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Essential Quick Review

With Free Companion FAQs on Orthodontics

Orthodontics

HIGHLIGHTS

- Supplementary FAQ book containing Definitions, Classifications and Viva-voce
- Diagrams with supporting answers
- Recent question bank of all India universities
- Covers entire undergraduate DCI syllabus

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Chapter 2

Growth and Development: General Principles

LONG ESSAYS

Question 1

Define growth and development. Describe in detail various theories of growth?

Answer

Growth is defined as:

- According to Todd: Growth refers to increase in size
- According to Moyers: Growth may be defined as the normal changes in the amount of living substance
- According to Profitt: Growth usually refers to an increase in size and the number.

Development can be defined as:

- According to Todd: Development is progress towards maturity
- According to Enlow: Development connotes a maturation process involving progressive differentiation at the cellular and tissue levels.

Growth Theories

- Genetic theory
- Sutural theory
- Cartilagnous theory
- Functional matrix theory
- Composite theory.

Genetic Theory

According to this theory the basic control of growth, both in magnitude and timing is located in the genes. The potential for growth is genetic.

The common ground shared by all the genetic studies has led the orthodontic specialty in general to conclude that genes are fundamental in causing malocclusion.

However the genetic theory is not complete in explaining the role of environmental and epigenetic factors influence on the characteristics of an individual including the dentofacial forms.

Sutural Theory

Proposed by Sicher in 1955.

According to Sicher, "The primary event in sutural growth is the proliferation of the connective tissue between the two bones. If sutural tissue proliferates, it creates the space for appositional growth at the border of the bones".

In Sicher's view all bone-forming elements, cartilage, sutures and periosteum are growth centres, which are responsible for facial growth and assumed all were under tight intrinsic genetic control.

He felt that the connective tissue in suture of both the nasomaxillary complex and vault produced forces that separated the bones, just as the synchondroses expanded the cranial base and the epiphyseal plates lengthened long bones.

Evidences Against Sicher's Theory

- Auto transplants of sutures fail to grow in cultural medium though provided with same environment and conditions
- Extirpation of sutures has no appreciable effect on growth of skeleton
- The shape and growth within sutures is dependent on external stimuli
- It is possible to bring the sutural growth to halt by mechanical stresses applied across the sutures.

Cartilaginous Theory (James Scott–1956)

Scott hypothesis emphasises that the intrinsic growth controlling factors are present in the cartilage and in the periosteum, with the sutures being only secondary and dependent on extrasutural influences. According to this theory, the determinant of craniofacial growth is growth of cartilages.

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According the Scott

- Spheno-occipital synchondrosis cartilage is responsible for the growth of cranial base
- Nasal septal cartilage is responsible for the growth of maxilla
- Condylar cartilage is responsible for the growth of mandible.

Sutural growth, Scott felt, came in response to the growth of the other structures including cartilaginous elements, brain, the eyes and so forth. Sutural growth is responsive to synchondrosis proliferation and local environmental factors that is, sutures are passive and secondary.

His theory expounds cartilage and periosteum as growth centres and classifies sutures as passive and secondary. The cartilaginous parts of the skull must be recognised as primary centres of growth, with the nasal septum being a major contributor in maxillary growth, per se.

Spheno-occipital Synchodrosis

Important growth centre of craniofacial skeleton, especially cranial base.

Cartilage of Nasal Septum

- Growth of maxilla is difficult to explain on the cartilage theory. Proponents of the cartilage theory hypothesise that the cartilaginous nasal septum serves as a pacemaker for other aspects of maxillary growth
- Two kinds of experiments have been carried out to test the idea that cartilage can serve as a true growth centre.
  - Transplanting nasal cartilage to cultural medium or any other place did not give equivocal results— that is sometime it grew, sometimes it did not. Indicating doubtful growth potential of the nasal septal cartilage whereas, if a piece of the epiphyseal plate of a long bone is transplanted, it will continue to grow in a new location or in culture, indicating that these cartilages do have innate potential
  - It was demonstrated that after the fracture of the mandibular condyle in a child, there was an excellent chance that the condylar process would regenerate to approximately its original size and a small chance that it would overgrow after the injury despite the damage to the condylar cartilage.

Cartilaginous theory was successful in explaining the growth of the cranial base and to a great extent maxilla too, it could not explain the growth of mandible and relate the growth of mandible to the condylar cartilage satisfactorily.

Functional Matrix Theory

Proposed by Melvin C Moss in 1965.

According to Moss, "the origin, growth and maintenance of all skeletal tissues and organs are always secondary, compensatory and obligatory to temporally and operational prior events or processes that occur in specifically related non-skeletal tissues, organs or functional spaces".

Each of these functions is completely carried out by *functional cranial component* (**Flowchart 2.1**).

- *Functional matrix*: Consisting of the soft tissue and space, which completely performs a particular function.
- *Skeletal unit*: A related skeletal unit that acts biomechanically to protect and/or support its functional matrix.

Functional Matrix

Functional matrices provide the extrinsic (environmental) influences which are morphogenetically primary for the form, growth, position and maintenance in being of all skeletal units.

This consist of soft tissue-muscle, gland, nerve, vessels, fat and non-skeletal cartilages.

There are two distinct types of functional matrix.

1. The periosteal matrix
2. The capsular matrix.

Periosteal Functional Matrix

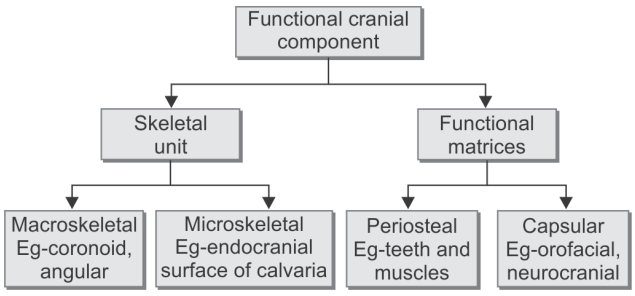
This term relates the matrix to those tissues that influence the bone directly through the periosteum.

Muscles are attached to the periosteum and consequently are excellent examples of this kind of matrix. Blood vessels and nerves lying in grooves or entering or exiting through foramen can also exert a periosteal influence on the skeletal unit.

Periosteal functional matrices are virtually self-defining.

All periosteal matrices act homologously, usually by means of the processes of osseous deposition and resorption. They

Flowchart 2.1: Different components of functional matrix theory



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act to alter either or both the size and shape of skeletal units per se.

The periosteal matrix affects a microskeletal unit meaning that the sphere of influences is usually limited to a part of one bone.

Capsular Functional Matrix

This is the second type of functional matrix. Included in this class of matrix are those masses and spaces that are surrounded by capsules.

All functional cranial components (skeletal units plus functional matrices) arise, grow, operate and are maintained within a series of cranial capsules.

Four capsules are present:

1. Neuro cranial
2. Orofacial
3. Otic
4. Orbital.

Each of these capsules is an envelope, which contains a series of functional cranial components (skeletal units plus their related functional matrices), which as a whole, are sandwiched in between two covering layers.

All spaces intervening between functional components themselves, and between them and the limits of the capsule, are filled with indifferent loose connective tissue.

These capsules tend to influence macroskeletal units, which mean that portions of several bones are simultaneously affected.

Capsular functional matrices act indirectly and passively on their related skeletal units, producing a secondary, compensatory translation in space.

Example: The inner surface of calvarium.

The neural mass within its capsules elicit a reaction on the surface of the calvarium that transcends a localised area. As a result, apposition on the occipital, parietal, temporal and frontal occurs as if all of them were but one bone. This sharing of reaction by several adjacent bones constitutes a macroskeletal unit.

Skeletal Units

Skeletal units may be composed of bone, cartilage, or tendinous tissues.

Moss divided the skeletal units into:

1. Microskeletal units
2. Macroskeletal units.

Microskeletal Unit

Formed by bones consisting of number of small skeletal units.

Maxilla

- Orbital
- Pneumatic
- Palatal
- Basal

Mandible

- Coronoid
- Angular
- Alveolar
- Basal

Macroskeletal Unit

When adjoining portions of a number of neighbouring bones united to function as a single cranial component, we term this as macroskeletal unit.

Van Limborgh's Composite Theory

It is a theory that unifies all the factors contributing to growth, namely the genetic, the epigenetic and the environmental factors.

Van Limborgh's summarisation:

- Intrinsic control of growth is at synchondroses
- Synchondroses act as Growth centre
- Sutural growth is controlled in part by growth of cranial base
- Periosteal bone growth (vault) is controlled epigenetically by adjacent structures
- Growth of cranial vault is also controlled by local environmental factors (muscle forces inclusive) **(Fig. 2.1).**

Enlow's Principles

Two important principles regarding growth were put forward by Enlow. They are:

1. Counterpart principle
2. 'V' principle.

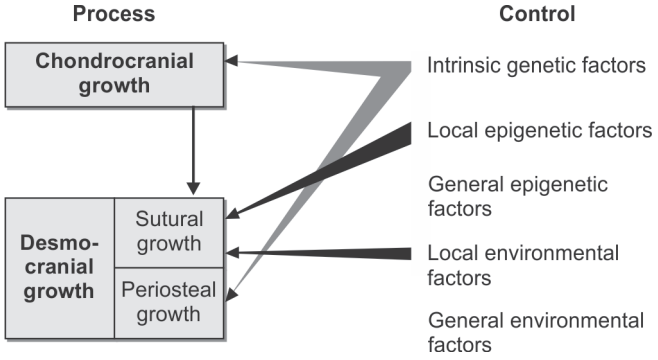


Fig. 2.1: Composite theory of Van Limborgh

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Counterpart Principle of Craniofacial Growth

This principle states that the growth of any given facial or cranial part relates specifically to other structural and geometric "counterparts" in the face and cranium.

- Maxilla: Mandible
- Anterior cranial fossa: Palate
- Palate: Maxillary apical bases
- Middle cranial fossa: Ramus: Zygomatic arch.

These are regional relationships throughout the whole face and cranium.

If each regional part and its particular counterpart enlarge to the same extent, balanced growth between them is the result.

This is the key to what determines the presence or lack of balance in any region.

Imbalances are produced by differences in respective amounts or direction of growth between parts and counterparts.

"V" principle: "V" principle is the most useful and basic concept in facial growth. Many facial and cranial bones, or part of bones, have a V-shaped configuration.

Bone deposition occurs on the inner side of the "V", resorption takes place on the outside surface **(Fig. 2.2)**.

The "V" thereby moves from position A to B and, at same time, increases in overall dimensions.

The direction of movement is towards the wide end of the "V" thus, a simultaneous growth movement and enlargement occurs by additions of bone on the inside with removal from the outside.

The outcome of these growth processes is **(Fig. 2.3)**:

- Enlargement in overall size of the "V"-shaped area
- Movement of the entire "V" structure towards its own wide end
- Continuous relocation.

Maxillary Arch

The anterior part of the bony maxillary arch has a periosteal surface that is resorptive because this area grows straight downwards.

The labial (external) side of the premaxillary region faces away from the downward direction of growth, and it is thus resorptive. The lingual side faces towards the downwards growth directions and is depository **(Fig 2.4)**.

This growth pattern also provides for the remodelling of the alveolar bone as it adapts to the variable positions of the incisors.

If the midsagittal section of the maxilla is displayed as a shallow "V" the inside or palatal side is found to be depository,

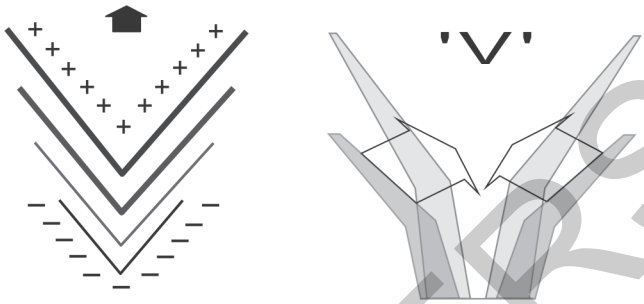


Fig. 2.2: Bone growth as described by Enlow's V- principle with deposition of bone occurring on the inner aspect of V and resorption of bone on outer aspect of V

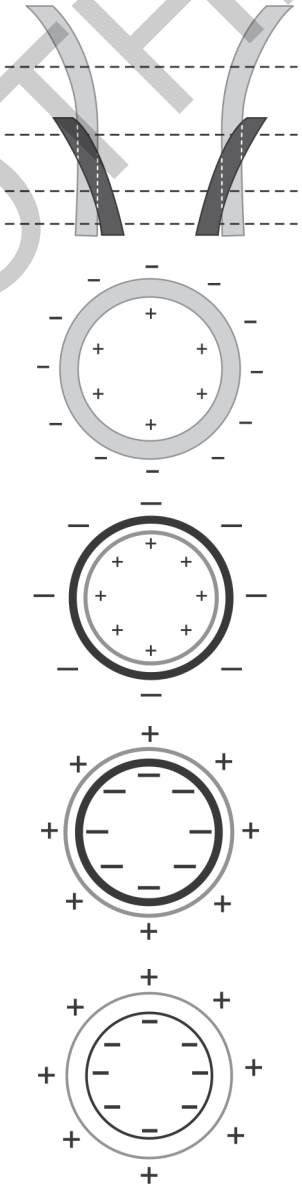


Fig. 2.3: Enlargement of Bone according to V-principle

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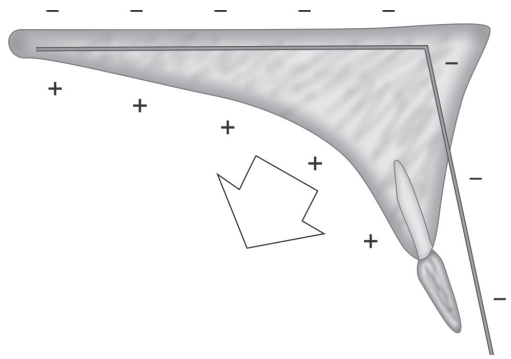


Fig. 2.4: Growth of maxilla in downward direction according to V principle

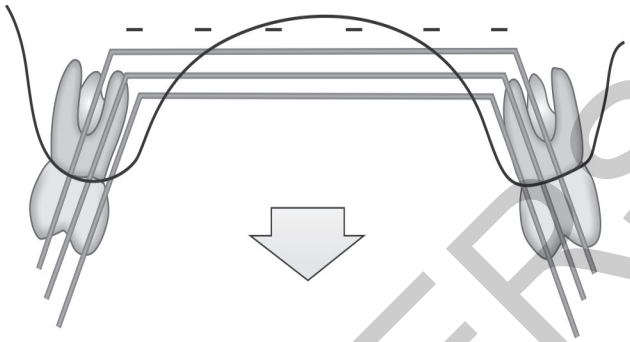


Fig. 2.5: Growth of palate in downward direction with deposition on the inferior aspect and resorption on the superior aspect

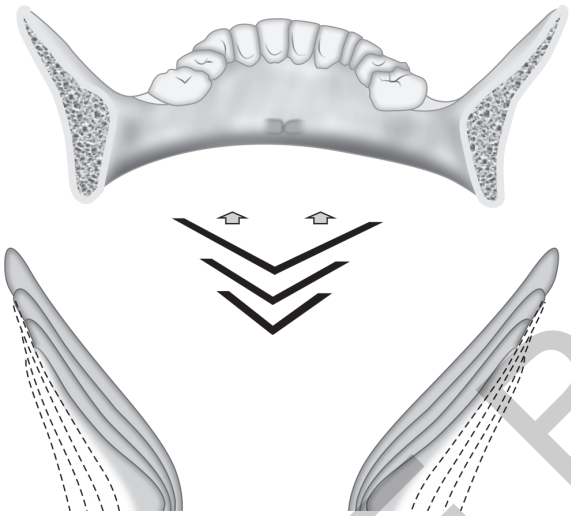


Fig. 2.6: Growth of mandible according to V principle in coronoid region

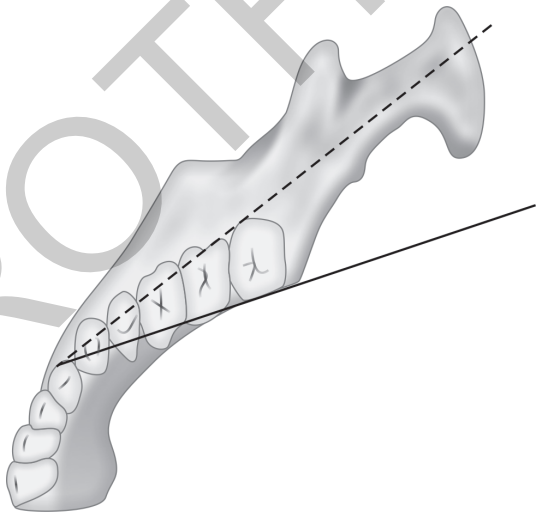


Fig. 2.7: Growth of lateral aspect of ramus from above view

while the floor of the nasal cavity and the surface just above the maxillary incisors (both of which are on the side opposite to the direction of growth) are resorptive **(Fig. 2.5)**.

Mandibular Growth

If we take a cross section of the mandible through the coronoid processes, we can see that the coronoid processes is an example of an ever-expanding "V" with the inside surface undergoing apposition and the outer surface resorption. Here the "V" is oriented vertically.

These same deposits of bone on the lingual side also bring about a posterior direction of growth movement, because this surface also faces posteriorly.

This produces a backward movement of the two coronoid processes, even though deposits are added on the inside (lingual) surface **(Fig. 2.6)**.

This is also an example of the expanding "V" principle, with the "V" oriented horizontally.

These same deposits of bone on the lingual side also bring about a posterior direction of growth movement, because this surface also faces posteriorly. This produces a backwards movement of the two coronoid processes, even though deposits are added on the inside (lingual) surface. This is also an example of the expanding "V" principle, with the "V" oriented horizontally.

Further applications of the "V" explain the apposition on the buccal surface of the ramus and the resorption of the lingual surface beneath the mylohyoid ridge.

These combined activities profoundly influence the shape of the mandible in two ways. First, the lateral ramus deposition is part of the drift that leads to the square jaw of the adult. Second, when one looks at the mandible from above **(Fig. 2.7)** it is apparent that the process is designed to

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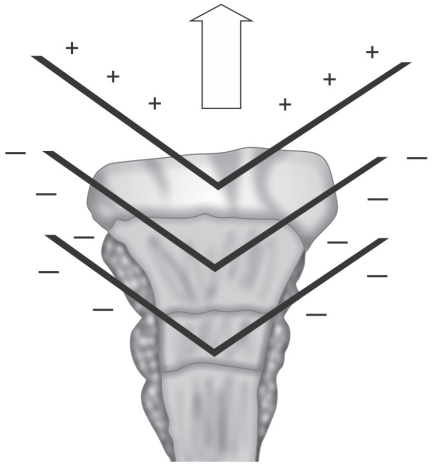


Fig. 2.8: Growth of condyle according to V principle

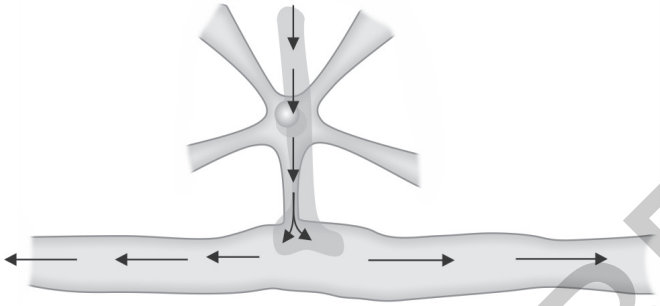


Fig. 2.9: Axoplasmic transport

keep the teeth closer to the midline then is either the rami or the coronoid processes.

In fact, the position of these lower teeth is virtually inviolate – orthodontists have met with little success in attempting to expand the lower arch.

Growth at the condyles also follows "V" principle. Each individual condyle is also remodeled according to the "V" principle **(Fig. 2.8)**.

The condylar cartilage can be visualised as being situated on the inside of an ever-expanding "V" with its neck lengthened by reduction of the bone situated on the side of the 'V' away from the direction of growth.

Neurotrophic Theory of Growth (by Melvin Moss)

Interaction between nerves and other cells which initiates or control molecular modifications in other cells.

Neurotrophic functions are fundamental expression of neurocellular activitiy indicating that the nervous system is also concerned with the integrity of body structure.

These functions act homeostatistically to maintain and renew the structure and functional capacity of body parts.

Types of Neurotrophism

Depending upon target cells and tissues there are three types:
1. Neuromuscular
2. Neuroepithelial
3. Neurovisceral.

Axoplasmic Transport

Definition: It is the presumed by means of which neurotrophic substances passes by utilizing the processes of axoplasmic transport, from thin sites of origin in the neural cell body to the innervated tissues **(Fig. 2.9)**.

Neuromuscular Trophism: Muscle development: Embryonic myogenesis, in vivo and in vitro, is independent of neural innervation, and hence of trophic control. Approximately at the myoblast stage of differentiation, the neural innervation is established without which further myogenesis usually cannot continue.

Neuroepithelial trophism: According to experiments done by Frank and Karli who electrolytically destroyed the trigeminal sensory gangalion in the adult rat, the subsequent epithelial changes include lingual ulcers, a sclero-hyperplastic lesion on check, and atrophy of palatal epithelium; apparently the homeostasis of this epithelium was lost following afferent deprivation.

Neurovisceral trophism: In the orofacial region, salivary glands among other splanchocranial viscera are trophically regulated at least partially.

Question 2

What are the features of growth?

Answer

Normal features of growth and development are:
- Differential growth
- Normality
- Variability
- Timing, rate and direction.

Differential Growth

- Not all tissue systems of the body grow at the same rate. Different tissues and in term different organs grow at different sides. This process is called "differential growth"
- Neural tissue grows early completing their maturation by 6–7 years of age
- Lymphoid tissue growth is completed in late childhood and growth of general tissue accelerates at the same time
- General body tissue follows an "S"-shaped curve with a definite slowing of the rate of growth during childhood and acceleration at puberty

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- Maxilla and mandible follow the general body growth, the mandible slightly slower than maxilla initially but catches up later **(Fig. 2.10)**.

Cephalocaudal Gradient of Growth

- Represents the changes in overall body proportions during normal growth and development **(Fig. 2.11A)**
- In fetal life, at about the third month of intrauterine development, the head takes up almost 50% of the total body length. At this stage, the cranium is large relative to the face and represents more than half the total head
- In contrast, the limbs are still rudimentary and the trunk is underdeveloped. By the time of birth, the trunk and limbs have grown faster than the head and face, so that the proportion of the entire body devoted to the head has decreased to about 30%.

The overall pattern of growth thereafter follows this course, with a progressive reduction of the relative size of the head to about 12% the adult.

Thus "Cephalocaudal gradient of growth". This simply means that there is an axis of increased growth extending from the head towards the feet.

Changes in Overall Body Proportions

At 3 month of intrauterine life the human fetus is almost 50% of the total body length. For this particular time, this is normal.

- At birth the trunk and limbs, which were earlier rudimentary have grown faster than the head and therefore the proportion of head size to the rest of the body length is 25–30%. Eventually at adulthood the head size is just 13%
- Changes in proportions of craniofacial region. At birth the face and jaws are relatively underdeveloped compared to their extent in adult. The mandible which is further away from brain tends to grow more and faster than the maxilla, which is closer **(Fig. 2.11B)**
- **Normality:** Normality usually refers to that which usually expected is ordinarily seen or typical
- Normals refers to a range, standard derivation is a way of depicting spread of values around the mean.

Variability

Variability quantitatively is categorised in terms of deviations from the usual patterns which is done using standard growth charts are useful in two ways:

1. Location of an individual relative to the peer gap established
2. Growth charts can be used to follow a clue overtime to evaluate whether there is an unexpected change in greater patterns.

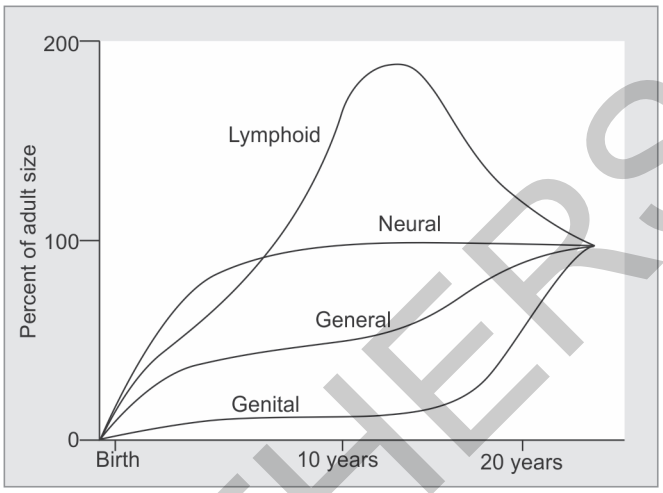


Fig. 2.10: This graph describes the growth of various tissue of body and is termed as "*Scammon's curve*"

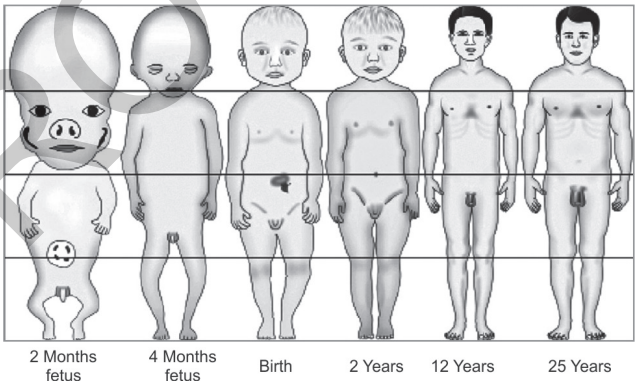


Fig. 2.11(A) Cephalocaudal Gradient in respect to whole body

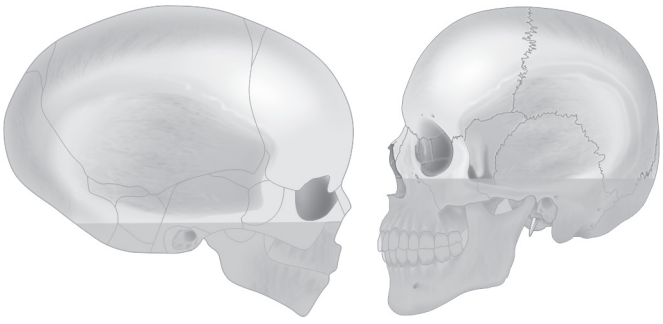


Fig. 2.11(B) Cephalocaudal gradient in respect to human skull

Growth Spurts

- Refers to sudden increase in growth of general body
- Woodside in his study of Burlington Group showed.

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	Girls	Boys
Just after birth	3 years	3 years
Juvenile growth Spurt	6–7 years	7–9 years
Pubertal growth spurt	10–12 years	12–15 years

Importance of Growth Spurts

Pubertal increments offer best time for large number of cases for the orthodontic and orthopaedic treatment. It also helps in determining the predictability, growth direction, patient management and total treatment time.

Orthopaedic correction of maxilla and mandible can be carried out.

Understanding the growth, predictability of future growth of maxilla, mandible and alveolar process helps in diagnosing and achieving excellent results of the mal-occlusion.

Growth spurts serve as excellent indicators for timing of orthodontic treatment.

SHORT ESSAYS

Question 1

Describe the methods of studying growth?

Answer

- Experimental approach
- Measurement approach.
  - Longitudinal study
  - Cross sectional study
  - Semilongitudinal study.

Longitudinal Study

These studies are carried over long period of time having the same sample.

Advantages

- Temporary temporal problems smoothen with time
- Variability in development within a group is put in proper perspective
- Serial comparison makes study of specific developmental pattern of individual possible.

Disadvantages

- Time consuming
- Expensive
- Sample loss or attrition.

Cross-Sectional Studies

These are measurements made of different samples or different individuals and studied at different periods.

Advantages

- Quicker, less expensive, statistical treatment of data is easier
- Studies can be readily repeated
- Method can be used in archaeological data.

Disadvantages

- It must be assumed that groups being measured and compared are similar
- Cross-sectional group averages tend to obscure individual variations.

Semilongitudinal Studies

Longitudinal and cross-sectional studies can be combined to seek the advantages of both in this way one might compress 15 years of study into 3 years of gathering growth data.

Implant Studies

Craniometry

- Involves measurements of skull found among human skeletal remains
- It was originally used to study the Neanderthal and Cro-magnon skull
- It can give information of extinct population and pattern of growth.

Advantages

Precise measurements can be made.

Disadvantages

All growth data must be cross sectional.

Anthropometry

- It includes measurements using soft tissue points overlying bony landmarks in living individuals
- It can also be done on dried skulls but variation in soft tissue thickness would produce different results
- Possible to follow the growth of an individual directly by making the same measurements repeatedly at different times thus producing longitudinal data.

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Cephalometric Radiography

It allows direct measurement of bony skeletal dimensions and also allows the same individual to be followed over time.

Disadvantages

- Depends upon precise orientation of head before taking radiographs
- Requires precise control of magnification
- Since, it is a 2D representation of 3D structure all measurements are not possible.

Radioisotope

- Radioisotopes of certain elements or compounds are often used as in vivo markers for studying bone growth
- Such labelled material is injected and after some time located within the growing bone by means of autoradiographic techniques.
- Commonly used markers are :
  - Technetium 99
  - Calcium 45
  - Potassium 32.

Autoradiography

In this method radioactive precursors for structural and metabolic materials are detected within tissue by coating histological sections with a nuclear track emulsion.

Localisation of radioactive disintegration reveals the location of the precursors.

The commonly used autoradiographic labels are:

- 3 H thymidine
- 3 H proline
- Bromodeoxyuridine.

Quantitative and qualitative assessment of the label uptake is a physiologic index of cell activity.

Vital Staning

- First reported by Belchier in 1796 and also by John Hunter
- They attributed their finding to alizarin dye. injection of alizarin forms a thin coloured line on all active surfaces of bone growth during the period in which the dye is in the bloodstream, hence subsequent depositions are not coloured.
- The method reveals manner in which bone is laid down, the sites of bone growth, the direction and amount of growth, and the timing and relative duration of growth at different sites
- Alizarin, tetracycline and procion are dyes which are used extensively in vital staining in bone research.

Natural Marker

- The persistence of certain developmental features has led to their use as natural markers by means of serial radiograph
- *Example*: Trabaculae, nutrient canals and lines of arrested growth can be used for reference to study deposition, resorption and remodelling.

Implant Markers Bjork devised a method of implanting tiny bits of tantalum or biologically inert alloys into growing bone which served as radiographic reference markers for serial cephalometric study. The method allows precise orientation of serial cephalograms and information on the amount and sites of bone growth.

Finite Element Modelling (FEM)

It is an analytical method for calculating stresses and strain within mechanically loaded structures by breaking the structure down into group of small elements of known mechanical behaviour so that the response of the entire structure to loading is estimated.

Question 2

What are the mechanisms of bone growth?

Answer

Mechanisms of bone growth:

- Modelling
- Remodelling
- Displacement
- Cortical drift.

Modelling

- Bone modelling involves independent sites of resorption and formation that change the size and shape of a bone
- Bone modelling is a dominant process in growth as well as in adaptation to applied loads produced with headgear rapid palatal expansion, functional appliances, etc.

Remodelling

- A process involving deposition and resorption occurring in opposite ends
- It is a process of reshaping and resizing within a growing bone as it is relocated sequentially into a succession of new areas **(Fig. 2.12)**
- It is defined as a process of adding new bone tissue on one side of a bony cortex and taking it away from the other side
- The surface facing towards the direction of progressive growth receives new bone deposition (+). The surface facing away undergoes resorption (–)
- It produces a direct growth movement of any given area of a bone.

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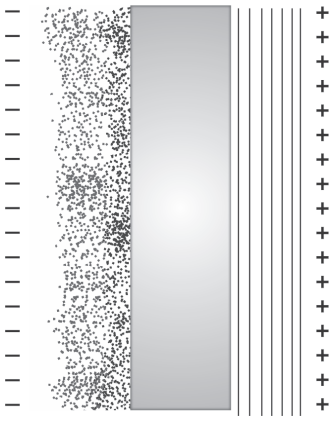


Fig. 2.12: Remodeling of bone with "-" depicting resorption and "+" depiction deposition

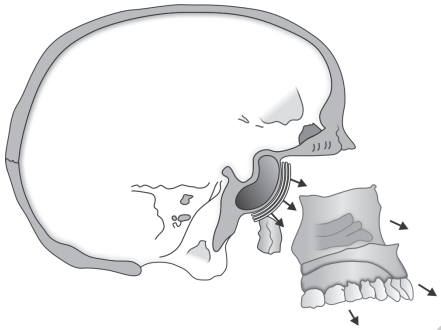


Fig. 2.13: Growth of maxilla due to displacement

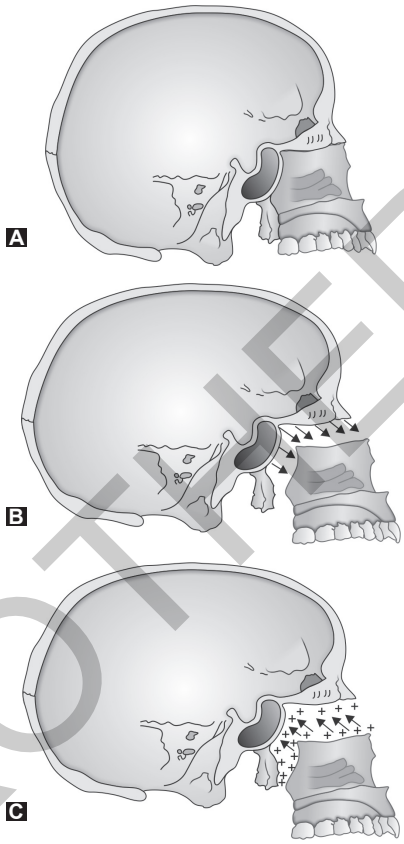


Fig. 2.14: (A) Diagram showing skull and maxilla; (B) Secondary displacement of maxilla in downward and forward direction because of bone deposition at cranial base; (C) Primary displacement of maxilla in downward and forward direction because of bone deposition on superior aspect of maxilla

Four Different Kinds of Remodelling Occur in Bone Tissues

- Biochemical remodelling, taking place at the molecular level. This involves the constant deposition and removal of ions to maintain blood calcium levels and carry out other mineral homeostasis functions
- Secondary reconstruction of bone by haversian systems and also the rebuilding of cancellous trabeculae
- Regeneration and reconstruction of bone during or following pathology and trauma
- Growth remodelling-remodelling process in facial growth.

Function of Growth Remodelling

- Progressively create the changing size of each whole bone
- Sequentially relocate each of the component regions of the whole bone to allow for overall enlargement
- Progressively shape the bone to accommodate its various functions
- Progressive fine-tune fitting of all the separate bones to each other to their contiguous, growing, functioning soft tissues; and
- Carry out continuous structural adjustments to adapt to the intrinsic and extrinsic changes in conditions.

Displacement

- Displacement is the movement of whole bone by some physical force that carries it, in toto, away from its contacts with other bones, which are also growing and increasing overall size at the same time
- This two-phase remodelling-displacement process takes place virtually simultaneously
- The displacement movement is presently believed by many researchers to be the pacemaking change with the rate and direction of the bone growth representing the transformative or secondary response **(Fig. 2.13)**
- It is of two types – primary and secondary displacement.

Primary Displacement

- As a bone enlarges, it is simultaneously carried away from other bones in direct contact with it. This creates

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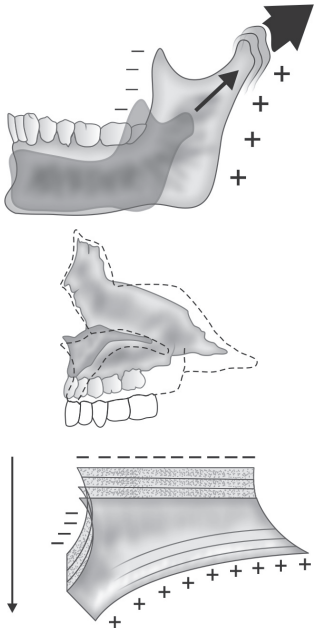


Fig. 2.15: Cortical Drift

the "space" within which bony enlargement takes place. The process is termed primary displacement (sometimes also called "translation") **(Fig. 2.14C)**

- The bone is carried away by the expansive force of all the growing soft tissues surrounding it. As this takes place, new bone is added immediately onto the contact surface, and the two separate bones thereby remain in constant articular junction
- As this takes place, new bone is added immediately onto the contact surface, and the two separate bones thereby remain in constant articular junction
- Primary displacement is associated with a bone's own enlargement, and it always takes place in the direction opposite to the vector of bone growth.

Secondary Displacement

- Secondary displacement is the movement of a whole bone caused by the separate enlargement of other bones, which may be nearby or quite distant **(Fig. 2.14B)**
- The secondary displacement is not associated with growth of the bone itself but initiated by enlargement of adjacent bones and soft structures and transferred to adjacent bones.

Cortical Drift

During the process of deposition of new bone on one surface and resorption on the surface (remodelling), the various components of the bone gets relocated to a new position with respect to a particular reference point. This process is called as Cortical Drift **(Fig. 2.15)**.

Question 3

Mechanism of bone formation or endochondral bone formation or intramembranous bone formation?

Answer

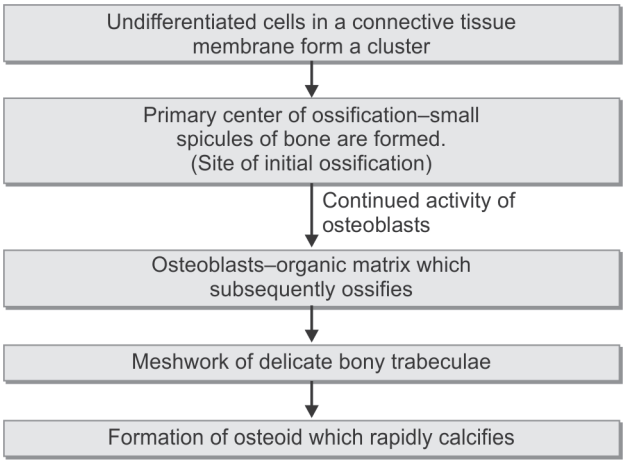
Bone formation occurs by two methods.

1. Intramembranous bone formation
2. Endochordal bone formation.

Intramembranous Bone Formation

- Occurs in areas exposed to tension **(Flowchart 2.2)**
- It differs from endochondral bone formation by formation of bone directly from mesenchymal tissues
- Seen in areas like:
  - Cranial vault
  - Maxilla
  - Mandible.

Flowchart 2.2: Intramembranous Bone Formation



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Endochondral Bone Formation

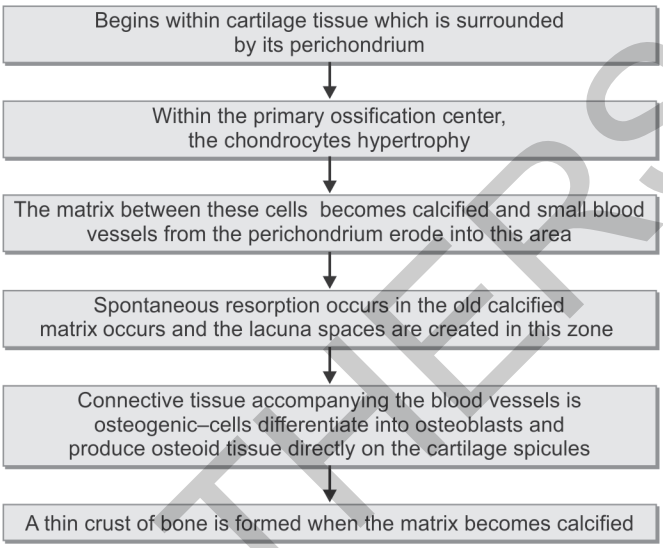
- Occurs in regions exposed to high levels of compression **(Flowchart 2.3)**
- Cartilages are of two types:
  1. Primary cartilage: Sphenooccipital synchodrosis nasal septal cartilage
  2. Secondary cartilage: Condylar, coronoid, angular.

In primary cartilages, cartilaginous matrix seems to isolate the dividing chondroblasts from local factors. In secondary cartilages local factors seem to modulate the growth rate due to absence of cartilaginous matrix.

In primary cartilage—chondroblasts divide and secrete intercellular matrix.

In secondary cartilage—prechondroblasts are the dividing cells and not surrounded by intercellular matrix.

Flowchart 2.3: Endochondral Bone Formation



SHORT NOTES

Question 1

What is Growth centre vs Growth site?

Answer

Growth Sites

- The remodelling of a bone is actually carried out by the osteogenic membranes and the surrounding tissues, rather than by the hard part of the bone
- This blanket of resorptive and depository areas surrounding the bone are called as Growth fields
- Fields that have some significant role in the growth process are often termed growth sites.

Growth Centres

- Some growth sites are called "growth centers"
- They are considered to be areas that somehow control the overall growth of the bone
- This term also implies that the "force", "energy" or "motor" for a bone resides primarily or solely within its growth centre.

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