

The background features abstract, flowing waves in shades of red, orange, and yellow, creating a dynamic and vibrant visual effect. The waves are layered and curved, giving a sense of movement and depth.

PHYSIOLOGY OF CORNEA

GROSS ANATOMY

- Cornea is highly transparent structure.
- Form ant.1/6th of the globe.
- Almost avascular & devoid of lymphatics.
- Appears watch glass.
- It gives maximum dioptric power of the eye.

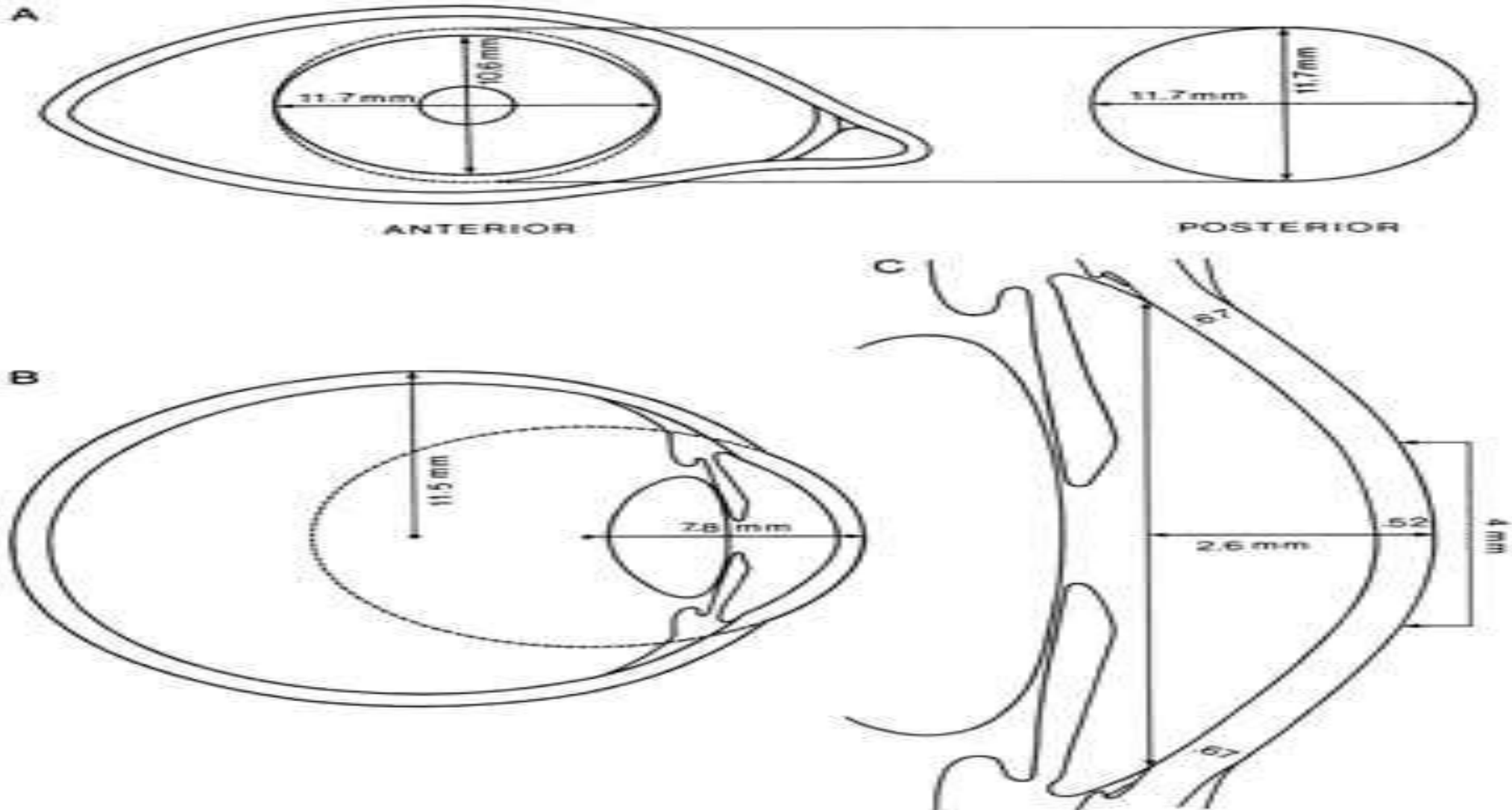
FUNCTIONS

- ✓ Maintain structural integrity of the eye.
- ✓ Allows light to enter inside the eye.
- ✓ Refraction.
- ✓ Protect the eye from infective organisms, noxious substances and ultra-violet rays.

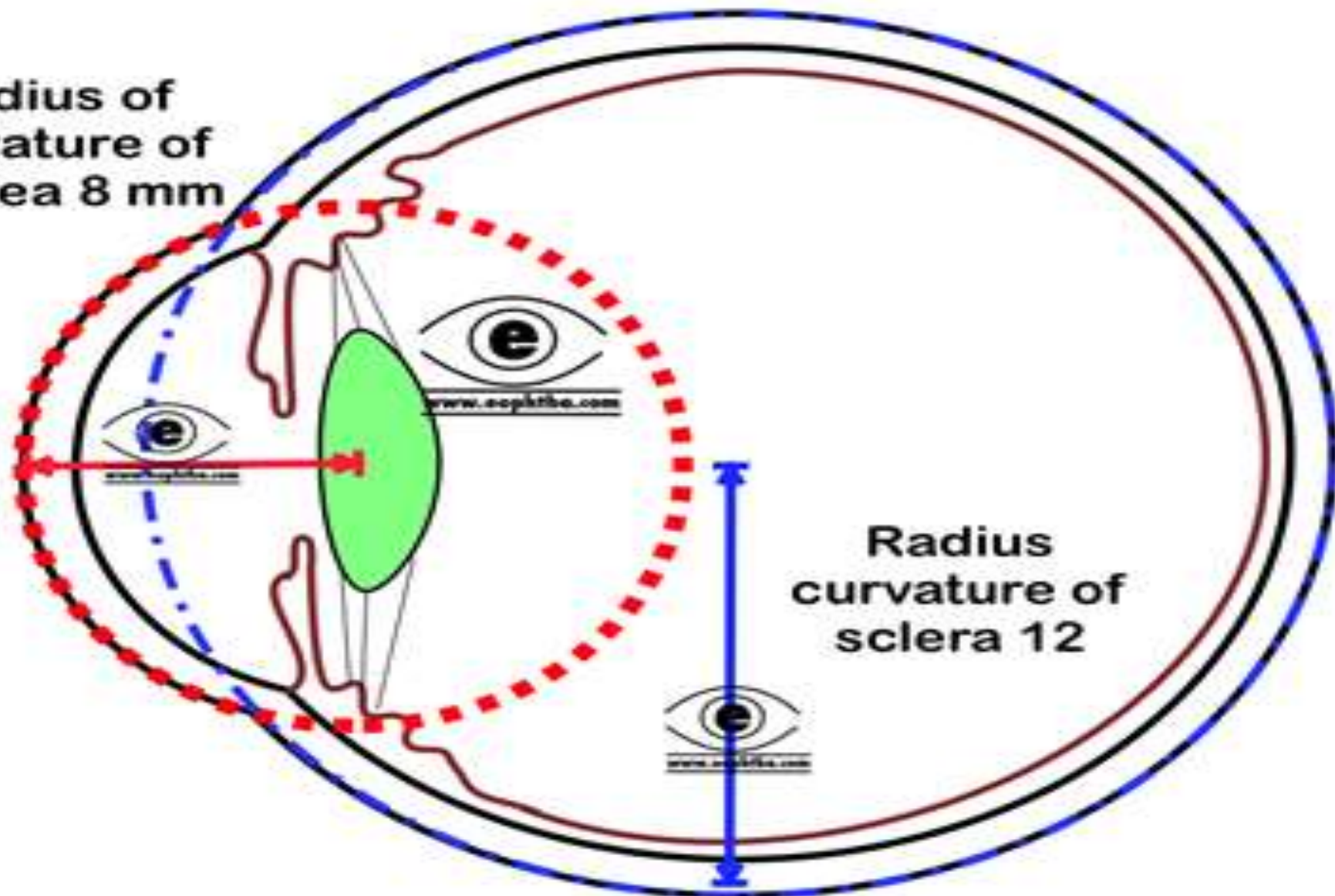
TOPOGRAPHY

- Ant. Surface –elliptical.
- Post. Surface—spherical.
- Horizontal diameter of ant. Surface—11.7mm.
- VD of ant. Surface—10.6mm.
- Diameter of post. Surface—11.7mm(ant & post)
- Radius of curvature of cornea –8 mm & that of post. Surf. Is 6.5mm in adult.

CORNEAL DIAMETER



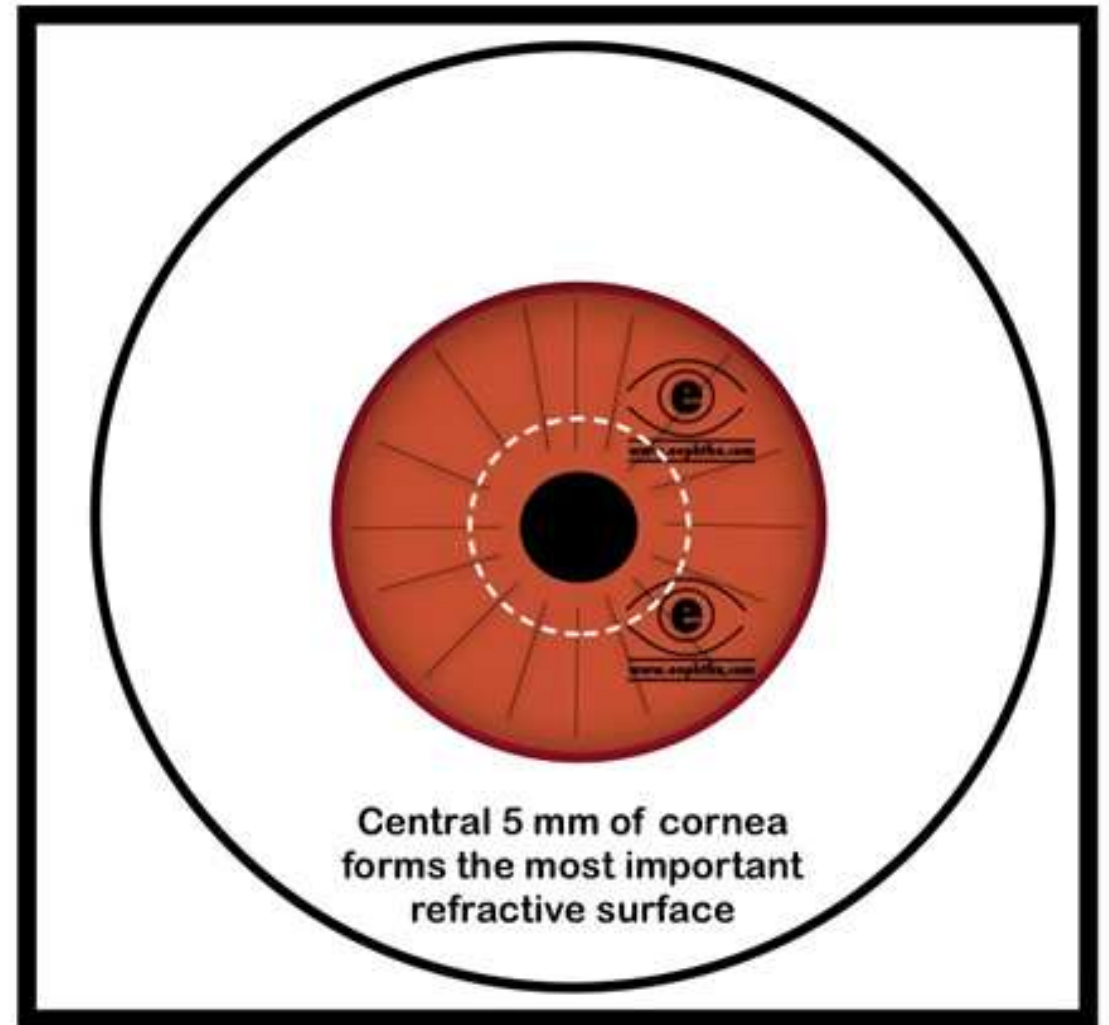
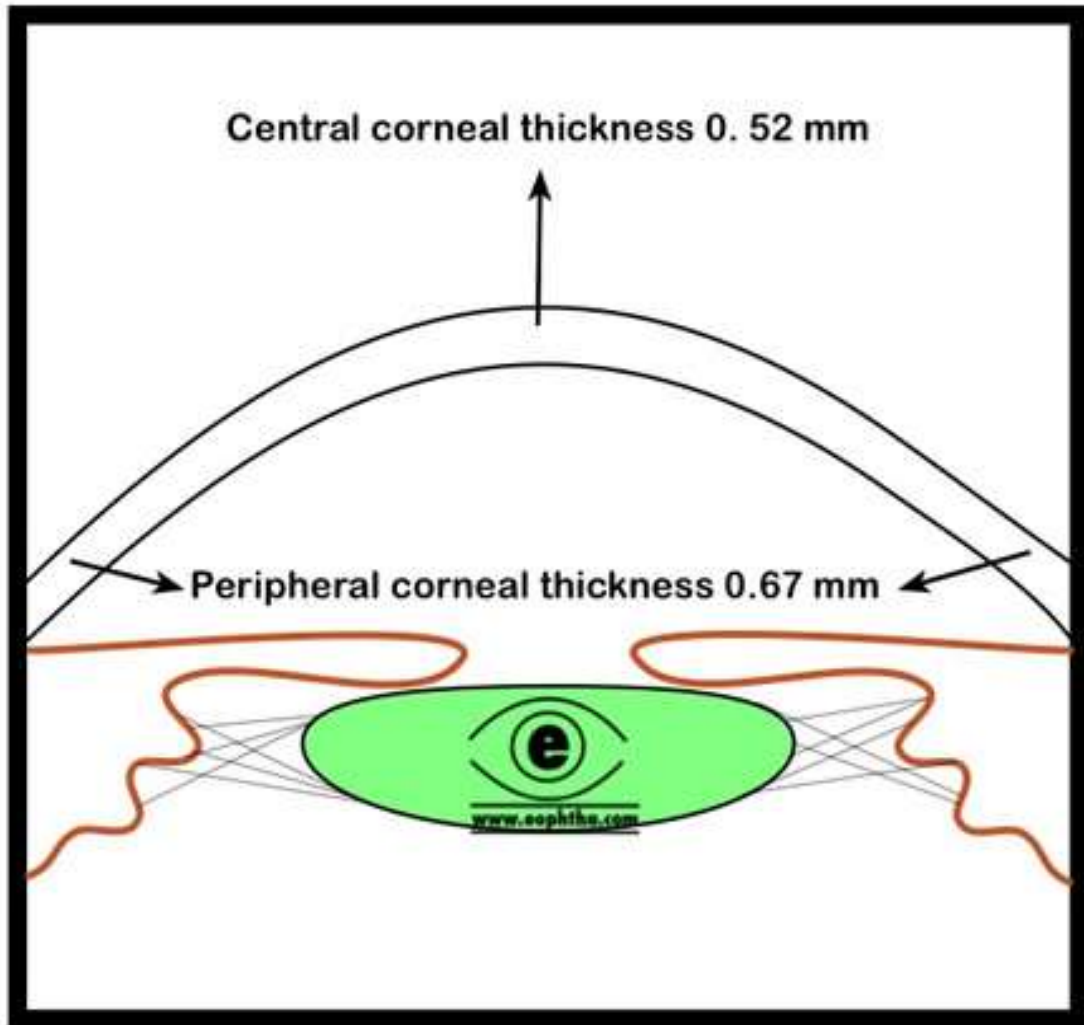
Radius of
curvature of
cornea 8 mm



Radius
curvature of
sclera 12

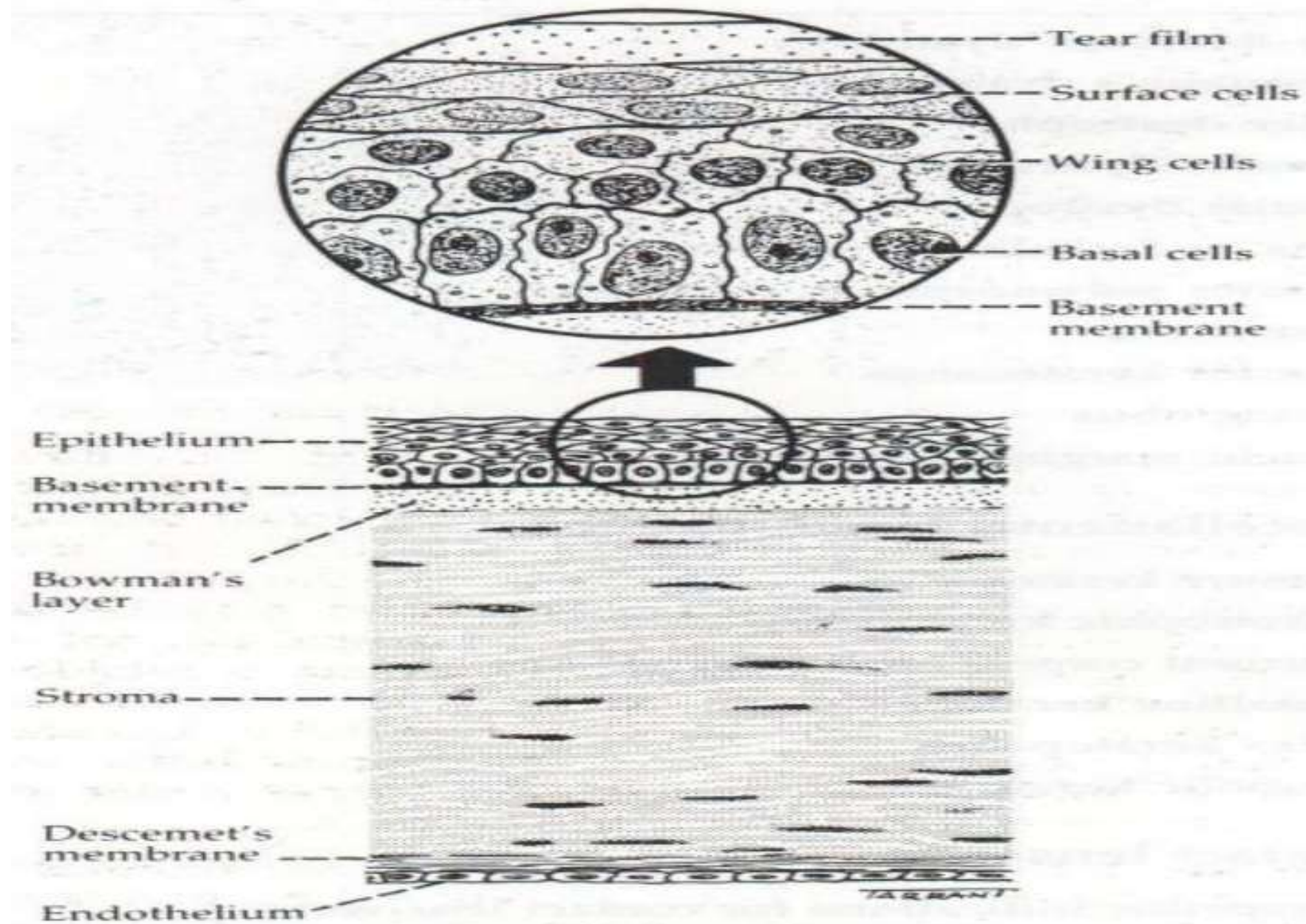
CONTD..(TOPOGRAPHY)

- Central corneal thickness—0.52mm.
- Peripheral corneal thickness—0.67mm.
- The central 5mm of the cornea forms the most powerful refractive surface of eye.
- The refractive power of the cornea ---+43D.
- The refractive index of cornea -1.376.



HISTOLOGY

- ✓ Cornea consists of 5 layers from superficial to deep--
 1. Epithelium.
 2. Bowmans membrane.
 3. Stroma.
 4. Descemet's membrane.
 5. Endothelium.

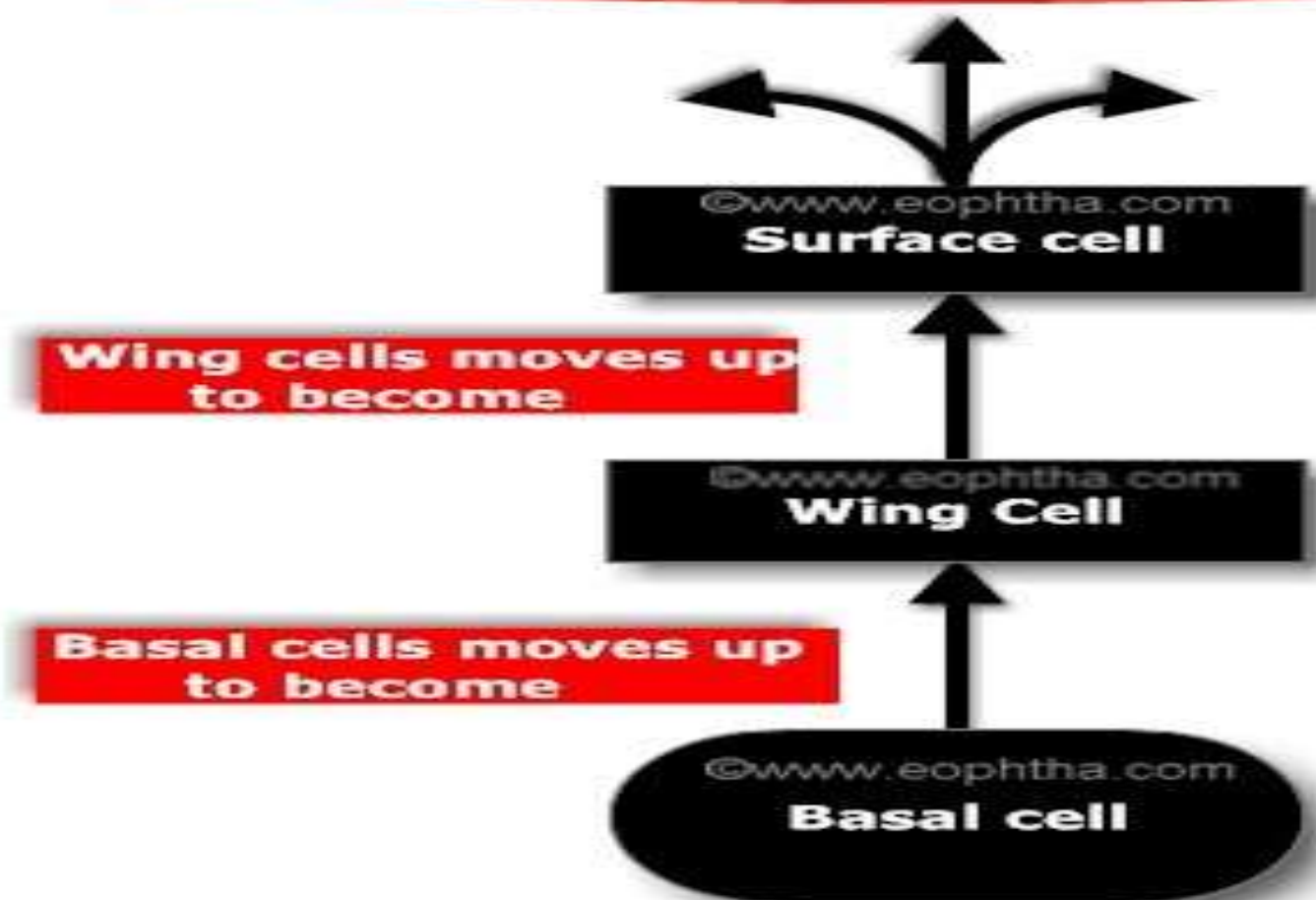


CORNEAL EPITHELIUM

- ❖ Non-keratinized stratified sq. epithelium.
- ❖ Resting on basal lamina.
- ❖ Consists of 5-6 layers.
 - a) Single layer of columner cells.
 - b) 2-3layers of wing cells.
 - c) 2 layers of sq. cells.
- ❖ Thickness is 50 micrometer.

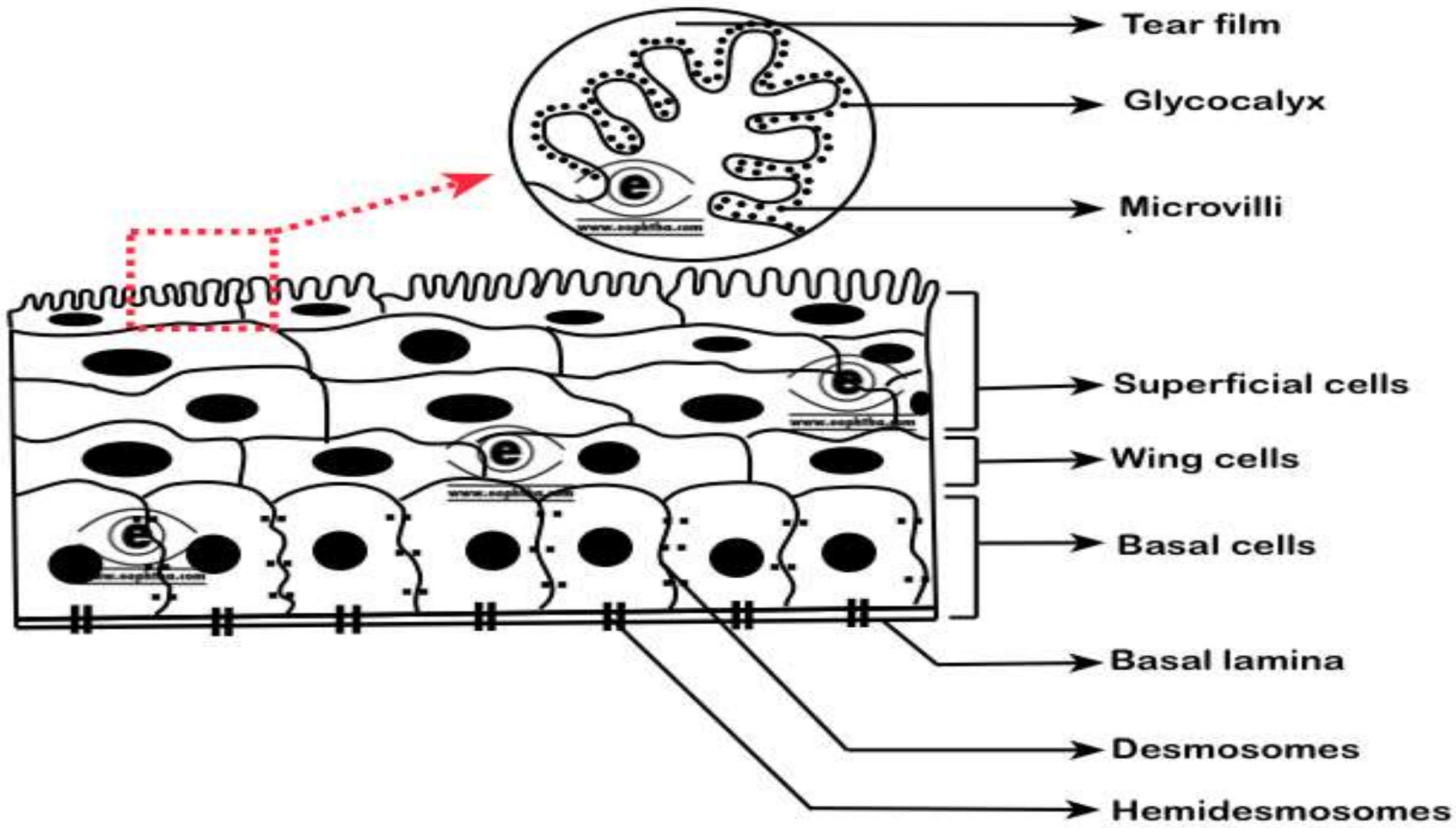
Aged surface cells lose their attachments and sloughed off into the tear film

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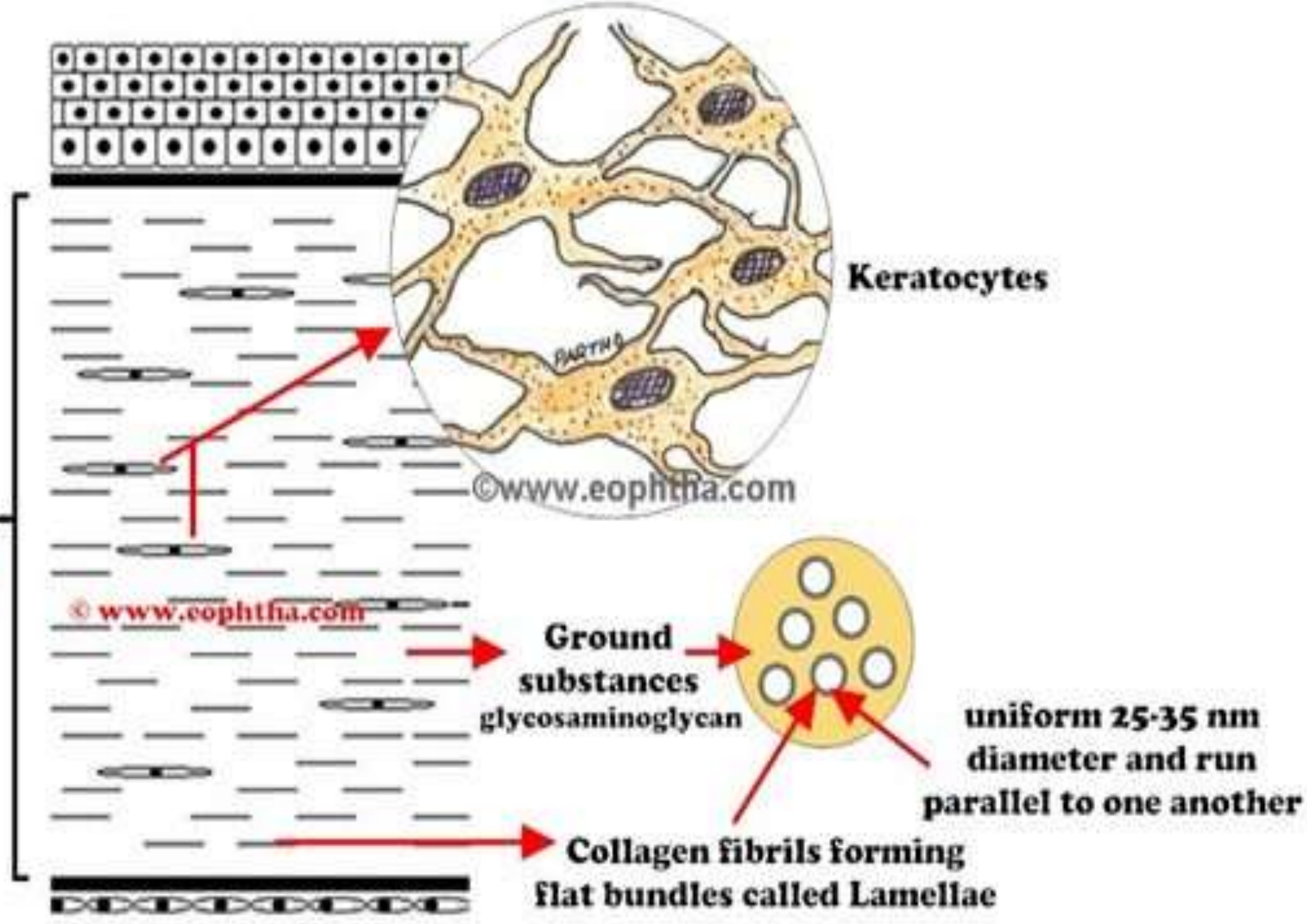


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only the cells adjacent to basement membrane can divide & proliferate. The sources of this renewal is stem cells located 0.5 to 1 mm wide band around corneal periphery.



Corneal Stroma
Occupies about 90%
of the total corneal
thickness



Keratocytes

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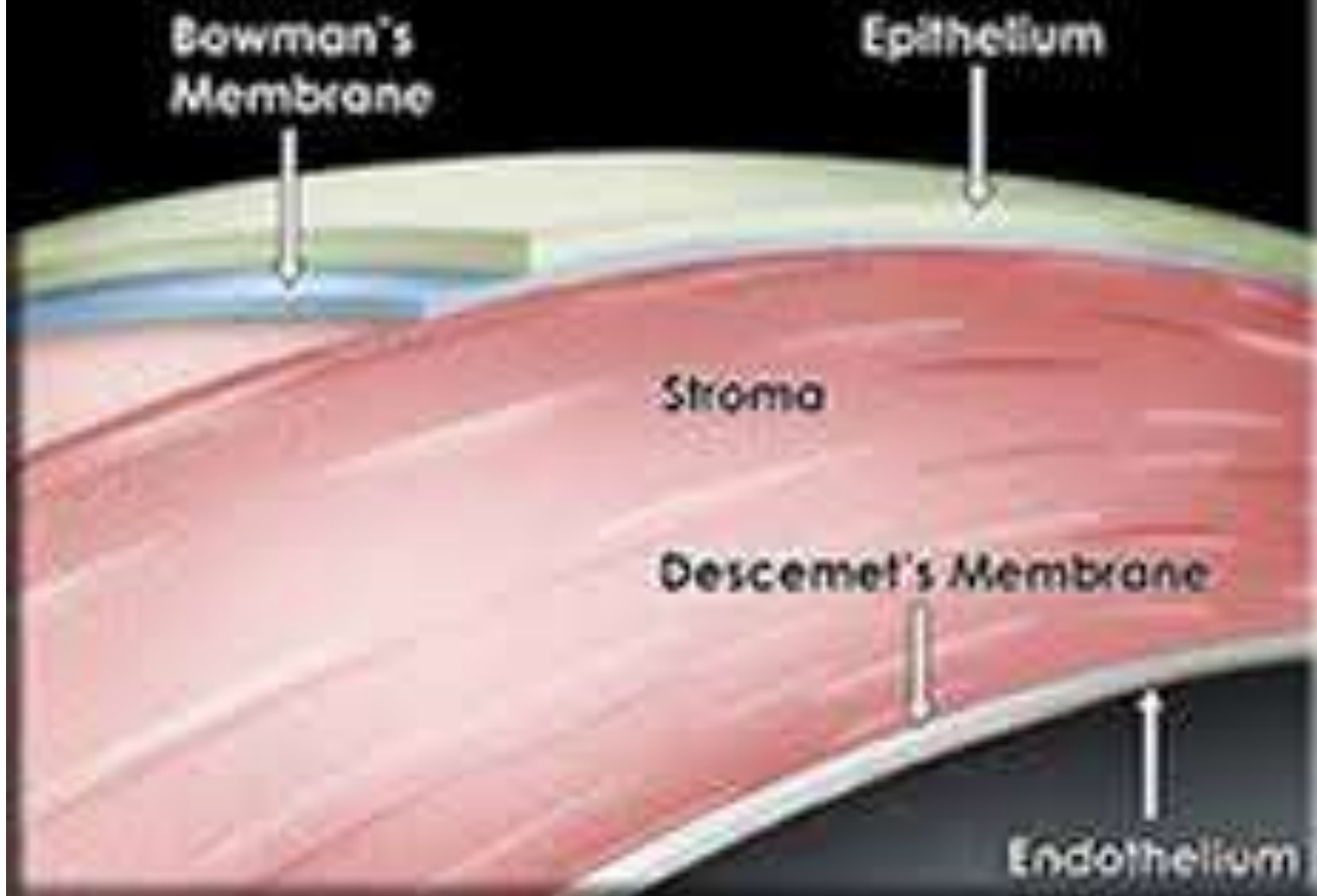
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Ground substances
glycosaminoglycan

uniform 25-35 nm diameter and run parallel to one another

Collagen fibrils forming flat bundles called Lamellae

Cornea



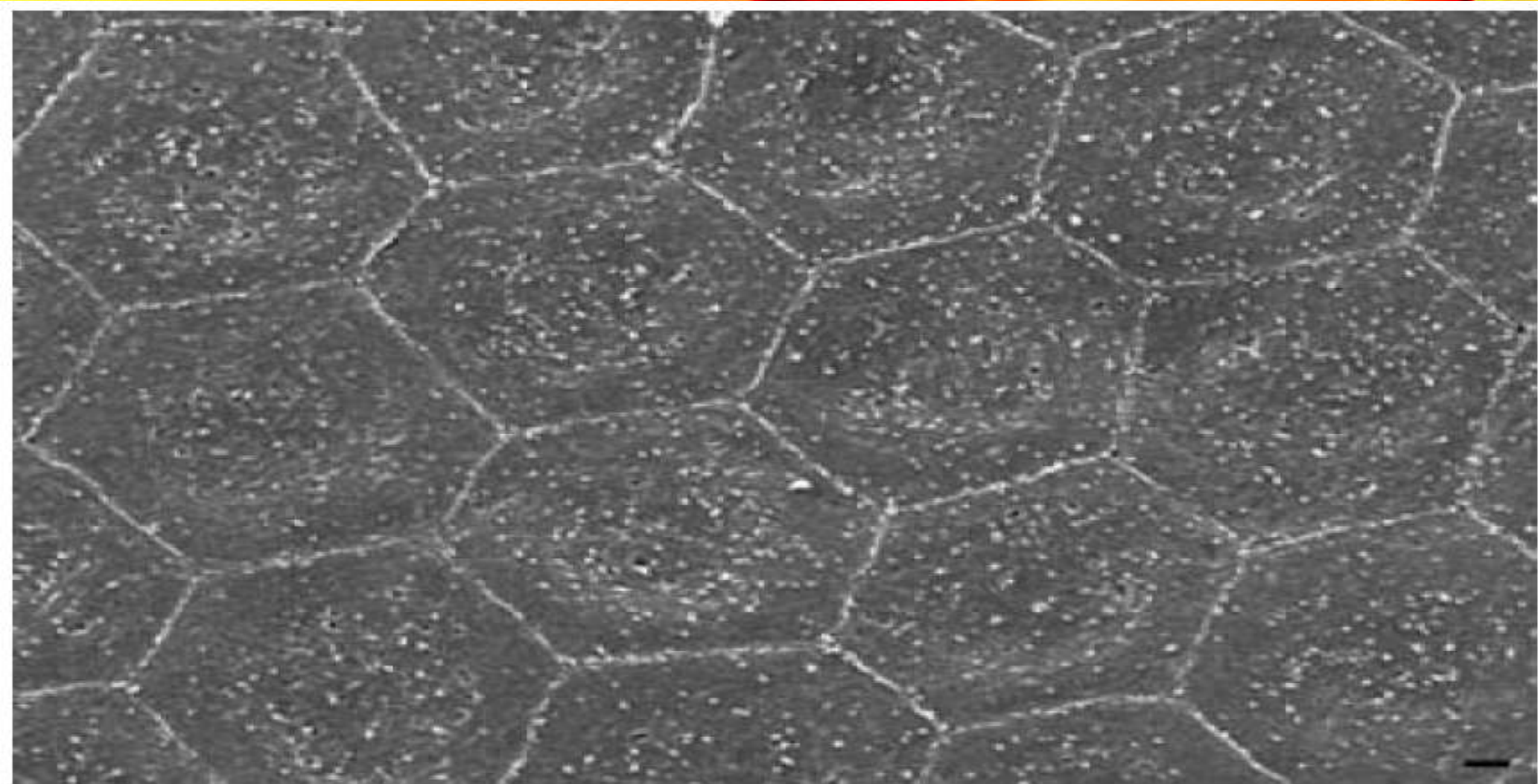


Figure 1 - Scanning electron micrograph of normal corneal endothelium of ostrich, showing polygonal cells of uniform in size and shape. The predominant number of cells are hexagonal. x 750; Bar = 10 μ m.

Corneal endothelial density



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Newborn 3000-4000 cells/mm²

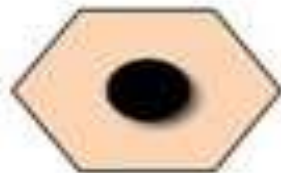
Adult 2500 cells/mm²

Old age 2000 cells/mm²

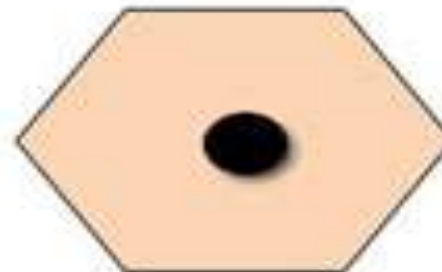
The gap left by the dying cells is filled by the enlargement of the remaining cells, which is known as Polymegathism

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18-20µ in early life



40µ or more in aged

BIOCHEMICAL COMPOSITION

- EPITHELIUM
 - Water 70%
 - Protein
 - Lipid-phospholipid & cholesterol.
 - Enzymes.
- STROMA
 - Water 75-80%
 - Solids 20-25%

BIOCHEMICAL COMPOSITION OF STROMA

| Substances | Percent |
|---------------------|----------------|
| Water | 78 |
| Collagen | 15 |
| Other proteins | 5 |
| Keratan sulfate | 0.7 |
| Chondroitin sulfate | 0.3 |
| salts | 1 |

DESCEMET'S MEMBRANE

- Consists of collagen 73% & glycoproteins.
- High cont of hydroxyproline, glycine & hydroxyglycine.
- Does not contain GAG.
- Collagen is insoluble except in strong acid or alkali.
- Extremely resistant to chemical & enzymes.

ELECTROLYTES(Mmol/L)

| Trait | Na ⁺ | K ⁺ | Cl ⁻ |
|-------------------|-----------------|----------------|-----------------|
| Tear Film | 150 | 17 | 131 |
| Epithelium | 75 | 140 | 30 |
| Stroma | 170 | 21 | 108 |
| Aqueous | 142 | 5.2 | 108 |

HOW CORNEA GETS NUTRITION

Mainly from 3 sources---

- Aqueous humor
- Pre corneal tear film.
- Perilimbal vessels

CORNEAL METABOLISM

- Cornea requires energy for normal metabolic activities as well as for maintaining transparency and dehydration
- Energy is generated by the breakdown of glucose in the form of ATP
- Most actively metabolizing layers are epithelium & endothelium

METABOLIC PATHWAYS

➤ Three processes or pathways –

1. Glycolytic pathway: (Embden-Myerhof pathway)

✓ glucose converted to pyruvic acid yielding 2 ATP

a) Glucose primarily metabolized by anaerobic glycolysis - under hypoxic condition pyruvate converted to lactate.

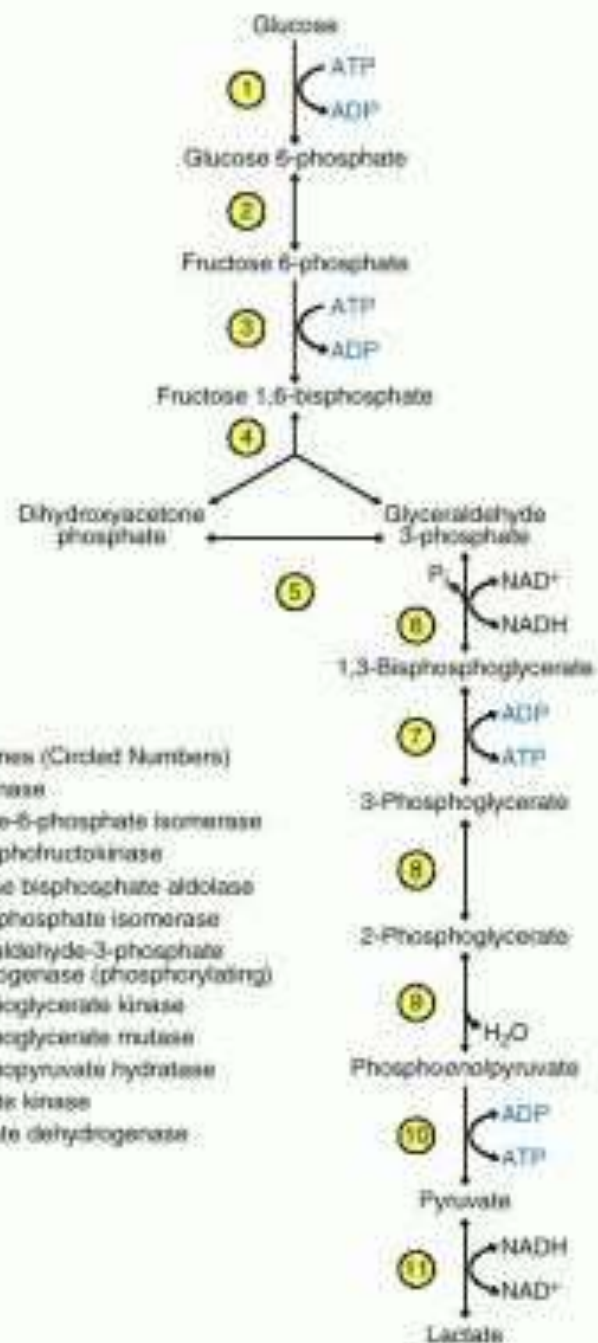
b) Under aerobic condition pyruvate from glycolysis can enter the kreb's cycle and yields 36 ATP, water & CO₂

2. HMP shunt:

✓ converts hexoses to pentoses required for nucleic acid synthesis and produces NADPH.

3. SORBITOL PATHWAY:

✓ Glucose may enter this pathway producing sorbitol & fructose.



Key to Enzymes (Circled Numbers)

1. Hexokinase
2. Glucose-6-phosphate isomerase
3. 6-Phosphofructokinase
4. Fructose bisphosphate aldolase
5. Triose-phosphate isomerase
6. Glyceraldehyde-3-phosphate dehydrogenase (phosphorylating)
7. Phosphoglycerate kinase
8. Phosphoglycerate mutase
9. Phosphopyruvate hydratase
10. Pyruvate kinase
11. L-Lactate dehydrogenase

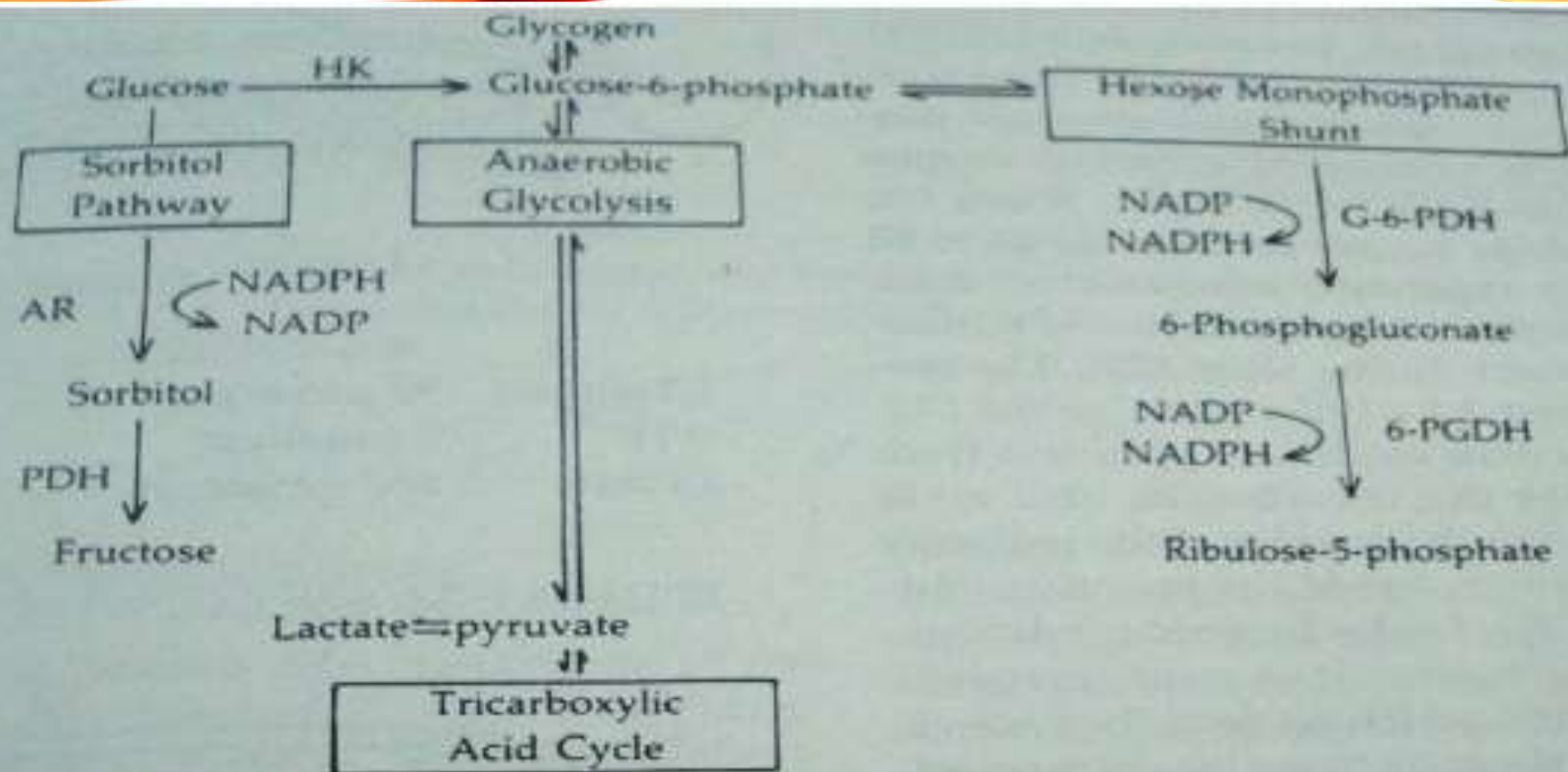
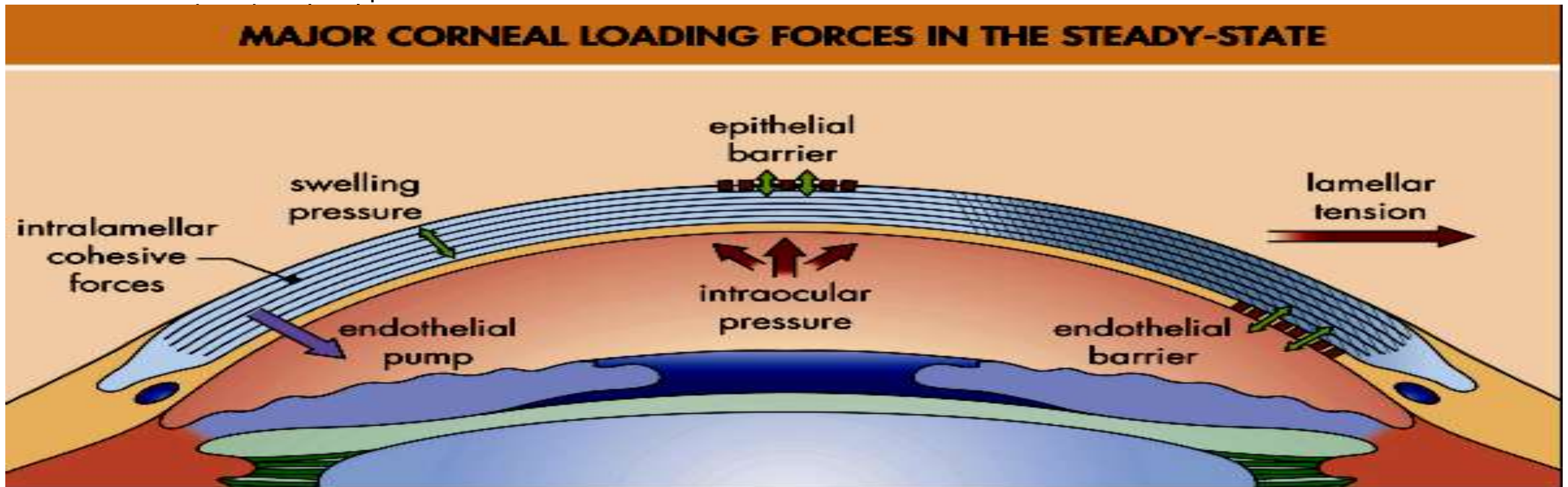


Fig. 2-13. Pathways of glucose metabolism. AR = aldose reductase; ATP = adenosine triphosphate; G-6-PDH = glucose-6-phosphate dehydrogenase; HK = hexokinase; NADP = nicotinamide-adenine dinucleotide phosphate; NADPH = nicotinamide-adenine dinucleotide phosphate, reduced form; PDH = polyol dehydrogenase; 6-PGDH = 6-phosphogluconate dehydrogenase.

CORNEAL HYDRATION

State of relative dehydration that is necessary for corneal transparency. Normal water content of cornea (80%) is kept constant by balance of factors that draw water in cornea (swelling pressure and IOP), factor which prevent flow of water in cornea (epithelial barrier) and that draw water out of cornea

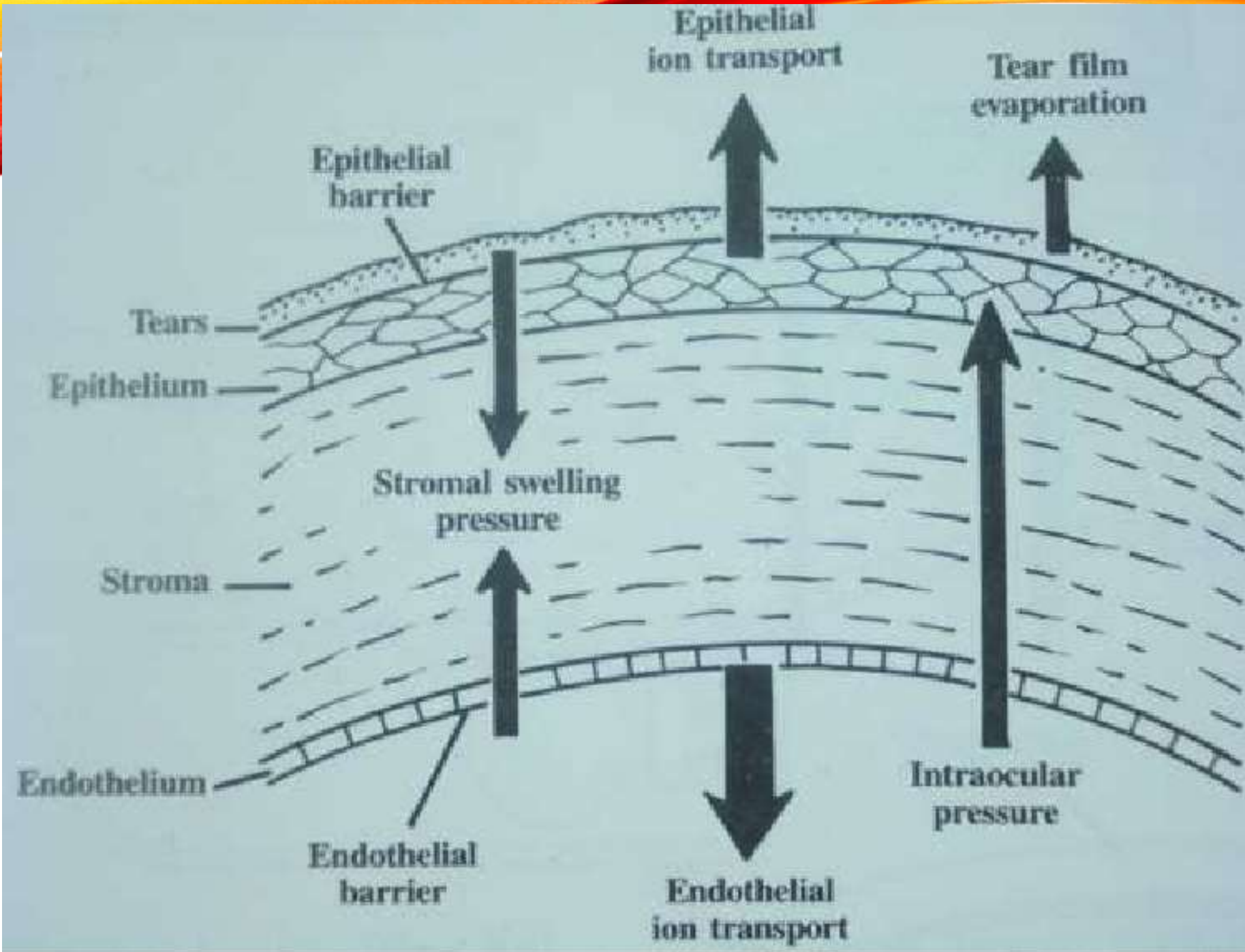


CORNEAL TRANSPARENCY

- Anatomical factors:
 - ✓ Uniform regular arrangement of the epithelium
 - ✓ Absence of blood vessels and
 - ✓ Nonmyelinated fibers
 - ✓ Packed stromal lamellae of uniform size

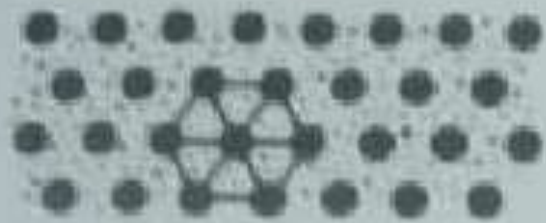
CORNEAL TRANSPARENCY

- Physiological factors:
 - ✓ Stromal swelling pressure
 - ✓ Metabolic pump
 - ✓ Barrier function
 - ✓ Evaporation from corneal surface
 - ✓ Intraocular pressure



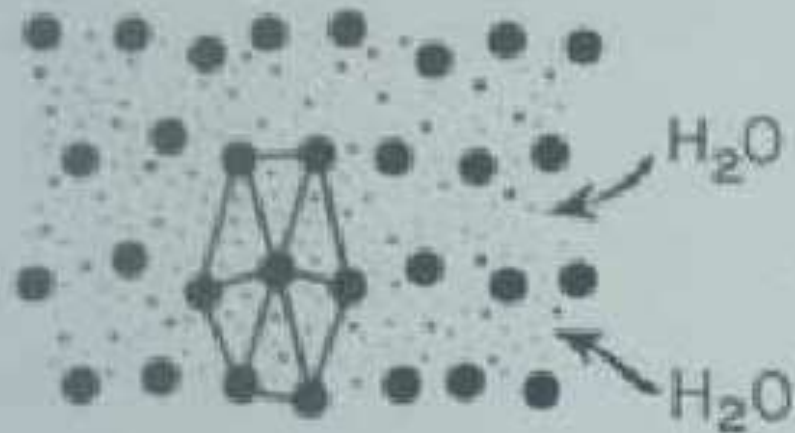
Stromal swelling pressure

- ❖ Negatively charged stromal GAG tend to repel each other producing swelling pressure (SP).
- ❖ 50mmHG exerted by GAGs and collagen of corneal stroma.



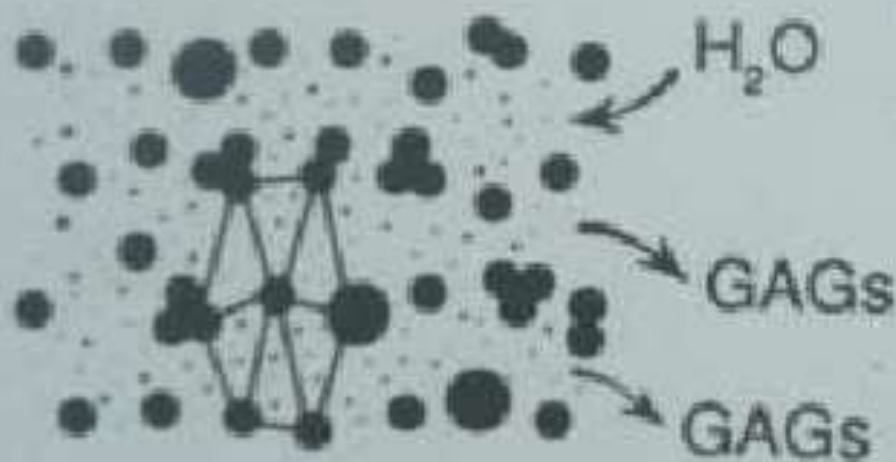
NORMAL CORNEA

- * equal diameter collagen fiber
- * equally distant from each other



SWOLLEN CORNEA

- * distance between collagen fiber increase



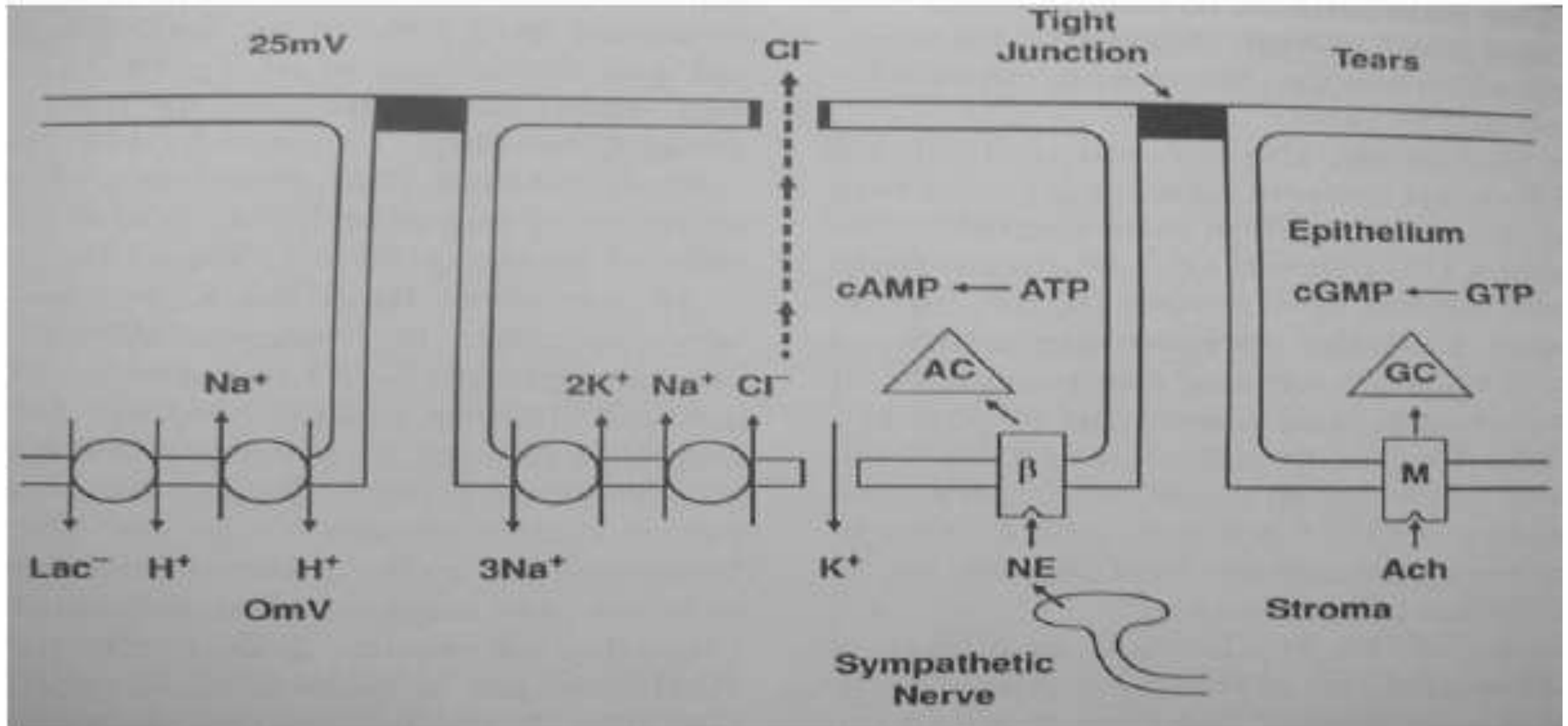
SWOLLEN CORNEA

- * distance between collagen fiber increase
- * collagen fiber aggregation occurs
- * loss of GAGs occur

Metabolic pump

- In epithelium –
 - ✓ Apical – Cl^- channel
 - ✓ Basal –
 - $\text{Na}^+ - \text{K}^+$ ATPase pump
 - $\text{Na}^+ - \text{H}^+$ transporter (exchange)
 - $\text{H}^+ - \text{Lactate}$ co-transporter
 - $\text{Na}^+ - \text{Cl}^-$ co-transporter

METABOLIC PUMP (EPITHELIUM)



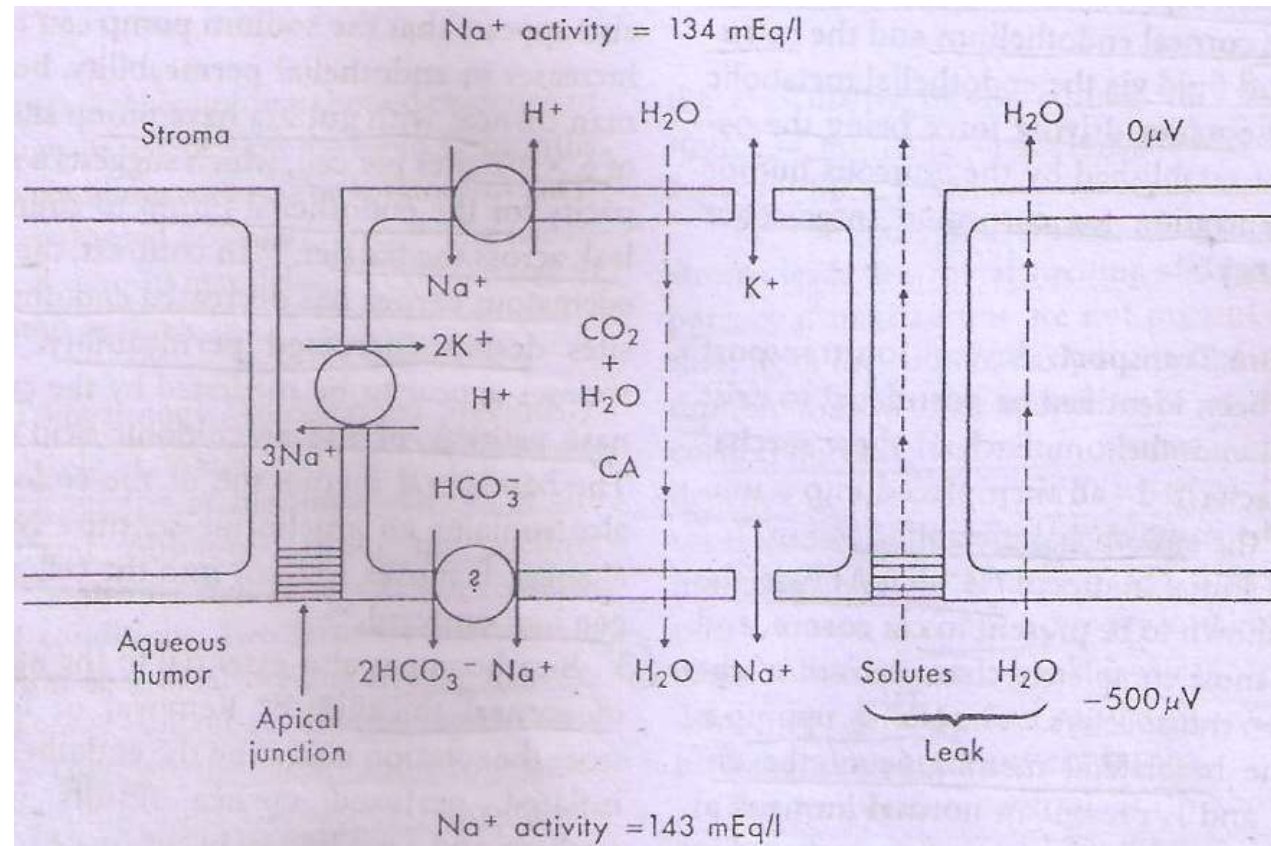
METABOLIC PUMP

➤ Endothelium

✓ Basolateral membrane –

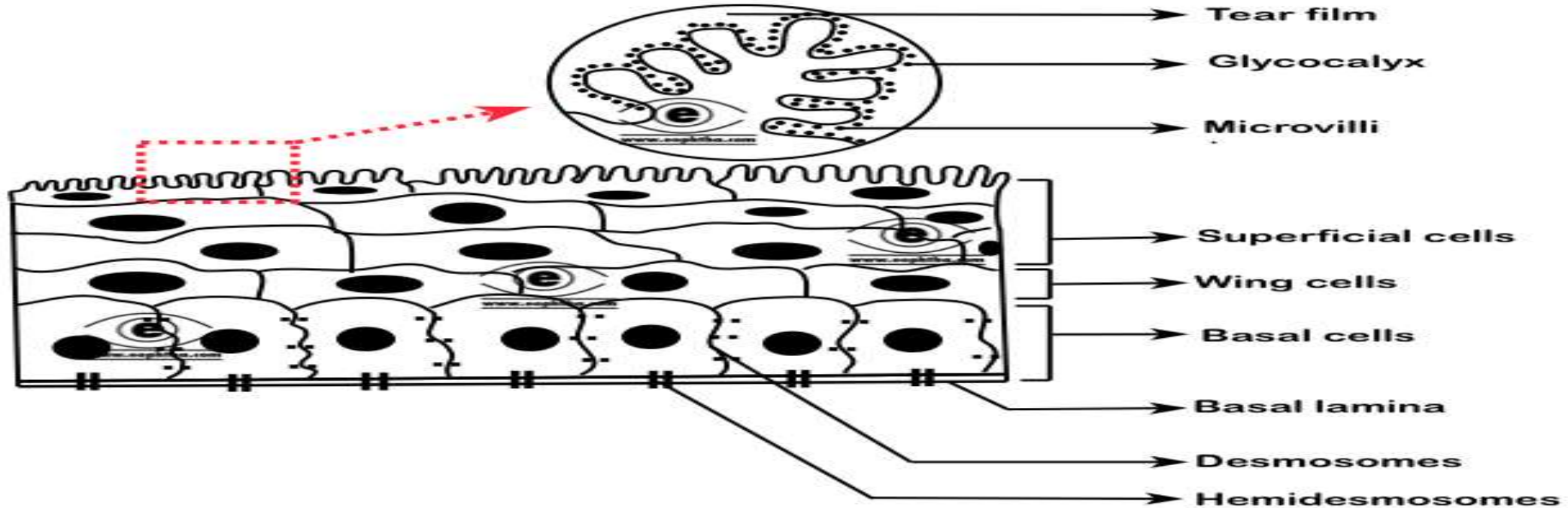
- $\text{Na}^+ - \text{K}^+$ ATPase Pump
- HCO_3^- pump
- $\text{Na}^+ - \text{H}^+$ exchange transporter

METABOLIC PUMP (ENDOTHELIIUM)



BARRIER FUNCTION

- Leaky barrier- presenting endothelium
- Complete barrier- presenting epithelium



EVAPORATION FROM CORNEAL SURFACE

Increase in concentration of precorneal fluid(osmolarity)



Water from cornea is drawn into tear film



Relative state of corneal dehydration

INTRAOCULAR PRESSURE

- IOP > Swelling pressure = corneal oedema occur
- The relation of swelling pressure of stroma to IOP is
IP (imbibition pressure of corneal stroma) = IOP - SP
 - As stromal pressure decreases precipitiously by increase in corneal thickness, mild corneal edema combined with increase in IOP leads to high imbibitions pressure and subsequent microbullous formation and epithelial edema.

CORNEAL TRANSPARENCY

The cornea transmits nearly 100% of the light that enters it. Transparency achieved by –

Arrangement of stromal lamellae

Two theories –

i) Maurice (1957):

- The transparency of the stroma is due to the lattice arrangement of collagen fibrils.
- He explained, because of their small diameter and regularity of separation, back scattered light would be almost completely suppressed by destructive interference

CORNEAL TRANSPARENCY

- ii) **Goldman et al. (1968)**: Proposed that lattice arrangement is not a necessary factor for stromal transparency. Cornea is transparent because fibrils are small in relation to light and do not interfere with light transmission unless they are larger than one half of a wavelength of light (2000 Å).
- Both theories failed to explain why there is corneal clouding occurs with raised IOP and why there is corneal clearing occurs on reduction of IOP.

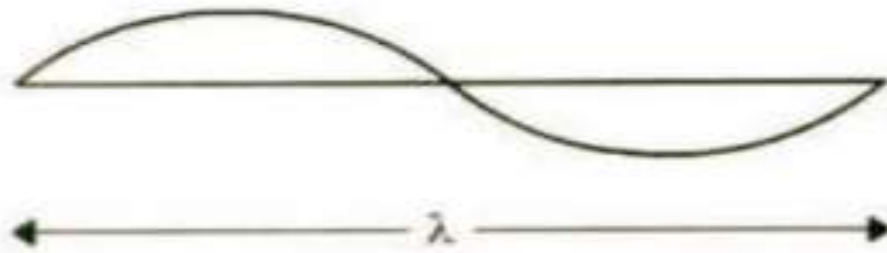
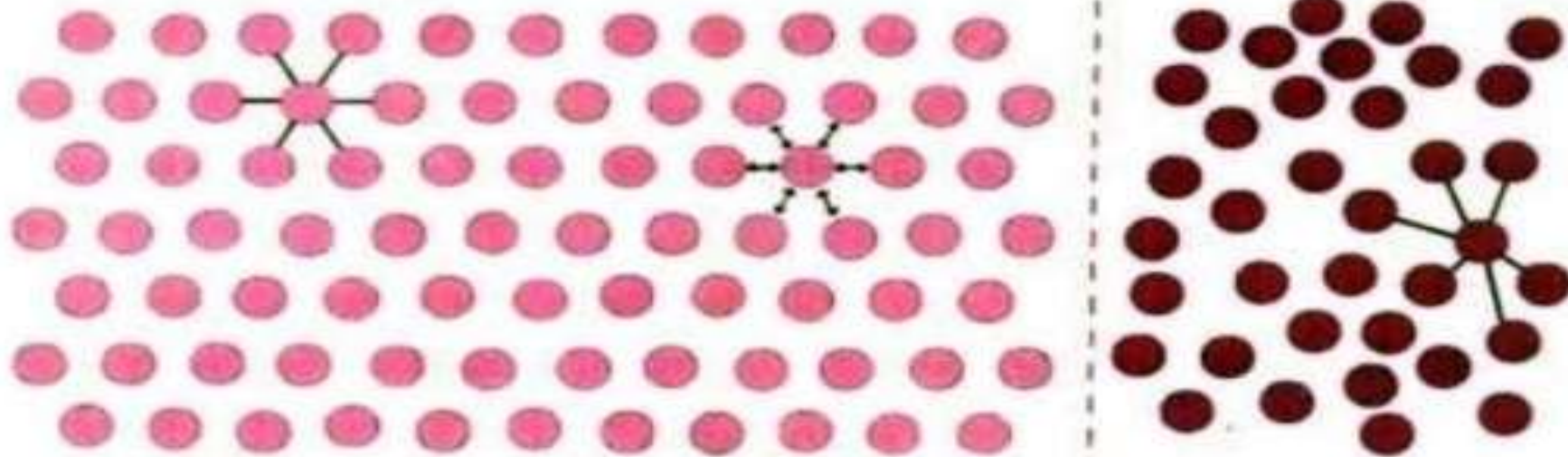
A**B**

Fig. 2.3. Cross-sectional view showing regular arrangement of corneal fibrils as basis of corneal transparency (Maurice theory) (A) vis-a-vis irregular arrangement of scleral fibres (B).

CORNEAL WOUND HEALING

- Injury to corneal epithelium..basal cells are moved to damaged area & fills the defect.
- Bowmans membrane does not regenerate.wound is replaced by stroma like fibrous tissue or epithelium.
- Trauma to corneal stroma..
 - Increase number of keratinocytes.

CORNEAL WOUND HEALING

- Increase ground substances & collagen fibril secreted by keratinocytes.
- Newly formed collagen is larger than normal.
- Collagens are not well organized & lose their normal tensile strength.

➤ ENDOTHELIAL WOUND HEALING

- ✓ Little or no mitosis occurs in human corneal endothelium.
- ✓ In injury of any kind defect covered by spreading of the cells from adjacent area to the wound.
- ✓ Depending upon the size of the wound the entire defect can be recovered within one or more weeks.
- ✓ Regenerating endothelium deposits new layer of DM.

Injury to cornea

Epithelium = responds immediately to reestablish barrier action & protect underlying tissues

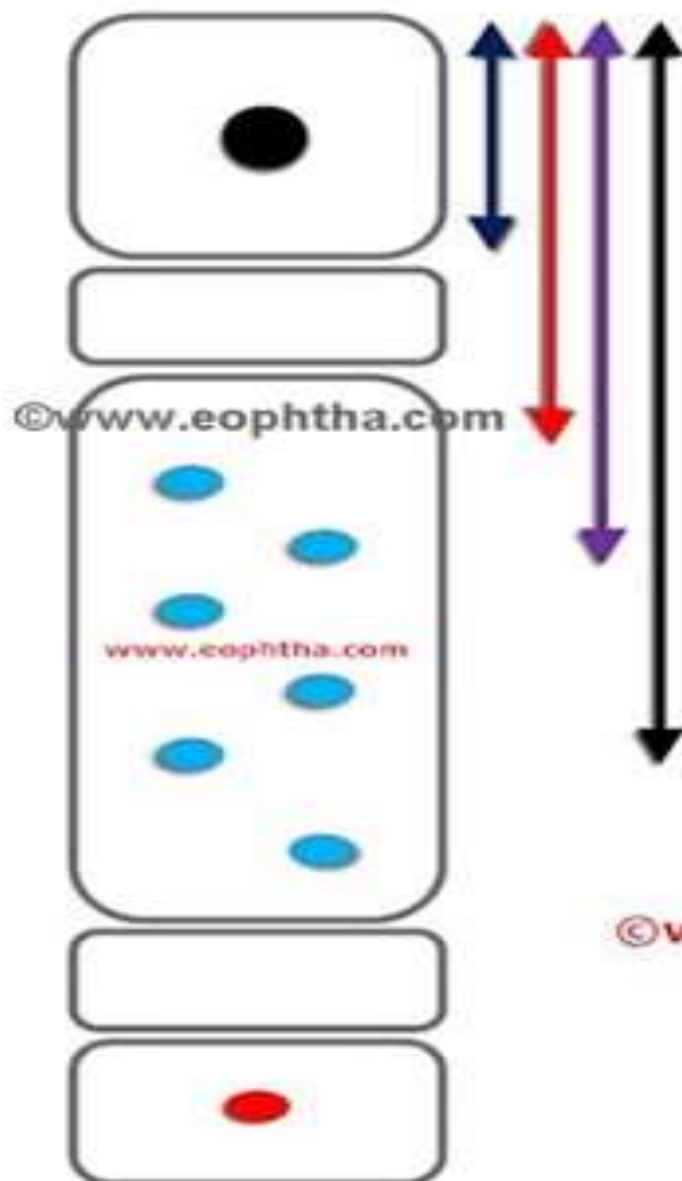
Bowman's membrane = no mechanism for repair

Stroma = Keratocytes, a special fibroblast, produce new reparative collagen & proteoglycan, but cornea loses its transparency

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Descemet's Membrane = rescreted by endothelium

Endothelium = no mechanism for repair



Involving only epithelium = No opacity

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Involving Bowman's Membrane & Superficial stroma = Nebula

Involving $\frac{1}{3}$ rd of stroma = Macula

Involving more than $\frac{1}{2}$ of stroma = leucoma

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THANKS TO ALL