"LACRIMAL SYSTEM" 💧

OVERVIEW

The lacrimal system of each eye consists of two major components:

1️⃣ Secretory System → *Produces tears*

- Main lacrimal gland
- Accessory lacrimal glands

2️⃣ Excretory System → *Drains tears*

- Lacrimal puncta
- Lacrimal canaliculi
- Lacrimal sac
- Nasolacrimal duct

SECRETORY SYSTEM

❑ MAIN LACRIMAL GLAND

General Features

- Type: Exocrine gland
- Size & shape: Almond-shaped
- Location: Lacrimal gland fossa at anterolateral part of roof of orbit

Lobes

- Lateral horn of levator palpebrae superioris aponeurosis indents the gland
  → Divides it into:
  - Orbital lobe (upper)
  - Palpebral lobe (lower)

Ducts

- 10–12 excretory ducts
- Open into upper outer conjunctival fornix

Histology

- Composed of secretory epithelial cells

Functional Activation: Ocular surface irritation → Sensory stimulation → Increased tear secretion

---

BLOOD, LYMPH & NERVE SUPPLY

Blood supply

- Lacrimal artery (branch of ophthalmic artery)

Venous drainage

- Lacrimal vein → superior ophthalmic vein

Lymphatic drainage

- Preauricular lymph nodes

Nerve supply

- Sensory: Lacrimal nerve (ophthalmic division of trigeminal nerve – VI)
- Parasympathetic (secretomotor): Facial nerve → pterygopalatine ganglion

- Sympathetic (vasomotor): Fibers from superior cervical ganglion

---

2️⃣ ACCESSORY LACRIMAL GLANDS

General Features

- Small glands
- Same epithelial structure as main lacrimal gland
- Provide basal tear secretion

TYPES

i) Glands of Krause

- Located in conjunctival stroma
- Present in upper & lower fornices

ii) Glands of Wolfring

- Located near:
  - Upper border of superior tarsal plate
  - Lower border of inferior tarsal plate

EXCRETORY SYSTEM 🚿

COMPONENTS (with dimensions)

- Lacrimal punctum → ~0.3 mm
- Vertical canaliculus → 1–2 mm
- Horizontal canaliculus → 6–8 mm
- Common canaliculus → ~2 mm (if present)
- Lacrimal sac → 12–15 mm
- Nasolacrimal duct → 15–18 mm

ℹ️ LACRIMAL PUNCTA

- Small rounded openings on upper & lower lid margins
- Diameter: ~0.3 mm
- Located ~6 mm temporal to inner canthus
- Each punctum lies on a small elevation called lacrimal papilla

(ii) LACRIMAL CANALICULI

- Superior & inferior canaliculi connect puncta to lacrimal sac
- Each canaliculus has two parts:
  - Vertical part: 1–2 mm
  - Horizontal part: 6–8 mm

Drainage pattern

- Canaliculi may open separately into lacrimal sac
  OR
- Unite to form common canaliculus (average 2 mm)
  → Opens into lateral wall of lacrimal sac

(iii) LACRIMAL SAC

Location

- Lies in lacrimal fossa on medial orbital wall
- Bordered by:

    - Anterior lacrimal crest (formed by frontal process of maxilla)
    - Posterior lacrimal crest (formed by lacrimal bone)

Formation of fossa

- Lacrimal bone
- Frontal process of maxilla

Relations

- Lies posterior to medial canthal tendon

Dimensions

- Length: 12–15 mm
- Breadth: ~5–6 mm

(iv) NASOLACRIMAL DUCT

Course & Anatomy

- Extends from lacrimal sac to inferior meatus of nose
- Length: 15–18 mm

Segments

- Upper 12 mm → bony nasolacrimal canal
- Lower 6 mm → membranous part in lateral nasal wall

Direction: Downwards, backwards, laterally

- Opens into inferior meatus
- Guarded by Valve of Hasner

PHYSIOLOGY OF TEAR DRAINAGE 🔄

- Tears secreted by lacrimal gland → Spread across ocular surface
- 10–20% of tears → Lost by evaporation

- 80–90% of tears → Pumped by orbicularis oculi muscle → Puncta → Canaliculi → Lacrimal sac → Nasolacrimal duct → Nasal cavity

---

TEARS 💧

GENERAL FEATURES

- Secreted by lacrimal gland
- Begins 3–4 weeks after birth

COMPOSITION

- Water
- Electrolytes (NaCl)
- Sugar
- Urea
- Proteins
- Lysozyme (bactericidal enzyme)

QUANTITATIVE FEATURES

- Normal secretion rate: 1–2 μL/min
- Nature: Slightly alkaline
- Normal pH: 7.5

PRE-CORNEAL TEAR FILM 👁️✨

A very thin fluid layer over cornea consisting of three layers:

1) Lipid layer (outer)
2) Aqueous layer (middle)
3) Mucin layer (inner)

1️⃣ MUCIN LAYER (INNERMOST)

- Thinnest layer
- Secreted by:
    - Conjunctival goblet cells
    - Glands of Henle
    - Glands of Manz

Function

- Converts hydrophobic corneal surface → hydrophilic
- Allows uniform spread of tears

2️⃣ AQUEOUS LAYER (MIDDLE)

- Thickest layer
- Secreted by:
  - Main lacrimal gland
  - Accessory glands (Krause & Wolfring)
- Contains water, electrolytes, proteins & antibacterial substances

---

3️⃣ LIPID LAYER (OUTERMOST)

- Secreted by:
  - Meibomian glands
  - Glands of Zeis
  - Glands of Moll

- Composed mainly of cholesterol, esters & lipids

Functions

- Prevents tear overflow
- Retards evaporation
- Lubricates eyelids

FUNCTIONS OF TEAR FILM 🎯

1️⃣ Maintains health & transparency of ocular surface

→ Provides moist environment for corneal & conjunctival epithelium

2️⃣ Optical role

→ Makes anterior corneal surface smooth

→ Essential for proper refraction & clear vision

3️⃣ Nutritional role

→ Supplies oxygen & nutrients to avascular corneal epithelium

4️⃣ Antimicrobial role

→ Due to IgA, lysozyme & lactoferrin

5️⃣ Cleansing role

→ Removes debris & noxious irritants

6️⃣ Lubrication

→ Reduces friction between cornea & eyelids

EXAM PEARLS ✨

- Accessory glands → basal tear secretion
- Orbicularis oculi → tear pump
- Valve of Hasner → prevents nasal reflux
- Lipid layer → prevents evaporation
- Mucin layer → makes cornea wettable

DISEASES OF THE LACRIMAL DRAINAGE SYSTEM

Classification

1. Nasolacrimal duct obstruction (NLDO)
    - Congenital
    - Acquired
2. Dacryocystitis
    - Acute dacryocystitis
    - Chronic dacryocystitis

CONGENITAL NASOLACRIMAL DUCT OBSTRUCTION (CNLDO)

Definition

Failure of normal canalization of the nasolacrimal duct, most commonly at its lower end (valve of Hasner), leading to obstruction of tear drainage.

Aetiology

- Most common congenital anomaly of the lacrimal drainage system

- Due to non-canalization of the membrane at the lower end of nasolacrimal duct (valve of Hasner)
- At birth, the lower end of the duct is frequently non-patent but usually opens spontaneously within the first few weeks of life
- Failure of spontaneous opening leads to:
    - Epiphora (watering of eye)
    - Secondary infection
- Other developmental anomalies (less common):
    - Maldevelopment or atresia of punctum
    - Canalicular anomalies

Epidemiology

- Occurs in ~5% of full-term newborns
- Can be unilateral or bilateral
- Bilateral involvement is more common
- Symptoms usually appear at 3-4 weeks of age in 80-90% cases

Clinical Features

- Persistent watering of eye (epiphora)
- Sticky mucoid or mucopurulent discharge
- Discharge accumulates:
    - On eyelid margins
    - On eyelashes
    - Near the medial canthus
- Eyelids may be stuck together on waking

Regurgitation Test (ROPLAS)

- Gentle pressure over the lacrimal sac →
    - Reflux of clear fluid or mucopurulent material from puncta
- Indicates obstruction distal to the lacrimal sac

Complications

- Mucocele of lacrimal sac

- Conjunctivitis
- Acute dacryocystitis
- Chronic dacryocystitis
- Lacrimal fistula formation

Flowchart:

Congenital NLD block → Tear stasis → Secondary infection →

• Conjunctivitis

• Mucocele → Acute dacryocystitis → Chronic dacryocystitis → Fistula

---

Differential Diagnosis

- Punctal atresia
- Neonatal conjunctivitis (e.g. Chlamydia)
- Congenital glaucoma ⚠️ (important to exclude)
    - Watering + photophobia + blepharospasm
- Keratitis
- Uveitis

Treatment

Conservative Management (First line)

1. Observation

- Spontaneous patency occurs in:
  - ~90% cases by 6 months
  - ~95% cases by 9 months
- Therefore, invasive procedures are usually delayed till 6–9 months of age

2. Lacrimal Sac Massage (Crigler massage)

- Digital pressure applied over lacrimal sac
- Increases hydrostatic pressure → may rupture membranous obstruction
- Technique:
  - Downward strokes over lacrimal sac
  - 10 strokes, 4 times/day

3. Antibiotics

- Topical antibiotic eye drops
    - Used to control secondary infection
- Systemic antibiotics
    - Indicated if complications develop (e.g. acute dacryocystitis)

Surgical Management

Indications

- Failure of conservative treatment after 4–6 months

1. Probing

- Done under general anaesthesia
- Probe passed through:
  Punctum → Canaliculus → Lacrimal sac → Nasolacrimal duct
- Breaks membranous obstruction at lower end of duct

Results:

- ~90% cured by first probing
- Additional ~6% cured by second probing
- Failure usually due to abnormal anatomy

2. Syringing (Irrigation)

- Done to confirm:
    - Patency
    - Functional integrity of lacrimal drainage system

3. Other Options (for repeated probing failure)

- Silastic tube intubation
- Balloon catheter dilatation of nasolacrimal duct

4. Dacryocystorhinostomy (DCR)

- Creation of an opening (ostomy) between the lacrimal sac (near the inner eye corner) and the nasal lining.
- Indicated when epiphora persists despite above procedures
- Usually performed after 5–6 years of age

AMNIOTOCELE (CONGENITAL DACRYOCELE)

Definition

Bluish-gray, cystic swelling over lacrimal sac region due to collection of:

- Amniotic fluid or
- Mucus

Occurs due to congenital nasolacrimal duct obstruction at the valve of Hasner

---

Clinical Features

- Present at birth or soon after
- Bluish, cystic swelling near medial canthus
- Usually non-tender

Treatment

- Lacrimal sac massage

- Topical antibiotic drops
- If no response within 1–2 weeks →
    - Probing of lacrimal drainage system

Exam Pearls ⭐

- Most common site of obstruction: Valve of Hasner
- Always rule out congenital glaucoma in watery eyes of infants
- Massage is first-line treatment
- Probing success rate ~90%
- DCR avoided in infants, done after 5–6 years

ACQUIRED NASOLACRIMAL DUCT OBSTRUCTION (ANDLDO)

Definition

Obstruction of the nasolacrimal duct occurring after birth, leading to impaired drainage of tears into the nose.

Causes

1. Involutional stenosis (Idiopathic)

- Most common cause
- Due to age-related fibrosis and narrowing of the duct
- Females affected more than males

2. Trauma

- Nasal fractures
- Orbital fractures
- Nasal or sinus surgery

3. Inflammatory diseases

- Sarcoidosis
- Granulomatosis with polyangiitis (Wegener's)

4. Infiltration

- Nasopharyngeal tumors compressing the duct

5. Dacryolith / Cast formation

- Stone-like material within lacrimal sac or duct

Clinical Features

- Excessive tearing (epiphora)
- Mucoid or mucopurulent discharge
- Recurrent attacks of dacryocystitis
- Recurrent unilateral conjunctivitis

Treatment

Dacryocystorhinostomy (DCR)

Principle:
A new passage is created between the lacrimal sac and nasal cavity, bypassing the obstructed nasolacrimal duct.

Success rate: 90–95%

Types of DCR

1. External DCR

- Skin incision approach
- Gold standard
- Success rate >90%
- Leaves a small skin scar

2. Endolaser (Transnasal) DCR

- Performed via nasal cavity using laser
- No skin incision → no scar
- Slightly lower success rate than external DCR

Flowchart: Pathogenesis of ANDLDO

Aging / Trauma / Inflammation / Tumor → Nasolacrimal duct narrowing or blockage → Impaired tear drainage → Tear stasis in lacrimal sac → Infection → Epiphora + mucopurulent discharge

---

DACROCYSTITIS

ACUTE DACRYOCYSTITIS

Definition

Acute inflammation of the lacrimal sac, usually due to infection.

Aetiology

- Usually secondary to nasolacrimal duct obstruction
- Pyogenic organisms:
  - *Staphylococcus*
  - *Streptococcus*
  - *Pneumococcus*

Clinical Features

Symptoms

- Sub-acute onset of:
  - Pain

    - Redness
    - Swelling at medial canthus
- Associated epiphora

On Examination

- Red, tender swelling at medial canthus
- Regurgitation test usually difficult due to pain
- Mucopurulent or purulent discharge
- Abscess formation in untreated cases

Complications

- Lacrimal sac abscess
- Preseptal cellulitis
- External fistula formation
- Rupture of abscess with pus discharge

Flowchart: Acute Dacryocystitis

Nasolacrimal duct obstruction → Tear stagnation → Bacterial infection of sac → Acute inflammation → Painful medial canthal swelling → Abscess → rupture / fistula (if untreated)

Treatment

Conservative (Acute Stage)

- Systemic antibiotics – mainstay
- Topical antibiotic eye drops
- Analgesics & anti-inflammatory drugs
- Hot fomentation (relieves pain, hastens resolution)

⚠ Important Note:

- Probing and syringing are contraindicated in acute dacryocystitis

Surgical

- Incision and drainage → if abscess present

- DCR is done only after acute inflammation subsides if epiphora persists

---

CHRONIC DACRYOCYSTITIS

Definition

Chronic inflammation of the lacrimal sac due to long-standing tear stasis.

Aetiology

Impaired tear outflow → Tear stagnation in sac → Secondary infection by low-virulence organisms → Chronic inflammation

---

Clinical Features

- More common than acute dacryocystitis

- Constant watering of eye
- Swelling at medial canthus
- Regurgitation test positive:
    - Pressure over sac → mucopurulent discharge from puncta
- Mucocele formation (if common canaliculus blocked)
- Associated chronic unilateral conjunctivitis

Investigation

- Nasal examination (rule out nasal pathology)

Treatment

Dacryocystorhinostomy (DCR)

- Definitive treatment
- External DCR or Endolaser DCR

Flowchart: Chronic Dacryocystitis

Nasolacrimal duct obstruction → Tear stagnation →
Low-grade infection → Chronic sac inflammation →
Epiphora ± sac swelling → Regurgitation positive

DISEASES OF THE LACRIMAL GLAND

1. Acute dacryoadenitis
2. Chronic dacryoadenitis
3. Keratoconjunctivitis sicca (Dry eye)

ACUTE DACRYOADENITIS

Definition

Acute inflammation of the lacrimal gland.

Aetiology

Viral (most common)

- Epstein-Barr virus
- Cytomegalovirus
- Mumps
- Infectious mononucleosis

Bacterial

- Staphylococcus
- Streptococcus
- Gonococcus

Fungal

- Histoplasma
- Blastomyces

Clinical Features

- Pain and discomfort in upper outer orbit
- Red, swollen eyelid with S-shaped margin
- Painful proptosis with:

    - Downward and inward displacement of eyeball
- Painful lid eversion with visible swollen gland
- Enlarged, tender preauricular lymph nodes

Differential Diagnosis

- Eyelid abscess
- Hordeolum internum
- Hordeolum externum (stye)
- Acute purulent conjunctivitis

Treatment

- Hot compresses
- Systemic analgesics
- Broad-spectrum antibiotics:
    - Topical + systemic
- Incision and drainage if abscess forms

CHRONIC DACRYOADENITIS

Definition

Chronic dacryoadenitis is a chronic inflammation of the lacrimal gland, usually due to inflammatory, autoimmune, or infiltrative disorders.

Aetiology

1. Infections

- Tuberculosis
- Syphilis

2. Granulomatous / Infiltrative causes

- Trauma
  → Foreign body granuloma
  → Post-traumatic granuloma
- Sarcoidosis
- Amyloidosis

- Leukaemia
- Lymphoma

3. Autoimmune disorders

- Sjögren's syndrome (most important)

4. Idiopathic

- Cause unknown

Clinical Features

- Painless, slow enlargement of lacrimal gland
- S-shaped curve of upper eyelid margin
- Downward and inward displacement of eyeball
- Restriction of upward and outward eye movements
- Diplopia on up-and-out gaze
- Lid eversion shows swollen lacrimal gland

👉 *Key differentiating point from acute dacryoadenitis:*

No pain, no redness, chronic course

Diagnosis

Diagnosis is based on:

- Clinical examination
- Laboratory investigations (guided by suspected cause)
- Imaging:
  - CT scan orbit
  - MRI orbit (better for soft tissue and infiltrative lesions)

Treatment

- Treat the underlying cause (infection, autoimmune disease, malignancy)
- Steroids / immunosuppressive therapy if indicated
- Condition improves once the primary disease is controlled

Flowchart: Chronic Dacryoadenitis

Autoimmune / Granulomatous / Infiltrative disorder → Chronic inflammation of lacrimal gland → Painless gland enlargement → S-shaped eyelid → Globe displacement ± diplopia

---

KERATOCONJUNCTIVITIS SICCA (KCS)

Dry Eye Syndrome (DES)

Definition

Keratoconjunctivitis sicca is a condition where:

- Aqueous tear production is insufficient,
  OR
- There is increased tear evaporation,

leading to an unstable tear film and ocular surface disease.

Aetiology

I. Aqueous Tear Deficiency

i. Pure Keratoconjunctivitis Sicca

(Only lacrimal gland involved)

- Congenital alacrima
- Denervation hyposecretion (e.g. trigeminal ganglion surgery)
- Idiopathic hyposecretion

ii. Primary Sjögren's Syndrome

- Autoimmune disorder
- Lymphocytic destruction of lacrimal & salivary glands
- Dry eye + dry mouth (xerostomia)

iii. Secondary Sjögren's Syndrome

Associated with systemic autoimmune diseases:

- Rheumatoid arthritis

- Systemic lupus erythematosus

iv. Non-Sjogren Causes

- Trauma: chemical, thermal, radiation
- Infection: trachoma
- Inflammation: sarcoidosis, thyroid ophthalmopathy
- Hypersensitivity: Stevens-Johnson syndrome
- Tumours of lacrimal gland
- Secondary infiltration: leukaemia, lymphoma

---

2. Evaporative Tear Dysfunction

- Most common cause: Meibomian gland dysfunction
- Lipid layer deficiency → increased evaporation

Clinical Features

Symptoms

- Dryness, irritation, burning sensation

- Foreign body sensation (worse in wind, sun, hot climate)
- Photophobia (due to punctate epithelial keratopathy)
- Stringy mucous discharge
- Transient blurring of vision
- Pain worse on blinking (due to corneal filaments)

Signs (On Examination)

- Posterior blepharitis with meibomian gland dysfunction
- Reduced tear meniscus
- Thinning of pre-corneal tear film
- Mucous strands and debris
- Punctate epithelial erosions
- Corneal filaments → mucus strands coated with epithelium attached to cornea

---

Diagnosis

Clinical Indicators

- Reduced marginal tear strip
- Increased mucus
- Corneal filaments

Special Tests

1. Tear Film Break-Up Time (TBUT)

- Normal: 15–20 seconds
- Dry eye: < 10 seconds

2. Epithelial Staining

- Fluorescein
  → stains corneal & conjunctival epithelial defects
- Rose Bengal
  → stains dead/devitalized cells, mucus, filaments
  → more sensitive but irritating
- Lissamine Green
  → similar to Rose Bengal, less irritation ✅

3. Schirmer Test

- Whatman filter paper (5 × 35 mm)
- Placed in lower fornix for 5 minutes
- Normal: >10 mm
- Dry eye: ≤ 6 mm

4. Impression Cytology

- Shows reduced goblet cells in dry eye

Treatment of Dry Eye Syndrome

Conservative (Mainstay)

1. Artificial Tear Substitutes

- Cellulose derivatives (methylcellulose)
- Polyvinyl alcohol
- Sodium hyaluronate
- Petroleum-based gels (e.g. Lacrilube)

2. Autologous Serum Eye Drops

- For severe dry eye

- Contains growth factors & vitamin A

3. Mucolytic Agents

- 5% acetylcysteine → breaks mucus threads

4. Topical Retinoids

- Vitamin A
- Restores ocular surface epithelium

5. Anti-inflammatory Therapy

- Topical steroids
- Topical NSAIDs
- Topical cyclosporine (very effective)
- Oral omega-3 fatty acids 🐟

6. Soft Contact Lenses

- Trap fluid behind lens
- Relieve corneal symptoms

Surgical Treatment

- Punctal plugs → reduce tear drainage
- Parotid duct transplantation into conjunctiva (rare, severe cases)

Flowchart: Dry Eye Pathogenesis

↓ Tear production / ↑ Evaporation → Unstable tear film → Ocular surface damage → Symptoms of dryness & irritation → Corneal epithelial damage

---

WATERY EYE

Watering of eye may be due to:

- Lacrimation
- Epiphora

LACRIMATION

Definition

Watering of the eye due to increased tear production caused by reflex stimulation.

Causes

- Foreign body in conjunctiva or cornea
- Conjunctivitis, keratitis, iridocyclitis
- Acute rise in IOP (acute congestive glaucoma)
- Aberrant regeneration of facial nerve → Crocodile tears (tearing while eating)
- Pseudobulbar palsy
- Hyperthyroidism
- Cholinergic stimulation
- Emotional causes (happiness, sorrow)

Diagnosis

- Anterior segment examination

Treatment

- Treat the underlying cause

EPIPHORA

Definition

Watering of eye due to decreased tear drainage

Causes

1. Obstructive Epiphora

Mechanical blockage at:

- Punctum
- Canaliculi
- Lacrimal sac
- Nasolacrimal duct

Causes include:

- Punctal stenosis
- Canalicular atresia
- Involutional NLD stenosis
- Dacryocystitis
- Chronic sinus disease
- Tumours of sac or nose
- Nasal polyp
- Trauma

---

2. Lacrimal Pump Failure

Drainage system patent but pump mechanism fails due to:

- Lower lid laxity
- Facial nerve palsy
- Lower lid ectropion

Diagnosis of Epiphora

1. Clinical Examination

- Eyelid position
- Orbicularis oculi function
- Regurgitation test
- Nasal examination (DNS, polyp, growth)

---

2. Lacrimal Patency Tests

i. Dye Disappearance Test

- Fluorescein instilled
- Dye retention after 5 minutes → obstruction

ii. Diagnostic Syringing

- Identifies level of obstruction

iii. Jones Dye Test (Partial obstruction only)

- Primary Jones Test:

→ Fluorescein in eye

→ Dye in nose = patent system

→ No dye = partial block or pump failure

- Secondary Jones Test

→ Primary test negative

→ Syringing done (syringe saline through the lacrimal passages)

→ Fluorescein-stained saline in nose = partial block (dye was stuck before)

→ Clear saline = canalicular block / pump failure (dye never entered the system)

iv. Dacryocystography

- Contrast + X-ray
- Detects fistula, diverticula, defects

v. Lacrimal Scintillography

- Radio-labelled tears
- Dynamic assessment of drainage

Treatment of Epiphora

- Pump failure → eyelid & punctum correction
- Obstruction → surgical treatment based on level of block

-> The End <-