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**ESTABLISHING RELIGIOUS IDEAS:  
EVOLUTION, CREATIONISM, AND  
INTELLIGENT DESIGN**

KENT GREENAWALT\*

I. INTRODUCTION

The enduring conflict between evolutionary theorists and creationists has focused on America's public schools. If these schools had no need to teach about the origins of life, each side might content itself with promoting its favored worldview and declaring its opponents narrow-minded and dogmatic. But educators have to decide what to teach, and because the Supreme Court has declared that public schools may not teach religious propositions as true, the First Amendment is crucially implicated.

On close examination, many of the controversial constitutional issues turn out to be relatively straightforward, but others, posed mainly by the way schools teach evolution and by what they say about "intelligent design" theory, push us to deep questions about the nature of science courses and what counts as teaching religious propositions.

In this article, I first sketch the basic conflict between evolutionary theory and creationism and describe the opposition of creationists to the teaching of standard evolutionary theory. I then state the basic educational and constitutional questions about evolution, standard creationism, and "intelligent design." After exploring of five fundamental premises that, in combination, generate the most troubling questions about science, religion, and the public schools, I turn to claims of miracles. Like

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assertions that God has intervened in natural processes of development, these claims suppose that God transcends or violates scientific principles; their investigation suggests that scientific procedures may help identify limits of science.

With this background set, I inquire whether evolution, Genesis creationism, and intelligent design qualify as appropriate subjects for science courses in public schools. I suggest that nothing should be presented as scientifically based unless it is minimally plausible from a scientific point of view. I briefly explain why evolutionary theory undoubtedly qualifies, and examine the status of negative arguments directed against scientific theories, including estimates of extreme improbabilities. I contend that if one is interested in what is true, overall, one cannot reasonably reject negative arguments out of hand on the ground that they fail to offer an alternative scientific explanation. I make the obvious point that a negative argument against one theory does not support any single alternative, unless that is itself the most persuasive of various alternatives to the challenged theory.

After arguing that a theory should not be disqualified from science courses simply because it suggests a supernatural power, I address the thorny problem of whether a theory fails if it does not offer a natural explanation of occurrences. I contend that a theory properly falls within the domain of science courses if, grounded in scientific evidence, it asserts a limit to scientific explanation. Finally, I suggest that a theory should not be rejected altogether on the basis that its proponents are not fairly open to alternative evidence, though that certainly is a reason for great caution in evaluating their claims.

This analysis leads to the conclusion that evolution definitely belongs in science courses and that any account approximating the literal reading of Genesis does not. Students should be informed of uncertainties and possible gaps in dominant evolutionary theory and told that, if any supplements are needed (a matter in doubt), intelligent design is one conceivable alternative.

The discussion then shifts from what belongs in a science course to what counts as teaching religion, the crucial issue for constitutional purposes. Teaching Genesis creationism is teaching religion, whether or not any reference is made to the Bible, because the only substantial basis for believing in that account is religious. Teaching intelligent design is religious if that theory is presented as true or as *the* alternative to dominant evolutionary theory. A decision not to teach evolution is also religious, because religious views are the only likely basis for exclusion.

Harder questions are raised by how a school treats perspectives that compete with scientific ones. Science teachers should note that not everyone accepts science as a more reliable source of truth than religious authority, but serious development of competing perspectives should be reserved for history courses or courses in culture or comparative religion (for the few schools that offer these).

The central principle of constitutional law for this subject is that public schools should not teach the truth or falsity of religious propositions. Judicial application of this principle leaves educators considerable latitude about how to treat the development of life and other scientific subjects, but Supreme Court decisions and constitutional analysis suggest that what I have indicated counts as religious teaching is out of bounds.

## II. EVOLUTION AND CREATIONISM: THE BASIC CONFLICT

Although not the first scientist to suggest the idea of evolution, Charles Darwin, in his 1859 *On the Origin of Species*, "was the first thinker to amass together, in one systematic volume . . . all the evidences from various scientific fields of study relevant to this topic."<sup>1</sup> The central thesis of evolution, Philip Kitcher has written, "is that species are not fixed and immutable. One kind of organism can have descendants that belong to a different kind. From one original species, a number of different kinds may be generated."<sup>2</sup> Darwin's main explanation for this evolutionary descent with modification contrasted with the earlier theory of Chevalier de Lamarck, who assumed that animals developed progressively as members of one generation passed on adjustments they had made during their lives to future generations; the illustration most commonly offered has been giraffes, who stretch their necks to eat foliage, giving birth to longer-necked offspring.<sup>3</sup> Although maintaining a place for Lamarckian-type

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1. JEFFRIE MURPHY, *EVOLUTION, MORALITY, AND THE MEANING OF LIFE* 47 (1982). According to Dorothy Nelkin, the primary contribution of *The Origin of Species* was "to organize and synthesize a set of ideas that had pervaded the scientific literature for more than fifty years." DOROTHY NELKIN, *THE CREATION CONTROVERSY* 25 (1982).

2. PHILIP KITCHER, *ABUSING SCIENCE: THE CASE AGAINST CREATIONISM* 7 (1982); see also ROBERT T. PENNOCK, *TOWER OF BABEL* 55 (1999) (noting that in one generic sense evolution means "change over time," but that Darwin meant by evolution "descent with modification").

3. EDWARD J. LARSON, *SUMMER FOR THE GODS: THE SCOPES TRIAL AND AMERICA'S CONTINUING DEBATE OVER SCIENCE* 14 (1997). However, according to Gordon Rattray Taylor, Lamarck did not write about the necks of giraffes; and, in fact, giraffes need long necks mainly to reach the ground (given their long

adjustments,<sup>4</sup> Darwin suggested that the leading engine of development was a process of natural selection, according to which characteristics that individual animals and plants possessed from their beginnings did or did not continue into subsequent generations according to their survival value.<sup>5</sup> Organisms better fitted for survival in their environments were more successful in generating offspring with their characteristics than were organisms poorly fitted for survival.

Darwin's own approach has been filled out and modified, but prevailing ideas fall within the general frame of Darwinian evolutionary theory and are referred to as a neo-Darwinian synthesis.<sup>6</sup>

Modern scientists place the age of the earth at somewhere between 4.2 and 4.8 billion years. Life appeared after roughly a billion years, and for the next two billion years and more, all life-forms were single-celled organisms, such as bacteria and algae.<sup>7</sup> Not until the last billion years did these single-cell life-forms develop into all the complex plants and animals that have populated Earth.

Genetic theory has supported Darwin's idea of natural selection.<sup>8</sup> Changes in organisms over generations occur both because of recombinations of genetic characteristics<sup>9</sup> and mutations (alterations in the molecular structure and arrangement of genes).<sup>10</sup> Diversity among similar species is largely explained by reproductive isolation; thus animals in Australia differ from those in other places in the world. Natural selection, the survival of changes that better suit their carriers to survive, accounts for at least a substantial amount of evolutionary development. Modern evolutionists disagree about just how much natural selection explains; "neutralists" contend against "selectionists" that chance—what is termed "genetic drift"—accounts for more

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legs), not to eat foliage. GORDON RATTRAY TAYLOR, *THE GREAT EVOLUTION MYSTERY* 38–42 (1983).

4. LARSON, *supra* note 3, at 16.

5. Although Darwin's account covers both plants and animals, I shall largely restrict myself to animals. See NELKIN, *supra* note 1, at 26.

6. KITCHER, *supra* note 2, at 17.

7. See John Horgan, *Life Against the Odds*, UNESCO COURIER, May 2001, at [http://www.unesco.org/courier/2001\\_05/uk/doss21.htm](http://www.unesco.org/courier/2001_05/uk/doss21.htm) (on file with the Notre Dame Journal of Law, Ethics & Public Policy).

8. KITCHER, *supra* note 2, at 16–21.

9. In a population in which half the people had two blue genes for eye color and half had two brown genes, the number of brown-eyed people would increase with intermarriages, because the brown-eye gene is dominant.

10. KITCHER, *supra* note 2, at 21, 55.

change than has commonly been recognized.<sup>11</sup> Scientists also disagree over Darwin's idea that evolutionary development was gradual. Some modern evolutionists have offered a punctuated-equilibrium model, according to which evolution is jerky rather than continuous—with periods of stability followed by ones of substantial change.<sup>12</sup> A few theorists claim further that not only the timing of evolution but also its mode differs from the gradualist account; major changes may occur from macromutations rather than from a succession of unnoticeable alterations.<sup>13</sup>

Darwin drew from various sources to support his theory.<sup>14</sup> Variation under domestication, that is, selective breeding by human beings, proved that species can be modified. The remarkable similarity of embryos of various species, and the similarities in the anatomy of widely variant species, such as lizards and human beings, suggested derivation from common ancestors. Fossils showed that species developed from simpler to more complex. Finally, variations in species in isolated locales, such as the Galápagos Islands, indicated evolution from ancestors that were common to those species and to related species found elsewhere.

The support of these sources for evolutionary theory has been bolstered by more recent discoveries. Molecules of closely related species have DNAs that are nearly identical in chemical composition and sequence.<sup>15</sup> Astronomical physics and the use of radioactive isotopes to date rock fragments show the earth is billions of years old. Although the fossil record has yielded rela-

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11. *Id.* at 26–27.

12. See N. ELDRIDGE, *TIME FRAMES: THE RETHINKING OF DARWINIAN EVOLUTION AND THE THEORY OF PUNCTUATED EQUILIBRIA* (1985); Stephen Jay Gould, *The Meaning of Punctuated Equilibrium, and Its Role in Validating a Hierarchical Approach to Macroevolution*, in *PERSPECTIVES OF EVOLUTION* 83–104 (R. Milkman ed., 1982). Richard Dawkins suggests that the difference between a standard neo-Darwinian view and the theory of punctuated equilibrium is slight. RICHARD DAWKINS, *THE BLIND WATCHMAKER* 223–52 (1987); see also KENNETH R. MILLER, *FINDING DARWIN'S GOD* 111–15 (1999) (“The driving force behind punctuated equilibrium was an attempt to enhance the novelty and importance of a relatively modest observation about the fossil record” that was not really at odds with what Darwin himself said.). H. Allen Orr describes changes in Stephen Jay Gould's account of punctuated equilibrium and notes the theory's decline in the 1990's. H. ALLEN ORR, *A Critic at Large: The Descent of Gould*, *NEW YORKER*, Sept. 9, 2002, at 132.

13. KITCHER, *supra* note 2, at 148–49.

14. MURPHY, *supra* note 1, at 47–50.

15. See generally Ernan McMullin, *Plantinga's Defense of Special Creation*, in *INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS: PHILOSOPHICAL, THEOLOGICAL, AND SCIENTIFIC PERSPECTIVES* 178 (Robert T. Pennock ed., 2001) [hereinafter *INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS*].

tively few species intermediate between earlier and later species, it clearly reveals that more complex life-forms followed simpler ones. Studies of existing species prove that over time animals can change characteristics to fit their environments better. In perhaps the best-known, but now controversial example, the great majority of peppered moths became darker, and thus less conspicuous to predators, where pollution had darkened the trunks of trees.<sup>16</sup> As Philip Kitcher puts it, “[o]rthodox neo-Darwinians believe that these modifications are the stuff of which large-scale evolution is made.”<sup>17</sup>

Darwin’s theory understandably disturbed many traditional Christians. It seemed to remove human beings from their exalted status in God’s plan of creation. According to Genesis, God created man (and woman) in His own likeness and with dominion over the animals. If God created human beings to rule the earth, one could easily assume that they have rational and moral capacities qualitatively different from those of other animals. According to evolutionary theory, the development of human life can be explained without reference to God’s creative hand; and if human beings are one link in a long continuous chain, no vast gulf may separate their qualities from those of similar animals.<sup>18</sup> Yet superior species may be in the offing if we do not manage to destroy life on Earth.

The deterministic quality of Darwinian evolution and its dependence on random mutations have also troubled those who believe that life is part of God’s plan and that human beings can achieve their own true good by responding to that plan. Ever since Darwin wrote, many religious people have regarded his theory as threatening the grounds of religious belief and of morality, though the precise objections have varied and their intensity has waxed and waned.<sup>19</sup> Those who search for an alternative scien-

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16. KITCHER, *supra* note 2, at 25. Critics have disputed the reliability of claims about peppered moths. See JONATHAN WELLS, *ICONS OF EVOLUTION—SCIENCE OR MYTH? WHY MUCH OF WHAT WE TEACH ABOUT EVOLUTION IS WRONG* 137–57 (2000), for a chapter debunking the “myth” of the peppered moth, whose evidentiary role in respect to evolution survived a close examination by Michael Majerus. MICHAEL E. N. MAJERUS, *MELANISM: EVOLUTION IN ACTION* 97–156 (1998); see also JUDITH HOOPER, *OF MOTHS AND MEN: AN EVOLUTIONARY TALE* (2002) (providing a narrative of events). The principle that natural selection can work changes *within* species is not doubted by most creationists.

17. KITCHER, *supra* note 2, at 26.

18. See PENNOCK, *supra* note 2, at 43–45.

19. See, e.g., LARSON, *supra* note 3, at 22–27; CHRISTOPHER P. TOUMEY, *GOD’S OWN SCIENTISTS: CREATIONISTS IN A SECULAR WORLD* 31–146 (1994). According to Toumey, from the early twentieth century to the latter part, the

tific theory have been largely motivated by their distress over the religious and moral implications of Darwinism.

Evolutionary theory conflicts with a literal reading of Genesis, according to which God created other animals and human beings within a span of days.<sup>20</sup> And if one uses the Bible to mark the earth's age, taking the days of creation as days of ordinary length, one would arrive at roughly 6,000 to 10,000 years.<sup>21</sup> Modern "creation scientists" reject prevailing Darwinian understandings to a far greater degree than did Darwin's early opponents.<sup>22</sup> A popular modern view, set out in a 1961 book called *The Genesis Flood*, attributes geological evidence to Noah's flood and claims that physical processes have not been uniform over time.<sup>23</sup> Creationists believe that God created all the basic "kinds" of animals at the same time. Whatever evolution has occurred is within kinds, not from one kind to another. Although the notion of "kinds" is imprecise, cats are not of the same kind as dogs, and human beings are not of the same kind as apes.<sup>24</sup> The fossils of simpler organisms tend to appear in lower strata of rocks because these creatures were less able to escape from the waters of Noah's flood that engulfed the earth. At the time of the great flood, the

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basic moral complaint about evolution has shifted from fear of determinism to fear of randomness. *Id.* at 49.

20. In the passages with which Genesis begins, *Genesis* 1:1–31, God created plant life on the third day, bird and water life on the fifth day, and land animals and human beings on the sixth day. (*Genesis* 2:4–24 also contains an account of creation, one that is variously interpreted as a separate creation story or as supplementing the first account.) Robert Pennock notes that many creationists accept the idea that the days of the creation represent ages. PENNOCK, *supra* note 2, at 15–16.

21. In *McLean v. Ark. Bd. of Educ.*, 529 F. Supp. 1255, 1268 (E.D. Ark. 1982), Judge Overton said that "creationist writings . . . place the age [of the earth] at between 6,000 and 20,000 years . . ."

22. Most earlier opponents acknowledged the ancient age of the earth and were concerned mainly to claim that human beings had not evolved from inferior species. STEVEN GOLDBERG, *SEDUCED BY SCIENCE: HOW AMERICAN RELIGION HAS LOST ITS WAY* 26–30 (1999). Among those taking this more moderate view was William Jennings Bryan, whose opposition to evolution spurred the Tennessee law under challenge in the Scopes case. See generally LARSON, *supra* note 3.

23. JOHN C. WHITCOMB, JR., & HENRY M. MORRIS, *THE GENESIS FLOOD* (1961); see GOLDBERG, *supra* note 22, at 30–32; TOUMEY, *supra* note 19, at 31–35. The basic idea of "flood geology" had been set out earlier in George McCready Price's *The New Geology*, published in 1923.

24. If separate species are understood to refer to categories of animals that cannot interbreed, many closely related animals are separate species. Creationists do not deny that one species, *in this sense*, could evolve into another species.



nature of physical processes changed to such an extent that modern techniques of dating rocks, etc., are wholly unreliable.

What evidence supports the creationist story? For the most part, the argument is that the theory of evolution is unconvincing. Creationism wins by default, because evolution and creationism are the only plausible explanations for the development of species. But positive evidence has been claimed. Notably, some creationists have asserted that the bedrock along the Paluxy River in Texas contains fossils of human beings alongside those of dinosaurs, who became extinct long before human beings appeared on the scene, according to evolutionary theory. (The particular claim about Paluxy River fossils has been substantially discredited.)<sup>25</sup>

One can find Darwinian evolutionary theory unconvincing as a complete explanation of life's development without claiming that science supports the literal reading of Genesis. What proponents have called "intelligent design"<sup>26</sup> is one such theory. Although the views of these theorists are far from uniform, they reject much less of the dominant scientific understanding than does standard creationism and they make far fewer claims about the details of what happened.<sup>27</sup> The theory has been said to involve two basic assumptions: intelligent causes exist, and they can be detected empirically (by discerning specified complexity).<sup>28</sup> Although intelligent design claims are reasonably understood as falling within a wider ambit of creationist approaches, I shall refer in this article to "intelligent design theory" to avoid any confusion with Genesis creationism. I shall also concentrate

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25. According to one recent summary, "[t]oday most 'scientific' creationists hedge or disavow the claim that dinosaurs and humans coexisted on the Paluxy. This is because scientists have shown that the putative human tracks were made by dinosaurs or were hoaxed." Rich Fox, *Debunking the Paluxy River Claims*, at <http://www.usd.edu/anth/cultarch/paluxybib.html> (presenting a list of references, both creationist and noncreationist, compiled by Paul V. Heinrich) (Mar. 4, 1996) (on file with the Notre Dame Journal of Law, Ethics & Public Policy). Robert Pennock provides a summary of events and also rebuts positive creationist evidence based on the scarcity of moon dust and on human population growth. PENNOCK, *supra* note 2, at 216–26.

26. See generally INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15.

27. They may actually *accept* major theses about evolution or may not commit themselves one way or another. Someone might refuse to commit himself because he is in genuine doubt or because he does not want to lose allies who would support a more generic creationist position.

28. See Access Research Network, *Frequently Asked Questions About Intelligent Design*, at [http://www.arn.org/id\\_faqs.htm](http://www.arn.org/id_faqs.htm) (2003) (on file with the Notre Dame Journal of Law, Ethics & Public Policy).

on the theory in its most modest form, because this is the form that has the most plausibility from a scientific point of view.<sup>29</sup>

### III. PUBLIC SCHOOL TEACHING ABOUT THE DEVELOPMENT OF LIFE

Many Christian Fundamentalists, accepting the literal truth of the Bible, have opposed the teaching of evolution as true in public schools.<sup>30</sup> Believing that evolutionary theory conflicts with God's revealed truth and that it is an atheist idea that undermines both religious faith and morality, they have tried to purge evolution from the curriculum, to have it balanced by "creation science," or to have it labeled as "only a theory."

During the past century, a few states adopted laws forbidding the teaching of evolution, one of which the Tennessee Supreme Court sustained in 1925 when it reviewed a teacher's conviction in the famous Scopes trial (the "Monkey Trial").<sup>31</sup> Of more practical importance was successful opposition to textbooks containing evolutionary theory, up through the 1950s.<sup>32</sup> Because publishers seek uncontroversial books that will sell in major markets, a determined minority can affect the content of texts. Conservative Christians lobbying for "acceptable" books have had an influence far beyond their numbers in states, most notably Texas and California, where texts are approved by a central state authority. Before 1960, high-school biology texts gave much less prominence to evolutionary theory than it enjoyed in the field of biology itself.

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29. That is, the more a theorist rejects about dominant evolutionary theory and the more he asserts about how divine intelligence created, the more difficult it becomes to render the claims plausible on the basis of naturalistic evidence.

30. The term "Fundamentalist" is drawn from a series of essays published from 1905 to 1915 called *The Fundamentals* which were opposed to modernism in religion. Some, but not all, of the early essays were conciliatory toward the scientific theory of evolution. See LARSON, *supra* note 3, at 20. The label "Fundamentalist" is itself now somewhat controversial, and critics use it more frequently than do the people whose views fall within the designation. But terms such as Conservative Christian or Evangelical Christian are less precise for our purposes, because many people within those designations do not accept biblical literalism. Robert Pennock remarks that many creationists "disavow the Fundamentalist label," and that many evangelicals believe in "biblical inerrancy." PENNOCK, *supra* note 2, at 8.

31. A perceptive and readable account of the trial and its significance is in LARSON, *supra* note 3.

32. NELKIN, *supra* note 1, at 33, writes, "A scholarly survey of the content of biology texts up to 1960 found the influence of anti-evolutionist sentiment to be persistent, if undramatic, and showed that the teaching of evolution actually declined after 1925."

After the Soviet Union's launch of Sputnik in 1957, the first rocket to circle the earth, government officials, concerned with the quality of science education, helped finance new series of science texts, including biology texts that treated evolution more fully.<sup>33</sup>

In 1968, in *Epperson v. Arkansas*,<sup>34</sup> the Supreme Court held invalid a statute that forbade teaching of the theory that mankind descended from a lower order of animals. Justice Fortas wrote that a state cannot require that teaching be tailored to the principles of any religious dogma; the Arkansas law proscribed teaching part of a body of knowledge "for the sole reason that it is deemed to conflict with . . . a particular interpretation of the Book of Genesis . . . ."<sup>35</sup>

*Epperson* set the stage for the modern conflict over evolution and creationism. Rather than aiming directly to block all mention of evolution, creationists have sought to have evolution downplayed, treated as only unconfirmed theory, not truth, and "balanced" by teaching of creationism, so that students can "make up their own minds." Finally, and importantly, many creationists have argued that creationism itself can have the status of science, "scientific creationism" or "creation science."

Creationists were successful in having Arkansas and Louisiana adopt Balanced Treatment Acts. The Arkansas law required schools to present both evolution and creation science; the Louisiana law declared that they should present both or neither. Five years after a district court rejected the Arkansas act<sup>36</sup> the Supreme Court held Louisiana's statute unconstitutional in *Edwards v. Aguillard*,<sup>37</sup> concluding that the legislature had a forbidden aim to advance religion. The Court has not explicitly ruled that all decisions by school boards or teachers to present scientific creationism are necessarily unconstitutional. A poll taken two decades ago indicated that, when asked, roughly three-fourths of American respondents said that both evolution and creationism should be taught in schools.<sup>38</sup>

In 1999, the Kansas State Board of Education took a different tack, one it rescinded less than two years later. It removed evolution (and the Big Bang theory) from its 71-page science cur-

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33. *Id.* at 39-53.

34. 393 U.S. 97 (1968).

35. *Id.* at 103.

36. *McLean v. Ark. Bd. of Educ.*, 529 F.Supp. 1255 (E.D. Ark. 1982).

37. 482 U.S. 578, 596-97 (1987).

38. NELKIN, *supra* note 1, at 145-46.

riculum.<sup>39</sup> Although local school districts were free to teach evolution, the subject was not included in statewide tests for evaluating students. Stephen Jay Gould, the late preeminent geologist, remarked caustically that the new standards provided “a virtual guarantee, given the realities of education, that this central concept of biology will be diluted or eliminated, thus reducing courses to something like chemistry without the periodic table, or American history without Lincoln.”<sup>40</sup>

#### IV. BASIC QUESTIONS

Between literal-Genesis creationism and dominant evolutionary theory, science provides a decisive verdict for evolution.<sup>41</sup> Even were these the only two alternatives, we would face educational questions about what public schools should teach students concerning perspectives that reject dominant scientific theories: Do these belong in science courses or elsewhere in the curriculum, or are they not the business of public education?

Crucial constitutional questions would stand in the wings: If the main reasons *for* teaching creationism or *for* not teaching evolution are religious, does that render either decision unconstitutional? Can religious reasons permissibly play a role in educational choices? What is the constitutional consequence if legislators (or educators) are persuaded, unjustifiably, that creationism is plausible scientifically? These particular constitutional questions raise a more general inquiry about judicial responsibilities: How far should courts leave curricular choices to educational authorities, rather than ruling that their choices trespass on the religion clauses of the First Amendment?

These questions hold substantial interest, but the gulf between Genesis creationism and dominant evolutionary theory conceals yet more perplexing issues. Suppose that educators are attracted by the more modest theory of intelligent design. Accepting major aspects of dominant evolutionary theory, they doubt that it completely explains the development of complex forms of life, further doubt that any natural scientific account

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39. See Steve Benen, *Evolution Evasion*, CHURCH & STATE, Oct. 1999, available at <http://www.au.org/churchstate/cs10991/htm> (on file with the Notre Dame Journal of Law, Ethics & Public Policy). For the Board's reversal, after a change in membership, see Kate Beem, *Emphasis on Evolution Adopted by Kansas Board*, KAN. CITY STAR, Feb. 15, 2001, at A1.

40. Stephen Jay Gould, *Dorothy, It's Really Oz*, TIME, Aug. 23, 1999, at 59.

41. This reflects my assessment, based both on what scientists believe and on my limited acquaintance with competing claims. The reader should be fully aware that I have not acquired competence to judge all that is scientifically relevant.

could ever do so, and conclude that a full explanation may include an input of "intelligent design" that is not subject to ordinary scientific explanation.

Does such a version of "intelligent design" represent a plausible assessment of the limits both of dominant evolutionary theory *and* of ordinary scientific explanation? Does that claim belong in a science course, or is it disqualified because it contains (or loosely implies) a religious conclusion or because it fails to meet the requisites of scientific theory? What exactly *is* science, and what belongs in a science course? Does intelligent design belong somewhere in the curriculum, if not in science courses?

When we turn to constitutional analysis, the issue about what is science turns into the question of whether "intelligent design" is a religious theory. If so, should it not be taught because doing so would establish a religion, or need (or may) it be taught, for reasons of fairness and balance, because dominant evolutionary theory contradicts widely held religious premises and may itself be religious?

Examination of these questions proves to have much broader application for thought about the uncertain boundaries of science and religion. The challenge to evolution provides the most striking modern illustration, but similar conflicts with respect to other branches of science could arise in the future, as they have in the past. I approach the narrower topics of this article via broader theoretical analysis and comparison. One reason for this is to provide a perspective liberated from the hot controversy about evolution and creationism. A second reason is that the article's major contribution lies exactly in this broader analysis, which not only assists resolution of what schools should teach about life's development, but also reaches other potential conflicts involving science and religion.

## V. SCIENCE, RELIGION, AND TRUTH

Five fundamental premises, in combination, generate the most troubling questions about science, religion, and the public schools. (1) Schools should not teach the truth of religious propositions. (2) For many people, the domains of science and religion overlap significantly. (3) Anyone's assessment of what is true, overall, will include an evaluation of all relevant sources of truth, including any religious sources he or she credits. (4) Modern science is committed to methodological naturalism. (5) Scientific conclusions can bear on the likely truth of religious propositions. An exploration of these premises helps us grasp

what public schools should teach about evolution and the alternatives of creationism and intelligent design.

### A. *Public School Teaching and Religious Propositions*

The Supreme Court has made evident that public schools may not teach particular religious doctrines as true or as false. A high-school text or teacher should not teach as the official truth that Jesus was God incarnate or that the doctrine of the Trinity is seriously misguided.<sup>42</sup> This article is not the occasion to defend this aspect of the Supreme Court's establishment jurisprudence against critics who would have the Establishment Clause interpreted much less expansively. (These critics may take my constitutional analysis as developing implications of a prevailing doctrine they would like the Court to abandon.)

If a teacher's only basis for believing a claim is religious, her assertion of it amounts to a teaching of religion, even though the claim does not involve any explicit religious proposition. Thus, if she says, "The earth is exactly 6,000 years old," and her belief is based solely on the words of the Bible, her assertion is religious.<sup>43</sup>

Public schools inevitably do teach as sound certain factual propositions and moral and political principles that conflict with the doctrines of particular religions. Students learn that the earth is round, although a few religious sects still believe it is flat. More important, teachers say that men and women of all races should have equal opportunity, even though some religions teach sharp gender differentiation or racial hierarchy. If the bases for teaching facts or values do not lie primarily in religious premises, teaching them does not become religious simply because they conflict with some religious convictions.<sup>44</sup>

This rule against teaching religion turns curricular choices that involve religion into constitutional issues to a much greater degree than is true for any other subject.<sup>45</sup> The historical explanation for this special treatment lies in the divisiveness of relig-

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42. How much a teacher may *reveal* her own personal beliefs is an issue I pass over here.

43. Someone might claim that the Bible is a source of historical truth, whatever its religious status. And, indeed, so viewed, the Bible does support the assertion that Israel had a king named David. But the Bible obviously does not have that authority about the moment of the earth's creation.

44. I deal with these issues at somewhat greater length in an article entitled *Teaching About Religion*, 19 J.L. & POL. (forthcoming Spring 2003).

45. Schools can take positions on many ideological issues, teaching that liberal democracy is preferable to monarchy, for example; but their adoption of certain political positions, say, supporting the Republican Party, would violate the Free Speech Clause or the Constitution as a whole.

ion in Western Europe and the American colonies; the modern justification rests in the desirability for both religion and government of the state's staying out of the business of teaching religion.

A corollary of the rule that schools may not teach religious propositions (although they may teach facts and values that conflict with some religious beliefs) is that educators and courts must be ready to decide what count as religious propositions and what it is to teach them. Nothing I say in this article is meant to suggest that the answer to these questions will necessarily be simple or that bright lines mark which propositions are religious; nonetheless a division must be made for constitutional purposes.

### B. *Domains of Science and Religion*

How, if at all, do science and religion intersect? How far are religious claims compatible with what science asserts about physical reality?

Some people believe that the domains of religion and science do not overlap, that—as Stephen Jay Gould has put it—they have “nonoverlapping magisteria,” science dealing with facts about the world, religion concerning itself with matters of the spirit and morality.<sup>46</sup> Few religious believers will be found within the category of people who suppose that the domains have *no* overlap. Religions typically include perspectives on human nature that could coincide or conflict with what social scientists assert. The idea that *natural science* does not overlap the domain of religion is more widely appealing,<sup>47</sup> but many religious believers think that a persuasive religious account of ultimate reality bears on subjects to which natural science speaks.

Even if science and religion address subject matters that overlap, we might escape any conflicts if science and religion are separate discourses, having no relation to each other, *or* if what a religion asserts is compatible with what science discovers.

The “separate discourses” approach founders on the reality that scientists and religious believers both care about what is really true, overall. Scientists often aspire to do more than offer

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46. STEPHEN JAY GOULD, *ROCKS OF AGES: SCIENCE AND RELIGION IN THE FULLNESS OF LIFE* (2001) [hereinafter *ROCKS OF AGES*]; Stephen Jay Gould, *Nonoverlapping Magisteria*, in *INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS*, *supra* note 15, at 737–49. Theorists differ about how exactly to characterize the two domains.

47. McMullin, *supra* note 15, at 173, has suggested that the biblical story requires certain suppositions about human nature, freedom, and moral responsibility, but that the domain of conflict between religion and science is limited.

theories that fit scientific criteria well.<sup>48</sup> Whatever the status of theories about unobservable quarks, evolutionists make claims about aspects of reality—about a series of events in the history of the earth.<sup>49</sup> A scientific assertion that the earth is over four billion years old is *like* the assertion that I am more than sixty-five years old. No one is foolish enough to claim that modern science is the *only* source of truth, and it is controversial whether scientific explanations could *conceivably* account for all of truth; but much of science, including evolutionary theory, does make claims about reality.

What about religious believers? Some may take accounts of physical reality and history in authoritative religious sources as mythic and symbolic, on a plane of truth that varies from that of science—this indeed is a version of the nonoverlapping domains theory—but many religious persons take these accounts more literally. Most notably for this article, fundamentalists who believe in the literal truth of Genesis have a view about how life *really* developed that conflicts with evolutionary theory.

Although one cannot dismiss the possibility of a conflict between scientific and religious perspectives, four understandings common among traditional religions may be compatible with scientific views. Two ways in which a Divine Creator might relate to physical events do not pose any conflict. The first is that a Creator created original matter and set things in motion according to scientific laws that the Creator established. The second is that the Creator continues to sustain the universe and life within it, even when things run wholly in accord with scientific principles.<sup>50</sup> Were the Creator to abandon the universe, scientific principles would cease to operate and life would end.

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48. Dorothy Nelkin has written, "Scientists accept theories and teach them, not because they represent 'truth,' but because they are accepted by the scientific community as useful explanations of reality." NELKIN, *supra* note 1, at 186.

49. Philip Kitcher, in *Science, Truth, and Democracy*, provides a persuasive defense of scientific realism. PHILIP KITCHER, *SCIENCE, TRUTH, AND DEMOCRACY* 11–82 (2001). Heinz Pagels, in *The Cosmic Code*, wrote, "One could debate the existential status of quarks for a long time." HEINZ PAGELS, *THE COSMIC CODE* 232 (1982).

50. These two possibilities may be viewed as aspects of traditional Christian faith. According to some passages in the antievolution literature, belief in these two aspects of divine control might be sufficient to qualify one as a creationist. Phillip Johnson, for example, in *DARWIN ON TRIAL* 113 (1991), says, "In the broadest sense, a 'creationist' is simply a person who believes that the world (and especially mankind) was *designed*, and exists for a *purpose*." One could believe this and also believe that life's development has occurred as neo-Darwinian theory asserts. I am considering as creationist and intelligent design



Each of these two possibilities could be realized despite the universal operation of scientific principles. Further, science cannot tell us whether either of these possibilities *is* realized.<sup>51</sup> It cannot explain how everything got started—it can tell us that a Big Bang began the universe, perhaps it can tell us why the Big Bang occurred, but it cannot tell us why there was any physical matter to be the subject of the Big Bang.<sup>52</sup> Similarly, science cannot tell us whether everything we perceive is sustained by a Creative Spirit.

The relation between two other common religious ideas and the findings of science is less straightforward. I mention them here to put them aside for the remainder of this article. Many religious people believe in a personal afterlife or reincarnation. No existing *scientific* principles directly support these beliefs, and many skeptics think that what science does establish suggests strongly that death is the end of personal existence. But science cannot rule out the possibility of an afterlife, and it is *conceivable* that in a distant time, human beings will come to understand a novel set of scientific principles that could explain stages of living.

Another widely held conviction is that a Divine Spirit inspires human understanding and behavior. Many people believe that God's grace leads them to grasp religious truths and act accordingly. As of now, scientific principles cannot explain every aspect of individual human behavior. Generalizations yield predictions about ranges of beliefs and actions among categories of people; but rarely can anyone predict with great confidence

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theories only those claims that to some degree, at least, conflict with a neo-Darwinian account.

51. It *might* be said that claims about these two possibilities are meaningless, because they are not subject to empirical investigation. By definition, I have said that they are not subject to *scientific* investigation. But their realization *is conceivable*, and we might imagine confirmation in some kind of an afterlife in which personalities are able to grasp things beyond what human beings on earth can perceive. More to the point, insofar as people now have a basis to assess claims of religious truth, these claims about a Creative Spirit might fit with a persuasive account of God's nature.

52. Conceivably, scientists might eventually be able to explain how original matter was formed (see PAGELS, *supra* note 49, at 278, for the possibility that "the universe itself sprang into existence out of nothingness—a gigantic vacuum fluctuation"); but I believe that at some point scientific explanations must stop. Of course, a standard religious explanation suffers the same defect, in a sense. It cannot tell us *why* there has been a Divine Creator. But this religious explanation does seem to reach one step further back than can any scientific explanation. And *this* reaching further back provides an assurance about the significance of their own lives for many religious persons.

just how a single person will behave;<sup>53</sup> when such a prediction is feasible, it usually reaches beyond ordinary scientific generalizations to personal insights not easily reduced to scientific laws. This limitation may flow from our comparative ignorance; perhaps a *full* understanding of how minute particles move would tell us whether a particular man will undergo a conversion experience or become more generous or greedy as he ages. All I want to claim here is that *if* a realm of individual choice and response is not subject, even in theory, to a scientific explanation, then belief that a Creator influences individual behavior to this degree raises no potential conflict with scientific principles.<sup>54</sup>

### C. *All Sources of Truth*

A person who believes that various sources of truth point in different directions must evaluate all these sources to decide where the truth probably lies. Almost no one denies that scientific investigation is *a* source of truth, so few will reject all scientific conclusions as without force. Numbers of people, including many scientists, do not believe in religious sources of truth;<sup>55</sup> they will not consult any religious sources to decide what is true.<sup>56</sup> But many people believe that scientific and religious sources both provide insights into truth and that the two domains overlap.<sup>57</sup> What is such a person to believe when science, taken alone, marks as most likely a reality different from what religious sources she credits, taken alone, suggest?

Part of the ethos of science is that particular conclusions and general theories are revisable in light of increases in evidence and scientific understanding. Radical revisions have occurred in the past, and presently dominant theories are continually qualified. No one can believe that exactly the scientific theories now prevailing are the final word of science. Still, certain conclusions

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53. I do not speak here about a person's immediate reaction if his fingers touch a hot frying pan. Certain human responses to direct physical stimuli are virtually universal.

54. Needless to say, the person who thinks that science, at least in theory, *can* explain all human actions cannot also concede that a Creator could influence belief and action in a manner that is inexplicable according to science.

55. Kenneth Miller says that over years of teaching in science he has "come to realize that a presumption of atheism or agnosticism is universal in academic life." MILLER, *supra* note 12, at 19.

56. I put aside their possible belief that atheism is true. Atheism, taken alone, does not produce positive ideas about how the physical world operates.

57. These people typically believe that perfect scientific and perfect religious understanding will coincide—that is, they do not think that God has created the natural world in a way to deceive our natural reason and test our faith—but that present understandings are fallible.

are so powerfully confirmed, their abandonment is extremely unlikely. Hundreds of years ago, people did not realize that the earth is round and that the blood of mammals circulates from the heart. The scientific evidence for both these propositions is overwhelming. That scientists will one day discover that the earth is really flat or that our blood does not circulate is nearly inconceivable. Part of the job of evaluating the weight to give to a scientific conclusion is assessing its degree of confirmation.

Ideas of error and revisability in religion are a bit more complicated. One may think that an authoritative source, such as the Bible or church teachings, is itself in error, or that those interpreting the source may err. Alvin Plantinga, a prominent philosopher of religion and evangelical Protestant, has suggested that the difficulty for Christians is discerning what message the Lord is conveying in Scripture: "Scripture is inerrant: the Lord makes no mistakes; what he proposes for our belief is what we ought to believe. Sadly enough, however, our grasp of what he proposes to teach is fallible."<sup>58</sup> One basis for rethinking what Scripture conveys is whether existing interpretations conflict with well-established conclusions of science. Nicholas Wolterstorff has talked more broadly of an "authentic Christian commitment"; Christians have frequently revised their understanding of the beliefs that such a commitment involves on the basis of accepted scientific theories.<sup>59</sup>

We need to imagine a person who concludes that sound religion and the best science suggest different conclusions about a subject. Her review of competing conclusions, to see if they seem valid on their own premises,<sup>60</sup> has not resolved the conflict, and she wants to do more than suspend judgment. She has to evaluate what seems most likely to be the truth overall—the scientific conclusion or the religious one or some compromise between them.<sup>61</sup> Much will depend on the clarity and confidence with which science or religion speaks. Many people will not credit a religious conclusion that conflicts directly with a

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58. Alvin Plantinga, *When Faith and Reason Clash: Evolution and the Bible*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 119.

59. NICHOLAS WOLTERSTORFF, REASON WITHIN THE BOUNDS OF RELIGION 77, 88–90 (1976). Thus, Christians once thought that their religious commitment entailed belief that the earth is the center of physical existence. They do no longer.

60. If an initial religious conclusion is based on Scripture, for example, a person might decide that Scripture should be read differently from some prevailing view.

61. Plantinga, *supra* note 58, at 117–22.

powerful scientific one, such as the roundness of the earth.<sup>62</sup> But if the evidence for the scientific conclusion is uncertain or weak, or full of gaps, though nonetheless the best that science can now do, and if the religious reasons for the competing conclusion are very strong, a person may well adhere to the religious view, believing that science will eventually revise its position. Inevitably, people who take seriously both religious and scientific understandings *and* think they can conflict over certain domains will *sometimes*, in their overall search for truth, credit a powerful religious conviction over a weakly supported and tentative scientific conclusion.

The attitudes of some religious critics of evolutionary theory are illustrative.<sup>63</sup> They believe that if one gave no credence to the existence of a Divine Creator, the neo-Darwinian explanation, as uncertain as it may be, would be the best we could do to explain the origins of life. But when one considers a Divine Creator, another explanation, involving God's creative action, seems much more likely.

For a person who believes that science and religion are both sources of truth,<sup>64</sup> the probability that a scientific conclusion is, overall, true may depend partly on what one thinks is persuasive from a religious perspective. At its most obvious, this reality is played out in strong religious arguments that evolutionary theory conflicts with the Genesis account or is otherwise at odds with how a Divine Creator would act. Such arguments are countered by religious arguments that a Creator would be likely to create a universe with "functional integrity," not intervening from time to time to violate its natural laws,<sup>65</sup> and that evolution, in all its contingency, fits well with a dynamic creation in which new life

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62. There is a certain asymmetry in how one regards the source that "loses out" in the final evaluation. If one thinks the scientific source is more reliable, one is likely to reinterpret the religious source not to assert seriously what science denies, e.g., that the earth is flat. If one credits the religious source, one may look at the competing science more skeptically, but one cannot simply produce a different scientific conclusion without the evidence on which science relies.

63. See Plantinga, *supra* note 58, 136–39.

64. Indeed, the conflict can arise even if one is not confident that religious sources are ever sound, so long as one thinks there is a substantial likelihood they are.

65. Howard J. Van Till, *When Faith and Reason Cooperate*, in *INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS*, *supra* note 15, at 158–59. I do not distinguish here between religious arguments and arguments of religious philosophy.

comes into being through natural processes and human beings enjoy true freedom.<sup>66</sup>

The examination of religious understanding also has more interesting twists. Evolutionary theorists from Darwin forward have employed an argument from imperfection. When we look at animals as they now are, we cannot imagine that this is how a Divine Creator, acting directly with each kind of animal, would have created them. Stephen Jay Gould has highlighted the panda's thumb, which is not like other digits in structure but which functions moderately well.<sup>67</sup> The explanation for its development must be the historical link of modern pandas with prior species, not the hand of God. Another author suggests that an even more powerful example is the laryngeal nerve in mammals, which is much longer than would be ideal and reaches a ridiculous length in giraffes.<sup>68</sup>

Why should we assume that a Divine Creator's standards for good design are ours? Of course, the Creator might be whimsical or malicious, or less than omnipotent, but perhaps evolutionists may reasonably take as their standard for comparison the idea of a benign, omnipotent Creator that has dominated Western religious thought. Even so, the creationist can answer that we may not know all the Creator's purposes, and apparent "imperfection" in one animal may somehow contribute to an overall perfection.<sup>69</sup> To this, the evolutionist may rejoin that unless we assume that the Creator's purposes are knowable to some degree, all religious arguments are doomed to failure; if we can discern such purposes, it is hard to understand why a Creator would choose to give mammals such an inefficiently long laryngeal nerve.<sup>70</sup>

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66. Arthur Peacocke, *Welcoming the "Disguised Friend"—Darwinism and Divinity*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 472–81; see also MILLER, *supra* note 12, at 270–75.

67. See Stephen Jay Gould, *The Panda's Thumb*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 669–76.

68. Kelly C. Smith, *Appealing to Ignorance Behind the Cloak of Ambiguity*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 724–25:

Consider the bizarre fact that, in mammals, the recurrent laryngeal nerve does not travel straight from the cranium to the larynx. Rather, it travels down the neck to the chest, where it loops around a pulmonary ligament and then travels back up the neck to the larynx. In animals like the giraffe, this can mean a twenty-foot length of nerve where twelve inches or so would suffice.

*Id.*

69. Paul A. Nelson, *The Role of Theology in Current Evolutionary Reasoning*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 688–89.

70. Smith, *supra* note 68, at 708–13, 723–24.

So the argument goes. What we can quickly grasp is that in this debate over the scientific theory of evolution, we are drawn deeply into theological and philosophical arguments about what a Divine Creator would or would not do if that Creator created individual kinds of animals directly, arguments that are not subject to scientific confirmation or disconfirmation. Such arguments are unavoidable, so long as our interest is in what is true overall, and scientific and religious conclusions are in potential competition; but they raise perplexities when we get to the subject matter of science courses and the teaching of religion.<sup>71</sup>

#### D. *Methodological Naturalism*

Thus far, I have implicitly assumed a central characteristic of modern science, that it is methodologically naturalist—approaching scientific problems on the assumption that physical events have natural causes and can be explained according to uniform laws that need not refer to any supernatural forces. Here are two formulations of this central idea. “The methodological naturalist is the person who assumes that the world runs according to unbroken law; . . . and that science involves just such understanding without any reference to extra or supernatural forces like God.”<sup>72</sup>

[W]hen it comes to unraveling scientific problems, most practicing scientists, regardless of their religious beliefs, refuse to invoke the existence of unknown supernatural forces—even in the absence of known naturalistic mechanisms. This suspended judgment is accompanied by the hope that human minds will eventually find a crack in the apparently impenetrable surface of the mystery.<sup>73</sup>

Methodological naturalism has thus far proven very productive; scientists have discovered natural explanations for countless phenomena not previously explicable according to scientific principles.<sup>74</sup>

71. I will conclude that *these* arguments may be presented, but should not be endorsed or delved into too deeply.

72. Michael Ruse, *Methodological Naturalism Under Attack*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 365.

73. Matthew J. Brauer & Daniel R. Brumbaugh, *Biology Remystified: The Scientific Claims of the New Creationists*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 325.

74. Ruse, *supra* note 72, at 377, writes that “in the past, the methodologically naturalist approach yielded fantastic dividends.” See also Robert T. Pennock, *Naturalism, Evidence, and Creationism: The Case of Phillip Johnson*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, 90–92.

Although it is sometimes suggested that most scientists are committed to a more far-reaching naturalism, one that denies the existence of any supernatural reality,<sup>75</sup> a modern scientist, as such, is committed only to methodological naturalism. She need not deny either that God sustains natural laws or that science may prove unable to explain some physical phenomena.

Science has not always been committed to methodological naturalism, and it conceivably could move away from that position in the future. Alvin Plantinga, among others, has argued that Christian scientists should abandon methodological naturalism in favor of "theistic science" or "Augustinian" science.<sup>76</sup> Others have rejected this proposal as unwise, both because it substitutes a science for Christians as contrasted with a science based on a shared, universal methodology,<sup>77</sup> and because it might abandon techniques of scientific investigation and empirical confirmation that have proven so valuable in the past.<sup>78</sup>

Just how radical is the proposal of "theistic science"? Were the suggestion only that scientists who are Christians should evaluate conclusions reached by methodological naturalism against their religious understandings before they make claims about what is true overall,<sup>79</sup> it would be relatively modest.<sup>80</sup> If the sug-

75. See Phillip E. Johnson, *Evolution as Dogma: The Establishment of Religion*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 72: "The problem with scientific naturalism as a worldview is that it takes a sound methodological premise of natural science and transforms it into a dogmatic statement about the nature of the universe." Pennock has criticized Johnson's failure clearly to distinguish methodological naturalism from ontological naturalism. Pennock, *supra* note 74, at 78–84.

76. Plantinga, *supra* note 58, at 139–41; Plantinga, *Methodological Naturalism?*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 355–56. See also Phillip Johnson's support of "theistic realism," in PHILLIP JOHNSON, *REASON IN THE BALANCE* 107 (1995), and Nicholas Wolterstorff's assertion in WOLTERSTORFF, *supra* note 59, at 77, that "one's authentic Christian commitment ought to function *internally* to scholarship."

77. McMullin, *supra* note 15, at 167–68. Pennock comments, "Such a balkanized science is at one with radical multiculturalists' calls for feminist science or Hispanic mathematics." PENNOCK, *supra* note 2, at 212.

78. See Ruse, *supra* note 72, at 377–78. At a panel discussion at the University of Virginia on April 10, 2002, it was suggested that science *requires* methodological naturalism, that whatever people in the future might call science, *we* should not acknowledge that anything that is not naturalist is really science. Evolution and Creationism, Science and Belief, Panel Discussion at the University of Virginia (Apr. 10, 2002).

79. In one place, Plantinga talks of scientists beginning with ordinary (Duhemian) science, with theists incorporating that science "into a fuller context" that includes their religious principles. Plantinga, *supra* note 76, at 355.

80. That most modern science is carried on jointly by many researchers, with different philosophical opinions, would pose a practical problem.

gestion included some reference by theists to their religious understandings when they choose research agendas, it would still be relatively modest. For example, a scientist who is a Christian could choose to investigate matters that might not yield to a naturalistic explanation, rather than filling in details of how natural selection produces viruses that resist antibiotics. But if “theistic science” were meant to include some different way of *doing* science, some significantly different mode of investigation and drawing conclusions, following the proposal would involve a crucial shift. Thus far, we have been given little concrete sense of what such a different approach might be; and it is doubtful whether many research programs developed in accord with it would prove as productive as those framed by methodological naturalists.

#### E. *Scientific Conclusions and the Truth of Religious Propositions*

Committed as it is to methodological naturalism, science may yield particular conclusions, and even theories, that bear on the truth of religious propositions. Most obviously, science may establish facts that are directly contrary to religious propositions. Thus, anyone who accepts the scientific view that the sun is at the center of our planetary system cannot also believe a religious proposition that God made the sun to circle the earth.

Scientific conclusions can threaten more fundamental religious propositions less directly. A number of prominent evolutionists have thought that the truth of evolution counts strongly against the possibility of a benign Creator.<sup>81</sup> We have reviewed the argument of imperfection against the possibility that God directly created all kinds of animals. But a related argument tells against the existence of *any* Divine Creator who is omnipotent and benign. Why would such a Creator have brought forth natural laws that produce imperfect life through the painful and arbitrary process of natural selection?

This question is, indeed, troubling for religious believers who accept the evolutionary story, but it is hardly novel. To any-

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81. Among the more notable arguments of this kind is that in DAWKINS, *supra* note 12. Given the complex machinery of life, Dawkins has said, “I could not imagine being an atheist at any time before 1859 . . . .” *Id.* at 5. “Darwin made it possible to be an intellectually fulfilled atheist.” *Id.* at 6. Dawkins subsequently calls the idea of a Divine Creator, as an explanation of complex life, a “feeble,” “self-defeating” argument, because it does not explain the origin of the complex Designer. *Id.* at 141. The force of this critique does not seem to depend on the advent of Darwinian theory. Dawkins does not tell us why he would have been unable to recognize the argument for a Divine Creator as feeble and self-defeating before 1859.



one who has paid the slightest attention, natural existence is full of conflict, pain, and death. Christians have always found natural evil hard to explain,<sup>82</sup> and many (including myself) believe it is beyond explaining. Trying to square the evolutionary process with a benign Creator is a particular variant of the pervasive problem of natural evil.<sup>83</sup>

In any event, when some scientists assert that evolutionary theory supports atheism or warrants strong skepticism about traditional religious views, they stray beyond the strict bounds of methodological naturalism; *but* we must understand that whenever scientific conclusions have a strong probability of being true overall, this can affect not only the likely truth of narrow religious doctrines that are directly opposed to the scientific conclusions, but also the persuasiveness of other, more basic, religious conceptions.

Science may also provide a kind of positive support for religious propositions. Although the “Big Bang” theory of the origin of the universe can hardly be called evidence for God, some theorists do think the theory fits more congenially than the once popular “steady state” theory with belief in a God who creates *ex nihilo*.

And scientific experiments can relate more sharply to religious beliefs. Part of science is establishing the existence of things that science cannot yet explain. These phenomena may possibly point to a supernatural power. In a recent study of intercessory prayer, the subjects of the experiment were 199 women in Korea

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82. Evils caused by human actions can plausibly be attributed to a freedom of choice given human beings. Although some have said human sin is also responsible for natural evil, the connection is much less obvious *and* natural evil existed long before human beings appeared on earth, if evolutionists are right about history.

83. Darwin wrote in a letter quoted in PENNOCK, *supra* note 2, at 70: “This very old argument from the existence of suffering against the existence of an intelligent first cause seems to me a strong one; whereas . . . the presence of suffering agrees well with the view that all organic beings have developed through variation and natural selection.”

Arthur Peacocke, in defending the consonancy of evolution with a Christian view, explicitly addresses the problem of natural evil:

Hence pain, suffering and death, which have been called ‘natural evil’—the features of existence inimical to biological life, in general, and human flourishing, in particular—appear to be inevitable concomitants of a universe that is going to be creative of new forms, some of which are going to be conscious and self-conscious.

Peacocke, *supra* note 66, at 481.

who sought assistance at a fertility clinic to become pregnant.<sup>84</sup> They received identical medical procedures—*in vitro* fertilization and embryo transfer. American researchers did not inform either the women or the medical personnel assisting them that they were engaging in a prayer experiment. Groups in the United States, Canada, and Australia, with pictures of the women for whom they prayed, prayed for half the women. Other groups prayed that these prayers might be effective. The researchers expected that prayers by strangers would be shown to be useless. To their surprise, the rate of pregnancy for women who were beneficiaries of prayers was 50%—“an amazingly high success rate for any fertility program”; the pregnancy rate for the control group was 25%. Of course, the experiment may have been ill-designed; it may prove not replicable by other experiments; the results may have been an astonishing coincidence. *If* the results are further confirmed by similar experiments, scientists may one day discover a kind of mental communication that affects physical processes that is subject to a natural explanation. Nonetheless, the experiment would lead an uncommitted observer to believe it more likely than he did before the experiment that a supernatural being or force responds to prayer.

Scientific methods may also be used to test a tentative religious explanation for a singular event. Someone has enjoyed a startling recovery from physical affliction. If doctors who investigate to find a possible natural explanation begin with doubt that any such explanation may suffice, their inquiry follows the strictures of methodological naturalism only in a sense. The investigators do try to determine if they can explain what has occurred naturally, but they do not *assume* that such an explanation will work. (An attempt to replicate the prayer experiment would be similar in this respect if undertaken by people who think intercessory prayer is probably successful and lacks any natural explanation.) Whether an investigation is scientific should not depend on the investigators' attitudes about the likelihood of success in finding natural causes; two researchers who shared a conviction about what would constitute a successful scientific explanation might commence with contrasting assumptions about whether they will find one. A scientist *could* address questions about the limits of natural evolutionary explanations with the same attitude that is brought to claims of miracles by investigators who credit the possibility of miracles, but also know that

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84. Sheila Anne Feeney, *Is Prayer Good Medicine?* MEDSCAPE HEALTH, Feb. 8, 2002; see also Eric Nagourney, *A Study Links Prayer and Pregnancy*, N.Y. TIMES, Oct. 2, 2001, at F6; Jim Holt, *Prayer Works*, N.Y. TIMES, Dec. 9, 2001, at 92.

many events believed to be miraculous may have been caused naturally.

## VI. MIRACLES

Before returning to the debate about evolutionary theory and creationism, I focus briefly on miracles. The question whether miracles occur connects closely to the question whether God answers prayers and bears more obliquely on assertions that a Creator has intervened in the development of life. Like claims that God created each kind of animal and plant, claims of miracles rest on a belief that God transcends or violates ordinary principles of natural processes. One argument for special creation is that a God who performs miracles might well also have directly created life,<sup>85</sup> though some theorists contend that God's performing "miracles" as an aspect of the "salvation" history of human beings is radically different from God's transcending natural principles many millions of years before humans existed.<sup>86</sup> Claimed miracles also matter, as we have seen, as one locus of "scientific" investigations that may conclude that no natural explanation of a phenomenon will suffice.

Individual miraculous events, at odds with scientific laws, are certainly *conceivable*,<sup>87</sup> and science cannot *establish* that miracles do not occur, because science cannot prove that every physical event occurs in accord with natural principles. Many scientists believe that the operations of scientific principles have no exceptions; if apparent events seem to contradict scientific principles, the events have not occurred, *or* a full account of the facts would show how science can explain them, *or* accepted scientific principles require emendation or qualification. Take mental telepathy. We hear stories about people intuitively realizing that loved ones have suffered tragedies or faced great danger. One can, of course, take the tough line and believe that all such stories are bogus or narrate purely coincidental connections of perception with actual tragedy or danger. Or one might assume that at some

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85. Plantinga, *supra* note 58, at 130–31.

86. McMullin, *supra* note 15, at 185–89. The basic idea is that the reasons for God to perform miracles within the stream of human history do not apply to the development of life.

87. Could someone claim, to the contrary, that miracles are conceptually impossible? The argument might run that there must be some explanation for what happens, that the explanation could be understood by human beings, and that therefore nothing miraculous *could* occur. The argument misses the point that not every explanation need be scientific. If the "explanation" for an event is that a Divine Being chose to intervene in earthly affairs in a manner that violated scientific principles, that would not constitute a scientific explanation.

distant time, science will be able to explain how human minds can communicate in the absence of hearing and seeing.<sup>88</sup> (Such an explanation might also cover the success of intercessory prayer.) Neither of these stances deviates from the conviction that science can, in theory, explain everything that occurs within the domains to which science speaks.

But what are we to make of miracles of the sort described in the Jewish Bible (*e.g.*, the parting of the Red Sea) and in the New Testament (*e.g.*, Jesus' raising of Lazarus from the dead) and miracles claimed to be authenticated by modern inquiry into medical cures attributed to divine intervention? A common skeptical response is that the events did not take place—either the story of Lazarus is mythical, or Lazarus had not really died. Does anyone say, “Yes, Lazarus did really die, remained dead for a few days, and was then raised to life by Jesus, but science will one day be able to explain just what happened.”?

That miracles occur is affirmed by many religious faiths;<sup>89</sup> in a *Newsweek* poll, eighty-four percent of adult Americans said they thought God performed miracles, and nearly half said they had personally experienced or witnessed a miracle.<sup>90</sup> The Jewish

88. Discussing an experiment that was undertaken to show that one could not accept both the objectivity of the microworld and the principle of local causality, Heinz Pagels remarked, “Some recent popularizers of Bell’s work . . . have gone on to claim that telepathy is verified or the mystical notion that all parts of the universe are instantaneously interconnected is vindicated . . . . That is rubbish.” PAGELS, *supra* note 49, at 174; *see also* John Polkinghorne, *The Quantum World*, in ROBERT PHYSICS, PHILOSOPHY, AND THEOLOGY: A COMMON QUEST FOR UNDERSTANDING 333, 340–41 (J. Russell et al. eds., 1988) (discussing “The Non-Consequences of Quantum Theory”).

Richard Dawkins takes what I call the tough line, remarking on “coincidences that give us an eerie spine-tingling feeling, like dreaming of a particular person for the first time in decades, then waking up to find that they died in the night.” DAWKINS, *supra* note 12, at 161. What “we commonly call miracles” are “part of a spectrum of more-or-less improbable natural events.” *Id.* at 139.

89. *See generally* KENNETH L. WOODWARD, *THE BOOK OF MIRACLES: THE MEANING OF MIRACLE STORIES IN CHRISTIANITY, JUDAISM, BUDDHISM, HINDUISM, ISLAM* (2000). In his introduction, Woodward defines a miracle as:

[A]n unusual or extraordinary event that is in principle perceivable by others, that finds no ordinary explanation in reasonable human abilities or in other known forces that operate in the world of time and space, and that is the result of a special act of God or the gods or of human beings transformed by efforts of their own through asceticism and meditation.

*Id.* at 28.

90. Kenneth L. Woodward, *What Miracles Mean*, *NEWSWEEK*, May 1, 2000, at 54. Since different individuals have different implicit understandings of what “miracles” are and what occurrences exemplify them, we cannot be confident what percentage of people believe in miracles, defined in any single precise way.

Bible and the New Testament report many miraculous interventions in natural processes. Some Christians take these stories with a large grain of salt, and others do not believe miracles have occurred since biblical times; but many Protestants believe in miraculous cures, and the Roman Catholic Church is officially committed to miraculous occurrences. Of course, events of this sort that natural science cannot explain might be caused by a devil or powerful aliens from outer space, rather than God.

Non-Catholics may be surprised to discover just how rigorous the Church is about distinguishing the unusual but possibly explicable from the truly miraculous. A person can be beatified only if a miracle has been performed when someone invokes his or her assistance (usually by prayer). A further miracle is needed after beatification if the person is to be canonized as a saint. The Congregation for the Causes of Saints has a body of medical consultants who must “determine that the extraordinary healing—these days virtually all accepted miracles are medical cures—is inexplicable by science.”<sup>91</sup> Members of the Consulta Medica, distinguished doctors, review the medical records of the person whose cure is claimed to be miraculous, as well as the written testimony of witnesses and other scientific evidence. The cure must be complete and lasting, and “inexplicable by all known scientific means.”<sup>92</sup> To qualify, the cure must not be of any cancer that has a substantial rate of spontaneous remission, nor can it be of a mental disorder. The doctors themselves do not decide that a cure is miraculous, only that it is scientifically inexplicable; the decision whether a miracle has taken place is left to theological consultants, to the Congregation, and finally to the Pope.<sup>93</sup>

A similar process is employed by local and international medical bureaus that certify cures at the Grotto of Lourdes. To qualify, a cure must be “certain, definitive and medically inexplicable;”<sup>94</sup> a Canonical Commission formed by the Bishop where the cured person lives determines whether the cure comes from God.<sup>95</sup> In the sixty-three years since church authorities have officially recognized extraordinary cures or healings at Lourdes,

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91. KENNETH L. WOODWARD, MAKING SAINTS: HOW THE CATHOLIC CHURCH DETERMINES WHO BECOMES A SAINT, WHO DOESN'T, AND WHY 192 (1990).

92. *Id.* at 195.

93. *Id.* at 205–06.

94. Lourdes Sanctuary lists the criteria for a cure on its web-site at <http://www.lourdes-france.org/gb/gbsb0027.htm>, § I (last visited on Feb. 9, 2003) (on file with the Notre Dame Journal of Law, Ethics & Public Policy).

95. *Id.* § II.

sixty-six have been proclaimed miraculous<sup>96</sup>—the latest, a man who was suddenly and completely cured after having been brought to Lourdes on a stretcher paralyzed with multiple sclerosis.<sup>97</sup>

Here is what Dr. Raffiello Cortesini, who was head of the Consulta Medica of the Congregation for the Causes of Saints, said about his experience:

There is skepticism about miracles, I know, even in the Catholic Church. I myself, if I did not do these consultations, would never believe what I read. You don't understand how fantastic, how incredible—and how well-documented—these cases are. They are more incredible than historical romances. Science fiction is nothing by comparison.<sup>98</sup>

Someone might reject claims of miracles on the general ground that a powerful Creator would never choose to violate the principles by which the Creator constituted the universe. This argument is religious, not scientific, and it is weak. The argument is religious because it adopts a religious perspective to suggest that the Creator would not violate the Creator's own laws, as it were. The argument is weak because we can imagine why a Creator might choose to establish physical relations that are subject to uniform scientific principles and yet, on occasion, act contrary to those principles. To take an example at the heart of traditional Christian belief, by raising Jesus from the dead, God marked his special status and confirmed the hope of life after death. Christians have tended to see miracles as signs of God's grace and love, and the Catholic Church has a developed theology about miracles that follow the intercessions of holy men and women. Believing that miracles occur is certainly not incoherent.

Although science cannot prove that miracles never happen, advances in science can make miracles seem less likely. Centuries ago, people thought that many events were miraculous which are now subject to scientific explanations. As science explains more and more events that have seemed miraculous, a person might reasonably conclude that no events are really at odds with accurate scientific principles. But science alone cannot yield a decisive answer about miracles; a full evaluation reaches beyond

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96. *Miracles as "Signs of Christ"*, MARIAN LIB. NEWSL., Summer 1999, at <http://www.udayton.edu/marty/respub/summer99.html>, ¶10 (on file with the Notre Dame Journal of Law, Ethics & Public Policy).

97. *Id.* ¶¶ 1–2.

98. WOODWARD, *supra* note 91, at 200.

science into the realm of persuasiveness from a religious point of view. From the religious perspective, the reasons for and against miraculous interventions in human history look significantly different from the reasons for and against creative intervention in natural processes of developing forms of life.

A modern view of science that introduces indeterminism may seem to pose a problem for miracles in a rather different direction. According to Heinz Pagels, "quantum theory . . . maintains that fundamental atomic processes occur at random . . ." <sup>99</sup> This has "destroyed the deterministic world view," implying "the existence of physical events that were forever unknowable and unpredictable."<sup>100</sup> Does this mean that physical events are only more probable or less probable, never impossible according to scientific principles?<sup>101</sup>

It is hard to know exactly how to take this element of indeterminism in the microworld. I think it has no relevance to many events in the macroworld.<sup>102</sup> Random movements of small particles will not cause a small mouse to give birth to an adult human being, water to turn into wine, or a paralyzing case of multiple sclerosis to vanish in an instant.

Suppose I am wrong, that all we can strictly say scientifically is that the chance of these occurrences is extremely slight. Could we then conclude that *if* they do occur, they conform with scientific principles and are not miraculous? I believe not. The scientific principle is that the movement of the smallest particles is random. If the probability of a large amount of water turning into wine is infinitesimally small, less than one in many billion, billion, billion instances of water, we may think it more likely that if water does become wine, the cause is divine intervention rather than *random* movements of small particles. Thus, even if indeterminism and probability infect *all* scientific judgments about particular occurrences, room remains for belief in miracles

99. PAGELS, *supra* note 49, at 23.

100. *Id.* at 64, 86. "[T]here is no absolute certainty for events" if one includes the "time of occurrence and the energy change." *Id.* at 117. Pagels wrote that a subquantum determinist theory is impossible according to quantum theory. *Id.* at 86. However, it seems hard to be confident about what scientists might discover in the future.

101. Richard Dawkins suggests that science would classify "a marble statue of the Virgin Mary suddenly wav[ing] its hand at us" as "very improbable" but not "utterly impossible." DAWKINS, *supra* note 12, at 159.

102. Pagels noted that quantum indeterminacy can affect our lives, as with certain kinds of computer errors, but that the amount of uncertainty quantum theory introduces for a flying tennis ball is one part in  $10^{-34}$ . PAGELS, *supra* note 49, at 148, 90.

understood as events that do not conform with scientific principles.<sup>103</sup>

For our purposes, individual miracles matter mainly as they bear on the likelihood of divine interventions or directions in the processes of developing life. We might regard these interventions, if they occurred, as large-scale miracles, although how they might relate to scientific principles may be more complex than the term “miracles” captures. Let us suppose that the neo-Darwinism synthesis fails to explain everything about the development of complex life. If what is left will never be explicable by science, it could represent a series of large-scale miracles. On the other hand, were scientists one day to discover new explanatory principles, science might fill present gaps.<sup>104</sup> Yet another possibility is that certain developments would be neither explicable by scientific principles nor at odds with them, occurring in a manner that science simply does not cover, or leaves open. One suggestion along these lines is that the indeterminacy of the movements of the smallest particles is ontological as well as epistemological,<sup>105</sup> and that a Creator’s moving of a particle in any particular direction would neither violate scientific principles nor be explicable by them. A Creator moving enough particles in this way could achieve extraordinary physical outcomes. In my view, such outcomes would not only be strikingly improbable according to scientific principles, they would violate the principle that the movements of particles *are random*;<sup>106</sup> but the example at least alerts us to the possibility of a conceptual space between physical events that conform with principles of science and those that violate these principles.

## VII. SCIENCE AND MATERIAL FOR SCIENCE COURSES

A careful evaluation of the place of evolution, creationism, and intelligent design in public schools requires matching the specific claims and methodological foundations of the three

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103. One reasonable response to claimed miracles is that either (1) they are subject to scientific principles we do not yet understand—perhaps many astonishing medical cures concern yet undiscovered connections of mind and body—or (2) they did not occur—as with turning water into wine or raising the dead.

104. Although these new principles would not themselves establish a Divine Creator, they *might* seem to make a Creator’s existence more likely.

105. See Robert John Russell, *Does the “God Who Acts” Really Act in Nature?*, in *SCIENCE AND THEOLOGY* 77–102 (Ted Peters ed., 1998).

106. This possibility suggests that the line may be thin between outcomes that “violate” scientific laws—miracles—and outcomes that involve actions that scientific principles leave open. My opinion that a Creator’s movement of particles would violate a scientific principle of randomness may be arguable.



approaches against an analysis of what belongs in a science course and what counts as teaching religion.

Educators need to evaluate whether any theory about the development of life is “scientific,” or nevertheless closely enough related to science to belong in a science course, and whether, from a scientific standpoint, the theory is minimally plausible. If any theory is not adequately scientific or is not minimally plausible from a scientific perspective, it should not be taught as science.

### A. *Minimum Plausibility*

The notion of minimum plausibility is more straightforward than the boundaries of science, so I shall begin with it. Although I am not well equipped to judge the plausibility of scientific claims,<sup>107</sup> my appraisals are nevertheless worth stating. If anyone is to try to figure out what is true overall, he will have to engage a field in which he is not expert.<sup>108</sup> Further, many officials with educational authority and virtually all of the judges who must discern if educational decisions are sufficiently grounded to pass constitutional muster will be lay persons like myself, without special expertise in the relevant physical sciences or in the philosophy of science.

Jeffrie Murphy says that scientific creationists regard their account as “literally true” and as “a highly confirmed scientific hypothesis.”<sup>109</sup> He goes on,

To say that it is a scientific hypothesis is to say that it is the sort of claim that can be established (or refuted) on the basis of empirical evidence.<sup>110</sup> To say that it is a highly confirmed hypothesis is to say that, given the evidence available to us, it is the most reasonable hypothesis to hold concerning the origin of the universe and life.<sup>111</sup>

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107. What strikes me as reasonable may be understood by those more expert as wildly implausible. (Most legal arguments can be made comprehensible to lay people, but nonlawyers may have little sense which of two positions has more legal strength.)

108. See Alvin Plantinga, *Evolution, Neutrality, and Antecedent Probability: A Reply to McMullin and Van Till*, in *INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS*, *supra* note 15, at 212–13. Of course, someone who is both biologist and theologian need not stray from a field in which he is expert to discuss evolution and creationism, but the rest of us cannot rely completely on the very few people who happen to be expert in both domains.

109. MURPHY, *supra* note 1, at 34.

110. Presumably, the empirical evidence must be of the sort that others can confirm. In this sense, an experience of one’s life being transformed is not relevant empirical evidence for the existence of God.

111. MURPHY, *supra* note 1, at 35.

Murphy remarks that some creationists claim only that their theory is *as* reasonable as the theory of evolution.

If evolution and creationism were both scientific theories and were about equally plausible from a scientific point of view, teaching them both in biology courses as alternative approaches would make sense. Years ago, scientists were about equally divided between “Big Bang” and “steady state” theories of the universe; these were properly taught as alternatives.

A theory might qualify as “scientific,” in the sense of relying on scientific evidence, but have almost no plausibility as possibly accurate science. The theory that the sun moves around the earth may once have been reputable from the scientific point of view. It is no longer. Probably this is now the case with the steady state theory of the universe, the Big Bang theory having been very widely accepted.

Science teachers, and textbook authors, should not present highly implausible scientific theories as having a substantial probability of being accurate from a scientific point of view. A teacher discussing the *history* of a scientific discipline may, of course, comment on theories overtaken by time, and a teacher may also illustrate the power of a dominant theory by comparing it to rejected competitors, but teachers should not present highly implausible theories as possibly convincing, leaving students to make up their own minds. Through high school and in introductory university courses, students will usually not have the capacity to weigh all the empirical evidence and arguments themselves. To warrant its being presented as possibly accurate, a theory should pass a threshold of plausibility.<sup>112</sup>

Someone might object to what I have said so far on the following ground: It is in the nature of scientific theories to be revisable. The most dominant, universally held theories—Newton’s theory is the leading example—have later been superceded or abandoned. If no scientific theory has a secure claim to being true, what now seems to be a highly implausible theory may turn out to be accurate.

This objection misconceives the import of revisability in science. Much of the point of science is reliance on empirical evidence. Although dominant theories are qualified or give way completely, that does not mean that every conceivable alternative is plausible or deserves equal consideration. The likelihood that further scientific advances will show that the earth is flat or the center of the solar system, or that blood does not circulate in the

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112. It need not necessarily be as persuasive as a competitor, but it needs to be somewhat persuasive.

bodies of mammals, is extremely slight. Science teachers should give students a sense of the relative certainty of various theories, insofar as scientists can now estimate that, but they should not present what seem to be extremely implausible alternatives.

Research scientists within the fields that count overwhelmingly accept evolution as the most convincing scientific theory about the development of species. Although some elements of the theory are more certainly true than others, scientific evidence from various branches of science helps to support all of the crucial aspects. If any theory of development of species qualifies as plausible, evolution does so.

Certain objections to evolutionary theory turn out to be misconceived or not to be very substantial. The theory does not assume "progress," but merely the continuing adjustment of organisms to changing environmental conditions, and it does not assume that mutations are generally beneficial or harmful.<sup>113</sup> Some creationists have claimed that the Second Law of Thermodynamics, that systems increase entropy or disorder, is at odds with evolutionary theory; but this law applies only to closed systems, whereas the development of life on earth is an open system with new energy continually supplied by the sun.<sup>114</sup>

A criticism that is sometimes made of evolutionary theory is that the idea of natural selection is essentially circular, able to "explain" any evidence that is forthcoming.<sup>115</sup> The theory would be circular in this way if it were unable to predict any changes and it declared that the survival of a characteristic proves that the characteristic was fitted for survival—however difficult it may be for us to see that the characteristic is competitively advantageous—or that the characteristic flows from a gene that confers a competitive advantage in some other respect.<sup>116</sup> The theory should not be understood as circular in this way.<sup>117</sup> With exam-

113. KITCHER, *supra* note 2, at 72, 98.

114. *Id.* at 91–92.

115. As Robert Pennock explains, the famous philosopher of science Karl Popper once expressed this view but later abandoned it. PENNOCK, *supra* note 2, at 99–100.

116. Stuart Kauffman writes, "Many biologists think that Darwin's theory explains but only weakly predicts." STUART KAUFFMAN, *AT HOME IN THE UNIVERSE* 16 (1995). Kitcher indicates how the recessive gene that produces sickle-cell anemia survives because the same gene protects against some forms of malaria. KITCHER, *supra* note 2, at 21.

117. The theory of descent of complex life from simple common ancestors is more easily subject to disconfirmation. If fossils showed that animals that must have appeared later, according to the theory, actually appeared earlier, that would be a serious blow to the theory. Dawkins writes, "If a single, well-verified mammal skull were to turn up in 500 million year-old rocks, our whole

ples like the peppered moth, we can clearly see that organisms better suited to survive in the environment do survive and pass on their characteristics to descendants. And scientists can predict that over generations viruses will develop resistance to antibiotics, as a theory of natural selection would indicate. In fact, no one denies that natural selection can occur within species. Although no single example can prove or disprove that natural selection largely explains development from one species to another, and evolutionists typically offer only educated guesses about why any particular change occurred as it did millions of years ago, nonetheless the cumulation of pieces of evidence can suggest that natural selection is more or less convincing as an explanation for developments.<sup>118</sup>

### B. *Negative Arguments*

Both Genesis creationists and proponents of intelligent design present various negative arguments against the plausibility of evolutionary theory. In addition to disagreement about the strength of particular arguments, there is confusion (or obfuscation) about the status of such arguments in general. Do negative arguments have force? Do they support a competing theory? Can opponents of a theory rely on disagreements among its proponents? What relevance have probabilistic estimates?

Negative arguments about an opposing position clearly are *one* proper part of a defense of one's own position; this is no less true in science than other disciplines. Creationists have complained that evolutionists arbitrarily rule their negative arguments out of bounds.<sup>119</sup> And, indeed, various assertions that

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modern theory of evolution would be utterly destroyed." DAWKINS, *supra* note 12, at 225. This remark is in some tension with the idea that scientific theories can accommodate anomalies and with the idea that scientists do not and should not abandon theories until more persuasive competitors are offered. See *infra* note 120.

118. Philip Kitcher writes, [P]hilosophers of science have shown how the refutation of a theory with broad scope proceeds, not by single decisive experiments but by the accumulation of cases that challenge defenders to find any way of supplementing the central principles. The history of science is full of theories that come to grief because of the building up of difficulties.

Darwin's theory of evolution isn't among the shipwrecks.

Philip Kitcher, *Born-Again Creationism*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 278.

119. Johnson has written that scientific naturalists "can impose a rule of procedure that disqualifies purely negative argument, so that a theory which obtains some very modest degree of empirical support can become immune to disproof until and unless it is supplanted by a better naturalistic theory." Johnson, *supra* note 75, at 73.

scientists do not, and should not, abandon a dominant theory until a more persuasive scientific theory is offered in its place do suggest a limited role for negative arguments.<sup>120</sup> To avoid confusion, it helps to clarify what negative arguments are good for.

Suppose that a critic presents a powerful argument that random mutation and natural selection, and other explanatory devices of neo-Darwinian theory, cannot persuasively account for certain developments toward complex life as we know it. Such an argument should make us believe it is *somewhat less likely* that present neo-Darwinian theory affords an accurate account. It will not establish the eventual unpersuasiveness of the neo-Darwinian explanation. And it certainly will not show the likely truth of any single alternative. A negative argument about one theory supports any particular alternative only if that alternative is itself plausible and stronger than other alternatives.

An illustration turns out to have a powerful significance for what schools might teach about the development of complex life. Perhaps the most common challenge to evolutionary theory is that imperceptible, gradual changes cannot explain the origin of complicated organs, such as the eye and the wing. The eye requires a great many parts to function in a particular and precise way. Yet a slight development toward any one of these parts would confer no competitive advantage; therefore, mutations of genes producing physical features in any of these directions would not survive; therefore, the eye could not develop by slow changes in a great many parts if these changes were "undirected" and depended on natural selection for their survival. No one, of course, knows just how the eye did develop, and since the parts of the eye are made up of soft tissue, we have no fossil record of its stages. Evolutionary theorists tell us that progressive gradual development is entirely plausible.<sup>121</sup>

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120. Having reviewed and rejected justificationist, probabilistic, and dogmatic falsificationist notions of scientific knowledge, Imre Lakatos defended what he called sophisticated methodological falsificationism, according to which "no experiment, experimental report, observational statement or well-corroborated low-level falsifying hypothesis alone can lead to falsification. There is no falsification before the emergence of a better theory." Imre Lakatos, *Falsification and the Methodology of Scientific Research Programmes*, in CRITICISM AND THE GROWTH OF KNOWLEDGE 91, 109 (Imre Lakatos & Alan Musgrave eds., 1970); see also Imre Lakatos, *Criticism and the Methodology of Scientific Research Programmes*, in LXIX PROCEEDINGS OF THE ARISTOTELIAN SOCIETY 149, 163 (1969). ("There must be no elimination without the acceptance of a better theory.")

121. See, e.g., DAWKINS, *supra* note 12, at 77–86. A degree of sensitivity to light could be very helpful in comparison with blindness (and various parts may also have served other purposes or have been genetically related to other valua-

A similar argument about complex parts has been advanced about the molecules that make up cells. According to Michael Behe, “the elegance and complexity of biological systems at the molecular level have paralyzed science’s attempt to explain their origins.”<sup>122</sup> Life is based on molecular machines, and many biochemical processes are “staggeringly complicated.”<sup>123</sup> When one looks at cilia, bacterial flagella, the mechanism for blood clotting, and other microsystems, one finds “irreducibly complex systems,” of which the mousetrap, with its various working parts, is a simple example. Such a system is “composed of several well-matched, intersecting parts that contribute to the basic function, wherein the removal of any one of the parts causes the system to effectively cease functioning.”<sup>124</sup> For such systems, a gradualist, neo-Darwinian explanation of development by natural selection is implausible because elements serving no function before full development of the entire system would not survive and elements of simpler systems (serving some function) would not combine in the right way to perform a different complex function. Behe notes that attempted explanations of how such systems could have developed by natural selection are few and far between.<sup>125</sup>

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ble features), so we can imagine a slow progression from blindness to the full eye.

122. MICHAEL J. BEHE, *DARWIN’S BLACK BOX: THE BIOCHEMICAL CHALLENGE TO EVOLUTION* x (1998) [hereinafter *DARWIN’S BLACK BOX*]; see also Michael J. Behe, *Molecular Machines: Experimental Support for the Design Inference, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS*, *supra* note 15, at 241–56. Miller suggests that Behe’s argument is closely similar to that made about the eye. Miller, *supra* note 12, at 130–36.

123. *DARWIN’S BLACK BOX*, *supra* note 122, at 22.

124. *Id.* at 39. It is fair to say that this is not a precise definition. As Professor Behe’s responses at a debate over intelligent design, at the American Museum of Natural History on April 23, 2002, made clear, a system could qualify if it had some redundant parts, or if the elimination of one (nonredundant) part would still permit the function to be served fairly well. An example, discussed by Miller, is animals whose blood clots without every aspect of the full clotting systems. MILLER, *supra* note 12, at 152–61. These clarifications may suggest that no sharp line exists between “irreducibly complex” and other systems, but they undercut Behe’s basic argument only insofar as they indicate a greater possibility than he acknowledges of development from simple to highly complex systems.

125. “[N]one of the papers published in [the *Journal of Molecular Evolution*] over the entire course of its life as a journal has ever proposed a detailed model by which a complex biochemical system might have been produced in a gradual step-by-step Darwinian fashion.” *DARWIN’S BLACK BOX*, *supra* note 122, at 176. Miller responds that there have been such articles written after Behe’s book and that the main reason more has not been done is that scientists do not yet know just how these biochemical systems work. MILLER, *supra* note 12, at 147–52. For further discussion, see FRANKLIN M. HAROLD, *THE WAY OF THE*

Let us suppose for now, contrary to what evolutionary biologists themselves claim, that organs like the eye or biochemical processes within cells are very hard for neo-Darwinian evolutionists to explain. Does it follow that Genesis creationism or intelligent design is true? Of course not. A neo-Darwinian explanation may prove to be accurate, even if now it does not seem highly convincing. Or, other elements may eventually figure in scientific explanations of evolution that are not aspects of the prevailing dominant theory.<sup>126</sup> One such possibility was offered by Gordon Rattray Taylor after he suggested that “the repeated occurrences of changes calling for numerous coordinated innovations” (such as the eye and the wing) is one among “a dozen areas where the theory of evolution by natural selection seems either inadequate, implausible or definitely wrong.”<sup>127</sup> He asserted that, in order to explain *all* aspects of evolution, we should imagine “some directive force or process [that] works in conjunction with it. I do not mean by that a force of a mystical kind, but rather some property of the genetic mechanism the existence of which is at present unsuspected.”<sup>128</sup> Stuart Kauffman has developed a “complexity theory,” according to which the “order of the biological world . . . is not merely tinkered, but arises naturally and spontaneously because of . . . principles of self-organization—laws of complexity that we are just beginning to uncover and understand.”<sup>129</sup> The development of life is the product of both the spontaneous order of self-organized systems and natural selection.

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CELL: MOLECULES, ORGANISMS AND THE ORDER OF LIFE 189–215 (2001) (offering a general evolutionary explanation for the development of complex cells).

126. Further, if no scientific explanation suffices, science may provide no basis to prefer the account in Genesis to the diverse creation myths of other religions.

127. TAYLOR, *supra* note 3, at 137. Taylor acknowledged that natural selection does very well in explaining relatively minor changes within species. Dawkins provides some idea of his regard for Taylor when he chastises a theologian for relying on him and three other authors rather than on biologists. DAWKINS, *supra* note 12, at 38.

128. TAYLOR, *supra* note 3, at 137. On this page, Taylor suggests only that the evidence he has presented makes “it necessary to consider” this possibility “quite seriously”; but the remainder of the book makes clear that Taylor believes, further, this explanation is probably correct.

129. STUART KAUFFMAN, *supra* note 116, at vii; *see also id.* at 23–25. In defending a neo-Darwinian approach, Pennock comments, “There might also turn out to be underlying patterns of order that emerge because of the self-organizing properties of non-equilibrium systems, or because of limits imposed on evolutionary change by developmental constraints.” PENNOCK, *supra* note 2, at 103.

At first glance we might suppose that if order or design may have had some role in the development of life, it must have been intelligent. Who is doing the designing if not an intelligent being? But think about the development of a single-cell human embryo into a multicell baby with bones, nerves, muscles, blood, and complex organs. The development from the single cell is not random; it is programmed according to the DNA in its genes. Although many people regard this development as an amazing sign of God's handiwork, we have a natural explanation that does not depend on any premise about an intelligent Creator. Kauffman sees this ontogeny as an example of spontaneous order,<sup>130</sup> and something similar *could* occur concerning the development of genes over generations, as Taylor and Kauffman suppose. In short, scientists may one day discover principles of order in the whole process of the beginning of life and evolutionary development that roughly resemble the design that undoubtedly exists in the development from the inception of single cells to the birth of babies.

If nonintelligent order or design is conceivable, could empirical evidence support intelligent design? If we *knew* from scientific evidence that one day human beings appeared on the earth without any close forebears (and without having been deposited by aliens from outer space), that would strongly suggest purposeful creative action, since the likelihood of *any* natural explanation would seem very slight. But much scientific evidence of order will be indecisive between intelligent design and the kind of design of which Taylor and Kauffman write. If we are only at the beginning of any full understanding of the development of life, how can we know whether someday we will comprehend how development might proceed by a nonrandom process that bears a resemblance to the development from embryo to baby? This recognition of our ignorance should make us very hesitant to move from negative arguments about one possibility to a confident embrace of any single alternative.<sup>131</sup> In any

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130. KAUFFMAN, *supra* note 116, at 93–112.

131. However, Behe argues that the same features that show the implausibility of a Darwinian explanation also establish the great likelihood of intelligent design. See generally DARWIN'S BLACK BOX, *supra* note 122. See also WILLIAM A. DEMBSKI, THE DESIGN INFERENCE (1998) (adopting a mathematical approach to complexity). Providing a detailed analysis of probability theory, Dembski argues that when the improbability of a patterned outcome is very high, one can rule out regularity and chance in favor of intelligent design. *Id.* (I discuss the inference to intelligent design in a later section.) Although he rejects claims about intelligent design, Miller suggests that most scientists he knows agree "that in a general way, we really do understand how nature works." MILLER, *supra* note 12, at 263.



event, the negative arguments themselves certainly do not get us there.

But that does not mean the negative arguments lack all force. Even were such arguments to present nothing of scientific plausibility to take the place of a prevailing theory, that would not be a sufficient ground to reject them out of hand. It is now common currency among philosophers of science that individual anomalies, instances in which observations do not comport with what a theory predicts (or “retrodicts”), do not undermine scientific theories; but a very powerful criticism of a theory *should* be taken seriously whether or not the critic offers a substitute. Were scientists to understand that a dominant theory has been rendered unpersuasive or highly vulnerable, some of them, at least, should search for a better theory, even if the critic himself cannot provide one.<sup>132</sup>

A second reason for not automatically rejecting negative challenges to evolutionary theory is that creationist and intelligent design criticisms are offered mainly on the issue of what is true overall. If the *positive claim* is that God has created by means that transcend ordinary natural processes, the critics do not have an alternative positive theory cast in terms of a *natural explanation*; the whole point is that any explanation that relies exclusively on standard science is false. I shall later pursue some important implications of this understanding, but how is the scientist, as scientist, to respond to negative criticisms of evolution offered by advocates of a position that the true explanation for much of the development of life is nonscientific? The scientist may reiterate her commitment to methodological naturalism as justifying her continuing reliance upon the best theory science has yet to offer, that is, evolutionary theory; but she cannot fairly dismiss negative arguments against evolutionary theory, so long as everyone understands that the negative arguments are offered for the proposition that some explanation other than a scientific one is accurate, and the challengers provide such an explanation. The evolutionist can argue that the alternative itself is highly implau-

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132. If other alternatives are already in the field, scientists might give them renewed attention. See Karl Popper, *Natural Science and Its Dangers*, in CRITICISM AND THE GROWTH OF KNOWLEDGE, *supra* note 120, at 51, 54–56. If there is a dominant paradigm of the sort described by THOMAS KUHN, *THE STRUCTURE OF SCIENTIFIC REVOLUTIONS* (1962), at least some scientists might devote their efforts to trying to imagine new possibilities that would significantly revise or overthrow crucial aspects of the dominant theory. However, since scientists require some theoretical framework to guide their work, it is understandable that most scientists will continue to use the prevailing theory until an alternative is put forward.

sible, much less persuasive than evolutionary theory, but she cannot rule the negative criticisms out of bounds because the critics put forward no *scientific* alternative to Darwinism.

Challenges to evolution that rely on disagreements among evolutionary experts present a variation on the overall theme of negative arguments. If two experts are strongly committed to a general theory, does their disagreement about how a process occurs influence one's confidence in their shared conclusion about that theory? It all depends. Suppose two sports fans agree that A beat B in a cross-country race. The first fan thinks that B was trying her hardest but that she ran out of steam near the end. The second fan, knowing of B's friendship with A, thinks he saw B intentionally slow down so that A could win. The two fans disagree about why B lost but that does not diminish in the slightest the confidence we should have that they have correctly perceived who won. To continue with the analogy, suppose neither fan saw the race's finish, but both say they are sure A won. The first fan says that A was well ahead at the halfway point and looked about as strong as did B. The second fan says that B was ahead by 100 yards at the halfway mark, but looked much more winded than A, who was closing fast. Here the disagreement about the reasons why A probably won would make us wary about the shared conclusion that A almost certainly did win. *Our* confidence that A won would go down from the time that we heard the fans' conclusion to the time we heard their conflicting explanations.

Our confidence in an aspect of evolutionary theory might be similarly shaken if two experts present powerful reasons why the theory of the other is not convincing. We might be led to doubt that either of the positive theories is persuasive and thus might be led to doubt that any account along those lines is persuasive.

Consider in this respect disagreement among leading scientists about the plausibility of gradualism. Opponents of gradualism, that is, imperceptible changes that slowly produce new features like the eye, say that the standard explanation cannot show how such changes occur, and that the fossil record does not support gradualism. Proponents of gradualism claim in part the implausibility of any scientific explanation of how larger, faster changes could have occurred.<sup>133</sup> If we think each side is convincing in its negative criticism of the other, we are left with the possibility of large, fast changes not easily explicable by present

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133. I am supposing, contrary to what Richard Dawkins has claimed in DAWKINS, *supra* note 12, at 223–52, that the disagreement is substantial and not mainly terminological. Among the points that Dawkins makes is that some relatively small mutations in genes could cause large physical effects. *Id.* at 234–36.

science.<sup>134</sup> Of course, future science may explain what present science cannot; but one could take the powerful negative criticisms as increasing the likelihood that a phenomenon is beyond scientific explanation.

Probability claims present another variation on the force of negative arguments about evolutionary theory.<sup>135</sup> Claims that the development of any life and of complex life were highly improbable are neither as powerful as opponents of evolution often believe nor as impotent as evolutionary theorists sometimes suggest. Let us suppose that, given the physical conditions of the earth four billion years ago, a very intelligent and informed observer from another galaxy would have concluded that the development of life-forms as complex as the "higher mammals" was extremely unlikely.<sup>136</sup> Does this show that natural processes did not produce life as we know it?

No, the scientist responds, highly improbable events do happen, and we have no doubt what life-forms have developed. Before-the-fact probabilities are irrelevant once we are aware what actually happened. Imagine that someone throws a die five times. The probability that the sequence will be exactly what it turns out to be was only one in 7776 ( $6^{-5}$ ), but that would have been true about any exact sequence of five throws of a die. The low probability of this particular sequence in advance creates no skepticism about its actual occurrence.<sup>137</sup>

But this response, as so far developed, assumes what is at issue, the persuasiveness of dominant evolutionary theory against an alternative of order or design. If a person threw a die five times and each time the die turned up six, we would wonder if the die was weighted to show six. If a gambler who had control of the die benefited from a throw of six, we would, at about the third throw, begin to ask ourselves if six was a random outcome or the consequence of his design. In an actual legal case, a Democratic official had the job of determining by a random process, outlined by a state statute, whether Democrats or Republicans

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134. Addressing two competing suggestions about how cilia might have developed according to standard evolutionary theory, Michael Behe concludes, "Each points out the enormous problems with the other's model, and each is correct." *DARWIN'S BLACK BOX*, *supra* note 122, at 69.

135. Behe remarks, "Mathematicians over the years have complained that Darwinism's numbers just do not add up." *Id.* at 29.

136. I am passing over the argument that the physical conditions necessary to sustain separate suns and planets were themselves highly improbable. I am also passing over arguments based on alternative universes, which seem to me to have little bearing, given our ignorance about whether other universes exist.

137. See Kitcher, *supra* note 118, at 266.

would have the advantageous top line of the ballot; on forty occasions the Democrats ended up on top as compared with one outcome favoring the Republicans.<sup>138</sup>

For many, the force of the improbability argument for the creation of complex life is to render more plausible the argument that design has been involved in the development of life.<sup>139</sup> Of course, the argument will have that force only for someone willing to entertain the possibility of design. A person who believes that design is wildly implausible will not be dissuaded from neo-Darwinism; he can respond that improbable events do happen *and* we still have much to learn about just how evolution proceeded. He *may* also respond that the bases for various probability estimates are extremely conjectural.

In his deservedly popular defense of dominant evolutionary theory, Richard Dawkins accepts the relevance of probability arguments,<sup>140</sup> but he adopts an unwarranted assumption that is highly favorable to evolutionary theory.<sup>141</sup>

Recognizing that any particular sequence of events, such as the exact order of letters a monkey would type, is highly improbable, Dawkins says that what matters is the improbability of an outcome that is particularly significant in some way, such as the words, "Methinks it is like a weasel," an outcome whose probability he puts at  $10^{40}$ .<sup>142</sup> He assumes that the likelihood

138. See *Mochary v. Caputo*, 494 A.2d 1028 (N.J. 1985) (a civil case seeking a reform of procedures). Caputo had not actually done the drawing himself in every instance. The state supreme court evinced no doubt that the procedure had not consistently been fair. The case is discussed in DEMBSKI, *supra* note 131, at 9–20, 162–67; Branden Fitchen et al., *How Not to Detect Design—Critical Notice: William A. Dembski, The Design Inference*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 599–600. Dembski, apparently relying on a newspaper report, supposes that a court would not be willing to determine that Caputo had violated the law without more positive evidence of what he had done; he also supposes that the court's hesitancy to *order* particular reforms was based on its problems with the evidence. *Id.* at 18–19. I understand the court's opinion somewhat differently. Caputo's personal "guilt" was not at issue in the suit to reform procedures. The court's hesitancy to *order* new procedures flowed from its belief that its recommendations would be followed and perhaps from its sense that the statutory scheme left "discretion" about details to administration officials.

139. One could believe an improbability argument undermines presently dominant explanations without believing that design or order is a needed supplement.

140. He writes, "Measuring the statistical improbability of a suggestion is the right way to go about assessing its believability." DAWKINS, *supra* note 12, at 41. DEMBSKI, *supra* note 131, at 155–62 (providing a more refined analysis of Dawkins's claims about probability).

141. DAWKINS, *supra* note 12, at 139–47.

142. *Id.* at 141–42.

that a planet would develop life with the degree of complexity of life on earth is extremely slight. (For him, the greatest element in the total improbability is life getting started at all from inanimate matter; once life exists, cumulative selection is available to push it to higher complexity.)

It is here that Dawkins makes his crucial moves. The relevant probability for judging evolutionary theory, the “luck” we can postulate, is correlated to the number of suitable planets for life in the universe. He assumes that 100 billion billion planets may be suitable. How much luck we could postulate depends on how many of those planets actually have complex life. It is quite consistent with highly improbable odds that complex life might have developed on one planet. It is not an incredible coincidence that the one planet with life is ours; of course, it has to be ours, since we are highly complex life, able to understand what has happened.

Dawkins persuasively establishes four propositions. (1) If the universe has 100 billion billion suitable planets, we would expect complex life to develop on at least one if the odds for each suitable planet were more favorable than one in 100 billion billion. (2) The existence of life on our planet does not necessarily establish a high likelihood of life on other planets; ours may be the single instance in which an incredibly long shot paid off. (3) There is nothing paradoxical about that planet being ours. (4) If the odds against any life beginning are extremely high, although more favorable than one in 100 billion billion, we should not be surprised that no one has yet figured out just how life arose from nonlife.<sup>143</sup>

But Dawkins’s central question is “how much luck are we allowed to assume in a theory of the origin of life on Earth?”<sup>144</sup> He implicitly acknowledges that if complex life has arisen often, say on one out of every thousand suitable planets, a theory according to which complex life arises only once in roughly every 100 billion billion times is in trouble. But if complex life has developed only once, or a very few times, such a theory can well account for what has happened. Dawkins proceeds:

[I]f we assume, as we are perfectly entitled to do for the sake of argument, that life has originated only once in the universe, it follows that we are *allowed* to postulate a very

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143. Dawkins discusses one broad approach. *See id.* at 146–58. Behe summarizes the initial optimism about discerning how life began, from nonlife, followed by a recognition of “staggering difficulties.” *DARWIN’S BLACK BOX*, *supra* note 122, at 166–73; *see also* KAUFFMAN, *supra* note 116, at 31–45.

144. DAWKINS, *supra* note 12, at 143.

large amount of luck in a theory, because there are so many planets in the universe where life *could* have originated.<sup>145</sup>

Thus, evolutionary theory is not vulnerable if it gives us reason to suppose that the chances of developing complex life are more than one in 100 billion billion.

The fly in the ointment is that we do not know about complex life on most other planets. We do know that within our solar system complex life is limited to earth, and we can draw negative inferences about life as complex as ours for a few neighboring solar systems, based on an absence of radio communication from them. We have not a clue about the vast majority of planets in the universe. If someone asserts that a creationist or design explanation is more plausible than that provided by dominant evolutionary theory, I do not see why we should assume, *in making that comparison*, that life exists only rarely or not at all on all those planets.<sup>146</sup>

Consider our analogous problems of the five throws of six and the real case of forty election ballots with Democrats on top. Suppose we were told that our die had been thrown enough times so that one would expect at least one sequence of five sixes in a row and that election officials that had done ballot determinations enough times so that one would expect at least one sequence of Democrats topping the ballot forty of forty-one times. If we knew, to follow the die example, that five sixes *had happened* only once, we would be reassured that its occurrence may not have reflected cheating.<sup>147</sup> But suppose we were given no information about all the other sequences. *Perhaps* many of them were also sequences of sixes; we just don't know. Our estimate of the probability of design—that is, cheating—would be about the same whether the five throws of six were the first sequence ever or one of a large number of other sequences whose outcomes were unknown to us.<sup>148</sup> Our conclusion about

145. *Id.* at 144.

146. Dawkins discusses the number of suns within relevant radio range under various assumptions about when radio technology would have been developed. *Id.* at 165. Ironically, if we knew that life existed *only* on Earth, that could support both evolutionary theory *and* a creationist account according to which human beings have a unique place in God's creation.

147. In fact, if someone with a powerful incentive to cheat controlled the die, we might worry about cheating if the sequence was highly favorable to him even if unremarkable from the standpoint of probabilities.

148. Of course, if an actual die never showed anything but six, we might expect that the gambler would be in serious trouble long before a large number of sequences of throws was made.

the ballot determinations would be similar if we had no idea of the outcomes of other sequences.

The opponent of evolution offers some form of design or creative intervention as an explanation for much development of life—including the crucial first step of no life to life. He argues that occurrence of this by ordinary natural causes is so unlikely that his theory is more persuasive than neo-Darwinism. For this purpose, the existence of planets about which we know nothing hardly seems relevant. If the evolutionist acknowledges that his theory would be the less plausible of the two if complex life existed on one suitable planet in every thousand in the universe<sup>149</sup> but would be the more plausible if complex life existed on only one planet in the universe, he cannot assume *for this purpose* that life exists on only one. Of course, if the evolutionist can wholly rule out all alternatives involving intelligent creation action on some other basis, he can rest content on the grounds that extremely improbable things *do happen*, and that evolutionary theory remains our best explanation of the highly improbable development of complex life. But if this is the response, whether there are a hundred planets in the universe or 100 billion billion planets hardly matters.

### C. *How Plausible Are the Contending Positions?*

Creationists and design theorists argue that the scientific evidence does not support neo-Darwinian evolutionary theory as a complete account of life's development. As I have mentioned, they contend that the development of any life, much less complex life, was extremely unlikely absent purposeful direction. They point out that many links between species supposed by evolutionary theory are not supported by the fossil record. And they refer to disagreements about the methods and timing of change as showing that proponents have no convincing version of evolutionary theory.

Evolutionists respond that there are reasons why the fossil record is seriously incomplete. It takes special conditions for fossils to be made; and soft tissue like eyes does not produce fossils at all. We can understand why only a very small percent of species that have ever existed are revealed by fossils and why the gaps are as they are.<sup>150</sup>

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149. I strongly doubt that Dawkins would make this concession. He thinks the observable facts are so out of line with a creationist or intelligent design approach that evolutionary theory should be preferred, even if it has big problems with probability.

150. KITCHER, *supra* note 2, at 106–15.

Biologists who disagree to some extent about the pace of evolution agree that evolutionary theory is correct in its major premises,<sup>151</sup> most notably that the earth is very old, that life somehow developed naturally from nonlife,<sup>152</sup> that all life proceeds from a common ancestor (or very few ancestors)<sup>153</sup> and that natural selection explains much of that development.

Relatively few research biologists and paleontologists believe that the attack on evolutionary theory is compelling. That, of course, may be because virtually all these professional scientists are biased, or locked into approaches in which they were educated;<sup>154</sup> but the weight of scientific opinion must give non-experts pause about accepting challenges to neo-Darwinism, especially since evolutionary theorists have reasonable-sounding answers to those challenges.<sup>155</sup>

Creation science in its full-blown, literal-Genesis form lacks scientific support. In this creationist account, as I have noted, fossils of different animals were made at roughly the same time. The reason why simpler species are found in lower rock strata and more complex species in higher strata is that the more complex species were able to climb higher before being overwhelmed by the Great Flood. Various modern techniques for dating rocks are inaccurate because the flood brought about changes in natural processes. All “kinds” were created in a period of days; development has occurred only within “kinds.” Fossils of animals that evolutionary theory posits were separated in time—such as dinosaurs and human beings—may be found together at some locations.

The problems with this theory are overwhelming. I have already mentioned the many scientific disciplines that suggest that the earth is far more than 10,000 years old. Geologists had

151. *Id.* at 144–55.

152. Strictly speaking, how life developed from nonlife is not an aspect of evolutionary biology, PENNOCK, *supra* note 2, at 161, but in discussions of evolution and creationism, it is usually included.

153. Pennock says, “Nothing in evolutionary theory *requires* a single origin . . . .” *Id.* at 144.

154. The history of science, as Thomas Kuhn has shown, does reveal instances in which scientists have clung to existing “paradigms” for reasons other than scientific evidence, *see* KUHN, *supra* note 132; but scientists did shift from a Newtonian view of physical laws when Einstein presented powerful arguments for special and general relativity, and scientists subsequently accepted a quantum theory that was highly counterintuitive and rejected in part by Einstein. *See* PAGELS, *supra* note 49, at 60–65, 96–97, 160–65.

155. Of course, one of the answers is that scientists do not have a full explanation for why things happened as they did; but that is an aspect of much of science.



already reached this conclusion long before Darwin came along.<sup>156</sup> Modern estimates of the age of the earth, based on various methods of dating, range between 4.2 and 4.8 billion years.<sup>157</sup> The ratio between 10,000 years and 4.5 billion years is approximately the same as that between 1 hour and 50 years. (We wouldn't have much of a problem figuring out whether a human being had been alive one hour or fifty years.) The creationist claim that the flood somehow altered natural processes, in a manner that makes all modern methods of dating unreliable, is implausible, at best.<sup>158</sup> Against the creationist idea that all "kinds" were created about the same time is very powerful evidence that simple life-forms preceded complex ones and further evidence that simpler species developed into more complex ones. Those claiming that the fossil record at places such as the Paluxy Riverbed contradicts evolutionary theory may have misread the natural evidence or been duped by fraud. All in all, the scientific case for creationism in its standard modern form is extremely weak.

The comparatively modest claims about intelligent design are more plausible, if they do not go beyond challenging the dominant explanation of why complex life developed as it did and proposing that intelligent design best accounts for a part of what dominant theory fails to explain. In this form, intelligent design is consistent with empirical evidence, which itself cannot rule out a possible role for creative intelligence that transcends ordinary scientific principles at various stages of the process; but the theory is not established by existing scientific evidence. One may think the development of life can be entirely explained without any reference to design (beyond the obvious ability of organisms to replicate their own characteristics) or with reference to an order or design that is not intelligent. And future scientific evidence might support one of those alternatives to intelligent design.

#### D. *Domains of Science and Science Courses*

Could "scientific" creationism and intelligent design qualify as science, or belong in a science course, if they were sufficiently plausible?

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156. KITCHER, *supra* note 2, at 63.

157. *Id.* at 159; *see also id.* at 155-64.

158. One might, of course, believe that God has made things so that our rational faculties will be deceived about reality; but if one accepts that premise, it is hard to know how one should understand the scientific enterprise generally.

In a decision striking down Arkansas's Balanced Treatment Act, Judge Overton wrote that the "essential characteristics of science are: (1) it is guided by natural law; (2) it has to be explanatory by reference to natural law; (3) it is testable against the empirical world; (4) its conclusions are tentative, i.e., are not necessarily the final word; and (5) it is falsifiable."<sup>159</sup> According to Judge Overton, creation science fails each of these criteria. Supernatural creation is neither guided by, nor explained by reference to, natural law. It is not testable against the empirical world; it is not falsifiable; and, given the commitment of creation scientists to the Genesis account, its conclusions are not regarded as tentative.<sup>160</sup>

Larry Laudan, a philosopher of science, responded to Judge Overton's opinion as "reached . . . by a chain of argument which is hopelessly suspect."<sup>161</sup> Because creation scientists make claims of fact, for which there is relevant scientific evidence, their claims are testable and falsifiable. It is true that not every claim of creationists is testable, but "it is now widely acknowledged that many scientific claims are not testable in isolation either, but only when they are embedded in part of a larger system of statements, some of whose consequences can be submitted to test."<sup>162</sup> If many claims of creationism are testable, then *the theory is revisable*, whatever may be the opinions of most creation scientists.<sup>163</sup> Laudan also pointed out that scientists may try to establish the existence of a phenomenon before they are able to explain it in a law-like way.<sup>164</sup> As of 1982, this was true about the theory of plate tectonics, and at the time of Darwin's *The Origin of Species*, it was true about major aspects of his own theory. Thus, the failure now to be able to explain how creation occurred does not necessarily disqualify creation science from being science.

Lamenting Judge Overton's anachronistic efforts to revive a variety of discredited criteria for distinguishing between the scientific and nonscientific, Laudan concluded, "The core issue is not whether creationism satisfies some undemanding and highly controversial definitions of what is scientific; the real question is

159. *McLean v. Ark. Bd. of Educ.*, 529 F. Supp. 1255, 1267 (E.D. Ark. 1982).

160. *Id.* at 1267-68.

161. Larry Laudan, *Commentary on Ruse: Science at the Bar—Causes for Concern*, in CREATIONISM, SCIENCE, AND THE LAW: THE ARKANSAS CASE 161-66 (M. LaFollette ed., 1983) (Larry Laudan, *Science at the Bar: Causes for Concern*, in MURPHY, *supra* note 1, at 149).

162. *Id.* at 151.

163. *Id.* at 151-52.

164. *Id.* at 152-53.

whether the existing evidence provides stronger arguments for evolution than for creationism.”<sup>165</sup>

### 1. Evolutionary Theory as Science

In the course of evaluating the scientific credentials of evolution and creationism, Philip Kitcher comments on the nature of scientific theories. Simple, popular ideas that scientific theories must necessarily be able to predict consequences or are necessarily falsifiable individually (naïve falsification) are misguided.<sup>166</sup> “[N]o major scientific theory has ever exemplified the relation between theory and evidence that the traditional model presents.”<sup>167</sup> What is true is that a scientific theory must have observational consequences, that it must be capable of being true or false. Three characteristics of successful science are independent testability, unification, and fecundity.<sup>168</sup> Independent testability occurs when one can “test auxiliary hypotheses independently of the particular cases for which they are introduced.”<sup>169</sup> Unification involves applying problem-solving strategies to a broad range of cases. Fecundity is the opening up of new lines of investigation.

By these criteria, evolution easily qualifies as science. Against creationist attacks that it is not really science, Kitcher responds that evolutionary theory is highly successful science. Not only has it solved problems, it “has unified biology and it has inspired important biological disciplines.”<sup>170</sup> Kitcher concludes after an examination of the claims of creationists that creation science is not genuine science.<sup>171</sup>

Why exactly might creation science not qualify as science, and do these reasons apply to the more modest theory of intelligent design? We can identify at least four conceivable grounds for disqualification. First, creation science posits a Divine Creator, which is not a scientific concept. Second, it provides an explanation that is not according to natural laws. Third, its proponents are not open to contrary evidence, and the theory is, therefore, not revisable or falsifiable. Fourth, little scientific evidence favors it; its arguments against most aspects of evolutionary theory are unconvincing and, in any event, do not establish its own truth. We have already concluded that creationism in the

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165. *Id.* at 154.

166. KITCHER, *supra* note 2, at 35–42.

167. *Id.* at 42.

168. *Id.* at 48.

169. *Id.*

170. *Id.* at 54.

171. *Id.* at 124–25.

literal Genesis version has little scientific plausibility; were that all that were involved, it would be hard to say whether creation science is exceptionally bad science or not science at all.

As we examine the other three possibilities, our final concern is what belongs in a science course, not precisely what constitutes a scientific theory.

## 2. Reference to Divine Intelligence

Insofar as the terms of creation science refer to a nonscientific Divine Creator, we can substitute “abrupt appearance of species in complex form” for “Divine Creation.” The language of “abrupt appearance” avoids making any explicit theological claim, while maintaining the idea that “kinds” of animals did not evolve from lower species. But “abrupt appearance” still fails to provide a scientific explanation for how it occurred and, thus, points to a creative force not explicable in terms of scientific explanations to which human beings are privy. The idea of intelligent design, though not specifying what form the intelligence beyond natural cause might take, suffers a similar disability.

However, a theory is *not* necessarily unscientific because its truth bears on the likelihood of some religious tenet. Suppose skeptical researchers replicate the experiment involving prayer by strangers and obtain similar positive results. A thousand studies to this effect would not *prove* the existence of a divinity (or devil) who intervenes in human affairs. The results might be explained by a power of mental telepathy no one yet understands.<sup>172</sup> Although showings that prayer consistently yields highly improbable favorable outcomes would not prove a divinity, it would constitute *some evidence* for that proposition. That would not make the studies, or their conclusions about prayer, unscientific and religious.

Many people believe that the Big Bang theory of the beginning of the universe fits more comfortably with the idea of a God

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172. Insofar as studies of prayer and illness have suggested that prayer helps people recover from serious physical ailments, the explanation may be that their mental states differ importantly from those of people who do not pray. See GOLDBERG, *supra* note 22, at 40–47. Goldberg writes, “When an individual prays for his own improvement, it is difficult to separate the power of prayer from the placebo effect, that is from the benefits that flow simply from the belief that one is doing something useful.” *Id.* at 42. Of course, that effect does not explain why prayer on behalf of others may be useful; but Goldberg, writing before the study of Korean women seeking to become pregnant, indicates that the scientific evidence that intercessory prayer, made without knowledge of the intended beneficiary, does help is weaker and more controversial than the evidence that prayer for oneself can help. GOLDBERG, *supra* note 22, at 42–43; see also *supra* note 84 and accompanying text.

who creates *ex nihilo* than the steady-state view of the universe, which used to be popular.<sup>173</sup> Acceptance of that theory as accurate might make a reasonable person think that a Creator was somewhat more likely than he previously thought.<sup>174</sup> This connection between its truth and the likelihood of a Creator does not make the Big Bang theory religious.

A theory about the development of species is not *necessarily* unscientific because it makes the existence of a Divine Creator seem more likely. On this point, Professor Kitcher has written, "Even postulating an unobserved Creator need be no more unscientific than postulating unobservable particles. What matters is the character of the proposals and the way in which they are articulated and defended."<sup>175</sup>

### 3. An Explanation That Is Not Fully Natural

That the explanations of creationists and intelligent design theorists seem to transcend scientific theory is a more troubling problem. Indeed, I think this turns out to be the central theoretical question about the status of intelligent design theory. Insofar as creationism purports to explain the development of life on the basis of religious authority rather than scientific evidence, it definitely moves from the realm of science into that of religion; but a proponent of intelligent design may claim only that species, individual organs, and molecular structures have appeared in a manner that now defies standard scientific explanations *and* seems likely to defy any future explanations that omit the action of some creative intelligence.<sup>176</sup>

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173. Behe suggests that steady-state theory always had a difficult time explaining much of the observational evidence from astronomy and that resistance to the Big Bang theory was based partly on its perceived religious implications. DARWIN'S BLACK BOX, *supra* note 122, at 244–46.

174. See Robert John Russell, *T=O: Is It Theologically Significant?*, in RELIGION AND SCIENCE 201–24 (W. Mark Richardson & Wesley J. Wildman eds., 1996); WARREN A. NORD & CHARLES C. HAYNES, TAKING RELIGION SERIOUSLY ACROSS THE CURRICULUM 147 (1998) ("If the big bang theory does not confirm creation *ex nihilo*, it is at least *consonant* with it . . .").

175. KITCHER, *supra* note 2, at 125. However, Murphy suggests that the most serious problem of creationist theory is: "how can scientific sense or intelligibility be given to creation as supernatural causation?" MURPHY, *supra* note 1, at 44.

176. Behe puts it this way: "No one would be foolish enough to categorically deny the possibility" of an "as-yet-undiscovered natural process that would explain biochemical complexity", but "no one has a clue how it would work" and "it would go against all human experience . . ." DARWIN'S BLACK BOX, *supra* note 122, at 203–04.

We need to recall, first of all, Laudan's point that scientists may establish that certain physical events happen, or have happened, although they do not yet have any plausible scientific explanation of *how* the events occur. Intelligent design is not disqualified from the status of science simply because it offers no present scientific explanation of how surprising changes may have occurred. Is intelligent design disqualified because proponents *also* claim that, on the basis of modern scientific evidence and understanding, natural explanations will never suffice to explain these changes?

Two points are crucially important here. The first is that we can never be sure that ordinary scientific explanations will always be unsatisfactory. What now seem miraculous medical cures may later become explicable scientifically. And, to revert to our prayer example, once scientists understand how mental processes work, they might develop a convincing explanation for the efficacy of intercessory prayer. A chemist may discover how life could naturally have developed from non-life three billion years ago. And, if human beings did not evolve from other species, we may later learn that they appeared on earth without any predecessor species because aliens from another galaxy put them there (a natural explanation).<sup>177</sup> So long as possible future accounts of life's development include theories that do *not* involve any creative intelligence that is beyond ordinary scientific explanation, we cannot be confident that a full understanding requires such a creative intelligence.

The second point is that it is not reasonably part of science to be certain that a *scientific* explanation is conceivable for every physical event that occurs in the universe. Many people, including many scientists, may believe that, in principle, science could explain everything (except perhaps the exact movements of particles); and scientific explanations have undoubtedly been forthcoming for various events that human beings once believed could not be explained by science; but it is a stretch to *assume* that science can explain everything factual. Advocates of Genesis creationism and intelligent design claim that the available scientific evidence suggests that a purely scientific explanation of the origin of species is not only not now forthcoming, but is unlikely in the future. So understood, the theories, relying on scientific evidence, are partly about the limits of science.

This insight is very important for whether intelligent design could qualify as science or belong in a science course. A particu-

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177. Sir Francis Crick has proposed that life on earth may have begun when aliens seeded the planet with spores sent by a rocket ship. *Id.* at 248–49.

lar theory that science “runs out” in some respect *is* subject to observation and to falsification. If new evidence is produced or scientific understanding of available evidence increases, scientists can explain what was heretofore not explicable in scientific terms.<sup>178</sup> We could not, of course, expect *an explanation of occurrences that is according to natural laws*, when the whole point of a theory is that in all probability natural laws cannot explain all the data. That would be a little like saying that an investigation of a claimed miracle cannot have been scientific if it concludes that no natural explanation can be given for what has taken place. We might conclude that theories about where science runs out are not themselves *scientific theories*, although they rely on empirical data and are about the limits of scientific explanation.

The idea that creation science and intelligent design theory are about the limits of science is a central assumption in what follows, and it is worth pausing over it. Although I am not claiming that any sharp line exists between ordinary observation and science, between ordinary observation and religion, or between positive theses and theories of limits, I nonetheless believe we can best understand creationism and intelligent design theories as being about the limits of science.

If a scientist ascertains the length of a day on a planet in another solar system, using the most advanced technology, we regard that as a scientific discovery. Yet the method of learning is no different from our ordinary experience that the time between one sunrise and the next is approximately what we have arbitrarily labeled as twenty-four hours. In his famous argument for design, William Paley said that if he finds a watch in a heath, he knows it has been designed.<sup>179</sup> Had we traced the origin of two thousand watches randomly chosen and found that all were designed by human beings, we might call this a scientific conclusion. As it is, we know that many watches have been designed, and we can't imagine how else they would be generated. Ordinary common sense tells us the watch in the field is designed.<sup>180</sup>

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178. It seems doubtful that a theory that science runs out should necessarily be unifying or fecund in the manner that Kitcher supposes successful science should be, since it might or might not be true that science runs out in similar ways across different subject matter areas.

179. WILLIAM PALEY, *NATURAL THEOLOGY; OR EVIDENCES OF THE EXISTENCE AND ATTRIBUTES OF THE DEITY. COLLECTED FROM THE APPEARANCES OF NATURE 9–10* (New York, American Tract Society 1809).

180. See WOLTERSTORFF, *supra* note 59, at 60 (remarking that a fisherman who says that fish will not bite after heavy rains is “propounding a theory”; “scientific activity is not to be differentiated from other human activities on the ground that it deals with theories, not even . . . theories of a special kind”).

In a somewhat similar way, ordinary observation can shade into, or shade toward, religious conclusions. If I observe a particular faith healer, invoking the power of Jesus, perform one amazing cure after another (and I somehow satisfy myself that more than fraud and more than suggestive influence on the afflicted is involved), I have strong evidence that the healer is tapping some extraordinary power, and I have weaker evidence that Jesus has some special status, a religious conclusion. If prayers to God for rain consistently brought rain, I would have some evidence that responses of a supernatural power to prayer could affect natural physical processes, a religious conclusion. And, as we have seen, a “scientific” experiment might also provide evidence for the power of prayer.

Could a claim about supernatural causation of life’s development be *part* of a scientific explanation?<sup>181</sup> We may begin with the possibility that a Creator has acted purposefully but for reasons we do not understand. Some may doubt whether such a claim involves an *explanation* at all.<sup>182</sup> It does involve explanation in a sense—it attributes a physical event to a powerful intelligent actor rather than to ordinary natural forces or another actor. It involves an explanation to roughly the same degree as the following comment: “Why did A die? B shot him, but I haven’t the foggiest notion why.” If one has no idea why the Creator has acted as the Creator has, one certainly has no scientific explanation for what has occurred.<sup>183</sup>

Suppose that we had the kind of knowledge of supernatural motivation that we find in Greek myths and the Bible. Zeus punished Prometheus because he was angered by his presumption; God parted the Red Sea so his chosen people could escape. Here our knowledge would be like that we have about the historical actions of individuals. We have some causal explanation, but not one formulated in terms of general principles or laws. (Of course, one might say that lurking in the background of any such causal explanation is the implicit idea that similar conditions would produce similar actions by similar individuals; but, whatever merit this view may have for ordinary historical explanations, it seems inapt as applied to an omnipotent God.)

Finally, we might think we do have an explanation formulatable in terms of a general principle, such as “God responds favor-

181. For the view that science cannot accommodate supernatural explanations, see PENNOCK, *supra* note 2, at 189–94.

182. On the ambiguity of the term “explanation,” see *id.* at 185–89.

183. Michael Behe urges that one can infer design “without knowing anything about the designer.” DARWIN’S BLACK BOX, *supra* note 122, at 97.



ably to every sincere prayer.”<sup>184</sup> If the basis for the explanation were evidence of a scientific sort, we might think the explanation itself should be viewed as scientific, expanding our view of what science covers beyond natural processes to supernatural processes subject to law-like explanations. (We could imagine a version of intelligent design theory that acknowledged that all aspects of the development of life could be explained *naturally*, according to ordinary scientific principles, but that the existence of these principles showed intelligent design.)<sup>185</sup>

When I say that creation science and intelligent design theory are about the limits of scientific explanation, I mean roughly that they do not offer an explanation of why a Creative Spirit acts that depends on scientific or ordinary observational evidence or an explanation of physical events that can be cast in terms of general principles, much less principles of a scientific sort.

Do theories about the limits of science belong in science courses? When one cuts through the rhetoric and wildly differing estimates about whether evolutionary theory, in roughly its present form, provides an adequate explanation for the development of life, this issue emerges as a central conflict between those who think intelligent design is a proper topic and those who think it is not.

A debate before the Ohio school board, as reported by *The New York Times*, is highly instructive.<sup>186</sup> According to the story, critics of intelligent design “warned that speculative theories of some ultimate agent underpinning evolution were the antithesis

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184. It might reasonably be objected that this formulation is too vague to be a general principle, since “responds favorably” could cover so many different kinds of response other than satisfaction of specific requests.

185. Usually when someone sees that an object is intelligently designed, she will have some rough idea about the purposes of the designer. She may have a pretty good idea of the immediate functional purpose (“so that blood may clot”) and a more limited idea of more ulterior purposes (“so that animals may survive,” “so that animals may flourish”). Thus, contrary to what Behe intimates, when one infers a design, one usually can infer something about the designer. DARWIN’S BLACK BOX, *supra* note 122, at 183. Behe concluded that “[t]he question of the identity of the designer will simply be ignored by science,” *Id.* at 251. This is somewhat arbitrary if it forecloses all inferences about what the Creator might be like. Such a limit might be justified if based on a sense that scientific evidence yields a high probability of intelligent design but little information about the designer.

186. Francis X. Clines, *Ohio Board Hears Debate on an Alternative to Darwinism*, N.Y. TIMES, Mar. 12, 2002, at A16. A further discussion, including comment on the resolution of the Ohio board, took place on Talk of the Nation. *Talk of the Nation: This Science Friday* (Nat’l Pub. Radio broadcast, Nov. 8, 2002), available at [http://www.sciencefriday.com/pages/2002/Nov/hour1\\_110802.html](http://www.sciencefriday.com/pages/2002/Nov/hour1_110802.html) (on file with the Notre Dame Journal of Law, Ethics & Public Policy).

of true science."<sup>187</sup> Darwin's theory had grown by "repeated experimentation and discovery that intelligent design had not been subject to."<sup>188</sup> One critic, Dr. Lawrence Krauss, said that proponents of intelligent design "were trying to force 'unanswerable questions' about some theoretical instigator of life onto a school curriculum properly limited to the rigorous proofs of science."<sup>189</sup> Another critic, Dr. Kenneth R. Miller, complained that claims of intelligent design "had not been submitted to peer review the way other theories must be tested to be scientifically accepted."<sup>190</sup> A proponent of intelligent design, Dr. Stephen C. Meyer, countered that "'the methods of science are part of the debate' that teachers should air."<sup>191</sup>

If intelligent design theorists contend that dominant natural explanations can only partly explain the development of life, and that a supplement of intelligent creative action is required, it is a little hard to know what "experiments" of their own they should be expected to produce and why they may not legitimately rely heavily on the evidence and explanations of evolutionists, arguing for the unpersuasiveness of the explanations.<sup>192</sup> And how can their own explanation be subjected to "the rigorous proofs of science" if the explanation is not in terms of natural causes?<sup>193</sup>

In this debate, evolutionists are implicitly claiming that theories about where scientific explanations may fall short do not belong in science classes; proponents of intelligent design strongly disagree. The answer to this fundamental theoretical issue is that the limits of science could be an appropriate subject for science courses; but this answer needs explication, and it may

187. Clines, *supra* note 186.

188. *Id.*

189. *Id.*

190. *Id.*

191. *Id.*

192. Behe proposes research into what systems are irreducibly complex and thus the product of design. DARWIN'S BLACK BOX, *supra* note 122, at 230–31. But these are not experiments "to prove" that such complex systems could only be the fruit of intelligent design.

193. About an individual claimed miracle, one might come close to ruling out a natural explanation; the rigorous proofs of science might be employed to show that a scientific explanation is not possible. It is hard to conceive of that happening for the history of the development of life, about whose details we are much more substantially ignorant, although Behe does claim that the inference to intelligent design from irreducibly complex systems is very powerful. *See id.*

Peer review is a more complex issue. In theory, there is no reason why scientists should not carefully review arguments made about the limits of science. But many scientists may not consider that to be within their domain.

have little practical bearing on whether schools should teach intelligent design.

We need first to distinguish between two kinds of limits. Roughly speaking, we can divide limits of the subject matter of science from limits within the range that scientific principles ordinarily cover. Science cannot explain why people should be ethical<sup>194</sup> or why anything exists at all.<sup>195</sup> These limits are intrinsic limits, set by the nature of the scientific enterprise. These intrinsic limits might well be mentioned in science courses, but their full development is not within the domain of science. But suppose a subject matter does fall broadly within the domain of science, and yet scientific evidence suggests that no natural explanation suffices for what has happened. So it is with claims of medical miracles and of interventions in the development of life. If convincing evidence of such limits lies within science itself, their analysis appropriately falls within the scope of science courses. To draw an analogy, a course in economics or political science would properly discuss the reasons why models fall short of predicting real world consequences.<sup>196</sup>

Scientists might concede the logic of this suggestion and deny its practical relevance. According to the premise of methodological naturalism, scientists proceed on the assumption that natural explanations will be forthcoming for physical events that are now inexplicable. That premise has proven extremely productive; and we have nothing close to convincing evidence that science will not be able to explain the development of life in the future. Scientists themselves cannot proceed without fruitful research programs,<sup>197</sup> and theories about limits may not provide these.<sup>198</sup> Rather than talk about limits, perhaps science teachers should follow scientists and tell students that science looks for natural explanations.

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194. Science might explain why people have come to value what they do, and it might show that ethical behavior helps preserve the species; but any such explanations fall short of providing reasons why people otherwise inclined, and caring more about their own satisfaction than human survival, should act ethically.

195. If science *can* explain how matter originated, it cannot explain why there was anything with the potentiality to turn into matter.

196. Because these subjects deal mainly with contemporary phenomena, and the limits concern human behavior, it is easier to design research that can establish the limited effectiveness of models for prediction than can be the case for possible interventions by God millions of years ago.

197. For a general discussion of this, see the two essays by Imre Lakatos cited *supra* note 120.

198. *But see supra* note 192 and accompanying text.

Although a strong connection exists between what practicing scientists do and the content of science courses, the teacher should explore certain issues the scientist may put to one side. Ideally, a science teacher or text might say something like this:

Modern science rests on an assumption that natural explanations can be given for physical events. We cannot be certain that natural explanations will always suffice, but physics, chemistry, and biology have made amazing advances by indulging in that assumption. Were there powerful evidence that science could not conceivably explain some phenomena, this evidence of limits would belong in science courses;<sup>199</sup> some people believe such evidence exists about evolutionary processes, but it is too soon to conclude that any difficulties with evolutionary theory cannot be rectified by scientific explanation.<sup>200</sup>

#### 4. Close-mindedness

Our third possible difficulty with creation science is that its proponents are not open to evidence that counts against their theory. No doubt, receptivity varies to some degree, but members of important creation science organizations, the Creation Research Society and the Institute for Creation Science, must affirm—indeed, must *take an oath*—that they believe in the Genesis account of creation.<sup>201</sup> Could such adherents possibly be genuine scientists about the origins of life?

We need to distinguish conceptual possibilities from probable realities. A scientist might have the following attitude: “I believe strongly in the Genesis account on religious grounds, but when I am working as a scientist I stick strictly to standard scientific methods. As a scientist, I am completely open to evidence that counts against Genesis. If strong contrary evidence actually

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199. One might think that such limits should be a small part of the subject matter of *science*, even if total exclusion is unwarranted.

200. I am not suggesting that these very words are the right ones to speak to ninth or tenth graders, but I am confident the ideas they express can be communicated to high-school students. Here is how Philip Kitcher put the views of a thoughtful evolutionist:

The evidence for the universal relatedness of life is compelling. Further, we know of a number of natural processes that have produced evolutionary change. We can't always say for sure which of these has been operative at which stage of life, nor do we know that our inventory of possible mechanisms is complete, but, on the evidence we have, there's no reason to think that any supernatural process was needed in the evolution of organisms.

Kitcher, *supra* note 118, at 272.

201. NELKIN, *supra* note 1, at 79–81.

existed, I would then have to decide whether I trusted religious authority more than scientific method.” Notice that even if our creationist were certain in advance that he would give more credit to religious authority, he could still be open to the possibility that scientific evidence would fail to support religious truth. Quite apart from the scientist’s own beliefs, he might propound a theory that was open to observational evidence.

When we turn from these conceptual possibilities to real life, we must acknowledge that those who are certain on religious grounds that Genesis is literally true are not the best people to consider the scientific evidence in a suitably detached way.<sup>202</sup> Their strong precommitments should render anyone who does not share their religious premises suspicious of their scientific claims. We might expect that their enterprise is seeking all available evidence and theory to support an account they already know is true, *not* to undertake a fair appraisal of the balance of scientific evidence.<sup>203</sup>

Someone who believes only in an undefined degree of intelligent design has much less of a precommitment.<sup>204</sup> He can be open to the possibility that science will establish other explanations for what he now thinks can best be explained by intelligent design.<sup>205</sup> Although most proponents of intelligent design undoubtedly have religious reasons for resisting the persuasiveness of the neo-Darwinian synthesis,<sup>206</sup> that alone is not an adequate reason to discount their arguments about its *scientific* inadequacy. Were it the case that proponents of intelligent design did not take their own scientific arguments very seriously, but saw intelligent design as a means to get as much religion as

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202. This will be especially true if they are firmly convinced, on theological grounds, that scientific evidence *must* support the account revealed to be true by religious authority.

203. I do not mean to imply that all neo-Darwinians who view evidence against natural selection make a “fair appraisal” and consider the evidence “in a suitably detached way.” However, evolutionists are less committed to specific details about life’s development. According to Nicholas Wolterstorff, we all, including scientific experts, have “control beliefs” that affect our evaluation of proposed theories: “the person who exhibits authentic Christian commitment cannot take for granted that the data beliefs and theories of contemporary scientists are true.” WOLTERSTORFF, *supra* note 59, at 78.

204. Such a person may or may not be open to the possibility that non-life became life according to some natural explanation, to the possibility that all complex life-forms developed from one-cell life, and to other possibilities that Genesis creationists deny.

205. See NORD & HAYNES, *supra* note 174, at 142–43, 158–59.

206. It is also true that many evolutionists think intelligent design is *not* plausible, because they reject its religious assumptions.

possible into teaching about the development of life,<sup>207</sup> stronger reasons would exist to discount what they say about science without close examination.

In its typical Genesis form, creation science does not belong in the science curriculum. Either it is non-science or very bad science. It does not present a reasonable scientific explanation of the development of life on earth, and it lacks substantial argument and evidence that anything other than Darwinian evolution is the primary explanation for that development. The appeal for “fair treatment” is misplaced. School students should not be expected to choose between a powerful scientific theory and one without merit that happens to coincide with many of their religious beliefs. As Kitcher says, “It is educationally irresponsible to pretend that an idea that is scientifically worthless deserves scientific discussion.”<sup>208</sup>

However, science teachers should cover the evidential gaps and controversies surrounding the neo-Darwinian synthesis. Any evidence for some kind of order or design, intelligent or otherwise, should be fairly presented. Teachers should indicate present uncertainties by no means show that the dominant theory, or the dominant theory supplemented by novel scientific principles, will not be able to explain everything important in the future. They should explain that if the development of life has proceeded partly on the basis of some order that neo-Darwinian theory neglects, that order may or may not reflect an intelligent design. Science teachers should *not* get far into the question of whether any principles of order in evolution, were they to exist, would come from a Creative Intelligence.<sup>209</sup>

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207. Some evolutionists seem to view Phillip Johnson in this way, relying partly on his characterization of his aims as “the Wedge strategy.” See Barbara Forrest, *The Wedge at Work: How Intelligent Design Creationism Is Wedging Its Way into the Cultural and Academic Mainstream*, in INTELLIGENT DESIGN CREATIONISM AND ITS CRITICS, *supra* note 15, at 5–53. As Johnson himself employs the term, it refers to splitting open the “apparently solid log” of “the ideology of scientific naturalism.” *Id.* at 13. See generally PHILLIP JOHNSON, *THE WEDGE OF TRUTH: SPLITTING THE FOUNDATIONS OF NATURALISM* (2000).

208. See JOHNSON, *supra* note 207, at 174.

209. This sentence implicitly rejects the conclusion of Michael Behe and others that an inference from complexity to *intelligent design* is very powerful. In part, this rejection is based on my own sense that one cannot move so easily from the complexity that signals intelligent design in ordinary life to what signals such design in basic life processes. In part, the rejection is based on the limited degree of acceptance the theory has among scientists.

## VIII. TEACHING RELIGION

Thus far, I have concentrated on what counts as science or belongs in a science course. It is time now to approach our topic from a different perspective, the one that matters for constitutional law. What counts as teaching religion, and does that have any place in a public school curriculum? In this section, I focus on the responsibilities of educators; but the topic of teaching and religion bears heavily on judicial enforcement of the Establishment Clause, to which the last section is devoted.

Here, we need to examine four questions. What counts as the teaching of religion? Does that category include decisions *not* to teach material? What should schools say about the aspirations of science as compared with other ways of understanding? How far should educational authorities respond to the religious sensibilities of parents? I assume that educators themselves should be substantially guided by the values of the religion clauses, and particularly the principle against teaching any religious propositions as true.

A. *Teaching Religion: Creationism*

Teaching creationism in its full-blown, literal Genesis version is teaching religion, even if the material is taught as creation science, scripture is not mentioned, and terms like “abrupt appearance” are substituted for Divine Creation. The difficulty is not that the theory has implications for some religious propositions, it is the absence of any real scientific basis for the theory. One could believe in the theory only for religious reasons.

Although creation science purports to rest on science, it has won extremely little support from mainstream scientists.<sup>210</sup> Douglas Futuyma has called the work of creation scientists a “caricature of science . . . [based upon] no evidence.”<sup>211</sup> Philip Kitcher has remarked that they “have constructed a glorious fake” useful “to illustrate differences between science and pseudoscience.”<sup>212</sup> Creation scientists are often explicit that they begin from a full belief in the literal truth of Scripture; Judge Overton commented that creationists “do not take data, weigh it against the opposing scientific data, and therefore reach . . . conclusions . . . . Instead, they take the literal wording of the Book of

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210. See GOLDBERG, *supra* note 22, at 33.

211. DOUGLAS J. FUTUYMA, *SCIENCE ON TRIAL: THE CASE FOR EVOLUTION* 21 (1995).

212. KITCHER, *supra* note 2, at 5.

Genesis and attempt to find scientific support for it.”<sup>213</sup> Creation science is not genuine science because neither its theses nor the techniques of its practitioners are genuinely scientific, and its conclusions conflict with the overwhelming weight of scientific evidence;<sup>214</sup> what makes the theory religious is that religious premises explain why the practitioners reach the conclusions they do.<sup>215</sup>

Creation science does not become less religious if it is taught as a plausible alternative to evolution, rather than being presented as the truth. One cannot believe that creationism, with its claims that the earth is new and that all kinds were created at the same time, is a remotely plausible account of how life developed on earth, except on religious grounds. Creation science remains religious if it is taught as one of two plausible alternatives.

What of the status of intelligent design? If the theory accepts most of the features of the neo-Darwinian synthesis, including natural selection as an explanation for many developments, it does not conflict sharply with what scientists can comfortably assert. On my present state of understanding, I think scientists looking at the scientific evidence can reasonably doubt the power of natural selection to explain *as much* as is often claimed for it; further, I think a scientist might reasonably suppose that some as yet unexplained idea of order or design is a plausible explanation for some of the changes that seem most difficult to explain by natural selection. However, as we have seen, there could be principles of “design” in the evolutionary process that do not involve *intelligent* purpose, just as we can find “design” in the growth of embryo to baby without assuming intelligent design. To assert that problems with evolutionary theory must be resolved by intelligent design is to rely on a religious premise; all one could say based on science is that intelligent

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213. *McLean v. Ark. Bd. of Educ.*, 529 F.Supp. 1255, 1269 (E.D. Ark. 1982).

214. One might take a “subjective” approach and ask whether creation scientists *believe* that their conclusions are scientifically grounded, but this approach seems unpromising, both because it is hard to know just how various creation scientists conceive science and what they *really* believe about their “science.”

215. Stephen L. Carter, *Evolutionism, Creationism, and Treating Religion as a Hobby*, 1987 DUKE L.J. 977, 980–82, and NORD & HAYNES, *supra* note 174, at 134–42, assume that creationism is a religious, not a scientific theory, despite their substantial empathy with the basic perspectives that underlie creationism.



design is one possible component of a full theory of how complex life developed.<sup>216</sup>

### B. *Decisions Not to Teach Evolution*

Can a decision not to teach a subject matter amount to a teaching of religion? If a subject matter, according to standards within the discipline, would be taught but for religious views, and it is not taught because of religious views, it amounts to a kind of teaching of religion. The religious view is not itself directly taught, but ideas that are opposed to the religious view are suppressed for religious reasons.

As we have seen, scientists regard evolution as by far the most convincing scientific explanation for the development of species. In the debate before the Columbus Board of Education, Dr. Krauss estimated that scientists would line up roughly 10,000 to 1 against teaching intelligent design.<sup>217</sup> Although scientists do not agree completely on scientific techniques or on the limits of science, they think alike about what constitute convincing scientific explanations. By scientific standards, evolutionary theory wins easily over any radically different alternatives.<sup>218</sup> In any biology course developed without respect to religious opinions, evolution would figure prominently, with whatever reservations might be offered about gaps and uncertainties. Were evolution not taught only because it conflicts with religious views, religious premises would be dictating the content of the curriculum—albeit in the negative form of causing material to be omitted.

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216. David K. DeWolf, Stephen C. Meyer, and Mark Edward DeForrest develop the argument that teaching intelligent design is not teaching religion. David K. DeWolf, *Teaching the Origins Controversy: Science, or Religion, or Speech?*, 2000 UTAH L. REV. 39; see also DAVID K. DEWOLF ET AL., INTELLIGENT DESIGN IN PUBLIC SCHOOL SCIENCE CURRICULA: A LEGAL GUIDEBOOK (1999), available at <http://arn.org/docs/dewolf/guidebook.htm> (on file with the Notre Dame Journal of Law, Ethics & Public Policy). Jay D. Wexler takes a contrary view. Jay D. Wexler, Note, *Of Pandas, People, and the First Amendment: The Constitutionality of Teaching Intelligent Design in the Public Schools*, 49 STAN. L. REV. 439 (1997).

One possible position is that teachers should encourage class discussion and even express their own opinions about what is true overall, including components of religious judgment, though making clear that the school has no official position. I argue for a more constrained approach to discussing religious tenets in *Teaching About Religion*. *Teaching About Religion*, *supra* note 44.

217. See Clines, *supra* note 186, at A16. I do not take this “estimate” as a serious effort to determine an actual ratio, but rather as an indication that research scientists overwhelmingly find evolution to be the most convincing account.

218. In this sentence, I do not take the theory that evolutionary theory is substantially accurate, but that causal explanations of life’s development need a supplement of something like design, to be a radically different alternative.

Such a decision would be unfaithful to the idea that the state must remain neutral about religion.

What is true about deciding *not* to teach evolution is also true about a decision at the state level to leave evolution off the required curriculum and not to make it a topic on state examinations. It is also true about teaching evolution as only “a theory,” if the implication is that it is less well confirmed than most scientific explanations.<sup>219</sup> If either of these downgradings of evolution is done for religious reasons, the competing religious approach is being promoted, though to a lesser degree than if the teaching of evolution is forbidden.

An opponent of teaching evolution might respond that if a school teaches evolution as the leading explanation of species development, it takes a position *against* religion. This would be a mistake. It is correct that if evolutionary theory is accurate, some religious accounts of the development of life are mistaken; and it is also correct that evolutionary theory has disturbing implications for certain religious (and some other) perspectives on morality.<sup>220</sup> But various government policies, such as desegregating schools and fighting wars, imply that certain religious positions are misguided, and some school instruction inevitably offends particular religious views. If the criteria for what is taught as true do not rest on any religious judgment, a conflict with some religious opinions does not establish that the state is taking an antireligious position.<sup>221</sup>

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219. See the requirement adopted by the Cobb County School District, Georgia, that texts covering evolution have a sticker with a disclaimer on their covers. Cobb County Bd. of Educ., *Approval of Purchase of Science, Health and Physical Education Textbook Adoption* (Apr. 17, 2002), available at <http://board.docs.cobbK12.org/Board.nsf/Public?OpenFrameSet> (on file with the Notre Dame Journal of Law, Ethics & Public Policy). Compare *Freiler v. Tangipahoa Parish Bd. of Educ.*, 185 F.3d 337 (5th Cir. 1999), cert. denied, 530 U.S. 1251 (2000). Among aspects of evolutionary theory, an “old earth” and “descent with modification” are established to a greater degree of certainty than the dominant role of natural selection. See MILLER, *supra* note 12, at 53. Miller writes that descent with modification “is as much a fact as anything we know in science.” The “detailed mechanism of change is *theory*,” but that is not “haphazard guess.” *Id.* at 54; see also PENNOCK, *supra* note 2, at 177 (commenting that many “parts of evolutionary theory . . . are also all facts”). Nord and Haynes say generally that a scientific theory “is not a hypothesis or (mere) speculation, but a comprehensive conceptual scheme that relates a broad range of phenomena in a way that provides explanatory power.” NORD & HAYNES, *supra* note 174, at 157.

220. See generally MURPHY, *supra* note 1.

221. This issue is explored in somewhat greater depth in *Teaching About Religion*, *supra* note 44.

### C. *Science and Other Ways of Understanding*

This problem, however, raises more subtle and difficult questions about *how* evolution is taught as true: questions about the authority of scientific claims of truth, and the relation between science and other methods to reach judgments about reality. These questions are far deeper and more general than the particular issue about evolution, creationism, and intelligent design.<sup>222</sup>

Because many scientific theories are overthrown and revised as understanding increases, one would be foolish to think that just the presently dominant scientific accounts of evolution contain no errors or omissions.<sup>223</sup> Understanding about aspects of evolution may well change, a reality sometimes summed up in the misleading statement that “Evolution is *only* a theory.”

What is misleading about the statement is that it obscures degrees of likelihood of revision, and the relation of evolution to other scientific theories. Before William Harvey’s discoveries in the seventeenth century, scientists did not understand that blood circulates (from the heart back to the heart) in the bodies of mammals. We now have evidence of various sorts, apparently irrefutable, that blood does circulate. The chance that this scientific finding will be overthrown is extremely slight; one would not now speak of a mere “theory” that blood circulates, although that scientific claim, like others, is potentially open to revision. More generally, much of evolutionary theory is no more insecure than many other prominent scientific views. It seems extremely unlikely that scientists will discover that the earth has existed only 6,000 years, that simple species did not precede complex ones, and that natural selection had no role in the development of life. If the term “theory” is here used to mean “not established to a high degree of probability,” that is at most true about only some aspects of evolutionary theory and, in particular, its claim to provide a full explanation of life’s development.<sup>224</sup>

The relation of science to other means of discerning truth is a more complicated subject, one we have already looked at in the discussion of using all relevant sources of truth. To recapitulate, do scientists tell us what really is true or do they tell us only what is supported by scientific inquiry and standards? The traditional

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222. See NORD & HAYNES, *supra* note 174, at 134–35.

223. I mean here omissions about basic explanation. Everyone agrees that there are omissions in the sense of accounting for why particular changes happened.

224. See discussion in note 219, *supra*.

aspiration of science has been to reveal what is really true.<sup>225</sup> Science may not discover all truth but what it does discover is true, insofar as it is accurate. Some people have always resisted the view that science reliably indicates what is true. If the Bible is the authoritative word of God, perhaps it is a better source of what is true overall than any purely human discipline;<sup>226</sup> after all, God the Creator *could* have made us and the world so that the world appears to be older than it is,<sup>227</sup> with a fossil record that does not accurately reflect stages of life. In an odd way, postmodernist approaches to knowledge support this kind of claim to a degree.<sup>228</sup> If one believes that *all* human modes of thought are partial, ideological, and inevitably subjective, science may have no favored status over competing avenues to truth.

Warren Nord and Charles Haynes have suggested four basic attitudes people may take about science and religion.<sup>229</sup> They may think that their basic claims conflict and that (1) religion trumps or (2) science trumps,<sup>230</sup> or (3) that the two domains are independent, dealing with different ways of understanding,<sup>231</sup> or (4) that an integration is possible, that the two domains can be understood to be compatible and mutually illuminating.<sup>232</sup>

A crucial issue for public schools is just what teachers should say to students about these issues. Science teachers should explain something about scientific methodology, about how the claims of science are conceived, and about the possibility of com-

225. See KITCHER, *supra* note 49, at 11–82. Evolutionary biologists think the world is much older than 6,000 years in much the same sense as I assume that I am really sixty-six years old, not one or two hours old.

226. Stephen Carter notes that Christian fundamentalists not only perceive evolution as contrary to their religious faith; they believe “it is demonstrably false.” Carter, *supra* note 215, at 981.

227. According to Goldberg, a nineteenth-century preacher and scientist, Philip Henry Gosse, asserted that God had created the earth to appear to be old. Goldberg, *supra* note 22, at 27.

228. Nord and Haynes discuss postmodern challenges to the pretensions of science. NORD & HAYNES, *supra* note 174, at 41, 160.

229. *Id.* at 117–39.

230. In areas where science and religion overlap, a person might see some irreconcilable conflicts, without having a confident belief that either science (as presently understood) or religion (as presently understood) necessarily trumps the other. *Id.*

231. One version of this approach, as we have seen, is to say that science deals with empirical truth, religion with the spiritual domain of life and with ethics. See ROCKS OF AGES, *supra* note 46; Gould, *supra* note 46. One might think, instead, that both science and religion concern empirical truth but in radically incommensurate ways.

232. An individual may, of course, have an amalgam of these attitudes. He might think that some aspects of religion are in a wholly different domain from science but that an area of overlap exists.

peting perspectives, concluding that science itself cannot establish with certainty that its modes of inquiry about what is true in the external world are more reliable than alternatives,<sup>233</sup> although in many respects their scientific conclusions are confirmed by direct observations<sup>234</sup> and by real world consequences, such as successful medical results based on the assumption that blood circulates.<sup>235</sup> Science teachers cannot be expected to teach nonscientific alternatives to science in detail, but probably they should suggest how science fits among human ways of conceiving reality and why some members of the community believe there are more reliable ways of ascertaining truth than scientific inquiry.<sup>236</sup> Ideally, these alternatives should appear elsewhere in the school curriculum, say in history or in courses on comparative religion, where they can be given fuller treatment.<sup>237</sup>

A special problem concerning science and other ways of understanding arises when arguments for a particular position are mixed or when religious conclusions are taken as the basis for beliefs about science or vice-versa.

People have made scriptural or theological arguments for and against the truth of evolutionary theory. Evolution is not, or is, compatible with God, as we understand God from a religious perspective. These arguments are straight-forwardly religious. A science teacher may tell students about these arguments, but he should not discuss whether they are sound or unsound.<sup>238</sup>

The same conclusion holds for arguments that begin from the truth of evolution and proceed to atheist or theist conclusions. Although many evolutionists may be drawn to atheist perspectives, and not a few have forthrightly defended them, that is not the business of science. As I have said, the full truth of evolutionary theory is logically consistent with a Creator who both establishes natural principles and sustains their operation through time. Although someone may reasonably believe that evolutionary theory bears on the likely truth of atheism, the latter proposition is a religious one and is most especially not the busi-

233. See Carter, *supra* note 215.

234. On sonograms and similar devices, people can observe what they are told are their own hearts doing what seems to be pumping blood.

235. A thoroughgoing skeptic about science might say that observations are subjective (even when virtually everyone observes the same thing) and that successful practical results may have a different explanation than the truth of any particular scientific views. Various skeptical positions are discussed in KITCHER, *supra* note 49, at 11–82.

236. NORD & HAYNES, *supra* note 174, at 157–60.

237. See *id.* at 154 (suggesting that studying religious accounts of origins and nature could serve a valid secular purpose of liberal education).

238. See *supra* note 216 and accompanying text.

ness of science teachers in a polity in which schools are not supposed to teach the truth of religious perspectives. The same holds for arguments that evolution poses no threat to theism.<sup>239</sup>

The most troubling category includes arguments from imperfection for evolutionary theory and responses to that argument. It helps initially to distinguish a positive and negative aspect of the argument from imperfection.<sup>240</sup> The positive aspect is that, given a process in which developments occur according to imperceptible changes that build on the qualities of existing organisms, we should not expect anything approximating perfection in design. That aspect of the argument uncontroversially asserts that the life-forms we find correspond with what evolutionary theory says we should find. Challenges to that aspect of the argument also should uncontroversially fall within the domain of science and outside the domain of religion.

The negative aspect of the argument is different. It asserts that a Divine Creator, acting directly, would not have made such a hash of things; God, or at least the God assumed by Western religions, would not have designed so badly. Therefore, evolution is much more plausible than Divine Creation. This argument is one of religion, or religious philosophy. It begins from assumed characteristics of the Divine, and draws conclusions about what we should expect from such a being. Because this argument was made by Darwin and can be significant in a culture in which many people begin by assuming direct creation by God, a science teacher understandably raises the issue whether the record science reveals is what we should expect from a Creator acting directly. But the teacher should not attempt to resolve that question or discuss it in depth. The negative argument that a Creator would not have produced such imperfection, and the responses to it, fall on the religious side of the divide between science and religion.

#### D. *The Proper Influence of Parental Views*

If schools should not make major decisions about the science curriculum exclusively on the basis of religious views, does it follow that such views should have no influence on curricular decisions? We know that these views have had a great influence—on text publishers, state educational authorities, school boards, and teachers. But is this influence wrong in some sense?

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239. Notice that an argument that evolution and theism are compatible can be employed to defend evolution against creationism *and* to defend theism against atheism.

240. See PENNOCK, *supra* note 2, at 246–47.

This question is very complicated. We may distinguish science from some other forms of inquiry, the religious views of educators from those of parents, dominant influence from slight influence, and influence in marginal cases from influence over major decisions. On the first point, moral instruction, and perhaps literature and history, differ from natural science. If most parents regard a practice, such as premarital intercourse, as immoral, that is *a* reason for school authorities not to recommend it as acceptable to students.<sup>241</sup> It should not matter in this respect whether or not the source of the parents' opinions happens to be religious.<sup>242</sup>

On the second point, educators should not rely on their own religious perspectives in deciding what should be taught if standards of the discipline clearly yield one answer or another.<sup>243</sup> Nor should they allow strong parental objections based on religion to defeat teaching what standards of the discipline would definitely indicate.<sup>244</sup>

Whether religious views should play *any* role in choices about what science to teach is more debatable, but modest influence may be all right. Religion may figure as one reason among many for major curricular decisions, and it may play a more decisive part if the choice is between subjects of roughly comparable scientific importance for students. Very generally, the argument is that parental resistance can be one factor in curricular choices,<sup>245</sup> and that resistance based on religious views should generally not be treated worse than resistance based on other opinions formed from outside the discipline.<sup>246</sup> Perhaps educators' own religious views properly figure to some degree, but that is more debatable.

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241. However, it may still be desirable to encourage those students who choose to engage in intercourse to use methods of birth control.

242. See Carter, *supra* note 215, at 985–86 (suggesting that religious objections to material should not be treated less favorably than other objections).

243. I put aside here the position of educators who, influenced partly by their religious convictions, believe the discipline should be redefined to include something that is now omitted but which does not involve the teaching of religion. A claim that science should pay more explicit attention to possible limits of science may be viewed in this light.

244. The issue about yielding to parental objections is somewhat more arguable than the issue of educators relying on their own religious convictions.

245. On the other hand, one can imagine a science teacher wanting to teach a topic just because students need to understand that rigorous scientific methods can yield conclusions at odds with popular conceptions.

246. See discussion in *supra* note 232. What I say here about resistance to material would also apply to a wish that material be taught.

The practical upshot of this analysis for the modern controversy about the development of life is this: in science courses, evolution should be presented as the dominant theory, with a clear indication about any gaps and uncertainties, and with a suggestion that some people believe evolution is perfectly compatible with a religious view of the origins of life and that other people believe religious sources provide a truer source of insight when the teachings of religion and the findings of science conflict. Any proposed alternative to neo-Darwinian theory should be taught in science as science, or as a perspective on the limits of science, *only* if the alternative has substantial support in scientific methodology. A teacher might comment that certain perplexities concerning the development of complex life and the way natural selection works may indicate that principles of order or design might help explain aspects of evolutionary processes, that whether such order would point toward intelligent design is a topic on which scientific evidence may be ill-fitted ever to speak decisively and, in any event, is now inconclusive.<sup>247</sup>

#### IX. CONSTITUTIONAL LAW: JUDICIAL ENFORCEMENT

It remains to relate these conclusions to constitutional principles. I shall oversimplify the connection between what is acceptable constitutionally, and what is judicially enforced. I shall do this by assuming that courts here apply the full measure of constitutional law, that any discretion they accord to boards of education and teachers concerns constitutionally permissible choices by those determining what shall be taught.<sup>248</sup> I shall not engage the topic of whether teachers should have any latitude to deviate from policy set by higher-ups, if both the policy and what the teachers want to do would be constitutionally appropriate, viewed in isolation.

Our clearest indication of prevailing constitutional principles, and a helpful standpoint from which to develop a critical analysis, is what the Supreme Court has said about these issues. In 1968, it reviewed an Arkansas statute that forbade the teaching of the theory that mankind descended from a lower order of animals.<sup>249</sup> The Arkansas Supreme Court had sustained the law, finding it unnecessary to resolve whether the statute "prohibits

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247. See discussion in *supra* note 209.

248. An alternative conceptualization is that the educators really are bound constitutionally to do certain things but that courts will not hold invalid decisions within a range, even if the decisions may exceed constitutional limits.

249. *Epperson v. Arkansas*, 393 U.S. 97 (1968). There was no record of prosecutions under the statute, but a science teacher challenged the law. *Id.* at 101-02.



any explanation of the theory of evolution or merely prohibits teaching that the theory is true . . . .”<sup>250</sup> The U.S. Supreme Court decided that the law was unconstitutional in either event.

Justice Fortas’s opinion indicated that courts should not often intervene in curricular decisions,<sup>251</sup> thus implicitly acknowledging that judges should not overturn every educational decision influenced by the religious views of parents or educators. Instead, “the First Amendment does not permit the State to require that teaching and learning must be tailored to the principles or prohibitions of any religious sect or dogma.”<sup>252</sup> The state law proscribed a segment of the body of knowledge “for the sole reason that it is deemed to conflict with . . . a particular interpretation of the Book of Genesis by a particular religious group.”<sup>253</sup>

*Epperson* is directly about forbidding subject matter on religious grounds, but its principle also reaches a religious-based decision *not* to teach evolution or *not* to require its teaching.

Two decades later, the Supreme Court faced the more complex variant on the evolution problem. The Louisiana legislature required that *if* teachers were to teach evolution, they must also teach creation science.<sup>254</sup> Although proponents of creation science claimed that substantial scientific evidence supported that perspective, the Court concluded that the purpose was again a forbidden aim to advance religion.

Justice Brennan wrote for the Court that the law, which defined the theories of evolution and creation science as “the scientific evidences for [creation or evolution] and inferences from those scientific evidences,”<sup>255</sup> impermissibly promoted a religious point of view. Officials claimed that the act’s purpose was academic freedom, but Justice Brennan wrote that it furthered neither the goal of providing a more comprehensive sci-

250. *Id.* at 101 n.7.

251. *Id.* at 104.

252. *Id.* at 106. No one had suggested that the law was justified by “considerations of state policy other than the religious views of some of its citizens.” *Id.*

253. *Id.* at 103. In a concurring opinion relying on the statute’s vagueness, Justice Black made the suggestion that removing evolution from the curriculum might leave the state in a neutral position between religious and anti-religious doctrines. *Id.* at 113. I have indicated why I do not think it is “neutral” to wipe from the curriculum an otherwise essential topic because its theories conflict with some religious views.

254. *Edwards v. Aguillard*, 482 U.S. 578 (1987).

255. *Id.* at 581.

ence curriculum nor the goal of freeing individual teachers to instruct as they thought best.<sup>256</sup>

Mentioning the “historic and contemporaneous link between the teachings of certain religious denominations and the teaching of evolution,”<sup>257</sup> Justice Brennan said, “[t]he preeminent purpose of the Louisiana Legislature was clearly to advance the religious viewpoint that a supernatural being created human-kind.”<sup>258</sup> During the legislative process, “creation science” was treated as including belief in a supernatural creator.<sup>259</sup> Since an improper purpose rendered the statute invalid, decision on the basis of summary judgment was appropriate.<sup>260</sup>

Justice Powell, concurring, emphasized that in ordinary usage “the theory of creation” is that God created the world and its life-forms out of nothing.<sup>261</sup> What were apparently the major organizations supporting creation science, the Institute for Creation Research and the Creation Research Society, both conceived their mission as encouraging belief in a Divine Creator.<sup>262</sup>

For Powell, the statute’s limitation to scientific evidences did not render its purpose secular. The “Establishment Clause limits the discretion of state officials to pick and choose among [subjects or theories] for the purpose of promoting a particular religious belief.”<sup>263</sup>

Justice Scalia’s lengthy dissent was in two parts, the second of which was a sweeping attack on any “purpose” test that

256. *Id.* at 586–87.

257. *Id.* at 591.

258. *Id.*

259. Various efforts after the law was adopted to define “creation science” without reference to a supernatural creator were not relevant to what the legislature’s purpose had been. *Id.* at 595–96.

260. Justice Brennan also urged that the statute discriminated in favor of creation science as against evolution because it provided curriculum guides and resource services (supplied by a panel of creation scientists) for the former but not the latter. The easy answer to this contention is that the legislature understood that science teachers in the main believed in evolution, and since plenty of teaching materials were available, no curriculum guides or resource services were needed for evolution. *See id.* at 630–31 (Scalia, J., dissenting).

261. *Id.* at 598–99. In its earlier drafts, the bill talked of creation *ex nihilo* by God. Only in subsequent stages was explicitly religious language eliminated, and there was no indication that the underlying purpose was then altered.

262. Members of the latter had to subscribe to the historical and scientific truth of all assertions in the Bible. *Id.* at 602.

263. *Id.* at 604. Justice Powell referred to the literary and historic value of the Bible, and thought schools should teach “all aspects of this Nation’s religious heritage.” Children might be “taught the nature of the Founding Father’s [*sic*] religious beliefs and how these beliefs affected the attitudes of the time and the structure of our government.” *Id.* at 606–07. He also said that courses in comparative religion would be appropriate.

depends on the subjective motivations of legislators.<sup>264</sup> The first part of Scalia's opinion argued that even one who accepts a motivation test should reject the Court's conclusion.<sup>265</sup> The secular purpose required by *Lemon*<sup>266</sup> has meant only a secular purpose, one that can be accompanied by religious purposes.<sup>267</sup> Examining the legislative history, Scalia found many claims in favor of the scientific evidence for creation science.<sup>268</sup> The legislators' idea of academic freedom was that students not be "indoctrinated" in evolution. Scalia acknowledged that legislative attention was drawn to evolution because of "the tension between evolution and the religious beliefs of many children. But . . . a valid secular purpose is not rendered impermissible simply because its pursuit is prompted by concern for religious sensitivities."<sup>269</sup> Justice Scalia's dissent raises serious questions about what is an impermissible purpose and whether the court should have sustained a summary judgment.

I have argued that at bottom creation science is a religious theory because inadequate empirical evidence of a scientific sort supports it. That determination could, I believe, be made as a matter of summary judgment. If "scientists" do not have literature explaining persuasively why their endeavors are scientific, and why their theory reaches a threshold of scientific plausibility, a court should not have to wait for oral evidence to conclude that their theory is essentially religious. Thus, whatever the assumptions of legislators who enacted the law, teaching creation science is teaching religious ideas. That is unconstitutional and could have been a basis for sustaining the summary judgment.

But that is not quite the ground the Court gives. It relies on an impermissible purpose. To resolve *this* issue, we need to discern what purposes would be impermissible and whether a court could be confident that they underlay the legislation. Clearly,

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264. *Id.* at 636–39. He urged that motives are mixed, and discerning why any single legislator voted as he or she did is virtually impossible. One certainly cannot infer what silent legislators believed from what a sponsor said, and there is no acceptable method to combine individual intentions into an overall legislative intent. Justice Scalia has consistently rejected a subjective intent approach to legislative purpose for interpreting statutes, and here he developed a similar challenge for assessing a statute's constitutionality.

265. *Id.* at 613.

266. 411 U.S. 192 (1973).

267. *Edwards*, 482 U.S. at 614. A law's purpose is not necessarily to advance religion simply because it coincides with the tenets of a religion.

268. *Id.* at 622–24. Witnesses also talked about the harmful effects if students were deprived of knowledge of this alternative scientific explanation of the origin of life. *Id.* at 624–25.

269. *Id.* at 633.

legislators could not permissibly seek to promote the Genesis account as true on religious grounds. Suppose, instead, a legislator wanted to satisfy his zealous fundamentalist constituents who wished to promote the Genesis account. That also would be an impermissible purpose. Suppose, finally, that the legislator's attitude was this: "The possible truth of the Genesis account (or my constituents' belief in that truth) inclines me not to have evolution presented as the unvarnished scientific truth; therefore, it should be matched by instruction in scientific creationism, though I understand that the latter has extremely weak scientific credentials." That also should count as a religious purpose.

The Court presents substantial evidence that the main proponents of the legislation inside and outside the state legislature had some variant of one of these attitudes. But Justice Scalia answers, in effect, that ordinary legislators were told that creation science has strong scientific credentials. They may have been persuaded that it warranted treatment equal to evolution on that basis. Even if a reason why they attended to the problem was because of people's religious beliefs, their decision in favor of equal treatment was based on their wish to avoid suppressing a theory with as much scientific merit as evolution. Note that the *actual* scientific merits of creation science would not then be critical; only what legislators thought.

Scalia has a point; legislators could have had a legitimate secular purpose even though, on analysis, creation science really amounts to religion.<sup>270</sup> But the Scalia position is subject to three rejoinders. First, it is hard to explain why legislators were satisfied with teachers instructing in neither evolution nor creation science if their ambition was to put a viable alternative theory before students. Must they not have realized that this aspect of the law, the aspect that allowed teaching neither theory, could be explained only by religious objections to evolution?

Second, if many ordinary uninformed legislators were persuaded that creation science is powerful science, this very fact may suggest that relevant purposes should be drawn from articulate proponents, not the silent mass. The views of proponents might provide a rough approximation of what others really believed; more important, perhaps the view of proponents should carry greater intrinsic significance than the opinions of the inert members of the legislature.<sup>271</sup>

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270. See Carter, *supra* note 215, at 990.

271. I explore this issue in *Statutory Interpretations: Twenty Questions*. KENT GREENAWALT, STATUTORY INTERPRETATION: TWENTY QUESTIONS (1999). This comment, of course, assumes that purpose analysis makes sense. Justice Scalia

Third, to reiterate a point made earlier, if reliance on the possible misapprehensions of not very well-informed legislators forecloses a reliance on impermissible purpose, *nonetheless*, teaching scientific creationism is teaching religion, and that is not permitted.

What are the implications of these cases, and of persuasive constitutional analysis, for “intelligent design”? I believe there are enough conundrums with the dominant neo-Darwinian account for text writers, science teachers, and boards of education to conclude that it would be useful for teachers to discuss them and, further, to suggest that whether the dominant theory may require substantial revision or supplementation is an open question. I am not here claiming that this qualified presentation of neo-Darwinism is better supported by scientific evidence than an unqualified presentation, only that it is within the range of constitutionally permissible judgment—something judges have to assess by the balance of scientific opinion *and* their own sense of the strength of arguments. Texts and teachers could further mention that some idea of order or design might be needed to fill in the gaps, although more standard explanations may well prove to suffice. Whether any design would reflect intelligent design is an issue science cannot now resolve and might not resolve in the future. Were educators to go further and insist that *intelligent design* is probably a needed supplement to natural selection and other aspects of neo-Darwinism,<sup>272</sup> they would step over the constitutional line, because this is a judgment that can now be made only on religious grounds.<sup>273</sup>

In explaining the reasons that support evolutionary theory, teachers cannot steer clear of all arguments that have some implications for religious propositions. But they should not advance religious arguments as sound or unsound. In particular, they should be careful about how they present the argument that imperfection supports evolution. They should not make assertions about what a Divine Creator would or would not do. Courts should decide that teachers have stepped over the constitutional line in this respect only if they unambiguously declare the truth or falsity of religious propositions.

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could point to the difficulty of weighing various opinions in support of his rejection of reliance on subjective purpose.

272. One objection to an intelligent design approach is that it would not make sense for God to establish natural laws and then alter them from time to time in accord with God's aims of design. This is more a religious or philosophical objection than a scientific one.

273. See discussion in *supra* note 209.

I have proposed a middle course somewhere between what evolutionists insist is the only sound scientific approach and what proponents of Genesis creation and intelligent design seek. I am well aware that this counsel of moderation will have little appeal for either side. The lines of struggle are sharply drawn between opposing camps that standardly accuse one another of dogmatism and dishonesty. The evolutionists suspect, with a good deal of justification, that intelligent design is supported by many as a device to sneak religious objections into the science curriculum. Proponents of intelligent design, with a good deal of justification, charge that their position is ruled out of court without a hearing. Each side often tries to make the arguments of the other look as ridiculous as possible, and neither seems much interested in a fair appraisal of, or even a candid debate about, how far scientific study should involve possible limits of science, and whether critics of evolutionary theory have any solid scientific basis to suppose that the development of life on earth may involve such limits. Nonetheless, the guidelines I have sketched make educational and constitutional sense.

