Development of musculoskeletal system

by: Fentahun A.

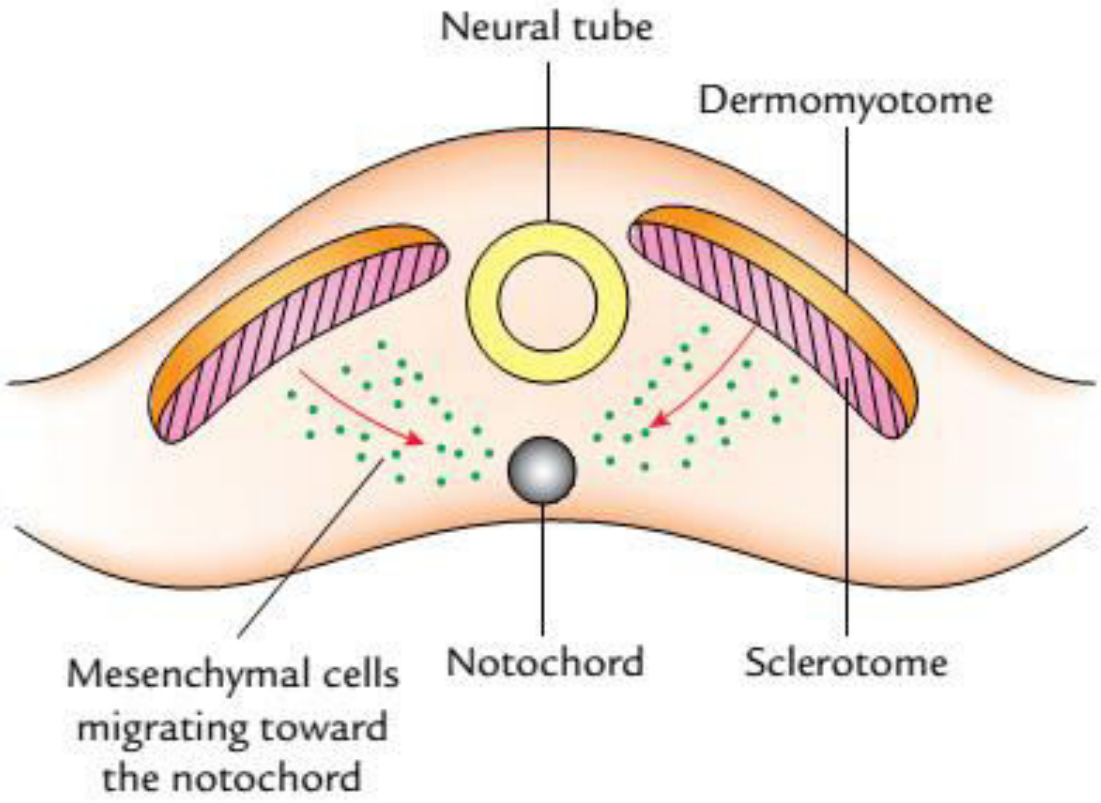
Development of skeletal system

- Develops from mesenchyme that originate from:
  - Paraxial mesoderm
  - Lateral plate mesoderm
  - Neural crest

Somites

- Each has a transitional small central cavity called **myocele** and differentiate into:

1. Sclerotome-ventromedially
2. Dermomyotome- dorsolaterally and differentiates into:
   - Dermatome- dermis
   - Motome –muscle



Development of skull

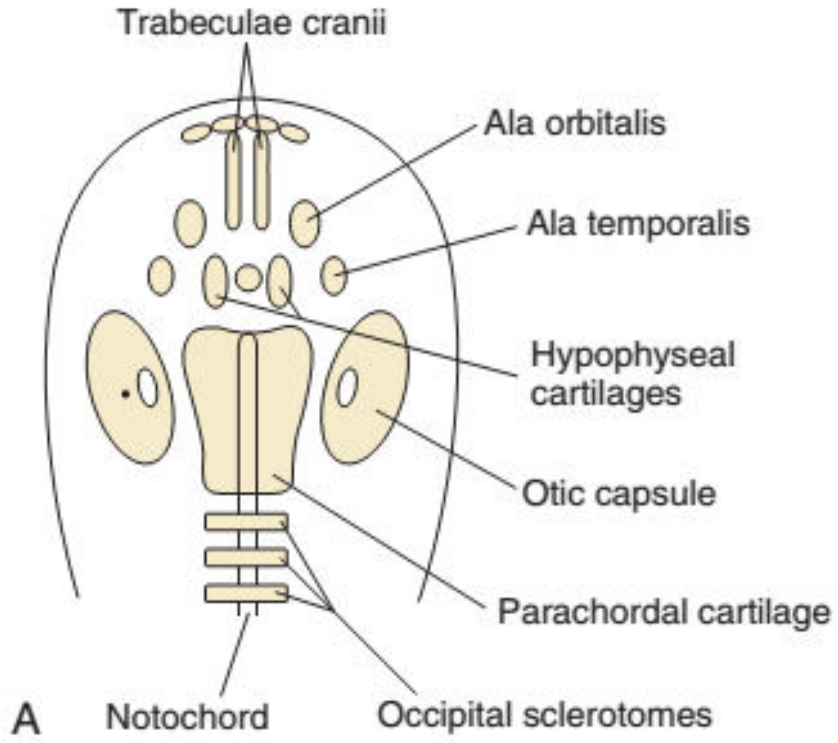
- Skull is made by:
  - Neurocranium
  - Viscerocranium

- Develop from paraxial mesoderm & neural crest

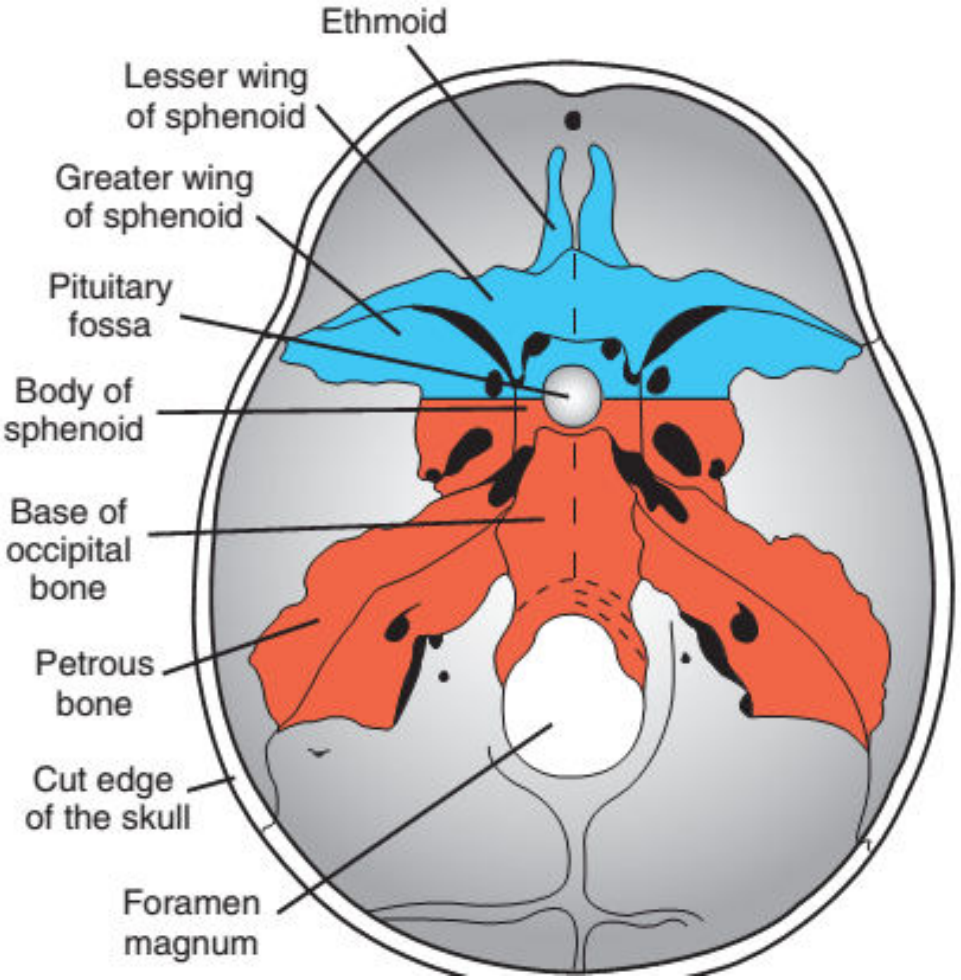
- Bones of both neurocranium and viscerocranium ossify through both **endochondral & membranous ossification**

Cartilaginous neurocranium

- The **base of cranial cavity** develops from:
  - Neural crest and paraxial mesoderm form bones located rostral & caudal to the rostral half of sella turcica respectively
  - Fusion & ossification of several cartilages leaving foramina for the exit of cranial nerves
- The cartilage include
  - Parachordal cartilage(basal plate)
  - Hypophyseal cartilage
  - Trabeculae carinii
  - Ala orbitalis
  - Ala temporalis
  - Otic capsule(preotic capsule)
  - Nasal capsule

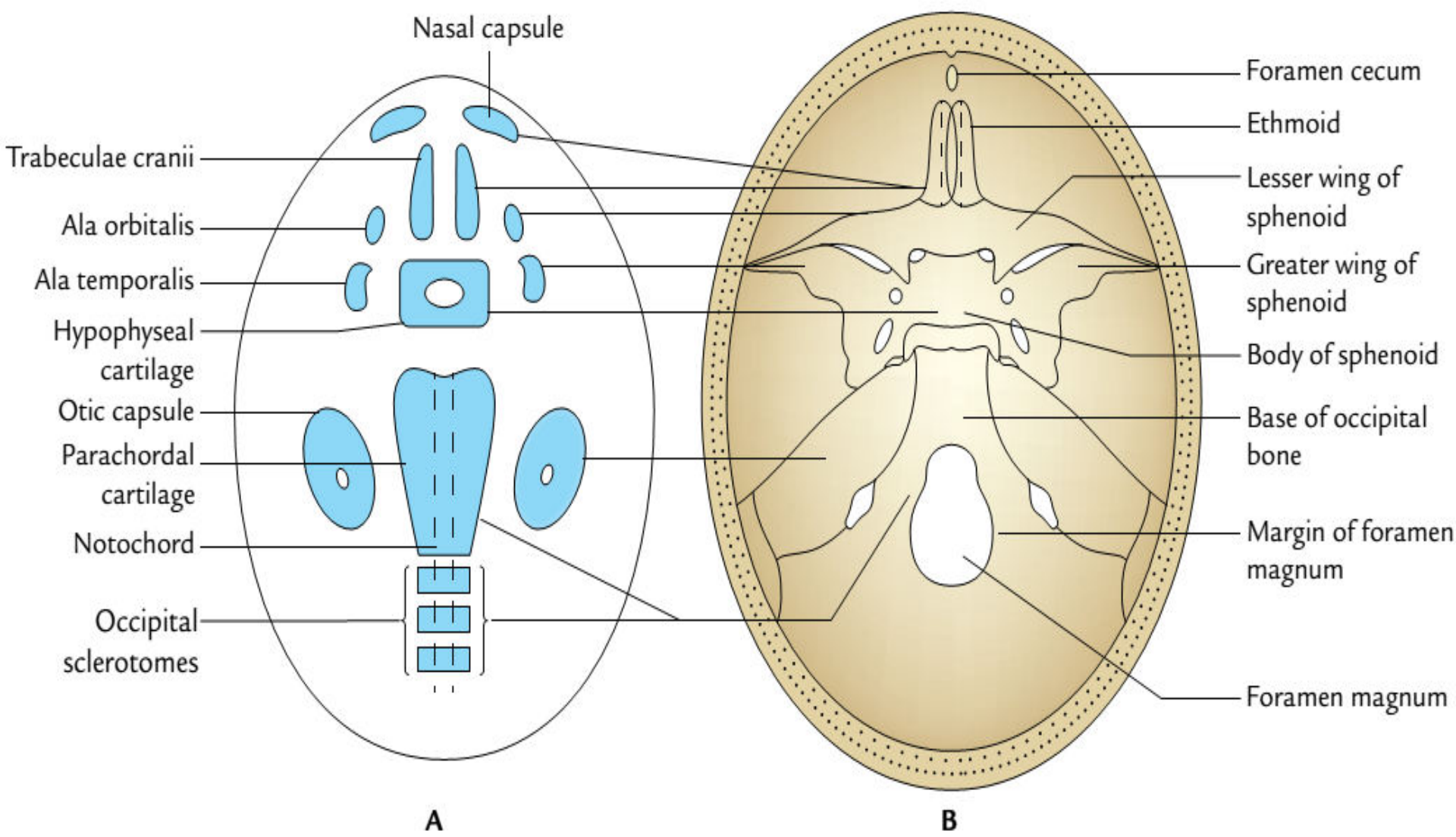


Dorsal view of the chondrocranium, or base of the skull, in the adult showing bones formed by endochondral ossification. Bones that form rostral to the rostral half of the sella turcica arise from neural crest and constitute the prechordal (in front of the notochord) chondrocranium. Those forming posterior to this landmark arise from paraxial mesoderm (chordal chondrocranium)



Cartilaginous neurocranium

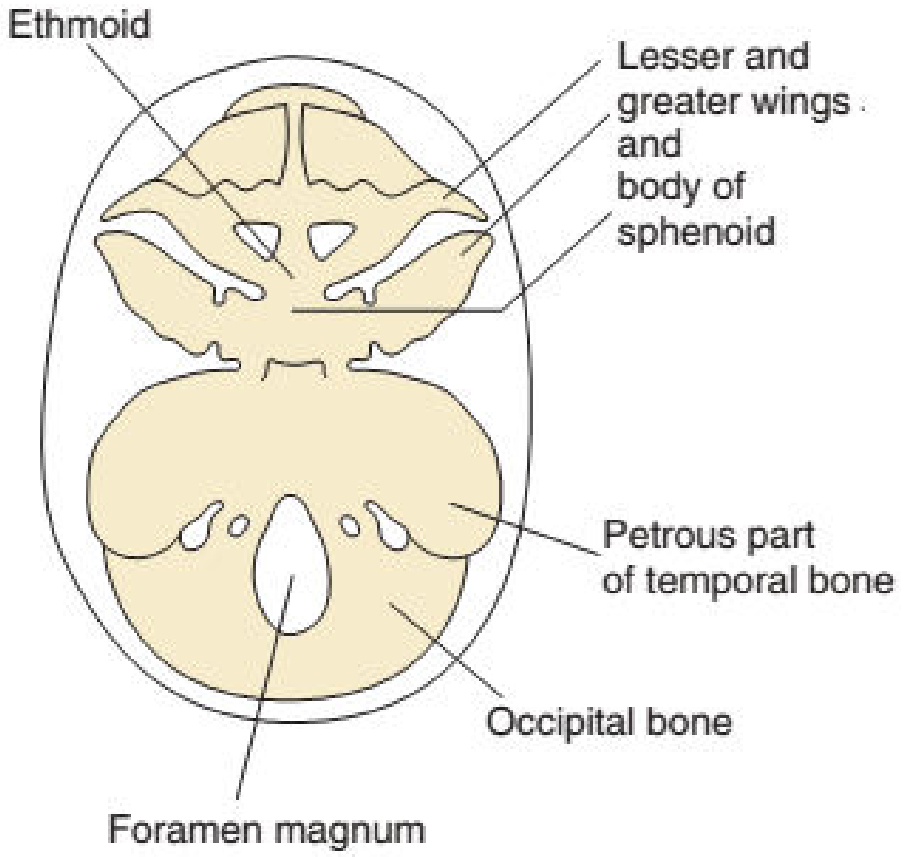
- Parachordal cartilage(basal plate)
  - With cartilages of occipital and first cervical somites gives base of occipital bone & boundaries of foramen magnum
- Hypophyseal cartilage
  - Give body of sphenoid bone
- Trabeculae carinii
  - Gives body of ethmoid bone



Development of the base of the skull (dorsal view). A. Cartilages that form cartilaginous neurocranium. B. Bones of the base of the skull formed by various cartilages of neurocranium by endochondral ossification

Cartilaginous neurocranium

- Ala orbitalis
  - Gives lesser wing of sphenoid bone
- Ala temporalis
  - Gives greater wing of sphenoid bone
- Otic capsule(preotic capsule)
  - Gives petros & mastoid part of temporal bone
- Nasal capsule
  - Gives parts of ethmoid bone around the nasal cavity

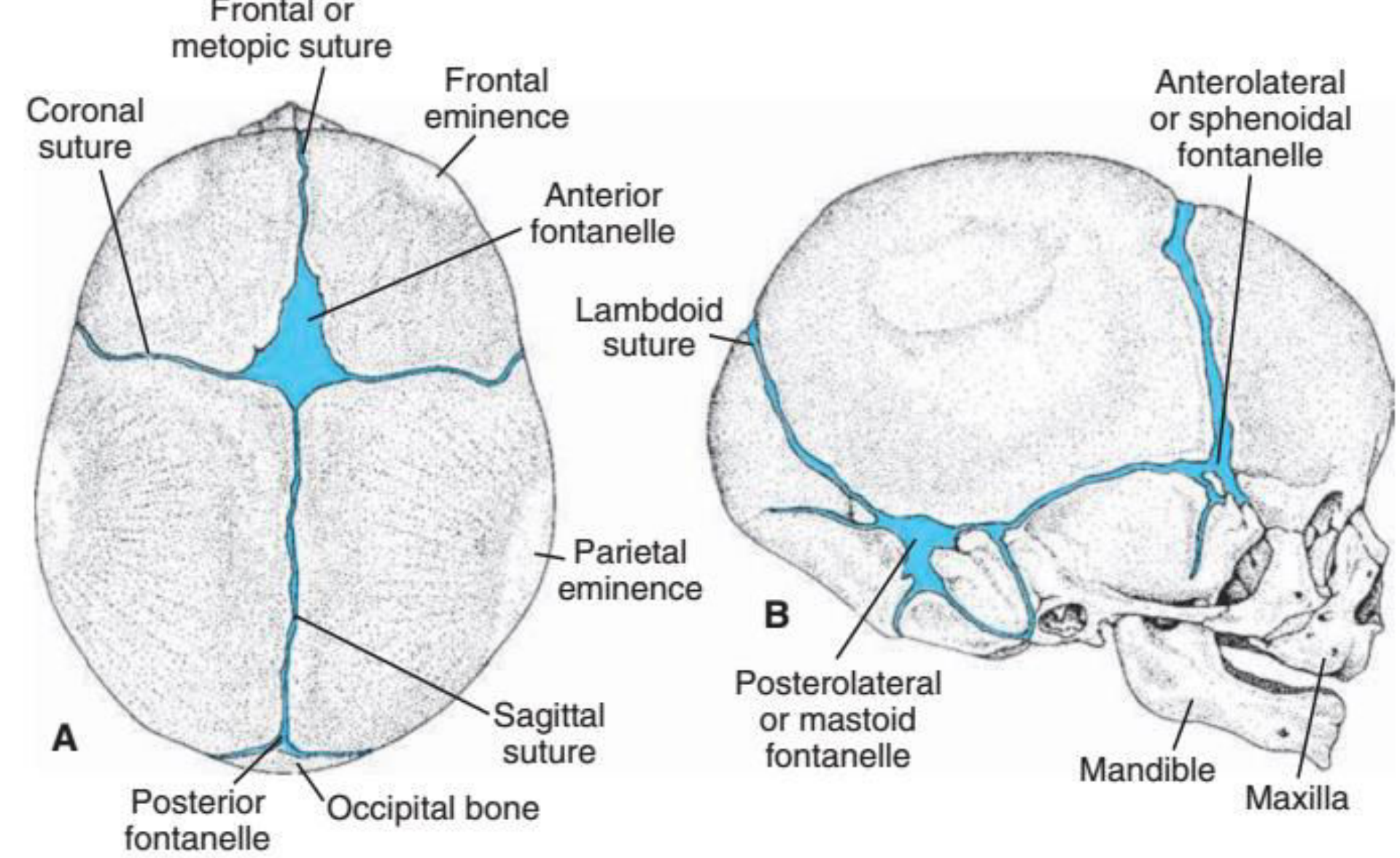


Membranous neurocranium

- Gives the **calvaria**
- Shows

1. Sutures b/n the bones, many of which ossify during adult life
2. The following six fontanelles at the junctions of more than two bones
    1. Anterior fontanell
    2. Posterior fontanell
    3. Two anterolateral (sphenoid) fontanell
    4. Two posterolateral or mastoid fontanell

- This fontanell allow molding during passage through the birth canal at the time of birth


Frontal or
metopic suture
Coronal
suture
Frontal
eminence
Anterior
fontanelle
Parietal
eminence
Sagittal
suture
A
Posterior
fontanelle
Occipital bone
Anterolateral
or sphenoidal
fontanelle
Lambdoid
suture
B
Posterolateral
or mastoid
fontanelle
Mandible
Maxilla

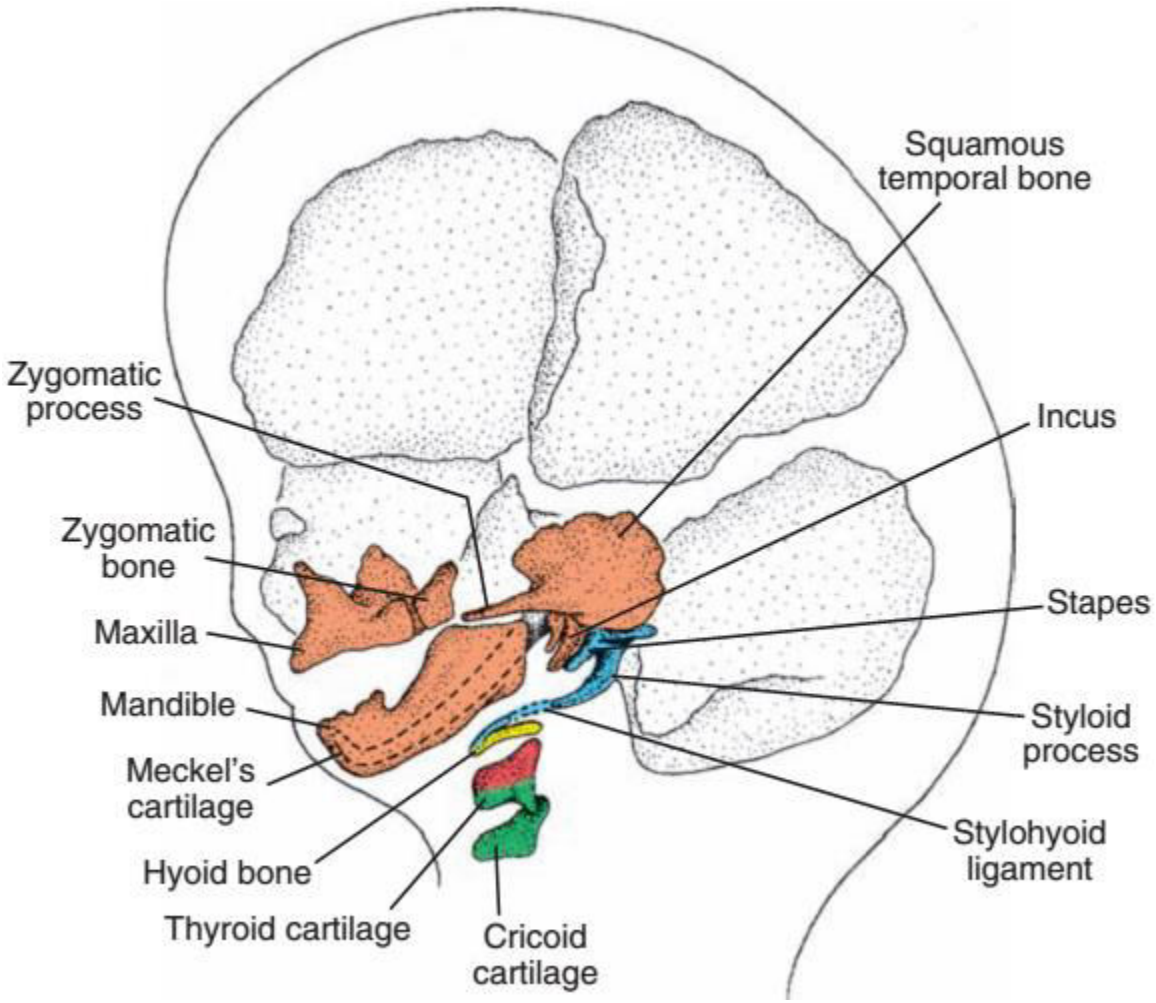
Cartilaginous visceroranium

- Develops from mainly from 1st & 2nd branchial arch cartiilages

- Include the ossicles , styloid processes of temporal bone & hyoid bone

Membranous viscerocranium

- Develops from mesenchyme in maxillary and mandibular process of 1st pharyngeal arch
- Gives rise to:
  - Squamosal part of temporal bone
  - Zygomatic bone
  - Maxilla and mandible



Development of vertebrae

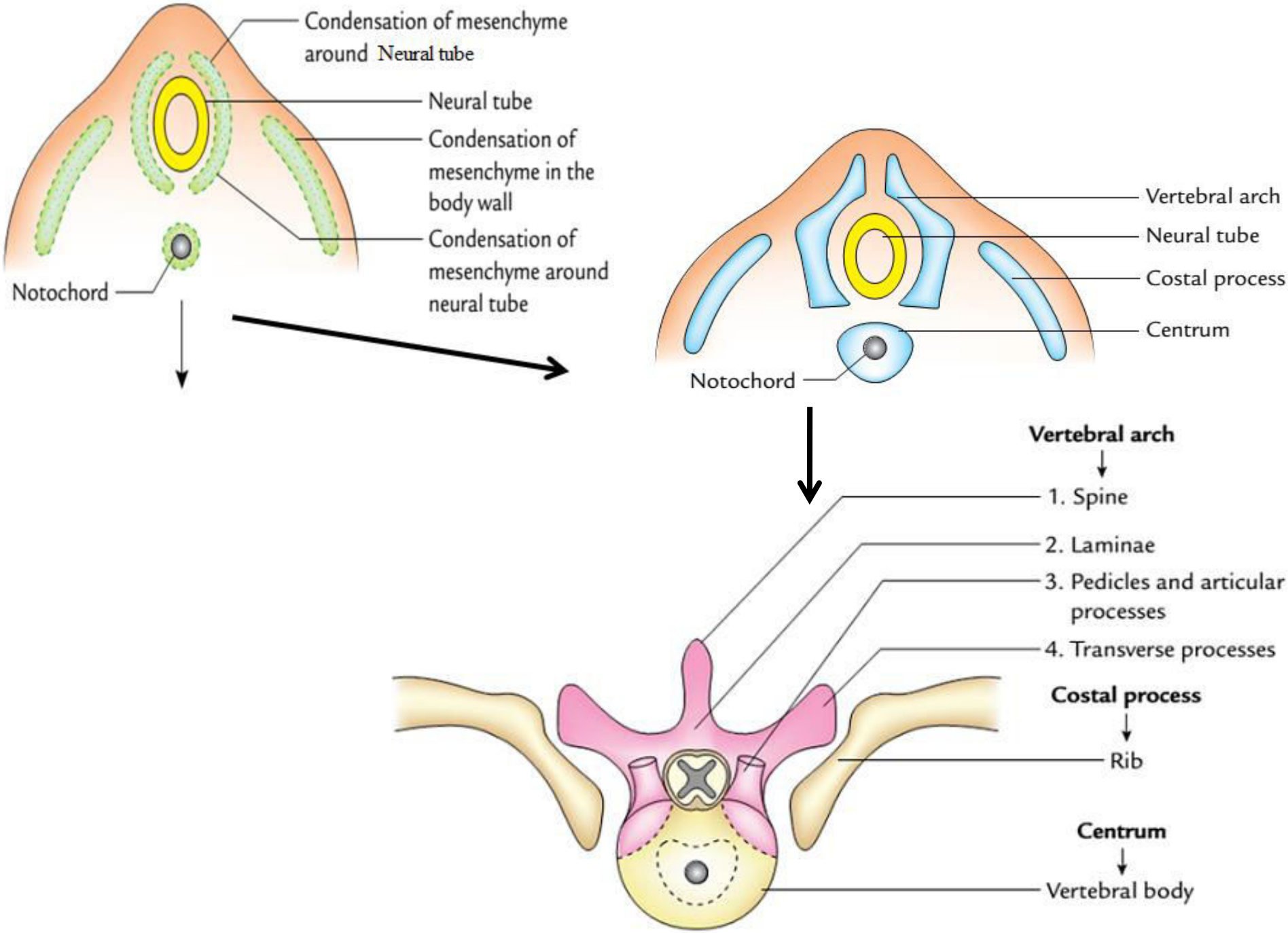
- Develop by endochondral ossifications passing through three stage

1. Mesenchymal stage as sclerotome
2. Cartilaginous stage
3. Bony stage

Development of vertebrae

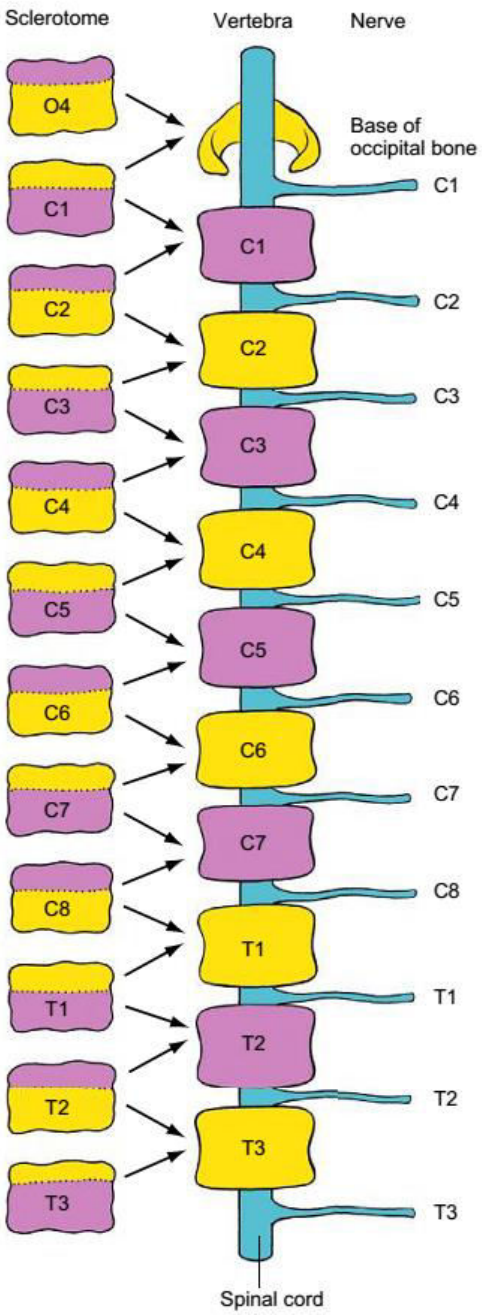
- Develops from the cells of **sclerotomes of somites** that multiply and migrate to:

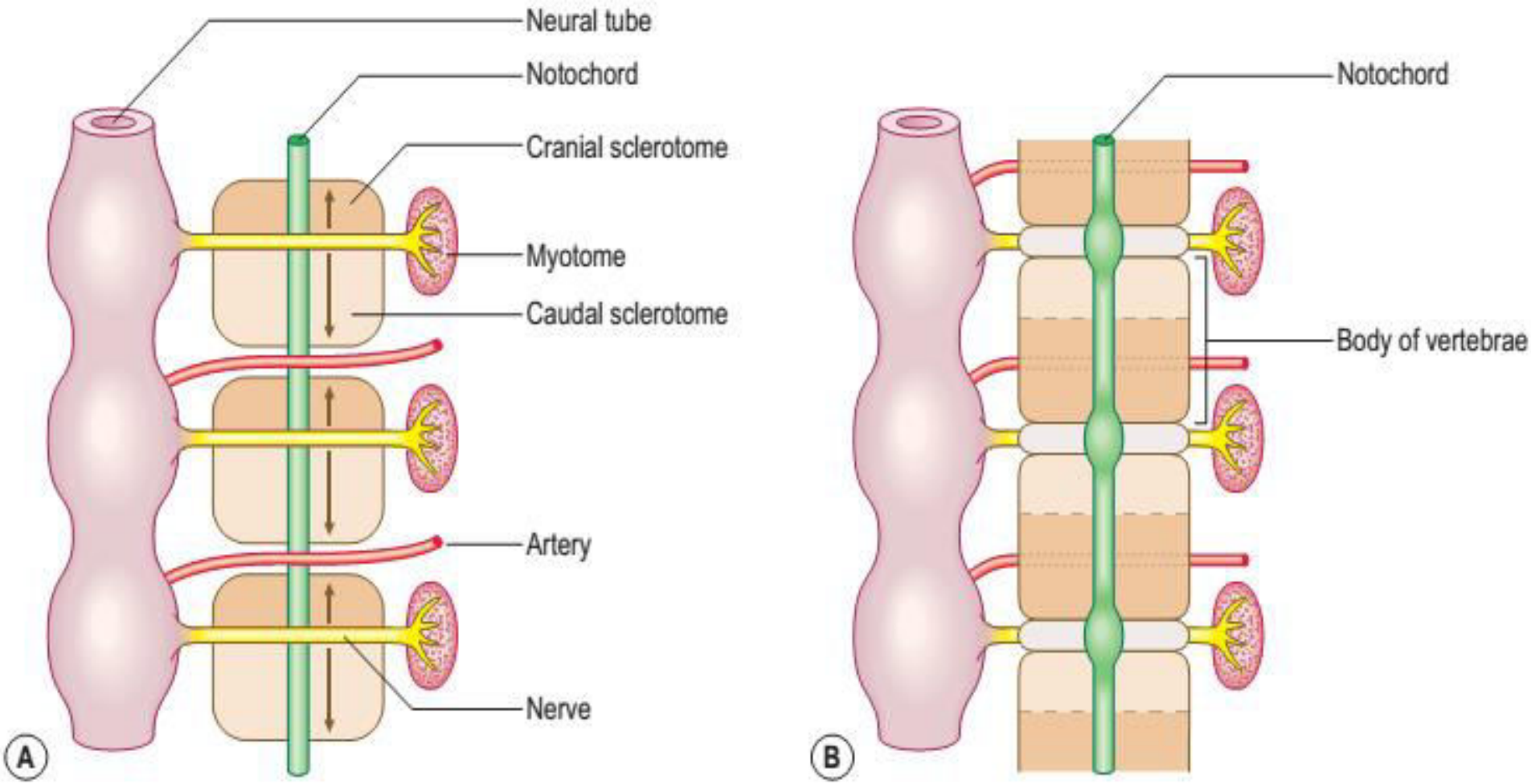
1. Surround the notochord to give rise to **centrum** which is the primordium of the body of the vertebra
2. Surround the neural tube to give rise to the **vertebral arches**
3. Project into the body wall to form **costal process**


Condensation of mesenchyme around Neural tube
Neural tube
Condensation of mesenchyme in the body wall
Condensation of mesenchyme around neural tube
Notochord
Vertebral arch
Neural tube
Costal process
Centrum
Notochord
Vertebral arch
1. Spine
2. Laminae
3. Pedicles and articular processes
4. Transverse processes
Costal process
Rib
Centrum
Vertebral body

Reconstitution of sclerotome to form vertebral bodies

- Each sclerotome splits
  - A loosly packed cranial part(half)
  - A densly packed caudal part(half)
- The cranial half of the 1st cervical sclerotome fuses with occipital sclerotomes and parachordal cartilage to form the **base of occipial bone & boundaries of foramen magnum**
- In all the remaning sclerotome, the caudal half of each fuses with the carnial half of its succeeding sclerotome to form **centrum** (primordium of the body of vertebrae)

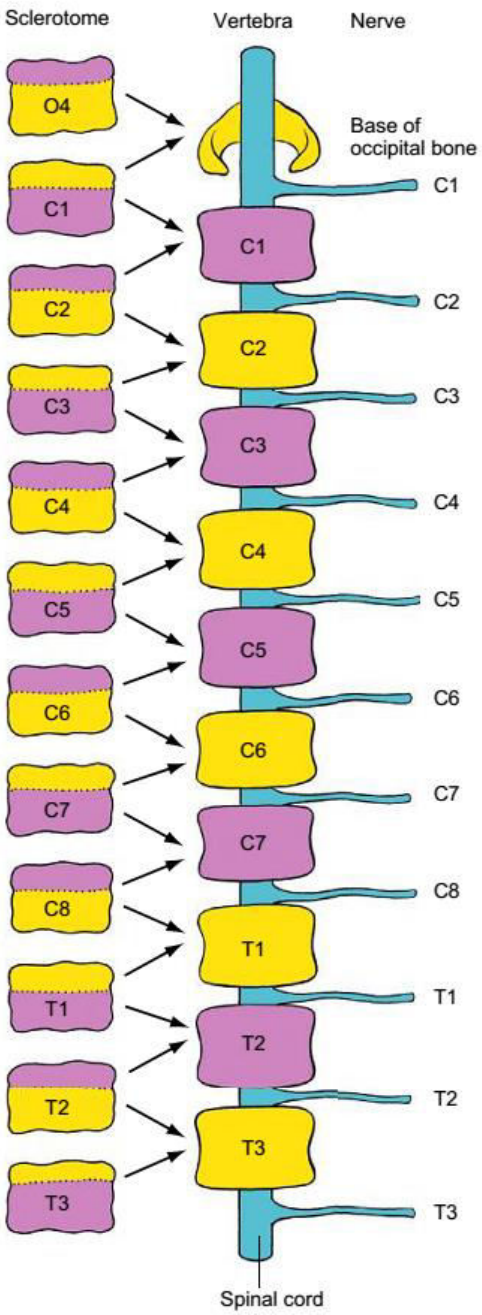




Diagrams of a 4-week embryo showing the formation of vertebral column from sclerotomes (A, B). In (A) the direction of migration of sclerotome cells is indicated by arrows

Reconstitution of sclerotome to form vetebral bodies

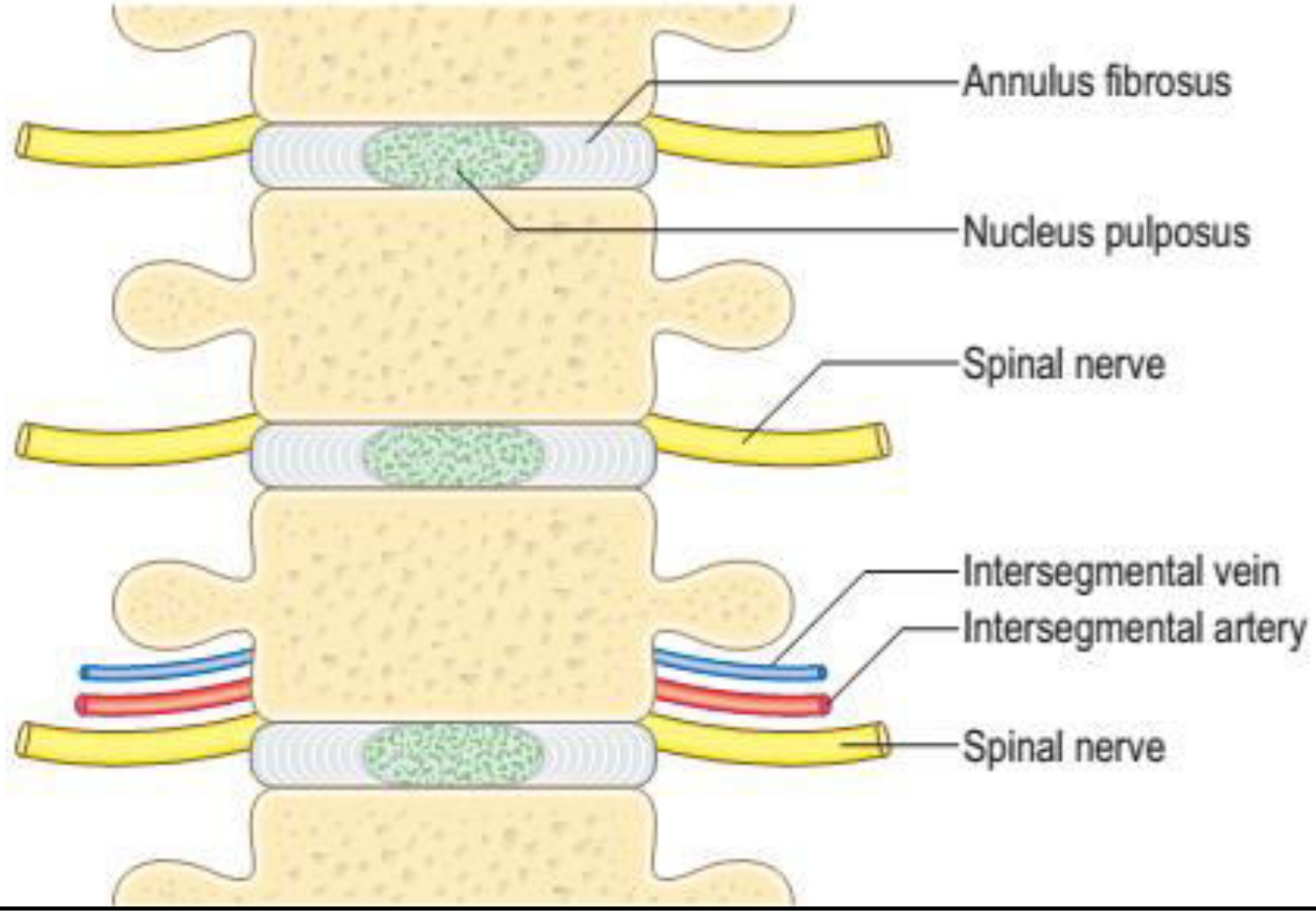
- All the **7 cervical vertabrae** are formed by fusion of caudal halves of corresponding sclerotomes with the cranial halves of succeeding halves of cervical sclerotomes
- The 1st thoracic vertebra is formed by fusion of caudal half of the 8th cervical sclerotomes with cranial half of 1st thoracic sclerotome
- All the remaining vertebrae are formed by fusion of the caudal halves of preceding sclerotome with the cranial halves of corresponding sclerotome



Development of spinal nerves

- Sprout segmentally from the developing spinal cord and traverse the middle of their corresponding scelrotome to innervate their respective dermomyotomes

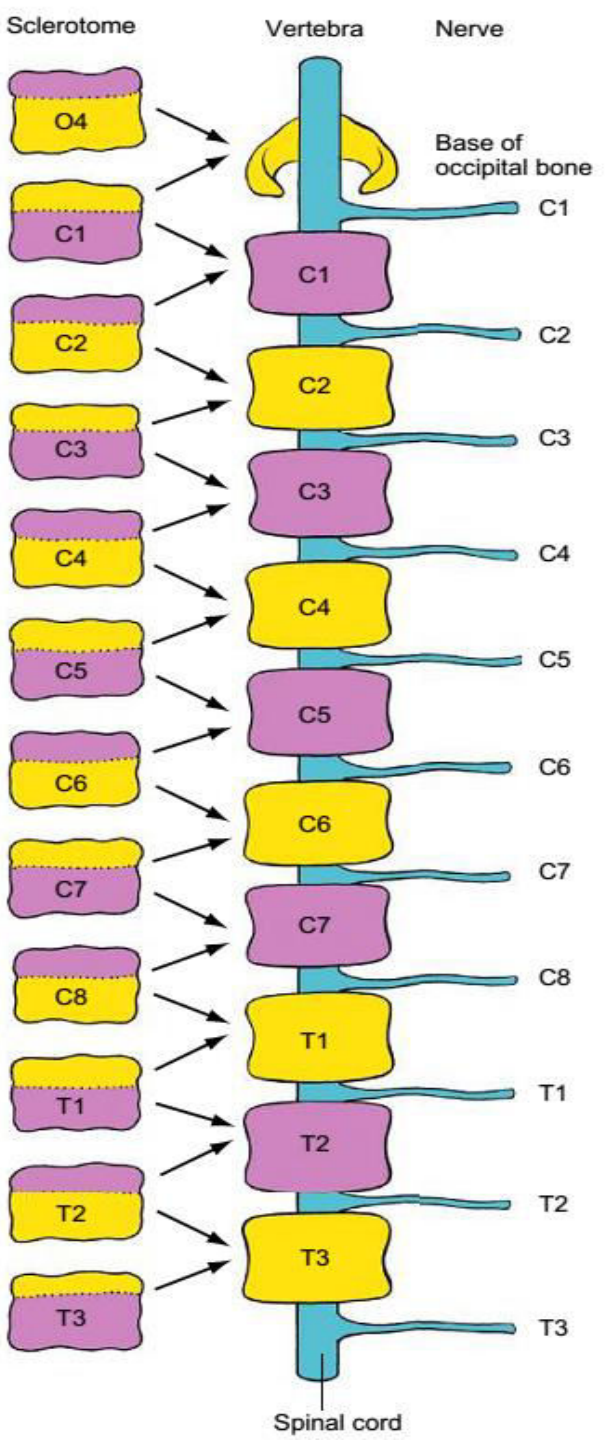
- After the split and reconstitution of the sclerotome to form the verebrae, the sites of crossing of spinal nerves through the scelrotome correspond to the intervertebral levels



Adult vertebrae and the position of spinal nerves and intersegmental vessels

Development of spinal nerves

- As result:
  - Each of the upper 7 cervical spinal nerve emerge above its corresponding cervical vertebra
  - The 8th cervical spinal nerve emerges below the 7th cervical vertebra
  - The remaining spinal nerves from 1st thoracic downwards emerge below their corresponding vertebrae



Development of intersegmental arteries

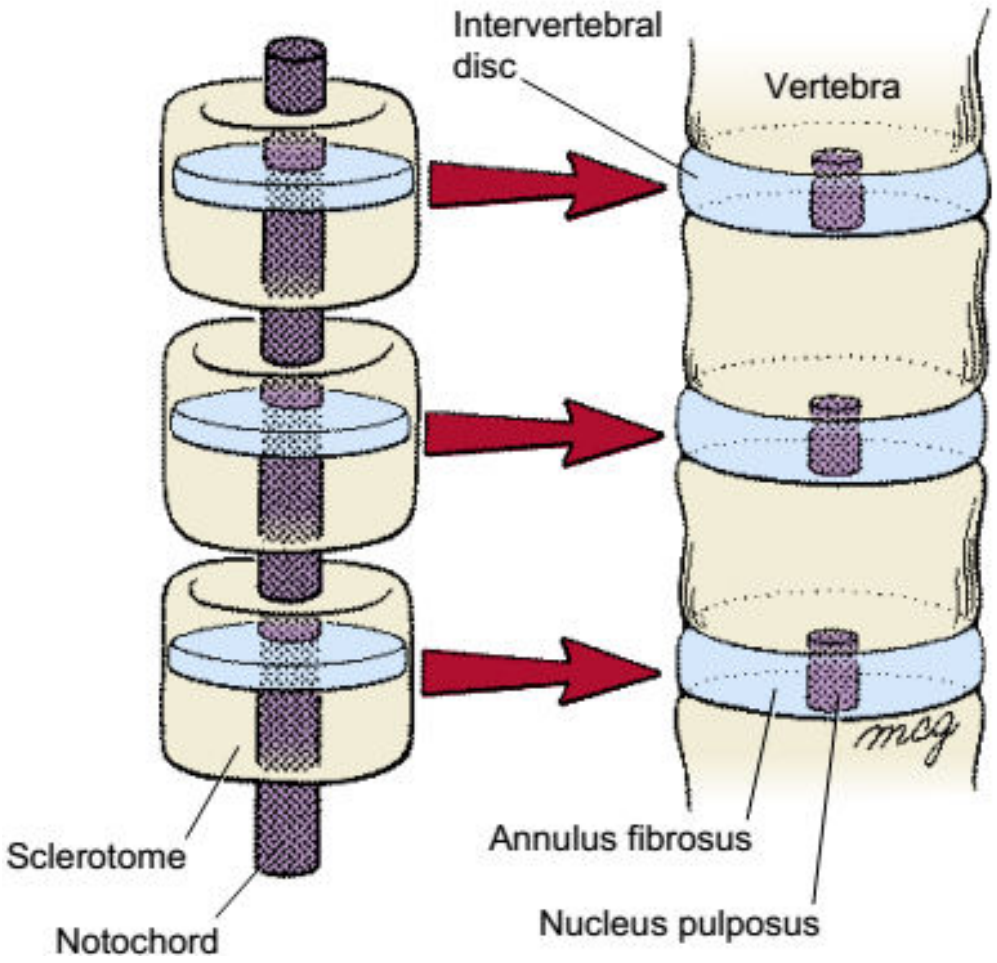
- Intially the intersegmental arteries are located b/n the sclerotomes

- After the split & reconstitution of the sclerotomrs the intersegmental arteries pass midway over the vertebral bodies

Development intervetebral disc

1. Nucleus pulposus of IVD develop from the remnants of notochord

2. Anulus fibrosus of IVD
   - Develop from cells of scelrotome that remain in the region where the scelrotomes split and surround the remnants of notochord that for nuclus pulposus



Development of vertebral arch

- Develop from parts of the scelrotomes which surround the **neural tube**
- Costal processes gives rise to
  - the transverse process laterally
  - the ribs in the thoracic region
  - foramina transversaria in the cervical region
  - lateral mass or ala of the cranium

Development of ribs

- Develop as extension from the costal process of the thoracic vertebrae

- Original sites of extensions from the vertebrae become the **costovertebral joints**

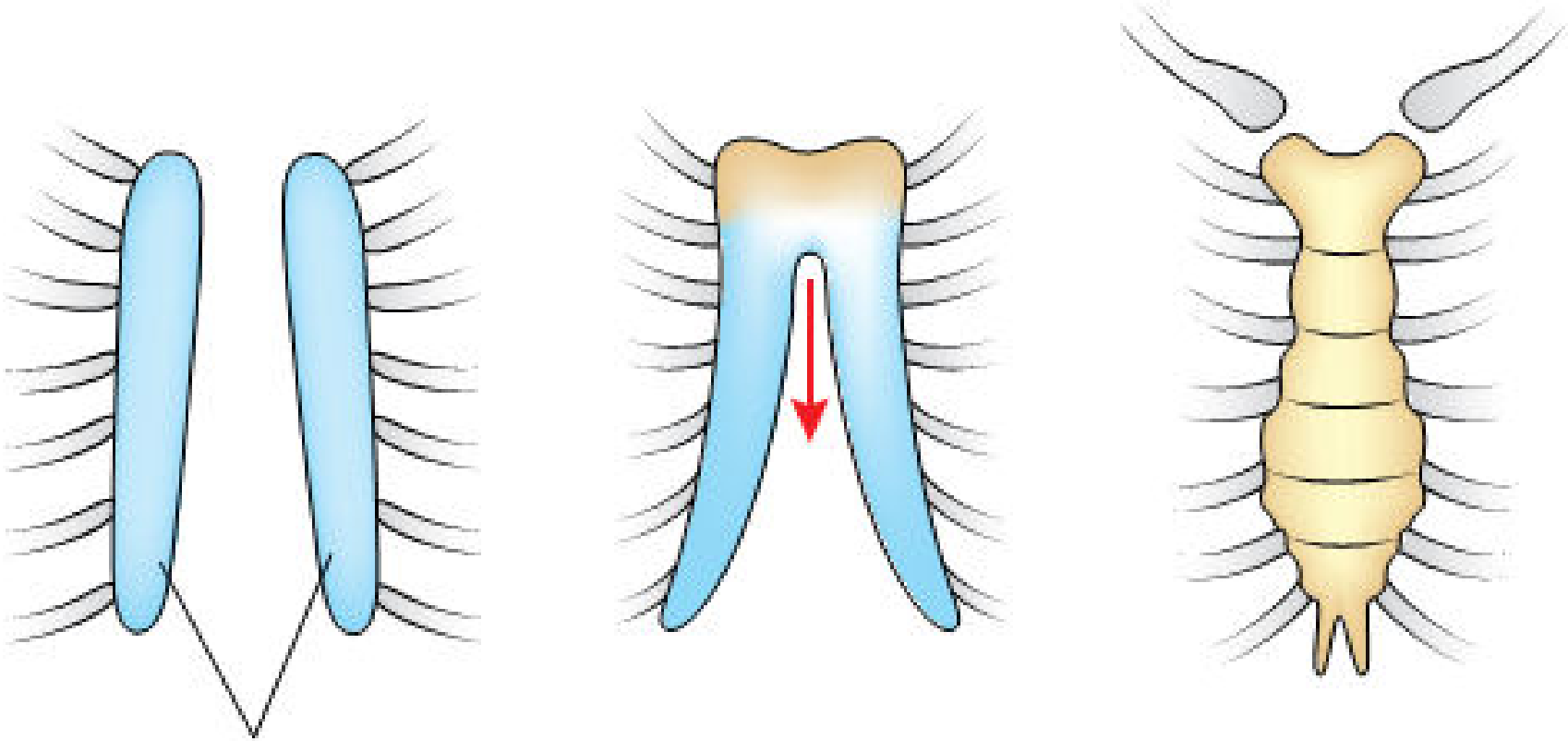
- Become cartilaginous by embryonic period & ossify by fetal period, with:
  - A primary center of ossification near the angle (**6th wk**)
  - Secondary centers of ossification centers in the tubercles & head(during adolescence)

Development of sternum

- Develop from the somatic layer of lateral plate mesoderm as paired sternal bars that fuse craniocaudally, ending distally with the formation of the xiphoid process

- Three chondrification centers appear one each for:
  - Manubrium
  - Sternabrae
  - Xiphoid proccess

- Ossification centers appear craniocaudally before birth beginning from the **5th month**, except for the xiphoid process which appears during childhood

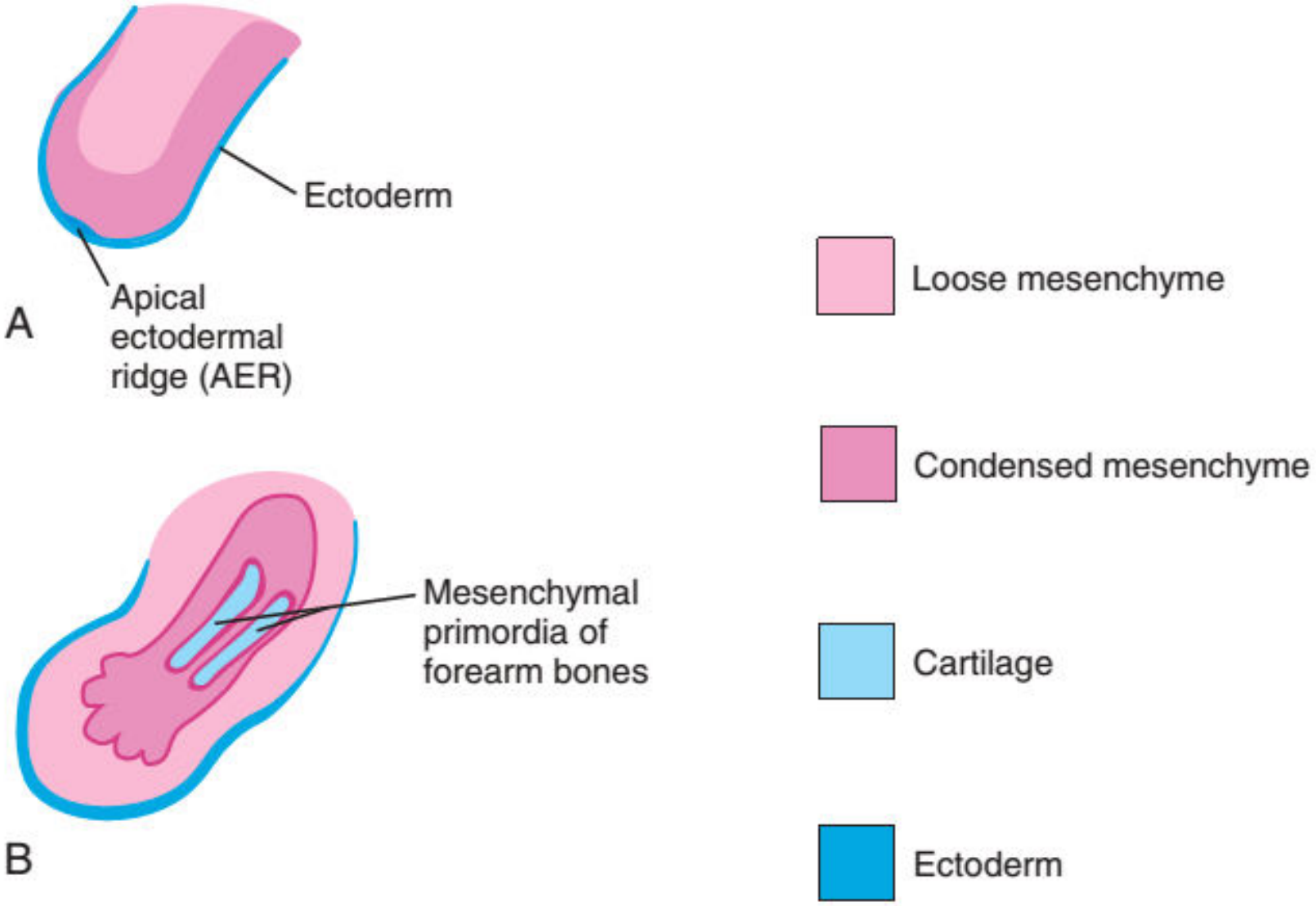

Cartilaginous sternal bars
Fusion of cartilaginous sternal bars in craniocaudal sequence
Completion of fusion
A
B
C

Development of appendicular Skeleton

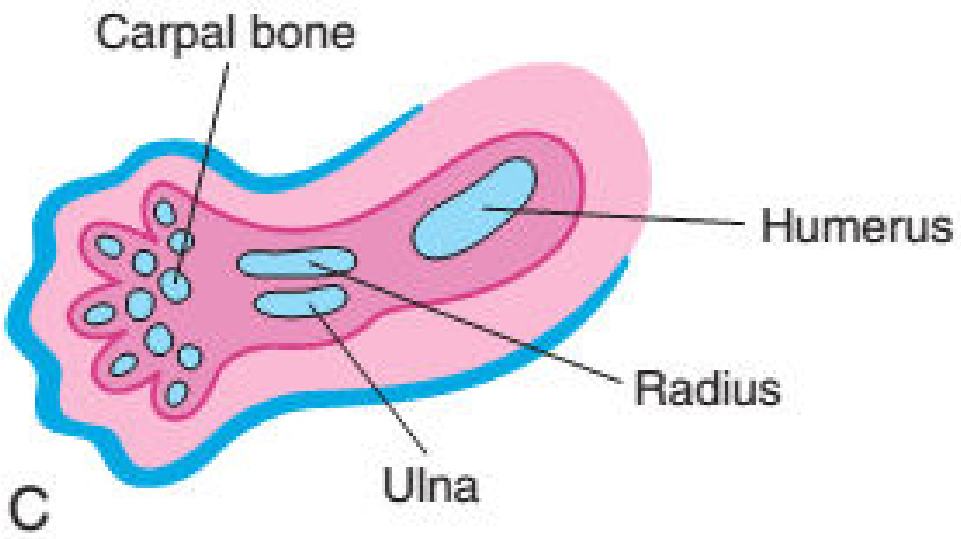
- The appendicular bones, along with tendons, ligaments and vasculature, but not musculature develop from the somatic layer of lateral plate mesoderm buds in the venterolateral body wall by the beginning of the **5th week**

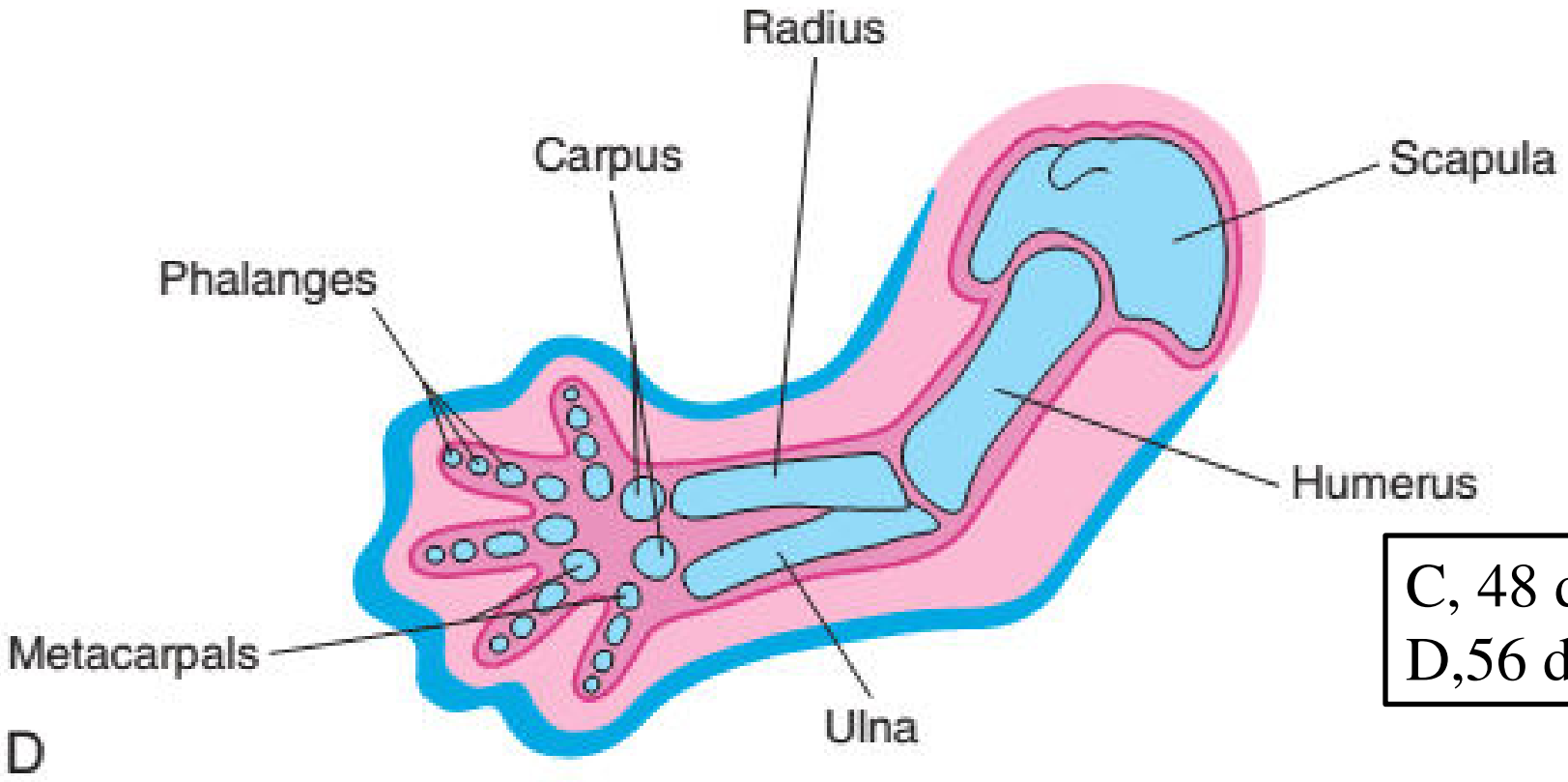
- An ectodermal proliferation known as **apical ectodermal ridge**(AER) induces the underlying mesoderm to proliferate & elongate more and more as the proximal one get differentiated.

- Programmed cell death in AER results in **5 digital rays** that will give rise to the development of the fingers & toes

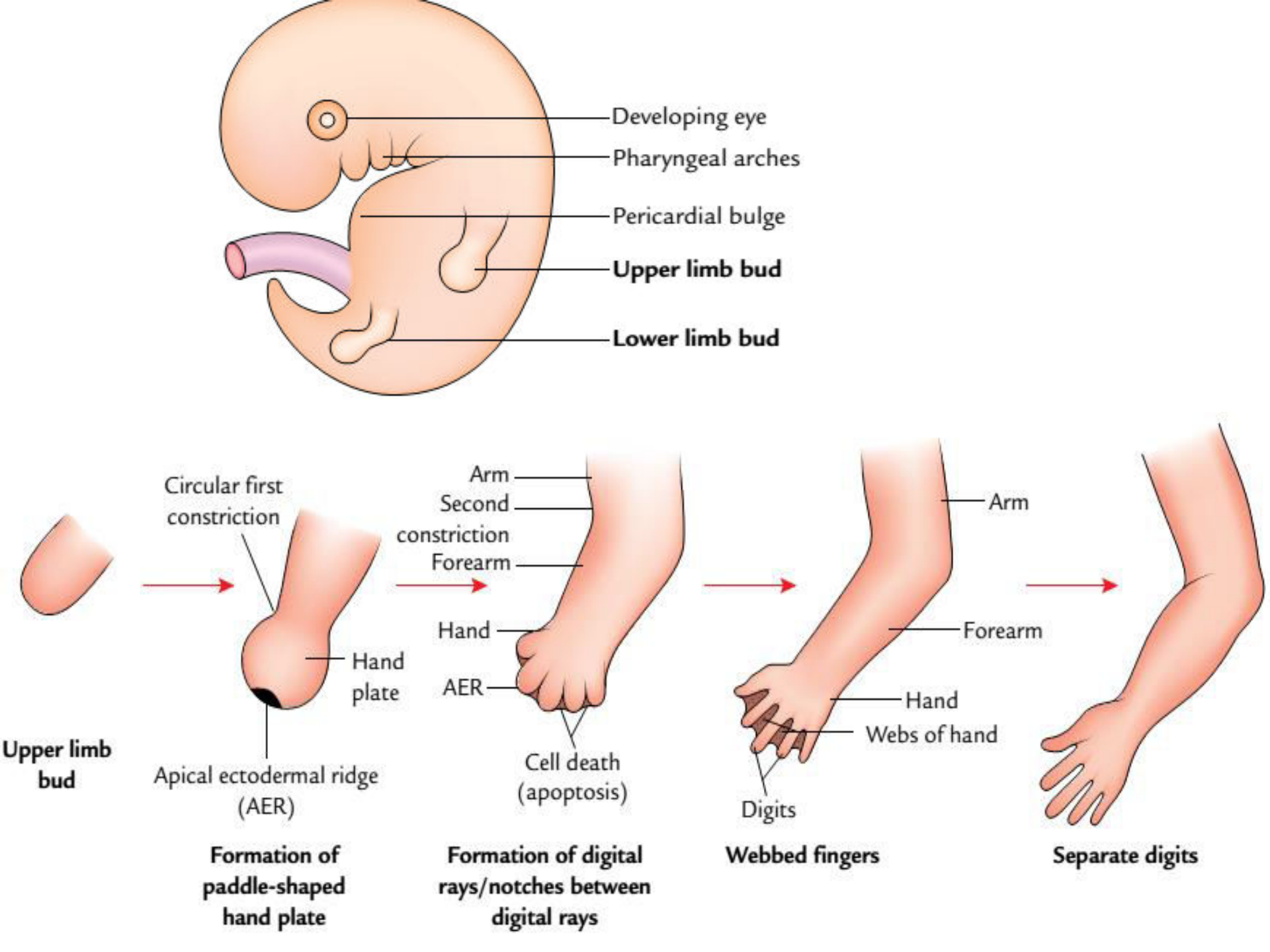


Longitudinal sections through an upper limb bud of a embryo showing development of the cartilaginous bones. **A**, At 28 days. **B** At 44 days





C, 48 days
D,56 days


Developing eye
Pharyngeal arches
Pericardial bulge
Upper limb bud
Lower limb bud
Upper limb bud
Circular first constriction
Hand plate
Apical ectodermal ridge (AER)
Formation of paddle-shaped hand plate
Arm
Second constriction
Forearm
Hand
AER
Cell death (apoptosis)
Formation of digital rays/notches between digital rays
Arm
Forearm
Hand
Webs of hand
Digits
Webbed fingers
Separate digits

Development of appendicular Skeleton

- At the **6th wk**, cartilage models appear for the bones of the limbs for endochondral ossification except the **clavicle**

- Clavicle ossifies largely intramembranously in the dermis, only the acromial and sternal ends ossifying endochondrally
    - A paired primary centers of ossification appear b/n the **5th & 6th wks** for the shaft making the clavicle the first bone to begin ossification

Development of appendicular Skeleton

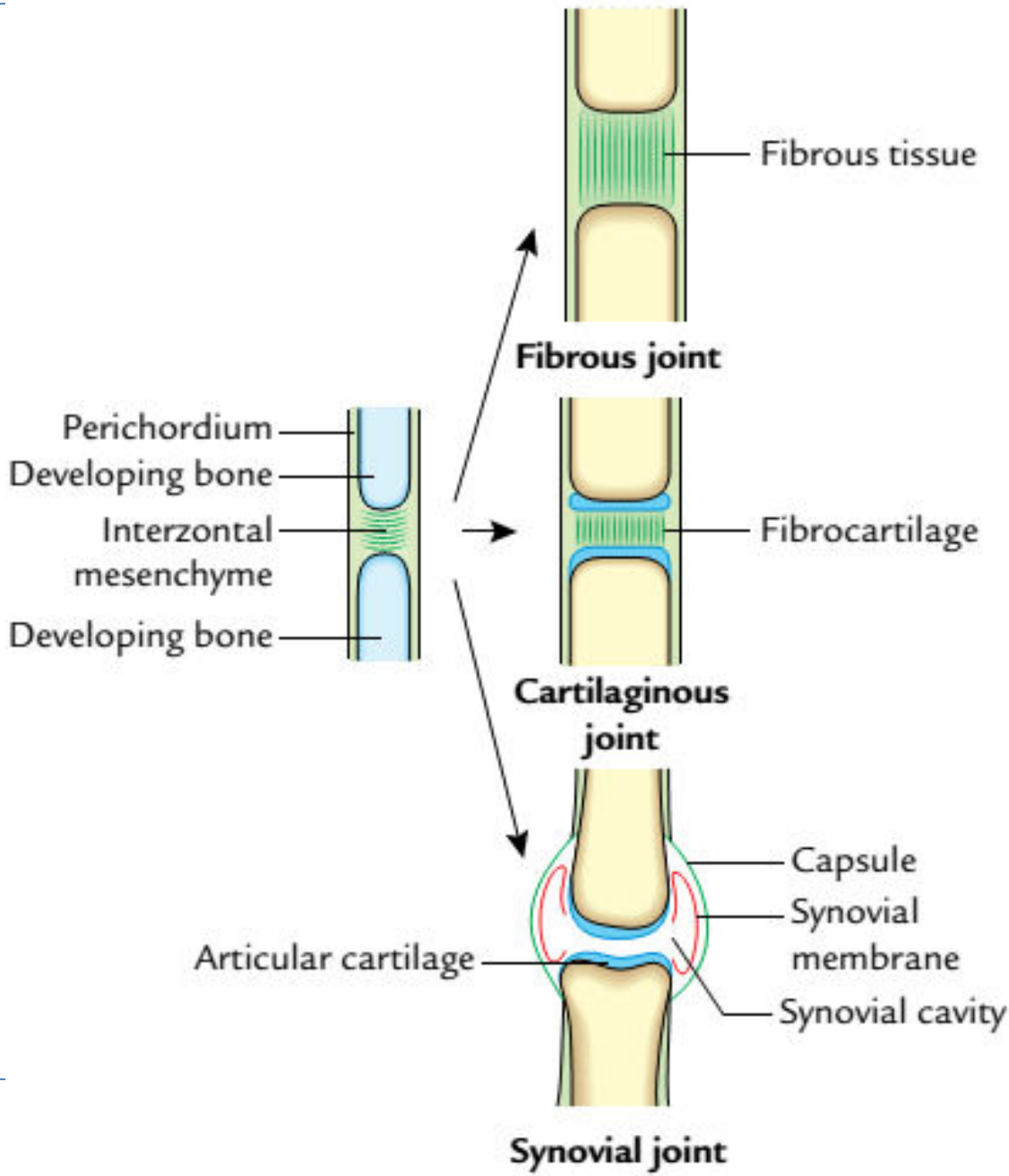
- Ossification occurs in:
  - Humerus, radius and ulna at the end of the **7th wk**
  - Femur and tibia by the **8th wk**
  - Scapula and ilium by the **9th wk**
  - By the **12th wk** ossification centers are found in all long bones

- At birth **diaphyses** are ossified
- Shortly after, secondary centers of ossifications appear
- At the **7th wk**
  - **Upper limb rotates 90 laterally**
  - **Lower limb rotates 90 medially**

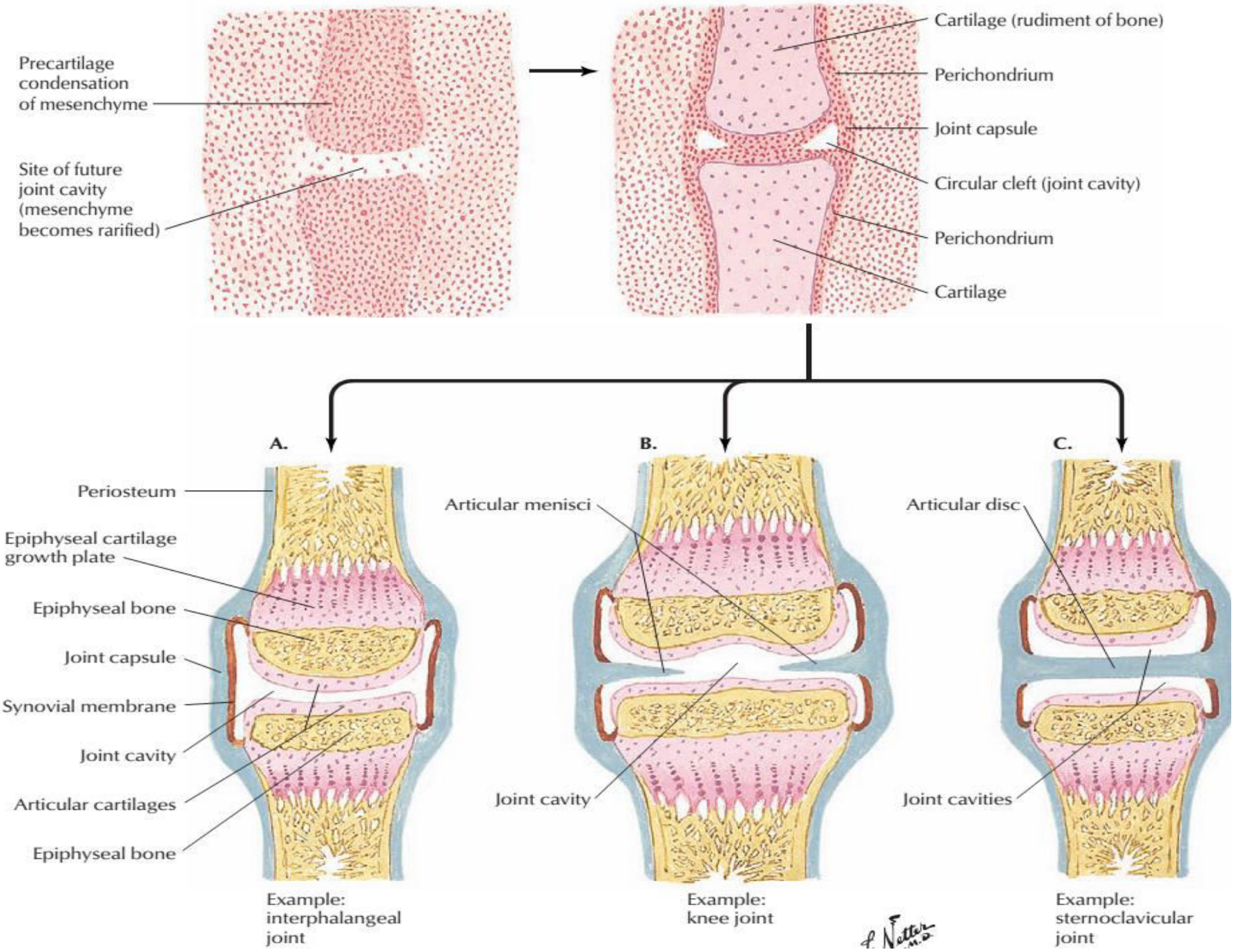
Development of joints of appendicular skeleton

- Initially develop as mesenchymal condensations in the **interzonal regions** b/n the chondrifing bone primordia

- Subsequently develop into the respective tissue components in each of the **fibrous, cartilaginous and synovial joints**

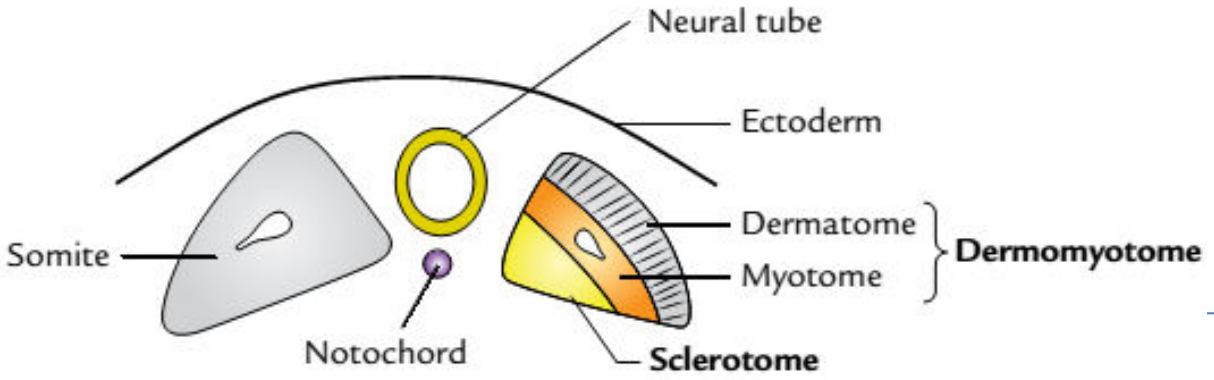


Development of three types of synovial joints



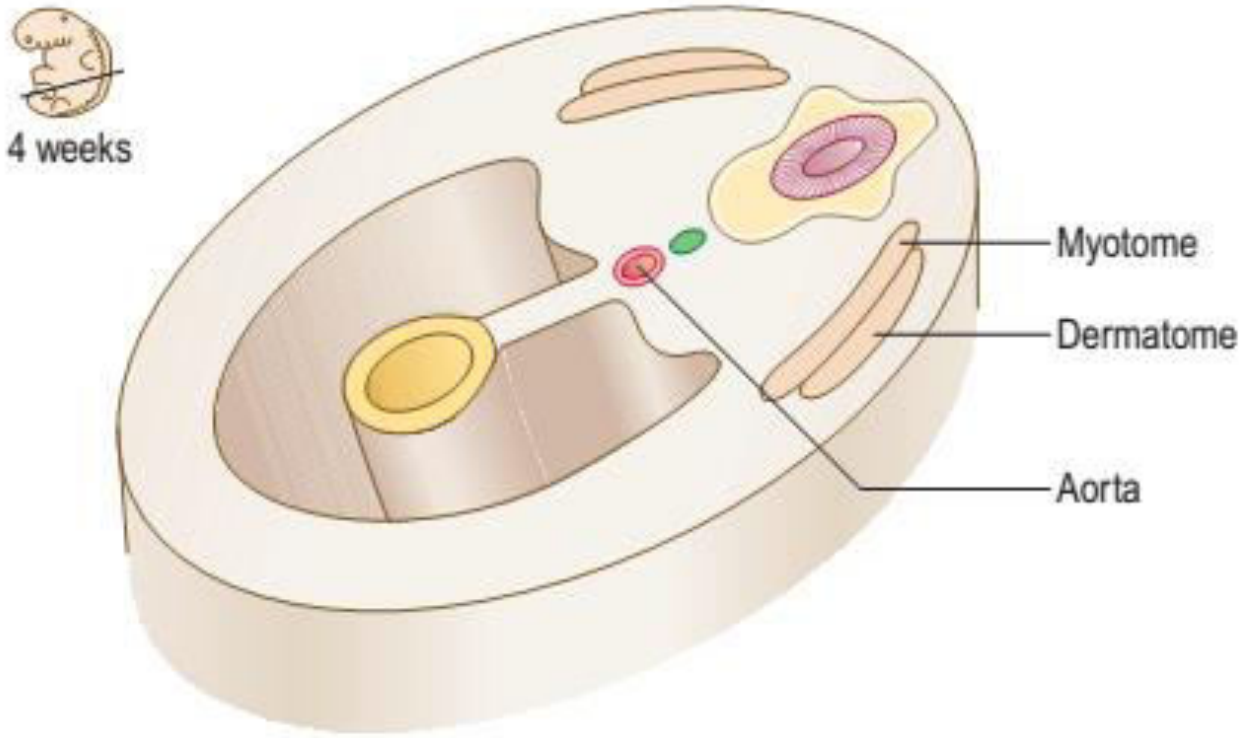
Development of joints of skeletal muscle

- Develop from somitomers & somites that give rise to myoblasts which elongate and fuse giving the multinuceated muscles cells
- **Somites**
  - Scelerotome
  - Dermatome
  - Two muscle forming region
    - Veterolateral edge or lip(VLL)
    - Dorsomedial edge or lip(DML)



Development of joints of skeletal muscle

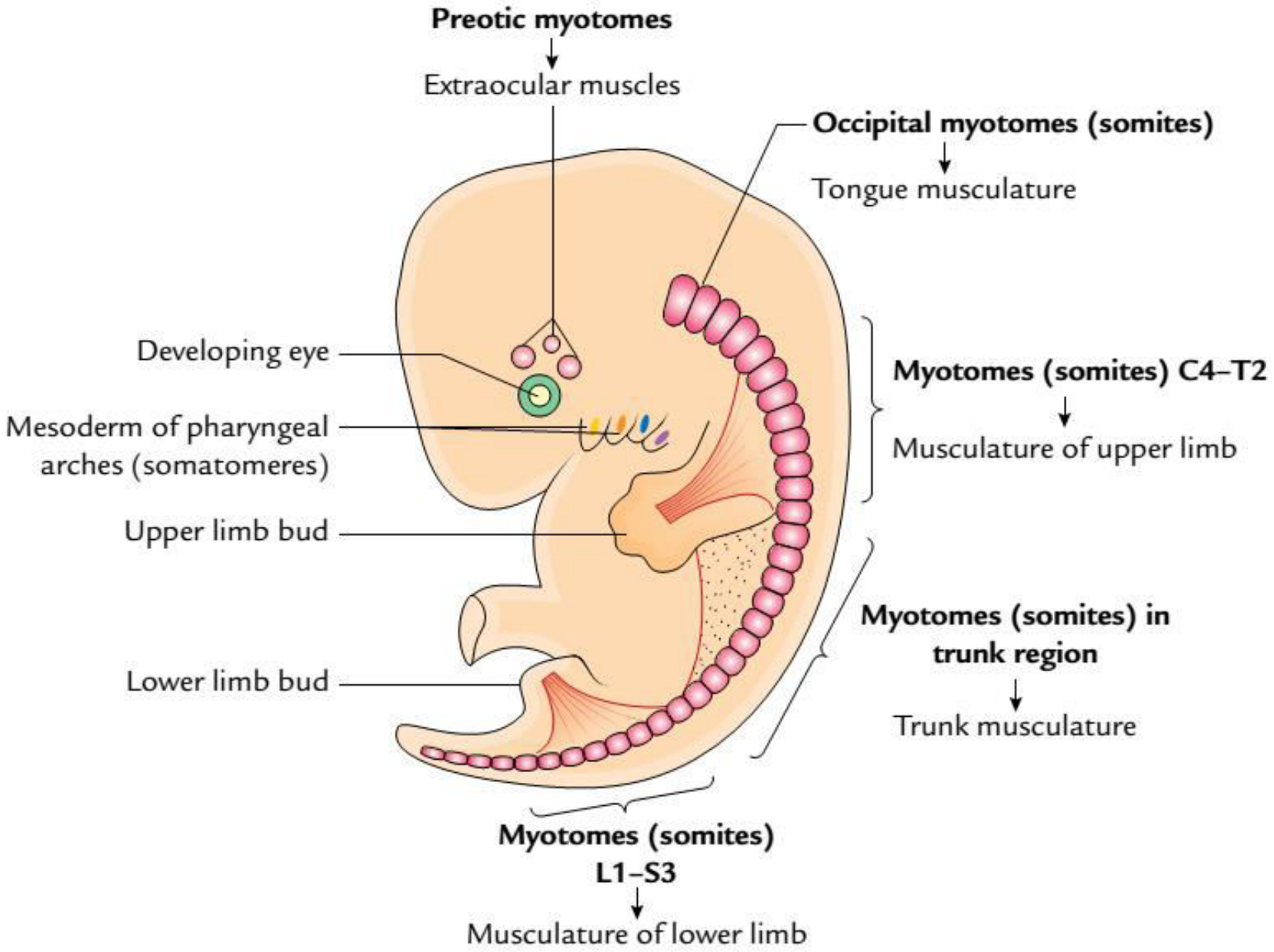
- Cells of **VLL** and **DML** along with dematome make **dermomyotome**
- **Dermomyotome** differentiates into:
    1. Dermatome-dermis
    2. Myotome –form muscles



Development of skeletal muscle of the head

- Development of **occular muscles**
  - Develop from somitomers 1-3 &5 (preotic myotomes), except the muscles of the iris which develop from the ectoderm of the **optic cup**

- Branchial(visceral) muscles such as muscles of facial expression and muscles of mastication
  - Develop from muscles of **branchial arches** that develop from:
    - 4^{th} , 6^{th} & 7^{th} somitomeres
    - 1^{st} occipital somite
    - 1^{st} & 2^{nd} cervical somites
- Muscles of the tongue develop from the 2^{nd} -4^{th} occipital myotomes

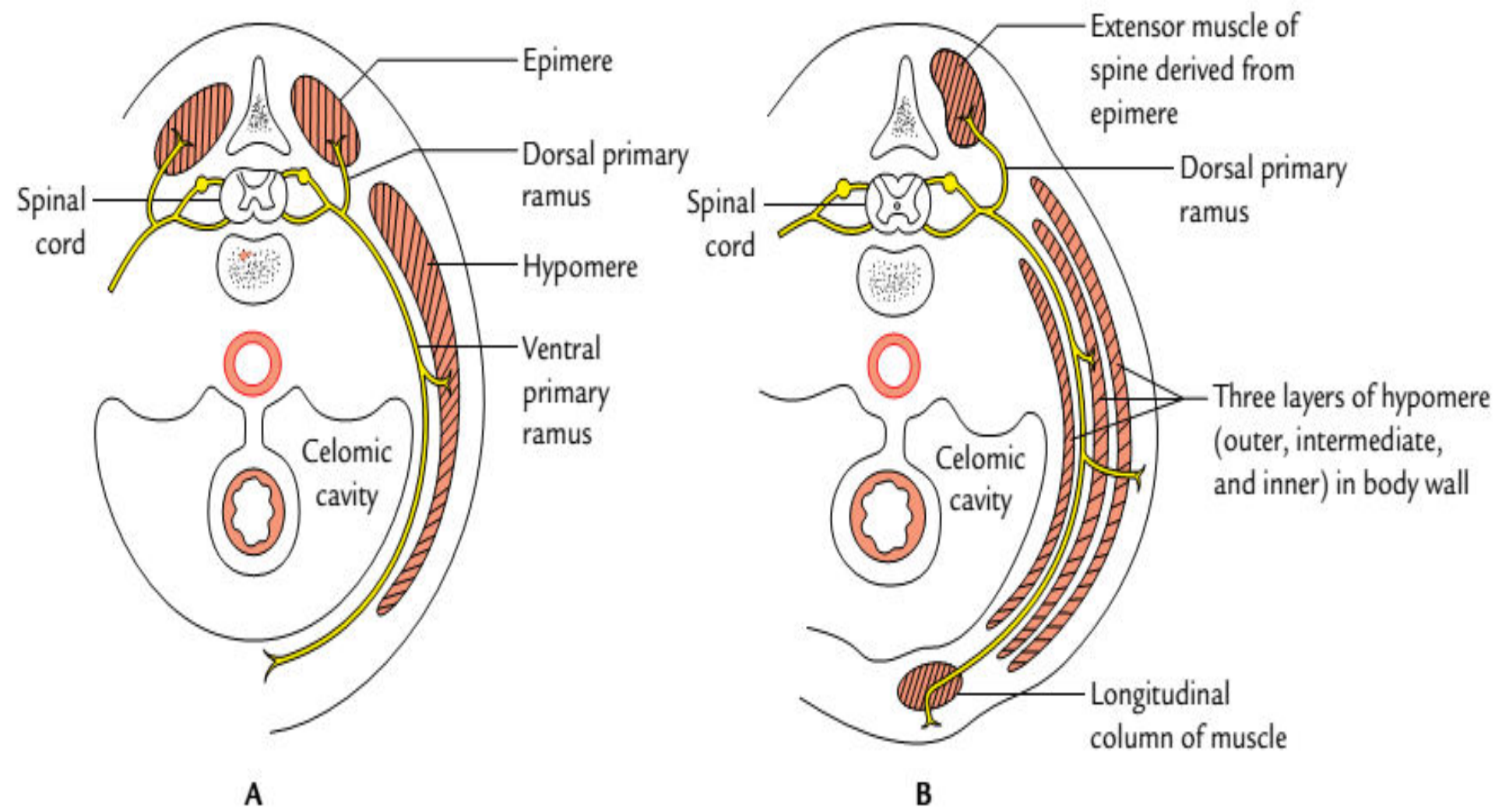


Myotomes derived from somites & somatomeres in different regions of the body which form skeletal muscles

Development of muscle of the trunk and limbs

- Develop by the **5th wk** from myotomes that divide into:

1. Epimers (epiaxial divisions)
   - Small & dorsally located
   - Innervated by the dorsal primary rami of the spinal nerves
   - Develop into the extensor muscles of the spine(vetebral column)
2. Hypomers (hyoaxial division)
   - Larger and ventrally located
   - Innervated by the ventral primary rami of the spinal nerves
   - Develop into:
     - Lateral flexor muscles
     - Ventral longitudinal column muscles
     - Limb musculature



A. Subdivision of myotome into epimere and hypomere, and their innervation by dorsal primary ramus and ventral primary ramus, respectively. B. Formation of three separate muscles layers from hypomere and ventral longitudinal muscles

Development of muscle of the trunk and limbs

Development of lateral flexor muscles

- Formed of 3 layers that give rise to the:

1. Intercostal muscles-remain segmented by the ribs

2. Abdominal muscles
   - External oblique abdominis
   - Internal oblique abdominis
   - Transversus abdominis

Development of muscle of the trunk and limbs

Development of ventral longitudinal column muscles

- Gives rise to:

1. Strap muscles of the neck including geniohyoid, infrahyoid and scalene muscles
2. Rectus abdominis and quadratus lumborum

Development of muscle of the trunk and limbs

Development of limb musculature

- Myoblasts from the hypomers of the myotomes migrate into the developing limb buds opposite:
  - C4-T2 levels for the upper limb
  - L2-S3 levels for the lower limb

Development of muscle of the trunk and limbs

Development of limb musculature

- In the limb bud the mesoderm forms:

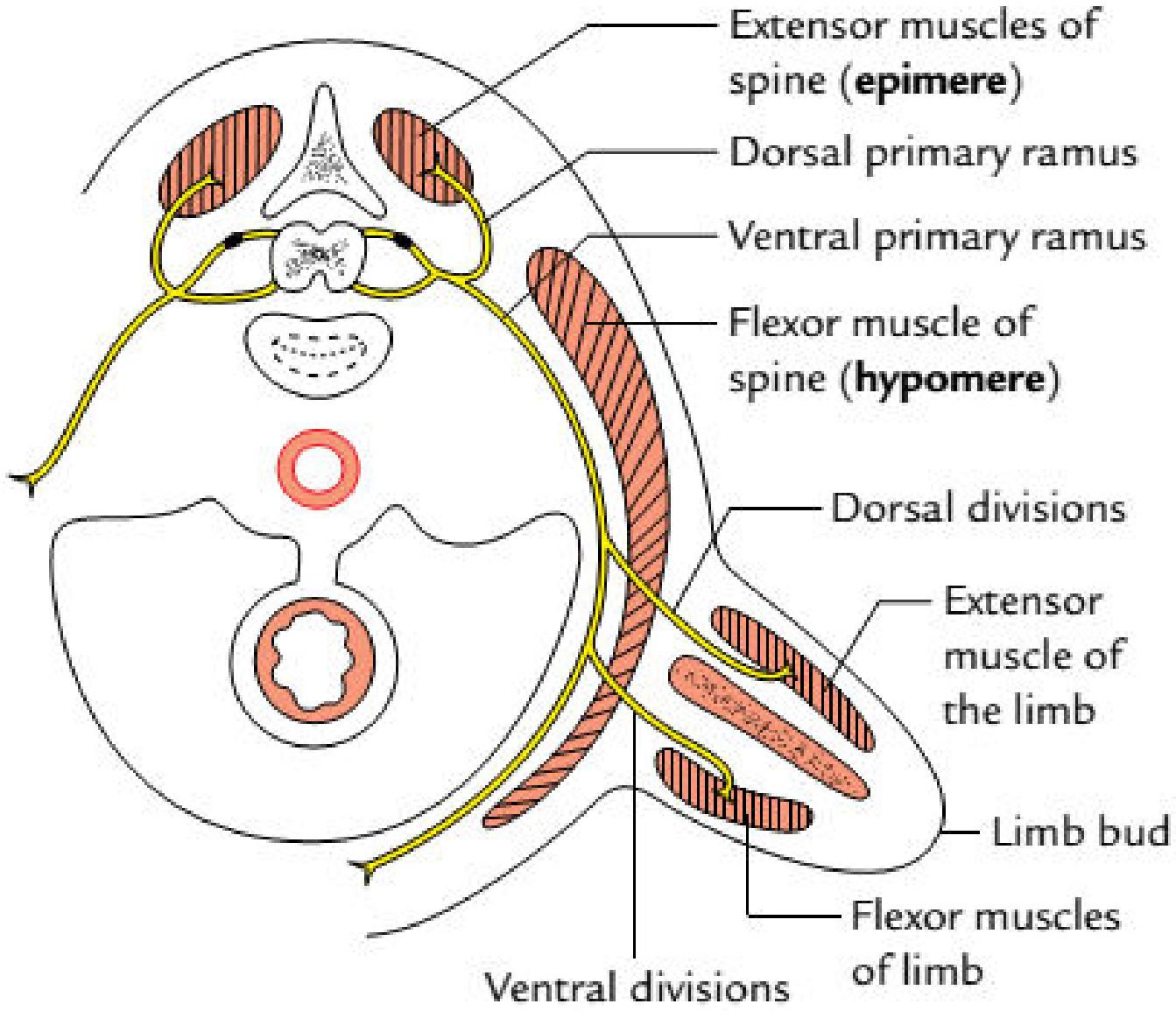
1. A ventral condensations(flexor component)
   - Located ventral to the axial mesenchyal column developing into the hypoaxial muscles
   - Innervated by the anterior divisions of the ventral rami of spinal nerves
   - Gives rise to the flexors & pronators of upper limb and flexor & adductors of lower limb

Development of muscle of the trunk and limbs

Development of limb musculature

- In the limb bud the mesoderm forms:

2. A dorsal condensation(extensor components)
   - Dorsal to the axial mesenchyal column developing into the epaxial muscles
   - Are innervated by the posterior divisions of the ventral rami of spinal nerves
   - Give rise to the extensors & supinators of upper limb and extensors & abductors of lower limb



Development of musculature into the limb bud. Note the extensor (dorsal) and flexor (ventral) components of limb musculature

Development of cardiac muscles

- Develop from splanchnic mesoderm surrounding the primitive heart tube

- Myoblasts adhere, but do not fuse, giving rise to the intercalated discs

Development of smooth muscles

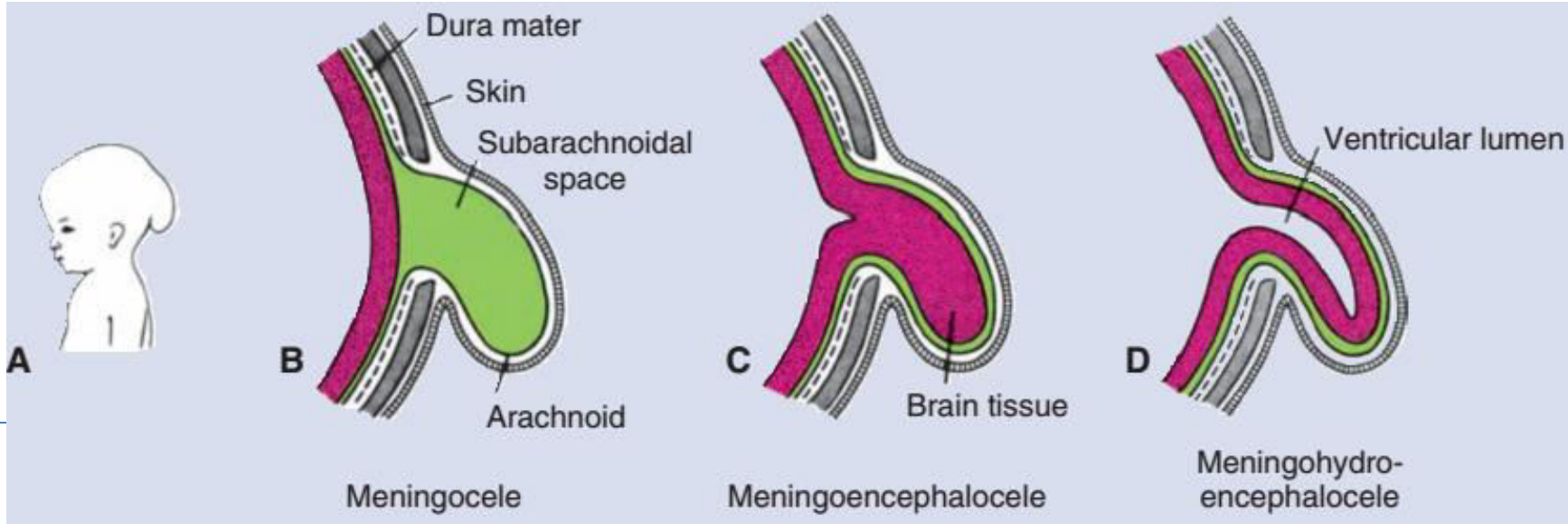
- Develop from the
  - Splanchnic mesoderm arround the primitive gut tube that give rise to musculature of:
    - Gut, respiratory and surrounding vessels
  - Somatic mesoderm that gives rise to musculature of :
    - Vessels in the head, body wall and limb
  - From **ectoderm**
    - pupillary, mammary gland, and sweat gland muscles

Congenital anomalies of musculoskeletal system

- **Anencephaly** :
  - In this condition, major portion of the cranial vault fails to form (**cranioschisis**).
  - It occurs if anterior neuropore of neural tube fails to close.
  - The brain tissue is exposed to amniotic fluid and gradually degenerates.
  - Children with such severe skull and brain defects cannot survive
  - If not, stillborn infants with anencephaly survive only few hours or weeks.

Congenital anomalies of musculoskeletal system

- Encephalocele:
  - It occurs due to small defects in the skull through which meninges and/or brain tissue herniate.
  - Depending upon severity, the encephalocele is divided into three types:
    - Meningocele
    - Meningoencephalocele
    - meningohydroencephalocele



Congenital anomalies of musculoskeletal system

Abnormalities of the shape of the skull

- **Scaphocephaly**: Boat-shaped skull due to frontal and occipital expansions. It occurs due to early closure of the sagittal suture (57% of cases).
- **Brachiocephaly**: Short skull due to premature bilateral synostosis (closure) of the coronal suture.
- **Plagiocephaly**: It occurs due to premature closure of coronal and lambdoid sutures on one side only. It results in grossly unequal curvatures of skull on two sides.
- **Acrocephaly**: Pointed skull due to premature closure of the coronal suture.
- **Microcephaly**: Small skull due to failure of proper development of the brain

Craniosynostosis

The **metopic suture** is supposed to close between three and nine months of age.

The **coronal**, **sagittal**, and **lambdoid** sutures are supposed to close between 22 and 39 months of age.


A


A


B

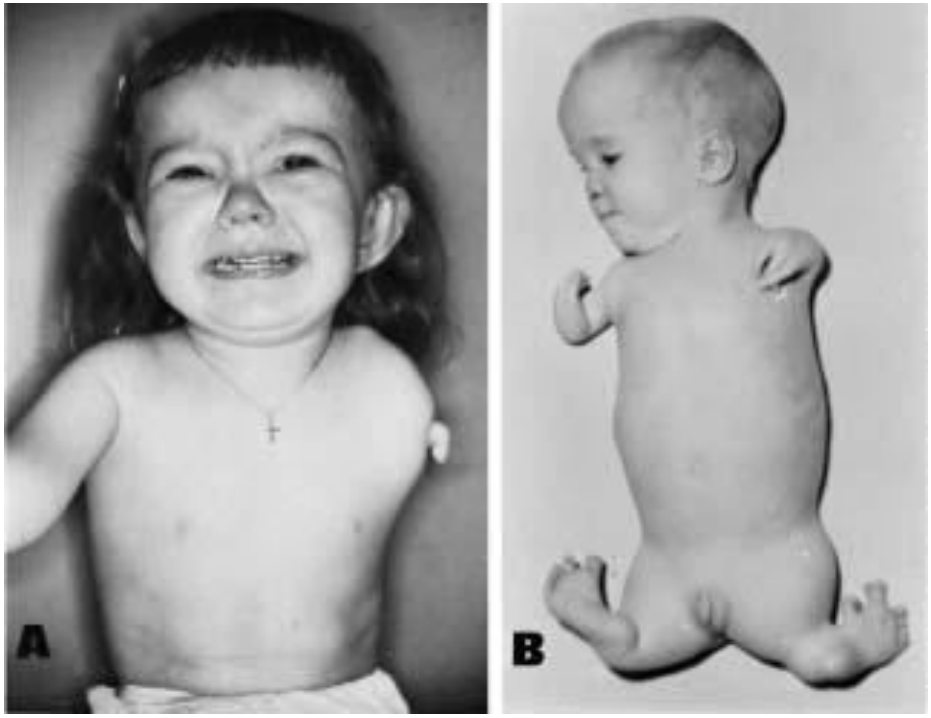
Congenital anomalies of musculoskeletal system

- **Achondroplasia (ACH):**
  - It is the most common type of dwarfism (shortness of stature). It occurs due to defective endochondral ossificationat the epiphyseal plates of cartilage, particularly of long bones. It occurs in about 1 in 26,000 live births.
  - The limbs become bowed and short; trunk remains normal and head is enlarged with bulging forehead.

Congenital anomalies of musculoskeletal system

- **Amelia**: In this condition, there is a complete absence of all four limbs.
- **Phocomelia**: In this condition, rudimentary hands and feet are directly attached to the trunk.
- **Meromelia**: In this condition, all three segments of limbs are short.
- **Syndactyly** (webbed fingers or toes):It is the common limb anomaly and results from failure of hand and foot webs to degenerate between the digits.
- **Polydactyly**: In this condition, there is a supernumerary digit in hand or foot, most commonly the thumb that may have an extra phalanx.
  - It is the most common congenital anomaly of the hand

Congenital anomalies of musculoskeletal system



A. Child with unilateral amelia.

B. Patient with a form of meromelia called phocomelia.The hands and feet are attached to the trunk by irregularly shaped bones.


A


C


D

Congenital anomalies of musculoskeletal system

- Talipes or clubfoot:
  - Any deformity of foot involving talus is called talipes or clubfoot.
  - There are various types but talipes equinovarusis the most common type occurring about 1 in 1000 births.
    - the foot is turned medially and is inverted.
    - It results from abnormal positioning or restricted movements of fetus's lower limbs in utero.

Congenital anomalies of musculoskeletal system

- Duchenne muscular dystrophy (DMD):
  - It is a hereditary disease of skeletal muscles that usually affects males.
  - occurs due to mutation of a gene responsible for the formation of protein (dystrophin)on the inner surface of sarcolemma of muscle fibers.
  - In this condition, the skeletal muscle becomes progressively weak from early childhood and by adulthood the person becomes practically immobile.

Congenital anomalies of musculoskeletal system

- Partial or complete absence of one or more muscles:
  - **Polland sequence-** absence of pectoralis minor and partial absence of pectoralis major muscle (usually sternal head).
  - **Prune belly syndrome-** partial or complete absence of abdominal wall musculature.
- **Congenital torticollis**:
  - It is congenital shortening of the sternocleidomastoid muscle, which occurs due to excessive stretching of this muscle during delivery.
  - The excessive stretching causes hemorrhage in the muscle and subsequent shortening due to fibrosis.

Prune belly syndrome: a distended abdomen from aplasia of abdominal wall musculature

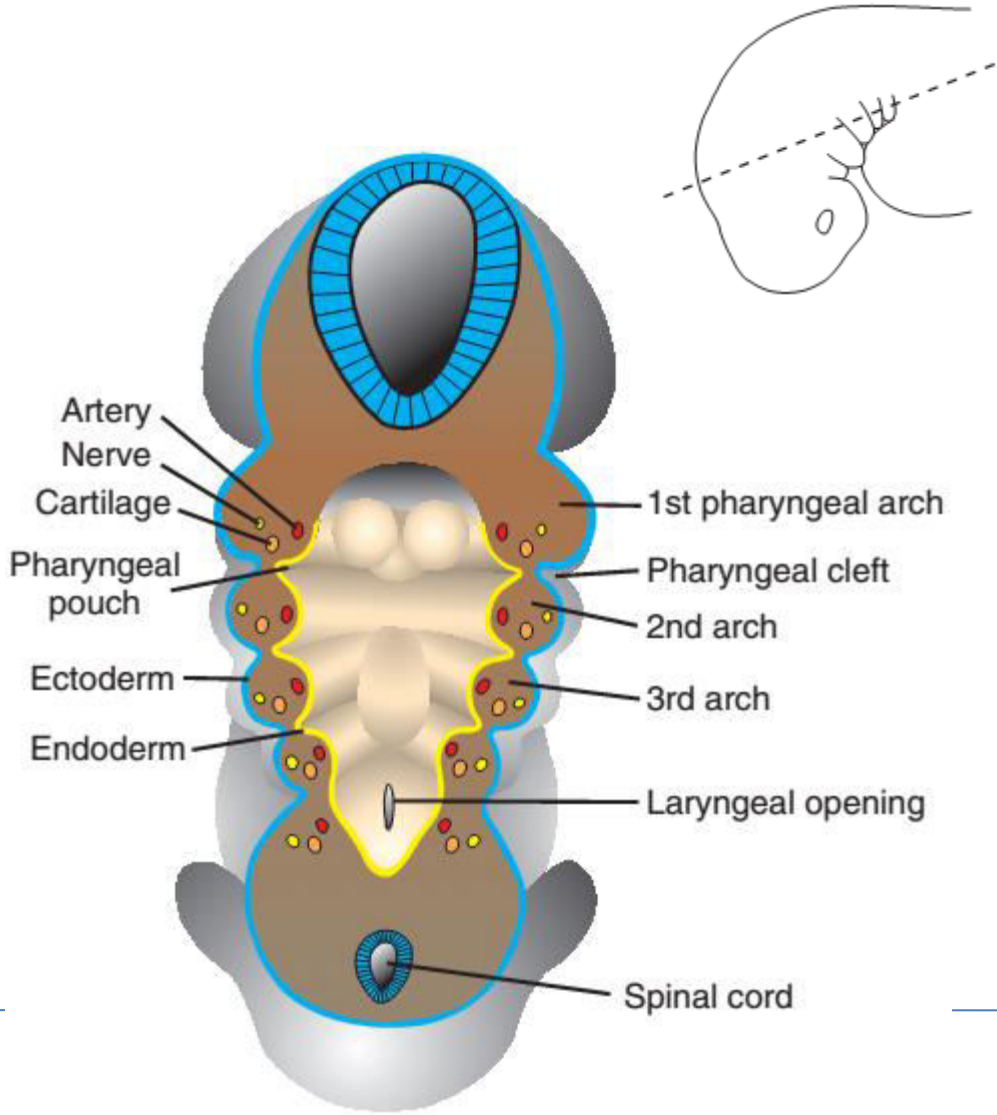
PHARYNGEAL APPARATUS, FACE & NECK

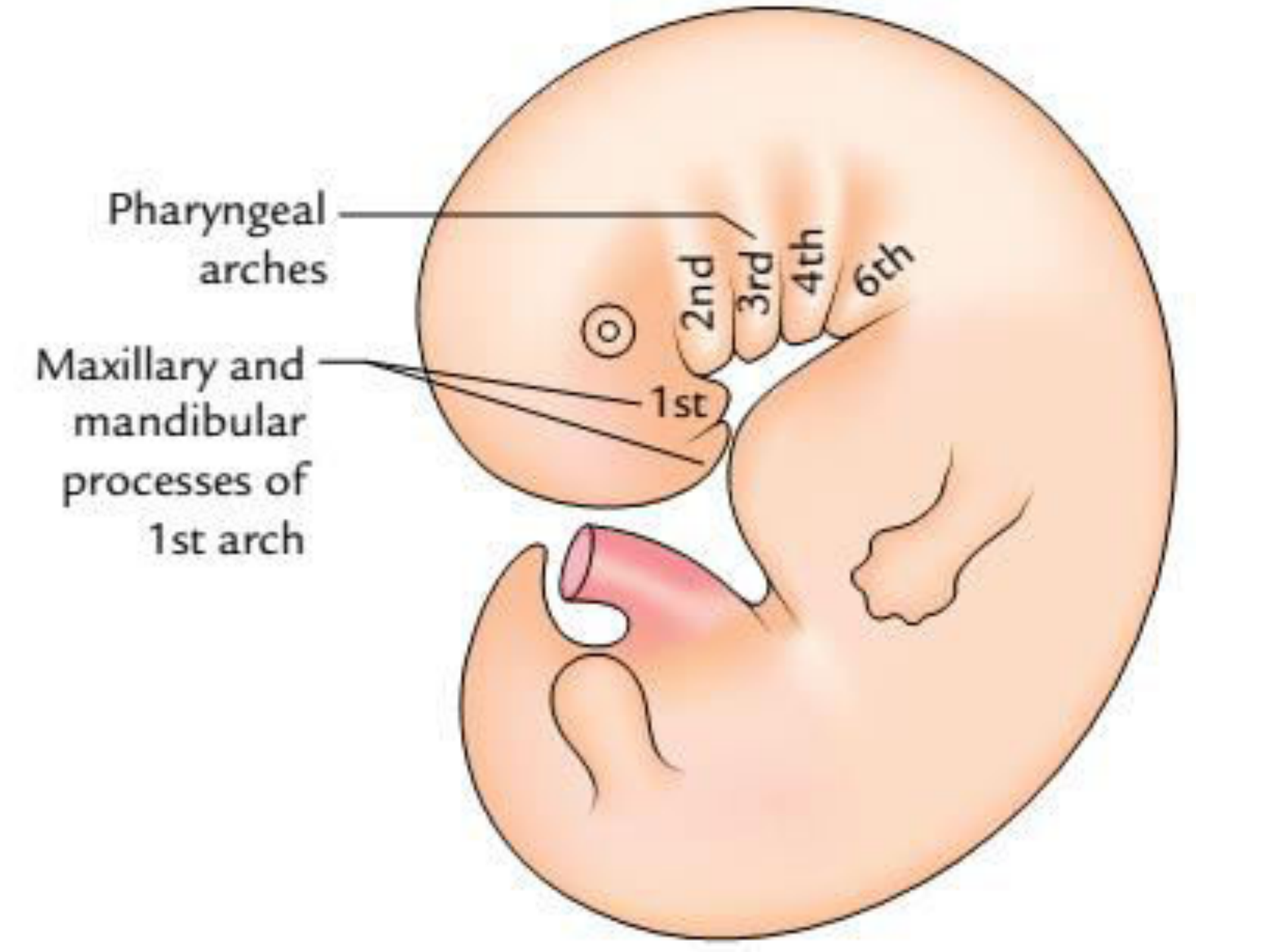
By: Fentahun A.

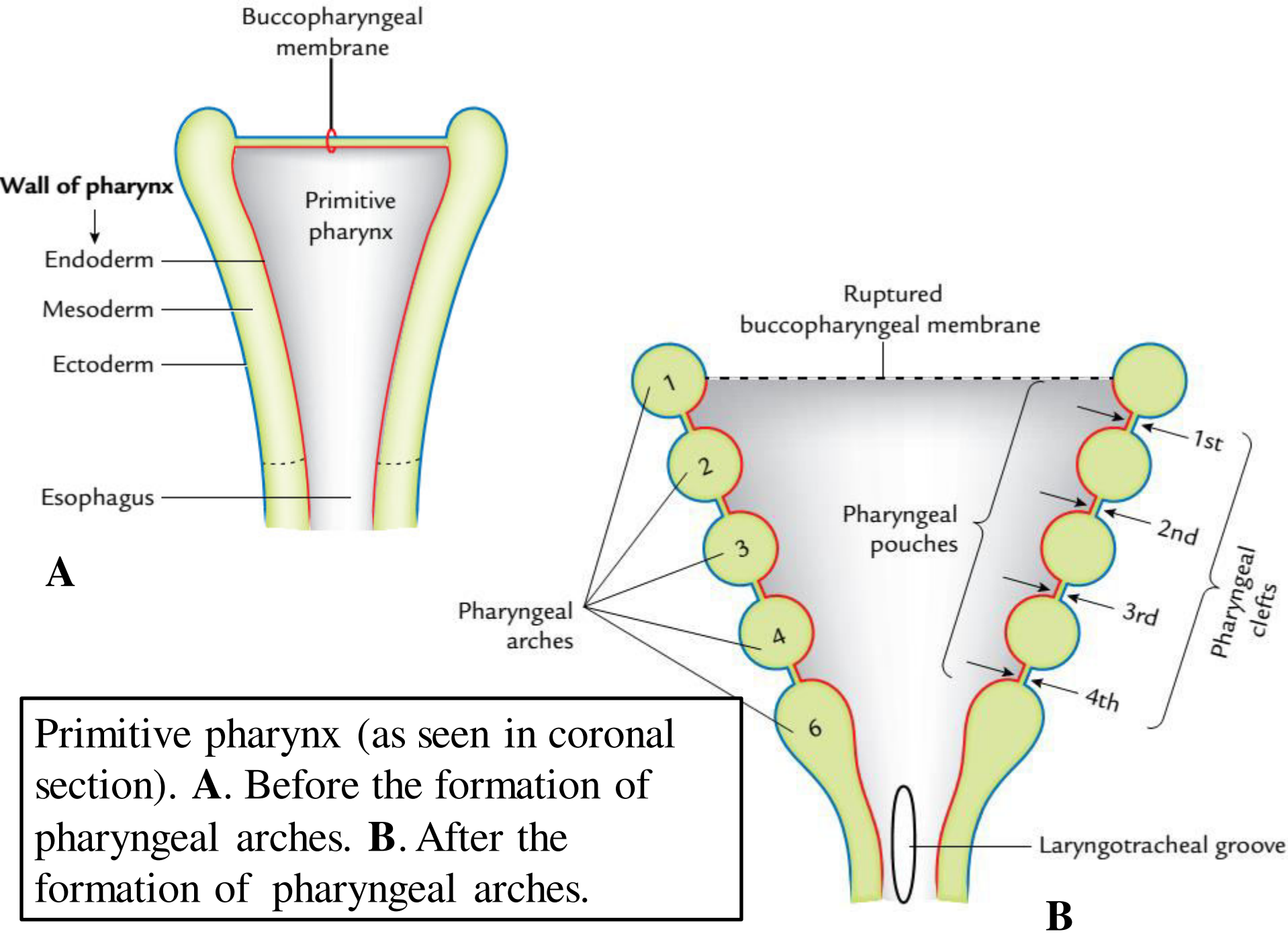
Pharyngeal apparatus

- Consists of
  - pharyngeal arches
  - pharyngeal pouches
  - pharyngeal grooves(clefts)
  - pharyngeal membranes

- These embryonic structures contribute to the formation of the face and neck.



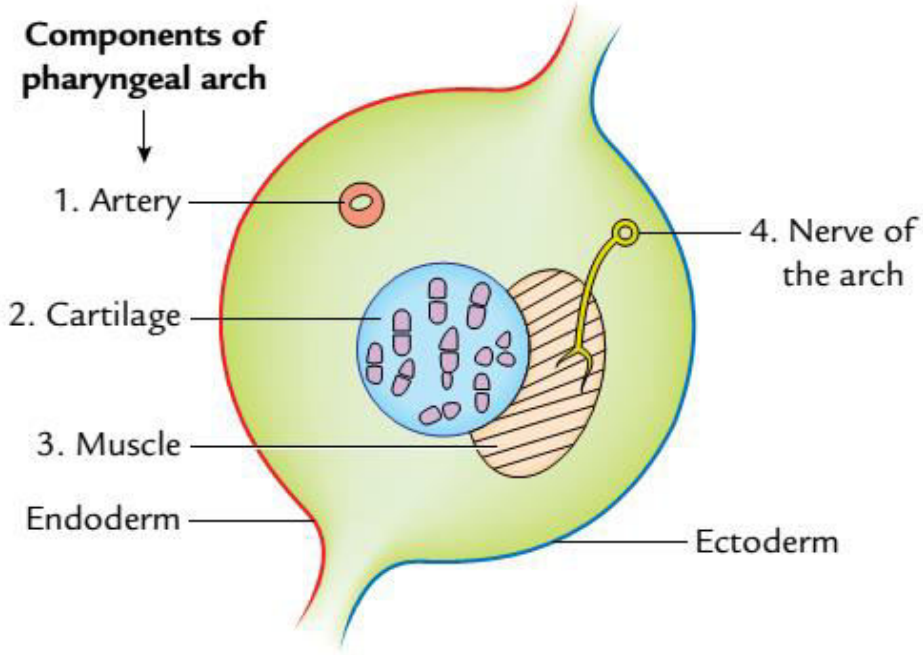

Pharyngeal arches
Maxillary and mandibular processes of 1st arch
2nd
3rd
4th
6th
1st



Primitive pharynx (as seen in coronal section). **A**. Before the formation of pharyngeal arches. **B**. After the formation of pharyngeal arches.

Pharyngeal arches

- 5 pairs of bars surrounding the primitive pharynx
- Appear in craniocaudal sequence
- The 5th one is absent or disappear immediately after appearance
- They are made by mesenchymal core with the following 4 components
  - A cartilage bar
  - A striated muscular component
  - An aortic arch artery
  - A nerve



Mesenchymal core of pharyngeal arches

- Lined internally by endoderm and externally by ectoderm

- Is formed from
  - Paraxial mesoderm
  - Lateral plate mesoderm
  - Neural crest
  - Ectodermal placodes

Mesenchymal core of pharyngeal arches…

- **Paraxial mesoderm**(somites & somitomers) form
  - Base of cranial cavity
  - All voluntary muscles of cranofacial region
  - The dermis & connective tissues in the dorsal region of the head
  - The meninges caudal to the prosencephalon

- **Lateral plate mesoderm** forms
  - The laryngeal cartilagess & connective tissues in this region

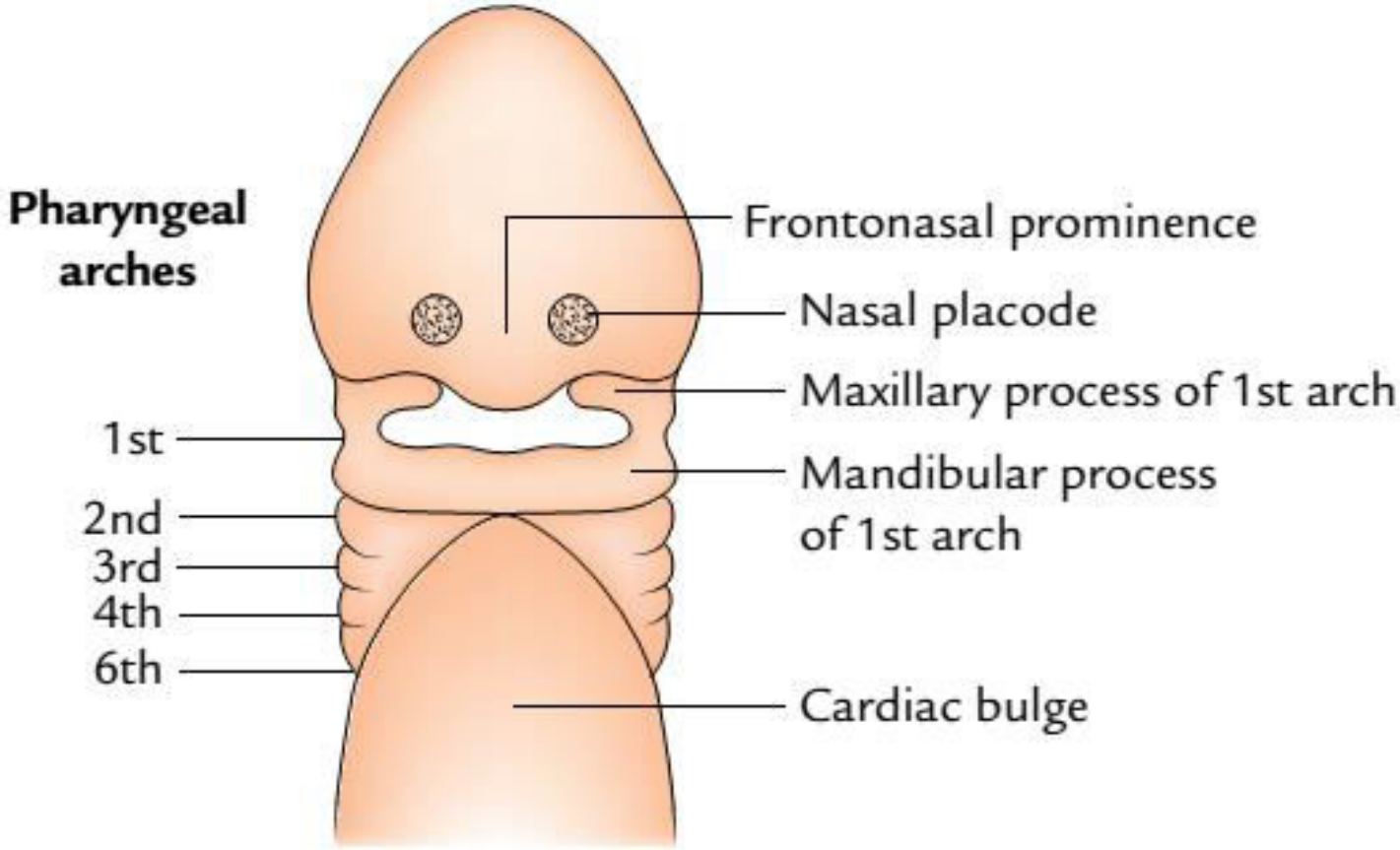
Mesenchymal core of pharyngeal arches…

- **Neural crest cells form**
  - Midfacial & pharyngeal arch skeletal structures and all other tissues in these regions, including cartilage, bone, dentin, tendon, dermis, pia and arachnoid, sensory neurons and glandular stroma

- **Cells from ectodermal placodes** together with neural crest forms
  - Neurons of the 5^{th}, 7^{th} , 9^{th},& 10^{th} cranial sensory neurons

1st pharyngeal arch

- Divides into:
  1. Maxillary process(prominence)
  2. Mandibular process(prominence



Cartilaginous bars of 1st pharyngeal arch

1. **Palatopterygoquadrate cartilage**

- In the maxillary process
- Retrogress, but surrounding mesenchyme gives rise to
  1. Maxilla
  2. Zygomatic bone
  3. Squamousal part of temporal bone

Cartilaginous bars of 1st pharyngeal arch…

2. Meckel's cartilage

- In the mandibular process

- Gives rise to
  - Incus
  - Malleus
  - Anterior ligament of malleus
  - Sphenomandibular ligament
  - Template for mandible

Muscular component of 1st pharyngeal arch…

- Derived from the 4th cranial somitomers of paraxial mesoderm
- Gives rise to
  - Muscles of mastication
  - Mylohyoid
  - Anterior belly of digastric
  - Tensor tympani
  - Tensor velli palatini

1st pharyngeal arch …

Nervous component of 1st pharyngeal arch

Develops into:

1. Maxillary nerve
2. Manadibular nerve

Arterial component of 1st pharyngeal arch

- Gives rise to terminal part of maxillary artery

Cartilaginous component of 2nd pharyngeal arch

- Known as Reichert's cartilage

- Gives rise to:
  - Stapes
  - Styloid process of temporal bone
  - Lesser horn & superior part of body of hyoid bone
  - Stylohyoid ligament

Muscular component of 2nd pharyngeal arch

- Derived from the 6th cranial somitomers of the paraxial mesoderm

- Gives rise to:
  - Muscles of facial expression
  - Stapedius muscles
  - Stylohoid muscles
  - Posterior belly of digastric muscle

2nd pharyngeal arch…

Nervous component

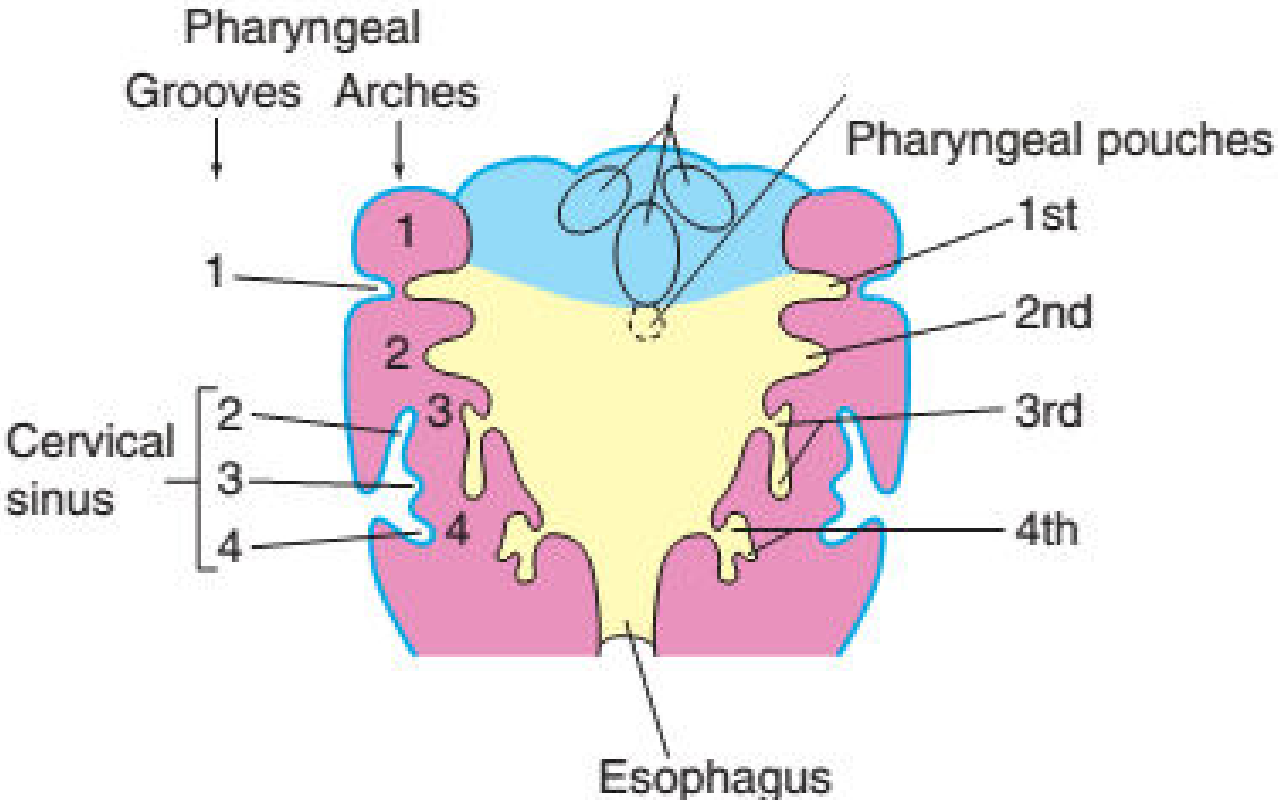
- Develops into facial nerve

Arterial component

- Disappears, except, the embryological hyoid & stapedial arteries

2nd pharyngeal arch…

- By the 5th wk grows laterally & down over the 3rd & 4th arches to fuse with the cardiac prominence
- Form a **cervical sinus** w/h disappears later giving the smooth outline at the side of the neck



3rd pharyngeal arch

Cartilaginous component

- Gives rise to:
  - Grater horn and inferior part of the body of hyoid bone

Muscular component

- Derived from the 7th cranial somitomers of the paraxial mesoderm
- Gives rise to stylopharyngeus muscle

3rd pharyngeal arch

Nervous component

- Develop into gossopharyngeal nerve

Arterial component

- Develop into:
  - Common carotid artery
  - Root of internal carotid artery

Cartilaginous bar of 4th & 6th pharyngeal arch

- Gives rise to the cartilage of larynx, except the epiglottis

- Epiglottis develops from mesnechyme in the hypobranchial eminence

Muscular component of 4th & 6th pharyngeal arch

- The muscular component of 4th arch is derived from 2nd - 4th occipital & 1st cervical somites of paraxial mesoderm & gives rise to:
  - Cricothyroid muscle
  - Levator veli palatini
  - Pharyngeal constrictor muscles

- The muscular component of 6th arch is derived from 2nd - 4th occipital & 1st cervical somites of paraxial mesoderm & gives rise to:
  - Intrinsic muscles of the larynx
  - Striated muscles of the esophagus

Arterial component of 4th & 6th pharyngeal arch

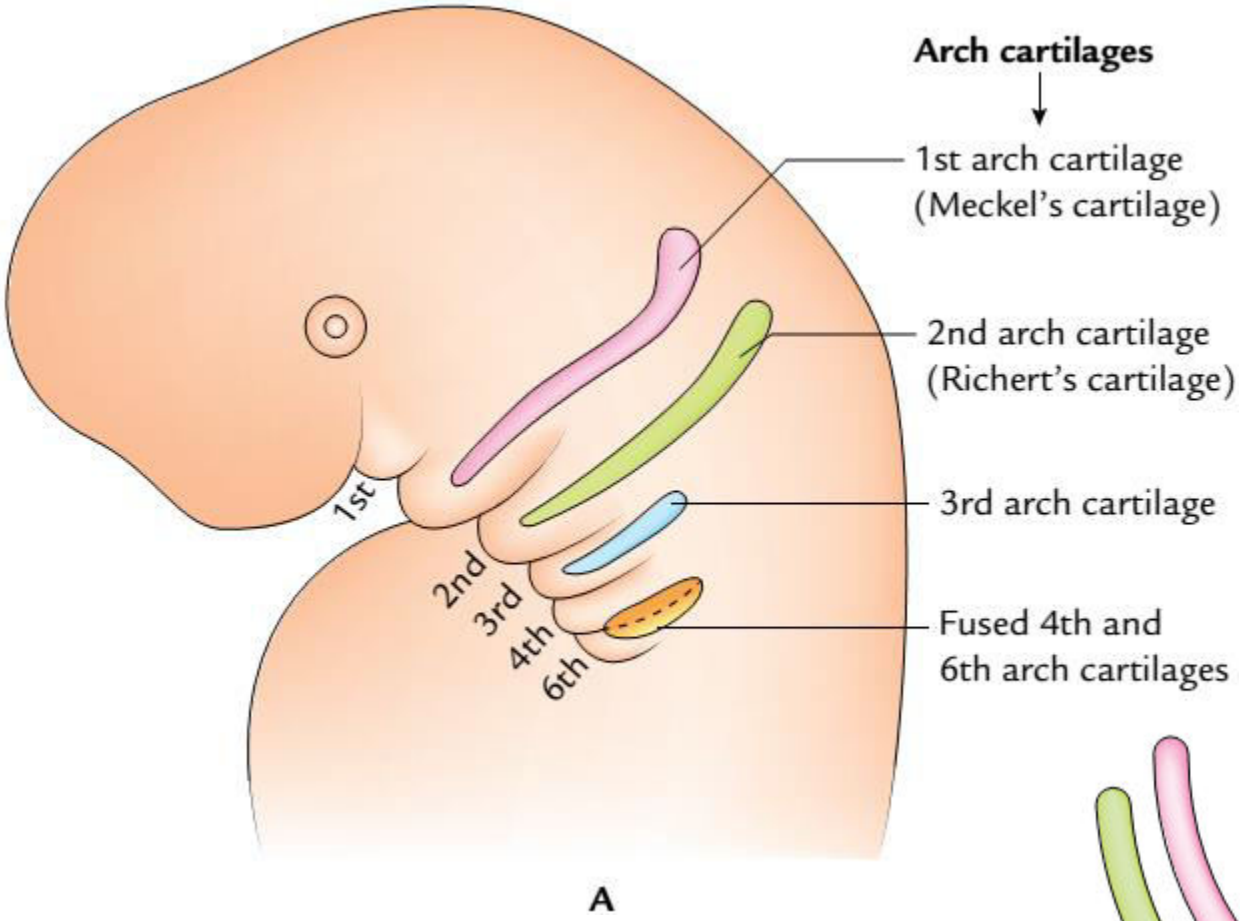
- 4th aortic arch develop into:
  - Part of arch of aorta on the left
  - Proximal part of right subclavian artery on the right side

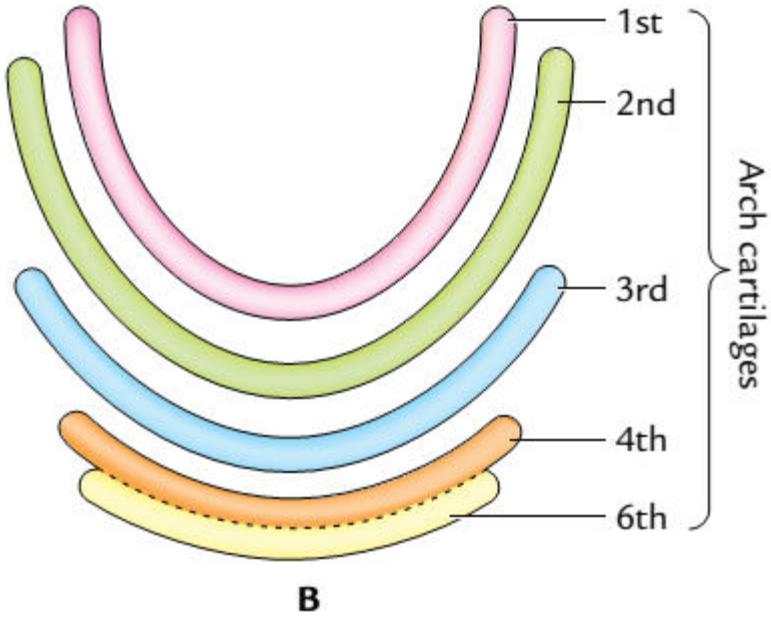
- 6th aortic arch artery give:
  - Right & left pulmonary artery (from the right & left 6th aortic arch arteries, respectively)
  - Ductus arteriosus from the left 6th aortic arch artery

Nervous component of 4^{th} & 6^{th} pharyngeal arch

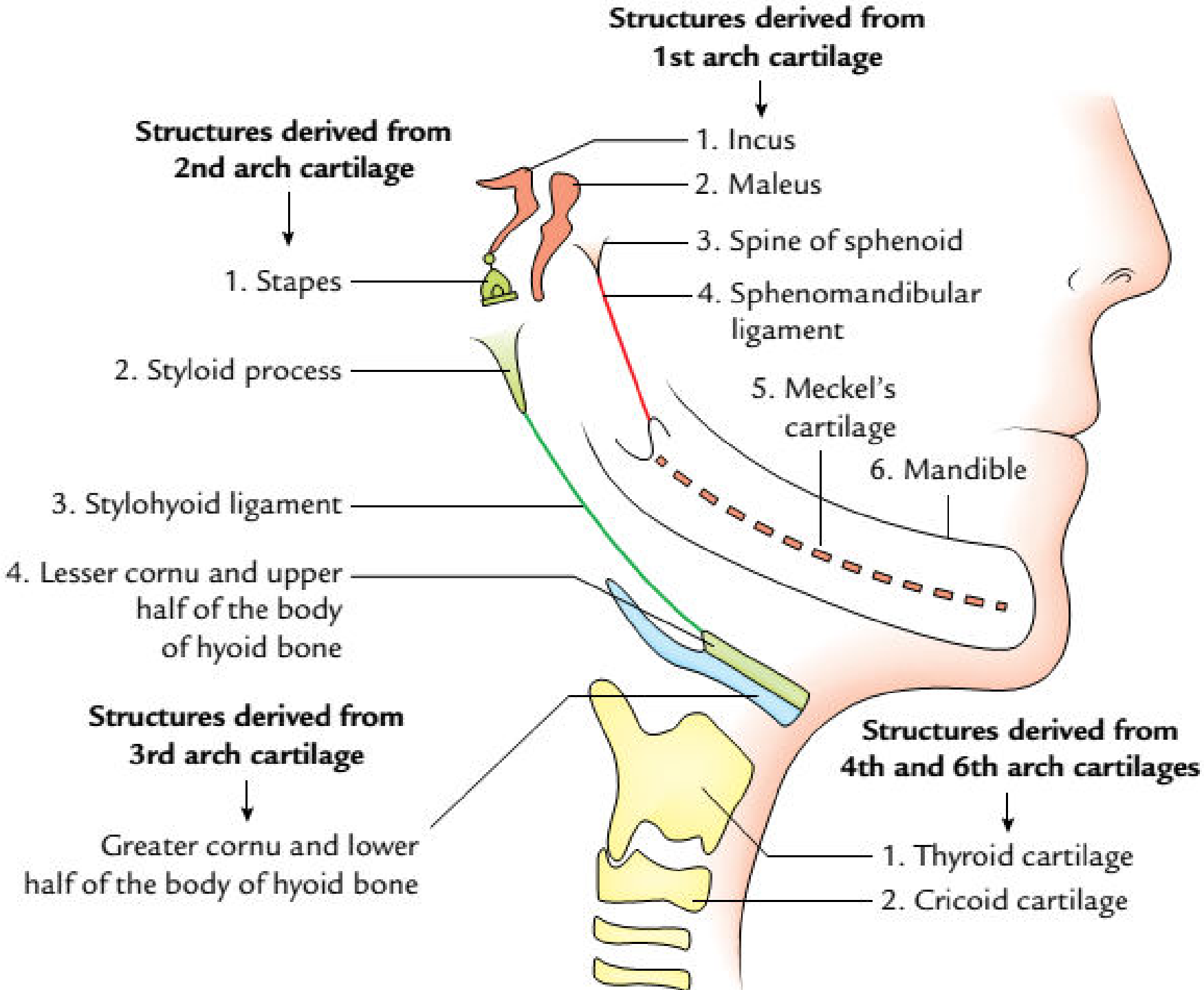
- Superior laryngeal branch of vagus nerve to innervates muscles derived from the 4^{th} arch musculature

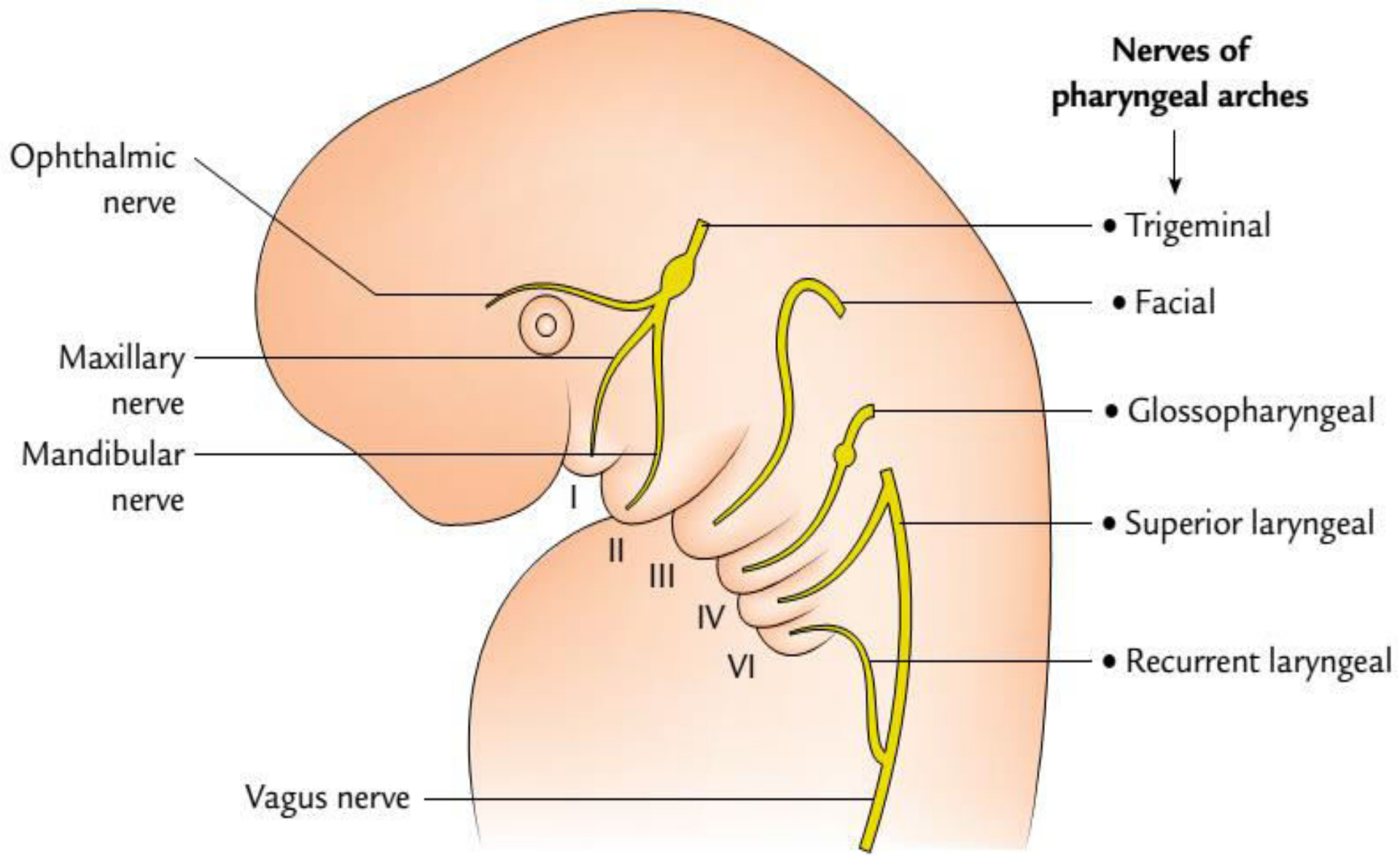
- Recurrent laryngeal branch of vagus nerve to innervates muscles derived from the 6^{th} arch musculature





Cartilages of pharyngeal arches. **A**. Lateral view. **B**. Frontal view. Note cartilages of fourth and sixth pharyngeal arches are fused


Structures derived from
1st arch cartilage
1. Incus
2. Maleus
3. Spine of sphenoid
4. Sphenomandibular ligament
5. Meckel's cartilage
6. Mandible
Structures derived from
2nd arch cartilage
1. Stapes
2. Styloid process
3. Stylohyoid ligament
4. Lesser cornu and upper half of the body of hyoid bone
Structures derived from
3rd arch cartilage
Greater cornu and lower half of the body of hyoid bone
Structures derived from
4th and 6th arch cartilages
1. Thyroid cartilage
2. Cricoid cartilage

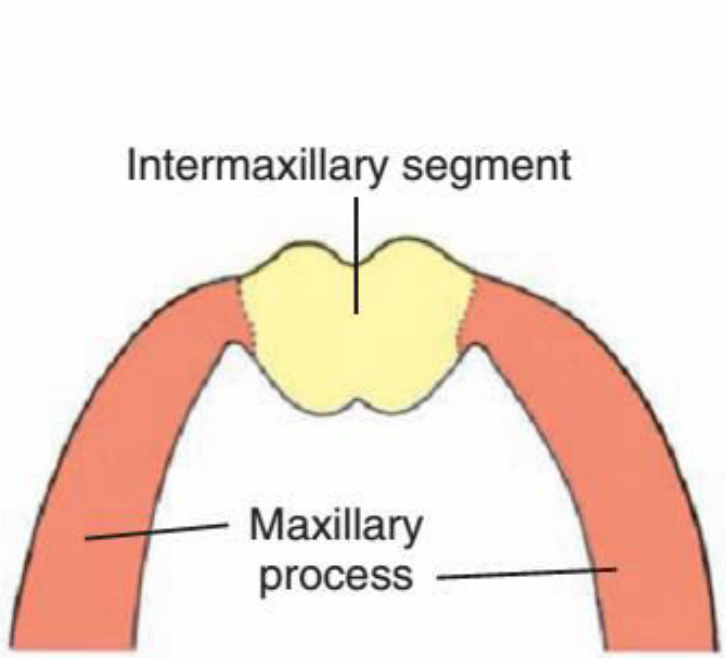

Nerves of pharyngeal arches
Ophthalmic nerve
Maxillary nerve
Mandibular nerve
Vagus nerve
• Trigeminal
• Facial
• Glossopharyngeal
• Superior laryngeal
• Recurrent laryngeal
I
II
III
IV
VI

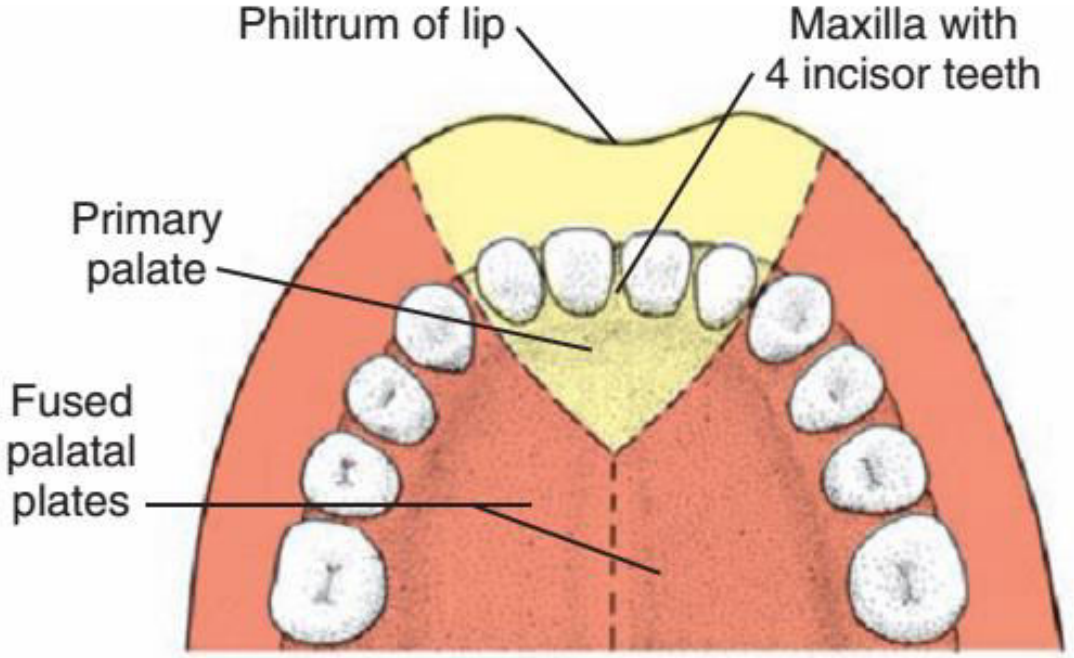
Development of the palate

- Develops as

1. Primary palate
2. Secondary palate

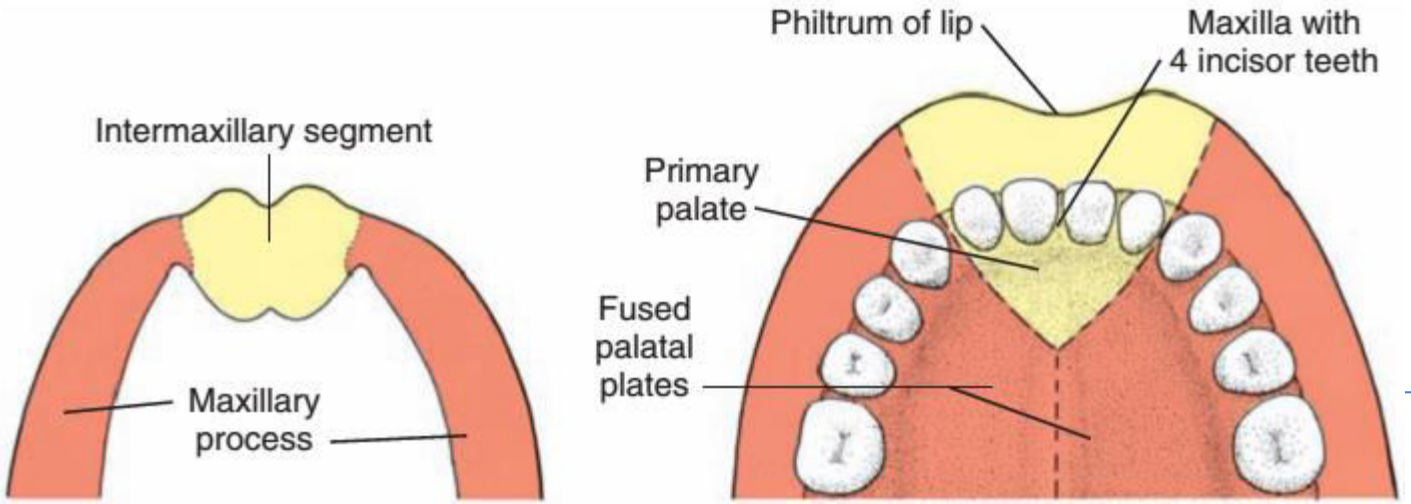
- Primary palate develops from the intermaxillary segment

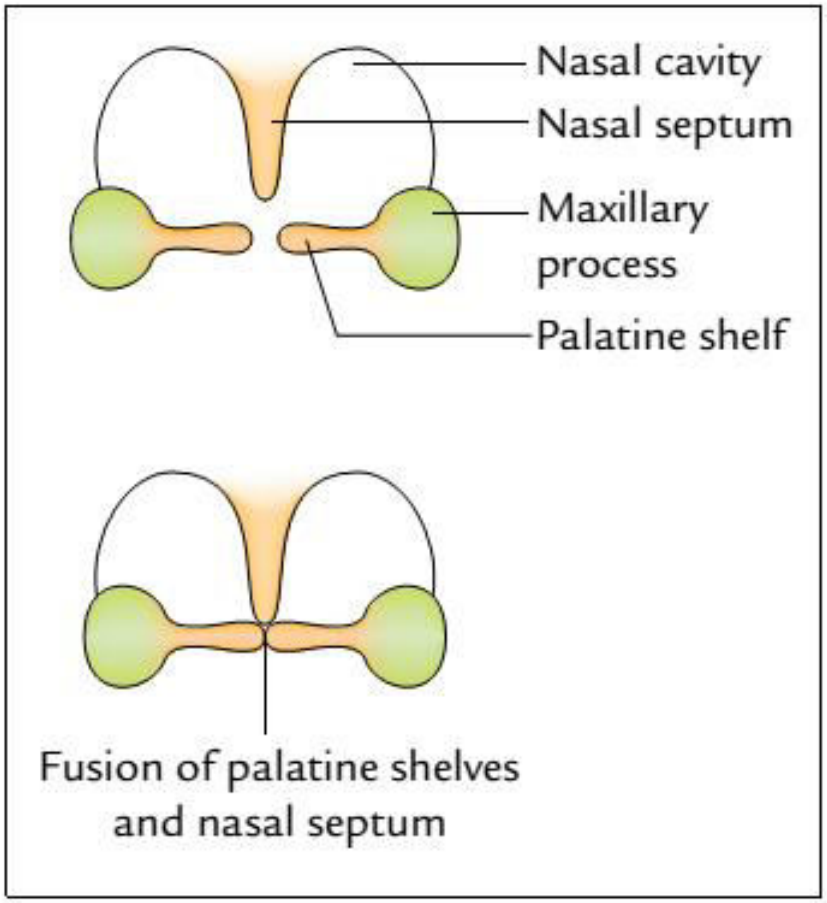


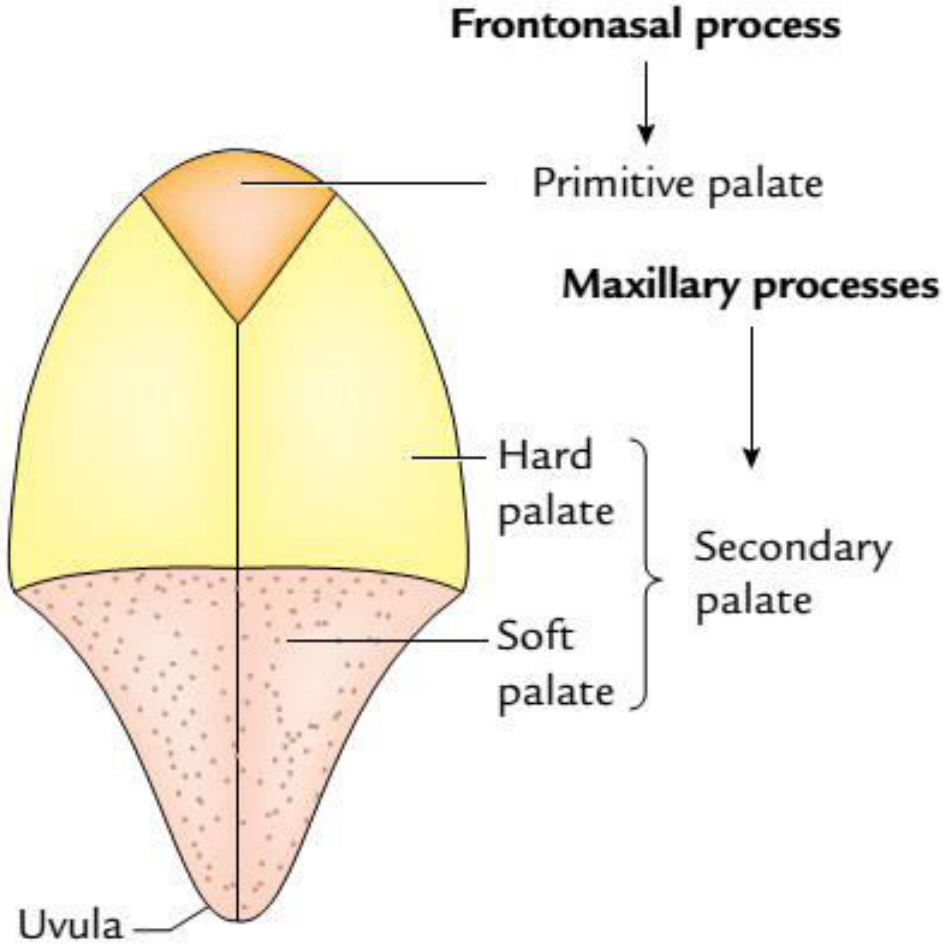


Development of secondary palate

- Develop from the right and left palatine shelves that develop from inferolateral aspects of maxillary prominences & grow inferomedially
- Palatine shelves fuse with each other, primary palate and nasal septum that grow from the inner aspects of frontonasal prominence
- Soft palate with uvula develop as two folds growing out from the posterior end of the secondary palate



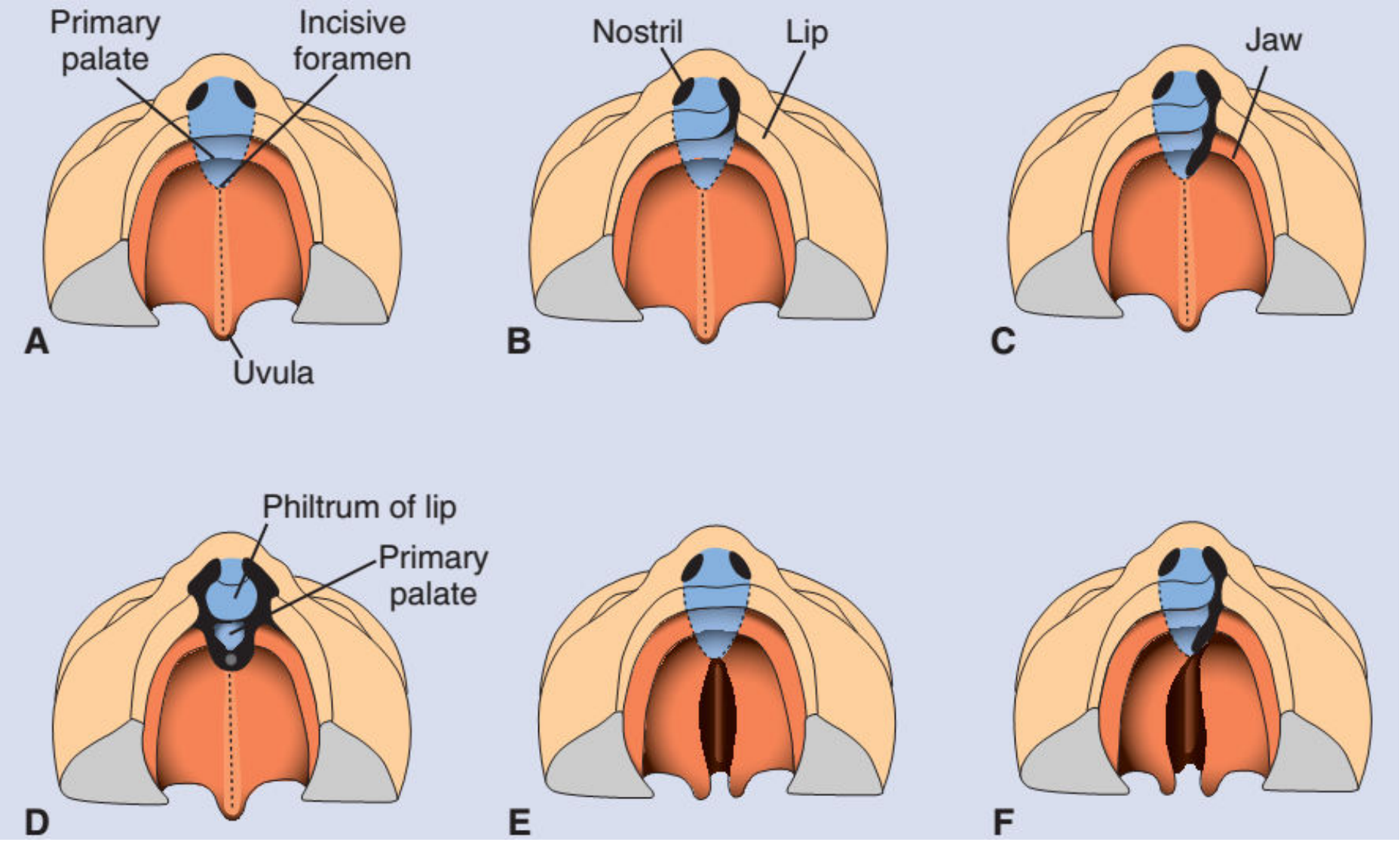




Development of definitive palate. Note derivation of its various parts from different sources. Figure in the inset (on the left side) shows separation of nasal cavities from each other and from the oral cavity.

Cleft Lip and Cleft Palate

- Clefts of the upper lip and palate are common.
- result in an abnormal facial appearance and defective speech
- By using incisive foramen as a landmark, two major group:
  - **Anterior cleft** defects include cleft found anterior to incisive foramen (lateral cleft lip, cleft upper law & cleft b/n primary and secondary palates)
  - **Posterior cleft** defects include clefts found posterior to incisive foramen i.e. cleft palate


Primary palate
Incisive foramen
Uvula
A
Nostril
Lip
B
Jaw
C
Philtrum of lip
Primary palate
D
E
F