Growth and Development

Maxilla (Nasomaxillary Complex)

Since there is no cartilage replacement in maxilla, the growth occurs in two ways: Sutural growth and surface remodeling.

Nasomaxillary complex grow out from under the cranium in forward and downward direction by action of:

1. Growth of cranial base from behind which move it forward, this continue until about 7 yr. (produce one third of the total forward movement of the maxilla).
2. Growth at superior and posterior sutures, which connect the maxilla to the cranium. (Produce the rest of forward growth).

Anteroposterior growth(length)

Since the maxilla is attached to the anterior end of the cranial base, lengthening of the cranial base pushes it forward. The displacement from cranial base growth is an important part of the maxilla’s forward growth. Failure of the cranial base to lengthen normally, as in achondroplasia and several congenital syndromes, creates a characteristic midface deficiency. At about age 7, cranial base growth stops, and Sutural growth is the only mechanism for bringing the maxilla forward.

A forward displacement of the maxilla by the cranial base and Sutural growth give a room for the deposition of bone at tuberosities and at palatal process of both maxillary and palatine bones. Much of anteroposterior growth of maxilla is in backward direction at the tuberosities which
lengthen the dental arch, allowing the permanent molars to erupt.

The maxillary growth is accompanied by complex pattern of surface remodeling on the anterior lateral surfaces, which maintain the overall shape of the bone as it enlarge. Despite being translated anteriorly, in fact much of the anterior surface is resorptive in order to maintain the concave contour of maxilla.

**Vertical growth (height)**

The sutures attaching the maxilla posteriorly and superiorly are ideally situated to allow its downward and forward repositioning. Downward displacement of maxilla occurs by bone apposition at those sutures.

Vertical growth occurs by development of alveolar process, which is associated with the eruption of the teeth, and also by inferior drift of the hard palate.

To allow for the increased functional demands in the nasal cavities, the nasal floor is lowered by being translated bodily downward and simultaneously undergoing surface resorption. This is accompanied by bone deposition on the oral side of the palatal shelves of the maxillary bone. It is of interest to note that in spite of the significant bone deposition on the oral side of the palatal vault, the depth of the vault actually continues to increase with age. This increase is the result of the significant growth of the alveolar processes that accompanies the eruption of the primary and permanent dentitions.

**Transverse growth (width)**

Growth in width occurs mostly at the intermaxillary and interpalatine sutures (midpalatal). Also, additional increase in the width of the anterior
maxilla occurs as a result of bone deposition on the outer surfaces of the maxilla and by the buccal eruption of the permanent teeth. Internal remodeling leads to enlargement of the air sinuses (especially the maxillary antrum) and nasal cavity as the bones of the mid-face increase in size.

**Mandible**

In the neonate the mandible is made of two halves (i.e., it is not completely united at the midline). By the end of the first year, the two halves of the mandible are essentially united as one bone and the symphyseal cartilage is replaced by bone. The growth is quite general during the 1st year of life. Both cartilaginous growth and periosteal activity are important in mandibular growth. The Cartilage covers the surface of the mandibular condyle at the TM joint, so the endochondral replacement do occur there. All other areas of the mandible are formed and grow by direct surface apposition and remodeling.

**Antero-posterior growth (length)**

The translation of the mandible occurs largely as the bone moves downward and forward along with the soft tissues in which it is embedded. At the same time, the mandible grows longer by apposition of new bone on the posterior surface of the ramus. In essence, the body of the mandible grows longer as the ramus moves away from the chin, and this occurs by removal of bone from the anterior surface of the ramus and deposition of bone on the posterior surface. This will provide the required space to accommodate for eruption of the molars.
The bone deposition at the posterior border and resorption at the anterior border of ramus with less rate than the deposition in a way that allow the ramus to become wider.

**Vertical growth (height)**

The ramus is very short at birth. After the first year of life, the condyle does show considerable activity so the ramus will increase in height by growth of condylar cartilage and bone deposition at the tip of coronoid process.

At the same time, this vertical ramus growth will move the body of mandible away from the maxilla leaving space for development of alveolar process (and eruption of teeth), which increase the vertical dimension of the body. At the inferior border of the body there is little opposition occurs during the 1st year of life.

**Transverse growth (width)**

After the first year, it occurs mainly due to the growth at the posterior border in an expanding V pattern. The two rami diverge to posterior and to outward from below to above so that the bone deposition on the posterior border of the ramus and the additive growth at condyle will increase the inter-ramus distance at the posterior aspect. The alveolar processes of the mandible grows upward and outward on an expanding arc to permits the dental arch to accommodate the larger permanent teeth. Relatively little increase in the mandibular body width occurs by the lateral surface appositional growth.
Timing of Growth

For the three planes of space in both the maxilla and mandible, there is a definite sequence in which growth is completed. Growth in width is completed first, then growth in length, and finally growth in height. Growth in width, including the width of the dental arches, tends to be completed before the adolescent growth spurt and is affected minimally if at all by adolescent growth changes. Growth in length and height of both jaws continues through the period of puberty. In both sexes, growth in vertical height of the face continues longer than growth in length, with the late vertical growth primarily in the mandible.

Soft Tissues Growth

Growth of the Lips

The lips trail behind the growth of the jaws prior to adolescence, and then undergo a growth spurt to catch up. Because lip height is relatively short during the mixed dentition years, lip separation at rest (often termed lip incompetence) is maximal during childhood and decreases during adolescence. Because the lips move downward relative to the teeth during adolescence (and continue to do so as the face ages), what looks like too much display of gingiva prior to and in adolescence can look perfectly normal in a young adult. Lip thickness reaches its maximum during adolescence, and then decreases to the point that in their 20s and 30s, some women consider loss of lip thickness a problem and seek treatment to increase it.

Growth of the Nose

Growth of the nasal bone is complete at about age 10. Growth thereafter is only of the nasal cartilage and soft tissues, both of which undergo a considerable adolescent spurt. The result is that the nose becomes much more prominent at adolescence, especially in boys.

The lips are framed by the nose above and chin below, both of which become more prominent with adolescent and post-adolescent growth while the lips do not, so the relative prominence of the lips decreases. This can become an important point in determining how much lip support should be
provided by the teeth at the time orthodontic treatment typically ends in late adolescence.

**Theories of Growth Control**

In general, the growth is strongly influenced by genetic factors, also it can be significantly affected by the environment in the form of nutritional status, degree of physical activity, health or illness.

A site of growth is merely a location at which growth occurs, it lacks the innate growth potential & it can be affected largely by environment. A center of growth is a location at which independently (genetically controlled) growth occurs, it has growth potential & cannot be influenced by environment.

Three major theories in recent years have attempted to explain the determinants of craniofacial growth:

(1) Bone, like other tissues, is the primary determinant of its own growth.

(2) Cartilage is the primary determinant of skeletal growth, while bone responds secondarily and passively.

(3) The soft tissue matrix in which the skeletal elements are embedded is the primary determinant of growth, and both bone and cartilage are secondary followers.

The major difference in the theories is the location at which genetic control is expressed (consider the growth center).

The first theory implies that genetic control is expressed directly at the level of the bone, its locus should be the periosteum. Therefore, the tissues that form bone carry with them their own stimulus to grow to the final size and form. The major sites of bone growth were also considered as centers, particularly the sutures between the bones of the cranium and jaws. By experiments, it is appeared that the sutures, and the periosteal tissues more generally, are not primary determinants of craniofacial growth.

The second, or cartilage, theory suggests that genetic control is expressed in the cartilage, so that the cartilage should be considered as pacemaker for bone growth. The craniofacial cartilages includes the condylar cartilage,
nasal septal cartilage and synchondroses. By experiments, both the cranial base synchondroses and to lesser extent the nasal septal cartilage can and do act as independently growing centers, while the growth at the mandibular condyles is much more analogous to growth at the sutures (entirely reactive), so it is a site and not a center.

The third (Moss) theory called "Functional Matrix Theory" assumes that genetic control is mediated to a large extent outside the skeletal system. The craniofacial skeleton grows in response to effect of the functional matrix which involve the nearby functional spaces and soft tissues. For example, the growth of maxilla and mandible is determined by enlargement of the nasal and oral cavities, which grow in response to functional needs. Another example is the relation of eyeball size to size of orbit, so an enlarged or small eye will cause corresponding change in size of the orbital cavity. On balance, the interference with function could be a reason for the growth deficiency.

In contemporary thought, the truth is to be found in some synthesis of the second and third theories.