CONTROVERSY

Darwinism Versus Intelligent Design

David Berlinski & Critics

PAUL R. GROSS:

Congratulations are in order. In his latest COMMENTARY essay on "Darwinism"—as it is often called by those who do not know much evolutionary biology—David Berlinski seems to have reversed himself ["Has Darwin Met His Match?," December 2002]. He is now critical of the effort to rehabilitate the ancient "argument from design," these days holiday-wrapped as "intelligent-design theory." This change of mind is all the more praiseworthy because Mr. Berlinski is not only the author of "The Deniable Darwin" (COMMENTARY, June 1996) but, according to his current author's note, closely associated with the Discovery Institute, the conservative Christian think tank that serves as the primary promoter of "intelligent design."

The manner of Mr. Berlinski's dismissal is less creditable, however. His argument might be paraphrased as follows: intelligent design has failed, evolutionary biology has failed, and therefore nobody has a plausible scientific explanation for the diversity of life on earth. This is absurd.

The reasons Mr. Berlinski gives for the failure of intelligent-design theory have all been given before—in the professional literature, in the introductory biology courses of all decent colleges, in half a dozen very recent specialist books, on fifty flourishing scientific websites. However well intelligent-design apologetics is doing as politics, there is nothing new about its abject failure as science.

On the other hand, none of the reasons Mr. Berlinski hints at for rejecting "Darwinism" stand up. They are the familiar creationist pabulum, supposedly demonstrating the grand flaws and gaps in evolutionary biology. But these arguments, too, have been addressed in the professional literature, in tens of thousands of papers, and in dozens of excellent, best-selling popular science books—and they have been soundly refuted. Unfortunately, a non-biologist reader of "Has Darwin Met His Match?," innocent of this vast body of knowledge, will have no notion of its content or even, perhaps, of its existence, and may therefore take Mr. Berlinski's assertions as true as well as deep, which they are not.

Mr. Berlinski says that the argument from design has been taken up again in evolutionary biology and mathematical physics. This, if true, would give it some scientific seriousness. But it is not true. There is not one publication in recent biological journals, out of the tens of thousands of articles published annually—a huge subset of them devoted specifically to evolution—that undertakes to rehabilitate the argument from design. None of the intelligent-design "theorists" mentioned in his essay has ever published the claim in an original article in a regular, refereed biological journal. Nor, of course, has Mr. Berlinski himself done so.

As for William Dembski's lucubrations on chance and probability—which even Mr. Berlinski now finds flawed—I know of no professional publications (other than Dembski's own books and his frenetic responses to critics) that treat them as of interest for mathematical physics. There are, however, a dozen point-by-point refutations of those claims, many of them available on the Internet, by well-known physicists, philosophers, mathematicians, and biologists.

University of Virginia
Charlottesville, Virginia

MARK PERAKH:

What is perhaps most amusing about David Berlinski's article is his apparent change of mind on the subject of intelligent design. Having supplied rave blurbs to the books of such prominent advocates of this "theory" as William Dembski and Michael Behe, he now casts doubt on the concepts they promote. What explains this new view? The advocates of intelligent design are anxious to be taken seriously as scientists. From their standpoint, it may seem to be a step forward that Mr. Berlinski gives their ideas a status equal to that of Darwinism, even if only by casting doubts on both equally.

The list of unsubstantiated assertions in Mr. Berlinski's paper is long. Though enviably eloquent, it adds nothing to the debate other than to try to put the failed hypothesis of intelligent design on a par with genuine science.

Bonsall, California

JASON ROSENHOUSE:

David Berlinski's arguments against intelligent-design theory suffer only from a lack of originality; critics have been making the same points for years. Still, he gives a good picture of why most scientists find this field unpromising.

Mr. Berlinski's ongoing antipathy to mainstream biology, by contrast, is based on a caricature. Blubbering about gaps in the fossil record cannot change the fact that, with millions of fossils collected and classified, not one is out of place from a Darwinian standpoint. Also, Darwinism requires continuity at the level of the genotype, not the phenotype. And while it is true that information is independent of the medium containing it, there is nothing mysterious about the idea that changing the medium can alter the information. Genes do mutate, thereby coding for different proteins from before, and new functions are sometimes observed to arise as a result. The source of the code is indeed mysterious, a fact that would be troubling if Darwinism were a theory about the origins of life. Since it is not, Mr. Berlinski's hand-wringing on the subject is inappropriate.

The fruits of evolutionary theory are disseminated in thousands of research articles in dozens of journals every year. Obviously, the people charged with the responsibility of entering their labs and solving problems find it useful. Numerous complex systems have been studied and the major steps of their evolution revealed. Where data are copious, they are all in accord with Darwinian expectations; where mysteries remain, the problem is a lack of data, not a lack of theoretical robustness.

In response to all this, intelligent-design theorists fold their arms and shake their heads. That is their right. But for all their bloated claims and hyperbolic rhetoric, they have made no contribution toward solving an actual biological problem. For that matter, neither has David Berlinski.

Kansas State University
Manhattan, Kansas

CLAY SHIRKY:

David Berlinski expends a lot of energy trying to make evolutionary theory look like religion. He mentions Darwin often and gestures toward a set of beliefs called "Darwinism," as if Darwin were some sort of high priest and Darwinism a sect. But biologists do not practice "Darwinism" any more than physicists practice "Einsteinism." For biologists, *The Origin of Species* is a historical work, not a how-to manual.

Unlike Berlinski's "Darwinism," evolutionary theory is a field of vigorous and current debate. Darwin had no idea how heredity worked—it took fifty years for R.A. Fisher and his colleagues to relate Darwin's work to Mendel's. Darwin likewise had no explanation for altruism—it took a hundred years and the work of William Hamilton to develop a plausible hypothesis. And there are still myriad open questions today.

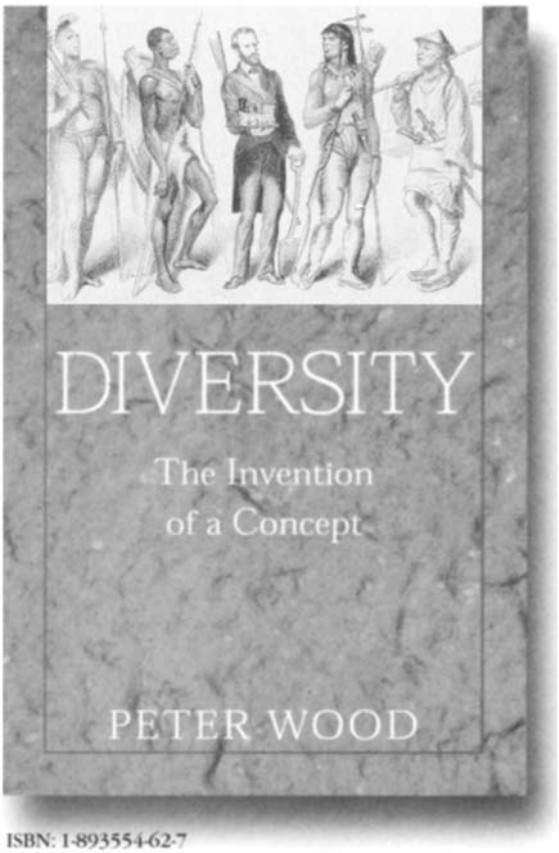
Mr. Berlinski does not mention Fisher or Hamilton or any of the other thousands of biologists exploring these open questions because he is anxious to present evolutionary theory as a fixed philosophy rather than a dynamic science. Indeed, the only publishing biologist he mentions is Jonathan Wells, the Unification minister whose prayers and conversations with the Rev. Sun Myung Moon convinced him, in Wells's own words, "that I should devote my life to destroying Darwinism," which he reports as his spur for studying biology.

But no matter how vivid his theological motivations may be, Wells (or indeed anyone in the intelligent-design camp) will eventually have to offer an alternative explanation of the variety we see among living things that does not rely on the key evolutionary idea of descent with modification. Furthermore, that explanation will have to be tested, and those tests will have to be scientific, not religious.

Here even Mr. Berlinski gets off the intelligent-design bus, because he can see where it is heading. If the only way to defeat a scientific hypothesis is with another scientific hypothesis, then we will never get to what he seemingly wants: a world where science stops trying to explain things. He likes intelligent design for criticizing evolutionary theory, but he dislikes it because it is itself too much like science, and may end up having to make testable assertions in the domain of what he calls "the ineffable inimitable."

Because he cannot get his hands on the steering wheel, Mr. Berlinski reaches for the brakes, asserting that a large domain of interest is or should be permanently exempt from scientific inquiry. This has been a standard plea of the religious for the last several centuries, and Mr. Berlinski's formulation—that the search for "the ineffable inimitable" is fruitless—is a classic of the genre. History has not been kind to those

DIVERSITY



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who predict an end to scientific progress, and declare God to be the sole possible explanation for the remaining mysteries.

Brooklyn, New York

S.L. BACCUS:

Intelligent-design theory can be summed up, as best I can determine, by two propositions: there is a creator and evolutionary theory is false. Its advocates do not believe the creator is sophisticated enough to have created our universe in such a complex way. It appears they would prefer a magician, waving a wand and shouting magical words of creation.

Nor should one overlook that the creator, as defined by Mr. Berlinski and his associates at the Discovery Institute's Center for Science & Culture (CSC), is the Christian God. The group's ultimate goal appears to be getting Christian beliefs taught in our schools. In his book, *The Wedge of Truth: Splitting the Foundations of Naturalism* (2000), Phillip E. Johnson writes,

> The proper metaphysical basis for science is not naturalism or materialism but the fact that the creator of the cosmos not only created an intelligible universe but also created the powers of reasoning which enable us to conduct scientific investigations. . . . [T]he materialist story thrives only as long as it does not confront the biblical story directly. . . . So it is of the greatest importance that we ask the question: "Has God *done* something to give us a start in the right direction, or has He left us alone and on our own?" When we have reached that point in our questioning, we will inevitably encounter the person of Jesus Christ, the one who has been declared the incarnate Word of God, and through whom all things came into existence.

In the mission statement on its website, the CSC bends over backward to avoid appearing as the Christian creationist group that it is. It is only in written material and speeches for Christian audiences that its representatives admit their real beliefs and goals.

Houston, Texas

MORTON ROSOFF:

Like creationists, David Berlinski targets natural selection in his critique of Darwinian theory, oblivious to other mechanisms of evolution that Darwin never knew about: pseudogenes, genetic drift, symbiosis, chromosomal rearrangements, interbreeding, developmental proteins, etc.

"Creation science," a slick variation of creationism, seeks to transport philosophical and theological ideas into a scientific program to investigate intelligent design, but offers no empirical evidence, no models, no verifiable predictions, no possibility of correction or elaboration. It is not intended to improve our knowledge or extend scientific horizons but to support religious faith.

The writers whose work Mr. Berlinski describes propose a version of the "anthropic principle": that the universe and its fundamental parameters must be such as to admit the creation of observers. The tautological foundation of this idea is that observers find themselves in universes that allow them to observe. It is only a short step from here to intelligent design, the advocates of which have expressed theological inclinations.

It is true that science has its own philosophical or faith-like underpinnings. They consist of methodological tools like Occam's Razor (don't invent unnecessary entities to explain something), falsification (can a hypothesis, in principle, be falsified?), and balance (extraordinary claims need extraordinary evidence). These devices have served science with great success for 300 years.

Yonkers, New York

MATT YOUNG:

Considering the great number of biologists whom David Berlinski charges with failing to read Dan E. Nilsson and Suzanne Pelger's paper on the evolution of the mammalian eye, I am flattered that he singled me, a physicist, out for criticism. It is Mr. Berlinski, however, not the biologists or I, who suffer, as he writes, from "an inability to read the literature."

In describing the paper by Nilsson and Pelger (not Pilger, as Mr. Berlinski misidentifies her), I wrote that they had performed a computer simulation of the development of the eye. I did not write, as Mr. Berlinski suggests, that they used nothing more than random variation and natural selection, and I know of no reference that says they did.

Mr. Berlinski's complaint that they described an eyeball, not an eye, is typical of those who tilt at neo-Darwinism. If Nilsson and Pelger had simulated the development of the light-sensitive patch with which they started, Mr. Berlinski would have asked where the original cells came from, and so on back to primordial ooze. Criticizing what we know about biology by harping on what we do not know is like criticizing a sturdy, durable, and functional concrete wall because there are chinks in it.

The paper by Nilsson and Pelger is a sophisticated simulation that even includes quantum noise; it is not, contrary to Mr. Berlinski's assertion, a back-of-the-envelope calculation. It begins with a flat, light-sensitive patch, which they allow to become concave in increments of 1 percent, calculating the visual acuity along the way. When some other mechanism will improve acuity faster, they allow, at various stages, the formation of a graded-index lens and an iris, and then optimize the focus. Unless Nilsson and Pelger performed the calculations in closed form or by hand, theirs was, as I wrote, a "computer simulation." Computer-*aided* simulation might have been a slightly better description, but not enough to justify Mr. Berlinski's sarcasm at my expense.

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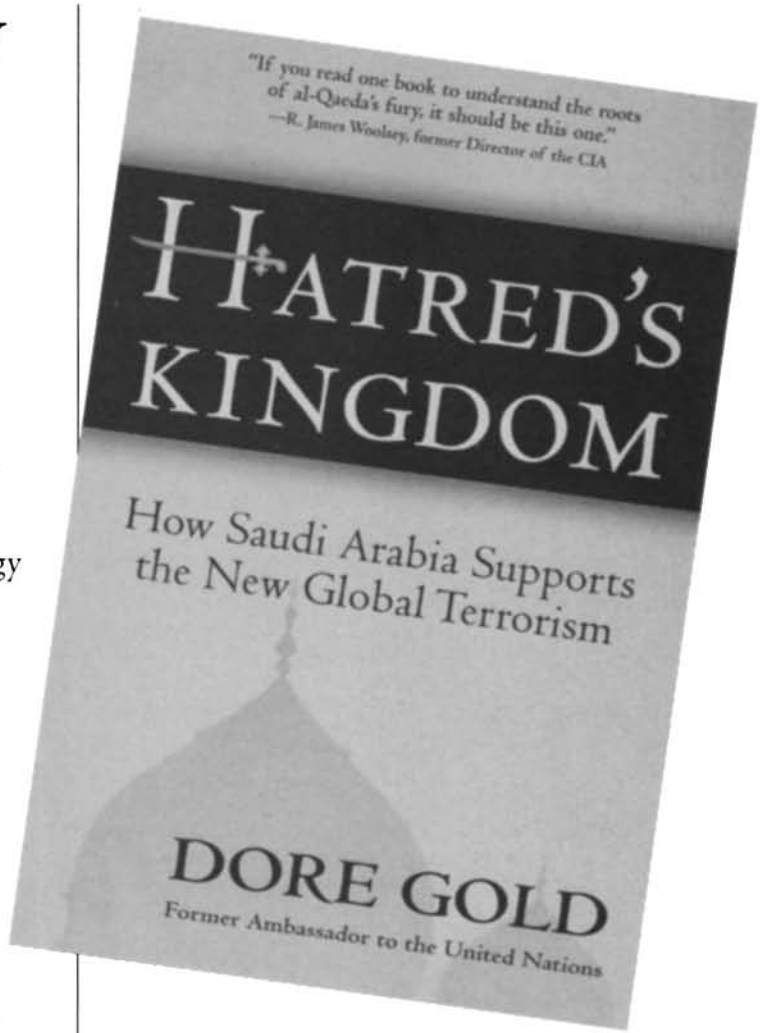

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More important, had Mr. Berlinski read more carefully, he would have recognized that Nilsson and Pelger's accomplishment was not to "flog" a collection of cells up an adaptive peak, "a point," he writes, "never at issue because never in doubt." Rather, they showed that the required time was geologically short—a point very much at issue among Mr. Berlinski and his neo-creationist colleagues.

Colorado School of Mines
Golden, Colorado

TONY DOYLE:

Although David Berlinski offers sharp criticisms of the theory of intelligent design, he is inclined to pull punches. First, he leaves unchallenged Phillip E. Johnson's claim that naturalism is "wholly extra-scientific" and thus no more justified than the theological account offered by those who would maintain that the organic world presents compelling evidence of design. This is misleading. Naturalists simply contend that, for any event or phenomenon that needs explaining, we should seek only physical causes.

This is not dogma. We have a robust idea of physical causation, supported by countless examples; time and again, the search for physical causes and only physical causes has paid off. By contrast, we do not have a clue about how the theist's non-physical "causation" is supposed to work. The appeal to nonphysical causes, to which intelligent-design theory is committed, amounts to an appeal to ignorance.

Mr. Berlinski rejects William Dembski's version of the argument from design, but he is well disposed toward Dembski's "very plausible general premise":

> [E]vents that can be explained neither by the laws of physics nor by chance must be explained by an appeal to the intervention of an intelligent agent. It is surely plain that many events cannot be explained in terms of the laws of mathematical physics, or any other laws for that matter. The precise way in which Shakespeare arranged 113 words to fashion his [eighteenth] sonnet ("Shall I compare thee to a summer's day . . .") owes nothing to any system of physical laws.

Not so fast. Shakespeare presumably moved his hand while composing those immortal lines. Hand movements are physical, so they have fully physical explanations, like any other physical event. It follows that they are strictly governed by the laws of physics; hence they are physically explicable. Of course this sort of explanation might not interest us much. We might prefer to know something about the person who inspired the lines or whether the poet penned the verse in July swelter. But this does not mean that his composition owed "nothing to any system of physical laws" or that we need to appeal to a divine "intelligent agent" to explain his behavior. The only eligible intelligent agent was Shakespeare himself, physical from head to toe.

Besides, suppose for the sake of argument that we cannot in principle explain physically how poetic inspiration produces a sonnet. Just how is a non-natural or supernatural agent supposed to help us? Can the theist explain how God is capable of creating self-conscious beings who occasionally write gorgeous love poems? Doesn't positing a designer or agent here just multiply mysteries?

New York City

CHRIS BEALL:

David Berlinski leaves untouched the major contradiction at the heart of the intelligent-design argument. Intelligent-design advocates want to have it both ways. On the one hand, they claim that wherever we find a very complex and ingeniously arranged organ, we have evidence of both design and a designer. From the design we can clearly infer the designer's purpose—to make an organ that serves its owner well. Astonishing engineering to an obvious purpose surely tells us that we are looking at the work of a purposeful designer.

But the world in which organisms really live consists, primarily, of other organisms. And some organisms have organs that are very complex and ingeniously arranged so as to do the work of killing or parasitizing other organisms. Their potential victims have equally complex organs whose purpose is clear—to evade, fight off, or endure the insults enabled by their enemies' ingenious designs. What is the purpose of a designer working out clever mechanisms for organisms to work so hard to take and kill, keep and survive?

At this point, design advocates retreat into mysticism. The designer, it turns out, works in mysterious ways, and his purposes are beyond us. But the problem with the mysterious designer should be obvious. It is from his purposefulness, not just his skill, that we should infer his existence, yet when his work is examined at a scale greater than a single organism, he appears to be working at cross-purposes.

The remaining mystery is that these contradictions, which logically weaken the claims of design advocates, seem instead to strengthen their conviction. This is cleared up by a simple observation: when belief grows as evidence wanes, we can be certain we are not dealing with science and uncertain knowledge, but with religion and certain faith. While there is nothing wrong with proclamations of faith, we are under no obligation to consider them serious contributions to our attempt to understand how the world really works.

Lafayette, Colorado

GEORGE C. WILLIAMS:

Though I do think the Reverend William Paley's approach a good one—for information about the Creator, examine creation—David Berlinski seriously understates God's

Partisan Review

Winter 2003

"I put much hope in the European Union. I think that if the post-communist states had been admitted to membership a couple of years ago, the present and future Europe would be safer. . . . This waiting and expecting is humiliating the people and making them more frustrated."

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less attractive features. It is an impressive universe out there, so that calling God *almighty* is appropriate. Calling Him *good* I will briefly deal with below. Calling Him *wise* was Paley's emphasis—as it is of recent anti-Darwin critics like Phillip E. Johnson—and is what I want to discuss here.

There are two ways of evaluating functional designs: according to their general plan or according to the quantitative precision of their parts. The second approach gives impressive positive results. We have come to understand the functional precision of such eye measurements as the distance from the lens to the retina, the dimensions and shape of the lens, etc. The eye is of nearly optimum dimensions.

As for general design features, consider two: our upside-down retinas and the number of our eyes. The retinal orientation is the result of its embryonic origin and positioning in a tiny and nearly transparent ancestor of all vertebrates. When descendants of this early ancestor got big enough for the upside-down retina to be disadvantageous, the problem was partly solved by making the blood vessels and other services between the retina and the lens as thin and transparent as possible. As for having just two eyes: it orients them optimally in relation to such conflicting ecological needs as distance perception and breadth of coverage. We have excellent distance perception because our arboreal ancestors maximized their ability to judge the distance to the next tree branch. Unfortunately, having merely two forward-pointing eyes is seriously deficient in seeing what may be sneaking up behind.

All our adaptations and those of other organisms are similarly compromised by historical constraints. Adaptive changes can come only by natural selection altering quantitative variables such as size and shape (or numbers when they are large, like scale rows of fishes).

As I argue in my book *Plan and Purpose in Nature* (1996), Paley was right that a scientific treatment of the creation can turn theology into a rigorous science. As noted above, God can make elaborate biological adaptations by trial-and-error selection, but it never occurs to Him to alter the basic plan. So He is stupid! Is He good? The answer is obvious from any objective evaluation of His biological creation. Go out into the woods and note the ratios of success to failure, of happiness to fear and pain. As Thomas Huxley recognized in his 1893 lecture "Evolution and Ethics," the Creator is clearly evil.

South Setauket, New York

KARL WESSEL:

In his critique of philosophical naturalism, David Berlinski fails to see that restricting scientific research to material causes and effects must follow as the immediate logical consequence of a position he himself defends in his article: that the intentions of supernatural beings cannot provide the basis of any falsifiable, or even testable, theories. Indeed, what *if* God is capable, as Mr. Berlinski writes, of "inadvertence, anger, mockery, incompetence" and so on? What if he is a surrealist painter? Whatever hypothesis is capable of explaining everything perforce explains nothing, which is why the intelligent-design movement resembles nothing so much as an obsessive hamster entertaining itself on an exercise wheel.

Of course, it is still possible that intelligent-design theory might explain the bare fact of the world's seeming design—which brings us to Mr. Berlinski's discussion of William Dembski's theory of complex specified information. Here he makes the obvious but important observation that specifications are human gestures.

Dembski often argues as if the passage from conventional kinds of specification involving, for example, archers and targets to the physical or biological patterns that chiefly concern him follows an untroubled continuum of inductive inference. Inductions are never untroubled, however, because they always depend on the human judgment that all of the examples to be tested in an experiment are sufficiently similar to warrant being included in the test set. From our observations of sparrows, pigeons, and blue jays we may feel entitled to infer that all feathered bipeds fly; but then we discover ostriches and kiwis. The question then becomes what the *relevant* analogy is; but relevance, unfortunately for Dembski's theory, is a very large concept that probably cannot be formalized.

As for Michael Behe, another intelligent-design prophet, Mr. Berlinski avers in reference to his work that "the origins of irreducibly complex biological systems remain . . . an utter mystery." The only mystery here is why Mr. Berlinski has failed to read the scientific literature relevant to this problem in the last five years. In a series of articles in *Science* and elsewhere, Albert Barabasi and his colleagues have shown that a scale-free, power-law topology is ubiquitous in the genomic regulatory, protein-interaction, and metabolic networks of the cells of dozens of organisms.

These biochemical networks are irreducibly complex in exactly the sense Behe intends: when the most highly connected nodes are removed from them they stop functioning. Because they neither develop nor evolve following Behe's naive assembly-line model, however, this fact is perfectly irrelevant. Rather, they increase in complexity over time in response to chance symmetry-breaking processes—in particular through gene duplication, which causes the preferential attachment of certain nodes to each other within the network, thereby producing the characteristic topology.

At least it is good to see Mr. Berlinski backpedaling from his 1996 COMMENTARY article, "The

Deniable Darwin." At this rate, by 2008 he may even backpedal into the truth.

Rancho Palos Verdes, California

ALEXANDER ETERMAN:

The intelligent-design theorists discussed by David Berlinski have their work cut out for them. They must decide whether the designer monitored his creation for a long time—possibly to this day—intervening in its workings, or whether he detached himself immediately upon the "launch." If the presumed designer has long since detached himself from his creation, it is crucial to determine whether he left it to its own devices, like an animal set free, or provided it with an in-built long-playing program that predetermined its operations, the way we leave the computer on over the weekend, having programmed it to perform certain calculations.

Before a design theoretician pits his strength against Darwin, he should express his own narrative in an intelligible manner. Thus, he should specify whether the evolution of biological species (regardless of its exact mechanism) took place at all, or whether the different species were produced by the designer gradually and independently of one another, or, perhaps, whether they all appeared simultaneously and went on in peaceful coexistence until some of them gradually became extinct.

If he accepts an evolutionary process of any kind, he must decide that blind natural selection is capable of creating things that are new and sensible or, on the contrary, that any biological change of the slightest complexity is the outcome of enlightened design. The proponent of design theory will most likely reject the suggestion that the mammalian eye is the product of natural selection; yet he might concede that the hearing apparatus of mammals evolved in a natural fashion, with no outside help; or at least that the Indian and African elephants, so similar and yet so different, are two naturally divergent branches of the same tree, rather than the product of a sophisticated design.

In short, a hypothesis of biological design must be built not merely as a negation of the theory of natural selection but as a series of diachronically expanded theoretical models of design, consistent in all of their links. It should be noted that building such a hypothesis is a thankless task, in the course of which a good half of "designers" empirically go over to the evolutionist side.

Jerusalem, Israel

GEOFFREY KENT:

David Berlinski purports to present evidence showing that the natural world is the result of necessity or chance, rather than design, and at the end of his article pronounces the ideas of those espousing intelligent design to be moribund. Though I find it difficult to defend the ideas with which Mr. Berlinski takes issue, I do not really think that he has proved anything, either—nor could he by reference only to the natural world.

Theoretical physicists now believe that our universe is one of an infinite number of universes that are constantly being created—that it exists, in effect, as a bubble formed from some other universe. Accordingly, it is entirely consistent with chance that the charges assigned to the subatomic particles that formed the material foundation of our universe at the "time" of the Big Bang should be the only charges (within a very small variation) that would sustain our universe for a sufficient period of time to permit the development of intelligent life.

Even given the extremely low probability that the particles would have the proper charges following the Big Bang, it is not improbable that, with an infinite number of universes and an infinite period of time, one explosion would eventually take place which would support a universe that would not either collapse back on itself or expand at such a tremendous velocity that no orderly development of stars and galaxies could ever take place.

That is precisely the problem with the argument that chance disproves design. Chance exists only within a limited period of time and space; it cannot exist in infinity. In this case, chance *is* the design. And the designer, if there is one, may exist outside time and space, outside our universe, outside any universe.

Chappaqua, New York

JONATHAN WELLS:

David Berlinski's "Has Darwin Met His Match?" is a breath of fresh air. Darwinism has become a sort of anti-religion, and defenders of the faith tend to demonize unbelievers rather than try to understand what they are actually saying. As a result, Darwinists typically distort intelligent-design theory—the latest and most powerful challenge to their orthodoxy—beyond recognition. Though a critic of intelligent-design theory, Mr. Berlinski is no Darwinist, and he is refreshingly fair-minded in his analysis.

I think Mr. Berlinski is mistaken, however, in characterizing the work that I and others have done as an attempt to resurrect William Paley's natural theology. Paley argued that design proves the existence of the Christian deity, but I, for one, have never been convinced by his argument. Design necessarily entails a designer; but the Christian deity is much more than a designer, and additional premises and evidences must be adduced to prove His existence. I happen to believe in the God of Moses and Jesus, but my belief is based on much more than design.

The basic issue for intelligent-design theorists is not whether design gets us to God, but whether design is real. Darwinists contend that it is not. For example, Richard Dawkins, in *The Blind Watchmaker* (1986), argues that though organ-

isms are "complicated things" and "give the appearance of having been designed," "the evidence of evolution reveals a universe without design." Dawkins's claim is false, despite the Darwinists' mantra that they have "overwhelming evidence" for their theory. I pointed this out in my book, *Icons of Evolution* (2000), and Mr. Berlinski agrees, writing that Darwinism is little more than a "fantastic extrapolation" in which the mechanism responsible for some minor changes within species "is read into the global record of life itself."

The evidence of evolution does *not* reveal a universe without design, and it remains a possibility that some features of living things really are designed. Intelligent-design theorists like Michael Behe and William Dembski have proposed ways to determine which features are designed and which are not. Mr. Berlinski argues that they have not succeeded. In any case, though, their proposals for establishing criteria to detect design are not attempts to prove the existence of the Christian deity.

If intelligent-design theory really were a reincarnation of Paley's natural theology, then Mr. Berlinski might be right that it is in danger of collapsing without a glimpse into the inscrutable mind of God. But it is not. It is an attempt to give a better explanation than chance and necessity for what our senses tell us is evidence for design in living things. In that light, it is poor Darwin who is (as Mr. Berlinski declares of Paley) "dead at last, or at least not very vigorously alive."

Discovery Institute
Seattle, Washington

MICHAEL J. BEHE:

I always find David Berlinski's writing delightful, and I agree with much that he says in "Has Darwin Met His Match?" Specific claims about how life arose in the murky past should always be examined skeptically, especially if accompanied by grand philosophizing. On the other hand, the fact that much remains mysterious does not mean we cannot conclude anything at all with reasonable certainty.

On the general question of the sufficiency of unintelligent physical processes to produce the astonishing complexity of life, I think a negative answer is justified, for reasons I gave in my book, *Darwin's Black Box* (1995). I quite agree with Mr. Berlinski that my argument against Darwinism does not add up to a logical proof. No argument that rests on empirical observations can have such force. Yet—despite my sloppy prose in suggesting that, "by definition," irreducibly complex systems cannot be approached gradually—I intended the argument to be a scientific one, not a purely logical one. In a scientific argument, conclusions are tentative, based on the preponderance of the physical evidence, and potentially falsifiable.

Here is my thumbnail sketch of the modern design argument as I see it: either unintelligent processes can explain all of life or they cannot. Virtually everyone (including Darwinists) agrees that life *appears* to be intelligently designed. The only physical mechanism ever proposed that could plausibly mimic design is Darwinian natural selection. Yet, as I have argued, the irreducible complexity of biochemical systems is a barrier to direct evolutionary construction by natural selection, leaving Darwinists to hope for circuitous, indirect routes. No plausible indirect routes have been proposed, let alone experimentally demonstrated.

That leaves us with biological features that look designed, but only promissory notes for how they can be explained by unintelligent processes. What's more, we know why the features we see in biological systems look designed: they are at once functional and very unlikely—exactly what William Dembski, whose work Mr. Berlinski also discusses, means by his phrase "specified complexity." They look designed for the same reason that nonbiological artifacts like mousetraps look designed, and non-design explanations have turned out to be so much bluster.

It seems reasonable to me to conclude, while acknowledging our fallibility, that at least some features of life were really designed by an intelligent agent.

Lehigh University
Bethlehem, Pennsylvania

WILLIAM A. DEMBSKI:

David Berlinski provides a clear and popular summary of my work on the theoretical basis for detecting design in nature. He also articulates several criticisms of my work. As it turns out, I specifically formulated my theory to meet the concerns that he raises. I am thus grateful for the opportunity to clarify several key points about my theory.

(1) As Mr. Berlinski explains, central to my theory of design detection are the twin notions of small probability and specification. I argue that highly improbable events that conform to independently given patterns are correctly attributed to intelligent design. Mr. Berlinski correctly points out, however, that some patterns are subjectively imposed upon events (or perceived in events) and do not justify inferring design. He is absolutely correct as far as he goes.

But he misses a critical distinction in my work. In *The Design Inference* (1998), I explain that there are artificially constructed patterns—I call them fabrications—that do not justify design inferences. There are other kinds of patterns that I call specifications, and these, in the presence of small-probability events, *do* justify design inferences. Moreover, I show that there is a clear way to distinguish specifications from fabrications. Specifications are patterns that, in the parlance of probabilists, are conditionally independent of the outcomes that they characterize and that, in the parlance of complexity

theorists, exhibit a low minimum-description length (see www.mdl-research.org). Fabrications fail this test.

The distinction between specifications and fabrications is readily illustrated. Consider an archer who shoots at a target. If the target is fixed and the archer repeatedly hits the bull's-eye, then we rightly draw a design inference by attributing skill to the archer. On the other hand, if the target is movable and always moves to where the arrow lands, then we may not draw a design inference by attributing skill to the archer. In the latter case, the target is a fabrication, in the former a specification.

(2) Mr. Berlinski is right that probabilities sometimes cannot be objectively assigned to various events. But sometimes they can be. And sometimes, when exact probabilities cannot be assigned, credible upper bounds can be. This suffices for a design inference. Sometimes probabilities can be determined on theoretical grounds. Sometimes they can be determined only on empirical grounds, as by running experiments or performing computer simulations. Assigning probabilities to biological systems to determine whether they are designed is an exciting area of research opened up by intelligent design.

(3) Throughout my writings I stress that the absence of specified improbability cannot rule out design, because a designing intelligence can act carelessly, or even deliberately, in ways that do not produce specified events of small probability. For instance, I might deliberately tip an inkwell so that the resulting ink stain is indistinguishable from a random accident. But with that same ink I might also spell a Shakespearean sonnet. In the latter case, the resulting ink "stain" would exhibit specified improbability and could not reasonably be referred to chance.

Thus, while I have always conceded that specified improbability is not a necessary condition for design, I have consistently argued that specified improbability is a sufficient condition for it. Mr. Berlinski argues against this, but his argument hinges on a failure to distinguish specifications from fabrications.

(4) According to Mr. Berlinski, highly improbable events happen "precisely as many times as one might expect, given their probabilities." This claim is easily disproved by flipping a coin a thousand times. The probability of the sequence you get is around one in ten raised to the 300th power. How often should you have expected this sequence to occur? Not at all! With all the elementary particles in the universe furiously flipping coins for trillions of years, the expected waiting time for a given sequence places it well beyond the predicted heat death (or big crunch) of the universe.

I still hope to persuade Mr. Berlinski that his concerns about detecting design can be (or have already been) satisfactorily addressed. In any case, he has identified several key issues raised by my theory, and I look forward to the critical conversation that his piece will engender in the design-theoretic research community.

Baylor University
Waco, Texas

PAUL A. NELSON:

As an admirer of David Berlinski's intellectual stubbornness and independence, I welcome his critical scrutiny of the theory of intelligent design. No theory was ever improved by being coddled.

Still, when Mr. Berlinski writes that design theorists "underestimate the enduring intellectual force behind [Jacques] Monod's claim that the categories of chance and necessity are mutually exclusive and jointly exhaustive," I must note that Monod himself did not rely solely on these categories. No sane human being does. The argument of Monod's masterpiece, *Chance and Necessity* (1970), leans heavily on the notion of "teleonomy," which he defines as a "characteristic property" of organisms as "objects endowed with a purpose or project." In other words: objects marked by teleology—or, if you will, by design.

But renaming a property to take away its metaphysical sting should fool no one. Monod claimed that he could dissolve teleonomy—the unmistakable designedness of organisms—into chance and necessity. Well, he did not, and if design theorists are right, he could not. *Chance and Necessity* is one long dance around the problem, ending with Monod's leaping into the arms of "a unique occurrence": the causally inexplicable origin of life on earth, an event, Monod observed, whose "probability was virtually zero."

Chance abused in this way can "explain" anything. As a philosophical naturalist, Monod was of course being true to his principles. But let us not give this sort of reasoning the good name of science. It is a philosophy—one contender among many—and not much of a contender at that.

The great theme that unites the intelligent-design community is the falsity of naturalism as a philosophy of explanation. Chance and necessity do not exhaust the causes that we know. The task facing design theorists is to turn this intuition into knowledge, by showing that their theory provides understanding and discoveries not forthcoming within a strictly naturalistic framework.

Mr. Berlinski doubts that this is possible. Time will tell. Paley is dead; so is Darwin; so, too, is Monod. Let the dead bury the dead.

Discovery Institute
Seattle, Washington

LEONARD LEVIN:

David Berlinski's declaration of a stalemate between Darwinism and intelligent-design theory strikes me as premature. After so many innovative moves in the past decade, the players on both sides are warming to what may be a long and interest-

ing match. My bets and sympathies are on the pro-design side.

I question Mr. Berlinski's argument that because improbability cannot be quantified, it cannot therefore be qualitatively asserted. Let me counter with an analogy. The improbability of a monkey typing a Shakespearean sonnet is quantifiable because the set of typewriter-strokes is finite. The improbability of the same monkey writing out a sonnet longhand is not precisely quantifiable, yet it is obviously more improbable than typing it. (The monkey can miss a "G" only 25 different ways when typing but an indeterminately large number of ways when writing by hand.) The typing case thus sets a lower limit to the longhand case. Similarly, the improbability of producing a specific gene within the set of DNA nucleotide permutations, though not defining the actual world of possibility, sets a finite lower limit to the improbability of the actual case of producing it within the indeterminate set of all matter configurations. It thus justifies our qualitative judgment that the latter is extremely improbable.

On the other hand, the molecular "scrabble" theorists have also ignored a crucial factor: determining the percent of syntactically correct formations within permutations of a given alphabet. What are the odds that a monkey will type not a specific sonnet but any syntactically correct string of 200 characters in English (or any language)? Not as small, but extremely small nonetheless. What are the odds (given the machinery of producing DNA) of randomly generating any syntactically correct string of nucleotides that will produce a viable protein? I have not seen this question addressed by either side. It should be amenable to analytical and experimental approaches and may move the debate forward.

Theologically, we must still distinguish between proving God's existence and presuming to describe the divine attributes. We may satisfy ourselves, rationally or subjectively, that life overcomes astronomical odds, yet the next step of inference is much harder. It is not chance—but what is it? Call it the anthropic principle, élan vital, quantum reduction, negentropy, or "design"—we have only the token outline of an answer, and the frontier of the eternal mystery. To know what "design" is may be to presume to see God's face.

Jewish Theological Seminary
New York City

MICHAEL SHERMAN:

As a professional biologist, I have always wondered why the Darwinian idea of evolution is so accepted among my colleagues. If one were to poll biologists, I would bet that almost all of them would say that there has been evolution and that it has taken place in accord with Darwin's theory. Probably 95 percent of them, however, have never thought seriously about evolution, and the rest are convinced of it because it is a clear, simple, materialistic idea.

On the other hand, reading the papers on evolution published in respected science journals like *Proceedings of the National Academy of Science* or *Nature*, one is surprised at the weakness of the arguments. Indeed, the standards of proof in the field are much lower than in the rest of biology. Such papers would never make it through the peer-review process if they concerned molecular or cellular biology. Of course, there are obvious reasons for such low standards, including the difficulty of testing evolutionary hypotheses through experimentation. But if the theory is based on poor arguments, why have criticisms of it not succeeded in convincing mainstream scientists?

I see a number of reasons. The first is that in arguments against Darwinism, people usually assume that the alternative is creationism—that is, the creation of nature by God without an element of evolution. This idea cannot be accepted by scientists because (a) it is not interesting from a scientific point of view (it does not point to further scientific research) and, more importantly, (b) there is an overwhelming body of arguments from many fields in favor of evolution.

From this follows the second main problem: that despite the large number of flaws in Darwinism, there is no scientifically sound alternative hypothesis. Criticisms of Darwinism will not convince professional biologists until the critics can describe a strong alternative mechanism of evolution that can be tested experimentally.

A third problem is that authors of publications against Darwinism mainly base their arguments on formal logic, e.g., the idea that complex systems cannot evolve in multiple minor steps. Such arguments may convince physicists or mathematicians, but they do not sway experimental biologists. From their experience dealing with enormously complicated biological systems, biologists know that hypotheses based purely on formal logic never work (especially if they involve some mathematics).

Finally, there is the problem of where criticisms of Darwinian theory are made. To convince the scientific community of something, one should not publish books; one should publish in peer-reviewed scientific journals of high profile.

To conclude on a positive note: I do believe that we can draw experimentally testable predictions from the theory of intelligent design. I say this based on three groups of recent findings: (1) paleontological data showing that all major groups of multicellular animals appeared almost simultaneously, indicating a lack of gradual evolution of large groups; (2) the very high homology of regulatory proteins that control development of systems with similar functions that evolved independently (e.g., the mammalian eye and the eye of a fly); (3) the fact that the

number of genes in the human genome is not very different from that of worms or flies.

I would suggest that since complex systems cannot, in fact, evolve by random changes, there *was* a design. When outlining multicellular animals, the designer would have introduced into the genomes of primitive species the information about complex organ systems required for future organisms. These complex organ systems are silent in the primitive organisms but can be activated, giving rise to new, more complicated organisms through the process of evolution.

This idea does not reject the possibility that these newly developed organisms were fine-tuned through random mutation and natural selection, but it does assume that the major complex organ systems were predesigned. With our present understanding of molecular biology, it should not be too difficult or expensive to test this idea by finding information about complex organ systems in the genomes of primitive multicellular organisms and trying to find ways to activate these systems.

School of Medicine
Boston University
Boston, Massachusetts

DAVID E. SAFIR:

I enjoyed David Berlinski's thoughtful and erudite article about intelligent design. As a scientist, I had found Michael Behe's *Darwin's Black Box* a refreshing critique of Darwin. It always troubled me that much of evolutionary theory seemed to be built on faith alone, with enormous leaps required to accept its view of how life formed and changed.

What strikes me after 56 years as a biologist is how improbable it is that life occurred randomly—improbable but not impossible. We are still left to make a "faith" choice. To me, it seems most likely that some sort of high intelligence designed life as we know it.

Los Gatos, California

DOUGLAS PORTER:

David Berlinski's otherwise excellent article is flawed by his example of a three-legged stool as an attempt to refute Michael Behe's argument that irreducibly complex systems cannot arise by small, random steps. On this point, it is Mr. Berlinski's logic that falls apart.

In the first place, Behe's argument pertains to *systems* requiring complex processes to work, the failure of any one of which dooms the system. A three-legged stool, however, is not a system but a static structure. Moreover, removing one leg from a three-legged stool only causes it to fail because of gravity, a force outside the "system" and therefore irrelevant to the argument. Finally, it may be true, as Mr. Berlinski argues, that a three-legged stool can be constructed by "numerous, successive, slight modifications" of a cylindrical block of wood, but such modifications can hardly be random or Darwinian in nature. They require a designer. Mr. Berlinski merely demonstrates one way in which a three-legged stool can be *designed*—an argument very much in support of Behe's position.

The refusal of biologists to come to terms with the colossal improbabilities of evolution is the reason that Behe's *Darwin's Black Box* has attracted so much attention.

Albuquerque, New Mexico

GEORGE JOCHNOWITZ:

David Berlinski writes that "Darwin's theory of evolution and theories of intelligent design are in conceptual conflict. Although they may both be false, they cannot both be true." Not so. To an intelligent designer, evolution would be a brilliant invention, a way of forever expanding and refining creation.

College of Staten Island
Staten Island, New York

REV. EDWARD T. OAKES:

According to a story that is perhaps *bien trouvé*, Alfred North Whitehead was once asked why he did not write more clearly, to which he is supposed to have replied: "Because I don't think more clearly." Based on the evidence of his various articles in COMMENTARY, if David Berlinski were ever to be asked why he writes so clearly, he could well reply: "Because I think clearly."

Clear thinking is especially evident in his latest essay, where he dissects the flaws in the arguments of those who claim that both the universe and biological systems have been intelligently designed (by God presumably, although some authors are annoyingly coy about saying so). True, Mr. Berlinski admits that members of the intelligent-design movement have highlighted genuine dilemmas in Darwinian theory. But more importantly, he has exposed how their own positive proposals cannot really provide an adequate explanation for the inexplicable mystery of life—or the existence of the universe. Complexity, even irreducible complexity, is not the same thing as a consciously intended effect.

I would only add that complexity, whether specified or not, cannot emerge at all except from a prior background of order, and that fact constitutes the real theological point that seems to animate the intelligent-design movement. The implicit (and sometimes explicit) theological agenda of this brigade leads Mr. Berlinski to his final thoughts on theism and natural theology, and here too I think I am largely in agreement with his reflections. The same issue that piqued the curiosity of Albert Einstein—whether the good Lord had any choice in creating the world or not—can be expressed in terms that dominated the debate among theist philosophers and theologians of the Middle Ages.

By the time of Thomas Aquinas it was assumed by all Jewish, Christian, and Muslim thinkers that Aristotle was right in defining God as Pure Act. But if that is the case,

then how can it be possible for God to create a *possible* world, since possibility is excluded in God? Either God has a choice in creating the world or He doesn't. But if He *can* create, then possibility is embedded in Pure Act, a contradiction. This dilemma remained unsettled down to the days of Gottfried Leibniz; his way of resolving the tension was to admit a range of possibilities facing the deity, who would then be constrained by his reality as Pure Act to choose the *best* of all possible worlds.

The disaster to theodicy that this hypothesis led to is well known and gave Voltaire his great opening to attack the notion of divine providence. My own point is that Leibniz's dilemma still lives on in precisely the antinomies pointed out by Mr. Berlinski. The only "solution" to that dilemma, really, is a line from Aquinas right after he concludes his famous five proofs for the existence of God: "As Augustine says, since God is the highest good, He would not allow any evil to exist in His works unless His omnipotence and goodness were such as to bring good even out of evil. This is part of the infinite goodness of God, that He should allow evil to exist, and out of it produce good."

Needless to say, such an assertion cannot be grounded in science, since it requires for its verification a view of the final outcome of the universe's career, a view not given to the finite human mind. Only faith avails here. To bring in science as a kind of almost literal *deus ex machina* only gums up the issue, for both theology and science.

University of St. Mary of the Lake
Mundelein, Illinois

YAFFA GANZ:

David Berlinski sums up his long article by writing, "God alone knows what God is thinking. . . . We are in the position of observers contemplating a vast, cosmic lottery." Not quite. What we contemplate is a vast, mind-boggling, perfectly orchestrated universe. Although God chose which "necessities" would govern this universe and we are not privy to His secrets, He Himself is not governed by the reality He has created. If ever He chose to do so, He is perfectly capable of changing the rules of the game.

But what difference does it make? Why are so many serious scientists determined to prove—refute—God's copyright of creation? As Mr. Berlinski himself writes, "Could a designer whose nature we cannot fathom, using principles we cannot specify, construct a system we cannot characterize? If the question is unyielding, so too is its answer: who knows?"

But this does not mean, as Mr. Berlinski states, that "chance now returns as the default hypothesis, if only because it is the only hypothesis that is completely consistent with our ignorance." After all, if we are so ignorant, how do we know that chance is a more likely source of creation than God? Our ignorance is not the problem; it is our absolute incapacity to confront God. Trying to analyze God's "mind" through human logic and science is doomed to failure: "Where were you when I laid the foundations of the earth? Speak—if you have wisdom!" (Job 38: 2-4). We can neither fathom nor confront nor comprehend God. We can only view His world, attempt to describe the mechanics that make it run, and serve Him in humility.

I would suggest breaking our scientific heads over more seemingly mundane, but more profitable, matters that explain and affect the world we live in. We should leave what Mr. Berlinski calls the "ineffable inimitable" (and I would call the Ineffable Inimitable) to theology.

Jerusalem, Israel

David Berlinski

On reading "Has Darwin Met His Match?," a number of my correspondents seem to have concluded that, like Saul on the road to Damascus, I have seen the light and changed my mind. A conversion to Darwinian orthodoxy is said to be imminent. These impressions I must correct at once. I have *never* expressed support for theories of intelligent design, much less for creationism, and my essay, far from representing a change of mind—no bad thing, in any case—does nothing more than amplify objections I have long held and often voiced.

Six and a half years ago, in responding to critics of "The Deniable Darwin" (COMMENTARY, June 1996), I made the point explicitly. "Some readers seem to be persuaded," I wrote in the September 1996 issue, "that in criticizing the Darwinian theory of evolution, I intended to uphold a doctrine of creationism. This is a mistake, supported by nothing that I have written." A few years later (September 2001), responding to critics of "What Brings a World into Being?" (COMMENTARY, April 2001), I was even more forthright: "If I thought that intelligent design, or any artful contrivance like it, explained anything in any depth, I would leap to the cannon's mouth and say so. I do not and I did not."

For the record: I do not believe that theories of intelligent design explain those features of living systems that Darwin's theory of evolution fails to explain. And vice-versa. I wrote "The Deniable Darwin" and "Has Darwin Met His Match?" to say why.

IN "HAS Darwin Met His Match?," I suggested that theories of intelligent design and Darwin's theory of evolution shared a strong family resemblance—the same guppy eyes, the same small ears, the same potato nose. PAUL R. GROSS will have none of it. Intelligent design is wrong and

I am right to affirm the fact, but Darwin's theory is right and I am wrong to deny it.

Mr. Gross's animadversions begin with a reminder. It is only those "who do not know much evolutionary biology" who refer to something called "Darwinism." The professionals know better. I quite understand Mr. Gross's concern. The term "Darwinism" conveys the suggestion of a secular ideology, a global system of belief. So it does and so it surely is. Darwin's theory has been variously used—by Darwinian biologists—to explain the development of a bipedal gait, the tendency to laugh when amused, obesity, *anorexia nervosa*, business negotiations, a preference for tropical landscapes, the evolutionary roots of political rhetoric, maternal love, infanticide, clan formation, marriage, divorce, certain comical sounds, funeral rites, the formation of regular verb forms, altruism, homosexuality, feminism, greed, romantic love, jealousy, warfare, monogamy, polygamy, adultery, the fact that men are pigs, recursion, sexual display, abstract art, and religious beliefs of every description. If Darwinian biologists have not yet appropriated the class struggle, this is only because of their respect for competing ideological prerogatives.

I am also hardly the only one to use the term "Darwinism" and so convey the suggestion of an ideological agenda. Adding his mite to D.S. Bendall's collection, *Evolution from Molecules to Men* (1983), Richard Dawkins entitled his essay "Universal Darwinism." Dawkins liked the word well enough to use it again in "Darwin and Darwinism," the title of his contribution to Microsoft's *Encarta Encyclopedia.* Then there is the series of short books appearing under the title *Darwinism Today* and published by Yale University Press. The first book in the series is by the eminent Darwinian biologist John Maynard Smith.

With regard to his other claims, Mr. Gross rather resembles a standard fixture of the schoolyard brawl: the boy who refuses actually to fight but instead adverts to the remarkable pugilistic powers of his older brother. My criticism of Darwin's theory? "Creationist pablum," Mr. Gross declares with a snort. A mighty host is prepared to enforce the point: tens of thousand of papers, dozens of books, scores of websites, courses in all the better colleges. Specialists are on call. In resting his case on what others are said to have said, Mr. Gross has issued a challenge that it is not possible rationally to meet. Let us by all means have the details—my claims, those refutations—and *then* you and I can fight.

In still other respects, Mr. Gross is concerned to show that his vigor in combating the evils of intelligent design exceeds my own. The men whom I criticize, he complains, have not published their work in peer-reviewed journals. Quite true. They have not. But anyone who understands how science works institutionally will find this unsurprising. "Being right," as one shrewd critic has observed, "isn't enough. What you say, however right, must be said in a currently acceptable language, must not violate too brutally currently acceptable taste, and must somehow signify your membership in a respectable club." That shrewd critic was Paul Gross himself, writing in a 1998 publication of the Marine Biological Laboratory. Allow me to introduce one Gross to the other.

As MARK PERAKH observes, I have indeed endorsed books by both Michael Behe and William Dembski. I would do so again. Behe's *Darwin's Black Box* and Dembski's *The Design Inference* challenge received opinion; they are carefully argued; and they address important issues. I agree with some of the claims made in both books, but not with all of the claims made in either. A man may admire a book without endorsing it completely. Had Darwin's publishers in 1859 asked for a blurb, I would gladly have said that *The Origin of Species* is both quirky and provocative. Sales might well have improved. I would do as much now for Richard Dawkins's *The Blind Watchmaker*, a book whose thesis I reject but whose title I admire.

JASON ROSENHOUSE assumes that I harbor an ongoing animus against "mainstream biology." Not so. Molecular biology, one of the glories of modern science, is where the mainstream lies; evolutionary biology remains what it has always been, a distant and rather muddy tributary. It is not molecular biology with which I scruple, needless to say, but Darwin's theory of evolution.

In my most recent essay—the one under discussion, I might remind Mr. Rosenhouse—I introduced Darwin only to suggest that both his theory and theories of intelligent design often lapse at the same points: the fossil record, for example. Mr. Rosenhouse denies this because he denies that Darwin's theory lapses at all. "Blubbering about gaps in the fossil record," he writes, his snort echoing Mr. Gross's, "cannot change the fact that, with millions of fossils collected and classified, not one is out of place from a Darwinian standpoint."

But what is at issue for Darwin's theory is not the fossils that exist but the ones that do not. The Cambrian explosion is mysterious precisely because the phyla that emerge during the Cambrian era have no obvious physical antecedents. By the same token, what is at issue for theories of design is not the fossils that do not exist but the ones that do. The reptile-to-mammal sequence is confounding to intelligent-design theorists precisely because the organisms, slotted head to tail, seem to form an unbroken Darwinian sequence. The fossil record is a puzzle for both views—a point urged on me, I should add, by Phillip Johnson.

Counterexamples are in any case open to challenge. In an essay entitled "Phylogenetic Hypotheses of the Relationship of Arthropods to Precambrian and Cambrian Problematic Taxa" (*Systematic Biology* 45, pp. 190-222), B.M. Waggoner argues that at least some Edicaran fossils fit into known phylogenetic groups and are thus ancestral to lower Cambrian metazoans: frond-like fossils died dreaming of hitting the big time as cnidarians, he suggests, and other members of the Edicara may have had ambitious plans to become annelids and arthropods. L. W. Buss and A. Seilacher, in "The Phylum Vendobionta: A Sister Group of the Eumetzoa?" (*Paleobiology* 20, pp. 1-4), have held the reverse, proposing gloomily that Edicaran fossils represent life forms that went nowhere because they had nowhere to go.

These are paleontological debates, of which the literature is by now considerable. The case against the Cambrian explosion has also been made from a theoretical perspective. Evidence from molecular clocks, Daniel Y.-C Wang, Sudhir Kumar, and S. Blair Hedges have argued in the *Proceedings of the Royal Society of London* (Series B, January 22, 1999), suggests that a great many organisms from at least three phyla must have been present on earth *before* the Cambrian era. Indeed, Hedges, the paper's principal author, is persuaded that the emergence of so many phyla during the Cambrian era is no longer a mystery—though in reaching this conclusion he has replaced one mystery by another, since the organisms whose existence he champions on theoretical grounds remain undiscovered. "Why don't we see any fossils of these species long before the Cambrian era?," Hedges asks, thus returning the discussion to the point at issue.

On the other hand, the reptile-to-mammal sequence, the jewel in the crown of Darwinian paleontology, is not without critics of its own in the intelligent-design camp. The indefatigable Phillip Johnson has drawn my attention to a paper by John Woodmorappe in *TJ* 15(1), 2001, pp. 44-52. (*TJ* is self-described as a "creation journal," a fact of no relevance to an assessment of Woodmorappe's arguments.) Using cladistic analysis, Woodmorappe investigated a discrete group of morphological characteristics that paleontologists have offered as evidence for the evolutionary nature of the reptile-to-mammal sequence. At issue is the claim that mammal-like reptiles, when arranged in succession from the pelycosaurs on up, "show an essentially unbroken chain of progressively more mammal-like fossils." With respect to 165 of the 181 anatomical characteristics cited in C.A. Sidor and J.A. Hopson's "Ghost Lineages and 'Mammalness': Assessing the Temporal Pattern of Character Acquisition in the Synapsida" (*Paleontology*, 24 (2), 1998, Appendix 2, pp. 269-270), Woodmorappe argues that "the majority... do *not* show a unidirectional progression toward the mammalian condition" (emphasis added).

I have not studied Woodmorappe's paper thoroughly, but I am quite sure that both his conclusions and the methodology upon which they rest will be widely disputed, if they are ever widely noted. I return to my own starting point: neither Darwinians nor design theorists can look to the fossil record with perfect equanimity.

"Darwinism," Mr. Rosenhouse writes, apparently unaware of Paul Gross's terminological strictures, "requires continuity at the level of the genotype, not the phenotype." I am not sure what this might mean, but I am willing to guess: small changes in the genotype may well give rise to large changes in the phenotype. I suspect that Mr. Rosenhouse is correct; I have argued the point myself, including in my response to Arthur Shapiro in the correspondence on "The Deniable Darwin."

A fascinating paper in the January 10, 2003 issue of *Cell* deals with this topic. In "Molecular Rheostats Control Expression of Genes Cell," Richard Freiman and Robert Tijian observe that the machinery of genetic regulation—which gene goes on, which goes off—constitutes a magnificently subtle and exquisitely complicated system, and one by no means completely understood. The small differences between a human being and an earthworm, they suggest, may owe as much to parametric changes in their respective regulatory systems as to the absolute difference in the number of their genes, which in any case is not very great.

What a remarkable shift in view this paper represents! The gene has been demoted: it is still the raw stuff of life—what else is there?—but not the source of life's variety. The picture now emerging suggests that the genome is like a billboard made up of thousands of lights. When the cell's rheostats are in one position, the billboard spells earthworm; when in another position, human being. How these regulatory systems themselves may have evolved, the authors do not say, largely because they do not know; indeed, since many of the structural elements in the systems have been conserved across long periods of evolutionary time, they do not know *whether* the systems have really evolved at all.

In concluding his defense of Darwin's theory, Mr. Rosenhouse appeals to thousands of satisfied researchers, rather as if he were framing advertising copy for arch supports. "Numerous complex systems have been studied," he writes, "and the major steps of their evolution revealed." I would ask Mr. Rosenhouse to supply a single example of a complex biochemical system whose major evolutionary steps have been revealed and then explained by Darwin's theory. A good place to start would be with the systems discussed by Michael Behe in *Darwin's Black Box.*

What Behe and I both require in this regard is quite simple: a detailed, step-by-step biochemical account demonstrating a plausible Darwinian pathway for the emergence of *any* irreducibly complex system. Plausible—meaning, no appeals to unlikely events; and Darwinian—meaning, incremental improvement at each step. Before Mr. Rosenhouse proposes to pester me during office hours, a copy of Kenneth Miller's *Finding Darwin's God* in hand, I would suggest he consult Behe's own expert demolition of Miller's proposals. References are available online at the Discovery Institute's website: www.Discovery.org.

CLAY SHIRKY is quite right to observe that physicists do not practice Einsteinism; but as I have already noted, Darwinists do refer constantly to Darwinism. "Like Freud and Marx," A.S. Byatt remarked recently, "Darwin has suffered from becoming a belief system, when he was simply a very original thinker." Mr. Shirky might ask himself why this is so.

I do not believe that Darwinism is a fixed philosophical system. Like some primordial jelly, the thing is both squishy and constantly in motion. Terms, claims, and stories multiply unceasingly.

An example: some organisms lose certain functional properties over time. There are wingless insects, flightless birds, blind moles. Evolutionary biologists have long maintained that what is lost is destined to stay lost: it has been an article of their faith. And one that has apparently been misplaced. In a recent research report entitled "Loss and Recovery of Wings in Stick Insects," Michael F. Whiting, Sven Bradler, and Taylor Maxwell demonstrate that stick insects of the order Phasmatodea, having lost their wings over evolutionary time, nonetheless retain the capacity to reacquire them later (*Nature* 421, January 16, 2003, pp. 264-267). "These results," they write, "suggest that wing-development pathways are conserved in wingless phasmids, and that 're-evolution' of wings has had an unrecognized role in insect diversification." Will evolutionary biologists be forced as a result to reassess evolutionary theory, concluding perhaps that a theory that has failed to account for the facts is in need of revision or, perhaps, rejection? What a thought. Within a few years, "Loss and Recovery of Wings in Stick Insects" will be counted a Darwinian triumph, as the theory successfully manages once again to adapt to alien circumstances.

At the time I wrote "The Deniable Darwin" in 1996, biologists were still concerned to keep their disputes from the public eye. Their reticence has given way. They are now inclined to exhibit their battle scars like stigmata; the late Stephen Jay Gould was a virtuoso of the form, his mournful recriminations filling entire issues of the *New York Review of Books*. Although Mr. Shirky is persuaded that the factional debates within Darwinian biology are a sign of glowing good health, another view is possible. These debates represent the conceptual confusions of a discipline that has simply not achieved sufficient clarity to count as a serious science.

I failed to discuss the work of R.A. Fisher or William Hamilton in my essay for the same reason that I did not discuss late Sung poetry: neither their work nor that of the late Sung poets has anything pertinent to say about theories of intelligent design.

The concluding paragraphs of Mr. Shirky's letter prompt me to wonder whose essay he has been reading. Why on earth should he imagine that I desire a world in which science stops trying to explain things? I am in favor of *scientific* explanations wherever they may lead.

NO LESS perplexing is that S.L. BACCUS should believe that I—of all people—have written a brief for the existence of the Christian God, and that my ultimate aim "appears to be getting Christian beliefs taught in our schools." I urge Mr. Baccus to consider my name, my devotion to Zion, and my dark Semitic good looks. Phillip Johnson's opinions—the ones that Mr. Baccus quotes—are interesting, but they have nothing directly to do with what I have written.

UNDER THE mistaken impression that my essay was a critique of Darwin's theory of evolution—perhaps he has confused it with "The Deniable Darwin"—MORTON ROSOFF is eager to establish my ignorance. Under the no less mistaken impression that I have endorsed intelligent design, he next offers his own criticism of the movement: "no empirical evidence, no models, no verifiable predictions, no possibility of correction or elaboration . . . , not intended to improve our knowledge or extend scientific horizons." When he catches his breath, Mr. Rosoff might wish to consult the essay I actually wrote for a few additional suggestions. I did not discuss the anthropic principle, but as for the other methodological tools he lists, I am all for them.

THE ISSUES that MATT YOUNG raises with respect to Nilsson and Pelger's evolutionary model of the development of the mammalian eye are of greater moment than they may appear to the casual reader. They require a detailed response, one that cannot be fitted into even a lengthy exchange of letters. Here I might just note in passing that while Mr. Young has obviously looked at the footnote in which I accuse him of reading carelessly, he seems to have read carelessly the essay to which it is attached: how else to explain his reference to me and my "neo-creationist colleagues"?

"NATURALISTS," TONY DOYLE writes, "contend that for any event or phenomenon that needs explaining,

we should seek only physical causes." This is indeed the claim often made, and I assume that Mr. Doyle endorses it. But naturalism, broadly conceived, is neither a premise to any of the great physical theories nor one of their conclusions. Its role in contemporary discourse is, as Phillip Johnson argued, wholly extra-scientific.

Mr. Doyle's defense of naturalistic doctrine is thus philosophical and historical. That is fine by me; I am in favor of what the *New York Times* calls the living arts. Still, I believe his philosophical views are incorrect and his historical analysis wrong. Mr. Doyle may have "a robust idea of physical causation," but David Hume, and the great Arabic theologian Abu Hamid al-Ghazzali before him, argued forcefully that, when analyzed, causation dwindles into temporal succession and constant conjunction: one thing following another. I urge Mr. Doyle to reread al-Ghazzali's *The Incoherence of the Philosophers* or Hume's *Inquiry Concerning Human Understanding*. The inner connection that attaches a cause to its effect remains beyond our grasp, part of the mystery of nature. When Mr. Doyle writes that "we do not have a clue about how the *theist's* nonphysical causation is supposed to work" (emphasis added), he is simply specifying a general lack of understanding. We are pretty much clueless across the board.

By the same token, it seems to me profoundly incorrect to say that in mathematical physics it is the "search for physical causes and only physical causes [that] has paid off." When Isaac Newton introduced the universal force of gravitation in the *Principia*, he was appealing to a power in nature that acted both instantaneously and at a distance. The connection between any "robust idea of physical causation" and the assumptions needed to explain gravity was thus broken from the very first. Mathematical physics has proceeded inexorably in the direction that Newton indicated. String theorists now explain the charges carried by D-branes in terms of algebraic K-theory. Every *direct* connection to a world of physical experience or causation has been lost. So too, for the moment, has every *indirect* connection, since string theory is not yet amenable to experimental tests of any sort.

I agree that Shakespeare was "physical from head to toe." So is a cat, and as every cat owner knows, there is absolutely no saying what a cat is going to do next. The laws of physics are both unavailing and irrelevant.

AS CHRIS BEALL notes, the design inference, inasmuch as it goes beyond the *existence* of a designer to conclusions about his nature, very often topples over into incoherence. I agree. Very often it does.

IT IS good to be reminded by the distinguished biologist GEORGE C. WILLIAMS that complex structures that are optimal in one dimension may well be sub-optimal in another. As well as we may be able to see, we cannot see what is going on behind our backs, not to mention what is often beneath our noses. I am not sure what follows.

May I also observe that no one with two ex-wives could possibly be unaware of the deity's less attractive features?

CONTRARY TO what KARL WESSEL writes, I did not provide a "critique" of philosophical naturalism in my essay. I mentioned it in passing, and paused only to agree with Phillip Johnson that as a principle it is wholly extra-scientific.

In commenting on my discussion of Michael Behe's work, Mr. Wessel suggests that I have failed to read the scientific literature, and in particular the work of A.-L. Barabási. Indeed? In a paper entitled "Hierarchical Organization of Modularity in Metabolic Networks" (*Science*, Vol. 297, August 30, 2002), Barabási and his colleagues argue that "spatially or chemically isolated functional modules composed of several cellular components and carrying discrete functions" should be considered "fundamental building blocks of cellular organization."

The result is a model of the cell resembling one of those horrible Swedish factories in which workers sit glumly at red and white Ikea desks and are isolated by glass partitions. But Barabási *et al.* also recognize that the "thousands of components of a living cell are dynamically interconnected," the Swedish factory now giving way to a second model, one resembling an equally horrible discotheque, rather like the old Studio 54, in which everyone is simultaneously involved with everyone else, frequently in ways no one wishes to know. Reconciling the Swedish factory to the discotheque is the burden of their paper.

This is modestly interesting stuff, if hardly calculated to induce an ardent desire to see a sequel. But its relevance to Mr. Wessel's concern is somewhat limited. In the first place, Barabási *et al.* do not often tie their work to biochemistry, and when they do, the results are inconclusive. "[I]t is . . . apparent," they write, "that putative module-boundaries do not always overlap with intuitive 'biochemistry-based boundaries.'" This prompts Barabási to the conclusion favored by every researcher facing a gap between his theories and the facts: "further experimental and theoretical analysis will be needed." No doubt.

In the second place, Barabási *et al.* are perfectly aware of a point that has escaped Mr. Wessel, namely, that their work does nothing to settle any issue that Michael Behe may have raised. "Understanding the evolutionary mechanism that explains the simultaneous emergence of the observed hierarchical and scale-free topology of the metabolism, as well as its generality [*sic*] to cellular organization, is now a prime challenge." A *prime chal-*

lenge—meaning a challenge that has not been met.

I THANK ALEXANDER ETERMAN for his thoughtful letter, with which I agree. Intelligent design *is* doomed to disappear as a movement if it can do no more than criticize Darwin's theory of evolution. Still, the purely negative criticisms made by members of the intelligent-design community have often been considerable in their effect—certainly more so than any criticisms I may have made. As a result, Darwin's theory has lost some of its intellectual respectability even as it has continued to extend its popular reach.

A great many scholars are now willing to say in public what they have long believed in private: that random variation and natural selection do not suffice to explain the observed facts in biology. An advertisement to this effect, placed by the Discovery Institute in the *New York Review of Books*,* was signed by one hundred academics: under the letter "S" alone, the list stretched from Henry F. Schaefer, the director of the center for computational quantum chemistry at the University of Georgia, to Richard Sternberg of the department of invertebrate zoology at the Smithsonian Institution. *Geshmak*, as we right-wing Christian fundamentalists say.

SOME PHYSICISTS may well entertain the idea that "our universe is one of an infinite number of universes," as GEOFFREY KENT writes—striking evidence that during hard times, some physicists will entertain anything and welcome anyone. But surely scientists who are happy to urge Occam's razor against design theory should hesitate before heedlessly multiplying universes themselves, the more so since the existence of the damn things is often invoked precisely to avoid the inference to design in the first place.

I am not sure what Mr. Kent means by asserting that chance "cannot exist in infinity." A random variable can certainly have a continuous distribution—but that may not be what he has in mind.

AS JONATHAN WELLS writes in his admirably clear letter, the gravamen of the intelligent-design movement is the inference to design, an inference that carries us from the observed properties of biological systems to the existence of a designer. The identification of the designer with the Christian deity requires a separate inference, one that design theorists need not make. I accept the point. In my essay, I tried to suggest as much, at least implicitly, by incorporating Fred Hoyle's supercalculating intellect into the class of possible designers. Hoyle was a life-long atheist, and in reading him I find no reason to believe that in fundamental matters he ever changed his mind.

Still, I admit to a tickle of discontent at Mr. Wells's attempt to dissociate the designer's existence from the designer's identity. It may be helpful to put the matter in deductive form. If there is design in nature, then there is a designer: that is Mr. Wells's leading premise. A second premise follows, embodying a factual claim: there is design in nature. The conclusion that there *is* a designer follows as a matter of logic.

But, articulated in this way, the conclusion seems suspiciously trivial. If the designer's nature is not known, then in what sense does his existence tell us anything that is not expressed in the second premise? To be sure, the twin propositions that there is design in nature and that there is a designer do not say *quite* the same thing; but, like certain houses in Paris, they have a tendency to collapse toward one another. Which designer? The one handling the design. Which design? The one handled by the designer. In the end, we are left with the fact that certain properties of living systems have not been explained. On this point Mr. Wells and I agree completely.

IN CHARACTERIZING his own work, MICHAEL J. BEHE is entirely too unassuming. By demonstrating that irreducibly complex systems cannot arise along one Darwinian path—the assembly-line model of construction—he has indeed provided a logical argument against Darwin's theory. This is an important achievement. My point was only that his argument has not been generalized to include *all* Darwinian paths. This is a modest criticism.

As long as I find myself explaining Mr. Behe's achievements to Mr. Behe, let me go a bit further. It seems to me that *Darwin's Black Box* is destined to play the same role in evolutionary thought that Karl Lashley's "The Serial Order of Behavior" played in behavioral psychology over fifty years ago (cf. L.A. Jefress, editor, *Cerebral Mechanisms in Behavior*, 1951). Although a behaviorist by training—and a student of John Watson, the founder of the field—Lashley came to understand that a certain class of familiar psychological acts involve a complicated serial order. In formulating a sentence, we typically see to the end of the sentence before venturing on its beginning, adjusting our stream of speech accordingly to account for grammatical relations of subordination and deferred placement. Serial order, Lashley realized, could not be explained by any system of associative "chaining" in which each act in a behavioral repertoire is explained by an act that has already taken place.

Psychologists were slow to appreciate the force of Lashley's critique. But when Noam Chomsky, writing ten years later, pointed to certain features of natural language that were inaccessible to finite-state mechanisms or even Markov processes, he was sharpening and extending Lashley's insight. There-

* The text reads: "We are skeptical of claims for the ability of random mutation and natural selection to account for the complexity of life. Careful examination of the evidence for Darwinian theory should be encouraged."

after, a shrewd insight became a movement in thought: the so-called cognitive revolution.

It is curious that so few biologists appreciate the formal similarities between Darwin's theory of evolution and behavioral theories in psychology. But the same basic idea is at work, with "reinforcement" in psychology called "natural selection" in biology. And here is an odd point. Although behaviorism is widely thought to have been stabbed through the heart, most especially by Chomsky's criticism of B.F. Skinner, the fact of the matter is that in the end, Skinner has proved more durable than anyone might have guessed, and with batwings flapping has burst buoyantly from his crypt.

We know that behavioral psychology provides an explanation for a limited class of experimental results; beyond those results, it fails. What an individual does in acquiring a natural language cannot be explained in terms of any schedule of reinforcement. Indeed, it cannot be explained in terms of the environment at all; reference must be made to the individual's innate endowment. But linguists who came early to scoff at Skinner—Chomsky now included—are involved in making Skinner's argument on the level of the species. For what are random variation and natural selection but a form of behavioral *biology*?

The intellectual history of the past half-century is not without its ironical aspects.

IN HIS graceful letter, WILLIAM A. DEMBSKI argues that in some respects I have misunderstood his views, and in other respects I have insufficiently appreciated their force. It is certainly possible; the issues that Mr. Dembski raises are subtle, and his letter and my response should both be regarded as efforts to get things a little clearer.

Under what conditions may we rationally eliminate chance as the explanation for certain events? This is Mr. Dembski's question. Two things, he argues, are necessary: small probabilities and reasonably tight specifications. When these criteria are met, we are entitled to strike off chance; if the event in question is also not explicable by natural laws, design emerges as the only plausible alternative.

In developing his argument, Mr. Dembski has a certain model in mind. The design comes first, expressed perhaps as a blueprint, agenda, schedule, or even a system of thought. Next comes the designed event or object. "How a designer," he writes in *No Free Lunch*, "gets from a thought to a thing is, at least in broad strokes, straightforward: (1) A designer conceives a purpose. (2) To accomplish that purpose, the designer forms a plan. (3) To execute that plan, the designer specifies the building materials and assembly instructions. (4) Finally, the designer or some surrogate applies the assembly instructions to the building materials. What emerges is a designed object, and the designer is successful to the degree that the object fulfills the designer's purposes."

This is *executive* design, to coin a phrase and mark a distinction. In my essay, I suggested that there is a range of states, acts, or processes that are clearly intentional—they are brought about by intelligent agency—and yet share none of the features of executive design. The design of a painting is very often revealed *in* its execution and not before. Design in this sense might well be called *immanent*. The painter Francis Bacon often stressed just this point in commenting on his own work (see *Francis Bacon*, 1975), and the distinction between executive and immanent design appears as well in Nelson Goodman's *Languages of Art*, a book that design theorists might study with profit. With respect to immanent design, there are no prior purposes, no plans, and no application of assembly instructions to building materials. For this class of artifacts, probabilities are not relevant and specifications are inapplicable.

I am well aware of Mr. Dembski's distinction between a specification and a fabrication, the more so since I discussed the distinction at length in my book *Black Mischief: Language, Life, Logic & Luck* (1986), where Mr. Dembski's "fabrications" appear as "retroactive specifications." But this distinction has nothing to do with the distinction between executive and immanent design. Both specifications and fabrications apply, and apply only, to events capable of possessing an executive design. Velasquez's painting of the royal court, which I cited in my COMMENTARY essay, lacks both a specification *and* a fabrication. A painting is not like a point in archery. It cannot be specified before it exists, and specifying it after it exists is useless, voiding the intended contrast between a specification and a fabrication.

Although both Mr. Dembski and I agree that specified improbabilities are not necessary to trigger a design inference, we do so for different reasons. On the question of whether they are sufficient, we part company altogether. In "Has Darwin Met His Match?" I argued that specifications are not necessary to trigger a sense that an unlikely event has occurred, and that if specified improbabilities are not necessary, they are also not sufficient to trigger an inference to design, since plainly improbability *by itself* tells us nothing about design.

The issue, then, turns on a tight circle. My argument for the irrelevance of Mr. Dembski's specifications begins with the obvious. A specification is a human gesture, a bit of descriptive apparatus. It does not change a system of probabilities, and so it has nothing to do with expectations based on those probabilities. Highly improbable specified events happen precisely as many times as one would expect, given their probabilities, but so, for that matter, do highly improbable *un*specified events.

It is this last claim that Mr. Dembski would deny. His counterexample is a fair coin flipped 1,000 times. The particular sequence of heads and tails that results has the probability of roughly one in ten to the 300th power. "How often should [I] have expected this sequence to occur?" Mr. Dembski asks. Not at all, he responds cheerfully. But the sequence *has* occurred, and the relevant record of heads and tails is there in plain sight. This persuades Mr. Dembski that, if left unspecified, unlikely events tend to occur more often than any assignment of probabilities would suggest.

I understand Mr. Dembski's reasoning, but I reject it as unwholesome. He is stuck, after all, with an expectation—a particular sequence should not occur at all—that is in plain contradiction to the facts—a particular sequence has indeed occurred. This is not necessarily a fatal flaw, but it does suggest that something has to give. What has to give is the nice coincidence between what the theory of probability affirms and what the facts reveal. Here Mr. Dembski's intuitions seem to be making certain clanging noises while emitting a good deal of smoke.

My own intuitions, by contrast, are smoke-free and purr like a charm. Is the sequence that has just been revealed highly improbable? It is. How often should it have occurred? Precisely as many times as one might expect, given its probability. In a sequence of identical and independent experiments, *this* particular outcome would not be realized again until the heat death of the universe or the rehabilitation of Senator Trent Lott, whichever comes first. The fact that the sequence has already occurred is of no significance. Nothing in the theory of probability prevents an extremely unlikely event from being realized in the very first experiment, just as nothing in the same theory prevents a man from winning the lottery after purchasing his very first ticket. I see no reason to be swayed from my conclusion that unlikely events happen as many times as one might expect, given their probability.

With the distinction between specified and unspecified improbabilities wiped out, the inference to design sputters. Improbabilities are not by themselves sufficient to trigger that inference, and, *a fortiori*, neither are specified improbabilities.

PAUL A. NELSON reminds me that, in *Chance and Necessity*, Jacques Monod *began* by acknowledging the fact that living creatures are driven by a sense of their purpose in life, and *then* persuaded himself that this obvious property was not so obvious after all. What seems to be their design, Monod concluded, is an illusion, or an artifact; there is necessity, and there is chance, and there is nothing more. Richard Dawkins has made almost the same argument in *The Blind Watchmaker*, and Mr. Nelson is right to remark that there is in all this something nutty. Monod's efforts to explain away the obvious did not succeed.

Of course, there is a distinction between saying that Monod did not succeed and saying that he *could* not have succeeded. Drawing that distinction, Mr. Nelson places his hopes for the latter possibility on the prospects for intelligent design. But to the extent that design theorists have overestimated their own arguments, to that extent—precisely—have they *under*estimated the enduring force of Monod's claim that necessity and chance exhaust our powers of explanation. In my essay, I went no further than this, and I am not prepared to go further now.

Whatever the issue between Mr. Nelson and Jacques Monod, it is (as he says) naturalism that is the real target of the intelligent-design movement, and, I presume, his target as well. If I cheer him on only weakly, that is because it is not entirely clear to me what the target is or how to fight it. From what he writes, I gather that naturalism is embodied in Monod's disjunction itself. But an inference to design is consistent with Monod's disjunction. A designer may have no choice in his design, a point I make in the concluding paragraphs of my essay. But, equally, a denial of Monod's disjunction is consistent with the failure of an inference to design. There may be facts in nature that are the result of neither necessity, chance, nor design, and we must accept the possibility, at least, that the most obvious facts about living systems—their existence and their nature—may have no deeper explanation than that this is the way things are.

Something more is at issue in the assessment of naturalism because something more must be at issue. I encourage Mr. Nelson to make that something clearer.

LEONARD LEVIN'S remarks are subtle and compelling. What he says about quantitative and qualitative aspects of probability is correct. We *do* make qualitative judgments of likelihood even when we are unable to promote those judgments quantitatively. I may not be able to determine the probability that Basque will be declared the official language of the People's Republic of China, but I can say that it is unlikely. Judgments of this sort are in constant use; they are the currency of trade.

But if commonly made, they are also commonly flawed. Our qualitative judgments are often insecure and frequently unstable, a point that emerges more clearly when artificial examples are put aside. Is it more or less likely that North Korea will prove a greater danger than Iraq? Some guesses are possible, but answers may change by the minute as information is presented or withdrawn, one reason that policy analysts often try frantically to place numbers on their judgments.

In pursuing this argument, Mr. Levin draws a suggestive distinction between two cases. In the first, the

proverbial monkeys are typing; in the second, they are writing (or scrawling) by hand. It is only the first case, he argues, that permits a quantitative judgment; the second case trails off because, given the monkey's scrawl, we cannot specify any set of discrete objects on which to peg a probability. "The improbability of the . . . monkey writing out a sonnet longhand is not precisely quantifiable, yet it is obviously more improbable than typing it."

Is it? Two events are being compared. The first may be quantified by means of the calculations of probability. The second, Mr. Levin argues, is "not precisely quantifiable." In fact, it is not quantifiable at all. "The monkey may miss a 'G'," Mr. Levin writes, "in only 25 different ways when typing but an indeterminately large number of ways when writing." But if the monkey may miss that "G" in any number of ways, he may also find that "G" in any number of ways. It depends on who is looking and who is counting and what criteria of success are in force. If we cannot assign precise probabilities to one of two events, then we cannot draw comparative judgments between them, either. To say of these events—one quantifiable, the other not—that the second is more improbable than the first is very much like saying of two men that one is taller than the other, given only that one is six feet tall and the other trim.

Mr. Levin complains that biologists have not addressed his questions about molecular syntax. His questions are precisely the questions I discussed in "The Deniable Darwin," and before that in *Black Mischief*.

MICHAEL SHERMAN's letter raises a great many interesting questions, most notably why evolutionary biologists are so dopey. If *he* is "surprised at the weakness of their arguments," imagine how I must feel. But having asked this question, he then asks a more difficult one: why has intellectual change not been

forthcoming? His own answers are canny but unsatisfying.

Biologists stick to Darwin, he suggests, "because the alternatives do not lead to further research." Now, this is not quite true, as Mr. Sherman himself indicates. The alternatives *do* lead to further research, and he has suggested the agenda. In fact, what is really at stake for most biologists is their chances of being funded, their place at the common trough. But here Mr. Sherman breaks the flow of his own argument. Biologists are not inclined to explore the options he has outlined, he writes, because there is "an overwhelming body of arguments from many fields in favor of evolution." If that is so, then Mr. Sherman has answered his own question in the most straightforward way possible: biologists stick with Darwin's theory because it is *true*. In fact, the "overwhelming body of arguments" to which Mr. Sherman alludes are more overpowering than overwhelming, and like Mexican food they keep coming up without ever quite going down. In this regard, Mr. Sherman has seen the light, but he has not used the light to see.

I am more than prepared to believe that, as Mr. Sherman asserts, formal logic does not often sway evolutionary biologists; as far as I can tell, it does not *ever* sway them. I am also prepared to believe that evolutionary biologists tend to dismiss theories of intelligent design because the authors of those theories publish books rather than peer-reviewed essays. I have already addressed this issue in my reply to Paul Gross, but I would point out that when Richard Dawkins and Daniel Dennett make *their* views known through trade books, which are, of course, not peer-reviewed, other evolutionary biologists tend to regard those efforts with quiet pride.

In his concluding paragraphs, Mr. Sherman takes an immensely daring position—something like old-fashioned preformationism. Now that he has ventured so far out on a limb, I might observe that something like this is just what recent work on genetic regulatory systems also suggests. Who knows what dreams of glory the earthworm harbors? But for a few parametric changes in its regulatory apparatus, and a missing gene or two, it might rule the world.

I AGREE with DAVID E. SAFIR that is it improbable but not impossible that life arose randomly. I would add only that the origins of mind and of matter are equally mysterious. I am not sure, however, what it would mean to make a "choice" of faith on these matters.

DOUGLAS PORTER is making too much of my stool. I invoked the thing only to make a modest point: small incremental changes may lead to an irreducibly complex system by paths that Michael Behe did not consider. I agree that biologists have not come to terms with the "colossal improbabilities" of evolution.

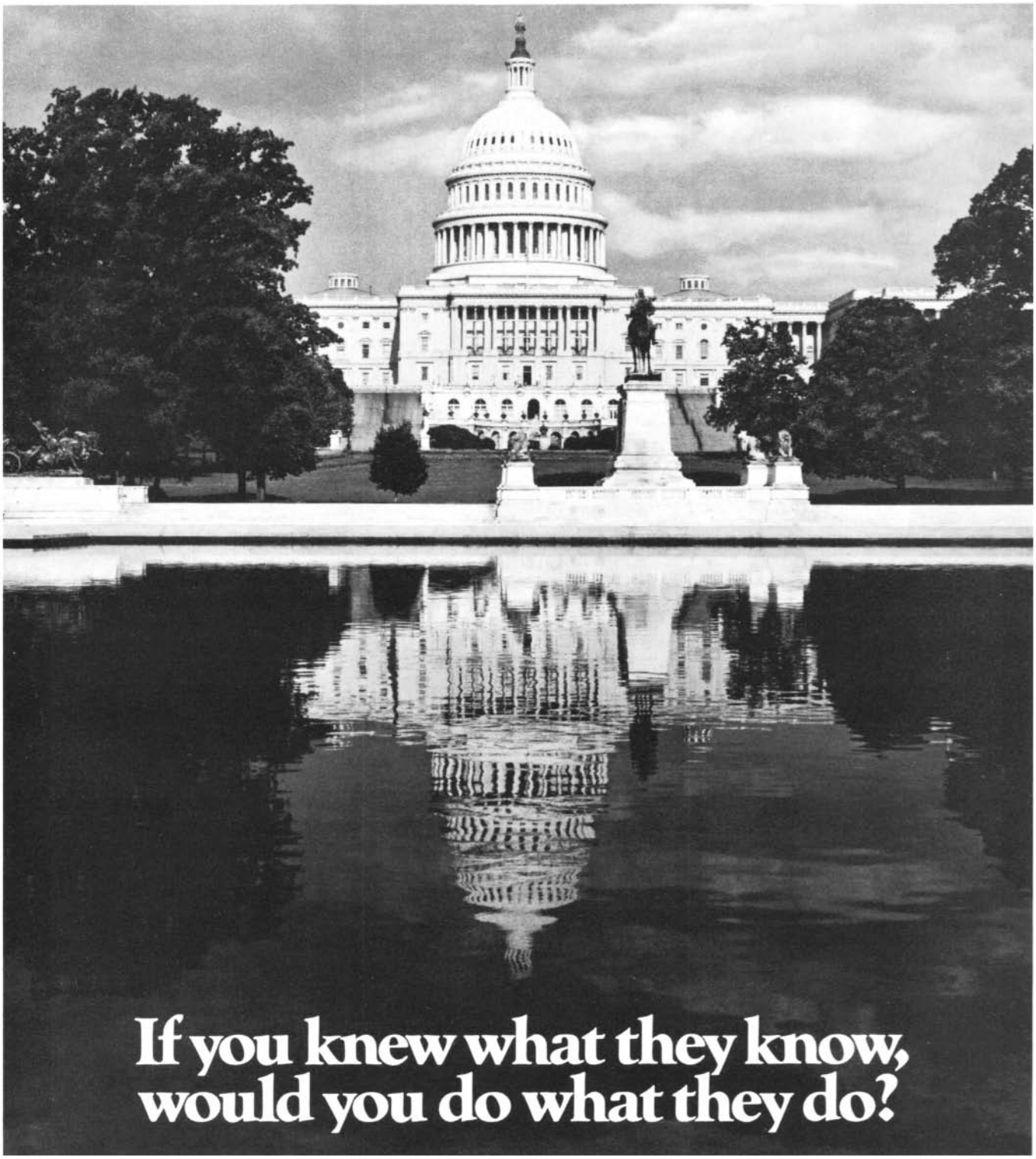
I SUPPOSE that, as GEORGE JOCHNOWITZ suggests, an intelligent designer might have favored evolution as a "brilliant invention," but this claim, which is often made by evolutionary biologists concerned to cover all of their bets, places the conclusion to certain arguments before their premises. How the designer works is one question. What he *did* is another, and this question is logically prior. If certain structures cannot arise by Darwinian means, then, no matter the designer's intentions, he could not have realized them by means of a Darwinian mechanism. He, too, has his limits.

I THANK FATHER EDWARD T. OAKES for his very generous comments, and would not dream of disputing theology with him. Still, in writing that by the time of Aquinas, Jewish, Christian, and Muslim thinkers had come to agree with Aristotle that God is Pure Act, it seems to me that he has underestimated the complexity of Muslim thought. Aquinas, after all, criticized Avicenna's distinction between essence and existence on the grounds that it came perilously close to implying that existence is an accident. Indeed, the more I study the extraordinary record of medieval Arabic thought, the less I am inclined to emphasize its unity and the more to stress its diversity.

The course that Father Oakes traces between the Aristotelian doctrine of Pure Act and its apparent collapse some four centuries later is fascinating, but beyond my competence to assess.

JAFFA GANZ writes to remind me that the concerns expressed in my essay may not matter very much in the end. We do what we can; we ask the questions that we can answer; and as for the rest, we face the illimitable, the unanswerable, and the incomprehensible.

So we do.



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