EMBRYOLOGY OF BONE

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OUTLINE

SUMMARY OF ABBREVIATIONS

ABBREV	Meaning

LEGENDS

Must know	Lecturer	Book	Presentation	Old Trans
❗	👩‍🏫	📖	🖥️	📝

LEARNING OBJECTIVES

At the end of the lecture, the student should be able to:

✔ Identify the areas and/or cells of origin of the bone

✔ Discuss the development of the components of the axial and appendicular skeletons, including their origins.

EMBRYOLOGY OF BONE: THE AXIAL SKELETON

- Made up of: Skull, vertebral column, ribs, and sternum
- Origin:
  - PARAXIAL MESODERM
  - LATERAL PLATE (PARIETAL LAYER) MESODERM
  - NEURAL CREST

PARAXIAL MESODERM

- Segmented series of tissue blocks on each side of the neural tube
  - **SOMITOMERES** – Head
  - **SOMITES** – Occipital region
    - **Sclerotome** – Ventromedial
    - **Dermomyotome** - Dorsolateral
- 👩‍🏫 Will form when cell migrate

MESENCHYME

- Polymorphous sclerotome cells at the end of the 4th week
- Loosely organized tissue
  - 👩‍🏫 Nawawala yung rounded appearance (pic A to pic B)
- Cells migrate and differentiate in many ways
  - **Fibroblasts**
  - **Chondroblasts**
  - **OSTEOBLASTS**: Bone-forming cells

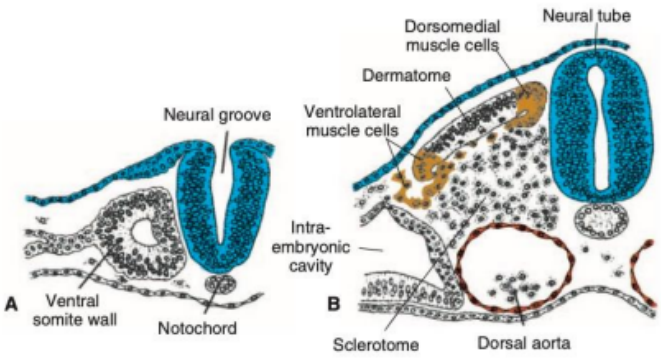

Figure 1. Mesenchyme

- **Neural Crest Cells:** Differentiate into mesenchyme
  - Formation of bones of the **face and skull**

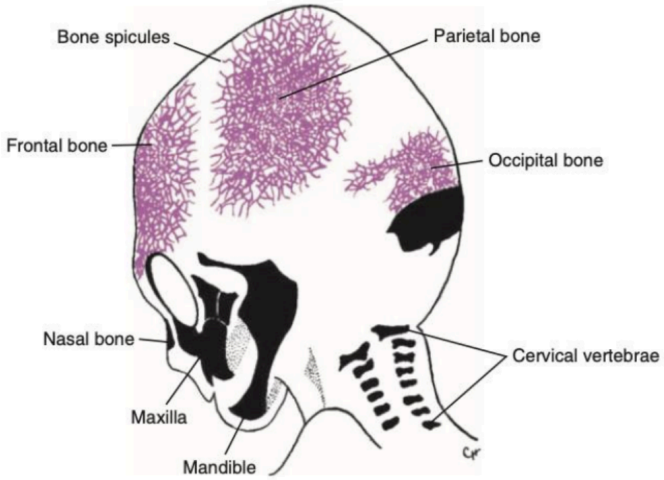

Figure 2. Intramembranous Ossification in Skull

- **Intramembranous Ossification:** FLAT BONES
  - Mesenchyme differentiates directly into bones
    - 👩‍🏫 *"Directly" meaning **Mesenchyme to Bone**. Pag naging cartilage muna that's endochondral to bone*
  - Most bones will undergo ***endochondral ossification***

THE AXIAL SKELETON: SKULL

- **Neurocranium:** protective case
  - Membranous - flat bones that surround the brain
  - Cartilaginous - bones of the base of the skull

Membranous Neurocranium

- Origin: Neural crest cells and paraxial mesoderm
  - 👩‍🏫 *Yung color blue sa figure below are the coming (originating) from the **neural crest cells***
  - 👩‍🏫 *Red naman comes from the **paraxial mesoderm***
  - 👩‍🏫 *Yellow - Originates from **lateral plate mesoderm***

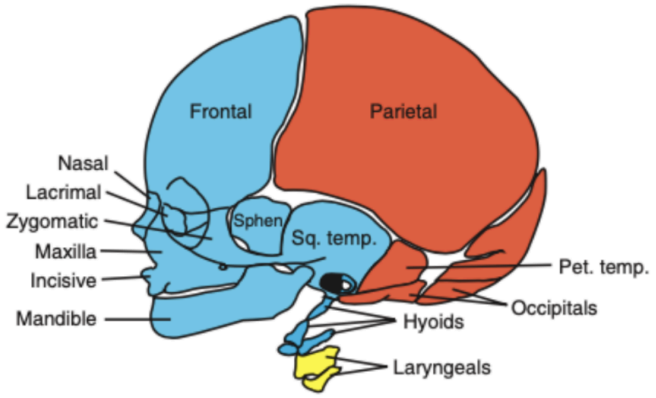

Figure 3. Skull.

- Mesenchyme undergoes **intramembranous ossification** (diretso sa bone from mesenchyme)
  - flat, membranous bones with **bone spicules** (needle-like) that radiate from primary ossification centers toward the periphery
  - 👩‍⚕️direction of bone spicules is away from the center, kumakalat
- enlarge by apposition of new layers and simultaneous osteoclastic resorption
  - 👩‍⚕️balance between apposition of new layers and resorption of old layers
    - 👩‍⚕️bone will be too dense if hindi enough ang resorption or too brittle if masyadong enhanced ang resorption

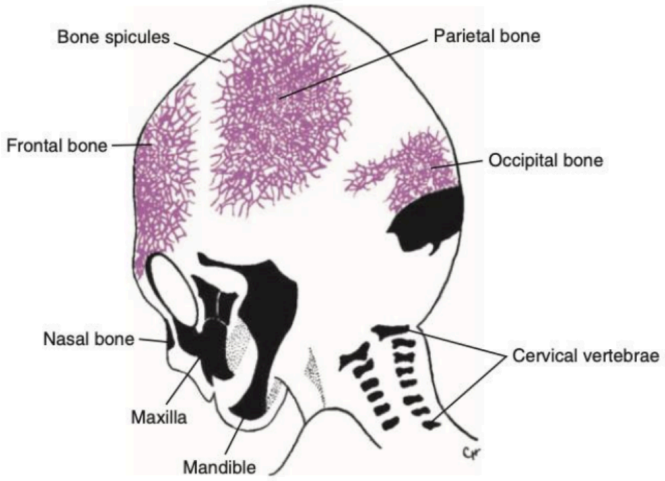

Figure 4. Intramembranous Ossification in Skull

- **Fontanelles**
  - wide sutures at points where more than **two bones** meet
  - **Anterior**: most prominent
    - where **two parietal and two frontal bones** meet
  - allows **molding** during birth
    - 👩‍⚕️as the head of the baby passes through the birth canal, namo-mold/nache-change ang shape para magkasya at makalabas
    - 👩‍⚕️paglabas, babalik sa normal shape, but sutures are still present kaya hindi pa ganoon ka-fixed ang bone

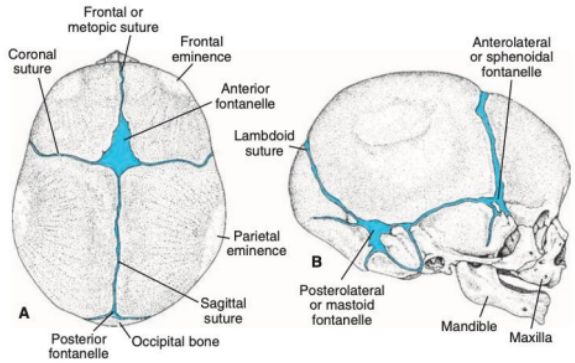

Figure 5. Fontanelles and Sutures of the skul
l

- move back to their **original positions**
- skull is **large and round**
- bones of the **vault** continue to grow after birth
- **Anterior fontanelle** may be palpable in the first few years after birth*
  - closes by **18 months**
  - Posterior fontanelle closes by **1 to 2 months**
  - 👩‍⚕️*very important structure for assessing pediatric patients; normal pa ba at a certain age if open or closed ‘yung anterior fontanelle; can also be used to assess a child’s overall demeanor or if may sakit ba? dehydrated ba siya? may increased intracranial pressure?

Cartilaginous Neurocranium/ Chondrocranium

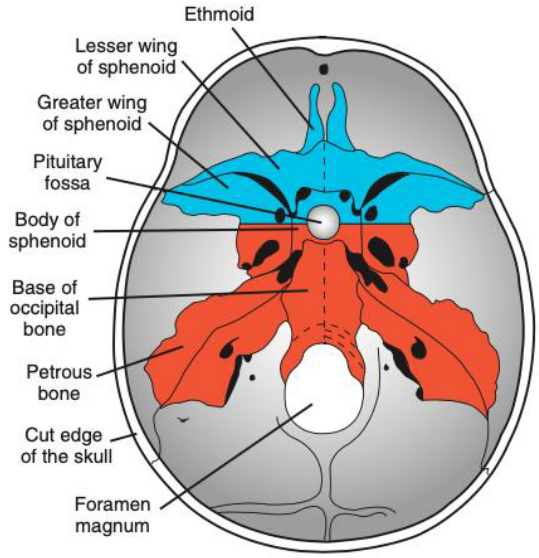

Figure 6. Neurocranium

- 👩‍⚕️ The chondrocranium can still be divided into 2 parts based on their origin

- **PRECHORDAL CHONDROCRANIUM (in blue)**
  - In front of the rostral limit of the notochord
    - 👩‍⚕️rostral = refers to brain structure, meaning lang is anterior or ventral
  - Ends at the level of the pituitary gland
  - Derived from the neural crest cells

- **PRECHORDAL CHONDROCRANIUM (in red)**
  - Posterior to the limit
  - Derived from occipital sclerotomes formed by paraxial mesoderm

Viscerocranium

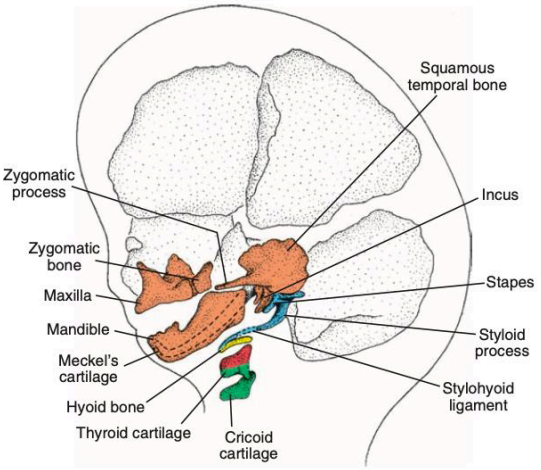

Figure 7. Viscerocranium.

- ❗ Skeleton of the face
- Primarily derived from the first and second pharyngeal arches

- **MAXILLARY PROCESS:** dorsal portion
  - FIrst pharyngeal arch
  - Forward beneath the region of the eye
  - Gives rise to the:
    - Maxila
    - Zygomatic bone
    - Part of the temporal bone

- **MANDIBULAR PROCESS:** ventral portion
  - FIrst pharyngeal arch
  - Significant structure: Meckel cartilage which gives rise to the:
    - Mandible
    - Disappears (normally) except in the sphenomandibular ligament.
    - 👩‍⚕️Because it becomes a ligament [yung sphenomandibular ligament], the rest will disappear, so mawawalan ng connection, mag separate yung dorsal and ventral portion, that will lead to the formation of the mandible

- 👩‍⚕️ **The Three little bones in the ears**
- **Incus, Malleus, stapes**
  - **Second pharyngeal arch** and dorsal tip of **mandibular process**
  - **First** to become **fully ossified -** begins in the **4th month**
- **Mesenchyme from neural crest**

- **Initially, the face is small in comparison with the neurocranium**
  - 👩‍⚕️ Kasi meron ka pang mga structures na underdeveloped:
  - Virtual absence of the paranasal air sinuses
  - Small size of the bones (jaw)
  - 👩‍⚕️ The facial area catches up to the size of the neurocranium based on the size of facial features
  -

THE AXIAL SKELETON: VERTEBRAE AND THE VERTEBRAL COLUMN

Scleretome

- Portions of the somites:
  - **PARAXIAL MESODERM**

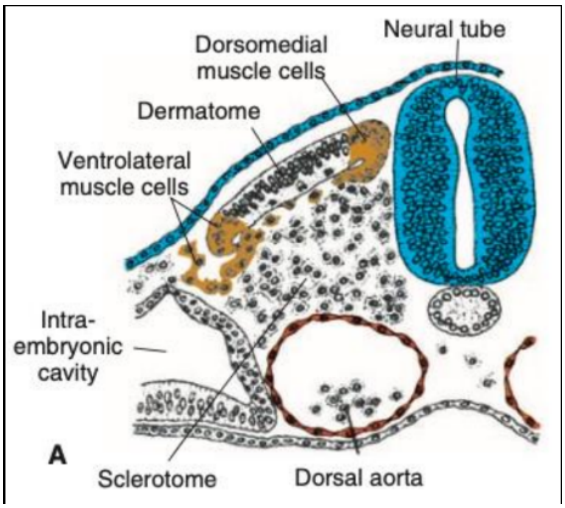

Figure 8. Paraxalial mesoderm

Vertebra

- A typical vertebra consists of:
  - Vertebral arch and foramen
  - Body
  - Transverse processes
  - Spinous process

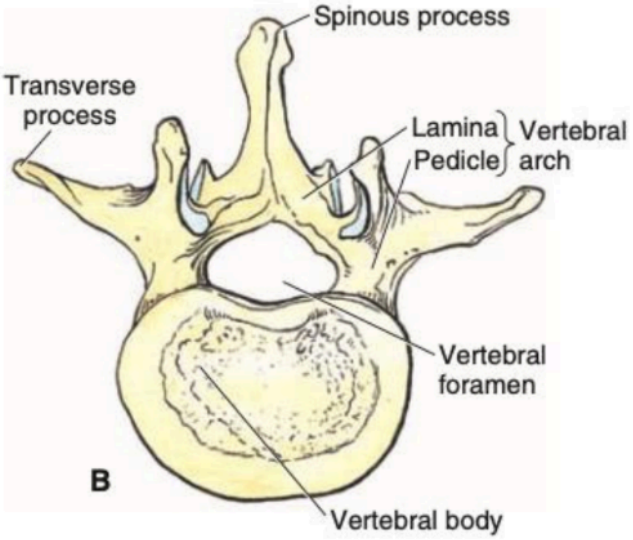

Figure 9. Vertebra

- 4th Week
  - Sclerotome cells migrate around the spinal cord and notochord
  - Merge with cells from the opposing somite on the other side of the neural tube

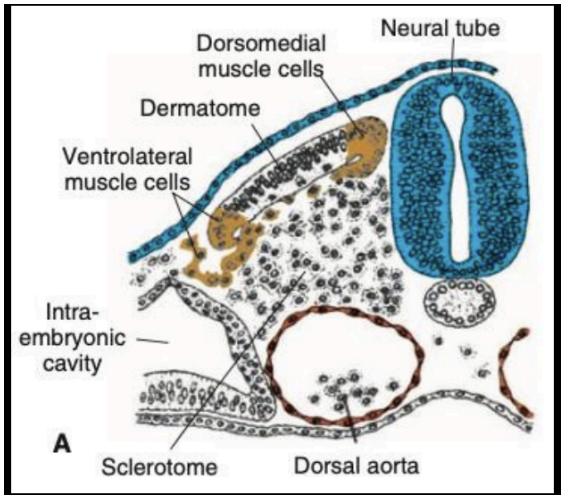

Figure 10. Paraxial mesoderm

- Resegmentation
  - Caudal half grows into and fuses with the cephalic half
  - Myotomes bridge the intervertebral discs– move the spine
- Vertebra - caudal half of one somite and cranial half of neighbor somite

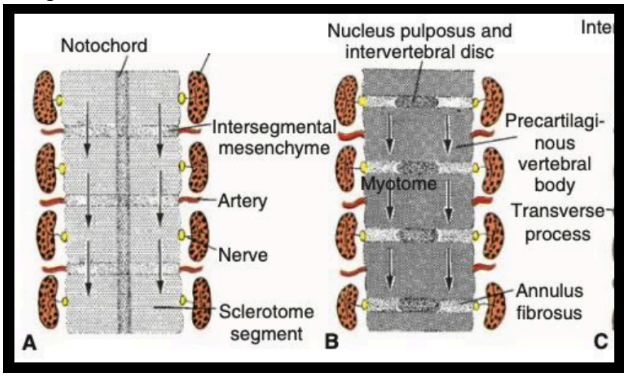

Figure11.. Sclerotome Resegmentation in Spinal Development

Intervertebral Disc

- Mesenchymal cells between the cephalic and caudal parts of sclerotome do not proliferate
- Fill the space between two precartilaginous vertebral bodies
- Nucleus Pulposus
  - Persistence and enlargement of the notochord in the region of the intervertebral disc
- Annulus Fibrosus

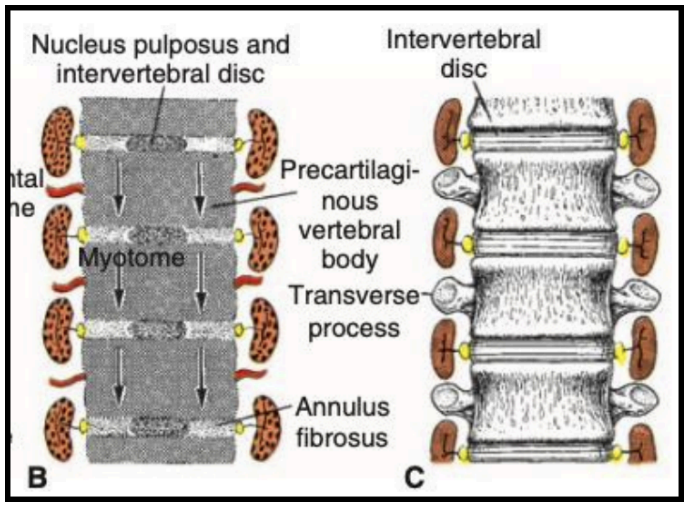

Figure 12. Formation of the Intervertebral Disc and Definitive Vertebral Bodies

- **Resegmentation**
  - **Intersegmental arteries** – midway over vertebral bodies
  - **Spinal nerve**s – near the intervertebral discs and leave through the intervertebral foramina

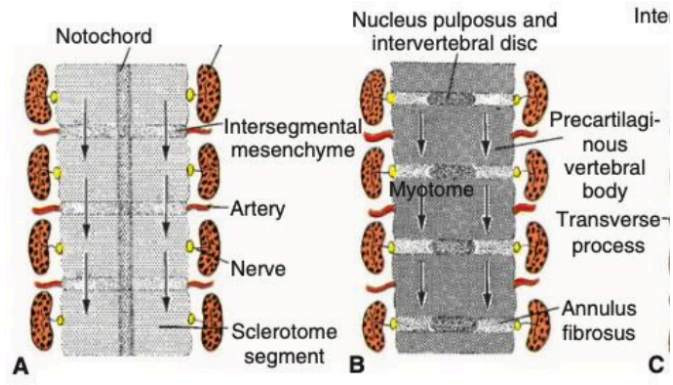

Figure 13. Formation of the Intervertebral Disc and Definitive Vertebral Bodies

- Primary curves
  - 👩‍⚕️First to develop (“Primary”)
  - Thoracic and Sacral curvatures
- Secondary curves
  - Cervical - 👩‍⚕️learning new skills like being able to hold your head up as a child
  - Lumbar curvatures - 👩‍⚕️When having learned how to stand and walk

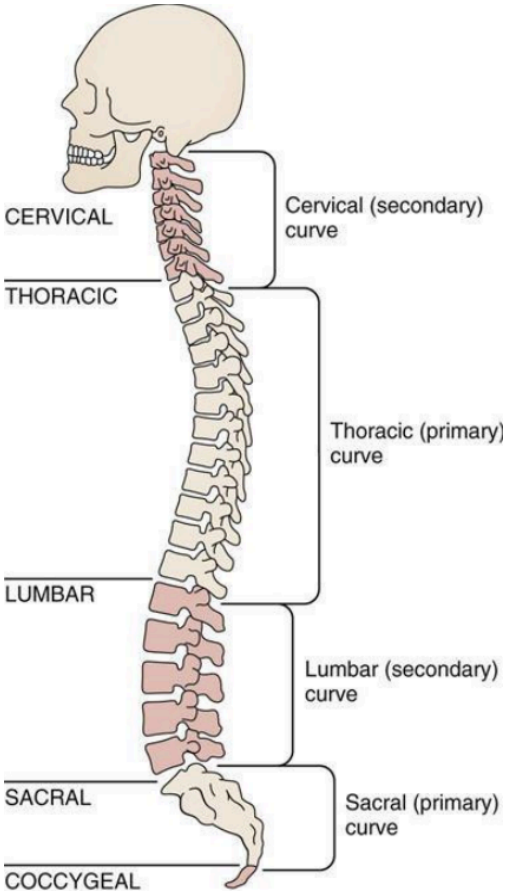

Figure 14. Regions of the Spinal Cord

THE AXIAL SKELETON: RIBS AND STERNUM

RIBS

- Bony portion
  - Sclerotome cells in the paraxial mesoderm and grow out from the thoracic costal processes
- Costal cartilages
  - Sclerotome cells that migrate across the lateral somitic frontier into the adjacent lateral plate mesoderm

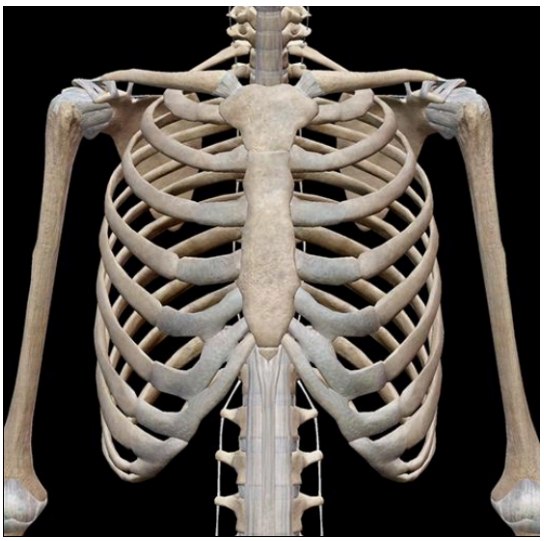

Figure 15. Ribs

STERNUM

- Parietal layer of the lateral plate mesoderm in the ventral body wall
  - Two sternal bands on either side of the midline - Small lines in the middle which eventually grow and develop, which then fuse forming cartilaginous models of the manubrium, sternebrae, and xiphoid process

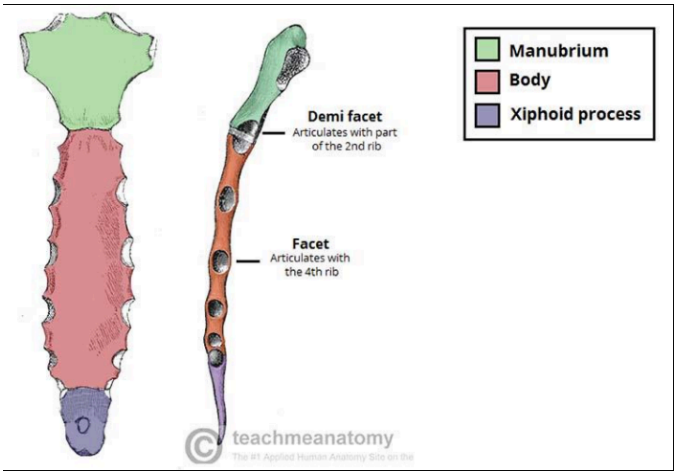

Figure 16. Parts of Sternum

APPENDIX

INSERT TABLE