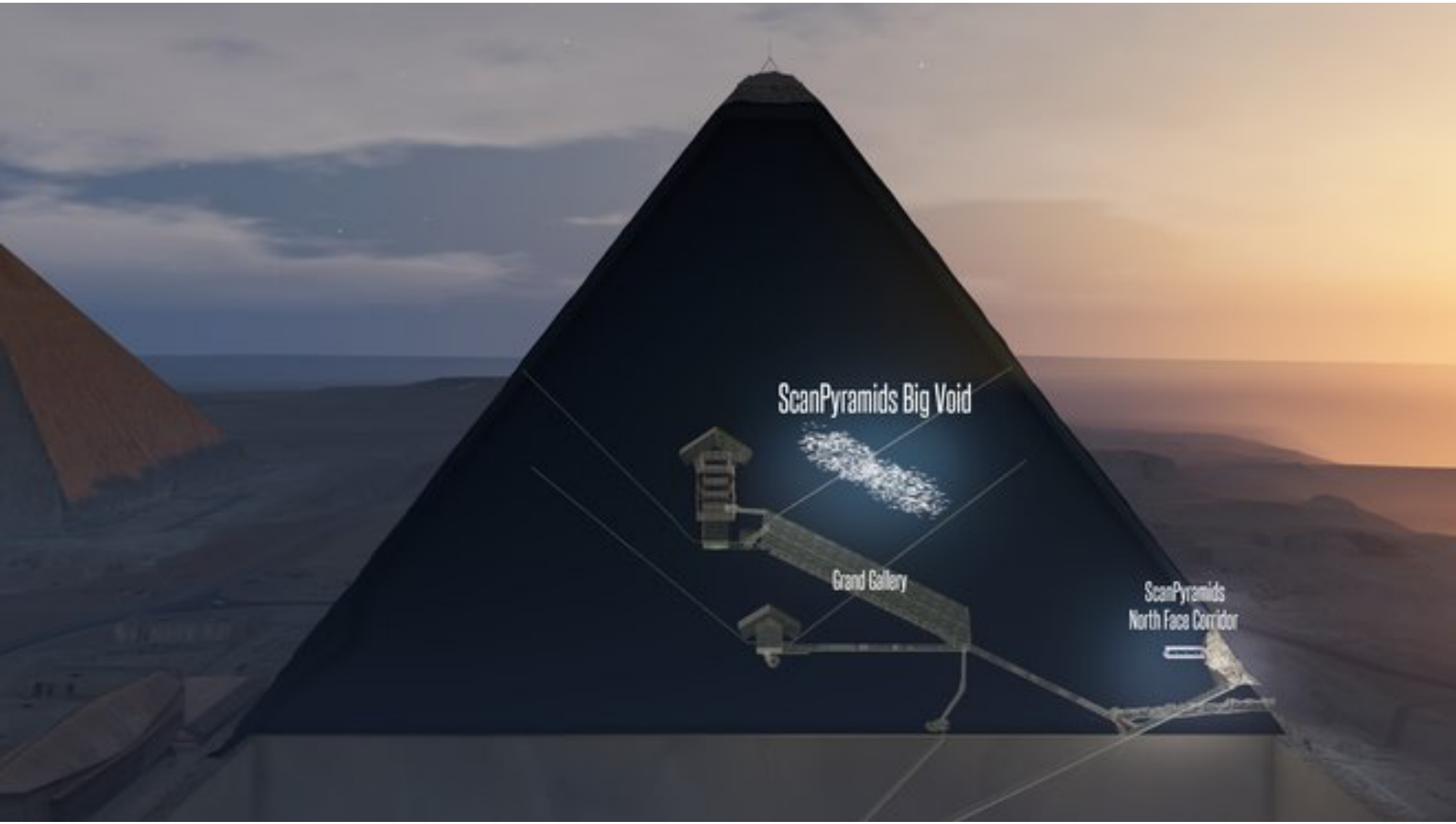
The Great Pyramid at Giza is the world's largest pyramid.
Credit: Vladimir Korostyshevskiy/Shutterstock

November 2, 2017
Secret Chamber? Cosmic Rays Reveal Possible Void Inside Great Pyramid

The team discovered the void using muon particles, which form when cosmic rays interact with Earth's upper atmosphere. The particles shower down on the planet constantly, moving through matter near the speed of light. When muons travel through a dense object, they lose energy and eventually decay. Thus, measuring the number of muons flowing through an object from a particular direction can reveal the density of that object. If there's a void, more muons than expected will penetrate.

https://www.livescience.com/60842-cosmic-rays-reveal-void-great-pyramid.html



New research looking at the density of particles called muons has found an empty space (shown in this illustration) more than 98 feet (30 meters) long right above the pyramid's Grand Gallery.

Earliest signs of life on land preserved in ca. 3.5 Ga hot spring deposits 9 May, 2017

The ca. 3.48 Ga Dresser Formation, Pilbara Craton, Western Australia, is well known for hosting some of Earth's earliest convincing evidence of life (stromatolites, fractionated sulfur/carbon isotopes, microfossils) within a dynamic, low-eruptive volcanic caldera affected by voluminous hydrothermal fluid circulation.

NATURE COMMUNICATIONS | 8:15263 |
DOI: 10.1038/ncomms15263 |
www.nature.com/naturecommunications

Earliest Signs of Life on Land Have Been Found in 3.48 Billion-Year-Old Australian Rocks 9 May, 2017

Scientists have found the earliest evidence of life on land in 3.48 billion-year-old hot spring deposits in Western Australia, and it could help us solve one of the most important debates in evolutionary biology - if life on Earth arose in small, terrestrial ponds, or deep in the ocean.

These fossil signatures are so old, they push back the earliest known evidence of inhabited hot springs by some 3 billion years - something that adds weight to Charles Darwin's suspicion that the origin of life occurred in "some warm little pond".

https://www.sciencealert.com/the-earliest-signs-of-life-on-land-have-been-found-in-3-48-billion-year-old-australian-rocks

In Canada, Signs of Life Nearly 4 Billion Years Old

Embedded within 3.95-billion-year-old rock, scientists have found graphite with a carbon signature that indicates biological activity.

In northeastern Canada, scientists have discovered what they believe are signs that bacterial life existed there 3.95 billions years ago—millions of years before the first fossils appeared in the geological record—according to a study published yesterday (September 27) in *Nature*.

http://www.the-scientist.com/?articles.view/articleNo/50530/title/In-Canada--Signs-of-Life-Nearly-4-Billion-Years-Old/

Living organisms prefer the most common carbon isotope, ^{12}C, to the rarer, heavier ^{13}C for building their cells. Once decomposed, those ^{12}C-rich organisms contribute to the ^{12}C enrichment of their environment. Finding a sample, such as a mineral, enriched in ^{12}C, therefore, can indicate that living organisms were present in the environment when that sample was formed. Study authors Yuji Sano and Tsuyoshi Komiya from the University of Tokyo found graphite enriched with ^{12}C embedded within 3.95-billion-year-old rocks in Labrador.

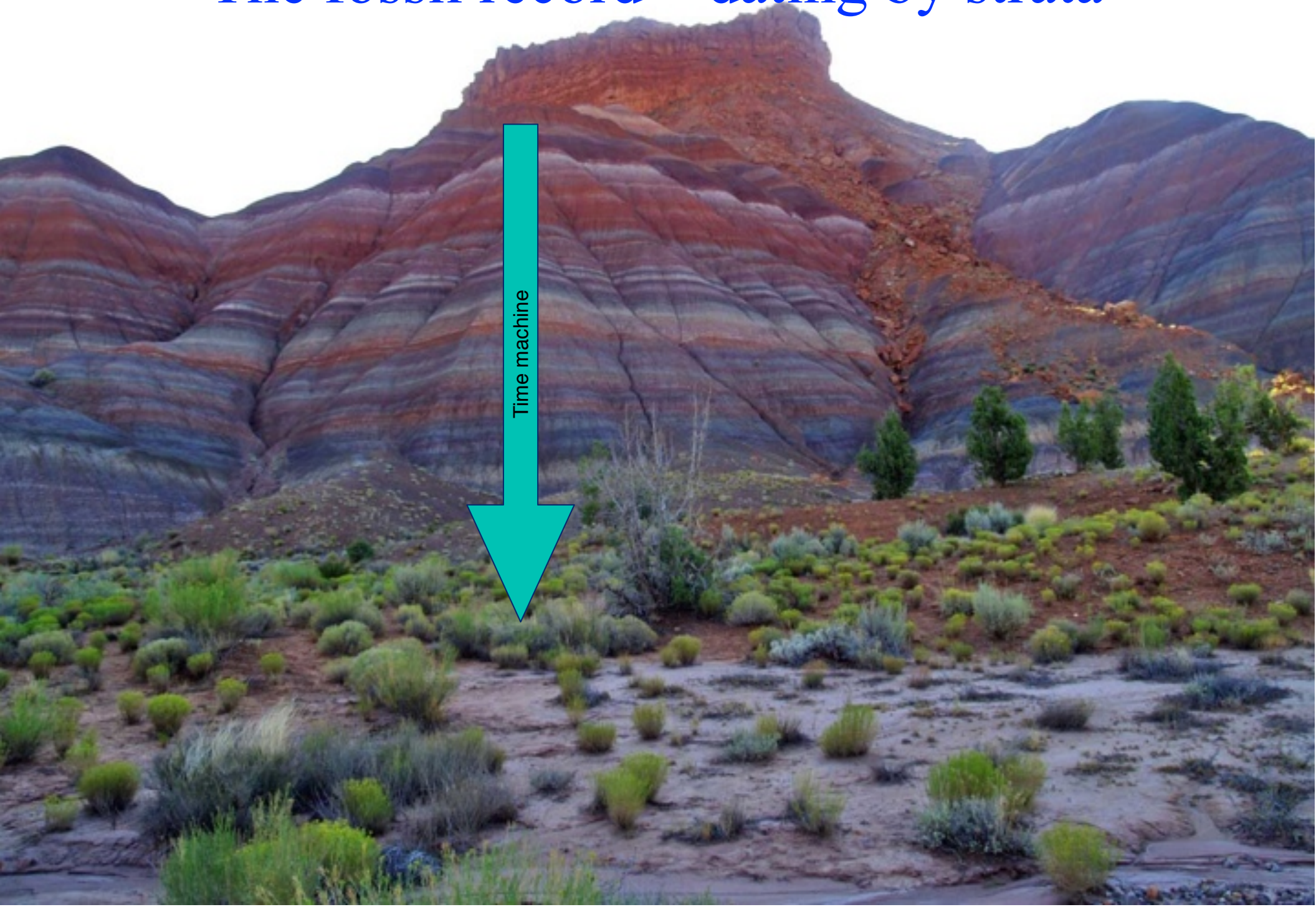
Building Blocks of Life May Have Formed in Water Droplets

Reactions that generate fundamental components of the cell run smoothly in microdroplets, study shows.

Reactions in tiny droplets of water may have given rise to some of the molecules essential for the origin of life. These reactions, which require a lot of energy in large vats of liquids, are nearly spontaneous in small droplets, researchers report today (October 23, 2017) in the *Proceedings of the National Academy of Sciences*. The finding suggests that the building blocks of life, including DNA, RNA, and materials used in cell walls and energy storage, may have been generated in mists and sea sprays on early Earth.

http://www.the-scientist.com/?articles.view/articleNo/50699/title/Building-Blocks-of-Life-May-Have-Formed-in-Water-Droplets/&utm_campaign=NEWSLETTER_TS_The-Scientist-Daily_2016&utm_source=hs_email&utm_medium=email&utm_content=57682692&_hsenc=p2ANqtz--vqA4xE55Kp1eYh3RY2bopx1h1dPBKoxUTFN8yhSLjoUF25_KRiMkgHXBPKnpAEX59KxBUkqTemW30gAP-0cNvVkGWaw&_hsmi=57682692

The fossil record – dating by strata



Life Form	Millions of years since first known appearance	
Microbial (prokaryotic cell)	3,500	
Complex (eukaryotic cell)	1,400	
First multicellular animals	600	
Shell-bearing animals	570	
Vertebrates (simple fishes)	490	
Amphibians	350	
Reptiles	310	
Mammals	200	
Non-human primates	60	
Earliest apes	25	
Australopithecine: ancestors of humans	5	
Modern humans	0. 2	(200, 000 years)

Many intermediate forms have been discovered between fish and amphibians, between amphibians and reptiles, between reptiles and mammals, and along the primate lines of descent.

In the fossil record,

amphibians always appear after fishes

reptiles after amphibians

mammals after reptiles

primates after mammals

Never has the order been broken!

Example of the transitional stages

The mammalian ear and jaw

Here are instances in which paleontology and comparative anatomy combine to show common ancestry through transitional stages.

The lower jaws of mammals contain only one bone, whereas those of reptiles have several.

The other bones in the reptile jaw are homologous with bones now found in the mammalian ear.

Paleontologists have discovered intermediate forms of mammal-like reptiles (Therapsida) with a double jaw joint--one composed of the bones that persist in mammalian jaws, the other consisting of bones that eventually became the hammer and anvil of the mammalian ear.

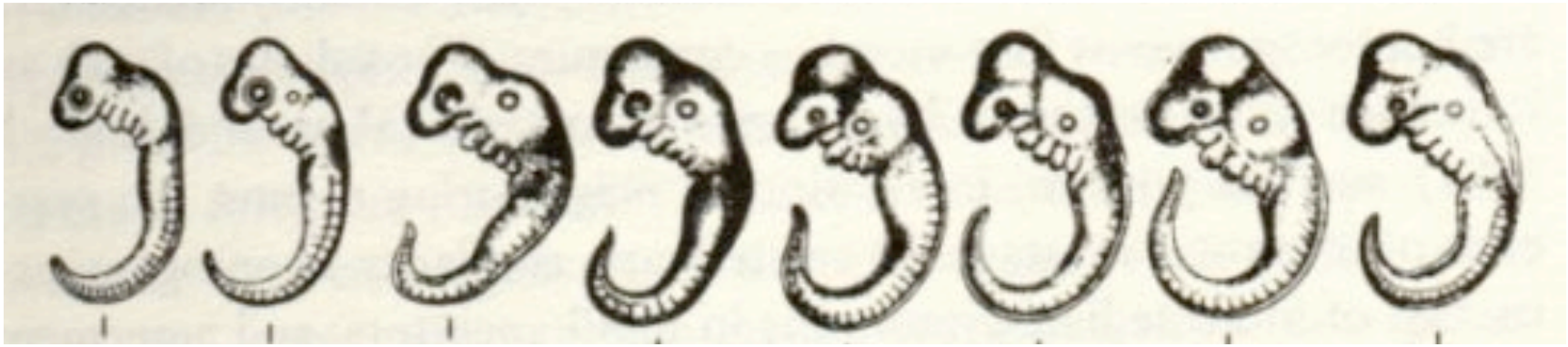
Biogeography

The Distribution of Species also has contributed evidence for descent from common ancestors.

This is the spatial clustering of species with similar body plans and characteristics.

Embryology

Similarities during development, the study of biological development from the time of conception, is another source of independent evidence for common descent.



A wide variety of organisms have very similar sequences of genes that are active early in development.

These genes influence body segmentation or orientation in all these diverse groups.

The presence of such similar genes doing similar things across such a wide range of organisms is best explained by their having been present in a very early common ancestor of all of these groups.

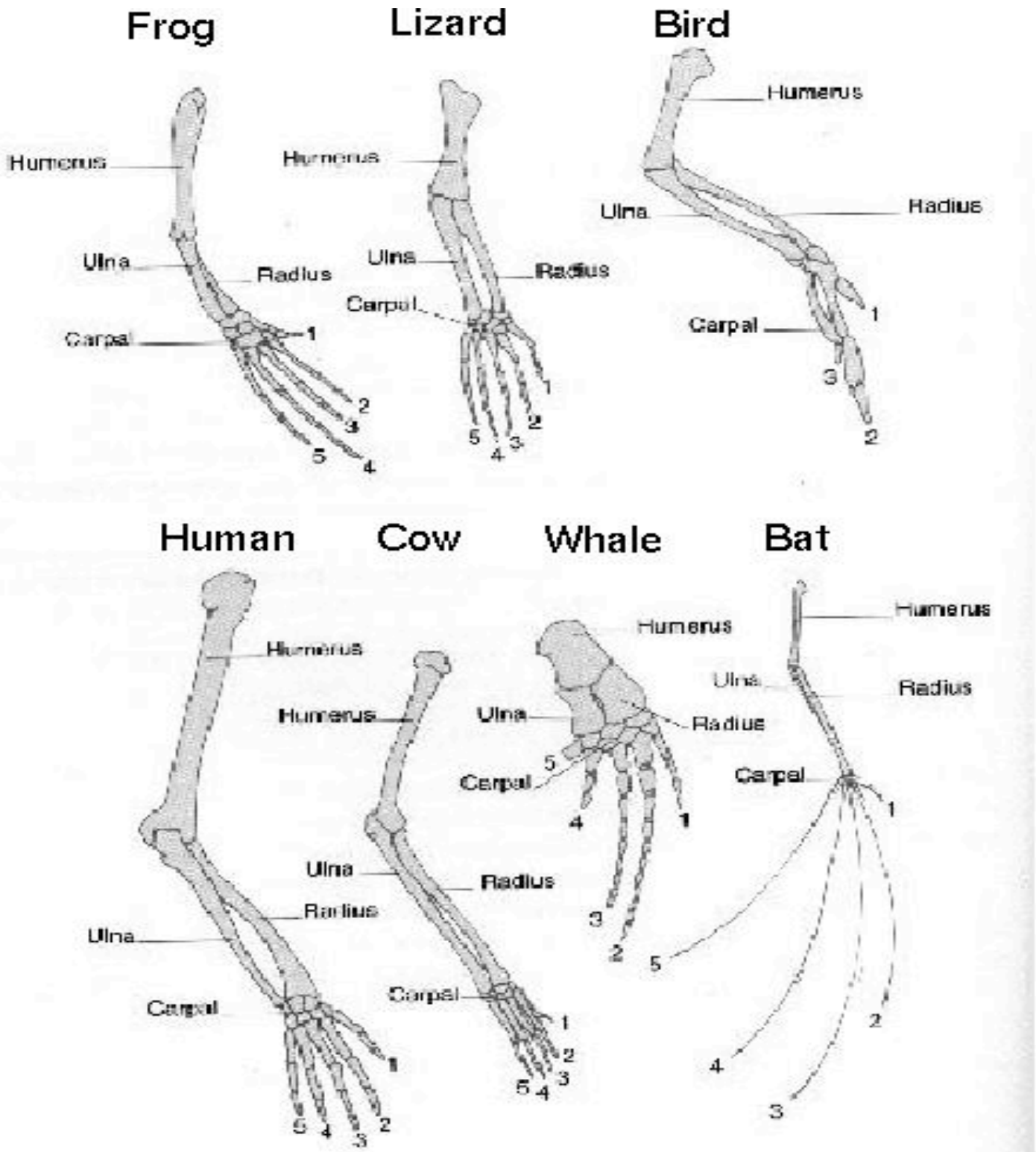
Common Structures

The inferences about common descent derived from paleontology are reinforced by comparative anatomy.

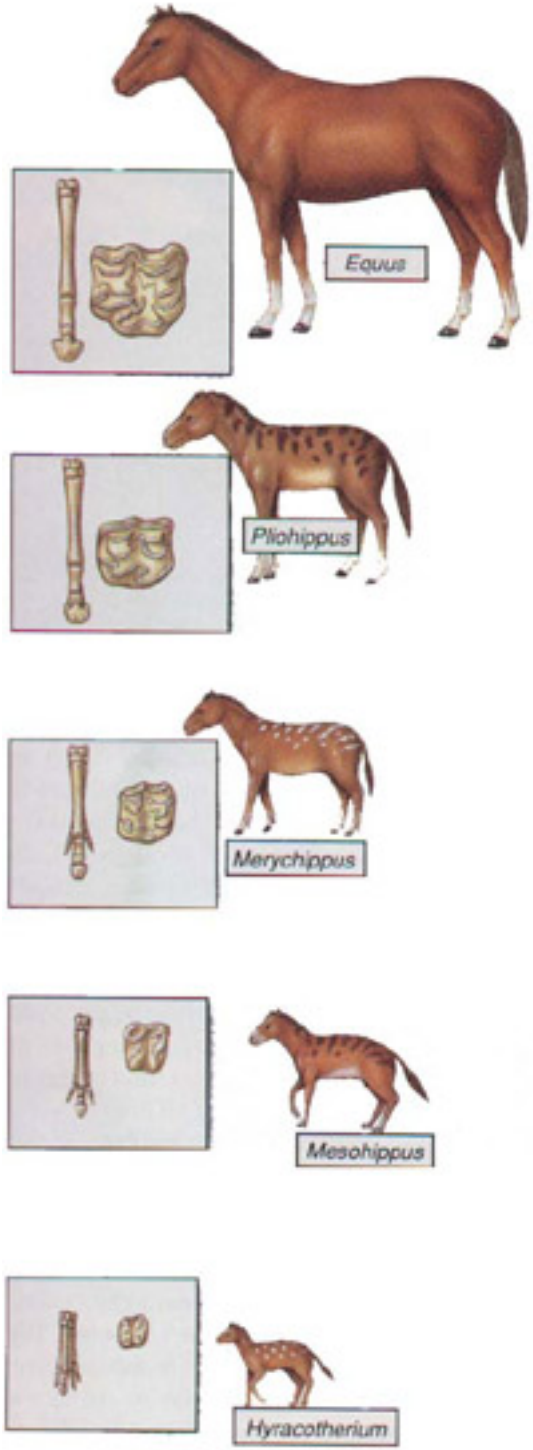
There are numerous other examples.

Mammals

We have the same number of neck vertebrae as a mole, a giraffe, a dog, a bat ...


Frog
Humerus
Ulna
Radius
Carpal
1
2
3
4
5
Lizard
Humerus
Ulna
Radius
Carpal
1
2
3
4
5
Bird
Humerus
Ulna
Radius
Carpal
1
2
3
Human
Humerus
Ulna
Radius
Carpal
1
2
3
4
5
Cow
Humerus
Ulna
Radius
Carpal
1
2
3
4
5
Whale
Humerus
Ulna
Radius
Carpal
1
2
3
4
5
Bat
Humerus
Ulna
Radius
Carpal
1
2
3
4
5

Horse feet, where are the digits? Fossil records show the 5 digit structure similar to all mammals with evolution to the modern hoof.



Horse

Orohippus pumilus
50 million years old
Early Eocene
Wyoming

One of the earliest perissodactyl, *Hyracotherium*, was also the oldest recognizable ancestor of the horse. Within a few million years, *Hyracotherium* evolved into *Orohippus*, which was slightly larger and had more complex teeth. Both animals differed from their five-toed condylarth ancestor in having lost the first toe ("thumb") of the front foot and the first ("big toe") and fifth ("little toe") of the hind foot.

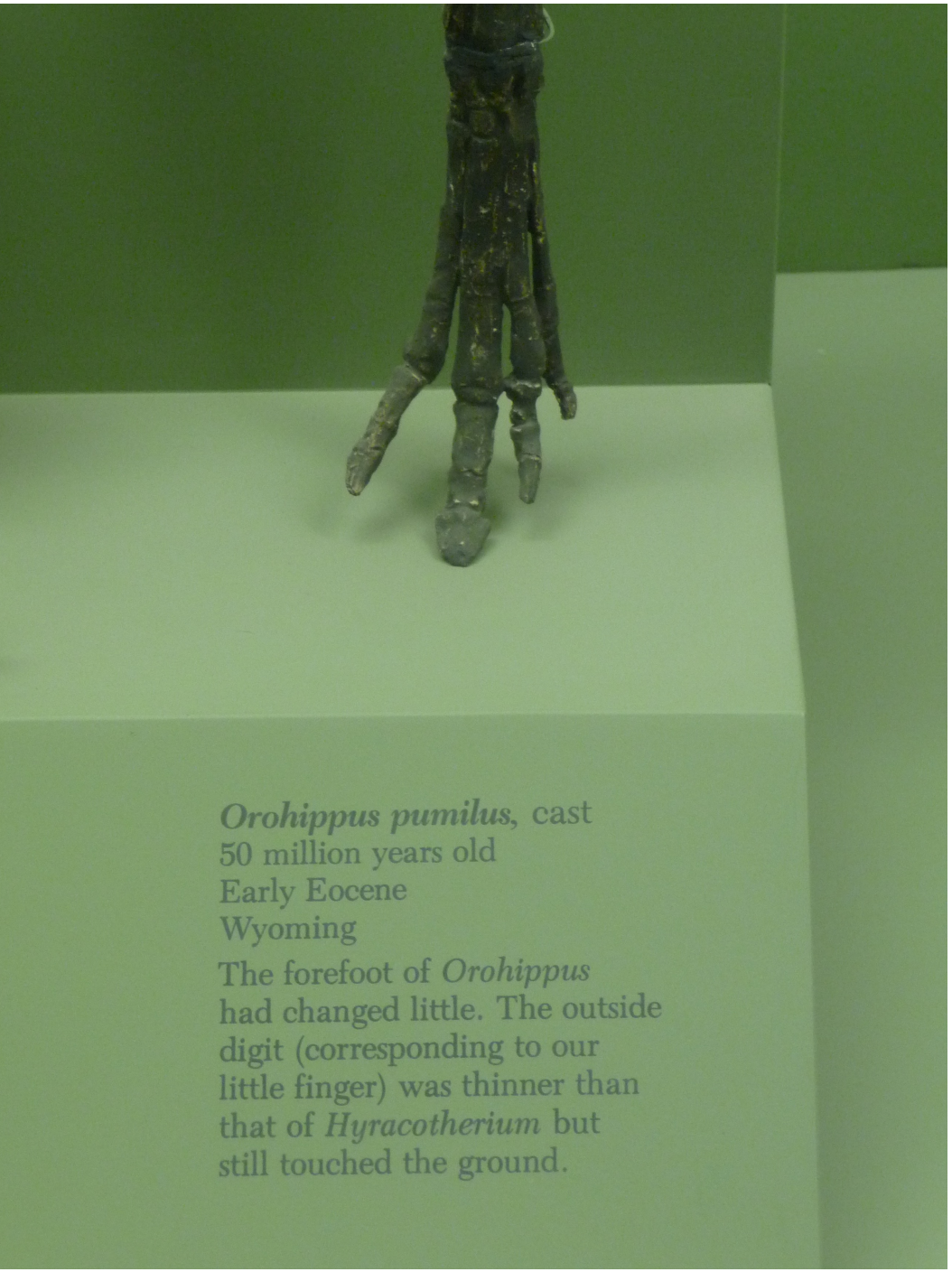

Hyracotherium evolved into

iensis

molar
nected by

Hyracotherium vasacciensis
55 million years old
Early Eocene
Colorado

Hyracotherium had four functional toes on its forefeet.



Orohippus pumilus, cast
50 million years old
Early Eocene
Wyoming

The forefoot of *Orohippus* had changed little. The outside digit (corresponding to our little finger) was thinner than that of *Hyracotherium* but still touched the ground.

Mesohippus montanensis
about 35 million years old
Early Oligocene
Wyoming

The outside digit of early *Mesohippus* is very slender but retains a hoof. This toe could not have borne much weight and probably rarely touched

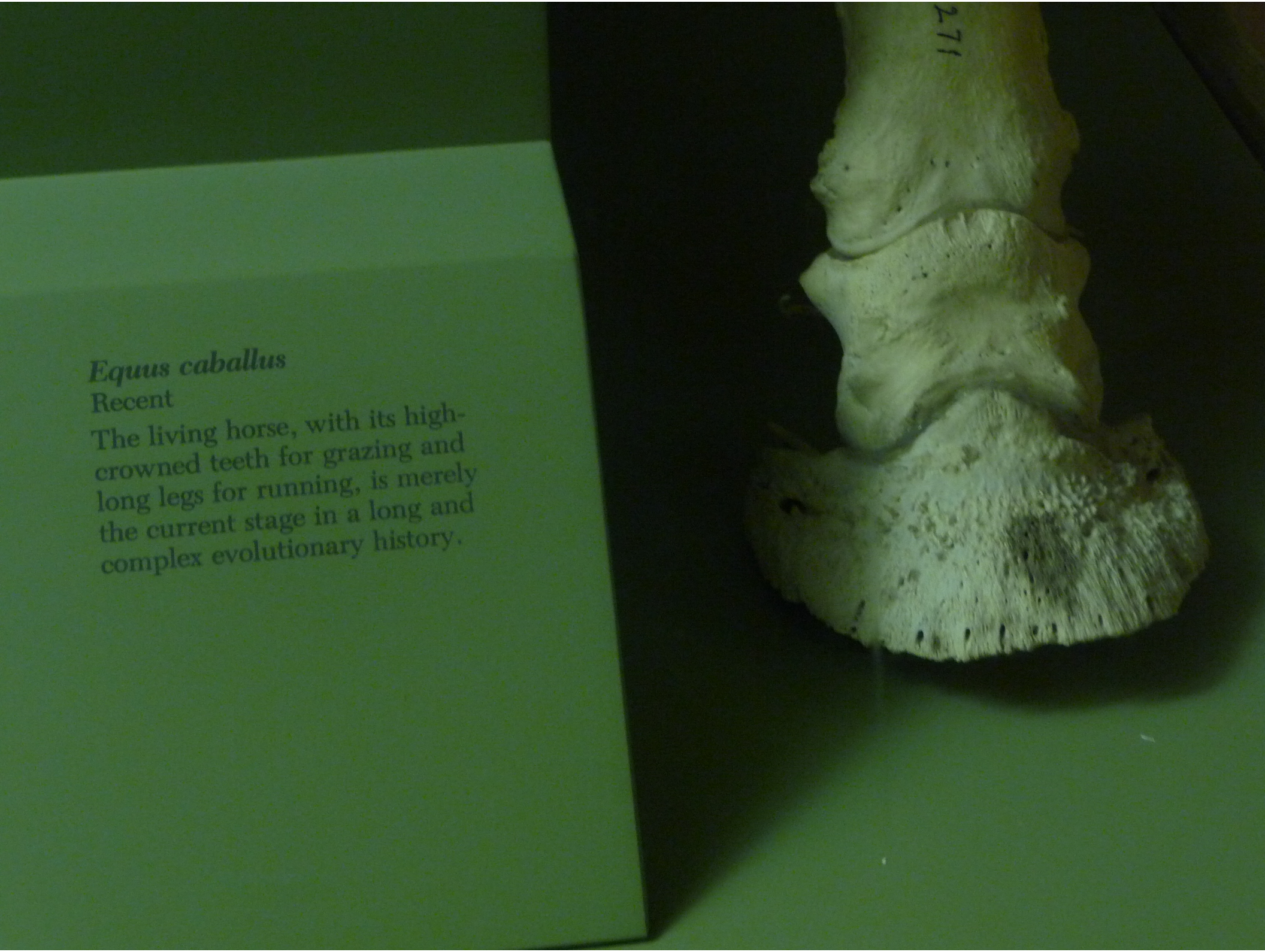
Miohippus gidleyi, cast
28 million years old
Late Oligocene
South Dakota

Miohippus continues the trend to lengthening the metacarpals in proportion to the other bones of the forelimb. Elongation of the "hand" below the "wrist"

Megahippus mckennai
12 million years old
Late Miocene
Nebraska

Equus simplicidens
3.4 million years old
Pliocene
Idaho

The metacarpals that supported the side toes in earlier horses are reduced in *Equus* to splints lying along the central metacarpal, or cannon bone.



Equus caballus
Recent
The living horse, with its high-crowned teeth for grazing and long legs for running, is merely the current stage in a long and complex evolutionary history.

Molecular Biology

The nail in the coffin!

New Evidence from Molecular Biology

The unifying principle of common descent that emerges from all the foregoing lines of evidence is being reinforced by the discoveries of modern biochemistry and molecular biology.

New Evidence from Molecular Biology

The code used to translate nucleotide sequences into amino acid sequences is essentially the same in all organisms.

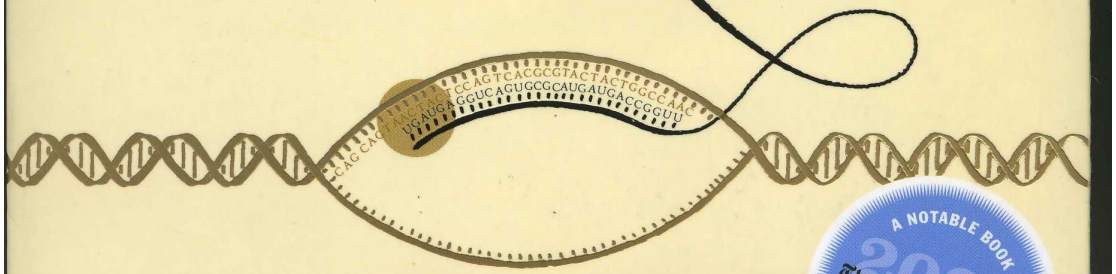
Moreover, proteins in all organisms are invariably composed of the same set of 20 amino acids.

This unity of composition and function is a powerful argument in favor of the common descent of the most diverse organisms.

THE *NEW YORK TIMES* BESTSELLER

"[A] magnum opus." — PHILADELPHIA INQUIRER

RICHARD DAWKINS



A NOTABLE BOOK
2004
The New York Times Book Review
OF THE YEAR

THE ANCESTOR'S TALE

A Pilgrimage to the Dawn of Evolution

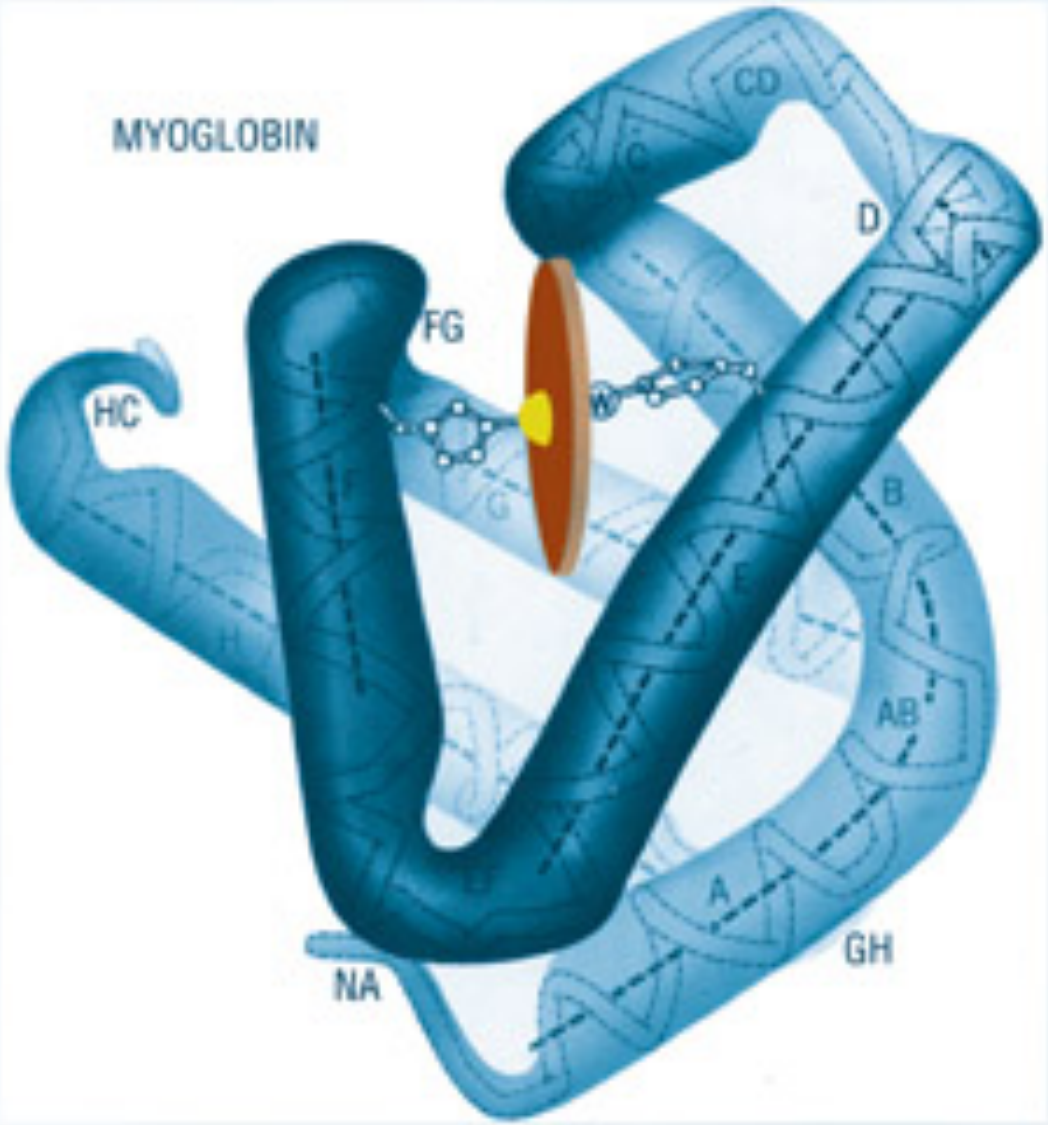
MARINER BOOKS

New Evidence from Molecular Biology

Globin genes

ey gene / Hox gene

Examples



Myoglobin, which stores oxygen in muscles, consists of a chain of 153 amino acids wrapped around an oxygen-binding molecule. The sequence of amino acids in myoglobin varies from species to species, revealing the evolutionary relationships among organisms.

Globin genes

Hemoglobin – oxygen carrier in blood

Careful letter-by-letter analysis of the DNA shows that the different kinds of globin genes are literally cousins of each other – members of a family.

Globin genes

"These distant cousins still exist inside you and me and inside every cell of every dog, every zebra, every owl, every lizard, and every vertebrate." Dawkins

The dozen or so different globin genes in humans comes down to us through the entire lineage of our vertebrate ancestors.

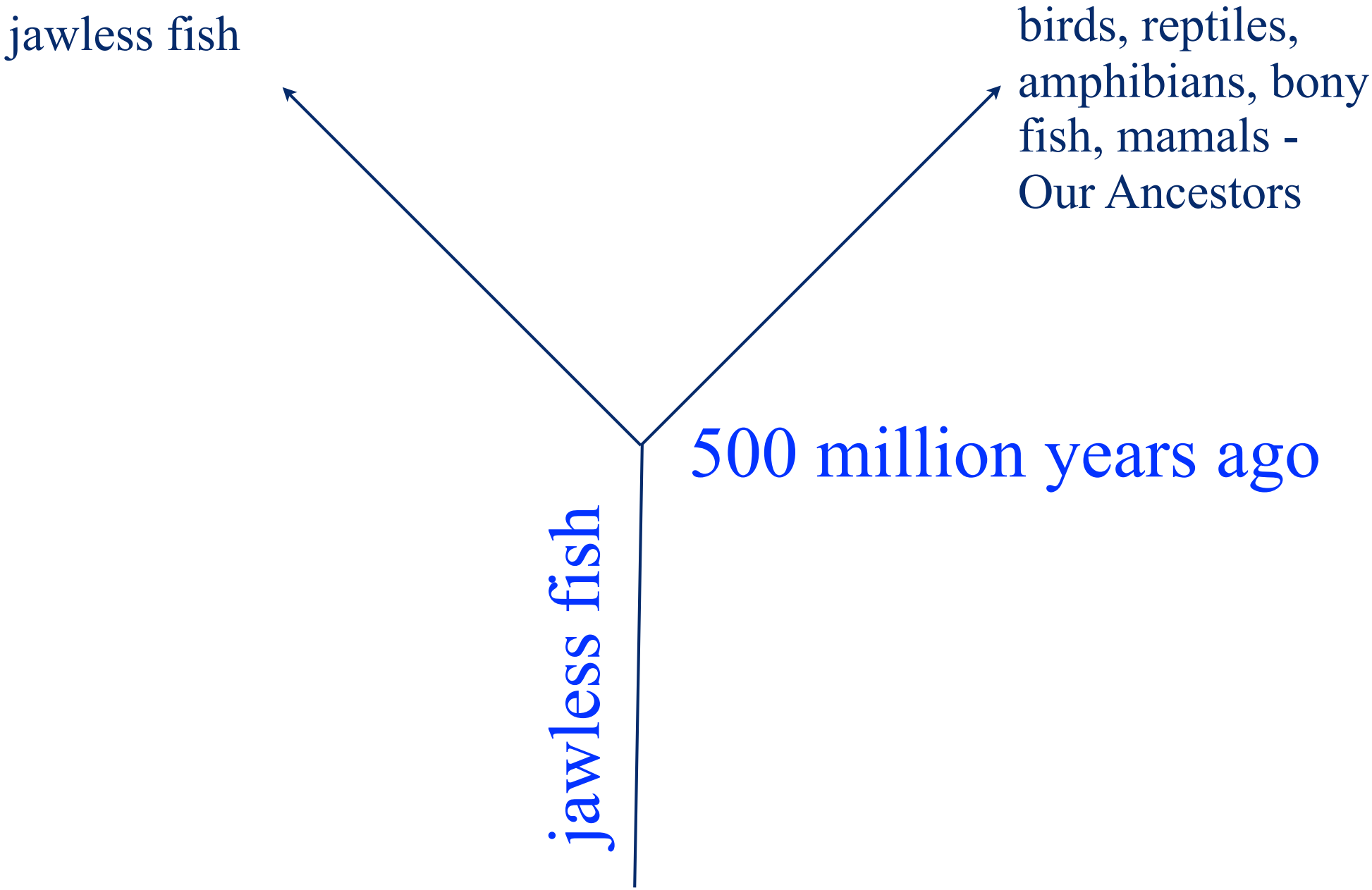
About half a billion years ago in a jawless fish an ancestral globin gene accidentally split into two.

One copy gave rise to the alpha cluster on what would eventually become chromosome 11 in our genome, the other to the beta cluster, now on our chromosome 16.

Life Form	Millions of years since first known appearance	
Microbial (prokaryotic cell)	3,500	
Complex (eukaryotic cell)	1.400	
First multicellular animals	600	
Shell-bearing animals	570	
Vertebrates (simple fishes)	490	
Amphibians	350	
Reptiles	310	
Mammals	200	
Non-human primates	60	
Earliest apes	25	
Australopithecine ancestors of humans	5	
Modern humans	0. 2	(200, 000 years)

Given the split between the alpha and beta cluster happened half a million years ago

– we should see the same alpha-beta split if we look at the genomes of any other mammals (and birds, reptiles, amphibians, bony fish) for our common ancestors that lived less than 500 millions year ago.


jawless fish
birds, reptiles, amphibians, bony fish, mamals - Our Ancestors
500 million years ago
jawless fish

Whenever investigated, the expectation is correct.

To find a vertebrate without the alpha-beta split we need to go to a common ancestor sufficiently ancient to predate the alpha-beta split.

Jawless fish, like lamprey and hagfish, are the only known vertebrates that lack the alpha-beta divide.

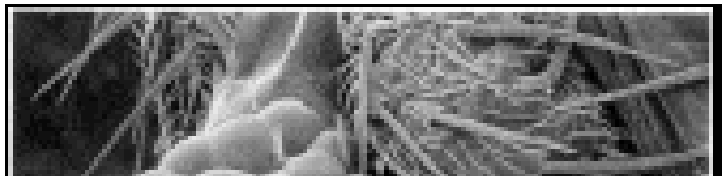
The *ey* gene

The *ey* gene normally makes eyes.

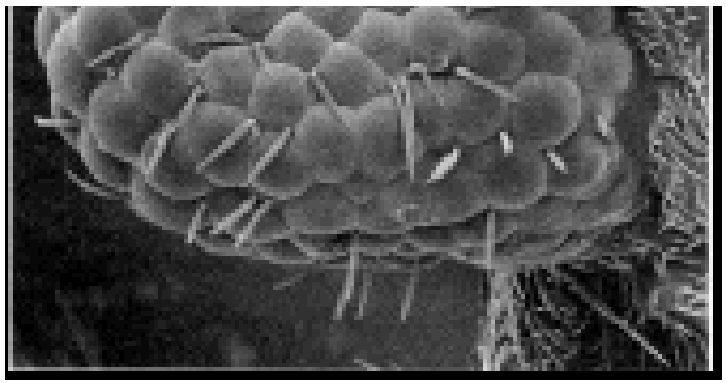
In Switzerland, scientists introduced the *ey* gene of a mouse into a region of a fruit fly embryo that was destined to make a leg.

The *ey* gene

The result was the adult fly had an "ectopic" eye on its leg. And it was a compound eye, not a mouse eye.



What is going on?



Georg Halder, Patrick Callaerts, Walter J. Gehring, Science. Vol. 267 24 March 1995

Hox genes

The egg divides, after a number of divisions an embryo is formed.

The development continues as the embryo grows. Chemical gradients occur within and between the cells. This causes different genes to be turned on and off. This is how differentiation of cells begins.

In arthropods there is a large scale partitioning of the body, not into cells, but into segments.

For example insects have six head segments in the embryonic stage. In the adult the segments are compressed and appear as one.

Each cell is told which segment it is in through the mediation of special control genes called Hox genes.

These genes are turned on and off within the cells. There are 8 Hox genes arranged in a particular order along one chromosome.

The Hox genes' mission is to know where it is in the body and inform other genes in the same cell so that the proper structure will be made. i.e. a hand where a hand belongs, etc..

Flies normally have one set of wings and a pair of gyroscopic halters.

Here is an example of a homeotic mutation *Ultrabithorax* which misleads the cells in the third thoracic segment into "thinking" they are in the second thoracic segment and the fly gets an extra pair of wings rather than halters.

Mammals like insects have a segmented body plan. Each vertebra can be thought of as corresponding to one segment. Blood vessels, nerves, muscle blocks, cartilage, discs and ribs, all follow the repetitive modular plan.

The cells, whether they are bone cells, muscle cells, cartilage cells, … need to know what segment they are in. They do from the Hox genes.

Example: Drosophila and a mouse

The mouse has four arrays of Hox genes.
The *a* series on chromosome 6,
the *b* series on chromosome 11,
c on chromosome 15 and
d on chromosome 2.

Resemblances between them show that they arose during evolution by duplication: *a*4 matches *b*4 matches *c*4 matches *d*4.

With minor exceptions, each gene from the *Drosophila* array of eight Hox genes resembles one of the Hox genes in the mouse more than it resembles the other seven genes in the *Drosophila* series.

And they are in the same order along their respective chromosome.

Every one of the eight *Drosophila* genes has at least one representative in the mouse series of 13.

The detailed gene-for-gene coincidence between the *Drosophila* and the mouse can only indicate shared inheritance.

The implication is that the vast majority of animals are descended from an ancestor that had Hox genes arranged in the same linear order as we see in modern *Drosophila* and modern vertebrates.

The split occurred some 590 million years ago; What Dawkins calls our 300 million greats grandparents.

Life Form	Millions of years since first known appearance	
Microbial (prokaryotic cell)	3,500	
Complex (eukaryotic cell)	1.400	
First multicellular animals	600	Hox genes appear ←
Shell-bearing animals	570	
Vertebrates (simple fishes)	490	
Amphibians	350	
Reptiles	310	
Mammals	200	
Non-human primates	60	
Earliest apes	25	
Australopithecine ancestors of humans	5	
Modern humans	0. 2	(200, 000 years)

Hox genes have been found in every animal studied except ctenophores and sponges.

They are found in sea urchins, shrimps, mollusks, annelid worms, acorn worms, sea squirts, nematode worms, and flatworms.

Not found in radially symmetric species such as cnidarians (hydra) which do not have an anterior/posterior axis or dorsal/ ventral one.

Hox genes have not been found in plants, nor fungi, nor in the single-cell organisms.

The same gene makes eyes in animals as different as *Drosophila* and mouse, even though the eyes produced are radically different in the two animals.

The Hox gene doesn't tell the cells how to make an eye, it tells them this is the place to make an eye.

The Hox story shows that animals are not a highly varied, unconnected miscellany of phyla, each with its own fundamental body plan acquired and maintained in lonely isolation.

If you look at the genes, it emerges that all animals are minor variations on a very particular theme.

Junction of animals and fungi

Going back so far leads to higher uncertainty in dates. Using fossil dating to calibrate molecular clocks, the best guess for the junction of animals and fungi is about 1100 million years.

Life Form	Millions of years since first known appearance	
Microbial (prokaryotic cell)	3,500	
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Modern humans	0. 2	(200, 000 years)

Nearly half of our DNA still resembles that of a fly.

We share one-fifth of our genetic code with yeast.

8 Dec. 1999 not 1599!

KANSAS VOTES TO DELETE EVOLUTION FROM STATE'S SCIENCE CURRICULUM

from The New York Times

CHICAGO -- The Kansas Board of Education voted on Wednesday to delete virtually any mention of evolution from the state's science curriculum, in one of the most far-reaching efforts by creationists in recent years to challenge the teaching of evolution in schools.

While the move does not prevent the teaching of evolution, it will not be included in the state assessment tests that evaluate students' performance in various grades, which may discourage school districts from spending time on the subject.

And the decision is likely to embolden local school boards seeking either to remove evolution from their curriculums, to force teachers to raise questions about its validity or to introduce creationist ideas. Some local boards have already said they will consider adopting creationist textbooks, while others have said they will continue teaching evolution.

"Our kids are being presented theories as though they are facts," said State Representative Tim Moore of Kentucky.

Darwin Foes Add Warming to Targets

By LESLIE KAUFMAN

Published: March 3, 2010 New York Times

Critics of the teaching of evolution in the nation's classrooms are gaining ground in some states by linking the issue to global warming, arguing that dissenting views on both scientific subjects should be taught in public schools.

http://www.nytimes.com/2010/03/04/science/earth/04climate.html?pagewanted=1&hp

What does the data say?

On the road to humans

Miocene Apes - the Age of the Apes

Miocene epoch of Tertiary period: 25-5 million years ago

In the early miocene the climate warmed and the environment was hot and humid. Forests grew throughout the semitropical and tropical parts of the World.

The conditions were ideal for the apes of the time.

Fossils found in The Rift Valley, China, and Europe indicate that at least twenty-three different genera and around two hundred species were part of this adaptive radiation of the apes.

Around 7 million years ago, the climate began to change.

Temperatures dropped, the forests began to recede. Savannah grasslands and scrub became more common.

As a result, many species of apes went extinct. Those that survived had to either possess or develop new ways to deal with the change in the ecosystem.

new species
the hominids

The oldest hominid fossils that have been found so far date back to the beginning of the Pliocene (~5.3 mya).

This indicates that the traits defining hominids as a group may have emerged to help to deal with this new environment.

Human Evolution

Studies in evolutionary biology have led to the conclusion that human beings arose from ancestral primates.

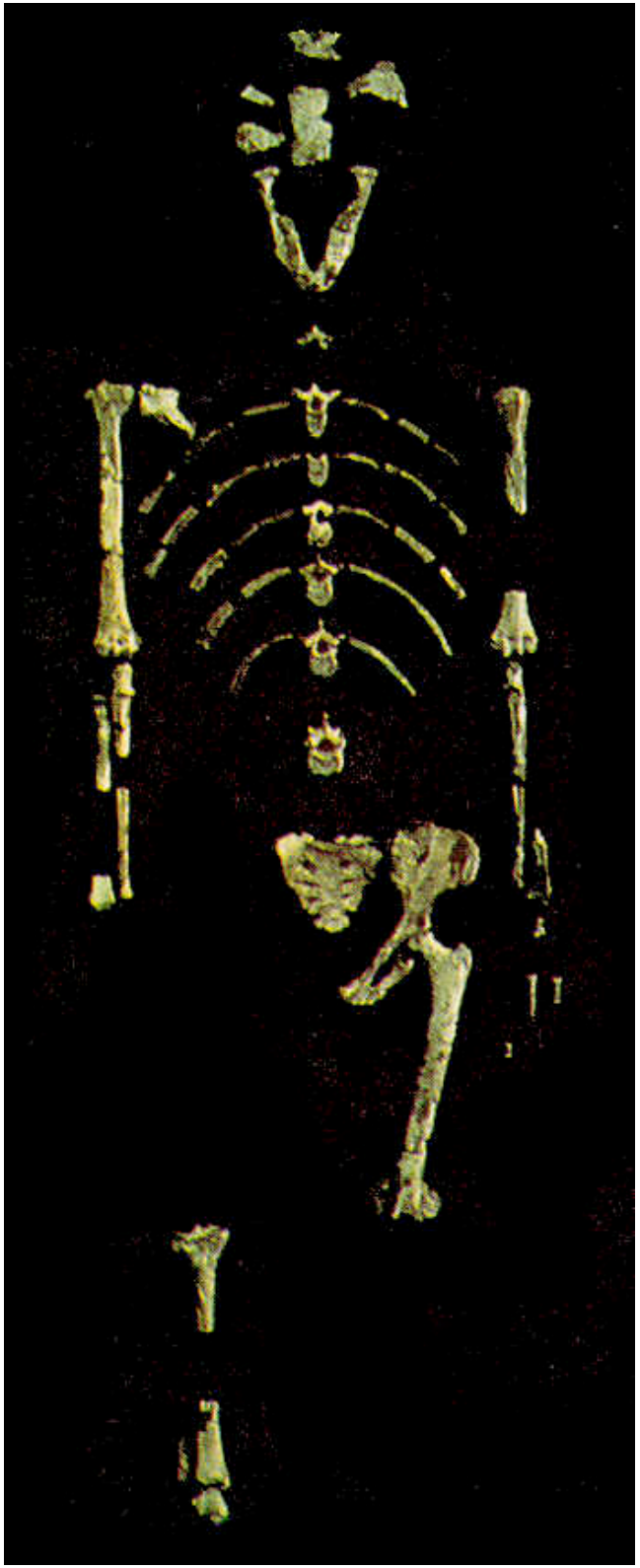
This association was hotly debated among scientists in Darwin's day. But today there is no significant scientific doubt about the close evolutionary relationships among all primates, including humans.

Scientists have unearthed thousands of fossil specimens representing members of the human family.

A great number of these cannot be assigned to the modern human species, Homo Sapiens.

Most of these specimens have been well dated, often by means of radiometric techniques.

They reveal a well-branched tree, parts of which trace a general evolutionary sequence leading from ape-like forms to modern humans.



In 1974, Prof. Donald Johanson discovered the skeleton of the oldest (3.2 millions years old) and most complete human ancestor, which he named LUCY **Australopithecus afarensis**

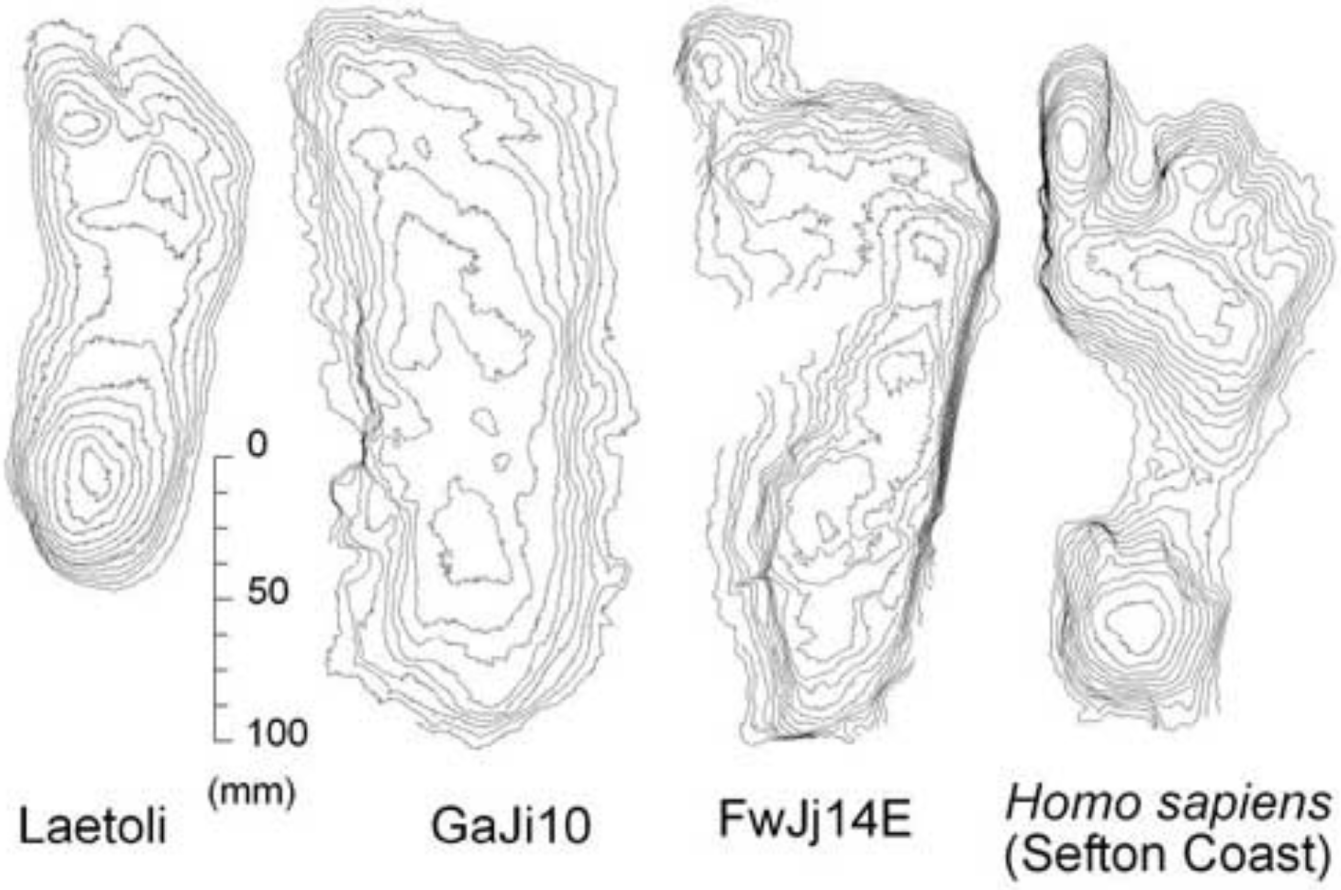
Lucy's brain was about one-third the size of the brain of a human, but Lucy had a human like characteristic: her knee could lock so she could stand up straight. Other apes did not have a locking knee, so they could not stand for long periods of time.

Johanson deduced that the locking knee gave Lucy and others like her an advantage over other apes.

In 1976, members of a team led by Mary Leakey discovered the fossilized footprints of human ancestors in Laetoli, Africa. The footprints were formed 3.5 million years ago when at least two individuals walked over wet volcanic ash.

Footprints laid down near lake Turkana in Kenya 1.5 million years ago were made by human ancestors with essentially modern foot anatomy and gait.

http://www.newscientist.com/articleimages/dn16673/2-fossil-footprints-reveal-our-modern-walk-in-the-making.html

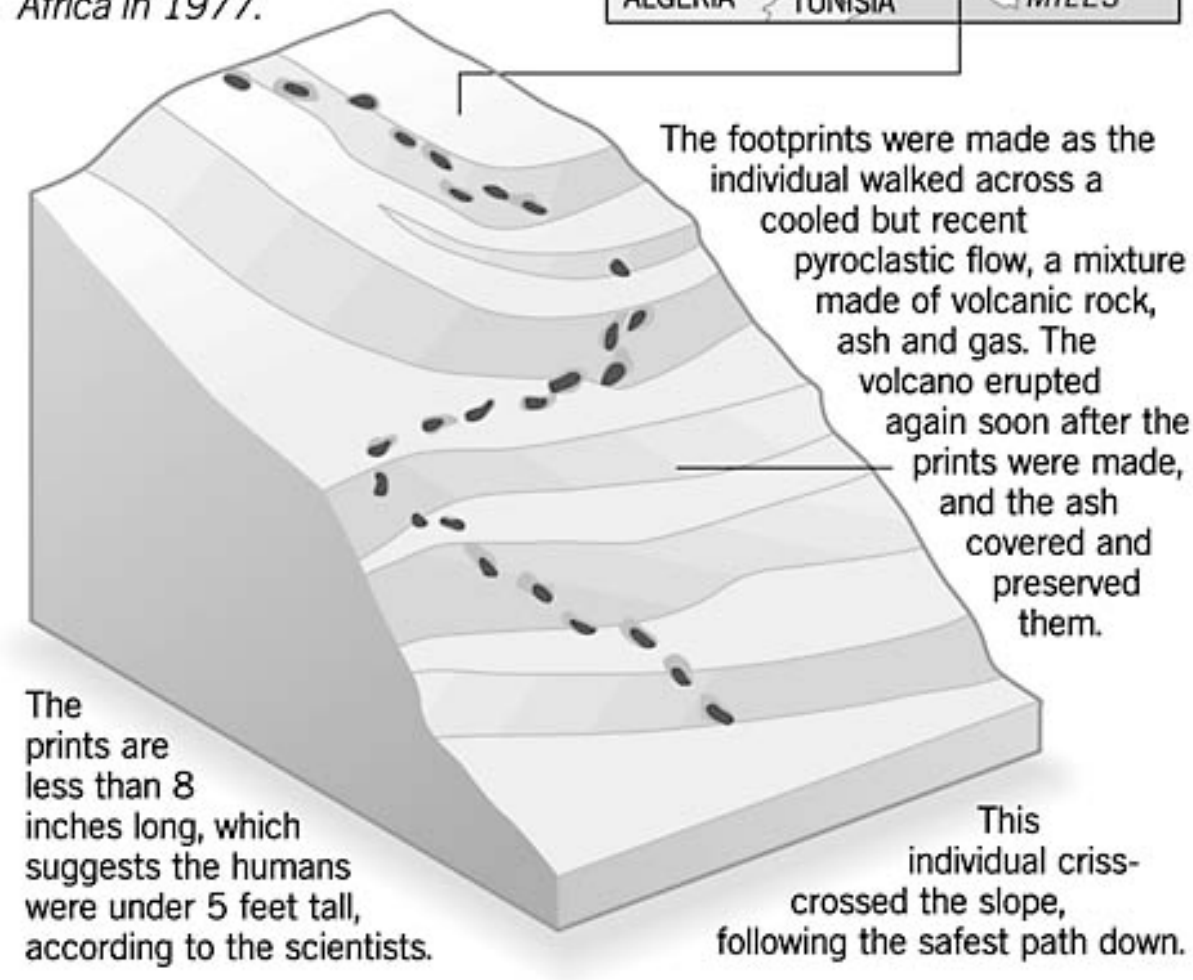


Contour maps of 4 different footprints. On the left is a print made by Australopithicus. The two middle prints are Homo erectus, while the right print was made by Homo sapiens

Walking back to the Stone Age

Scientists discovered three fossilized trails left by humans about 350,000 years ago on the Roccamonfina volcano in Italy. They think these are the oldest discovered footprints made by Paleolithic humans.

Other footprints left by much older hominids were found in Africa in 1977.



Sources: Nature; ESRI

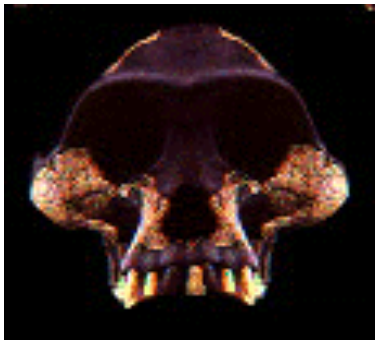
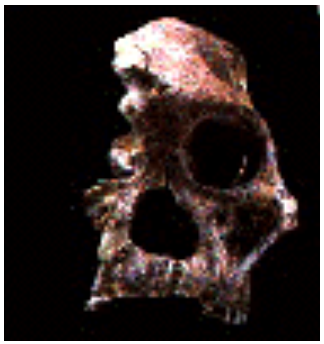
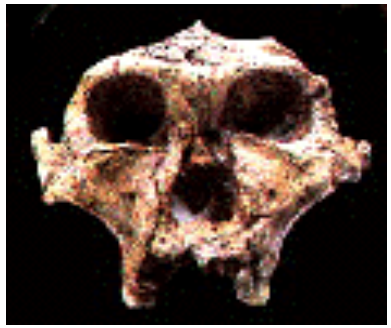
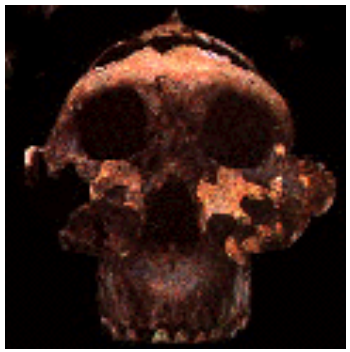
Associated Press Graphic

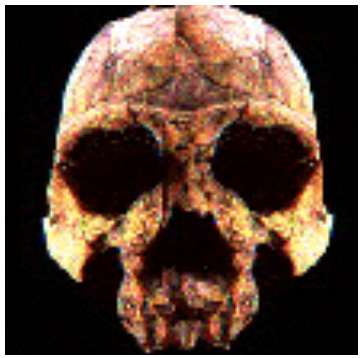
325 000 year old early human foot prints

Molecular biology

DNA extracted from a well-preserved skeleton of the extinct human creature known as Neanderthal (often considered either as a subspecies of Homo sapiens or as a separate species) suggests that Neanderthal's lineage diverged from that of modern Homo sapiens less than **half a million** years ago.

This is entirely compatible with evidence from the fossil record.

			
A. Afarensis	A. Africanus	A. Robustus	A. Boisei

			
Homo Habilis	Homo Erectus	Homo Sapiens	Neandertalensis

Based on molecular and genetic data, evolutionists favor the hypothesis that modern Homo sapiens, individuals very much like us, evolved from more archaic humans about 200,000 years ago.

They also believe that this transition occurred in Africa, with modern humans then dispersing to Asia, Europe, and eventually Australasia and the Americas.

Human fossils dated to 195,000 years

BY BRYN NELSON
Staff Writer, Newsday Inc.
February 16, 2005, 3:56 PM EST

A new study concludes that the earliest known humans appeared in southern Ethiopia by about 195,000 years ago, about 35,000 years earlier than previously thought, based on what researchers say are the oldest anatomically modern human fossils ever found.

These Early Humans Lived 300,000 Years Ago—But Had Modern Faces

JUNE 7, 2017

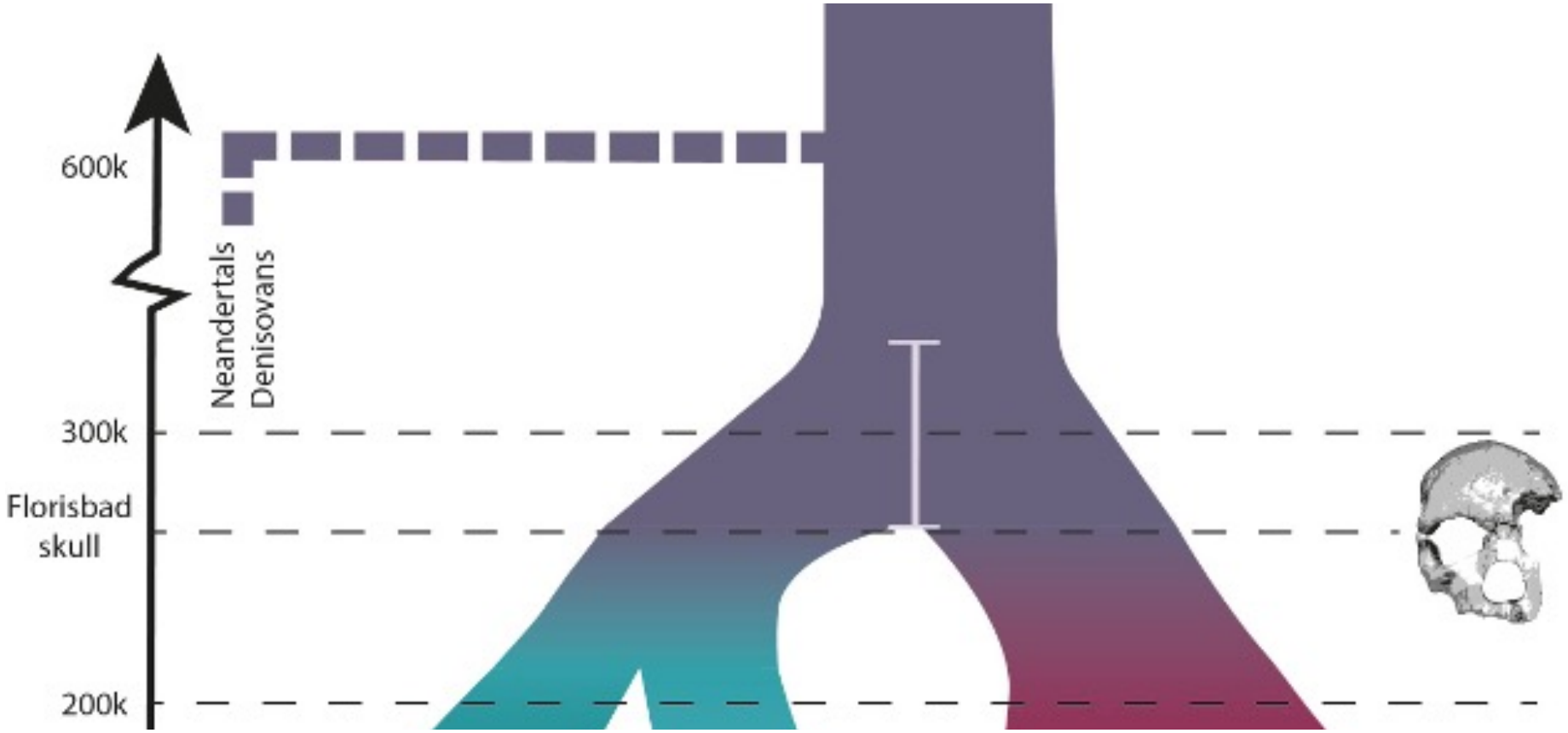
This fossil jawbone from an adult hominin, discovered at the Jebel Irhoud site in Morocco, includes teeth that are reminiscent of those from anatomically modern humans. Examinations of fire-baked tools from the site suggest that these ancient people lived more than 300,000 years ago, making them twice as old as previously thought.

http://news.nationalgeographic.com/2017/06/morocco-early-human-fossils-anthropology-science/

From DNA evidence, researchers estimate the split from other spec took place between 260,000 and 350,000 years ago. September 29, 2017

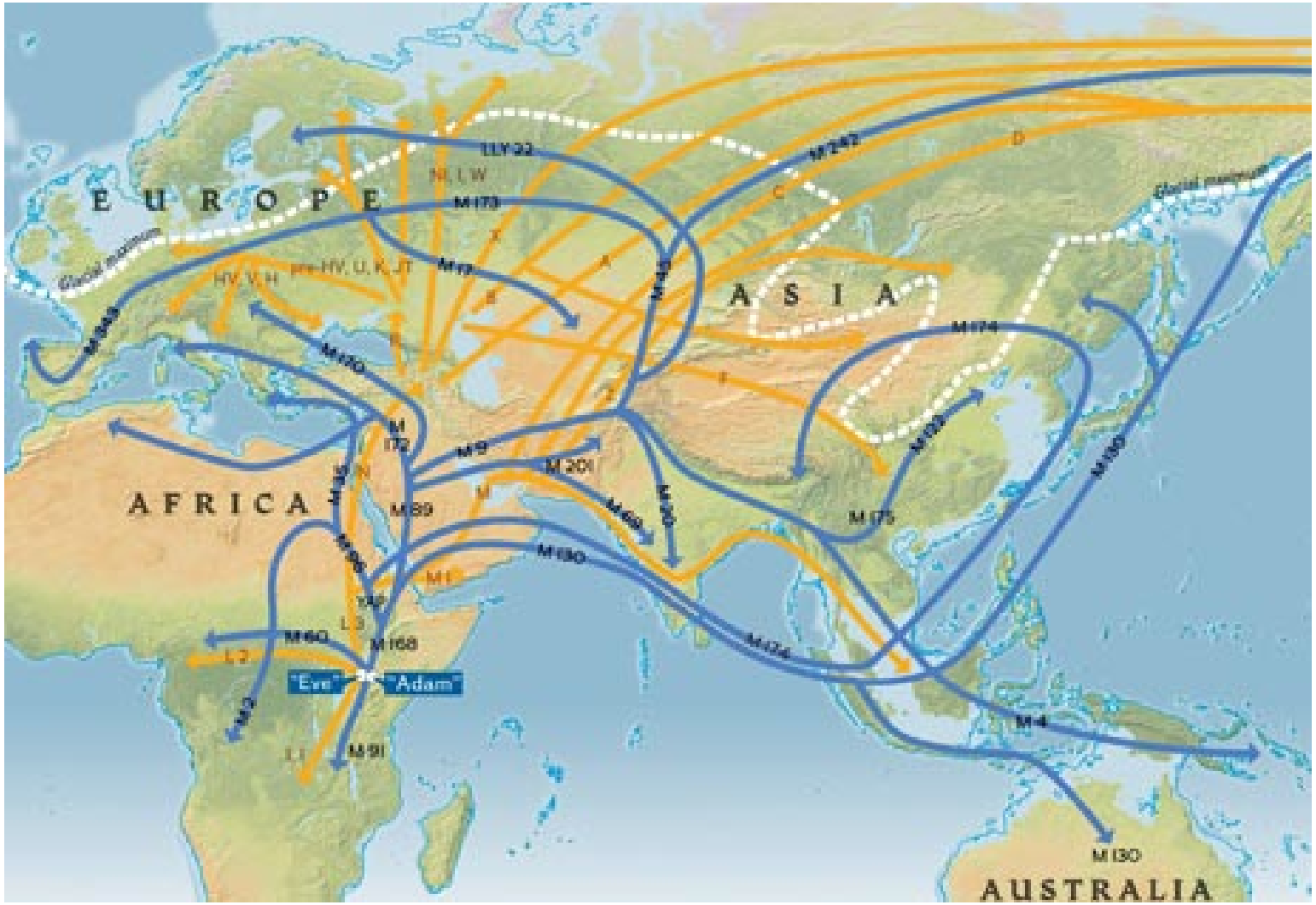
A comparison of the genomes of Stone Age hunter-gatherer bones found in South Africa with those of other populations suggests *Homo sapiens* arose much earlier than the commonly accepted estimate of 200,000 years ago, researchers reported (September 28) in *Science*.

http://www.the-scientist.com/?articles.view/articleNo/50538/title/Human-Species-May-Be-Much-Older-Than-Previously-Thought/&utm_campaign=NEWSLETTER_TS_The-Scientist-Daily_2016&utm_source=hs_email&utm_medium=email&utm_content=56907538&_hsenc=p2ANqtz-9Zdob9otrmDB44ycBklncHoRYvL_wEW-Rqfkme2Rx4XEv96mqT40QOueWmn4Ib2XT3NtVfxrKiht5PS16PiwV8Np3cDg&_hsmi=56907538



Todd Disotell, an anthropologist at New York University, tells the Associated Press he's sceptical of assumptions used in the study's calculations, and thinks the evidence is still compelling that the split between species that produced *Homo sapiens* occurred closer to 200,000 years ago.

Human migrations map image



http://news.nationalgeographic.com/news/2008/02/080221-human-genetics_2.html

The Great Leap Forward

Archaeology suggests that something very special began to happen to our species around 40, 000 years ago.

Before this time only crudely shaped weapons and tools.

After the Great Leap Forward

Paintings, carvings, figurines, grave goods, ornamentation.

Musical instruments –bone flutes

Slightly later, stunning creations like the Lascaux Cave Murals created by Cro-Magnon people.


3

Lascaux Cave, France

Backward convergence of all apes (including humans) indicates a shared ancestor, who lives about 18 million years ago.

Molecular evidence suggests that chimpanzees and bonobos are more closely related to humans than they are to gorillas.

From this is follows that humans are exactly as close to gorillas as chimpanzees and bonobos are. And we are exactly as close cousins of orangutans as chimpanzees, bonobos, and gorillas are.

Molecular biology also has provided strong evidence of the close relationship between humans and apes.

Analysis of many proteins and genes has shown that humans are genetically similar to chimpanzees (97% match) and gorillas and less similar to orangutans and other primates.

Ancient human unearthed in China

The remains include a lower jaw as well as leg bones**The remains of one of the earliest modern humans to inhabit eastern Asia have been unearthed in a cave in China.**

2 April 2007

The find could shed light on how our ancestors colonised the East, a movement that is only poorly understood by anthropologists.

Researchers found 34 bone fragments belonging to a single individual at the Tianyuan Cave, near Beijing.

Details of the discovery appear in Proceedings of the National Academy of Sciences journal.

Radiocarbon dates, obtained directly from the bones, show the person lived between 42,000 and 39,000 years ago.

http://news.bbc.co.uk/2/hi/science/nature/6518527.stm