LACRIMAL OUTFLOW PHYSIOLOGY

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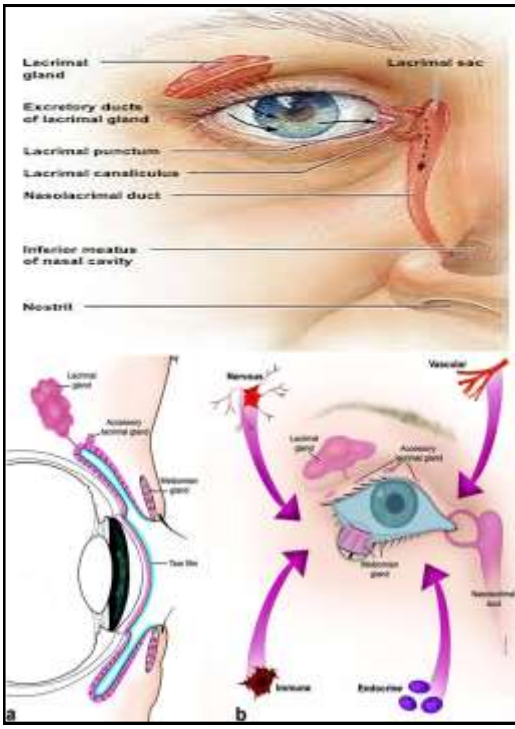


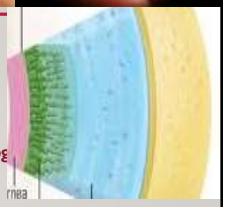
LACRIMAL SYSTEM

- The function of the lacrimal system is to create an ideal environment for visual functions of the eye.
- And optimizing the nutrition and defence of the ocular surface.
- It accomplished by balance between the lacrimal secretion and drainage system .
- both components of the system are linked functionally and anatomically by continuity of the epithelia, by innervation, and by the endocrine, vascular and immune systems
- failure of drainage system , produces not only epiphora but also compromises the functional balance of the entire ocular surface .

TEAR FACTS

- Average tear flow of 1.2 µl /min with a range of 0.5 to 2.2 µl /min
- The average normal tear volume is 6.2 ± 2.0 µl.
- So The entire tear volume in the eye turns over every 2 to 3 minutes.
- Capacity of conjunctival sac 25-30 ul which when exceeded tearing occurs .

CHALLENGES OF LACRIMAL DRAINING



CHALLENGING ASPECTS IN TEAR DRAINAGE

- How to push the tear in the very narrow 0.3 mm wide opening (punctum)
- How to drain a Diversity of viscosity and rheological characteristic of tear components (mucin ,aqueous and lipid layer.)
- How to Drain the debris and F,B without adhering to the already narrow lacrimal drainage system .
- How to Drain bacteria and other organisms that might infect the drainage system it self .
- How to drain a wide range of volumes (dry to cry) from same sized punctum .

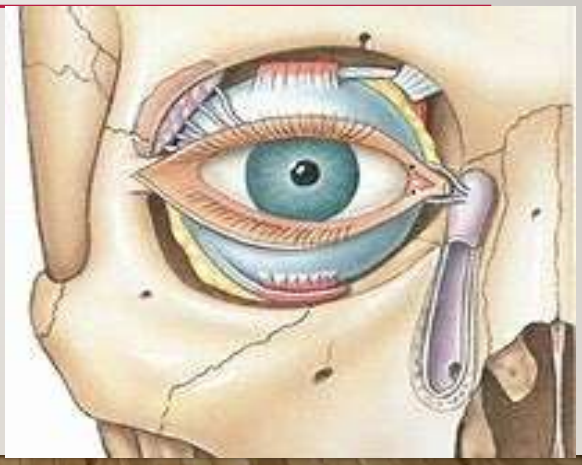
IDEAL DRAINAGE SYSTEM

- **Should have a pump to push the tears into the lacrimal system.**
- **Fits for drainage of different viscosity and different rheolog structures.**
- **Should have non adhering properties .**
- **Should have antimicrobial capabilities .**
- **Should have some feed back inhibition or excitation on the ocular surface to control the amount of tears .**
- **Should accommodate wide change of amount drained ???**
- **Should not allow retrograde tear flow back in the conjunctival sac .**

TEAR DRAINAGE IS THE SUM OF INTERACTION BETWEEN 3 POTENTIAL SPACES

- **Conjunctival space .**
- **Lacrimal space.**
- **Nasal space** .

- ***Variation of the pressure between the 3 spaces created and aided by blinking ,sac factors and nasal factors help in drainage of tears .***



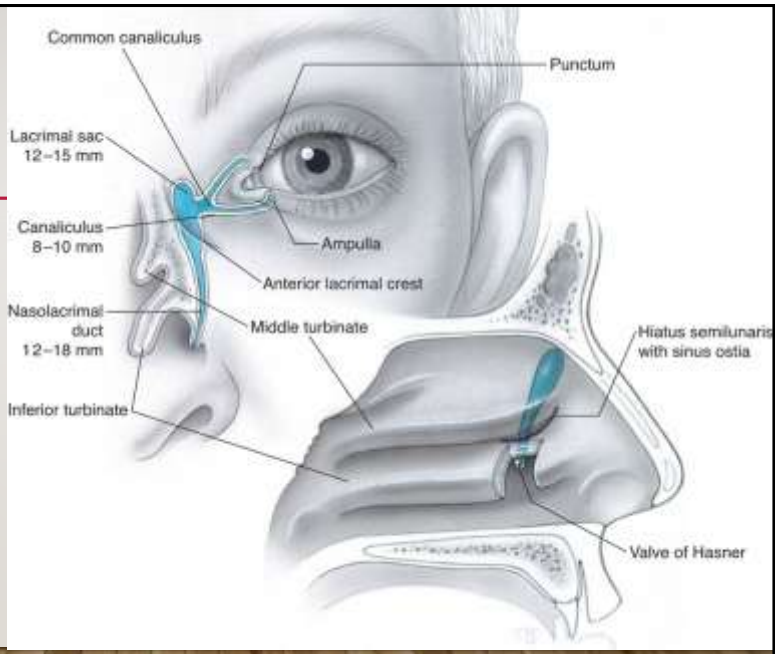
MECHANISMS OF TEAR DRAINAGE

Physical	Prelacrimal system	Lacrimal	Nasal
gravity	Lacrimal pump mechanism	**Epithelial secretion products (mucins and TFF peptides of the epithelium of the lacrimal sac and nasolacrimal duct).**	Air current in the nose induce negative pressure to in relation to nasolacrimal duct help in draining .
Capillarity.		**Wringing-out" mechanism governed by a system of helically arranged fibrillar structures** Valvular system keep unidirectional flow	
		role of cavernous body	
Evaporation 10-25% of tears is eliminated by evaporation		**Absorption of tear by the lining epithelium of the lacrimal sac and nasolacrimal duct**	

LACRIMAL PUMP SYSTEM

FUNCTIONAL ANATOMY

- For good Draining of Tears
- **Good lid margin and fair lid muscle tone.**
- **Smooth external ocular surface .**
- **Normal position of punctum**

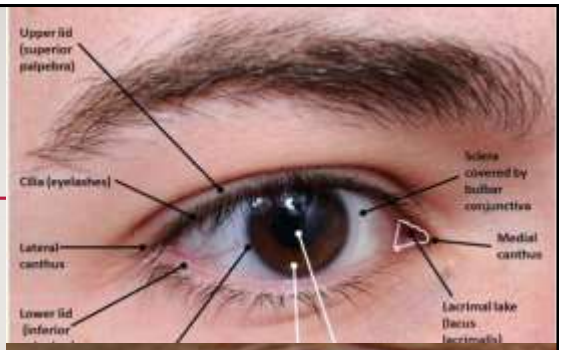


TEAR PATHWAY

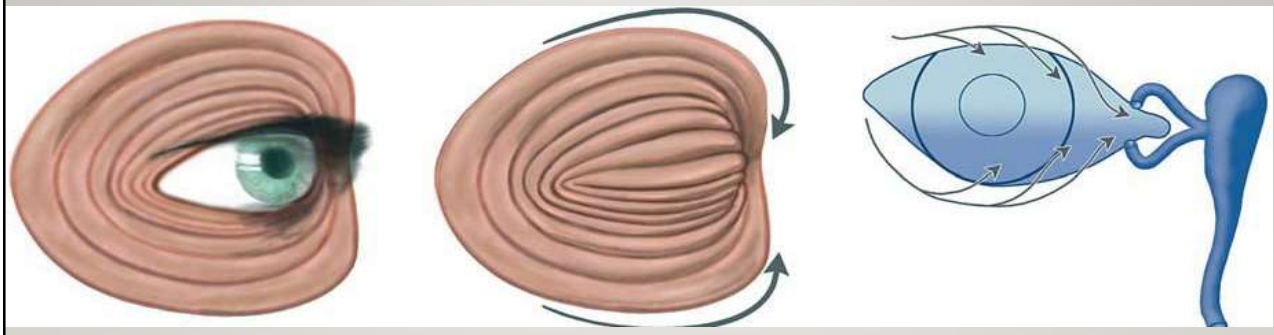
Tears → Lacrimal lake → Canaliculus via Punctum mainly by capillarty → Lacrimal sac → Nld and nose

LACRIMAL LAKE

- is the area in the inferior medial angle of eye in apposition with the puncta .
- is the like a lake of tears formed by meeting of 2 tributaries (the upper and lower marginal tear strips)
- The volume of the lacrimal lake is between 7 and 10 µL.
- ***CLINICAL HITS***
- PUNCTAL MALPOSITION PUNCTUM IS NOT FACING THE LAKE , epiphora occurs .(ectropion .fascial palsy).
- DECREASE LAKE AREA AND RESERVOIR IN Enlarged caruncle due to mass or chronic inflammation or mucus fishing leads to epiphora
- Scarring of lower fornix decrease the lake capacity leading to epiphora (OCP.TRACHOMA)



HOW TEARS COLLECT IN THE LACRIMAL LAKE . I ST **STEP** IN TEAR DRAINAGE.



- **Active** :Lid closure leads to a time shifted contraction of the palbebral part of orbicularis from temporal to nasal with pushing the tears to the lacrimal lake .
- **Passive**. gravity effect (lateral canthus is higher than medial canthus by 2mm)

2ND FROM LACRIMAL LAKE TO PUNCTUM

- ***CAPILLARITY***. is the ability of a liquid to flow in narrow (punctum) without the assistance of, or even in opposition to, external forces like gravity. **Avoid over dilation of the punctum and cheese wiring not to interrupt capillarity .**
- **LACRIMAL PUMP.**

3 DIFFERENT THEORIES OF LACRIMAL PUMP MECHANISM .

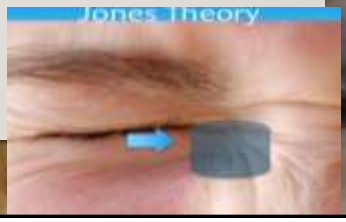
VIA PRETARSAL AND LACRIMAL PART OF ORBICULARIS SURROUNDING CANALICULUS AND UPPER PART OF THE SAC

ROSENGREN-DÖANE

- **. Eye open Tears are sucked into the canalicular system .**
- **Eye closed tear moves along the nasolacrimal duct due to sac compression**

JONES

- 0pen eye :Tears moves along the sac and NLD
- eye closed tears are sucked into the canalicular system.



BECKER'S THEORY TRICOMPARTMENT THEORY

COMBINES ELEMENTS FROM BOTH JONES' AND ROSENGREN-DÖANE THEORIES

LID CLOSURE

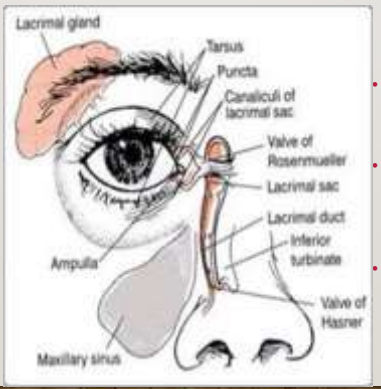
orbicularis muscle contracts

- **close the canaliculi .**
- **superior half of the lateral wall of the lacrimal sac laterally.**

This creates a NEGATIVE pressure in the superior sac SO tears moves from the canaliculi into the sac

At the same time.

the inferior half of the lateral sac wall moves medially positive pressure in the inferior sac and nasolacrimal duct forcing tears down the duct into the nose

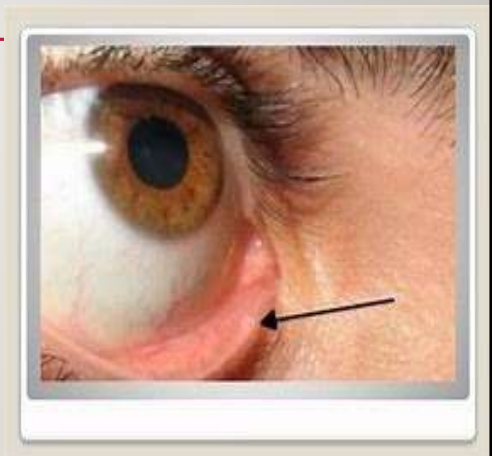


LID OPEN

- 0rbicularis muscle relaxes:
  - **Open the Canaliculi .**
- **Superior half of the lateral sac wall to move medially.**
- The resulting negative intracanalicular pressure allows tears to flow from the lacrimal lake into the canaliculi.
- the higher pressure in the superior sac closes the valve of Rosenmueller and forces tears from the superior to inferior sac and proximal nasolacrimal duct.
- At the same time, **the inferior half of the lateral sac wall moves laterally,** resulting in a negative pressure in the inferior sac and nasolacrimal duct.

CANALICULAR VS LACRIMAL PUMP MECHANISM

- Canalicular pump is probably more important than the sac pump(because following DCR, sac pump decrease and still tears are well drained)
- ***The pressure gradient between the canaliculi and the sac cannot be produced if the canaliculus is slit open.***
- The lacrimal canaliculi should be preserved and should not be damaged.
- Canalicular Pump action is equivalent in the upper and lower canalicular systems.



LACRIMAL 'PUMP' FUNCTION FAILURE

- Manifested with Watery epiphora.
- It often occurs despite the lack of obvious causative factors(eyelid malpositions, trichiasis, ocular surface inflammations and any stenosis at the lacrimal outflow route).
- Watery epiphora (not mucopurulent epiphora) can follow a successful DCR.
- It compromises the results of an anatomically successful procedure.
- Horizontal shortening of the lower eyelid to augment the action of the lacrimal "pump".

LACRIMAL SAC AND NLD ROLE IN DRAINAGE

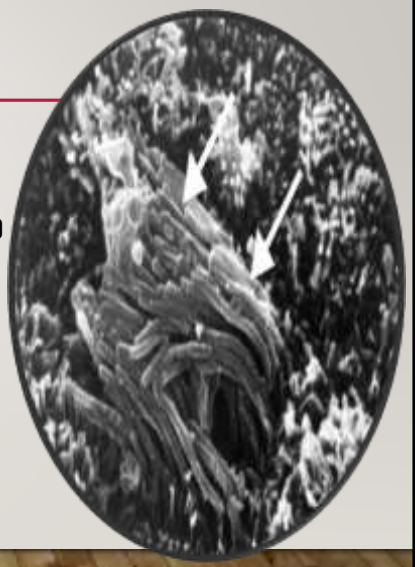
- **Continues unidirectional movement of sac and NLD microvilli towards the nose .**

- **Epithelial secretion products (mucins and TFF peptides) of the lacrimal sac and nasolacrimal duct.**

lubricating the mucosa and "waterproofing" to regulate epithelial cell hydration.

Mucins protect mucosal surfaces against potentially harmful substances;

Secretory IgA (sIgA) is incorporated into the mucus layer of mucosal surfaces, supplementing the protective activity.



- **"Wringing-out" mechanism : due to contraction of**

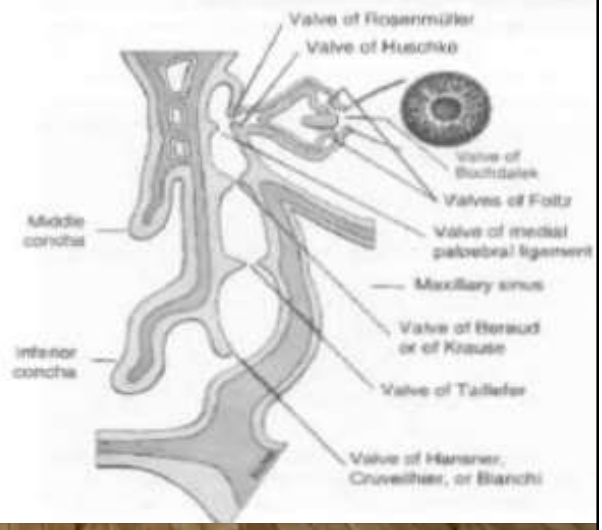
Helically arranged fibrillar structures of the lacrimal sac wall.

- **Absorption of tear by the lining epithelium of the lacrimal sac and nasolacrimal duct helps in tear elimination .**

UNIDIRECTIONAL FLOW DUE TO VALVE ACTION

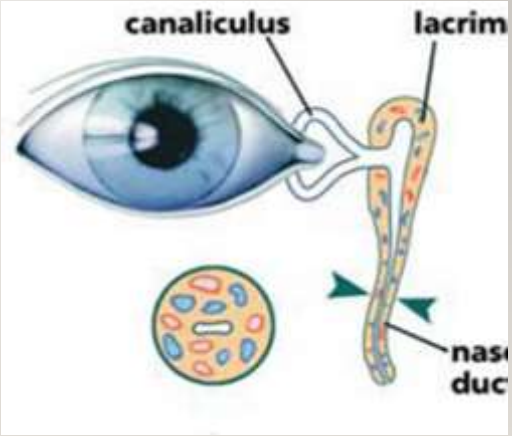
The valves

- They are folds of mucous membrane with no valvular function.
- The most constant is the 'valve' of Hasner at the lower end.
- It prevents sudden blast of air (when blowing the nose) from entenng the lacrimal sac.



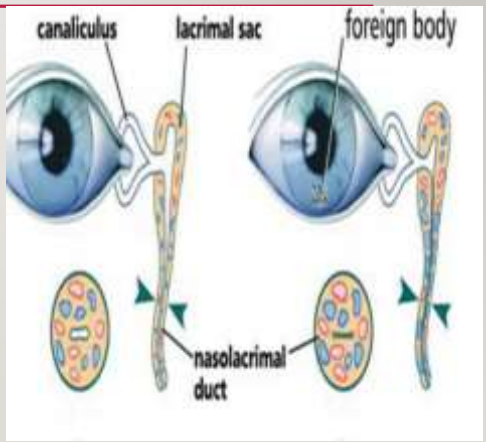
CAVERNOUS BODY OF THE LACRIMAL PASSAGE

- The lacrimal sac and NLD are surrounded by a wide cavernous system of veins and blood vessels .
- It richly innervated to permit regulation of tear flow by engorgement and subsidence of the cavernous body.
- It's presence explained the occurrence of epiphora related to emotional responses ..



EMOTIONAL AND REFLEX TEARING

- Epiphora related to emotions such as sorrow or happiness occur by
  - **increased tear secretion from the lacrimal gland**
  - **closure of the lacrimal passage due to engorgement of cavernous tissue in the sac wall (NERVOUS EFFECT).**
  - If F.B enter the conjunctival sac the engorgement of the cavernous tissues provide protection against foreign bodies by flushing out the foreign body and protect the efferent tear ducts themselves



NASAL MECHANISM OF DRAINAGE .

- Gravity helps down ward flow .
- Air current in the nose induce negative pressure within NLD.
- This draw the fluid down the potential lumen of the duct into the nose .
- Hasner's valve at lower end of NLD remains open as long as the pressure within nose is less than NLD .
- This allow the tears to flow from NLD to the nose .
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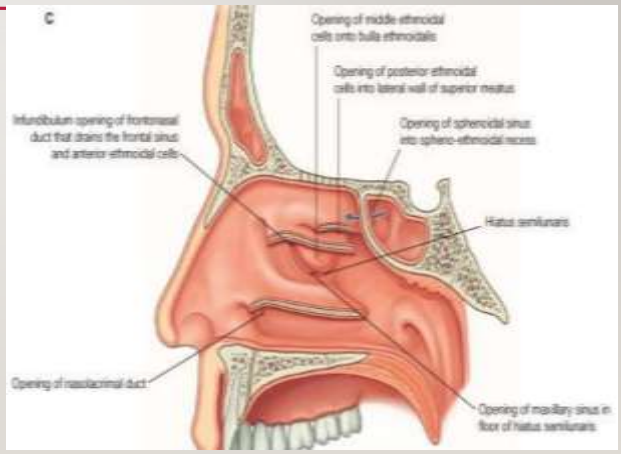

THE LACRIMAL MUCOSAL IMMUNE SYSTEM

- The mucosa of the nasolacrimal ducts has a number of different nonspecific defence systems that can protect against dacryocystitis.
- has lymphoid tissues
- The epithelial cells produce a spectrum of different antimicrobial substances,
- **lysozyme, lactoferrin, and secretory phospholipase A2, and defensins**.
- which protect against the physiological germ flora inside the lacrimal passage.
- **With threatened infectious and/or infl ammatory dacryocystis,** changes in the expression pattern occur, inducing production of some of the antimicrobial substances, e.g., antimicrobial peptides, such as human inducible beta defensins 2 and 3, which are not produced under healthy conditions.

THANK YOU