Neural Canal Ridges: A Novel Osteological Correlate of Post-Cranial Neurology in Dinosaurs

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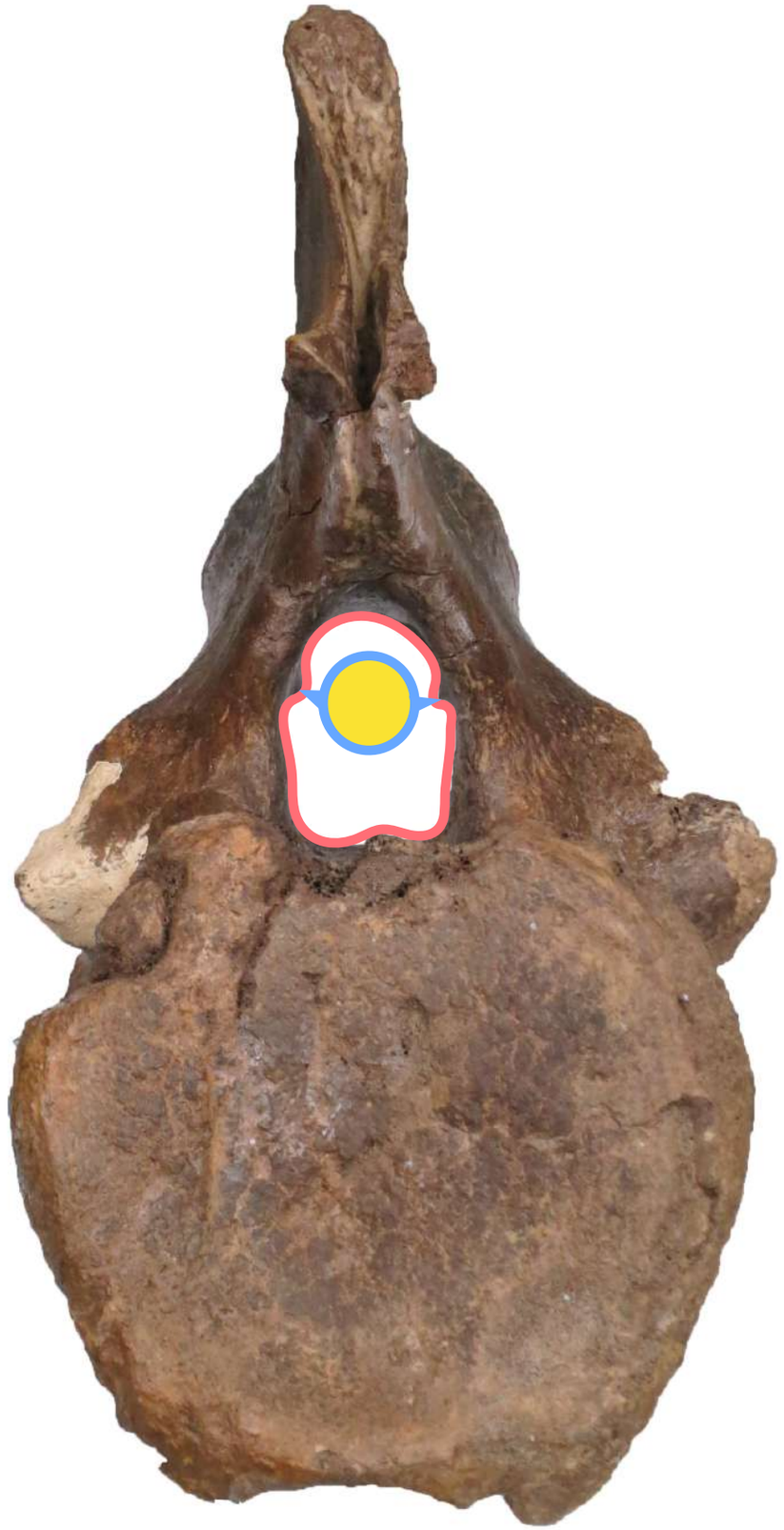

Acknowledgments

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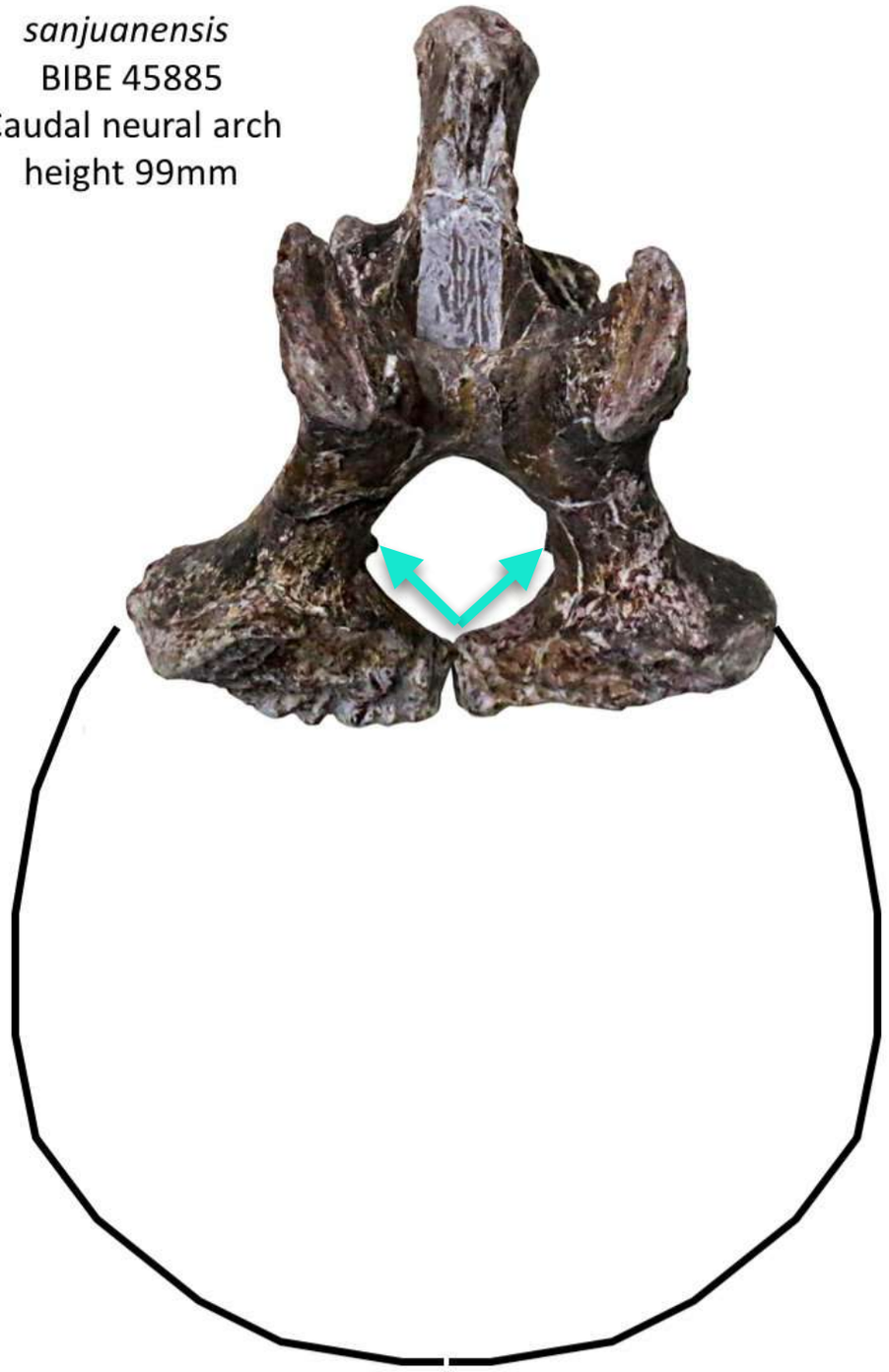
— CT scanning and digital reconstruction: John Yasmer and Thierra Nalley at Western University of Health Sciences.

— Literature and discussion: David Wake and Marvalee Wake at UC Berkeley, Vicki Wedel at Western University of Health Sciences, and Anne Weil at OSU-Tulsa Health Sciences Center.

Previous Work

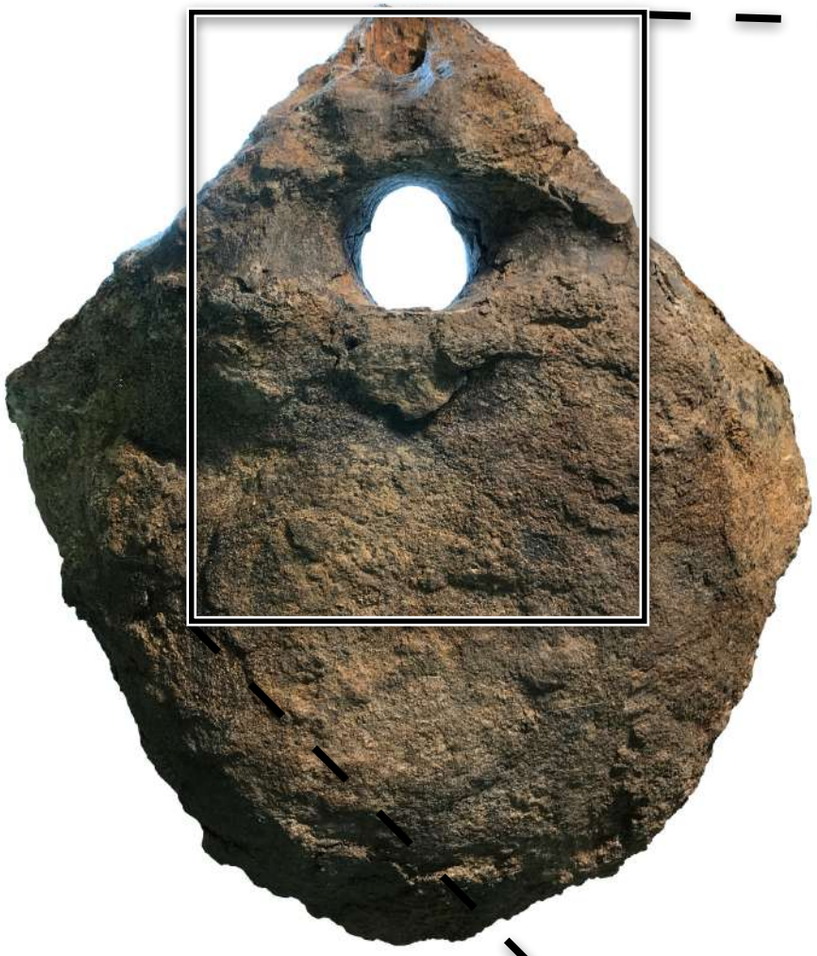
Alamosaurus sanjuanensis
BIBE 45885
Caudal neural arch
height 99mm



Astrophocaudia slaughteri
SMU 61732
Caudal 14
height 198mm

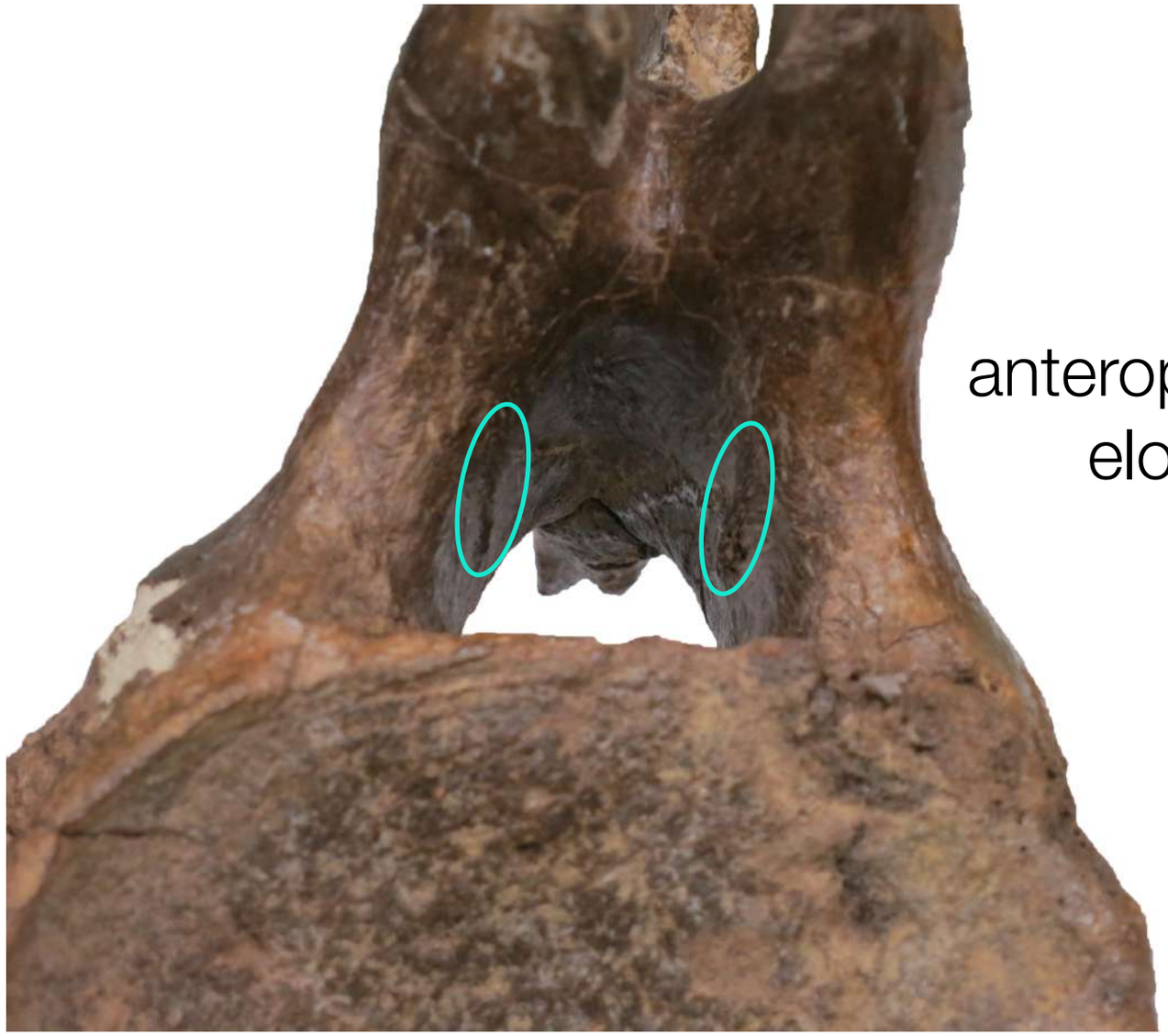
Matt Wedel — SVPCA 2014

Neural Canal Ridges in Sauropods



Apatosaurus
caudal vertebra

Neural Canal Ridges in Sauropods



Astrophocaudia
caudal vertebra

anteroposteriorly elongate

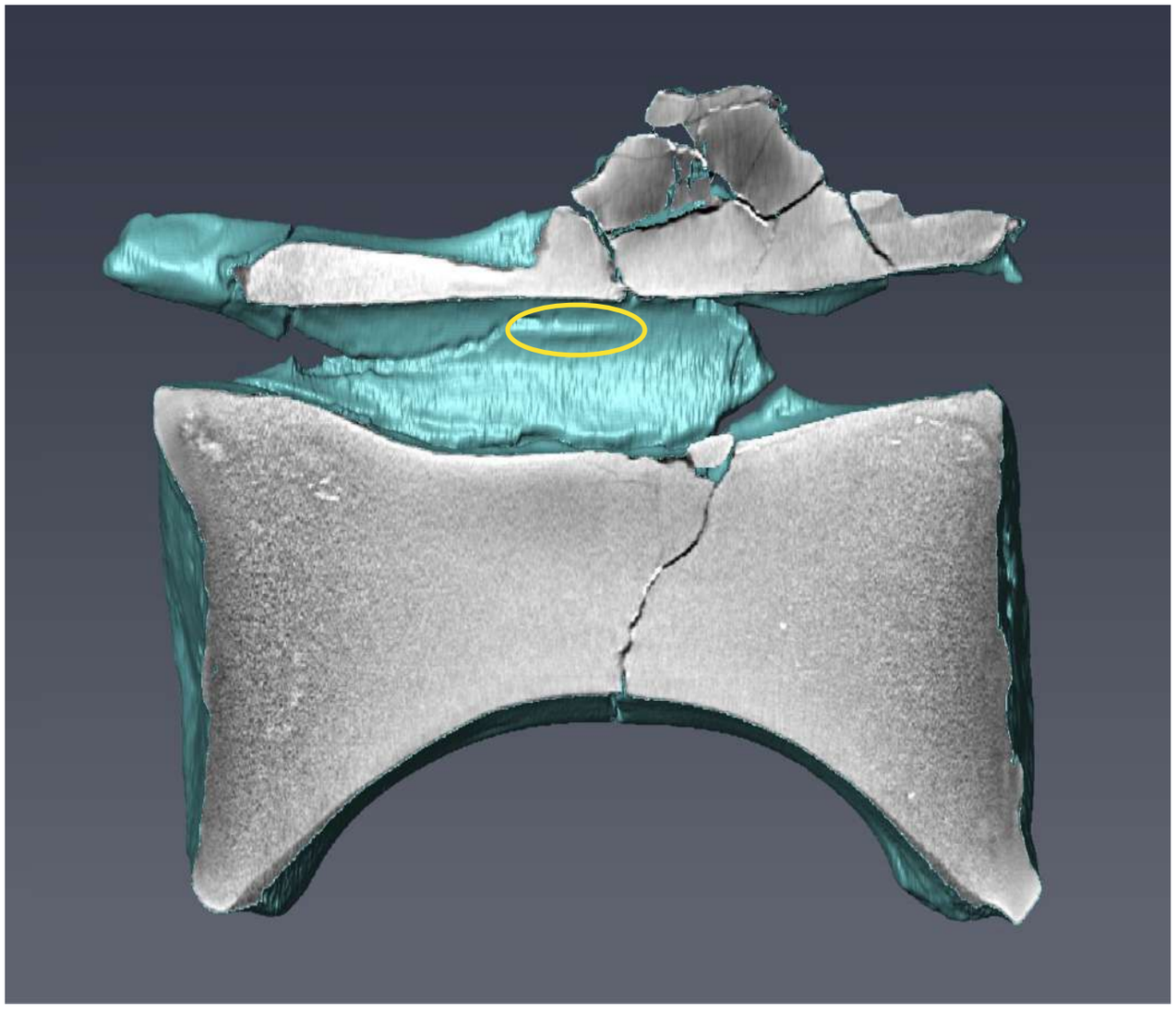
Neural Canal Ridges in Sauropods

ridges do not
extend to
ends of canal

Camarasaurus
caudal vertebra

Neural Canal Ridges in Sauropods

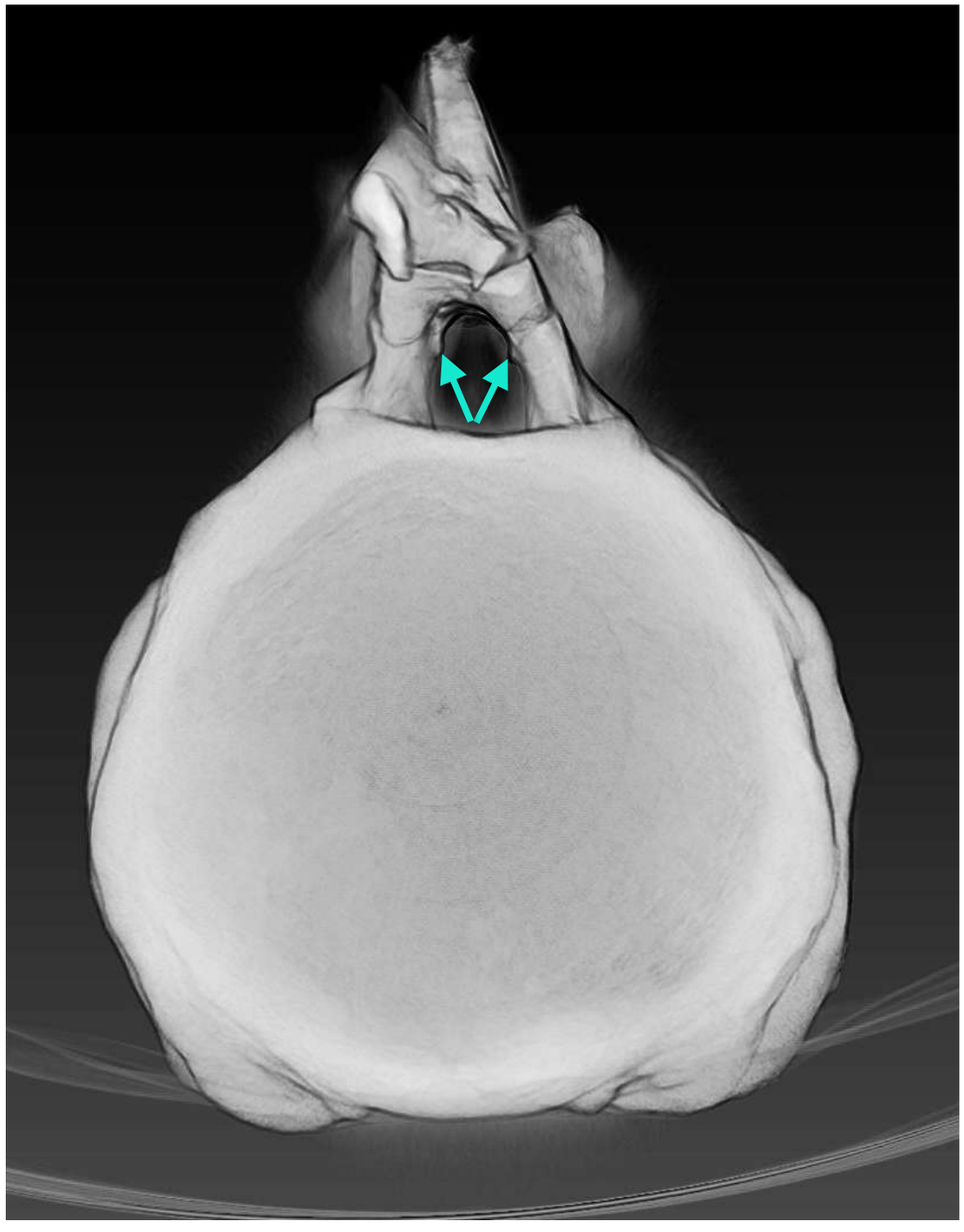
size and position is variable



virtual sagittal section

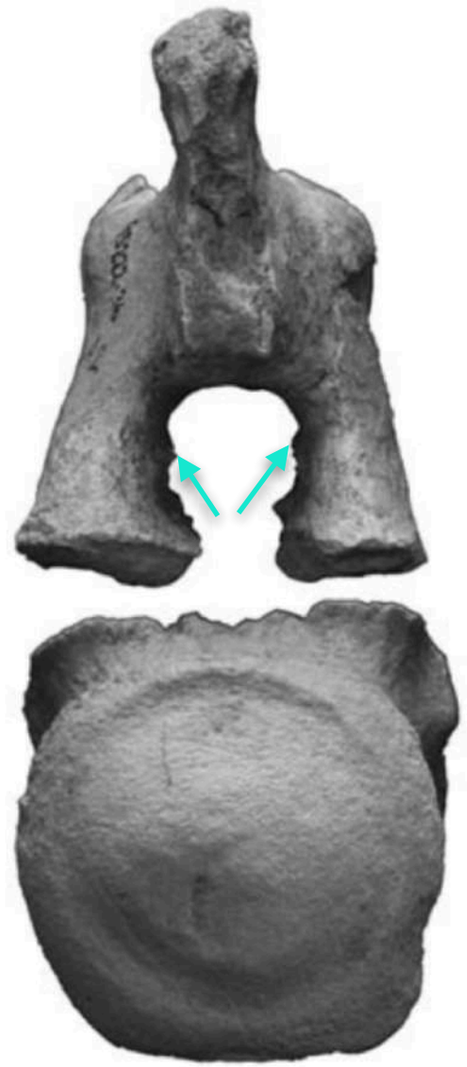
Diplodocus

caudal vertebra



Previous Work

Rapetosaurus
distal caudal

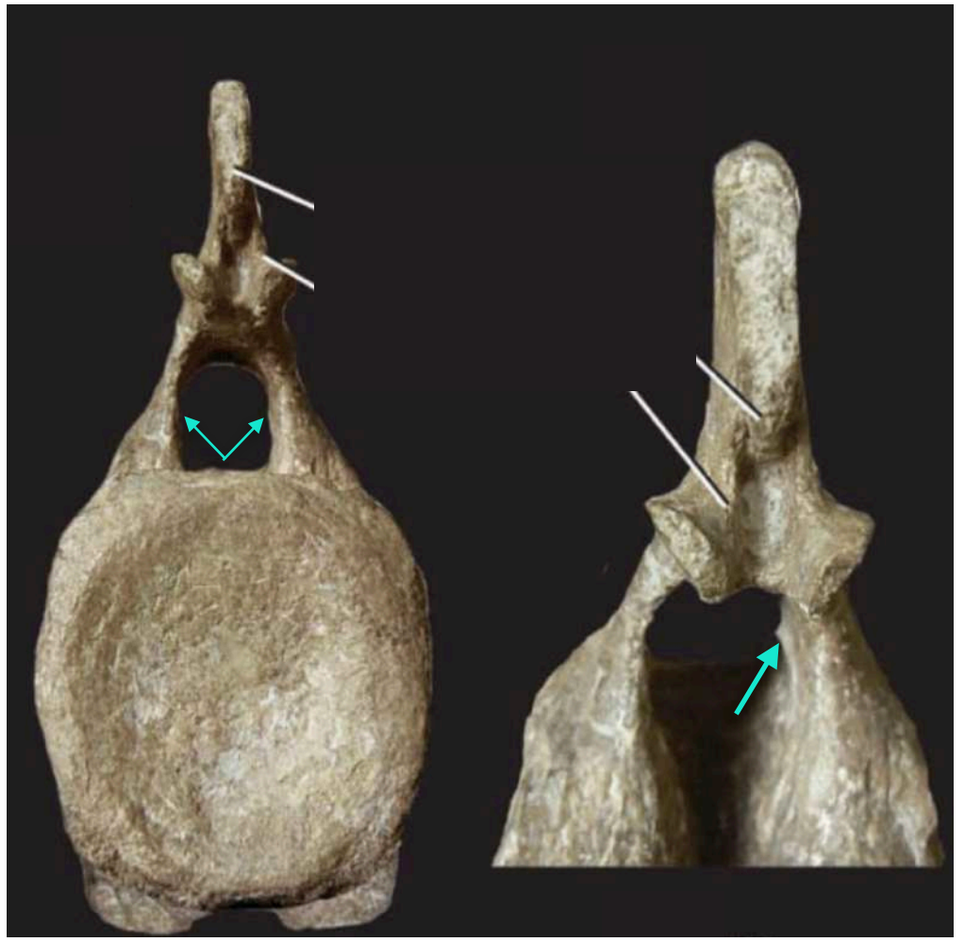


(Currey-Rogers, 2009)

Brontomerus
middle caudal

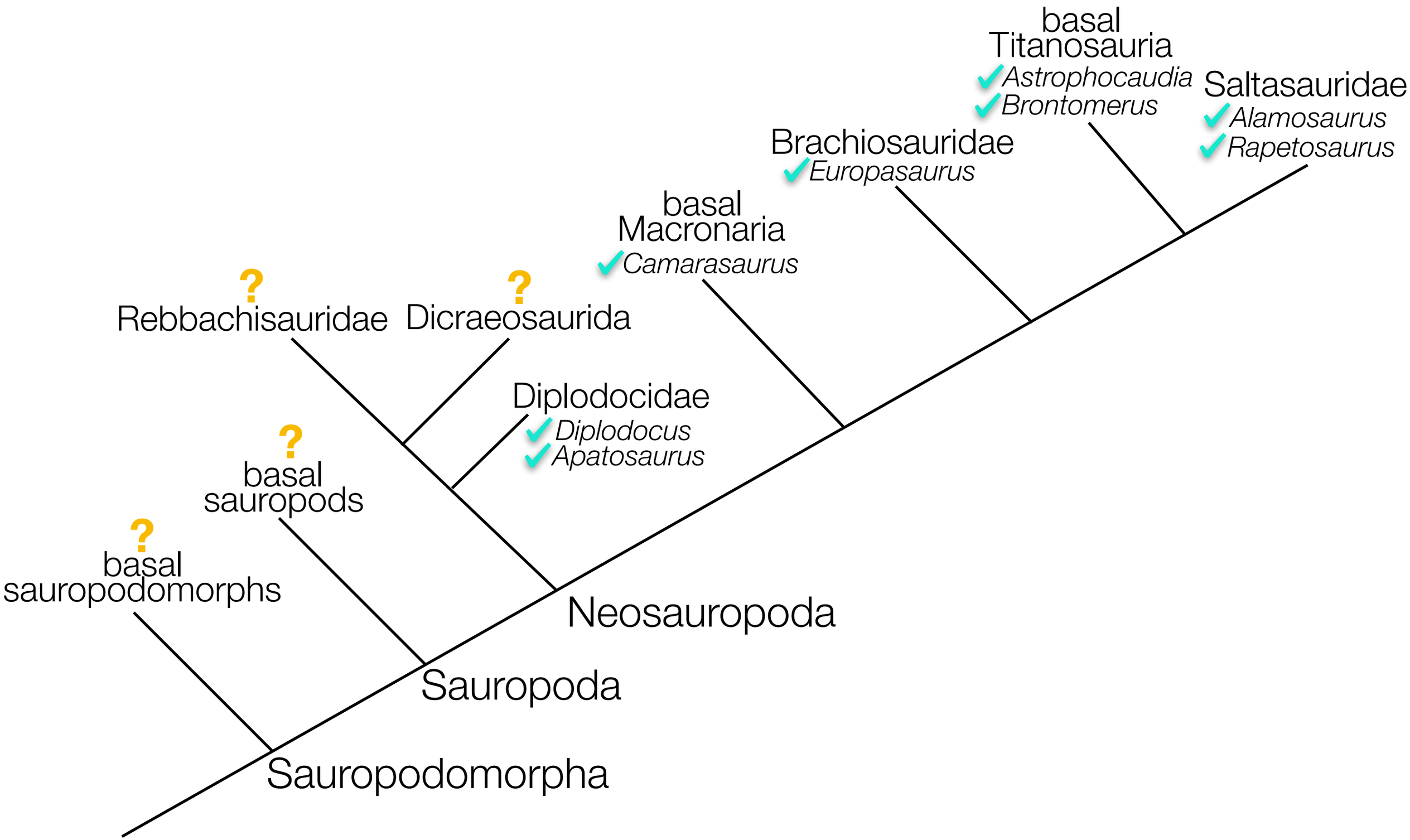
(Taylor et al., 2011)

Europasaurus
middle caudal

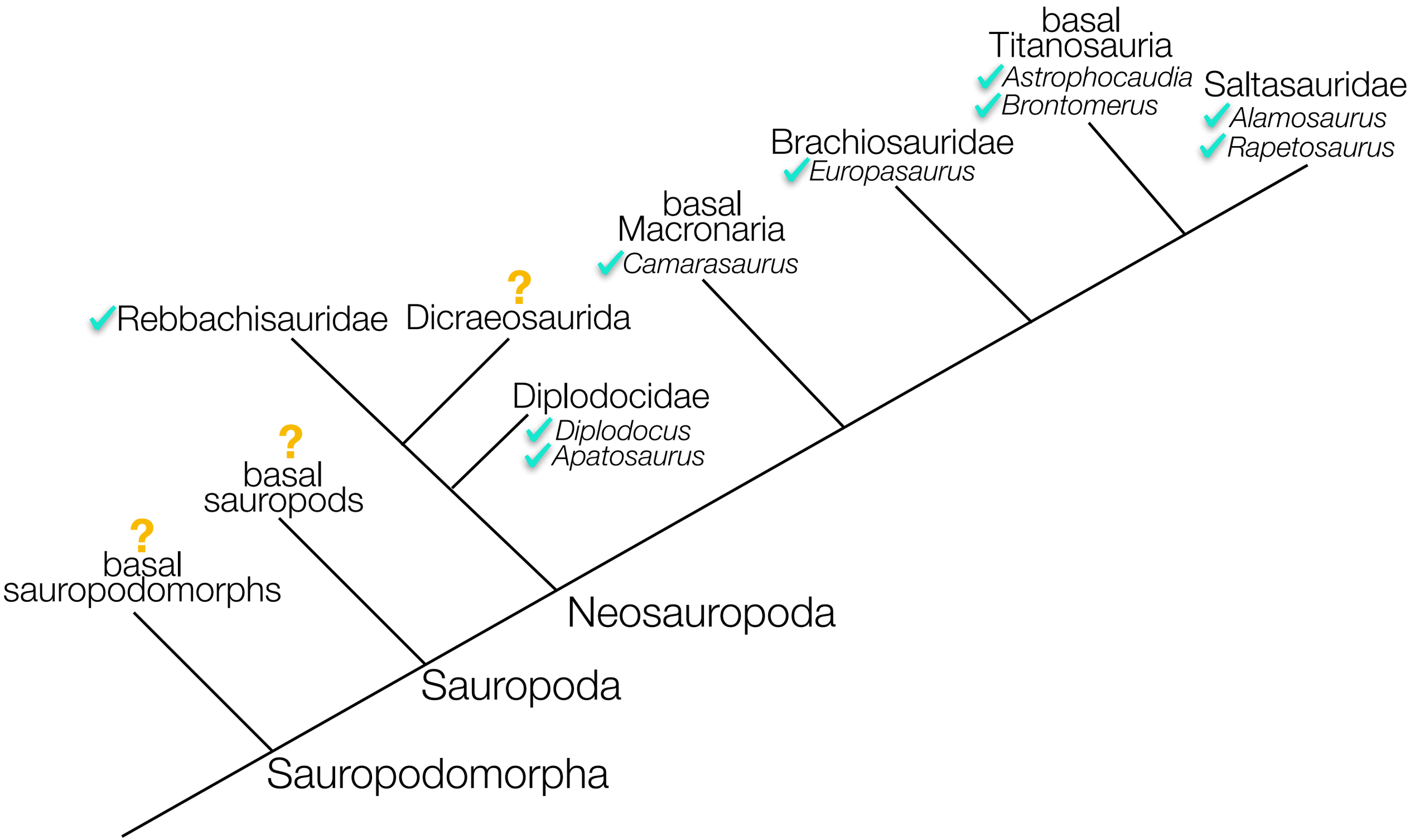


(Carballido & Sander, 2013)

Neural Canal Ridges in Sauropods



Neural Canal Ridges in Sauropods



Neural Canal Ridges in Sauropods

— bony projections into neural canal

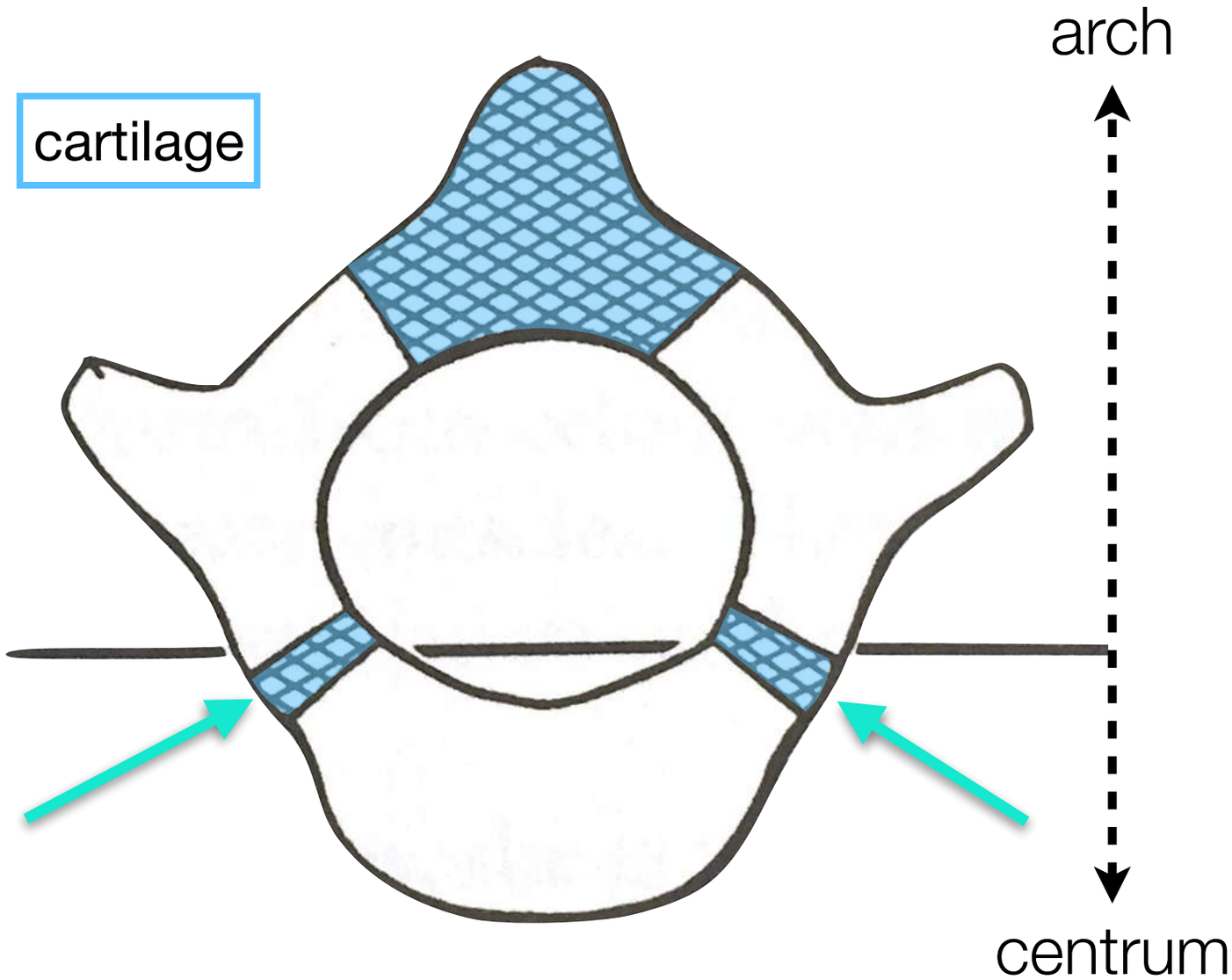
— located on lateral wall of canal

— anteroposteriorly elongate BUT

— do not extend to ends of canal

— size and position vary serially and taxonomically

Fusion of Neurocentral Joints

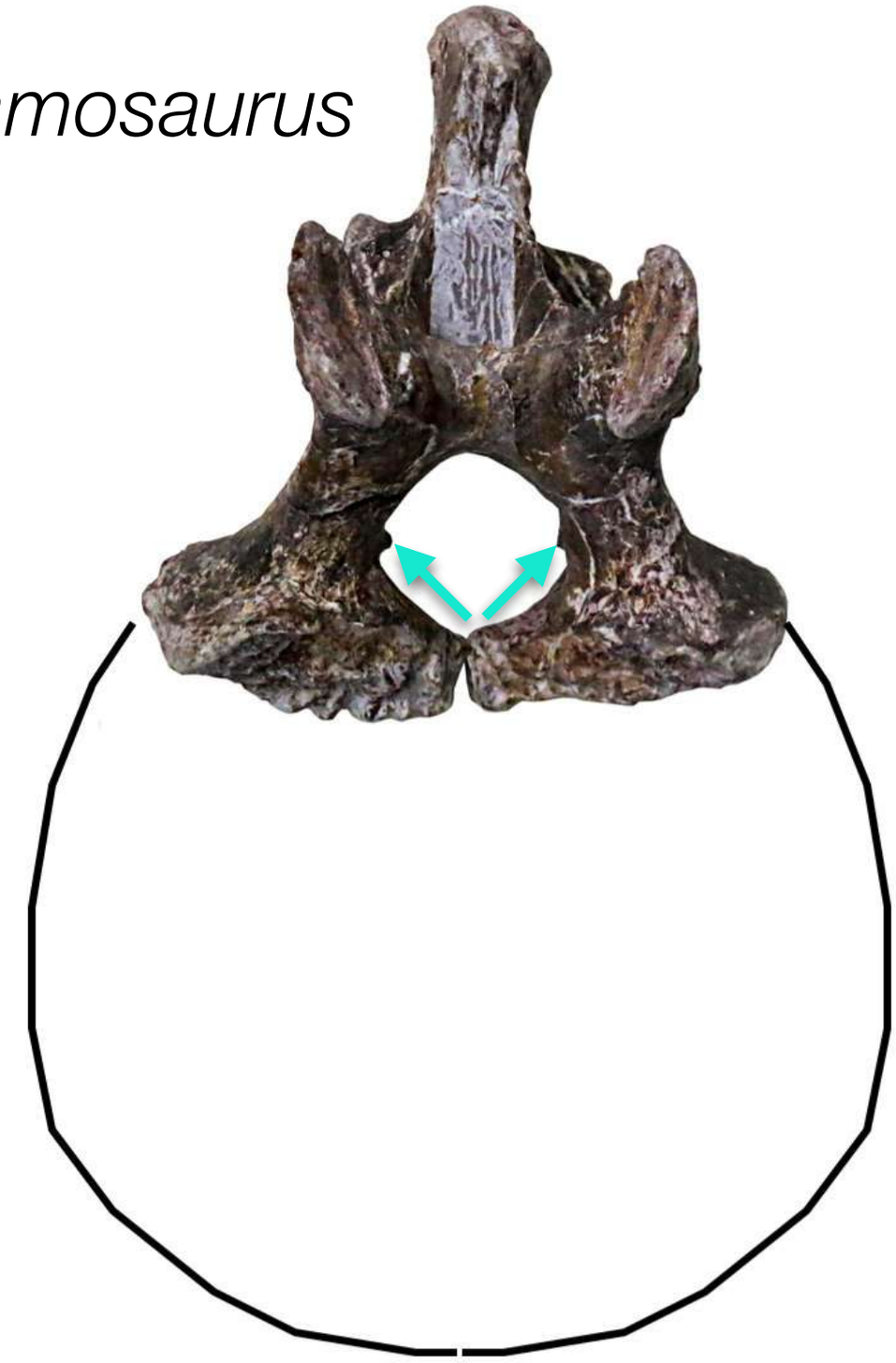


vertebra of a newborn *Homo sapiens*

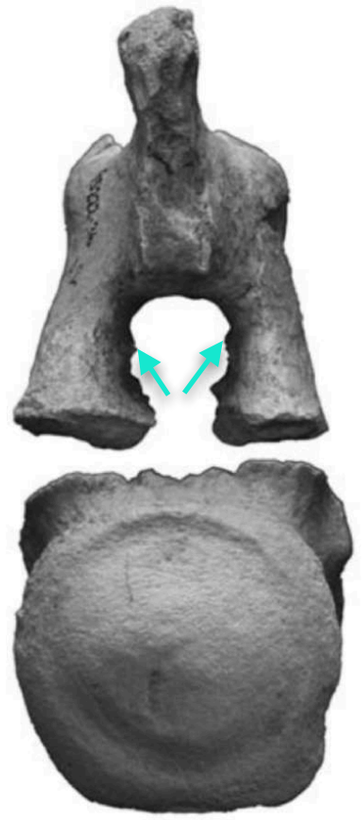
Image: Human Structure (Cartmill et al., 1987)

Fusion of Neurocentral Joints

Alamosaurus

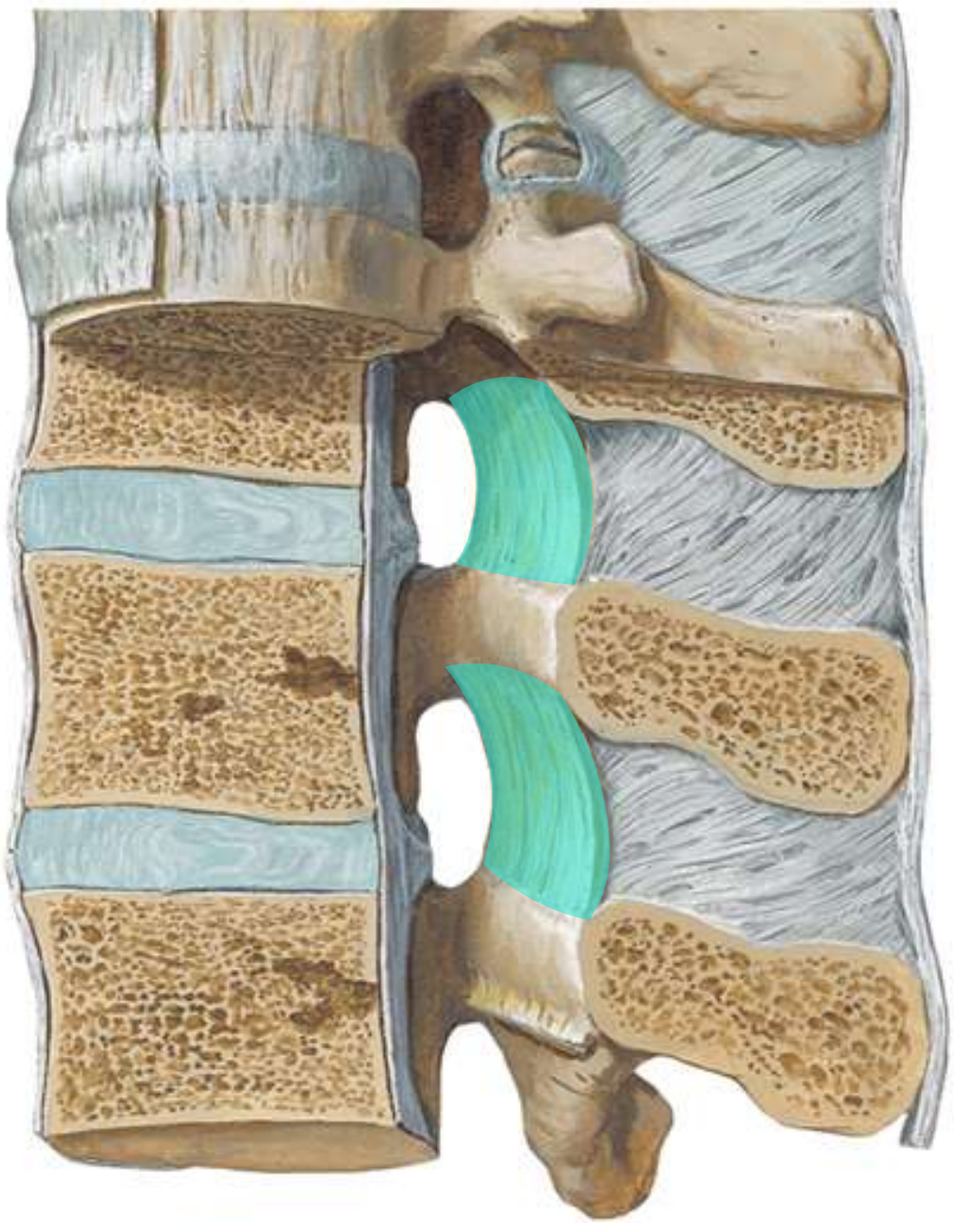


- ✗ found in juvenile specimens
- ✗ located dorsal to neurocentral joints

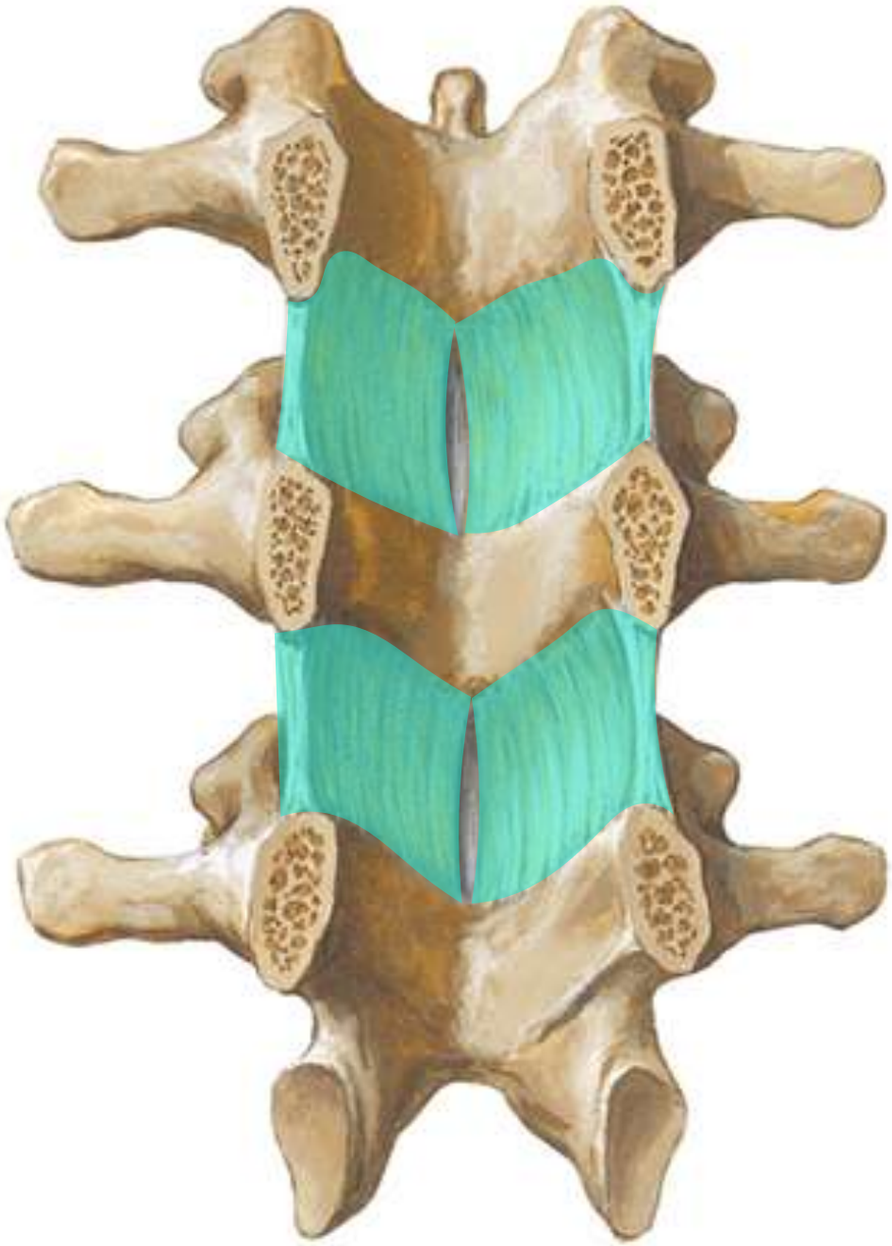


Rapetosaurus

Ligamentum Flavum Scars



sagittal view



anterior view

Ligamentum flavum: connects roofs of neural canals of consecutive vertebrae

Image: Atlas of Human Anatomy, Netter 7th ed.

Ligamentum Flavum Scars

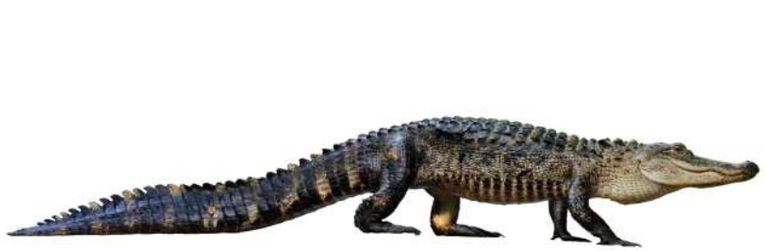
caudal view

- ✗ occur at ends of dorsal roof of canal
- ✗ ligamentum flavum not known outside Mammalia

Homo sapiens
thoracic vertebra

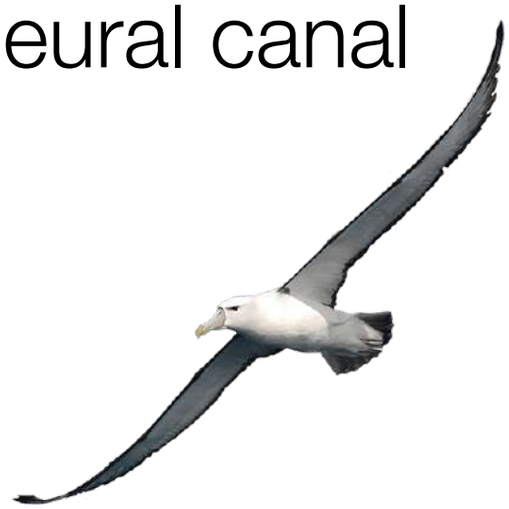
scar for attachment of ligamentum flavum

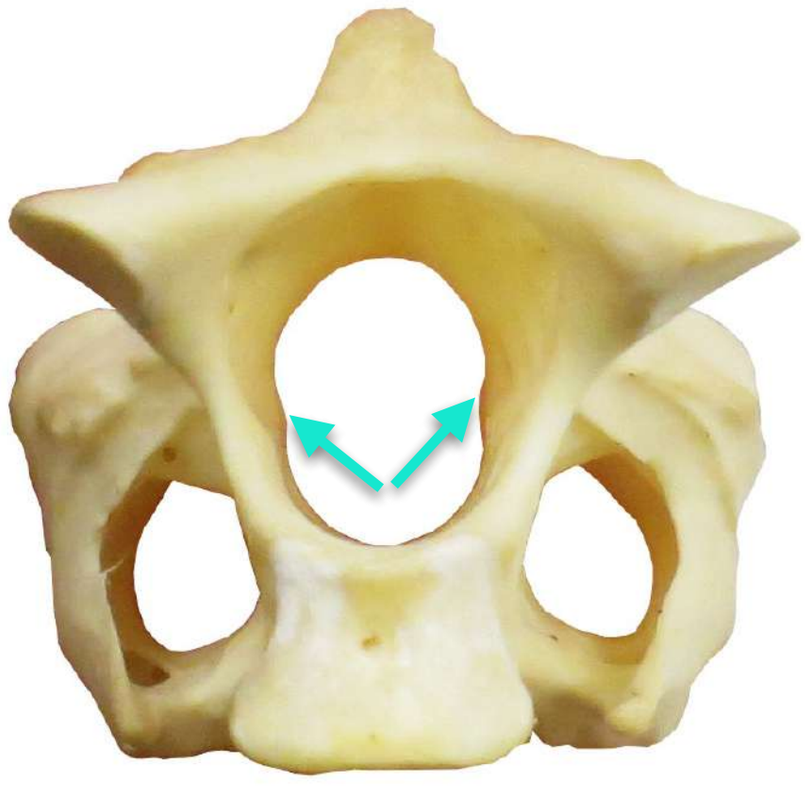
Soft Tissue Separation



Alligator mississippiensis

✓ridges in neural canal

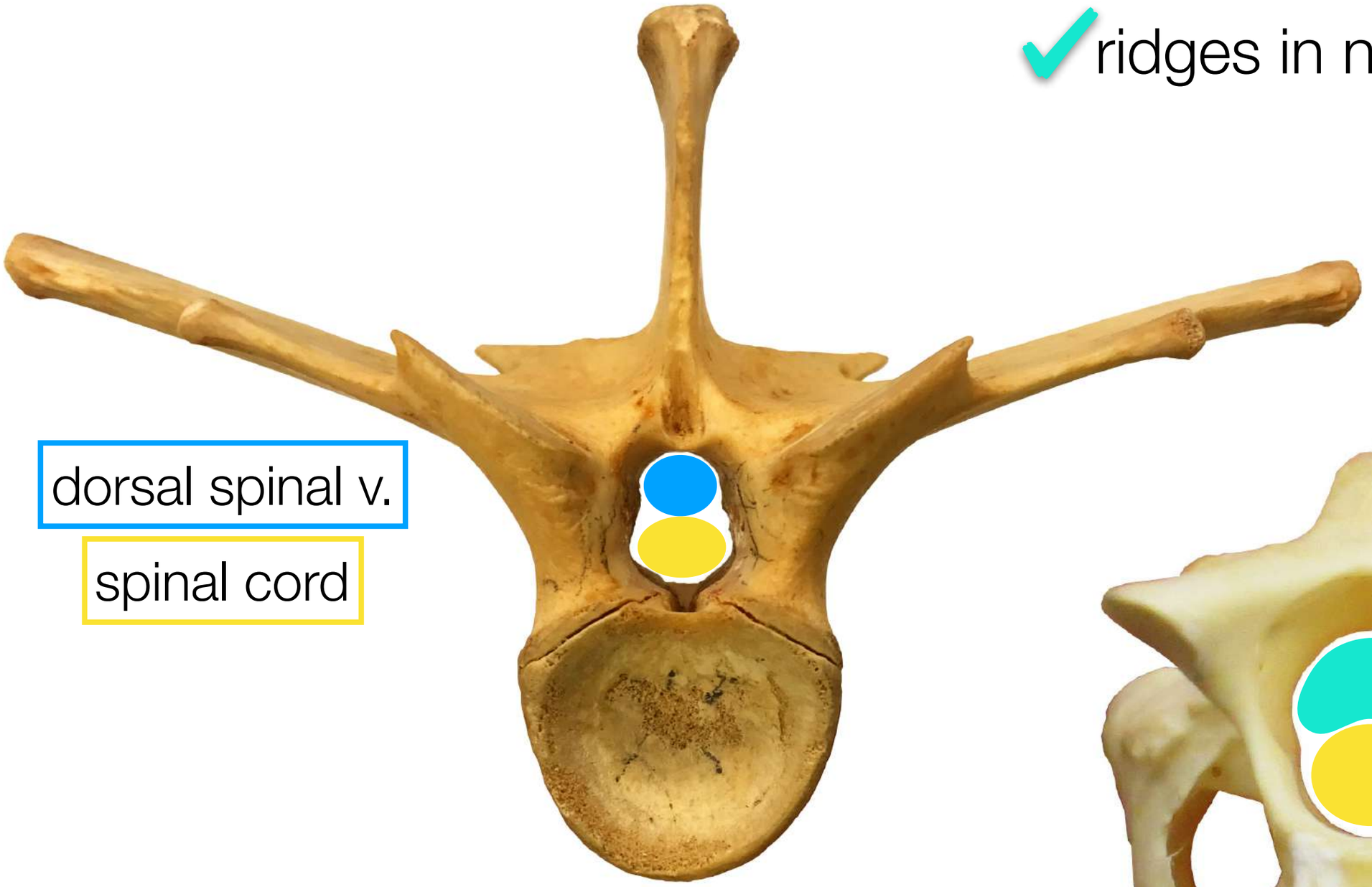




Phoebastria

Soft Tissue Separation

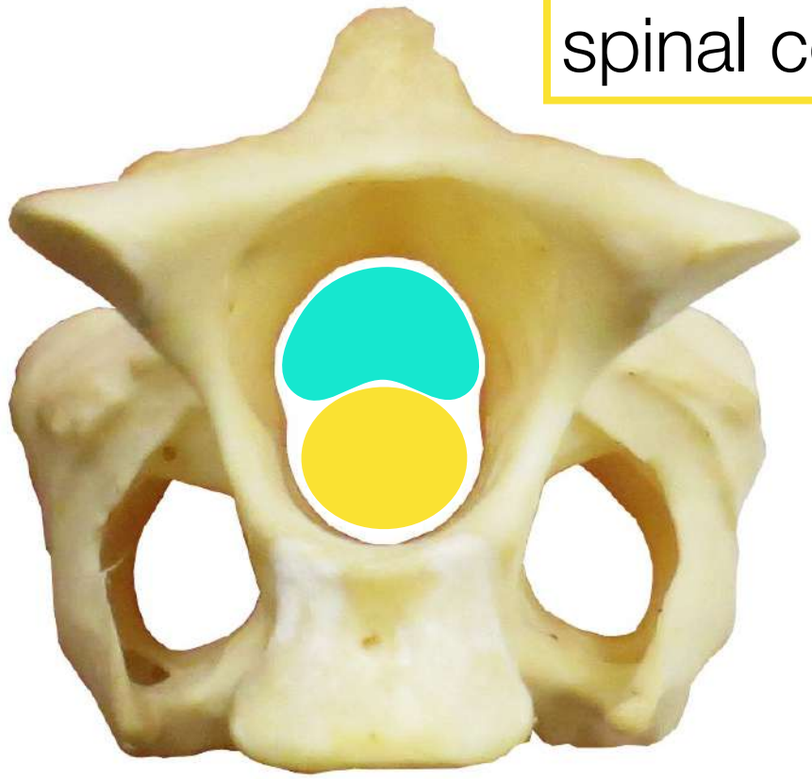
✓ridges in neural canal



Alligator mississippiensis

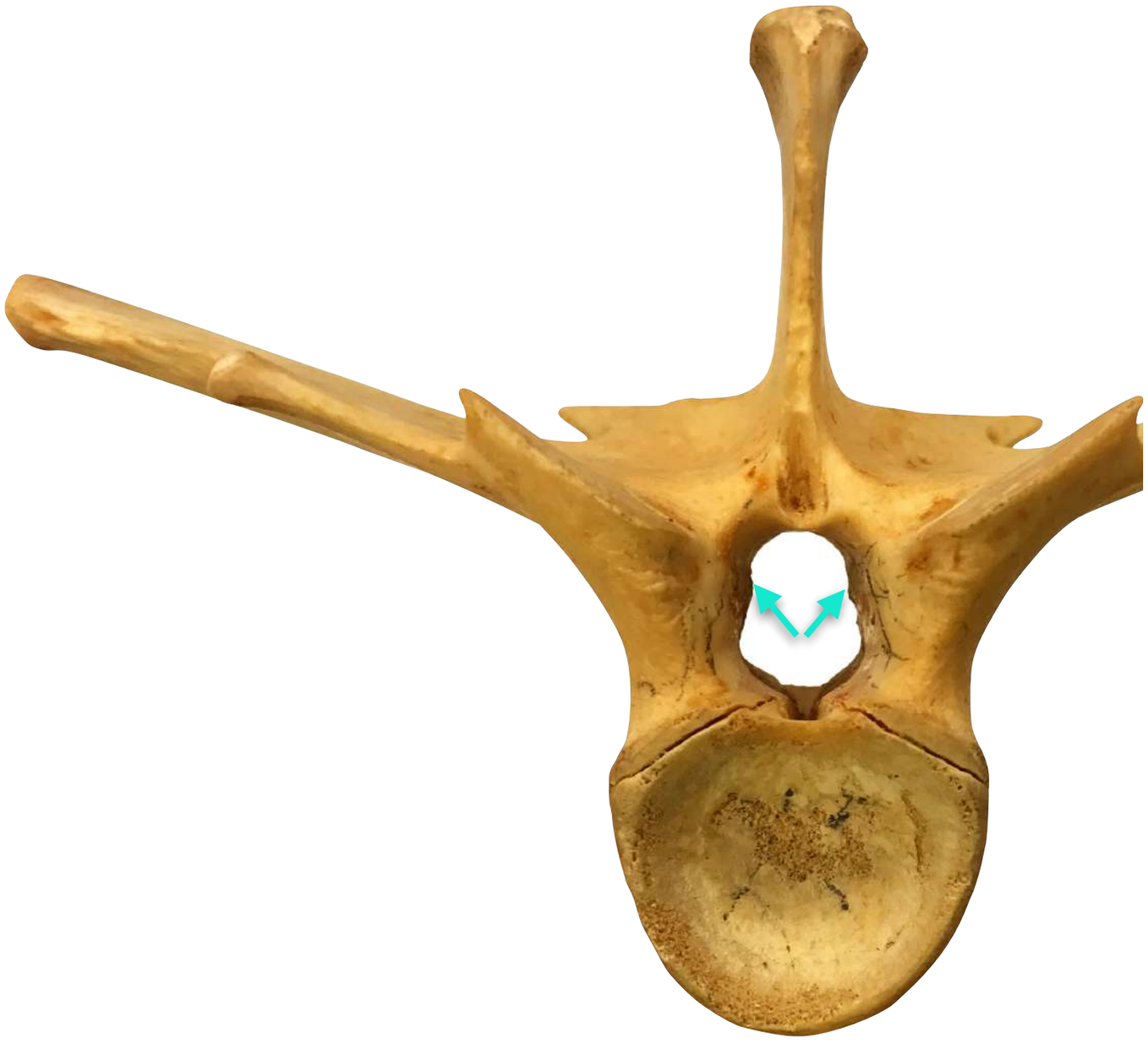
paramedullary diverticula

spinal cord



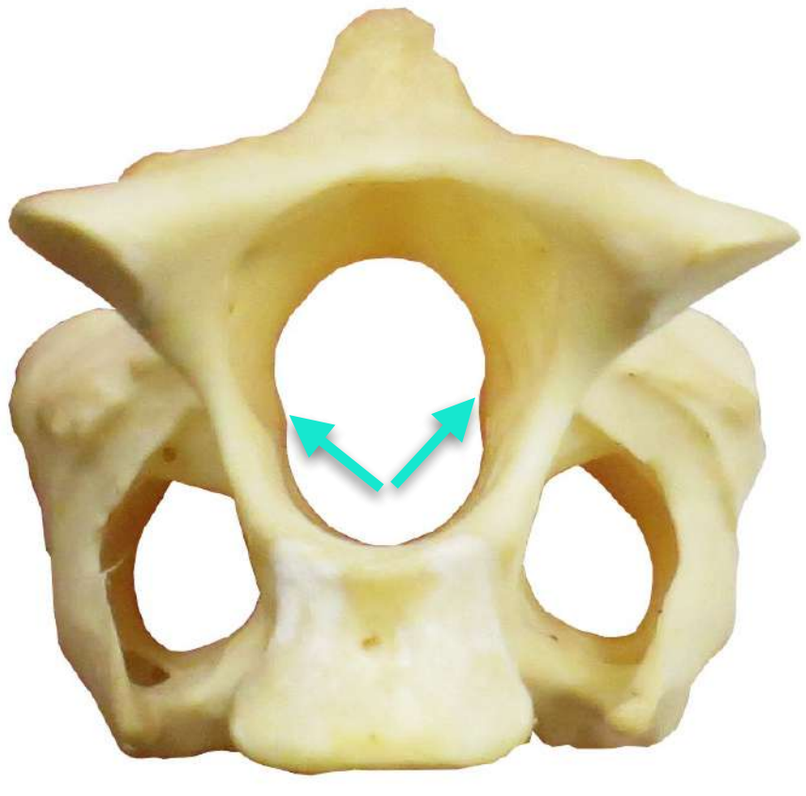
Phoebastria

Soft Tissue Separation



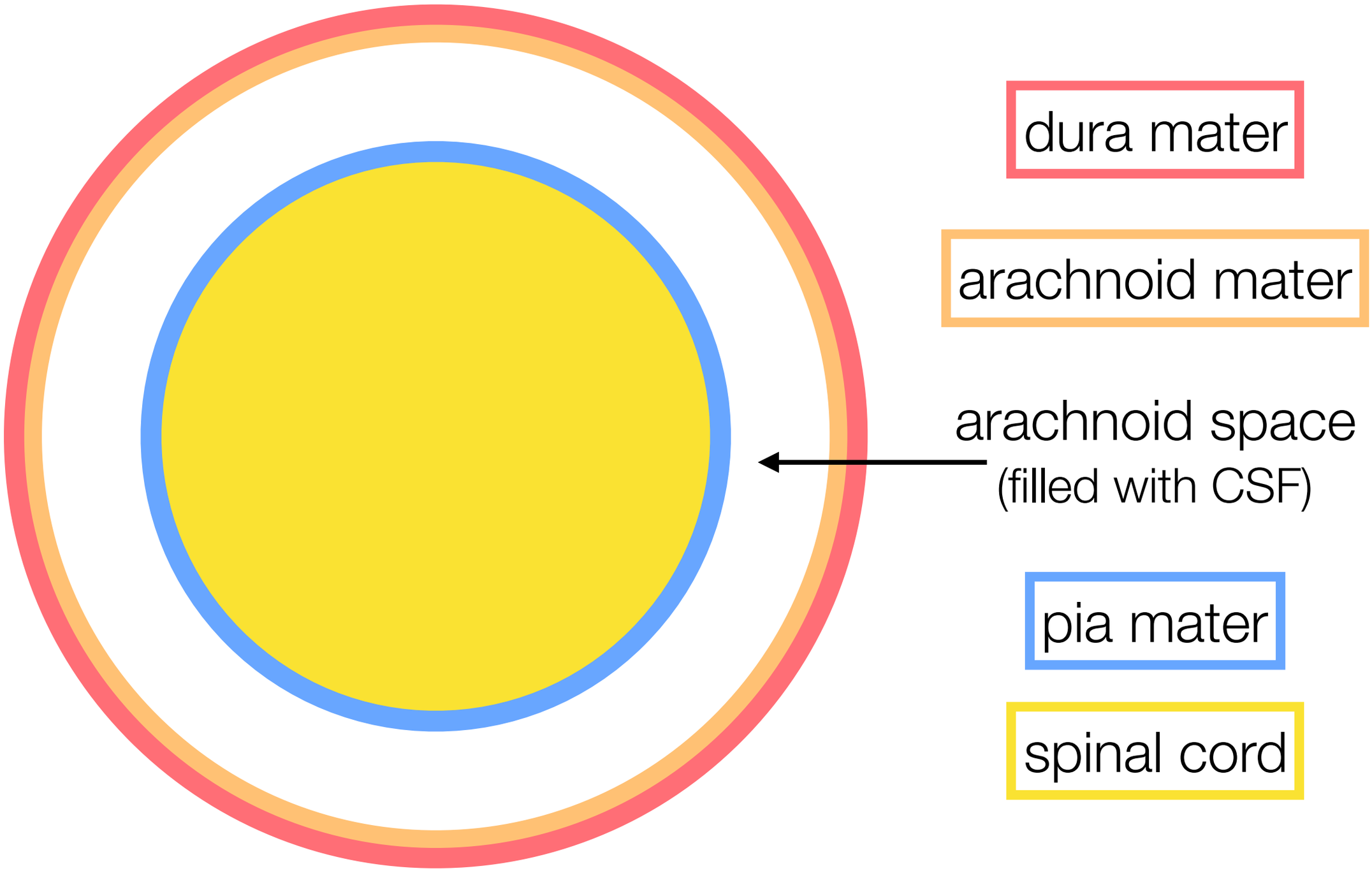
Alligator mississippiensis

- ✓ ridges in neural canal
- ✗ ridges extend to ends of canal
- ✗ change geometry of neural canal



Phoebastria

Spinal Cord Supports



Spinal Cord Supports

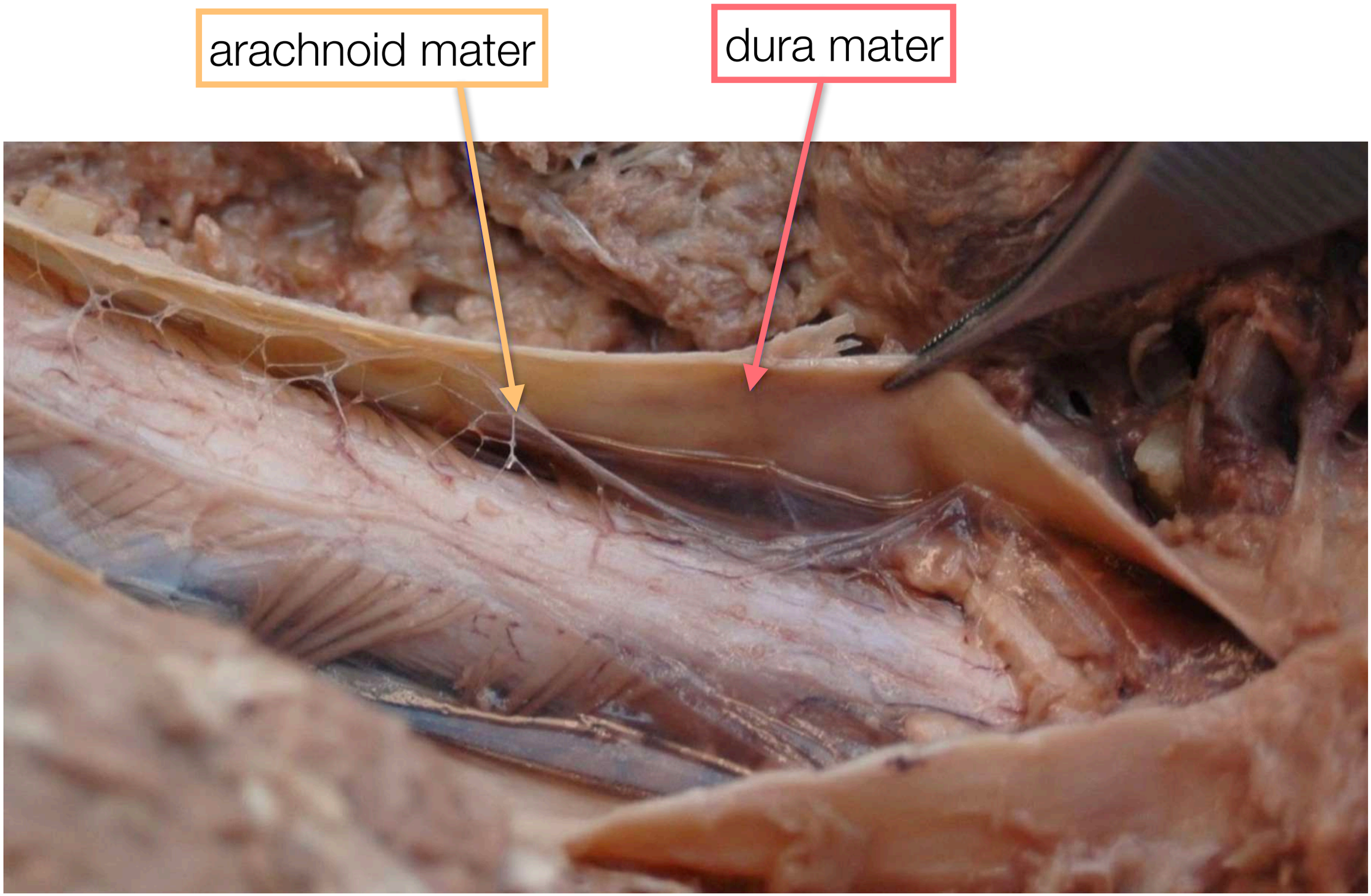
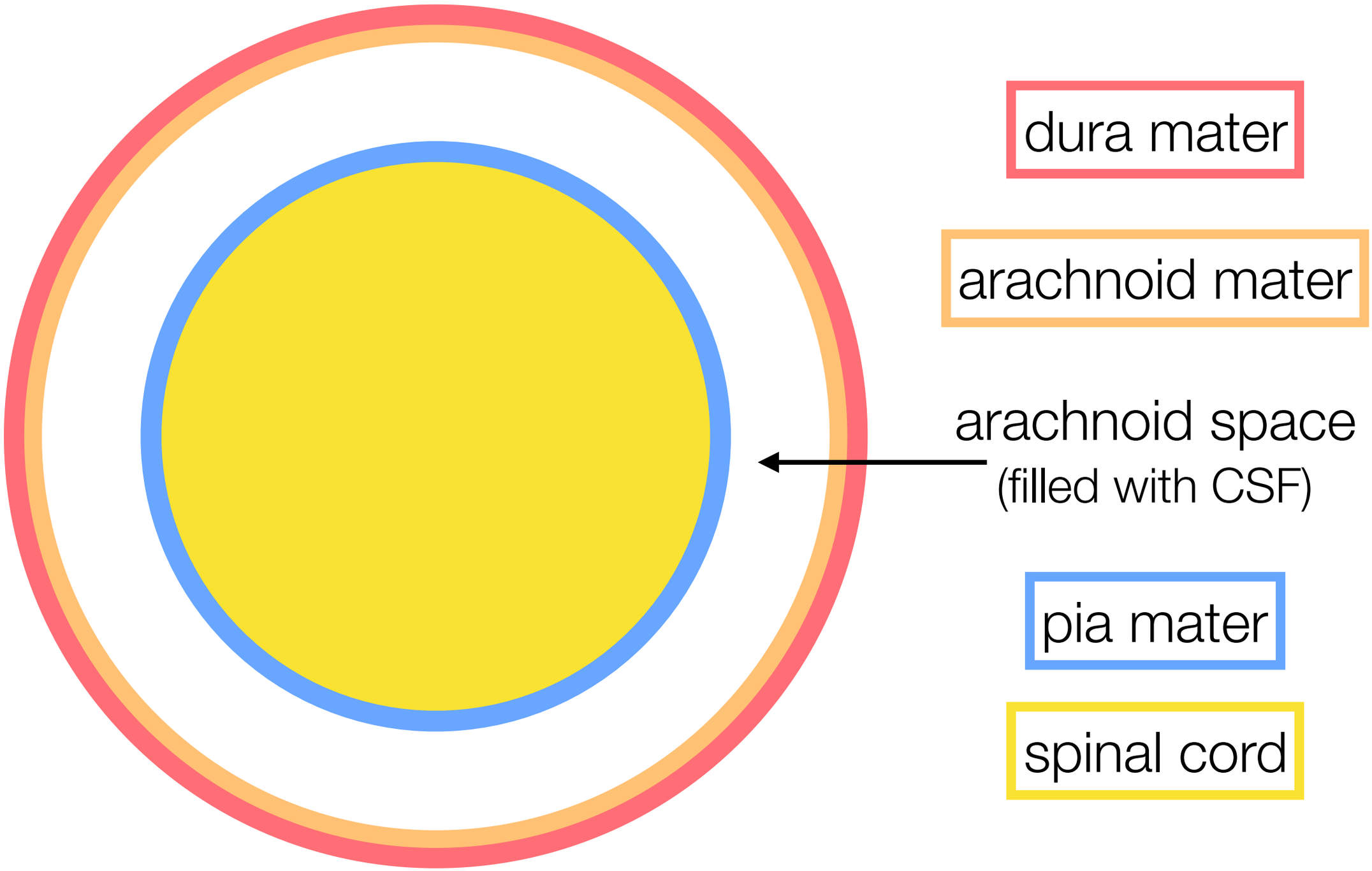
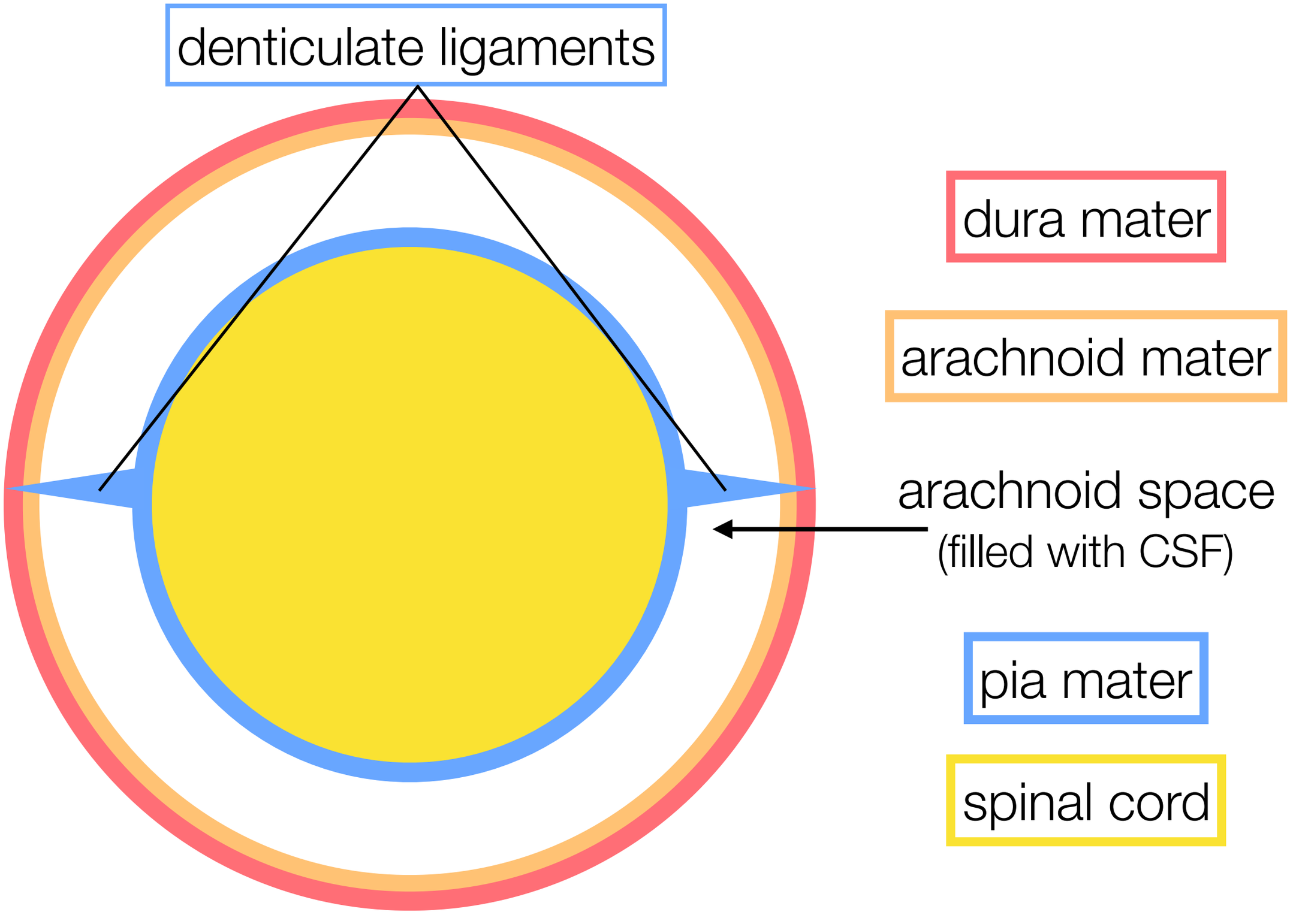


Image: BlueLink Cadaveric Atlas

Spinal Cord Supports



Spinal Cord Supports



Spinal Cord Supports

dura mater

arachnoid mater

pia mater

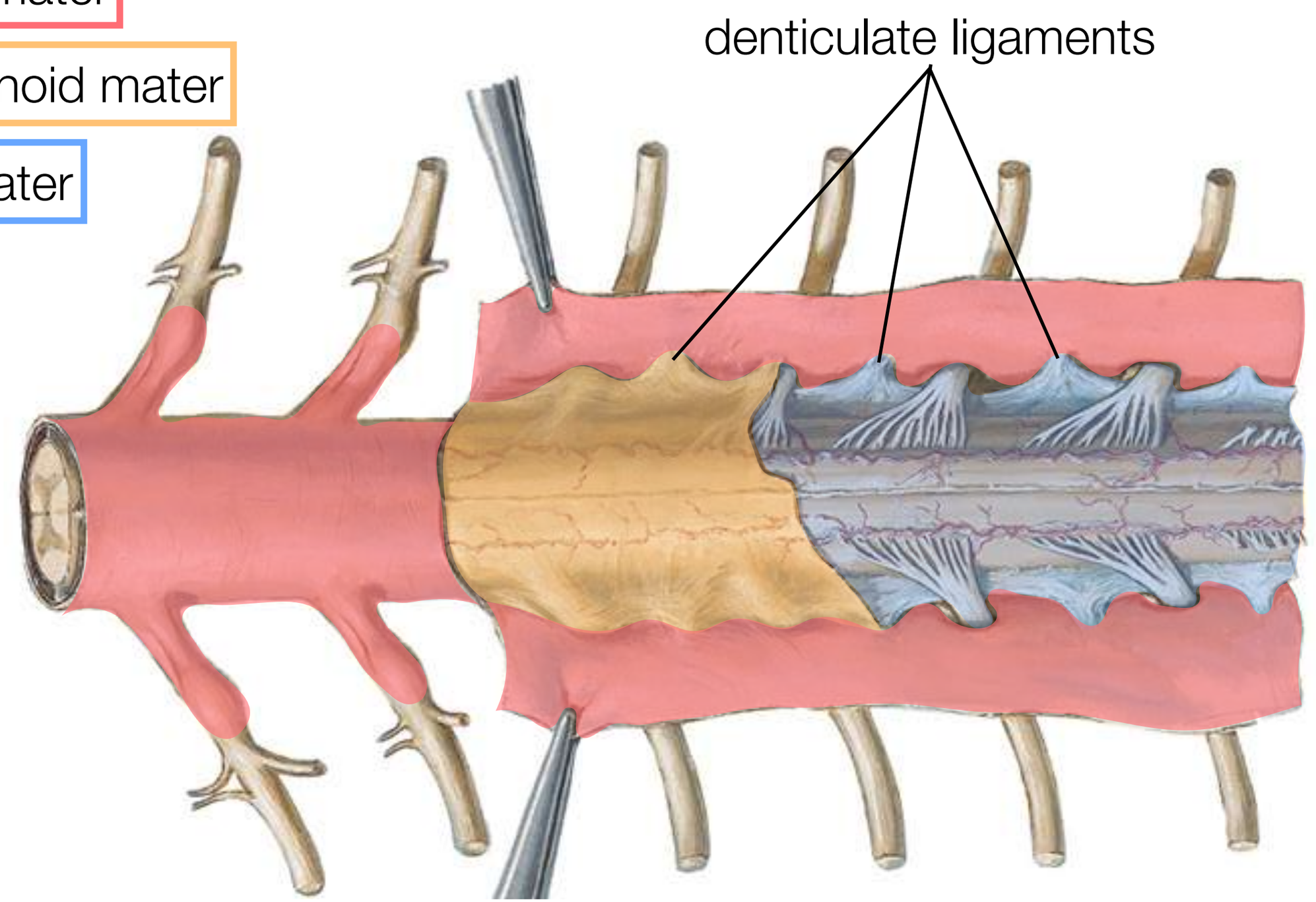


Image: Atlas of Human Anatomy, Netter 7th ed.

Spinal Cord Supports

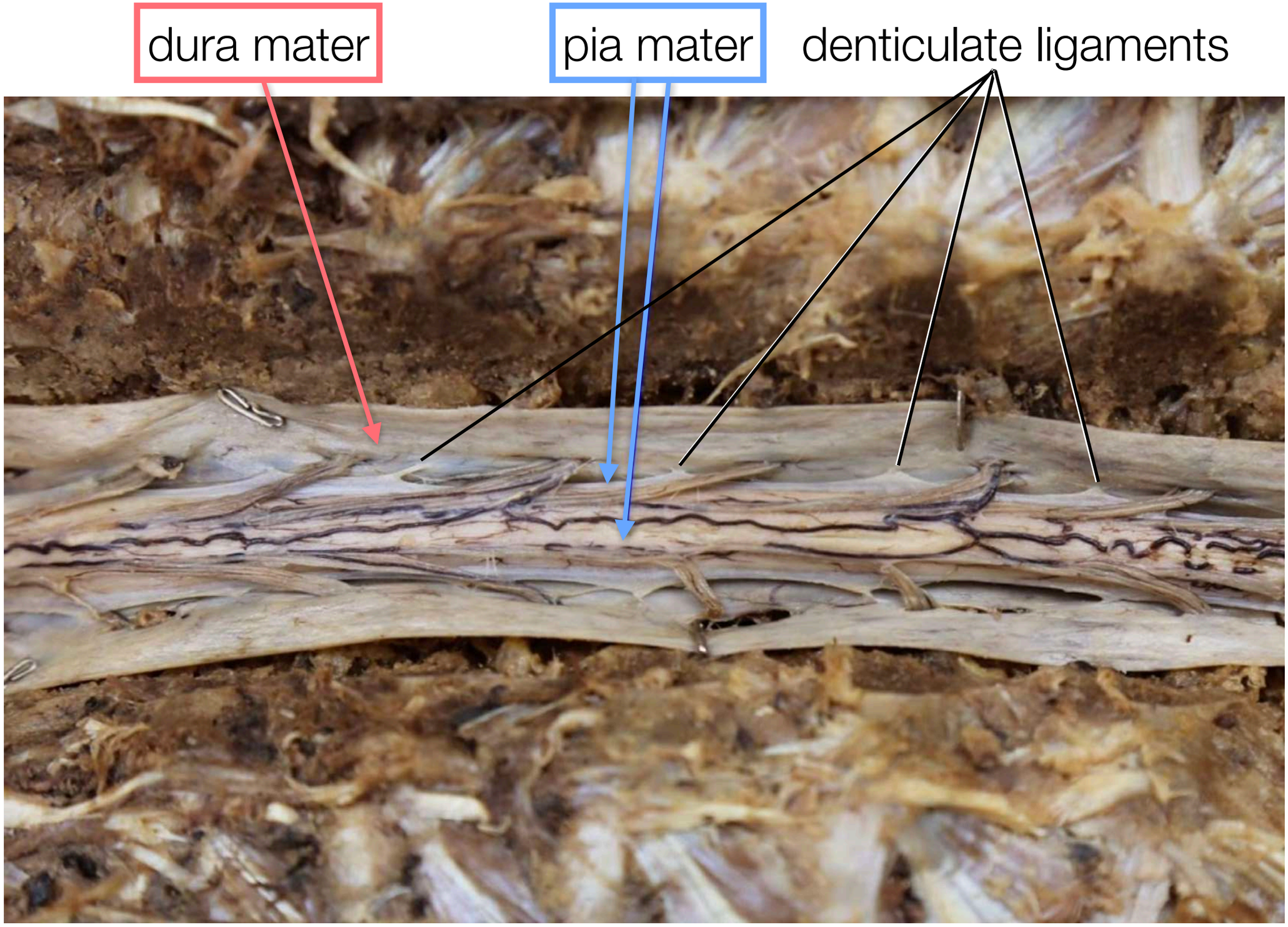


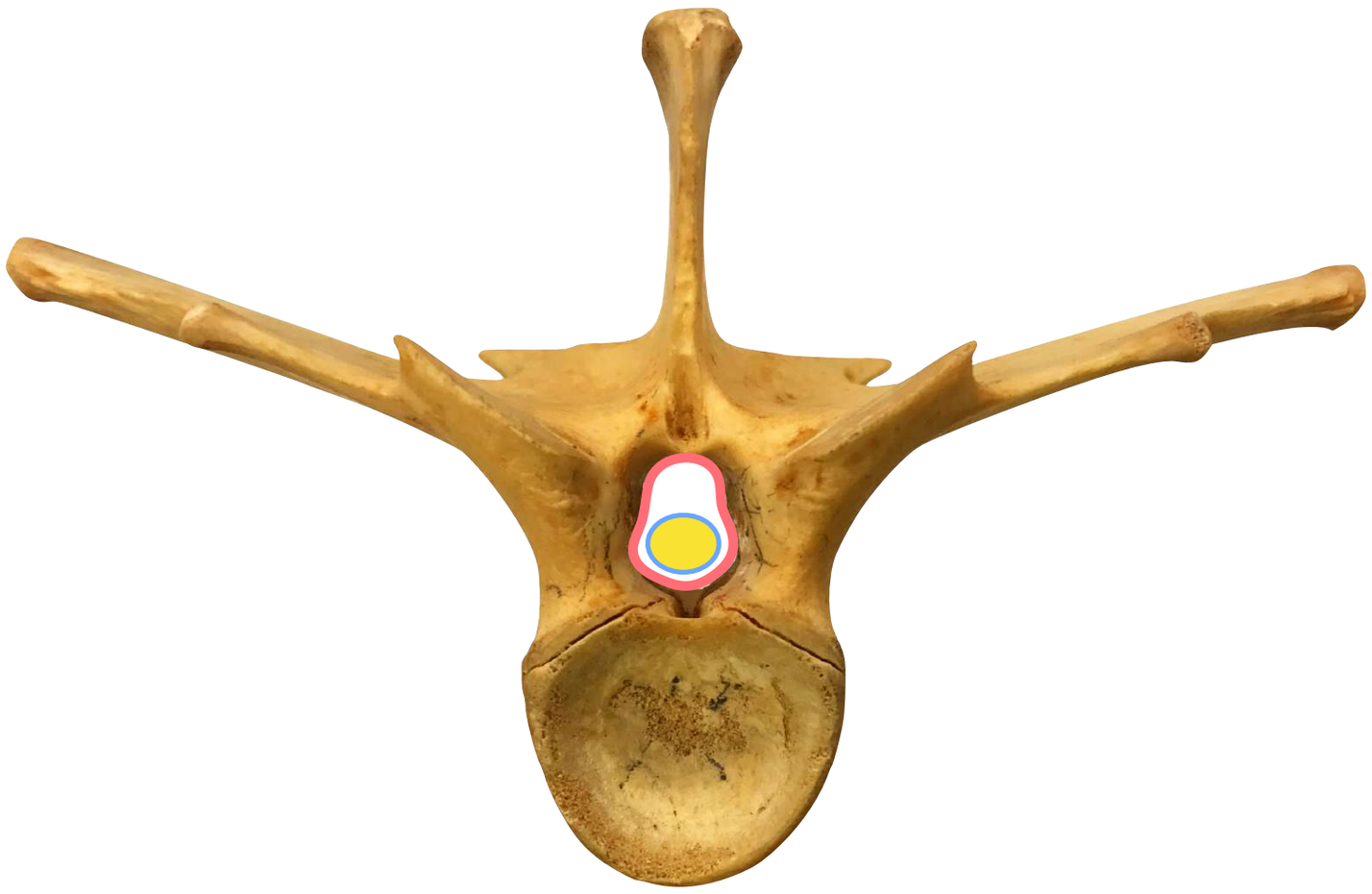
Image: BlueLink Cadaveric Atlas

Spinal Cord Supports

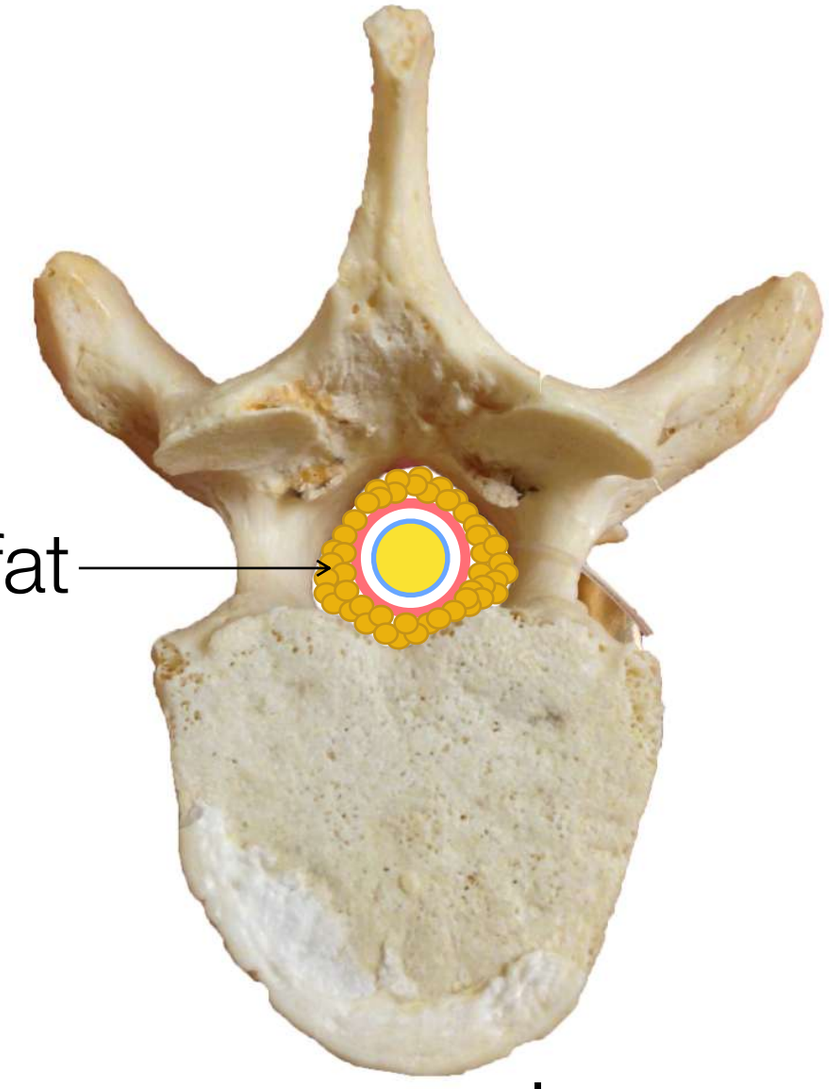
dura mater

pia mater

spinal cord

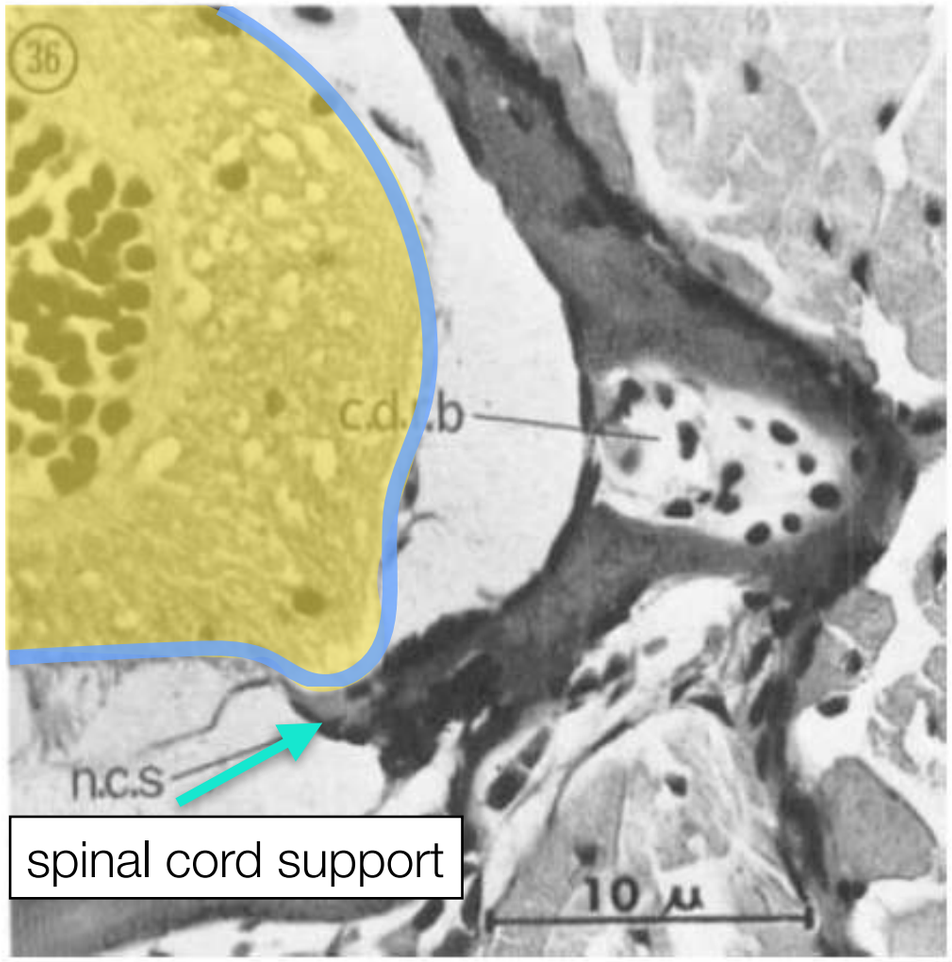


other vertebrates:
dura fused to
periosteum

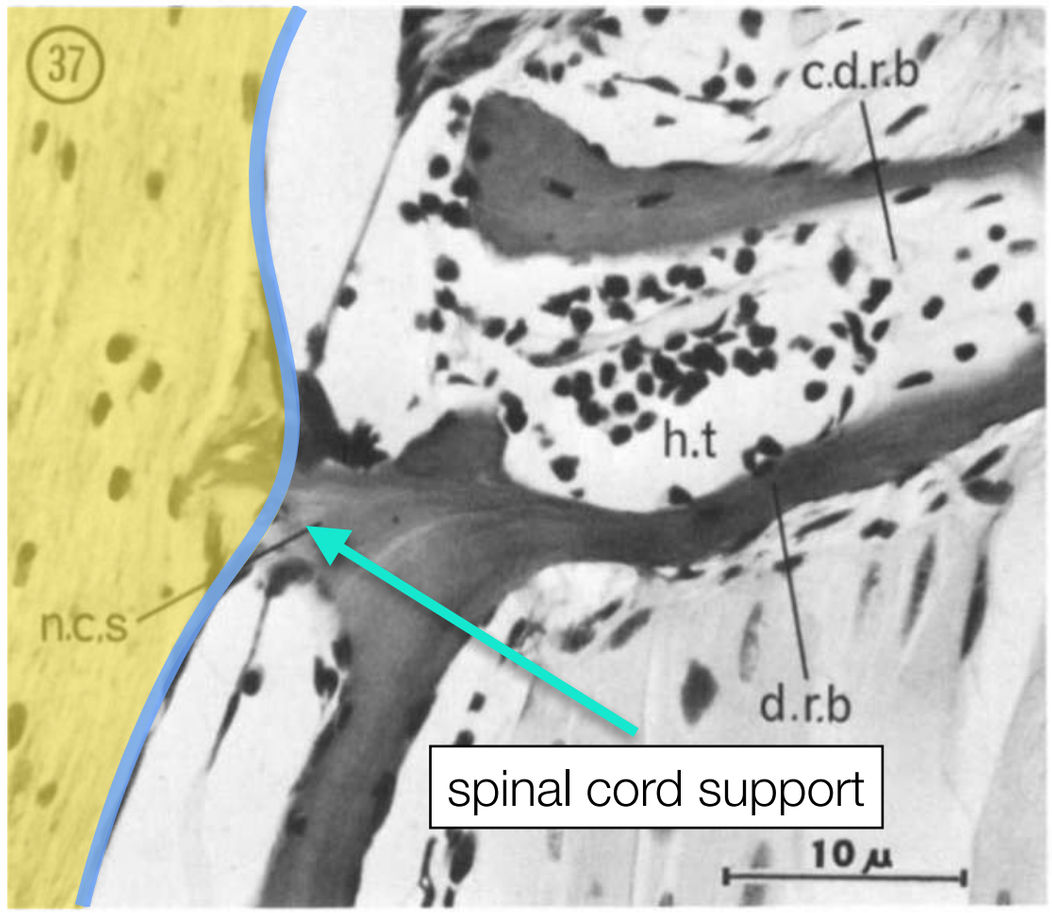


mammals:
epidural space
filled with fat

Spinal Cord Supports



transverse section,
lateral side of neural
arch of larval *Eurycea*



horizontal section,
neural canal of adult
Eurycea

pia mater

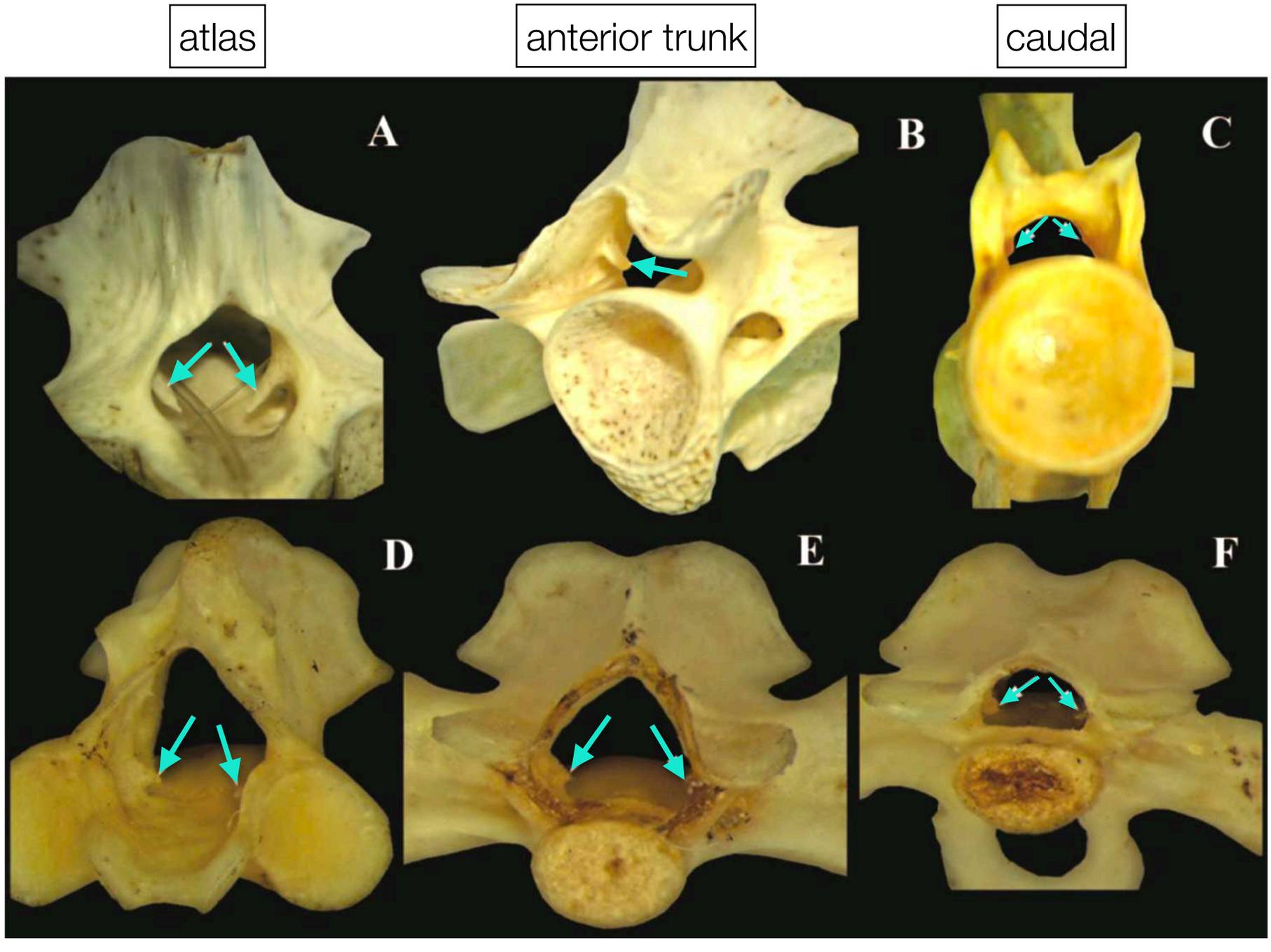
spinal cord

Wake & Lawson (1973)

Spinal Cord Supports

Andrias

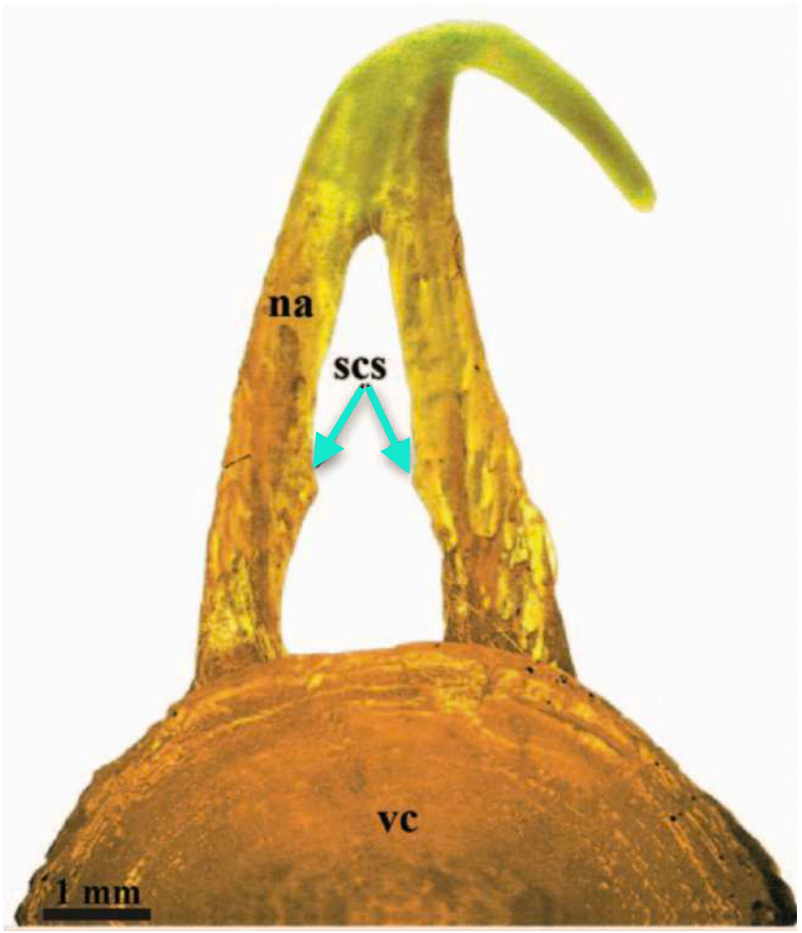
Salamandra



Skutschas & Baleeva (2012)

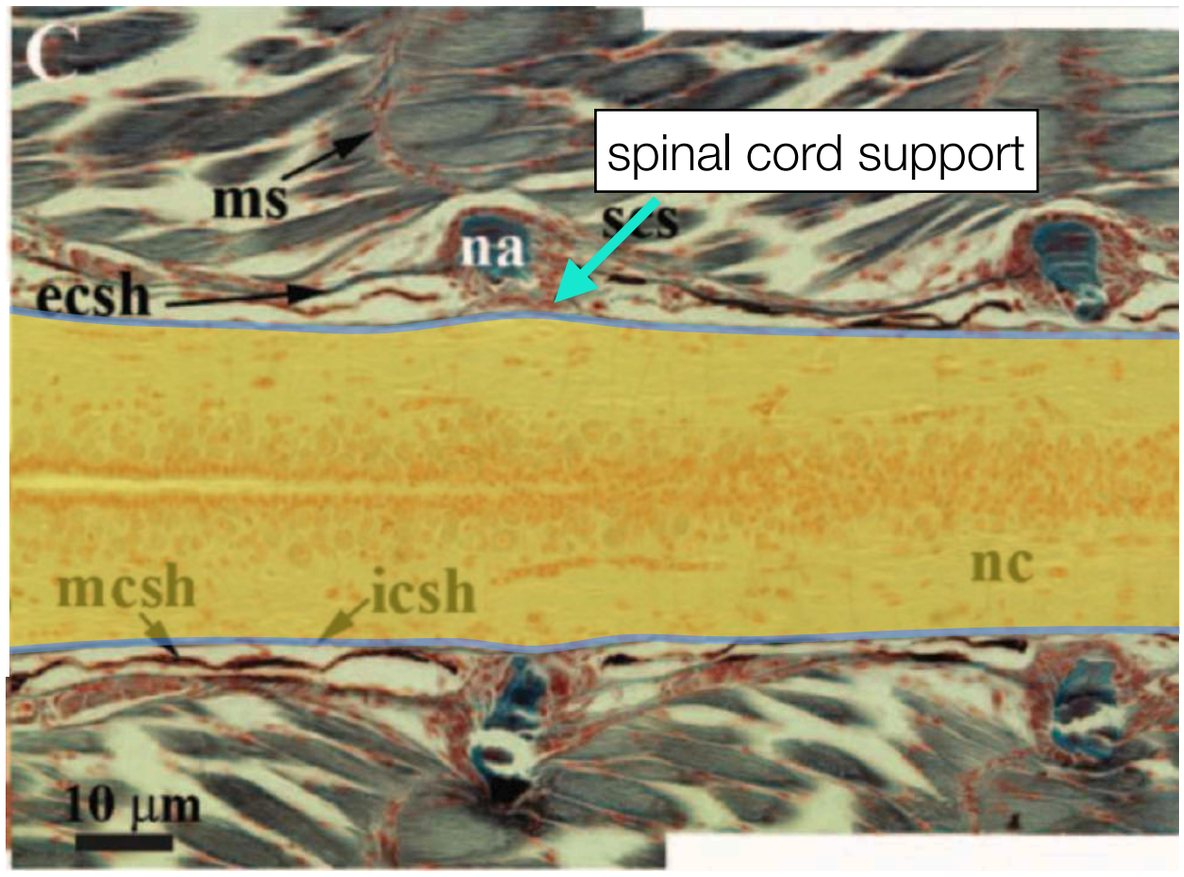
Spinal Cord Supports

Salmo



trunk vertebra

Oncorhynchus



frontal section of embryo

Skutschas & Baleeva (2012)

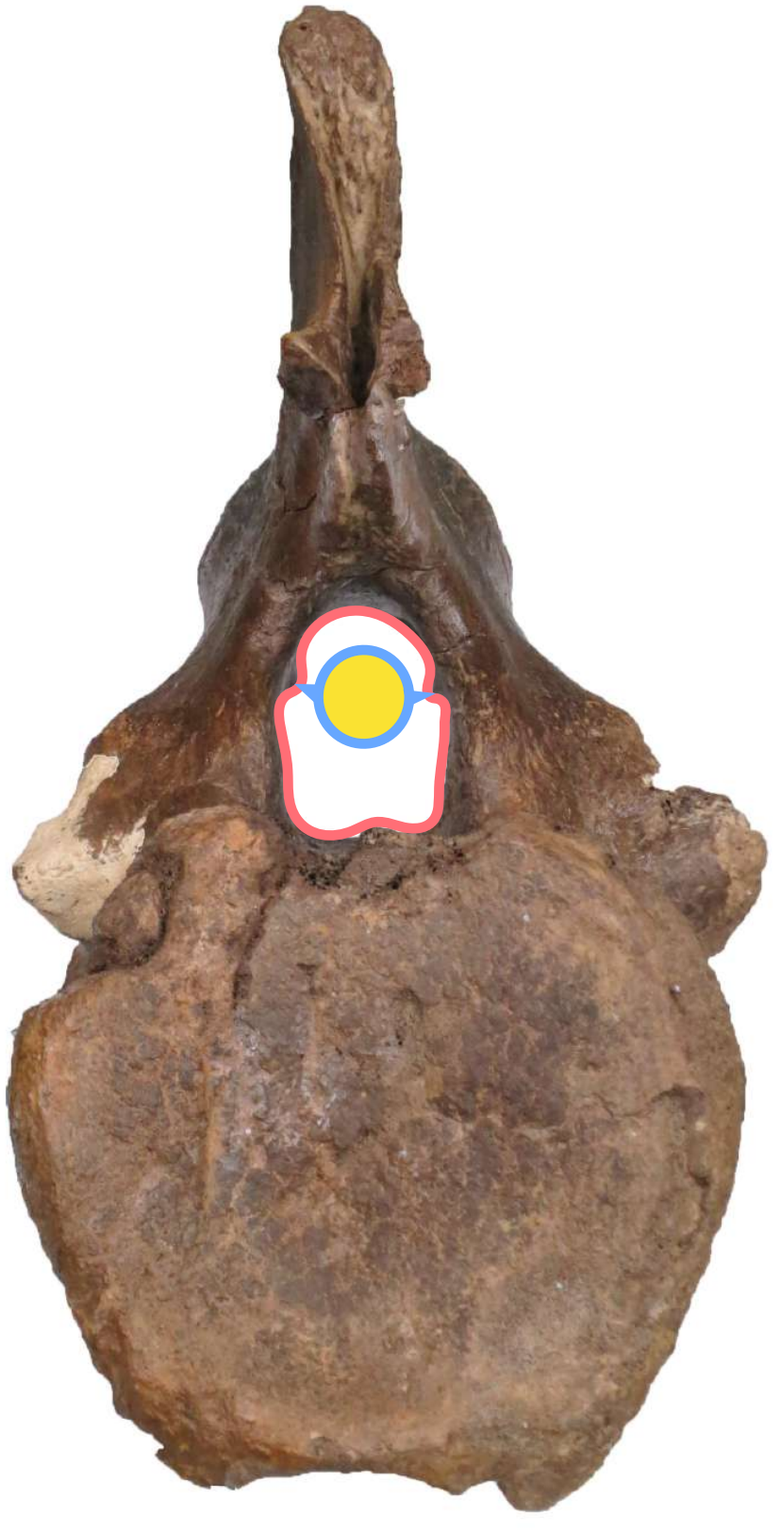
Spinal Cord Supports

- ✓ bony projections in neural canal
- ✓ located on lateral wall of canal
- ✓ do not extend to ends of canal
- ✓ variable size and position across taxa and vertebral regions

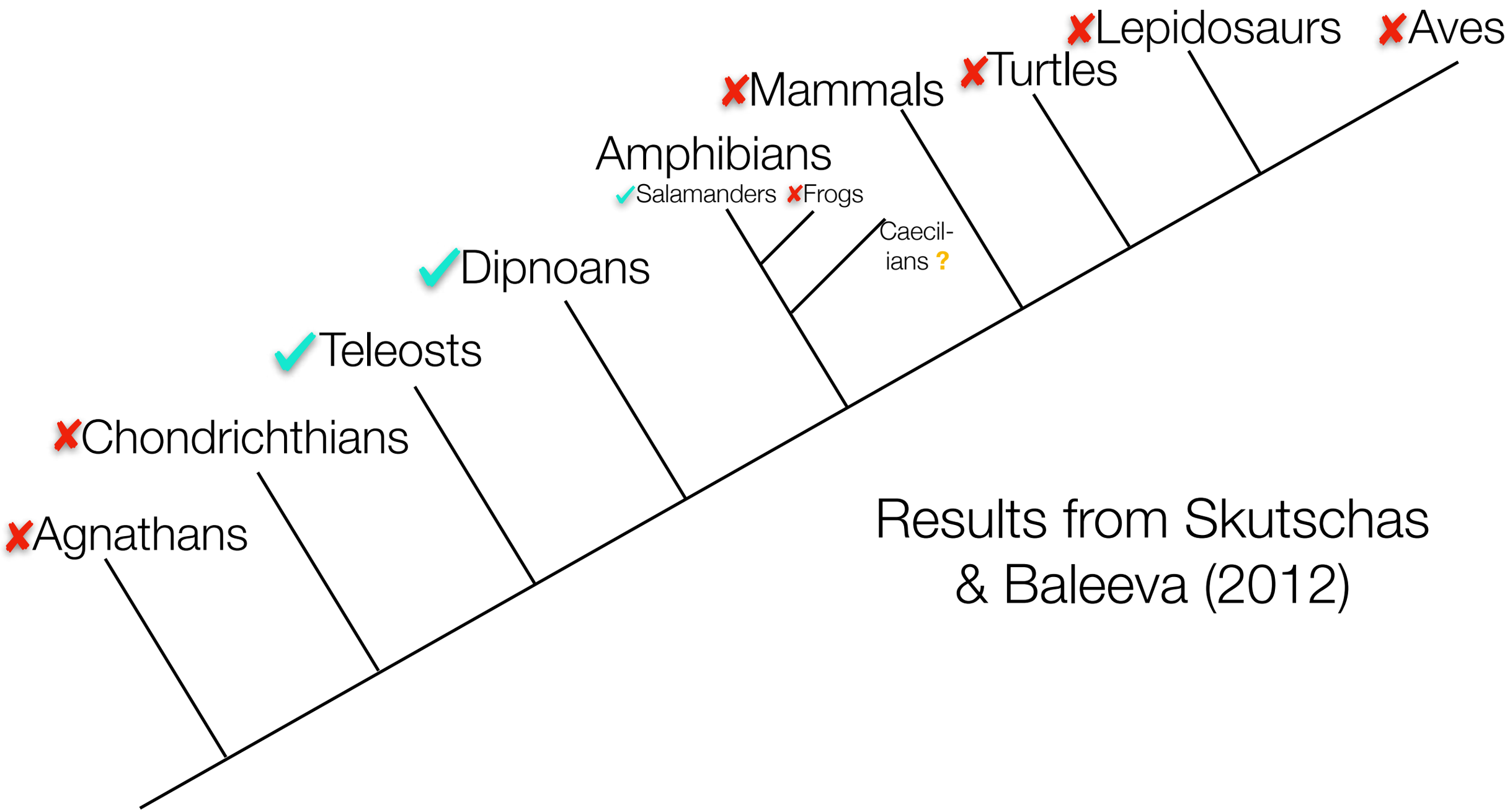
Thunnus

Spinal Cord Supports

Spinal Cord Supports

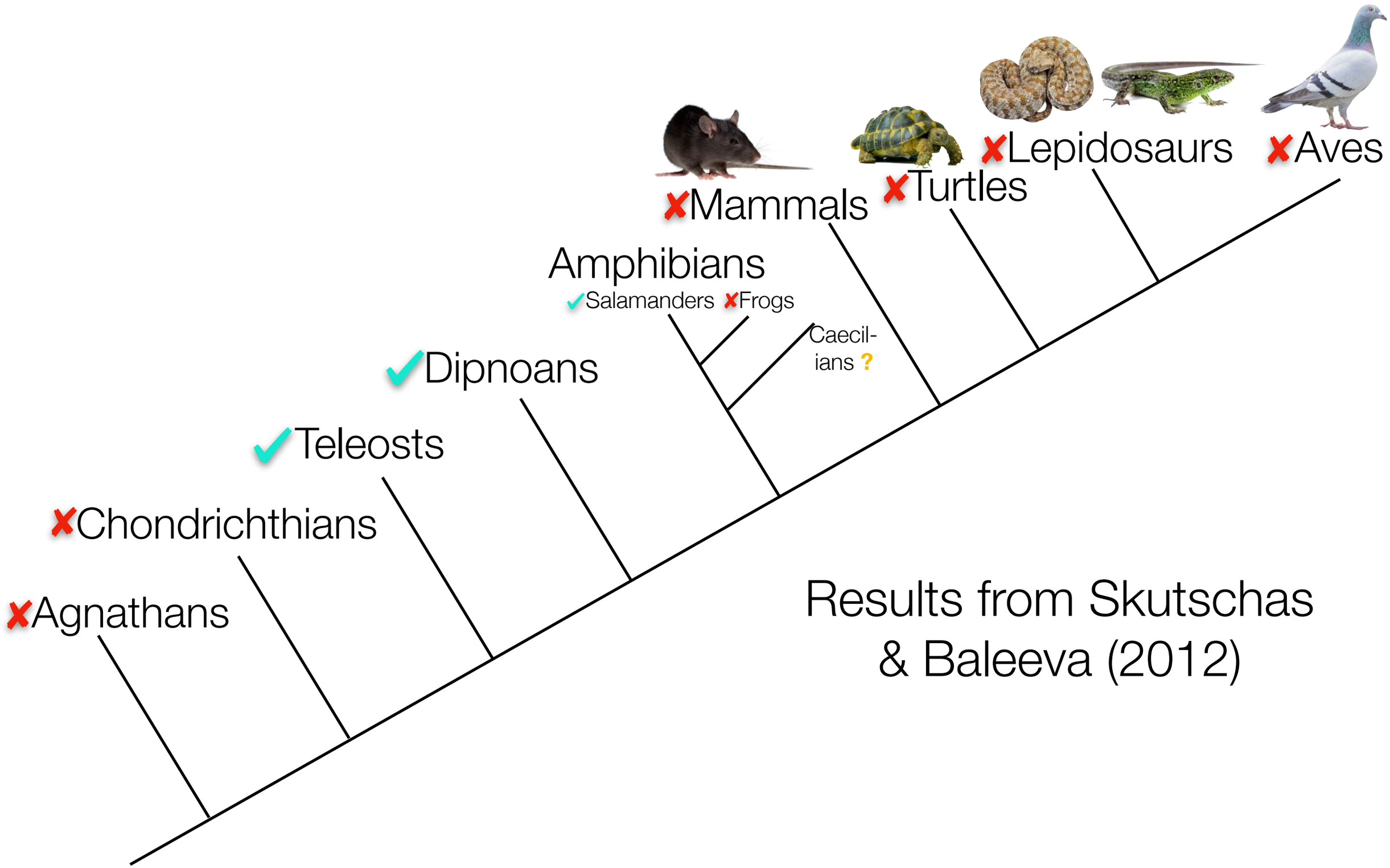


Evolution of Spinal Cord Supports



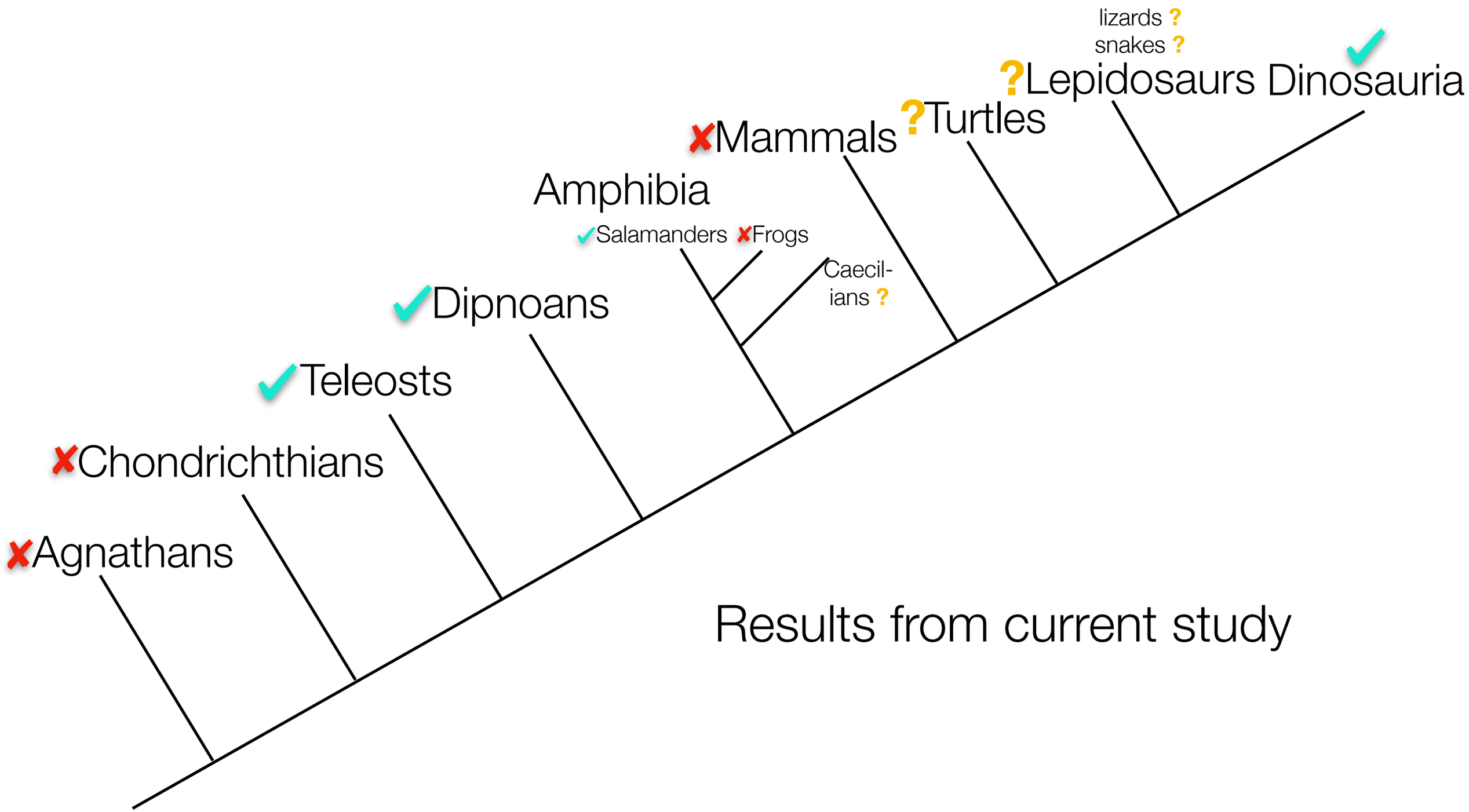
Results from Skutschas & Baleeva (2012)

Evolution of Spinal Cord Supports



Results from Skutschas & Baleeva (2012)

Evolution of Spinal Cord Supports



Results from current study

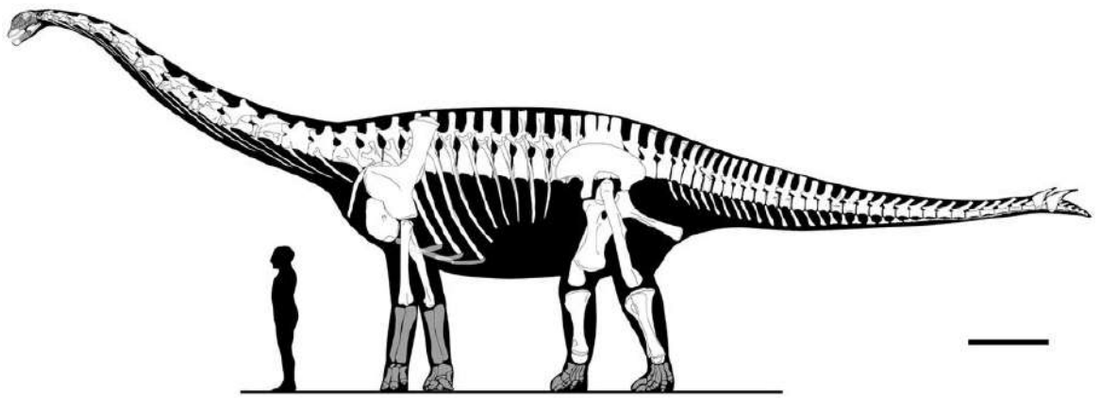
Function

Stabilize spinal cord during lateral movement?

Function

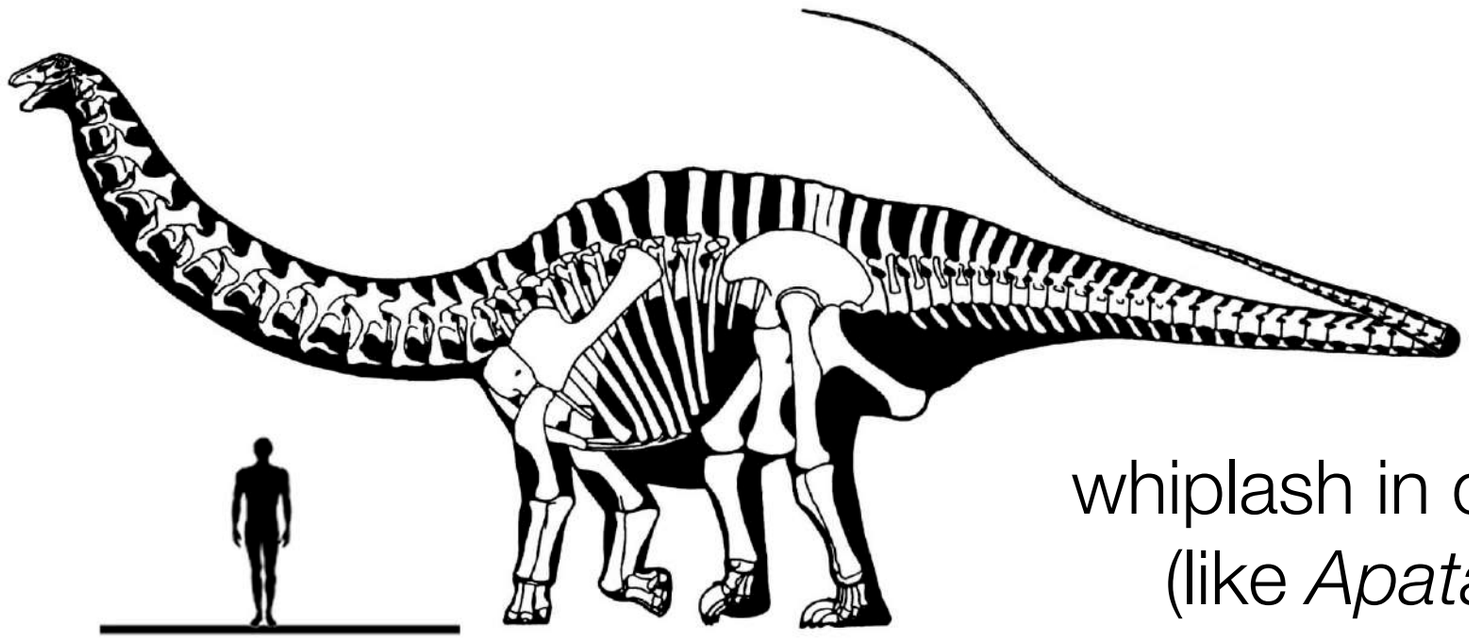
Weapons on the ends of sauropod tails

tail spikes in *Spinophorosaurus*



tail club in *Shunosaurus*

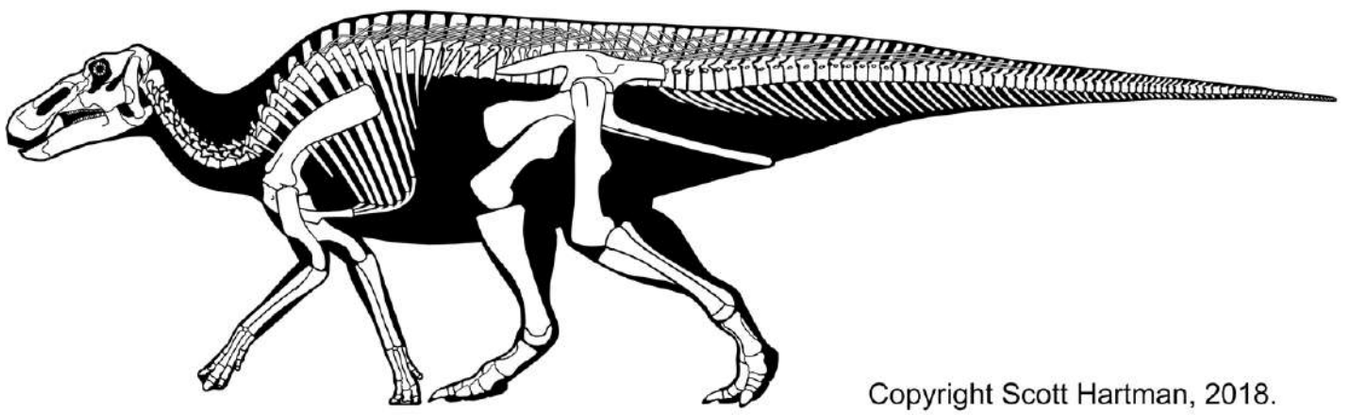
图39 李氏蜀龙的后部尾椎与“尾刺”左视. NO.T5401. 原大×1/4



whiplash in diplodocids
(like *Apatasaurus*)

Stabilize spinal cord during movement & impact?

Function



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Stabilize spinal cord during movement & impact?

Future Work

1. Continue survey of neural canals in dinosaurs.

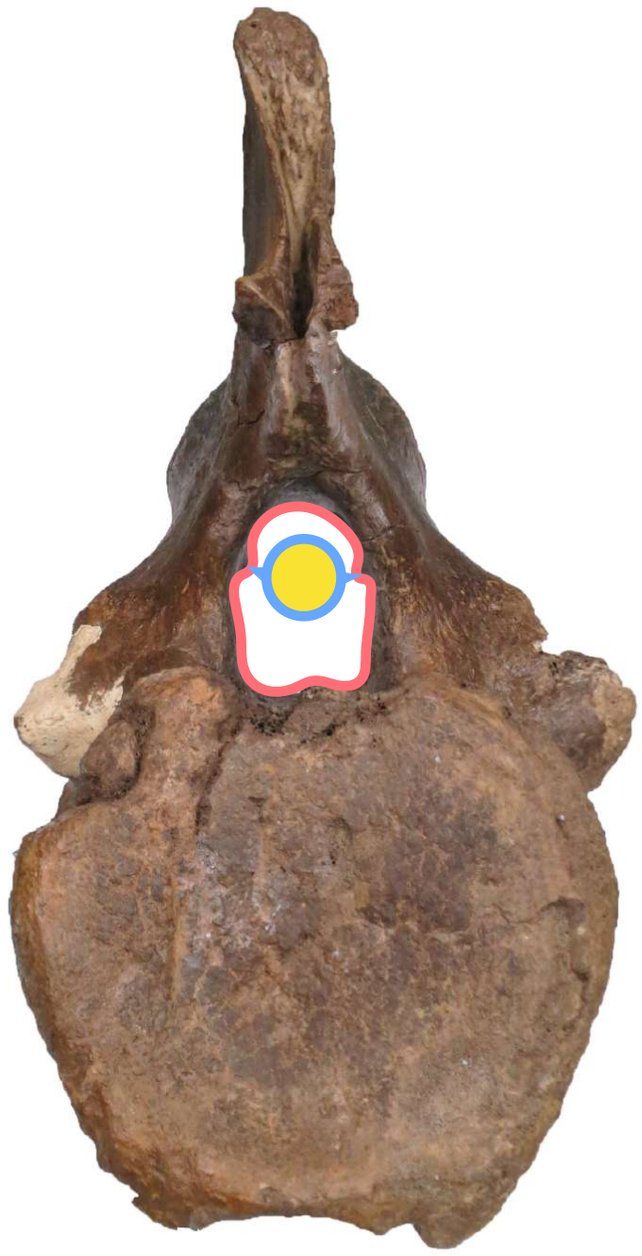
2. Continue survey of neural canals in other extant and extinct vertebrate groups.

3. Histology of extant vertebrates.

4. Further probe for correlation between spinal cord supports and specific behaviors.

Looking In Neural Canals

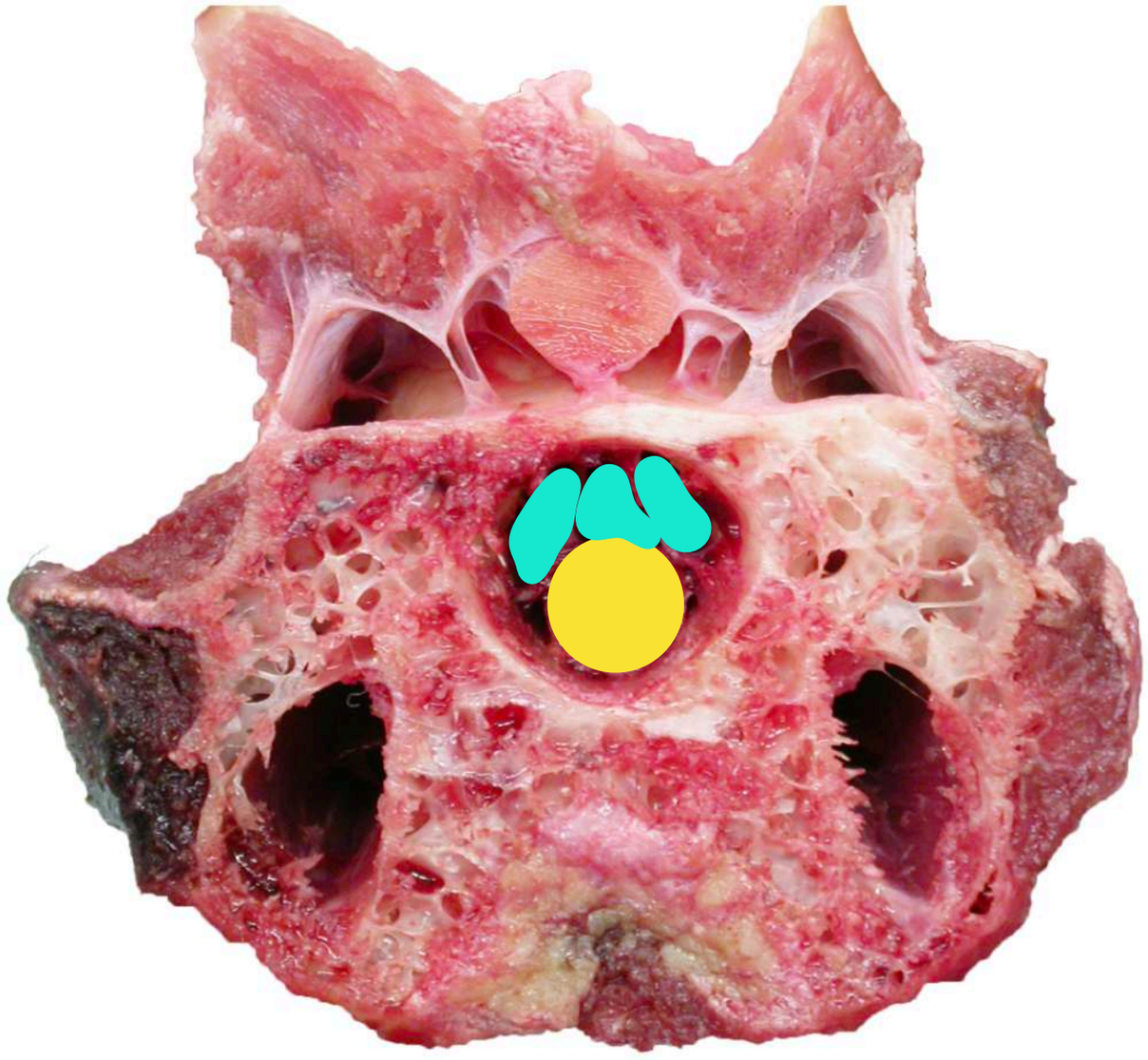
bony spinal cord supports



Astrophocaudia caudal vertebra

dura mater | pia mater | spinal cord

invasion of respiratory system into neural canal



ostrich cervical vertebra cross-section

supramedullary airways | spinal cord

Questions?

svpow.com @theladyanatomica