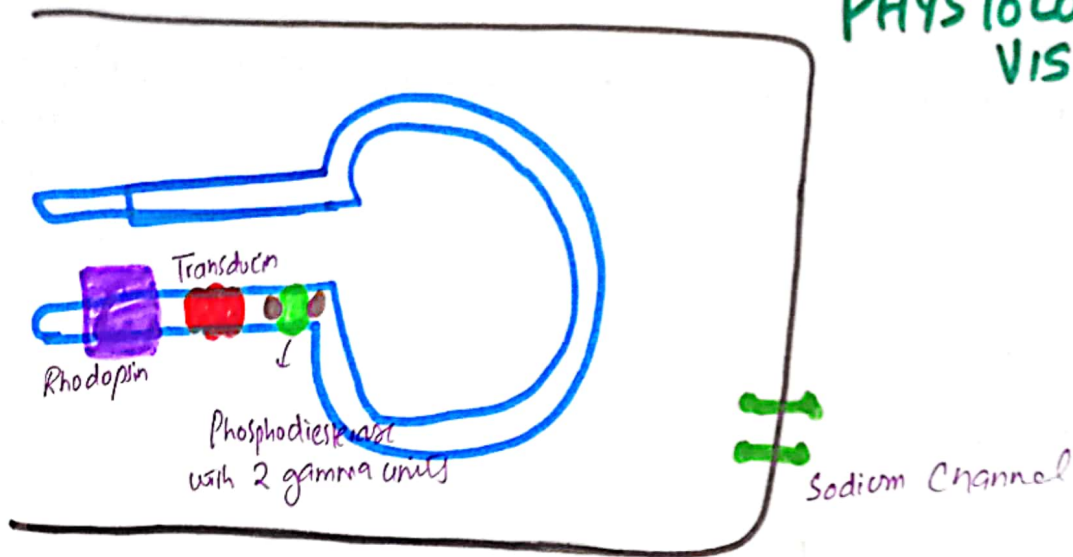


# PHYSIOLOGY OF VISION



## \* Rhodopsin

- photosensitive visual pigment present in the disc of outer segment of rods
- consist of protein opsin + carotenoid (11 cis retinal)

Rhodopsin (11 cis Retinal)



Bathorhodopsin



Lumirhodopsin



Metarhodopsin I



Metarhodopsin II (Active Rhodopsin with all trans Retinal)

## \* Rhodopsin Bleaching / PhotoDecomposition

The All trans Retinal produced from light induced isomerization of the 11 cis Retinal can no longer remain binded to opsin and they both separate

## \* Transducin

The all trans Retinal activates Transducin  
GDP is replaced with GTP

## \* Phosphodiesterase

- Inactive phosphodiesterase has 2 gamma units on either side
- Activated Transducin activate phosphodiesterase

## \* Sodium Channels

- These channels open in dark (due to  $\uparrow$  cGMP)
- close in ~~dark~~ Light

## \* Other Sensory cells

- Receptor activation by depolarization
- Action potential generation
- Neurotransmitter release

## Rods and Cones

- Receptor activation by hyperpolarisation
- Graded change in potential
- Graded change in release of the neurotransmitter at the post synaptic neuron

• In Dark  $\rightarrow$  RMP  $\rightarrow$   $-40$  mV

• Light  $\rightarrow$  Hyperpolarization  $\rightarrow$   $-65$  mV

• Dark  $\rightarrow$  Depolarization  $\rightarrow$   $\uparrow$  Neurotransmitter Release

Light  $\rightarrow$  Hyperpolarization  $\rightarrow$   $\downarrow$  Neurotransmitter

• Each PDE can break down 6 cGMP molecules

# Eyelids

## \* Normal Position of Eyelids

- In the primary gaze, the upper lid covers  $\frac{1}{6}$ th of cornea
- The lower lid just touches the inferior limbus

\* Eccrine sweat glands are distributed throughout eyelid skin and are not confined to lid margin, in contrast to glands of Moll

## \* Glands of Zeiss

- modified sebaceous glands located on margin of eyelid
- produce sebum that keep eyelashes from becoming dry and brittle

## \* Gland of Moll

- modified apocrine sweat glands
- lie in b.w cilia at anterior lid margin
- unbranched spiral shape

## \* Palpebral Aperture / Fissure

- Elliptical space b.w upper and lower eyelid margins
- Measurements in adults: 28-30 mm horizontally  $\leftrightarrow$   
9-11 mm vertically  $\updownarrow$

## - \* Layers of Eyelid

- Skin
- Subcutaneous Areolar tissue
- Striated muscle layer (orbicularis + Levator palpebrae superioris)
- Submuscular Areolar tissue
- Fibrous layer (tarsal plate and orbital septum)
- Non striated muscle fibers (Mullers muscle)
- Conjunctiva

## \* Tarsal Plate

- Dense fibrous tissue  $\rightarrow$  skeleton of eyelid giving the shape and firmness
- Height of Tarsus  
Upper : 10-11 mm  
Lower : 4-5 mm
- Tarsal glands (meibomian glands) are embedded in it

## \* Meibomian Glands

- modified sebaceous glands found in tarsal plates
- They empty through a single row of 20-30 orifices on each lid
- They synthesize lipids (meibum) that form outer layer of tear film

# Conjunctiva

## \* Conjunctiva

- It is a thin, translucent mucus membrane
- Palpebral portion → lines posterior surface of eyelid
- Bulbar portion → lines anterior surface of globe
- ~~Conj~~ Forniceal conjunctiva → joins palpebral and bulbar conjunctiva

The conjunctiva is firmly adherent to the lids over the tarsal plates and loosely attached in the fornices and over the globe, with the exception of the limbus.

## > Sulcus SubTarsalis

- Groove / sulcus present 2mm away from lid margin
  - common site for lodgement of foreign bodies
  - perforating branches of marginal arcade pierce the tarsal plate to supply the conjunctiva
- In trachoma, conjunctival scar in sulcus subtarsalis develop, which is referred to as **Frit's line**



# Conjunctivitis (Red eye / pink eye)

## \* Hyperemia vs. Conjunctivitis

Hyperemia → Dilation of conjunctival blood vessels without exudation or cellular infiltration

• Cause of Hyperemia

- Smoke or smog
- Chemical fumes
- UV radiation and wind

Conjunctivitis → Conjunctivitis is characterised by

- Exudation
- Cellular infiltration
- Chemosis

\* Acute → Resolves in less than 4 weeks

Chronic → more than 4 weeks

├ Inflammatory Conjunctivitis

├ Angular Conjunctivitis

└ Follicular → Trachoma, Granulomatous Conjunctivitis

## SYMPTOMS

Non-Specific Symptoms

- Lacrimation (excessive watering of eyes)
- Grittiness (foreign body sensation)
- Stinging
- Burning

[Significant pain, photophobia or a marked foreign body sensation suggest corneal involvement - (keratoconjunctivitis)]

Remember Conjunctivitis usually not associated with pain

- Itching is the hallmark of allergic disease, blepharitis and in patients with dry eye syndrome
- Visual Acuity not usually affected
- Colored halos can be seen (must be carefully distinguished from those seen in glaucoma)

## SIGNS

- Hyperemia
- Hemorrhage
- Chemosis
- Follicle
- Papillae
- Granulomatous Reaction
- Fibrosis / Cicatrix formation

→ called Conjunctival Injection

\* Hyperemia in Conjunctivitis → much more towards the fornix and fades towards the limbus (distinguish it from ciliary injection of iridocyclitis)

\* Hemorrhages can be

- petechial → viral conjunctivitis
- Large and diffuse → severe bacterial conjunctivitis

\* Chemosis (Conjunctival edema)

- seen as translucent swelling which may protrude through eyelids
- Acute chemosis usually indicates a hypersensitivity response (e.g pollen), but can occur in severe infective conjunctivitis

\* Papillae

- In contrast to follicles, a vascular core is present
- Micropapillae < 1 mm → elevated red dots
- Macropapillae > 1 mm → develop with prolonged inflammation
- Limbal papillae have a gelatinous appearance

\* Follicles

- multiple, discrete, slightly elevated lesions resembling translucent grains of rice
  - yellowish-white, most prominent in fornices
  - blood vessels run around or across rather than within the lesion
- In trachoma, follicles are more numerous in upper palpebral conjunctiva than on the lower, which is unlike any other condition

\* True Membrane

- involves superficial layers of conjunctival epithelium
- Attempted removal leads to tearing and bleeding

\* Pseudo membranes

- Pseudo membranes of coagulated exudate adherent to inflamed conjunctival epithelium
- They can be peeled away leaving the underlying epithelium intact
- caused by pneumococcus

## \* Subconjunctival Cicatrization (Scarring)

- may occur in trachoma and other severe forms of conjunctivitis
- Severe scarring is associated with loss of goblet cells and accessory lacrimal glands and can lead to cicatricial entropion

## \* Granuloma Formation

### • Type 4 HSN Reaction

- presents with a mass in conjunctiva
- usually associated with systemic disease e.g TB, Tularemia, Syphilis etc
- Conjunctival granulomata form in response to foreign body, allergen, infectious organism or as part of systemic disease

## \* Lymphadenopathy

- Most common cause of lymphadenopathy associated with conjunctivitis is
  - Viral infection
  - Chlamydial infection
  - Severe bacterial conjunctivitis (esp gonococcal)
  - Parinaud oculoglandular Syndrome
- The preauricular site is typically affected

# VIRAL CONJUNCTIVITIS

- \* Keratoconjunctivitis → both cornea and conjunctival epithelium inflamed
- \* DNA viruses → severe inflammation, vision threatening conjunctivitis
  - Adenovirus
  - Herpes Simplex virus
  - Varicella zoster virus
  - EBV
  - CMV
- \* RNA viruses → Mild/benign inflammation
  - Picorna virus
  - Paramyxo virus
  - Toga virus
  - Flavi virus
- \* Conjunctival Signs
  - unilateral or bilateral diffuse conjunctival congestion
  - Follicular reaction on lower tarsal plate
  - Conjunctival hemorrhages
  - Membranes and pseudo membranes
- \* Corneal Signs
  - Epithelial microcysts
  - Punctate epithelial keratitis
  - Anterior stromal infiltrates
  - Pseudo dendritic epithelial formations
- \* Systemic Signs
  - Lymphadenopathy → mostly pre auricular lymphadenopathy
  - Prodromal features like fever/diarrhea
  - Upper Respiratory Tract Infection / cold / sore Throat



## Adenovirus

### Clinical Presentation

- Pharyngo conjunctival fever
- Epidemic keratoconjunctivitis
- Acute follicular conjunctivitis
- Chronic conjunctivitis

### Epidemic Keratoconjunctivitis (EKC)

It is the severest ocular disease caused by adenoviruses

#### Clinical Signs

- Subconjunctival hemorrhages
- Membranes
- Follicular Reaction / Mixed Reaction
- Hyperemia
- Marked worsening of photophobia, tearing, and discomfort heralds the presence of keratitis

#### Stages of EKC

Stage 0 → Imperceptible vesicle/cystic stage  
As early as 2 days

Stage 1 → Perceptible elevated lesion  
Appear as dark holes in stained tear film  
As early as 2 days

Stage 2 → Superficial keratitis  
coalescence of lesions and involvement of deep epithelium

Stage 3 → Faint subepithelial infiltrates  
Detected during 2nd week  
Seen in 43% of the patients

Stage 4 → Classic subepithelial infiltrate  
weeks or months after infection

Stage 5 → Punctate Granularity  
overlying the subepithelial infiltrates

## What are Subepithelial Infiltrates

- SEIs most commonly diminish with time
- Even with treatment, SEIs may cause photophobia and blurred vision for many months and, in some cases, may lead to visually significant scarring

## Evolution of EKC

### Infective Phase

- Conjunctivitis
- Punctate keratitis

### Immune Phase

- Severe inflammation
- Pseudomembranes (20-60%)
- Subepithelial infiltrates (50%)

### Healing Phase

- Complete Resolution
- Permanent Corneal Scarring
- Symblepharon formation
- Subconjunctival scarring
- Dry eye

## \* Pharyngo Conjunctival Fever

- Pharyngitis
- Follicular conjunctivitis
- Fever
- Adenopathy (preauricular and cervical)

### Symptoms

- Sequential involvement
- Second eye is clinically less severe
- Initially, the patient complains of abrupt onset of itching and irritation

### Lid edema and crusting

The serous discharge may be abundant and often leads to crusting of superior and inferior lashes, causing difficulty with opening the eyes on awakening

## Signs

- Hyperemia and congestion
- Mild punctate keratitis may be detectable by 2 days to 1 week after onset of symptoms
- These dots may become diffuse and persist for up to a week
- The subepithelial infiltrates of the type seen in EKC are not frequent in patients with PCF

# PIGMENTED LESIONS OF CONJUNCTIVA

## Primary lesions

- Benign Epithelial melanosis
- Nevus of Ota
- Primary Acquired melanosis
- Pigmented Nevus
- Conjunctival melanoma

## Ocular melanosis

It is a blue-gray and/or brown lesion of the conjunctiva that can be separated into:

- Benign Conjunctival epithelial melanosis
- Primary Acquired melanosis

## Benign Conjunctival Epithelial Melanosis

- non cancerous
- Racial melanosis → 95% associated with dark skinned individuals
- Appears at birth and remain stable
- Bilateral
- Flat
- Perilimbal
- ↑ melanin production

## Primary Acquired Melanosis

- seen in elderly
- New onset heterogenous colored patches
- Precancerous and needs treatment

## Conjunctival Nevus

- localised
- Unilateral
- elevated or flat lesion
- Pre cancerous
- may be cystic also



## Conjunctival melanoma

- Nodular
- Fixation
- Excessive vascularisation / sentinel vessels
- enlarged lymph nodes

## Secondary Pigmentation of <sup>Conjunctiva</sup> Eye: Causes

- Addison Disease
- Alkaptonuria
- Radiation
- Chronic Inflammation / irritation

# CORNEA

## Topography of Cornea

- Anterior surface is elliptical whereas posterior surface is spherical
- Average diameter is 11.5 mm
- Horizontal diameter of anterior surface (HCD) is 11.7 mm and vertical diameter (VCD) is 11 mm
- Radius of curvature of cornea is 8 (7.8 mm)
- Microcornea = when HCD < 10 mm
- Macrocornea = when HCD > 13 mm
- Central corneal thickness is 0.52 mm (520  $\mu$ m)
- Central corneal thickness has an effect on IOP measurement
- Central 5 mm of cornea  $\rightarrow$  most powerful refracting surface

## Corneal Layers

- Epithelium
- Bowman's membrane
- Stroma (collagen)
- Descemet's membrane
- Endothelium

## Corneal Epithelium

- 10% of corneal thickness
- Stratified squamous non keratinized epithelium
- Desmosomes and hemidesmosomes
- It takes normally 7 days for replacement of entire corneal epithelium
- Microvilli with glycocalyx helps in adhesion and stability of tear film

## Bowman's membrane

- Acellular tough membrane like zone situated in between corneal epithelium and stroma
- It is 8-14  $\mu$ m thick and composed of randomly arranged collagen fibres
- Comparatively resistant to trauma
- However, once destroyed cannot be regenerated

## Corneal Stroma / Substantia propria

- 90% of total corneal thickness
- collagen fibrils + keratocytes + extracellular ground substance
- collagen fibrils with uniform 25-35 nm diameter are arranged in flat bundles called lamellae
- Two important ~~structures~~<sup>theories</sup> of corneal collagen fibers, which accounts for transparency of cornea, are:
  - (1) Collagen fibres are highly uniform in diameter
  - (2) The distance b/w 2 corneal fibers is also highly uniform

2 Theories — Maurice Theory  
                  — Lattice Theory

## Reasons for Corneal Transparency

- Optically smooth tear film
- Role of corneal epithelium
- Arrangement of stromal fibers
- Avascularity of cornea
- Absence of myelination in corneal nerves

## Descemet's Membrane

- Thick basement membrane secreted by endothelium cells
- constantly produced so thickens throughout life
- weakly attached to stroma
- Resistant to enzymatic degradation by phagocytes and toxins
- **Desmetzelle**: remains intact in corneal ulcer and herniate due to raised IOP

## Corneal Endothelium

- Hexagonal, which forms continuous mosaic pattern, seen in specular microscopy
- The endothelial cells are interconnected with each other with various junctional complexes like zonula occludens, macula occludens and macula adherens
- These cells possess ion transport system which is known as endothelial pump, to regulate water content



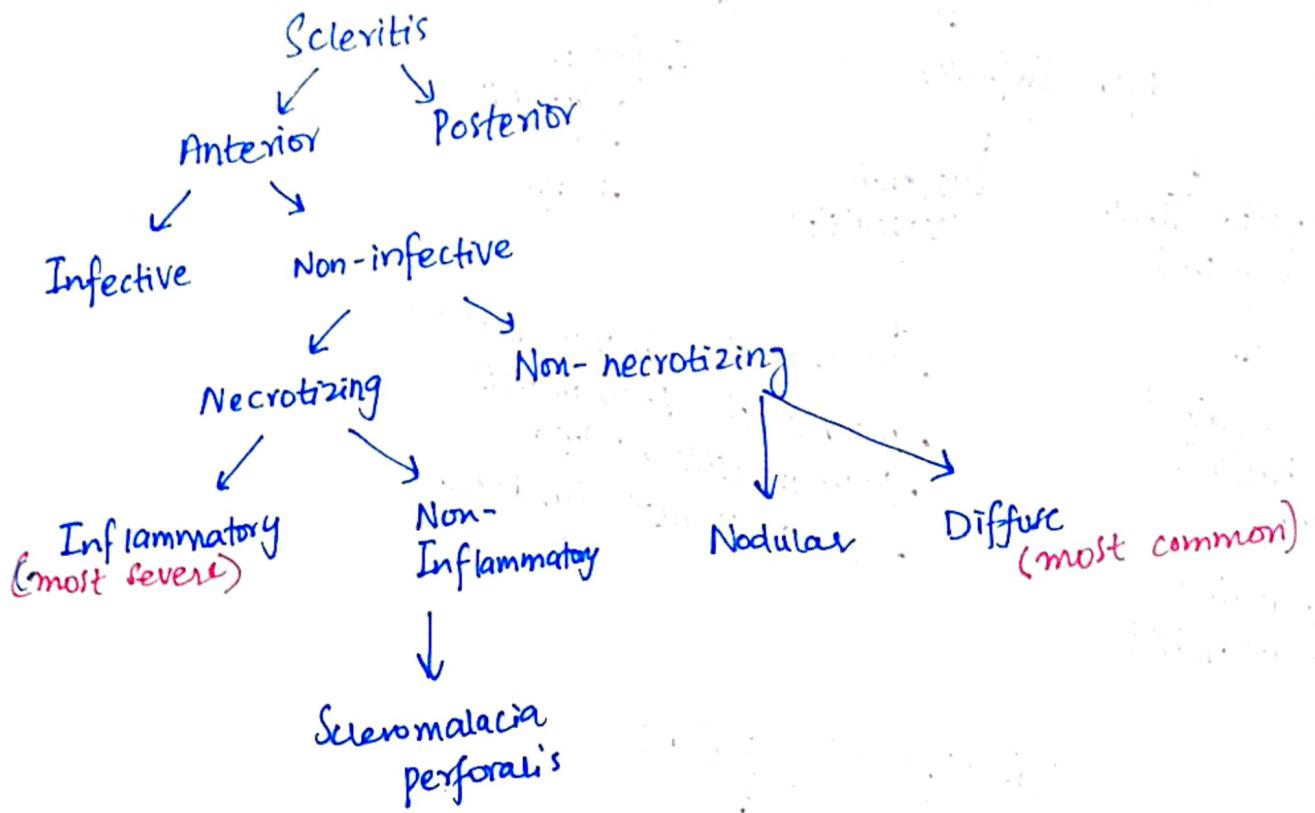
## Importance of Endothelial Cells

- Endothelial cells cannot divide or replicate
- With ageing, the cell density of endothelium decrease which is compensated by an increase in cell size (polymegathism) or shape (pleomorphism)
- As these endothelial cells are involved in corneal hydration (which helps in maintenance of corneal transparency), endothelial cell density below  $800 \text{ cells/mm}^2$  leads to corneal decompensation

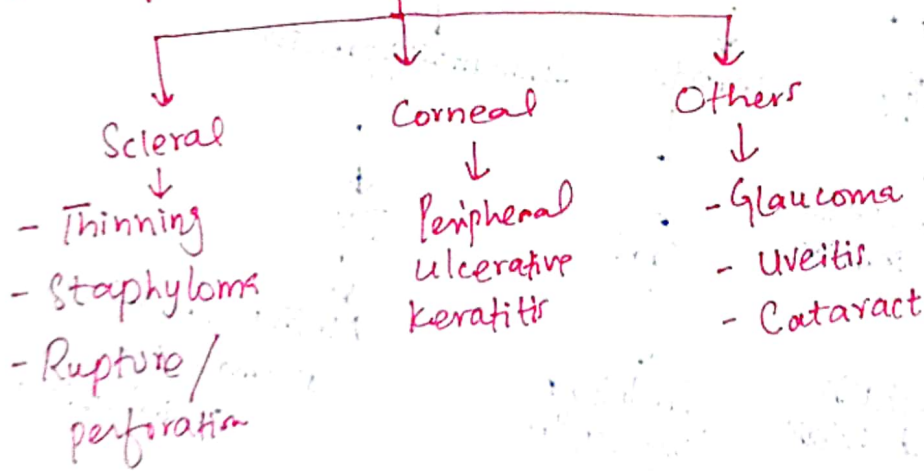
## Corneal Response To Injury

- Responds immediately to establish barrier action and protect underlying tissue
  - Bowman's membrane = no mechanism of repair
  - Stroma = keratocytes produce reparative collagen and proteoglycan
  - Descmetr = Resecreted by corneal endothelium
  - Endothelium = No mechanism of repair
- 
- Nebula → involving Bowman's membrane and superficial stroma
  - Macula → involving  $\frac{1}{3}$ rd of stroma
  - Leucoma → involving more than  $\frac{1}{2}$  of stroma



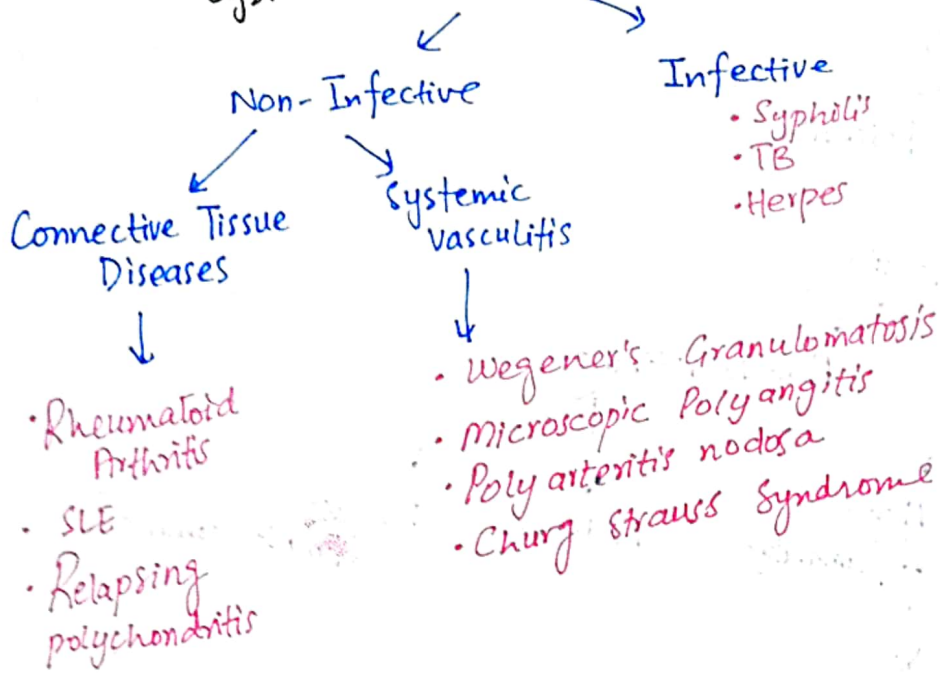


### \* Complications of Scleritis

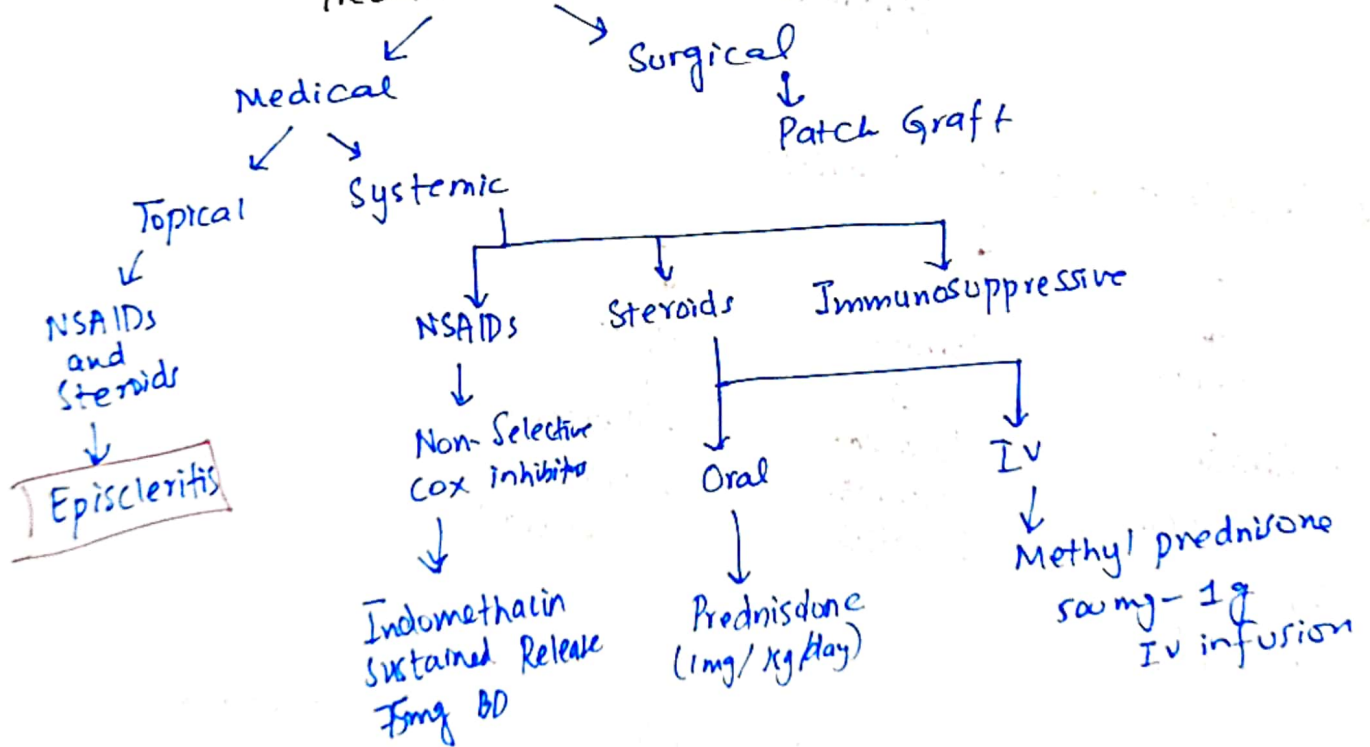


\* Infectious Scleritis is the only indication where scleral biopsy may be required

# Systemic Associations of Scleritis



# Treatment Options



# Acute Red Eye Approach

