The Methodological Equivalence of Design & Descent: Can There Be a Scientific "Theory of Creation"?

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During the last thirty years the idea of design has undergone a renaissance in some scientific and philosophical circles. Developments in physics and cosmology, in particular, have placed the word *design* back in the scientific vocabulary as physicists have unveiled a universe apparently fine-tuned for the possibility of human life (see discussion in chapter four). The speed of light, the strength of gravitational attraction, the properties of the water molecule and many other features of the cosmic architecture appear to have been fortuitously arranged and balanced for human benefit.

While many have postulated so-called anthropic principles or "many worlds scenarios" to explain (or explain away) this apparent design without recourse to God, some have eschewed these secular notions and posited the activity of a preexistent intelligence a Creator as the simplest explanation for the "coincidences" upon which life seems to depend. As Sir Fred Hoyle has suggested, a common sense interpretation suggests that "a superintellect has monkeyed with physics" in order to make life possible. Similarly, astronomer George Greenstein wrote in a recent book provocatively subtitled *Life and Mind in the Cosmos:* "The thought insistently arises that some supernatural agency or rather Agency must be involved. Is it possible that suddenly, without intending to, we have stumbled upon scientific proof of the existence of a Supreme Being? Was it God who stepped in and so providentially crafted the cosmos for our benefit?"

Despite this renewal of interest in the (intelligent) design hypothesis among physicists and cosmologists, biologists have remained reluctant to consider such notions. As historian of science Timothy Lenior has observed, "Teleological thinking has been steadfastly resisted by modern biology. And yet, in nearly every area of research biologists are hard pressed to find language that does not impute purposiveness to living forms."

The tendency Lenior has observed among biologists seems both puzzling and ironic. At first glance, the complexity of living systems far exceeds any encountered in the physical sciences. Information-storage and transfer systems, regulatory and feedback mechanisms, structures for manufacturing and repairing precisely coded and sequenced strings of chemical "symbols"all on a miniaturized scale characterize even the simplest cells. Ernst Haeckel's nineteenth-century vision of simple "homogeneous globules of plasm" has yielded to the modern molecular image of a complex cellular factory.

Moreover, the growing awareness of biological complexity has created something of an impasse in contemporary origins theory (see the chapter by Bradley and Thaxton in this volume). Various contradictory conjectures have appeared as scientists have attempted to explain how purely natural processes could have given rise to the unlikely and yet functionally specified systems found in biology systems that comprise, among other things, massive amounts of coded genetic information. The origin of such information, whether in the first protocell or at those discrete points in the fossil record that attest to the emergence of structural novelty, remains essentially mysterious on any current naturalistic evolutionary account.

Not surprisingly, critical scientific analyses of both chemical and neo-Darwinian evolutionary theory have proliferated in recent years. Some observers have gone so far as to characterize origin-of-life studies and neo-Darwinism as paradigms in crisis or degenerate research programs. As biophysicist Dean Kenyon, a once-prominent origin-of-life researcher, said concerning his own discipline several years ago: "The more .

. . we have learned in recent two or three decades about the chemical details of life, from molecular biology and origin-of-life studies . . . the less likely does a strictly naturalistic explanation of origins become."

Similarly, Francis Crick has written, "An honest man, armed with all the knowledge available to us now, could only state that in some sense, the origin of life appears at the moment to be almost a miracle, so many are the conditions which would have been satisfied to get it going."

While Kenyon has since embraced the design hypothesis (thus explaining his fall from prominence), Crick and most others in the biological community have remained firmly committed to the view that naturalistic processes will eventually suffice to explain the origin of new biological information and structure. Thus, despite the current impasse and a growing body of at least highly suggestive evidence for intelligent design, discussion of the design hypothesis has remained almost entirely out of bounds in biology. Why?

At least part of the reason for this reticence may not be hard to discern. Biologists, and scientists generally, assume the rules of science prohibit any deviation from a strictly materialistic mode of analysis. Even most physicists sympathetic to design would quickly label their intuitions "religious" or "philosophical" rather than "scientific." Science, it is assumed, must look for exclusively natural causes. Since the postulation of an intelligent Designer or Creator clearly violates this methodological norm, such a postulation cannot qualify as a part of a scientific theory. Thus Stephen J. Gould refers to "scientific creationism" not just as factually mistaken but as "self-contradictory nonsense." As Basil Willey put it, "Science must be provisionally atheistic, or cease to be itself."

Most scientists who are theists also accept this same conception of science. As Raymond Grizzle wrote in a prominent evangelical scientific journal recently, "God cannot be part of a scientific description. . . . [Further], any description that *implies* a creator will probably also be looked at as improper by most scientists." Nancey Murphy, a philosopher and Fuller Seminary professor, agrees. She wrote recently in the same journal: "Science qua science seeks naturalistic explanations for all natural processes. Christians and atheists alike must pursue scientific questions in our era without invoking a Creator. . . . Anyone who attributes the characteristics of living things to creative intelligence has by definition stepped into the arena of either metaphysics or theology."

Yet on what basis is this definition of science asserted? For Murphy and Grizzle the answer seems clear. A respect for the rules and practices of science as they have come down to us dictates that Christians should avoid invoking creative intelligence in their theories. In Murphy's words, *"For better or worse,* we have *inherited* a view of science as methodologically atheistic" (emphasis added). Grizzle, too, appeals to convention to justify methodological naturalism:

All modern science, not just biological evolutionary theory, by definition excludes God. . . . There is no rule book that spells this out, and indeed it has been argued that it is an arbitrary restriction. Furthermore, this has become the case only in the last 100 years or so. Nonetheless, this is one of the restrictions almost universally put upon science by those who practice it, and it seems to me quite desirable and likely that science will retain this restriction in the foreseeable future.

Of course, it does not follow that just because science is or has been wholly naturalistic, it should remain so. The indicative does not, after all, imply the imperative. Therefore, Murphy and Grizzle's appeal to convention and current practice invites scrutiny of the grounds on which the scientific community has asserted naturalism as normative to its practice. Indeed, if the customary definition of science is exposed as *just* an arbitrary convention, some practicing scientists may wish to repudiate it, especially if they now judge empirical evidence sufficient to motivate a consideration of some nonnaturalistic theory of origins. In any case, beyond a fallacious appeal to power, it would be difficult to see why those disinclined to accept methodological naturalism should not be free to operate under a less restrictive definition of science.

However Christian intellectuals might go about defending methodological naturalism, secular defenders of the principle assure us that the prohibition against invoking God or creative intelligence is anything but

arbitrary. Instead, they assert that good independent reasons exist for the conventional exclusion of such notions from all scientific theories. Theories of design or creation do not, they say, meet objective standards of scientific method and practice. Such theories do not explain by reference to natural law, nor do they manifest a host of other features of true scientific theories such as testability, observability and falsifiability. Thus, unlike naturalistic evolutionary theories, creationist or design theories are methodologically deficient. Creationist theories may or may not be true, but they can never, that is, in principle be considered scientific.

The use of what philosophers of science call "demarcation arguments "arguments that purport to distinguish science from pseudoscience, metaphysics or religion in defense of a favored theory has a long history. Darwin himself employed such arguments to defend his theory from idealist and creationist challenges. While philosophical arguments about what does or does not constitute science have generally been discredited within philosophy of science, they nevertheless continue to play a vital role in persuading biologists that alternative scientific explanations do not, and in the case of nonnaturalistic theories *cannot,* exist for biological origins. Indeed, various demarcation criteria are often cited by scientists as reasons for rejecting the very possibility of intelligent design.

The purpose of this chapter is to examine the case against the possibility of a scientific theory of intelligent design or creation. Several of the criteria said to distinguish the scientific status of naturalistic evolutionary theories (hereafter "descent") from admittedly nonnaturalistic theories of creation or design (hereafter "design") will be examined. It will be argued that a priori attempts to make distinctions of scientific status on methodological grounds inevitably fail and, instead, that a general equivalence of method exists between these two competing approaches to origins. In short, I will argue that intelligent design and naturalistic descent are methodologically equivalent--that is, that design and descent prove equally scientific or equally unscientific depending upon the criteria used to adjudicate their scientific status and provided metaphysically neutral criteria are selected to make such assessments. In the process of making this argument, I will also discuss whether a scientific theory of creation or design could be formulated or whether methodological objections, forever and in principle, make the assertion of a scientific theory of creation an "oxymoron" or "self-contradictory nonsense," as Ruse, Stent, Gould and others have claimed.

Throughout this paper, the alliterative terms *design* and *descent* will be used as a convenient shorthand to distinguish two types of theories: (1) those that invoke the causal action of an *intelligent* agent (whether divine or otherwise) as part of the explanation for the origin of biological form or complexity and (2) those (such as Darwin's "descent with modification") that rely solely on *naturalistic* processes to explain the origin of form or complexity.

By way of qualification, it should be noted that by defending the methodological and scientific legitimacy of design, this chapter is not seeking to rehabilitate the empirically inadequate biology of many nineteenth-century creationists or their belief in the absolute fixity of species; nor is it attempting to endorse modern young-earth geology. The following analysis concerns the methodological legitimacy of design in principle as defined above, not the empirical adequacy of specific theories that might invoke intelligent design in the process of making other empirical claims.

The methodological equivalence of intelligent design and naturalistic descent will be suggested in three stages by three lines of argument. First, the reasons for the failure of demarcation arguments within philosophy of science generally will be examined and recapitulated. This analysis will suggest that attempts to distinguish the scientific status of design and descent a priori may well be suspect from the outset on philosophical grounds. Second, an examination of specific demarcation arguments that have been employed against design will follow. It will be argued that not only do these arguments fail, but they do so in such a way as to suggest an equivalence between design and descent with respect to several features of allegedly proper scientific practice that is, intelligent design and naturalistic descent will be shown equally capable or incapable of meeting different demarcation standards, provided such standards are applied disinterestedly. Third, design and descent will be compared in light of recent work on the logical and methodological character of historical inquiry. This analysis will show that the mode of inquiry utilized by advocates of both design and descent conforms closely to that evident in many other characteristically

historical disciplines. Thus a more fundamental methodological equivalence between design and descent will emerge as a result of methodological analysis of the historical sciences.

Part 1: The General Failure of Demarcation Arguments

To show that design "can never be considered a scientific pursuit," biologists and others have asserted that design does not meet certain objective criteria of scientific method or practice. In short, biologists have employed so-called demarcation arguments to separate a scientific approach to origins (descent) from an allegedly nonscientific approach (design). While an examination of the particular criteria employed in such arguments will not concern us in the first part of this chapter, the general practice of demarcation will.

From the standpoint of the philosophy of science, the use of demarcation arguments is generally problematic. Historically, attempts to find methodological "invariants" that provide a set of necessary and sufficient conditions for distinguishing true science from pseudoscience have failed. Moreover, most current demarcation arguments presuppose an understanding of how science operates that reflects the influence of a philosophy of science known as logical positivism. Yet since the 1950s philosophers of science have decisively rejected positivism for a number of very good reasons (see below). As a result, the enterprise of demarcation has generally fallen into disrepute among philosophers of science.

In his essay "The Demise of the Demarcation Problem," philosopher of science Larry Laudan gives a brief but thorough sketch of the different grounds that have been advanced during the history of science for distinguishing science from nonscience. He notes that the first such grounds concerned the degree of certainty associated with scientific knowledge. Science, it was thought, could be distinguished from nonscience because science produced certainty whereas other types of inquiry such as philosophy produced opinion. Yet this approach to demarcation ran into difficulties as scientists and philosophers gradually realized the fallible nature of scientific disciplines and theories. Unlike mathematicians, scientists rarely provide strict logical demonstrations (deductive proofs) to justify their theories. Instead, scientific arguments often utilize inductive inference and predictive testing, neither of which produces certainty. As Owen Gingerich has argued, much of the reason for Galileo's conflict with the Vatican stemmed from Galileo's inability to meet scholastic standards of deductive certainty a standard that he regarded as neither relevant to nor attainable by scientific reasoning. Similar episodes subsequently made it clear that science does not necessarily possess a superior epistemic status; scientific knowledge, like other knowledge, is subject to uncertainty.

By the nineteenth century, attempts to distinguish science from nonscience had changed. No longer did demarcationists attempt to characterize science on the basis of the superior epistemic status of scientific theories; rather, they attempted to do so on the basis of the superior methods science employed to produce theories. Thus science came to be defined by reference to its method, not its content. Demarcation criteria became methodological rather than epistemological.

Nevertheless, this approach also encountered difficulties, not the least of which was a widespread disagreement about what the method of science really is. If scientists and philosophers cannot agree about what *the* scientific method is, how can they disqualify disciplines that fail to use it? Moreover, as the discussion of the historical sciences in part three of this chapter will make clear, there may well be more than one scientific method. If that is so, then attempts to mark off science from nonscience using a single set of methodological criteria will most likely fail. The existence of a variety of scientific methods raises the possibility that no single methodological characterization of science may suffice to capture the diversity of scientific practice. Using a single set of methodological criteria to assess scientific status could therefore result in the disqualification of some disciplines already considered to be scientific.

As problems with using methodological considerations grew, demarcationists shifted their focus again. Beginning in the 1920s, philosophy of science took a linguistic or semantic turn. The logical positivist tradition held that scientific theories could be distinguished from nonscientific theories not because scientific theories had been produced via unique or superior methods, but because such theories were more

meaningful. Logical positivists asserted that all meaningful statements are either empirically verifiable or logically undeniable. According to this "verificationist criterion of meaning," scientific theories are more meaningful than philosophical or religious ideas, for example, because scientific theories refer to observable entities such as planets, minerals and birds, whereas philosophy and religion refer to such unobservable entities as God, truth and morality.

Yet as is now well known, positivism soon self-destructed. Philosophers came to realize that positivism's verificationist criterion of meaning did not achieve its own standard. That is, the assumptions of positivism turn out to be neither empirically verifiable nor logically undeniable. Furthermore, positivism's verificationist ideal misrepresented much actual scientific practice. Many scientific theories refer to unverifiable and unobservable entities such as forces, fields, molecules, quarks and universal laws. Meanwhile, many disreputable theories (e.g., the flat-earth theory) appeal explicitly to "common-sense" observations. Clearly, positivism's verifiability criterion would not achieve the demarcation desired.

With the death of positivism in the 1950s, demarcationists took a different tack. Other semantic criteria emerged, such as Sir Karl Popper's falsifiability. According to Popper, scientific theories were more meaningful than nonscientific ideas because they referred only to empirically falsifiable entities. Yet this, too, proved to be a problematic criterion. First, falsification turns out to be difficult to achieve. Rarely are the core commitments of theories directly tested via prediction. Instead, predictions occur when core theoretical commitments are conjoined with auxiliary hypotheses, thus always leaving open the possibility that auxiliary hypotheses, not core commitments, are responsible for failed predictions.

Newtonian mechanics, for example, assumed as its core three laws of motion and the theory of universal gravitation. On the basis of these, Newton made a number of predictions about the positions of planets in the solar system. When observations failed to corroborate some of his predictions, he did not reject his core assumptions. Instead, he scrutinized some of his auxiliary hypotheses to explain the discrepancies between theory and observation. For example, he examined his working assumption that planets were perfectly spherical and influenced only by gravitational force. As Imre Lakatos has shown, Newton's refusal to repudiate his core in the face of anomalies enabled him to refine his theory and eventually led to its tremendous success. Newton's refusal to accept putatively falsifying results certainly did not call into question the scientific status of his gravitational theory or his three laws.

The function of auxiliary hypotheses in scientific testing suggests that many scientific theories, including those in so-called hard sciences, may be very difficult, if not impossible, to falsify conclusively. Yet many theories that have been falsified in practice via the consensus judgment of the scientific community must qualify as scientific according to the falsifiability criterion. Since they have been falsified, they are obviously falsifiable, and since they are falsifiable, they would seem to be scientific.

And so it has gone generally with demarcation criteria. Many theories that have been repudiated on evidential grounds express the very epistemic and methodological virtues (testability, falsifiability, observability, etc.) that have been alleged to characterize true science. Many theories that are held in high esteem lack some of the allegedly necessary and sufficient features of proper science. As a result, with few exceptions most contemporary philosophers of science regard the question "What methods distinguish science from nonscience?" as both intractable and uninteresting. What, after all, is in a name? Certainly not automatic epistemic warrant or authority. Thus philosophers of science have increasingly realized that the real issue is not whether a theory is scientific but whether it is true or warranted by the evidence. Thus, as Martin Eger has summarized, "demarcation arguments have collapsed. Philosophers of science don't hold them anymore. They may still enjoy acceptance in the popular world, but that's a different world."

The "demise of the demarcation problem," as Laudan calls it, implies that the use of positivistic demarcationist arguments by evolutionists is, at least prima facie, on very slippery ground. Laudan's analysis suggests that such arguments are not likely to succeed in distinguishing the scientific status of descent vis-a#2-vis design or anything else for that matter. As Laudan puts it, "If we could stand up on the side of reason, we ought to drop terms like 'pseudo-science.'. . . They do only emotive work for us."

If philosophers of science such as Laudan are correct, a stalemate exists in our analysis of design and descent. Neither can automatically qualify as science; neither can be necessarily disqualified either. The a priori methodological merit of design and descent are indistinguishable if no agreed criteria exist by which to judge their merits.

Yet lacking any definite metric, one cannot yet say that design and descent are methodologically equivalent in any nontrivial sense. In order to make this claim we must compare design and descent against some specific standards. Let's now consider the specific demarcation arguments that have been erected against design. For though demarcation arguments have been discredited by philosophers of science generally, they still enjoy wide currency in the scientific and "popular world," as the following section will make abundantly clear.

Part 2: Specific Demarcation Arguments Against Design

Despite the consensus among philosophers of science that the demarcation problem is both intractable and ill-conceived, many scientists continue to invoke demarcation criteria to discredit quacks, cranks and those otherwise perceived as intellectual opponents. Yet to the average working scientist Laudan's arguments against demarcation may seem counter intuitive at best. On the surface it may appear that there ought to be some unambiguous criteria for distinguishing such dubious pursuits as parapsychology, astrology and phrenology from established sciences such as physics, chemistry and astronomy. That most philosophers of science say that there are not such criteria only confirms the suspicions many scientists have about philosophers of science. After all, don't some philosophers of science say that scientific truth is determined by social and cultural context? Don't some even deny that science describes an objective reality?

Well, as it turns out, one does not need to adopt a relativistic or antirealist view of science to accept what Laudan and others say about the demarcation problem. Indeed, the two positions are logically unrelated. Laudan is not arguing that all scientific theories have equal warrant (quite the reverse) or that scientific theories never refer to real entities. Instead, he simply says that one cannot define science in such a way as to confer automatic epistemic authority on favored theories simply because they happen to manifest features alleged to characterize all "true science." When evaluating the warrant or truth claims of theories, we cannot substitute abstractions about the nature of science for empirical evaluation.

Nevertheless, establishing Laudan's general thesis is not the main purpose of this chapter. This chapter is not seeking to establish the impossibility of demarcation in general, but the methodological equivalence of intelligent design and naturalistic descent. Since some may yet doubt that demarcation *always* fails, the following section will examine some of the specific demarcation arguments that have been deployed against design by proponents of descent. It will suggest that these arguments fail to provide any grounds for distinguishing the methodological merit of one over the other and, instead, that careful analysis of these arguments actually exposes reasons for regarding design and descent as methodologically equivalent. Indeed, the following analysis will suggest that metaphysically neutral criteria do not exist that can define science narrowly enough to disqualify theories of design *tout court* without also disqualifying theories of descent on identical grounds.

Unfortunately, to establish this conclusively would require an examination of all the demarcation arguments that have been used against design. And indeed, an examination of evolutionary polemic reveals many such arguments. Design or creationist theories have been alleged to be necessarily unscientific because they (a) do not explain by reference to natural law, (b) invoke unobservables, (c) are not testable, (d) do not make predictions, (e) are not falsifiable, (f) provide no mechanisms, (g) are not tentative, and (h) have no problem-solving capability.

Due to space constraints, a detailed analysis of only the first three arguments will be possible. Nevertheless, an extensive analysis of (a), (b) and (c) will follow. These three have been chosen because each can be found in one form or another all the way back to the *Origin of Species*. The first one, (a), is especially important because the others derive from it a point emphasized by Michael Ruse, perhaps the world's most

ardent evolutionary demarcationist. Consequently an analysis of assertion (a) will occupy the largest portion of this section. There will also be a short discussion of arguments (d), (e) and (f) and references to literature refuting (g) and (h). Thus while an exhaustive analysis of all demarcationist arguments will not be possible here, enough will be said to allow us to conclude that the principal arguments employed against design do not succeed in impugning its scientific status without either begging the question or undermining the status of descent as well.

Explanation via natural law. Now let us examine the first, and according to Michael Ruse most fundamental, of the arguments against the possibility of a scientific theory of design. This argument states: "Scientific theories must explain by natural law. Because design or creationist theories do not do so, they are necessarily unscientific."

This argument invokes one of the principal criteria of science adopted by Judge William Overton after hearing the testimony of philosopher of science Michael Ruse in the Arkansas creation-science trial of 1981-82. As recently as March 1992, Ruse has continued to assert "must explain via natural law" as a demarcation criterion, despite criticism from other philosophers of science such Philip Quinn and Larry Laudan. Ruse has argued that to adopt the scientific outlook, one must accept that the universe is subject to natural law, and further, that one must never appeal to an intervening agency as an explanation for events. Instead, one must always look to what he calls "unbroken law" if one wishes to explain things in a scientific manner.

There are several problems with this assertion and the conception of science that Ruse assumes. In particular, Ruse seems to assume a view of science that equates scientific laws with explanations. There are two problems with this view and correspondingly two main reasons that "explains via natural law" will not do as a demarcation criterion.

First, many laws are descriptive and not explanatory. Many laws describe regularities but do not explain why the regular events they describe occur. A good example of this drawn from the history of science is the universal law of gravitation, which Newton himself freely admitted did not explain but instead merely described gravitational motion. As he put it in the "General Scholium" of the second edition of the *Principia,* "I do not feign hypotheses"in other words, "I offer no explanations." Insisting that science must explain by reference to "natural law" would eliminate from the domain of the properly scientific all fundamental laws of physics that describe mathematically, but do not explain, the phenomena they "cover."

For the demarcationist this is a highly paradoxical and undesirable result, since much of the motivation for the demarcationist program derives from a desire to ensure that disciplines claiming to be scientific match the methodological rigor of the physical sciences. While this result might alleviate the "physics envy" of many a sociologist, it does nothing for demarcationists except defeat the very purpose of their enterprise.

There is a second reason that laws cannot be equated with explanations or causes. This, in turn, gives rise to another reason that science cannot be identified only with those disciplines that explain via natural law. Laws cannot be equated with explanations, not just because many laws do not explain but also because many explanations of particular events, especially in applied or historical science, may not utilize laws. While scientists may often use laws to assess or enhance the plausibility of explanations of particular events, analysis of the logical requirements of explanation has made clear that the citation of laws is not necessary to many such explanations. Instead, many explanations of particular events or facts, especially in the historical sciences, depend primarily, even exclusively, upon the specification of past causal conditions and events rather than laws to do what might be called the "explanatory work." That is, citing past causal events often explains a particular event better than, and sometimes without reference to, a law or regularity in nature.

One reason laws play little or no role in many historical explanations is that many particular events come into existence via a series of events that will not regularly reoccur. In such cases laws are not relevant to explaining the contrast between the event that has occurred and what could have or might have ordinarily

been expected to occur. For example, a historical geologist seeking to explain the unusual height of the Himalayas will cite particular antecedent factors that were present in the case of the Himalayan orogeny but were absent in other mountain-building episodes. Knowing the laws of geophysics relevant to mountain-building generally will aid the geologist very little in accounting for the contrast between the Himalayan and other orogenies, since such laws would presumably apply to all mountain-building episodes. What the geologist needs in the search for an explanation in this case is not knowledge of a general law but evidence of a unique or distinctive set of past conditions. Thus geologists have typically explained the unique height of the Himalayas by reference to the past position of the Indian and Asian land masses (and plates) and the subsequent collision that occurred between them.

The geologist's situation is very similar to that faced by historians generally. Consider the following factors that might help explain why World War I began: the ambition of Kaiser Wilhelm's generals, the Franco-Russian defense pact and the assassination of Archduke Ferdinand. Note that such possible explanatory factors invariably involve the citation of past events, conditions or actions rather than laws. Invoking past events as causes in order to explain subsequent events or present evidences is common both in history and in natural scientific disciplines such as historical geology. As Michael Scriven has shown, one can often know what caused something even when one cannot relate causes and effects to each other in formal statements of law. Similarly, William Alston has shown that laws alone often do not explain particular events even when we have them. The law "Oxygen is necessary to combustion" does not explain why a particular building burned down at a particular place and time. To explain such a particular fact requires knowing something about the situation just before the fire occurred. It does little good to know scientific laws; what one requires is information concerning, for example, the presence of an arsonist or the lack of security at the building or the absence of a sprinkler system. Thus Alston concludes that to equate a law with an explanation or cause "is to commit a 'category mistake' of the most flagrant sort."

Perhaps another example will help. If one wishes to explain why astronauts were able to fly to the moon when apples usually fall to the earth, one will not primarily cite the law of gravity. Such a law is far too general to be primarily relevant to explanation in this context, because the law allows for a vast array of possible outcomes depending on initial and boundary conditions. The law stating that all matter gravitates according to an inverse square law is consistent with both an apple falling to the earth and with an astronaut flying to the moon. Explaining why the astronaut flew when apples routinely fall, therefore, requires more than citing the law, since the law is presumed operative in both situations. Accounting for the differing outcomes the falling apple and the flying astronaut will require references to the antecedent conditions and events that differed in the two situations. Indeed, explanation in this case involves an accounting of the way engineers have used technology to alter the *conditions* affecting the astronauts to allow them to overcome the constraints that gravity ordinarily imposes on earthbound objects.

Such examples suggest that many explanations of particular events--explanations that occur frequently in fields already regarded as scientific such as cosmology, archaeology, historical geology, applied physics and chemistry, origin-of-life studies and evolutionary biology would lose their scientific status if Ruse's criterion of "explains via natural law" were accepted as normative to all scientific practice.

Consider an example from evolutionary biology that impinges directly on our discussion. Stephen Jay Gould, Mark Ridley and Michael Ruse argue that the "fact of evolution" is secure even if an adequate theory has not yet been formulated to describe or explain how large-scale biological change generally occurs. Like Darwin, modern evolutionary theorists insist that the question whether evolution did occur can be separated logically from the question of the means by which nature generally achieves biological transformations. Evolution in one sense historical continuity or common descent is asserted to be a well-established scientific theory because it alone explains a diverse class of present data (fossil progression, homology, biogeographical distribution, etc.), even if biologists cannot yet explain how evolution in another sense a general process or mechanism of change occurs. Some have likened the logical independence of common descent and natural selection to the logical independence of continental drift and plate tectonics. In both the geological situation and the biological there exist theories about *what happened* that explain why we observe many present facts, and separate theories that explain *how* things *could have* happened as they apparently did. Yet the former purely historical explanations do not require the latter

nomological or mechanistic explanations to legitimate themselves. Common descent explains some facts well, even if nothing yet explains how the transformations it requires could have occurred.

This example again illustrates why historical explanations do not require laws. More important, it also demonstrates why Ruse's demarcation criterion proves fatal to the very Darwinism he is seeking to protect. Common descent, arguably the central thesis of the *Origin of Species,* does not explain by natural law. Common descent explains by postulating a hypothetical pattern of historical events which, if actual, would account for a variety of presently observed data. Darwin himself refers to common descent as the *vera causa* (that is, the actual cause or explanation) for a diverse set of biological observations. In Darwin's historical argument for descent, as with historical explanations generally, postulated past causal events (or patterns thereof) do the primary explanatory work. Laws do not.

At this point the evolutionary demarcationist might grant the explanatory function of antecedent events but deny that scientific explanations can invoke *supernatural* events. To postulate naturally occurring past events is one thing, but to postulate supernatural events is another. The first leaves the laws of nature intact; the second does not and thus lies beyond the bounds of science. As Ruse and Richard Lewontin have argued, miraculous events are unscientific because they violate or contradict the laws of nature, thus making science impossible.

Many contemporary philosophers disagree with Ruse and Lewontin about this, as have a number of good scientists over the years Isaac Newton and Robert Boyle, for example. The action of agency (whether divine or human) need not violate the laws of nature; in most cases it merely changes the initial and boundary conditions on which the laws of nature operate. But this issue must be set aside for the moment. For now it will suffice merely to note that the criterion of demarcation has subtly shifted. No longer does the demarcationist repudiate design as unscientific because it does not "explain via natural law"; now the demarcationist rejects intelligent design because it does not "explain naturalistically." To be scientific a theory must be naturalistic.

But why is this the case? Surely the point at issue is whether there are independent and metaphysically neutral grounds for disqualifying theories that invoke nonnaturalistic events--such as instances of agency or intelligent design. To assert that such theories are not scientific because they are not naturalistic simply assumes the point at issue. Of course intelligent design is not wholly naturalistic, but why does that make it unscientific? What noncircular reason can be given for this assertion? What independent criterion of method demonstrates the inferior scientific status of a nonnaturalistic explanation? We have seen that "must explain via law" does not. What does?

Unobservables and testability. At this point evolutionary demarcationists must offer other demarcation criteria. One that appears frequently both in conversation and in print finds expression as follows: "Miracles are unscientific because they can not be studied empirically. Design invokes miraculous events; therefore design is unscientific. Moreover, since miraculous events can't be studied empirically, they can't be tested. Since scientific theories must be testable, design is, again, not scientific." Molecular biologist Fred Grinnell has argued, for example, that intelligent design can't be a scientific concept because if something "can't be measured, or counted, or photographed, it can't be science." Gerald Skoog amplifies this concern: "The claim that life is the result of a design created by an intelligent cause can not be tested and is not within the realm of science." This reasoning was recently invoked at San Francisco State University as a justification for removing Professor Dean Kenyon from his classroom. Kenyon is a biophysicist who has embraced intelligent design after years of work on chemical evolution. Some of his critics at SFSU argued that his theory fails to qualify as scientific because it refers to an unseen Designer that cannot be tested.

The essence of these arguments seems to be that the unobservable character of a designing agent renders it inaccessible to empirical investigation and thus precludes the possibility of testing any theory of design. Thus the criterion of demarcation employed here conjoins "observability and testability." Both are asserted as necessary to scientific status, and the converse of one (unobservability) is asserted to preclude the possibility of the other (testability).

It turns out, however, that both parts of this formula fail. First, observability and testability are not both necessary to scientific status, because observability at least is not necessary to scientific status, as theoretical physics has abundantly demonstrated. Many entities and events cannot be directly observed or studied in practice or in principle. The postulation of such entities is no less the product of scientific inquiry for that. Many sciences are in fact directly charged with the job of inferring the unobservable from the observable. Forces, fields, atoms, quarks, past events, mental states, subsurface geological features, molecular biological structures all are unobservables inferred from observable phenomena. Nevertheless, most are unambiguously the result of scientific inquiry.

Second, unobservability does not preclude testability: claims about unobservables are routinely tested in science indirectly against observable phenomena. That is, the existence of unobservable entities is established by testing the explanatory power that would result if a given hypothetical entity (i.e., an unobservable) were accepted as actual. This process usually involves some assessment of the established or theoretically plausible causal powers of a given unobservable entity. In any case, many scientific theories must be evaluated indirectly by comparing their explanatory power against competing hypotheses.

During the race to elucidate the structure of the genetic molecule, both a double helix and a triple helix were considered, since both could explain the photographic images produced via x-ray crystallography. While neither structure could be observed (even indirectly through a microscope), the double helix of Watson and Crick eventually won out because it could explain other observations that the triple helix could not. The inference to one unobservable stucture the double helix was accepted because it was judged to possess a greater explanatory power than its competitors with respect to a variety of relevant observations. Such attempts to infer to the best explanation, where the explanation presupposes the reality of an unobservable entity, occur frequently in many fields already regarded as scientific, including physics, geology, geophysics, molecular biology, genetics, physical chemistry, cosmology, psychology and, of course, evolutionary biology.

The prevalence of unobservables in such fields raises difficulties for defenders of descent who would use observability criteria to disqualify design. Darwinists have long defended the apparently unfalsifiable nature of their theoretical claims by reminding critics that many of the creative processes to which they refer occur at rates too slow to observe. Further, the core historical commitment of evolutionary theory that present species are related by common ancestry has an epistemological character that is very similar to many present design theories. The transitional life forms that ostensibly occupy the nodes on Darwin's branching tree of life are unobservable, just as the postulated past activity of a Designer is unobservable. Transitional life forms are theoretical postulations that make possible evolutionary accounts of present biological data. An unobservable designing agent is, similarly, postulated to explain features of life such as its information content and functional integration. Darwinian transitional, neo-Darwinian mutational events, punctuationalism's "rapid branching" events, the past action of a designing agent none of these are directly observable. With respect to direct observability, each of these theoretical entities is equivalent.

Each is roughly equivalent with respect to testability as well. Origins theories generally must make assertions about what happened in the past to cause present features of the universe (or the universe itself) to arise. They must reconstruct unobservable causal events from present clues or evidences. Positivistic methods of testing, therefore, that depend upon direct verification or repeated observation of cause-effect relationships have little relevance to origins theories, as Darwin himself understood. Though he complained repeatedly about the creationist failure to meet the *vera causa* criterion a nineteenth-century methodological principle that favored theories postulating observed causes he chafed at the application of rigid positivistic standards to his own theory. As he complained to Joseph Hooker: "I am actually weary of telling people that I do not pretend to adduce *direct* evidence of one species changing into another, but that I believe that this view in the main is correct because so many phenomena can be thus grouped and *explained"* (emphasis added).

Indeed, Darwin insisted that direct modes of testing were wholly irrelevant to evaluating theories of origins. Nevertheless, he did believe that critical tests could be achieved via indirect means. As he stated elsewhere: "This hypothesis [common descent] must be tested . . . by trying to see whether it explains several large and

independent classes of facts; such as the geological succession of organic beings, their distribution in past and present times, and their mutual affinities and homologies." For Darwin the unobservability of past events and processes did not mean that origins theories are untestable. Instead, such theories may be evaluated and tested indirectly by the assessment of their explanatory power with respect to a variety of relevant data or "classes of facts."

Nevertheless, if this is so it is difficult to see why the unobservability of a Designer would necessarily preclude the testability of such a postulation. Though Darwin would not have agreed, the basis of his methodological defense of descent seems to imply the possibility of a testable theory of design, since the past action of an unobservable agent could have empirical consequences in the present just as an unobservable genealogical connection between organisms does. Indeed, Darwin himself tacitly acknowledged the testability of design by his own attempts to expose the empirical inadequacy of competing creationist theories. Though Darwin rejected many creationist explanations as unscientific in principle, he attempted to show that others were incapable of explaining certain facts of biology. Thus sometimes he treated creationism as a serious scientific competitor lacking explanatory power; at other times he dismissed it as unscientific by definition.

Recent evolutionary demarcationists have contradicted themselves in the same way. The quotation cited earlier from Gerald Skoog ("The claim that life is the result of a design created by an intelligent cause can not be tested and is not within the realm of science") was followed in the same paragraph by the statement "Observations of the natural world also make these dicta [concerning the theory of intelligent design] suspect." Yet clearly something cannot be both untestable in principle and subject to refutation by empirical observations.

The preceding considerations suggest that neither evolutionary descent with modification nor intelligent design is ultimately untestable. Instead, both theories seem testable indirectly, as Darwin explained of descent, by a comparison of their explanatory power with that of their competitors. As Philip Kitcher no friend of creationism has acknowledged, the presence of unobservable elements in theories, even ones involving an unobservable Designer, does not mean that such theories cannot be evaluated empirically. He writes, "Even postulating an unobserved Creator need be no more unscientific than postulating unobserved particles. What matters is the character of the proposals and the ways in which they are articulated and defended."

Thus an unexpected equivalence emerges when design and descent are evaluated against their ability to meet specific demarcation criteria. The demand that the theoretical entities necessary to origins theories must be directly observable if they are to be considered testable and scientific would, if applied universally and disinterestedly, require the exclusion not only of design but also of descent. Those who insist on the joint criteria of observability and testability, conceived in a positivistic sense, promulgate a definition of correct science that evolutionary theory manifestly cannot meet. If, however, a less severe standard of testability is allowed, the original reason for excluding design evaporates. Here an analysis of specific attempts to apply demarcation criteria against design actually demonstrates a methodological equivalence between design and descent.

Other demarcation criteria. I claim that a similar equivalence between design and descent will emerge from an analysis of each of the other criteria (d) through (h)listed above. Falsification, for example, in addition to the problems mentioned in part one, seems an especially problematic standard to apply to origins theories. So does prediction. Origins theories must necessarily offer *ex post facto* reconstructions. They therefore do not make predictions in any strong sense. The somewhat artificial "predictions" that origins theories do make about, for example, what evidence one ought to find if a given theory is true are singularly difficult to falsify since, as evolutionary paleontologists often explain, "the absence of evidence is no evidence of absence."

Similarly, the requirement that a scientific theory must provide a causal mechanism fails to provide a metaphysically neutral standard of demarcation for several reasons. First, as we have already noted, many theories in science are not mechanistic theories. Many theories that explicate what regularly happens in

nature either do not or need not explain why those phenomena occur mechanically. Newton's universal law of gravitation was no less a scientific theory because Newton failed indeed refused to postulate a mechanistic cause for the regular pattern of attraction his law described. Also, as noted earlier, many historical theories about *what* happened in the past may stand on their own without any mechanistic theory about *how* the events to which such theories attest could have occurred. The theory of common descent is generally regarded as a scientific theory even though scientists have not agreed on a completely adequate mechanism to explain how transmutation between lines of descent can be achieved. In the same way, there seems little justification for asserting that the theory of continental drift became scientific only after the advent of plate tectonics. While the mechanism provided by plate tectonics certainly helped render continental drift a more persuasive theory, it was nevertheless not strictly necessary to know the mechanism by which continental drift *occurs* (1) to know or theorize that drift *had occurred* or (2) to regard the continental drift theory as scientific.

Yet one might concede that causal mechanisms are not required in all scientific contexts, but deny that origins research is such a context. One might argue that since origins theories necessarily attempt to offer causal explanations, and since design admittedly attempts to explain the origin of life or major taxonomic groups, its failure to offer a mechanism disqualifies it as an adequate theory of origins.

But this argument has difficulties as well. First, an advocate of design could concede that his theory does not provide a complete causal explanation of how life originated without forfeiting scientific status for the theory. Present clues and evidences might convince some scientists *that* intelligence played a causal role in the design of life, without those same scientists' knowing exactly *how* mind exerts its influence over matter. All that would follow in such a case is that design is an incomplete theory, not that it is an unscientific one (or even an unwarranted one). And such incompleteness is not unique to design theories. Both biological (as just discussed) and chemical evolutionary theories have often provided less than completely adequate causal scenarios. Indeed, most scientific theories of origin are causally incomplete or inadequate in some way.

In any case, asserting mechanism as necessary to the scientific status of origins theories begs the question. In particular, it assumes without justification that all scientifically acceptable causes are *mechanistic* causes. To insist that all causal explanations in science must be mechanistic is to insist that all causal theories must refer only to material entities (or their energetic equivalents). Yet this requirement is merely another expression of the very naturalism whose methodological necessity has been asserted because of ostensibly compelling demarcation arguments. Insofar as the statement "All scientific theories must be mechanistic" *is* a demarcation argument, this requirement is evidently circular. Science, the demarcationist claims, must be mechanistic because it must be naturalistic; it must be naturalistic because otherwise it would violate demarcation standards in particular, the standard that all scientific theories must be mechanistic.

This argument clearly assumes the point at issue, which is whether or not there are independent that is, metaphysically neutral reasons for preferring exclusively materialistic causal explanations of origins over explanations that invoke putatively immaterial entities such as creative intelligence, mind, mental action, divine action or intelligent design. While philosophical naturalists may not regard the foregoing as real or (if real) immaterial, they certainly cannot deny that such entities could function as causal antecedents if they were.

Thus we return to the central question: What noncircular reason can be offered for prohibiting the postulation of nonmechanistic (e.g., mental or intelligent) causes in scientific origins theories? Simply asserting that such entities may not be considered, whatever the empirical justification for their postulation, clearly does not constitute a justification for an exclusively naturalistic definition of science. Theoretically there are at least two possible types of causes: mechanistic and intelligent. The demarcationist has yet to offer a noncircular reason for excluding the latter type.

Part 3: The Methodological Character of Historical Science

Let us now turn to a more fundamental reason for the methodological equivalence of design and descent. As stated earlier, the equivalence of design and descent follows from an understanding of the distinctive logical and methodological character of the historical sciences. An examination of scientific disciplines concerned with past events and causes, such as evolutionary biology, historical geology and archaeology, reveals a distinctive pattern of inquiry that contrasts markedly with nonhistorical sciences such as branches of chemistry, physics or biology that are concerned primarily with the discovery and explication of general phenomena. This section will show that both design and descent do, or could, instantiate this distinctive historical pattern of scientific investigation. In other words, a fundamental methodological equivalence between design and descent derives from a common concern with history--that is, with historical questions, historical inferences and historical explanations.

We can see this historical concern first by looking at why the demarcation arguments analyzed earlier fail. Consider, for example, the assertion that to be scientific one must explain by reference to natural law. To insist that "science must explain by natural law" betrays much confusion about the alleged universality of explanation in science, about the necessary role of laws in explanations and about the distinction between laws and causes. But fundamentally this demarcation criterion fails to do the work required of it by evolutionary writers because it ignores that some scientific disciplines ("historical" according to my lexicon) seek to explain events or data not primarily by reference to laws but by reference to past causal events or sequences of events what might be called "causal histories." Since natural laws are not necessary to such activity, the demarcation criterion "must explain by natural law" can't be used to distinguish between two competing programs of historical scientific research, whether evolutionary or otherwise.

Next consider the idea that scientific theories must not postulate unverifiable or unobservable entities. Certainly this criterion is untenable in light of many fields, not the least of which is modern physics. Yet it is completely irrelevant to historical study almost in principle. All historical theories depend on what C. S. Peirce called "abductive inferences." Such inferences frequently posit unobservable past events in order to explain present phenomena,facts or clues. Making a claim about history nearly always involves postulating,invoking, or inferring an unobservable event or entity that cannot be studied directly. The attempt to distinguish the methodological merit of competing origins theories on the basis of unobservables therefore seems quite misguided and futile.

Finally, consider the claim that to be scientific a theory must be testable. As we saw above, neither design nor descent can meet standards of testability that require strict verifiability. I have also emphasized that neither can meet standards of testability that depend on notions of repeatability. Yet both can meet alternate standards of testability, such as inference to the best explanation or "consilience," that involve notions of comparative explanatory power. This equivalence was suggested again from the historical nature of the claims that design and evolutionary theorists make. Like other historical theorists, both make claims about events they believe occurred in the past that cannot be directly verified and may never recur. Yet like other historical theories, these theories can be tested after the fact by reference to their comparative explanatory power. To impose stricter standards ignores the limitations inherent in all historical inquiry and thus again fails to provide grounds for distinguishing the status of competing historical or origins theories.

So the evolutionary demarcation arguments above seem to fail in part because they attempt to impose (as normative) criteria of method that ignore the historical character of origins research. Indeed, each one of the demarcationist arguments listed above fails because it overlooks a specific characteristic of the historical sciences. But what are these characteristics? And could *they* provide grounds for distinguishing the scientific, or at least methodological, status of design and descent?

The nature of historical science. Answering these questions will require briefly summarizing the results of my doctoral research on the logical and methodological features of the historical sciences. Through that research I have identified three general features of historical scientific disciplines. These features derive from a concern to reconstruct the past and to explain the present by reference to the past. They distinguish disciplines motivated by historical concerns from disciplines motivated by a concern to discover, classify or explain unchanging laws and properties of nature. These latter disciplines may be called "inductive" or "nomological" (from the Greek word *nomos,* for law); the former type may be called "historical." I contend

that historical sciences generally can be distinguished from nonhistorical scientific disciplines by virtue of the three following features:

1. The historical interest or questions motivating their practitioners: Those in the historical sciences generally seek to answer questions of the form "What happened?" or "What caused this event or that natural feature to arise?" On the other hand, those in the nomological or inductive sciences generally address questions of the form "How does nature normally operate or function?"
2. The distinctively historical types of inference used: The historical sciences use inferences with a distinctive logical form. Unlike many nonhistorical disciplines, which typically attempt to infer generalizations or laws from particular facts, historical sciences make what C. S. Peirce has called "abductive inferences" in order to infer a past event from a present fact or clue. These inferences have also been called "retrodictive" because they are temporally asymmetric that is, they seek to reconstruct past conditions or causes from present facts or clues. For example, detectives use abductive or retrodictive inferences to reconstruct the circumstances of a crime after the fact. In so doing they function as historical scientists. As Gould has put it, the historical scientist proceeds by "inferring history from its results."
3. The distinctively historical types of explanations used: In the historical sciences one finds causal explanations of particular events, not nomological descriptions or theories of general phenomena. In historical explanations, past causal events, not laws, do the primary explanatory work. The explanations cited earlier of the Himalayan orogeny and the beginning of World War I exemplify such historical explanations.

   In addition, the historical sciences share with many other types of science a fourth feature.
4. Indirect methods of testing such as inference to the best explanation: As discussed earlier, many disciplines cannot test theories by direct observation, prediction or repeated experiment. Instead, testing must be done indirectly through comparison of the explanatory power of competing theories.

Descent as historical science. Enough has been said previously--about the function of common descent as an explanatory causal history, the retrodictive character of Darwin's inference of common descent and his use of indirect methods of theory evaluation--to suggest that evolutionary research programs conform closely to the general methodological pattern of the historical sciences. But a few additional observations may make this connection more explicit.

With respect to the first characteristic of historical science enumerated above (historical motive or purpose), Darwin clearly was motivated by such a purpose. One of Darwin's primary goals in the *Origin of Species* was to establish a historical pointnamely, that species had not originated independently but had derived via transmutation from one or very few common ancestors. Indeed, Darwin sought to show that the history of life resembled a single, continuous branching tree, with the first and simplest living forms represented by the base of a tree and the great diversity of more complex forms, both past and present, represented by the connecting branches. This picture of biological history contrasted markedly with that of his creationist opponents, who envisioned the history of life as an array of parallel (nonconvergent) lines of descent. Darwin's (perhaps primary) purpose in the *Origin of Species* was to argue for this continuous view of life's history as opposed to the discontinuous view favored by his creationist opponents.

Thus he would repeatedly explicate his priorities in such a way as to show the primacy of his concern to demonstrate the historical thesis of common descent, even over his concern to establish the efficacy of his proposed mechanism, natural selection. He himself tells us what he had in mind: "I had two distinct objects in view; *firstly* to shew that species had not been separately created [i.e., that they had evolved from common ancestors], and *second,* that natural selection had been the chief agent of change" (emphasis added).

Similarly, at the close of his chapter 13 Darwin states the priorities of his argument by concluding: "The several classes of facts which have been considered . . . proclaim so plainly that the innumerable species,

genera, and families with which the world is peopled are all *descended* . . . from common parents and have been modified in the course of descent, that I should without hesitation adopt this view, *even if* it were unsupported by other facts or arguments" (emphasis added).

Not only was Darwin motivated by a historical purpose, but he also used (concerning feature 2 above) a characteristically historical mode of reasoning. As Gould has argued so persuasively, Darwin used historical inferences. Beginning in the middle of his chapter on the "Geological Succession of Organic Beings" and continuing through his next three chapters, Darwin offered a series of arguments to support his historical claim of common descent. These arguments are instances of retrodictive or abductive reasoning. In each case, extant evidence from the fossil record, comparative anatomy, embryology and biogeography were used as clues from which to infer a pattern of past biohistorical events. Notice, for example, the language Darwin uses in his argument from vestigial structures: "Rudimentary organs may be compared with the letters in a word, still retained in the spelling but become useless in the pronunciation, but *which serve as a clue in seeking for its derivation."*

Notice, too, the temporally asymmetric character of each of the inferences he employs: "The several *classes of facts* which have been considered . . . proclaim so plainly that the innumerable species, genera, and families with which the world is peopled are all *descended,* each within its own class or group, *from common parents.*" As Gould has written, Darwin used a method of "inferring history from its results."

Darwin not only inferred an historical past, but (with respect to feature 3 above) he also formulated historical explanations. Indeed, a reciprocal relationship exists between historical inferences and explanations. Historical scientists will often seek to infer causal antecedents that, if true, would explain the widest class of relevant data. The causal past inferred on the basis of its potential to explain will often serve, when accepted, as an explanation. Darwin repeatedly argued that the supposition that all organisms descended from common parents should be accepted because it "explains several large and independent classes of facts." Moreover, common descent (and the past events implied by it) served as a *causal* explanation for Darwin. He refers to "propinquity of descent" as *"the only known cause* of the similarity of organic beings." Elsewhere he refers to common descent or "propinquity of descent" as the *vera causa* (or true cause) of organic similarity. By inferring descent as a past cause, Darwin constructed a historical explanation in which a pattern of past events did the primary explanatory work in relation to the facts of biogeography, fossil progression, homology and so on. As Gould has put it, the *Origin of Species* makes "the claim that *history* stands as the coordinating reason for relationships among organisms."

The explanatory function of antecedent events and causal histories is perhaps even more readily apparent in the work of many chemical evolutionary theorists. Alexander Oparin, Russian scientist and father of modern origin-of-life research, formulated detailed causal histories involving a sequence of hypothetical past events to explain how life emerged in its present form. The formulation of these "scenarios," as they are called in origin-of-life biology, has remained an important part of origin-of-life studies to the present. Thus evolutionary biologists employ not only historical inferences but also historical explanations in which past causal events, or patterns thereof, serve to explain the origin of present facts.

As already discussed, Darwin also (with respect to feature 4 above) employed a method of indirect testing of his theory by assessing its relative explanatory power. Recall his statement that "this hypothesis [i.e., common descent] must be tested . . . by trying to see whether it explains several large and independent classes of facts" He makes this indirect and comparative method of testing even more explicit in a letter to Asa Gray:

> I . . . test this hypothesis [common descent] by comparison with as many general and pretty well-established propositions as I can find--in geographical distribution, geological history, affinities &c., &c. And it seems to me that, *supposing* that such a hypothesis were to explain such general propositions, we ought, in accordance with the common way of following all sciences, to admit it till some *better* hypothesis be found out. (emphasis added)

Design as historical science. The foregoing suggests that evolutionary biology, or at least Darwin's version of it, does conform to the pattern of inquiry described above as historically scientific. To show that design and descent are methodologically equivalent with respect to the historical mode of inquiry outlined above, it now remains to show that a design argument or theory could exemplify this same historical pattern of inquiry.

In the case of feature 1 this equivalence is quite obvious. As just noted, a clear logical distinction exists between questions of the form "How does nature normally operate or function?" and those of the form "How did this or that natural feature arise?" or "What caused this or that event to occur?" Those who postulate the past activity of an intelligent Designer do so as an answer, or partial answer, to questions of the latter historical type. Whatever the evidential merits or liabilities of design theories, such theories undoubtedly represent attempts to answer questions about what caused certain features in the natural world to come into existence. With respect to an interest in origins questions, design and descent are clearly equivalent.

Design and descent are also equivalent with respect to feature 2. Inferences to intelligent design are clearly abductive and retrodictive. They seek to infer a past unobservable cause (an instance of creative mental action or agency) from present facts or clues in the natural world such as the information content of DNA, the functional coadaptation of biomolecules, the sudden appearance of a new form in the fossil record, the uniqueness of human language and the hierarchical organization of biological systems. Moreover, just as Darwin sought to strengthen the retrodictive inferences that he made by showing that many facts or classes of facts could be explained on the supposition of descent, so too may proponents of design seek to muster a wide variety of clues to demonstrate the explanatory power of their theory. In the second half of this volume, for example, evidence from at least four distinct domains of the natural world will be cited to demonstrate the explanatory power (or "consilience") of the design inference.

With respect to feature 3, design inferences, once made, may also serve as causal explanations. The same reciprocal relationship between inference and explanation that exists in arguments for descent can exist in arguments for design. Thus, as noted, an inference to intelligent design may gain support because it could, if accepted, explain many diverse classes of facts. Clearly, once adopted it will provide corresponding explanatory resources. Moreover, theories of design involving the special creative act of an agent conceptualize that act as a causal event, albeit involving mental rather than purely physical antecedents. Indeed, design theories--whether posited by young-earth Genesis literalists, old-earth progressive creationists, theistic macromutationalists or religiously agnostic biologists--refer to antecedent causal events or express some kind of causal scenario just as, for example, chemical evolutionary theories do. As a matter of method, advocates of design and descent alike seek to postulate antecedent causal events or event scenarios in order to explain the origin of present phenomena. With respect to feature 3, design and descent again appear methodologically equivalent.

Much has already been said to suggest that with respect to feature 4 design may be tested indirectly in the same way as descent. Certainly, advocates of design may seek to test their ideas as Darwin did--against a wide class of relevant facts and by comparing the explanatory power of their hypotheses against competitors'. Indeed, many biologists who favor design now make their case for it on the basis of its ability to explain the same evidences that descent can as well as some that descent allegedly cannot (such as the presence of sequentially encoded information in DNA).

Thus design and descent again seem methodologically equivalent. Both seek to answer characteristically historical questions, both rely upon abductive inferences, both postulate antecedent causal events or scenarios as explanations of present data, and both are tested indirectly by comparing their explanatory power against that of competing theories.

A theory of everything? Yet before one is willing to concede this methodological equivalence, one might demand to know that design can really function as a valid explanation without trivializing scientific inquiry. The perennial worry about allowing theories of design, of course, concerns not their explanatory power but the inability to constrain that power. This concern lies behind some secular scientists' worry that

a theory of design would leave them nothing to do, since presumably the phrase "God did it" could be invoked as the answer to every scientific question. As David Hull wrote recently, "Scientists have no choice [but to define science as totally naturalistic]. Once they allow reference to God or miraculous forces to explain the first origin of life or the evolution of the human species, they have no way of limiting this sort of explanation." This worry also finds expression in the familiar theistic worry about embarrassing "God-of-the-gaps" arguments, as J. P. Moreland pointed out in chapter one. So both theists and secularists may worry: "If design is allowed as a (historically) scientific theory, couldn't it be invoked at every turn as a theoretical panacea, stultifying inquiry as it goes? Might not design become a refuge for the intellectually lazy who have refused to study what nature actually does?"

Well, of course it might. But so might the incantation "Evolution accomplished *X.*" Nevertheless, design need not stultify inquiry, nor can it be offered appropriately in every context as a theoretical panacea. The distinction between the historical sciences and the nomological or inductive sciences helps to explain why. Indeed, it helps to show how design can be both legitimated (as a possible historical explanation) and at the same time constrained or even prohibited, depending on the context of inquiry. In other words, the distinction between the historical and the nomological helps to show why the past action of an intelligent agent may serve as a legitimate explanation in the historical sciences, whereas it would not in many nonhistorical scientific contexts.

When a research program concentrates on questions of how nature normally (unassisted by the special activity of agency) operates, any reference to agency (whether divine or human) becomes inappropriate because it fails to address the question motivating the inquiry. A geologist who inquires about the stress-strain relationship of a particular type of rock at various temperatures will rightly regard the postulation of God's creative activity (or, for that matter, a corresponding evolutionary scenario) as irrelevant to her inquiry. As noted above, nomological or inductive scientific endeavor typically seeks to infer or explain general nomological relations (i.e., scientific laws), whereas historical sciences typically infer past causal events. To propose the action of agency (as an event in space and time) when a law is required simply misses the context and character of nomological inquiry. Neither divine nor human action qualifies as a law. To offer either when a law is sought is syntactically inappropriate. To offer "God did it" as an answer to a question such as "How does weightlessness generally affect crystal growth?" clearly misses the point of the question. The answer does not so much violate the rules of science as the rules of grammar. Such an answer not only stultifies inquiry but misses the point of such inquiry altogether.

It does not follow, however, that references to agency are necessarily inappropriate when we are reconstructing a causal history that is, when we are attempting to answer questions about how a particular feature in the natural world (or the universe itself) arose. In the first place, classical examples of inappropriate postulations of divine activity (God-of-the-gaps arguments) occur almost exclusively in the inductive or nomological sciences, as Newton's ill-fated use of agency to provide a more accurate description of planetary motion suggests. Second, many fields of inquiry routinely invoke the action of agents to account for the origin of features or events within the natural world. Forensic science, history and archaeology, for example, all sometimes postulate the past activity of human agents to account for the emergence of particular objects or events. Several such fields suggest a clear precedent for inferring the past causal activity of intelligent agents within the historical sciences. Imagine the absurdity of someone's claiming that scientific method had been violated by the archaeologist who first inferred that French cave paintings had been produced by human beings rather than by natural forces such as wind and erosion.

There is another, more fundamental reason that postulating the past action of agency can be appropriate in the historical sciences. That again has to do with the nature of historical explanations. As already noted, historical explanations require the postulation of antecedent causal events; they do not seek to infer laws. To offer past agency as part of a historical explanation is therefore logically and syntactically appropriate. The type of theoretical entity provided--a past causal event--corresponds to the type required by historical explanations. Simply put, past agency is a causal event. Agency, therefore, whether seen or unseen, may serve as a logically and syntactically appropriate theoretical entity in a historical explanation, even if it could not do so in a nomological or inductive theory. Mental action may be a cause, even if it is certainly not a law.

In any case, postulations of design are constrained by background knowledge about the causal powers and proclivities of both nature and agency. In addition to the features of historical explanation mentioned already, successful historical explanations (as I have discussed elsewhere) must usually meet independent criteria of causal adequacy. This criterion, which seems to function normatively in much historical scientific practice, expresses the idea that postulated causal antecedents should generally be known to be capable of producing the relevant *explanandum*--that is, the event or object requiring explanation. In other words, before a cause can be postulated to have been present in the past, one should know that some causal precedent (which is not the same thing as knowing a law) exists for believing the cause capable of producing the effect of interest. Intelligent design can be offered, therefore, as a necessary or best causal explanation only when naturalistic processes seem incapable of producing the *explanandum* effect, and when intelligence is known to be capable of producing it and thought to be more likely to have produced it. Thus modern scientific advocates of design such as Charles Thaxton or Walter Bradley (see their chapter in this present volume) insist that they postulate antecedent intelligent activity not because of what we do not know but because of what we *do* know about what is and is not capable of producing coded information. Conversely, there are many effects that do not, based on our present background knowledge of causal powers, suggest design as a necessary, best or most likely historical explanation.

Postulations of design are constrained in yet another way. There are many particular events, even in history, for which design could not be considered the best or most likely explanation. The reason for this is that postulations of intelligent design are constrained by background assumptions about the proclivities of potential designing agents, both human and divine. Most biblical theists, for example, assume that God acts in at least two ways: (1) through the natural regularities or laws that he upholds and sustains through his invisible power and (2) through more dramatic, discernible and discrete actions at particular points in time. Because theists assume that the second mode of divine action is by far the rarer and usually associated with the accomplishment of some particular divine purpose on behalf of human beings (e.g., creation or redemption), they assume that divine action of the second variety will be unlikely as an explanation of most particular events. In philosophical terms, theists generally approach their study of nature with a set of background assumptions that would lead them to regard most hypotheses of divine action as unlikely, though not completely impossible. Theism itself constrains design inferences. Thus theistic background assumptions would generally allow consideration of special divine action as the best or most likely explanation for a particular event only when it seemed empirically warranted *and theologically plausible.* Nevertheless, given a biblical (though not necessarily literalist) understanding of creation and sufficient empirical justification, there is no reason to believe that both these conditions could not be met in some cases, as with, for example, explanations of the origin of life, human consciousness and the universe.

The above considerations suggest that allowing the design hypothesis as the best explanation for some events in the history of the cosmos will not cause science to grind to a halt. While design does have the required logical and syntactic features of some scientific (i.e., historical) explanations, it cannot be invoked appropriately in all scientific contexts. Furthermore, because effective postulations of design are constrained by empirical considerations of causal precedence and adequacy and by extraevidential considerations such as simplicity and theological plausibility, concerns about design theory functioning as a "theory of everything" or "providing cover for ignorance" or "putting scientists out of work" can be shown to be largely unfounded. Many important scientific questions would remain to be answered if one adopted a theory of design. Indeed, *all* questions about how nature normally operates without the special assistance of agency remain unaffected by whatever view of origins one adopts. And that, perhaps, is yet another equivalence between design and descent.

Conclusion: Toward a Scientific Theory of Creation

So what should we make of these methodological equivalencies? Can there be a scientific theory of intelligent design? At the very least it seems we can conclude that we have not yet encountered any good in principle reason to *exclude* design from science. Design seems to be just as scientific (or unscientific) as its evolutionary competitors when judged according to the methodological criteria examined above. Moreover, if the antidemarcationists are correct, our lack of universal demarcation criteria implies there cannot be a negative a priori case against the scientific status of design--precisely because there is not an agreed

standard as to what constitutes the properly scientific. To say that some discipline or activity qualifies as scientific is to imply the existence of a standard by which the scientific status of an activity or discipline can be assessed or adjudicated. If no such standard presently exists, then nothing positive (or negative) can be said about the scientific status of intelligent design (or any other theory for that matter).

But there is another approach that can be taken to the question. If (1) there exists a distinctively historical pattern of inquiry, and (2) a program of origins research committed to design theory could or does instantiate that pattern, and (3) many other fields such as evolutionary biology also instantiate that pattern, and (4) these other fields are already regarded by convention as science, there can be a very legitimate if convention-dependent sense in which design may be considered scientific. In other words, the conjunction of the methodological equivalence of design and descent and the existence of a convention that regards descent as scientific implies that design should by that same convention be regarded as scientific too. Thus, one might quite legitimately say that both design and descent are historically scientific research programs, since they instantiate the same pattern of inquiry.

Perhaps, however, one just really does not want to call intelligent design a scientific theory. Perhaps one prefers the designation "quasi-scientific historical speculation with strong metaphysical overtones." Fine. Call it what you will, provided the same appellation is applied to other forms of inquiry that have the same methodological and logical character and limitations. In particular, make sure both design and descent are called "quasi-scientific historical speculation with strong metaphysical overtones."

This may seem all very pointless, but that in a way is just the point. As Laudan has argued, the question whether a theory is scientific is really a red herring. What we want to know is not whether a theory is scientific but whether a theory is true or false, well confirmed or not, worthy of our belief or not. One can not decide the truth of a theory or the warrant for believing a theory to be true by applying a set of abstract criteria that purport to tell in advance how all good scientific theories are constructed or what they will in general look like.

Against method? Now none of the above should be construed to imply that methodology does not matter. The purpose of this essay is not to argue, as Paul Feyerabend does, against method. Methodological standards in science can be important for guiding future inquiry along paths that have been successful in the past. The uniformitarian and/or actualistic method in the historical sciences, for example, has proved a very helpful guide to reconstructing the past, even if it can't be used as demarcation between science and pseudoscience, and even if some theories constructed according to its guidelines turn out to be false.

Standards of method may also express some minimal logical and epistemic conditions of success--for example, the conditions related to causal explanation. Successful causal explanations must as a condition of logical sufficiency cite more than just a necessary condition of a given outcome. To explain why a given explosion occurred, it will not suffice to note that oxygen was present in the atmosphere; nor can the death of a patient be explained simply by citing the patient's birth, though clearly birth is necessary to death. These cases illustrate how methodological guidelines (whether tacit or explicit) can help eliminate certain (in this case logically) inadequate hypotheses, even if such guidelines cannot be used to define science exhaustively. Methodological anarchism need not result from a rejection of methodological demarcation arguments.

Nevertheless, following methodological criteria and recipes (of any of the preceding types) does not guarantee theoretical success; nor, again, can such recipes be used to define science exhaustively, if for no other reason than the variety of scientific methods that exist. Moreover, methodological recipes can sometimes become fatal to the success of inquiry if they so dictate the content of acceptable theorizing that they automatically eliminate empirically and logically possible explanations or theories.

And this, I believe, has occurred within origins research. The deployment of flawed or metaphysically tendentious demarcation arguments against legitimate theoretical contenders has produced an unjustified confidence in the epistemic standing of much evolutionary dogma, including "the fact of evolution" defined

as common descent. If competing hypotheses are eliminated before they are evaluated, remaining theories may acquire an undeserved dominance.

So the question isn't whether there can be a scientific theory of design or creation. The question is whether design should be considered as a competing hypothesis alongside descent in serious origins research (call it what you will). Once issues of demarcation are firmly behind us, understood as the red herrings they are, the answer to this question *must* clearly be yes that is, if origins biology is to have standing as a fully rational enterprise, rather than just a game played according to rules convenient to philosophical materialists.

Naturalism: the only game in town? G. K. Chesterton once said that "behind every double standard lies a single hidden agenda." Advocates of descent have used demarcation arguments to erect double standards against design, suggesting that the real methodological criterion they have in mind is naturalism. Of course for many the equation of science with the strictly materialistic or naturalistic is not at all a hidden agenda. Scientists generally treat "naturalistic" as perhaps the most important feature of their enterprise. Clearly, if naturalism is regarded as a necessary feature of all scientific hypotheses, then design will not be considered a scientific hypothesis.

But must all scientific hypotheses be entirely naturalistic? Must scientific origins theories, in particular, limit themselves to materialistic causes? Thus far none of the arguments advanced in support of a naturalistic definition of science has provided a noncircular justification for such a limitation. Nevertheless, perhaps such arguments are irrelevant. Perhaps scientists should just accept the definition of science that has come down to them. After all, the search for natural causes has served science well. What harm can come from continuing with the status quo? What compelling reasons can be offered for overturning the prohibition against nonnaturalistic explanation in science?

In fact, there are several. First, with respect to origins, defining science as a strictly naturalistic enterprise is metaphysically gratuitous. Consider: It is at least logically possible that a personal agent existed before the appearance of the first life on earth. Further, as Bill Dembski argues in the next chapter, we do live in the sort of world where knowledge of such an agent could possibly be known or inferred from empirical data. This suggests that it is logically and empirically possible that such an agent (whether divine or otherwise) designed or influenced the origin of life on earth. To insist that postulations of past agency are inherently unscientific in the historical sciences (where the express purpose of such inquiry is to determine what happened in the past) suggests we know that no personal agent could have existed prior to humans. Not only is such an assumption intrinsically unverifiable, it seems entirely gratuitous in the absence of some noncircular account of why science should presuppose metaphysical naturalism.

Second, to exclude by assumption a logically and empirically possible answer to the question motivating historical science seems intellectually and theoretically limiting, especially since no equivalent prohibition exists on the possible nomological relationships that scientists may postulate in nonhistorical sciences. The (historical) question that must be asked about biological origins is not "Which materialistic scenario will prove most adequate?" but "How did life as we know it actually arise on earth?" Since one of the logically and syntactically appropriate answers to this later question is "Life was designed by an intelligent agent that existed before the advent of humans," it seems rationally stultifying to exclude the design hypothesis without a consideration of all the evidence, including the most current evidence, that might support it.

The a priori exclusion of design diminishes the rationality or origins research in another way. Recent nonpositivistic accounts of scientific rationality suggest that scientific theory evaluation is an inherently comparative enterprise. Notions such as consilience and Peter Lipton's inference to the best explanation discussed above imply the need to compare the explanatory power of competing hypotheses or theories. If this process is subverted by philosophical gerrymandering, the rationality of scientific practise is vitiated. Theories that gain acceptance in artificially constrained competitions can claim to be neither "most probably true" nor "most empirically adequate." Instead such theories can only be considered "most probable or adequate among an artificially limited set of options."

Moreover, where origins are concerned only a limited number of basic research programs are logically possible. (Either brute matter has the capability to arrange itself into higher levels of complexity or it does not. If it does not, then either some external agency has assisted the arrangement of matter or matter has always possessed its present arrangement.) The exclusion of one of the logically possible programs of origins research by assumption, therefore, seriously diminishes the significance of any claim to theoretical superiority by advocates of a remaining program. As Phillip Johnson has argued, the use of "methodological rules" to protect Darwinism from theoretical challenge has produced a situation in which Darwinist claims must be regarded as little more than tautologies expressing the deductive consequences of methodological naturalism.

An openness to empirical arguments for design is therefore a necessary condition of a fully rational historical biology. A rational historical biology must not only address the question "Which materialistic or naturalistic evolutionary scenario provides the most adequate explanation of biological complexity?" but also the question "Does a strictly materialistic evolutionary scenario or one involving intelligent agency or some other theory best explain the origin of biological complexity, given all relevant evidence?" To insist otherwise is to insist that materialism holds a metaphysically privileged position. Since there seems no reason to concede that assumption, I see no reason to concede that origins theories must be strictly naturalistic.

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