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# Chapter 19

## The Evolution of Vertebrate Diversity

PowerPoint Lectures

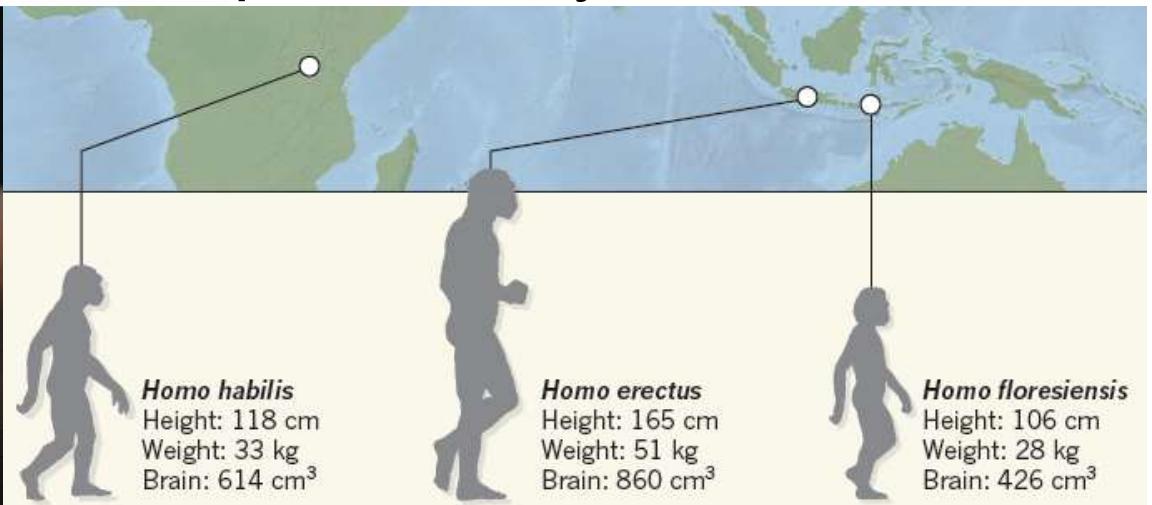
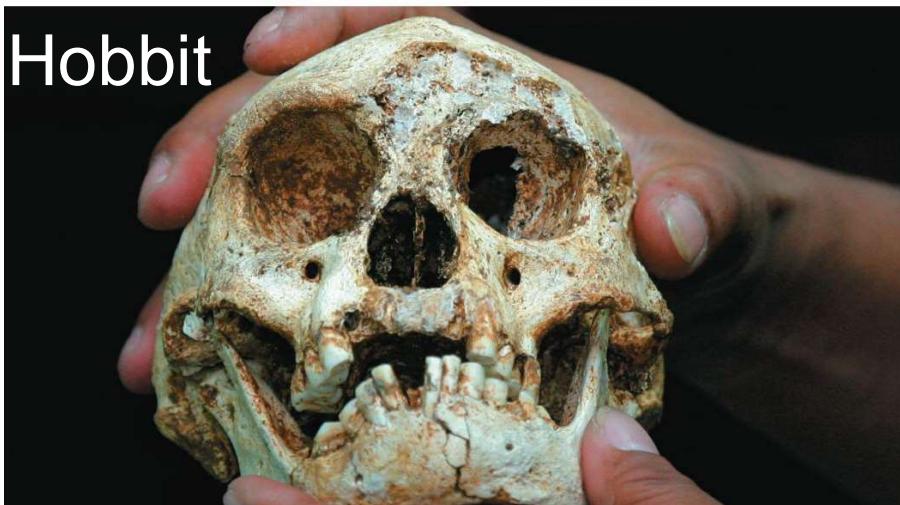
***Campbell Biology: Concepts & Connections, 8th Edition, Global Edition***

REECE • TAYLOR • SIMON • DICKEY • HOGAN

Lecture by Edward J. Zalisko

# Introduction

- Vertebrates have been evolving for half a billion years.
- There are currently more than 60,000 vertebrate species.
- Scientists are piecing together the evolutionary history of vertebrates using clues from genetics, morphology, and developmental homologies among present-day animals.



人類曾經遇見哈比人嗎？

2016-10-09 *Homo floresiensis*

<http://www.natgeomedia.com/column/external/50545>

智人到來的其他佐證是，梁布亞洞穴在46000年前之後，再也沒有劍齒象（*Stegodon florensis insularis*）、禿鷲（*Trigonoceps*），與巨型禿鶲（*Leptoptilos robustus*）的化石，頗為符合智人走到哪，動物滅絕到哪的模式；另外還新出現洞中前所未見，但常見於智人遺址的淡水軟體動物，以及新的石器種類。



全球科學家上千頁報告警告，人類文明導致**物種滅絕**

科技新報 TechNews - 2019年5月6日

報告揭示人類如何蹂躪支持其社會的生態系統，從為人類作物授粉的蜜蜂，到阻止洪水的森林，使得數十年內面臨**滅絕**的**物種**高達100 萬種動植物， ...

人類文明加速**物種滅絕**！最新報告：100萬種生物深陷危機，速率之快 ...

風傳媒 - 2019年5月6日

[查看全部](#)



聯合國報告：人類加速**100萬個物種滅絕**將自食惡果

世界日報 - 20 小時前

聯合國6日發布具有指標意義的自然生態評估報告。報告指人類正在加速破壞他們賴以維生的大自然，百萬種動植物恐將面臨**滅絕**。圖為去年4月在 ...

回顧五次大規模**滅絕**地球恐進入另一次大**滅絕**

深入報道 - 由中廣播電台 - 2019年5月6日

人口與經濟成長是大自然最大殺手。報導指出，自 1970 年以來，世界人口成長一倍，全球經濟成長四倍，而國際貿易成長 10 倍，為了給這個新興世界提供食物、衣服和能量，森林以驚人的速度消失，特別是在熱帶地區。1980~2000 年期間，有 1 億公頃的熱帶森林喪失，主要來自南美洲的牧場和東南亞的棕櫚油種植園。

報告警告，世界各地的自然生態正在以前所未見的速度消退，人類對更多食物和能源的需求是主要因素。報告揭示人類如何蹂躪支持其社會的生態系統，從為人類作物授粉的蜜蜂，到阻止洪水的森林，使得數十年內面臨滅絕的物種高達 100 萬種動植物，破壞率比過去 1 千萬年的平均值高幾十到幾百倍。

## Chapter 19: Big Ideas



**Vertebrate Evolution and Diversity (19.1-19.8)**



**Primate Diversity (19.9-19.10)**



**Hominin Evolution (19.11-19.17)**

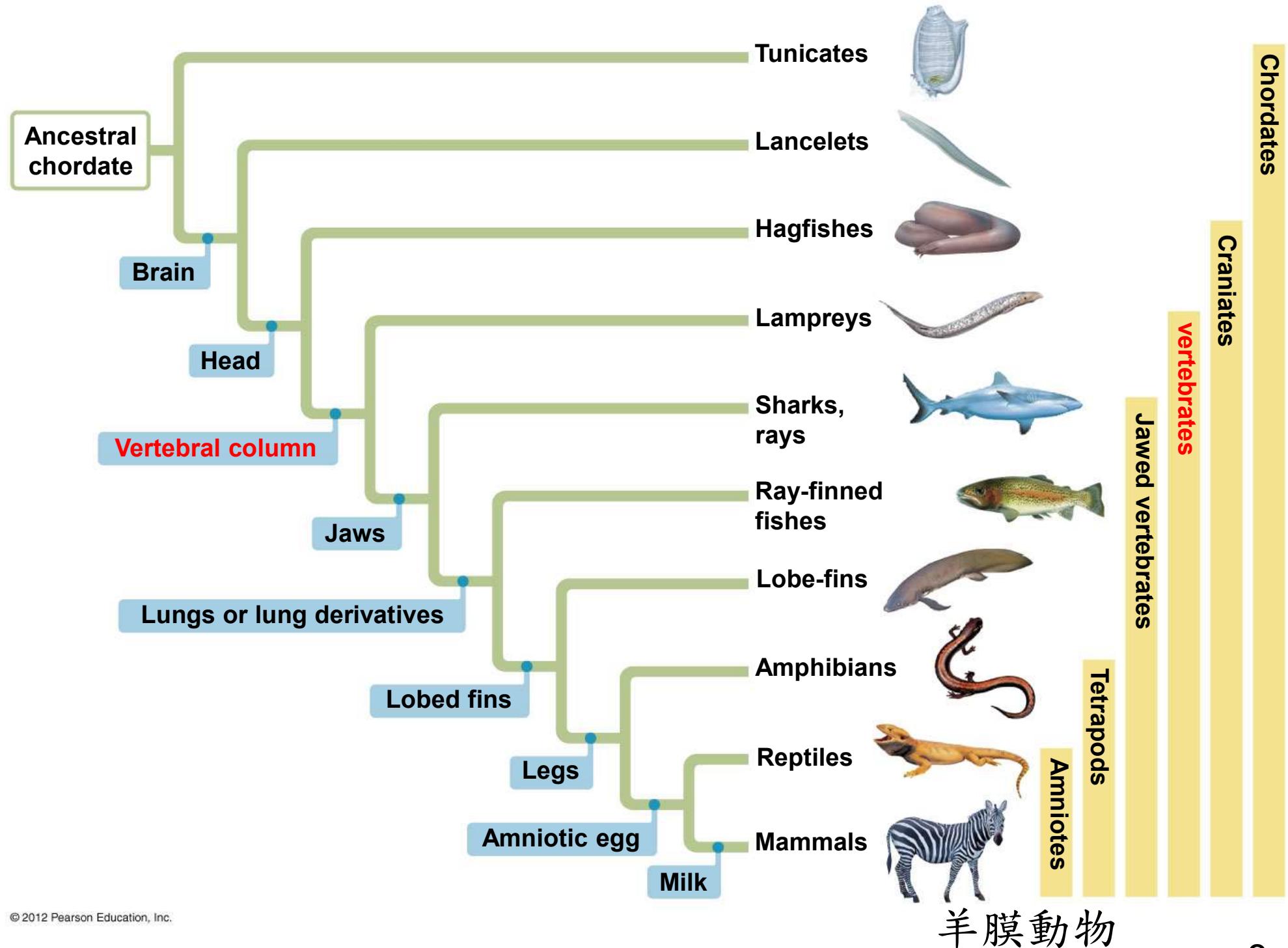
# VERTEBRATE EVOLUTION AND DIVERSITY

## 19.1 Derived characters define the major clades of chordates

- Biologists have developed hypotheses for the evolution of chordate groups using anatomical, molecular, and fossil evidence.
- Figure 19.1 illustrates a current view of the major clades of chordates and lists some of the derived characters that define the clades. 分支
- Tunicates are thought to be the first group to branch from the **chordate** lineage.
- The next transition was the development of a **head**, creating the group craniates.

- Next, vertebrates evolved, with
  - an extensive **skull** and
  - a **backbone**, or vertebral column, composed of a series of bones called vertebrae.
- The next major transition was the origin of **jaws**.
- The evolution of lungs or lung derivatives, followed by **muscular lobed fins with skeletal support**, opened the possibility of life on land.
- Tetrapods, jawed vertebrates with two pairs of limbs, were the first vertebrates on land.
- The evolution of **amniotes**, tetrapods with a **terrestrially adapted egg**, completed the transition to land.

Figure 19.1



## 19.2 Hagfishes and lampreys lack hinged jaws

- Hagfishes and lampreys

盲鳗 – are craniates, 七鳃鳗、八目鳗

- have a notochord, but
- lack hinged jaws and paired fins.

<http://www.zoology.ubc.ca/abs/biomaterials/slime.html>



© C. Ortlepp

- Lampreys but not hagfishes have rudimentary vertebral structures.

Thus,

- lampreys are vertebrates but hagfishes are not vertebrates.

- Hagfishes are deep-sea scavengers that produce slime as an antipredator defense. “knot”

- Lamprey adults are **parasites** that penetrate the sides of fishes with their rasping tongues.

- Larval lampreys

- resemble lancelets and
- are suspension feeders that live in freshwater streams, where they feed, buried in sediment.

Hagfish predatory behavior and slime defense mechanism

<https://www.nature.com/articles/srep00131>

## 19.2 Hagfishes and lampreys lack hinged jaws



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Eelskin Wallets - What Are They  
Really Made Of?  
<http://hubpages.com/education/eelskin-wallets>

LV春夏新裝少女熟女都愛！ | 西洋名人 | 時尚名人 | udnSTYLE

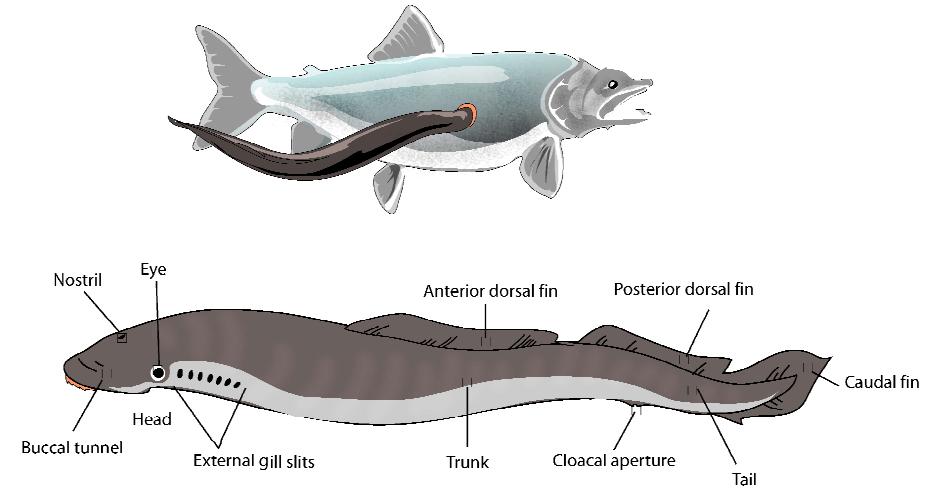
<https://style.udn.com> , udnSTYLE , 時尚名人 , 西洋名人 ▾

2015年2月12日 - 而同樣穿上**鰻魚皮**，「超殺女」克蘿伊摩蕾茲（Chloe Moretz）與氣質路線的茱莉安摩爾（Julianne Moore）可不吃「懃」。克蘿伊摩蕾茲以白色蕾絲上衣 ...

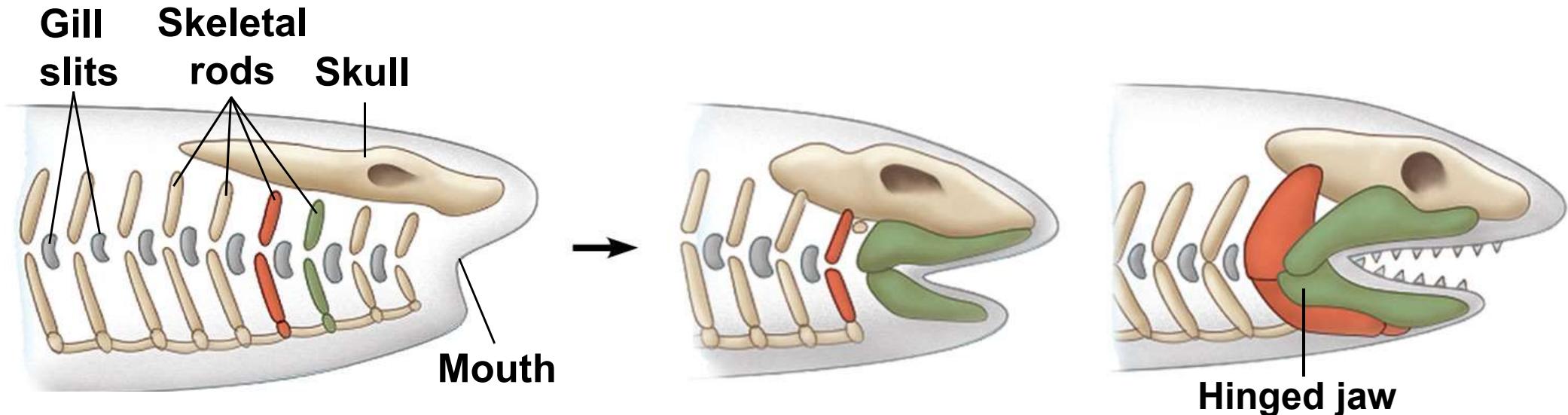
穿LV不稀奇姊穿的是鰻魚皮 | 蘋果新聞網 | 蘋果日報 - 娛樂時尚

<https://tw.english.apple.com/daily/20150212/36383889/> ▾

2015年2月12日 - LOUIS VUITTON (LV) 2015春夏系列大量選用**鰻魚**皮質材，洋裝、外套和短裙都各有所好，影后茱莉安摩爾（Julianne Moor...



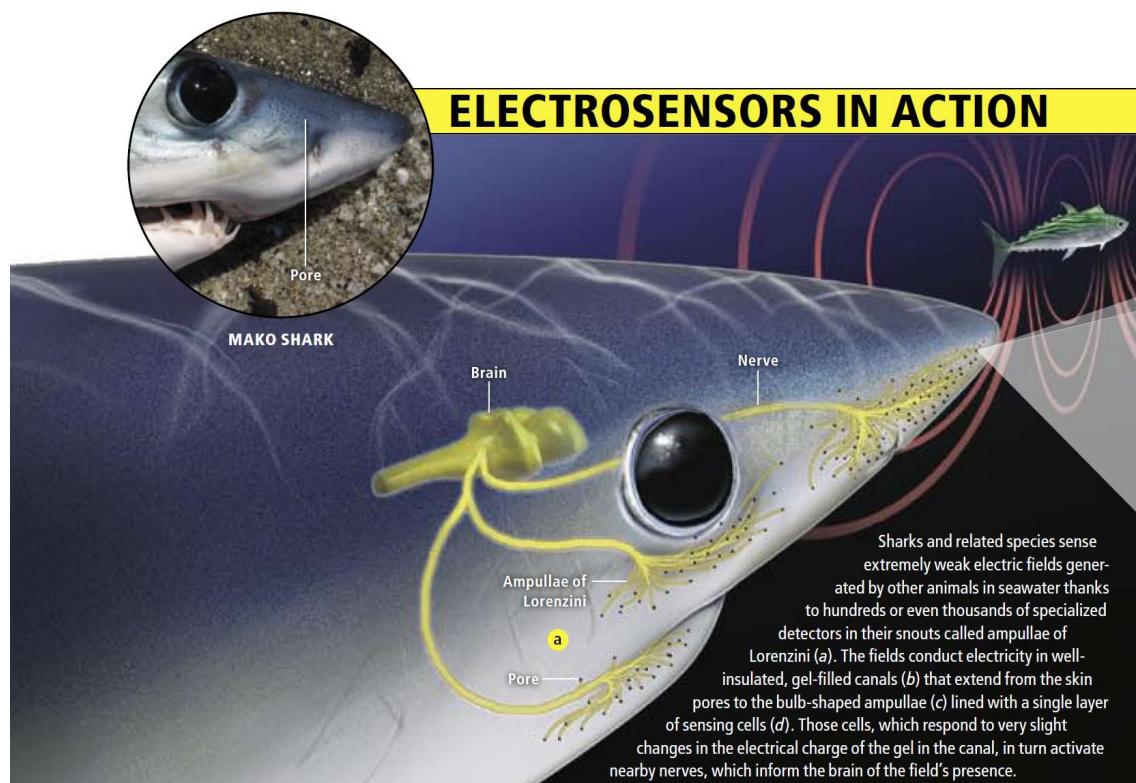
## 19.3 Jawed vertebrates with gills and paired fins include sharks, ray-finned fishes, and lobe-finned fishes



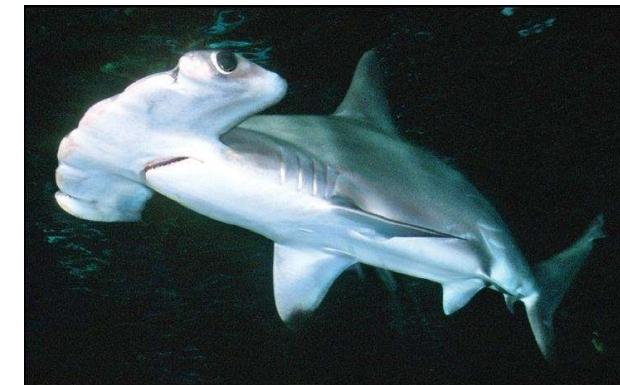
- Jawed vertebrates
  - appeared in the fossil record about 470 million years ago
  - quickly diversified using their paired fins and tail to **chase** a wide variety of prey.
- Jaws may have evolved by modifications of skeletal supports of the **anterior pharyngeal (gill) slits**.
- The remaining gill slits remained as sites of gas exchange.

## 19.3 Jawed vertebrates with gills and paired fins include sharks, ray-finned fishes, and lobe-finned fishes

- Three lineages of jawed fishes with gills and paired fins are commonly called fishes:
  1. chondrichthyans—sharks and rays, 軟骨魚綱
  2. ray-finned fishes—tuna, trout, and goldfish, and 輻鰭魚類
  3. lobe-finned fishes—coelacanths and lungfishes. 肉鰭魚類
- **Chondrichthyans** have
  - a flexible **skeleton** made of **cartilage**,
  - electrosensors on their heads, and
  - a **lateral line system** that helps them locate prey.
  - Most sharks are fast-swimming predators, with sharp **vision** and a keen sense of **smell**.
  - Most rays are adapted for life on the bottom, with dorsoventrally flattened bodies and eyes on the top of their heads.



鎧頭鯊 (Sphyrnidae)

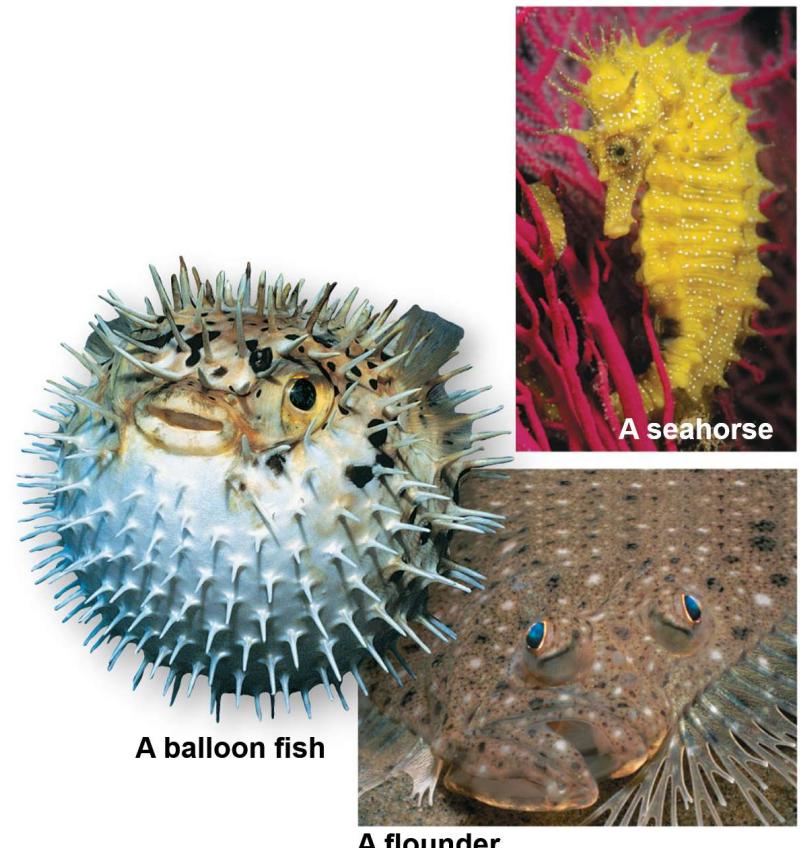


[http://www.goldenage.hk/photos/article/1573/article\\_3\\_enlarge.jpg](http://www.goldenage.hk/photos/article/1573/article_3_enlarge.jpg)

<http://faculty.bennington.edu/~sherman/the%20cean%20project/shark's%20electric%20sense.pdf>

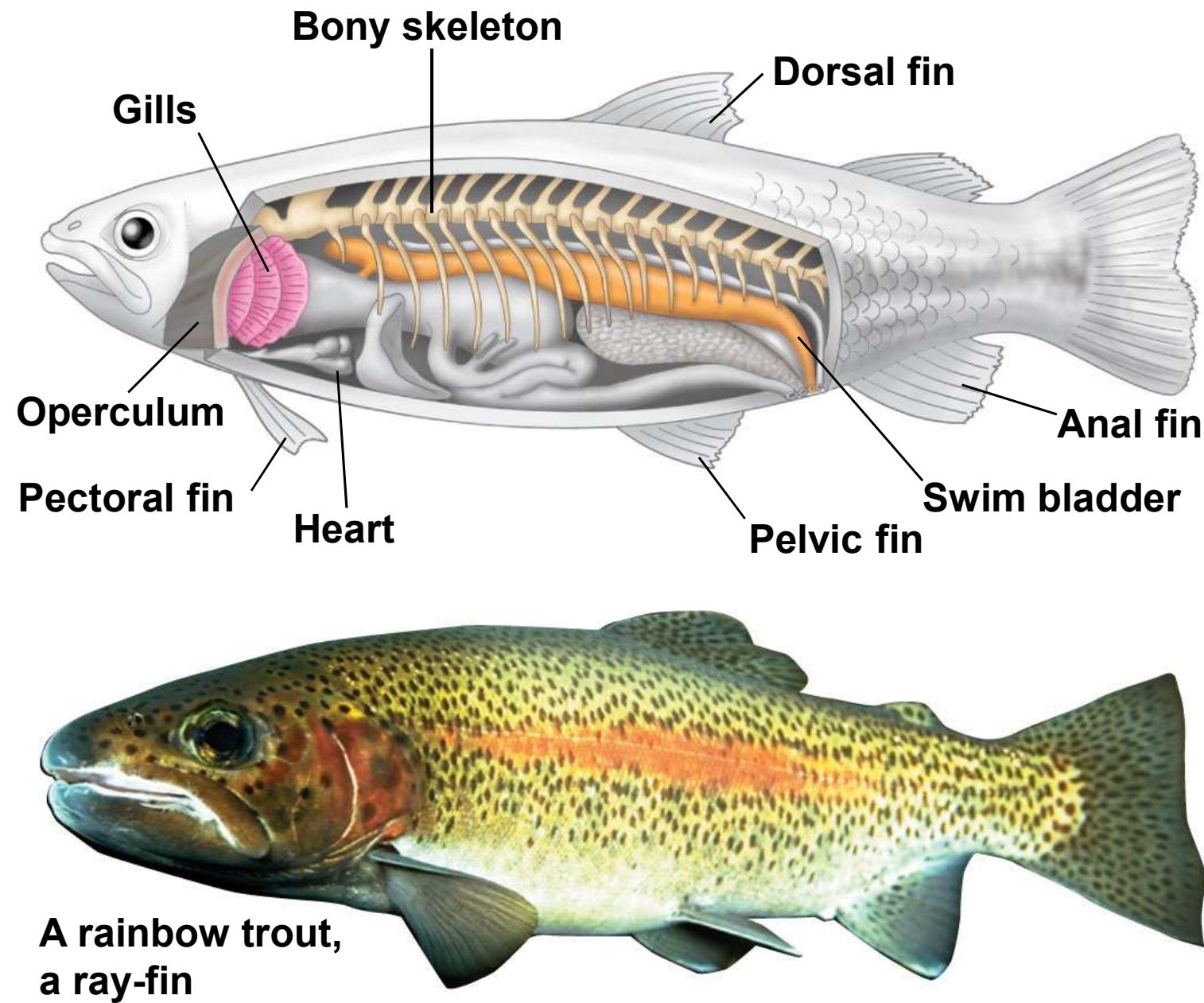
- Ray-finned fishes have

- an **internal skeleton** reinforced with a hard matrix of **calcium phosphate**,
- flattened **scales** covered with mucus,  
    鰓蓋
- an **operculum** that covers a chamber of gills, and  
    鱗
- a buoyant **swim bladder** (derived from an ancestral lung).



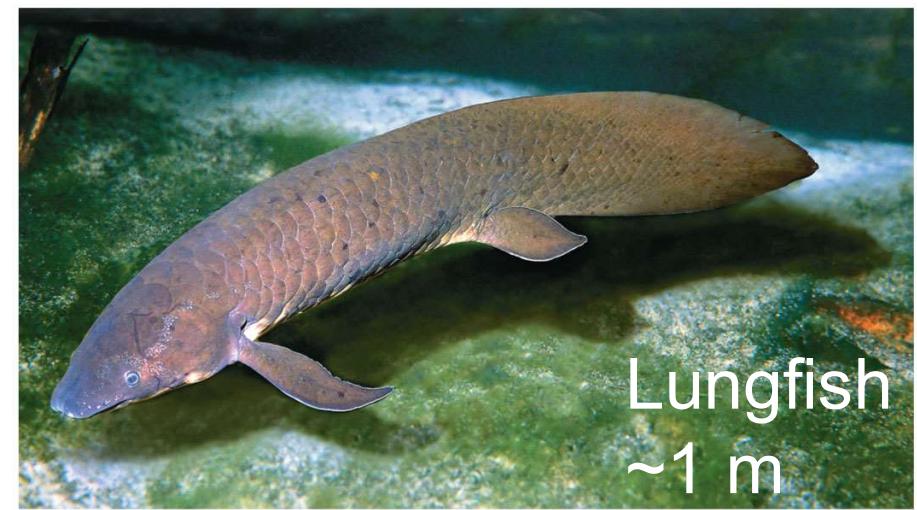
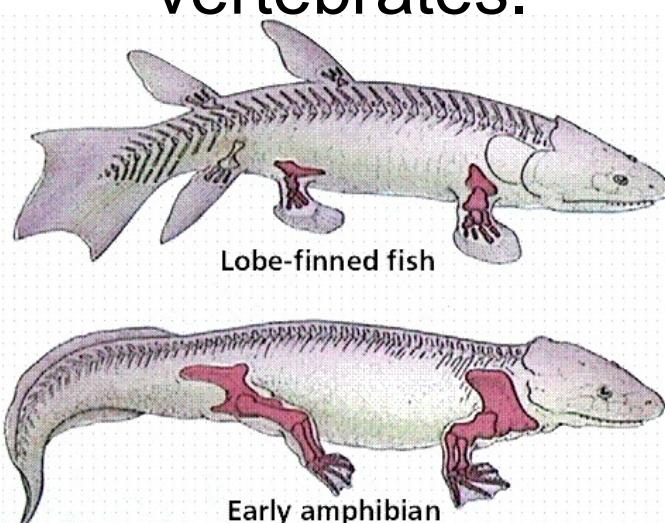
- With more than 27,000 species, ray-finned fishes are the most diverse group of vertebrates.

Figure 19.3D



## 19.3 Jawed vertebrates with gills and paired fins include sharks, ray-finned fishes, and lobe-finned fishes

- Lobe-fins have **muscular pelvic and pectoral fins** that are supported by rod-shaped **bones**. 骨盤…胸
- Today, three lineages of lobe-fins survive:
  1. coelacanths, living deep in the oceans, were once thought to be extinct, 腔棘魚
  2. lungfishes, which can gulp air into lungs, inhabit stagnant waters in the Southern Hemisphere, and
  3. **tetrapods**, adapted to life on land, include terrestrial vertebrates.



Lungfish  
~1 m

## 19.4 EVOLUTION CONNECTION: New fossil discoveries are filling in the gaps of tetrapod evolution

- During the late Devonian, a line of lobe-finned fishes gave rise to **tetrapods**, jawed vertebrates with limbs and feet that can support weight on land.      泥盆紀 ~4億年
- Adapting to life on land was a key event in vertebrate history.
- All subsequent groups are descendants of these early land-dwellers.
- Like plants, vertebrates faced obstacles on land in regard to
  - **gas** exchange, **water** conservation, structural **support**, a means of **locomotion**, adapting **sensory** organs that worked well in water but not on land, and **reproduction**.

Figure 19.4a

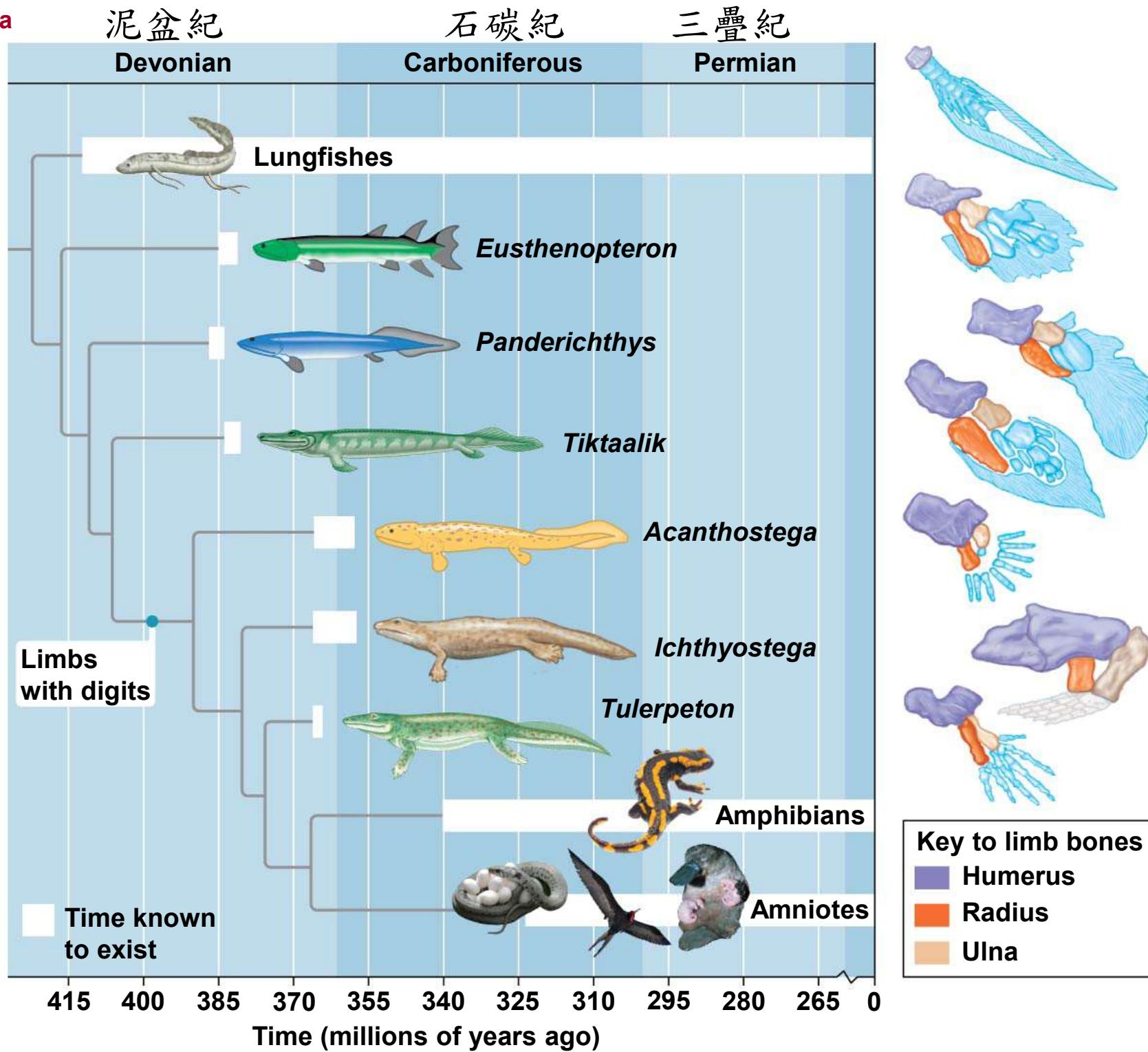
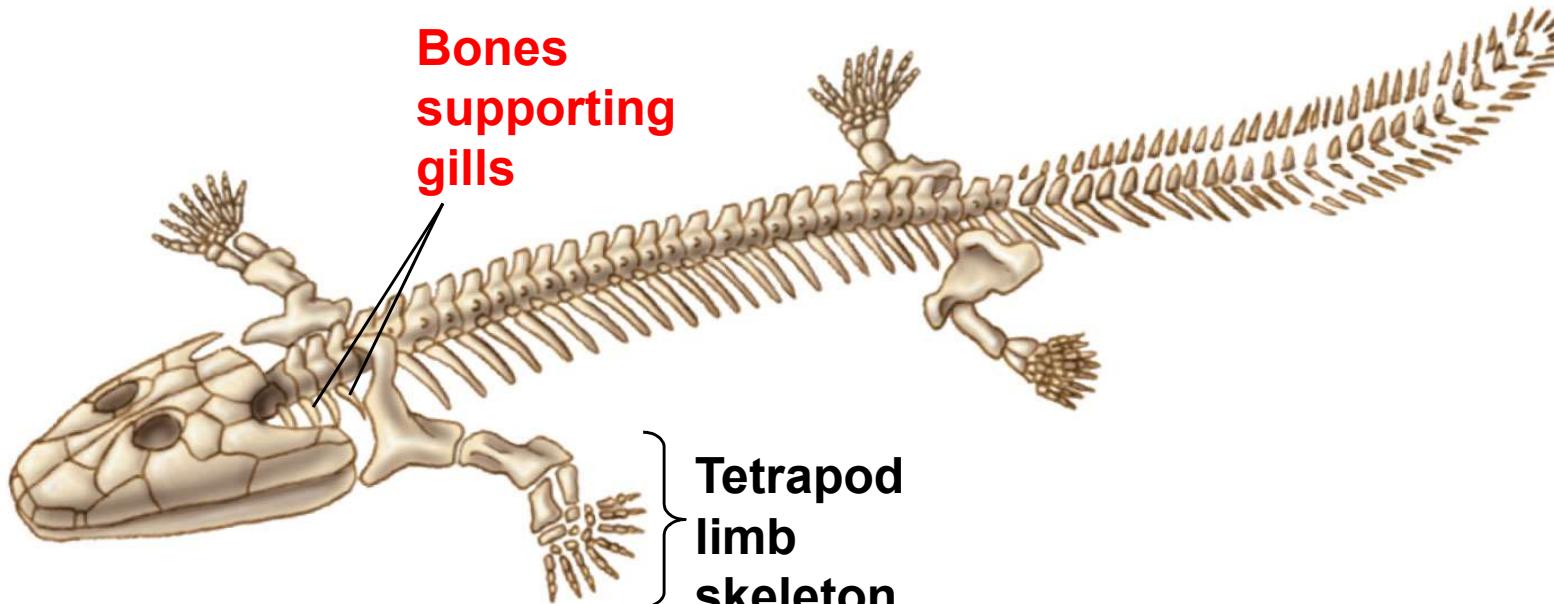


Figure 19.4B



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## Acanthostega

Neck: strengthens its backbone



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Limbs could not support on land

Ribs could not prevent lung collapsing in air.

NOT Fish with lungs and walk among ponds

Fish with **necks** and 4 limbs that raised their heads above water  
and could breathe oxygen from the air.

Oxygen is not enough in stagnant water

## 19.5 Amphibians are tetrapods—vertebrates with two pairs of limbs

### ■ **Amphibians** 兩棲類

蟾蜍

蚓螈（無足目）

- include salamanders, frogs, and caecilians,
- use their **moist skins** to supplement their lungs for gas exchange,
- often have poison glands in their skins,
- usually **return** to standing water to reproduce,
- undergo **metamorphosis** from a larval stage to the adult form, and
- were the first tetrapods able to **move on land**.



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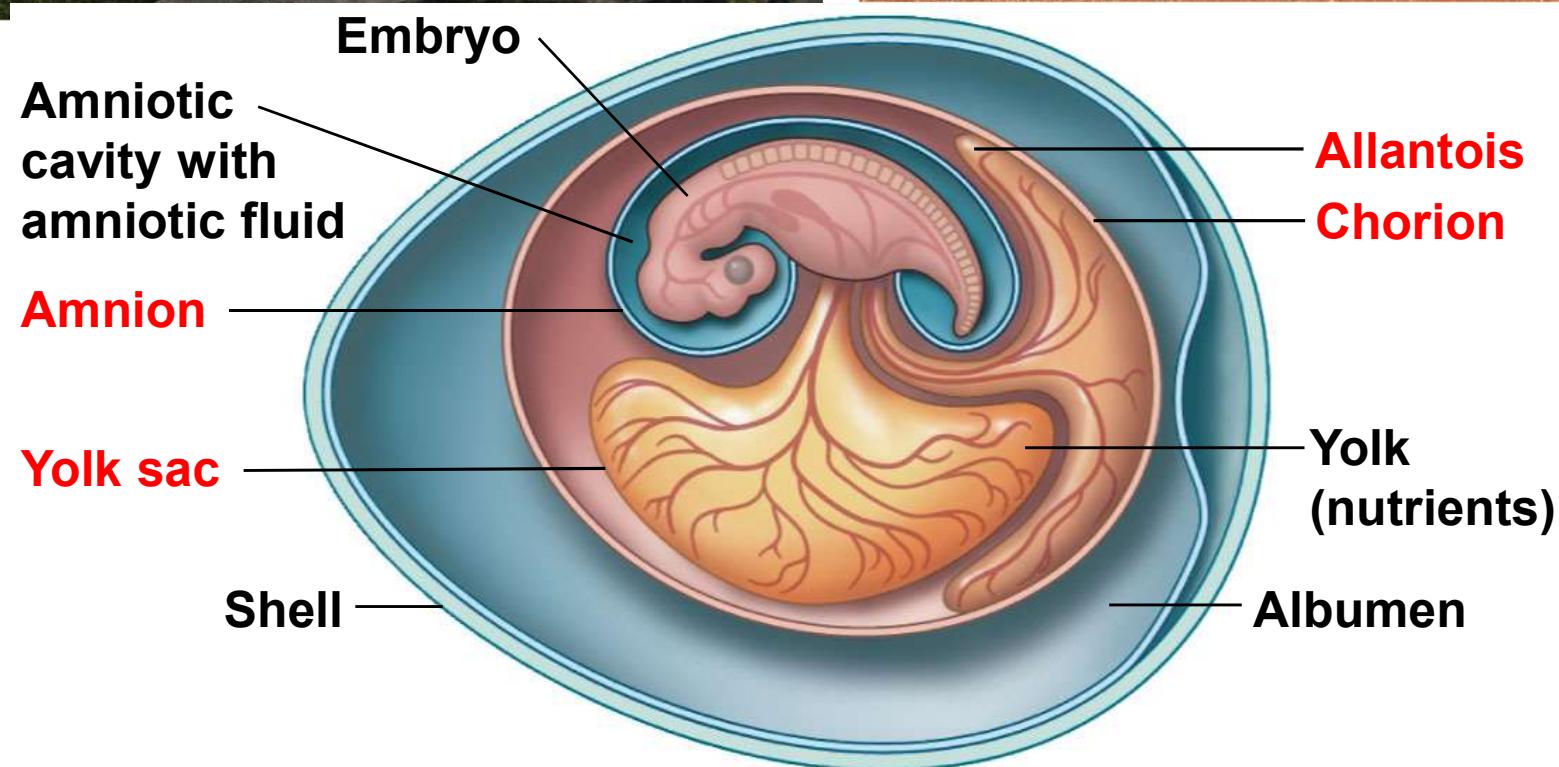
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From legged ancestor

## 19.6 Reptiles are amniotes—tetrapods with a terrestrially adapted egg

- Reptiles (including birds) and mammals are **amniotes**. 羊膜動物
- The major derived character of this clade is an **amniotic egg** with four internal membranes.
  1. The **amnion** is a fluid-filled sac surrounding the embryo. 羊膜
  2. The **yolk sac** contains a rich store of nutrients for the developing embryo. 卵黃囊
  3. The **allantois** (尿囊) also helps dispose of metabolic waste.
  4. The **chorion** (絨毛膜)(and allantois) enable the embryo to obtain oxygen from the air and dispose of carbon dioxide.
- **Reptiles**
  - include lizards, snakes, turtles, crocodilians, birds, and extinct dinosaurs,
  - have a skin covered with scales and **waterproofed** with keratin,
  - obtain most of their oxygen using lungs, and
  - are **ectothermic**, absorbing external heat rather than generating much of their own.

Figure 19.6A



## 19.7 Birds are feathered reptiles with adaptations for flight

- Most **birds** can fly, and nearly every part of their bodies reflects adaptations that enhance flight.
  - The **forelimbs** have been remodeled as feather-covered wings that act as airfoils.
  - Large **flight muscles** anchored to a central ridge along the breastbone provide power.
  - Many features help **reduce weight** for flight:
    - Present-day birds **lack teeth**.
    - The tail is supported by only a few small vertebrae.
    - Feathers have hollow shafts.
    - Their bones have a honeycombed structure that makes them strong but light.
- Flight is very costly, and present-day birds have **a high rate of metabolism**.
- Unlike other living reptiles, birds are **endothermic**, using heat generated by metabolism to maintain a warm, steady body temperature.
- Birds have relatively large brains and display complex behaviors. They have
  - acute senses, fine muscle control, and excellent eyesight.

## 19.7 Birds are feathered reptiles with adaptations for flight



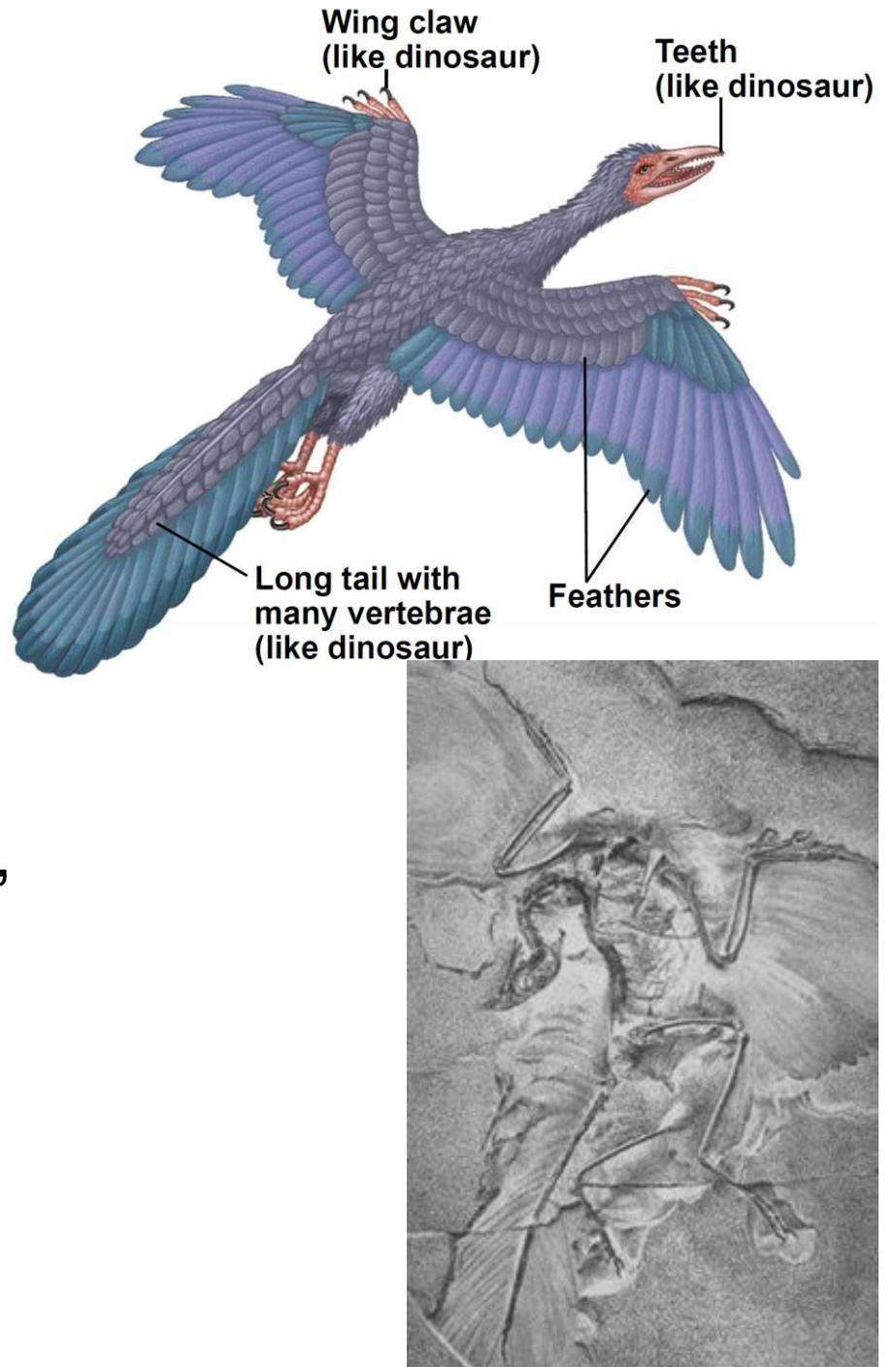
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- Birds typically display very complex behaviors, particularly during breeding season.
- Courtship often involves elaborate rituals.

## 19.7 Birds are feathered reptiles with adaptations for flight

- **Birds** evolved from a lineage of small, **two-legged dinosaurs** called theropods.
  - *Archaeopteryx* is the oldest, most primitive known bird (150 million years old), with feathered wings. 50 cm
  - It resembled a small bipedal dinosaur, with teeth, wing claws, and a long tail with many vertebrae.



- Chinese paleontologists have excavated fossils of many feathered theropods, including specimens that predate *Archaeopteryx* by 5–10 million years. 獸腳亞目 (雙足恐龍)
- Such findings imply that feathers, which are homologous to reptilian scales, evolved long before powered flight.
- Early feathers may have functioned in
  - insulation or courtship displays.



聖賢孔子鳥 *Confuciusornis*  
遼寧  
~30 cm  
1.25億年到1.2億年



中華龍鳥 *Sinornithosaurus*  
遼寧  
60 ~ 100 cm  
~1.2億年

## 19.8 Mammals are amniotes that have hair and produce milk

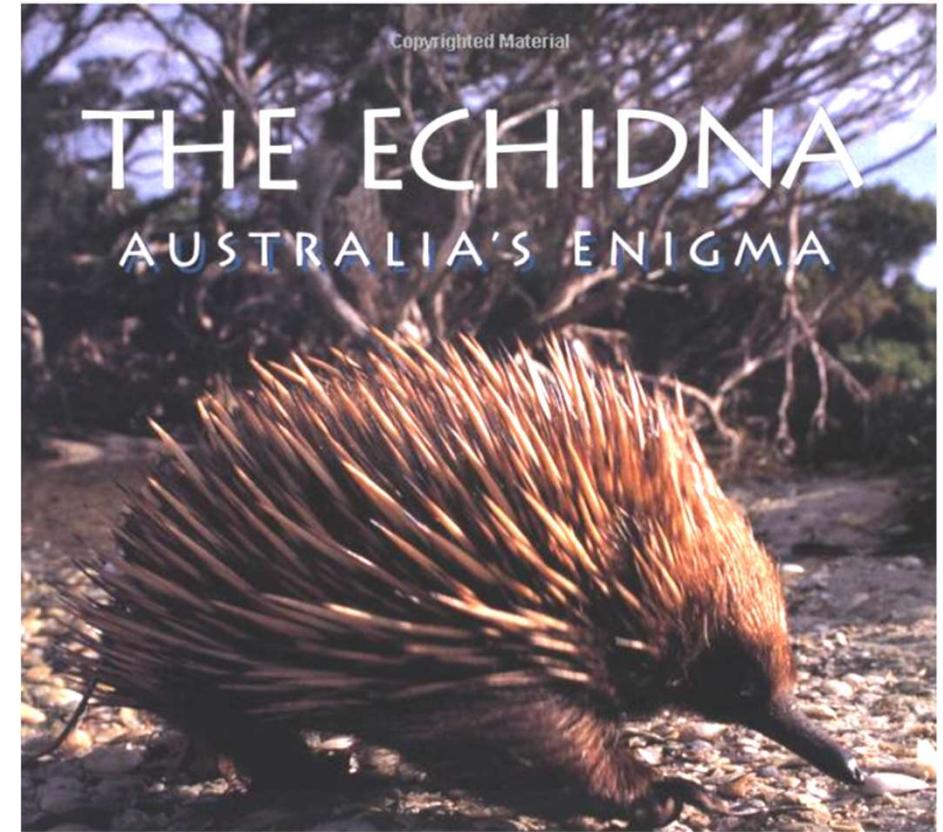
- Mammals are **endothermic amniotes** with
  - **hair**, which insulates their bodies, and
  - **mammary glands**, which produce milk.
- Mammals have efficient respiratory and circulatory systems that support their high rate of metabolism.
- Mammalian teeth are differentiated for many kinds of diets.
- **Monotremes** are egg-laying mammals. Living monotremes include 單孔目、沒有分開的尿道、肛門及產道，而是由統一的泄殖腔代替。爬行動物。
  - the duck-billed platypus
  - Echidnas 有刺食蟻獸 or 針鼴

有袋類 真哺乳亞綱動物
- Unlike monotremes, the embryos of marsupials and eutherians are nurtured by a **placenta**, in which nutrients from the mother's blood diffuse into the embryo's blood. 胎盤

Figure 19.8A



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針鼴, spiny anteaters, belong to the monotreme order of egg-laying mammals

## Knuckles the Echidna

Sonic the Hedgehog (刺蝟)



## 19.8 Mammals are amniotes that have hair and produce milk

- **Marsupials** have a brief gestation and give birth to tiny, 妊娠 **embryonic offspring** that complete development while attached to the mother's nipples. 有袋動物
- **Eutherians** are mammals that bear **fully developed live young**. They are commonly called **placental mammals** because their placentas are more complex than those of marsupials. 真哺乳亞綱動物



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- The first **true mammals** arose 200 million years ago and were probably small, nocturnal insectivores.

夜行性

- Monotremes are the oldest lineage of mammals.
  - Marsupials diverged from eutherians (placental mammals) about 180 million years ago.
  - Mammals underwent an adaptive radiation following the **Cretaceous extinction** of dinosaurs, giving rise to large terrestrial carnivores and herbivores, bats, and aquatic whales and porpoises.

(白堊紀大滅絕；65.5 million yrs)

# PRIMATE DIVERSITY

## 19.9 Primates include lemurs, tarsiers, monkeys, and apes

- The mammalian order Primates includes the lemurs, tarsiers, monkeys, and apes.
  - 狐猴 眼镜猴
  - Primates probably arose as small arboreal (樹棲) mammals before 65 million years ago, when dinosaurs still dominated the planet.
- Many primate characters are arboreal adaptations.
  - Shoulder and hip joints allow climbing and brachiation (臂力擺蕩).
  - Grasping hands and feet are highly mobile and flexible.
  - Sensitive hands and feet aid in manipulation.
  - A short snout and forward-pointing eyes enhance depth perception.
- Although humans never lived in trees, the human body retains many of the traits that evolved in our arboreal ancestors.

## PRIMATE DIVERSITY

### Distinguishing primate features

- Primates include lorises, lemurs, tarsiers, and anthropoids (monkeys and apes)
- Short snout; eyes set close together on front of face
- Limber shoulder and hip joints
- Five highly mobile digits on hands and feet
- Flexible thumb



▲ Slender loris

► Coquerel's sifaka, a lemur



## PRIMATE DIVERSITY

### Anthropoids

- Include monkeys and apes
- Have a fully **opposable thumb** that functions in grasping

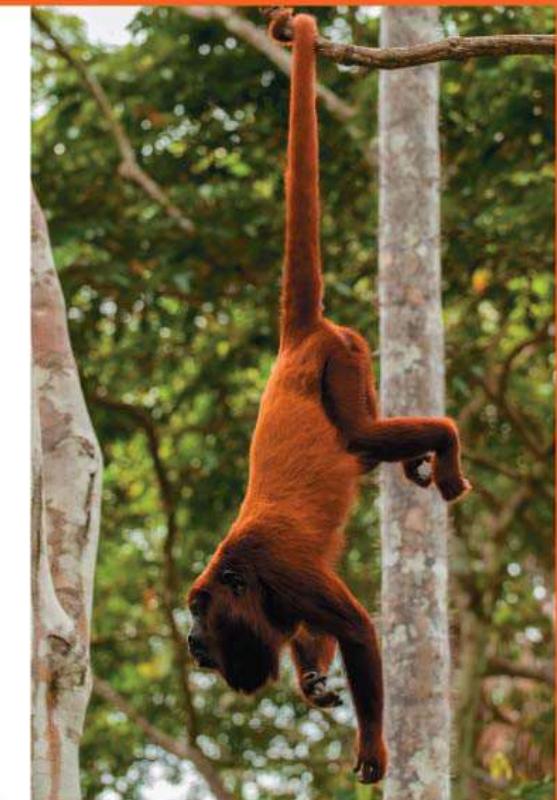
### Monkeys

- Have forelimbs about **equal** in length to their hind limbs
- Have tails; some have a long, prehensile (grasping) tail, others lack a prehensile tail

### Apes

- Most have relatively **long arms** and short legs
- Lack a tail**

▼ Gorilla (a type of ape) and offspring



▲ Red howler monkey

## PRIMATE DIVERSITY

### Anthropoids

#### Monkeys

- Include Old World (Africa and Asia) and New World (the Americas) monkeys
- Old World and New World monkeys have been evolving separately for over 30 million years.

##### Old World monkeys

- Many arboreal, but some ground dwelling
- Nostrils open downward
- Lack prehensile tail
  - ▶ Lion-tailed macaque



##### New World monkeys

- All arboreal
- Nostrils open to side; far apart
- Many have a long, prehensile (grasping) tail
  - ▶ Golden lion tamarin



# PRIMATE DIVERSITY

## Anthropoids, continued

### Apes

- Include gibbons, orangutans, gorillas, chimpanzees, and humans
- Compared to other primates, they have **larger brains** relative to body size; thus, their behavior is more flexible.



◀ Orangutan

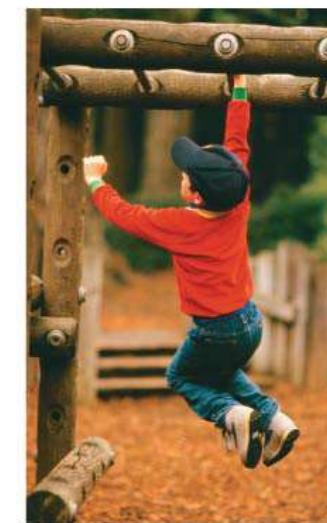


◀ Chimpanzee and offspring



▼ Gorilla and offspring

▼ Gibbon



▲ Human child

## 19.10 The human story begins with our primate heritage

- A phylogenetic tree shows that all **primates** are divided into three groups: 狐猴 懶猴 樹熊猴
  1. lemurs, lorises, and pottos,
  2. tarsiers, 眼鏡猴
  3. **anthropoids**, including monkeys and apes with a fully **opposable thumb**, in which the tip of all four fingers can touch the thumb. 類人猿

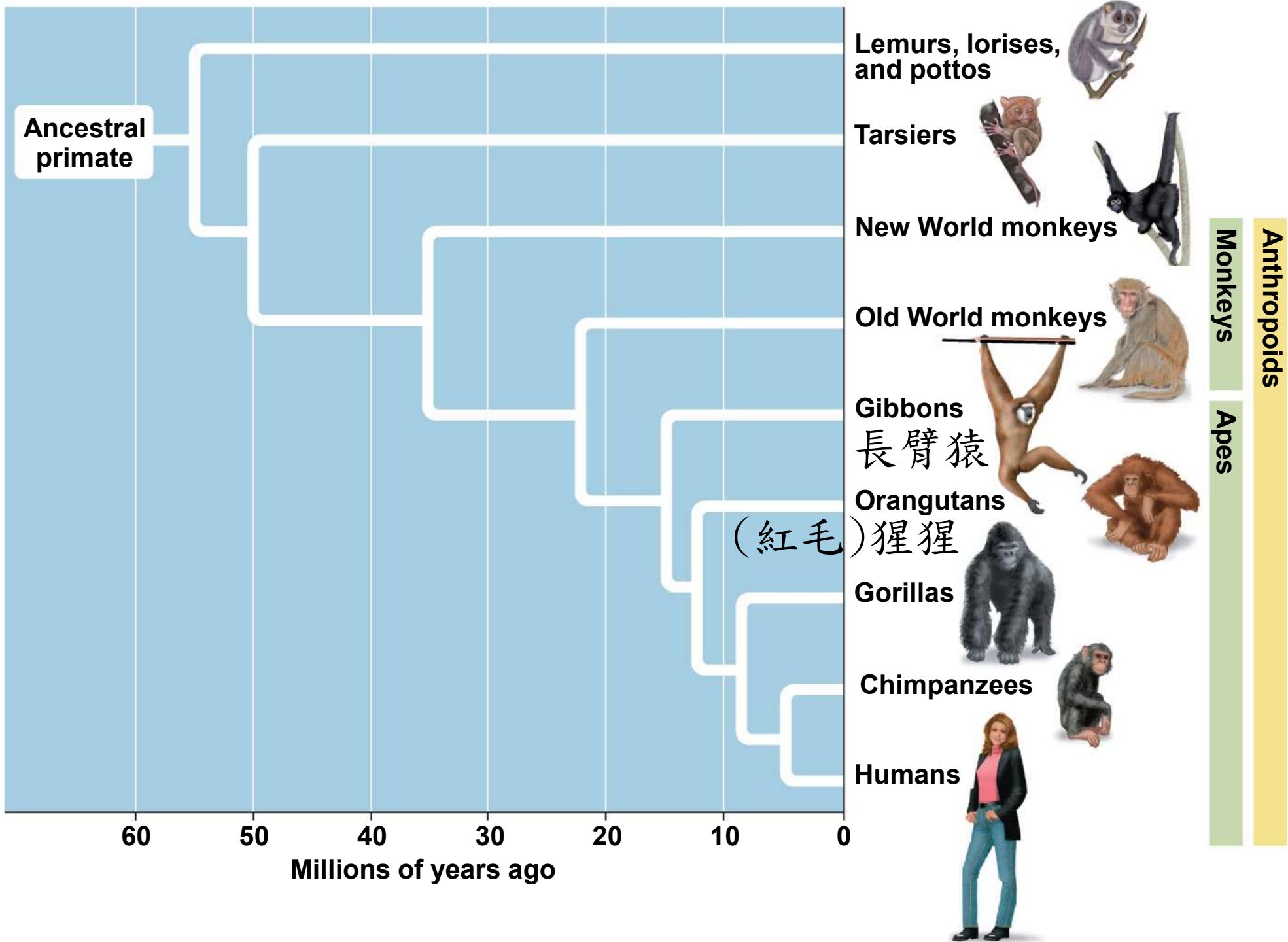
Anthropoids began diverging from other primates about 50 million years ago.

Old World monkeys and apes, which include gibbons, orangutans, gorillas, chimpanzees (and bonobos), and humans, diverged about 20–25 million years ago.

Molecular evidence indicates that chimpanzees and gorillas are more closely related to humans than they are to other apes.

Humans and chimpanzees are especially closely related; their genomes are 99% identical.

Figure 19.9B



## 19.10 The human story begins with our primate heritage

- Monkeys do not constitute a monophyletic group.

- Old World monkeys (Africa and Asia) 單系

- probably evolved first,
    - lack a prehensile tail, and 適于盤卷的
    - have nostrils that open downward.

- New World monkeys have central and south Am.

- Arboreal, a prehensile tail
    - nostrils that are wide open and farther apart.



Pygmy mouse lemur



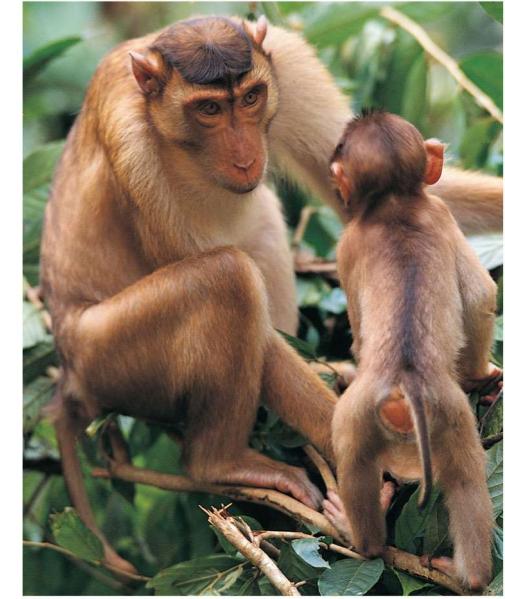
A tarsier



A golden lion tamarin 猋猴  
(note nostrils that open to the side)



A black spider monkey (note prehensile tail)



A macaque (短尾猴, 包括臺灣獮猴) with its young; old world monkey

## 19.10 Humans and four other groups of apes are classified as anthropoids

- In addition to monkeys, the anthropoid group includes apes: gibbons, orangutans, gorillas, chimpanzees (and bonobos), and humans.
- Apes 猿、類人猿
  - lack a tail and
  - have relatively long arms and short legs,
  - have relatively larger brains with respect to size, and
  - more flexible behavior.
- Gorillas, chimpanzees, and humans have a high degree of social organization.
- Nonhuman apes
  - live only in Africa and Southeast Asia, in tropical rain forests
  - have a smaller geographic range than monkeys.

## 19.10 Humans and four other groups of apes are classified as anthropoids

- **Gibbons** are

- monogamous 一夫一妻制
- the only **fully arboreal** apes.



長臂猿

A gibbon

- **Orangutans** are

- shy,
- solitary, and
- live in rain-forest trees and the forest floor.



(紅毛)猩猩

An orangutan

- **Gorillas** are

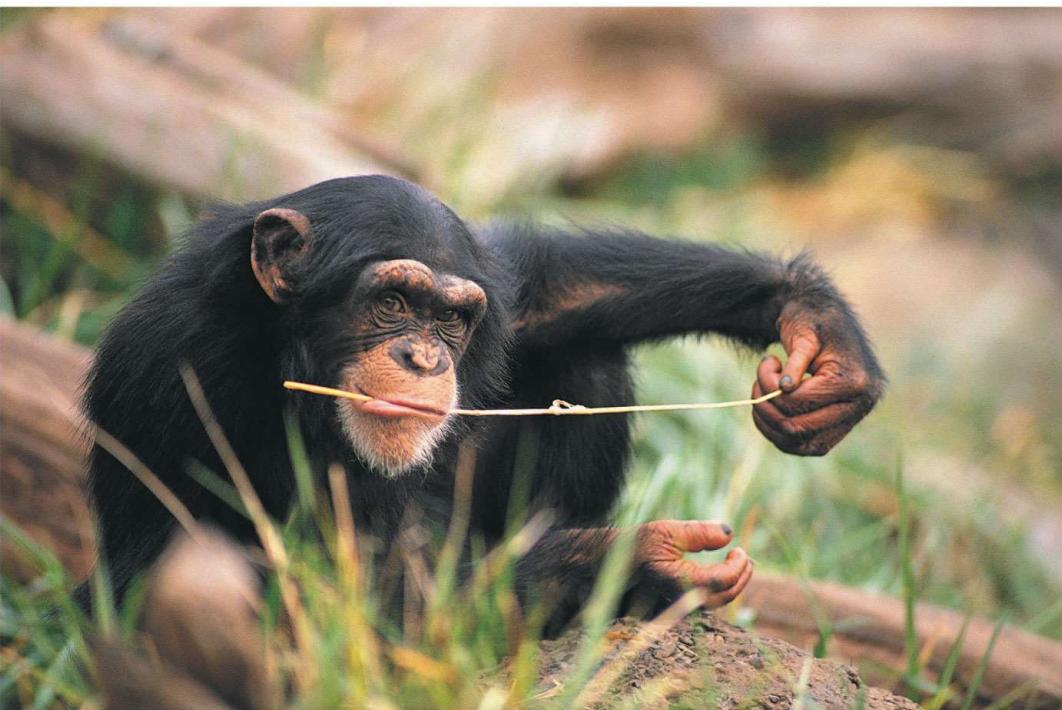
- the largest of the apes and
- **fully terrestrial**.



A gorilla and offspring

# 19.10 Humans and four other groups of apes are classified as anthropoids

- **Chimpanzees** make and use tools.
- Humans and chimpanzees
  - are closely related,
  - share 99% of their genes, and
  - diverged from a common ancestor between 5 and 7 million years ago.



A chimpanzee

# HOMININ EVOLUTION

Recent scientific findings about human evolution

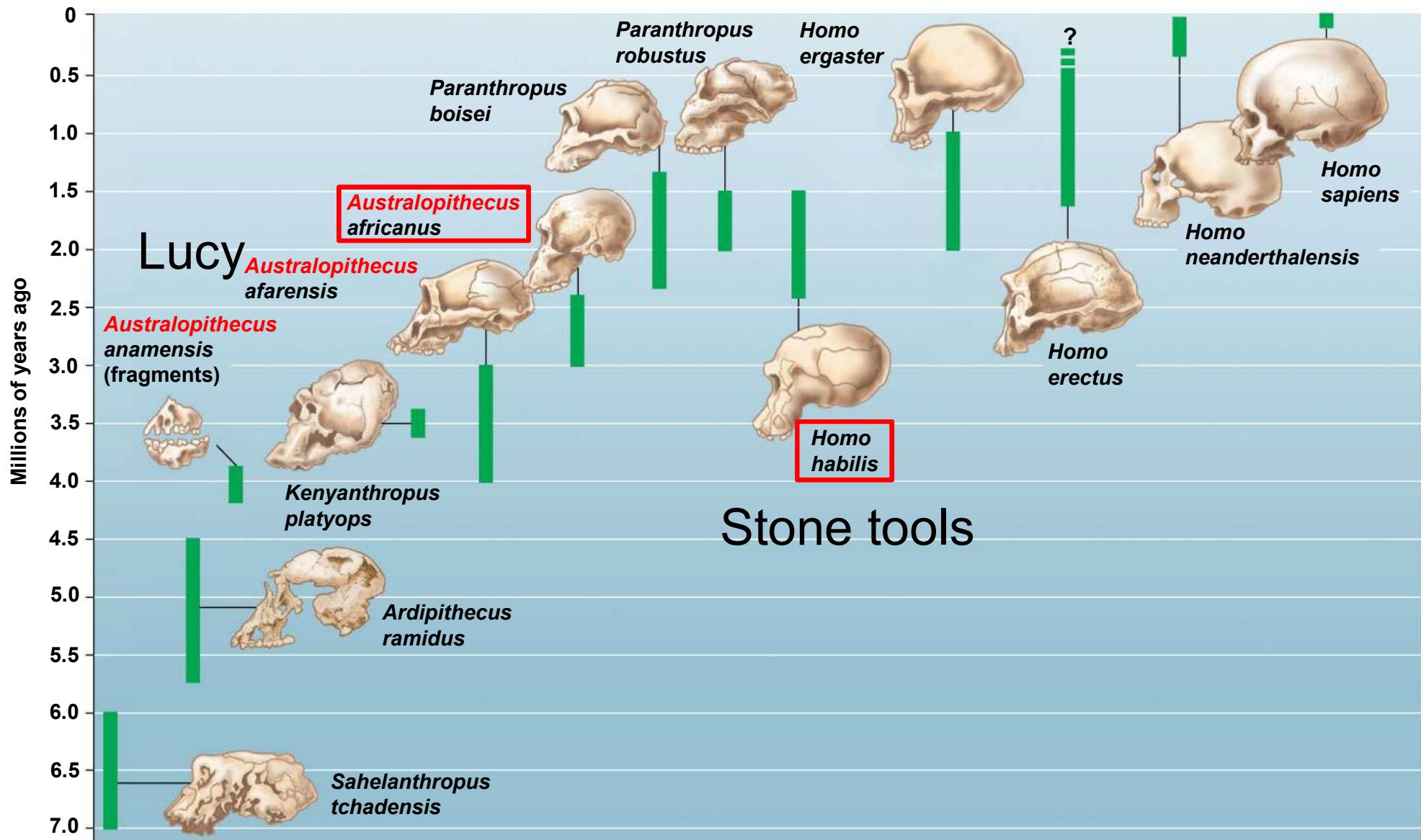
<https://www.nature.com/collections/ffjxdjnlcq>

# 19.11 The hominin branch of the primate tree includes species that coexisted

古人類學 (人類學系 Dept Anthropology)

- **Paleoanthropology** is the study of human origins and evolution, the brief history since the divergence of human and chimpanzee lineages.
- Paleoanthropologists have unearthed
  - about 20 species of extinct **hominins**, species that are more closely related to humans than to chimpanzees, and
  - thousands of hominin fossils.
- The oldest hominin yet discovered, *Sahelanthropus tchadensis*, lived about 7 to 6 million years ago.
- The fossil record suggests that hominin diversity increased dramatically between 4 and 2 million years ago.
  - The first fossil member of our own genus, *Homo*, dates from that time.
  - By 1 million years ago, only species of *Homo* existed.
  - Eventually, all *Homo* species except one—our own—ended in extinction.

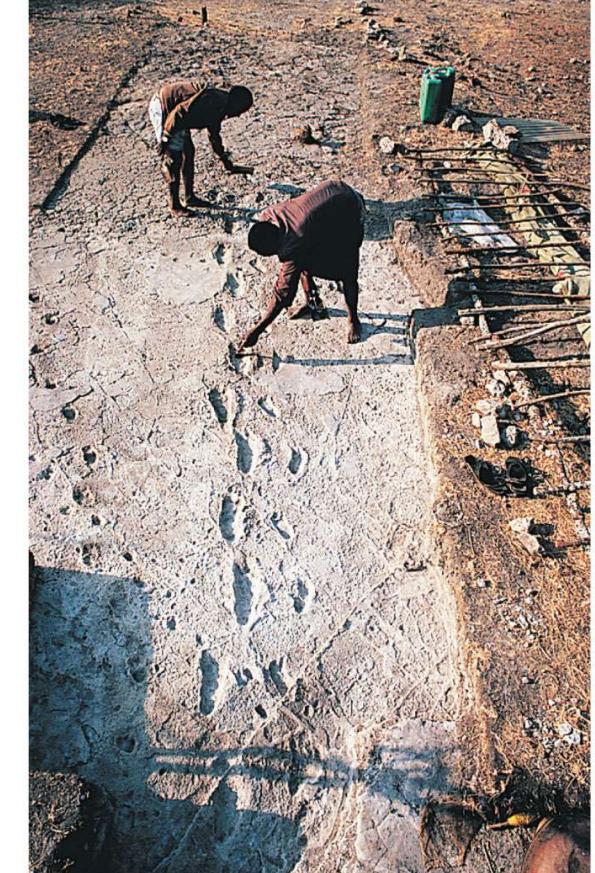
*Australopithecus*: woodland creature, move in the **tree branches**, walk upright,



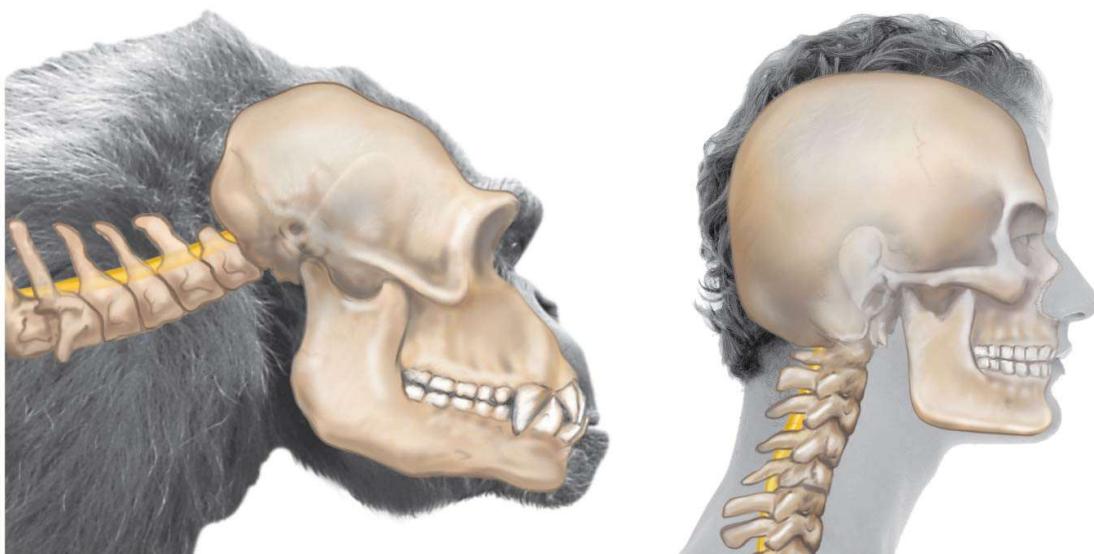
© 2012 Pearson Education, Inc.

## 19.12 Australopiths were bipedal and had small brains

- Unlike chimpanzees, humans
  - walk upright and
  - have larger brains.
- Bipedalism arose millions of years **before** larger brain size. **Evidence of bipedalism includes**
  - 3.6-million-year-old upright-walking hominin footprints and
  - fossil skeletons.



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The angle of spinal cord exit from skull in chimpanzee (left) and human (right)

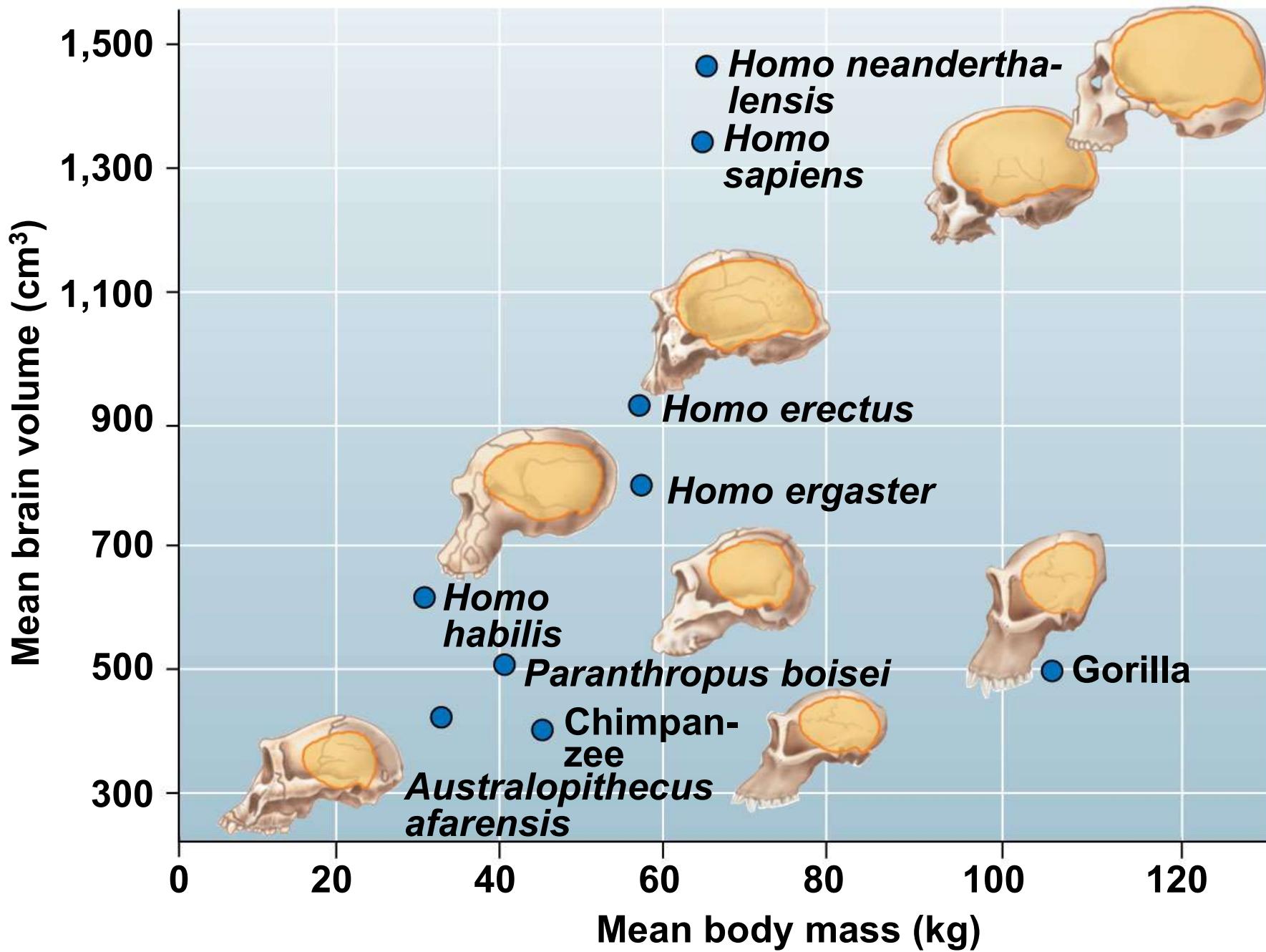
## 19.12 Australopiths were bipedal and had small brains

- A clue to bipedalism is the location of the opening in the base of the skull through which the spinal cord exits.
  - In chimpanzees and other species that are primarily quadrupeds, the spinal cord exits toward the rear of the skull, at an angle that allows the eyes to face forward.
  - In bipeds, including humans, the spinal cord emerges from the floor of the braincase, so the head can be held directly over the body.

## 19.13 Larger brains mark the evolution of Homo

- Australopiths had such small brains (400–450 cc) that they were too small to be members of *Homo*.
- *Homo habilis* (2.4–1.6 million years ago) had a brain size of 510–690 cc. Their fossils are found with **stone tools**.
- *Homo ergaster* (1.9–1.6 million years ago) had a brain size ranging from 750 to 850 cc. Their
  - fossils are found with more sophisticated stone tools and
  - long, slender legs were adapted for long-distance walking.  
Did not climb trees
- *Homo sapiens* has a brain size of around 1,300 cc.

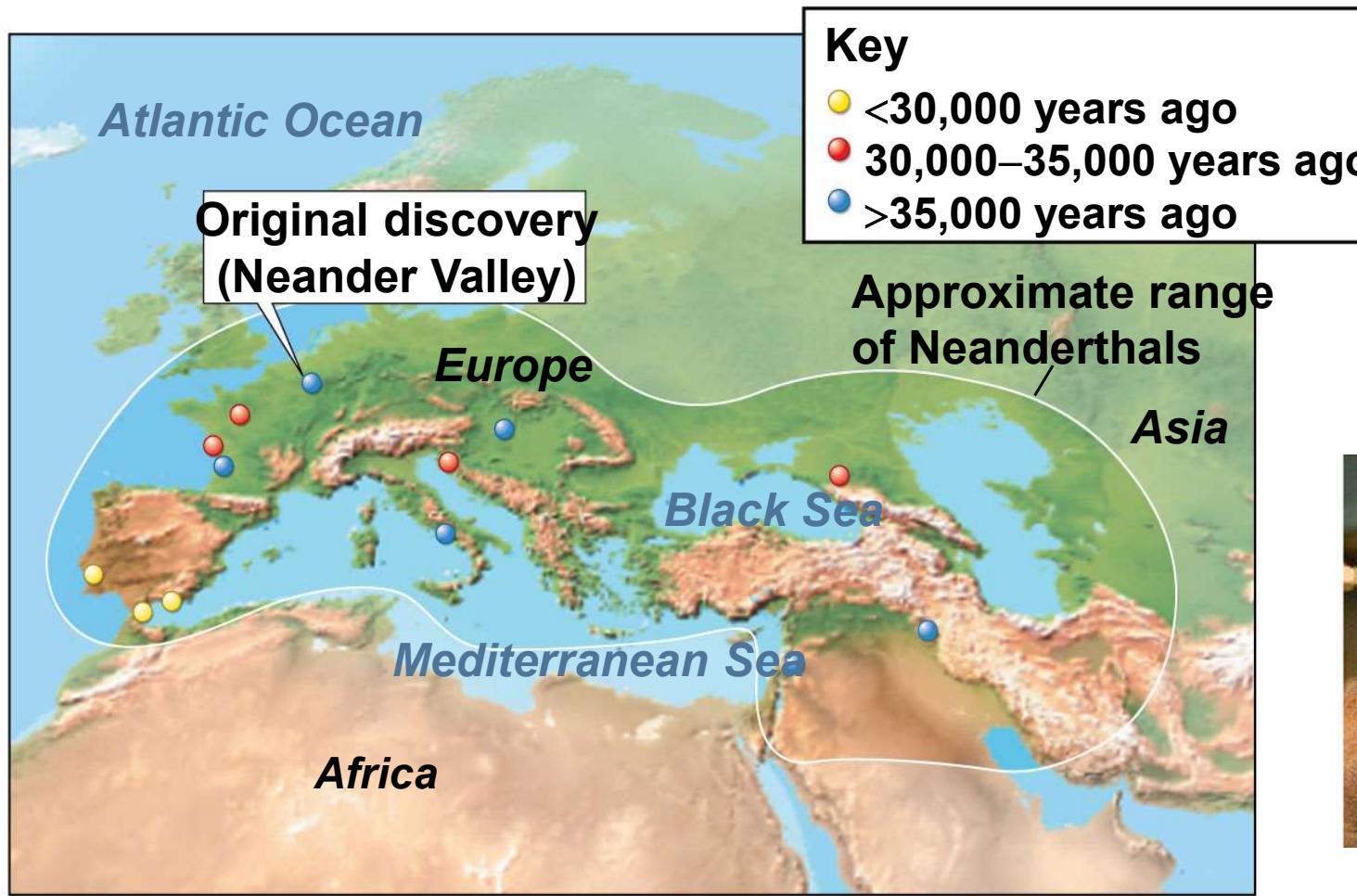
Figure 19.13A



## 19.13 Larger brains mark the evolution of *Homo*

- *Homo erectus*
  - had a brain volume of around 940 cc and
  - was the first hominin to **leave Africa**.
- The oldest known fossils of hominins outside of Africa are about **1.8 million years** old.
- *Homo neanderthalensis*, commonly called Neanderthals
  - lived in Europe from about 350,000 to 28,000 years ago when they went extinct,
  - had brains as large as modern humans, and
  - hunted big game with tools made of stone and wood.
- How are Neanderthals related to modern humans?
  - An analysis of **mtDNA** isolated from Neanderthal bones suggests that they were a distinct species from modern humans.
  - The last common ancestor between humans and Neanderthals lived about 500,000 years ago.

Figure 19.13B



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- However, a comparison of the nuclear genome sequence of *Homo sapiens* with that from Neanderthal fossils, completed in 2010, suggests that
  - Neanderthals and some *H. sapiens* that had left Africa probably did interbreed and
  - this genetic exchange left many of us with genomes that are roughly 3% Neanderthal.

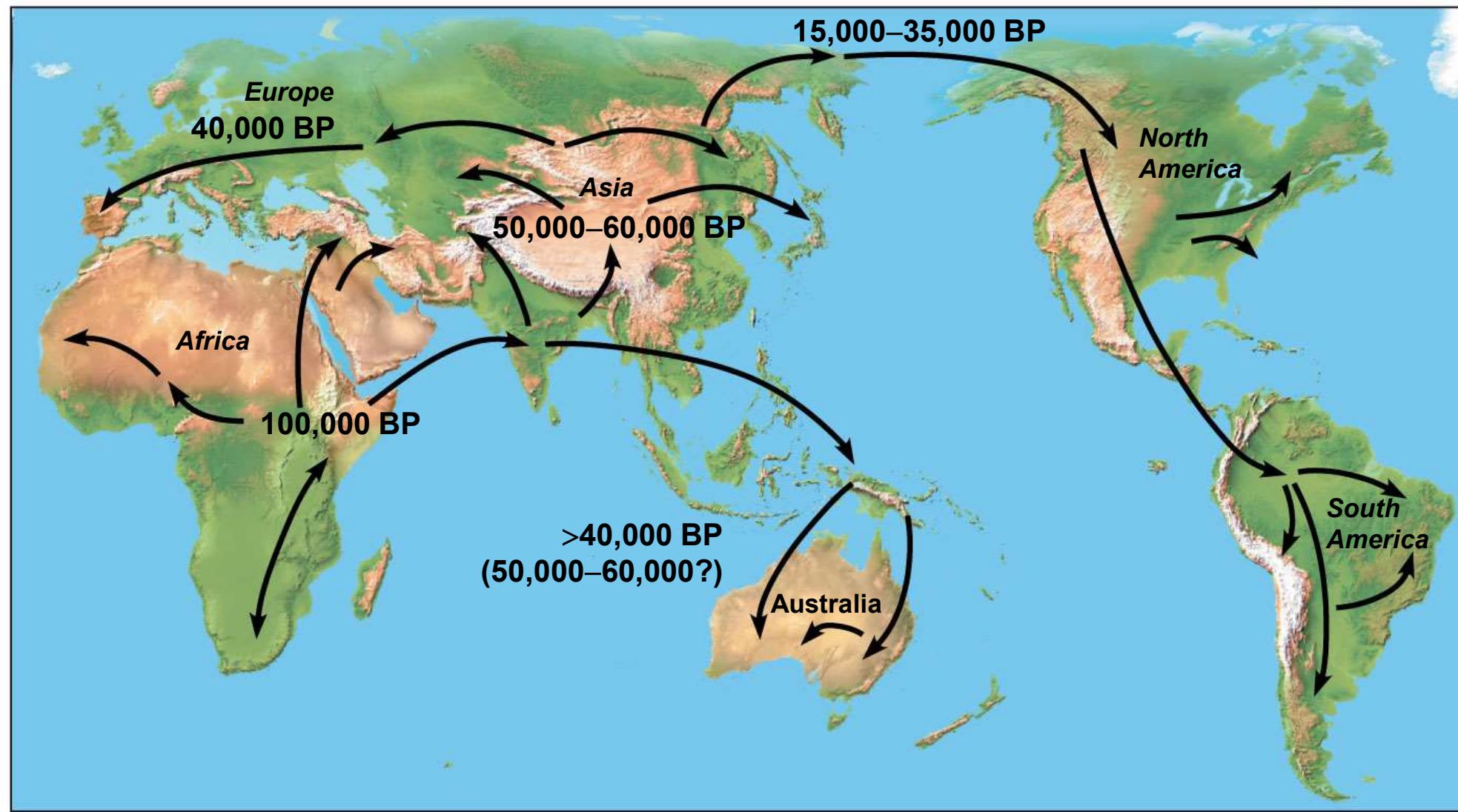
## 19.14 From origins in Africa, *Homo sapiens* spread around the world

- The ancestors of humans originated in Africa.
- The oldest known fossils with the definitive characteristics of our own species
  - were discovered in Ethiopia and
  - are 160,000 and 195,000 years old.
- Analysis of **mtDNA and Y chromosomes** suggests that all living humans
  - inherited their mtDNA from a woman who lived 160,000–200,000 years ago and
  - diverged from a common African ancestor.
- Molecular evidence about the origin of humans supports the conclusions drawn from fossils.

## 19.14 From origins in Africa, *Homo sapiens* spread around the world

- DNA studies indicate
  - that Europeans and Asians share a more recent common ancestor,
  - that many African lineages represent earlier branches on the human tree, and
  - that all living humans have ancestors that originated as *H. sapiens* in Africa.
- Our species emerged from Africa in one or more waves, migrating to Asia 50,000–60,000 years ago and then to Europe, Southeast Asia, and Australia.
- The capacity for **creativity** and **symbolic thought** may have spurred human evolution.

Figure 19.14



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## 19.15 New discoveries raise new questions about the history of hominins

- The researchers who discovered the first “hobbit” skeleton described them as a new hominin species named *Homo floresiensis*.
- Numerous hypotheses exist to explain the relationship of hobbits to hominins.
- Some researchers suggest that *Homo floresiensis*
  1. was a dwarf descendent of *H. erectus*,
  2. is more closely related to *Homo habilis* than to *Homo erectus*, or
  3. is not a species at all, but instead is *Homo sapiens* with a **genetic disorder** that causes bone malformations.

## 19.15 New discoveries raise new questions about the history of hominins

- Scientists continue to accumulate further evidence to determine which hypothesis is correct.
- Fossils of small hominins named *Homo floresiensis* that were found in Indonesia are controversial. The 2004 discovery of the nearly complete skeleton was of a hominin that
  - was about 1 meter tall,
  - had a chimp-sized brain, and
  - had a skull that displayed some humanlike traits.
- Scientists are trying to determine their relationship to other hominins.
- Genetic disorder?
- Left Africa even earlier than *H. erectus*?

## 19.16 EVOLUTION CONNECTION: Human skin color reflects adaptations to varying amounts of sunlight

- Human skin color varies geographically, likely as a result of natural selection.
- Natural selection may have selected for the competing abilities of skin to
  - block UV radiation, which degrades **folate**, and
  - absorb UV radiation to synthesize **vitamin D**.
    - Folate is vital for fetal development and spermatogenesis.
    - Vitamin D is essential for proper bone development

TABLE 19.16

CORRELATION OF UV RADIATION WITH RISK OF VITAMIN D AND FOLATE DEFICIENCIES			
Latitude	UV Radiation	Risk of Vitamin D Deficiency	Risk of Folate Deficiency
Tropical latitudes 0–23.5°	High	Low	High
Higher latitudes 23.5–90°	Low	High	Low

# 人類學：人類的演化到此為止了嗎？

[http://www.sciscape.org/news\\_detail.php?news\\_id=1923](http://www.sciscape.org/news_detail.php?news_id=1923)

從靈長類動物笨重下顎的粗臉到現代人頭顱明顯朝小型而圓、纖細優美的臉形及下顎，發現天擇作用可能驅使長相的演化朝向早期人種的生成，但他們也發現長相的變化可能因工具的使用，致使咬及咀嚼動作的變少而變小。

Humans are still evolving—and we can watch it happen

By [Elizabeth Pennisi](#)

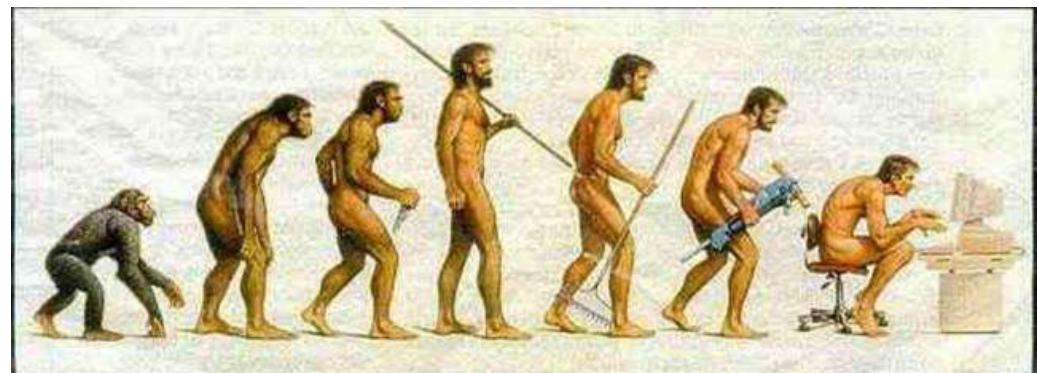
<http://www.sciencemag.org/news/2016/05/humans-are-still-evolving-and-we-can-watch-it-happen>

Using gene as the tool; big data

Plaeo diet

Why did humans evolve blue eyes?

<http://www.abc.net.au/science/articles/2015/09/04/4294967.htm>



## 19.17 CONNECTION: Our knowledge of animal diversity is far from complete

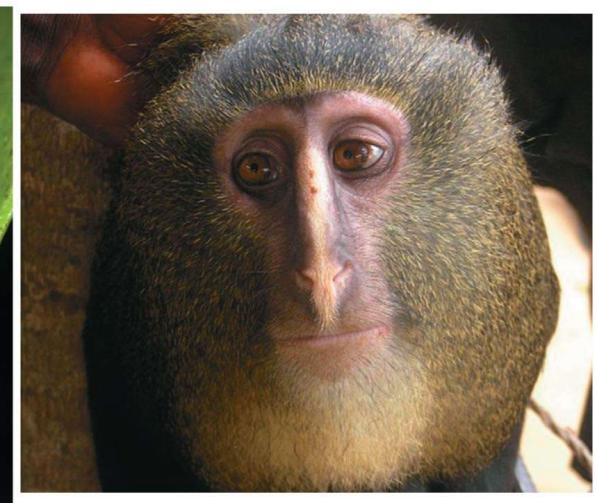
- Thousands of new species of organisms are discovered each year. 2007: 18,156 (vertebrate 1,200)
- The pace of discovery has recently increased due to
  - better access to remote areas and
  - new mapping technologies. (Endangered soon after being discovered)



Leopard gecko  
Northern Vietnam



Pinocchio frog  
New Guinea



Lesula, a new monkey species, Congo

- When a new species is described, taxonomists
  - learn as much as possible about its physical and genetic characteristics and
  - assign it to the appropriate groups in the Linnaean system.
- Most new species automatically acquire a series of names from domain through genus.
  - But every species also has a unique identifier, and the honor of choosing it belongs to the discoverer.
  - Species are often named for their habitat or a notable feature.




## 穿山甲木鼻白蟻 的兵蟻與工蟻

<https://www.ettoday.net/news/20190301/1389507.htm>

國立中興大學昆蟲系副教授李後鋒與博士生梁維仁發現新的白蟻品種，命名為「穿山甲木鼻白蟻」，是第一個由台灣人發表命名的白蟻。據了解，此物種屬於木鼻白蟻科，是介於木白蟻演化至鼻白蟻的過渡類群，現存的物種稀少且分布侷限，從未在台灣被採集，屬昆蟲中的「活化石」。



## 臺灣物種名錄

<http://taibnet.sinica.edu.tw/home.php>



# Top 10 new species 2018

<https://www.esf.edu/top10/>



The institute's international committee of taxonomists selects the Top 10 from among the approximately 18,000 new species named the previous year. The list is made public around May 23 to recognize the birthday of Carolus Linnaeus, an 18th century Swedish botanist who is considered the father of modern taxonomy.

## You should now be able to

1. Describe the key derived traits of the chordates and the chordate subgroups.
2. Describe the characteristics of and distinguish between each of the following vertebrate groups: hagfishes, lampreys, chondrichthyans, ray-finned fishes, lobe-finned fishes, amphibians, reptiles, birds, and mammals.
3. Describe the transitional species that occupy the range between fishes and amphibians in evolutionary history.
4. Distinguish between monotremes, marsupials, and placental mammals.
5. Compare the three main groups of living primates.
6. Distinguish between monkeys and apes.
7. Describe the evidence that suggests that hominins did not evolve in a straight line leading directly to our species.
8. Describe the evidence that suggests when upright posture and large brains first evolved in humans.
9. Describe the relationships between Neanderthals and modern humans.
10. Describe the unusual characteristics of the newly discovered *Homo floresiensis*.
11. Describe the adaptive advantages of darker skin in humans living near the equator but lighter skin in humans living in northern latitudes.
12. Explain why the total number of animal species alive today remains an estimate.