

قال تعالى : (وَلَقَدْ خَلَقْنَا الْإِنْسَانَ مِنْ صَلْصَالٍ مِنْ حَمَإٍ مَسْنُونٍ)

EMBRYOLOGY 437



Important
Dr. notes
Explanation

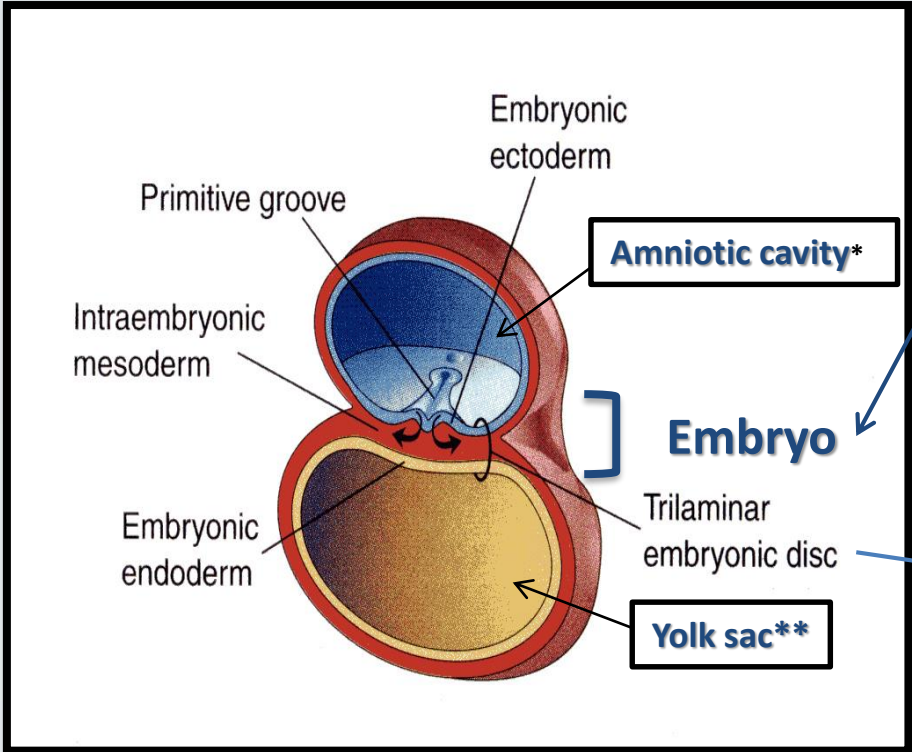


OBJECTIVES

At the end of the lecture, students should be able to:

- 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.

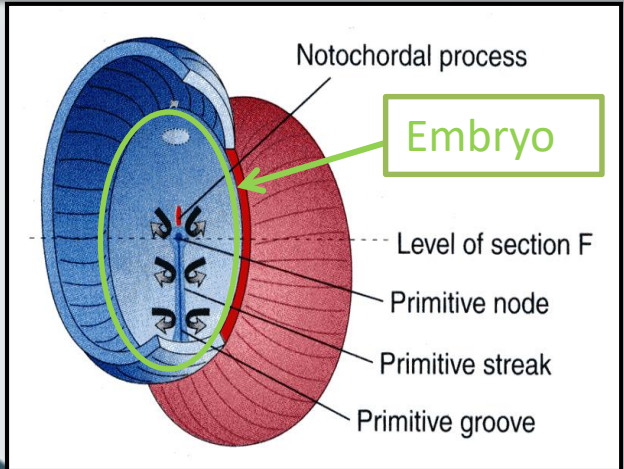
Lecture Overview



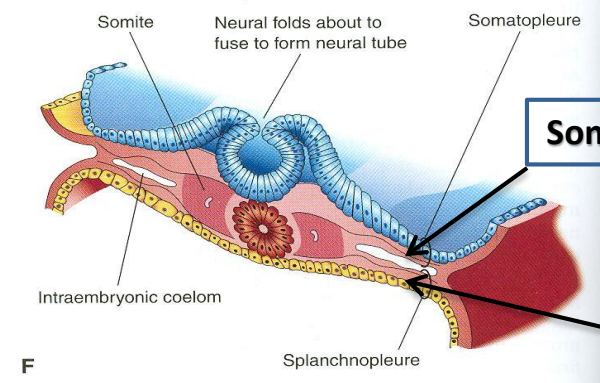
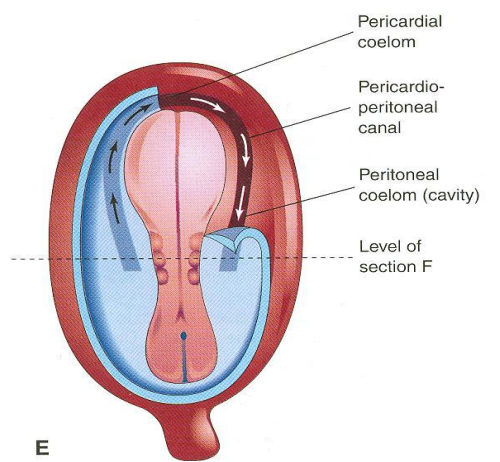
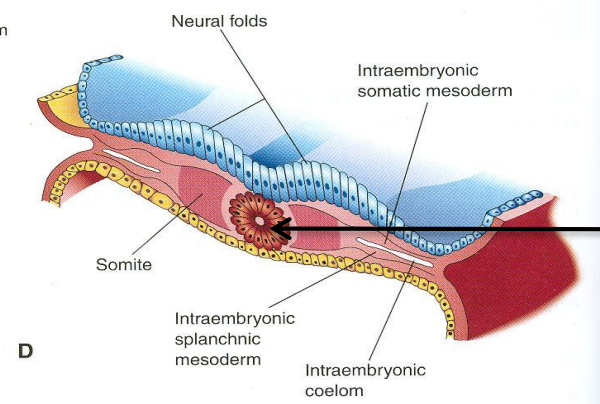
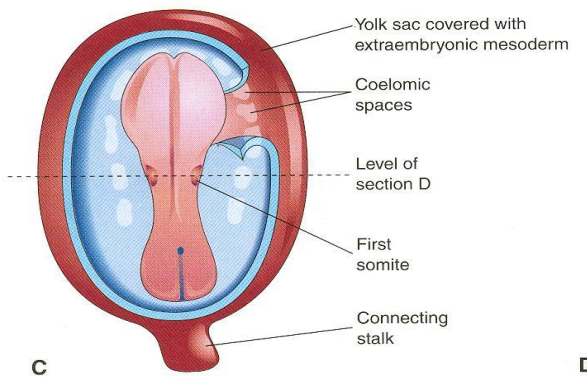
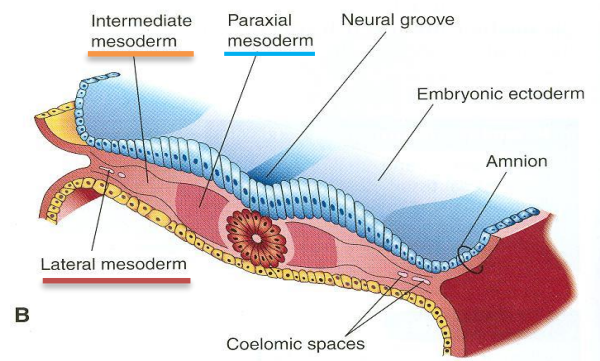
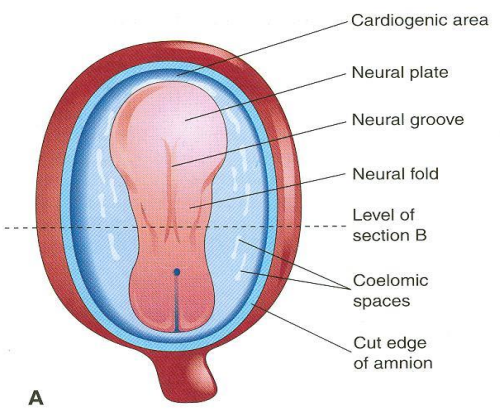
Embryo is composed three layers :-

1. Embryonic ectoderm
2. Intraembryonic mesoderm [^]what gives musculoskeletal system
3. Embryonic endoderm :skin ^{الذي يكون الـ}

Trilaminar embryonic disc will divide structure into :
1- Amniotic Cavity *dorsally
2-Yolk sac *ventrally



For more understanding 😊 :-
*Embryo will fold and as a result , amniotic cavity will form what is called fetal membrane
**most of it will dissolve after folding and a part of it will form the gut



Mesoderm divided into :

1. Paraxial Mesoderm
2. Intermediate mesoderm
3. Lateral mesoderm

Notochord:
stimulates neural tube formation (where CNS will be formed)

Somatic mesoderm

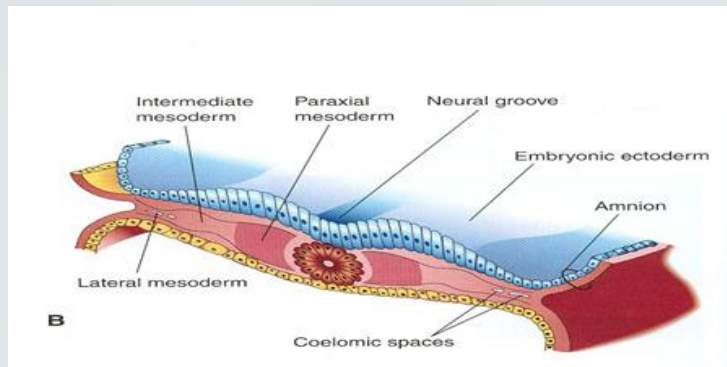
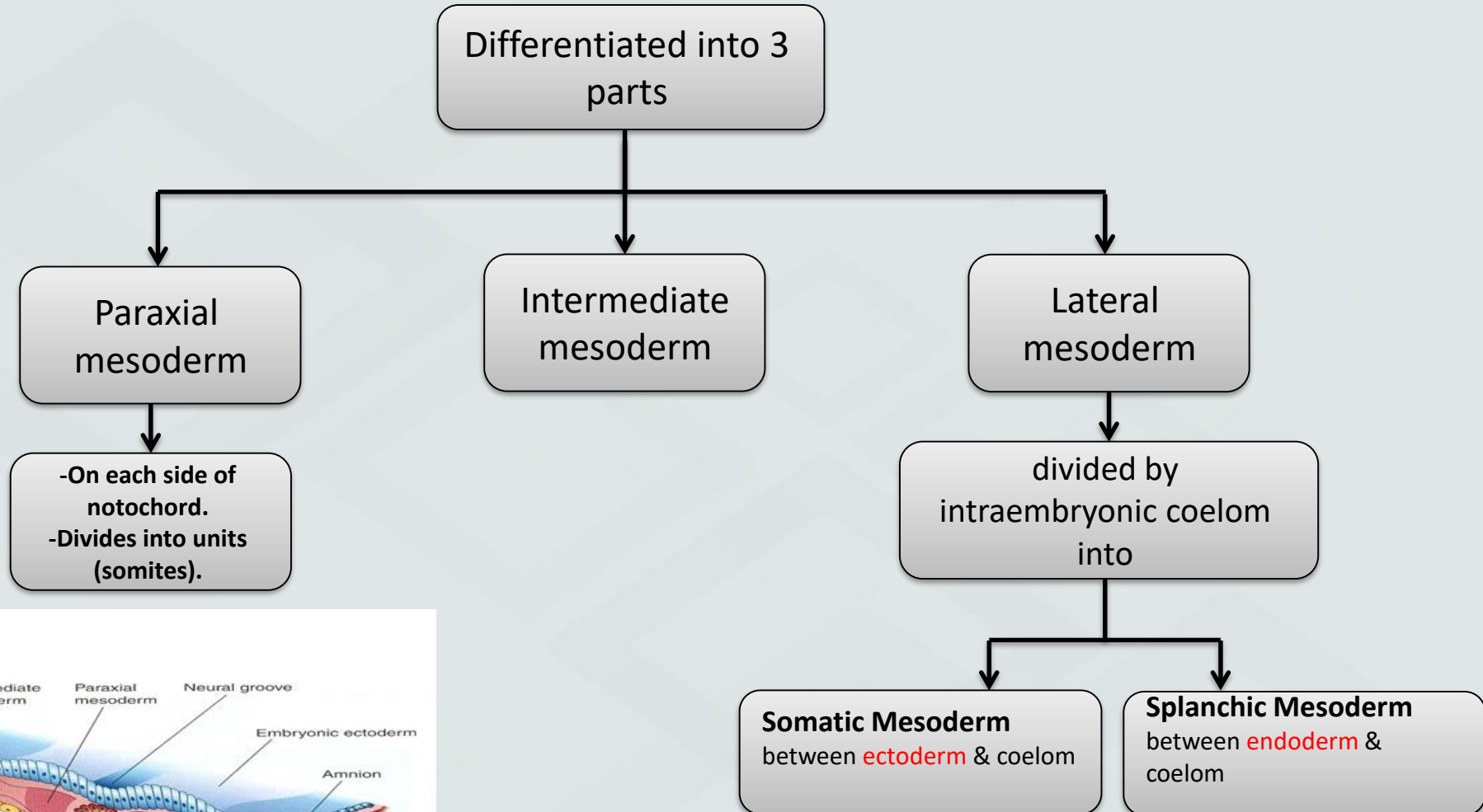
Splanchnic mesoderm

Lateral mesoderm contains intraembryonic coelom into :

- Somatic Mesoderm : it is enclosed by ectoderm , وهي التي تكون العظم
- Splanchnic Mesoderm

INTRAEMBRYONIC MESODERM

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



Paraxial mesoderm

Formed of units "SOMITE"

SOMITE

Myotome

Sclerotome

forms the axial skeleton :-
1-Vertebral column
2-Ribs & sternum
except skull

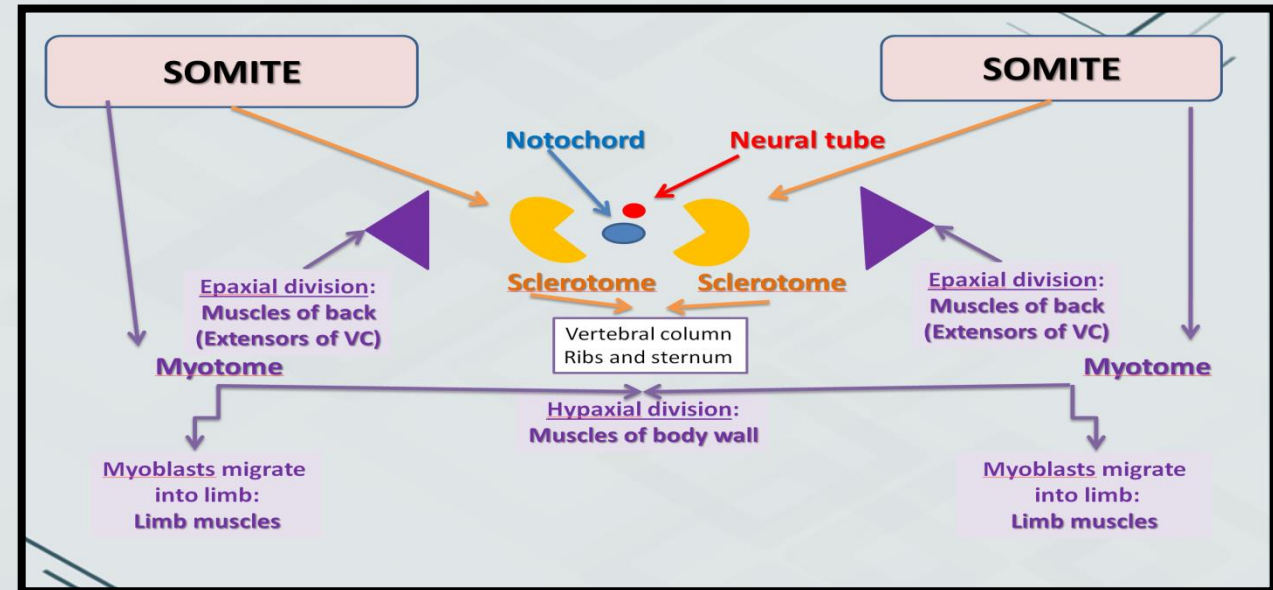
Dermatome : FORM SKIN

Epaxial division : **Muscles of back**
(Extensors of vertebral column and neck)

Myoblasts : migrate into limb:
Limb muscles
(to form the flexors and extensors muscles of the limbs)
both upper and lower limb

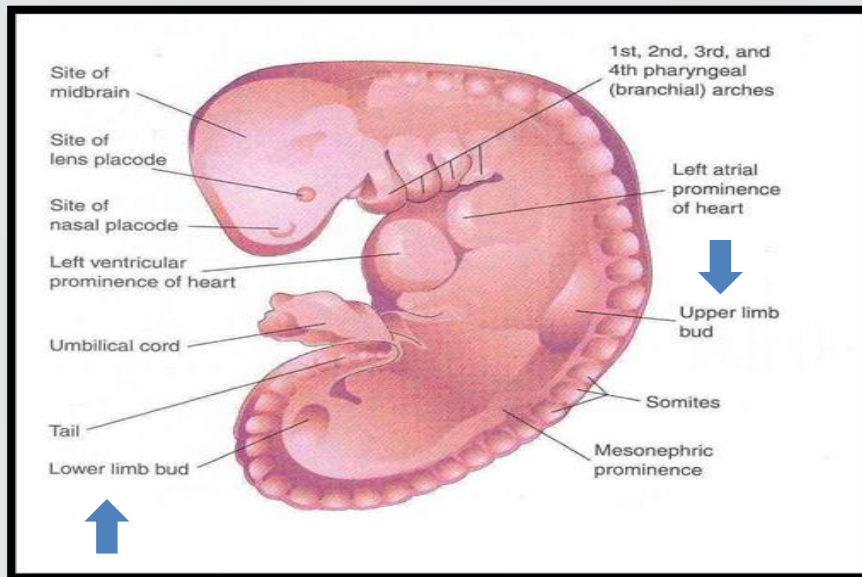
Hypaxial division : **Muscles of body wall**
(abdominal wall , pelvic, thoracic, etc..)

Dermatome : area of skin supplied by cutaneous branches of single cranial or spinal nerve ,, **dermal layers وهي تعطينا
****ectoderm** skin نفسه يتكون من

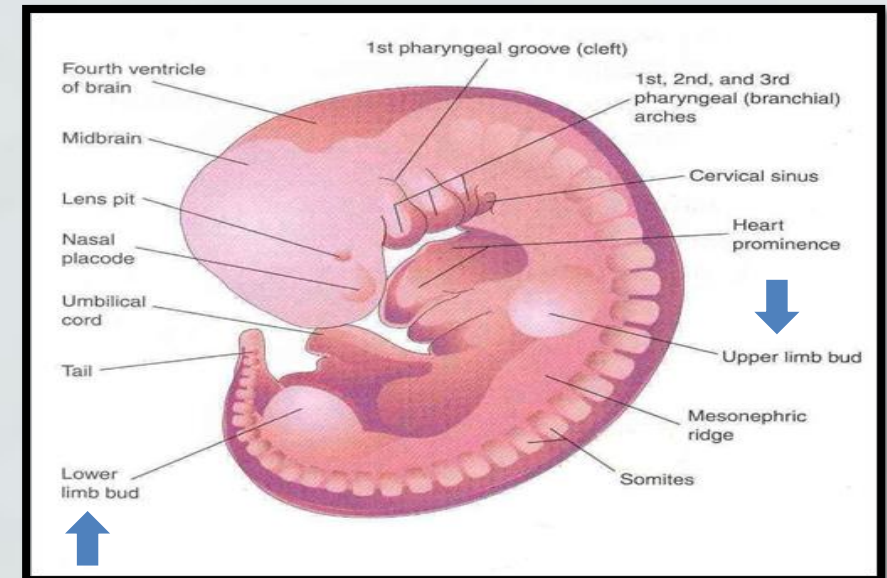


DEVELOPMENT OF LIMBS - 1

- The limbs bud appears as an **elevation** on the *ventrolateral body wall* resulting from proliferation of mesenchyme of the somatic layer of lateral mesoderm.
- Each limb bud is surrounded by an area of ectoderm.
- Upper limb buds appear at day **26** opposite the lower cervical segments.
- Lower limb buds appear at day **28** opposite the lumbar & sacral segments.



28 DAYS



32 DAYS

DEVELOPMENT OF LIMBS - 2

A&G

- Apical ectodermal ridge: appears at the apex of limb bud and stimulates proliferation of mesenchyme and **elongation** of limb bud.
- Some people born with bud limb, there is no proliferation of mesenchyme, because this apical ectodermal ridge does not work or exist, so there is no stimulation which results in no elongation

B&H

- Distal ends of buds flatten into paddle-like hand & foot plates. (زي المجداف)

C&I

- appear as **mesenchymal condensations** that outline the patterns of digits

D&J

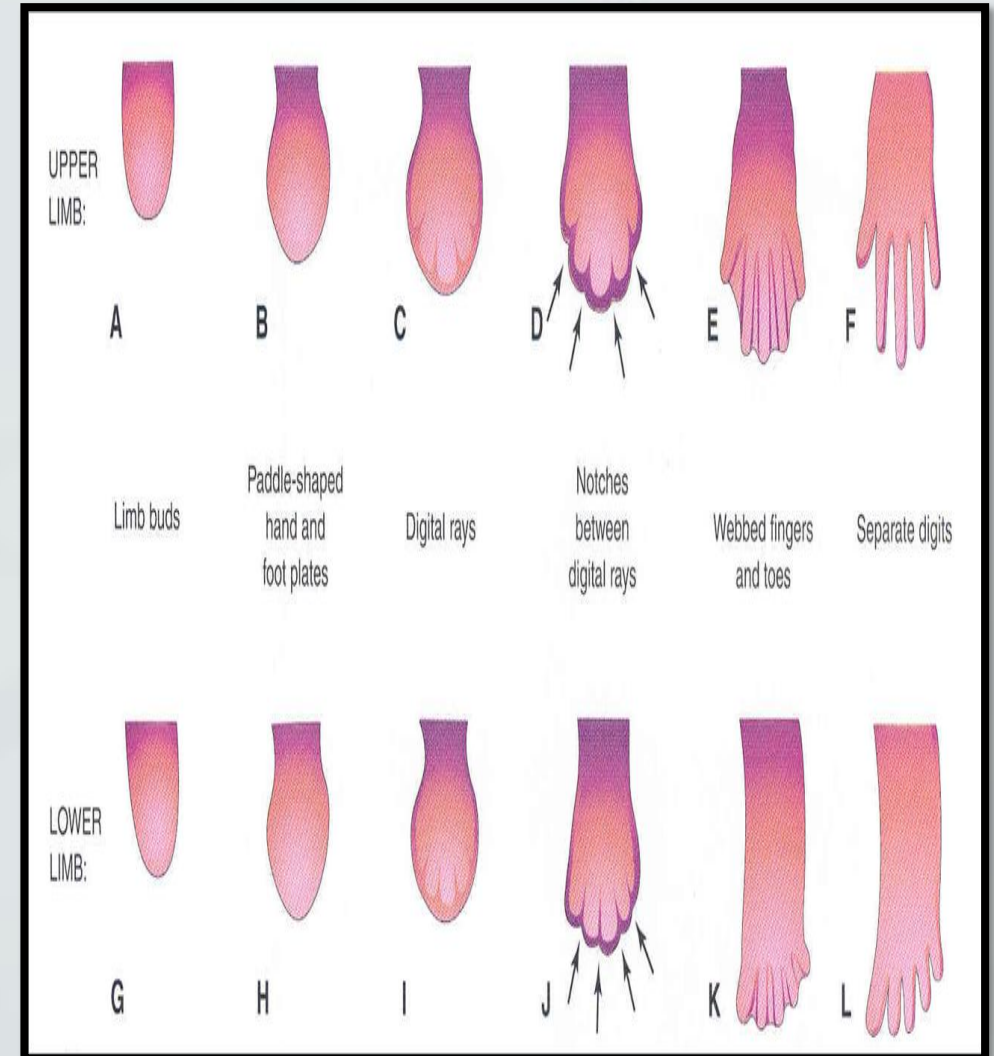
- Mesenchyme between rays disappears to form notches.

E&K

- Digits form inside rays, elongate & appear **webbed**.

F&L

- Mesenchyme between digits disappear to separate them.



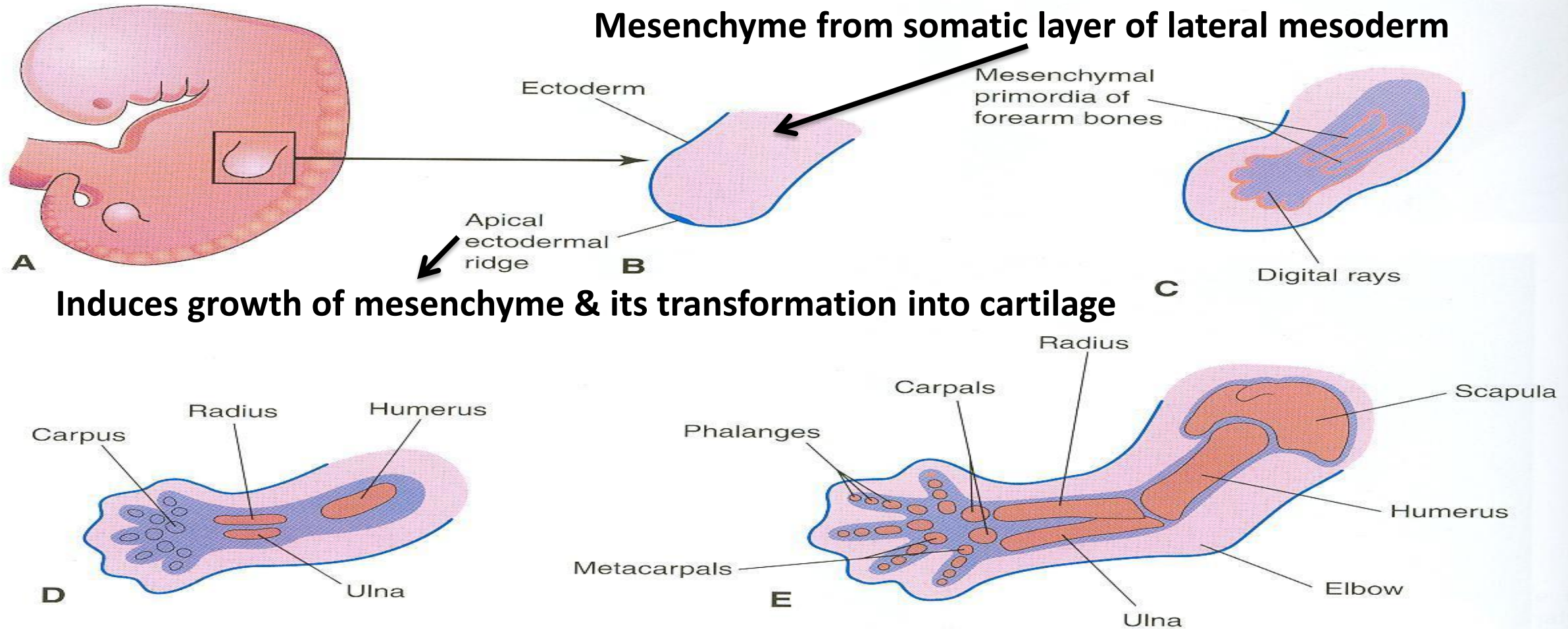
Distal part of limb will form and THEN elongate to proximal part ^^next slide

Loose mesenchyme

Condensed mesenchyme

Cartilage

Mesenchyme from somatic layer of lateral mesoderm



Induces growth of mesenchyme & its transformation into cartilage

*Cartilage ossifies by: Endochondral ossification

*Myoblasts migrate from myotomes to form: Muscles of limbs

NOTE : Elongation of limbs occurs after mesenchyme appears and separates the digits

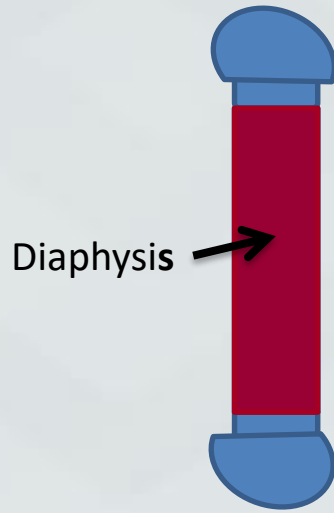
OSSIFICATION OF LONG BONES

في البداية تكون الأطراف غضروف ، ثم قبل الولادة
تجي مرحلة primary ossific center فيولد الطفل
والـ diaphysis عظم والـ epiphysis غضروف
ومن بعد الولادة تبدأ مرحلة secondary ossific
center وهو المسؤول عن الإطالة فيستمر النمو حتى
يصير ossification للغضروف بين الـ
epiphysis والـ diaphysis وكذا يصير العظم كله
متحد ومكتمل النمو

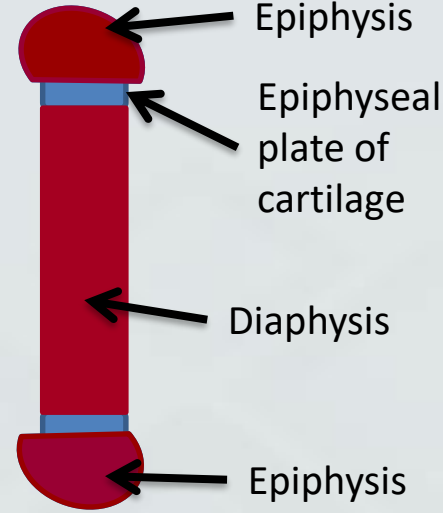
Bone in
cartilaginous state



Appearance of
primary ossific
centers: ossification
of diaphysis



Appearance of
secondary ossific
centers: ossification
of epiphysis



BIRTH

PUBERTY

Bone increases in length by proliferation
of epiphyseal plate **IN THIS RANGE**

Ossification of
epiphyseal plate:
Complete union of
epiphysis & diaphysis



Growth of
bone stops

*Bone age is a good index of general maturation.

*Bone age is determined by:

Appearance of ossific centers in diaphysis & epiphysis (specific for each bone & sex).

Disappearance of epiphyseal plate (specific for each bone & sex).

DEVELOPMENT OF LIMBS - 3

- Originally, limb buds were at right angle of the trunk with:

1- Cranial (preaxial) & caudal (postaxial) borders: radius and tibia are preaxial bones.

2- Ventral & dorsal surfaces: flexor muscles are ventral and extensors are dorsal.

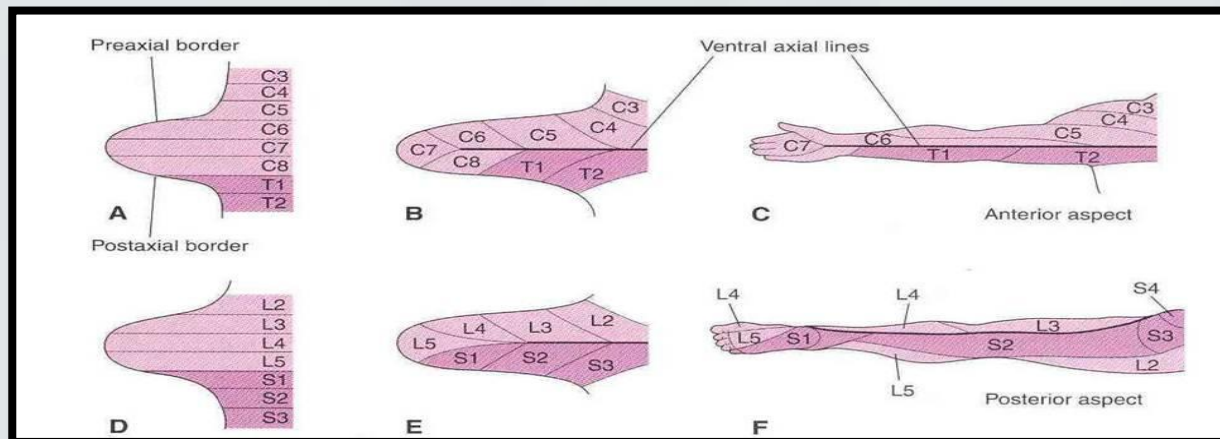
- During 7th week, adduction of limb buds occurs with 90° rotation:

1- In upper limb, rotation occurs **laterally**: radius is lateral & flexor muscles are anterior.

بسبب اتجاه الـ rotation صارت الـ radius هي الـ lateral والـ ulna الـ medial

2- In lower limb, rotation occurs **medially**: tibia is medial & flexor muscles are posterior.

بسبب اتجاه الـ rotation صارت الـ tibia هي الـ medial والـ fibula الـ lateral



DEVELOPMENT OF CRANIUM (SKULL)

- The skull develops from mesoderm around the developing brain.

- The skull consists of:

1- **Neuro-cranium**: protective case for brain

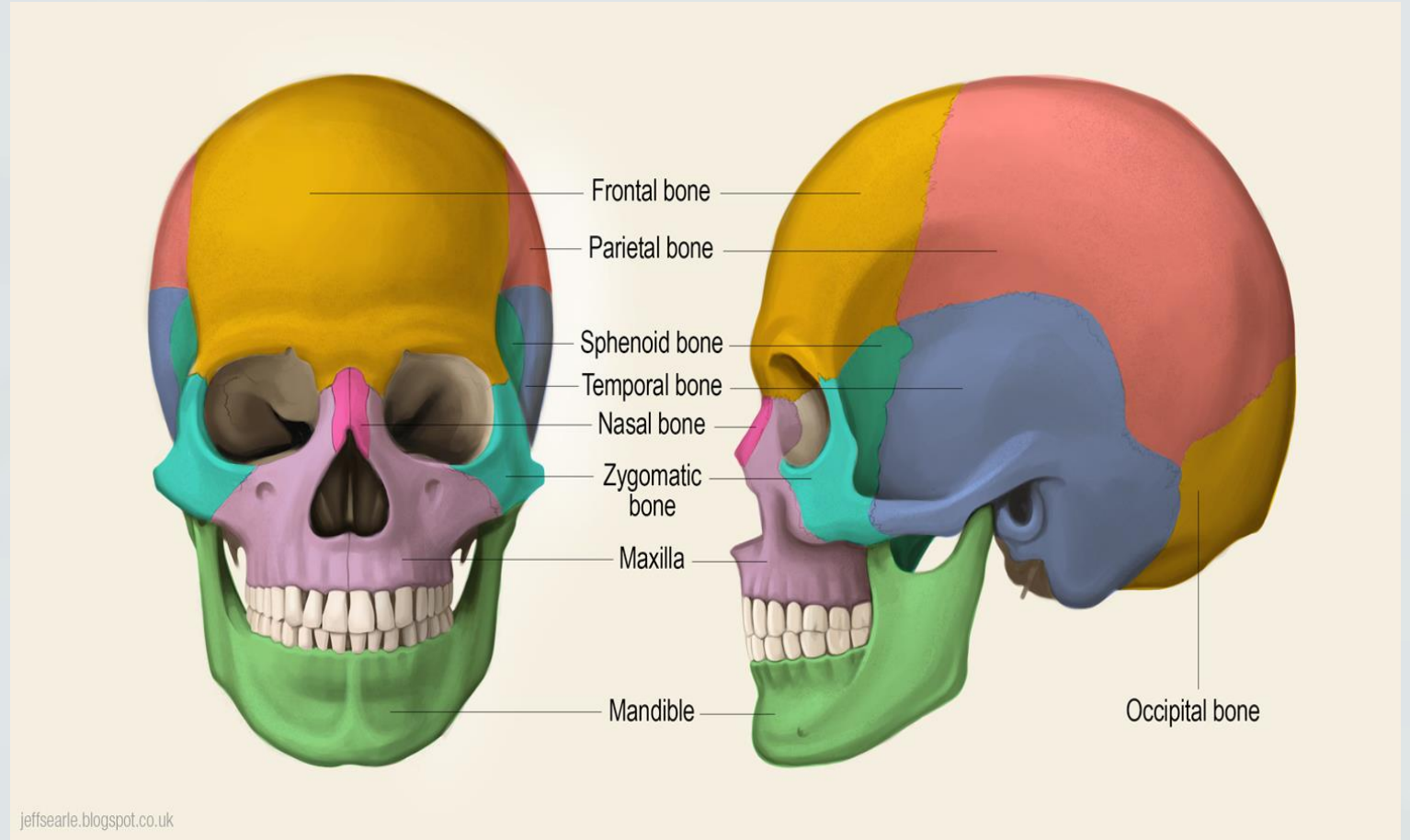
2- **Viscero-cranium**: skeleton of face

- Bones of skull ossify either by:

- Endochondral ossification :
mesenchymal cells → cartilage → bone
- Intramembranous ossification :
mesenchymal cells → bone (directly)

- **Bones of skull that ossify by intramembranous ossification:**

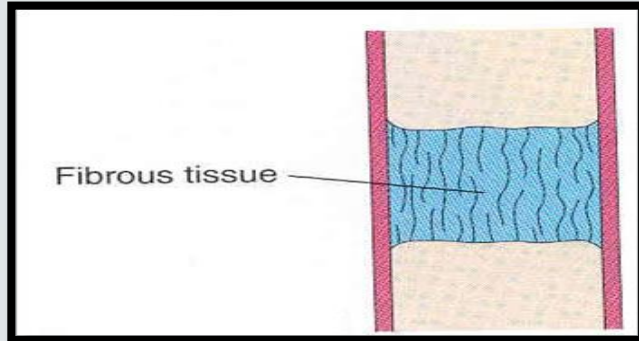
- Frontal
- Parietal
- Zygomatic
- Squamous temporal
- Mandible ^ except condyles ^
- Maxilla



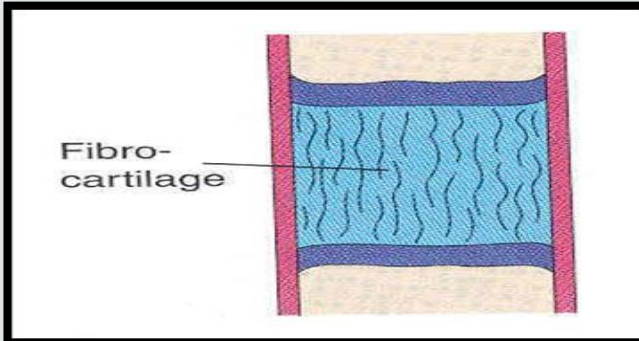
JOINTS

JUST READ IT ! 😊

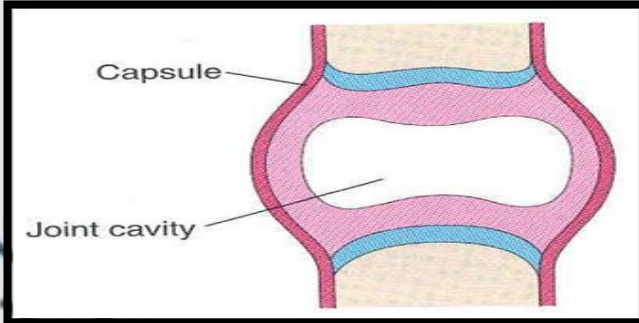
They develop from mesoderm between bones:



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 & ligaments.

Summary

BONE

- All bones develop from **MESODERM**.

AXIAL SKELETON:

1. Vertebrae, ribs & sternum: from sclerotomes of **somites** (paraxial mesoderm)
2. Skull: from mesoderm surrounding the brain.

APPENDICULAR SKELETON: from somatic part of lateral mesoderm

- All bones ossify by endochondral ossification EXCEPT :

- **Frontal**
- **Parietal**
- **Zygomatic**
- **Squamous temporal**
- **Mandible**
- **Maxilla**
- **And Clavicle**

MUSCLES

- All muscles develop from MESODERM EXCEPT:

1. Muscles of iris (eyeball) **ECTODERM**
2. Myoepithelial cells of mammary & sweat glands, **ECTODERM**

- All skeletal muscles develop from myotomes of paraxial mesoderm EXCEPT: some head & neck muscles from **mesoderm of pharyngeal arches**

- Cardiac & smooth muscles develop from **lateral mesoderm**:

1. Cardiac muscles from: splanchnic part of lateral mesoderm
2. Smooth muscles:
 - * In the wall of viscera from: splanchnic part of lateral mesoderm
 - * In the wall of blood & lymphatic vessels from: somatic part of lateral mesoderm

LIMBS

- 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.

Quiz and some Helpful Videos

1- which of the following does the skull come from:

- a-lateral mesoderm b- intermediate mesoderm c- mesoderm d- paraxial mesoderm

2-all the following ossifies by intramembranous ossification except :

- a-Frontal bone b Parietal bone c-Zygomatic bone d-occipital bone

3-muscles of abdominal wall comes from :

- a- ectoderm b- lateral mesoderm c paraxial mesoderm d- intermediate mesoderm

4-Primary ossific centers appears :

- a-Before birth b-after birth c- during puberty d-after puberty

5-all the following ossifies by endochondral ossification except :

- A-clavicle b- humerus c femur d-tibia

Answers → 1-c, 2-d, 3-c, 4-a, 5a

All Germ Layers:

<https://www.youtube.com/watch?v=QPvhl66QCqo>

Overview of embryogenesis :

<https://www.youtube.com/watch?v=G2HvEGUYwAU>





Wish You All The Best 😊

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