Head and Neck

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Embryology – Head and Neck

I. Sources of Mesenchyme for Head Formation

Mesenchyme in the head comes from four main sources:

◈ Paraxial Mesoderm (Somites + Somitomeres)

- Forms:
    - Neurocranium → large portion (membranous + cartilaginous components of skull)
    - Voluntary muscles of craniofacial region
    - Dermis & connective tissue of dorsal head region
    - Meninges (caudal to prosencephalon)

◈ Lateral Plate Mesoderm

- Forms:
    - Laryngeal cartilages (arytenoid, cricoid)
    - Connective tissue in laryngeal region

◈ Neural Crest Cells (NCCs)

- Origin → Neuroectoderm of forebrain, midbrain, hindbrain

- Migration → Ventral into pharyngeal arches & rostrally around forebrain/optic cup → facial region

- Derivatives:

    - Entire viscerocranium (face)
    - Part of neurocranium (membranous + cartilaginous)
    - Other tissues: cartilage, bone, dentin, tendon, dermis, pia & arachnoid, sensory neurons, glandular connective tissue

◈ Ectodermal Placodes

- With NCCs → form sensory neurons of cranial ganglia:

    - CN V (Trigeminal)
    - CN VII (Facial)
    - CN IX (Glossopharyngeal)
    - CN X (Vagus)

2. Pharyngeal Arches

- Definition: Bars of mesenchymal tissue → separated by pharyngeal clefts

- Appearance: 4th–5th week of development

- Associated structures:

    - Pharyngeal clefts (external ectodermal invaginations)
    - Pharyngeal pouches (endodermal outpocketings from pharynx wall → do not open externally)

- Resemblance: Fish/amphibian gills (branchia), but no real gills in humans → hence "pharyngeal" is preferred over "branchial."

3. Role of Pharyngeal Arches

- Contribute to formation of neck and face

- End of 4th week:

    - Stomodeum (primitive mouth) forms center of face
    - Surrounded by 1st pharyngeal arch

- By 42 days (6th week) → 5 prominences visible:

- Mandibular prominences (from 1st arch) → caudal to stomodeum
- Maxillary prominences (dorsal 1st arch) → lateral to stomodeum
- Frontonasal prominence → cranial to stomodeum
- Later: Nasal prominences develop

4. Key Concept – Epithelial–Mesenchymal Interactions

- All differentiation of arches, pouches, clefts, prominences depends on reciprocal signaling between epithelium and mesenchyme.

- Disruption → congenital anomalies (e.g., craniofacial malformations).

📌 Exam Points

- Paraxial mesoderm → skull, muscles, meninges

- Neural crest → face (viscerocranium), sensory ganglia, connective tissue

- Lateral plate mesoderm → laryngeal cartilages

- Placodes + NCCs → cranial sensory ganglia
- Pharyngeal arches appear in 4th–5th week → essential for face + neck
- 5 prominences by 42 days: mandibular, maxillary, frontonasal, nasal

Pharyngeal Arches

1. General Structure of a Pharyngeal Arch

- Each arch has:
  - Core → mesenchymal tissue (from paraxial + lateral plate mesoderm + neural crest cells)
  - Outer covering → surface ectoderm
  - Inner lining → endodermal epithelium
- Neural crest cells → skeletal elements of face
- Mesodermal core → musculature of face & neck
- Each arch has:
  - Muscles → with its own cranial nerve

- Artery (aortic arch component)

👉 Key principle: Muscles may migrate away, but nerve supply remains from the arch of origin (basis of exam trick questions).

2. Individual Pharyngeal Arches & Their Derivatives

🔶 First Arch (Mandibular Arch)

- Processes:
  - Maxillary process (dorsal) → Premaxilla, maxilla, zygomatic bone, part of temporal bone (via membranous ossification)
  - Mandibular process (ventral) → contains Meckel's cartilage
    - Mostly disappears
    - Dorsal remnants → malleus, incus
    - Surrounding mesenchyme → mandible (via membranous ossification)
- Muscles:
  - Muscles of mastication: temporalis, masseter, medial & lateral pterygoids

    - Mylohyoid
    - Anterior belly of digastric
    - Tensor tympani
    - Tensor palatini

- Nerve: Trigeminal (CN V) → Mandibular division (V3)

- Extra: Sensory supply to face via ophthalmic (VI), maxillary (V2), mandibular (V3)

Second Arch (Hyoid Arch)

- Cartilage: Reichert's cartilage →

    - Stapes (middle ear ossicle)
    - Styloid process of temporal bone
    - Stylohyoid ligament
    - Lesser horn + upper body of hyoid

- Muscles:

    - Muscles of facial expression (buccinator, auricularis, frontalis, platysma, orbicularis oris, orbicularis oculi)
    - Posterior belly of digastric
    - Stylohyoid

- Stapedius

- Nerve: Facial nerve (CN VII)

Third Arch

- Cartilage: Greater horn + lower body of hyoid
- Muscle: Stylopharyngeus
- Nerve: Glossopharyngeal (CN IX)

Fourth and Sixth Arches

- Cartilage: Fuse → laryngeal cartilages (thyroid, cricoid, arytenoid, corniculate, cuneiform)

- Muscles:

  - 4th arch: Cricothyroid, levator veli palatini, pharyngeal constrictors
  - 6th arch: Intrinsic muscles of larynx (except cricothyroid)

- Nerve: Vagus (CN X)

  - 4th arch → Superior laryngeal branch
  - 6th arch → Recurrent laryngeal branch

3. High-Yield Derivatives Table

Arch	Nerve	Muscles	Skeletal Derivatives
1st (Mandibular)	CN V (Mandibular div.)	Mastication (temporalis, masseter, pterygoids), mylohyoid, anterior belly of digastric, tensor tympani, tensor palatini	Maxilla, zygomatic, part of temporal, mandible (from mesenchyme), malleus, incus, sphenomandibular ligament
2nd (Hyoid)	CN VII (Facial)	Facial expression, stapedius, stylohyoid, posterior belly digastric	Stapes, styloid process, stylohyoid ligament, lesser horn + upper hyoid body

3rd	CN IX (Glossopharyngeal)	Stylopharyngeus	Greater horn + lower hyoid body
4th	CN X (Superior laryngeal branch)	Cricothyroid, levator veli palatini, pharyngeal constrictors	Part of laryngeal cartilages
6th	CN X (Recurrent laryngeal branch)	Intrinsic laryngeal muscles (except cricothyroid)	Part of laryngeal cartilages

4. Exam Pointers

- Meckel's cartilage → malleus + incus (NOT mandible itself; mandible from surrounding mesenchyme).
- Reichert's cartilage → stapes + styloid process + stylohyoid ligament + upper hyoid.
- Muscles migrate but nerve supply doesn't change → basis for cranial nerve distribution in adult anatomy.
- Only one muscle from 3rd arch → Stylopharyngeus

(CN IX).

- Vagus nerve split: superior laryngeal (4th arch) vs recurrent laryngeal (6th arch).

Pharyngeal Pouches

1. Overview

- Human embryo → 4 well-defined pairs of pharyngeal pouches (5th is rudimentary).
- Lined by endodermal epithelium.
- Each pouch gives rise to important head, neck, and endocrine structures.

2. Individual Pouches & Their Derivatives

◈ First Pharyngeal Pouch

- Forms a tubotympanic recess → contacts 1st pharyngeal cleft (external auditory meatus).
- Derivatives:
    - Distal part → Primitive tympanic cavity (middle ear

cavity)
    - Proximal narrow part → Auditory (Eustachian) tube
    - Lining → contributes to tympanic membrane (eardrum)

Second Pharyngeal Pouch

- Epithelium proliferates → buds → invaded by mesoderm → primordium of palatine tonsils.
- During 3rd–5th month → infiltration by lymphatic tissue.
- Adult remnant → Tonsillar fossa.

Third Pharyngeal Pouch

- Each pouch has dorsal wing + ventral wing.
- Dorsal wing → Inferior parathyroid glands
- Ventral wing → Thymus
- Developmental changes:
    - Thymus detaches, migrates caudally + medially →

to anterior mediastinum (thorax), fuses with opposite side.
    - Inferior parathyroids are "dragged down" with thymus → final position on dorsal thyroid surface.
    - Thymus grows until puberty, then involutes (replaced by fat).
    - Occasionally, accessory thymic tissue may persist in neck or thyroid.

◈ Fourth Pharyngeal Pouch

- Dorsal wing → Superior parathyroid glands (attach to dorsal thyroid).

- Ventral wing → Ultimobranchial body → incorporated into thyroid → gives parafollicular (C cells).

- Function of C cells: secrete calcitonin → lowers blood calcium (antagonizes parathyroid hormone).

3. High-Yield Derivatives Table

Pharyngeal Pouch	Derivatives

1st	Tympanic (middle ear) cavity, Auditory (Eustachian) tube, Contributes to tympanic membrane
2nd	Palatine tonsil primordium, Tonsillar fossa
3rd	Inferior parathyroid glands (dorsal wing), Thymus (ventral wing)
4th	Superior parathyroid glands (dorsal wing), Ultimobranchial body → C cells of thyroid (calcitonin)

4. Exam Tips

- Mnemonic for parathyroids:
    - "3 goes Low, 4 goes High" → 3rd pouch → inferior parathyroids, 4th pouch → superior parathyroids.
- Clinical correlation:
    - DiGeorge Syndrome (22q11.2 deletion): failure of 3rd & 4th pouch development → absent thymus & parathyroids → T-cell deficiency + hypocalcemia.

- Accessory thymic tissue can be found in neck or thyroid gland.

- Ultimobranchial body origin of C cells is a frequent viva question.

Pharyngeal Clefts (Grooves)

1. General Features

- At 5 weeks → embryo shows 4 pharyngeal clefts (ectodermal invaginations).

- Only the 1st cleft contributes to definitive structures.

- Others (2nd–4th) are normally obliterated.

2. Fate of Individual Clefts

- First pharyngeal cleft
    - Dorsal part deepens → forms external auditory meatus.
    - Lining at bottom → contributes to tympanic membrane (eardrum) (with 1st pouch & mesoderm).

- Second, third, and fourth clefts
    - Overgrown by proliferating tissue of 2nd arch, which fuses with the epicardial ridge.
    - Lose external contact → form a cervical sinus (lined by ectoderm).
    - Normally, the cervical sinus disappears.

3. Clinical Correlates

◈ Ectopic Thymic & Parathyroid Tissue

- Due to migration of glands from pouches.
- Accessory glands or remnants may persist.
- Inferior parathyroids → highly variable (can be found near carotid bifurcation).
- Thymic tissue may persist in neck or thyroid.

◈ Branchial Fistula

- Cause: Failure of 2nd arch to overgrow 3rd & 4th arches → persistence of clefts.

- Remnants form a canal (fistula) that connects cervical sinus to the surface.

- Location: Lateral neck, anterior to sternocleidomastoid muscle.

- Usually opens externally → drains a lateral cervical cyst.

4. Exam Essentials

- Only 1st cleft is normal → external ear canal.

- 2nd–4th clefts normally obliterated → if not → cysts, fistulas, sinuses.

- Cervical cysts/fistulas → always on lateral neck (contrast with thyroglossal cyst → midline).

- Tympanic membrane has 3 germ layer contributions:

    - Ectoderm (from cleft),
    - Endoderm (from pouch),
    - Mesoderm (intervening connective tissue).

5. Quick Table – Derivatives of Pharyngeal Clefts

Pharyngeal Cleft	Fate / Derivative
1st cleft	External auditory meatus, contributes to tympanic membrane
2nd, 3rd, 4th clefts	Normally obliterated → transient cervical sinus (disappears)
Abnormality	Persistence → Branchial cysts/fistulas

Branchial Cysts & Fistulas + Neural Crest Cell Defects

1. Lateral Cervical Cysts

- Origin → Remnants of cervical sinus (2nd–4th clefts fail to regress).
- Common site → Just below angle of the jaw, along anterior border of sternocleidomastoid.
- Often not visible at birth → enlarge in childhood.

2. Branchial Fistulas

- External fistula → Persistence of cleft canal → opens on lateral neck (anterior to SCM).

- Internal fistula (rare):

    - Cervical sinus connects with pharyngeal lumen.
    - Opening usually in tonsillar region (2nd cleft–pouch membrane ruptures).

🔑 Exam point:

- Lateral cervical cyst/fistula → lateral neck.

- Thyroglossal cyst/fistula → midline neck.

Neural Crest Cells & Craniofacial Defects

Role of Neural Crest Cells

- Essential for:

    - Craniofacial skeleton & connective tissue.
    - Conotruncal endocardial cushions (heart outflow tract).
    - Regulation of secondary heart field.

👉 Hence, craniofacial anomalies often associated with congenital heart defects.

- Common cardiac anomalies: Persistent truncus arteriosus, TOF, Transposition of great vessels.

Key Syndromes

1. Treacher Collins Syndrome (Mandibulofacial dysostosis)

- Cause: Mutation in TCOF1 gene → defective treacle protein → impaired neural crest differentiation.
- Inheritance: Autosomal dominant (60% new mutations).
- Features:
    - Malar hypoplasia (zygomatic bone underdeveloped)
    - Mandibular hypoplasia
    - Down-slanting palpebral fissures
    - Lower eyelid colobomas
    - Malformed external ear
- Mimicked by: Retinoic acid teratogenicity.

2. Robin Sequence

- Defect: Mandibular hypoplasia (first arch).
- Triad:
    - Micrognathia
    - Glossoptosis (posterior tongue)
    - Cleft palate (palatal shelves fail to fuse).
- Causes: Genetic, environmental (e.g., oligohydramnios → chin compressed on chest).
- Incidence: ~ 1 in 8,500 births.

3. 22q11.2 Deletion Syndrome

(= DiGeorge syndrome / Velo-cardio-facial syndrome / Conotruncal anomaly face syndrome)

- Cause: Microdeletion on chromosome 22q11.2.
- Incidence: ~ 1 in 4,000 births.
- Features:
    - Congenital heart defects (esp. conotruncal

anomalies)
    - Thymic hypoplasia/aplasia → ↓ T-cell immunity → recurrent infections
    - Hypocalcemia → seizures (due to abnormal parathyroid development)
    - Mild facial dysmorphology
    - Learning disabilities

- Pathogenesis: Failure of neural crest cell contribution to mesenchyme → defective epithelial–mesenchymal interaction.

4. Oculoauriculovertebral Spectrum (Goldenhar Syndrome / Hemifacial Microsomia)

- Incidence: ~ 1 in 5,600 births.

- Features:

    - Craniofacial asymmetry (65%)
    - Maxillary, temporal, zygomatic bones small/flat
    - Ear defects → microtia, anotia
    - Eye defects → epibulbar dermoids, tumors
    - Vertebral anomalies → hemivertebrae, fused vertebrae, spina bifida

- Associated anomalies: Cardiac defects (TOF, VSD) in ~ 50%.

- Cause: Unknown.

Exam-Oriented Pearls

- Treacher Collins → 1st arch + TCOF1 mutation.

- Robin sequence → micrognathia → glossoptosis → cleft palate.

- 22q11 deletion → "CATCH-22" mnemonic:

    - C → Cardiac defects
    - A → Abnormal facies
    - T → Thymic hypoplasia
    - C → Cleft palate
    - H → Hypocalcemia

- Goldenhar → oculo-auriculo-vertebral defects + hemifacial microsomia.

Development of the Tongue

Embryonic Origin

- Appears as swellings in the floor of the pharynx.

1. Anterior 2/3 (Body of Tongue)

    - Derived from 1st pharyngeal arch:
        - Tuberculum impar (median swelling).
        - Two lateral lingual swellings → enlarge, overgrow tuberculum impar → fuse.
    - Separated from posterior part by terminal sulcus (V-shaped groove).

2. Posterior 1/3 (Root of Tongue)

    - From 2nd, 3rd, and part of 4th arches.
    - 3rd arch overgrows 2nd arch, explaining innervation by CN IX (not CN VII).

3. Epiglottis & Extreme Posterior Tongue

    - Derived from posterior part of 4th arch (hypobranchial eminence).
    - Related to laryngeal orifice & arytenoid swellings.

4. Muscles of Tongue

    - From occipital somites (myoblasts).
    - Nerve: Hypoglossal nerve (CN XII).

Innervation of Tongue

👉 Key principle: Mucosa → from pharyngeal arches → supplied by their respective cranial nerves.

👉 Muscles → from occipital somites → CN XII.

1. Anterior 2/3 (Body of Tongue)

    - Pharyngeal Arch Origin: 1st arch (tuberculum impar + lateral lingual swellings)
    - Muscle Origin: Occipital somites
    - General Sensation: CN V3 (lingual nerve)
    - Taste (Special Sensory): CN VII (chorda tympani)
    - Motor Innervation: CN XII (hypoglossal)

2. Posterior 1/3 (Root of Tongue)

    - Pharyngeal Arch Origin: 3rd arch (overgrows 2nd) + part of 4th arch
    - Muscle Origin: Occipital somites

- General Sensation: CN IX (glossopharyngeal)
- Taste (Special Sensory): CN IX
- Motor Innervation: CN XII

3. Epiglottis & Extreme Posterior Tongue

- Pharyngeal Arch Origin: 4th arch
- Muscle Origin: Occipital somites
- General Sensation: CN X (superior laryngeal branch)
- Taste (Special Sensory): CN X
- Motor Innervation: CN XII

Clinical Correlate

- Ankyloglossia (Tongue-tie)
  - Cause: Frenulum abnormally short, extends to tip of tongue.
  - Embryology: Normally, degeneration of cells frees tongue from floor → only frenulum remains.
  - Effect: Restricts tongue movement; may interfere with speech/feeding.

Exam Pearls

- Development: Body (1st arch), Root (3rd arch), Epiglottis (4th arch).

- Innervation: CN V3, VII, IX, X for mucosa; CN XII for muscles.

- Taste vs. sensation → classic MCQ:

    - Ant. 2/3 taste = CN VII.
    - Ant. 2/3 sensation = CN V3.

- Tongue-tie = frenulum persistence.

Thyroid Gland Development

Origin

- Appears as epithelial proliferation in the floor of pharynx:

    - Between tuberculum impar and copula
    - Marked later by the foramen cecum

Descent

- Moves anterior to pharyngeal gut as a bilobed diverticulum

- Connected temporarily to tongue by thyroglossal duct → later disappears
- Descends in front of hyoid bone and laryngeal cartilages
- Reaches final position in front of trachea by 7th week
- Forms median isthmus + two lateral lobes

Function

- Begins at end of 3rd month
- Formation of thyroid follicles containing colloid:
    - Follicular cells → thyroxine (T4) & triiodothyronine (T3)
    - Parafollicular (C) cells → from ultimobranchial body → secrete calcitonin

Clinical Correlates

1. Thyroglossal Duct Cyst
    - Midline neck cyst anywhere along thyroid's

migratory path
    - ~50% located just below hyoid bone
    - Can be connected to skin → thyroglossal fistula

2. Ectopic Thyroid Tissue

    - Commonly at base of tongue (lingual thyroid)
    - Can develop same diseases as normal thyroid

Facial Development

Timeline

- End of 4th week: facial prominences appear, mainly neural crest–derived mesenchyme.

    - Maxillary prominences → lateral to stomodeum
    - Mandibular prominences → caudal to stomodeum
    - Frontonasal prominence → above stomodeum (forms upper border)
    - Nasal (olfactory) placodes form on frontonasal prominence under forebrain influence

Nasal Prominences

- Week 5: nasal placodes invaginate → nasal pits

    - Medial nasal prominences → inner edge
    - Lateral nasal prominences → outer edge

- Weeks 6–7: maxillary prominences grow medially → fuse with medial nasal prominences

    - Cleft between them disappears
    - Forms upper lip:
        - Medial nasal prominences (2) + maxillary prominences (2)
    - Lower lip & jaw → mandibular prominences merge

Nasolacrimal Duct Formation

- Initially: nasolacrimal groove between maxillary & lateral nasal prominences

- Ectoderm in floor → solid epithelial cord → canalizes → nasolacrimal duct

- Lacrimal sac → upper widened end

- Final position: medial corner of eye → inferior meatus of nasal cavity

- Maxillary prominences → form cheeks & maxillae

Summary Table: Prominences & Structures

Prominence	Structures Formed
Frontonasal (unpaired)	Forehead, bridge of nose, medial & lateral nasal prominences
Medial nasal	Philtrum, crest & tip of nose
Lateral nasal	Ala of nose
Maxillary	Cheeks, lateral upper lip
Mandibular	Lower lip, jaw

Mnemonic for nose formation:

"5 Fingers for Nose" → 1 frontonasal, 2 medial nasal, 2 lateral nasal prominences

✅ Exam Points

- Foramen cecum → thyroid origin

- Thyroglossal duct cyst → midline neck, below hyoid
- Lingual thyroid → base of tongue
- Upper lip = 2 medial nasal + 2 maxillary prominences
- Lower lip/jaw = mandibular prominences
- Nasolacrimal duct → nasolacrimal groove → canalization

Intermaxillary Segment (IMS)

Formation

- Formed by medial growth and deep fusion of two medial nasal prominences
- Composed of three components:
    1. Labial component → Philtrum of upper lip
    2. Upper jaw component → carries 4 incisor teeth
    3. Palatal component → forms triangular primary palate

- Continuous with rostral nasal septum (from frontonasal prominence)

  Mnemonic: "Phil In Palate" → Philtrum, Incisors, Palate = Intermaxillary segment

Palate Development

Primary Palate

- Derived from intermaxillary segment
- Forms triangular portion anterior to incisive foramen

Secondary Palate

- Formed by palatine shelves (shelf-like outgrowths of maxillary prominences)
- Timeline:
  - Week 6: palatine shelves grow downward beside tongue
  - Week 7: shelves ascend above tongue, fuse in midline → secondary palate
- Fusion:

- Anterior: with primary palate → incisive foramen marks boundary
- Superior: nasal septum grows down and fuses with secondary palate

3. Clinical Correlates: Facial Clefts

Cleft Lip & Palate

- Incisive foramen → dividing landmark between anterior & posterior clefts

Anterior Clefts (anterior to incisive foramen)

- Structures involved: maxillary prominence + medial nasal prominence

- Examples:

  - Cleft lip
  - Cleft upper jaw
  - Cleft between primary & secondary palate

- Severity: from minor vermilion defect → entire maxilla split between lateral incisor & canine

- Epidemiology: ~1/700 births, more common in males (65%)

Posterior Clefts (posterior to incisive foramen)

- Structures involved: palatine shelves
- Examples:
    - Cleft secondary palate
    - Cleft uvula
- Causes:
    - Small or underdeveloped palatine shelves
    - Failure of shelves to elevate
    - Tongue obstructing fusion (micrognathia)
- Epidemiology: ~1/1,500 births, more common in females (55%)

Combination Clefts

- Involve both anterior & posterior regions
- Can affect lip, jaw, primary & secondary palate

Oblique Facial Clefts

- Failure of maxillary prominence to merge with lateral nasal prominence
- Nasolacrimal duct may be exposed

Median (Midline) Cleft Lip

- Rare
- Caused by incomplete fusion of two medial nasal prominences
- Often associated with cognitive impairment & brain midline defects
- Severe cases → holoprosencephaly (fusion of lateral ventricles)
- Induced very early: Days 9–21, during neurulation

4. Etiology of Clefts

- Multifactorial
- Types:

1. Syndromic → associated with genetic syndromes

2. Nonsyndromic → isolated; may involve IRF6, MSX1

3. Teratogenic exposures:

    - Anticonvulsants (e.g., valproic acid)
    - Cigarette smoking during pregnancy

High Points

- Intermaxillary segment → philtrum, 4 incisors, primary palate

- Secondary palate → palatine shelves from maxillary prominences

- Incisive foramen → landmark separating anterior & posterior clefts

- Anterior cleft → failure of maxillary + medial nasal fusion

- Posterior cleft → failure of palatine shelf fusion

- Oblique cleft → failure of maxillary + lateral nasal

fusion

- Midline cleft → failure of medial nasal prominences, possible holoprosencephaly

- Epidemiology:
  - Cleft lip ± palate → males > females
  - Isolated cleft palate → females > males

Nasal Cavities

1. Development of Nasal Cavities

Stage 1: Formation of Nasal Pits

- Week 6 → nasal pits deepen due to:

  1. Growth of surrounding nasal prominences

  2. Penetration into underlying mesenchyme

Stage 2: Primitive Nasal Cavities

- Initially separated from oral cavity by oronasal membrane

- Breakdown of membrane → formation of primitive choanae
    - Location: behind the primary palate, on either side of midline

Stage 3: Definitive Nasal Cavities

- With secondary palate formation → primitive nasal chambers expand
- Definitive choanae shift posteriorly:
    - Final position: junction of nasal cavity & pharynx

2. Paranasal Sinuses

- Develop as diverticula of the lateral nasal wall
- Extend into surrounding bones:
    - Maxilla
    - Ethmoid
    - Frontal
    - Sphenoid

- Growth: small in childhood → reach maximum size at puberty
- Function: contribute to final shape of the face

3. Exam Points

- Oronasal membrane → separates nasal pits from oral cavity early
- Primitive choanae → lie behind primary palate
- Definitive choanae → after secondary palate formation, at nasopharyngeal junction
- Paranasal sinuses → develop late, enlarge at puberty
- Clinical importance: their growth → contributes to facial contour