ASSOCIATION OF CHRISTIAN SCHOOLS ET AL.
v. ROMAN STEARNS ET AL.

EXPERT WITNESS REPORT

OF

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(BIOLOGY AND PHYSICS)

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Expert Report of Michael J. Behe, Ph. D

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I. Biology texts

A. Biological Science content

1. California State Board of Education standards

a. Criteria for deciding if a textbook meets a standard

Two biology textbooks that are currently used in high school courses approved by the University of California were compared for their degree of adherence to the California State Board of Education science content standards for Biology/Life Sciences with two textbooks by Christian publishers. The two approved textbooks are *Biology: Visualizing Life* (Holt, 1998) and *Biology: The Living Science* (Prentice Hall, 1998). The two Christian texts are *Biology: for Christian Schools* (BJU Press, 1999) (I compared both the second and third editions of the textbook) and *Biology: God's Living Creation* (A Beka Book, 1997, with *Ecology* supplement).

The California State Board of Education lists a total of 67 biology standards, which are divided into 10 categories in the sub-fields of Cell Biology (1 category), Genetics (4 categories), Ecology (1 category), Evolution (2 categories), and Physiology (2 categories) (F0074-F0076). All of the textbooks meet a large majority of the standards. None of the textbooks meet all of the standards.

Keeping in mind the California State Board of Education intends that the "Standards describe what to teach, not how to teach it" (F0071), I did not consider how much detail or depth a text went into on a given standard. Rather, in deciding if a textbook met a standard, I examined whether the text mentioned the concept that the standard concerned, either directly or nearly directly (using language that closely implied the concept, but not necessarily language from the standards). For example, none of the four textbooks explicitly states the point of Standard 1c, "*Students know* how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure." Nonetheless, all texts discuss the structure of viruses, prokaryotic cells, and eukaryotic cells (generally in different sections of the texts), and so the explicit point could easily be made by the teacher, based on material from the textbook. Similarly, none of the texts uses the term "central dogma" found in Standard 1d ("*Students know* the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.) Nonetheless, all show illustrations of the flow of genetic information.

I also counted a textbook as having met a standard if it contained material which in my view the teacher could easily use as a springboard to discuss the standard in class. These standards are marked in Table 2 with an asterisk. For example, three of the four texts do not explicitly meet standard 3d, "**Students know* how to use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes." (The fourth text does not meet the standard explicitly either, but does include an exercise to help illustrate the concept.) Nonetheless, the three texts discuss meiotic recombination and contain illustrations of chromosomes undergoing recombination, which could be used by the teacher as the basis for discussion of the standard, perhaps by improvising a paper-and-pipe-cleaner model lab as the fourth text does.

Again keeping in mind that the California State Board of Education intends that "Standards describe what to teach, not how to teach it" (F0071), as well as that "Ultimately, students should be made aware of the difference between *understanding,* which is the goal of education, and *subscribing to* ideas" (F0094), I counted a textbook as having met a standard to "discuss" or "analyze" evidence even when it did so from a skeptical point of view. For example, the Christian texts discuss the fossil record skeptically with respect to standard interpretation. These standards are marked in Table 2 with a double asterisk.

b. Number of standards met

By my count, the textbooks range from meeting a low of 58/67 standards (Holt) to a high of 64/67 standards (BJU, 3rd ed.). Thus none of the textbooks is markedly better or worse than the others in the number of standards met. Table 1 is a summary table of standards met by subsection. Table 2 shows the page numbers of the texts where the concept of a particular standard is to be found. A double 'X' indicates that I could find no material in a text which mentioned the concept or a closely related topic. For example, the Holt text contains no wording that refers to the concept indicated by Standard 1i ("*Students know* how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.")

2. University of California "a-g Requirements"

a. The requirements

The University of California briefly lists (F0011-F0012) the following as Certification Criteria for Laboratory Science:

> Certification Criteria. To be considered for certification in the "d" subject area, a course must:
>
> * specify, at a minimum, elementary algebra as a prerequisite or co-requisite
> * take an approach consistent with the scientific method in relation to observing, forming hypotheses, testing hypotheses through experimentation and/or further observation, and forming objective conclusions, and
> * include hands-on scientific activities that are directly related to and support the other classwork, and that involve inquiry, observation, analysis, and write-up. These hands-on activities should account for at least 20% of class time, and should be itemized and described in the course description.

All textbooks can be used to meet these general criteria.

(1) Elementary algebra

A biology course using any of the biology texts could specify elementary algebra to be a prerequisite or co-requisite. Compared to high school physics textbooks, for example, none of the biology texts relies heavily on algebraic concepts and calculations. Nonetheless, all of the texts could be used to support instruction in elementary algebraic calculations during the discussion of some biological topics, for example in calculating the expected Mendelian distribution of phenotypic traits in dihybrid crosses.

(2) "Hands-on scientific activities"

Because all texts cover the great majority of the California State Board of Education biology standards, all texts can be used as the basis for "hands-on scientific activities that are directly related to and support the other classwork." The approved texts, the A Beka text, and the 3rd edition BJU text contain suggested scientific activities. The second edition BJU text could be used with a separate laboratory program.

(3) The scientific method

(a) Descriptions and examples of the scientific method

All texts have explicit discussions of the scientific method. The approved Holt (p. 15) and Prentice Hall (p. 11) texts contain relatively brief discussions. The Holt text points out that the scientific method is not some recipe for progress; rather, everything a scientist knows can come into play (page 15):

> It was once fashionable to claim that scientific progress was the result of applying a series of steps called "the scientific method." In this view, science is a sequence of logical "either/or" steps, each step rejecting one of two incompatible alternatives. Trial-and-error testing could inevitably lead one through a maze of uncertainty. If this view were true, a computer could be programmed to be a good scientist. But science is not done this way. If you ask successful scientists how they do their work, you will find that they design experiments with a good idea of the results they will get. Not just any hypothesis is tested—only a hunch or educated guess that is based on all the scientist knows and that allows his or her imagination full play. Because insight and imagination are so important in scientific progress, some scientists are

better than others.

The Christian texts have lengthier discussions. The A Beka text has a section (page 351) entitled "Steps in the Scientific Method". The steps are described as follows: *State the problem clearly*; *Think of possible solutions*; *Test the hypothesis*; *Reach a conclusion*. It emphasizes, "*Hypotheses are not the answer to the problem*, but after they are tested, one or more of the hypotheses *may* be the solution." Figure 13.7 of the text shows arrows pointing toward and back from the words "Observing", "Hypothesizing", and "Experimenting", to emphasize the iterative nature of the scientific method. It stresses the value of a controlled experiment, where only a single variable is tested. It summarizes the major steps of the scientific method as follows (p. 352):

> 1. State the problem clearly and completely.
> 2. Examine the available facts and suggest as many probable solutions (hypotheses) as possible.
> 3. Test every hypothesis; modify or reject faulty ones.
> 4. Form a conclusion that is based upon all known facts, causes, and effects.
> 5. If the facts are not sufficient to justify forming a conclusion, keep an open mind toward the problem until enough is know to justify a conclusion.
> 7. Test the conclusion with additional controlled experiments.

The BJU, 2nd ed. text contains a similar, detailed section (page 14) entitled "The Scientific Method". (The 3rd edition has similar language.) One subsection is entitled "Steps of the Scientific Method":

> **Steps of the Scientific Method**
>
> The activities used to test a hyposthesis can be an experiment or a survey. If an **experiment** is to be used, you must tailor it to answer the problem precisely. When the problem asks what exists in a particular area or what is common practice, a **survey** is necessary. For example, which pain remedy doctors recommend most or what kind of tree is most common in a certain area would be answered by surveys, not experiments. Once the experiment or survey has been constructed, you will go through the following steps:

□*Observe* the experiment or survey carefully.

□*Collect* information from the experiment or survey and record it accurately. The recorded information is the **data** you will use to solve the problem.

□*Classify* the data into a logical order or into logical groups.

□*Analyze* the data to determine what it reveals about the problem.

□*Choose* from among the several answers suggested by the data the one that best answers the question. (In some cases the data may suggest only one answer.) If the data point to an answer different from the original hypothesis, then the original hypothesis should be discarded.

□*Verify* the chosen answer by repeating the experiment. The more often a well-designed experiment is repeated and produces similar results, the more valid and reliable is the answer.

□*Predict* what will happen in similar situations. The goal of using the scientific method is to be able to draw conclusions that can be applied to similar cases.

The BJU 2nd ed. text follows with a subsection stressing the importance of controlled experiments (page 16):

Controlled Experiments

An ideal scientific experiment is sometimes called a **controlled experiment**. In a controlled experiment there are two identical groups, and the difference between the two groups is a single factor called the **experimental variable**.

The group not exposed to the experimental variable is the **control group**, and the group exposed to the experimental variable is the **experimental group**. During an experiment, the researcher measures a factor in both the control and the experimental groups—the **dependent variable**. As an example, consider two sets of mice grown in identical cages in the same room with the same diets. If one group has a vitamin dissolved in its water, it would be the experimental group, and the vitamin would be the experimental variable; the other group of mice would be the control group....

(b) Limits of the scientific method

The Christian texts also contain discussions of the limits of the scientific method. For example, the BJU 2nd ed. text states (page 16):

> **Limitations Inherent in the Scientific Method**
>
> Scientific investigations must deal with physical phenomena, because experiments or surveys must have *observable, measurable* data to support a conclusion. A problem investigated by the scientific method is generally stated so that it can be answered with a yes, a no, or a number (such as a percent or ratio). Questions using how or why are not measurable and are therefore beyond the scope of science. The scientific method cannot *explain* a phenomenon.
>
> . . . .
>
> The beginning of life, what is in the future, and spiritual concepts such as heaven, angels, man's soul, and hell cannot be observed or measured; thus they are beyond the domain of science. These things are part of a person's faith.

The text also emphasizes to its students that science is very important (page 27):

> **God Expects Man to Use Science**
>
> The physical world is made of substances which operate under God-ordained laws. Scripture teaches that God created the world and sustains it. Man is to subdue and have dominion over it. If he uses his God-given intelligence, he can subdue and have dominion over the world without destroying it. If he ignores what science can teach, he will have wasted two God-given gifts: the earth and his intelligence.

And that science can be used for good or ill (page 27):

> **Some Improper Attitudes of Christians Toward Science**
>
> A wrong attitude toward science is to believe that science is anti-God. Since science is the discovering of usable information about God's creation, science is not inherently bad. Scientific information can be used for good or bad purposes, but science does not decide how information is used. Men do. Science is not evil just because men have abused scientific knowledge.

3. Comparison with approved biology course outline

I examined the "New Course Description" form application of University High School for a biology course that was approved by the University of California. In my opinion the BJU and A Beka Christian texts could be used to address the great majority of points in the course outline, and to meet the great majority of the course objectives in that application, which itself is tailored to meet the California State Board of Education standards. For example, the University High School application states that "Students will meet the California State Science Content Standards for Biology/Life Science". The first seven course objectives are the following:

1. In order for students to understand the fundamental life processes of plants and animals, students will know that:

1.1. cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings.

1.2. enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium, and the affect temperature, ionic conditions, and pH have on their activity

1.3. the information flows from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.

1.4. usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.

1.5. the role of the mitochondria is making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.

1.6. most macromolecules (polysaccharides, nucleic acids, proteins, and lipids) in cells and organisms are synthesized from a small collection of simple precursors.

1.7. how chemiosmotic gradients in the mitochondria and chloroplasts store energy for ATP production

These are essentially seven out of the ten first set of objectives for biology of the California State Board of Education. As explained earlier, the Christian texts also address those standards. Thus the Christian texts could be used to address the great majority of points in the outline for a biology course that has been approved by the University of California.

4. General conclusions concerning science content of biology textbooks

All of the biology texts I examined, both the approved texts and the Christian texts, meet the great majority of the California State Board of Education Standards for biology. In my opinion all of the texts also can be used to meet the University of California Certification Criteria for Laboratory Science, including an understanding of the scientific method. Furthermore, in my opinion they can be used to address the great majority of the topics listed in outlines of biology courses approved by the University of California. Thus in my opinion the Christian textbooks address the great majority of the topics that should be addressed in a high school biology textbook to prepare a high school student to do well in college level classes.

B. Viewpoints in textbooks

1. Cultural Perspectives

All of the textbooks contain material which is not strictly science, but which concerns viewpoints, attitudes, and behavior. The Holt and Prentice Hall texts, which are marketed to schools serving students from diverse backgrounds, offer diverse viewpoints. The Christian texts, which are marketed to schools serving students from a certain Christian background, concentrate on that viewpoint. The A Beka text notes that it is written from a "Christian Perspective". (p. xi) On the other hand, the Teachers's Edition of the Holt text features "Multicultural Perspectives":

> **Multicultural Perspectives** provide information about people of various cultures who have been associated with ideas presented in the text, or about the influence of culture on a biological issue. (page T43)

Here are several examples:

> **Multicultural Perspective**: Legends of the Bears (p. 13)

Legends of the Navajo, Chippewa, and Sioux Native Americans have told of bears teaching people to use herbs and roots for medicine. Scientists are now giving serious attention to these legends. Some tribes observed and described bears digging for roots and bulbs to eat. The Native Americans found that some of these roots could be used to treat certain ailments and fight infections and parasites. In some tribes, strong medicine is still called "bear medicine." Throughout the world, scientists are seeking the wisdom of indigenous peoples and observing the eating habits of animals to learn which plants hold medicinal value.

Multicultural Perspective: Understanding Sickle cell Anemia (p. 128)
Working with limited laboratory facilities but a strong determination to fight the disease that was killing their friends and families, Dr. Angela Ferguson and Dr. Roland Scott published a paper on sickle cell anemia in the 1940s. Dr. Scott, known as a pioneer of sickle cell anemia research, is the founder and former director of Howard University's Center for Sickle Cell Anemia Research. Dr. Ferguson was an associate professor of pediatrics at Howard University. In 1970, she was listed in *Who's Who of American Women.*

Multicultural Perspective: Australian Aborigines (p. 235)
To the early European colonists of Australia, the technology of the Aborigines indicated a very primitive people. The Aborigines could produce only a limited variety of tools because they did not know how to mine, smelt, or work metal. They had to rely on hunting and gathering because they did not practice agriculture. Most groups did not wear clothes, even in winter. The largest "structures" they created were piles of discarded shells. However, as the Europeans soon learned, the Aborigines compensated for their technological "deficiencies" with a deep and detailed knowledge of their environment, which allowed them to survive in areas where European explorers and settlers perished. In particular, the Aborigines were expert on the behavior of animals, and they used this knowledge to help capture game and to find water in dry areas.

The Prentice Hall text contains a feature called "Managing Classroom Diversity", in which activities are tailored to different groups of students. Here is one example (p. 151):

Managing Classroom Diversity: Educational Equity

> Some students may be interested to learn more about Nettie Stevens, her work with mealworms, and her contributions to scientific knowledge. Encourage those students to write a short biography about her. Point out that in 1905, when Nettie Stevens discovered the sex chromosomes, women scientists, even women with a Ph.D., were something of an oddity. Explain that women like Nettie Stevens have made it easier for women today to make major contributions to scientific research.

Texts discuss the background of people who later became successful scientists. The Holt text contains a feature called "Career Opportunities", which highlights the backgrounds of persons who went into various biological fields. Here are several excerpts:

- Career Focus: Diana Punales-Morejon, Genetic Counselor at a medical center in New York (p. 131)

  "I was born in Cuba and didn't learn to speak English until the first grade...."
- Career Focus: Dr. Eloy Rodriguez, Biochemist at Cornell University, Ithaca, New York (p. 165)

  "It was a good thing that I ignored a school counselor's advice to go to technical school, which was standard advice for many minority students at the time. I grew up in Hidalgo County, Texas, the county with the lowest average income per person in the country..."
- Career Focus: Dora Duncan, Clinical Research Associate for Pharmaco International, Inc. (p. 665)

  "When I was growing up, a woman had few career choices—she became either a teacher or nurse...."

The career examples implicitly teach students that, despite prevailing adverse attitudes, people from diverse backgrounds can become successful biological professionals. Similarly, the A Beka text shows that in the past persons who share aspects of the religious background of their target student population were very successful scientists. For example, page 349 of the text has a Table labeled "Scientific Disciplines Established by Creationist Scientists". Among the eminent scientists listed are: Isaac

Newton, Joseph Lister, Louis Pasteur, Johann Kepler, James Maxwell, Linnaeus, Michael Faraday, and others.

2. Social issues

All of the texts discuss some social issues that impinge on biology, such as human health and environmental concerns. For example, the A Beka text contains a discussion of abortion methods, including suction, dilation and curettage, saline abortion, and intact dilation and extraction or partial-birth abortion. (p. 128). It has sections discussing the ill effects of smoking, as well as the problem of AIDS from a certain Christian perspective. It has a section entitled "Good Stewardship" (p. 662) concerning the environment, which states:

> With man's right of dominion comes the responsibility to exercise good stewardship.... This can be accomplished in many different ways:
>
> 1. Conservation and management of natural resources including soil, fossil fuels, forests, water, and minerals.
> 2. Replanting of trees and other vegetation to continue the oxygen-carbon cycle and supply the crucial first link in all food chains.
> 3. Proper management of natural ecosystems to provide food for man as well as for plants and animals.
> 4. Wise use of biotechnology to produce higher-yielding crop varieties and medicines such as insulin.
> 5. Reducing unnecessary consumption of resources and also reusing and recycling resources whenever feasible.

Another example is the following. In addition to discussing the physical effects of alcohol, including fetal alcohol syndrome, the BJU 2nd ed. text discusses alcohol from a certain Christian perspective (p. 618):

> Knowing these things, the writer of Proverbs reminds us that strong drink is deceitful (20:1). Scripture condemns drunkenness repeatedly (Luke 21:34; Rom. 13:13; Gal. 5:19-

> 21). Besides the fact that we should not abuse our bodies, we, as Christians, are told to bring our burdens to the Lord, for He will take them away or give us the grace and strength to bear them. A Christian disobeys God if he depends on strong drink to relieve or solve his troubles.

The author of the Holt text also makes clear that on the topic of drugs he intends to influence student behavior (p. T24):

> *Coverage of Adolescent Issues*
>
> To get some sense of what I mean, look at Chapter 30, which contains a pointed discussion of drugs. Almost every high school text discusses drugs, but this one is different in that it does not devote the bulk of its space to a boring litany of drug types or preaching about the evils of drug abuse. Instead it focuses on explaining just how drugs work to create addicts. In my teaching I have found that if I explain the mechanism of addiction to students so that they see it as a simple cause-and-effect process, then I don't need to preach to them, because the danger is so obvious....

As does the Prentice Hall teacher's text (page 798):

> *Discussion*
>
> Ask students to compare the effects of stimulants, depressants, and opiates on the nervous system. In this discussion, make sure students relate the effects of these drugs on neurotransmitters, synapses, and action potentials. Challenge students to think of specific examples of how the effects of these drugs are manifested in human behavior and how such behavior can lead to harm or injury.

The Holt textbook also contains a feature called "Science, Technology, and Society", which "explores the conflicts that can arise between new technologies and the needs of society." (p. T17) One example is called "DNA Profiling: Promise or Peril?" (p. 38) In a section called "Analyzing the Issues", it asks, "Should Genetic Testing Be Mandatory?", which invites students to discuss legal and political issues:

> Read "DNA Profiling," in National Geographic, May 1992, pages 112-124. Do you think

> the police searching for Lynda Mann's killer were justified in requiring DNA profiling of the young men from nearby towns? Would a similar action in the United States violate the Fourth Amendment?...

Another section in the feature series is "Who Pays the Bill for Growing Old?" (p. 716) It considers "Quantity Versus Quality":

> The common use of life-extending procedures is an indication of how far medical discoveries have come. Even though doctors can help a person live longer, the quality of that life may be poor; a cancer patient may live two years longer but be in constant pain. Some feel we need to improve the quality of life rather than just extend it. Other recent studies seem to indicate that every year there is a smaller percentage of people unable to care for themselves.

The Prentice Hall text has a feature called "BioFrontier Connections" which encourages students to discuss biological topics with moral and ethical implications. Thus moral and ethical values would be discussed in biology class. For example, one concerns the conundrum of organ donations (page 839):

> *The Price of an Organ Donation*
>
> Heart and lung diseases strike millions of people each year. Those people whose organ cannot perform at a level that can keep them alive are candidates for heart or lung transplants. In order to receive a heart or lung transplant, these people must meet strict guidelines. After qualifying for a transplant. their names are placed on national waiting lists that match them with organs as they become available.
>
> *The Problems of Organ Donations*
>
> The problem with waiting for a heart or a lung is that there are not enough donors to keep up with the demand. In fact, twice as many people are on waiting lists as there are healthy organs available.
>
> Unfortunately, organs of this type are donated only when other people die. That is, if they have given written permission or if their families give permission upon their death. Some states have a check-off box on driver's licenses that authorize organ donation in the event of death.
>
> Although most people say they would be willing to donate their organs, few

actually fill out a donor card. As a result, there are not enough available organs to meet the needs.

The Debate

Recently someone suggested that families should be paid for the organs. This plan would require that a 1984 federal law making it illegal to receive payment for organs be changed. Some people believe that donating organs is a moral duty and that payment would merely encourage people to do the right thing.

Others believe that it is unethical to pay for organs. They fear that families might be too eager to receive payment and go against the wishes of the potential donor.

Critics also say that the idea of paying for organs would increase the costs of organ transplants. At present, the cost of obtaining an organ for transplant is nearly $50,000.

<u>Making the Connection</u>

There is also concern over who would be able to pay for the organs. Would only those patients who could afford them get organs because they could pay the price? Or would insurance companies be responsible for payment? What other reasons for or against this plan are there? Would you support this plan? Explain why or why not.

Other political, legal, moral, or ethical topics students are asked to discuss include the following.

If a law to reduce acid rain lead to a loss of your family's income, would you support the law? Should the government compensate or relocate the coal miners who lost their jobs? What do you think? (page 31)

If you were Arthur, would you allow the company to test your child prenatally? What if the company threatened to fire you if you didn't submit to the test? What are some of the pros and cons of genetic testing? (page 162)

What are other uses of land that can cause lasting harm to our resources or the environment? How can people begin to adopt sustainable ways of using their land? (page 365)

One of the problems doctors often face is just how much (or how little) to tell a patient. On the one hand, patients like Kim need to know certain information before they can consent to surgery or other procedures that might have serious side effects. In fact, there

> are laws that make it mandatory for doctors to keep their patients informed of all possible outcomes. On the other hand, how much information is too much information, which might only cause more fear in the patient? How much knowledge does a patient need in order to give informed consent? There is a fine line between knowing enough and knowing too much. (page 790)
>
> Do you think employers should have the right to require all their employees to be tested for HIV? Why or why not? (page 910)

3. General conclusions concerning viewpoints in biology textbooks

All biology textbooks that were examined, both the approved texts and the Christian texts, contain material which is not strictly science, but which includes viewpoints, and all texts ask students to discuss nonscientific topics, such as religious, legal, political, ethical, or moral topics. In my opinion this unanimous practice is pedagogically sound. Science does not exist in a vacuum, and students will naturally have questions about how science relates to other aspects of their world. Discussion of how scientific and other topics impinge on each other and interrelate with each other can equip students to integrate seemingly separate areas into a more coherent whole.

4. Viewpoints in approved courses

The University of California lists in part the following certification categories for high school laboratory science courses: (F0011)

> **Certification Categories**. Generally, courses that are suitable for satisfying the minimum requirement will fall into one of three categories:
>
> 1. College preparatory courses in biology, chemistry, or physics.
>
> 2. College preparatory courses which may incorporate applications in some other scientific or career-technical subject area, but which nonetheless cover the core concepts that would be expected in one of the three foundational

> subjects. A few examples could include some courses in marine biology or agricultural biology, which may qualify as providing appropriate content in basic biology; and some advanced courses in earth and space sciences, which may provide suitable coverage of chemistry or physics. These are only examples; other possibilities exist. However, it is emphasized that courses in this second category must cover, with sufficient depth and rigor, the essential material in one of the foundational subjects in order to qualify for "d" certification.

It seems clear from this description that the university's prime concern is that the "essential material in one of the foundational subjects" must be covered, and that schools otherwise have wide latitude ("These are only examples; other possibilities exist.") in their approach once that goal has been met. Numerous courses have been approved by the university which address the "foundational subject" of biology from an agricultural point of view. For example, an approved "New Course Description" form was submitted by the Red Bluff Joint Union High School for a proposed course entitled "Agricultural Biology." The 52 "Learning Objectives" listed on that form are simply paraphrases of the majority of California Department of Education standards in biology. Thus the University of California has approved a course which addresses the Department of Education standards for a "foundational subject" and also adds a particular additional viewpoint, that of an agricultural perspective. The Christian textbooks reviewed in this report also address the great majority of the California Department of Education standards for biology. Thus they too cover the "essential material in one of the foundational subjects" while adding a particular additional viewpoint.

II. Physics texts

A. Physics content

1. California State Board of Education standards

a. Criteria for deciding if a textbook meets a standard

A physics textbook that is currently used in high school courses approved by the

University of California was compared for its degree of adherence to the California State Board of Education science content standards for Physics (F0077-F0079) with a textbook by a Christian publisher. The approved textbook is *Conceptual Physics* 3rd edition (Scott Foresman Addison Wesley, 1999). The Christian text is *Physics: for Christian Schools* (BJU Press). I reviewed both the first (1996) and 2nd (2004) editions of the Christian text.

The California State Board of Education lists a total of 49 physics standards, which are divided into 5 categories in the sub-fields of Motion and Forces, Conservation of Energy and Momentum, Heat and Thermodynamics, Waves, and Electric and Magnetic Phenomena. Both textbooks meet a large majority of the standards. Neither textbook meets all of the standards.

Keeping in mind the California State Board of Education intends that the "Standards describe what to teach, not how to teach it" (F0071), I did not consider how much detail or depth a text went into on a given standard. Rather, in deciding if a textbook met a standard, I examined whether the text mentioned the concept that the standard concerned, either directly or nearly directly (using language that closely implied the concept, but not necessarily language from the standards). For example, the SFAW text does not explicitly state the point of Standard 1f, "*Students know* applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed)" that a perpendicular force is acting, but an accompanying illustration (Figure 14.10) shows vectors which appear perpendicular, and so the point could easily be explained by the teacher.

I also counted a textbook as having met a standard if it contained material which in my view the teacher could easily use as a springboard to discuss the standard in class. These standards are marked in Table 4 with an asterisk. For example, neither text explicitly meets advanced standard 5o, "*Students know* how to apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy." Nonetheless, the texts compare electrical potential energy to gravitational potential energy, and so a teacher could make the point easily using the texts as a base.

b. Number of standards met

By my count, the PFAW textbook meets 43/49 standards and both editions of the BJU text meet 46/49 standards. Thus neither textbook is markedly better or worse than the other in the number of standards met. Table 3 is a summary table of standards met by subsection. Table 4 shows the page numbers of the texts where the concept of a particular standard is to be found. A double 'X' indicates that I could find no material in a text which mentioned the concept or a closely related topic. For example, neither text met Standard 2e, "*Students know* momentum is a separately conserved quantity different from energy."

2. University of California "a-g Requirements"

a. The requirements

The University of California briefly lists (F0011-F0012) the following as Certification Criteria for Laboratory Science:

> Certification Criteria. To be considered for certification in the "d" subject area, a course must:
>
> * specify, at a minimum, elementary algebra as a prerequisite or co-requisite
> * take an approach consistent with the scientific method in relation to observing, forming hypotheses, testing hypotheses through experimentation and/or further observation, and forming objective conclusions, and
> * include hands-on scientific activities that are directly related to and support the other classwork, and that involve inquiry, observation, analysis, and write-up. These hands-on activities should account for at least 20% of class time, and should be itemized and described in the course description.

Both textbooks can be used to meet these general criteria.

(1) Elementary algebra

Both texts contain much material which requires at a minimum elementary algebra to understand it. For example, the PFAW text (page 18) states:

> The instantaneous speed *v* of an object falling from rest after an elapsed time *t* can be expressed in equation form*
>
> $v = gt$
>
> The letter *v* symbolizes both speed and velocity. Take a moment to check this equation with Table 2.2. You will see that whenever the acceleration $g = 10$ m/s^2 is multiplied by the elapsed time in seconds, the result is the instantaneous speed in meters per second.

An example from the BJU text, 3rd ed, (both editions of the BJU text contain similar, but not identical language) of the need for algebra is the following passage (pages 53-54):

> A position-time graph also helps to determine the speed at which an object moves. The *average speed* ($\bar{v}$) of a train is the ratio of the distance traveled $|x - x_0|$ over an interval of time $(t - t_0)$. The absolute value sign is required because distance is always positive. If the train *does not change its direction*, its average speed is
>
> $$\bar{v} = \frac{|x - x_0|}{t - t_0}$$
>
> The symbol) (Greek letter delta) conventionally means "change in," so)*x* means "the change in position *x*" or x-x_0. On a position-time graph,)*x* is the difference in height between some position (x) and the initial position (x_0). The "change in time" ()*t*, or $t - t_0$), which is always positive (unless you are using a time machine), is the horizontal distance between the points on the timeline marking the beginning and the end of the time interval. In any linear graph, the change in height between two points (the *rise*) divided by the change in horizontal distance (the *run*) between the points is the *slope* of the line. In the position-time graph, the slope of the graph is the ratio of the change in position and the change in time. The magnitude of the slope represents the average speed that a train travels between two points. The formula for average speed is

$$\bar{v} = \frac{|\Delta x|}{\Delta t}$$

(2) "Hands-on scientific activities"

Because both texts cover the great majority of the California State Board of Education biology standards, both can be used as the basis for "hands-on scientific activities that are directly related to and support the other classwork." The PFAW text has an associated laboratory component. The BJU text could be used with a separate laboratory program.

(3) The scientific method

Both texts have explicit discussions of the scientific method in their first chapter. The approved PFAW text has a section of its first chapter entitled "The Scientific Method" which lists as its steps (p. 2):

> 1. Recognize a problem
> 2. Make an educated guess—a hypothesis—about the answer.
> 3. Predict the consequences of the hypothesis.
> 4. Perform experiments to test predictions.
> 5. Formulate the simplest general rule that organizes the three main ingredients: hypothesis, prediction and experimental outcome.

The text cautions students that this formula is not a guarantor of success (p. 2):

> Although this cookbook method has a certain appeal, it is not the universal key to the discoveries and advances in science. Trial and error, experimentation without guessing, or just plain accidental discovery accounts for much of the progress in science.

The BJU text contains a section of its first chapter entitled "Scientific Methodolgy" (p. 11). A subsection is "The Scientific Method" which states in part:

> Scientific methodology helps scientists describe nature with as much objectivity as possible. The goal is to produce a workable explanation of how a natural process occurs. Workable implies that the explanation actually accounts for the data. It does not imply that the explanation is the absolutely "true" description of nature. Nor does it imply that the explanation will endure: new facts sometimes contradict the explanation, forcing scientists to seek a better one.

The BJU text follows with separate subsections on "Observations" (p. 11), "Hypotheses (p. 12), and "Testing the hypothesis" (p. 14). In the section "Hypotheses" the text lists qualities of a good hypothesis:

> What are the qualities of a good hypothesis? First, the hypothesis must be reasonable.... Second, the hypothesis must be testable.... Third, the hypothesis should not contradict well-established principles.... Fourth, the hypothesis must explain all current observations and predict new ones.... Fifth, the hypothesis should be as simple as possible.

3. General conclusions concerning science content of physics textbooks

Both of the physics texts I examined, both the approved text and the Christian text, meet the great majority of the California State Board of Education Standards for physics. In my opinion both texts also can be used to meet the University of California Certification Criteria for Laboratory Science, including an understanding of the scientific method. Thus in my opinion the Christian textbooks address the great majority of the topics that should be addressed in a high school physics textbook to prepare a high school student to do well in college level classes.

B. Viewpoints in the physics textbooks

1. PFAW viewpoint on religion

Both textbooks contain material which is not strictly science, but which concerns viewpoints. In its first chapter the PFAW text includes a section titled "Science, Art, and Religion", which holds forth its viewpoint on the proper relationship between those three subjects. (Pages 6-7)

> The search for order and meaning in the world takes different forms; one is science, another is art, and another is religion. Although the roots of all three go back thousands of years, the traditions of science are relatively recent. More important, the domains of science, art, and religion are different, even though they overlap. Science is mostly concerned with discovering and recording natural phenomena, the arts are concerned with the values of human interactions as they pertain to the senses, and religion is concerned with the source, purpose, and meaning of everything.
>
> The principal values of science and the arts are comparable. Literature describes the human experience. It allows us to learn about human emotions, even if we haven't yet experienced them. The arts do not necessarily give us those experiences, but they describe them to us and suggest what may be in store for us. Similarly, science tells us what is possible in nature. Scientific knowledge helps us to predict possibilities in nature even before these possibilities have been experienced. It provides us with a way of connecting things, of seeing relationships between and among them, and of making sense of many natural events we find around us. Science widens our perspective of nature. A truly educated person is knowledgeable in both the arts and science.
>
> Science and religion are different. The domain of science is natural order; the domain of religion is nature's purpose. Religious beliefs and practices usually involve faith in and worship of a supreme being and the creation of human community—not the practices of science. In this respect, science and religion are as different as apples and oranges and do not contradict each other.
>
> When we study the nature of light later in this book, we will treat light first as a wave and then as a particle. To the person who knows only a little physics, waves and particles are contradictory. Light can be only one or the other, and we have to choose between them. But to the enlightened physicist, waves and particles complement each other and provide a deeper understanding of light. Similarly, people who are either uninformed or misinformed about the deeper nature of both science and religion often feel they must choose between them. But if we have an understanding of science and religion, we can embrace both without contradiction.

It contains a cartoon drawing (Figure 1.5) of a smiling boy and girl, the boy saying "Science is about cosmic order", the girl saying "Religion is about cosmic purpose." The

PFAW text likens houses of worship to spaceships. "To the people of that time, the structures they erected were their 'spaceships of faith'—firmly anchored but pointing to the cosmos." (p. 7) It also suggests to students an ambitious view in which humanity is entering a new phase, and likens the motivation for space travel to religious inspiration. (p. 7)

> We seem to be at the dawn of a major change in human growth, not unlike the stage of a chicken embryo before it fully matures. When the chicken embryo exhausts the last of its inner-egg resources and before it pokes its way out of its shell, it may seem to be at its last moments. But what seems like an end is really only a beginning. Are we like the hatching chicks ready to poke through to a whole new range of possibilities? Are our space-faring efforts the early signs of a new human era?
> The earth is our cradle and has served us well. But cradles, however comfortable, are outgrown one day. With inspiration similar to the inspiration of those who built the early cathedrals, synagogues, temples, and mosques, we aim for the cosmos.

2. BJU viewpoint on religion

Like the PFAW text, the BJU text, 2nd ed, discusses the relationship of science to religion in its first chapter. For example, in section 1.17 "Revealing God's Order" (not present in the 1st ed), it states:

> You are about to embark on an adventure. The study of physics reveals the wonderful orderliness of God's creation—so orderly that it can be comprehended in terms of relatively simple principles (mathematical formulas). The realm of physics encompasses everything from the tiny elementary particles that combine to form the nuclei of atoms to the immense clusters of thousands of galaxies containing billions of starts in the expanse of the universe. Physics is important because through it mankind learns how creation actually works. It satisfies our God-given curiosity about nature. Seeing that God does "great things and unsearchable; marvelous things without number" (Job 5:9), men have dedicated their lives to unraveling the rich mysteries of creation.

The chapter also contains a discussion of the nature of science, the history of science from ancient times through modern times, instances where most scientists have been wrong in their view of the world, and deductive vs. inductive reasoning. Additionally, the BJU text, 2nd ed, begins each chapter with a verse from the Bible, usually connected to the title of the chapter. For example, Chapter 2, Measurement, begins with the following verse: "But thou shalt have a perfect and just weight, a perfect and just measure shalt thou have: that thy days may be lengthened in the land which the Lord thy God giveth thee. *Deuteronomy 25:15*"

3. General conclusions concerning viewpoints in physics textbooks

Both physics textbooks that were examined, both the approved PFAW text and the Christian text from BJU, contain material which is not strictly science, but which discusses the relationship of physics and religion. In my opinion this practice is pedagogically sound. Science does not exist in a vacuum, and students will naturally have questions about how science relates to other aspects of their world. Discussion of how scientific and other topics impinge on each other and interrelate with each other can equip students to integrate seemingly separate areas into a more coherent whole.

III. UC position on the science texts from Christian publishers

In his email of 1/12/04 Roman Stearns quotes "standard language" that is sent to schools concerning the Christian texts discussed above. Part of that language asserts that courses which use those texts are not consistent with "knowledge generally accepted in the scientific community." (F0003) I find that to be incorrect. The California State Board of Education standards reflect the knowledge generally accepted by the scientific community. As Tables 1-4 show, the Christian texts meet about the same number of standards as do the approved texts. Thus by that measure they are as consistent with the "knowledge generally accepted by the scientific community" as the approved texts. Furthermore, as discussed above, the Christian texts can also be used to meet the general criteria of the University of California for Certification Criteria for Laboratory Science, including a good understanding of the scientific method. The

Christian texts discuss nonscientific topics which impinge on the study of science; so do the approved texts.

The Christian texts also discuss some biological topics skeptically, and discuss limits on the scientific method; for example, they point out, correctly, that there have been many times in the past that scientific consensus has been wrong, and that some questions are not amenable to scientific inquiry. In my opinion this is quite consistent with the California State Board of Education's judicious view that, "Ultimately, students should be made aware of the difference between *understanding,* which is the goal of education, and *subscribing to* ideas." (F0094)

In fact, in my opinion it is personally abusive and pedagogically damaging to de facto require students to subscribe to an idea, no matter how well supported the bulk of the scientific community judges it to be. A decision about what is ultimately true of the world involves not only scientific factors, but nonscientific ones as well, and the decision about how to weigh those factors is a nonscientific, personal one. Requiring a student to, effectively, consent to an idea violates his/her personal integrity. Such a wrenching violation may well cause a student to develop a profound distaste for a subject area, or to avoid it entirely, which would be a terrible educational outcome.

The decision of a private school to employ textbooks which explain concepts, but which also contain material that questions the validity of those concepts, is in my opinion simply the practical exercise of the student's right that the California State Board recognized—of understanding but not necessarily subscribing to a concept—and the right is exercised on behalf of the students by their parents who place them in the private schools.

While the Christian texts do address the great majority of the standards for Biology/Life Science of the California Department of Education, and therefore by that measure they are as consistent with the "knowledge generally accepted by the scientific community" as the approved texts, it is also important to keep in mind that being generally accepted by the scientific community is no guarantee that a concept or purported fact is correct, and that while general features or concepts might be widely accepted, critical details of those concepts may be severely controverted. For example, in the 19th century the physics community widely believed that outer space was filled with "ether", a medium that was then thought necessary to conduct light waves. Modern physics discounts the ether. Some modern physicists think the universe contains "dark energy" which drives an accelerating expansion; others dispute this. In biology, it had been thought that the demise of dinosaurs in the distant past coincided with the diversification of mammalian species; a recent paper, however, disputes that. And while most biologists think that Darwin's basic theory can account for the most important features of life, others dispute that. Thus the very concept of "knowledge generally accepted by the scientific community" is problematic, requiring a person to ignore the history and philosophy of science.

In the "University of California Position Statement: 'A-G' Course Approval for High School Science Courses Taught From Textbooks from Selected Christian Publishers" the underlying objection to texts from Bob Jones University Press and A Beka Books is that "The texts in question are primarily religious texts; science is secondary." (F0005) I find that to be incorrect. Although the texts do comment on some science topics from a certain Christian viewpoint, there is no systematic treatment of religion in the texts. Therefore they are not primarily religious texts. The texts do treat science topics systematically, and cover the great majority of the Standards listed by the California State Board of Education, as the reviewed approved texts do. Therefore they are primarily science texts.

A second objection from the University of California Position Statement is that "Courses that utilize these texts teach students that their conclusions must conform to the Bible, and that scientific material and methods are secondary." (F0005) I find that to be misleading for several reasons:

First, the texts do not tell the students that their conclusions must conform to the Bible. Rather, the texts state (roughly) that people who hold the certain Christian viewpoint will hold the Bible to be the most reliable source of knowledge concerning topics it discusses. That, of course, is a tautology, since the viewpoint itself is that the Bible is the most reliable source of knowledge concerning topics it discusses. However, there is no statement in the texts that says students "must conform" to that viewpoint. Furthermore, at least one other science textbook approved by the University of California discusses the nonscientific topic of the proper relationship between religion and science. As discussed earlier, the approved PFAW physics textbook tells students that those who view the relationship of science to religion in the same way that it does will have fewer difficulties: "[P]eople who are either uninformed or misinformed about the deeper nature of both science and religion often feel they must choose between them. But if we have an understanding of science and religion, we can embrace both without contradiction." (page 7)

Second, the texts do not assert that science is "secondary" in its proper domain. As discussed previously in this report, the texts explicitly affirm the value of science and the scientific method.

Finally, a decision about whether "scientific material and methods are secondary" or primary, or whether they should be accorded some other degree of importance, is not itself a scientific decision. There is no experiment that can tell a person whether the scientific method should have priority over nonscientific views in his own life. That is a personal decision, which in my opinion is wisely accommodated by the California State Board of Education's view that, "Ultimately, students should be made aware of the difference between *understanding,* which is the goal of education, and *subscribing to* ideas." (F0094)

IV. The appropriateness of discussing alternatives to Darwin's theory of evolution in nonpublic high school biology classes

In my opinion it is pedagogically quite appropriate for a nonpublic high school biology class to present the strengths and weaknesses of Darwin's theory of evolution, some of which have been discussed in my book *Darwin's Black Box: The Biochemical Challenge to Evolution* (10th anniversary edition, 2006), as well as in *Icons of Evolution* by Jonathan Wells, both of which are incorporated into this report by reference, and for the nonpublic class to discuss alternatives such as intelligent design or creation. The reason is that, if the topic of a class is the question of how life originated or developed, then it is pedagogically sound to discuss a range of possible answers to that question, as well as to point out the strong points and weak points of each idea.

Table 1. Summary of CDE standards addressed in Biology subfields.

Sub-field	**Holt**	**PH**	**BJU, 2nd ed**	**BJU, 3rd ed**	**A Beka**
Cell Biology	8/10	10/10	10/10	10/10	10/10
Genetics	21/22	19/22	22/22	22/22	21/22
Ecology	5/7	6/7	7/7	7/7	6/7
Evolution	9/13	10/13	8/13	10/13	8/13
Physiology	15/15	15/15	14/15	15/15	15/15
SUMMARY					
Total Standards	**Standards Met**				
67	58/67	60/67	61/67	64/67	60/67

Table 2. CDE Biology/Life Sciences standards

Stan-dard	Brief Description	Holt	PH	BJU, 2nd ed	BJU, 3rd ed	A Beka
Cell Biology		page	page	page	page	page
1a	cells are enclosed within semipermeable membranes that regulate their interaction with their surroundings	41	53	74	77, 91	592
1b	enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings	79	38	59	57	586
1c	prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure	50, 345	60, 401	72, 239	75, 269	310, 582
1d	the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm	141	182	67	112	627
1e	the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins	52	63	76, 77	80	589
1f	usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide	52	65	77	84	588
1g	the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide	52	65	76	77	587
1h	most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors	32, 33	184	102	59, 113	203, 622

Table 3. Summary of standards addressed in Physics subfields.

Sub-field	PFAW	BJU, 2nd ed	BJU, 3rd ed
Motion and Forces	12/13	13/13	13/13
Conservation of Energy and Momentum	6/8	7/8	7/8
Heat and Thermodynamics	7/7	7/7	7/7
Waves	6/6	5/6	5/6
Electric and Magnetic Phenomena	12/15	14/15	14/15
SUMMARY			
Total Standards	**Standards Met**		
49	43	46	46

Table 4. CDE Physics standards

Standard	Brief Description	SFAW	BJU, 2nd ed	BJU, 3rd ed
	Motion and Forces	page	page	page
1a	solve problems that involve constant speed and average speed.	11	39	52
1b	when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).	51	88	117
1c	apply the law F=ma to solve one-dimensional motion problems that involve constant forces (Newton's second law).	61	92	125
1d	when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).	75	96	128
1e	relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth	175	112	155
1f	applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed)	205	104	139
1g	circular motion requires the application of a constant force directed toward the center of the circle	205	105	140
1h	**Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important*	232	530	597
1i	**solve two-dimensional trajectory problems*	34	73	98
1j	**resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.*	31	59	73

1k	**solve two-dimensional problems involving balanced forces (statics).*	53	89	119
1l	**solve problems in circular motion by using the formula for centripetal acceleration in the following form: a=v2/r.*	XX	105	140
1m	**solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation)*	172	112	155
	Conservation of Energy and Momentum			
2a	calculate kinetic energy by using the formula $E=(1/2)mv^2$.	108	155	198
2b	calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) =mgh	107	157	201
2c	solve problems involving conservation of energy in simple systems, such as falling objects	109	164	208
2d	calculate momentum as the product mv.	86	187	233
2e	momentum is a separately conserved quantity different from energy.	XX	XX	XX
2f	an unbalanced force on an object produces a change in its momentum.	87	189	235
2g	solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.	95	195	243
2h	**solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.*	XX	165	206
	Heat and Thermodynamics			

3a	heat flow and work are two forms of energy transfer between systems.	309	264	331
3b	the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics)	361	283	349
3c	the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy.	308	265	330
3d	most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.	364	294	361
3e	entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.	365	294	361
3f	the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).	365	296	362
3g	solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.	363	299	367
Waves				
4a	waves carry energy from one place to another	372	XX	XX
4b	identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves)	378	213	273

4c	solve problems involving wavelength, frequency, and wave speed	377	215	274
4d	sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates	390	216	275
4e	radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s	408	442	503
4f	identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization	382, 390, 442, 480	485, 496, 499, 463, 416	278, 527, 558, 562
Electric and Magnetic Phenomena				
5a	predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.	556	358	436
5b	solve problems involving Ohm's law	535	356	434
5c	any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) × I (current) = I^2R.	XX	356, 357	433, 434
5d	properties of transistors and the role of transistors in electric circuits.	509*	430	XX
5e	charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges	517	335	413

5f	magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources	568	382	464
5g	determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil	XX	383	465
5h	changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors	577	390	471
5i	plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity	255	XX	460
5j	**electric and magnetic fields contain energy and act as vector force fields*	XX	401*	482*
5k	**the force on a charged particle in an electric field is qE*	518	338	415
5l	**calculate the electric field resulting from a point charge.*	518	336	414
5m	**static electric fields have as their source some arrangement of electric charges*	502	341	418
5n	**the magnitude of the force on a moving particle in a magnetic field is qvB sin(a); use the right-hand rule to find the direction of this force.*	570*	383	464
5o	**apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy*	523*	339*	416*
	SUMMARY			
		Standards Met		
	total standards = 49	43	46	46
	XX - missing standard			

	* - can be taught using text material as starting point			

Tables 1-4 in Larger Type

Table 1. Summary of CDE standards addressed in Biology subfields.

Sub-field	Holt	PH	BJU, 2nd ed	BJU, 3rd ed	A Beka
Cell Biology	8/10	10/10	10/10	10/10	10/10
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1b	enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings	79	38	59	57	586
1c	prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure	50, 345	60, 401	72, 239	75, 269	310, 582
1d	the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm	141	182	67	112	627
1e	the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins	52	63	76, 77	80	589
1f	usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide	52	65	77	84	588
1g	the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide	52	65	76	77	587

1h	most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors	32, 33	184	102	59, 113	203, 622
1i	*chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production	XX	93	52, 99	102, 108	588
1j	*eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both	XX	64	79	82	586
section subtotal		8/10	10/10	10/10	10/10	10/10
Genetics		**Holt**	**PH**	**BJU, 2nd ed**	**BJU, 3rd ed**	**A Beka**
2a	meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type	110	131	121	130	605
2b	only certain cells in a multicellular organism undergo meiosis	110	132	122	130	605
2c	random chromosome segregation explains the probability that a particular allele will be in a gamete	124	135	135	145	611
2d	new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization)	124	137	134	143	611
2e	approximately half of an individual's DNA sequence comes from each parent	124	148	123	148	604
2f	the role of chromosomes in determining an individual's sex	103	151	136	147	612

2g	predict possible combinations of alleles in a zygote from the genetic makeup of the parents	120	137	128	144	612
3a	predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive)	124	136	135	144	611
3b	genetic basis for Mendel's laws of segregation and independent assortment	123	127	130	145	612
3c	*predict the probable mode of inheritance from a pedigree diagram showing phenotypes	130	149	138	140, L47	615*
3d	*use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes	112*	134, 140	149*	132*	614*
4a	the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA	141	184	107	112	627
4b	apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA	143	184	108	113	623
4c	mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein	127	XX	152	161	630
4d	specialization of cells in multicellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves	XX	XX	150	163	603*
4e	proteins can differ from one another in the number and sequence of amino acids	32	35	64	63	203

4f	*proteins having different amino acid sequences typically have different shapes and chemical properties	32	XX	65	63	XX
5a	general structures and functions of DNA, RNA, and protein	29	34	64-68	Ch 2	620
5b	apply base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA	137	175	67	64	623
5c	genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products	158	208	163	194	628
5d	*DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules	155	203	163	185	628
5e	*exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products	162	205	164	185	628
section subtotal		21/22	19/22	22/22	22/22	21/22
Ecology		**Holt**	**PH**	**BJU, 2nd ed**	**BJU, 3rd ed**	**A Beka**
6a	biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats	254	268	459*	586	639
6b	analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size	272	338	478	577, 605	660

6c	how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death	XX	311	471	L161	637, 640
6d	water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration	260	294	458, 469	580, 594	650
6e	a vital part of an ecosystem is the stability of its producers and decomposers	256	289	462	579	642
6f	at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.	258	289	463	585	645
6g	*distinguish between the accommodation of an individual organism to its environment and the gradual adaptation through genetic change	XX	XX	224	548, 599	XX
section subtotal		5/7	6/7	7/7	7/7	6/7
Evolution		**Holt**	**PH**	**BJU, 2nd ed**	**BJU, 3rd ed**	**A Beka**
7a	natural selection acts on the phenotype rather than the genotype of an organism	180	229	157, 196	170, 223	386
7b	alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool	183	156	155	168	616
7c	new mutations are constantly being generated in a gene pool	140	242	152	160	630

7d	variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions	182	254	158	171	387
7e	*the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature a population and why these conditions are not likely to appear in nature	XX	XX	XX	173	XX
7f	*know how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes	XX	XX	XX	173*	XX
8a	natural selection determines the differential survival of groups of organisms	175	229	196	223	386
8b	a great diversity of species increases the chance that at least some organisms survive major changes in the environment	XX	XX	XX	XX	XX
8c	the effects of genetic drift on the diversity of organisms in a population	XX	250	XX	173	XX
8d	reproductive or geographic isolation affects speciation	184	244	196	XX	386
8e	analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction	177*	388*	178, 193**	208, 223**	366**
8f	*use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships	179, 321	267	203, 339**	230, 445**	389**

8g	*several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another	322	272	XX	XX	XX
section subtotal		9/13	10/13	8/13	10/13	8/13
Physiology		**Holt**	**PH**	**BJU, 2nd ed**	**BJU, 3rd ed**	**A Beka**
9a	complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide	650, 698	827, 862	506	678	116
9b	nervous system mediates communication between different parts of the body and the body's interactions with the environment	600	782	580	711	160
9c	feedback loops in the nervous and endocrine systems regulate conditions in the body	634	771	XX	734	163
9d	the functions of the nervous system and the role of neurons in transmitting electrochemical impulses	601	783	581	712	162
9e	the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response	611, 619	792	582	716	163
9f	*the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts	707	859	543	670	218
9g	*the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance	709, 710	860, 863	577, 541	707, 668	261

9h	*cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca+2 , and ATP	593	814	522	645	153
9i	*hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms	634	771	599	733	293
10a	the role of the skin in providing nonspecific defenses against infection	679	905	509	632	279
10b	the role of antibodies in the body's response to infection	685	907	570	699	325
10c	vaccination protects an individual from infectious diseases	687	908	238, 536	704	322
10d	there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections	342, 348	903	238, 245	289, 700	310, 317
10e	an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign	691	911	571	703	331
10f	*roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system	684	908	574	699	324
section subtotal		15/15	15/15	14/15	15/15	15/15
SUMMARY						
		Standards Met				
	total standards = 67	58	60	61	64	60
	XX - missing standard					

	* - can be taught using text material as starting point					
	** - analyzed/discussed from alternative viewpoint					

Table 3. Summary of standards addressed in Physics subfields.

Sub-field	PFAW	BJU, 2nd ed	BJU, 3rd ed
Motion and Forces	12/13	13/13	13/13
Conservation of Energy and Momentum	6/8	7/8	7/8
Heat and Thermodynamics	7/7	7/7	7/7
Waves	6/6	5/6	5/6
Electric and Magnetic Phenomena	12/15	14/15	14/15
SUMMARY			
Total Standards	**Standards Met**		
49	43	46	46

Table 4. CDE Physics standards

Standard	**Brief Description**	**SFAW**	**BJU, 2nd ed**	**BJU, 3rd ed**
	Motion and Forces	page	page	page
1a	solve problems that involve constant speed and average speed.	11	39	52
1b	when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).	51	88	117
1c	apply the law F=ma to solve one-dimensional motion problems that involve constant forces (Newton's second law).	61	92	125
1d	when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).	75	96	128
1e	relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth	175	112	155
1f	applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed)	205	104	139
1g	circular motion requires the application of a constant force directed toward the center of the circle	205	105	140
1h	**Newton's laws are not exact but provide very good approximations unless an object is moving close to the speed of light or is small enough that quantum effects are important*	232	530	597
1i	**solve two-dimensional trajectory problems*	34	73	98

1j	**resolve two-dimensional vectors into their components and calculate the magnitude and direction of a vector from its components.*	31	59	73
1k	**solve two-dimensional problems involving balanced forces (statics).*	53	89	119
1l	**solve problems in circular motion by using the formula for centripetal acceleration in the following form: $a=v^2/r$.*	XX	105	140
1m	**solve problems involving the forces between two electric charges at a distance (Coulomb's law) or the forces between two masses at a distance (universal gravitation)*	172	112	155
Conservation of Energy and Momentum				
2a	calculate kinetic energy by using the formula $E=(1/2)mv^2$.	108	155	198
2b	calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) =mgh	107	157	201
2c	solve problems involving conservation of energy in simple systems, such as falling objects	109	164	208
2d	calculate momentum as the product mv.	86	187	233
2e	momentum is a separately conserved quantity different from energy.	XX	XX	XX
2f	an unbalanced force on an object produces a change in its momentum.	87	189	235
2g	solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.	95	195	243
2h	**solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.*	XX	165	206
Heat and Thermodynamics				
3a	heat flow and work are two forms of energy transfer between systems.	309	264	331

3b	the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics)	361	283	349
3c	the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as thermal energy.	308	265	330
3d	most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.	364	294	361
3e	entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.	365	294	361
3f	the statement "Entropy tends to increase" is a law of statistical probability that governs all closed systems (second law of thermodynamics).	365	296	362
3g	solve problems involving heat flow, work, and efficiency in a heat engine and know that all real engines lose some heat to their surroundings.	363	299	367
Waves				
4a	waves carry energy from one place to another	372	XX	XX
4b	identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves)	378	213	273
4c	solve problems involving wavelength, frequency, and wave speed	377	215	274
4d	sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates	390	216	275
4e	radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s	408	442	503

4f	identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization	382, 390, 442, 480	485, 496, 499, 463, 416	278, 527, 558, 562
Electric and Magnetic Phenomena				
5a	predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.	556	358	436
5b	solve problems involving Ohm's law	535	356	434
5c	any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) × I (current) = I^2R.	XX	356, 357	433, 434
5d	properties of transistors and the role of transistors in electric circuits.	509*	430	XX
5e	charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges	517	335	413
5f	magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources	568	382	464
5g	determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil	XX	383	465
5h	changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors	577	390	471
5i	plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity	255	XX	460
5j	**electric and magnetic fields contain energy and act as vector force fields*	XX	401*	482*

5k	**the force on a charged particle in an electric field is qE*	518	338	415
5l	**calculate the electric field resulting from a point charge.*	518	336	414
5m	**static electric fields have as their source some arrangement of electric charges*	502	341	418
5n	**the magnitude of the force on a moving particle in a magnetic field is qvB sin(a); use the right-hand rule to find the direction of this force.*	570*	383	464
5o	**apply the concepts of electrical and gravitational potential energy to solve problems involving conservation of energy*	523*	339*	416*
SUMMARY				
		Standards Met		
	total standards = 49	43	46	46
	XX - missing standard			
	* - can be taught using text material as starting point			

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Darwin's Black Box selected one of "The 100 Best Non-Fiction Books of the Century" by *National Review* magazine (1999) and *World* magazine (1999)
Darwin's Black Box chosen "Book of the Year" by *Christianity Today* (1997)
Darwin's Black Box voted Best Religion/Politics/Current Issues by Logos Bookstores (1997)
National Institutes of Health Research Career Development Award (1984-89)
Jane Coffin Childs Fund for Medical Research Postdoctoral Fellowship (1979)
American Cancer Society Postdoctoral Fellowship (1979) declined
National Research Service Award Postdoctoral Fellowship (1979) declined
Sigma Xi professional chemical society award for "Outstanding Thesis" (1978)
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2000-2003 Expert analyst, *ChemTracts—Biochemistry and Molecular Biology*
1998-2003 Member, American Bioethics Advisory Commission
1996-2003 Editorial advisory board, *Origins & Design*
1995-1997 Molecular Biochemistry Review Panel, Division of Molecular and Cellular Biosciences, National Science Foundation
6/95-8/97 Associate Professor of Biological Sciences, Lehigh University
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COURSES TAUGHT

Fall 2006	BIOS 468	Principles of Protein Structure
	BIOS 371	Elements of Biochemistry
Summer 2006	BIOS 371	Elements of Biochemistry
Spring 2006	BIOS 381	Physical Biochemistry
	BIOS 295	Controversies in Biology
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Spring 2003	BIOS 396	Physical Biochemistry
	BIOS 396	Controversies in Biology
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	BIOS 090	Popular Arguments on Evolution
	BIOS 468	Principles of Protein Structure
Spring 2002	BIOS 396	Physical Biochemistry
	BIOS 371	Elements of Biochemistry
	BIOS 396	Controversies in Biology
Fall 2001	BIOS 371	Elements of Biochemistry
Spring 2001	BIOS 396	Physical Biochemistry
	BIOS 361	Special Topics, Protein Structure

Fall 2000	BIOS 371	Elements of Biochemistry
Spring 2000	BIOS 396	Physical Biochemistry
Fall 1999	BIOS 371	Elements of Biochemistry
Spring 1999	BIOS 361	Principles of Protein Structure
Fall 1998	BIOS 396	Controversies in Biology
Spring 1998	BIOS 467	Principles of Nucleic Acid Structure
Fall 1997	BIOS 371	Elements of Biochemistry
	BIOS 408	Responsible Conduct of Science
Spring 1997	BIOS 468	Principles of Protein Structure
Fall 1996	A&S 006	Choices and Decisions
	BIOS 251	Writing and Molecular Biology
	BIOS 090	Popular Arguments on Evolution
Spring 1996	BIOS 225	Introduction to Biological Research
Fall 1995	BIOS 371	Elements of Biochemistry
	BIOS 251	Writing and Molecular Biology
Spring 1995	CHEM 468	Principles of Protein Structure
Fall 1994	CHEM 090	Popular Arguments on Evolution
Spring 1994	CHEM 090	Popular Arguments on Evolution
Fall 1993	CHEM 467	Principles of Nucleic Acid Structure
Spring 1993	CHEM 201	Technical Writing
	CHEM 468	Principles of Protein Structure
Fall 1992	CHEM 090	Popular Arguments on Evolution
	CHEM 371	Elements of Biochemistry
Spring 1992	CHEM 467	Principles of Nucleic Acid Structure
	CHEM 201	Technical Writing
Fall 1991	CHEM 090	Popular Arguments on Evolution

Spring 1991	CHEM 468	Principles of Protein Structure
	CHEM 201	Technical Writing
Fall 1990	CHEM 53	Organic Chemistry Laboratory
Spring 1990	CHEM 477	Principles of Nucleic Acid Structure
Fall 1989	None: Sabbatical leave	
Spring 1989	CHEM 477	Principles of Protein Structure
	CHEM 481	Graduate Student Seminar
Fall 1988	CHEM 371	Elements of Biochemistry
	CHEM 477	Problem Solving in Biochemistry

SERVICE TO LEHIGH UNIVERSITY

College of Arts & Science Promotions Committee	2001-2003
Biology Faculty Search Committee	
Libsch Research Award Committee	
Biol. Science Department Graduate Affairs Committee	1995-present
Biol. Science Department Graduate Coordinator	1996-1998
Freshman Advisor	1996-2000
University Committee on Discipline	1995
Biomedical Research Support Grant Award Committee	1988-1992
Institutional Recombinant DNA Biosafety Committee	1987-1992
Molecular Biology Faculty Search Committee	1989
Biochemistry Faculty Search Committee	1988
Chemistry Department Library Liaison	1987-1994
Chemistry Department Graduate Advisory Committee	1989-1991
Chemistry Department Undergraduate Teaching Committee	1988-1989
Chemistry Department Graduate Admissions Committee	1991-1992

MICHAEL J. BEHE, PH. D.

DATA AND INFORMATION CONSIDERED

As Basis and Reasons for Opinions

Publications referred to in the report
Appendix (if any) to the report
His years of research and teaching
(Research is continuing on these issues)
Complaint in this case, the parties' briefs on Motion To Dismiss, and Opinion on Motion To Dismiss
Exhibits: 1-9, 86-93, 96, 102, 241-50, 177, 187-88, 202-07, 217-19, 263, 303, 343-75
Documents provided within 3 days to Defendants (F001-626):

1. Exhibit to complaint
2. UC a-g Guide excerpt
3. UC checklist
4. UC Helpful Hints
5. UC sample course descriptions
6. CBSE Standards (California State Board of Education)
7. CBSE Curriculum Framework
8. CBSE Criteria for Evaluating Instructional Materials
9. Other

Michael Behe, Ph.D., Darwin's Black Box
Jonathan Wells, Ph.D., Icons of Evolution

CD of UC Courses: which was produced to Plaintiffs as Word and Adobe documents by UC (without Bates stamps) pursuant to Public Records Act Request No. 1 (which were subsequently partially reproduced by UC as .tiff files with Bates numbers beginning "UCPROD"), and which was copied for each expert to provide the relevant "a-f" subject area plus the "g" elective subject area

Textbooks:

- *Biology: The Living Science*, Prentice Hall 1998 (Teacher's Edition).
- *Biology: Visualizing Life*, Holt, Rinehart & Winston 1998 (Teacher's Edition).
- *Conceptual Physics*, Foresman/Addison Wesley 1999 (Teacher's Edition).
- *Biology for Christian Schools*, BJU Press 2005 (Second Edition & Third Edition).
- *Biology: God's Living Creation*, A Beka Book 1997 (Second Edition))
- *Physics for Christian Schools*, BJU Press 2004 (First Edition & Second Edition).

ACSI scores on Stanford Achievement Test (A0164-87)
Deposition of Dr. Barbara Sawrey

COPIES ATTACHED

Copies are attached of the following items, not publicly available or produced in discovery in this action:

Appendix (if any) to report

Sent by Federal Express 3 day delivery, separately:

- F001-626
- Michael Behe, Ph.D., Darwin's Black Box
- Jonathan Wells, Ph.D., Icons of Evolution

COMPENSATION

The compensation to be paid for the study and deposition testimony, excluding trial testimony, is $20,000.

TESTIMONY IN OTHER CASES

In preceding four years, Kitzmiller v. Dover (District of Pennsylvania)