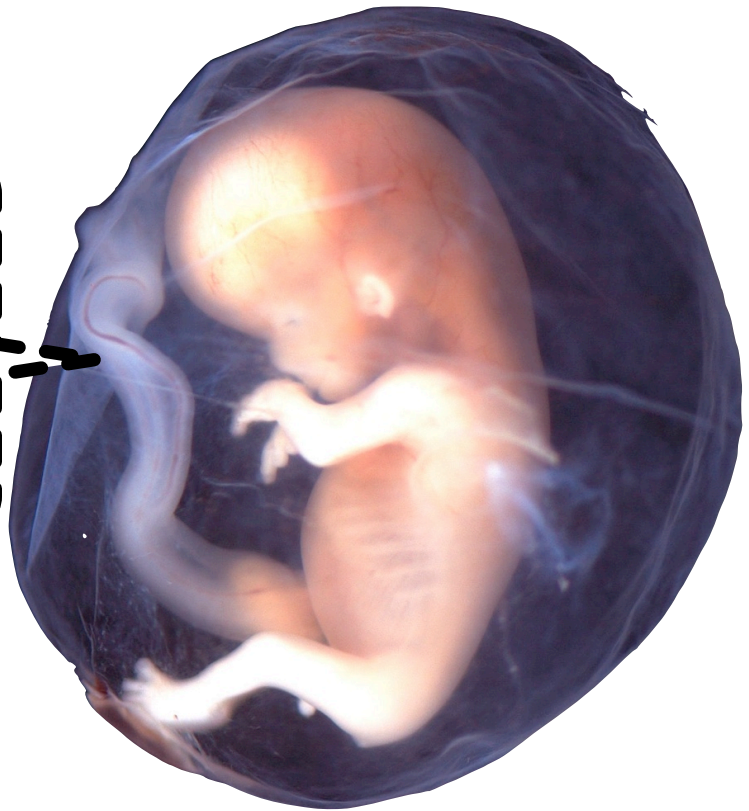


EMBRYOLOGY

Muskuloskeletal block (I)

Objectives:

- List different parts of mesoderm and divisions of somites
- Differentiate bone according to origin and mode of ossification
- Describe main steps of development of limbs
- Differentiate muscles according to embryological origin.



Asma Al-Mohizea
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DEVELOPMENT OF MUSCULAR AND SKELETAL SYSTEMS

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***Intraembryonic mesoderm:** Develops between ectoderm and endoderm except in the center where the notochord is found.

***Differentiates into 3 parts:**

A) **Paraxial mesoderm** (on sides of notochord): develops **somites**.

- A small cavity develops in each somite but soon disappears (myocoel).

- Each somite divides into a **ventromedial sclerotome** and **dorsolateral dermatomyotome**.

- **Scelrotome:** Bones of axial skeleton (cranium, spine, ribs and sternum).

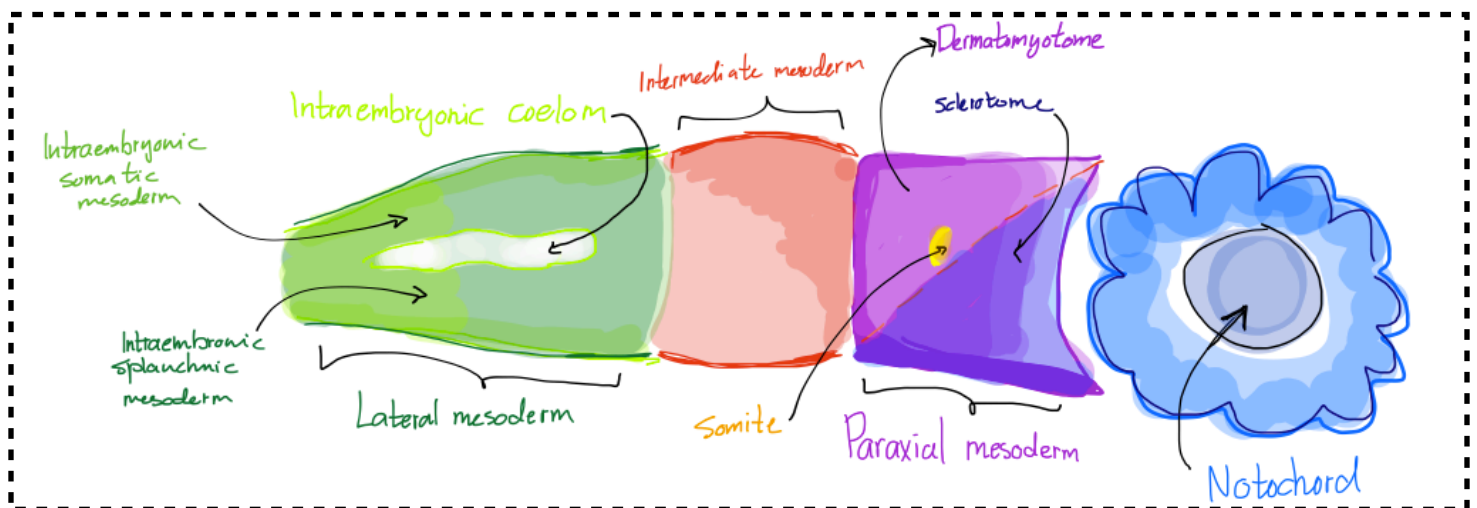
- **Myotome:** Associated muscles of the back.

- **Dermatome:** Adjacent dermis of skin

B) **Intermediate mesoderm.**

C) **Lateral mesoderm:** divides by **intraembryonic coelom** into:

1) **Somatic mesoderm** 2) **Splanchnic mesoderm**



Intraembryonic Mesoderm.

INTRAEMBRYONIC MESODERM

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

Paraxial mesoderm:
divides into units called
SOMITES

N.B: Skeletal muscle forms in the embryo from paraxial mesoderm

Intermediate mesoderm

Lateral mesoderm:
divides by intraembryonic coelom into:
Somatic mesoderm (between ectoderm & coelom).
Splanchnic mesoderm (between endoderm & coelom).

Development of Bones

*Depending on mode of development, bones are divided into:

A) **Membrane bones:** develop directly from mesenchymal cells.

- Ex: Majority of bones of the face and skull.

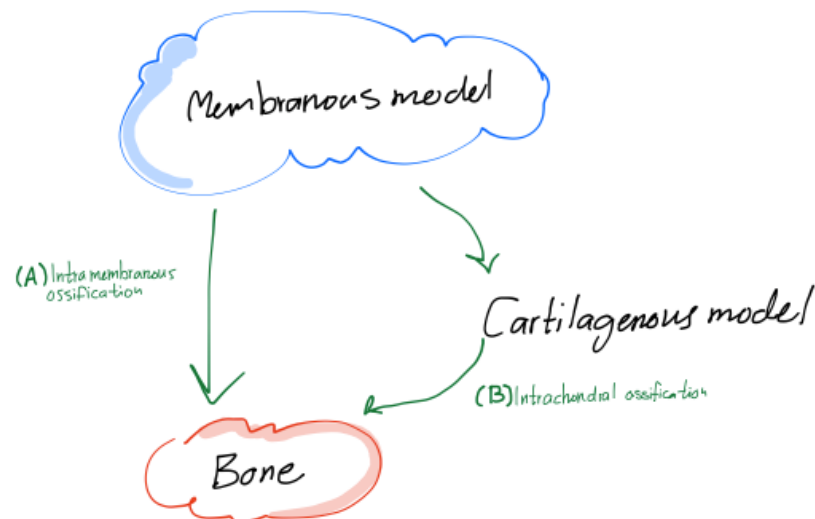
- Thinner.

- Intramembranous ossification.

B) **Cartilage bones:** a cartilagenous model forms first and then ossifies.

- Ex: Bones of the axial and appendicular skeleton, the cranial base.

- Thick, strong, more compact, weight bearing.



***Development of skull:** Develops from mesoderm around developing brain.

THE SKULL	
Neurocranium: protective case of brain	Viscerocranium: skeleton of face

*The skull bones develop by 2 ways of ossification.

(A) Bones that develop by intramembranous ossification:

F = Frontal , P = Parietal

Z = Zygomatic , ST = Squamous temporal

Mand = Mandible , Max = Maxilla

(B) Bones that develop by intracartilagenous ossification:

Base of skull.

Development of Limbs

*The development of limbs is sensitive and affected by drugs (teratogenic drugs).

*They appear as small projections -elevations- in the cervical (upper limbs) and lumbosacral (lower limbs).

*Upper limb buds appear at **day 26**.

*Lower limb buds appear at **day 28**.

*N.B: Each limb bud is surrounded by an area of ectoderm.

* **Apical Ectodermal Ridge**: A thickening of ectoderm that appears at the apex (tips) of limb buds and stimulates proliferation of mesenchyme and elongation of limb buds. It is important because without it → no changes will occur in the limbs.

*Development of limbs:

1) The **AER** appears at the apex to stimulate proliferation of mesenchyme.

Then the distal ends flatten into a *paddle-like* hand and foot plates.

2) Digital rays appear as mesenchymal condensations that outline the digits.

3) Digits form inside rays, elongate and appear webbed.

4) The webs disappear (cells in between die by apoptosis) to form separate digits. Not all cells during development grow and divide. There are cells that die during development.

• • •
So, the mesenchyme of the somatic layer will proliferate and that will result in the appearance of an elevation on the ventro-lateral body wall, which is the limb bud.

• • •

***Rotation of limbs:** The limb buds were originally at right angle with the trunk.

***-Cranial (preaxial or superior) & caudal (postaxial or inferior) borders:** radius and tibia are cranial bones.

***-Ventral (anterior) & dorsal (posterior) surfaces:** flexor muscles are ventral.

***During the 7th week adduction of the limb buds occurs with 90° rotation.**

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

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

***Ossification of long bones:**

***Local mesenchymal cells chondrify then ossify to form the limb bones.**

***Ossification takes time & doesn't appear in all bones but in specific sites called ossification center then spread.**

***Ossification center place where ossification starts (there can be more than one center).**

***No primary ossification centers appear after birth**

***No epiphyseal plate after puberty thus growing stops.**

***Development of joints:** from mesoderm.

A) Fibrous joints: mesoderm differentiates into dense fibrous tissue.

B) Cartilagenous joints: mesoderm differentiates into cartilage.

C) Synovial joints: a cavity is formed inside the mesoderm. Mesoderm differentiates into synovial membrane, capsule and ligaments.

***Development of muscles:**

*All muscles develop from the mesoderm except for: muscles of the iris, myoepithelial cells of mammary and sweat glands which develop from the **ectoderm**.

*Cardiac muscles: **Splanchnic part** of the lateral mesoderm.

*Smooth muscles: Walls of the viscera > **Splanchnic part** of lateral mesoderm.
Walls of blood and lymphatic vessels > **Somatic part** of lateral mesoderm.

*Skeletal muscles: **Myotomes of the paraxial mesoderm** *except for* some head and neck muscles which develop from **mesoderm of pharyngeal arches**.

SOMITES

Myotome

1- **Hypaxial division**: Muscles of body wall

2- **Epaxial division**: Muscles of back (Extensors of vertebral column)

3- **Myoblasts** migrate into the limb buds where they will produce the limb muscles

Sclerotome

It will contribute in the formation of the bone of the vertebral column, ribs and sternum.

Myotomes:

*Each myotome divides into

* a *dorsal epaxial* division > muscles of the back.

* *ventral hypaxial* division > muscles of the ventral body wall.

*Myoblasts migrate from the hypaxial division to limb buds to form limb muscles

All bones develop from MESODERM

Vertebrae, ribs & sternum: from sclerotomes of somites (paraxial mesoderm)

APPENDICULAR SKELETON: from somatic part of lateral mesoderm

All muscles develop from MESODERM, except:

1- **Muscles of iris (eyeball):** ectoderm

2- **Myoepithelial cells of mammary & sweat gland:** ectoderm

All skeletal muscles develop from myotomes of paraxial mesoderm, except:

Some head & neck muscle: from mesoderm of pharyngeal arches

Cardiac & smooth muscles develop from lateral mesoderm:

Cardiac muscles from: splanchnic part of lateral mesoderm

Smooth muscles:

In the wall of viscera from: splanchnic part of lateral mesoderm

SUMMARY

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.

Questions:

1) Which of the following muscles are derivatives from the paraxial division of myotomes:

- (a) Muscles of the back.
- (b) muscles of the limbs.
- (c) muscles of the viscera.
- (d) cardiac muscles.

(a)

2) Which of the following bones ossifies via intramembranous ossification

- (a) Vertebrae.
- (b) Humerous.
- (c) Ribs.
- (d) Mandible.

(d)

3) Regarding ossification of long bones, which of the following statements is correct:

- (a) 1ry ossification centers appear after birth.
- (b) 2ry ossification centers leads to ossification of diaphysis.
- (c) Long bones ossify by intramembranous ossification
- (d) When epiphysis unites with diaphysis, growth stops.

(d)

