EVOLUTION OF BIRDS

Fastovsky
Chapter 10 & 11

Is it a Dinosaur or Bird?

DINOSAUR!

Jinfengopteryx

Is it a Dinosaur or Bird?

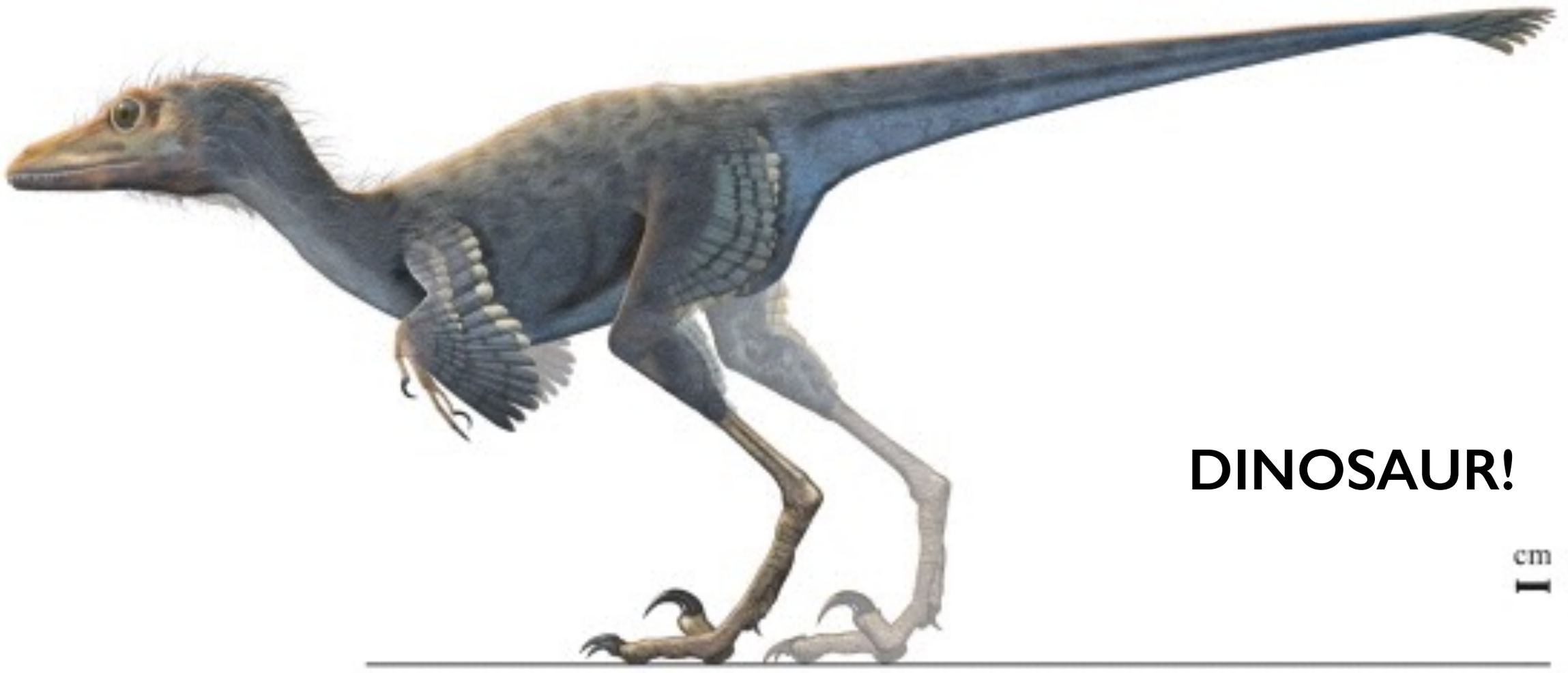
DINOSAUR!
Microraptor

Is it a Dinosaur or Bird?

BIRD!

Jeholornis

Is it a Dinosaur or Bird?



Mahakala

Is it a Dinosaur or Bird?

BIRD!
Archaeopteryx

Is it a Dinosaur or Bird?

DINOSAUR!

Rahonavis

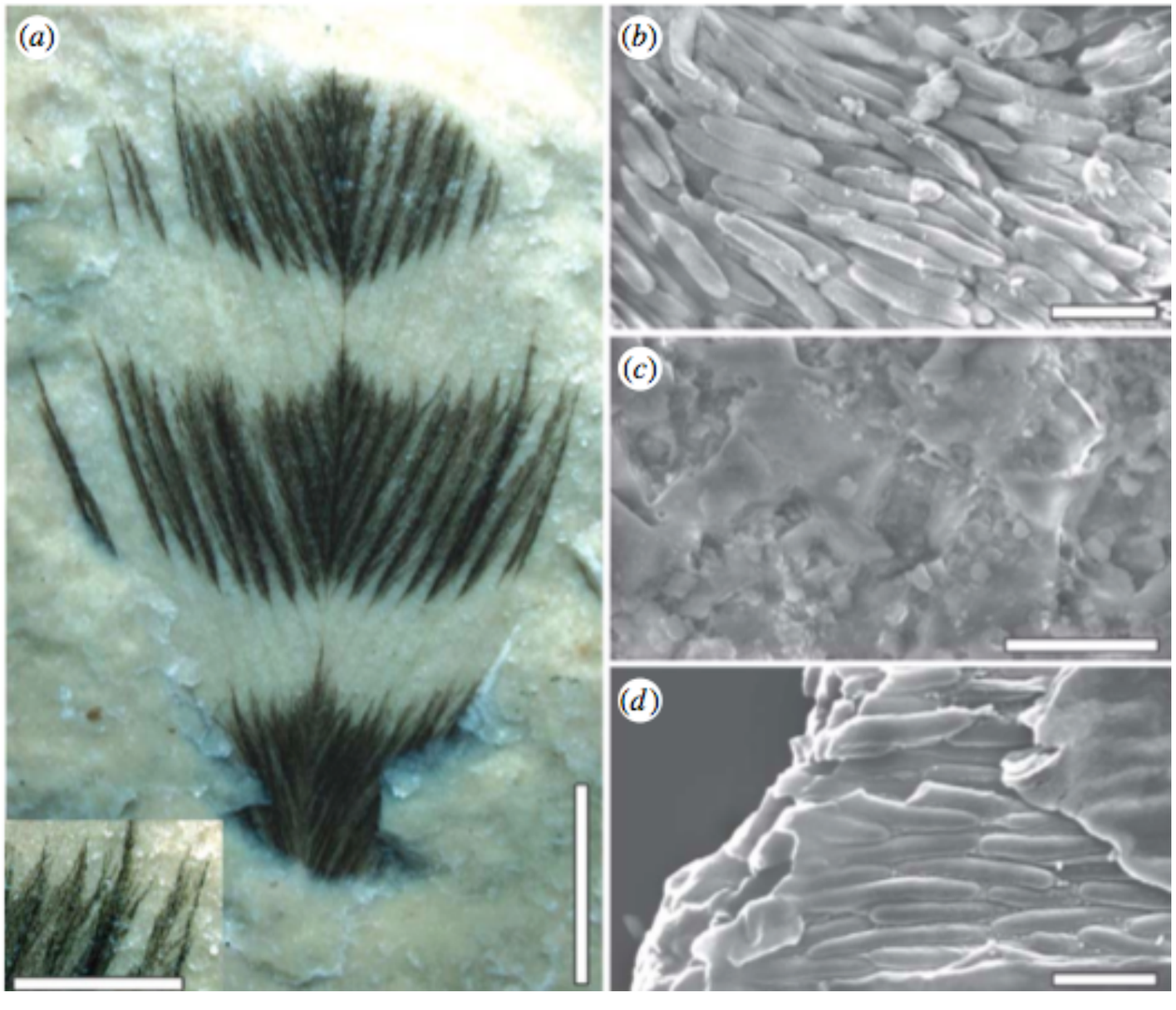
Is it a Dinosaur or Bird?

DINOSAUR!

Anchiornis

Dinosaur Color Patterns

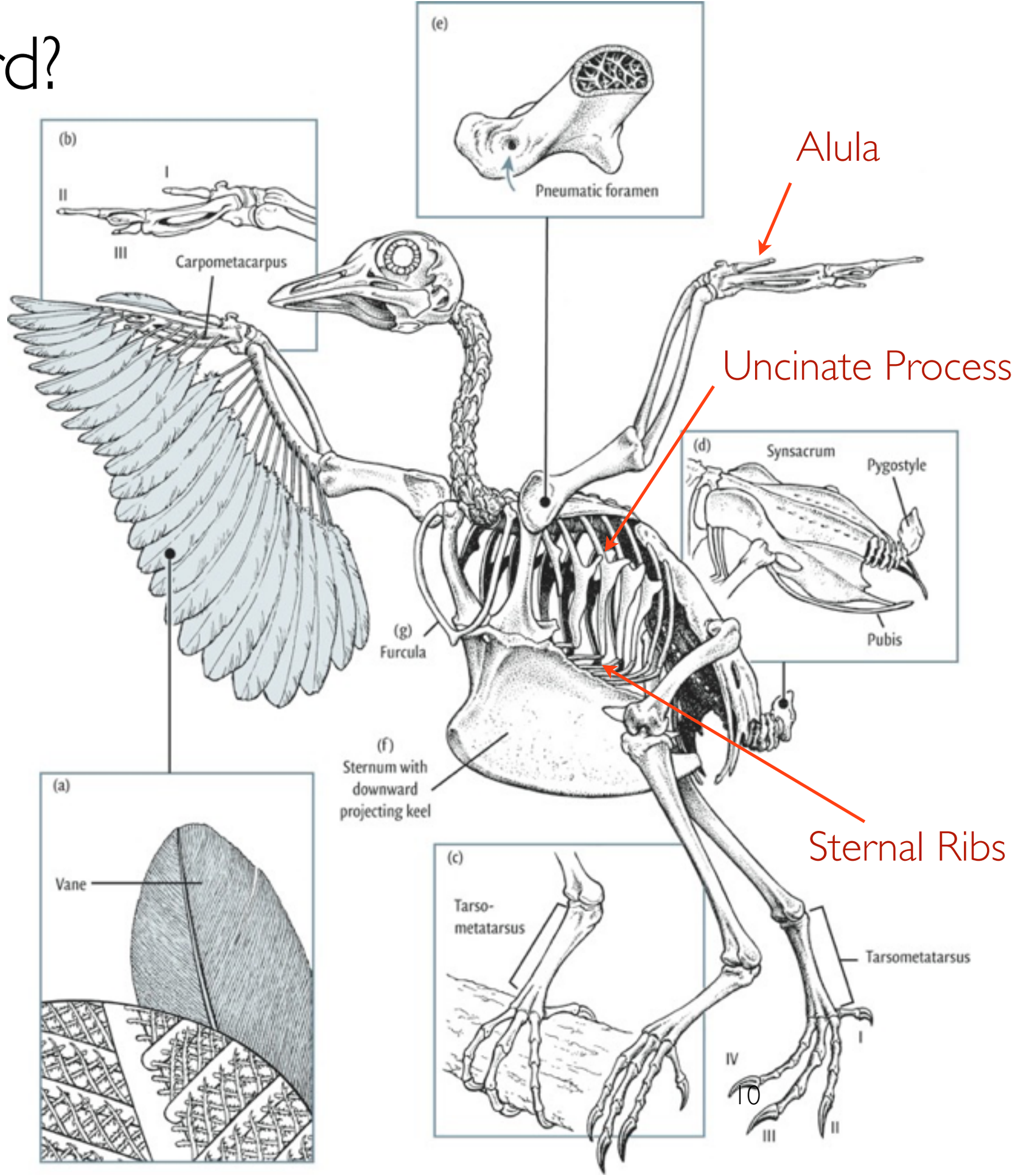
This is the actual coloration of the Jurassic dinosaur *Anchiornis*



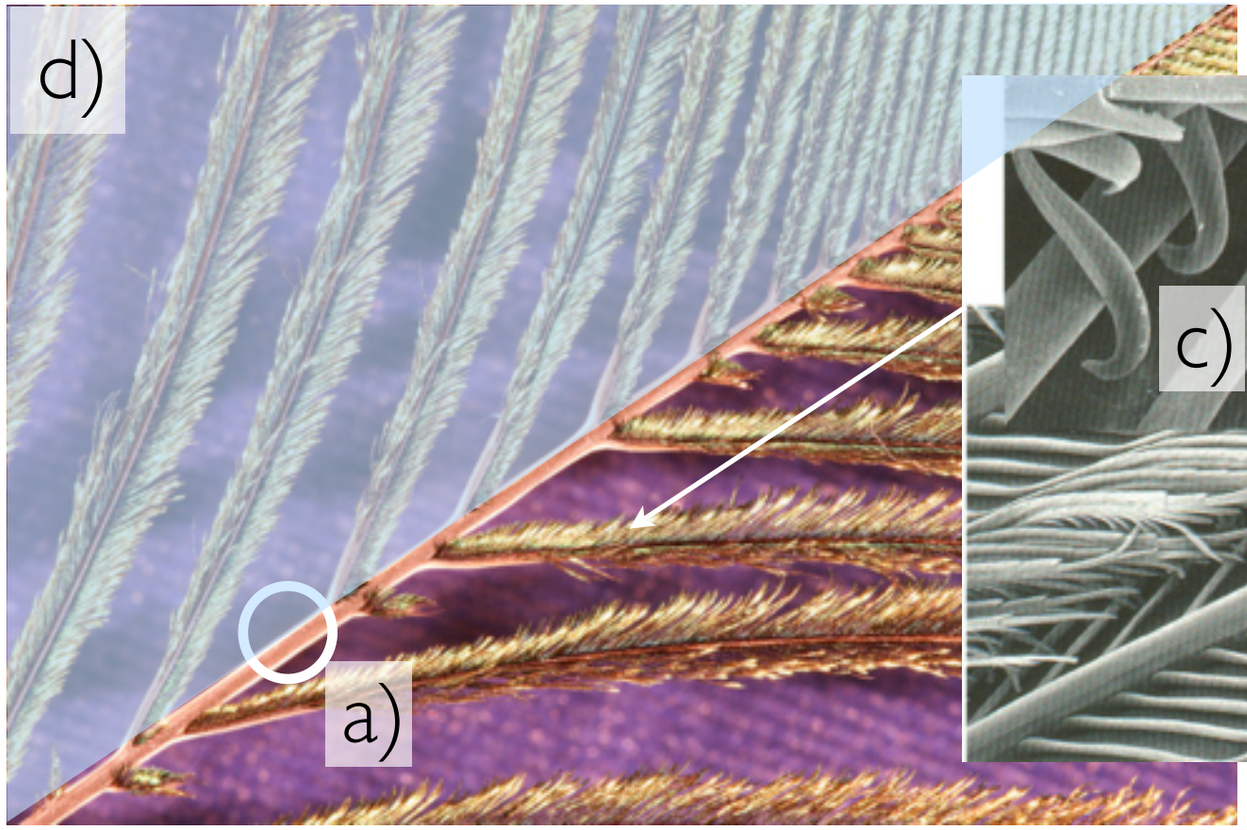
Distribution of two types of preserved pigment cells (melanosomes) allows actual color pattern to be determined

First, what is a bird?

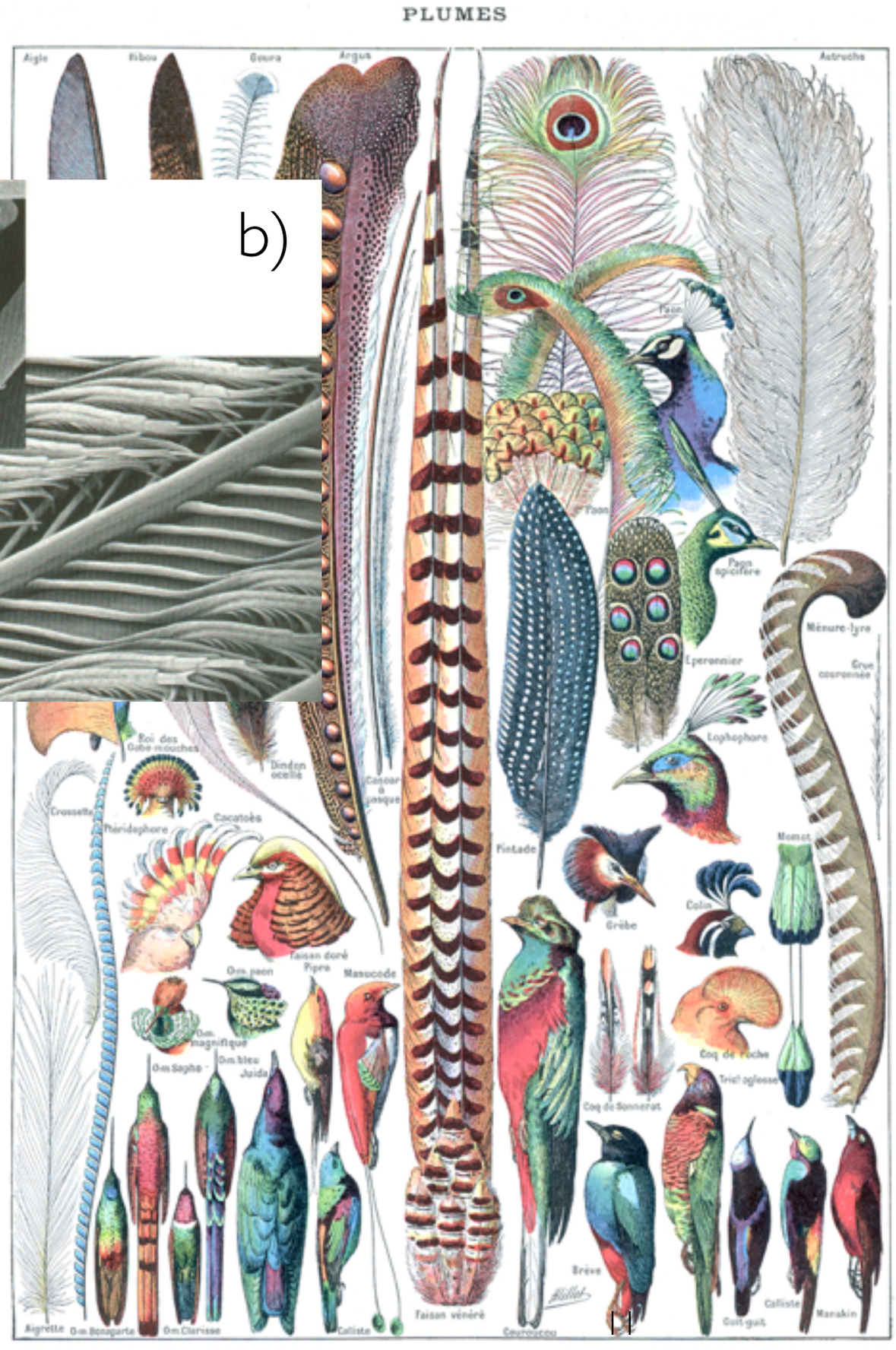
- Feathers
- Loss of teeth
- Large brains, adv. sight
- Carpometacarpus
- Bipedal
- Pygostyle
- Pneumatic bones
- Rigid skeleton
- Furcula (wish bone)



Feathers



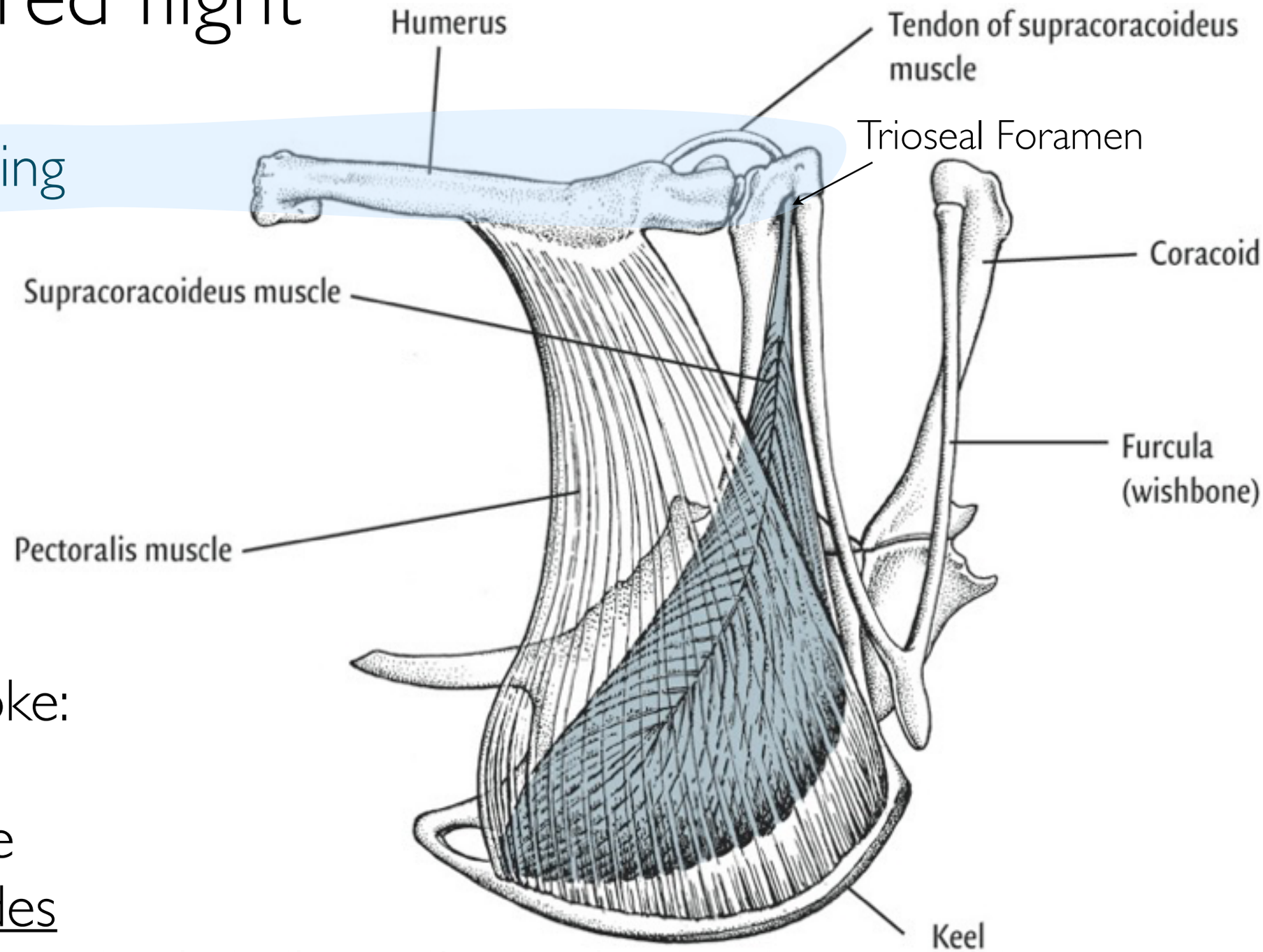
a) Central shaft
b) Barbs radiate from shaft
c) Barbs can be linked by Barbules
d) A sheath of linked barbs = Vane



Parrot Feather

Birds: Powered flight

Wing



Downward stroke:

Pectoralis

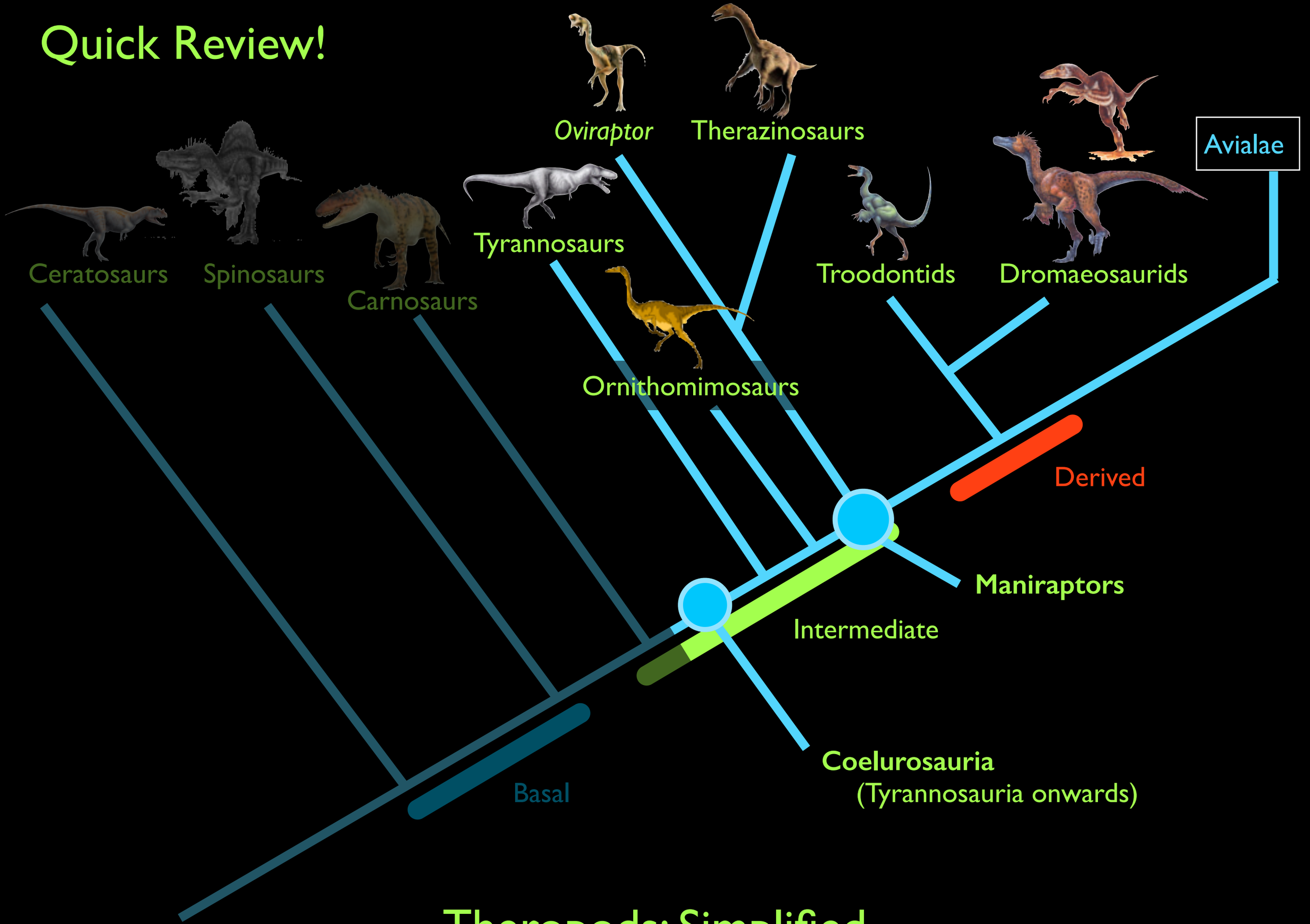
Recovery stroke

Supracoracoides

Attached to to the keel; similar to Pectoralis... but how does it cause opposite motion?

Hooked via tendon through the TRIOSEAL FORAMEN... unique in Animal Kingdom

Quick Review!



Theropods: Simplified

Now we know what birds are...
But which traits are unique?

Feathers

Loss of teeth

Large brains, adv. sight

Carpometacarpus

Bipedal

Pygostyle

Pneumatic bones

Rigid skeleton

Furcula

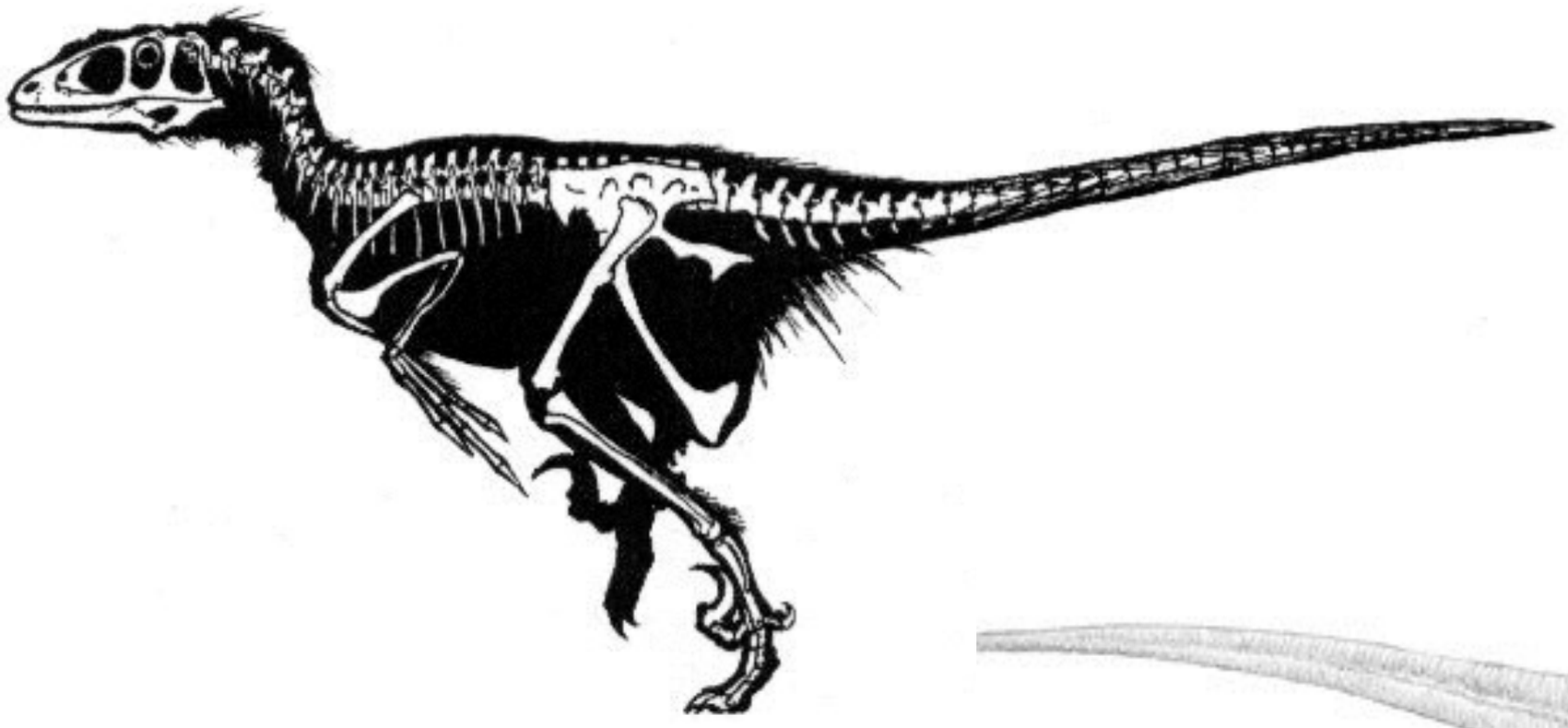
All Theropods

Coelurosauria

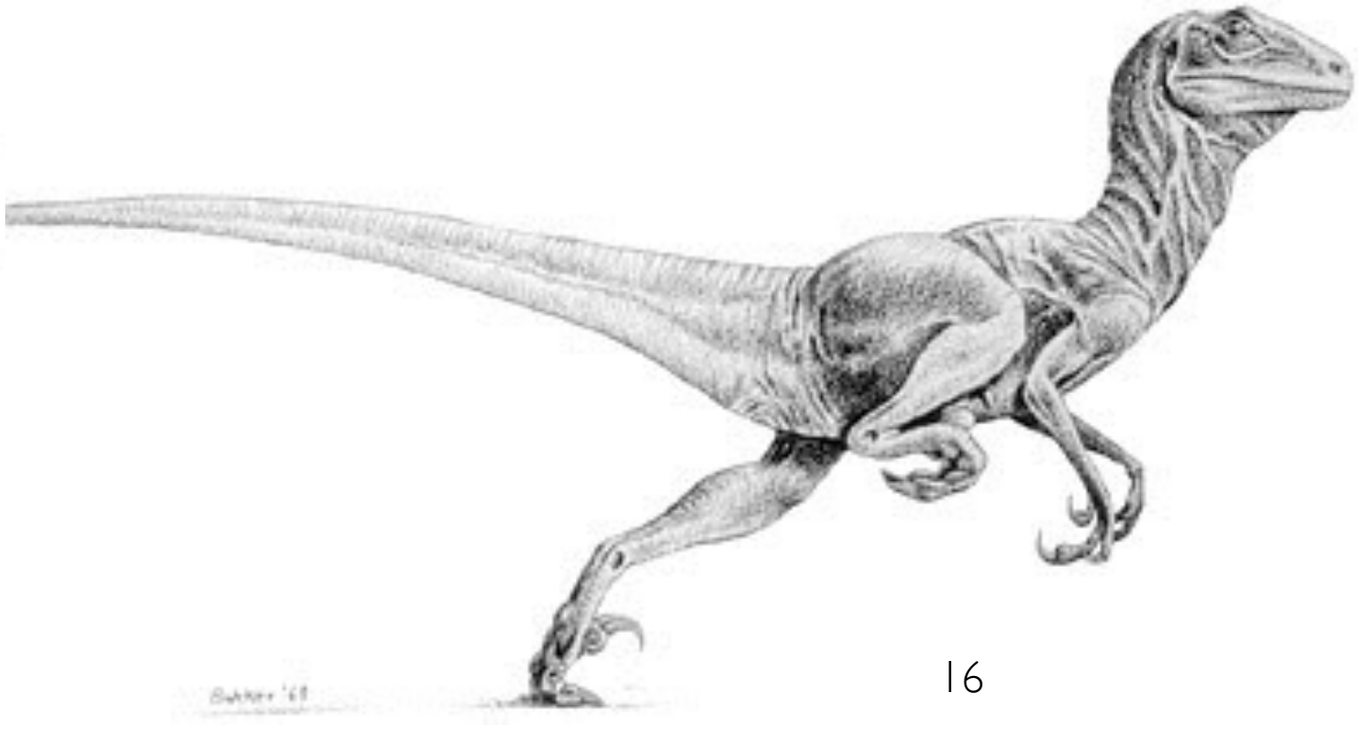
Derived Theropods

Bird Ancestors

In the 1960s, paleontologist John Ostrom championed the idea that birds descended from theropod dinosaurs



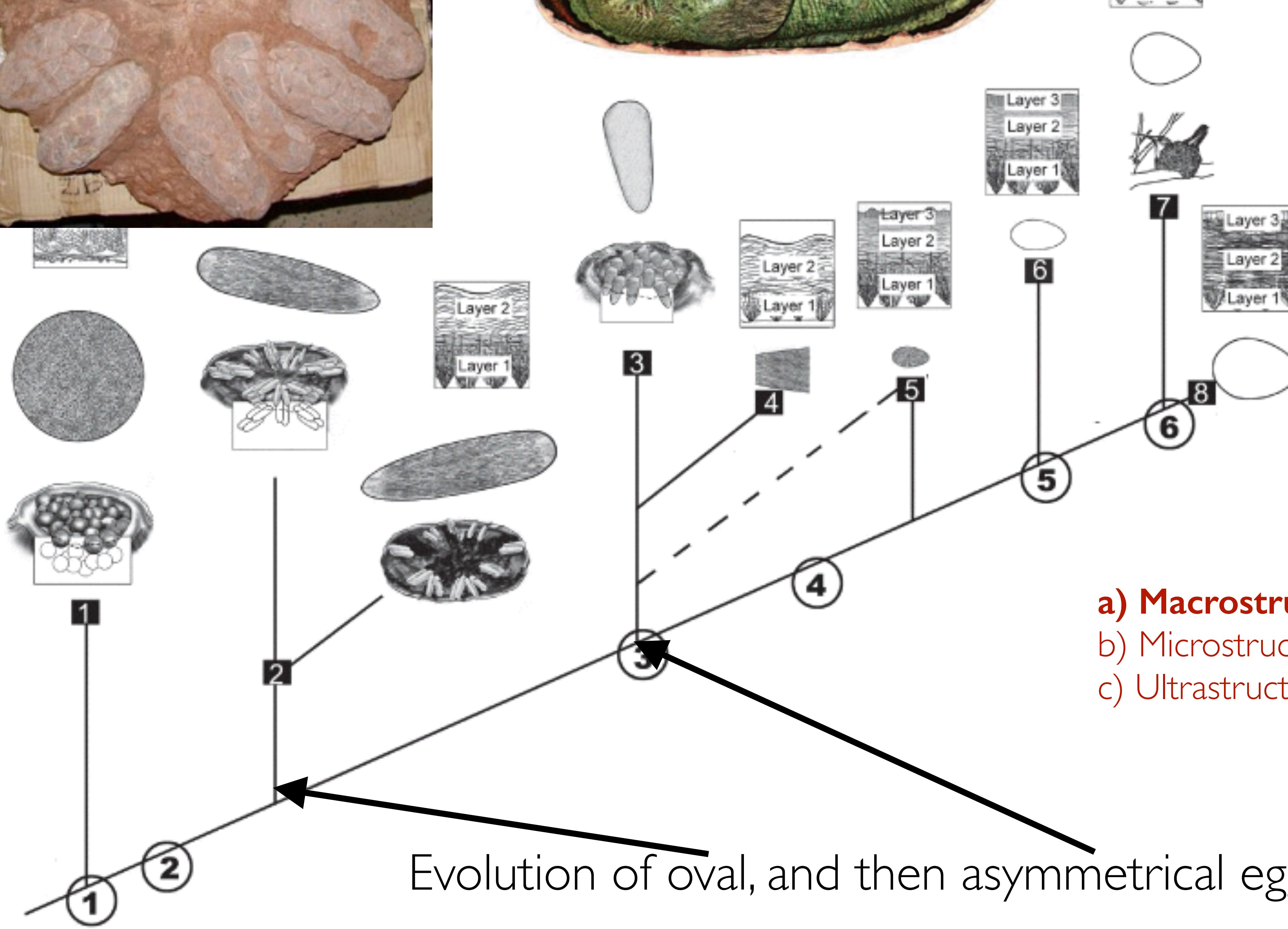
Deinonychus
(Dromaeosauridae)



Bird Ancestors

Evidence that theropod dinosaurs are the ancestors of birds comes from four major aspects of their biology

1. Oology (eggshell, nest, and egg-laying)
2. Behavior
3. Osteology (bone structure)
4. Integument (skin covering)
5. Molecular Evidence (Amino Acid sequences from T. rex)

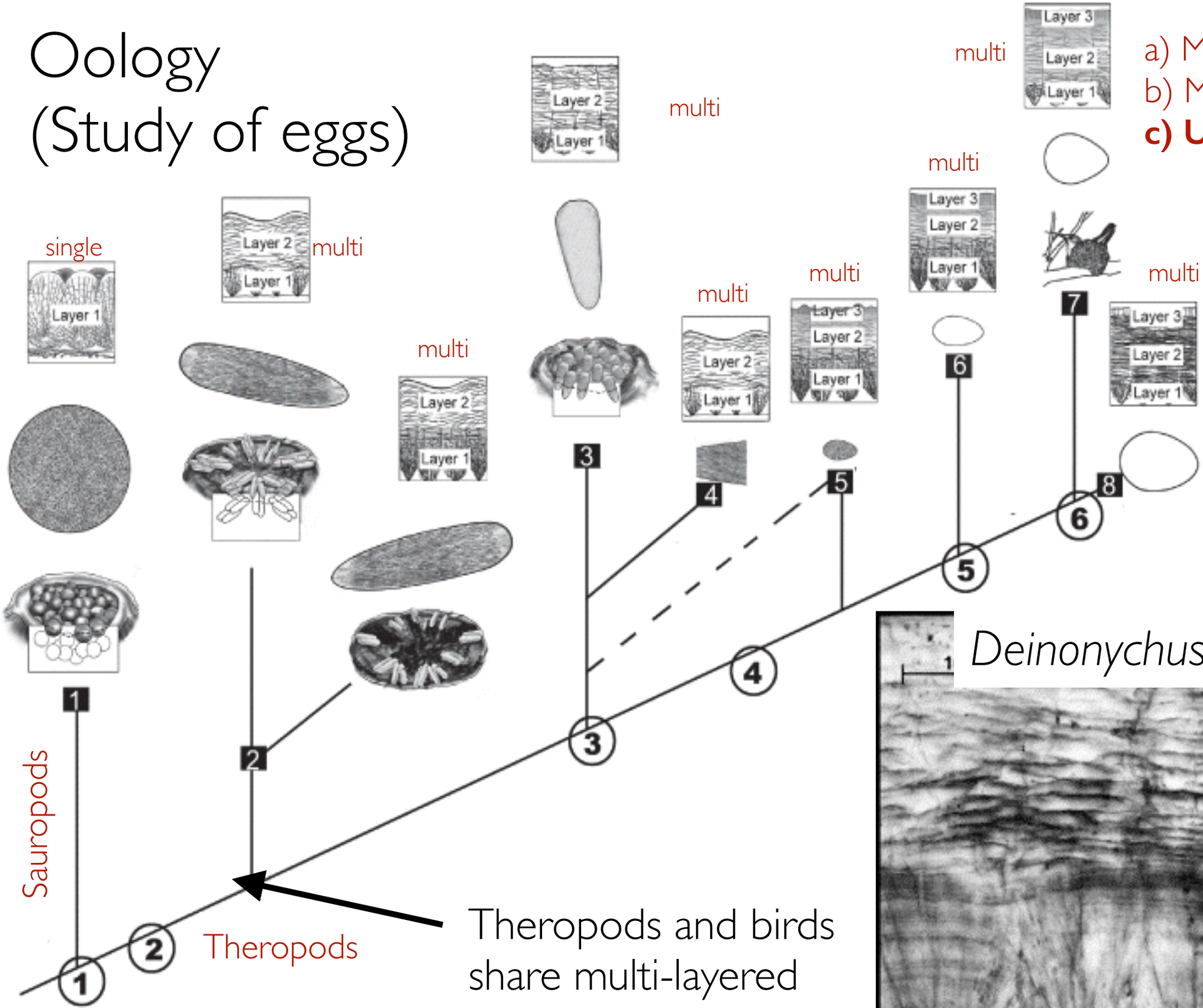


a) Macrostructure
b) Microstructure
c) Ultrastructure

Evolution of oval, and then asymmetrical eggs

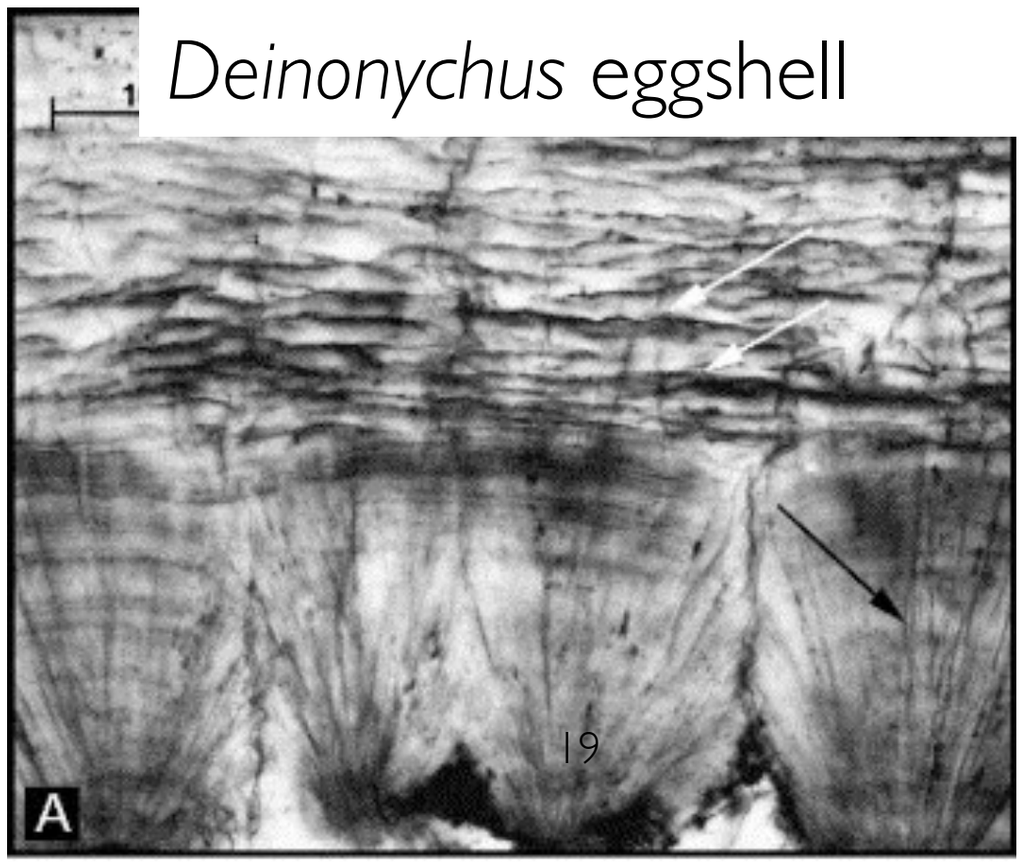
Oology
(Study of eggs)

a) Macrostructure
b) Microstructure
c) Ultrastructure



Theropods and birds share multi-layered eggshell structure (prismatic and laminar)

Deinonychus eggshell

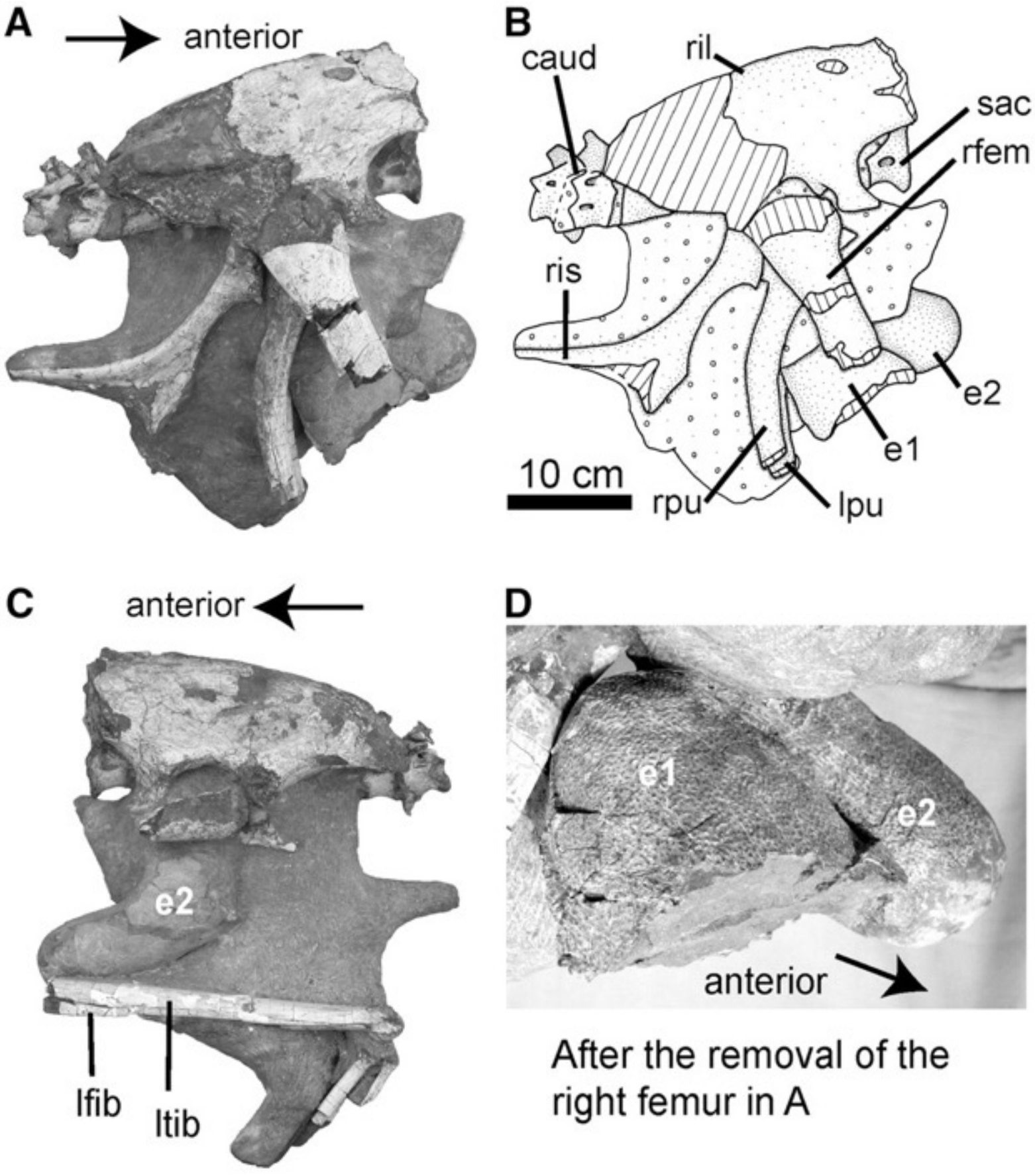


Autochronous Ovideposition

Crocodiles, sauropods, and ornithischians laid all eggs at once

Theropods and birds laid two (or one) eggs at a time

Asymmetrical eggs in advanced non-avian theropods may indicate single functional oviduct



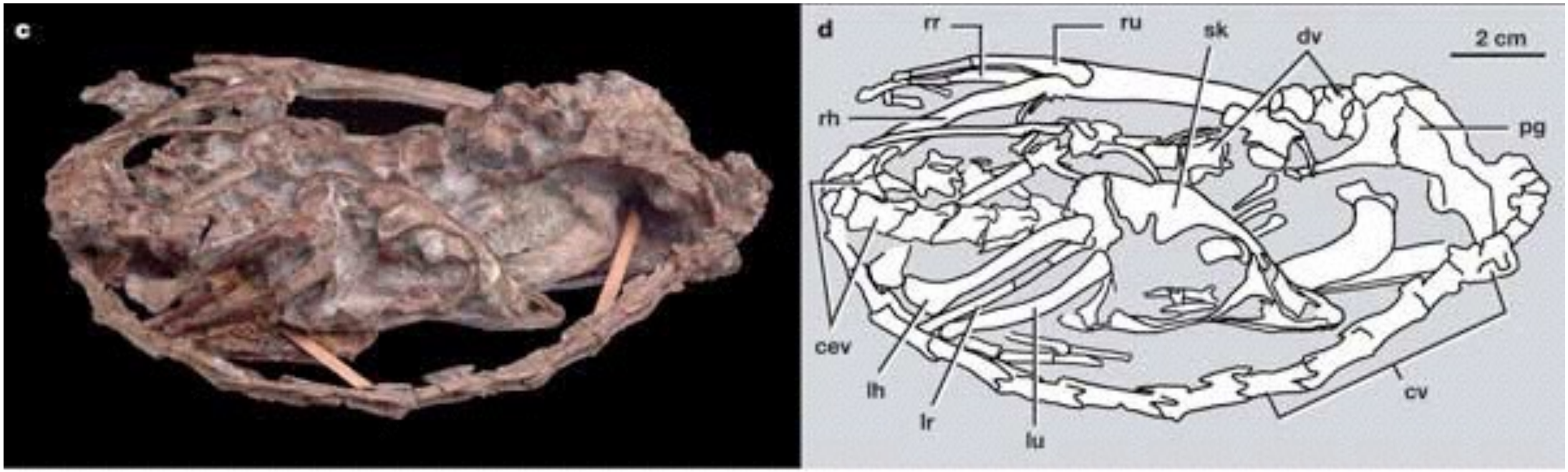
After the removal of the right femur in A

Theropods actively brooded their egg clutch, like birds

Crocodiles and sauropods have minimal parental care and buried eggs in pile of sand/leaves

Behavior – Sleeping Position

Troodontid *Mei long*



Furculum ("Wishbone")

Formed by fusion of clavicles, gradually changed from boomerang shape to wishbone shape

In birds, acts as strut or spring to resist compressional forces during flight stroke

Tyrannosaurus

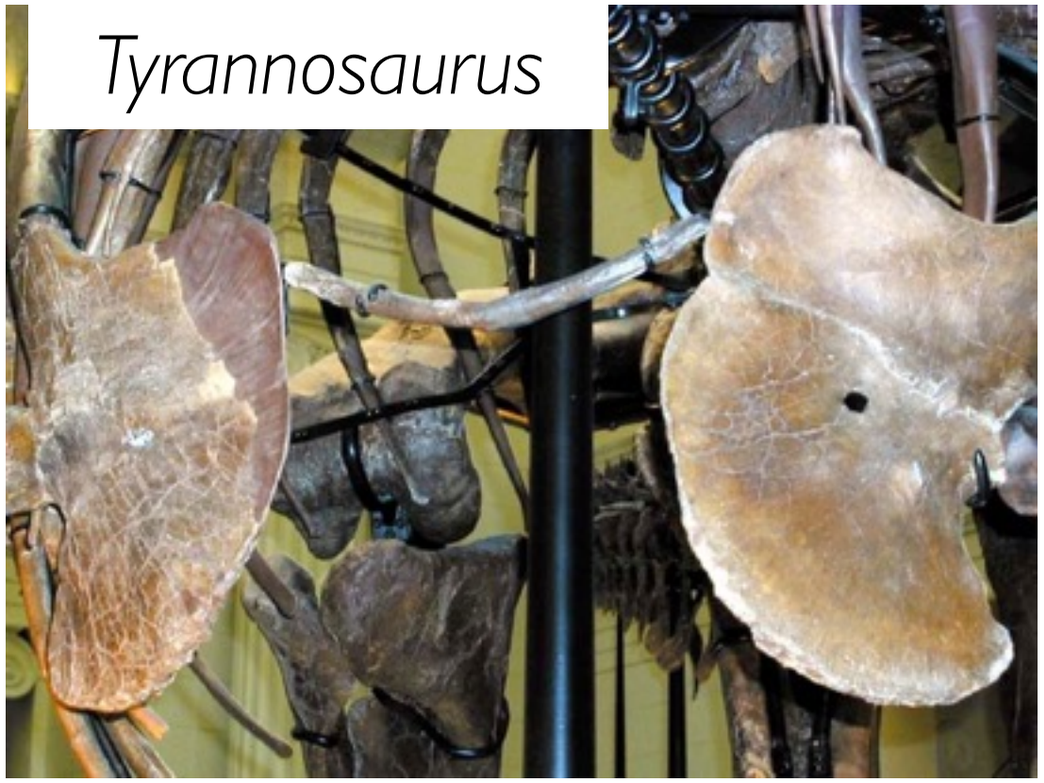
Archaeopteryx

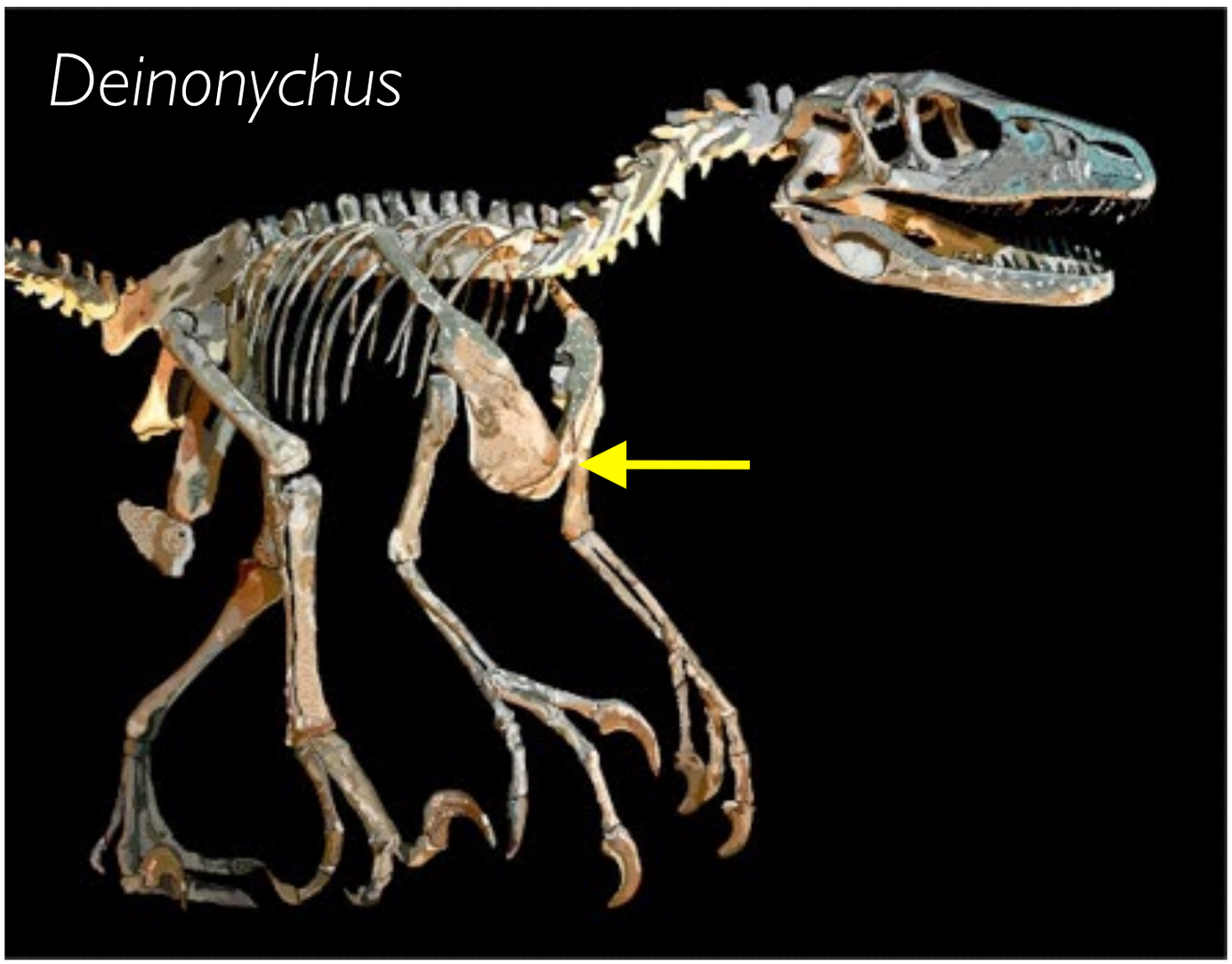
Turkey

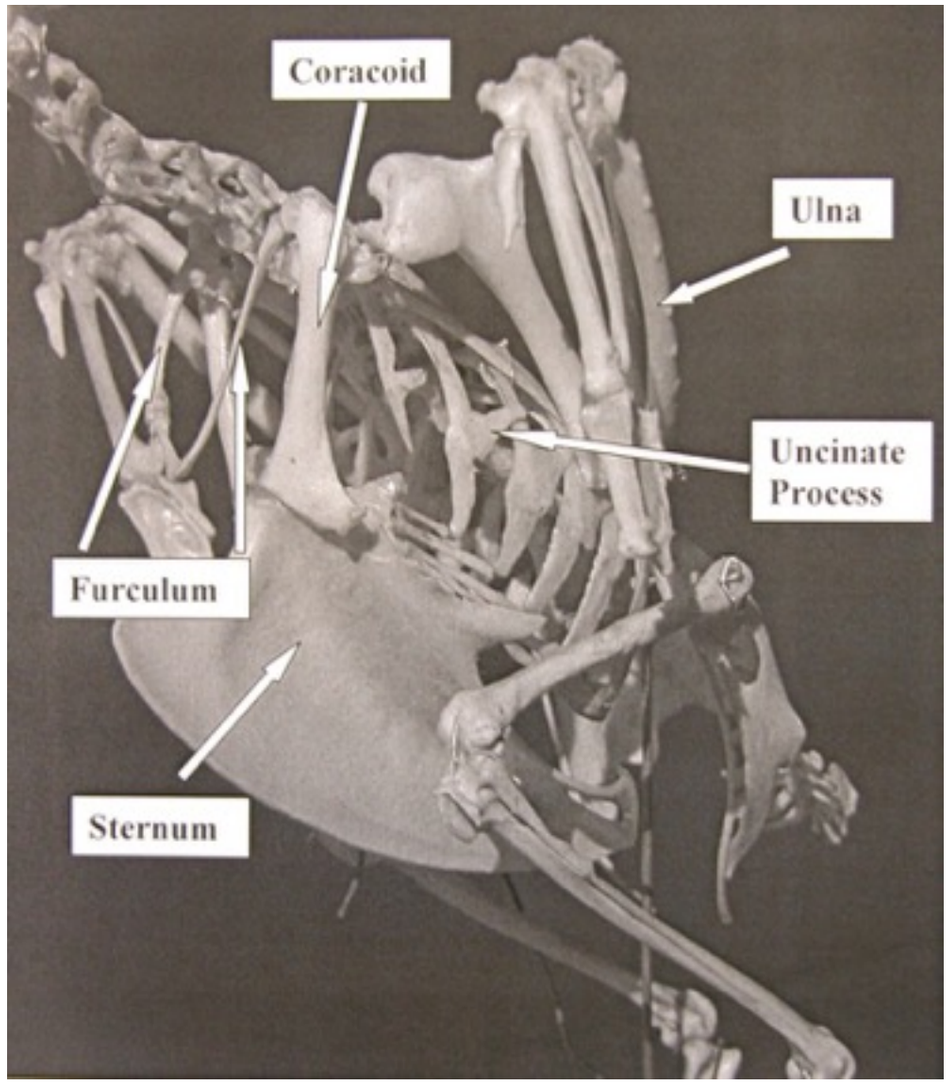
Fused Sternum

Pectoral girdle fused into large sternum in later theropods and birds

In birds, provides large attachment surface for flight muscles

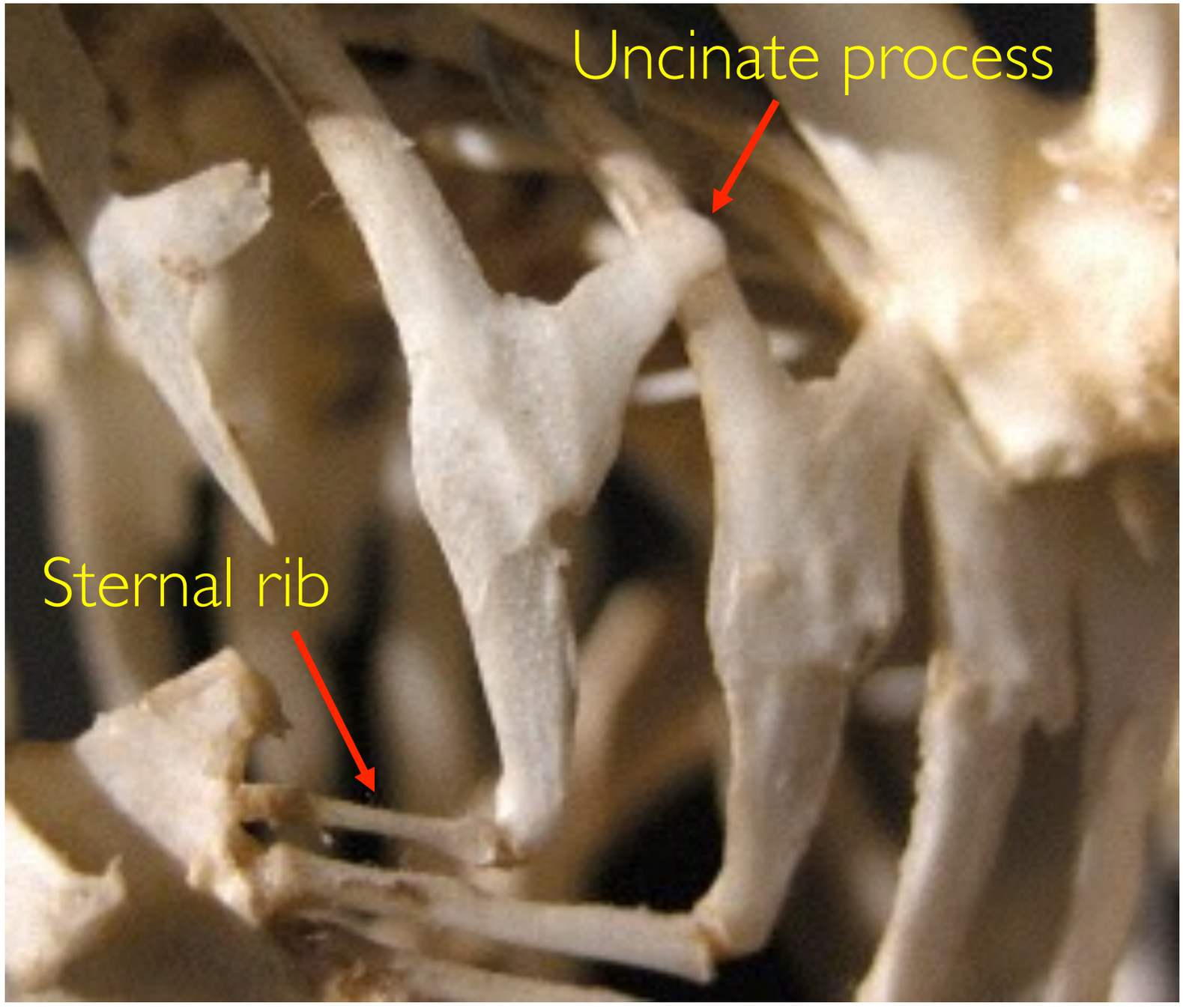






Ventral Ribs

Theropods and birds have bony sternal ribs and uncinate processes connecting ribs



Uncinate Processes

In birds, prevent ribcage from being crushed during powerful flight stroke

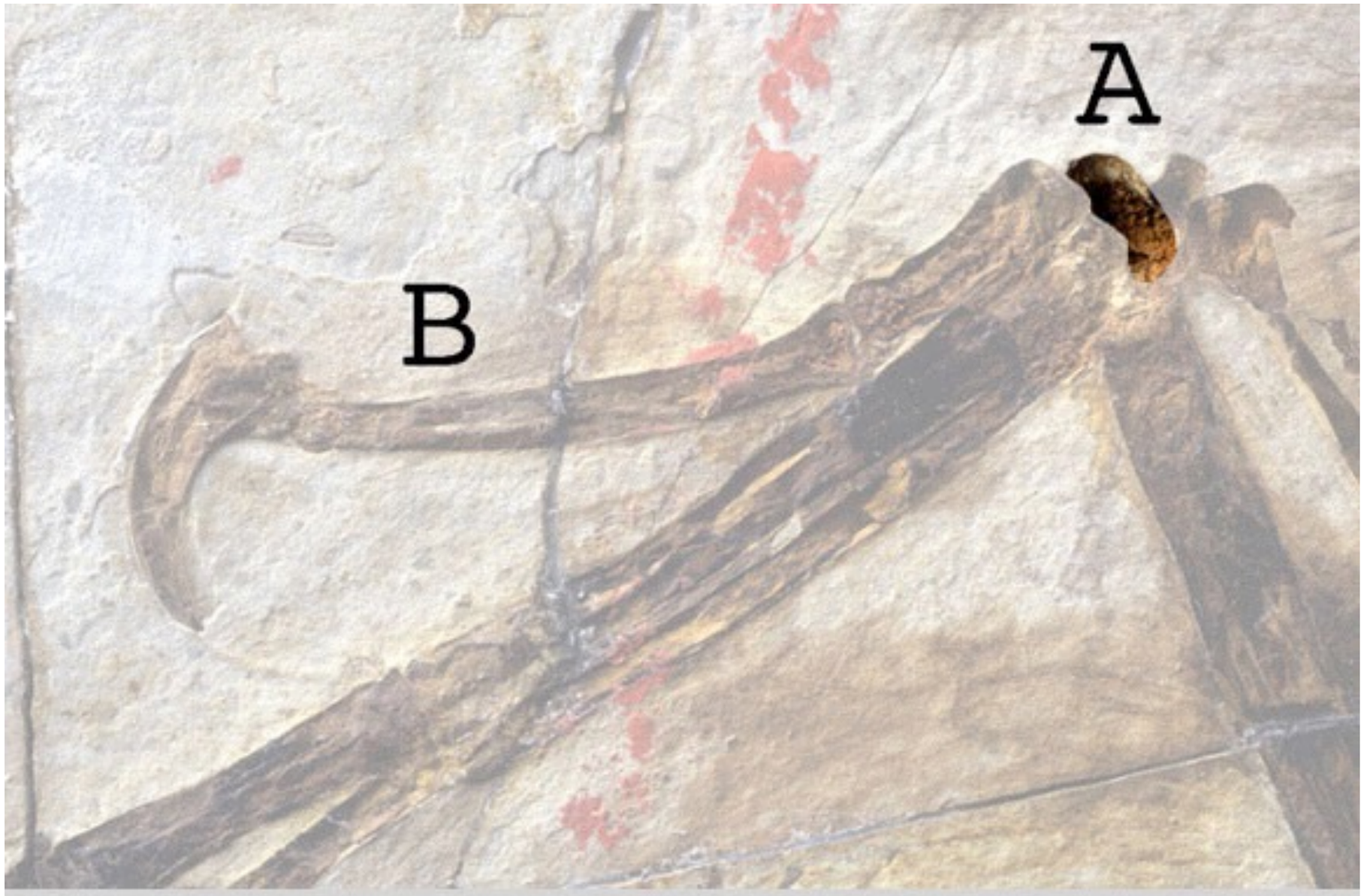
An integral part of theropod and bird respiratory system

(e)

Semilunate Carpal

Half-moon shaped wrist bone first found in advanced theropods

Important for wing folding during avian flight stroke



A. Semilunate wrist bone **B.** First finger

Integument – Feathers

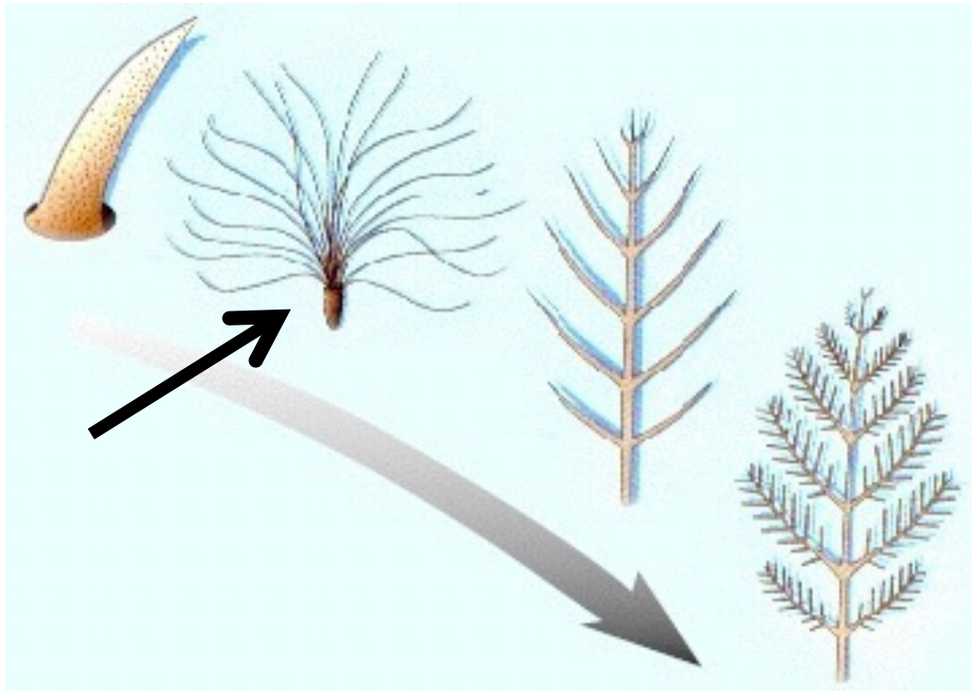
Animals with feather MUST be endothermic.

Logic: If you require external heat, why would you insulate yourself?

No ectothermic animals have insulation

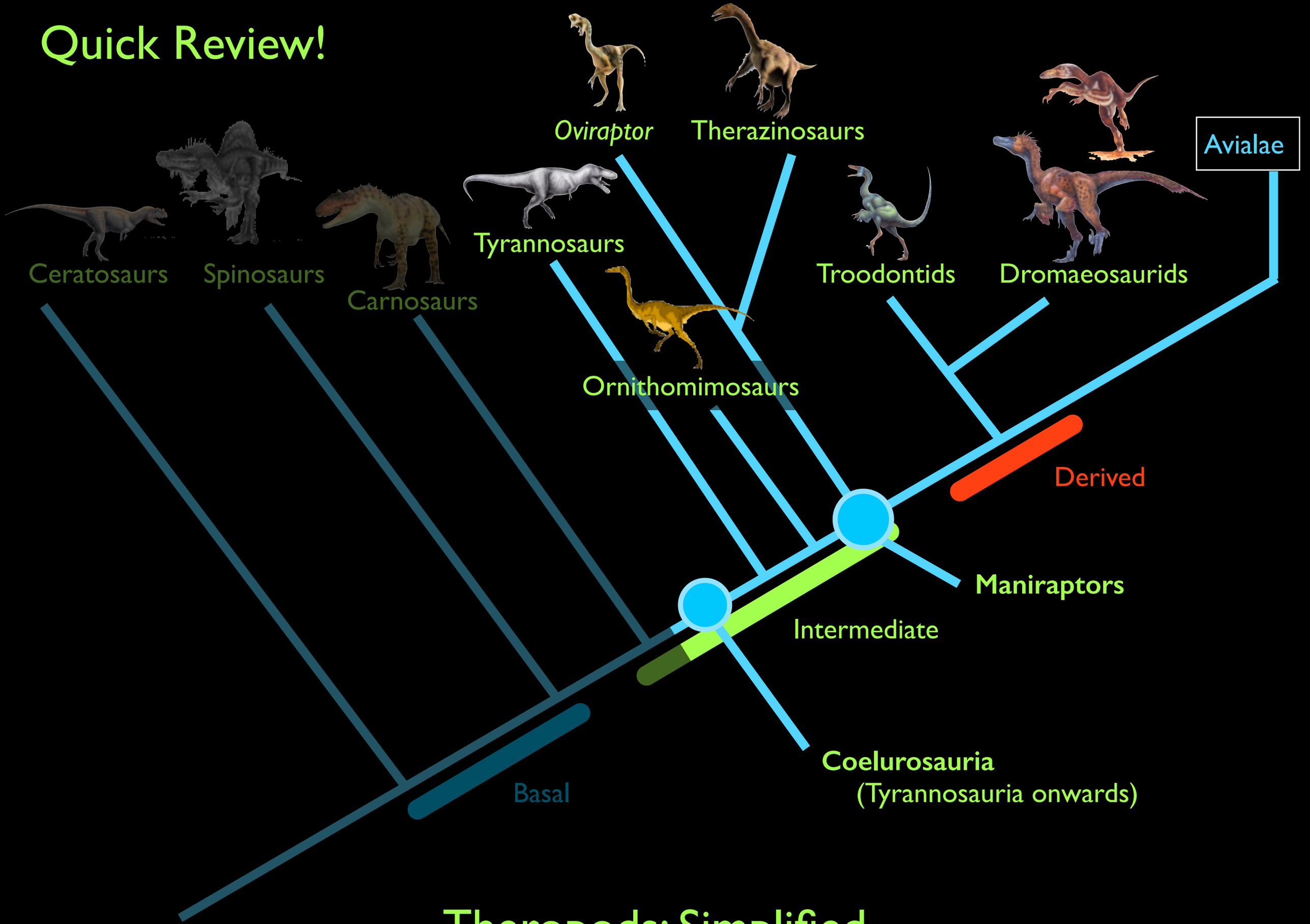
Integument – Feathers

Feathers first evolved in non-avian theropods



Downy (plumulaceous) feathers in coelurosaurians like *Sinosauropteryx* and tyrannosaurs

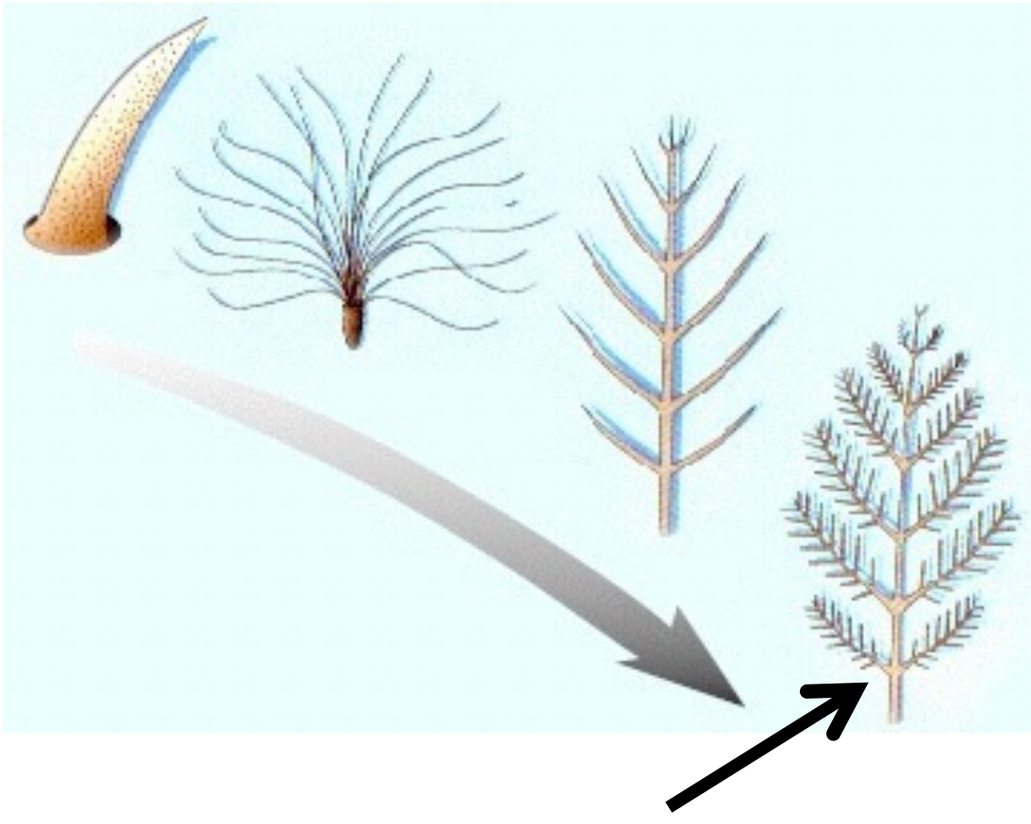
Quick Review!



Theropods: Simplified

Integument – Feathers

Vaned (pennaceous) feathers in maniraptorans (oviraptorids, troodontids, dromaeosaurs) like *Microraptor*



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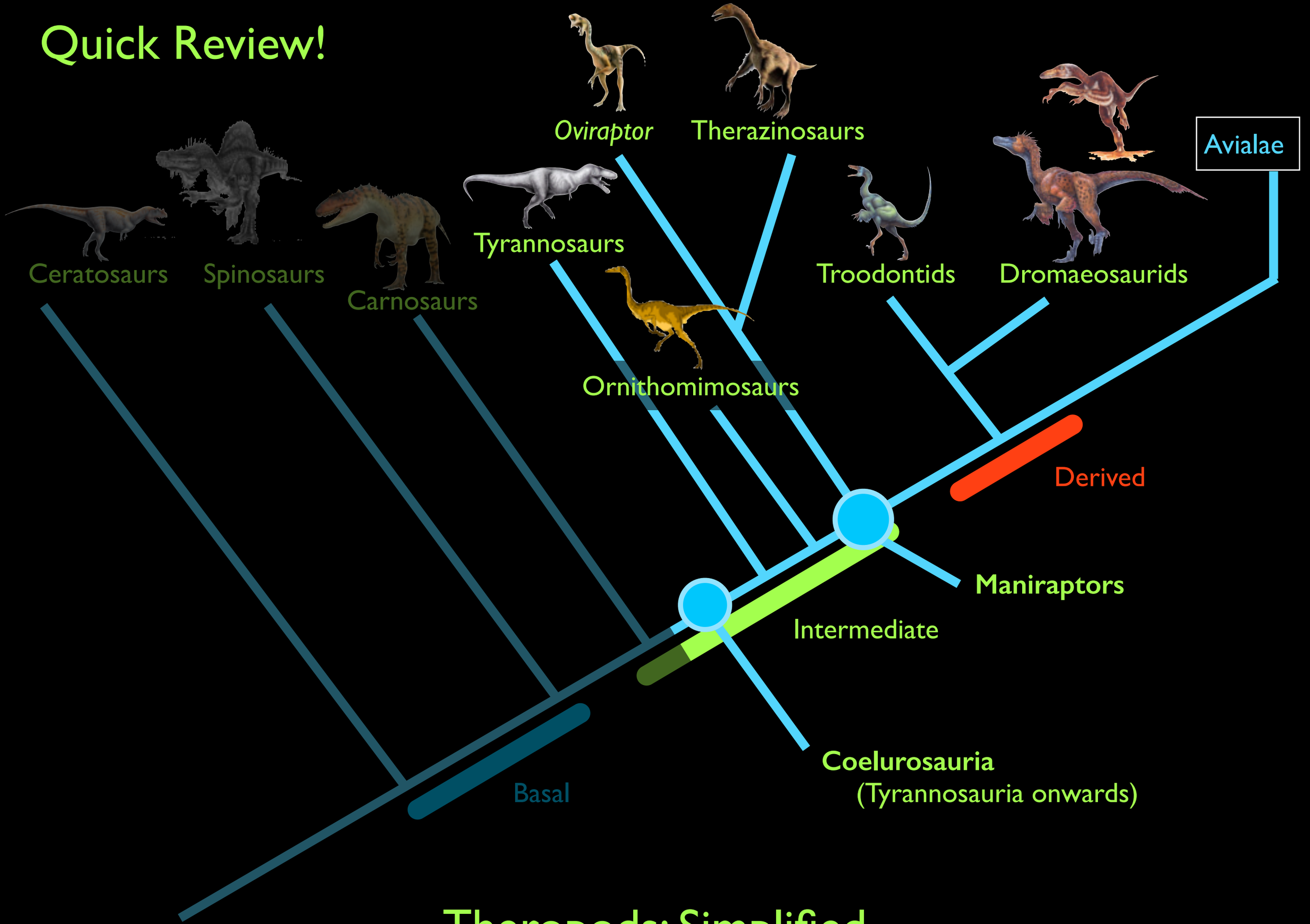
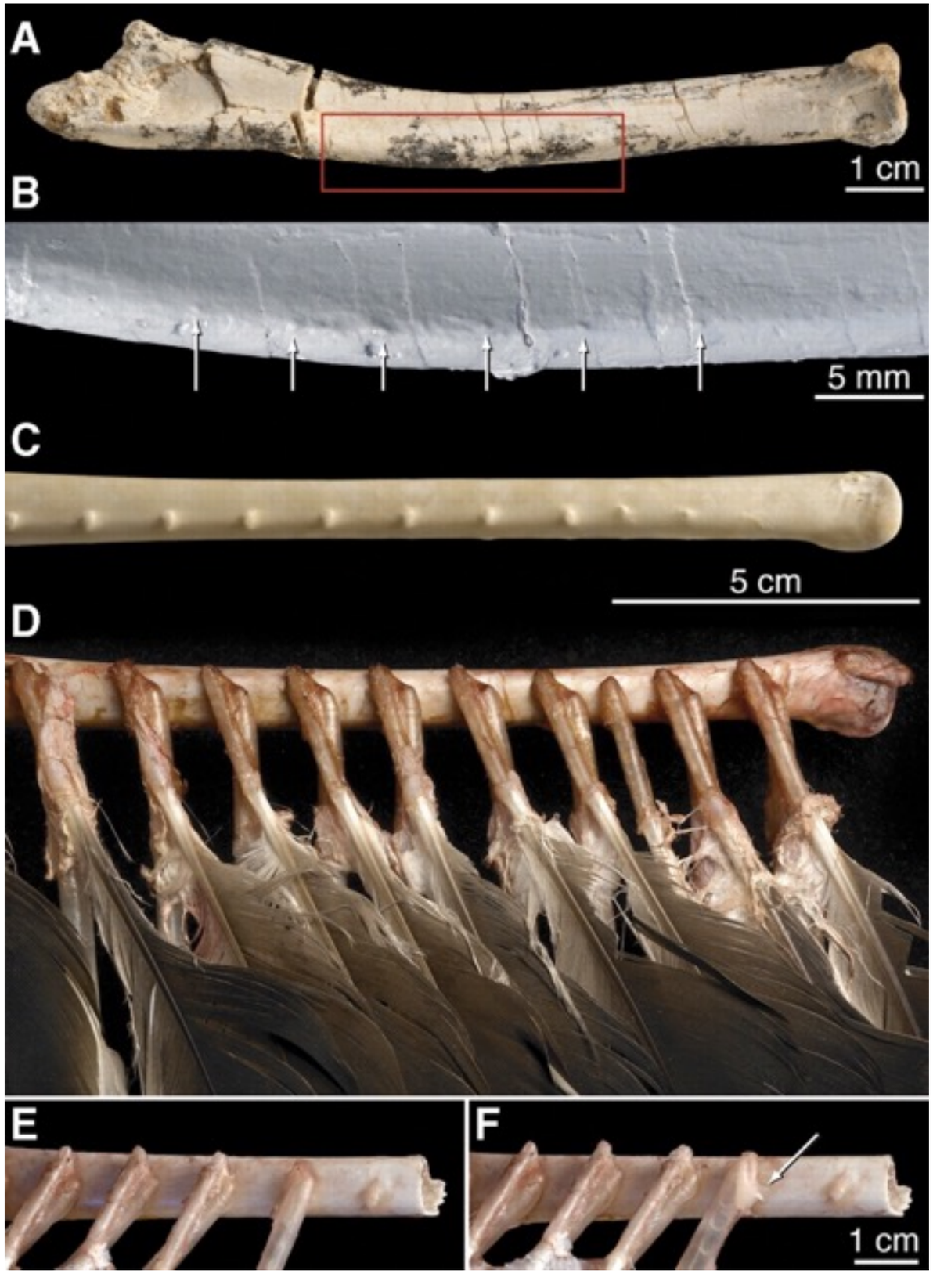


Theropods: Simplified

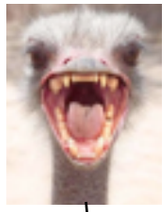
Integument – Feathers

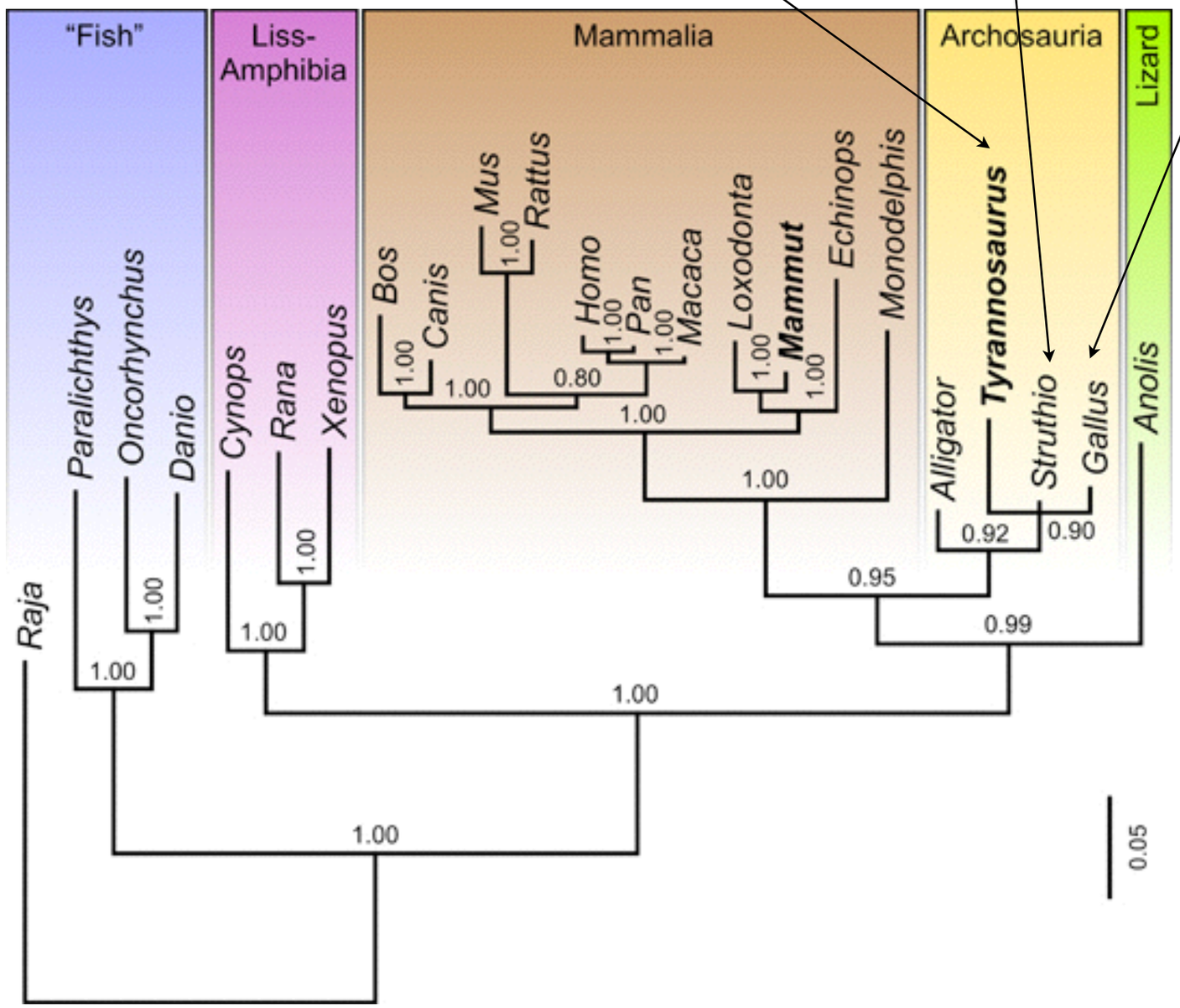


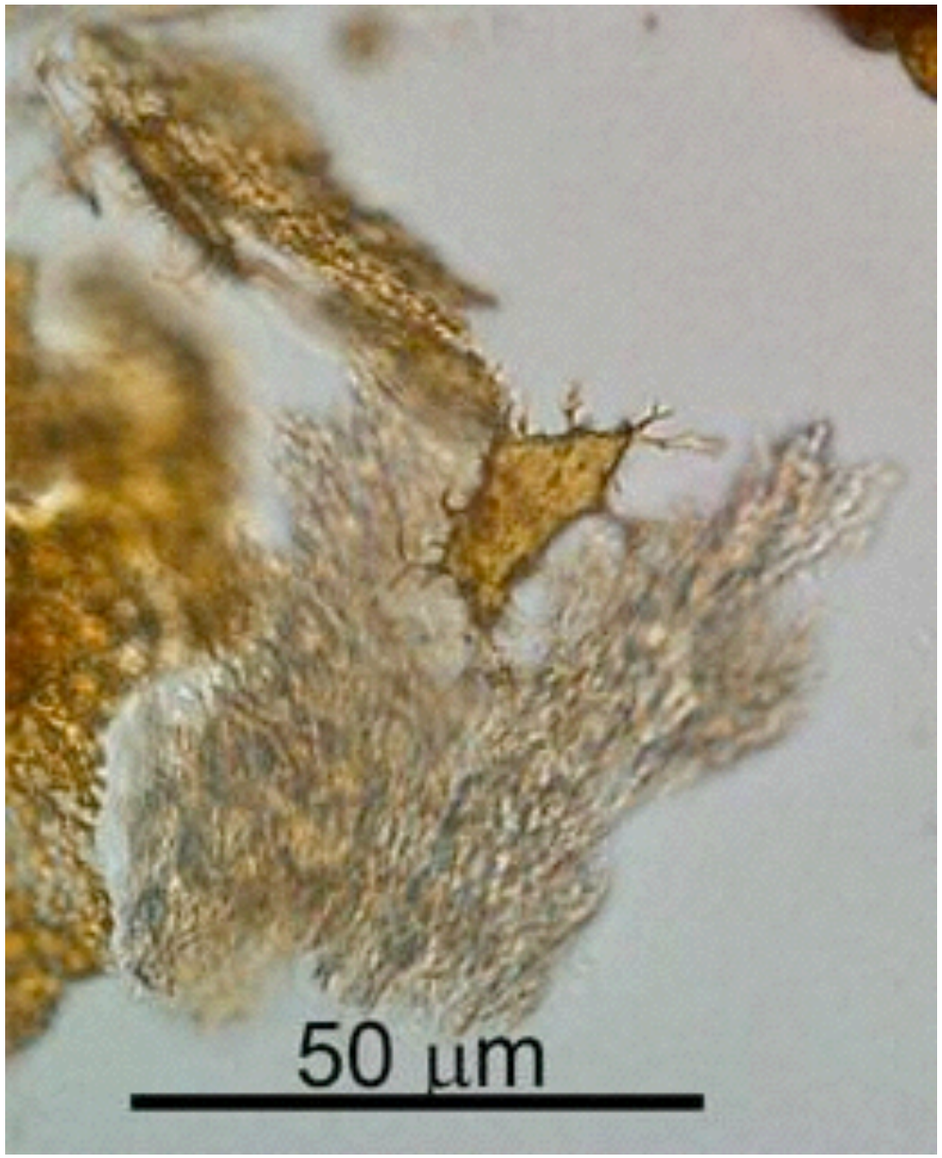
Even larger theropods like *Velociraptor* had feathers

Quill knobs on ulna (lower arm bone) indicate attachment sites for large vaned feathers

Molecular Evidence: Amino Acid Sequences

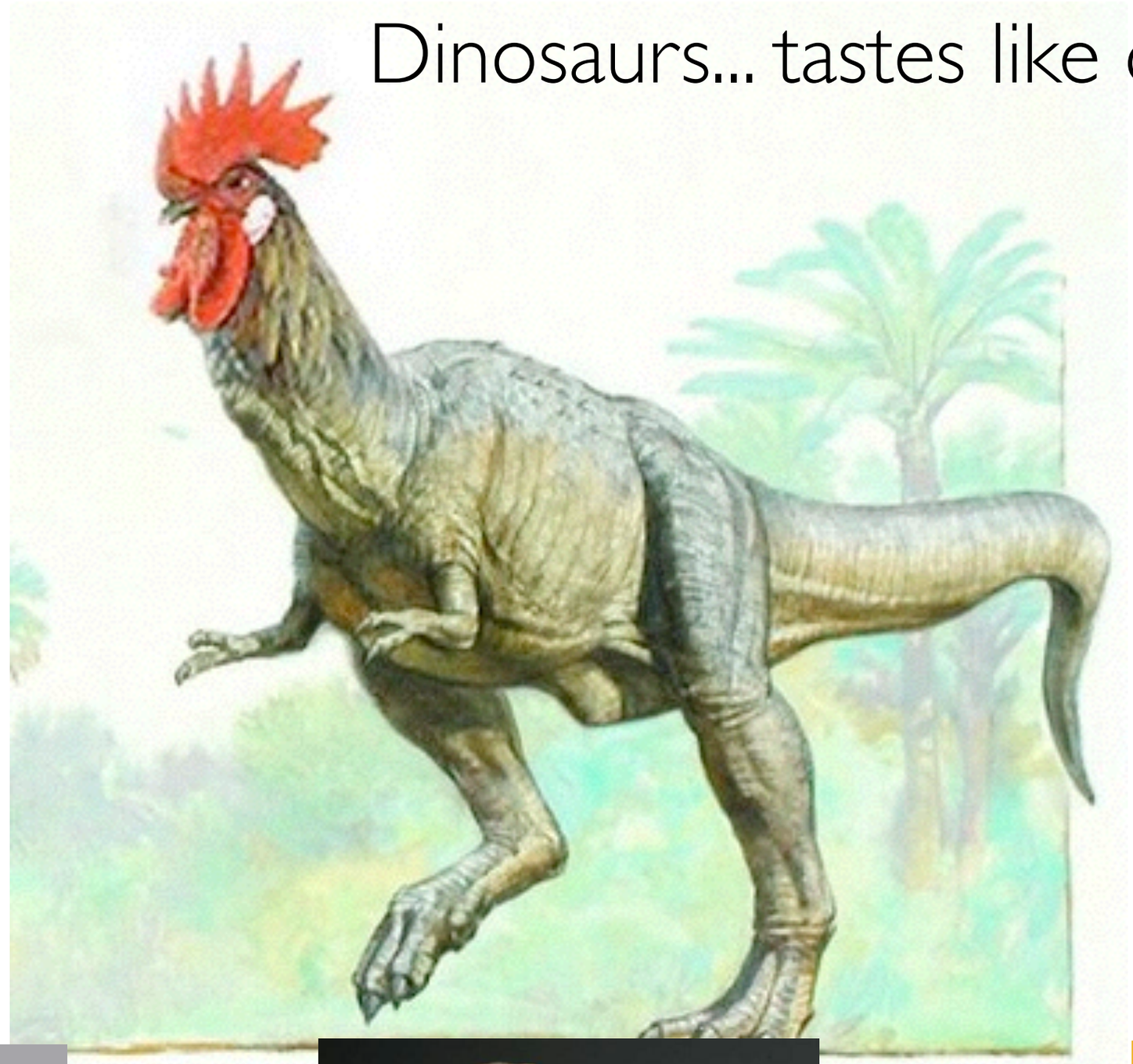






Collagen: a protein coded by a sequence of amino acids
Compare collagen amino acid sequences across many different lifeforms and group by similarity!

Dinosaurs... tastes like chicken...



Now let's think about flight...

Feathers

Loss of teeth

Large brains, adv. sight

Carpometacarpus

Bipedal

Pygostyle

Pneumatic bones

Rigid skeleton

Furcula

All Theropods

Coelurosauria

Derived Theropods

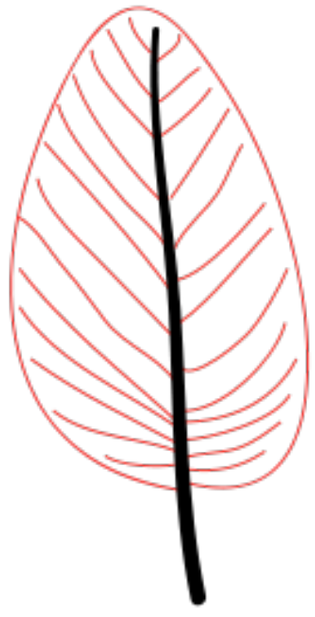
Did feathers and pneumatic bones evolve for flight? Obviously not... evolved long before flight

Embryological Evidence

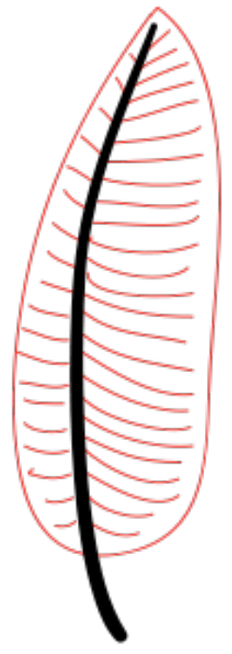
Feather Development:
There are 4 stages of feather development controlled by a series of genes.
<u>Each stage is a developmental modification of the last!</u>

Formation of shaft

Formation of loosely connected, unhooked, barbs



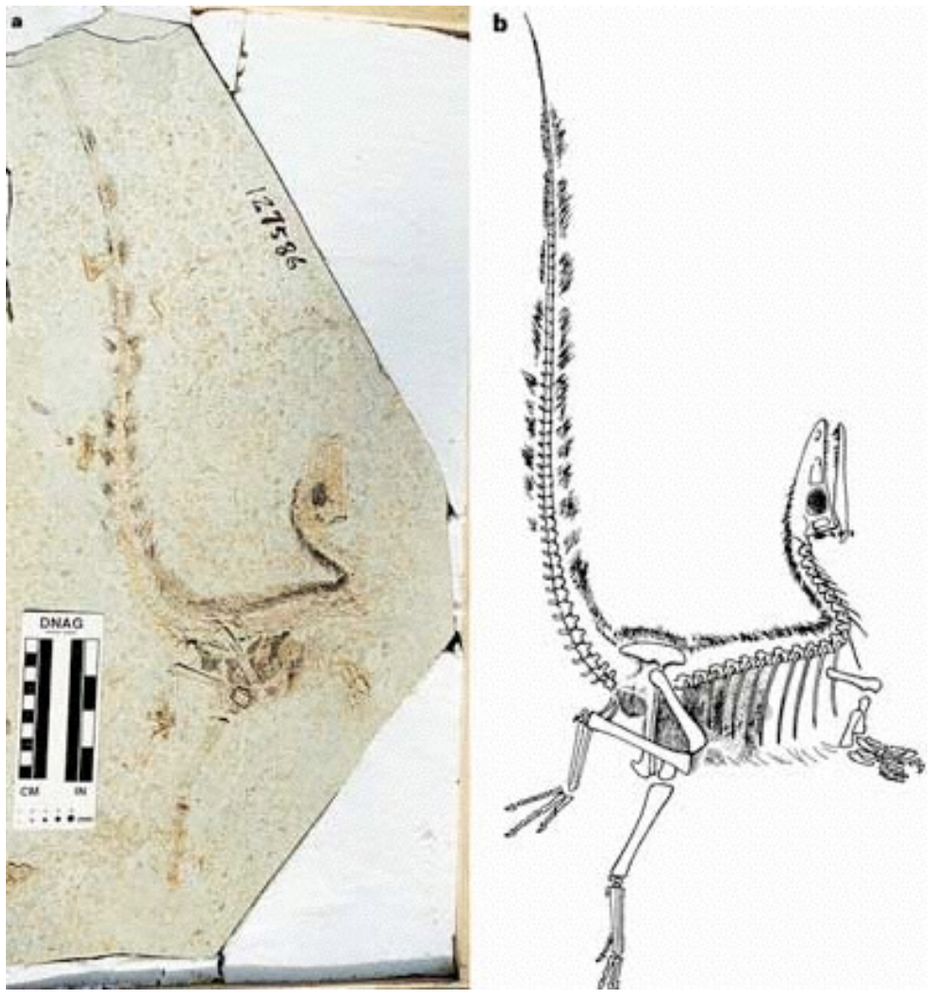
Hooked barbs on a symmetrical vane



Hooked barbs on an asymmetrical vane

Did feathers and pneumatic bones evolve for flight? Obviously not... evolved long before flight

Paleontological Evidence



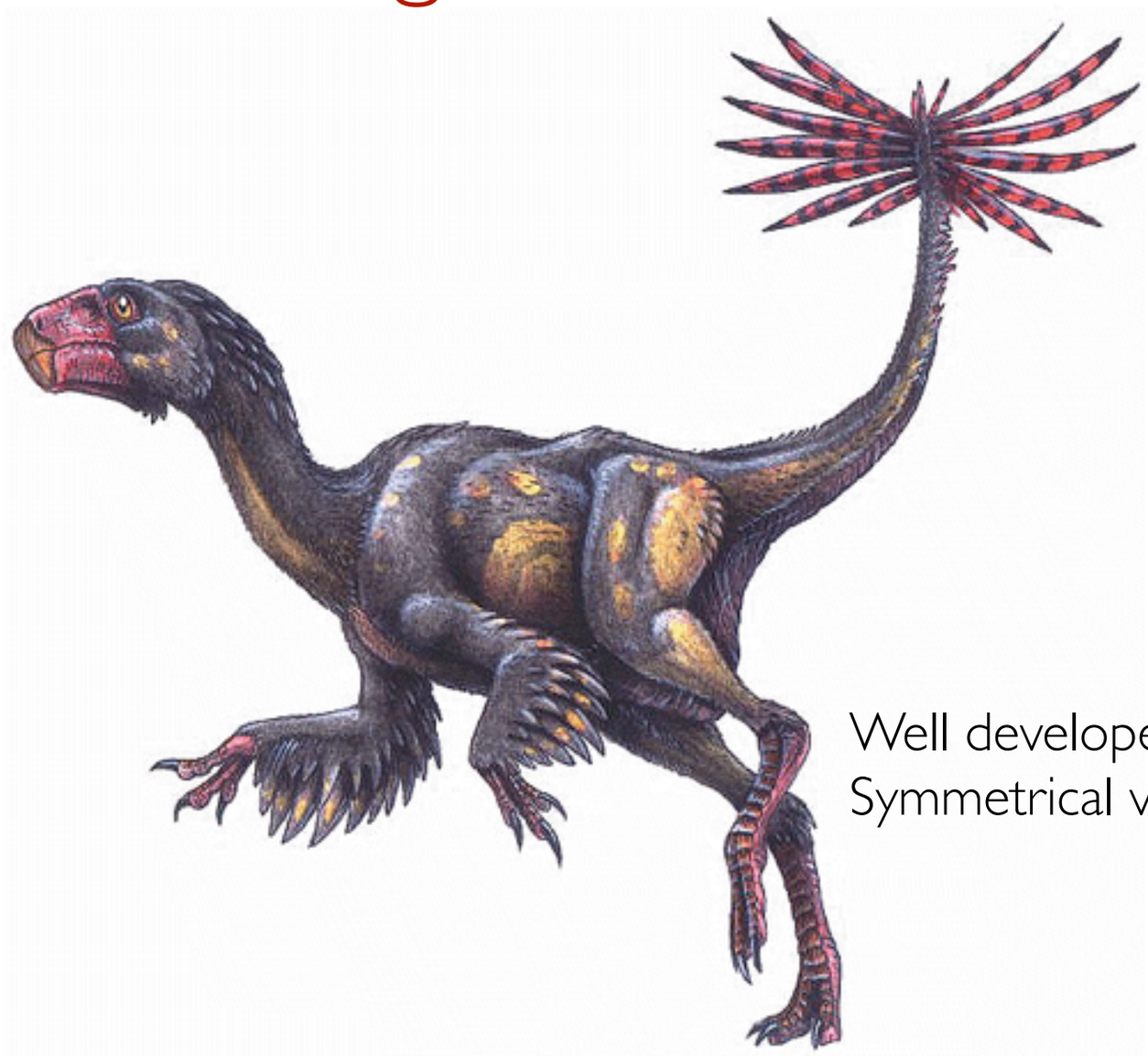
Covered in barbed filaments

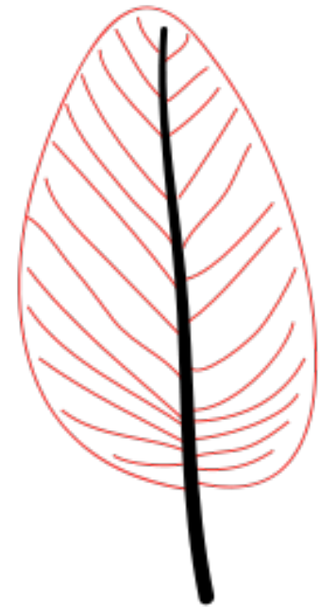
Sinosauropteryx:

small Coelurosaur; was not capable of flight

Did feathers and pneumatic bones evolve for flight? Obviously not... evolved long before flight

Paleontological Evidence





Well developed barbs & barbules
Symmetrical veins

Caudipteryx:

Oviraptorid

Did feathers and pneumatic bones evolve for flight? Obviously not... evolved long before flight

Paleontological Evidence

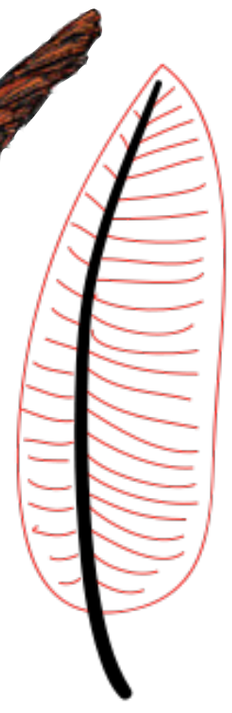
Covered in barbed filaments

Beipiaosaurus

Ostrich-sized Therizinosauroid

Did feathers and pneumatic bones evolve for flight? Obviously not... evolved long before flight

Paleontological Evidence



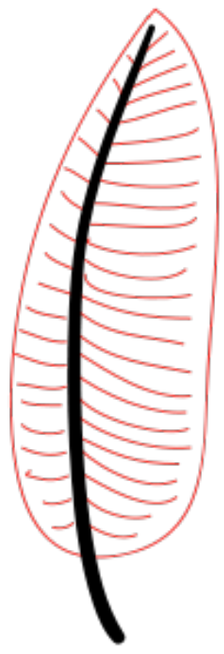
Bird-like Feathers

Sinornithosaurus

non-flying Deinonychosaur

Did feathers and pneumatic bones evolve for flight? Obviously not... evolved long before flight

Paleontological Evidence



Bird-like Feathers

Microraptor
flying *Deinonychosaur*


BBC
Microraptor

Allosaurus
Compsognathus
Sinosauropteryx
Alvarezesaurids
Therizinosaurs
Ornithomimids
Tyrannosaurus
Caudipteryx
Oviraptor
Troodon
Sinornithosaurus
Microraptor
Dromaeosaurus
Archaeopteryx
Living birds
Avialae
Type 5
Type 4
Type 2–3
Type 1
Tetanurae
Coelurosauria