



Anatomy Team
433

**King Saud University
College of medicine
Musculoskeletal Block**



Development of Skeletal & Muscular System

10

Objectives

- ❖ List the different parts of mesoderm and the different divisions of somites.
- ❖ Differentiate bones according to their embryological origin and mode of ossification.
- ❖ Describe the ossification of long bones.
- ❖ Describe the main steps for development of limbs.
- ❖ Differentiate muscles according to their embryological origin.

Color Index

- Red: Important.
- Violet: Explanation.
- Gray: Additional Notes.

Other colors are for
Coordination

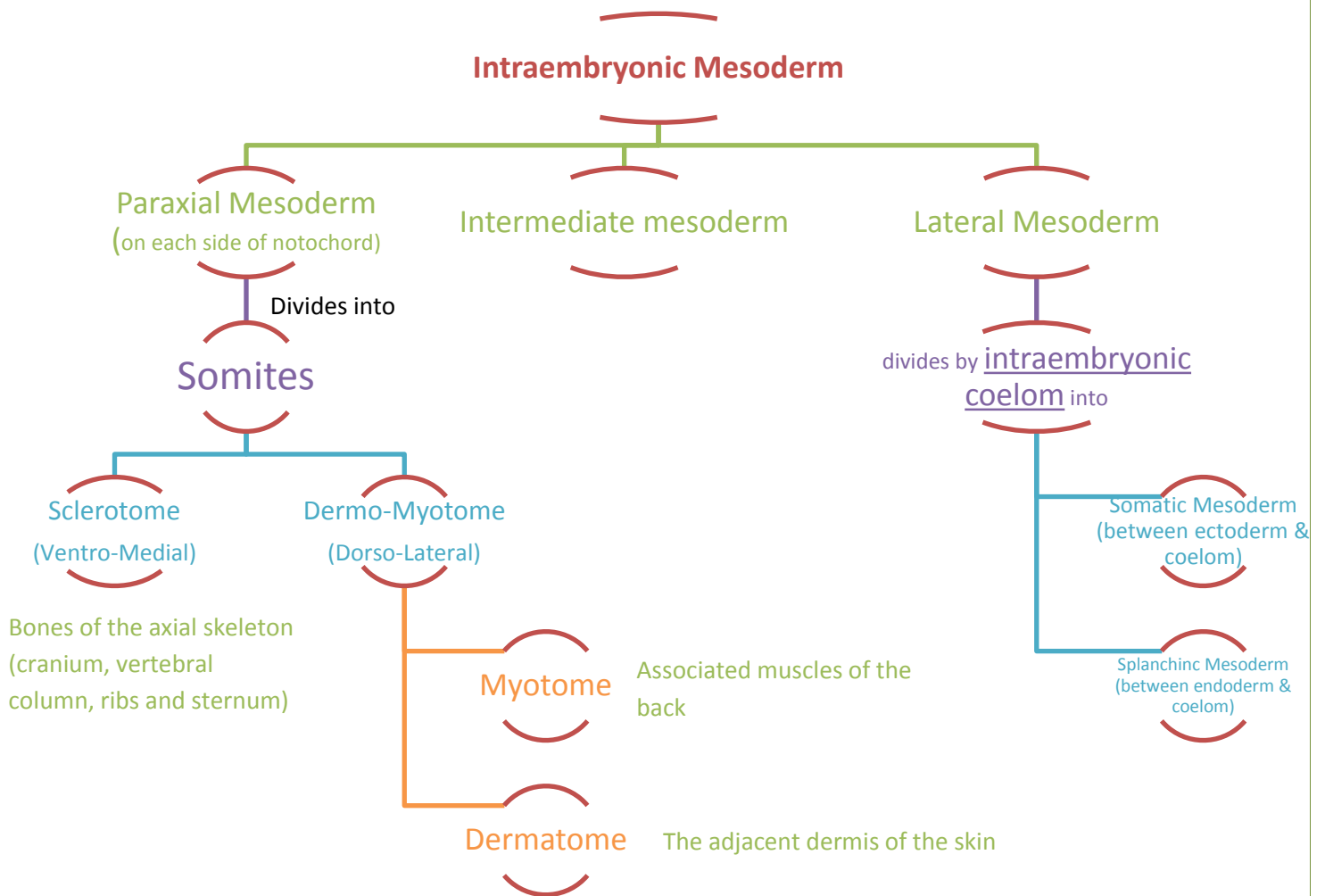
Say " bsm Allah" then start

Mind Map

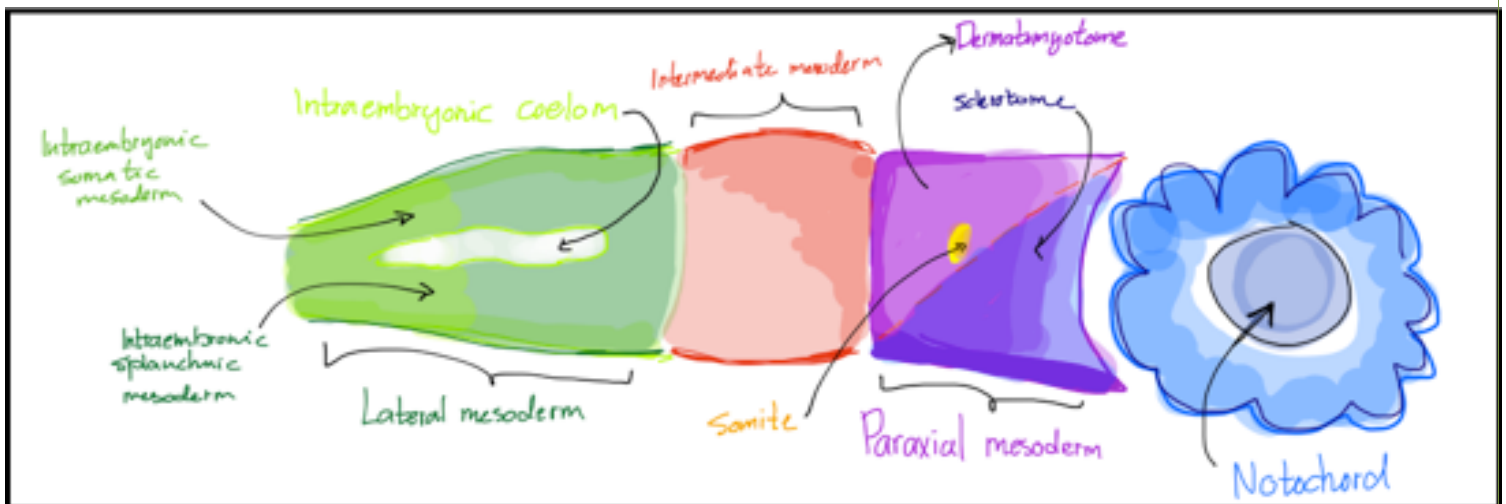
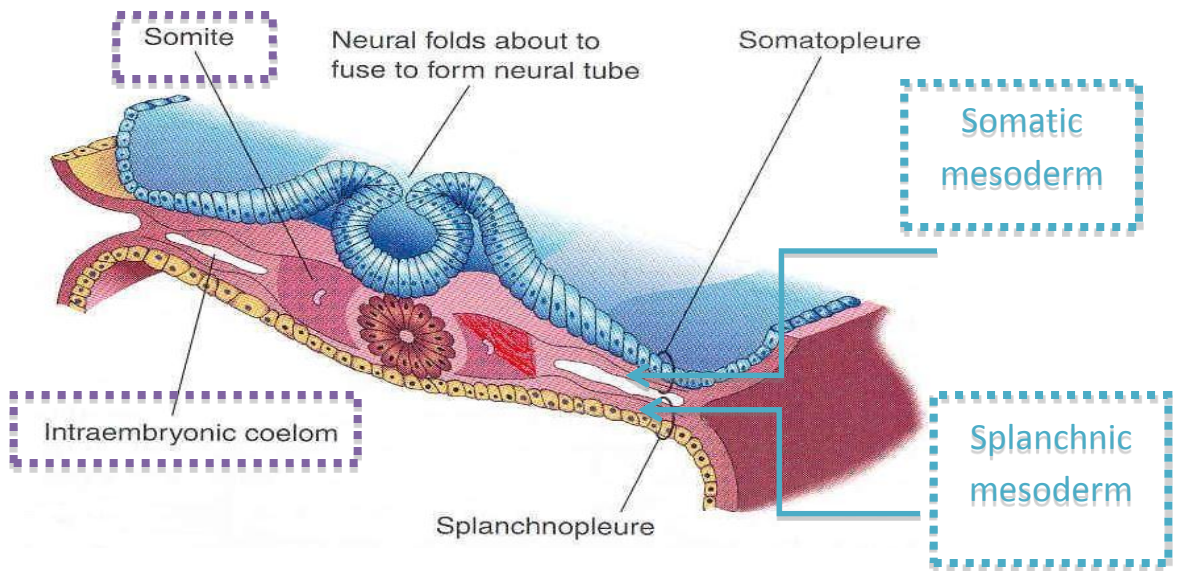
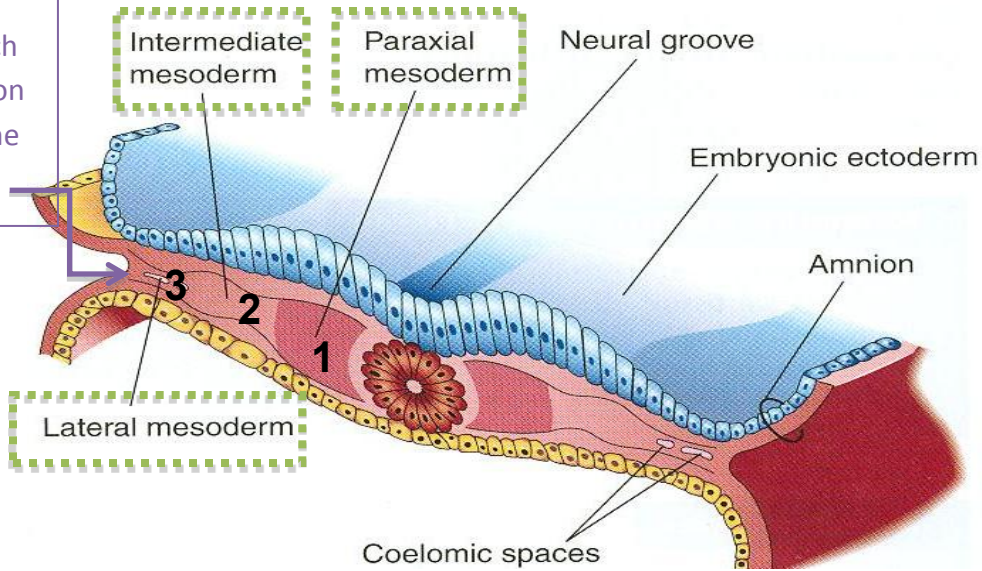


Intraembryonic Mesoderm

Develops between Ectoderm & Endoderm EXCEPT in the central axis of embryo where NOTOCHORD is found.



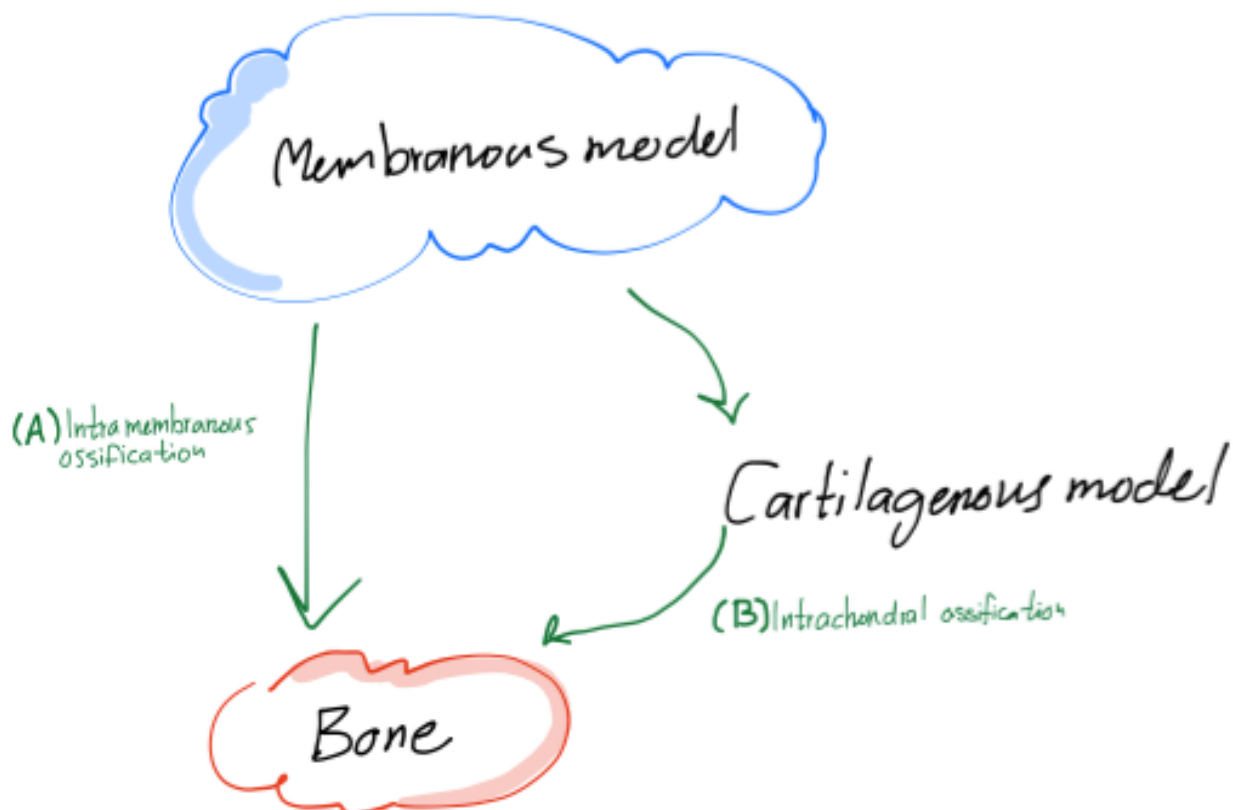
The myocoel, a small cavity appears in each somite but soon disappears (The white space)



Development of the Bones

Based on the **mode of development**, there are **two types** of bones in the body:

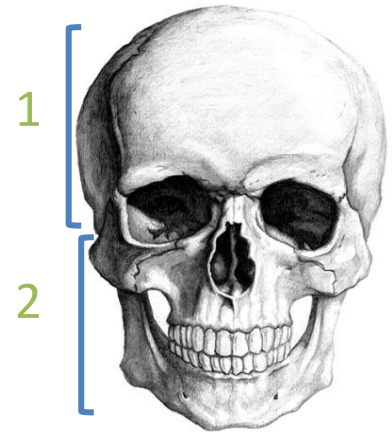
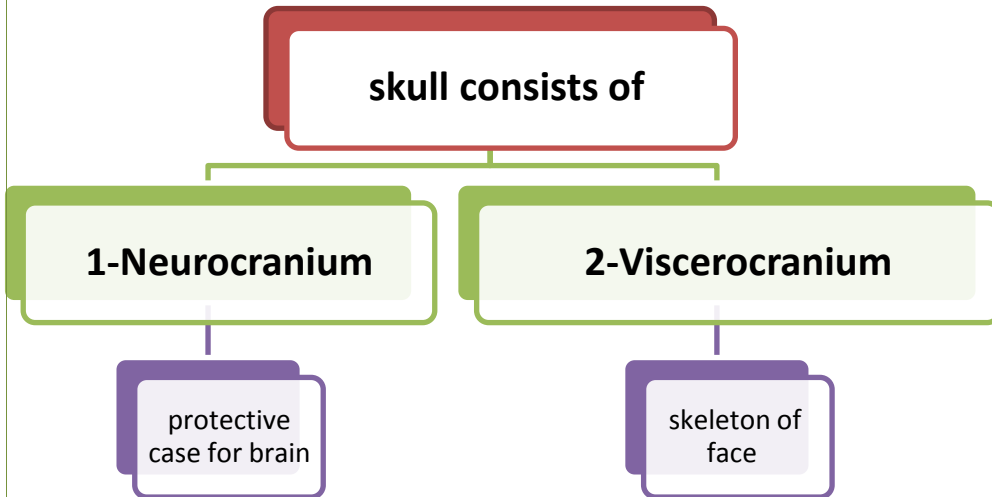
Types of bones	Cartilage bones	Membrane bones
Type of ossification	Intracartilagenous (endochondral) ossification.	Intramembranous ossification
Mechanism of development	A cartilage model first forms and is eventually replaced with bone	Bone forms directly from mesenchymal cells without the prior formation of cartilage
Example	Bones of the axial & appendicular skeletons and the cranial base.	Majority of bones of the face and skull



Development of Cranium (Skull)

The skull bones develop from mesoderm around the developing brain.

The brain develops first then > the skull bones start surrounding it, then > the bones ossify via intramembranous ossification



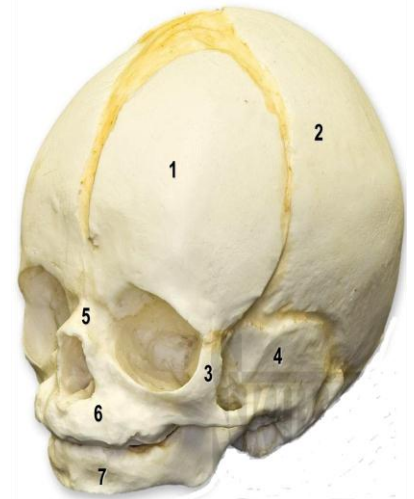
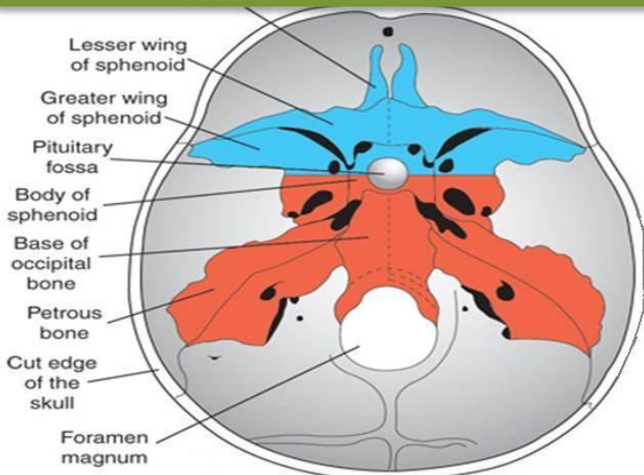
Bones of skull ossify either by

Intracartilagenous (Endochondral) ossification

intramembranous ossification

Base of skull (cranial base bones) develops by intracartilagenous

- 1- Frontal
- 2- Parietal
- 3- Zygomatic
- 4- Squamous temporal
- 5- Nasal
- 6- Maxilla
- 7- Mandible



Bones of the cranial base

Development of Limbs

The limbs bud appears as an elevation on the *ventrolateral body wall* resulting from proliferation of mesenchyme of the somatic layer of lateral mesoderm.

Upper limb

- buds appear at **day 26** opposite the **lower cervical segments**

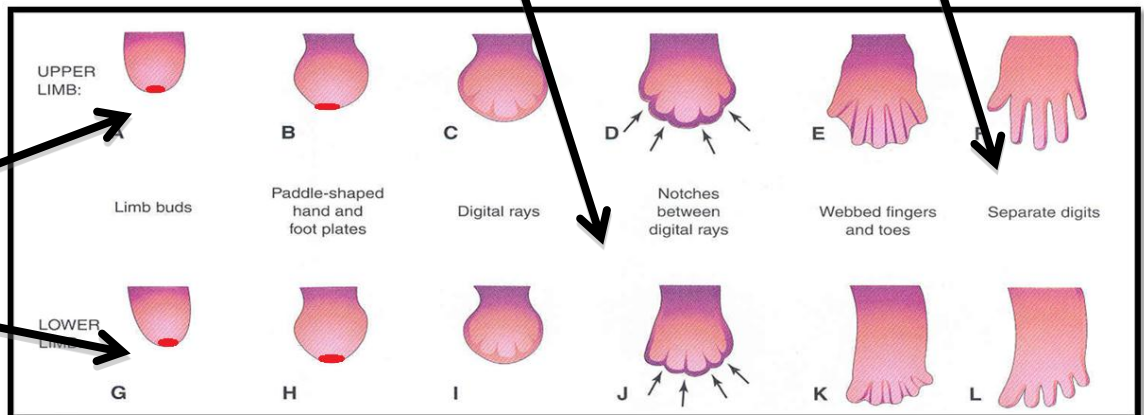
Lower limb

- buds appear at **day 28** opposite the **lumbar & sacral segments**

Mesenchyme disappear

Mesenchyme disappear

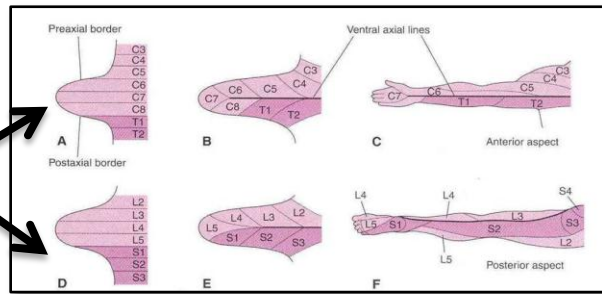
AER



Rotation of Limbs

During 7th week, adduction of limb

radius and tibia are preaxial bones.



rotate laterally so that the radius becomes lateral & the flexor muscles lie anteriorly.

The upper

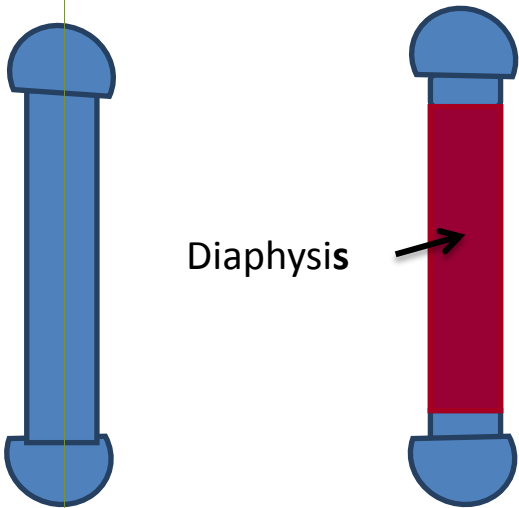
rotate medially so that the tibia lies medially & the flexor muscles lie posteriorly.

The lower

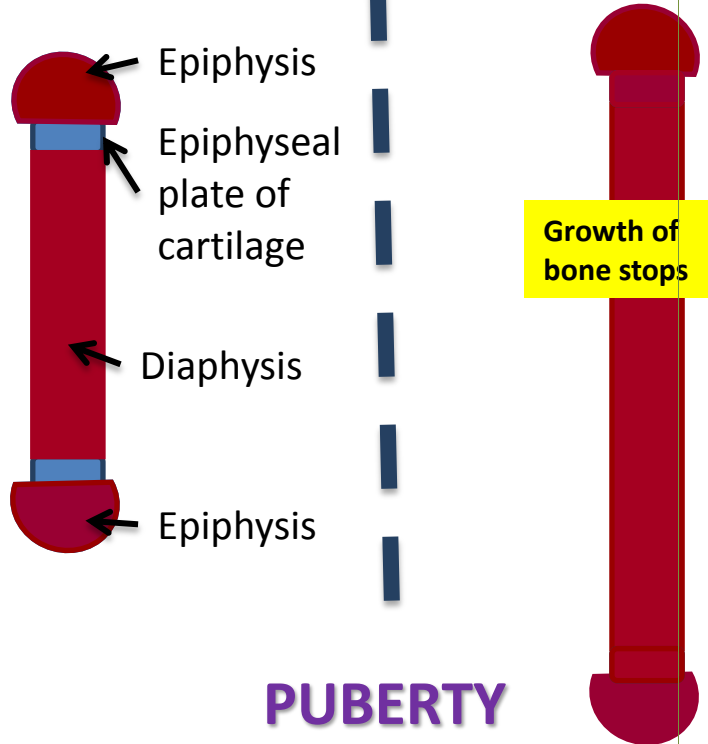
Ossification of Long Bones

Appearance of primary ossification centers: ossification of diaphysis

Appearance of secondary ossification centers: ossification of epiphysis



Bone in cartilaginous state



BIRTH

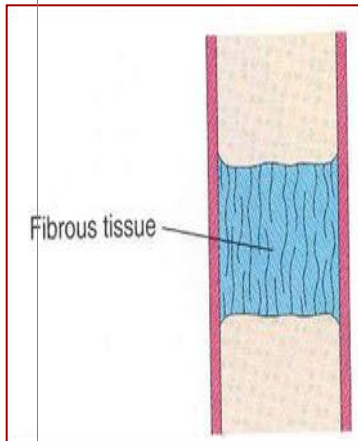
PUBERTY

Bone increases in length by proliferation of epiphyseal plate

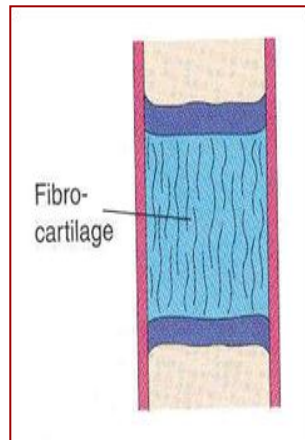
Ossification of epiphyseal plate: Complete union of epiphysis & diaphysis

Development of Joints

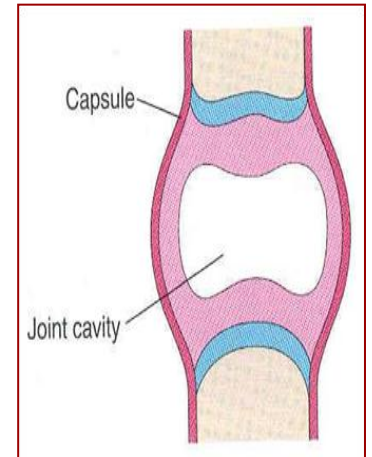
Joints develop from mesoderm lying between bones:



- ❑ In fibrous joints: mesoderm differentiates into dense fibrous connective tissue.



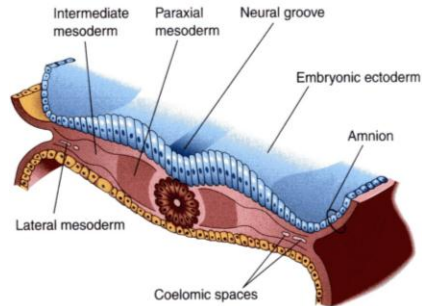
- ❑ In cartilaginous joints: mesoderm differentiates into cartilage.



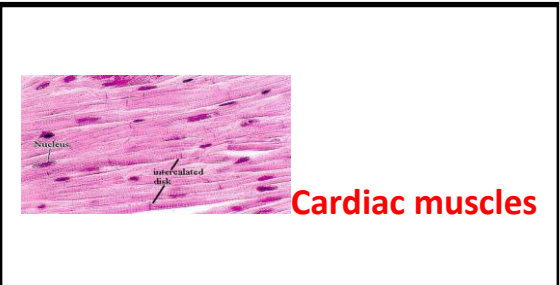
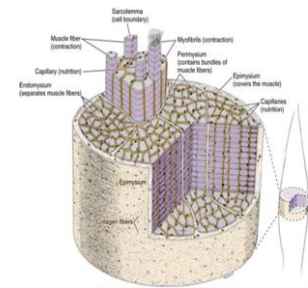
- ❑ In synovial joints: a synovial cavity is formed inside mesoderm; mesoderm differentiates into synovial membrane, capsule & --

DEVELOPMENT OF MUSCLES

- All muscles develop from **MESODERM EXCEPT** muscles of iris (eyeball) and myoepithelial cells of mammary & sweat glands which develop from **ECTODERM**



DEVELOPMENT OF MUSCLES



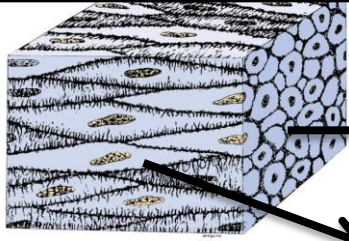
Cardiac muscles

All skeletal muscles

- develop from: **splanchnic part of lateral mesoderm**

develop from **myotomes of paraxial mesoderm EXCEPT** some **head & neck muscles** which develop from **mesoderm of pharyngeal arches**

Smooth muscles

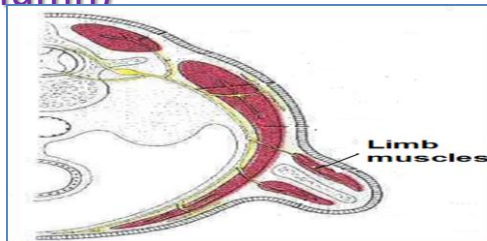


In the wall of blood & lymphatic vessels from:
somatic part of lateral mesoderm

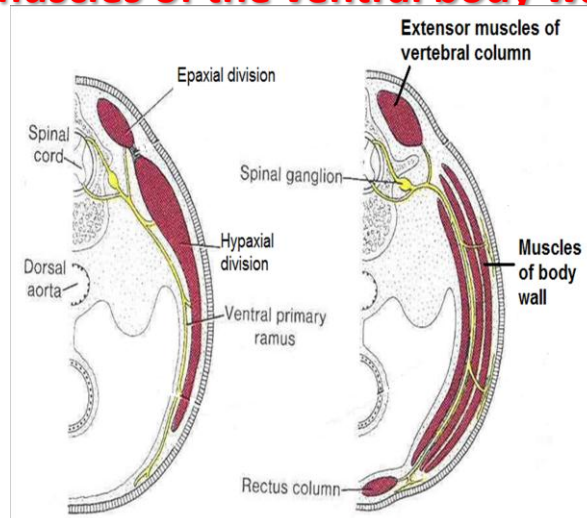
In the wall of viscera from: **splanchnic part of lateral mesoderm**

Myotome

- Each myotome divides into:
 - **Dorsal Epaxial** division, which gives rise to the **muscles of the back** (extensor muscles of the vertebral column)



- **Ventral Hypaxial** division which gives rise to the **muscles of the ventral body wall**

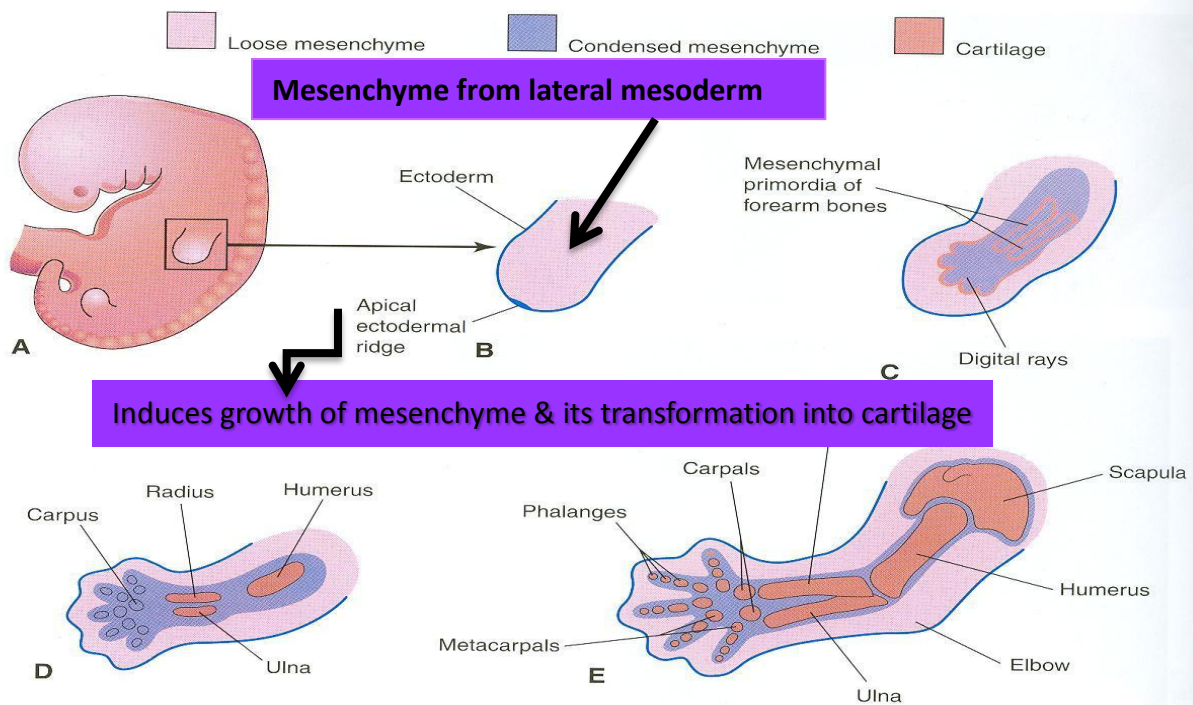


SUMMARY

- ❖ Mesenchyme from somatic layer of lateral mesoderm proliferates to form limb buds.
- ❖ Apical ectodermal ridge stimulates proliferation & elongation of buds then cartilage formation.
- ❖ All bones of limbs ossify by endochondral ossification EXCEPT: clavicle.
- ❖ Muscles of limbs develop from myotomes. Rotation of limbs occur in opposite direction. Development of upper limb precedes that of lower limb
- ❖ All bones develop from MESODERM
- ❖ Vertebrae, ribs & sternum: from sclerotomes of somites (paraxial mesoderm)
- ❖ APPENDICULAR SKELETON: from somatic part of lateral mesoderm All muscles develop from MESODERM, except: 1- Muscles of iris (eyeball): ectoderm 2- Myoepithelial cells of mammary & sweat gland: ectoderm
- ❖ All skeletal muscles develop from myotomes of paraxial mesoderm, except:
- ❖ Some head & neck muscle: from mesoderm of pharyngeal arches Cardiac & smooth muscles develop from lateral mesoderm: Cardiac muscles from: splanchnic part of lateral mesoderm Smooth muscles:
- ❖ In the wall of viscera from: splanchnic part of lateral mesoderm

Remember That:

- ✓ ... **Bone age is a good index of general maturation. Bone age is determined by:**
- ✓ ...
 1. Appearance of ossification centers in diaphysis & epiphysis (specific for each bone & sex)
 2. Disappearance of epiphyseal plate (specific for each bone & sex)



Myoblasts migrate from myotomes to form: Muscles of limbs

Myoblasts migrate from myotomes to form: Muscles of limbs

Multiple Choice Questions

Q1 : The lateral mesoderm is divided by :

- A- Somites B- intraembryonic coelom C- Somatic mesoderm D- Splanchnopleure

Q2: which one of the following is responsible for the development of the axial skeleton's bones :

- A- Sclerotome B- Myotome C-dermomyotome D- dermatome

Q3: Which one of the following bony structure ossify by endochondral ossification and intramembranous ossification :

- A- Axial and appendicular skeleton B- Cranial base C- cranium D- vertebral column

Q2: Which one of the following group of muscles are derivatives from epaxial division of myotomes?

- A. Muscles of limbs
- B. Muscles of back
- C. Muscles of viscera
- D. Cardiac muscles

Q Ans. :

1- B 2- A 3-
C 4-B 5-

❑ Q4: Regarding the ossification of long bones, which one of the following statement is correct?

- A. Primary ossification center appears after birth.
- B. Secondary ossification center leads into ossification of diaphysis.
- C. When epiphysis unites with diaphysis, growth of bone stops.
- D. Long bones ossify by intramembranous ossification.

• Q5 : Upper limb bud appear at day 26 opposite the

- A. 1- lumbar & sacral segments .
- B. 2- lower cervical segments .
- C. 3- all

• Q6: Lower limb buds appear at day 28 opposite the

- A. lumbar & sacral segments .
- B. 2- lower cervical segments .
- C. 3- all

Q Ans. :

4-C 5- B 6-A



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For any comments Please don't hesitate

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Done by:

Reviewed by:



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