Growth and Development in orthodontics II

GROWTH SITES: Are growth fields that have a special significance in the growth of a particular bone, e.g. mandibular condyle in the mandible, maxillary tuberosity in the maxilla. The growth sites may possess some intrinsic potential to grow (debatable).

GROWTH CENTERS: Are special growth-sites, which **control** the overall growth of the bone, e.g. epiphyseal plates of long bones. These are supposed to have an intrinsic growth potential (unlike growth sites).

REMODELING: It is the differential growth activity involving deposition and resorption on the inner and outer surfaces of the bone, e.g. ramus moves posteriorly by a combination of resorption and deposition.

Mechanism of bone growth:

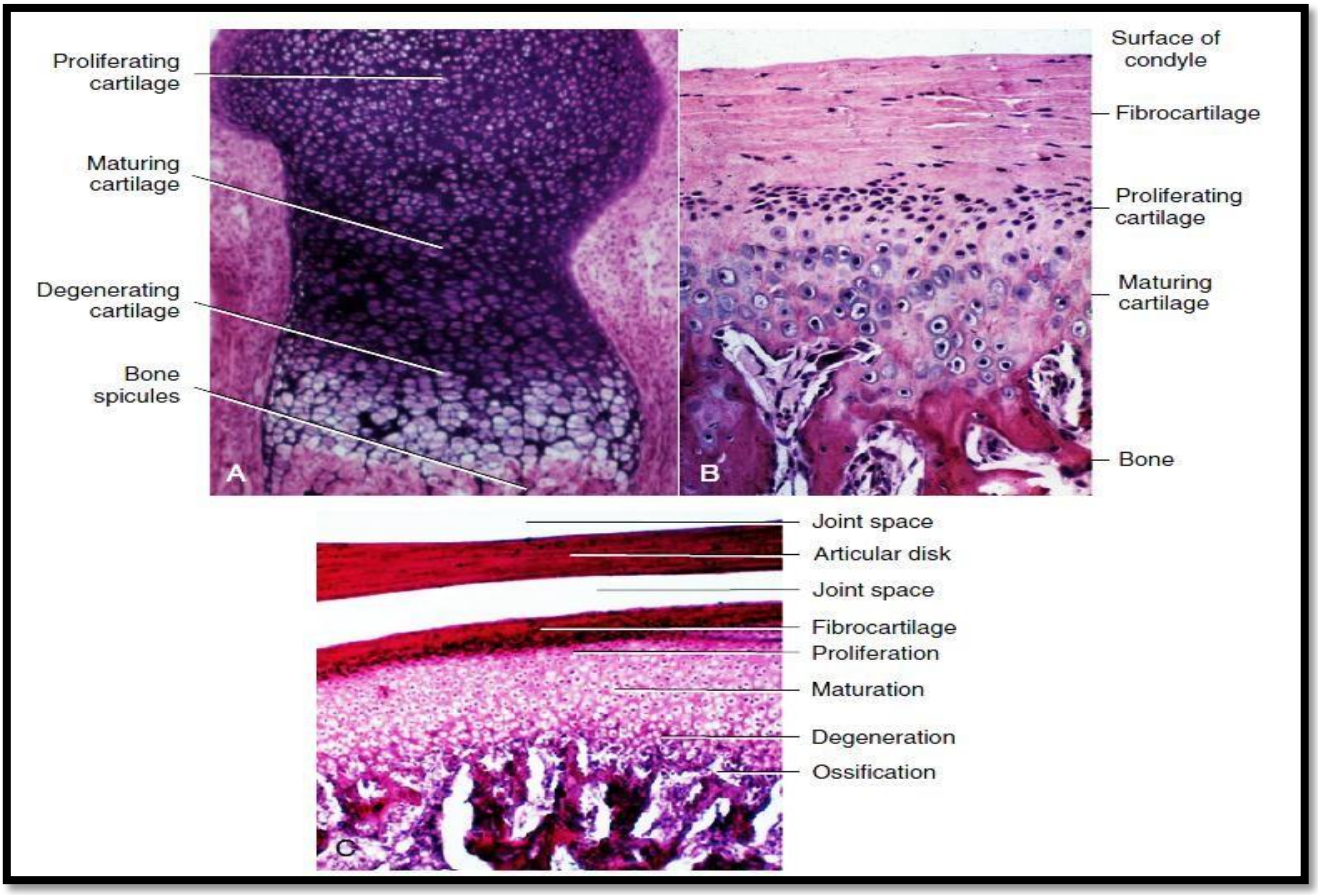
Bone does not grow interstitially (i.e. it does not expand by cell division within its mass) rather, it grows by activity at the margins of the bone tissue.

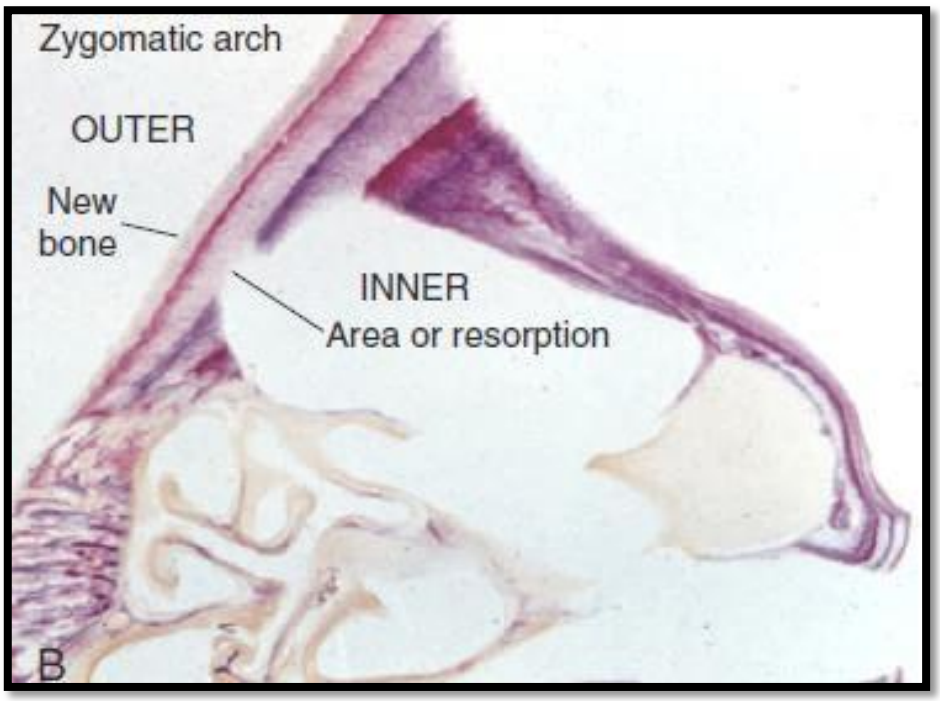
Bone is laid down in two ways:

1. Endochondral Ossification: At cartilaginous growth center, chondroblasts lay down a matrix of cartilage within which ossification occurs. At primary growth centers there are zones of cell division, cell hypertrophy and calcification aligned in columns along the direction of the growth. This process is seen in both the epiphyseal plate of long bones and the synchondroses of the cranial bone.

Near the outer end of each epiphyseal plate is a zone of actively dividing cartilage cells. Some of these, pushed toward the diaphysis" by proliferative activity beneath, undergo hypertrophy, secrete an extracellular matrix, and eventually degenerate as the matrix begins to mineralize and then is rapidly replaced by bone. As long as the rate at which cartilage cells proliferate is equal to or greater than the rate at which they mature, growth will continue. Eventually, however, toward the end of the normal growth period, the rate of maturation exceeds the rate of proliferation, the last of the cartilage is replaced by bone, and the epiphyseal plate disappears. At that point, the growth of the bone is complete, except for surface changes in thickness,

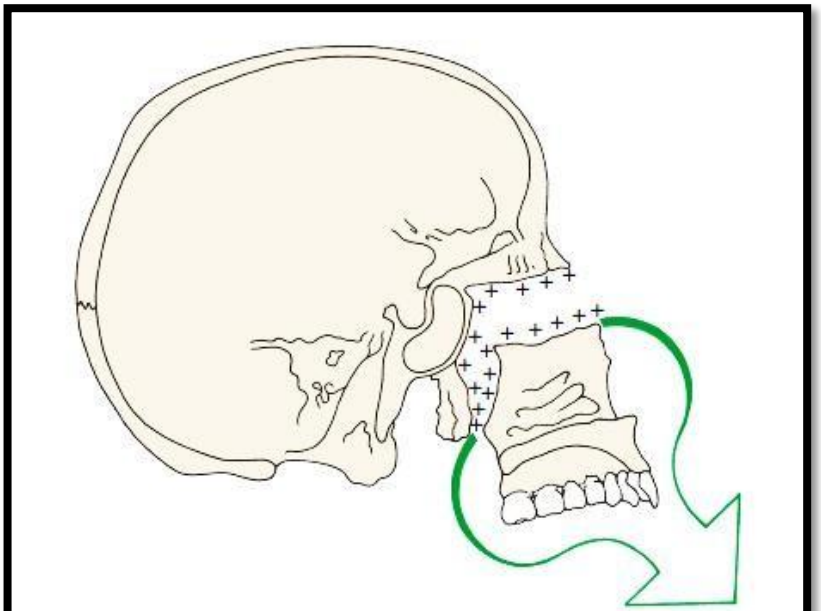
which can be produced by the periosteum.





2. Intramembranous ossification**:** Growth is gained by the process of remodeling (resorption and deposition), usually growth is occur by enlargement of bone by deposition on its periosteal (surface) and by resorption in some parts of its surface to maintain the overall shape of the bone in addition to that, the endosteal remodeling (deposition and resorption) maintains the internal architecture of cortical plate and trabeculae**.**

- **Sutural growth**: The bone of the face and skull articulate together mostly at sutures, and growth at sutures can be regarded as a special kind of periosteal remodeling -an infilling of bone in response to tensional growth forces separating the bones of either side of the suture.
- **Displacement:** Growth which causes the mass of the bone to be moved relative to its neighbors, usually brought about by forces exerted by the soft tissues and by intrinsic growth of the bones themselves, e.g. epiphyseal plates and synchondroses; an example is forward and downward translation of the maxillary complex.



• **Fig. 2.27** As growth of surrounding soft tissues translates the maxilla downward and forward, opening up space at its superior and posterior sutural attachments, new bone is added on both sides of the sutures. (Redrawn from Enlow DH, Hans MG. *Essentials of Facial Growth*. Philadelphia: WB Saunders; 1996.)

Drift: The change in the position of the bony structure owing to the remodeling of that structure, in which the palate moves downward during growth as a result of

bone being laid down on its inferior surface and resorbed on its superior surface.

The post-natal growth of the craniofacial complex:

1. Can be divided into **four** areas that grow rather differently:
2. The cranial vault the bone that covers the upper and outer surface of the brain.
3. The cranial base the bony floor under the brain, which is also a dividing line between the cranium and the face.
4. C. The nasomaxillary complex made up of the nose, maxilla, and the associated structures.
5. d. The mandible.

A- THE CRANIAL VAULT

Is the part of the skull which develops from the membranous bones surrounding brain and the therefore it follows the neural growth pattern (the growth in the cranial vault is because of the enlarging brain). It comprises:

1. Parietal bones (2)
2. Fontal bone
3. Squamous part of temporal bones (2)
4. Occipital bone.

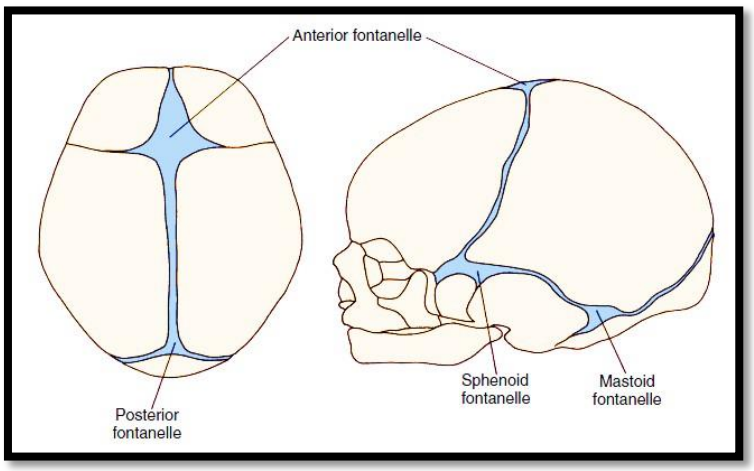
The rate of bone growth is more during infancy and by the fifth year of life more than 90 percent of the growth of cranial vault is achieved.

It is made up of a number of flat bones that are formed directly by intramembranous ossification, without cartilaginous precursors.

Remodeling and growth occur primarily at the periosteum lined contact areas between adjacent skull bone, called the skeletal sutures.

At birth, the flat bones of the skull are rather widely separated by relatively loose connective tissues. These open spaces, (the fontanelles) allow a considerable amount of transient deformation of the skull at birth-a fact which is important in allowing the relatively large head to pass through the birth canal.

After birth, apposition of bone along the edges of the fontanelles eliminates these open spaces fairly quickly, then closes by 18 months.



Growth of cranial vault consists of:

Drift: Internal cranial aspects of the bones are resorbed while bone is laid down on the external surface.

Displacement: The bones are separated by growing brain, with fill

in bone growth occurring at the sutures to maintain continuously of the cranial vault. It should be realized that there is actual translation as well as remodeling of the individual bones, with the structures being moved outward by the growing brain. Despite early accomplishment of the pattern, the parietal bones do not close until the middle of third decadeof life.

B-THE CRANIAL BASE:

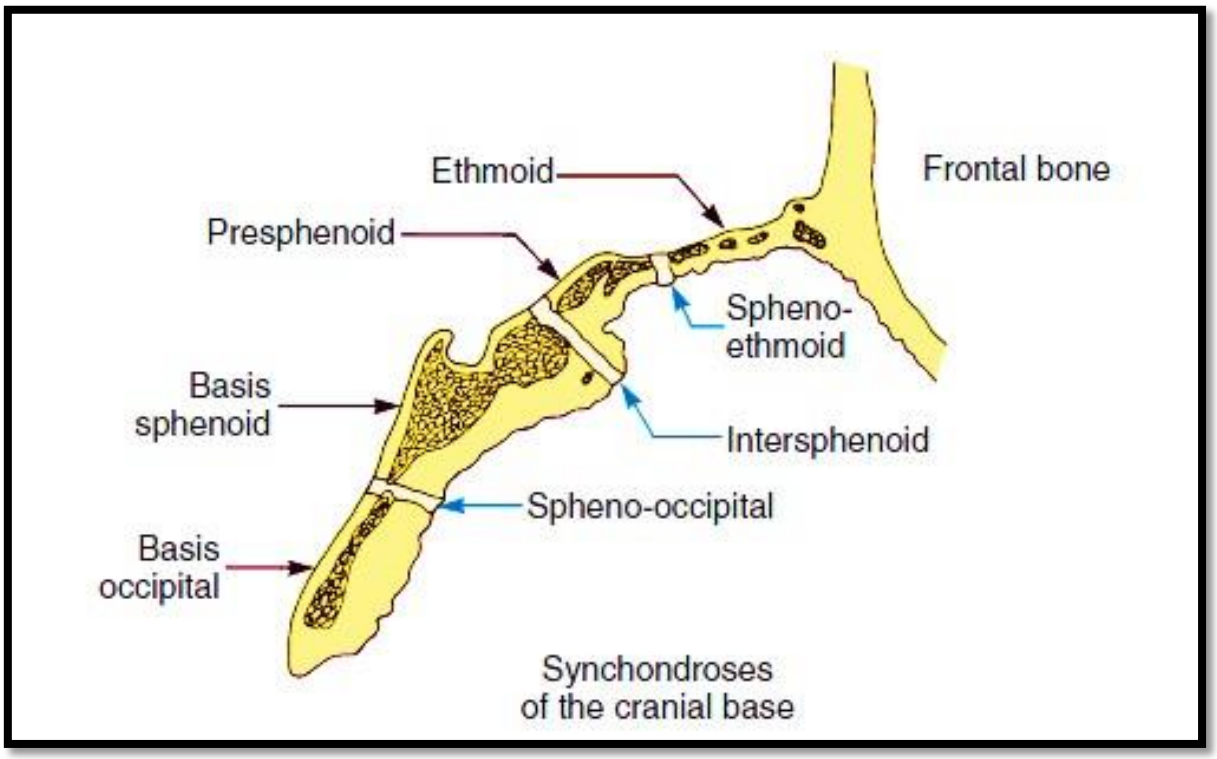
The cranial base, unlike cranial vault, is not completely dependent on brain growth and may have some intrinsic genetic guidance and a pattern that is, similar in some dimensions, to that of the facial skeleton.

In contrast to the cranial vault, the bones of the cranial base are formed initially in the cartilage and are later transformed by endochondral ossification into bone which is particularly true of the midline structures.

Growth of the cranial base is influenced by both neural and somatic growth patterns, with 50 per cent of postnatal growth being complete bythe age of 3 years.

As in the calvarium (cranial vault), there is *both remodeling and sutural* infilling as the brain enlarges, but there are also primary cartilaginous growth sites in this region (*the synchondroses*). One of these, the **spheno-occipital** synchondrosis is of special interest as it makes an important contribution to growth of the cranial base during childhood, continuing to grow until 13–15 years in females and 15-17 years of age in males, fusing at approximately 20 years.

The spheno-occipital synchondrosis is anterior to the temporomandibular joints, but posterior to the anterior cranial fossa, and therefore, its growth is significant clinically as it influences the overall facial skeletal pattern.



The cranial base plays an important part in determining how the mandible and maxilla relate to each other, For example, Class II skeletal facial pattern is often associated with the presence of a long cranial base which causes the mandible to be set back relative to the maxilla.

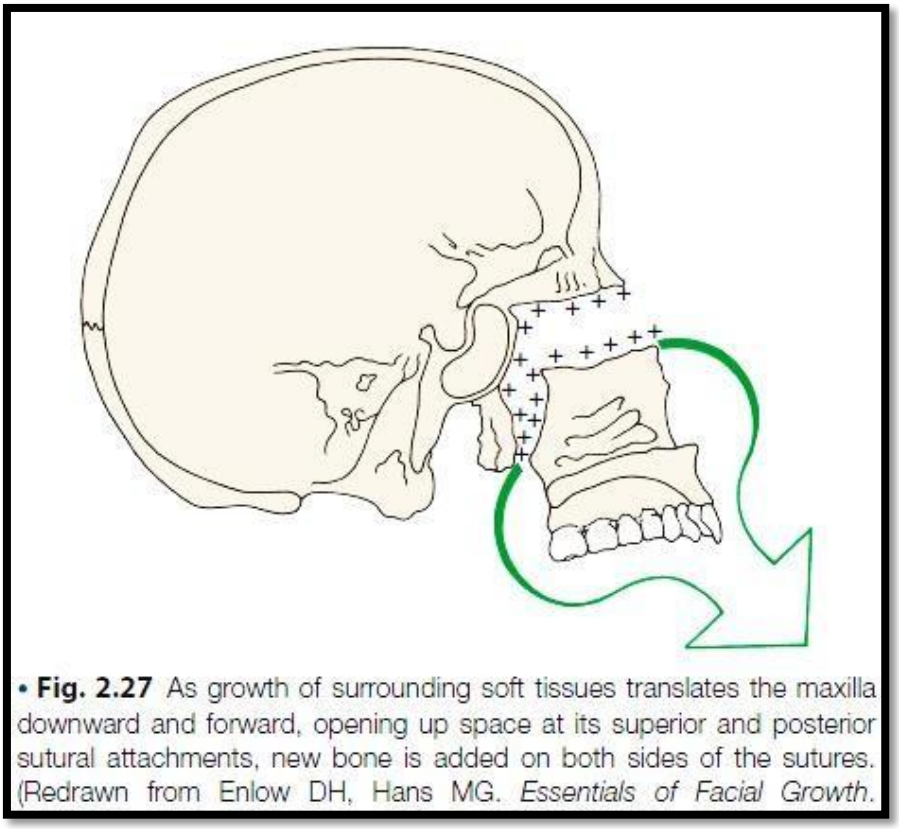
In the same way, the overall shape of the cranial base affects the jaw relationship, with a smaller cranial base angle tending to cause a Class lll Skeleton pattern and a larger cranial base angle being more likely to be associated with a Class ll Skeletal pattern .

C- NASOMAXILLARY COMPLEX

The middle third of facial skeleton is a complex structure and also includes, among others, the palatal, zygomatic, ethmoid, vomer, and nasal bones. These articulate with each other and with the anterior can sutures.

Growth of the maxillary complex occurs in part by displacement with fill-in growth at sutures and in part by drift and periosteal remodeling. Passive forward displacement is important up to the age of 7 years, due to the effects of growth of the

cranial base.



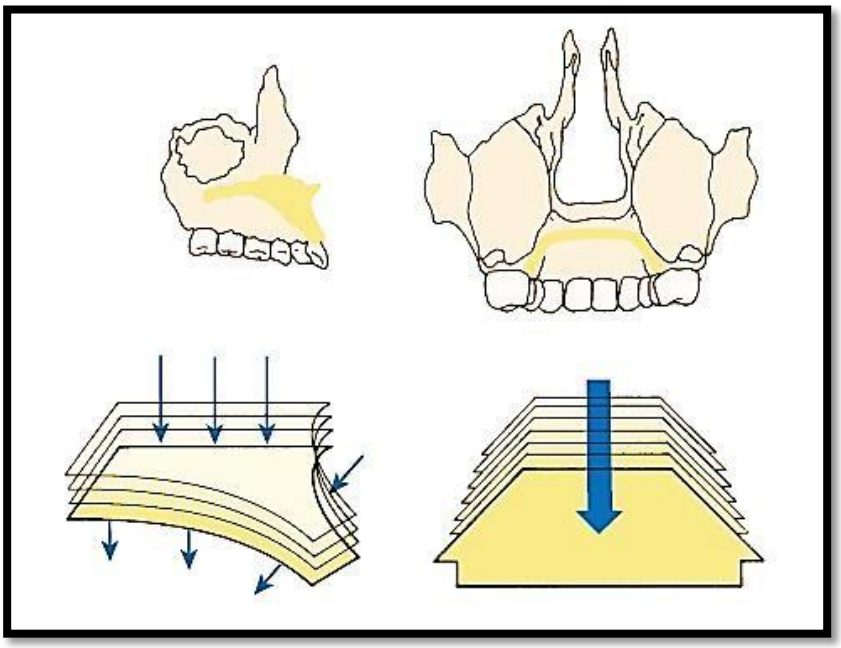
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<u>Downward growth of the mid face occurs by</u>:

1. Vertical development of the alveolar process
2. Eruption of the teeth
3. Inferior drift of the hard palate,

i.e. the palate remodels downwards by deposition of bone on its inferior surface (the palatal vault) and resorption on its superior surface (the floor of the nose and maxillary sinuses).

These changes are also associated with some downward displacement of the bones as they enlarge, again necessitating infilling at sutures.



Maxillary growth **ceases** on average at about 14 years in girls and rather later at about 16 years in boys.

D- THE MANDIBLE

The mandible is derived from the first pharyngeal arch and it is a membrane bone ossifying laterally to Meckles cartilage. The role of the condylar cartilage in the growth of the mandible is not yet entirely clear. However, normal growth at the condylar cartilage is required for normal mandibular growth to take place.

Most mandibular growth occurs as a result of periosteal activity. As the mandible is displaced forwards; growth at the condylar cartilage fills in posteriorly. Bone is laid down on the posterior margin of the vertical ramus and resorbed on the anterior margin, and this posterior drift of the ramus allows lengthening of the dental arch posteriorly. At the same time the vertical ramus becomes taller to accommodate the increase in height of the alveolar processes.

Before puberty growth occurs at steady rate with an increase of 1-2 mm per year in ramus height and 2–3 mm per year in body length. However, growth rates can double during puberty and the associated growth spurt. Mandibular growth slows to adult levels rather later than maxillary growth, on average at about 17 years in girls and 19 years in boys, although it may continue for longer.