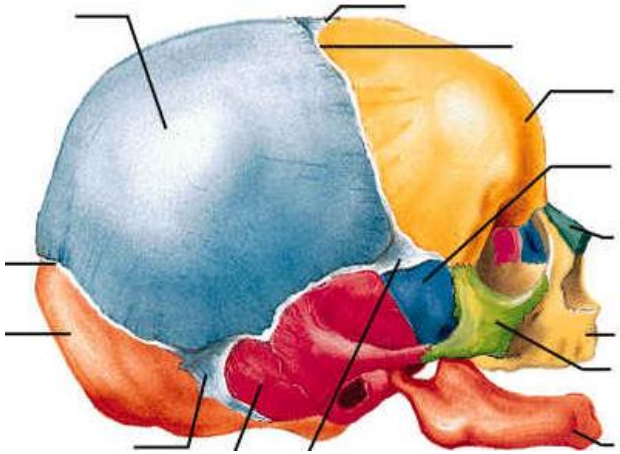
Development of the Skull



Dr. Andrea D. Székely

Semmelweis University
Department of Anatomy, Histology and Embryology
Budapest

WHERE DOES THE CRANIUM COME FROM?

PARAXIAL MESODERM

NEURAL CREST

LATERAL PLATE MESODERM ***in the cervical region***

Desmocranium vs Chondrocranium

The cranial components develop by

MEMBRANOUS and ENDOCHONDRAL ways

*They produce **Compacta** and **Spongiosa** of the*

Viscerocranium and Neurocranium

CARTILAGINOUS ***VISCEROCRANIUM***
NEUROCRANIUM

MEMBRANOUS ***NEUROCRANIUM***
VISCEROCRANIUM

COMPONENTS OF THE CRANIUM

NEUROCRANIUM

Chondrocranium
- Occipital
- Sphenoid
- Ethmoid
- Petrous and mastoid part of temporal

Membranous neurocranium
- Interparietal part of occipital
- Parietal
- Frontal
- Squamous part of temporal

VISCEROCRANIUM

Pharyngeal Arch I

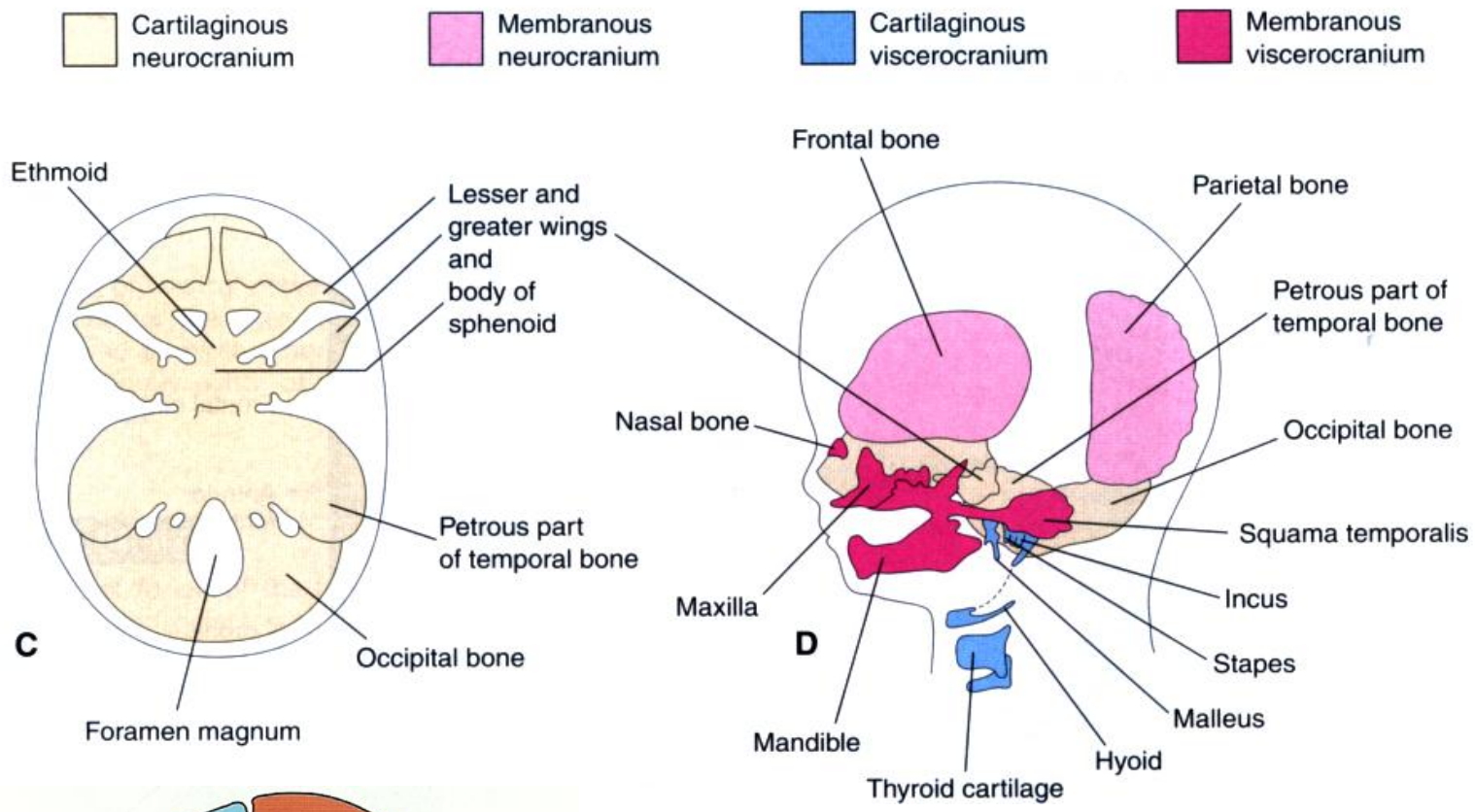
Cartilaginous viscerocranium
- Meckel's cartilage
  - Malleus
  - Incus

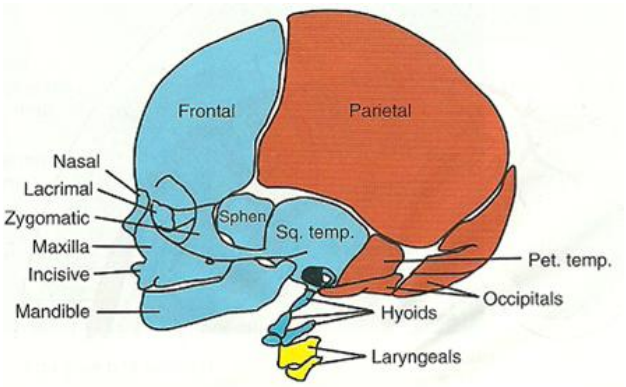
Membranous viscerocranium
- Maxillary process (superficial)
  - Squamous part of temporal
  - Zygomatic
  - Maxillary
  - Premaxillary
  - Nasal?
  - Lacrimal?
- Maxillary process (deep)
  - Palatine
  - Vomer
  - Pterygoid laminae
- Mandibular process
  - Mandible
  - Tympanic ring

PHARYNGEAL ARCH II

Cartilaginous viscerocranium
- Reichert's cartilage
- Stapes
- Styloid process

NEUROCRANIUM AND VISCEROCRANIUM





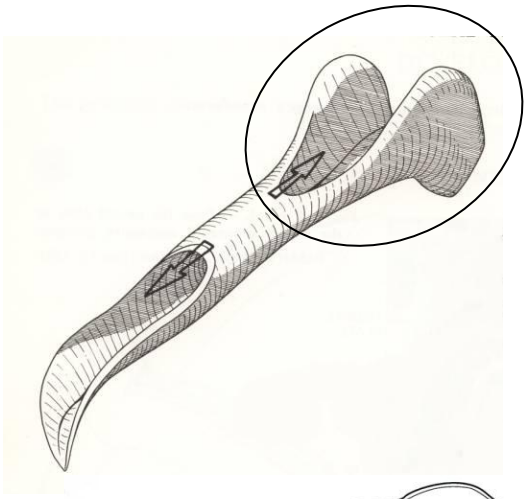
BLUE– neural crest

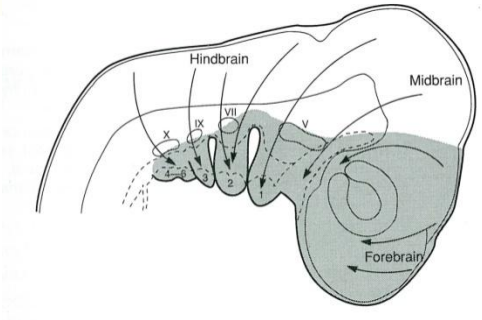
BROWN – paraxial mesoderm (somites)

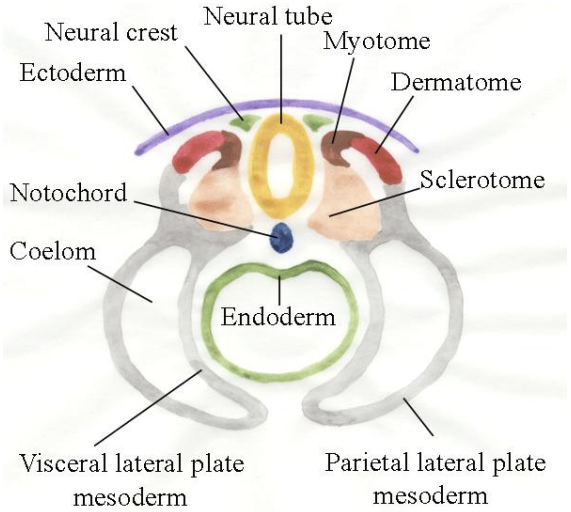
YELLOW – lateral plate mesoderm

EMBRYOLOGICAL ORIGINS OF THE CRANIUM

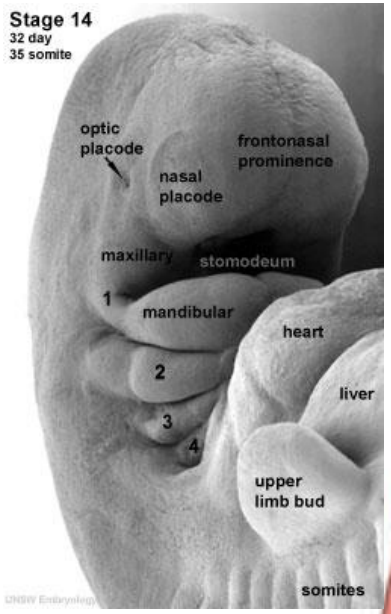
- ***Mesenchyme*** from around the proximal end of the neural tube (connective tissue capsule of the ***prosencephalon***)
- Neural crest (***ectomesenchyme***)
- The first 3 Somites (***sclerotom***)
- ***Mesenchyme*** of the 1st and 2nd branchial arches



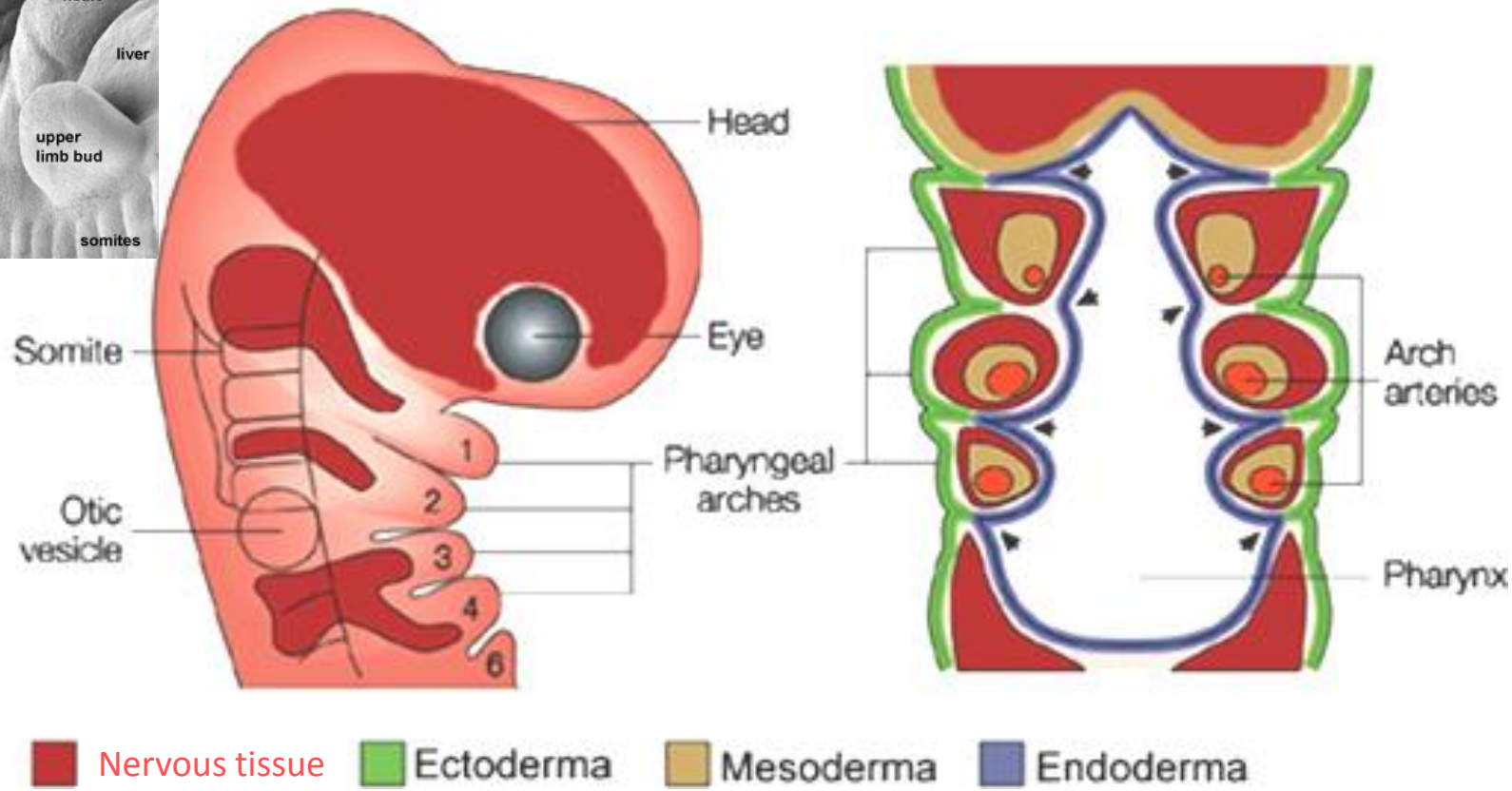




EMBRYOLOGICAL ORIGINS OF THE CRANIUM



PHARYNGEAL ARCHES, GROOVES, POUCHES AND DERIVATIVES



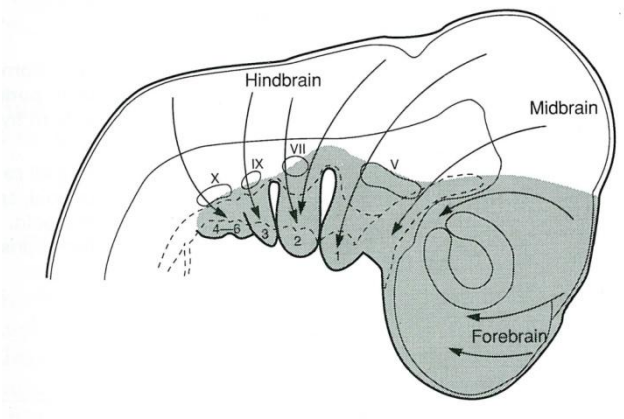
CEPHALIC PRIMORDIA - MESENCHYME

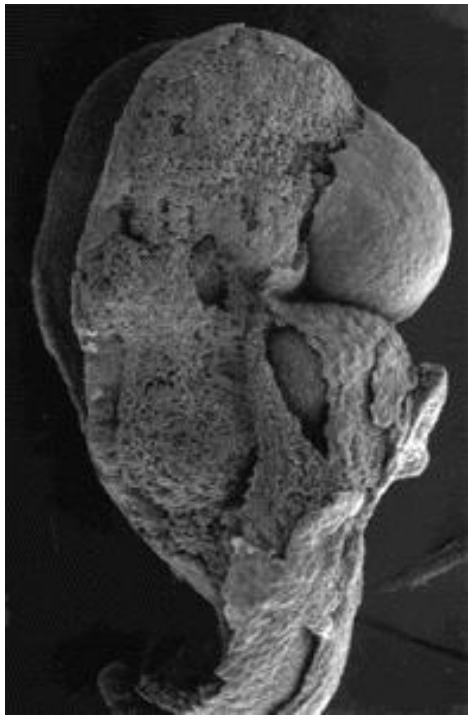
Mesenchyme in general

- embryonic connective tissue
- loosely organized
- has the ability to migrate & differentiate into different cell types
- can develop from any germ layer

Ectomesenchyme

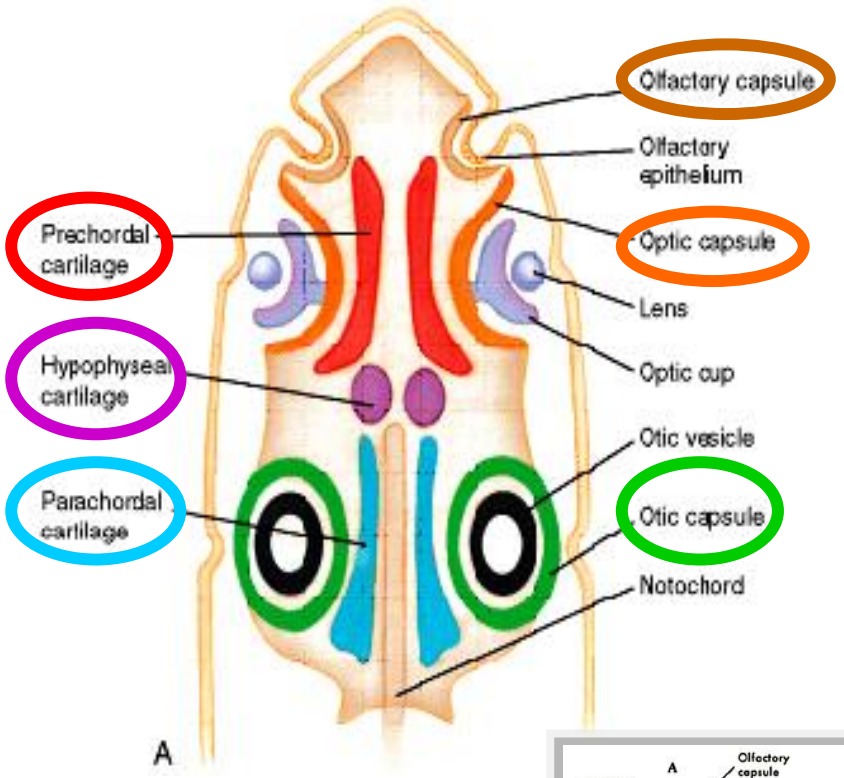
(head mesenchyme) - derived from neural crest cells

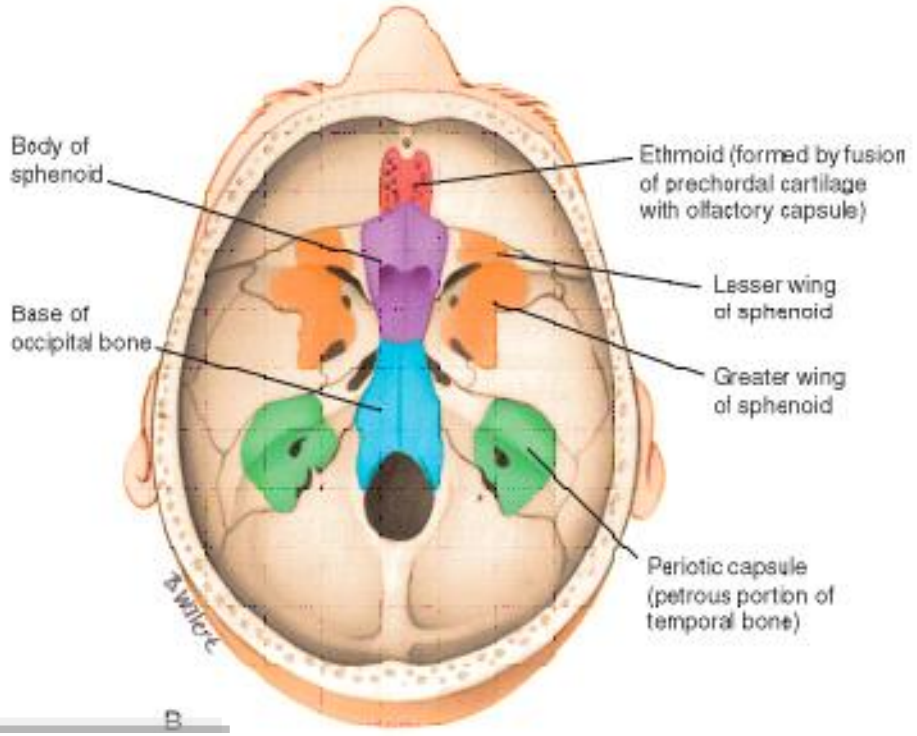


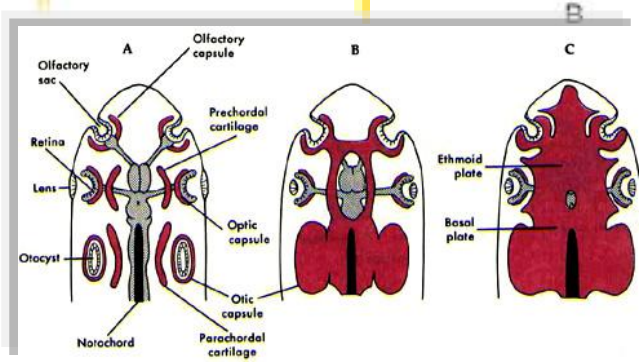


CARTILAGINEOUS NEUROCRANIUM - *CHONDROCRANIUM*

6th week







CARTILAGINEOUS NEUROCRANIUM - *CHONDROCRANIUM*

Parachordal cartilage

Cartilages of the occipital sclerotom

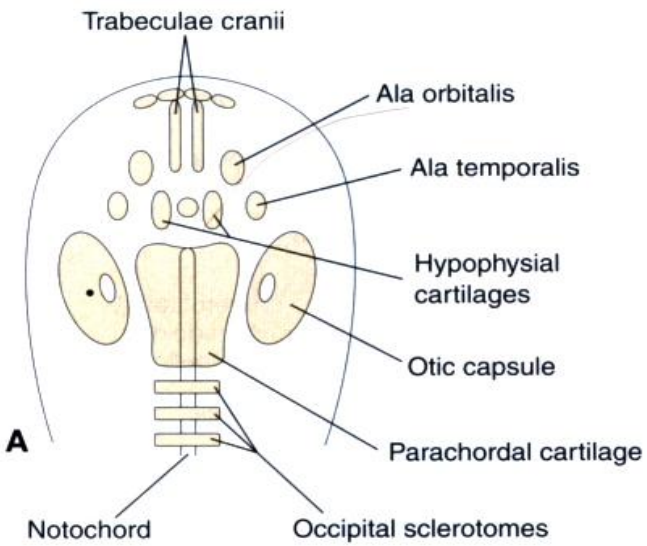
→ **occipital bone** surrounding the foramen magnum

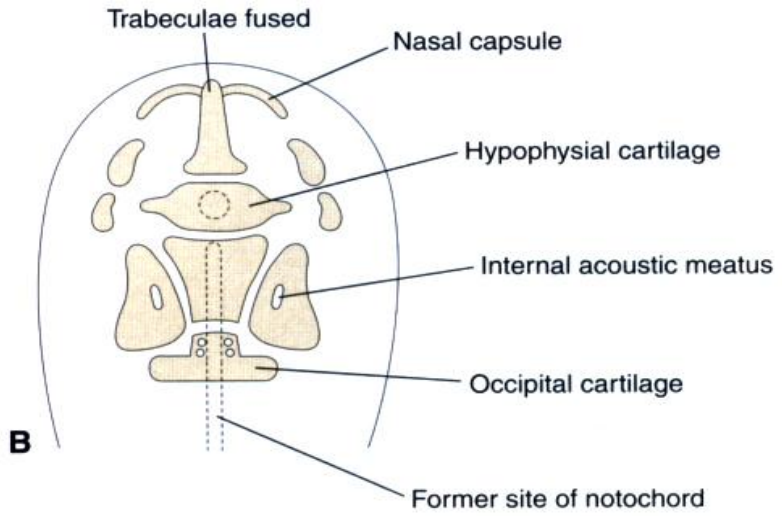
Hypophysial cartilage (around the hypophysis) → **body of sphenoid**

greater wing, lesser wing, lateral plate of the pterygoid process

Otic cartilage (at the otic placode) → **temporal bone**: petrous part, mastoid part

Nasal capsule → **ethmoidal bone, inferior nasal concha, nasal cartilage**

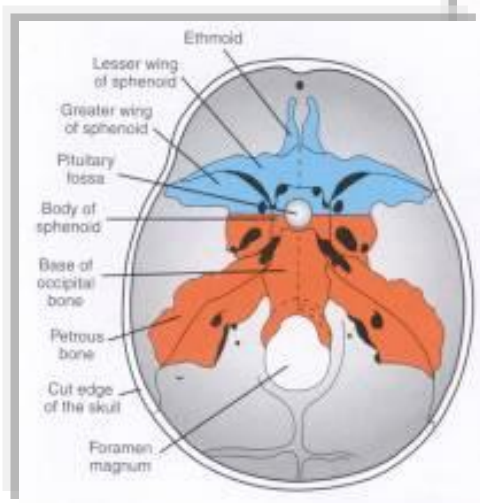


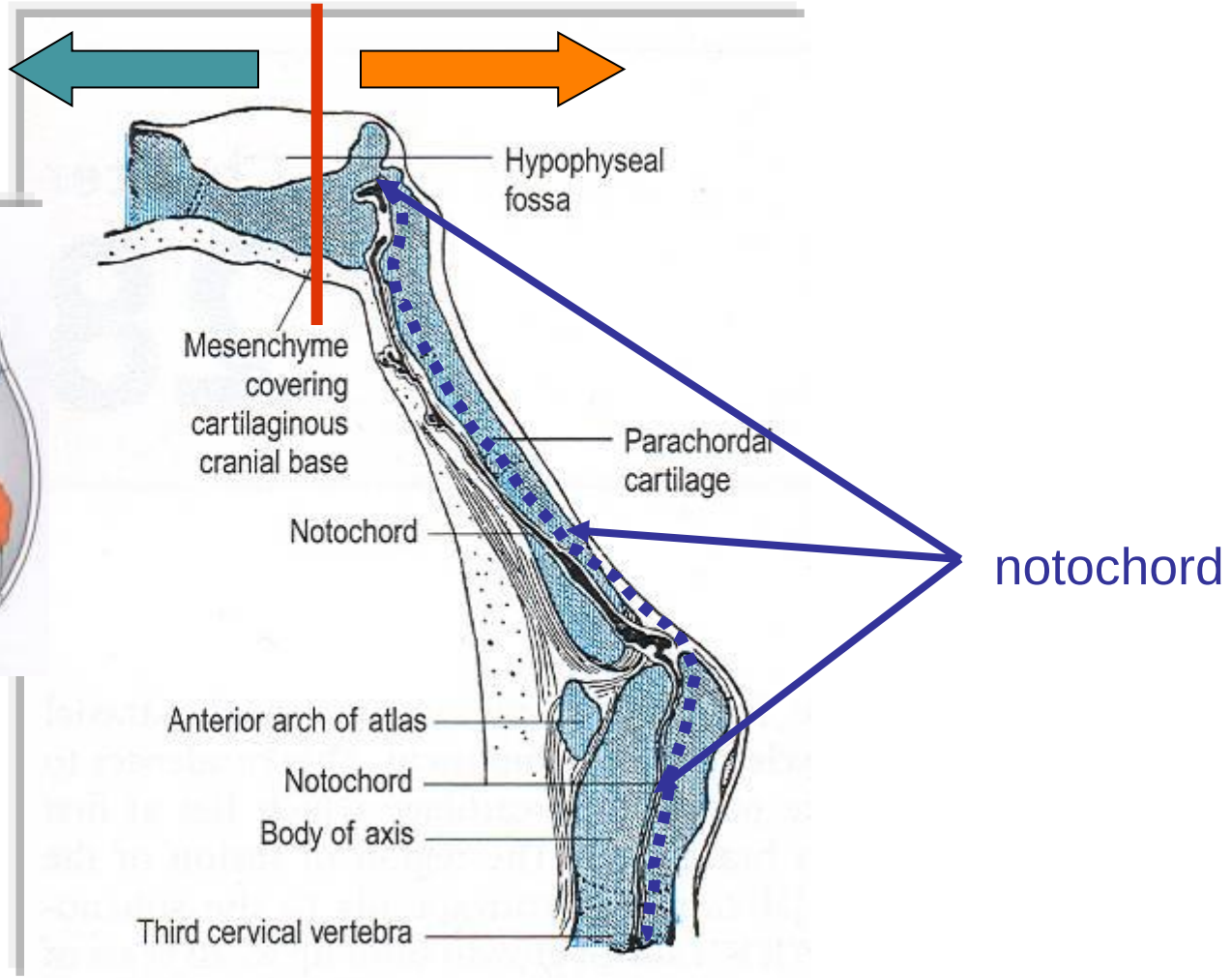


CARTILAGINEOUS NEUROCRANIUM - *CHONDROCRANIUM*

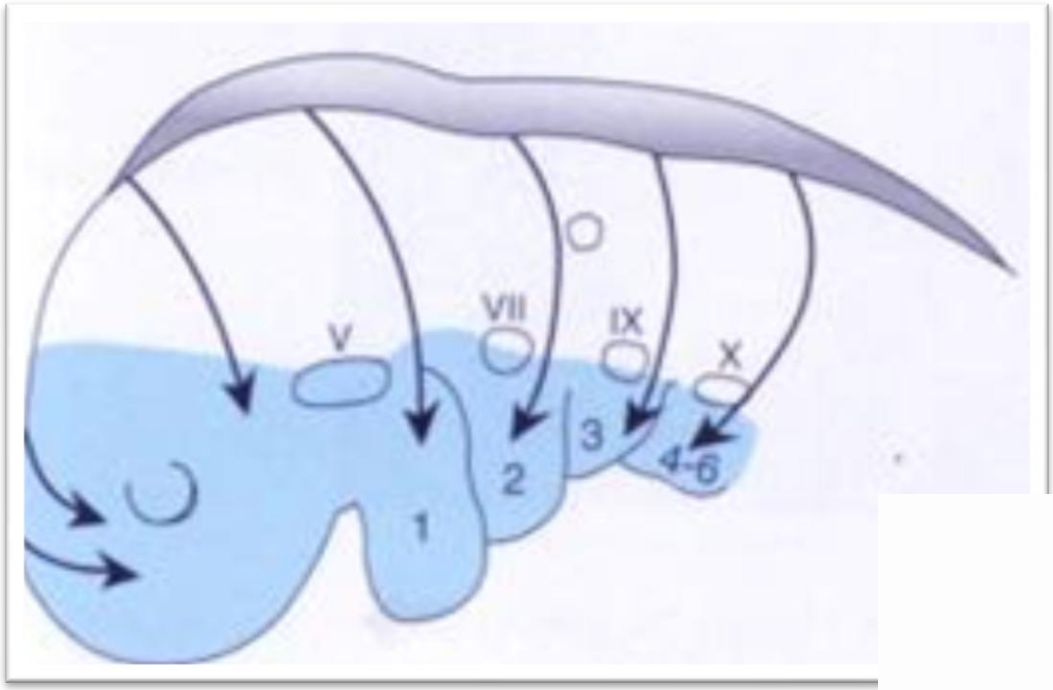
in front of rostral end of notochord
neural crest origin
praechordal chondrocranium

at the level of notochord
paraxial mesodermal origin
chordal chondrocranium

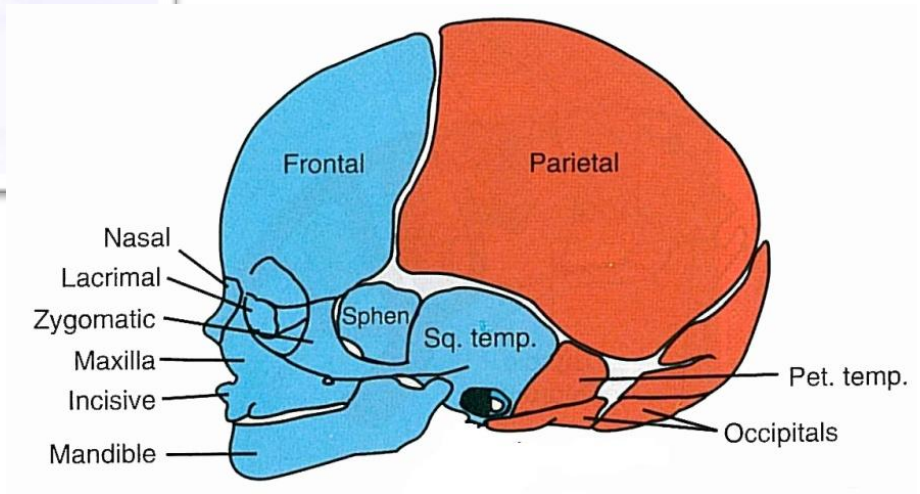




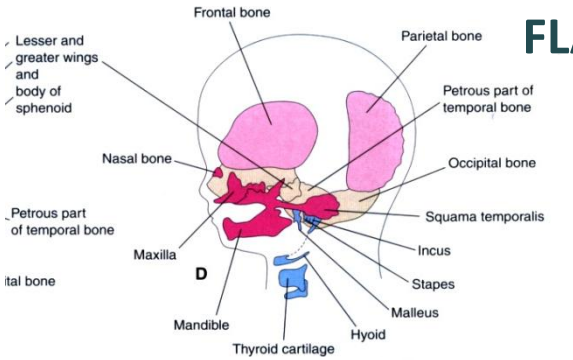
NEURAL CREST MESENCHYME (ECTOMESENCHYME) COMPOSES THE FRONTAL BUT NOT THE PARIETAL BONE



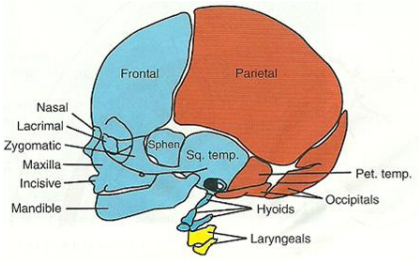
The coronal suture forms at the interface between the neural crest-derived osteogenic mesenchyme of the frontal bone and the mesoderm-derived osteogenic mesenchyme of the parietal bone.



MEMBRANOUS NEUROCRANIUM

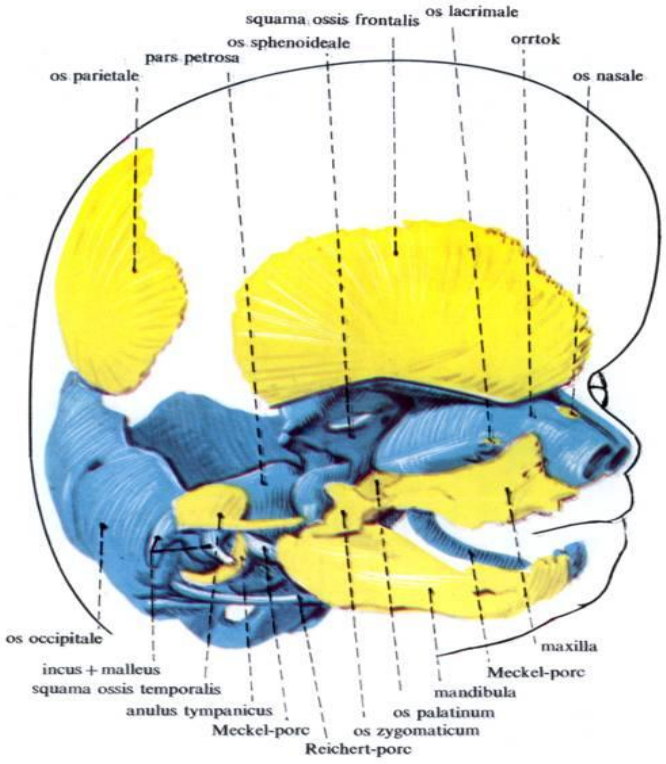


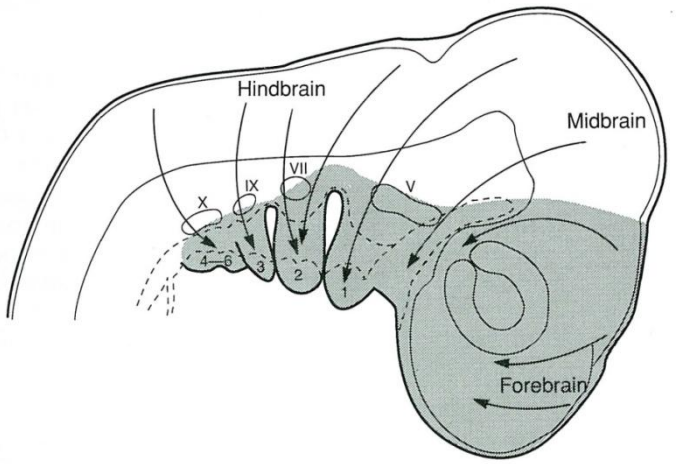
FLAT BONES - INTRAMEMBRANOUS OSSIFICATION



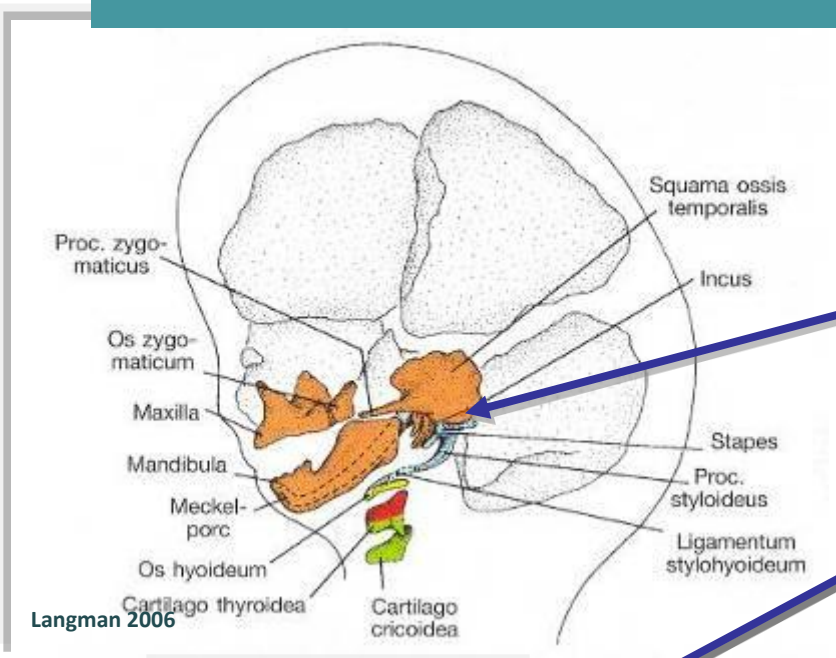
frontal,
parietal
tympanic part
squamous part of temporal
squamous part of occipital

the cells derive either from
NEURAL CREST *(blue)* ***or PARAXIAL MESODERM***
(brown)





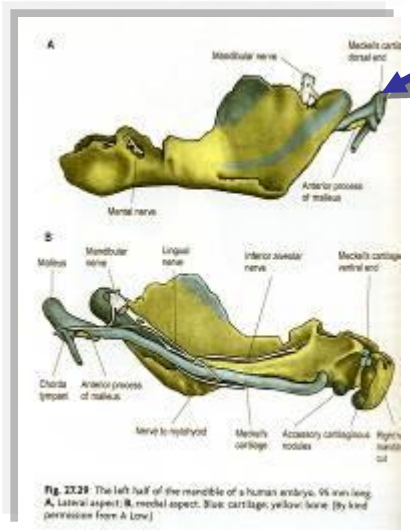
CARTILAGENOUS VISCEROCRANIUM
BONES OF THE FACIAL SKELETON

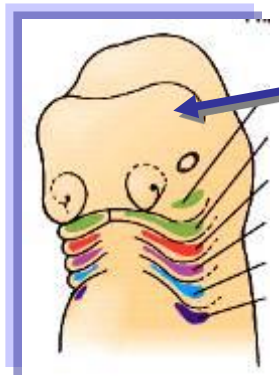


Langman 2006

Circumoral first pharyngeal arch
mandibular prominence

Meckel's cartilage
dorsal end
rudiments of incus, malleus



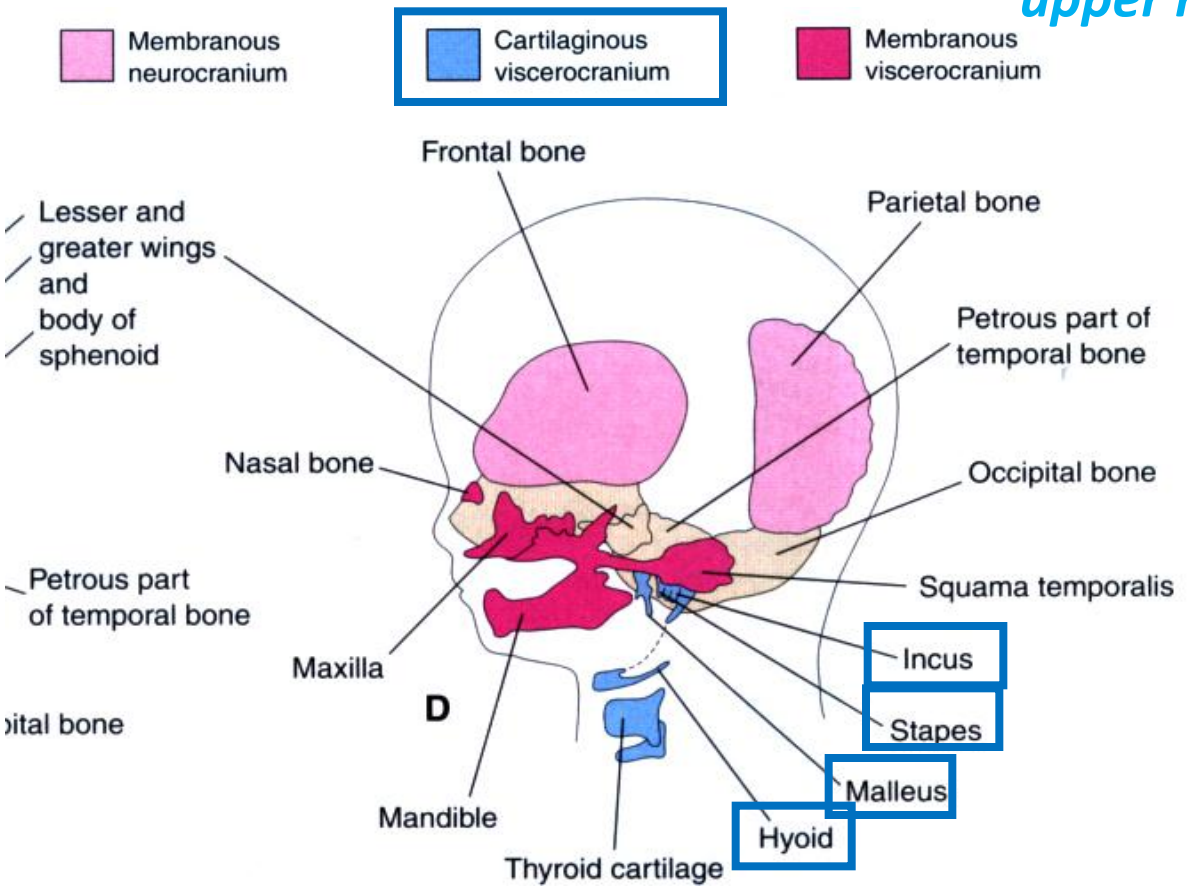


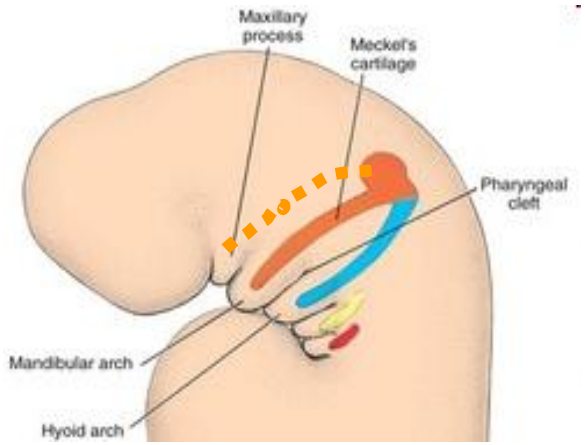
Second pharyngeal arch
Reichert's cartilage
stapes,
temporal
styloid process

CARTILAGINEOUS VISCEROCRANIUM

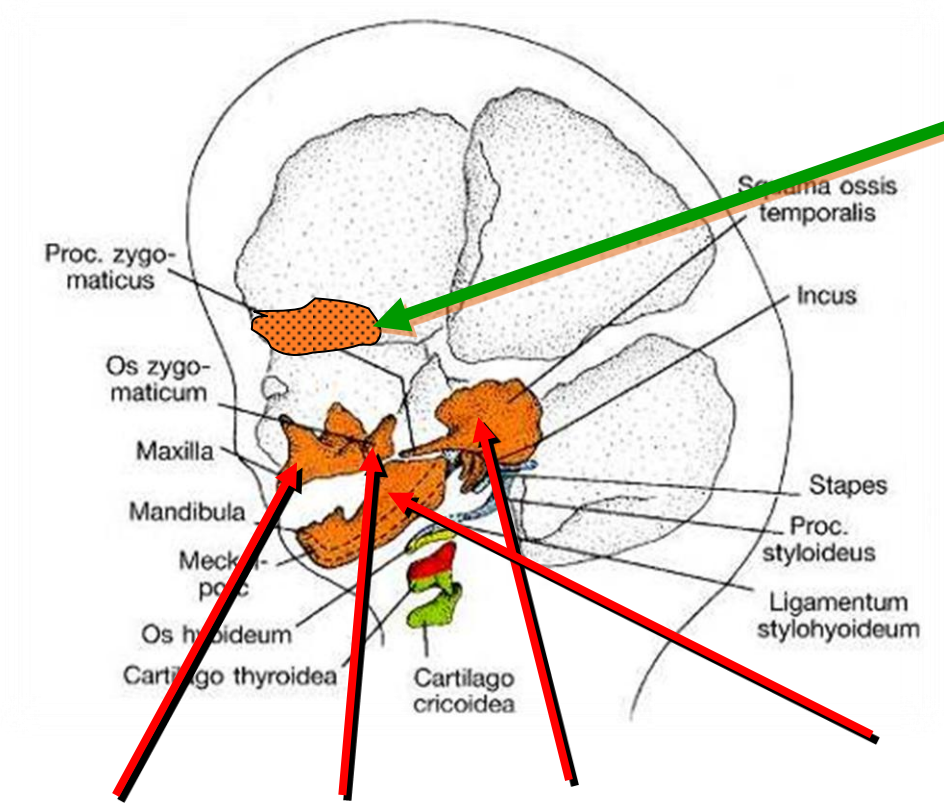
1. ***Pharyngeal arch*** – (Meckel's cartilage) *forms* ***MALLEUS and INCUS***

2. Pharyngeal arch - (Reichert's cartilage) *forms* ***STAPES***
styloid proc. of the temporal bone
upper half and lesser wing of the hyoid bone

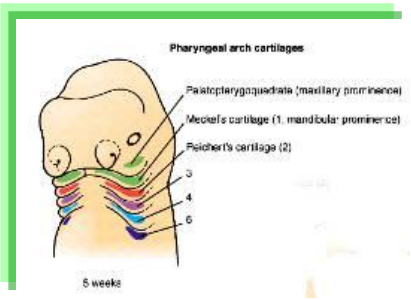




MEMBRANOUS VISCEROCRANIUM
BONES OF THE FACIAL SKELETON



frontonasal prominence
frontal bone
orbital and nasal parts



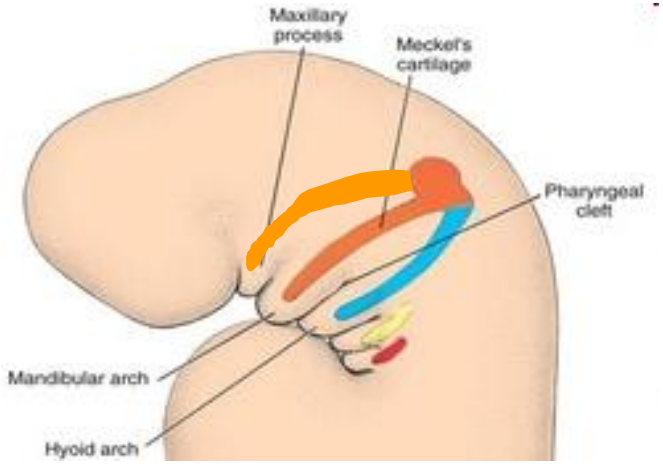
first pharyngeal arch
two prominences:
mandibular and maxillary prominences

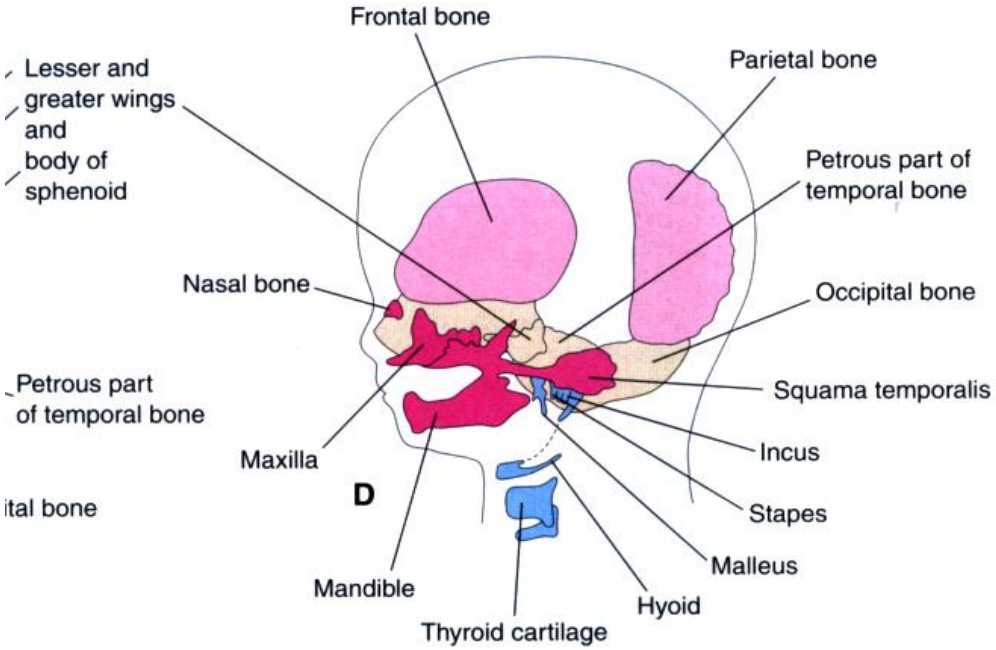
maxilla, zygomatic, temporal squama
membrane bones
maxillary prominence

mandible
intramembranous ossification
around the ventral part of Meckel's cartilage
mandibular prominence

MEMBRANOUS VISCEROCRANIUM

1. *Pharyngeal arch*





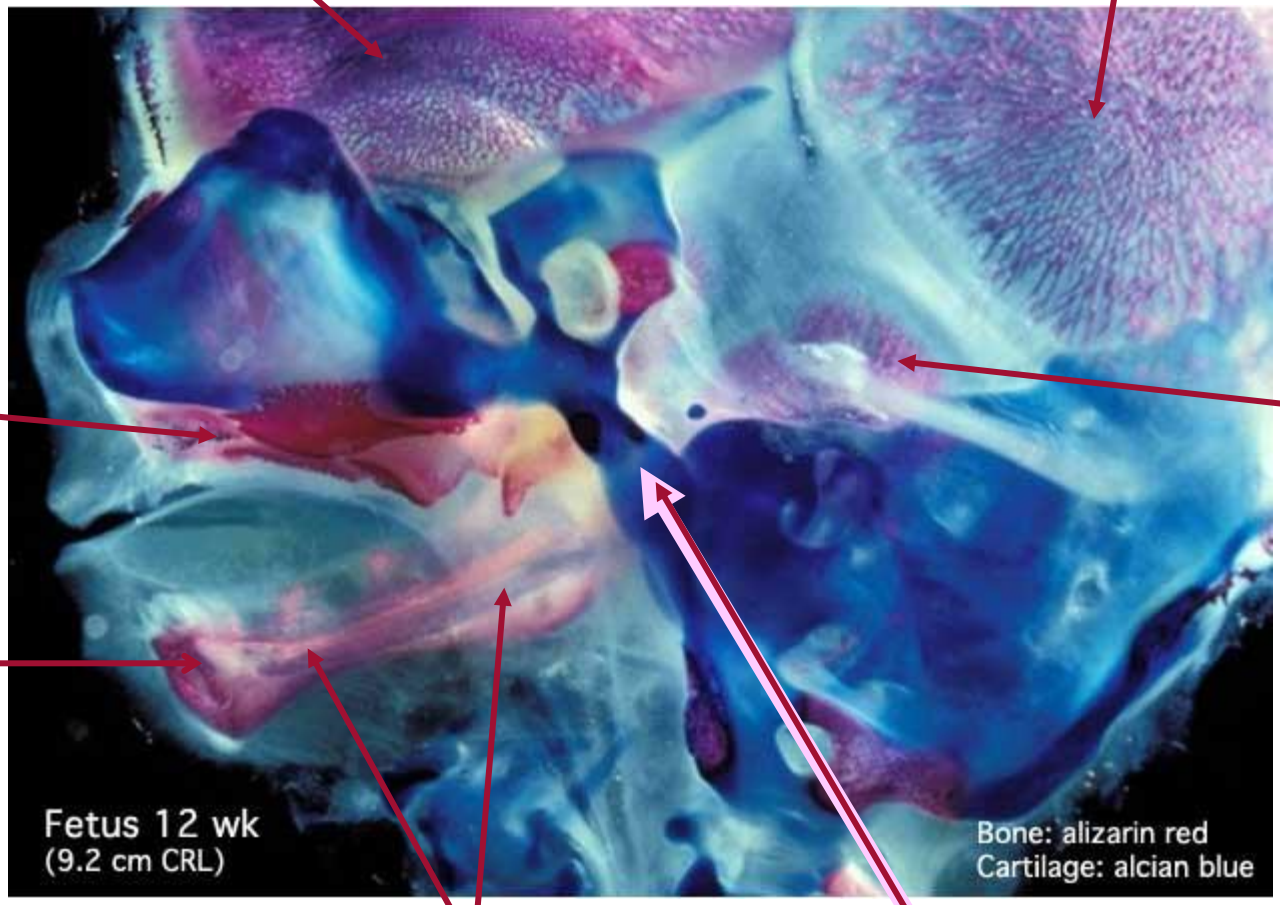
Dorsal subdivision ***MAXILLARY process***

DERIVATIVES : maxilla, zygomatic bone, vomer and palatine bone, temporal squama (later joins the neurocranium)

Ventral subdivision ***MANDIBULAR process*** *(contains the Meckel's cartilage)*

DERIVATIVES: mandible (but the ***condyle*** *is formed by endochondral ossification)*

FETAL CRANIUM



frontal bone

parietal bone

maxilla

temporal squama

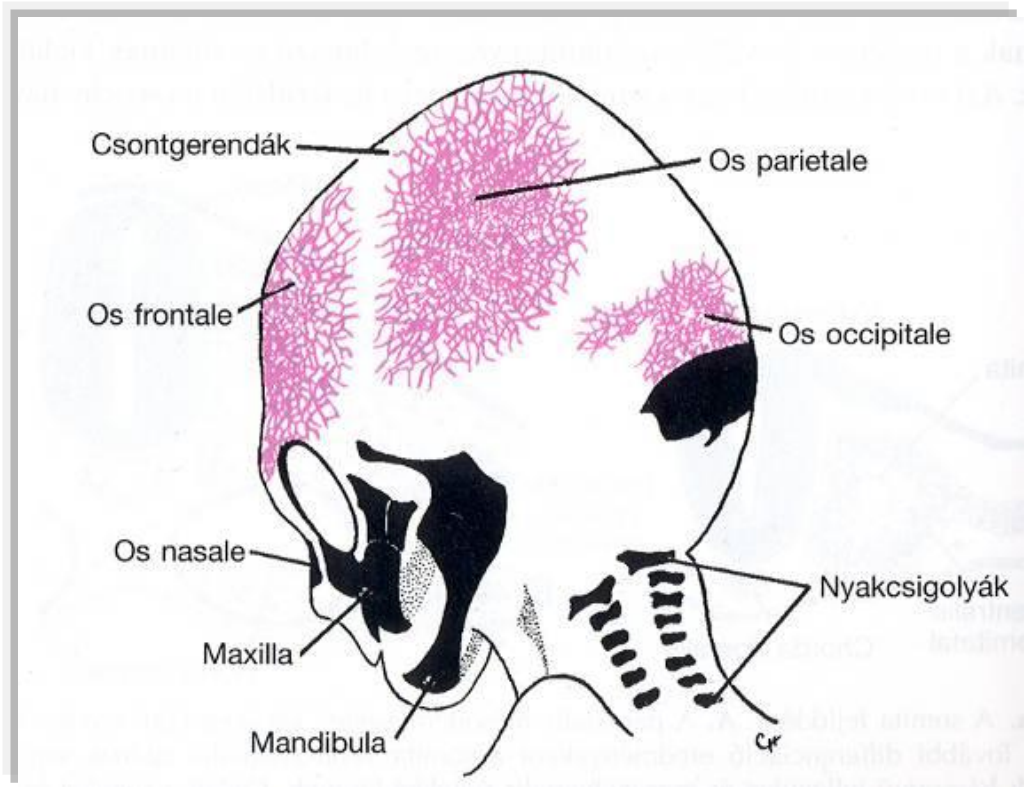
mandible

Ossifying Meckel's cartilage

chondral basicranium

MEMBRANOUS NEUROCRANIUM, CALVARY

3rd month



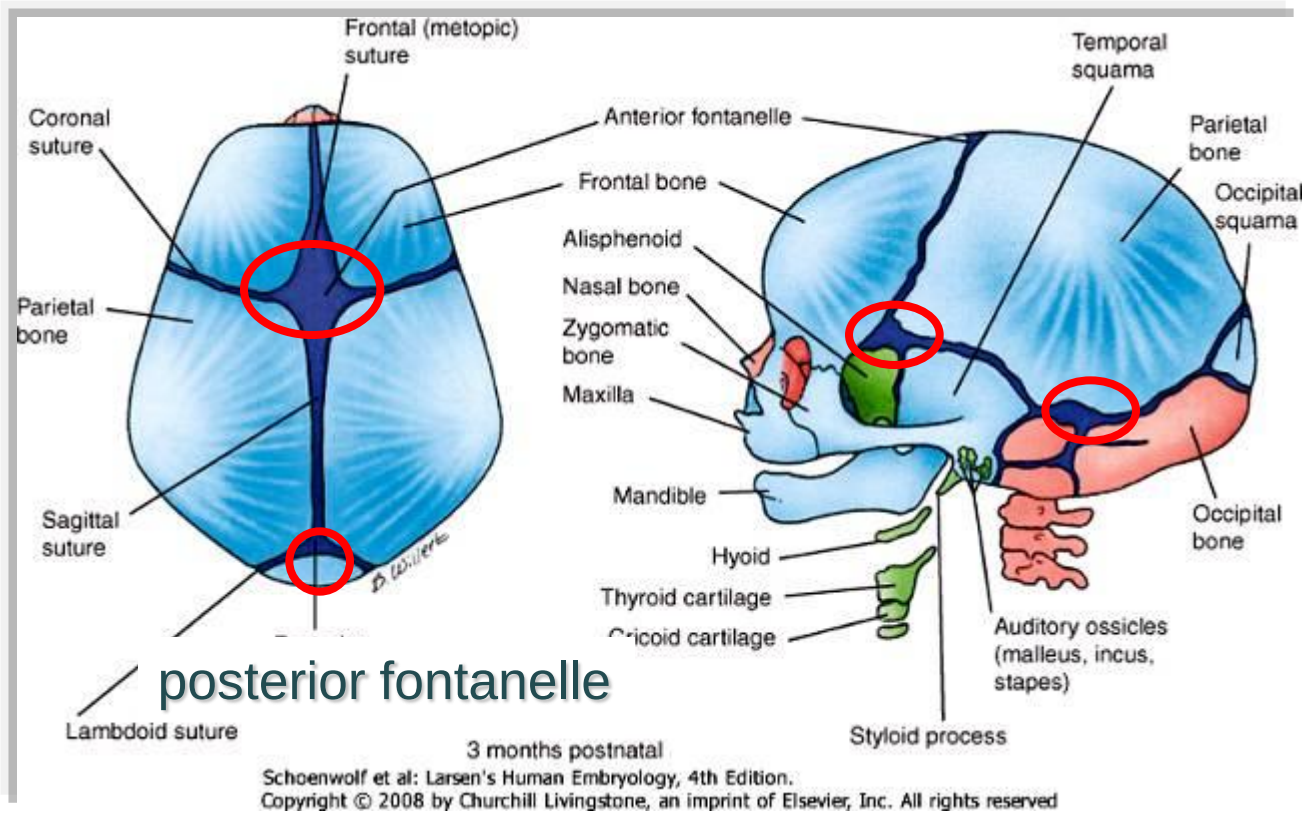
-primary ossification centre

radial orientation of bony trabeculae

spiculum

MEMBRANOUS NEUROCRANIUM SUTURES AND FONTANELLES

anterior fontanelle



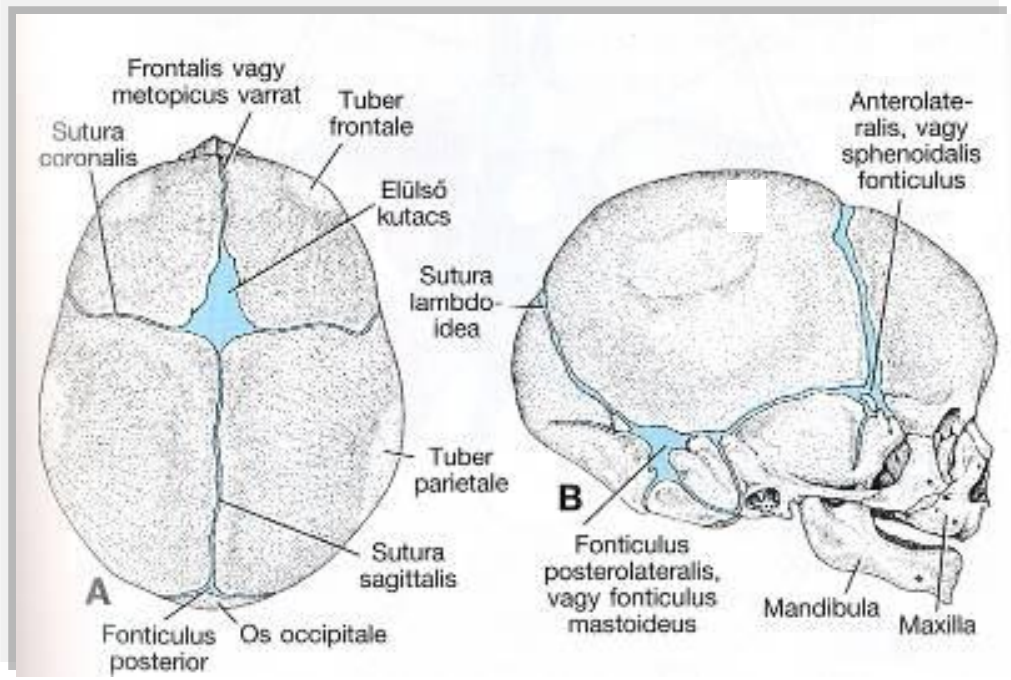
anterolateral fontanelle

posterolateral fontanelle

The connective tissue of the sutures/ fontanelles derives from the neural crest and acts as an

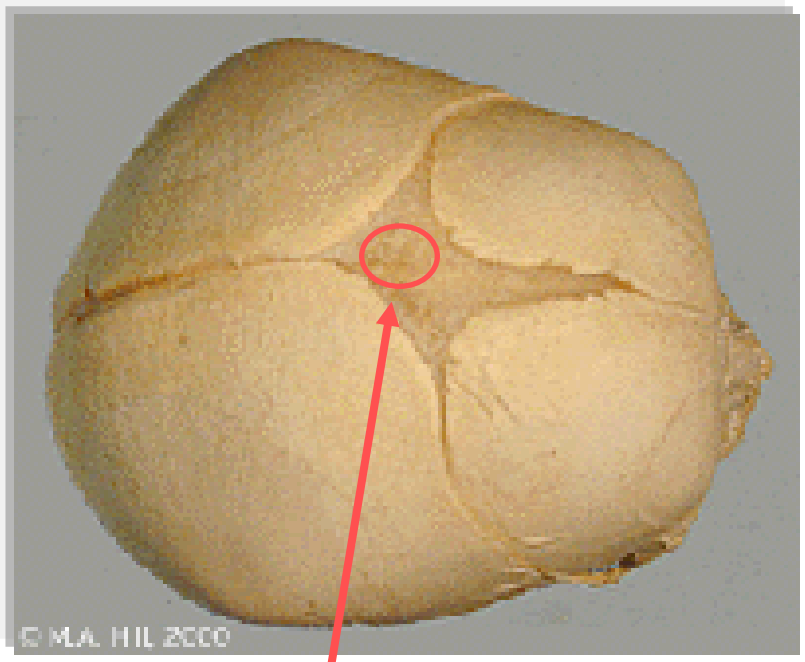
ORGANIZER

SKULL OF A NEWBORN



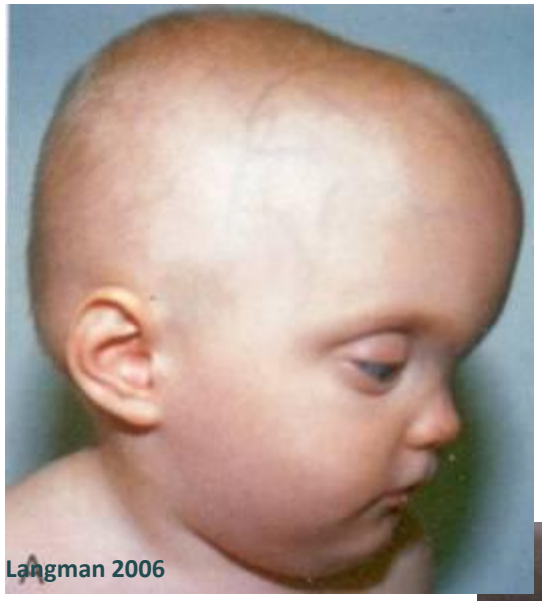
anterior fontanelle
(closes in the middle of 2nd year)

fibrous sutures



Location of the parietal eye of reptiles
(phylogenetic relevance)

CRANIOFACIAL MALFORMATIONS



Scaphocephaly

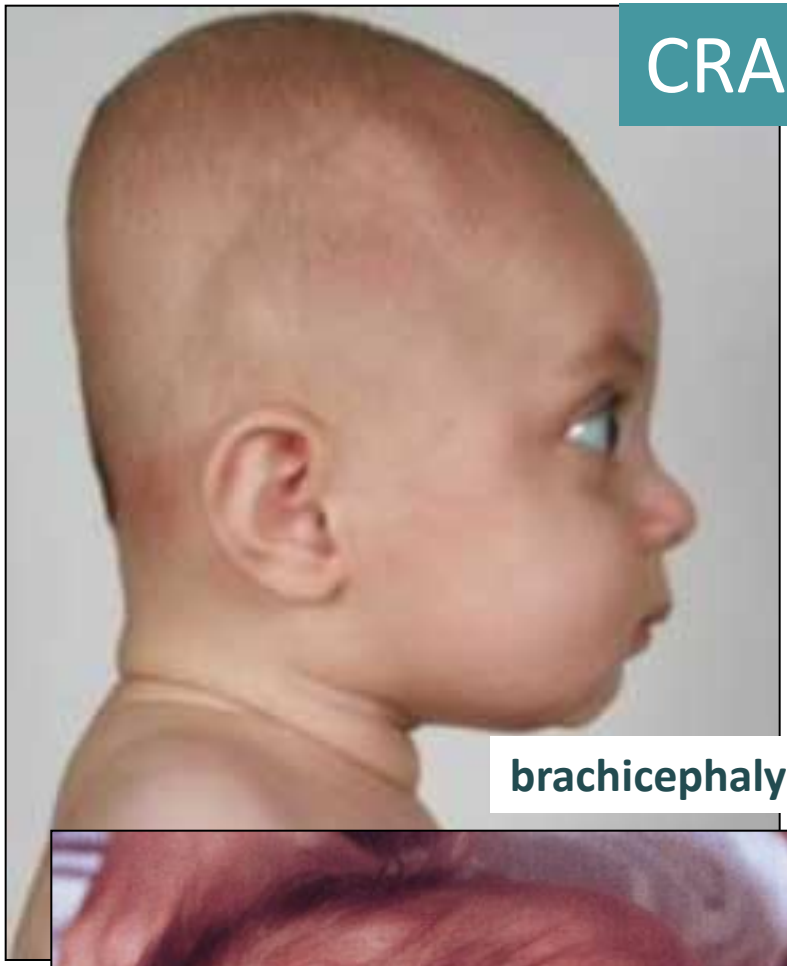
FGF Receptor 3 mutation

Clover leaf Syndrome

Craniosynostosis

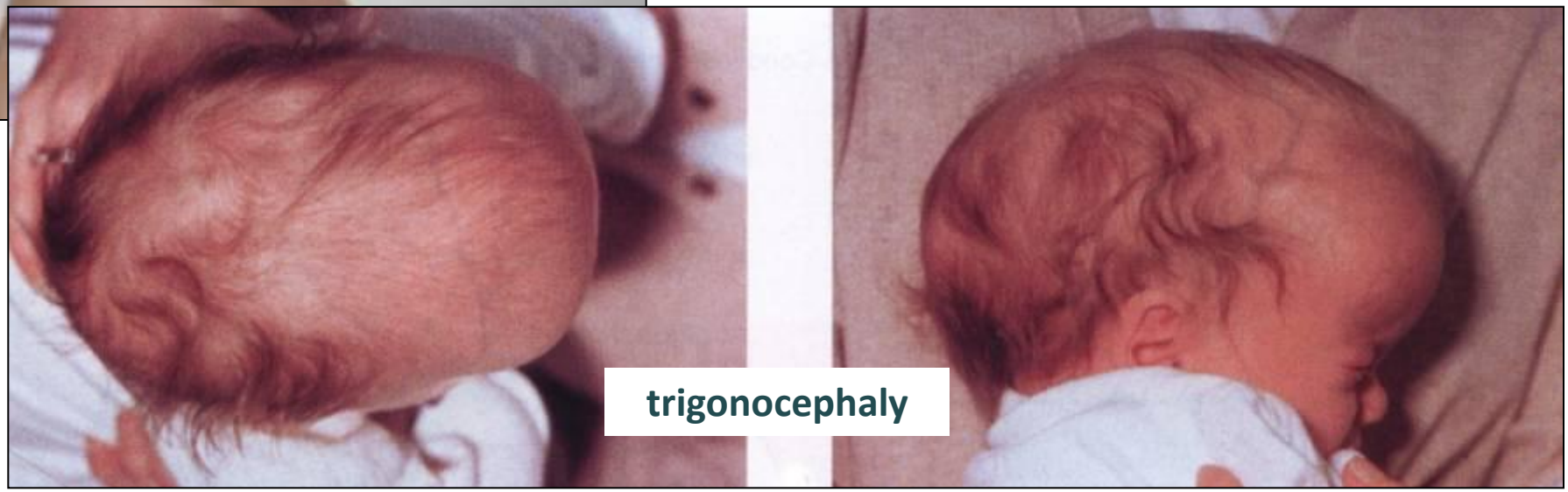
Turricephaly

CRANIOFACIAL MALFORMATIONS



brachicephaly

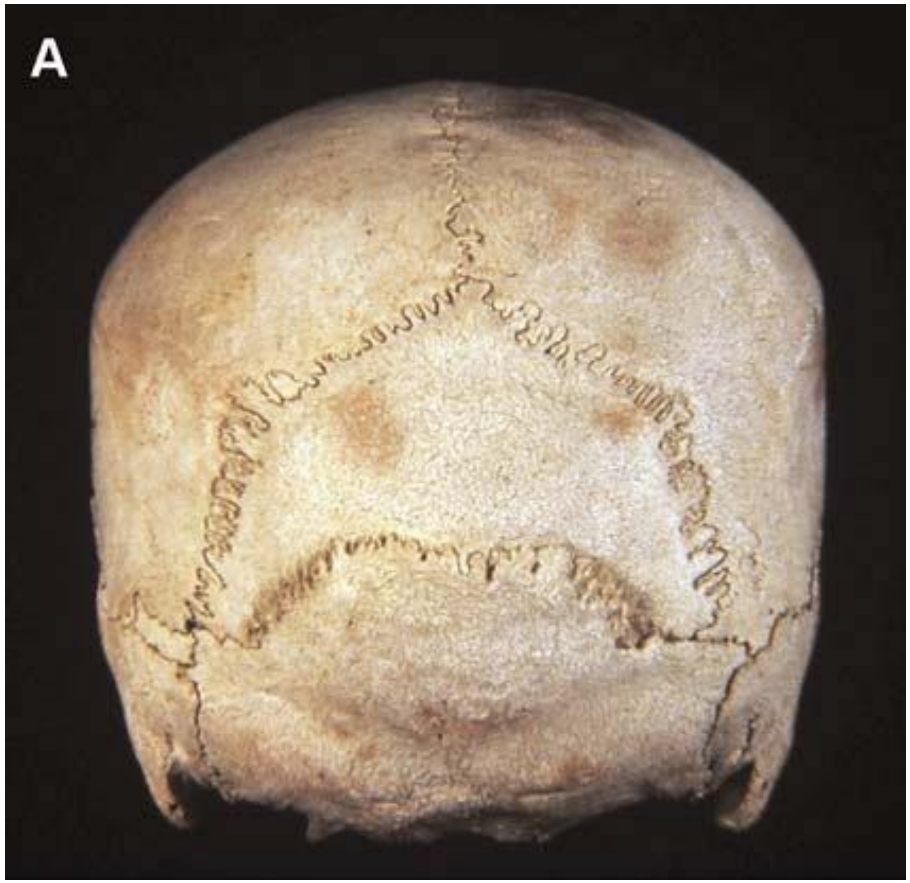
dolichocephaly



trigonocephaly

INTERPARIETAL OR INCA BONE

BONY INCLUSION IN THE LAMBDOID SUTURE



THANK YOU VERY MUCH FOR YOUR ATTENTION