Lec:3,4 اضافة لمحاضرة

Classification of malocclusion

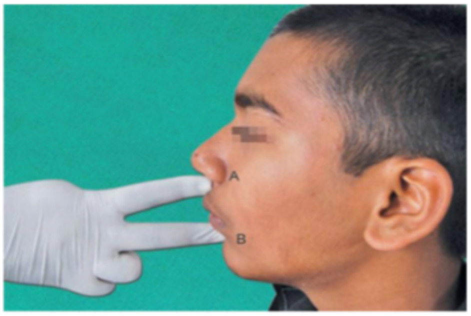
❑ Skeletal classification

Skeletal malocclusion is classified into ***Class I, II, and III*** based on the relationship between the upper and lower jaw bones, with Class I indicating normal jaw relationship, Class II showing a retrognathic (recessive) lower jaw or a prognathic (protruding) upper jaw, and Class III presenting a prognathic lower jaw or a retrognathic upper jaw. These relationships are assessed clinically and radiographically

❖ Clinical Analysis

ASSESSMENT OF ANTEROPOSTERIOR JAW RELATIONSHIP

A fair picture of the sagittal skeletal relationship can be obtained clinically by placing the index and middle fingers at the approximate A and B points after lip retraction. Ideally, the maxilla is 2 to 3 mm anterior to the mandible in centric occlusion. In skeletal Class II cases, the index finger is much ahead of the middle finger whereas in Class III the middle finger is ahead of the index finger.

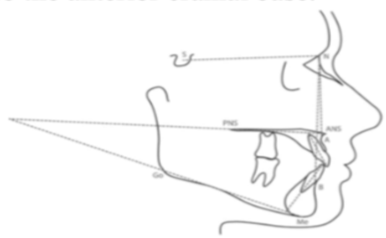


ASSESSMENT OF VERTICAL SKELETAL RELATIONSHIP

A normal vertical relationship is one where the distance between the glabella and subnasale is equal to the distance from the subnasale to the underside of the chin. Reduced lower facial height is associated with deep bites while increased lower facial height is seen in anterior open bites.

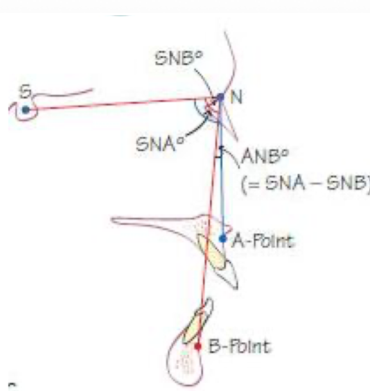
❖ Cephalometric Analysis

Orthodontists use a lateral cephalogram (an X-ray of the side of the head) to assess skeletal malocclusion. using cephalometric analysis, which involves measuring angles and lengths on a lateral cephalogram of the face to determine the anteroposterior (AP) positions of the maxilla and mandible relative to the anterior cranial base.



There are several angular and linear measurement that measure various angles and lengths on the cephalogram but most common are:

- **SNA angle:** Measures the anteroposterior (AP) position of the maxilla (upper jaw) relative to the anterior cranial base.
- **SNB angle:** Measures the AP position of the mandible (lower jaw) relative to the anterior cranial base.
- **ANB angle:** Relates the position of the maxilla to the mandible, helping to classify the skeletal relationship



GROWTH AND DEVELOPMENT

Introduction

Growth is defined as an increase in size, change in proportion, and progressive complexity, while **Development** means progress toward maturity.

Knowledge about growth and development is very important for orthodontists since the face changes from its embryologic form through childhood, adolescence, and adulthood. Understanding how and where growth occurs, how much growth is remaining, in which direction, and what role the genetic and environmental factors play in influencing facial growth can, in turn, influence these factors with treatment to achieve the optimum results in each individual.

Growth can be divided into two periods: <u>prenatal</u> and <u>postnatal</u>.

The prenatal (neonatal) period: It could be divided into three periods:

1. <u>Period of ovum (from fertilization to the 14th day)</u>

During this period, human development begins when a sperm fertilizes the oocyte, forming a zygote. Fertilization occurs in the uterine tube (oviduct). The zygote undergoes a series of mitotic divisions as it moves along the uterine tube toward the uterus. The cells resulting from this division are called blastomers. They adhere to one another and form a ball of cells called a morula (16- 32-celled stage), which enters the uterus about three days after fertilization. Fluid from the uterine cavity enters the intercellular spaces between the inner and outer cell mass. Later, the intercellular spaces fuse to form a single cavity called blastocele, and this stage of the embryo is called blastocyst.

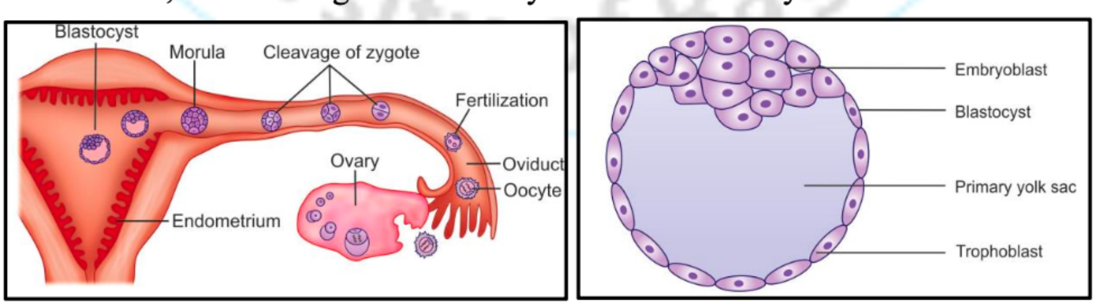


Figure 1

Six days after fertilization, two distinct cell types comprise the blastocyst:

- The **trophoblast** forms a single layer of cells covering the outside of the blastocyst. The inner cell mass which is a cluster of cells located inside the trophoblast.
- The inner cell mass develops into embryo whereas the trophoblast forms the embryonic part of the placenta and other peripheral structures associated with the embryo.

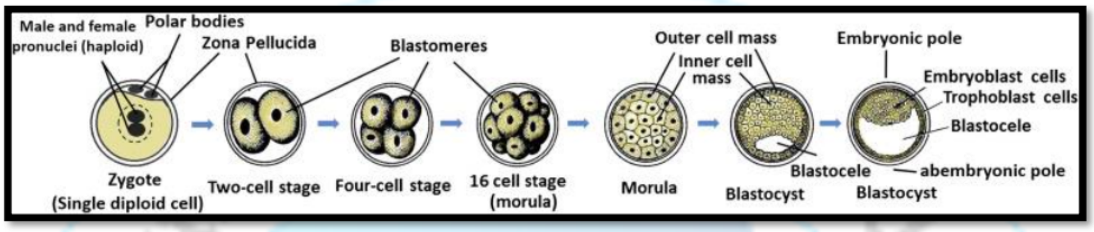


Figure 2

2. Period of embryo (from 14th to 56th day)

During this period, most organs and organ systems are formed. It is also the period of differentiation, and most congenital malformations develop during this period. At the end of this period, the developing individual has a recognizable human appearance.

3. Period of fetus (56th day to birth)

Continued development is predominantly growth without significant further differentiation. Overall increase in the size of the fetus also occurs due to an accelerated growth. In addition to the increase in size, the proportion of the structures also changes. Most of the craniofacial structures are formed in the first trimester of pregnancy.

The growth of the cranial, facial, and oral structures begins around the 21st day (period of the embryo) after conception. At this stage, the embryo is about 3 mm in size, and the head begins to take shape. After the formation of the head fold, the developing brain and the pericardium form two prominent bulgings in the ventral aspect of the embryo. In between them, there is a depression called the stomodeum, the floor of which is formed by the buccopharyngeal membrane. This membrane separates the stomodaeum from the foregut (Fig 3).

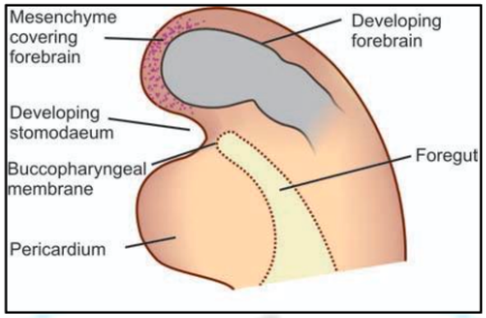
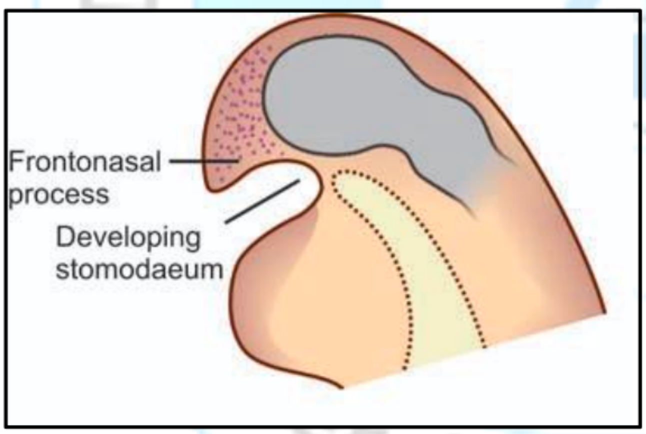


Figure 3

Soon the mesoderm covering the developing brain proliferates and forms a downward projection that overlaps the upper part of the stomodaeum. This downward projection is called the frontonasal process (Fig. 4). As is evident till now, the neck is not yet present. The neck is formed by the elongation of the region between the stomodeum and the pericardium. This is achieved partly by a descent of the developing heart and mainly due to the appearance of a series of mesodermal thickenings in the wall of the foregut. These are called the pharyngeal or the branchial arch (Fig. 5).



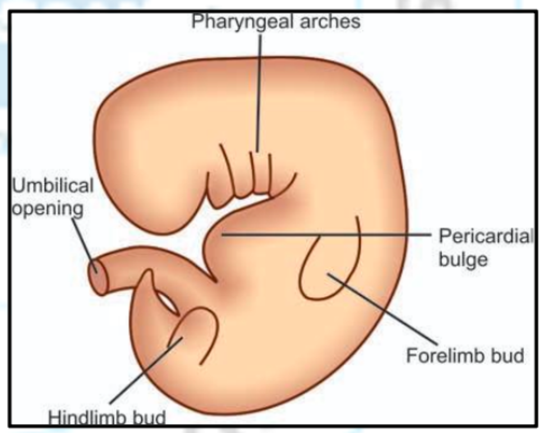


Figure 4

Figure 5

In the third week, the head is composed mainly of the pros-encephalon, with frontal prominence representing the most caudal portion of the pros-encephalon and overhanging the developing oral groove. This oral groove is bounded on its lateral sides by the rudimentary maxillary processes. The mandibular arch is below the groove, while the frontal process is above (Figure 6).

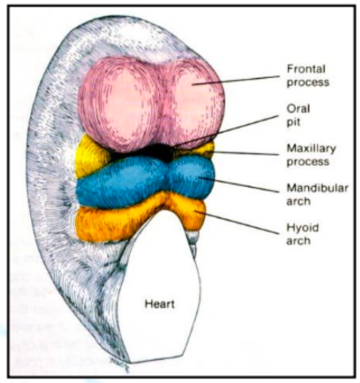


Figure 6

The frontal prominence, mandibular arch, and maxillary processes are called together the stomodeum. During the following few weeks, the oral groove deepens, and the oral plate (buccopharyngeal membrane), which consists of an ectodermal floor of the stomodeum and endodermal lining of the foregut ruptures to establish the oral opening.

During the fourth week, two ectodermal proliferations can be noticed on either side of the frontal process. These will later give rise to the nasal placodes, which develop into nasal pits and the olfactory epithelium, Figure 7.

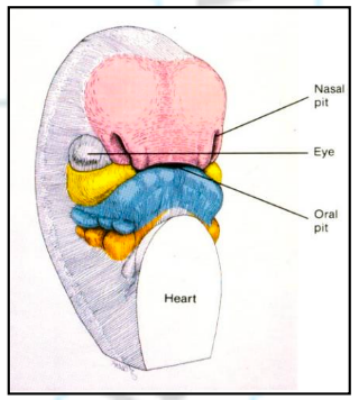


Figure 7

At this time, the branchial arches could also be seen, distinguished as four arches with a fifth transitory branchial arch. The first arch is called the mandibular arch, while the second is called the hyoid arch, Figure 8.

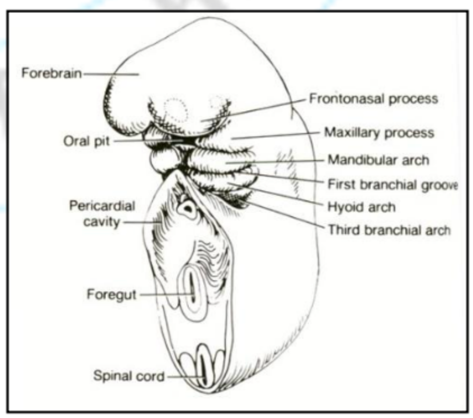


Figure 8

Development of Palate

The palate develops between 6th and 9th week of gestation. The entire palate develops from the following two structures:1. Primary palate. 2. Secondary palate.

Primary Palate

The primary palate is the triangular-shaped part of the palate anterior to the incisive foramen. It is developed from frontonasal process. The primary palate forms the premaxilla, which carries the incisor teeth **(Fig. 12)**.

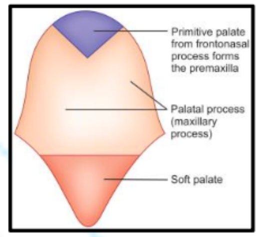


Figure 12

Secondary Palate

The secondary palate gives rise to the hard and soft palate posterior to the incisive foramen. It develops from the fusion of three parts as follows:

- Two "palatine shelves" which extend from left and right maxillary process towards the midline.
- Nasal septum, which grows downwards from the frontonasal process along the midline.
- The developing palatine shelves are first directed vertically downward with the tongue interposed between them **(Fig. 12A)**. After withdrawal of the tongue, the elongated shelves get oriented horizontally **(Fig. 12B)**.
- Horizontally oriented palatine shelves grow towards each other in the midline and are in close proximity with each other by 8 weeks of gestation
- The left and right palatine shelves fuse with the posterior margins of the primary palate, as well as with each other in midline.
- Fusion does not occur simultaneously in all fronts. Initial contact occurs in the center posterior to incisive foramen between the palatine shelves. From this point, fusion progresses in anterior and posterior directions as indicated by arrows in **Figure 12C**.
- The nasal septum grows downward and gets fused with the medial edges of palatine shelves in the midline thus, separating the stomatodeum into nasal and oral cavities.

In the 5th week, the nasal pits widen, and the medial and lateral walls of the nasal pits start to proliferate and grow downward, giving rise to the medial nasal and lateral nasal processes, Figure 9.

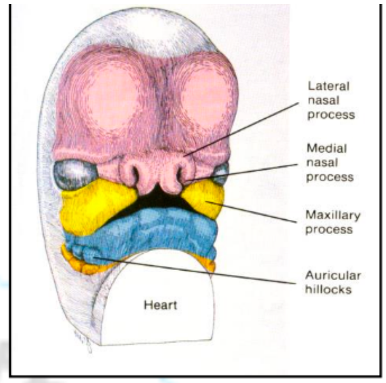


Figure 9

The maxillary processes on either side start to proliferate toward the medial nasal processes, and the union between the medial nasal and the maxillary processes gives rise to the maxilla, palate, upper lip, and the lower central part of the nose. The line of fusion of the two medial nasal processes is represented by a depression on the upper lip called the philtrum, the fusion of the medial nasal processes and the maxillary processes completes during the 7th week. Cleft lip develops if failure of fusion of these two processes takes place. This cleft may be unilateral or bilateral, but it is also can be complete or incomplete, Figure 10.

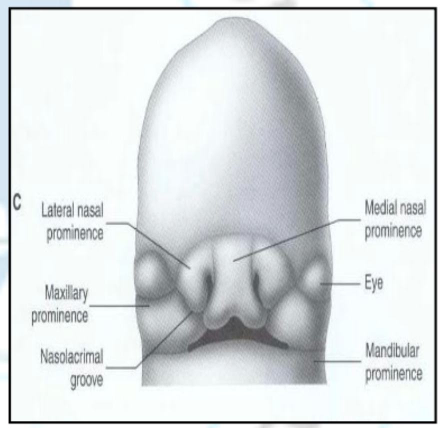


Figure 10

By the 8th week, the facial structures are apparent. The nose is more prominent, and the nasal septum elongates and narrows. The eyes migrate toward the midline, and the ears begin to develop. The nostrils are formed by an opening in the nasal pit area, which communicates with the upper part of the oral cavity, Figure 11. By the 12th week, the eyelids and nostrils have formed, and subsequent intrauterine changes lead to little further differentiation. These intrauterine changes involve increasing in size and changing in proportions.

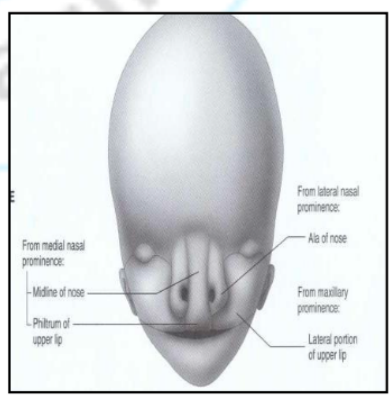


Figure 11

Development of Skull

The skull can be divided into the following components

I. Neurocranium: Cranial vault and Cranial base

II. Viscerocranium: The facial skeleton including Maxilla and Mandible.

The cranial vault and face develop from intramembranous ossification where bones are formed directly in mesenchyme with no cartilaginous precursors. The cranial base undergoes endochondral ossification. Some of the membranous bones may develop secondary cartilages subsequently that provide further growth.

I. ***Neurocranium*** **(calvaria and base of the skull)**

*The cartilaginous neurocranium (chondrocranium) consists of several cartilages that fuse and undergo endochondral ossification to give rise to the base of the skull. The cartilage junctions between two bones are called synchondroses. The occipital bone, the body of the sphenoid bone, the ethmoid bone, the vomer bone of the nasal septum, and the petrous and mastoid parts of the temporal bone are formed by the cartilaginous neurocranium.

*The membranous neurocranium gives rise to the flat bones of the calvaria, including the superior portion of the frontal, parietal, and occipital bones.

II. Viscerocranium which arises from the pharyngeal arches.

The cartilaginous viscercranium includes the middle ear ossicles, the styloid process of the temporal bone, the and hyoid bone.

*The membranous viscerocranium includes the maxilla, zygomatic bones, the squamous temporal bones, and the mandible. These bones form by intramembranous ossification except for the mandibular condyle and the midline of the chin.

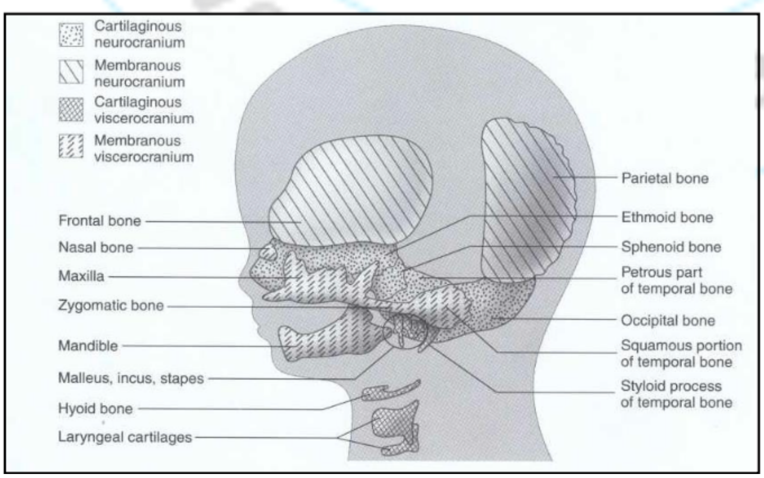


Figure 14

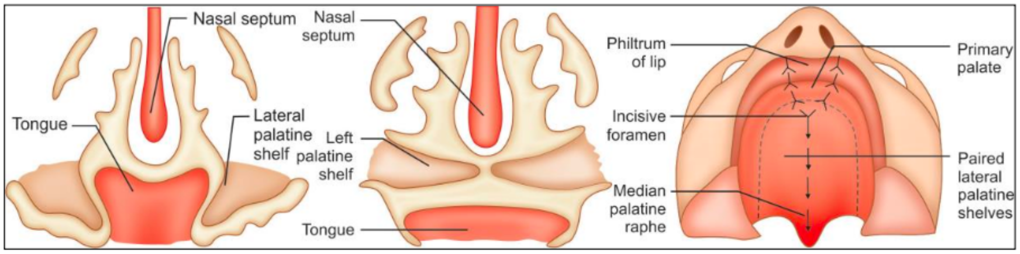


Figure 12

Development of Tongue

- The tongue begins to develop at about 4th week of gestation. The development of tongue begins as a midline enlargement in the floor of primitive pharynx called the "tuberculum impar." Two other bulges arise adjacent to the tuberculum impar called "lingual swellings". All these structures from the Ist arch mesenchyme.
- The lateral lingual swellings quickly enlarge and merge with each other and the tuberculum impar to form a large mass from which the two-thirds of the anterior tongue is formed. At this stage, a large swelling develops in the midline from mesenchyme of the II, III and IV arches. This swelling consists of a small part "copula" (associated with 2nd arch) and a large part "hypobranchial eminence" (primarily composed of 3rd arch mesenchyme).
- As the tongue develops, the hypobranchial eminence overgrows the copula and fuses with the tuberculum impar and lateral lingual swellings. The copula disappears without contributing to the formation of tongue. Thus, the posterior one-third or base of the tongue is derived from the third branchial arch. The body and base of the tongue are separated by a line of demarcation called "sulcus terminals." "Foramen caecum" is found in the midline of this structure (Fig. 13).

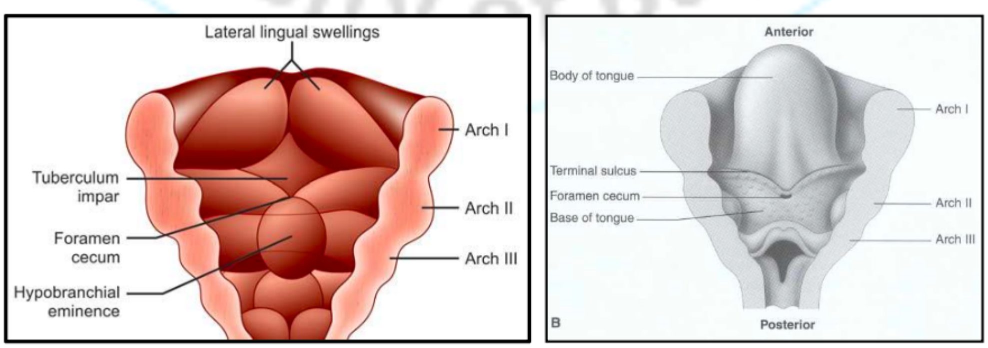


Figure 13

The development of Maxilla and Maxillary Sinus

The maxilla develops from a center of ossification in the mesenchyme of the maxillary process of the first pharyngeal arch. No primary cartilage exists in the maxillary process but the center of ossification is closely associated with the cartilage of the “nasal capsule.”

„ Similar to the mandibular development, the center of ossification appears in the angle between divisions of a nerve that is between “anterosuperior alveolar” and “inferior orbital nerve.” From this center, ossification spreads posteriorly towards the developing zygoma, anteriorly towards the premaxillary region and superiorly to form the frontal process of maxilla.

„ Ossification also spreads into the palatine processes to form the hard palate. The medial alveolar plate develops from the junction of the palatal process and the main body of the developing maxilla.

„ The medial alveolar plate, together with the lateral alveolar plate, forms a trough of bone around the maxillary tooth germs. The alveolar process contains the tooth germs in their bony crypts.

„ A secondary cartilage called “zygomatic/malar cartilage” also contributes to the development of maxilla. It appears in the developing zygomatic process and adds considerably to the development of the maxilla.

„ The maxillary sinus forms around 3rd month. The body of the maxilla remains relatively small at birth as the maxillary sinus is still small at birth about the size of a small pea.

The development of the mandible

The mandible initially develops intramembranously but its subsequent growth is related to the appearance of secondary cartilages. The “condylar cartilage” is the most important. During the 2nd month of intra-uterine, the primary cartilage of the 1st arch, Meckel’s cartilage, serves as a precursor of the mandibular mesenchyme, which forms around it and is responsible for mandibular growth activity. A condensation of mesenchyme occurs on the lateral aspect of Meckel’s cartilage in relation to the inferior alveolar nerve. At 7th week, intramembranous ossification begins in this mesenchymal condensation. Further spread of the developing bone in anterior and posterior directions produces a plate of bone on the lateral aspect of Meckel’s cartilage, which extends toward the midline, where it comes into approximation with a similar bone forming on the opposite side. However, the two plates of bone remain separated by fibrous tissue mandibular symphysis until shortly after birth. By the 10th week, the rudimentary mandible is formed almost entirely by membranous ossification with little or no direct involvement of Meckel's cartilage.

Further growth of the mandible until birth is influenced greatly by the appearance of secondary cartilages and the development of the muscular attachments. The mandible develops largely from intramembranous ossification, except in the following three areas where endochondrial ossification occurs aided by their respective secondary cartilages:

I. Condylar process—condylar cartilage

II. Coronoid process—coronoid cartilage

III. Mental region—symphyseal cartilage.

The activity of the condylar cartilage does not appear until the 4th or 5th month of postnatal life and continues until the age of 20 years so it has no role in the prenatal life.

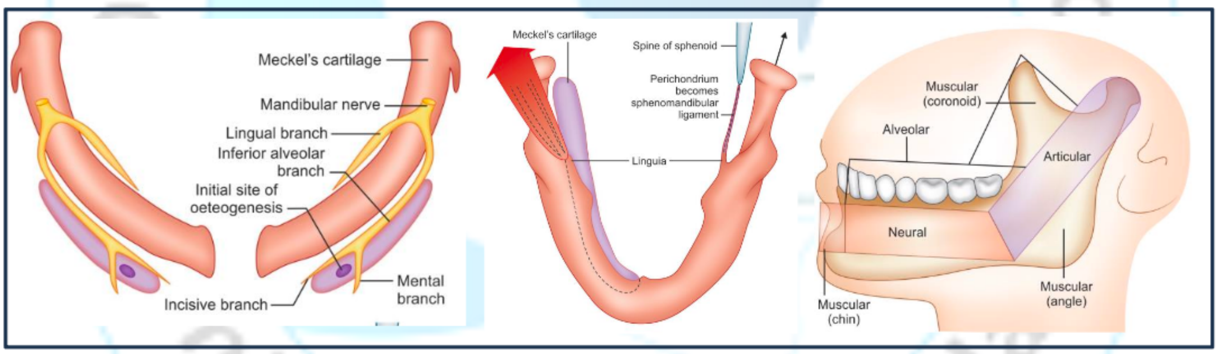


Figure 15

THEORIES OF CRANIOFACIAL DEVELOPMENT

A number of theories have evolved over the years in an attempt to understand the complex nature of craniofacial development. The major theories of growth are:

1. Genetic Theory — Brodie

This earliest theory proposed that skull growth was controlled by genetic factors and was preplanned. According to him, genes determine the overall growth control and the persistent pattern of facial configuration is under tight genetic control.

The genetic theory was antagonized by Moss and other investigators. Primary genetic control determines only certain features and does not have complete influence on growth.

2. Sutural Dominance Theory — Sicher

The sutural concept adhered to the notion that within each suture resided the genetic information that would determine the amount of growth occurring at the site of that suture.

The sutural theory advocated that the craniofacial suture generated tissue separating forces during growth thereby pushing apart the various bones of the craniofacial complex. However, this theory is disproved now and the research evidence show that the sutures are adaptive. Compensatory growth mechanisms and sutures act as "growth sites" rather than as "growth centers". Thus, growth in sutural area is secondary to functional needs. Thus, craniofacial sutures are now considered as important growth sites that serve to facilitate the growth of cranial vault and mid-face. Sutures respond to mild tension forces by surface deposition of bone, thereby enabling bones of the face and skull to adapt.

3. Cartilaginous Theory/Nasal Septal Theory — Scott

The cartilaginous theory emphasizes that the intrinsic growth controlling factors are present in the cartilage and in the periosteum, with sutures having only a secondary adaptive role. It considers the cartilaginous parts of the skull as primary centers of growth and suggests that primary cartilage present in the nasal septum is the main mechanism responsible for the growth of the nasomaxillary complex. Nasal septum is considered to influence the downward and forward growth of the maxilla. In mandible, condylar cartilage is considered to be the growth center present bilaterally with the U-shaped mandible in between. The following evidence supports the cartilaginous theory:

- Experimental studies on rats and rabbits showed retarded mid-face development when nasal septal cartilage was extirpated.
- Many bones grow by cartilaginous growth in which a precursor cartilage is replaced by bone.
- Transplantation of epiphyseal plate and synchondroses results in continued growth on transplanted area indicating intrinsic growth potential of the cartilage.

Primary cartilage found on the head and face is identical to the growth plate of long bone. It first appears in the head during the fifth week of gestation. By eighth week of gestation independent sites of craniofacial cartilage coalesce to form a cartilaginous mass called the chondrocranium. The chondrocranium is the precursor to the adult cranial base and nasal and otic structures. By mid-childhood, most primary cartilage is replaced by bone-endochondral bone formation. The overall influence of primary cartilage on craniofacial growth is most profound in early years of life, up to early childhood. At birth, cartilage forms a major portion of the nasal septum and cranial base. The sphenooccipital synchondrosis contributes significantly to craniofacial growth up to 6 years. After this age relative contribution of primary cartilage to craniofacial growth is small.

4. Functional Matrix Theory — Melvin Moss

The functional matrix theory, as postulated by Moss, regarded functional matrix as the primary requirement of growth and skeletal units as secondary responses, According to Moss, the growth of skeletal components, whether endochondral or intramembranous in origin, is largely dependent on the growth of the functional matrices, as:

* The vault of the cranium will grow by the stimulation of growing brain to accommodate its increase in size.

* The orbital cavity, this will grow by stimulation of growing orbit.

* The growth of the mandible can also be stimulated by the growth of tongue.

* Alveolar bone growth can also be stimulated by development and eruption of teeth.

5. Expanding 'V' Principle by Enlow

The concept of expanding 'V' principle was put forward by Enlow. The 'V' principle is an important facial skeletal growth mechanism since many facial and cranial bones have a 'V' configuration or 'V' shaped regions. In "V' shaped bones/areas, bone resorption occurs on the outer surface of the 'V' and deposition on the inner surface. As the remodeling continues, the 'V' moves away from its tip and enlarges simultaneously. In this way, growth as well as movement of the bone occurs simultaneously, Fig.7.

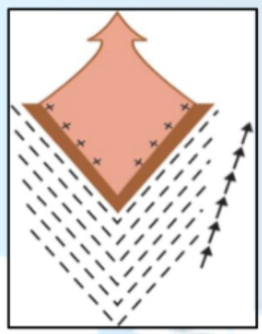


Fig. 7

Most of the craniofacial bones including mandible, maxilla and palate grow on an expanding 'V'. Growth of the palate is one of the best examples of expanding 'V' principle. Deposition occurs on the palatal periosteal surface and resorption occurs on the side of nasal floor. In this way, palate expands on lateral direction and also moves downwards **(Fig. 8)**.

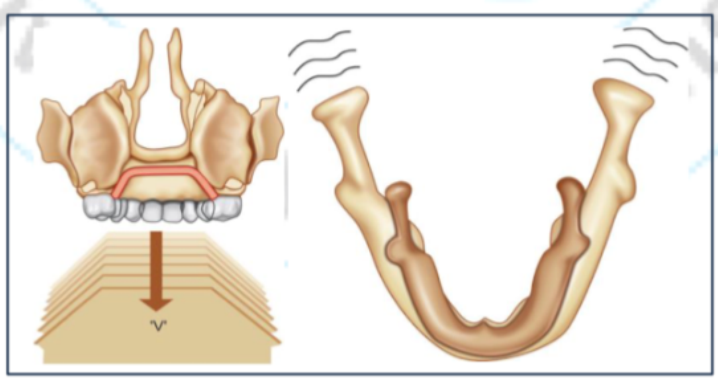


Fig. 8: Expanding 'V' Principle of **A.** palate**. B.** mandible.

Good luck