



Lecture 1: Embryology of the Limbs (Development of Skeletal and Muscular Systems)

Musculoskeletal Block

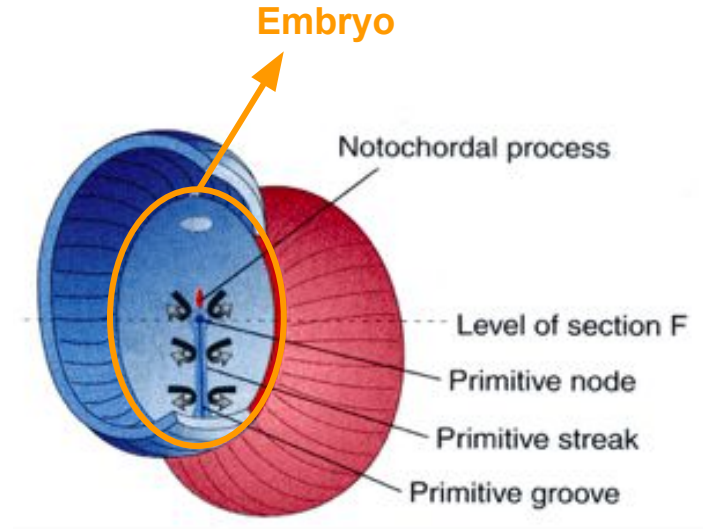
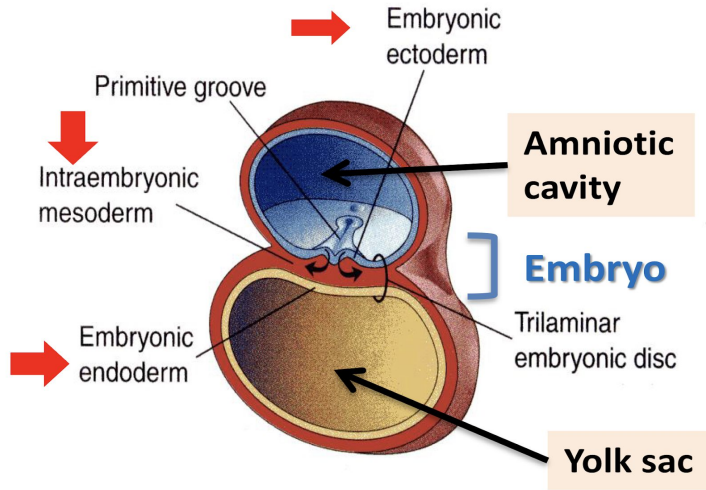
[Editing file](#)

Colour Index:
Red: Important
Gray: Notes
Green: Dr.'s notes

After this lecture you should be able to:

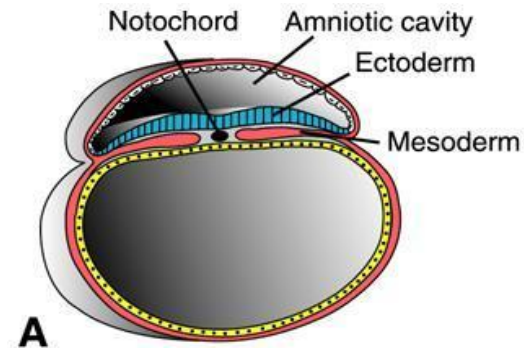
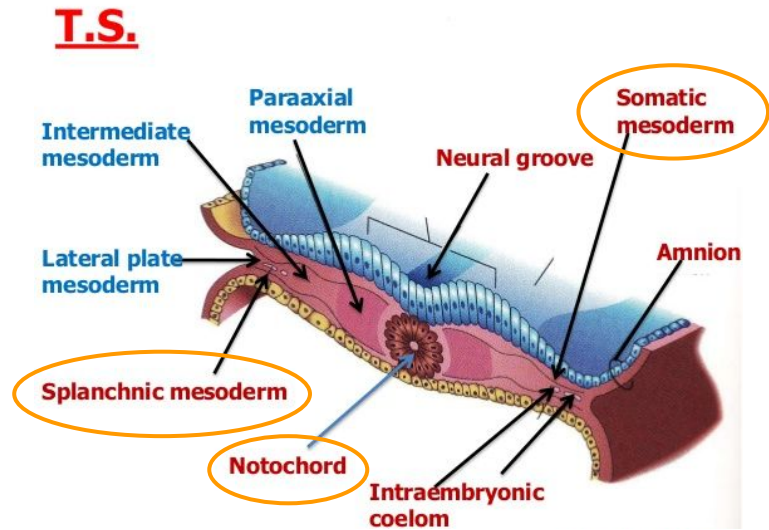
- List the different parts of mesoderm and the different divisions of somites.
- Differentiate bones according to their embryological origin and mode of ossification.
- Describe the ossification of long bones.
- Describe the main steps for development of limbs.
- Differentiate muscles according to their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

Revision



Intraembryonic mesoderm

- Proliferates between the **ectoderm** & **endoderm** except in the central axis of the embryo where **notochord** is found (**notochord stimulates neural tube formation**).
- Differentiates into **3** parts:
 1. **Paraxial mesoderm**: on each side of the notochord.
 - On each side of the notochord.
 - Divides into units (**Somites**).
 2. **Intermediate mesoderm**
 3. **Lateral mesoderm**
 - Divided by an **intraembryonic coelom** into:
 - 1) **Somatic mesoderm** (between ectoderm & coelom).
 - 2) **Splanchnic mesoderm** (between endoderm & coelom).



Paraxial mesoderm differentiates into units, each unit is called a:

SOMITE

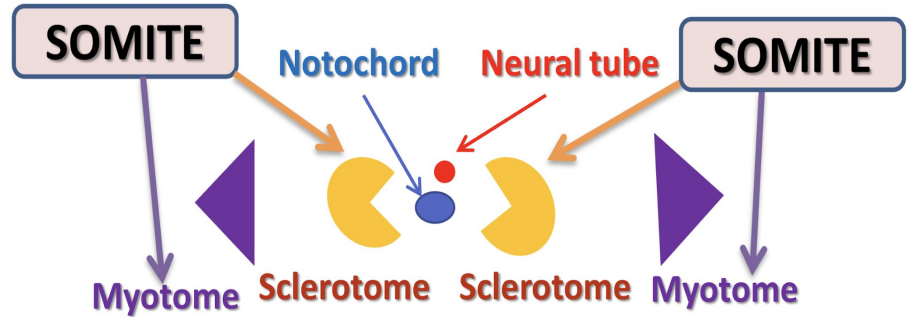
Dermatome

Forms the skin.

Sclerotome

Forms the axial skeleton except for skull (i.e. 1- Vertebral column 2- Ribs & sternum).

Myotome



Medial

Hypaxial division

Muscles of body wall

(abdominal wall, pelvic wall, thoracic wall, etc..).

Myoblasts

Migrate into limbs:

Limb muscles

(to form the flexor and extensor muscles of the limbs) in both the upper and lower limb.

Lateral

Epaxial division

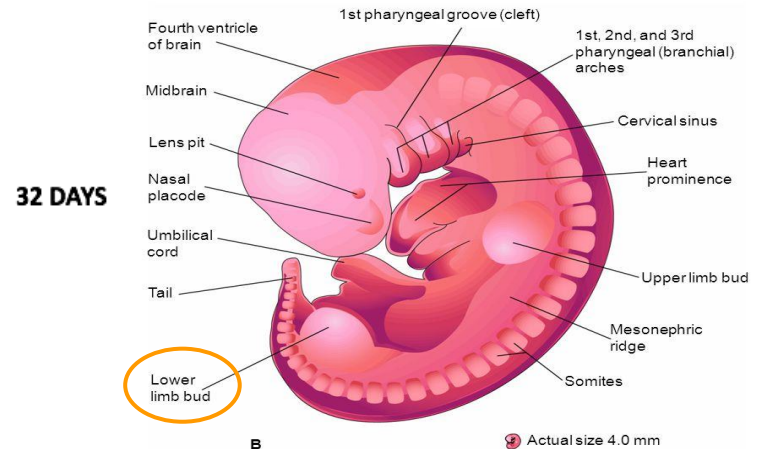
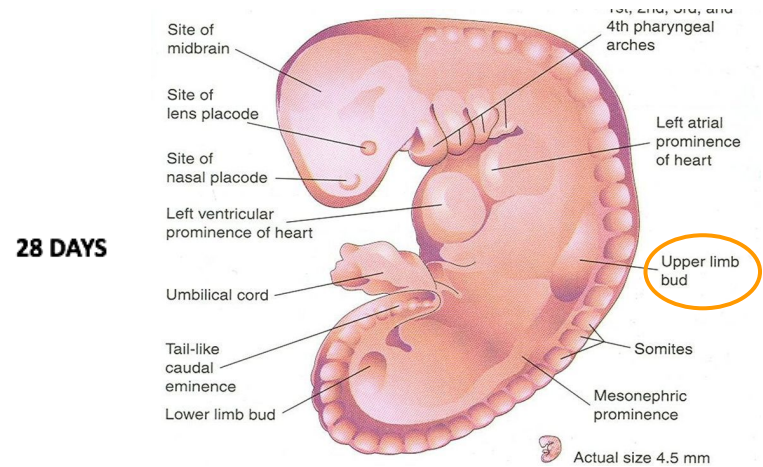
Muscles of back

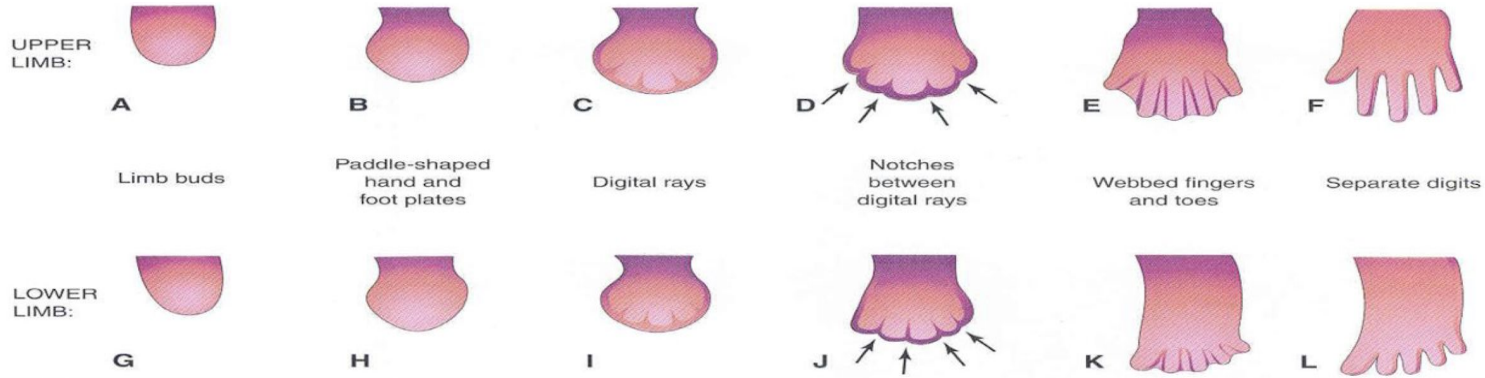
(Extensors of vertebral column and neck).

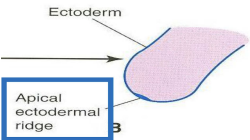
Development of the limbs

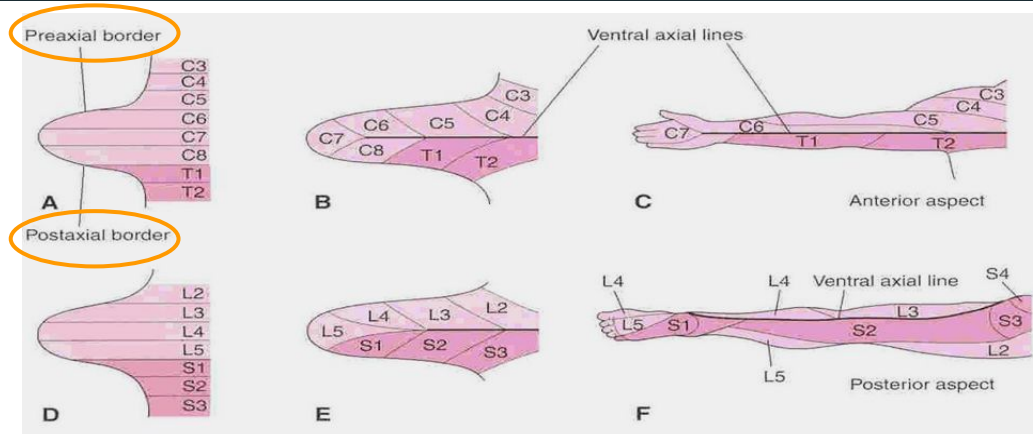
The **limb bud** appears as an elevation on the ventrolateral body wall resulting from proliferation of mesenchyme of the somatic layer of the lateral mesoderm. Each limb bud is surrounded by an area of ectoderm.

1. **Upper limb bud**: Appear at **day 26** opposite to the lower cervical segments.
2. **Lower limb bud**: Appear at **day 28** opposite to the lumbar & sacral segments.





A & G:	B & H:	C & I:	D & J:	E & K:	F & L:
<p>Apical ectodermal ridge: Appears at the apex of the limb bud and stimulates proliferation of mesenchyme and elongation of limb bud.</p>  <p>Without the apical ectodermal ridge, the bud won't be proliferate and the limbs will be small</p>	<p>Distal ends of buds flatten into paddle-like hand & foot plates.</p> <p>- Note: عشان الأصابع بدت تتكون تصير شكلها نفس يد البط.</p>	<p>Digital rays: Appear as mesenchymal condensations that outline the patterns of digits.</p> <p>- Note: تتكون ال digital rays بسبب تكتاف وتركيز ال mesenchymal condensations الأصابع (لكنها ماهي الأصابع نفسها).</p>	<p>Mesenchyme between rays disappears to form notches.</p> <p>- Girls slides: Notches appear between digital rays.</p>	<p>Digits form inside rays elongate & appear webbed.</p> <p>- Note: تكونت الأصابع ولكنها متشابهة كأصابع الكلب أو القط.</p>	<p>Mesenchyme between digits disappear to separate them.</p>



- 436 Note:

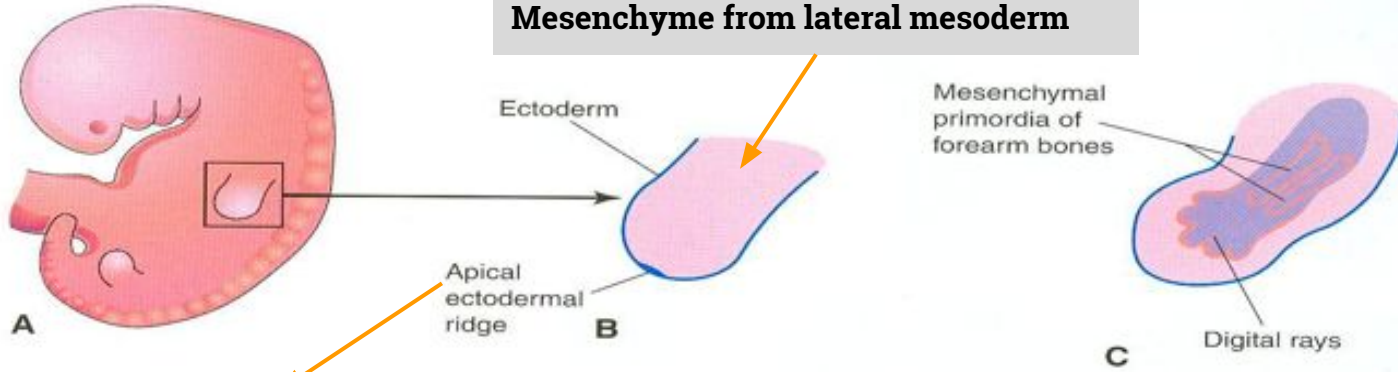
When the limbs first appear they are at a right angle (as if they are abducted at 90°) and they are rotated (the arm is in midprone position). Then in the 7th week adduction occurs and 90° rotation. The arms rotate laterally and the legs rotate medially (to be in the anatomical position). This is why in the end the flexor group in the arm is anterior and in the leg it is posterior.

- 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.

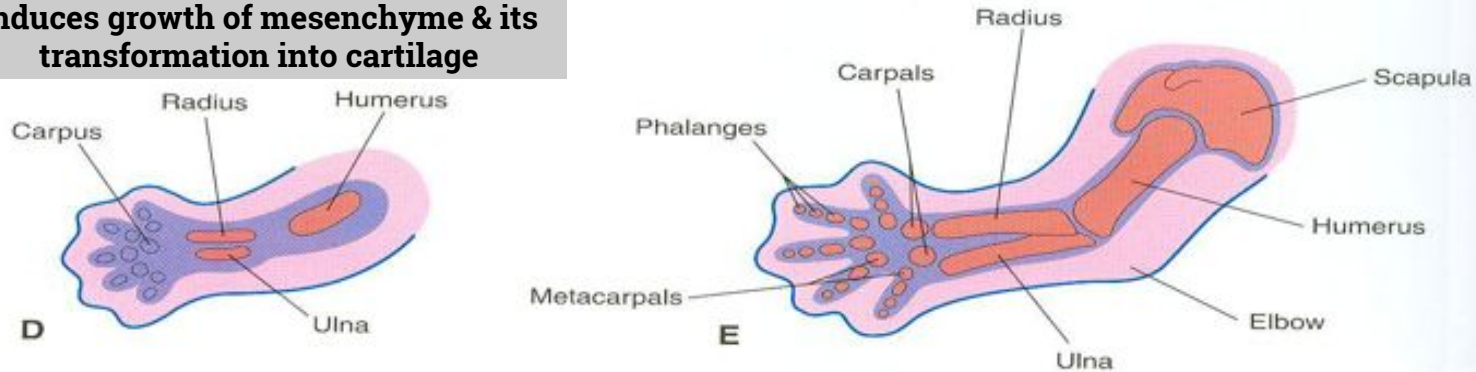
- During **7th** week, adduction of limb buds occurs with 90° rotation:
 - 1) In **upper limb**, rotation occurs laterally → radius is lateral & flexor muscles are anterior.
 - 2) In **lower limb**, rotation occurs medially → tibia is medial & flexor muscles are posterior.

Loose mesenchyme
 Condensed mesenchyme
 Cartilage

Mesenchyme from lateral mesoderm

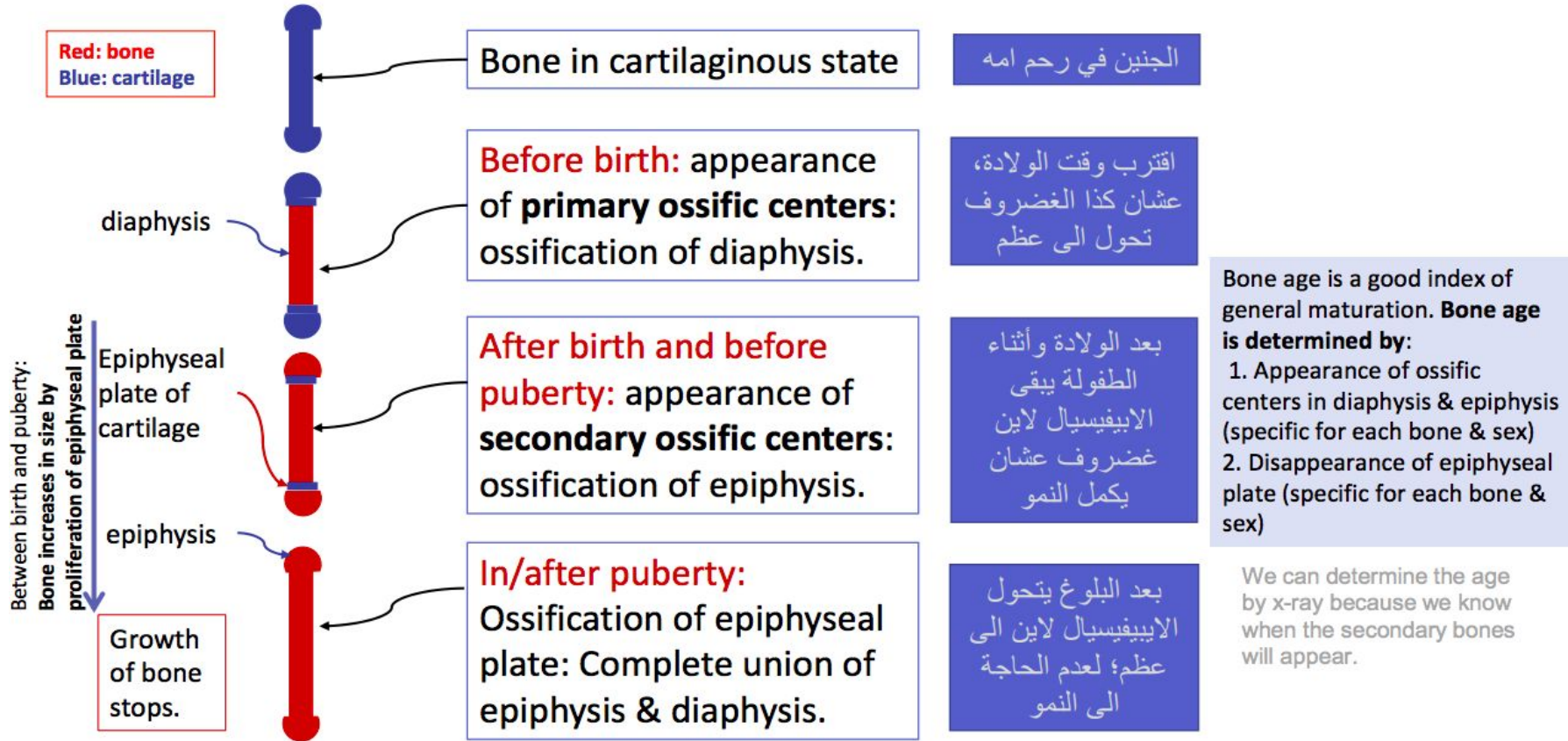


Induces growth of mesenchyme & its transformation into cartilage



- Cartilage ossifies by: Endochondral ossification.
- Myoblasts migrate from myotomes to form: Muscles of limbs.

Ossification of long bone - 436 team



Development of the cranium (skull)

The skull develops from the **mesoderm** around the developing brain.

Skull consists of:

1. Neurocranium:

Protective case of the brain.

2. Viscerocranium:

Skeleton of the face.



Cartilage is formed first then the bone.

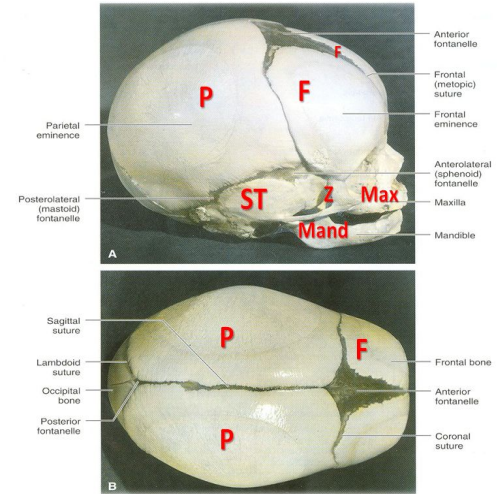
Endochondral ossification

Bones of skull ossify by:

Intramembranous ossification

أثناء تكون العظام لا يمر بمرحلة cartilage

Bone is directly formed.

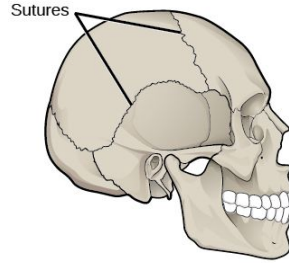


Bones of skull that ossify by intramembranous ossification:

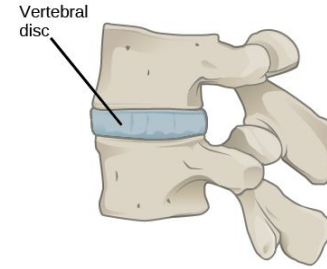
1. F = Frontal
2. P = Parietal
3. Z = Zygomatic
4. ST = Squamous temporal
5. Mand = Mandible
6. Max = Maxilla

Joints

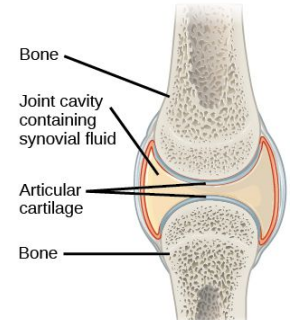
Fibrous joint



Cartilaginous joint



Synovial joint



Joints develop from the **mesoderm** between the bones.

3 types

1. Fibrous joints:

Mesoderm differentiates into dense fibrous connective tissue.

2. Cartilaginous joints:

Mesoderm differentiates into cartilage.

3. Synovial joints:

A synovial cavity is formed inside the mesoderm.

Mesoderm differentiates into:

Synovial membrane

Capsule

Ligaments

Summary - 436 team

BONE	MUSCLES	LIMBS
<p>All bones develop from MESODERM.</p> <p>AXIAL SKELETON: *Vertebrae, ribs & sternum: from sclerotomes of somites (paraxial mesoderm) *Skull: from mesoderm surrounding the brain.</p> <p>APPENDICULAR SKELETON: from somatic part of lateral mesoderm</p> <p>All bones ossify by enchondral ossification EXCEPT:</p> <ol style="list-style-type: none">1. Some bones of skull2. Clavicle	<p><input type="checkbox"/> All muscles develop from MESODERM EXCEPT:</p> <ol style="list-style-type: none">1. Muscles of iris (eyeball) ECTODERM2. Myoepithelial cells of mammary & sweat glands, ECTODERM <p><input type="checkbox"/> All skeletal muscles develop from myotomes of paraxial mesoderm EXCEPT: some head & neck muscles from mesoderm of pharyngeal arches</p> <hr/> <p><input type="checkbox"/> Cardiac & smooth muscles develop from lateral mesoderm:</p> <ol style="list-style-type: none">1. Cardiac muscles from: splanchnic part of lateral mesoderm2. 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	<p><input type="checkbox"/> Mesenchyme from somatic layer of lateral mesoderm proliferates to form limb buds.</p> <p><input type="checkbox"/> Apical ectodermal ridge stimulates proliferation & elongation of buds then cartilage formation.</p> <p><input type="checkbox"/> All bones of limbs ossify by enchondral ossification EXCEPT: clavicle.</p> <p><input type="checkbox"/> Muscles of limbs develop from myotomes.</p> <p><input type="checkbox"/> Rotation of limbs occur in opposite direction.</p> <p><input type="checkbox"/> Development of upper limb precedes that of lower limb.</p>

MCQs

- 1) **Which of these steps occurs right after Paddle-like hand or foot plates development?**
- A. Mesenchyme between digits disappear to separate them
 - B. Apical ectodermal ridge
 - C. Digital rays appearance
 - D. Endochondral ossification
- 2) **Which of the following develops the muscles of the back?**
- A. Epiaxial division of myotome
 - B. Dermatome
 - C. Hypaxial division of myotome
 - D. Sclerotome

- 3) **Which one of the following is the protective case of the brain?**

- A. Endochondral ossification
- B. Viscerocranium
- C. Neurocranium
- D. Intramembranous ossification

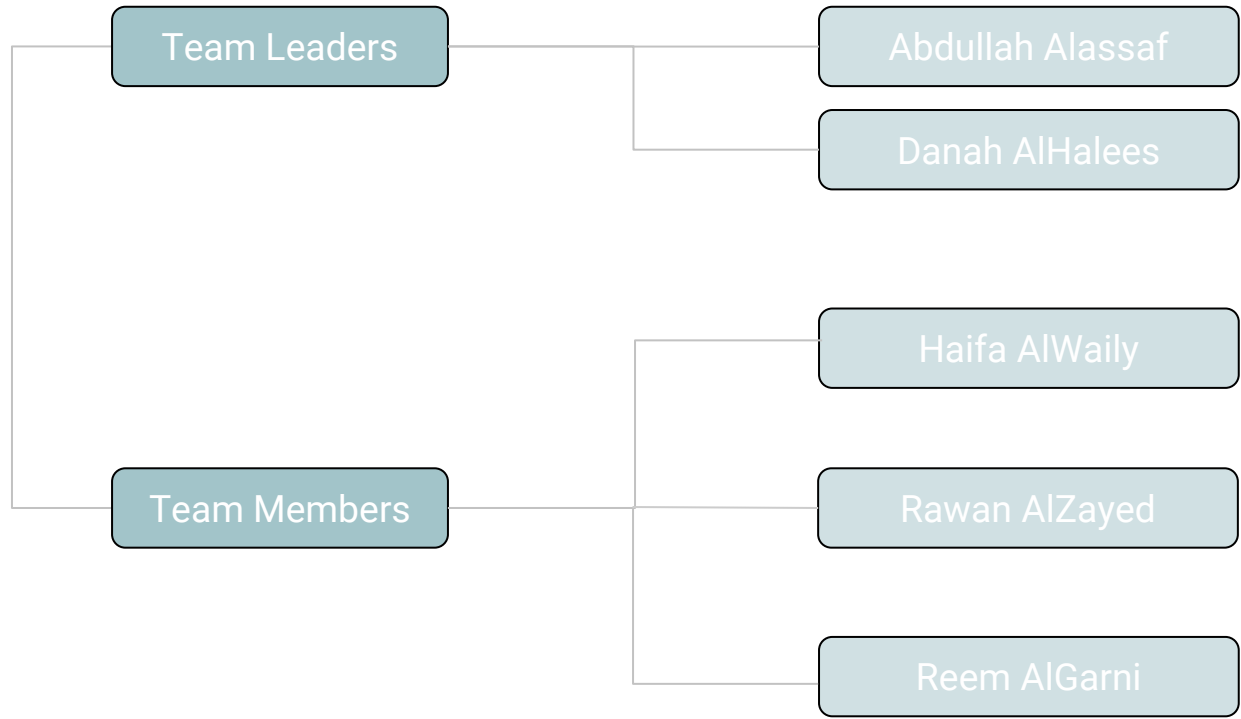
- 4) **The bone increases in length by the proliferation of:**

- A. union of epiphysis & diaphysis
- B. Epiphyseal plate
- C. Diaphysis
- D. Epiphyseal

- 5) **During which week does the adduction of limb buds at 90 degrees rotation occur?**

- A. 10th
- B. 6th
- C. 9th
- D. 7th

Answers : 1C / 2A / 3C / 4B / 5D



Special thank you to 436 Anatomy Team



Thank you