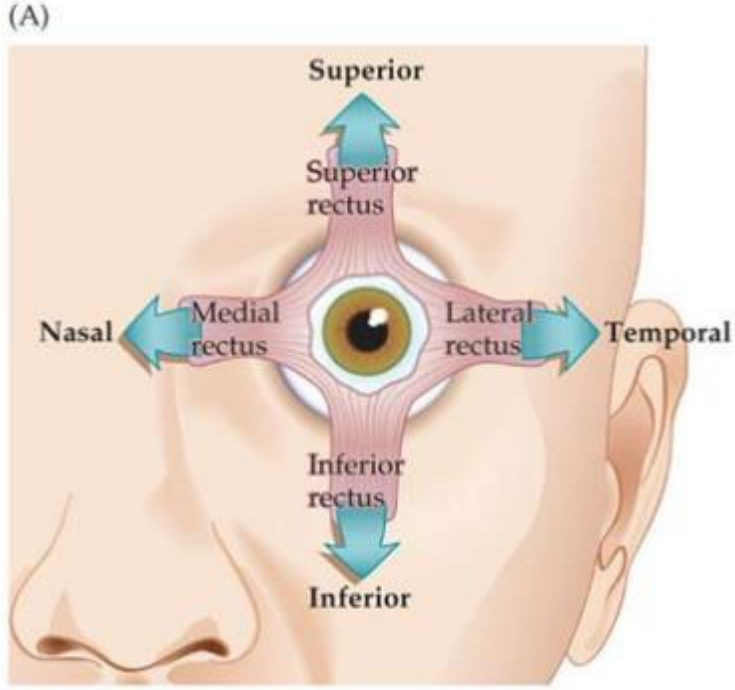

(C)
Intorsion
Intorsion
Left
Right
Elevation
Superior rectus muscles

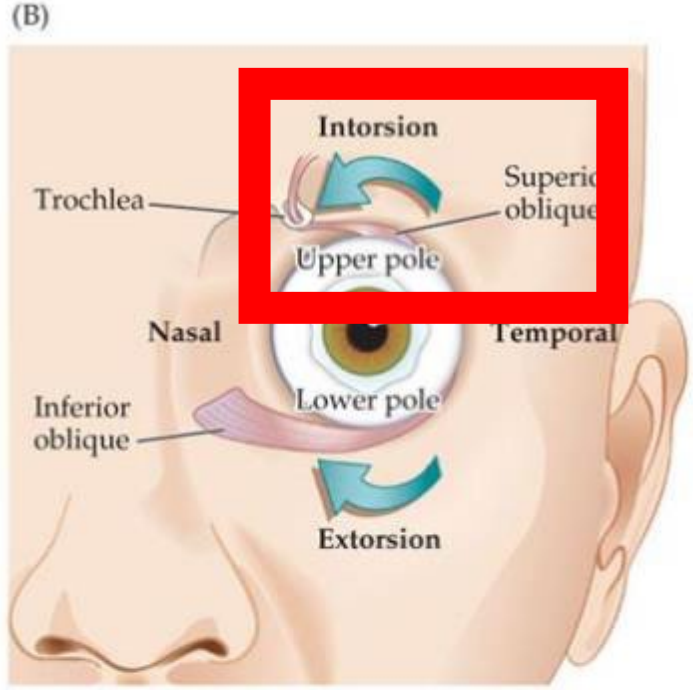

(D)
Adducted eye—depression
Abducted eye—intorsion
Left
Right
Superior oblique muscles

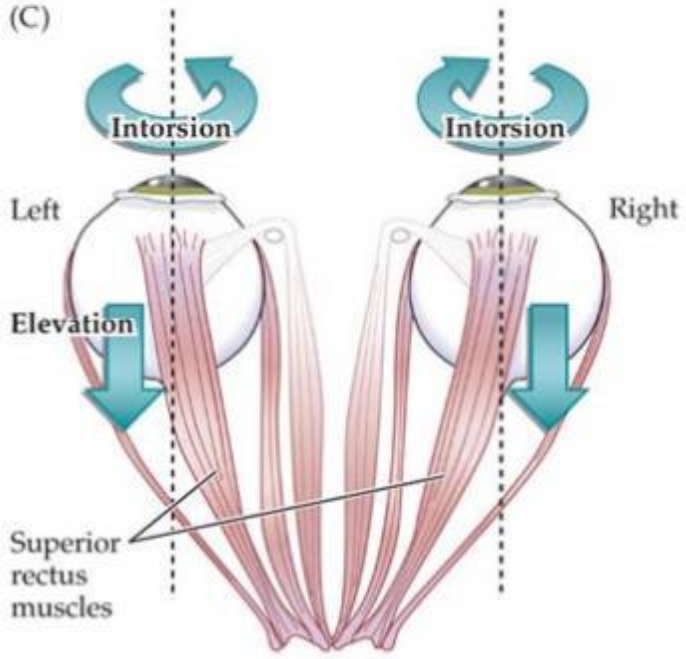


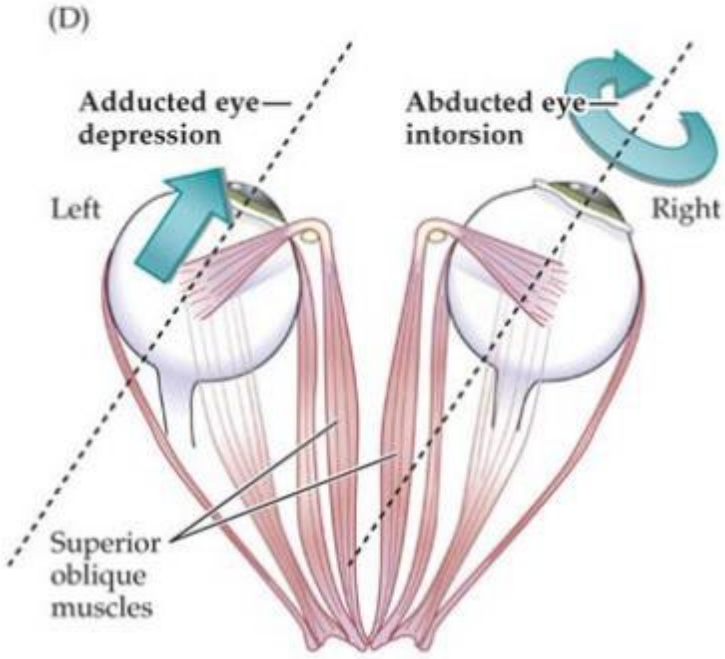
A 70-year-old woman with a new severe headache and complete left ptosis and new left 3rd nerve palsy (A). Computed tomography angiography shows a posteriorly projecting left posterior communicating artery aneurysm (red arrow) and signs of a subarachnoid hemorrhage (yellow arrows demonstrating blood in the subarachnoid space). Digital subtraction angiography pre-(C) and post-(D) endovascular coiling demonstrating the untreated (blue arrow) and treated (orange arrow) aneurysm.

CN IV


(A)
Superior
Superior rectus
Nasal
Medial rectus
Lateral rectus
Temporal
Inferior rectus
Inferior

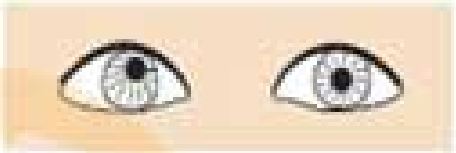

(B)
Intorsion
Trochlea
Superior oblique
Upper pole
Nasal
Temporal
Lower pole
Inferior oblique
Extorsion


(C)
Intorsion
Intorsion
Left
Right
Elevation
Superior rectus muscles


(D)
Adducted eye—depression
Abducted eye—intorsion
Left
Right
Superior oblique muscles

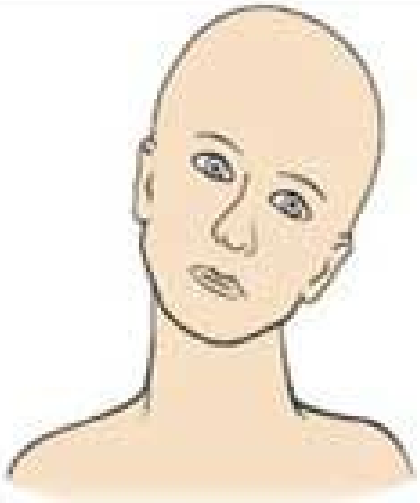
Trochlear nerve palsy

Straight-ahead gaze

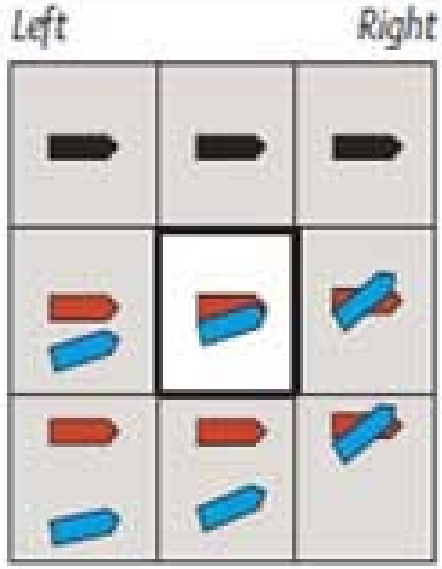


Largest divergence

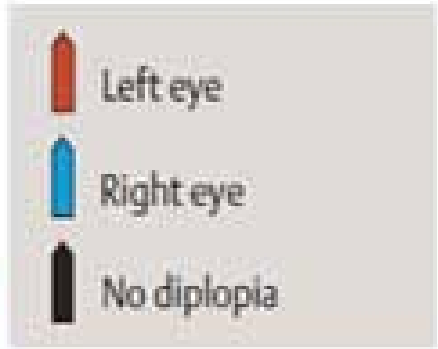
Head tilt to side of paretic muscle (Bielschowsky phenomenon)



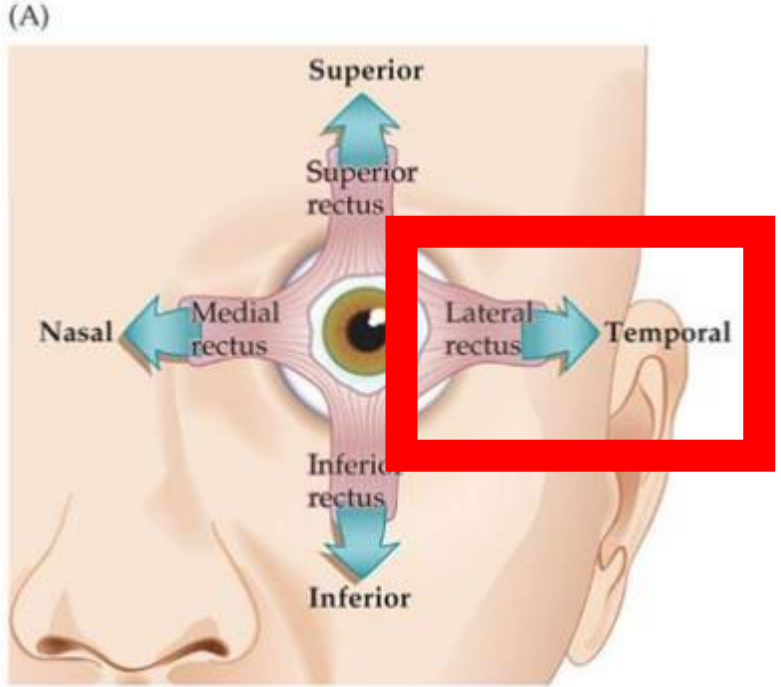
Head tilt to unaffected side

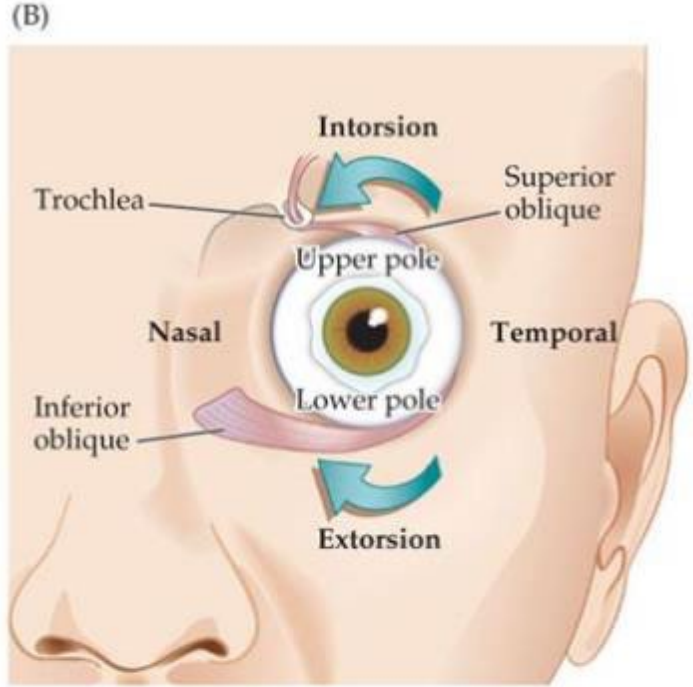


Paresis of superior oblique m.



CN VI


(A)
Superior
Superior rectus
Nasal
Medial rectus
Lateral rectus
Temporal
Inferior rectus
Inferior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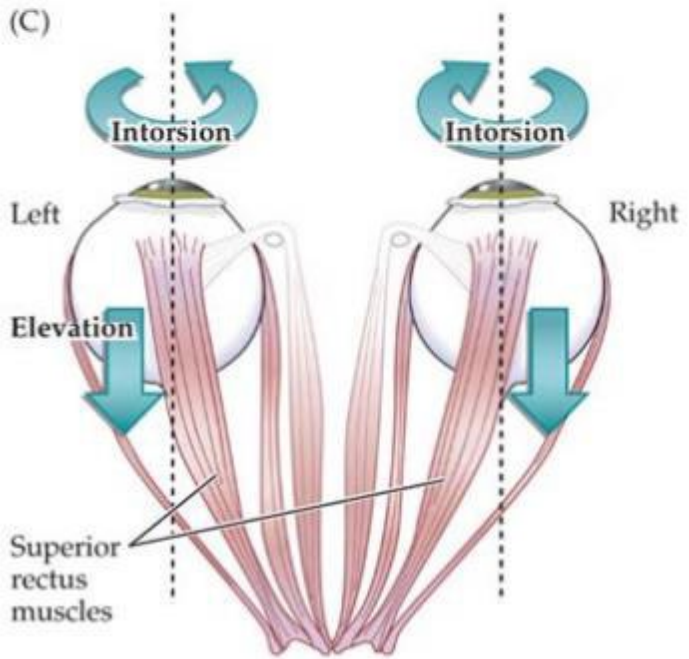
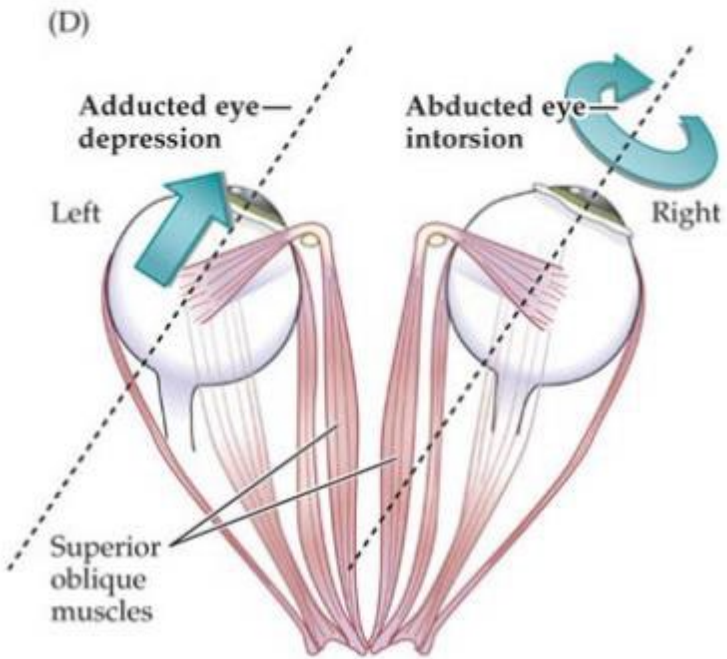
Intorsion
Trochlea
Superior oblique
Upper pole
Nasal
Temporal
Lower pole
Inferior oblique
Extorsion


(C)
Intorsion
Intorsion
Left
Right
Elevation
Superior rectus muscles

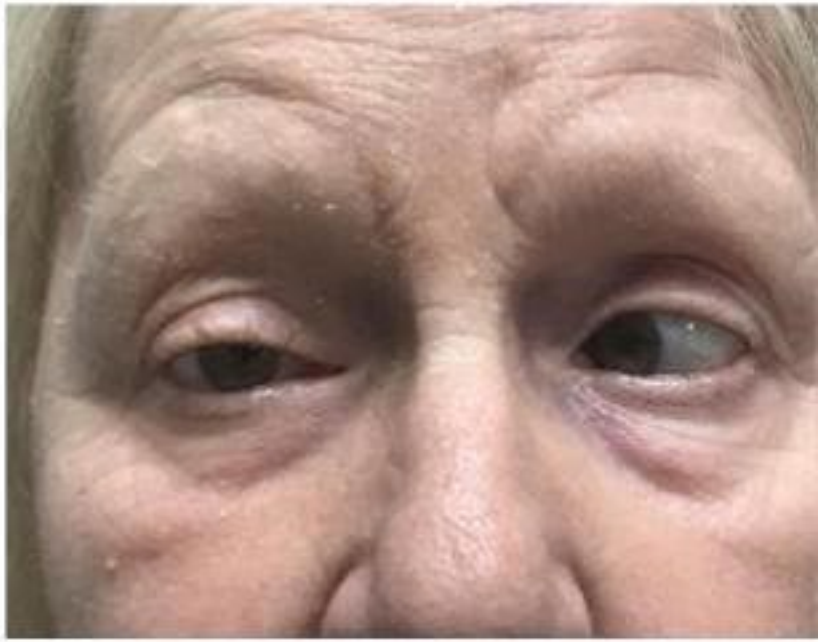

(D)
Adducted eye—depression
Abducted eye—intorsion
Left
Right
Superior oblique muscles

CN VI

- Which side has the problem?

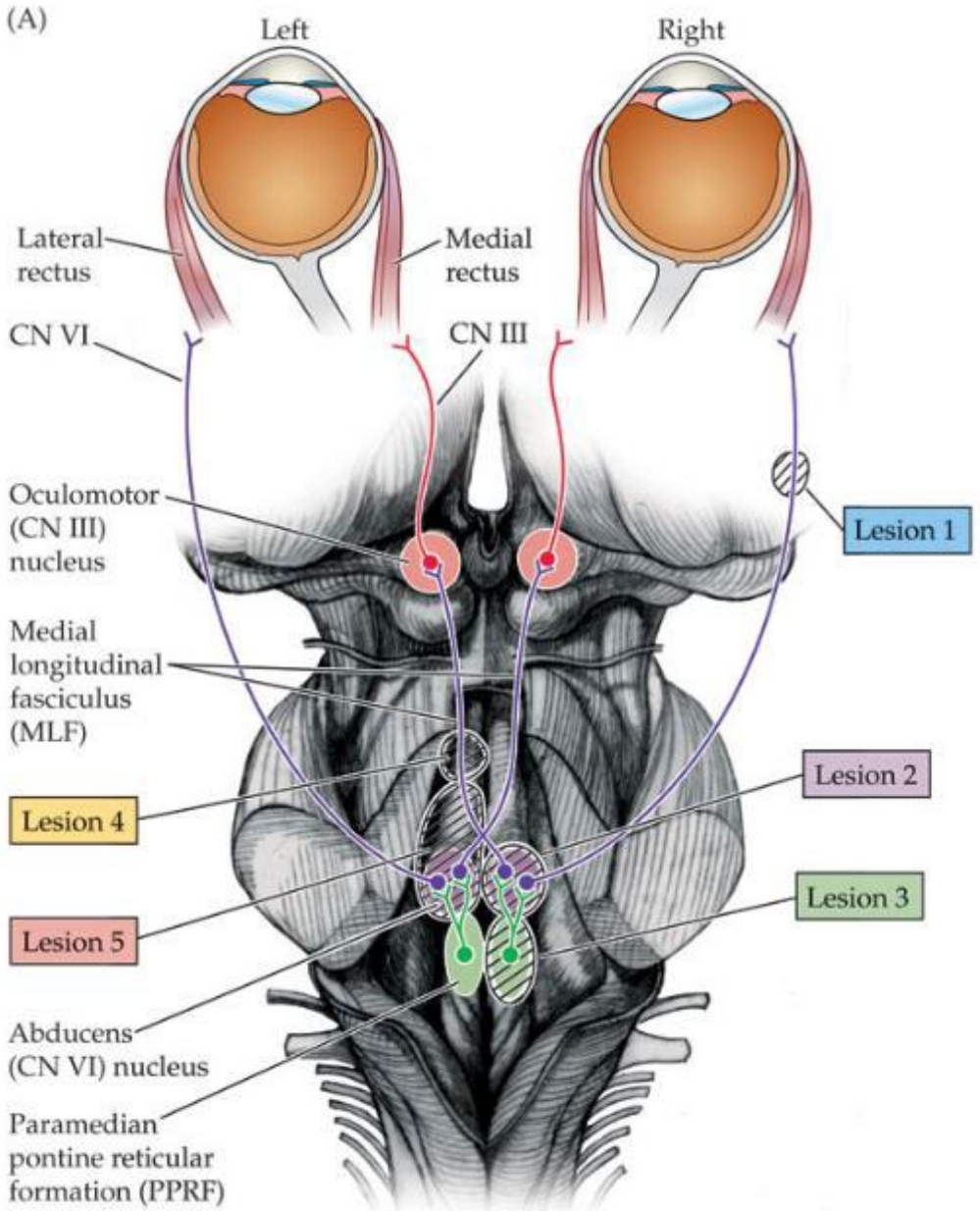
Left gaze: no deviation

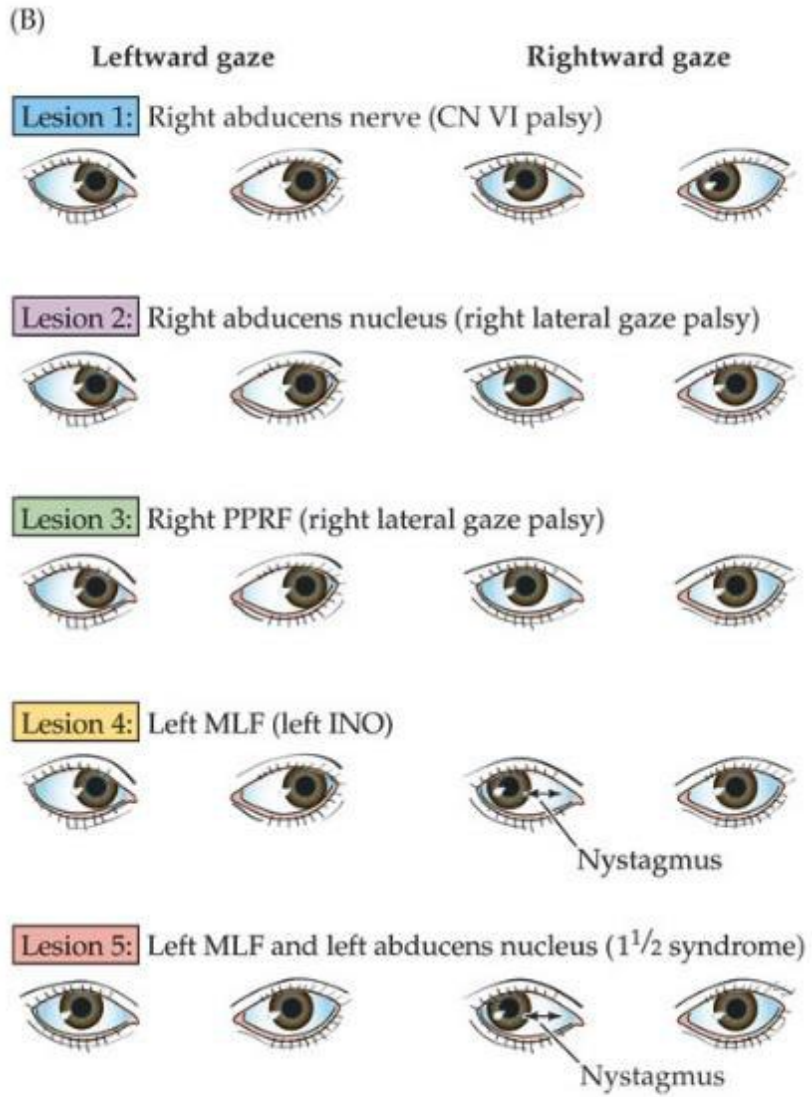
Primary position: right esotropia



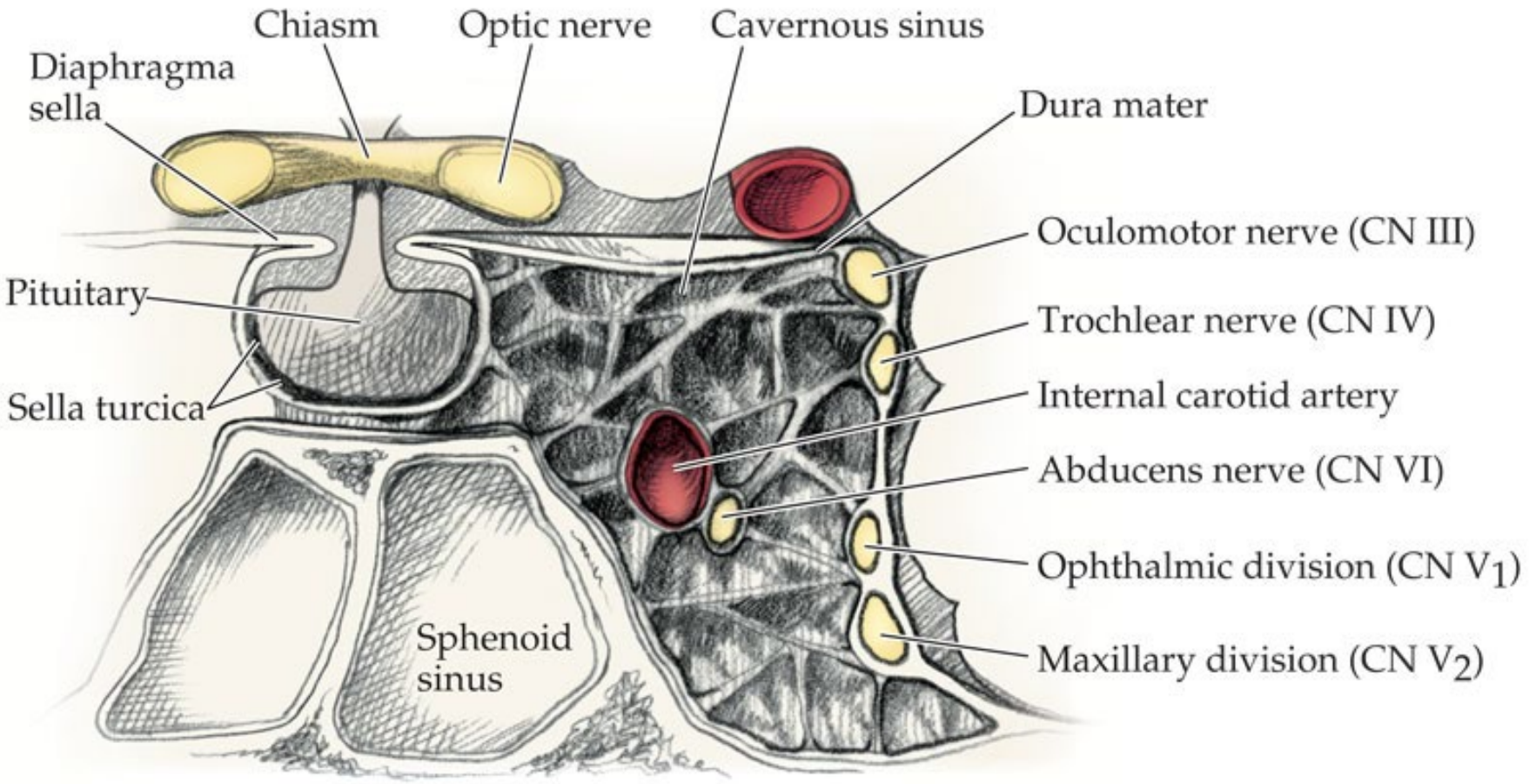
Right gaze: left esotropia

Internuclear Ophthalmoplegia (INO)





Cavernous Sinus

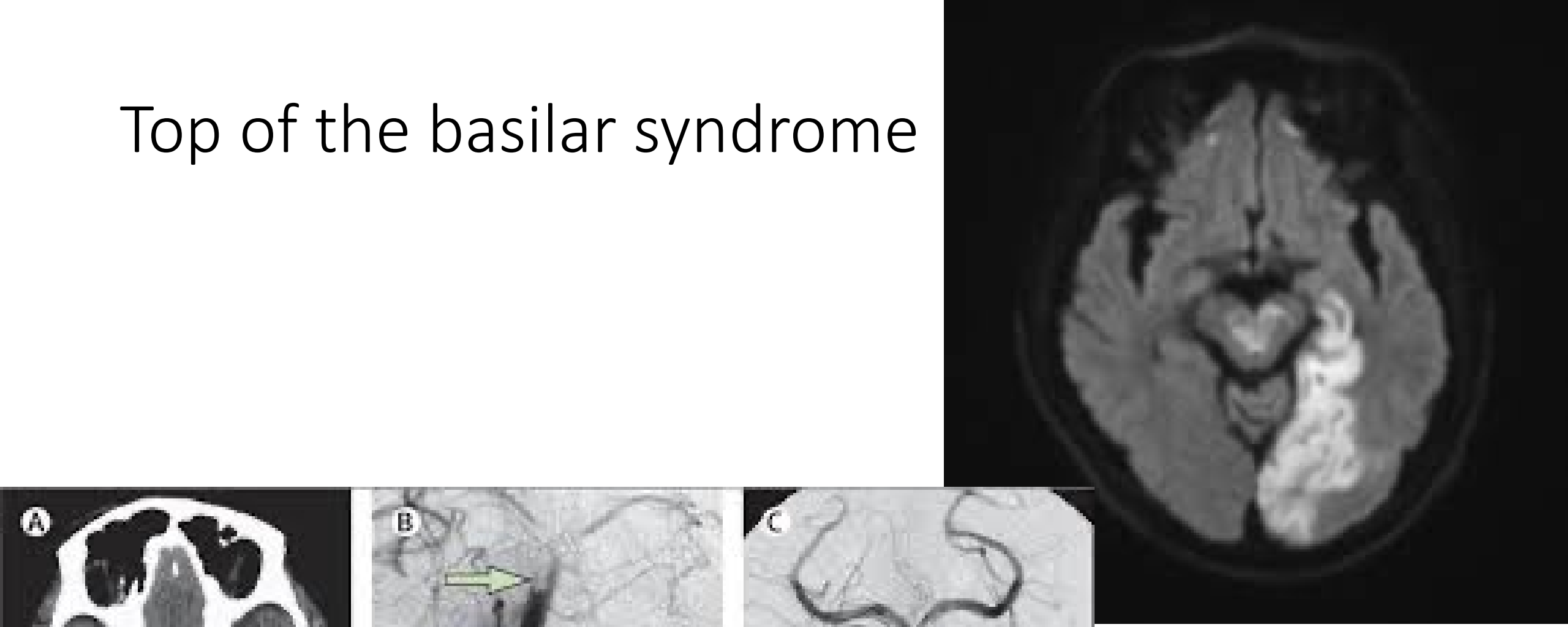


Case 1

A 69 year old man presented to the hospital 1 hour after suffering sudden onset blindness and difficulty opening his eyes. On exam, he is sleepy and his pupils are fairly large and don’t react very briskly.

A. Bilateral Optic Neuritis
B. Basilar Artery Thromboembolus
C. Diabetic Third Nerve Palsy
D. Cavernous Sinus Thrombosis

Top of the basilar syndrome

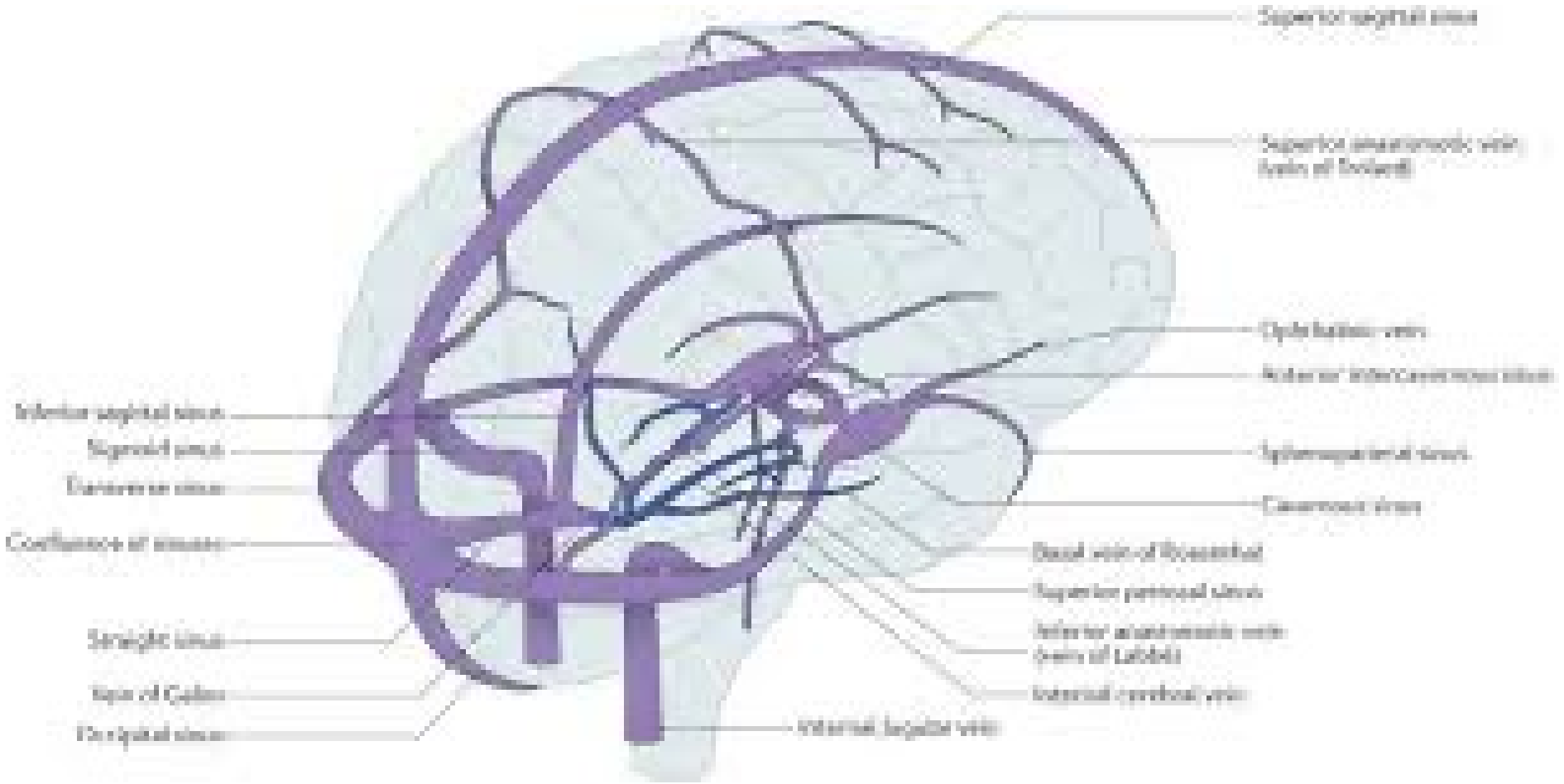


Case 2

A young woman reports a headache behind her right eye that started about a week ago and has been getting worse. Her right eye does not seem to move very much in any direction.

A. PCA aneurysm
B. Cavernous Sinus Thrombosis
C. Midbrain Stroke
D. Cerebellar Tumor

Venous Sinus Thrombosis



Case 3

As he went along, he saw a man blind from birth. His disciples asked him, “Rabbi, who sinned, this man or his parents, that he was born blind?”

“Neither this man nor his parents sinned,” said Jesus, “but this happened so that the works of God might be displayed in him. As long as it is day, we must do the works of him who sent me. Night is coming, when no one can work. While I am in the world, I am the light of the world.” After saying this, he spit on the ground, made some mud with the saliva, and put it on the man’s eyes. “Go,” he told him, “wash in the Pool of Siloam” (this word means “Sent”). So the man went and washed, and came home seeing. His neighbors and those who had formerly seen him begging asked, “Isn’t this the same man who used to sit and beg?” Some claimed that he was. Others said, “No, he only looks like him.”

But he himself insisted, “I am the man.”

“How then were your eyes opened?” they asked.

He replied, “The man they call Jesus made some mud and put it on my eyes. He told me to go to Siloam and wash. So I went and washed, and then I could see.” “Where is this man?” they asked him.

“I don’t know,” he said.

Case 3

They brought to the Pharisees the man who had been blind. Now the day on which Jesus had made the mud and opened the man's eyes was a Sabbath. Therefore the Pharisees also asked him how he had received his sight. "He put mud on my eyes," the man replied, "and I washed, and now I see." Some of the Pharisees said, "This man is not from God, for he does not keep the Sabbath." But others asked, "How can a sinner perform such signs?" So they were divided. Then they turned again to the blind man, "What have you to say about him? It was your eyes he opened."

The man replied, "He is a prophet." They still did not believe that he had been blind and had received his sight until they sent for the man's parents. "Is this your son?" they asked. "Is this the one you say was born blind? How is it that now he can see?"

"We know he is our son," the parents answered, "and we know he was born blind. But how he can see now, or who opened his eyes, we don't know. Ask him. He is of age; he will speak for himself." His parents said this because they were afraid of the Jewish leaders, who already had decided that anyone who acknowledged that Jesus was the Messiah would be put out of the synagogue. That was why his parents said, "He is of age; ask him." A second time they summoned the man who had been blind. "Give glory to God by telling the truth," they said. "We know this man is a sinner." He replied, "Whether he is a sinner or not, I don't know. One thing I do know. I was blind but now I see!"