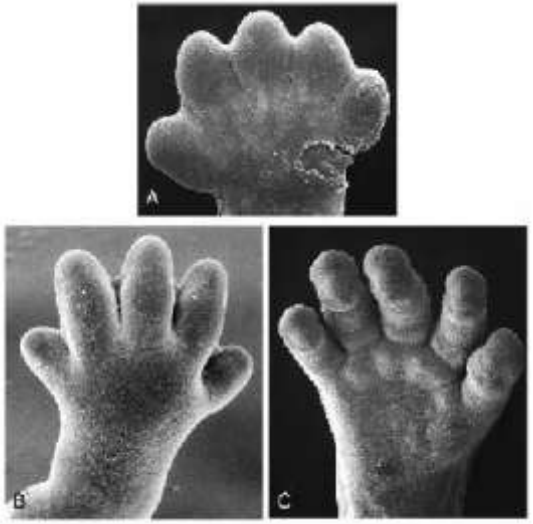

Embryology of the Hand

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ST3 UHND

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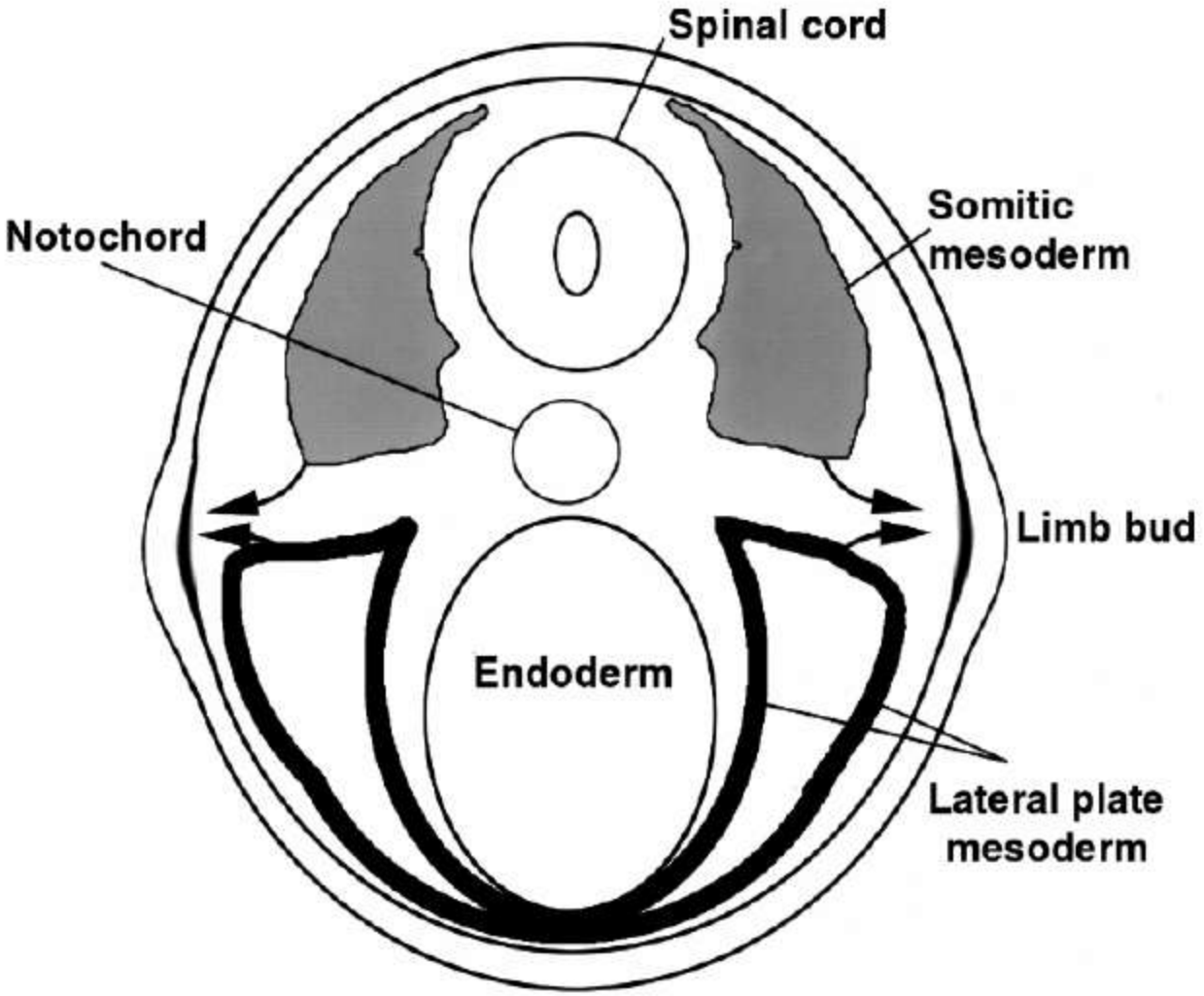
Limb bud development

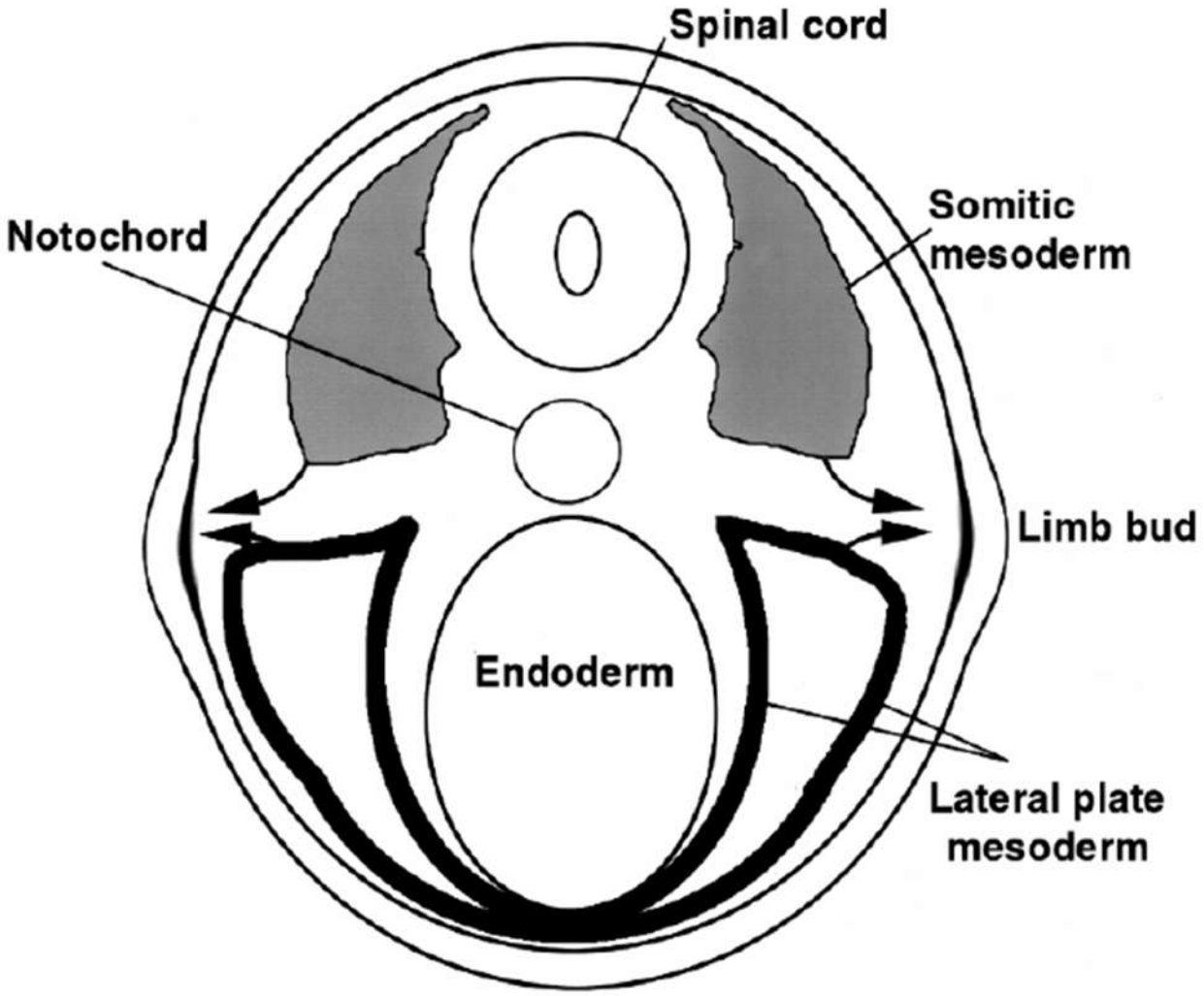
Timetable

- Onset of development of arm bud - 26 days
- Well-developed arm bud - 28-30 days
- Elongation of arm bud - 34-36 days
- Formation of hand paddle - 34-38 days
- Onset of finger separation - 38-40 days
- Full separation of fingers - 50-52 days


Spinal cord
Notochord
Somitic mesoderm
Limb bud
Endoderm
Lateral plate mesoderm

2 mesodermal layers

- Somatic – Becomes muscles
- Lateral plate – Bones and joints


Spinal cord
Notochord
Somitic mesoderm
Limb bud
Endoderm
Lateral plate mesoderm

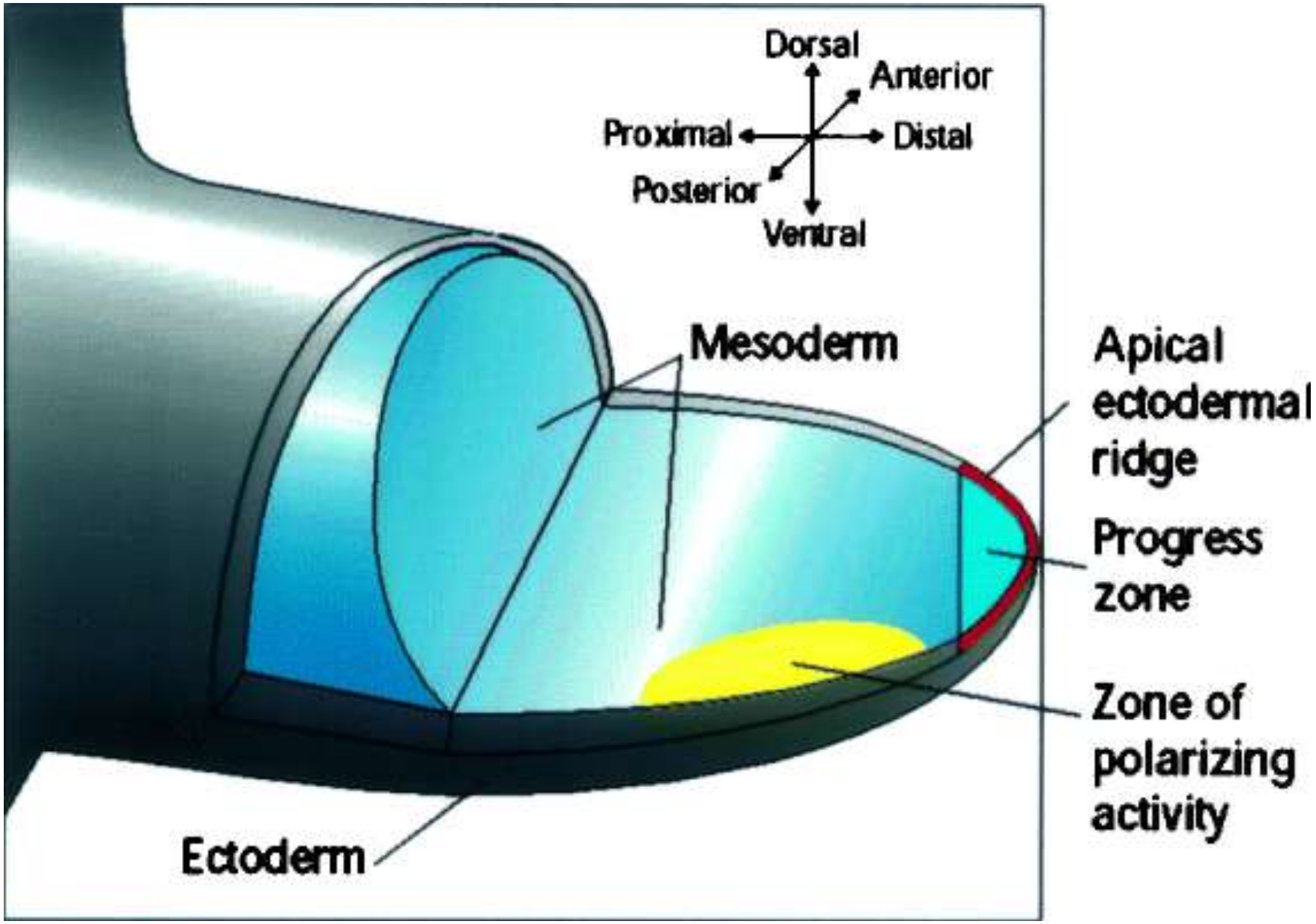
- First visible as a bulge or limb bud that develops on the ventro-lateral wall of the embryo on day 26
- The limb buds are composed of a mesenchymal core
- Derived from the lateral plate mesenchyme and an ectodermal covering

- Surface ectoderm thickens to form apical ectodermal ridge that guides development

- Mesoderm = zone of polarising activity and Progress zone

3 Signalling Centres

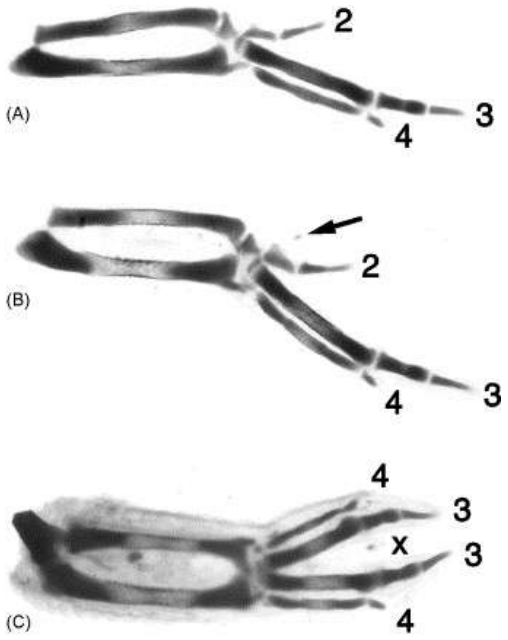
- Apical ectodermal ridge
- Zone of polarising activity
- Wingless type signalling centre

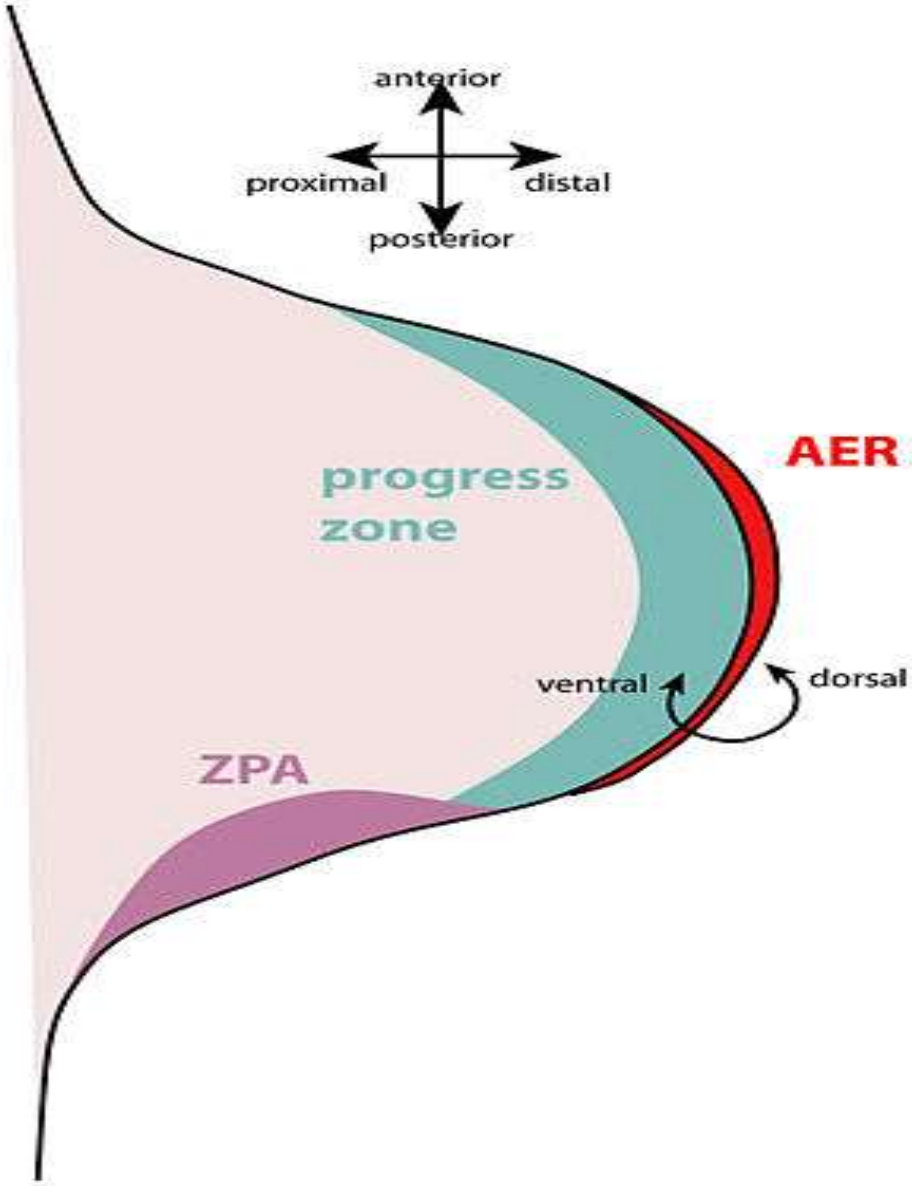

Dorsal
Anterior
Proximal
Distal
Posterior
Ventral
Mesoderm
Apical ectodermal ridge
Progress zone
Zone of polarizing activity
Ectoderm

Apical Ectodermal ridge

- Thickened layer of ectoderm
- Acts as a signalling centre to guide the underlying mesoderm to differentiate into appropriate structures
- Obligated for limb development in a proximal-to-distal direction

- Responsible for interdigital necrosis which separates the webbed hand (Syndactyly)
- If AER is implanted at remote site, extra limb bud forms

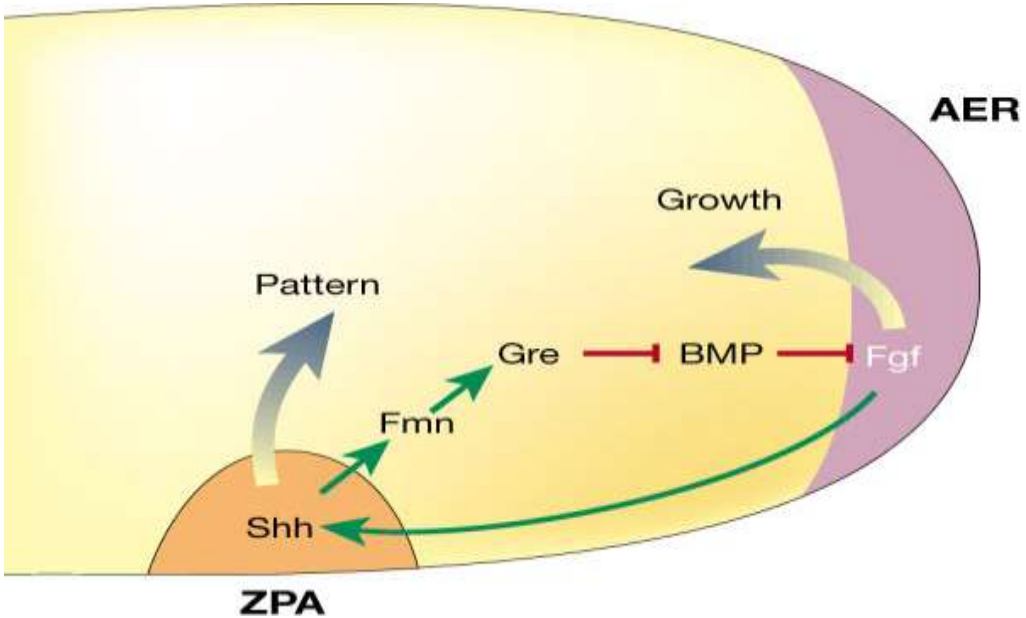



anterior
proximal
distal
posterior
AER
progress
zone
ventral
dorsal
ZPA

Zone of polarizing activity

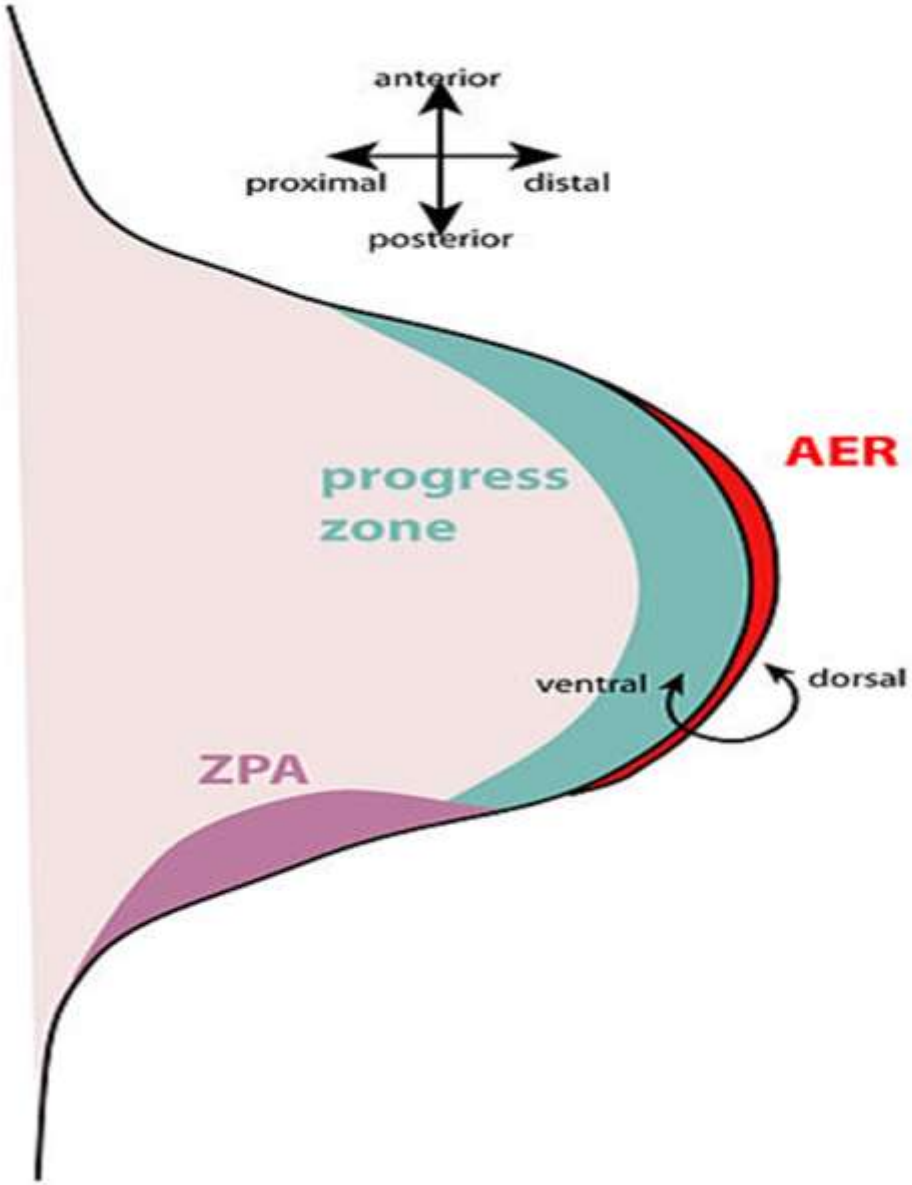
- Resides within the posterior margin of the limb bud
- Functions as a signalling centre for anterior-to-posterior (radio-ulnar) limb development
- Signalling molecule necessary for limb orientation is the sonic hedgehog protein

- The Zone of Polarizing Activity also contributes to the maintenance of the AER
- The sonic hedgehog signal (mesenchymal) stimulates the production of the fibroblast growth factor 4 (FGF-4) in the AER (ectodermal), i.e. there is a positive feedback loop between both.



Progress zone

- The progress zone is responsible for the orientation and progression of limb development and specifies the position of the skeletal elements.
- A loss of the progress zone leads totruncation of the limb. Proximal structures are absent or small (e.g. the humerus) but distal structures are formed


anterior
proximal
distal
posterior
progress
zone
AER
ventral
dorsal
ZPA

What controls growth?

Signalling centre	Responsible substance	Action
Apical ectodermal ridge	Fibroblast growth factors	Prox to distal limb development. Inter-digital necrosis
Zone of polarising activity	Sonic Hedgehog protein	Radioulnar limb formation
Wnt Pathway	Wnt glycoproteins	Dorsalisation of limb

Wingless type signalling centre

- The Wnt signalling centre resides in the dorsal ectoderm
- Secretes factors that induce the underlying mesoderm to adopt dorsal characteristics
- Mediates the development of dorsal-to-ventral axis configuration and alignment of the limb with a dorsal orientation (dorsalisation).

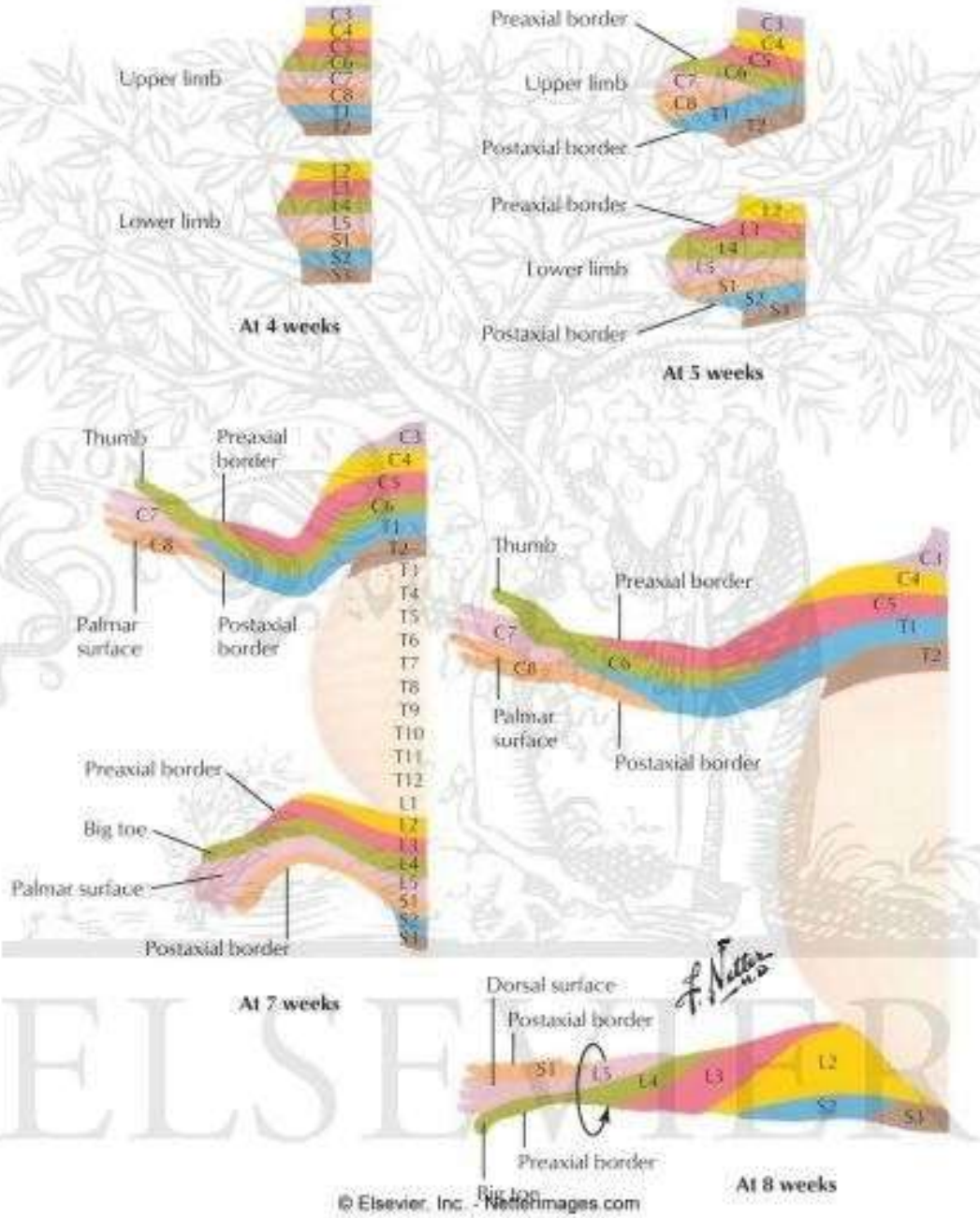
Pre and post axial

- Embryonic period — 4 limb/ buds have parallel axes
- Pre-axial borders — Cephalad (thumb)
- Post-axial borders — Caudad (little)

- Foetal period - upper limb rotation occurs around axis of long finger

- Upper limb rotates 90 degrees externally

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



Thank you