GROWTH AND DEVELOPMENT OF MANDIBLE

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DEFINITION OF THE GROWTH

- "The self multiplication of living substance." (J.S.HUXLEY)
- "Increase in size ,change in proportion and progressive complexity."(Krogman)
- "An increase in size."(Todd)
- "Entire series of sequential anatomic and physiologic changes taking place from the beginning of prenatal life to senility."(Meridith)
- "Quantitative aspect of biologic development per unit of time."(Moyers)
- Change in any morphological parameter which is measurable."(Moss)

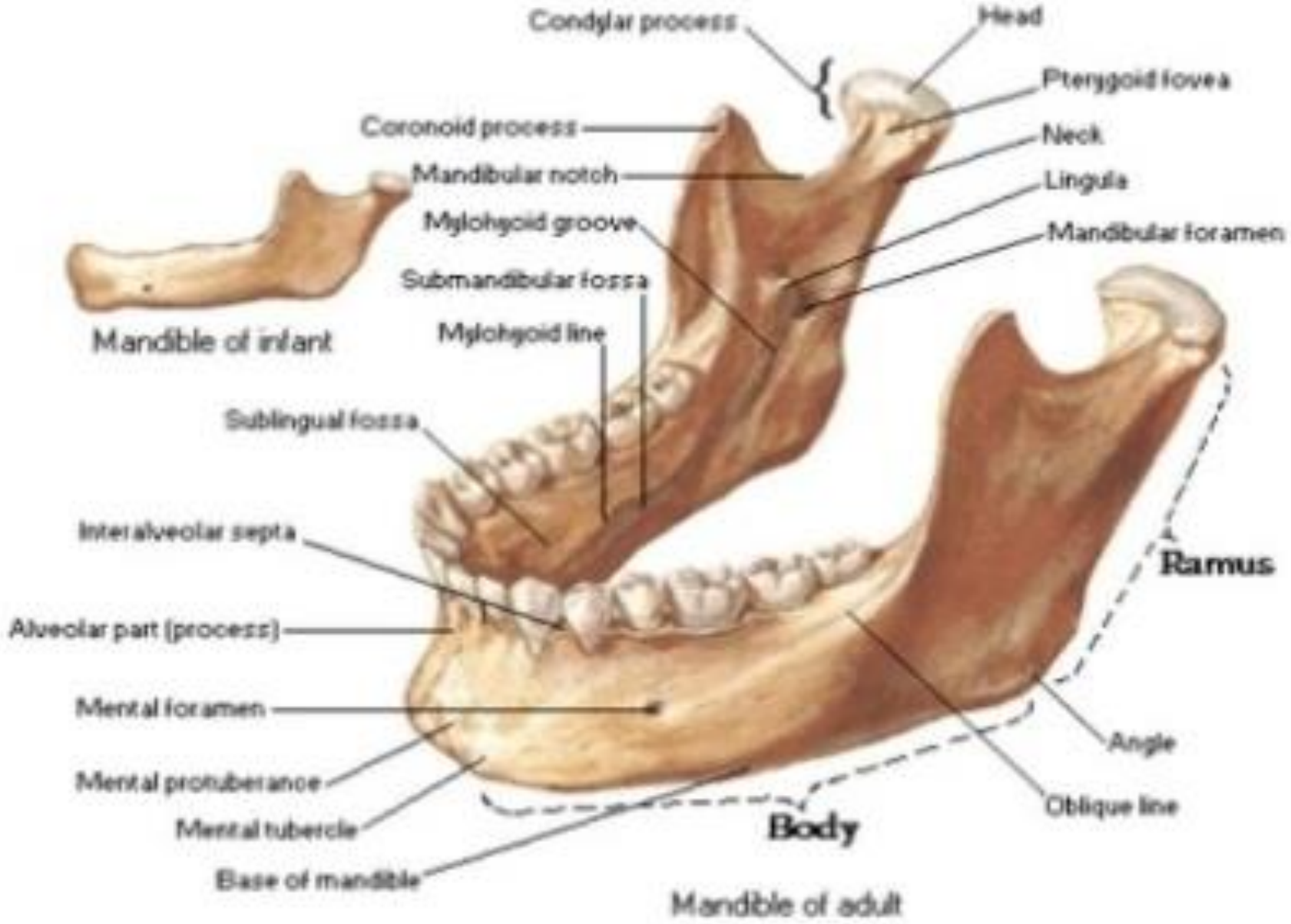
DEFINITION OF THE DEVELPOMENT

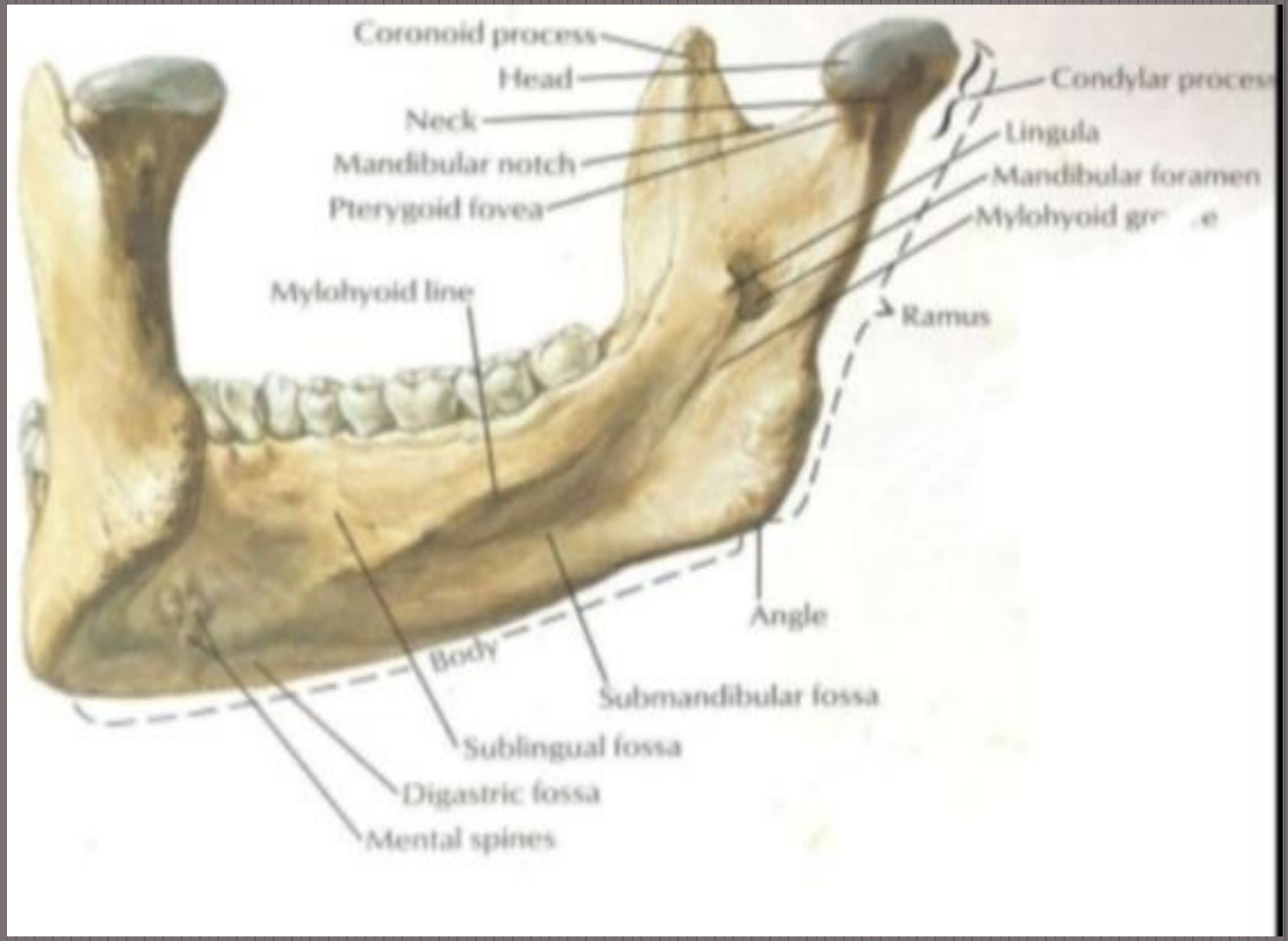
- “Development,”according to Todd,is progress towards maturity”.

- Development refers to all the naturally occuring unidirectionalchangesin the life of an individual from its existence as a single cell to its elaboration as a multifunctional unit terminating in death.

INTRODUCTION

- MANDIBLE- largest and strongest bone of the face
- Greek word ‘mandere’-to masticate /chew
- Latin word ‘mandibula’-lower jaw
- It forms the lower jaw and holds the lower teeth in place.


Condylar process
Head
Pterygoid fovea
Coronoid process
Neck
Mandibular notch
Lingula
Mylohyoid groove
Mandibular foramen
Submandibular fossa
Mylohyoid line
Mandible of infant
Sublingual fossa
Interalveolar septa
Ramus
Alveolar part (process)
Mental foramen
Angle
Mental protuberance
Oblique line
Mental tubercle
Body
Base of mandible
Mandible of adult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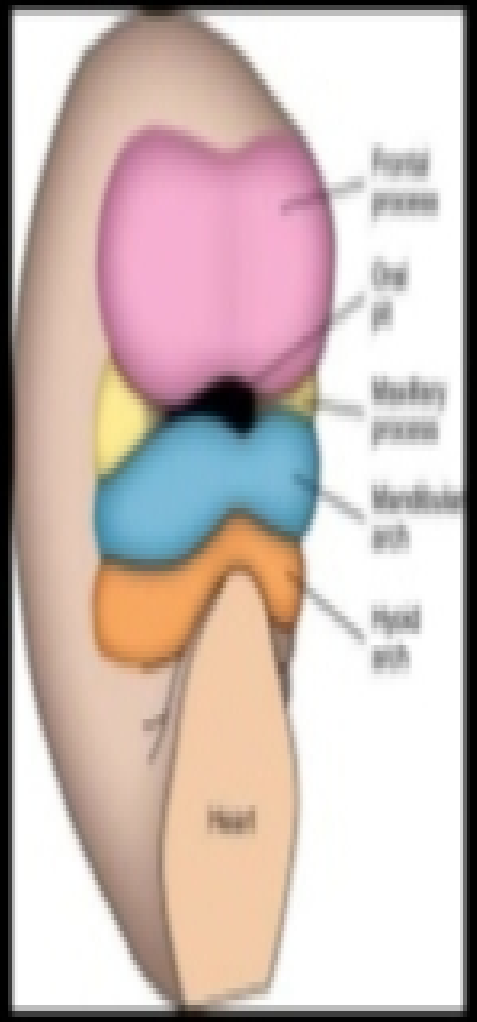
Angle
Body
Submandibular fossa
Sublingual fossa
Digastric fossa
Mental spines



PRE NATAL GROWTH

PRENATAL GROWTH AND DEVELOPMENT

INCLUDES 3 STAGES:

PERIOD OF OVUM (7-8 DAYS OF IUL)

PERIOD OF EMBRY0 (2^{ND} TO 8^{TH} WEEK IUL)

- PRESOMITE 8-20 DAYS
- SOMITE 21-31 DAYS
- POSTSOMITE 4^{TH} - 8^{TH} WEEK

PERIOD OF FETUS (3^{rd} -10^{th} LUNAR MONTH)

PERIOD OF OVUM

FERTILIZATION –AMPULAL OF UTERINE WALL

↓

ZYGOTE

↓ mitosis

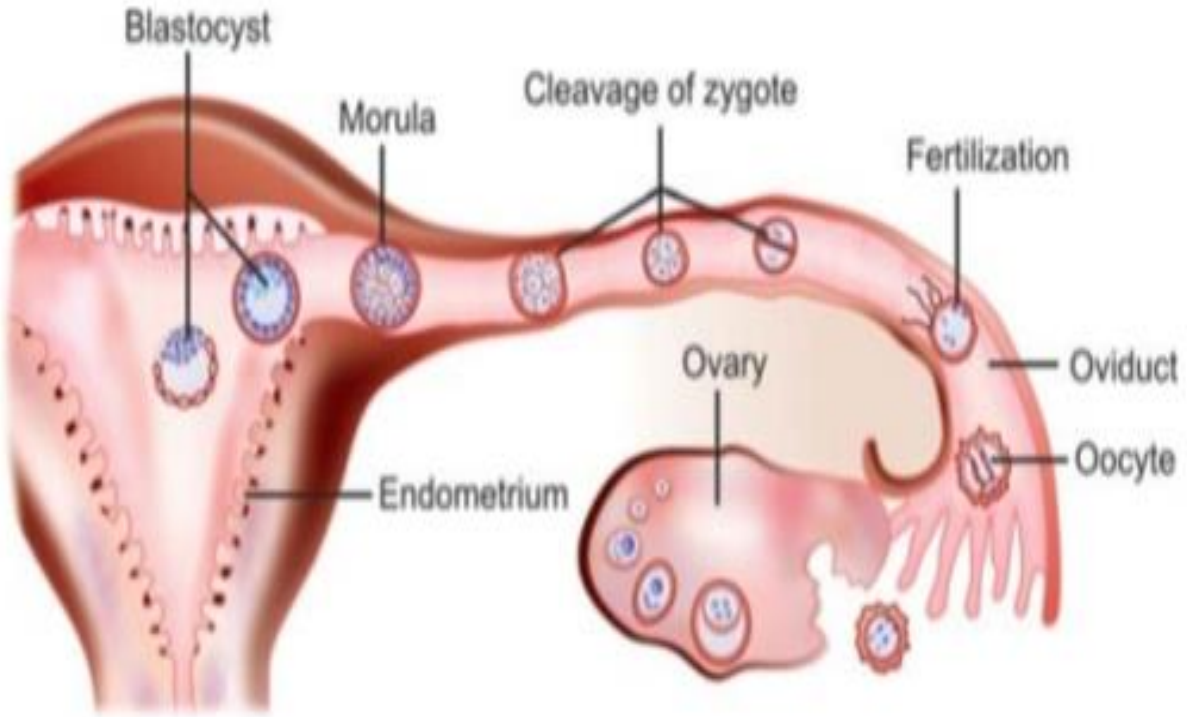
CLUSTERS OF CELLS (BLASTOMERE)

↓ mitosis

MORULA(16 CELL STRUCTURE)

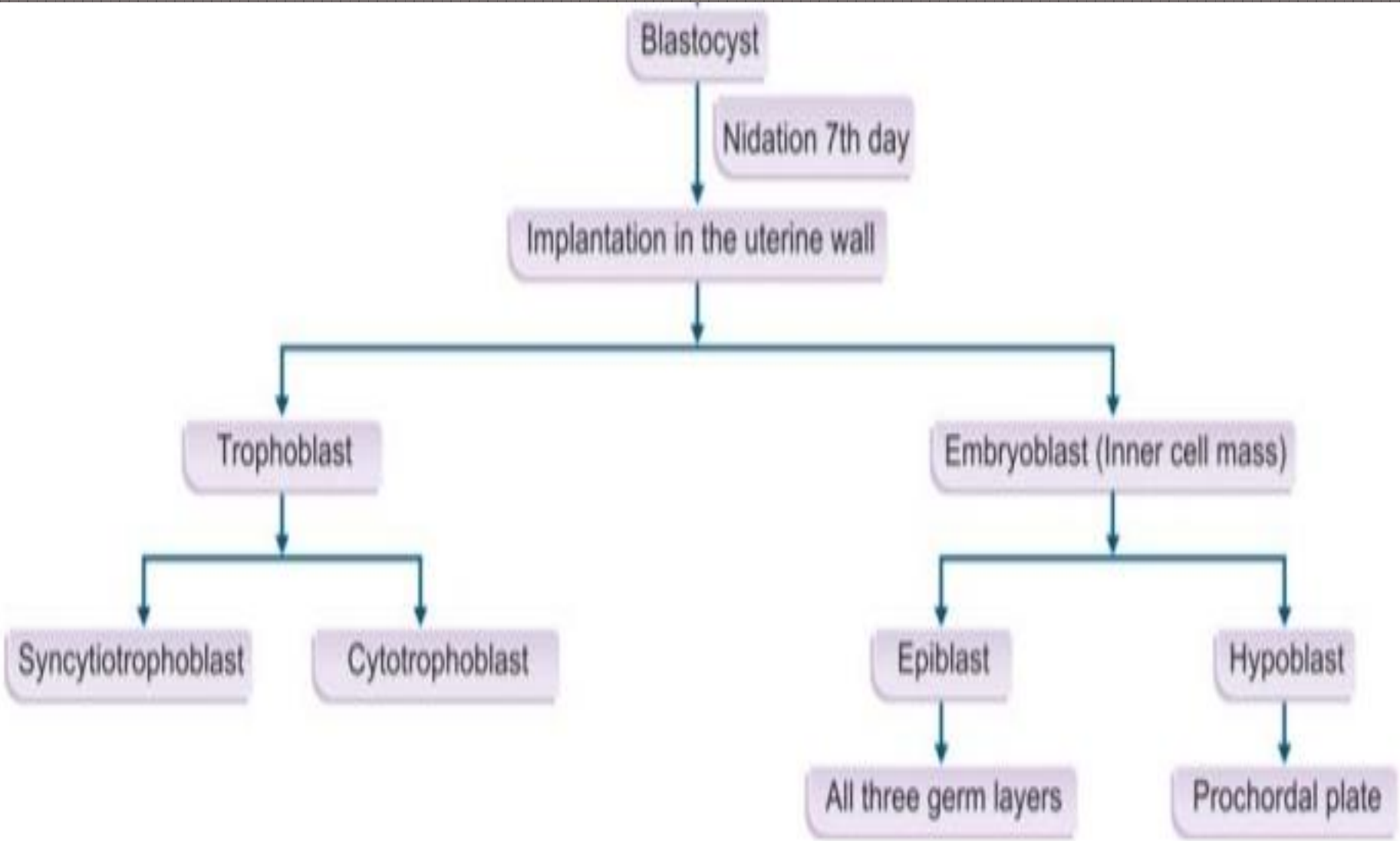
↓

BLASTOCYST



: The stages of development of blastocyst as the fertilized ovum traverses through the fallopian tube

PERIOD OF EMBRYO



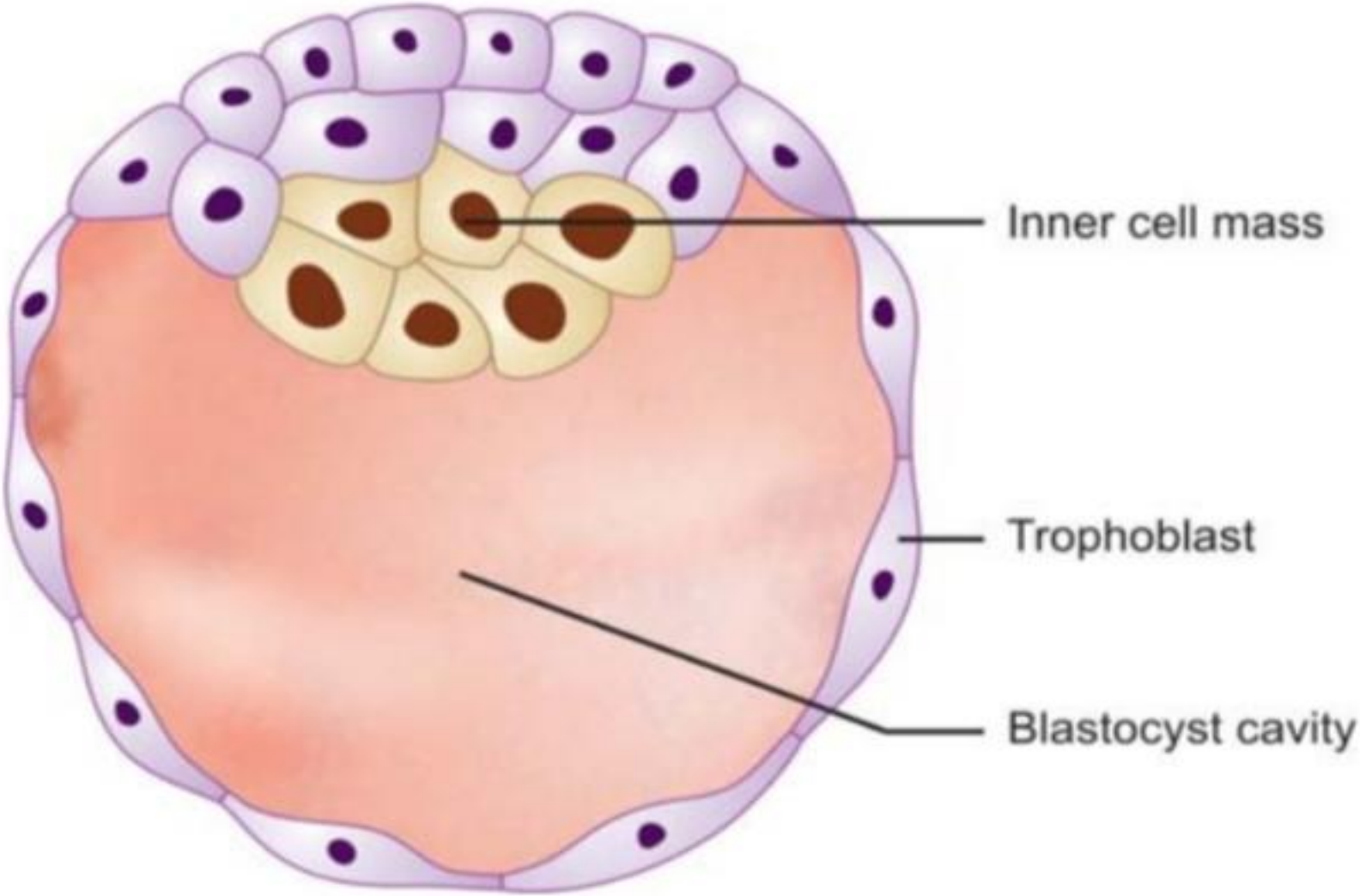


Fig. 3.2: The blastocyst with the embryoblast and trophoblastic layer. Blastocystic cavity is seen within the trophoblastic layer

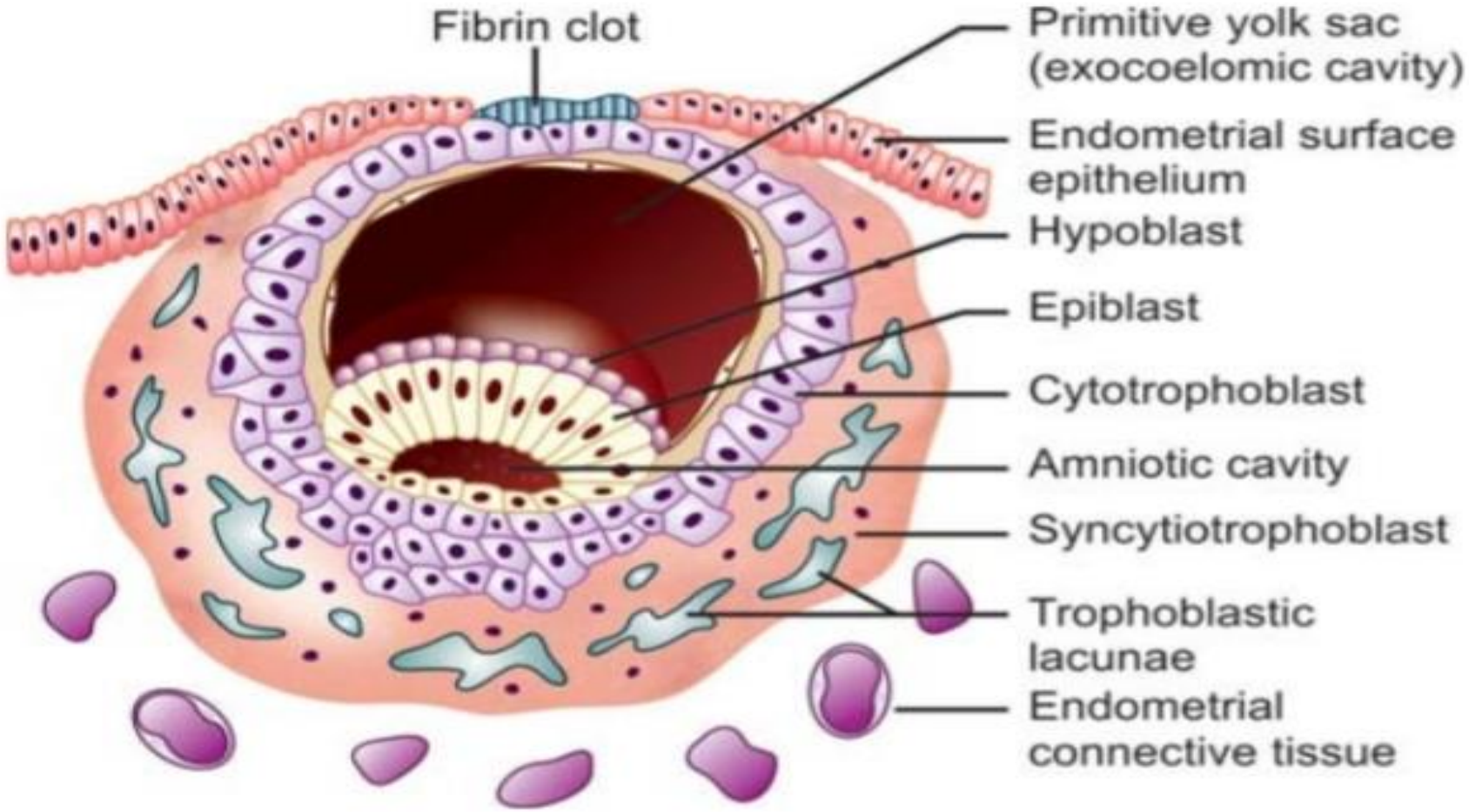


Fig. 3.3: The blastocyst with amniotic cavity developed. Inner cell mass has differentiated into epiblast and hypoblast layers. Syncytiotrophoblast and cytotrophoblast layers are seen. The inner cell mass is a bilaminar disk made of epiblast and hypoblast

PRESOMITE PERIOD

- Trophoblastic layer differenciate into synctiotrophoblast and cytotrophoblast layers

- Synctiotrophoblast-Outer cells that invades endometrium and its vessels to establish maternal blood circulation to developing embryo-Uteroplacental circulation.

INNNER CELL MASS

- Differentiates into HYPOBLAST AND EPIBLAST
- BLASTOCYSTIC CAVITY is now called PRIMITIVE YOLK SAC
- AMNIOTIC CAVITY develops between epiblast and cytotrophoblast

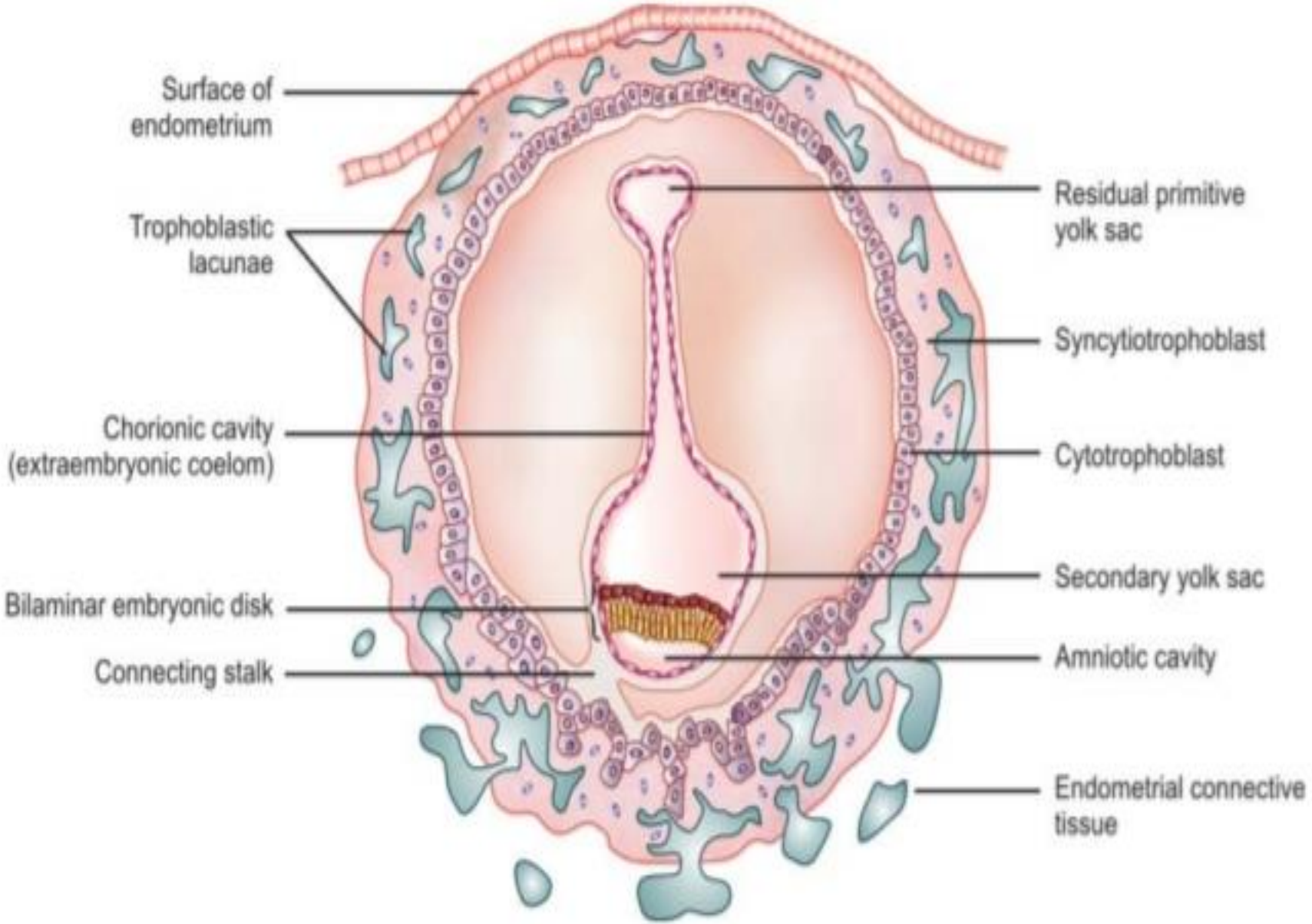


Fig. 3.4: Formation of secondary yolk sac in the bilaminar embryonic disk (13 days after fertilization)

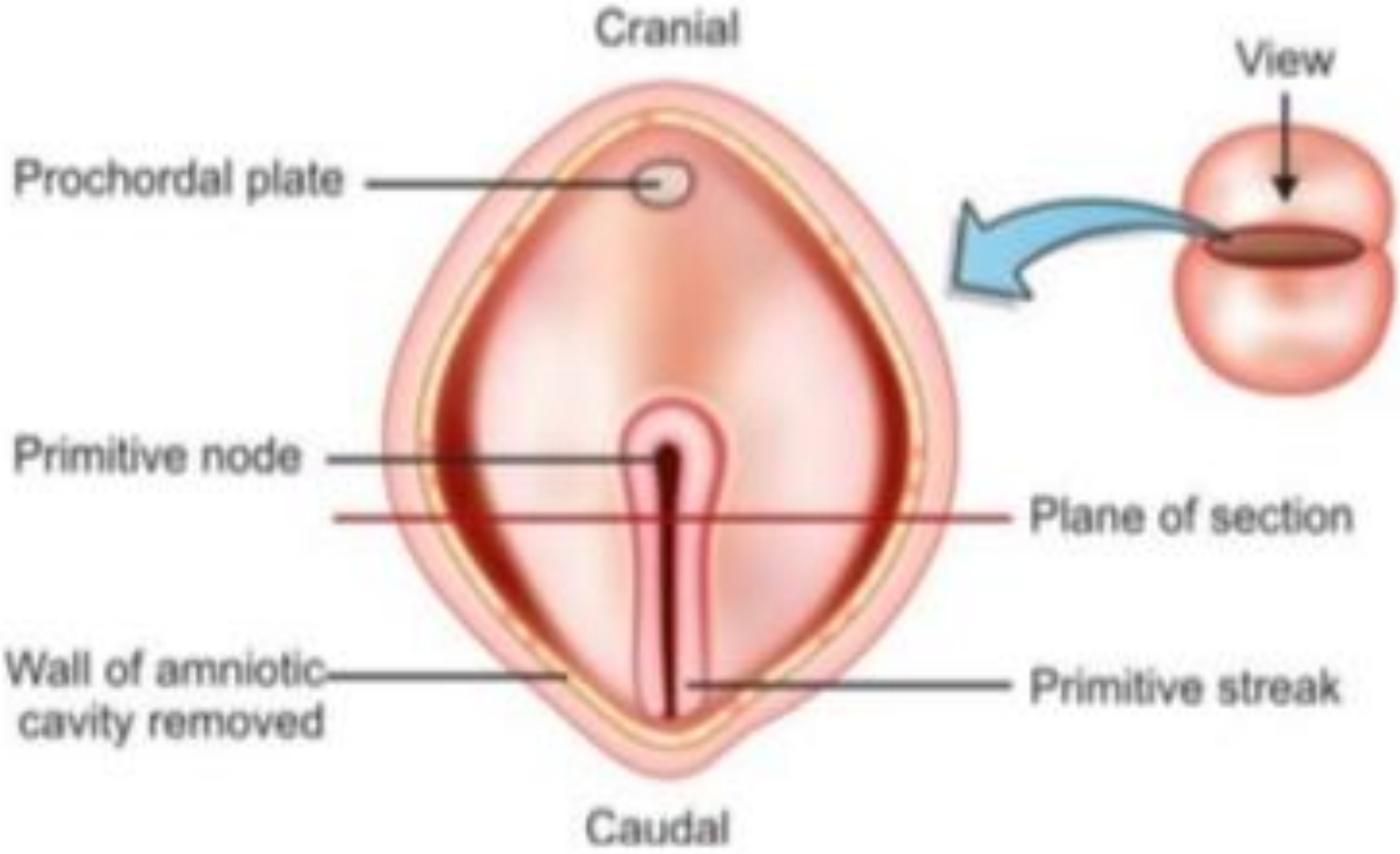


Fig. 3.5: Formation of primitive streak. Note the expansion of cranial end of the streak to form primitive node

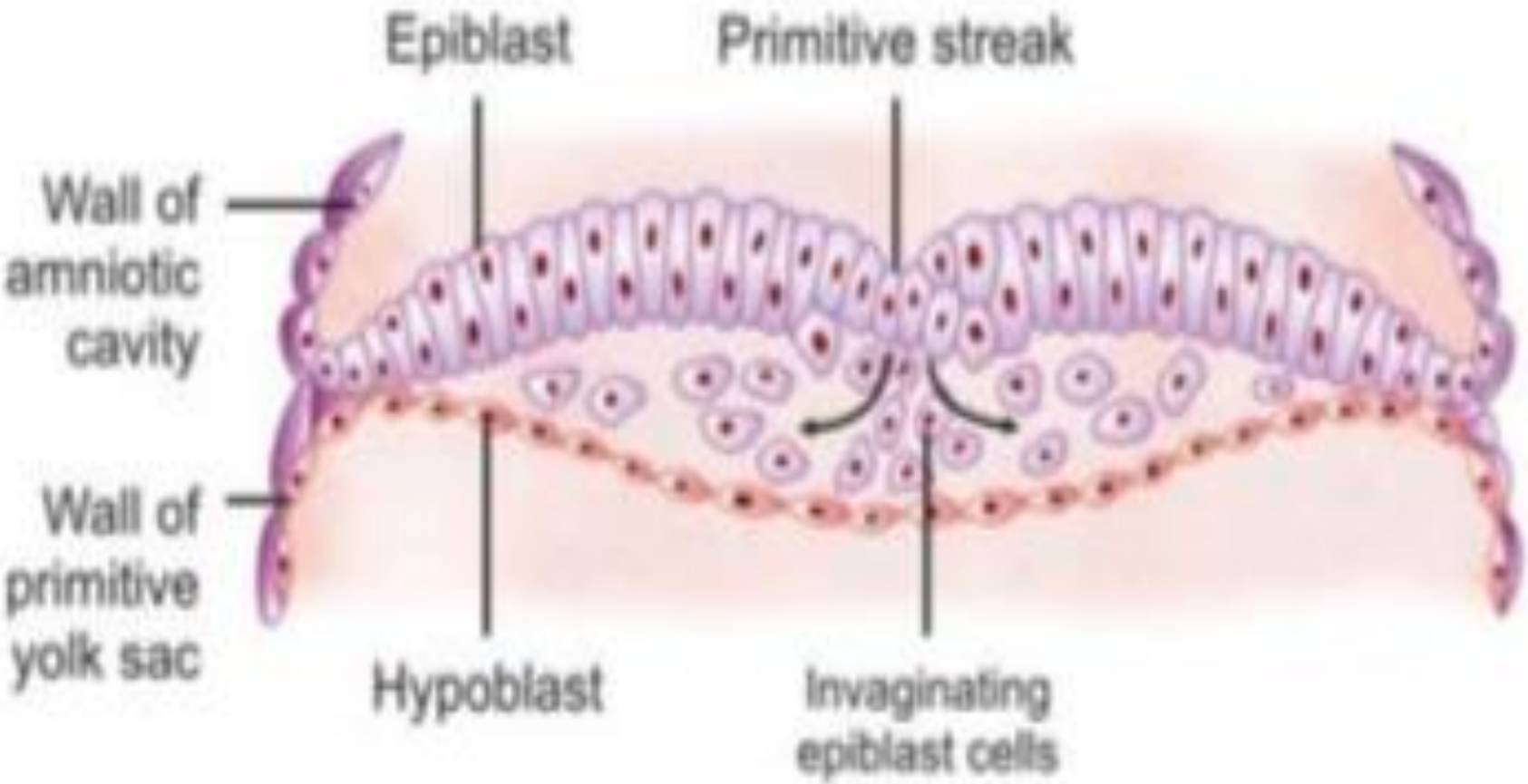
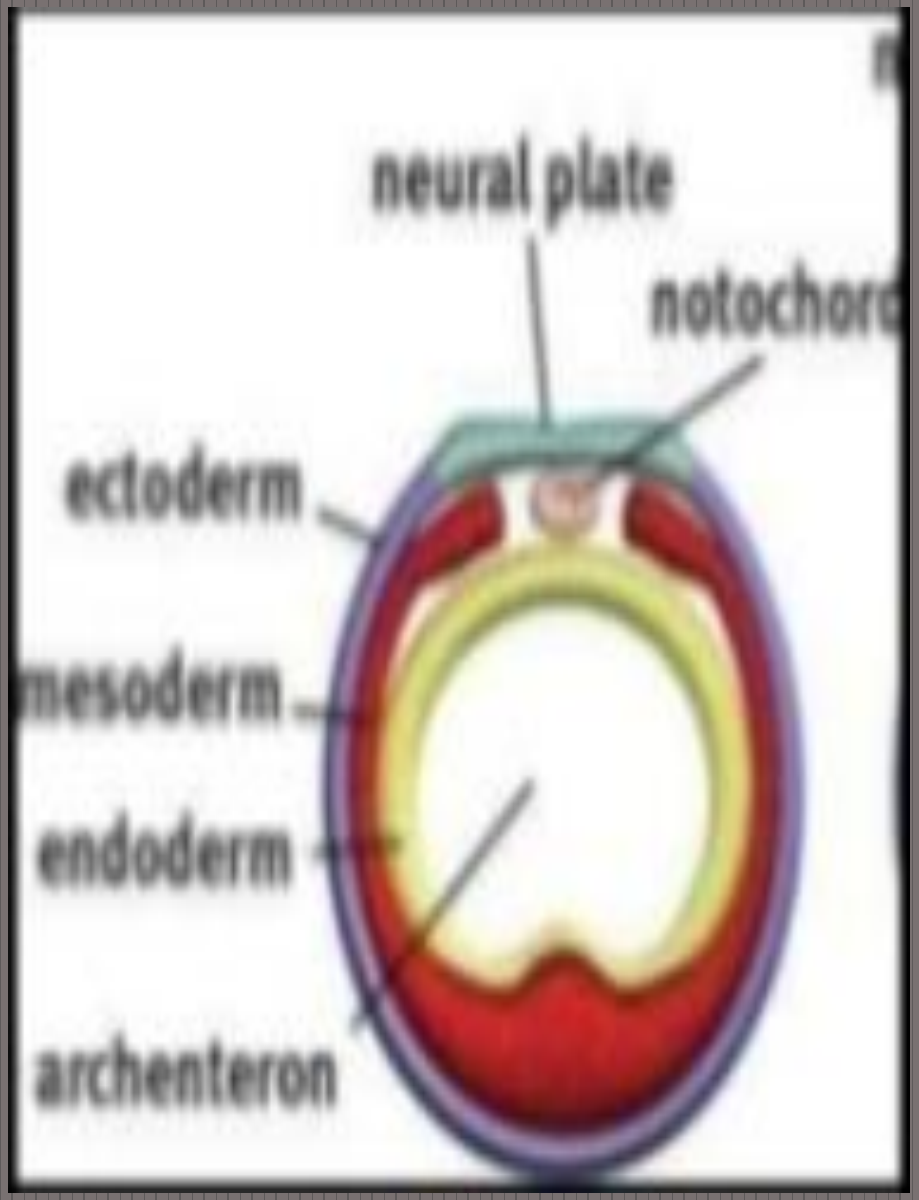


Fig. 3.6: Differentiation of three germ layers from the epiblastic layer. Invagination of epiblastic cells gives rise to endoderm

- Cells of primitive streak grow cranially to reach the prochordal plate to form notochord which is a solid cylinder of cells,axial skeleton of fetus forms around notochord.



NEURAL TUBE FORMATION

Ectoderm above notochord thickens

↓

neural plate

↓

Midline of neural plate deepens

↓

Neural groove

↓

Neural folds grow towards each other

fuse to form NEURAL TUBE -CNS

↓

Edged of neural tube on either side-NEURAL CREST

↓

Anterior end of NEURAL TUBE-fore ,mid,hind brain

↓

certain elevations called RHOMBOMERESin areas of hind brain –cells that proliferates from neural crests.

Somite period

- Rapid growth of cranial emnd of embryo,caudal end legs behind –CEPHALOCAUDAL GRADIENT OF GROWTH.

BRANCHIAL /PHARYNGEAL ARCHES

In specific areas,the migrating and rapidly proliferating ectomesenchyme cells develops elevations between ectoderm and endoderm

4th week of IUL

↓

Elevations seen in ventral foregut

↓

Formation of 6 pharyngeal arches

↓ (bilaterally)

5th arch perishes

↓

finally 5 arches remain

BRANCHIAL ARCHES

Seperated externally by small clefts called BRANCHIAL GROOVES(ectodermal clefts)-4 in number

On the inner aspect of pharyngeal wall are corresponding small depressions called PHARYNGEAL POUCHES-5 in number

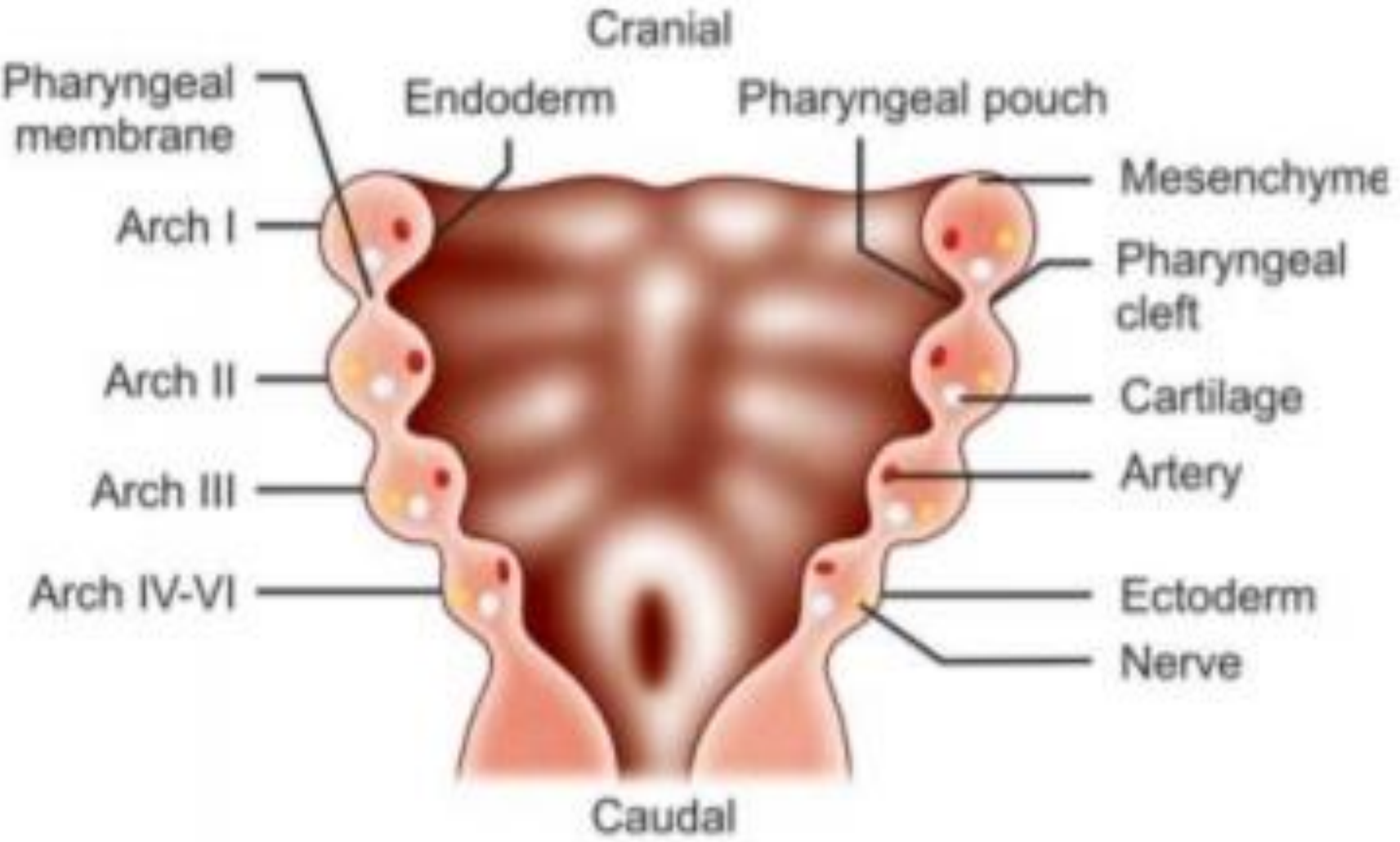


Fig. 3.8: Branchial arches. Pharyngeal pouch on the endodermal side and branchial groove on the ectodermal side are evident

Table 3.1: Branchial arch elements

S.No.	Branchial arch element	Derived from
1.	Cartilage	Neural crest derivative organized by pharyngeal endoderm
2.	Branchimeric muscle component	Lateral plate mesoderm
3.	Muscles	Mesoderm core
4.	Blood vascular system	Lateral plate mesoderm

Table 3.2: Derivatives of branchial arches

S.No.	Arch	Skeleton	Muscle	Nerve	Blood vessel	Pharyngeal pouch
1.	First mandibular	Meckel's cartilage, maxilla, secondary palate, mandible, incus, malleus, anterior malleolar ligament, spheno-mandibular ligament, spine of sphenoid	Muscles of mastication, mylohyoid, anterior belly of digastric, tensor tympani, tensor palatini	Mandibular division of trigeminal nerve (V cranial nerve)	Maxillary artery and part of external carotid artery	Tubotympanic recess forming auditory tube and middle ear cavity
2.	Second hyoid	Riechert's cartilage, styloid process, stapes, smaller (lesser) horn) and superior part of body of sphenoid bone, stylohyoid ligament	Muscles of facial expression, stylohyoid, stapedius, posterior belly of digastric	Facial nerve (VII cranial nerve)	Stapedial artery probably later contributes to facial artery	Tonsillar fossa and palatine tonsil
3.	Third	Greater horn and lower part of body of hyoid bone	Stylopharyngeus	Glossopharyngeal nerve	Internal carotid artery	Inferior parathyroid, thymus
4.	Fourth	Thyroid cartilage, laryngeal cartilages	Constrictors of pharynx, cricothyroid, palatoglossus	Superior laryngeal nerve, pharyngeal plexus	Arch of aorta, right subclavian artery	Superior parathyroid
5.	Sixth	Laryngeal cartilages	Laryngeal muscles	Inferior laryngeal	Pulmonary	—

DEVELOPMENT OF MANDIBLE

- Develops from the mandibular processes of 1 st branchial arch
- The cartilage of the 1st arch(meckel's cartilage)forms lower jaw in the primitive vertebrates
- In human beings meckel's cartilage has close positional relationship to the the developing mandible but makes no contribution to it.
- The mandibular nerve has close relationship to the meckel's cartilage,beginning two third on the way along the length of cartilage
- At this point mandibular nerve divides into lingual and inferior alveolar branches.

At around 36-38 days of IUL there is ectomesenchymal condensation

↓

Some mesenchymal cell enlarges,acquire abasophilic cytoplasm and form osteoblasts

↓

Osteoblast secrete a gelation matrix called osteoid and result in ossification of osteogenic membrane

↓

The resulting intramembranous bone lies lateral to meckels cartilage of mandibular arch

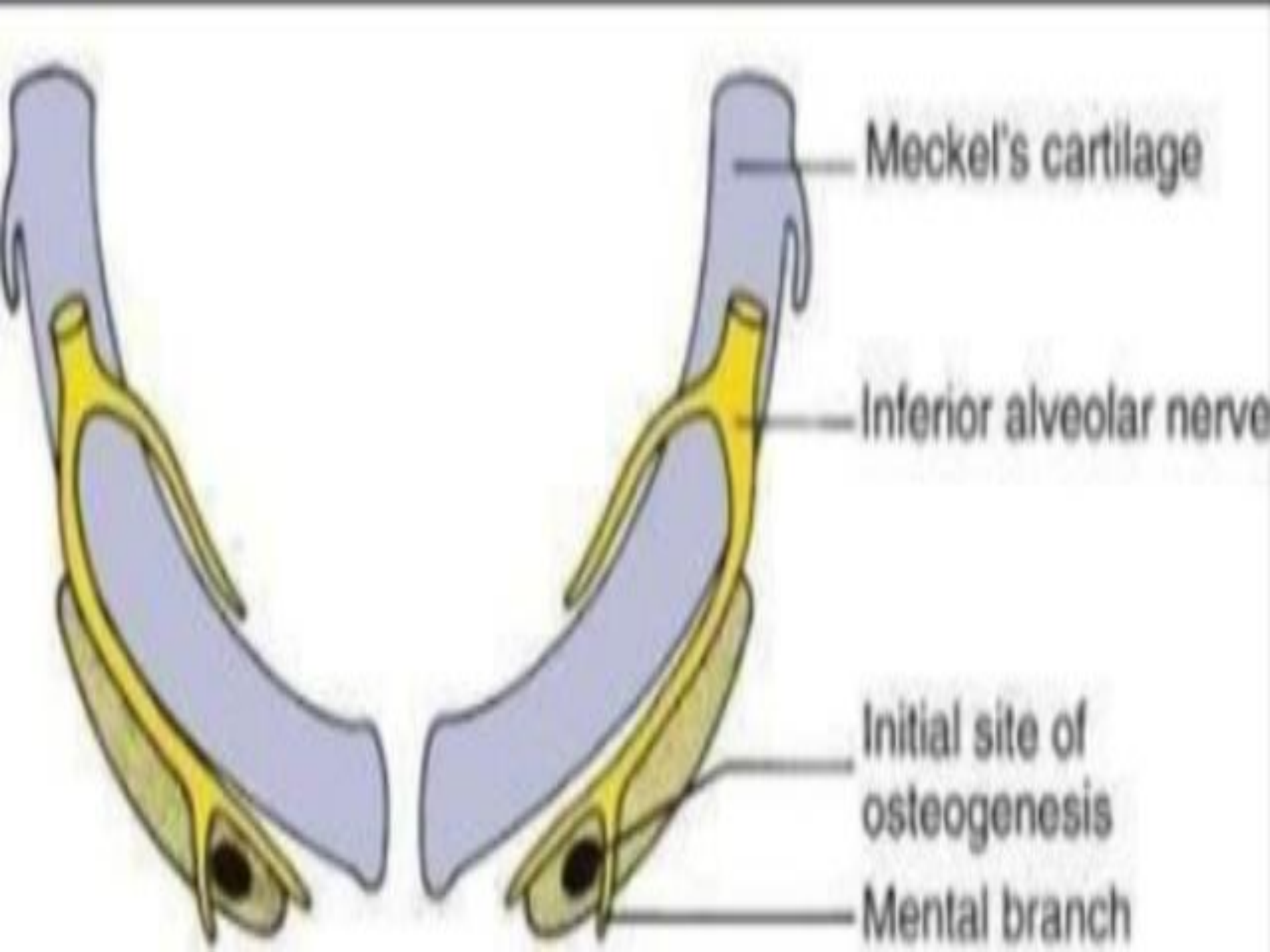
In sixth week,a single ossification centre for each half arises in the bifurcation of inferior alveolar nerve into mental and incisive

↓

7^{th} week bone begin to develop lateral to meckels cartilage and continues until the posterior aspect is covered with bone

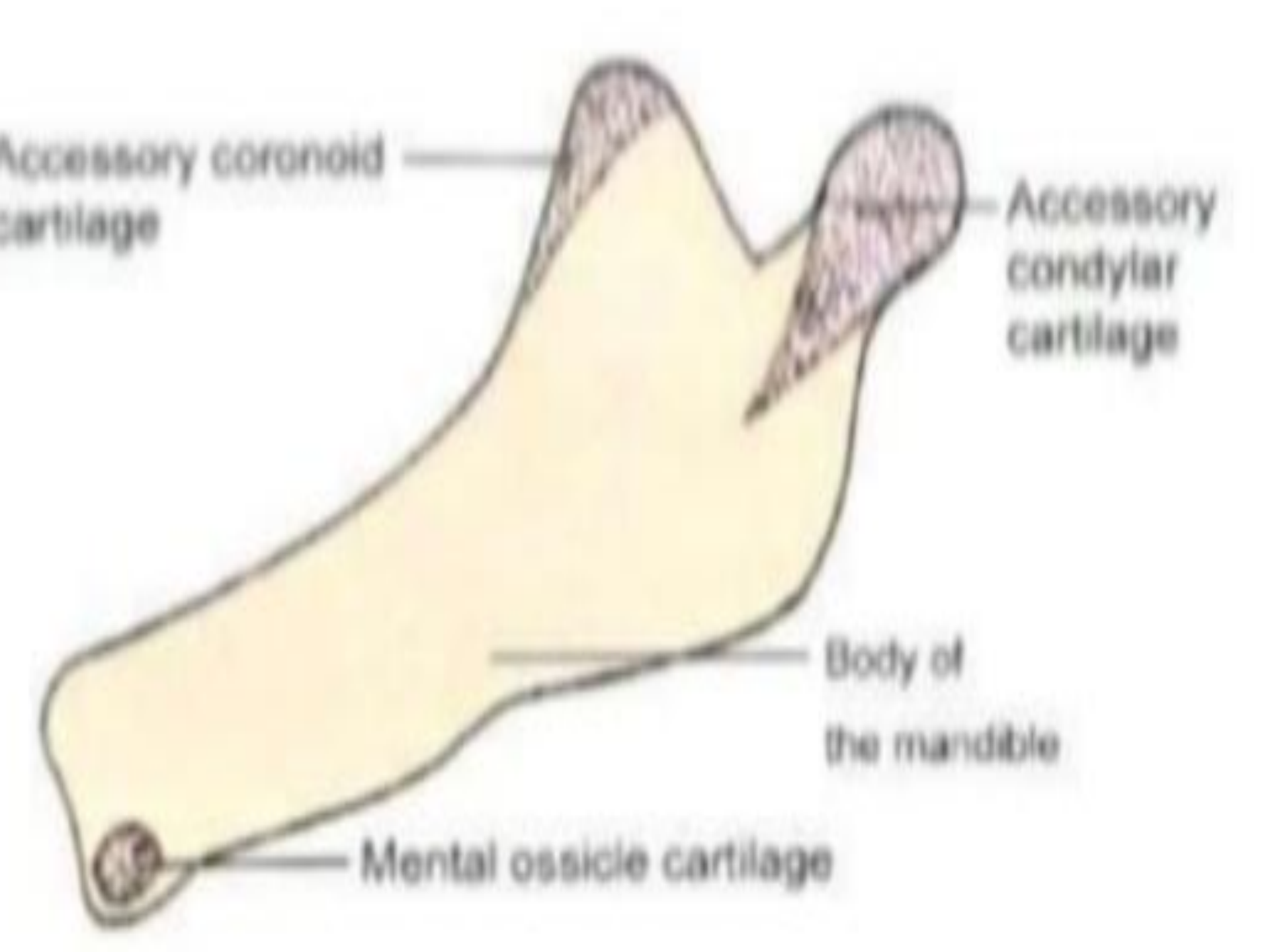
↓

Between 8^{th} 12^{th} week ,mandibular growth accelerate ,as a result mandibular length increases


Meckel's cartilage
Inferior alveolar nerve
Initial site of osteogenesis
Mental branch

Ossification stops at apoint ,which later become lingula ,the remaining part of meckels cartilage continuesto form sphenomandibular ligament and spinous process of sphenoid

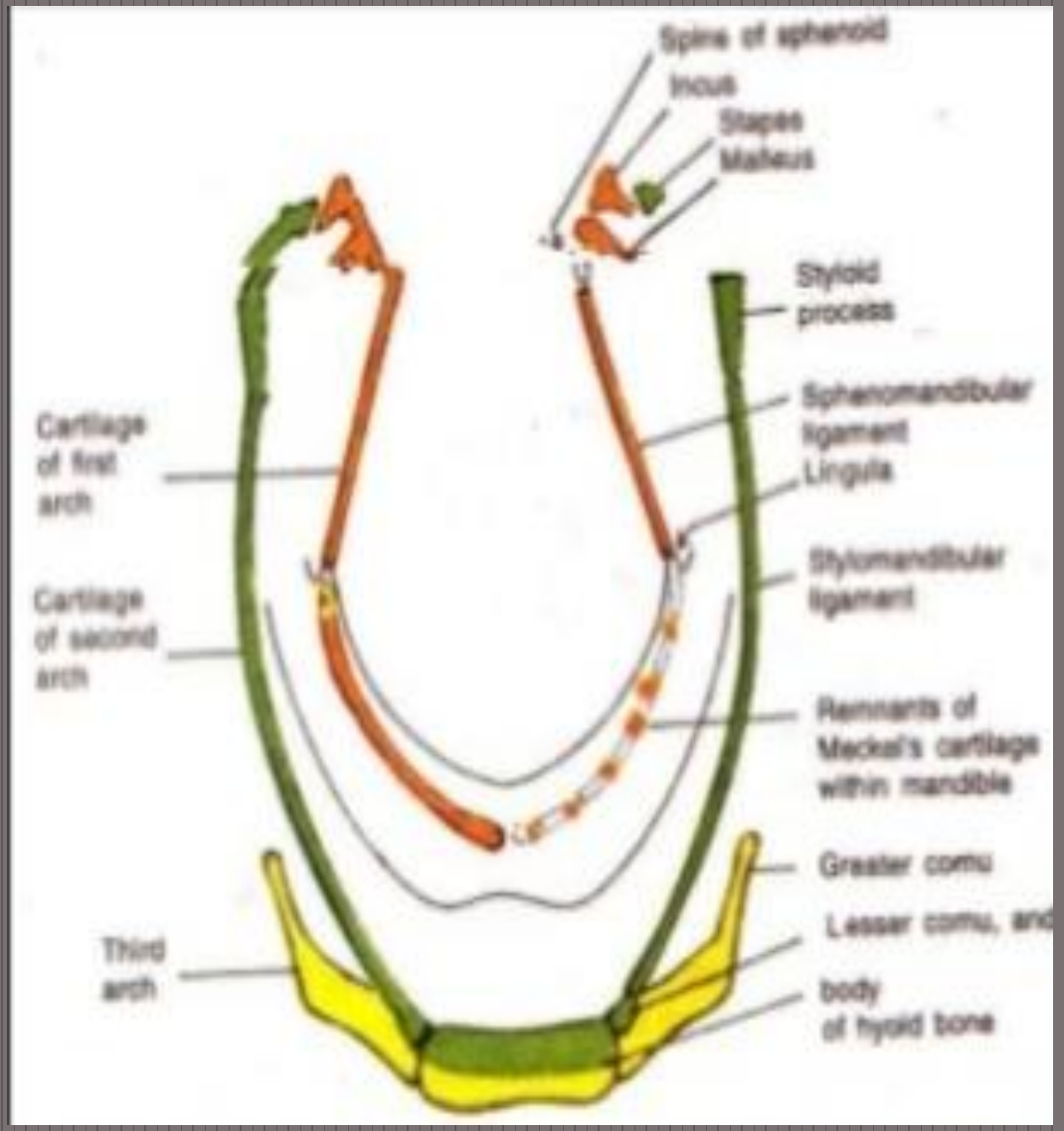
Secondary accesory cartilage appears between 10^{th} and 14^{th} week to form head of condyle,part of coronoid process and metal protruberance


Accessory coronoid cartilage
Accessory condylar cartilage
Body of the mandible
Mental ossicle cartilage

FATE OF MECKELS CARTILAGE

- Posterior extremity forms sphenomandibular ligament ,malleus and incus

- Most of the cartilage is absorbed except for some some proportion in midline which may cause endochondral ossification



Fetal period

- Endochodral bone formation seen only in 3 areas:

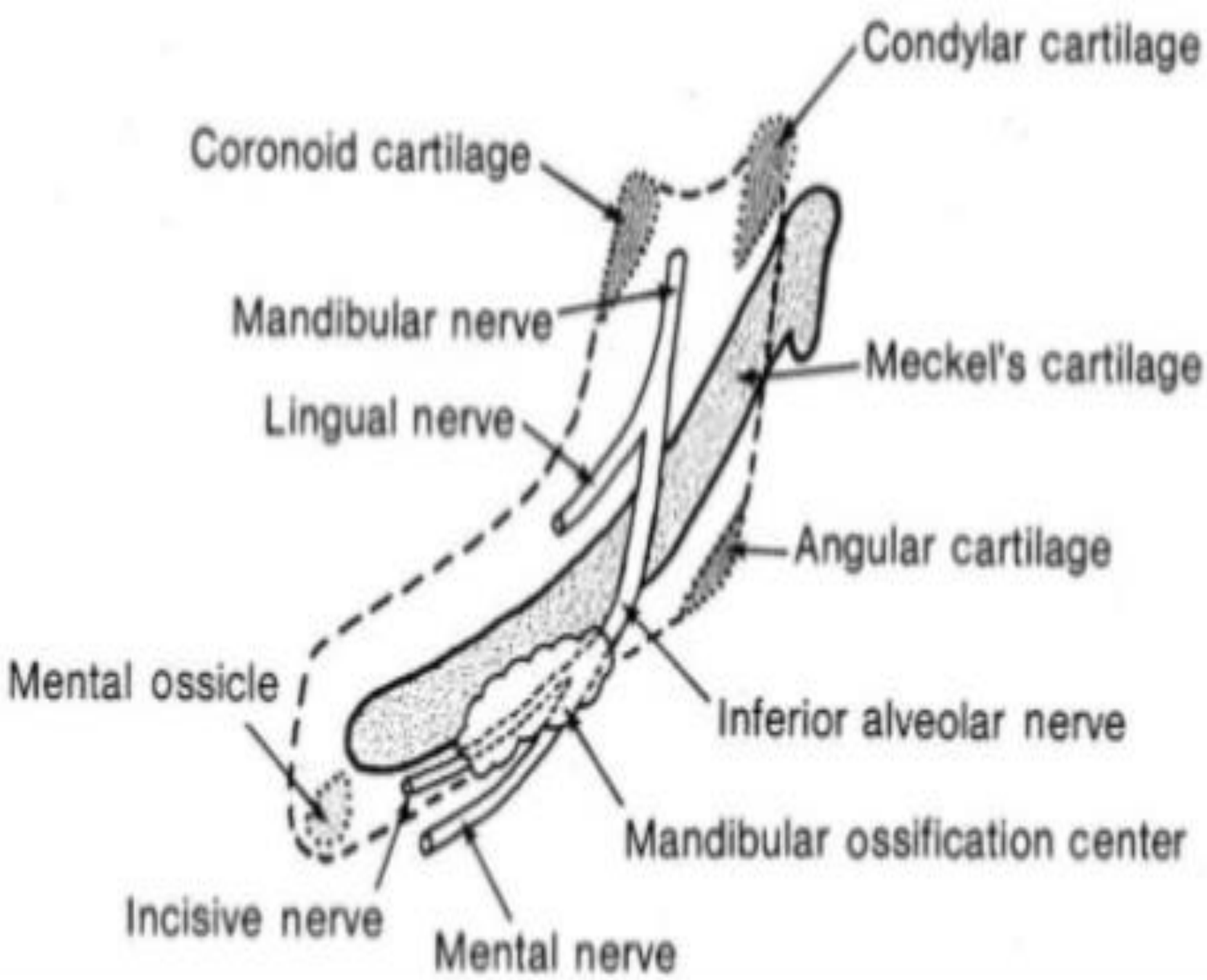
- CONDYLAR PROCESS
- CORONOID PROCESS
- MENTAL REGION

CONDYLAR PROCESS

- About 5th week of IUL area of mesenchymal condensation above the ventral part of developing mandible
- About 10th week develops into cone shaped cartilage
- By 14th week stars ossification
- By 4 months migrates inferiorly and fuses with ramus
- 4th month onward replaced by bone but proximal end persists into adulthood acting as growth cartilage and articular cartilage
- Condylar head seperated from temporal bone by the disc of connective tissue –future articular disc.

CORONOID PROCESS

- By 10^{th} to 14^{th} of IUL secondary cartilage seen in region of coronoid
- This cartilage becomes incorporated into expanding inmembranous bone of ramus and disappears before birth
- MENTAL REGION
- Secondary cartilages seen on both sides –ossify by 7^{th} week IUL
- They ossify to form mental ossicles in fibrous tissue of symphysis and later on gets incorporated into it


Condylar cartilage
Coronoid cartilage
Mandibular nerve
Meckel's cartilage
Lingual nerve
Angular cartilage
Mental ossicle
Inferior alveolar nerve
Mandibular ossification center
Incisive nerve
Mental nerve

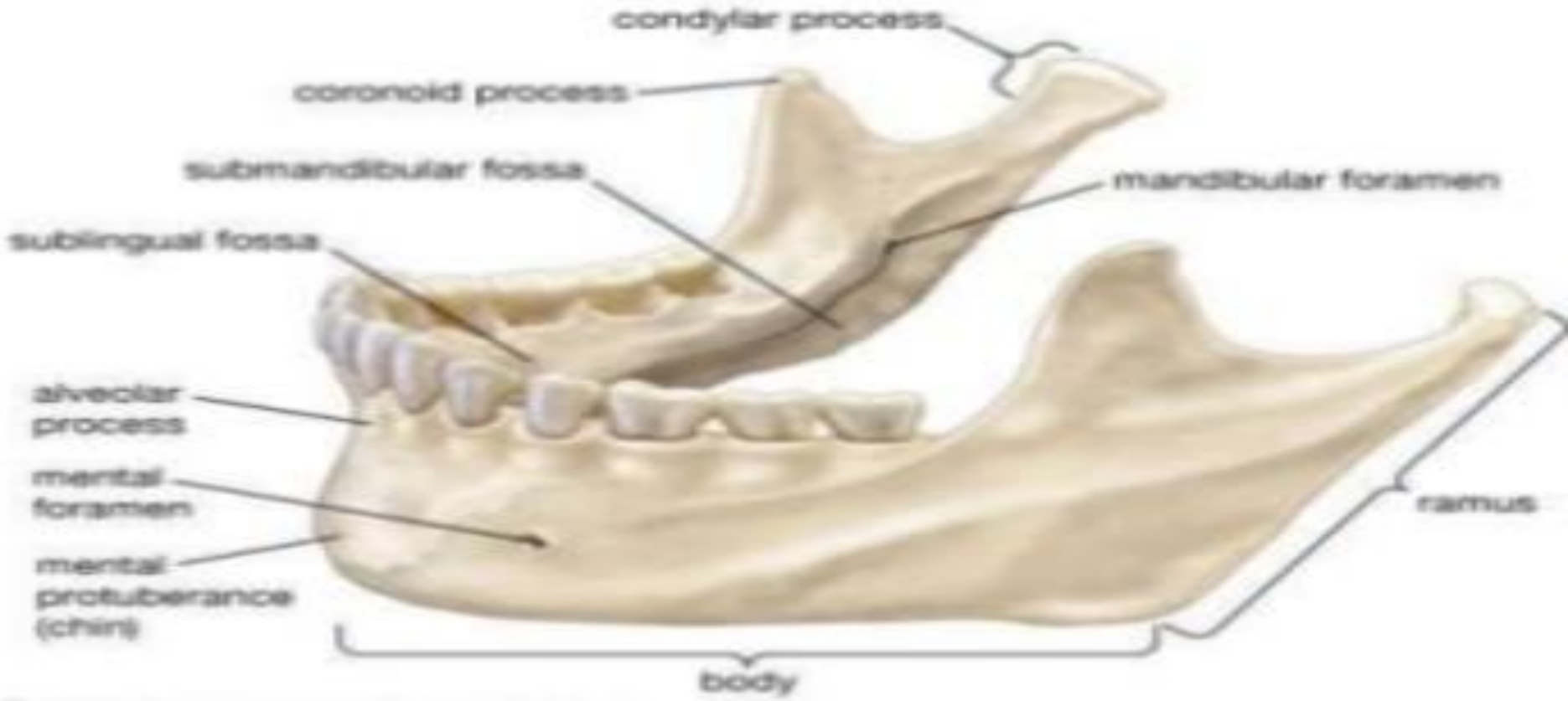
POST NATAL GROWTH OF MANDIBLE

- The shape and size of the diminutive fetal mandible undergoes considerable transformation during its growth and development.
- Some instructions of the directions of growth of the mandible can be obtained by superimposing traces of neonatal and adult mandible.
- There is some evidence ,th eregion around the mental foramen is a fixed point for such an endeavor.
- Growth of the mandible occurs by the remodeling of bone.

- At birth the two rami of the amndible are quite short.condylar development is minimal and there is practically no articular eminence in the glenoid fossa.
- A thin line of fibrocartilage and connective tissue exists at the midline of the symphysis to separate right abd the left mandibular bodies .between 4 months of ageand the end of first year,the symphyseal cartilage is replaced by bone.
- During the 1st year of life,appositional growth is especially active at the alveolar border,at the distal and the superior surfaces of the ramus, at the condyle,along the lower border of the mandibleand on its lateral surfaces.

POST NATAL GROWTH OF THE MANDIBLE

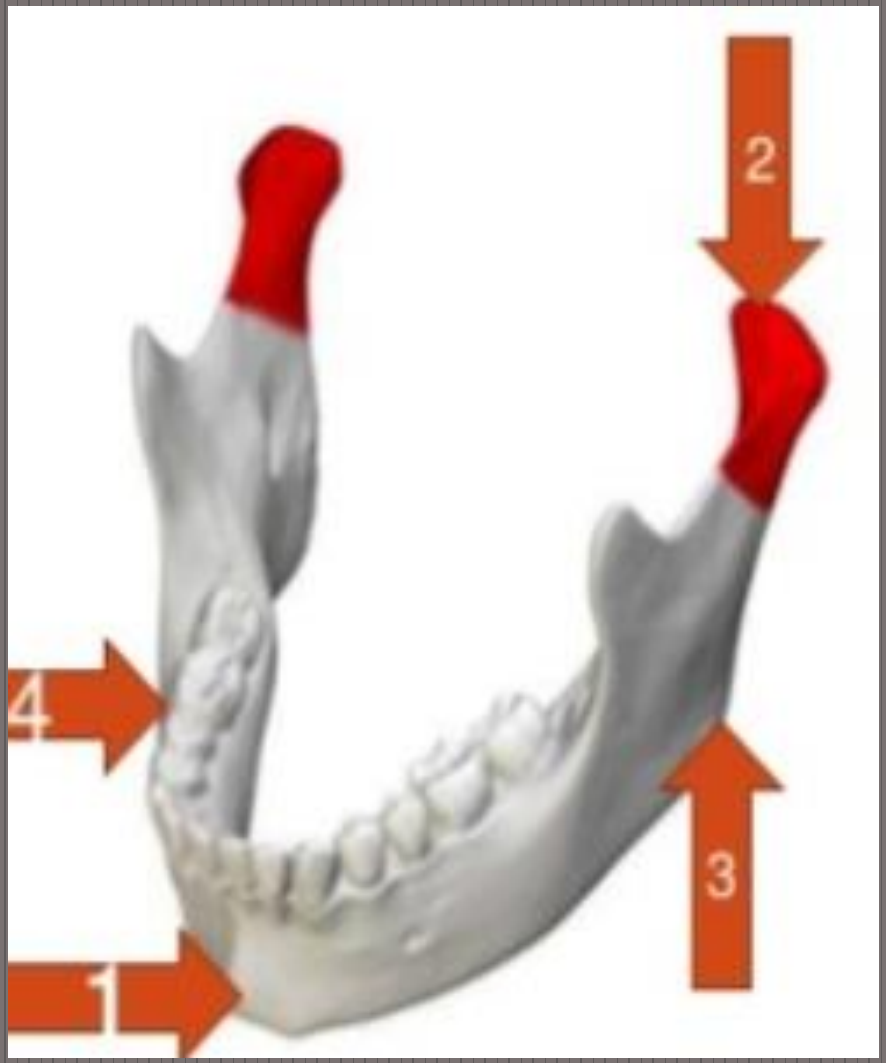
- Although the mandible appears as asingle bonein the adult, it is developmentally and functionally divisible into several skeletal subunits.



- The growth pattern of each of these skeletal subunits is influencedby a functional matrix that acts upon the bone
- 1) the teeth act as a functional matrix for the alveolar unit
- 2)the action of temporalis muscle in fluences the coronoid process
- 3)the masseter and the medial pterygoid has some influence on the condylar process
- Of all the facial bones , the mandible undergoes the most growth postnatally and evidences the greatest variation in morphology.

Growth sites in mandible

- 1)limited growth takes place at rhe symphysis
- 2)at the condylar cartilages
- 3)the posterior border of ramua
- 4)alveolar ridges



- These areas of bone deposition largely account for increase in the height , the length and the width of the mandible

- Superimposed upon this basic incremental growth are numerous regional remodelling changes that are subjected to the local functional influences involving selective resorption and the displacement of individual mandibular elements.

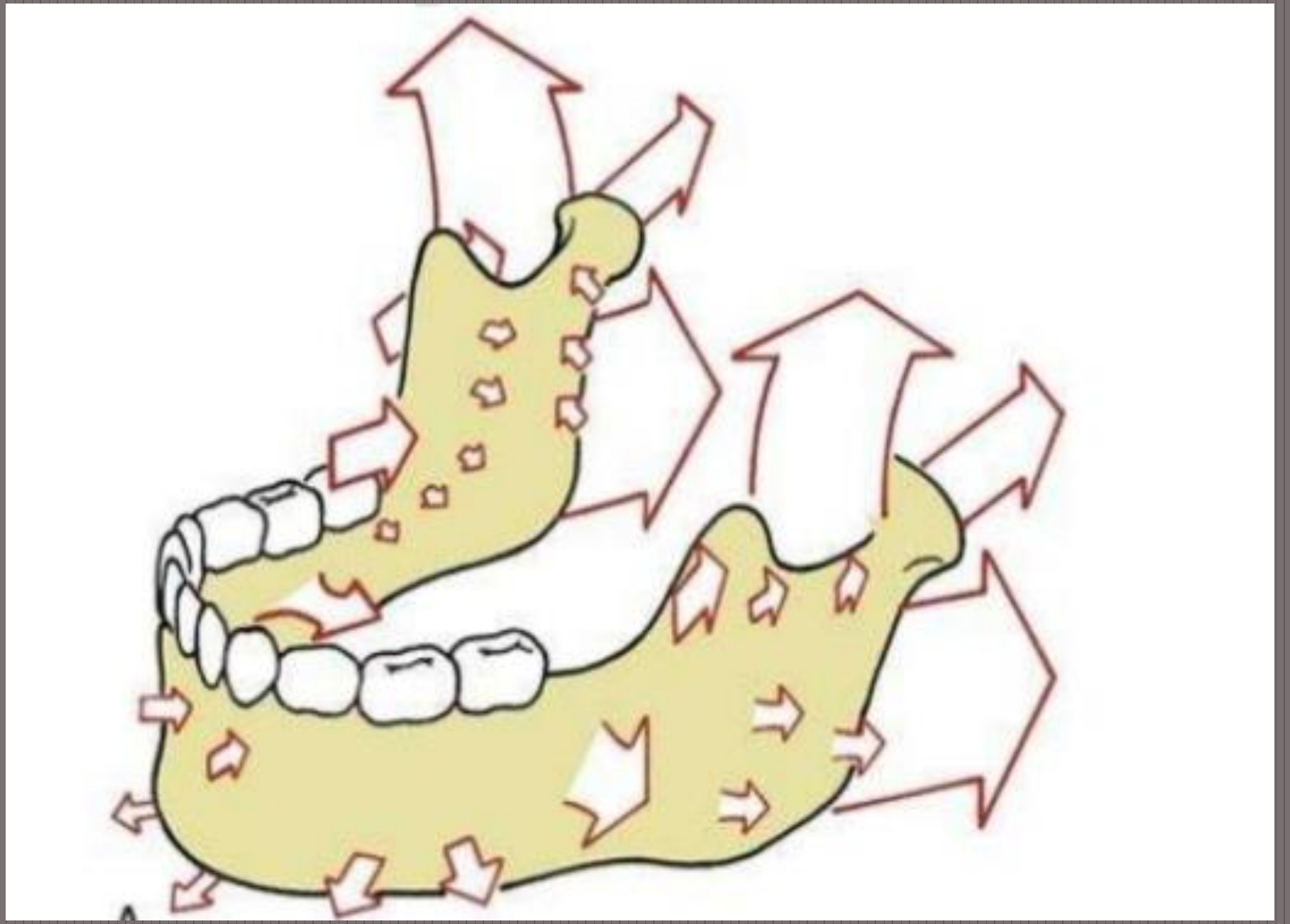
The condylar cartilage of the mandible uniquely serves as both

1)an articular cartilage in the TMJ ,characterized by afibrocartilage surface layer

2)a growth cartilage analogous to the epiphysial plate in a long bone,characterized by a deeper hypertrophying cartilage layer

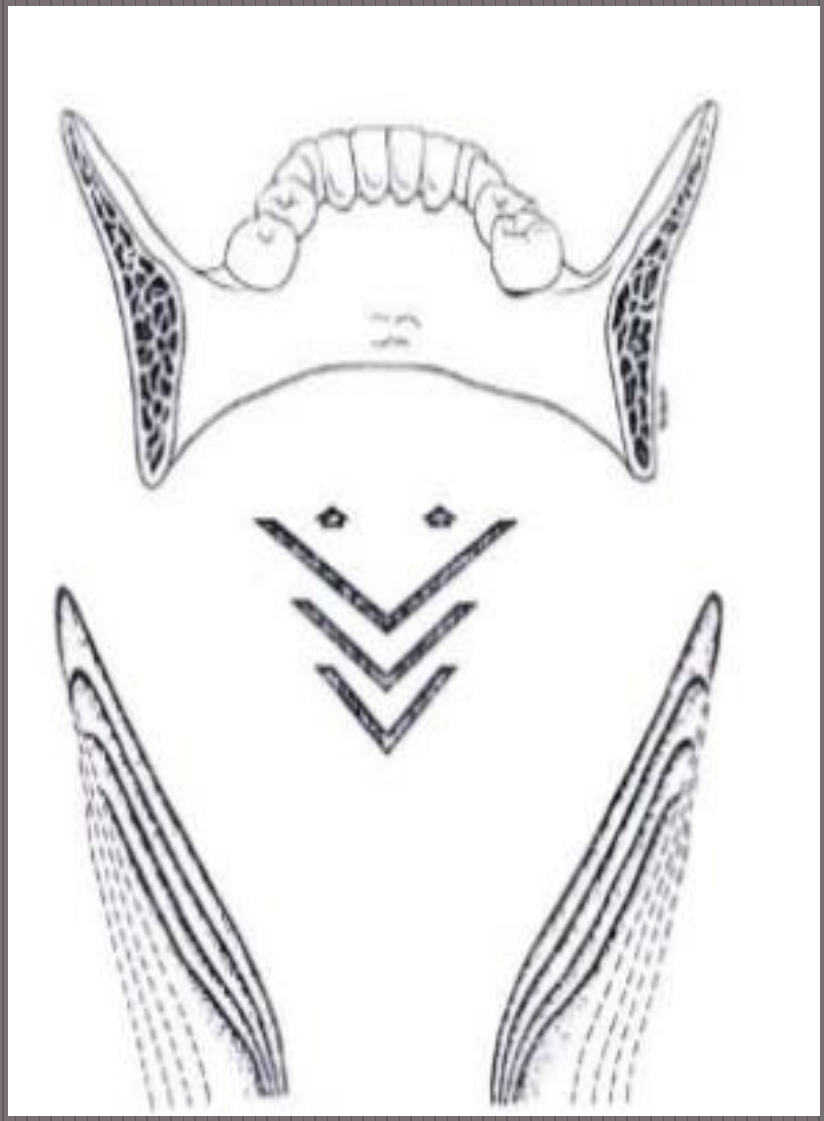
The growth cartilage may act as a functional matrix to stretch the periosteum , inducing the lengthened periosteum to form intramembranous bone beneath it.

- The formation of bone within the condylar heads causes the mandibular rami to grow upward and backward,displacing the entire mandible in an opposite downward and forward direction
- Bone resorption subjacent to the condylar head accounts for the narrowed condylar neck
- Any damage to the condylar cartilage restricts the growth potential and the normal downward and forward displacement of the mandible,unilaterally or bilaterally according to the sides damaged.

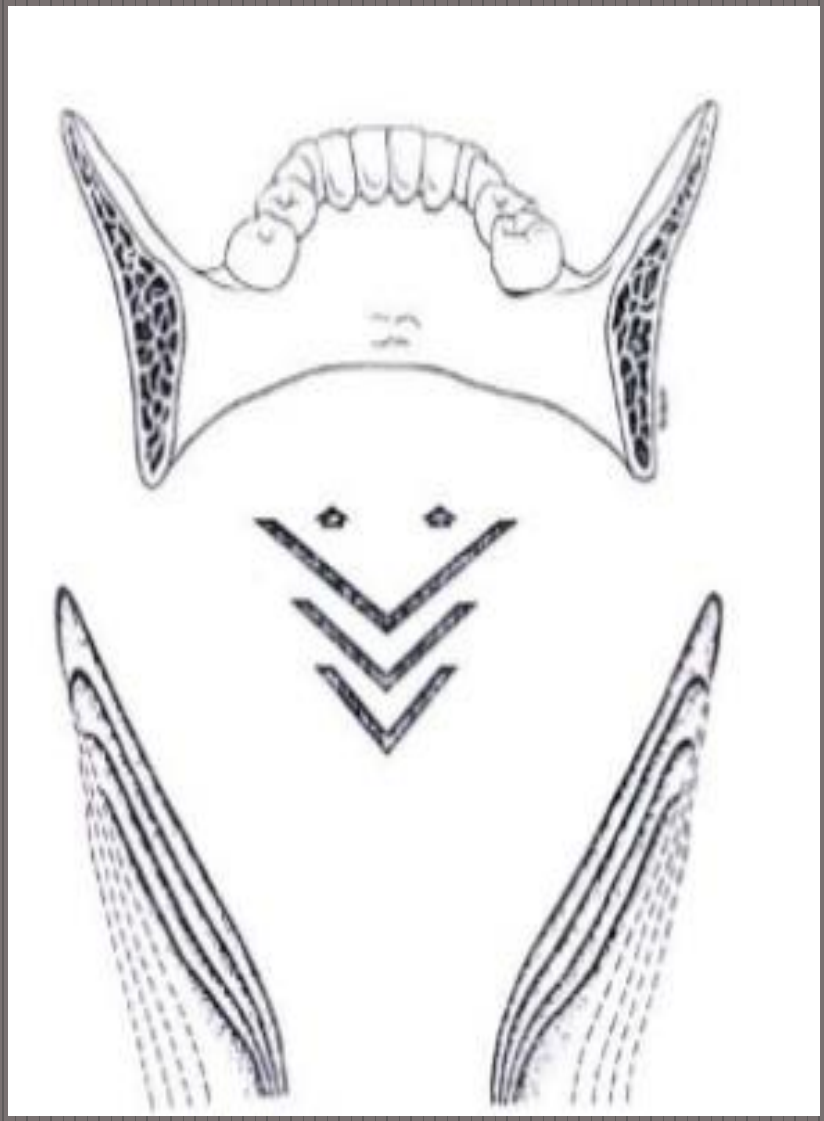


- In infants condyles of the mandible are inclined almost horizontally ,so the condylar growth leads to an in crease in height .
- After first year of life ,the mandibular growth becomes more selective. The condyle does show considerable activity as the mandible moves and grows downward and forward
- Heavy appositional growth occurs at the posterior border of ramus and on the alveolar border .
- Significant growth still observed in at the tip of the coronoid process.

- Resorption occurs along the anterior border of the ramus lengthening the alveolar border and maintaining the anteroposterior dimension of the ramus.
- Major width contribution of the mandible is growth at the posterior.



- Literally the mandible is an “expanding V”,
- Additive growth at the ends of this “v” naturally increase the distance betweenthe terminal points.
- Continued growth oif alveolar bone with the developing dentition increases the height of the mandibular body



- Scott divides the mandible into 3 basic typesof bone-basal,muscular,alvoelar (or)tooth supporting.
- Basal portion is a tube like central foundation running from the condyle to the symphysis
- Muscular portion is under the influence of masseter,internal pterygoid and temporal muscles
- The third portion alveolar bone exists to hold the teeth

- Moss speaks to the mandible as a group of microskeletal units.
- Thus the coronoid process is one skeletal unit under the influence of the temporalis muscle.
- The gonial angle is another skeletal unit under the influence of masseter and internal pterygoid muscles.
- The alveolar bone under the influence of teeth.

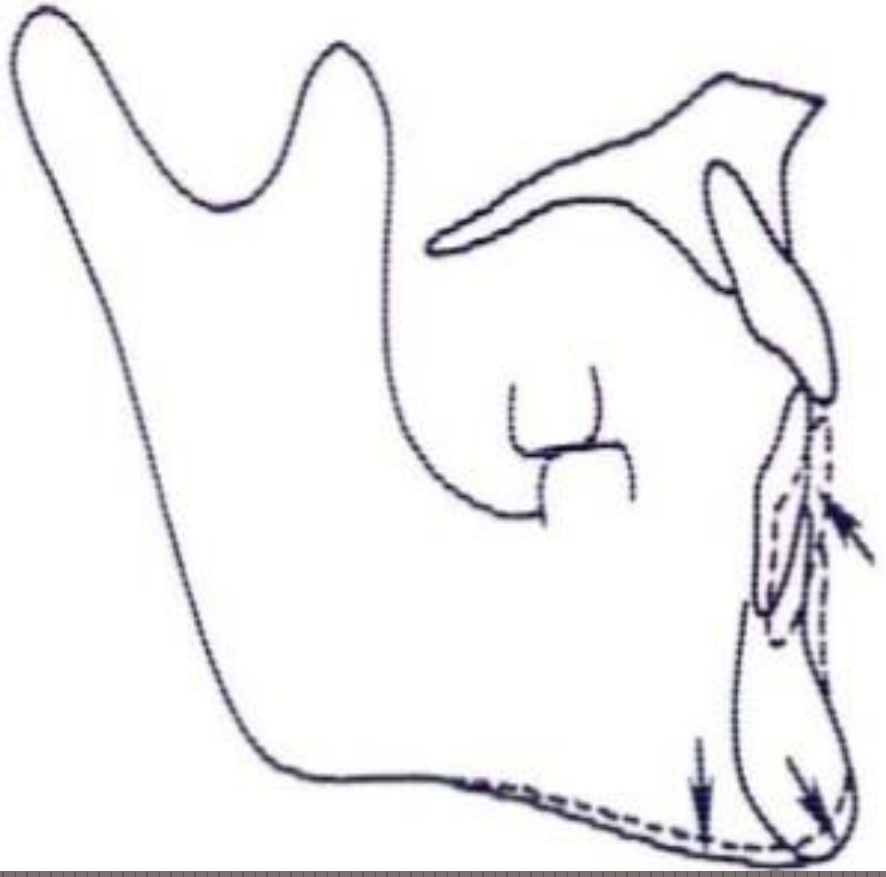
- Moss delineates two basic types functional matrices.
- 1) periosteal matrices
- 2)capsular matrices
- Mandibular growth demonstrates the integrated activity of periosteal and capsular matrices in facial growth
- Since the condyles are not primary sites of mandibular growth but loci with secondary,compensatory growth potential ,condylar removal does not inhibit the spatial translation of contaguous mandibular functional components.

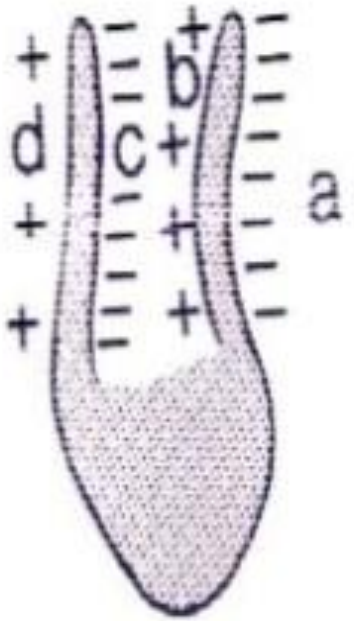
- Mandibular growth is seen now to be a combination of the morphologic effects of both capsular and periosteal matrices
- The capsular matrix growth causes an expansion of the capsule as a whole.
- Under normal conditions then the periosteal matrices related to constituent mandibular microskeletal unit also respond to this volumetric expansion.such alteration in spatial position inevitably causes them to grow

CHIN

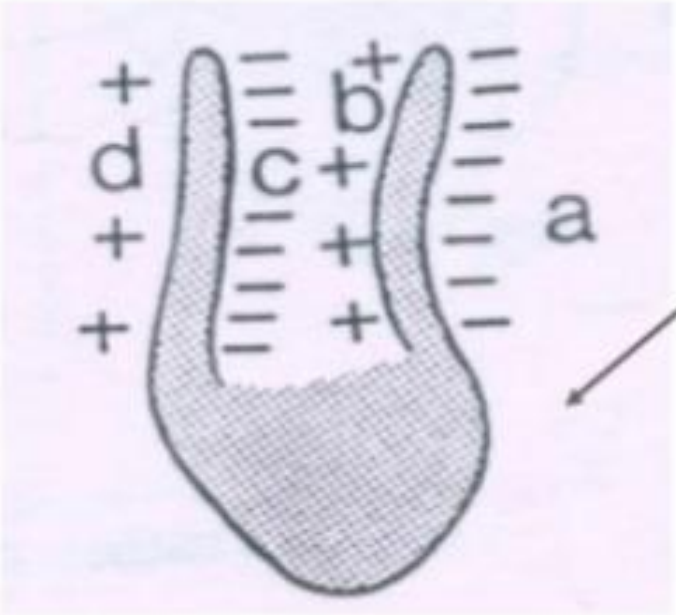
- In infancy chin is under developed
- As age advances the growth of chin becomes significant
- Males are seen to have prominent chin compared to females the prominence is accentuated by bone resorption in the alveolar region below it ,creating a concavity

Chin





Mental Protuberance



- Forms by osseous deposition during childhood
- Prominence is accentuated by bone resorption above it

Theories of mandibular growth

- Genetic theory :
  - This theory states that all growth is compelled by genetic influences
  - i.e :gentic encoding of mandible determines its growth.

- Sutural theory

- This theory states that genetic control is expresses directly at the level of the bone and its locus is the periosteum.

Cartilaginous theory

- This theory states that the cartilage is the primary determinant of skeleton growth while bone responds secondarily and passively

- According to this theory ,the condyle by means of endochondral ossification deposits bone,which tends to the growth of the mandible.

FUNCTIONAL MATRIX THEORY

- According to this theory ,the soft tissue matrix in which the skeletal elements are embedded is the primary deteminant of growth and both bone and cartilage are secondary followers.

- Which means the muscles ,connective tissues etc.caries the entire mandible away from the cranial base.the bone follows secondarily at the condyle to maintain constant contact with the glenoid fossa.

ENLOWS EXPANDING "V" PRINCIPLE

- This theory states that many facial bones or a part of the bone follows a "v" pattern of enlargement
- Due to differential deposition and selective resorption deposition is in the inner surface of wide ends of"v"and along the ends of "v". Resorption is seen along the outer surface of "v" .
- CORONOID: Deposition –lingual surface,

  Resorption –buccal

CONDYLE: Deposition-anterior and posterior margins ,

Resorption –buccal and lingual surfaces.

COUNTERPART PRINCIPLE

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

- E.g the maxillary arch is the counter part of the mandibular arch.

Mechanism of bone growth

- Growth of the mandible primarily involve
- 1) Bone remodelling
- Process of bone deposition and resorption
- 2) Cortical drift
- Combination of bone deposition and resorption resulting in growth movement towards deposition surface
- 3) Displacement

- Movement of whole bone as a unit
- 1)Primary displacement
- 2)secondary displacement

MECHANISM OF BONE GROWTH

- Bone growth is based on certain basic principles.bones do not grow symmetrically but grows by complex differentiation mechanism. All bone growth is a complicated mixture of the two basic principles deposition and resorption

- Deposition and resorption which are carried out by the growth fields comprised of the soft tissue investing the bone.As the fields grows and function differently on different parts of the bone ,the bone undergoes remodeling.

DEPOSITION AND RESORPTION

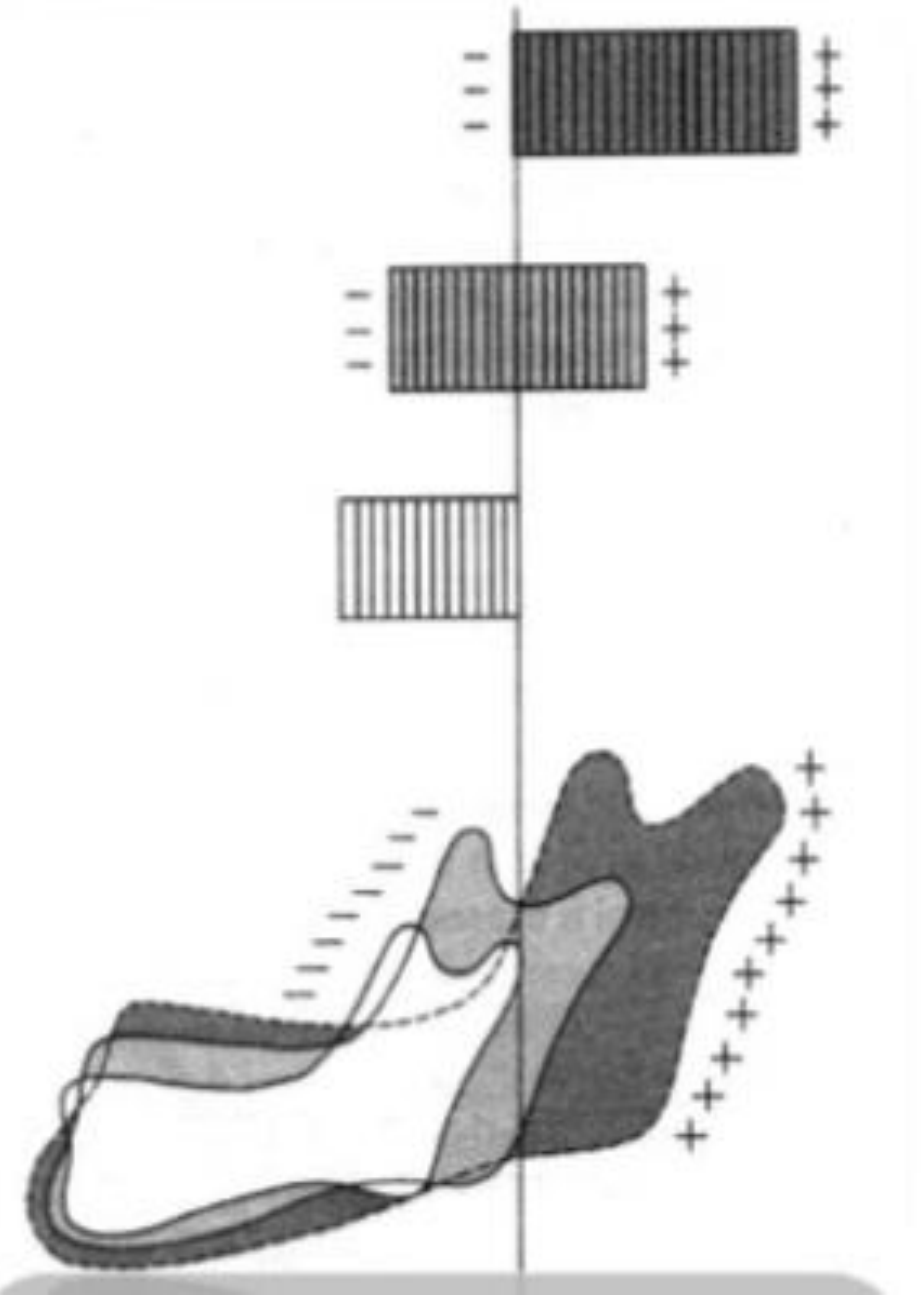
- Bone grows by addition of new bone tissue on one side of the bony cortex.

- Bone formative changes occurs on the surface facing towards the direction of progressive growth resulting in new bone deposition.

Deposition is observed on the tension side.

BONE REMODELING

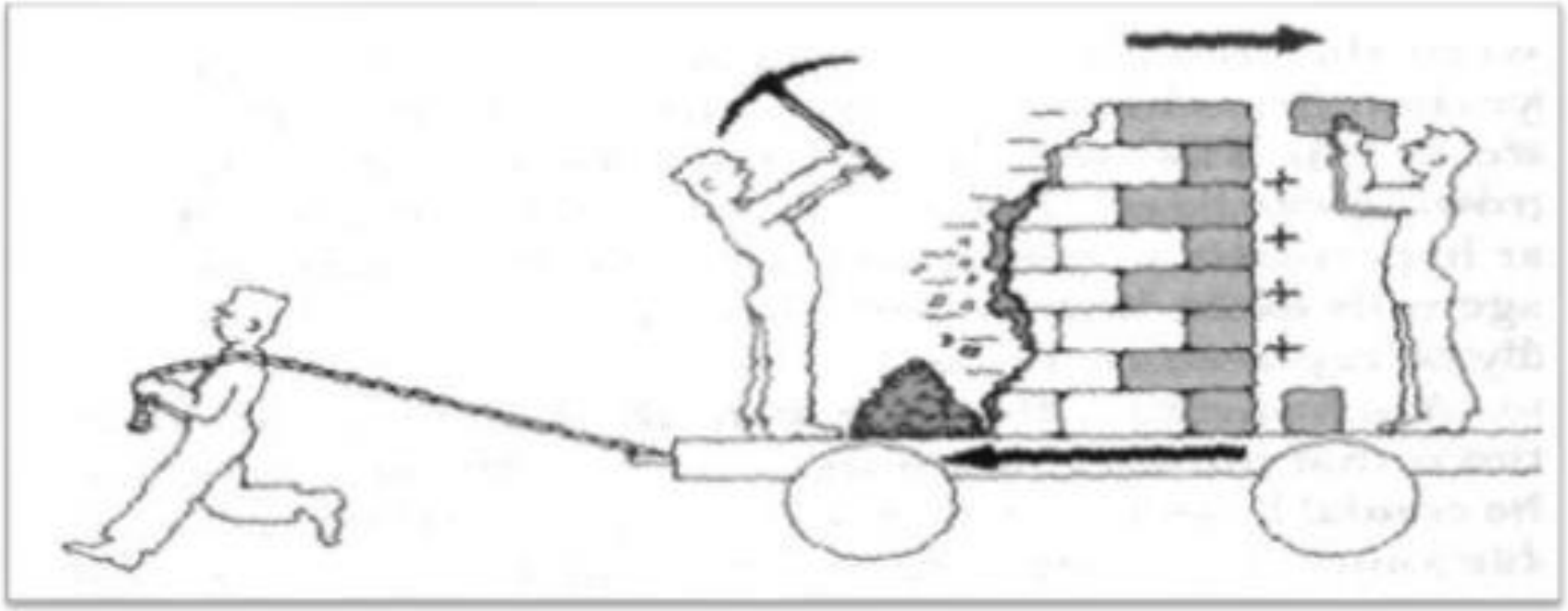
- Bone remodelling involves independent sites of resorption and formation that changes the size and the shape of a bone



- E.g. The ramus moves posteriorly by the combination of deposition and resorption.
- So the anterior part of the ramus gets remodeled

Functions of Remodeling

1. Progressively change the size of whole bone
2. Sequentially relocate each component of the whole bone
3. Progressively change the shape of the bone



4. Progressive fine tune fitting of all the separate bones to each other and to their contiguous, growing, functioning soft tissues.

5. Carry out continuous structural adjustments to adapt to the intrinsic and extrinsic changes in conditions .

Displacement

- It is the movement of the whole bone as a unit.

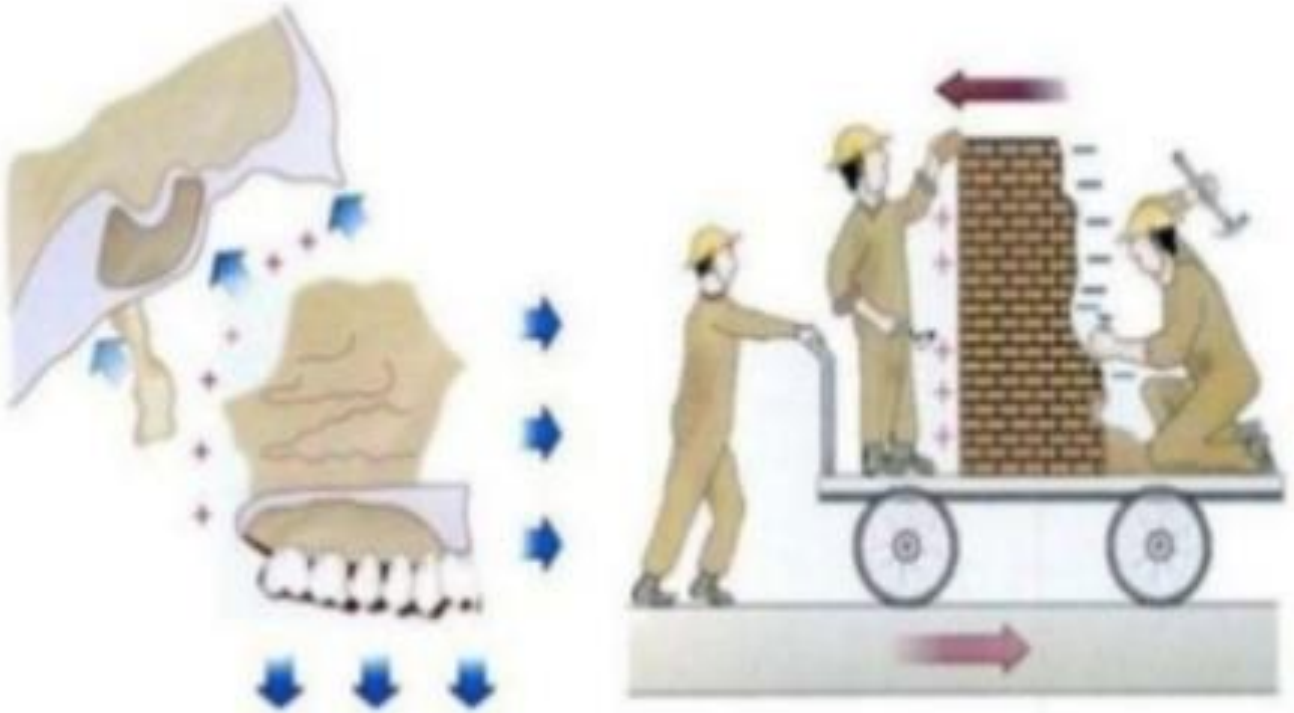
- It is a translatory movement of the whole bone caused by surrounding physical forces, and is the second characteristics mechanism of skull growth.

- The entire bone is carried away from its articular interfaces(sutures , synchondroses, condyle) with adjacent bones.

- Displacement is of two types namely:

- **Primary displacement**- As a bone enlarges , it is simultaneously carried away from the other bones in direct contact with it.This creates space within which bony enlargement takes place.

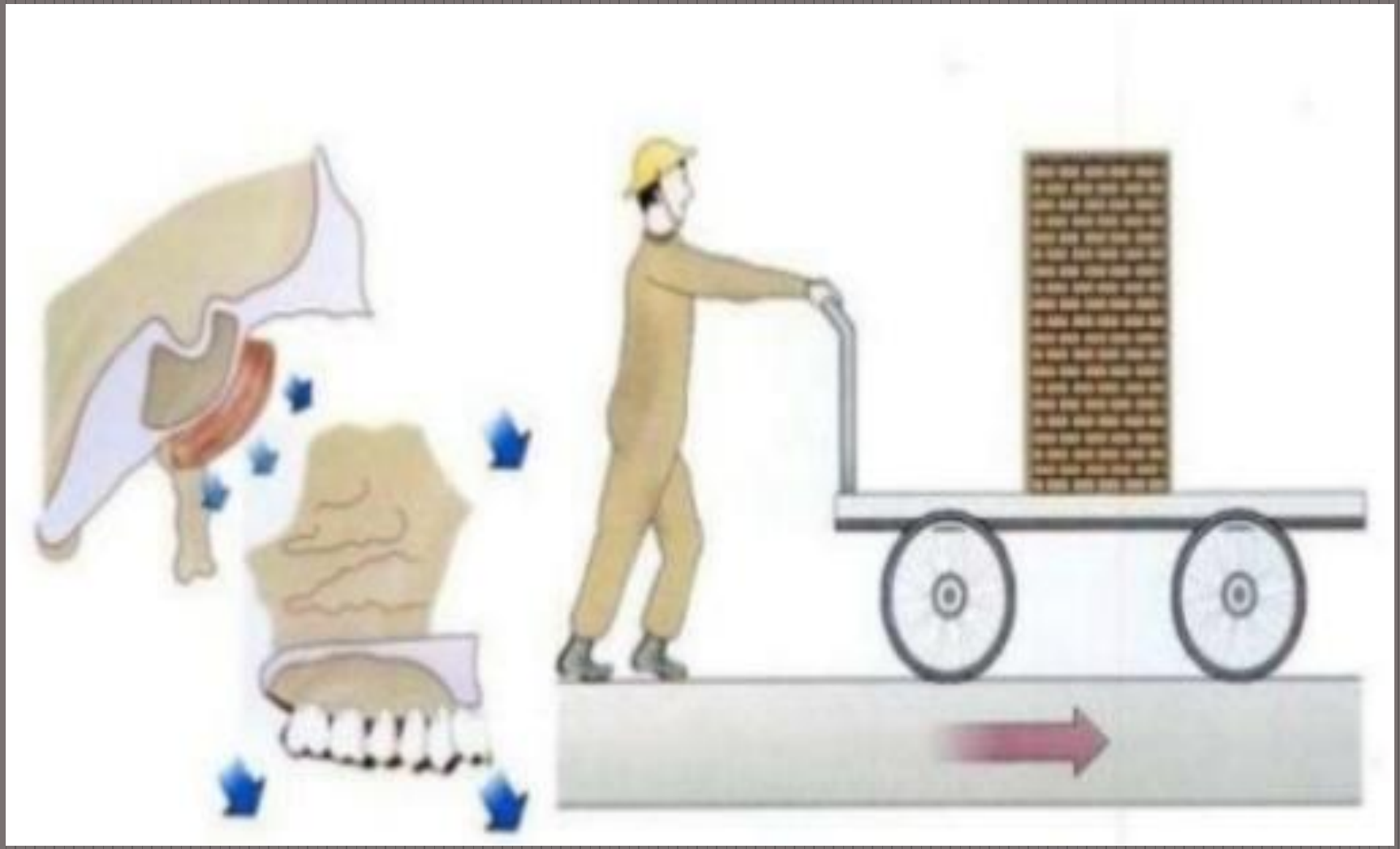
It is the physical movement of the whole bone ,as the bone grows & remodels by resorption and apposition.



- **Secondary displacement** :It is the movement of a whole bone caused by the separate enlargement of other bones which may be nearby or quite distant.

- It is related to enlargement of other bone.

- For example: growth in the middle cranial fossa results in the movement of the maxillary complex anteriorly& inferiorly .



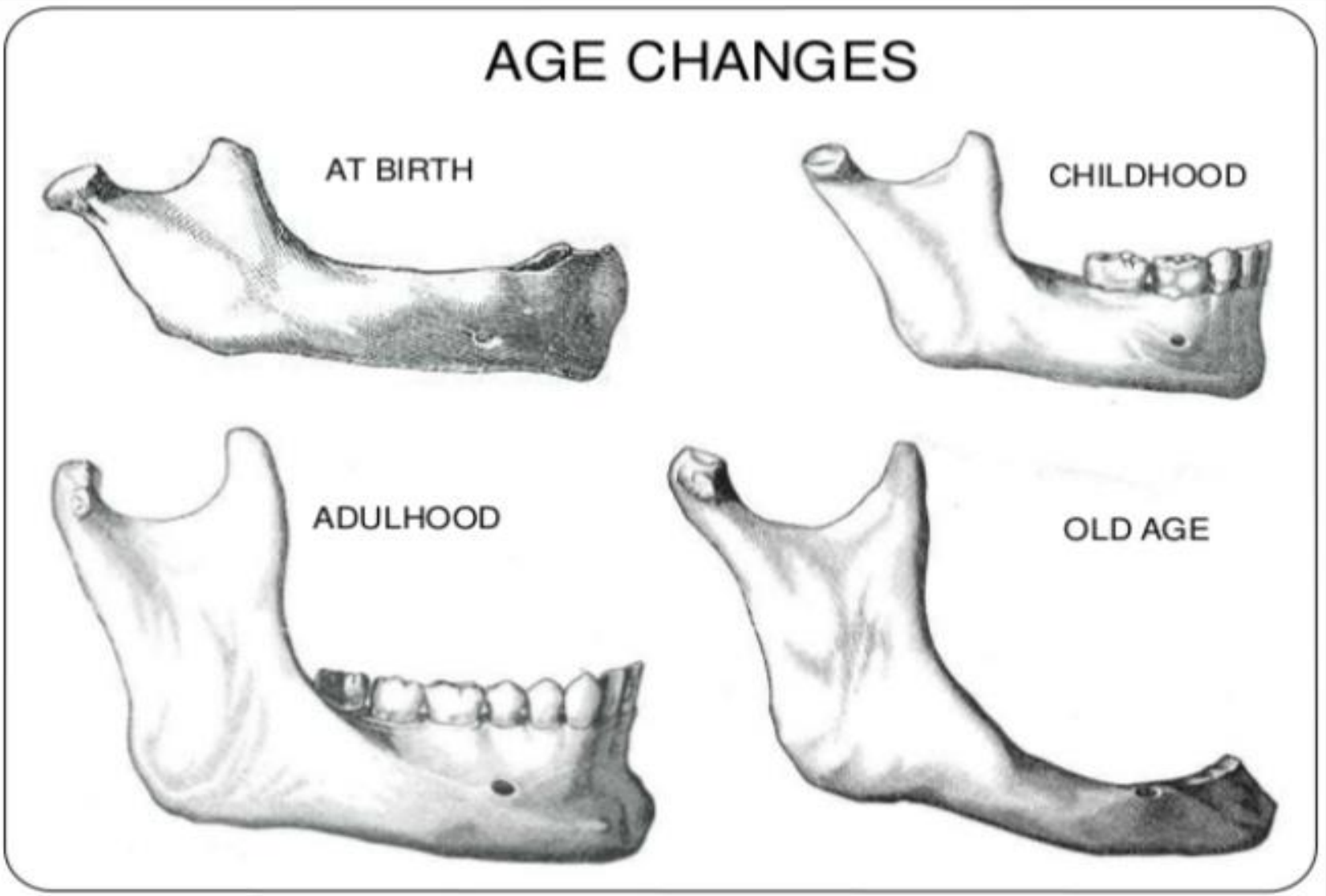
Age Changes Of The Mandible

	At birth	Adult	Old age
1. Mental foramen	nearer the lower border.	midway between upper and lower borders.	nearer the upper border.
2. Angle of the mandible	obtuse (nearer 180°)	right angle (about 90°).	obtuse (nearer 140°).
3. Coronoid & condyloid processes	Coronoid process is larger and above the level of condyloid process.	Condyloid process is above the level of the coronoid process.	condyloid process is above the level of the coronoid process but in extreme old age it is bent backwards.
4. Mandibular canal	lies a little above the level of the mylohyoid line.	runs nearly parallel with the mylohyoid line.	runs close to the upper or alveolar border.
5. Symphysis menti	present; the bone remains in two halves united together by fibrous tissue.	represented by a faint ridge only in the upper part.	not recognisable or absent.

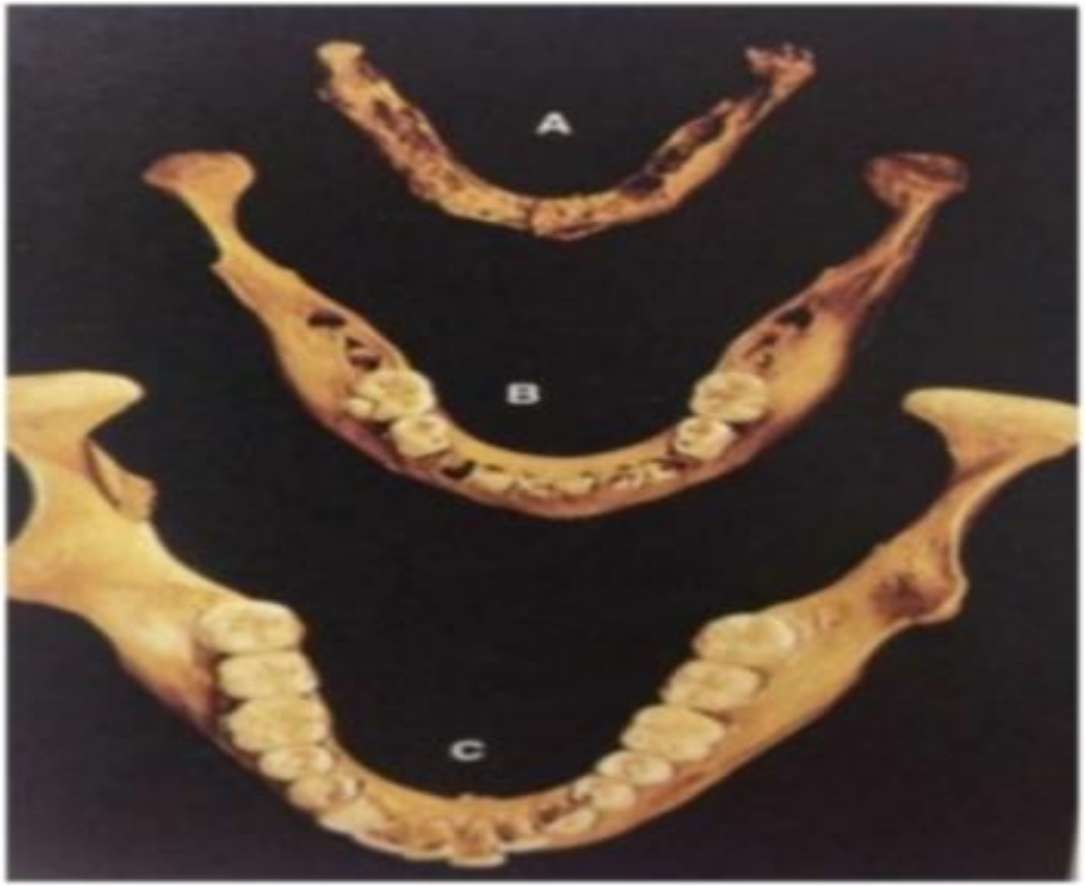
Age Changes Of The Mandible

In the adult

In the elderly


AGE CHANGES
AT BIRTH
CHILDHOOD
ADULHOOD
OLD AGE

Age Changes Of The Mandible



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THANK YOU