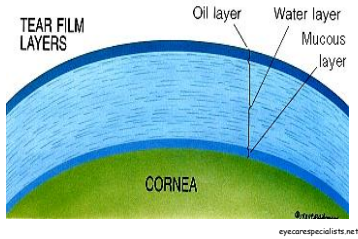
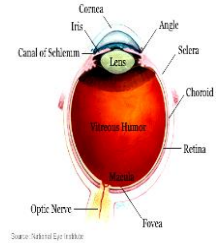


A Team Approach To Dry Eyes: Anatomy & Testing



Fun Facts About The Cornea

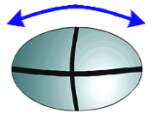
The cornea is the *first* and most powerful refracting surface in the optical system. It is the anterior 1/6th of the eye and inserts into the sclera at the **limbus**.



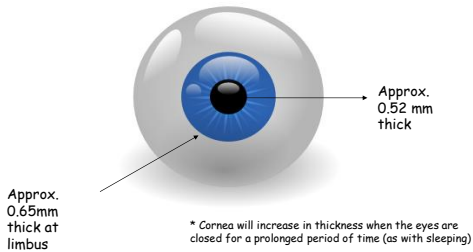
- Transparent
- Radius of curvature of the anterior surface is approx. 7.8 mm (*this can vary between 7.0 - 8.5mm and still give good vision*)
- **Shorter** the radius, **higher** the refractive error and **higher myopia**
- Curvature may be different in various meridians. This is an indication of **astigmatism** (one meridian being steeper than the other)



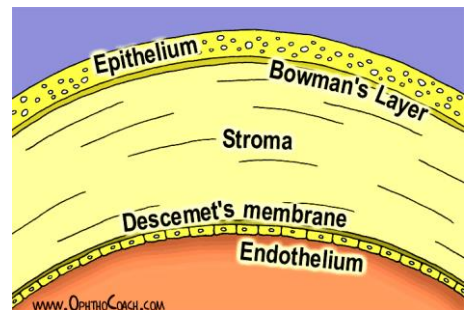
- Refractive index = 1.376
- Refractive power = 43.0D
- **Astigmatism with the rule:** more radius of curvature in the **vertical** meridian (90°) than the horizontal.
- **Astigmatism against the rule:** as we age, this changes so the power is more **horizontal** (180°) than vertical.

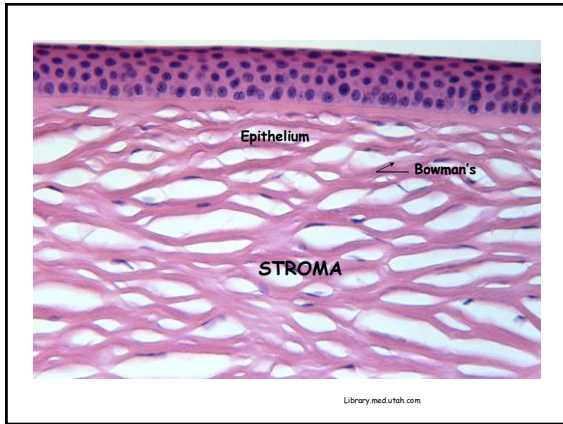


Average corneal thickness = 540 microns
measured by pachymetry



Layers Of The Cornea





Layers of the Cornea

- a. **Epithelium:** regenerates easily. Made 5-6 layers of cells
- b. **Bowman's membrane:** hyaline (transparent) membrane. Epithelium is loosely attached but stroma is very adherent. *Does not regenerate.*
- c. **Stroma:** 90% of cornea. Primarily made of collagen.

Composite image showing three layers of the cornea. The top part shows the epithelium (5-6 layers of cells) and Bowman's membrane. The middle part shows the corneal stroma. The bottom part shows the Descemet's membrane and endothelium. Labels: epithelium, Bowman's membrane, corneal stroma, Descemet's membrane, endothelium. Source: Slideshare.net

- d. **Descemet's membrane:** clear, elastic membrane.
- e. **Endothelium:** *single layer* of cells that are bathed posteriorly by aqueous. Does not regenerate. As we age, cells *are* lost. Responsible for maintaining "deturgescence" of the stroma

Composite image showing the layers of the cornea. The top part shows the epithelium and Bowman's membrane. The middle part shows the corneal stroma. The bottom part shows the Descemet's membrane and endothelium. Labels: epithelium, Bowman's membrane, corneal stroma, Descemet's membrane, endothelium. Source: Quizlet.com

Corneal Dehydration

The cornea remains clear by "**deturgescence**" ("relative state of **de**hydration"). The endothelial cells pump water out of the cornea to keep it dehydrated.

If the cornea is injured, the *stroma* begins to swell, causing **edema** (loss of transparency). Patients may complain of "halos" around lights.

Illustration of a person using a pump to remove water from a container, symbolizing the process of deturgescence.

Cornea In Disease

The cornea is **avascular**. Bowman's offers **little** resistance to disease and is easily injured, whereas Descemet's is **very** resistant. If the cornea is injured, it *will* begin to grow new blood vessels (vascularization). These vessels may eventually empty of blood, but the vessels will remain ("ghost vessels").

Two images showing corneal vascularization. The top image shows a normal cornea. The bottom image shows a cornea with vascularization, where new blood vessels have grown into the stroma. Source: Studyblue.com

Cornea Vascularization

"Ghost Vessels"

Two images showing corneal vascularization. The left image shows a cornea with vascularization, where new blood vessels have grown into the stroma. The right image shows "ghost vessels", which are empty vessels that remain after the blood has been removed. Source: Studyblue.com

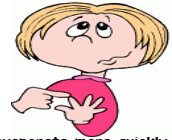
Corneal Disease Symptoms

- a. Halos (edema is present)
- b. Decreased vision
- c. **PAIN !!!!!**
- d. Foreign body sensation or burning
- e. Reflex tearing



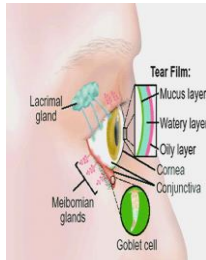
How Do You Get Dry Eyes

- **Medications:** Antihistamines, decongestants, antidepressants, BP medications and birth control pills.
- **Medical conditions:** Blepharitis and diseases that cause eye inflammation because they affect tear production. Allergies and seasonal allergies. Diabetes, rheumatoid arthritis, and thyroid problems. Vitamin overuse or deficiency.
- **Environmental conditions:** Tears may evaporate more quickly when exposed to smoke, dry air, or wind. Computer screen/television chronic use because you blink less frequently.
- **Long term contact lens use and laser vision correction**



Dry Eye Anatomical Changes

A reduction in the number of conjunctival goblet cells occurs on the surface of the eye .
 "Goblet cells" are **mucous** containing cells. Mucous is one of the most slippery substance in the human body.



Oph.edu.com

Dry Eye Symptoms

The main symptom is a scratchy, sandy or foreign body sensation.

- Other symptoms *may* include:
- stinging or burning of the eye
 - episodes of excess tearing
 - stringy discharge from the eye
 - pain and redness .
 - blurred, fluctuating, or decreased vision



Who Is More Prone To Dry Eyes ?

Dry eye is more common in **women**, especially women who are **post menopausal**.

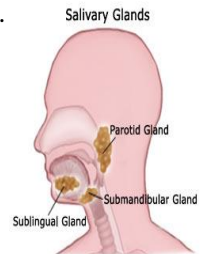
Some dry eye patients may have tears that run down their cheeks due to they eye producing less of the **lipid** and **mucin** layers of the tear film.

When this happens, tears don't stay in the eye long enough to moisten it.



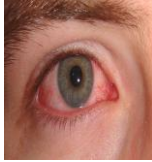
People with **connective tissue diseases** (i.e. rheumatoid arthritis) .

Dry eye can be a symptom of **Sjogren's Syndrome**, an **autoimmune** disease that attacks lubricating glands, such as the tear and salivary glands.



Medication and Dry Eyes - Vasoconstrictors

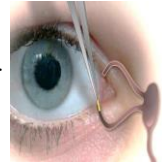
• Drops that are advertised to "get the red out" or to treat dry eyes. These drops *can* reduce or eliminate eye redness temporarily, but not because the problem is resolved. The drops cause the blood vessels to shrink and appear less red and injected. They may or may not be lubricating the eye.



• The vasoconstrictors that reduce redness by contracting the eye's blood vessels can be "**addictive**" because more and more is needed to achieve the same effect. Frequent use causes the effect to diminish after a while. The blood vessels simply won't constrict as much as they did when you first used the drops!

Punctal Plugs

A **punctal plug** is inserted into the tear duct (puncta) of the eye to block the duct. This prevents drainage of tears from the eye. They are a temporary occlusion that is often tried before permanent occlusion. They are made of **collagen** and are dissolvable. There are also permanent plugs that are usually made of **silicone**. For maximum effectiveness, use the largest size that fits should be used. Silicone plugs are usually more effective than collagen plugs.



Eyetebeed.com

Plugs vs. Cautery

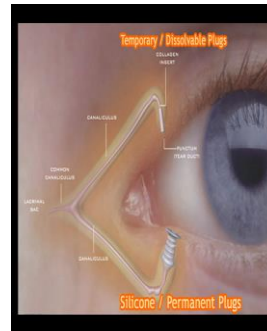
Punctal plugs

Originally designed as a temporary solution, punctal plugs can be left in for long periods or they can be reversed/removed easily.



Punctal cautery

The puncta is permanently occluded by creating scar tissue using heat.



Some doctors use a local anesthetic before inserting the punctal plugs, but in most cases, no anesthetic is needed. Materials used to make punctal plugs include silicone, collagen, and hydrogel. Some punctal plugs are coated with a "slick" surface for easier insertion

Punctal Cautery

Permanent (irreversible) alternative to plugs. If your dry eye symptoms disappear after using temporary plugs, the doctor may decide to do permanent occlusion.

The most common methods are:

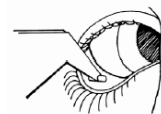
- **Electrodesiccation** - closing with electricity
- **Thermal cautery** - closing with heat



Occasionally, permanent occlusion may need to be repeated in order to be fully effective.

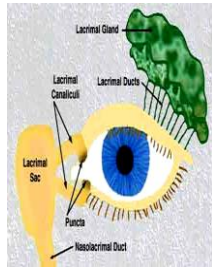
Lacriserts

A sterile, translucent, rod-shaped, water soluble, ophthalmic insert made of hydroxypropyl cellulose. Designed to "sit" in the inferior cul-de-sac of the eyelid



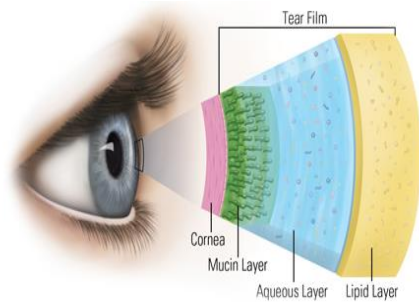
Lacrimal System

Lacrimal gland : tear secretor.
Tears drift down over the cornea and the conjunctiva.
Puncta : upper and lower lids nasally.
Canalicula : 1mm in diameter and approx 8 mm long.
"Wet spaghetti".
Lacrimal sac : Opens into the **Nasolacrimal duct** :
in the back of the nose



Newporteyecare.com

Tear Film Layer

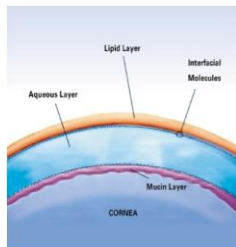


Theeyecarecompany.com

What "Makes" Your Tear Film ?

• **Lipid Layer**
("top layer"):

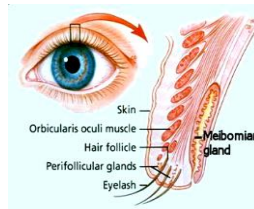
Oily layer secreted by the **meibomian glands**.
Decreases evaporation



Dryeyes.com

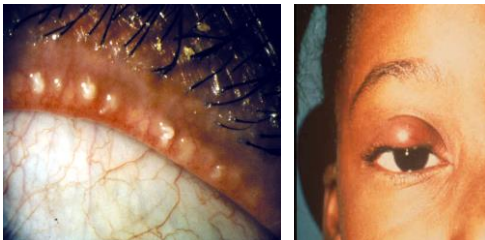
Meibomian Glands

Meibomian glands are **sebaceous** glands located in the tarsal plates. They produce a fatty substance that helps create an "oily" layer to the tear film



Suggest-keywords.com

Problems With Meibomian Glands



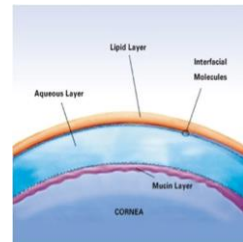
Lookfordiagnosis.com

What "Makes" Your Tear Film ?

Aqueous Layer
("middle layer"):

Watery layer secreted by:
a. the lacrimal gland
b. glands of Krauss & Wolfring

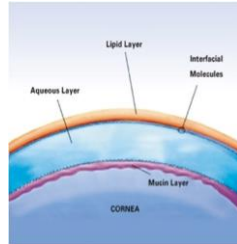
Contains salts and proteins and forms bulk of the tear film



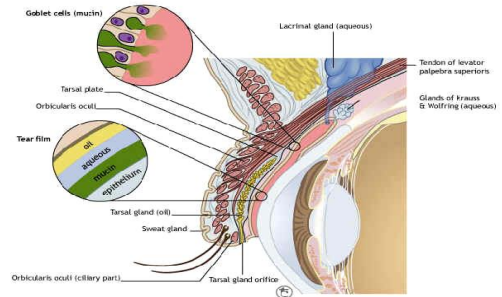
What "Makes" Your Tear Film ?

Mucin Layer ("inner layer"):

"Anchored" to the epithelial surface cells of the cornea and conjunctiva and aids tear adherence to the cornea. Secreted by the goblet cells (located in the conjunctiva). A decrease in this would cause the tears to "slide" off the cornea.

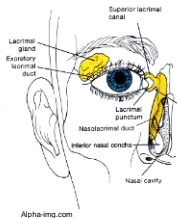


Goblet Cells

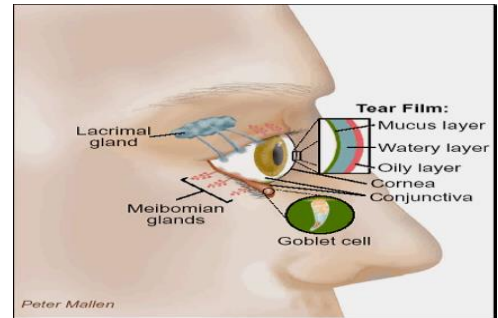


Lacrimal Gland

The lacrimal gland and the glands of Kraus and Wolfring make up the bulk of the layer of the tears. Tears emitted from the gland wash over the eye and are pulled toward the puncta by **capillary attraction**.



Alpha-imp.com



Peter Mallen

Tear Facts

- Protein (albumin) makes up 60 % of your tears
- Immunoglobulins IgA, IgG and IgE
- There are glucose *and* urea tears
- Average pH of tears is 7.35**
- Tears are *isotonic* (has the same salt concentration as blood)

Concentration of hydrogen ions compared to distilled water	pH	Examples of solutions and their respective pH
1/10,000,000	14	Liquid drain cleaner, Caustic soda
1/1,000,000	13	Struhen, oven cleaner
1/100,000	12	Soppy water
1/10,000	11	Household Ammonia (11.5)
1/1,000	10	80% of soapwater (10.5)
1/100	9	Toothpaste (9.5)
1/10	8	Baking soda (8.4), Bessener, Rige
0	7	"Pure" water (7)
10	6	Urine (6.5-8)
100	5	Acid rain (5.6)
1,000	4	Black coffee (5)
10,000	3	Tomato juice (4.5)
100,000	2	Grapefruit & Orange juice, 50% juice
1,000,000	1	Lemon juice (2.3), Vinegar (2.5)
10,000,000	0	Hydrochloric acid secreted from the stomach (strong 0)
		Battery Acid

Ingrcode.com

So... How Do You Measure Tears ?



Schirmers Testing

- Paper is 3mm x 20mm
- Paper is placed between the middle and nasal third of the lower eyelid margin
- Have patient blink normally !
- Perform testing for 5 minutes



Schirmers Testing

- **Schirmers Ia** : *without* topical anesthesia. Measures reflex tear (the eye thinks there is something in it and tears to "wash" it out)
- **Schirmers Ib** : Basic tears. The eye is "numbed" so it does not feel the paper. It is important that after you instill the drop, you swab the fornix to remove the excess fluid.

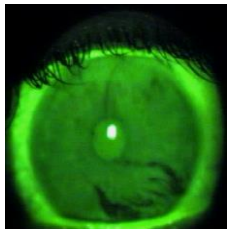
Jones Testing

- * Instill one drop of fluorescein into the conjunctival sac
- * Put a cotton bud soaked in anesthetic in the nose.
If fluorescein is detected after **five minutes**, the system is patent (open).
If no fluorescein is discovered, this is a negative Jones I
- * Next, wash the excess fluorescein from the conjunctival sac with a syringe. *If* fluorescein is detected, then this shows it had entered the sac and constitutes a positive Jones II Test



Tear Break Up Time (TBUT)

TBUT is the time elapsed between a complete blink and the development of the first random dry spot on the tear film. A drop of fluorescein is instilled. The doctor times how long it takes for the first dry spots to show.



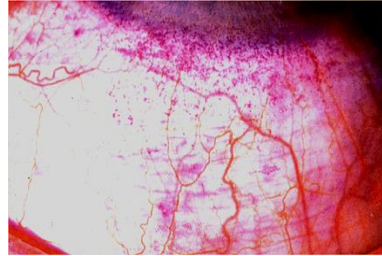
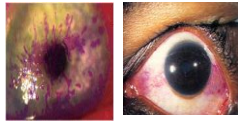
Lasikcomplications.com

The normal blink interval is every 5 seconds and tear film is typically stable for about 10 seconds.
A TBUT of **less than 10 seconds** is considered **abnormal** and suggests an unstable tear film.
Mucin and lipid tear film problems produce an unstable tear film and result in a **rapid** TBUT.



Rose Bengal

Rose bengal is a water soluble dye. When applied to the ocular surface, it is absorbed by epithelial cells (corneal or conjunctiva) that are **damaged** or is absorbed by mucin. Positive staining of the conjunctiva with rose bengal is consistent with a diagnosis of dry eye syndrome.



0.5% Lissamine Green

Stains epithelium that is **mucin deficient or degenerating**.

Lissamine green is best viewed in low intensity white light at 16 mag. The dye will start to diffuse out of the tissue after 90 seconds.

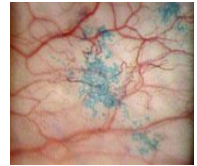


GRobmed

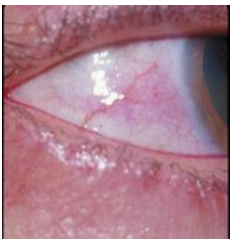
Both stain dry and dying cells on the eye, with rose bengal being used more often.

Lissamine green has a better patient acceptability because it stings less and is pain free. It is just as effective as rose bengal in terms of staining ability.

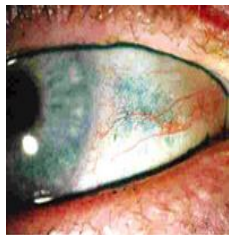
Ideally, the doctor would look at both fluorescein staining and lissamine staining to evaluate the extent of the damage to the eye surface.



Rose Bengal vs Lissamine Green

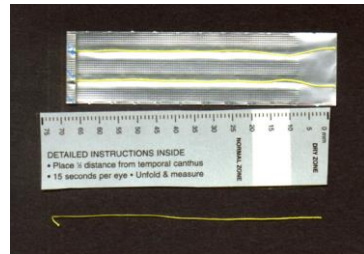


Rose Bengal Staining



Lissamine Green Staining

Phenol Red Thread



Whiteop.ca

- A sterile cotton thread is draped over the *non-anesthetized lid margin*.
- When aqueous touches the thread, the thread changes color.
- The colored thread is then measured.
- Evaluates tear secretion quantity *without* inducing significant reflex tearing. It *may* be a better test of **aqueous** production than the Schirmer test because it doesn't stimulate reflex tearing and only lasts **15 seconds** vrs 5 minutes. Normal is a reading of **13±4 mm** of wetting over a fifteen second period.

So... now we can see that the phrase: "Dry Eyes" can leave you out on a ledge! It's not enough to say "I don't have enough tears." What has to be evaluated is what **part** of the tear film is deficient!

