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On the Origin of Controversies: Improving California's Science Standards for K-12 Education

By Samara Ashley, Sara Carmack, Sam Jeffrey, Jeff Jones, Mackenzie Kirby, and Ryan Maguire



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Executive Summary

“The *Science Content Standards for California Public Schools, Kindergarten through Grade Twelve* represents the content of science education and includes the essential skills and knowledge students will need to be scientifically literate citizens in the twenty-first century... The *Science Content Standards* serves as the basis of statewide student assessments, the science curriculum framework, and the evaluation of instructional materials. *The Science Framework for California Public Schools* is being revised to align with the standards. The framework will suggest ways in which to use the standards and make connections within and across grades; it will also provide guidance for instructional planning.”ⁱ

The *Science Content Standards*, as adopted in 1998, go a long way towards improving student achievement. They present a comprehensive vision of what students ought to know and be able to accomplish. Unfortunately, the current standards fail to adequately account for the major scientific and societal debate over the origin and development of life. The standards emphasize biological evolution as *the* unifying concept in science—supporting Theodosius Dobzhansky’s proposition that “nothing in biology makes sense except in the light of evolution.”ⁱⁱ

Meanwhile, alternative scientific theories that seek to explain and test hypotheses in opposition to evolutionary thinking are left out of the standards. The presentation of evidence against evolution is largely discouraged and leads to the perpetuation of evolutionary myths as facts. By not introducing the controversy over origins into California’s public school classrooms, the State Board of Education is promoting inadequate instruction. The current “one theory” approach fails to provide students with “the opportunities to build connections that link science to technology and societal impacts.”ⁱⁱⁱ

The dominance of evolutionary theory in California’s *Science Content Standards* can be attributed to the legal debate surrounding the teaching creation and evolution in public schools that began more than 75 years ago. Since the famous *Scopes-Monkey Trial* of 1925, the controversy over origins has remained a constant in American public policy. The opinions of the Supreme Court have significantly altered the content of science education

throughout the nation. Today, it is clear that religiously motivated efforts to discredit evolution and introduce theistic explanations of the origin of life are unconstitutional. However, scientific inquiry in a variety of disciplines has made it possible to challenge evolutionary assumptions on purely scientific grounds and to put forth competing theories without reference to God or a creator. The scientific community has finally caught up to Supreme Court’s position espoused in *Edwards v. Aguillard*, (1987) – “teaching a variety of scientific theories about the origins of humankind to schoolchildren might be validly done with the clear secular intent of enhancing the effectiveness of science instruction.”^{iv}

The policy recommendation of this report attempts to correct the inadequacies of California’s *Science Content Standards* by calling for revisions to the standards that take into account the debate over origins. Introducing the debate in public classrooms will enhance the comprehensiveness of science instruction in California in a constitutionally sustainable manner. Revisions to the standards should be simple and straightforward:

- Discuss the controversy and debate between alternative origin theories;
- Acknowledge the gaps in evolutionary theory; and
- Introduce competing scientific explanations.

To assist in revising the standards in accordance with the policy proposal, the report presents a comprehensive review of the current *Science Content Standards* along with recommended modifications. The proposed modifications are meant to serve as a guide to what the new standards might look like. This is important because the formal process of adopting revised standards through the Academic Standards Commission necessitates community, parent, teacher and administrator involvement. However, should the commission fail to adequately revise the standards; improvements to science instruction can still be affected through the legislature or initiative process.

Any revisions to the *Science Content Standards* must be supported with legal assurances and instructional resources so that teachers can effectively implement the changes in their classrooms. This requires further amendments to the *Science Framework for California Public Schools*, updated science textbooks, curriculum alternatives and proper teacher training.

As we speak, students are being shielded from valid scientific criticisms of evolution and alternative explanations. It appears that a “fear of revision” controls the teaching about the origin and development of life. Yet public policy should be guided by what is in the best interest of our students, not by emotion. The surest way to improve science education is to expand the scope of discussion. This is what the scientific method teaches and what the Supreme Court affirms.

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Part 1

A Standard for Standards?

“A Smith and Wesson beats four aces.” This folksy proverb tells a story of the old frontier of the American West, when a hand was taken by force and the rules of the game were suspended at will.

With the taming of the western frontier came the full establishment of American civil order as envisioned by our Founding Fathers. This order left little room for the capricious transactions of power that had come to define the West. The American rule of law, supported by the Constitution, provided the framework for the settlement of disputes between parties. However, it is evident that America still struggles at times with areas of authority guided by force of will rather than good law—what could be called “perennial problem areas” in constitutional law. These areas have been established and exploited by various groups seeking to acquire a de-facto domain of control. Building on cultural momentum, certain beliefs have become so entrenched in society that few dare to challenge their validity.

One pocket of privileged authority is the teaching of evolution in public schools, including California’s public schools. Students studying the fields of biology and life sciences are largely unexposed to competing views regarding the origin and development of life. Darwin’s theory of evolution has gradually become the central unifying concept of science, shutting out alternative theories in the process (see Appendix A for definitions used throughout the text). However, there now exists a “disconnect” between the practice of teaching evolution in schools and the legal authority to introduce competing theories alongside Darwin’s. The Supreme Court has affirmed “teaching a variety of scientific theories about the origins of humankind to schoolchildren might be validly done with the clear secular intent of enhancing the effectiveness of science instruction.”^v

The dominance of the theory of evolution in the public school science curriculum is evident in the *Science Content Standards for California Public Schools: Kindergarten through Grade Twelve*. Currently, the State Board of Education passes content standards that serve as the primary guide for what all students should learn before the completion of each specified grade level. These requirements differ with every field and are constantly being revised, updated and improved. While the science standards were updated as recently as 1998, their core theories have remained largely unchanged and continue to prohibit discussions of competing viewpoints about biological origins in the teaching of natural sciences.

In the elementary grades (K-5), the *Science Content Standards* focus on practicing the scientific method, making observations, asking meaningful questions and conducting careful investigations. The standards for middle school (6-8) are more detailed in their theories,

recommending experiments and the like. In the seventh grade, students are introduced to the theory of evolution.^{vi} They are given the evolutionary hypothesis and then perform experiments to “prove” evolution. The theory of evolution is then used in high school to develop a scientific understanding of the world, again using the scientific method.

Throughout grades 9-12 the focus on evolutionary theory in the biology/life sciences area is so prevalent that evolution, by default, becomes the sole explanation for all of the complex systems and structures of life. Indeed, the standards as currently enacted, are in line with the National Science Teachers Association’s position statement on the teaching of evolution: “science curricula and teachers should emphasize evolution in a manner commensurate with its importance as a unifying concept in science, and its overall explanatory power.”^{vii}

Clearly, evolution remains a driving force in California’s science instruction. But does the dominance of evolution preclude the teaching of alternative scientific theories? To determine if/how the current standards account for non-evolutionary theories, it is necessary to examine the Science Framework for California Public Schools as adopted by the California State Board of Education. The framework is intended to provide teachers, educators and prepares of instructional material with specific guidance for how to teach the standards. On February 6, 2002, the board of education modified the framework to include a “Policy on the Teaching of Natural Science” (see Appendix B). It is interesting to note that term “evolution” is never referred to in this document. Instead, the board draws an impenetrable line between natural science and divine creation or ultimate purposes/causes. The effect of this separation is to require science teachers to present only origins and development theories that are entirely based on “naturalistic” mechanisms and to preclude all other explanations. This restriction is at best arbitrary and at worst an attack on academic freedom. Although the nature and mechanisms of the universe remain largely a mystery to scientists across all fields, the California Board of Education has determined that science can and must explain everything in materialist terms.

The purpose of this policy brief is to outline the inadequacies of teaching only evolution as compelled by California’s *Science Content Standards* and then to put forth a plan that resolves these shortcomings. We begin with an examination of the how the current content standards fail to account for the ongoing debate within the scientific community and society over the origin of life. Next, we explore the historical roots of the debate over evolution in public school in an effort to determine why alternatives are prohibited and what legal possibilities remain. We continue with a two-part prescription that introduces our policy proposal and demonstrates what revised *Science Content Standards* might look like. We conclude by outlining the process for policy adoption and implementation in the schools. At the end of the day, students in our public education system must be afforded the opportunity to learn about and tackle the hard issues of origins science. Science is knowledge and to do any less is to fall short of goal of illuminating “the methods of science that will be used to extend that knowledge during the students’ lifetimes.”^{viii}

Part 2

Falling Short

The *Science Content Standards for California Public Schools: Kindergarten through Grade Twelve*, as adopted in 1998, fail to guide educators in preparing students with an adequate exposure to and understanding of competing viewpoints of the origin and development of life. The one-sided presentation of Darwinian evolution to account for the existence of the universe and life on earth is a barrier to developing “sufficiently literate students in the fields of biology, technology, and life sciences” as mandated by the California State Board of Education.^{ix}

Advocates of the current standards argue that evolution is the only legitimate “scientific” account for the origins of life. They contend that all non-naturalistic theories are inherently religious in nature and therefore out-of-bounds for discussion in the science classroom. Such preclusions make a mockery of the scientific method and violate constitutional provisions that encourage the inclusion of multiple viewpoints in public schools. While advocates of an exclusively evolutionary discussion put up a united front, they need not fear the debate surrounding origins that is flourishing within the scientific community. Their concerns result in the formation of education policy that stifles rather than encourages scientific inquiry. Fears of state-sponsored religious viewpoints coupled with anxiety about an inadequate scientific discussion are unfounded.

Proponents of an open discussion regarding biological origins encourage not a particular cultural or theistic view, but rather competing views often espoused within the evolutionary community. It is a great misconception that all evolutionists deny the existence of any design. Many scientists, including William Dembski, have begun to develop arguments showing empirically detectable design. The advancement of these alternative theories within the evolutionary community proves that a vibrant debate over biological origins exists. Schoolchildren would benefit from exposure to this debate and the concerted effort to withhold information does a disservice to our students.

To the Exclusion of All Others

Within the scientific community there exists a growing body of evidence that supports competing theories including those that contemplate an element of design in nature. The *Science Content Standards* in California fail to encourage scientific inquiry into these competing theories.

There is a very real controversy centering on how properly you account for biological complexity...and it is a scientific controversy^x.

The present system holds that the public school science classroom is an inappropriate place to discuss the debate over the origin and development of life. However, the classroom may be one of the most important places to acknowledge that evolution is only one among many theories. Within the past twenty years, discoveries in biology, physics, archeology and other science have increasingly revealed the inadequacy of Darwin's original conception of evolution as gradual decent and modification over long periods of time. The introduction of competing views that intelligent causes are necessary to explain the complex, information-rich structures of biology and that these causes are empirically detectable, can only serve to enhance science instruction.

Advocates of alternative theories promote the concept of 'specified complexity' as a legitimate objective standard.^{x1} Oxford biologist Richard Dawkins phrased it this way, "Biology is the study of complicated things that give the appearance of having been designed for a purpose."^{xii} The biological journal *Cell* featured an article by Bruce Alberts, President of the National Academy of Scientists, in which he states, "We have always underestimated cells, we call cells machines...because they function like machines invented by humans to deal efficiently with the macroscopic world, these protein assemblies contain highly coordinated moving parts."^{xiii} Examples like the cell suggest that complicated systems found throughout the earth have distinct levels of complexity to them.

The competing origin theories, such as specified complexity, intelligent design and theistic evolution are scientifically based. Unfortunately, the current standards do not provide for the introduction of these theories into the classroom. The response by most schools and teachers in California is to teach only what the majority of scientists believe in. "Until a design theory wins the support of the majority of scientists, they argue, students may not be exposed to the evidence or arguments for it."^{xiv}

Scientists themselves have failed to design a system that would allow the teaching of various origins theories. This outcome appears contradictory:

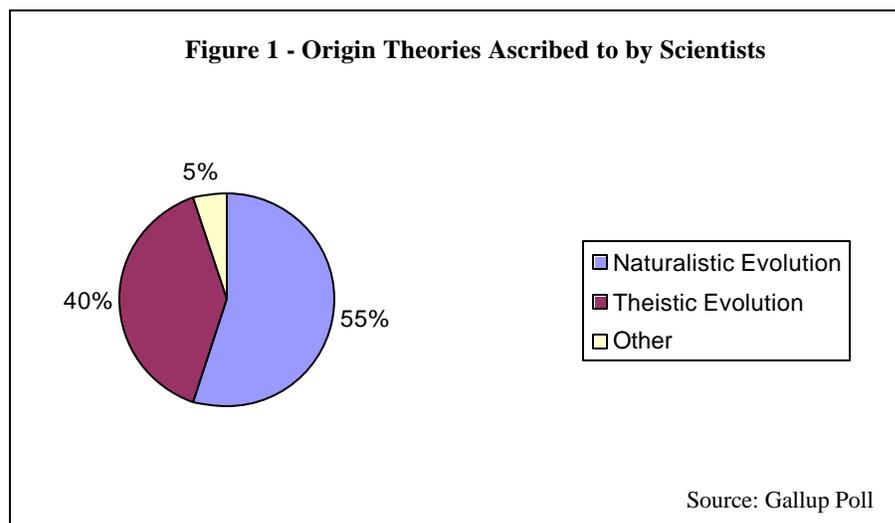
Such a view seems profoundly at odds with scientific practice, which itself involves dialogue and debate between scientists, some of whom advocate, from time to time, for new interpretations against established views. Those who insist that teachers may present only the majority view on a scientific issue, or that only majority opinions constitute 'the scientific perspective,' overlook the history of science. Many established scientific theories originally met opposition from the majority of scientists. And science often involves argument between competing theoretical perspectives. As the Supreme Court stated in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 'Scientific conclusions are subject to perpetual revision...The scientific project is advanced by broad and wide-ranging consideration of a multitude of hypotheses, for those that are incorrect will eventually be shown to be so, and that in itself is an advance.'^{xv}

Introducing the debate and using the scientific method to test theories is consistent with the naturalistic goals of science. Many scientists are beginning to encourage an open scientific

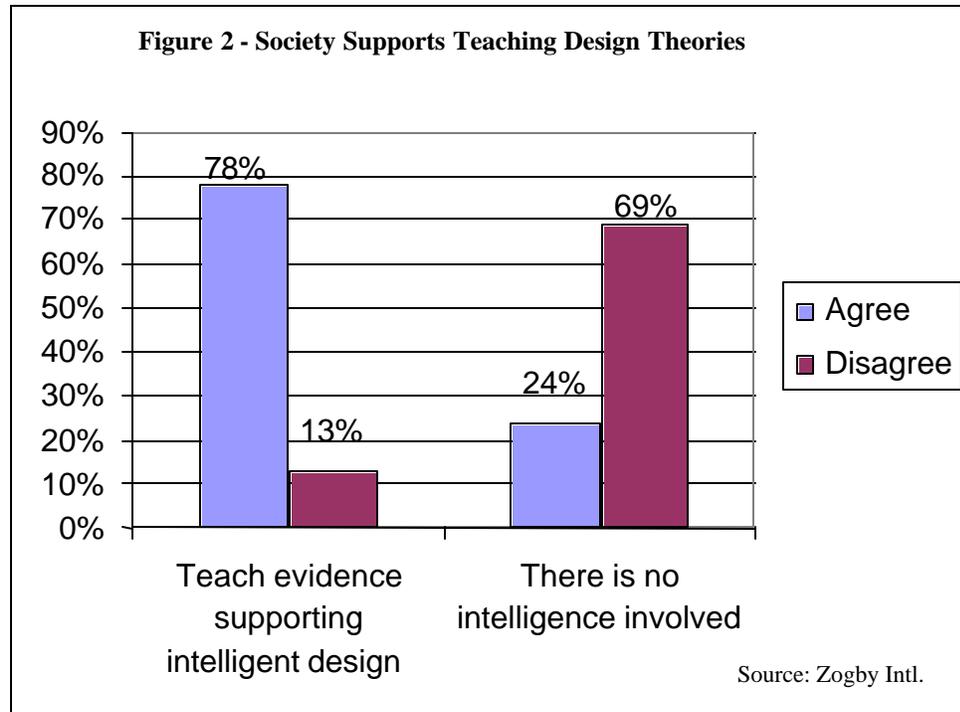
debate concerning origins. In response to the seven-part PBS series entitled “Evolution,” 100 scientists signed their names to the following statement:

We are skeptical of the claims for the ability of random mutation and natural selection to account for the complexity of life. Careful examination of the evidence for Darwinian theory should be encouraged.^{xvi}

It is also widely reported that when scientists are routinely surveyed, 95 percent say that they believe in evolution (see Figure 1). However, the “majority” position is not as vast as it seems on the surface. If the numbers are examined further, one finds that 55 percent of scientists believe in naturalistic evolution, but 40 percent of scientists believe in theistic evolution—that humans did develop over millions of years from lower life forms, but under the guidance of a creator or intelligent being. The fact that a large percentage of scientists affirm some basic understanding of intelligent design supports introducing these concepts into the origins debate in schools.



Although a majority of scientists believe in naturalistic evolution, the scientific establishment is largely at odds with the beliefs of the general public on these very issues. In August of 2001, Zogby International conducted a nationwide poll of 1,202 American adults.^{xvii} When adults were presented with statements pertaining to their beliefs regarding the importance of design in explaining life and the universe, they overwhelmingly supported the introduction of competing design theories. The first statement reads, “When Darwin’s theory of evolution is taught in school, students should also be able to learn about scientific evidence that points to an intelligent design of life.” The second statement reads, “The universe and life are the product of purely natural processes that are in no way influenced by God or any intelligent design.” The responses are shown in Figure 2.



Scientific “Carte Blanche”

The universe is a dynamic place, with evolving systems as large as the universe and as small as an atom. Across all sciences, the theory of evolution is important to the greater discussion. Thus, every student studying the life sciences needs a strong understanding of the most fundamental principles of evolutionary theory:

- All living things reproduce;
- Offspring are similar, but not identical to its parents;
- Offspring must age before reproducing;
- There is a direct relationship between species and their environment;
- Not all living things live long enough to reproduce and this has a direct consequence on the universe;
- Species specialize in response to their environments; and
- Genetic variation can result in mutation.

While evolutionary theory should be taught in public schools, the current standards do not encourage the introduction of evidence against evolution and the competing theories that challenge Darwinian assumptions. This outright acceptance of evolution without corresponding scientific challenges ends up harming the learning process. In the scientific

community, evolution is acknowledged to contain gaps in explanation. There are several issues for which it cannot account and multiple instances in which it cannot logically make allowance. Evolution, like other theories that attempt to explain the origin of the universe, offers hypotheses about past events that are difficult, if not impossible, to duplicate in a laboratory. Thus, explanations concerning origins invariably fall short of “fact.” As Nobel Laureate Milton Friedman put it, “factual evidence can never ‘prove’ a hypothesis; it can only fail to disprove it, which is what we generally mean when we say, somewhat inexactly, that the hypothesis is ‘confirmed’ by experience.”^{xviii} To elevate evolution to the level of a scientific principle or theorem, like Newton’s Law of Gravity, is misguided and illogical.

The current science standards largely ignore evidence against evolution and competing explanations, giving the false impression that evolution has been proven. The *Science Content Standards* state, in part:

- Grade 7 - Life Sciences Standards: “biological evolution accounts for the diversity of species developed through gradual processes over many generations.”
- Grade 7 - Earth and Life History: “evidence from rocks allows us to understand the evolution of life on earth.”
- Grade 8 - Earth in the Solar System: “the structure and composition of the universe can be learned from studying stars and galaxies and their evolution.”
- Grade 9-12 - Biology/Life Sciences: “the frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. Evolution is the result of genetic changes that occur in constantly changing environments.”

The August 2001 Zogby poll referenced earlier also asked respondents to take a position on the presentation of evidence against Darwin’s theory. A significant number of adults surveyed favored introducing, into the classroom, the evidence that goes against Darwin’s theory of evolution. Clearly, the *Science Content Standards* are out-of-step with what the general population wants from its science program (see Table 1).

Table 1: Adults Position on Teaching Evolution

<i>Position Statement</i>	<i>%</i>
Biology teachers should teach Darwin's theory of evolution, but also the scientific evidence against it.	71%
Biology teachers should teach only Darwin's theory of evolution and the scientific evidence that supports it.	15%
Neither/Not sure	14%

The lack of challenges to evolutionary theory encourages further confusion. In particular, there is significant confusion over the use of the term evolution throughout K-12 education. Depending on the circumstances, “evolution” can refer to different aspects of change over time. First, plants and animals that we now see did not always exist and some that did, no longer exist—we easily observe extinction in action. The second definition, all living things descended over a long period of time from one or a few common ancestors, is known as common descent. Although it is presented in the content standards as fact, common descent is much more debatable than change in general. Third, populations evolve through random variations and natural selection. There is considerable evidence that change occurs through natural selection of random variations within species and within features, known as microevolution. However there is much contention over the scientific validity of extrapolating these observations to macroevolutionary theory.

Without a clear definition of what we mean by evolution, students are given a false impression of the validity of certain evolutionary concepts and their acceptance within the scientific community. As documented further on in this report, when criticisms are shut off in the classroom, experiments that have been disproved or significantly undermined often continue to be used for demonstrating the authority evolutionary theory.

Uncritical Thinking

The current *Science Content Standards* fall short of the ideals set forth by the California Board of Education.

This content should be taught so that students have the opportunity to build connections that link science to technology and societal impacts. Science, technology, and societal issues are strongly connected to community health, population, natural resources, environmental quality, natural and human-induced hazards, and other global challenges. These standards should be viewed as the foundation for understanding these issues.^{xix}

If this is the goal of educators, then they must work to create an educational environment in which this type of learning can thrive. The structure and content of the current standards get in the way of this type of learning. To begin with, the biological origins standards in their present form are intellectually dishonest. The collusion of fact and theory teaches students that there is only one option, when in reality there are several well recognized options. If we want to make sure that our students have the ability to think critically, we must give them things to think critically about. In the words of Dr. Michael Behe, a science professor at Lehigh University, “...if we want our students to become educated citizens, we have to broaden discussion, not limit it.”^{xx}

Furthermore, the standards must be changed so that students can identify the weaknesses, as well as the strengths, of evolutionary theory. For education to be effective and authentic, students must be given the whole picture. In mathematics and many other subjects, students know that they are being taught everything they need to know in order to reach a minimum

level of competency. Part of this competency includes the discussion over the inadequacy of current explanations and the need for further theorizing, research, and experimentation. Is it unreasonable to expect the same in the field of science? Again, quoting Dr. Behe, “teach Darwin’s elegant theory. But also discuss where it has real problems accounting for the data, where data are severely limited, where scientists may be engaged in wishful thinking, and where alternative, even ‘heretical’, explanations are possible.”^{xxi} In order for our students to have the best possible education, they must at the very least be taught that there are “real problems” with the theory of evolution, and at best, be made aware of some of the competing theories about human origins and development.

Finally, California’s *Science Content Standards* should encourage an environment for students that is enlightening and challenging rather than the current restricted environment. By limiting the subjects that can be talked about we are restricting the discussion and constricting the areas of thought in which the students can enter. In order for the students to get the best education possible, we need to enlighten them by opening up all areas to discussion. We should challenge them to engage in critical assessment of ideas and perspectives. It is only in making these changes to the science standards that we can hope to give California’s students the education that they deserve.

Part 3

Evolving Law

One of the hallmark public policy debates in modern American history is the debate over the teaching of evolution in our public schools. Many states have attempted over the past 77 years to change what is taught to schoolchildren regarding the origin and development of life. The earliest efforts focused on preventing Charles Darwin's theory of evolution from being introduced into the science classroom. From these very first moments, the debate pitted "secular" evolutionists against "Biblical" creationists in a battle to "prevent or limit the teaching of evolutionary theory in America's public schools."^{xxii} The policy agenda of the day sought to impose a belief system rather than advance the scientific learning and understanding of students. As evolution became more firmly entrenched in schools, opponents changed tactics and put forth proposals supported by non-religious arguments. All the while, scientific discoveries were opening up new lines of inquiry and debate within the broader scientific community over the adequacy of Darwin's grand theory. Today, we have come full circle, reaching the point where it is scientifically possible to challenge the dominance of evolution in public schools without any reliance on Biblical or fundamentalist claims. However, the same attitude that "bullied" instruction more than 75 years ago, reins over the science classroom today – except the winners and losers have traded places. The arguments waged against the inclusion of evolutionary theory in years past are now used to defend it against any and all possible dissent.

In order to understand this reversal of ideological dogmatism it is necessary to trace back the roots of the origins controversy from its beginning to the present day. The following is a brief historical overview of the main struggles to prevent the teaching of evolution in public schools (in the past) and the introduction of competing origin theories (in the present). These largely failed endeavors have had a marked impact on the ability of concerned citizens to address the inadequacies of K-12 science instruction. In order to move the policy debate forward towards a sustainable solution, it is necessary to explicate the mistakes of the past, for "those who cannot remember the past are condemned to repeat it."^{xxiii}

Scopes Lost?

In the early part of the 20th Century, evolution was beginning to set foot in American culture and increasingly found a ready audience in the public schools. Darwin's theory was showing up clearly in biology, zoology and botany textbooks of the early 1900s. Respect for evolutionary theory was growing in large measure due to its promised ability to explain life on earth through one unifying "natural" hypothesis. This development concerned many creationists of the day whose own theories depended on "supernatural" origin accounts.

The proponents of creationism declared war on the evolutionists, a war whose biggest battlefield would become the nation's public schools.^{xxiv}

The struggle began largely with an emphasis on limiting instruction in evolutionary theory. Creationists lobbied state legislatures in an effort to forbid the teaching of evolution in public schools. Between 1921 and 1929, antievolutionary bills were introduced in thirty-seven state legislatures, although only three states ever passed a “banning” statute: Arkansas, Mississippi, and Tennessee. The American Civil Liberties Union (ACLU), looking for a test case to challenge the constitutionality of such laws, placed an ad in the *Chattanooga Times* in early 1925 seeking volunteers. As a publicity stunt to draw tourists to their small town, a group of businessmen in Dayton, Tennessee responded to the ad and enlisted John Scopes as their “wide-eyed” defendant. Scopes was a general science instructor who primarily taught physics, math, and football but had recently substituted for the ill biology teacher at his school.^{xxv}

Scopes had helped students review Hunter’s *Civic Biology* textbook but was unsure whether or not he had actually taught evolution. It did not matter. The text he used contained evolutionary theory and John Scopes was thereby guilty of violating Tennessee’s law. He was arrested by a conspiring prosecutor and put on trial – little did anyone know that it would turn out to be the “Trial of the Century.” Immortalized by historians, participants, playwrights, and Hollywood, the “Scopes-Monkey” trail pitted two notable Americans—William Jennings Bryan and Clarence Darrow—in “a quintessentially American episode exposing powerful cultural tensions.”^{xxvi} On the merits of the law, the jury found Scopes guilty in nine minutes.^{xxvii} The ACLU lost its case in court and for the next twenty-five years played second fiddle to the efforts of antievolutionists to restrict the teaching of evolution through laws and textbook revision. “Darwinism disappeared from many high school texts, and for years, probably until at least the 1950s, many American teachers feared being identified as evolutionists.”^{xxviii}

This changed in 1957 with the successful launching of the Russian satellite Sputnik. The American scientific establishment was shocked and began pouring resources into science education. One result was the *Biological Sciences Curriculum Study* (BSCS), which placed evolution at the center of modern biology. The new BSCS texts of the 1960s had no place for design and purpose, and thus no room for a creator. In its place, evolution became the major unifying concept of science as evidenced by the famous quote of scientist Theodosius Dobzhansky who said: “Nothing in biology makes sense except in the light of evolution.”^{xxix}

In 1968 the Supreme Court declared anti-evolution legislation to be unconstitutional in *Epperson v. Arkansas*.^{xxx} The Arkansas statute at issue made it unlawful for any teacher in a publicly funded school to teach the theory that humans ascended or descended from lower forms of life. In reaching its decision, the Court looked at the purpose of similar laws, like the one used to try John Scopes, and other evidence of the “true” intentions of the lawmakers. The plain language of the statute was less informative to the Court’s ruling that found that an antievolutionary statute’s primary purpose was to protect “the belief of some that the Book of Genesis must be the exclusive source of doctrine as to the origin of man.”^{xxxi} The law

therefore violated the Establishment Clause of the First Amendment. The precedent set in this case was to favor the historical record and extraneous discussion over the statute's plain language when ascertaining the purpose of legislation regulating the teaching of evolution in public schools.

The Epperson opinion is replete with historical references establishing the religious intent and nature of the law, which reveal the motivations and objectives of the law itself.^{xxxii}

A Balancing Act

Before we continue with the controversy over origins, we need to take a brief detour and examine one of the defining modern rulings of the Supreme Court. *Lemon v. Kurtzman* (1971) sought to determine whether the First Amendment was violated by statutes providing state aid to church-related elementary and secondary schools, and to teachers therein, with regard to instruction in secular matters. In an opinion by Chief Justice Warren Burger, it was held that the statutes of both Rhode Island and Pennsylvania were unconstitutional under the religion clauses of the First Amendment, as fostering, by their cumulative impact, excessive entanglement between government and religion.

The precedent set by the Court is often referred to as the three-part Lemon Test and is used to identify violations of the First Amendment religion clause which states, "Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof."^{xxxiii} Statutes in question must pass all three prongs of the Lemon Test:

1. The statute must have a secular legislative purpose;
2. Its principal or primary effect must be one that neither advances nor inhibits religion; and
3. It must not foster an excessive government entanglement with religion.

With the Lemon Test in mind, we move on. Because *Epperson* had prevented states from barring the teaching of evolution, legislators instead proposed bills that would require teachers to give balanced treatment or "equal time" to both evolution and "creation-science."

The state of Arkansas attempted to implement this new balanced-treatment strategy in 1981. Although never reaching the Supreme Court, a lower court in *McLean v. Arkansas Board of Education* determined the actions of the Arkansas legislature to be religiously motivated, rather than scientifically based, and issued a permanent injunction against enforcement of the "Arkansas Balanced Treatment for Creation Science and Evolution-Science Act." Judge William Overton found the legislation to violate all three prongs of the Lemon test: First, the statute's purpose was religious, namely, to promote the fundamentalist perspective; Second, the statute's primary effect was the advancement of religious tenets; and Third, "the pervasive

nature of religious concepts in creation-science texts" demonstrated that there would be excessive entanglement between government and religion.^{xxxiv}

The Supreme Court had occasion to address balanced treatment legislation in 1987 with *Edwards v. Aguillard*. In *Edwards*, the Court struck down a nearly identical Louisiana act requiring equal time for both creation science and evolution. Analyzing this action under the Lemon Test, the Court concluded that the legislative history revealed that the actual intent of the Act was to narrow the science curriculum. Additionally, the history of the relationship between evolution and creationism, and of anti-evolution legislation, alerted the Court to the true nature and purpose of this action. The Court determined that the Act did not grant teachers any greater flexibility than they already had in presenting theories about life's origins. Rather, it had the distinctly "different purpose of discrediting evolution by 'counterbalancing its teaching at every turn with the teaching of creationism.'"^{xxxv}

In terms of controlling jurisprudence, *Edwards* is the last case heard by the Supreme Court regarding the teaching of evolution in public schools and remains the Court's official word on the origins controversy. While this case struck down the "balanced treatment" strategy as a violation of the Establishment Clause, it left the door open for further public policy in regards to teaching competing origins theories in the classroom, as we shall see later on.

Modern Modifications

With the balanced treatment approach ruled unconstitutional, efforts to reduce the monopoly of evolution in public schools switched to an emphasis on local decision making. The most publicized efforts to interpret and act on the leeway granted by the Supreme Court are from Kansas and Ohio.

In 1999, the Kansas Board of Education amended aspects of its State Science Education Standards in an effort to render the state neutral towards evolution and alternative origin theories. The method for achieving neutrality was to grant local school districts control over the teaching of evolution in their schools. The new standards changed existing state policy in two ways:

1. The state's 304 local school boards were given discretion over whether or not macroevolution would be included in their science standards.
2. The state Board eliminated macroevolution from the standardized tests used to evaluate students' comprehension of science.

This approach differs from past efforts in two significant regards. First, the new standards did not prohibit school districts, schools, or teachers from teaching evolutionary theory, but by not requiring the curriculum to address macroevolution and by not testing students' knowledge of evolution, the new standards implicitly downplayed the role of evolution in the state's science instruction. Second, the new guidelines imposed no duty to teach creation

concepts and therefore did not explicitly establish religion in the science classroom. In this way, the Kansas Board of Education sought to remain neutral towards both evolution and creation.

The standards were rescinded prior to review by the courts and so “what remains unclear...is whether these actions violate[d] the Establishment Clause due to their underlying religious intentions and motivations or whether their apparent facial neutrality [would] withstand legal scrutiny.”^{xxxvi} There is some evidence to suggest that the courts would have ruled against the new standards, especially given the established precedent of reading beyond the text and deriving intent from historical and verbal claims. Some Board members were known to have enlisted the aid of the Creation Science Association of Mid-America when drafting the final version of the standards. In addition, some revisions to the standards contained familiar creationist themes regarding the young age of the earth (ex., hypotheses related to laying down stratified rocks and mountains quickly). These connections, while lacking the force towards religious intent exhibited in earlier attempts, would likely have given the courts enough justification to overturn the Board of Education’s revisions.

If evolutionists claimed a right to question the likely effects of the 1999 Board’s standards on promoting creationism, non-naturalistic supporters may have an equal gripe against the newer 2001 standards. There are several instances in which the newer standards remove language that encouraged in the scientific evaluation and debate about evolution. Collectively, they can be seen as imposing stricter evolution requirements. The key concerns raised by opponents of the 2001 standards include: removal of a standard that prevented contradictory evidence to current science theory from being censored; the inclusion of standards that propose that “the teacher should explain why the question is outside the domain of natural science;”^{xxxvii} and finally, the elimination of a Supreme Court recognized definition of science – that “an idea is in the realm of science if it has the potential of being ‘falsified’ by an experiment.”^{xxxviii} Together these concerns demonstrate that evolutionary theory will gain an even stronger footing in Kansas over the coming years.

As we write today, the quest to amend evolutionary components of public school science instruction continues. The State of Ohio in House Bill 481 (presently in committee) is trying to answer the question, “where does life come from,” by introducing intelligent design theories into the classroom. The stated goal of such action is to make it clear that evolution is only one theory among many and cannot be construed as “fact.” Arguing there is room for both biological evolution and design theories in Ohio’s public school science classrooms, teachers and students are encouraged to criticize weaker aspects of evolutionary theory and discuss competing views such as intelligent design. The legislation up for review is grounded in the following requirement:

That whenever an explanation for the origins of life and its diversity is included in the instructional program of a school district or educational service center the instructional program shall encourage the presentation of scientific evidence objectively and disclose the historical nature of origins of life science and any material assumptions on which the explanation is based.^{xxxix}

More specifically, the legislation seeks to clarify the science standards in such a way as to emphasize four key components to any origins instruction. First, there must be a clear understanding of the relationship between micro and macroevolution. Biological evolution teaches that microevolution (minor genetic variation) leads to macroevolution (common ancestry descent). Microevolution is experimentally strong and supported by nearly everyone in the scientific community. The theory of macroevolution, on the other hand, is subject to fierce debate due largely to the difficulty inherent in replicating experiments based on change over extensive periods of time.

Second, the bill distinguishes between empirical sciences, which are tested in a laboratory and through various experiments, from historical sciences, which are attempts to explain events from the distant past. Most of the sciences are empirical in nature and supported by testing and experimentation. Biological sciences with their exclusive focus on macroevolution, however, do not permit rigorous scientific testing to prove the theory as fact. Theories about biological origins, being a historical science, cannot be proven as fact and should therefore be discussed only in the language of theory.

Third, Ohio is seeking to disclose that naturalistic origin theories are based on material assumptions. The concept of naturalism asserts that all things in the universe have a material or physical explanation. This assertion leaves no room for design theories as explanations of the origins of life.

Finally, HB 481 encourages the inclusion of Intelligent Design explanations of origins enhances the objectivity of science education. Design theories seek to show that a designing force may explain the origins of life. While design theory makes no claim about the makeup or nature of the designer, it does assert that biological evolution alone does not sufficiently explain the origins of life. Intelligent design seeks to avoid the religious nature of other design theories such as creationism by not advocating any particular assignment to the nature of the designing force.

Understanding the historical and legal roots of the origins controversy is crucial if policymakers seek to bring diversity of opinion into the classroom. The misguided and unconstitutional strategies of the past must not be repeated. Yet legal possibilities remain and are even encouraged by the Supreme Court. The next section introduces revisions to California's *Science Content Standards* that demonstrate a clear break with the past and go a long way towards developing informed and inquiring students.

Part 4

Reigniting Debate

Truth is great and will prevail if left to herself, that she is the proper and sufficient antagonist to error, and has nothing to fear from the conflict, unless by human interposition disarmed of her natural weapons, free argument and debate, errors ceasing to be dangerous when it is permitted freely to contradict them.
~ Thomas Jefferson

Comprehensive, Rigorous, and Constitutional

In order to choose the best of the options that are before us we must make sure that they meet certain criteria. The subject of changing the science standards for the State of California is a controversial one, to say the least. There will no doubt be those who vehemently oppose any change to the current standards. Months of hard, well intentioned work went into their creation and thus, resistance to change is expected. The modified standards we propose seek to provide the best education possible for the children of California. In order to make sure that our solutions meet the educational, as well as legal standards that have been set before us, we have established the following criteria.

First, any option must pass the test of comprehensiveness and effectiveness. In order for the options that we have laid out to be viable in the educational system, we have to first make sure that they comprehensively remedy the problems that the California school system faces and that they are effective in how they deal with the issues at hand. Each option should adequately deal with the introduction of multiple origin hypotheses. The chosen option must also be comprehensive in its avoidance of bias. It is unacceptable to implement a change in the *California Science Content Standards* that would be biased toward religion or against religion, as this would fail to correct the problems addressed by the paper. Each option must also be effective in its approach to the problems at hand. For instance, to simply introduce another materialist theory alone would not be effective in overcoming the problem of the current bias in the school system. The problem, as it has been stated, is that students are taught only one theory when there are multiple explanations in the scientific community. In order to find a cure for the problem we must seek to add to the standards that which they do not already have. More of the same will not solve anything. Different perspectives and different views on the subject are the only way in which to introduce the intellectual diversity that is needed in California schools.

Second, any option that we set forth to remedy the current situation must meet the criteria of scientific rigor. While this may seem like the most obvious of the criteria, it is certainly not met by the current standards. Whatever solution is proposed must be able to stand against

the strongest of scientific inquiry. The laws of science must be the ultimate teacher in the science classroom. The current standards only show students the nebular cloud theory and the theory of evolution but they do not mention that neither of these theories has ever been reproduced in a laboratory. While the majority of scientists may agree that evolution and the nebular cloud theory are the most believable theories, they still remain theories and should be taught as such. They are added into the standards, surrounded by facts and thus are treated with the same respect as fact. In areas in which science has no answer, such as the aforementioned areas, the standards must admit that there is no scientific answer. Science instruction must do its best to stimulate inquiry by the students into these areas. It is only in stimulating the minds of the students that we can hope to overcome the current problems that plague the intellectual honesty of the school system.

Third, and what many view as the largest hurdle that any potential solution must clear, is the test of Constitutionality. In particular, we will examine the policy proposal in light of the three-pronged Lemon Test. In the 31 years since Chief Justice Burger wrote the majority opinion, the Lemon Test has been used to strike down a diverse number of cases. Of all the criteria that the solution to California's problems must meet, the Lemon Test is the most ominous. Any violation of the Court's ruling would result in an immediate dismissal of the proposal.

Policy Recommendation

Our policy recommendation is to expand California *Science Content Standards* to:

1. Discuss the controversy and debate between alternative origin theories.
2. Acknowledge gaps in evolutionary theory.
3. Introduce competing scientific explanations.

1. Discuss the Controversy and Debate Between Alternative Origin Theories

The current standards consider biological evolution as the only possible explanation in origins science. While the teaching of evolution is certainly appropriate, it is the exclusion of other possibilities that many scientists find objectionable. The new standards reflect the debates over the origins of life and modify current operational state standards to ensure that Darwinian evolution is portrayed as a theory – not proven fact. These modifications add language to introduce the controversy over origins, distinguish between microevolution and macroevolution, make a distinction between empirical and historical sciences and include the alternative theory of specified complexity.^{x1}

Origins science is the science that seeks to explain to our children the sources of the origin of life and the explanation for it. It is the science that seeks to answer an admittedly religiously

charged question, ‘where do we come from?’ in a non-religious manner. When students explore the questions of ‘where did I come from?’ and ‘how was the earth formed?’ they are offered exclusively macro-evolutionary theory as a response. A growing number of scientists and parents view this as an incomplete view on human origins, and support the teaching of many different theories of the origins of life on this planet. The study of multiple theories regarding the origins of life would provide students with some degree of knowledge regarding competing theories, along with the support and criticism that each encounter within the scientific community.

Instruction regarding origins shall encourage the presentation of scientific evidence objectively and disclose the historical nature inherent in the study of origins of life. It will also fully disclose any material assumptions on which these theories are based. Currently, the version of evolutionary theory that is used to explain origins is called methodological naturalism, and although portions of the assumption have value in experimental sciences like physics and chemistry, its exclusive use in historical sciences (and particularly origins science) is inappropriate and does not address the core issues of origins science. Historical sciences, by definition attempt to explain singular events that happen in the distant past cannot be entirely validated or absolutely proven experimentation. Therefore, the only way to validate an explanation is to postulate competing hypotheses and, based on observation and analysis of the available evidence; seek to rule out various hypotheses.

The current system of exclusive methodological naturalism in origins science shelters the naturalistic explanation of origins from the possibility of the introduction of competing hypotheses. This limits scientific inquiry regarding origins. The naturalistic assumption provides Darwinian evolution with an intellectual monopoly on the origins debate, regardless of the fact that this type of evolution is deficient in explaining the origins of life. Effective science education requires that origins science be conducted objectively and without the promotion of an irrefutable naturalistic assumption, and without the promotion of any other religious assumption. For this scientific reason, we believe schools should encourage their teachers to teach origins science in a way that is most consistent with the scientific method.

The design and naturalistic hypotheses derive from an explanatory concept that an event may have only one of three causes. The three causes are chance, necessity, and a design resulting in irreducible complexity. Patterns of events are arranged by one or a combination of the three causes. The naturalistic hypothesis assumes that only chance and necessity have operated to arrange the patterns of events that generate life and the diversity of life, whereas specified complexity postulates that all three causes may be involved. The following discussion provides a summary of the three causes.

Events Caused by Design: A designed event is one that is caused to occur by some form of intelligence. As an example, this document consists of a pattern of many events (letters, numbers, characters and punctuation marks) produced and arranged by several minds. Also, the nest of a bird consists of a pattern of events arranged by the mind of a bird. Nature is filled with minds that arrange events by intent into known designs. A theory that emphasizes complexity and design does not seek to attribute any design to that of a supernatural designer

or God. Indeed, any design that is detected could be a product of an alien mind that is currently being searched for by the SETI program (Search For Extraterrestrial Intelligence).^{xli}

Events Caused by Necessity: Events and patterns of events can also be arranged by "necessity." A necessary event is one that is required to happen due to the laws of chemistry and physics. A salt crystal is an example of a pattern of events arranged only by chance and necessity without any direct input from a mind. When a solution of sodium and chlorine ions becomes supersaturated, the positively charged sodium ions will be attracted to the negatively charged chlorine ions to form a very regular three-dimensional crystal lattice in the form of a cube. The mineral that is produced is called halite. A block of sandstone is also a pattern of events arranged by necessity. The size of the grains found in the rock will vary with the strength of the current in which the grains were deposited. In this case the pattern reflects the operation of the law of gravity in an aquatic environment.^{xlii}

Events Caused by Chance: Events can also occur by chance. A chance event is one that a.) can not be predicted, and b.) is not controlled by intent or necessity/law. Assume I have a bag of 26 scrabble pieces, each of which bears a different letter of the alphabet. What are my chances of spelling the word "DESIGN" by blindly putting my hand in the bag and pulling out the correct letters in the correct sequence (assuming that I put each piece back after I have noted the letter pulled)? The chance of pulling the D is 1/26, the chance of pulling D and E in that sequence is 1/26 x 1/26 or 1/676, etc. Thus the chance of spelling DESIGN in sequence is $1/26 \times 1/26 \times 1/26 \times 1/26 \times 1/26 \times 1/26 = 1/308,915,776$. As the complexity of the pattern increases, the probability of its occurrence by chance decreases exponentially. These are the principles behind specified complexity. The greater the complexity of a system or event, the greater the likelihood for intent. Conversely, the greater the level of complexity, the lower the likelihood for chance.^{xliii}

2. Acknowledge Gaps in Evolutionary Theory

The following are several examples of where standards, curricula and textbooks often get the science of evolution wrong – recently referred to as “Icons of Evolution.”^{xliiv} Scientists, who are themselves evolutionists, have largely disproved these components of evolutionary theory. However, these hypotheses are still referenced in many science textbooks and used by teachers in their instruction. The practice of teaching evolution fails to present our students with the best evidence available because it has a monopoly position in the standards. Without alternative theories challenging the validity of certain Darwinian assumptions, the educators have little incentive to correct the misinformation documented below. In addition, a general attitude of refusing to acknowledge the gaps in developmental progression as theorized by evolution allows bad science to propagate.

Icon #1 The Miller-Urey Experiment: Darwin’s theory of evolution starts by assuming the existence of “one or a few” original forms—though he speculated that life may have originated in a “warm little pond.” Introductory biology textbooks usually include a section on the origin of life in their chapters about evolution. The centerpiece of such sections is invariably the 1953 Miller-Urey experiment. The 1953 Miller-Urey Experiment is as

follows: a.) Miller put methane, ammonia, hydrogen and water vapor in a flask to simulate the Earth's early atmosphere; b.) He then discharged an electric spark in the mixture to simulate lightning; c.) After a week, the experiment had produced some simple amino acids, the molecular building blocks of proteins. The Miller-Urey experiment is used in introductory biology textbooks as evidence that life originated naturally on the early Earth.^{xlv}

There are however significant problems with this experiment, because the Miller-Urey Experiment probably did not simulate the atmosphere of the early Earth. What is the evidence for a primitive methane-ammonia atmosphere on Earth? The answer is that there is no evidence for it, but much against it.^{xlvi} John Horgan states in the "Scientific American," that an atmosphere of carbon dioxide, nitrogen and water vapor "would not have been conducive to the synthesis of amino acids." He also states that when a realistic mixture of gases is used, the experiment does not work.

Although this experiment has been disproven repeatedly, many textbooks, such as *Biology: The Dynamics of Life*, tells students that the Miller-Urey experiment "remains the cornerstone of the theories of the origin of life." This may be a reflection of the desire to maintain the status quo. "We have reached a situation where theory has been accepted as fact by some, and possible contrary evidence is shunted aside." This is "mythology rather than science."^{xlvii}

Icon # 2 Darwin's Tree of Life: The Cambrian Explosion tends to contradict Darwin's macroevolution theory: it is a geological period marked by sudden appearance of all basic forms of animals now in existence. There are no transitional forms between them and no new basic forms have appeared since then. So the sudden appearance and disappearance of species in the fossil record has been called "punctuated equilibria" by paleontologist Stephen J. Gould and Niles Eldridge. Specified complexity would introduce here, the possibility of design. The detailed methods of observation stated later in the paper, indicate that sudden dramatic changes such as these tend to rule out the more gradual Darwinian progression theories.

Harry Whittington the renowned paleontologist whose work is critical to documenting the Cambrian explosion said in 1985 "I look skeptically upon diagrams that show the branching diversity of animal life through time and come down at the base to a single kind of animal...animals may have originated more than once, in different places and at different times."^{xlviii} Molecular biologist Michael Denton states, "however attractive the extrapolation, it does not follow that, because a certain degree of evolution has been shown to occur, therefore any degree of evolution is possible. [Not] one single empirical discovery or scientific advance since 1859" has validated the extrapolation."^{xlix}

Icon #3 Homology in Vertebrate Limbs: Before Darwin, homology was defined as similarity of structure and position, and it was explained by construction on a common archetype or design. Darwin also defined homology as similarity of structure and position, but he explained it by inheritance from a common ancestor.^l The recommended instruction in this subject area includes the "Use a series of photos from a particular model of automobile that

shows the automobile has changed over time. Have students observe and explain ways in which auto-mobiles are the same and ways in which they have changed over time in a process called evolution.”ⁱⁱ The natural mechanism generally cited in textbooks to account for homologous features in evolution is genetic: a.) Similar genes are inherited by different organisms from their common ancestor; b.) Embryo development is controlled by a genetic program.

Therefore, similar genes produce homologous features. “What mechanism can it be that results in the production of homologous organs, the same ‘patterns,’ in spite of their not being controlled by the same genes? I asked this question in 1938, and it has not been answered.”^{lii} In the absence of evidence showing that homologous features are due to descent with modification from a common ancestor, Darwin’s followers simply re-defined homology to mean “similarity due to common ancestry.” “After 1859 there has been only one definition of homologous that makes biological sense. Attributes of two organisms are homologous when they are derived from an equivalent characteristic of the common ancestor.”^{liii} Once homology is re-defined as similarity due to common descent, it cannot be used as evidence for common descent except by reasoning in a circle: “Structures derived from a common ancestor are derived from a common ancestor.” This precludes any discussion or introduction of competing theories and is in direct conflict the scientific method of inquiry. “Homologous structures are structures with a common evolutionary origin.”

“By making our explanation into the definition of the condition to be explained, we express not scientific hypothesis but belief. We are so convinced that our explanation is true that we no longer see any need to distinguish it from the situation we were trying to explain. Dogmatic endeavors of this kind must eventually leave the realm of science.”^{liv}

Icon #4 Vertebrate Embryos: Charles Darwin wrote, “the embryos of the most distinct species belonging to the same class are closely similar, but become, when fully developed, widely dissimilar. [This is] by far the strongest single class of facts in favor of my theory.”^{lv} “A higher animal, like the mammal, passes through an embryonic stage when there are structures that resemble the gill clefts of fish. But this resemblance is illusory and the structures in the mammalian embryo only resemble the structures in the embryonic fish that will give rise to gills.”^{lvi} More importantly, the earlier stages of vertebrate embryos are strikingly different. It is “only by semantic tricks and subjective selection of evidence,” by “bending the facts of nature,” that one can argue that the earliest stages of vertebrate embryos “are more similar than their adults.”^{lvii}

Icon #5 Peppered Moths: Two hundred years ago, most moths were light-colored. During the industrial revolution, dark moths became much more common. When pollution was reduced in the 1950s, light moths became common again. The theory - dark moths became more common because they were better camouflaged on soot-darkened tree trunks, and birds preyed selectively on light moths. The experiment - in the 1950s, Bernard Kettlewell released both varieties onto nearby tree trunks and watched as birds ate the less camouflaged moths. Kettlewell called his observations “Darwin’s missing evidence.”

Since this experiment, most biology textbooks since the 1950s have featured the peppered moth story, illustrated with photos of moths on tree trunks, as the classic example of natural selection in action. However, many scientists feel that this theory has been disproved because, in many localities, the shift from dark moths back to light moths occurred without a shift in the color of tree trunks. Another development calling into question Kettlewell's finding came in the 1980s, when researchers discovered that peppered moths don't normally rest on tree trunks in the wild. This has caused many biologists to question the classic story about camouflage and predatory birds.

Developments such as these have brought many of the macro-evolutionary principles into question, and it is therefore important that science standards include evolutionary principles as well as some of their criticisms.

3. Introduce Competing Scientific Explanations

In addition to criticisms of evolution, and explorations of alternative theories, our standards add theories of varying specified complexity. This theory attempts to explain areas where other theories may be lacking, or to provide another alternative for explaining complex systems of nature. The detection of intended complexity within a pattern depends upon 3 steps. First, examine a pattern of events to determine whether it has some discernable function, structure or purpose - whether it reflects "specified complexity." Second, rule out necessity as a cause of the pattern. Third, rule out chance as a cause of the pattern. If you find a pattern that reflects function, structure or purpose and you conclude that it is not likely that it resulted from chance or necessity, then you should be able to reasonably infer that the pattern was designed.^{lviii}

Step 1 Ascertaining the existence of a purpose: Although this may be an oversimplification of the detailed description in William Dembski's *The Design Inference*, specified complexity exists when the pattern conveys a message, consists of a direction or performs some function that is independent of the function of each of the events that make up the pattern. Specified complexity reflects an ordering of events by intention. Once function, structure or purpose is observed in a pattern of events, then we have evidence of intention that provides support for a design inference. This falls under the scientific cause of 'intent,' and is not, at this point, in contradiction to micro-evolutionary principles.

For example, assume that the pattern of events to be analyzed is the sequence of nucleotide bases that appear in the DNA sequence of the postulated first cell. Current science textbooks suggest that this sequence was arranged only by chance and necessity operating in a pre-biotic soup containing the necessary chemical constituents. The competing theory states that the pattern of events consisting of the DNA together with all the other machinery necessary to the existence of the first replicating cell is incredibly complex and highly specified, therefore likely not a result of chance.

Using design detection, we would consult with biochemists and inquire whether the DNA sequence has structure, function or carries a message. The answer is that the sequence does all three. In fact the sequence reflects a language. The apparent design exhibited by living organisms is reflected by the words used by modern science to describe cellular systems: the genetic "code"; the "blueprint" of life; this biological system uses this "strategy"; "biological information"; and "hardware and software" in the cell.

Not all scientists adhere to this notion of intended specified complexity. Perhaps the most famous critic of all theories advocating some version of design is Richard Dawkins. He admits that living organisms give the appearance of design: "Biology is the study of complicated things that give the appearance of having been designed for a purpose."^{lix} Accordingly, the first step in the design detection process is more or less acknowledged by modern science. Strict evolutionists and design theorists agree that complex patterns appear to have been designed.

Step 2 Ruling out necessity: The next step is to determine whether or not necessity played a role in the formation of the pattern. If we are able to rule out necessity (physical and chemical laws) as an explanation for the arrangement of the pattern, as in the example of the DNA sequence, that satisfies the requirement of step two. Scientists interested in design detection note that there is no known chemical or physical characteristic that requires any particular arrangement of nucleotide bases along the sugar and phosphate backbones of the DNA strand.^{lx} Since there is no required arrangement, law or necessity does not appear to play a role in the arrangement of the precise instructions which provide one of the "blueprints" for the formation of the entire living organism. Scientists have also noted that if there were a law that would require a particular arrangement, it would be impossible for the DNA to have the capacity to effectively carry any biological information. The structure or pattern of DNA therefore was not designed by a notion of necessity, or a law of nature. The answer to this step often relies heavily on observations that are guided by the use of physics, chemistry and biochemistry.

Step 3 Ruling out chance: The final step is to rule out chance as a mechanism for producing a pattern of events that appear, thus far, to have been arranged by design. Without getting into the detail, the estimates of the probability of a simple DNA sequence coding for a single protein with 100 amino acids by chance has been set at effectively zero. Recent scientific studies suggest that the first cell would have had DNA coding for at least 300 proteins, each consisting of 100 or more amino acids.

Thus, ruling out chance involves a knowledge and use of several scientific disciplines, including statistics, mathematics and probability theory as well as biochemistry. Because probability is affected by the amount of time involved and the number of trials that may be involved, the fossil record comes into play. Darwin postulated that his theory would not work if there were not enough time over which change could be effected gradually in a continuum of numerous small steps. Hence, a design theorist will examine the fossil record to determine the amount of time that exists between changes in the development of diversity. Sharp bursts

of development with intervening periods of biological stasis support a notion of design; while gradualism tends to support chance-based mechanisms. In summary, if a highly improbable pattern of events or object exhibits purpose, structure or function and cannot be reasonably and rationally explained by the operation of the laws of physics and chemistry or some other regularity or law, then it is reasonable to infer that the pattern was designed. Based on the above it is reasonable to conclude that design is the best explanation for the complexity of the postulated ancestral cell.

Part 5

What Modified Standard Might Look Like

Origin Theory Standards

There are many competing belief systems concerning the origins of life on earth. Almost every religion contains a creation story; as a result of this there are hundreds of explanations for the formation of the universe. Some of the more prevalent theories are Methodological Naturalism (macro and micro evolution), scientific creationism, and simply micro- evolution. The recommended standards are an alternative to all three of these theories. It incorporates micro evolutionary principles and forms heretofore-unseen notions of the complexity of life.

Methodological Naturalism is the current theory adopted in most Californian public schools and has been detailed in the above sections. Scientific creationists believe in the book of Genesis and that God created the universe and all of its creatures in 6 days. Scientific creationists tend to believe that the story relayed in the book of Genesis is accurate and often attempt to harmonize Genesis with the findings of earth and biological scientists. The following is an assessment of the evolutionary policies currently taught in origins science, and recommendations for changing to the new model of Specified Complexity in origins science.

Fourth Grade: Earth Science

Current standard: “Students know how to differentiate among igneous, sedimentary, and metamorphic rocks by referring to their properties and methods of formation.”

Current Standard: “Students know some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes...”

Modification: Students know that many evolutionary scientists believe that the earth’s crust has changed and shifted as the earth evolved over millions of years. They use processes such as carbon dating, etc. to prove their figures. Students know other scientists that do not use carbon dating arrive at a very different age for the planet. These scientists look at the fossil record and find examples of rapid changes in the weather, creating ice ages, etc. that may not have taken millions of years to develop.

Fifth Grade: Life Science

Current Standard: “Plants and animals have structures for respiration, digestion, waste disposal and transport of materials.”

Modification: There are many different types of organisms living on this planet, some have extremely simple systems (single celled organisms) and others have incredibly complex systems for respiration, digestion, waste disposal and transport of materials.

Current Standard: “Students know many multicellular organisms have specialized structures to support the transport of materials.” Subsequent standards in the same area explain in great detail the functions of the digestive system, and the circulatory system in humans.

Modification: The modification to this section would keep the current language, and would add an argument on the nature of complexity of these systems. “Methodological Naturalism relies on chance and force to explain the formation of life on this planet and the systems and organisms which inhabit the planet. Some other explanations use the incredible complexity of such systems to imply that they possess an internal design system, and to reduce the role played by ‘chance’ in the formation of these systems.”

Sixth Grade: Plate Tectonics and Earth’s Structure

Current Standard: “Students know evidence of plate tectonics is derived from the fit of the continents; the location of earthquakes, volcanoes and midocean ridges; and the distribution of fossils, rock types, and ancient climatic zones.”

Modification: Include current language, and revisit earlier distinctions made regarding the competing views of the causes, significance and ages of phenomena such as the fossil record.

Seventh Grade: Cell Biology

Current Standard: “Students know cells function similarly in all living organisms.”

Modification: Students know that all living organisms are composed of cells, and that the number of cells in their make-up is directly related to how complex the organism will be. Organisms with a very low number of cells, will not have incredibly complex systems like those found in the human body. These cells serve many different purposes for the many different functions of the human body, and do not all behave in the same way. The cellular make-up of an organism determines its functions.

Current Standard (Evolution): “Biological evolution accounts for the diversity of species developed through gradual processes over many generations.”

Modification: There is an important distinction that needs to be made here between macro and microevolution. Macro evolution states that small, gradual changes over time add up to hypothetical big changes and from this point, attempts to explain the unobservable past by working backwards with created, and disputed dating methods. Microevolution utilizes observable evidence and explains mutation within a species, genetic recombination, extinction, adaptation, etc., which are all observable phenomena.

Current Standard: “Students know both genetic variation and environmental factors are causes of evolution and diversity of organisms.”

Modification: Students know that many factors are responsible for the diversity of organisms on this planet, including both genetic variation and environmental factors.

Current Standard: The subsequent teachings in this section for the remainder of seventh grade discuss in detail the tenets of Darwinian evolution. The teacher then supports this theory as fact, using various activities; including searching for shared derived characteristics among species.

Modification: The inclusion of many different hypotheses is essential to completely understanding the variations within each theory, and their criticisms. “How does science distinguish and discredit various aspects of origin theories?” Science discredits some theories while proving others, by comparing established theories with geological evidence and using the scientific method. The evidence for evolution is contained in many examples, such as Darwin’s tree of life, etc. However, although most scientists believe in the principles of mutation, extinction and adaptation, they are still disputing the evidence for many of the evolutionary examples.

Development of Life Standards

This origins discussion carries over into the debate regarding the development of life on this planet. In this area, many of the micro evolutionary theories are accepted as being derived from observable occurrences. However, as evolutionary theory develops it is also used for ‘operational science’. Naturalistic science entails a detailed analysis of evolutionary theory and reinforces the notion that macro evolutionary theory is indisputable. In contrast to this closed approach, Specified Complexity introduces criticisms to macro evolutionary theory alongside the teachings of the theory, as well as cites new methods for determining levels of complexity within natural systems.

Elementary:

“Scientific progress is made by asking meaningful questions and conducting careful investigations;” As a basis for understanding this concept and supplying the most rudimentary base for the theories that will be taught in high school, students should develop their own questions and perform investigations. The following is a brief overview of current standards guiding investigation and experimentation. “Students will: Perform experimentations using ‘tools’ available that we see everyday. (Common measurements, etc.); Solve scientific problems by using logic and evidence; Distinguish between hypothesis and theory as scientific terms; Explain the uses of theories, and why we have them; Read and interpret topographic and geologic maps; Analyze the locations, sequences, or time intervals that are characteristic of things found in nature; Analyze situations and solve problems that require combining and applying concepts from more than one area of learning. (i.e. mathematics: grouping, counting, etc.)”

First Grade:

The introduction of ‘theories’ what they are, (in the most general and abstract terms), why some people believe in them, what we hope to explain by using theories and by examining competing theories: a working application of the scientific method.

Middle School:

In order to advance the effectiveness of science education, the middle grades, 6-8 will introduce the controversy in detail. These standards will use operational science to advance both the theories of evolution and its criticisms. Through the practice of experimentation and investigation students will use their critical thinking to differentiate between models of scientific theory. Students should develop their own questions and perform investigations.

Seventh Grade:

Current Standard: “Biological evolution accounts for the diversity of species developed through gradual processes over many generations.”

Modification: Know that biological evolution may be defined as a change in gene frequency in a population over time. Know that evolutionary theory posits that microevolution (minor genetic variation within a population) over long periods of time results in macroevolution (descent with modification from a single common ancestry).

Current Standard: “Students know both genetic variation and environmental factors are causes of evolution and diversity of organisms.”

Modification: Analyze how natural selection and its evolutionary consequences may explain the diversity and unity of all past life forms as depicted in the fossil record and present life forms. Know that natural selection does not

Current Standard: “Students know the reasoning

used by Charles Darwin in reaching his conclusion that natural selection is the mechanism of evolution.”

explain the origin of life itself, and that biological evolution is a naturalistic theory that specifically excludes design from consideration.

Macroevolution, or Darwinian evolution, would require *modification* of existing genes (by forming new combinations of existing genes or by mutation of genes). The Standards need to make a distinction between microevolution, which is well supported experimentally, and macroevolution, which is ultimately based on similarities rather than experimentation.

Current Standard: “Students know how independent lines of evidence from geology, fossils, and comparative anatomy provide the bases for the theory of evolution.”

Modification: Students know that evolutionary scientists use carbon dating methods to establish a link between fossil records and the current species. Students know that evolutionary theory also bases many of its arguments on the relative similarity between anatomies of vertebrae species.

Current Standard: “Students know how to construct a simple branching diagram to classify living groups of organisms by shared derived characteristics and how to expand the diagram to include fossil organisms.”

Modifications: Students know that biological classifications are based on how organisms are related. Know that organisms are classified into a hierarchy of groups and subgroups based on similarities in form and/or function. Know that species is the most fundamental unit of classification. The Linnaean classification system (which is still used to a large extent) was developed during the 18th century, long before the advent of Darwinian evolution. Thus it is inaccurate to say that classifications of organisms “reflect their evolutionary relationships.”

It is true that some modern methods seek to develop classifications based on evolutionary relationships. Cladistic taxonomy is troublesome in practice, however. For example, Richard Dawkins (*The Blind Watchmaker*, 1996, p. 284) says “it is difficult to pin down the precise identity of ancestors...” Taxonomy is also difficult because once again it supposes a historical origin for which it has little evidence. Michael Denton (*Nature’s Destiny*, 1998, p. 293) says “despite an enormous effort, we still have no idea how this [the beginning of life] occurred, and the event remains as enigmatic as ever.” Under the new theory of Specified Complexity, students will at the very least begin to understand and contemplate this debate.

Eighth Grade: Earth in the Solar System (Earth Science)

Current Standard: “The structure and composition of the universe can be learned from

Modifications: These standards would need to reinforce the ability of scientists to test and measure and would need to distinguish this

studying stars and galaxies and their evolution.” ability from the historical aspects of explaining the origins of our solar system.

High School:

At this level, scientific progress is made by delving deeper into the debate between competing theories, and attempting to explain the variances in results produced by these theories.

Current standards for investigation and experimentation guidelines:

1. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
2. Identify and communicate sources of experimental error, discuss why they occur and attempt to reduce them by repeating the experiment using a different set of theories.
3. Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
4. Formulate explanations by using logic and evidence.
5. Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic function.
6. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
7. Analyze the competing views on, and explanations for differing locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
8. Recognize the issues of statistical variability and the need for controlled tests.
9. Recognize the cumulative nature of scientific evidence.
10. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
11. Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e. g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).”

Modifications: Add to the last sub point: “Know that there are many different theories in science,

Explanation: The current standard notes that a problem arises when an observation does not

and when an observation does not agree with a scientific theory, the observation is sometimes mistaken or it may prove that certain aspects of the theory are mistaken.”

agree with “an accepted scientific theory.” Darwinian evolutionary theory is the only ‘acceptable’ theory in the science classroom, so if an observation comes into conflict with Darwinian evolution, according to this standard it must be incorrect. This is just another example of the refusal to accept even the slightest variation within the evolutionary argument.

Ninth Grade:

Current Standard: “Students know how the evolution of life on earth has changed the oxygen composition of the earth’s atmosphere.”

Modification: Students know how the presence of life on earth has changed the oxygen composition of the earth’s atmosphere.

Current Standard: “Students know how life on earth is thought to have begun as simple, one-celled organisms about 4 billion years ago. During most of the history of the earth, only single-celled microorganisms existed, but once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved.”

Modification: Students know that according to evolutionary theory, life on earth is thought to have begun as simple, one-celled organisms shortly after the time when the earth first became habitable. During most of the history of the earth, only single-celled microorganisms existed, but once cells with nuclei developed, increasingly complex multicellular organisms developed. Know that evolutionary biology, as a historical science, forms a tentative reconstruction of events and processes that have already taken place.

Notes: The original indicator assumes that (Darwinian) evolution occurred. The modified wording makes it clear that evolution is a *theory* for the development of life on earth. Origins science is a *historical* discipline. As such, in the words of Ernst Mayr (“Darwin’s Influence on Modern Thought,” *Scientific American*, July 2000, p. 80): “Evolutionary biology, in contrast with chemistry and physics, is a historical science – the evolutionist attempts to explain events and processes that have already taken place. Laws and experiments are inappropriate techniques for the explication of such events and processes. Instead one constructs a historical narrative, consisting of a tentative reconstruction of the particular scenario that led to the events one is trying to explain.” Theories that are proposed in a historical science are always tentative, and alternative explanations are possible.

Tenth Grade:

Current Standard: “Students know historical scientific developments occurred in evolutionary thought (e.g., Darwin, Mendel, Lamarck).”

Modification: Know historical scientific developments that occurred in evolutionary thought, including alternative theories that have been considered (e.g., Paley, Darwin, Lamarck, Mendel, Behe).

Current Standard: “Understand that natural selection leads to organisms that are well suited for survival in particular environments. Chance alone can result in the persistence of some heritable characteristics having no survival or reproductive advantage or disadvantage for the organism. When an environment changes, the survival value of some inherited characteristics may change.”

Notes: No modification is suggested for this indicator, since it basically describes microevolution (which is well accepted). In any case, the validity of natural selection is not the issue. The issue is whether natural selection is a sufficient mechanism to enact *macro evolutionary* change.

Current Standard: “Understand that natural selection provides the following mechanism for evolution: some variation in heritable characteristics exists within every species, some of these characteristics give individuals an advantage over others in surviving and reproducing, and the advantaged offspring, in turn, are more likely than others to survive and reproduce. The proportion of individuals that have advantageous characteristics will increase.”

Notes: Again no modification is suggested, since this basically describes microevolution. None of the original indicators states the Darwinian argument that natural selection over long periods time results in macroevolution.

Eleventh Grade:

Current Standard: “Know other mechanisms for evolutionary change, including genetic drift, immigration, emigration, and mutation.”

Modification: Describe these proposed mechanisms for evolutionary change: genetic drift, immigration, emigration, and mutation.

Notes: This seems to appear out of context. The word "other" implies that the indicator is making a contrast with something else, probably "natural selection". A minor wording change is recommended to help the statement stand better on its own.

Current Standard: “Students know how the evolution of life has changed the physical world

Modification: Know how the presence of life has changed the physical world over geological time.

over geological time.”

Explanation: These indicators are very similar in nature, and both assume that (Darwinian) evolution has occurred. It is the *presence* of life, not its *evolution*, that has changed the physical earth over time.

Current Standard: “Students know that ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.”

Modification: Know that ecosystems always change when climate changes or when one or more new species appear as a result of migration, local evolution, or another mechanism.

Explanation: This statement assumes that migration and evolution are the only mechanisms for the appearance of new species in an ecosystem. The modified wording allows for other mechanisms to be considered.

Part 6

Putting the Standards into Practice

Methods of Adoption

There are three methods that can be used in order to implement the standards that we have proposed. The first of these methods is through the California Academic Standards Commission. In 1995 the California Academic Standards Commission was developed and given the authorization from the legislature to design and implement academic standards in California. The Academic Standards Commission encompasses a board of 21 members laden with the task of designing new academic standards that school districts are encouraged, but not mandated to adopt. Twelve of the 21-member Board are elected by the state of California's governor, the Superintendent of Public Instruction, the State Senate and State Assembly. The Science Committee consists of twelve of the board members who are the Superintendent of Public Instruction, community leaders, teachers and scientists. Along with designing standards for the public school curriculum, the Commission also develops standards that textbook publishers are required to be in line with. This commission is the normal venue and proper first step towards changing the *Science Content Standards*.

The last standards change in science, which took place in 1998 was done in this way. By simply submitting our proposed standards to the commission and making a case for them we give them the opportunity to vote immediately for their adoption. This is the best option for the adoption of the proposed standards. Because the standards could be adopted by a majority vote on the Academic Standards Commission there would be no need for cumbersome legislative action. The California Academic Standards Commission would prove to be the better method for adopting new science standards because it is not bogged down in legislative substance, but it allows the public to be involved in the proposed education standards. After public approval, the standards then go through a few public hearings and a final draft is approved by the Academic Standards Commission and given to the California State Board of Education. The Commission has been charged with the duty of obtaining and developing ideas and proposals for new science standards. Through a combination of working sessions and public meetings with the community and teachers, the Commission is able to solicit insight and commentary on proposed academic content standards. Unlike dealing with legislative action, the Commission is able to review standards as they are being written to ensure that they are written in a fashion that reflects our science mandate.

Legislative action however is not entirely unworkable. If we were not successful in getting the majority vote of the Academic Standards Commission we would be best served in taking the proposed standards before the legislative bodies in California. Two methods could be

employed at this stage. The first would be to write our standards in the form of a department research position paper which could be placed before the legislature and serve as a guide for new standards. The second option is to find the support of a legislator who would be able to introduce our proposed standards as pending legislation before the Senate or the Assembly. The legislature could vote to adopt the standards and the governor could sign them into law. Similar to the steps taken by the Academic Standards Commission a hearing would take place to determine the whether the education bill proposed should be “marked up” and recommended to a full committee. The full committee is then given the task of voting on the proposed science standards bill. Seeking legislative action is thus an arduous task because the committee’s vote on the bill determines whether or not it moves to the floor of the legislature.

The third and final strategy for the adoption of the proposed standards is the citizen referendum. In California there is the ability of the people to directly vote on issues that they feel strongly about. First, our proposed standards would have to be written in the proper format and submitted to the Secretary of State along with the verifiable signatures of five percent of the voting population who voted in the last gubernatorial election. The Secretary would certify that the signatures were authentic. Then he or she will assess the possible economic impact of the new standards. Once these things have been done the proposed standards could be voted on in a statewide initiative in either March or November, which, if successful, would make them law.

Legal Support

The newly revised standards comply with established law and in no way violate the Establishment Clause of the First Amendment. In demonstrating they’re constitutionality, we first look to the Lemon Test. Evaluating the proposed policy against each prong we begin by asking “Does the statute have a secular legislative purpose?” YES. The secular purpose is to enhance the comprehensiveness and effectiveness of California’s science instruction. Additionally, if the standards are put into practice as proposed, the Court would be hard pressed to find any religious intent connected to their adoption.

Moving on we ask, “Is the statute’s principal or primary effect one that neither advances nor inhibits religion?” YES. The introduction of competing religiously-based scientific origin theories amounts to teaching about religion – a method the Supreme Court has upheld on numerous occasions (not true). Also, because our proposed standards do not limit the presentation of evolutionary concepts, religious concepts are never advanced by default.

Finally, can the policy be said to “not foster an excessive government entanglement with religion?” YES. The only excessive entanglement encouraged by the new standards is a greater use of the scientific method in determining what ideas students are exposed to. The new standards for teaching about the development of life stipulate that only scientifically rigorous alternative theories can be introduced alongside evolution.

The newly revised standards also build upon the precedent established by the Supreme Court in *Edwards v. Aguillard*. In its ruling striking down balanced treatment legislation, the Court established guidelines for policies that would pass constitutional muster. First, Supreme Court affirmed that schools might legitimately “*teach a variety of scientific theories about the origins of humankind to schoolchildren...with the clear secular intent of enhancing the effectiveness of science instruction.*” Second, the Court determined that scientific critiques of prevailing theories could be taught. The revised standards introduce concepts that further these two guidelines and nothing more.

California should develop resources that allow for teaching without fear. The state is experiencing a growing shortage of qualified teachers and must adopt reforms (like the ones proposed) that support teachers in their work. Teachers and school districts should be freed to discuss multiple origin theories in their classes without fear of being dragged into court. To support teachers, the State’s attorney will prepare a legal memorandum outlining the lawful nature of the revised standards. It is also imperative that newly adopted Science Framework be amended to include guidance concerning the revised standards. Teachers, educators and designers of science instructional materials all look to the framework for direction and the direction must be up-to-date.

Constitutional Detail

The Supreme Court affirmed that schools might legitimately “teach a variety of scientific theories about the origins of humankind to schoolchildren...with the clear secular intent of enhancing the effectiveness of science instruction.” The Court’s decision did not fully exonerate the teaching of only evolution in public schools. In fact, the Court affirmed that schools might legitimately “teach[] a variety of scientific theories about the origins of humankind to schoolchildren...with the clear secular intent of enhancing the effectiveness of science instruction.”^{lxii} Subsequent to the Court’s ruling, very little in public policy and case law has emerged to provide guidance in how best to teach the origins controversy.^{lxiii}

The First Amendment prohibits any law respecting the establishment of religion and is violated by a public school if that school adopts policies or exercises of a religious character that are part of the curricular activities of its students who are required to attend school. The test in determining whether the Establishment Clause of the First Amendment has been violated is the purpose or the primary effect of the act itself. If it advances or inhibits religion then the act exceeds the scope of power laid out by the Establishment Clause of the First Amendment. The test in determining whether the Free Exercise Clause of the First Amendment has been violated is whether or not the act has a coercive effect on the individual and his/her ability to practice their religion. A violation of the Free Exercise Clause of the First Amendment is predicated on coercion while a violation of the Establishment Clause is not.

The Establishment Clause of the First Amendment requires that the government remain neutral towards religion. However, an amateur devotion to the principles of neutrality could lead to approval of policies not simply reflecting neutrality towards religion but instead

reflecting a pervasive hostility towards religion. Government must recognize, at some point and under certain circumstances outlined by the First Amendment, the existence of religion in a nation composed largely of religious citizens.

The seeming tension between the First Amendment religion clauses, the Establishment Clause and the Free Exercise Clause, is most clearly highlighted by the many cases in federal courts involving religion in the public schools. The Establishment Clause states that Congress shall not make laws that have the effect of establishing religion. The Framers of our nation recognized the great importance of preventing the entanglement of the religions of the nation's people with their government. The Constitution's First Amendment also contains the Free Exercise Clause, which the Framers designed to protect the rights of individuals to practice free exercise of religion.^{lxiii} These religion clauses of the First Amendment were meant to work together to protect religious freedoms. However, more often than working together, the Supreme Court's interpretations of the Establishment and Free Exercise Clauses have tended to conflict with one another. The Framers could not have imagined the remarkable demands that the First Amendment's religion clauses would place on the American society with such religious heterogeneity that is today's reality. Public education, the source of so many of these disputes, was unknown to them.

The First Amendment Establishment Clause states "Congress shall make no law respecting an establishment of religion"(U.S. Const. Amend. I). Misunderstandings of what was intended by this seemingly simple phrase has resulted in fierce debate regarding the law respecting the Establishment Clause. According to Justice Scalia, "[o]ur Religion Clause jurisprudence has become bedeviled (so to speak) by reliance on formulaic abstractions that are not derived from, but positively conflict with, our long-accepted constitutional traditions"(*Lee v. Weisman*, 505 U.S. 577, 644 (1992) Justice Scalia dissenting).

The current test used to determine a violation of the Establishment Clause was developed in *Lemon v. Kurtzman*. (403 U.S. 602, 612-613 (1971)) The Lemon Test has three prongs: "First, the statute must have a secular legislative purpose; second, its principal or primary effect must be one that neither advances nor inhibits religion; finally, the statute must not foster an excessive government entanglement with religion" (*Lemon v. Kurtzman*). This test has been much debated and criticized but nevertheless is still law and lower courts must rely on it to evaluate the constitutionality of legislation under the Establishment Clause.^{lxiv} Recent movements within the Court, however, have reflected a movement away from the Lemon Test towards the approach championed by Justice O'Connor, the "endorsement" test. This test finds an Establishment Clause violation when government "endorses religion" which means it "sends a message to non-adherents that they are outsiders, not full members of the political community, and an accompanying message to adherents that they are insiders, favored by members of the political community" (*Lynch v. Donnelly*, 465 U.S. 668 (1984) Justice O'Connor, concurring).

The Free Exercise Clause of the First Amendment states "Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof" (U.S. Const. Amend I.). Before the 19th century, the Courts interpretation of the Free Exercise Clause

was unsympathetic towards religious freedoms. In a case regarding the conviction of a Mormon to practice polygamy, based on religious beliefs, the Court distinguished between an individual's "freedom to believe" and their "freedom to act." "Laws are made for the government of actions, and while they cannot interfere with mere religious belief and opinions, they may with practices" (*Reynolds v. United States*, 98 U.S. 145 (1879)). To hold otherwise, "would be to make the professed doctrines of religious belief superior to the law of the land, and in effect to permit every citizen to become a law unto himself." This distinction between belief and action remained well into this century and even to the decision in *Cantwell v. Connecticut* when the court retained this distinction but added that, in the latter instance, the governments "power to regulate must be so exercised as not, in attaining a permissible end, unduly to infringe the protected freedom"^{lxv} (*Cantwell v. Connecticut*, 310 U.S. 296 (1940)). Although the Court has held that the Free Exercise Clause may require religious exemption from a general law regulating conduct when the legislation conflicts with religious precepts, the Court has never granted such an exception.

Teacher Training and Resources

We propose three additional strategies to ensure that the standards are put into practice in California's classrooms. First, once the framework is amended, designers of instructional material will be expected to comply with state law. According to the Criteria for Evaluating K-8 Science Instruction Materials which was adopted by the State Board of Education on March 10, 1999:

Science materials must support teaching aligned with the Standards. Materials that fail to meet the science content criteria will not be considered satisfactory for adoption.^{lxvi}

We agree that it is imperative for all science instruction materials to meet the standards set forth by the state and that the revisions would bring valuable resources to teachers and students alike.

Second, in California, teachers have, and should retain, the ability to write their own curriculum. However, anytime new standards are adopted, the state must work to ensure that teachers have the resources to prepare curricula in accordance with the changes. Thus, the state must work with publishers to enable teachers to use the newly revised science instruction materials as the basis for their curriculum.

In addition, the state should promote the use of "curriculum exchanges" where teachers around the state post their newly revised lesson plans on the Internet for access by other teachers. Through the use of the Internet we could pool the talent and resources of the teachers of California in such a way as to help teachers in every part of the state. The use of curriculum exchange would allow teachers to find a variety of lesson plans and resources from around the country. The curriculum exchange program would serve as an essential means for teachers to improve the quality of education in science classrooms. Not only would the curriculum exchange benefit the quality and performance of teachers, but of

students as well. This comprehensive approach could lead to strategies that encourage schools to adapt cohesive approaches to professional development. Curriculum exchange programs could serve as a means to encourage teachers to adopt the mandated guidelines.

Third, universities and colleges in the State of California that train teachers must be informed concerning the newly revised standards and amend their coursework in order to prepare teachers to teach the various aspects of origin theory. Building links between professional development and education practices that will improve the outcome of the science curriculum is beneficial to everyone. The focus is clearly not just on professional development for teachers, but on encouraging teachers and schools to develop strategies that will produce a more critical and engaged environment for all students.

Part 7

Conclusion

Teach Darwin's elegant theory. But also discuss where it has real problems accounting for the data, where data are severely limited, where scientists may be involved in wishful thinking, and where alternative—even “heretical”—explanations are possible. ~ Dr. Michael Behe^{lxvii}

A “fear of revision” should not guide improvements in science instruction. As we speak, students are being shielded from valid scientific criticisms of evolution and alternative explanations for no better reason than fear of revision. Students thrive when learning is open to new fields of inquiry, not the other way around. If education is to improve in California then public policy must be guided by what is in the best interest of our students, not by emotion.

The surest way to enhance the comprehensiveness and effectiveness of science instruction is to expand the scope of discussion. In the scientific community a vibrant debate over the origin and development of life is taking place. Now is the time to bring that debate into the classrooms of California's public schools. Both the scientific method and the Supreme Court affirm the importance of introducing broad and wide-ranging considerations of multiple theories. Why not allow these discussions to bear on the most fundamental question in life: where did we come from?

Success in education is only possible to the extent that teachers are empowered in their work. In order to implement revised standards and benefit students' comprehension of the critical scientific debate over origins, teachers must have legal protection and instructional resources. The teaching community is very resourceful and along with the state will develop support services to successfully introduce critiques of evolution and competing origin theories.

At the end of the day, students in public schools must be afforded the opportunity to learn about and tackle the hard issues of origins science. Science is knowledge and to do any less is to fall short of goal of illuminating “the methods of science that will be used to extend that knowledge during the students' lifetimes.”^{lxviii}

About the Authors

Samara Ashley earned a Bachelor's degree in Sociology and Black Studies from the University of California at Santa Barbara (UCSB). She is the recipient of the UCSB Chancellor's Scholarship. Samara has been president of local chapters of the NAACP and Zeta Phi Beta Sorority, Inc., board member of the Student Coalition on Racial Equality and a tutor for the Isla Vista Family Literacy Program. She also hosted a radio program on KCSB.

Sara Carmack holds a Master's degree in Public Policy from Pepperdine University, as well as a Bachelor's degree in History from the University of California at Davis. She has written analyses on both state and national education programs, as well as the role of Faith Based Organizations.

Samuel Jeffrey earned a Bachelor's degree in Communications from Abilene Christian University where he was a leadership scholarship recipient. Sam has worked with Senator Kay Bailey Hutchison, the Bill Simon for Governor Campaign, and recently completed a bible missionary assignment in Africa where he has volunteered in ten different countries. Sam and his wife Emille are from Texas.

Jeffrey Jones earned his Bachelor's degree in Political Science from Wheaton College where his studies focused on political thought, history and poverty issues. After graduation, he served as an Americorps*VISTA member creating a viable jobs project targeting the homeless. Jeff continued in social service and eventually became the Executive Director of a non-profit employment agency in Illinois where he met and married his wife Lori. He was a Hansen Scholar and Fletcher Jones Scholar while at Pepperdine University.

Mackenzie Kirby earned a Political Science degree from Michigan State University in 1998 where she was a Student Leadership Award recipient. While there, she coordinated a campaign to register new voters and was a first-chair violinist with the Michigan State University Symphony Orchestra. Mackenzie has been employed by the UCLA and Hoffman & Associates, a capital management firm. She has traveled extensively throughout the world.

Ryan Maguire is the second oldest of ten sisters and two brothers. He earned a Bachelor's degree from Grand Canyon University, where his studies consisted of political philosophy, law, the natural sciences and Lisa, whom he later married. While in college he interned with the Goldwater Institute where his interest in public policy was piqued. He is a participant of the joint degree program with the Business School and the School of Public Policy at Pepperdine and will graduate in 2003.

Appendix A

Definitions

Affirmed - When an appellate court rules that in a particular case the ruling of the lower court will stand as rendered by the lower court.

Appellate - About appeals, an appellate court has the power to review and overturn the ruling of a lower court.

Balanced treatment - A term used to describe a school curriculum that presents both evolution and creationism as equally valid explanations for human origins.

Creation science - A field of science with the goal of underpinning the biblical account of human origins.

Establishment clause - Found in the first amendment to the United States Constitution this clause provides that the federal government shall make no laws “respecting the establishment of religion.” The courts have consistently held that this clause also applies to state and local governments as well.

Evolution - The theory routinely attributed to Charles Darwin and detailed in his book *Origin of the Species*—it contends that all life on earth evolved from the same simple one cell organism that were guided by natural selection to bring us to where we are today.

Intelligent design - seeks to show that a designing force may explain the origins of life. While design theory makes no claim about the makeup or nature of the designer, it does assert that biological evolution alone does not sufficiently explain the origins of life. Intelligent design seeks to avoid the religious nature of other design theories such as creationism by not advocating any particular assignment to the nature of the designing force.

Nebular cloud theory - this theory explains that the earth was formed out of a nebular cloud 4.6 billion years ago. It is currently the only theory taught in California public schools.

Lemon Test - A three-pronged test formulated by the Supreme Court in 1971 in the case *Lemon v. Kurtzman* to show how to apply the establishment clause to actual cases. There are three, equally important prongs to the Lemon Test. The first of these prongs states, “the action of the government must not promote a particular religion or religious view.” The second prong states, “the action of the government must not have the primary effect of either advancing or inhibiting religion.” The third and final prong states, “the action of the government must not result in an ‘excessive entanglement’ of the government and religion.”

Scopes Monkey Trial - The still famous trial, in which a Tennessee substitute biology teacher named John Thomas Scopes, challenged a state enforced ban on the teaching of evolution in public schools. Scopes was represented by Clarence Darrow and the state was represented by William Jennings Bryan. Scopes was found guilty and forced to pay a \$100 fine.

Specified complexity - The belief that that intelligent causes are necessary to explain the complex, information-rich structures of biology and that these causes are empirically detectable.

Theistic evolution - A belief that while some of the principles of evolution are correct, at the very least there was a divine hand that set it in motion.

Appendix B

Policy on the Teaching of Natural Sciences

Science Framework for California Public Schools
Kindergarten Through Grade Twelve
Adopted by the State Board of Education on February 6, 2002*
[*Subject to technical editing]

On January 13, 1989, the State Board of Education adopted the following policy statement on the teaching of natural sciences, which was printed in the 1990 Science Framework for California Public Schools Kindergarten Through Grade Twelve. This policy statement supersedes the State Board's 1972 Antidogmatism Policy that was distributed statewide in 1981 and printed in the 1984 Science Framework Addendum. To this policy statement are appended standard scientific dictionary definitions of several scientific terms to emphasize their meanings in scientific contexts.

State Board of Education Policy on the Teaching of Natural Sciences

The domain of the natural sciences is the natural world. Science is limited by its tools - observable facts and testable hypotheses.

Discussions of any scientific fact, hypothesis, or theory related to the origins of the universe, the earth, and life (the how) are appropriate to the science curriculum. Discussions of divine creation, ultimate purposes, or ultimate causes (the why) are appropriate to the history-social science and English-language arts curricula.

Nothing in science or in any other field of knowledge shall be taught dogmatically. A dogma is a system of beliefs that is not subject to scientific test and refutation. Compelling belief is inconsistent with the goal of education; the goal is to encourage understanding.

To be fully informed citizens, students do not have to accept everything that is taught in the natural science curriculum, but they do have to understand the major strands of scientific thought, including its methods, facts, hypotheses, theories and laws.

A scientific fact is an understanding based on confirmable observations and is subject to test and rejection. A scientific hypothesis is an attempt to frame a question as a testable proposition. A scientific theory is a logical construct based on facts and hypotheses that organizes and explains a range of natural phenomena. Scientific theories are constantly

subject to testing, modification, and refutation as new evidence and new ideas emerge. Because scientific theories have predictive capabilities, they essentially guide further investigations.

From time to time natural science teachers are asked to teach content that does to meet the criteria of scientific fact, hypothesis, and theory as these terms are used in natural science and defined in this policy. As a matter of principle, science teachers are professionally bound to limit their teaching to science and should resist pressure to do otherwise. Administrators should support teachers in this regard.

Philosophical and religious beliefs are based, at least in part, on faith and are not subject to scientific test and refutation. Such beliefs should be discussed in the social science and language arts curricula. The Board's position has been stated in the Board's adopted *History-Social Science Framework* (2001). If a student should raise a question in a natural science class that the teacher determines is outside the domain of science, the teacher should treat the question with respect. The teacher should explain why the question is outside the domain of natural science and encourage the student to discuss the question further with his or her family and clergy.

Neither the California nor the United States Constitution requires, in order to accommodate the religious views of those who object to certain material or activities that are presented in science classes, that time be given in the curriculum to those particular religious views. It may be unconstitutional to grant time for that reason.

Nothing in the California *Education Code* allows students (or their parents) to excuse class attendance based on disagreements with the curriculum, except as specified for certain topics dealing with reproductive biology and for laboratory dissection of animals. [See California *Education Code* sections Science Framework for California Public Schools. However, the United States Constitution guarantees the free exercise of religion, and local governing boards and districts are encouraged to develop statements like this one that recognize and respect that freedom in the teaching of science. Ultimately, students should be made aware of the difference between understanding, which is the goal of education, and subscribing to ideas, which is not.

Appendix C

Dissenting Scientists National Advertisement

A Scientific Dissent on Darwinism

"I am skeptical of claims for the ability of random mutation and natural selection to account for the complexity of life. Careful examination of the evidence for Darwinian theory should be encouraged."

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Appendix D

AB 2160

If adopted, 2160 would “give teacher’s the right to negotiate the procedures for:

- Developing and implementing any program designed to enhance student academic performance;
- Selecting textbooks and instructional materials;
- Developing and implementing local educational standards;
- Developing and implementing the definition of educational objectives, content of courses and curriculum;
- Developing and implementing additional professional training for teachers;
- Involving teachers on school site councils and other advisory or representative committees that make decisions about their school and school district;
- Developing and implementing programs to encourage parental involvement in student education;
- The maintenance of school facilities;
- The utilization and assignment of mentors;
- Selecting external evaluators and school assistance and intervention teams for IIUSP schools.^{lxix}”

As can be seen in the words of the California Teachers Association this bill would dramatically increase the powers of the Teachers union. Their new found abilities to develop and implement any program designed to enhance student academic performance and select textbooks and instructional materials would give them large amounts of power to counteract the intentions of the new standards. One other factor that forces a second consideration of AB 2160 is our skepticism of the California Teachers Association’s possible unwillingness to implement any standards that call for the introduction of any ideas that challenge the authority of Darwinian evolution. While the CTA has not released a statement regarding their stance on evolution, they are affiliated with the National Education Association, who as recently as 1982 made it clear that “the NEA opposes all efforts to alter the science standards in any way that would place the teaching of scientific creationism on equal footing with the teaching of evolution.”^{lxx}

This affiliation, coupled with the new, expansive powers that would be delivered to the California Teachers Association with the passage of AB 2160 forces us to oppose its passage.

AB 2160 TEXT:

February 20, 2002: An act to amend Sections 52054 and 52055.650 of the Education Code, and to amend Section 3543.2 of the Government Code, relating to public school employment.

AB 2160, as introduced, Goldberg. Public school employees: scope of representation.

(1) Existing law provides that public school employees have the right to form, join, and participate in the activities of employee organizations for the purpose of representation on all matters of employer-employee relations. Existing law provides that the scope of representation shall be limited to matters relating to wages, hours of employment, and other terms and conditions of employment, as defined. Existing law also provides that the exclusive representative of certificated personnel has the right to consult on the definition of educational objectives, the determination of the content of courses and curriculum, and the selection of textbooks, as provided.

This bill would provide that the scope of representation for the exclusive representative of (a) certificated personnel employed by a school district, (b) a county superintendent of schools, or (c) a charter school that has declared itself to be a public school employer, shall include additional matters, including, among other things, the selection of an external evaluator under the Immediate Intervention/Underperforming Schools Program and the selection of a school assistance and intervention team under the High Priority Schools Grant Program for Low Performing Schools. The bill would make related changes.

By requiring specified public school employers to negotiate additional matters, the bill would impose a state-mandated local program.

(2) The California Constitution requires the state to reimburse local agencies and school districts for certain costs mandated by the state. Statutory provisions establish procedures for making that reimbursement, including the creation of a State Mandates Claims Fund to pay the costs of mandates that do not exceed \$1,000,000 statewide and other procedures for claims whose statewide costs exceed \$1,000,000.

This bill would provide that, if the Commission on State Mandates determines that the bill contains costs mandated by the state, reimbursement for those costs shall be made pursuant to these statutory provisions.

Vote: majority. Appropriation: no. Fiscal committee: yes. State-mandated local program: yes.

Appendix E

Teacher Certification and Training

Federal Certification

In accordance with the Goals 2000: Educate America Act of 1994 many states have passed legislation that has required them to change the standards set in their science curriculum. The eight national education goals established in the Goals 2000: Educate America Act was designed to improve the quality of schools in all academic fields. Title II of the Higher Education Act which was amended in 1998 also required that the public schools system be held responsible for the quality of teachers and students that it produced. According to Title II, the federal government required that three annual reports on teacher preparation, the amount of pass rates on state certification assessments and the states be reported to the state and the U.S. Department of Education.^{lxxi} The annual reports most importantly accounted for the amount of teachers that are certified by the state, state wide pass rate, teacher standards and information regarding low performing schools. Improving the quality and knowledge of teachers has not only been a state concern, but a national concern as well. The question regarding teacher performance continues to be whether national certification standards can improve the quality of public education. National certification has indicated that certain teachers have been able to attain a higher level of accomplishment and knowledge in a certain subject areas. In addition to the already mandated California state certification standards, national certification should serve to enhance the professionalism and quality of a teacher's performance.

National certification standards have paved the way for teachers who have desired further professional development. The National Certification Board has currently three policy goals that are to be accomplished in the effort to produce a higher quality of educators: (1) Ensure that teacher preparation programs offer master degree programs coordinated with NBPTS certification (2) Achieve the goal of one National Board Certified Teacher in every school in California by 2005 and (3) Increase the funds available for teacher incentives, candidate stipends, and support programs.^{lxxii} These policy goals are expected to hone more accomplished and professional teachers, increase teacher knowledge in order to create better standards for public schools.

National certification of teachers will enhance the contributions that science teachers can make to the classroom. California currently has over 1,300 teachers who are National Board certified and another 1,500 are working on becoming nationally certified.^{lxxiii} The National Board for Professional Teacher Standards (NBPTS) recently concluded a study regarding the national certification of teachers.^{lxxiv} The study conducted was designed to determine whether teachers who were nationally certified differed from those who were not. Facets such as the

quality of teaching, the quality of student performance and post-assessment professional activities were tested. This study found that the nationally certified teachers fared better than those who were not certified, based on the fact that their knowledge and teaching tactics produce a more conducive learning environment.^{lxxv} The NBPTS' goal for California currently consists of creating and motivating teachers to raise the quality of their teaching standards. Thus, according to such research national certification would in fact create more professional development among teachers, as a result of the advanced certification and teacher training programs designed to promote greater teacher development.

State Board Certification

Because each state is required to establish its own teacher licensure requirements, the state is responsible for ensuring that all teachers enter the public school environment with a level of competence in their subject area and have the adequate teaching skills needed to produce a more conducive educational environment, educational methods, teaching skills, and classroom management abilities. The California Basic Educational Skills Test (CBEST) was designed to evaluate the reading, writing, and mathematics skills of future teachers. The CBEST is designed to meet the legal requirements regarding credentialing and employment, as well as measure teacher quality and performance.

Prior to becoming a teacher, some aspirants are placed in a teacher preparation program, in which they are placed in an environment where their skills can be honed. The teacher preparation program's initial goal was to allow future teachers the ability to develop skills needed for a more conducive classroom environment. Through this program teachers are able to gain the "how to" and the "what to" aspects of teaching. Prior to becoming credentialed, teachers must obtain a bachelor's degree from an accredited university, take the CBEST and a teacher preparation program at an educational institution that has a Commission-approved credentialing program.

The standard and quality of student's knowledge concerning the science curriculum depends significantly on teacher preparation. In 1992 the California Commission on Teacher Credentialing initiated new standards that science teachers were to abide by. Two science teaching credentials were originally enforced, one being the Single Subject Teaching Credential in Life Science and the other being the Single Subject Teaching Credential in Physical Science, which authorized teachers to teach science at any grade level. Currently the Commission has decided to combine the Life Science and Physical Science Credentials into one science credential.^{lxxvi} The combined credential requires teachers to demonstrate a specialized knowledge of science across the board (i.e. biological science, chemistry, geo-science and physics)

California currently has a two-tier credential structure, in which the first credential issued is a preliminary credential and the second being the professional clear credential that is issued after all credential requirements are completed. The Single Subject Teaching Credential is currently one means by which California teachers can teach a special subject, such as science. This credential allows teachers to teach in departmentalized classrooms in K-12

public schools. Despite the fact that teachers who obtain such a credential is authorized for a single subject, they can be required to teach any subject in their authorized field.^{lxxvii} As a result teachers should be responsible for obtaining the special training (i.e. Masters Degree, language training, etc.) needed from an accredited university. According to current state regulations the preliminary credential is issued for a maximum of five years and teachers who do not complete the requirements prior to the expiration of the credential are not eligible to teach. In order to ensure that teachers are competent in a subject matter, they should have taken the necessary courses from a university in the subject matter that they plan to teach and be tested on their ability to pass an examination for that same subject. Science teachers should therefore obtain a single subject credential to ensure that they have the necessary knowledge needed to teach all aspects of the science curriculum, as well as be versed in the various debates in the science field and trained on how to handle those debates.

Training Teachers

As a means of ensuring that teachers fulfill their requirement for the professional clear credential, teachers should have already obtained a single subject preliminary credential as well as taken teacher preparation courses. Teacher preparation institutions should be designed to ensure that teachers are prepared to teach a particular subject matter such as science. The School Board Commission should verify teacher's competence levels through vigorous subject oriented tests. The Commission on Teacher Credentialing has recently requested that development standards be created to ensure that teachers are knowledgeable and can effectively teach the science curriculum. Organizations such as the Comprehensive Teacher Education Institute (CTEI), WestEd and the California Commission on Teaching Credentialing have been designed to create new and inventive models of teacher preparation. The state of California has strived to create a more conducive learning environment for students and teachers. As a result of CTEI's partnerships, the state of California placed state wide reforms designed to produce better quality and performance from its teachers.

Today, there remains to be a growing interest in high standards for teachers. Professional development programs for teachers are necessary in the effort to produce a more conducive learning environment for students. The goal behind professional development programs would be to provide teachers with a higher standard of knowledge and skills that are needed in order for them to provide students with a greater understanding of scientific debates as well as make go teachers need to make good decisions. At the state and local levels, curriculum standards should be tested by using standard testing formats to evaluate the extent to which students are benefiting and learning from the new methods. Implementation of new science standards will only be successful through professional development, because it is necessary that teachers and administrators have the proper skills and resources needed to implement the reforms. Without the proper training teachers and administrators would not understand the need for reform and the relationship between the new science standards and the reforms themselves.

A teacher's ability to effectively teach the science curriculum and their ability to adequately address debates that arise in the science curriculum would greatly affect the quality and

performance of a teacher. In 1986 the California Commission on Teacher Credentialing adopted 32 qualifying principles of a well-trained science teacher in the Standards of Program Quality and Effectiveness for Professional Teacher Preparation Program.^{lxxviii} These standards have served as markers to determine the degree of teacher preparation programs for Single Subject Teaching Credentials. According to these standards open-mindedness, the promotion of commonly shared scientific values and objectivity should be promoted. Teachers should be willing to improve the science education by making parents and community members aware of new approaches to the curriculum, discuss new initiatives. Teachers on the other hand, also have the ability to make decisions about implementing new curriculum. Because teachers are ultimately responsible for implementing new standards at the various grade levels, they should be given the opportunity to develop their own science curriculum framework that is in line with the state standards. Time-honored traditional classroom standards at certain instances will have to be abandoned in order to foster a more innovative and in-depth dialogue concerning the science curriculum.

Endnotes

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- ⁱ “Science Content Standards for California Public Schools: Kindergarten Through Grade Twelve,” *California State Board of Education*, (Sacramento: California Department of Education, 2000).
- ⁱⁱ See http://www.cs.colorado.edu/~lindsay/creation/quote_dobzhansky.html. Biological evolution is alternatively referred to as naturalistic or Darwinian evolution and although each term has a specific meaning, they are often used interchangeably.
- ⁱⁱⁱ “Science Framework for California Public Schools,” *State Board of Education*, (Sacramento: California Department of Education, February 6, 2002).
- ^{iv} *Edwards v. Aguillard*, 482 U.S. 578 (1987). Majority opinion by Justice Brennan.
- ^v *Ibid.*
- ^{vi} “‘Biological evolution,’ according to the National Academy’s booklet, ‘explains that living things share common ancestors. Over time, evolutionary change gives rise to new species. Darwin called this process ‘descent with modification,’ and it remains a good definition of biological evolution today.’” Jonathan Wells, *Icons of Evolution Science or Myth?: Why much of what we teach about evolution is wrong*, (Washington, D.C.: Regnery Publishing, 2000), 4.
- ^{vii} <http://www.nsta.org/159&id=10>
- ^{viii} “Science Framework.”
- ^{ix} “Science Content Standards.”
- ^x William Dembski, “Teaching Intelligent Design – What Happened When? A Response To Eugene Scott.” [text on-line], available from <http://www.meta-list.org>; Internet.
- ^{xi} Specified: a system that fits a recognizable pattern; Complexity: level of sophistication within a system that allows for a ‘hopelessly small’ probability of random outcomes
- ^{xii} See Richard Dawkins. *The Blind Watchmaker*. (Norton, W. W. & Company, Inc, 1996).
- ^{xiii} See <http://www.cell.com/>
- ^{xiv} DeForrest, DeWolf, and Meyer, “Teaching the Origins Controversy: Science, Religion, or Speech?,” *Utah Law Review*, (Utah L. Rev., 2000), 39.
- ^{xv} *Ibid*
- ^{xvi} See Appendix C.
- ^{xvii} “Zogby American Report.” Zogby International. September 21, 2001. The margin of error for the poll results is +/- 3.0%.
- ^{xviii} See *JAMA*, July 24/31, 2002—Volume 288, No. 4, p. 482.
- ^{xix} *Science Content Standards* for California Public Schools: Kindergarten through Grade Twelve, P. 3
- ^{xx} Michael J. Behe. *Darwin’s Black Box*. Free Press. 1996.
- ^{xxi} *Ibid.*
- ^{xxii} Derek H. Davis. “Kansas Versus Darwin.” *The Kansas Journal of Law & Public Policy*. Winter, 1999.

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- xxiii George Santayana, *The Life of Reason*.
- xxiv Kansas Versus Darwin, 1999.
- xxv Edward J. Larson. *Summer for the Gods: The Scopes Trial and America's Continuing Debate Over Science and Religion*. Cambridge, MA: Harvard University Books, 89-91.
- xxvi Karl W. Giberson and Donald A Yerxa. "Darwin Comes to America." *Books & Culture*. Christianity Today International, November/December 1999.
- xxvii A decision later overturned on a technicality by the appellate court.
- xxviii Davis.
- xxix See note ii.
- xxx *Epperson v. Arkansas*, 393 U.S. 97 (1968).
- xxxi Ibid.
- xxxii Deborah A. Reule. "The New Face of Creationism." *Vanderbilt Law Review*. November, 2001.
- xxxiii Constitution of the United States, Amendment 1.
- xxxiv *McLean v. Arkansas*
- xxxv *Edwards v. Aguillard*
- xxxvi *McLean v. Arkansas*
- xxxvii Kansas Board of Education, 2001 Science Standards
- xxxviii Phyllis Schlafly. "Kansas Dumbs Down Science to Promote Evolution." *Eagle Forum*, 02/01/2001.
- xxxix State of Ohio, 124th General Assembly. 2001-2002, H.B. No. 481.
- xl Specified complexity is a theory developed by William A. Dembski, see <http://www.leaderu.com/offices/dembski/menus/articles.html>
- xli Ibid.
- xlii Ibid.
- xliii Ibid.
- xliv Jonathan Wells, *Icons of Evolution Science or Myth?: Why much of what we teach about evolution is wrong*, (Washington, D.C.: Regnery Publishing, 2000).
- xlv Alton Biggs, Chris Kapicka, and Linda Lundgren, *Biology: The Dynamics of Life* (1995, 1998), p. 412, 413
- xlvi Philip H. Abelson, *Proceedings of the National Academy of Sciences USA* (1966) and John Horgan, "Scientific American" (1991)
- xlvii Robert Shapiro, "Origins: A Skeptic's Guide to the Creation of Life on Earth" (1986)
- xlviii See Stephen Jay Gould. *Wonderful Life: The Burgess Shale and the Nature of History*. (W. W. Norton; 1989).
- xlix Michael Denton. *Evolution: A Theory in Crisis*. (Adler and Adler, 1997).
- ¹ Alton Biggs, Chris Kapicka, and Linda Lundgren, *Biology: The Dynamics of Life* (1995, 1998), p. 432
- ^{li} Alton Biggs, Chris Kapicka, and Linda Lundgren, *Biology: The Dynamics of Life* (1995, 1998), p. 442
- ^{lii} Gavin de Beer, *Homology: An Unsolved Problem* (1971)
- ^{liii} Ernst Mayr, *The Growth of Biological Thought* (1982)
- ^{liv} Ronald H. Brady, *Cladistics* (1985)

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- ^{lv} Charles Darwin. *The Origin of Species*. (1859).
- ^{lvi} Lewis Wolpert, *The Triumph of the Embryo* (1991), p. 185
- ^{lvii} William Ballard, *BioScience* (1976)
- ^{lviii} William A. Dembski, Ph.Ds, "The Design Inference"
- ^{lix} Richard Dawkins, *The Blind Watchmaker*, (W.W. Norton & Company, 1996)
- ^{lx} See http://www.intelligentdesignnetwork.org/legalopinion.htm#N_12_#N_12_
- ^{lxi} *Edwards v. Aguillard*, 482 U.S. 578 (1987)
- ^{lxii} "The term "origins controversy" refer[s] to the scientific debate over "the origin of complexity—the appearance of design—in living things. While Darwin himself never claimed to explain the origin of the first life, he claimed that natural selection possessed the ability to transform simple forms of life into much more complex and ultimately intelligent organisms. Thus, the scientific debate, whether it is concerning the first life or the origin of intelligence, centers around whether intelligence can be derived from unintelligent processes or whether it is more reasonable to conclude that an intelligent end was probably the result of an intelligent cause." Dewolf, David K., "Academic Freedom After Edwards," *Regent University Law Review*. Vol. 13, No. 2, 2000-2001.
- ^{lxiii} Although it is clear that government absolutely may not establish religion, individual rights to the free exercise of religion does not translate to an absolute and supreme right to practice all religious activity, regardless of its nature. Exercising religious activity that otherwise violates valid laws of the nation is not protected under the Free Exercise Clause of the First Amendment. (See *Employment Div. Department of Human Resources v. Smith* 494 U.S. 872, 882-90 (1990).
- ^{lxiv} Hugh Baxter, *Managing Legal Change: The Transformation of Establishment Clause Law*, 46 *UCLA L. Rev.* 343, 385-391 (1998)
- ^{lxv} *Cantwell v. Connecticut*, 310 U.S. 296 (1940). This case was the Court's first invalidation of a government action on free exercise ground. It is a landmark case also because of its application of the Free Exercise Clause of the First Amendment to the states, under the Fourteenth Amendment.
- ^{lxvi} California State Board of Education
- ^{lxvii} Michael J. Behe. *Darwin's Black Box*. Free Press. 1996.
- ^{lxviii} "Science Framework."
- ^{lxix} Goldberg, Wesson, Strom-Martin. California Teachers Association, AB 2160 "Fact Sheet"
- ^{lxx} "Statement in Support of the Teaching of Evolution" National Education Association. www.cta.org/who_we_are/cta_today.html
- ^{lxxi} United States Board of Education, Title II, www.title2.org
- ^{lxxii} The National Board for Professional Teacher Standards, www.nbpts.org
- ^{lxxiii} The National Board for Professional Teacher Standards, www.nbpts.org
- ^{lxxiv} The National Board for Professional Teacher Standards, www.nbpts.org
- ^{lxxv} The National Board for Professional Teacher Standards, www.nbpts.org
- ^{lxxvi} California State Board of Education
- ^{lxxvii} California State Board of Education
- ^{lxxviii} California Commission on Teacher Credentialing