Round 8:
Ocular Motor System

01/29/2021

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Elevation

Depression

Abduction

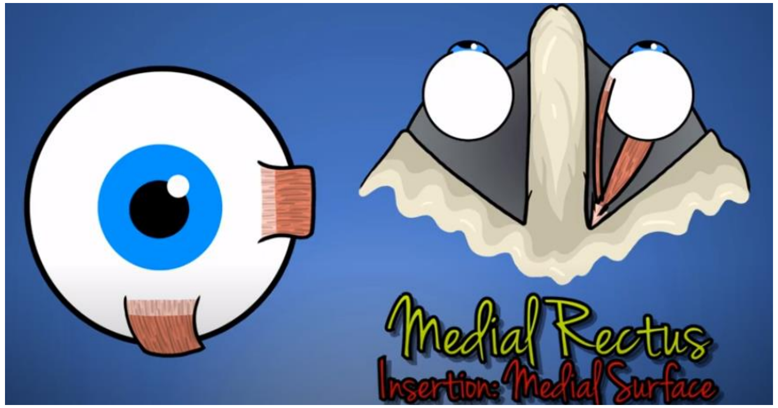
Adduction

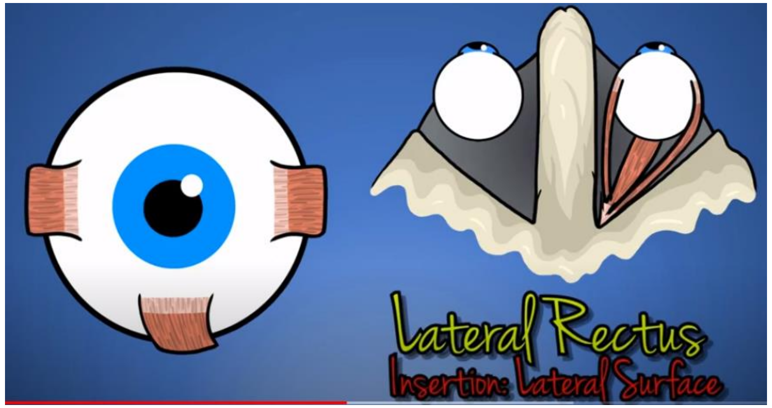
Intorsion

Extorsion

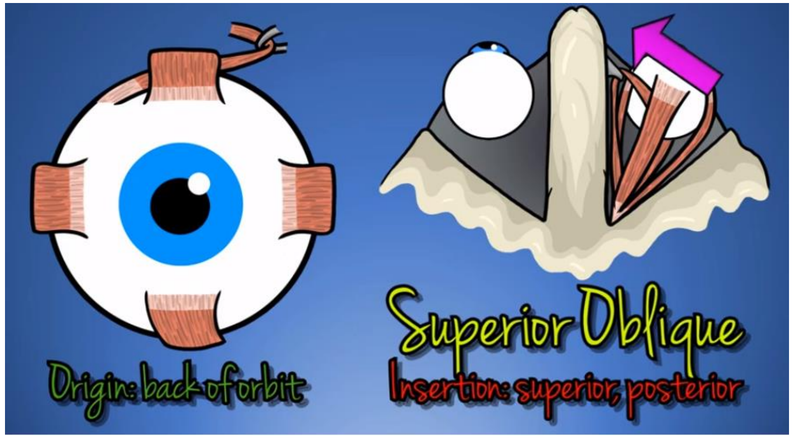
Eye Muscles

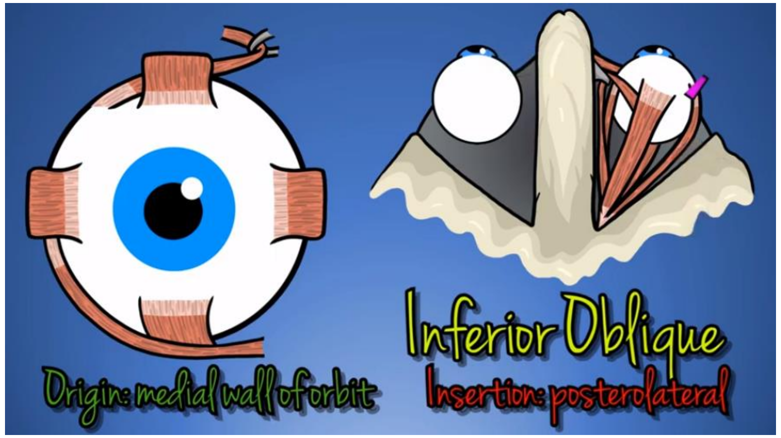

Inferior Rectus
Insertion: Inferior Surface

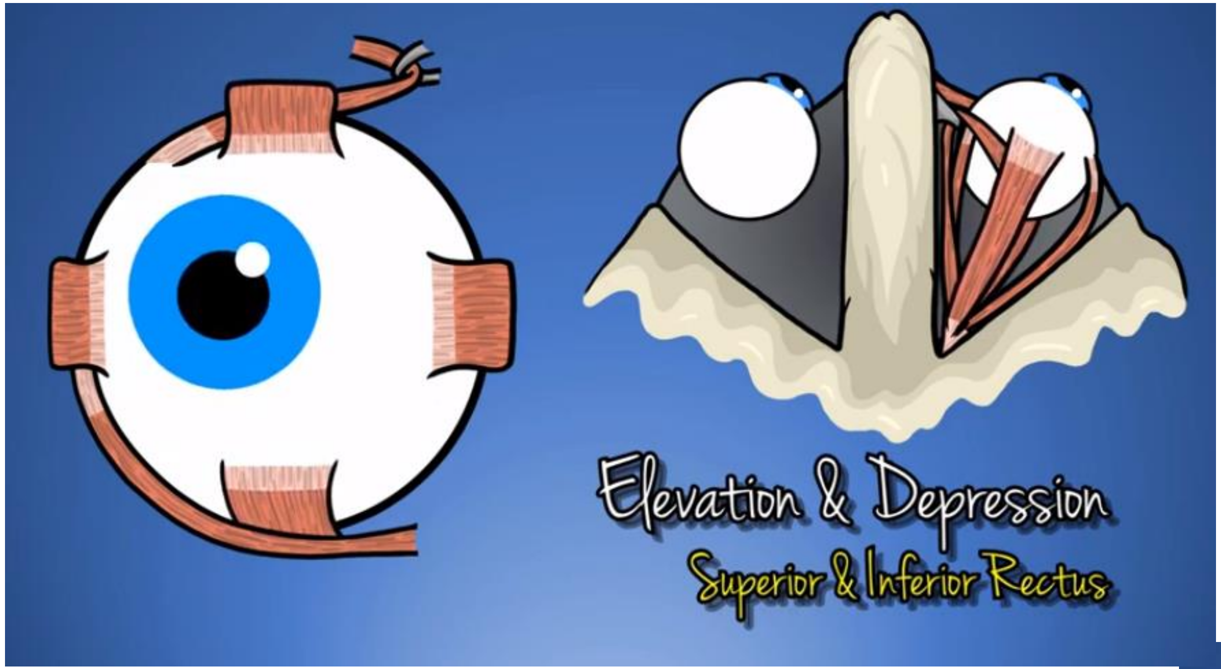

Medial Rectus
Insertion: Medial Surface

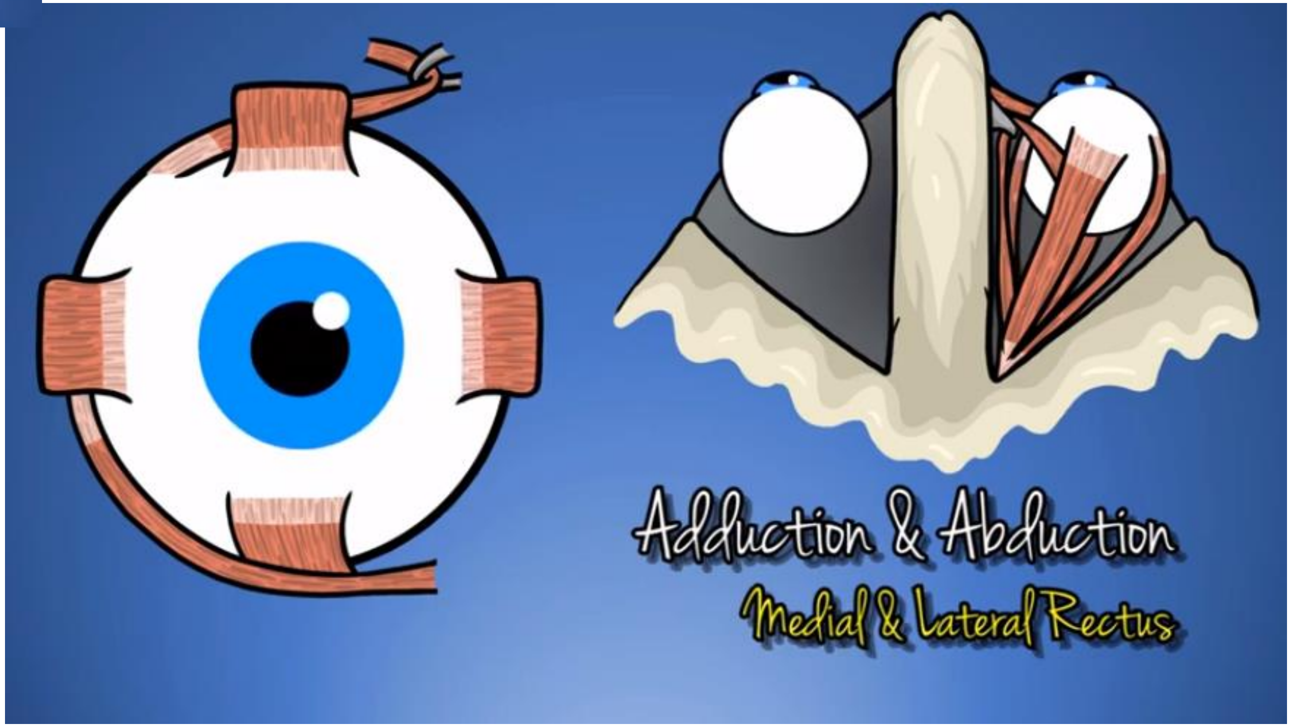

Lateral Rectus
Insertion: Lateral Surface

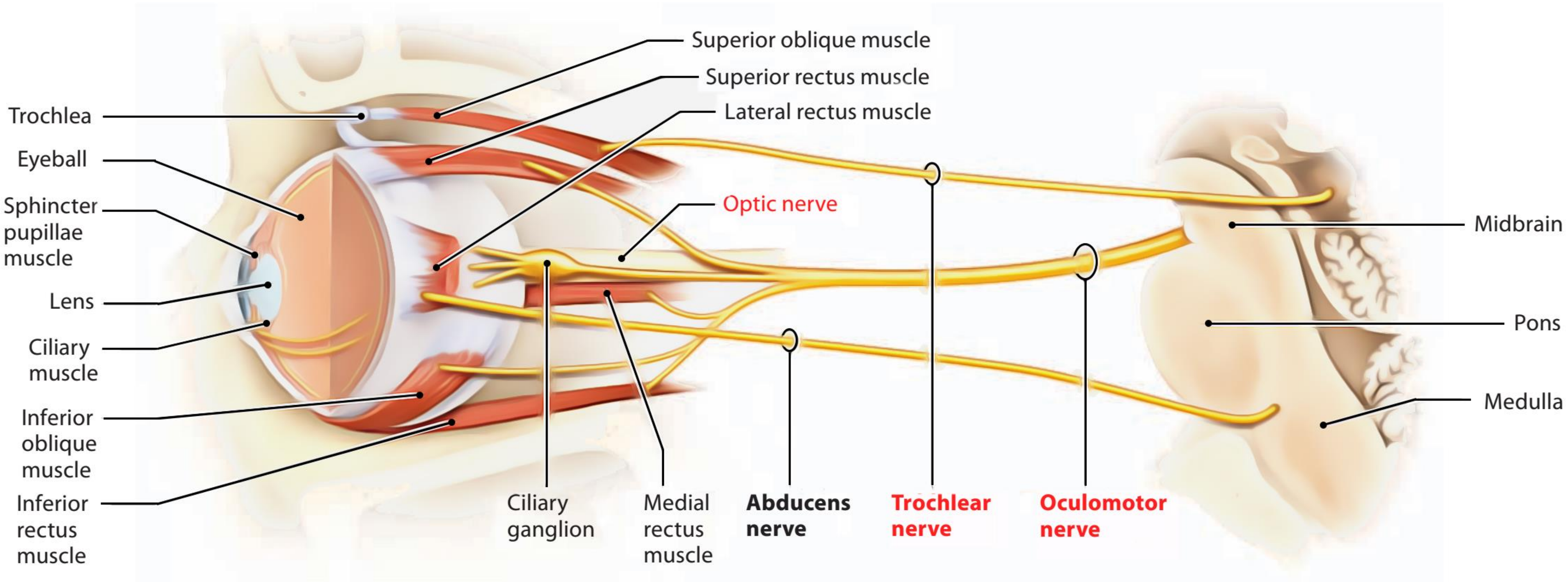

Superior Rectus
Insertion: Superior Surface


Superior Oblique
Origin: back of orbit
Insertion: superior, posterior


Inferior Oblique
Origin: medial wall of orbit
Insertion: posterolateral

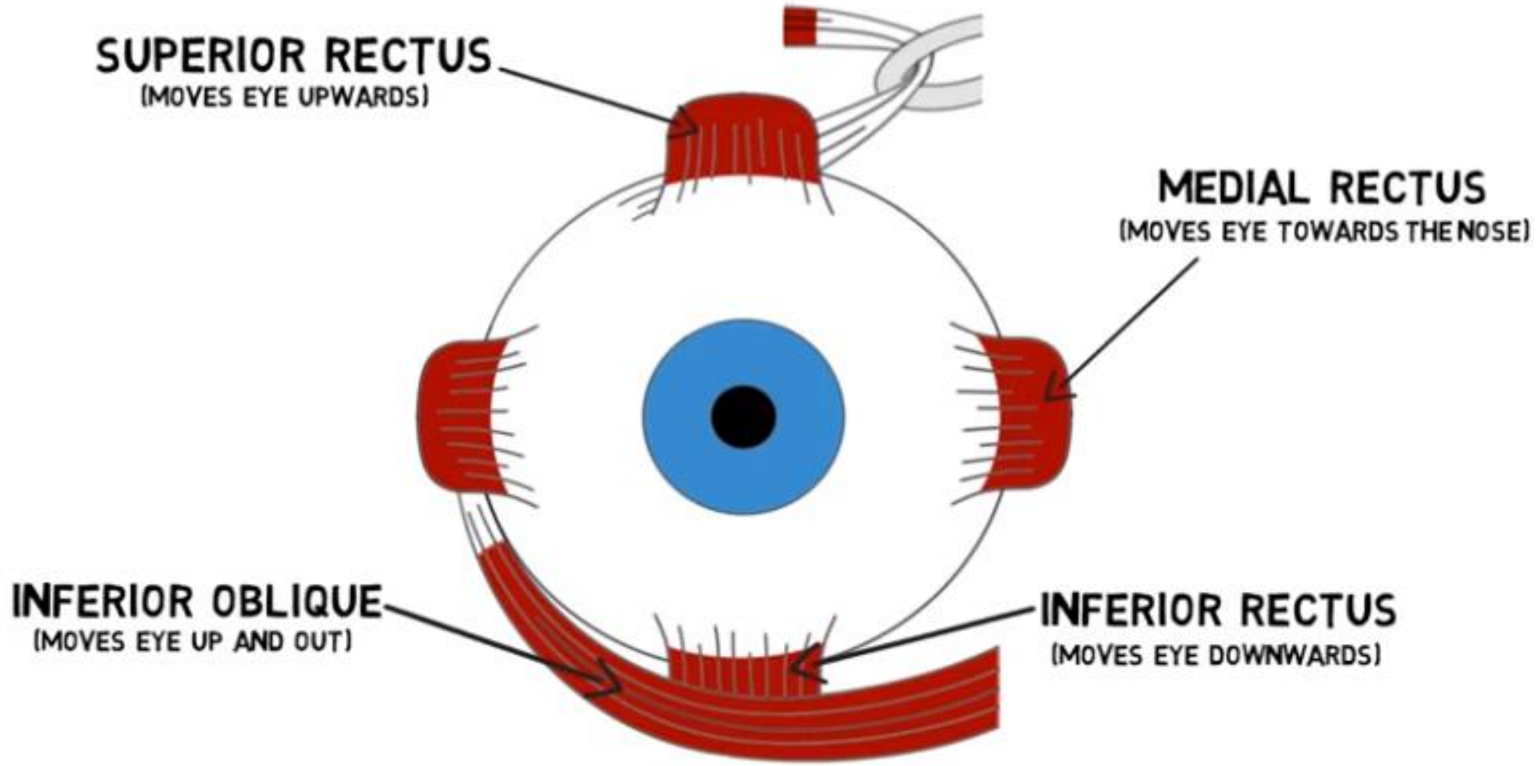

Elevation & Depression
Superior & Inferior Rectus


Adduction & Abduction
Medial & Lateral Rectus


Superior oblique muscle
Superior rectus muscle
Lateral rectus muscle
Trochlea
Eyeball
Sphincter pupillae muscle
Optic nerve
Midbrain
Lens
Pons
Ciliary muscle
Medulla
Inferior oblique muscle
Inferior rectus muscle
Ciliary ganglion
Medial rectus muscle
Abducens nerve
Trochlear nerve
Oculomotor nerve

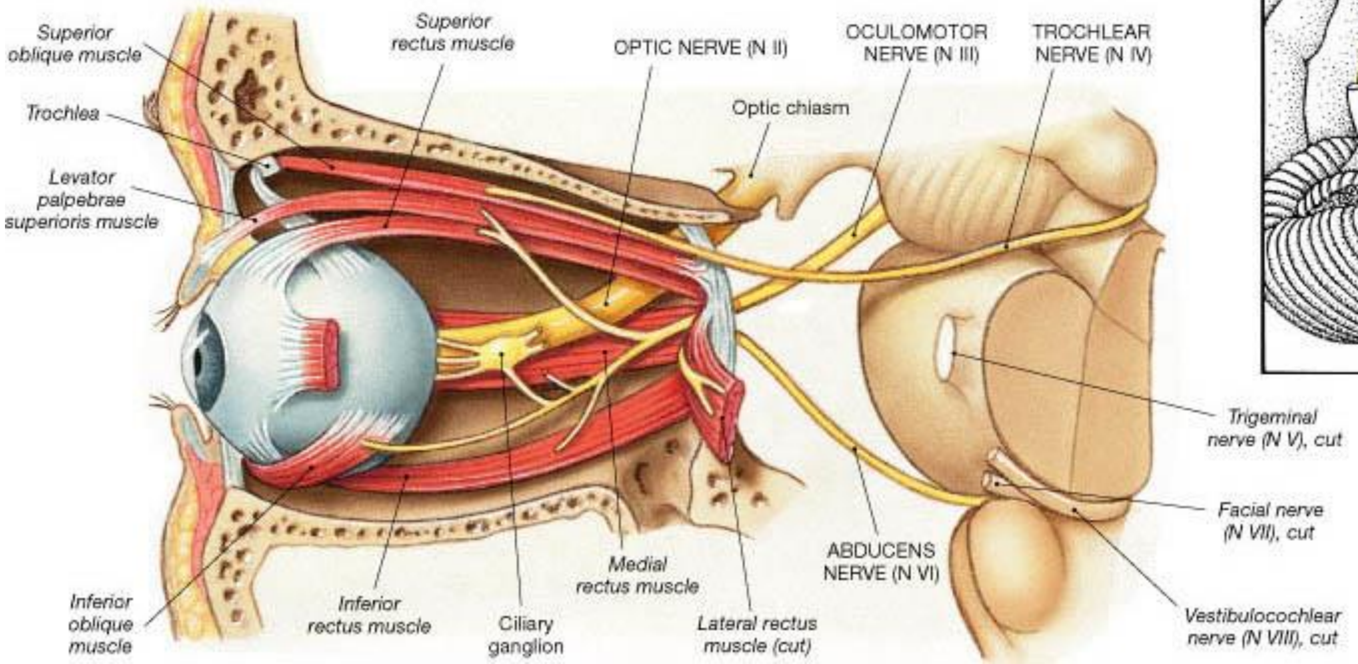
OCULOMOTOR NERVE (Cranial Nerve III)

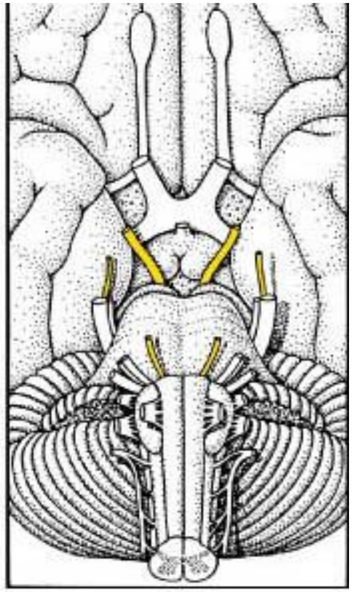
MOTOR NERVE THAT SUPPLIES 4 OF 6 EXTRAOCULAR MUSCLES



ALSO SUPPLIES LEVATOR PALPEBRAE SUPERIORIS MUSCLE (EYELID), CILIARY GANGLION (PUPILLARY CONSTRICTION), AND CILIARY MUSCLE (LENS ACCOMMODATION)

Oculomotor Nerve



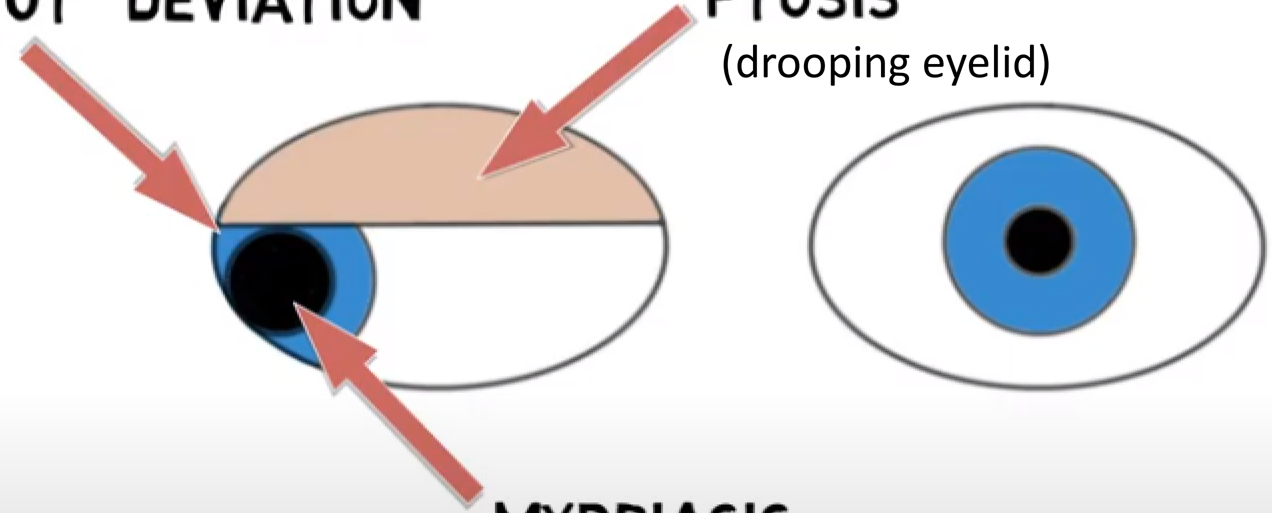


Originates in the midbrain at the level of the superior colliculus

OCULOMOTOR NERVE DAMAGE

CAUSES DEFICITS IN IPSILATERAL EYE

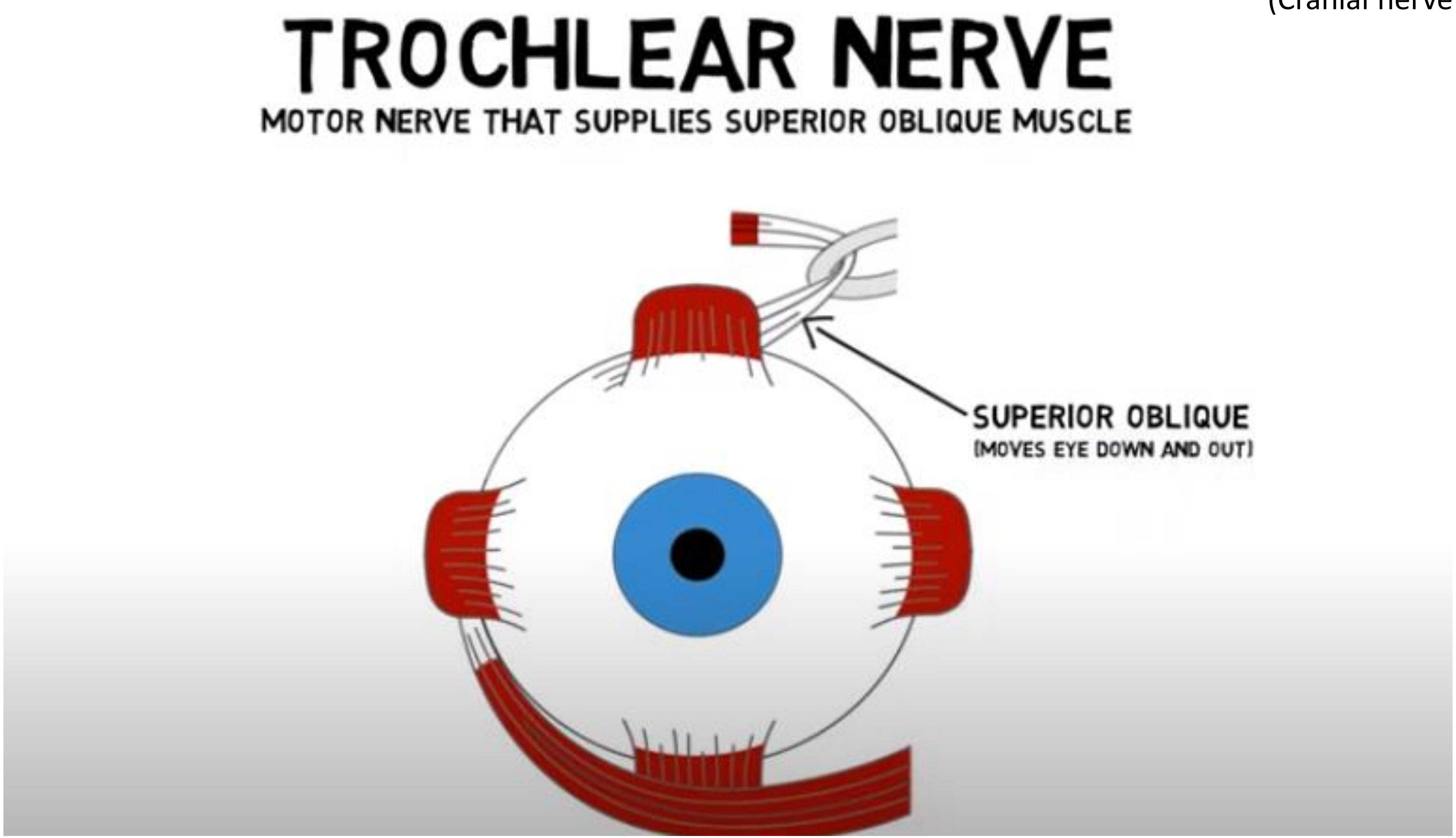
(SAME SIDE AS THE DAMAGE)



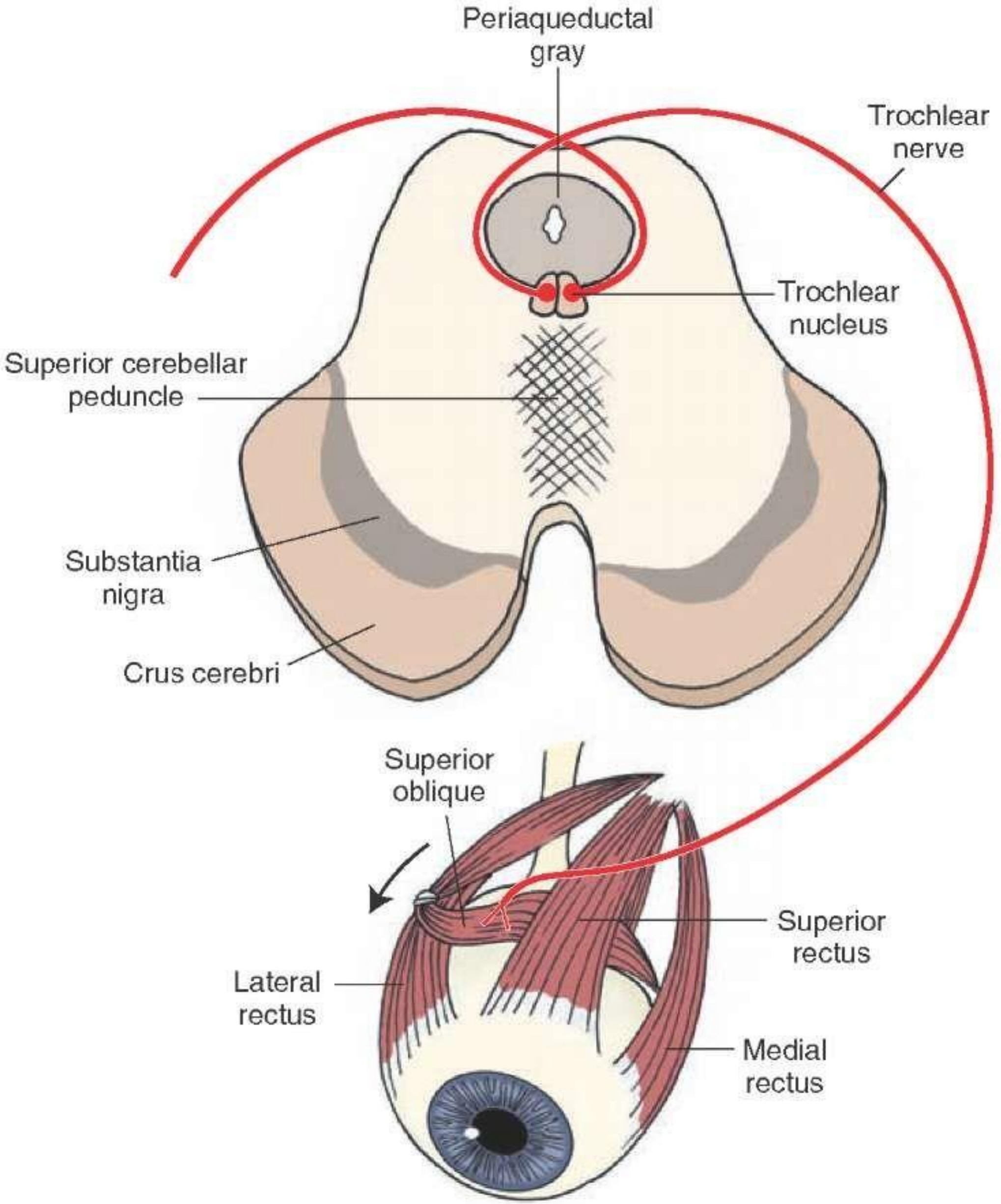
DIFFICULTY MOVING EYE MEDIALLY AND VERTICALLY

DIPLOPIA (DOUBLE VISION)

(Cranial nerve IV)

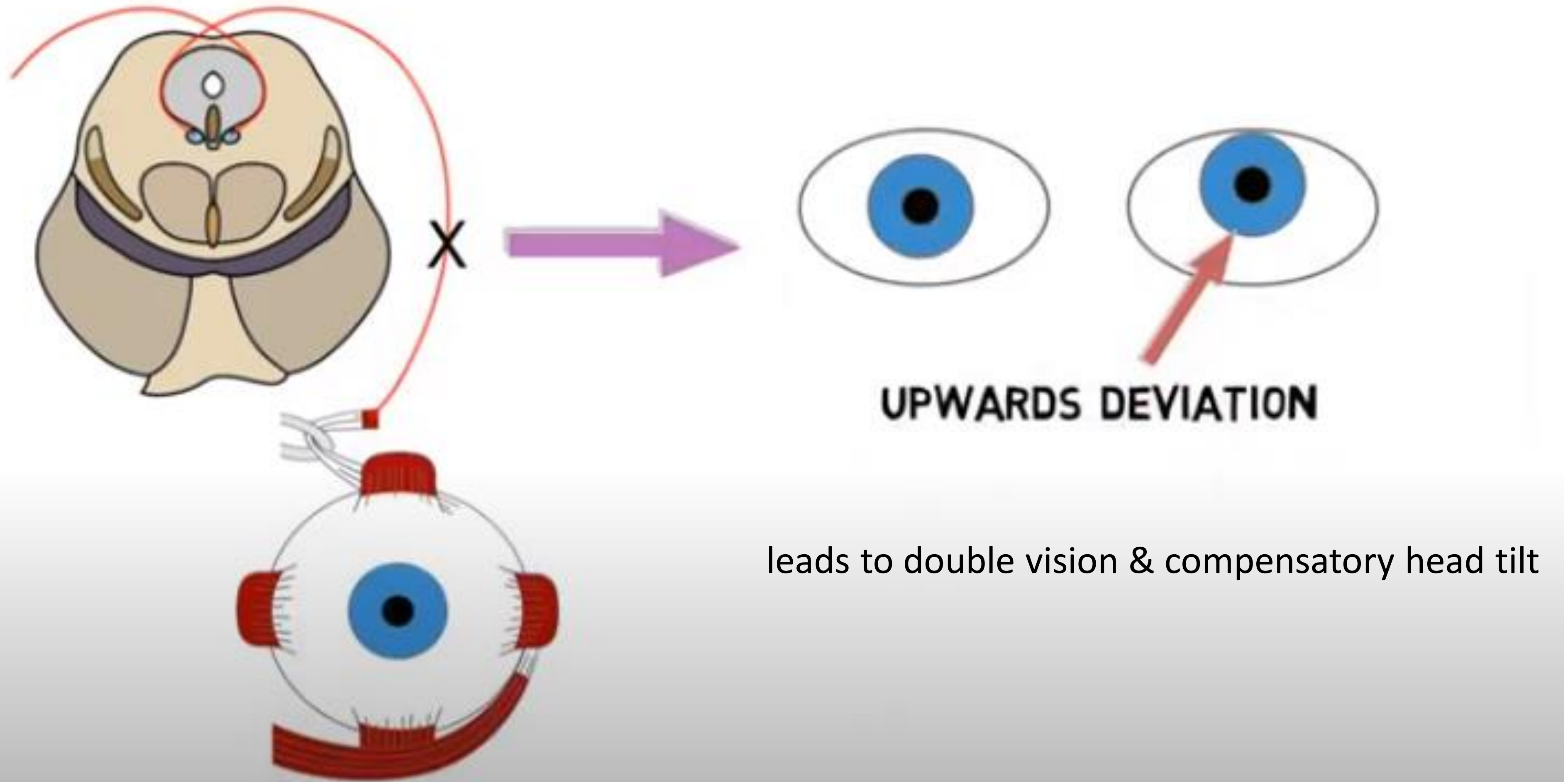


Trochlear Nerve



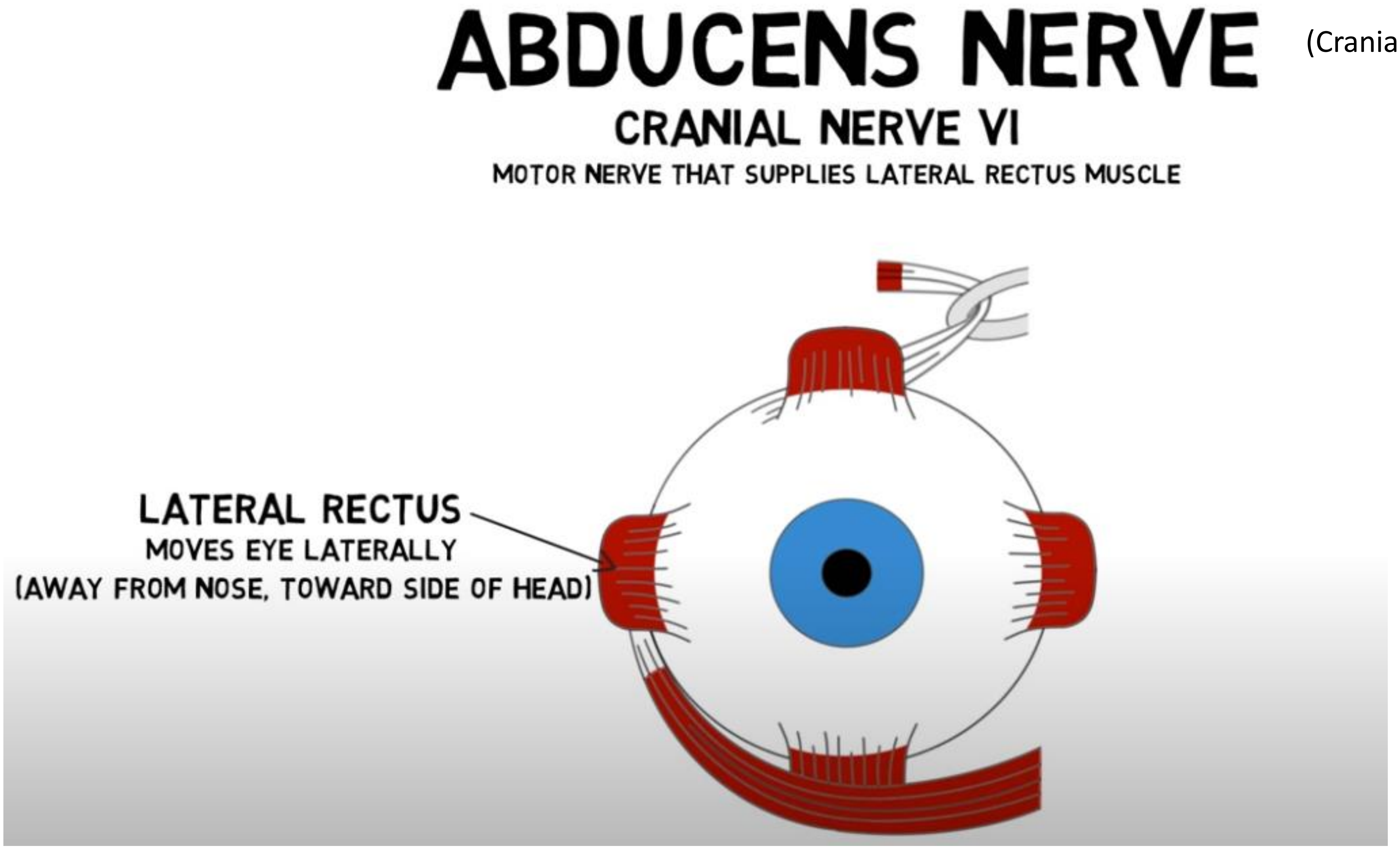
Originates in the midbrain at the level of the inferior colliculus

TROCHLEAR NERVE DAMAGE



leads to double vision & compensatory head tilt

(Cranial nerve VI)



Trochlear Nerve

Originates in the pons

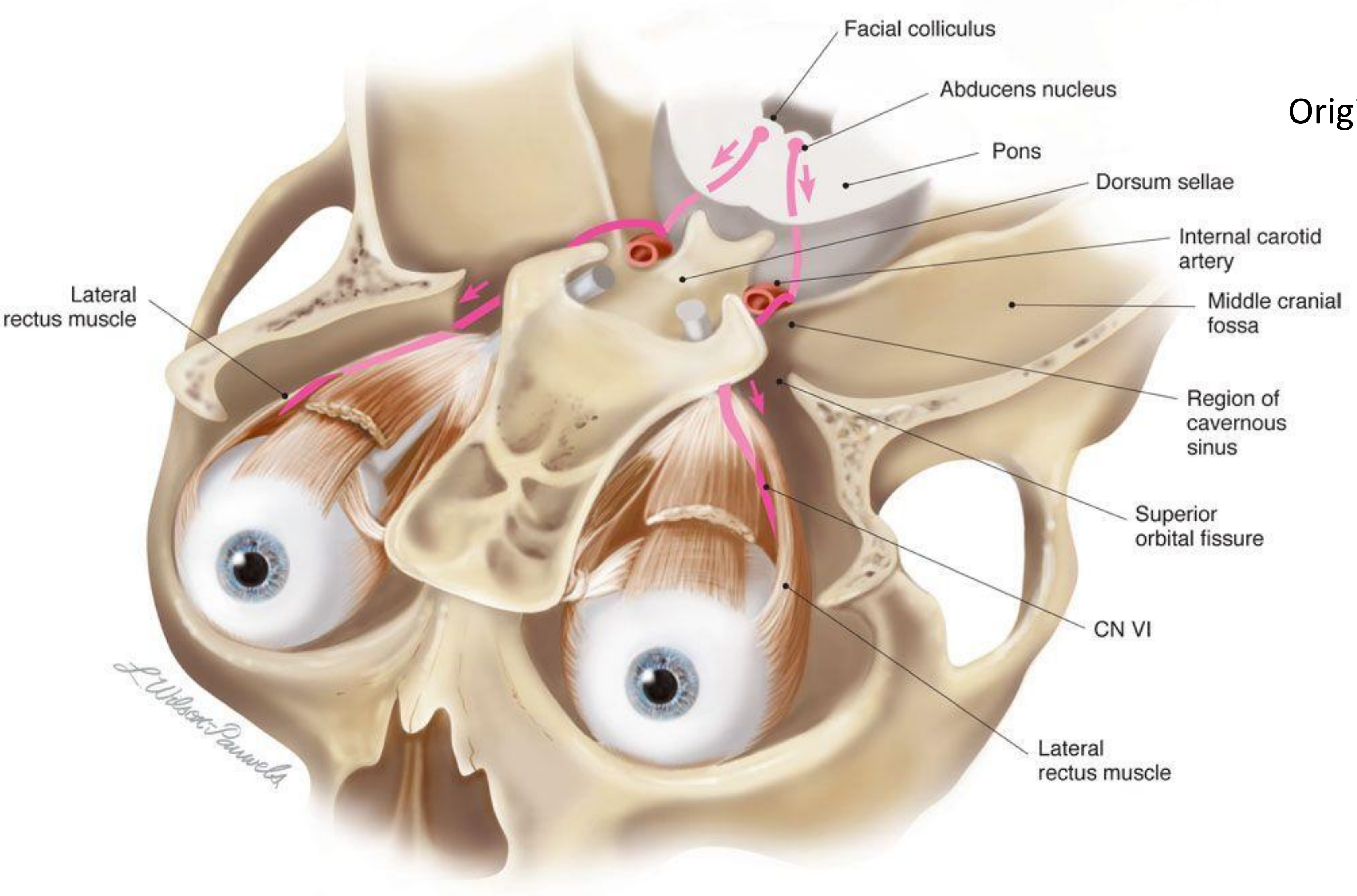
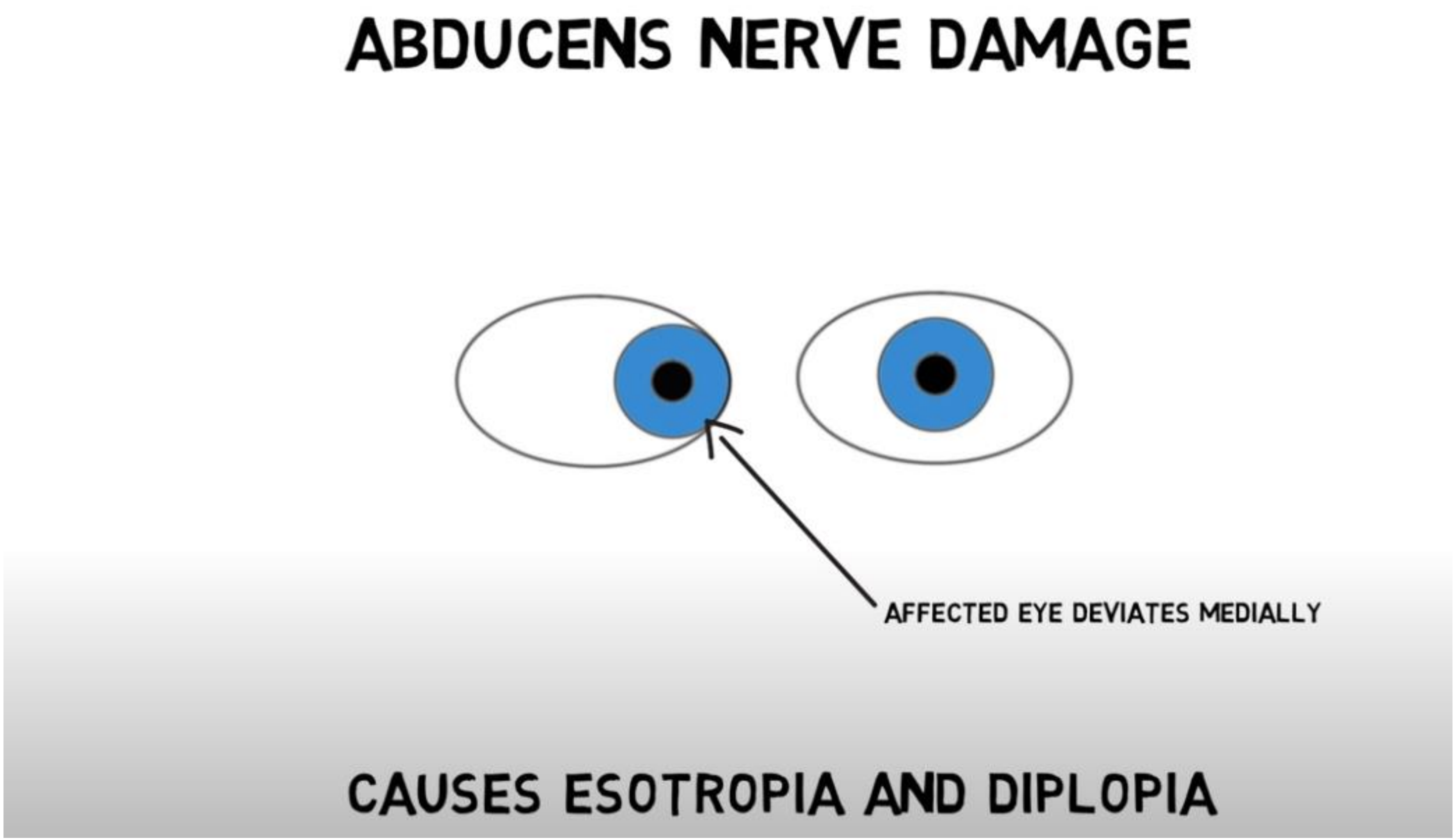


Figure VI–2 Route of the abducens nerve (cranial nerve VI) from the pons to the lateral rectus muscle.



(inward turn) (double vision)

Eye Movements

- We can see about 200 degrees but we see best in fovea which is 1 degree of visual field
- We need to keep the object of interest in the fovea, whether it moves or the head moves

Movement	Function
Stabilize the eye when the head moves	
Vestibulo-ocular	Uses vestibular input to hold images stable on the retina during head movement
Optokinetic	Uses visual input to images stable on the retina during head movement
Keep the fovea on the visual target	
Saccade	Brings new objects of interest onto the fovea
Smooth Pursuit	Holds the image of a moving target on the fovea
Vergence	Adjusts the eyes for different viewing distances in depth

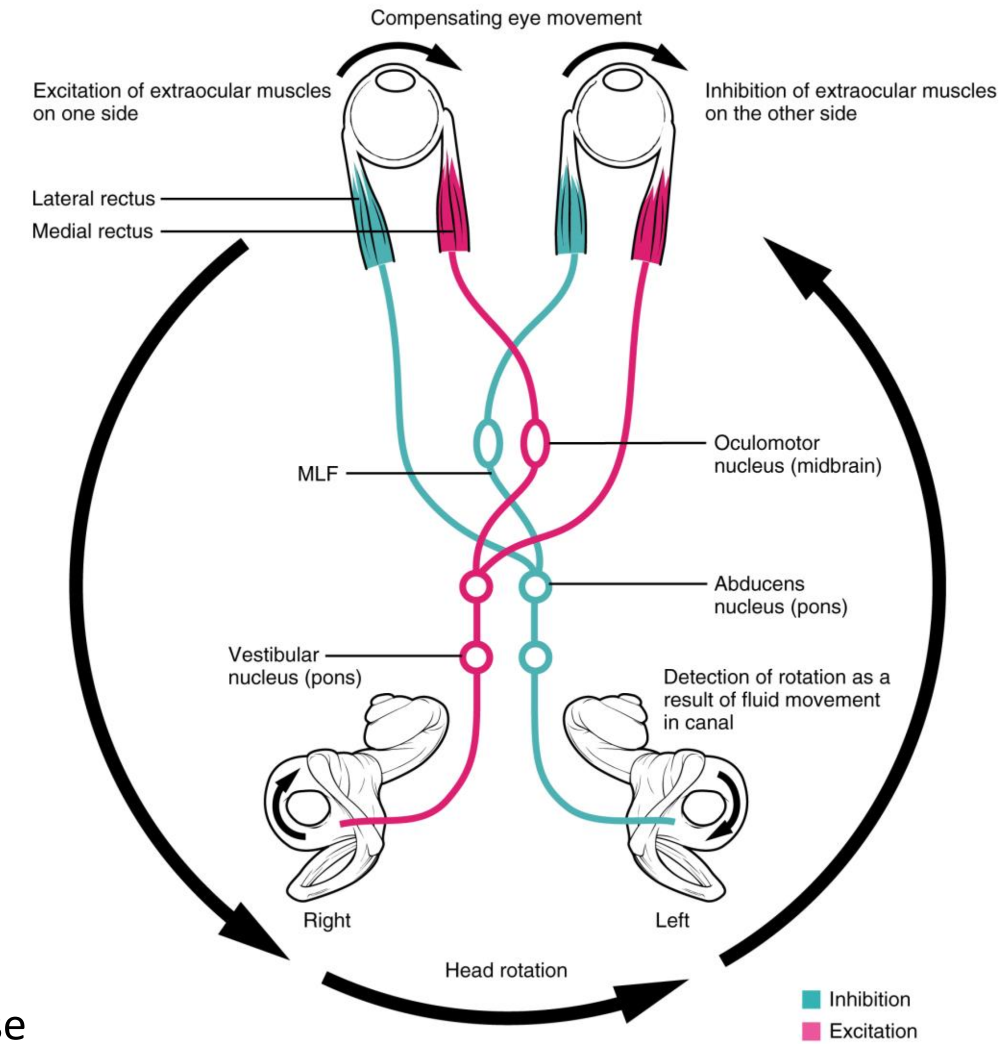
Vestibulo-Ocular Movements

1. Afferent neurons innervating hair cells in semicircular canals
2. Signal velocity of head movement to interneurons
3. Synapse onto oculomotor neurons

- Semicircular canals 3 axes correspond to pairs of muscles that work in coordinated movements
    - Excite/inhibit complementary muscles

- Also contribution of vestibulocerebellum (cerebellar flocculus)
- Modulates gain – adaptation how far to move eye relative to head movement

- Does not respond well to slow head movements because info from vestibular system is attenuated



Optokinetic Movements

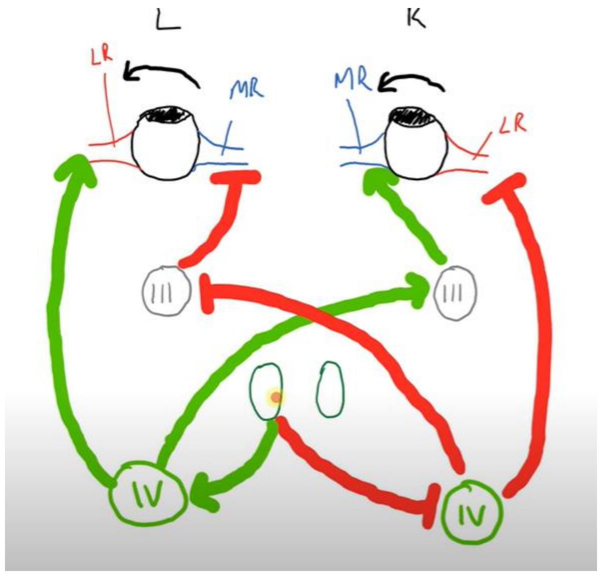
- As head move in space, stable aspects of the environment (e.g., trees, buildings) move on the retina in a direction opposite to that of the heads. This system drives the eyes in the direction of this movement which is opposite to head movement
- Responds well to slow visual motion induced by slow head movement
- Interprets visual motion as head movement
    - sensation of backward movement you get when you are at a red light and the car next to you moves forward

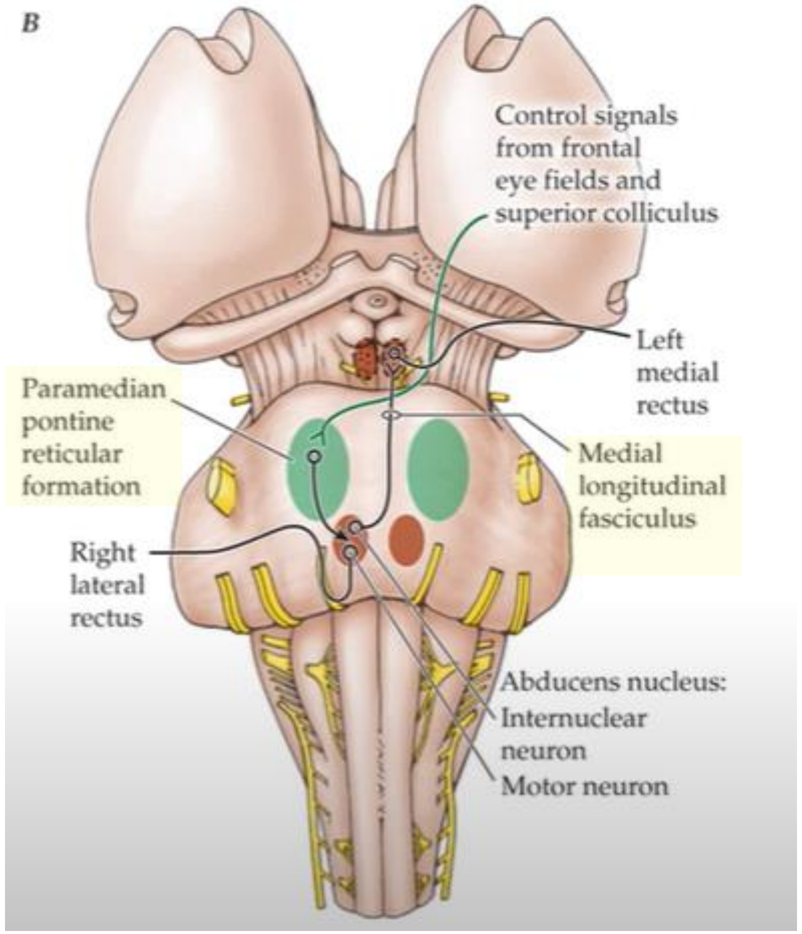
Saccades

- Quick movement or jump in response to visual item moving, auditory or tactile stimulation, or memory of item's location
- Velocity determined by distance required to move up to 900 degrees/s

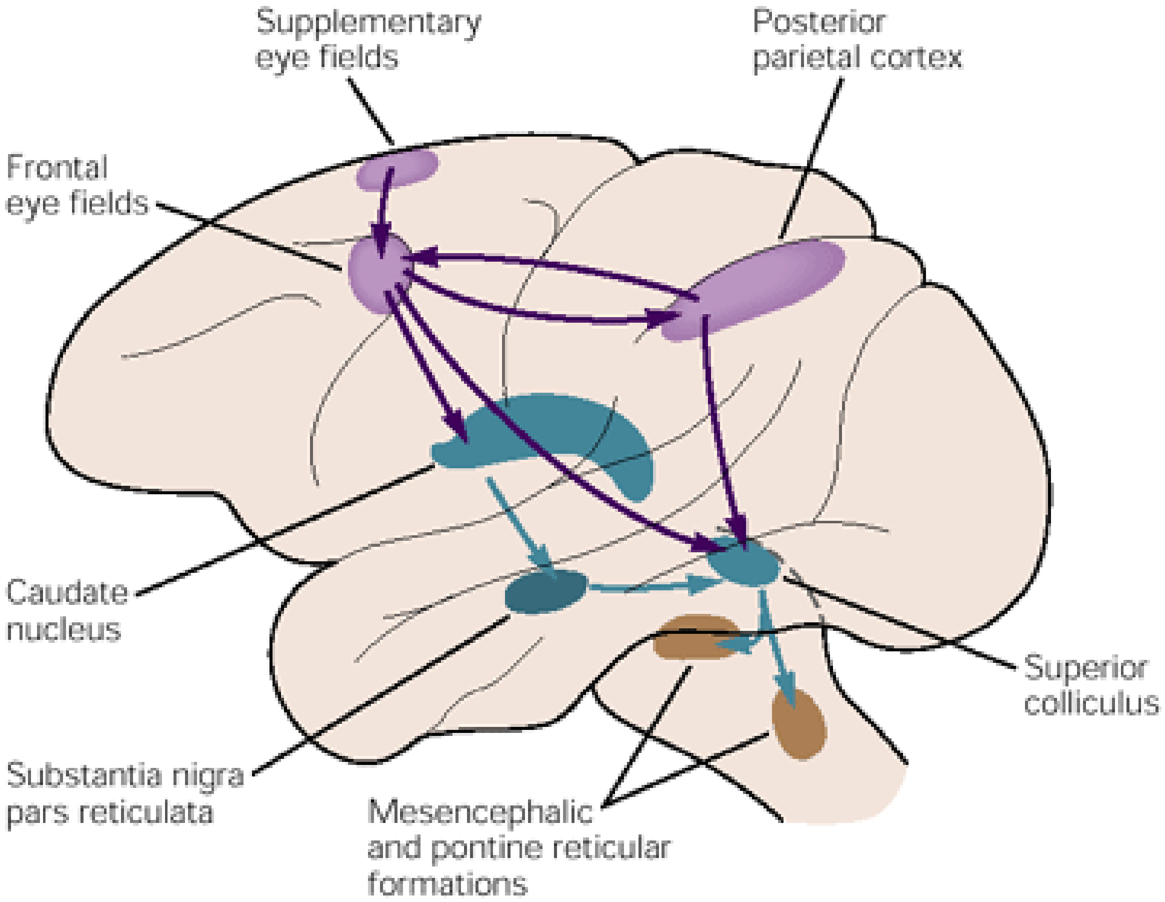
Saccades

- Paramedian Pontine Reticular Formation - Horizontal saccades
- Medial Longitudinal Fasciculus of the Mesencephalic Reticular Formation - Vertical Saccades
- Both work together for diagonal saccades
- Gain mediated by cerebellum (flocculus) –
  - compensate for weak muscles
  - (vermis deals with pupil size)





Saccades



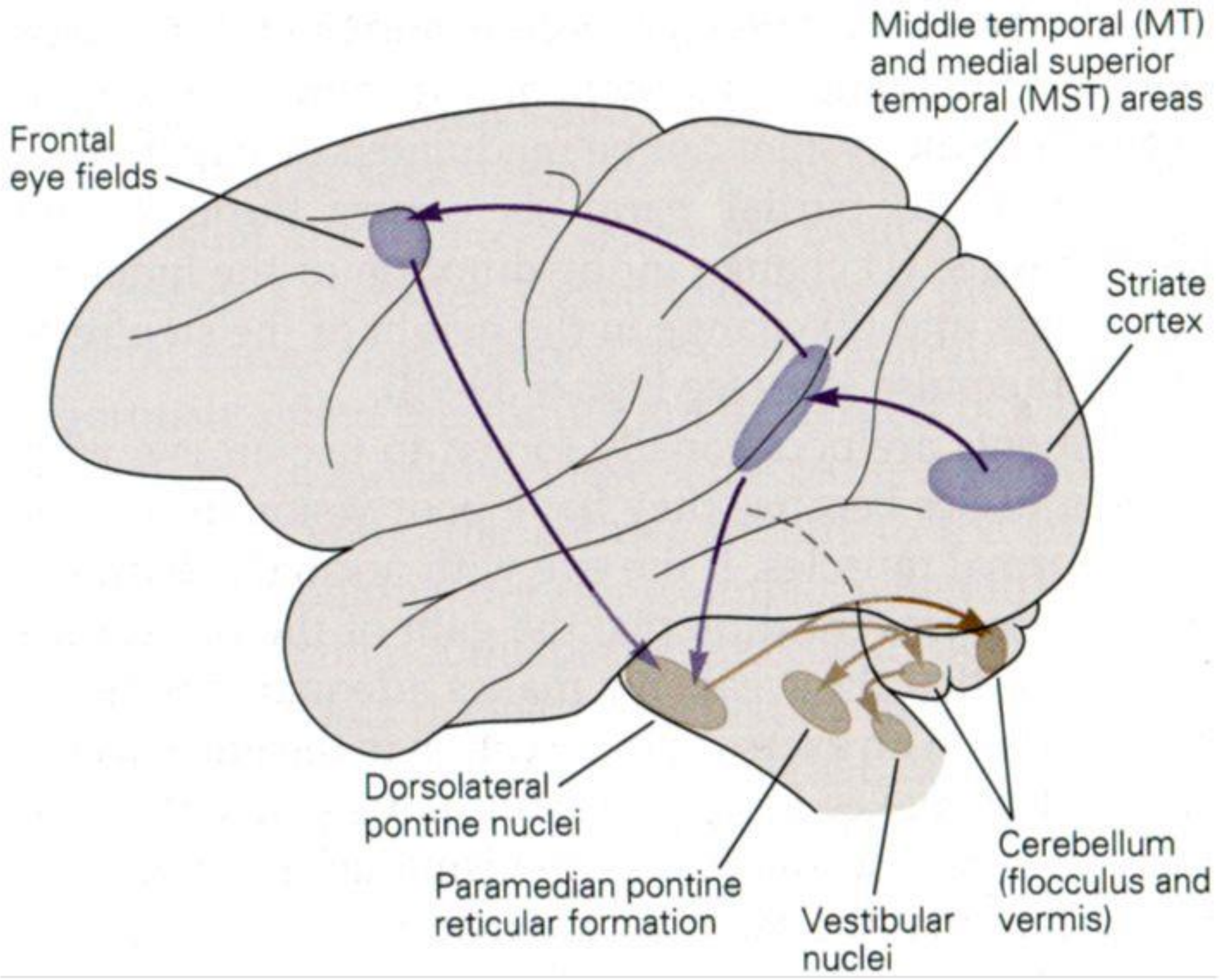
- Pathway
  - Supplementary eye field -> Frontal eye field -> Superior Colliculus -> Caudate -> Substantia Nigra -> Mesencephalic & Pontine Reticular Formations

Smooth Pursuit Movements

- Moves the eyes in space to keep a single target on the fovea by calculating how fast the target is moving and moving the eyes accordingly
- Voluntary
- Requires a moving stimulus to calculate proper eye velocity
- Maximum speed is 100 degrees/s

- Drugs, fatigue, alcohol degrade quality –
    - Field sobriety test Horizontal gaze Nystagmus
    - look for
        - exaggerated jerking at the edge
        - if jerking occurs within 45 degrees
        - if eyes cannot follow smoothly

Smooth Pursuit Pathways



- Pathway
  - Striate cortex -> motion sensitive region of medial superior temporal area -> Frontal Eye fields -> Pontine reticular formation –> velocity of movement mediated by cerebellar flocculus

Vergence

- Eyes move in opposite directions as they converge (as move closer) or diverge (move further away) to focus on objects at different distances
- Midbrain oculomotor nucleus

Clinical Implications

- Intro
  - Humans rely on vision for information intake more than any other sense. In order to consume visual information, we must be able to direct our eyes to regions of interest and keep the object of interest in the fovea. This requires appropriate function of the extra-ocular muscles that we have been discussing today. Essentially, information needs to hit the retina and stay there long enough to be processed appropriately. As such, we need to be able to generate appropriate saccades and fixate on information of interest. However, if there is trouble with the extraocular muscles or the neurons that direct them, then either the information does not get input into our nervous systems at all or what is input to the system is insufficient and, as such, cannot be processed efficiently.

Clinical Implications

- Dyslexia - learning disorder
  - difficulty reading, spelling, writing, or speaking despite having average intelligence.
  - trouble matching sounds to letter symbols (e.g., frequently confuse bs and ds).

  - Studies have found that
    - Greek dyslexic children - high number of regressive saccades & unstable fixation
    - English dyslexic children - frequent saccades of smaller amplitude and longer duration fixations
    - Italian dyslexic children - frequent fixations with longer durations
    - German dyslexic children - slower reading speed & high number of saccades and regressions

  - Poor binocular coordination during prolonged fixation and poor eye alignment during fixation.
    - Poor fusion of the two retinal images during convergence between the angles of the two eyes

Clinical Implications

- Brain Injury visual symptoms:

  - Loss of visual acuity
  - Photophobia – fear or aversion to bright lights. This is often co-morbid with migraine
  - Alterations in color vision
  - Deficits in stereopsis – which is depth perception
  - Pupillary responses are disturbed
  - Accommodation
    - Convergence insufficiency - eyes drift apart when they should be converging to focus on near objects
  - 90 % Concussion/Blast injury -> Eye movement disfunction
    - Conjugate movements (i.e., eyes are should move in unison)
    - Insufficient saccades
      - Position errors, reduced amplitudes, longer durations
    - Smooth pursuit movements - trouble following a moving target
  - Loss of the vestibulo-ocular reflex
  - Car accident whiplash -> nystagmus (i.e., uncontrolled eye movements)