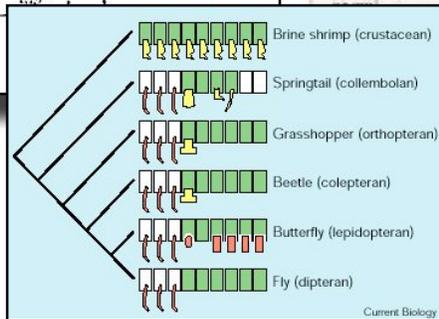
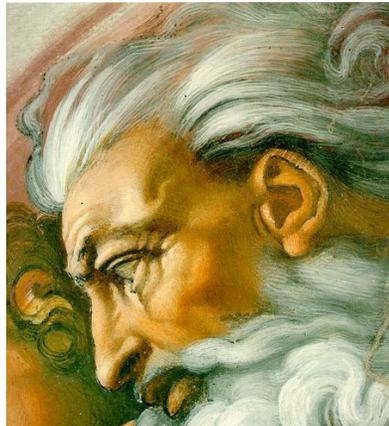
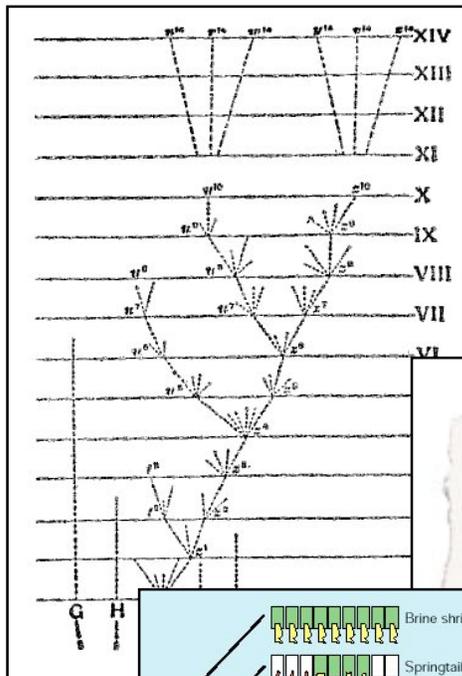


Teaching Evolution in a Climate of Controversy

Meshing Classroom Practice with Science and Common Sense



Kenneth R. Miller
Brown University

Preliminary Notes

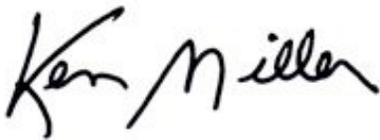
The issues that confront all educators in the teaching of evolution are social, religious, and even political. And these are the things that make them troublesome. I will propose that the most effective and most respectful way to deal with these issues is also the simplest — to treat them simply as matters of science education.

It is true that evolution — even when properly taught — is a topic that engenders passionate resistance from many members of the public. I will not suggest that careful, accurate, respectful teaching of evolution will ever silence all critics, especially those who feel that their fundamental values are threatened by the whole of modern science. What I do propose is that evolutionary biology, fully described and examined, need not be in conflict with community values in Tennessee, Kansas, Massachusetts, or anywhere else.

I will suggest this can be achieved by teaching evolution in ways that seek to avoid unnecessary conflict with religion, that encourage respect for the variety of religious beliefs, and that emphasize the tentative, evolving nature of scientific knowledge.

Finally, I will argue that science educators have a powerful, surprising ally that can be enlisted in our efforts to normalize the teaching of evolution — 21st century American popular culture. Evolution's power as an explanatory narrative of our planet's human and biological past has influenced movies, television shows, books, even games and toys. By using these media as classroom tools, one can fire the imagination of our students and simultaneously defuse the issue of evolution as a "controversial" theory.

Our goal as educators is never to compel belief, but always to promote an understanding of evolution as it really is: an essential, expansive, powerful explanatory tool that fuses the vast diversity of biology into a single compelling narrative of change through time.

A handwritten signature in black ink that reads "Ken Miller". The signature is written in a cursive, flowing style.

www.millerandlevine.com



Teaching Evolution in a Climate of Controversy: New Challenges in the Science Classroom

As science educators, the challenges we face today in the United States include an issue that science itself settled nearly a century and a half ago — the issue of evolution. Opposition to evolution comes in many forms, and it can be understood in a number of ways. We might, for example, analyze the philosophical, religious, or cultural roots of anti-evolutionism, and several writers have done exactly this. Tonight, however, I will propose that we, as science educators, ought to do something different. We should deal with anti-evolutionism purely as an issue of science education.

We might begin with the National Science Education Standards, a document prepared by the National Academy of Sciences, that sets an ambitious series of goals for American education. As we will see, evolutionary science is woven through every level of the Standards, beginning with the principles of earth and physical science at grades K-4, and culminating with a sophisticated review of evolutionary theory at the secondary level.

In many ways, what we can learn tonight from the specifics of the Standards are less important than their general theme, which is that evolution is not a subject apart, an isolated concept, a discipline separable from the rest of sciences. Rather, evolution is part and parcel of a unified science of biology. Therefore teaching evolution properly isn't an issue of slipping a specific, isolated set of teachings into a science curriculum that can exist with or without it. It's simply a matter of teaching all of biology, all of science, and teaching it well. This means that teaching evolution does not require us to do something "special." It requires only that we do our jobs completely.

In many school districts, where evolution is a controversial topic, this advice will seem to run contrary to experience and common sense. Evolution in many places is, indeed, viewed as a *special* topic that provokes parental concern, letters to the editor, calls to superintendents, and even debates in state legislatures. Why is this so? The answer is simple enough — evolution is generally believed to conflict with religious and community values, to present a threat to what parents wish to teach their children at home and in church.

What I propose we ask tonight is to ask if this really and truly has to be the case. If evolution, properly taught, if science, fully acknowledged and examined, has to be in conflict with community values in Tennessee, in Kansas, in Massachusetts, or anywhere else. I don't think it does. I propose that we begin by refusing to accept that conflict between science and religion is unavoidable.

There are a number of ways in which evolutionary science can be reconciled with the most conventional and literal of religious teachings, and I will discuss several of these. Each, I will argue, encourages the same sensible strategy for dealing with religious conflicts that might arise in science education. The strategy is:

- (1) Never to seek conflict where it is avoidable.
- (2) Always to encourage respect and understanding for religious belief.
- (3) Always to teach science "correctly," by which I mean to emphasize the tentative, evolving nature of scientific knowledge.

It is especially important that we begin this process in the early grades. Keeping evolution's integration with the other sciences in mind, science education in early grades should concentrate on developing a scientific view of nature. Such a view includes appreciation of:

- The size and scale of the universe.
- Ages of the earth and the solar system.
- The unity of the physical and biological worlds

As younger students gain confidence in the scientific approach, more complex concepts can be developed in the middle grades. These include:

- The ability of organisms to reproduce their own numbers without limit.
- Individual variation among members of every species.
- The heritability of variation.
- Differential reproductive success among individuals.
- The dramatic changes over time found in natural history.

You will, of course, recognize that these exact scientific concepts formed the basis of Darwin's reasoning and remain, today, as the foundations of evolutionary thinking. Finally, evolution itself should be presented not as an isolated just-so story with an unwelcome message, but as the unavoidable conclusions of a framework of facts and principles that lead one to recognize evolution as a well-understood, well-supported process of change through time. The educational elements of this process including demonstrating to students that:

- Organisms routinely generate new variation.
- Sometimes this variation is beneficial (the flu, HIV, insects)
- Natural selection, acting on this variation, changes the nature of populations (not individuals!) over time.

- The range of variation in recognized species sometimes is so great it makes it hard to tell where one species leaves off and where two should be recognized.... the very fact that we have a word (variety) to refer to such cases tells us they are common, and allows us to recognize numerous cases of incipient species around the world.

As I will emphasize, my central thesis is not that scientific knowledge can or should be withheld from those who resist it. Rather, I will argue that evolutionary science can and should be taught in a way that respects and enriches religion. All science educators should realize that western religions were essential to the intellectual transformation that made the scientific revolution possible. Religious motivations to understand nature have motivated many scientists, including Darwin himself.

Finally, I will emphasize two crucial things about science:

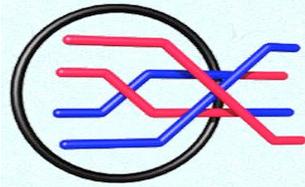
First, science never provides us with the definitive, final answer to any question. This means that one doesn't "believe" in evolution any more than one "believes" in organic chemistry. Rather, one accepts evolution as an explanation well supported by fact, as a theory that explains facts and makes sense of them, and as a productive and useful way to conduct further research. This doesn't mean that anyone ever has to accept evolution to learn biology; but it *does* mean that no person is fully educated without an understanding of it.

Second, science never provides absolute knowledge. It answers limited questions about nature in a limited (but very useful way). This means that science by itself can never address questions of meaning and purpose, even though such questions are important to each of us.

Evolution, properly taught and properly understood, is never a challenge to belief or faith. I would argue, perhaps surprisingly, that our tasks as biology educators are not complicated by the controversies associated with the teaching of evolution, but are actually made simpler. Evolution is the central organizing principle of the life sciences, an explanatory theory that reveals, exactly as Darwin wrote, the "grandeur" of life and the majesty of the natural world. The misunderstandings of those who oppose the teaching of evolution should never cause us to lose heart or tempt us to set Darwin's great idea aside. I would hope instead that the opposition to science education will make us refine and improve our methods of teaching, and appreciate more than ever the extraordinary insights that evolution gives to each and every branch of the science of life.

Kenneth R. Miller
Professor of Biology
Brown University
Providence, Rhode Island 02912

The National Center for Science Education



**National Center for
Science Education**

<http://www.natcensci.org/>

The National Center for Science Education should be thought of as your primary resource in defending the integrity of science teaching. NCSE maintains a web site with a range of information useful in meeting challenges to the teaching of evolution, and NCSE staff are always willing to provide support to teachers and school boards in crisis situations.

**NCSE
420 40th Street Suite 2
Oakland, CA 94609-2509 · Phone: (510) 601-7203 · Fax: (510) 601-7204**

The Talk Origins Archive



The Talk.Origins Archive

Exploring the
Creation/Evolution
Controversy

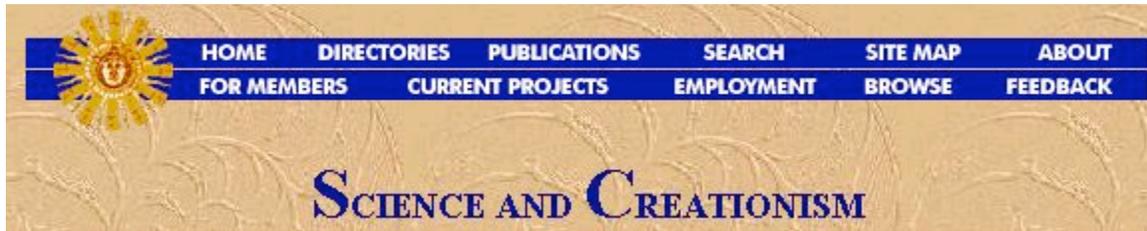


<http://www.talkorigins.org/>

An extraordinary resource of facts, analyses, and arguments devoted to the Evolution-Creation controversy. When looking for the answer to a specific scientific challenge to evolution, such as the age of the earth or the supposed lack of transitional forms, Talk Origins should be your first stop. For a quick introduction to some of the resources available at this site, visit the "Must-Read" files at this address:

<http://www.talkorigins.org/origins/faqs-mustread.html>

The National Academy of Sciences



<http://nationalacademies.org/evolution>

Dr. Bruce Alberts, outgoing President of the National Academy, has been outspoken in defense of evolution, and has placed the full weight of the National Academy behind efforts to defend the teaching of evolution in the schools.

Publications from the National Academy:

Several publications are available from the National Academy that should be on every biology teacher's bookshelf (you can also read each of them on-line). They include:

- Science and Creationism (1999)
- Teaching About Evolution and the Nature of Science (1998)
- Evolution in Hawaii: A Supplement to Teaching About Evolution and the Nature of Science (2004)



Teaching About Evolution and the Nature of Science

The American Association for the Advancement of Science

AAAS Evolution Resources



<http://www.aaas.org/spp/dser/evolution/>

AAAS is the leading American scientific organization. It maintains a useful web page on evolution featuring educational and historical resources, records of court cases on evolution and creation science, and scientific resources including the complete text of *On the Origin of Species*.

The National Association of Biology Teachers



The NABT maintains a web page with a series of strong statements on the teaching of evolution:

<http://www.nabt.org/sub/evolution/>

"Nothing in biology makes sense except in the light of evolution." This often-quoted assertion accurately illuminates the central, unifying role of evolution in nature, and therefore in biology.

"Teaching biology in an effective and scientifically-honest manner requires classroom discussions and laboratory experiences on evolution."

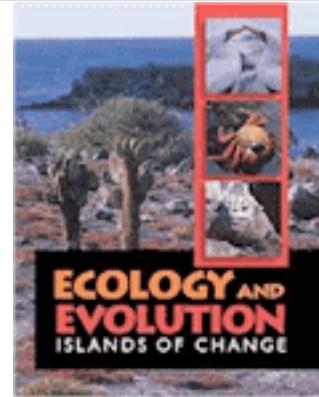
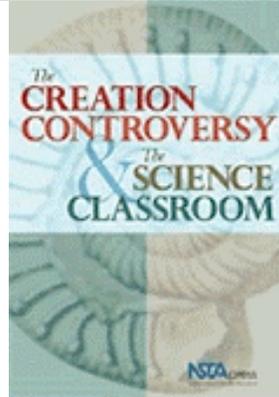
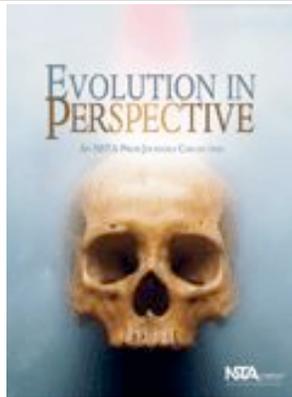
"Frequently-Encountered Criticisms of Evolution"

This is one of the most complete sites I have found, dealing with every conceivable criticism of evolution, from the age of the earth to the amount of dust on the surface of the moon. With extensive links to more detailed references such as Talk.Origins.

<http://www.vuletic.com/hume/cefec/>

Special Note: This site is maintained by Mark I. Vuletic, a doctoral candidate in philosophy. Marc is currently deployed in Iraq with the USMC, so he's not in a position to provide immediate responses to written questions.

National Science Teachers Association



The National Science Teachers Association maintains a page of excellent evolution resources, and has published a series of books directly addressing classroom controversies.

www.nsta.org/evresources

Teaching Resources with Classroom and Field Exercises on Evolution



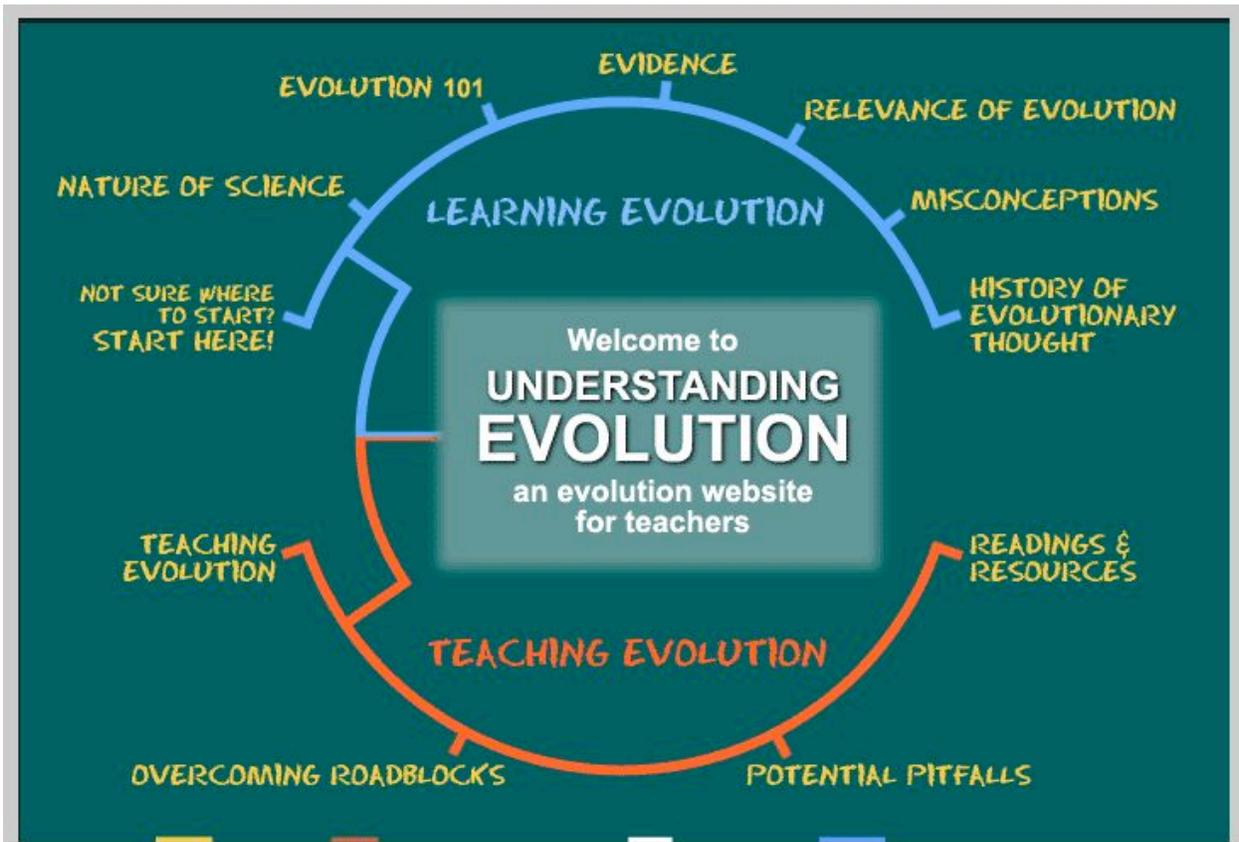
<http://www.accessexcellence.org/AE/AEPC/WWC/1995/>

A series of superb teaching exercises on the principles of evolutionary biology. More than 30 exercises are archived at the site, including demonstrations, exploration projects, classroom and field activities, and even songs!



<http://www.indiana.edu/~ensiweb/less.fs.html>

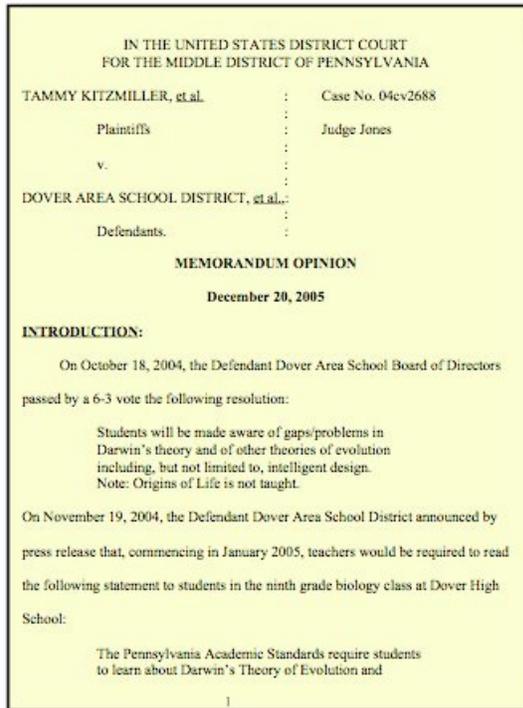
A series of lessons and classroom exercises (from Indiana University) relating to different aspects of evolution.



The Natural History Museum of the University of California at Berkeley has a wonderful web site supporting both teachers and students in the study of evolution.

<http://evolution.berkeley.edu/>

Kitzmiller v. Dover - The trial of “Intelligent Design”



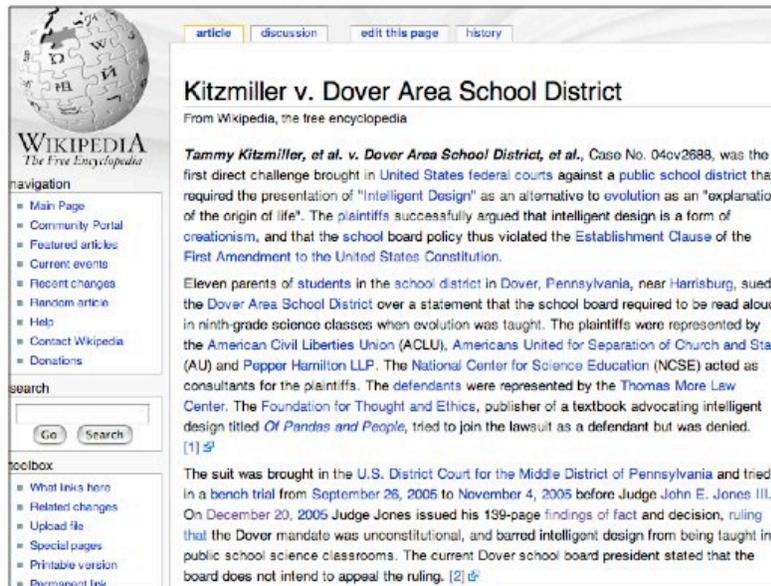
• The 2005 Federal lawsuit in Dover, Pennsylvania over the teaching of “intelligent design” is a watershed of valuable information for science educators. Written in plain, non-legalistic English, Judge John E. Jones’ decision is a masterpiece of analysis and scientific understanding. *Kitzmiller v. Dover*, as the decision is known, is available from several sources on the web, and can be downloaded in PDF format.

Resources from the trial include file transcripts of testimony by expert witness, and images used during the trial.

Web sites at the National Center for Science Education (NCSE) and Talk Origins contain most of the trial documents.

<http://www2.ncseweb.org/kvd/>
http://www.talkorigins.org/faqs/dover/kitzmiller_v_dover.html

Also not to be missed is the Wikipedia article on the Dover trial:



Ken Miller's Evolution Page
<http://www.millerandlevine.com/km/evol/index.html> Google

Google Maps Apple Amazon News Brown Travel Journals HASTI TEA Numbers Mac eBay Yahoo!

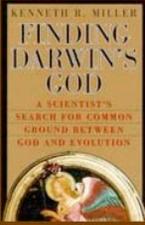
Brown University

Evolution Resources

(Kenneth R. Miller)



return to:
[Ken Miller's Home Page](#)



New Articles on the Failure of "Intelligent Design:"

["The Flagellum Unspun - The Collapse of Irreducible Complexity."](#)
 Scientific studies of ID's "poster child," the bacterial flagellum, have destroyed this "icon" of the anti-evolution movement.

["Answering the Biochemical Argument from Design"](#)
 The ID movement pretends that its biochemical arguments against evolution are new, novel, and scientific. In fact, they are nothing of the sort.

["Remove Stickers. Open Minds"](#) (My January, 2005 *Boston Globe* Op-Ed piece on the anti-evolution textbook warning stickers in Cobb County, Georgia)

Evolution & Religion:

[Evolution and the Catholic Church \(op-ed 2005\)](#)

Interviews @ ChristianityToday Library:
["Finding Darwin's God" \(2004\)](#)
["A Higher Opinion of God" \(2004\)](#)

Talks on Evolution:

Nov. 8, 2002: NPR's Science Friday. An hourlong discussion of "Intelligent Design" and the new science curriculum in Ohio.

April 23, 2002: Debate on Intelligent Design at American Museum of Natural History (NYC) (A transcript of the debate is available on-line)

March 2, 2002: Evolution & God: Why Intelligent Design Theory Isn't Science (Cleveland, OH)

[Click Here](#) for an account of my remarks in a debate on Evolution in front of the Ohio Board of Education on March 11, 2002.

Opponents of Evolution in Ohio and other states have pretended that the teaching of "intelligent design" is required by the new Education Bill. **They're not telling the truth.** [Click Here](#) to check the facts about the "Santorum amendment" for yourself.

Anti-evolutionist Jonathan Wells is now trying to recover from the March 11th debate in Ohio by leveling personal attacks. [Click Here](#) for details.

Finally, don't overlook the web site that I maintain on evolution. It contains a variety of links to op-ed pieces, scientific articles, as well as my book on evolution and religion, *Finiding Darwin's God*.

<http://www.millerandlevine.com/km/evol/>



BROWN UNIVERSITY

Kenneth R. Miller
Professor of Biology

Division of Biology & Medicine • Box G-B5 • Providence, RI 02912
 Phone: 401-863-3410 • kenneth_miller@brown.edu
<http://bms.brown.edu/faculty/m/kmiller/>
<http://www.millerandlevine.com>