Orofacial development

The development of the primitive oral cavity (or **stomodeum**) begins as a shallow depression in the embryonic surface ectoderm between the neural plate cranially and the developing heart caudally. This depression appears as result of growth of the forebrain anteriorly and enlargement of the developing heart during the end of third week and beginning of fourth week.

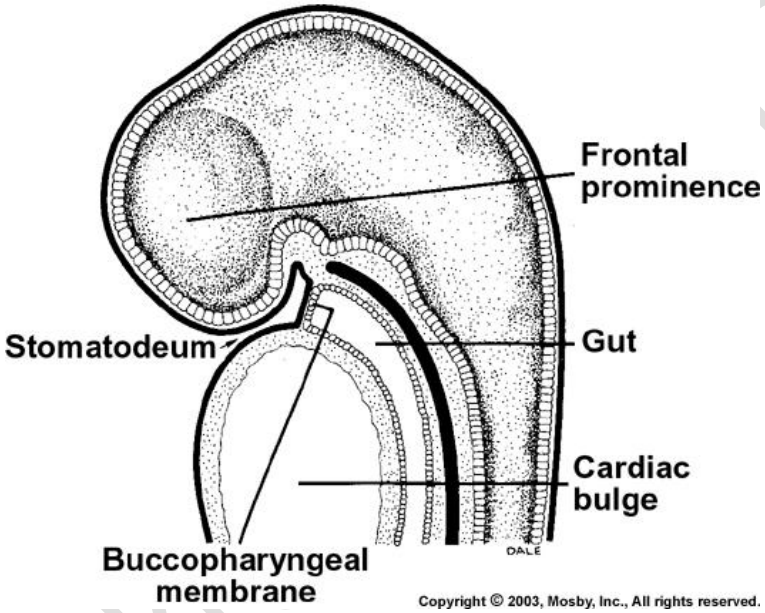
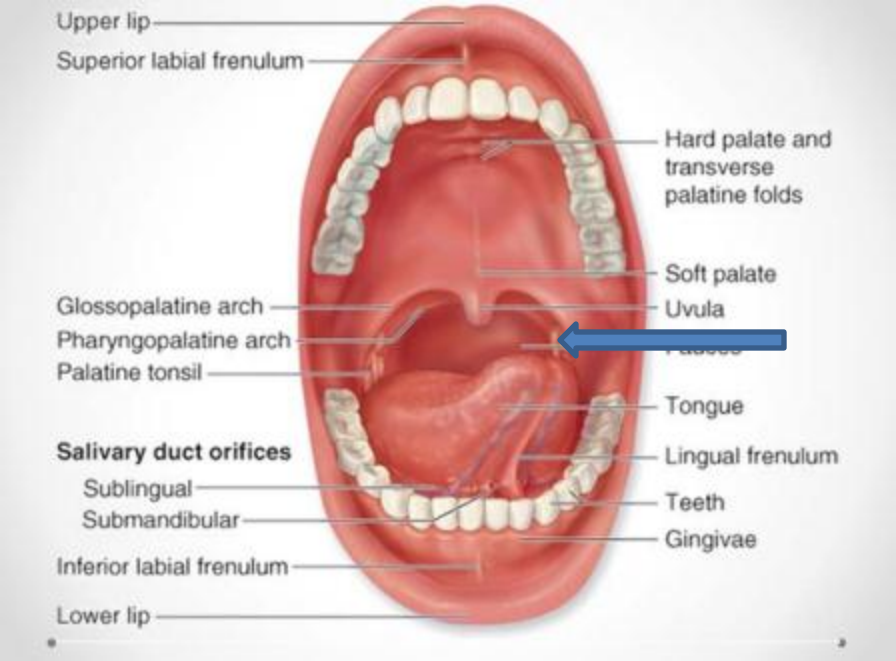


Fig. (3): Sagittal section through a 4- week embryo showing the stomodeum delimited by the frontal prominence and the cardiac bulge. The buccopharyngeal membrane separates the stomodeum from the foregut.

The buccopharngeal membrane also separates the stomodeum from the primitive pharynx, but soon this membrane breaks down so that the stomodeum communicates directly with the foregut.The remnant of the buccopharyngeal membrane in our body is called glossopalatine folds With this disintegration of the buccopharyngeal membrane, the primitive mouth is increased in depth. As the stomodeum enlarges, two important endocrine glands developed in relation to it. They are the **ANTERIOR LOBE OF PRTUATRY GLAND** (the adenohypophysis) and from the floor of primitive pharynx the **THYROID** gland developed.



Notice the glossopalatine folds

BRANCHIAL ARCHES:

They are bilateral swellings of tissue appear inferior to the stomodeum appear during the fourth week of prenatal development.

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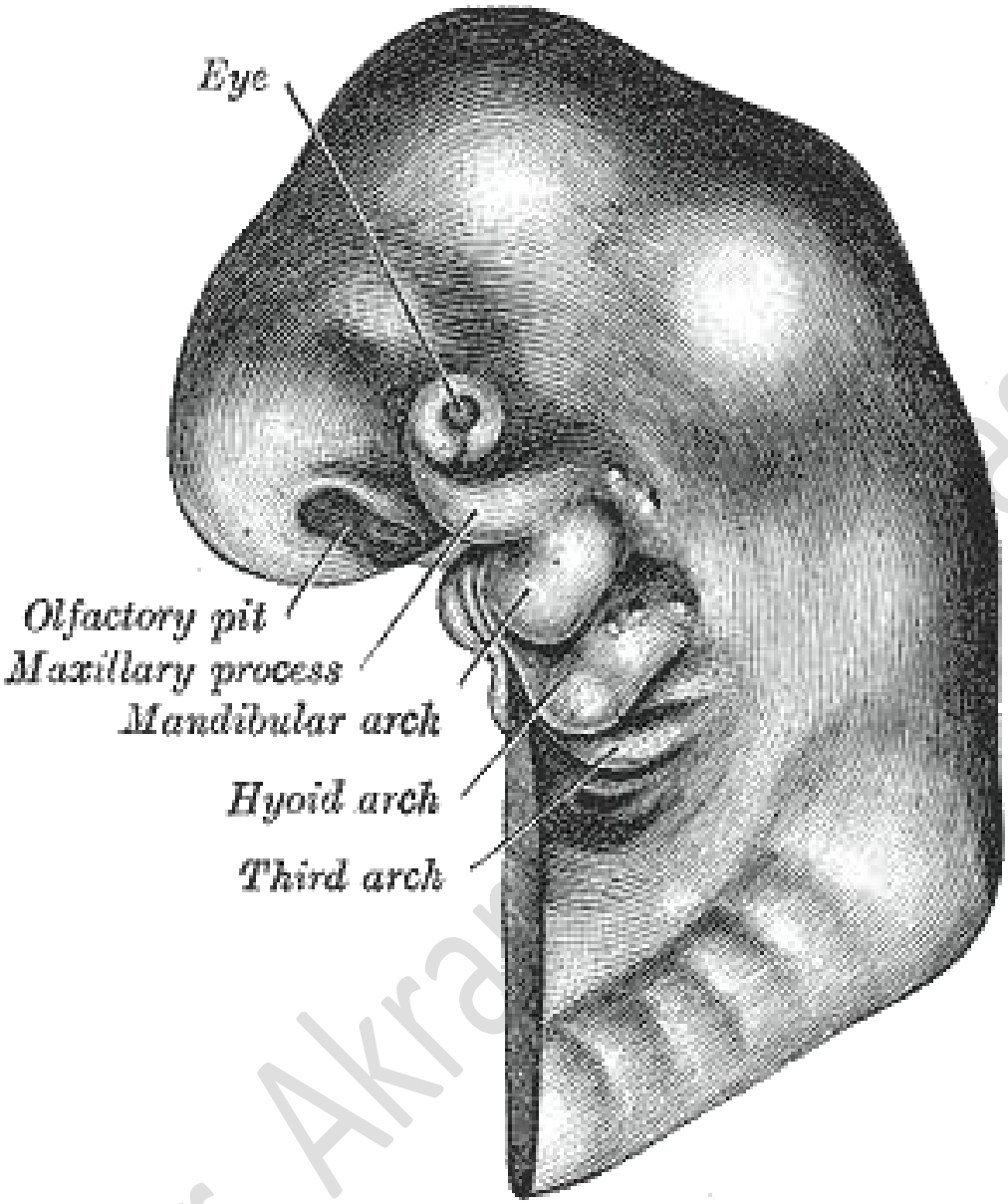


Fig. (5): A 27 old embryo viewed from the front. The beginning elements for facial development and three branchial arches are seen

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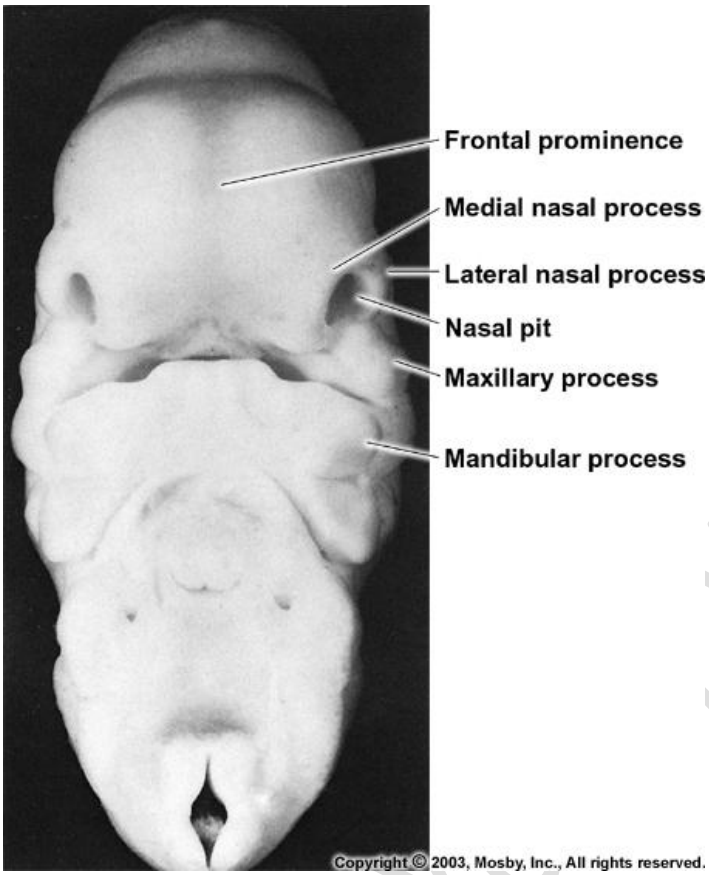


Fig. (6): A 34 days embryo viewed from the front. The nasal pits have formed, thereby marking the lateral and medial nasal processes. The first branchial arch is consisting of mandibular process and maxillary processes.

The branchial arches form the most typical feature in the development of head and neck. Each pharyngeal arch has the same basic plan.

Each arch is consisting of:

1. A core of mesodermal tissue for striated muscles development.
2. Neural crest cells (ectomesenchymal cells) surrounding a mesodermal core.
3. Cartilage derived forms the ectomesenchymal cells.
4. Specific cranial nerve .
5. An artery:

The branchial arches are numbered 5, i.e., 1st, 2nd, 3rd, 4th, and 6th. The 5th has degenerated very early due to the early degeneration of its blood supply. They appear one after another in a craniocadual direction.

First branchial arch: -

The nerve of the first arch is the trigeminal nerve. It is also called the **mandibular** arch.

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It contains cartilage called Meckel's cartilage derived from the neural crest cells. It helps in the development of mandible. - The myoblasts, which originate in the mesodermal core of first arch, give rise to the muscles of mastication and also myliohyoid and anterior belly of the digastric muscles.
- The ectoderm lines the first pharyngeal cleft located between the first and second arches give rise to external auditory meatus.
- The endoderm lined first pharyngeal pouch gives rise to the Eustachian tube and to the middle ear cavity.
The nerve supply to the muscles of the first branchial arch is provided by the mandibular branch of the trigeminal nerve.
The first branchial arch is divided into two doubled processes:
a) **Maxillary processes** (left and right) which give rise to most of the upper lip and upper jaw and part of primary palate and also the secondary palate. The maxillary process is innervated by maxillary nerve.
b) Mandibular processes (left and right): form the lower lip, mandible, chin, and it is also merging with the maxillary processes to form the cheek.

The second branchial arch (hyoid arch):

The nerve supplying the second arch is the facial nerve.
The cartilage of hyoid arch is called **Reichert's cartilage**. Most of the cartilage disappears but part of it is responsible for the formation of:
a) Stapes bone of middle ear.
b) Styloid process.
c) Lesser and part of body of hyoid bone.
The myoblasts from the mesodermal core give rise to:
a) Muscles of facial expression.
b) Stapedius.
c) Posterior belly of digastric muscle.
d) Stylohyoid muscle.

Since these muscles are derived from the hyoid arches, they are all innervated by the nerve of the second arch, the seventh cranial nerve, the **facial nerve**.
Its endodermal lining gives origin to the palatine tonsils during 5^{th} month of intrauterine life (embryonic age).

The third branchial arch:

Has unnamed cartilage, this cartilage will be responsible for the formation of greater horn of hyoid bone and body of hyoid. The arch is innervated by the glossopharyngeal nerve. The endoderm of the third arch gives rise to inferior parathyroid glands and the fetal thymus gland.

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The fourth branchial arch derivatives:

- The nerve is superior laryngeal N. of vague. The cartilaginous component of this arch contributes to thyroid cartilage of larynx.

- The muscle derived from mesoderm of the 4th arch are: -
a) Cricothyroid.
b) Pharyngeal constrictors.
c) Palatoglossus.
d) Muscles of uvula.

The sixth arch derivatives:

- The nerve of this arch is the recurrent laryngeal branch of vague. The cartilage component of this arch gives off the cricoid and arytenoids laryngeal cartilages The mesodermal cells of this arch are differentiating into the intrinsic muscles of the larynx except the cricothyroid.

The endoderm gives rises to the C-cells (parafollicular cells) which join the thyroid gland where they secrete the calcitonin hormone.

Development of the thyroid gland

The thyroid gland begins its development by day 24.

It first appears as a median endodermal thickening which is located on the floor of primitive pharynx between the first and second arches and caudal to the site of the future tuberculum impair. At a point later indicated by the foramen caecum, this endoderm soon forms a blilobed primordium, which penetrates the underlying mesoderm and descends anterior to the pharynx. This structure is the thyroid diverticulum.

By the 7th week the thyroid gland has reached its location anterior to larynx. The gland begins to function at end of 3rd month of fetal period.

Developmental abnormalities:

1. The thyroglossal duct may remain open to form the thyroglossal cyst.
2. The other developmental abnormalities include the aberrant thyroid tissue which may be found anywhere along the path of descent of thyroid gland. It is commonly found in the base of the tongue, just behind the foramen caecum as (lingual thyroid) and it is subjected to the some diseases as the gland itself.

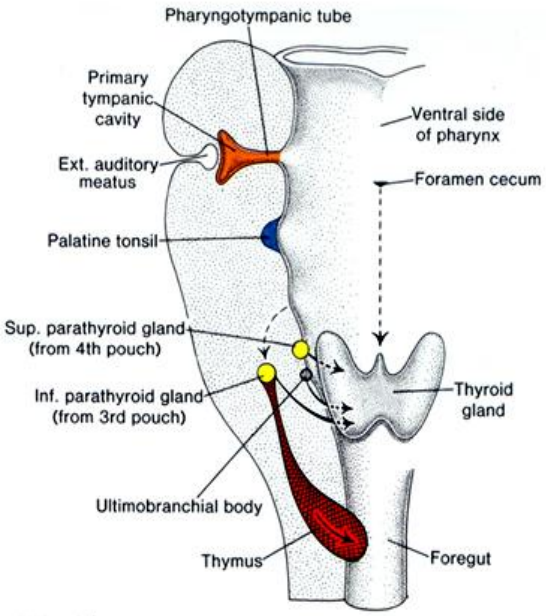
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Dorsal → superior parathyroids

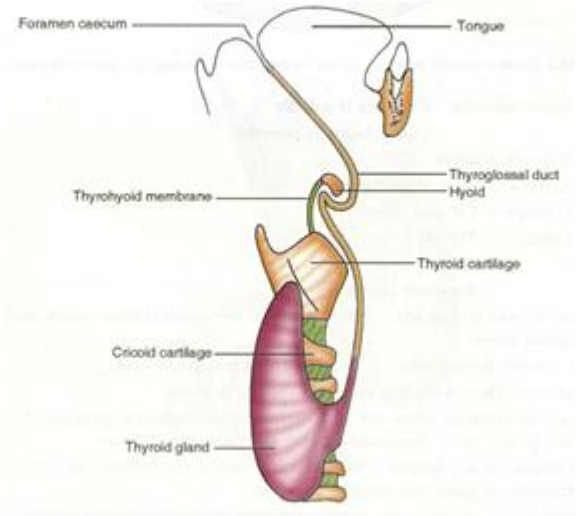
Ventral → degenerates

4.5 5th pouch → ultimobranchial body → (in thyroid)

Neural crest cells → parafollicular cells



Descends of developing thyroid gland through the thyroglossal duct



Development of the face (its middle and lower parts): -

The face developed during 5-7th wk of gestation from 5 primordia that surround the central depression of primitive oral pit. These primordia are:

1) Single frontonasal process.

2) Two mandibular processes
3) Two maxillary processes
The mandibular and the maxillary processes are all developed from first arch.

The mandibular processes appear initially as bilateral structure but soon merge with each other at the median line eliminating the groove between them.

BY THE 5TH WEEK: -

The **two** nasal placodes develop bilaterally on the lower part of the frontonasal process where they border the oral cavity (the nasal placodes are thickening of surface ectoderm that overlies the fore brain). During the 6th week, the underlying ectomesenchyme proliferates leading to transfer of the nasal placodes into elevations known as the medial and lateral nasal processes, which surround the newly formed depressions called the nasal pit (nostrils). These two processes appear as a horse shoe shaped elevations with open end of the slit in contact with the oral cavity.

Development of the upper lip: -

During the 6th week the two medial nasal processes merge in the midline with one another, they also merge they also merged with the two maxillary processes.

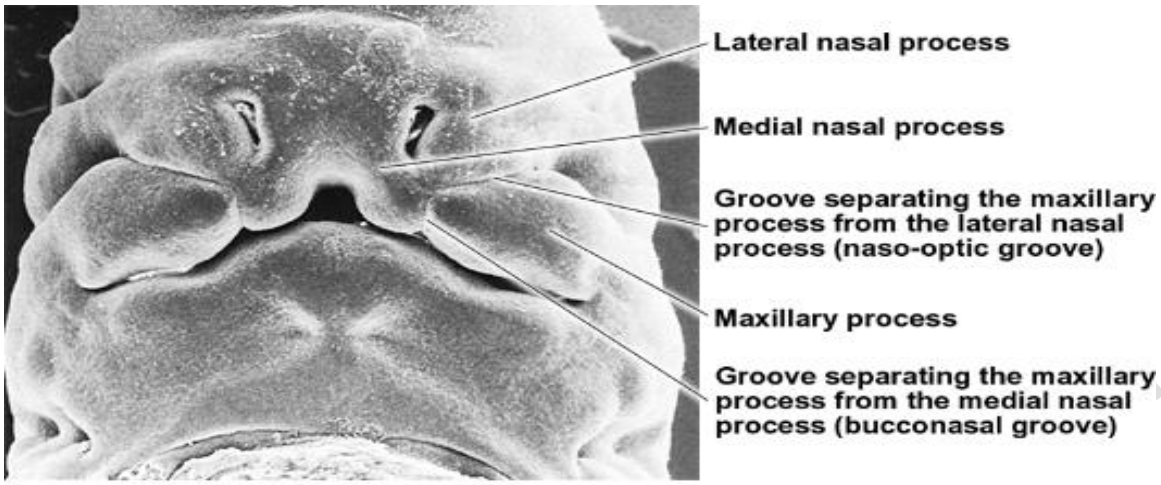
The merged medial nasal processes give rise to: -

1) The middle portion of the upper lip (philtrum).
2) The middle portion of the upper jaw.
3) The primary palate which is going to house the upper incisor teeth.

Thus the upper lip is formed by 1/3 from medial nasal processes and the other 2/3 from maxillary processes. Maxillary processes also give rise to parts of the upper jaw and the secondary hard palate. They also give rise to part of the cheek horizontally when merging with the mandibular processes.

The lower lip is formed entirely within the mandibular process.

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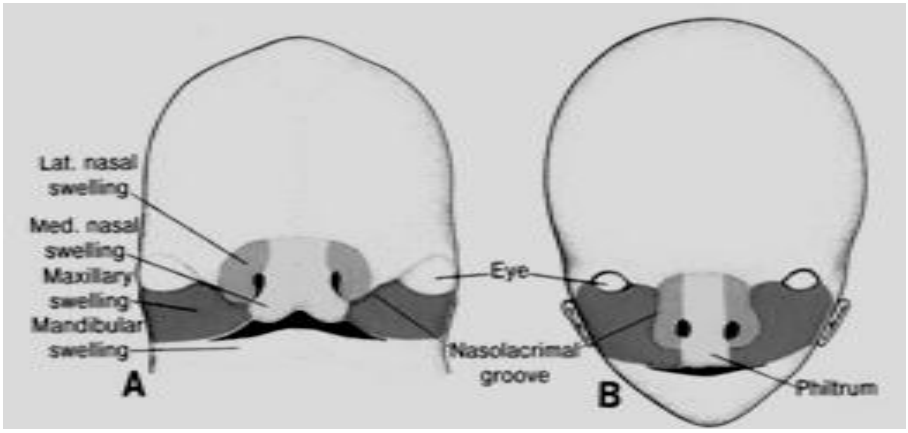


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Fig. (7) :Sixth week human embryo ,showing the development of the face. Notice the fusion between the maxillary process and medial nasal processes to form the upper.

Lateral nasal prominence → alae, lateral wall of nose;
↓ fuse
Maxillary prominence → nasolacrimal duct

6) Maxillary prominence + mandibular prominence → smaller oral fissure.



THE SIZE OF THE MOUTH: -

The size of the mouth is determined by the maxillary and mandibular processes as they merge at the lateral corners of the mouth.

EARLY DEVELOPMENT OF THE PALATE: -

The palate is the tissue between the oral cavity and nasal cavity.

The palate is formed of two tissues, the primary and secondary palates.

Primary palate:

It is so named because it appears earlier than secondary palate at beginning of 6th Week. The primary palate gives support to the maxillary incisors, which developed inside it.

DEVELOPMENT OF PRIMARY PALATE: -

The two medial nasal processes merge not only at the surface but also at deeper level. The structure formed by the two merged processes is known as the intermaxillary segment. The intermaxillary segment together with the frontonasal process give rise to: -

a) Middle portion of the nose.

b) Philtrum of upper lip.

c) Upper jaw components, which carries the four incisor teeth.

d) Primary palate. The incisive foramen is the midline landmark between the primary and secondary palates.

e) Cranially the intermaxillary segment is continuous with the anterior portion of the nasal septum which is formed by the frontonasal process.

The primary palate is also called premaxillary bone, which support the 4 maxillary incisor teeth.

THE SECONDARY PALATE: -

1) At the end of the 6 week two lateral palatine shelves (right and left) which form the secondary palate develop from the medial edges of the maxillary processes.

2) The palatine shelves grow first medially then downward or vertically on either side of the tongue.

At about 8th and ½ week the lateral palatine shelves roll over the body of the tongue due the growth of the jaw, leading to the descends of the tongue. This allows the vertical palatine shelves to f lip upward to become horizontal palatine shelves, which gradually grow toward each other and fuse in the midline to complete the secondary palate formation.

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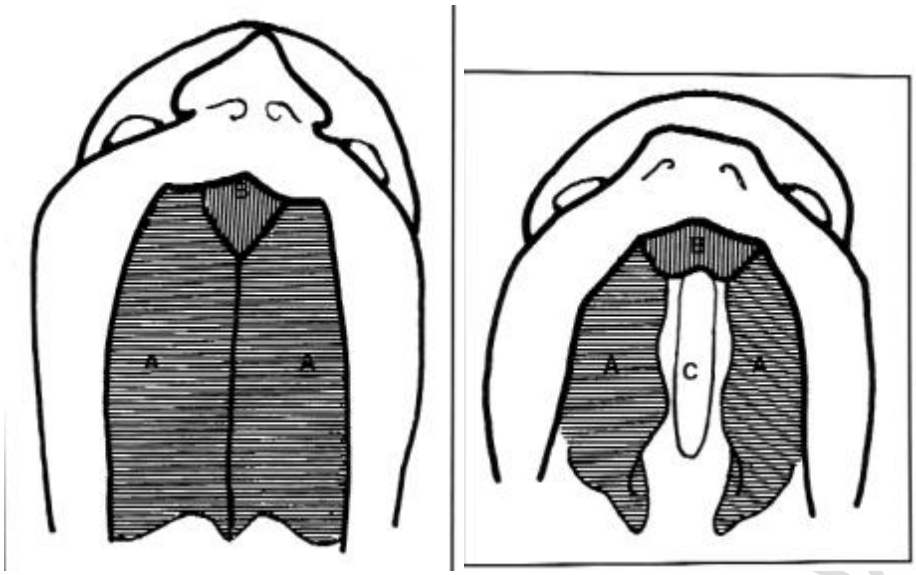




Fig.(8) : Showing steps in the development of primary and secondary . Note the vertical descend of the two palatine shelves in the lower photo.

Developmental anomalies:-

1. Cleft lip: this is a malformation of the upper lip it may be unilateral or bilateral.

a) Unilateral: failure of maxillary processes To merge with the medial nasal process on one side.

b) Bilateral: occur on same way on both sides.

2. Median cleft lip: failure of the two medial nasal processes to merge together (hare lip).

4) Cleft palate:

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Development of the tongue

The tongue is composed of body (movable part) and the root (the posterior firmly attached or pharyngeal part).
The tongue begins to develop at about 4 weeks.

The **body** of the tongue develops from **3 swelling:**
a) The tuberculum impar: which arise in the midline as a single structure from the mandibular process of the first branchial arch on the floor of primitive pharynx.
b) Two lateral lingual swellings.

The two lateral lingual swellings rapidly increase in size and merge with each other and overgrow the tuberculum impar to form the anterior two thirds or body of the tongue. The **tuberculum impar** give no part in the tongue development.

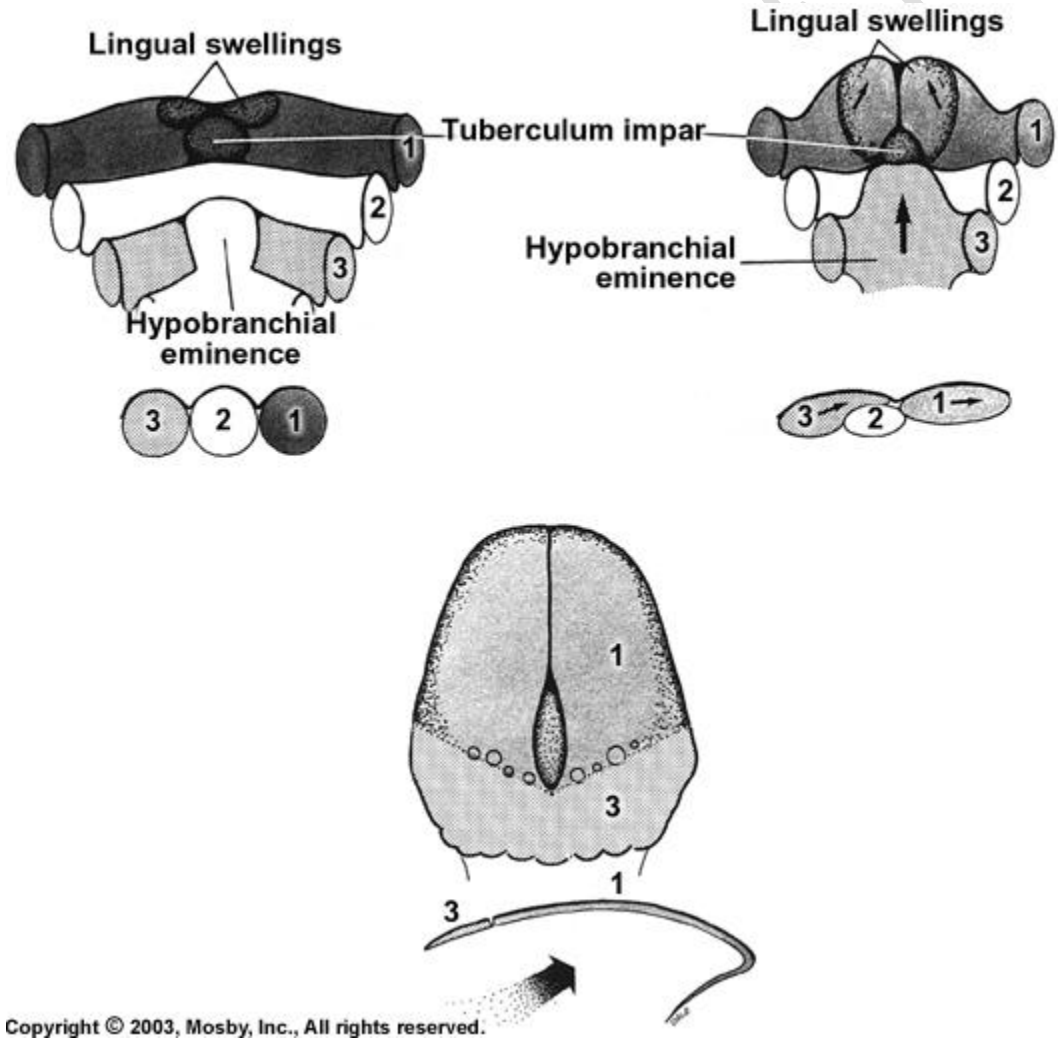


Fig. (9) : Steps in the development of the tongue;1= lingual swelling;3=root of tongue.

The formation of the **base or the posterior one-third** (root) of the tongue is as follow: -
A midline elevation develops posterior to the tuberculum impar. This elevation is the hypobranchial eminence, which is developed from the third branchial arch. The anterior part of this eminence is the copula, which unites the processes of the 2nd arch in the ventral midline. The foramen caecum is located between the tuberculum impar copula.
The foramen caecum is located at the center of the v-shaped sulcus terminalis, which demarcates, between the anterior 2/3 and posterior 1/3 of tongue in the adult.

The posterior 1/3 has a lingual tonsil under the epithelium.

The muscles of the tongue have different origin; they arise from the occipital somites which have migrated into the tongue area, carrying with them their nerve supply, the hypoglossal nerve.

Tongue innervation: -

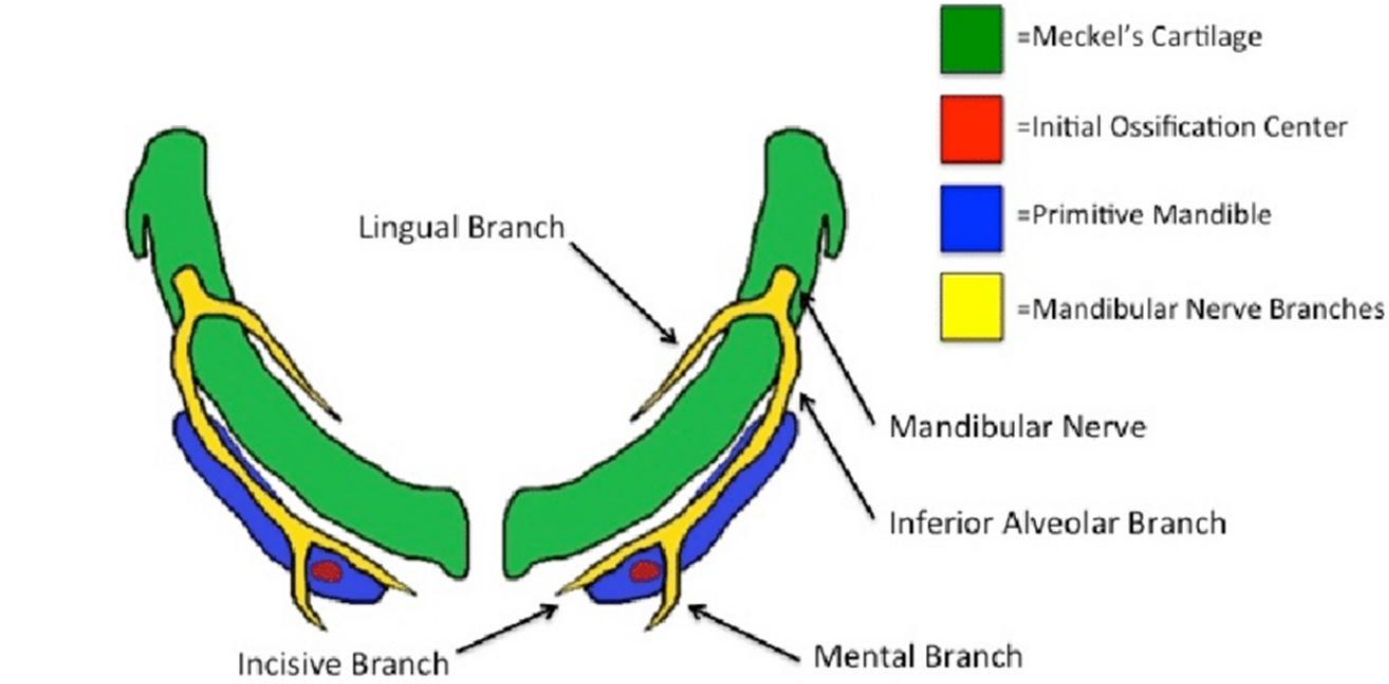
The unusual development of the tongue explains its multiple innervations:
1) The mucosa of anterior tow third is supplied by the nerve of 1st arch, the 5th (trigeminal) cranial N. through its lingual branch for general sensation (mandibular N.).
2) The mucosa of post-1/3 derived from 3rd arch, is supplied by the 9th cranial N. (the glossopharyngeal nerve).
3) The motor supply to the muscle of tongue is the hypoglossal N.
4) For the taste buds in the anterior 2/3 of tongue there is the chorda tympani nerve from the facial nerve.

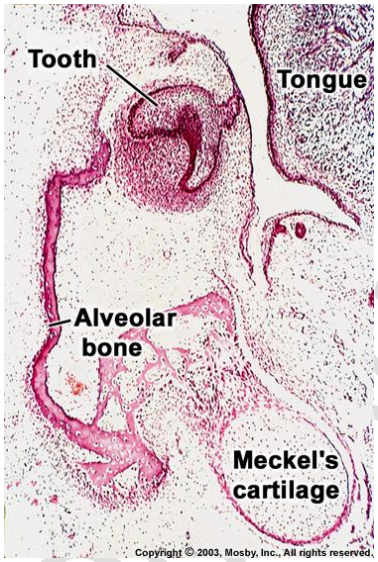
CONGENITAL ANOMALIES OF TONGUE DEVELOPMENT: -
1- Ankyloglossia: complete adherence to floor of mouth.
2- Tie tongue: partial adherence of tip of tongue.
3- Macroglossia: large sized tongue.
4- Microglossia: small sized tongue.

DEVELOPMENT OF THE MANDIBLE: -

- Begins at 6th week of embryonic period.
- As a bilateral structure in the mandibular processes of the first branchial arch.
- Its development is coinciding with the development of the Meckel's cartilage of the first branchial arch.
- Meckel's cartilage is not going to change in to mandible but it is helping in the development of the mandible. The Meckel's cartilage will act as scaffolding for the developing mandible.

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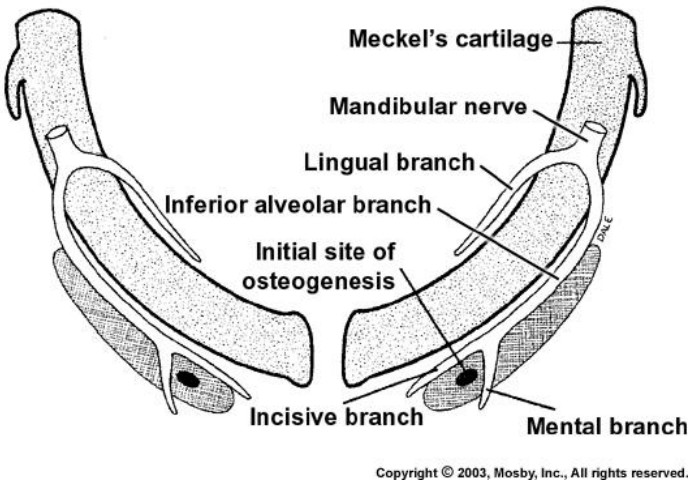
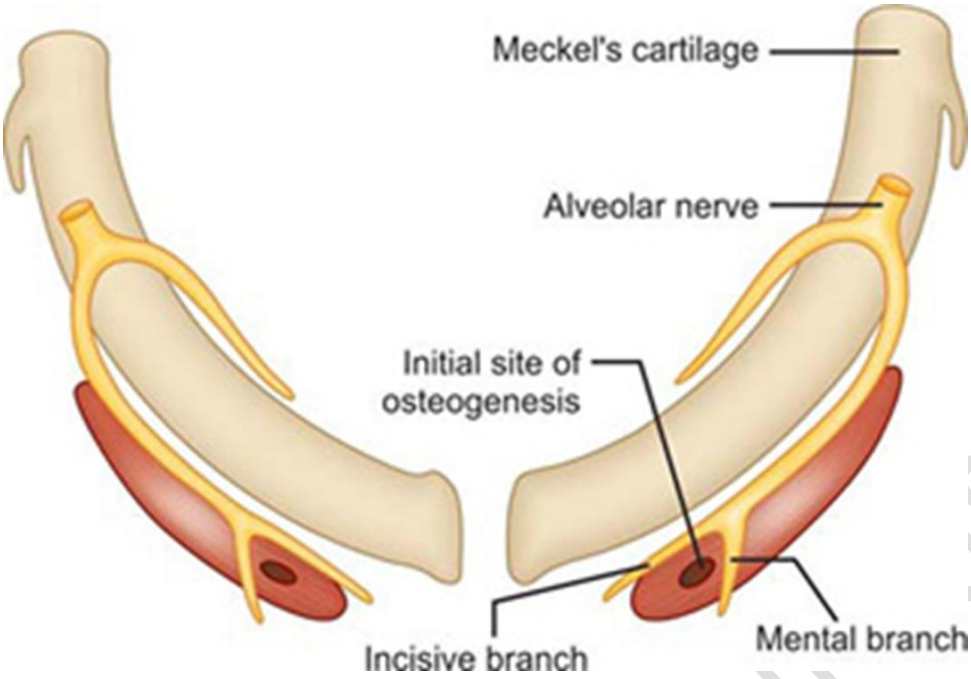


Fig.(10): Note the contribution of the Meckel's cartilage in the development of mandible



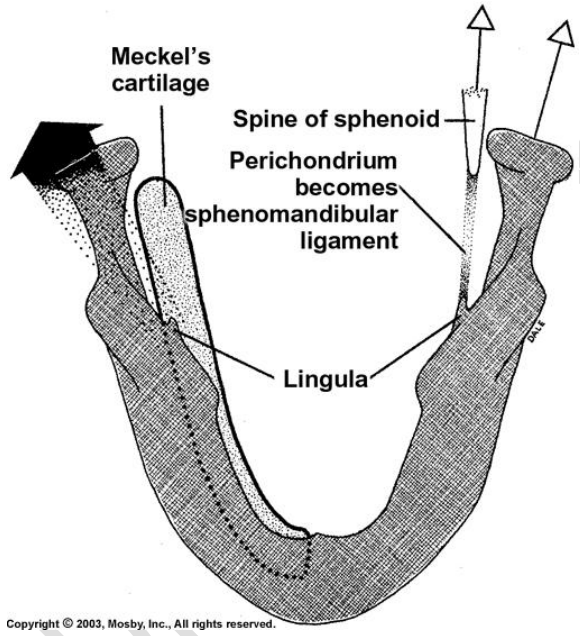


Fig.(11): The fate of Meckel's of cartilage posterior to the lingual

- The initial site of the osteogenesis (intramembraneous ossification) is occurring at the point of the division of the inferior alveolar nerve into mental branch and incisive branch, this position is marked in the future by the position of the mental foramen.
- The intramembraneous ossification in the mesenchymal tissue which leads to form the body of the mandible spread in a posterior direction toward the position of future lingual. The Meckel's

cartilage from the position of lingual anteriorly degenerate after formation of mandible, while the remaining part of
The Meckel's cartilage posteriorly converted into: -
a) Sphenomandibular ligament.
b) The very posterior part of the Meckel's cartilage gives rise to the malleus and incus of the middle ear.

- The formation of primitive or early mandible by the intramembraneous ossification is completed at 10 weeks.
- Future growth of the mandible is helped by :-
a) Appearance of tree **secondary cartilages** named: - condylar, coronoid and symphyseal.
b) **Development of muscle of mastication.**

Future and further growth of the mandible is helped by:

a) Appearance of three **secondary cartilages** named: - condylar, coronoid and symphyseal.
b) **Development of muscle of mastication.**

The secondary cartilages: -

I) Condylar cartilages: They appear at week 12 of fetal period. The cartilages are quickly subjected to endochondral ossification to form the ramus of mandible.

At 20^{th} weeks of development only a thin layer of the cartilages remain in the condylar head. This remnant of cartilages persists until the end of 20^{th} years, giving growth for the mandible.
II) The coronoid cartilage: appears at 4^{th} months of development and disappear before birth.
III) Symphyseal cartilage: two in number appear at the two ends of Meckel's cartilage but are independent of it. The symphyseal cartilage ossifies at the end of first year of life after birth.

Dr. Akram Yousif Yasear

Development of Mandible
The rami

I. The condylar cartilage

- **Carrot shaped** cartilage appears at 14 WIU in the region of the condyle and occupies most of the developing ramus.
- It is rapidly converted to bone by **endochondral ossification.**
- It acts as an **active center of growth** till the age of **20 years**.
- It gives rise to:
    1. Condyle head and neck of the mandible.
    2. The posterior half of the ramus to the level of inferior dental foramen



Development of the maxilla

It is developed from a center of intramembraneous ossification appears in the mesenchyme of maxillary processes of the first arch around the seventh week of prenatal life. The center of ossification appears at the point where the anterosuperior dental nerve is given off from the inferior orbital nerve .From this center, bone formation spreads posteriorly below the orbit toward the developing zygote. No arch or primary cartilage exists in maxillary process. A secondary cartilage also contributes to the development of maxilla. A zygomatic, or malar, cartilage appears in the developing zygomatic process and for a short time adds to development of maxilla.

Ossification also spreads to palatine process to form the hard palate. Secondary ossifications centers, the zygomatic, orbitonasal, nasopalatine anmd intermaxillary, then appear and fuse rapidly with the primary centers. The primary bone (embryonic bone) is soon replaced by secondary bone as the face and oral cavity developed.

At birth the body of maxilla is small because maxillary sinus is still rudimentary, about the size of small pea

Dr. Ahlam Yous