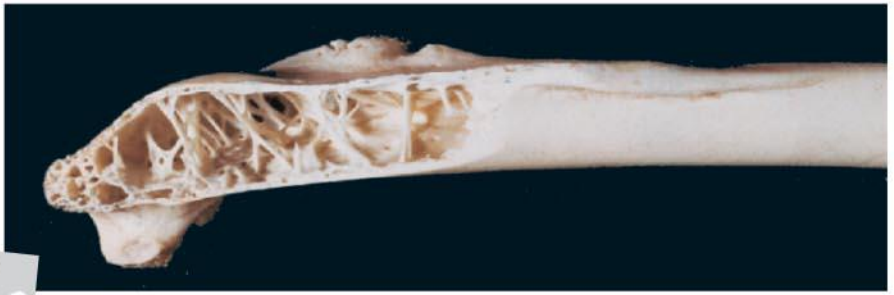
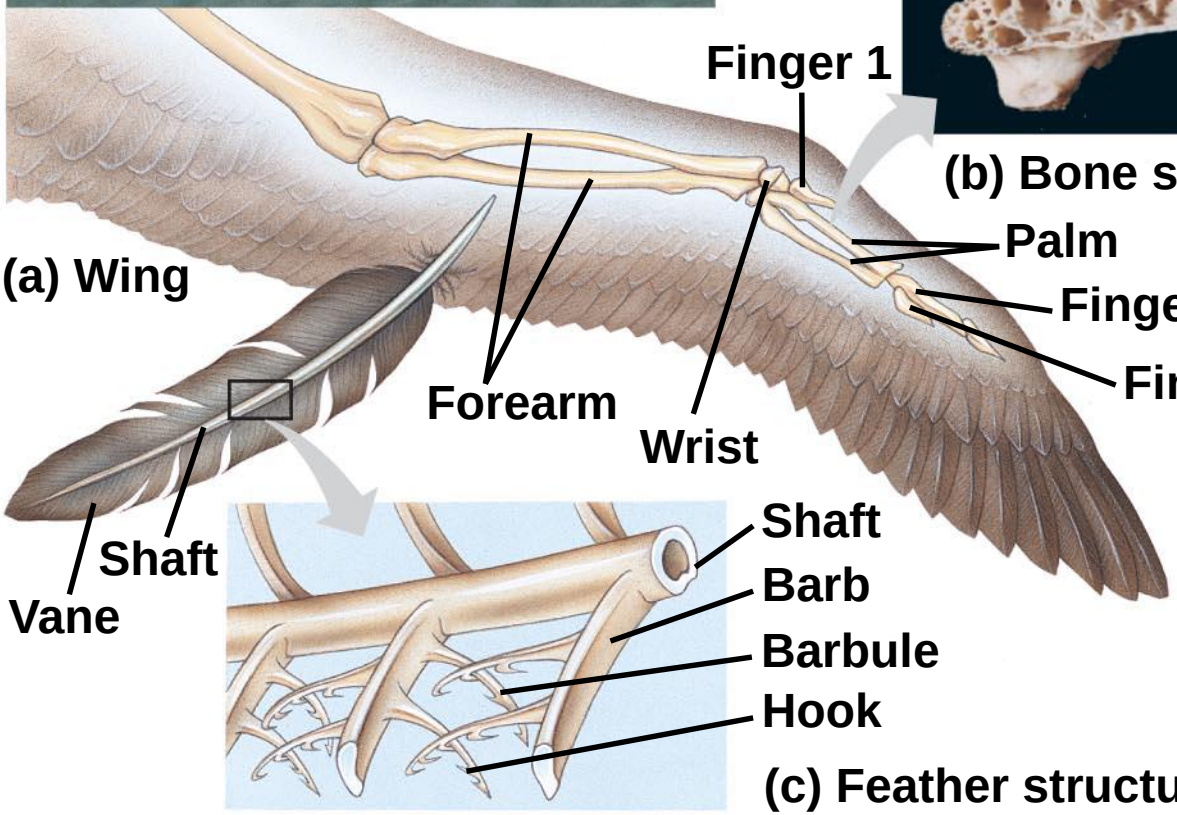
Birds - reptilian anatomy modified for Flight

Derived Characters of Birds:

- Many characters of birds are adaptations that facilitate flight
- The major adaptation is wings with keratin feathers
- Other adaptations include lack of a urinary bladder, females with only one ovary, small gonads, and loss of teeth.

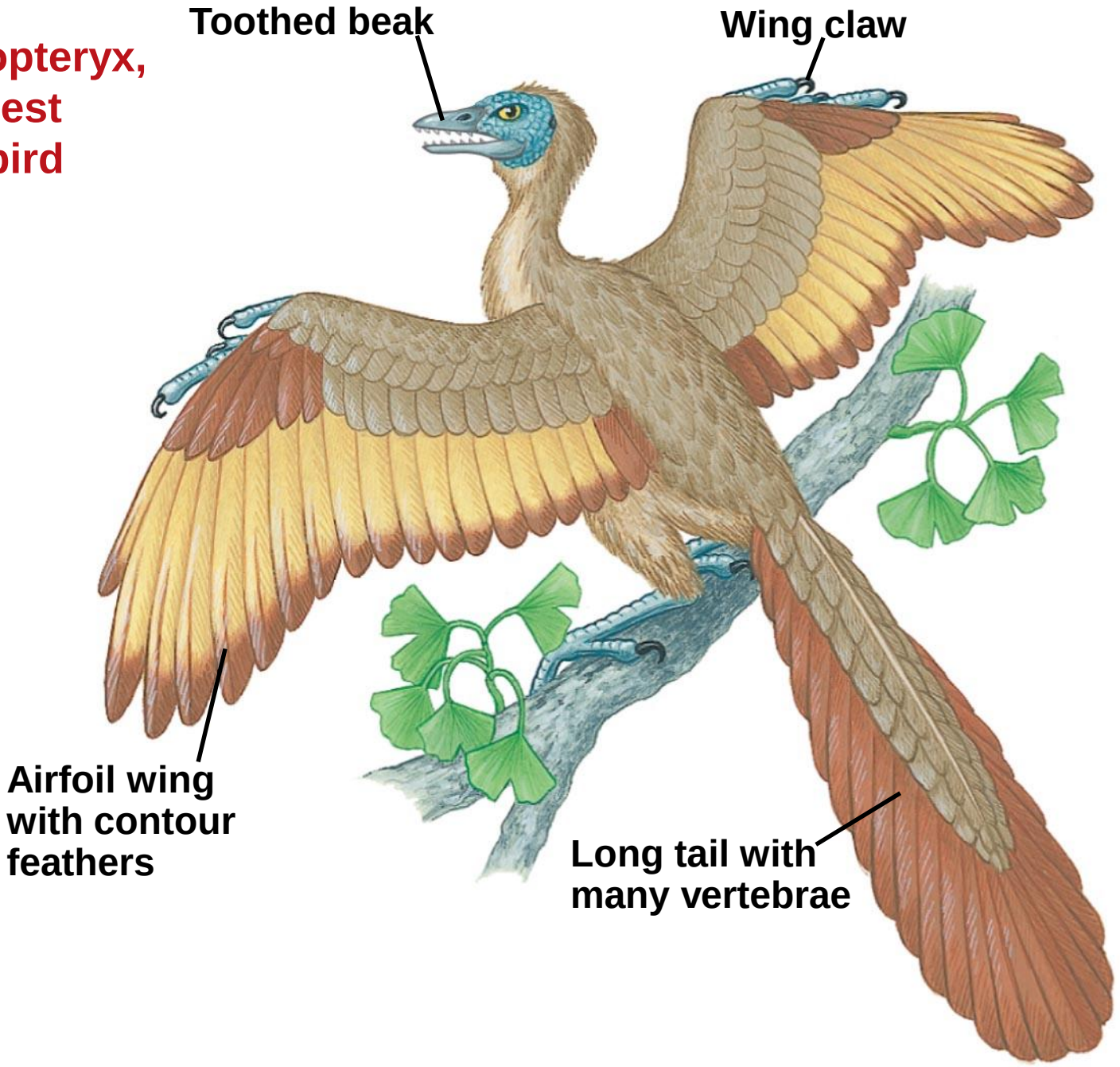
Form fits function: the avian wing and feather





- Flight enhances hunting and scavenging, escape from terrestrial predators, and migration.
- Flight requires a great expenditure of energy, acute vision, and fine muscle control.
- Birds probably descended from small theropods, a group of carnivorous dinosaurs. By 150 million years ago, feathered theropods had evolved into birds.
- *Archaeopteryx* remains the oldest bird known.

Archaeopteryx, the earliest known bird



Diversity among living birds

(a) Emu - flightless

(b) Mallards - web feet

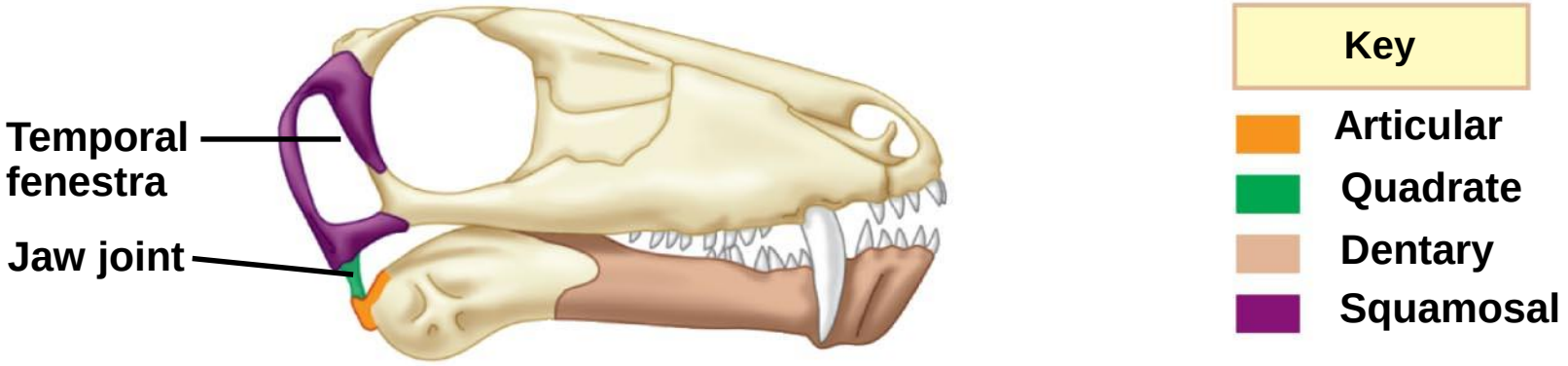
(c) Laysan albatrosses

(d) Barn swallows

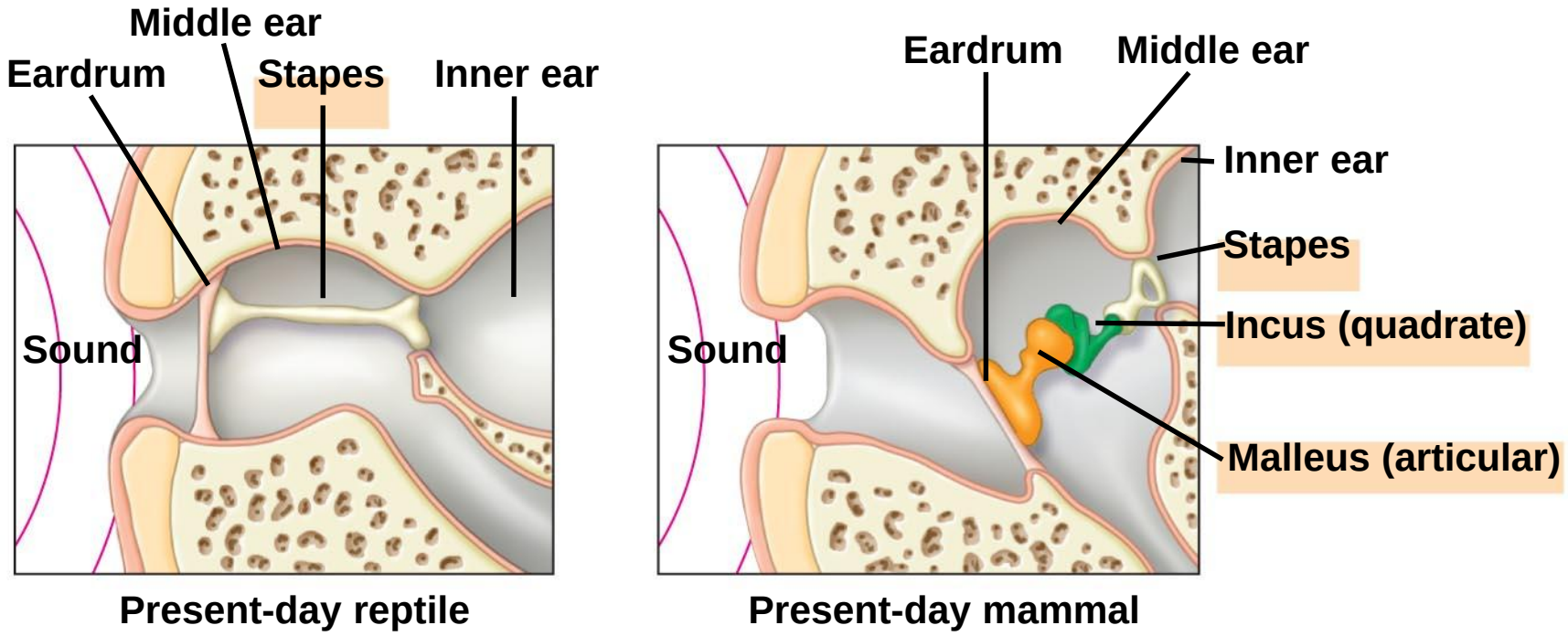
Derived Characters of Mammals

- **Mammals**, class Mammalia, are represented by more than 5,300 species.
- ***Mammals have***
  - ***Mammary glands, which produce milk***
  - ***Hair***
  - ***A larger brain than other vertebrates of equivalent size***
  - ***Differentiated teeth*.**

evolution of the mammalian ear bones



(a) In *Biarmosuchus,* an early synapsid, the articular and quadrate bones formed the jaw joint.



(b) In mammals, the articular and quadrate bones are incorporated into the middle ear.

- By the early Cretaceous, the three living lineages of mammals emerged: monotremes, marsupials, and eutherians.
- **Monotremes** are a small group of egg-laying mammals consisting of echidnas and the platypus.

an Australian monotreme

Marsupials

- **Marsupials** include opossums, kangaroos, and koalas.
- The embryo develops within a **placenta** in the mother's uterus.
- A marsupial is born very early in its development. It completes its embryonic development while nursing in a maternal pouch called a marsupium.

Australian marsupials

(a) A young brushtail possum

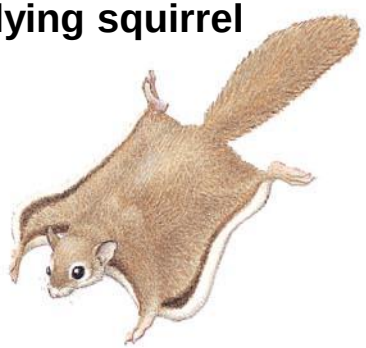
(b) Long-nosed bandicoot

Evolutionary convergence of marsupials and placental mammals

Marsupial mammals	Eutherian mammals
Plantigale	Deer mouse
Marsupial mole	Mole
Sugar glider	Flying squirrel
Wombat	Woodchuck
Tasmanian devil	Wolverine
Kangaroo	Patagonian cavy





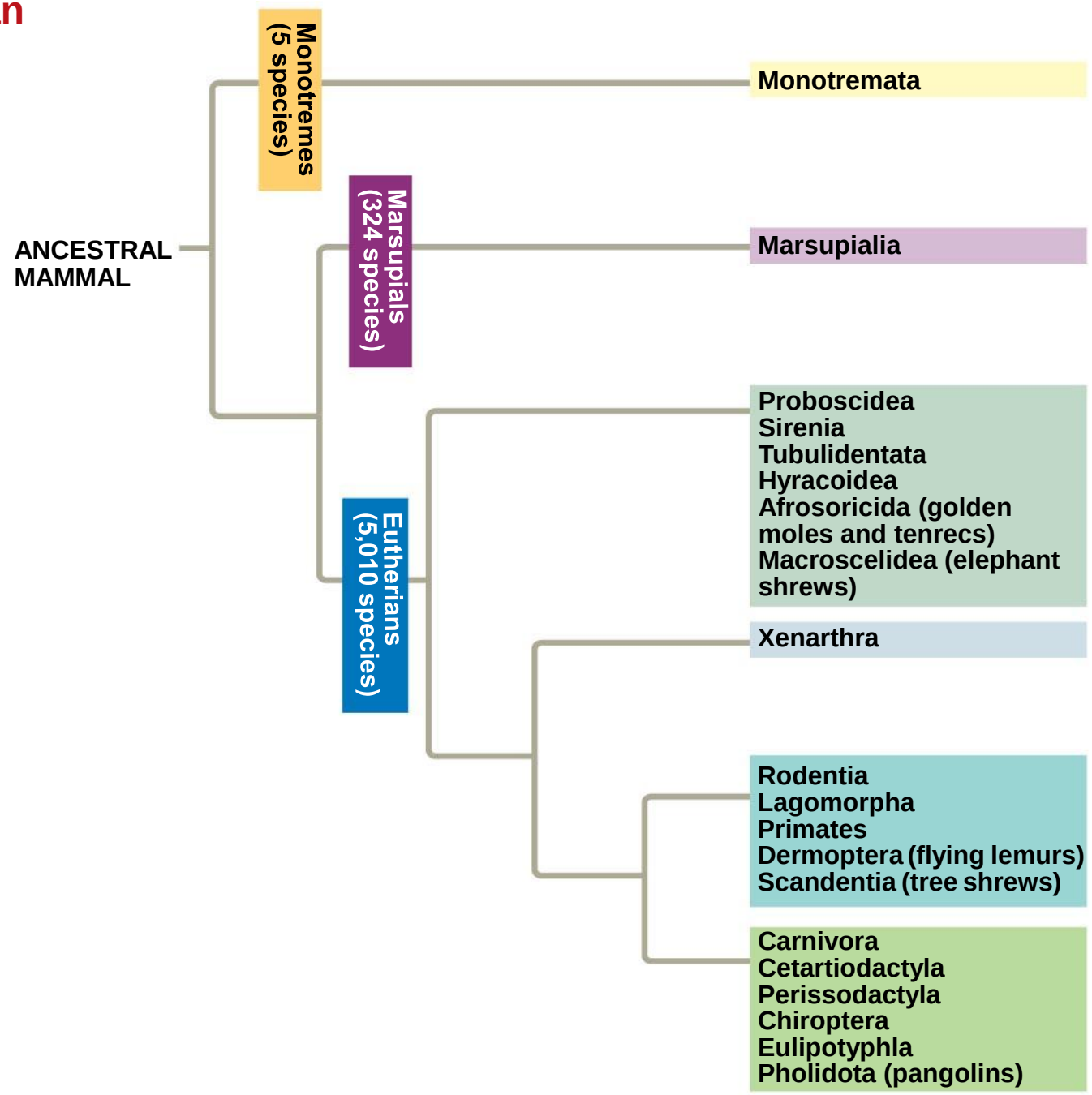




Eutherians - Placental Mammals

- Compared with marsupials, ***eutherians = placental mammals*** have a longer period of pregnancy.
- *Young complete their embryonic development within a uterus, joined to the mother by the placenta*.
- Molecular and morphological data give conflicting dates on the diversification of eutherians.
- In Australia, convergent evolution has resulted in a diversity of marsupials that resemble the eutherians in other parts of the world.

Mammalian Diversity



Mammalian diversity

Orders and Examples	Main Characteristics
Monotremata Platypuses, echidnas  Echidna	Lay eggs; no nipples; young suck milk from fur of mother
Proboscidea Elephants  African elephant	Long, muscular trunk; thick, loose skin; upper incisors elongated as tusks
Sirenia Manatees, dugongs  Manatee	Aquatic; finlike forelimbs and no hind limbs; herbivorous
Xenarthra Sloths, anteaters, armadillos  Tamandua	Reduced teeth or no teeth; herbivorous (sloths) or carnivorous (anteaters, armadillos)
Lagomorpha Rabbits, hares, picas  Jackrabbit	Chisel-like incisors; hind legs longer than forelegs and adapted for running and jumping; herbivorous
Carnivora Dogs, wolves, bears, cats, weasels, otters, seals, walruses  Coyote	Sharp, pointed canine teeth and molars for shearing; carnivorous
Cetartiodactyla **Artiodactyls** Sheep, pigs, cattle, deer, giraffes  Bighorn sheep	Hooves with an even number of toes on each foot; herbivorous
Cetaceans Whales, dolphins, porpoises  Pacific white-sided porpoise	Aquatic; streamlined body; paddle-like forelimbs and no hind limbs; thick layer of insulating blubber; carnivorous

Orders and Examples	Main Characteristics
Marsupialia Kangaroos, opossums, koalas  Koala	Embryo completes development in pouch on mother
Tubulidentata Aardvarks  Aardvark	Teeth consisting of many thin tubes cemented together; eats ants and termites
Hyracoidea Hyraxes  Rock hyrax	Short legs; stumpy tail; herbivorous; complex, multichambered stomach
Rodentia Squirrels, beavers, rats, porcupines, mice  Red squirrel	Chisel-like, continuously growing incisors worn down by gnawing; herbivorous
Primates Lemurs, monkeys, chimpanzees, gorillas, humans  Golden lion tamarin	Opposable thumbs; forward-facing eyes; well-developed cerebral cortex; omnivorous
Perissodactyla Horses, zebras, tapirs, rhinoceroses  Indian rhinoceros	Hooves with an odd number of toes on each foot; herbivorous
Chiroptera Bats  Frog-eating bat	Adapted for flight; broad skinfold that extends from elongated fingers to body and legs; carnivorous or herbivorous
Eulipotyphla "Core insectivores": some moles, some shrews  Star-nosed mole	Diet consists mainly of insects and other small invertebrates

Primates

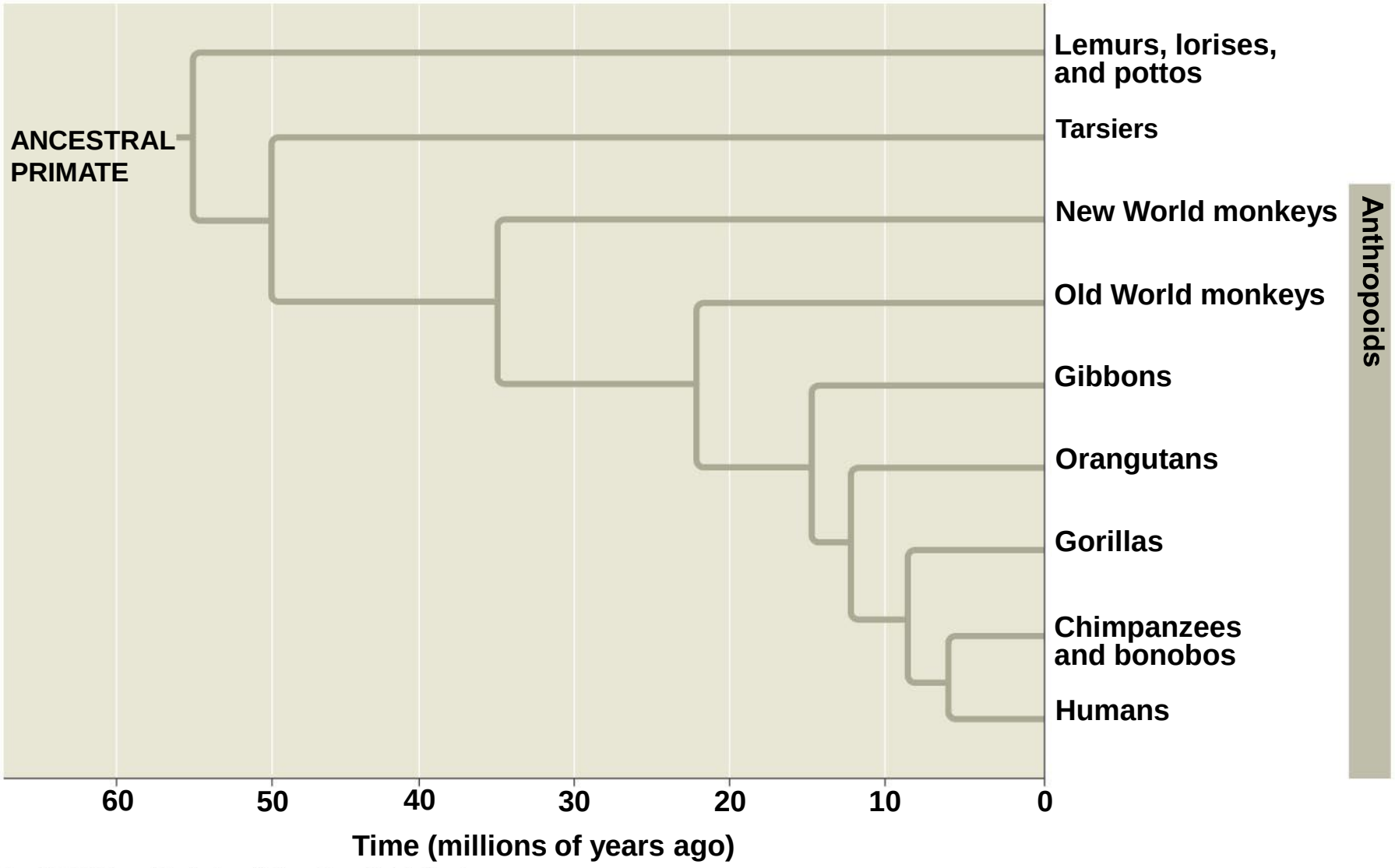
- The mammalian order Primates includes lemurs, tarsiers, monkeys, and apes.
- There are three main groups of living primates:
  - Lemurs, lorises, and pottos
  - Tarsiers
  - **Anthropoids** (monkeys and apes)
- Humans are members of the ape group.

Lemurs

Derived Characters of Primates

- Most primates have hands and feet adapted for grasping.
- Other derived characters of primates:
  - A large brain and short jaws
  - Forward-looking eyes close together on the face, providing depth perception
  - Complex social behavior and parental care
  - A fully **opposable thumb** (in monkeys and apes).

A phylogenetic tree of primates



- The first monkeys evolved in the Old World (Africa and Asia).
- In the New World (South America), monkeys first appeared roughly 25 million years ago.
- New World and Old World monkeys underwent separate adaptive radiations during their many millions of years of separation.

New World monkeys and Old World monkeys

(a) New World monkey

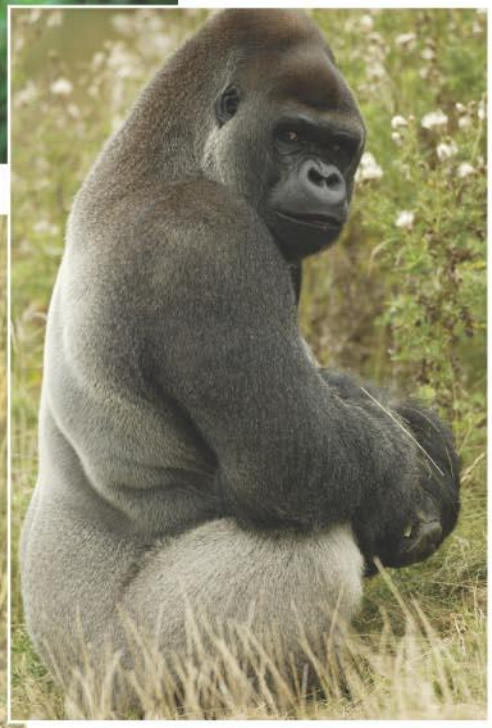
(b) Old World monkey

Nonhuman apes

(a) Gibbon

(b) Orangutan

(c) Gorilla



(d) Chimpanzees

(e) Bonobos

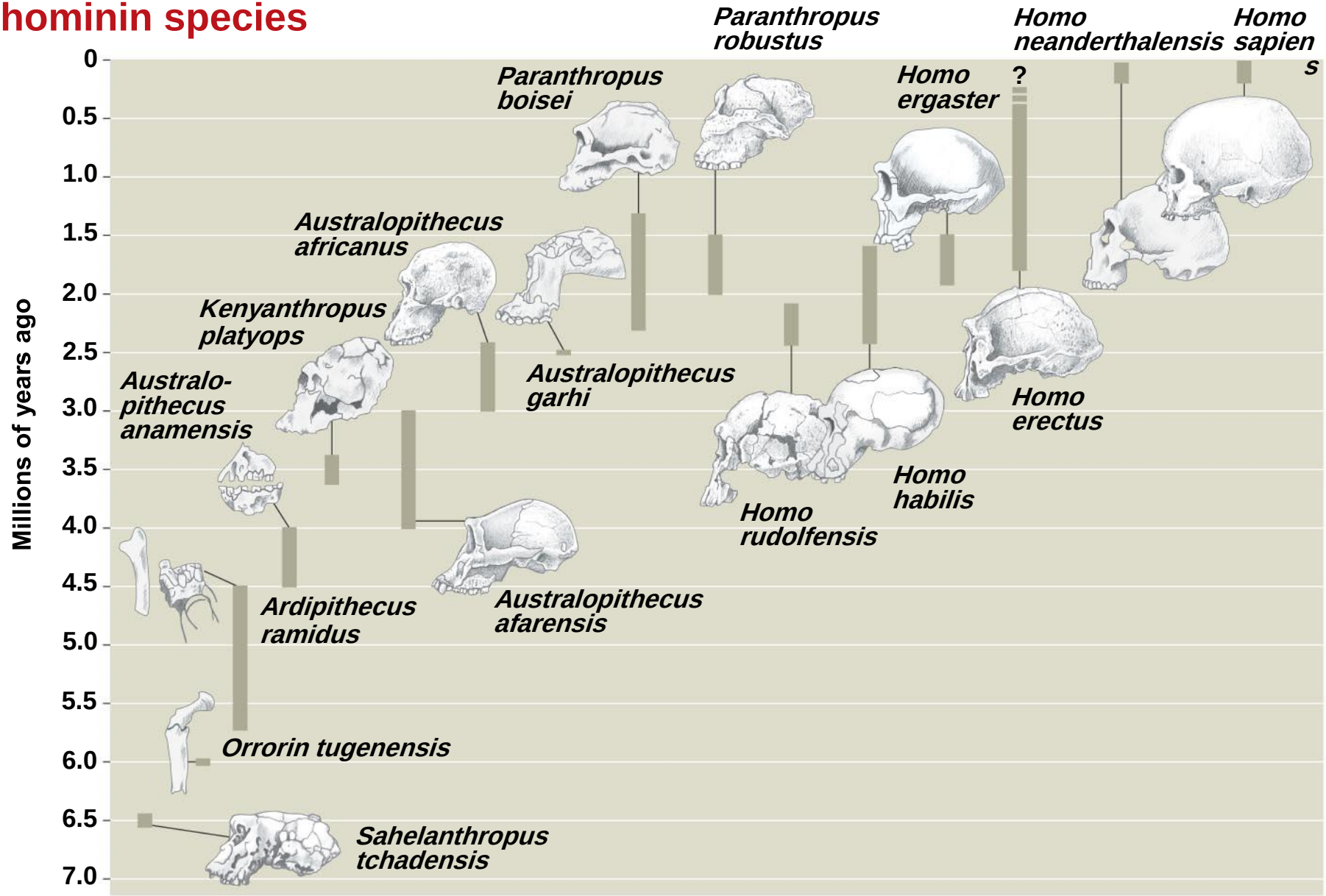
Concept 34.8: Humans are mammals that have a large brain and bipedal locomotion

- The species *Homo sapiens* is about 200,000 years old, which is very young, considering that life has existed on Earth for at least 3.5 billion years.
- The study of human origins is known as **paleoanthropology.**
- **Hominins** (formerly called hominids) are more closely related to humans than to chimpanzees.
- Paleoanthropologists have discovered fossils of about 20 species of extinct hominins.

Derived Characters of Humans

- A number of characters distinguish humans from other apes:
  - Upright posture and bipedal locomotion
  - Larger brains
  - Language capabilities and symbolic thought
  - The manufacture and use of complex tools
  - Shortened jaw
  - Shorter digestive tract.

A timeline for some selected hominin species

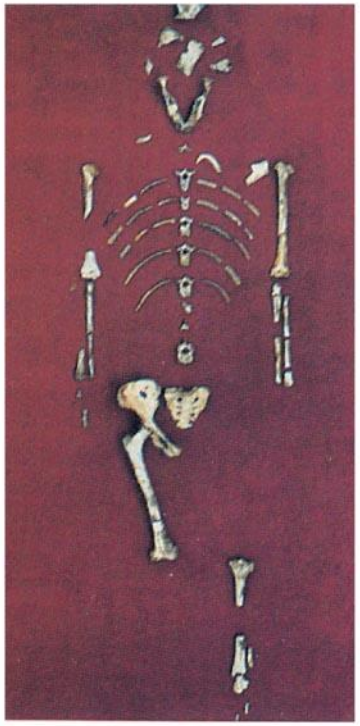


- Hominins originated in Africa about 6–7 million years ago
- Early hominins had a small brain but probably walked upright.
- Two common misconceptions about early hominins:
  - Thinking of them as chimpanzees
  - Imagining human evolution as a ladder leading directly to *Homo sapiens.*

Australopiths

- Australopiths are a paraphyletic assemblage of hominins living between 4 and 2 million years ago.
- Some species walked fully erect.
- “Robust” australopiths had sturdy skulls and powerful jaws.
- “Gracile” australopiths were more slender and had lighter jaws.

Upright posture predates an enlarged brain in human evolution



(a) *Australopithecus afarensis* skeleton

(b) The Laetoli footprints

(c) An artist's reconstruction of what *A. afarensis* may have looked like

Bipedalism & Tool Use

- Hominins began to walk long distances on two legs about 1.9 million years ago.
- The oldest evidence of tool use, cut marks on animal bones, is 2.5 million years old.
- The earliest fossils placed in our genus *Homo* are those of *Homo habilis*, ranging in age from about 2.4 to 1.6 million years.
- Stone tools have been found with *H. habilis*, giving this species its name, which means “handy man.”

- ***Homo erectus*** originated in Africa by 1.8 million years ago
- It was the first hominin to leave Africa.
- ***Neanderthals****, Homo neanderthalensis,* lived in Europe and the Near East from 200,000 to 28,000 years ago.
- They were thick-boned with a larger brain, they buried their dead, and they made hunting tools.

Homo Sapiens

- *Homo sapiens* appeared in Africa by 195,000 years ago.
- All living humans are descended from these African ancestors.
- The oldest fossils of *Homo sapiens* outside Africa date back about 115,000 years and are from the Middle East.
- Humans first arrived in the New World sometime before 15,000 years ago.

160,000-year-old fossil of Homo sapiens

- Rapid expansion of our species may have been preceded by changes to the brain that made cognitive innovations possible.
  - For example, the ***FOXP2 gene is essential for human language***, and underwent intense natural selection during the last 200,000 years.
- *Homo sapiens* were the first group to show evidence of symbolic and sophisticated thought.

You should now be able to:

1. List the derived traits for: chordates, craniates, vertebrates, gnathostomes, tetrapods, amniotes, birds, mammals, primates, humans.
2. Describe the trends in mineralized structures in early vertebrates.
3. Describe and distinguish between Chondrichthyes and Osteichthyes.
4. Describe an amniotic egg and explain its significance in the evolution of reptiles and mammals.
5. Explain why the reptile clade includes birds.

6. Distinguish among monotreme, marsupial, and eutherian mammals.

7. Define the term hominin.

8. Describe the evolution of Homo sapiens from australopith ancestors, and clarify the order in which distinctive human traits arose.

9. Explain the significance of the *FOXP2* gene.