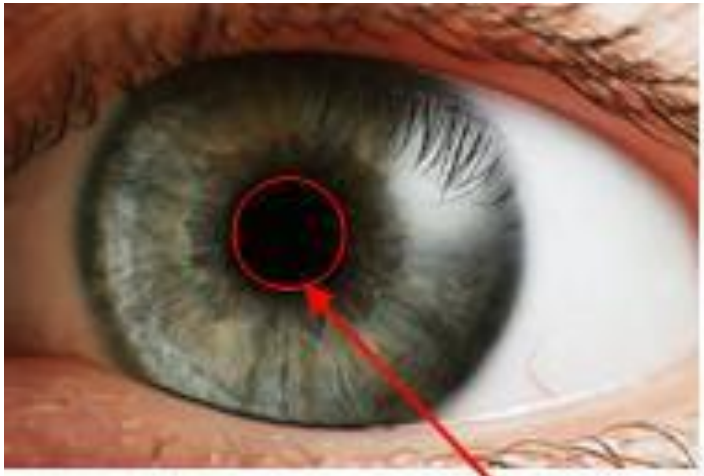
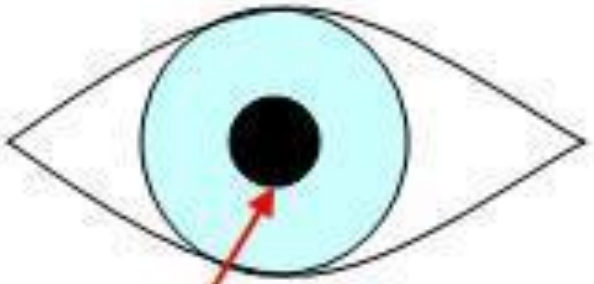
The Pupil, Its Responses and Disorders

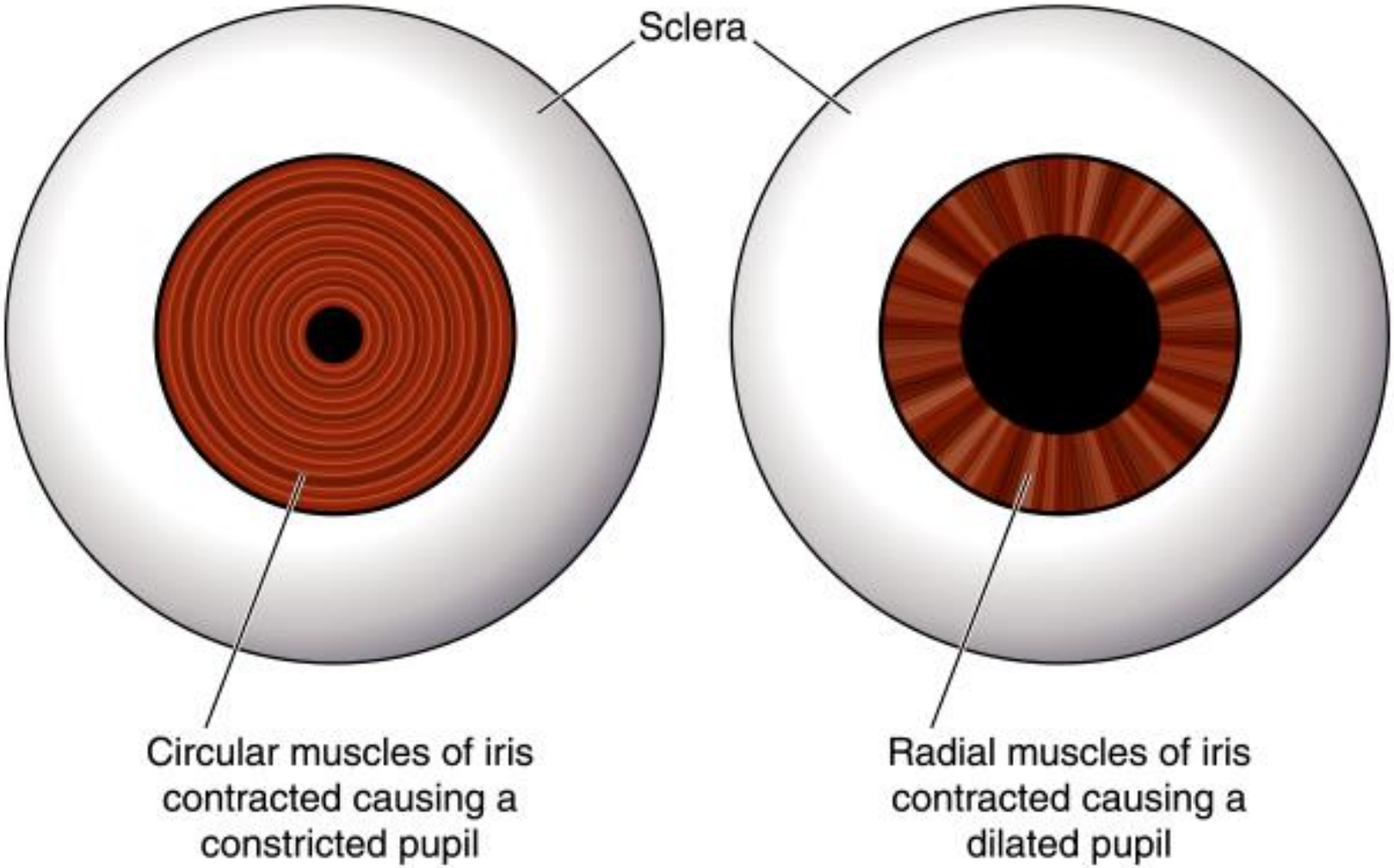




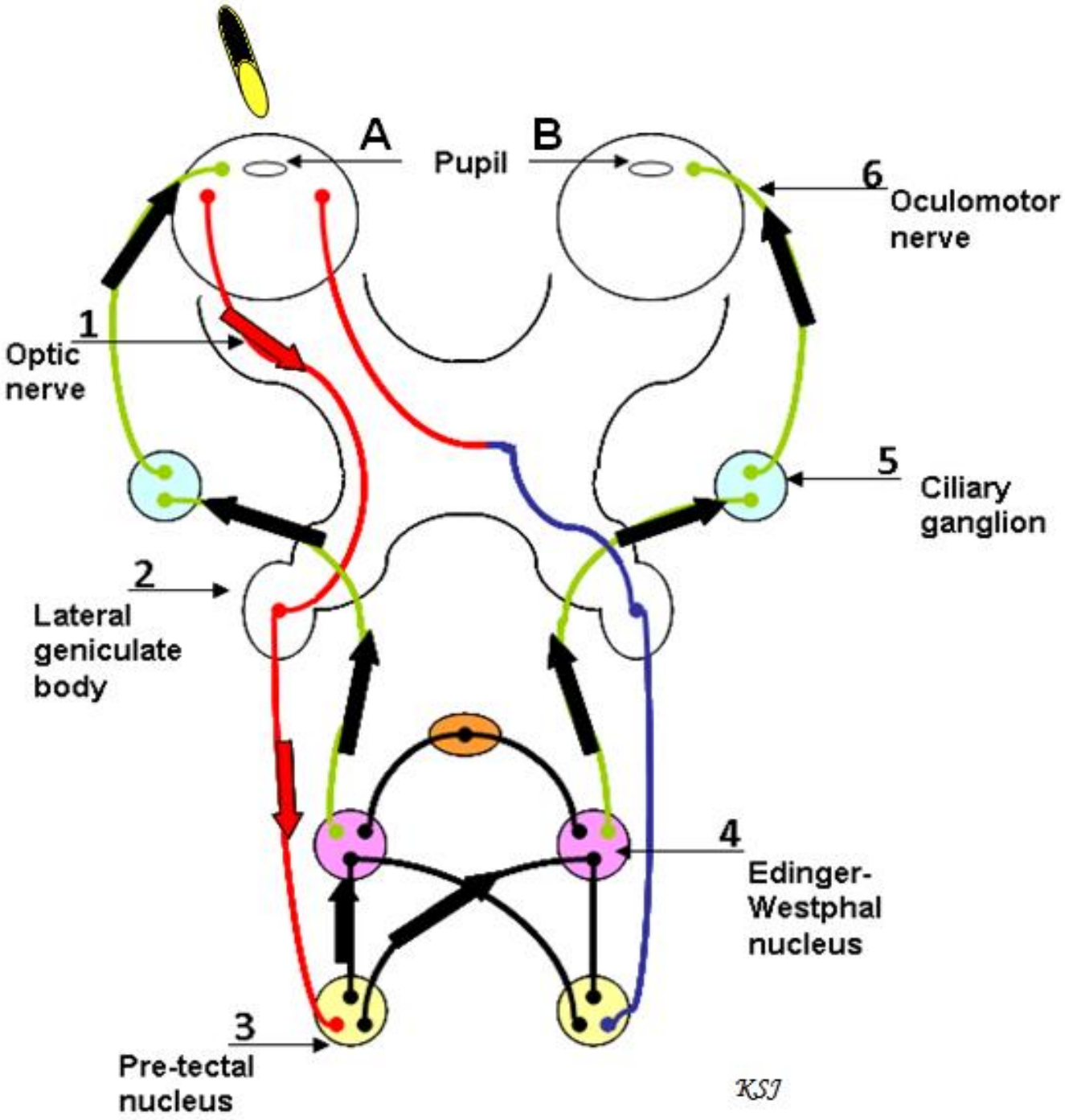
pupil

Normal Physiology:

- Movements of the pupil are controlled by the **parasympathetic and sympathetic nervous systems.**
  - The pupils constrict **(*miosis*)** when the eye is **illuminated** (parasympathetic activation, sympathetic relaxation). ach
  - Dilate **(*mydriasis*)** in the **dark** (sympathetic activation, parasympathetic relaxation). NE


Sclera
Circular muscles of iris contracted causing a constricted pupil
Radial muscles of iris contracted causing a dilated pupil

Light Response (Parasym) Direct and indirect



Sympathetic supply to the eye.

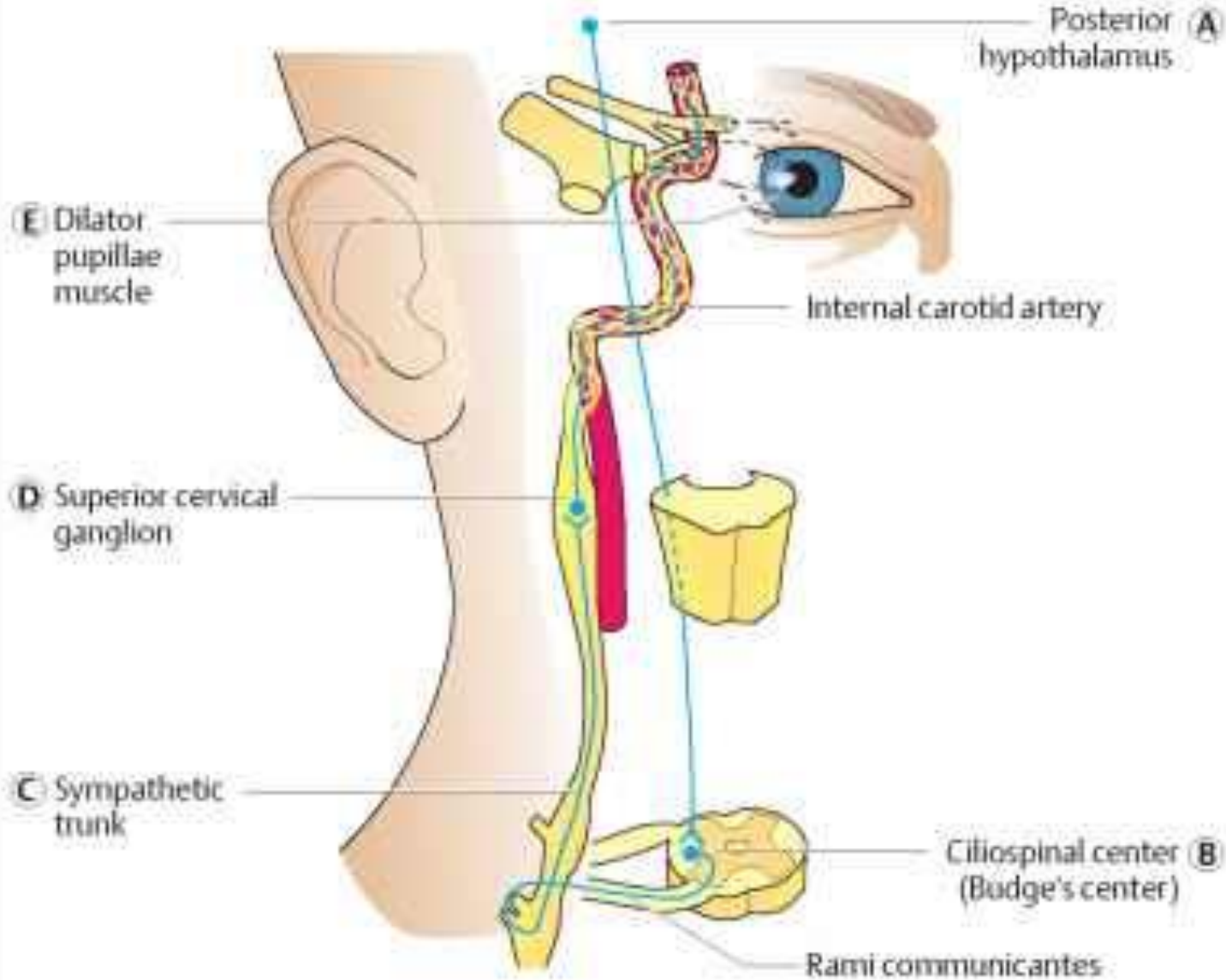
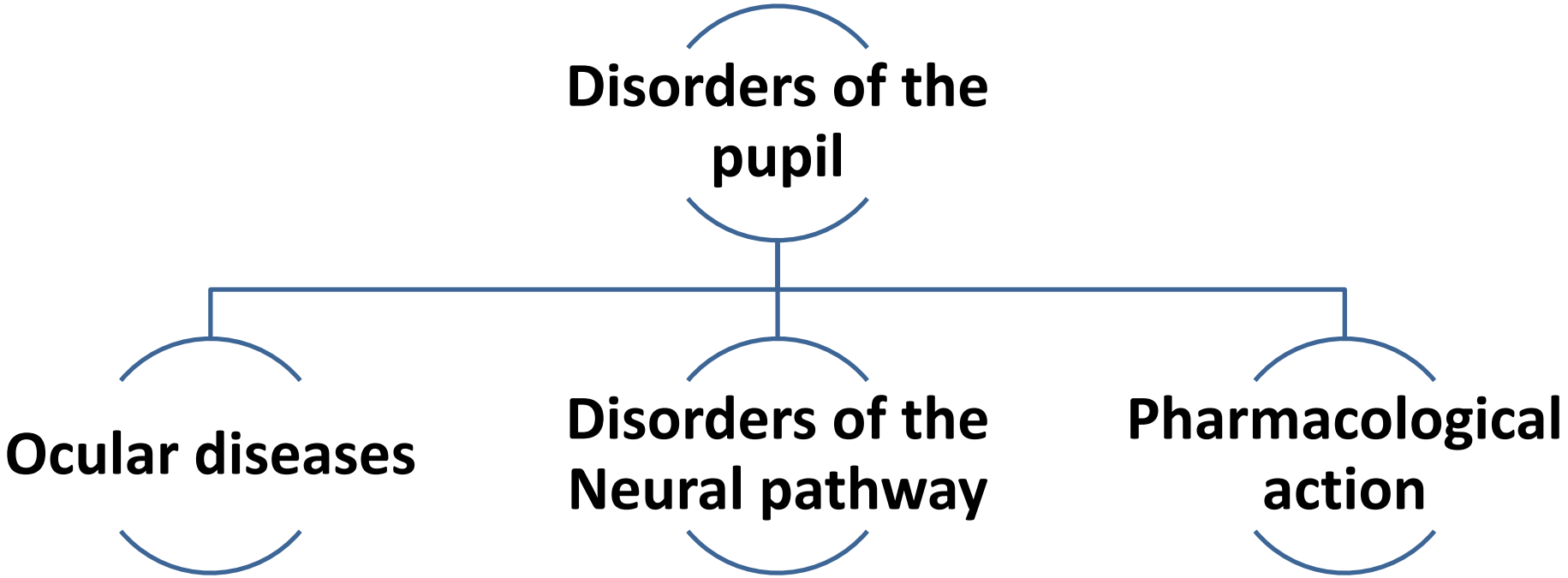


Fig. 9.2 See discussion in text.

- The **parasympathetic fibres** reach the eye through the **third cranial nerve**.

- When the eyes focus on a near object, they converge, the pupils constrict and there is accommodation of the lens by ciliary body **(the *near response*) TRIAD**

- The pupils are normally equal in size but some **20%** of people may have noticeably unequal pupils **(*anisocoria*)** with **no associated** disease.

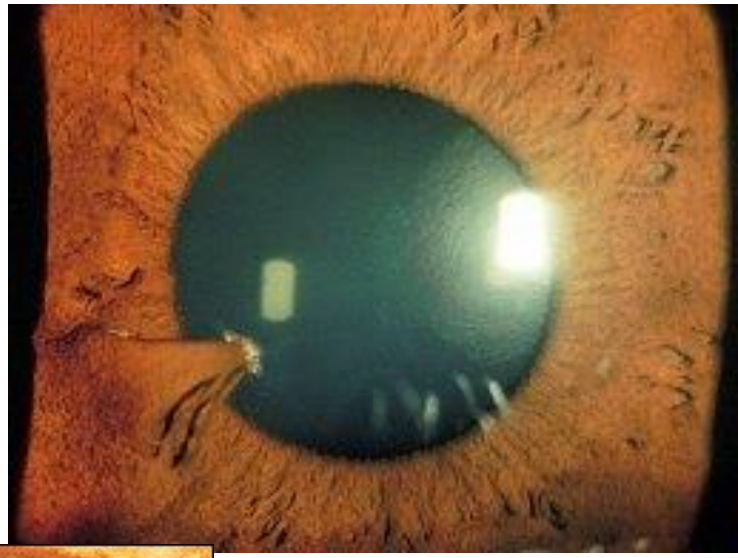

Disorders of the pupil
Ocular diseases
Disorders of the Neural pathway
Pharmacological action

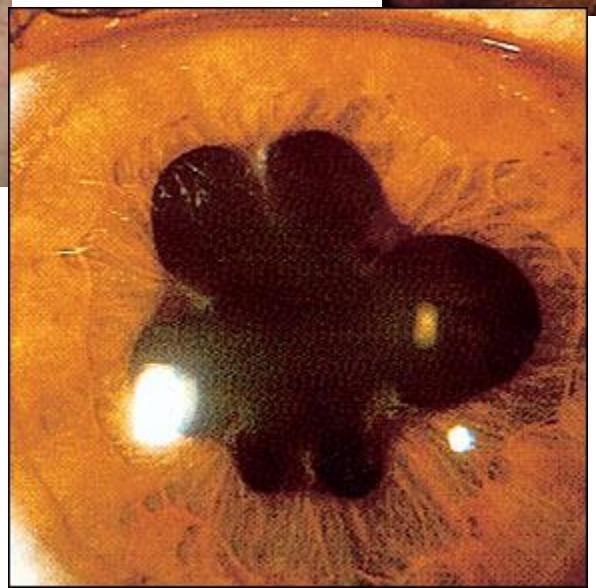
Ocular causes:

- **Anterior Uveitis**, when posterior synechiae give the pupil an irregular appearance.
- The sequelae of **intraocular surgery**
- **Blunt Trauma** to the eye, which may rupture the *sphincter muscle*, causing irregularity or fixed dilation (***traumatic mydriasis***)
- An acute and severe rise in ocular pressure – as in **Acute Glaucoma**

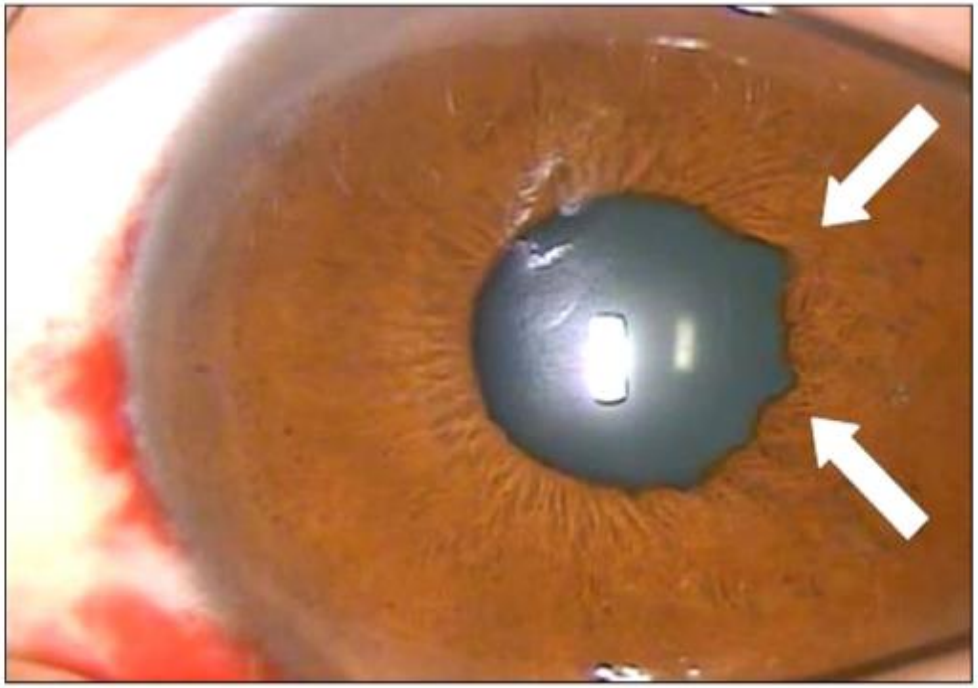
Posterior Synechiae

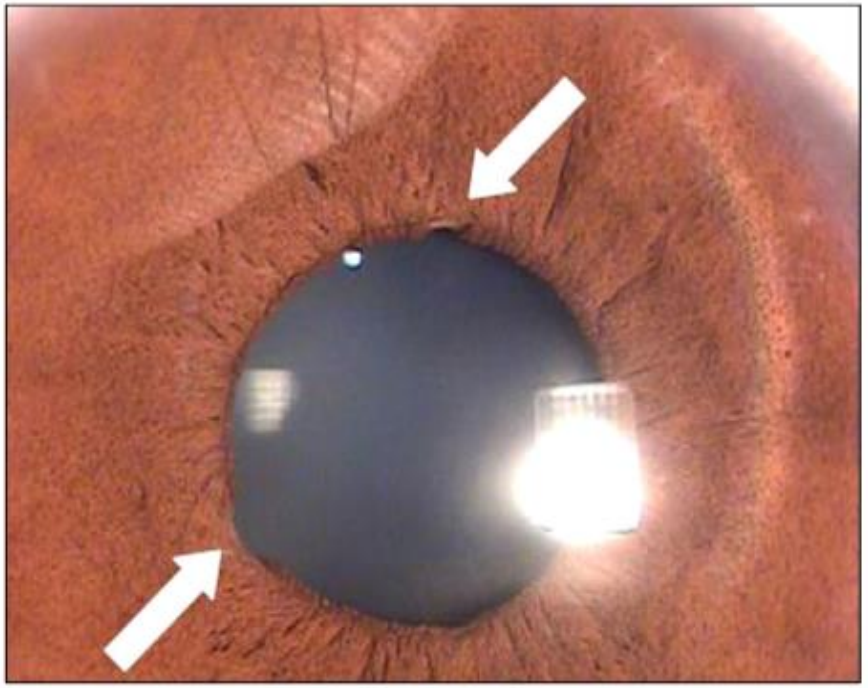
where the iris adheres to either the cornea (i.e. anterior **synechia**) or lens (i.e. **posterior synechia**)



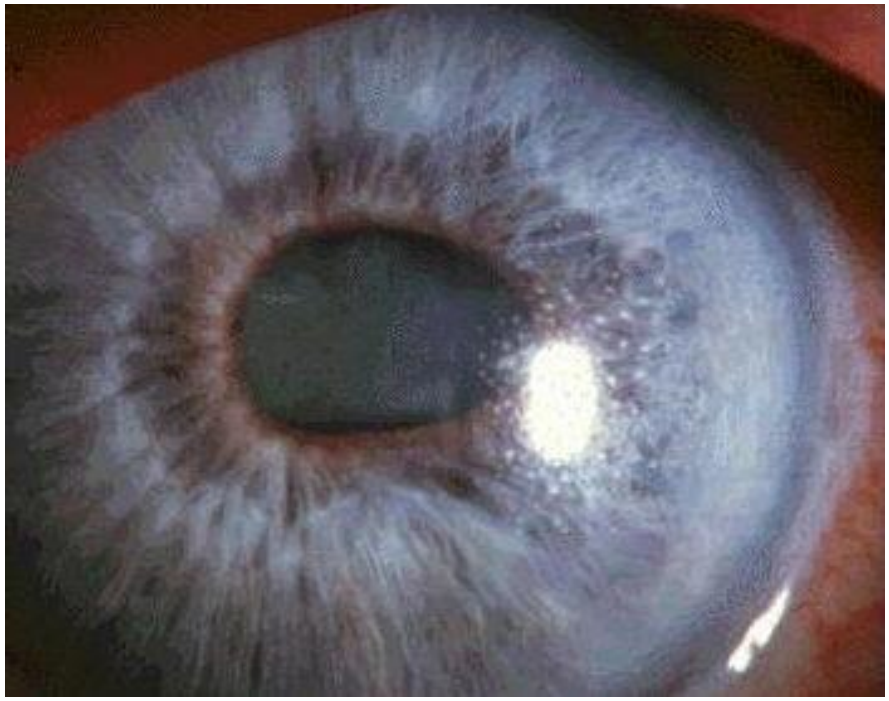


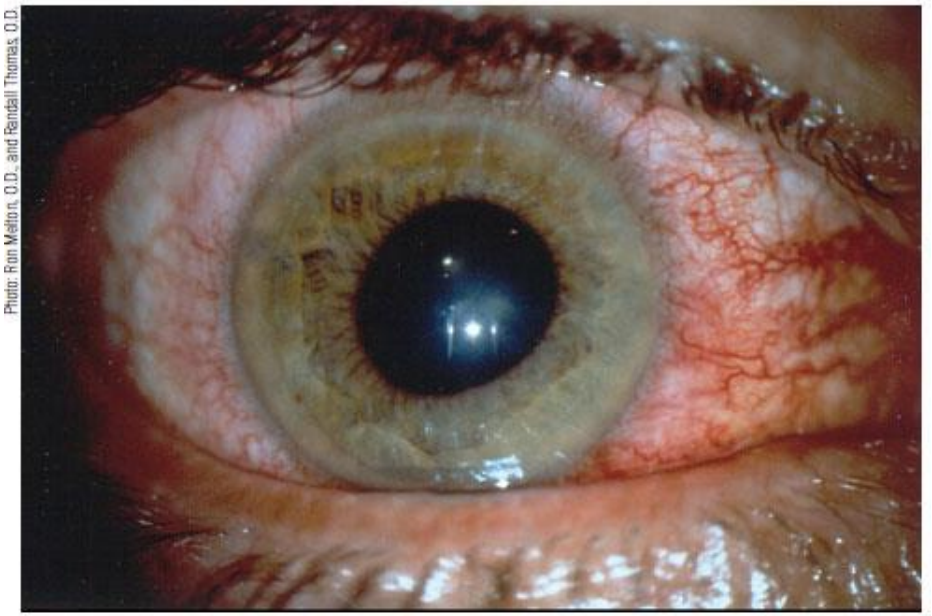
Traumatic Mydriasis





Acute Glaucoma





- Note the hazy cornea with semi-dilated and distorted pupil which are the common signs in this condition

Neurological Causes:

1. **Horner's syndrome: (Ptosis, Miosis, Anhydrosis)**

   – Interruption of the ***sympathetic pathway*** causes:

   1. **Small pupil** on the affected side due to **loss of the dilator function**. This is more noticeable in the *dark*
   2. **Slight ptosis** on the affected side.
   3. ***Enophthalmos:*** An apparent recession of the globe into the orbit. The reduced palpebral aperture size gives an impression of recession.
   4. **Lack of sweating on the affected side**, if the *sympathetic pathway is affected proximal to the base of the skull.*

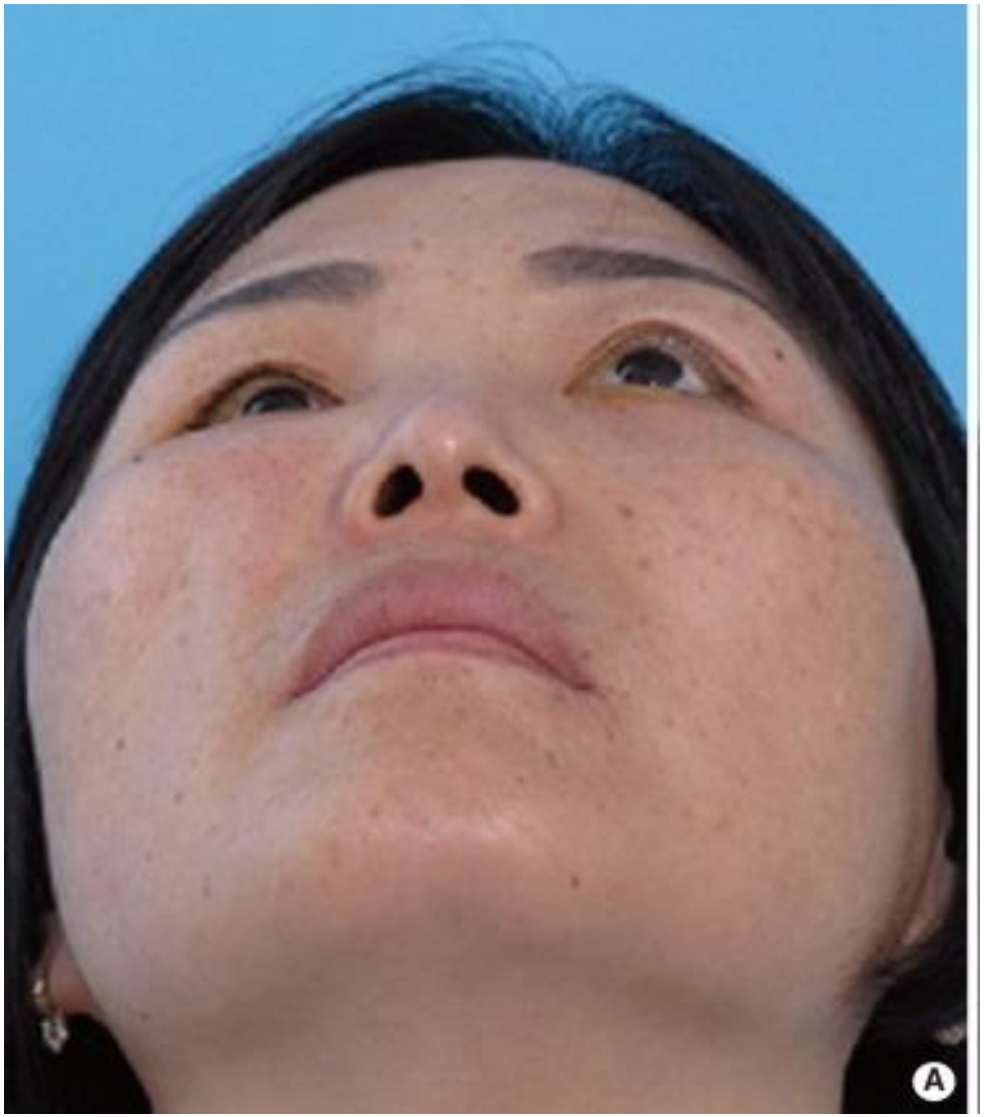
Horner's Syndrome Features

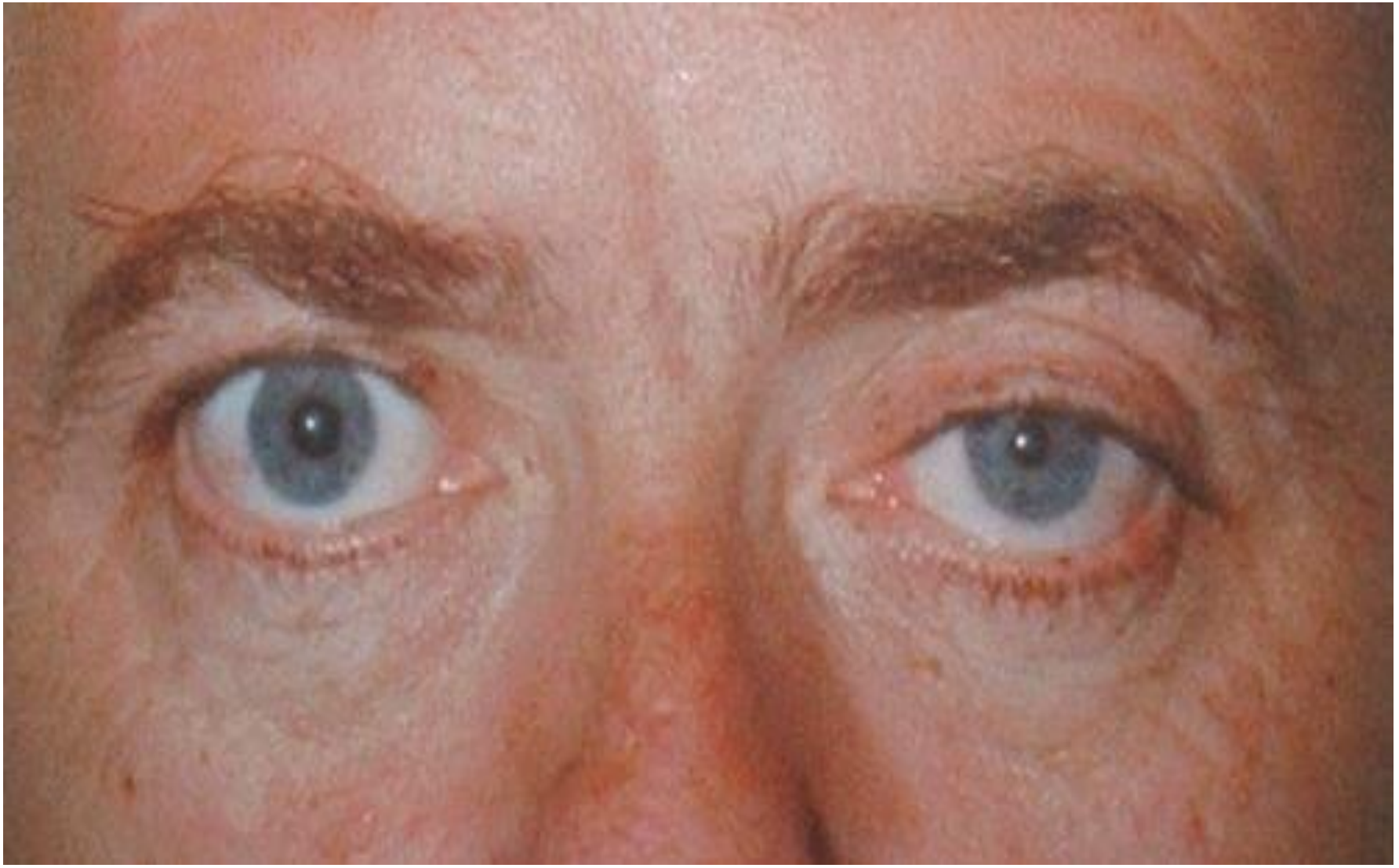
knowmedge

Mnemonic: "SAMPLE"

S	Sympathetic Nerve Fiber Injury
A	Anhidrosis
M	Miosis
P	Ptosis
L	Loss of ciliospinal reflex
E	Enophthalmos

Enophthalmos





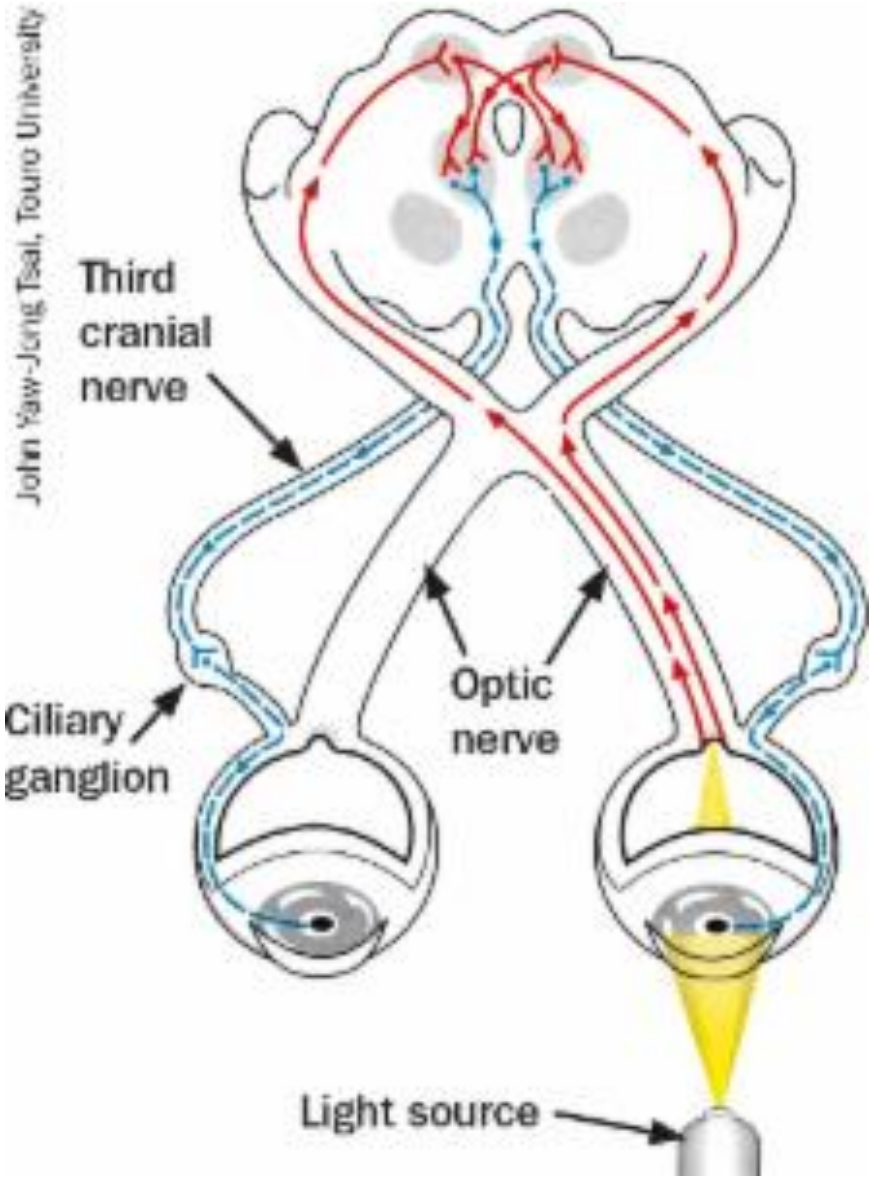
Causes of Horner's Syndrome

- **Because of its extended course, the sympathetic pathway may be affected by many pathologies:**
  - ***Syringomyelia:*** an expanding cavity within the spinal cord. It also causes wasting of the hand muscles and loss of sensation.
  - ***Small - cell carcinoma* at the lung apex:** catches the *cervical sympathetic chain*. Involvement of the brachial plexus gives rise to *pain and to T1 wasting* of the small muscles of the hand in Pancoast's syndrome.
  - **Neck injury, disease or surgery.**
  - **Cavernous sinus disease** – catching the sympathetic carotid plexus in the sinus.

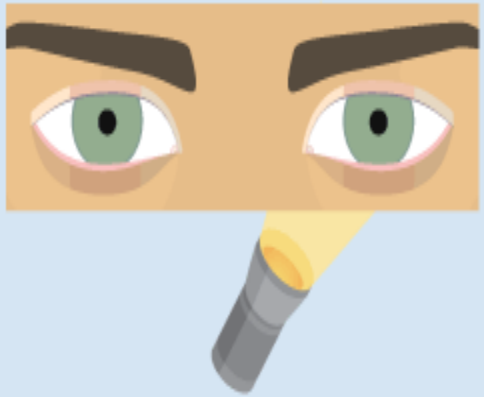
Horner's syndrome may also be congenital, in which case the iris colour may be altered when compared to the fellow eye (***heterochromia*).**

2- Relative Afferent Pupillary Defect (RAPD):

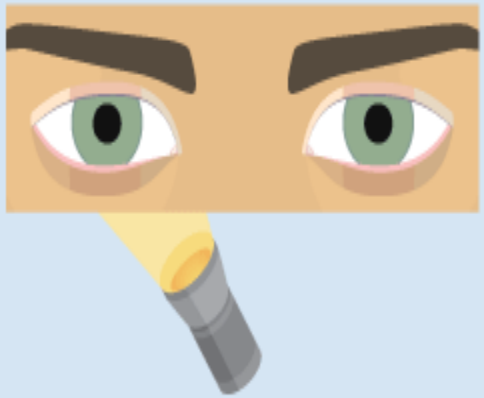
- A lesion of the **optic nerve** on one side blocks the **afferent limb** of the light reflex.
- The pupils are equal and of normal size, but the pupillary response to light directed to the affected side is **reduced direct and consensual**, while the near reflex is intact.
- Seen in **optic neuritis**, very **severe disease of the retina** but not with opacities of the cornea or lens



The patient focuses on a distant target in a darkened room — pupils are dilated.



A bright torch is shone into the left (normal) eye, evoking direct and consensual pupil constriction.



The torch is swung to the right (affected) eye, evoking temporary paradoxical dilation of the pupils; this indicates a defect in the afferent limb of the right eye pupillary reflex. The torch may need to be swung back and forth several times. ♦

3- Light–near dissociation

– The key feature is an **impaired reaction of the pupils to light**, while the **near response to accommodation is retained**.

– It is seen with:

A. **Adie's Tonic Pupil**
B. **The Argyll Robertson pupil**
C. **Periaqueductal brainstem lesions such as Parinaud's syndrome.**
D. **Other causes include: DM & MS.**

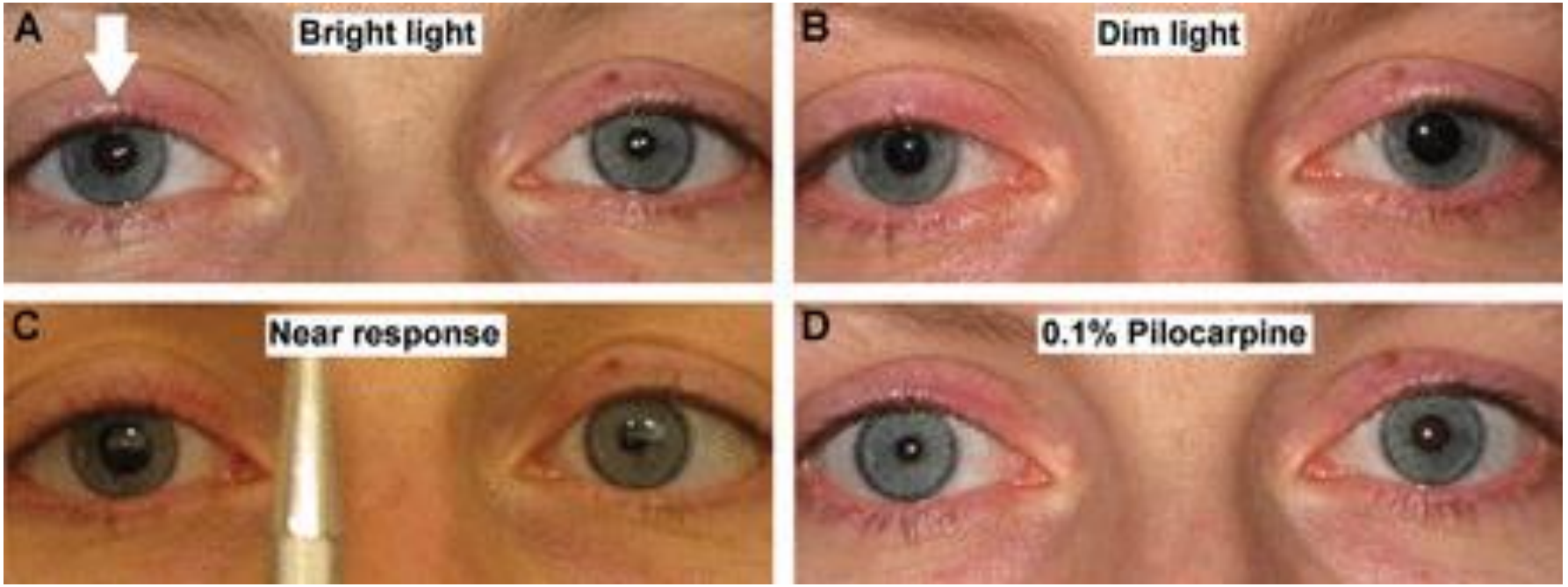
A) Adie's Tonic Pupil

- A common cause of unequal pupil size **(*anisocoria*)** in young adults, but has **no serious consequences**.
- Onset is **subacute,** affects **females** more commonly.
- It is due to a ***ciliary ganglionitis*** which denervates the parasympathetic supply to the *iris* and *ciliary body.*
- Normally, the ciliary body receives about **nine** times more nerve fibres than the iris sphincter.
- As the sphincter is partially denervated its muscarinic receptors are supersensitive to cholinergic agonists.

– The consequence is that the pupil:

- **Dilated** – because the sphincter is relatively denervated
- **Poorly reactive to light** – because few of the innervating fibers were originally destined for the sphincter.
- **Slow, sustained miosis on accommodation**

– Also, because of the irregular fiber distribution, pupil movement in response to light consists of **a slow, worm-like (*vermiform*) contraction**, on biomicroscopy.


A
Bright light
B
Dim light
C
Near response
D
0.1% Pilocarpine

- Because the ciliary body is also *partially* denervated, **the ability to accommodate is impaired too** and the patient may complain of blurred vision when looking from distance to near, or *vice versa* .

- Pupil constricts to *dilute pilocarpine* (0.1%), unlike the normal pupil. **This is a diagnostic test.**

- Systemically the disorder is associated with loss of tendon reflexes. (Holmes-Adie Syndrome)

B) Argyll Robertson Pupil

- The pupils are **bilaterally small and irregular.**
- They **do not react to light** but respond to accommodation.
- The iris stroma has a typical *feathery appearance* and loses its architectural detail.
- Classically it is seen in **neurosyphilis**.
- It is suggested that a lesion on the dorsal aspect of the Edinger Westphäl nucleus involves fibres associated with the response to light, **but spares** those associated with the near response.

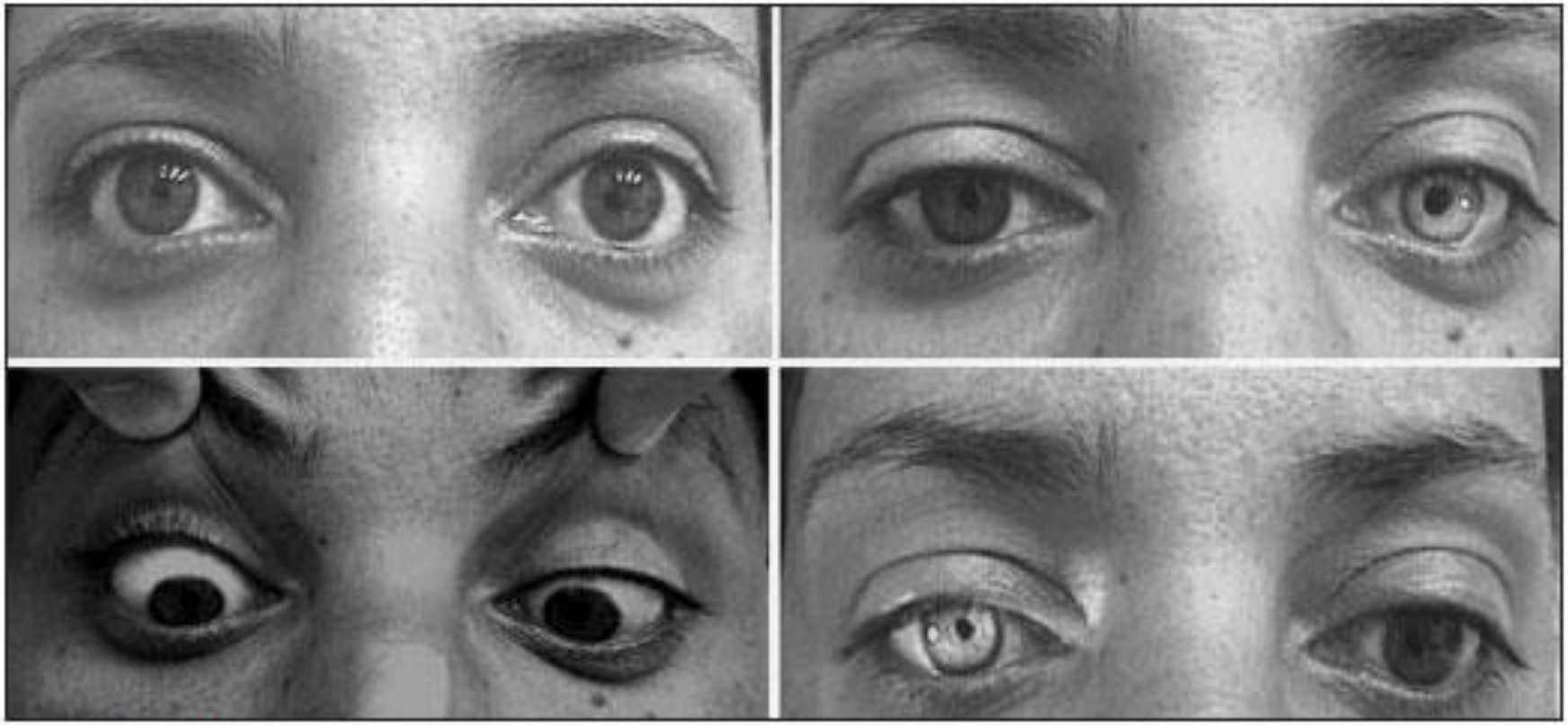
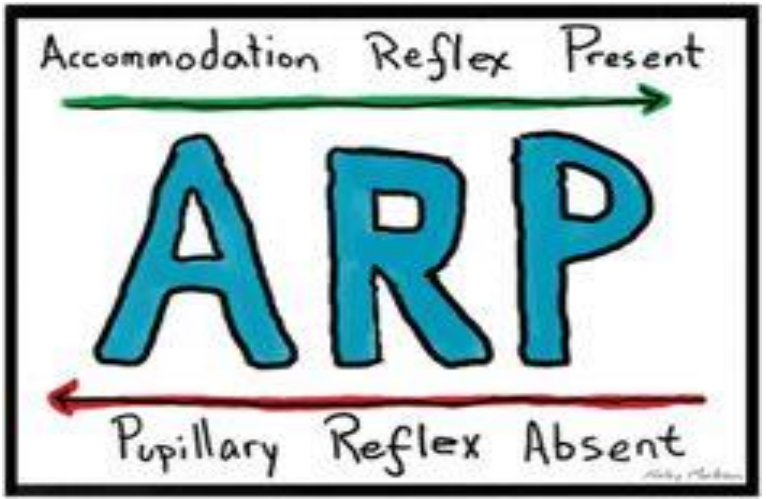
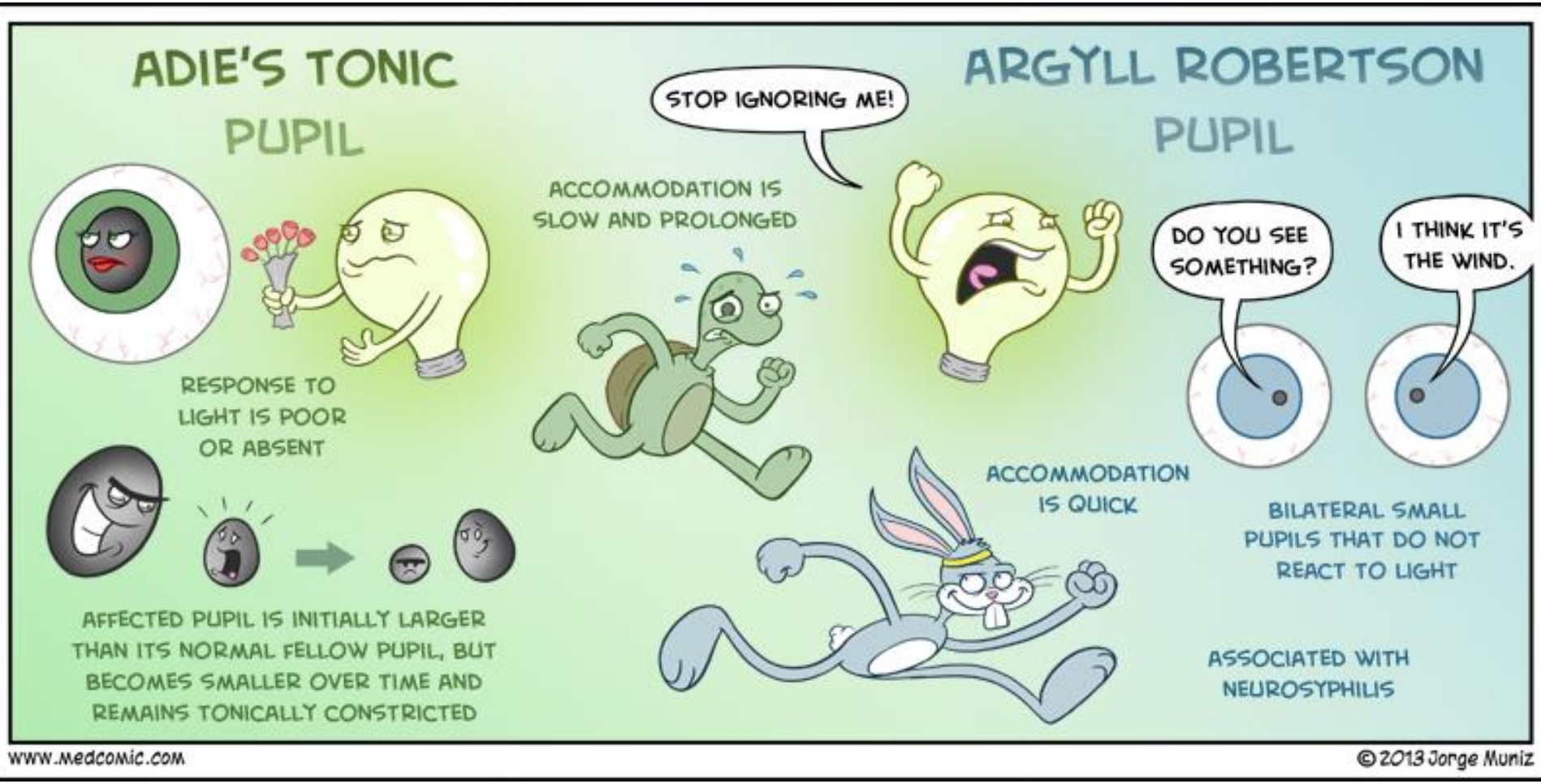


Figure. Argyll Robertson pupil.





C) Midbrain pupil

- Lesions affecting the pretectal nuclear complex in the dorsal region of the midbrain can disrupt retinotectal fibres while preserving the supranuclear accommodative pathway.
- **This produces mydriasis and a light-near dissociation**.
- **Causes include:**
  - Demyelination
  - Infarction
  - Enlargement of the third ventricle and space–occupying tumours such as pinealoma, as part of a *dorsal midbrain (Parinaud ‘s) syndrome*

Other causes of pupillary abnormality:

- In coma, both pupils may become **miosed** with preservation of the light reflex **if a pontine lesion is present**.
- Coma associated with a unilateral expanding supratentorial mass, e.g. a haematoma, results in pressure **on the third nerve and dilation of the pupil.**
- Intrinsic third nerve lesions also cause a dilated pupil.
- Patients taking pilocarpine for glaucoma or receiving morphine also show **bilateral miosis.**
- Midbrain lesions cause loss **of the light reflex with mid-point pupils.**

Pharmacological causes:

Agent route	Effect on pupil	Action
Topical	Dilate	Muscarinic blockers (cyclopentolate, tropicamide)
		Alpha-agonist (phenylephrine, adrenaline)
	Constrict	Muscarinic agonist (pilocarpine)
Systemic	Dilate	Muscarinic blocker (atropine)
		Alpha-agonist (adrenaline)
	Constrict	Opioids (morphine)

Thank you