will serve as a good introduction for high school students or for an introductory course for non-biology majors in college. Those who want more depth to the background information on Darwin's life would do well to read Janet Browne's two volumes on the subject, and those who would like more detail about Darwin's arguments should read a reprint of the first edition of the *Origin*. But the more casual reader will find a reasonably good synopsis of the theory and its more modern developments within the pages of this book. It is to these readers that I recommend this slim volume, with the minor reservations mentioned above.

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Signature in the Cell: DNA and the Evidence for Intelligent Design.

by Stephen C Meyer
New York: HarperOne, 2009. 624 pages.

Reviewed by David W Ussery

The main thesis of Stephen C Meyer's book *Signature in the Cell* — that DNA contains information and that this information could not have evolved but must have been created — is pretty much a warmed-over restatement of a claim that he has been making through his career over the past 20 years. But a lot has happened since then. For the past 10 years, I have been leader of the Comparative Microbial Genomics group in the Center for Biological Sequence Analysis (CBS) at the Technical University of Denmark, studying the flow of biological information in bacterial genomes. When I first started teaching my course on comparative genomics, there were only 8 completely sequenced bacterial genomes to compare. Now, there are over 1000 bacterial genomes to compare. I have been busy investing in building tools and technology to analyze this flood of data, and my small research group has published more than a hundred papers about comparative genomics — and the folks at the Discovery Institute, where Meyer is in charge of the Center for Science and Culture, what have they done? They have had lots of talks and lectures and written several books, and they claim to have produced a smattering of scientific publications, but they seem still to be stuck trying to revive Paley's early-19th-century argument from design.

As the subtitle of *Signature in the Cell* suggests, the book argues that DNA is evidence for the existence of a "mind outside of nature". (Meyer emphasizes repeatedly that this mind does not have to be *God* — just something supernatural and outside the physical universe.) How is DNA supposed to provide evidence for the existence this "mind"? According to Meyer, the most satisfactory explanation of the way in which DNA carries information appeals to the existence of an intelligent designer. But his account is wrong on many levels.

It would take a book at least the same length as Meyer's to explain how far he is from the current scientific consensus. For starters, the origin of the genetic code is not "irreducibly complex" as Meyer implies — in fact, since the 1960s, people have been toying with the idea that early versions of the genetic code contained fewer amino acids based on a 2-letter code, and it is likely that ancient codes contained only a few stable, readily formed amino acids (Higgs and Pudritz 2009). Interested readers should visit PubMed (<http://www.ncbi.nlm.nih.gov/sites/entrez>) and type in the words "genetic code evolution". There were more than 6000 articles there in September 2009). Claiming that DNA was "intelligently designed" is as problematic as similar claims for whole organisms: the patterns and processes of evolution involve extinctions, inefficiencies, and similar features that it is awkward to explain on the "intelligent design" hypothesis.

The methodology of *Signature in the Cell* is based on William Dembski's "design filter": the information flow of DNA in the cell is contingent, complex, and specified. Therefore, Meyer concludes, it is the result of design: *supernatural* design, since "natural means" have been ruled out by the "explanatory filter"). This is presented subtly and intentionally, so as not to wave too many flags that this is actually a book advocating a disguised form of creationism. It is clear, nevertheless, that Meyer wants to convince his readers that if something cannot be explained by our current understanding of natural processes, then it is reasonable to assume a supernatural explanation. This is not how science has been done for centuries, and there is no reason to think that invoking supernatural forces will be a fruitful approach now.

Meyer is adept at disguising his views as scientific, but in fact they are phrased in such a way as to be void of meaning. Take the first of the "dozen ID-inspired predictions" listed in the appendix of the book: "No undirected process will demonstrate the capacity to generate 500 bytes of new information starting from a nonbiological source" (p 496). As I was writing this review, an article in the

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An Inordinate Fondness for Bacteria?

Where is most DNA found, and what does it code for? The human intestinal tract contains more than ten times as many bacterial cells than the total number of *human* cells in the whole body. The total number of bacteria on earth is more than a billion times as large as the number of stars in our universe. According to data in a wonderful table in a recent review article (Kyrpides 2009), if one were to take all the bacterial viruses on the earth, and stretch them out end-to-end, they would be about a hundred million light years in length — a thousand times the length of the Milky Way galaxy. And there is perhaps a thousand times as much bacterial DNA on the planet as viral DNA, meaning that the total length of bacterial DNA on earth is a million times the length of the Milky Way galaxy. So if a theologian were to ask me what I could say about the Creator, based on my knowledge of how DNA is distributed, I would likely paraphrase of the response JBS Haldane and reply, "God must have an inordinate fondness for bacteria."

Journal of Genome Research (Xing and others 2009) described how insertions from a common transposable element in humans (Alu, which makes up about 10% of the human genome) creates about 1 structural variant per 21 births in humans. That is, for every 21 humans born, there is a *new* protein structure created by *random* insertion of this element into the coding region of a gene. This sounds as though it should qualify as generating new information. Does it? I do not know, since what Meyer means by "500 bytes of new information" is left vague and ambiguous, so it is difficult to test.

Another recently published article describes how three new human genes have evolved from non-coding "junk-DNA" (Knowles and McLysaght 2009). Again, new information has been generated, in this case from what appears to be random sequences, but without any rigorous, clearly applicable definition of "new information" on the table for all to see, one cannot tell whether Meyer's prediction has been falsified.

Why would anyone regard Meyer's arguments as persuasive? I suspect that the answer is the fear of the alternative — if life were not created directly by God, then (the argument goes) life is random, meaningless, and pointless. So much is at stake here. Meyer views "materialistic science" and religion as being at war with each other, and in this sense he agrees with Richard Dawkins (and many others). They *both* view the battle as between materialism and religion, with science deciding who wins — the only difference is that Meyer thinks that science can prove God did it, while Dawkins thinks that science can prove there is no God.

But must we choose between Meyer (who in my opinion preaches bad science as well as teaches bad theology) and Dawkins (who is an excellent scientist, but virulently atheistic)? Is there not a third alternative? Is it possible to be both a good scientist and also a good theist? You wouldn't know it from *Signature in the Cell*, which is largely silent about the views of people like Francis Collins (*The Language of God: A Scientist Presents Evidence for Belief*, 2006). Indeed, the views of many scientists and theologians who have no problem reconciling evolution with theism are missing in this book of over 600 pages.

Meyer was slated to testify for the defendants in *Kitzmiller v Dover*, and I was looking forward to read his take on the trial, hoping for some sort of explanation for why Meyer and Dembski pulled out before the trial started. Instead, Meyer argues that the judge is a materialist (p 433). In contrast, the Dover Area School Board lost its case because Judge Jones paid careful attention to the evidence about the nature of science presented to him. He did not blindly accept the evidence one side presented; rather, he saw that it reflected the way that modern science is done. I am surprised that any scientist (as Meyer portrays himself) would have problems with the idea that supernatural explanations do not belong in science. Yet, a large part of *Signature of the Cell* is a long argument that someone or something acting *outside* the laws of nature is responsible for DNA.

The scientific sterility of ID is evidence that Judge Jones was right. In "The theory of intelligent design: A briefing packet for educators" (Discovery Institute 2007), published after the *Kitzmiller* decision, it is claimed that the idea that ID has no publication record is wrong, and a list is given of "selected peer-reviewed publications that directly support intelligent design" — containing only six publications. To put this in perspective, there are more than 19 million papers listed in PubMed (over 276 000 on evolution alone). To argue that ID be taught as science, there must be at least some "science" to teach. It is as if the ID people want to put in five minutes' work and get paid for a year!

A promotional website claims:

> unlike previous arguments for intelligent design, *Signature in the Cell* presents a radical and comprehensive new case, revealing the evidence not merely of individual features of biological complexity but rather of a fundamental constituent of the universe: information" (<http://www.signatureinthecell. com/about-the-book.php>).

The claim for a "radical and comprehensive new case" is simply not truthful. In fact, there is *nothing* new here: the book contains little more than a rehash of old creationist arguments, many clearly borrowed from Meyer's previous work. The argument from personal incredulity is the theme of this book, repeated *ad nauseam*. In science trust and integrity are important; in my opinion, the history of lies, error, and lack of scientific productivity from the ID movement does not inspire trust.

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