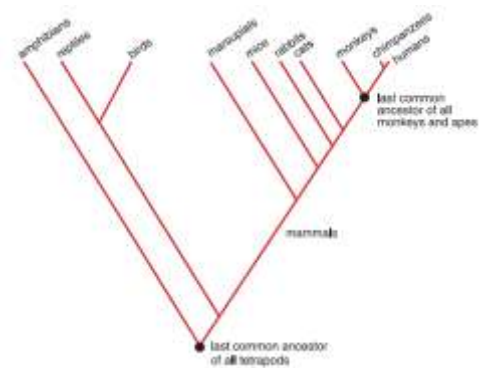


Unpacking the Science of Evolutionary Biology



Lifetime Learning Institute
June 2 and 9, 2020



Jay Labov

Senior Advisor for Education and Communication
National Academies of Sciences, Engineering, and Medicine
(Retired)

jblabov@gmail.com

Suggestions for additional readings and other resources are available by clicking on the link in the chat box.

[The Howard Hughes Medical Institute](#) has produced a series of short education videos, some of which are directly related to this course. The entire compendium of videos can be found at:

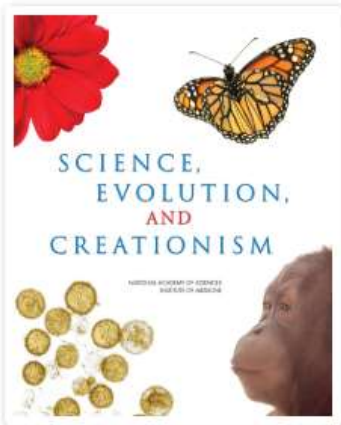
https://www.biointeractive.org/classroom-resources?search=&f%5B0%5D=resource_type%3A10

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Science, Evolution, and Creationism (2008)

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Learning Goals For Our Two Sessions:

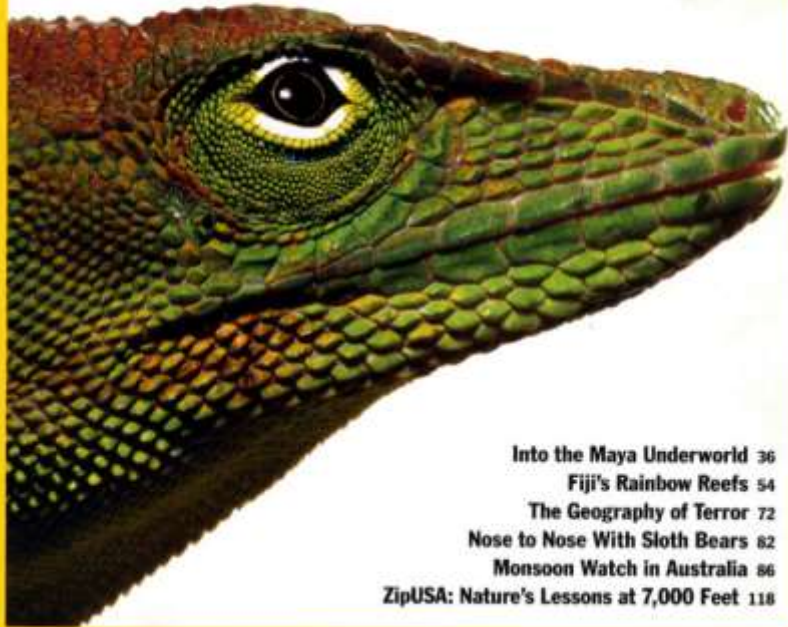
1. Examine the “controversy” surrounding the teaching of evolution in U.S. public schools.
 2. Examine what constitutes scientific evidence (the nature and limits of science).
 3. Processes of Science: Explore how scientific hypotheses are developed. (Group participation!)
 4. Discuss why evolution is an essential component of biological and other sciences.
-
5. Examine basic principles and some scientific debates within the science of evolution.
 6. Answer your questions about evolution and science more generally (both sessions).

**NEW
MAP OF
THE WORLD**

NATIONALGEOGRAPHIC.COM/MAGAZINE NOVEMBER 2004

NATIONAL GEOGRAPHIC

WAS DARWIN WRONG?



Into the Maya Underworld 36

Fiji's Rainbow Reefs 54

The Geography of Terror 72

Nose to Nose With Sloth Bears 82

Monsoon Watch in Australia 86

ZipUSA: Nature's Lessons at 7,000 Feet 118

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NO.

The evidence for
Evolution is
overwhelming.

By DAVID QUAMMEN

Photographs by ROBERT CLARK

Charles Darwin's grand theory, evolution by natural selection, links diverse biological facts into a coherent whole. Domestic breeding of fancy pigeons like the Jacobin (preceding pages) was his analogy for selection in the wild. The naked mole rat (opposite) shows that mammals can evolve, like social insects, to include specialized workers and queens.

Evolution by natural selection, the central concept of the life's work of Charles Darwin, is a theory. It's a theory about the origin of adaptation, complexity, and diversity among Earth's living creatures. If you are skeptical by nature, unfamiliar with the terminology of science, and unaware of the overwhelming evidence, you might even be tempted to say that it's "just" a theory. In the same sense, relativity as described by Albert Einstein is "just" a theory. The notion that Earth orbits around the sun rather than vice versa, offered by Copernicus in 1543, is a theory. Continental drift is a theory. The existence, structure, and dynamics of atoms? Atomic theory. Even electricity is a theoretical construct, involving electrons, which are tiny units of charged mass that no one has ever seen. Each of these theories is an explanation that has been confirmed to such a degree, by observation and

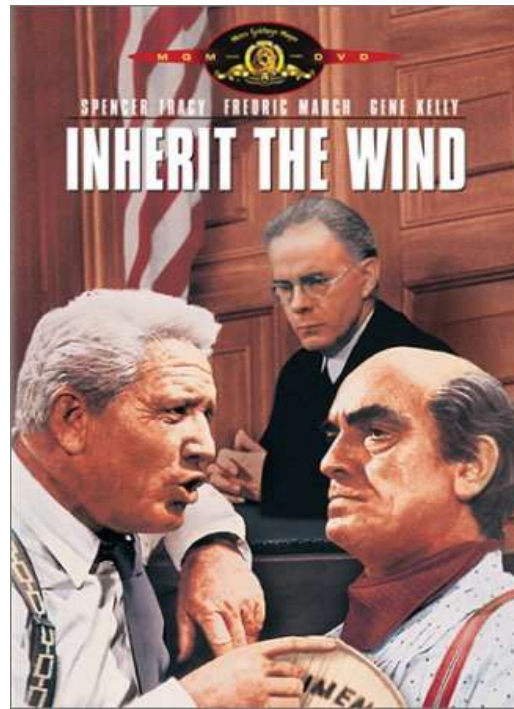
“Nothing in biology
makes sense except
in the light of
evolution.”

Theodosius Dobzhansky
1973

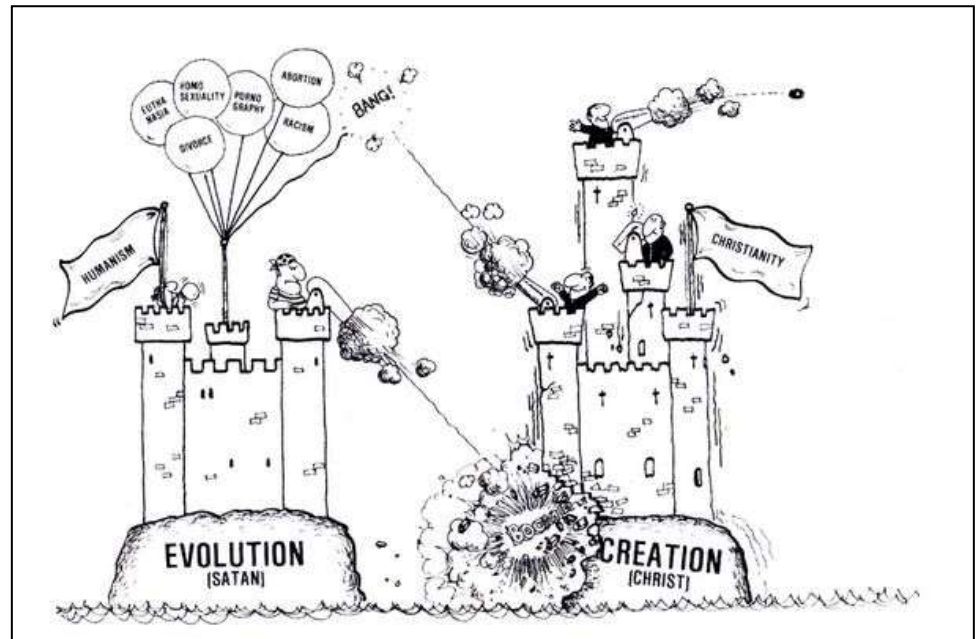


However:

Since the Scopes trial in 1925, teaching and learning about evolution in the nation's public schools has resulted in political and legal challenges at the local, state, and national levels that continue today.



Judge John Jones III
Kitzmiller v. Dover
(2009)



Superintendent orders pages of textbooks glued together

Science offers one-sided theory, school chief says

DRAFFENVILLE (AP) — Marshall County Superintendent Kenneth Shadowen didn't want fifth- and sixth-grade students exposed to the one-sided theory presented in science textbooks on the formation of the universe.

So he had hundreds of books confiscated from students so school personnel could glue together two pages that dealt with the "big-bang theory."

Shadowen's objection was that there was no mention of the biblical account of creation that is in Genesis.

"We're not going to teach one theory and not teach another theory," Shadowen told *The Courier-Journal* on Thursday. "We're in a conservative area and a conservative county, and we want to maintain the relationship with our local churches and community. It has nothing to do with censorship or anything like that."

But that's exactly how several parents in the western Kentucky

high school science teacher. "The issue is censorship, and a small group of people have decided to censor material."

Terie Hall of Calvert City, the mother of a sixth-grader, said the episode reminded her of a "witch hunt in the 1600s."

"I'm outraged, disappointed and embarrassed," she said. "I was so impressed with this school system. Now I plan to protest it to the fullest. I want my child to be informed about all theories."

The book, which says that the big bang is only a theory and not a proven fact, had already passed through the school system's textbook-screening committee and was also approved by the state textbook commission.

The action probably is not illegal, state officials said Thursday.

"It's unusual," said Lisa Gross, a spokeswoman for the Kentucky Department of Education. "But we are not going to send curriculum police down there to unglue pages."

The big-bang theory holds that all matter in the universe was once concentrated in a tiny, dense ball, and that billions of years ago the

Shadowen's objection was that there was no mention of the biblical account of creation that is in Genesis.

"We're not going to teach one theory and not teach another theory..."

“I am always amazed at how evolution and creationism are treated as if they are right or wrong. They are both belief systems that can never be truly or fully proved or discredited.”

Illinois Biology Teacher

**Defeating Creationism in the
Courtroom, But Not in the Classroom**

Data from *National Survey of
High School Biology Teachers*

CREATIONISM ON TRIAL

Landmark federal court cases have ruled that creationism and, more recently, intelligent design creationism are religious rather than scientific and therefore unconstitutional to teach in public school science classrooms.

Science, Evolution, and Creationism, pp. 44-45

Supreme Court of the United States, *Epperson v. Arkansas*, 1968

Government in our democracy, state and national, must be neutral in matters of religious theory, doctrine, and practice. It may not be hostile to any religion or to the advocacy of non-religion, and it may not aid, foster, or promote one religion or religious theory against another or even against the militant opposite.

Supreme Court of the United States, *Edwards v. Aguillard*, 1987

[The] primary purpose [of the Louisiana "Creation Act," which required the teaching of "creation science" together with evolution in public schools] was to change the public school science curriculum to provide persuasive advantage to a particular religious doctrine that rejects the factual basis of evolution in its entirety. Thus, the Act is designed either to promote the theory of creation science that embodies a particular religious tenet or to prohibit the teaching of a scientific theory disfavored by certain religious sects. In either case, the Act violates the First Amendment.

District Court for the Middle District of Pennsylvania, *Kitzmiller et al. v. Dover Area School District et al.*, 2005

[W]e find that ID [intelligent design] is not science and cannot be adjudged a valid, accepted scientific theory, as it has failed to publish in peer-reviewed journals, engage in research and testing, and gain acceptance in the scientific community. ID, as noted, is grounded in theology, not science. . . . Moreover, ID's backers have sought to avoid the scientific scrutiny which we have now determined that it cannot withstand by advocating that the controversy, but not ID itself, should be taught in science class. This tactic is at best disingenuous, and at worst a canard. The goal of the IDM [intelligent design movement] is not to encourage critical thought, but to foment a revolution which would supplant evolutionary theory with ID.

“Those who would renegotiate the boundaries between church and state must answer a difficult question: Why would we trade a system that has served us so well for one that has served others so poorly?”

Justice Sandra Day O'Connor

McCreary County, Ky. v. ACLU of Ky., 545 U.S. 844 (2005)

Kitzmiller v. Dover Area School District,
400 F. Supp. 2d 707 (M.D. Pa. 2005)



Hon. John E. Jones III

“[W]e have addressed the seminal question of whether ID is science. We have concluded that it is not, and moreover that ID cannot uncouple itself from its creationist, and thus religious, antecedents.

The students, parents, and teachers of the Dover Area School District deserved better than to be dragged into this legal maelstrom, with its resulting utter waste of monetary and personal resources.”

From the Creation Museum (KY)

Every person must make a choice. Individuals must choose God's Word as the starting point for all their reasoning, or start with their own arbitrary philosophy as the starting point for evaluating everything around them, including how they view the Bible.

The Creation/Evolution Continuum

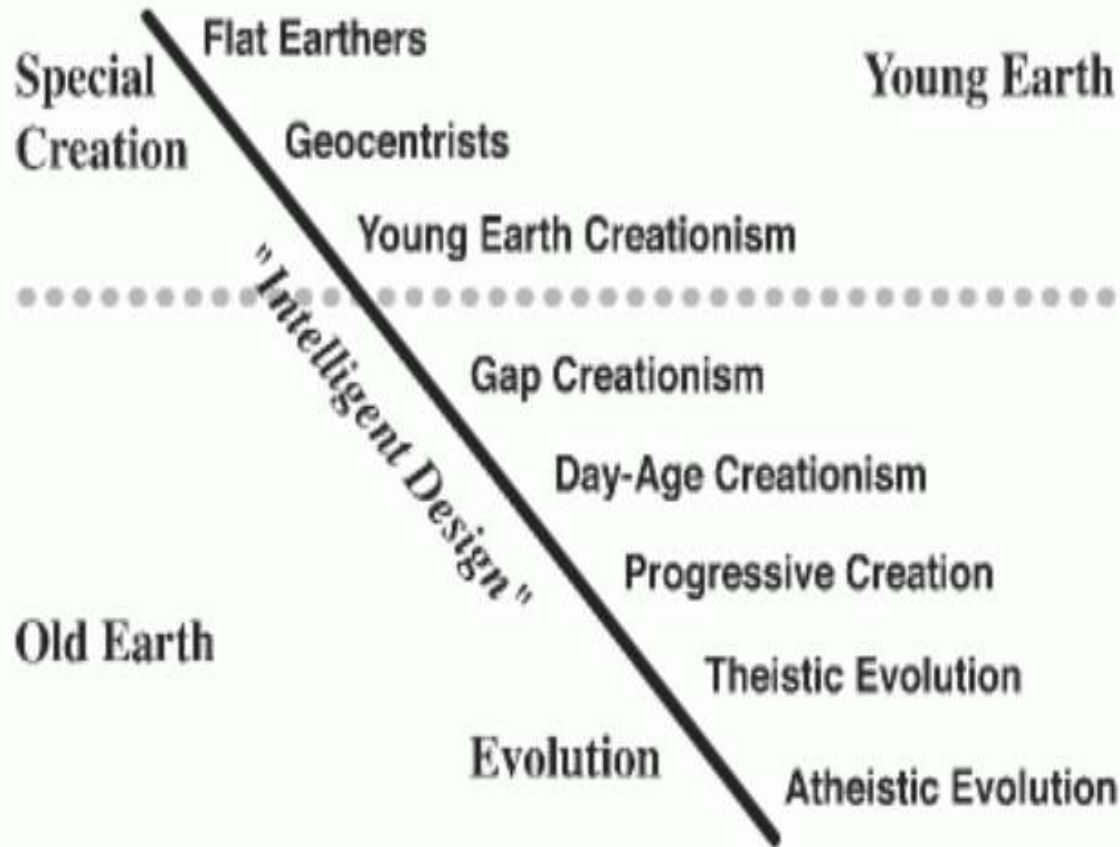


Figure 1: The relationship between evolution and creationism in Christianity is a continuum, not a dichotomy between two choices.

Source: National Center for Science Education.

<https://ncse.com/library-resource/creationevolution-continuum>

Acceptance of the Evidence for Evolution Can Be Compatible with Religious Faith

Statements from Religious Leaders

"In his encyclical *Humani Generis* (1950), my predecessor Pius XII has already affirmed that there is no conflict between evolution and the doctrine of the faith regarding man and his vocation, provided that we do not lose sight of certain fixed points....Today, more than a half-century after the appearance of that encyclical, some new findings lead us toward the recognition of evolution as more than an hypothesis. In fact it is remarkable that this theory has had progressively greater influence on the spirit of researchers, following a series of discoveries in different scholarly disciplines. The convergence in the results of these independent studies -- which was neither planned nor sought -- constitutes in itself a significant argument in favor of the theory."

— Pope John Paul II, Message to the Pontifical Academy of Sciences, October 22, 1996.

"[S]tudents' ignorance about evolution will seriously undermine their understanding of the world and the natural laws governing it, and their introduction to other explanations described as 'scientific' will give them false ideas about scientific methods and criteria."

— Central Conference of American Rabbis

"[T]here is no contradiction between an evolutionary theory of human origins and the doctrine of God as Creator."

— General Assembly of the Presbyterian Church

"We the undersigned, Christian clergy from many different traditions, believe that the timeless truths of the Bible and the discoveries of modern science may comfortably coexist. We believe that the theory of evolution is a foundational scientific truth, one that has stood up to rigorous scrutiny and upon which much of human knowledge and achievement rests. To reject this truth or to treat it as 'one theory among others' is to deliberately embrace scientific ignorance and transmit such ignorance to our children. We believe that among God's good gifts are human minds capable of critical thought and that the failure to fully employ this gift is a rejection of the will of our Creator. . . . We urge school board members to preserve the integrity of the science curriculum by affirming the teaching of the theory of evolution as a core component of human knowledge. We ask that science remain science and that religion remain religion, two very different, but complementary, forms of truth."

—"The Clergy Letter Project" signed by more than 10,000 Christian clergy members For additional information, see http://www.butler.edu/clergyproject/clergy_project.htm.

Science, Evolution, and Creationism, pp. 13-14

"Scientific Insights into the Evolution of the Universe and of Life," put on by the Pontifical Academy of Sciences **in 2008. The Pontifical Academy gathered together some of the world's best scientists to discuss evolution. Pope Benedict XVI not only sanctioned the meeting, he addressed the scientists.**

The sense of the meeting was well summarized by Nobel laureate Christian de Duve who wrote, **"The participants unanimously accepted as indisputable the affirmation that the Universe, as well as life within it, are the products of long evolutionary histories."** He also noted that "the actual occurrence of biological evolution is no longer just a theory, strongly suggested by fossil evidence, but not conclusively demonstrated by it. **Evolution is now supported by overwhelming molecular proofs and has acquired the status of established fact. In the words of His Holiness John Paul II, it is 'more than a hypothesis'."**

The Pontifical Academy itself, on January 24, 2009 issued a statement arising from the meeting that is as powerful as it is clear. **"It is important for scientific knowledge on evolution to become integrated into our world-view and for our world-view to be steadily updated. The extraordinary progress in our understanding of evolution and the place of man in nature should be shared with everyone."**

Reported by Michael Zimmerman
Political Machine
February 22, 2012

Acceptance of the Evidence for Evolution Can Be Compatible with Religious Faith

Statements from Scientists

"Creationists inevitably look for God in what science has not yet explained or in what they claim science cannot explain. Most scientists who are religious look for God in what science does understand and has explained."

—Kenneth Miller, professor of biology at Brown University and author of *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Religion*. Quote is excerpted from an interview available at <http://www.actionbioscience.org/evolution/miller.html>.

"In my view, there is no conflict in being a rigorous scientist and a person who believes in a God who takes a personal interest in each one of us. Science's domain is to explore nature. God's domain is in the spiritual world, a realm not possible to explore with the tools and language of science. It must be examined with the heart, the mind, and the soul."

—Francis Collins, director of the Human Genome Project and of the National Human Genome Research Institute at the National Institutes of Health. Excerpted from his book, *The Language of God: A Scientist Presents Evidence for Belief* (p. 6).

"Our scientific understanding of the universe . . . provides for those who believe in God a marvelous opportunity to reflect upon their beliefs."

—Father George Coyne, Catholic priest and former director of the Vatican Observatory. Quote is from a talk, "Science Does Not Need God, or Does It? A Catholic Scientist Looks at Evolution," at Palm Beach Atlantic University, January 31, 2006. Available at <http://chem.tufts.edu/AnswersInScience/Coyne-Evolution.htm>.

The Clergy Letter Project

The Clergy Letter Project

Home

Background

This Month's Newsletter

Newsletter Archive

The Clergy Letters

A Total of 17,283 signatures appear on The Clergy Letters as of 05/30/20

Christian Clergy Letter

(15,642 signatures as of 05/30/20)

Rabbi Letter

(830 signatures as of 05/30/20)

UU Clergy Letter

(684 signatures as of 05/30/20)

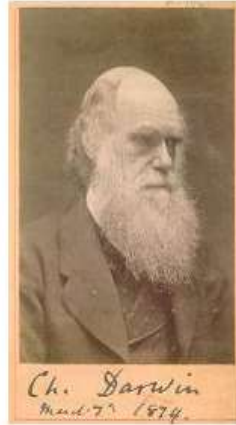
Buddhist Clergy Letter

(75 signatures as of 05/30/20)

Humanist Clergy Letter

(54 signatures as of 05/30/20)

Welcome to The Clergy Letter Project



The Clergy Letter Project is an endeavor designed to demonstrate that religion and science can be compatible and to elevate the quality of the debate of this issue.



To learn more about The Clergy Letter Project, please browse our site.

***** LATEST NEWS *****

<https://www.theclergyletterproject.org/>

16,657
signatures

The Clergy Letter Project

Home

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The Clergy Letters

Christian Clergy Letter

*(15,177 signatures as of
07/05/19)*

Rabbi Letter

*(761 signatures as of
07/05/19)*

UU Clergy Letter

*(595 signatures as of
07/05/19)*

Buddhist Clergy Letter

*(73 signatures as of
07/05/19)*

Humanist Clergy Letter

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February 29, 2016

Voices for Evolution

Voices for Evolution is a project of the NCSE to collect the full diversity of organizations and perspectives in support of teaching evolution in the public schools. These statements represent the consensus view of the scientific community that evolution is well-supported, and that failing to teach it is a disservice to students.

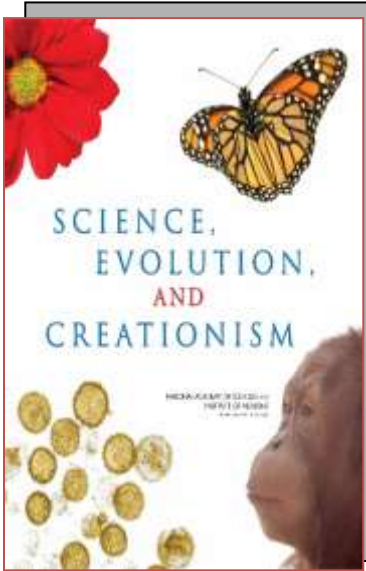
[Statements from Scientific and Scholarly Organizations](#)

[Statements from Educational Organizations](#)

[Statements from Religious Organizations](#)

[Statements from Civil Liberties Organizations](#)

<https://ncse.ngo/voices-evolution-0>



National Academy of Sciences and Institute of Medicine
(now National Academy of Medicine)
2008
Washington, DC: National Academies Press

As Science, Evolution, and Creationism makes clear, the evidence for evolution can be fully compatible with religious faith. Science and religion are different ways of understanding the world. Needlessly placing them in opposition reduces the potential of each to contribute to a better future.

Ralph J. Cicerone
President
National Academy of Sciences

Harvey V. Fineberg
President
Institute of Medicine

Francisco J. Ayala
Committee Chair

2. The Nature and Limits of Science

DEFINITION OF SCIENCE

FROM THE NATIONAL ACADEMY OF SCIENCES AND
INSTITUTE OF MEDICINE

The use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.

*Science, Evolution, and
Creationism, p. 10*

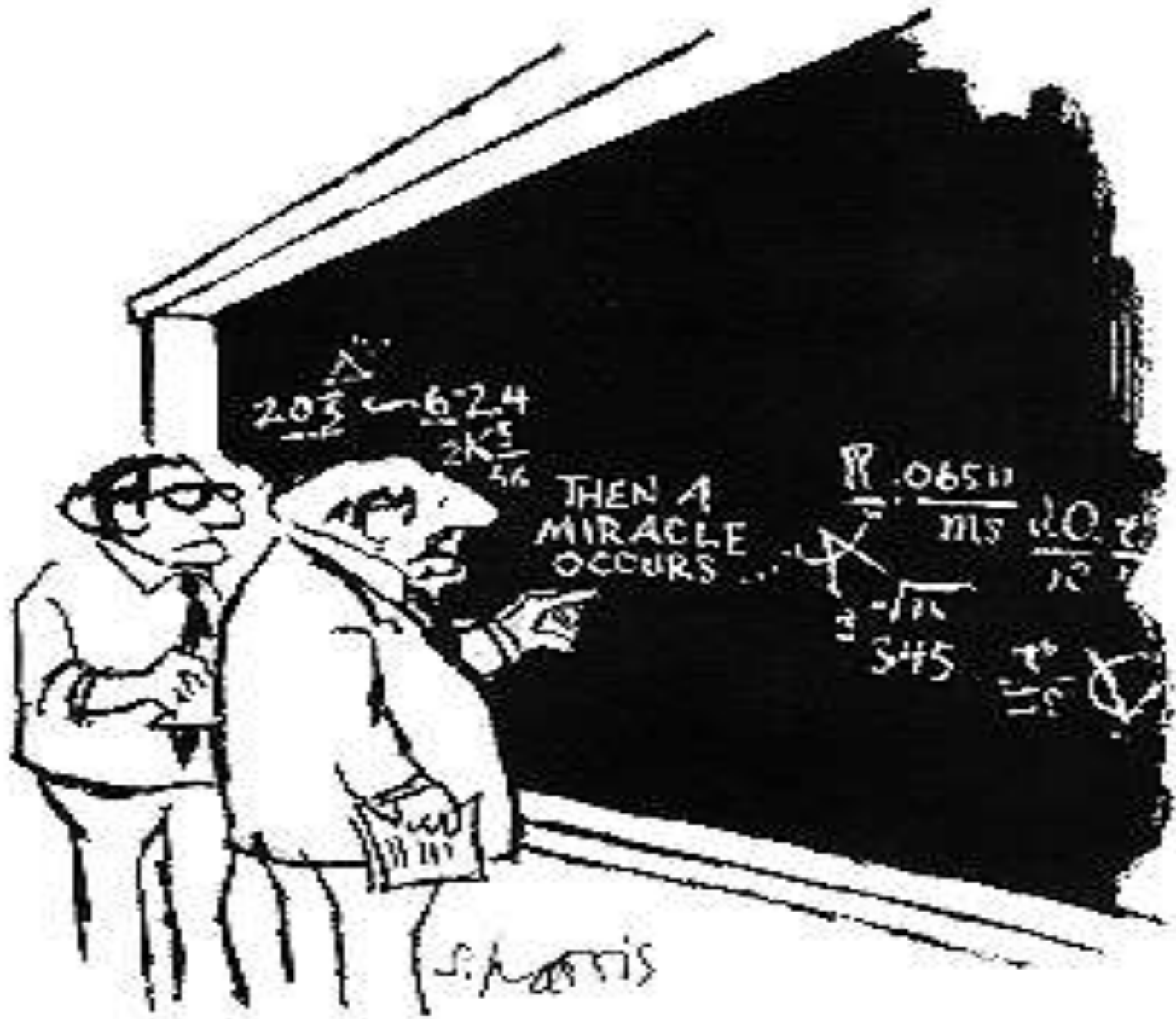
What is Science?

- **Science focuses exclusively on the natural world. It does not deal with supernatural explanations.**
- **Science is a way of learning about what is in the natural world,, e.g.,**
 - **how the natural world works,**
 - **how the natural world got to be the way it is.**
 - **predictions about the natural world of the future.**
- **Science is not simply a collection of facts; it is also a path to understanding.**
- **Science relies on testing ideas by figuring out what expectations are generated by an idea and making observations to find out whether those expectations hold true.**
- **Accepted scientific ideas are as reliable as the quality of questions asked and the level of rigor in testing those ideas.**
- **As new evidence is acquired and new perspectives emerge these ideas can be, and often are revised.**
- **Science is a community endeavor.**

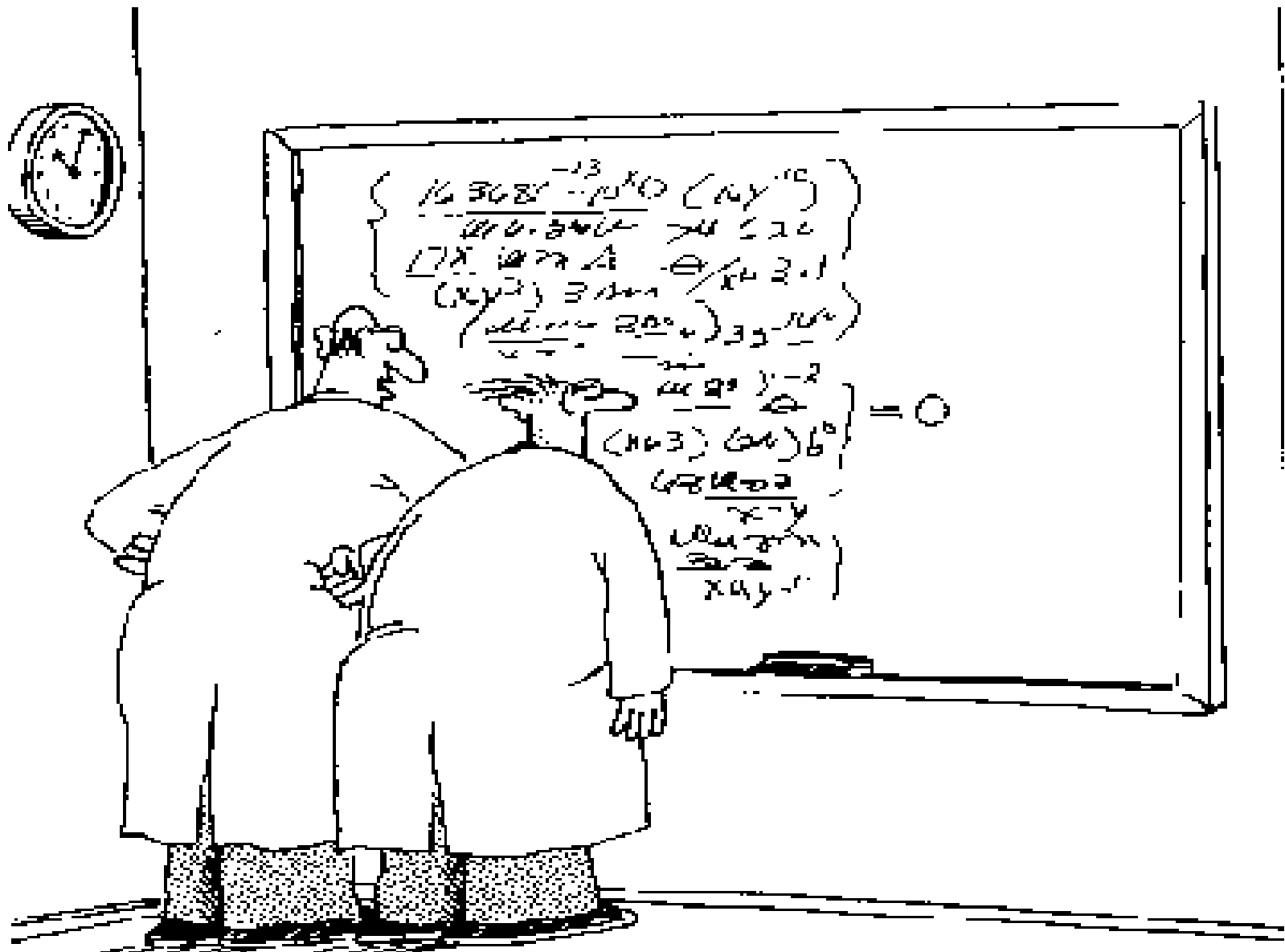
Science isn't a tall stack of hard facts; it's a difficult and deeply human process that lurches toward an approximation of the truth.

Joel Achenbach
Washington Post, page A1
July 24, 2014

http://www.washingtonpost.com/national/health-science/bicep2-experiments-big-bang-controversy-highlights-challenges-for-modern-science/2014/07/23/707bc9e6-02c6-11e4-b8ff-89afd3fad6bd_story.html



"I think you should be more explicit in step two"



“No doubt about it, Ellington--we’ve mathematically expressed the purpose of the universe. Gad, how I love the thrill of scientific discovery!”

3. Processes of Science: How Scientific Hypotheses are Developed

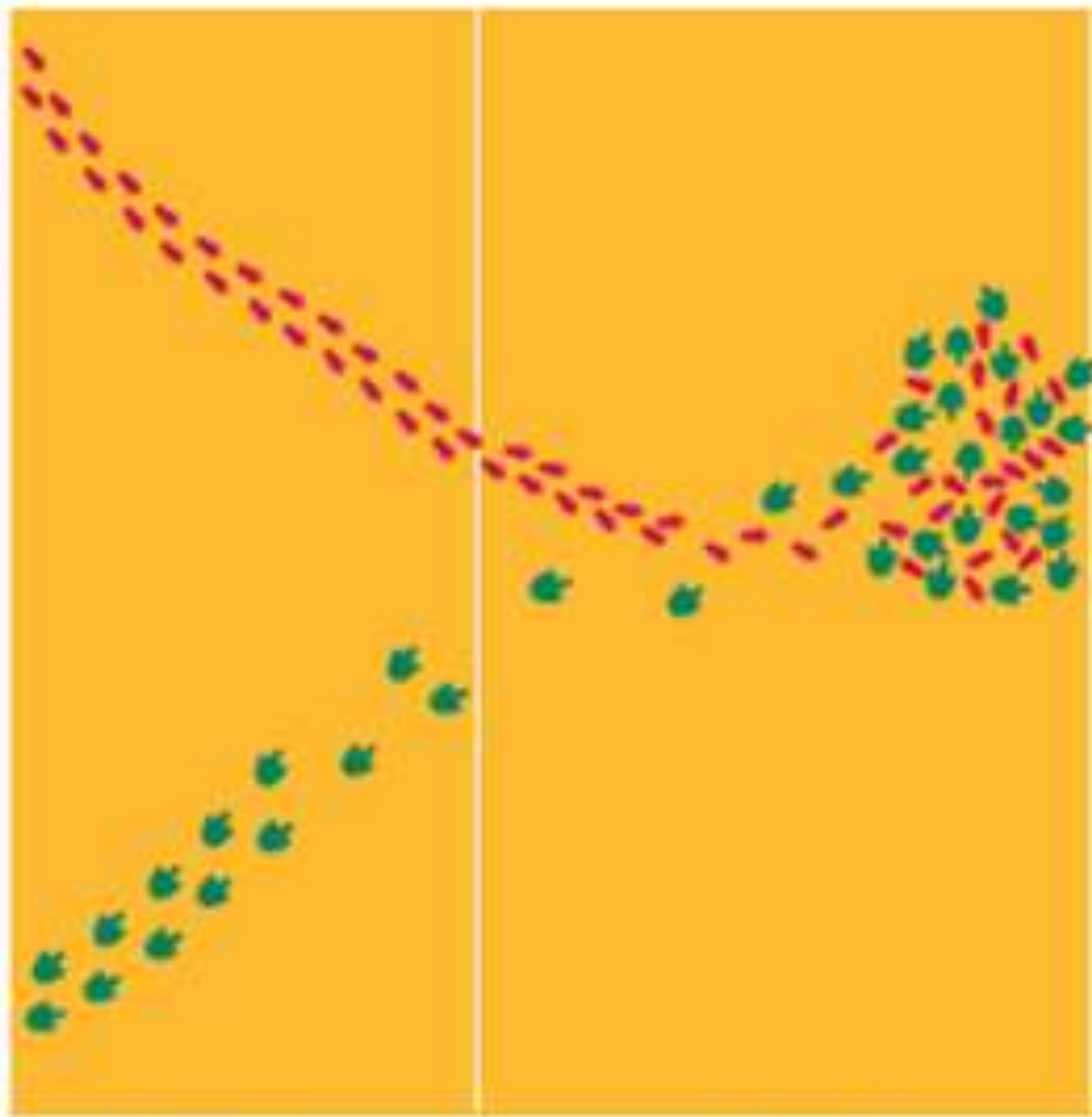
(Group Participation)



Position 1

Position 2

Position 3

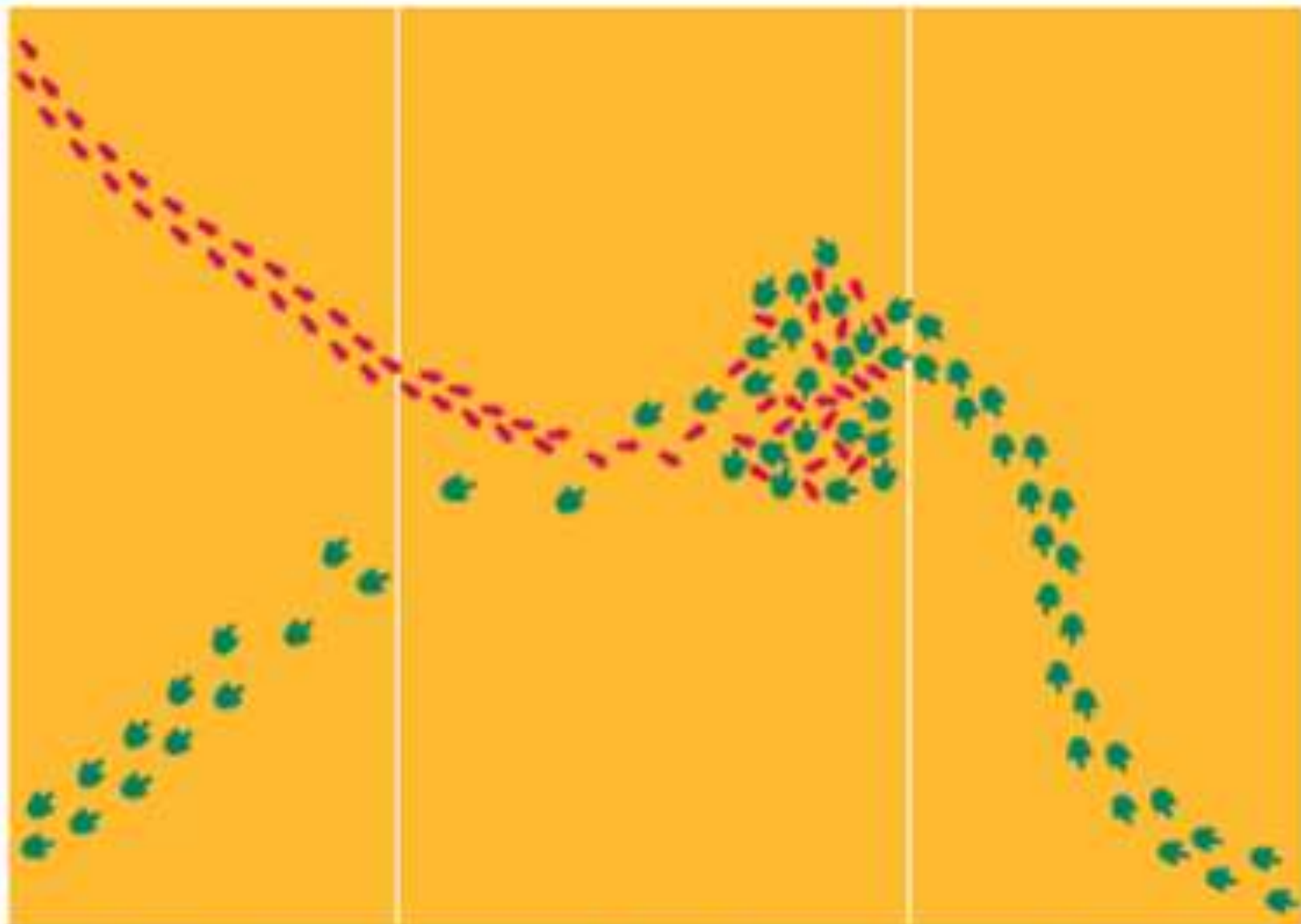


Position 1

Position 2

Position 3

Footprint Puzzle



Position 1

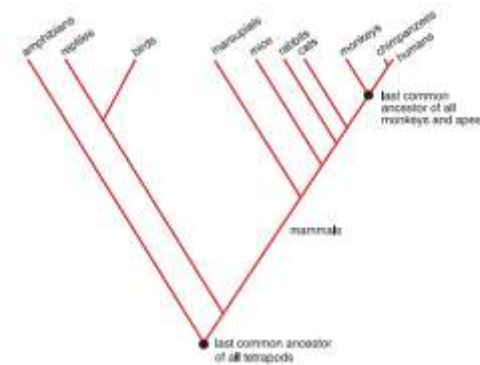
Position 2

Position 3

Unpacking the Science of Evolutionary Biology

Session 2

Lifetime Learning Institute
June 9, 2020



Jay Labov

Senior Advisor for Education and Communication
National Academies of Sciences, Engineering, and Medicine
(Retired)

jblabov@gmail.com

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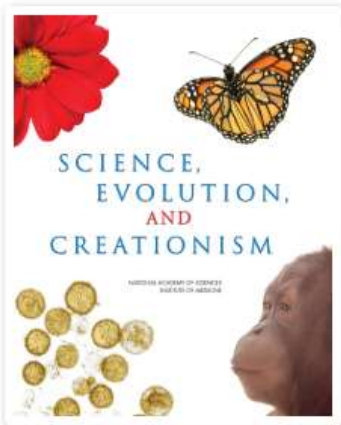
https://www.biointeractive.org/classroom-resources?search=&f%5B0%5D=resource_type%3A10

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Learning Goals For Our Two Sessions:

Last Week:

1. Examined the “controversy” surrounding the teaching of evolution in public schools.



The Nature Lab is a gift to Los Angeles to celebrate all of God's creatures and enable NHM to broaden our understanding of the natural world through the process of scientific discovery.'

Anonymous Donor - 2013

The Natural History Museums of Los Angeles County Statement on Evolution

<https://nhm.org/statement-evolution>

Learning Goals For Our Two Sessions:

LAST WEEK:

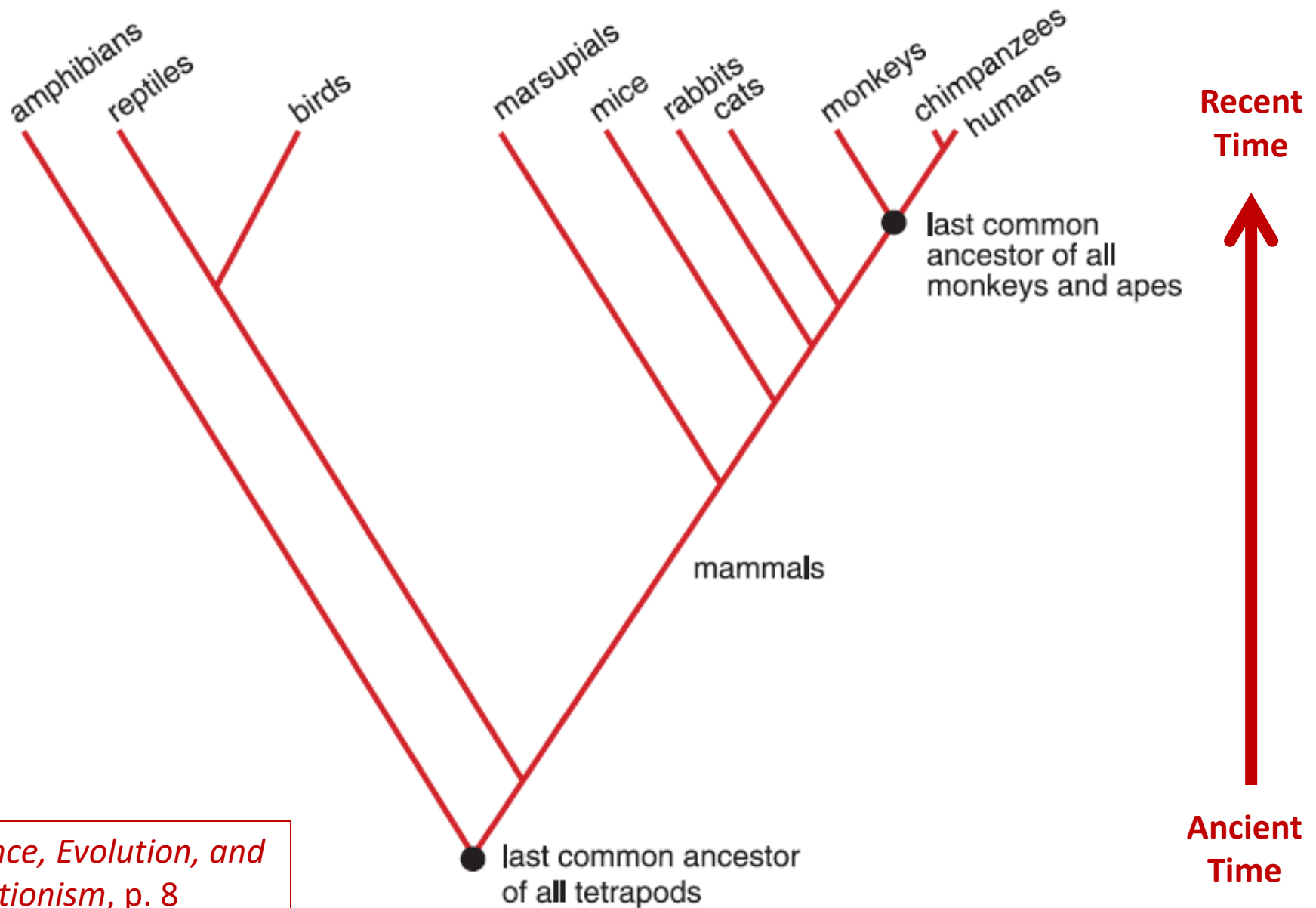
1. Examined the “controversy” surrounding the teaching of evolution in public schools.
2. Examined what constitutes scientific evidence (the nature and limits of science).
3. Processes of Science: Explored how scientific hypotheses are developed.

THIS WEEK:

4. **Discuss why evolution is an essential component of biological and other sciences/ Evidence for Evolution**
5. **Examine basic principles and some scientific debates within the science of evolution.**
6. **Answer your questions about evolution and science more generally (both sessions).**

4. Why Evolution is an Essential Component of the Biological and Other Sciences / Evidence for Evolution

Common Ancestry



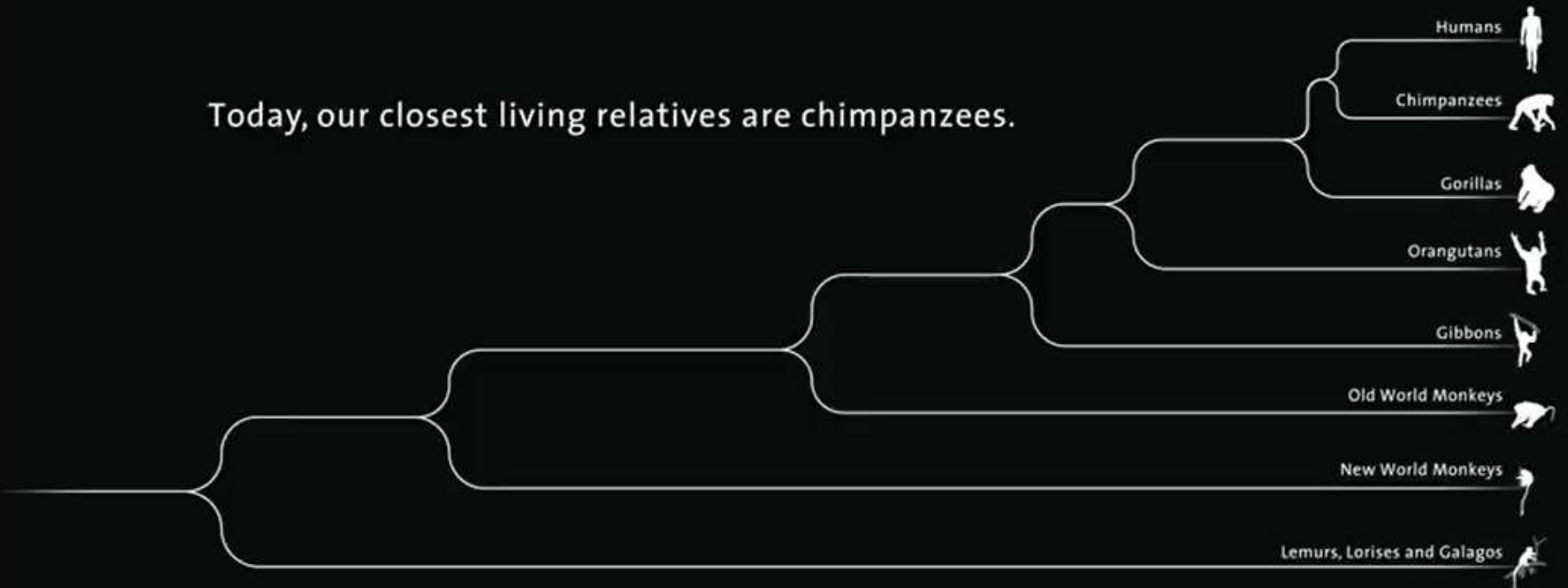
Science, Evolution, and Creationism, p. 8

OUR FAMILY TREE

7 MILLION YEARS OF HUMAN EVOLUTION



Today, our closest living relatives are chimpanzees.



Play (k)

50

40

30

20

10

TODAY



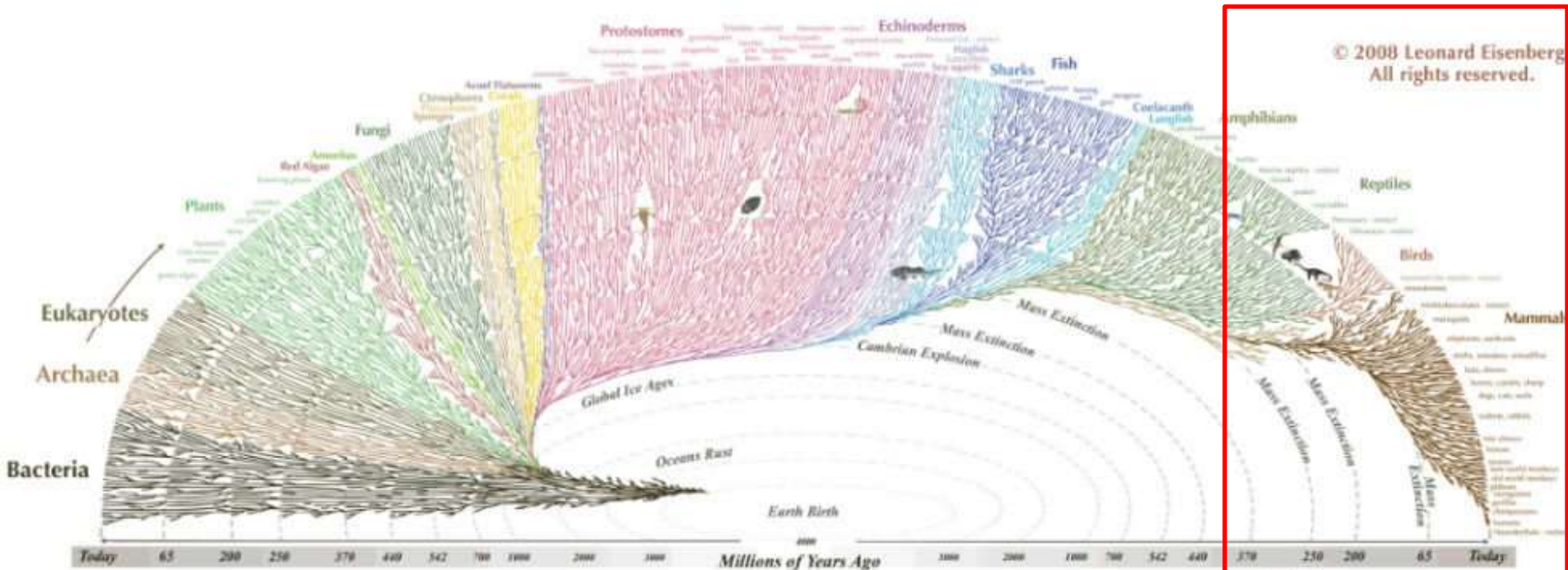
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MILLIONS OF YEARS AGO



<https://www.youtube.com/watch?v=DZv8VyIQ7YU>

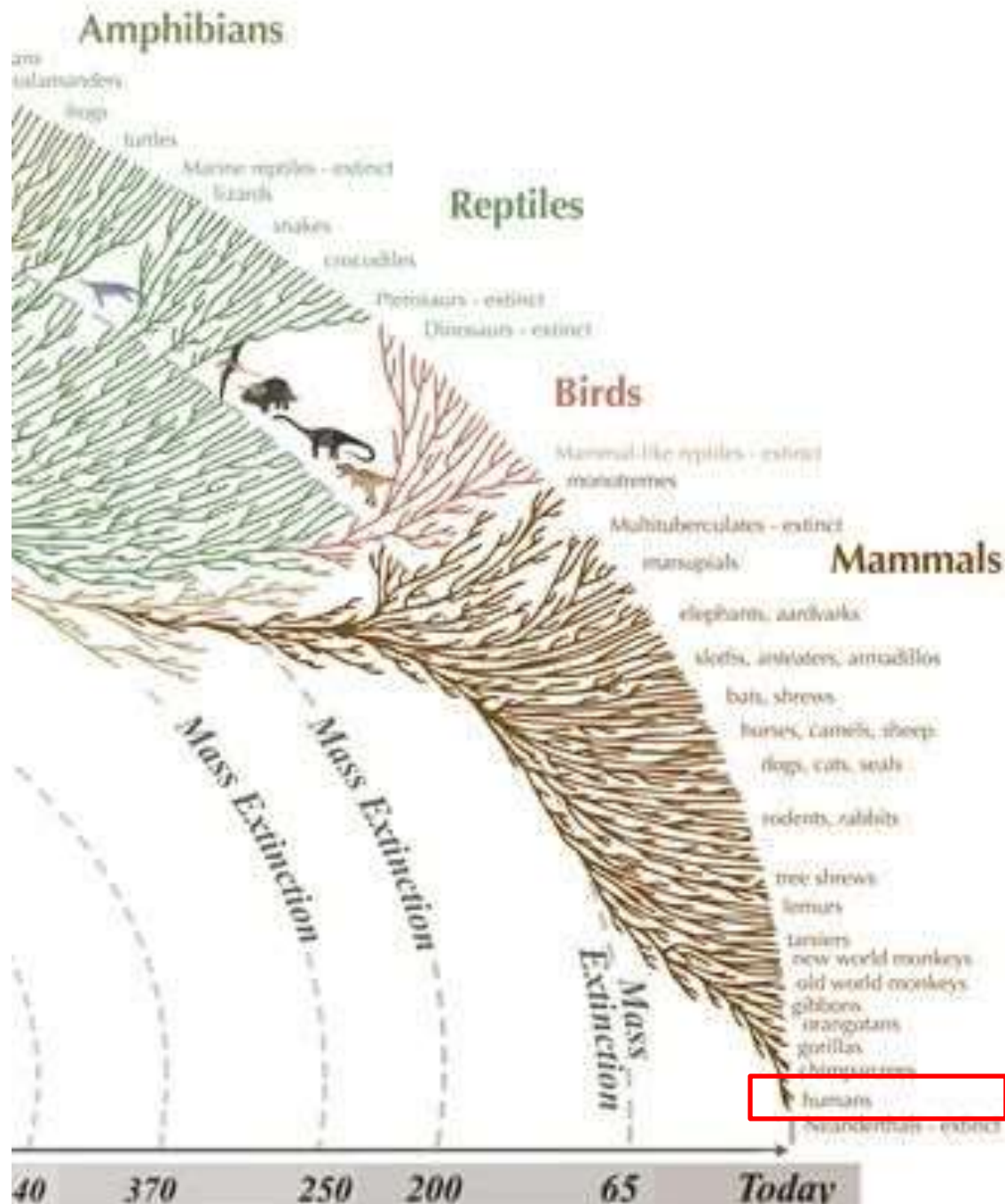
How Biologists View the Tree of Life



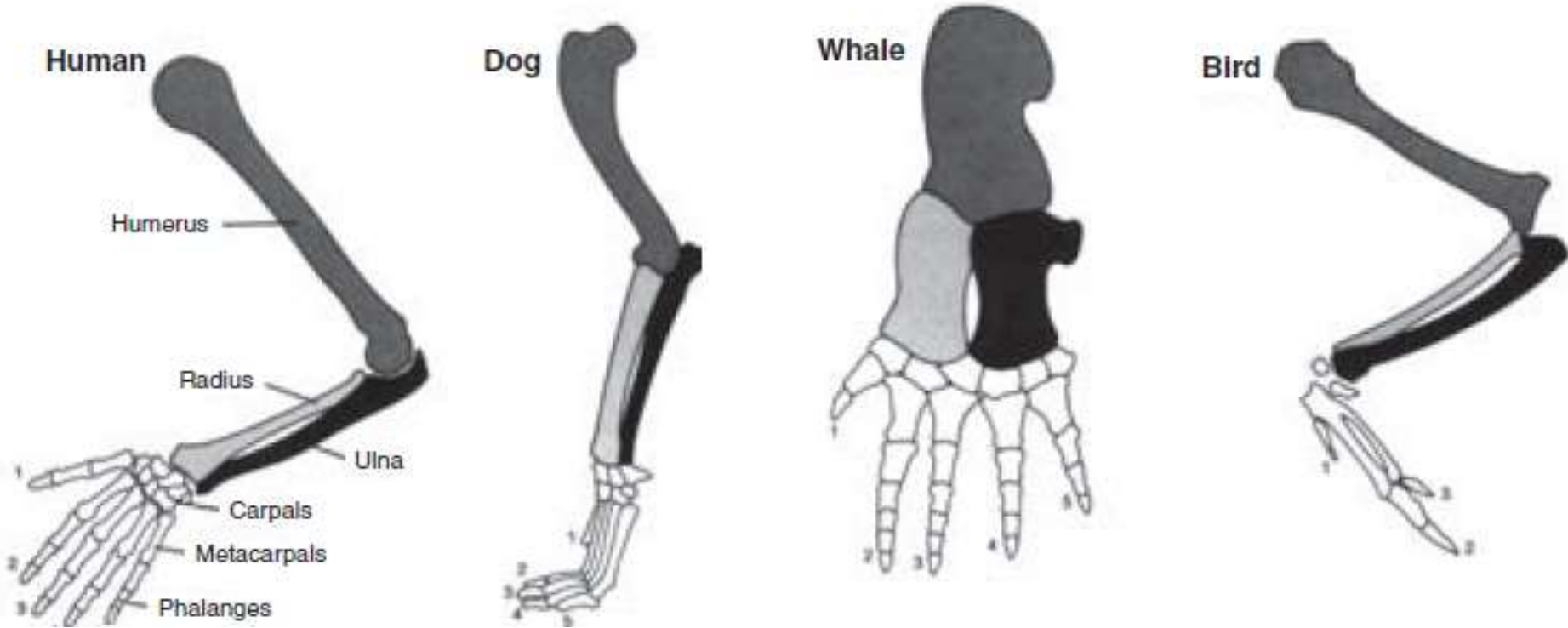
All the major and many of the minor living branches of life are shown on this diagram, but only a few of those that have gone extinct are shown. Example: Dinosaurs

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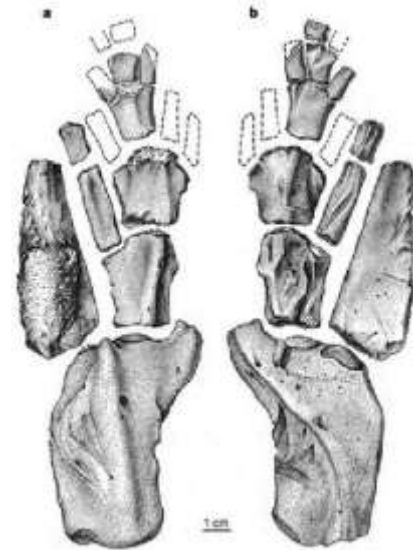
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Comparative Anatomy

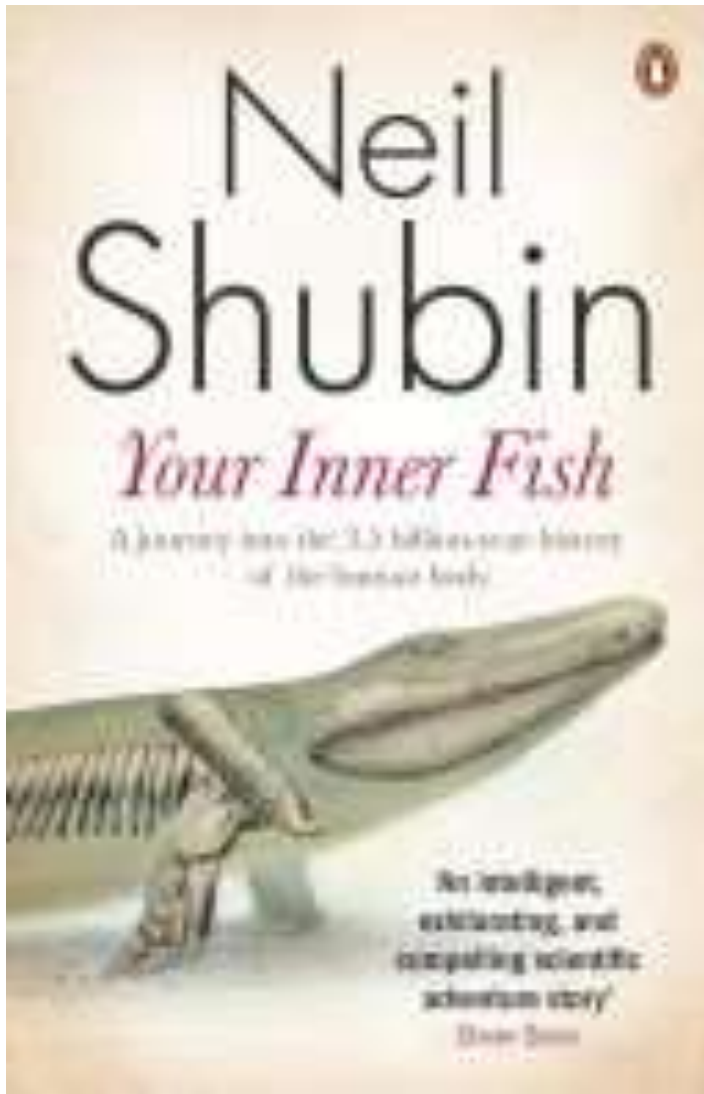


Transitional Fossils



Scientists have caught a fossil fish in the act of adapting toward a life on land, a discovery that sheds new light on one of the greatest transformations in the history of animals.

NY Times, April 2006



PBS/HMI Three Part Series:
Your Inner Fish
Your Inner Reptile
Your Inner Primate

Transition Fossils: Evolution of Whales, Dolphins, and Porpoises



*Science, Evolution, and
Creationism, p. 32*

Evidence from Genetics and Genomics

gorilla A

human GTGCCCATCCAAAAGTCCAAGATGACACCAAAACCCCTCATCAAGACAATTGTCACCAGG
|||||
chimp GTGCCCATCCAAAAGTCCAGGATGACACCAAAACCCCTCATCAAGACAATTGTCACCAGG

human ATCAATGACATTTACACACAGCAGTCAGTCTCCTCCAAACAGAAAGTCAACCGGTTTGGAC
|||||
chimp ATCAATGACATTTACACACAGCAGTCAGTCTCCTCCAAACAGAAAGTCAACCGGTTTGGAC

gorilla G

gorilla C

human TTCATTCTGGGCTCCACCOCATCCTGACCTTATCCAAGATGGACCAGACACTGGCAGTC
|||||
chimp TTCATTCTGGGCTCCACCCTATCCTGACCTTATCCAAGATGGACCAGACACTGGCAGTC

human TACCAACAGATCCTCACCAGTATGCCTTCCAGAAACGTGATCCAAATATCCAACGACCTG
|||||
chimp TACCAACAGATCCTCACCAGTATGCCTTCCAGAAACATGATCCAAATATCCAACGACCTG

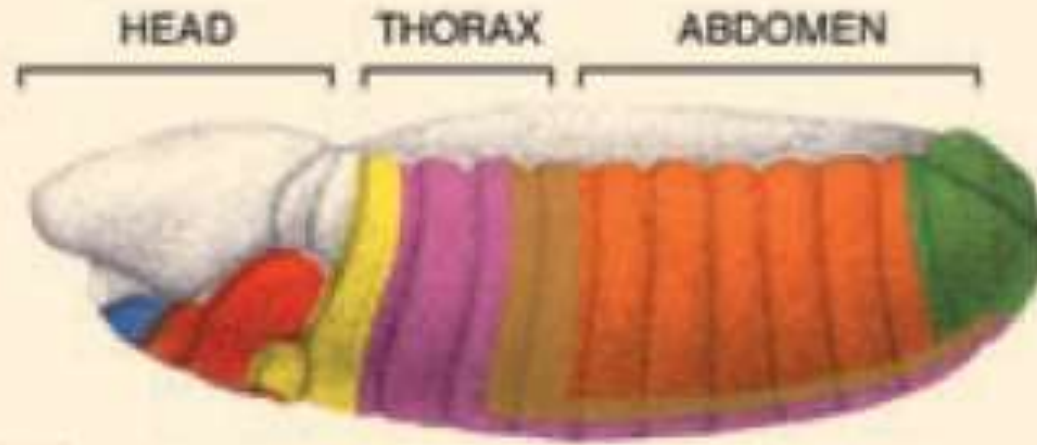
gorilla A

human GAGAACCTCCGGGATCTTCTTCAGGTGCTGGCCTTCTCTAAGAGCTGCCACTTGCCCTGG
|||||
chimp GAGAACCTCCGGGACCTTCTTCAGGTGCTGGCCTTCTCTAAGAGCTGCCACTTGCCCTGG

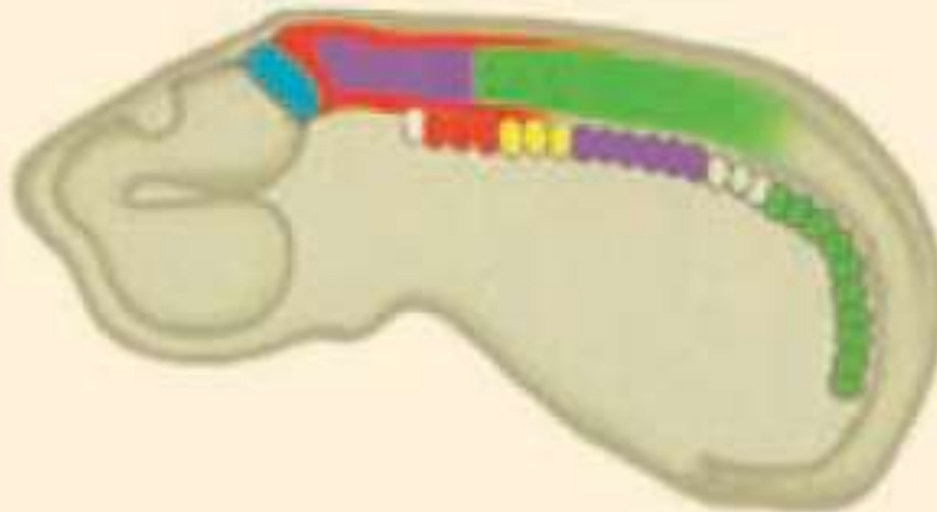
gorilla C

Evidence from Developmental Biology

Drosophila embryo



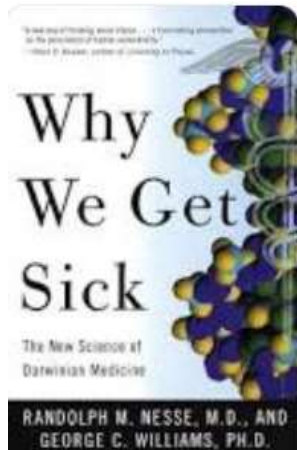
Mouse embryo



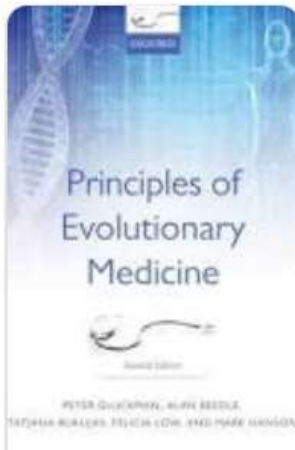
Contributions of Evolution to Better Understanding of Human Health and Disease



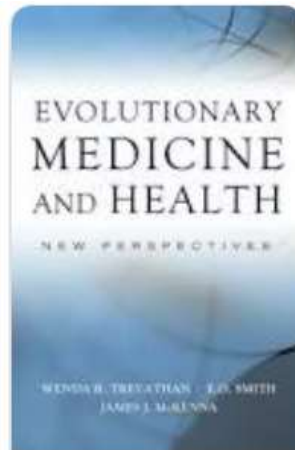
Science, Evolution, and Creationism, p. 5



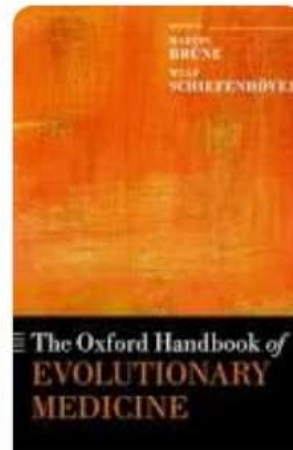
Why we get sick
Randolph M....



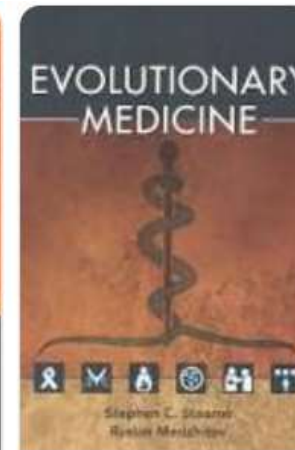
Principles of Evolutionary...
2009



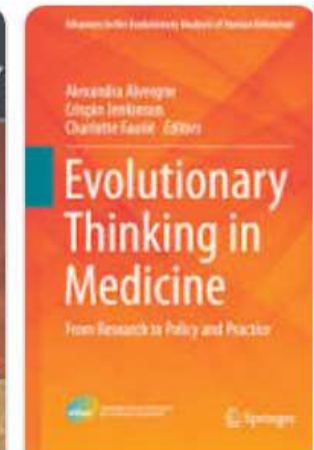
Evolutionary Medicine an...
2008



The Oxford Handbook of...
2019



A Primer of Evolutionary...
2015



Evolutionary Thinking in...
2016

Source: https://www.google.com/search?q=evolutionary+medicine+book&sa=X&ved=2ahUKEwjf5q_z7KHjAhWkdN8KHZiHD0cQ1QloAHoECA8QAQ&biw=776&bih=469

Evidence from Genetics and Genomics



Cancer genes help deer antlers grow

5. Basic Principles and
Some Scientific
Debates Within the
Science of Evolution

AN IMPORTANT CAVEAT!

Evolution is the most widely accepted SCIENTIFIC explanation for the diversity of life observed on Earth once life appeared on earth.

Evolution does NOT provide insights or explanations about the ORIGINS of life on Earth.

Essential Components Required for Evolution to Occur:

1. Variation within a population (random mutations)
2. Heritability of those variations
3. Selection for some traits over others
 - Physical Environment
 - Natural
 - Human
 - Biological Environment, e.g.
 - Intraspecific and Interspecific Competition
 - Sexual and Social
4. Sufficient Time for Changes in Gene Frequencies in Populations
 - “Microevolution” (changes within individual species)
 - ”Macroevolution” (speciation)

Variation and Heritability of Those Variations

1. Selective Breeding of Desired Traits
2. Natural Variation in Wild Populations

We may have helped give our canine pals ‘puppy dog eyes’



A new study of dog facial anatomy suggests we may have helped create this expression by favoring canines with “puppy dog eyes” over the course of thousands of years of dog evolution.

Science News, June 22, 2019

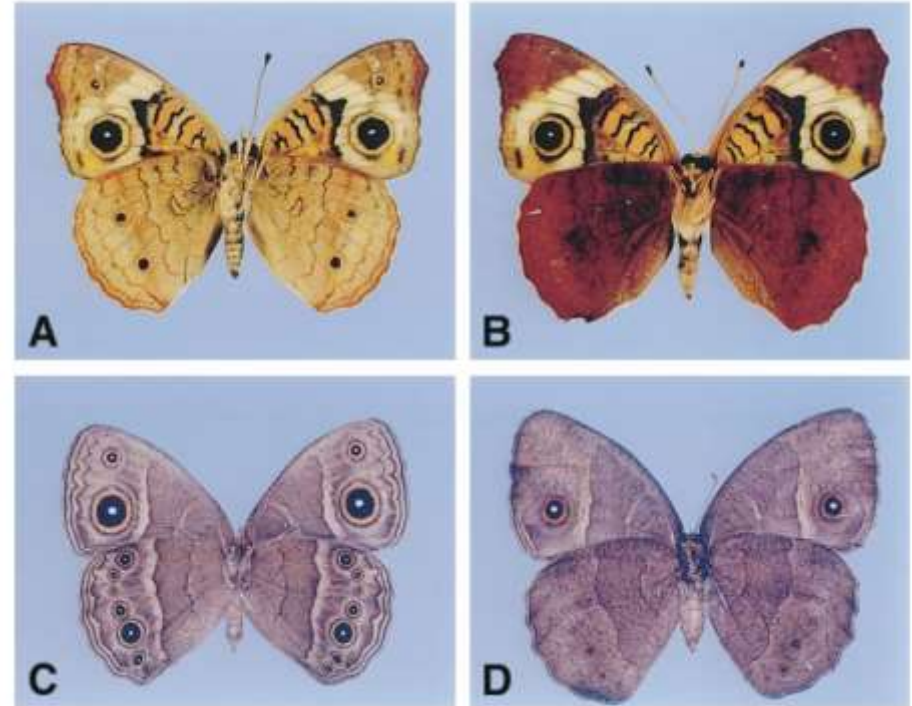
https://www.sciencemag.org/news/2019/06/we-may-have-helped-give-our-canine-pals-puppy-dog-eyes?utm_campaign=news_weekly_2019-06-21&et rid=327995191&et cid=2871045

Examples of Natural Variation Within Species



Genetic variation in the shells of *Donax variabilis*. Source:

<https://courses.lumenlearning.com/boundless-ap/chapter/sources-of-genetic-variation/>



Ventral wing surfaces, illustrating the seasonal forms of *Precis coenia* (A: "linea" form; B: "rosa" form) and *Bicyclus anynana* (C: wet season form; D: dry season form). Source:

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.462.2307&rep=rep1&type=pdf>.



How reindeer evolved to survive freezing Arctic winters

Compared with genomes from 43 other ruminant species:

- More efficient production of Vitamin D
- Loss of biological clock for activity during day vs. night
- Improved uses of fat:
 - Fat transport in the body
 - Building of fat reserves

Science News, June 22, 2019 <https://www.sciencemag.org/news/2019/06/how-reindeer-evolved-survive-freezing-arctic-winters>

Selection for some traits over others

- Physical Environment
 - Natural
 - Human
- Biological Environment, e.g.
 - Intraspecific and Interspecific Competition
 - Sexual and Social

Examples of Sexual Dimorphism



← Source: *Science, Evolution, and Creationism*, p. 7

Peafowls



Mandarin ducks



Elephant seals



Extremes of Sexual Dimorphism



Source: https://www.google.com/search?q=photo+irish+elk&tbm=isch&source=univ&sa=X&ved=2ahUKEwj7q_D6aHjAhWEg-AKHZVgCK0Q7A16BAgFEA0&biw=776&bih=469

THE FORGOTTEN FEMALE

NOW A FOCUS OF STUDY

More than a century after Darwin proposed that female choice could drive evolution in birds, scientists are training their eyes—and ears—on female birds and unlocking discoveries about avian biology.

BY KATHI BORGMANN



During breeding season, a female Hooded Warbler (right) may wander away from her nest and call loudly to nearby males to elicit extra-pair copulations.



The Importance of Time

How long could it take to produce 1,000 generations?

How many generations might occur in a million years?

	1 Generation	1,000 Generations	Generations per 1 million years
Bacteria	1 hour to 1 day	1,000 hours (42 days) to 2.7 years	8.7 billion to 370.4 million
Pets: dog/cat	2 years	2,000 years	500,000
Humans	22 years	22,000 years	45,000

Considering Macroevolution (Speciation)

Amphibians to Reptiles? **NOT THIS WAY!**



Reptiles to Birds?



Birds to Mammals?



What is a Species?

- Closely related individuals genetically
- Capable of breeding with each other
- Capable of producing fertile offspring

Several Examples of Potential Drivers of Speciation:

Geographic Isolation

Genetic/Physiological/Developmental Isolation

Competition in a Common Environment

Behavioral Isolation

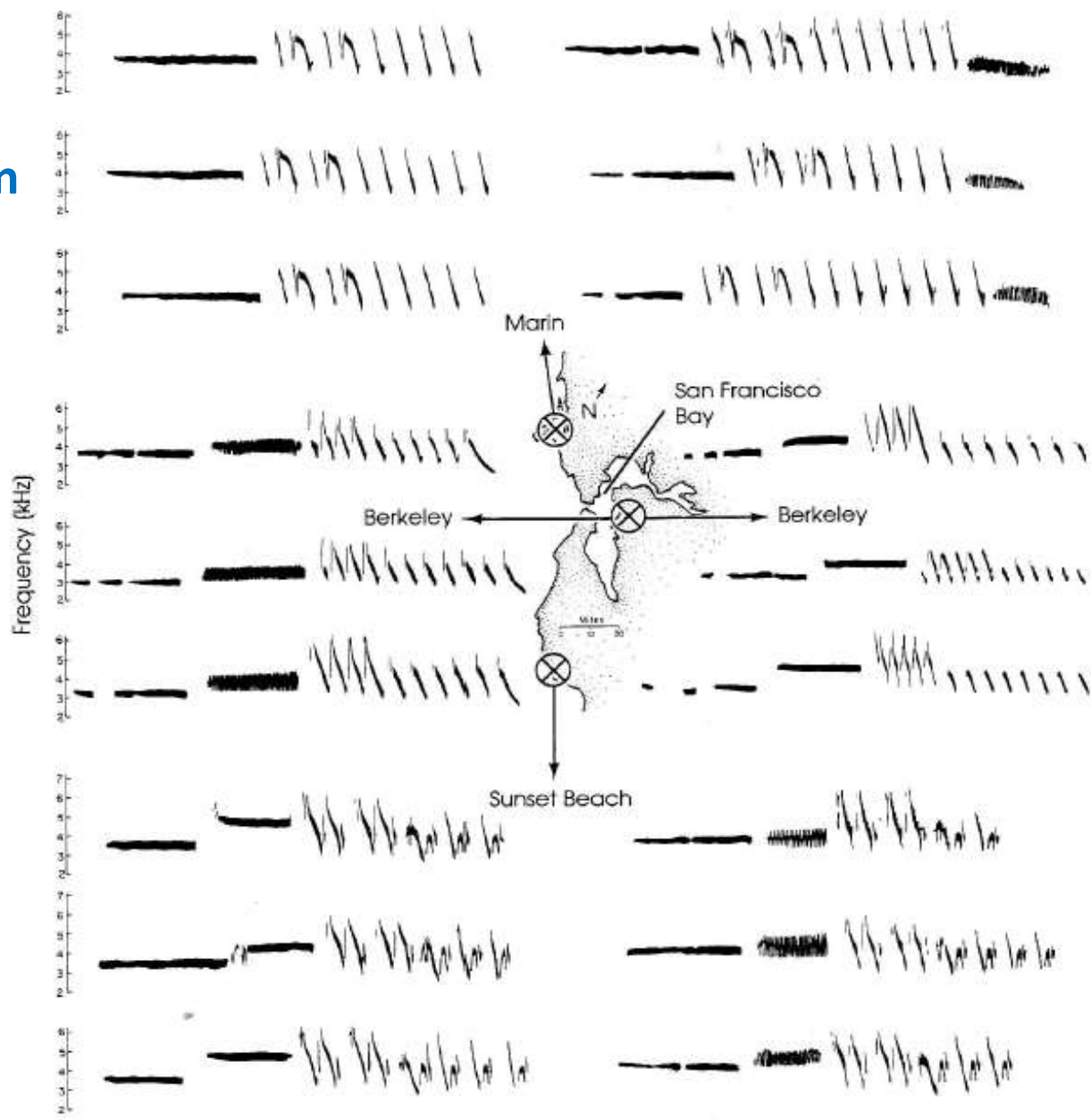
Incipient Speciation in the White-Crowned Sparrow through Behavioral Isolation from Song Dialects



Adult



Immature



7 SONG DIALECTS of white-crowned sparrows from Marin, Berkeley, and Sunset Beach, California. Males in each location have their own distinctive song, as revealed in these sound spectrograms of six singers from each location. Sonograms courtesy of Peter Marler.

While evolution is considered established science, like all other branches of science, it is always subject presentation of new scientifically-based evidence and modification when appropriate.



Researchers Challenge E. O. Wilson Over Evolutionary Theory

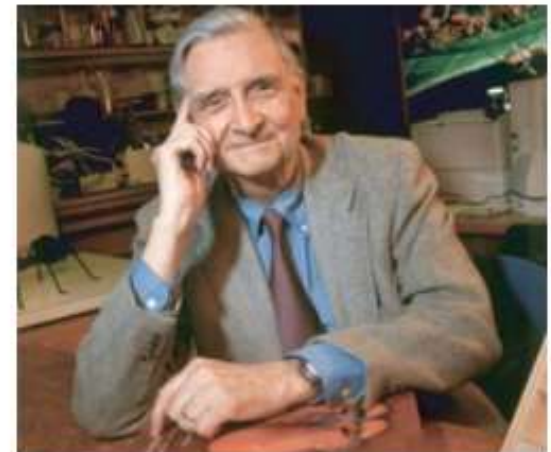
by [Elizabeth Pennisi](#) on 23 March 2011, 2:00 PM | [Permanent Link](#) | [6 Comments](#)

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Online today in *Nature*, nearly 150 evolutionary biologists challenge Harvard University's [Edward O. Wilson](#), one of the world's most preeminent scientists, and two colleagues. At issue is the usefulness of a 50-year-old theory about the role of relatedness in the evolution of complex social systems like those of ants, bees, and humans. Wilson, along with Harvard mathematicians Martin Nowak and Corina Tarnita [argue](#) that the theory, called inclusive fitness, does not explain how these complex societies arose; in a [rebuttal](#) today in *Nature* and in an upcoming issue of the *Journal of Evolutionary Biology*, their critics say that the Harvard trio have misrepresented the literature and are simply wrong.



Credit: Jim Harrison/Wikipedia

Thank you!!
Questions??
Comments??

SOCIAL MEDIA
MEETS
DARWINISM



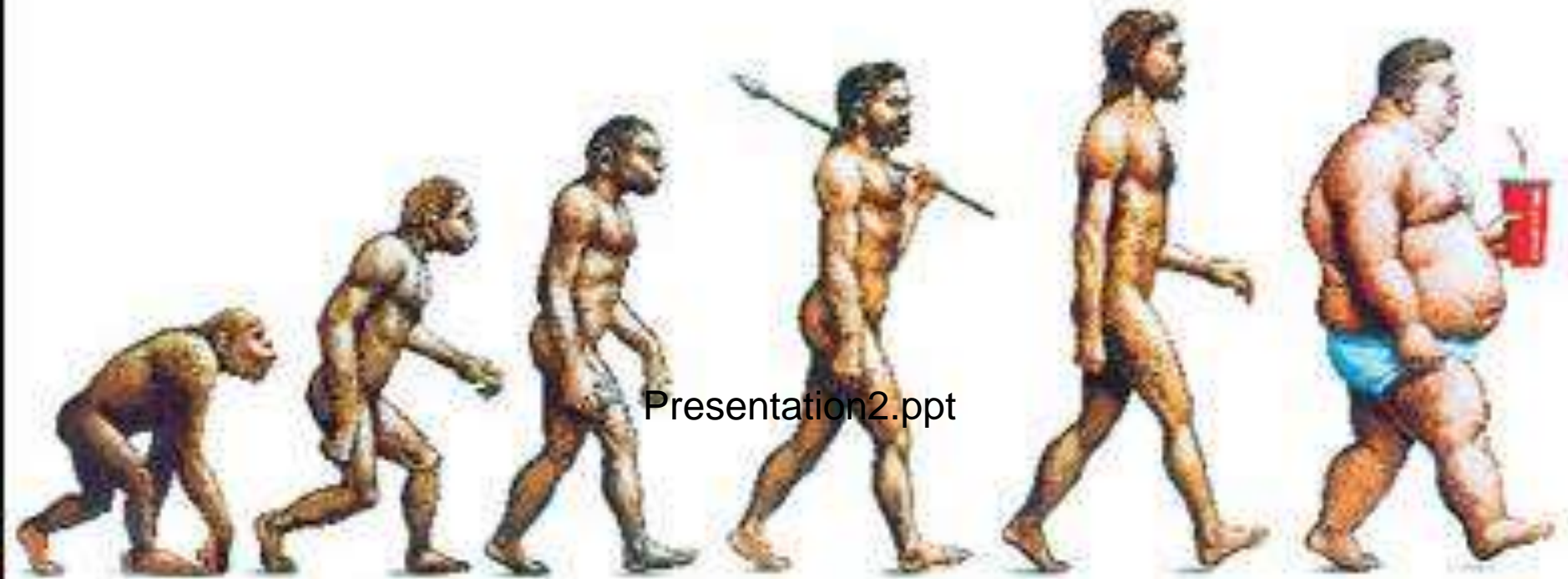
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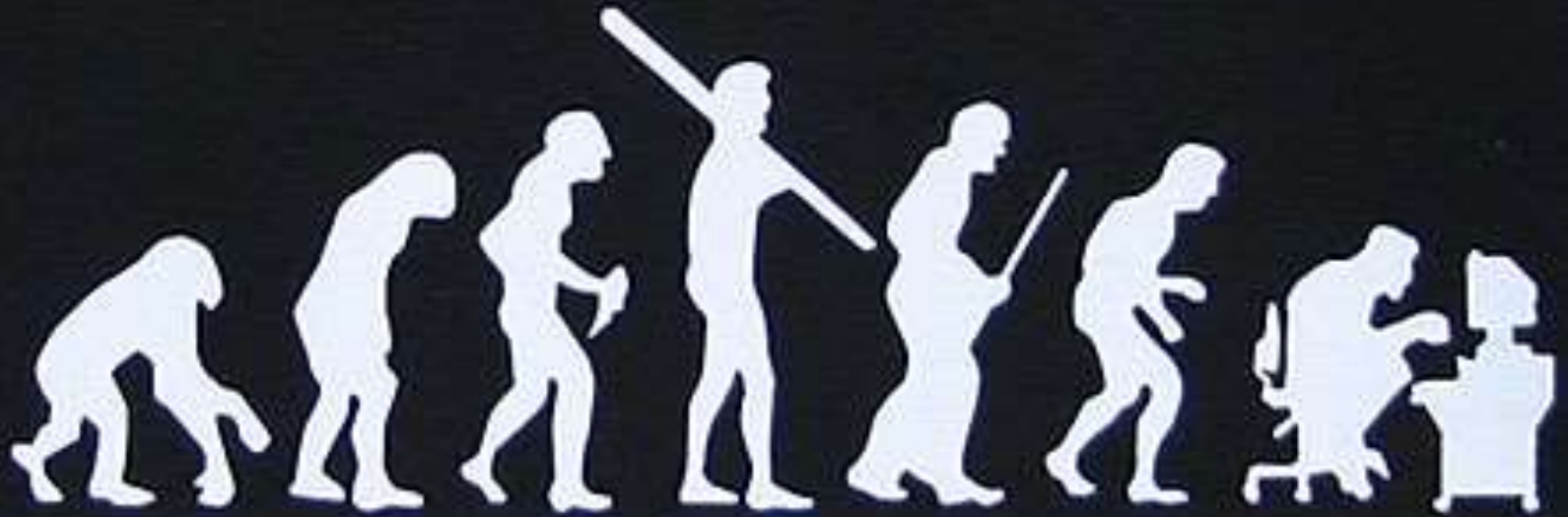
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**SOMETHING, SOMEWHERE
WENT TERRIBLY WRONG.**