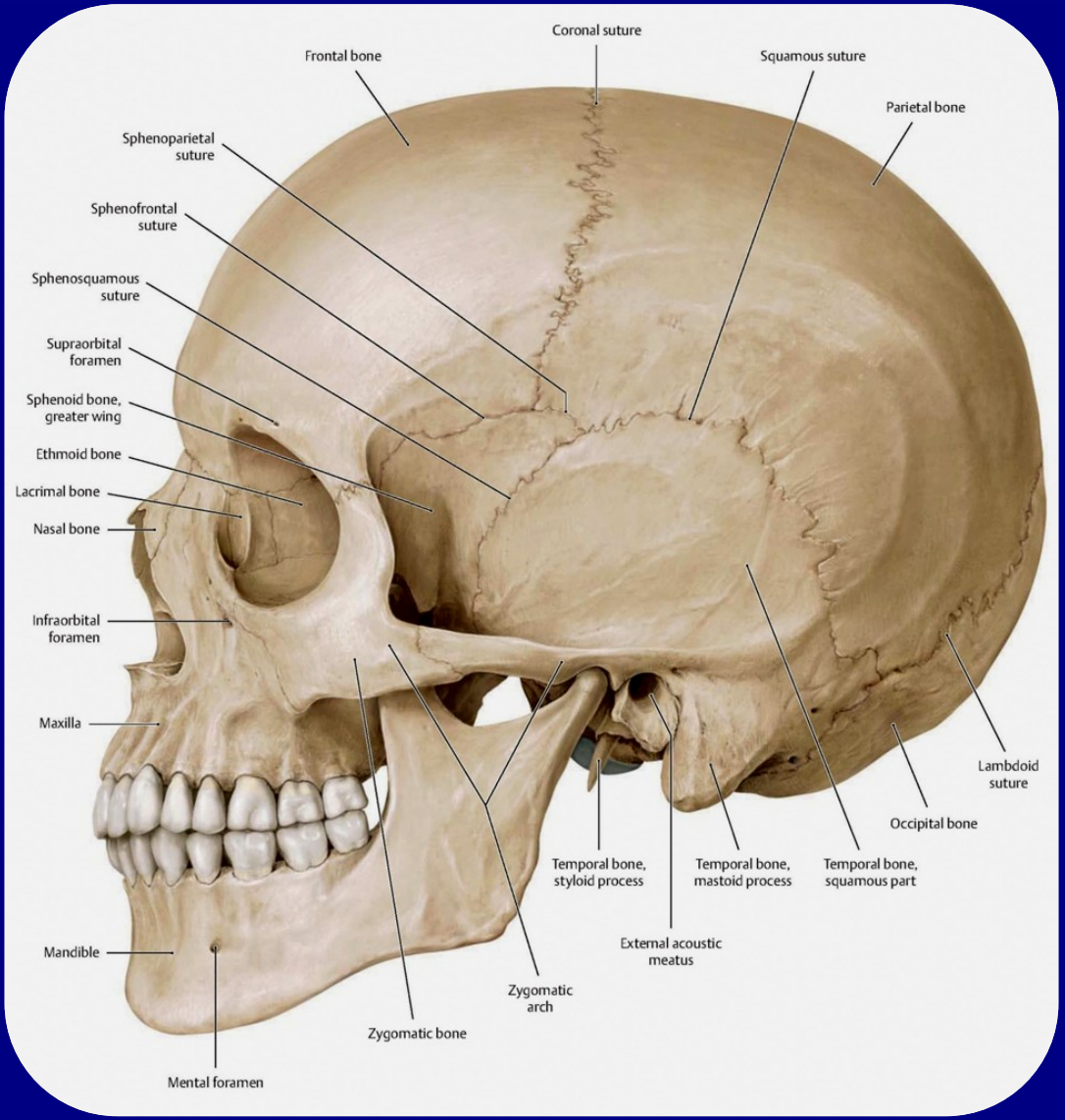
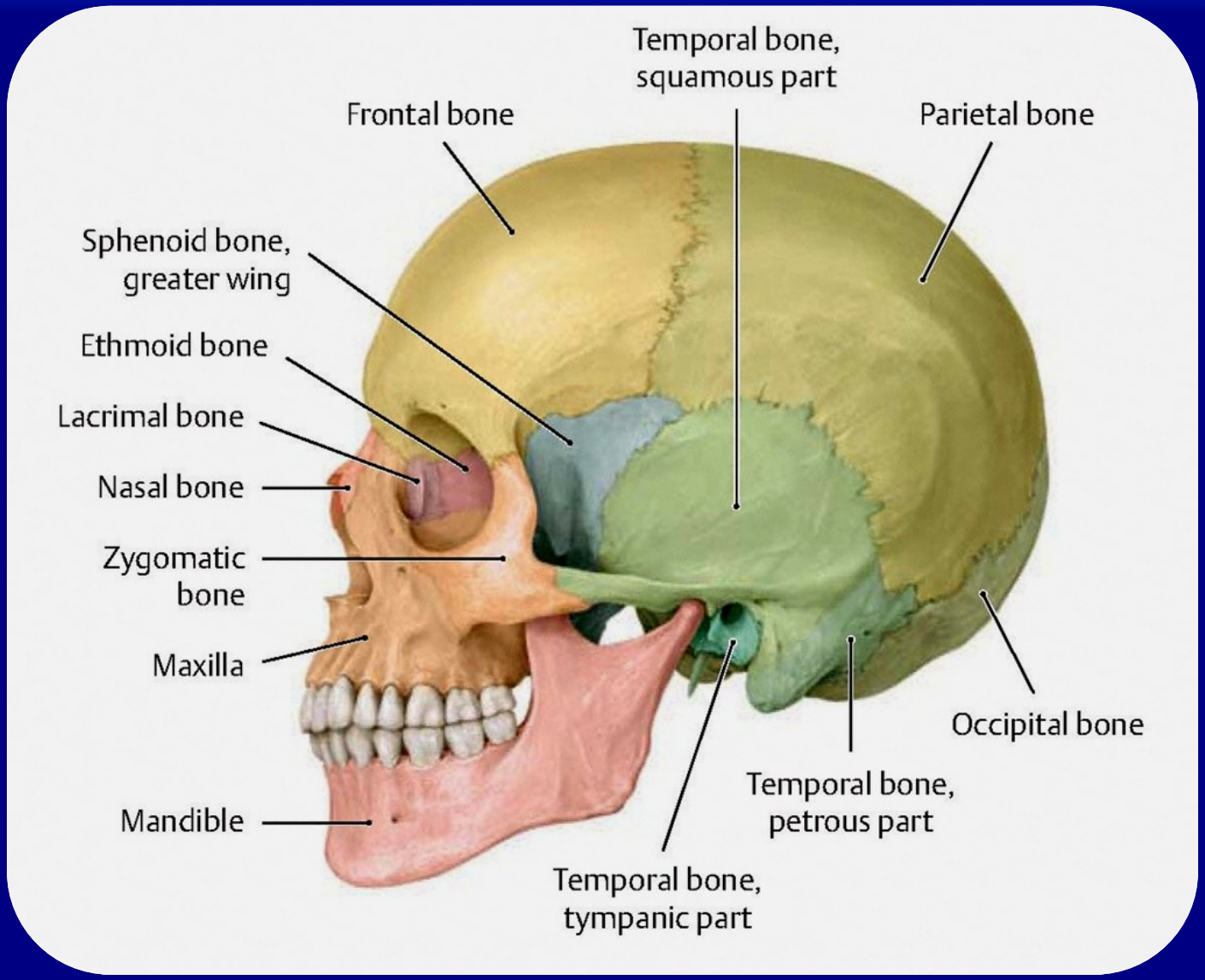
SKULL

– DEVELOPMENT AND OVERVIEW

Thieme F. Netter M.D. Sobotta GRAY'S Anatomy



Lateral view of the skull



Lateral view of the cranial bones

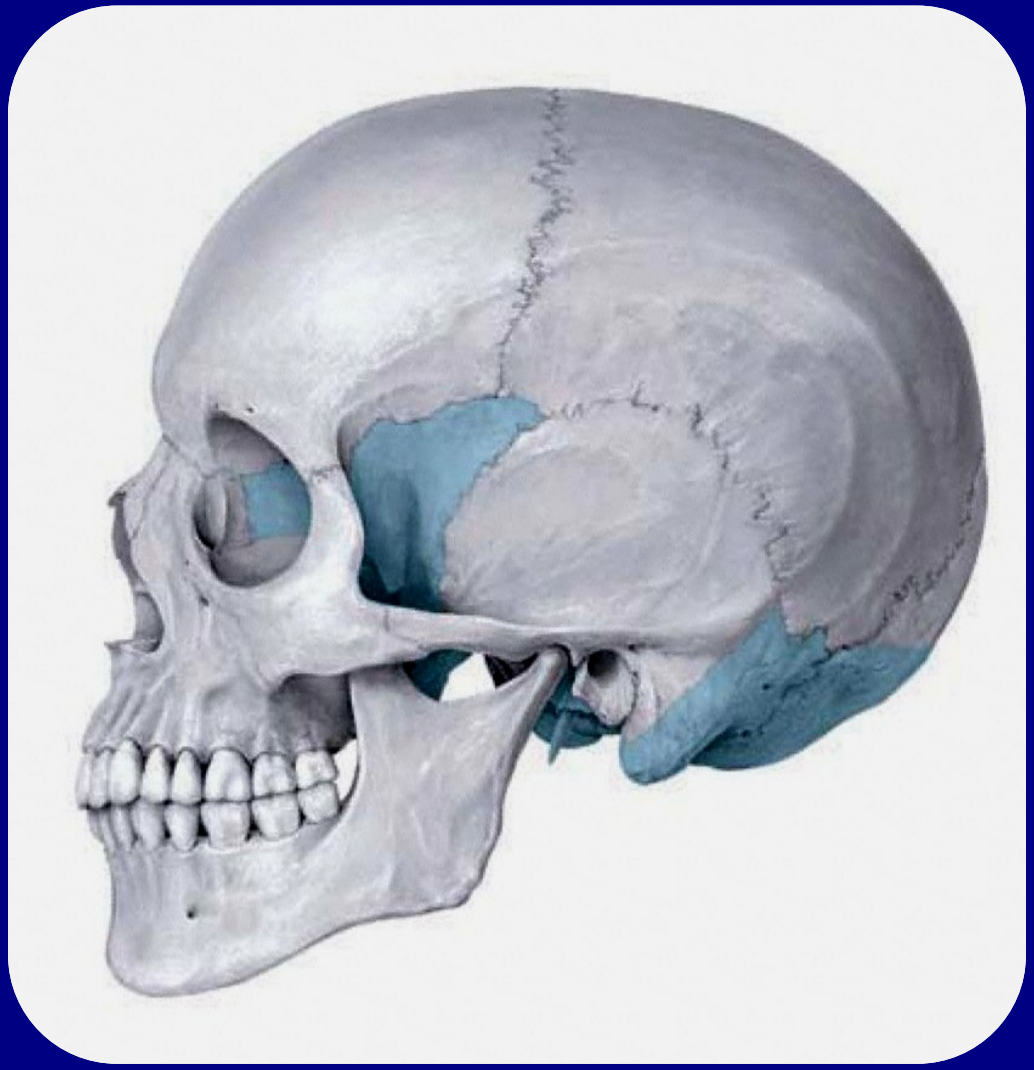
Bones of the neurocranium and viscerocranium

Neurocranium (gray)	**Viscerocranium** (orange)
• Frontal bone • Sphenoid bone (excluding the pterygoid process) • Temporal bone (squamous part, petrous part) • Parietal bone • Occipital bone • Ethmoid bone (cribriform plate)	• Nasal bone • Lacrimal bone • Ethmoid bone (excluding the cribriform plate) • Sphenoid bone (pterygoid process) • Maxilla • Zygomatic bone • Temporal bone (tympanic part, styloid process) • Mandible • Vomer • Inferior nasal turbinate • Palatine bone • Hyoid bone (see p. 31)

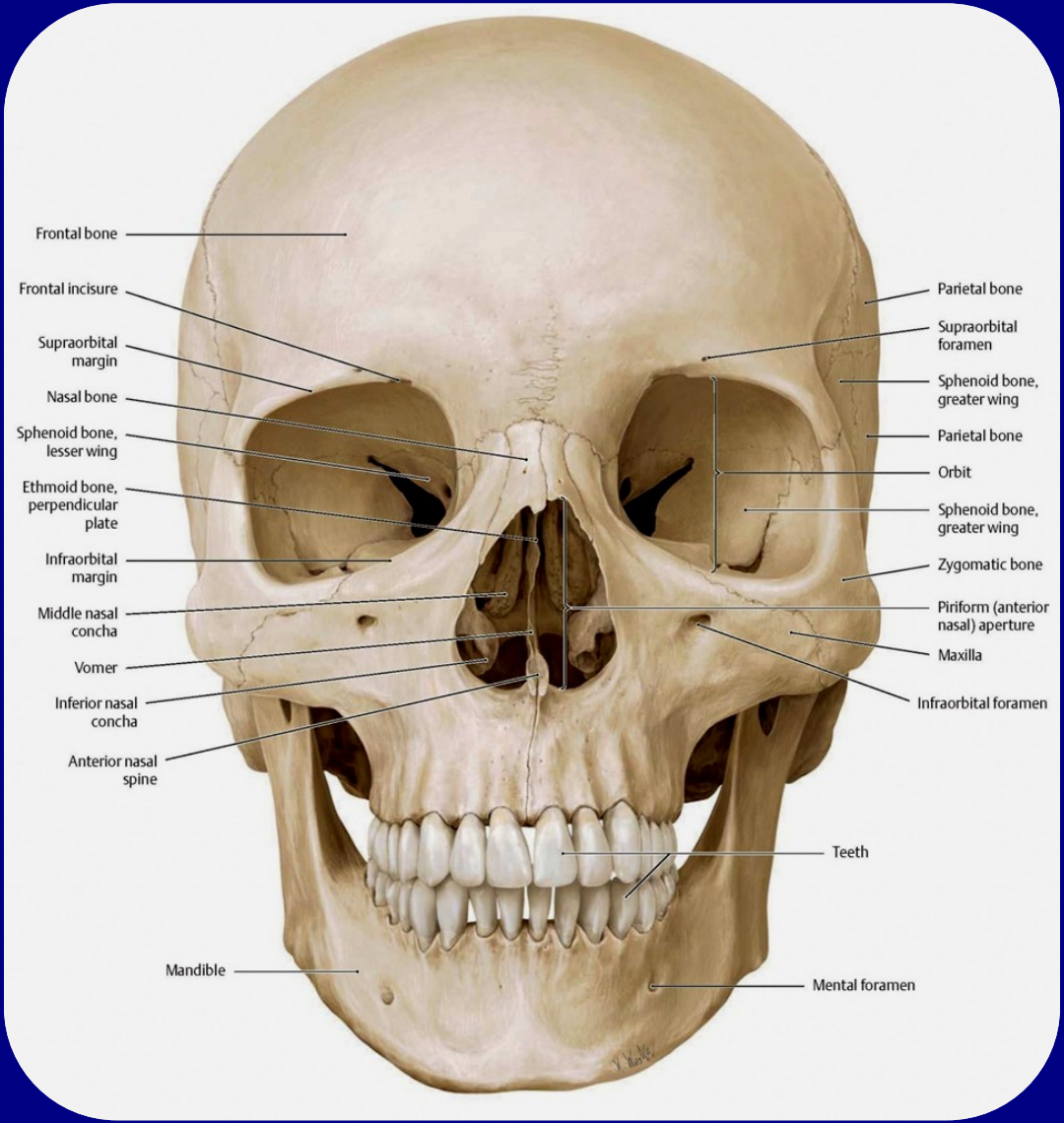
Bones of the neurocranium (gray) and viscerocranium (orange)

Bones of the desmocranium and chondrocranium

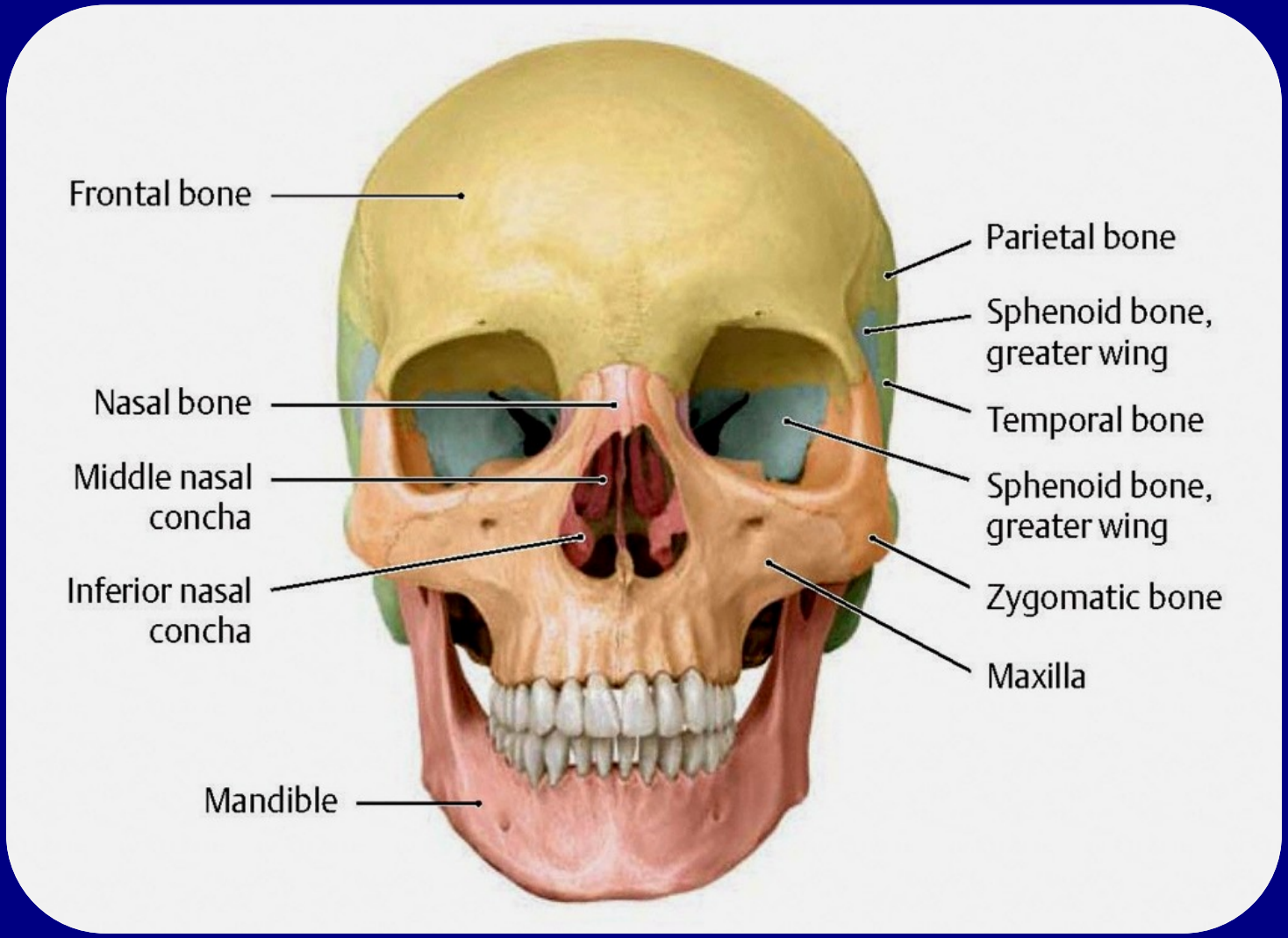
Desmocranium (gray)	**Chondrocranium** (blue)
• Nasal bone • Lacrimal bone • Maxilla • Mandible • Zygomatic bone • Frontal bone • Parietal bone • Occipital bone (upper part of the squama) • Temporal bone (squamous part, tympanic part) • Palatine bone • Vomer	• Ethmoid bone • Sphenoid bone (excluding the medial plate of the pterygoid process) • Temporal bone (petrous and mastoid parts, styloid process) • Occipital bone (excluding the upper part of the squama) • Inferior nasal turbinate • Hyoid bone (see p. 31)



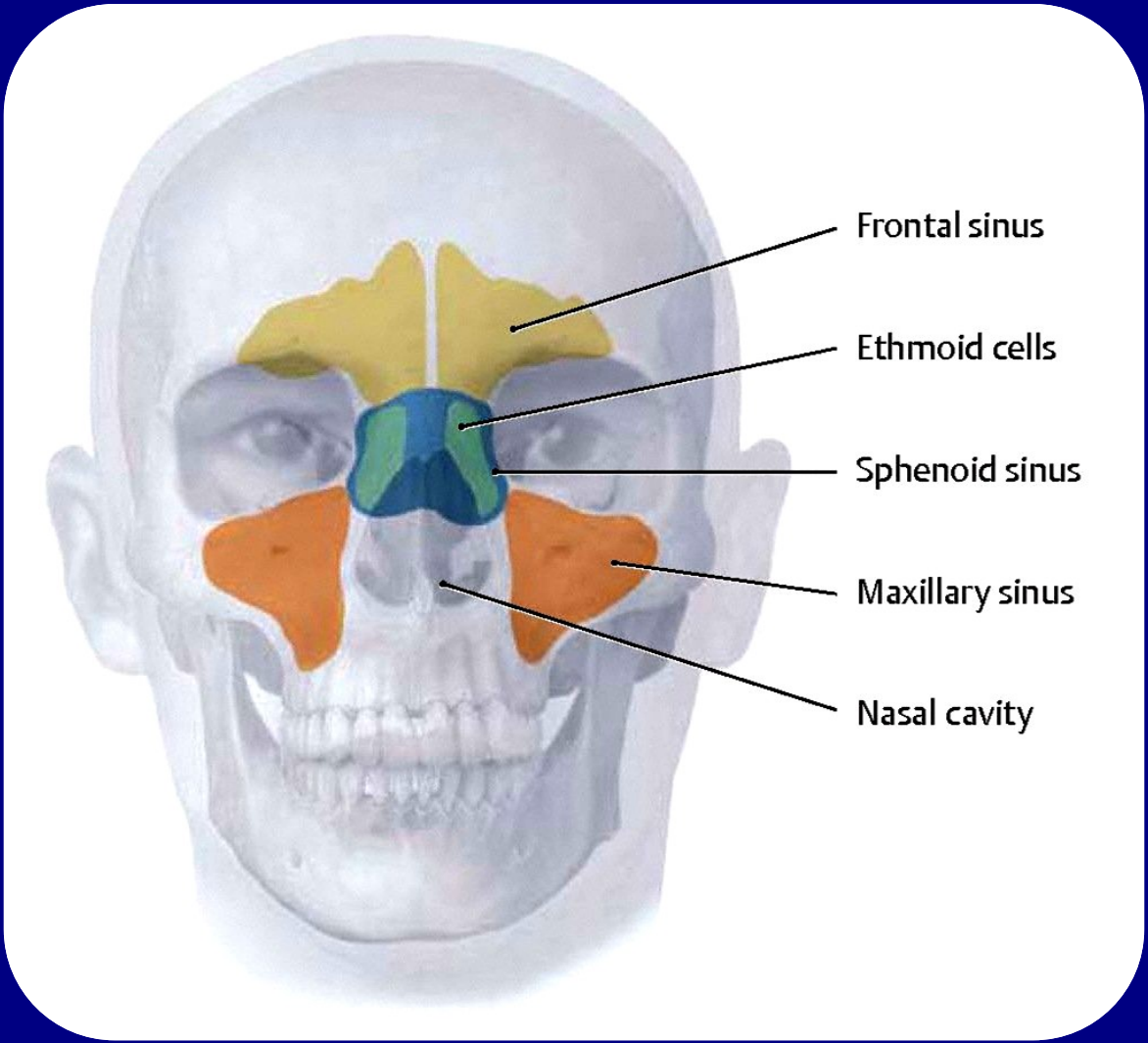
Ossification of the cranial bones



Anterior view of the skull

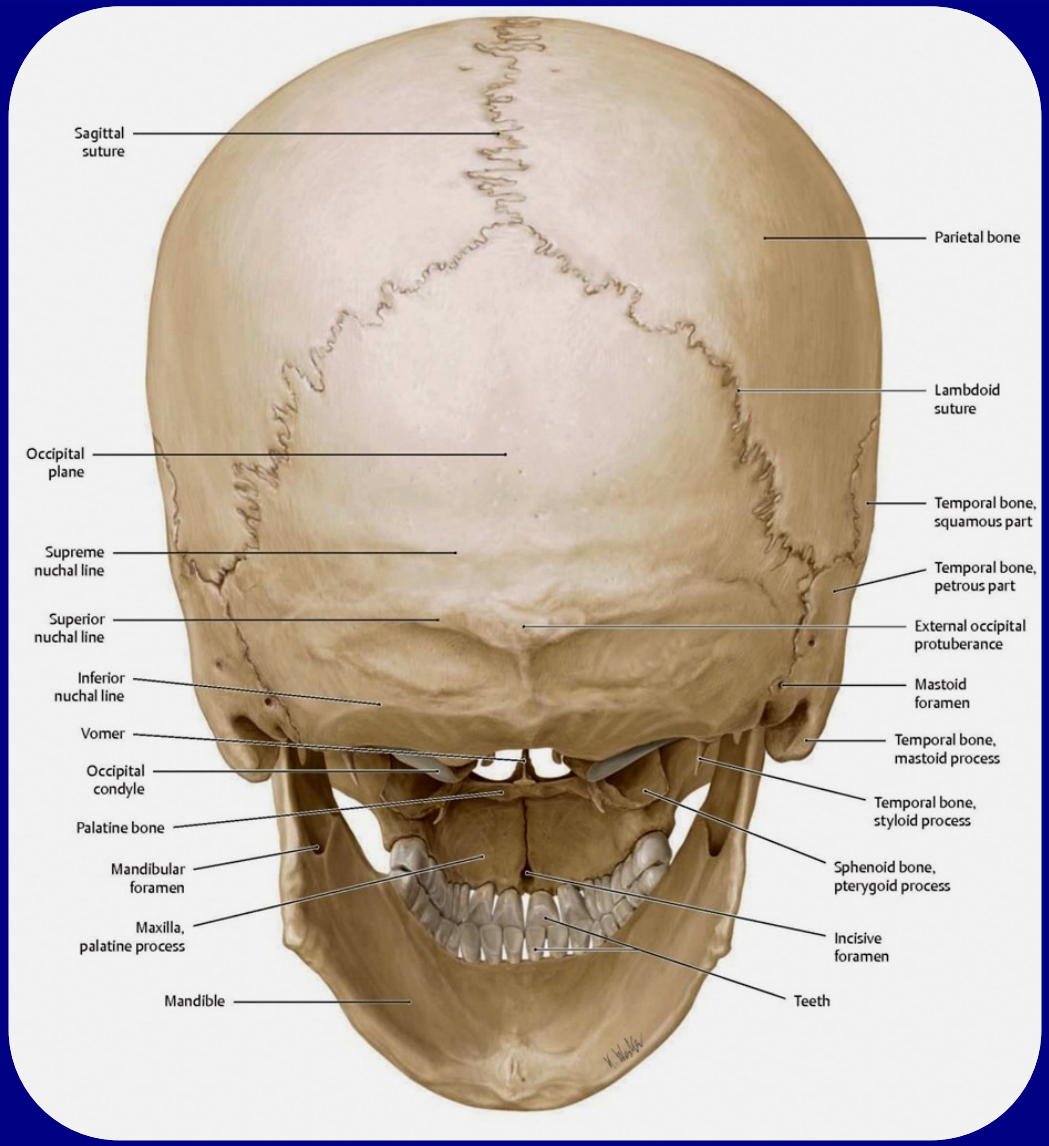


Cranial bones, anterior view

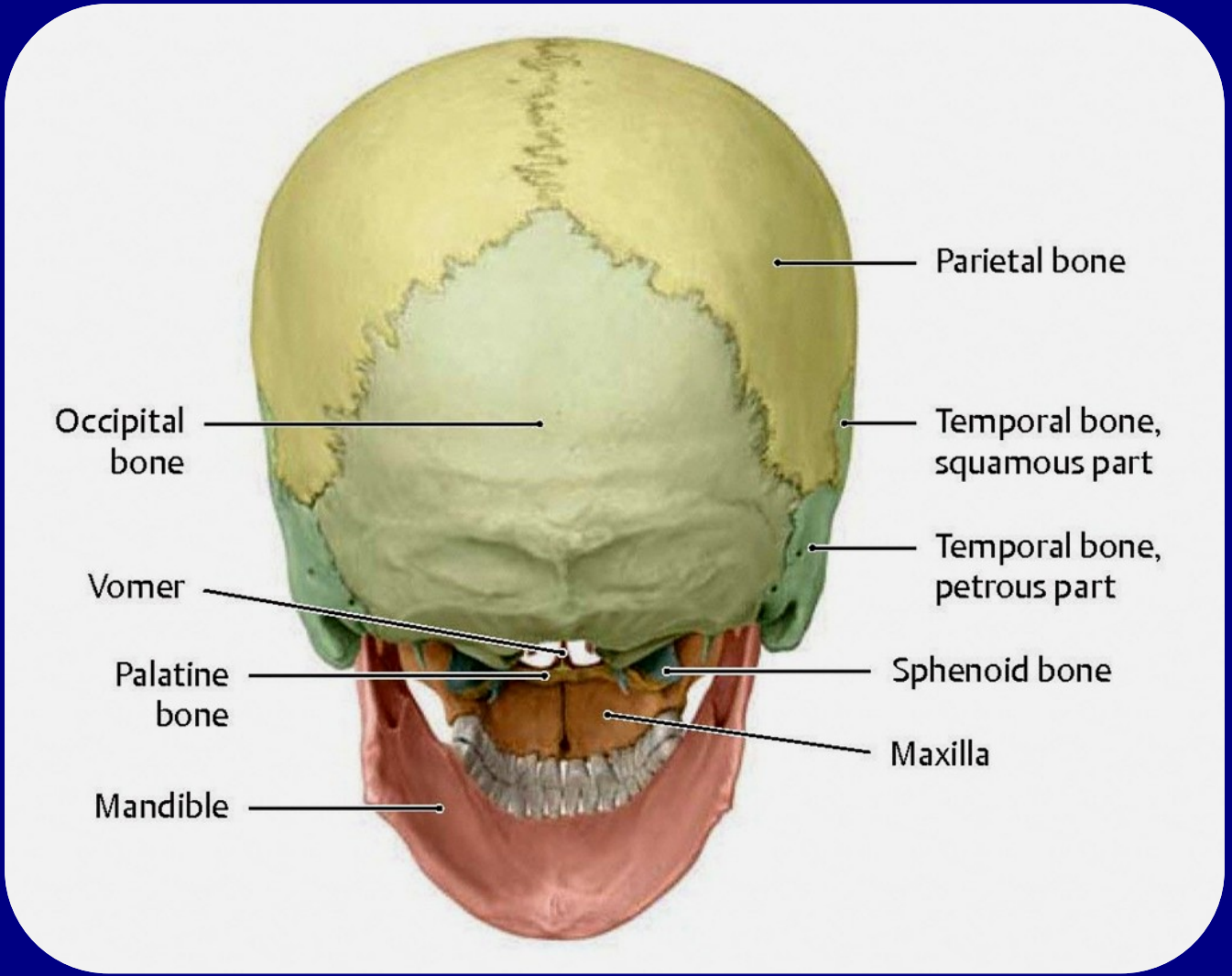


Paranasal sinuses: pneumatization lightens the bone

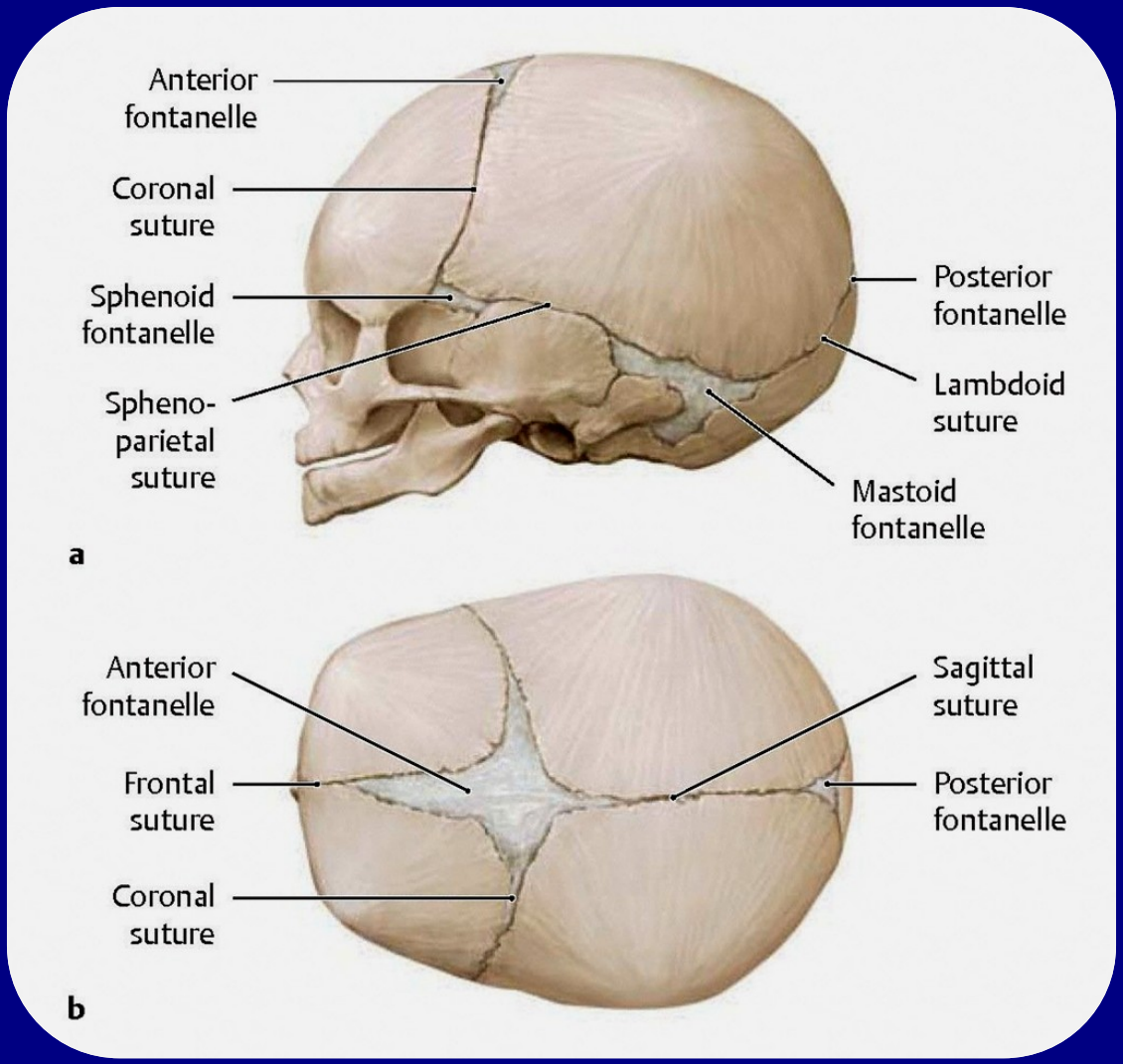
LeFort classification of midfacial fractures



Posterior view of the skull



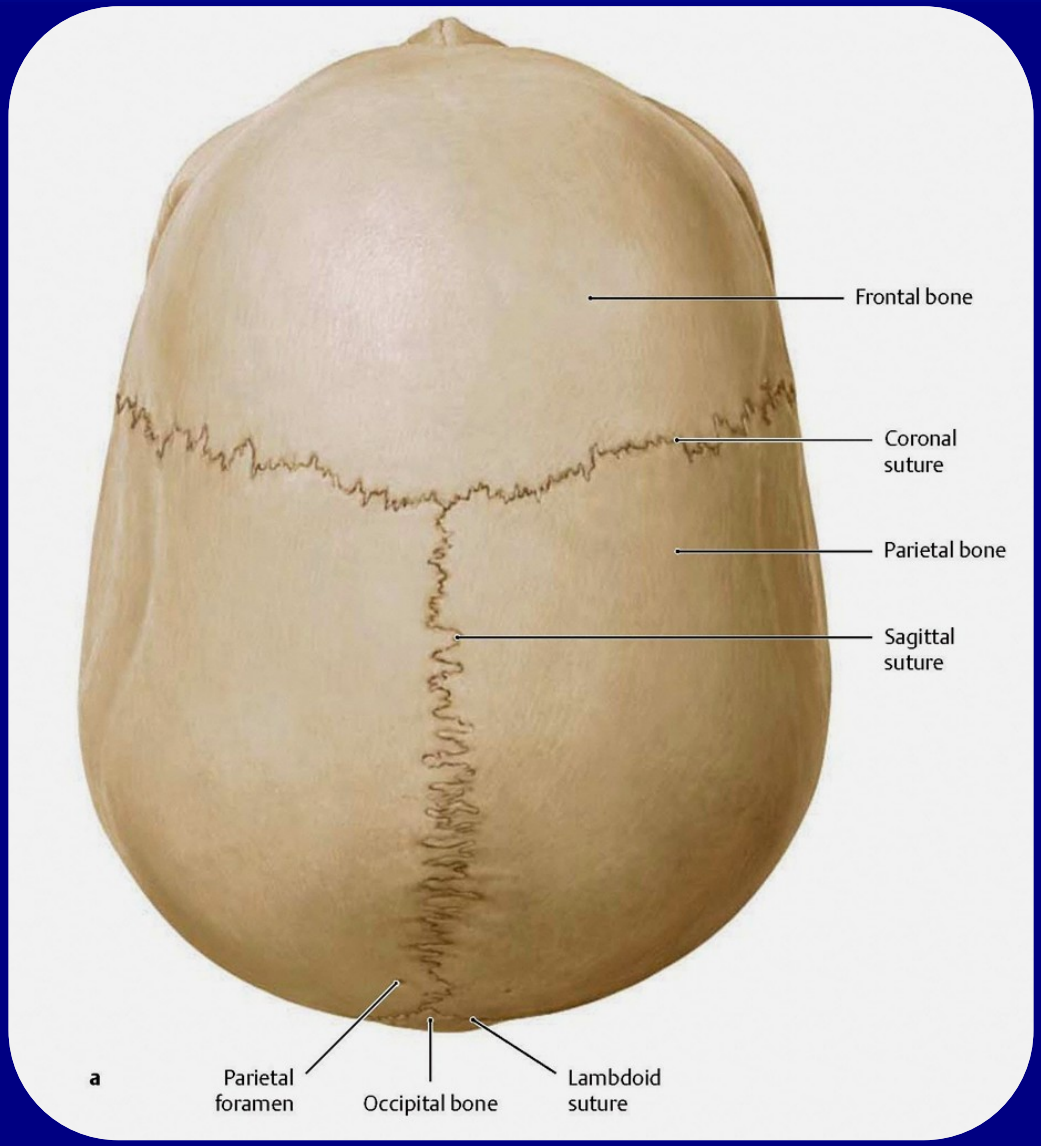
Posterior view of the cranial bones



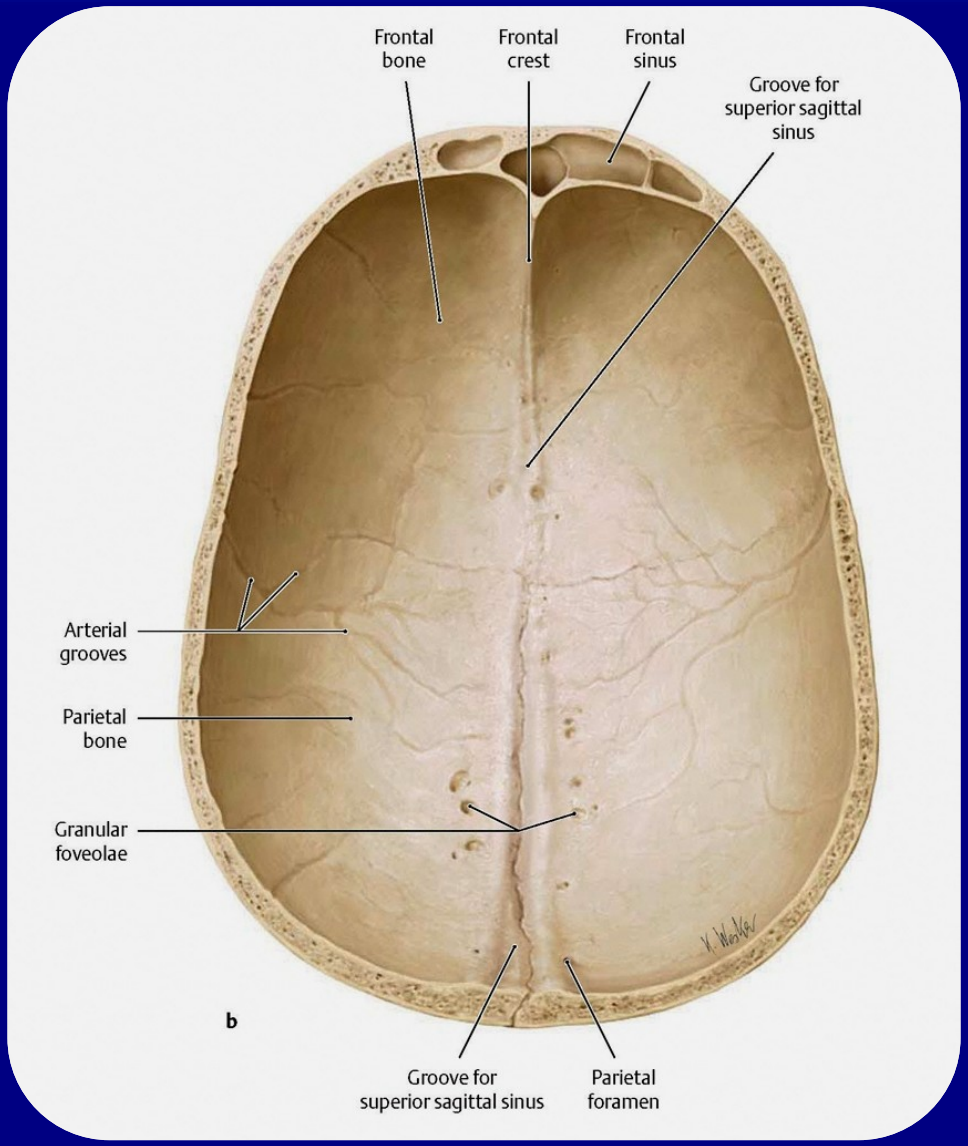
The neonatal skull

Age at which the principal sutures ossify

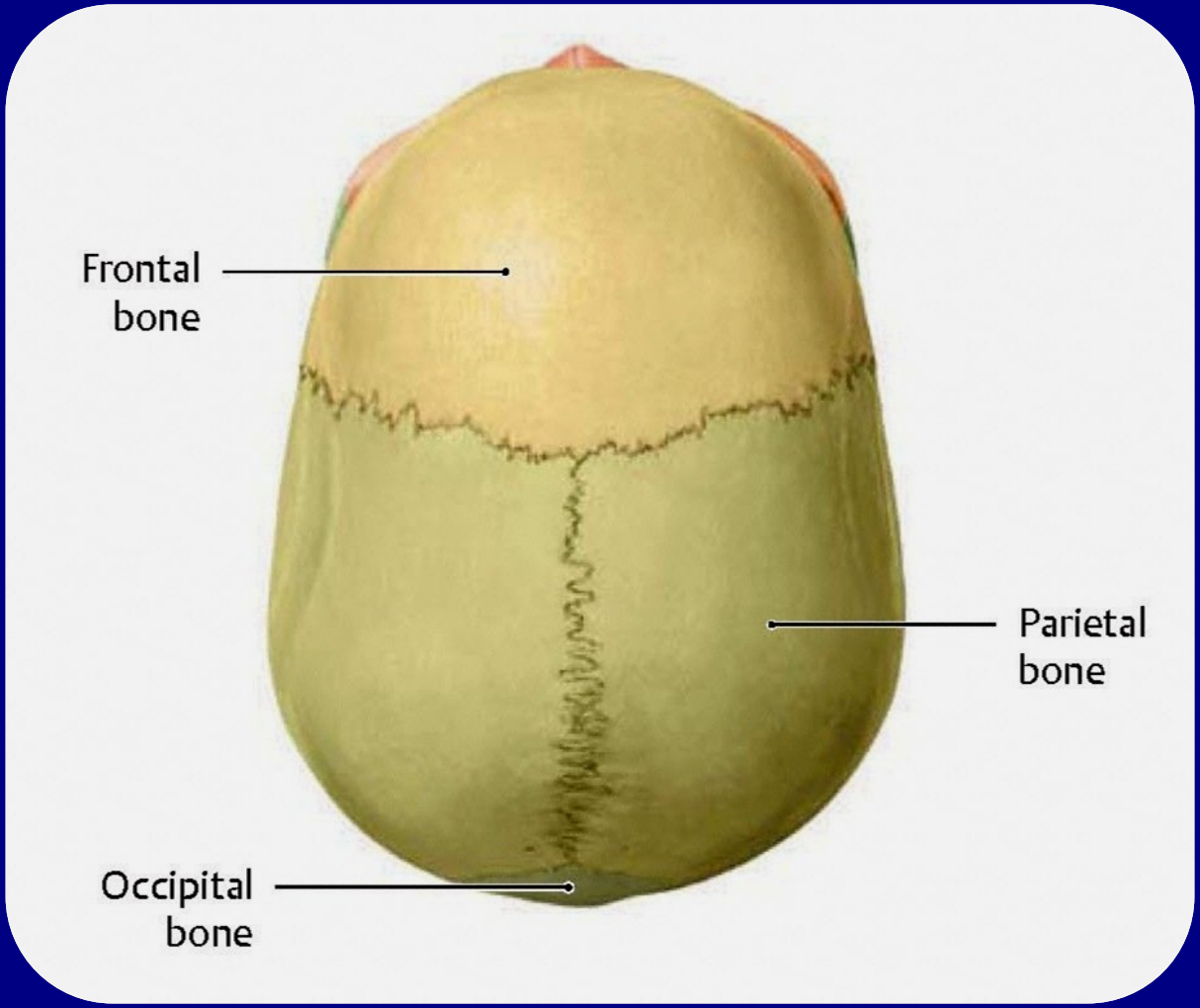
Suture	Age at ossification
Frontal suture	Childhood
Sagittal suture	20–30 years of age
Coronal suture	30–40 years of age
Lambdoid suture	40–50 years of age



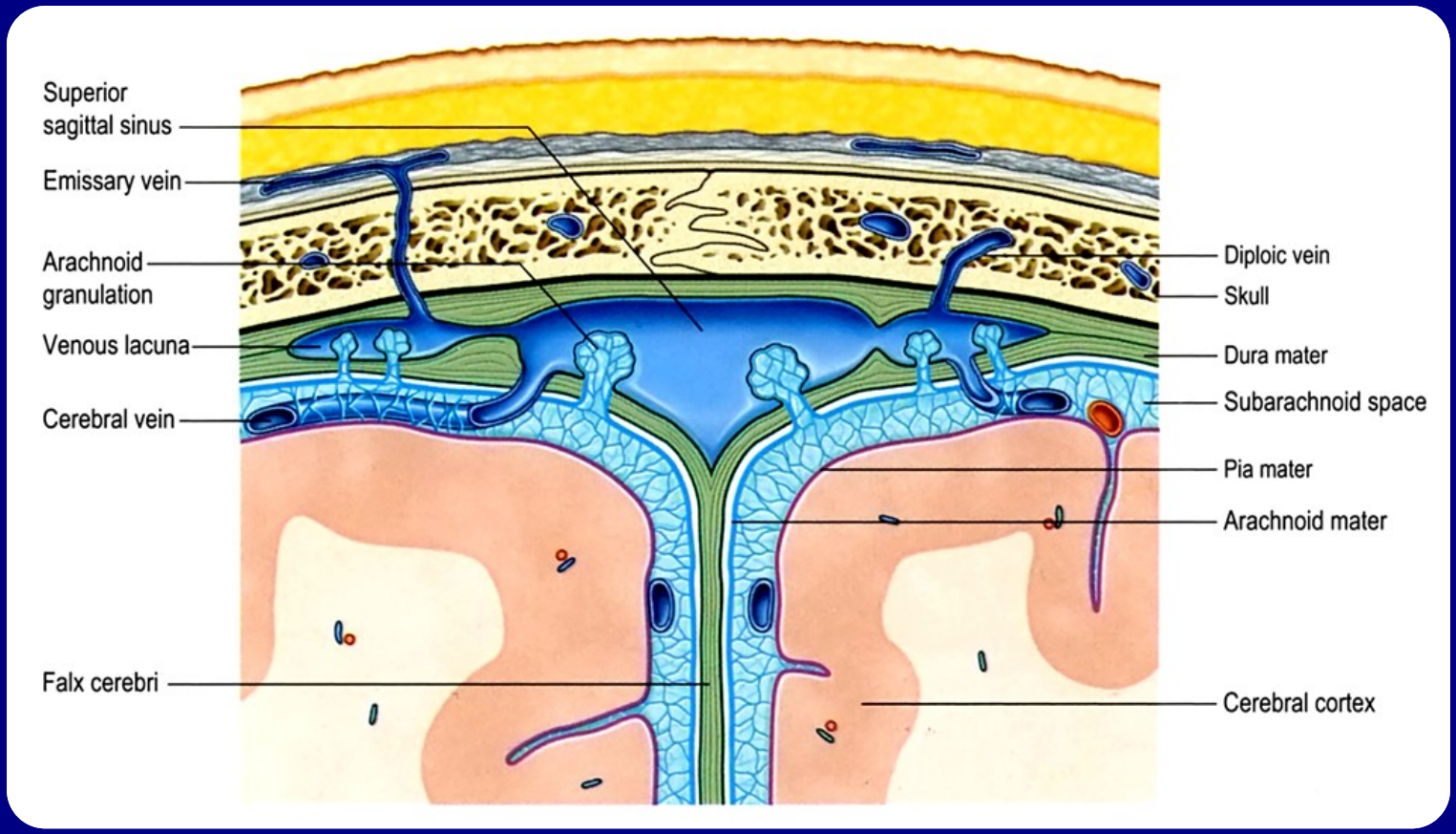
Exterior of the calvaria



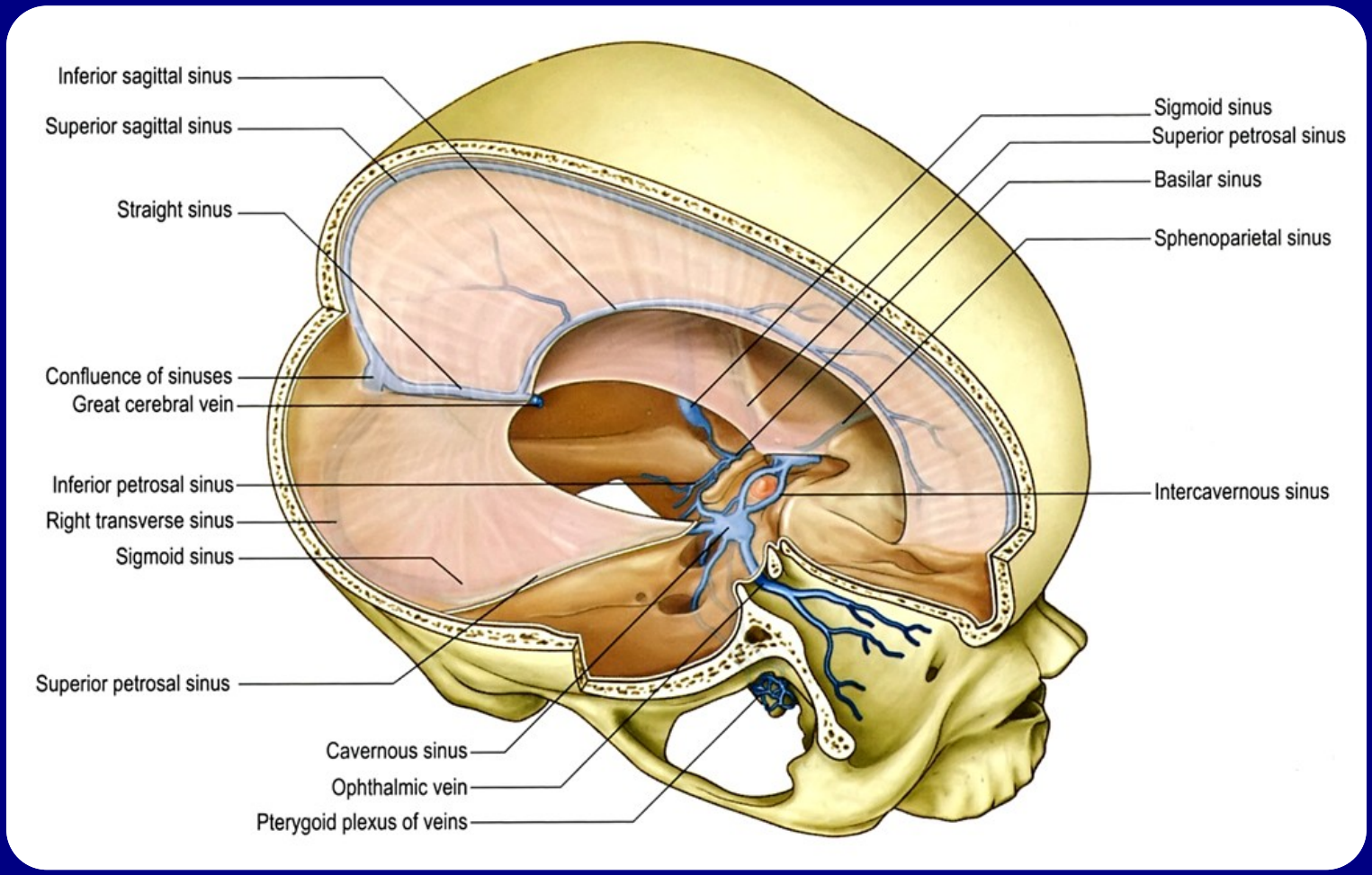
Interior of the calvaria



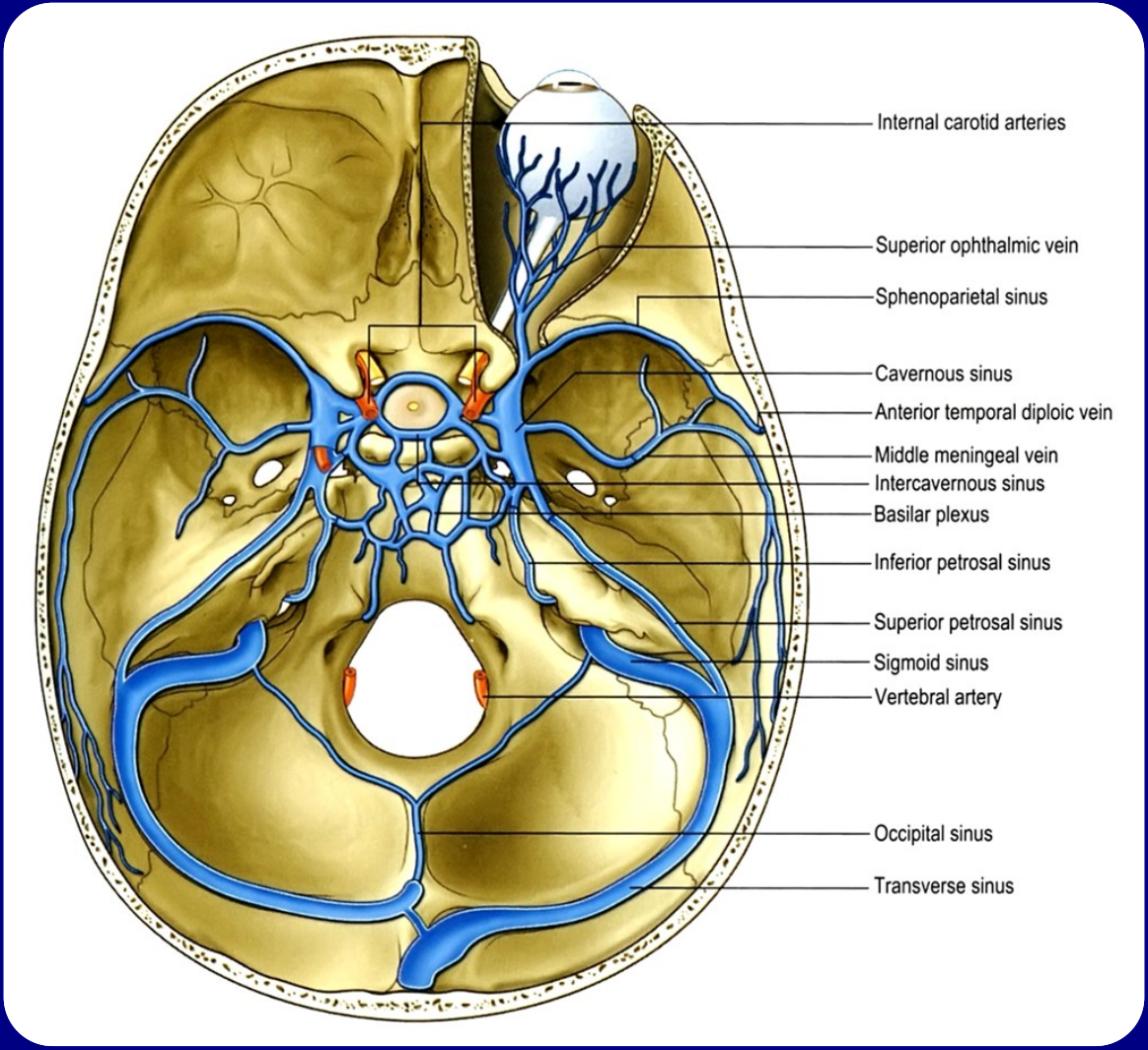
Exterior of the calvaria viewed from above



Coronal section through the vertex of the skull to show the relationships between the superior sagittal sinus, meninges and arachnoid granulations.

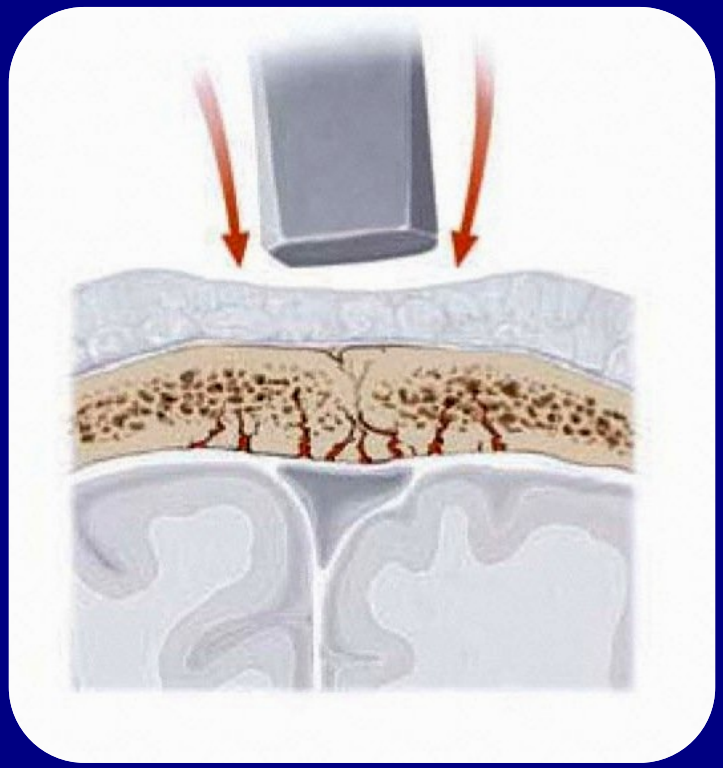


The cerebral dura mater, its reflections and associated major venous sinuses.

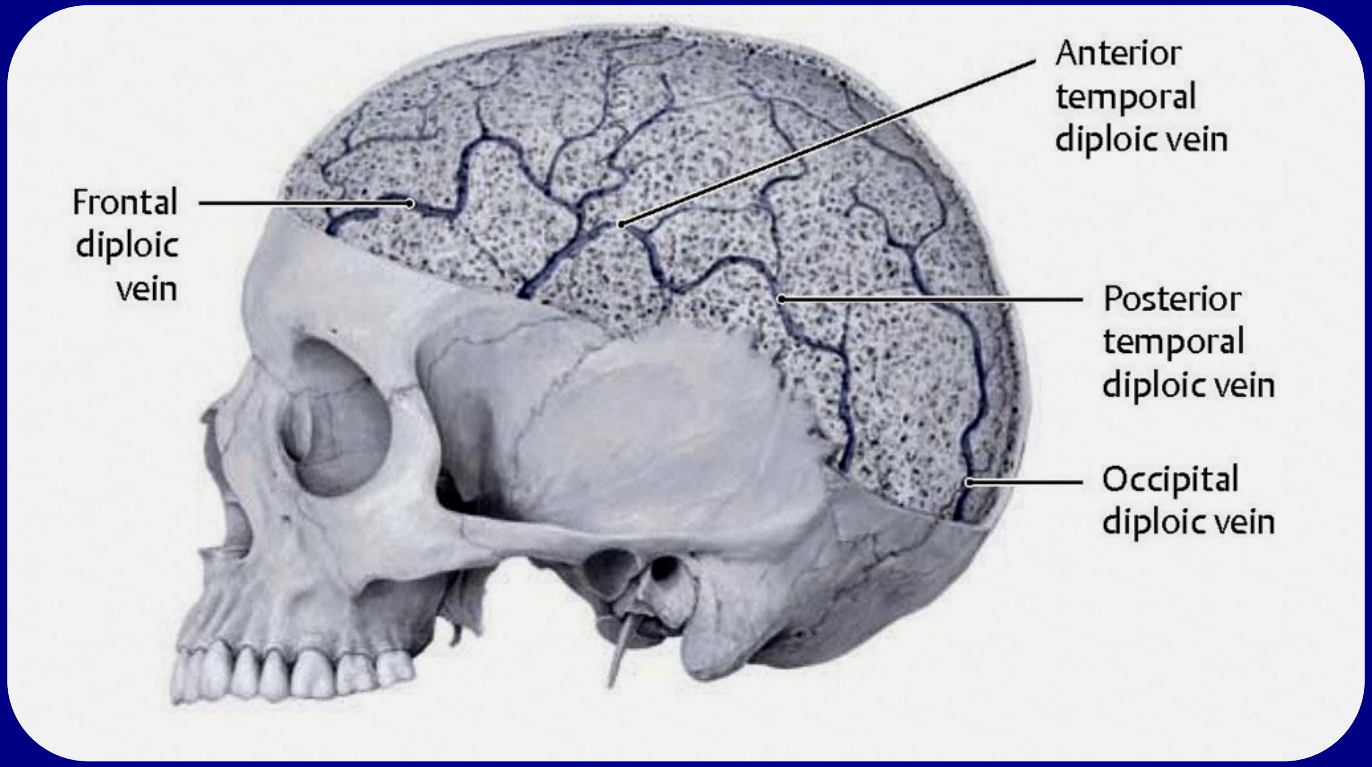


The major venous sinuses at the base of the skull.

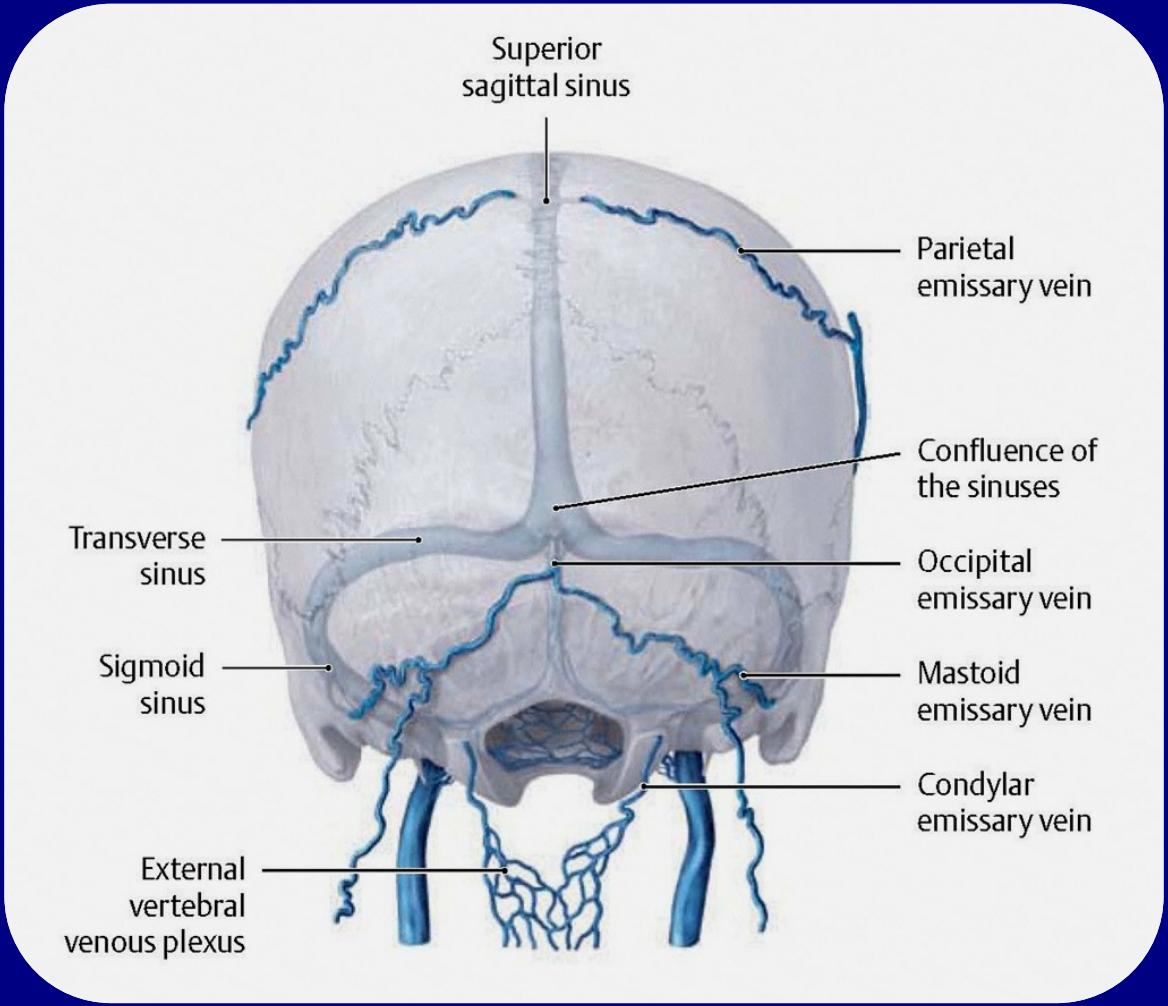
The sinuses coloured dark blue have been opened up.



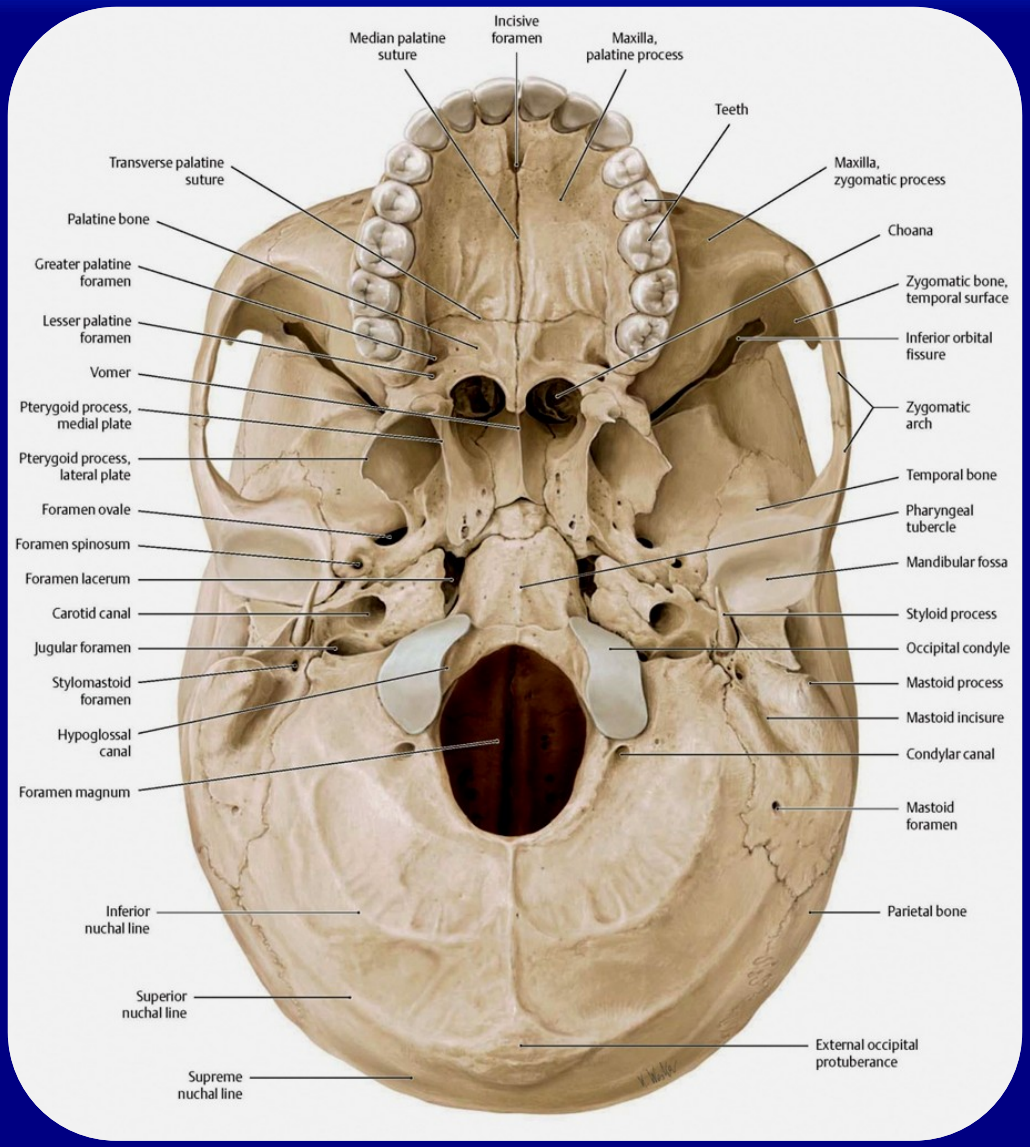
Sensitivity of the inner table to trauma



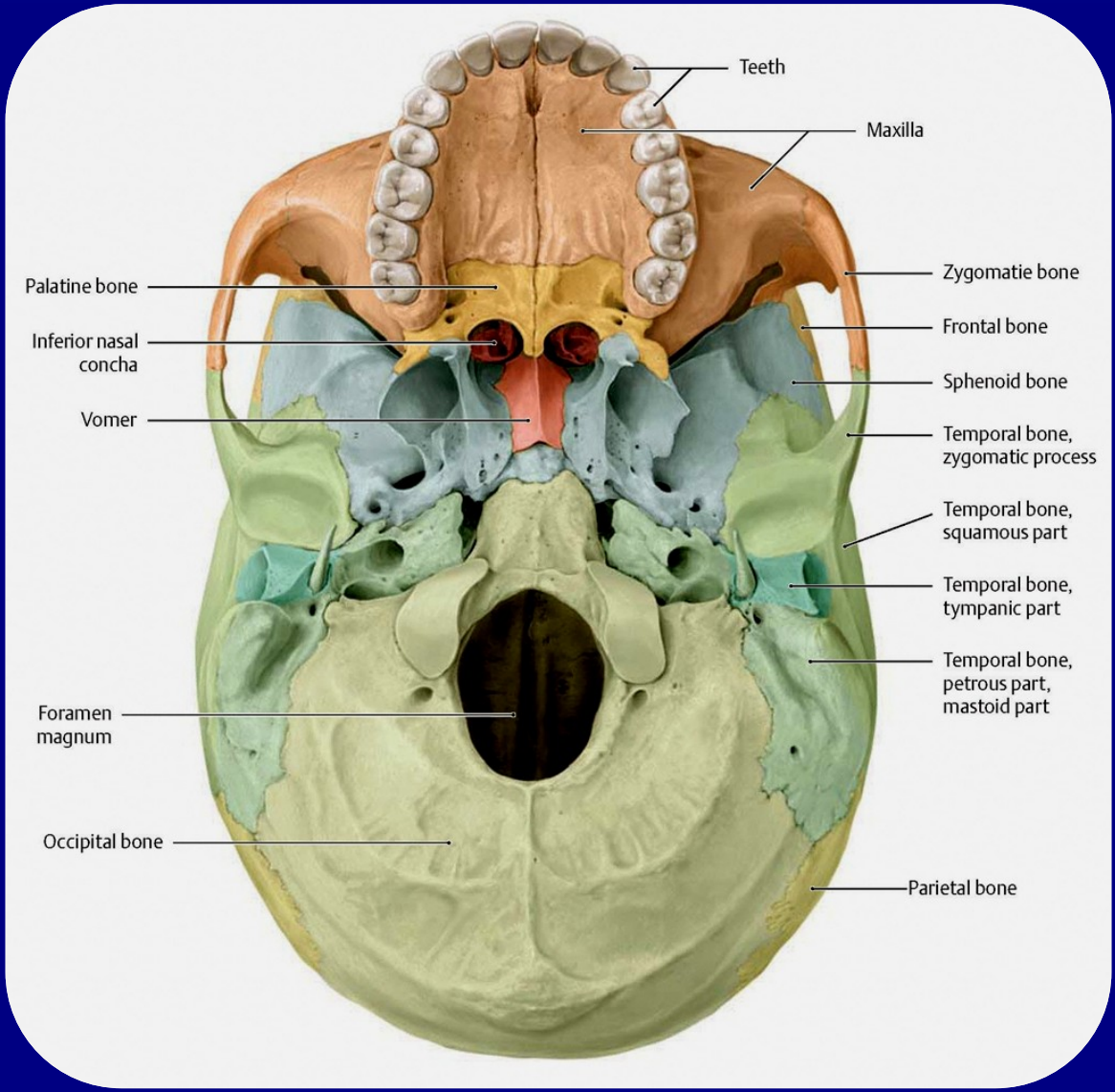
Diploic veins in the calvaria



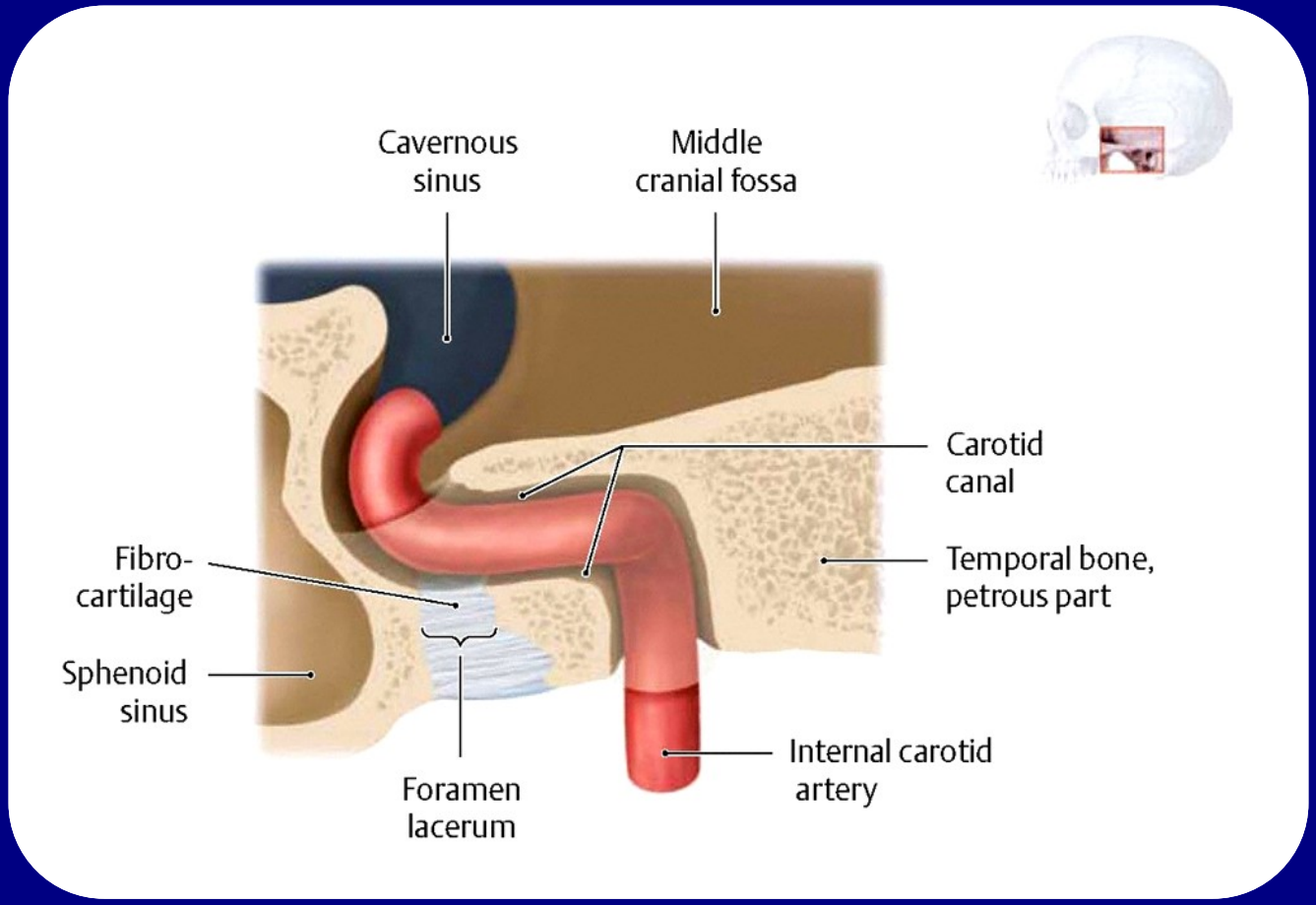
Emissary veins of the occiput



The basal aspect of the skull

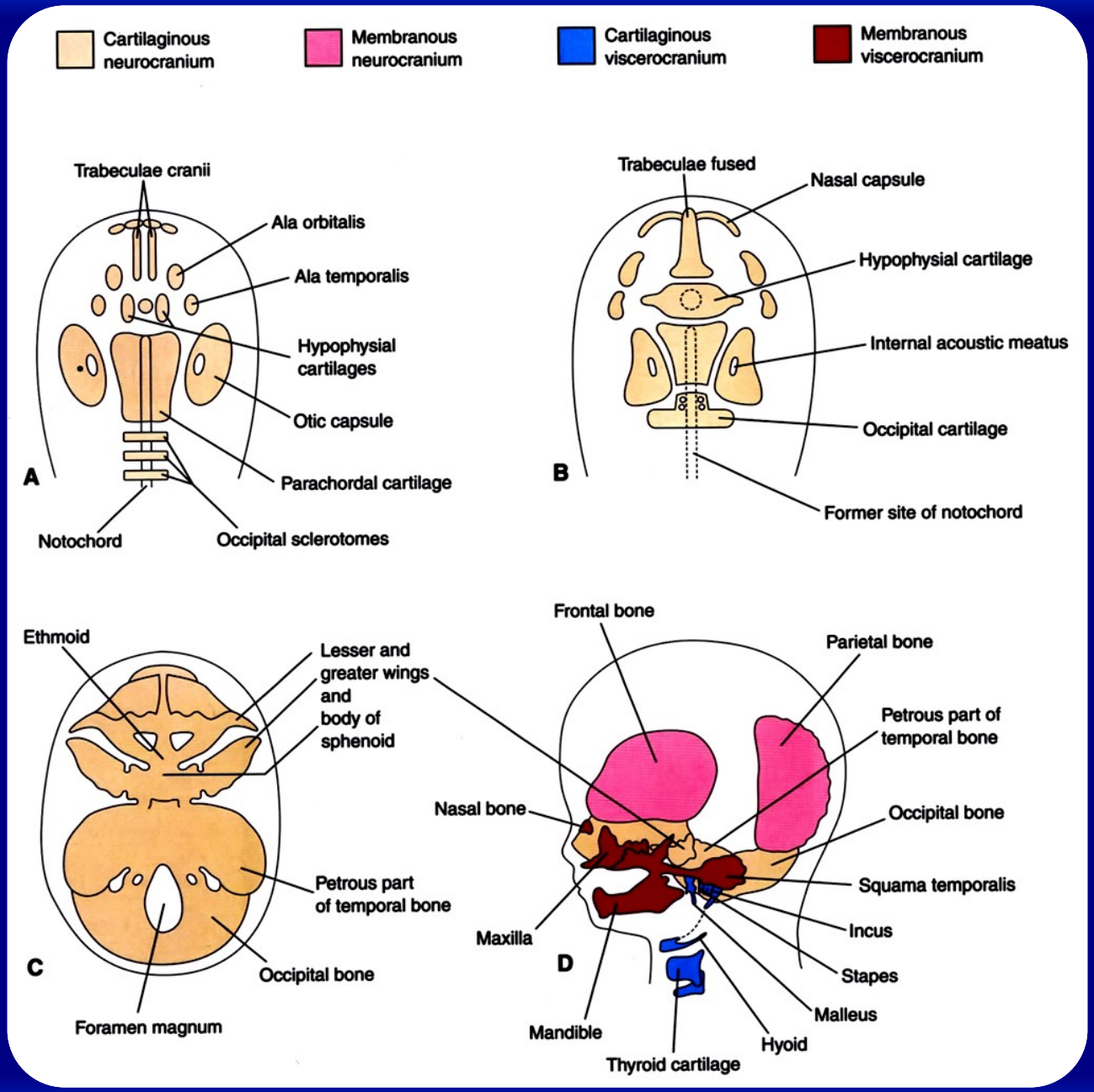


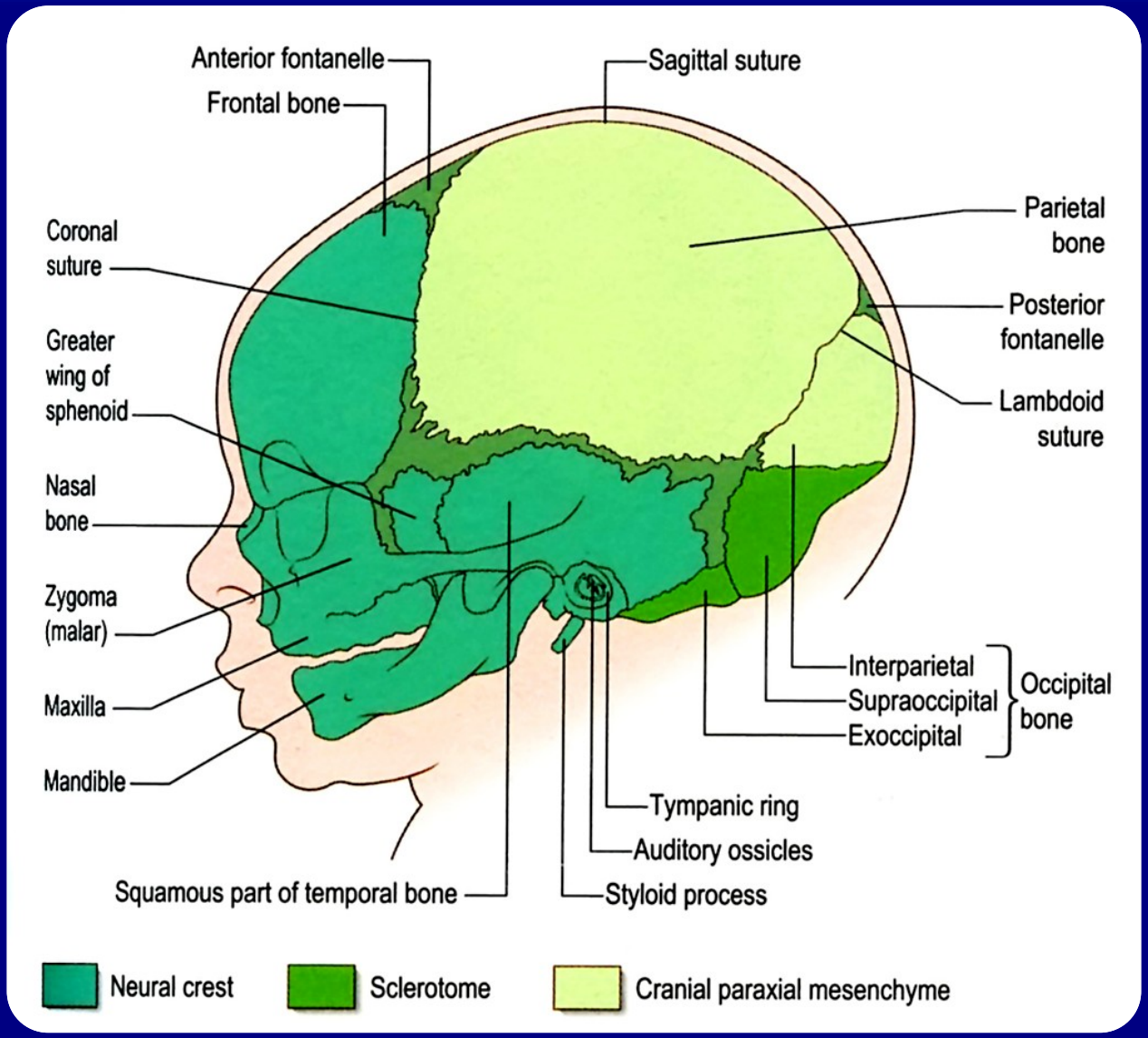
Bones of the base of the skull



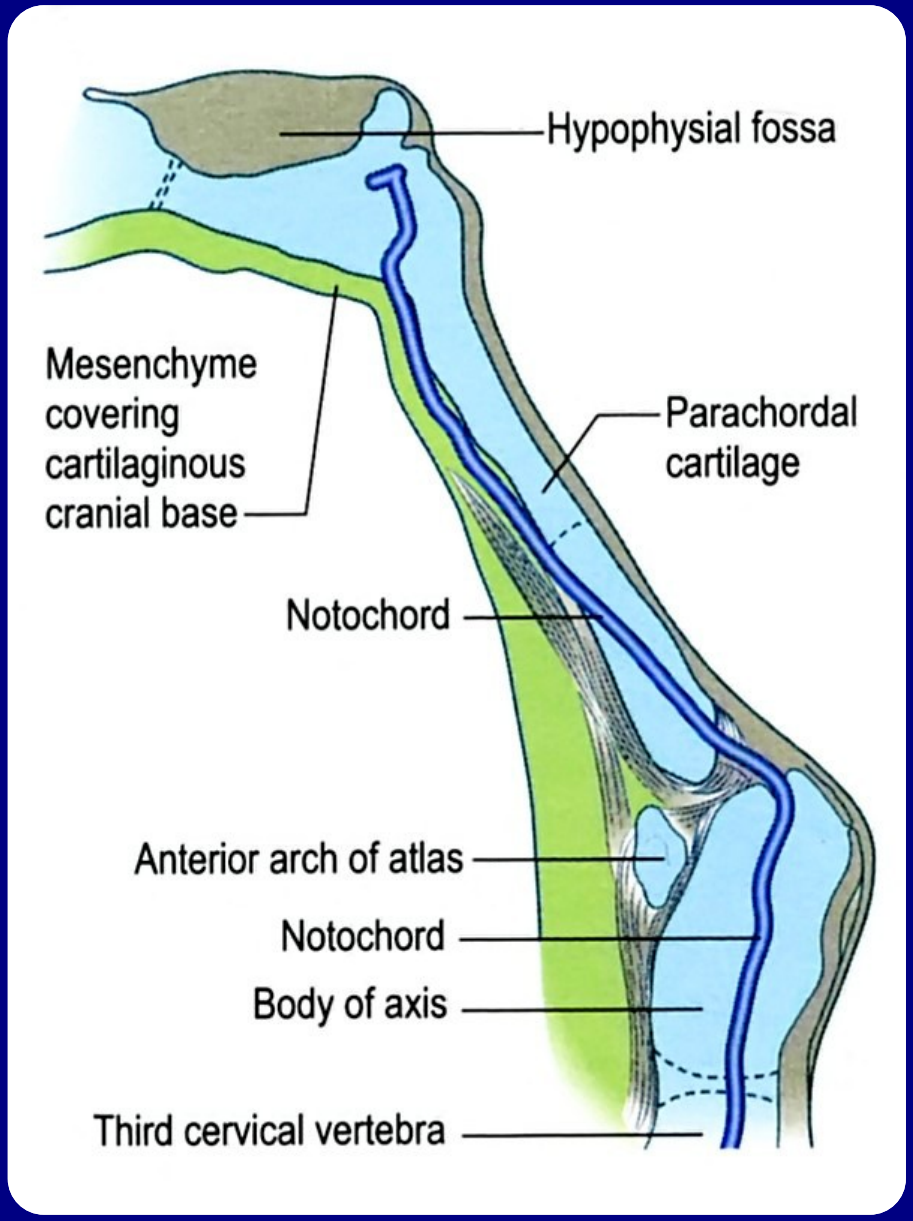
Relationship of the foramen lacerum to the carotid canal and internal carotid artery

SKULL DEVELOPMENT

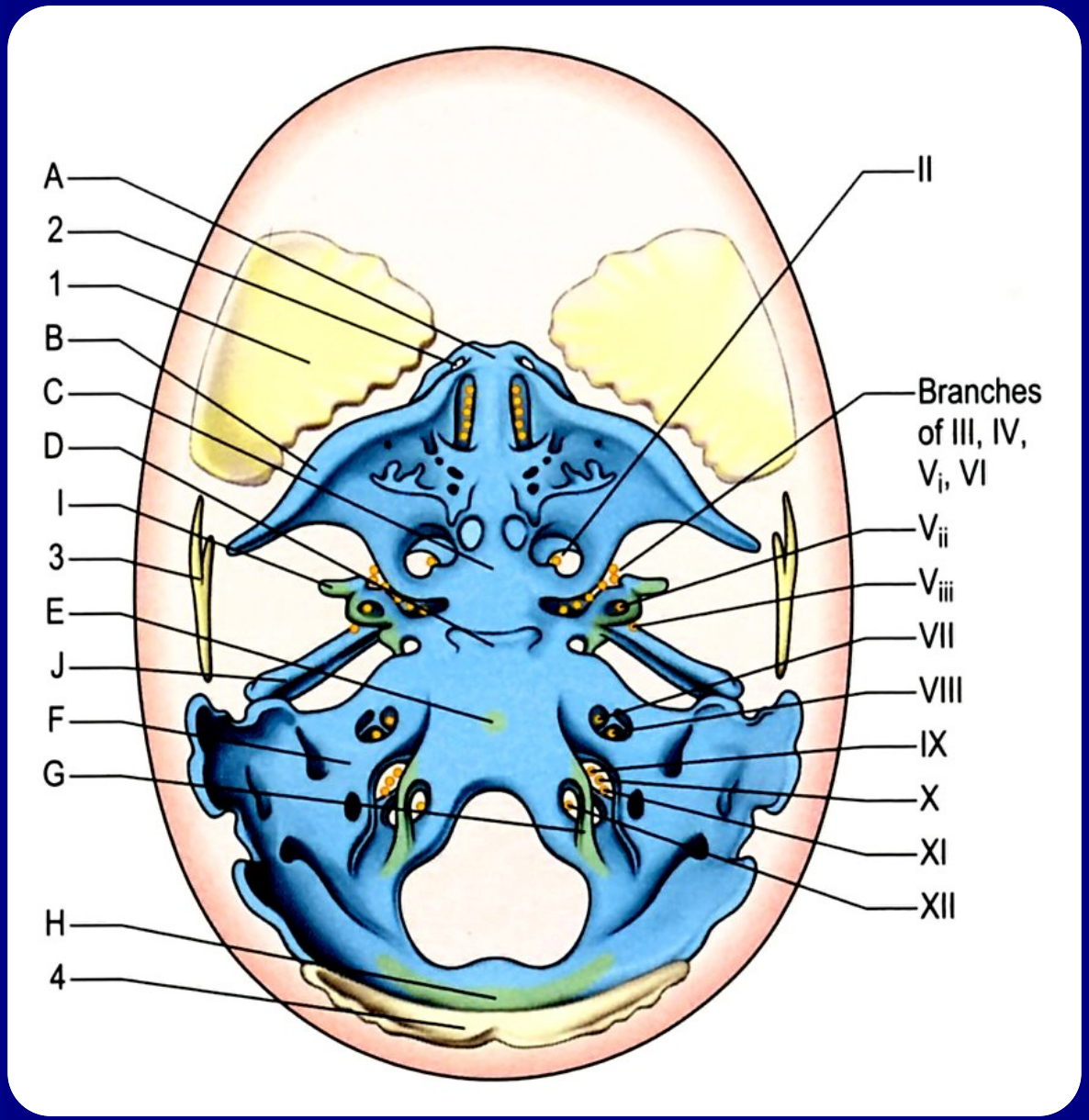

Cartilaginous neurocranium
Membranous neurocranium
Cartilaginous viscerocranium
Membranous viscerocranium
Trabeculae cranii
Ala orbitalis
Ala temporalis
Hypophysial cartilages
Otic capsule
Parachordal cartilage
Notochord
Occipital sclerotomes
A
Trabeculae fused
Nasal capsule
Hypophysial cartilage
Internal acoustic meatus
Occipital cartilage
Former site of notochord
B
Ethmoid
Lesser and greater wings and body of sphenoid
Petrous part of temporal bone
Occipital bone
Foramen magnum
C
Frontal bone
Parietal bone
Petrous part of temporal bone
Nasal bone
Occipital bone
Squama temporalis
Maxilla
Incus
Stapes
Malleus
Mandible
Hyoid
Thyroid cartilage
D



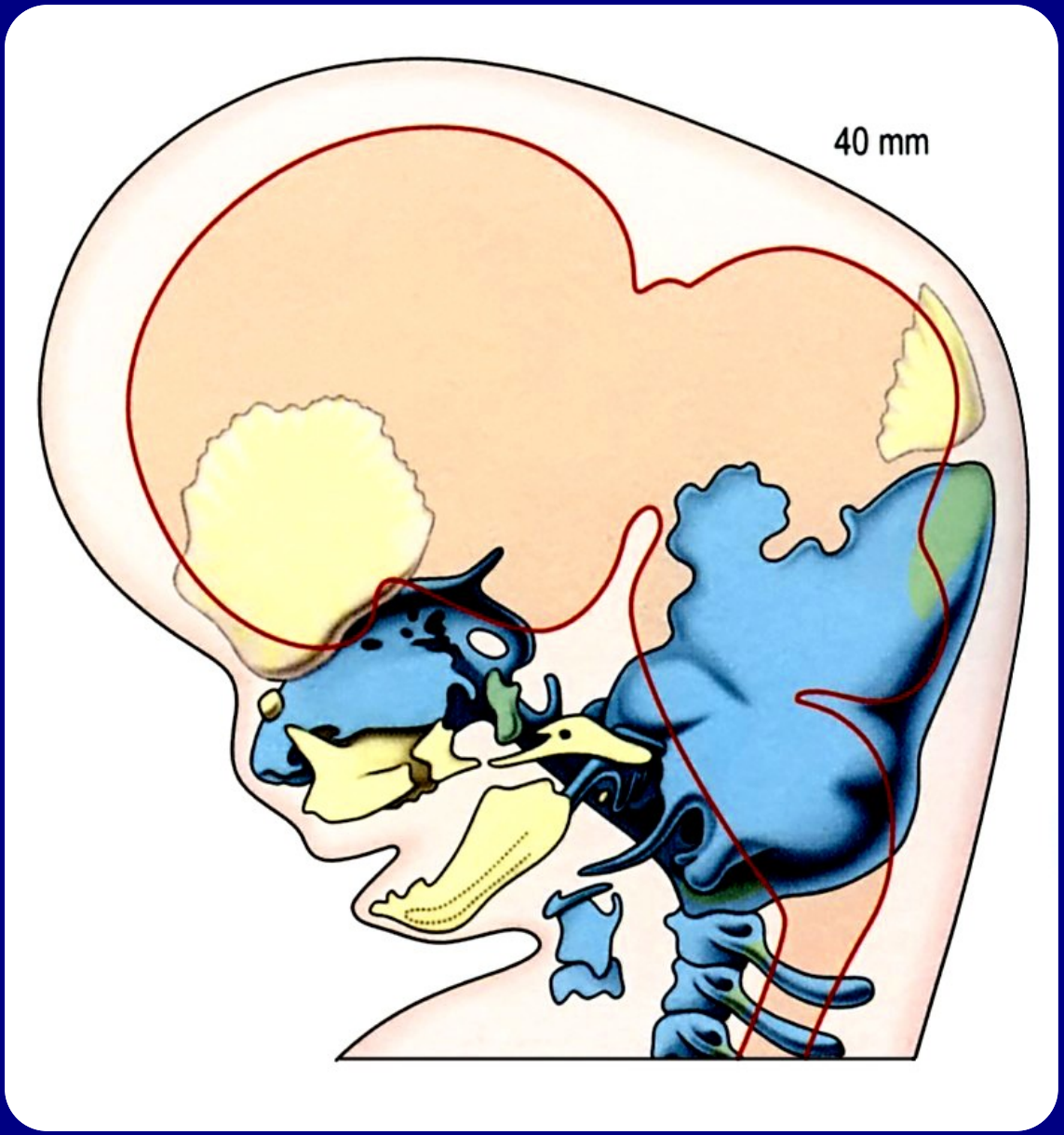
Newborn skull, showing tissue origins of the bones (based on combined mouse and human data).



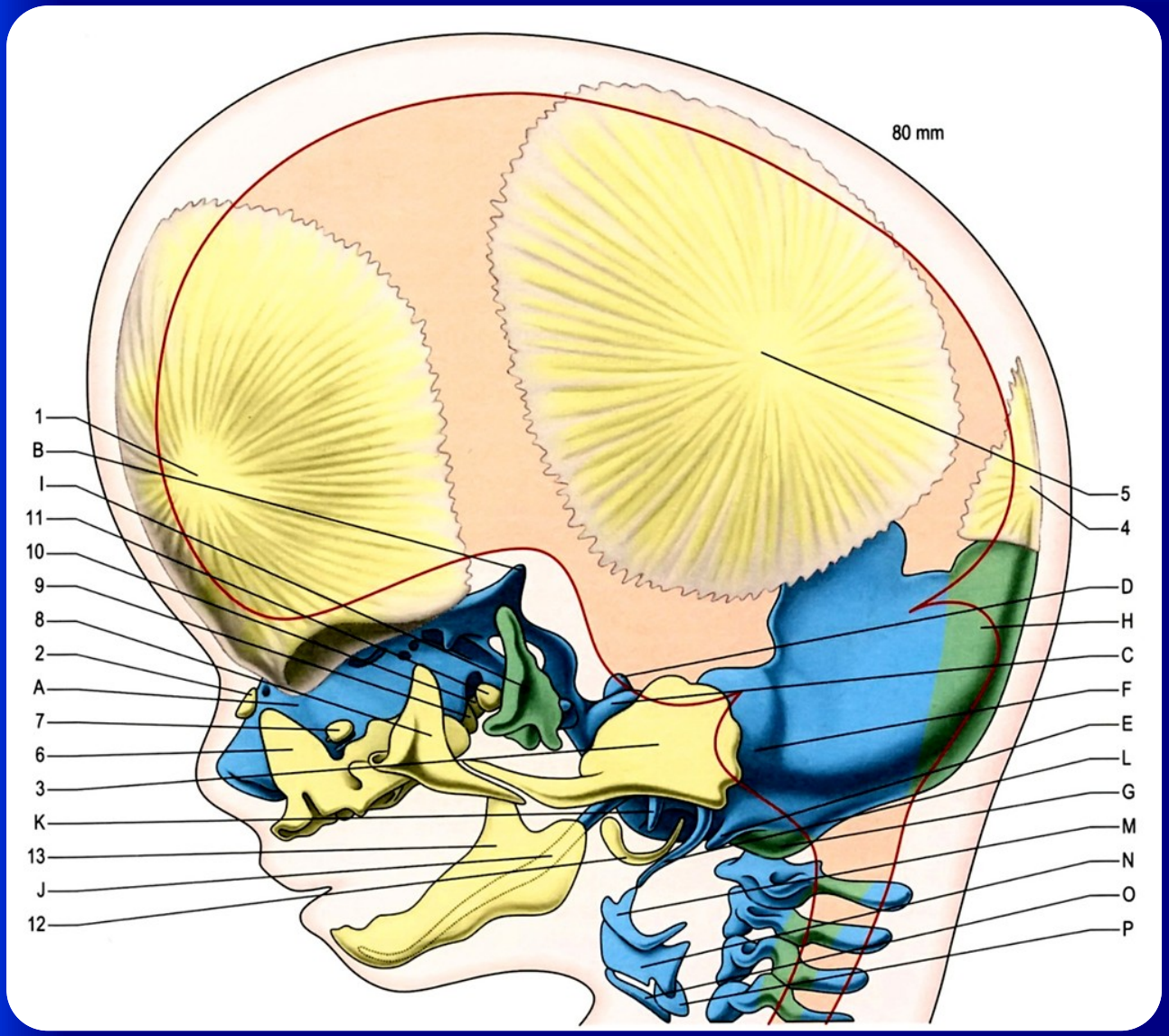
Sagittal section through the cranial end of the developing axial skeleton in an early human embryo of approximately 10 mm, showing the extent of the notochord.



Superior aspect of cranium of human embryo at 40 mm.



Lateral aspect of cranium of human embryo at 40 mm.



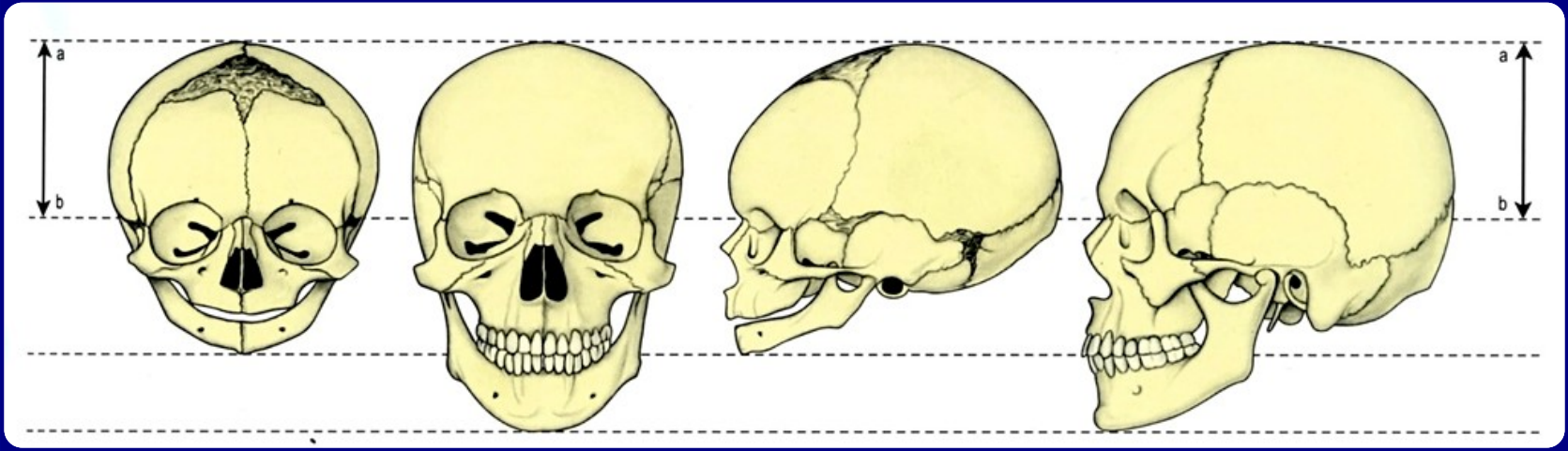
Key to chondral elements

A	Nasal capsule
B	Orbitosphenoid
C	Presphenoid
D	Postsphenoid
E	Basi-occipital
F	Otic capsule
G	Exoccipital
H	Supra-occipital
I	Alisphenoid
J	Meckel's mandibular cartilage
K	Cartilage of malleus
L	Styloid cartilage
M	Hyoid cartilage
N	Thyroid cartilage
O	Cricoid cartilage
P	Arytenoid cartilage

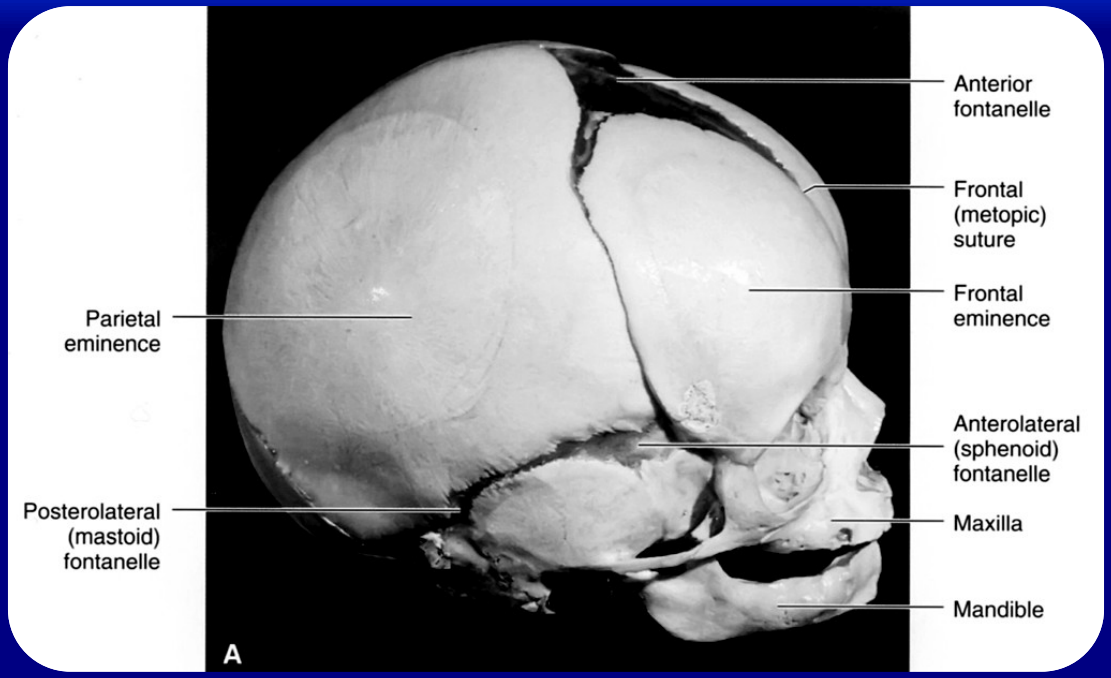
Key to dermal (membrane) elements

1	Frontal bone
2	Nasal bone
3	Squama of temporal bone
4	Squama of occipital bone (interparietal)
5	Parietal bone
6	Maxilla
7	Lacrimal bone
8	Zygomatic bone
9	Palatine bone
10	Vomer
11	Medial pterygoid plate
12	Tympanic ring
13	Mandible

Lateral aspect of cranium of human embryo at 80 mm.



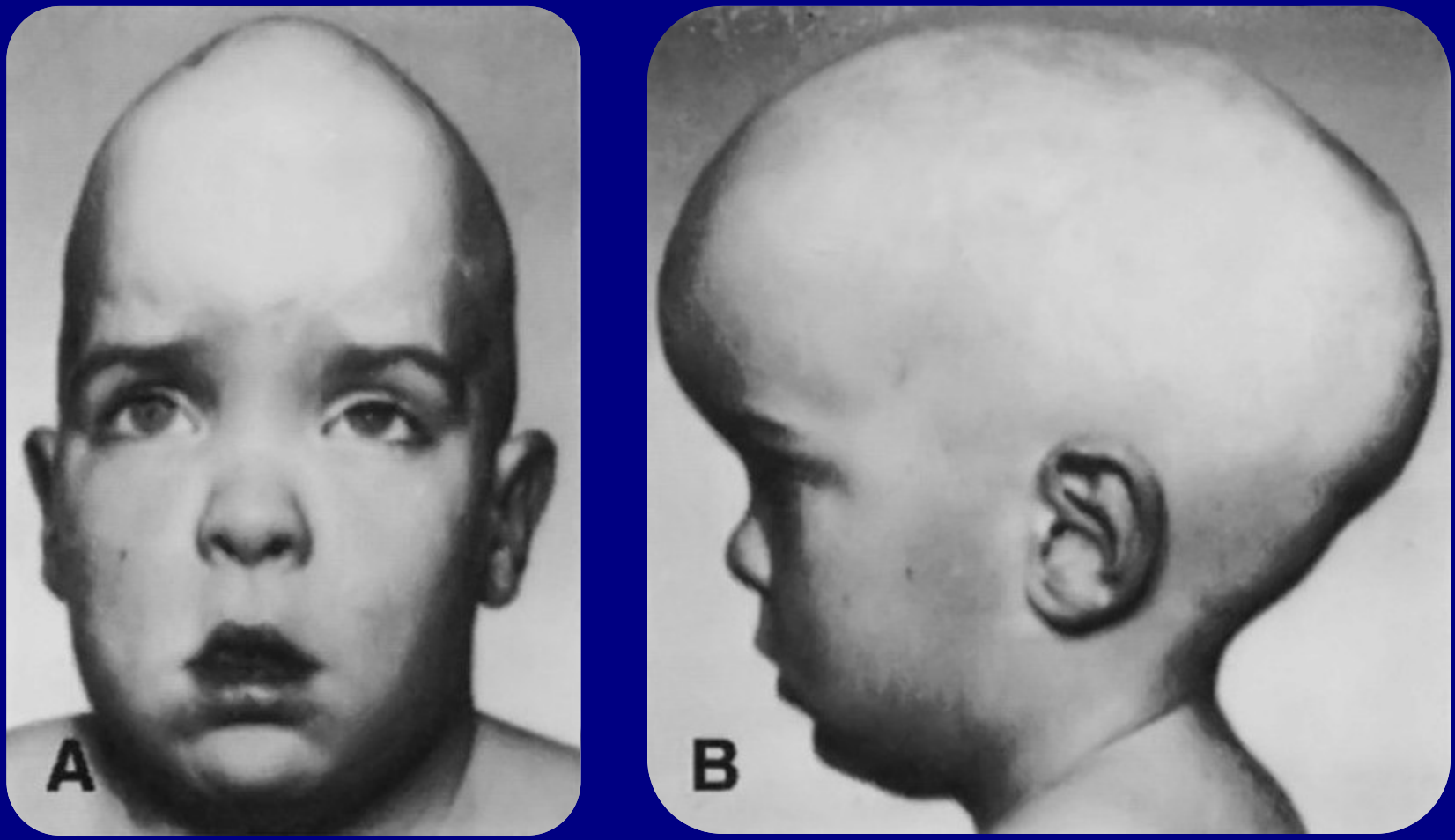
Much of the postnatal growth of the skull is concerned with development of the viscerocranium. This diagram shows that with the height of the cranial vault expressed as similar in newborn and adult skulls (lines a↔b), the facial skeleton increases particularly during childhood and puberty.


Anterior fontanelle
Frontal (metopic) suture
Frontal eminence
Parietal eminence
Anterolateral (sphenoid) fontanelle
Posterolateral (mastoid) fontanelle
Maxilla
Mandible
A

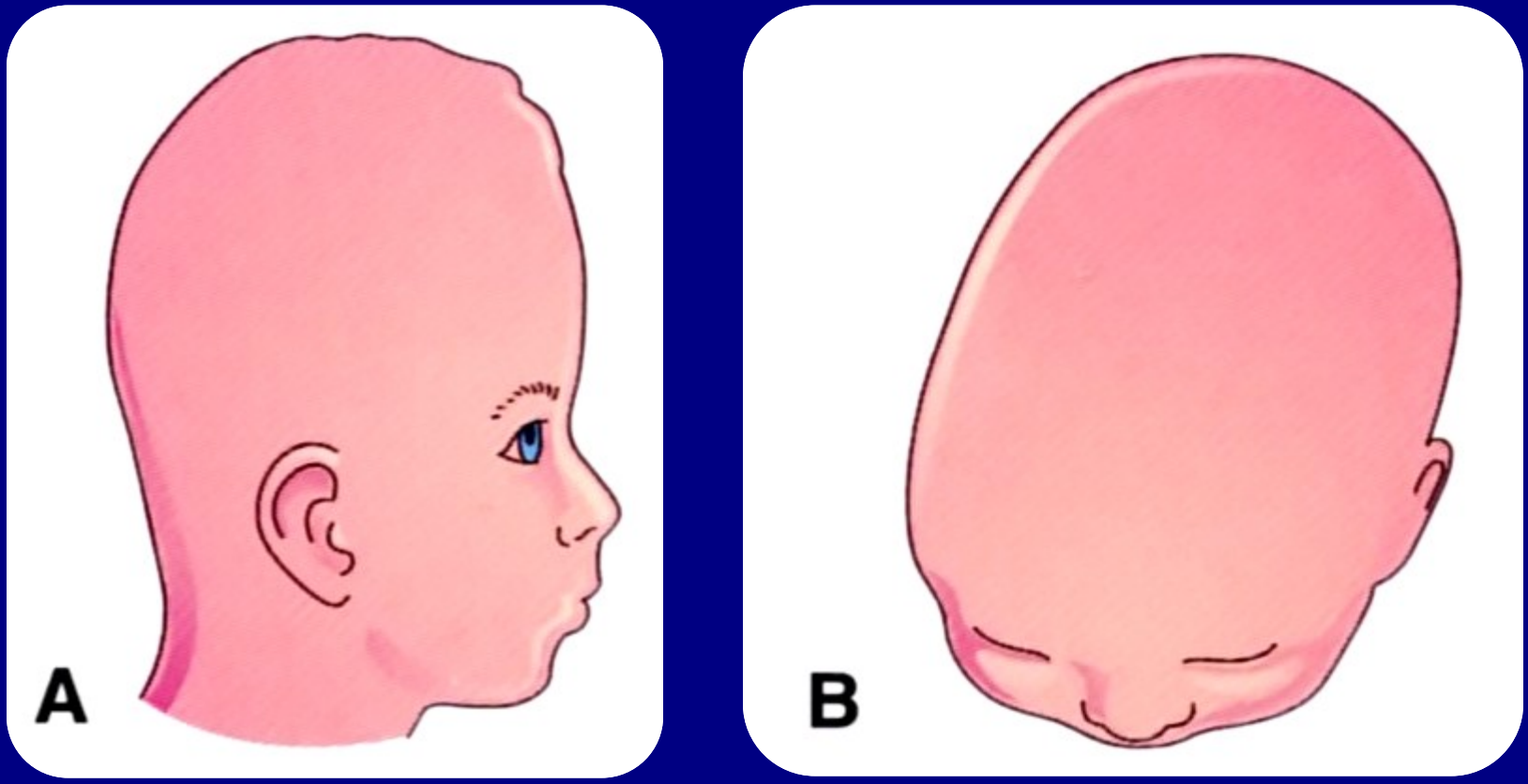

Sagittal suture
Lambdoid suture
Occipital bone
Posterior fontanelle
Frontal bone
Anterior fontanelle
Coronal suture
B


A


B



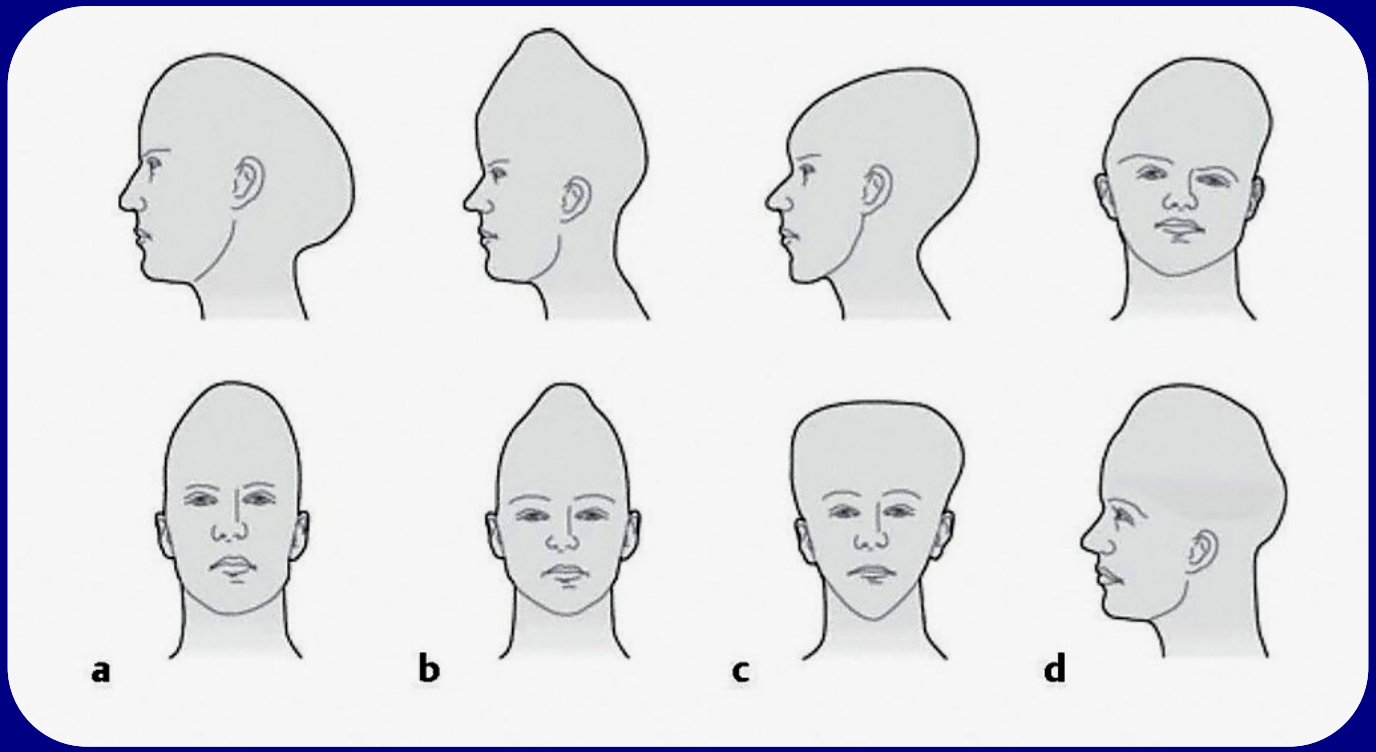
A. and B. Photographs of a boy with a long, wedge-shaped skull (scaphocephaly) resulting from craniosynostosis – premature closure of the sagittal suture.



Drawings illustrating skull anomalies.

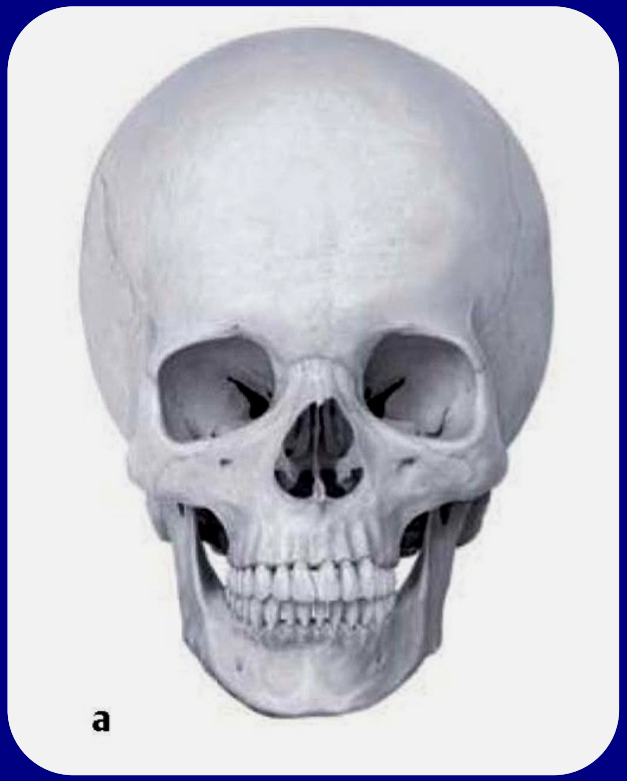
A. Oxycephaly (turricephaly), showing the towerlike skull resulting from premature closure of the coronal suture.

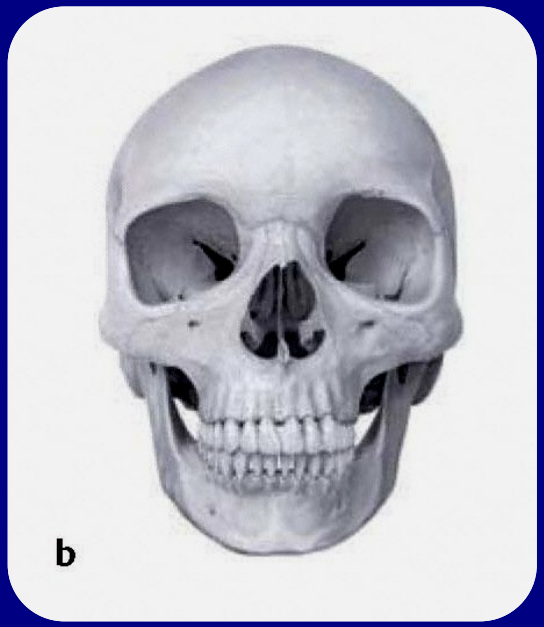
B. Plagiocephaly, illustrating an asymmetrical skull resulting from premature closure of the coronal and lambdoid sutures on the left side.



Cranial deformities due to the premature closure of cranial sutures

a. Sagittal suture: scaphocephaly (long, narrow skull).
b. Coronal suture: oxycephaly (pointed skull).
c. Frontal suture: trigonocephaly (triangular skull).
d. Asymmetrical suture closure, usually involving the coronal suture: plagiocephaly (asymmetrical skull).





Hydrocephalus and microcephaly

Mesodermal cells

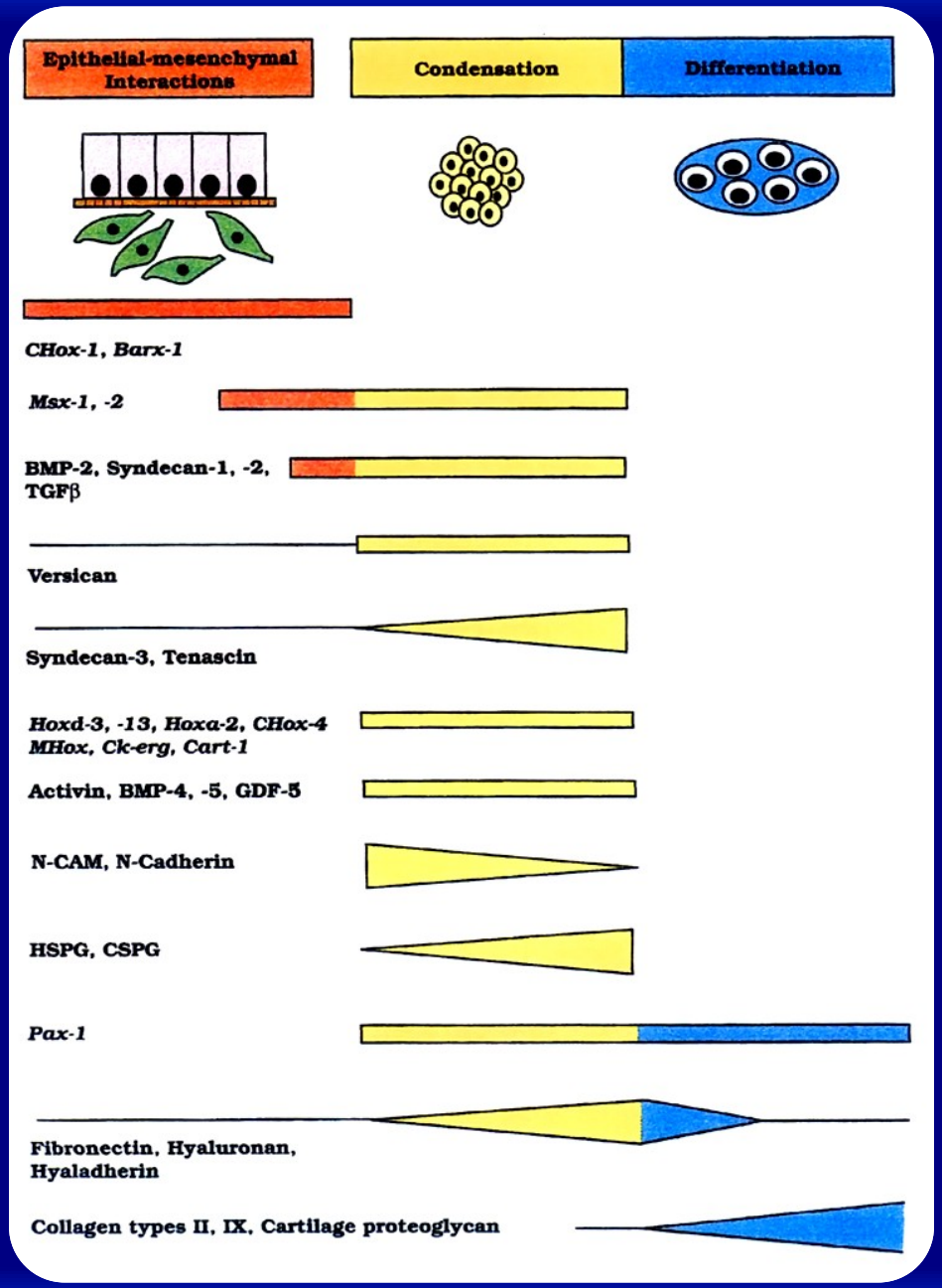
mesenchyme – embryonic connective tissue

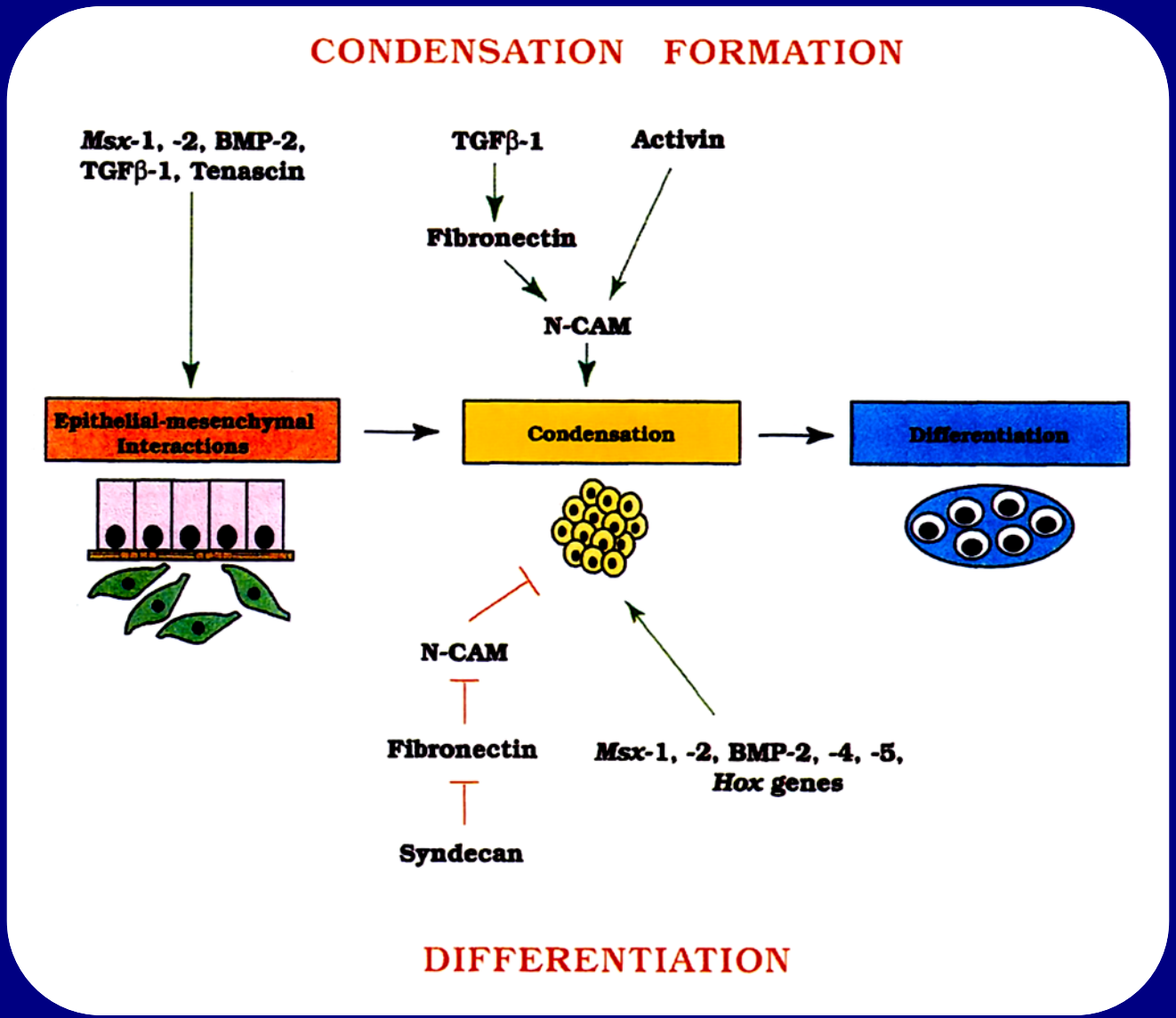
Neural crest cells

migrate into the pharyngeal arches

(bones and connective tissue of craniofacial structures)

Homeobox (Hox) genes regulate the migration and subsequent differentiation pf the neural crest cells, which are crucial for the complex patterning of the head and face.


Epithelial-mesenchymal Interactions
Condensation
Differentiation
CHox-1, Barx-1
Msx-1, -2
BMP-2, Syndecan-1, -2, TGFβ
Versican
Syndecan-3, Tenascin
Hoxd-3, -13, Hoxa-2, CHox-4 MHox, Ck-erg, Cart-1
Activin, BMP-4, -5, GDF-5
N-CAM, N-Cadherin
HSPG, CSPG
Pax-1
Fibronectin, Hyaluronan, Hyaladherin
Collagen types II, IX, Cartilage proteoglycan


CONDENSATION FORMATION
Msx-1, -2, BMP-2,
TGFβ-1, Tenascin
TGFβ-1
Activin
Fibronectin
N-CAM
Epithelial-mesenchymal Interactions
Condensation
Differentiation
N-CAM
Fibronectin
Syndecan
Msx-1, -2, BMP-2, -4, -5,
Hox genes
DIFFERENTIATION