

Development of Limbs

- At the **end of 4th week**, **limb buds** are formed as a protrusion or outpocketing from anterolateral aspect of the trunk .

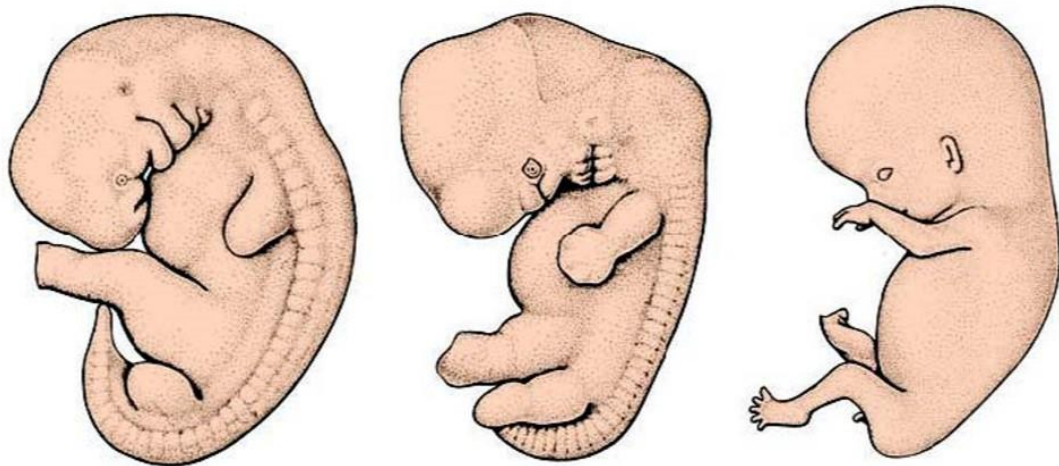
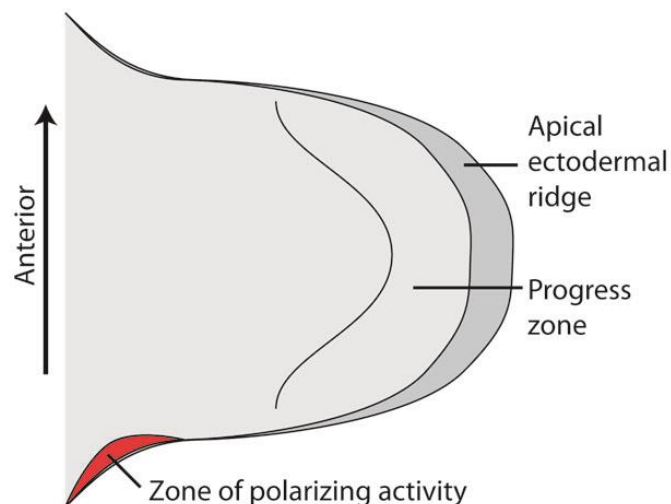
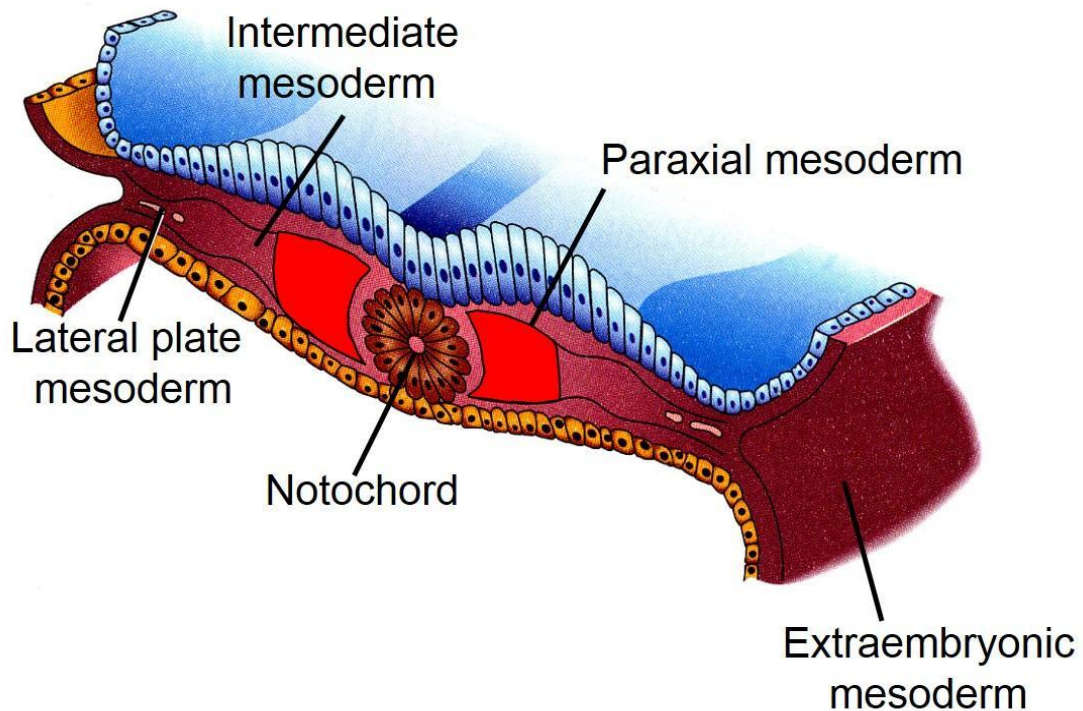


Fig. 1 : Stages of growth of upper and lower limbs.

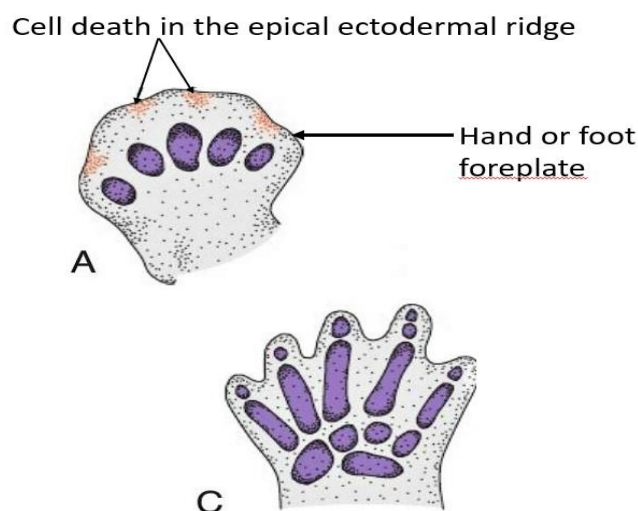
- Each bud is **composed of** :
 - 1) A **core** of mesenchym that is derived from **lateral plate mesoderm** which forms **skeleton and connective tissue** of the limb.
 - 2) A **covering** of **ectoderm** that gives rise to **epidermis** of the skin.
- Thickening of the distal margin of the bud is known as apical ectodermal ridge (AER).



Development of limbs



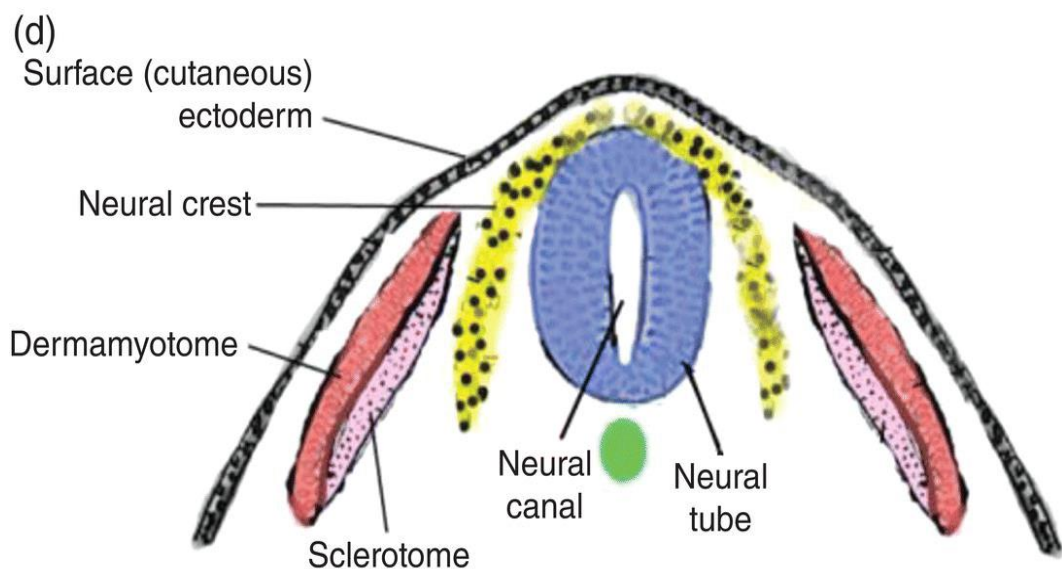
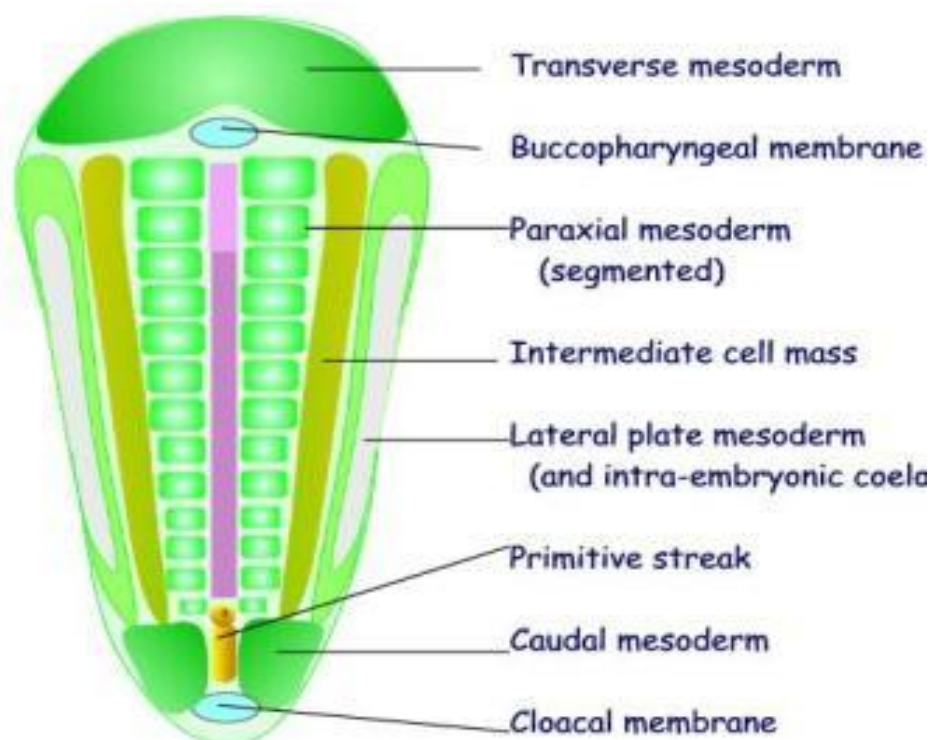
- In **6-week**-old embryos, the **terminal part** of the limb buds becomes flattened to form the **hand and foot plates** and is separated from the proximal segment by a **circular constriction**.
- Later, a **second constriction** divides the proximal portion into two segments. Now the limb is divided into three segments.
- **Fingers and toes** are formed when **programmed cell death** in the AER separates this ridge into **five parts** that grow to form digits with the first digit (thumb or great toe) located cranially (i.e. superiorly)



Development of limbs

★ Development of muscles of limbs:

- Limb **musculature and dermis** of the skin are derived from **dermo-myotomes** of the **somites** (of the paraxial mesoderm) that **migrate** into the limb.
- Initially the somatic mesoderm forms ventral and dorsal muscle masses that migrate with their nerve & blood supply to the limb buds to form the flexors and extensor muscles respectively.



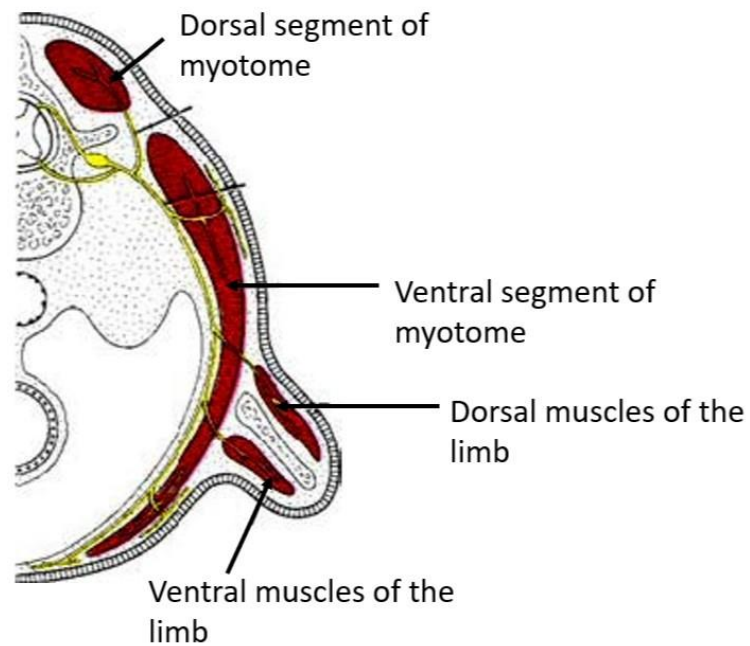
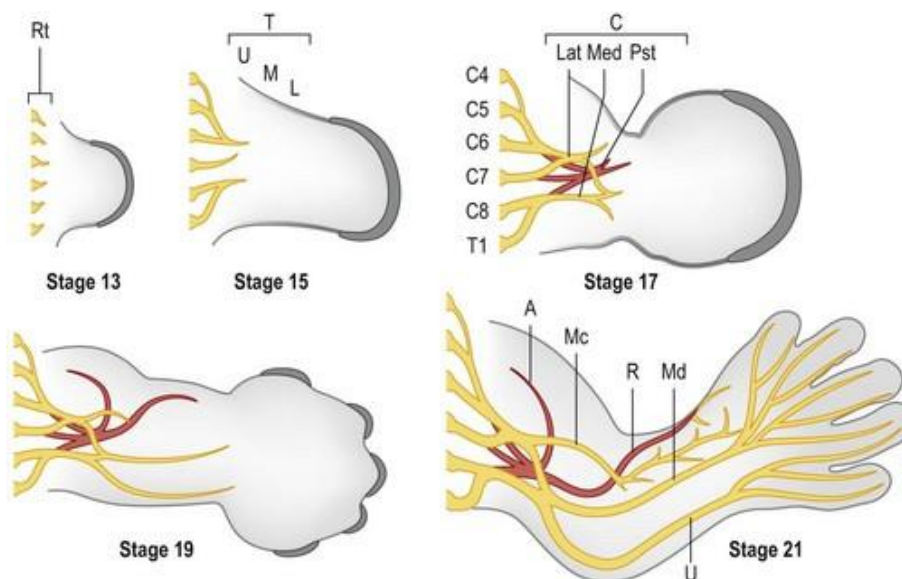


Fig. 3 : Formation of skeletal muscles in body and limbs



- Initially, these muscles are segmented according to the somites from which they are derived.
- With elongation of the limb buds, the muscle tissue first splits into flexor and extensor components.
- Then additional splitting and fusions occur, such that a single muscle may be formed from more than one somites.

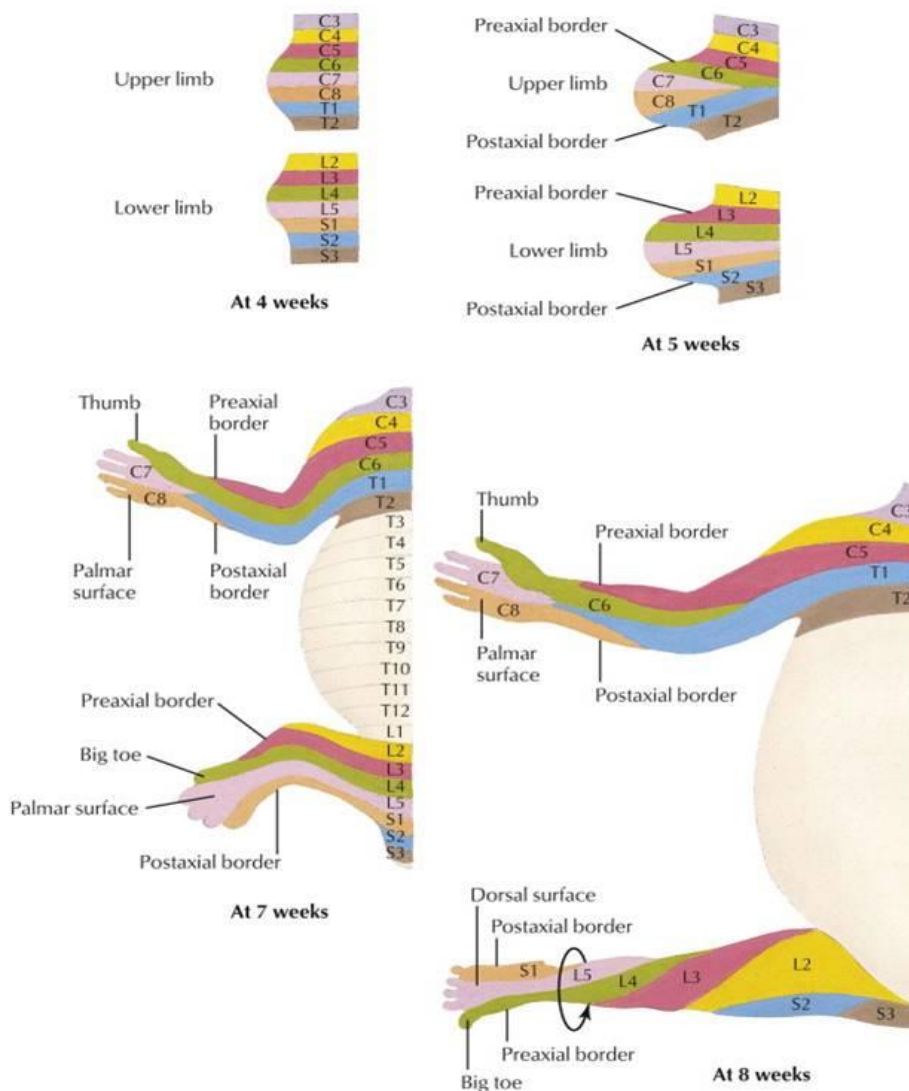
Development of limbs

- Upper limb buds lie opposite the lower five cervical and upper two thoracic segments, and the lower limb buds lie opposite the lower four lumbar and upper two sacral segments.
- Nerve supply of the limb depends on the somites from which skeletal muscles and dermatomes are derived.

★ Rotation of the limbs:

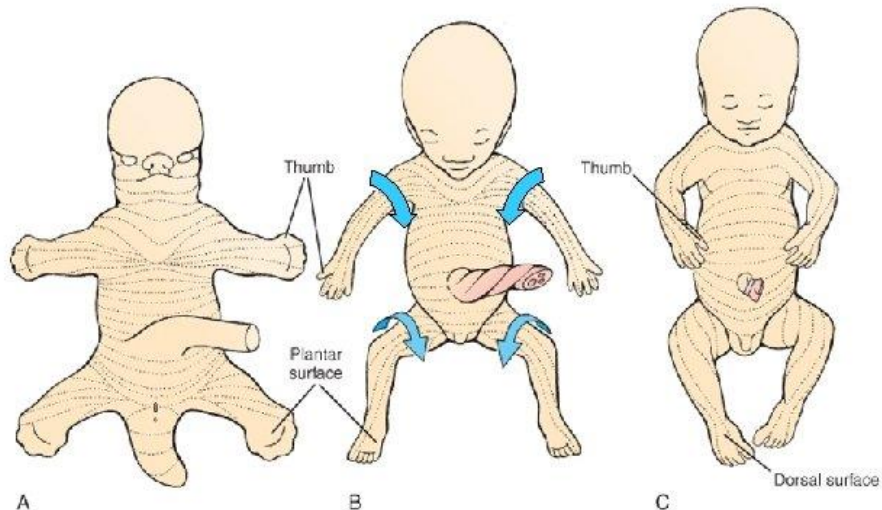
- During the **7th week** of gestation, the **limbs rotate** in opposite directions.
- The upper limb rotates 90° laterally, so that the extensor muscles lie on the posterior surface, and the thumbs lie laterally
- The lower limb rotates approximately 90° medially, placing the extensor muscles on the anterior surface and the big toe medially.

Changes in ventral dermatome pattern (cutaneous sensory nerve distribution) during limb development



The limbs rotate inward:

forelimb ~90 degrees
hindlimb ~180 degrees



Schoenwolf et al: Larsen's Human Embryology, 4th Edition.
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★ Formation of skeleton of limbs :

- At the **beginning**, the mesenchymal core is transformed into **skeleton composed of hyaline cartilage**.
- **Endochondral ossification** of the hyaline cartilage of the limbs, begins by the end of the embryonic period (**8th week**).

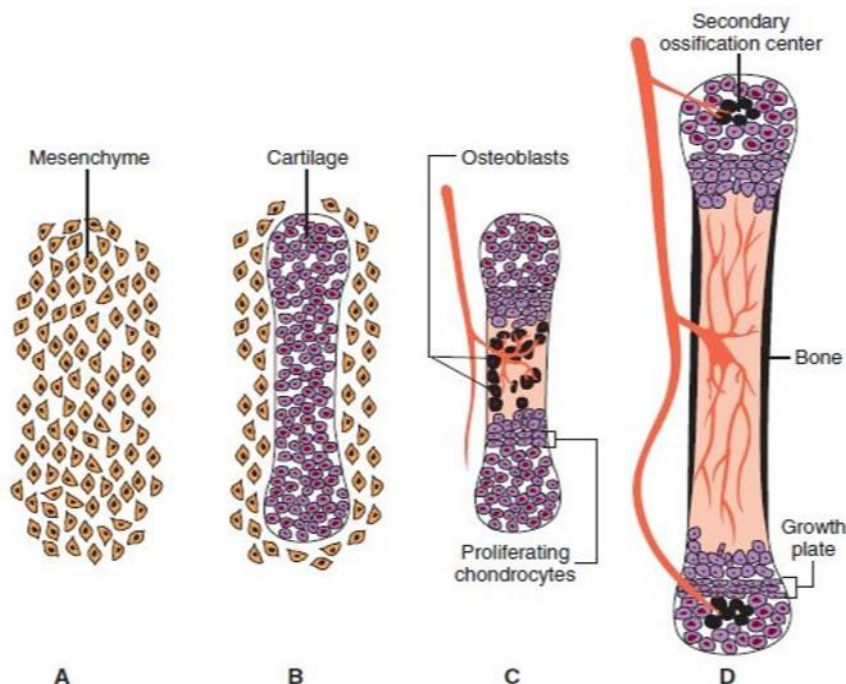


Fig. 4 : Ossification of hyaline cartilage in limbs

- **Primary ossification centres** are formed in the **shafts (diaphysis)** of hyaline cartilage models transferring the cartilaginous shaft into **bone** tissue **except their ends**.
- **At birth**, the **shafts** are usually completely **ossified**, but the two ends, the epiphyses, are still cartilaginous.
- **Secondary ossification** centres appear in the **epiphyses**.
- **Temporarily**, a cartilage plate remains between the diaphyseal and epiphyseal ossification centres. This plate, the **epiphyseal plate**, plays an important role in **growth in the length** of the bones.
- When the bone has acquired its **full length**, the epiphyseal plates **disappear**, and the epiphyses unite with the shaft of the bone.

❖ **N.B.** In **long bones**, an epiphyseal plate is found on **each extremity**; in smaller bones, such as the phalanges, it is found only at **one extremity**; and in **irregular bones**, such as the vertebrae, **one or more primary centres** of ossification and usually **several secondary centres** are present.

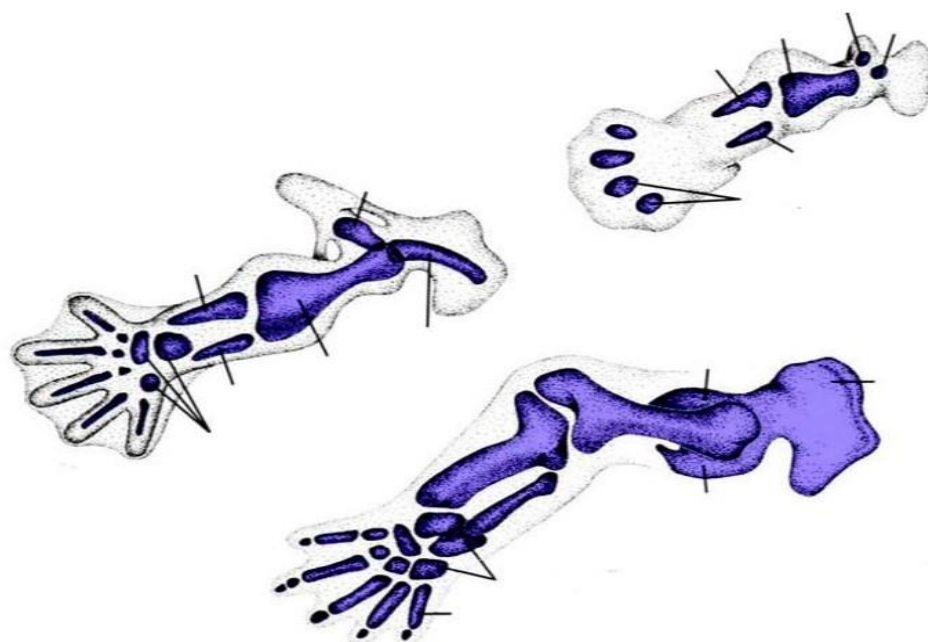


Fig. 5 : Formation of limb skeleton.

★ **Development of joints of limbs:**

- By the **sixth week** of development, joints are formed by arresting chondrogenesis to form joint cavity.
- Surrounding cells differentiate into a joint capsule.

★ **Anomalies of limbs:** examples of anomalies are:

- Amelia: complete absence of a limb.
- Meromelia: short limb.
- Brachydactyly: Abnormally short digits.
- Syndactyly: Fused two or three digits.
- Polydactyly: presence of extra digit.
- Cleft hand or foot: Two fingers in either hand or foot.



Fig. 8 : A photograph showing right amelia and left cleft hand.



Fig. 7 : A photograph showing meromelia on both upper limbs.



Fig. 9 : Photographs showing hand brachydactyly (A), Syndactyly (B), polydactyly (C) and cleft foot (D).