

# EMBRYOLOGY TEAM

435



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# Development of skeletal and muscular system

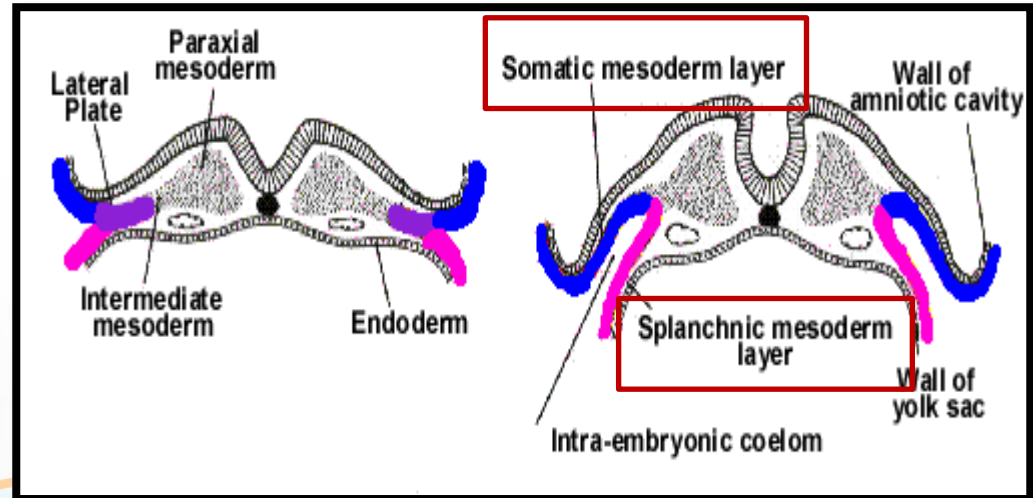
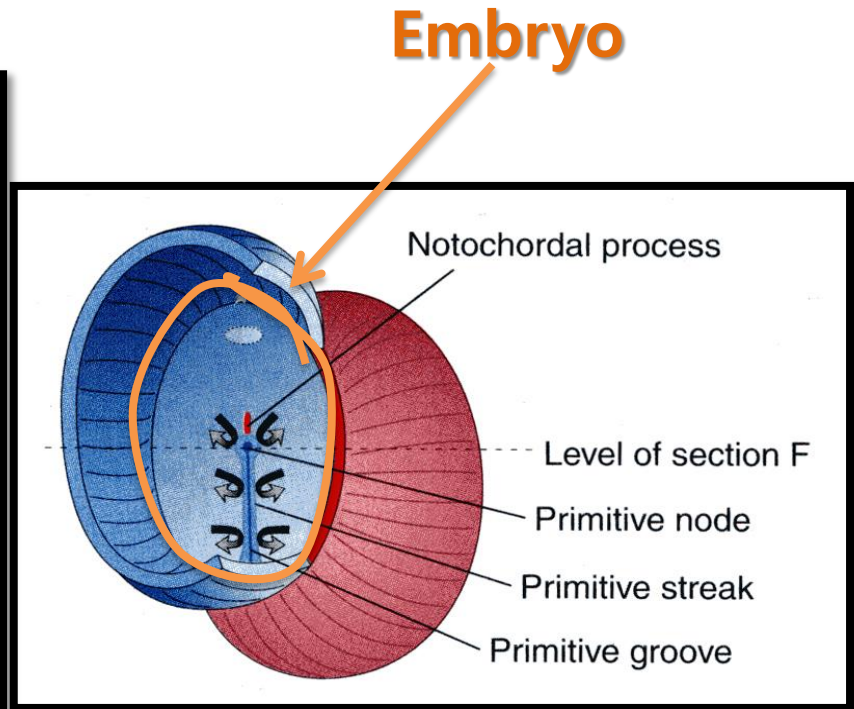
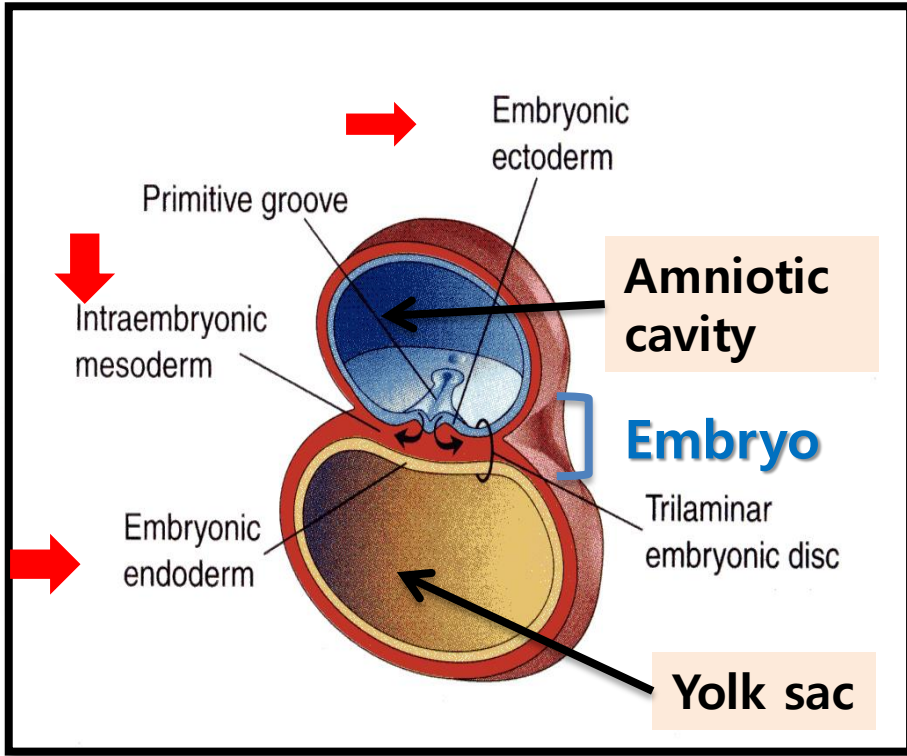
## Objectives

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.



- Important
- Extra



# INTRAEMBRYONIC MESODERM

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

Intraembryonic mesoderm differentiates into 3 parts

Lateral mesoderm: divided by **intraembryonic coelom** into

Intermediate mesoderm

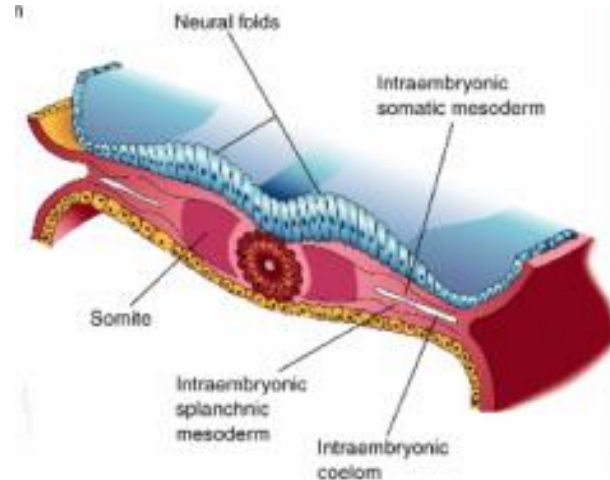
Paraxial mesoderm: on each side of notochord divided into unites (Somites)

Somatic mesoderm

(between ectoderm & coelom)

Splanchnic mesoderm

(between endoderm & coelom)



# INTRAEMBRYONIC MESODERM Cont.

## Paraxial mesoderm

Differentiated into units each unit called

### Somite

#### dermatome

Form skin

#### Sclerotome

medial to the notochord

**forms the axial skeleton except skull**

The notochord will form the CNS ( brain and spinal cord ) , the spinal cord will be surrounded by the vertebral column. The vertebral column with the ribs and the sternum forms the axial skeleton . So the sclerotome which is medial to the notochord will form the axial skeleton .

#### Myotome

Triangular in shape and it has two sides. lateral to the notochord.

#### Hypaxial

medial to the sclerotome

Forms the muscles of body walls (abdominal wall and chest wall )

#### Epaxial

Most lateral side

Forms the muscles of the back (extensors of vertebral column and the neck )

# INTRAEMBRYONIC MESODERM Cont.

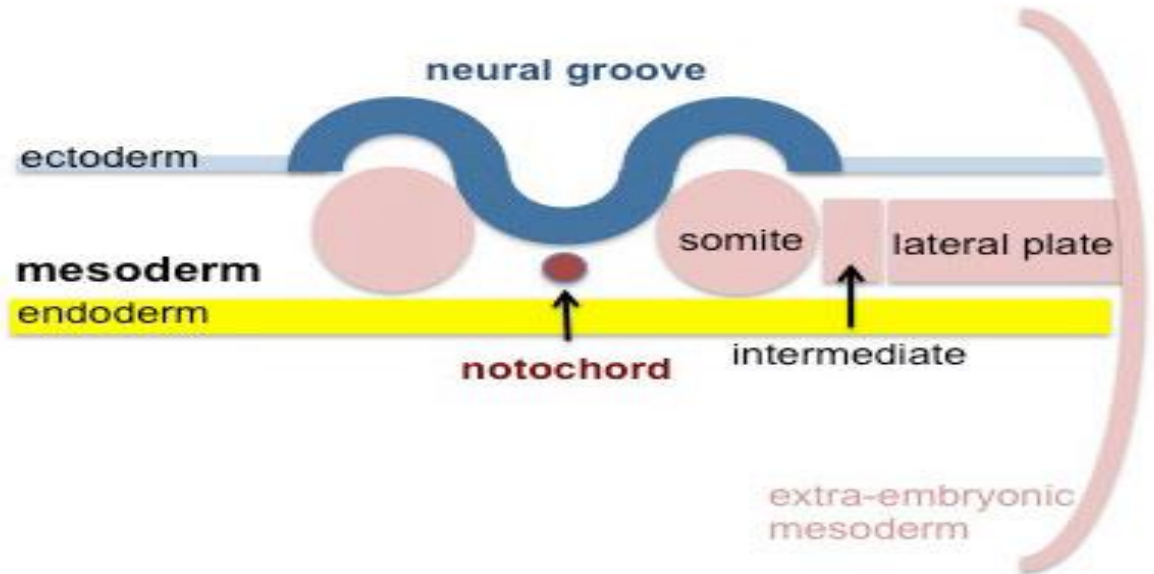
muscles of body walls → **Epaxial**

muscles of the back → **Hypaxial**

muscles of the limbs  ?

how the muscles of the limbs formed ?

Some cells migrate (تهاجر) from the **myotome**, they are called **myoblast** to the limbs to form the flexors and extensors muscles of the limbs ✓



# Development of limbs-1

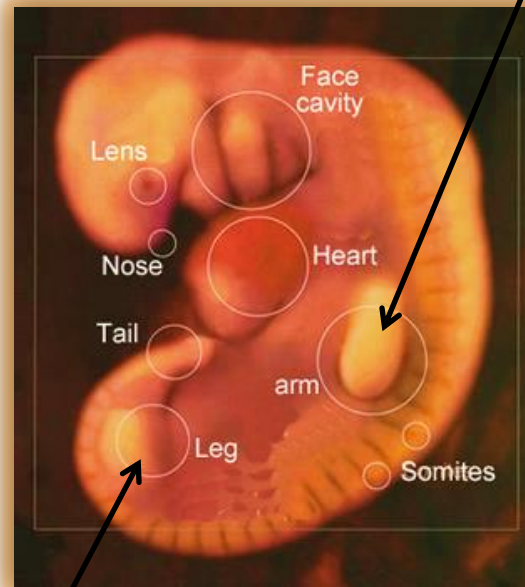
What is a **Limb Bud**?

It is an **elevation** on the ventrolateral body wall that is resulted from the proliferation of the mesenchyme of the somatic layer of the **lateral mesoderm**..

Each Limb Bud is surrounded by an area of **ectoderm**.

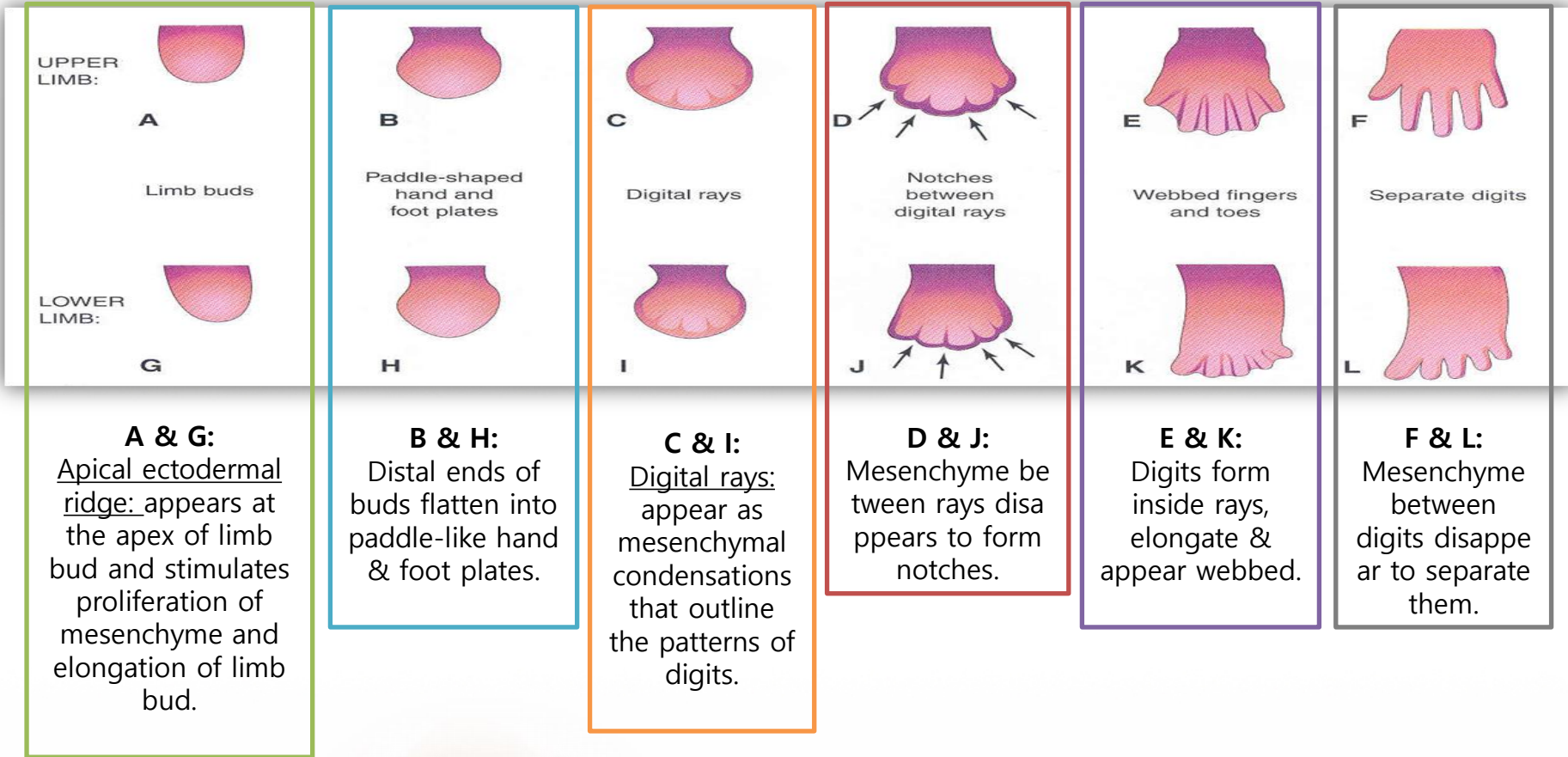
The ectoderm forms the skin  
**The buds form the bone.**

Lower Limb Buds:  
• Appear at **Day 28** opposite the **lumbar & sacral** segments



Upper Limb Buds:  
• Appear at **Day 26** opposite the **lower cervical** segments

# Development of limbs-2



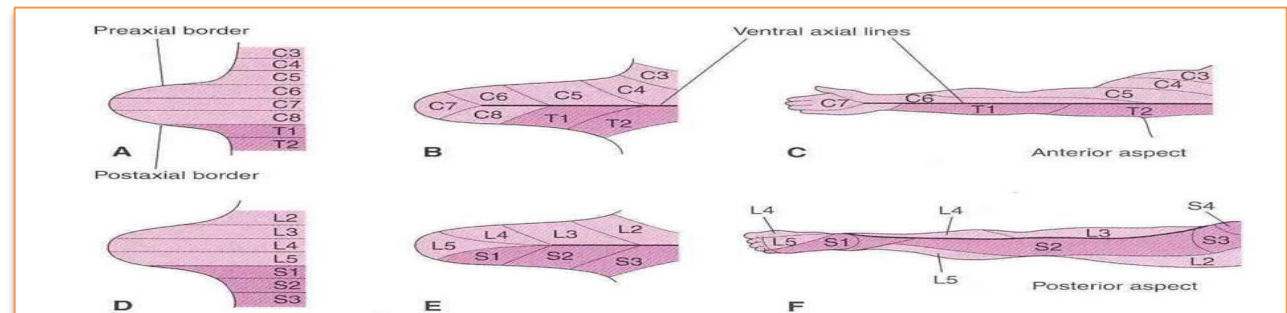


# Development of limbs-3

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

2 BORDERS	Cranial (pre-axial) e.g. radius & tibia	Caudal (post-axial)
2 SURFACES	Ventral e.g. flexor muscles	Dorsal

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

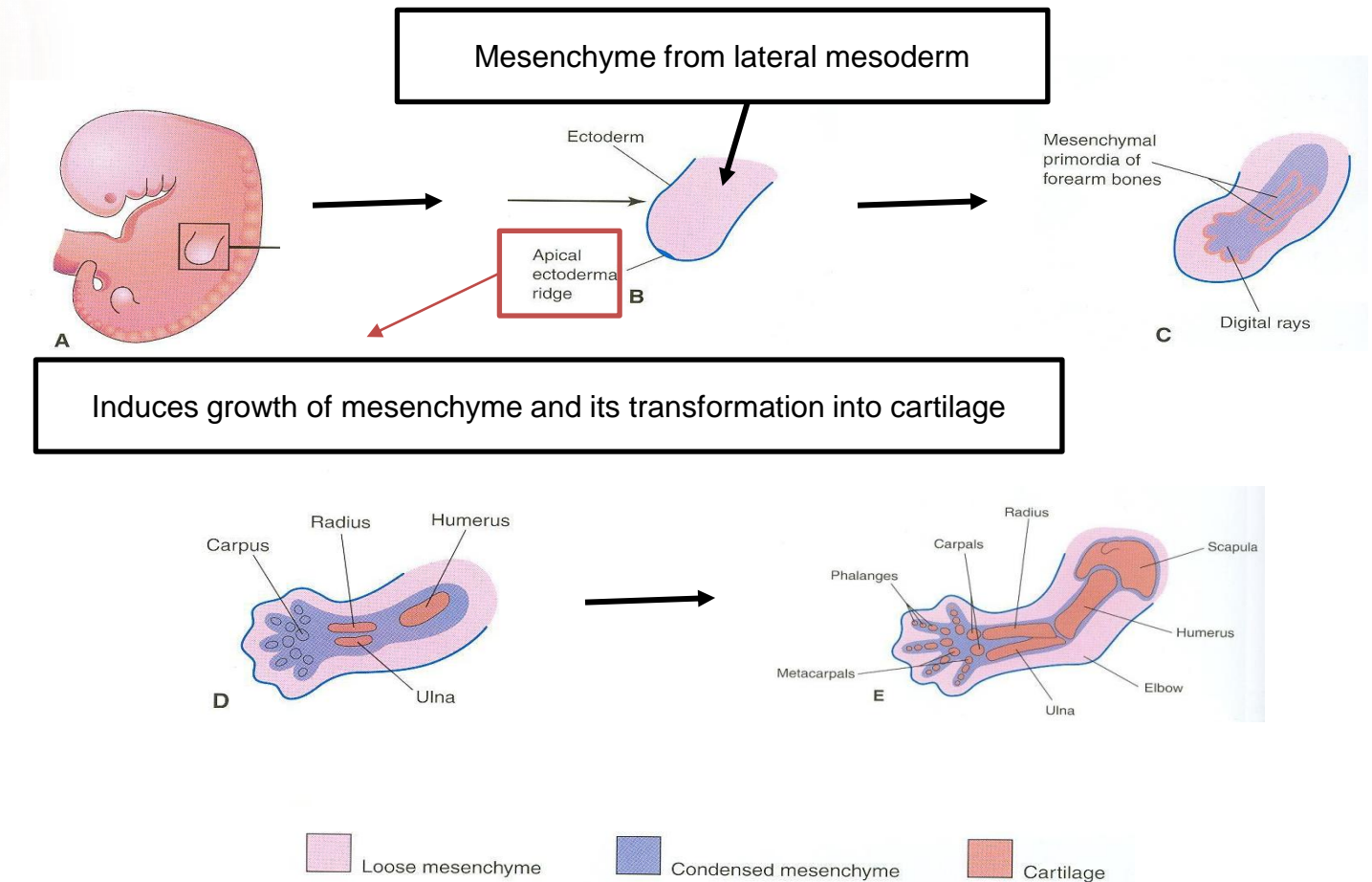


Upper Limb	Rotation: Lateral	Radius: Lateral	Flexor muscles: anterior
Lower Limb	Rotation: Medial	Tibia: Medial	Flexor muscles: posterior

Cartilage ossifies by:

- ENDOCHONDRAL OSSIFICATION

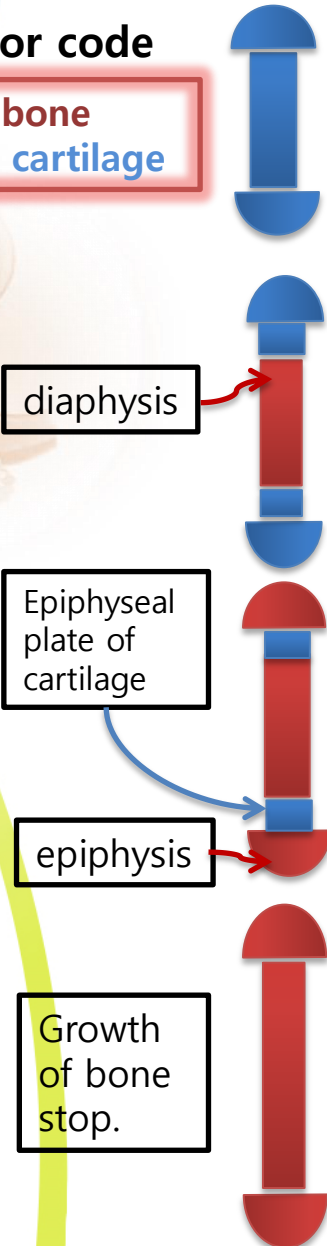
Myoblasts migrate from myotomes to form: Muscles of limbs



# Ossification of long bones

## Color code

Red: bone  
Blue: cartilage



Bone in cartilaginous state

الجنين في رحم امه وما اقترب وقت الولادة

**Before birth:** appearance of **primary ossific centers:** ossification of diaphysis.

اقترب وقت الولادة وبيغادر الجنين الرحم فلزام ياخذ استعدادته عشان يقدر يتكيف في العالم الخارجي ، تبدأ الدياتيسيز تصير قويه وتتحول من غضروف الى عظم

**After birth and before puberty:** appearance of **secondary ossific centers:** ossification of epiphysis."

طفلنا طلع للعالم الخارجي بس ما تكفي الاستعدادات الي حدثت قبل الولادة، لازم نزيد ، فنتحول اليبيفيسس من غضروف الى عظم

**In puberty:** Ossification of epiphyseal plate: complete union of epiphysis & diaphysis.

وصل طفلنا لسن البلوغ ماتحتاج عظامه تطول اكثر فيتحول البلبيت الي كان مسؤول عن زيادة الطول إلى عظم

# Ossification of long bones

Bone age is a good index of general maturation.

**Bone age is determined by:**

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

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

Remember from radiology:  
This X Ray shows child hand



Specific for each bone:

For example femurs

يقف نموها بالطول قبل باقي عظام الجسم

Specific for sex:

يقف نمو العظام بالطول عند الإناث قبل الذكور بسنتين

Remember from histology:

- Bone grow interstitially (increase in length)

by proliferation of epiphyseal plate.

- Bone grow appositionally (increase in wi  
dth) by the activity of osteoblast in  
periosteum

# Development of cranium ( skull )

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- The skull develop from **mesoderm** around the **developing brain**



- The skull consists of:
  1. **Neurocranium**: protective case for brain

1. **Viscerocranium**: bones of the face .

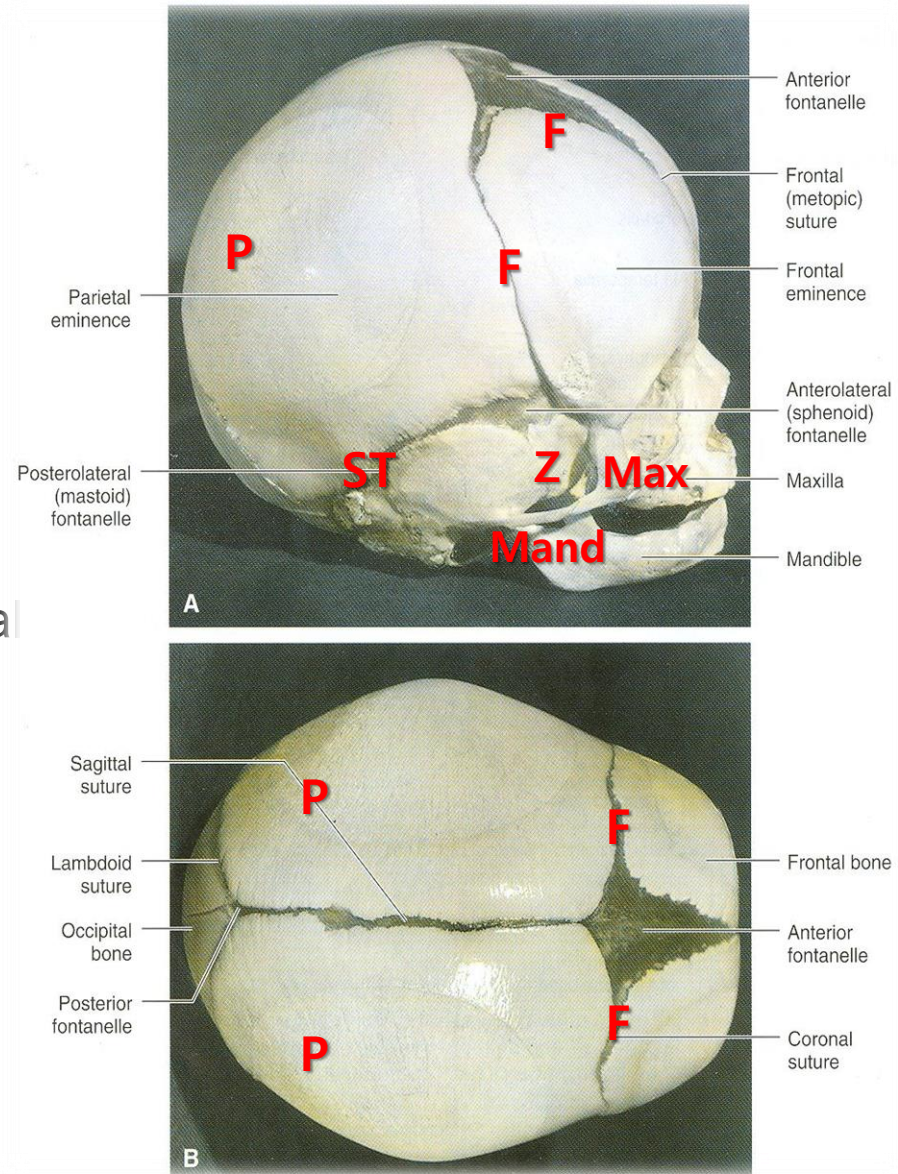
- Bones of skull ossify either by:
  - 1- **Endochondral** ossification.
  - or
  - 2- **Intramembranous** ossification.

- 
- Frontal
  - Parietal
  - Temporal
  - Sphenoid
  - Ethmoid
  - occipital



# Bones of skull that ossify by Intermembranous ossification

1. F = Frontal
2. P = Parietal
3. Z = Zygomatic
4. ST = Squamous temporal
5. Mand = Mandible
6. Max = Maxilla



# Summary of development of bone

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- All bone develop from **Mesoderm**.
- All bone ossify by **endochondral** ossification , except :
  1. Some bones of skull.
  2. Clavicale

## axial skeleton

Vertebrae , ribs and sternum from **sclerotomes of somites ( paraxial mesoderm )**

Skull from **mesoderm** surrounding the brain.

## Appendicular skeleton

From **somatic part of lateral mesoderm**



# Development of joint

Joints develop from the **mesoderm** between bones

## Note:

As we know any two bones separated by a mesoderm which could be:  
**1st** a fibrous tissue or composed fibrous tissue so the type of joint between these two bones is fibrous!  
**2nd** if the mesoderm is cartilage so the type of the joint is cartilaginous  
**3rd** if the mesoderm is disappear (convert to a cavity) the joint type is synovial!.

## Fibrous joints

mesoderm differentiates  
Into:

Dense fibrous  
connective tissue

## Cartilaginous joints

mesoderm differentiates  
Into:

Cartilage

## Synovial joints

A synovial cavity is formed  
inside mesoderm, mesoderm  
differentiates into:

Synovial  
membrane

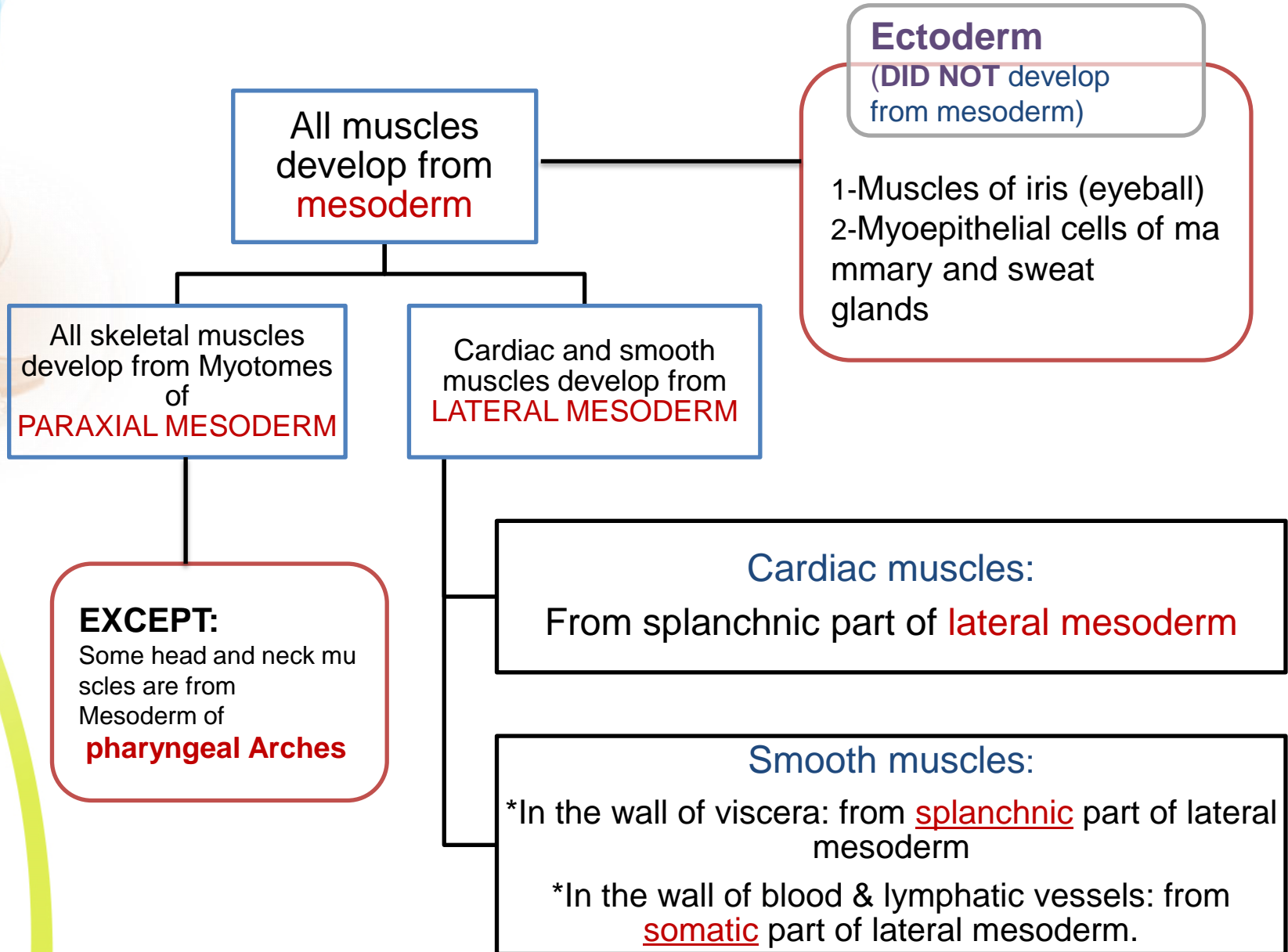
Capsule

Ligament





# Development of muscle



# Summary - 1

Limb	Develop from	Limb bud.
skull		Mesoderm around the developing brain
Bone 1. Axial ( vertebrae , ribs and sternum ) 2. Appendicular		Mesoderm 1. Sclerotoma of somites ( paraxial mesoderm ) 2. Somatic part of lateral mesoderm
Joint		Mesoderm between bones
All Muscles Except : 1-Muscles of iris (eyeball) 2-Myoepithelial cells of mammary and sweat glands		Mesoderm Ectoderm
All skeletal muscle Except : Some head and neck muscles		Myotoma of paraxial mesoderm Mesoderm of pharyngeal arches
Cardiac muscles		Splanchnic part of lateral mesoderm
Smooth muscles 1. In the wall of viscera 2. In the wall of blood and lymphatic vessels		1. Splanchnic part of lateral mesoderm 2. Somatic part of lateral mesoderm



# Ossification

\* تبدأ مرحلة التعظيم من النص الى الاجزاء الجانبية من العظم ، وفي هذي المرحلة يزيد طول العظم.

\* المرحلة الأولى وتكون في جزء الـ diaphysis من العظم.

\* المرحلة الثانية وتكون في الأطراف وهي epiphysis .

\* المرحلة الأخيرة وهي عند **البلوغ** وتكون في مكان الـ epiphyseal plate وبكذا تنتهي مرحلة التعظم ويتوقف عن الزيادة في الطول.

\* كيف نعرف عمر العظم ؟

١- ظهور مراحل التعظيم في اجزاء العظم diaphysis & epiphysis .

٢- اختفاء الـ epiphyseal plate وهي تختفي عند البلوغ.

# Summary -3

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day	What happens
day 26	<b>Upper limb</b> buds appear opposite the lower cervical segments.
day 28	<b>Lower limb</b> buds appear at opposite the lumbar & sacral segments.
During 7th week	<b>adduction</b> of limb buds occurs with 90° rotation:

# MCOs -1

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1- lateral mesoderm divides by intraembryonic coelom into :

- A-somites and somatic mesoderm
- B-somatic mesoderm and sclerotoma
- C-splanchnic mesoderm myoblast
- D-somatic mesoderm and splanchnic mesoderm.

2- when does the upper and lower limbs bud appears respectively?

- A-24 / 26
- B-26 / 28
- C-24 / 28
- D-26 /32

3- In which of the following stages does the Mesenchyme between rays disappears to form notches?

- A- C&I
- B- D&I
- C- D&J
- D- C&J

في هذا السؤال لازم تعرفون ايش بيصير في كل خطوة لان بالاختبار مايجي حروف كذا !

4- When does the shift of the long bone ossify

- A-Before birth
- B-At birth
- C-After birth
- D-After puberty

# MCOs -2

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5- Which one of the following is another name for the shaft :

- A-Epiphysis
- B-Diaphysis
- C- epiphysis plate
- D-None of the above

6- The bone of the skull ossify by

- A-Endochondral ossification
- B-Intramembranous ossification
- C-Both A&B
- D-None of the above

7-Which of the following Bones ossify by intramembranous ossification?

- A- scaphoid
- B- frontal
- C- humerus
- D- metatarsal

8-During which week does the addition of the limb buds happens ?

- A-9th week
- B-Between the 4th and 6th week
- C-8th week
- D-7th week

# MCOs -3

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9-Which one of the following group of muscles are derivatives from epaxial division of myotomes?

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

10-Which one of the following bones ossifies by intramembranous ossification?

- A-Vertebra
- B-Humerus
- C-Ribs
- D-Mandible

11-Regarding the ossification of long bones, which one of the following statements is correct?

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

12-Which one of the following is the result of rotation of upper limb?

- A-The tibia becomes lateral.
- B-The flexor muscles become posterior.
- C-The ulna becomes medial.
- D-The preaxial digit becomes medial.

## The answers

1-D	5-B	9-A
2-B	6-C	10-D
3-C	7-B	11-D
4-A	8-D	12-C

KEEP CALM  
AND  
CHECK THE  
ANSWERS !!

*A short demonstration of how limbs develop*

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<http://www.youtube.com/watch?v=VpbdqGJ9LWk&channel=Itzy2512>

*Bones develop*

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<https://www.youtube.com/watch?v=xXgZap0AvL0>





# Thank you for checking our work

Embryology team

Girls  
team

أفنان المالكي  
سارة المطوع  
رزان السبتي  
لينا الشهري  
فرح مندوزا  
ياسمين الفارسي  
لميس التميمي  
وضحى العتيبي  
سهى العنزي  
أسرار باطرفي  
شادن العمران

Boys  
team

حلمي السويركي  
ناصر المجيول  
غسان المقبل  
سعيد الشهري  
محمد القرني  
نايف الزيايدي

