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Contact Lenses And Dry Eye: The Impact Of Soft Lens Wear On Ocular Surface Homeostasis

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HOMEOSTASIS

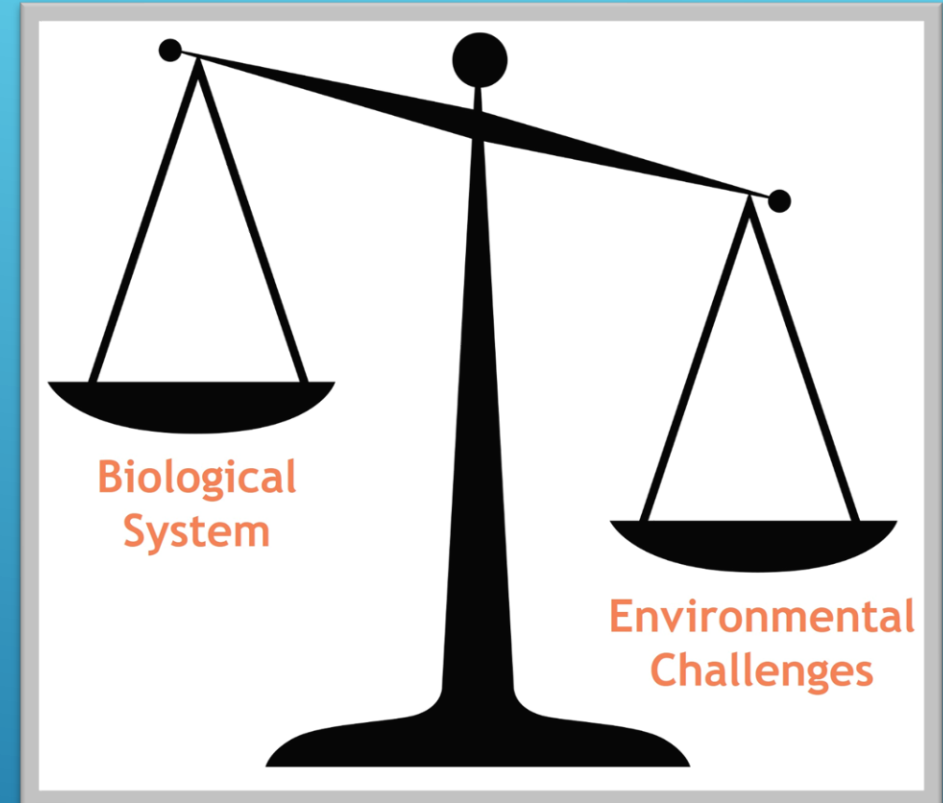


Homeostasis

DEFINITION: A SELF-REGULATING PROCESS BY WHICH BIOLOGICAL SYSTEMS MAINTAIN STABILITY WHILE ADJUSTING TO CHANGING EXTERNAL CONDITIONS

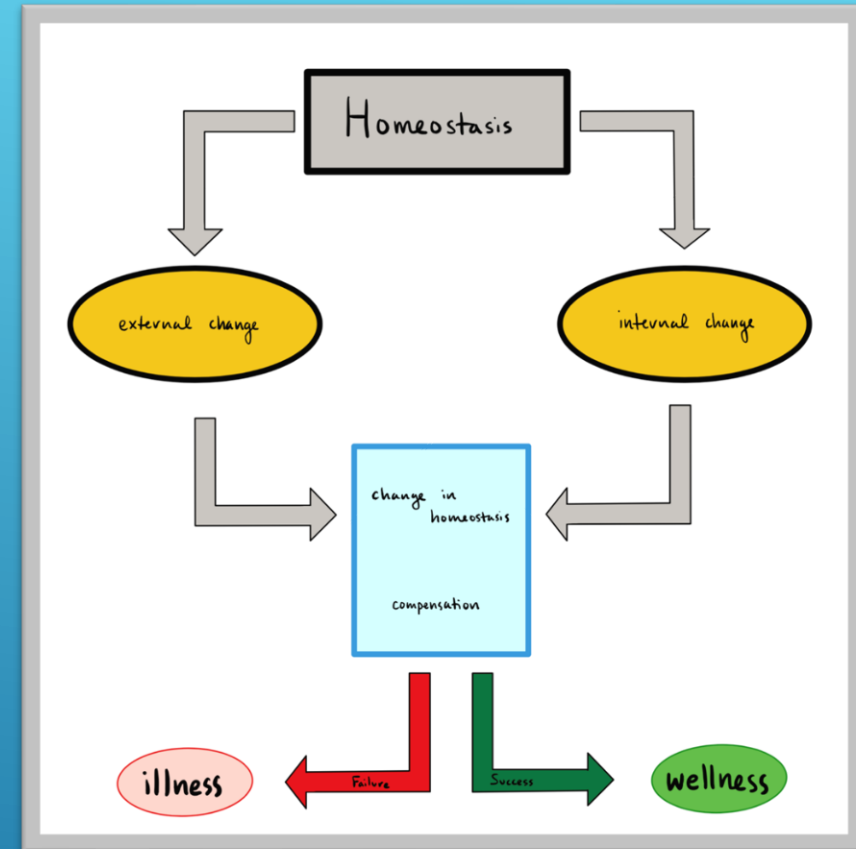


- **Dynamic Equilibrium**
- **State of balance**
 - Resists change
 - Continuously adjusted
 - Adapts to external challenges
- **Inability to maintain homeostasis**
 - **Disease and Death**



HOMEOSTASIS

- Feedback-Dependent Control
- Self-regulated
- Complex and integrated
 - Inputs from multiple systems
 - Can be modified by higher level control



HOMEOSTASIS

Homeostasis

DRY EYE IS A MULTIFACTORIAL DISEASE OF THE OCULAR SURFACE CHARACTERIZED BY A **LOSS OF HOMEOSTASIS** OF THE TEAR FILM, AND ACCOMPANIED BY OCULAR SYMPTOMS, IN WHICH TEAR FILM INSTABILITY AND HYPEROSMOLARITY, OCULAR SURFACE INFLAMMATION AND DAMAGE, AND NEUROSENSORY ABNORMALITIES PLAY ETIOLOGICAL ROLES

- TFOS DEWS II Definition & Classification Subcommittee Report



SOFT CONTACT LENS WEAR & OCULAR SURFACE HOMEOSTASIS



SOFT CONTACT LENSES: A HOMEOSTATIC CHALLENGE

Benefits:

- Refractive
 - Vision correction
- Therapeutic
 - BCL
- Interventional
 - Myopia management

Challenges:

- Innately disrupts homeostasis
 - Foreign body on the ocular surface
 - Disrupts tear film
 - Intrinsically inflammatory
- Complications
 - Infection
 - Inflammation



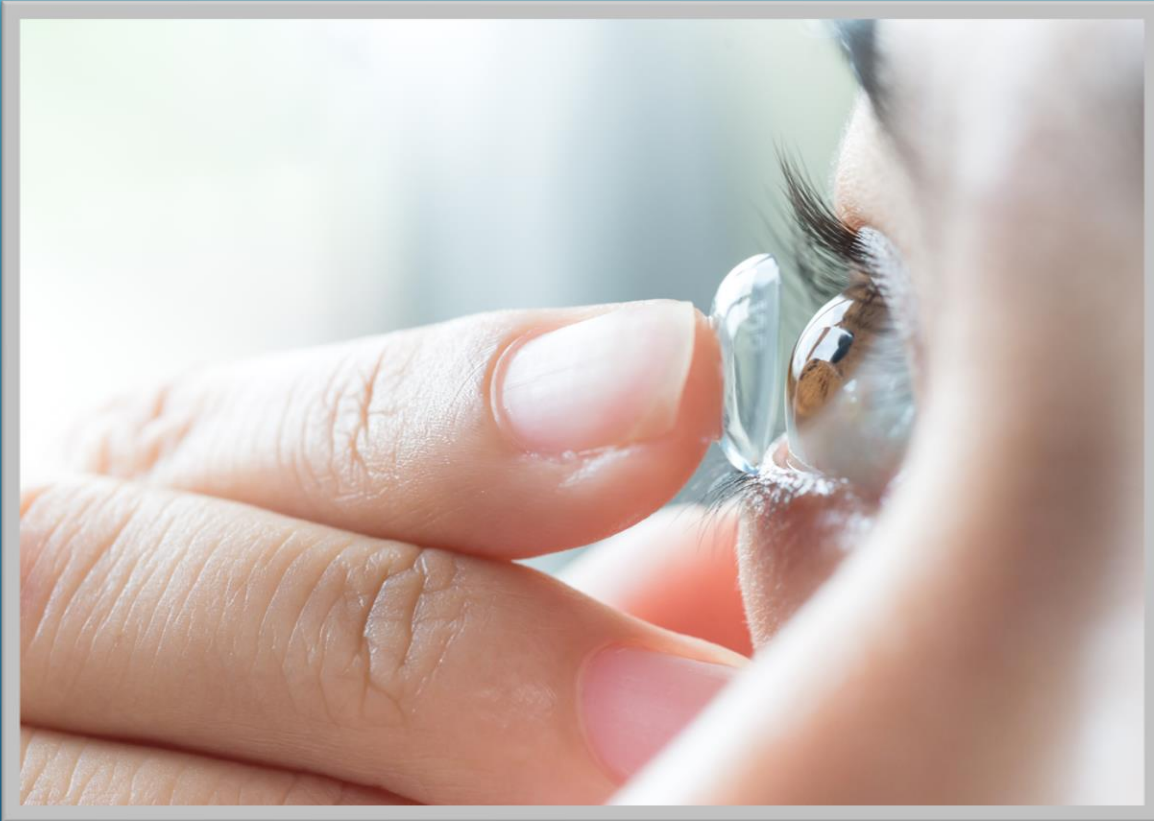
UP TO 51% OF CONTACT LENS WEARERS ULTIMATELY END UP DISCONTINUING USE

20% dropout within the first year of wear



WHY DOES THIS HAPPEN?
WHAT CAN WE DO TO AVOID IT?





THINGS TO KEEP IN MIND

- Conflicting findings
- No consensus on many points
- Some effects more historical

BUT

- General trends have emerged

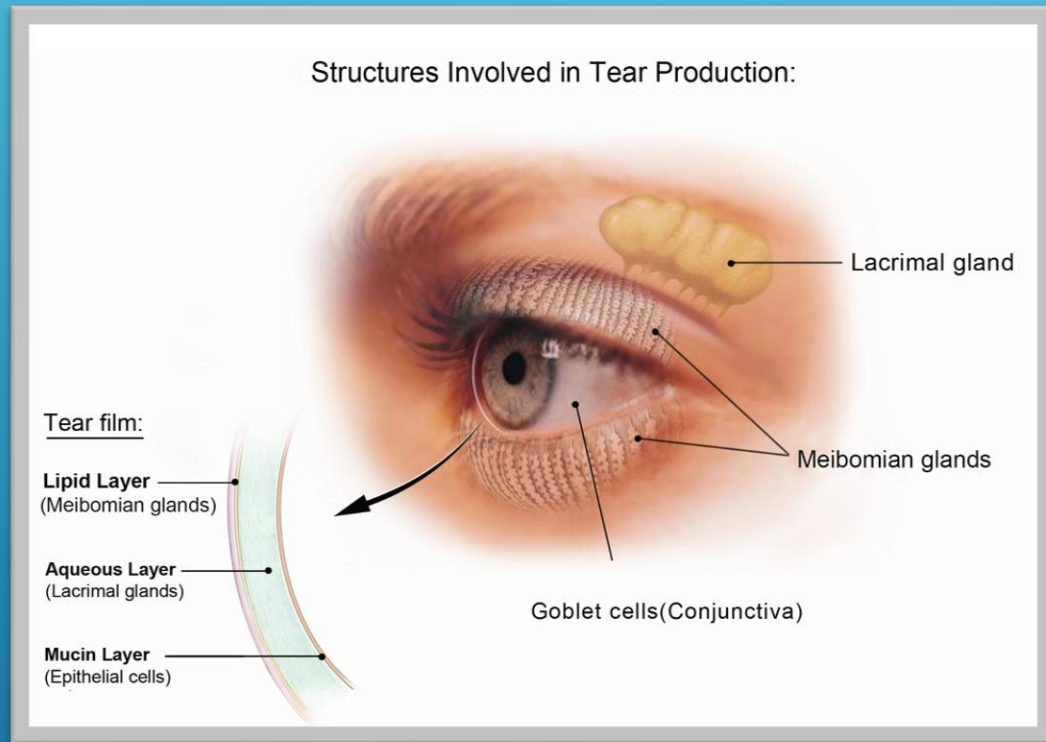


SOFT CONTACT LENS WEAR & THE OCULAR SURFACE



OCULAR SURFACE

- Cornea
- Conjunctiva
- Eyelids & Lashes
- Meibomian Glands
- Main & Accessory Lacrimal Glands
- Goblet Cells
- Tear Film



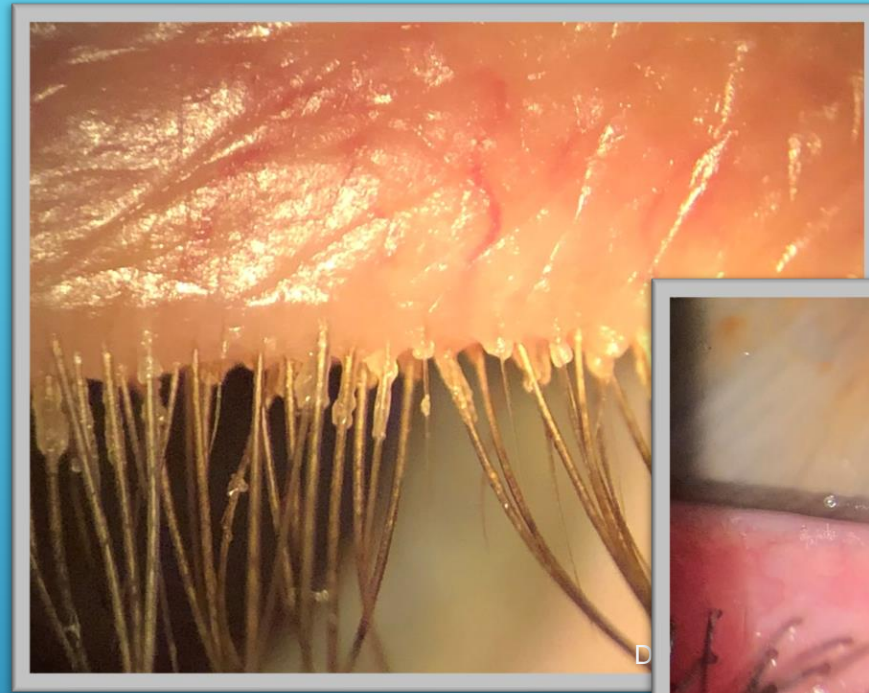
Function:

- Protection
- Tear spread



LIDS & LASHES

- **Lens Impact on Surface:**
 - Increased blink rate
 - Increased incidence of ptosis
- **Surface Impact on Lens:**
 - Demodex blepharitis
 - Collarettes
 - Bacterial blepharitis
 - Saponification

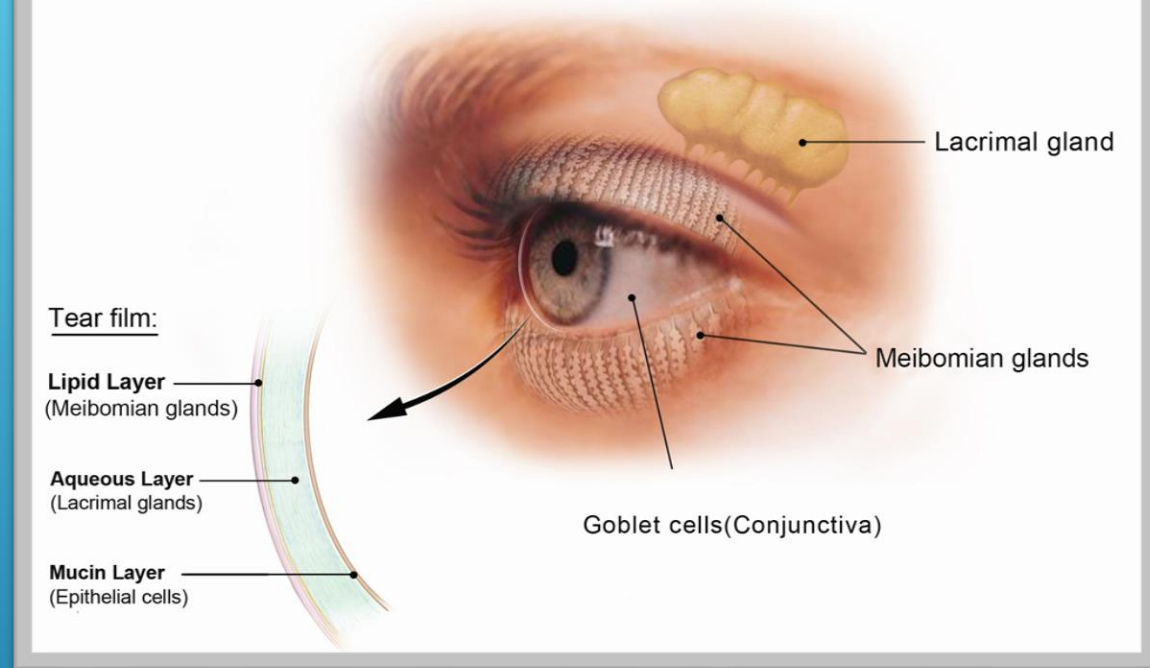


SOFT CONTACTS LENSES: LIDS & LASHES

Function:

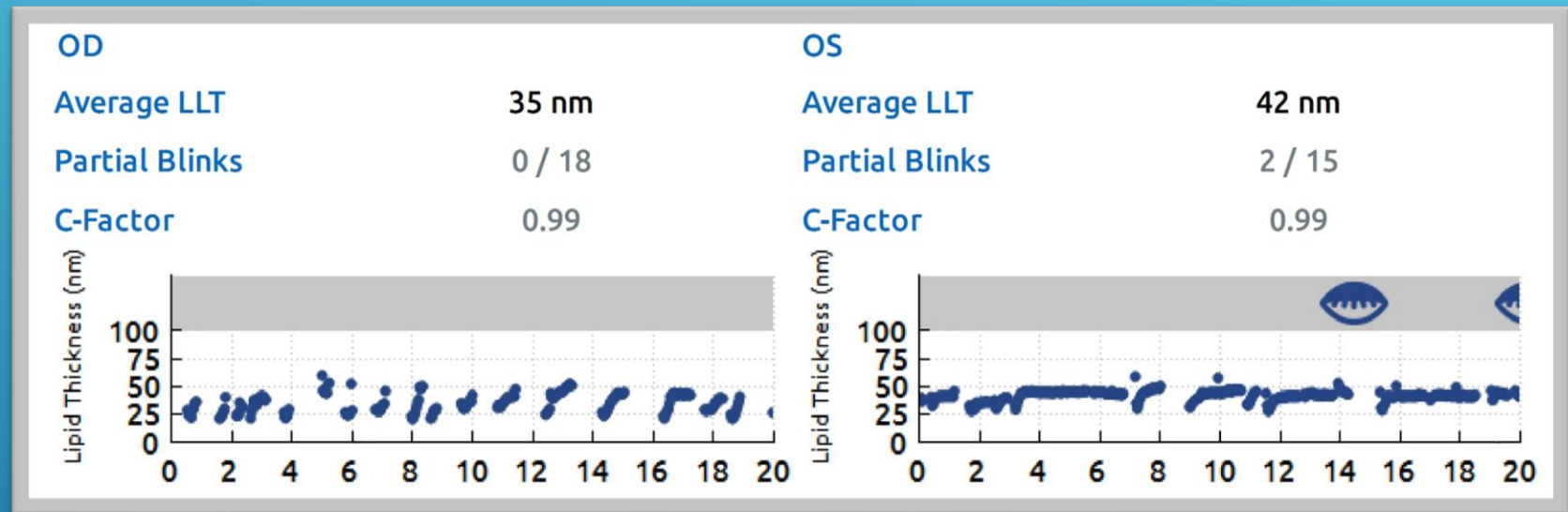
- Protection
- Nourishment
- Smooth optical surface
- Refract light

Structures Involved in Tear Production:



TEAR FILM

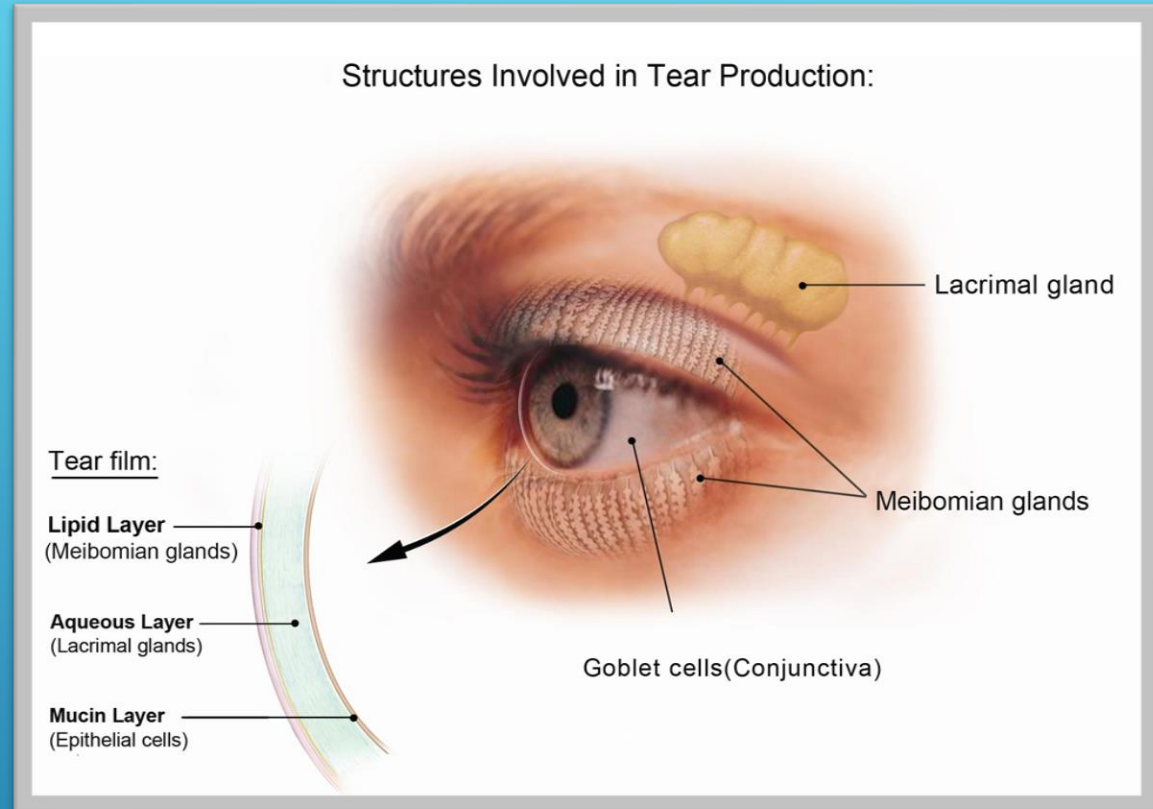
- **Lens Impact on Surface:**
 - Splits tear film into two
 - Pre-lens tear film
 - Post-lens tear film
 - Reduced
 - Lipid layer thickness
 - Tear volume
 - Tear film turnover
 - TBUT
 - Increased
 - Evaporation
 - Osmolarity



SOFT CONTACTS LENSES: TEAR FILM

- **Surface Impact on Lens:**

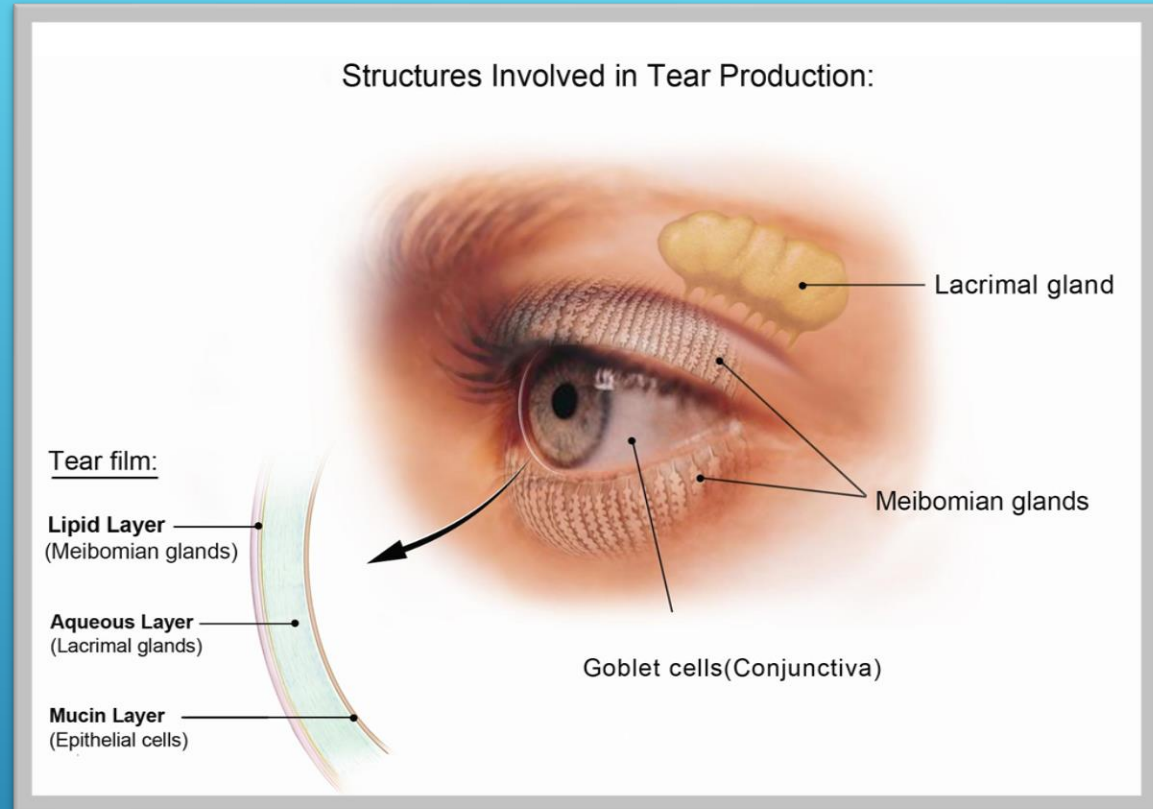
- Poor tear quality reduces
 - Comfort
 - Wear time
 - Visual quality
- Lens dehydration
 - Tightening



SOFT CONTACTS LENSES: TEAR FILM

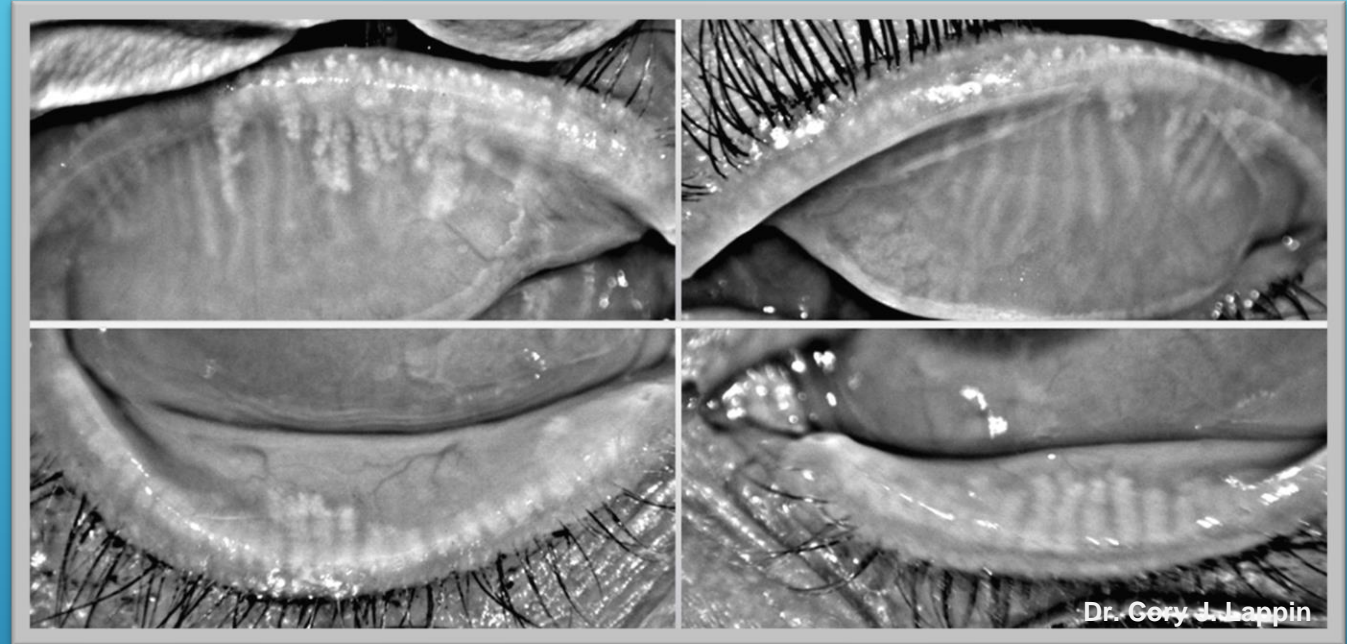
Function:

- Produce meibum component of tear film
 - Prevents evaporation
 - Provides smooth optical surface
 - Lowers surface tension



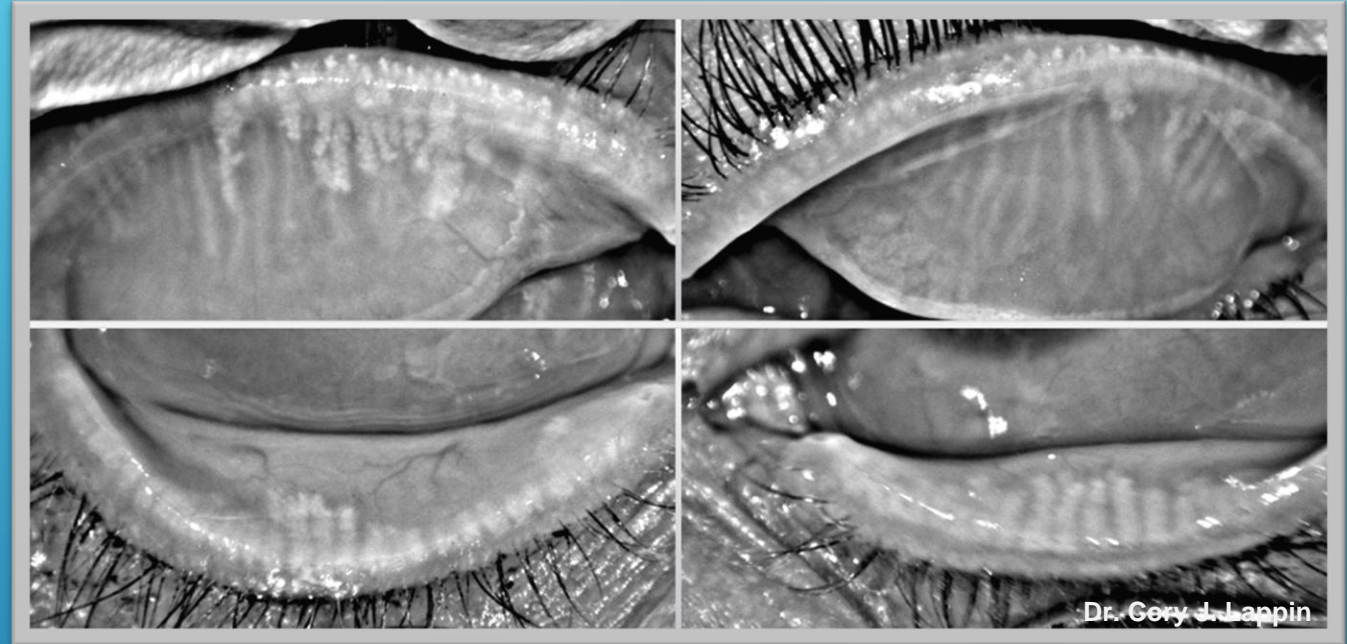
MEIBOMIAN GLANDS

- **Lens Impact on Surface:**
 - Altered meibum quality
 - Higher melting point
 - Independent of structural changes
 - Altered meibomian gland structure
 - Controversial
 - May worsen with wear
 - Starts after 1 year of wear
 - Stops after 2-3 years of wear
 - Upper lid glands more affected



SOFT CONTACTS LENSES: MEIBOMIAN GLANDS

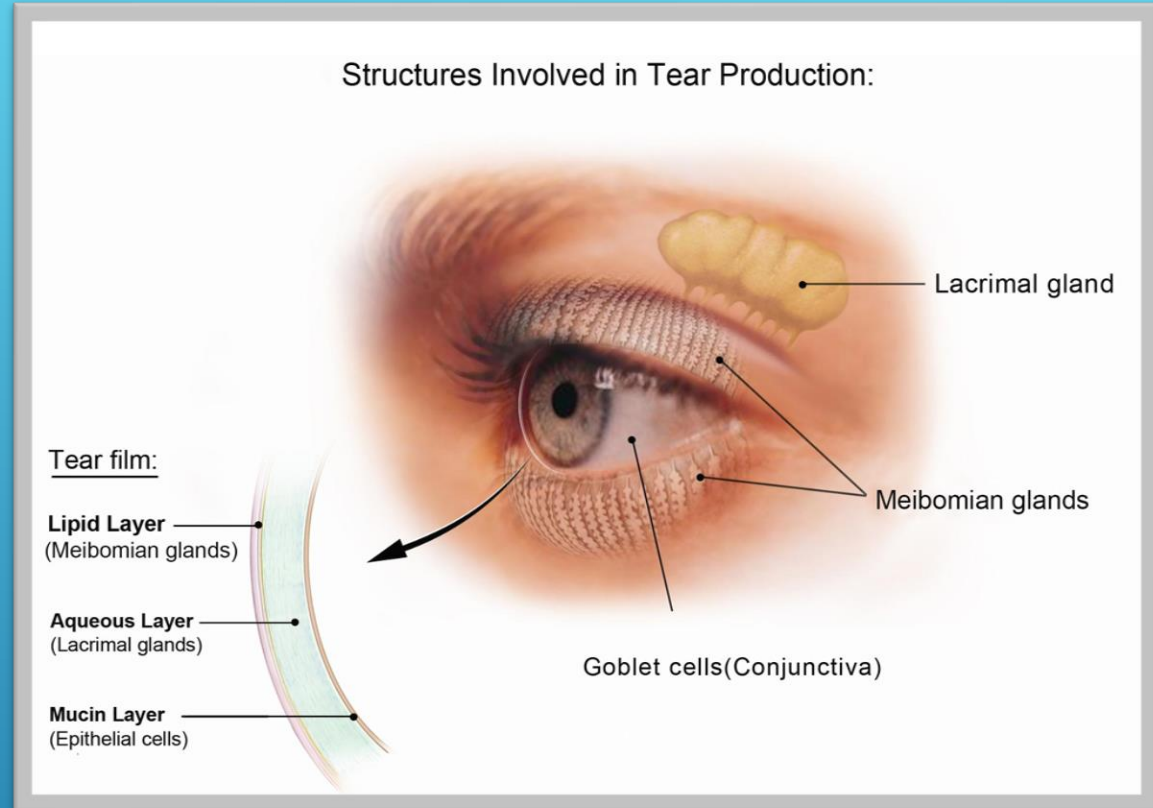
- **Surface Impact on Lens:**
 - Reduced tear film stability
 - Reduced
 - Comfort
 - Wear time
 - Visual quality



SOFT CONTACTS LENSES: MEIBOMIAN GLANDS

Function:

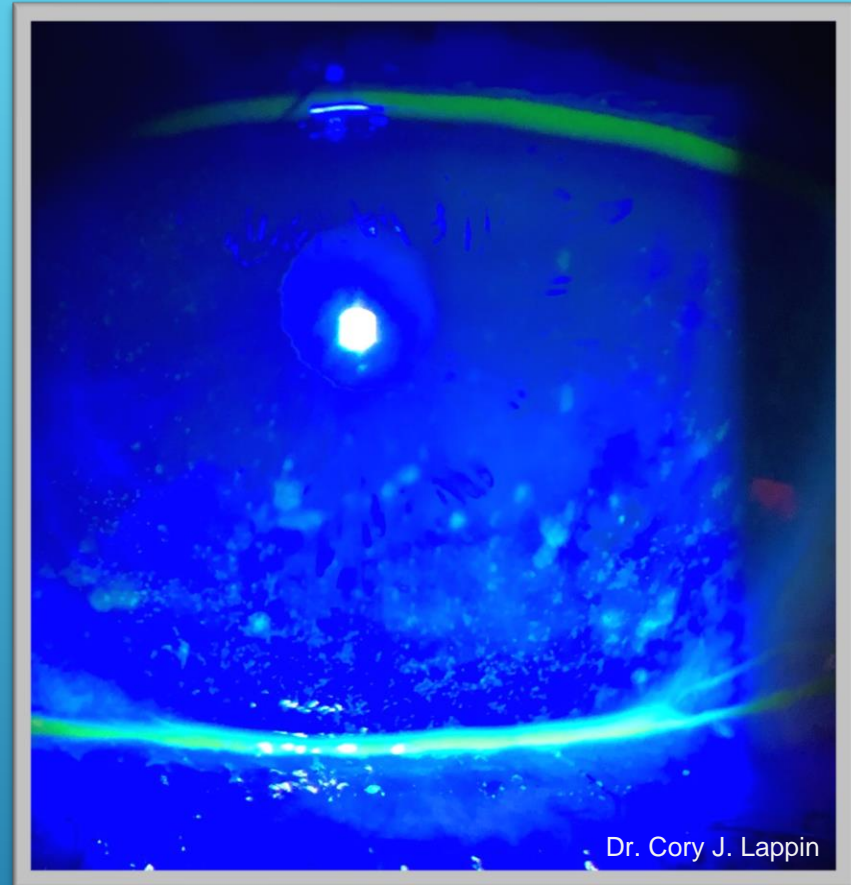
- Produces aqueous component of tears
 - Lubrication and hydration
 - Nourishment
 - Protection



MAIN & ACCESSORY LACRIMAL GLANDS

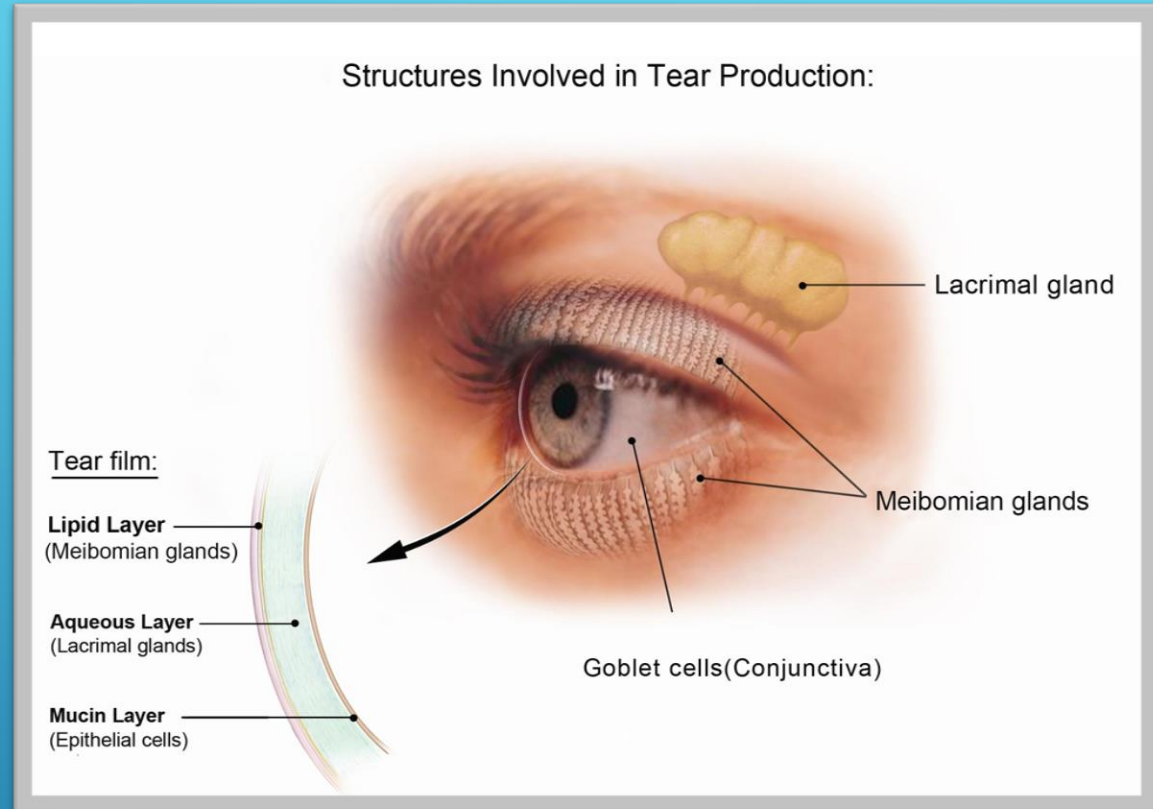
- **Lens Impact on Surface:**
 - Splits tear film
- **Surface Impact on Lens:**
 - Can stabilize cornea and ocular surface
 - Sjogren's Syndrome

SOFT CONTACTS LENSES: LACRIMAL GLANDS & AQUEOUS TEARS



Function:

- Protection
 - Immune
- Contribute mucin component of tear film
 - Anchors tear film to cornea
 - Lowers surface tension
 - Protection



CONJUNCTIVA & GOBLET CELLS

- **Lens Impact on Surface:**
 - Hyperemia & Staining
 - Circumlimbal
 - Lens fit, edge interaction
 - Reduced
 - Goblet cell density
 - Mucin production
 - Increased
 - **Lid-parallel Conjunctival Folds (LIPCOF)**
 - Friction



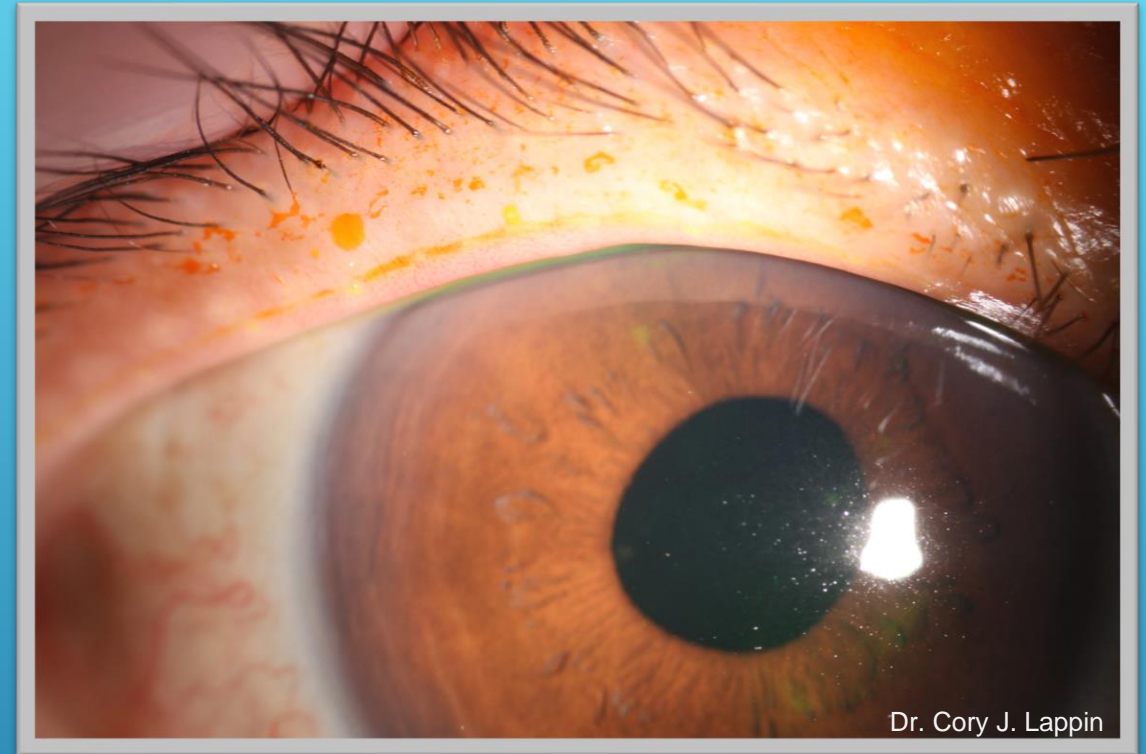
SOFT CONTACTS LENSES: CONJUNCTIVA & GOBLET CELLS

- **Lens Impact on Surface:**
 - **Giant Papillary Conjunctivitis (GPC)**
 - Giant papillae ($\geq 1\text{mm}$)
 - Due to mechanical friction
 - Lens surface dryness, deposits
 - 6-12% of Hydrogel wearers will develop GPC
 - Reduced likelihood with daily disposable CLs



SOFT CONTACTS LENSES: CONJUNCTIVA & GOBLET CELLS

- **Lens Impact on Surface:**
 - **Lid Wiper Epitheliopathy (LWE)**
 - Region is adjacent and posterior to the line of Marx
 - In contact with globe
 - Spreads tears across ocular surface
 - Staining of lid wiper due to friction
 - Microtrauma with blinking
 - More common with SCL wear
 - Poorly wettable surface
 - Less severe with SiHy wear

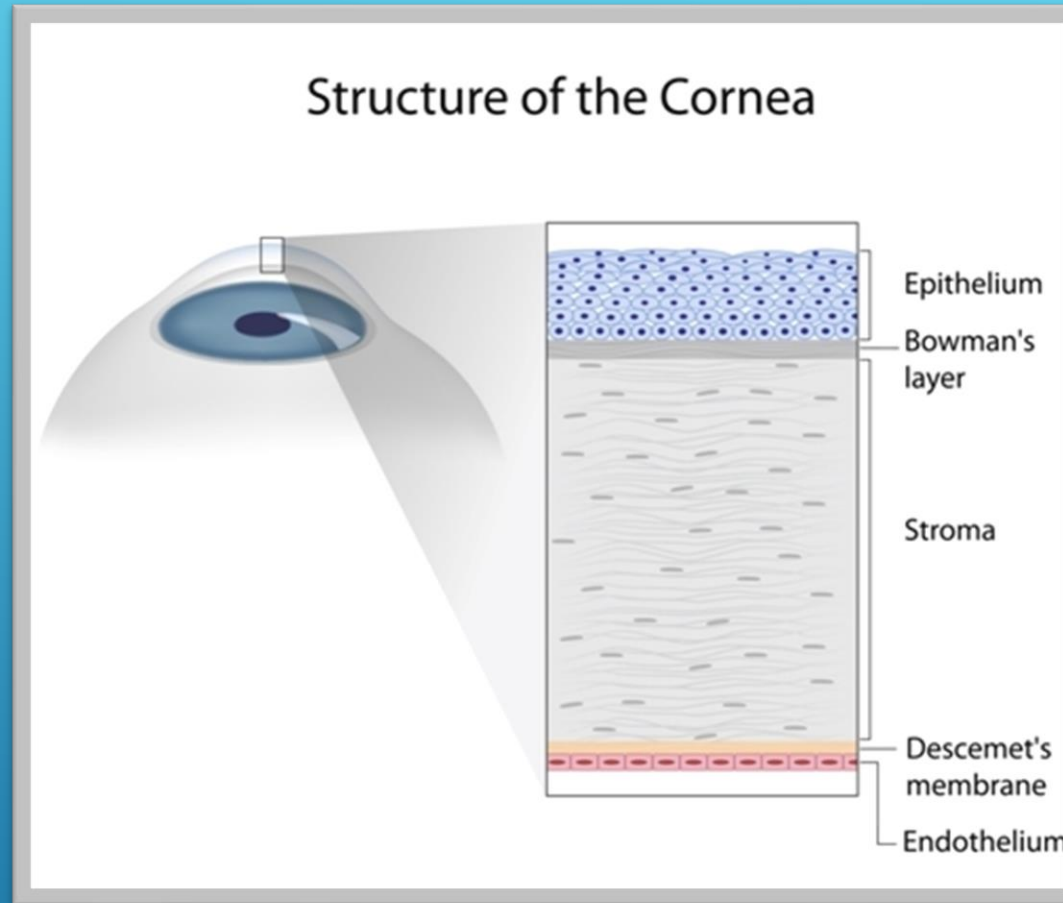


SOFT CONTACTS LENSES: CONJUNCTIVA & GOBLET CELLS

Function:

- Protection
- Optical clarity
- Refract light

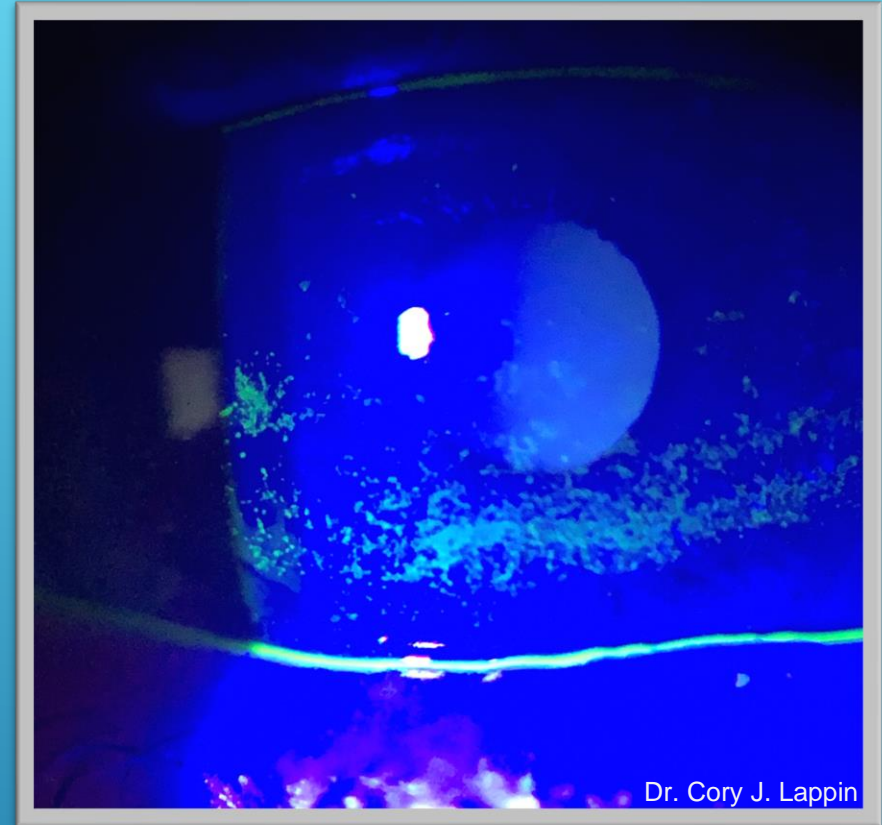
CORNEA



- **Lens Impact on Surface:**

- **Staining**

- Present in 54% of SCL wears
 - Less with SiHy wear
 - “Smile” pattern
 - Lens desiccation
 - Limbal staining
 - Excess movement



SOFT CONTACTS LENSES: CORNEA

- **Lens Impact on Surface:**

- **Hypoxia**

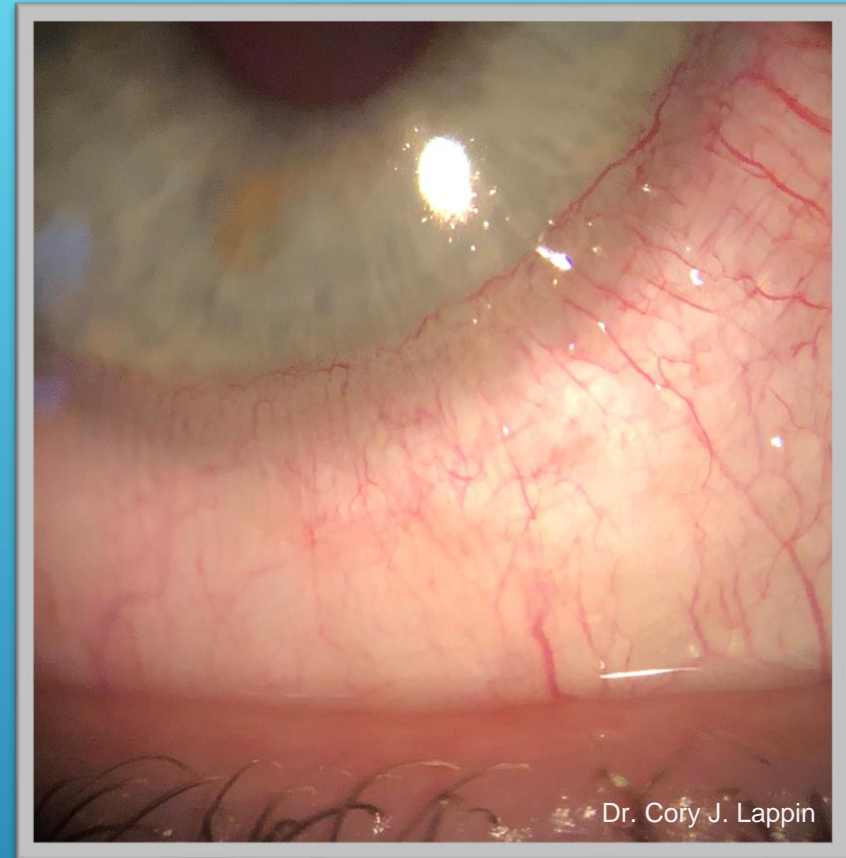
- Reduced epithelial cell metabolism and mitosis
 - Epithelial thinning
 - Premature endothelial cell loss
 - Increased bacterial binding to surface

- **Epithelial microcysts**

- Reverse illumination (appear dark)
 - Associated with Hydrogels
 - Degenerated basal epithelial cells
 - Rare with SiHy wear

- **Vacuoles**

- Fluid between epithelia cells
 - Unreversed illumination
 - Neovascularization
 - Edema

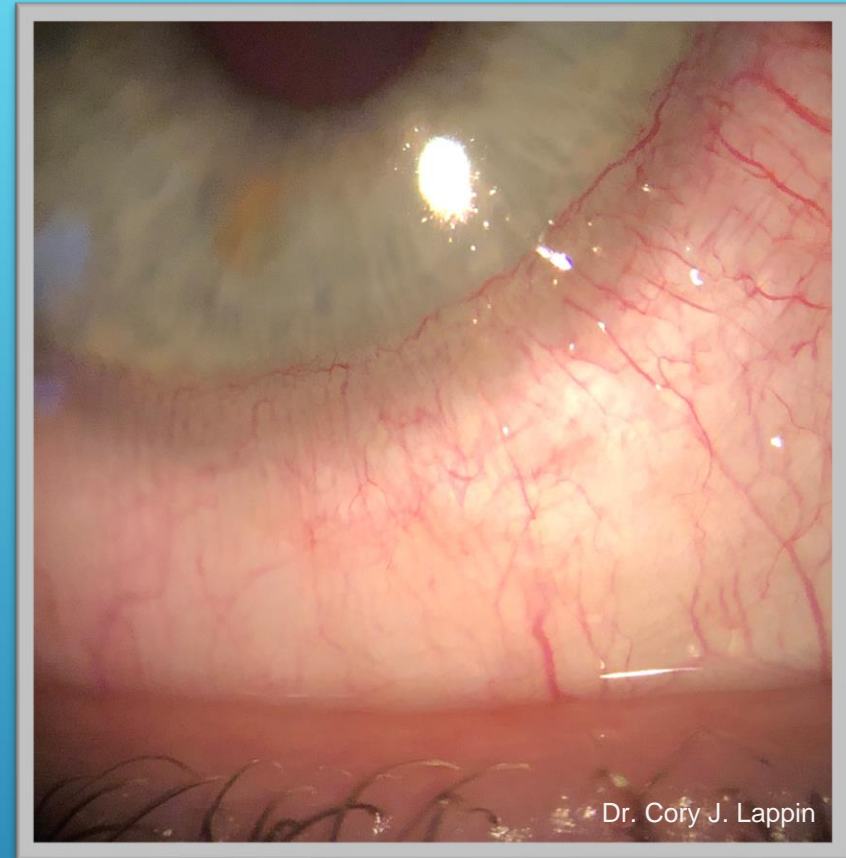


SOFT CONTACTS LENSES: CORNEA

- **Lens Impact on Surface:**

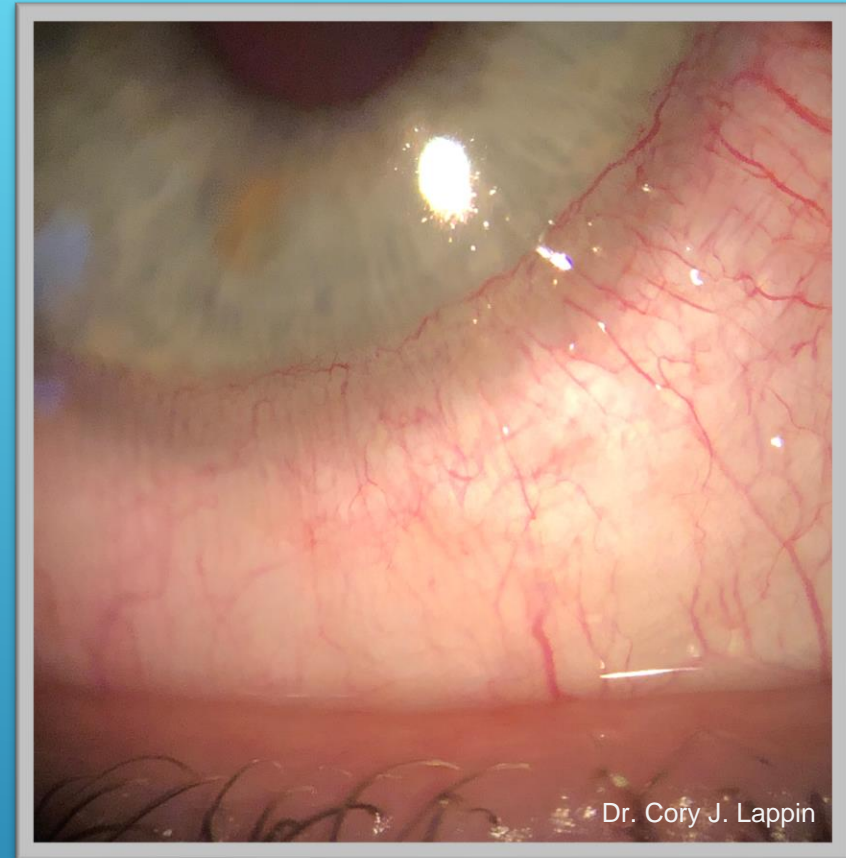
- **Neovascularization**

- Due to hypoxia
 - Limbal injection
 - Precursor
 - Lipid exudation
 - Scarring
 - Greater risk with overnight lens wear



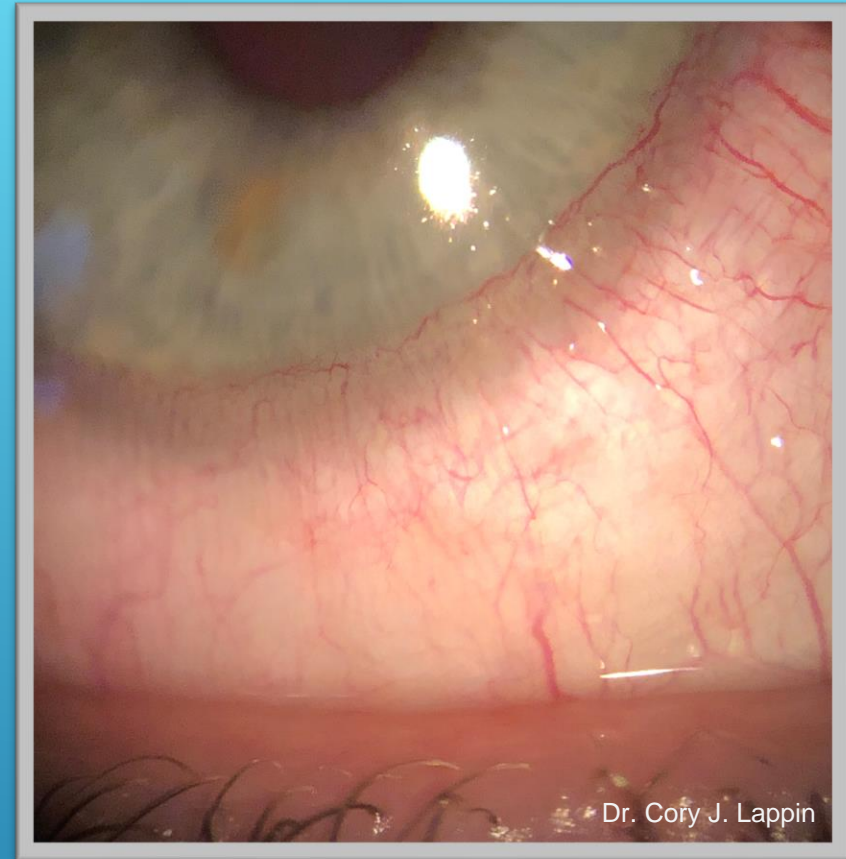
SOFT CONTACTS LENSES: CORNEA

- **Lens Impact on Surface:**
 - **Edema**
 - CL wear can reduce oxygen availability
 - Increased anaerobic metabolism by epithelial cells
 - Lactic acid byproduct diffuses into stroma and alters osmotic gradient
 - Stromal edema
 - Striae and/or folds
 - Visual disturbances
 - Glare, halos, rainbows
 - Increased risk with overnight lens wear
 - Less common with SiHy wear



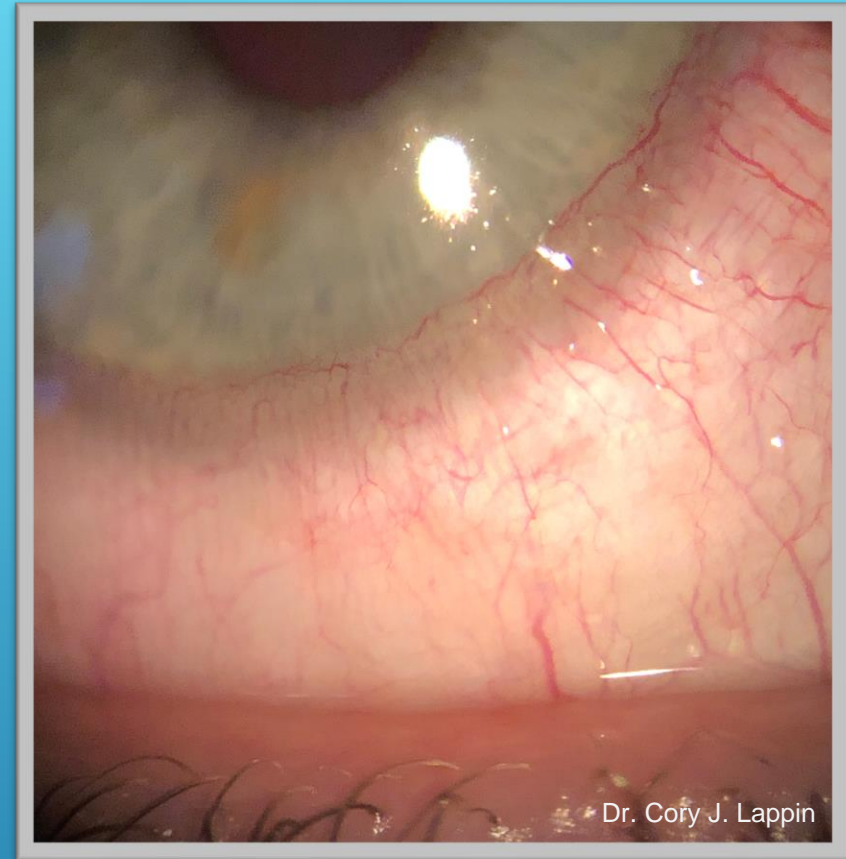
SOFT CONTACTS LENSES: CORNEA

- **Lens Impact on Surface:**
 - **Stromal thinning**
 - Reduced keratocyte density
 - Due mechanically induced inflammation
 - Present in both SiHy and Hydrogel wear



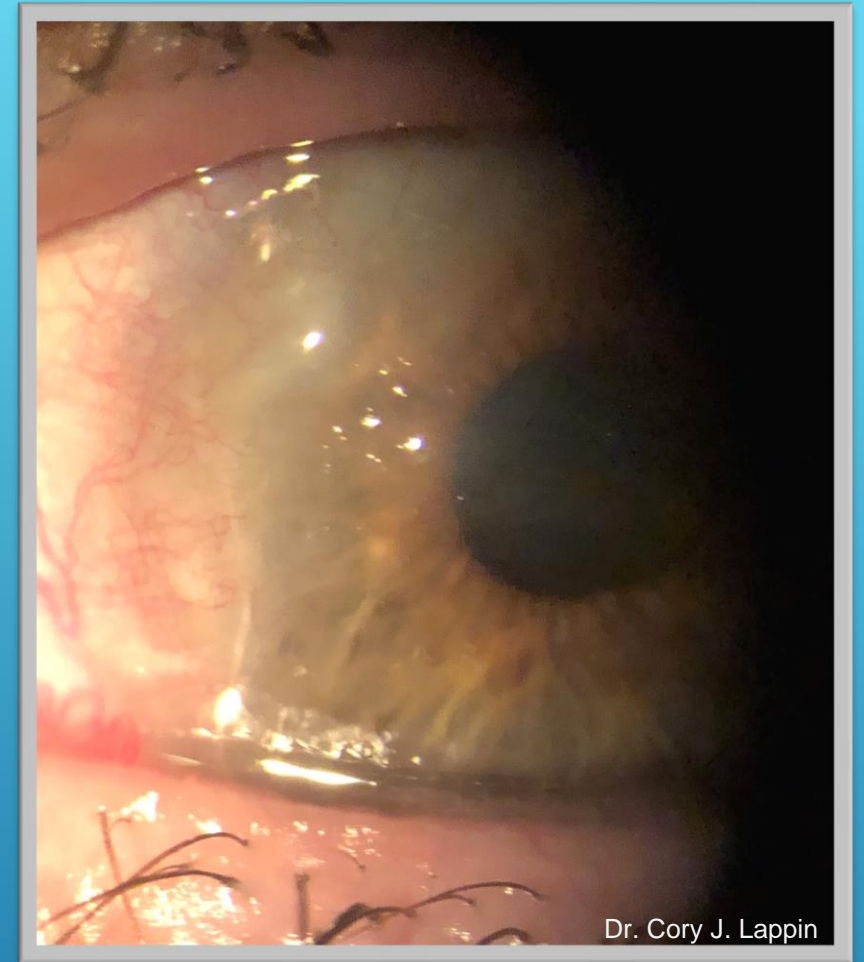
SOFT CONTACTS LENSES: CORNEA

- **Lens Impact on Surface:**
 - **Corneal warpage**
 - Increased regular astigmatism
 - Irregular astigmatism
 - More common in older, low Dk/t Hydrogels



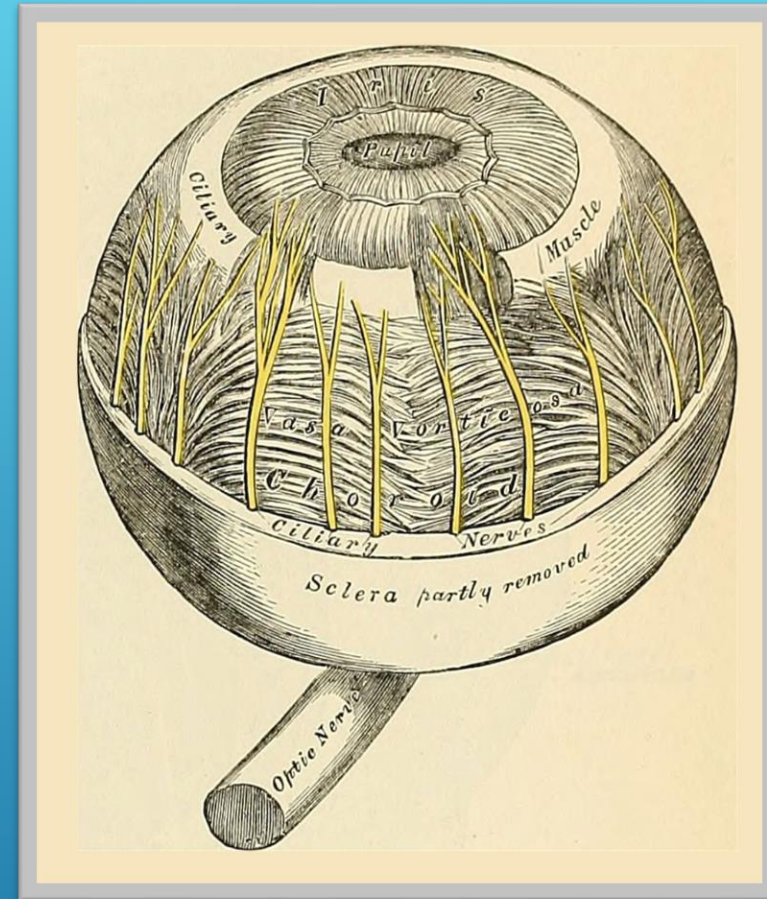
SOFT CONTACTS LENSES: CORNEA

- **Lens Impact on Surface:**
 - **Limbal Stem Cell Deficiency (LSCD)**
 - Chronic contact lens-induced:
 - Limbal hypoxia
 - Mechanical trauma to limbus
 - Results in loss of limbal stem cells
 - Impaired wound healing
 - Reduced epithelial cell turnover
 - Corneal conjunctivalization
 - Neovascularization
 - Loss of transparency



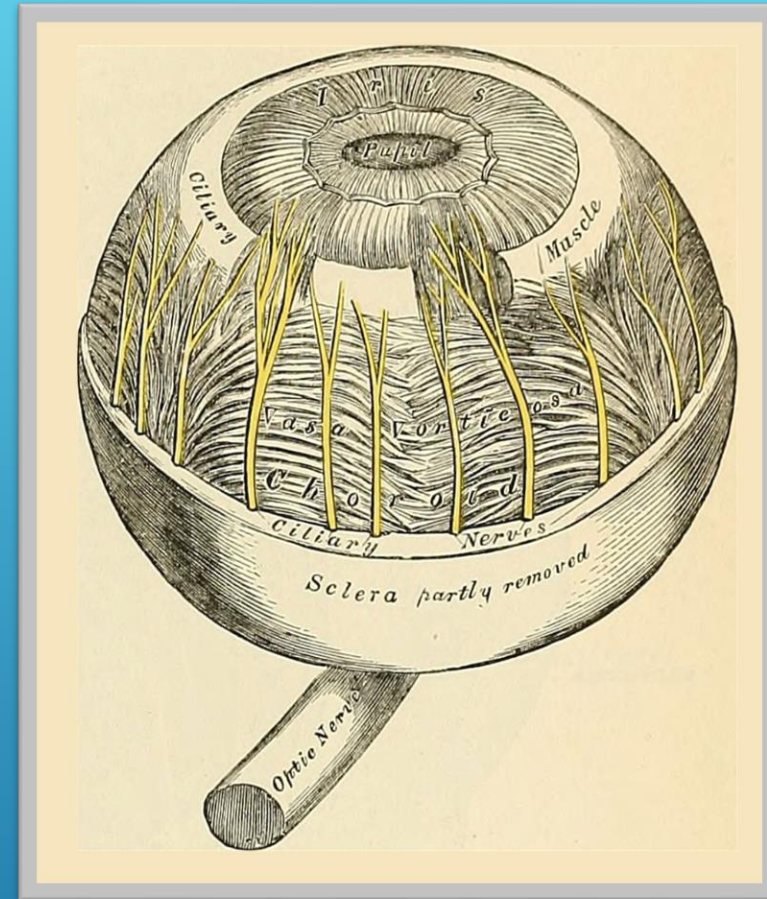
SOFT CONTACTS LENSES: CORNEA

- **Function:**
- Cornea densely innervated
 - 7,000 nerve enders per mm²
- Control
 - Sensation
 - Blinking & Lacrimation
 - Protection
- Corneal surface maintenance
 - Routine epithelial cell turnover
 - Wound healing
 - Nourishment and metabolism



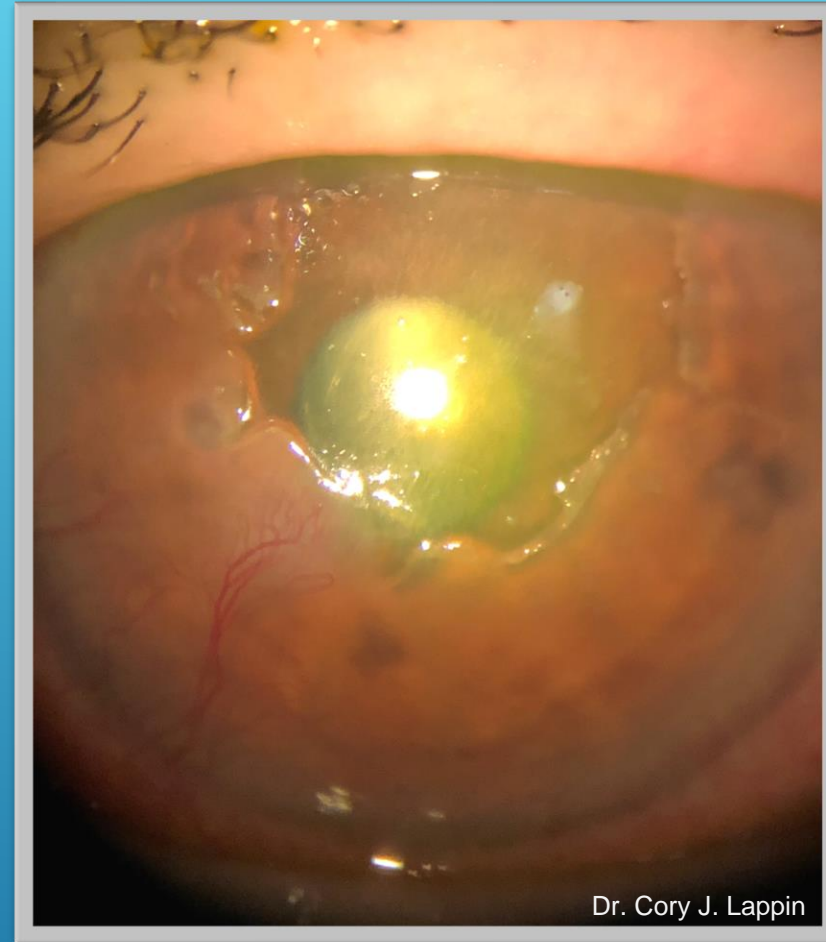
NERVES

- **Lens Impact on Surface:**
 - Reduced corneal sensitivity
 - Adaptation
 - Increased sensitivity at limbus
 - Interaction with lens edge
 - Specialized pressure sensors
 - Reduced palpebral conjunctival sensitivity
 - Reduced lid margin sensitivity
 - Second most sensitive ocular surface structure
 - NGF upregulated in contact lens discomfort
 - Sign of nerve damage



SOFT CONTACTS LENSES: NERVES

- **Lens Impact on Surface:**
 - **Neurotrophic Keratitis (NK)**
 - Can be induced by chronic CL-related inflammation
 - Damages corneal nerves resulting in loss of sensation
 - Impaired blinking and lacrimation
 - Reduced epithelial cell turnover
 - Disrupted wound healing



SOFT CONTACTS LENSES: NERVES

- **Surface Impact on Lens:**
 - **Neuropathic Ocular Pain**
 - Pain derived from nerves rather than external stimulus
 - Peripheral or Central
 - Leads to hypersensitivity of cornea
 - Allodynia
 - Photoallodynia
 - Hyperalgesia
 - Lens wear can improve or exacerbate condition



SOFT CONTACTS LENSES: NERVES

- **Lens Impact on Surface:**

- CLs may be intrinsically inflammatory
 - Subclinical
 - Dendritic cells (DC)
 - pathognomonic for immune response
- Bulbar Conjunctiva and Lid Margin
 - Transient increase in DC
 - Due to deposits, microbes on case
- Cornea
 - Transient increase in DC
 - Possible microtrauma
 - Less pronounced with daily disposables



SOFT CONTACTS LENSES: INFLAMMATION

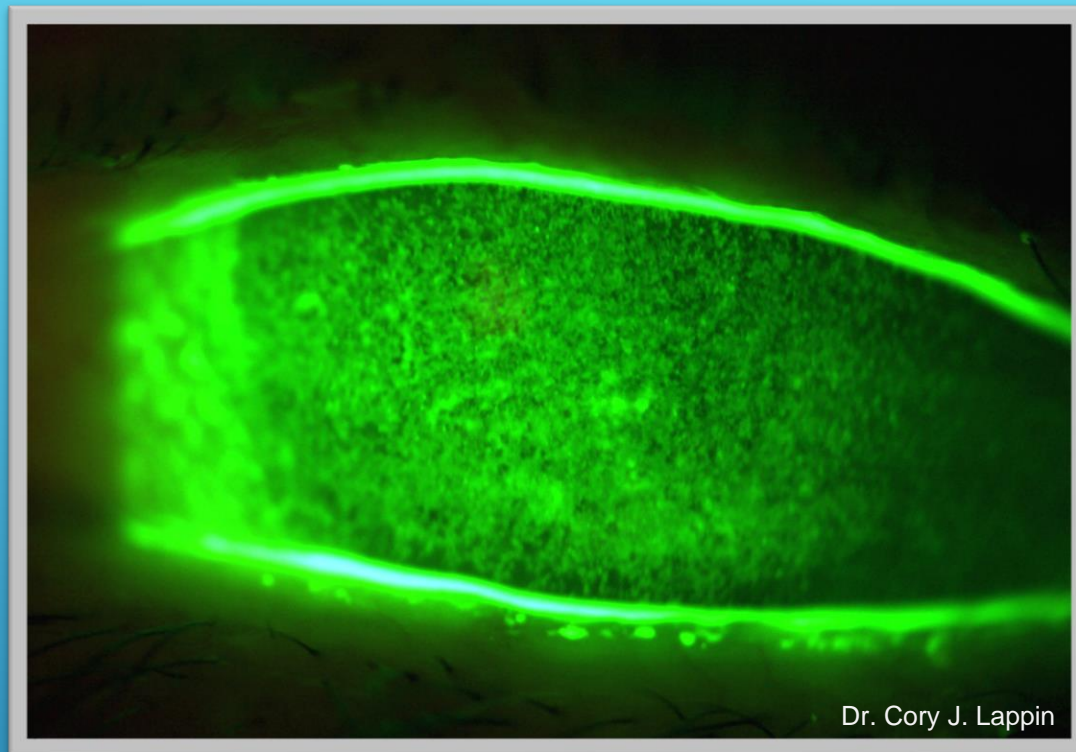
- **Surface Impact on Lens:**
 - Ocular Allergies
 - 40% of contact lens wears experience allergies
 - Lens discomfort
 - Itching
 - Mucus discharge



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SOFT CONTACTS LENSES: ALLERGIES

- **Impact on Surface:**
 - Packing solutions
 - Borate
 - Phosphate
 - Both potentially cytotoxic to corneal epithelium
 - Care solutions
 - Multipurpose
 - Preservatives as Antimicrobials
 - PBHB
 - Polyquad (BAK-derived)
 - Potential preservative toxicity



SOFT CONTACTS LENSES: PACKING SOLUTIONS AND CARE SYSTEMS

- **Lens Impact on Surface:**
 - **Contact Lens Discomfort (CLD)**
 - Due to lens itself, **NOT** external condition
 - Only occurs when lens is worn, discomfort improves upon removal
 - Mechanism unknown
 - Likely nervous component
 - Can be influenced by
 - Lens material
 - Lens design
 - Wear schedule
 - Care solution



SOFT CONTACTS LENSES: CONTACT LENS DISCOMFORT (CLD)

MANAGEMENT



Soft Contact Lens and Ocular Surface Management

Lens Selection

Ocular Surface Optimization



LENS SELECTION



LENS SELECTION: SOFT CONTACT LENS MATERIAL PROPERTIES

- **Dk/t**
 - Oxygen permeability
- **Modulus**
 - Rigidity
- **Lubricity**
 - Friction
- **Wettability**
 - Tear spread & adherence
- **Surface treatments**
 - Surfactants
 - Plasma
 - Wetting Agents
 - Polyvinyl alcohol
 - Hyaluronic acid



LENS SELECTION: SOFT CONTACT LENS DESIGN

- **Base curve**
 - Flatter
 - Steeper
- **Diameter**
 - Larger
 - Smaller
- **Lens edge design**
 - Rounded
 - Knife
 - Chisel
- **Thickness**



LENS SELECTION: SOFT CONTACT LENS POLYMER TYPES

Silicone Hydrogels

- High oxygen permeability
- Better comfort
- Silicone intrinsically hydrophobic
 - Requires surface treatments
- Lower water content
- Lipid deposition
- “Stiffer” modulus

Hydrogels

- Relatively lower oxygen permeability
- More potential issues with comfort
- More hydrophilic
- Higher water content
- Protein deposition
- “Softer” modulus



LENS SELECTION: WEAR SCHEDULES

Daily Disposables

- Deposits negligible
- Increased comfort
- Care solutions not required
- Parameter limitations (relative)
- Convenience
- Higher cost
- Environmental concerns

Monthly & Biweekly Replacement

- More prone to deposit buildup, lens degradation
- Variable comfort with wear duration
- Require care solutions
- Wider parameters (relative)
- Cost effective
- Compliance issues



CARE SOLUTION SELECTION

Hydrogen Peroxide

- Convenience
 - One step
- Preservative-free
- Better comfort
- Better protection
 - Coverage against Acanthamoeba

Multipurpose Solutions

- Compliance issues
 - Two-step (Rubbing or Rinsing)
- Preservative-containing (Antimicrobial agents)
 - Polyquaternium-1 (PQ-1)
 - Polyhexamethylene biguanide (PHMB)



Lens Selection: Takeaways

DAILY DISPOSABLES WHENEVER POSSIBLE

SILICONE HYDROGELS TEND TO PROVIDE BETTER COMFORT

HYDROGEN PEROXIDE SOLUTIONS ARE THE CARE SYSTEMS
OF CHOICE



OCULAR SURFACE MANAGEMENT



- **Bacteria (Staph)**
 - Hypochlorous acid
- **Demodex**
 - Xdemvy (lotilaner ophthalmic solution)
 - Tea tree oil
 - Okra-based cleansers (Zocular)
- **Manual Debridement**
 - BlephEx (in-office treatment)
 - NuLids PRO (in-office treatment)
 - ZEST (in-office treatment)
 - NuLids (at-home treatment)
- **IPL Treatment**
 - OptiLight



LIDS & LASHES

- **Dietary Treatment**
 - Omega-3 fatty acid supplementation
 - Shown to improve contact lens-related dryness
- **Tear Film Stabilizers**
 - Perfluorohexyloctane (Miebo)
 - Blink exercises
 - 20-20-20 Rule
- **Palliative Treatment**
 - Warm compresses + massage
 - Preservative-free artificial tears



MEIBOMIAN GLANDS & LIPID LAYER

- **Procedures**
 - **Thermal Pulsation & Gland Expression**
 - LipiFlow
 - iLux
 - TearCare
 - **Radiofrequency**
 - **IPL Treatment**
 - OptiLight



MEIBOMIAN GLANDS & LIPID LAYER

- **Anti-inflammatories**
 - Immunomodulators
 - Lifitegrast (Xiidra), Cyclosporine (Cequa, Restasis, Vevye), Tacrolimus
 - Steroids
 - “Soft” steroids (loteprednol)
- **Neurostimulators**
 - Varenicline (Tyrvaya)
 - iTear100
- **Lubricants**
 - Preservative-free artificial tears



LACRIMAL GLAND & AQUEOUS LAYER

- **Regenerative Treatments**

- Autologous serum
- Platelet-rich plasma
- Amniotic membranes
 - Cryopreserved (Prokera)
 - Dehydrated

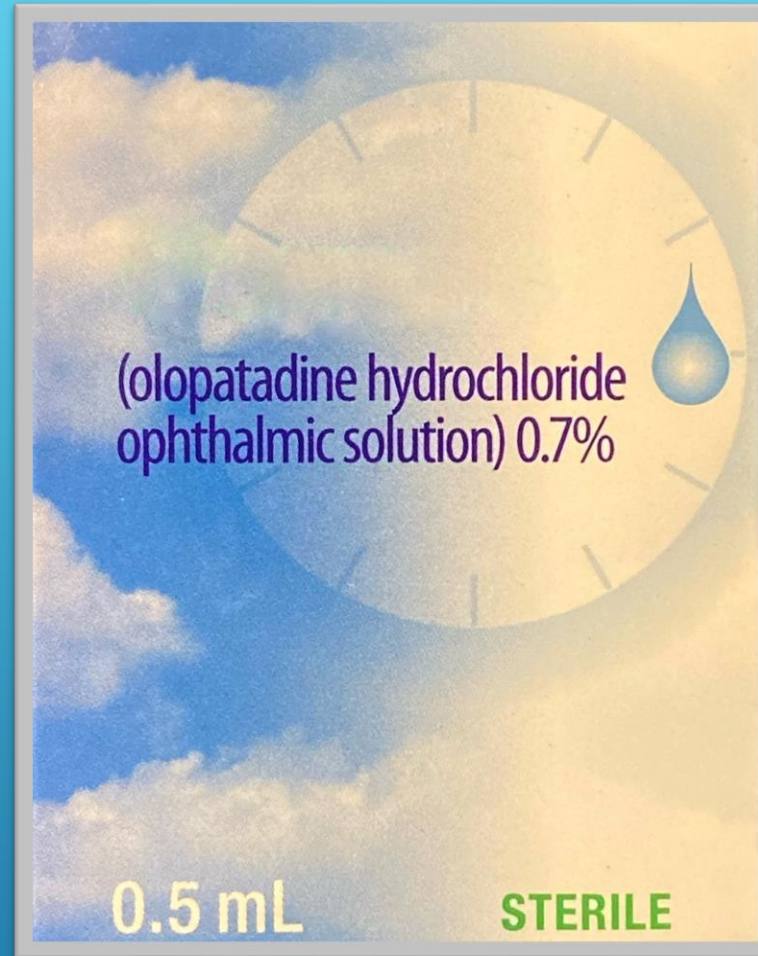
- **Procedures**

- IPL Treatment
- OptiLight

LACRIMAL GLAND & AQUEOUS LAYER

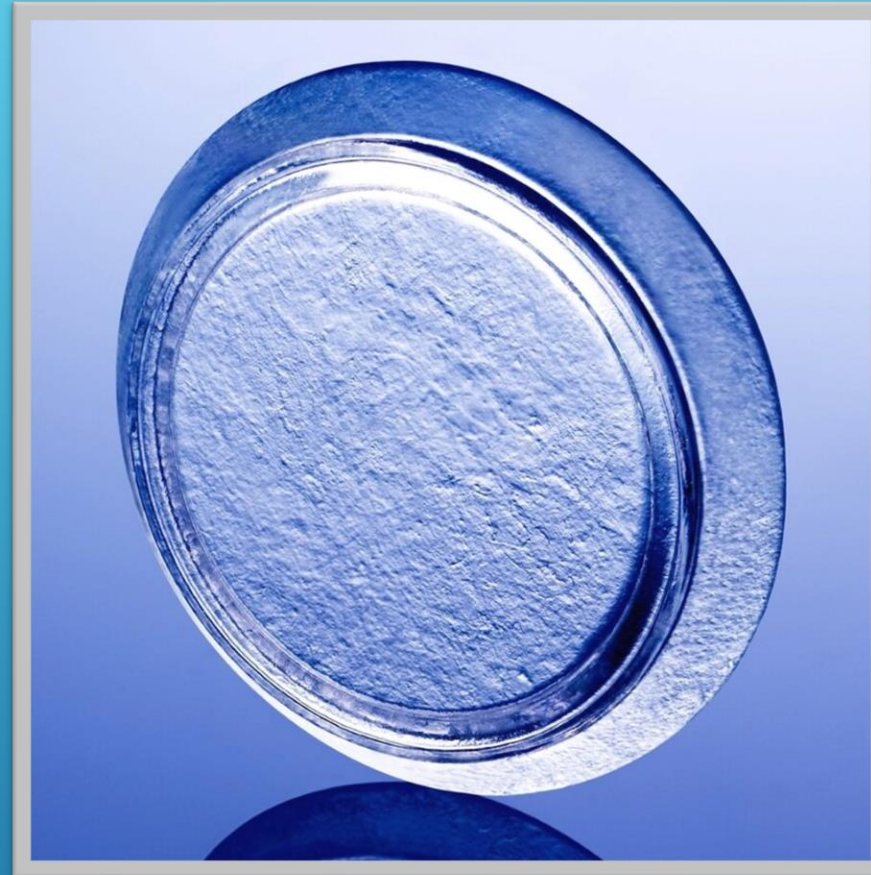


- **Antihistamine-Mast Cell Stabilizer Combos**
 - Olopatadine
 - Alcaftadine
- **Preferential Exclusion**
 - Ectoin (Allegro)
- **Anti-inflammatories**
 - Steroids (topical and oral)
- **Immunomodulators**
 - Cyclosporine (Verkazia)
 - Tacrolimus
- **Ketotifen-eluting Contact Lenses**



ALLERGIES

- **Regenerative Treatments**
 - Cenegermin-bkbj (Oxervate)
 - Recombinant human NGF
 - Autologous serum
 - Platelet-rich plasma
 - Amniotic membranes
 - Cryopreserved (Prokera)
 - Lyophilized (XcellerEYES)
 - Dehydrated
- **Neurostimulators**
 - Tyrvaya
 - iTear100
- **Surgical**
 - Tarsorrhaphy
 - Conjunctival flap
 - Corneal neurotization surgery



NERVES

INTENSE PULSED LIGHT (IPL)

- **MGD**
 - Improves meibomian gland structure, function, quality of meibum, and tear breakup time
- **Inflammation**
 - Reduces inflammatory factors found in tear film and ocular surface
- **Ocular Rosacea**
 - Destroys proinflammatory telangiectatic blood vessels
- **Blepharitis**
 - Decreases Demodex and bacterial populations on lids and lashes
- **Contact Lens-Related Dry Eye**
 - Has been shown to improve symptoms



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CLINICAL PEARLS



CLINICAL PEARLS

- A sign of things to come
- Do not overestimate adaptation
- Discuss expectations
- Save wearing time for when most needed
- “If it ain't broke, don't fix it”
- Do not fear spherical equivalent
- The right artificial tear for the job
- Red means stop
- Rinse lenses out of blister pack
- Part-time wearers are excellent candidates for dailies
- When in doubt, go with dailies
- Complications: Strike one...you're still out (and into an new lens)
- Lens selection **AND** ocular surface optimization, **NOT OR**
- Personally try lenses



SUMMARY



Summary

SOFT CONTACT LENS WEAR PRESENTS A HOMEOSTATIC
CHALLENGE

PROPER LENS SELECTION MINIMIZES DISRUPTION TO THE
OCULAR SURFACE

OPTIMIZING THE OCULAR SURFACE WILL MAXIMIZE
CONTACT LENS COMFORT AND SUCCESS



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Thank you!

