PERSPECTIVES ON SCIENCE AND CHRISTIAN FAITH
VOLUME 62, NUMBER 4
DECEMBER 2010

PERSPECTIVES on Science and Christian Faith

JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

In This Issue …

"The fear of the Lord
is the beginning of Wisdom."
Psalm 111:10

VOLUME 62, NUMBER 4 **DECEMBER 2010**

(US ISSN 0892-2675) (CPM #40927506)

Perspectives on Science and Christian Faith

Perspectives on Science and Christian Faith (ISSN 0892-2675) is published quarterly for $40 per year by the American Scientific Affiliation, 55 Market Street, Ipswich, MA 01938-0668. Phone: 978-356-5656; Fax: 978-356-4375; asa@asa3.org; www.asa3.org

Periodicals postage paid at Ipswich, MA and at additional mailing offices. POSTMASTER: Send address changes to: *Perspectives on Science and Christian Faith*, The American Scientific Affiliation, PO Box 668, Ipswich, MA 01938-0668.

Manuscript Guidelines

The pages of *Perspectives on Science and Christian Faith (PSCF)* are open to original, unpublished contributions that interact with science and Christian faith in a manner consistent with scientific and theological integrity. Published papers do not reflect any official position of the American Scientific Affiliation.

1. Submit all manuscripts to: **Arie Leegwater, Editor, Calvin College, De Vries Hall, 1726 Knollcrest Circle SE, Grand Rapids, MI 49546-4403. E-mail: leeg@calvin.edu**. Submissions are typically acknowledged within 10 days of their receipt.
2. Authors must submit **an electronic copy of the manuscript formatted in Word** as an email attachment. Typically 2–3 anonymous reviewers critique each manuscript submitted for publication.
3. Use endnotes for all references. Each note must have a unique number. Follow *The Chicago Manual of Style* (14th ed., sections 15.1 to 15.426).
4. While figures and diagrams may be embedded within the Word text file of the manuscript, authors are required to also send them as individual electronic files (JPEG or TIFF format). Figure captions should be provided as a list at the end of the manuscript text. Authors are encouraged also to submit a sample of graphic art that can be used to illustrate their manuscript.

ARTICLES are major treatments of a particular subject relating science to a Christian position. Such papers should be at least 2,000 words but **not more than 6,000 words in length**, excluding endnotes. An abstract of 50–150 words is required. Publication for such papers normally takes 9–12 months from the time of acceptance.

COMMUNICATIONS are brief treatments of a wide range of subjects of interest to *PSCF* readers. Communications **must not be longer than 2700 words**, excluding endnotes. Communications are normally published 6–9 months from the time of acceptance.

NEWS & VIEWS are short commentaries on current scientific discoveries or events, or opinion pieces on science and faith issues. Lengths range **from 200 to 1,500 words**. Submissions are typically published 3–6 months from the time of acceptance.

BOOK REVIEWS serve to alert the readership to new books that appear significant or useful and engage these books in critical interaction. Guidelines for book reviewers can be obtained from the book review editors. Note respective subject areas:

- **Louise Freeman** (lfreeman@mbc.edu): anthropology, biology, environment, neuroscience, origins, and social sciences.
- **James C. Peterson** (peterso@mcmaster.ca): apologetics, biblical studies, bioethics, ethics, genetics, medical education, philosophy, and theology.
- **Arie Leegwater** (leeg@calvin.edu): cosmology, engineering, history of science, mathematics, non-bio technologies, and physical sciences.

The viewpoints expressed in the books reviewed, and in the reviews themselves, are those of the authors and reviewers respectively, and do not reflect an official position of the ASA.

LETTERS to the Editor concerning *PSCF* content may be published unless marked not for publication. Letters submitted for publication **must not be longer than 700 words** and will be subject to editorial review. Letters are to be submitted as electronic copies. Letters accepted for publication will be published within 6 months.

ADVERTISING is accepted in *PSCF*, subject to editorial approval. Please address inquiries for rates or further information to the Managing Editor. The ASA cannot take responsibility for any orders placed with advertisers in *PSCF*.

Arie Leegwater

Loving the Kingdom and Responsible Technology

Teaching a section of an introductory chemistry course to fifty students this fall semester, of which more than one-half were prospective engineering majors, I was at a loss in imagining a thematic structure for the course. Should I provide an apologetic for theism? Would an appeal to natural (physical) law or an acceptance of a form of critical realism suffice to engage my students? Should I reflect on the wondrous awe-inspiring conjunction of physical constants and the specific character of fermions which make chemical reactions possible and provide an explanatory framework? Perhaps I should employ reverse engineering arguments giving evidence for the wise design of physical entities and their interrelationships. These apologetic moves could be interesting, could even lead to fruitful discussions, but I considered them to be too defensive, too restrictive and reactionary, and ill-suited for whetting my students' interest. What if I followed another path: provide a thetical approach and allow the students to become part of the narrative, that is, to enter into the story of redemption and renewal that is afoot in the world? Would it capture the imagination of my students and appeal to their deep-seated interests to be God's agents in his world? And so I began the course with this narrative: loving the kingdom and responsible technology.

At first glance, loving the kingdom of God and technology have little, if anything, to do with each other. We live in the period of the biblical story that anticipates the return of the King, Jesus Christ. Christ's resurrection and our bodily resurrection is the Gospel's good news and it provides us with a political, social, and technological mandate. The mission of the church, the body of Christ, is nothing more or less than the outworking, in the power of the Spirit, of Jesus' bodily resurrection. We are promised a new type of bodily existence, the fulfillment and redemption of our present bodily life. This new life includes activities we presently do as humans: our academic studies, our vocations, and our collective cultural pursuits—even those involving technological matters. Technique and technological practices need no justification. They are ingrained in the very makeup of our humanness. The vision of Isaiah 60 describes ships bringing in instruments of culture into the New Jerusalem. These instruments have been thoroughly transformed into proper instruments of service. A similar theme is echoed in 2 Peter 3:10 in which, at the last day, "the earth and everything in it will be laid bare [or will be found]." Our present earthly life and its cultural productions, though perhaps transformed beyond our recognition, will be carried into the new heavens and the new earth. The cultural achievements of history will be purified and re-appear on the new earth (Rev. 21:24–26). There is continuity between this life and the life to come: our bodily resurrection is the guarantee.

What could follow from this inspiring vision? God's call to live as kingdom citizens exercising our responsibilities in using our creational opportunities. For an academic institution, it also carries curricular implications. Students need to be adequately equipped to find their place in the biblical story. Paul exhorts us to work out our salvation in fear and trembling (Phil. 2:12), responding to all of God's revelation. We should begin to view our technological work as a calling infused by a faith that invites allegiance and is open to the wonders of God's world. That sense of wonder and joy in exploring and unfolding creation's potentialities, expressed in service to our neighbors, is what we need to impress upon our students. As professors and leaders, we need to help them identify the problems that should be addressed with Christian insight. These are often complex issues in which we need to balance a diverse array of normative principles such as cultural appropriateness, openness and communication, stewardship and sustainability, and justice. These not only concern the ethical application of various technologies, but they are also found at the very heart of theorizing, experimentation, and technologi-

Editorial

Loving the Kingdom and Responsible Technology

cal design. A past research team, which I coordinated, attempted to work out the implications for technological design, which is the central focus of technological activity, and reported their work in the now outdated book *Responsible Technology: A Christian Perspective* (Grand Rapids, MI: Eerdmans, 1986).

In summary, several themes and concerns in our collective efforts at creating a responsible technology require attention.

1. A recurring question: Are our technological practices, and the manner, in which they are taught and applied, in need of change and reform? Do they genuinely promote human flourishing and foster sustainable development?

2. We need to continually acknowledge an important check on our overly optimistic views of technology, namely, to remember the two-edged character of technology: good and evil run through each other in our practices. The famous quote by Aleksandr Solzhenitsyn captures this truth: "But the line dividing good and evil cuts through the heart of every human being."

3. The authors of *Responsible Technology* concluded with this statement on page 244:

> [R]esponsible technology must rest upon a servant-like commitment to love God above all and our neighbor as oneself. It is as all of us—designers, research scientists, consumers, public policy makers, citizens, fabricators, corporate executives, journalists, scholars, and others—seek to love as Christ loved us that we will be able to live in the line of creation and redemption. We will then broaden the standards by which our technologically relevant decisions are made to simultaneously include all the biblically based normative principles, and at the same time narrow the application of the economic, the technical, the scientific, and the political.

I look forward to suggestions and submissions for a *PSCF* theme issue devoted to appropriate technology. As an ASA community, we need to tussle with a normative approach in our technological practices, one that desires to be of service to our neighbors and enhances their flourishing as God's image bearers.

Arie Leegwater, *Editor*
leeg@calvin.edu

In This Issue

After two successive theme issues of *PSCF*, we return to a more traditional fare. Three major articles and an essay book review highlight this issue. The first article by Wayne D. Norman (Simpson University) and Malcolm A. Jeeves (University of St. Andrews) walks us through a historical survey of phrenological methodology and considers what we can learn, of benefit, for neurotheological considerations today. Second, an article by Michael L. Peterson (Asbury University) offers a comprehensive study of the views of the ever popular Christian apologist C. S. Lewis on the theory of evolution and the argument from intelligent design. The third article by Joseph L. Spradley (Wheaton College), detailing the importance of the moon for the unique character of life on Earth, provides support for the belief that God can work through natural processes to achieve his creational purposes. The last article is an essay book review by Dennis R. Venema (Trinity Western University) of *Signature in the Cell: DNA and the Evidence for Intelligent Design* written by Stephen C. Meyer, a leading spokesperson in the intelligent design community. Besides the usual array of book reviews, several letters, and a three-year index complete the issue.

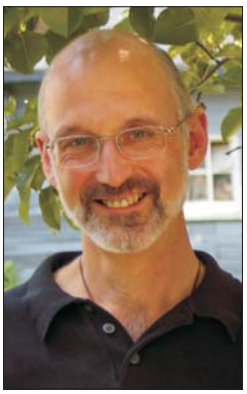
In a Future Issue

In my editorial, I welcomed submissions on responsible technology. If a sufficient number of quality articles are submitted, I would like to generate a theme issue on appropriate technology. As editor, I would favor an issue having both theoretical-reflective articles, articles that develop normative principals essential for sustainable technological development, and those that describe a number of case studies in which responsible technology has been practiced.

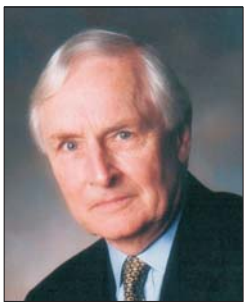
Arie Leegwater, *Editor*
leeg@calvin.edu

Neurotheology: Avoiding a Reinvented Phrenology

Wayne D. Norman and Malcolm A. Jeeves



Wayne D. Norman



Malcolm A. Jeeves

Over the past several decades, a number of proposals have been advanced to explain the relationship between human brain functioning and religious experiences and behaviors. In the nineteenth century, phrenologists were also interested in these relationships. A wide variety of positions existed amongst deist and Christian phrenologists and continues in neurotheological writings today. More importantly, some of the conceptual and methodological issues that plagued phrenology may function as a cautionary tale for neurotheological endeavors today, including investigations that are empirical but not scientific, issues related to the relationship between brain and spiritual activities, and the relationship between natural law and spiritual activity.

Neurotheology is the latest in a long history of attempts to link bodily processes and spirituality. Widespread current interest in the topic may be largely attributable to its almost daily media coverage with dramatic color pictures using the latest brain-imaging techniques. Interpretations vary widely. For some, it shows that researchers have now found "where God lives in the brain." For others, it confirms that spirituality and claims to be in touch with a transcendent God are "nothing but" the chattering of millions of brain cells. What is frequently not realized is that attempts to localize specific spiritual activities to particular brain regions is not new. As in some other episodes at the science and faith interface, there may be important lessons to be learned from how these issues were handled in the past.

Almost two centuries ago, when phrenology was as popular as neurotheology is today, thoughtful scholars tried to answer questions about how most constructively to relate knowledge about localization of function in the brain with current Christian beliefs. We believe there are important lessons to be learned from a study of nineteenth-century phrenology.

Accordingly, we begin by describing phrenology in its heyday and ask how its relationships with religion were viewed then by different Christian positions. From this review, we seek to identify pointers that may help today in formulating constructive evaluations of neurotheology.

Nineteenth-Century Phrenology

What Was Phrenology?

A central doctrine of nineteenth-century phrenology was that mental functioning is the result of a discrete number of faculties, each of which corresponds to

Wayne D. Norman *is professor of psychology at Simpson University in Redding, California, where he teaches courses in experimental and neuropsychology; and professor of psychology, emeritus, at Redeemer University College in Ancaster, Ontario, Canada, where he taught for twenty-one years and was also director of research and faculty development. He earned a PhD in experimental psychology at Washington State University, was a visiting scholar at the University of St. Andrews where he collaborated with Malcolm Jeeves in cognitive neuropsychology, and was a 1999–2001 Templeton-Oxford Scholar conducting historical research on the relationship between Christianity and phrenology during the nineteenth century.*

Malcolm A. Jeeves *is emeritus professor and foundation professor at the School of Psychology at the University of St. Andrews, Scotland. He was formerly Editor-in-Chief of* Neuropsychologia *and is past president of the Royal Society of Edinburgh, Scotland's National Academy. His most recent book is* Neuroscience, Psychology, and Religion *(with Warren Brown), Templeton Press, 2009.*

a separate cerebral organ on the surface of the brain. In the earliest attempts at localizing mental life in the brain, the goal had been to find a single "cerebral organ" for all the mental processes. Soon, however, psychology was freed from the earlier dominant view that consciousness must be an indivisible whole. A new, so- called, "faculty" psychology developed. According to this view, there were specialized mental faculties, and it became proper to search for a material substrate for each of them. The brain became regarded as an aggregate of many organs, each of which embodied one particular faculty.

The task was to relate the contemporary picture of a "psychology of faculties" with current knowledge of the structure of the brain. In this endeavor, it was the leading anatomists of the time who gave the impetus to research.[1] In his 1835 treatise on the functions of the brain, Franz Gall took as one of his starting points, the contemporary "psychology of faculties." He argued that the whole cerebral cortex is an aggregate of individual organs, each of which is the substrate of a particular mental faculty.[2] It was left to the German physician Johann Spurzheim, a collaborator with Gall in his neuroanatomical research, to popularize the term phrenology. As early as 1805, Gall had been content to refer simply to cranioscopy or organology.[3] It was after Spurzheim left Gall and departed for Britain that the former popularized the term phrenology.[4]

Basic Varieties of Nineteenth-Century Phrenology

When one surveys the writings of phrenologists, one sees a wide variety of systems, motivations, and emphases. Some, like Gall, focused on establishing phrenology's empirical basis.[5] Spurzheim wrote about the philosophical and moral implications of phrenology.[6] George Combe believed phrenology was important in understanding the laws governing individual and social behavior.[7] And for Orson Fowler, phrenology had practical lessons to teach about every aspect of one's life, from career decisions to child-rearing to marriage.[8] Of course, there were those who used phrenology for political reform, as justification for theological claims, and for pecuniary gain.[9]

Recently John van Wyhe has argued that "phrenology was used as an alternative or supplementary foundation for intellectual and epistemological authority."[10] Van Wyhe's point is that it was the "certain knowledge" which phrenology supposedly provided that formed the foundation for its various claims and aspirations. This is important. Because phrenology was seen as based on scientific "facts," advocates used this authority to make claims about issues far removed from phrenology's core claims. A similar accusation might be made when examining some of the claims of neurotheology.

Aims of Phrenology

Although the Enlightenment eludes any precise definition, it has been said that one defining characteristic of the movement was "an emphasis upon the ability of human reason to penetrate the mysteries of the world."[11] These mysteries included the physical world of planetary motion and electricity and the mental world of human perception and the workings of the mind itself. More-ancient mysteries, those of religious belief, also came under the scrutiny of human reason. This led to explanations of belief and attitudes toward institutionalized religion that varied from skepticism to hostility.[12] Interactions between revealed and natural religion ranged from warfare to reconciliation to harmonization.[13] While the Enlightenment is often situated in the eighteenth century, modified forms of Enlightenment thinking seeped into nineteenth-century thought. One such outlet was the field of phrenology.[14]

The Impact of Phrenology on Religion and Religious Thinking

For the purposes of this article, we make a distinction between two groups of phrenologists, recognizing that the line between them is sometimes easier to draw than to defend. The first group comprises deists, and includes Gall, Spurzheim, and Combe. Although similar to theists in believing in the existence of God, deists generally hold that God has created the cosmos but does not subsequently directly intervene in it by miracles, prophecy, or divine revelation. Accordingly, religious beliefs should be founded on human reason and what is observed in the natural order.

The second group comprises Christian phrenologists. Although their theological positions varied widely, they all subscribed to the basic tenets of Christianity. It is important to note that they did not reject science or, indeed, a naturalistic approach to understanding the world, including the human mind. The nineteenth century was a time that saw a dramatic increase in the acceptance of a naturalistic

methodology for studying all of nature. This acceptance occurred among Christians as well as theists, deists, and nonbelievers.[15]

Deist Phrenologists

One of Franz Gall's (1758–1828) favorite mottos was "God and the Brain: Nothing but God and the Brain." It may be possible to glean what Gall meant by this from some of his writings. For example, in *On Innate Dispositions*, he says,

> If we can demonstrate that a relationship exists between the exercise of the soul properties and the origination of their existence in the brain it would no longer be possible to doubt that it is possible to establish a doctrine which will enable us to know the noblest part of the organism.[16]

Gall's anatomical work led him to conclude that there was no single location of the soul since the fibers of the brain did not converge in one spot. He noted instead that the convolutions of the cerebral cortex are the peripheral expansions of those fibers.[17] In other words, the functions of the soul are mapped across the entire cortex.[18]

Gall did not deny the existence of the soul; on the contrary, his position advocated the organs of the cortex as the instruments through which the soul acts. He was, therefore, not an eliminative materialist. His research certainly advocated methodological naturalism, but as Patrick McDonald has pointed out with reference to mid-nineteenth century research,

> … the move toward more naturalistic methods was not primarily motivated by a prior commitment to any particular worldview, whether theistic, naturalistic, pantheistic, or other.[19]

If this assessment is correct, then we can see Gall's position foreshadowing current debates about the impact of neurotheology on some widely held traditional religious views of human nature.[20]

Johann Spurzheim (1776–1832) sought to defend himself against charges of materialism and fatalism when he wrote *A View of the Philosophical Principles of Phrenology*.[21] In his work, *Phrenology, or the Doctrine of the Mental Phenomena*, he gives his phrenological explanation for religion.

> In my opinion the religious phenomena are the result of several faculties. Causality searches for a cause for every thing and of every event. Individuality personifies the Supreme cause it arrives at; another faculty inspires admiration and wonder, and believes in some relationship between God and man; a third feeling inspires respect and reverence, and religion exists. It is strengthened by the feelings of hope, conscientiousness and cautiousness.[22]

The purpose of religion, as regulated by the phrenological organs, was to improve morality. "All religious regulations, therefore, ought to be only auxiliary means of rendering mankind morally good."[23] Religious behavior and experiences could, for Spurzheim, be understood completely as the result of brain activity.

In writing about historical psychological texts, Thomas Dixon identifies three categories: theological, antitheological, and atheological. Theological texts privilege God-talk and antitheological texts explicitly reject God-talk. The third category is the more interesting one. Dixon suggests that atheological texts make no crucial reference to God. While God language may populate the text,

> it is a secular and often "scientific" psychology that seems simply to neglect or ignore the language and concerns of the religious traditions and to adopt instead an epistemology and ontology proper to certain scientific enterprises.[24]

Spurzheim's writing seems to be a variant form of atheological texts. God-talk is used but does not appear to be crucial, or even important, to many arguments being made.

George Combe (1788–1858) became a convert to phrenology after attending lectures by Spurzheim in Edinburgh around 1817, and he began publishing articles on the topic shortly thereafter.[25] He believed that religion was good if religious emotions were guided by an enlightened intellect. In such cases, individuals would care less for the "formulas" of religion, would be more tolerant of members of other faiths, and would be more progressive in their opinions. On the other hand, he had harsh words for organized religions, viewing them as "the instrument of priests and sovereigns to maintain themselves in authority, and to repress the moral and intellectual life of nations."[26]

Combe focused on one central question, "How does God govern the world?" and it was the moral world which most concerned Combe. Since it was

obvious to him that God governed the *material* world through natural laws, Combe reasoned the same must hold for the *moral* world. He used the principles of phrenology to explicate, through study and reason, how the constitution of the brain gave rise to natural religion and morality. His writings on the relationship between phrenology and religion focused primarily on defining the effects of the moral and intellectual phrenological organs on religious life.

Throughout his writings, Combe argued that we do not possess any faculty which would allow us to know the essence of a thing, nor would such knowledge be of any practical importance.[27] However, even though we cannot know with certainty the essence of matter, Combe makes his position clear. The "spiritual hypothesis," namely an understanding of human nature based on our possession of an immaterial soul or spirit, blinds us to a true understanding of our constitution. For Combe, "The world is material, man's nature is material, and the whole relation between them depend on material conditions."[28]

Combe questioned the veracity of Christianity even before his involvement with phrenology. Judging from autobiographical statements and the main thesis of his major work, *The Constitution of Man*, his primary interest in phrenology was to show that it provided for law-like regularities in our moral nature, something he concluded was lacking in most forms of Christianity. Our phrenological make-up, as determined by the Creator, specifies how we should conduct ourselves and on what basis rewards and punishments will occur. He came to phrenology as a deist and argued for deism from phrenological principles. Thus, Combe's critique of Christianity can be seen as an argument for the replacement of orthodox Christian doctrine with deistic principles. The hypothesis that God actively intervenes in the world had been pushed out of explanations in physics, meteorology, geology, and aspects of biology. Combe sought to extend that line of thinking to human actions, including moral behavior.

Christian Phrenologists

The second group we examine might be labeled Christian phrenologists. In various ways, advocates of this position claimed that Christianity and phrenology were not, and in fact, could not be opposed because they dealt with two separate spheres of life, the scientific and the spiritual. For many, phrenology did, however, harmonize with the moral doctrines that flowed from "natural religion."[29] Some put Christianity in the upper story; others gave precedence to the science of phrenology. It is instructive to examine five such phrenologists (Henry Clarke, Charles Cowan, W. Easton, William Scott, and Orson Fowler) and their strategies for relating phrenology and Christianity.

In 1835, Henry Clarke, a minister in Dundee, Scotland, published *Christian Phrenology; or the Teachings of the New Testament Respecting the Animal, Moral, and Intellectual Nature of Man*.[30] While his writing shows a strong emphasis on Scripture, Bible selections are limited to those which speak to human beings' moral nature. Phrenology (in the upper story) was seen as a friend and helpmate to (lower level) Christianity. Sanctification and redemption are not supernatural phenomena but follow from complete self-government as provided by phrenology. Human nature is threefold: animal, moral, and intellectual, with the "inward man" (or law of mind) made up of the moral sentiments.

Charles Cowan, a British MD, published *Phrenology Consistent with Science and Revelation* in 1841, advocating harmony between scriptural Christianity (which he believed to be of Divine origin) and the science of phrenology.[31] Since God is the God of both nature and revelation, such harmony must exist. Any evidence we have of a future life, the immortality of the soul, or free agency, comes from direct revelation. Science, including phrenology, cannot interfere with revealed truths. All matter, including the brain, is an instrument of the Creator's will. Cowan disagreed with those of a more materialistic bent who proposed that the brain secreted thought.

Somewhat later another Scot, W. Easton, wrote *The Harmony of Phrenology and Scripture on the Doctrine of the Soul*. Easton's view is more sympathetic to a materialistic reading. "The truths of Nature discovered by science must be respected, and Scripture must accommodate itself to these truths."[32] The soul is not immortal nor is it an "invisible, immaterial second self." It exists and is manifested through the harmonious organization of the phrenological faculties.

Theologically the most conservative of the Christian phrenologists, William Scott held a high view of revelation yet wanted to vindicate phrenology.

In his book, *The Harmony of Phrenology with Scripture,* Scott stated that our phrenological faculties "require the aid of revelation and of spiritual influences to lead us to the ultimate ends of our being …"[33] The speculations of philosophy (including the science of phrenology) are subordinate to enlightened religious faith. The soul (or self) is a "simple and indivisible being of which the brain is the organ during life,"[34] and the phrenological faculties "are merely different states of this simple being; that the separate organs of the brain afford the means by which these states of mind are induced and manifested."[35]

Probably the most interesting of the Christian phrenologists, and certainly the most prolific and popular American phrenologist, was Orson Fowler (1809–1887).[36] Fowler promoted a phrenology that sounded more like a new religion than a science. Fowler's writings are liberally sprinkled with biblical references and phraseology. His is not the carefully thought-out argumentation of Combe, the lawyer, but reads more like revivalist preaching. His religious writings focused on more practical matters such as prayer, conversion, and the Sabbath. Most importantly, they contain a strong antisectarian element. Combe's deism certainly led him to speak out against sectarianism. In Fowler's case, however, the arguments take on a religious zeal. Sectarianism, but not Christianity, must be eliminated, and phrenology will accomplish it.

For Fowler, "Man has a soul—a spiritual essence—which sees without eyes, hears without ears, operates disembodied, and connects him with heaven, and with God."[37] Such talk is, however, misleading, for one's spiritual essence is due to the fact that one has an organ of spirituality. We have spirituality in the same sense in which we have color vision, because the brain is organized to make it possible. Fowler, like Combe, sought a scientific basis for religion. Being less theoretically oriented and operating in a climate that endorsed individual interpretation, he was deeply concerned with countering sectarianism. He can hardly be called a materialist of the eliminitivist variety. But he appears to have been committed to a form of methodological naturalism and perhaps even methodological materialism. Fowler's critique of Christianity, while questioning a number of orthodox doctrines by elevating reason over revelation, is in many ways a call for a purifying of Christianity.[38]

Note that by considering the views of this small sample of nineteenth-century Christians and deists seeking to relate the nineteenth-century "brain science" of phrenology with their religious beliefs, we find a wide variety of proffered solutions. Some wanted to *replace* religion with science (Combe), some to *purify* religion (Fowler), some to find in science *a friend and helpmate* (Clarke), some to *harmonize* science and faith (Cowan and Scott). The soul might use the brain or be a manifestation of its workings; revelation might be superior or inferior to the truths of science. However, those claiming to be Christian phrenologists found various ways to accommodate some degree of materialism and fatalism in terms of phrenological faculties while still maintaining a position within the Christian faith. In neurotheology, we will find a similar variety of viewpoints.

Neurotheology

At the 1997 annual conference of the Society for Neuroscience, V. S. Ramachandran presented findings from a study with epileptic patients. In that paper, Ramachandran referred to the "God module," a portion of the temporal lobes involved with religious experiences.[39] Upon learning of the research findings on this topic, a spokesman for Richard Harries, the Bishop of Oxford, said, "It would not be surprising if God had created us with a physical facility for belief."[40] Neurotheology is the general term used to describe the relationships between human brain functioning and religious or spiritual experiences and behavior. It is an unfortunate term in many ways, not least of which is that many so-called neurotheological investigations contain questionable neurology and/or theology.[41] Matthew Ratcliffe and Warren Brown have discussed some of the conceptual, methodological, and philosophical difficulties facing neurotheological investigations.[42]

While an exhaustive survey of neurotheology is beyond the scope of this article, we briefly examine some of the major research programs on the topic. In addition, we describe several studies related to the overall intent of neurotheology. After giving a general overview, our discussion is then limited to a sample of neuroscientists who have actually conducted research on or related to the topic. Finally, we examine several issues and problems common to both phrenology and neurotheology.

There is no single definition of neurotheology that will suffice for all current work being done. However, one starting place might be the response given by philosopher Matthew Alper to the interview question, "What do you mean exactly by a 'God' part of the brain?"

> What I mean by this is that the human species possesses a mechanism, an evolutionary adaptation in our brain—a religious/spiritual function—which compels us to perceive and believe that there exists a transcendental/supernatural quality in the universe. But differences of opinion exist as to whether the neural basis of religious experience involves a relatively localized region or a network of interconnected areas.[43]

Using the latest brain imaging techniques, researchers have claimed to identify the part or parts of our brains most active when we are meditating, praying, or seeking to be in touch with the Transcendent. The multicolored pictures from such brain scans make eye-catching media material and some dramatic results have been published and gained wide media exposure. Such findings echo the phrenologists' maps of the "spiritual bumps."[44] We begin with a sketch of various neurotheological questions and cautions.

In early attempts to localize where in the brain we make contact with the Transcendent, interest focused on what appeared to be an above-average reporting of visions in those suffering from some forms of epilepsy. This led to the idea that it was in the temporal lobes that the capacity for being in touch (or believing that one was in touch) with the Transcendent is localized.

One of the earliest volumes on this topic had the provocative title *Where God Lives in the Human Brain*. The authors, Carol Albright and James Ashbrook, believed they had begun to identify the elusive "God spot," and suggested that it is possible that we are indeed hardwired to seek God. For example, they wrote, "All that may be new here is an analysis that finds in the human brain a mirror of these *imagines Dei* and thus may suggest further ways of comprehending them."[45] Clarke would have approved of this statement.

A more recent advocate of the temporal lobe as the elusive "God spot" is writer and researcher Willoughby Britton. Reporting on Britton's work, Julia Keller wrote, "The temporal lobe, Britton said, is considered 'the God module,' the part of the brain that connects with the transcendent."[46] Others look elsewhere in the brain. Osamu Muramoto, a research neurologist, describes his interest in what might lead one to become hyper-religious. He writes,

> Hyper-religiosity may stem from increased activity in the medial prefrontal cortex of the brain … my theory is that the medial prefrontal cortex plays the role of the conductor of an orchestra in religiosity.[47]

Still others are more cautious in their interpretations. For example, Mario Beauregard who works in the Departments of Radiology and Psychology at the Université de Montréal is reported by Christopher Stawski as saying,

> Obviously, the external reality of God can neither be confirmed nor disconfirmed by delineating neural correlates of religious/spiritual/mystical experiences. In other words, the neuroscientific study of what happens to the brain during these experiences does not tell us anything new about God.[48]

Scott would have applauded this sentiment.

The distinguished Jewish physician Jerome Groopman expressed his concerns about some of the motivations for neurotheology when he wrote, "Why do we have this strange attempt, clothed in the rubric 'neurotheology,' to objectify faith with the bells and whistles of technology?"[49] He went on, "Man is a proper subject for study in the world of science. God is not."[50] While acknowledging that the possibility that we are intrinsically wired for spirituality cannot be dismissed, Groopman wisely notes that "as has been the case with all attempts to 'prove' the presence or intent of God, SPECT (brain) scans and cerebral anatomy fall far short of doing so."[51] He concludes,

> Indeed to believe that science is a way to decipher the divine, that technology can capture God's photograph, is to deify man's handiwork. And that, both religious mystics and scholars agree, is the essence of idolatry.[52]

What have we learned from the phrenologists that may be of help as we begin to review different contemporary approaches to brain research? Everyone, including scientists, comes to their work with presuppositions, sometimes whole systems of presuppositions that we call worldviews. It is even the case, at times, that the authority-carrying names of the past, the great writers, are replaced by some of today's

leading philosophers. But they, too, have presuppositions, and these should be examined when they have things to say about the implications of contemporary brain research.

Combe sought to use phrenology to attack traditional religious understandings of society and morals, and Fowler attempted to find a scientific basis for religion from phrenology. Both men believed their critiques were validated by the scientific facts of phrenology. Given that the principles of phrenology turned out to be based on bad science, what happened to their critiques? Phrenology seemed to provide scientific evidence for "spiritual bumps" on the brain's surface and an explanation of religious behavior and experience. Today, neurotheology has followed a similar process. Where will current explanations of religion stand when the neuroscience in neurotheology has moved on?

In the past, the leading figures such as Gall and Spurzheim looked over their shoulders at the powerful ecclesiastical and secular authorities of the day. It is not likely that today many scientists will be overly concerned about the views of ecclesiastical authorities. But there is an equal temptation to share and be influenced by widespread culturally determined views of human nature. One such set of views, shared by religious and nonreligious people, is an enduring package view of the human being as an immaterial something, whether of mind or soul, linked to a material base, the brain or body. There remains a lively debate among the well-informed about what contemporary neuroscience research on mind and brain relations means for our understanding of human nature, a debate which is sure to affect pronouncements on religion.

Another currently held view among many scientists is that of scientific naturalism. As Ronald Numbers points out, during the latter part of the nineteenth century, a widely accepted naturalism became more strident at the hands of scientists and philosophers such as Thomas H. Huxley and John Tyndall. The emerging scientific naturalism claimed to provide the "only reliable knowledge of nature, humans, and society."[53] Yet prior to Huxley and Tyndall, many scientists, those religiously inclined and those not, held to some form of methodological naturalism. Today, with the distinction between methodological and scientific naturalism blurred, many believe that to hold a religious position, especially one involving transcendence, entails a rejection of science. Within the context of those holding religious beliefs, and more specifically, some form of Christian belief, we saw that phrenology evoked a spectrum of different reactions. If we do not see the same variety of views today among neurotheologians, we should ask why that is the case.

With all that in mind, we now examine the major outlines of four models of neurotheology. The intent is not to critique these models but to present them as exemplars of current neuroscientific thinking on religious belief.

Michael Persinger

In 1987, Michael Persinger published *Neuropsychological Bases of God Beliefs* in which he argued that god beliefs are composed of two components: the god experience and the god concept.[54] According to Persinger, everyone experiences aberrant, but transient, electrical activity, especially in the right temporal lobe. However, the frequency of such activity is distributed in the population such that some individuals experience more of these temporal lobe transients (TLTs). This occurs because temporal lobe structures such as the amygdala and hippocampus are susceptible to electrical instability. TLTs are similar to micro-seizures but lack, for the most part, any motor component. Persinger targets the temporal lobe for several reasons. First, he relies on the work of others[55] to link temporal lobe epilepsy to temporal lobe personality, a condition supposedly characterized by hyper-religiosity, among other traits.[56] Persinger also argues that since the amygdala and hippocampus are structures associated with processing a sense of self and meaningfulness, those would be likely structures to give rise to what we term "religiosity."

Persinger's theory of the relationship between brain functioning and religious behavior and experience has two major features. It is reductionistic in that religious behavior and experience can be fully explained on the basis of temporal lobe functioning and verbal conditioning. It is also a theory that categorizes religiosity as resulting from abnormal brain functioning. While all individuals experience TLTs, religious individuals do so in a pathological manner.[57]

According to Persinger, our sense of self is maintained by structures in the left hemisphere. Activity

between the left and right hemispheres is usually matched. If activity becomes mismatched, as he proposes happens during TLT events, then the left hemisphere interprets right hemisphere activity as another self or "sensed presence." In addition, activation of amygdalar and hippocampal areas results in attributing intense personal meaning to experiences. Precipitating factors for TLT events include natural events, such as loss of blood sugar or increased right temporal lobe lability, and stressful situations, such as fasting, prolonged anxiety, and near-death events.[58]

Andrew Newberg

In *The Mystical Mind,* Eugene d'Aquili and Andrew Newberg aim to show that religious experience and, in particular, mystical experiences, can be understood as the outcome of the integrated functioning of specific processing units in the brain.[59] The generation of such experiences is neither the result of malfunctioning in these systems nor is it an epiphenomena of brain functioning. Rather, it is a primary function of these systems, working together, to generate religious experiences.[60]

In certain respects, d'Aquili and Newberg's model is an updated and more detailed version of one put forward by Michael Gazzaniga in his 1985 book, *The Social Brain*.[61] D'Aquili and Newberg propose an explanation of mystical experiences with a model based on the two divisions of the autonomic nervous system (one, ergotropic or arousing; the other, quiescent), portions of the limbic system (namely, the hippocampus and amygdala), and tertiary association areas of the neocortex which function as primary cognitive operators (holistic, reductionist, causal, abstractive, binary, quantitative, and emotional value operators). In addition to these components is added the process of deafferentation whereby incoming information to one component of the system is inhibited. When this happens that portion of the system functions on its own according to its own internal logic.[62]

Peter Brugger

While some researchers have investigated neurotheology on a grand scale, others have examined more limited topics. Peter Brugger's work falls into the latter category. Brugger has looked at the relationships between belief and various neuropsychological functions. For example, in a 2001 study, Brugger and associates contended that believers in the paranormal are more likely to form original associations presumably because believers adopt a looser response criterion when confronted with semantic noise.[63] Earlier work had shown that on a lateralized tachistoscopic lexical-decision task believers in ESP failed to display task-related hemispheric asymmetry. Nonbelievers displayed the expected right-visual field/left hemisphere dominance.[64] Brugger interpreted the results (enhanced left-visual field/right hemisphere performance) as indicative of right hemisphere processing bias among believers.

In another study, he showed that ESP believers perceived more meaningful patterns in visual noise, again indicating possible right hemisphere involvement.[65] This interpretation has been supported with electrophysiological evidence.[66] Those classified as strong believers in the paranormal differed from nonbelievers in terms of active, cerebral neural populations during resting state, and they showed relatively higher right hemispheric activation and reduced hemispheric asymmetry.[67]

It should be noted that Brugger has never portrayed his work as neurotheological. He sees his findings as relevant to an understanding of belief systems of schizophrenics and schizotypes. However, recently he stated, "The aptitude for drawing meaning from seeming abstraction must also inform psychic believers' worldview, which is so often colored by magical thinking and heightened spirituality."[68] Brugger may not draw the connection, but others have, between religious belief, schizotypal traits, and psychopathology.[69]

Mario Beauregard

In their book *The Spiritual Brain: A Neuroscientist's Case for the Existence of the Soul,* Mario Beauregard and Denyse O'Leary argue for three key ideas.

> The nonmaterialist approach to the human mind is a rich and vital tradition that accounts for the evidence much better than the currently stalled materialist one. Second, nonmaterialist approaches to the mind result in practical benefits and treatments, as well as promising approaches to phenomena that materialist accounts cannot even address. Lastly … our book shows that when spiritual experiences transform lives, the most reasonable explanation and the one that best accounts for all the evidence, is that people who have such experiences have actually contacted a reality outside themselves,

> a reality that has brought them closer to the real nature of the universe.[70]

For Beauregard, religious, spiritual, and/or mystical experiences (RSMEs) are neither a direct proof of the existence of God or the spiritual world, nor are they "nothing but" their associated brain states. RSMEs are, instead, a fundamental aspect of human nature.

What evidence does Beauregard present in favor of this nonmaterialist view? One key study included functional magnetic resonance imaging (fMRI) and quantitative electroencephalography (QEEG) of the mystical experiences of Carmelite nuns.[71] Beauregard and his colleagues concluded that mystical experiences are mediated by many brain regions and systems.[72] There is, in other words, no "God spot."[73] RSMEs, they conclude, are mediated by brain regions that subserve perception, cognition, emotion, body representation, and self-consciousness.[74]

Beauregard also draws on studies that indicate individuals are able to intentionally modify patterns of brain activity.[75] To explain why mental phenomena appear to alter brain activity, Beauregard proposes the psychoneural translation hypothesis in which the mind and brain "represent two epistemologically different domains that can interact because they are complementary aspects of the same transcendental reality."[76]

Where then does this leave us? Investigations of the relationship between brain functioning and religious and spiritual experiences and behavior emphasize neural systems and networks rather than centers, as did phrenology. Those networks are more circumscribed for some investigators than for others. Some take a materialist position, some a nonmaterialist one, and others are noncommittal. We found the same diversity of opinions in phrenology. In the last section, we turn to several issues and problems at the time of phrenology and ask what bearing they might have for neurotheology.

Issues and Problems

Empirical but Not Scientific

Franz Gall certainly believed that he was engaged in empirical, scientific work when he first laid out the principles of his "organology." Gall's position as an antivivisectionist led him to adopt noninvasive methods for investigating brain-behavior relationships. There is no question that Gall employed empirical techniques. He worked at a time before sophisticated statistical analyses had been developed, and yet he was attempting to correlate many measurements of the cranium with behavioral dispositions such as murder or aggression. This he attempted by measuring the heads of the living and the skulls of deceased individuals.

Stuart Zola-Morgan draws a distinction between Gall's descriptive anatomical research (for which he was and continues to be highly regarded) and his functional anatomical research, on which he based his organology. Even in this more speculative, functional anatomy, Gall attempted to proceed by empirical means. His collaborator, Spurzheim, however, did not share his scientific caution. As Zola-Morgan points out, Spurzheim "leaned more toward speculation and introspection."[77] This, plus Spurzheim's desire to popularize the findings of organology, contributed to his split with Gall. And once the process of popularization of phrenology was begun, the discipline continued in this speculative manner. Phrenologists were happy to point out Gall's "scientific basis" for phrenology; but no one was prepared to explore the discipline in a scientific manner. Very few were even prepared to carry out empirical observations, being content to use, as had Spurzheim, speculation and introspection.

There were no systematic attempts to formulate hypotheses about the location or functioning of phrenological organs and then rigorously test those hypotheses, particularly by trying to disprove them. It is not the case that phrenology was not scientific because it was not experimental. That misses the point. On the one hand, not all experiments are scientific and on the other hand, some descriptive investigations can follow the scientific method. Phrenology's descriptive statements, after Gall, were not based on rigorous and systematic observations. There was no good rationale for situating particular organs in particular spots. And disconfirming evidence was quickly and easily explained away.

Modern-day neurotheology runs the risk of following in phrenology's footsteps. No one doubts the mass of empirical data that has been collected relating brain activity and various measures of religiosity. The question is whether investigations of the *relationship* between brain activity and religious/spiritual activity have been scientific. While many neurotheological investigations would only claim

to be exploratory, some purport to be experimental in nature. But are these empirical data collected in support of hypotheses? One must ask whether the investigations are conducted in a manner that could, in principle, disprove the hypotheses. As was true for phrenology, there is a problem if investigations are designed only to collect confirming evidence or if results are explained in a *post hoc* manner.

Orson Fowler lacked convincing neurophysiological evidence for his phrenological claims about religious experience. By 1985, Michael Gazzaniga could cite numerous research findings in explaining how the brain processes information. His application of that knowledge to an understanding of religious belief was, however, highly speculative. From 1985 to 1999, the corpus of neurophysiological and neuropsychological knowledge had probably doubled or tripled. Nevertheless, neurotheological models, like the one proposed by d'Aquili and Newberg in *The Mystical Mind*, are disappointing on several counts. First, and foremost, while these models yield interesting hypotheses regarding some religious/spiritual experiences, their extension to more-garden-variety religious experiences, the ones experienced by the average "believer," is strained. Not only is the evidence for applying the models to such experiences lacking, but it is also unclear how these models would test hypotheses related to such phenomena.

Michael Persinger's temporal lobe model does not fare much better. He asserts that temporal lobe transients are a key element in explaining religious experiences. The purported microseizures are, however, sometimes too weak to detect. Perhaps technological advances will allow for measurement of these transients. However, until that happens, they appear to be a convenient fiction that fills in gaps in the theory. Persinger proposed "temporal lobe sensitivity" as a measure of one's susceptibility to these transients.[78] Unfortunately, the methodology used to measure temporal lobe sensitivity appears to have been flawed.[79] In addition, research linking temporal lobe epilepsy and religiosity has produced inconsistent and controversial results.[80]

The Relationship between Brain and Spiritual Activities

It is hard to imagine someone taking the position that religiosity, be it affective, perceptual, or behavioral, could occur without some accompanying brain activity. The position of a dualism between mind/soul and body might argue that activity could occur in the mind or soul without accompanying brain activity. But for that soul activity to find expression in the affective, perceptual, or behavioral life of the individual, areas of the brain would need to be involved.

What kinds of possible relationships might exist between brain and spiritual activities? The answer would appear to depend on how we define and then operationalize our terms. Defining what we mean by brain activity may not be a problem. Once we decide on the level we wish to examine (e.g., neurochemical, single-cell recording, patterns of blood flow), we would then choose an established procedure for making measurements. Of course, there is always the possibility that nonstandard or less commonly used procedures could be used (e.g., Persinger's transcranial stimulation procedure). This might raise questions about just what is being measured or manipulated.

Most would agree that spiritual activity is the more difficult part of the relationship to define and measure. Many neurotheological investigations have examined "extra-ordinary" aspects of spiritual activity such as visions, trances, and ecstasies.[81] More mundane aspects, such as reading and thinking about Holy Scriptures or participating in a worship service, have received less attention, although Brugger's work is a move in this direction. Perhaps there is an assumption that the mundane activities are subserved by the same brain systems that would be active when we read or think about nonholy writings or participate in nonreligious social activities. The "extra-ordinary" activities, on the other hand, might be supposed to involve unique brain circuits or at least some unique combination of circuits. Such a distinction would need to be justified, and to date no justification has been put forth. And then there are activities that might not even be considered by some as spiritual activities: feeding the poor, caring for the sick, visiting the prisoners.

These distinctions have led to debates about whether spiritual activity should be regarded as a way of perceiving, a way of experiencing, or a way of behaving. Studies such as the one by Azari and her colleagues argue that religious experience (at least the recitation of religious texts), rather than being an immediate affective event, is a cognitive event involving the reflexive evaluation of thought.[82]

Most researchers, however, seem to define spirituality or religiosity in terms of how we interpret the world or in affective terms.

It is usually assumed that phrenology explained human activity by emphasizing the size of a given phrenological organ. If someone had a large organ of veneration, that individual would be more prone to display behaviors and attitudes of devotion and respect. What is less well known is that phrenology also crafted explanations in terms of "networks" of brain areas. Taking veneration as an example, most phrenological charts show that organ in close proximity to the organs of spirituality, benevolence, hope, and firmness. Recall how Spurzheim proposed the interaction of numerous brain organs in producing religious behavior. When confronted with what looked to be disconfirming evidence (e.g., a devout individual who nonetheless appeared to have a very small organ of veneration), it was standard practice for phrenologists to point out the relative strengths and weaknesses of surrounding organs.

Many phrenologists resorted to such explanations in order to fudge their assessments of an individual's character. An analysis based on the relative size of individual organs was easier to comprehend and explain to others. Interpretations based on combinations of interacting organs was complicated, and although they might be invoked, they were seldom explicated. A similar path has occurred in neurotheology. Explanations of religious/spiritual behavior based simply on "temporal lobe activity" are no longer acceptable. Later models, like that of d'Aquili and Newberg, recognized the need to expand the number of brain areas involved. And Beauregard reported significant activity in many areas of the brains of the Carmelite nuns in his study. It would be neat and simple if there was a single "God spot" in the brain or perhaps abnormal activity in the temporal lobes and underlying limbic structures. However, it appears religious/spiritual behavior must be understood in terms of emotion, perception, self-consciousness, memory, and many other functions. The relationship between brain activity and religious/spiritual behavior may be diffuse and context-dependent; too much so, in fact, to build a neurotheology.

The Relationship between Natural Law and Spiritual Activity

In a brief *Newsweek* article, Kenneth Woodward commented that "… religion comprehends a whole range of acts and insights that acknowledge a transcendent order without requiring a transcendent experience."[83] While Woodward intended the article to address the distinction between religious feelings and a more full-orbed faith that expresses itself on a variety of levels, there is an assumption in his argument about the reality of a transcendent order.[84]

It can be argued that scientific investigations conducted in the context of neurotheology will, by definition, deal with the natural order of things. The question is, to what extent can a naturalistic understanding further our understanding of spiritual activity that is conceived as transcendent? Of course, one need not presume transcendence to be the correct position. There are a number of scholars today who argue instead for some version of a naturalistic understanding of religion. This is evident in a recent series of responses to Loyal Rue's book, *Religion Is Not About God*.[85] The variety of positions on this issue can be seen among phrenologists, some of whom argued for religion to be viewed as part of our natural make-up while others argued for religion as something revealed by God. Some believed that the science of phrenology informed our understanding of religion. Others held that revelation informed phrenological understanding. And of course, some believed that phrenology provided a complete explanation of religion. We should expect to see the same range of positions among those engaged in neurotheological investigation and debate.[86] And, of course, those holding differing theological stances will be more comfortable with some, but not other, neurotheological positions.

The Way Ahead

How might this review of phrenology help neurotheology avoid the kinds of errors that eventually brought phrenology into disrespect? This is important to consider while we keep an open mind about potential new insights regarding how our spirituality is both embodied in our physical make-up and, at the same time, embedded in a context of shared beliefs about the Transcendent. We suggest two main areas where caution is needed: careful attention to conceptualizing and operationalizing terms, and rigorous hypothesis testing.

Most investigators recognize the inherent difficulty in conceptualizing the theology portion of neurotheology. It will not do to simply refer to religious behavior or spirituality. At the same time,

the results of investigations of mystical experience or artificially induced "spiritual experiences" may not tell us much about the day-to-day religious behavior and experiences of most people. We also need to recognize the conceptual difficulties on the "neuro" side of the relationship. Brain-imaging techniques have provided tremendous insights into brain functioning, but there are questions about what such techniques can tell us about cognitive functioning, especially complex functions.[87] For neurotheology to advance, it will have to be engaged in a careful, critical discussion about what its underlying methodologies and technologies can tell us.

The second area of concern is related to the first. Phrenology quickly became divorced from any serious attempts to ground its findings in rigorous hypothesis testing. New adherents to the discipline tacked their own observations onto previous systems with little or no regard for empirical verification. While current neurotheological investigations are based on empirical research, most currently have an observational and descriptive tone. Advances will accrue when carefully crafted hypotheses, capable of being disconfirmed, are put to the test.

There may be too much concern about whether empirical neuroscientific research on religious and spiritual activities will support either a transcendental theological, or an antitheological position. As shown by several investigators,[88] theoretical and even worldview assumptions are sometimes underdetermined by their empirical research base. To those concerned that neuroscientific research will undermine their faith position, we encourage them to explore the conceptual linkages between the empirical base and possible worldview positions. On the flip side, we caution those committed to an antitheological (and especially an antitranscendental) worldview that theirs may not be the only position which can be legitimately derived from the empirical record. Phrenology was adopted by Christians, deists, agnostics, and atheists. A variety of neurotheological positions may likewise result from the same empirical base. ⋆

Notes

[1]For example, in 1664 the English anatomist Thomas Willis proposed that imagination was located in the corpus callosum while sensation and movement were situated in the corpus striatum (Thomas Willis, *"Cerebri anatome: cuiaccessit nervorum descriptio et usus,"* in *Thomas Willis: The Anatomy of the Brain and Nerves,* ed. J. Martyn and J. Allestry, Tercentenary ed., 1664–1964 [Montreal: McGill University Press, 1965]). A historical survey of brain anatomy and function can be found in Stanley Finger, *Origins of Neuroscience: A History of Explorations into Brain Function* (Oxford: Oxford University Press, 1994), 18–31.

[2]Gall accepted the labeling of the faculties from contemporary psychological teachings. Thus, relatively simple functions (as they then thought) such as vision, auditory memory, or orientation in space, were assigned to separate areas of the cortex. In addition, he localized such traits as "an instinct for the continuation of the race," a "love of parents," "sociability," "courage," "ambition," etc. There was immediate opposition to some of Gall's ideas of localization of function. The view that the brain is an aggregate of separate organs was rejected by some physiologists who supported an alternative localization theory. Previous to Gall, Albrecht von Haller (1708–1777), for example, while accepting that the brain is a single organ, had argued that it is composed of parts of equal importance. Half a century later, Pierre Flourens, in 1824 (Marie Jean Pierre Flourens, *Recherches expérimentales sur les propriétés et les fonctions du système nerveux, dans les animaux vertébrés*, 1st ed. [Paris: J. B. Ballière, 1824]. See also Marie Jean Pierre Flourens, *Recherches expérimentales sur les propriétés et les fonctions du système nerveux, dans les animaux vertébrés*, 2d ed. [Paris: J. B. Ballière, 1842]) based his alternative views on the results of his physiological experiments on animals. He noted that when isolated areas of the cerebral hemispheres of birds were destroyed, the behavior of the birds was nevertheless largely preserved and that there was approximately the same degree of recovery, whichever part of the cerebral hemispheres was destroyed.

[3]Owsei Temkin, "Gall and the Phrenological Movement," *Bulletin of the History of Medicine* 21, no. 3 (1947): 275–321.

[4]Arguments for and against structural differentiation in the cerebral cortex were to continue over the following centuries and are still alive and well today. However, the localizationist views were to progress and prevail. When Flourens was publishing his antilocalization observations, Bouillaud, soon to become head of the Paris Medical School, argued from his observations on patients, that the principle of localization extended to more complex processes such as speech (J. Bouillaud, "Recherches cliniques propres à démontrer que la perte de la parole correspond à la lésion des lobules antérieurs du cerveau et à confirmer l'opinion de M. Gall, sur le siège de l'organe du langage articulé," *Archives générales de médecine* VIII [1825]: 24–45; and J. Bouillaud, *Essai sur la philosophie médicale et sur les généralités de la clinique médicale* [Paris, 1836]). From then onwards, further reports, notably by Dax in 1836 (see H. W. Buckingham, "The Marc Dax (1770–1837)/Paul Broca (1824–1880) Controversy over Priority in Science: Left Hemisphere Specificity for Seat of Articulate Language and for Lesions That Cause Aphemia," *Clinical Linguistics and Phonetics* 20, no. 7–8 [2006]: 613–9); and Broca in 1861 (see Paul Broca, "Remarques sur le siège de la faculté du langage articulé; suivies d'une observation d'aphémie (perte de la parole)" (Remarks on the seat of the faculty of articulate language, followed by an observation of aphemia) in G. von Bonin, trans., *Some Papers on the Cerebral Cortex* [Springfield, IL:

Charles C. Thomas, 1960], 49–72) followed by those of Wernicke in 1874 (see Carl Wernicke, "Der aphasische Symptomenkomplex: eine psychologische Studie auf anatomischer Basis," in G. H. Eggert, trans., *Wernicke's Works on Aphasia: A Sourcebook and Review* [The Hague: Mouton, 1977]), accumulated many more findings and observations to support the localizationist views. The results of these three workers were focused on the localization of speech and language mechanisms in the left hemisphere of the brain.

[5]Franz J. Gall, *On the Functions of the Brain and of Each of Its Parts: With Observations on the Possibility of Determining the Instincts, Propensities, and Talents, or the Moral and Intellectual Dispositions of Men and Animals, by the Configuration of the Brain and Head* (Boston, MA: Capen and Lyon, 1835).

[6]J. G. Spurzheim, *A View of the Philosophical Principles of Phrenology* (London, 1825, 1826, 1840).

[7]George Combe, *The Constitution of Man Considered in Relation to External Objects* (London: Simpkin and Marshall, 1828).

[8]Orson Fowler, *The Practical Phrenologist, and Recorder and Delineator of the Character and Talents ...: A Compendium of Phreno-Organic Science* (Boston, MA: 1869).

[9]See John D. Davies, *Phrenology: Fad and Science – A 19th-Century American Crusade* (1955; Reprint, New Haven: Yale University Press, 1971).

[10]J. van Wyhe, "Was Phrenology a Reform Science? Towards a New Generalization for Phrenology," *History of Science* 42 (2004): 326. See also J. van Wyhe, "The Authority of Human Nature: The *Schädellehre* of Franz Joseph Gall," *British Journal for the History of Science* 35, no. 124 (2002): 17–42.

[11]Alister E. McGrath, "Enlightenment," in *The Blackwell Encyclopedia of Modern Christian Thought*, ed. Alister E. McGrath (Oxford: Blackwell Publishing, 1993), 150.

[12]John Hedley Brooke, *Science and Religion: Some Historical Perspectives* (New York: Cambridge University Press, 1991).

[13]Craig James Hazen, *The Village Enlightenment in America: Popular Religion and Science in the Nineteenth Century* (Chicago, IL: University of Illinois Press, 2000).

[14]McGrath ("Enlightenment," 150–6) has pointed out that the Enlightenment critique of Christianity had both general and specific aspects. At the general level, "an attitude of respect for the sciences, but condescension toward orthodox religion, was usually sustained by extolling the power of human reason" (Brooke, *Science and Religion*, 153). McGrath refers to this as the principle of the omnicompetence of human reason, arguing that it developed over several stages. Religious beliefs, being rational, could be critically examined and, in fact, could even be derived from reason itself, thus negating the need for divine revelation. Having thus attained this status, reason could judge religious beliefs and practices, eliminating irrational and superstitious elements. As we will see, one might argue that in neurotheology, the purported scientific "facts" related to neural functioning serve in the place of reason. "The concept of natural law provided another channel through which the achievements of science could be favorably compared with the effects of religious complacency" (McGrath, "Enlightenment," 154.). As Brooke explains, the physical sciences provided the model for the development of law-like explanations in the study of social structures and human nature. The proposed dichotomy between scientific reason and religious superstition "was often expressed through the complaint that institutionalized Christianity was a perversion of *natural* religion—a rational religion that would have been common to all humanity had it not been for the interference of priests" (Brooke, *Science and Religion*, 163). Together these assumptions promoted negative and sometimes hostile critiques of institutionalized religion, religion that was viewed as irrational and bigoted.

[15]Thomas Dixon, "Theology, Anti-Theology and Atheology: From Christian Passions to Secular Emotions," *Modern Theology* 15, no. 3 (1991): 297–330; Gary Hatfield, "Psychology, Philosophy, and Cognitive Science: Reflections on the History and Philosophy of Experimental Psychology," *Mind and Language* 17, no. 3 (2002): 207–32; Patrick McDonald, "Naturalistic Methodology in an Emerging Scientific Psychology: Lotze and Fechner in the Balance," *Zygon* 43, no. 3 (2003): 605–25; Ronald L. Numbers, "Science without God: Natural Laws and Christian Beliefs," in *When Science and Christianity Meet,* ed. David C. Lindberg and Ronald L. Numbers (Chicago, IL: The University of Chicago Press, 2003), 265–85.

[16]Franz J. Gall, *On Innate Dispositions* (Paris: Schoell, 1811), 292. See also Robert W. Rieber, "The Multiplicity of the Brain, the Unity of the Soul and the Duality of the Mind: Can You Have It All the Way?" (paper presented at the International Society for the History of the Neurosciences, Providence, RI, June 2003), note 3.

[17]Temkin, "Gall and the Phrenological Movement," 279.

[18]Robert Rieber has argued that Gall's statement about God and the brain is an example of the neopantheistic worldview held by Gall. It is these views which clashed with those of the Catholic Church in Austria. The church primarily embraced a Thomistic theory of causation diametrically opposed to any kind of pantheistic theory of causation. The place of potential conflict between true dogma and Gall's views is seen by Rieber as Gall's assumption that "living bodies are the result of the union of the body and soul" (Gall, *On Innate Dispositions*, 47). This position, Rieber says, was in direct opposition to the church's long-held dogma that placed the soul above any material object. This was important because of its pragmatic consequences, namely, pertaining to the notion of free will. Thus, the leaders of the church in Vienna saw Gall's unified theory of mind-body as a threat to the notion of free will, especially as related to their responsibility to guide all Catholics toward a proper form of moral conduct. All of this leads Rieber to conclude, "… it is my opinion that Gall was struggling, either consciously or unconsciously, with how to reconcile a holistic, monistic, theoretical concept of the organism, with an elementalistic brain-mind faculty type of psychology" (Rieber, "The Multiplicity of the Brain, the Unity of the Soul and the Duality of the Mind," 18). This struggle continues today in discussions of the nature of the soul. See, for example, Malcolm A. Jeeves, ed., *From Cells to Souls and Beyond: Changing Portraits of Human Nature* (Grand Rapids, IL: Wm. B. Eerdmans Publishing, 2004).

[19]McDonald, "Naturalistic Methodology in an Emerging Scientific Psychology," 605–25. For an argument advocating methodological naturalism for all scientists, regardless of religious commitments, see Patrick McDonald and Nivaldo

J. Tro, "In Defense of Methodological Naturalism," *Christian Scholar's Review* 38, no. 2 (2009): 201–29.

[20]See Dixon, "Theology, Anti-Theology and Atheology," 297–330; and Numbers, "Science without God," 265–85 for a similar argument.

[21]Spurzheim, *A View of the Philosophical Principles of Phrenology*, 100–8.

[22]J. G. Spurzheim, *Phrenology, or the Doctrine of the Mental Phenomena* (Philadelphia, PA: 1838), 94.

[23]Ibid., 97.

[24]Dixon, "Theology, Anti-Theology and Atheology," 299.

[25]George Combe's first phrenology book, *Essays on Phrenology, or an Inquiry into the Principles and Utility of the System of Drs Gall and Spurzheim, and into the Objections Made against It* (Edinburgh: Bell and Bradfute) appeared in 1819, with *Elements of Phrenology* (London: Simpkin and Marshall) published in 1824. Along with his brother Andrew and others, he established the Edinburgh Phrenological Society in 1820. Around 1826, Combe began presenting his views to the Society, and in 1828, he published his most famous work, *The Constitution of Man Considered in Relation to External Objects*. A heated controversy arose from those discussions that led to a split in the Society between the evangelical Christians in the group and those taking Combe's more deistic view. In 1847, Combe produced a pamphlet titled, "The Relation between Religion and Science." Years later, Combe revised and expanded this work to a full-length book which he published with the slight title change, *On the Relation between Science and Religion* (Edinburgh: Maclachlan and Stewart, 1857). Combe's other work dealing with science and religion, *An Inquiry into Natural Religion: Its Foundation, Nature, and Applications,* appeared in 1853 [not published, but confidentially communicated by the author].

[26]Combe, *On the Relation between Science and Religion*, 216–7.

[27]Combe, *An Inquiry into Natural Religion: Its Foundation, Nature, and Applications*, 173.

[28]Ibid., 175.

[29]Charles Caldwell, *Thoughts on the True Connexion of Phrenology and Religion, in a Letter to the Editor of the* American Phrenological Journal and Miscellany*, in Philadelphia* (Louisville, KY: J. Maxwell Jr., 1839).

[30]Henry Clarke, *Christian Phrenology; or the Teachings of the New Testament Respecting the Animal, Moral, and Intellectual Nature of Man* (Dundee: Advertiser Office, 1835).

[31]Charles Cowan, *Phrenology Consistent with Science and Revelation* (London: Sherwood and Co., 1841).

[32]W. Easton, *The Harmony of Phrenology and Scripture on the Doctrine of the Soul* (Edinburgh: Printed for the Author by Dr. R. Collie and Son, 1867), 33.

[33]William Scott, *The Harmony of Phrenology with Scripture: Shewn in a Refutation of the Philosophical Errors Contained in Mr Combe's "Constitution of Man"* (Edinburgh: Fraser and Co., 1837), 6.

[34]Ibid., 178.

[35]Ibid.

[36]Fowler was waiting to enter Lane Theological Seminary in the fall of 1833 in preparation for the ministry. That summer, however, he and classmate Henry Ward Beecher began lecturing on phrenology. The enterprising Orson gave character readings of his classmates' heads at two cents each. At the end of the summer and with forty dollars in his pocket, Fowler abandoned the ministry of the church for the ministry of phrenology (Davies, *Phrenology: Fad and Science – A 19th-Century American Crusade*, 31–2). Nathan Hatch has pointed out that deep and powerful undercurrents of democratic Christianity distinguish the United States from other modern industrial democracies. These currents insured that churches did not withhold faith from the rank and file. Instead, religious leaders challenged them to think, to interpret Scripture, and to organize the church for themselves. Religious populism, reflecting the passions of ordinary people and the charisma of democratic movement-builders, remains among the oldest and deepest impulses in American life (Nathan O. Hatch, *The Democratization of American Christianity* (New Haven, CT: Yale University Press, 1989), 5. See also Christopher G. White, "Minds Intensely Unsettled: Phrenology, Experience, and the American Pursuit of Spiritual Assurance, 1830–1880," *Religion and American Culture: A Journal of Interpretation* 16, no. 2 (2006): 227–61.

[37]Orson Fowler, *Religion; Natural and Revealed: or, the Natural Theology and Moral Bearings of Phrenology and Physiology, etc.* (New York: Fowler and Wells, 1844), 95.

[38]In 1843 he published *The Christian Phrenologist* with the alternative title *The Natural Theology and Moral Bearings of Phrenology; Its Aspect on, and Harmony with Revelation. Religion; Natural and Revealed*, published by Fowler in 1844, was written in a flowery evangelical style. And while he argues that phrenology provides the strongest arguments in favor of an immaterial soul, this spiritual aspect of human nature is to be understood in the same sense as having "a friendly nature, or an observing nature, or a moving nature" (p. 117). The mind, for Fowler, is known only as it manifests itself and acts by means of the phrenological organs. Natural religion (as discovered by the science of phrenology) uncovers our moral nature. Revealed religion (as discerned from Scripture) builds on this foundation "a system of doctrines and conditions of salvation" (p. 21).

[39]V. Ramachandran, W. Hirstein, K. Narmel, E. Tecoma, and V. Iragui, "The Neural Basis of Religious Experience" (paper presented at the annual conference of The Society for Neuroscience, New Orleans, LA, October 25–30, 1997): 23.

[40]Steve Connor, "'God Spot' Is Found in Brain," *LA Times*, October 29, 1997, http://cas.bellarmine.edu/tietjen/images/new_page_2.htm (last accessed September 2, 2010).

[41]Some recent, more narrowly focused work provides welcome exceptions. For example, see Andrea Hollingsworth, "Implications of Interpersonal Neurobiology for a Spirituality of Compassion," *Zygon* 43, no. 4 (2008): 837–60; Brick Johnstone and Bret A. Glass, "Support for a Neuropsychological Model of Spirituality in Persons with Traumatic Brain Injury," *Zygon* 43, no. 4 (2008): 861–74; and the discussion below of Peter Brugger's work.

[42]Matthew Ratcliffe, "Neurotheology: A Science of What?" in *Where God and Science Meet: How Brain and Evolutionary Studies Alter Our Understanding of Religion,* ed. Patrick McNamara (Westport, CT: Praeger, 2006), 81-104; Warren S. Brown, "The Brain, Religion, and Baseball: Comments on the Potential for a Neurology of Religion and Religious Experience," in *Where God and Science Meet,* ed. McNamara, 229–244.

[43]F. Tremblay, an interview with Matthew Alper, posted July 1, 2003, www.suite101.com/article.cfm/rational_spirituality/101114/1 (last accessed September 2, 2010).

[44]There is a danger, however, in assuming that these brain images provide the same type of evidential devices as normal photographs. As Roskies states, "We do not 'see through' the visual properties of neuroimages to the visual properties of their subjects; we do not understand the causal and counterfactual relationships between the images and the data they represent to the same extent that we understand them with photography." Adina L. Roskies, "Are Neuroimages like Photographs of the Brain?" *Philosophy of Science* 74 (2007): 871.

[45]Carol R. Albright and James B. Ashbrook, *Where God Lives in the Human Brain* (Naperville, IL: Sourcebooks, 2001), 164.

[46]Julia Keller, "Brushes with Death Transform Life and the Brain," *Science and Theology Research News* (June 2004): 8.

[47]Muramoto Osamu, an interview on "Cortex Keeps Time in the Brain's Religious Orchestra," *Science and Theology Research News* (June 2004): 9.

[48]C. Stawski and M. Beauregard, "Spiritual Transformation Q&A: Mario Beauregard," *The Global Spiral* (March 1, 2004): www.metanexus.net/Magazine/ArticleDetail/tabid/68/id/10321/Default.aspx (last accessed September 2, 2010)

[49]Jerome Groopman, "God on the Brain," *The New Yorker* (September 17, 2001): 168.

[50]Ibid.

[51]Ibid.

[52]Ibid.

[53]Numbers, "Science without God: Natural Laws and Christian Beliefs," 281.

[54]"God Experiences are transient phenomena that are loaded with emotional references. The nature of the experiences is influenced by the specific portion of the brain from which they originate. God Concepts are determined by verbal conditioning" (Michael A. Persinger, *Neuropsychological Bases of God Beliefs* [New York: Greenwood Press, 1987], 1).

[55]D. M. Bear and P. Fedio, "Quantitative Analysis of Interictal Behavior in Temporal Lobe Epilepsy," *Archives of Neurology* 34 (1977): 454–67.

[56]However, see D. M. Tucker, R. A. Novelly and P. J. Walker, "Hyperreligiosity in Temporal Lobe Epilepsy: Redefining the Relationship," *Journal of Nervous and Mental Disease* 175, no. 3 (1987): 181–4.

[57]There is, however, some ambiguity on this point since Persinger also asserts that TLTs can arise in normally healthy individuals.

[58]Michael A. Persinger, "Religious and Mystical Experiences as Artifacts of Temporal Lobe Function: A General Hypothesis," *Perceptual and Motor Skills* 57 (1983): 1255–62; Michael A. Persinger, "The Sensed Presence within Experimental Settings: Implications for the Male and Female Concept of Self," *The Journal of Psychology* 137, no. 1 (2003): 5–16; L. S. St.-Pierre and M. A. Persinger, "Experimental Facilitation of the Sensed Presence Is Predicted by the Specific Patterns of the Applied Magnetic Fields, Not by Suggestibility: Re-analyses of 19 Experiments," *International Journal of Neuroscience* 116 (2006): 1079–96.

[59]Eugene G. d'Aquili and Andrew B. Newberg, *The Mystical Mind: Probing the Biology of Religious Experience* (Minneapolis, MN: Fortress Press, 1999).

[60]Based on their model, which was originally developed to explain mystical experiences in general, they propose expanding their neurotheology into a metatheology. While devoid of specific theological content, this metatheology provides the rules by which any given theology can be generated. And finally, they use their neurotheology to construct the outlines for a megatheology which would contain most of the key elements of the world's major religions. From the functioning of the fight-or-flight response of the autonomic nervous system and association areas of the neocortex to a theology of theologies, this is the scope of *The Mystical Mind*.

[61]Michael Gazzaniga, *The Social Brain: Discovering the Networks of the Mind* (New York: Basic Books, 1985). Writing about the "inevitability of religious beliefs," Gazzaniga proposed systems of the brain that are built to interpret events around us, and systems that provide the capacity for magical thinking. In some not-so-obvious manner, unexplained happenings are processed through these systems and the result is religious belief.

[62]For additional comments on neurotheology by d'Aquili and Newberg, see "The Neuropsychological Basis of Religions, or Why God Won't Go Away," *Zygon* 33, no. 2 (1998): 187–201; "The Neuropsychology of Aesthetic, Spiritual, and Mystical States," *Zygon* 35, no. 1 (2000): 39–51; "The Creative Brain/the Creative Mind," *Zygon* 35, no. 1 (2000): 53–68; Newberg, "Putting the Mystical Mind Together," *Zygon* 36, no. 3 (2001): 501–7; Newberg and Bruce Y. Lee, "The Neuroscientific Study of Religious and Spiritual Phenomena: or Why God Doesn't Use Biostatistics," *Zygon* 40, no. 2 (2005): 469–89; Newberg, "Religious and Spiritual Practices: A Neurochemical Perspective," in *Where God and Science Meet,* ed. McNamara, 15–31.

[63]L. R. R. Gianotti et al., "Associative Processing and Paranormal Belief," *Psychiatry and Clinical Neurosciences* 55 (2001): 595–603.

[64]P. Brugger et al., "Functional Hemispheric Asymmetry and Belief in ESP: Towards a Neuropsychology of Belief," *Perceptual and Motor Skills* 77 (1993): 1299–308.

[65]P. Brugger et al., "Meaningful Patterns in Visual Noise: Effects of Lateral Stimulation and the Observer's Belief in ESP," *Psychopathology* 26 (1993): 261–5.

[66]D. Pizzagalli et al., "Brain Electric Correlates of Strong Belief in Paranormal Phenomena: Intracerebral EEG Source and Regional Omega Complexity Analyses," *Psychiatry Research: Neuroimaging Section* 100 (2000): 139–54.

[67]Recently, Brugger has summarized much of his research on this topic in his article, "Tracking a Finer Madness," *Scientific American Mind* 18, no. 5 (2007): 76–9.

[68]Ibid., 76.

[69]J. Maltby et al., "Religious Orientation and Schizotypal Traits," *Personality and Individual Differences* 28 (2000): 143–51; E. Peters, "Are Delusions on a Continuum? The Case of Religious and Delusional Beliefs," in *Psychosis and Spirituality: Exploring the New Frontier,* ed. I. Clarke (London: Whurr Publishers, 2001), 191–207; M. Jackson and K. W. M. Fulford, "Spiritual Experiences and Psychopathology," *Philosophy, Psychiatry, and Psychology* 4, no. 1 (1997): 41–65.

[70]M. Beauregard and D. O'Leary, *The Spiritual Brain: A Neuroscientist's Case for the Existence of the Soul* (New York: HarperOne, 2007), xvi.

[71]The nuns were not actually engaged in a mystical experience but were instructed to remember and re-live a mystical experience.

[72]To be sure they found, as have others, significant activity in the temporal lobe. But they also report significant activity in the inferior parietal lobule, caudate nucleus, left brain stem, visual cortex, left anterior cingulate cortex, right medial prefrontal cortex, left insula, right superior parietal lobule, right medial orbitofrontal cortex, and right middle temporal cortex.

[73]M. Beauregard and V. Paquette, "Neural Correlates of a Mystical Experience in Carmelite Nuns," *Neuroscience Letters* 405 (2006): 186–90; M. Beauregard et al., "The Neurobiology of the Mystical Experience: A Quantitative EEG Study" (paper presented at the annual conference of the Society for Neuroscience, San Diego, CA, October 23–27, 2004).

[74]Beauregard and O'Leary, *The Spiritual Brain*, 272.

[75]Research has been conducted with patients with obsessive-compulsive disorder: J. M. Schwartz et al., "Systematic Changes in Cerebral Glucose Metabolic Rate after Successful Behavior Modification Treatment of Obsessive-Compulsive Disorder," *Archives of General Psychiatry* 53 (1996): 109–13; healthy young men suppressing sexual arousal: M. Beauregard, J. Lévesque and P. Bourgouin, "Neural Correlates of Conscious Self-Regulation of Emotion," *Journal of Neuroscience* 21, RC165 (2001): 1–6 and M. Beauregard, J. Lévesque and V. Paquette, "Neural Basis of Conscious and Voluntary Self-Regulation of Emotion," in *Consciousness, Emotional Self-Regulation and the Brain,* ed. M. Beauregard (Amsterdam: John Benjamins, 2004), 163–94; healthy adult women experiencing sadness: J. Lévesque et al., "Neural Circuitry Underlying Voluntary Suppression of Sadness," *Biological Psychiatry* 53 (2003): 502–10; children experiencing sadness: J. Lévesque et al., "Neural Basis of Emotional Self-Regulation in Childhood," *Neuroscience* 129 (2004): 361–9; spider phobia sufferers: V. Paquette et al., "Change the Mind and You Change the Brain: Effects of Cognitive-Behavioral Therapy on the Neural Correlates of Spider Phobia," *Neuroimage* 18, no. 2 (2003): 401–9; Parkinson's patients given placebo treatment for tremor relief: R. de la Fuente-Fernández et al., "Expectant and Dopamine Release: Mechanism of the Placebo Effect in Parkinson's Disease," *Science* 293 (August 10, 2001): 1164–6; and healthy adult men given placebo treatment for experimentally induced pain: T. D. Wager et al., "Placebo-Induced Changes in fMRI in the Anticipation and Experience of Pain," *Science* 303, no. 5661 (2004): 1162–7.

[76]Beauregard and O'Leary, *The Spiritual Brain*, 150.

[77]S. Zola-Morgan, "Localization of Brain Function: The Legacy of Franz Joseph Gall (1758–1828)," *Annual Review of Neuroscience* 18 (1995): 371.

[78]K. Makarec and M. A. Persinger, "Temporal Lobe Signs: Electroencephalographic Validity and Enhanced Scores in Special Populations," *Perceptual and Motor Skills* 60 (1985): 831–42; K. Makarec and M. A. Persinger, "Electroencephalographic Validation of a Temporal Lobe Signs Inventory in a Normal Population," *Journal of Research in Personality* 24 (1990): 323–37; M. A. Persinger and L. Makarec, "Complex Partial Epileptic-Like Signs as a Continuum from Normals to Epileptics: Normative Data and Clinical Populations," *Journal of Clinical Psychology* 49 (1993): 33–45.

[79]W. S. Brown and C. Caetano, "Conversion, Cognition and Neuropsychology," in *Handbook of Conversion,* ed. H. N. Malony and S. Southard (Birmingham, AL: Religious Education Press, 1992), 147–58.

[80]Steven C. Schachter, "Religion and the Brain: Evidence from Temporal Lobe Epilepsy," in *Where God and Science Meet,* ed. McNamara, 171–88.

[81]See J. L. Saver and J. Rabin, "The Neural Substrates of Religious Experience," *The Journal of Neuropsychiatry and Clinical Neurosciences* 9 (1997): 498–510.

[82]N. P. Azari et al., "Neural Correlates of Religious Experience," *European Journal of Neuroscience* 13 (2001): 1649–52. See also N. P. Azari, "Neuroimaging Studies of Religious Experience: A Critical Review," in *Where God and Science Meet*, ed. McNamara, 33–54.

[83]K. Woodward, "Faith Is More than a Feeling: The Problem with Neurotheology Is That It Confuses Spiritual Experiences—Which Few Believers Actually Have—with Religion," *Newsweek* (May 7, 2001): 58.

[84]Transcendence, in religion, refers to that which is beyond physical existence. God may be said to be transcendent in the sense that God is independent of and beyond the physical reality in which we live. Two other theological positions have also been proposed: immanentism, in which the divine exists within the physical or natural order, and pantheism, where the divine is indistinguishable from the natural order. It should be clear that the position one holds will greatly influence how one conceptualizes the relationship between natural law and spiritual activity.

[85]Loyal Rue, *Religion Is Not About God: How Spiritual Traditions Nurture Our Biological Nature and What to Expect When They Fail* (New Brunswick, NJ: Rutgers University Press, 2005). For responses to Rue's thesis, see Donald M. Braxton, "Religion is Not About God—Responding to Loyal Rue," *Zygon* 42, no. 2 (2007): 317–41; David E. Klemm, "Religious Naturalism or Theological Humanism?" *Zygon* 42, no. 2 (2007): 357–67; Leslie Marsh, "Taking the *Super* out of the Supernatural," *Zygon* 42, no. 2 (2007): 343–56; and William A. Rottschaefer, "Mythic Religious Naturalism," *Zygon* 42, no. 2 (2007): 369–408.

[86]These distinctions have led to debates about whether spiritual activity should be regarded as a way of perceiving, a way of experiencing, or a way of behaving. In so far as "spirituality" is a fundamental aspect of religion, these distinctions bring to mind Bartlett's Riddell Memorial lectures entitled "Religion as Experience, Action and Belief" in which he argues that there is evidence that religion in all its variety and richness at times includes all of these. Studies such as the one by Azari (see note 82) argue that religious experience (at least the recitation of religious texts), rather than being an immediate affective event, is a cognitive event involving the reflexive evaluation of thought. Most researchers seem to define spirituality or religiosity either in affective terms or in terms of how we interpret the world.

[87]For differing views on the ability of brain imaging techniques to elucidate cognitive functioning, see M. Brett, I. S. Johnsrude and A. M. Owen, "The Problem of Functional Localization in the Human Brain," *Nature Reviews: Neuro-*

science 3 (2002): 243–9; David Dobbs, "Fact or Phrenology?" *Scientific American Mind* 16, no. 1 (2005): 24–31; David I. Donaldson, "Parsing Brain Activity with fMRI and Mixed Designs: What Kind of State Is Neuroimaging In?" *Trends in Neuroscience* 27, no. 8 (2004): 442–4; Karl Friston, "Beyond Phrenology: What Can Neuroimaging Tell Us about Distributed Circuitry?" *Annual Review of Neuroscience* 25 (2002): 221–50; John-Dylan Haynes and Geraint Rees, "Decoding Mental States from Brain Activity in Humans," *Nature Reviews: Neuroscience* 7 (2006): 523–34; D. J. Heeger and D. Ress, "What Does fMRI Tell Us about Neuronal Activity?" *Nature Reviews: Neuroscience* 3 (2002): 142–51; S. M. Kosslyn, "If Neuroimaging Is the Answer, What Is the Question?" *Philosophical Transactions of the Royal Society of London B* 354 (1999): 1283–94; N. K. Logothetis and B. A. Wandell, "Interpreting the BOLD Signal," *Annual Review of Physiology* 66 (2004): 753–69; C. B. Nemeroff, C. D. Kilts, and G. S. Burns, "Functional Brain Imaging: Twenty-First Century Phrenology or Psychobiological Advance for the Millennium?" *American Journal of Psychiatry* 156, no. 5 (1999): 671–3; R. A. Poldrack and A. D. Wagner, "What Can Neuroimaging Tell Us about the Mind? Insights from the Prefrontal Cortex," *Current Directions in Psychological Science* 13, no. 5 (2004): 177–81; and William R. Uttal, *The New Phrenology: The Limits of Localizing Cognitive Processes in the Brain* (Cambridge, MA: MIT Press, 2001).

[88]For early emotion research, see Dixon, "Theology, Anti-Theology and Atheology: From Christian Passions to Secular Emotions," 297–330; and for early psychophysics research, see McDonald, "Naturalistic Methodology in an Emerging Scientific Psychology," 605–25.

Note from the Editor

I am pleased to present a tabular breakdown of the articles submitted to *PSCF* during the period from August 1, 2009 through July 31, 2010.

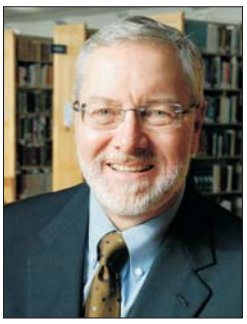
Statistics: August 1, 2009–July 31, 2010

Articles and Communications	Total Submitted	Accepted	Pending	Rejected	Submitted by ASA/CSCA	Accepted from ASA/CSCA
Apologetics	1	0	0	1	0	0
Biology	2	1	0	1	2	1
Computers/AI	1	0	0	1	0	0
Cosmology	1	0	0	1	0	0
Design/ID	5	2	1	2	3	2
Environment	5	0	0	5	1	0
Evolution	6	0	1	5	4	0
Mathematics	2	0	0	2	0	0
Medicine	3	0	0	3	1	0
Philosophy	2	0	0	2	2	0
Physical Science	7	1	2	4	3	1
Sci/Rel/HOS	7	3	0	4	4	2
Social Sciences	12	6	0	6	5	4
Theology	16	4	1	11	6	1
Scripture/Science	3	0	0	3	2	0
YEC/Flood	1	1	0	0	1	1
Essay Review	2	2	0	0	2	2
Totals	**76**	**20 (26.3%)**	**5 (6.6%)**	**51 (67.1%)**	**36 (47.4%)**	**14 (18.4%)**

Arie Leegwater, *Editor*
leeg@calvin.edu

C. S. Lewis on Evolution and Intelligent Design

Michael L. Peterson



Michael L. Peterson

This article is a comprehensive study of the views of Christian author and apologist C. S. Lewis on the theory of evolution and the argument from intelligent design. It explains how he would distinguish expressly philosophical arguments for a Transcendent Mind from the current claims of the intelligent design (ID) movement to provide scientific evidence for such a reality. It also expounds Lewis's important distinction between evolution as a highly confirmed scientific theory and evolution as co-opted by naturalistic philosophy. In the end, Lewis's rich Trinitarian framework—stemming from his commitment to historic orthodoxy, or "mere Christianity"—is developed as a context for how he engaged all human knowledge, which includes his acceptance of evolution as well as his criticism of ill-conceived versions of the design argument.

> *Always be prepared to give an answer to everyone who asks you to give the reason for the hope that you have. But do this with gentleness and respect.* 1 Peter 3:15 (NIV)

Probably no other modern Christian thinker fulfills this admonition better than C. S. Lewis as he engaged in what may be called intellectual evangelism, pre-evangelism, natural theology, or apologetics. Consider a well-known passage in Lewis:

> If all the world were Christian it might not matter if all the world were uneducated. But, as it is, a cultural life will exist outside the Church whether it exists inside or not. To be ignorant and simple now—not to be able to meet the enemies on their own ground—would be to throw down our weapons [and have] no defense against … intellectual attacks … Good philosophy must exist, if for no other reason, because bad philosophy needs to be answered. The cool intellect must work … against the cool intellect on the other side …[1]

Lewis is saying here that Christian faith has intellectual content that can effectively engage the best information from all fields of knowledge as well as opposing points of view. This article explores how Lewis relates historic, orthodox belief—or, "mere Christianity"—to the debate between Evolution and intelligent design, and then shows how he incorporates these subjects into his Trinitarian vision of reality.[2]

Early in the twentieth century, some religious groups objected to Evolution because it contradicts a literal interpretation of Genesis.[3] The "creation science"

Michael L. Peterson *is professor of philosophy at Asbury University. He has written or been senior author of five books, including* Reason and Religious Belief *(Oxford);* God and Evil *(Westview);* With All Your Mind: A Christian Philosophy of Education *(Notre Dame); and* Evil and the Christian God *(Baker). He has edited* Philosophy of Religion: Selected Readings *(Oxford);* Contemporary Debates in Philosophy of Religion *(Blackwell); and* The Problem of Evil: Selected Readings *(Notre Dame). He is working on* Christian Theism and Atheism Engage Evolution: Michael Peterson and Michael Ruse in Debate. *Peterson's chapters appear in* Encountering Religious Diversity: Contemporary Challenges, Global Responses; The Oxford Handbook of Eschatology; Blackwell Companion to Philosophy of Religion; The Chronicles of Narnia and Philosophy; C. S. Lewis as Philosopher: Truth, Goodness, and Beauty; Handbook on Science and Religion; *and* Basketball and Philosophy: Thinking outside the Paint. *He is managing editor of* Faith and Philosophy.

movement was formed to provide scientific support for this position, which included commitment to a young earth (approximately 6,000–10,000 years old), the fixity of biological species, and the direct creation of Adam. The Creation Museum near Cincinnati, Ohio, energetically marketed in parts of the Christian community, represents a relatively recent expression of this approach. In the late 1990s, the "intelligent design" (ID) movement emerged, still rejecting evolutionary principles and purporting to have a hot, new scientific argument for God.

What is Evolution, scientifically speaking? All too briefly, *cosmic evolution* refers to the process of development of the universe—beginning with the Big Bang 13.7 billion years ago and, through many stages, producing all of the chemical elements, all of the galaxies, planets, and other constituents of the cosmos. *Biological evolution* refers to the origin and development of life on this planet, through many forms and species, including the appearance of human beings on one branch of the Tree of Life with common genetic ties to chimpanzees and other primates. All of the natural sciences converge and tell this story, from astronomy to geology, from paleontology to biology.

Lewis on Intelligent Design

Lewis stands within the long Christian tradition of natural theology: the enterprise of giving reasons for the existence of an Ultimate Being or God, reasons that are based on some feature of the world rather than on special revelation.[4] The classic approaches may be summarized as follows:

- *Cosmological Argument:* God as the cause of the existence of the universe
- *Moral Argument:* God as the source of moral law and our consciousness of it
- *Teleological Argument:* God as the cause of rational, lawful, end-directed order in the universe.

Obviously, the teleological argument is about a Transcendent Intelligence that accounts for the rational order of nature—and supreme intelligence is obviously a characteristic of the theistic deity. Historically, labels such as "argument from design" and "design argument" have also been used to refer to some versions of teleological argument. The various arguments for an Intelligence beyond nature should be seen as forming a "family" of teleological or design-type arguments. In the past several decades, a new approach, drawing from science and articulated in elaborate mathematical detail, has been added to the family:

- *The Fine-Tuning Argument:* God as the source of the surprising precision and interrelation of nature's physical constants, from the beginning state of the universe onward, which makes the universe exactly suited for life, including intelligent life. (The anthropic principle involved here is that the universe is fine-tuned for intelligent life.)[5]

Clearly, natural theology as a whole includes a number of different kinds of arguments for an Ultimate Being. The cosmological argument keys on the power of the Ultimate Being while the moral argument focuses on its moral nature. Additionally, several arguments fall within the family of design-type arguments. Whereas the intelligence of the Ultimate Being is implicit in the cosmological and moral arguments, it is the explicit conclusion of design-type arguments.

As a classicist, Lewis knew about such traditional lines of reasoning pointing to an Intelligence behind nature. He also added some reasoning of his own, arguing in *Miracles* that, in order for human thought to be rational, it must be free: we must be able to form beliefs by a logical process that is not completely determined by physical processes in the brain. However, a naturalistic worldview, observes Lewis, assumes that matter and its operations are the foundation of all phenomena, including what we call rational thought. It is at this very point that he says Naturalism is self-defeating: it undercuts rational thought by subsuming it under physical causation and therefore removes any basis for regarding human thought as rational, and for regarding the naturalist's belief in Naturalism as rational.[6] Lewis further argues that finite rationality is best explained by something outside of nature which must be more like a Mind than anything else. This is Lewis's "argument from reason"—not technically a design-type argument but a closely related consideration pertaining to a Transcendent Intelligence.[7]

Lewis also advanced a fascinating "argument from desire": it begins with the idea that every natural human desire (such as hunger and thirst) corresponds to some real object which satisfies that desire (food, water). But human beings also have a deep natural longing which cannot be satisfied by finite and temporal things, no matter how good or beautiful, and can only be satisfied by something Infinite.

This poignant human longing—which Lewis calls by the German word *Sehnsucht*—is best understood as the deep desire for enduring joy, which, of course, the temporal realm does not contain. The conclusion, then, is that there must be an Ultimate Being, which people call God, whose existence alone can satisfy this longing.[8] I cannot pursue the nuances of this argument here, but certainly the satisfaction of this natural desire of rational creatures would require a rational Being. So, the idea of a Transcendent Intelligence is implicit in this interesting piece of reasoning.

Additionally, all readers and interpreters of Lewis know how effectively he employed his own version of the moral argument. From the arsenal of traditional natural theology, he seemed to prefer this argument, which launches the discussion in *Mere Christianity* and permeates *Abolition of Man*.[9] And a Supreme Being as a Source of Moral Law would necessarily be rational in nature. A fair summary of Lewis, then, on the possibility of arguing for an Intelligence beyond nature is that he embraced several lines of reasoning in which this theme is either implicit or explicit. Interestingly, however, none of these lines of reasoning are really design-type arguments—and we shall explore the reasons for this shortly.

The recent ID argument gets some support in the evangelical community because it taps into the conviction that "in some important sense" God is a Designer or Intelligent Agent behind the universe. This new argument, however, is not the first to go by the rubric of "intelligent design," since design-type arguments have a long history, as noted earlier. In assessing the viability of all arguments from some orderly feature of the world to an Intelligence beyond the world, we must make some crucial distinctions. There are significant differences between traditional teleological or design arguments, on the one hand, and the new ID argument, on the other. These differences are reflected in their respective answers to two key questions: In what exact sense is God the Designer? And, what sorts of considerations, if any, legitimately point to a Designer? Although a comprehensive treatment of the intellectual history and logical structure of design-type arguments would review a generous handful of versions, here we will simply employ a two-fold classification: traditional teleological approaches and the much newer ID approach, as two very different ways of answering these questions.

Natural theology through the centuries includes a range of design-type arguments—from Aquinas's reasoning to a Transcendent Intelligence as the best account of the teleology of natural objects, to Richard Swinburne's contention that a Supremely Rational Mind is required to think and uphold natural laws.[10] In 2004, the news broke that Antony Flew, one of the most famous atheistic philosophers of the twentieth century, had announced that he had come to embrace a more or less Deistic belief that there is a Supreme Being who intelligently structured the universe but neither interacts with it nor underwrites an afterlife. Soon thereafter, Flew's book *There Is a God: How the World's Most Notorious Atheist Changed His Mind* appeared and provided a lucid retelling of his intellectual journey—a journey shaped by engaging the findings of science with insights from the traditional teleological argument, the fine-tuning argument (including the anthropic principle), and the cosmological argument.[11] Throughout the book, Flew repeatedly explains that his arguments for a Supreme Mind are distinctively philosophical in nature, grounded in philosophical reflections on recent scientific findings as well as on the scientific enterprise itself. Flew distinguishes his approach from misguided attempts to provide scientific arguments for a Supreme Mind. Francis Collins and John Polkinghorne, both severe critics of ID, wrote enthusiastic recommendations of Flew's book.

Flew, who deceased on April 8, 2010, is also interesting here because of his exposure to Lewis during the 1950s when Lewis was chair of the Socratic Club at Oxford. Flew's approach to the present subject reflects a classical outlook similar to Lewis's: a deep respect for the enterprise of science and informed awareness of the phenomena it studies, combined with the insight that both science and its important findings require philosophical explanation. Why does physical nature conform to mathematically precise laws? Why are there conscious minds which perceive this? And why does life seem inherently end-directed? Flew came to answer these sorts of philosophical questions by positing a Supreme Mind. ID, by contrast, is critical of mainstream science and seeks to develop an argument for a Transcendent Intelligence from within its remodeled version of science, as we shall soon see. One last fascinating point concerning Flew's change of mind: from his

newly adopted position of Deism, he considers Christianity to be the most rationally respectable living religion. He even includes in his book an appendix written by N. T. Wright, Bishop of Durham, presenting reasons why orthodox Christian claims about the historical Jesus are credible.

ID views itself as reviving and updating the eighteenth-century argument for God which assumes that science can discover traces of a designing intelligence in the natural world. William Dembski, founder and leading spokesperson for ID, states that "God's design is … accessible to scientific inquiry." The ID movement claims to work within the field of biology (specifically, biochemistry) in order to show that an Intelligence above nature is a better explanation of certain phenomena than is Evolution. Dembski says that mainstream biology operates on the evolutionary assumption that complex life forms developed gradually from simpler forms over long periods of time as natural selection winnows through genetic variations which occur by blind chance. This means that biological complexity should be reducible to simpler components—and we do, indeed, have such reducible complexity in a wide variety of organic forms. Yet, some special cases, Dembski claims, are "irreducibly complex." Irreducibly complex forms have parts which themselves have complete and complex functions of their own, making it highly unlikely that all independently working parts could come together through evolutionary processes. Dembski writes: "The irreducible complexity of … biochemical systems counts powerfully against the Darwinian mechanism and indeed against any naturalistic evolutionary mechanism proposed to date."[12] Dembski and his allies, such as Michael Behe, have advanced several much-discussed examples of irreducible complexity—such as the bacterial flagellum, the blood-clotting mechanism, and the eye.[13]

IDers formulate statistical arguments to show how mathematically improbable it is that random genetic variations plus natural selection, even over great spans of time, could result in the highly complex structures they identify. These arguments involve lots of zeroes after a decimal point. Think of this strategy in terms of probabilities in poker. The probability of being dealt a royal flush on one hand is 0.000002. The probability of being dealt two royal flushes in a row is this number squared (0.000002^2 or 0.00000000004). If a person keeps getting dealt royal flushes, we have to suspect cheating, which is a sort of "intelligent design" in cards.

Back to ID calculations: the probability of irreducibly complex forms being brought about by evolution is argued to be infinitesimally small, making ID the only reasonable alternative. Behe cites the blood-clotting mechanism as a case in point. Animals with blood-clotting cascades have about 10,000 genes, and each gene has three pieces. This totals 30,000 gene pieces. TPA (tissue plasminogen activator) has four different types of domains. As Behe argues, the odds that the right pieces can come together for blood-clotting to occur are therefore supposed to be 1 in $30{,}000^4$ (or 0.00000000000000000012407). Behe estimates that it would take about a thousand billion years before blood-clotting occurred, whereas the earth is only about 6 billion years old, and even the simplest life forms did not occur until perhaps about 3 billion years ago.[14] So, blood-clotting represents too many royal flushes in a row, so to speak. Behe's claim, then, is that natural laws plus time simply cannot account for the phenomenon. According to the new ID argument, it is much more probable that an intelligence beyond nature instantaneously brought about this fully functioning mechanism. In effect, blood-clotting becomes a candidate for special creation, a miracle. Now, IDers will not say that the Intelligent Being behind nature is God, but it is clear that they think they are establishing two attributes of God: (1) intelligence and (2) the power to act on intelligent planning.

Three Features of ID and Lewis's Reaction to Each

1. ID claims to be an alternative way of doing science.

Mainstream science restricts its investigation to the natural world—and the world of modern biology is a world of evolutionary processes. However, IDers insist that certain biological structures are better explained scientifically by referring to intelligent design than to blind, random evolutionary processes. The clash over these two approaches to science has been at the heart of recent academic debates, cultural divides, and court cases. In their crusade against establishment biology, IDers style themselves as the oppressed minority who cannot get a fair hearing. Ben Stein took up their cause in the recent film *Expelled*.[15] (I have to admit that I strongly dislike this film: both its logical fallacies and its convenient

editing that makes some experts who were interviewed seem to support ID although they are on record in many other venues criticizing it.) Also, the Discovery Institute, established in Seattle in 1990, supports, among other projects, intelligent design research that challenges the accepted Darwinian approach. So far, the Institute has made no groundbreaking discoveries or overturned any widely accepted biological explanations.

What would Lewis say about an alternative science that claims to detect Intelligent Agency beyond nature? Lewis was a purist regarding the role of science and rejected any notion that its methods can deal with qualitative matters and values, let alone prove (or disprove) a Transcendent Intelligence or God. Although he was a scholar and lover of the humanities, Lewis still appreciated established science and the integrity of its method. As a Christian theist, Lewis envisioned the constellation of all fields of knowledge as providing different avenues for discovering various kinds of truths about God's creation (historical, mathematical, scientific, and so forth). Not that every scientific theory is always correct or that the findings of science can never be revised as science progresses, but that the method of science is geared only for discovering the linkages between natural causes and natural effects. In Lewis's own words:

> Science works by experiments. It watches how things behave. Every scientific statement in the long run, however complicated it looks, really means something like, "I pointed the telescope to such and such a part of the sky at 2:20 am on January 15th and saw so-and-so," or, "I put some of this stuff in a pot and heated it to such-and-such a temperature and it did so-and-so." Do not think I am saying anything against science: I am only saying what its job is.
>
> And the more scientific a man is, the more (I believe) he would agree with me that this is the job of science—and a very useful and necessary job it is too. But why anything comes to be there at all, and whether there is anything behind the things science observes—something of a different kind—this is not a scientific question. If there is "Something Behind," then either it will have to remain altogether unknown to men or else make itself known in some different way. The statement that there is any such thing, and the statement that there is no such thing, are neither of them statements that science can make. And real scientists do not usually make them. It is usually the journalists and popular novelists who have picked up a few odds and ends of half-baked science from textbooks who go in for them. After all, it really is a matter of common sense. Supposing science ever became complete so that it knew every single thing in the whole universe. Is it not plain that the questions, "Why is there a universe?" "Why does it go on as it does?" "Has it any meaning?" would remain just as they were?[16]

This brief sketch of the descriptive aspect of science should be augmented with information about the testing of hypotheses, which is central to science as it pursues its explanatory mission. But Lewis's critical point for present purposes, in current parlance, is that we must distinguish the appropriate *methodological naturalism* of science from *philosophical naturalism*—something ID fails to do. Methodological naturalism is the scientific approach of restricting the explanation of *natural phenomena* to *natural causes*. Philosophical naturalism, on the other hand, is the philosophical view that nature alone is real, that there is no supernatural. Confusing these two definitions leads to the misunderstanding that mainstream science is inherently atheistic. In reality, methodological naturalism is completely neutral as to whether God exists or life has meaning; such lofty matters take us into the areas of theology and philosophy.[17]

2. ID makes its living on what it takes to be deficiencies, incompletions, or gaps in existing science.

This specific strategy for formulating a design argument was first developed during the European Enlightenment when the scientific picture of the universe was that it is like a vast machine operating according to completely specifiable scientific laws. Many people looked for divine activity in this clockwork universe in events that science had not yet explained. Isaac Newton, for example, developed a precise mathematical formula "on paper" to describe how the planets move, but the actual motion of the planets varied slightly from the formula. So, Newton suggested that God periodically adjusts their orbits. The problem with god-of-the-gaps arguments was that they were already semi-Deist (admitting that God is only involved in special cases) and readily gave way to total Deism as science found natural explanations for what was previously explained by

reference to God. In fact, historically, Deism eventually gave way to Naturalism, as God's explanatory role in the scientific world was progressively eliminated. The mistake of making God-explanations competitive with natural explanations is now classic.

Yet this is exactly the mistake that ID is repeating. As ID arguments—regarding the irreducible complexity of the bacterial flagellum, the eye, etc.—are rapidly being undercut by new and existing scientific knowledge, educated people, particularly scientists, wonder about the intellectual credibility of the underlying faith that seems to motivate the arguments. By contrast, Lewis calls us to a richer, more nuanced understanding of what kinds of explanations are appropriate within the various disciplines—e.g., empirical and scientific questions require natural explanations as distinct from questions about ultimates, values, and meaning, which require philosophical and theological explanations. Grasping this distinction allows us to explore more productively how different types of explanation are not necessarily mutually exclusive but can be entirely compatible—e.g., explanation in terms of physical causes and explanation in terms of personal agency. Consider a personal anecdote which makes the point. While driving on a family vacation many years ago, I asked my two sons why a certain billboard was standing along the highway. Adam, who was six years old and fascinated by building things, said, "Because trucks and high lifts came in and built it." Aaron, twelve years old and wiser about life, responded, "Because the owner of that business wants to market a product and make a profit." Here we have a causal and mechanical explanation alongside an explanation referring to intelligent agency. Both explanations of the billboard are correct, not at odds. The key is to be clear about the kind of question we are asking and what disciplines properly address it. The flaw in the ID argument is that it treats natural causes and supernatural action as incompatible, such that the explanation of some selected phenomenon must always be one type of cause or the other.[18]

3. ID trades on a number of misleading dichotomies.

If space permitted, we could more fully expose the dichotomies between theology and science, divine action and physical process, primary and secondary cause, efficient and final causality, and so on. One dichotomy in ID that Lewis would certainly address in the present context involves pitting purpose and design against chance and evolution. Lewis rejects the view that reality exists completely by chance and without purpose as inconsistent with Theism, as we shall later see. But for biology to identify chance as a factor in the unfolding life process does not imply that the world is purposeless and not guided by a greater intelligence. The assertion that the biological realm involves chance as nondetermined contingency and thus the potential for development is not equivalent to the declaration that existence is ultimately without meaning or purpose. There are finer distinctions to be made in thinking carefully about the roles and levels of chance in relation to intelligent guidance.

Let us turn from a Lewisian evaluation of certain characteristics of ID per se to a more general and very perceptive point that Lewis makes. In *The Problem of Pain*, Lewis categorically rejects unqualified, stand-alone intelligent design arguments—and, of course, this would include ID arguments—because their strategy for explaining order in the world in terms of God's guidance is always countered by the problem of suffering:

> You ask me to believe that this is the work of a benevolent and omnipotent spirit, I reply that all the evidence points in the opposite direction. Either there is no spirit behind the universe, or else a spirit indifferent to good and evil, or else an evil spirit … [Regarding the basis of religion, reasoning] from … this world to the goodness and wisdom [or intelligence] of the Creator [is] preposterous.[19]

In nearby passages, Lewis states the scientific fact that the universe is running down and that all life will ultimately come to an end, as well as the obvious fact that pain is experienced by all sentient animals, including human beings. Lewis knows that such important facts must be included in the complete rational evaluation of any case for an Ultimate Being or Transcendent Intelligence. This is why Lewis would say that it is too glib—and conveniently selective—for IDers to argue that a Transcendent Intelligence is the best explanation of selected complex forms (e.g., the whip-like tail of a certain bacterium) while ignoring other phenomena in the biological realm such as carnage, pain, and death. Lewis clearly believed that, when the arguments for and against God are weighed, Theism indeed appears more rational than any other philosophical position. Yet his knowledge of the relevant arguments on both sides makes him sensitive to

weak or fallacious forms of theistic argument which he felt no obligation to defend. This is why Lewis's own apologetic approach is helpfully characterized as a "cumulative case" which connects some of the stronger individual arguments for specific divine attributes, such that all of the arguments taken together provide coherent and convergent philosophical support for a theistic deity.[20]

For Christian theists to identify the defects of ID's core argument from irreducible complexity is not to dismiss all design arguments in a wholesale way or to abandon the idea of God as intelligent Creator and Sustainer of nature. It is simply to analyze objectively the strategy of one highly specific line of argument based on an understanding of what counts as good theistic argumentation and a commitment to the integrity of various fields of knowledge. Understandably, many people mistakenly associate ID with the larger family of design-type and design-related arguments, both historic and recent. In fact, in the past decade or so, discussions of ID such as those collected on the website of the Discovery Institute, have touched on various philosophical arguments from natural theology: the fine-tuning argument, the traditional teleological argument, the cosmological argument, and the moral argument.[21] As we know, Lewis believed in the effectiveness of many of these types of arguments, making it possible to acquire the misimpression that Lewis would endorse ID, or that perhaps he had offered his own argument for intelligent design. We should note, too, that ID advocates have also proposed that their position be viewed as—or at least be closely associated with—a theory of information, particularly regarding the intelligent origin of information embedded in organic nature.[22] While interesting and important, information theory really forms the basis for yet another distinct design-type argument that must be distinguished from ID's irreducible complexity argument. The argument from information is a relative newcomer to the family of design arguments and will need to survive legitimate scrutiny on its own terms.

The basic point here is that well-constructed design arguments, when conjoined with other well-constructed theistic arguments, can mount a formidable case for a Transcendent Intelligence—which even Antony Flew felt was compelling. But these other intelligent design considerations originated independently of ID, have their own inherent philosophical weight, and do not logically lend support to ID's quite specific assumptions and strategy. No doubt it is helpful to find a number of design-type and design-related arguments assembled in one location, such as on the Discovery Institute's website; but these arguments can be found in many other locations and without association with ID's idiosyncratic approach. Wisdom counsels us, then, to distinguish between the arguments for a Transcendent Intelligence that are specific to ID and the broader lines of teleological reasoning. It is entirely possible to reject the ID movement's attempt to prove this Intelligence from within science while endorsing expressly philosophical arguments for it. The philosophical approach is to consider critically what is required for the very existence of science, its rational nature, and the overall structure of the world it studies, as well as to reflect on the significant findings of science in an effort to find their larger meaning and relevance to theology.

We may now employ the distinctions above in developing judicious answers to the two previous questions. To make important distinctions between ID and traditional teleological argumentation, we first asked: In what exact sense is God the Designer? We learned that Christians need not accept the notion that there are complex biological structures created directly by God without antecedent forms; they may hold a different view of how God brought about biological complexity. Avoiding ID's dichotomy between primary and secondary causes, for example, allows natural process (including evolutionary process) to be seen as the manner in which God brings about complex forms or the presence of complex information. The second question was, What sorts of considerations, if any, legitimately point to a Designer? Again, a Christian believer can be critical of attempts to prove scientifically that there is an intelligent designer while still embracing insightful philosophical renditions of the teleological argument. Progress is made in this discussion when we avoid the category mistake of proposing God as a scientific explanation of certain phenomena and instead consider God philosophically—and, of course, theologically—as the best ultimate explanation of nature, science, and human rationality.

Lewis on Evolution

Since Lewis rejects ID in the narrower sense, what does he think about Evolution? Lewis accepted both cosmic and biological evolution as highly confirmed

scientific theories. He understood that when a scientific theory—which is a proposal about how some natural phenomenon is caused by some natural mechanism—is confirmed by many factors, we call it a fact. We should not understand the terms *theory* and *fact* as though "theory" means "not a fact" or "lacking adequate support." Sometimes Lewis uses the term "hypothesis" as synonymous with a scientific theory, as do many scientists.

Regarding cosmic evolution, Lewis comments that his Space Trilogy contains "only enough science" to lift the reader's imagination away from the ordinary; but the science it does contain is informed by the basic scientific picture of the cosmos and space and the planets. In his more overtly philosophical (and apologetic) books, Lewis sometimes alludes to well-known information about the universe. In *The Problem of Pain*, he writes,

> Look at the universe … By far the greatest part of it consists of empty space, completely dark and unimaginably cold. The bodies which move in this space are … few and so small in comparison with the [vastness] of space …[23]

Elsewhere Lewis speaks of "nebulae" coming into being in the early history of the cosmos; therefore he knew something about cosmology and astronomy.

Lewis then transitions to biological evolution in that same passage in *The Problem of Pain*:

> [I]n our own [galaxy and solar] system it is improbable that any planet except the Earth sustains life. And Earth herself existed without life for millions of years and may exist for millions more when life has left her. And what is life like while it lasts? … [A]ll the forms … can live only by preying upon one another.[24]

Here he reflects on what science tells us about key elements of organic evolution—the struggle for survival and natural selection. He continues:

> [T]hat man is physically descended from animals, I have no objection … For centuries God perfected the animal form which was to become the vehicle of humanity and the image of Himself … The creature may have existed for ages in this state before it became man … [I]n the fullness of time, God caused to descend upon this organism … a new kind of consciousness which could say "I" and "me," … which knew God … [and] could make judgements of truth, beauty, and goodness …[25]

Clearly, Lewis accepts the Darwinian concept of "common descent with modification." In other writings, he calls biological evolution a "genuine scientific hypothesis"[26] and scientists who study it "real biologists" and "real scientists."[27] He even refers in various locations to the age of "monsters," "dragons," "huge, very heavily armored creatures," the great reptiles, dinosaurs, which had to pass so that mammalian life could emerge and flourish.[28]

So, Lewis never voices any objection to the scientific facts of Evolution as though they are somehow incompatible with orthodox Christian doctrines—and, in fact, he was completely comfortable integrating Evolution into a comprehensive worldview. For Lewis, positively engaging the growing body of human knowledge does not mean accommodating the latest fad but responsibly reflecting on how the Christian vision makes best sense of the facts and broad principles we learn from a variety of sources, including the sciences. Since Lewis's time, of course, the findings of the sciences have converged more strongly on the truths of Evolution, such that it now has as high a degree of confirmation as anything else we know in science.[29]

Why do certain religious groups continue to have problems with Evolution? One factor is the low quality of science education in our schools that makes it difficult to have informed discussion in which all parties adequately understand the methods and aims of science. Also, we noted earlier the perception that Evolution contradicts a literal reading of Genesis, which, for Christian fundamentalism, violates biblical authority. But the factor that requires attention here is that some people—both Christian and non-Christian—see Evolution as implying that there is no God, as being a form of atheism. So, Evolution becomes identified with the view that matter alone is real, chance and randomness eliminate design and purpose, moral absolutes do not exist, and a human being is merely a complex animal with no special dignity. However, these are not scientific claims; they define the philosophical worldview of Naturalism (or Materialism).

Lewis, of course, was a sworn opponent of Naturalism, but not of Evolution. He carefully distinguished Evolution as science from Evolution as co-opted by philosophical naturalism.[30] Naturalism has been around since the dawn of philosophical thought in Greece 2,500 years ago. Its advocates have always claimed that "Naturalism-plus-the-science-

of-the-day" explains all that needs to be explained, and that therefore theological and metaphysical explanations are obsolete. In our day, thinkers who take this approach have been dubbed "the New Atheists." Lewis shrewdly cautions us not to fall for their spin:

> Please do not think that one of these views [i.e., either Naturalism or Supernaturalism] was held a long time ago and that the other has gradually taken its place. Wherever there have been thinking men both views turn up … You cannot find out which view is the right one by science in the ordinary sense.[31]

Lewis is making two important points: (1) That it is pure propaganda that Supernaturalism was believed when people were prescientific and intellectually unsophisticated, but that science has now shown that Naturalism is true. In point of fact, classical Christian orthodoxy is always capable of the most sophisticated engagement with any new information. (2) That science—legitimately operating by methodological naturalism—cannot decide between the two philosophical options of Naturalism and Supernaturalism. For naturalists to think that science itself provides evidence for Naturalism is, ironically, to commit the same category mistake earlier attributed to ID: failing to distinguish what sorts of issues are properly addressed in the fields of science and philosophy, respectively. The New Atheists fallaciously claim that their philosophical position is closely linked to a scientific case for atheism which is supported by evolutionary science, whereas ID proponents fallaciously claim that their version of science exposes weaknesses in evolutionary approaches and thus provides grounds for thinking that something like Theism is true.

Lewis's incisive criticisms of Naturalism masquerading as evolutionary science are still very relevant to the growing cultural discussion. Consider two famous examples of scientists promoting Naturalism in the name of science. In the 1980s, Cornell astronomer Carl Sagan burst on the scene with his book *Cosmos* and the PBS series it inspired. The first sentence of the book declares: "The cosmos is all that is or ever was or ever will be."[32] The sum total of reality is matter, continually and endlessly changing in space. There is no intelligent and benevolent being behind it all.

More recently, Oxford zoologist Richard Dawkins makes the *New York Times* Best Seller List from time to time with books arguing that Evolution combined with philosophical naturalism provides a complete and compelling explanation of the world. As a leader of the New Atheism, he writes,

> An atheist before Darwin could have said, following Hume: "I have no explanation for complex biological design. All I know is that God isn't a good explanation, so we must wait and hope that somebody comes up with a better one." I can't help feeling that such a position, though logically sound, would have left one feeling pretty unsatisfied, and that although atheism might have been *logically* tenable before Darwin, Darwin made it possible to be an *intellectually fulfilled atheist*.[33] [emphasis added]

So, for Sagan and Dawkins, the philosophical view that physical stuff is ultimate reality can now be coupled with a comprehensive scientific account of how the physical realm developed and operates. You have the complete package: Naturalism co-opts Evolutionary Science. No need for a Creator-God; the physical realm simply explains itself!

Lewis was extremely critical of Evolutionary Naturalism as a total package because Naturalism involves the denial of God, moral relativism, and human devaluation. What science legitimately reveals about Evolution is then pressed into the service of a completely secular and godless vision that justifies the technological and political manipulation of humans—and this is touted as a "progressive scientific outlook." Lewis's Space Trilogy is not primarily about advanced space travel or futuristic warfare but about the irreconcilable conflict between the Christian tradition and the "developmental" or "progressive" tendencies of modern thought. Professor Weston and Richard Devine, for example, represent different versions of the secular scientific vision. In *That Hideous Strength*, the final book of the trilogy, Lord Feverstone (Devine who has become politically influential) reveals the real purpose of N.I.C.E. (the National Institute of Coordinated Experiments) to Mark Studdock, a young sociologist he is recruiting as a propagandist for the cause:

> If science is given a free hand it can now take over the human race and re-condition it: make man a really efficient animal … [T]he question of what humanity is to be is going to be decided in the next sixty years … Man has got to take charge of Man. That means, remember, that some men have got to take charge of the rest … You

> and I want to be the people who do the taking charge, not the ones who are taken charge of.[34]

In "The Funeral of a Great Myth," Lewis explains that the myth of Developmentalism or Evolutionism or Progressivism—i.e., the "Scientific Outlook"—twists Darwin's achievement in biology into a grand, sentimental narrative about how—from elemental beginnings, against all odds, over enormous spans of time—life and then consciousness and then rational thought arose. The narrative continues: although the distant future is bleak and all existence ultimately meaningless, this courageous creature that the universe has produced, *Homo sapiens*, can now shape its own future.[35] In *The Abolition of Man*, Lewis warns about people of this persuasion who gain political power and calls them "the Conditioners."[36] No doubt, Hitler's insidious crusade to "improve the species" through eugenics helped fuel Lewis's incisive critique. Of course, Lewis knew that Darwin's theory of organic evolution had been used to defend despicable acts toward humanity; but the preeminently logical Lewis knew full well that anyone could fallaciously dismiss any genuine fact by pointing out some misuse of it.

Unpublished correspondence with his friend Captain Bernard Acworth displays Lewis's distress that Darwin's theory had "run mad" and become the basis for the most fanatical views about the inevitable progress and limitless possibilities of the human race. Yet Lewis cannily describes his own thinking on this subject as the process of measuring scientific claims (as well as any other claims) by whether they contradict Christian orthodoxy—"the Creed," as he says.[37] Since scientific evolution does not conflict with orthodoxy, he politely refuses to reject it and equally politely declines to write a recommendatory preface to Acworth's antievolutionary book, *The Lie of Evolution*. Some commentators place undue emphasis on Lewis's remark that he has come to regard Evolution as "*the* central and radical lie in the whole web of falsehood" which so strongly influences modern thought. Such interpretations fail to account for the many contextual clues in the letters indicating that Lewis is not making this pronouncement about Evolution as science but about evolutionary science turned into a philosophical viewpoint which is naturalistic at its core. Although the correspondence transpires later in Lewis's life, it is consistent with Lewis's earlier published writings. The little-known letters to Acworth still show a lucid Lewis who remains focused on Progressive Evolutionary Philosophy, commonly known as Social Darwinism, as his real target, not the science of Evolution. He is not concerned about the prospect of our subhuman ancestry but consistently attacks the reductionism of our personhood in theory which leads ultimately to dehumanization in practice.[38] "Reductionism," of course, is reducing something to what it is not—qualitative matters to quantitative, the rich dimensions of our humanity to the purely physical.

The real debate is between the worldviews of Naturalism and Theism, or, really, *Christian* Theism. To demonstrate the conceptual advantages of Christian Theism, Lewis uncompromisingly works at such questions as, Which philosophical perspective provides a better explanation of everything we know? Which provides a more adequate vision of reality as a framework for making sense of important features of life and the world? Throughout his writings, Lewis hammers away at Naturalism's inadequacies, at its reduction of many important features of reality to a deterministic material process. He is particularly worried about the distortions of consciousness of moral law, rational thought, and finite personhood. Christian Theism, as he argues in many venues, is philosophically far superior to Naturalism—which is frequently encountered in the guise of "the Scientific Outlook"—in explaining these fundamental phenomena. He also argues that Christian Theism is superior to Naturalism in explaining science itself, since Naturalism undercuts the validity of rational thought, which is essential for science. Lewis maintains that science as a knowledge-gathering enterprise makes best sense within a Christian worldview, which affirms that a rational God creates and upholds a rational finite reality and gives human beings the rational powers to investigate it.[39] As Lewis says, "The scientific point of view cannot fit in … even science itself. I believe in Christianity as I believe that the Sun has risen, not only because I see it, but because by it I see everything else."[40]

Furthermore, since Lewis affirms that "all truth is God's truth, wherever it may be found," he refuses to surrender the scientific truths of Evolution to Naturalism.[41] One reason for this is that he believes that the facts are what they are and must be accepted when properly established. This allowed Lewis to see evolutionary science as revealing fascinating details about how God's physical creation has developed and continues to function. Another reason is

that Lewis believed that the very character of the scientific facts can reveal something about God and his ways. In this regard, he perceives compatibilities and even deep resonances between Christian Theism and Evolution that are important to the articulation of a comprehensive and informed Christian worldview.[42] Lewis knew that the doctrine of creation entails that, in principle, all truths fit together as a consistent, unified whole; they are not disparate beads on a string. But in practice we are always working toward greater comprehension, trying to perceive more connections and develop a holistic perspective—in other words, we practice "faith seeking understanding."[43] Lewis himself is a wonderful model of a Christian mind seeking understanding of the role of science in the human search for knowledge and insight into the evolutionary contours of the universe which science investigates.

In *Miracles*, Lewis offers a charming description of what it is to see Nature properly as a creature—a description that even heightens our awareness of the resonances between Christian faith and Evolution:

> Only Supernaturalists really see Nature. You must go a little away from her, and then turn round, and look back. Then at last the true landscape will become visible. You must have tasted, however briefly, the pure water from beyond the world before you can be distinctly conscious of the hot, salty tang of Nature's current. To treat her as God, or as Everything, is to lose the whole pith and pleasure of her. Come out, look back, and then you will see.[44]

Supernaturalism—not just any old supernaturalism, but orthodox Christian Theism—is the best vantage point for understanding the natural world. Lewis affirmed that an infinite personal Creator willed that the physical universe come into being and, through a long and complicated process, bring forth a special kind of being, the human being, in which rationality and animality are united.[45] From this perspective, the evolutionary character of the universe can be seen as physical nature's exploration of contingent possibilities within lawful structure, but still as having a divinely willed trajectory leading to a creature who could relate to God. Classical Christian theology does not entail that either the natural world or the human enterprise was created without chanciness and contingency, without the potential for development along alternative possible routes, and therefore strictly determined. Evolution in the physical realm and free will in the moral realm mutually attest to the significant degree of openness in God's creation.

Lewis's Trinitarian Vision

Both Classical Christian Theology and Evolution suggest a dynamic, self-actualizing aspect to reality. Lewis is insightful about this congruence and incorporates it into his articulation of the Christian vision. In doing this, he is clearly a Christian Theistic Evolutionist, or an Evolutionary Christian Theist. So, what does Lewis say God is up to in this evolutionary universe? In answering this question, Lewis is at his best.

Book Four of *Mere Christianity* is entitled "Beyond Personality: Or First Steps in the Doctrine of the Trinity." In this section, Lewis summarizes the ancient vision of the church: that the heart of reality is a Self-Living, Self-Giving Life which created everything else and seeks relationship with it. The Triune God is inherently personal and interpersonal, meaning that his created universe is deeply relational, a context for finite persons to enter loving relations with God and others. The Triune God is the original Person and the fulfillment of our own creaturely personhood. Evolutionary science investigates *Bios*, as Lewis calls it, or the very important but finite biological life we possess. However, Lewis explains that God offers us *Zoe*: the higher kind of life, the life of unspeakable and unending joy and beatitude radiating from God's own life. *Bios* is not opposed to *Zoe*, not contradictory to it. *Bios* is not evil or the root of sin. It is simply the physical life with which human rational nature is intimately and essentially identified. But *Bios* is invited to be taken up into *Zoe*—to be completed, transformed, and given ultimate significance by *Zoe*. This is amazing! Our destiny is beyond the physical, not by diminution or rejection of the physical but by its inclusion in a higher dimension of reality, the very Life of God.[46]

Lewis paints a word picture of the Higher Life in a compelling discussion of the Trinity and the essential love relations among the Divine Persons:

> God is not a static thing—not even a person—but a dynamic, pulsating activity, a life, almost a kind of drama. Almost, if you will not think me irreverent, a kind of dance … The whole dance, or drama, or pattern of this three-Personal life is to be played out in each one of us: or (putting it the other way round) each one of us has got to enter that pattern, take his place in that dance.

> There is no other way to the happiness for which we were made. Good things as well as bad, you know, are caught by a kind of infection. If you want to get warm you must stand near the fire: if you want to be wet you must get into the water. If you want joy, power, peace, eternal life, you must get close to, or even into, the thing that has them. They are not a sort of prize which God could, if He chose, just hand out to anyone. They are a great fountain of energy and beauty spurting up at the very centre of reality. If you are close to it, the spray will wet you: if you are not, you will remain dry. Once a man is united to God, how could he not live forever? Once a man is separated from God, what can he do but wither and die?[47]

The Great Dance is a major theme in Lewis's writings: that the relational reality God has created is about giving and receiving, about cooperation with God as our True Center; but we have gotten out of step and need to find our way again in the Dance. In *Perelandra* (Book Two of the Space Trilogy), Lewis spends several pages developing this theme.[48] But it is not novel; it is a creative restatement of a profound idea stemming from the ancient church. St. Gregory of Nazianzus (Great Patriarch of Constantinople in the fourth-century Eastern Church) characterized God's inner life as "the Great Dance." This was Gregory's way of portraying the idea of "mutual indwelling" (*perichoresis*) in Jesus's comments in chapters 14–17 of the Gospel of John (about the mutual indwelling of the Father and the Son, the Son and believers, and so forth). This is a deeply relational universe, a perichoretic universe. And although we have broken relations at all levels, God's faithful redemptive activity is at work to heal, uplift, and restore us. Our transformation is the goal.

The last lines of *Mere Christianity* incorporate Evolution into the Christian vision while rejecting human engineering based on a misuse of evolutionary ideas. Let us meditate on these lines and allow them to serve as a fitting benediction to this study:

> Perhaps a modern man can understand the Christian idea [of transformation] best if he takes it in connection with Evolution. Everyone now knows … that man has evolved from lower types of life. Consequently, people often wonder, "What is the next step?" "When is the thing beyond man going to appear?" … [Some suppose a] "Superman" [will appear] with extra legs or arms … [P]opular guesses at the Next Step [envision] men developing great brains and getting greater mastery over nature … [But] I cannot help but think that the Next Step will be really new … I should expect the next stage not to be a stage in Evolution [as science studies it] at all. And I should not be surprised if, when the thing happened, very few people noticed that it was happening.
>
> [T]he Christian view is precisely that the Next Step has already appeared. And it is really new. It is not a change from brainy men into brainier men: it is a change that goes off in a totally different direction—a change from being creatures of God to being sons of God. The first instance appeared in Palestine two thousand years ago. In a sense, the change is not "Evolution" at all, because it is not something arising out of the natural process of events but something coming into nature from outside. But that is what I should expect. We arrived at our idea of "Evolution" from studying the past. If there are real novelties in store then of course our idea, based on the past, will not really cover them …
>
> At the earlier stages living organisms … had … no choice or very little choice about taking the new step … But the next step … of being turned from creatures into sons is voluntary … I have called Christ the "first instance" of the new man. But of course He is something much more than that … He is … *the* new man [who takes *Bios* up into *Zoe*] …
>
> At the beginning I said there were Personalities in God. I will go further now. There are no real personalities anywhere else. Until you have given up your self to Him you will not have a real self … But there must be a real giving up of the self. You must throw it away "blindly" so to speak … Submit to death, death of your ambitions and favourite wishes every day and death of your whole body in the end: submit with every fibre of your being, and you will find eternal life. Keep back nothing. Nothing that you have not given away will be really yours. Nothing in you that has not died will ever be raised from the dead. Look for yourself, and you will find in the long run only hatred, loneliness, despair, rage, ruin, and decay. But look for Christ and you will find Him, and with Him everything else thrown in.[49] ⋆

Notes

[1]C. S. Lewis, "On Learning in Wartime" in *The Weight of Glory: And Other Addresses*, ed. Walter Hooper (1949; revised, New York: HarperOne, 1980), 47–63.

[2]This article is an expanded version of my presentation at the Science for Ministry Conference "Exploring the Wonders of God's World" held at Asbury Theological Seminary, March 10, 2010.

[3]It will soon become apparent that, throughout this article, I adopt Lewis's convention of capitalizing important nouns. Admittedly, this convention was more common in Lewis's day and is not standard contemporary American usage.

[4]See Peterson et al., *Reason and Religious Belief: An Introduction to the Philosophy of Religion*, 4th ed. (New York: Oxford University Press, 2009), 8 and 90–122. It should be noted that the Reformed objection to natural theology (advanced by Alvin Plantinga and others) argues both that some assumptions underlying the argument strategy of natural theology are too strong and that there are conditions under which a person is rationally warranted in believing in God without providing an argument for God's existence. But this simply means that we must refine our understanding of the project of natural theology and its arguments, not that there is no viable conception of natural theology. For further discussion of this approach, see *Reason and Religious Belief*, 123–4. To consult key primary sources on natural theology as well as the Reformed objection, consult the companion volume: Peterson et al., eds., *Philosophy of Religion: Selected Readings*, 4th ed. (New York: Oxford University Press, 2010), Parts 5 and 6.

[5]See Peterson, *Reason and Religious Belief*, 206–8. See also Peterson, *Philosophy of Religion*, 222–30. Owen Gingerich, "What is the 'fine-tuning' of the universe, and how does it serve as a 'pointer to God'?" http://biologos.org/questions/fine-tuning/ (last accessed September 22, 2010)

[6]This argument is made in "The Cardinal Difficulty of Naturalism" in Lewis, *Miracles* (1947; reprint, San Francisco, CA: HarperSanFrancisco, 1960), chap. 3. More recently, Alvin Plantinga has offered his own argument, quite reminiscent of Lewis's, that Naturalism is self-defeating: Plantinga's evolutionary argument against Naturalism is that the conjunction of biological evolutionary theory and philosophical naturalism makes the probability low that we have reliable cognitive faculties that can produce warranted beliefs. On the other hand, there is no such low probability on the conjunction of biological evolution and Theism. Plantinga first proposed the argument in *Warrant and Proper Function* but improves it in his *Warranted Christian Belief* (New York: Oxford University Press, 2000), 228–9. For a helpful discussion of this approach, see James Beilby, ed., *Naturalism Defeated? Essays on Plantinga's Evolutionary Argument against Naturalism* (Ithaca, NY: Cornell University Press, 2002). For a book-length debate which involves this argument, see Daniel Dennett and Alvin Plantinga, *Science and Religion: Are They Compatible?* (New York: Oxford University Press, forthcoming 2011).

[7]In *Miracles*, Lewis develops his "argument from reason," which is the logical complement of his case for the irrationality and self-defeating character of Naturalism. See also Victor Reppert, *C. S. Lewis's Dangerous Idea: In Defense of the Argument from Reason* (Downers Grove, IL: InterVarsity Press, 2003).

[8]Chapter on "Hope" in *Mere Christianity* (1952; reprint, San Francisco, CA: HarperSanFrancisco, 1980), Bk. III, chap. 10. The best-known location for this position is *The Weight of Glory*, especially pp. 32–3. An earlier statement of this argument appears in his *The Pilgrim's Regress* (1933; reprint, Grand Rapids, MI: Eerdmans, 1943).

[9]Lewis, *Mere Christianity*, Book I; *The Abolition of Man* (1947; reprint, New York: HarperOne, 1974).

[10]Aquinas, *Summa Theologica*, trans. Fathers of the English Dominican Province (Westminster, MD: Christian Classics, 1948), Question 2, Art 3. Richard Swinburne, *The Existence of God* (Oxford: Oxford University Press, 2004), 153–91. See also Laura Garcia, "Teleological and Design Arguments" in *A Companion to Philosophy of Religion*, 2d ed., ed. Charles Taliaferro, Paul Draper, and Philip L. Quinn (Oxford: Wiley-Blackwell, 2010), 375–84.

[11]Antony Flew, *There Is a God: How the World's Most Notorious Atheist Changed His Mind* (New York: HarperOne, 2007).

[12]William Dembski, *Intelligent Design: The Bridge between Science and Theology* (Downers Grove, IL: InterVarsity Press, 1999), 148.

[13]Critics of ID have provided sound scientific explanations for these phenomena without reference to a transcendent intelligence. See, for example, Philip Kitcher, *Living with Darwin: Evolution, Design, and the Future of Faith* (New York: Oxford University Press, 2007); Francisco Ayala, *Darwin and Intelligent Design* (Minneapolis, MN: Fortress Press, 2006) and ____, *Darwin's Gift to Science and Religion* (Washington, DC: Joseph Henry Press, 2007). It is particularly fascinating to account for the significant weight that the mapping of the Human Genome lends to the confirmation of biological evolution. Francis Collins, Director of the Human Genome Project in the 1990s and now Director of the NIH, who was greatly influenced in his faith by Lewis's *Mere Christianity*, makes the scientific case for evolution based on the amazing accomplishments of research in molecular biology in recent years. See Collins's *The Language of God: A Scientist Presents Evidence for Belief* (New York: Simon and Schuster, 2006). Collins founded the Biologos Foundation to promote engagement of science and faith as well as to help navigate various errors committed by both secular and religious perspectives (http://biologos.org, last accessed September 22, 2010).

[14]Michael Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: Free Press, 1996), 94.

[15]*Expelled*, Ben Stein (Director), Premise Media Corporation, 2008.

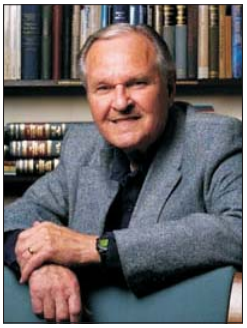
[16]Lewis, *Mere Christianity*, 22–3.

[17]Again, in the words of Lewis, science—including evolution as "a purely biological theorem"—"makes no cosmic statements, no metaphysical statements, no eschatological statements." See Lewis, "The Funeral of a Great Myth," *Christian Reflections*, ed. Walter Hooper (Grand Rapids, MI: Eerdmans, 1967), 86.

[18]For a thorough discussion of this point, see Michael J. Murray, "Natural Providence (Or Design Trouble)," *Faith and Philosophy: Journal of the Society of Christian Philosophers* 20, no. 3 (July 2003): 307–27.

[19]Lewis, *The Problem of Pain* (New York: The Macmillan Company, 1962), 14–6.
[20]On the possibility of a cumulative case, see Peterson, *Reason and Religious Belief*, 115–6.
[21]Ironically, these arguments are at home within the ambit of natural theology; but Dembski is extremely critical of natural theology. For example, see William Dembski, *Intelligent Design*, 107.
[22]See, for example, David Myer, *Signature in the Cell: DNA and the Evidence for Intelligent Design* (New York: HarperOne, 2009).
[23]Lewis, *The Problem of Pain*, 13.
[24]Ibid., 13–4.
[25]Ibid., 72–7.
[26]Lewis, "The Funeral of a Great Myth," 83.
[27]Ibid., 85.
[28]Ibid., 87; Lewis, *Mere Christianity*, 218.
[29]It is actually quite fair to say that evolution shares equal status with such established concepts as the roundness of the earth, its revolution around the sun, and the molecular composition of matter. See Ayala, *Darwin's Gift*, 130–2.
[30]Lewis, "The Funeral of a Great Myth," 83.
[31]Lewis, *Mere Christianity*, 22.
[32]Carl Sagan, *Cosmos* (New York: Ballantine, 1980), 1.
[33]Richard Dawkins, *The Blind Watchmaker* (New York: W.W. Norton & Co., 1986), 6.
[34]C. S. Lewis, *That Hideous Strength* (1945; reprint, New York: Scribner, 1974), 39–40.
[35]Lewis, "The Funeral of a Great Myth," 83; Lewis, *The Problem of Pain*, 14–5.
[36]Lewis, *The Abolition of Man*, Book 3.
[37]See Lewis's Letter, September 23, 1944, reproduced and discussed in Gary B. Ferngren and Ronald L. Numbers, "C. S. Lewis on Creation and Evolution: The Acworth Letters, 1944–1960," *Perspectives on Science and Christian Faith: Journal of the Scientific Affiliation* 48 (March 1996): 28–33. The Creed here is probably the Apostles' Creed, but it could be the universal ecumenical Nicene Creed, which is Lewis's shorthand way of alluding to one of his most important themes: concentrating on and working intellectually out of the framework of doctrine that "has been common to nearly all Christians at all times" (*Mere Christianity*, Preface, viii).
[38]Reading all of Lewis's letters to Acworth, we see Lewis basically reacting to the evidences against evolution that Acworth proposed by saying that at his age he could not become an expert and adjudicate such matters. He was certainly open-minded and willing to consider all putative evidence for any view. But any suspicion Lewis expressed about the factual nature of Evolution can be overblown by fastening on just a comment or two. The larger context which Lewis always establishes for any particular remarks about Evolution is his deep hostility toward Evolution as a kind of secular theological creed. Misunderstanding this aspect of Lewis, Marxist geneticist J. B. S. Haldane wrote an inflammatory article accusing Lewis of engaging in wrongfully degrading scientists in his fictional novels. See "Auld Hornie, F.R.S.," *Modern Quarterly*, n.s., 1 (Autumn 1946): 32–40. Although never completed, Lewis's partial rejoinder can be found in "A Reply to Professor Haldane" in *Of Other Worlds: Essays and Stories*, ed. Walter Hooper (London: Geoffrey Bles, 1966), 74–85.
[39]Lewis, "Is Theology Poetry?" in *The Weight of Glory*, 139–40. This point again picks up on the recurrent theme in Lewis (found in *Miracles*, *Mere Christianity*, etc.) that reason cannot be ultimately derived from and dependent on matter. Lewis explores supporting themes in "Meditations in a Toolshed" in *God in the Dock: Essays on Theology and Ethics*, ed. Walter Hooper (Grand Rapids, MI: Eerdmans, 1974), 212–5.
[40]Lewis, "Is Theology Poetry?" 140.
[41]Arthur Holmes is well known for coining this felicitous and quite profound statement which is the title for his *All Truth Is God's Truth* (Downers Grove, IL: InterVarsity Press, 1983). The idea behind this statement, of course, has deep roots in Christian history: the doctrine of creation, the concept of Christ as *Logos*, Augustine's writings (on creation, the light of the mind, etc.), and Aquinas's magisterial works (aimed at interpreting and synthesizing all knowledge under Christian understanding). Not surprisingly, the idea is pervasive in the Lewis corpus.
[42]I explore this point in depth in Peterson, "Evolution and the Deep Resonances between Science and Theology" in *The Continuing Relevance of Wesleyan Theology: Essays in Honor of Laurence W. Wood* (Eugene, OR: Wipf & Stock Publishers, forthcoming 2011).
[43]This famous phrase (Latin: *fides quaerens intellectum*) echoes throughout the writings of the great medieval Christian thinkers from Augustine to Aquinas. But it is usually attributed more directly to Anselm of Canterbury. See his *Proslogion* in *The Major Works*, ed. Brian Davies and G. R. Evans, trans. M. J. Charlesworth (New York: Oxford University Press, 1998), 83.
[44]Lewis, *Miracles*, 104–5.
[45]"God has guided nature up to the point of producing creatures which can [be turned] into 'gods.'" See Lewis, *Mere Christianity*, 222. Here again Lewis is reflecting another ancient theme of the church: that proper human destiny is participation in the divine life. See also Lewis's restatement of the classical Aristotelian definition of Man—as "an animal, yet also a reasonable soul"—in *Perelandra* (1944; reprint, New York: Scribner, 1972), 178.
[46]Lewis writes: "The whole purpose for which we exist is to be thus taken into the life of God." See *Mere Christianity*, 161. Note that all of Book 4 should be read carefully to understand Lewis's Trinitarian vision of the amazing meaning of human destiny.
[47]Lewis, *Mere Christianity*, 175–6.
[48]Lewis, *Perelandra*, chapter 17. Note that the Great Dance is envisaged as the mutual love exchange among Maleldil and his creatures. This is a relational reality—which has been graciously populated with created personal beings—in which "all is gift" and "the best fruits are plucked for each by some hand that is not his own" (p. 180). Although Maleldil's joy is not dependent on created things, all was made so that Maleldil's loving purposes might be realized: "Where Maleldil is, there is the centre. He is in every place … Each thing was made for Him. He is the centre. Because we are with Him, each of us is at the centre … He has immeasurable use for each thing that is made, that His love and splendour may flow forth …" (pp. 185–6).
[49]Lewis, *Mere Christianity*, 218–27.

Ten Lunar Legacies: Importance of the Moon for Life on Earth*



Joseph L. Spradley

Joseph L. Spradley

The origin, size, and location of our Moon play a unique and essential role for the existence of life on Earth. Earth's Moon is the largest moon in the solar system in relation to its host planet and appears to have formed in a unique way, compared to all other known moons, by a giant glancing collision. Computer simulations of this giant-impact theory have led to a new recognition of the importance of the Moon for life on Earth. Ten apparently life-sustaining results from a glancing collision and large Moon are summarized, along with their implications for the uniqueness of life on Earth.

It has long been assumed that many earthlike planets exist around the billions of stars in our galaxy, and that life is therefore widespread in the universe.[1] Recent considerations have shown that the conditions for a habitable planet are quite strict and that life on Earth may be a highly unusual result of many unique features of our planet.[2] Many of these life-sustaining features can now be traced to the formation of our Moon, an event that itself is highly random and rare, but appears to be an essential requirement for producing a habitable planet.[3] Such an event is the result of probabilistic natural processes, but can also be viewed as a providential legacy.

Our Moon has several unusual features that have long confounded attempts to explain its origin. It is about fifty times larger than any other moon in the solar system relative to the mass of its host planet. It has the largest angular momentum relative to the mass of the planet about which it revolves. It has a much lower density and much less iron than that of Earth and the other terrestrial planets. The Apollo missions of the early 1970s revealed other unusual features, including a lack of volatiles and evidence that a deep ocean of magma once existed on the Moon.[4]

None of the historical theories for the origin of the Moon could account for all of these unusual features. The coaccretion (sister) theory that the Moon was formed together with Earth out of the proto-planetary disc was suggested by Immanuel Kant in 1755 and developed by Edouard Roche in 1873.[5] However, it could not account for the differences in chemistry and density between the two bodies. In 1898, George Darwin, son of Charles Darwin, introduced the fission (daughter) theory that the Moon was spun off from Earth. Although this theory failed because fission would require a much faster rotation of Earth (about two hours), it did reveal that tidal friction is slowing Earth's rotation and that the Moon was once much closer when

Joe Spradley *received his PhD in engineering physics at UCLA in 1958. He is emeritus professor of physics at Wheaton College, where he recently retired after teaching for fifty years, including several extended leaves of absence to teach at Haigazian College in Lebanon, Ahmadu Bello University in Nigeria, American University in Cairo, Daystar University in Kenya, and Shandong University in China. Most of his publications are in the history of science, including the 1994 book,* Visions That Shaped the Universe: A History of Scientific Ideas about the Universe. *He and his wife Marilyn enjoy traveling, walking, and eclipse chasing, and he regularly practices 3-meter diving. They have four children and thirteen grandchildren, including two who currently attend Wheaton College.*

the day was only about five hours long.[6] In 1909, Thomas Jefferson See proposed the capture (spouse) theory that Earth's gravity captured the Moon as it passed nearby.[7] This theory failed despite efforts by Harold Urey in the 1950s, since there was no accepted way to slow the Moon enough for capture.[8]

The giant-impact theory combines features of all the previous theories and resolves most of their problems. It was first suggested in a 1946 paper by Canadian geologist Reginald Daly at Harvard, but was largely overlooked.[9] After the Apollo program, William Hartmann and Donald Davis began to apply computer programs to the problem of planetesimal formation in the early solar system, and confirmed the power law for the size distribution of planetesimals consistent with crater sizes on the Moon's surface: for roughly every thousand 1-km craters, there are one hundred 10-km craters, ten 100-km craters, and one 1000-km basin. Their work showed that planetesimal accretion by collisions, leading to the formation of Earth, could produce bodies in its accretion zone as large as the Moon. It then occurred to Hartmann that such an object in Earth's orbit could have impacted Earth in a glancing collision to form the Moon. Such a collision would provide vast energy, explaining the Moon's magma ocean, lack of volatiles (evaporated in the collision), and lack of an iron core (sunk into Earth). In 1975, he and Davis published their giant-impact theory.[10]

When Hartmann first presented these ideas in 1974, he learned that Alastair Cameron, another Canadian at Harvard, was working on the same theory with a postdoctoral student, William Ward. An abstract of their work was published in 1976.[11] Using computer simulations of a glancing collision, they could account for the formation of the Moon if the impactor was a Mars-sized object about ten times larger than the Moon. About half of the debris blasted into space by the collision would remain in orbit around Earth and in a few weeks would coalesce to form the Moon, at that time about fifteen times closer than today. The collision would increase the daily rotation period of Earth to about five hours, increase its mass by about 10 percent, and produce a Moon lacking volatiles and an iron core.

Little attention was given to the giant-impact theory until, nearly a decade later, a post-Apollo conference was held in 1984 at Kona, Hawaii, on the origin of the Moon. Several papers were presented on the giant-impact model, leading to an unprecedented agreement among many of the conferees on the advantages of the model.[12] This Kona consensus led to more and improved computer simulations, notably by Cameron, now retired to Arizona, and by Robin Canup at the Southwest Research Institute in Boulder, Colorado.[13] They began using the "smooth particle hydrodynamics" (SPH) method, which had been developed for modeling bomb explosions. These new simulations differentiated between rock and iron "particles" (several thousand of each) and now showed the melted iron core of the impactor falling back and sinking into Earth's core. Accretion models suggest that the giant impact occurred about 40 million years after the formation of the solar system at about 4.57 billion years ago as determined from the oldest meteorites, giving the date for the birth of the Moon at about 4.53 billion years ago. (See Figure 1.)

Several benefits of our Moon have long been recognized, such as illumination of the night sky, the phases of the Moon for keeping time, and the lunar tides for helping to cleanse and oxygenate the oceans. With the growing consensus in support of the giant-impact theory, there has been an increasing recognition that the formation of the Moon was critical in providing the conditions needed for life on Earth.[14] Several authors have suggested this lunar legacy over the last two decades: In his 1993 book *What if the Moon Didn't Exist?* Neil Comins lists three or four of these necessities for life, depending on how they are counted; Peter Ward and Donald Brownlee list about four or five in their 2000 book *Rare Earth*; Guillermo Gonzalez and Jay Richards list about five or six in their 2004 book *Privileged Planet*; and Hugh Ross lists about six or seven in his 2009 book *More Than a Theory*.[15] Summaries of ten such factors essential for life on Earth, which now appear to be related to the formation of a large Moon, are discussed below under the assumption that complex life requires liquid water. The first five of these factors relate to the giant impact itself, and the last five relate to the subsequent influence of the Moon on Earth. Many of these factors are debatable, but they provide a framework for further discussion and research. Arguably, the absence of any one of these lunar legacies might have prevented the existence of life on Earth.

Lunar Legacies for a Habitable Earth

1. Faster rotation rate for Earth. The glancing collision that formed the Moon appears to have given Earth its initial 5-hour rotation rate, much faster than any other planet in the solar system.[16] This rotation rate was sufficiently rapid so that over the time for life to develop, the rate could be slowed by the Moon's tidal action on Earth's oceans to our current 24-hour day, which moderates daily temperature variations and makes photosynthesis a viable possibility. Wide temperature variations occur on Mercury with its rotation rate of fifty-nine days produced by the Sun's tidal action, causing its long 100K nights and 700K days to vary far beyond the freezing and boiling points of water.

Recent computer simulations suggest that Mars also sustained a giant impact, causing the hemispheric dichotomy of southern highlands and northern lowlands.[17] These simulations required an oblique collision at between 30° and 60° to account for the unusual surface of Mars, which apparently gave it a rotation rate similar to that of Earth's current rate, but without enough energy to produce a large moon to slow its rotation. The slow retrograde rotation of Venus (-243 days) suggests a large collision of some kind, reversing its rotation but not forming a moon.[18] Although giant impacts of a random nature appear to have had a variety of effects on terrestrial planets,[19] only Earth gained a large Moon with its favorable results that allow for life.

2. Favorable axial tilt of Earth. The glancing collision that formed the Moon would almost certainly have changed Earth's axial tilt (obliquity), leading sooner or later to its favorable axial tilt of about 23° relative to a perpendicular to Earth's orbital plane (ecliptic) and thus its relatively mild seasonal variations.[20] In the giant-impact model, the debris cloud that formed

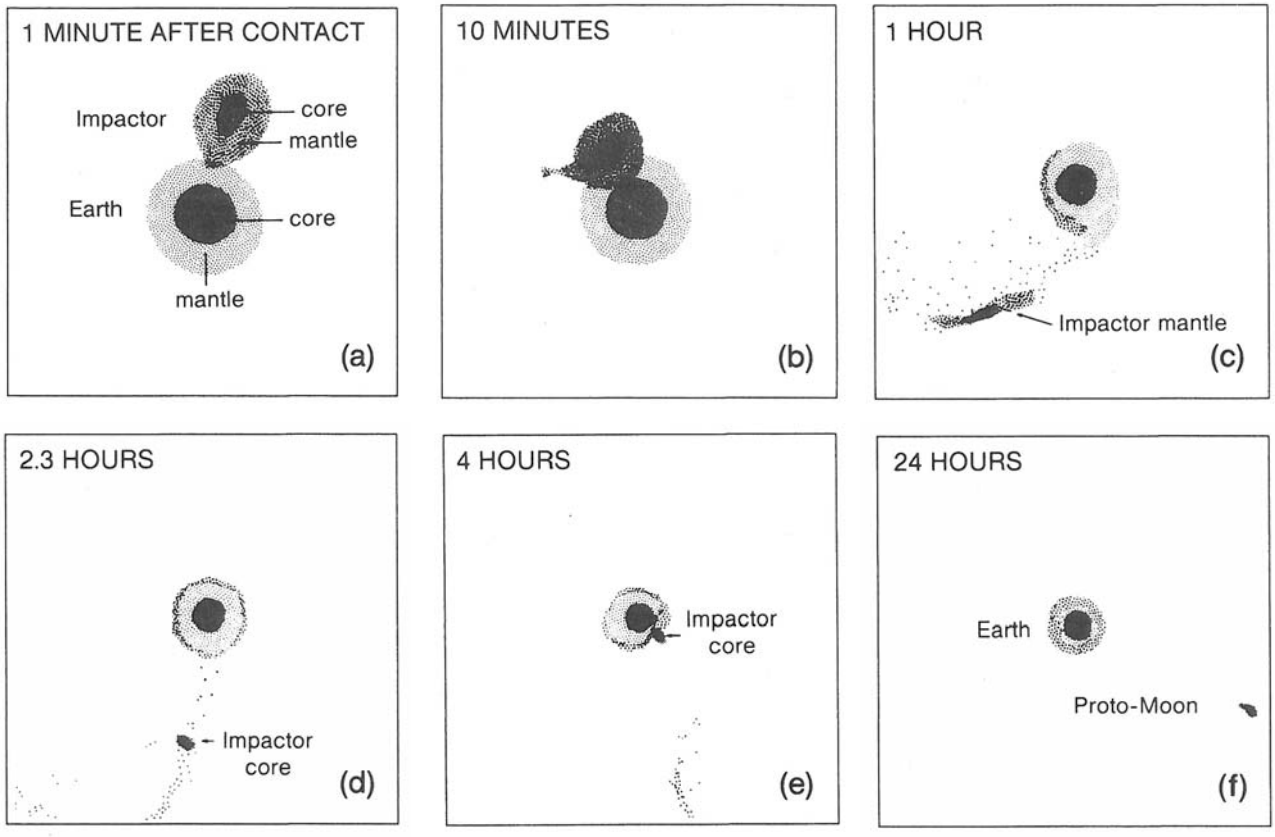


Figure 1. Giant-impact computer simulation for oblique collision of a 0.14-Earth-mass body at a velocity of 5 km/s. It encourages a new appreciation for the special gift of life and an environment suitable for its survival. It echoes the words of Psalm 8:3–4, "When I look at your heavens, the work of your fingers, the moon and the stars, which you have set in place, what is man that you are mindful of him, and the son of man that you care for him?" Figure courtesy of A. G. W. Cameron and W. Benz, Smithsonian Astrophysics Institute, from S. R. Taylor, *Solar System Evolution* (Cambridge, Cambridge University Press, 1992), 159.

the Moon would likely be in the equatorial plane of Earth's rotation, but the Sun's gravity would tend to pull it toward the ecliptic plane. The small (5°) inclination of the Moon's orbit relative to the ecliptic plane remains unexplained, but probably arises from tidal interactions with the Sun and Earth. A large axial tilt beyond 60° would make life difficult due to frozen oceans extending to the equator, and a small tilt would allow little or no seasonal variations to help stimulate evolutionary processes.[21] By comparison, the larger gravity from the Sun on Mercury has resulted in no tilt, which allows for no seasonal variations.

For several years, evidence has suggested that Earth experienced widespread glaciation, reaching nearly to the equator between 800 and 600 million years ago, the melting of which might have triggered the Cambrian evolutionary explosion.[22] The usual explanation for this "snowball Earth" effect is the fact that the early Sun was dimmer and the oceans had absorbed most greenhouse gases such as carbon dioxide. A radical suggestion in 1993 claimed that the axial tilt of Earth was greater than 54° during most of its history, making equatorial regions the coldest part of the planet, and that core-mantle dissipation reduced it to 23° about 600 million years ago.[23] But this does not explain why such viscous dissipation occurred over only a short period of Earth's history. Another suggestion is a process called climate friction (oblateness-obliquity feedback), in which axial tilt shifts from redistribution of glacial ice masses.[24] Recent analysis has shown that such a mechanism can only account for a shift of 3° or 4° over the last 800 million years.[25] Evidence from the growth patterns of an 850-million-year-old stromatolite, assuming growth toward the noontime Sun (heliotropism), suggests a 26.5° axial tilt at that time.[26]

3. Greenhouse gases removed. Several investigators have suggested that a giant-impact formation of the Moon would have stripped Earth of much of its primordial atmosphere.[27] Venus, our nearest planet in both distance and mass, has an atmospheric pressure about 90 times that of today's Earth. The thick atmosphere on Venus consists mostly of carbon dioxide, which traps solar radiation by the greenhouse effect, causing a surface temperature of about 700K that boils away all surface water.[28] Surface water on Earth helps to absorb excess carbon dioxide, but may not have been able to remove quantities like that on Venus without a giant impact.

With Earth's surface in a molten state after the collision, a new atmosphere would form from outgassing and comet collisions. A few million years after the giant impact, Earth's surface would be cool enough to form a crust and for water vapor to condense and form the oceans, which then would begin to absorb carbon dioxide.[29] The reformulated atmosphere on Earth after the collision and water condensation was thin enough to prevent a runaway greenhouse effect and sufficiently transparent to eventually allow photosynthesis to occur with its associated production of oxygen.

4. Strong magnetic field formed. Computer simulations of the giant-impact theory show the molten iron core of the impactor sinking into Earth's iron core (see Figure 1e).[30] Enlargement of Earth's liquid-iron core together with a much faster rotation rate from the giant impact increased Earth's magnetic field to about 100 times larger than any other rocky planet. The dynamo theory of Earth's magnetic field is analogous to the magnetic field from a current-carrying coil of wire (electromagnet), but involves the more complex rotation, convection, and electrical conduction of Earth's liquid-iron core.[31] Such a strong magnetic field deflects the high-energy charged particles in the solar wind, which would otherwise strip much of Earth's atmosphere and threaten any emerging life.[32]

A small magnetic field on Mars indicates a limited iron core as suggested by its low density; in addition the slow rotation rates of Mercury (59 days) and Venus (243 days) produce little or no magnetism to deflect the solar wind. This was confirmed in 2008 when the European Space Agency's Mars Express and Venus Express spacecrafts detected significant atmospheric depletion on both planets due to the solar wind. Apparently the atmosphere on Venus is sustained by large-scale volcanic activity, but Venus Express detected hydrogen and oxygen atoms escaping from the atmosphere of Venus during solar storms, leaving little water vapor in its atmosphere.[33]

5. Stronger gravity holds water vapor. In the giant-impact simulations, most of the mass of the Mars-size impactor is accreted to Earth, increasing its mass by about 10 percent. This increased mass is especially critical in providing sufficient gravity to hold enough of Earth's water vapor in its atmosphere for a long period before condensing to form the oceans.[34] Too much mass might have held even more water vapor, which could have inundated all land and produced

a "waterworld" that would support only sea life. The loss of planetary atmospheres is a complex process involving several thermal and nonthermal mechanisms with no single threshold, but the most important factors are temperature and gravity. High upper-atmosphere temperatures produce high molecular speeds, and larger mass and its gravity increase the escape velocity.[35]

The escape velocity for molecules in Earth's atmosphere is more than twice that of Mercury and Mars, which have lost most of their atmospheres even though Mars is much further from the Sun. The escape velocity on Venus is only about 10 percent less than that on Earth, but insufficient to prevent the loss of water vapor by thermal processes and by the solar wind.[36] Some estimates indicate that Venus could have lost an ocean's worth of water in a few tens of millions of years.[37] Water vapor is especially vulnerable to leakage since its molecular weight is among the smallest of atmospheric gases, and dissociation of water molecules by collisions or ultraviolet radiation nearly inevitably leads to loss of hydrogen.

6. Plate tectonics supported by giant impact. Several features of a giant impact appear to have contributed to the unique tectonic activity on Earth, occurring on no other known planet. These features include a removal of up to 70 percent of Earth's silicate crust to form the Moon, a large increase in core and mantle heat, and an increase in radioactive isotopes to sustain this heat. A similar giant impact on Mars appears to be the cause of crustal thinning of the northern hemisphere lowlands of Mars, but not energetic enough to support plate tectonics.[38] As a thinner crust re-formed on Earth after the collision, it was more susceptible to cracking and the driving forces of heat convection.[39] The giant impact added to the internal heat of Earth both from the collision energy and from an increase in radioactive isotopes. Plate tectonics built the mountains and continents of Earth, without which it would be mostly covered by water with little chance for developing land-based life. For example, if water covered the thicker crust on Venus to an average depth of only 3 kilometers, it would cover more than 90 percent of its surface, and any remaining land would eventually erode.

Tectonic activity also recycles the crust, bringing minerals to the surface and controlling long-term climate by the carbon cycle that balances atmospheric carbon dioxide.[40] When volcanic carbon dioxide traps heat and temperatures increase, more evaporation occurs and increased rainfall washes the carbon dioxide into the oceans, causing the water and air temperatures to drop. This carbon dioxide eventually forms limestone on the ocean bottom, which is then recycled by plate tectonic activity (subduction) and returns to the atmosphere again by associated volcanic activity. Without this cycle Earth would have undergone either a runaway greenhouse effect with too much carbon dioxide, or a runaway snowball effect without enough carbon dioxide in the atmosphere to trap heat.

7. Huge tides enrich oceans with minerals. In the giant-impact model, many minerals needed for life probably sank with iron into the mantle and core of the molten Earth, but turbulent convection probably retained some minerals near the outer mantle boundary. Some of the impact debris was vaporized into a silicate disk around Earth, about half of which formed the Moon.[41] After the impact, the surface cooled by radiation and the crust began to form within about one thousand years.[42] Condensation of the disk followed, and some metals condensed from the giant-impact debris and fell back into Earth's re-forming crust to form a veneer of life-essential minerals, some of which were later brought to the surface by tectonic activity.

Another possibility is that these minerals might have also been enriched in Earth's crust by a late heavy bombardment of asteroids and comets that occurred about 4 billion years ago, as shown by the crater record on the Moon, although there is little evidence of these minerals on the Moon's surface. Recent evidence has identified zircons in Earth's crust dating before this bombardment at 4.4 billion years ago.[43] When the Moon was about ten times closer than it is now and the day had slowed to perhaps ten hours, the tidal forces would be one thousand times larger, since they increase as the inverse-cube of the distance, and tides would be hundreds of times higher than today. Huge tides from the early Moon would erode minerals from far inland about every five hours, enriching the oceans with the minerals needed for life.[44]

8. Lunar tides slow Earth's rotation. As shown by George Darwin, the tidal forces between Moon and Earth slowed Earth from its initial 5-hour rotation to its present 24-hour rotation, and the Moon moved outward from at least 3 Earth-radii, the so-called Roche

limit for forming a satellite, to its current 60 Earth-radii. Early recession of the Moon in the first few hundred million years would be rapid due to much stronger crustal and ocean tidal action, and Earth's rotation would also decrease rapidly.[45] Early rapid rotation would produce super hurricane-force winds, similar to those observed on Jupiter with its rapid ten-hour rotation, which would pose severe threats to most life forms.

After the initial rapid decrease in rotation of Earth and the formation of its oceans, ocean tides would continue the slowing process. A slower rotation rate optimizes wind circulation and surface temperatures for life. Geological evidence for slowing of Earth's rotation comes from measurements of tidal rhythmites, alternating layers of silt and sand offshore from tidal estuaries, showing that Earth's rotation had slowed to about eighteen hours by about 900 million years ago, and to about twenty-two hours by 600 million years ago.[46]

9. Tides produce tidal pools for emerging life. In addition to the role of lunar tides in helping to cleanse and oxygenate the oceans, tidal pools have long been recognized as good locations for concentrating nutrients, by evaporation, for emerging life forms. Rapid tidal cycling occurred when the day was shorter and the Moon was closer, so that the tides would have been larger and tidal pools would cover larger areas. It has been suggested that cycles of wetting and evaporation along the shorelines of the early oceans might have provided the kind of environment in which protonucleic acid fragments could begin to associate and assemble molecular strands leading to the origin of life.[47]

Since the early Moon receded much more rapidly due to strong crustal and ocean tides, it may not have been much closer to Earth when life was emerging than it is now.[48] As the Moon recedes, its force on Earth weakens, eventually reaching about twice the force of the Sun and producing lunar cycles of spring and neap tides, which allow for longer periods of evaporation and concentration of nutrients for early life forms to develop in intertidal pools. Since organic reactions proceed slowly, these longer cycles increase the possibility of long sequences of chemical reactions favorable to emerging life forms. Incidentally, this condition of similar forces by the Sun and Moon happens to correspond to each having nearly the same angular size, which allows for dramatic eclipses.[49]

10. The Moon stabilizes the tilt of Earth's axis. As mentioned above (legacy 2), there have been suggestions that Earth's axial tilt might have been much larger during much of Earth's history, even though the tendency of the Sun's gravity is to minimize axial tilt on the closer planets. If Earth did have a larger axial tilt, the early Moon's strong tidal effects might have had a role in reducing this tilt since its orbit is closer to the ecliptic plane. However, a larger tilt could also have resulted in chaotic changes in Earth's axial tilt with disastrous results on climate and life. Since the early 1990s, it has been known that the axial tilts of both Earth and Mars are subject to the possibility of chaotic variations due to gravitational forces from the outer giant planets.[50]

Fortunately, the large size of our Moon produces sufficient gravitational force to keep the axis of Earth inclined in a narrow range between about 22° and 25°, stabilizing annual climate variations in a favorable range for living organisms and producing the regular seasons that occur on Earth.[51] In this respect, the Moon acts as a kind of regulator for climate on Earth. It prevents the kind of large and chaotic changes in tilt that have been shown to occur over a few million years on Mars, which has two very small moons but no large moon to stabilize its axial tilt.[52]

Conclusion

All of the above legacies are potential contributions to making life on Earth possible, and it appears that the lack of any one of them might have prevented the development of complex life forms, if not life itself as we know it. Not only is it remarkable that Earth has all these life-sustaining features, but that they all appear to be the legacy of our Moon. Beyond these features, Earth has many other properties that are needed for life, such as the right size Sun, a favorable location in the galaxy, the right location in the solar system, the ozone layer to protect from ultraviolet radiation, and many others. These conditions greatly restrict the possibilities of life elsewhere in the universe when factored into the 1961 Drake equation for estimating how many other planets might support extraterrestrial life, which led to the oft-quoted estimate of one million.[53] In spite of these restrictions, Frank Drake, as late as 1992, still insisted that there

should be about 10,000 planets with intelligent life in our galaxy.[54] He made no attempt to take into account the importance of a large moon for life.

Computer studies have shown that any accreting planet has some chance of being hit by a planetesimal object one-tenth its size in the same accreting zone, and that the giant-impact theory of the Moon fits within this probabilistic framework. However, it is also evident that the right kind of glancing collision is not inevitable and, in fact, has very low probability. One estimate of this probability takes into account five independent parameters, each with its own estimated probability (in parenthesis): the right size impactor (0.001), the right time for the impact to occur (0.1), the right direction for an effective glancing collision (0.03), the right point of impact on the proto-earth (0.2), and the right speed to place enough debris in orbit (0.01). The product of these factors gives an estimated probability of about 10^{-8} for this event.[55] Although these probability factors are somewhat arbitrary, the final estimate is consistent with the fact that no other planet is known to have had a similar glancing collision that produced a large moon. It is also consistent with recent data from an infrared survey of more than four hundred young stars (about 30 million years old, and thus past their planet-forming age), carried out by NASA's Spitzer telescope, revealing only one dust cloud signature large enough to be a possible moon-forming collision.[56]

Applying the above probability for a large moon from a glancing collision to the very optimistic Drake estimate in 1992 of 10,000 intelligent civilizations in our galaxy, suggests a very low probability (10^{-8} x 10,000 = 0.0001) for any other planets in our galaxy with intelligent life. This probability is much lower if other factors ignored by Drake for a habitable planet are taken into account, such as proto-planet size and composition prior to a glancing collision, size and location of its parent star, and many other critical factors.[57] Although such low probabilities do not prove divine intervention, they do suggest the possibility of a plan and purpose behind natural events. The random or stochastic nature of such events can be viewed in a Christian framework, where "random" could be translated as "non-predictable" within a generalized doctrine of divine providence.[58] In such a view, God can work through a preordained plan or a continuous supervision of his creation, perhaps through quantum uncertainties consistent with the causal order of creation.[59] This is reflected in Charles Darwin's prefatory quote of Anglican priest and historian of science William Whewell in the first edition of *On the Origin of Species*:

> But with regard to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general laws.[60]

The special nature of our Moon and its Earth-shaping role reveal the unusual legacy that makes life possible. The apparently unique nature of our Earth-Moon system violates the contemporary materialistic faith that life is commonplace in the universe. For Christians, it supports the belief that God can work through natural and seemingly random processes to achieve his purposes in creation.[61] It encourages a new appreciation for the special gift of life and an environment suitable for its survival. It echoes the words of Psalm 8:3–4, "When I look at your heavens, the work of your fingers, the moon and the stars, which you have set in place, what is man that you are mindful of him, and the son of man that you care for him?" ⋆

Notes

*An abbreviated version of this paper was presented at the ASA Annual Meeting at Baylor University, Waco, TX, in August 2009.

[1]Iosef Shklovskii and Carl Sagan, *Intelligent Life in the Universe* (San Francisco, CA: Holden-Day, 1966), 410–3. This early use of the Drake equation to predict a million planets with intelligent life in our galaxy was later repudiated by Shklovskii as much too optimistic.

[2]Peter Ward and Donald Brownlee, *Rare Earth: Why Complex Life is Uncommon in the Universe* (New York: Copernicus, 2000); Guillermo Gonzalez and Jay Richards, *The Privileged Planet: How Our Place in the Cosmos is Designed for Discovery* (Washington, DC: Regnery Publishing, 2004).

[3]Dana Mackenzie, *The Big Splat, or How Our Moon Came to Be* (Hoboken, NJ: John Wiley and Sons, 2003).

[4]G. Jeffrey Taylor, "The Scientific Legacy of Apollo," *Scientific American* (July 1994): 40–7.

[5]M. J. Boussinesq, "Notice sur la Vie et les Travaux de M. Edouard Roche," in Edouard Roche, *Mémoires Astronomiques et Météorologiques* 1 (Montpellier, France: Boehm et Fils, 1883).

[6]E. W. Brown, "The Scientific Work of Sir George Darwin," in George Darwin, *Scientific Papers* 5 (Cambridge: Cambridge University Press, 1916). The 5-hour Earth rotation is obtained by conservation of angular momentum at the Roche limit of about 3 Earth radii for satellite stability.

[7]Thomas Jefferson Jackson See, *Researches on the Evolution of the Stellar Systems*, vol. 2, *The Capture Theory* (Lynn, MA: T. P. Nichols and Son, 1910).

[8]Harold Urey, "The Space Program and Problems of the Origin of the Moon," *Bulletin of the Atomic Scientists* (April 1969): 14–30.

[9]See R. B. Baldwin and D. E. Wilhelms, "Historical Review of a Long-Overlooked Paper of R. A. Daly concerning the Origin and Early History of the Moon," *Journal of Geophysical Research* 97 (1992): 3837; James H. Natland, "Reginald Aldworth Daly (1871–1957): Eclectic Theoretician of the Earth," *GSA Today* 16, no. 2 (2006); R. A. Daly, *Proceedings of the American Philosophical Society* 90 (1946): 109–19.

[10]W. K. Hartmann and D. L. Davis, "Satellite-Sized Planetesimals and Lunar Origin," *Icarus* 23 (1975): 504–15.

[11]Alastair G. W. Cameron and William R. Ward, "The Origin of the Moon," *Abstracts of the Lunar and Planetary Science Conference* 7 (1976): 120.

[12]W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds., *Origin of the Moon* (Houston, TX: Lunar and Planetary Institute, 1986); G. Jeffrey Taylor, "Lunar Origin Meeting Favors Impact Theory," *Geotimes* 30, no. 4 (1985): 16–7.

[13]R. M. Canup and E. Asphaug, "Origin of the Moon in a Giant Impact near the End of the Earth's Formation," *Nature* 412 (2001): 708–11; A. G. W. Cameron, "From Interstellar Gas to the Earth-Moon System," *Meteoritics and Planetary Science* 36 (2001): 9–22.

[14]Chris R. Benn, "The Moon and the Origin of Life," *Earth, Moon, and Planets* 85/86 (2001): 61–7; Dave Waltham, "Anthropic Selection for the Moon's Mass," *Astrobiology* 4, no. 4 (Winter 2004): 460–8.

[15]Neil F. Comins, *What if the Moon Didn't Exist? Voyages to Earths That Might Have Been* (New York: HarperCollins Publishers, 1993); Ward and Brownlee, *Rare Earth;* Gonzalez and Richards, *The Privileged Planet*; Hugh Ross, *More Than a Theory: Revealing a Testable Model for Creation* (Grand Rapids, MI: Baker Books, 2009).

[16]George Darwin, *The Tides and Kindred Phenomena in the Solar System* (San Francisco, CA: W. H. Freeman, 1962).

[17]Margarita M. Marinova, Oded Aharonson, and Erik Asphaug, "Mega-Impact Formation of the Mars Hemispheric Dichotomy," *Nature* 453 (June 2008): 1216–9.

[18]J. Huw Davies, "Did a Mega-Collision Dry Venus' Interior?" *Earth and Planetary Science Letters* 268 (30 April 2008): 376–83; Alex Alemi and David Stevenson, presentation on two- collision Venus model at the Division for Planetary Sciences conference in Pasadena, CA, October 9, 2006.

[19]William M. Kaula, "Formation of the Terrestrial Planets," *Earth, Moon, and Planets* 67 (1995): 1–11.

[20]Stuart R. Taylor, *Solar System Evolution: A New Perspective* (Cambridge: Cambridge University Press, 1992), 178.

[21]Ward and Brownlee, *Rare Earth,* chap. 10.

[22]L. A. Frakes, *Climates throughout Geologic Time* (Amsterdam: Elsevier, 1979); P. F. Hoffman, A. J. Kaufman, G. P. Halverson, and D. P. Schrag, "A Neoproterozoic Snowball Earth," *Science* 281 (1998): 1342–6.

[23]G. E. Williams, "History of the Earth's Obliquity," *Earth Science Review* 34 (1993): 1–45.

[24]D. M. Williams, J. F. Kasting, and L. A. Frakes, "Low-Latitude Glaciation and Rapid Changes in the Earth's Obliquity Explained by Obliquity-Oblateness Feedback," *Nature* 396 (1998): 453–5.

[25]B. Levrard and J. Laskar, "Climate Friction and the Earth's Obliquity," *Geophysical Journal International* 154, no. 3 (2003): 970–90; M. A. Pais, J. L. LeMouël, K. Lambeck, and J. P. Poirier, "Late Precambrian Paradoxical Glaciation and the Obliquity of the Earth," *Earth and Planetary Science Letters* 174 (1999): 155–71.

[26]J. P. Vanyo and S. M. Awramik, "Length of the Day and Obliquity of the Ecliptic 850 Ma Ago—Preliminary Results of a Stromatolite Growth Model," *Geophysical Research Letters* 9 (1982): 1125–8; S. M. Awramik and J. P. Vanyo, "Heliotropism in Modern Stromatolites," *Science* 231 (1986): 1279–81.

[27]Hidenori Genda and Yutaka Abe, "Enhanced Atmospheric Loss on Protoplanets at the Giant Impact Phase in the Presence of Oceans," *Nature* 433 (2005): 842–4; T. J. Ahrens, "Impact Erosion of Terrestrial Planetary Atmospheres," *Annual Review Earth and Planetary Science Letters* 21 (1993): 525–55.

[28]J. F. Kastings, "Runaway and Moist Greenhouse Atmospheres and the Evolution of Earth and Venus," *Icarus* 74 (June 1988): 472–94.

[29]N. H. Sleep, K. Zahnle, and P. S. Neuhoff, "Initiation of Clement Surface Conditions on the Earliest Earth," *Proceedings of the National Academy of Sciences* 98, no. 7 (2001): 3666–72.

[30]A. G. W. Cameron and W. Benz, "The Origin of the Moon and the Single Impact Hypothesis IV," *Icarus* 92 (August 1991): 204–16.

[31]Ataru Sakuraba and Paul H. Roberts, "Generation of a Strong Magnetic Field Using Uniform Heat Flux at the Surface of the Core," *Nature Geoscience* 2 (4 October 2009): 802–5.

[32]David J. Dunlop, "Paleomagnetism: A More Ancient Shield," *Nature* 446 (5 April 2007): 623–5.

[33]J. G. Luhmann, A. Fedorov, S. Barabash, E. Carlsson, Y. Futaana, T. L. Zhang, C. T. Russell, J. G. Lyon, S. A. Ledvina, and D. A. Brain, "Venus Express Observations of Atmospheric Oxygen Escape during the Passage of Several Coronal Mass Ejections," *Journal of Geophysical Research* 113 (26 August 2008).

[34]M. H. Hart, "The Effect of a Planet's Size on the Evolution of Its Atmosphere," *Southwest Regional Conference on Astronomy and Astrophysics* 7 (1982): 111–26.

[35]David C. Catling and Kevin J. Zahnle, "The Planetary Air Leak," *Scientific American* (May 2009): 36–43.

[36]B. Bézard, C. C. C. Tsang, R. W. Carlson, G. Piccioni, E. Marcq, and P. Drossart, "Water Vapor Abundance Near the Surface of Venus from Venus Express/VIRTIS Observations," *Journal of Geophysical Research* 114 (May 2009).

[37]James F. Kasting, Owen B. Toon, and James B. Pollack, "How Climate Evolved on the Terrestrial Planets," *Scientific American* 258 (February 1988): 90–7.

[38]Jeffrey C. Andrews-Hanna, Maria T. Zuber, and W. Bruce Banerdt, "The Borealis Basin and the Origin of the Martian Crustal Dichotomy," *Nature* 453 (26 June 2008): 1212–5.

[39]C. P. Conrad and C. Lithgow-Bertelloni, "How Mantle Slabs Drive Plate Tectonics," *Science* 298 (2002): 207–9.

[40]Ward and Brownlee, *Rare Earth*, chap. 9.

[41]A. G. W. Cameron, "The Origin of the Moon and the Single Impact Hypothesis V," *Icarus* 126 (March 1997): 126–37.
[42]For a summary of these processes, see David J. Stevenson, "A Planetary Perspective on the Deep Earth," *Nature* 451 (17 January 2008): 261–5.
[43]Simon A. Wilde, John W. Valley, William H. Peck, and Colin M. Graham, "Evidence From Detrital Zircons for the Existence of Continental Crust and Oceans on the Earth 4.4 Gyr Ago," *Nature* 409 (17 January 2001): 175–8.
[44]Richard Lathe, "Early Tides: Response to Varga et al.," *Icarus* 180, no. 1 (January 2006): 277–80.
[45]Robert J. Malcuit, "The First 800 Million Years of Earth History: Can We Neglect the Tidal Effects of the Moon?" presented at a meeting of the *Geological Society of America* in Eau Claire, WI, August 2005.
[46]C. P. Sonett, E. P. Kvale, A. Zakharian, Marjorie A. Chan, and T. M. Demko, "Late Proterozoic and Paleozoic Tides, Retreat of the Moon, and Rotation of the Earth," *Science* 273, no. 5271 (July 1996): 100–4; George E. Williams, "Geological Constraints on the Precambrian History of Earth's Rotation and the Moon's Orbit," *Reviews of Geophysics* 38, no. 1 (2000): 37–60.
[47]Richard Lathe, "Fast Tidal Cycling and the Origin of Life," *Icarus* 168, no. 1 (2003): 18–22.
[48]Lathe, "Early Tides."
[49]C. R. Benz, "The Moon and the Origin of Life," *Earth, Moon, and Planets* 85/86, no. 61 (2001): 61–7. This article covers five features related to the origin of life.
[50]J. Laskar, "The Chaotic Motion of the Solar System. A Numerical Estimate of the Size of the Chaotic Zones," *Icarus* 88 (1990): 266–91.
[51]J. Laskar, F. Joutel, and P. Robutel, "Stabilization of the Earth's Obliquity by the Moon," *Nature* 361 (18 February 1993): 615–7.
[52]Jihad Touma and Jack Wisdom, "The Chaotic Obliquity of Mars," *Science* 259, no. 5099 (February 1993): 1294–7.
[53]Shklovskii and Sagan, *Intelligent Life in the Universe*.
[54]Frank Drake and Dava Sobel, *Is Anyone Out There? The Scientific Search for Extraterrestrial Intelligence* (New York: Delacorte Press, 1992), 52.
[55]Stanley L. Jaki, *Maybe Alone in the Universe After All* (Pinckney MI: Real View Books, 2000), 16–20.
[56]N. Gorlova, Z. Balog, G. H. Riske, J. Muzerolle, K. Y. L. Su, V. D. Ivanov, and E. T. Young, "Debris Disks in NGC 2547," *Astrophysics Journal* 670 (2007): 516–35.
[57]Hugh Ross, *The Creator and the Cosmos* (Colorado Springs, CO: NavPress, 1995), chapter 15.
[58]Alister E. McGrath, "The Enigmas of Evolutionary Biology," (lecture 4 of the Gifford Lectures presented at the University of Aberdeen, Aberdeen, Scotland, 19 February 2009), 5.
[59]William G. Pollard, *Chance and Providence: God's Action in a World Governed by Scientific Thought* (New York: Charles Scribner's Sons, 1958), chap. 4; Nancey Murphy and George F. R. Ellis, *On the Moral Nature of the Universe* (Minneapolis, MN: Fortress Press, 1996), 214.
[60]William Whewell, *Bridgewater Treatise*, quoted in Charles R. Darwin, *On the Origin of Species*, 1st ed. (London: John Murray, 1859), inside front cover.
[61]John W. Hall, "Chance for a Purpose," *Perspectives on Science and Christian Faith* 61, no. 1 (2009): 3–11.

Dennis R. Venema

Essay Review

Seeking a Signature

Dennis R. Venema

SIGNATURE IN THE CELL: DNA and the Evidence for Intelligent Design *by Stephen C. Meyer. New York: Harper Collins Publishers, 2009. viii + 613 pages. Hardcover; $28.99. ISBN: 9780061472787.*

Stephen C. Meyer's recent tome *Signature in the Cell* (hereafter, *Signature*) represents the "state of the art" for the intelligent design (ID) movement with respect to the origin of biological information. With *Signature*, Meyer claims to have established ID as the best scientific explanation for information in DNA, and thus, to have established the presence of a designing intelligence at the origin of life. The book is a landmark for the ID movement, and, in light of its claims, is of significant interest to Christians in the sciences. If Meyer's claims indeed are found to have scientific support, they would represent perhaps the most significant scientific advance in the last several hundred years, and at the same time, provide no less than "a blueprint for twenty-first-century biological science."[1]

Signature in the Cell—Overview

Meyer begins *Signature* with a personal history of his entry into the design movement and his growing interest in what he terms "the DNA enigma—the mystery of the origin of the information needed to build the first living organism."[2] From there he moves on to an introduction to early origin-of-life research (chap. 2) and a narrative of Watson and Crick's discovery of the structure of DNA (chap. 3). In chapter 4, Meyer discusses his ideas on the information content of DNA, and in chapter 5, he describes cellular information processing (transcription and translation), presenting these as a "chicken-and-egg" problem for naturalistic origin-of-life research to explain. In chapters 6 and 7, Meyer outlines his strategy by which he will argue for ID as the best scientific explanation for the information present in DNA.

The core of Meyer's argument can be found in chapter 7. Here he proposes three criteria for establishing ID as the best explanation for the origin of biological information: evidence that the cause was (1) present at the required time, (2) known to be causally adequate for the effect in question, and (3) the "absence of evidence (despite a thorough search) … of … other possible causes." Meyer also argues that the first criterion can be met if there is only one possible cause of the effect in question:

> If there is only one possible cause of a salient piece of evidence, then clearly the presence of that evidence establishes the past existence of its cause.[3]

This, in a nutshell, is the argument of the entire book. The second criterion (that

Dennis Venema *is associate professor and chair of biology at Trinity Western University. He obtained his BSc and PhD in cell biology and genetics from the University of British Columbia. His research interests include the genetics of tissue patterning in Drosophila, genetics education, and the interaction between evolutionary biology and Christian faith. He was the recipient of the 2008 College Biology Teaching Award from the National Association of Biology Teachers. Recently, he has co-authored a series of blog posts discussing comparative genomics and human evolution for the Biologos Foundation. He and his wife Val have a son Elijah (7) and daughter Davin (5), and as a family they enjoy numerous outdoor activities that the Pacific coast region has to offer.*

intelligence can be the origin of information) is taken as a given. All that remains is for Meyer to establish with a "thorough search" that intelligence is the *only* possible source of biological information. In so doing, he will argue that ID qualifies as the best *scientific* inference for the information we find in DNA. Of course, the power of this argument lies squarely in the quality of his "thorough search" for alternate causes.[4]

Meyer's quest for other explanations spans seven chapters, only one of which (at a slim twenty-eight pages) deals with the RNA world, one current hypothesis for the origin of life from abiotic precursors. The remaining six chapters of this section (totaling 123 pages) discuss historical models of abiogenesis that are no longer under serious consideration (if, indeed, they ever were). Having surveyed, to his satisfaction, natural causes for the origin of biological information and found them wanting, Meyer concludes that ID is the best explanation (chap. 15), compares his findings with William Dembski's "Explanatory Filter" (chap. 16), and argues that his approach is not an argument from ignorance (chap. 17). Importantly, Meyer claims that he argues not from *absence of knowledge*, but rather from *knowledge of absence* of competing natural explanations:

> True, some of the chapters of this book do argue that, at present, all types of material causes and mechanisms fail to account for the origin of biological information from a prebiotic state. And clearly this lack of knowledge of any adequate material cause does provide part of the grounds for inferring design from information in the cell, although it is probably more accurate to characterize this supposed "absence of knowledge" as knowledge of absence, since it derives from a thorough search for alternative materialistic causes and a thorough evaluation of the results of numerous experiments performed over several decades.[5]

Meyer then wraps up the book with an argument for ID as science, framed as a rebuttal to the devastating *Kitzmiller vs. Dover Board of Education* ruling in 2005[6] (chap. 18), a chapter comparing his approach to standard science (chap. 19), and a more personal section entitled "Why it Matters" (chap. 20). Here Meyer explains his motivation for engaging the debate:

> … intelligent design, arguably, has theistic implications because intelligent design confirms a major tenet of the theistic worldview, namely, that life was designed by a conscious and intelligent being, a purposive agent with a mind.[7]
>
> According to scientific materialism, reality is ultimately impersonal … though this view of existence proved initially liberating in that it released humans from any sense of obligation to an externally imposed system of morality, it has also proved profoundly and literally dispiriting. If the conscious realities that comprise our personhood have no lasting existence, if life and mind are nothing more than unintended ephemera of the material cosmos, then, as the existential philosophers have recognized, our lives can have no lasting meaning or ultimate purpose. Without a purpose-driven universe, there can be no "purpose-driven life."[8]

The book also contains an epilogue and two appendices (one discussing ID predictions; the other, multiverse cosmology) which round out its 500-plus pages (excluding endnotes). Whatever else, *Signature* is not a light read.

Rationale for a Thorough Scientific Critique

So, does Meyer's scientific case hold together? I would say no. It suffers from what I perceive as fatal flaws that scuttle Meyer's case for a design inference as the best explanation for the origin of biological information. While there is much that could be said about less important issues in *Signature* (e.g., Is ID "scientific creationism"? Poor theology?), I will focus this review on the core of Meyer's scientific case for design. Meyer claims to have achieved a scientifically robust argument that establishes intelligent intervention as the best *scientific* explanation for the information content of DNA. Accordingly, this argument should be evaluated on its scientific merit. However, be forewarned: in what follows, I focus on what I see as serious scientific flaws in *Signature*, and leave what praise I have for the book (and there is some) left unsaid. I do this not out of disrespect, but rather out of respect. Meyer has presented his case, and he deserves to have this case thoroughly tested. If it can stand, so be it. If it cannot, then this critique may be useful to him in the future as he continues his work. In either case, my platitudes will avail nothing; only scientific critique has lasting merit.

No Biological Information by Natural Means?

The first fatal flaw, as I see it, is that Meyer claims there is no known natural mechanism that can add information to DNA. This claim is key to the entire argument, since Meyer cannot claim information as the direct action of a designing intelligence at the origin of life unless he rules out all natural causes that may add information to DNA. In doing so, he has to deny natural selection as such a mechanism:

> Since the case for intelligent design as the best explanation for the origin of biological information necessary to build novel forms of life depends, in part, upon the claim that functional (information-rich) genes and proteins cannot be explained by random mutation and selection, this design hypothesis implies that selection and mutation will not suffice to produce genetic information and that, consequently, functional sequences of amino acids within protein-sequence space will be extremely rare rather than common. Axe's mutagenesis experiments have tested, and continue to test, this prediction of ID theory.[9]

Meyer's main argument for the inability of random mutation coupled with natural selection (hereafter, "RM + NS") to add information to DNA is based on the research of Douglas Axe, a scientist currently working at the Discovery Institute's Biologic Institute.[10] Meyer claims that Axe's work demonstrates that proteins are rare in sequence space—and argues therefore that functional proteins cannot be converted to different functions through RM + NS due to the intervening nonfunctional space between islands of function. There are several reasons why Axe's work cannot be used as evidence for such an assertion.

The most obvious issue is that the rarity or commonality of function in protein sequence space is irrelevant to the discussion. What counts is whether functional sequences in protein space are *isolated* from each other in a way RM + NS cannot bridge.[11] This, as far as I can tell, is, in fact, what Meyer is arguing, though he does not appear to understand the distinction and conflates the two ideas in *Signature*. Even if one accepts Axe's work uncritically, it only attempts to evaluate the rarity of functional sequences, not their evolutionary isolation. There are several very important differences between Axe's work and a natural protein exploring sequence space through RM + NS.[12] First, the protein Axe used as a "test bench" was intentionally "hamstrung" with multiple mutations to render it far less functional than its natural counterpart. Secondly, the cellular environment for this altered protein was held constant, whereas proteins exploring sequence space through RM + NS experience drift in their cellular environment as well as in their own sequences. Thirdly, and most significantly, Axe did not mutate his test protein with single point mutations, but rather by adding partially randomized groups of ten amino acids at a time, something that does not resemble natural processes. While these features of Axe's work are useful standardizations for estimating the relative rarity of function protein folds in his specific experimental setup, they render his work irrelevant to the issue of evolutionary isolation of functional sequences. Axe himself does not draw this conclusion from his work in the paper in question, and it is inappropriate for Meyer to attempt to do so. Moreover, Meyer ignores (or is unaware of) research in this area that is directly relevant to his argument. There is a large body of evidence from structural biology studies that proteins do transition between varied structures and functions across evolutionary time.[13] If Meyer wishes to justify his argument, he needs to address this evidence.

Beyond the evidence from structural biology, evidence from comparative genomics also strongly supports the hypothesis that the orthologous proteins we see in related species are indeed modified versions of an ancestral sequence. Consider the example of insulin sequences in various species and their conservation at the nucleotide level as well as at the amino acid level.[14] These sequences, when compared across widely diverged species, produce the exact pattern one would predict if they were, in fact, the results of an ancestral protein sequence "exploring sequence space" across evolutionary time through random point mutations and purifying selection of its nucleotide code. If Meyer wants to argue that Axe's work demonstrates that proteins cannot explore sequence space through RM + NS, he needs to address this pervasive pattern. As we shall see, however, Meyer does not tackle this evidence or, for that matter, any evidence relevant to common ancestry.

Meyer's denial of RM + NS as an information generator notwithstanding, in a discussion about evolu-

tionary computer simulations, Meyer makes the following claim:

> If computer simulations demonstrate anything, they subtly demonstrate the need for an intelligent agent to elect some options and exclude others—that is, to create information.[15]

Employing this argument, Meyer claims that any mechanism that prefers one variant over another creates information. As such, the ample experimental evidence for natural selection as a mechanism to favor certain variants over others certainly qualifies as such a generator. Meyer, however, makes no mention of evidence for natural selection in the book. The closest Meyer comes to discussing this issue is in the same section on computer simulations:

> Nothing in nature (biology or chemistry) corresponds to the role that the computer plays in selecting functionally non-advantageous sequences that happen to agree "one bit better" than others with a target sequence.[16]

This statement, while technically true, is misleading. It is technically true that nothing in nature distinguishes between nonfunctional sequences. It is misleading to suggest, however, that natural selection cannot work because it has no way of attaining a future idealized target. What natural selection can do, and do very well, is select between variants within a population, based on differential reproductive success. As such, it is not working toward a future target, but rather disproportionally preserving the most successful variants in a given generation. Natural selection works not because it has *foresight*, but because it has *hindsight*: sequences converge on highly functional sequences not because they "know" where they are going, but because they "know" where they have been, and they use this sequence as the starting point for exploring sequence space. As mutations "explore" the space around a previously selected sequence, variants that have an increase in function relative to the environment at that point in time are again selected. This process, as it is repeated, can rapidly converge on sequences highly suited to their tasks.

I happened to be teaching an upper-level class on immunology while I was reading *Signature*. The differences between Meyer's arguments against RM + NS as a generator of information and the process by which the human body produces specific antibodies stood in sharp contrast for me. An overview of this process recently appeared in this journal,[17] and I was pleased to see that this issue was raised on the ASA blog discussing *Signature*.[18] Antibodies are generated through successive rounds of mutation and selection. In the first instance, antibody gene segments are spliced together to form a coding sequence for the variable tip of the antibody; this process also includes the addition of random nucleotides in the joints between the segments. Each antibody-producing cell (a B cell) makes one antibody through this process. Of the vast numbers of antibodies produced, the few that bind foreign material trigger the selective reproduction of the B cells that harbor them. This replication is accompanied by further random mutation of the originally selected antibody sequence, and the resulting cells with the strongest-binding antibodies are selected (and the process may repeat if the same pathogen attacks the host again in the future). Through this process of repetitive mutation and selection, an antibody progresses from relatively weak affinity to very strong affinity—a feature that greatly improves its function as an agent to fight infection. By any reasonable definition, this is an increase in biological information, but it proceeds effectively (a) through random mutation and a form of natural selection, and (b) with no planned target in mind, only repetitive selection for the best variants at any given time. What "creates" the information is the *environment*: the presence of the specific pathogen elects certain B cells and excludes others. By Meyer's definition, the pathogen is the antibody designer.

While antibody generation is a particularly compelling case of natural processes increasing biological information, the same principles are seen time and again with RM + NS at the population level. For example, the work of Richard Lenski and colleagues on long-term evolution of *E. coli* has documented numerous mutations that have increased biological fitness within their experimental populations which have arisen through spontaneous mutations.[19] Other examples abound: the mutation and selection of the nylonase enzyme (which allowed its host to metabolize nylon),[20] the production of an antifreeze protein in fish from an enzyme gene,[21] and other examples of proteins arising *de novo* through mutation.[22]

Therefore, the demonstration that RM + NS can add information to DNA without the intervention of a designer means that Meyer's argument for the

exclusivity of intelligence in producing biological information fails. As such, RM + NS now becomes a candidate for the origin of biological information from nonliving precursors. What is required, of course, is a plausible pathway leading from nonliving precursors to a replicating entity capable of variation on which natural selection can act.

Abiogenesis: God's Last Gap?

While Meyer is correct that no complete mechanism for abiogenesis has yet been put forward, his argument here suffers from additional major flaws: he focuses disproportionately on outdated, discarded origin-of-life hypotheses, gives current science on the issue short shrift, and does not fairly represent the science he does discuss. For example, the major model favored by many scientists is the "RNA world" hypothesis, yet Meyer spends little time on it. Other current models, such as "metabolism first" hypotheses,[23] receive no attention at all. This seriously compromises Meyer's argument, since his conclusion of design depends on his assertion that he has performed a "thorough search" to exclude all natural alternatives to intelligent intervention at the origin of life. Yet his search is not extensive, but selective and misleading at several key points.

In total, Meyer discusses origin-of-life hypotheses in a section spanning four chapters totaling approximately 150 pages. Of this section, the only current origin-of-life model (the RNA world) merits a slim chapter of twenty-eight pages; the remainder is a review of outdated ideas which he uses to argue that biological information cannot be assembled by chance alone or through self-assembly of the monomers that make up proteins or nucleic acids. The length of time Meyer spends on these various discredited origin-of-life hypotheses (if, indeed, several of them were ever serious contenders) suggests he is either attempting to inflate the appearance of their importance to his nonspecialist audience or that he himself is not capable of evaluating them at their key points.

Once Meyer does arrive at discussing a current model (the RNA world hypothesis), he does so without mentioning several key pieces of evidence in its favor. Indeed, the discussion is not so much a description of the hypothesis as it is a polemic against it. Further, it is a flawed polemic. The first and most obvious error is that Meyer claims that the RNA world must explain a transition from an RNA-based enzyme for protein synthesis to a protein enzyme in the modern system. The error is, of course, that the "modern" system uses an RNA enzyme for protein synthesis: the enzymatic core of the ribosome (i.e., the portion of the complex that catalyzes peptide bond formation) is a ribozyme, not a protein enzyme. The modern ribosome uses proteins to stabilize and direct peptide bond formation, but they do not perform an enzymatic role.[24] Meyer, however, claims that modern ribosomes are "protein dominated" and presents this as a hurdle for the RNA world to explain.

While Meyer's lack of depth in modern origin-of-life research appears in several places, one key error relevant to the RNA world hypothesis arises on multiple occasions. A rhetorical thread that Meyer weaves throughout the book is that the genetic code is arbitrary: that, in principle, any codon could have been assigned to any amino acid since there is no physical connection between them. Meyer claims that this feature of the translation apparatus is a "mystery" for origin-of-life research:

> Self-organizational theories have failed to explain the origin of the genetic code for several reasons. First, to explain the origin of the genetic code, scientists need to explain the origin of the precise set of correspondences between specific nucleotide triplets in DNA (or codons on the messenger RNA) and specific amino acids (carried by transfer RNA). Molecular biologists have failed to find any significant chemical interaction between the codons on the mRNA (or the anticodons on the tRNA) and the amino acids on the acceptor arm of tRNA to which the codons correspond. This means that the forces of chemical attraction between amino acids and these groups of bases do not explain the correspondences that constitute the genetic code … the code is physically and chemically arbitrary. All possible codes are equally likely; none is favored chemically.[25]

This point is a major one for Meyer: if the code is chemically arbitrary, then there can be no mechanistic pathway leading to it from nonliving chemical precursors. However, Meyer either avoids, or is simply unaware of,[26] a significant amount of research in this area that *has* demonstrated chemical interactions between amino acids and their cognate anticodons or codons.[27] This productive area of research was

recently reviewed in extensive detail.[28] In brief, several amino acids directly bind RNA sequences corresponding to their anticodon or codon. This finding is strong evidence that the genetic code was established, at least in part, by the exact sort of chemical interactions that Meyer explicitly denies have ever been found. If, indeed, the genetic code was arbitrary, there would be no reason to expect these correspondences; conversely, their presence is good evidence that the modern genetic code passed through a "stereochemical era" where proteins were synthesized by direct organization on an RNA template, consonant with the hypothesis that RNA was the original genetic material.[29] While he does mention one discarded direct-coding hypothesis from the 1950s,[30] there is no mention of this more recent, and relevant, data. Meyer's failure to address this research, while claiming that such evidence does not exist, is a serious flaw in his argument.

What of Common Ancestry?

An additional flaw in Meyer's work is that it almost completely avoids the issue of common ancestry. Surely, in a study attempting to eliminate a natural origin for biological information, the evidence for how biological information has been transmitted and modified by natural processes would be highly relevant. I found it very odd that in *Signature's* five hundred pages, no DNA evidence for common ancestry is discussed. The only time Meyer broaches the issue is to claim that his work on the information content of DNA is compatible with all ID models: those that accept common ancestry, and those that deny it. Here, too, Meyer avoids a huge body of genetics evidence that overwhelmingly favors common ancestry[31] and has been described as such by the only well-known ID advocate who accepts it.[32] Meyer is claiming that his analysis, while robust enough to rule out all natural mechanisms for the origin of information in DNA, is insufficient to adjudicate between two competing ideas about the transmission of genetic information currently advocated *within* the ID movement. Put more simply, it means that ID as an explanatory framework is insufficiently powerful to test a hypothesis for which there is much relevant evidence. Given the strength of that evidence, this waffling on Meyer's part can only be for the benefit of the ID "big tent" approach or because he personally rejects common ancestry.[33] A serious scientific work would not equivocate on such a well-supported area of research: at a minimum, it would engage the relevant evidence even if it argued for a conclusion at odds with the consensus. Meyer simply avoids the evidence altogether.

Odds and Ends

Although other flaws are less serious in and of themselves, they are still indicative of the level of argumentation in the book, as well as of the quality of its peer review. For example, it was in chapter three that I first arrived at what I now call a "Behe moment" when reading antievolutionary literature. In Michael Behe's book *Edge of Evolution*, he makes a few obvious "rookie errors" when discussing how probabilities work in population genetics.[34] This, for me, was the clear signal that the book was written by an amateur in the field and not adequately peer reviewed. In *Signature*, this moment arrived when Meyer calls *Pnemonococci* a bacterium *and* a virus in the same paragraph.[35] This impression was confirmed anew when Meyer describes, over the course of several pages, his epiphany that DNA bases do not have bonds between them and thus cannot self-organize into specified sequences. This "epiphany" is something that biology majors learn (or at least, *should* learn) in their introductory courses. This theme continued apace in the figure describing translation.[36] *Signature* shows tRNAs aligning to the mRNA in a 5' to 5' orientation, tRNAs with codon instead of anticodon sequences, and several inappropriate nucleotide pairings: all very basic mistakes. In short, *Signature* clearly was not written or peer reviewed by individuals with a working knowledge of molecular biology.

Now, these issues in and of themselves would not be a serious problem for *Signature,* if not for the fact that the strength of Meyer's argument rests entirely on his assertion that he has made a thorough search through all proposed mechanisms for generating biological information through natural means and found them lacking. Meyer is asking his audience to trust him that his analysis is thorough and sound. However, that Meyer's understanding of molecular biology appears to be at or below a first-year college level should give even the most pro-ID reader pause here. It means that Meyer, well intentioned though he may be, is simply not equipped to grapple with these issues beyond an introductory textbook level. Nor has Meyer sought the advice of those who are able to do so. And as we have seen, Meyer has made

neither a thorough search for the origin of biological information by natural mechanisms, nor a fair assessment of current origin-of-life research.

Concluding Thoughts

In some ways, the disappointment for me in reading *Signature* was its too obvious weaknesses. An ID argument with some scientific teeth to it would be intellectually invigorating, and I expected *Signature* would deliver more than it did. It has no theory of design, and no vigorous hypotheses to advance the movement. As Randy Isaac noted in an ASA blog, Meyer's predictions do not distinguish between ID and other hypotheses:

> It is laudable that Meyer takes the step to explore predictions that ID would make. Predictions that are testable are a vital part of the scientific process. But just making a prediction isn't sufficient to indicate viable science. Astrologers and tasseologists can also make predictions and sometimes they may be right. Predictions must also be based on causal factors that are understood independently to exist and whose adequacy can be independently verified. The predictions must clearly differentiate between competing hypotheses. It is unfortunate that this set of dozen predictions is very weak on all counts.[37]

Effectively, Meyer requests that we trade pursuing an ongoing area of productive research for his pronouncement that it will never succeed. Not so. Biologists know full well that natural mechanisms can add functional information to DNA sequences, and it thus makes good sense to look for pathways that exploit these mechanisms at the origin of life. True, research in this field has not solved the origin-of-life problem, and there are several competing hypotheses on the table, all with some experimental support. Quite a lot has been accomplished in this area in the last few decades, and it is a reasonable expectation that further research will continue to pay dividends. To halt research in this field and to label it "design" (and therefore unsolvable) accomplishes nothing scientifically, especially when there is no workable theory of design to guide future work.

While popular-level books written by nonspecialists can be very helpful to a lay audience if they are carefully reviewed by experts and adhere to consensus science, *Signature* is not such a book. Like *Edge of Evolution* before it, *Signature in the Cell* represents a layman's attempt to overturn an entire field of research based on a surface-level understanding (and, at times, significant misunderstanding or ignorance) of the relevant science, published in a form that bypasses review by qualified peers, and that is marketed directly to a nonspecialist audience. This is not good science, nor science in any meaningful sense. If ID is going to advance as an intellectual framework, it simply must do better. I, for one, would be fascinated by a scientifically plausible design argument. It would demonstrate that something is fundamentally wrong with the interpretation of very wide swaths of data across numerous disciplines. That would not be a scientific problem, but rather a monumental scientific opportunity that would reshape research for decades to come. Such times are the occasions of scientific legend—careers to be made, Nobel prizes to be won. Alas, *Signature* is not that argument. I do recommend it for those who follow the ID literature, for it represents the current state-of- the-art in ID thought for an important area of biology. However, for those of us waiting for the science behind ID, it looks as if the wait goes on. ⋆

Notes

[1]As claimed by Steve Fuller on *Signature's* dust jacket.
[2]Meyer, *Signature*, 14.
[3]Ibid., 167.
[4]As we shall see, this search leaves much to be desired.
[5]Meyer, *Signature*, 376.
[6]The *Kitzmiller* decision is available online at www.talkorigins.org/faqs/dover/kitzmiller_v_dover_decision.html (last accessed September 28, 2010). Additionally, transcripts of the Kitzmiller case are available online at several locations including www.talkorigins.org/faqs/dover/kitzmiller_v_dover.html and http://ncse.com/webfm_send/73 (last accessed September 28, 2010).
[7]Meyer, *Signature*, 443.
[8]Ibid., 449. I agree with Meyer here, as far as it goes, but I disagree that finding a "natural" explanation is equivalent to finding a "purposeless" explanation. I view both nature and the supernatural as part of the providence of God and as appropriate means of divine action in the cosmos, since God is the Author of nature.
[9]Ibid., 495.
[10]See http://biologicinstitute.org/people/ (last accessed September 28, 2010).
[11]I was pleased to see that this point was also picked up by Steven Matheson. See http://sfmatheson.blogspot.com/2010/05/bread-and-circus-signature-in-cell-at_28.html (last accessed September 28, 2010).
[12]See http://aghunt.wordpress.com/2008/12/26/axe-2004-and-the-evolution-of-enzyme-function/
[13]N. V. Grishin, "Fold Change in Evolution of Protein Structures," *Journal of Structural Biology* 134 (2001): 167–85; and

T. Newlove, J. H. Konieczka, and M. H. J. Cordes, "Secondary Structure Switching in Cro Protein Evolution," *Structure* 12 (2004): 569–81.

[14]For example, see Figure 1A in D. R. Venema, "Genesis and the Genome: Genomics Evidence for Human-Ape Common Ancestry and Ancestral Hominid Population Sizes," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 166–78.

[15]Meyer, *Signature*, 283.

[16]Ibid., 282.

[17]C. Story, "The God of Christianity and the G.O.D. of Immunology," *Perspectives on Science and Christian Faith* 61, no. 4 (2009): 221–32.

[18]See www.asa3online.org/Book/category/books/sitc/ (last accessed September 28, 2010).

[19]See http://myxo.css.msu.edu/ (last accessed September 28, 2010) for an extensive listing of research publications presenting data from the Lenski group.

[20]S. Ohno, "Birth of a Unique Enzyme from an Alternative Reading Frame of the Preexisted, Internally Repetitious Coding Sequence," *Proceedings of the National Academy of Sciences USA* 81 (1984): 2421–5.

[21]A discussion of this example written at a level accessible to nonspecialists is found in S. B. Carrol, "In Cold Blood: The Tale of the Icefish," in *Into the Jungle: Great Adventures in the Search for Evolution* (San Francisco, CA: Pearson [Benjamin Cummings], 2009).

[22]For example, T-urf13. See http://pandasthumb.org/archives/2007/05/on-the-evolutio-1.html (last accessed September 28, 2010).

[23]For example, L. E. Orgel, "Self-Organizing Biochemical Cycles," *Proceedings of the National Academy of Sciences USA* 97 (2000): 12503–7.

[24]For a recent review on ribosome structure and function, see V. Ramakrishnan, "What We Have Learned from Ribosome Structures," *Biochemical Society Transactions* 36 (2008): 567–74.

[25]Meyer, *Signature,* 246–7, 248.

[26]Frankly, I suspect the latter. My overall impression of Meyer's grasp of molecular/cell biology after reading *Signature* is that he has an approximately introductory-college-level understanding of the field. See further discussion of this point below.

[27]For this point and direction to relevant literature I am indebted to Arthur Hunt, whose excellent blog, *The RNA Underworld* at http://aghunt.wordpress.com/ (last accessed September 28, 2010) is on my regular reading list. See http://aghunt.wordpress.com/2010/01/03/signature-in-the-cell/ (last accessed September 28, 2010) for a thorough discussion of this problem with Meyer's argument.

[28]M. Yarus, J. J. Widmann, and R. Knight, "RNA-Amino Acid Binding: A Stereochemical Era for the Genetic Code," *Journal of Molecular Evolution* 69 (2009): 406–29.

[29]Ibid.

[30]The "direct template model" of Gamow; see Meyer, *Signature*, 114.

[31]I review multiple lines of evidence for human-chimpanzee common ancestry in D. R. Venema, "Genesis and the Genome: Genomics Evidence for Human-Ape Common Ancestry and Ancestral Hominid Population Sizes," *Perspectives on Science and Christian Faith* 62, no. 3 (2010): 166–78.

[32]M. Behe, *The Edge of Evolution: The Search for the Limits of Darwinism* (New York: Free Press, 2007).

[33]Though Meyer later claims, as one of his ID "predictions," that the fossil record should show "discrete infusions of information into the biosphere at episodic intervals" seems to tip his hand as to the model he prefers.

[34]See http://sfmatheson.blogspot.com/2010/04/behe-and-probability-one-more-try.html (last accessed September 28, 2010).

[35]Meyer, *Signature*, 66.

[36]Ibid., 128, Figure 5.7.

[37]See www.asa3online.org/Book/2010/04/13/id-prediction-summary/ (last accessed September 28, 2010).

Environment

GARDENING EDEN: How Creation Care Will Change Your Faith, Your Life, and Our World by Michael Abbaté. Colorado Springs, CO: WaterBrook Press, 2009. 272 pages. Paperback; $13.99. ISBN: 9780307444998.

This is a book on environmental stewardship that is biblical and balanced in terms of the applications that it recommends. It should be well received by Christians with a wide range of persuasions about our specific responsibilities for creation care. The jacket summarizes the book well with the following two comments: "*Gardening Eden* invites you to consider a new, spiritual perspective to practical environmentalism … Discover creation care as an act of worship and a call to deeper harmony with our Creator, our fellow gardeners and our living earth."

Michael Abbaté is a nationally recognized expert in green development strategies with LEED and ASLA certifications. He is also the founder of Green Works, an award-winning landscape architectural design firm. He currently directs urban design and planning for Gresham, Oregon, near Portland. His works have been featured in national trade publications, newspapers, and magazines. Abbaté writes clearly, but sensitively, as a leading conservationist who is motivated and guided as a Christian by his commitment to scriptural teaching. Many ASA members had the opportunity to hear him speak at our 2009 annual meeting at Baylor University, where he gave an outstanding presentation at our Sunday morning service.

Gardening Eden begins with a very helpful foreword by Randy Alcorn, who sets the stage for Abbaté's presentation by describing an experience he had speaking to a conference of several thousand college students at which his own message on creation care was received with coolness, apparently because environmentalism is usually associated with a liberal political agenda, and is therefore suspect in many Christian circles. He applauds (as I do) Michael's efforts at helping evangelical Christians see creation care as our responsibility.

The book is divided into two parts: the first deals with conceptual questions about creation care, and the second explores very simple and practical things that most of us can do and probably do not do, at least consistently. The conceptual part of the book avoids trying to motivate the reader to take action by apocalyptic predictions or by bludgeoning the reader with guilt. Rather, Abbaté develops a theological perspective that begins with the concept that "This is my Father's world." The five key themes from Scripture are as follows: what God made is good; God loves the world he created; what God made is God's, not ours; everything was created to glorify God; and God appointed us as stewards.

After establishing our stewardship responsibility to God, Abbaté develops the blessing that the beauty of nature is to provide for us, and the special sense of communion with God that we experience in a unique way when we are surrounded by God's creation. Then he evaluates how well we are carrying out our collective stewardship responsibilities by reviewing some of the growing concerns in nature that are man-made and that can be alleviated by corrective action on our part.

In a very personal and specific way, Part II of the book deals with things that each of us can do to be better gardeners in our patch of "Eden." This part of the book considers food, energy, transportation, and making our home in the garden. The treatment here is positively encouraging, and the suggestions are very practical. As an engineer, and given my finite time and financial resources, the only thing that I missed, and would have appreciated seeing more of, was a cost/benefit analysis which could help in deciding what is worth doing. For example, hybrid automobiles are recommended as a good way to practice creation care. But the last time I purchased an automobile, the cost of a hybrid with fuel for 100,000 miles was $4,000 more than a conventional car of similar size that would use maybe 20% more fuel. Was the small, positive impact that this decision would have on the environment really worth $4,000? I decided not to purchase the hybrid, but rather to use the $4,000 to buy a used Toyota van for a missionary family in Nepal who had no automobile at all. Stewardship of nature must be practiced in the greater context of stewardship of our financial and time resources. And there are some "Gardening in Eden" options that are not really worth the creation care benefits that they produce.

I would highly recommend this excellent book to anyone interested in being encouraged and directed to be a better "Gardener in Eden."

Reviewed by Walter L. Bradley, Distinguished Professor of Mechanical Engineering, Baylor University, Waco, TX 76798.

THE NATURE OF CITIES: Ecological Visions and the American Urban Professions, 1920–1960 by Jennifer S. Light. Baltimore: Johns Hopkins University Press, 2009. 328 pages. Hardcover; $60.00. ISBN: 9780801891366.

Those interested in the way the sciences can influence each other, inform federal policy and, finally, shape the human habitat, will find in *The Nature of Cities* a compelling and detailed story of the relation between biology, urban sociology, and the American city from 1920 to 1960.

Nature and the city are often opposed to each other in the American imagination. In the early years of European settlement on the North American continent, the city was valued as a safe haven, a source of protection and provisions; nature was feared for its harsh seasons, hidden dangers and merciless powers. After the industrial revolution, the city became known for its crime, social inequity, and general shabbiness; nature, on the other hand, was revered as the untouched realm of harmony, beauty and serenity. In *The Nature of Cities*, Northwestern University Professor Jennifer Light indicates how this conventional contrast was effaced in the early 20th century by the growing conviction among urban theorists that the city was governed by laws much like those that rule the natural world of living things. Like living organisms, cities have a life cycle of birth, growth, decline and death; like ecological zones, urban neighborhoods are subject to Clementsian laws of colonization, succession, and climax. The city could be modeled on nature. An explanatory science of urban sociology could be built on biological analogies.

Moreover, just as the science of biology informed the federal conservation of natural resources, so the newly developed urban ecology could be used to guide the conservation of urban resources—especially after the worrisome deterioration of American cities during the Depression years. The laws would enable not only the explanation of urban life, but also grant the power to predict and control it. Some phases of the natural life cycle—namely, decline and death—are clearly undesirable. Science could outline methods of their prevention. "Incipient blight need not run its course," claimed Herbert Thelen, University of Chicago professor, as he surveyed Southside of Chicago in the 1950s (p. 119). Scientifically guided interventions could forestall the decline of a neighborhood, even reverse its deterioration. Maps were made of urban regions, designating neighborhoods for different forms of federally sponsored intervention: conservation, rehabilitation, and demolition/redevelopment.

The applied science of urban resource management, however, ran into its share of problems. Designating an area for demolition was a politically volatile act; and the actual demolition of such areas, in the heyday of urban renewal, often only made things worse: it destroyed fragile social networks and informal economies, uprooted and displaced entire populations, putting even more downward pressure on neighborhoods marked for conservation. In addition, focus on the physical condition of an urban neighborhood often excluded, Light points out, other equally important factors, most notably the racial attitudes of its inhabitants. This, in turn, exposed the theoretical poverty of the analogical project that sought to build an urban sociology on a biological basis. Plants do not have racial attitudes; humans do. This difference is emblematic of the fact that the complexity of human urban life cannot be reduced to a linear model of birth, growth, and decay, or the natural course of vegetative succession. For that reason, the sociology rooted in a few biological concepts was ill prepared to handle the complex interactions of physical, social and economic factors at work in urban neighborhoods.

By the 1960s, the ecological model for urban sociology had run its course, a victim of its own inadequacies. Entering the Cold War era, the discipline reached for nonlinear systems thinking, especially as it was developed for the purposes of military planning. At the same time, the dominant metaphors in the language of urban policy changed: the war on poverty was declared, security maps were drawn, neighborhoods braced for invasions of heterogeneous racial groups, and neighborhood associations elected block captains. When the Housing and Urban Development Department (HUD) was formed in 1965 under President Eisenhower, the model, Light claims, was no longer the Department of Agriculture, but the Department of Defense (p. 171).

The Nature of Cities is well researched and documented. The first chapter, 29 pages, has 128 endnotes; the endnotes for the entire book run to 128 pages. This inspires confidence in the accuracy of the claims. It also makes for heavy sledding at the ground level of the narrative. Be prepared for a barrage of dates, names of persons, committees, government agencies, titles of reports, even lists of university course offerings. At the conceptual level, however, the book is an instructive and sobering lesson in the sociology of knowledge and the rhetoric of science.

Reviewed by Lee Hardy, Professor of Philosophy, Calvin College, Grand Rapids, MI 49546.

GREEN REVOLUTION: Coming Together to Care for Creation by Ben Lowe. Downers Grove, IL: IVP Books, 2009. 206 pages. Paperback; $15.00. ISBN: 0830836241.

Ben Lowe works for Renewal, an organization that seeks to equip and empower creation care in churches, campuses, and communities. This book relates his journey in coming to an awareness of the importance of creation care and his subsequent activism. It is a helpful guide for people new and sympathetic to the idea of creation care, as it introduces the reader to basic theological reasons to engage in creation care, gives insight into effective ways to start and sustain creation care groups, and most extensively introduces the major figures, organizations, and initiatives in the creation care movement.

The first part of the book establishes the theological basis for creation care, often illustrating the principles with examples from the creation care movement. The degradation of the environment through overconsumption, greed, and exploitation is a perversion of how God intended humanity to live on the earth. God desires *shalom*, every aspect of creation in right relationship, and this includes humanity's relationship to the environment. Instead of behaving as proper stewards of the creation, we have squandered our inheritance and, like the prodigal son, must return to our Father and seek forgiveness. In order to understand the brokenness between humanity and the environment, we need to see the suffering of people and nature, resulting from humanity's failure of stewardship.

The second part intertwines the history of the creation care movement, narratives of the movement in action, and guidance in starting and running a creation care group. Lowe deals almost exclusively with the recent creation care movement within the evangelical church in the United States. Highlights include an exploration of Lowe's own journey to accepting the problem of global warming, a discussion of obstacles to creation care, and the need to seek sustainability in one's activism. The strength of this section is the exposure to the myriad of creation care organizations and initiatives.

The final part stresses the importance of having all parties of the creation care movement working together (especially to nurture young activists), and of positioning the movement as a nonpartisan, yet political, entity in the context of American politics. Lowe emphasizes that creation care on its own is an incomplete gospel; evangelism and social concern must go together. In fact, he has found that engaging in environmental activism has enabled him to share the gospel with many nonbelievers. The book contains an excellent set of resource appendices including a bibliography for further reading and information on many of the creation care organizations discussed in the text. Another feature of the book is the "Uplink" section following each chapter. These sections are essentially

afterwords written by people of influence, often from the creation care movement.

Since Lowe seeks to provide a relatively brief overview of the creation care movement, he is not able to venture in depth into specific areas. The book is not a comprehensive theological explanation or apology for why Christians should engage in creation care. Complex theological topics such as *shalom* theology, incarnational modeling, and the relationship of the new earth to the old one at the final judgment, are treated relatively briefly. Similarly, the book is not focused on presenting a robust scientific case for creation care beyond providing some arguments that humans are the primary cause of the climate change crisis. Therefore, if an intended audience is not sympathetic or at least open to the theology and scientific evidence used in the creation care movement, the book will not convince them. Additionally, the book is not a comprehensive "how-to" guide to organizing, launching, and sustaining activist groups, although it does contain many excellent and helpful insights in this area.

What Lowe is most successful in providing is sharing the "good news" of the creation care movement and inviting the reader to take part. The book is ideal for evangelical communities already interested in creation care or moving in that direction. It would be appropriate for youth groups, small groups, adult Sunday school, and campus groups, helping to generate discussion, encourage action, and point to further resources and organizations in the creation care movement. Although Lowe is speaking primarily to his own generation of youth, students, and recent graduates, the book is accessible to anyone interested in creation care. Additionally, it should find its way into the supplemental bibliography of any courses on Christian environmental ethics or creation care/stewardship of creation.

Reviewed by Nikola T. Caric, McMaster University Divinity College, Hamilton, ON L8S 4K1.

Ethics

ETHICS AND NEWBORN GENETIC SCREENING: New Technologies, New Challenges by Mary Ann Baily and Thomas H. Murray, eds. Baltimore, MD: Johns Hopkins University Press, 2009. 330 pages, appendix, index. Hardcover; $50.00. ISBN: 9780801891519.

Ethics and Newborn Genetic Screening is a jarring challenge to the momentum of prevailing practice and legislation. Screening at birth for PKU began forty years ago and has become routine. As new genetic tests have become available, caregivers and legislatures have struggled to determine which tests should be added to the standard of care. The National Human Genome Research Institute of NIH funded a Hastings Center project to guide professionals and policy makers responsible for such selection. In this volume, the editors gather fourteen reports commissioned for that project. The thrust of many of the essays and the editors in their conclusion is that the most influential working group before their study has prescribed far more newborn genetic tests than are warranted. They argue that the widely followed recommendations developed by the American College of Medical Genetics (ACMG) in 2006 are deeply flawed.

The ACMG recommends that all states implement a screening panel for twenty-nine primary disorders and twenty-five secondary disorders. The report was endorsed by groups such as the American Academy of Pediatrics and applied substantially in legislation across most states. Baily and Murray argue that far fewer tests can be justified if screening is to be evidence based and to take into account opportunity costs, fair distribution of costs and benefits, and respect for human rights. The central charge is that the availability of multiplex testing from tandem mass spectrometry has spurred approval of tests that would not have been recommended on their own. Many of the prescribed tests do not have enough evidence of efficacy, particularly when they draw funds away from more effective services. A multiplex examination of a single blood spot implies one cost whether bearing five tests or twenty-nine, but ignores the fact that added tests extend costs for further training, false positives, counseling for parent understanding, and so forth. The editors show, for example, that Mississippi increased screening and counseling from five disorders to forty at the same time as prenatal care suffered reduced funding. The infant mortality rate rose. The example is heartrending but it may not be directly relevant, since the benefits of genetic screening, such as for PKU, would improve survival *after* infancy, not the infant mortality rates per se. Such screening can also dramatically improve quality of life, but this too is something that infant mortality statistics do not take into account. Most genetic screening is not aimed at initial infant mortality. It pursues different ends. Even so, the underlying point is well taken, that investing in one health intervention often means investing less in another. Genetic testing has been quite successful and economical in some cases, but that does not verify that every test is cost effective. The authors agree that cost effectiveness in a finite health-care delivery context is an ethical concern. It is not ethical to spend limited resources where they will not best serve.

Besides contesting the prescribed list of tests and arguing for what criteria would better assess the value of inclusion on that list, the authors also offer specific practical advice. There is, for example, a helpfully distilled set of four key messages that parents now need to hear: "Newborn screening will happen soon after your baby is delivered; your obstetrician recommends it; most babies picked up by screening for a disorder do not have the disorder but those few who do, need urgent treatment; you must follow up immediately if notified of a positive result."

The essays throughout are carefully argued by scholars in their respective disciplines. The strongest theme is a call for further research, as the range of available tests, their costs, and what treatment can actually be offered for those who prove positive are all changing rapidly. The book would be useful not only to professionals specifically involved in genetic testing services, but also to anyone interested in an example of how a particular science is funded and practiced for the public interest.

Reviewed by James Peterson, R. A. Hope Professor of Theology and Ethics, McMaster University Divinity College and Faculty of Health Sciences, Hamilton, ON L8S 4K1.

HEALTH & MEDICINE

MEDICINE AND HEALTH CARE IN EARLY CHRISTIANITY by Gary B. Ferngren. Baltimore, MD: The Johns Hopkins University Press, 2009. 152 pages + notes, bibliography. Hardcover; $35.00. IBSN: 9780801891427.

In this superb work of historical and conceptual scholarship, Gary B. Ferngren unfolds for the reader a cultural milieu of healing practices during the early centuries of Christianity. A professed historian of classical texts, Ferngren presents, in the beginning pages, his two primary objectives: (1) to correct a perceived misapprehension that "religious healing" was normative among Christians in the New Testament period and (2) to unravel the origins of Christian philanthropy that led to the establishment of hospitals as institutions of care. The book's stated key underlying assumptions include (1) accepting the credibility of the New Testament and early Christian witnesses in their portrayal of Jesus' ministry and the origins of the Christian community and (2) the belief that early Christians accepted and participated in Greek medical practice. The Christianity to which Ferngren refers is "the incarnational Christian movement," as defined by the early creeds, and exclusive of heretical and cultic sects, save for the Montanists who receive special attention.

Ferngren lays out his methodology as a historical-philological approach, which he says is meant to complement textual-philological-historical methodology. He cautions against sociological approaches that he feels privilege social forces over theological and philosophical aspects of the text, and against post-structural interpretations. He is particularly critical of the tendency of discourse analysis to see charitable motives as the ideology of a power-hungry church hierarchy, justifying its growing power over society. In attempting to avoid such pitfalls, the author tries to wade through the consciousness of those who constituted the early church, so as to understand their struggle to reconceptualize ideas of health and medicine in light of Christ's redeeming power.

He is also critical of dualistic interpretations that see early Christians as generally favoring supernatural over physical means of healing. For example, he eloquently tries to show that Origen's teaching of seeking prayer alone for healing is a reflection of seeking a closer dependence on God, rather than a dualistic preference for spirituality over bodily healing through medicine (though this reader is not fully convinced that Origen is free from such dualistic tendencies). While the rise of asceticism in the third and fourth centuries, with its contempt of the material, fostered such a dualism, according to the author, it should not be generalized to the Christian community at large.

Ferngren offers particularly pointed criticism toward those who err in the use and interpretation of quotations taken out of context, and who fall into the methodological traps that he tries so hard to avoid. However, he also gives credit, when credit is due, to the novel insights of fellow scholars.

In organizing the book's chapters, the author posits position statements or theses with each one, acknowledging when sources are limited, while providing copious references. At the end of each chapter, he provides crisp and faithful summaries of his main points and themes; these are welcome after sometimes intense and rich academic expositions. In the first four chapters, he articulates Christian responses regarding causes of disease and the evolution of Christianity as a distinct religion of healing. In the next three chapters, he traces the development of Christian *agape* love toward others as a novel concept in the ancient world. He contrasts it with Jewish, Stoic, Gnostic, and other prevalent worldviews, showing its influence on the outworking of benevolent expressions within the church and toward those outside the church.

Whereas pagan public health isolated the afflicted socially and physically during times of epidemic plague, Christians witnessed to their pagan neighbors their belief in *agape* love, to their pagan neighbors, through their self-sacrifice for victims. Ferngren methodically traces the organization of such expressions of healing and caring love that manifested itself in the diaconal model of philanthropy, through the mid-fourth century. With time, fuller and more public expressions developed in the form of early hospitals established by monastic orders as well as lay orders, whose members sought out the homeless and provided palliative care as extensions of various churches. He also distinguishes different streams of conceptual understanding of disease in the Eastern and Western churches, such as a greater acceptance of demonic influence on illness in the East, and a greater use of physicians in the West.

Despite his judicious and systematic precautions against misinterpretations, Ferngren has his own moments of interpretive lapse. For example, in his admission of the paucity of sources, he also admits to a consequent reliance on circumstantial evidence. On the topic of ritual healing, he concludes that it is "more reasonable" to consider the silence of available sources as evidence for its very low prevalence, a claim of dubious merit in light of the possibility of inherent selection bias.

The author also repeatedly makes the fundamental claim that the prevalent Greco-Roman medicine of the day was value-neutral by virtue of its "naturalistic basis." While his arguments are well laid out in his customary way, his idea that a pagan concept of medicine can be readily adopted into a Christian way of life without resultant tensions with that way of life, exposes his own unacknowledged dualistic tendencies. He says of the early Christians, "their understanding of medicine reflected the values that had permeated the Mediterranean world" (p. 10), seemingly contradicting his value-neutral hypothesis.

Ferngren provides a marvelous window into the mind of the early church on matters of medical care, healing, and the struggle with its surrounding pagan cultures, largely accomplishing his primary objectives. His arguments are always compelling and usually convincing. He shows how Christians lived out their faith as a positive healing and caring witness, boldly living out their Christianity as a persuasive alternative to the failed pagan responses to fellow human beings in need.

Reviewed by James J. Rusthoven, Professor of Oncology, McMaster University, Hamilton, ON L9G 1G4.

Book Reviews

History of Science

FRANCIS CRICK: Hunter of Life's Secrets by Robert C. Olby. Woodbury, NY: Cold Spring Harbor Laboratory Press, 2009. 538 pages, illus., indexes. Hardcover; $45.00. ISBN: 9780879697983.

This book by Robert Olby provides a detailed intellectual biography of Francis Crick, best known for his work on the DNA double helix. As the term 'intellectual biography' suggests, the book has the primary task of describing Crick's life-long intellectual journey. We are afforded insights to his personality and other nonscientific aspects of his life which informed and guided his scientific work. Given Crick's flamboyant personality and often highly controversial views about broader issues, it would have been easy to have these aspects dominate the account. Despite the intentional intellectual focus of the book, I nevertheless found myself most intrigued by the nonscientific aspects of the account, though they are a minor part of the whole.

Of course, we do learn much about Crick the man from the way in which he pursued his science. Olby does a masterful job of showing Crick in action as a scientist, from the time he began his doctoral research in physics until his pursuit of a scientific explanation for human consciousness at the end of his career. We are offered wonderful descriptions of the community of scientists in which he participated, the different personalities, unusual scientific styles, and their responses to the unique and dominating style of Crick himself. As a scientist, I found the descriptions of the intense competition, the practical jokes between scientists, the Cambridge environment, the unique worldwide working groups for idea generation, and the like, extremely interesting.

As readers, we are drawn into the scientific drama of those pursuing important questions not yet answered. We experience the mixed feelings of excitement and uncertainty as Crick and his compatriots develop the structural model for DNA and then explore the various potential mechanisms by which DNA could use its genetic code to manufacture proteins. Crick's scientific style was formulated and put on display very clearly in his early work with Jim Watson that led to the discovery of the double helix structure for DNA. Having gained scientific stature from this success, he later seemed to serve as research advisor for the entire field, not doing experiments directly himself, but staying abreast of important developments in the field and using his keen intellect and broad background to develop models for their explanation. At times this led him precariously close to the edge of scientific impropriety. Yet, his prolific generation of new ideas, and his ability to pursue them unwaveringly to their logical conclusion, set him apart from his peers, and produced stunning advances in our understanding of many of the most important questions in molecular biology, a field he helped define.

The readers of *PSCF* will be especially interested in the way in which Crick's uncompromising scientific naturalism informed and guided his choice of scientific problems and his approach to their solution. This intense search for purely naturalistic explanations for all phenomena is clearly at the heart of his plunge late in life into neuroscience, pursuing just such explanations for human consciousness. He had an unwavering belief that, once explanations were proven to be scientifically valid, all thoughtful people would find them complete and fully satisfying. He clearly loathed nonscientific explanations, and considered them to arise out of intellectual weakness. This comes through clearly in his last book, titled "The Astonishing Hypothesis," where he states, "The Astonishing Hypothesis is the 'You,' your joys and your sorrows, your memories and your ambitions, your sense of personal identity and free will, which are in fact no more than the behavior of a vast assembly of nerve cells and their associated molecules" (p. 410).

Throughout the book, Olby does a credible job of explaining the science to the lay reader, not as a textbook, after the fact, but from the point of view of the active participants who form their hypotheses and test them in the midst of unfolding and incomplete data. For those of us who are less knowledgeable in biology, the later chapters on vision and human consciousness are somewhat less accessible, and perhaps less interesting, since major breakthroughs in understanding eluded Crick. One senses a growing frustration on Crick's part as his life draws to a close, wishing for more time to pursue his science and leave his mark.

In summary, Olby has written an interesting and informative intellectual biography of Crick, one of the foremost scientists of the twentieth century. By means of the book, we see both the scientific genius and personal foibles of Crick, the hunter of life's secrets.

Reviewed by Timothy S. Zwier, Professor of Chemistry, Purdue University, West Lafayette, IN 47907-2084.

Natural Sciences

STEPHEN JAY GOULD AND THE POLITICS OF EVOLUTION by David F. Prindle. Amhurst, NY: Prometheus Books, 2009. 249 pages. Hardcover; $26.98. ISBN: 9781591027188.

The book is well written, and terms from evolutionary biology are defined in a glossary, making it accessible to those with more background in politics than in evolution. By confining itself to published sources, it may miss out on more-personal insights; however, published sources are likely to be written carefully and at greater length, and less subject to misinterpretation. As might be expected from a political scientist, there are errors in detail when specific biological issues are mentioned, but as a rule the errors do not affect, or even moderately undermine, the claims being made (for example, stating that most mutations are fatal or that full new species have not been made are errors that would tend to support anti-evolutionism). However, most social sciences have the statistics to not misidentify negative correlation as no correlation (p. 160), and politics gets a surprisingly superficial treatment.

As a political scientist, Prindle may have missed some of the nuances of the controversies associated with Gould

within evolutionary biology. Prindle begins with a discussion of Gould's popular style and appeal to the public, linking the controversy his style generated to the tradition of scientific suspicion of popularizing in contrast to "serious" work. While that was a factor, Gould's popular style sometimes intruded into his research articles as well. I consider popularizing a good thing, but recall my annoyance in reading an article by Gould. If I read *Paleobiology*, I already think that it is exciting to find an unusual pattern in organisms and want to know about the pattern, not how "exquisite" Gould's thrill was to find it. Also, as a paleontologist, I see most of the science issues raised by Gould as having now arrived at the stage of recognizing that sometimes evolution follows a more Gouldian pattern and sometimes it does not. Relative frequencies are still being debated, but I feel that we have moved on to investigating, for example, what situations produce a more punctuated or more gradualistic pattern, or the interaction of constraints and adaptation, rather than having mutually opposed options.

The glossary does not cover the key political terms. The political left is defined in the text as viewing inequality as a problem, to be addressed by some degree of redistribution; the right as accepting differences as merited. Such a simplistic dichotomy is amenable to selective identification of individuals or ideas by focusing on aspects that do or do not match the favored category (the left for Prindle). Thus, abortion is mentioned as part of the liberal agenda, and creationism is viewed as part of a conservative agenda, ignoring the exclusion of the unborn and the creationists from equal opportunity. Likewise, scientists are opposed to creationists as exclusive categories, and evolution is said to entail atheism. (Prindle endorses NOMA as a politically expedient lie.) Mentioning only Kuhn's and Popper's views limits the philosophy of science to a very simplistic version.

Prindle describes some misappropriations of punctuated equilibrium and other natural scientific models as buzzwords for social science ideas with no more than metaphorical connections to the original. However, he does not rigorously examine the merits of the purported links between Gould's scientific ideas and the political position that Gould (and, evidently, Prindle) wanted to advance. I think it is good to have a diversity of hypotheses in science; people drawing on different political and philosophical views can be inspired to look at things differently. However, I believe that the hypotheses must then be assessed solely on their empirical merit as scientific models, not on whether you like the perceived external implications. Despite occasional assertions of intent to avoid endorsing a particular position in the internalist-externalist debate, Prindle wants political implications to be linked with evolutionary biology. But the claim that evolutionary biology has implications for politics is not carefully considered. The is-ought problem is dismissed as futile; after all, a "minor" premise can be made affirming a particular link between "is" and "ought" (p. 70–1). Prindle admits that contradictory political positions claim to draw on the same evolutionary biology. Also, he notes that biologists who advocate a deterministic, adaptionist, and/or sociobiological position that supposedly supports a politically right-wing position are, in fact, politically overwhelmingly on the left. Nevertheless, the book promotes the idea that indeterminism in evolution (Gould's position) supports the political left. In reality, one could support the acceptance of inequality while claiming it is the product of luck, just as one can claim that society ought to help those who are deterministically disadvantaged by their evolutionary heritage. Political left and right can both invoke either Gouldian or non-Gouldian evolutionary biology, because they are merely imposing their own "minor" premises about the desired moral value.

Thus, the book provides an interesting survey of an interface between evolutionary biology and politics, but is far from convincing in its advocacy of a particular politically liberal conclusion.

Reviewed by David Campbell, Paleontological Research Institution, Ithaca, NY 14850.

Origins & Cosmology

WHY EVOLUTION WORKS (AND CREATIONISM FAILS) by Matt Young and Paul K. Strode. Piscataway, NJ: Rutgers University Press, 2009. xviii + 241 pages. Paperback; $21.95. ISBN: 9780813545509.

The dedication expresses the hope that this book will not be needed in a generation. Unfortunately, other books are needed if this hope is to be fulfilled. The book does a good job of presenting scientific evidence and particular scientific problems common in young-earth or intelligent design arguments, at a generally accessible level. There are some passing errors in detail: for example, page 69 refers to chemosynthetic bacteria as plants and says that eyes, being soft tissues, do not fossilize (some eyes have hard parts, as in most arthropods; rarely are soft-tissue eyes fossilized). The discussion of pseudoscience versus science is also good, and the index and bibliography are good.

However, on philosophical and religious topics, the book means well, but does poorly. Like many works by nonbelievers who are not antagonistic to religion, there is a mix of statements supporting the compatibility of religion and science, and ones that suggest incompatibility, at least without significant watering down. For example, defining higher criticism as "careful, dispassionate efforts to deduce the origin, age, or veracity of various sections of the Bible" (p. 21) will make many theologically conservative readers question the authors' reliability as judges of credible work. Conversely, asserting that a local Flood is unbiblical (p. 56) provides fodder for opponents of conventional geology. Statements of the erroneousness of creationism are made before the detailed discussion, again probably putting off the target audience.

Poor philosophical arguments against ID (such as who made the designer, p. 62) are included. The glossary definition of ID is that "evolution must have been guided, at least at times, by a designer, who is presumed to be the Christian God." The assertion that God guides evolution is more typical of theistic evolution than of ID, which usually invokes stronger intervention than simple guidance, and not all ID advocates are Christian.

The glossary is very thorough and generally does well with the scientific terms, but sometimes has problems on the philosophical or religious end. On the other hand, probably almost all of the ASA would agree with their assertion that Gould's NOMA is incorrect, because science and religion do interact and overlap in at least some ways.

Thus, this is probably not the book to give to a friend who is skeptical about evolution. It is, however, a good book to read discerningly, picking out useful parts.

Reviewed by David Campbell, Paleontological Research Institution, Ithaca, NY 14850.

PHILOSOPHY & THEOLOGY

HIDDEN WORLDVIEWS: Eight Cultural Stories That Shape Our Lives by Steve Wilkens and Mark L. Sanford. Downers Grove, IL: IVP Academic Press, 2009. 218 pages. Paperback; $22.00. ISBN: 9780830838547.

With at least twenty-five books currently available on Christian worldview, one can wonder whether another book on the subject is necessary. The opening paragraph of *Hidden Worldviews* makes a case for its own existence by acknowledging that it is, like most of the books on Christian worldview, an apologetic for Christian faith—but its special aim "is to provoke Christians to adopt a Christian worldview" (p. 11). Why? Because while Christians have become adept at spotting the unbiblical worldviews that are spawned by the academy, too many Christians have failed to see that "the most powerful influences [on them] come from worldviews that emerge from culture" (p. 12). In the lives of too many Christians, such worldviews are "hidden in plain sight" (p. 12).

Part of the reason for this, the authors wisely point out, is that many Christians forget that our worldviews are "lived" as well as thought. Worldview beliefs are more likely to be absorbed through cultural contact than adopted through a rational evaluation of competing theories (p. 12). The authors' claim is that "worldviews are more than just intellectual systems" (p. 14)—they flow from the commitments of our hearts (pp. 15f.). This is a refreshing insight. When one examines the roots of the term "worldview"[1] and its appropriation by the evangelical world via Wolters' *Creation Regained*[2] and Walsh and Middleton's *Transforming Vision*,[3] it is clear that, originally, worldview meant a tacit vision of life that works at a pretheoretical as well as a theoretical level. Yet a number of those twenty-five worldview books are little more than updated Christian systematic apologetics.[4] Wilkens and Sanford are off to a good start in trying to alert their readers to the messy, less-systematic character of worldviews. They do this by treating worldviews as stories.

The heart of the book is the authors' chapter-length examinations of eight worldviews: Individualism, Consumerism, Nationalism, Moral Relativism, Scientific Naturalism, the New Age, Postmodern Tribalism, and Salvation by Therapy. Rather than focus on the academic sources of these beliefs, Wilkens and Sanford describe the everyday cultural experiences and beliefs that produce these worldviews. After an introduction to each worldview, each chapter highlights the truths of the worldview and also its potential problems. This is a helpful approach, for too many Christian analyses of worldviews are almost exclusively critical in focus. Given the book's intended general audience, the analysis and critique are brief and succinct.

Perhaps the weakest chapter is that on Moral Relativism. Wilkens and Sanford correctly point out that many Christians today are reticent about making strong moral judgments but are not therefore absolute relativists. Rather, these Christians are striving for greater humility and compassion in such judgments. Unfortunately, at this point, the authors fall back on the rather facile claims that we should be humble because "we do not have the God's-eye view" and God is more tolerant than we think (pp. 98f.). While in the earlier part of the chapter they have quite effectively pointed out the logical and practical inconsistencies to which this soft relativism leads (pp. 92–7), they overlook the problems of this moral humility (for example, is not the critique of the God's-eye view itself pronounced as if from on high?) or the difficulties attendant upon the suggestion that God's patience with our sin means he is tolerant (what, then, of divine judgment?) (p. 99).

Of interest to readers of this journal, one of the better chapters is on the worldview of scientific naturalism. No fresh ground is broken here, but the best arguments illustrating the weakness of scientific naturalism as a worldview are nicely summed up. For example, the authors correctly note that scientific naturalism's basic beliefs amount to a metaphysics, i.e., a belief in the nonphysical (pp. 109ff.). If so, then scientific naturalism's rejection of religious belief in science because it brings in nonempirical factors, is self-contradictory. Again, Wilkens and Sanford observe that scientific naturalism's worldview ultimately offers no explanation of the validity of rationality (pp. 114f.), a claim similar to Alvin Plantinga's evolutionary critique.

The book concludes with two chapters on developing a Christian worldview. The themes of creation-fall-redemption are outlined and the reader is offered a specific approach to worldview issues rooted in the Wesleyan Quadrilateral of Scripture-Reason-Experience-Tradition. This section leaves this reviewer with a number of unanswered questions. For example, while the authors acknowledge that reason is affected by the Fall, they give only a general discussion of what this means (pp. 212–3). Again, while God is recognized as Creator, the manner in which he governs creation is largely unaddressed (pp. 185–8). Maybe this is more of a comment on the authors' desire to address a general audience than it is a shortcoming (thus the book has no bibliography or further suggested readings). But these questions have huge implications for how we think in and live out a Christian worldview, especially in the natural sciences.

Likewise, it has become fashionable to try to avoid an overly rationalistic approach to Christian worldview by speaking, as Wilkens and Sanford do, of the biblical "story" (e.g., p. 200). Yet this approach is fraught with difficulties and potential pitfalls. Stories, to be sure, have a less-than-formal logical orderliness—but they also are

human inventions whose coherence derives as much from their rhetorical qualities as it does from their truth. Wilkens and Sanford attempt to address some of these concerns in their section titled "But is God's Story a True Story?" (pp. 200f.). The language of "story" needs more support than this if it is to be used as a Christian worldview term.

Readers interested in a deeper and more nuanced approach to worldview will need more than *Hidden Worldviews* on their shelf. But within the above limitations, this is a good book—well written and pastoral in its tone. Readers new to worldview thinking will come away from *Hidden Worldviews* wiser about the false worldviews that affect our lives.

Notes

[1]See, e.g., David Naugle, *Worldview: The History of a Concept* (Grand Rapids, MI: Eerdmans, 2002).
[2]Albert Wolters, *Creation Regained*, 2d ed. (Grand Rapids, MI: Eerdmans, 2005).
[3]Brian J. Walsh and J. Richard Middleton, *The Transforming Vision: Shaping a Christian Worldview* (Downers Grove, IL: InterVarsity Press, 1984).
[4]See my "Evangelicals and Worldview Confusion," in *After Worldview*, ed. J. Matthew Bonzo and Michael Stevens (Sioux Center, IA: Dordt College Press, 2009) for the fuller case.

Reviewed by George Pierson, Department of Philosophy, Trinity Christian College, Palos Heights, IL 60463.

KNOWING CHRIST TODAY: Why We Can Trust Spiritual Knowledge by Dallas Willard. New York: HarperOne, 2009. 245 pages, index. Hardcover; $24.99. ISBN: 9780060882440.

Dallas Willard, author of a number of best-selling books on Christian discipleship and spiritual formation, is also a first-rate philosopher. *Knowing Christ Today* combines philosophical insight with pastoral sensitivity in a book geared for the general reader. His central concern is with the isolated status of spiritual knowledge. In particular, Willard is disturbed by "the trivialization of faith apart from knowledge," as well as "the disastrous effects of a *repositioning* of faith in Jesus Christ … *outside* the category of knowledge" (p. 1). The upshot of the restricted understanding of knowledge widely held today is that Christians are urged "to treat their central beliefs as something *other* than knowledge—something, in fact, far *short of* knowledge" (p. 1). Core Christian beliefs are demoted to the status of opinions or blind commitments that are dismissed on the public stage, particularly in the academy, as being largely irrelevant. This state of affairs has been noted by others. But what is profoundly troubling to Willard is that the decoupling of belief and knowledge has pernicious effects on Christian faith and practice: it undermines the spiritual lives of Christians. "*A life of steadfast discipleship to Jesus Christ*," he asserts, "*can be supported only upon assured knowledge of how things are, of the realities in terms of which that life is lived*" (p. 7).

Willard's exploration should be welcomed on a number of levels. He correctly points out that, in today's academy, methodology seemingly dictates both epistemology and ontology. Science has become the presumed authority on public knowledge, but too few—especially the new atheists—recognize its fundamental limits. Science cannot provide "scientific knowledge *of science*" (p. 59). Regrettably, knowledge has been redefined and restricted so as to exclude the kind of moral knowledge that for centuries was understood as knowledge of reality that guided efforts to answer life's fundamental questions. We have witnessed "*the removal of* [heretofore] *recognized values and principles of Christian/traditional moral understanding … from the domain of knowledge that must be taught by the knowledge institutions of Western society*" (p. 71). As a result there has been a "*triumph of desire over good at the public level*" (p. 70). And moral standards are seen as "*mere displays of social and economic power*" (p. 79).

Willard contends that modern believers can "know Christ." Such knowledge, moreover, has as much authority—indeed, more—as that generally accorded to the academic disciples. He effectively argues for the existence of nonphysical reality and points out that the new atheists have "a haunted universe on their hands" (p. 109). In addition, he makes a brief case for the plausibility of God's existence and the possibility of divine action. His thinking is informed by some of the best work coming out of the ongoing science-and-religion conversation.

What makes this book so valuable, however, is Willard's linkage of an essentially philosophical argument to the quest for a more authentic spiritual life. Ultimately, we know Christ by acquaintance—"direct awareness of him and his kingdom" (p. 142). This interactive knowledge comes when we welcome God "into every dimension of our character and life" and "abandon ourselves to a total transformation of *who we are on the inside*, to taking on the character of Christ through living with him day by day and hour by hour" (p. 152). This is not some irrational leap of faith. It is *real* knowledge, confirmed experientially again and again over the centuries.

Willard has some strong closing words—necessarily so, I suspect—for institutions of Christian higher education and their faculties. They must discard the outlook fostered in graduate training, that "genuine knowledge is secular" in nature and that "being a follower of Christ is simply a matter of what one believes and feels, a 'personal preference' … not something essentially involving knowledge of truth and of a reality that everyone must come to terms with … Only when 'faith' is understood to deal with things that can be known, only when faith is at home with knowledge," he asserts, "does the project of integrating 'faith and learning' have a manageable sense" (pp. 207–8).

While there is much more subtlety to *Knowing Christ Today* than this brief review can convey, some academic philosophers no doubt will accuse Willard of oversimplification. It should be noted that he has a more scholarly treatment, tentatively titled *The Disappearance of Moral Knowledge*, in the offing. That said, there is much to be gained from this accessible volume. As we have come to expect from Dallas Willard, it is a wise book whose argument is both analytically provocative and saturated with rich spiritual insight.

Reviewed by Donald A. Yerxa, co-director of The Historical Society and senior editor of Historically Speaking, *Boston, MA 02215-2010; Professor of History Emeritus, Eastern Nazarene College, Quincy, MA 02170.*

PURPOSE IN THE LIVING WORLD? Creation and Emergent Evolution by Jacob Klapwijk. New York: Cambridge University Press, 2008. 311 pages. Paperback; $24.99. ISBN: 9780521729437.

Jacob Klapwijk, Professor Emeritus in the Department of Philosophy at the Free University of Amsterdam, offers a valuable philosophical analysis of evolutionary biology and of the faith perspectives present in discussions of evolutionary biology. The central thrust of Klapwijk's book is to provide an alternative theory of evolution to the Darwinian theory of evolution that is aimless and purposeless. The quest for meaning, according to Klapwijk, represents a general human interest—one could really say it represents the human condition. Thus, a starting point for Klapwijk is the judgment that "a theory of evolution that trumpets forth the view of an evolution that is totally due to chance has, in the final analysis, little or nothing to do with truth, and everything with imposing behavior and survival" (p. 7). Klapwijk thereby seeks to develop an alternative theory of evolution that is empirically based, yet also provides a meaning perspective on the living world. Klapwijk bases his alternate theory of evolution on the recognition of a multilevel ontology.

One of the fundamental problems that contributes to the ongoing discussion in debates among evolutionary biologists, intelligent design theorists, and many creation theorists is that most of the theorists assume a one-level ontology. At the foundation of these views is the fundamental notion that reality is essentially physical and chemical in nature. This reflects an underlying physicalism shared among the various diverging perspectives. But a one-level ontology really falls short in providing an adequate account of reality. Physicalist one-level ontology leads one to a forced reductionism that lacks the requirements for an explanation of the complex life phenomena that we experience among and within living things. The intelligent design theorists correctly recognize the shortcomings of this physicalist framework as an explanation of life phenomena. This is especially so in their analysis of irreducibly complex systems. But the arguments presented by intelligent design theorists for a non-natural intelligent design cause fail to provide an adequate account of life phenomena that are indeed inherently complex. As Klapwijk argues, life phenomena are themselves natural, but natural as understood within a multilevel ontology. "Intelligent design" is not logically one of the levels in this multilevel ontology.

In his analysis of evolutionary theory, Klapwijk makes an important distinction between evolutionary theory and evolutionary naturalism. The failure to make such a distinction leads to intertwining theory and ideology. The ideology of evolutionary naturalism, he claims, is based on two postulates: (1) a fundamental continuity between nonliving and living beings; and (2) all nonphysical phenomena are reducible to physical phenomena. These two postulates, in turn, greatly influence what the concept of evolution contains or even what it excludes. This is illustrated in his discussion of the so-called "mechanisms" of competition, variation, selection, and transmission (he refers to these as the CVST principles). The CVST principles, Klapwijk argues, are not mechanical operations of matter that lead to life, but rather they are functional aspects of life itself. The CVST principles presume the existence of life; they do not lead to living things from inanimate matter. Thus, CVST principles are biological principles, not physical principles that are mechanistic in nature. Furthermore, these biological principles cannot be derived from physical principles; nor are they reducible to physical principles. How does this apply to theories of the origin of life? This entails the key distinction between necessary and sufficient conditions. Chemical processes are necessary for life phenomena, but they are not sufficient for the origin of life phenomena. The reductionist postulate leads to a view of living things such that living things are devoid of purpose or meaning. The meaning or purpose of living things cannot be found in chemical and physical processes that constitute a lower ontological level. Rather, the meaning or purpose originates in the higher ontological levels of living beings.

The continuity principle also hinders the development of a conceptual framework that fosters a deeper understanding of biological ordering principles. Biological principles provide for the functionality in the many levels which living things express. A biological way of thinking is more functionalistic, concerned with the "for which," rather than instrumentalistic, that is, concerned with the "how" of a mechanistic way of thinking. The recognition of a multilevel ontology entails a fundamental discontinuity of the ordering principles for each ontological level. Each level is determined by ordering principles (laws) that are not reducible to the ordering principles at lower levels and that are not derived from the lower level principles. In reference to these ordering principles, Klapwijk distinguishes between idionomy (having laws of its own) and autonomy (setting its own laws). This correlates with the recognition of a hierarchy of ontological domains in which all living things participate. Klapwijk distinguishes four ontological domains: physical, biotic, vegetative, and sensitive. The ontological domains are not reducible to lower domains. Each domain is idionomic and thus possesses a different causality, a causality that is not reducible to the causality of a lower level. Each ontological domain has its own explanatory theories.

The recognition of ontological domains does not, however, explain how these domains originated. It is here that Klapwijk introduces his particular notion of emergent evolution. He accepts the basic framework of phylogenetic evolution and the idea of descent with modification. But he redefines modification as the emergence of new modalities, as new modes of being that resulted from an emergent process involving a reprogramming of ordering principles into a new level of ordering principles that are not reducible to the entities of the lower domain. Klapwijk emphasizes that this idea of emergence is not an explanatory theory; rather, it is a framework in which the theories of different explanatory levels with their respective ordering principles provide a deeper explanation of purpose and meaning in the living world.

In developing a theory of emergent evolution, Klapwijk does so in the context of a deep belief in a biblical creation. His belief in creation provides the conceptual framework for accepting the basic findings of evolutionary science, including the common ancestry of living things. He accepts Augustine's view of time itself as a creature of God and thereby rejects the notion that the drama of creation occurred in time. He therefore rejects all biblical interpre-

tations that attempt to place God's creative works within a framework of time.

I commend this work by Klapwijk as an important contribution in cutting through the impasse in the ongoing dialogue among creationists and evolutionists and those who affirm some type of theistic evolution. Klapwijk introduces many fresh insights, but most importantly, he provides a conceptual framework for a deeper understanding of the nature of living things that also leads to a deeper understanding of meaning and purpose in the living world.

Reviewed by Uko Zylstra, Department of Biology, Calvin College, Grand Rapids, MI 49546.

WITHOUT NATURE? A New Condition for Theology by David Albertson and Cabell King, eds. New York: Fordham University Press, 2009. 469 pages, index. Paperback; $39.00. ISBN: 9780823230709.

It is the nature of most birds to fly. It is ethical to intervene to restore that nature by repairing a broken wing. Would it be ethical to intervene to change that nature? This book is a discussion of how ecological changes and genetic manipulation might shift both the "understanding and valuation of nature" and "how alterations of nature impact theological categories" across disciplines. Such Christian-based interdisciplinary dialogue in bioethics has been seen in anthologies such as *Viewing New Creations with Anabaptist Eyes: Ethics of Biotechnology*, edited by Roman J. Miller, Beryl H. Brubaker, and James C. Peterson in 2005. *Without Nature?* is a welcome addition to that type of discussion in its drawing from a wide disciplinary base to then focus on a formative question.

The book explores five disciplines in relation to nature: ecology, genetics, geography, anthropology, and theology. In each section, three authors examine how ecological collapse or genetic engineering might affect the nature of "nature" and might accordingly invoke attention to related elements in each discipline. The first essays in each category speak from philosophical and essentialist perspectives of nature and maintain negative views regarding the advancement of technology and biogenetics. In contrast, the third essays address, from a Protestant and nonessentialist approach, nature as always in flux, and so are more open to the humanitarian use of such engineering. The second essays, often from Catholic approaches, hold perspectives that share some of both.

Multiple contributors, specializing in areas such as philosophy, ethics, science, anthropology and urban planning as well as theology, make this book highly informative. It extensively covers the context and issues that revolve around ecology and biotechnology, including technical details, politics, economics, social science, and philosophical development, in order to inform ethical and theological discussions.

The book reveals how the concept of nature plays a vital role in the discussion of technological and genetic interventions as a determinative element regarding development and direction of the interventions. By juxtaposing three contrastive views, the book illuminates how different views of nature might affect one's ethical views toward technological and bioengineering advancement.

The book's editors describe themselves as students of Kathryn Tanner, those who understand human nature to be dynamic, as in Eastern Orthodox thought. They persistently contrast this position with essentialist views of nature that argue from secular philosophical perspectives such as those of Aristotle and Nietzsche. However, this might lead to an impression that philosophical views and Protestant Christian views are always polarized in terms of the view of nature and attitudes toward technology, which is not necessarily the case. To assist readers in comparing purely philosophical discussions with Christian thought, it would have helped to explain how the former views might inform or conform to the latter.

The editors acknowledge that this book is "an *ambitious* interdisciplinary agenda." It is, in wrestling with such a polyvalent term as "nature." Admitting the ambiguousness of the term, the authors provide some unique definitions, and the editors organize them by arranging each section around common definitions such as "natural world," "human biological nature," or "human nature." The complexities of the term "nature" warrant further scrutiny; yet despite such challenges, the book clarifies the importance of the understanding of nature for the presented topic.

This edition is beneficial for readers who are interested in ecology, environmental ethics, bioethics, anthropology, and ethics in general. Some knowledge of technical terms may be needed for readers to attempt the section on "genetics and nature." Including a general introduction and conclusion would have been useful to clarify the intent of the book and to summarize its contributions. It is a large and unwieldy volume, yet worth significant effort to hear its varied perspectives.

Reviewed by Shigemi Tomita, McMaster University Divinity College, Hamilton, ON L8S 4K1.

CREATURELY THEOLOGY: On God, Humans and Other Animals by Celia Deane-Drummond and David Clough, eds. London: SCM Press, 2009. 294 pages. Paperback; $45.00. ISBN: 9780334041894.

Creaturely Theology is a collection of thirteen essays exploring the theology (or relationship) of humans and nonhuman creatures. The question is explored from a variety of theological traditions: Thomistic (John Berkman); Lutheran (David Clough); and Orthodox (Esther Reed). Other chapters use a historical figure to focus the question: Athanasius (Denis Edwards); Emmanuel Levinas (Aaron Gross); and Augustine (Rachel Muers). The authors use these historical approaches to suggest a closeness of humans to nonhuman animals. Other essays focus more on the description of human beings as alone being created in the image and likeness of God (one by David Cunningham and another by Celia Deane-Drummond). Some of the essays use prehistory (Stephen Clark), evolution (Neil Messer), or climate change (Christopher Southgate) as a tool to explore the question. Peter Manley Scott's essay imagines a human-animal coalition and its implications.

Michael Northcott's essay examines the violence animals experience in their connection with humans. This brief summary inadequately describes the diverse investigations of the topics readers will find in the book. It also minimizes the interconnections evident between the essays. Not always "easy reads," the essays are scholarly in nature (603 footnotes in 265 pages plus nineteen pages of references in a bibliography as well as six index pages). Readers will probably select one essay at a time to read and then ponder its approach to the topic rather than read all of the essays at once. They will discover that each essay is a doorway to further study. Each one could serve as the basis for discussion (if the members of the group are professional or interested in scholarly concerns).

Several authors use the recent findings of animal behaviorists to inform their thinking. I found such surveying to be accurate (for further study, readers should look at Sara Shettleworth's new edition of *Cognition, Evolution, and Behavior* [New York: Oxford University Press, 2009]). In addition, biblical texts were often utilized. As a result, my understanding of some of the texts was significantly expanded. The one exception was Michael Northcott's translation of *nephesh* as blood (p. 236) in a context of a moral sensibility regarding animals in ancient Israel. His point was that the sacrificial system enjoined a respect for the lives of animals, but he could have used the Hebrew word for blood instead of *nephesh*, which means breath or spirit. Finally, the essays provide "nuances of argument that are truly valuable" (a phrase from Rolf Bouma's review of Vantassel's book on the same subject matter—see *Perspectives on Science and Christian Faith* 62, no. 1 [2010]: 62). I would recommend *Creaturely Theology* to anyone interested in thinking about the relationship of humans to animals.

While I appreciated the book, it does have its challenges. The title is poorly phrased. The editors define "creaturely theology" as "engaging in the theological task conscious of one's creatureliness" (p. 1). This definition certainly describes the agenda of the essays, especially if one subscribes to a broad use of the word theology. Nevertheless, it could have been entitled better, something similar to *Interdisciplinary Perspectives on Animals and Theology*. The reader would then have a clearer idea of the book's subject matter. Another lingering irritation is the lack of closure. I am used to scientific papers closing with a discussion of what the results mean. Often future research is indicated, but I leave the article with the impression of another brick added to the scientific edifice. These essays often open with reasons to question a position and then close by outlining possible routes to explore in the future. The book ends with an editorial postscript setting out five different areas for further research. This lack of closure may reflect the complexity of the question, but it is disconcerting for readers such as myself who expect conclusions to provide answers and not just more questions. Finally, the essays seek to minimize the distance between humans and other animals. While this may represent the current thinking of many people, I (and perhaps readers of this journal) will continue to suspect the existence of an intangible, qualitative difference between humans and other animals. Nonetheless, the arguments presented are thoughtful and thought provoking. If I were asked to present on this topic, having read *Creaturely Theology*, I would note both the objective certainty that humans are animals and the subjective possibility of humans surpassing animals.

Reviewed by Bruce Buttler, Professor of Biology, Canadian University College, Lacombe, AB T4L 2E5.

Religion & Science

EMINENT LIVES IN TWENTIETH-CENTURY SCIENCE AND RELIGION, 2d rev. and much expanded ed. by Nicolaas A. Rupke, ed. Frankfurt am Main: Peter Lang, 2009. 371 pages, index. Paperback; $70.95. ISBN: 978-3631581209.

There have been many recent books by scientists, some of whom are also theologically educated, that reflect on faith in the first person. A short list would include R. J. Berry, ed., *Real Scientists, Real Faith* (Monarch Books, 2009); Charles Birch, *Science and Soul* (Templeton Foundation Press, 2008); Philip Clayton and Jim Schaal, *Practicing Science, Living Faith: Interviews with Twelve Leading Scientists* (Columbia University Press, 2007); Celia Deane-Drummond, *Christ and Evolution* (Fortress Press, 2009); Lawrence Fagg, *Electromagnetism and the Sacred* (Continuum, 1999); Owen Gingerich, *God's Universe* (Belknap Press of Harvard University Press, 2006); Alister McGrath, *A Fine-Tuned Universe* (Westminster John Knox Press, 2009); John Polkinghorne, *The Faith of a Physicist* (Augsburg Fortress Press, 2005); Mark Richardson, Robert J. Russell, Philip Clayton, and Kirk Wegter-McNelly, eds., *Science and the Spiritual Quest: New Essays by Leading Scientists* (Routledge, 2002); and Joan Roughgarden, *Evolution and Christian Faith: Reflections of an Evolutionary Biologist* (Island Press, 2006).

Rather than autobiographical reflections, *Eminent Lives* offers a collection of scholarly case studies of the relationships—some robust, others rather less so—between scientists and their religious upbringings, values, beliefs, and/or practices. This is biography not as apologetics but as critical, contextual, narrative examination of particular lives, complete with helpful bibliographies.

The first edition, reviewed in the March 2008 issue of this journal by Owen Gingerich, focused on eight figures: Arie Leegwater on Charles Coulson, Jitse van der Meer on Theodosius Dobzhansky, James Moore on Ronald Fisher, Peter Bowler on Julian Huxley, Richard Beyler on Pascual Jordan, Torsten Rüting on Ivan Pavlov, Edward Davis on Michael Pupin, and Mark Stoll on Edward Wilson. These interesting and revealing portraits were framed by the editor Nicolaas Rupke's historiographic introduction to the craft of writing biographies—see also his superb metabiography of Alexander von Humboldt (University of Chicago Press, 2008) and *Richard Owen: Biology without Darwin*, the revised edition of his 1994 study of the Victorian naturalist (University of Chicago Press, 2009) for examples—and by Ronald Numbers's nuanced epilogue on science and secularization, including the retreat of God-talk from public to private life. All this in 255 pages, originally for $49.95.

According to Rupke, this second edition is "significantly expanded and corrected" (p. 8). Revisions to the

first set of essays are not indicated, but there are five new chapters to expand our understanding of the faith-and-science landscape in the twentieth century. Mark Stoll (who, following Michael Ruse, uncovered E. O. Wilson's "inner Baptist") discerns a Presbyterian ethos in the American naturalist Rachel Carson's writing, including her "secular sermon," *Silent Spring*. Jason Rampelt explores how the noncreedal, antidogmatic Quaker religion of the English physicist-astronomer Arthur Eddington affected both his philosophy of science and his research program; see also Matthew Stanley's *Practical Mystic: Religion, Science, and A. S. Eddington* (University of Chicago Press, 2007). Einstein's "cosmic religion" is well known, rooted in childlike wonder, Spinoza's pantheism, Jewish ethics, and expressive of scientific convictions about the physical world. Gebhard Löhr seeks also to open up the question of Einstein's religion in relation to non-Western perspectives such as Buddhism, which also rejected a personal God. Edward Davis, in addition to his groundbreaking chapter on the Serbian Orthodox physicist Pupin, discusses Pupin's student Robert Millikan, that giant of American physics, who left behind his Congregationalist past, along with the God of the Bible, but who still espoused a Christian vision of science and morality, divine immanence in nature, and a (modernist) rapprochement between science and faith. Millikan believed in both Jesus, the noncreedal preacher, and an Einsteinian "God of Science." Finally, Martin Riexinger shows how and why the Pakistani physicist (and Nobel laureate with Steven Weinberg for their unification of the electromagnetic and weak nuclear forces) Abdus Salam kept his Ahmadiyya Muslim faith separate from his science.

Collectively, these sometimes brilliant, occasionally strained interpretations indicate some of the many ways religious and scientific beliefs and behaviors can interact (or not) in specific circumstances.

Among the basic questions this volume raises is how coherent can a life be when the person's commitments, interests, experiences, values, practices, beliefs, and knowledge span both faith and science? Or, how compartmentalized can a person's scientific and spiritual sides be? On the spectrum from complete integration to outright rejection of either religion or science, some—like the late Stephen J. Gould—seek peace through apartheid: an unsatisfying and unstable position in which "science" and "religion" are separate-but-sovereign in their own mutually irrelevant domains.

Biographies, almost by definition, in creating coherent narratives out of the centrifugal messiness, contingencies, inconsistencies, and continuities of unique, incarnate subjects, tend to impose a kind of order, unity, and teleology on people's lives. To defend a thesis about what a person's life and work meant is to create a kind of fiction, albeit one grounded in documentary evidence. Biographers must consider the roles of place, time, memory, identity, context, class, gender, assumptions, intentions, practices, personality, beliefs and relationships—while leaving room for the odd and unexpected, which can disrupt narrative neatness.

This is difficult work to do well. We perform our lives as much as we live them; we deliberately conceal as well as disclose ourselves. And we contain multitudes of contradictions, themes and variations, even if it all seems to make sense to us in the living; even if lives lived in the intersecting worlds of faith and science can and do make sense, and real tensions are, at least provisionally, resolved.

I recommend this book to all readers of this journal. Those not interested in historiographical issues will still find lots to learn and enjoy. But was Ted Davis really born in 1944 (p. 355)?

Reviewed by Paul Fayter, History of Science, Bethune College, York University, Toronto, ON M3J 1P3.

FOR THE ROCK RECORD: Geologists on Intelligent Design by Jill S. Schneiderman and Warren D. Allmon, eds. Berkeley, CA: University of California Press, 2009. 261 pages. Paperback; $21.95. ISBN: 9780520257597.

Discussions of intelligent design (ID) typically revolve around the remarkably fine-tuned features of the cosmos or the stunning, allegedly irreducible, complexity of molecular structures and processes within cells or biological systems. Ordinarily ID takes us into the realms of cosmology and biochemistry. Why then, one might inquire, are geologists concerned about ID? The obvious concern expressed by the contributors to this volume about the inroads of ID comes into focus when we learn that most of the ten writers are paleontologists. Paleontologists (including Christian paleontologists), of course, overwhelmingly endorse the theory of biological evolution primarily by natural selection, a theory held in low repute by aficionados of ID. As a result, these geologists view the efforts of ID proponents, to introduce their view of science into public education, with alarm, and they express concern about the potentially detrimental effects of ID upon the scientific enterprise.

The main text of *For the Rock Record* consists of three sections. Part One (Rocks and Bones) focuses on scientific matters. Jill Schneiderman, one of the editors, leads off by demonstrating the inapplicability of ID to inorganic geological features. To do so, she explains, in terms of natural geological and chemical processes, both the development of the geology of the New York City area and spiral inclusion trains in metamorphic minerals.

In Chapter 2, Timothy Heaton, a Quaternary paleontologist, summarizes "Creationist Perspectives on Geology," including young-Earth creationism, progressive creationism, and Intelligent Design. Given the primary allegiance of young-Earth creationists to the authority of Scripture over that of scientific investigation in regard to Earth's history, Heaton judges that "young-Earth creationism must be ruled nonscientific at its foundation." Even so, he credits young-Earth advocates who have impressive scientific credentials with at least having attempted to construct testable models of Earth history. Moreover, Heaton recognizes that they generally seek for natural explanations for Earth's natural features and events even though their explanations fail rigorous scrutiny. He notes the irony of the invocation by proponents of a young Earth of "periods of hyperevolution … to explain the diversity and character of species" after the Flood. Heaton's analysis of progressive creationism focuses on astronomer-apologist Hugh Ross, an advocate of an old universe and of strictly natural explanations for geological and astronomical phenomena.

Ross, however, inconsistently invokes supernatural explanations for biological events because of his distaste for evolution. Heaton attributes Ross' inconsistency to his close familiarity with astronomy coupled with a corresponding lack of expertise in biology. He interprets Ross' mixture of empirical data and Scripture as an arbitrary blend of science and religion and finds that his hunt for fine-tuning in nature leads to outlandish examples bordering on "pure fantasy." Heaton notes that most ID advocates (and Ross might well have been included in this category, too) accept long geological ages. On the whole, he perceives that ID advocates pay little attention to geology, arguably because they "have unwittingly selected examples lacking a fossil history in their search for 'gaps' in structural development." Heaton faults ID proponents for adopting the strategy of placing the burden of proof on advocates of natural processes rather than on themselves. As those seeking to shake up the current scientific order, it is the school of ID that needs to put forward some credible theories.

The third chapter, "Missing Links Found," by vertebrate paleontologist Donald Prothero, concisely summarizes fossil evidence for evolution among several vertebrate lineages, primarily horses, rhinos, camels, whales, and elephants. Like Heaton, he chides ID advocates for generally ignoring the fossil record, and he delights in pointing out their obvious lack of paleontological credentials and experience. Prothero takes *Pandas to People* to task for insisting on a lack of transitional fossils, a claim that he regards as nonsense in view of the wealth of evolutionary lineages. Those whose appetites are whetted by Prothero's summary of evolutionary transitions in the fossil record will do themselves a favor by digesting his recent book *Evolution: What the Fossils Say*. Unfortunately, rather than letting the overwhelming fossil evidence for evolution speak for itself, Prothero tends to level pejorative language at those with whom he disagrees. Little is to be gained by accusing young-Earth creationists, for example, of lies and deliberate deception.

The final chapter in the first part, "Pigeon-Holing the 'Dino-Birds'" by Allison Tumarkin-Deratzian, a specialist in bone growth in tetrapods and ceratopsian dinosaurs, examines aspects of the lineage that records the transition from theropod dinosaurs to birds. In the process, Tumarkin-Deratzian deftly demolishes four kinds of arguments that anti-evolutionists employ to "contest the relationship of *Archaeopteryx* and the feathered dinosaurs to the evolution of birds." She convincingly demonstrates that these anti-evolution arguments are based on a failure to recognize that, because it was designed to classify modern organisms into categories, the Linnéan classification scheme is ill equipped to recognize evolutionary lineages. Because of its mixed bird and reptile characters, she claims, *Archaeopteryx* defies attempts to fit neatly into the Linnéan classification, based as it is only on modern forms. Tumarkin-Deratzian also points out that "confusion over what a cladogram is and is not lies at the heart of the most common critiques of evolutionary portrayals of bird origins." Anti-evolutionary arguments are based on a failure to understand that cladograms neither depict genealogical ancestor-descendant relationships nor recognize Linnéan class boundaries. To correct the misunderstandings she presents a very clear explanation of cladograms. Despite the fact that the numerous feathered dinosaurs unearthed in China are actually younger than *Archaeopteryx* and are, therefore, not its ancestors, Tumarkin-Deratzian confidently asserts that "the discovery of feathers in non-avian theropod dinosaurs has shown that feathers are actually a shared primitive character of birds, and a shared derived character of a larger group that includes both birds and several lineages of small theropods."

Part Two (Education, Politics, and Philosophy) also contains four chapters. In Chapter 5 ("Pangloss, Paley, and the Privileged Planet"), Mark Terry, head of the Science Department at the Northwest School in Seattle, acknowledges the appeal of ID to the general public inasmuch as it feeds on the American passion for free speech, fair play, and the underdog. Nonetheless, because of the desire expressed in the ID movement's Wedge Document of establishing Christian principles at the center of American life by way of changing public school science education, Terry sees a threat to that education. After reviewing examples of the application of the Wedge strategy in *The Privileged Planet* by Guillermo Gonzalez and Jay Richards and an article by Marcus Ross in *Journal of Geoscience Education*, Terry warns teachers to be on the alert for the Wedge strategy. "It would be wrong to suppress ID as a religious idea," he notes, "but not suppressing a religious idea and labeling it science are two different things." Terry's hope for Earth science education is that instructors "need to teach Earth science as science, to be clear about what science is and what it isn't, and to hope that this understanding grows into the consciousness of new generations of lawmakers, school board members, parents, and teachers."

Charles Mitchell, a graptolite expert, focuses on the methodology for acquiring knowledge in the natural sciences in contrast to the epistemology of religion in "It's Not about the Evidence." He claims that ID starts from a clearly philosophical/faith basis rather than a scientific basis and then wants to redefine science by introducing final causes to suit its own philosophical-religious goals. Mitchell argues that "final cause just isn't accessible to the same degree" in the scientific approach as are efficient, material, and final causes, because these latter three are relatively much more objective. For him, "science and spirituality serve very different purposes and hinge on very different underlying metaphysical presuppositions." To his credit, Mitchell repudiates the atheistic inferences of Dawkins, Provine, and Dennett. He comments that even if such theories about the non-existence of God and purpose were true, nevertheless, "scientific knowledge cannot exclude what it is not constructed to encompass, and scientific knowledge is constructed entirely within the domain of natural causes." He perceptively points out that "people who believe the world contains no ultimate purpose adopt their atheism because of some prior commitment."

ASA's own Keith B. Miller addresses the "Misguided Attack on Methodological Naturalism" in Chapter 7. Miller, whose interests focus on paleoecology and stratigraphy, skillfully brings out the fact that numerous ID advocates fail to appreciate the crucial distinction between naturalism as a species of ontology and epistemology and naturalism as a general methodology that enables the natural sciences to proceed and succeed. By way of several

examples from the effort to rewrite Kansas science standards, objections to the national science standards, the Dover ID trial, and the writings of Phillip Johnson, Miller shows that a central element in ID arguments is the misguided conflation of methodological naturalism with philosophical materialism, with the result that contemporary science is portrayed as being biased toward atheism. He rightly asserts that "from the perspective of scientific inquiry, a supernatural agent is effectively a black box, and appeals to supernatural action are essentially appeals to ignorance." Because a "supernatural agent is unconstrained by natural laws," it can act any way it chooses and, therefore, "appeals to such agents can provide no insight into understanding the mechanisms by which a particular observed or historical event occurred." For Miller, appeals to action of a supernatural agent are really admissions that "we don't know" how an event occurred, and they have the effect of killing further investigation.

In Chapter 8, "*On the Origin of Species* and the Limits of Science," according to David Goldsmith, a paleontologist with expertise on the morphology and ecology of mollusks, the attempt of the ID movement to redefine the limits of scientific methodology is nothing new. Goldsmith points out that Charles Darwin challenged the scientific community to rethink scientific methodology by his use of a deductive approach in advocating his theory of natural selection. Until Darwin, scientists (Bacon, Newton, the Geological Society of London) typically claimed to eschew the formulation of hypotheses and favored patient accumulation of facts from which a reasonable theory might eventually emerge. In contrast, in *On the Origin of Species*, Darwin laid out his theory of natural selection and then asked what the world would look like if the theory were correct. His book contained no experimental results and proposed no experimental tests. Rather, Darwin asserted the adequacy of selection to effect biological change, then supported this assertion through numerous lines of observation, and finally refuted potential objections to his hypothesis. In part, the way was paved for the ultimate reception of Darwin's idea by the fact that a deductive approach in science was already being promoted by philosophers of the stature of Whewell and Mill. In light of that historical reality, Goldsmith suggests that, although ID advocates, like Darwin, would like to expand scientific methodology, no one has independently and antecedently proposed *their* methodology. Moreover, proponents of ID have failed to convince the scientific community that the ID approach bears any potential scientific fruitfulness. Goldsmith condemns the ID movement on the grounds that its program to foster deeper thinking about scientific issues in reality leads to its opposite, namely, repudiation of "deep inquiry and discovery in favor of superficial wonder and mystery." In line with Miller, Goldsmith believes that "accepting the role of a potentially capricious unknowable intelligence in one branch of science undermines not just future discoveries in that one field but all scientific knowledge, past, present, and future."

Part Three (On Religion) contains the final two chapters. "Teaching Evolution during the Week and Bible Study on Sunday" by Patricia Kelley lays out a personal approach to relating paleontology and Christian faith. Kelley is, like Goldsmith, another mollusk paleontologist as well as the wife of a Presbyterian pastor. She has also taught adult Sunday Bible classes for many years. Convinced of the reality of biological evolution, in part as a result of her own research on lineages of mollusks from the Atlantic and Gulf coasts of the United States, Kelley finds her Christian faith threatened by neither science generally nor evolution in particular, because she does not accept the notion that the biblical creation accounts are to be interpreted literally. In essence, scientific discoveries and the Bible tell the same story but in different ways. Readers will enjoy her personal story, but some may not be willing to follow her in accepting higher critical conclusions about Genesis 1–2.

Editor Warren Allmon, yet another paleontologist, concludes with the longest chapter. Here he lays out an overview of what he calls the "God spectrum"—a gradational series of possible ways of dealing with the relations between religion and science from complete hyper-supernaturalism at one end to complete naturalism of *The God Delusion* type at the other end. In between are a variety of ways in which religion and science might accommodate one another. Of particular interest is his summary of the approaches to accommodating religion and science to one another that have been adopted by three prominent paleontologists: Peter Dodson, Patricia Kelley, and Richard Bambach. Allmon recognizes that religion encompasses a vast and very diverse terrain of belief and that some religions may simply be incompatible with science. As a result, he focuses specifically on Judaism, Christianity, and Islam and explores accommodation in that context.

For the Rock Record includes a list of selected resources (books and websites) for further study. The cover of the paperback version offers a magnificent photograph of the world-famous angular unconformity discovered in the late 18th century by James Hutton at Siccar Point in Scotland. The book is a constructive contribution in that it provides an assessment of intelligent design from the vantage point of the geological sciences. The authors are to be commended for adopting a generally positive stance in regard to the practice of religion, for their fair treatment of Christian believers, and for their recognition that it is not the role of science to solve theological and religious questions. On the other hand, what one misses is an understanding (although hinted at by Allmon) that religion and science are not simply two parallel, equal-value but different approaches to knowledge, but that the scientific approach to knowledge is invariably and unavoidably subservient to each individual scientist's religious worldview.

Reviewed by Davis A. Young, Professor of Geology, Emeritus, Calvin College, Grand Rapids, MI 49546.

GOD IS GREAT, GOD IS GOOD: Why Believing in God Is Reasonable and Responsible by William Lane Craig and Chad Meister, eds. Downers Grove, IL: InterVarsity Press, 2009. 262 pages, bibliography, index. Paperback; $19.00. ISBN: 9780830837267.

This September, Mary will enter college. Mary's parents have lovingly raised her in a traditional Christian home. She has been part of the family's church since her "cradle roll" days, was confirmed, sang in the choir, was active in

her youth group. Mary is about to experience a sea change. In college, she will encounter a diversity of worldviews, philosophies, learned professors, and other young people who seem to "have it all together," who challenge her with questions and claims she had never before considered, in particular, the views of Richard Dawkins and the "New Atheists." Some of the new ideas will seem very plausible over a late night pizza party. Mary needs help!

This book appears to have Mary as its primary target audience. Fourteen authors contribute essays to address what they believe are her main concerns. Some of the writers are very good, John Polkinghorne and Alvin Plantinga being particularly outstanding. Unfortunately, the book fails to meet its objective on many counts.

First, it overreaches, presenting a "Reader's Digest" of philosophy and Christian theology, attempting to address all the important questions from atheism's refutation to a defense of traditional Christianity. The objective is admirable; but it was not achieved in 236 pages.

Second, the book includes a defense of intelligent design (ID) by Michael Behe, who confidently writes, "That should have been the end of Darwinism's strong claim right there—to explain all of life as the product of random mutation and natural selection—but intellectual inertia and wishful thinking kept it going" (p. 82). His argument is unpersuasive and Mary will have trouble in biology class if she takes it seriously. The implication is, of course, that a Christian must necessarily embrace ID.

Third, the last essay, by author Mark Mittelberg, is an unconvincing "altar call." His recommended bibliography includes a book by Josh McDowell, who not long ago was preaching young-earth creationism.

Fourth, the book does not end with Mittelberg's sermon, but adds a postscript. In it, Antony Flew argues his case for simple theism. Following Flew is an appendix by Alvin Plantinga. These two articles seem seriously out of place.

Fifth, the essay by William Lane Craig contains a particularly inept argument against Dawkins' idea that the universe "just popped out of nothing." Craig's argument (p. 14) seems to be as follows: (a) It is a necessary truth that something cannot come from nothing; (b) The very idea of something else is resorting to magic; (c) If one thing popped out, why are there not other things? (d) Our experience confirms that everything has a cause. These arguments can also be used, of course, to "refute" some of quantum mechanics.

Craig also attacks the person of Dawkins. He describes him as "marvelously oblivious" (p. 19), "laboring under the delusion" (p. 23), "apparently unaware" (p. 25), "smug and self-congratulatory" (p. 28), and imagines Dawkins as "making a silly ass of himself" (p. 30). It may be argued that Dawkins deserves such treatment, but Col 3:12 refutes that argument. I do not want Mary to read that kind of stuff and possibly conclude it is OK for a Christian.

There are other defects in the book, such as no discussion of natural evil, a reliance on only Euro-American writers, and no feminist, Afro-American, Hispanic, or Asian voices. Scot McKnight commits a serious blunder, repeating one of C. S. Lewis's rare errors when he writes, "either the disciples are liars or they are truth-tellers" (p. 200). And some other writers seem to delight in "digging" Richard Dawkins; one of them, Michael Murray, makes the gratuitous aside that Dawkins was on his second marriage (obviously moral turpitude).

I believe that acceptance of Christ usually happens through social interactions with real Christians, not as an intellectual process. Skip the book. If you do buy a copy, do not give it to Mary. She will get hurt.

Reviewed by John W. Burgeson, Houston, TX 77070.

THE FALL OF MAN AND THE FOUNDATIONS OF SCIENCE by Peter Harrison. New York: Cambridge University Press, 2007. xi + 300 pages, bibliography, index. Paperback; $43.00. ISBN: 9780521117296.

> For man by the fall fell at the same time from his state of innocency and from his dominion over creation. Both of these losses however can even in this life be in some part repaired; the former by religion and faith, the latter by arts and sciences. For creation was not by the curse made altogether and forever a rebel, but in virtue of that charter, "In the sweat of thy face shall thou eat bread," it is now by various labors (not certainly by disputations or idle magical ceremonies, but by various labors) at length and in some measure subdued to the supplying of man with bread, that is, to the uses of human life.
>
> —Francis Bacon, *Novum organum* II, §52

Few scientists today would take these words from Francis Bacon as foundational to modern science, but they were. In this fascinating, original, and carefully researched book, historian Peter Harrison argues that the biblical story of the Fall deeply influenced concepts of scientific knowledge and how it ought to be obtained during the seventeenth century, when science as we now know it took shape. According to many early modern writers, Adam's knowledge of the natural world prior to the Fall was very extensive and fully accurate, reflecting the fact that he had been made in the image of God. Most of that was lost after the Fall, which affected all aspects of human nature at least to some extent. Thus, "the standard pattern for early modern epistemological enterprises," Harrison says, involved "self-examination, assessment of the extent of the wound caused by sin, [and] determination of what traces of the divine image remain" (p. 99).

European thinkers had inherited from the Greeks the idea of science as demonstrably certain knowledge, obtained by the methods of Aristotelian philosophy. During the Scientific Revolution, a debate took place over how much of the traditional view of knowledge needed to be discarded: was it simply the method that needed to be replaced, or did the certainty of scientific knowledge also need to be discarded? For some, such as Philipp Melanchthon, Johannes Kepler, and Galileo Galilei, fallen humanity still retained enough of the divine image to guarantee the veracity of mathematics; science could still achieve certainty through a priori demonstration, especially through mathematics, which Aristotle had largely ignored. For others, especially Bacon, Robert Boyle, and many other Englishmen, the whole project of natural philosophy had to be rebuilt from the ground up; our minds

were not sufficiently reliable to achieve certainty, and the best we could do was gradually to accumulate empirical facts, slowly recovering bits and pieces of the knowledge that Adam had so suddenly lost.

Harrison has never hesitated to tackle the big historical questions, and this is one of the biggest: was the Scientific Revolution a deeply secularizing episode, with progressive reason emerging triumphant over backward and recalcitrant religion? What I have just described was the standard picture a generation ago, but in recent decades, dozens of scholars have shown its many serious flaws. Harrison pretty much demolishes any residual tendency to give the seventeenth century an eighteenth-century, Enlightenment-style interpretation: "The birth of modern experimental science was not attended with a new awareness of the powers and capacities of human reason, but rather the opposite—a consciousness of the manifold deficiencies of the intellect, of the misery of the human condition, and of the limited scope of scientific achievement" (p. 258). To be sure, many modern minds are still afflicted with what Harrison calls "a degree of historical amnesia about the role of religion" in the origins of modern science (p. 245), but there is no way to escape the force of his argument without ignoring the wealth of primary sources he musters to support it. No one can fairly accuse Harrison of being too clever, of playing fast and loose with the words and ideas of the historical actors themselves. His command of their world is admirable, his argument subtly nuanced, and his account almost breathless. Intellectual history of this quality is all too rare, and when it involves a subject of this import, we should all stand up and pay attention. Put this one on your required reading list as soon as you can.

This is not to say that I have no reservations about *The Fall of Man and the Foundations of Modern Science*. As Harrison realizes, he is not the first scholar to assess the ways in which religion influenced early modern science; nor will he be the last. Of the various alternative theses, one of the best known holds that "voluntarist" theology (which emphasizes divine freedom in the creation) was closely linked with empiricism during the Scientific Revolution. On this view, those natural philosophers who stressed God's freedom to act in the world, unbound by restrictions imposed by reason, were more likely to ground scientific knowledge in observations and experiments; whereas those who stressed God's reason were more likely to hold a rationalist conception of scientific knowledge and methods. Several leading scholars have defended this thesis, including John Hedley Brooke, John Henry, the late Reijer Hooykaas, Francis Oakley, and Margaret Osler. Harrison advances a competing claim. Instead of finding the origins of empirical attitudes in views of God's nature, he finds them in views of our own nature—a subtle, but significant, distinction.

Having worked on this problem myself, I will be the first to admit that sometimes it is hard to tell which is more important when a given conception of scientific knowledge is being analyzed. I certainly agree that for many of the figures discussed in Harrison's book, the effects of the Fall on human reason seem more important than the implications of divine freedom, which is usually not even mentioned in the cited passages. Nevertheless, Harrison recognizes that some leading early modern thinkers did not put too much emphasis on the noetic effects of the Fall. Indeed, Isaac Newton "showed little interest in the Fall of Adam or the doctrine of original sin" (p. 234). Robert Boyle, whom Harrison describes accurately as "undoubtedly the leading exponent of experimental philosophy in the seventeenth century," was "reluctant to attribute all the limitations of human knowledge to Adam's lapse" (pp. 217–8). Instead, in one of the unmistakable features of his thought, Boyle repeatedly appealed to the freedom of the Creator as a foil to any effort to reduce nature to rational necessity.

If Harrison errs by downplaying the role of voluntarist theology, vis-à-vis an Augustinian view of the Fall, it is mainly because he has so much to say about the latter—and all on the basis of hard evidence. His argument might not encapsulate the whole story, but anyone who overlooks it will risk misunderstanding the rich interaction of theology and science at a crucial historical moment: the moment when modern science was born.

Reviewed by Edward B. Davis, Professor of the History of Science, Messiah College, Grantham, PA 17027.

REAL SCIENTISTS, REAL FAITH by R. J. Berry, ed. Grand Rapids, MI: Monarch Books, 2009. 288 pages, index. Paperback; $14.99. ISBN: 9780825462894.

Robert James (Sam) Berry is a recognized British genetic scientist and environmentalist. Beyond his contributions to the sciences, Berry is also recognized by a broader community for his contributions to topics related to science and the Christian faith. This book, *Real Scientists, Real Faith*, is the second of the same title. The earlier title was also edited by Berry and was published in 1991. In both books, the contributors are primarily British, along with a few Americans.

Real Scientists, Real Faith is a collection of essays, solicited by Berry, on issues in science, the Christian walk, and the relationship of the two. Contributing authors are well-recognized scientists, theologians, and philosophers. Some of the British contributors may be unfamiliar to the American reader, but Americans will likely recognize Alister McGrath and Simon Conway Morris. Familiar American contributors include ASA Fellows Joan Centrella, astronomer at NASA; David Myers, psychology professor at Hope College; Cal DeWitt, founder of the Au Sable Institute and professor at the University of Wisconsin; and Francis Collins, director of the NIH.

Readers may be disappointed that the contribution from Francis Collins is a reprint of an earlier published interview in which Collins restates the story of his coming to Christ, also found in Collins' book, *The Language of God*. The contribution of the late British Donald MacKay is a reprint of one of his earlier lectures. Except for the reprints of Collins and MacKay, the other sixteen contributions appear to be original to this work.

Upon looking at the titles and abstracts, there does not appear to be a conscious progression in theme throughout the collection. Each contributor describes biographic information of his formative years as a scientist and Christian and mentions specific issues within his area of expertise and experience. Issues range from the age of the earth

and biological evolution to the ethics of abortion, homosexuality, and environmentalism. However, the book may well have a cumulative effect on the reader; each essay leads the reader, even if unconsciously, to a greater understanding of the reality of scientific life and the life of Christian faith.

I expect critics will disagree with various positions expressed in *Real Scientists, Real Faith*. The abortion of a defective fetus in preference to watching the death of a small child and the acceptance of the biological orientation of homosexuality are two likely examples. But to remove ammunition for debate from these pages would be the reader's loss. Though some contributions to the book may not be as well developed logically or theologically as might be hoped, this is not the purpose of the book. If the reader can find strength through the candid discussion of faith-filled struggles with science issues, such that the personal strengths that result from these struggles can be internalized by the reader, then the reader will have gained much.

There are several groups of people who would benefit from reading *Real Scientists, Real Faith*. College students at the beginning of their scientific careers will benefit scientifically and spiritually from the mentoring perspectives of these successful scientists and committed Christians. Older scientists, who have similar experiences as the authors, will also benefit from the reflection and thoughts in this book. Theologians and clergy who are interested in both the formal academic philosophy of science as well as the practical, less formal, working scientific philosophies which contribute to the doing of real science, should read this book. Regardless of the reader, there are both intellectual and spiritual nuggets which can be mined from these pages. If the reader can refine these nuggets into a form that fits their own personal questions of science and faith, they will have obtained a great treasure.

Reviewed by Gary De Boer, Professor of Chemistry, LeTourneau University, Longview, TX 75607-7001.

TIBETAN BUDDHISM AND MODERN PHYSICS: Toward a Union of Love and Knowledge by Vic Mansfield. West Conshohocken, PA: Templeton Foundation Press, 2008. 180 pages. Paperback; $19.95. ISBN: 9781599471372.

Unlike such 1970s' works as *The Tao of Physics* and *The Dancing Wu-Li Masters*, which were motivated by short-lived 1960s' interpretations of particle physics such as "particle democracy," this book seems to be a serious attempt to compare and contrast essential aspects of quantum theory (e.g., uncertainty and entanglement) with the principles of Tibetan Buddhism. Though Mansfield is a professor of physics, throughout the book he inspires trust that he also knows something about Tibetan Buddhism by sprinkling in references concerning conversations and experiences he has had in his personal acquaintance with the Dalai Lama.

Mansfield begins in chapter 1 by focusing on knowledge, being, meaning, and purpose, in the context of science and Buddhism. I must confess that I found many of the comparisons contrived. For example, he states that in science, the final arbiter is experiment, operating in the "public domain," meaning that experiments must be repeatable. Then he points to a contrast, the Buddhist concept of *shamatha: shamatha* occurs when the mind is focused upon itself. Since "first person accounts … are not objectifiable or in the public domain" (p. 11), such essential Buddhist practice is different from science. However, he claims that "[s]uch subjective experiences are repeatable and controlled but not conventional scientific objects" (p. 11), and because experience is the focus in both cases, there is a similarity. As to purpose, according to the Dalai Lama, "the purpose of life is to be happy" (p. 16). As we learn later in the book, this principle leads to an ethic of compassion. What does this have to do with science? In contrast to a materialist view of the laws of physics in which no purpose can be found, Mansfield asserts that Buddhism concludes no such thing, because Buddhism includes phenomena that are both subjective and objective, personal and meaningful.

The main point of chapter 2, entitled "Quantum Mechanics and Compassion," is to make an analogy between the indistinguishability of fundamental particles and the fact that all humans find themselves in a similar situation with regard to the purpose of life, in the desire for happiness. According to Buddhism, the desire for happiness is closely intertwined with the freedom from suffering. Though everyone is unique as an individual, *with respect to the desire for happiness and the right to achieve it,* we are all identical (p. 33). Considering exchanging ourselves with one another leads to a kind of golden rule, that we ought to put ourselves in others' shoes and help everyone in the endeavor for happiness and the right to achieve it. Again, the analogy between particles and people is a stretch.

Chapters 3 and 4 are perhaps the heart of the book. In chapter 3, Mansfield introduces us to "Middle Way emptiness" which is a major tenet of Buddhism. The Middle Way doctrine seems to be a way of saying that nothing exists in and of itself, but everything is in relation to many other things. The claim is that if something were to exist independently, having no interactions, it would be an unchanging essence.[1] However, the Buddhist denies the existence of such an essence, and this denial leads to the concept of "emptiness." However, as Mansfield cautions, it is easy to get the wrong idea about "emptiness"; it does not mean "nothing," but rather it is a reference to changeableness, to impermanence, and to dependence. In chapter 4, Mansfield describes the Einstein, Podolsky, and Rosen (EPR) thought experiment, Bell's inequalities, and provides a fairly clear explanation of the phenomenon of entanglement[2] that follows from these, which he links to the concepts of the "Middle Way" and "emptiness." Perhaps the most telling statement is that because quantum theory seems to tell us that particles do not have definite properties until measured, and the measurements inexplicably affect each other at a distance, "we can clearly see that the mind project[s] independent existence into the particles, but the experimental violation of Bell's Inequalities shows that nature refuses to accept the projection" (p. 90). In other words, we should not impose our ideas of definite properties on independent particles, for that is a projection of our thoughts on a reality that does not fit that experimental picture. The interrelatedness comports well with the Middle Way.

In chapter 5 Mansfield explains his uncomfortableness with the a-causal behavior of the quantum world. He

states that cause and effect is an important principle in Buddhism in that "[o]ur past actions are the causes of our present condition" (p. 98) (think of reincarnation). Given that causes, as things, do not have inherent existence in Buddhism, there is still a notion of the "I," a "constantly changing mental designation upon the impermanent mind and body" (p. 104) that somehow propagates into the future, carrying its *karma* with it. But why should this nonphysical causality of Buddhism, which is "not susceptible to scientific analysis" (p. 106), be intertwined with the causality as found in the physical realm? That is not clear to me. Incidentally, it may be of interest that he uses the similarity of quantum a-causality to the random mutations in Darwin's theory to conclude that "there can be no purpose, endpoint, or teleology in Darwinian evolution." This is a point that many evangelical Christians have made, going back to Charles Hodge in the nineteenth century.

In chapter 6, Mansfield turns his attention toward relativity theory. His main point here is to claim that relativity theory implies that such quantities as mass, length, and time have no independent existence, because there is no preferred reference frame from which to measure them. This, he claims, comports well with the Middle Way. However, I think his claim goes too far. Each object when considered in its own rest frame has definitive rest mass and rest length, which can be considered to be characteristic of the object. Finally, in the summary chapter, he argues that the wave/particle duality is a confirmation of the Middle Way. Thus, he says, in order that knowledge and love may unite, we should not disassociate scientific knowledge from its role in relieving suffering. I guess this is his way of saying that Buddhist science is *human* science, a conclusion Christians might draw for entirely different reasons.

Tibetan Buddhism and Modern Physics is a book that covers a lot of ground, such that a short review cannot do justice to the project that Mansfield has undertaken. However, it also suffers for that very reason. In trying to introduce both the important tenets of modern physics as well as those of Tibetan Buddhism in one short book, I think he fails in introducing either well. There are reasonable discussions of some aspects of physics, such as his introduction to Bell's inequality and the EPR paradox, but most are cursory and some even suggest misconceptions.[3]

So when he tells us in chapter 3 that although "physics and Buddhism have significant similarities and differences," that "[n]evertheless, no other religious worldview has such an arresting and detailed connection to modern physics," does he make his case? I think not; most Christians would find many of his analogies weak and unconvincing. Though I do not think his "compare and contrast" method is a particularly good way to integrate faith and science, I will say that the book was thought provoking.

Who would want to read this volume? From among the readers of this journal, I would expect that there would be rather few. For those of you who want to keep up with what other religions are saying about science, or who simply like a stimulating recreational read, you might enjoy the book. But if you do not fit one of those categories, and you do not already know a fair amount about both modern physics and Buddhism, you will probably want to learn both your modern physics and your Buddhism elsewhere. I was left with too many misgivings about how the physics was presented, and with too many questions about Tibetan Buddhism, to recommend this book for either purpose.

Notes

[1]In terms of Greek thought, this is reminiscent of Platonic forms.

[2]Entanglement is the phenomenon well known in quantum theory that the measurement of two particles at different places apparently affect each other instantaneously. So they are said to be "entangled."

[3]For example, in chapter 2, he says "indistinguishability leads directly to the famous Pauli exclusion principle (not true—one also needs the fermionic nature of electrons) and in chapter 6, he tells us that an "elevator's acceleration due to gravity cancels the gravitational force, and the freely falling elevator becomes an inertial reference frame" (gravity—that is, the curvature of space—causes the acceleration, rather than canceling it; by "inertial frame" we usually mean a non-accelerating frame).

Reviewed by Donald N. Petcher, Department of Physics, Covenant College, Lookout Mountain, GA 30750.

THE FAITH OF SCIENTISTS: In Their Own Words by Nancy K. Frankenberry, ed. Princeton, NJ: Princeton University Press, 2008. xviii + 542 pages, bibliographic references, index. Hardcover; $29.95. ISBN: 9780691134871.

This volume belongs to a new genre of publication about religion and science. Books in this genre describe the religious faith of past and living scientists. What used to be considered private or sometimes confined to popular writings has become public over the last decade or so. Frankenberry's book is an anthology of selected writings of twenty-one practicing scientists about their religious faith. Commentary by the editor provides context.

The first eight chapters cover the "founders of modern science" from the mid-sixteenth century to the mid-twentieth century, including Galilei, Kepler, Bacon, Pascal, Newton, Darwin, Einstein, and Whitehead. The second set of thirteen chapters features scientists from the twentieth century to the present, covering Carson, Sagan, Gould, Dawkins, Goodall, Weinberg, Polkinghorne, Dyson, Hawking, Davies, Wilson, Kauffman, and Goodenough.

The introduction explains the main features of the book. It is aimed at the general public including nonspecialists, students, and seekers (p. viii). Therefore, the editor has included only working scientists of major historic stature or contemporary public interest who had written about their faith in its relation to their science. Her stated focus on individuals facilitates access to the personal and historical context in which they lived and worked and avoids the distortions that arise when the issues are framed in terms of the abstractions of "religion" and "science."

Since it is impossible to review each of the twenty-one chapters let me highlight two representative examples of how Frankenberry stimulates further reading. On page 38, Kepler:

> A Lutheran, Kepler disagreed with Lutheran orthodoxy and made concessions to both Catholics and Calvinists. On the matter of Communion, Catholics believed that "transubstantiation" physically transformed the wafer and wine into the body and blood

> of Christ. Lutherans explained that "consubstantiation" occurred: Christ's real body and blood were present even though the bread and wine looked unchanged, because, as divine, Christ's body and blood become "ubiquitous" and everywhere present. Calvinists held that the bread and wine remained mere bread and wine but provided true communion with Christ, who is in heaven with the Father. Kepler got into trouble for not embracing the "ubiquity" doctrine of his fellow Lutherans.

On page 147, Einstein:

> How was Einstein's determinism compatible with his well-known devotion to justice, humanitarian ideals, and social responsibility, all of which presume at least some degree of free will and indeterminism in the universe? It is far from clear how Einstein reconciled his espousal of determinism with his social and ethical principles.

The project left Frankenberry with two impressions. First, scientists associated with the scientific revolution were able to interrelate their Christian faith and their scientific discovery seamlessly, but "pockets of perplexity, elements of eccentricity and unconventional forms within conventional Christian faith stand out" (p. ix). Secondly, "in contrast to the historical titans, many of the contemporary scientists … are moved by fresh visions and alternative forms of spirituality" (p. x).

As a popular-level introduction, this book admirably fills a gap between scholarly anthologies such as N. A. Rupke, ed., *Eminent Lives in Twentieth-Century Science and Religion* (rev. and expanded ed.; Frankfurt, DL: Peter Lang Verlag, 2009) and book-length biographies. Frankenberry sets a high standard. Generally, her commentaries succeed in succinctly capturing the excitement of exploring nature in the context of "faith" and in introducing the perplexities that can emerge in the process. She teaches religion at Dartmouth College, and this shows in the quality of the commentary, as in the thoughtful way she captures the complexity of Pascal's reflections on faith and reason, explains the three versions of Pascal's wager, and corrects his caricature as an irrational fideist. There is an occasional flaw, as, for instance, in the passage about Kepler and Communion cited above. It is true that for Calvinists the bread and wine remain mere bread and wine, but they do not provide true communion with Christ, who is in heaven with the Father. Rather, the bread and wine are visible reassurances of the spiritual presence of Christ through the work of the Holy Spirit in the participants. On the side of the history of science, the editor fails to point out that it was the impossibility of Jesus' physical body to be in more than one place simultaneously, that kept Kepler from agreeing with the Lutheran view. On this point, Kepler's physics affected the practice of his religious faith.

In her scholarly work, Frankenberry defines religion as "a communal system of propositional attitudes and practices that are related to superhuman agents." This definition would have excluded most contemporary scientists from her list, as their religion is not related to superhuman agents. So in this book she has replaced it with "faith" which she takes in the broadest possible sense. Two advantages accrue. First, it captures views, attitudes, and stances that function as a religion while not fitting the standard views of religion. This approach allows her to include the creative, the heterodox, and even the antireligious views of scientists. For instance, it allows her to characterize the science of sociobiologist E. O. Wilson as "akin to faith" (p. 437). Secondly, she avoids the controversies about definitions of religion in academia.

Only major historical figures or public intellectuals were included (p. viii). Their public status introduces the possibility that they were writing for the public and with ulterior motives, rather than about their private beliefs. This is a historiographic concern that has entered certain textbooks, for instance, P. J. Bowler and I. R. Morus, *Making Modern Science* (Chicago, IL: University of Chicago Press, 2005). The editor appears unaware that this situation raises the question of bias. So-called minor figures might have been more interesting to consider for their lack of bias.

An extensive index and suggestions for further reading at the end of each chapter make the book very accessible. Sometimes the reading list fails to include studies of importance to the theme of the book. [See, for example, the chapter "Edward Osborne Wilson (b. 1929)" by Mark Stoll in Rupke's, book cited earlier]. Highly recommended for anyone who wants to scout what is on offer in science and religion studies, or for students who need an essay topic.

Reviewed by Jitse M. van der Meer, Redeemer University College, Ancaster, ON L9K 1J4. ✭

Letters

A Reply to Lamoureux's Review of Beale's *The Erosion of Inerrancy in Evangelicalism*

Lamoureux (*PSCF* 62, no. 2 [June 2010]: 133–8) is, as he says, "quite critical" of the evangelical position on inerrancy maintained by Beale in his 2008 publication, *The Erosion of Biblical Inerrancy.* Over against Beale's view that the Scriptures must not be held to contain errors of fact, Lamoureux argues, following Peter Enns, that "literary genre *dictates* biblical interpretation" (p. 137, Lamoureux's italics). Thus, properly, one "treats the ancient science as ancient science, and the ancient understanding of human history as an ancient understanding of human history" (p. 137). Indeed, for Lamoureux and Enns, "under the inspiring guidance of the Holy Spirit, the science and history of the day were employed as incidental vessels to reveal inerrant messages of faith" (p. 136); "God accommodated to the level of ancient humans in the revelatory process" (p. 136). After all, did not the incarnation itself involve accommodation (the "humbling" of Phil. 2:8)?

Let me provide just a few of the many reasons why the Lamoureux-Enns accommodation approach to Scripture is entirely incompatible with biblical inerrancy, as well as being destructive to a meaningful Christian theology.

1. Spiritual facts ("messages of faith") cannot be placed in an airtight compartment so as to separate them from secular facts (scientific and historical information). This is true in general, since all areas of knowledge interpenetrate each other; it is especially true in the case of special revelation, since the heart of biblical religion lies in God's revealing himself in the secular realm (as the Creed says, our Lord "suffered under Pontius Pilate"). The question, "Are the death of Christ on the cross and his resurrection *secular* events or *faith* events?" parallels the question, "Have you stopped beating your wife?"—since it should be painfully obvious that the cross and the resurrection are *both historical and spiritual events at the same time,* and, if not historical, of little or no value spiritually. Doubt as to the historicity of biblical events will, logically and inevitably, produce equivalent doubt as to their spiritual value.

2. If the scientific and historical material in the Bible—which can in principle be checked for accuracy—is not reliable, why should anyone accept the spiritual/faith material set forth there—which cannot be checked? If the writers were not preserved from error in human geography, why would anyone trust what they recorded as to heavenly geography ("In my Father's house are many mansions," etc.)? A fundamental epistemological theme of Jesus' teaching is, "If I have told you earthly things and you do not believe, how will you believe if I tell you of heavenly things?" (John 3:12). Indeed, it is exactly this solid factuality of Christian revelation which gives Christianity its character of "meaningfulness"—in contrast with virtually all other religious positions, cults, and worldviews which, lacking in any factual testability (verifiability/falsifiability), suffer from epistemological "nonsensicality" or "meaninglessness" (to use the expressions of contemporary analytical philosophy).

3. Accommodatist approaches to Scripture are never justified by an appeal to *kenosis* ("limitation") by way of Phil. 2:8. Of course, in becoming man, God took on human characteristics; but this did not include sin or error; had that been the case, one could not trust anything Jesus said about God, since (as Strack and Billerbeck have well shown in their *Kommentar zum Neuen Testament aus Talmud und Midrasch*) the vast majority of Jesus' teachings can be paralleled in intertestamental Jewish writings—so he could well have simply accommodated himself to the fallible spiritual ideas of his time rather than offering fallen humankind eternal verities and the one divinely true way of salvation. Modern theologians such as Rudolf Bultmann and ecclesiastical liberals such as the late Bishop James Pike have gone this route, thereby evacuating not just the Old Testament of meaning by reducing its content to myth, but also destroying the New Testament gospel by demythologizing Jesus' ministry and existentially dehistoricizing Jesus' words and work.

Two wee bibliographical suggestions: ponder my essay, "Inspiration and Inerrancy: A New Departure," included in my *Crisis in Lutheran Theology,* together with the appropriate sections (especially proposition 4.0) of my *Tractatus Logico-Theologicus* (www.ciltpp.com).

John Warwick Montgomery
ASA Fellow
Professor Emeritus, University of Bedfordshire (England)
Distinguished Professor, Patrick Henry College (Virginia)

Two Book Interpretation of Revelation

My thanks to Mary VandenBerg for her article (*PSCF* 62, no. 1 [2010]: 16–24) on the two-book interpretation of revelation, nature and the Bible. She traces the use of general revelation through nature back through Calvin to Augustine to Paul in Romans 1 and makes the solid point that Paul sees nature as pointing to God himself (good, loving, just) and not to the details of natural processes—as some scientific creationists might have it. Theirs is a descriptive/causal/hypothetical task and, insofar as researchers come up with convincing evidence, Christians need to be free to rejoice and to see the natural processes as part of God's creative work.

As a theologian, VandenBerg wants to maintain a "high view" of the biblical text (supernatural revelation) and the distinctive feature of her methodology is, no doubt, teleological—what is the book trying to say to its original hearers and to us today? And what does it reveal about the purposive-redemptive nature of the Lord God? So, in her conclusion (p. 22 and endnote 47, p. 24), she warns against "rushing to reinterpret" the special book every time something seemingly conflicting arises from science.

In keeping with these Reformed commitments, it would be of interest to see her evaluation of a work like John H. Walton's *The Lost World of Genesis One: Ancient Cosmology and the Origins Debate* (InterVarsity Press, 2009) reviewed by Sean M. Cordry (*PSCF* 62, no. 3 [2010]: 227–8) Perhaps she would agree with the following comments.

In Reformed theological language, Walton's thesis can be reduced to one sentence: To read Gen. 1:1–2:3 as Moses may have intended, don't necessarily see it as referring to a material creation, but rather view it as an outline of God's eternal plan for that creation.

Back in my seminary days, I began researching the ancient Near East culture into which Abraham was born in Ur. The seven tablets of the old (2000+ BC) Babylonian creation story ("*Enuma elish*") had recently been uncovered. As I read them, I could not help but wonder how Abraham reacted to the account of the fighting of the many gods, to the chief male god's (Marduk's) killing of the head female deity (Tiamat), his standing on her body and then cutting her in two to make the heavens and earth, and then using the blood of another god he had killed to make humans to be slaves of the deities. What a shock it must have been for him to discover the one and only God who made humankind in his own image, who each "day" added something to creation that would be for the good of men and women, and finally on the seventh day to come and dwell with the people he loved in his holy Temple!

If Walton had played up this sharp contrast on the theological level, his own major points would have been considerably clarified for his readers (for example, his interesting reflections on the seventh day). The differences in cosmology between the old polytheistic and the Hebrew monotheistic one may turn out to be more enlightening than the similarities he concentrates on. In the Babylonian case, for example, Marduk commands the lesser gods to honor him, and they build a temple somewhere in the heavens away from us inferior beings. [Cordry's contention that the polytheistic deities' "relationship to people was of utmost importance" (p. 227) was

in error. Humans tended to fear the gods and sought to appease them.] In the Bible story—as Walton's elaboration shows so beautifully—God wants to be with his creation and has a plan for building his tabernacle which he gives to his people to construct, to dedicate, to inaugurate, and to care for, and in which to worship their living Lord.

Walton has done some solid work, bringing his readers back into that ancient time, by using the number of creation texts now available to throw light on a possible way of understanding Genesis 1 and its implications for Old Testament studies and for science-faith questions. I hope my few suggestions will stimulate further discussion.

William W. Paul
Retired Professor of Philosophy of Science
Central College
Pella, IA 50219
paulw@wpmcrc.org

Eisegesis Denies Inerrancy

C. John Collins, "Adam and Eve as Historical People, and Why It Matters," (*PSCF* 62, no. 3 [2010]: 147) practices eisegesis in his approach to Genesis 2 f. and ignores the first chapter. Both reports in Hebrew are clear that a pair of individuals are described. In Gen. 1:29, "male" and "female" are singular nouns, whereas "them," involving both, is plural. Genesis 2:5 refers to "the man" plus a negation. Verse 7 has "the man" formed and vivified. The reference is singular throughout. The succeeding passage is clear that this is one individual. The reference to building the woman is also clearly singular. But Collins references a tribe as supported by Scripture and history (p. 151).

To argue that the children of Adam and Eve were less civilized than depicted because they were much more ancient (p. 158), living at least 40,000 years ago rather than about 6,000 (p. 159), has no basis in the text. That there were contemporaries (pp. 158, 160) is clearly not in the text.

Here we run into a theological problem. If Adam's federal headship of the thousands of contemporary human beings involved their receiving the divine image and likeness and being subjected to his disobedience (p. 160; cf. p. 159), then the righteousness of Jesus Christ should apply to all human beings alive since the resurrection. Consequently, Collins should adopt at least some version of Universalism.

Of course, Collins could argue that Adam, Eve, and the talking, walking serpent either organized the tribe to march past the tree and to partake, or arranged distribution to all. On this view, a pregnant woman's eating would affect the fetus, but even newborns would have to consume a little juice.

Note may also be taken that my commendation of McGrath (p. 165, n. 73) was limited to his matching interpretation of the biblical chronology. Collins, in contrast, expands his chronology without biblical warrant.

David F. Siemens Jr.
ASA Fellow
2703 E. Kenwood Ave.
Mesa, AZ 85213-2384

Historical Adam?

The historicity of Adam was the theme of the September 2010 issue of *PSCF*. An article by John Collins stated in the abstract, "that Adam and Eve were real persons, and the forebears of all other human beings" (p. 147). Although entirely wrong anthropologically, it was a well-articulated article. Dennis Venema authored a thought-provoking article that showed "evidence of human-ape common ancestry" (pp. 166–78). Brachiators swinging on the family tree, eh, Dennis? Good article.

Daniel Harlow read Genesis "in an age of evolutionary science" (pp. 179–95). "Modern science has amply demonstrated that phenomena such as predation, death, and the extinction of species have been intrinsic and even necessary aspects of life on earth for billions of years, long before the arrival of *Homo sapiens*. For this reason, many Bible-believing Christians have long found it difficult to read Genesis 1–3 as a factual account of human origins" (p. 179). True, but what about reading Genesis as a "factual account" of Jewish origins? Did Harlow think of that? No, Adam is a "type of Christ" (p. 181), a "literary figure" (p. 181), according to him. And thus Adam is erased from the line of biblical patriarchs who once breathed air.

John Schneider volleyed, "… in the event that conflict between science and Scripture *seems* to exist, it follows that at least one of the two—the *science* or the *reading* of Scripture—is mistaken" (p. 197). Right on! Here succinctly stated is the heart of the problem.

Sometime in the first century AD a funny thing happened. The beginning history of the Israelite nation contained in Genesis 2–11, which Moses had handed down to the children of Israel, began being interpreted by early Christians as the start of the entire human race. When they received the canon of the Hebrew Old Testament, due to their ignorance, they read themselves into what they should have, or at least could have realized, was a Jewish history book. A simple mistake in thinking Jewish history was human history is a common misunderstanding that has endured for 2,000 years and even left its stamp on this issue of *PSCF*.

Here is what the authors Collins and Harlow apparently did not know and certainly did not recognize. The likely existence of Adam as a legitimate, historical personality has already been substantiated with archaeological and historical evidence. This evidence was first presented in a series of articles that appeared in the December 1993 and March 1994 issues of *PSCF* entitled, "In Search of the Historical Adam, Parts 1 and 2."[1] A book was published in 2008 entitled, *Historical Genesis: From Adam to Abraham* (www.HistoricalGenesis.com).[2] A whole school of thought and a movement has sprung up in recent months focused on the historicity of Adam in full recognition of the antiquity of the human race—the Historical Adam Society.

"Historical Adam" is a Christian apologetic that embraces the Genesis narrative concerning Adam and his descendants, and operates completely within the bounds of scientific discovery and historical evidence. This position considers Adam to have been a real historical person,

but not to have been the biological progenitor of the entire human race since our species, *Homo sapiens*, is known from the fossil record to have been living 200,000 years ago. As evidenced by both Genesis and archeological discovery, Adam lived around 5000 to 4000 BC in southern Mesopotamia, present-day Iraq, near the confluence of the four rivers of Eden.

The Bible links Christ with Adam biologically through its genealogies and theologically in Romans, and therefore a historical Adam is important in preserving the integrity of Scripture. While not the first human, Adam was the first in God's covenant line leading to Christ, and began the era of individual accountability. The knowledge of God for all humanity started with the Adamic covenant. It was through one man, Adam, that sin was imputed to the human race, just as grace is dispensationally given by God to followers of Christ.

The rationale for "Historical Adam" and the foundation for this belief are based fully upon the integrity of Scripture, the history of the ancient Near East as recorded in Sumerian and Akkadian literature, and upon related archaeological evidence. We have a movement. All we need are more members. Join at www.HistoricalAdam.org.

Notes

[1]Dick Fischer, "In Search of the Historical Adam: Part 1," *PSCF* 45, no. 4 (1993): 241–51; ____, "In Search of the Historical Adam: Part 2," *PSCF* 46, no. 1 (1994): 47–57.
[2]Richard James Fischer, *Historical Genesis: From Adam to Abraham* (New York: University Press of America, 2008).

Dick Fischer
ASA Member
PO Box 2245
Centreville, VA 20122
dickfischer@verizon.net

Cultural Development and Adam

A series of cultural events, initiated in approximately 5000 BCE, might shed some light on the creation of Adam. Evolution theory holds that modern man has evolved over millions of years. The Bible teaches that Adam was the first [modern] man created on the sixth day in the likeness of God.[1] This appears to be a conflict. Cultural development may be helpful in resolving this conflict.

Historian Will Durant describes five categories of artifacts that reflect cultural development: language, government, religion, engineering, and architecture. Using these five categories, he describes the first nineteen significant cultural achievements, all of which occurred between 5000 and 3000 BCE.[2]

At about four million years ago in the evolutionary process, *Australeopithicus aferensis* had the same body plan as modern man, but was somewhat smaller with a proportionate brain size. Modern man has a larger brain, particularly the neocortex, where calculations, comparisons, judgments, and planning take place.[3] Without networks, the brain is more likely to provide a linear output (e.g., danger in; flee or fight out). On the other hand, neural networks can produce an iterative response to stimuli with an output based on learning, experience, culture, and judgments.[4] The neocortex contains several billion nerve cells which are highly networked by branching. It seems reasonable that the cultural achievements of modern man are facilitated by this neural network. Of course, we know very little about the function of the brain of *A. aferensis*, or to what degree it was networked, but without question modern man is more culturally sophisticated.

The cited 2,000-year window of cultural expansion represents only 0.05% of the period from four million years ago to the present. Thus, the question is raised as to what could have generated this almost explosive cultural expansion around 5000 BCE. How did the brain change?

In 1986 Rita Levi-Montalcini and Stanley Cohen received the Nobel Prize for the discovery and study of the Nerve Growth Factor (NGF).[5] NGF results from cleavage of a relatively simple peptide of 307 amino acid residues located on the proximal arm of human chromosome one. They showed that NGF was critical to the generation of neural networks within hours, while neuronal cells failed to survive unless NGF was added daily to the culture medium. Specific life molecules such as a protein take a long time to evolve. However, for every such molecule derived from a precursor, there would be a very short period when the final side group (using hydrogen, oxygen, nitrogen, etc.) is put into place. One moment this new side group is absent, the next moment it is present, and the new molecule can begin its work. In the case of Adam, the final side group may have been put in place in his nuclear genome, or into an existing molecule to allow his brain's neural branching to proceed. Thus, a final step allowing for the production of NGF could have been very fast. If the cultural explosion took place early in the hypothesized time frame, that is, around 5000 BCE, then this timing is relatively consistent with the often-criticized creation date of 4004 BCE.

Notes

[1]Gen. 1:27, Gen. 2:7, Gen. 5:1.
[2]Will Durant, *The Story of Civilization*, vol. 1, *Our Oriental Heritage* (New York: Simon and Schuster, 1954). Events are described on pp. 98–329.
[3]Dean Hamer and Peter Copeland, *Living With Our Genes* (New York: Doubleday, 1998), 16.
[4]Francis Crick, *The Astonishing Hypothesis* (New York: Scribner and Sons, 1994). Chapter 13 deals entirely with neural networks.
[5]Rita Levi-Montalcini, "The Nerve Growth Factor 35 Years Later," *Science*, 237 (1987): 1154–62. Paper presented at the Nobel Award Conference in Stockholm.

Jon W. Martin
Retired Industrial Scientist
Loudon, TN 37774
Mjonandjan@bellsouth.net ★

Index

Volumes 60–62, 2008–2010

The locations of indices for previous volumes are listed on the inside back cover of the journal. Numbers in each entry refer to volume, issue, page number, month, and year. For example, 62:4, 250, D 2010 refer to volume 62, issue number 4, page 250, December 2010. The names of the book reviewers are listed in parentheses after each book review.

Articles

Author Exchanges

Book Notices

Index

Volumes 60–62, 2008–2010

Book Reviews

Index

Volumes 60–62, 2008–2010

Index

Volumes 60–62, 2008–2010

Communication

Editorials

Index

Volumes 60–62, 2008–2010

Essay Book Reviews by Book Author

Essay Book Reviews by Reviewer

In Memoriam

Interviews

Letters

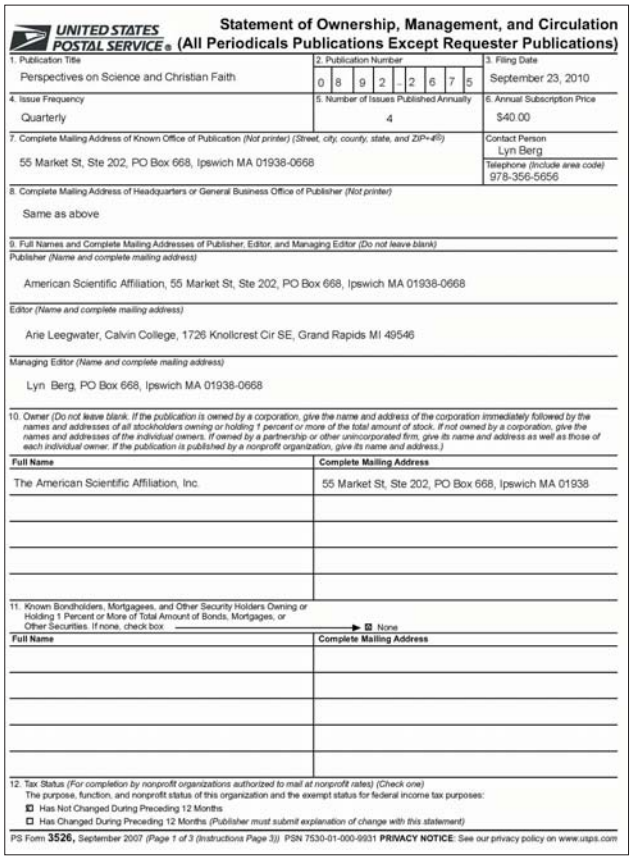
Index

Volumes 60–62, 2008–2010

Review and Response

Reviewers

Students and Early Career Forum



UNITED STATES POSTAL SERVICE®

Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)

1. Publication Title	2. Publication Number	3. Filing Date
Perspectives on Science and Christian Faith	0 8 9 2 - 2 6 7 5	September 23, 2010
4. Issue Frequency	5. Number of Issues Published Annually	6. Annual Subscription Price
Quarterly	4	$40.00

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®): 55 Market St, Ste 202, PO Box 668, Ipswich MA 01938-0668 — Contact Person: Lyn Berg; Telephone (Include area code): 978-356-5656

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer): Same as above

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)

Publisher (Name and complete mailing address): American Scientific Affiliation, 55 Market St, Ste 202, PO Box 668, Ipswich MA 01938-0668

Editor (Name and complete mailing address): Arie Leegwater, Calvin College, 1726 Knollcrest Cir SE, Grand Rapids MI 49546

Managing Editor (Name and complete mailing address): Lyn Berg, PO Box 668, Ipswich MA 01938-0668

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)

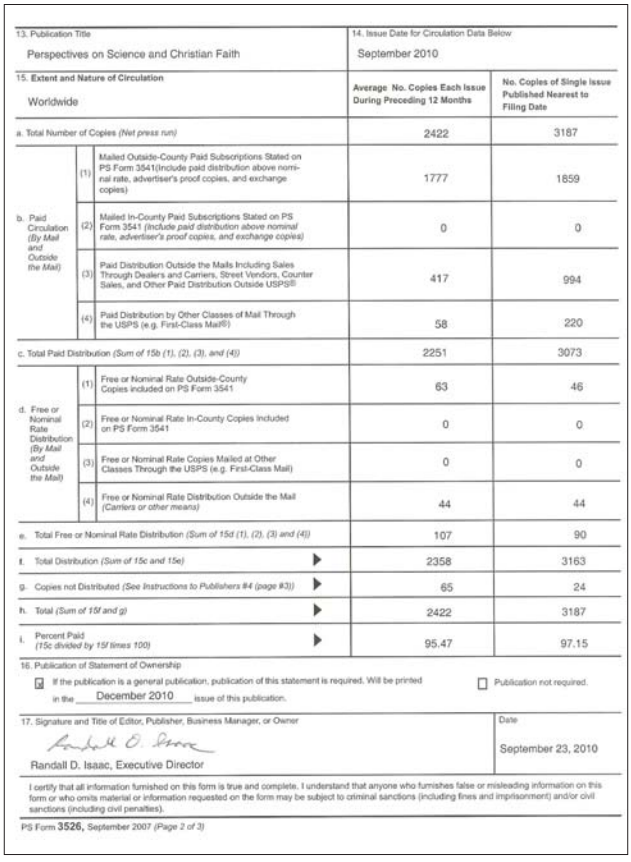
Full Name	Complete Mailing Address
The American Scientific Affiliation, Inc.	55 Market St, Ste 202, PO Box 668, Ipswich MA 01938

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box → ☒ None

Full Name	Complete Mailing Address

12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
☒ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)

PS Form **3526**, September 2007 (Page 1 of 3 (Instructions Page 3)) PSN 7530-01-000-9931 **PRIVACY NOTICE**: See our privacy policy on www.usps.com



13. Publication Title	14. Issue Date for Circulation Data Below
Perspectives on Science and Christian Faith	September 2010

15. Extent and Nature of Circulation: Worldwide		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)		2422	3187
b. Paid Circulation (By Mail and Outside the Mail)	(1) Mailed Outside-County Paid Subscriptions Stated on PS Form 3541(Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	1777	1859
	(2) Mailed In-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	0	0
	(3) Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS®	417	994
	(4) Paid Distribution by Other Classes of Mail Through the USPS (e.g. First-Class Mail®)	58	220
c. Total Paid Distribution (Sum of 15b (1), (2), (3), and (4))		2251	3073
d. Free or Nominal Rate Distribution (By Mail and Outside the Mail)	(1) Free or Nominal Rate Outside-County Copies included on PS Form 3541	63	46
	(2) Free or Nominal Rate In-County Copies Included on PS Form 3541	0	0
	(3) Free or Nominal Rate Copies Mailed at Other Classes Through the USPS (e.g. First-Class Mail)	0	0
	(4) Free or Nominal Rate Distribution Outside the Mail (Carriers or other means)	44	44
e. Total Free or Nominal Rate Distribution (Sum of 15d (1), (2), (3) and (4))		107	90
f. Total Distribution (Sum of 15c and 15e)		2358	3163
g. Copies not Distributed (See Instructions to Publishers #4 (page #3))		65	24
h. Total (Sum of 15f and g)		2422	3187
i. Percent Paid (15c divided by 15f times 100)		95.47	97.15

16. Publication of Statement of Ownership
☒ If the publication is a general publication, publication of this statement is required. Will be printed in the December 2010 issue of this publication. ☐ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Randall D. Isaac, Executive Director — Date: September 23, 2010

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

PS Form **3526**, September 2007 (Page 2 of 3)

American Scientific Affiliation

The American Scientific Affiliation (ASA) is a fellowship of Christians in science and related disciplines, who share a common fidelity to the Word of God and a commitment to integrity in the practice of science. Founded in 1941, the purpose of the ASA is to explore any and every area relating Christian faith and science. *Perspectives on Science and Christian Faith* is one of the means by which the results of such exploration are made known for the benefit and criticism of the Christian community and of the scientific community. The ASA Statement of Faith is at www.asa3.org/ASA/faithASA.html

American Scientific Affiliation Blogs

We encourage members to submit comments and questions on the articles published in this journal on the **ASA PSCF Discussion Forum** at www.asa3online.org/PSCF. The public is invited to read all posts and comments; ASA members have permission to write comments.

The **ASA PSCF Discussion** home page also contains links to two other discussion groups. **ASA Voices**, www.asa3online.org/Voices, is a general forum for thoughtful discussion of various issues in science and faith. **ASA Book Discussion**, www.asa3online.org/Book, hosts a series of discussions on seminal books on science and faith.

Canadian Scientific & Christian Affiliation

A closely affiliated organization, the Canadian Scientific and Christian Affiliation, was formed in 1973 with a distinctively Canadian orientation. The CSCA and the ASA share publications (*Perspectives on Science and Christian Faith* and the *ASA/CSCA Newsletter*). The CSCA subscribes to the same statement of faith as the ASA, and has the same general structure; however, it has its own governing body with a separate annual meeting in Canada. Contact CSCA by writing to: Canadian Scientific and Christian Affiliation, PO Box 63082, University Plaza, Dundas, ON L9H 4H0 or visit their website at www.csca.ca

How Do I Join the ASA?

Anyone interested in the objectives of the Affiliation may have a part in the ASA. Membership and subscription applications are available at www.asa3.org/ASA/joinASA.html

Full membership is open to all persons with at least a bachelor's degree in science who can give assent to our statement of faith. Science is interpreted broadly to include anthropology, archeology, economics, engineering, history, mathematics, medicine, political science, psychology, and sociology as well as the generally recognized science disciplines. Philosophers and theologians who are interested in science are very welcome. Full members have voting privileges and can hold office.

Associate membership is available to interested nonscientists who can give assent to our statement of faith. Associates receive all member benefits and publications and take part in all the affairs of the ASA except voting and holding office.

Full-time students may join as **Student Members** (science majors) with voting privileges or as **Student Associates** (nonscience majors) with no voting privileges.

Spouses and **retirees** may qualify for a reduced rate. **Full-time overseas missionaries** are entitled to a complimentary membership.

An individual wishing to participate in the ASA without joining as a member or giving assent to our statement of faith may become a **Friend** of the ASA. Friends receive all member benefits and publications and take part in all the affairs of the ASA except voting and holding office.

Subscriptions to *Perspectives on Science & Christian Faith (PSCF),* are available at $40/year (individuals), $65/year (institutions) and $20/year (students).

How Do I Find Published *PSCF* Articles?

Articles appearing in *Perspectives on Science and Christian Faith* are abstracted and indexed in the *Christian Periodical Index; Religion Index One: Periodicals; Religious & Theological Abstracts*, and *Guide to Social Science and Religion in Periodical Literature*. Book Reviews are indexed in *Index to Book Reviews in Religion*. Present and past issues of *PSCF* are available in microfilm form at a nominal cost. For information, write to NA Publishing, Inc. PO Box 998, Ann Arbor, MI 48106-0998 or go to www.napubco.com.

Contents of past issues of *PSCF* are available at www.asa3.org/ASA/PSCF.html

American Scientific Affiliation
55 Market Street, Suite 202
PO Box 668
Ipswich, MA 01938-0668

Phone: (978) 356-5656
FAX: (978) 356-4375
E-mail: asa@asa3.org
Website: www.asa3.org

"Upholding the Universe by His Word of Power" Hebrews 1:3

Editorial

Articles

Essay Review

Book Reviews

Letters

Index

Volume 62, Number 4 **December 2010**