MEDICAL EDUCATION RESOURCE

Scalp, Temple and Face

Introduction

- The **scalp** and **superficial temporal region** together cover the **vault and upper part of the lateral aspect** of the skull.
- It extends **from the eyebrows in front to the superior nuchal lines behind**.
- Laterally, it extends to the **zygomatic arch**.
- Functionally, it **protects the cranial vault** and **houses superficial arteries and veins** important in head and neck surgery.

Surface Landmarks

1. Vertex

- The highest point on the skull when the head is in anatomical position.
- Lies midway between **glabella and external occipital protuberance**.

2. Bregma

- Meeting point of **coronal and sagittal sutures**.
- Corresponds to the **anterior fontanelle** in infants.

3. Lambda

- Junction of **sagittal and lambdoid sutures**.
- Represents the **posterior fontanelle** of infancy.

4. Pterion

- H-shaped junction of **frontal, parietal, sphenoid (greater wing), and temporal bones**.
- Lies 4 cm above the midpoint of the zygomatic arch.
- **Clinical importance:** Related to the **anterior branch of the middle meningeal artery**.

5. Asterion

- Junction of **parietal, occipital, and mastoid parts of temporal bone**.
- Overlies **transverse–sigmoid sinus junction**.

6. External Occipital Protuberance

- Midline projection at the back of skull; palpable landmark for neck muscle attachments.

7. Superior Nuchal Line

- Curved ridge extending laterally from the external occipital protuberance.
- Provides attachment to **trapezius** and **sternocleidomastoid**.

8. Temporal Line

- Arching ridge on parietal bone marking the attachment of **temporalis fascia and muscle**.
- Upper line ? fascia; lower line ? muscle.

9. Zygomatic Arch

- Bony bridge connecting **zygomatic** and **temporal bones**.
- Lies opposite the lower part of the external auditory meatus.
- Landmark for **middle meningeal artery** (crosses 1 inch above it).

Scalp

Extent

- **Anteriorly:** Up to **supraorbital margins**.
- **Posteriorly:** To **superior nuchal lines**.
- **Laterally:** Up to **zygomatic arches**.

Five Layers of the Scalp (Mnemonic: S-C-A-L-P)

1. **S – Skin**
    - Thick, hair-bearing, and richly supplied with **sebaceous glands**.
    - Contains sweat glands and hair follicles ? prone to infection.

2. **C – Connective Tissue (Superficial fascia)**
    - Dense fibrofatty tissue with **vessels and nerves** tightly bound by fibrous septa.
    - Injury causes **profuse bleeding** due to inability of vessel walls to retract.
3. **A – Aponeurosis (Epicranial aponeurosis)**
    - Strong tendinous sheet connecting **frontalis** and **occipitalis** muscles.
    - Also called **galea aponeurotica**.
    - Provides mobility and expression (raising eyebrows).
4. **L – Loose Areolar Tissue**
    - “Danger area” of scalp — allows movement of scalp over pericranium.
    - Contains **emissary veins** connecting superficial veins ? intracranial sinuses ? infection risk.
5. **P – Pericranium**
    - Periosteum of skull bones.
    - Loosely attached except at sutures (where it continues as sutural ligaments).

Blood Supply

- **Arteries:**
    - *From external carotid:* Superficial temporal, posterior auricular, occipital.

- *From internal carotid:* Supraorbital, supratrochlear (branches of ophthalmic).

- **Veins:** Follow arteries; communicate via emissary veins with dural sinuses.

Nerve Supply

- **Anterior region:**
  - Supratrochlear and Supraorbital (branches of ophthalmic division of trigeminal nerve).
- **Lateral region:**
  - Zygomaticotemporal (maxillary division), Auriculotemporal (mandibular division).
- **Posterior region:**
  - Greater occipital (C2), Third occipital (C3), Lesser occipital (C2).

Lymphatic Drainage

- **Anterior scalp:** Pre-auricular and parotid nodes.
- **Posterior scalp:** Occipital and posterior auricular nodes.
- **Lateral scalp:** Parotid nodes.

> **Dissection Notes**

- Incision: Coronal incision across vertex behind hairline, extend downward in midline.

- Reflect skin and superficial fascia together with vessels and nerves.
- Note:
    - The **dense connective tissue** retains cut arteries open ? **profuse bleeding**.
    - The **epicranial aponeurosis** glides over the loose areolar tissue.
    - The **danger area** (loose tissue layer) communicates with **intracranial sinuses** via emissary veins.

Superficial Temporal Region

Boundaries

- **Above:** Temporal line.
- **Below:** Zygomatic arch.
- **In front:** Frontal process of zygomatic bone.
- **Behind:** Auricle.

Contents

- **Temporalis fascia** and **superficial temporal vessels and nerve**.
- **Auriculotemporal nerve** (branch of mandibular nerve).
- **Superficial temporal artery** – one of the terminal branches of **external carotid artery**.

- **Vein** – joins maxillary vein ? forms **retromandibular vein**.
- **Lymphatics** – drain to preauricular nodes.

Clinical Anatomy

- **Scalp wounds** bleed profusely ? dense connective tissue prevents vasoconstriction.
- **Infection spread:**
  - From loose areolar tissue (danger area) ? emissary veins ? intracranial venous sinuses ? meningitis.
- **Black eye (periorbital ecchymosis):**
  - Due to collection of blood under loose areolar tissue tracking forward into eyelids.
- **Sebaceous cysts** – common on scalp due to blocked ducts of sebaceous glands.
- **Scalp avulsion** – in accidents, entire scalp can be torn at the loose areolar layer; prompt reattachment possible.
- **Temporal artery biopsy** – for diagnosing **giant cell arteritis**.
- **Temporal pulse** – felt just above the zygomatic arch, anterior to ear.

Face

Extent

- Extends from **hairline above** to **chin and base of mandible below**.
- **Laterally** up to the **auricle**.
- The **forehead** belongs to both **face and scalp**.

Dissection

- Make an incision along the midline of the face, from forehead to chin.
- Make horizontal incisions across zygomatic arch and mandible.
- Reflect skin laterally with care to preserve:
    - **Facial artery and vein**
    - **Parotid duct**
    - **Branches of the facial nerve**

Skin

1. **Highly vascular** ? facial wounds bleed profusely but heal rapidly.
2. Rich in **sebaceous and sweat glands** ? causes oily texture and acne.
3. Skin is **thick and elastic** due to muscle insertions; wounds gape widely.
4. **Lax** in most parts ? edema spreads easily, especially in renal disease (starts in eyelids).

5. **Fixed** over cartilages (nose, ear) ? boils are painful.

Superficial Fascia

- Contains:
    - **Facial muscles** (inserted into skin).
    - **Vessels and nerves** supplying muscles and skin.
    - **Variable fat** — abundant in cheeks (buccal pads) for sucking in infants.
- **Deep fascia:** Absent except:
    - Over **parotid gland** (forms parotid fascia).
    - Over **buccinator muscle** (forms buccopharyngeal fascia).

Facial Muscles

- **Subcutaneous muscles** responsible for facial expressions.
- Develop from **second branchial arch mesoderm** ? supplied by **facial nerve (VII cranial)**.
- Represent **remnants of panniculus carnosus** (muscle sheet in lower animals).
- Act as **sphincters and dilators** around three facial openings:

- **Palpebral fissure:** orbicularis oculi (sphincter), frontalis (dilator).
- **Oral fissure:** orbicularis oris (sphincter); other muscles act as dilators.
- **Nostrils:** dilator naris, compressor naris, depressor septi.

Groups of Muscles

1. Muscles of the Scalp

- **Occipitofrontalis** – elevates eyebrows, wrinkles forehead.

2. Muscles around Auricle

- **Auricularis anterior, superior, posterior** – vestigial, move auricle slightly.

3. Muscles of Eyelids and Orbit

- **Orbicularis oculi:** sphincter; closes eyelids.
- **Corrugator supercilii:** produces vertical wrinkles over nose.
- **Levator palpebrae superioris:** elevates upper eyelid (not a facial muscle).

4. Muscles of the Nose

- **Procerus, Compressor naris, Dilator naris, Depressor septi.**

5. Muscles around Mouth

- **Orbicularis oris:** sphincter; closes lips.
- **Buccinator:** aids in blowing and chewing; pierced by parotid duct.

- **Levator labii superioris, Zygomaticus major/minor, Levator anguli oris:** elevate mouth angle/lip.
- **Depressor anguli oris, Depressor labii inferioris, Mentalis:** depress lip.
- **Risorius:** retracts mouth angle (smile).
- **Platysma:** tenses skin of neck, depresses mandible in fright.

6. Modiolus (corner of mouth)

- Fibromuscular node 1.25 cm lateral to mouth angle.
- Formed by interlacing of 5 muscles:
  Zygomaticus major, Buccinator, Levator anguli oris, Risorius, Depressor anguli oris.

Nerve Supply of the Face

Motor Supply

- **Facial nerve (VII cranial)** divides within the parotid gland into **five terminal branches**:
  1. **Temporal** ? Frontalis, orbicularis oculi (upper part).
  2. **Zygomatic** ? Orbicularis oculi (lower eyelid).
  3. **Buccal** ? Muscles of upper lip, cheek.
  4. **Marginal mandibular** ? Lower lip muscles.
  5. **Cervical** ? Platysma.

(Mnemonic: To Zanzibar By Motor Car)

Test: Place wrist on ear, spread fingers over face—each finger represents a branch.

Sensory Supply

- Derived from **Trigeminal nerve (V cranial)**:
    - **Ophthalmic division (V1):** Supraorbital, supratrochlear, infratrochlear, external nasal.
    - **Maxillary division (V2):** Infraorbital, zygomaticofacial, zygomaticotemporal.
    - **Mandibular division (V3):** Buccal, auriculotemporal, mental nerves.

Clinical Anatomy

1. **Facial wounds:**
    - Bleed freely but heal well due to rich blood supply.
2. **Facial nerve palsy (Bell’s palsy):**
    - Paralysis of muscles of expression ? face deviates to opposite side; inability to close eyelid, drooping of mouth, loss of nasolabial fold.
3. **Parotid gland injury:**
    - May affect terminal branches of facial nerve within the gland.
4. **Buccinator function:**

- Paralysis causes food to accumulate between cheek and gums.

5. **Infection and edema:**
   - Spread rapidly due to loose areolar tissue and rich blood supply.
6. **Angular vein (danger area):**
   - Communication between **facial vein and cavernous sinus** ? risk of intracranial spread of infection.
7. **“Black eye”:**
   - Blood from scalp injury tracks to eyelids through loose tissue of face.
8. **Plastic surgery:**
   - Excellent healing and minimal scarring due to vascularity and elasticity of skin.

Arteries of the Face

Features

- The **face is richly vascular**, ensuring rapid healing and excellent results in plastic surgery.
- Blood supply is mainly from branches of the **external carotid artery**, assisted by branches of **ophthalmic artery (internal carotid)**.

Main Arteries

1. **Facial artery** – chief artery of the face.
2. **Transverse facial artery** – branch of superficial temporal artery.
3. **Small branches** – accompany cutaneous nerves (from ophthalmic, maxillary, and superficial temporal arteries).

Dissection

- Identify **facial artery** at the **lower border of the mandible**, anterior to the **masseter muscle** — known as **“Anaesthetist’s artery”** (palpable point).
- Trace its **tortuous course** upwards and medially across the face:
    - Crosses body of mandible ? angle of mouth ? side of nose ? medial angle of eye.
- Deep to **zygomaticus major** and **levator labii superioris**, but superficial to **buccinator**.

Facial Artery (Facial Part)

Origin

- From **external carotid artery**, just above the greater cornu of hyoid bone.

Course

1. Cervical part ? through submandibular region, enters face by winding around mandible.
2. Facial part ? passes obliquely across face up to medial angle of eye.

Branches

- **Cervical branches:**
  - Ascending palatine, tonsillar, submental, glandular branches.
- **Facial branches:**
  - Inferior labial
  - Superior labial
  - Lateral nasal
  - Angular (terminal branch).

Distribution

- Supplies **lips, nose, cheek, and lower eyelid**.

Veins of the Face

Facial Vein

- **Formation:** Union of **supratrochlear and supraorbital veins** near medial angle of eye.
- Continuation of **angular vein** down the face.
- Runs behind the facial artery, straight and superficial.
- **Termination:** Drains into **internal jugular vein**.

Tributaries

- Correspond to branches of the facial artery.
- **Important communications:**
  - **Angular vein ? superior ophthalmic vein ? cavernous sinus.**
  - **Deep facial vein ? pterygoid venous plexus.**

Clinical Anatomy (Face Vessels)

1. **Danger area of the face:**
   - Bounded by **nose and upper lip** triangle.
   - Infection can spread from facial vein ? angular vein ? cavernous sinus ? **cavernous sinus thrombosis** (fatal).
2. **Anaesthetist’s artery:**
   - Facial artery palpable where it crosses mandible.
3. **Facial vein injuries:**
   - No valves ? spread of infection possible in both directions.
4. **Facial bleeding:**
   - Profuse due to rich anastomoses; easily controlled by pressure.

Lymphatic Drainage of the Face

1. Upper face (forehead, eyelids, lateral nose, upper lip)

? **Pre-auricular (parotid) lymph nodes.**

2. Cheek and lateral face

? **Submandibular lymph nodes.**

3. Lower lip and chin

? **Submental lymph nodes.**

4. Deep structures (e.g., buccinator, gums)

? **Deep cervical nodes.**

Clinical note:
In **carcinoma of lower lip**, metastasis occurs to **submental nodes**;
In **upper lip**, to **submandibular nodes**.

Eyelids (Palpebrae)

Structure

- Two movable folds guarding the **palpebral fissure**.
- **Skin:** Thin, delicate, hairless.
- **Superficial fascia:** Very loose ? rapid swelling in edema or inflammation.
- **Orbicularis oculi:** Closes eyelids.
- **Tarsal plates:** Dense fibrous plates giving shape and firmness.

- **Tarsal glands (Meibomian glands):**
    - Modified sebaceous glands opening at lid margins; prevent tear overflow.
- **Conjunctiva:** Thin mucous membrane lining inner surface of lids.

Nerve Supply

- **Motor:**
    - Orbicularis oculi ? Facial nerve (VII).
    - Levator palpebrae superioris ? Oculomotor nerve (III).
    - Superior tarsal (Müller's) muscle ? Sympathetic fibers.
- **Sensory:**
    - Upper lid ? Supraorbital, supratrochlear, lacrimal, infratrochlear (V1).
    - Lower lid ? Infraorbital (V2).

Blood Supply

- **Arteries:** Ophthalmic artery (from internal carotid).
- **Veins:** Ophthalmic veins ? cavernous sinus.

Clinical Anatomy (Eyelids)

1. **Stye:** Acute infection of eyelash follicle or gland of Zeis.

2. **Chalazion:** Chronic inflammation of Meibomian gland.
3. **Ptosis:** Drooping of upper eyelid due to paralysis of:
    - **Oculomotor nerve (complete ptosis)** or
    - **Sympathetic fibers (partial ptosis).**
4. **Blepharospasm:** Involuntary eyelid closure from facial nerve irritation.
5. **Black eye:** Blood spreads to eyelid from scalp injury (loose areolar tissue).
6. **Conjunctivitis:** Redness due to dilated conjunctival vessels.

Lacrimal Apparatus

Introduction

- The **lacrimal apparatus** maintains the **tear film** and **drainage system** of the eye.
- Its main function is **lubrication**, **protection from dust**, and **nutrition of cornea and conjunctiva**.

Components

1. **Lacrimal gland** – secretes tears.
2. **Lacrimal ducts** – convey tears to the conjunctival sac.
3. **Conjunctival sac** – space between eyeball and eyelid.

4. **Lacrimal canaliculi** – small ducts draining tears from puncta.
5. **Lacrimal sac** – tear reservoir at medial angle of eye.
6. **Nasolacrimal duct** – drains tears into inferior meatus of the nose.

Lacrimal Gland

Position:

- Lies in the **lacrimal fossa** of the frontal bone in the superolateral angle of orbit.
- Size: ~20 mm × 12 mm × 5 mm.

Parts:

- **Orbital part:** Large, above the aponeurosis of levator palpebrae superioris.
- **Palpebral part:** Small, below the aponeurosis.
    - Separated by **levator aponeurosis**, but connected by ducts.

Ducts:

- About **10–12 small ducts** open into the **superior fornix** of conjunctiva.

Nerve Supply

- **Sensory:** Lacrimal nerve (from ophthalmic division, V?).
- **Parasympathetic (secretomotor):**

- From **lacrimal nucleus (facial nerve)** ? greater petrosal nerve ? nerve of pterygoid canal ? pterygopalatine ganglion ? zygomatic branch of V? ? lacrimal nerve ? gland.

- **Sympathetic:** From **internal carotid plexus** via deep petrosal nerve ? same route.

Blood Supply

- **Lacrimal artery** (branch of ophthalmic artery).

- **Vein:** Drains into **superior ophthalmic vein**.

Dissection

- Reflect the upper eyelid laterally to expose the superolateral part of orbit.

- Locate the **lacrimal gland** in the lacrimal fossa of frontal bone.

- Identify ducts entering superior fornix.

- Follow medial drainage route:
  Lacrimal puncta ? canaliculi ? sac ? nasolacrimal duct ? inferior meatus.

Clinical Anatomy

1. **Epiphora:**
   - Overflow of tears due to blockage in nasolacrimal duct (common in elderly).

2. **Dacryocystitis:**

- Infection of lacrimal sac ? swelling at medial canthus; may form abscess or fistula.

3. **Dry eye (keratoconjunctivitis sicca):**
   - Due to lacrimal gland hyposecretion or facial nerve lesion.
4. **Neonatal dacryocystitis:**
   - Congenital blockage of nasolacrimal duct at **valve of Hasner**.
5. **Crocodile tears syndrome:**
   - Misrouted parasympathetic fibers after facial nerve injury ? lacrimation during eating.
6. **Lacrimal gland tumors:**
   - Cause proptosis and inferomedial displacement of eyeball.

Development of Face

Origin

- Develops mainly between **4th and 10th weeks of intrauterine life**.
- Derived from **frontonasal prominence** and **first pharyngeal arch** components.

Prominences Involved

1. **Frontonasal process:**

- Forms **forehead**, **bridge of nose**, and **medial and lateral nasal prominences**.

2. **Maxillary processes (from first arch):**
   - Form **cheeks**, **lateral part of upper lip**, and **upper jaw**.
3. **Mandibular processes (from first arch):**
   - Fuse to form **lower lip** and **lower jaw**.

Steps in Formation

- **Nasal placodes** appear on frontonasal process ? become **nasal pits**.
- **Medial nasal prominences** fuse ? form **intermaxillary segment** ? gives rise to:
  - Philtrum of upper lip
  - Premaxilla
  - Primary palate
- **Lateral nasal prominences** ? form **sides (alae) of nose**.
- **Maxillary processes** grow medially ? fuse with **medial nasal prominences** forming:
  - Upper lip (excluding philtrum)
  - Upper jaw
  - Secondary palate

Derivatives

- **Upper lip:** Fusion of two maxillary and two medial nasal prominences.
- **Lower lip and jaw:** From two mandibular prominences.
- **Cheeks:** Maxillary processes.
- **Nose:**
  - Bridge ? frontonasal process.
  - Dorsum and sides ? lateral nasal processes.
  - Tip and nasal septum ? medial nasal processes.
  - Alae ? lateral nasal processes.

Developmental Anomalies

- **Cleft lip:** Non-fusion of medial nasal and maxillary processes.
- **Oblique facial cleft:** Failure of fusion between lateral nasal and maxillary processes.
- **Median cleft lip:** Non-fusion of two medial nasal processes.
- **Macrostomia:** Incomplete fusion of maxillary and mandibular processes (large mouth).
- **Microstomia:** Excessive fusion ? small mouth.
- **Cleft lower lip:** Rare, due to failure of mandibular fusion.

Molecular Regulation of Facial Development

- **Facial development** guided by interplay of **gene expression gradients and signaling pathways.**
- **Key molecular factors:**
  - **SHH (Sonic hedgehog):** Controls midline fusion and frontonasal process outgrowth.
  - **FGFs (Fibroblast growth factors):** Regulate proliferation in facial prominences.
  - **BMPs (Bone morphogenetic proteins):** Induce nasal placode formation.
  - **TGF-? and MSX genes:** Govern epithelial–mesenchymal interactions.
  - **Retinoic acid gradients:** Critical for symmetry; imbalance causes craniofacial anomalies.
  - **Homeobox genes (DLX, HOX):** Determine regional identity of facial arches.

Clinical correlation:

- Mutations in **SHH** ? *holoprosencephaly* (single midline structure).
- Mutations in **FGF or BMP signaling** ? *cleft lip/palate* or *craniofacial dysmorphia.*

Mnemonics

1. Components of the Lacrimal Apparatus

Mnemonic — **“Giant Cats Can Sing Naturally”**

- **G** ? *Gland* (lacrimal gland)
- **C** ? *Canaliculi* (superior and inferior)
- **C** ? *Conjunctival sac*
- **S** ? *Sac (lacrimal)*
- **N** ? *Nasolacrimal duct*

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2. Nerve Supply of Lacrimal Gland

Mnemonic — **“Face Loves Pretty Tears”**

- **F** ? *Facial nerve* (parasympathetic source)
- **L** ? *Lacrimal nucleus ? greater petrosal nerve*
- **P** ? *Pterygopalatine ganglion* (relay station)
- **T** ? *Terminal lacrimal nerve* (branch of V?)

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3. Developmental Prominences of the Face

Mnemonic — **“Five Prominent Parts Make Faces”**

- **F** ? *Frontonasal process*
- **P** ? *Paired maxillary processes*
- **P** ? *Paired mandibular processes*

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4. Derivatives of Medial Nasal Prominences

Mnemonic — **“Phil Prepares Palate”**

- **Phil** ? *Philtrum* of upper lip
- **Prepares** ? *Premaxilla*
- **Palate** ? *Primary palate*

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5. Derivatives of Lateral Nasal Prominences

Mnemonic — **“Lateral ? Lateral walls of Nose”**

- Form the *alae* (sides) of nose.

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6. Dangerous Triangle of Face

Mnemonic — **“Upper Lip and Tip”**

- *Area between nose and upper lip* — infections here spread to **cavernous sinus** via **angular vein**.

> **Facts to Remember**

1. **Lacrimal gland** lies in the **lacrimal fossa of the frontal bone**, with **orbital and palpebral parts**.
2. **Parasympathetic fibers** to the lacrimal gland originate from the **facial nerve**, relaying in the **pterygopalatine ganglion**.

3. **Tears** drain through the **puncta ? canaliculi ? sac ? nasolacrimal duct ? inferior meatus of nose**.

4. **Valve of Hasner** guards the opening of the nasolacrimal duct; failure to open causes **neonatal dacryocystitis**.

5. **Epiphora** = overflow of tears; **dacryocystitis** = inflammation of lacrimal sac.

6. **Development of face** begins in the **4th week** from **five prominences** — one frontonasal and paired maxillary and mandibular.

7. **Medial nasal processes** form **philtrum, premaxilla, and primary palate**.

8. **Lateral nasal processes** form the **sides (alae) of nose**.

9. **Maxillary processes** fuse with **medial nasal** to form **upper lip and secondary palate**.

10. **Mandibular processes** fuse in the midline to form **lower lip and mandible**.

11. **Cleft lip** results from non-fusion of **maxillary and medial nasal processes**.

12. **Cleft palate** occurs due to failure of fusion of **palatine shelves**.

13. **Craniofacial anomalies** often result from disruption of **SHH, FGF, BMP, or retinoic acid signaling**.

14. The **nasolacrimal duct** develops from a **solid cord of ectoderm** in the **naso-optic groove** that later canalizes.

15. The **nasal placodes** invaginate to form **nasal pits**, which later become the **nostrils**.

16. **Face develops faster** than brain; therefore, malformations often have both cranial and facial involvement.

17. **Medial nasal fusion failure** ? *median cleft lip*; **lateral nasal fusion failure** ? *oblique facial cleft*.

18. The **facial artery** forms the chief arterial supply to face; **facial vein** communicates with **cavernous sinus** via angular vein.

19. **Lacrimal secretion increases** by parasympathetic stimulation (crying, emotion, irritation).

20. **Tears contain lysozyme**, which destroys bacterial cell walls, providing antimicrobial defense.

Clinicoanatomical Problems

1. Epiphora (Overflow of Tears)

- **Cause:**
  - Blockage in **nasolacrimal duct** or **puncta** prevents tear drainage.
- **Symptoms:**
  - Constant tearing and wetness at medial canthus.
  - Skin excoriation from chronic moisture.
- **Anatomical Basis:**
  - Tears accumulate in conjunctival sac ? cannot drain via lacrimal passages.

- **Treatment:**
    - *Dacryocystorhinostomy (DCR)* — surgical creation of new passage between lacrimal sac and nasal cavity.

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2. Dacryocystitis (Inflammation of Lacrimal Sac)

- **Cause:**
    - Infection due to stasis of tears in obstructed sac.
- **Clinical Features:**
    - Painful swelling at **medial canthus of eye**.
    - Tenderness, redness, pus discharge on pressure over sac.
- **Complication:**
    - May burst ? **lacrimal fistula** discharging tears on cheek.
- **Treatment:**
    - Drainage and antibiotics; chronic cases ? DCR surgery.

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3. Crocodile Tears Syndrome (Bogorad Syndrome)

- **Mechanism:**
    - Misrouted regeneration of **facial nerve** fibers after injury.
- **Effect:**

- Parasympathetic fibers to lacrimal gland are wrongly connected to salivary fibers.

- **Clinical Feature:**
  - **Lacrimation during eating** (“gustatory lacrimation”).
- **Relevance:**
  - Occurs after **Bell’s palsy** or **facial nerve trauma**.

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4. Congenital Dacryocystitis

- **Cause:**
  - Failure of canalization of **nasolacrimal duct** at **valve of Hasner** in newborns.
- **Clinical Feature:**
  - Mucopurulent discharge from eyes since birth.
- **Treatment:**
  - Massage of lacrimal sac; if persistent ? probing to open the duct.

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5. Cleft Lip (Harelip)

- **Cause:**
  - Non-fusion of **maxillary process** with **medial nasal process**.
- **Types:**

- *Unilateral or bilateral; complete or incomplete.*

- **Effect:**
  - Gap in upper lip, may extend to nostril.
- **Functional Problems:**
  - Difficulty in sucking and speech.
- **Treatment:**
  - Surgical correction (cheiloplasty) after 3 months of age.

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6. Cleft Palate

- **Cause:**
  - Failure of fusion of **palatine shelves (maxillary processes)**.
- **Clinical Feature:**
  - Communication between oral and nasal cavities.
  - Regurgitation of fluids through nose.
  - Nasal tone of voice.
- **Treatment:**
  - Surgical closure (palatoplasty) between 9–18 months.

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7. Oblique Facial Cleft

- **Cause:**
  - Failure of fusion between **lateral nasal** and **maxillary processes**.
- **Appearance:**
  - Cleft extending from **upper lip to medial angle of eye**.
- **Accompanied by:**
  - Defective formation of **nasolacrimal duct**.
- **Clinical Note:**
  - Rare; often associated with severe craniofacial anomalies.

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8. Median Cleft Lip

- **Cause:**
  - Failure of fusion between **two medial nasal processes**.
- **Feature:**
  - Midline cleft in upper lip, sometimes extending into nasal septum.
- **Association:**
  - May accompany **holoprosencephaly** (defective forebrain division).

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9. Macrostomia and Microstomia

- **Macrostomia:** Incomplete fusion of **maxillary and mandibular processes** ? abnormally large mouth.
- **Microstomia:** Excessive fusion of same processes ? abnormally small mouth.
- **Clinical Significance:** Both may coexist with facial clefts or mandibular anomalies.

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10. Holoprosencephaly and Midline Facial Defects

- **Cause:**
  - Mutation in **Sonic hedgehog (SHH) gene** ? failure of midline patterning.
- **Clinical Spectrum:**
  - Single central incisor ? cyclopia (severe).
  - May include **median cleft face**, **hypotelorism**, and **agenesis of corpus callosum**.

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11. Facial Asymmetry

- **Cause:**
  - Unequal development or hypoplasia of one side of face.
  - Common after **first arch syndromes** (e.g., *Treacher Collins*).
- **Effect:**
  - Distorted oral commissure and jaw alignment.

---

12. Tear Film Disorders

- **Deficiency of aqueous layer:** due to lacrimal gland dysfunction.
- **Deficiency of lipid layer:** due to meibomian gland dysfunction.
- **Deficiency of mucin layer:** due to conjunctival goblet cell loss.
- **Effect:**
    - Dry eye syndrome, corneal ulceration, irritation.

Frequently Asked Questions

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1. What is the lacrimal apparatus?

It is the **system of structures that produce, secrete, and drain tears** from the eye.
Components: Lacrimal gland, ducts, canaliculi, lacrimal sac, and nasolacrimal duct.

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2. Where is the lacrimal gland located?

In the **lacrimal fossa of the frontal bone**, at the **superolateral angle of the orbit**.

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3. What are the two parts of the lacrimal gland?

- **Orbital part:** Large, lies above levator palpebrae aponeurosis.
- **Palpebral part:** Small, lies below the aponeurosis.

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4. How do tears reach the conjunctival sac?

Through **10–12 small ducts** from the palpebral part of the lacrimal gland, opening into the **superior conjunctival fornix**.

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5. What is the nerve supply of the lacrimal gland?

- **Sensory:** Lacrimal branch of ophthalmic nerve (V?).
- **Parasympathetic (secretomotor):**
  - From **facial nerve (VII)** ? greater petrosal nerve ? nerve of pterygoid canal ? pterygopalatine ganglion ? zygomatic branch (V?) ? lacrimal nerve ? gland.
- **Sympathetic:** From internal carotid plexus.

---

6. What is the arterial supply of the lacrimal gland?

By the **lacrimal branch of ophthalmic artery** (from internal carotid).

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7. Where does the nasolacrimal duct open?

Into the **inferior meatus of the nose**, guarded by the **valve of Hasner**.

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8. What is the function of tears?

- Lubricate and clean the eyeball.
- Nourish the cornea and conjunctiva.
- Contain **lysozyme** — antibacterial enzyme.

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9. What causes epiphora (overflow of tears)?

Blockage of the **nasolacrimal duct** or **lacrimal puncta**.

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10. What is dacryocystitis?

Inflammation of the **lacrimal sac**, often due to nasolacrimal duct obstruction.

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11. What is the “danger area” of the face?

The **upper lip and lower part of the nose**.

- Infections here can spread via **angular vein ? superior ophthalmic vein ? cavernous sinus**, leading to **cavernous sinus thrombosis**.

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12. From which embryonic structures does the face develop?

From **five facial prominences**:

1. **Frontonasal process**
2. **Paired maxillary processes**
3. **Paired mandibular processes**

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13. What are nasal placodes and what do they form?

- **Nasal placodes** are ectodermal thickenings on the frontonasal process.
- Invaginate to form **nasal pits**, which develop into **nostrils** and **nasal cavities**.

---

14. What is the origin of the upper lip?

From **two medial nasal** and **two maxillary processes**.

- **Philtrum** from medial nasal processes.

- Rest of upper lip from maxillary processes.

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15. What forms the lower lip and mandible?

By fusion of **two mandibular processes**.

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16. What forms the cheeks?

By **maxillary processes** on either side.

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17. What are the derivatives of the medial nasal processes?

- **Philtrum of upper lip**
- **Premaxilla**
- **Primary palate**
- **Nasal septum**

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18. What are the derivatives of the lateral nasal processes?

- **Alae (sides) of the nose**
- **Lateral walls of nasal cavities**

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19. What causes cleft lip?

Failure of **fusion between medial nasal and maxillary processes**.

---

20. What causes cleft palate?

Failure of **fusion of the palatine shelves** from maxillary processes.

21. What is an oblique facial cleft?

A cleft extending from **upper lip to medial angle of eye**, due to failure of fusion between **lateral nasal and maxillary processes**.

---

22. What is a median cleft lip?

Failure of fusion between **two medial nasal processes**, producing a midline defect.

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23. What is the embryological basis of macrostomia and microstomia?

- **Macrostomia:** Incomplete fusion of **maxillary and mandibular processes** ? large mouth.
- **Microstomia:** Excessive fusion ? small mouth.

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24. What molecular factor controls midline facial development?

Sonic Hedgehog (SHH) gene — regulates frontonasal process fusion and midline patterning.

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25. What is the role of retinoic acid in facial development?

It regulates the **anterior-posterior axis**; imbalance causes **cleft lip/palate** and other anomalies.

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26. What is the function of the valve of Hasner?

Prevents regurgitation of nasal contents into the **nasolacrimal duct**.

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27. What is the clinical importance of the pterygopalatine ganglion?

It relays **parasympathetic fibers** to lacrimal gland, nasal glands, and palatine glands.

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28. What are the layers of the tear film?

1. **Lipid layer** – from Meibomian glands (prevents evaporation).
2. **Aqueous layer** – from lacrimal gland (provides nutrients).
3. **Mucin layer** – from goblet cells (spreads tears evenly).

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29. What are the main causes of congenital dacryocystitis?

Failure of canalization of **nasolacrimal duct** at the **valve of Hasner**.

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30. What is the clinical importance of facial clefts?

- Cause **feeding and speech difficulties**.
- Associated with **nasal and maxillary maldevelopment**.
- Require surgical correction early in life.

Multiple Choice Questions

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1. The lacrimal gland is located in the:
a) Sphenoid bone
b) Ethmoid bone
? **c) Frontal bone**
d) Maxilla

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2. The nasolacrimal duct opens into the:
a) Middle meatus of nose
b) Superior meatus of nose

? **c) Inferior meatus of nose**

d) Common meatus

---

3. Parasympathetic fibers to lacrimal gland relay in the:

a) Otic ganglion

? **b) Pterygopalatine ganglion**

c) Submandibular ganglion

d) Ciliary ganglion

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4. The valve guarding the opening of nasolacrimal duct is:

? **a) Valve of Hasner**

b) Valve of Krause

c) Valve of Bochdalek

d) Valve of Kerckring

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5. The facial nerve supplies secretomotor fibers to:

? **a) Lacrimal gland**

b) Parotid gland

c) Sublingual gland

d) Thyroid gland

---

6. The nerve carrying secretomotor fibers to lacrimal gland is:

? **a) Lacrimal nerve**

b) Auriculotemporal nerve

c) Zygomaticotemporal nerve

d) Infraorbital nerve

---

7. The lacrimal gland drains into the:

a) Inferior fornix

? **b) Superior fornix of conjunctiva**

c) Caruncle

d) Nasal cavity

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8. The nasolacrimal duct develops from:

? **a) Ectodermal cord in naso-optic groove**

b) Endodermal pouch

c) Mesodermal condensation

d) Neural crest

---

9. Cleft lip results from failure of fusion between:

? **a) Maxillary and medial nasal processes**

b) Medial and lateral nasal processes

c) Two maxillary processes

d) Mandibular processes

---

10. Cleft palate results from failure of fusion of:

? **a) Palatine shelves**

b) Medial nasal processes

c) Lateral nasal processes

d) Mandibular arches

---

11. The upper lip is formed by:

? **a) Maxillary and medial nasal processes**

b) Lateral nasal processes only

c) Mandibular processes

d) Frontonasal process alone

---

12. The lower lip develops from:

? **a) Fusion of mandibular processes**

b) Maxillary and medial nasal processes

c) Lateral nasal processes

d) Frontal process

---

13. The alae (sides) of nose are derived from:

? **a) Lateral nasal processes**

b) Medial nasal processes

c) Maxillary processes

d) Mandibular processes

---

14. The philtrum of upper lip is derived from:

? **a) Medial nasal processes**

b) Maxillary processes

c) Mandibular processes

d) Lateral nasal processes

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15. The premaxilla is derived from:

? **a) Intermaxillary segment (medial nasal fusion)**

b) Maxillary process

c) Lateral nasal process

d) Mandibular process

---

16. The frontonasal process gives rise to:

? **a) Forehead and bridge of nose**

b) Philtrum

c) Upper jaw

d) Mandible

---

17. The oblique facial cleft results from failure of fusion between:

? **a) Lateral nasal and maxillary processes**

b) Medial nasal and maxillary processes

c) Mandibular and maxillary processes

d) Two medial nasal processes

---

18. The median cleft lip results from failure of fusion between:

? **a) Two medial nasal processes**

b) Medial and maxillary processes

c) Lateral nasal and maxillary processes

d) Two maxillary processes

---

19. The palatine shelves are derivatives of which embryonic structure?

? **a) Maxillary process**

b) Mandibular process

c) Medial nasal process

d) Frontonasal process

---

20. The most common cause of congenital dacryocystitis is:

? **a) Failure of canalization at valve of Hasner**

b) Infection of lacrimal gland

c) Facial nerve lesion

d) Overproduction of tears

---

21. Crocodile tears (Bogorad syndrome) occur due to:

? **a) Misrouting of facial nerve fibers**

b) Damage to glossopharyngeal nerve

c) Lacrimal gland tumor

d) Pterygopalatine ganglion lesion

---

22. Which molecular signal regulates midline facial fusion?

? **a) SHH (Sonic Hedgehog)**

b) BMP

c) FGF

d) Retinoic acid

---

23. Which gene regulates the patterning of the first pharyngeal arch?

? **a) DLX genes**

b) SHH

c) HOX A5

d) MSX-1

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24. Which bone develops from the frontonasal process?

? **a) Frontal bone**

b) Maxilla

c) Mandible

d) Palatine bone

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25. Failure of development of nasal placodes leads to:

? **a) Absence of external nose (arhinia)**

b) Hypertelorism

c) Cleft palate

d) Cleft lip

Viva Voce Questions

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1. What are the components of the lacrimal apparatus?

- **Lacrimal gland**
- **Lacrimal ducts**
- **Lacrimal canaliculi**
- **Lacrimal sac**
- **Nasolacrimal duct**

---

2. Where is the lacrimal gland situated?

In the **lacrimal fossa of the frontal bone**, at the **superolateral angle of the orbit**.

---

3. What are the two parts of the lacrimal gland?

- **Orbital part** (large)

- **Palpebral part** (small)

---

4. Into which structure do the lacrimal ducts open?

Into the **superior conjunctival fornix**.

---

5. What is the nerve supply of the lacrimal gland?

- **Sensory:** Lacrimal nerve (V?)
- **Secretomotor:** Facial nerve (via greater petrosal ? pterygopalatine ganglion ? zygomatic ? lacrimal)
- **Sympathetic:** From internal carotid plexus

---

6. What is the function of the lacrimal gland?

To secrete **tears** that lubricate, cleanse, and protect the eyeball.

---

7. What is the course of tears from the gland to the nose?

Lacrimal gland ? ducts ? conjunctival sac ? puncta ? canaliculi ? sac ? nasolacrimal duct ? inferior meatus.

---

8. What prevents reflux of nasal fluid into the nasolacrimal duct?

The **valve of Hasner**, at the lower end of the duct.

---

9. What is the cause of watery eyes (epiphora)?

Obstruction of the **nasolacrimal duct** or **lacrimal punctum**.

---

10. What is dacryocystitis?

Inflammation of the **lacrimal sac**, often due to nasolacrimal duct obstruction.

---

11. What is the embryological origin of the nasolacrimal duct?

From an **ectodermal cord** in the **naso-optic groove**, between maxillary and lateral nasal processes.

---

12. When does the face begin to develop?

During the **4th week of intrauterine life**.

---

13. Which processes take part in the formation of the face?

- **Frontonasal process**
- **Paired maxillary processes**
- **Paired mandibular processes**

---

14. What are nasal placodes and what do they form?

- Ectodermal thickenings on frontonasal process.
- Form **nasal pits**, which later become **nostrils** and **nasal cavities**.

---

15. What forms the upper lip?

Fusion of **two medial nasal** and **two maxillary processes**.

---

16. What forms the lower lip and mandible?

Fusion of **two mandibular processes**.

---

17. What are the derivatives of the medial nasal process?

- Philtrum of upper lip
- Premaxilla
- Primary palate
- Nasal septum

---

18. What are the derivatives of the lateral nasal process?

- Alae (sides) of nose
- Lateral walls of nasal cavity

---

19. What causes cleft lip?

Failure of fusion between **medial nasal** and **maxillary processes**.

---

20. What causes cleft palate?

Failure of **palatine shelves** (from maxillary processes) to fuse in midline.

---

21. What causes oblique facial cleft?

Failure of fusion between **lateral nasal** and **maxillary processes**.

---

22. What causes median cleft lip?

Failure of fusion between **two medial nasal processes**.

---

23. What causes macrostomia and microstomia?

- **Macrostomia:** Incomplete fusion of maxillary and mandibular processes.
- **Microstomia:** Excessive fusion of the same processes.

---

24. Which molecular factor controls midline facial development?

Sonic Hedgehog (SHH) gene.

---

25. Which molecular factors regulate facial prominence growth?

FGF, BMP, and TGF-? signaling pathways.

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26. What is the clinical importance of SHH mutation?

Results in **holoprosencephaly**, with midline facial defects such as single central incisor or cyclopia.

---

27. What is the role of retinoic acid in facial morphogenesis?

It regulates anterior–posterior patterning; imbalance causes **cleft lip/palate**.

---

28. What is the function of the pterygopalatine ganglion?

Relay station for **parasympathetic fibers** to lacrimal, nasal, and palatine glands.

---

29. Which muscle helps drain tears into the lacrimal sac?

The **lacrimal part of orbicularis oculi** — acts as a “tear pump.”

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30. What are common developmental anomalies of the face?

- Cleft lip
- Cleft palate

- Oblique facial cleft
- Median cleft lip
- Macrostomia
- Microstomia
- Hypotelorism
- Arhinia