Signature in the Cell – by Stephen C. Meyer

Book summary by Jeff Stauffer

Chapter 1: DNA, Darwin, and the Appearance of Design

In this opening chapter, Meyer introduces us to some of the topics to be discussed in greater detail later on, as well as providing a brief account of how he started his involvement in the intelligent design (ID) movement. With the advent of the discovery of the structure of DNA by James Watson and Francis Crick in the 1950s, the "appearance of design" became a hotly debated issue. As the DNA structure contained an immense amount of information, the science of DNA led to a widening interest in information theory. This raises philosophical questions regarding the question of what information is, where it comes from, and how one knows it when one sees it!

Meyer concludes this chapter with his story as a young physics and geology student working for an oil company, and how questions of life's origins spurred on his interest in the philosophy of science. He later went on to receive his PhD in philosophy of science on the topic of origin-of-life biology.

Chapter 2: The Evolution of a Mystery and Why It Matters

Questions concerning where life came from (as well as what "life" is in the first place) are not new to our generation. As Meyer points out, from the time of the ancient Greeks, people's opinions have generally fallen into two camps: that ultimate reality consists of either mind or matter. Either all matter comes from and was shaped by an intelligent being (i.e. mind), or physical matter or energy is all that exists. The implications of this mystery are so profound that they permeate every aspect of humanity.

Meyer walks us through some of the theories concerning a scientific investigation of life leading up to the DNA discovery. He discusses the very influential Russian Aleksandr Oparin and his work on theories of the cell and the origin of life. The chapter concludes with the Miller-Urey experiment from 1952, where Stanley Miller attempted to reproduce how life began on Earth. His experiment involved mixing various gases believed to be present in the early Earth atmosphere, along with boiling water and electricity to simulate lightning. Upon discovering the creation of amino acids in the mix, it was heralded as a major breakthrough, with a theory of life's origins now within reach. However, his findings have since been discounted due to several incorrect assumptions about ancient conditions on Earth.

Chapter 3: The Double Helix

Here, Meyer tells the story of how Watson and Crick stumbled their way to discovering the structure of DNA. Their brief paper (only 900 words long) appeared in *Nature* magazine in 1953, and it "revolutionized biology." They wrote how the structure of DNA allowed for many different permutations, but also particular sequencing. This sequencing, they wrote, carries "genetic information." This idea of information will be central to Meyer's developing thesis.

Chapter 4: Signature in the Cell

Understanding some fundamentals in information theory is crucial to grasping how closely the analogy of information applies to DNA. Meyer begins with a short overview of Claude Shannon's work on this topic from the 1940s. Shannon attempted to measure the amount of information stored in a system. In the case of the English language, the sentence "I believe it is raining outside" carries more information than the sentence, "I am wet," because it contains more characters. A second concept is introduced at this point: that of *specificity*. Something that is *specified* is not only improbable, but also has function or message-bearing capacity. This is what separates a long string of random letters ("jh liqns nn vc qoas k lponqa") from Shakespeare's *Hamlet* ("methinks it is like a weasel") even though both are the same length and can store the same amount of information. *Hamlet* is not only improbable, but also conveys meaning, and is therefore *specified.* Once you apply these concepts to DNA, a direct correlation is apparent. Francis Crick wrote on this in the 1960s, realizing that DNA requires strict rules regarding sequencing of proteins and amino acids, just like we have rules of grammar in the English language. This is "profoundly mysterious," writes Meyer, realizing the direct analogy between DNA, an English poem, or even computer software. He goes on to point out that this level of specified information is not found anywhere in the natural world, apart from human involvement.

Chapter 5: The Molecular Labyrinth

Chapter five is a fairly technical illustration of how DNA directs the synthesis of proteins through stages including transcription, translation, and replication. Meyer provides an analogy that may help with the importance of this issue without having a background in biology: It's not good enough to find a system that contains encoded information; you also need a method to read it or somehow process it. Like finding a computer program in some outdated language, DNA would be useless if it couldn't be processed. A cell has an information-processing system that provides this function. However, this creates a chicken-and-egg dilemma: the cell needs proteins to process DNA, but DNA construction requires proteins. So which came first? Some contend that this is an example of "irreducible complexity," the idea that this kind of system couldn't have evolved gradually, for all parts are required for any functional advantage to survive the natural selection process. The origin of life debate must solve this question.

Chapter 6: The Origin of Science and the Possibility of Design

Switching gears away from the biology of the cell and DNA, Meyer turns to a less technical discussion regarding the nature of science, and what are acceptable methods in how we do science today in the academic world. He reflects on a pre-conceived notion in the public's mind that "science" is strictly sitting in some laboratory repeating experiments over and over. But, according to him, some of the greatest discoveries have come from simply stepping back and drawing together multiple lines of evidences that others have gathered in new and novel ways. He cites Copernicus, Einstein, and Newton as some who were successful in this manner. While some criticize the ID movement for not "doing science" in a lab (Actually, the 'Biologic Institute' started a few years ago to do just that), Meyer counters that this is an extremely narrow view of how science is performed. Even Darwin's *Origin of Species* "contains neither a single mathematical equation or any report of original experimental research. Yet he formulated a great scientific theory" Meyer then questions why positing an intelligent cause is such taboo in the modern academy, given that many of the grandfathers of science (Robert Boyle, Kepler, Newton, Faraday, etc.) all presumed an intelligent agent behind the universe. He provides an insightful quote from astronomer Johannes Kepler who said scientists have the job of "thinking God's thoughts after him," implying that studying the world reveals God's handiwork.

Chapter 7: Of Clues to Causes

In Meyer's study of scientific endeavors dealing primarily with past events, he found that laboratory reproduction of ancient one-time events simply isn't possible. In determining why the dinosaurs died off, we can't get dinosaurs from a mail-order catalog and begin testing! Instead, he found a common method called "abduction." This is where one posits various hypotheses, and then compares relevant data to see which theory holds up the best. This is sometimes called the "inference to the best explanation." However, deciding which theory is "best" is not so easy. The "best" theory, according to Meyer, involves the greatest amount of information, and also employs "causes now in operation." In other words, using an observable cause in the world around us is a better source than some far-fetched, never-seen event. He relates this to the intelligent design movement by pointing out that we witness intelligent agents act as sources of information. Therefore, why can't an intelligent source be the cause of DNA?

Chapter 8: Chance Elimination and Pattern Recognition

In order for an intelligent source to be a legitimate cause for life's origin, Meyer realizes that the alternate hypothesis of "chance" must also be evaluated. This chapter lays some groundwork on just what chance is and how we decide if something is caused by chance or by some other factor. This is best explained through an analogy:A professor is reading a paper from one of her students when she notices a long string of words that sounds familiar. Sure enough, another student had used the same three sentences, word for word. She immediately then accused one of them of plagiarism. Why? Because even though the odds of any three-sentence long set of words has the same probability of any other series of letters, it's the *match* to an outside pattern that draws her attention. . Here, Meyer introduces us to Bill Dembski and his work on pattern recognition. Dembski points out that there are particular patterns that have outside meaning that makes their occurrence so recognizable. In this case, since the professor knows that plagiarism is a purposeful attempt to get out of doing one's own work, she knows that this particular outcome is not merely random. She can confidently conclude that foul-play must be involved. Meyer then begins to question whether this idea of pattern recognition could be applied to DNA and eliminate chance as a reasonable option.

Chapter 9: Ends and Odds

This a chapter where those without a biology background may not grasp the full nature of the argument, but the mathematics involved is the crucial point to take away. Meyer explains how proteins and amino acids are formed and how improbable are the odds of their occurrence by chance. Even with some amino acids sequences which are as “short” as 150 units long, the mathematical chance of their random alignment into this chain quickly grows to number greater than the number of all particles (10 to the 65th power) in the known universe! Meyer concludes this chapter with the work of Douglas Axe whose recent publications attest to the exceedingly rare chance of “random processes producing functional proteins.”

Chapter 10: Beyond the Reach of Chance

Continuing on the discussion from the previous chapter, Meyer calls on the expertise of Bill Dembski to help him compute an “upper bound” for the probability of any event to occur in the universe. Dembski combines the number of particles in the known universe, the number of seconds since the Big Bang, and the number of possible interactions per second (i.e. the time limit on how fast any known event can occur) and computes a number of 10 to the 139th power! The implication here is that any event with a probability greater than this value can be assumed to never occur. And to put biology into perspective, a single 150-amino acid has a chance of forming randomly of 10 to the 164th power. Thus, pure chance is mathematically shown to be an unreasonable answer to the question of life’s origins.

Chapter 11: Self-Organization and Biochemical Predestination

If pure chance did not create a favorable condition for life, then perhaps there was an unknown set of physical forces at work that preferred certain combinations of nucleic acids. Meyer explores this theory by introducing us to Dean Kenyon, who in the 1970s pursued this line of reasoning in what he called “biochemical predestination.” Kenyon later doubted his own work and gave up on the project.

Meyer narrates how he later made a key discovery in his own research into DNA. Various nucleic acids bond to the helix structure of DNA (abbreviated by the English letters A,T,C, and G). It is the various combinations of these “letters” that provide the information-rich capacity of DNA. What Meyer realized was that, even though these nucleic acids are able to bond to the helix, *there are no affinities causing the four letters to be attracted to each other!* If there was any hope of DNA being naturally created, it would be through this “self-organizing” principle, but none exists. Meyer provides a helpful analogy: Picture your refrigerator covered in letter magnets. Each letter can bond to the fridge, but the individual letters are not attracted to each other in any special way. This creates an information-rich environment for someone to walk up and make any set of words they want, but words cannot occur “naturally” by someone scrambling the letters together as all combinations are of equal probability. To carry the analogy into the DNA world, the hope of Kenyon and others was that certain letter combinations would be preferred over others (like a letter magnet fridge having a natural affinity for spelling English sentences) through some yet undiscovered laws of nature. But the opposite has become apparent: the letter magnet fridge has no preference between English, pig-latin, or alphabet soup.

Chapter 12: Thinking Outside the Bonds

Meyer describes two other "self-organization" theories that attempt to solve the problem in new and novel ways by invoking forces of energy. Just like magnetic forces create lines of order in iron fragments, or gravitational forces create an orderly swirling motion as a bathtub drains, maybe a force is being applied to biological structures to create order? After reviewing several of these claims, Meyer concludes that these models are becoming "increasingly abstract and disconnected from biological reality." The central issue is the same: law-like forces cannot produce information; they can only produce order (which lacks specificity). A swirling bathtub drain, although orderly, is not high in information content.

Chapter 13: Chance and Necessity, or the Cat in the Hat Comes Back

Summarizing various computer models that propose to solve the dilemma of biological information, Meyer points out their flaws and summarizes the over-arching problem. For example, Richard Dawkins wrote a simple program that took a random string of letters and, through a 40 or 50 step series of simple changes, produced a sentence from a Shakespeare play. These programs that supposedly result in high-information content only are successful because of the directed programming of their creators, says Meyer. It is because of the information added into the software that allows for a directed result, something that nature does not have the luxury of providing. He concludes with the "law of conservation of information," showing that computers are not able to create more information than what they initially contained.

Chapter 14: The RNA World

Realizing the struggles scientists have confronted with theories involving DNA or proteins as the main catalyst for life's origins, an early-Earth environment made up of RNA molecules "is now probably the most popular theory of how life began," states Meyer in the opening page of this chapter. The remainder of this chapter is a fairly technical analysis of why RNA does not bring one any closer to the origin-of-life problem, with the same basic issue unsolved: this theory provides no explanation for the origin of the genetic information contained in RNA. Frustrations seem to be mounting within the scientific community on this issue. One of Meyer's advisors at Cambridge even said, "The field is becoming increasingly populated with cranks. Everyone knows everybody else's theory doesn't work, but no one is willing to admit it about his own."

Chapter 15: The Best Explanation

Meyer's last two sentences in this chapter sum it up the best: "I concluded that a rigorous scientific argument for intelligent design could be formulated. This chapter has described exactly how I came to that conclusion and why I think it best." He walks the reader through three main reasons for his decision: 1) There simply is no other causally adequate explanation, 2) the empirical evidence confirms the adequacy of the intelligent design theory, and 3) intelligent design is the only known cause of specified information.

Chapter 16: Another Road to Rome

In this chapter, Meyer takes us back to chapter 8 in his discussion involving Bill Dembski's work on pattern recognition. There, we read how Dembski was able to infer design in a system due to an event's high improbability and also because it is was highly specified. (To review, an event is specified if it provides some function or conformity to an independent pattern. When we see Mt. Rushmore, not only is the rock pattern highly improbable, but we recognize it from independent sources of seeing human faces.) The question then becomes, do the base sequences in DNA match an independent pattern, thereby justifying design? Meyer believes it does, as these sequences perform an independent function. He argues for strong similarities between the information-processing capabilities of the human cell and the software industry. Since we clearly recognize software as being designed, the same comparison should be made for the human cell. One software engineer was quoted as saying, "When I see how the cell processes information, it gives me an eerie feeling that someone else figured this out before we got here."

Chapter 17: But Does It Explain?

Here Meyer attempts to dispel some common complaints towards the Intelligent Design movement, with his rebuttal in italics following each bullet:

- "It's an argument from ignorance. Since we don't have all the answers today, you give up and say 'God did it,' thus stopping the progress of science." *The ID position is not based solely on what we do not know, but some positive instances of what we do know. We are not ignorant of how information arises: It is through intelligent agents! Also, the design option is an "inference to the best explanation." Design, given the evidence, is a better explanation.*

- "David Hume repudiated design in the 1700's. Arguments from analogy between living forms and human artifacts are flawed as the degree of similarity can be questioned." *ID does not depend on the degree of similarity between DNA to human or computer language, but on an identical feature in both: that of "complex and functionally specified sequences of symbols." Materialistic theories have yet to produce a cause for this, and intelligent agents are the only known source for information.*

- "Yes, but who designed the designer?" *The inability to fully describe the designer doesn't have any bearing on inferring intelligence in something the designer created. This would be analogous to refusing to believe humans made the statues on Easter Island because we currently cannot describe who sculpted them.*

Chapter 18: But Is It Science?

In 2005, a judge ruled on a Dover, Pennsylvania school district that a book about intelligent design could not be used in a biology classroom. The judge in his ruling said that, *by definition*, ID was not science. Here, Meyer points out, we get into murky water regarding just what science is and is not. He points out that there is no single criterion for what science is, and many disparate methodologies are employed, depending on what kind of science you study. So Meyer sets out how ID fits the various models of science: It is based on empirical evidence, it uses established scientific methods, it is testable, it has been peer-reviewed in many journals, et.al.

Chapter 19: Sauce for the Goose

This is largely a continuation from the previous chapter. Here, Meyer points out that when the many definitions of "science" are equally applied to other scientific endeavors, their disciplines would also fail to fit the mold! For example, ID is critiqued for not having explanatory power. But if we look at Newton's law of gravity, we see a law that merely *describes* what happens, not *explains* how! Therefore gravitational theory has no explanatory power and must not be science! He goes on with a positive case for how ID is clearly scientific: It is observable, testable, and falsifiable. It makes predictions and provides a mechanism for its use.

Chapter 20: Why it Matters

Meyer believes the public has a general view of science and religion as being dichotomous: theories are either based on science or religion. But this does not follow. They might be both. Or, more importantly, scientific theories may have religious implications. However, this does not prove or disprove the theory. When the Big Bang model of the universe was proposed, the religious implications were obvious: the universe had a beginning! But this did not stop the model from being accepted. The intelligent design movement, strictly speaking, does not attempt to identify the designer. It merely points out that there is evidence pointing towards one. If the evidence makes certain religious implications, shouldn't we follow the evidence regardless of where it leads? Isn't that good science?