
Reader comments

“Irreducible complexity” or “delightful challenge”?

In the January issue of the *BUMC Proceedings*, Joseph Kuhn, MD, presented his views on evolution in his article “Dissecting Darwinism” (1). In the article, he expresses his personal doubts about contemporary concepts held by most scientists regarding the evolution of life and diverse species on our planet. He offers no alternative explanation, but rather expresses his pessimism that we will ever understand how complex organisms have developed. The essence of his opinion is expressed in his term the “irreducible complexity of cellular systems,” in which he suggests that this issue is just too difficult to understand and that there is no hope that we will ever know how biological systems have evolved.

But one man’s “irreducible complexity” is another man’s “delightful challenge.” Why assume that these issues will never be understood? Look at what has transpired in the time since the discovery of the structure of DNA by Watson and Crick in 1953. This field is an extremely active area of science, and our understanding of biological processes continues to increase in a logical, iterative, and immensely interesting way. Why be a pessimist about this? What would Ben Franklin think if we magically transported a laptop computer or cell phone back to the 18th century? Wouldn’t that be a bewildering, complex experience? Do you think he could be convinced that this would be the work of human hands in less than three centuries?

In his somewhat rambling narrative (with unnecessary tangents on John Hunter—who briefly confounded our understanding of venereal diseases—and the activities of the Texas State Board of Education in 2010), a number of misconceptions and factual errors were offered by Kuhn. First, many of us were taught the Miller and Urey experiments in high school biology, which demonstrated that complex molecules could be generated from simple ones present in the primordial seas when subjected to pulses of energy, such as ionizing radiation or electrical storms, both ubiquitous in the early life of the earth. So, what were the earliest chemical precursors of life? Since the mid 1980s, evolutionary biologists have realized that RNA—and not DNA—was the likely initial macromolecule of life, a point noted by Kuhn but apparently not completely comprehended. RNA is unique by having the ability to self-replicate, but it also has intrinsic enzymatic activities and can catalyze chemical reactions. Given enough time (and most scientists estimate that the earth is about 4.5 billion years old), it is not surprising that somewhere in the primordial soup of our planet, a variety of complex compounds would spontaneously form. Miller and Urey did not know the full range of compounds that would appear under these circumstances—it was 1953! However, they provided hard evidence that complex compounds could evolve from simple ones in the soup. Again, given immense amounts of time, and the huge “test tube” involved, some of the RNA precursors would eventually

polymerize into ever larger macromolecules with self-replicating ability in the RNA world. It’s not that complicated.

The origin of the biochemical precursors of life did not depend upon a single electrical spark that gave rise to a fully replicating DNA strand or a completely functioning genome. Rather, this occurred over millions of years due to *cooperation* between strands of nucleic acids, some facilitating strand extension, others facilitating replication. The early RNA strands would replicate simply because it was a chemical possibility. It’s just chemistry. In fact, the ability of RNA strands to spontaneously replicate is reasonably accurate for strands up to 100 ribonucleotide units long. For RNAs to grow longer may seem difficult (or “irreducibly complex”) until you take into account that cooperation takes place between RNA strands in what might be called the “primordial pizza” of life (2), which takes into account that these molecules were not necessarily randomly scattered throughout the early oceans. One strand of RNA can catalyze other reactions through chemical cooperation. Cooperation would positively select for increasingly complex molecules. The intrinsic chemical properties of these macromolecules, plus natural selection, are the driving forces in this wondrous process. Eventually, randomly growing nucleic acid chains would evolve into what we would recognize as primitive genes, and the combination of genes on a single nucleic acid chain would reduce the randomness of their distribution, further increasing the chances for positive interactions among these macromolecules. The issues of biologic cooperation are discussed in detail in Martin Novak’s *Super-Cooperators* (2) and Mark Ridley’s *The Cooperative Gene* (3), both highly recommended for scientific optimists.

Taking the concept of cooperativity further, the organization of complex genomes takes advantage of additional layers of regulation through which a minor change in one genetic element can broadly influence the expression of many other genes. The evolution of highly complex organs such as the eye—an issue that bothered Newton, in fact—became less mysterious when it was discovered that there are classes of genes that can orchestrate the expression of dozens or scores of other genes simultaneously. For example, homeobox genes control the differentiation fates of tissues and organs by influencing the expression of multiple other genes that act in concert with one another to direct complex cellular behaviors. Similarly, microRNAs interact with the untranslated regions of messenger RNAs and can influence the stability and expression of >100 target genes. The human genome has >1000 microRNAs. Increasing the expression of just one of these “master genes” can have an enormous, coordinated effect. One of the insights gained by sequencing the human genome was not that we have more genes than other organisms—we don’t. However, we have a very large number of genes that are involved in the regulation of many others, which can orchestrate complex biological processes.

One way to make complex issues seem “irreducibly complex” is to misunderstand or willfully misstate the data involved in the complexity. Kuhn explores the genetic relationship between humans and chimps and makes the erroneous claim that the similarity between human and chimp genomes is 70% to 75% (1). Moreover, the paper cited to support this actually reported that the number of single nucleotide substitutions between the chimp and human is actually 1.23% (making the degree of similarity over 98.7%! (4). This means that there are 35 million single nucleotide differences, which may seem to be a large number until you divide that by the 3 billion base pairs in our genome and recognize that this occurred over 30 million years of evolutionary time. There are additional differences in the noncoding repetitive sequences between humans and chimps (i.e., in the historically disparaged “junk DNA”), just as there is a large amount of diversity in these sequences between different humans; these are not thought to be of major functional significance. These polymorphisms at repetitive sequences are so common in humans that forensic science can use them to identify each human individually. None of the 67 authors of the chimp genome article is likely to support any of Dr. Kuhn’s interpretations. Also, in the interests of accuracy, the human genome consists of 2.91 billion base pairs (5), not 5 billion (1).

Some of the complexity is reduced by getting the facts right. In the words of Alexander Pope from *An Essay on Criticism*:

A little learning is a dang’rous thing;
 Drink deep, or taste not the Pierian Spring.

So, what it comes down to is whether you think that evolutionary biology is “irreducibly complex,” too difficult for anyone to ever comprehend and take a pessimist’s view, or embrace the delightful challenge of learning about the biology of life. Frankly, it’s a fool’s errand to make a case that anything is permanently beyond human comprehension. As for myself, I get considerable enjoyment out of each step forward in the scientific literature and find the journey worth all the effort.

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2. Novak MA. *SuperCooperators. Altruism, Evolution, and Why We Need Each Other to Succeed.* New York: Free Press, 2011.
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Further discussion on Darwinism

The paper on evolution by Joseph A. Kuhn, MD, can only be referred to as the ramblings of a religious creationist, who

believes that god created life, and Darwinian evolution is a fraud. The published paper has nothing at all to do with medical science, but is a thinly veiled, fundamentalist religious attempt to get unscientific biological “facts” into the peer-reviewed literature.

If the sadly misguided Dr. Kuhn had bothered to thoroughly read some of the many real scientific references he cites . . . , especially the landmark court ruling *Kitzmiller v Dover*, he would have found that all his presented “evidence” against evolution by natural selection has been thoroughly debunked by real scientists time and time again. Dr. Kuhn is doing nothing but reheating intelligent design talking points—which science and the law agree are, in fact, religious creationism and a far, far cry from real science.

—DENNIS HANSEN, PhD,
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 and Environmental Studies,
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Dr. Kuhn is breathtakingly ignorant of basic facts surrounding the data used to support the conclusion that life has evolved, and he is amazingly ignorant of what modern biologists actually think about the origin of life and how evolution works. Dr. Kuhn should at least have had to accurately characterize the state of the art of evolutionary thought. Just as one basic example: his Figure 3 bears no resemblance to what the fossil record says. First, it should have zoomed in to look at roughly 60 million years around the Precambrian-Cambrian boundary (instead of encompassing 600 Myr to make things look as instantaneous as possible), and second, he should have based his figure on one that reflects actual data. The fossil data show that most phyla progressively appear over at least 20 to 30 million years before and after the Precambrian-Cambrian boundary. And really, these data just reflect the first appearances of many phyla of preservable hard parts (as opposed to their genetic differentiation). So, when you add estimates for genetic divergence times derived from molecular clocks, the origin of many of the phyla is pushed back further into the Precambrian, over an even more extended period of time. Instead, Dr. Kuhn avoided the primary literature, or any literature produced by actual experts in paleontology, and drew his Figure 3 from an evangelical website hostile to evolution.

One thing I would strongly emphasize is that evolution is a theory that allows scientists to make lots of predictions: about what will be found in the fossil record, about genes we might expect to find in distantly related organisms, and so on. It is the success of evolution in making predictions about what we will find in the future that testifies to the correctness of the conclusion that all life has evolved from earlier common ancestors. If you want examples appropriate for the medical community, how about the Nobel Prizes awarded for medicine for research that never would have been done without evolution proposing that we can look in other organisms for genes that we can do experiments on that would be ethically impossible in humans. Here are a few examples:

1995: Genetic controls of embryonic development in humans (et al.) as derived from the study of fruit flies

- 2001: Discovery of key compounds controlling cell division in all eukaryotes (including humans) as derived from yeast and sea urchins
- 2002: Genetic regulation of organ development and programmed cell death in nematodes, which also applies to humans
- 2006: RNA interference—gene silencing by double-stranded RNA, based on nematodes, again applicable to humans

Virtually any research done on other organisms with a view toward understanding human biology has as its starting point the evolutionary conclusion that humans are biologically related to the rest of life on earth, that we are not a completely separate creation. In contrast, as you would gather from Dr. Kuhn's summary of intelligent design arguments, intelligent design argues that every organism is too horribly complex to understand except in the context of an intelligent designer designing it. An intelligent design researcher would calculate the astronomically terrible odds that any given aspect of another organism would be so similar to humans as to be worth researching for its potential medical benefit. Thus, no research would get done.

Dr. Kuhn's mischaracterizations of the prebiotic molecules research is decades out of date, and his material on transitional fossils in the fossil record is simply an argument from ignorance: I can't possibly imagine how B could evolve from A; therefore, it didn't.

—CHARLES E. JONES, PHD,

Department of Geology and Planetary Science,
University of Pittsburgh, Pittsburgh, Pennsylvania

Dr. Joseph Kuhn's recent paper, "Dissecting Darwinism," cites the title of Charles Darwin's book as *On the Origin of the Species* whereas the actual title of this book is *On the Origin of Species*. This common misconception is probably important since the former suggests a theory concerning the origin of life, whereas the latter is primarily concerned with divergence of species in the process of adaptation and natural selection.

Darwin himself attempted to clarify this distinction in the conclusion to later editions (2 through 6) of this book, which ends with the following statement:

There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone circling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved.

—JOSEPH M. GUILYARDO, MD

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DEAR DR. KUHN:

Your article, "Dissecting Darwinism," published in the January 2012 issue of the *Baylor University Medical Proceedings*, was astonishing for its clarity and its coherent analysis of a widely accepted theory whose advocates, such as myself, never knew the questions to ask to challenge its cohesiveness. I have been

awakened to the cellular and molecular aspects that must be understood before sweeping concepts of natural selection are used to postulate the very beginning of life on this planet. Having read your paper, I shall be forever changed. I had no idea that you were a student of this science.

This paper contains such substance that eclipses the usual papers published or presented at meetings. Congratulations on a job well done.

—JAY HOPPENSTEIN, MD, FACS
Dallas, Texas

Response from Dr. Kuhn

I appreciate the opportunity to address the reader comments regarding my article, "Dissecting Darwinism."

There are a few overarching issues. First, the scrutiny or concerns about certain aspects of Darwinian evolution belong to many eminent scientists. In fact, over 800 PhD scientists have signed a letter stating their concerns about the full scope of Darwinian evolution (1). Second, there is no dispute with many aspects of Darwinian evolution, such as natural selection and variation within a species (most of the examples in Dr. Dimijian's article). Third, a few absolute stumbling blocks remain for even the most impassioned Darwinists: the origin of DNA, the origin of the cell, and the issue of irreducibly complex systems that require numerous essential proteins to accomplish a function.

Response to Dr. Boland

1. Contrary to Dr. Boland's assessment, I have not expressed "pessimism that we will ever understand how complex organisms have developed," nor that "there is no hope that we will ever know how biological systems have evolved." This is an equivocation on the word "complex." Irreducible complexity is a testable, scientific term that does not mean that something is "too complex to understand," as proposed by Dr. Boland. It is important for the reader to understand that many cellular functions or systems cannot be built through step-by-step mutational processes, since the intermediate versions are not functional for the designated purpose and offer no survival advantage. The concrete examples of irreducible complexity in my article were too numerous to mention here (2). However, his examples of the laptop or cell phone represent "systems" that did not likely arise one step at a time, nor did they arise through a natural process. I agree that Ben Franklin would be surprised to see a laptop, though I suspect he would not imagine that it arose from boron, polysilicon, gold, and lithium over billions of years.

2. The origin of DNA and the inherent coding information is a major obstacle for step-by-step Darwinian explanations. Although newspapers and high school biology texts often assert (without providing detail) an RNA-world hypothesis, there are strongly dissenting scientists who argue that the essential RNA polymerase enzyme does not form by itself (3). Stephen Meyer listed additional insurmountable obstacles to an RNA-first hypothesis: 1) the inability to account for the necessary

nucleotides or ribose molecules (they don't form spontaneously), 2) the nonfunctional early ribosome, 3) the nonexistent RNA translation and coding system, and 4) the origin of the inherent genetic information. He specifically stated, "RNA-first theories, like their predecessors, had failed to explain the central question of the origin of the 'information' that living cells require." As William Dembski noted, "The origin of information is not a problem of chemistry. Chemistry can be a carrier of information, but it cannot be its source" (4).

Dr. Boland stated: "Given enough time, it is not surprising that somewhere in the primordial soup, a variety of complex compounds would spontaneously form." But modern geochemists doubt that a "primordial soup" existed. He made the mistake that origin-of-life researcher David Abel warned against: "Mere possibility is not an adequate basis for asserting scientific plausibility," and "just because a hypothesis is possible should not grant that hypothesis scientific respectability" (5). In this case, the odds of producing a self-replicating RNA molecule go beyond the available probabilistic resources.

My article, "Dissecting Darwinism," simply suggested that students and doctors have a right to know that the mechanism proposed by Dr. Boland is not universally supported. Even ardent evolutionists admit that the origin-of-life research is "completely in the dark" (6).

3. Dr. Boland notes the "homeobox genes" as key regulatory genes that orchestrate the expression of dozens of other genes simultaneously. Awareness of many functions of noncoding DNA, including the micro RNA noted by Dr. Boland, has rapidly increased over the past 5 years. Surprisingly, he noted, "These are not thought to be of major functional significance." However, as we learn more about the role of the human genome, it is exciting and optimistic that we are learning how this remarkable strand of approximately 5 billion nucleotides (2.5 billion base pairs) is responsible for everything, such as development, repair, inhibition, replication, coordination, and interaction with all other biological systems. The DNA also has layering aspects, which allow for coding of more than one protein/RNA molecule during the same transcription. In any case, mutations in homeobox genes cannot explain the origin of body form. As one author in *Nature* stated, "Homeobox genes are selector genes. They can do nothing if the genes regulated by them are not there. . . . It is totally wrong to imply that an eye could be produced by a macromutation when no eye was ever present in the lineage before" (7).

4. Finally, Dr. Boland's comment that the characterization of 70% to 75% similarity between human and chimp genomes "willfully misstated the data" is not consistent with the published literature. First, it is important to acknowledge that nearly all DNA is now shown to directly code for either protein or RNA (responsible for numerous regulatory, differentiation, replication, or structural actions) (8). In other words, we must consider the entire human genome and not presume that some of the human genome is useless. The alignment of 2.4 billion nucleotides (chimp) compared to 3.16 billion nucleotides (human) has been calculated to represent an approximate 76% similarity, according to geneticist Richard Buggs (9, 10). A 2007 article in

Molecular Biology and Evolution stated: "For about 23% of our genome, we share no immediate genetic ancestry with our closest living relative, the chimpanzee. We conclude that about 1/3 of our genes started to evolve as human-specific lineages before the differentiation of human, chimps, and gorillas took place" (11). Finally, an important article in *Nature* in 2010 revealed the flaws in the earlier 2005 human-chimp draft report and presented the most species-specific analysis of the Y chromosome (12). The authors found only a 70% similarity. As far as looking at specific genes, the chimp and human Y chromosome had a dramatic difference in gene content of 53%. Regardless of the formula, it should be remembered that even a conservative estimate of 30 million DNA changes from chimp to human would require almost 60 beneficial mutations per generation (20 years) in order to account for a direct lineage from chimp to man in 10 million years. Based on a generation time of 20 years, Haldane's dilemma predicts that only a few thousand mutations could become fixed into an evolving population during the time period (10 million years) from chimp to man.

Response to Dr. Hansen

Dr. Hansen chose to use ad hominem arguments, charging that I am a "religious creationist." His attacks are inaccurate, and any aspersions to my religion are irrelevant, as I did not make any theological arguments. I am just a surgeon with experience in molecular medicine and with respect for objective scientific inquiry. The articles I cited are from mainstream scientific sources. Some Darwinists have a certain degree of indoctrination that makes it difficult for them to accept papers that are critical of their "paradigm." These papers have raised specific concerns about the ability of Darwinian evolution to explain (a) the origin of DNA, (b) the origin of the cell, and (c) the inability of irreducibly complex systems to form in a step-by-step fashion.

Response to Dr. Jones

The letter from Dr. Jones, a geologist, wrongly assumes that the paper was promoting intelligent design. No ideological alternative to Darwinian evolution was offered, though scientifically valid arguments have been proposed by theists, agnostics, and atheists who independently question whether stepwise mutation and natural selection could account for DNA, the cell, or irreducibly complex systems (3, 4, 13, 14). In addition, he is incorrect in his assessment of the current state of affairs regarding prebiotic molecules research. I would acknowledge an enormous amount of modern research into molecular chemistry, hydrothermal vents, lipid formation, and many aspects of prebiotic science. But many of these ideas have problems. To take hydrothermal vents, for one, they would serve as a poor location for the origin of life to take place since their high heat would quickly degrade any organic molecules. As William Dembski noted, "Most of origin-of-life research is as relevant to the real problem of life's origin as rubber-band powered propeller model planes are to the military's most sophisticated stealth aircraft." In other words, there is not a single paper that has demonstrated the autoformation of DNA, RNA, or a functioning cell. The

paper “Dissecting Darwinism” simply summarized the facts and controversy.

Dr. Jones’ argument regarding the fossil data being expressed graphically in a manner that emphasizes the abrupt formation of most major animal phyla is accurate and an excellent observation. In addition, molecular clocks have been shown to be a variable and unsteady process, requiring a host of assumptions that are not widely accepted, including the assumption that the organisms are related in the first place. As one paper in *Annual Review of Earth and Planetary Sciences* recognized, “The second area where molecules and morphology are in serious disagreement concerns the origins of the metazoan phyla. . . . The discord between the two for the animal phyla may be as much as 500 million years,” and concluded, “the idea that there is a universal molecular clock ticking away has long since been discredited” (15). A 2006 article in *Biological Therapy* stated that a “review of the history on molecular systematics and its claims in the context of molecular biology reveals that there is no basis to the ‘molecular assumption’” (16). Moreover, molecular clocks simply assume that any genetic similarity results from common ancestry; they do not demonstrate that is the case. My article indicated that there are paleontologists who feel strongly that the fossil data do not fully support Darwinian evolution. As *Nature* editor Henry Gee commented, “To take a line of fossils and claim that they represent a lineage is not a scientific hypothesis that can be tested, but an assertion that carries the same validity as a bedtime story—amusing, perhaps even instructive, but not scientific” (17). Thus, the fossil data remain controversial based on abrupt formation of species, less-than-convincing missing links (transitional species), and variable and assumption-laden conclusions of molecular clocks.

The examples of Nobel Prizes in molecular medicine further emphasize the incredible elegance of DNA and actually make it appear even more unlikely that DNA arose through a process of random mutation and natural selection. The inability of mutations to form new DNA or even a single new protein is demonstrated in the real-world experimental stage of bacteria, viruses, and parasites representing hundreds of millions of years of evolutionary study (18).

These letters to the editor have shown the following prediction to be true: As the paradigm is questioned, there will be many who will cry “ignorance and heresy” (2). I believe that it is imperative to allow journals and scientists the opportunity to investigate the inability of Darwinism to explain the origin of life, the origin of DNA, the concept of irreducible complexity, and the controversial fossil evidence for speciation.

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Kudos

The January issue of the *Baylor University Medical Center Proceedings* is the best issue I have read. The medical topics chosen for inclusion in this issue were interesting; however, those article that dealt with subjects of historical content, especially Dr. Kuhn’s article on Dissecting Darwinism, were outstanding.

I was pleased to see that Dr. Fenves has become an associate editor. I remember when he first started practice.

Proceedings is a wonderful journal and a platform for Baylor physicians to publish their work; however, I believe that the inclusion of other authors outside of the Baylor universe adds to the quality of the publication.

I started my general surgical practice at Baylor in 1971 and was chairman of the general surgery department at Presbyterian Dallas at the time of my retirement about 6 years ago. Reading *Proceedings* keeps me in touch with former colleagues and abreast of the progressive advancement of medicine. I know of no other hospital publication in Texas that compares to *Proceedings*.

—Jay Hoppenstein, MD, FACS
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