

THE THEORY OF EVOLUTION IS COMPATIBLE WITH BOTH BELIEF AND UNBELIEF IN A SUPREME BEING

David M. Belnap

Abstract: The crux of the creation–evolution conflict is a futile desire to scientifically prove or disprove the existence of God. The conflict is manifest in the common belief that creation means a divine, supernatural process and that evolution denotes an atheistic, accidental event. Evolution involves a random change in an inherited trait followed by selection for or against the altered trait. If humans use this principle to design machines, solve complex mathematical problems, engineer proteins, and manipulate living organisms, then certainly a super-intelligent being could have used evolution to create life on earth. This reasoning indicates that evolution does not prove atheism and that evolution is a constructive process. The theory of evolution is a mechanistic description and therefore, like all other scientific principles, is neutral on the question of God’s existence. Evolution is compatible with the simple scriptural accounts of creation. Consequently, belief or unbelief in God is put back where it should be — on individual choice.

One of my science teachers in junior high school was especially memorable. His classes and field trips were very interesting, and he was enthusiastic. He greatly stimulated my budding interest in science. For these gifts, I owe him a tremendous debt of gratitude. He also inadvertently helped me learn a valuable lesson in the relationship of science and religion.

One day he introduced my classmates and me to the school’s human skeleton. He explained that it was real and came from a young woman whose body had been donated. He showed us that the pelvis was broad and explained that this was characteristic of female skeletons — facilitating the carrying and delivery of children. I was fascinated! He also pointed out the rib cage and told us that men and women have the same number of ribs. Hence, he said, that Bible story about Eve being formed from one of Adam’s ribs was not true. (He assumed that if the

rib story were true, human males and females would have a different number of ribs.)

At home, I excitedly told my family about the skeleton. I also proudly explained my new understanding of the Adam and Eve story. My devoutly religious parents were not impressed with this new perception. They contacted the school administration to voice their concern that my teacher's comment about Adam and Eve was inappropriate. Nonetheless, what is most impressive was how my parents responded to me.

Instead of jumping into the scriptures and making this conflict a contest between science and religion, they only reasoned with me. With the full support of my father, my mother pointed out that children are still born with arms, legs, eyes, and so forth even if one or both parents lost one or more of those body parts before conceiving the child. Therefore, she patiently reasoned, a rib could have been taken from Adam, and his male children would still have the same number of ribs as his female children.^{1,2} As proof of this principle, my parents also noted that baby boys are still born with foreskins even though many generations of their forefathers were circumcised.

My parents were not trained scientists, but their arguments were the perfect response. Not only did my mother and father convince me that my teacher's interpretation of the biblical rib story was wrong, but also, I have come to realize, they showed me that the use of reasoning, data, and patience is the best way to handle questions between science and religion and that these conflicts can be resolved to the detriment of neither scripture nor science.³ My parents' example was invaluable in helping me later reconcile evolution and creation.

1. My mother told me recently that she thought then of acquired vs. inherited traits (see note 2), concepts she had learned in college. My father told me recently that he had a biology teacher in college who left him with the impression that science and scripture were compatible.

2. *Inherited traits* are those an organism inherits from its biological parents and will pass on to its progeny. In humans, these traits include such things as hair color, hair type, eye color, and ear shape. *Acquired traits* give an organism characteristics that are not passed on and include such things as learned behaviors, environmental effects, deliberate actions, and accidents. Cuts, broken bones, amputations, burns, and learned skills are examples of acquired traits.

3. I came to understand then that the authenticity of the Adam and Eve story was not dependent on boys having fewer ribs than girls. However, my parent's reasoning does not prove that the rib story is true. The validity of that story depends on factors beyond human anatomy.

Introduction

In the 1850s, Charles Robert Darwin and Alfred Russel Wallace put forth the theory of evolution by natural selection. The theory was incompatible with popular interpretations of the scriptural record of creation, and in the more than fifteen decades since, many have considered the theory an affront to belief in God. Some believers in God argue that evolutionary concepts are heretical and that alternative models can explain the record of nature (i.e., the observations documented by Wallace, Darwin, and many other scientists). Institutions have been set up to promote these non-evolutionary ideas. On the other hand, the overwhelming majority of scientists attest that the record of nature unambiguously shows that evolutionary processes occurred and continue to occur. But because the scriptural account seems incompatible, some evolutionists promote the idea that scripture should be regarded as fictitious tales from an ancient and unenlightened people.

A much quieter group of people — including many scientists — accepts both the record of scripture and the record of nature.⁴ For example, most Americans appreciate science and faith in God. Evidence of this duality is the fact that both scientific and religious institutions are well funded and enjoy broad support in the United States. In general, people who accept both scripture and science are uncomfortable when asked to choose between creation and evolution. Many profess that with advancing knowledge, the controversies will eventually be resolved. However, despite this “middle ground,” the idea persists that evolution is incompatible with belief in God.

The root of the conflict between creation and evolution is a desire for the “golden prize” — physical proof of God’s existence or nonexistence. Therefore, each side in this debate stands to win or lose a cherished conviction, but neither side should claim dominance because the theory of evolution is compatible with both faith in God and faith in atheism.

4. Examples of scientists who accept evolution and divine creation: Henry Eyring, *Reflections of a Scientist*, ed. H. R. Romney (Salt Lake City: Deseret Book, 1983, 1998); Francis S. Collins, *The Language of God: A Scientist Presents Evidence for Belief* (New York: Free Press, 2006); Karl W. Giberson, *Saving Darwin: How to be a Christian and Believe in Evolution* (New York: HarperOne, 2008); Kenneth R. Miller, *Finding Darwin’s God: A Scientist’s Search for Common Ground between God and Evolution* (New York: HarperCollins, 1999); National Academy of Sciences and Institute of Medicine, *Science, Evolution, and Creationism* (Washington, D.C.: The National Academies Press, 2008), 12, 15, 54; Simon Conway Morris, “Darwin’s Compass: How Evolution Discovers the Song of Creation.” The Boyle Lecture, London, 23 February 2005, <http://www.stmarylebow.co.uk/#/boyle-lecture-2005/4535725162> (accessed 3 September 2015).

The Theory of Evolution

Mechanistically, the theory of evolution by means of natural selection can be summarized in two simple principles: First, changes occur in inherited traits (see footnote 2). Second, changed traits are selected or rejected.

Characteristics passed from parent to offspring can vary randomly. For example, changes may be mutations within an existing gene, the insertion or deletion of an entire gene or a portion of a gene, or changes to how a gene is regulated. Modifications can also result from normal genetic variation among individuals of the same species as genes are recombined during reproduction.

Selection of changed, inherited traits occurs. Modifications that give offspring advantage are carried forward to successive generations. Unharmful (neutral) mutations or changes also are passed forward. Disadvantageous modifications result in premature death or diminished reproductive capacity, and hence the trait is either not passed on to offspring, or the prevalence of that trait diminishes over time.

Genetic change followed by selection allows successive generations of living things to be modified compared to their ancestors. This process allows organisms to adapt to changing conditions, or the lack of adaptation causes the population to become extinct. Different species can arise from a common ancestor after long periods of time, many changes in traits, a physical separation, or a combination of these events. However, between successive generations, the change may be imperceptible. Rapid changes also have been observed.⁵ For example, in some cases when a new animal species was introduced into an area, significant and rapid changes in anatomy, physiology, behavior, or life span have been observed. Adaptations in guppies were observed within only four to eight years or seven to thirteen generations.⁶ Studies of

5. Two review articles: S. P. Carroll, A. P. Hendry, D. N. Reznick, and C. W. Fox, "Evolution on Ecological Time-Scales," *Functional Ecology* 21 (June 2007): 387–93; A. P. Hendry, P. Nosil, and L. H. Rieseberg, "The Speed of Ecological Speciation," *Functional Ecology* 21 (June 2007): 455–64.

6. D. N. Reznick, F. H. Shaw, F. H. Rodd, and R. G. Shaw, "Evaluation of the Rate of Evolution in Natural Populations of Guppies (*Poecilia reticulata*)," *Science* 275 (28 Mar. 1997): 1934–37. An earlier study on guppy evolution showed changes within eleven years or thirty to sixty generations; D. A. Reznick, H. Bryga, and J. A. Endler, "Experimentally Induced Life-History Evolution in a Natural Population," *Nature* 346 (26 July 1990): 357–59.

lizards showed notable changes within ten to thirty-six years or twenty to thirty generations.⁷

The theory of evolution is a mechanistic explanation of how the diversity of life developed from primitive or ancestral life forms. The theory also provides an explanation for how traits are related among living things. In addition, evolutionary studies often estimate when an organism appeared or disappeared.

Evolutionary principles provide powerful tools for understanding biology, including disease. For example, these principles are used to understand and develop treatments for drug-resistant pathogens. Genes in pathogenic organisms mutate, often conferring resistance to drugs such as penicillin. The often-rapid evolutionary response of pathogens prevents many new drugs from being used. Evolutionary principles also help researchers understand how a protein from a bacterium, yeast, plant, worm, fruit fly, fish, mouse, or other organism is relevant to a similar, but mutant and malfunctioning, human protein. Within a person suffering from cancer, malignant cells evolve and compete with healthy cells in the same way that whole organisms evolve and compete with each other.⁸

Evolution theory does not explain *why* the earth was created nor the agent responsible, if any. As far as the theory is concerned, the earth and living things could have a purpose or they could not. They could have been a random accident or the plan of an intelligent creator. The theory is silent on these matters. Any claim otherwise is conjecture.

On the existence of a supreme being, the theory of evolution is no different from any other scientific principle. For example, atomic theory,

7. A. Herrel, K. Huyghe, B. Vanhooydonck, T. Backeljau, K. Breugelmans, I. Grbac, R. Van Damme, and D. J. Irschick described adaptations that occurred within thirty-six years (approximately thirty generations) in "Rapid Large-Scale Evolutionary Divergence in Morphology and Performance Associated with Exploitation of a Different Dietary Resource," *Proceedings of the National Academy of Sciences of the United States of America* 105 (25 Mar. 2008): 4792–95. Changes within ten to fourteen years were observed by J. B. Losos, K. I. Warhelt, and T. W. Schoener, "Adaptive Differentiation Following Experimental Island Colonization in *Anolis* lizards," *Nature* 387 (1 May 1997): 70–73. Modifications occurring within twenty generations (fifteen years) were reported in Y. E. Stuart, T. S. Campbell, P. A. Hohenlohe, R. G. Reynolds, L. J. Revell, and J. B. Losos, "Rapid Evolution of a Native Species Following Invasion by a Congener," *Science* 346 (24 Oct. 2014): 463–66. An example of rapid evolution in cane toads, which were introduced into Australia to control insects, is found in B. L. Phillips, G. P. Brown, J. K. Webb, and R. Shine, "Invasion and the Evolution of Speed in Toads," *Nature* 439 (16 Feb. 2006): 803.

8. L. M. F. Merlo, J. W. Pepper, B. J. Reid, and C. C. Maley, "Cancer as an Evolutionary and Ecological Process" *Nature Reviews Cancer* 6 (Dec. 2006): 924–35.

laws of motion, germ theory of disease, the “Big Bang” theory, and so forth are silent on the question. One may argue that scientific principles are compatible with the existence of God who made an orderly, complex, precisely tuned universe, but no scientific idea proves or requires a supreme being. Conversely, one may argue that the universe can be explained through random or accidental processes, but no established scientific principle proves or requires the lack of a supreme being.⁹ The same reasoning applies to the question of whether life on earth has a purpose. Science only describes physically observable events. Science cannot answer whether God exists and if life on earth has a purpose.

Just a “Theory”

In scientific language, *theory* means “a well-established set of principles that explain observed phenomena.” An explanation that is not well grounded is a *hypothesis*. Therefore, the common use of *theory* to mean “a guess” or “speculation” does not apply to Darwin’s and Wallace’s ideas. The theory of evolution is well justified in numerous observations and is a foundation principle of modern biology. Like hypotheses, theories can be overturned or modified by new data, but thus far, the theory of evolution has stood for over 150 years. One of the most surprising things about the theory is how well new discoveries have fit with the ideas that Wallace and Darwin proposed in the 1850s.

The Creation

Divine revelation gives us *why* and *who* answers. The scriptures say that God is responsible and that he created the earth and living things to give humans, his children, a place where we could learn to develop faith and show our willingness to follow the Lord’s commandments.¹⁰

9. In mathematics, for example, a person can argue that if $A = B$ and $B = C$, then A must equal C . No proof or physical observation says that God exists or does not exist. Therefore, the arguments that observations of nature are consistent with the existence or nonexistence of God are statements of faith. In the Book of Mormon, Alma used an analogous argument to Korihor, who wanted a sign that God exists (see Alma 30:44). Alma tells Korihor that if he wants a sign he should think about the world around him. The earth, life on earth, and the motion of the earth and other planets are testimony of God’s existence. However, this is not proof that God exists, and faith is still needed to accept that a supreme being created the earth. Faith is also required to accept the atheistic argument that the world can be explained without a supreme creator. Belief in God comes from spiritual observations.

10. Genesis 1–2; Moses 1–3; Abraham 3:24–26; 4–5.

Although the scriptures give a brief, simplified account of what happened during the Creation, the emphasis is (1) who was responsible, (2) why the earth was created, (3) humans are made in God's image, (4) humans are to populate the earth and care for the Lord's handiwork, and (5) physical creations have a spiritual counterpart. Before relating the Creation to Moses, the Lord explained that he created the world (Moses 1:4, 31–34). God also answered Moses's specific question "why these things are so?" (Moses 1:30): to give us immortality and the opportunity for eternal life (Moses 1:39). The simple story cannot have been intended as a detailed scientific account. The purpose of the scriptures is to explain spiritual concepts, not scientific observations.

The Conflict

At one extreme of the creation–evolution debate are people who reject divine creation. At the other end are people who reject evolution. Ironically, despite contempt for each other's point of view, both groups interpret scripture and scientific data in the same way with regards to the creation–evolution controversy: (1) The Genesis account is a literal account of a creation process that took place in six consecutive twenty-four-hour periods (as we currently measure time) and occurred only a few thousand years ago. No symbolism or metaphor exists in the scriptural account. It is a precise description — that is, a scientific document. (2) If the theory of evolution is true, then God cannot exist. (3) If the establishment of life on earth can be explained only by the use of miraculous (i.e., unexplainable or supernatural) processes, then God must exist and must have created the earth. (4) If random processes occur, then God cannot be involved.

The conflict is rooted in the assumption that scientific observations can be used to prove or disprove God. At stake is the desire to once and for all settle the question of God's existence or nonexistence with physical evidence and scientific proof. The biblical declarations that God created the earth have led some to look for evidence of his creative hand in nature; essentially, they have tried to use natural phenomena to prove that God exists. After the theory of evolution was deduced, some have used its postulates to try to prove that God does not exist.

Before the theory of evolution was put forward, scientists assumed that animals and plants were formed in their present states. This was the principal idea that Darwin's and Wallace's work overthrew. Their work and the vast amount of study since showed that present animals and plants have changed or evolved from earlier forms. The pre-evolution

idea that animals and plants were formed in their present states was assumed to be consistent with the biblical story. After that conjecture was shown to be scientifically incorrect, many have made another assumption — that God does not exist because the scientific model supposedly based on scripture was found to be erroneous and because evolution involved random events. Consequently, the conflict is between (1) extending the biblical record beyond its intended scope and purpose to say that animals and plants were created in their present form a few thousand years ago or (2) extending the scientific theory beyond its limits to say that God does not exist.¹¹

Evolution Is a Constructive Process

One of Darwin's most effective arguments was his comparison of artificial and natural selection. Humans selected domestic animals and plants based on desired characteristics, he noted, which led to many varieties with vastly different attributes. For example, the dog breeds Great Dane and chihuahua are thought to have a common ancestor, the wolf.¹² Maize, the common grain also known as *corn*, was domesticated from teosinte. Modern maize looks very different from its wild ancestor.¹³ These types of artificial selection, Darwin reasoned, were analogous to what nature did through natural selection.

Similar reasoning, comparing artificial and natural evolution, can help us with the creation–evolution controversy. Because random manipulation followed by selection can lead to correct solutions for complex problems and can be used to design machines and proteins, we can deduce that life on earth *could* have developed via evolutionary processes that were put in place by an intelligent creator.

The seeming randomness of evolution leads many to conclude that evolution must be a godless process. But, must *randomness* mean

11. For a discussion of the social and religious consequences of extending evolution theory beyond its bounds see, for example, Stephen H. Webb, *The Dome of Eden: A New Solution to the Problem of Creation and Evolution* (Eugene, Oregon: Cascade Books, 2010) and Karl W. Giberson, *Saving Darwin: How to be a Christian and Believe in Evolution* (New York: HarperOne, 2008). These consequences include not only support for devastating ideas like racism, but also the reluctance of many people to accept the legitimate scientific claims of evolutionary theory.

12. Or a wolf-like animal that is the common ancestor of both modern wolves and dogs.

13. Assuming modern teosinte resembles the teosinte from which maize was developed.

godlessness? Is the evolution of life analogous, as is commonly suggested, to the production of a dictionary via an explosion in a printing shop?

If the complete process were random, then yes, evolution might be like such an explosion. However, evolution is not just a random process. Evolution is a random procedure followed by a selection mechanism. The combination of random variation followed by selection is a constructive and orderly process. Such a combination is a powerful way to solve physical or mathematical problems that have a large number of potential solutions.

For example, antibodies are protein molecules that recognize and chemically attach to foreign objects within our bodies. Once attached, the antibody neutralizes the object or signals an additional response by the immune system. Antibodies can be extremely specific. For example, an antibody to a specific virus will not bind to even closely related viruses. How is such specificity produced? The answer is via a random procedure followed by a selection mechanism.¹⁴

Every day a human body manufactures millions of B cells; each produces an antibody with randomly different specificity. To make different specificities, a random selection is made from several antibody genes. Then random misalignments occur as the genes are spliced together, giving additional variety. Finally, random mutations may occur within the selected genes. This provides enough different specificities so that the variety of foreign antigens (foreign molecules) encountered can be recognized. The immune system has no way of knowing what new foreign molecules will be present, so randomly generating an enormous number of antibody specificities is an efficient way to be prepared. Each B cell that encounters a foreign object is activated and copied to fight invaders. Cells that do not encounter foreign antigens die or are inactivated. Therefore, the selection process allows “correct” and “incorrect” solutions to be determined. Although antibody production includes a random process, the overall production is an orderly and efficient way to fight pathogens.

In addition to having a selection mechanism following a random event, evolution of life or evolution in problem solving is iterative. In other words, each generation builds upon the previous one. Complex mathematical problems can be difficult to solve because the path to the

14. S. Tonegawa, “Somatic Generation of Antibody Diversity” *Nature* 302 (14 Apr. 1983): 575–81; C. Branden and J. Tooze, *Introduction to Protein Structure*, 2nd Ed. (New York: Garland Publishing, 1999), 302–3; K. Murphy, *Janeway’s Immunobiology*, 8th ed. (New York: Garland Science, 2012), 12–16, 157–69, 179–84, 192–94, 275–90, 316–27.

solution is unknown, or the solution is one number in a very large set of possibilities. Beginning with an initial estimate or random number and then iterating until a solution converges can be a productive way to find a solution. A key to success is to also have a selective mechanism to choose correct answers from incorrect ones.

In three-dimensional electron microscopy, my own field of research, randomly selecting a starting point can lead to the correct answer (see Figure 1). Objects lie in random, unknown orientations in the electron microscope and are imaged in two dimensions (see Figure 1A, B). To properly reconstruct the three-dimensional object, the unknown orientation angles must be determined. My laboratory and other laboratories¹⁵ have shown that assigning random starting angles can lead to the correct result through an iterative process (see Figure 1C). However, wrong answers are also possible. Proper selection criteria are essential to distinguish correct and incorrect results.¹⁶

Evolutionary processes can be used to design and build machines.¹⁷ Analogous to evolution of living things,¹⁸ an engineer makes an initial design and then does the following:

15. E. Sanz-García, A. B. Stewart, and D. M. Belnap, "The Random-Model Method Enables *Ab Initio* Three-Dimensional Reconstruction of Asymmetric Particles and Determination of Particle Symmetry," *Journal of Structural Biology* 171 (Aug. 2010): 216–22 and references therein. See also H. Elmlund, D. Elmlund, and S. Bengio, "PRIME: Probabilistic Initial 3D Model Generation for Single-Particle Cryo-Electron Microscopy," *Structure* 21 (6 Aug. 2013): 1299–306 and J. Vargas, A. L. Álvarez-Cabrera, R. Marabini, J. M. Carazo, and C. O. S. Sorzano "Efficient Initial Volume Determination from Electron Microscopy Images of Single Particles," *Bioinformatics* 30 (15 Oct. 2014): 2891–98.

16. Another example is in X-ray crystallography, a closely related field to 3D electron microscopy. There, crystals of proteins or nucleic acids (DNA or RNA) are placed in an X-ray beam. The resulting patterns are a series of spots. Each spot represents a sinusoidal function with an amplitude and phase. By combining the amplitudes and phases of each spot in the whole pattern, the atomic-resolution structure of the crystallized molecule can be solved. However, only the amplitudes are known; the phases of each spot are unknown and must be determined. One way to determine phases is to use a "genetic algorithm," see S. T. Miller, J. M. Hogle, and D. J. Filman, "*Ab initio* Phasing of High-Symmetry Macromolecular Complexes: Successful Phasing of Authentic Poliovirus Data to 3.0 Å Resolution," *Journal of Molecular Biology* 307 (23 Mar. 2001): 499–512.

17. For example, A. E. Eiben and J. E. Smith, *Introduction to Evolutionary Computing* (Berlin: Springer, 2003), and P. J. Bentley, ed., *Evolutionary Design by Computers* (San Francisco: Morgan Kaufmann, 1999).

18. These methods are also known as "genetic algorithms."

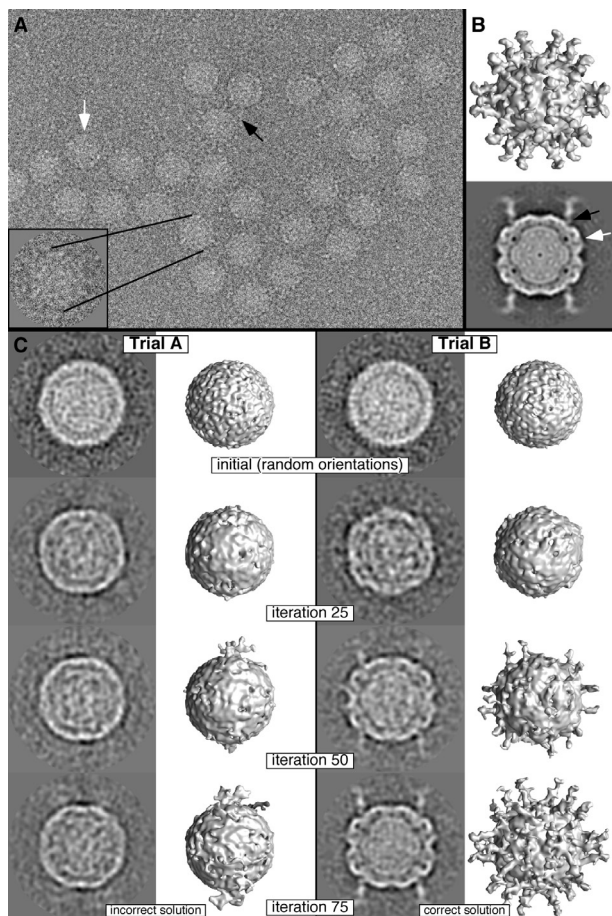


Figure 1. Use of a random starting point followed by iteration to solve a complex mathematical problem. In this example, three-dimensional (3D) structures are computed from two-dimensional (2D) images. Poliovirus particles (white arrows) with protein receptors attached (black arrows) are shown.

A) Image of polioviruses recorded in a transmission electron microscope.¹⁹ This 2D view is analogous to an X-ray image of a human body part — that is, the 3D structures of the viruses are superimposed onto a 2D plane. *Inset*, example of an extracted particle image. Each particle image in the micrograph is extracted separately and then can be combined with other images to reconstruct the average 3D structure of the poliovirus particle. But first, the view orientation

(given by three angles) of each particle image must be determined.

B) Two views of the 3D structure computed from 2D images.²⁰ *Top*, a view from the outside. *Bottom*, a slice through the center.

C) A few thousand particle images were used for these two tests.²¹ In each test, each particle image was randomly assigned an initial orientation. A 3D structure was computed (*top row*). This structure is just a round meaningless blob because the orientation angles are randomly incorrect. Then, an iterative process was begun, and the orientations were allowed to change. After 75 iterations, trial A did not converge to the correct orientations, but trial B did. For comparison, the 3D structure solved from the same 2D data, but by a different method,²² is shown in panel B.

Panels B and C were adapted from a previous study.²³ Poliovirus is 30 nm in diameter.

19. D. M. Belnap, B. M. McDermott Jr., D. J. Filman, N. Cheng, B. L. Trus, H. J. Zuccola, V. R. Racaniello, J. M. Hogle, and A. C. Steven, "Three-Dimensional Structure of Poliovirus Receptor Bound to Poliovirus," *Proceedings of the National Academy of Sciences of the United States of America* 97 (4 Jan. 2000): 73–78.

20. *Ibid.*

21. E. Sanz-García et al., "The Random-Model Method."

22. D. M. Belnap et al., "Three-Dimensional Structure."

23. E. Sanz-García et al., "The Random-Model Method."

1. Random changes (“mutations”) are made in the design. Each random change results in an altered characteristic of the machine.
2. The new machine is constructed and tested. A selection process determines if the change is advantageous or detrimental.

Advantageous changes are kept and used as a starting point for additional “mutations.” Over time, cumulative changes produce an improved machine. Random alterations cause a variety of changes,²⁴ and the selection process keeps only those modifications that improve or do not debilitate the device. The entire process can be automated in a computer. This significantly improves efficiency because many “generations” can be produced and tested without physically constructing each one.

In 2000, Hod Lipson and Jordan Pollack used this engineering process to build and optimize small machines to crawl across a surface.²⁵ Each machine could have bars connected by ball joints to allow flexibility, actuators to change the length of a bar to produce movement, and an electrical network (termed “neurons”) to stimulate movement. A standard stepper motor provided propulsion. At the beginning, two hundred separate machines with no bars or neurons were each given random characteristics and allowed to evolve for 300–600 generations. Characteristics that were allowed to mutate included length of bars, number of bars, number of joints, number of neurons, connecting a neuron to a bar (allowing it to become an actuator), and neuronal function. As the authors stated, “Both body (morphology) and brain (control) were thus co-evolved simultaneously.” Selection, or fitness, of each machine was assessed by locomotive ability — each device was tested for how well it could move on a horizontal surface. A machine was selected if it could move farther in a certain time than other machines. Interestingly, this artificial evolution experiment showed similarities to natural, biological evolution: (1) From the similar starting point of the 200 machines, significantly different machines were produced. Differences were both structural and functional. (2) Some machines diverged into different forms. (3) Other machines that had diverged

24. Variations can be made throughout the device or only in regions specified by the designer.

25. H. Lipson and J. B. Pollack, “Automatic Design and Manufacture of Robotic Lifeforms,” *Nature* 406 (31 Aug. 2000): 974–78. See also commentary by Rodney Brooks, “From Robot Dreams to Reality,” *Nature* 406 (31 Aug. 2000): 945–47.

earlier in the experiment converged into similar forms. (4) Despite never being specified or favored, symmetry was found in some machines.

In a process termed *directed evolution*, evolutionary principles are used to design new proteins or alter the functions of existing proteins.²⁶ Just as the sequence of the twenty-six letters of the alphabet determines the meaning of words and sentences, the sequence of the twenty amino acids determines the structure and function of a protein. In directed evolution of proteins, a person starts with an initial amino-acid sequence, which may be random or based on a known protein. Next, the sequence of amino acids in the protein is altered randomly. All or only some of the amino acids within the protein may be allowed to change. The result is tested. Products with enhanced function are selected, and products with debilitated function are rejected. The randomization and selection steps are repeated. In addition, multiple trials are necessary to produce the desired output because many runs will not be successful.²⁷ In one notable example, directed evolution was used to form proteins that could perform an entirely new function.²⁸

A common microbiological method is to use evolution to make bacteria or viruses with a desired characteristic. Mutations can be induced by radiation (e.g., ultraviolet light) or chemicals. The researcher then sets up conditions to select for a specific characteristic. For example, in a technique known as bioremediation, many are seeking to use bacteria to clean up toxic chemicals. Commonly, evolution is used to induce or generate organisms to tolerate and metabolize these compounds.

If human beings can use evolutionary principles to design machines and solve problems, an intelligent creator also could use random variation coupled to selection to produce and maintain life on earth. If humans

26. C. Jäckel, P. Kast, and D. Hilvert, "Protein Design by Directed Evolution," *Annual Reviews of Biophysics* 37 (2008): 153–73. See also, R. Kazlauskas and S. Lutz, "Engineering Enzymes by 'Intelligent' Design," *Current Opinion in Chemical Biology* 13 (Feb. 2009): 1–2 and other articles within that same issue.

27. As was seen in Lipson and J. B. Pollack, "Automatic Design and Manufacture of Robotic Lifeforms" and in my laboratory's experiment (Fig. 1C), many trials fail to produce satisfactory results. Therefore, multiple runs are necessary. This is analogous to what happened during natural selection as many species became extinct and others survived.

28. The function was catalysis of a chemical reaction for which no known natural enzyme exists. D. Röthlisberger, O. Khersonsky, A. M. Wollacott, L. Jiang, J. DeChancie, J. Betker, J. L. Gallaher, E. A. Althoff, A. Zanghellini, O. Dym, S. Albeck, K. N. Houk, D. S. Tawfik, and D. Baker, "Kemp Elimination Catalysts by Computational Enzyme Design," *Nature* 453 (8 May 2008): 190–95.

can use evolutionary means to make microbes or proteins with desired characteristics and the selective process to get desired traits in animals and plants, then a super-intelligent being could have used evolution to physically make people, animals, plants, and microbes.

Evolution is a process that started with simple organisms and then gradually increased to more complex organisms and more complex interactions among living things. Evolution allowed the complexity of life to increase in a natural, orderly way. Evolution allowed, and continues to allow, living things to respond effectively to each other and to environmental changes. As with foreign antigens and antibodies, the situations each species may face are unknown. Randomly generating mutations allows each species to respond to a variety of conditions.

“Intelligent Design”

The idea that an intelligent creator could have used evolution to form life on earth is much different from the ideas promoted by the “intelligent design” movement. Proponents of intelligent design postulated that some biological machines and processes are so complex that evolution could not produce them. However, others showed that such mechanisms could evolve from simpler components.²⁹ Indeed, the vast complexity of life suggests that evolutionary processes must be involved to improve functionality, allow adaptability, build complexity, and permit trade-offs.

Simple Explanations

Parents, teachers, museum curators, authors, documentary filmmakers, and others use simple explanations to enlighten and educate. They do not intend to deceive or hide important information. Rather, they exclude or minimize details to explain an important principle, process, or event in a way that the intended audience understands. Otherwise, the audience may misunderstand or lose interest. Details can be learned later.

If modern teachers, curators, parents, and others use simple explanations for their audiences, why do some expect the ancient scriptural record to be correct according to our modern understanding of astronomy, geology, and biology? The accounts by Moses and Abraham were written thousands of years ago to people who, for example,

29. See, for example, K. R. Miller, *Finding Darwin's God: A Scientist's Search for Common Ground between God and Evolution* (New York: HarperCollins, 1999), and National Academy of Sciences and Institute of Medicine, *Science, Evolution, and Creationism* (Washington, D.C.: The National Academies Press, 2008).

understood nomadic agriculture but had little if any understanding of science, as even lay people do today. The scriptural explanations are very simple and should be taken as such.³⁰

When given at different times or to different audiences, simple explanations often vary. For example, depending on a child's maturity, parents give divergent answers to the question "where do babies come from?" Because of differing elements or details, simple explanations given to one audience may seem inconsistent, confusing, or even inappropriate when given to another. Details unimportant in one context may be important in another. Latter-day Saints have four scriptural accounts of the Creation: in the books of Genesis, Moses, and Abraham, and in the temple endowment ceremony. The differences in these narratives — and in particular, as noted by Bruce R. McConkie, the "different division of events" between the temple account and the accounts by Moses and Abraham³¹ — suggest that one should indeed view the four renderings as simple descriptions. All accounts relate the most important messages: God was responsible, the divine purpose of Creation, and so forth. Only the details differ.³²

30. "Let us not try to wrest the scriptures in an attempt to explain away what we cannot explain. The opening chapters of Genesis, and scriptures related thereto, were never intended as a text-book of geology, archeology, earth-science or man-science. ... We do not show reverence for the scriptures when we misapply them through faulty interpretation." James E. Talmage, "The Earth and Man," *The Latter Day Saints' Millennial Star* 93 (No. 53; 31 December 1931), 851–852.

31. Bruce R. McConkie, "Christ and the Creation," *Ensign*, June 1982, 8–15.

32. The four New Testament accounts of Christ's resurrection are another example of how a simple, but important, scriptural story is told in multiple ways that are not consistent in detail:

- In Matthew (28:1–10), two women go to the tomb where they meet one angel who tells them Jesus is risen and instructs them to go tell the other disciples. The two women then meet the risen Jesus on their way to tell the disciples. Jesus instructs them that he will meet the others in Galilee.
- In Mark (16:1–14), three women meet one "young man" at the tomb. He tells them Jesus is risen and instructs them to tell the other disciples that Jesus will meet them in Galilee. Jesus then appears to Mary Magdalene, who reports this to the other disciples. Afterwards, two disciples traveling "into the country" see Jesus, and they report this to the other disciples. Finally, Jesus appears to the eleven apostles.
- In Luke (23:55–56; 24:1–49), five or more women meet two "men" at the tomb. The men inform the women that Jesus has risen from the dead. The women return from the tomb and tell the eleven apostles

If we regard the scriptural accounts of the Creation as simple explanations, then remarkable parallels exist between those stories and the record of nature. The fossil record and scripture indicate that initially the earth was barren of life. Then, vegetative life appeared followed by animal life, which began in the sea. Terrestrial animals followed, and humans appeared after other animals.³³

But, what of the inconsistencies between our current understandings of the scriptural and natural records? For example, Genesis states that the creation occurred in six days, flowering plants appear on the same day as other plants, and whales appear before terrestrial animals. Each of these points disagrees with the record of nature.

Some define each creation “day” as a twenty-four-hour period. Yet, for example, the fossil record shows millions of years between the first-known fossilized plants and animals. If one imagines teaching the creation to very young children, the use of a day as a metaphor for a creative period is perfectly appropriate. The Hebrew word for *day*, used in the Genesis account, can also be interpreted as an indefinite period of

and other disciples. Peter runs to the tomb and finds it empty. Later that day, Jesus appears to two disciples who were walking to Emmaus. The two disciples return to Jerusalem and notify the eleven apostles and other disciples. As the two disciples give their report, Jesus appears to the group.

- In John (20:1–21), Mary Magdalene goes to the tomb and finds it empty. She hurriedly leaves and informs Peter and John. They run to the tomb and also find it empty. They leave, but Mary, who has returned, sees two angels inside the tomb who ask her why she is weeping. Mary turns away and then sees the risen Jesus. She leaves and tells the disciples she saw Jesus. Later that day, Jesus appears to a group of disciples who are in hiding.

If one focuses on details such as who was at the tomb first, when heavenly messengers appeared, how many heavenly messengers appeared, why the disciples were told to meet Christ in Galilee when he appeared to them later that day in Jerusalem, and so forth, one misses the important fact that Jesus rose from the dead — the consistent and important point in all four accounts! Likewise, if we insist on strict consistency and scientific rigor in the Creation stories, we miss valuable spiritual insights and unique lessons we can learn from each account.

33. Elder James E. Talmage expressed a similar idea: “But this we know, for both revealed and discovered truth, that is to say both scripture and science, so affirm—that plant life antedated animal existence and that animals preceded man as tenants of earth.” James E. Talmage, “The Earth and Man,” *The Latter Day Saints’ Millennial Star* 93 (No. 53; 31 December 1931), 850.

time.³⁴ Therefore, considering the geologic record, *day* in Genesis 1 most likely means “an unspecified time period.” Because the latter definition is compatible with both the Hebrew text and the fossil record, we can assume this is the correct interpretation.

The other two examples are not as easy to reconcile. However, if we remember the purpose of the story was not to recount a detailed chronology, then the following reasonings may be credible.

Flowering plants reproduce sexually as pollen from the male anther is placed in the female stigma. Genesis states that flowering, or fruit-bearing, plants were created on the same “day” that other plants were created, implying that flowering plants were present before animals appeared. However, in the fossil record, the first-known flowering plants appeared after animals were already in existence. In addition, although some aquatic or terrestrial flowering plants are fertilized as pollen drifts through water or air, most flowers require an animal to transfer the pollen. These plants cannot reproduce if animals are not present to pollinate them. In other words, most flowers are useless without animals. So, is the scriptural record in error in saying flowering plants were formed before animals were formed? No, to explain simply, one could group flowers with the other plants because the mechanism was in place for flowers to develop. The flowering plants could then evolve with the pollinating animals. Explaining this in the simple biblical story would be an unnecessary detail.

The record of nature indicates that whales evolved from terrestrial animals, but Genesis states that whales were created when aquatic life was created. Rather than explain the complex process of aquatic life leading to terrestrial life followed by some terrestrial animals adapting back to aquatic life, a simpler explanation would be to say that all aquatic life was created on the same “day.” The detail that whales actually came after land animals could be omitted — the mechanism was in place for whales to develop because land animals developed from aquatic ones. Explaining that whales developed from terrestrial animals would be an unnecessary complication that would likely be misunderstood by the people of Moses’s day.

34. See, for example, meanings of the word *Yom* (H3117) in *Strong’s Exhaustive Concordance of the Bible*. See also Greg Neyman, “Word Study – Yom,” Old Earth Creation Ministries, http://www.oldearth.org/word_study_yom.htm, accessed 15 Mar. 2015.

An Imperfect World

One argument for godless evolution is the fact that life is messy and the design is far from ideal. The retina of the vertebrate eye has the sensory layer facing away from incoming light, not towards it. The plant enzyme that converts carbon dioxide to sugars is “notoriously inefficient.”³⁵ The human mouth grows more teeth than it has room to hold — forcing people to have wisdom teeth extracted; many of us get expensive orthodontic work to straighten the teeth. An intelligent designer, the argument goes, would have made things more intelligently.

In addition, incredible suffering occurs in the world. Not only are human beings often cruel to each other, but animal brutality abounds. For example, as Darwin noted, some wasps are extraordinarily cruel as they lay eggs in living caterpillars and the larvae eat their host alive.³⁶ Why would a truly loving God make a world with such brutality and inefficiencies? The scriptures provide explanations for these apparent

35. This chemical reaction is critical to plant and animal life. R. J. Spreitzer and M. E. Salvucci, “RUBISCO: Structure, Regulatory Interactions, and Possibilities for a Better Enzyme,” *Annual Reviews of Plant Biology* 53 (2002): 449–75.

36. “With respect to the theological view of the question. This is always painful to me. I am bewildered. I had no intention to write atheistically. But I own that I cannot see as plainly as others do, and as I should wish to do, evidence of design and beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent and omnipotent God would have designedly created the *Ichneumonidæ* with the express intention of their feeding within the living bodies of Caterpillars, or that a cat should play with mice. Not believing this, I see no necessity in the belief that the eye was expressly designed. On the other hand, I cannot anyhow be contented to view this wonderful universe, and especially the nature of man, and to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance. Not that this notion at all satisfies me. I feel most deeply that the whole subject is too profound for the human intellect. A dog might as well speculate on the mind of Newton. Let each man hope and believe what he can. Certainly I agree with you that my views are not at all necessarily atheistical. The lightning kills a man, whether a good one or bad one, owing to the excessively complex action of natural laws. A child (who may turn out an idiot) is born by the action of even more complex laws, and I can see no reason why a man, or other animal, may not have been aboriginally produced by other laws, and that all these laws may have been expressly designed by an omniscient Creator, who foresaw every future event and consequence. But the more I think the more bewildered I become; as indeed I have probably shown by this letter.” Charles Darwin to Asa Gray, 22 May 1860, published in *The Life and Letters of Charles Darwin*, vol. 2, ed. Francis Darwin (London: John Murray, 1887), 311–12.

inconsistencies. This is another example in which scripture is compatible with the record of nature.

The scriptures speak of Adam and Eve leaving the peaceful Garden of Eden and entering a world of competing organisms (see Genesis 3:16–19, 23; Moses 4:22–25, 29). Adam and Eve would have to work for their food and other sustenance. The world would contain sorrows. Death would come. Childbirth would be extremely difficult. Wasps cruelly enslaving caterpillars and animals brutally killing each other are consistent with the world where God sent Adam and Eve.

Scripture speaks of God having a perfected body and humans being made in God's image (see Philippians 3:21; Genesis 1:26–27). Therefore, humans are similar to God but not exact copies. Each of us likely has more defects than simply a retinal layer on the opposite side of input light and too many teeth. Therefore, one should not be surprised that life on earth is not perfectly designed. How could it be perfect and be the testing ground that the scriptures say it is? How could you and I develop faith if our bodies were perfect, if we were not challenged by physical limitations?

These gospel teachings are compatible with an imperfect world that came to be through messy evolutionary processes. The argument that a designer would create perfect organs and a perfect world assumes a peaceful, perfect "Garden of Eden" world, not the messy, competitive, cruel, and sorrowful world into which, the scriptures say, Adam and Eve were sent.³⁷

Conclusion

Scientists often express frustration that many people do not accept evolution. The scientists point out the overwhelming biological evidence and cannot comprehend how anyone can deny that evolutionary processes occurred. On the other hand, believers in God point out the order, complexity, and beauty of nature and cannot fathom how anyone can claim it arose by accident. Are the only alternatives *really* godless evolution and a "miraculous" six-day process? The creation–evolution conflict exists because (1) science has been extended beyond its bounds to say God does not exist and (2) scripture has been extended beyond its bounds to say evolutionary theory is false.

37. In his book *The Dome of Eden*, theologian Stephen H. Webb proposes a way to reconcile the cruelty of the world ("natural evil"), creation by a loving God, and evolution.

My former teacher erroneously assumed that males should have fewer ribs than females if the Genesis rib story was correct. Likewise, many have surmised similarly unfounded ideas about evolution and creation. If these ideas are tied to deeply held values of faith (in God or atheism), people are reluctant to give them up when confronted with contradictory evidence. Hence, we have conflict. However, data, reasoning, humility, and patience can help us resolve the conflict.

At the root, the creation–evolution conflict presumes that God’s existence or nonexistence can be proven, but attempts to scientifically verify or refute a supreme being are futile. The randomness and messiness of evolution does not prove the nonexistence of God, just as the existence of God is not proven by the beauty and order found in nature. Scientific or mechanistic methods do not have the capability to answer questions about God’s existence or the meaning of life. What would be the physical test or observation that would confirm or deny his existence? Besides, the scriptures are clear that belief in God is a choice and cannot be forced on others (e.g., see Alma 30:7–9; Joshua 24:15). People must be free to choose to follow God or not. People cannot be free if his existence is proven scientifically because that proof would be another way people could be forced to follow him. As the scriptures say, faith is hope or belief in “things which are not seen” (Alma 32:21; Hebrews 11:1). If scientific observations are “seen” things and if science cannot prove or disprove God, then faith in atheism and faith in God should be viewed as equivalent positions as far as science is concerned. Logical arguments for either belief can be made.

Therefore, we should call a truce in this war and concede that belief or unbelief in God cannot be proven by current scientific understanding, no matter how much one may wish it to be otherwise. Believers in God need to renounce the notion that evolution must be disproved to save the faith; likewise, atheists need to abandon the idea that evolution is evidence of God’s nonexistence.

Also, some have attempted to resolve the concern of God-fearing people by noting that many scientists believe in God and accept evolution. Merely pointing this out is not enough. Too many believers in God view such people with suspicion. The idea that evolution is incompatible with faith in God has persisted for so long and the conflict is so deep that many believers in God are convinced that if a person starts to accept anything about evolution, the individual will eventually discard his or her faith in God. The scientific community needs to acknowledge that science is

neutral on the existence of God and needs particularly to note that the theory of evolution does not disprove the existence of a supreme being.³⁸

Believers in God must realize that insistence on a creation model that excludes evolution facilitates the argument by atheistic evolutionists that God does not exist. Believers and prospective believers in God should not have to choose between accepting scientific observations and having faith in God.

If humans can use evolution to construct machines, engineer proteins, produce living organisms with desired characteristics, or solve complicated problems, then certainly a super-intelligent creator could have used the same principle to create life on earth. But this does not prove that God created life by means of evolution; this reasoning means that evolution is compatible with belief or nonbelief in God. Therefore, faith (in God or atheism) is put back where it should be — on each person's spiritual conviction and choice.

I thank family members, friends, and colleagues who have helped me develop these ideas and prepare this article for publication. I also thank the editors and anonymous reviewers for their helpful suggestions.

David Michael Belnap received a BS degree in biochemistry from Brigham Young University in 1989 and a PhD in biology from Purdue University in 1995. Since his days at Purdue University, he has studied the structure of viruses primarily by three-dimensional electron microscopy. He has also studied other biological macromolecules and helped develop 3DEM methods. Following graduate studies, he worked at the National Institutes of Health (Bethesda, Maryland; 1995 to 2004) and Brigham Young University (2004 to 2012). He currently is a research faculty member in the Departments of Biochemistry and Biology at the University of Utah, where he also directs the Electron Microscopy Core Laboratory. David enjoys serving in the church and especially enjoys being outdoors with his wife Julie and family.

38. An example of this being done is National Academy of Sciences and Institute of Medicine, *Science, Evolution, and Creationism* (Washington, D.C.: National Academies Press. 2008).

