

## Critique of “Proposed Revisions to Science Standards Draft 1

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I am a molecular biologist researching the causes of cancer at the molecular level. Evolutionary biology is fundamental to biology in general and is essential to understanding the genetic and molecular causes of human diseases, including cancer and viral, bacterial, environmental, and inherited diseases. The *Proposed Revisions to the Science Standards* significantly weaken the ability of students to learn real evolutionary theory, due to the many serious and fundamental scientific inaccuracies proposed in these *Revisions*.

These *Revisions* have been formulated by IDNet, a political “think tank” advocating the pseudoscientific concept of “intelligent design” (ID). While I personally believe that the universe was designed by an intelligence, the current ID political movement has no scientific credibility. ID proponents distort scientific knowledge by claiming that contemporary evolutionary theory cannot explain the diversity of life. So far, the ID movement has failed to provide any scientific evidence to support their claims. ID proponents have never published any original research in peer-reviewed scientific journals providing evidence for ID. Most importantly, ID adherents have not proposed any scientific tests for their claims. ID is therefore rejected by the vast majority of active scientific researchers in the life sciences, not because of any philosophical or religious bias, but rather because ID currently has no scientific support or utility whatsoever.

In the following I will step through the seven major revisions given in the *Summary of Proposed Revisions* (p. 1), explaining the errors in each one with reference to the main text of the revisions.

1b) The Revisers want to “use an evidence based rather than a naturalistic definition of science.” However, in science “naturalistic” just means is “based on evidence”, so this revision is confusing and misleading. If an idea can be tested against evidence, it is natural and it is scientific. If the idea can’t be tested then it’s not science, it’s philosophy. In their explanation for this change, the Revisers make a big deal out of “methodological naturalism”, making grandiose claims that it assumes that “design conceptions of nature are invalid” and that it leads to the belief that “life ... is the result of an unguided, purposeless natural process.” Methodological naturalism does nothing of the sort. The Revisers ignore the fact that many scientific disciplines use design to explain certain phenomena *naturalistically*, such as archaeology and criminal forensics.

Most importantly, the Revisers make a huge blunder in confusing methodological naturalism (which is how real science is practiced) with *metaphysical naturalism* (which is an atheistic philosophy). Using methodological naturalism does not entail a belief in metaphysical naturalism. Everybody uses methodological naturalism all the time in their everyday lives, regardless of whether they are theists, agnostics, or atheists. For instance, you use methodological naturalism when you figure out why your car doesn't run well or why the light doesn't turn on when you flick the light switch. When the light doesn't turn on, we don't consider the possibility that a ghost blew it out, rather we perform a test of the hypothesis that the filament in the bulb burned up (usually by looking at the bulb and replacing it with a new one). If the light bulb is missing, we might consider the hypothesis that somebody removed it, which is hardly supernatural, it is a *natural* cause. It should be clear that I can ignore ghosts and fairies while figuring out what's wrong with the light bulb and at the same time believe that life is guided and purposeful.

The only people I know of who consistently confuse methodological and metaphysical naturalism are proselytizing fundamentalists and atheists. I am neither one, but unlike the Revisers, I do understand a little basic philosophy.

Even if the Revisers were correct about methodological naturalism (which they are not), would it matter? If the purpose is to teach *real* science in a science class, as practiced by *real* scientists, then we should teach that, shouldn't we? The Revisers want to teach their own pet philosophy about how they wish science would be performed -- instead of teaching how science really is. Pretending that science is something it is not, and teaching impressionable students that the scientific method includes supernatural explanations, is not only unfair and erroneous, it is a insidious form of deception.

1d) (p. 6) Proposed change: **“Although science proposes theories to explain changes, the actual causes of many changes are currently unknown (e.g. the origin of the universe, the origin of fundamental laws, the origin of life and the genetic code, the origin of major body plans during the Cambrian explosion, etc.).”**

Much of this is just false – the causes of several of these (or parts of these) are known in science. For instance, the Big Bang as the origin of the universe in a singularity, the cause of electromagnetic forces, and much is known about the origin and evolution of major body plans before, during, and after Cambrian times (the term “Cambrian explosion” is a bit outdated and biased since the “explosion” occurred over dozens of millions of years).

2) (p. 7) Proposed change **“Biological evolution theorizes that ...”**

Only *people* theorize, biological evolution theorizes nothing. The Revisers explain in the *Summary* that their “addition makes it clear that evolution is a theory, and not a fact.” This is false and is fundamentalist nonsense, a code phrase that Creationists have used historically as justification for their religiously motivated opposition to evolution. Evolution is both a scientific theory and a scientific fact. Many nonscientists use the informal, non-technical definition of 'theory', which is basically equivalent to 'some

random guess'. In science, however, a theory is the end-all-be-all scientific statement, the end product of the scientific method. Technically it is "only a theory" that the earth is round, that the earth circles the Sun every year, that X-rays cause mutations, that DNA molecules carry genetic information, that HIV causes AIDS, that fusion of hydrogen to helium powers the Sun, etc. **But it is just as valid to call each of these 'scientific facts'.** Claiming that evolutionary biology is "a theory, and not a fact" only confuses students and muddies the correct usage of scientific terms.

(p. 9) Proposed change in box concerning **"historical sciences"**.

Much of this proposed change is just factually incorrect. The Revisers list several ways that "historical sciences" are supposedly scientifically different from "present" sciences like physics and chemistry. However, everything in science concerns past events, some are just farther in the past than others. The Revisers state "historical hypotheses *may* not be confirmed by experiment due to unknown variables". Yet the same is true of any scientific hypothesis. This is why science uses statistics. They also claim that:

"As new clues are developed, historical hypotheses frequently change or are discarded entirely. As a consequence, in historical science one generally seeks 'an inference to the best current explanation,' with the understanding that the explanation may not be the 'best' in the future."

These are beneficial features of the scientific method in general, and they do not just apply to "historical hypotheses." To imply that these characteristics pertain only to historical sciences is false. In the *Explanation* (bottom p. 9), the Revisers claim that "historical hypotheses ... are not susceptible to confirmation by experiment". This also is false and displays a lack of familiarity with real science. As one simple counterexample, consider the "historical hypothesis" that my light bulb stopped working yesterday because the filament burned out. I can certainly subject that hypothesis (a hypothesis about a past event) to an experimental test. Similarly, consider the hypothesis that lactalbumin, a milk protein found in all mammals, evolved from lysozyme, an animal defense protein that degrades the cell wall of bacteria. We can experimentally determine the amino acid sequences of these proteins from many different animals (via molecular biology laboratory techniques) and we can investigate these sequences via statistical and phylogenetic analysis. Depending on the results of these experimental analyses, we could conclude either that yes, the evidence supports the hypothesis that lactalbumin did evolve from lysozyme, or no, the evidence does not support the hypothesis that lactalbumin evolved from lysozyme. We could also perform *in vitro* evolution experiments to see if we could evolve, in the lab, a lactalbumin protein from a lysozyme protein.

4) (p. 13) Proposed change: **"The order of the nucleotide sequences within the gene is not dictated by any known chemical or physical law."**

This is preposterously, absolutely false (unless one considers biology unphysical). Innumerable genetics and molecular biology experiments over the past 40 years have demonstrated that physical processes like mutation, natural selection, and random genetic

drift all affect and direct the composition and order of nucleotides in genes. The Revisers attempt to justify this change with a quote from James Watson where he explains that the order of nucleotides (bases) in DNA is not regular. That in no way supports their proposed change, since a chemical or physical law could dictate an irregular order. And of course that is exactly what the physical processes I mentioned above do.

5) (p. 14) Proposed change: **“1. a. Biological evolution postulates an unpredictable and unguided natural process that has no discernable direction or goal. [see NABT Statement on teaching evolution]”**

All scientific theories, including evolution, remain silent about “guidance”. Weather processes may be guided by a Deity, yet all meteorology assumes is that weather can be explained by appeals to highs and lows and cold fronts, etc. whether it is “guided” or not. Furthermore, the NABT statement does not support this proposed change, as the NABT statement mentions nothing about “guidance”.

Here is the text of the NABT statement:

“The diversity of life on earth is the outcome of biological evolution—an unpredictable and natural process of descent with modification that is affected by natural selection, mutation, genetic drift, migration and other natural biological and geological forces.”

Even though the NABT statement uses the term “unpredictable”, this characterization is also confusing. The most fundamental evolutionary forces (such as natural selection, mutation, and random genetic drift) are all predictable to a large extent. Natural selection also has a “discernable direction” in that the partial change in average fitness due to selection is always positive (Fisher’s Fundamental Theorem of Natural Selection).

(p. 14) Proposed change: **“1. b. It [biological evolution] assumes that life arose from an unguided natural process.”**

This is also false. Biological evolution does not concern the origin of life. Biological evolution concerns the origin of the diversity of life, once life began.

(p. 14) Proposed change: **“2. f. changes in allelic frequency (genetic drift).”**

***There are two extremely major errors here.*** I cannot emphasize this strongly enough. The Revisers equate changes in allelic frequency with genetic drift, which is wrong. Allelic frequencies can change for many reasons, including genetic drift, natural selection, gene flow, nonrandom mating, mutation, and sexual selection. This is a fundamental error. Second, they include genetic drift as part of natural selection. Genetic drift is not part of natural selection. This is another basic and fundamental error, something any college freshman in genetics or biology would know. These two errors alone demonstrate the extreme incompetence of the Revisers in criticizing these biological science standards.

(p. 15) Proposed change: **“3. b Except in very rare cases, mutations that may be inherited are, neutral, deleterious or fatal. [Douglas J. Futuyma, *Evolutionary Biology*, p. 278]”**

This reference is faulty. Futuyma does not make this claim.

(p. 15) Proposed change: **“4. c. Whether microevolution can be extrapolated to explain macroevolutionary changes (such as new complex organs or body plans and new biochemical systems which appear irreducibly complex) is not clear. These kinds of macroevolutionary explanations generally are not based on direct observations and are historical narratives based on inferences from indirect or circumstantial evidence. [Ernst Mayr, "Darwin's Influence on Modern Thought," p. 80, (July 2000, *Scientific American*)]”**

The term “irreducibly complex” is not found in the scientific biological literature, and the concept is not used by real research biologists. Rather, it is a term from the pseudoscientific publications of intelligent design proponents. This piece of ID jargon is certainly not used by Ernst Mayr, and ascribing it to him is dishonest. Furthermore, the modern biological consensus is that microevolutionary processes are sufficient to account for new complex organs and body plans. Here the Revisers are confusing macroevolutionary novelties (such as organs and body plans) with macroevolutionary trends (such as general increases in body sizes of entire groups of organisms). The latter may not be completely explained by microevolutionary processes. For example, S. J. Gould has proposed that species selection may be partly responsible. Regardless, these are advanced topics that are probably of an inappropriate level for grade school students.

(p. 15) Proposed change: **“4. d. The fossil record provides evidence that simple, bacteria like life **may** have existed as far back as 3.8+ billion years ago (**about the time earth first became habitable to any form of life**)**

The insertion of “may” is unwarranted. The fossil record provides unequivocal evidence that bacteria like life existed 3.8 billion years ago.

(p. 15) Proposed change: **“4. d. In many cases the fossil record is not consistent with gradual, unbroken sequences postulated by biological evolution.”**

This is also false, and is probably the result of a misunderstanding of the theory of Punctuated Equilibrium.

(p. 16) Proposed change: **“5. a. Microevolution provides the context to ask research questions and yields valuable insights ...”**

The addition of “micro” is unwarranted and misleading. Evolution in general, including especially common descent (macroevolution), provides research questions, testable hypotheses, and biological insight.

(p. 16) Proposed change: **Section 5, challenges to common ancestry**

Nearly all of the proposed changes in this section are fallacious. Common ancestry, defined as a common genetic heritage of all life, is considered scientific fact in biology, and has not “been challenged in recent years”. See:

“Although most of the details of the history of evolution remain to be described (as is true also of human history), the statement that there has been a history of common ancestry and modification is as fully confirmed a fact as any in biology. p. 5”

"Evolution, Science, and Society: Evolutionary biology and the national research agenda." (2001) *American Naturalist*. 158: S1. Full-text at <http://www.rci.rutgers.edu/~ecolevol/fulldoc.pdf> and <http://www.rci.rutgers.edu/~ecolevol/fulldoc.html>

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American Association for the Advancement of Science (1990) “Science for All Americans.” <http://www.project2061.org/tools/sfaaol/sfaatoc.htm>

National Academy of Sciences. (2003) *multiple statements*. [http://www.nationalacademies.org/attic/evolution/statements\\_from\\_the\\_nas.html](http://www.nationalacademies.org/attic/evolution/statements_from_the_nas.html)

(p. 16) Proposed changes: **“A fossil record that shows sudden bursts of increased complexity (the Cambrian Explosion), long periods of stasis and the absence of transitional forms rather than steady gradual increases in complexity, and iii. Studies that show animals follow different rather than identical early stages of embryological development.”**

This is typical Creationist misinformation. There are plenty of transitional forms, nothing in evolutionary theory predicts “steady gradual increases in complexity”, and animals show very similar embryological development, especially in early stages and especially between more closely related animals. Development is more similar between two animals the more recent is the common ancestor between them. The final statement in the proposed change is obviously a play off of the usual Creationist charge about Ernst Haeckel falsifying his embryological drawings over 100 years ago (which he did), but that does not invalidate all of modern developmental biology!

The revisions proposed by the Revisers misrepresent scientific practice. They know little real biology, not enough to know the very basic and elementary difference between genetic drift and natural selection. They misrepresent real predictions from evolutionary theory and downplay its essential importance in modern medicine, ecology, and agriculture. They suggest a nihilistic view of biology, as if it is impossible to know anything about the history of life (or of anything, for that matter) with any certainty. They engage in the classic Creationist tactic of using misleading quotes from scientists, implying that the scientists meant something which they never intended. In sum, the proposed revisions do not accurately reflect modern scientific biological knowledge.