

Testimony for Textbook Hearing, Austin, Texas, September 10, 2003

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William A. Dembski

My name is William Dembski. I'm an associate research professor in the conceptual foundations of science at Baylor University. I hold a Ph.D. in mathematics from the University of Chicago. One of the things I do for a living is study the probabilistic underpinnings of neo-Darwinian evolution.

In his testimony to you on July 9th, UT biology professor David Hillis claimed, "There is no debate about the existence of evolution in scientific circles." That may be, depending on how you define evolution. But there is considerable debate in scientific circles about the *mechanism* of evolution, namely, how it happened. Cambridge paleontologist Simon Conway Morris, writing for the premier biology journal *Cell*, remarks: "When discussing organic evolution the only point of agreement seems to be: 'It happened.' Thereafter, there is little consensus...." (Jan. 7, 2000)

Despite that, the illusion of scientific consensus is all we get in the textbooks. What's more, pro-Darwinian lobbyists, like Eugenie Scott, strive to maintain that illusion. In an interview with *Salon* (May 4, 2001), Scott tells us why. According to her, for textbooks to admit the lack of consensus over how evolution happened will "confuse kids about the soundness of evolution as a science."

Whatever happened to science education nurturing the capacity of young minds for critical thought? Whatever happened to exposing students to as much information as required to form balanced scientific judgments? All the textbooks under consideration grossly exaggerate the evidence for neo-Darwinian evolution, pretending that its mechanism of natural selection acting on random genetic change is a slam-dunk. Not so.

As a probability theorist, I, and many other mathematically-trained scientists, regard claims for the creative power of natural selection as implausible in the extreme. To see why, MIT's Murray Eden asks us to imagine a library evolving from a single phrase: "Begin with a meaningful phrase, retype it with a few mistakes, make it longer by adding letters, and rearrange subsequences in the string of letters; then examine the result to see if the new phrase is meaningful. Repeat until the library is complete." (Wistar Symposium, p. 110) From the standpoint of probability, neo-Darwinism is even more absurd.

Mathematicians aren't the only ones criticizing neo-Darwinism. Consider Franklin Harold, a professor emeritus of cell biology at Colorado State University. In 2001 he published *The Way of the Cell* with Oxford University Press. He remarked: "There are presently no detailed Darwinian accounts of the evolution of any biochemical or cellular system, only a variety of wishful speculations." (p. 205)

Last year I debated Brown University biologist Kenneth Miller, the lead author for one of the biology textbooks under consideration here (Fourth World Skeptics Conference, June 21, 2002). At that debate I read Harold's criticism. Miller didn't dispute the truth of Harold's statement, but merely made the irrelevant observation that Harold had retired fifteen years earlier. Sadly, such failures to address meaningful criticism of neo-Darwinian theory also pervade Miller's textbook and the others under consideration.

In his July testimony David Hillis implored you to "ignore the push to take the science out of our school science textbooks." Hillis missed the point entirely. The point is to put *more* science into our textbooks by including not only the strengths but also the weaknesses of neo-Darwinian evolutionary theory. Don't believe for one moment that all meaningful scientific debate about biological evolution has ceased or that it is only about loose ends and trivial details. If that were the case, none of us would be here today.

Texas State Board of Education
Public Hearing on Biology Textbooks
September 10, 2003
Raymond G. Bohlin, Ph.D.
Fellow, Discovery Institute

In the late 70s I spent 2 1/2 years at the University of North Texas as a graduate student in the Department of Ecology and Evolution. My research project involved the study of races of pocket gophers in North Texas, Oklahoma, and Louisiana. (Genic differentiation of two chromosome races of the *Geomys bursarius* complex, R. G. Bohlin and E. G. Zimmerman, *J. Mammalogy* 63(1982):218-228).

My research specifically concerned the process of what is now known as microevolution. Microevolution involves real life studies of the processes of natural selection and speciation. The process of speciation is often documented, as in my research, in populations that show little morphological difference between the parent species and the offspring species.

But if evolution is true, the concept that all living creatures are descended from a common ancestor, there must be processes that explain the origin of major morphological changes. How did we get such widely divergent creatures such as earthworms, fruit flies, pocket gophers, and scientific observers? Evolution above the species level is usually referred to as macroevolution.

There is a long-standing controversy in evolutionary biology as to whether the well-documented processes of microevolution are the same as those leading to macroevolution.

In 2002, Andrew Simons said in the *Journal of Evolutionary Biology*,

"A persistent debate in evolutionary biology is one over the continuity of microevolution and macroevolution – whether macroevolutionary trends are governed by the principles of microevolution."

(Andrew M. Simons, "The continuity of microevolution and macroevolution," *Journal of Evolutionary Biology* 15 (2002): 688-701.)

The reason for this long-standing discussion is that differences between major taxonomic groups require changes in what is called the body plan. Sea anemones and horses are not built on the same body plans. But if they have a distant common ancestor then there must be a way to change from one body plan to another.

But as Wallace Arthur put it in his book, *The Origin of Animal Body Plans* in 1997,

"Those genes that control key early developmental processes are involved in the establishment of the basic body plan. Mutations in these genes will usually be extremely disadvantageous, and it is conceivable that they are always so." P. 14

It seems that most genes involved in microevolutionary events occur late in development. Arthur states further,

“In a developmentally explicit approach it is clear that many late changes can not accumulate to give an early one. Thus if taxonomically distant organisms differ right back to their early embryogenesis, as is often the case, the mutations involved in their evolutionary divergence did not involve the same genes as those involved in the typical speciation event. P. 22.

Eight of the eleven textbooks up for adoption either do not even mention microevolution and macroevolution, or if they mention them, do not define the terms or if they define them they do not acknowledge a controversy. Of the remaining three, Raven and Johnson's *Biology*, 6th edition simply falls back on the usual explanation that microevolution will explain macroevolution, Campbell and Reece's *Biology*, 6th edition acknowledges only that developmental mutations are necessary but does not discuss the myriad problems with these mutations, and Purves, et al, *The Science of Biology*, 6th edition, only suggests that infrequent, slow and unobservable events might be the culprit.

All of the texts ultimately leave the impression that there is simply no problem. This is misleading and false and needs to be corrected in order for students to adequately understand the strengths and weaknesses of evolution.

Good afternoon. Thank you for the opportunity to speak on behalf of Texas students and teachers.

As a public high school biology teacher, I experienced great frustration when presenting evolution to my students because the textbook did not adequately explain the modern theory of evolution - also called **Neo-darwinism**. For example, the textbook and many teachers tend to use the rather innocuous phrase, "change over time" to characterize evolution. Nobody debates that organisms and populations change over time. But that is somewhat misleading, because the phrase "change over time" does not necessarily explain the more weighty philosophical commitment of Neo-darwinism. Therefore, I made sure that students understood that an accurate definition of modern evolutionary theory must include two parts:

1. change over time due to natural selection and
2. the common descent of all organisms from one original cell

I also pointed out the distinction between **microevolution** and **macroevolution**. Again, nobody in science doubts that microevolution occurs -it's observable and repeatable. But evidence for the mechanisms of macroevolution, specifically the appearance of novel designs or new types of creatures, is broadly debated. Therefore, students of biology should be exposed to that debate so that they can evaluate Neo-darwinism in its entirety.

Because the textbook did not adequately explain Neo-darwinism, I used a wide variety of supplemental materials to prepare my lectures and to instruct my students. This extensive information-gathering had two purposes: to give students a thorough, honest, accurate definition of Neo-darwinism and to present its strengths and weaknesses. My resources included numerous high school and college textbooks, books by authors from a broad spectrum of backgrounds, information gleaned from the Internet, and a guest speaker.

The students engaged the topic wholeheartedly, intrigued by the controversy surrounding evolution and intellectually stimulated by the bold claims of Neo-darwinism. Because we discussed and debated both strengths and weaknesses of Neo-darwinism before our guest speaker came, the students were well-equipped to participate intelligently during the Q/A time, asking thoughtful questions and clearly benefiting from the speaker. When we revisited the text, it was evident to the students that, at best, the textbook offered an incomplete definition of Neo-darwinism.

Although my students benefited from our discussion of evolution, using higher order thinking skills and truly enjoying the learning experience, one parent objected. He feared that my use of supplemental materials, rather than the exclusive use of the text, opened the door to the interjection of personal and/or non-scientific opinions. On the contrary, my goal was and is to allow students access to accurate information about the modern theory of evolution so that they can draw their own conclusions. In spite of my efforts, I was immediately asked by the administration to discontinue the use of outside materials and guest speakers and even urged to "avoid digging deeper" into the subject of evolution. That is why it is critical that the state of Texas give teachers textbooks which tell the whole story of modern evolutionary theory. Please consider adopting biology textbooks that clearly explain modern evolutionary theory, including both its strengths and weaknesses. If they are given accurate information, I trust that our students can draw their own conclusions based on the scientific evidence.

Thank you for your time.

**Testimony before Texas State School Board by Forrest M. Mims III
September 10, 2003**

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My name is Forrest Mims. I live in Seguin, Texas. I was born in Houston and graduated from Texas A&M. While preparing for this hearing, I read that an organization here today believes there is no problem with the books before you and no serious scientific doubt that evolution occurred. Well, I do serious science, and I have doubts about evolution and the books.

I have written many books about science and technology, invented instruments and conducted biological research in Brazil, Hawaii and Texas. My papers have been published in leading scientific journals, including *Nature*. I've been a member of many professional societies, including the National Science Teachers Association and the Texas Academy of Science.

The books and lab kits I develop for RadioShack, a Texas Corporation, are used by many schools. RadioShack has sold more than 7 million copies of my books, which we carefully review for errors before publication. It's a strict policy. It's a Texas policy. We fix errors.

The publishers of some of the books before you have a different standard. The descriptions of the Miller-Urey experiment in most of these books fail to state the experiment does not work as described. Several books feature staged photographs of the peppered moth. One book doesn't even mention the Cambrian explosion. Well, this Cambrian-era trilobite was there. It knows that life appeared in a geological blink of an eye, and our students deserve to know the same. Errors and omissions like these fail to meet the standards of a high school science report, much less the error-free mandate of the Texas Education Code.

I experienced a publisher's reaction to the evolution lobby when *Scientific American* magazine terminated my column assignment after the editor learned I no longer accepted Darwinian evolution. He said he was worried about the "public relations nightmare" that would occur if my doubts became public. His dream came true in the form of an international media event that led to a unanimous letter of support from the 16-member Committee on Scientific Freedom of the American Association for the Advancement of Science.

Since 1992, I've told this story to science students from more than 20 countries at the University of the Nations in Hawaii and Switzerland. I've learned that students around the world are perfectly capable of making analytical judgements about evolution. Why not Texas students?

Folks, Texas students deserve biology books without errors and omissions. My three children have excelled in science. Sarah won First Place at the Texas Junior Academy of Science last year and again this year. She won \$20,000 in scholarships at science fairs last year. Sarah is only 16, yet she knows how to write accurate science reports. It's time for Texas to insist that publishers provide biology books having the same accuracy we expect in our children's science projects.

TESTIMONY BY J. BUDZISZEWSKI

Texas State Board of Education textbook hearing
September 10, 2003

Honorable members of the Texas State Board of Education, my name is J. Budziszewski. I am a full Professor in both the Department of Government and the Department of Philosophy at the University of Texas at Austin. In my twenty-two years as a scholar of political philosophy, I have written six books and am a nationally recognized authority in my field of specialization. The subjects that I teach most often are the tradition of natural rights and natural law, the problem of toleration, the Constitutional thought of the American Founders, and the influence of religion on law and politics.

Although my teaching has included the philosophy of science, I am obviously not a natural scientist myself. Why then am I here? I speak today in support of the principle that young people should be educated, not propagandized -- and I know something about what that means.

One of the most important differences between education and propaganda is how they deal with great controversies.

- ① In education, students are taught about the controversies. In propaganda, they are shielded from them.
- ② In education, students are taught both sides of the important debates. In propaganda, they are taught only one.
- ③ In education, students are taught both the strengths and the weaknesses of the officially favored theory. In propaganda, they are taught only its strengths.

In short, education is the training of minds, while propaganda is the training of prejudices. In a democratic republic, the public schools should not propagandize, but educate.

The mandatory curriculum guidelines for Texas, called Texas Essential Knowledge and Skills (TEKS), agree with me. As we find in the science section of these guidelines, students must learn to "analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information."

If the TEKS guidelines agree with me, then what is the issue? The issue is that some advocates defend making an *exception* to the TEKS guidelines in the case of the neo-Darwinist orthodoxy. The view is urged upon you, the Board, that although students should be taught about theoretical controversy in other scientific fields, *they should not hear about the controversy about biological origins*; that although they should be told about both sides of other scientific debates, *they should be told only one side of the origins debate*; that although they should learn to weigh both the strengths and the weaknesses of other controversial theories, *they must be shielded from the weaknesses of the neo-Darwinist theory*. Against this special pleading, I urge that biology should be taught like the other sciences, and that within biology, the neo-Darwinist theory should be taught like other controversial theories -- with honesty about both sides.

Honorable members of the Board, when biology textbooks are biased, you are the check and balance. I urge you to require biology textbooks to let fresh air into the discussion of neo-Darwinist orthodoxy. I urge you require that the important scientific controversy about origins be taught, not suppressed. To do so would be not only good training in science, but good education in citizenship. Thank you.

Written Testimony to the State Board of Education of Texas

Robert C. Koons

September 2003

My written testimony comprises two parts: a personal statement of my own, and a letter to the Board written by Profs. Poenie and Milner of the University of Texas at Austin.

I. Personal Statement

My name is Robert Koons. I am a Professor of Philosophy at UT Austin. One of my areas of research focuses on applications of logic to questions that are foundational to science, including causation, inference and theoretical knowledge. I have been the recipient of research grants from the National Science Foundation and the National Research Council.

I am here today as a father of three children in public schools in Texas. I believe Texas students should be able to study the scientific weaknesses as well as the strengths of Darwinian theory, but I'm concerned that they may not be allowed to do so because some supporters of Darwin's theory have overreacted to the perceived threat of "creationism" by proclaiming that the Darwinian theory is already known to be true beyond all reasonable doubt, and so can't be responsibly questioned. As someone who analyzes the logical inferences that lead to conclusions about scientific theories, I believe that, given our current ignorance about how genes regulate the construction of complex systems, and, so given our ignorance of the probabilities involved in new systems' arising by blind chance, the truth of Darwin's model is not a settled fact. Students should be encouraged to examine critically arguments both for and against the adequacy of Darwin's model.

Of course, if evolution is defined broadly enough, there is little doubt it occurred. We do find a gradual "unfolding" of life (the original meaning of "evolution"): invertebrates appear before vertebrates, coniferous before flowering plants, small primates before great apes, and so on. This fact was well known before Darwin's work appeared. Darwin's crucial contention was that he had found the underlying mechanism driving this unfolding: the culling of variation by the competition for survival, with the variations appearing by means of some then-mysterious process (Mendelian genetics being unknown), but a process that was hypothesized to be blind and purposeless.

Except in the case of a few minor adjustments in pre-existing functions (like those required for bacterial resistance to antibiotics), evolutionary biologists have not yet met the burden of proof of demonstrating that the Darwinian mechanism of accidental variations and natural selection is causally sufficient to explain biological complexity. The mere fact that it is conceivable that such scenarios might someday be found is not sufficient to prove that the Darwinian mechanism is a physically and chemically possible

explanation of life as we know it.

To meet the burden of proof, there are two gaps that have to be filled: (1) Darwin's sketchy schema of variation and selection has to be filled out with sufficient detail in particular cases to enable us to verify that it could in fact be responsible for adaptations that bear the mark of apparent design, and (2) particular hypotheses produced in this way have to be tested against the available evidence (both in the fossil record and in vestigial homologies). Note that the second task presupposes success at the first: to attempt to test a vague, schematic model of "variation with selection" or "random mutations and selection" rather than specific scenarios is to attempt the impossible. Any evidence that is found can be made to accord with a schematic Darwinism, and so can be counted as evidence "for" the theory. Only by replacing the vague Darwinian schema with a specific sequence of possible mutations and selective pressures can we find something that is both falsifiable and confirmable by the evidence. But this is exactly what has never happened, due, no doubt, to the very great problems of reconstructing the genotypes of extinct and even hypothetical ancestors. Nonetheless, whatever the reason, the fact remains that Darwinian biologists have never met their burden of proof.

Take, for example, Richard Dawkins attempts to prove that Darwinism is able to explain the emergence of the vertebrate eye. In *Climbing Mount Improbable*,¹ Dawkins refers to a simulation by Nilsson and Pelger,² showing that one can gradually improve a light sensitive spot and reach, in 1800 steps or so, a fully functional, lens-bearing eye. This would be impressive, except that the simulation (like every other simulation used by Dawkins in the book), entirely omits the two crucial details about real biology: the genotype/phenotype distinction, and the processes of embryological development. The steps in Nilsson and Pelger's model are phenotypical (i.e., changes in gross, morphological features in the fully formed adult). We are not given a model in which the successive forms of the eye are determined by successive trajectories of embryological development, nor are we given a model of how these successive trajectories are determined by successive, feasible mutations. Given these limitations, it is of course impossible to estimate the probabilities of the mutations required for each of the 1800 steps Nilsson and Pelger say are needed in the creation of the vertebrate eye. The model cannot be used to generate even a single prediction about present-day residues of the actual history of the eye. In other words, Dawkins's favorite model, the best now available, has not made even the smallest significant step beyond the kind of pure speculations found already among the ancient Greeks.

We're still waiting for Darwin's Newton: for a theorist who can take Darwin's proposal and produce even one hypothesis about the origin of one interesting biological mechanism, a hypothesis which specifies, step by step, the genetic changes that had to take place, the embryological alterations that these changes produce, and the quantifiable selective pressures that enable each new step to reach a significant proportion of the population.

¹ Richard Dawkins, *Climbing Mount Improbable* (W. W. Norton & Co., New York, 1996), pp. 161-8,

² D.-E. Nilsson and S. Pelger, "A pessimistic estimate of the time required for an eye to evolve," *Proceedings of the Royal Society of London*, B 256 (1994), 53-8.

I don't need to use physics or chemistry as the comparison class. Compare, for example, the Darwinian theory of evolution with the germ theory of disease. The germ theory has generated thousands of specific hypotheses, linking specific microorganisms with specific communicable diseases, and explaining in each case how the microorganism is transmitted from subject to subject and how infection by the microorganism produces the symptoms associated with the disease. Such hypotheses are eminently testable: one can treat the disease with an antibiotic known to be fatal to the hypothesized infectious agent, or one can block the channels known to transmit the germ, and then observe whether the disease is cured or contained. Nothing remotely like this is available in the Darwinian case. To take a famous example, we still do not know what genetic factors are responsible for the varying size and shape of Galapagos finches, and so, of course, we cannot demonstrate that these could all have plausibly resulted by mutation from some ancestral form, nor can we show that measurable selective pressures would have promoted the spread of such hypothetical mutations. If we have failed to produce a testable hypothesis in such long-standing and relatively simple example (a case in which, I believe, there is a very good probability that a Darwinian explanation may one day be found), consider how far we are from having such hypotheses at hand for the emergence of such really impressive biological functions, such as blood clotting, the central nervous system, or multi-cellular body plans.

The slowness of the development of the Darwinian paradigm has not been due simply to laziness or sloppiness on the part of its participants. The complexity of life makes the construction of testable hypotheses far more difficult in the case of Darwinism than in comparable cases from other sciences (for example, the Newtonian model of the solar system or quantum models of the hydrogen atom). Our understanding of the genetic code, gene expression, and developmental processes are still rudimentary at best, and our powers of computation are still far too weak to be able to reverse-engineer a hypothetical phenotype into a corresponding genotype, or vice versa.

Thus, I am not arguing that Darwinism is "only a theory". In fact, Darwinism is not even a theory: it is rather a vague and sketchy blueprint for the future construction of theories. As long as it remains so, it is grossly premature to proclaim that the origin of biological complexity has already been explained. It is vitally important that students understand both what we now know and what we do not know. Non-Darwinian models, such as the Neo-Platonic model of protein folds proposed by Michael Denton and his colleagues in a recent issue of the *Journal of Theoretical Biology*,³ are being developed and defended scientifically. Where the final answers are not yet known, students should be prepared to test and weigh the relative merits of competing models.

I predict that, in the lifetimes of our children, it will be possible to generate genuine hypotheses from the Darwinian template and subject them to rigorous testing. It is critical for our children's understanding of science that our textbooks do not prejudge the results

³ Denton, Marshall and Legge, "The Protein Folds as Platonic Forms: New Support for the Pre-Darwinian Conception of Evolution by Natural Law," *Journal of Theoretical Biology* 219(2002):325-342.

of such tests. Let's teach them instead to let the chips fall as they may and to adapt their opinions to future empirical results.

What, from a pedagogical point of view, is the consequence of following the advice of the "hyper-Darwinists", who would teach our children that the big questions of biology have already been finally and definitively answered? It is to make biology less attractive as a career choice, and to reduce biology to the memorization of a list of officially promulgated "facts". If, instead, we give our children an accurate assessment of what is not yet known and cannot yet be explained, we reveal biology to be on the cusp of an exciting period of revolutionary change and discovery. Students understand that the origin of biological design is a big question, and if they are correctly taught that the right answer to this question is still a matter of lively scientific controversy, they will be highly motivated to inform themselves about the evidence for and against Darwin's conjecture. Biological education will be revived.

Even if I believed that Darwinism was clearly the right answer to the question of biological origins, I would want my children exposed to scientific arguments on both sides of the issue. Many opinion polls reveal that only about 10% of Americans accept the fully Darwinian model of the origin of biological adaptations (i.e., that these adaptations are wholly the result of purposeless forces). I believe that the reason this percentage is so low, despite a Darwinian monopoly in control over biology textbooks for the past 70 years, is that Americans are naturally skeptical when they know they are being allowed to hear only one side of the story, just as a member of a jury would be skeptical of the prosecution's claims if she knew that the defense was not allowed to present its case. If there is in fact a compelling scientific case to be made for Darwinism, this case can be presently persuasively only by allowing the skeptics and dissenters the opportunity to present their scientifically grounded doubts and objections.

II. Letter to Board from Martin Poenie and Thomas Milner

Begins on the next page.

Sept 8, 2003

A Letter to the Texas State Board of Education

We preface this letter by stating our intent is NOT to oppose the idea that there is a long evolutionary history to life nor to oppose common descent nor the teaching of these ideas to students. That said, there remain grave issues regarding what is happening in the name of student education. A letter submitted to the State Board of education asserts "that students should have full exposure to contemporary evolutionary theory from which there is no scientifically credible dissent nor is there any empirical evidence that would make such dissent plausible." This statement may sound good but is loaded with potentially erroneous implications and strikes at the heart of a free and open scientific enterprise. At its worst, it amounts to a bait and switch approach to indoctrination of students enforced by a heavy-handed authoritarian establishment.

We ask the board if they can define what is meant by the term "Evolutionary theory"? Evolutionary theory can refer to anything from classical Darwinian evolution to the idea that some sort of natural mechanisms have molded the history of life on this planet. We could resort to a classical definition of evolution as mutation and natural selection. But then we ask "what is a mutation?" Is it a small change in DNA due to (as an example) a DNA replication error, is it duplication of an entire genome, is it the simultaneous serendipitous insertion of several new genes into the organism that were never there before or is it a sudden massive rearrangement of the genome due to some kind of recombination event? In reality, a mutation could be any of these, some of which fit the Darwinian mold and others that do not. Given the wide latitude of events that mold the genome, one can slant the story of life on this planet in radically different ways. Moreover, depending on how the story is slanted and sold, students can get an education that reflects prejudice more than science.

In teaching students, we can show them that mutations alter DNA and that the prevalence of genes in the population can be altered by selection. Does it follow that such a mechanism can and did, over long periods of time, produce all the transformations seen in the history of life? If we succeed in convincing students that it did, have we done them a service as educators? My answer is no - a resounding no for several reasons. First, at a theoretical level, the mechanism proffered above is depicted as one that can produce any necessary changes to heredity. It can be invoked whether or not we know what really happen. Moreover, one might even lead students to believe this explanation is true even when we know otherwise, as we illustrate below.

The best way for me to illustrate this fallacy is by an allegory. Let's imagine the excavation of human civilization by archaeologists who have no independent written history of the civilization's activities. The archaeologists find that tools used by this civilization progressively change from crude stone implements to bronze devices and finally to iron tools. The archaeologists postulate a tool gene must have undergone a mutation from stone to bronze to finally an iron tool form of the gene. The archaeologists show the selective advantage of bronze over stone and finally iron over bronze and thus explain why the mutant gene became more prevalent. They attempt to "prove" the theory by showing that genes can change by mutation and natural selection. Finally, questioning of the theory is silenced by squashing any dissent.

If one is unable to dissent from current evolutionary theory, then the door for infusion of new ideas requisite for scientific progress is regrettably shut. Such an imposition is not without historical precedent and is reflective of an authoritarian regime that self proclaims to be above scrutiny. Such views are not new to science in general nor evolutionary biology in particular. In the late 1960's Susumo Ohno wrote a book entitled *Evolution by gene duplication*. "Ohno postulated that the major advances in evolution such as the transition from single-celled organisms to complex multicellular animals and plants could not simply have been brought about alone through processes such as natural selection based on existing allelic variation at particular genetic loci in populations." (Meyer and Van de Peer, 2003). Instead, he believed that genome duplication provided the fodder for major evolutionary change. Although Ohno's idea is widely (though not universally) held today, he was ridiculed by some in the scientific community for rejecting the capabilities of Darwinian evolution. We might add, that Ohno's idea was published in a book, not a peer reviewed journal. We could discredit his ideas on that count also. Today, the 2R hypothesis is still controversial having vigorous adherents as well as detractors but that is as it should be, not squashed by an authoritarian regime.

In a similar vein, we can look at the immunological big bang. In the transition between agnathans (lampreys) and gnathostomes (sharks and above) we observe the sudden appearance of the combinatorial immune system. In lampreys no combinatorial immunity is present (the B and T cell system) along with associated organs (thymus and spleen). If one looks at specific genes central to generating antibody diversity (the Rag1 and Rag2 genes) we find they are absent from lampreys and lower organisms but present in sharks and all higher organisms that have the combinatorial immune system. Furthermore, we find no recognizable precursor to the major histocompatibility complex (MHC) genes in organisms below sharks. Given Darwinian assumptions, we might assume that Rag 1 and 2 evolved by mutation and natural selection from precursors in lower animals. In reality, the evidence indicates that Rag 1 and 2 are homologous to bacterial transposases (although they are not homologous to each other). Thus we are left with the explanation that Rag 1 and Rag 2 were derived from two lateral gene transfer events where bacterial genes are somehow introduced into the germline to become expressed in cells of the immune system. Interestingly, these transposase-like genes are not homologous to each other but both are required for the VDJ recombination that generates diversity of T cell receptors and antibody. This is not the end of the story since the combinatorial immune system has been estimated to involve 1% of the genome.

One has to consider the dangers of starting with a foregone conclusion that is, at the same time, often outside the realm of experimental scrutiny. The danger is that inferences, seeming parallels, extrapolations, and sheer prejudice become substitutes for hard experimental evidence (as if there were no surprises ahead). It gets worse when this mode of substantiation blends into philosophical arguments aimed at leveraging science to disprove the notion of a creator. As an example, we might note how the National Center for Science Education (NCSE) parrots an argument, originally given by Richard Dawkins, on the 'poor design' of the inverted retina. The essence of the argument is that no good designer would do something as silly as design the retina with inverted photoreceptors such that light has to pass through the wiring and accessory cells before intercepting the photosensitive rods and cones. The inversion of photoreceptors IS the basis for their unmatched performance which in terms of combined sensitivity, speed, resolution, contrast and noise characteristics surpasses anything we can make today. Inversion of the

photoreceptors is what places them as close as possible to the rich blood supply which, in turn, is essential for maintaining the high metabolic rate that underlies their extraordinary sensitivity to light. But rather than promote the real science of the photoreceptors, the NCSE promotes a shoot from the hip argument about 'poor design.'

We do not denigrate the research and teaching of evolution. Rather we are excited about the dramatic discoveries that are being made, some of which open up new vistas in thinking about the history of life. We oppose the idea that this history be made to look as if it can be shoehorned into a simple mechanism that is beyond question. To suggest that any area of science is beyond question is not only unscientific but antiscientific.

We conclude by quoting from an article by James Shapiro entitled "Genome System Architecture and Natural Genetic Evolution in Evolution" (Annals of the NY Acad of Sci . 870:32). He writes:

"In summary, as we approach a new century, molecular genetics has provided us a more detailed view of the genome and revealed previously unsuspected cellular capabilities for genome restructuring. These molecular insights lead to new concepts of how genomes are organized and reorganized, opening a range of possibilities for thinking about evolution. Rather than being restricted to contemplating a slow process depending on random (i.e. blind) genetic variation and gradual phenotypic change, we are now free to think in realistic molecular ways about rapid genome restructuring guided by biological feedback networks."

James Shapiro suggests we are free to think in new ways about evolution, ways that involve criticisms of the old paradigms of random (i.e. blind) genetic variation and gradual phenotypic change.

Over the years many students have been attracted to careers in science by the intellectual stimulation and personal satisfaction in being able to investigate the natural world in an open, honest and free manner. We contend that closing the door for scientific dissent to any theory not only hinders true progress but also may regrettably discourage students from entering an enterprise where an authoritarian dogma is maintained.

Martin Poenie
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Molecular Cell and Developmental Biology
University of Texas at Austin

Thomas Milner
Associate Professor
Biomedical Engineering
University of Texas at Austin

Texas State Board of Education Presentation

September 10, 2003

I am a registered Professional Engineer in the State of Texas. I am here because I have five children in grades one through eight who attend public schools in Texas. I volunteer in their elementary school science lab and I am also a substitute teacher at their schools.

Many things from the past that are currently known to be scientifically incorrect, but still being taught to our students.¹

Last year, while my son was in his seventh grade science class,² his teacher asked the class, "What do all animals have in common?" Many students gave good responses. Then she said, "I know of a similarity that you have probably never thought of." She showed the class this sketch of a human embryo [Illustration 1]³ and she stated, "When you were in this stage of development, you and other vertebrates had "gill slits", like those shown in this drawing."

The sketch is part of Ernst Haeckel's drawings, published between 1866 and 1874. [Illustration 2]^{3,4} In 1874, Wilhelm His, Sr. found them to be inaccurate and fraudulent.^{5,6} [Illustration 3]^{7,8} You are seeing a comparison of Haeckel's sketches and actual photographs of embryos.

Human, mammal, bird and reptile embryos don't have "gill slits" and do not go through a "fish stage" of development. You never had DNA instructions for gills, nor the type of blood vessels designed to absorb oxygen from water.^{9,10}

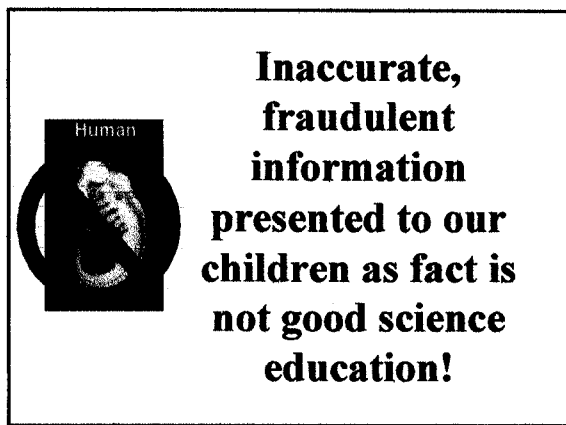
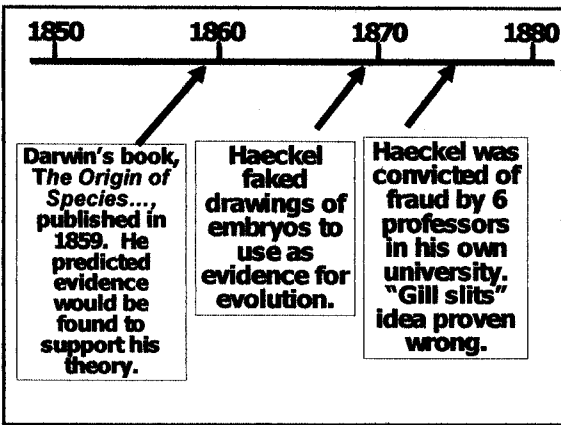
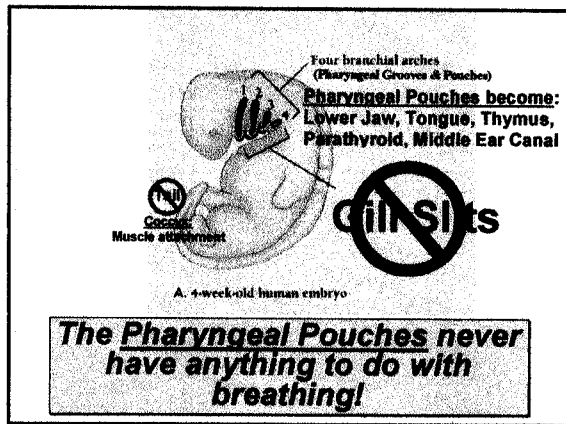
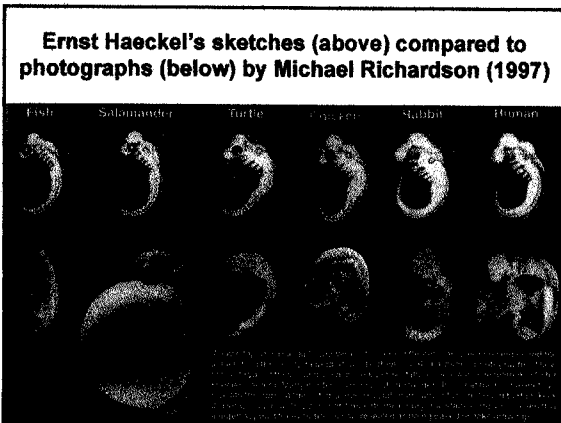
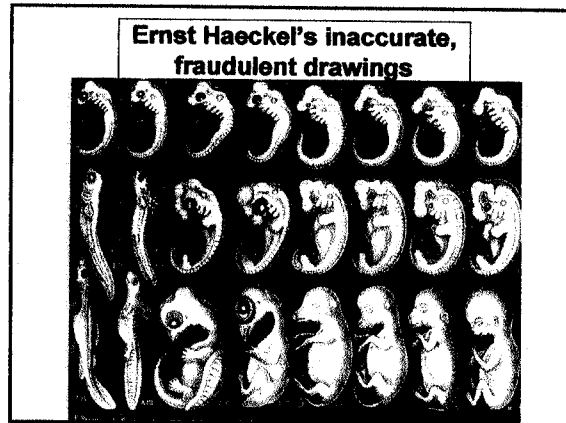
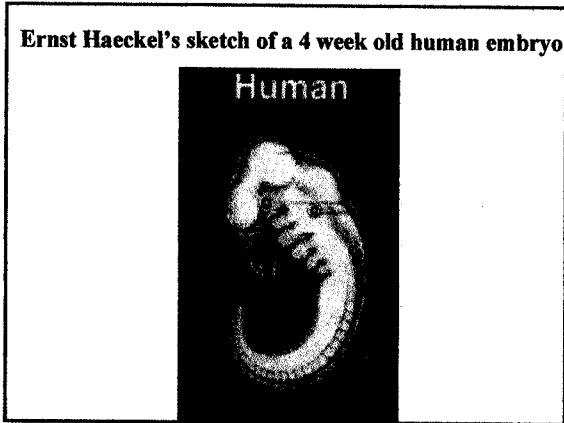
When you were in the embryonic stage, [Illustration 4]^{9,10} you had wrinkles in your skin which became your pharyngeal grooves and pouches. These then developed into essential parts of your body, like your lower jaw, tongue, thymus gland, parathyroids, and middle ear canals.¹⁰

Charles Darwin published *The Origin of the Species*, in 1859. He predicted that evidence would be found that supports his theory. Ten years later, Ernst Haeckel began publishing fraudulent drawings of embryos to support Darwin's theory. In 1874, Haeckel was convicted of fraud by his colleagues.⁶ The idea that humans had "gill slits" was proven wrong over 100 years ago! Exposure of Haeckel's fraud has been published many times in the last 100 years in the peer-reviewed literature.^{1,7,9}

Unfortunately, during this same time period, Haeckel's sketches have been published in many biology textbooks.

The sixth edition *Biology* textbook by Raven and Johnson that you are considering has sketches of embryos in Figure 21.16 on page 450, which reads "Our embryos show our evolutionary history. The embryos of various groups of vertebrate animals show the features they all share early in development, such as gill slits and a tail." Inaccurate sketches of embryos that are very similar to Haeckel's sketches are also found in Figure 60.18 on page 1229 along with a discussion of embryology as proof of evolution.¹¹

Inaccurate, fraudulent information presented to our children as fact is not good science education! I am asking you to follow the law, follow TEK 3(A), and to remove the fallacies from my children's science textbooks.



can be found in other fields of biology.

The Anatomical Record

Much of the power of the theory of evolution is its ability to provide a sensible framework for understanding the diversity of life. Many observations from a wide variety of fields of biology simply cannot be understood in any meaningful way except as a result of evolution.

Homology

As vertebrates evolved, the same bones were sometimes put to different uses. Yet the bones are still seen, their presence betraying their evolutionary past. For example, the forelimbs of vertebrates are all homologous structures, that is, structures with different appearances and functions that all derived from the same body part in a common ancestor. You can see in figure 21.15 how the bones of the forelimb have been modified in different ways for different vertebrates. Why should these very different structures be composed of the same bones? If evolution had not occurred, this would indeed be a riddle. But when we consider that all of these animals are descended from a common ancestor, it is easy to understand that natural selection has modified the same initial starting blocks to serve very different purposes.

Development

Some of the strongest anatomical evidence supporting evolution comes from comparisons of how organisms develop. In many cases, the evolutionary history of an organism can be seen to unfold during its development, with the embryo exhibiting characteristics of the embryos of its ancestors (figure 21.16). For example, early in their development, human embryos possess gill slits, like a fish; at a later stage, every human embryo has a long bony tail, the vestige of which we carry to adulthood as the coccyx at the end of our spine. Human fetuses even

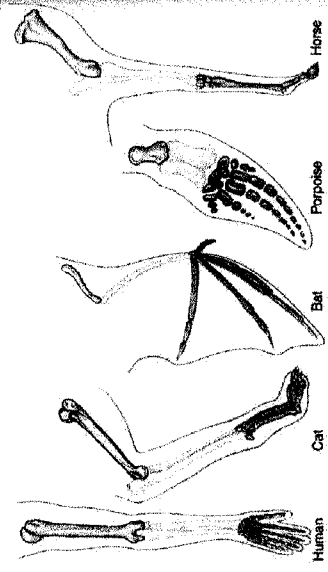


FIGURE 21.15 Homology among the bones of the forelimb. Although these structures show considerable differences in form and function, the same basic bones are present in the forelimbs of humans, cats, bats, porpoises, and horses.

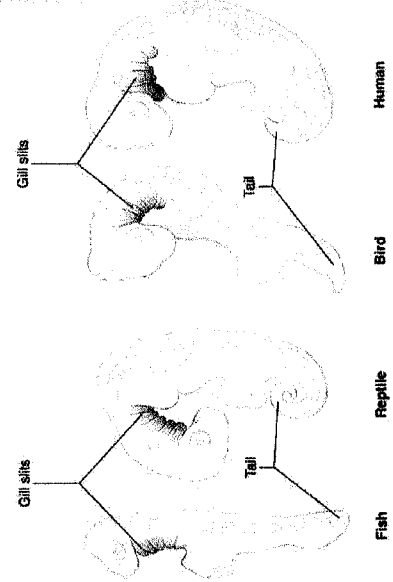


FIGURE 21.16 Our embryos show our evolutionary history. The embryos of various groups of vertebrate animals show the features they all share early in development, such as gill slits (in purple) and a tail.

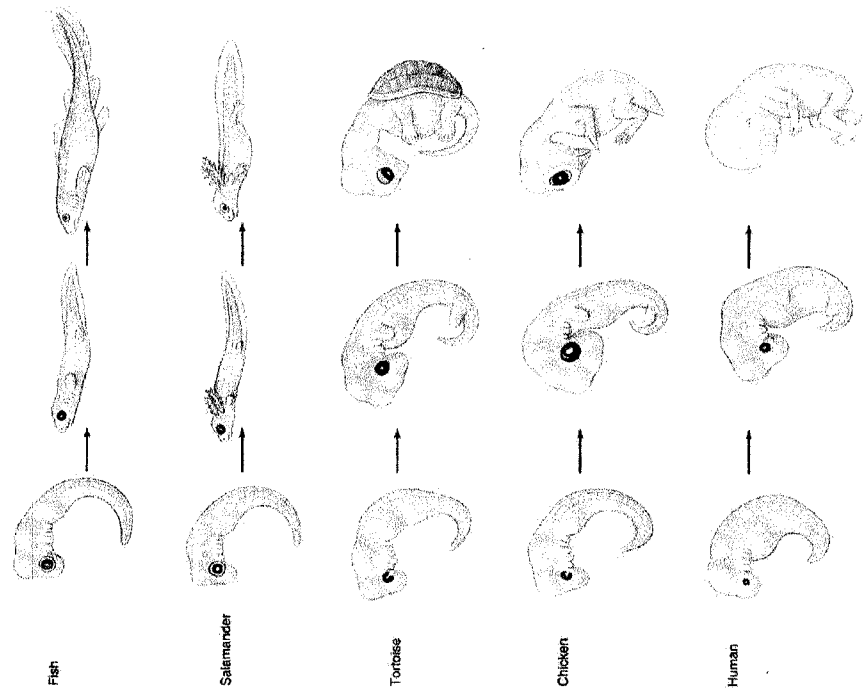


FIGURE 60.18 Embryonic development of vertebrates. Notice that the early embryonic stages of these vertebrates bear a striking resemblance to each other, even though the individuals are from different classes (fish, amphibians, reptiles, birds, and mammals). All vertebrates start out with an enlarged head region, gill slits, and a tail regardless of whether these characteristics are retained in the adults.

additional steps in the developmental journey. This hypothesis, proposed in the nineteenth century by Ernst Haeckel, is referred to as the "biogenic law." It is usually stated as an aphorism: *ontogeny recapitulates phylogeny*; that is, embryological development (ontogeny) involves the same progression of changes that have occurred during evolution (phylogeny). However, the biogenic law is not literally true when stated in this way because embryonic stages are not reflections of *adult* ancestors. Instead, the embryonic stages of a particular vertebrate often reflect the *embryonic* stages of that vertebrate's ancestors. Thus,

the pharyngeal slits of a mammalian embryo are *not* like the gill slits its ancestors had *when they were adults*. Rather, they are like the pharyngeal slits its ancestors had *when they were embryos*.

Vertebrates seem to have evolved largely by the addition of new instructions to the developmental program. Development of a mammal thus proceeds through a series of stages, and the earlier stages are unchanged from those that occur in the development of more primitive vertebrates.

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Notes and References:

1. Wells, Jonathan, Ph.D. (Molecular Biology from the University of California at Berkeley) in an article in *American Biology Teacher*, the leading peer review journal for Secondary School biology teachers.
2. At Space Center Intermediate School in the Clear Creek Independent School District, Spring, 2003.
3. Ernst Haeckel, *Anthropogenie*, 1874.
4. Ernst Haeckel proposed the theory that the human embryo undergoes stages of "evolution" as it develops. He also claimed that "gill slits" were indicative of a "fish stage", and a "tail" was indicative of a "monkey stage". Haeckel called this process the "Biogenetic Law" (or the "law of recapitulation"). It has been proven to be completely false.
5. Wilhelm His, Sr. was a professor of anatomy at the University of Leipzig.
6. Adapted from: Ian Taylor, *In the Minds of Men*, TFE Publishing, Toronto, 1984, p.276, 475, which references Wilhelm His, *Unsere Korperform*, C. W. Voegel, Leipzig, 1874.
7. In 1997, Michael Richardson, a lecturer and embryologist at St. George's Hospital Medical School in London, published an article that concluded that the drawings made by Ernst Haeckel were so inaccurate that they could not possibly have been done from real specimens. Michael Richardson *et al*, *Anatomy and Embryology*, 196(2):91-106, 1997.
8. Photographs by Michael Richardson, 1997.
9. Evolutionist Stephen J. Gould has said, 'Both the theory [of recapitulation] and 'ladder approach' to classification that it encouraged are, or should be, defunct today.' 'Dr. Down's Syndrome', *Natural History*, 89:144, April 1980.
10. <http://www.columbia.edu/itc/hs/medical/humandev/Slides/HNPOU.PDF>
<http://anatomy.med.unsw.edu.au/cbl/embryo/Notes/head.htm>
11. Peter H. Raven and George B. Johnson, *Biology*, sixth edition, McGraw-Hill.

Textbook Reviews for State of Texas: High School Science Books
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Distinguished Professor of Mechanical Engineering
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My scientific training is in Materials Science and Engineering and a considerable part of my professor work has been in polymer science and engineering. I co-authored "The Mystery of Life's Origin: Reassessing Current Theories". My comments are specific to the discussions of the origin of life in the textbooks.

1. In general the books give the impression that we know how to make the building blocks of life such as amino acids. They further give the impression that the assembly of these into polymer chains is relatively straightforward. Finally, they leave the impression that any old sequence of building blocks will somehow give biological function.
2. The Miller-Urey experiments which all the books discuss triumphantly as the solution to the production of building blocks was done with an atmosphere of ammonia, methane, and hydrogen. We know today that the early earth's atmosphere contained at best trace amounts of these gases. When one uses nitrogen, water vapor, and carbon dioxide, the yields of useful building blocks is nil. Try to make even small yields of building blocks with atmospheres is still so challenging that it is an area of current research, with success coming only with the use of extraordinary sources of energy. The books should be more candid about the challenges of making building blocks. Robert Shapiro noted in a recent paper in the Proceedings of the National Academy of Sciences (2000) that making one of the critical bases cannot be done under prebiotic conditions and he claims that the earliest life cannot have been a replicator like RNA.
3. The production of polymer chains to give proteins, RNA or DNA is also challenging. RNA which is often thought to be the best bet for the origin of life appears to be impossible to make under any plausible prebiotic conditions. Reasons for this are clearly summarized by Robert Shapiro in his paper in the 1988 in the journal Origin of Life and Evolution of the Biosphere.
4. Finally, and most importantly, the sequencing of the building blocks like the sequencing of the letters on this page is crucial to biological function. The biological information is crucial to function. Everyone who works in the origin of life area understands this challenge. Yet none of the textbooks seems to hint at the enormous complexity that is essential to give biological function. The problem of getting right sequencing to give even primitive biological function needs to be clearly addressed.

It is such contrast to go to the International Society for the Study of the Origin of Life and then read high school textbooks. It is hard to imagine that we are talking about the same topic. The conferences are very candid about the enormous challenges and difficulties while the textbooks give such a facile treatment of this subject. It is a shame that we can't seem to get this scientific topic treated accurately in the textbooks.