PHARYNGEAL APPARATUS (BRANCHIAL APPARATUS)

1. The **most typical feature** in development of the head and neck is formed by the **pharyngeal or branchial arches**.
2. There are ***6 pharyngeal arches*** which are separated from each other:
   - Internally by 5 ***pharyngeal pouches.***
   - Externally by 4 ***pharyngeal clefts.***

PHARYNGEAL ARCHES

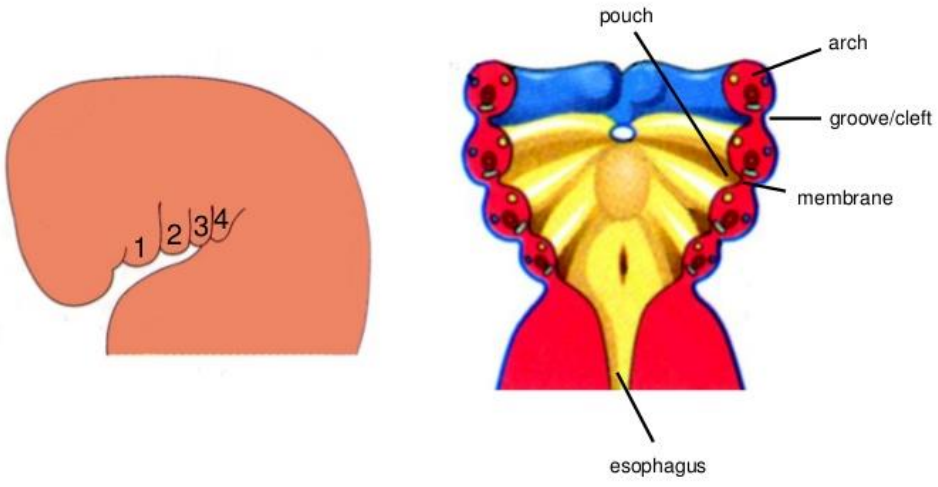
*Definition

1. Pharyngeal arches are 6 curved cylindrical thickenings **on each side of the pharyngeal gut** , forming lateral wall of primitive pharynx .
2. Each pharyngeal arch **consists of** a core of mesenchymal tissue covered on the outside by surface ectoderm and lined inside by epithelium of endodermal origin.
3. Each arch has its own ***cartilage*** , ***artery*** and ***nerve*** .

*Time of appearance

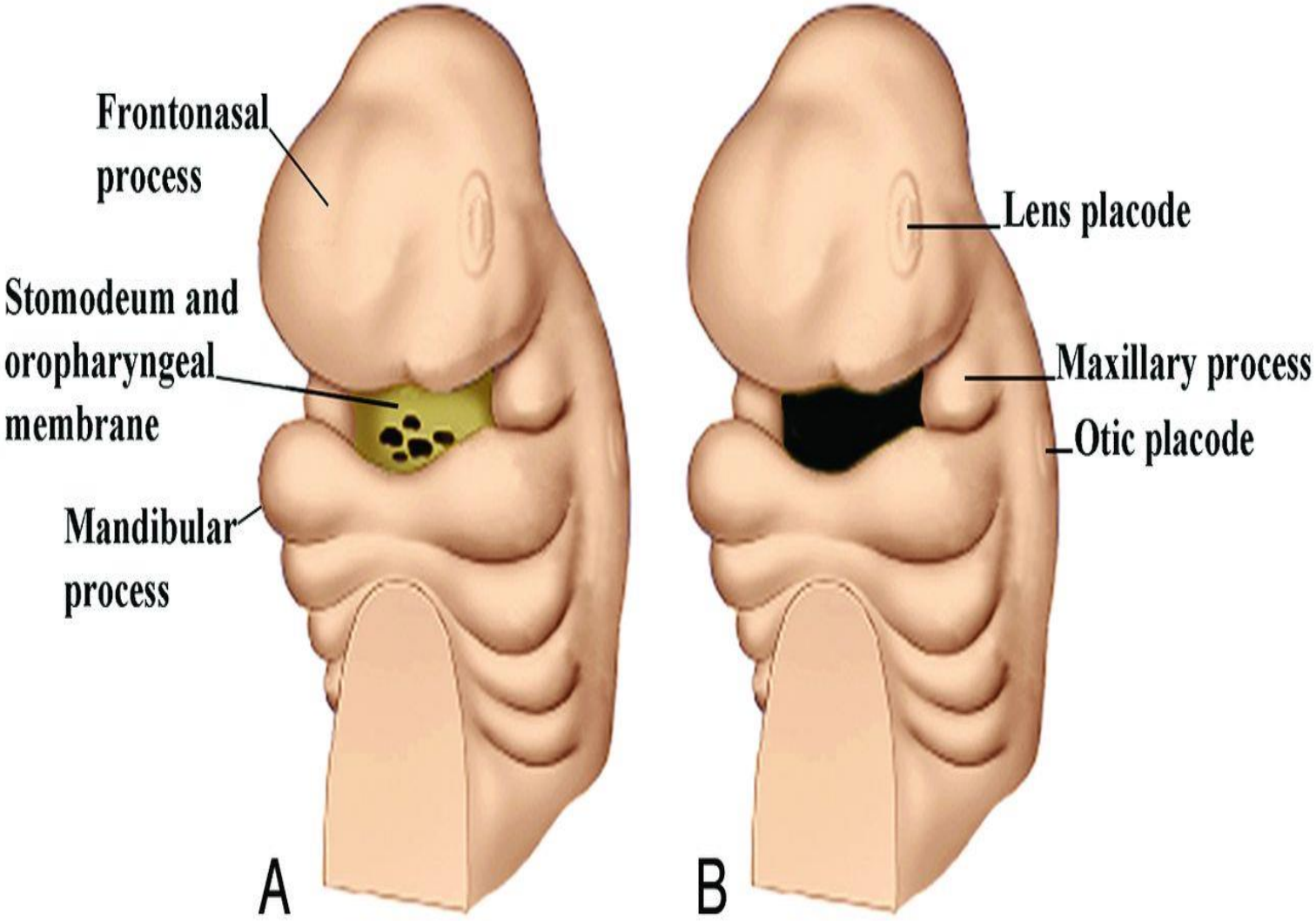
- These arches appear in the **4th and 5th** weeks of development.
- The **cranial** arches **precede** the caudal ones and are more **prominent.**

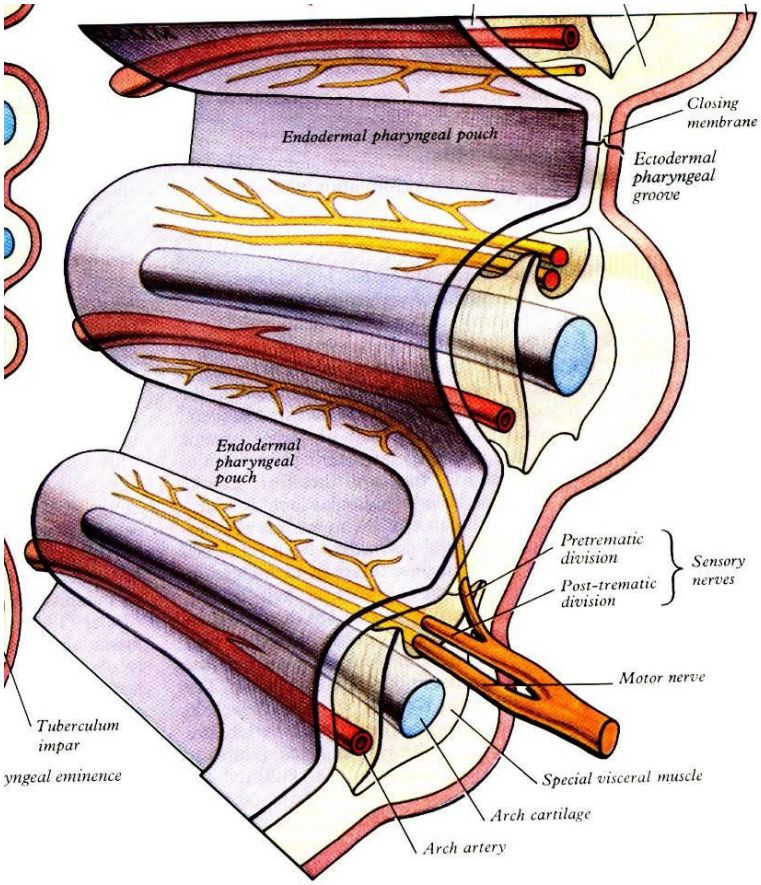
The pharyngeal apparatus

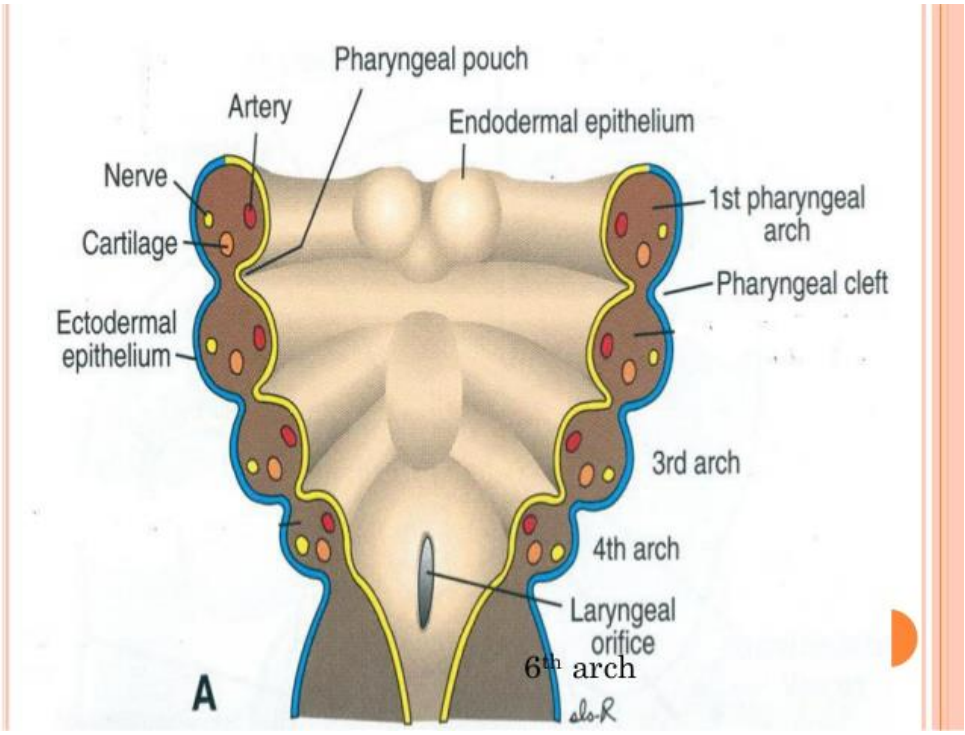


Branchial arches form in the pharyngeal wall (which has lateral plate mesoderm sandwiched between ectoderm and endoderm) as a result of lateral plate mesoderm proliferation and subsequent migration by neural crest cells

The Developing Human by Moore & Persaud


Frontonasal process
Stomodeum and oropharyngeal membrane
Mandibular process
A
Lens placode
Maxillary process
Otic placode
B



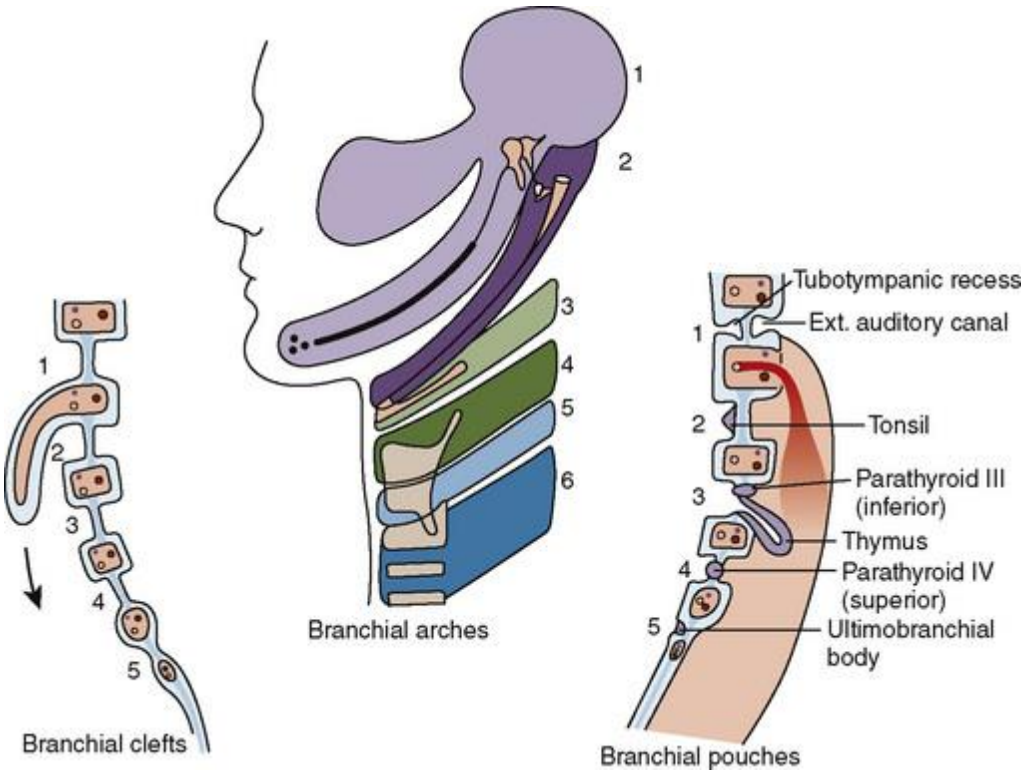


Component of each pharyngeal arch

*Fate

1-DERIVATIVES OF THE PHARYNGEAL ARCHES (MESODERM) :

Arch	***Skeletal derivatives***	***Muscular derivatives***	***Nerve***
1st arch (mandibular arch): consists of maxillary and mandibular processes:	****maxillary process*** gives rise to the maxilla, zygomatic and part of the temporal bones. ****Mandibular process, which contains Meckel's cartilage:*** differentiates into malleus, incus , lower jaw Sphenomandibular ligament and anterior ligament of malleus.	***(A) 4 muscles of mastication:*** - Temporalis, masseter, - Medial and lateral pterygoid. ***(B) 4 other muscles*** - Mylohyoid, -Anterior belly of digastric, tensor palati and tensor tympani.	- Mandibular and maxillary nerves. - Chorda tympani (pretrematic nerve of the 1st arch).
2nd arch (hyoid arch):	***REICHERT'S CARTILAGE: differentiates into*** stapes, styloid process, stylohyoid ligament, lesser horn and upper part of body of hyoid bone.	***-Muscles of*** scalp and face, platysma, stylohyoid muscle, posterior belly of digastric and stapedius muscle.	Facial nerve
3rd arch:	***lower part of body and Greater horn of hyoid bone.***	***Stylopharyngeus.***	Glossopharyngeal nerve.
4th arch:	***Thyoid cartilage.***	***Cricothyroid.***	Superior laryngeal nerve.
6th arch:	***Other cartilages of larynx***	***-All muscles of palate except tensor palati.*** ***-All muscles of pharynx except stylophayngeus.*** ***-Intrinsic muscles of larynx.***	Recurrent laryngeal nerve.

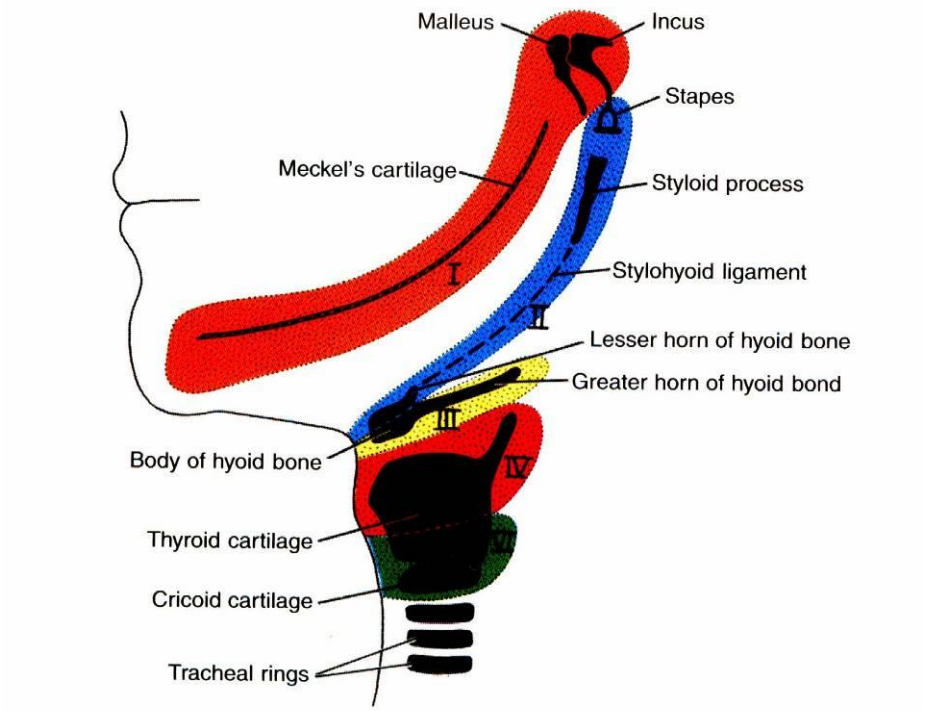


**** N.B.:***

1-The 5th arch never forms and rapidly regresses.

2- Vascular element of pharyngeal arches :

- 1st. arch : maxillary artery .
- 2nd. Arch : caroticotympanic branch of internal carotid artery .
- 3rd. arch : internal & external carotid arteries .
- 4th arch : arch of aorta on left side & subclavian artery on the right side .
- 6th arch : pulmonary artery on each side & ductus arteriosus on left side .



Definitive structures formed by the cartilaginous components of the various pharyngeal arches.

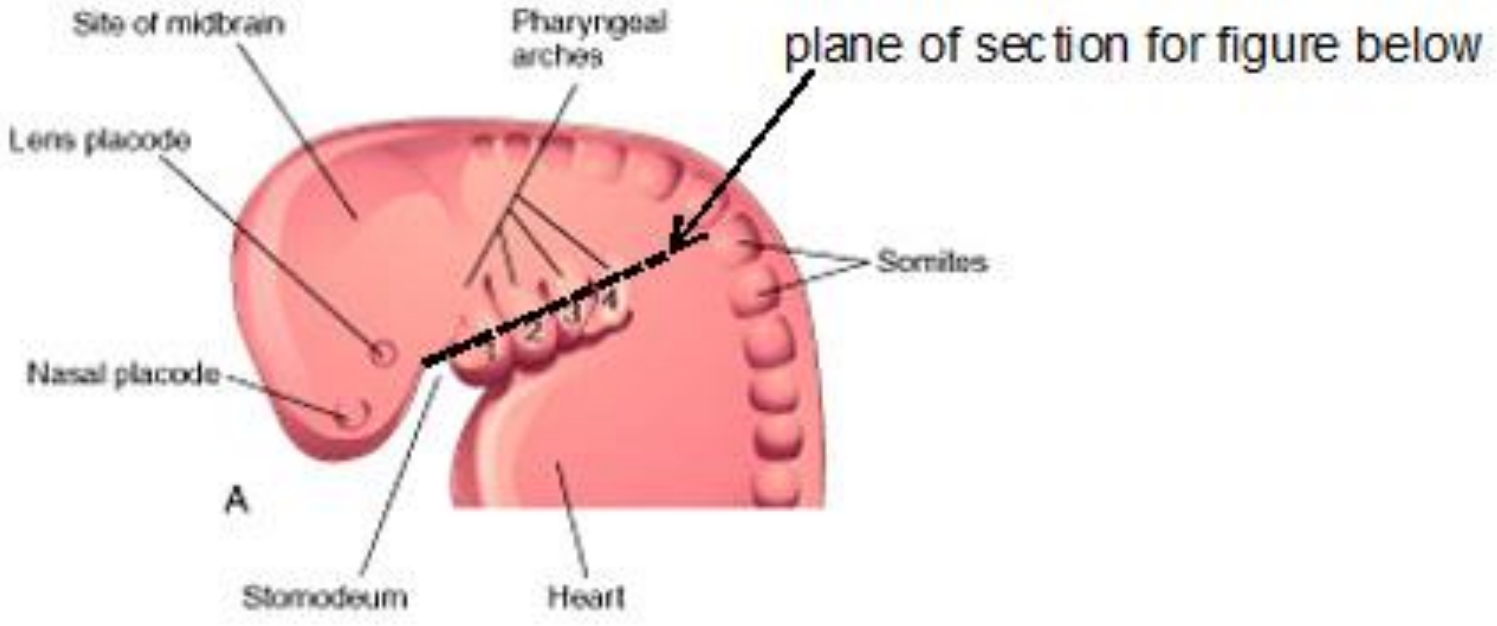
Skeletal derivatives of pharyngeal arches

2- DERIVATIVES OF THE PHARYNGEAL CLEFTS (ECTODERM):

1st cleft: forms the external auditory meatus and the outer layer of the ear drum.

2nd , 3rd and 4th clefts :

1. Active proliferation of mesenchymal tissue in the 2nd arch causes it to overlap the 3rd and 4th arches. Finally, it fuses with the epicardial pulg in the neck.
2. The 2nd, 3rd and 4th cleft lose contact with the outside and form a cavity called the ***cervical sinus*** which disappears and does not give rise to any structure.



Derivatives of pharyngeal clefts Cervical sinus

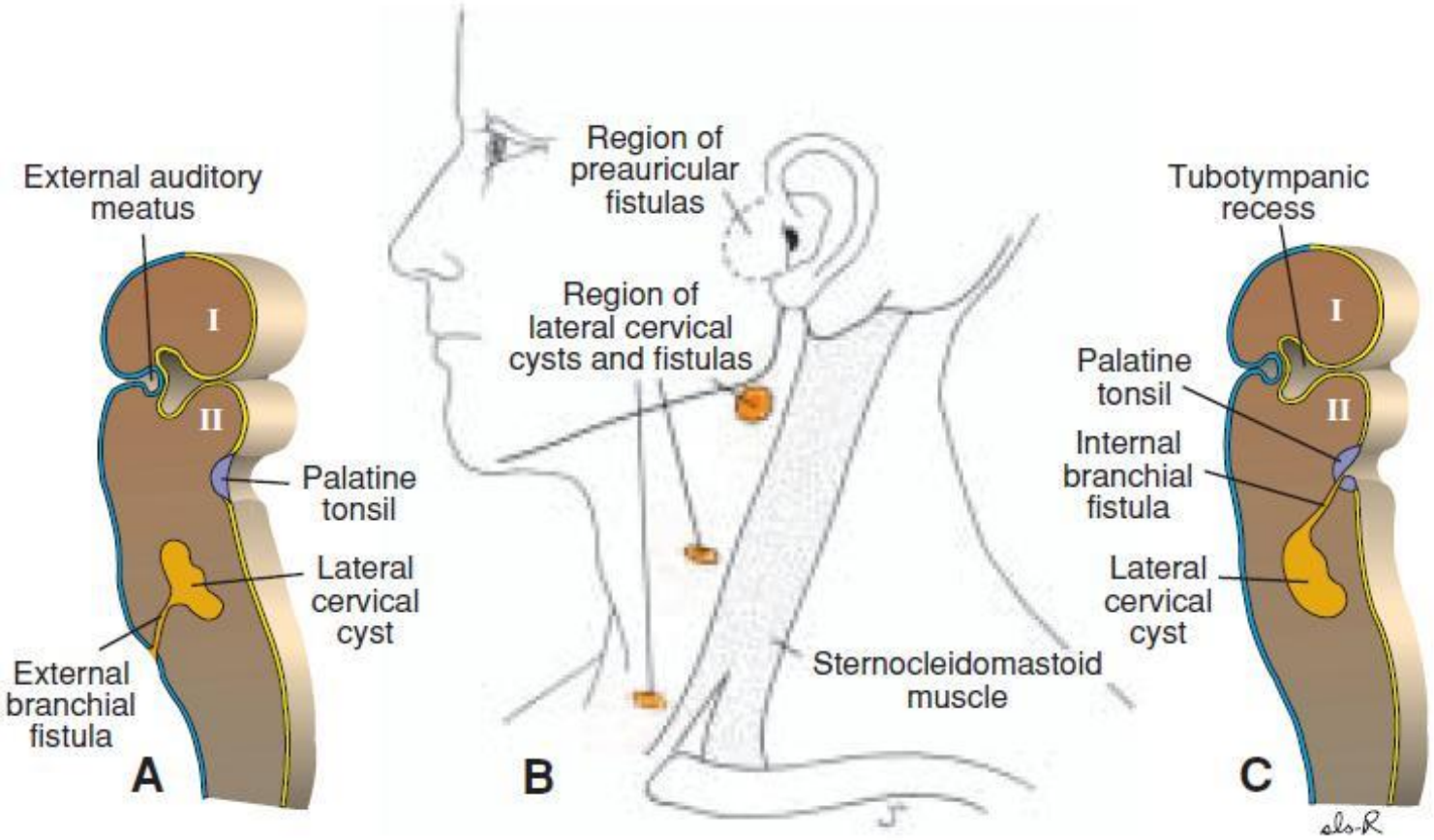
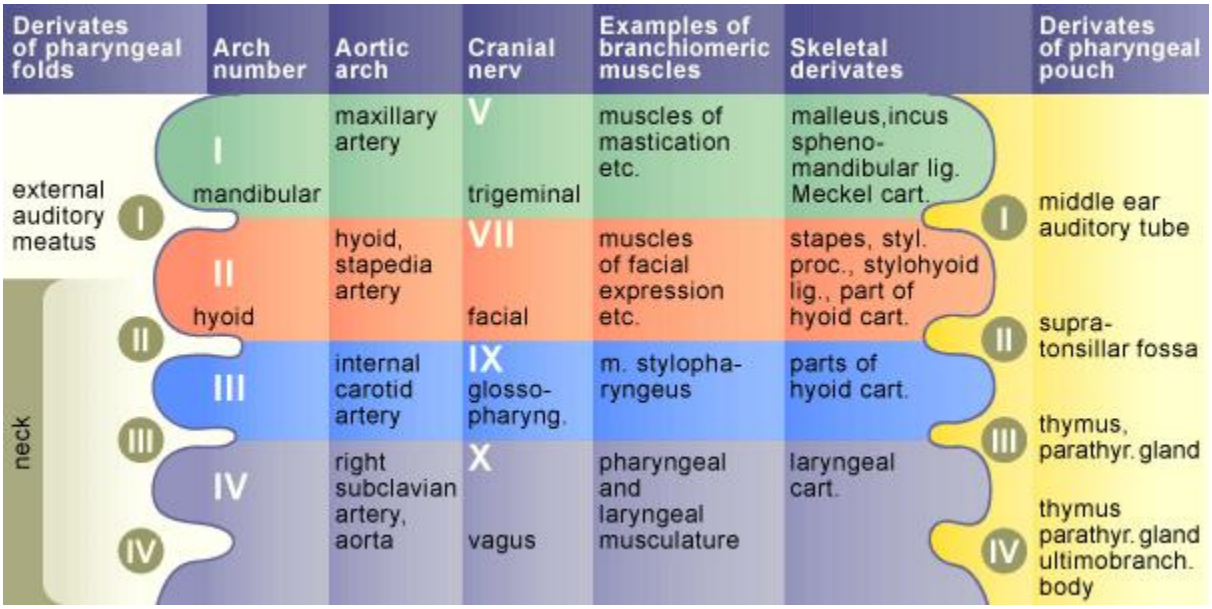
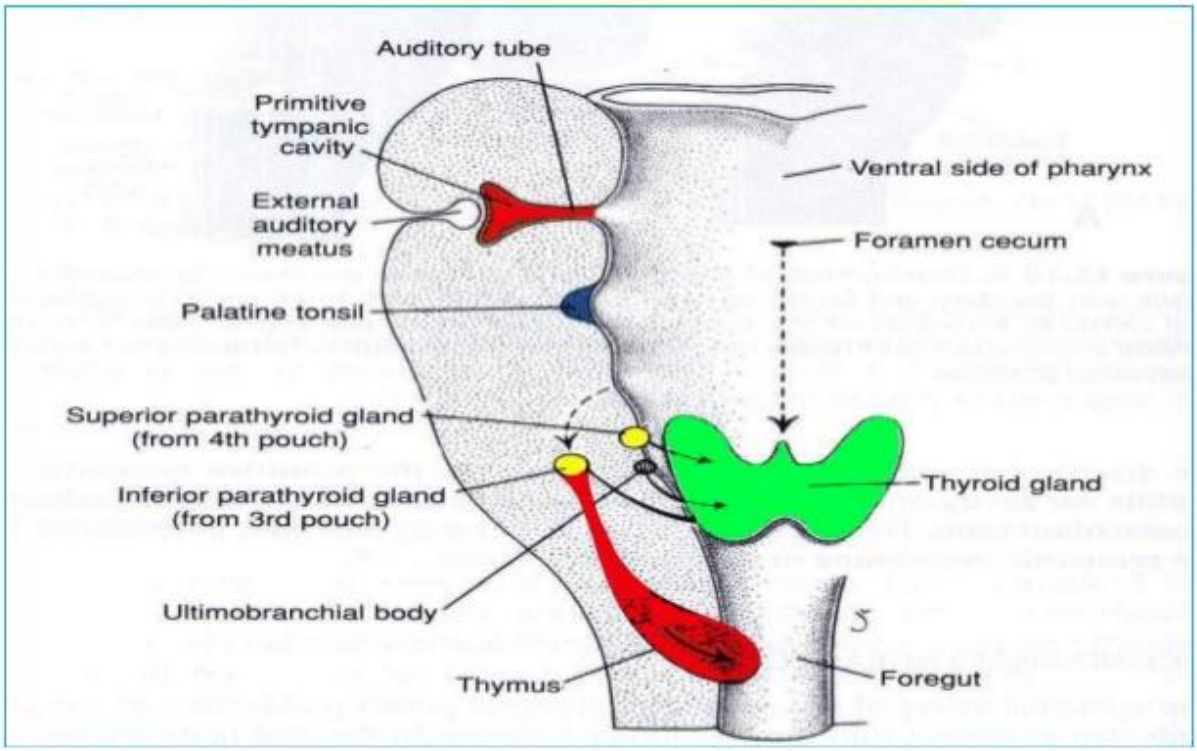


Figure 1 Branchial cleft cyst in the neck



Development of Pharyngeal pouches and clefts



Prof. Mohamed A. Autifi

Derivatives of pharyngeal pouches

3-DERIVATIVES OF THE PHARYNGEAL POUCHES (ENDODERM) :

- Each pouch is characterized at its extremity by a dorsal and a ventral wing.

- ***1st pouch :***

- It forms the ***tubotympanic recess*** which gives rise to Eustachian tube, middle ear cavity, mastoid antrum and inner layer of the ear drum.

- ***2nd pouch :***

- The epithelial lining of the second pharyngeal pouch proliferates and forms buds.
- The buds are secondarily invaded by mesodermal tissue, forming the **palatine tonsil.**

- ***3rd pouch :***

- The dorsal wing of the 3rd pouch forms the ***inferior parathyroid gland***.
- The ventral wing forms the ***thymus gland.***
- Both gland primordia lose their connection with the pharyngeal wall and then the thymus migrates pulling the inferior parathyroid gland with it.

- ***4th pouch:***

- The dorsal wing of the 4th pouch forms the **superior parathyroid gland**.

- ***5th pouch :***

- It gives rise to the **ultimobranchial body**, which is later incorporated into **thyroid gland.**
- The ultimobranchial body gives rise to the **parafollicular (C) cells** of the thyroid gland.

BIRTH DEFECTS IN THE PHARYNGEAL REGION

1-Ectopic thymic and parathyroid tissue :

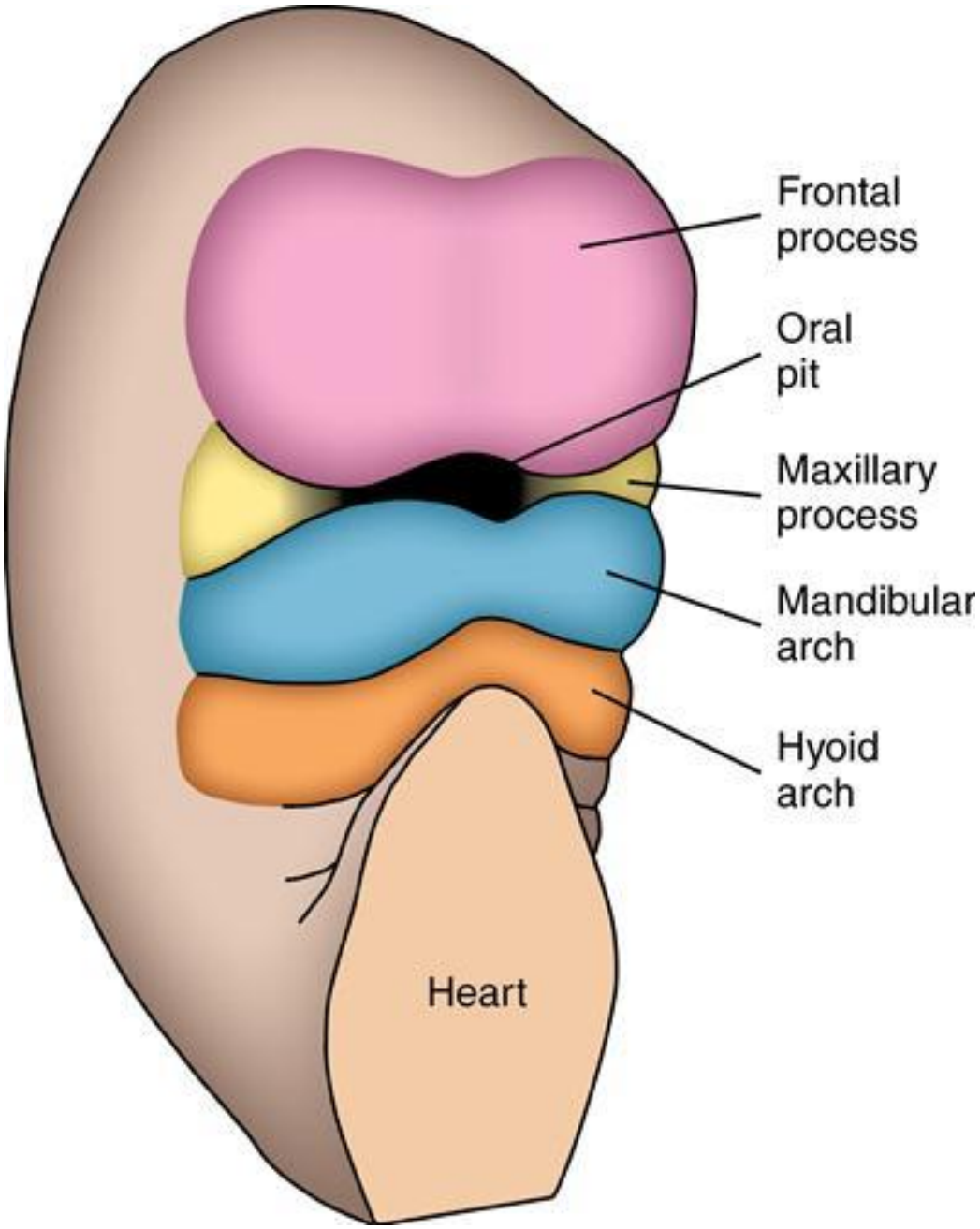
- The thymus may remain in the neck.
- The inferior parathyroid is more variable in position than the superior one.

2-Branchial cyst :

1. It is a cystic swelling lying anywhere along the anterior border of sternomastoid.
2. It results from failure of obliteration of the **cervical sinus**.

3-External branchial fistula: the cervical sinus opens externally into the skin.

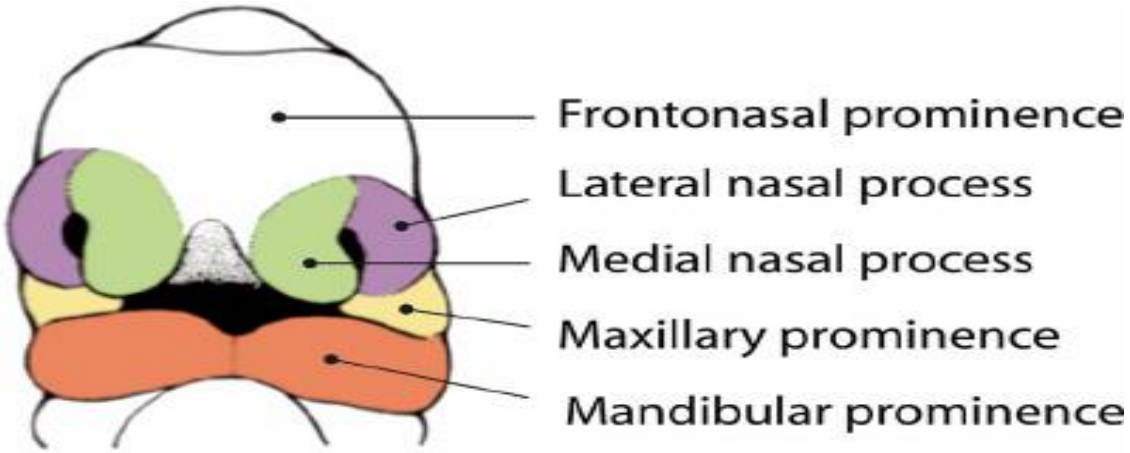
4-Internal cervical branchial fistula: the cervical sinus opens internally into the pharynx.

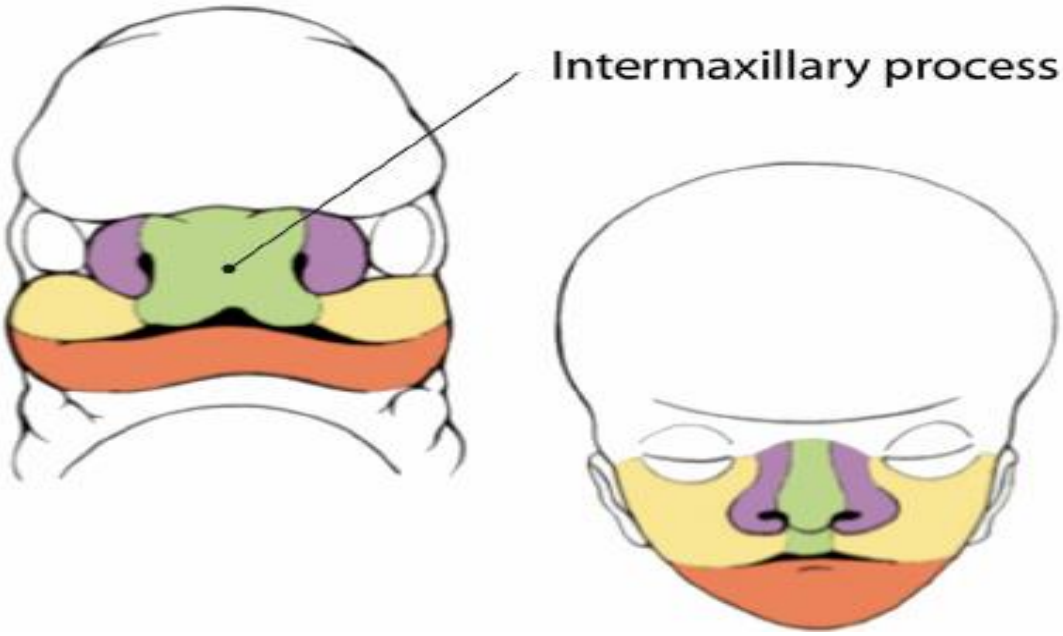


*DEVELOPMENT OF THE FACE *

*Formation of 5 processes around the stomodeum :

1. The 1st pharyngeal arch develops 2 processes:
   - ***Maxillary processes***: lateral to the stomodeum.
   - ***Mandibular processes***: caudal to the stomodeum.
2. ***The frontonasal processe,*** formed by proliferation of mesenchyme ventral to the brain vesicles. It forms the upper border of the stomodeum.
3. So the stomodeum becomes surrounded by 5 processes:
   - ***Frontonasal processe*** lies cranially.
   - ***2 maxillary processes*** lie on each side and cranially.
   - ***2 mandibular processes*** lie caudally.





**DIFFERENTIATION AND FUSION OF THE 5 processes :*

a) The fronto-nasal prominence :

1. ***Two nasal placodes*** develop on both sides of the fronto-nasal prominence.
2. The nasal placodes invaginated to form ***nasal pits*** (***olfactory pits***). Each pit is surrounded by **lateral and medial nasal prominences.**
3. The **maxillary** prominences grow medially, **compressing** the medial nasal prominences toward midline.
4. The two medial nasal prominences **fuse** together to form **median nasal prominence** and the cleft between the medial nasal prominence and the maxillary prominence is lost.

**Fate:*

- ***The fronto-nasal prominence*** contributes to the forehead .
- ***The median nasal prominence*** contributes to the middle part of nose & philtrum of upper lip .
- ***The lateral nasal prominence*** contributes to the ala & lateral part of the nose.
- **The Nasal Septum :**The nasal septum descends vertically downwards from the frontonasal processes to fuse with the upper surface of the palate in the middle line.
- ***Intermaxillary segment:***

  -It is the free lower part of the frontonasal prominence which lies between the tips of the 2 maxillary prominences.

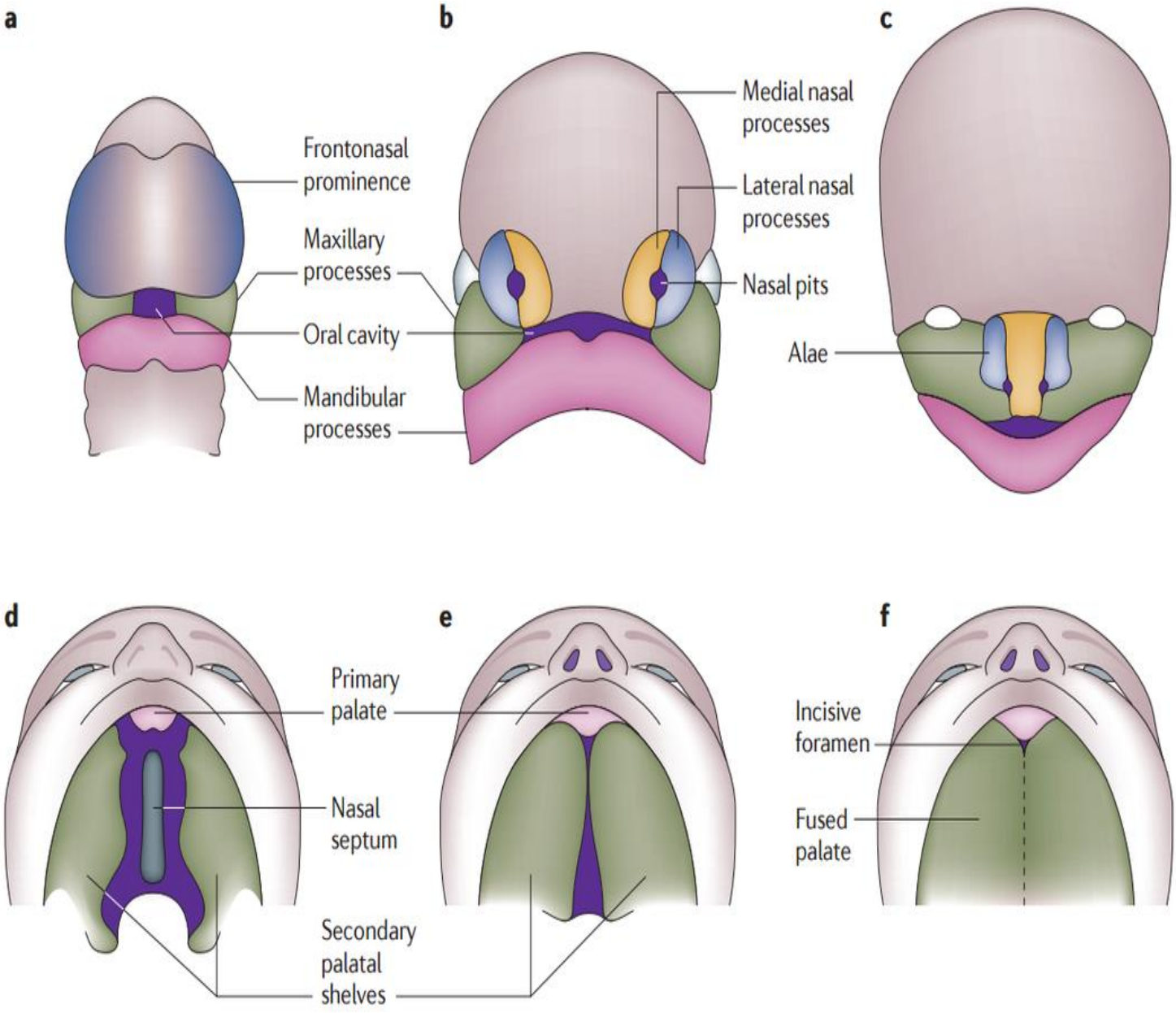
  - Derivatives:
  - **A labial component**, which forms the philtrum of the upper lip.
  - **Median part of upper jaw component**, which carries the upper four incisors .
  - **A palatal component**, which forms the triangular primary palate.

b) The 2 maxillary processes : They give rise to:

- Upper part of the cheek.
- The lateral part of upper lip .
- Lateral part of upper jaw .
- The 2ry palate.

c) The 2 mandibular processes :

- It forms **lower part of the cheek**.
- They fuse with each other medially forming the **lower lip and lower jaw**.



Development of face& palate

DEVELOPMENT OF THE PALATE

*The palate is formed of 2 components:

1) The primary palate :

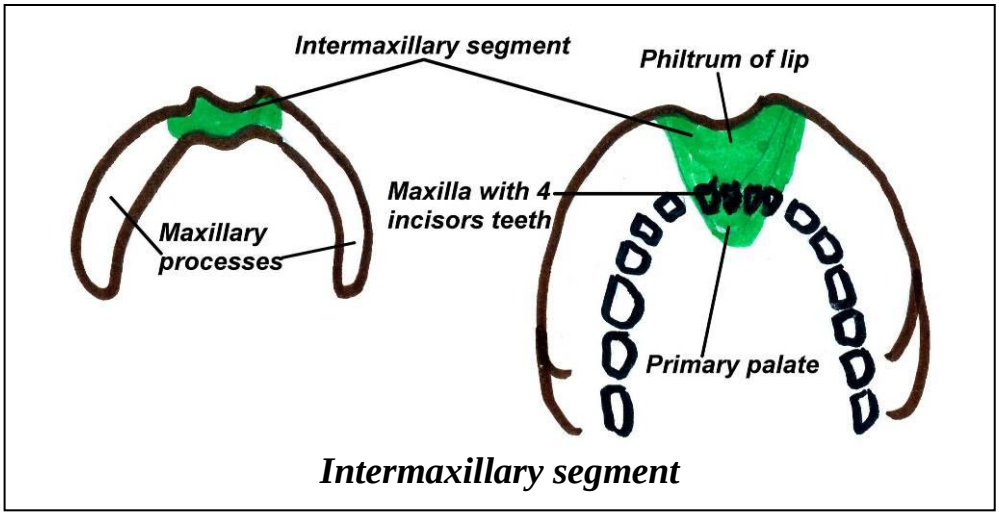
- It is the small **anterior triangular** part of the palate which carries the incisors .
- It develops from the **intermaxillary segment** of the frontonasal process.

2) The secondary palate :

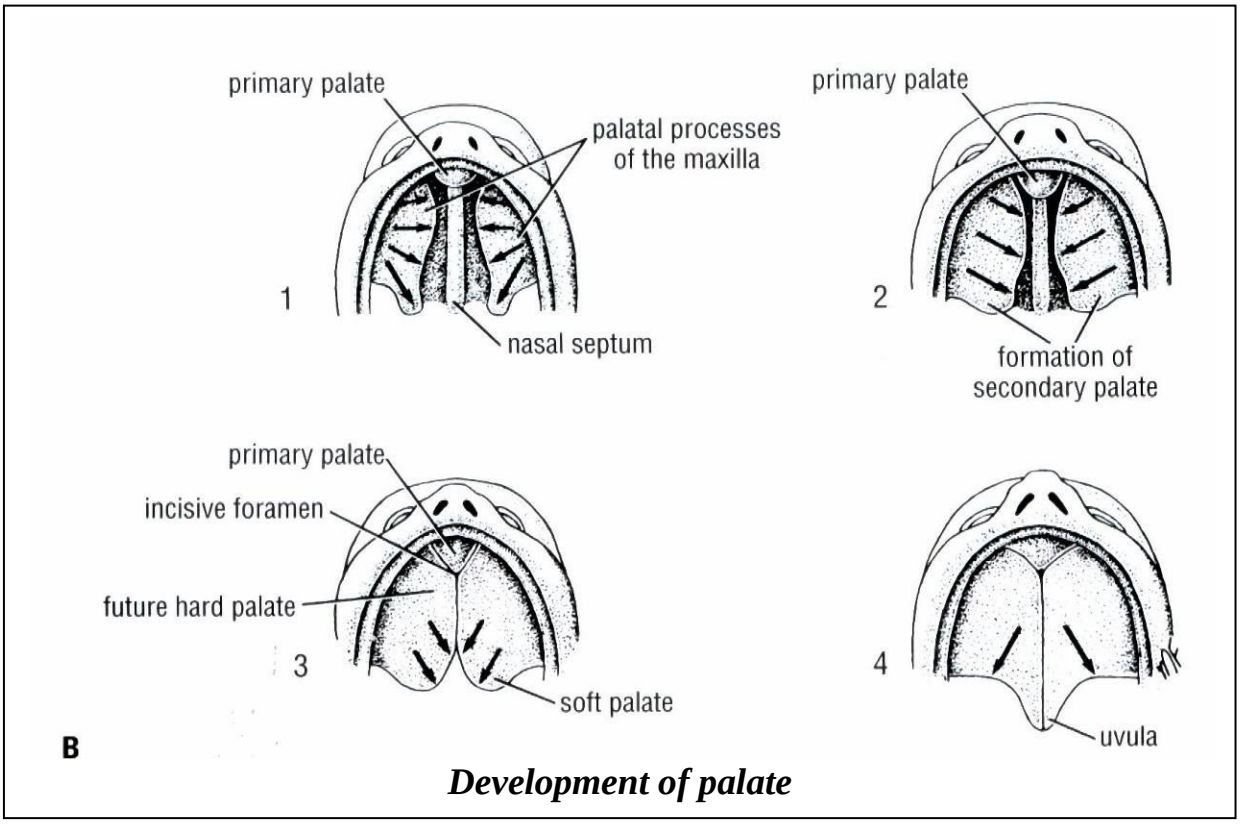
- It is the **remaining** posterior part of the palate.
- It is formed by **2 palatine shelves** which arise from the maxillary processes .
- The 2 palatine shelves **grow** medially to **fuse** with each other and with the 1ry palate anteriorly. Fusion occur from anterior to posterior .

3) The ossification occurs in the ***anterior part of the palate*** forming the hard bony palate.

4) The ***posterior part of the palate*** remains fleshy and forms the soft palate.



Intermaxillary segment



Development of palate

CONGENITAL ANOMALIES OF THE FACE and PALATE

1-OBLIQUE FACIAL CLEFT :

- There is a cleft lip which extends along the side of the nose.
- It results from failure of fusion between the maxillary process and the frontonasal process .

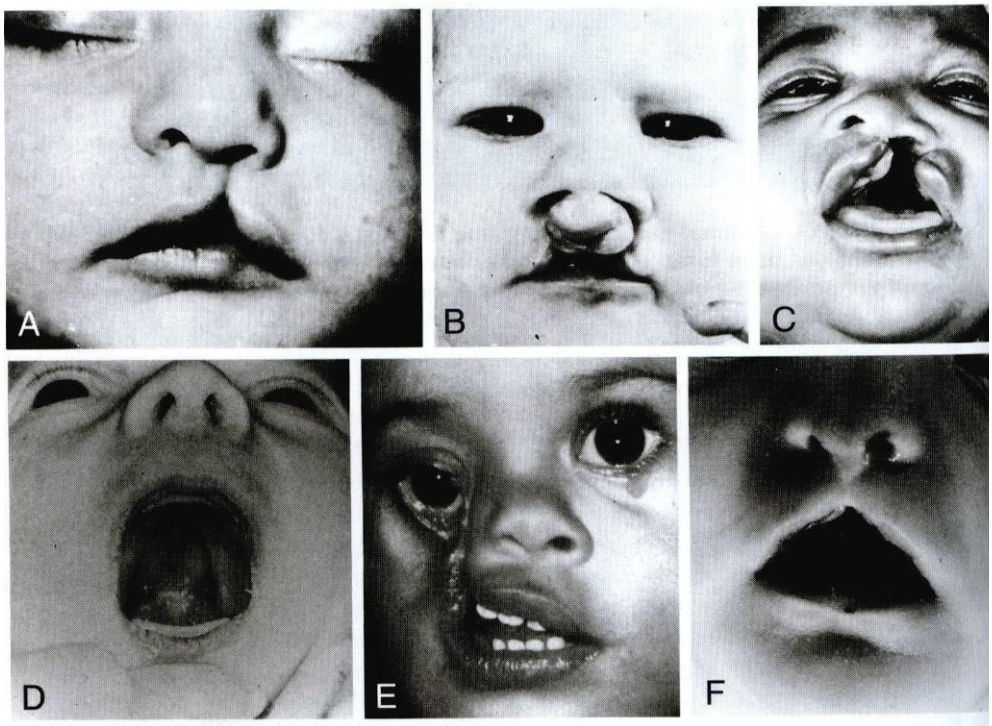
2-CLEFT LIP : (HARE LIP)

- ***Unilateral lateral cleft lip:*** is due failure of fusion between the maxillary process and the frontonasal process on one side only.
- ***Bilateral lateral cleft lip:*** is due failure of fusion between the maxillary process and the frontonal process on both sides.
- ***Median cleft lip***: is caused by incomplete fusion of the two medial nasal processes in the midline in cleft upper lip or fusion of the two mandibular processes in cleft lower lip .

3-CLEFT PALATE :

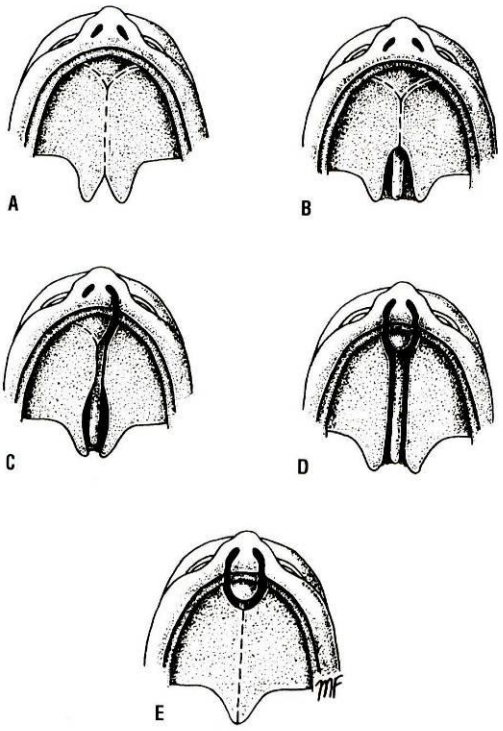
- It is due to failure of fusion between the different segments of the palate.
- Types:

1) ***Unilateral complete cleft palate:*** A cleft runs between the 2 palatine shelves then between the pre-maxilla and one palatine process.
2) ***Bilateral complete cleft plate:*** the cleft between the 2 palatine processes extends anteriorly in a V shaped manner separating the pre-maxilla from the 2 palatine shelves.
3) ***Partial cleft palate:*** may affect the soft palate alone or the posterior part of hard palate due to failure of fusion between the 2 palatine shelves of maxillary processes
4) ***Cleft uvula:*** the cleft affects the uvula alone.



A. Incomplete cleft lip. **B.** Bilateral cleft lip. **C.** Cleft lip, cleft jaw, and cleft palate. **D.** Isolated cleft palate. **E.** Oblique facial cleft. **F.** Midline cleft lip.

Cleft lip



Different forms of cleft palate: cleft uvula **(A)**, cleft soft and hard palate **(B)**, total unilateral cleft palate and cleft lip **(C)**, total bilateral cleft palate and cleft lip **(D)**, and bilateral cleft lip and jaw **(E)**.

Cleft palate

DERVATIVES OF THE FLOOR OF THE PHARYNGEAL GUT

1- DEVELOPMENT OF THE TONGUE

(I) Muscles of the tongue:

1. Most of the tongue muscles are derived from the 2nd, 3rd and 4th **occipital myotomes**.
2. Some of the tongue muscles differentiated in situ.

(II) Mucous membrane :

a. ***Anterior 2/3:*** arises from 3 swellings derived from the ventral parts of both 1st pharyngeal arches as follow:

- ***Tuberculum impar:*** a median elevation between the ventral ends of 1st pharyngeal arches.
- ***2 lingual swelling:*** one on either side of tuberculum impar.

b. ***Posterior 1/3 of tongue:*** develops from the upper ½ of the ***hypobranchial eminence. The posterior 1/3 fuses with the anterior 2/3*** along a V- shaped ***sulcus terminalis.***

N.B.: At first the tongue is fused with the floor of the pharyngeal gut. Later on ***linguo-gingival groove*** appears on either side and frees the tongue from the floor of the mouth.

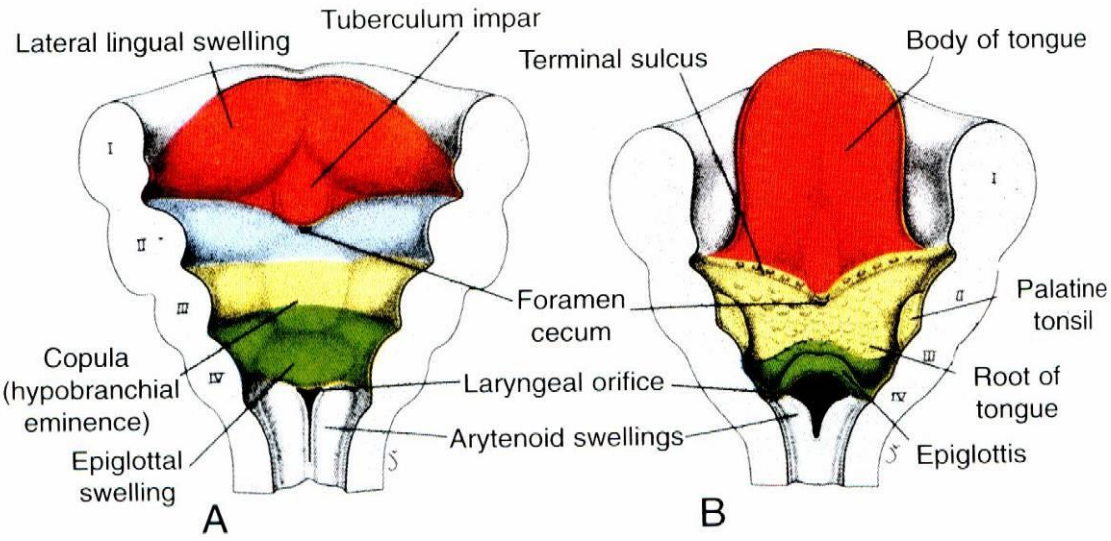
(III)NERVE SUPPLY OF THE TONGUE :

The composite character of the tongue is indicated by its innervation.

Motor :		Hypoglossal nerve (nerve of occipital myotomes).
Sensory	***Anterior 2/3:***	***General sensation:*** lingual of mandibular (nerve of 1st arch).
		Taste sensation: Chorda tympani (pretrematic nerve of the 1st arch).
	Posterior 1/3:	***General and taste sensation:*** - *Glossopharyngeal nerve* (nerve of the 3rd arch).

*CONGENITAL ANOMALIES :

1- Bifid tongue: a rare anomaly due to failure of fusion of the 2 lingual swellings.



Development of tongue

Tie tongue

Bifid tongue

2- Microglossia: is abnormally small-sized tongue.

3- Macroglossia: is abnormally large-sized tongue.

4- Tongue tie: due to failure of complete development of the linguo-gingival groove. The frenulum extends to the tip of the tongue preventing its protrusion.