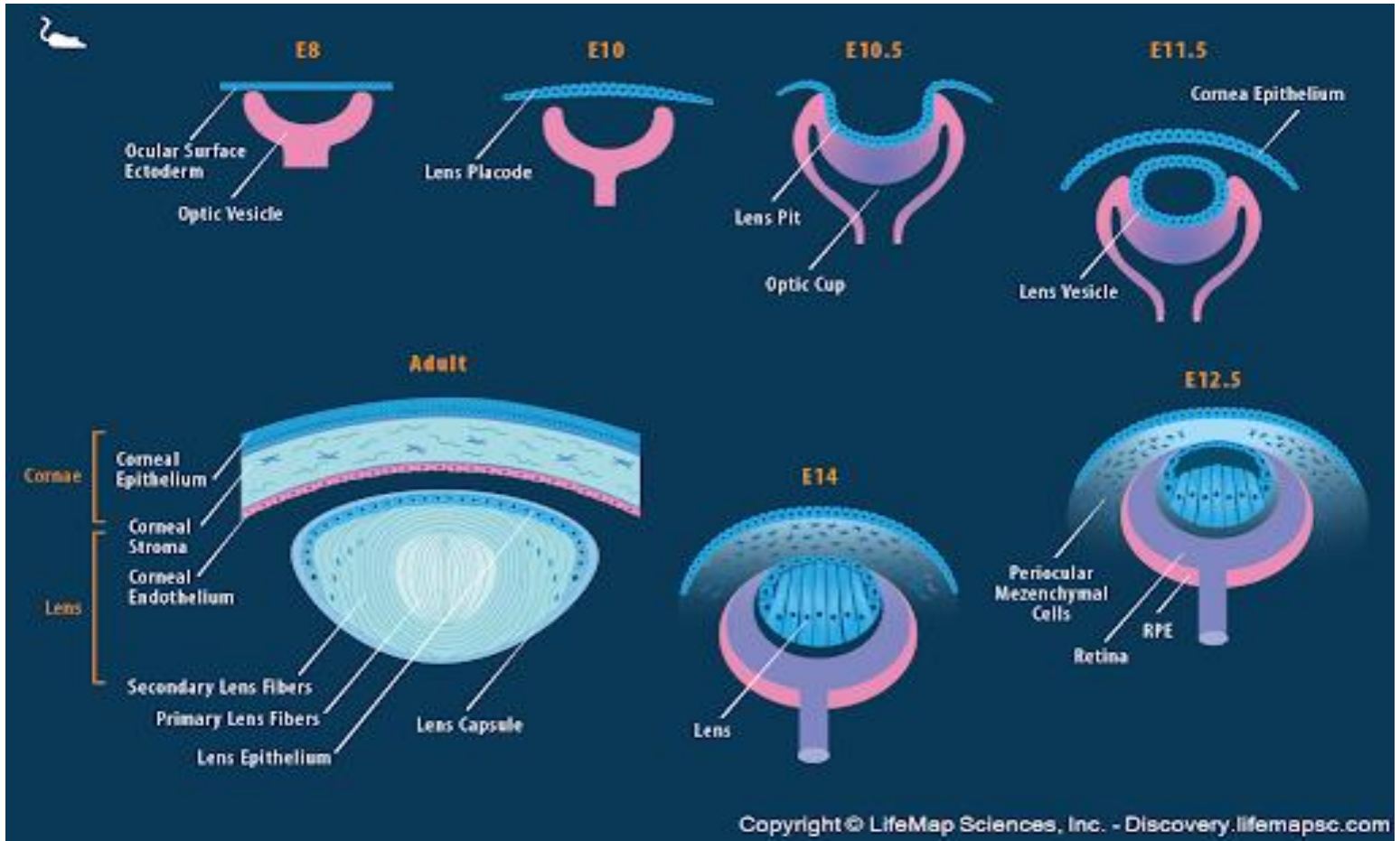
Cornea- Anatomy & Physiology

Dept. of Shalakyatantra

Embryology:

- Corneal epithelium: From Surface Ectoderm
- Other layers of Cornea: From fibrous layer of mesenchyma of Optic vesicle
- Diseases affecting organs with similar embryonic origin : Atopic dermatitis causes keratitis



Dimensions:

- Transparent avascular structure- resembling Watch glass
- Forms 1/6th of the outer fibrous coat of the eye
- Dimensions:

  I. Anterior Surface : Elliptical

  ➢Horizontal Diameter: 11.7 mm

  ➢Vertical Diameter: 11 mm

  II. Posterior Surface: Circular

  ➢Average Diameter: 11.5 mm
- Thickness:

  ➢Centrally: 0.5-0.6 mm

  ➢Periphery (at limbus) : 1-1.2 mm
- Radius of curvature: (of central 5mm of Cornea)

  ➢Anteriorly- 7.8mm, Posteriorly- 6.5 mm

Pathologies

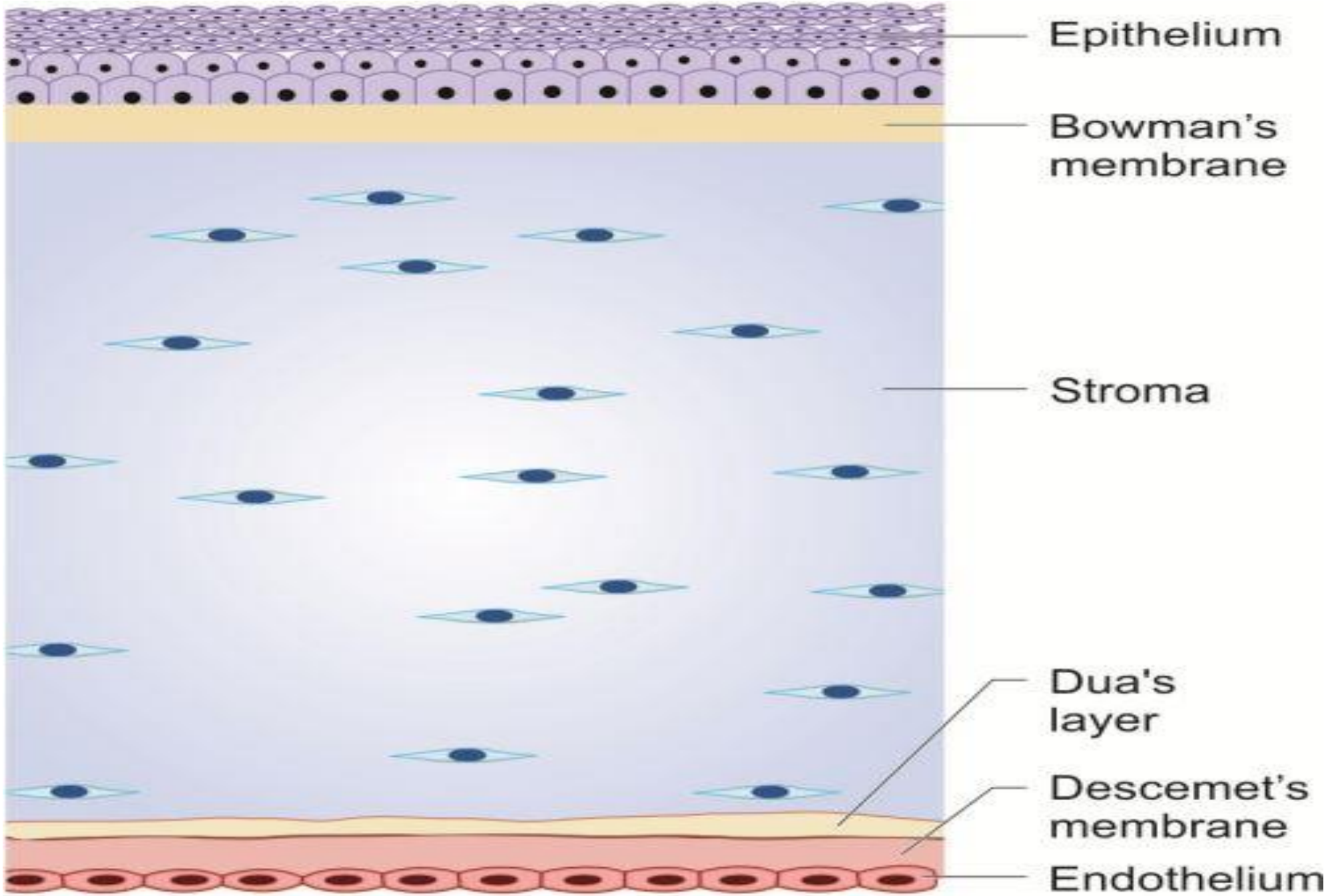
- Microcornea : if AHD <10 mm
- Megalocornea: if AHD >13 mm

Refractive dimensions of Cornea

- RI: 1.376
- Refractive power: Approx. 45 D
  - Ant. Surface: +48 D
  - Post. Surface: -5.80 D

- Refractive errors

Histology:

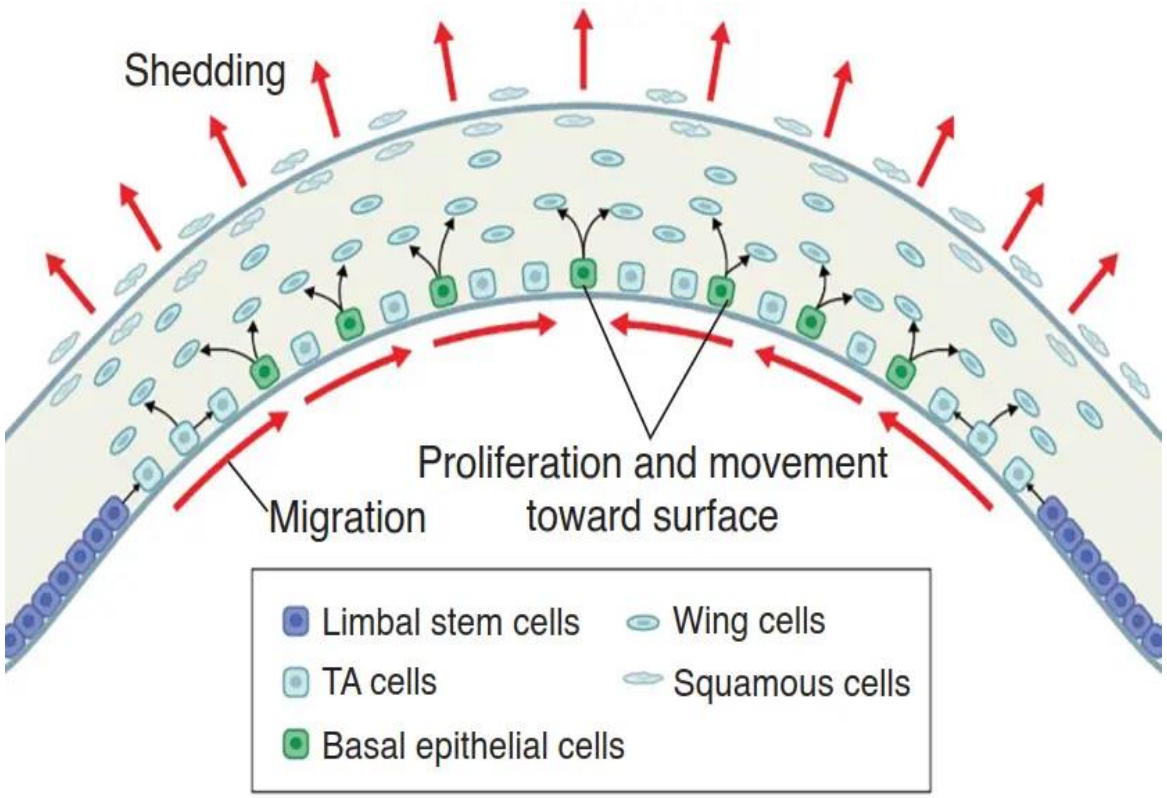

Epithelium
Bowman's membrane
Stroma
Dua's layer
Descemet's membrane
Endothelium

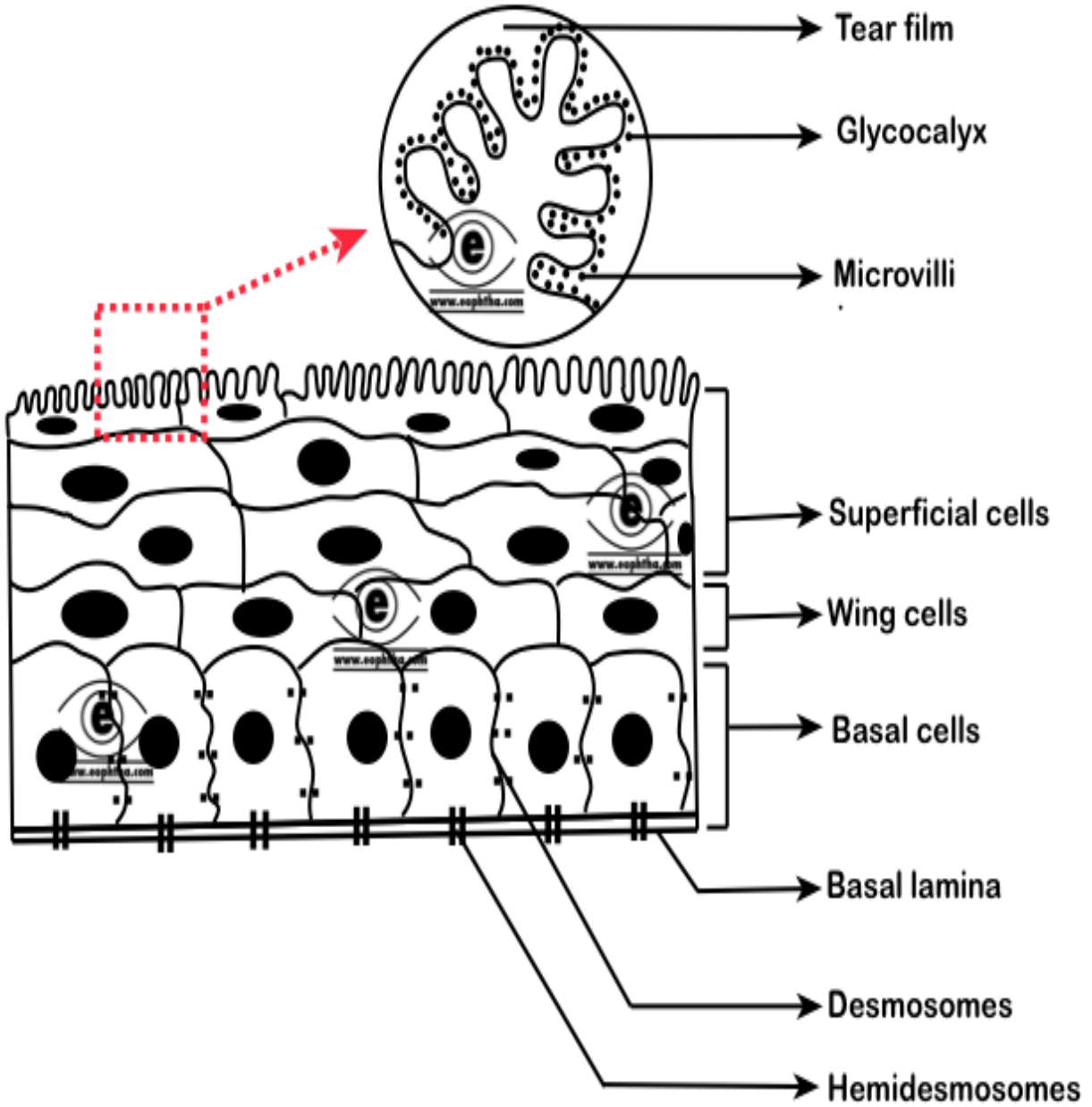
1. Epithelium:
   - Stratified squamous non-keratinized epithelial cells in 5-6 layer
   - Continuous with epithelium of bulbar conjunctiva at limbus (lacks the goblet cells)
   - Limbal epithelium :

     limbal stem cells – amplify, proliferate and differentiate into corneal epithelium (Damage/ deficiency to this area → invasion of conjunctival epithelium into the cornea)
   - Microplica and microvilli : increase the surface area of outermost cells
   - Sheds at regular interval and entire epithelium replaced in 6-8 days
   - 10% of total corneal thickness

Layers of Epithelium

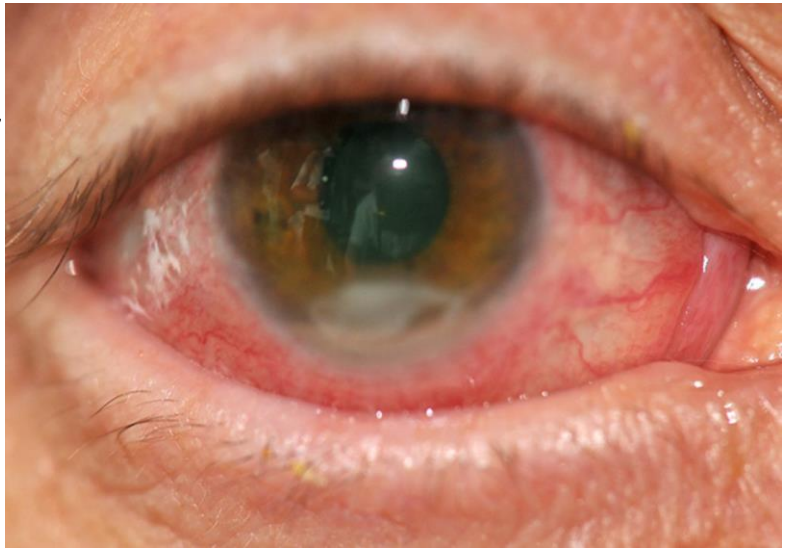
- Superficial cells
- Wing cells
- Basal cells (Germinative layer)





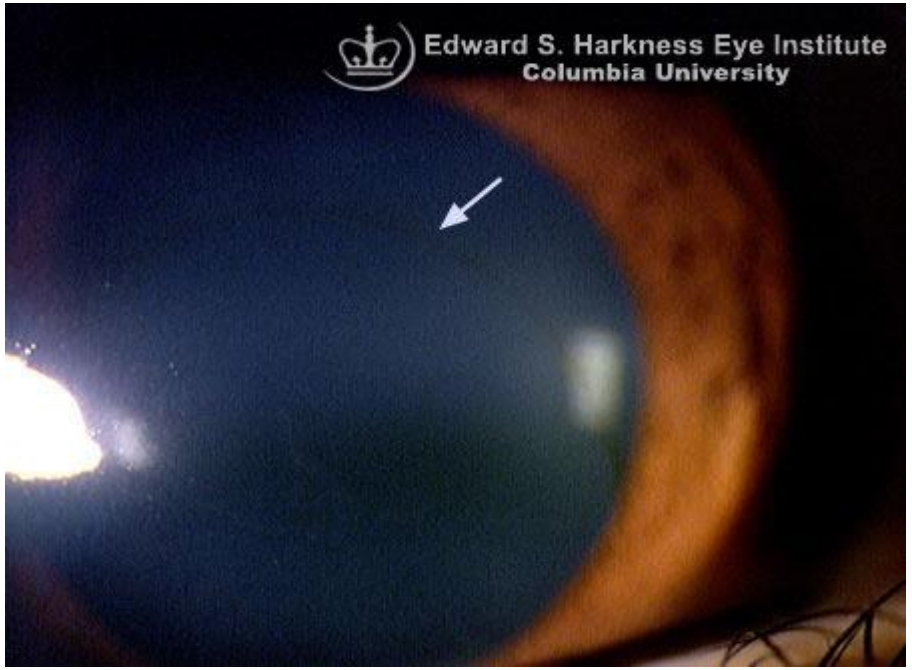
Applied Aspects

- Keratinization of Corneal epithelium in Vit. A deficiency



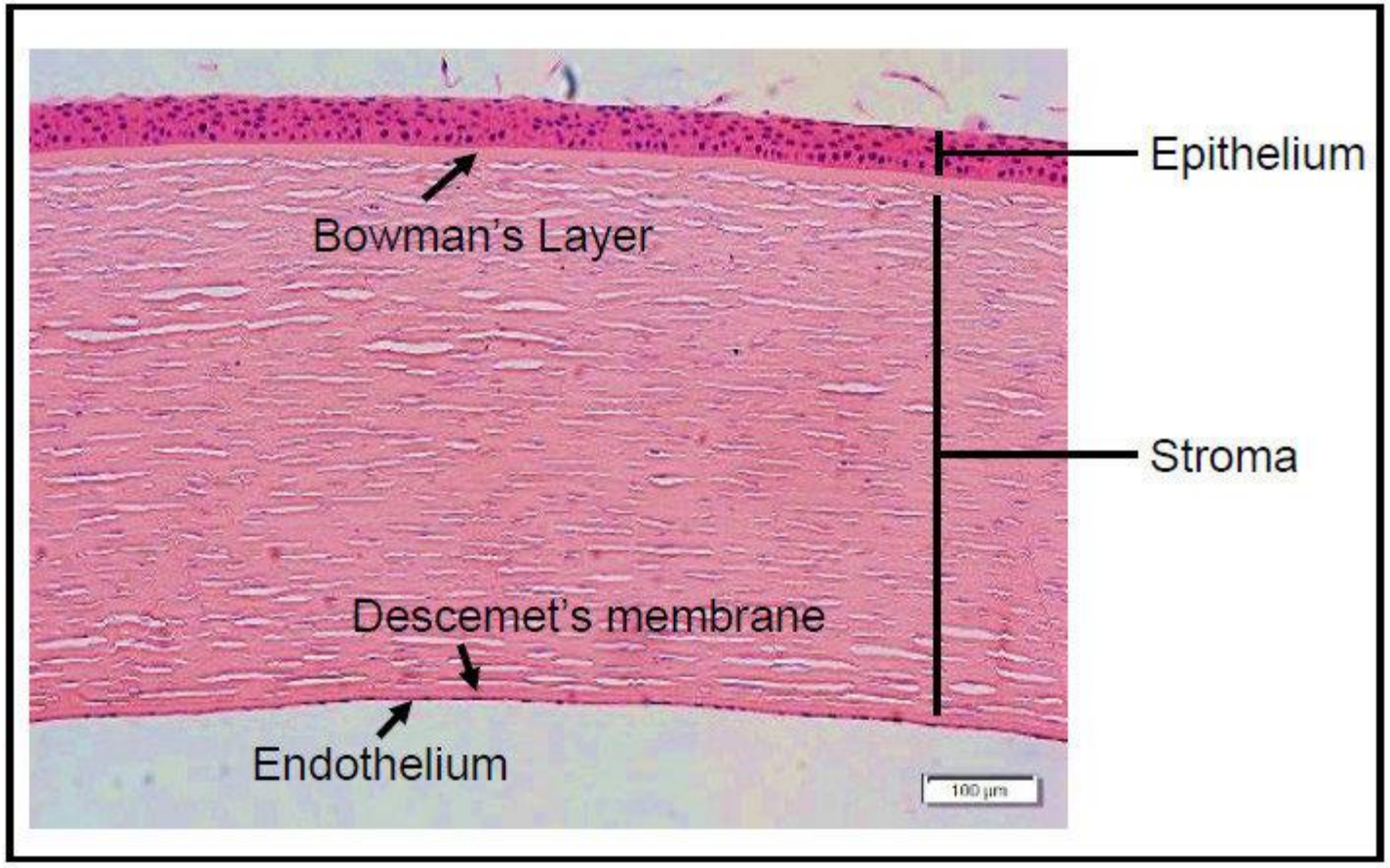
- Fleischer rings: pigmented rings in peripheral cornea due to iron deposits in basal epithelial layers

  (hemosiderin deposits)



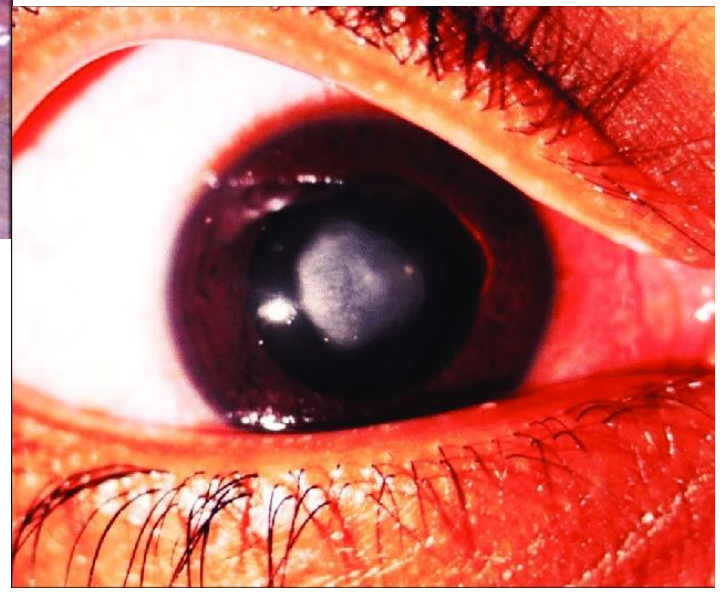
2. Bowman's membrane:

- Acellular mass of condensed collagen fibrils
- 12 μm thick
- Binds corneal stroma with basement membrane of epithelium
- Condensed superficial part of stroma
- Shows considerable resistance to infection, but once destroyed, unable to degenerate ∴heals with scar



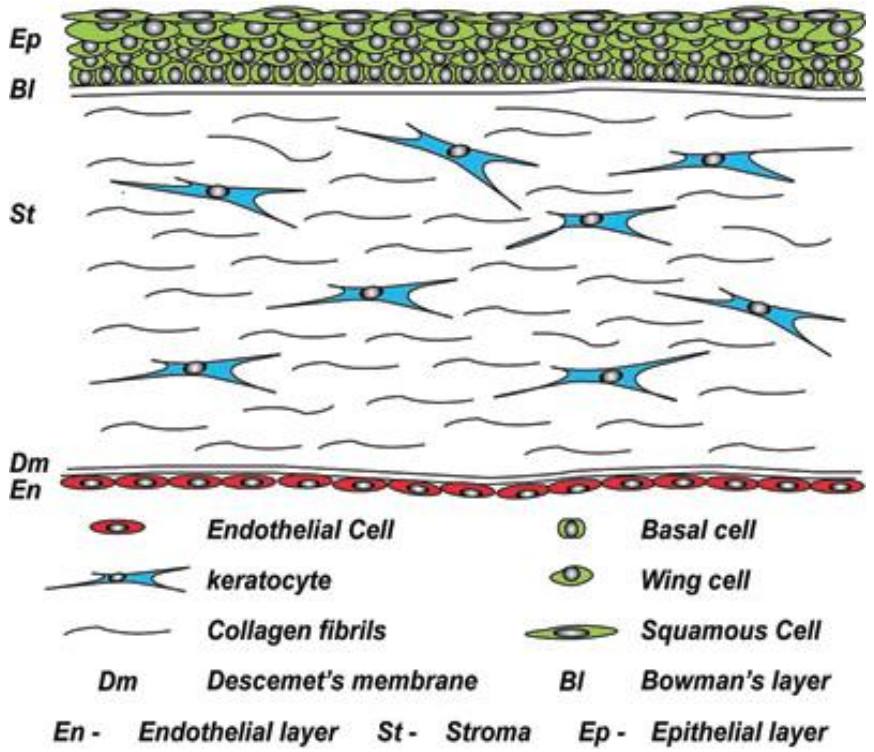
Corneal opacity

1. Nebular : Bowmans membrane + Superficial stroma
2. Macular: BM+ ½ of Stroma
3. Leucomatous : BM + > ½ of stroma
4. Adherent Leucoma: Healing after perforation with incarceration of iris



3. Corneal stroma/ Substantia propria

- 90% of total cornea
- 0.5 mm thickness
- Consists of collagen fibrils embedded in hydrated matrix of proteoglycans
- Keratocytes, wandering macrophages, histiocytes and few leucocytes are present in lamellae
- Can scar but not regenerate following a damage
- Regular arrangement of lamellae for transparency



4. Pre-Descemets membrane/ Dua’s Layer

- Discovered in 2013 by Dr. Harminder Dua
- 15 µm thick, Acellular layer
- Strong and impervious to air

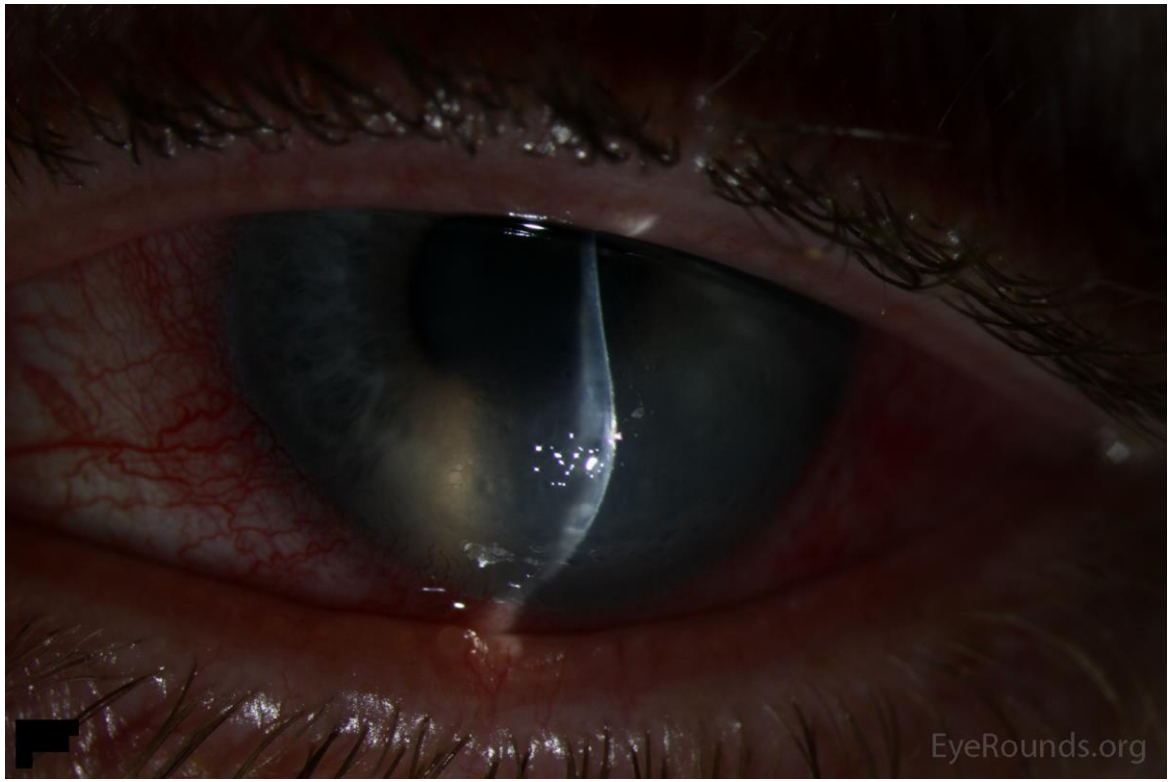
Prevents hydrops after tear of Descemets membrane

Once Dua’s layer ruptures, acute hydrops and stromal edema occurs.

(Common in keratoconus-

Significant leakage of aqueous.

DOV, Photophobia and pain)

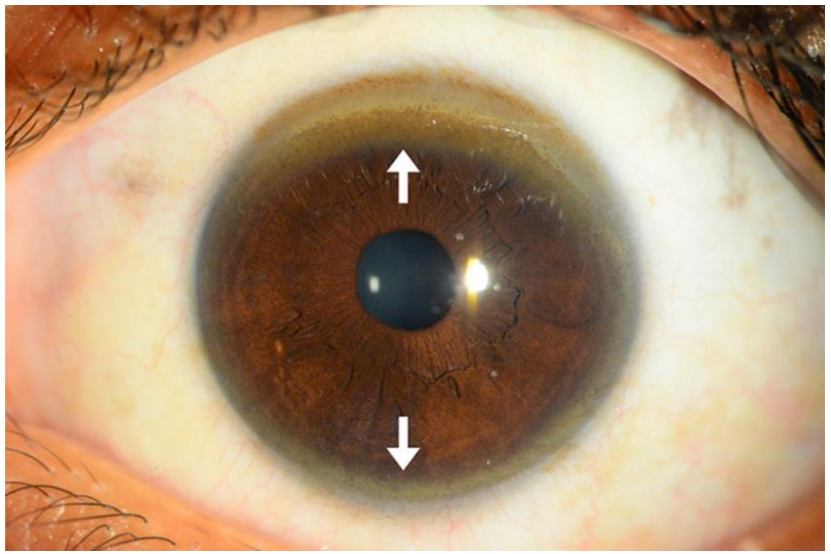


5. Descemets membrane/ Posterior elastic lamina

- Strong homogenous basement membrane of endothelium
- Contains collagen and glycoproteins (lattice work of collagen fibrils)
- Peripherally ends at anterior limit of trabecular meshwork as Schwalbe’s line
- Posteriorly attached with hemidesmosomes
- Can regenerate
- Normally in the state of tension but when torn, curls inward on itself
- Very resistant to chemical agents, trauma and pathological processes

∴ Descemetocele maintains integrity of eyeball for long

Descemetocele



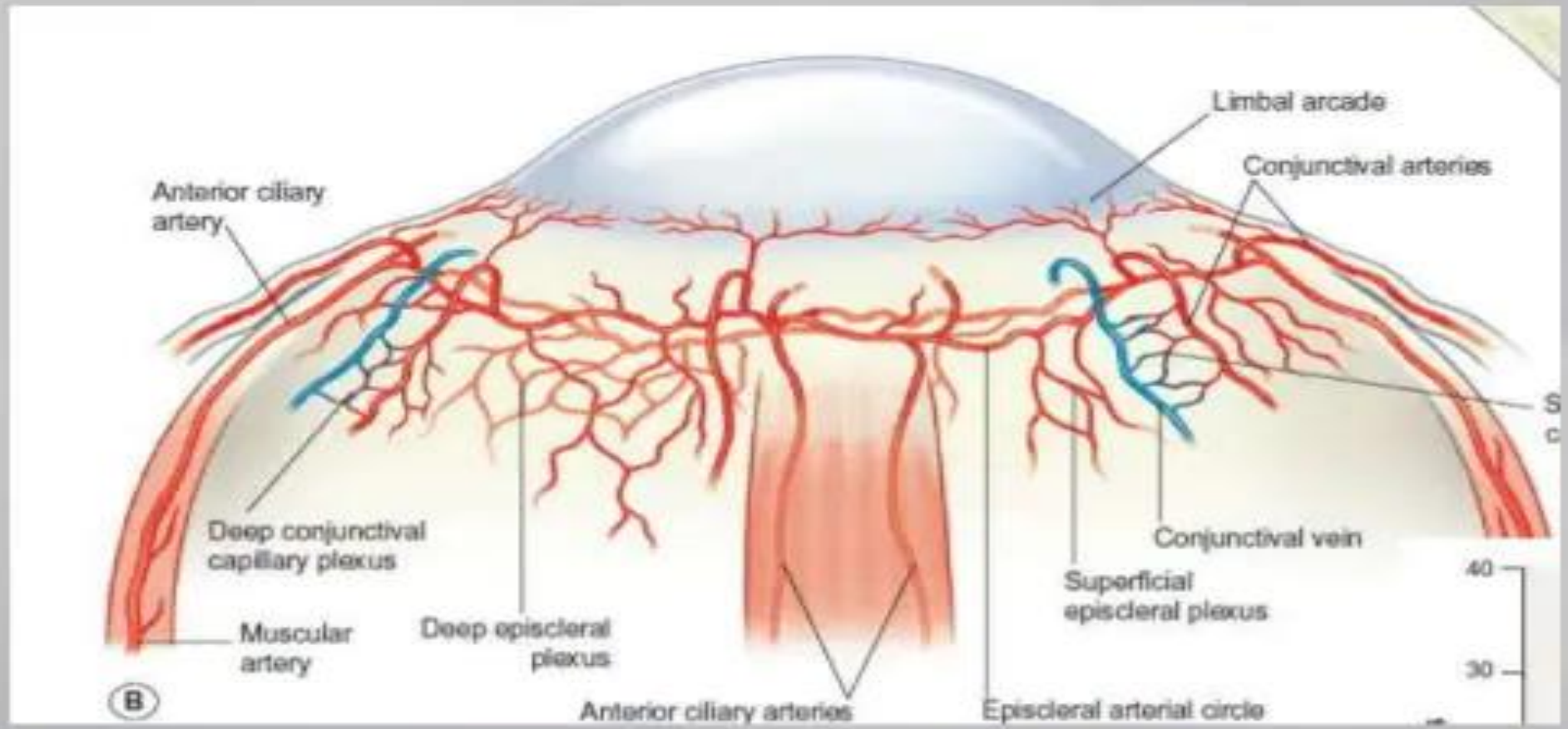
Kayser-Fleischer Ring

- Wilsons Disease

6. Corneal endothelium:

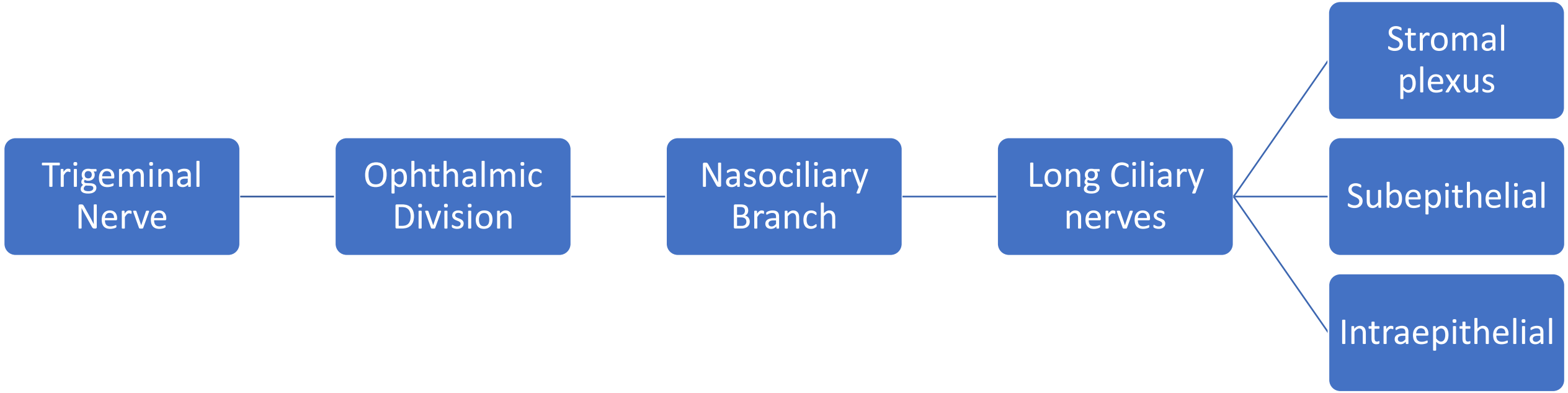
- Single layer of flat polygonal epithelial cells
- 3000 cells/mm^2 in young adults and decrease with advancing age (6000 at birth)
- Compensated by migration and enlargement of migratory cell
- Corneal decompensation after >75% cells are lost
- Active pump mechanism (Na^+/K^+ ATPase pump, Bicarbonate dependent ATPase) keep cornea in relative state of dehydration ∴ transparency of cornea

Blood supply to the cornea



Nerve Supply

- Has body's highest number of nerve endings.



Physiology

- 2 major functions:
  - ➢ As a major refracting medium
  - ➢ Protects the intraocular contents

- Corneal Transparency:
  - i. Anatomical Factors
  - o Avascularity
  - o Arrangement of corneal lamella (parallel , crisscross)
  - o Minimum variation of RI in corneal lamellae
  - o Homogenecity of RI throughout epithelium and tear film

ii. Physiological Factors : Relative state of dehydration of cornea

- Barrier function of limiting layers
- Endothelial pumps
- Surface evaporation
- Normal IOP
- Swelling pressure of stroma
- Corneal crystallins/ water soluble proteins of keratocytes

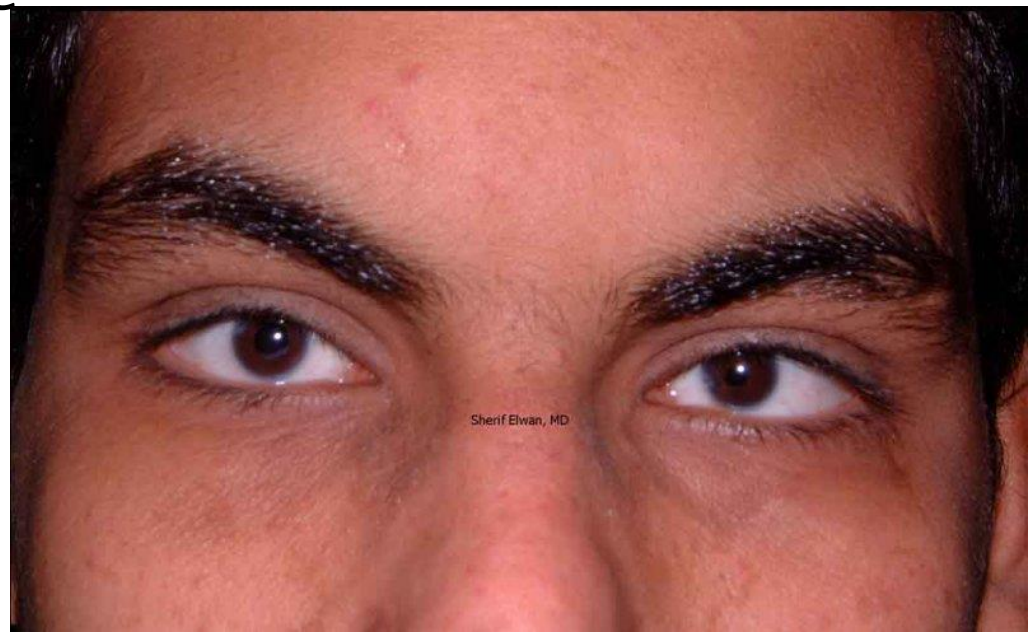
❑Corneal Metabolism:

- Epithelium and endothelium
- For Solutes and for Oxygen

Examination of Cornea

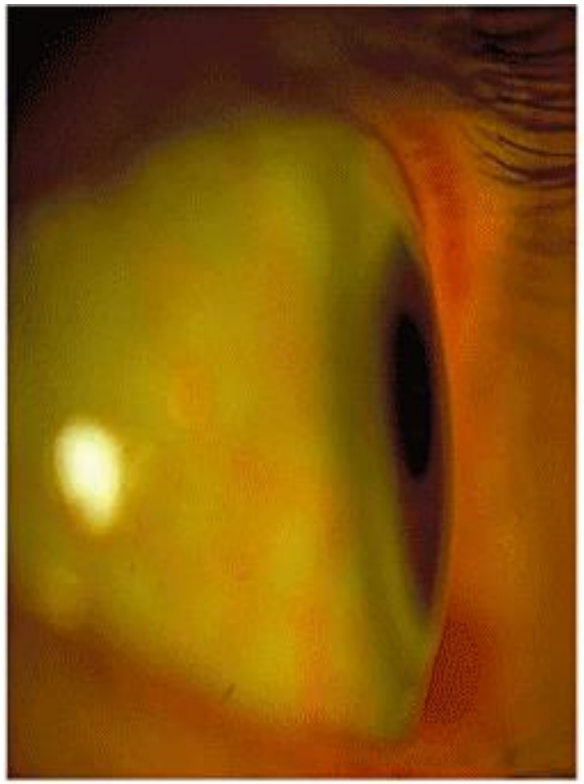
- Done through Slit lamp biomicroscopy or loupe & lens examination

1. Size : Horizontal diameter of Anterior surface
   - Microcornea: <10 mm Eg: Congenital microcornea with or without microphthalmos, Pthisis bulbi
   - Megalocornea: >13 mm Eg: Buphthalmos

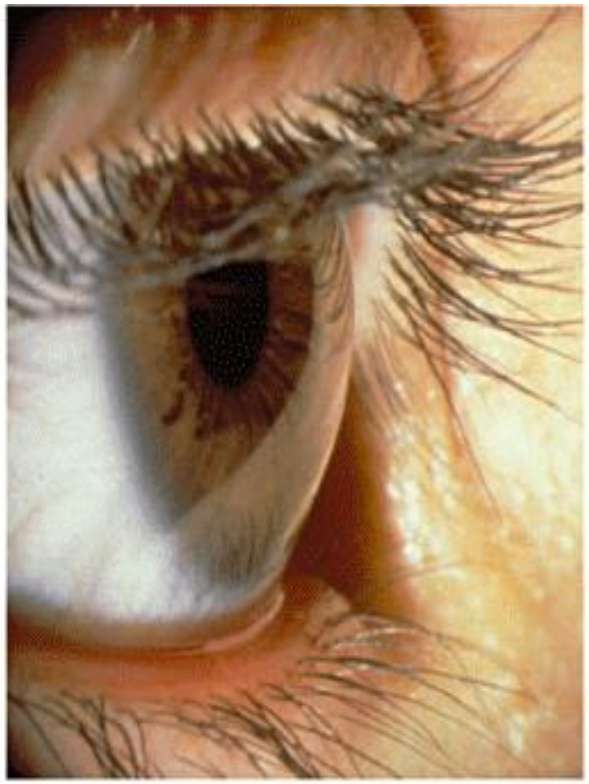


2. Shape: Curvature of Cornea

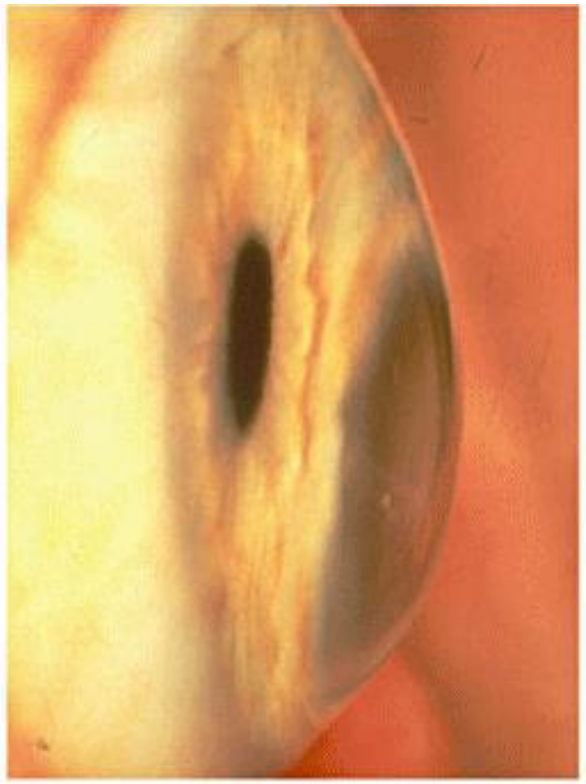
- Keratometry and Corneal topography required
- Keratoglobus: bulged, thin like a globe
- Keratoconus: Cone Shaped
- Cornea Plana: flat cornea as in severe hypotony and Pthisis bulbi



Cornea plana



Normal cornea



Keratoconus

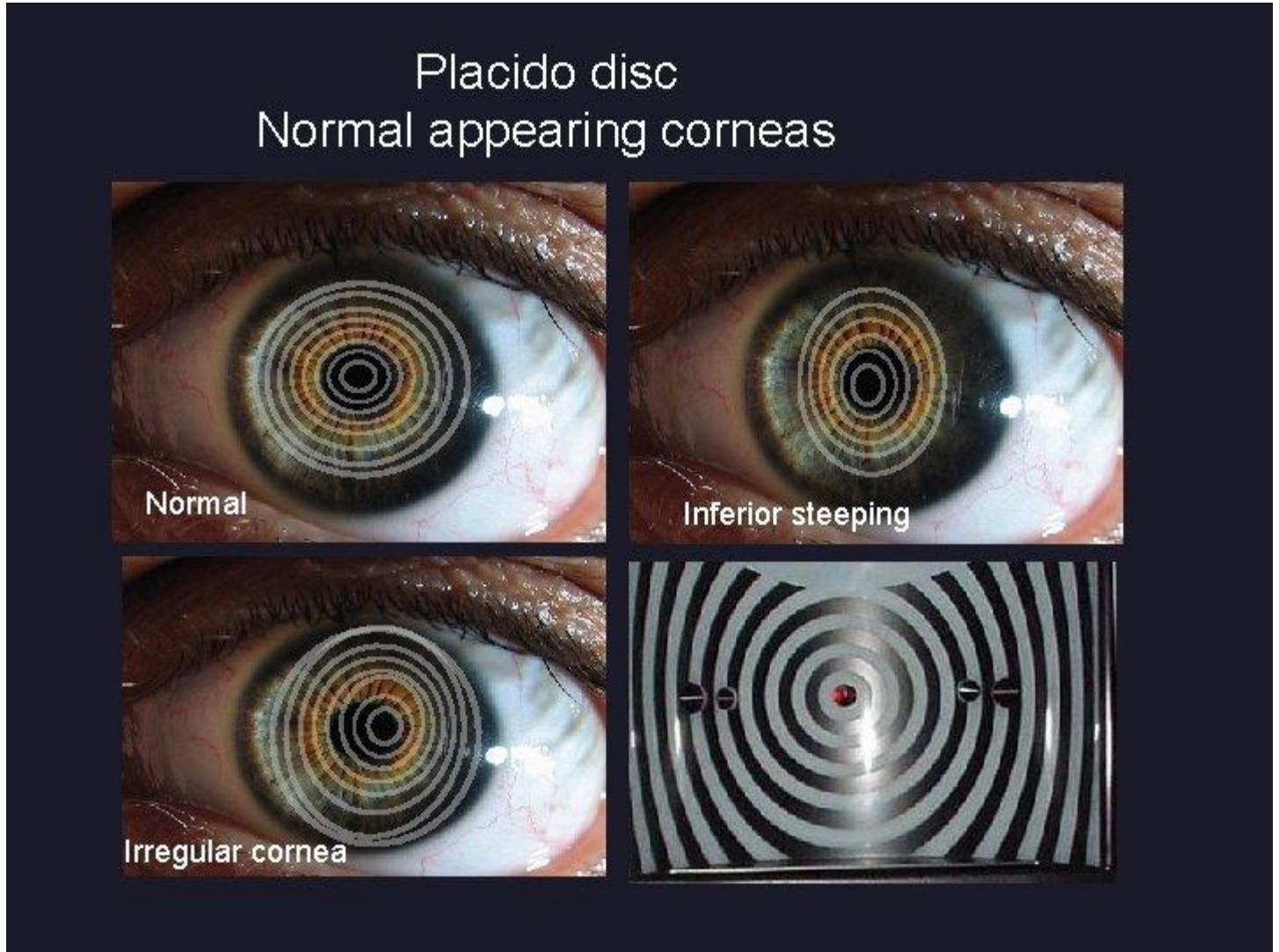
Keratoglobus

Importance of corneal curvature measurement

- To determine Astigmatism
- Fitting Corneal lenses
- IOL power calculation
- Monitor Keratoconus and Keratoglobus progression

3. Surface : Normally smooth

- Disturbed due to abrasions, ulceration, ectatic scar and facets
- Detected through Slit lamp biomicroscopy, Window reflex test and Placido keratoscopic disc

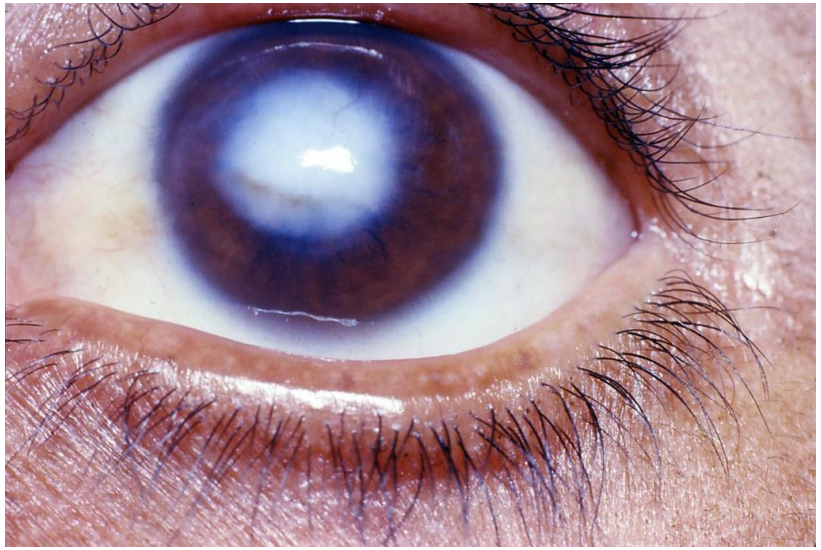


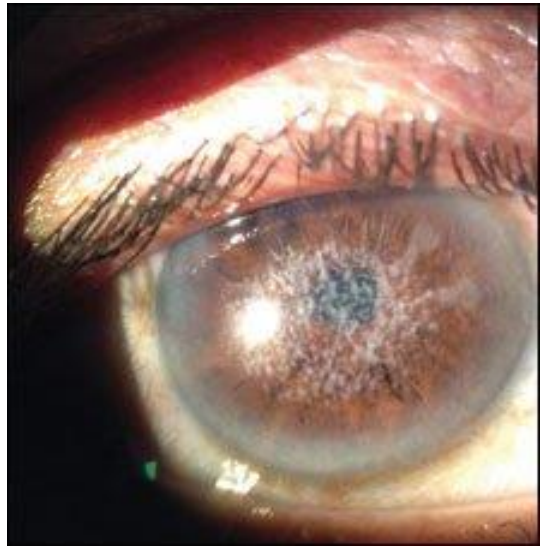
4. Sheen : Bright shine of cornea

- Lost in dry eye
- Loss of Sharpness of outline of images of circle in placido disc test

5. Transparency:

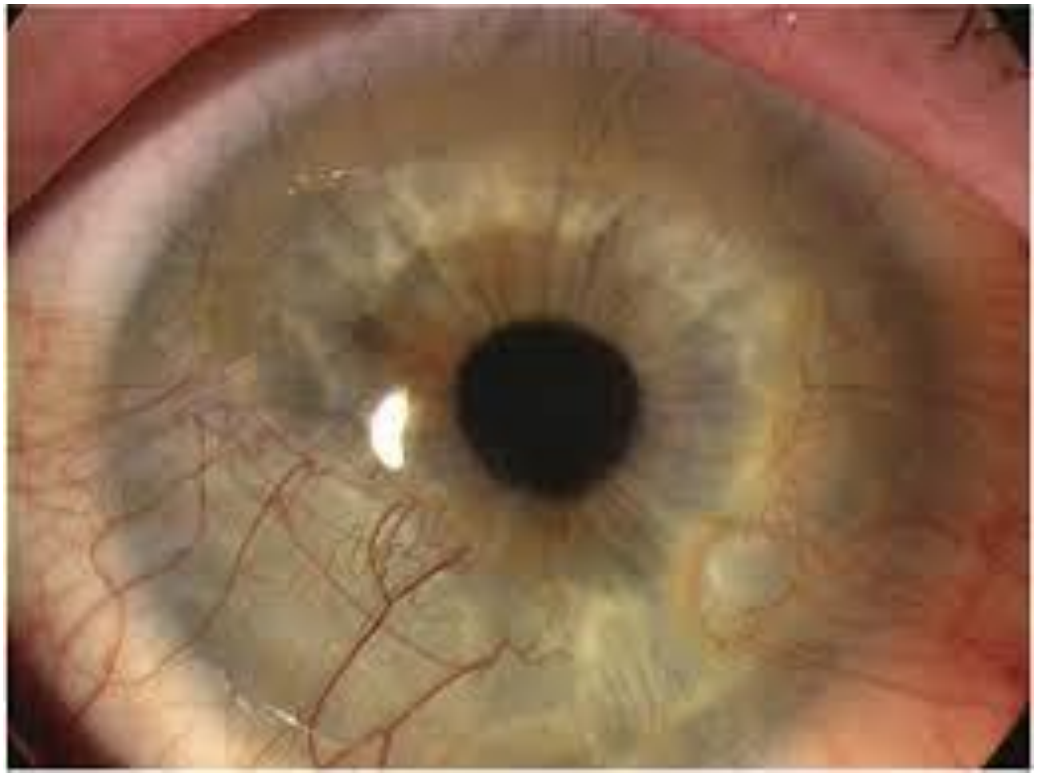
- Lost in corneal edema, opacity, ulcerations, Dystrophies, Vascularization, Degeneration and deposits in cornea

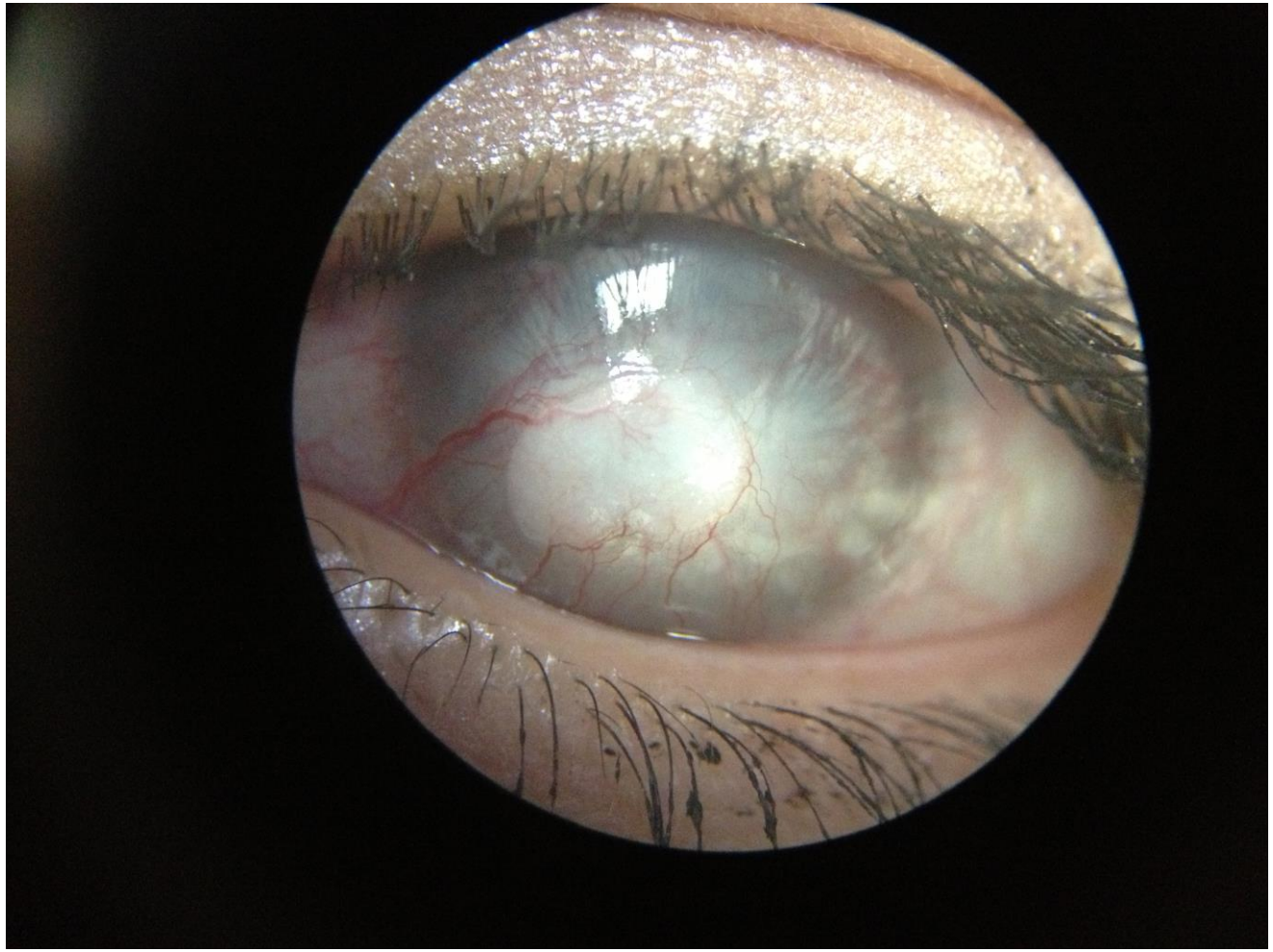




6. Corneal Vascularization :

- Note the position, distribution (localized, generalized or peripheral)
- Superficial or Deep





7. Corneal Sensations:

- Diminished in Herpetic keratitis, neuroparalytic keratitis, Leprosy, DM, etc.
- Color : the lighter, the sensitive
- Test: Cotton Wick test
- Compare with other side
- Exact quantitative measurement with aesthesiometer

8. Back of cornea: for Keratitic precipitates

- Slit lamp (Sign of anterior uveitis)

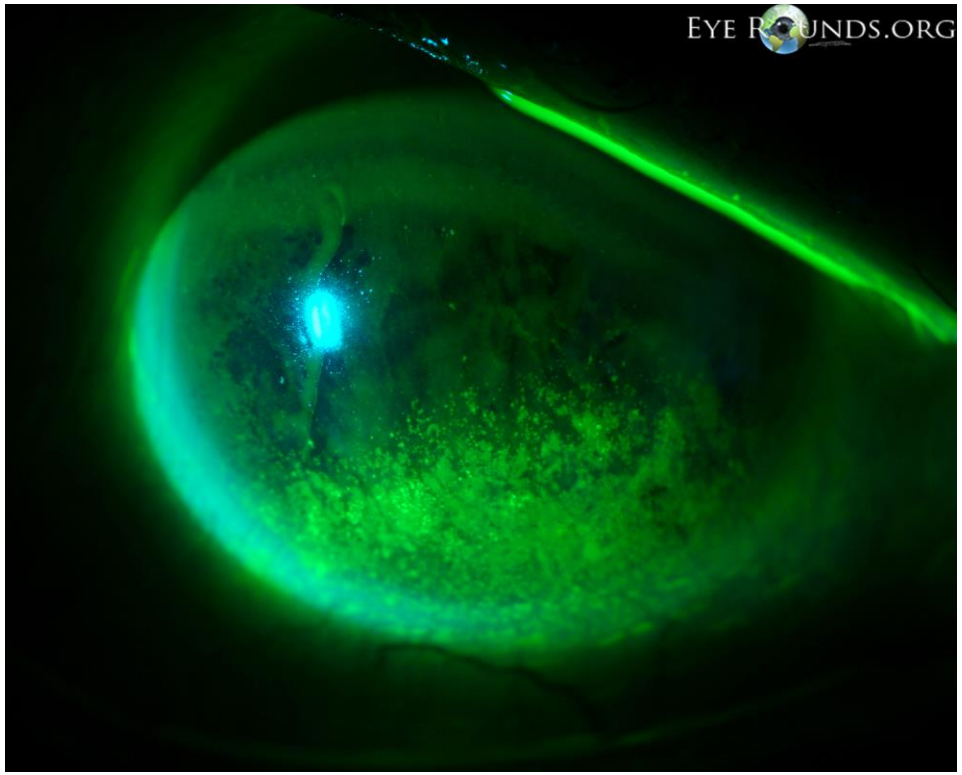
9. Corneal Endothelium Examination: to measure the cell density

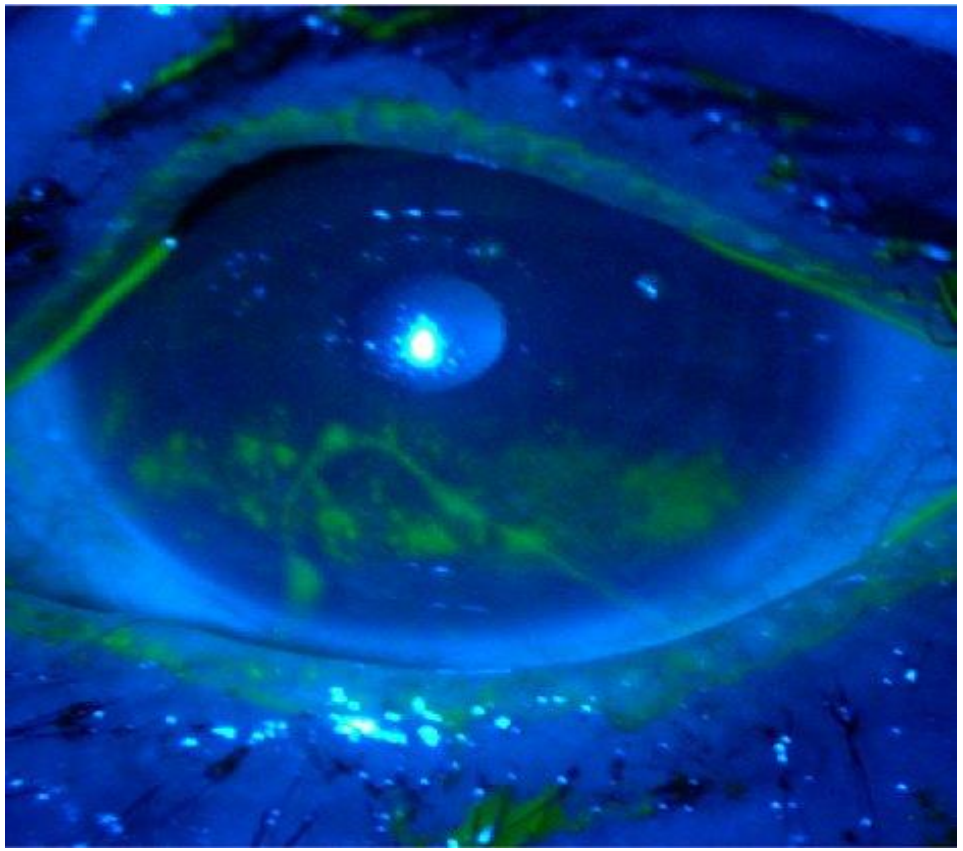
- Done with Specular microscope
- Fuschs' Corneal Dystrophy

Average Cell Densities by Age[3]	
Age	Average CD (cells/mm^2)
10-19	2,900-3,500
20-29	2,600-3,400
30-39	2,400-3,200
40-49	2,300-3,100
50-59	2,100-2,900
60-69	2,000-2,800
70-79	1,800-2,600
80-89	1,500-2,300

Biomicroscopic examination with Staining

I. Fluorescein Staining

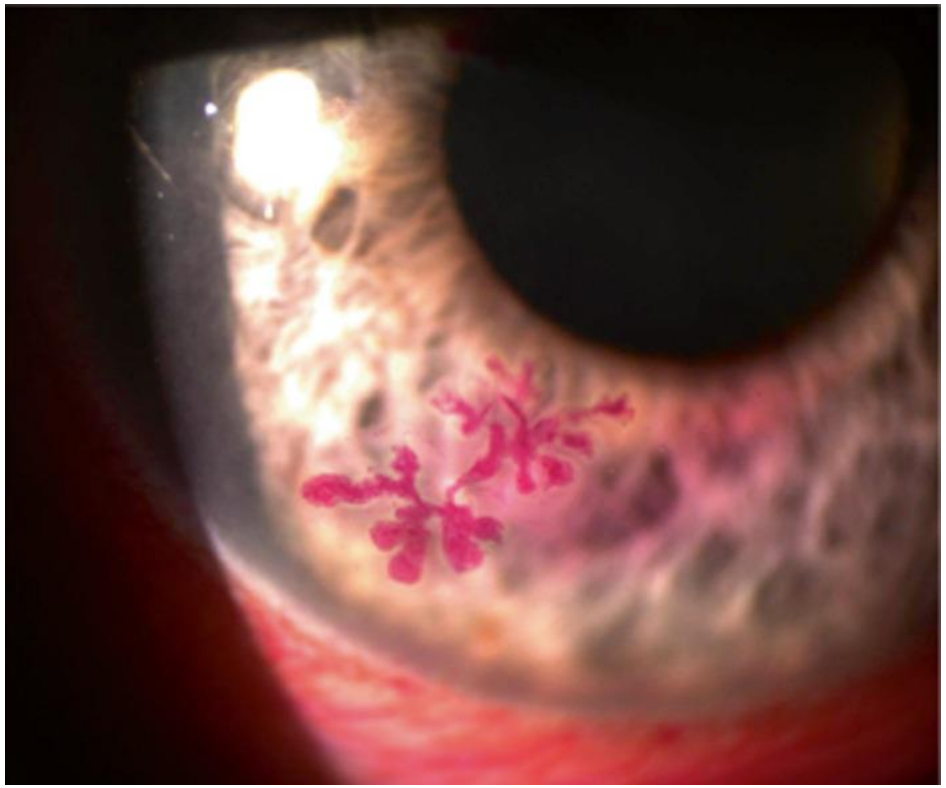




Punctate Epithelial Erosions

II. Rose Bengal Staining: 1%

- Under 2% xylocaine
- Superficial punctate keratitis and filamentary keratitis
- Wash thoroughly to avoid phytotoxicity



III. Alcian blue:

- Stains Excess mucous selectively
- Keratoconjunctivitis sicca, macular dystrophy of cornea


THANK YOU FOR YOUR KIND
ATTENTION !!!